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MACX MCR-EX-T-UIREL-UP...

Temperature transducers with intrinsically safe input for temperature sensors, voltage signals, resistance-type sensors and potentiometers

Data sheet
104602_en_06

1 Description

The configurable and programmable **MACX MCR-EX-T-UIREL-UP...** temperature transducer is used for the intrinsically safe (Ex i) operation of all standard temperature sensors (RTDs and thermocouples), voltage signals, remote resistance-type sensors and potentiometers. The temperature input signals are output in a linearized format at the output. In addition to an analog current and voltage output, the module also has three switching outputs. If you use the device in safety-related applications, relay 2 and 3 are connected to create a safety-related switching output. The power supply has been designed as a wide range power supply.

The devices can be installed in zone 2 in the protection type "n" (EN 60079-15).

Features such as sensor type, connection method, measuring range, measuring unit, filter, alarm signal and output range can be configured using the ANALOG-CONF software and a device-specific DTM (Device Type Manager).

Features

- Input for all standard temperature sensors (RTDs and thermocouples), voltage signals, remote resistance-type sensors and potentiometers.
- With intrinsically safe inputs [Ex ia] IIC
- Current and voltage output
- Switching output (3 PDT relay)
- Switching output SIL: 1 relay
- Configuration via software (FDT/DTM, ANALOG-CONF) or operator interface (IFS-OP-UNIT)
- Up to SIL 2 according to EN 61508 on output 4 ... 20 mA
- 3-way electrical isolation
- Installation in zone 2 permitted
- Wide range power supply 19.2 ... 253 V AC/DC
- With screw or spring-cage connection (push-in technology)

WARNING: Explosion hazard
The device is an item of associated electrical equipment for intrinsically safe circuits. It is designed for use in zone 2, if specific conditions are observed.

When installing and operating the device, the applicable safety directives (including national safety directives), accident prevention regulations, as well as general technical regulations must be observed.

WARNING: Explosion hazard
Please observe the safety regulations and installation notes on page 8.

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

This data sheet is valid for the products listed in section 3 “Ordering data” .

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Appendix
Safety-related applications (SIL 2) A-1

3 Ordering data

Temperature transducer, Ex i

Description	Type	Order No.	Pcs. / Pkt.
Standard configuration/in-stock article, with screw connection	MACX MCR-EX-T-UIREL-UP	2865751	1
Standard configuration/in-stock article, with spring-cage connection	MACX MCR-EX-T-UIREL-UP-SP	2924799	1

Accessories

Description	Type	Order No.	Pcs. / Pkt.
Operator interface for the configuration of compatible MACX modules.	IFS-OP-UNIT	2811899	1
Cradle unit, for snapping the operating and display unit onto the DIN rail	IFS-OP-CRADLE	2811886	1
Programming adapter for MACX MCR... devices. With USB interface for programming with the ANALOG-CONF software	IFS-USB-PROG-ADAPTER	2811271	1
Cold junction compensation connector for thermocouples	MACX MCR-EX-CJC	2925002	1

For additional accessories, please refer to the Interface technology and switching devices catalog from Phoenix Contact.

4 Technical data

Input	
Resistance thermometer	Pt, Ni, Cu sensors: 2-, 3-, 4-wire
Thermocouple sensor	B, E, J, K, N, R, S, T, L, U, CA, DA, A1G, A2G, A3G, MG, LG (see example, “Sensor types” on page 9)
Resistors	0 Ω ... 50 kΩ
Potentiometer	0 Ω ... 50 kΩ
Voltage	-1000 mV ... 1000 mV
Output	
Output signal	4 mA ... 20 mA with SIL ON (further output signals can be configured with SIL OFF)
Maximum output signal	
Voltage output	±11 V
Current output	22 mA
Load	
Voltage output	≥ 10 kΩ
Current output	≤ 600 Ω (at 20 mA)
Behavior in the event of a sensor error	According to NE 43 (or freely definable)
Switching outputs	
Contact type	3 PDT contacts For SIL: 1 safety-related relay, 1 non safety-related PDT contact
Contact material	AgSnO2, hard gold-plated
Maximum switching voltage	250 AC (250 V DC)
Maximum switching current	2 A (250 V AC) , 2 A (28 V DC)
Cycles	
With ohmic load	1×10^5
General data	
Supply voltage range	24 V ... 230 V AC/DC (-20%/+10%, 50/60 Hz)
Current consumption	< 100 mA (24 V DC)
Power consumption	< 2.4 W
Temperature coefficient	0.01 %/K, maximum
Step response (0 ... 99 %)	
With SIL	Typ. 1000 ms
Without SIL	Typ. 700 ms
Transmission error, total	< 0.1% (e.g., for Pt 100, 300 K span, 4 ... 20 mA)
Electrical isolation	4-way, between input/output/power supply/switching output
Input/output	375 V P (according to EN 60079-11)
Input/power supply	375 V P (according to EN 60079-11)
Input/switching output	375 V P (according to EN 60079-11)
Output/power supply	300 V rms reinforced insulation (according to EN 61010/50178)
Power supply/switching output	300 V rms reinforced insulation (according to EN 61010/50178)
Ambient temperature	
Operation	-20 °C ... +65°C
Storage/transport	-40 °C ... +85°C
Permissible humidity (operation)	5 % ... 95% (no condensation)
Shock	15g, IEC 60068-2-27
Vibration	5g, IEC 60068-2-6

General data [...]

Status indicators	Green LED (supply voltage, PWR) Red LED, flashing (cable error, sensor error, ERR) Red LED (module error, ERR) Yellow LED (switching output)
Housing material	PA 66-FR
Color	Green
Degree of protection	IP20
Pollution degree	2
Dimensions (width x height x depth)	35 x 99 x 114.5 mm
Inflammability class according to UL 94	V0
Design	Terminal housing for mounting on DIN rails

Conformance

EMC directive 2004/108/EC	EN 61326-1; EN 61000-6-2[1]; EN 61000-6-4
Ex directive (ATEX)	EN 60079-0, EN 60079-11, EN 60079-15, EN 61241-0, EN 61241-11

[1] During the interference, there can possibly be small deviations.

