MACX MCR-T-UI-UP(-SP(-C))



Temperature measuring transducer

Data sheet
104595_en_12

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1 Description

The programmable temperature transducer is designed for operating temperature sensors (RTD and thermocouples), voltage signal and resistance-type sensors as well as potentiometers. The measured values are converted into a linear current or voltage signal.

The temperature measuring transducer is delivered configured (either with a standard configuration or on an order-specific basis following customized configuration via the website) and calibrated ready for operation (C versions).

In addition to an analog current and voltage output, the temperature measuring transducer also has a switching output. The power supply has been designed as a wide-range supply.

The devices can be installed in Ex zone 2.

Features such as sensor type, connection technology, measuring range, measuring unit, filter, alarm signal, and output signal can be configured using the clipx ENGINEER DEVICE PARAMETERIZATION software (item no. 1371665) or a device-specific DTM (Device Type Manager).

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

Features

- Input for all common temperature sensors (RTDs and thermocouples), voltage signals, resistance-type sensors, and potentiometers
- Temperature sensors (RTDs and thermocouples), resistance-type sensors, and potentiometers can be used in applications up to SIL 2 / SC 2
- Voltage signals can be used with restrictions in applications up to SIL 2 / SC 2
- Current and voltage output
- Switching output (1 changeover contact relay)
- Configuration via software (FDT/DTM or clipx ENGINEER DEVICE PARAMETERIZATION) possible
- Up to SIL 2/SC 2 in accordance with IEC/EN 61508 at output 4 mA ... 20 mA
- PL d in accordance with EN ISO 13849
- 3-way electrical isolation
- Installation in Ex zone 2 permitted
- Wide-range supply 19.2 V AC/DC ... 253 V AC/DC
- Plug-in connection terminal blocks, with either screw or push-in connection technology

Observe these notes

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.com/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.
Freely programmable temperature measuring transducer with analog output and 1 limit value relay, resistance thermometer in 2-, 3-, or 4-conductor technology, thermocouples, wide-range supply. Standard configuration, 4-way isolation, Safety Integrity Level (SIL, IEC 61508): 2, Performance Level (ISO 13849-1): d, Systematic Capability: 2, Screw connection	MACX MCR-T-UI-UP	2811394	1
Freely programmable temperature measuring transducer with analog output and 1 limit value relay, resistance thermometer in 2-, 3-, or 4-conductor technology, thermocouples, wide-range supply. Standard configuration, 4-way isolation, Safety Integrity Level (SIL, IEC 61508): 2, Performance Level (ISO 13849-1): d, Systematic Capability: 2, Push-in connection	MACX MCR-T-UI-UP-SP	2811860	1
Freely programmable temperature measuring transducer with analog output and 1 limit value relay, resistance thermometer in 2-, 3-, or 4-conductor technology, thermocouples, wide-range supply. Order configuration, 4-way isolation, Safety Integrity Level (SIL, IEC 61508): 2, Performance Level (ISO 13849-1): d, Systematic Capability: 2, Push-in connection	MACX MCR-T-UI-UP-SP-C	2811970	1

Accessories	Type	Item no.	Pcs./Pkt.
Cover for screw shafts of the MSTB connector ranges with a pitch of 5.0 mm and 5.08 mm. These can be aligned and shortened for use with different numbers of positions.	EA-MSTB 2,5/ 5	1831016	50
The divider 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
Parameterization software for Phoenix Contact devices. It includes online monitoring of current device process values, adjustment of device parameters, and logging of parameter changes. Windows installation version with online update.	CLIPX ENGINEER DEVICE PARAMETERIZATION	1371665	1
Parameterization software for Phoenix Contact devices. It includes online monitoring of current device process values, adjustment of device parameters, and logging of parameter changes. Windows version can be used straight away without online update.	CLIPX ENGINEER DEVICE PARAMETERIZATION P	1371666	1
Bluetooth adapter with micro USB and S-PORT interface for wireless communication with the MINI Analog, MINI Analog Pro, MACX Analog, Interface System Gateways, and PLC logic device series.	IFS-BT-PROG-ADAPTER	2905872	1
Programming adapter with USB interface, for programming with software. The USB driver is included in the software solutions for the products to be programmed, such as measuring transducers or motor managers.	IFS-USB-PROG-ADAPTER	2811271	1

Accessories	Type	Item no.	Pcs./Pkt.
Connection terminal block for current signals, +20 mA ... -20 mA, for safe switching of limit values, in combination with MACX ...-T-UI... temperature transducers	MACX MCR-I20	2905680	1
Plug for cold junction compensation for thermocouples, for safe switching of limit values, in combination with MACX ...-T-UI... temperature transducers.	MACX MCR-CJC	2924993	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 plug, with solder connection up to 1 mm² conductor cross-section, number of positions: 1, color: gray	MPS-MT	0201744	10
Plastic label, Sheet, white (RAL 9010), unmarked, can be labeled with: BLUEMARK E.CARD, BLUEMARK ID COLOR, BLUEMARK ID, BLUEMARK CLED, PLOTMARK, CMS-P1-PLOTTER, mounting type: adhesive, Number of individual labels: 10, text field height: 9 mm, text field width: 11 mm	UC-EMLP (11X9)	0819291	10
Plastic label, Sheet, yellow (RAL 1018), unmarked, can be labeled with: BLUEMARK E.CARD, BLUEMARK ID COLOR, BLUEMARK ID, BLUEMARK CLED, PLOTMARK, CMS-P1-PLOTTER, mounting type: adhesive, Number of individual labels: 10, text field height: 9 mm, text field width: 11 mm	UC-EMLP (11X9) YE	0822602	10
Plastic label, can be ordered: by sheet, white (RAL 9010), labeled according to customer specifications, mounting type: adhesive, text field height: 9 mm, text field width: 11 mm	UC-EMLP (11X9) CUS	0824547	1
Plastic label, can be ordered: by sheet, yellow (RAL 1018), labeled according to customer specifications, mounting type: adhesive, text field height: 9 mm, text field width: 11 mm	UC-EMLP (11X9) YE CUS	0824548	1
Plastic label, Sheet, unmarked, can be labeled with: BLUEMARK E.CARD, BLUEMARK ID COLOR, BLUEMARK ID, BLUEMARK CLED, PLOTMARK, CMS-P1-PLOTTER, mounting type: adhesive, Number of individual labels: 10, text field height: 9 mm, text field width: 11 mm	UC-EMLP (11X9) SR	0828094	10
Plastic label, can be ordered: by sheet, labeled according to customer specifications, mounting type: adhesive, Number of individual labels: 10, text field height: 9 mm, text field width: 11 mm	UC-EMLP (11X9) SR CUS	0828098	1

Accessories	Type	Item no.	Pcs./Pkt.
Plastic label, Card, white (RAL 9010), unmarked, can be labeled with: BLUEMARK ID COLOR, BLUEMARK ID, THERMOMARK PRIME, THERMOMARK CARD 2.0, THERMOMARK CARD, THERMOMARK PRIME 2.0, mounting type: adhesive, Number of individual labels: 135, text field height: 9 mm, text field width: 11 mm	US-EMLP (11X9)	0828789	10
Plastic label, Card, yellow (RAL 1018), unmarked, can be labeled with: BLUEMARK ID COLOR, BLUEMARK ID, THERMOMARK PRIME, THERMOMARK CARD 2.0, THERMOMARK CARD, THERMOMARK PRIME 2.0, mounting type: adhesive, Number of individual labels: 135, text field height: 9 mm, text field width: 11 mm	US-EMLP (11X9) YE	0828871	10
Plastic label, Card, unmarked, can be labeled with: BLUEMARK ID COLOR, BLUEMARK ID, THERMOMARK PRIME, THERMOMARK CARD 2.0, THERMOMARK CARD, THERMOMARK PRIME 2.0, mounting type: adhesive, Number of individual labels: 135, text field height: 9 mm, text field width: 11 mm	US-EMLP (11X9) SR	0828872	10
Device marker, Sheet, white (RAL 9010), unmarked, can be labeled with: TOPMARK NEO, TOPMARK LASER, mounting type: adhesive, Number of individual labels: 255, text field height: 9 mm, text field width: 11 mm	LS-EMLP (11X9) WH	0831678	10
Device marker, Sheet, unmarked, can be labeled with: TOPMARK NEO, TOPMARK LASER, mounting type: adhesive, Number of individual labels: 255, text field height: 9 mm, text field width: 11 mm	LS-EMLP (11X9) SR	0831705	10
Device marker, Sheet, yellow (RAL 1018), unmarked, can be labeled with: TOPMARK NEO, TOPMARK LASER, mounting type: adhesive, Number of individual labels: 255, text field height: 9 mm, text field width: 11 mm	LS-EMLP (11X9) YE	0831732	10
Primary-switched power supply, QUINT POWER, screw connection, DIN rail mounting, supply of devices possible via the TBUS DIN rail connector, protective coating, input: single-phase, output: 24 V DC/2.5 A	QUINT4-SYS-PS/1AC/24DC/2.5/SC	2904614	1
Actuation tool, for ST terminal blocks, insulated, also suitable for use as a bladed screwdriver, size: 0.6 x 3.5 x 100 mm, 2-component grip, with non-slip grip	SZS 0,6X3,5	1205053	10