Safety data according to ATEX for intrinsically safe circuits

Maximum voltage (Uo)	6 V					
Maximum current (Io)	7.4 mA					
Maximum power (Po)	11 mW					
Gas group	Ex ia II C			Ex ia II B		
Maximum external inductance (Lo)	100 mH	10 mH	1 mH	100 mH	10 mH	1 mH
Maximum external capacity (Co)	1.3 µF	1.7 µF	2.6 µF	6.8 µF	9.2 µF	15 µF
Maximum internal inductance (Ci)	44 nF	44 nF	44 nF	44 nF	44 nF	44 nF
Maximum internal inductance (Li)	Negligible					
Maximum voltage U_m	253 V AC (125 V DC)					

Approvals

ATEX	Ⓔx II (1) G [Ex ia Ga] IIC; Ⓔx II (1) D [Ex ia Da] IIIC; Ⓔx II 3 G Ex nA nC ic IIC T4 Gc X	IBExU 10 ATEX 1044
IECEx approval	[Ex ia Ga] IIC; [Ex ia Da] IIIC; Ex nA nC ic IIC T4 Gc X	IECEx IBE 10.0004X
UL, USA/Canada	cULus, C.D.-No 83104549 UL 508 Listed	
Functional safety (SIL)	Can be used up to SIL 2	

Connection data MACX MCR-EX-T-UIREL-UP

Conductor cross section	
Solid (minimum/maximum)	0.2 mm^2/2.5 mm^2
Stranded (minimum/maximum)	0.2 mm^2/2.5 mm^2
AWG (minimum/maximum)	24/14
Stripping length	7 mm
Connection method	Plug-in screw connection
Tightening torque	Minimum 0.5 Nm/maximum 0.6 Nm

Connection data MACX MCR-EX-T-UIREL-UP-SP

Conductor cross section	
Solid (minimum/maximum)	0.2 mm^2/1.5 mm^2
Stranded (minimum/maximum)	0.2 mm^2/1.5 mm^2
AWG (minimum/maximum)	24/16
Stripping length	8 mm
Connection method	Spring-cage connection

5 Safety regulations and installation notes

5.1 Installation notes

- The device is a piece of equipment (category 1) which belongs to the "Intrinsic Safety" ignition protection class and can be installed in Ex zone 2 as a category 3 device. It meets the requirements of EN 60079-0:2012, EN 60079-11:2012, EN 60079-15:2010, IEC 60079-0 ed. 6.0, IEC 60079-11 ed. 6.0, and IEC 60079-15 ed. 4.0.
- Installation, operation, and maintenance may only be carried out by qualified electricians. Follow the installation instructions as described. When installing and operating the device, the applicable regulations and safety directives (including national safety directives), as well as general technical regulations, must be observed. For the safety technology data, see this packing slip and the certificates (EC examination certificate and other approvals if appropriate).
- 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 protection (IEC 60529/EN 60529) of the device is intended for use in a clean and dry environment. The device must not be subject to mechanical strain and/or thermal loads, which exceed the limits described.
- 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.
- Only specified devices from Phoenix Contact may be connected to the 12-pos. S-PORT interface.

5.2 Intrinsic safety

- The device is approved for intrinsically safe (Ex-i) circuits up to Ex zone 0 (gas) and Ex zone 20 (dust). The safety technology values for intrinsically safe equipment and the connecting lines must be observed for the hook-up process (IEC/EC 60079-14) and the values specified in this installation note and/or the EC examination certificate must be observed.
- When carrying out measurements on the intrinsically safe side, observe the relevant regulations regarding the connection of intrinsically safe equipment. Use only these approved measuring devices in intrinsically safe circuits.
- If the device was used in circuits which are not intrinsically safe, it is forbidden to use it again in intrinsically safe circuits. Label the device clearly as being not intrinsically safe.

5.3 Installation in Zone 2

- Observe the specified conditions for use in potentially explosive areas! Install the device in a suitable approved housing with a minimum of IP54 protection) that meets the requirements of EN 60079-15. Observe the requirements of 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.
- Connecting and disconnecting cables in zone 2 is permissible only when the power is switched off.
- The device must be stopped and immediately removed from the Ex area if it is damaged, was subject to an impermissible load, stored incorrectly or if it malfunctions.

5.4 Potentially dust-explosive areas

- The device is not suitable for installation in zone 22.
- If you nevertheless intend to use the device in Zone 22, you must install it in a housing according to IEC/EN 60079-31. Observe the maximum surface temperatures in this case. Adhere to the requirements of IEC/EN 60079-14.
- Only make the connection to the intrinsically safe circuit in potentially dust-explosive areas of zones 20, 21 and 22 if the equipment connected to this circuit is certified for this zone (e.g., category 1D, 2D or 3D).

5.5 UL notes

Safety regulations related to the UL approval are contained in the "Control Drawing". The "Control Drawing" is part of the package slip.

5.6 Use in safety-related applications (SIL 2)

When using the MACX MCR-EX-T-UIREL-UP... in safety-related applications, observe the instructions in the appendix, as the requirements differ for safety-related functions.

Switching output 1 is not intended for safety-related applications.

In safety-related applications (SIL), switching outputs 2 and 3 must be combined according to the requirements of the application (see “Connection examples” on page 26).

The configuration of switching output 2 is also applied to switching output 3.
In SIL ON mode, switching output 3 cannot be configured separately.

6 Sensor types

Description	Sensor type	Measuring range		Measuring unit	Smallest measuring range span
		Start	End		
Resistance thermometers (RTD) Others can be selected or freely configured in the software.	Pt 100 acc. to IEC/EN 60751	-200	850	°C	20 K
	Pt 200 acc. to IEC/EN 60751	-200	850	°C	20 K
	Pt 500 acc. to IEC/EN 60751	-200	850	°C	20 K
	Pt 1000 acc. to IEC/EN 60751	-200	850	°C	20 K
	Pt 100 acc. to Sama RC21-4-1966	-200	850	°C	20 K
	Pt 1000 acc. to Sama RC21-4-1966	-200	850	°C	20 K
	Pt 100 acc. to GOST 6651	-200	850	°C	20 K
	Pt 1000 acc. to GOST 6651	-200	850	°C	20 K
	Pt 100 acc. to JIS C1604/1997	-200	850	°C	20 K
	Pt 1000 acc. to JIS C1604/1997	-200	850	°C	20 K
	Ni 100 acc. to DIN 43760/DIN IEC 60751	-60	250	°C	20 K
	Ni 1000 acc. to DIN 43760/DIN IEC 60751	-60	250	°C	20 K
	Ni 100 acc. to Sama RC21-4-1966	-60	180	°C	20 K
	Ni 1000 acc. to Sama RC21-4-1966	-60	180	°C	20 K
	Ni 1000 (Landis & Gyr)	-50	160	°C	20 K
	Cu 10 acc. to Sama RC21-4-1966	-70	500	°C	100 K
	Cu 50/Cu 100 acc. to GOST 6651 (α = 1.428)	-50	200	°C	100 K
	Cu 53 acc. to GOST 6651 (α = 1.426)	-50	180	°C	100 K
	KTY81-110 (Philips)	-55	150	°C	20 K
	KTY84-130 (Philips)	-40	300	°C	20 K
Thermocouples (TC) Others can be selected in the software.	B acc. to IEC/EN 60584 (Pt30Rh-Pt6Rh)	500	1820	°C	50 K
	E acc. to IEC/EN 60584 (NiCr-CuNi)	-230	1000	°C	50 K
	J acc. to IEC/EN 60584 (Fe-CuNi)	-210	1200	°C	50 K
	K acc. to IEC/EN 60584 (NiCr-Ni)	-250	1372	°C	50 K
	N acc. to IEC/EN 60584 (NiCrSi-NiSi)	-250	1300	°C	50 K
	R acc. to IEC/EN 60584 (Pt13Rh-Pt)	-50	1768	°C	50 K
	S acc. to IEC/EN 60584 (Pt10Rh-Pt)	-50	1768	°C	50 K
	T acc. to IEC/EN 60584 (Cu-CuNi)	-200	400	°C	50 K
	L acc. to DIN 43760 (Fe-CuNi)	-200	900	°C	50 K
	U acc. to DIN 43760 (Cu-CuNi)	-200	600	°C	50 K
	CA C ASTM JE988 (2002)	0	2315	°C	50 K
	DA D ASTM JE988 (2002)	0	2315	°C	50 K
	A1G A-1 GOST 8.585-2001	0	2500	°C	50 K
	A2G A-2 GOST 8.585-2001	0	1800	°C	50 K
	A3G A-3 GOST 8.585-2001	0	1800	°C	50 K
	MG M GOST 8.585-2001	-200	100	°C	50 K
	LG L GOST 8.585-2001	-200	800	°C	50 K
Remote resistance-type sensors (R) (2, 3, 4-wire) Other areas can be selected in the software.	Resistance 0...50000 Ω	0	50000	Ω	10% of the selected measuring range
Potentiometers (3-wire) Other areas can be selected in the software.	Potentiometer: 0…50000 Ω	0	100	%	10% of the selected measuring range