4 Technical data

Input data Resistance thermometer/thermocouple	
Sensor types (RTD) that can be used	Pt, Ni, Cu sensors: 2, 3, 4-wire
Sensor types that can be used (TC)	B, E, J, K, N, R, S, T, L, U, CA, DA, A1G, A2G, A3G, MG, LG
Potentiometer	0 Ω ... 50 kΩ
Linear resistance measuring range	0 Ω ... 50 kΩ
Temperature measuring range	-250 °C ... 2500 °C (Range depending on the sensor type)
Voltage	-1000 mV ... 1000 mV

Output data Current output	
Configurable/programmable	Yes
Max. voltage output signal	± 11 V
Current output signal	0 mA ... 20 mA (SIL off) 4 mA ... 20 mA (SIL on)
Max. current output signal	22 mA
Load/output load voltage output	≥ 10 kΩ
Load/output load current output	≤ 600 Ω (20 mA)
Behavior in the event of a sensor error	freely programmable

Output data Relay output	
Number	1
Configurable/programmable	Yes
Contact switching type	1 changeover contact
Contact material	$AgSnO_2$, hard gold-plated
Maximum switching voltage	30 V AC/DC
Max. switching current	0.5 A (30 V AC) 1 A (30 V DC)
Mechanical service life	1x 10^5 cycles

Supply	
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)
Typical current consumption	< 50 mA (24 V DC)
Power consumption	< 1.5 W

General data	
Step response (0–99%)	≤ 1.75 s (SIL on) 1.3 s (SIL off)
Maximum transmission error	0.1 % (E.g., at Pt 100, 300 K min. span)
Maximum temperature coefficient	0.01 %/K
Degree of protection	IP20
Flammability rating according to UL 94 (Housing)	V0 (Housing)
Status display	LED supply voltage, PWR (green) Red LED, flashing (line, sensor error, ERR) Red LED (module error, ERR) Yellow LED (switching output)
Dimensions W/H/D	17.5 mm / 112.5 mm / 113.7 mm (MACX MCR-T-UI-UP) 17.5 mm / 107.9 mm / 113.7 mm (MACX MCR-T-UI-UP-SP) 17.5 mm / 107.9 mm / 113.7 mm (MACX MCR-T-UI-UP-SP-C)
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 … 65 °C
Ambient temperature (storage/transport)	-40 °C … 85 °C
Permissible humidity (operation)	typ. 5 % … 95 % (non-condensing)
Shock (operation)	15g (IEC 60068-2-27)
Vibration (operation)	5g (IEC 60068-2-6)
Height range Ambient temperature (operation)	> 2000 m … 3000 m -20 °C … 55 °C
Height range Ambient temperature (operation)	> 3000 m … 4000 m -20 °C … 50 °C
Height range Ambient temperature (operation)	> 4000 m … 5000 m -20 °C … 45 °C

Electrical isolation (≤2000 m above mean sea level)	
Electrical isolation	4-way isolation
Test voltage	2.5 kV AC (50 Hz, 60 s)
Overvoltage category	II (≤ 5000 m)
Pollution degree	2 (≤ 5000 m)
Input/output/power supply	
Standards/regulations	IEC/EN 61010-1
Rated insulation voltage	300 V_{rms}
Insulation	Safe isolation
Input/output, supply, switching output	
Standards/regulations	IEC/EN 60079-11
Rated insulation voltage	265 V_{rms}

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

Conformance with EMC directive
Noise immunity according to EN 61000-6-2
When being exposed to interference, there may be minimal deviations.
Noise emission according to EN 61000-6-4

Conformance/approvals	
CE CE-compliant	
ATEX IBExU 10 ATEX 1044 X	II 3 G Ex ec ic nC IIC T4 Gc
IECEx IECEx IBE 10.0004 X	Ex ec ic nC IIC T4 Gc
CCC / China-Ex 2025122310128118	Ex ec ic IIC T4 Gc
INMETRO DNV 18.0143 X	Ex ec ic nC IIC T4 Gc
UL, USA/Canada	UL 61010-1 Listed Class I, Div. 2, Groups A, B, C, D T6 Class I, Zone 2, Group IIC T6
Shipbuilding approval DNV GL TAA000020C	
Temperature	B
Humidity	B
Vibration	A
EMC	A
Enclosure	Required protection according to the Rules shall be provided upon installation on board
Safety Integrity Level (SIL, IEC 61508) SEBS-A.150520/17, V2.0	2
Systematic Capability	2
Performance Level (ISO 13849-1)	d

5 Safety regulations and installation notes

5.1 Content of the EU Declaration of Conformity

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

Product designation:	Item No.:
MACX MCR-T-UI-UP	2811394
MACX MCR-T-UI-UP-SP	2811860
MACX MCR-T-UI-UP-SP-C	2811970

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

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

5.2 Safety notes

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

5.3 Installation notes

- The EPL Gc (ATEX category 3) device is suitable for installation in zone 2 potentially explosive areas. It meets the requirements of the following standards:
  IEC/EN 60079-0, IEC/EN 60079-7, IEC/EN 60079-11, and IEC/EN 60079-15
  ABNT NBR IEC 60079-0, ABNT NBR IEC 60079-7, ABNT NBR IEC 60079-11, ABNT NBR IEC 60079-15
  GB/T 3836.1, GB/T 3836.3, GB/T 3836.4, GB/T 3836.8
  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.
- Only Phoenix Contact devices may be connected to the programming interface that have been specified for this – see respective data sheet.
- 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 products must be installed in accordance with all applicable standards for electrical systems in potentially explosive areas.
- Only use copper connecting cables.

5.4 Installation in the Ex area (zone 2)

- Observe the specified conditions for use in potentially explosive areas! Install the device in a suitable, approved housing with a minimum degree of protection of IP54 that meets the requirements of IEC/EN 60079-0 (section 1), ABNT NBR IEC 60079-0 and GB/T 3836.1, or IEC/EN 60079-7 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 connectors in non-intrinsically safe circuits and the actuation of DIP switches is only permitted in a de-energized state or when there is no potentially explosive atmosphere present.
- Do not use the programming interface for configuration in a potentially explosive area.
- 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).
- Warning - Explosion hazard - Substitution of components may impair suitability for Class 1, Division 2 or Class 1, Zone 2.

5.5 Installation in areas with a danger of dust explosions (zone 22)

- The device is not suitable for installation in zone 22.
- If, however, you wish to use the device in zone 22, it must be installed in a housing that complies with IEC/EN 60079-31. In doing so, observe the maximum surface temperatures. Observe the requirements of IEC/EN 60079-14.

5.6 Safety-related applications (SIL, PL)

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

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

WARNING: Danger of death!

The configuration tools provide the option of setting SIL ON/SIL OFF. For applications in accordance with the Machinery Directive (EN ISO 13849-1), only the SIL ON setting is permitted. Any other operation implies danger to life and is not permitted.

5.7 UL notes

PROCESS CONTROL EQUIPMENT FOR HAZARDOUS LOCATIONS

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

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

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

6 Installation

6.1 Connection notes

WARNING: Electrical danger due to improper installation

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

- Disconnecting devices and branch circuit protection with suitable AC or DC rating shall be provided in the building installation.
- The device is intended for installation in a control cabinet or in a comparable enclosure. The device may only be operated when it has been installed. The control cabinet must meet the requirements of UL/IEC 61010-1 in terms of protection against spread of fire and protection against electric shock or burn.
- Provide a switch/circuit breaker close to the device, which is labeled as the disconnecting device for this device.
- Provide for an overcurrent protection device (I ≤ 16 A) in the installation.
- For UL applications, install a UL-approved (JDYX2) overcurrent protection unit (I ≤ 16 A, U > 30 V DC, usable in DC circuits, slow-blow) in the installation.
- During installation, servicing, and maintenance work and during configuration, disconnect the device from all effective power sources, provided you are not dealing with SELV or PELV circuits.
- If the device is not used as described in the documentation, the intended protection can be negatively affected.
- To protect the device against mechanical or electrical damage, install it in suitable housing with an appropriate degree of protection according to IEC/EN 60529.
- 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.
- Depending on the application, it can be the case that a voltage that is dangerous to the touch (> 30 V AC / > 60 V DC) against the ground could be present on the device. For this event, safe electrical isolation from the other connections has been implemented.
- For UL applications, use only copper conductors rated for a temperature $T_{cable} = T_{amb}$ +20°C of the expected ambient temperature (T_{amb}).