Description	Sensor type	Measuring range		Measuring unit	Smallest measuring range span
		Start	End		
Voltage signals (mV) Others can be selected in the software.	Voltage (mV)	-1000	+1000	mV	10% of nominal span
Temperature conversion guide for °C to °F: $T[°F] = \frac{9}{5} T[°C] + 32$					
Other setting options can be configured with the ANALOG-CONF software, e.g., a freely configurable user characteristic curve with 30 interpolation points.					

Depending on the connection method, the following terminal points are to be connected for temperature measurement (see Figure 1 on page 13):

6.1 Thermocouple (TC) with internal cold junction compensation

– Thermocouple connection: Terminals 4.1 “+“, 4.2 “-“

Use the MACX MCR-EX-CJC cold junction compensation connector provided (Order No. 2925002).

TC+CJ: Use the cold junction compensation connector provided at connection terminal blocks 4.1, 4.2 and 4.3.

6.2 Thermocouple (TC) with external or without cold junction compensation

– Thermocouple connection: Terminals 5.1 “+“, 5.2 “-“

TC+CJ external: Use the external cold junction sensor (e.g., PT100) at connection terminal blocks 4.2 and 4.3.

6.3 Voltage input

– Connection for U ≤ ±1000 mV: Terminals 5.1 “+“, 5.2 “-“

6.4 Potentiometer

– Connection: Terminals 4.1, 4.2, 4.3

6.5 Resistance thermometer (RTD)

RL ≤ 25 Ω for each lead.

– 2-wire connection method: Terminals 4.2, 4.3
  The cable resistance can be compensated with the help of the ANALOG-CONF PC program, the IFS-OP-UNIT operator interface or in service mode (DIP switch).
– 3-wire connection method: Terminals 4.1, 4.2, 4.3
  In the case of the 3-wire connection method, ensure that all three cable resistances are the same.
– 4-wire connection method: Terminals 4.2, 4.3, 5.1, 5.2
– 2 x 2-wire connection method
  Terminals RTD 1: 4.2, 4.3
  Terminals RTD 2: 5.1, 5.2

6.6 Measuring resistances

Up to 75 Ω: RL ≤ 2.5 Ω for each lead.
Up to 150 Ω: RL ≤ 5 Ω for each lead.
Up to 300 Ω: RL ≤ 10 Ω for each lead.

The terminal points 4.2 and 4.3 are used for measuring differing resistances.

7 Minimum span and measuring accuracies

7.1 Pt and Ni-RTD inputs

Minimum measuring span:
With 10 Ω ≤ R0 < 100 Ω : 100 K
With 100 Ω ≤ R0 ≤ 10 kΩ : 20 K

Measuring accuracy:

For 10 Ω ≤ R0 < 100 Ω : **0.2 K x 100 Ω / R0**
= 0.1% x (100 Ω/R0) x (200 K/measuring span)

For 100 Ω ≤ R0 ≤ 1 kΩ : **0.2 K**
= 0.1% x (200 K/measuring span)

For 1 kΩ < R0 ≤ 10 kΩ : **0.4 K**
= 0.1% x (400 K/measuring span)

7.2 Cu-RTD inputs

Minimum measuring span:

For 10 Ω ≤ R0 < 100 Ω: 100 K
For 100 Ω ≤ R0 ≤ 10 kΩ: 20 K

Measuring accuracy:

For 10 Ω ≤ R0 < 100 Ω : **0.5 K x 100 Ω/R0**
= 0.1% x (100 Ω/R0) x (500 K/measuring span)

For 100 Ω ≤ R0 ≤ 1 kΩ : **0.5 K**
= 0.1% x (500 K/measuring span)

For 1 kΩ < R0 ≤ 10 kΩ : **1.0 K**
= 0.1% x (1000 K/measuring span)

7.3 NI1000 input (Landis & Gyr), KTY 81-110, KTY 84-130 (Philips)

Minimum measuring span: 20 K
Measuring accuracy: 0.2 K

7.4 Thermocouple input

Minimum measuring span with TC: 50 K

Measuring accuracy of the input with TC signals:
TC type E, J, K, N, T, L, U, M, Lr
Without cold junction error: 0.30 K

TC types B, R, S, C, D, A1, A2, A3
Without cold junction error: 0.50 K

7.5 Cold junction error

Cold junction error: ± 1 K, maximum
(with internal cold junction compensation).
With external compensation it depends on the quality of the cold junction and the sensor used.

7.6 Voltage signal input

Minimum measuring span:

10% of the nominal span of the respective range.