6.2 Electrostatic discharge

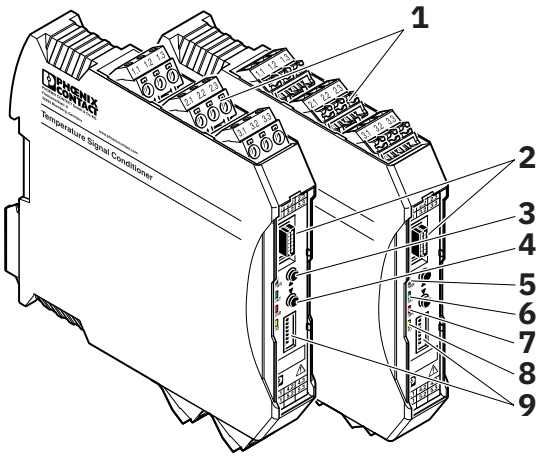
NOTE: Electrostatic discharge!

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

Take protective measures against electrostatic discharge before opening the front cover!

6.3 Structure

Figure 1 Design of MACX MCR-T-UI-UP



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

2 S-PORT (12-pos. programming interface)

3 Button S3 (UP)

4 Button S2 (DOWN)

5 PWR LED, green, power supply

6 Green DAT LED

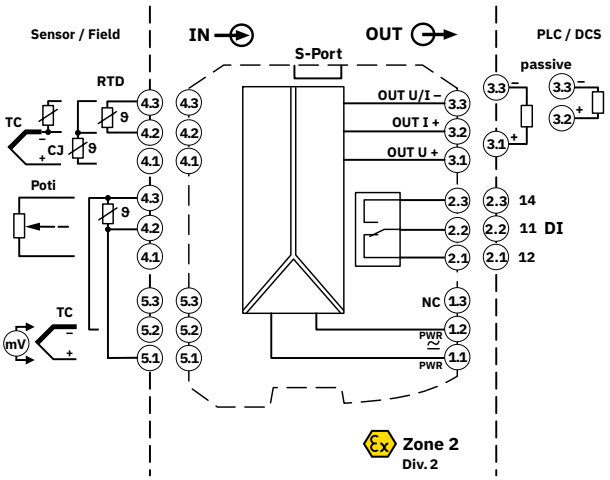
7 ERR LED, red
Lights up: module error
Flashing slowly (1.4 Hz): simulation mode
Flashing quickly (2.8 Hz): sensor error or line fault at the input and output

8 DO LED, yellow, status of switching output

9 DIP switch S1 for service mode

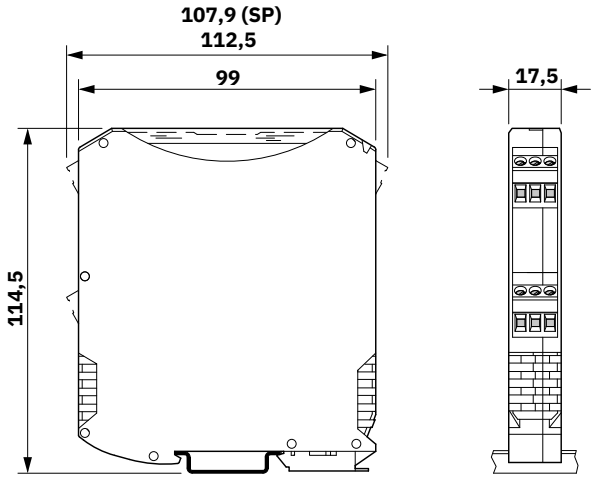
6.4 Basic circuit diagrams with connection terminal blocks

Figure 2 Sensor connections



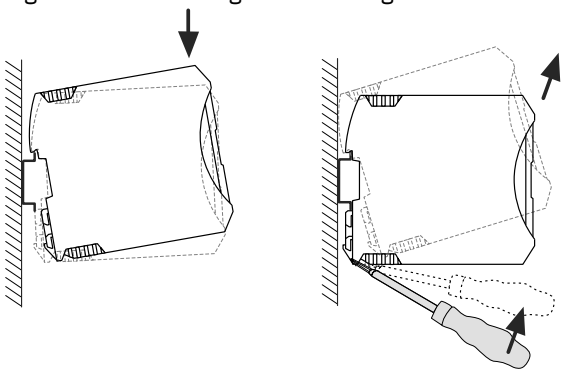
6.5 Dimensions

Figure 3 Dimensions (in mm)



6.6 Mounting

Figure 4 Mounting and removing



- Mount the module on a 35 mm DIN rail in accordance with EN 60715.
- Install the module in a suitable housing to meet the requirements for the protection class.
- Before startup, check that the device is operating and wired correctly, in particular with regard to the wiring and marking of the intrinsically safe circuits.

6.7 Divider 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 divider plate (item no. 1430594). The divider plate ensures that Ex i isolating distances are maintained.

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

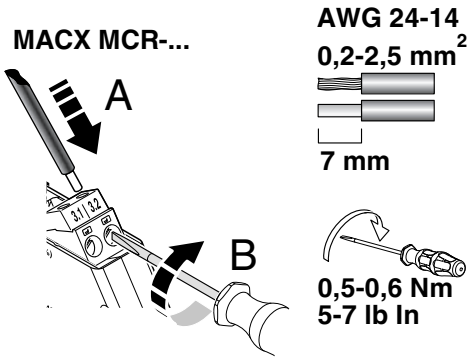
The divider plate is compatible with the ME … TBUS DIN rail connectors (e.g., item no. 1090049, 2695439).

6.8 Connecting the cables

- Screw terminal blocks: fit the litz wires with ferrules, permitted conductor cross-section: 0.2 mm² to 2.5 mm²
- Push-in terminal blocks: Fit the litz wires with ferrules, permissible cable cross-section: 0.2 mm² ... 2.5 mm²

Screw connection

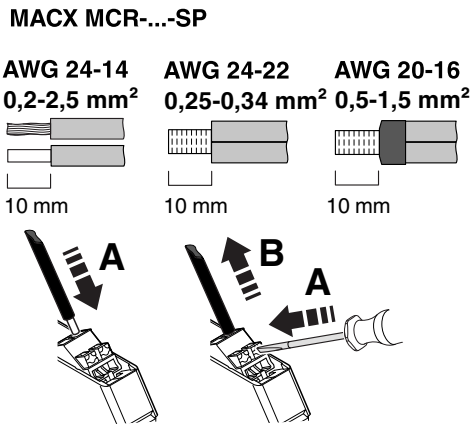
Figure 5 Screw connection



- Strip the wire by approximately 7 mm and crimp the ferrules.
- Insert the wire into the corresponding connection terminal block.
- Use a screwdriver to tighten the screw in the opening above the connection terminal block.
  Tightening torque: 0.6 Nm

Push-in connection (PSPT):

Figure 6 Push-in connection (PSPT)



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.

6.9 Power supply

The power supply has been designed as a wide-range supply (19.2 V AC/DC ... 253 V AC/DC).

The device is supplied with voltage via connection terminal blocks 1.1 and 1.2.

6.10 Current output

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

– Connection: terminal blocks 3.2 "+", 3.3 "-"

Insert a wire bridge at the terminals of the current output (terminals 3.2 and 3.3) when not using the current output. Otherwise, the module will detect a wire break and switch to the safe state (relays drop out).

6.11 Voltage output

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

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

– Connection: terminal blocks 3.1 “+” and 3.3 “-”

6.12 Switching output

The switching output has one changeover contact. The behavior of the switching output can be selected. Switching points SPL[1] and SPH[2] can be configured across the entire sensor range.

Switching behavior of the switching outputs

Figure 7 Switching behavior 0: Switching output is permanently dropped

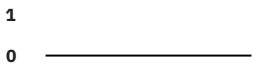


Figure 8 Switching behavior 1: Switching output is permanently picked up

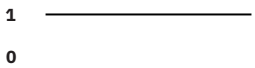


Figure 9 Switching behavior 2: Switching behavior picks up when SPH[2] is exceeded



Figure 10 Switching behavior 3: Switching output drops out when SPH[2] is underrange

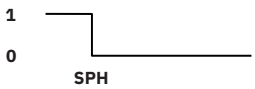


Figure 11 Switching behavior 4: Switching output picks up when SPH[2] is exceeded and drops out when SPL[1] is underrange (hysteresis)

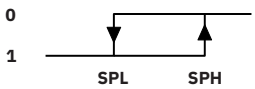


Figure 12 Switching behavior 5: Switching output drops out when SPH[2] is exceeded and picks up when SPL[1] is exceeded (hysteresis)

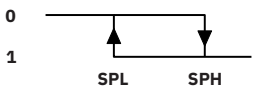


Figure 13 Switching behavior 6: Switching output picks up between SPL[1] and SPH[2]

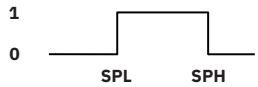
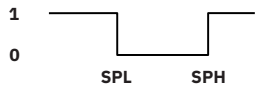


Figure 14 Switching behavior 7: Switching output drops out between SPL[1] and SPH[2]



[1] SPL = Set Point Low (lower switching point)
[2] SPH = Set Point High (upper switching point)

The switching output is not intended for safety-related applications.

If only the switching output is to be used, the current output (connection terminal blocks 3.2 and 3.3) must be short circuited or subjected to a load. Otherwise, the device switches to the safe state if line fault detection is activated.

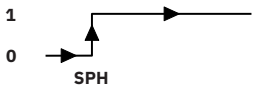
6.13 Switching output behavior with manual acknowledgment (latching)

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

Disable the “Restart after failsafe” option in the configuration software.

6.13.1 Switching behavior 2: undertemperature limit (≤ SPH)

Figure 15 Switching behavior 2: Switching behavior picks up when SPH[2] is exceeded



Normal operating state > SPH

Step	Measure	
1	Measured value	> SPH, and module is 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.

Acknowledgment is only possible if there is no critical state anymore and the delay time has elapsed.

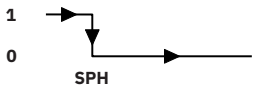
Critical operating state ≤ SPH

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

Acknowledgment is only possible if there is no critical state anymore and the delay time has elapsed.

6.13.2 Switching behavior 3: overtemperature limit (≥ SPH)

Figure 16 Switching behavior 3: Switching output drops out when SPH[2] is underrange



Normal operating state < SPH

Step	Measure	
1	Measured value	< SPH, and module is 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.

Acknowledgment is only possible if there is no critical state anymore and the delay time has elapsed.

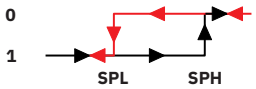
Critical operating state ≥ SPH

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

Acknowledgment is only possible if there is no critical state anymore and the delay time has elapsed.

6.13.3 Switching behavior 4: undertemperature limit with hysteresis (≤ SPL)

Figure 17 Switching behavior 4: Switching output picks up when SPH[2] is exceeded and drops out when SPL[1] is underrange (hysteresis)



Normal operating state > SPL

Step	Measure	
1	Measured value	> SPL, and module is 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.

Acknowledgment is only possible if there is no critical state anymore and the delay time has elapsed.

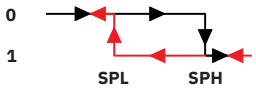
Critical operating state ≤ SPL (red line)

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

Acknowledgment is only possible if there is no critical state anymore and the delay time has elapsed.

6.13.4 Switching behavior 5: overtemperature limit with hysteresis (≥ SPH)

Figure 18 Switching behavior 5: Switching output drops out when SPH[2] is exceeded and picks up when SPL[1] is exceeded (hysteresis)



Normal operating state < SPH

Step	Measure	
1	Measured value	< SPH, and module is 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.

Acknowledgment is only possible if there is no critical state anymore and the delay time has elapsed.

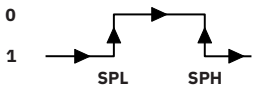
Critical operating state ≥ SPH (red line)

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

Acknowledgment is only possible if there is no critical state anymore and the delay time has elapsed.

6.13.5 Switching behavior 6: temperature range limit (≤ SPL and ≥ SPH)

Figure 19 Switching behavior 6: Switching output picks up between SPL[1] and SPH[2]



Normal operating state > SPL and < SPH

Step	Measure	
1	Measured value	> SPL and < SPH, module is 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.

Acknowledgment is only possible if there is no critical state anymore and the delay time has elapsed.

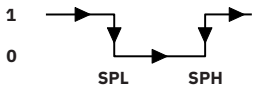
Critical operating state ≤ SPL and ≥ SPH

Step	Measure	
1	Measured value	a) ≤ SPL, and module is activated b) ≥ SPH, and module is 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.

Acknowledgment is only possible if there is no critical state anymore and the delay time has elapsed.

6.13.6 Switching behavior 7: temperature range limit (≥ SPL and ≤ SPH)

Figure 20 Switching behavior 7: Switching output drops out between SPL[1] and SPH[2]



Normal operating state < SPL and > SPH

Step	Measure	
1	Measured value	a) < SPL, and module is activated b) > SPH, and module is 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.

Acknowledgment is only possible if there is no critical state anymore and the delay time has elapsed.

Critical operating state ≥ SPL and ≤ SPH

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

Acknowledgment is only possible if there is no critical state anymore and the delay time has elapsed.

6.14 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.

With 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 because 0 V can be a valid signal. Short circuits can be detected in the event of underrange, provided that a life-zero signal is configured.

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

When using the mV input, a line break is not detected. When connecting a resistance (10 kΩ/0.6 W or similar) between input terminals 5.1 and 5.2, line break can be detected in the event of measuring value underrange.

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

Output monitoring function

The current output can be monitored for line breaks and maximum load. This is activated via the configuration. In safety-relevant applications (SIL = ON), output monitoring is always active.

The voltage output is not monitored.

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

6.15 Operating modes

If the configuration is modified using PC-based software (e.g., clipx ENGINEER DEVICE PARAMETERIZATION) or via the DIP switch, the changes made must always be checked again and released before transfer to the temperature measuring transducer. After the transfer, the new data in the temperature measuring transducer is applied by means of activation and a warm start.

6.15.1 SIL ON / SIL OFF

The temperature measuring transducer can either be operated in normal SIL ON or SIL OFF operating mode. The standard configuration is SIL ON operating mode with the DIP switches set to the OFF position.

6.15.2 Service mode

Service mode can be set at any time via the configuration software, e.g., clipx ENGINEER DEVICE PARAMETERIZATION or via the S1 DIP switches.

If settings are changed during service mode and service mode is then exited, the temperature measuring 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-relevant applications, the safety function of the device is deactivated and the initial value for the analog output signal is 2 mA, which enables downstream devices to detect the deviation from normal mode as a result of the measured value being below the measurement range.

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

7 Sensor types

Description	Sensor type and standard		Measuring range	Smallest measuring range span
Resistance temperature detectors RTD (others can be selected in the software or freely configured)	PT10	Pt 10 in accordance with IEC/EN 60751	-200 °C ... +850 °C	20 K
	PT50	Pt 50 in accordance with IEC/EN 60751	-200 °C ... +850 °C	20 K
	PT100	Pt 100 in accordance with IEC/EN 60751	-200 °C ... +850 °C	20 K
	PT200	Pt 200 in accordance with IEC/EN 60751	-200 °C ... +850 °C	20 K
	PT500	Pt 500 in accordance with IEC/EN 60751	-200 °C ... +850 °C	20 K
	PT1000	Pt 1000 in accordance with IEC/EN 60751	-200 °C ... +850 °C	20 K
	PT2000	Pt 2000 in accordance with IEC/EN 60751	-200 °C ... +850 °C	20 K
	PT5000	Pt 5000 in accordance with IEC/EN 60751	-200 °C ... +850 °C	20 K
	PT10000	Pt 10000 in accordance with IEC/EN 60751	-200 °C ... +850 °C	20 K
	PT50S	Pt 50 in accordance with SAMA RC21-4-1966	-200 °C ... +850 °C	20 K
	PT100S	Pt 100 in accordance with SAMA RC21-4-1966	-200 °C ... +850 °C	20 K
	PT200S	Pt 200 in accordance with SAMA RC21-4-1966	-200 °C ... +850 °C	20 K
	PT500S	Pt 500 in accordance with SAMA RC21-4-1966	-200 °C ... +850 °C	20 K
	PT1000S	Pt 1000 in accordance with SAMA RC21-4-1966	-200 °C ... +850 °C	20 K
	PT2000S	Pt 2000 in accordance with SAMA RC21-4-1966	-200 °C ... +850 °C	20 K
	PT5000S	Pt 5000 in accordance with SAMA RC21-4-1966	-200 °C ... +850 °C	20 K
	PT100G	Pt 100 in accordance with GOST 6651-2009 (α = 0.00391)	-200 °C ... +850 °C	20 K
	PT200G	Pt 200 in accordance with GOST 6651-2009 (α = 0.00391)	-200 °C ... +850 °C	20 K
	PT500G	Pt 500 in accordance with GOST 6651-2009 (α = 0.00391)	-200 °C ... +850 °C	20 K
	PT1000G	Pt 1000 in accordance with GOST 665-2009 (α = 0.00391)	-200 °C ... +850 °C	20 K
	PT100J	Pt 100 in accordance with JIS C1604/1997	-200 °C ... +850 °C	20 K
	PT200J	Pt 200 in accordance with JIS C1604/1997	-200 °C ... +850 °C	20 K
	PT500J	Pt 500 in accordance with JIS C1604/1997	-200 °C ... +850 °C	20 K
	PT1000J	Pt 1000 in accordance with JIS C1604/1997	-200 °C ... +850 °C	20 K
	NI10	Ni 10 in accordance with DIN 43760/DIN IEC 60751	-60 °C ... +250 °C	20 K
	NI100	Ni 100 in accordance with DIN 43760/DIN IEC 60751	-60 °C ... +250 °C	20 K
	NI200	Ni 200 in accordance with DIN 43760/DIN IEC 60751	-60 °C ... +250 °C	20 K
	NI500	Ni 500 in accordance with DIN 43760/DIN IEC 60751	-60 °C ... +250 °C	20 K
	NI1000	Ni 1000 in accordance with DIN 43760/DIN IEC 60751	-60 °C ... +250 °C	20 K
	NI10000	Ni 10000 in accordance with DIN 43760/DIN IEC 60751	-60 °C ... +250 °C	20 K
	NI100S	Ni 100 in accordance with SAMA RC21-4-1966	-60°C ... +180°C	20 K
	NI200S	Ni 200 in accordance with SAMA RC21-4-1966	-60°C ... +180°C	20 K
	NI500S	Ni 500 in accordance with SAMA RC21-4-1966	-60°C ... +180°C	20 K
	NI1000S	Ni 1000 in accordance with SAMA RC21-4-1966	-60°C ... +180°C	20 K
	NI1000L	Ni 1000 (Landis & Gyr)	-50°C ... +160°C	20 K
	CU10	Cu 10 in accordance with SAMA RC21-4-1966	-70°C ... +500°C	100 K
	CU50	Cu 50 in accordance with GOST 6651 (α = 0.00428)	-50 °C ... +200 °C	100 K
	CU100	Cu 100 in accordance with GOST 6651 (α = 0.00428)	-50 °C ... +200 °C	100 K
	CU53	Cu 53 in accordance with GOST 6651 (α = 0.00426)	-50 °C ... +180 °C	100 K
	KTY81	KTY81-110 (Philips)	-55 °C ... +150 °C	20 K
	KTY84	KTY84-130 (Philips)	-40 °C ... +300 °C	20 K