Measuring accuracy:

-1000	...	1000 mV	: 0.01%	(of measuring range)
-500	...	500 mV	: 0.01%	(of measuring range)
-250	...	250 mV	: 0.01%	(of measuring range)
-125	...	125 mV	: 0.01%	(of measuring range)
-60	...	60 mV	: 0.01%	(of measuring range)
-30	...	30 mV	: 0.01%	(of measuring range)
-15	...	15 mV	: 0.01%	(of measuring range)

7.7 R transducers and resistors

50% of measuring range ≤ (nominal value of R transducer + lead resistance) ≤ measuring range

Minimum measuring span: 10% of the selected measuring range

Measuring accuracy:

0	...	75 Ω	: 0.10%	(of measuring range)
0	...	150 Ω	: 0.05%	(of measuring range)
0	...	300 Ω	: 0.02%	(of measuring range)
0	...	600 Ω	: 0.01%	(of measuring range)
0	...	1200 Ω	: 0.01%	(of measuring range)
0	...	2400 Ω	: 0.01%	(of measuring range)
0	...	4800 Ω	: 0.01%	(of measuring range)
0	...	6250 Ω	: 0.02%	(of measuring range)
0	...	12500 Ω	: 0.02%	(of measuring range)
0	...	25000 Ω	: 0.02%	(of measuring range)
0	...	50000 Ω	: 0.02%	(of measuring range)

Example:

R transducer with nominal value: 1000 Ω

Measuring range to be selected: 0 ... 1200 Ω

Minimum measuring span: 10% of the selected measuring range = 120 Ω

Measuring accuracy: 0.01% of the selected measuring range = 120 mΩ

7.8 Potentiometer

50% of measuring range ≤ (nominal value of potentiometer + lead resistance) ≤ measuring range

Minimum measuring span: 10% of the selected measuring range

Measuring accuracy:

0 ...	75 Ω	: 0.10%	(of measuring range)
0 ...	150 Ω	: 0.05%	(of measuring range)
0 ...	300 Ω	: 0.02%	(of measuring range)
0 ...	600 Ω	: 0.02%	(of measuring range)
0 ...	1200 Ω	: 0.02%	(of measuring range)
0 ...	2400 Ω	: 0.02%	(of measuring range)
0 ...	4800 Ω	: 0.02%	(of measuring range)
0 ...	6250 Ω	: 0.10%	(of measuring range)
0 ...	12500 Ω	: 0.10%	(of measuring range)
0 ...	25000 Ω	: 0.10%	(of measuring range)
0 ...	50000 Ω	: 0.10%	(of measuring range)

Example:

Potentiometer with nominal value: 1000 Ω

Measuring range to be selected: 0 ... 1200 Ω

Minimum measuring span: 10% of the selected measuring range = 120 Ω

Measuring accuracy: 0.02% of the selected measuring range = 240 mΩ

7.9 Output signals

Analog output error

2 mV	0.01% at -10 ... 10 V
2 mV	0.02% at 0 ... 10 V
4 µA	0.02% at 0 ... 20 mA

8 Installation

NOTE: Electrostatic discharge!

The device contains components that can be damaged or destroyed by electrostatic discharge. When handling the device, observe the necessary safety precautions against electrostatic discharge (ESD) according to EN 61340-5-1 and EN 61340-5-2.

Take precautions against electrostatic discharge before opening the front cover.

8.1 Basic circuit diagrams

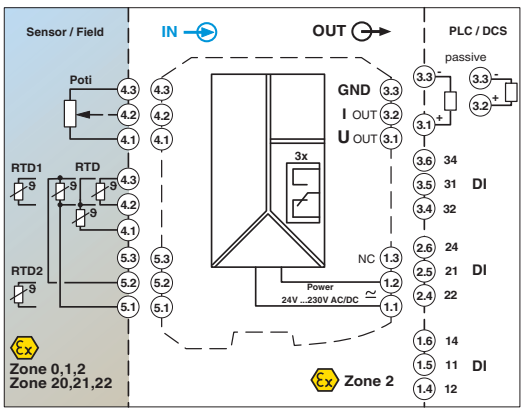


Figure 1 Sensor connection - resistance thermometers and potentiometers

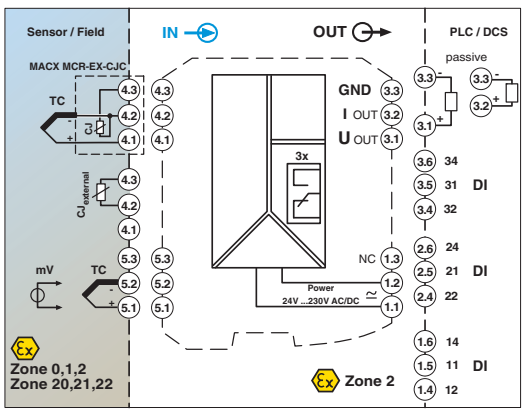


Figure 2 Sensor connection - thermocouples and mV sources

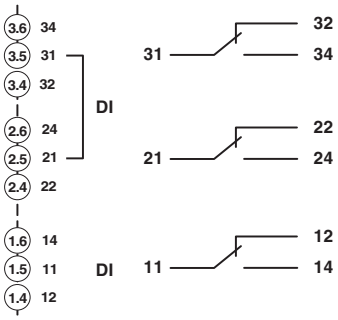


Figure 3 Terminal designations of the PDTs

Information for safety-related applications (SIL/PL):

You have to jumper the relays in parallel for a normally-closed contact (see “Connection example 2:” on page 26).

You have to jumper the relays in series for a normally-open contact (see “Connection example 1:” on page 26 and “Connection example 4:” on page 26).

8.2 Structure

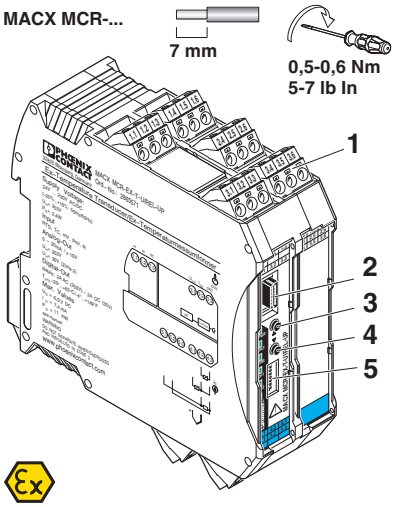


Figure 4 Structure MACX MCR-EX-T-UIREL-UP

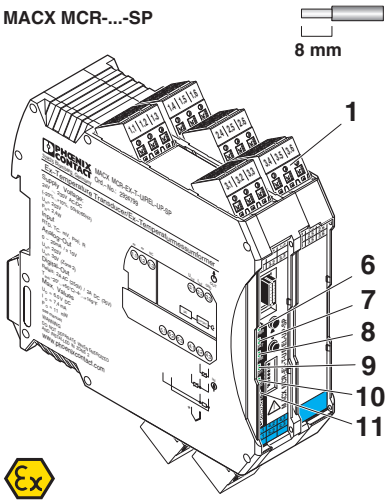


Figure 5 Structure MACX MCR-EX-T-UIREL-UP-SP

1 Plug-in COMBICON connectors
2 S-PORT (12-pos. programming interface)
3 Button S3 (UP), adjustment and reset functions
4 Button S2 (DOWN), adjustment and reset functions
5 DIP switch S1 for service mode
6 PWR LED, green, power supply
7 DAT LED, green, no function at present
8 ERR LED, red, module, cable and sensor error, underrange or overrange, service mode
9 DO1 LED, yellow, status of switching output 1
10 DO2 LED, yellow, status of switching output 2
11 DO3 LED, yellow, status of switching output 3

8.3 Dimensions

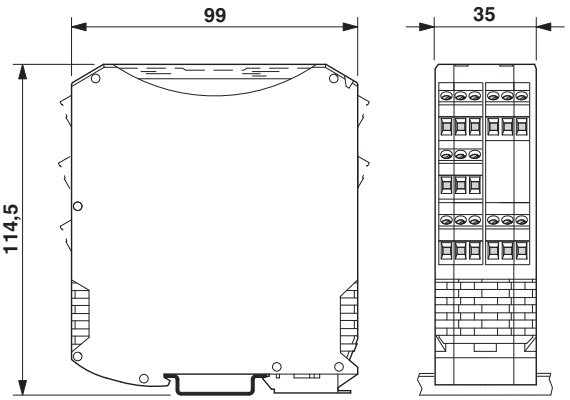


Figure 6 Dimensions (in mm)

8.4 Mounting

WARNING: Explosion hazard

If the **module has been used in non-intrinsically safe circuits,** it must **not** be used again in intrinsically safe circuits.
The module must be clearly labeled as non-intrinsically safe.