Description	Sensor type and standard		Measuring range	Smallest measuring range span
Thermocouples TC (others can be selected in the software)	A1G	A-1 GOST 8.585-2001	0 °C ... +2500 °C	50 K
	A2G	A-2 GOST 8.585-2001	0 °C ... +1800 °C	50 K
	A3G	A-3 GOST 8.585-2001	0 °C ... +1800 °C	50 K
	B	B in accordance with IEC/EN 60584 (Pt30Rh-Pt6Rh)	+500 °C ... +1820 °C	50 K
	C	C in accordance with ASTM E988	0°C ... +2315°C	50 K
	D	DA in accordance with ASTM E988 (2002)	0°C ... +2315°C	50 K
	E	E in accordance with IEC/EN 60584 (NiCr-CuNi)	-230 °C ... +1000 °C	50 K
	J	J in accordance with IEC/EN 60584 (Fe-CuNi)	-210 °C ... +1200 °C	50 K
	K	K in accordance with IEC/EN 60584 (NiCr-Ni)	-250 °C ... +1372 °C	50 K
	MG	MG M GOST 8.585-2001	-200 °C ... +100 °C	50 K
	N	N in accordance with IEC/EN 60584 (NiCrSi-NiSi)	-200 °C ... +1300 °C	50 K
	R	R in accordance with IEC/EN 60584 (Pt13Rh-Pt)	-50 °C ... +1768 °C	50 K
	S	S in accordance with IEC/EN 60584 (Pt10Rh-Pt)	-50 °C ... +1768 °C	50 K
	T	T in accordance with IEC/EN 60584 (Cu-CuNi)	-200 °C ... +400 °C	50 K
	L	L in accordance with DIN 43760 (Fe-CuNi)	-200 °C ... +900 °C	50 K
	LG	LG L GOST 8.585-2001	-200 °C ... +800 °C	50 K
	U	U in accordance with DIN 43760 (Cu-CuNi)	-200 °C ... +600 °C	50 K
Resistance-type sensors R (2-, 3-, 4-conductor, other ranges can be selected in the software)			Resistance 0 Ω ... 50000 Ω	10 % of the selected measuring range
Potentiometers (3-conductor, other ranges can be selected in the software)			Potentiometer 0 Ω ... 50000 Ω	10 % of the selected measuring range
Voltage signals mV (other signals can be selected in the software)			Voltage (mV)	10 % of the nominal span

Other setting options can be configured with the clipx ENGINEER DEVICE PARAMETERIZATION software (item no. 1371665) or a device-specific DTM, e.g., a freely configurable user characteristic curve with 30 interpolation points.

7.1 Thermocouple (TC) with internal cold junction compensation

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

Use the MACX MCR-CJC cold junction compensation connector provided (item no. 2924993).

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

7.2 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., Pt 100) at connection terminal blocks 4.2 and 4.3.

7.3 Voltage input

– Connection for U ≤ ± 1,000 mV: Terminals 5.1 "+", 5.2 "-"

7.4 Potentiometer

– Connection: terminals 4.1, 4.2, 4.3

7.5 Resistance temperature detector (RTD)

RL ≤ 25 Ω for each lead

– 2-conductor connection technology: terminal blocks 4.2, 4.3
  The line resistance can be compensated using the PC program clipx ENGINEER DEVICE PARAMETERIZATION (item no. 1371655) or in service mode (DIP switch).
– 3-conductor connection technology: terminal blocks 4.1, 4.2, 4.3
  In the case of 3-conductor connection technology, ensure that all 3 cables have the same resistance.
– 4-conductor connection technology:
  Terminals 4.2, 4.3, 5.1, 5.2
– 2 x 2-conductor connection technology
  RTD 1 terminal blocks: 4.2, 4.3
  RTD 2 terminal blocks: 5.1, 5.2

7.6 Resistance measurement

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

Terminal points 4.2 and 4.3 are used for measuring differing resistances.

7.7 Notes on using thermocouples

Thermocouples consist of two conductors made from different metals with different thermoelectric properties which are connected together on one side and are exposed to a temperature gradient and, therefore, convert heat flow to electrical voltage. Electrical voltage is measured at both thermocouple connections.

7.7.1 Cold junction compensation

In a thermocouple, however, voltage will not only be generated at the contact point of the connected conductors, but also at both connection points of the measuring transducer, as each of these points together with the connected thermocouple cable will form another thermocouple.

In order to be able to calculate the absolute measurement point temperature value from this voltage difference, and thus also the temperature difference, the temperature of the connection points must be the same and known.

To this end, the connection points are artificially maintained at a known temperature: for laboratory measurements, for example, at 0°C using ice water, in industrial applications with thermostatically controlled heating and cooling.

When considering the connection point temperature, this is referred to as cold junction compensation.

Cold junction compensation can also be implemented with a separate temperature measurement at the connection points.

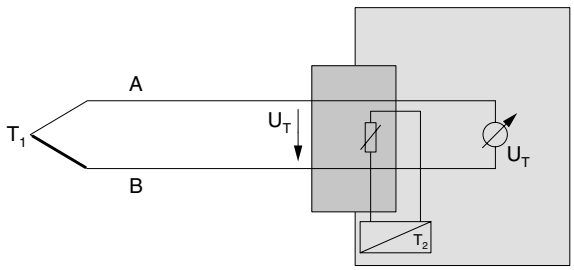
Interface modules are available for the connection of thermocouples, in which cold junction compensation is already integrated. Interface modules of this type are also signal transformers with cable connections to the evaluation unit.

Thermocouples are often referred to with the abbreviation TC.

Thermocouples are suitable for high temperatures or large temperature ranges.

Resistance thermometers are more suitable for temperatures up to a maximum of 800°C.

Figure 21 Thermocouple and interface module at the sensor including cold junction compensation



T_1 Temperature at the measurement point

T_2 Temperature at the connection point

U_T Voltage generated between the measurement point and the connection point. Indicates the absolute temperature T_1 at the measurement point by considering the connection point temperature T_2.

8 Minimum spans and measuring accuracy

8.1 Input for Pt RTDs and Ni RTDs

Minimum measuring span:

At 10 Ω ≤ R_0 ≤ 100 Ω: 100 K
At 100 Ω ≤ R_0 ≤ 10 kΩ: 20 K

R_0 is the resistance value of the sensor at 0°C.

Measuring accuracy:

For 10 Ω ≤ R_0 ≤ 100 Ω: 0.2 K x 100 Ω/R_0
= 0.1% x (100 Ω/R_0) x (200 K/measuring span)

For 100 Ω ≤ R_0 ≤ 1 kΩ: 0.2 K
= 0.1% x (200 K/measuring span)

For 1 kΩ ≤ R_0 ≤ 10 kΩ: 0.4 K
= 0.1% x (400 K/measuring span)

8.2 Input for Cu RTDs

Minimum measuring span:

At 10 Ω ≤ R_0 ≤ 100 Ω: 100 K
At 100 Ω ≤ R_0 ≤ 10 kΩ: 20 K

Measuring accuracy:

For 10 Ω ≤ R_0 ≤ 100 Ω: 0.5 K x 100 Ω/R_0
= 0.1% x (100 Ω/R_0) x (500 K/measuring span)

For 100 Ω ≤ R_0 ≤ 1 kΩ: 0.5 K
= 0.1% x (500 K/measuring span)

For 1 kΩ ≤ R_0 ≤ 10 kΩ: 1.0 K
= 0.1% x (1000 K/measuring span)

8.3 Input for Ni 1000 (Landis & Gyr), KTY 81-110, KTY 84-130 (Philips)

Minimum measuring span: 20 K

Measuring accuracy: 0.2 K

8.4 Input for thermocouples

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 type B, R, S, C, D, A1, A2, A3

Without cold junction error: 0.50 K

8.5 Cold junction error

Cold junction error: Max. ± 1 K

(for internal cold junction compensation)

For external cold junction compensation it depends on the quality of the cold junction and the sensor used.

8.6 Input for voltage signals

Minimum measuring span: 10% of the nominal span of the relevant range

Measuring accuracy:

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

8.7 Resistance-type sensors and resistors

50% of the measuring range ≤
(nominal value of resistance-type sensor + lead resistance) ≤ measuring range

Minimum measuring span: 10% of the nominal span of the relevant range

Measuring accuracy:

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

Example:

Resistance-type sensor with nominal value: 1000 Ω

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

Minimum measuring span:

10% of the selected measuring range

= 120 Ω

Measuring accuracy:

0.01 % of the selected measuring range

= 120 mΩ

8.8 Potentiometer

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

Minimum measuring span:

10% of the selected measuring range

Measuring accuracy:

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

Example:

Potentiometer with nominal value: 1000 Ω

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

Minimum measuring span:

10% of the selected measuring range

= 120 Ω

Measuring accuracy:

0.02% of the selected measuring range

= 240 mΩ

8.9 Output signals

Error analog output

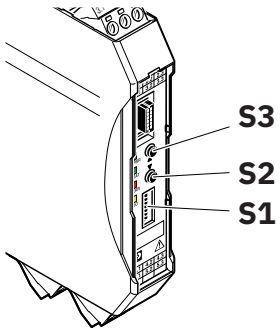
2 mV	0.01% at -10 V ... 10 V
2 mV	0.02% at 0 V ... 10 V
4 µA	0.02% at 0 mA ... 20 mA

9 Configuration

The device is supplied with the following standard configuration:

Functional safety:	SIL on
Restart after fail-safe:	Active
Sensor:	Pt 100 (IEC 751)
Unit of measurement:	Celsius
Connection technology:	4-conductor
Measuring range:	-50 °C ... 150 °C
Output signal:	4 mA ... 20 mA
Alarm signal:	Error evaluation according to NE43 (downscale)
Monitoring:	Line break in the field circuit and load
Password:	1111 (default setting)
Relay switching behavior:	OFF
Relay switching behavior in case of wire break:	OFF
Relay switching behavior in case of short circuit:	OFF
Relay switching delays:	Every 0 s

Figure 22 Position of the DIP switch and buttons



When one of the S1-2 ... S1-8 DIP switches is switched on (ON), the device is switched to service mode.

9.1 Delivery 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 buttons S2 and S3 simultaneously 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 S2 and S3 (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 buttons S2 and S3 simultaneously 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 it with button S2 (descending value) and S3 (ascending value).
- The specification/simulation is reset and ended by setting DIP switch S1-4 back to OFF.

Switch position, DIP S1							
OFF	OFF	OFF	**ON**	OFF	OFF	OFF	OFF

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

- Set the RTD 1 cable compensation by setting DIP switches S1-1 to OFF and S1-5 to ON.
- Short circuit the sensor.
- Apply the current measured value as the line 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 RTD 2 cable compensation with 2 x RTD or TC with external cold junction compensation (TC + CJ external)

- Set the RTD 2 cable compensation by setting DIP switches S1-1 to ON and S1-5 to OFF.
- Short circuit the sensor.
- Apply the current measured value as the line 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 function by setting DIP switch S1-6 to ON.
- Set the potentiometer to the start of range.
- Press the S2 button.
- Set the potentiometer to the 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 acknowledgment of switching outputs (latch function)

Switching output 1

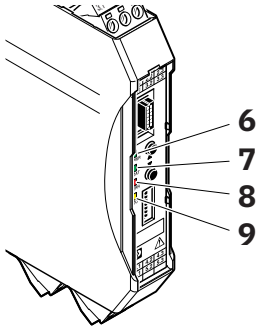
- Set manual acknowledgment of switching output 1 by setting DIP switch S1-7 to ON.
- Press buttons S2 and S3 simultaneously for > 3 seconds.

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

9.9 LED status indicators

Figure 23 LED status indicators



No.	LED	Color/status	Description
6	PWR	Green	Supply voltage
		On	Indicates the ready-to-operate state of the temperature measuring transducer if supply voltage is available.
			The temperature measuring transducer is configured without device supply via the IFS-USB-PROG-ADAPTER programming adapter (item no. 2811271), or with device power supply via the IFS-BT-PROG-ADAPTER Bluetooth adapter (item no. 2905872).
7	DAT	Green	No function
8	ERR	Red	Error
		On	Module error
		Flashing (1.4 Hz)	Simulation mode
		Flashing (2.8 Hz)	Line error
9	DO	Yellow	Switching output 1
		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-relevant applications, you should change the password set in the factory.

If the password is lost, a reset is not possible.

In this case, please contact Phoenix Contact.

NOTE:

To save the password, write the changed password to the temperature measuring transducer.

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 via a service PC with connected IFS-USB-PROG-ADAPTER programming adapter (item no. 2811271) or via
IFS-BT-PROG-ADAPTER Bluetooth adapter
(item no. 2905872) and the
clipx ENGINEER DEVICE PARAMETERIZATION configuration software (item no. 1371665).

WARNING:

If Functional Safety is activated by a reconfiguration or if configuration changes are made with Functional Safety activated, you must observe the rules in the section “Safety-relevant applications, installation and startup”.

WARNING: Limitations for safety-relevant applications

Only 4 mA ... 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.

11 Configuration with the service PC

Use the clipx ENGINEER DEVICE PARAMETERIZATION configuration software to change the configuration data (free download, item no. 1371655).

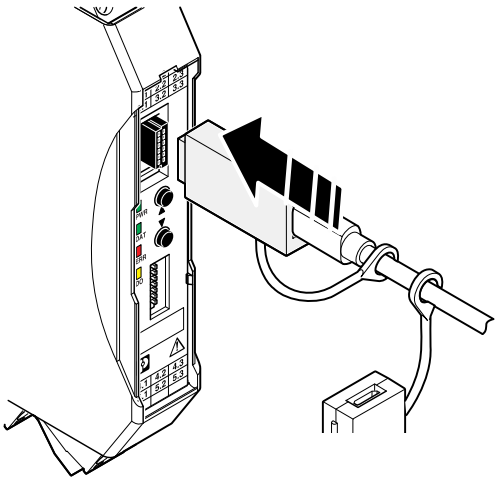
The device is supplied with the following standard configuration:

Functional safety:	SIL on
Restart after fail-safe:	Active
Sensor:	Pt 100 (IEC 751)
Unit of measurement:	Celsius
Connection technology:	4-conductor
Measuring range:	-50 °C ... 150 °C
Output signal:	4 mA ... 20 mA
Alarm signal:	Error evaluation according to NE43 (downscale)
Monitoring:	Line break in the field circuit and load
Password:	1111 (default setting)
Relay switching behavior:	OFF
Relay switching behavior in case of wire break:	OFF
Relay switching behavior in case of short circuit:	OFF
Relay switching delays:	Every 0 s

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 using the IFS-USB-PROG-ADAPTER programming adapter (Item No.: 2811271).

Figure 24 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

For a complete list of system requirements, please refer to the CLIPX ENGINEER DEVICE PARAMETERIZATION website at https://www.phoenixcontact.com/product/1371665.

Use the IFS-USB-PROG-ADAPTER (Item No.: 2811271) for connecting the device to the PC. The drivers for the USB programming adapter are installed automatically.

Alternatively, you can use the Bluetooth programming adapter (Item No. 2905872).

11.2 Configuring the user characteristic curve

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

The user characteristic curve is created with the PC-based clipx ENGINEER DEVICE PARAMETERIZATION software and stored in the temperature measuring transducer.

12 Connection examples

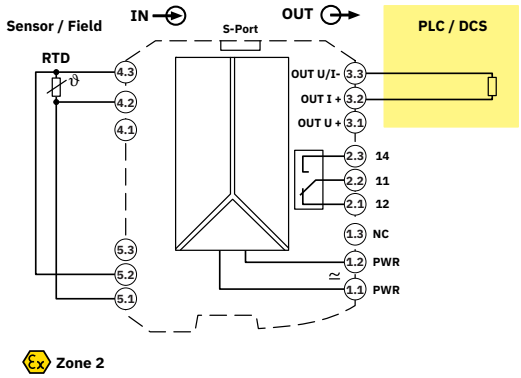
12.1 Current output

Connection example 1

Input: 4-conductor RTD

Output: Current output: 4 mA ... 20 mA on passive safe controller

Figure 25 Connection example



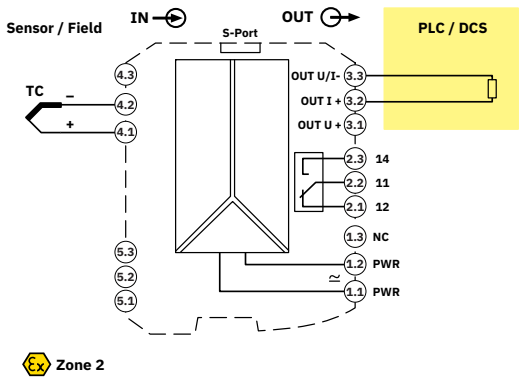
Connection example 2

Input: Thermocouple with internal cold junction compensation

Use the MACX MCR-CJC cold junction compensation connector provided (item no. 2924993).