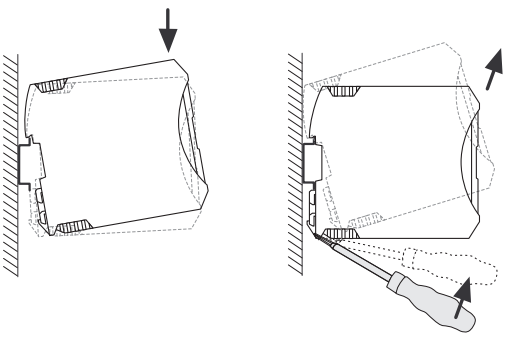


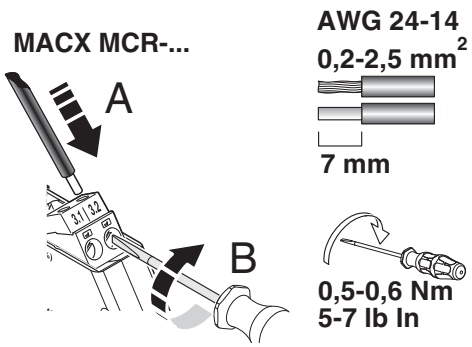
Figure 7 Mounting and removal

– Mount the module on a 35 mm DIN rail according to EN 60715.
– Install the module in a suitable housing to meet the requirements for the protection class.
– Before startup, check for correct function and wiring of the MACX MCR-EX-T-UIREL-UP..., in particular the wiring and marking of the intrinsically safe circuits.

8.5 Connecting the cables

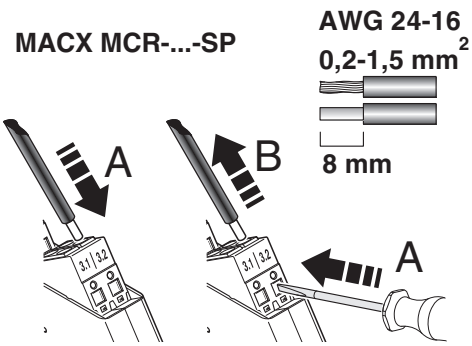
– Screw terminal blocks (for MACX MCR-EX-T-UIREL-UP); litz wires provided with ferrules.
  Permissible cable cross section: 0.2 mm^2 to 2.5 mm^2
– Spring-cage terminal blocks (for MACX MCR-EX-T-UIREL-UP-SP); litz wires provided with ferrules.
  Permissible cable cross section: 0.2 mm^2 to 1.5 mm^2
– Install intrinsically safe and non-intrinsically safe cables separately.

Screw connection



- Insert the conductor into the corresponding connection terminal block.
- Use a screwdriver to tighten the screw in the opening above the connection terminal block.

Spring-cage connection



- Insert the conductor into the corresponding connection terminal block.

8.6 Power supply

The power supply has been designed as a wide range power supply (19.2 ... 253 V AC/DC). The module is supplied with voltage via connection terminal blocks 1.1 and 1.2.

8.7 Current output

The current output can be freely configured between 0 and 20 mA. The minimum span is 4 mA. In safety-related applications (SIL = ON), the output is fixed at 4 ...20 mA.

– Connection: Terminals 3.2 “+“, 3.3 “-“

8.8 Voltage output

The voltage output cannot be used for safety-related applications (SIL = ON).

The voltage output can be freely configured between -10 and +10 V. The minimum span is 2 V.

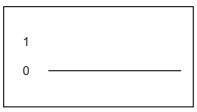
– Connection: Terminals 3.1 “+“, 3.3 “-“

8.9 Switching output

The three switching outputs each have a PDT. The behavior of each switching output can be configured independently. The switching points SPL[1] and SPH[2] can be configured across the entire sensor range:

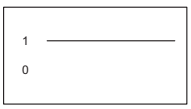
Switching behavior of the switching output

Switching behavior 0



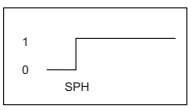
Switching output is permanently dropped.

Switching behavior 1



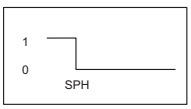
Switching output is permanently picked up.

Switching behavior 2



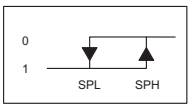
Switching output picks up when SPH[2] is exceeded.

Switching behavior 3



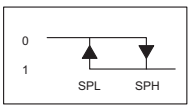
Switching output drops out when SPH[2] is underrange.

Switching behavior 4



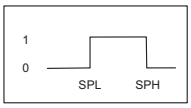
Switching output picks up when SPL[2] is exceeded and drops out when SPH[1] is underrange (hysteresis).

Switching behavior 5



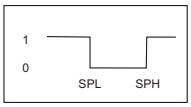
Switching output drops out when SPL[2] is exceeded and picks up when SPH[1] is underrange (hysteresis).

Switching behavior 6



Switching output picks up between SPL[1] and SPH[2].

Switching behavior 7



Switching output drops out between SPL[1] and SPH[2].

1 SPL = Set Point Low (lower switching point)

2 SPH = Set Point High (upper switching point)

Switching output 1 is not intended for safety-related applications.

In SIL ON mode, switching output 1 functions as a simple alarm contact. Switching output 2 in combination with switching output 3 is used for safety-related limit values.

In safety-related applications (SIL), switching outputs 2 and 3 must be combined according to the requirements of the application (see also application examples).

The configuration of switching output 2 is also applied to switching output 3.
In SIL ON mode, switching output 3 cannot be configured separately.

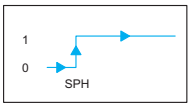
If only the switching outputs are to be used, the current output (connection terminal blocks 3.2 and 3.3) must be short circuited or subjected to a load.

8.10 Switching output behavior with manual acknowledgement (latching)

Latching: No automatic restart after exceeding limit value (SPH: SET Point High) or falling below limit value (SPL: Set Point Low).

Disable the option “Restart after fail safe” in the configuration software.