Output: Current output: 4 mA ... 20 mA on passive safe controller

Figure 26 Connection example

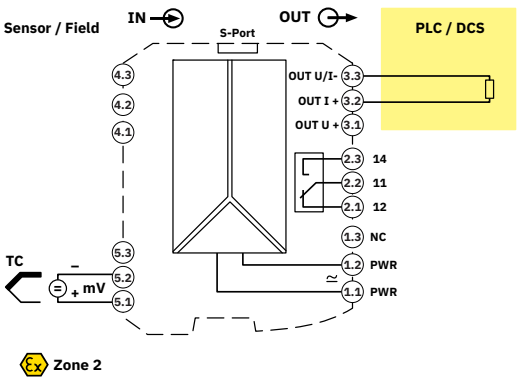


Connection example 3

Input: Thermocouple with external or without cold junction compensation or voltage input

Output: Current output: 4 mA ... 20 mA on passive safe controller

Figure 27 Connection example



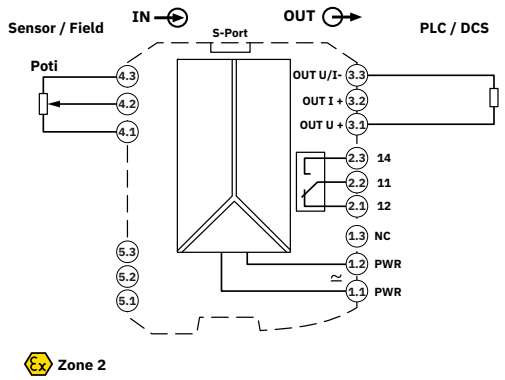
When using the mV input in applications up to SIL 2, only a limited range of functions is possible (see the section “Safety-related applications, functional restrictions”)

12.2 Voltage output

Connection example 4

Input:	Potentiometer
Output:	Voltage output (-10 V ... 10 V) on passive controller

Figure 28 Connection example

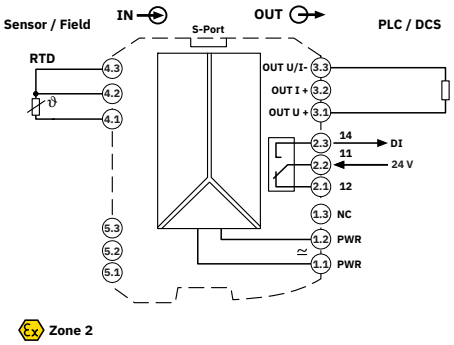


12.3 Switching output

Connection example 5

Input:	3-conductor RTD
Output:	Voltage output (0 V ... 10 V) on passive controller
Switching output:	Dependent on selected switching behavior

Figure 29 Connection example



13 Safety-related applications (SIL 2/SC 2)

Valid hardware and firmware versions

NOTE: Only those devices with SIL identification and module firmware with version 0.92 or higher are certified for SIL 2.

SIL regulations apply to the following modules:

Designation	Item No.
Standard configuration	
MACX MCR-T-UI-UP	2811394
MACX MCR-T-UI-UP-SP	2811860
MACX MCR-EX-T-UI-UP	2865654
MACX MCR-EX-T-UI-UP-SP	2924689
Order configuration	
MACX MCR-T-UI-UP-SP-C	2811970
MACX MCR-EX-T-UI-UP-SP-C	2924692

The safety-related temperature measuring transducers listed above from the MACX MCR(-EX)-T... series have been certified by TÜV Nord.

Certificate number: SEBS-A.150520/17, V 2.0

13.1 Safety function and safety requirements

The safety-related measuring transducers are used for the acquisition of a sensor signal (RTD sensors, TC sensors, resistance-type sensors, mV sources [can be used with restrictions in SIL applications, see “Functional restrictions”]) that is converted into a scaled signal and from which a standardized “live zero” current signal is generated.

The entire conversion is continuously monitored to a maximum transmission error of 5%.

In the event of greater deviations, the device switches to the safe state.

The safe state is an output signal of either <3.6 mA or >21 mA.

NOTE:

The evaluation unit downstream of the measuring transducer (e.g., safety-related PLC) must know these states and control the actuator accordingly as the final link in the safety chain.

The hardware is continuously monitored. If an internal fault is detected, the measuring transducer also switches to the safe state (current output < 3.6 mA or > 21 mA).

The transition to the safe state always takes place within the internal fault detection time of 50 s.

The measuring transducer is released (restarted) by switching off the supply voltage and switching it back on again, by resetting the transducer via the serial interface, or by activating the “Restart” option during configuration. The integrated startup tests are then performed. These tests will detect if the fault is still present. If it is still present, the measuring transducer switches back to the safe state.

In addition to the safety functions, there are also monitoring functions for the input and the current output.

Evaluation

Faults that are detected in the measuring transducer and to which the transducer responds by switching to the safe state are safe faults (λs).

Faults where the measuring transducer does not follow a change of input signal or generates an output signal that deviates from the intended value by more than ±5% are evaluated as dangerous faults (λd).

Both safe (λs) and dangerous (λd) faults can be detected by diagnostic measures.

Detected dangerous faults (λdd) are handled in the same way as safe faults.

The monitoring functions refer to events whose cause is detected and reported outside of the device.

Summary

Safety/monitoring function	Output signal range	Safe state	Reason
Safety function	4 mA ... 20 mA	<3.6 mA or >21 mA relay is not actuated	Deviation >5%
Input monitoring	4 mA ... 20 mA	2 mA ... 3,6 mA, >21 mA	Line fault, input
Output monitoring	4 mA ... 20 mA	= 0 mA	Line fault, output

Together with the actual signal transmission, continuous checks and diagnostic functions are performed in the measuring transducers in order to detect faulty behavior.

Please note that the scope of monitoring functions is limited when using mV sources (see “Function limitations”).

The internal fault monitoring time (diagnostics test interval) is the time taken to carry out and repeat these tests in full.

Random hardware faults are detected during this time.

The internal fault monitoring time is 50 seconds.

13.2 Safety properties

Safety property	Requirement/remark	
SIL	SIL 2/SC 2	
Subsystem type	Type B	
Safety architecture	$1oo1_D$	
Safety architecture	SIL 2: $1oo1_D$	
Hardware fault tolerance (HFT)	SIL 2: HFT = 0	
Safe fault fraction ($\lambda_{S)}$)	SIL 2: HFT = 0: 90 % ... < 99 %	
Common cause failure (CCF)	Determination in accordance with IEC 61508 Part 7 Appendix D or ISO 13849-1 Table F.1, 65%, minimum	
Average probability of failure on demand of a safety function (overall system) (PFD_{avg}/PFH)	SIL 2: "Low demand": $PFD_{avg} < 10^{-2}$ "High demand": $PFH < 10^{-6}$	
Planned operating time	10 years	
Safe state of the analog output	$I_{out} \leq 3.6$ mA or $I_{out} \geq 21$ mA	
Safe state of the relay	“De-energized”, N/O contact is open or N/C contact is closed	
Architecture in accordance with ISO 13849-1	1-channel: Cat. 2	2-channel: Cat. 3
$MTTF_D$ - DC_{avg} in accordance with ISO 13849-1 Table K.1	PL d: > 62 years ($DC_{avg} \geq 60\%$)	PL e: > 62 years ($DC_{avg} \geq 90\%$)

13.3 Requirements for safety integrity

As a result of the wide range of connection options, only the two configurations for “RTD 3-conductor” and “mV” are considered below.

They represent all configurations with a variable resistance at the input terminals, or they represent voltage or thermocouple inputs, and always indicate the most conservative case.

FIT (Failure in Time)
1 FIT is 1 failure per 10^9 hours

13.3.1 RTD with 3-conductor connection technology

Input	RTD 3-conductor connection technology
Output	Current output: 4 mA ... 20 mA

- PL d
- Type B device (in accordance with IEC 61508-2)
- Safety Integrity Level (SIL) 2 / SC 2
- HFT 0
- Architecture $1oo1_D$
- Category 2
- MTTF = 2038 years
- DC_{avg} = 94%
- CCF = 80
- PFH = $5.6 * 10^{-8}$/h

Failure rates in FIT

λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	DC_D
0	0	$8.05 * 10^{-7}$	$0.43 * 10^{-7}$	94 %	94 %
0 FIT	0 FIT	805 FIT	43 FIT		

The total failure rate is: $1.18 * 10^{-6}$

The MTBF is 97 years.