8.10.1 Switching behavior (2): Undertemperature limit (≤ SPH)



Normal operating state > SPH

Step	Measure	
1	Measured value	> SPH and module are activated
2	Relay	ON
3	Measured value	≤ SPH
4	Relay	OFF
5	Measured value	> SPH
6	Relay	Remains OFF (latches) until delay time has passed and then acknowledged manually

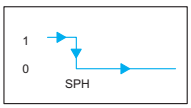
Acknowledgement is only possible when there is no critical state anymore and the delay time has passed.

Critical operating state ≤ SPH

Step	Measure	
1	Measured value	≤ SPH and module are activated
2	Relay	OFF
3	Measured value	> SPH
4	Relay	Remains OFF (latches) until delay time has passed and then acknowledged manually

Acknowledgement is only possible when there is no critical state anymore and the delay time has passed.

8.10.2 (Switching behavior (3): Overtemperature limit (≥ SPH)



Normal operating state < SPH

Step	Measure	
1	Measured value	< SPH and module are activated
2	Relay	ON
3	Measured value	≥ SPH
4	Relay	OFF
5	Measured value	< SPH
6	Relay	Remains OFF (latches) until delay time has passed and then acknowledged manually

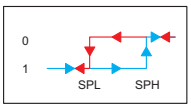
Acknowledgement is only possible when there is no critical state anymore and the delay time has passed.

Critical operating state ≥ SPH

Step	Measure	
1	Measured value	≥ SPH and module are activated
2	Relay	OFF
3	Measured value	< SPH
4	Relay	Remains OFF (latches) until delay time has passed and then acknowledged manually

Acknowledgement is only possible when there is no critical state anymore and the delay time has passed.

8.10.3 Switching behavior (4): Undertemperature limit with hysteresis (≤ SPL)



Normal operating state > SPL

Step	Measure	
1	Measured value	> SPL and module are activated
2	Relay	ON
3	Measured value	≤ SPL
4	Relay	OFF
5	Measured value	> SPH
6	Relay	Remains OFF (latches) until delay time has passed and then acknowledged manually

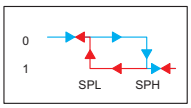
Acknowledgement is only possible when there is no critical state anymore and the delay time has passed.

Critical operating state ≤ SPL

Step	Measure	
1	Measured value	≤ SPL and module are activated
2	Relay	OFF
3	Measured value	> SPH
4	Relay	Remains OFF (latches) until delay time has passed and then acknowledged manually

Acknowledgement is only possible when there is no critical state anymore and the delay time has passed.

8.10.4 Switching behavior (5): Overtemperature limit with hysteresis (≥ SPH)



Normal operating state < SPH

Step	Measure	
1	Measured value	< SPH and module are activated
2	Relay	ON
3	Measured value	≥ SPH
4	Relay	OFF
5	Measured value	< SPL
6	Relay	Remains OFF (latches) until delay time has passed and then acknowledged manually

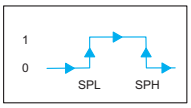
Acknowledgement is only possible when there is no critical state anymore and the delay time has passed.

Critical operating state ≥ SPH

Step	Measure	
1	Measured value	≥ SPH and module are activated
2	Relay	OFF
3	Measured value	< SPL
4	Relay	Remains OFF (latches) until delay time has passed and then acknowledged manually

Acknowledgement is only possible when there is no critical state anymore and the delay time has passed.

8.10.5 Switching behavior (6): Temperature range limit (≤ SPL and ≥ SPH)



Normal operating state > SPL and < SPH

Step	Measure	
1	Measured value	> SPL and < SPH module are activated
2	Relay	ON
3	Measured value	≤ SPL or ≥ SPH
4	Relay	OFF
5	Measured value	> SPL or < SPH
6	Relay	Remains OFF (latches) until delay time has passed and then acknowledged manually

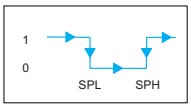
Acknowledgement is only possible when there is no critical state anymore and the delay time has passed.

Critical operating state ≤ SPL and ≥ SPH

1	Measured value	a) ≤ SPL and module are activated b) ≥ SPH and module are activated
2	Relay	OFF
3	Measured value	a) > SPL and < SPH b) < SPH and > SPL
4	Relay	Remains OFF (latches) until delay time has passed and then acknowledged manually

Acknowledgement is only possible when there is no critical state anymore and the delay time has passed.

8.10.6 Switching behavior (7): Temperature range limit (≥ SPL and ≤ SPH)



Normal operating state < SPL and > SPH

Step	Measure	
1	Measured value	a) < SPL and module are activated b) > SPH and module are activated
2	Relay	ON
3	Measured value	a) ≥ SPL and ≤ SPH b) ≤ SPH and ≥ SPL
4	Relay	OFF
5	Measured value	< SPL or > SPH
6	Relay	Remains OFF (latches) until delay time has passed and then acknowledged manually

Acknowledgement is only possible when there is no critical state anymore and the delay time has passed.

Critical operating state ≥ SPL and ≤ SPH

Step	Measure	
1	Measured value	≥ SPL and ≤ SPH and module are activated
2	Relay	OFF
3	Measured value	< SPL or > SPH
4	Relay	Remains OFF (latches) until delay time has passed and then acknowledged manually

Acknowledgement is only possible when there is no critical state anymore and the delay time has passed.

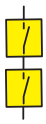
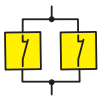
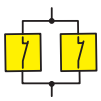
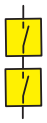
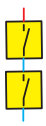
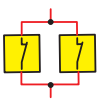
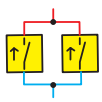
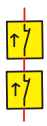
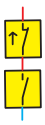
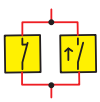
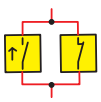
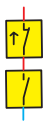
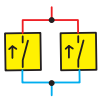
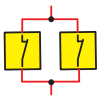
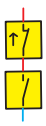
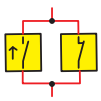
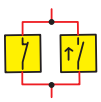
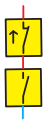
8.11 Connection of relay contacts

In order to select a suitable relay to be used, you must define which state you require when the measuring transducer fails.

If you require a closed contact in the event of a fault, you must connect two N/C contacts in parallel.

If you require an open contact in the event of a fault, you must connect two N/O contacts in series.

You can continue to configure the behavior of the measuring transducer as desired in normal operation, however the connection used for a fault must be taken into account.

Regular function		Closing behavior	Opening behavior	Closing behavior	Opening behavior
Safe state of switch contact		Open	Closed	Closed	Open
Connecting the relay contacts					
Set switching behavior (SV)		Normal (SV 0, 2, 4, 6)	Normal (SV 0, 2, 4, 6)	Inverse (SV 1, 3, 5, 7)	Inverse (SV 1, 3, 5, 7)
Relay contacts before reaching the switching thresholds	Without errors				
	With errors	Defective function working 	Defective function working 	Defective function disrupted 	Defective function disrupted 
Relay contacts after reaching the switching thresholds	Without errors				
	With errors	Defective function disrupted 	Defective function disrupted 	Defective function working 	Defective function working 
Blue cable = voltage-free					
Red cable = live					
 if defective		Defective = the contact is incorrectly actuated or it has been mechanically short-circuited			
 if defective		Defective = the contact is incorrectly not actuated or it has been mechanically short-circuited			
 if defective		Defective = the contact is incorrectly actuated or it has been mechanically interrupted			
 if defective		Defective = the contact is incorrectly not actuated or it has been mechanically interrupted			

8.12 Monitoring function

The temperature transducer is equipped with monitoring functions for the input and output range.

Input monitoring function

The input monitoring function for line break and short circuit refers to the sensor connected to the input. When an error is detected, the output signal is set to the configured error value. In the case of RTD sensors and resistance-type sensors, short-circuit failures are detected resistance values < 1 Ω.

Short circuits of thermocouples and mV sources cannot be detected, since 0 V can be a valid signal.

On RTD sensors, resistance-type sensors and potentiometers, a line break is detected when the current flow through the sensor is faulty.

As soon as the fault has been eliminated, the temperature transducer continues to perform its normal functions. (see “LED status indicators” on page 23, Line faults)

Output monitoring function

The current output can be monitored for line breaks and maximum load. This is activated via the configuration. In safety-related applications (SIL = ON), the output monitoring is always active. The voltage output is not monitored. As soon as the fault has been eliminated, the temperature transducer continues to perform its normal functions. (see “LED status indicators” on page 23, Line faults)

8.13 Operating modes

If the configuration is modified using the IFS-OP-UNIT operator interface and PC-based software (e.g., ANALOG-CONF) or via DIP switch, the changes made must always be checked again and released before transfer to the temperature transducer.

After the transfer, the new data in the temperature transducer is applied by means of activation and a warm start.

8.13.1 SIL ON/SIL OFF

The temperature transducer can either be operated in SIL ON or SIL OFF. The standard configuration is SIL ON with DIP switch S1 set to the OFF position. With the order configuration, customer-specific configurations can be selected in the order key (see “Sensor types” on page 9).

8.13.2 Service mode

Service mode can be selected at any time via the IFS-OP-UNIT operator interface and the configuration software, e.g., ANALOG-CONF or via DIP switch S1.

If settings are changed during service mode and service mode is then exited, the temperature transducer performs a warm start in order to apply the newly set values. If no changes are made, the transducer starts up in normal measuring mode without a warm start. The switching output switches according to its configuration.

In service mode, it is also possible to simulate the output signal independently of the input signal (force). In this case, in safety-related applications the safety function of the device is deactivated and the initial value for the analog output signal is 2 mA, which allows subsequent devices to detect the deviation from normal operation as a result of the measured value being underrange.

During service mode, the switching output is deactivated and remains in its idle position.

9 Configuration

WARNING: Explosion hazard

When configuring in zone 2, the PC used must be approved for use in zone 2.

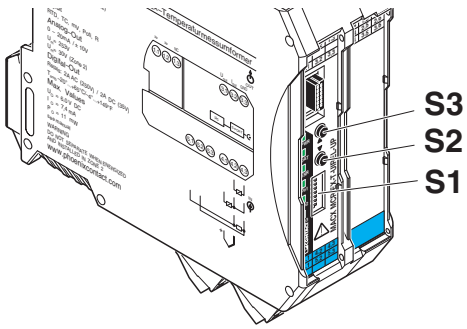


Figure 8 Position of the DIP switch and button

When a DIP switch from S1-2 ... S1-8 (ON) is switched on, the device is switched to service mode. The red ERR LED flashes (1.2 Hz) and a diagnostic I/O fault is displayed in the start screen.

9.1 Delivered state/standard configuration

Switch position DIP-S1							
1	2	3	4	5	6	7	8
OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

9.2 Zero adjust, adjustment via buttons S2 and S3 (only possible with SIL OFF)

- Set the adjustment by setting DIP switch S1-2 to ON.
- Observe the analog output and set it with button S2 (descending value) or S3 (ascending value)
  or
  press the buttons S2 and S3 simultaneously time for > 3 seconds to reset the cable compensation.
- Save the set value by setting DIP switch S1-2 back to OFF.

Switch position DIP-S1							
1	2	3	4	5	6	7	8
OFF	**ON**	OFF	OFF	OFF	OFF	OFF	OFF

9.3 Span adjust, adjustment via buttons 2 and 4 (only possible with SIL OFF)

- Set the adjustment by setting DIP switch S1-3 to ON.
- Observe the analog output and set it with button S2 (descending value) or S3 (ascending value)
  or
  press the buttons S2 and S3 simultaneously time for > 3 seconds to reset the cable compensation.
- Save the set value by setting DIP switch S1-3 back to OFF.
- Pressing buttons S2 and S3 simultaneously for > 3 seconds resets the adjustment.

Switch position DIP-S1							
1	2	3	4	5	6	7	8
OFF	OFF	**ON**	OFF	OFF	OFF	OFF	OFF

9.4 Force output

When SIL is activated, the analog output starts at 2 mA and the switching output is deactivated.

- Set the adjustment by setting DIP switch S1-4 to ON.
- Observe the analog output and set with the S2 (descending value) or S3 (ascending value) button.
- The specification/simulation is reset and ended by setting DIP switch S1-4 back to OFF.

Switch position DIP-S1							
1	2	3	4	5	6	7	8
OFF	OFF	OFF	**ON**	OFF	OFF	OFF	OFF

9.5 Cable compensation, 2-wire RTD or RTD 1 with 2 x RTD

- Set the cable compensation RTD 1 via DIP switches S1-1 to OFF and
  S1-5 to ON.
- Short circuit the sensor.
- Apply the current measured value as the cable resistance by pressing the S2 button.
- Save the set value by setting DIP switch S1-5 back to OFF.

Pressing buttons S2 and S3 simultaneously for > 3 seconds resets the cable compensation.

Switch position DIP-S1							
1	2	3	4	5	6	7	8
OFF	OFF	OFF	OFF	**ON**	OFF	OFF	OFF

9.6 Cable compensation RTD 2 with 2 x RTD or TC with external cold junction compensation (TC + CJ external)

- Set the cable compensation RTD 2 via DIP switches S1-1 to ON and
  S1-5 to ON.
- Short circuit the sensor.
- Apply the current measured value as the cable resistance by pressing the S2 button.
- Save the set value by setting DIP switches S1-1 and S1-5 back to OFF.

Pressing buttons S2 and S3 simultaneously for > 3 seconds resets the cable compensation.

Switch position DIP-S1							
1	2	3	4	5	6	7	8
ON	OFF	OFF	OFF	**ON**	OFF	OFF	OFF

9.7 Automatic potentiometer adjustment (teach-in)

- Set the teach-in by setting DIP switch S1-6 to ON.
- Set potentiometer to start of range.
- Press the S2 button.
- Set potentiometer to end of range.
- Press the S3 button.
- Save the new measuring range by setting DIP switch S1-6 back to OFF.