The probability of a dangerous failure per hour for “continuous demand” operating mode and the average probability of the specified function failing on demand for “low demand” operating mode are determined based on the error rates.

PFD_{avg} values

T [PROOF]	1 year	2 years	5 years
PFD_{avg}	$2.95 * 10^{-4}$	$4.76 * 10^{-4}$	$1{,}02 * 10^{-3}$

PFH* = $4.3 * 10^{-8}$/h

The calculation is performed assuming a checking interval (T_{PROOF}) of one year, a repair time (MTTR) of 24 h, and a test coverage (PTC) of 95%.

On the basis of the value determined for the average probability of failure PFD_{avg}, the checking interval can be increased to up to 5 years.

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 24 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.

13.3.2 mV input

Please note that the scope of monitoring functions is limited when using mV sources (see “Function limitations”).

Input	Voltage input mV
Output	Current output: 4 mA ... 20 mA

- PL d
- Type B device (in accordance with IEC 61508-2)
- Safety Integrity Level (SIL) 2 / SC 2
- HFT 0
- Architecture $1oo1_D$
- Category 2
- MTTF = 2038 years
- DC_{avg} = 94%
- CCF = 80
- PFH = $5.6 * 10^{-8}$/h

Failure rates in FIT

λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}	SFF	DC_D
0	0	$7.89 * 10^{-7}$	$0.56 * 10^{-7}$	93 %	93 %
0 FIT	0 FIT	789 FIT	56 FIT		

The total failure rate is: $1.19 * 10^{-6}$

The MTBF is 96 years.

The probability of a dangerous failure per hour for “continuous demand” operating mode and the average probability of the specified function failing on demand for “low demand” operating mode are determined based on the error rates.

PFD_{avg} values

T [PROOF]	1 year	2 years	5 years
PFD_{avg}	$3,75 * 10^{-4}$	$6.08 * 10^{-4}$	$1.31 * 10^{-3}$

PFH* = $5.6 * 10^{-8}$/h

The calculation is performed assuming a checking interval (T_{PROOF}) of one year, a repair time (MTTR) of 24 h, and a test coverage (PTC) of 95%.

On the basis of the value determined for the average probability of failure PFD_{avg}, the checking interval can be increased to 5 years if the percentage of the device for the entire safety circuit is assumed to be 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 24 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.

13.4 Mission time

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

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

Measures by the manufacturer

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

Examples of measures that can be taken by the operator:

– Application-specific maintenance measures
– Verification by error detection

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

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

13.5 MACX MCR(-EX)-T-UI-UP(-SP) in accordance with DIN EN ISO 13849-1

Through a 1oo2 connection of the devices that are already tested in accordance with SIL 2 or PL d, the PL can be increased from “d” to “e”.

If the SIL-capable sensor used consists of hardware and software, then regardless of the architecture, the maximum SIL that can be achieved is the one according to which the software was developed. If the sensor software has SIL 2, for example, this means that the maximum that can be achieved is SIL 2.

The following table can be used to determine the PL, provided the $MTTF_D$ value of the sensor is 100 years. The DC achieved by these means for detecting the faults in a sensor is assumed to be ≥ 90%.

PL of the sensor used $MTTF_D$ = 100 years	d
The maximum achievable PL of the system in the case of 1oo1 architecture for the sensors DC_{avg} ≥ 90%	d
The maximum achievable PL of the system in the case of 1oo2 architecture for the sensors DC_{avg} ≥ 90%	e

13.5.1 Monitoring function

If a fault is detected, the output signal is set to the configured fault value. With 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.

The current output is monitored for line break and maximum load.

13.6 Configuring a SIL device

The measuring transducer can be ordered with a standard configuration (see 1.) or with a configuration for safety-related applications (see 2.), or can be configured for safety-related applications by the users themselves (see 3.).

1. The measuring transducers are delivered with a standard configuration for safety-relevant applications with a 4 mA ... 20 mA output.
2. Customer-specific preconfigured devices (-C) can be delivered for both safety-related applications and “normal” usage.
3. The measuring transducers can also be configured by users for both safety-related applications and “normal” usage.

The configuration can be read and changed at any time for all devices.

For safety-relevant applications, you should change the password set in the factory.

If the password is lost, a reset is not possible.

In this case, please contact Phoenix Contact.

13.7 Configuring safety-relevant applications

- Connect the device to a PC using the IFS-USB-PROG-ADAPTER programming adapter (item no. 2811271).
- Call up the clipx ENGINEER DEVICE PARAMETERIZATION configuration software (free download, item no. 1371665).
- Read out the current configuration.
- Enter the password in the clipx ENGINEER DEVICE PARAMETERIZATION software in the “PIN” hardware configuration (set to 1111 in the factory).
- Activate SIL.

For “SIL ON”, it is possible to deactivate the “Restart after failsafe” function here.

In the event of a failure, this means that the measuring transducer enters the failsafe state in accordance with the safety functions, but is not restarted.

- Write the modified configuration data to the measuring transducer.
- Check that the new configuration data in the control window is correct and confirm with “OK”, or “Cancel” if not correct.

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

WARNING:

If Functional Safety is activated by a reconfiguration or if configuration changes are made with Functional Safety activated, you must observe the rules in the section “Installation and startup”.

WARNING: Limitations for safety-relevant applications

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

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.

WARNING:

The device must be write-protected to prevent improper use.

Write protection is established by assigning a password.

13.8 Installation and startup

During installation, observe the instructions in the package slip:

Designation	MNR No.
PACKB.MACX MCR-T-UI-UP...	9055145
PACKB.MACX MCR-EX-T-UI-UP...	9055147

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

A lockable housing with IP54 degree of protection is recommended for the installation of the measuring transducers.

- Check that the configuration of the measuring transducer is correct for the intended application.
- Connect the measuring transducer in accordance with the installation notes.
- Make sure that the connected sensor corresponds to the configuration.
- Check the measuring transducer with the sensor connected for correct function. A calibrated sensor simulator (RTD/TC) and a calibrated digital multimeter are necessary for checking the measuring transducer.
- Start up the loop and check that it operates correctly.

13.9 Notes on operation

Only the green LED (PWR) is on during normal operation.

If a malfunction occurs during operation and the red LED (ERR) flashes, there is a line fault.

The output current of the measuring transducer is between 2 mA … 3.6 mA or is > 21.0 mA (in the case of faults in the sensor circuit) or is 0 mA (in the case of a line break in the output circuit).

The response of the relays depends on the connected sensor and on the error diagnostic options.

Check all signal lines.

The device will automatically switch back to normal operation once the fault has been eliminated.

If a fault occurs during operation and the red LED (ERR) is permanently lit, the device has switched to the “safe state” (output current is less than 2 mA).

Restart the device in order to set it to normal operation again.

If no PC/laptop has been connected, you can also interrupt the power supply.

Or you can use the configuration software (Service > Reset) to perform a warm start.

The measuring transducer should then return to normal operation.

– If it does not, the measuring transducer must be replaced.

13.10 Functional restrictions

Thermocouples

When connecting a thermocouple to the input, you can configure the input signals as a life zero signal. In this way, short circuit is detected as underrange.

mV input

When using the mV input, the input signal must be configured as a life zero signal. As a result, a short circuit is detected as underrange.

Underrange therefore is always an error state.

When using the mV input, a resistance (10 kΩ/0.6 W) must be connected between input terminals 5.1 and 5.2.

As a result, a sensor break is detected as underrange.

Underrange therefore is always an error state.

13.11 Recurring checks

The function of the entire safety loop must be checked regularly in accordance with IEC/EN 61508 and IEC/EN 61511.

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

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

The measuring transducers must be checked at least every 7 years (maximum proof test interval).

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 (RTD/TC) and a calibrated digital multimeter are necessary for checking the measuring transducer.

- Connect the sensor simulator to the input of the measuring transducer using the appropriate connection technology.
- Connect the digital multimeter to the output in current measuring operating mode (20 mA 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.

Simulate the line faults (break and short circuit) at the input terminals; determine the configured residual currents at the output.

If the function test result is negative, the measuring transducer must be taken out of operation and the process put into a safe state by other measures.

13.12 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

13.13 Standards

The measuring transducers are developed and tested in accordance with the following standards:

IEC/EN 61508: 2010	Functional Safety of electrical/electronic/programmable electronic safety-related systems
EN 61326-1:2006	Electrical equipment for measurement, control and laboratory use - EMC requirements
IEC 61326-3-2	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

13.14 Abbreviations

Abbreviation		Meaning
DC_D	Diagnostic coverage of dangerous failures	Diagnostic coverage: DC = $\lambda_{DD}/(\lambda_{DU} + \lambda_{DD})$
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
MTBF	Mean time between failures	Mean time between consecutive failures
PFD_{avg}	Average probability of failure on demand	Average probability of dangerous failure on demand of a safety function
PFH	Probability of a dangerous failure per hour	Probability of failure per hour for the safety function
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 (SIL)	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.

14 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 30 Scan QR code