Pressing buttons S2 and S3 simultaneously for > 3 seconds resets both values.

Switch position DIP-S1							
1	2	3	4	5	6	7	8
OFF	OFF	OFF	OFF	OFF	**ON**	OFF	OFF

9.8 Manual acknowledgement of switching outputs (latch function)

Switching output 1

- Set manual acknowledgment of switching output by setting DIP switch S1-7 to ON.
- Press buttons S2 and S3 simultaneously for > 3 seconds.

Reset DIP switch S1-7 to OFF.

Switch position DIP-S1							
1	2	3	4	5	6	7	8
OFF	OFF	OFF	OFF	OFF	OFF	**ON**	OFF

Switching output 2

- Set manual acknowledgment of switching output 2 by setting DIP switch S1-8 to ON.
- Press buttons S2 and S3 simultaneously for > 3 seconds.

Reset DIP switch S1-8 to OFF.

Switch position DIP-S1							
1	2	3	4	5	6	7	8
OFF	OFF	OFF	OFF	OFF	OFF	OFF	**ON**

Switching output 3

- Set manual acknowledgment of switching output 3 by setting DIP switches S1-7 and S1-8 to ON.
- Press buttons S2 and S3 simultaneously for > 3 seconds.

Reset DIP switches S1-7 and S1-8 to OFF..

Switch position DIP-S1							
1	2	3	4	5	6	7	8
OFF	OFF	OFF	OFF	OFF	OFF	**ON**	**ON**

9.9 LED status indicators

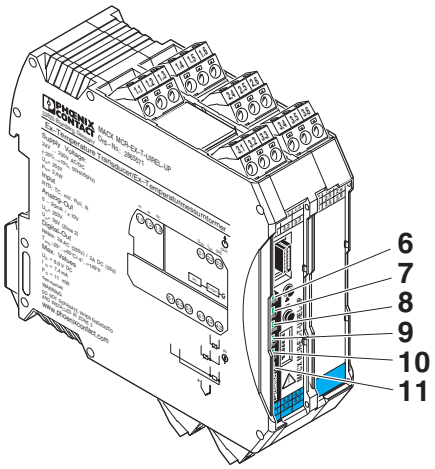


Figure 9 LED status indicators

No.	LED	Color	Description
6	PWR	Green	Supply voltage
		ON	Indicates the readiness for operation of the temperature transducer if supply voltage is available.
			The temperature transducer is configured without device supply via programming adapter IFS-USB-PROG-ADAPTER.
7	DAT	Green	No function at present
8	ERR	Red	Error
		ON	Module error
		Flashing (1.2 Hz)	Service mode active
		Flashing (2.4 Hz)	Line fault
9	DO1	Yellow	Switching output 1
		ON	Switching output active
10	DO2	Yellow	Switching output 2
		ON	Switching output active
11	DO3	Yellow	Switching output 3
		ON	Switching output active

10 Password

The device is protected by means of a four-digit password set in the factory in order to prevent impermissible changes to the configuration.

Default setting: 1111

For safety-related applications, the password set in the factory must always be changed.

If the password is lost, it is not possible to reset it.

In this case, please contact Phoenix Contact.

If, however, only data from the device is to be displayed or the device is to be used in non-safety-related applications, the password can be deactivated.

Setting: 0000

The device can be accessed either via the IFS-OP-UNIT (Order No. 2811899) or via a service PC with connected programming adapter IFS-USB-PROG-ADAPTER (Order No.: 2811271) and the ANALOG-CONF configuration software.

Further information on configuration with the IFS-OP-UNIT or the ANALOG-CONF configuration software can be found in the relevant user manual.

WARNING: If *Functional Safety* is activated by a reconfiguration or changes are made to the active *Functional Safety* configuration, the rules under “Installation and startup” must be observed.

WARNING: Limitations on safety-related applications

Only 4 ... 20 mA, limited programming of output current in the event of line faults
(2 mA ≤ I_{Out} ≤ 3.6 mA or I_{Out} ≥ 21 mA)

WARNING: Once new configuration data has been written, the device performs a warm start that changes the properties of the device. The following control device must be adapted to these modifications.

NOTE: Write the changed password to the temperature transducer in order to save it.

11 Configuration with the service PC

When making changes to the configuration data, use the ANALOG-CONF software
(free download:phoenixcontact.net/products).

Information on configuration, parameterization and service options (e.g., online monitoring) and their execution can be found in the online help of the software and in the associated user manuals of the DTMs (Device Type Manager).

- Connect the device and PC with the help of the IFS-USB-PROG-ADAPTER programming adapter (Order No. 2811271).

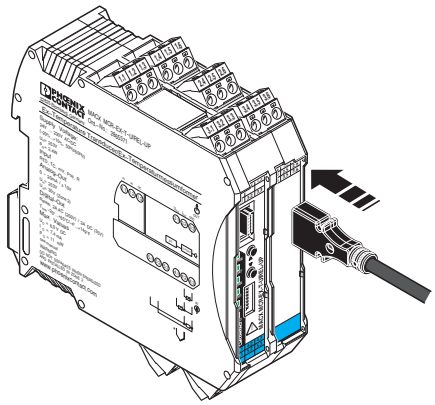


Figure 10 IFS-USB-PROG-ADAPTER

Changes to the configuration and parameterization data can be made during operation with a connected Ex measuring circuit as well as in a disconnected state.

11.1 System requirements

– IBM PC or compatible computer with 400 MHz or higher with at least 256 Mbyte RAM
– At least 15 Mbyte available hard disk space
– Free USB interface, at least USB 1.1.
– Screen resolution of 1024 x 768 pixels
– Windows 2000 SP4, Windows XP SP2

The drivers for the IFS-USB-PROG-ADAPTER USB programming adapter are installed automatically.

11.2 Configuring the user characteristic curve

Freely configurable user characteristic curve for individual adaptation of resistance temperature detectors (RTD) and thermocouples (TC).

The user characteristic curve is created with the PC-based ANALOG-CONF software and stored in the temperature transducer.

The user characteristic curve is either selected with the ANALOG-CONF or with the IFS-OP-UNIT software.

12 Comparison of safety data

WARNING: Explosion hazard

Compare the safety data before connecting a device located in the intrinsically safe area to the MACX MCR-EX-T-UIREL-UP....

Safety data for the

Field devices:	U_i, I_i, P_i, L_i, C_i
Temperature transducers:	U_o, I_o, P_o, L_o, C_o

The values for U_o, I_o, P_o, L_o and C_o can be found under “Safety data according to ATEX for intrinsically safe circuits” on page 7.

Requirements for intrinsic safety (simple circuits):

$U_i \geq U_o$

$I_i \geq I_o$

$P_i \geq P_o$

$L_i + L_c \leq L_o$

$C_i + C_c \leq C_o$

(L_c and C_c depend on the cables/lines used).