Operating instructions
MESSKO® BETECH®. Pointer thermometer

9181336/01 EN

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The product is delivered in accordance with MR's technical specifications, which are based on information provided by the customer. The customer has a duty of care to ensure the compatibility of the specified product with the customer's planned scope of application.
The original operating instructions were written in German.

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1 Introduction

This technical file contains detailed descriptions on the safe and proper installation, connection, commissioning and monitoring of the product.

This technical document is intended solely for specially trained and authorized personnel.

1.1 Manufacturer

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MR Reinhausen customer portal: https://portal.reinhausen.com.

Further information on the product and copies of this technical file are available from this address if required.

1.2 Completeness

This technical file is incomplete without the supporting documents:
- Order confirmation

1.3 Safekeeping

Keep this technical file and all supporting documents ready at hand and accessible for future use at all times.

1.4 Notation conventions

This section contains an overview of the symbols and textual emphasis used.

1.4.1 Hazard communication system

Warnings in this technical file are displayed as follows.

1.4.1.1 Warning relating to section

Warnings relating to sections refer to entire chapters or sections, sub-sections or several paragraphs within this technical document. Warnings relating to sections have the following format:

⚠ WARNING

Type of danger!
Source of the danger and its consequences.

- Action
- Action

1.4.1.2 Embedded warning information

Embedded warnings refer to a particular part within a section. These warnings apply to smaller units of information than the warnings relating to sections. Embedded warnings use the following format:

⚠ DANGER! Instruction for avoiding a dangerous situation.

1.4.1.3 Signal words

Depending on the product, the following signal words are used:

Signal word	Meaning
DANGER	Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE	Indicates measures to be taken to prevent damage to property.

Table 1: Signal words in warning notices

1.4.2 Information system

Information is designed to simplify and improve understanding of particular procedures. In this technical file it is laid out as follows:

Important information.

1.4.3 Instruction system

This technical file contains single-step and multi-step instructions.

Single-step instructions

Instructions which consist of only a single process step are structured as follows:

Aim of action
✓ Requirements (optional).
1. Step 1 of 1.
   » Result of step (optional).
» Result of action (optional).

Multi-step instructions

Instructions which consist of several process steps are structured as follows:

Aim of action
✓ Requirements (optional).
1. Step 1.
   » Result of step (optional).
2. Step 2.
   » Result of step (optional).
» Result of action (optional).

1.4.4 Typographic conventions

Typographic convention	Purpose	Example
UPPERCASE	Operating controls, switches	ON/OFF
[Brackets]	PC keyboard	[Ctrl] + [Alt]
Bold	Software operating controls	Press **Continue** button
...>...>...	Menu paths	Parameter > Control parameter
Italics	System messages, error messages, signals	*Function monitoring* alarm triggered
[► Number of pages]	Cross reference	[► Page 41].
Dotted underscore	Glossary entry, abbreviations, definitions, etc.	Glossary entry

Table 2: Typographic conventions used in this technical file

1.5 Open source software

This product contains open source software, which has been developed by third parties. The respective license conditions are listed in the following.

The open source software is protected by copyright. You are free to use the open source software provided that you comply with the respective license conditions. In the event of a conflict, these license conditions will take precedence over other license conditions.

The open source software is provided free of charge. Insofar as this is provided for by the license conditions of the open source software, you can obtain the source text of the open source software at least for three years from receipt of the product against payment of the corresponding costs from your respective contact person at Maschinenfabrik Reinhausen GmbH.

You will find the license conditions in the section "Appendix" [▶Section 12, Page 101].

2 Security

Read this technical file through carefully to familiarize yourself with the product. This technical file is a part of the product.
- Read and observe the safety instructions provided in this chapter in particular.
- Observe the warnings in this technical file to avoid function-related dangers.

The product is manufactured based on state-of-the-art technology. Nevertheless, danger to life and limb for the user or impairment of the product and other material assets may arise in the event of improper use.

2.1 Appropriate use

The pointer thermometer measures the temperature in power transformers, distribution transformers, reactors, shunt reactors and similar devices.

The product is designed solely for use in stationary large-scale systems.

If used as intended and in compliance with the requirements and conditions specified in this technical file as well as the warning notices in this technical file and attached to the product, then the product does not present any danger to people, property or the environment. This applies throughout the service life of the product, from delivery, installation and operation to removal and disposal.

The following is considered intended use:
- Use the product only with the transformer specified in the order.
- Operate the product in accordance with this technical documentation, the agreed-upon delivery conditions and the technical data.
- Ensure that all necessary work is performed by qualified personnel only.
- Use the equipment and special tools supplied solely for the intended purpose and in accordance with the specifications of this technical file.
- Operate the product in electrical energy systems and facilities.

- Only operate the product in industrial areas.
- Observe the notices in this technical document regarding electromagnetic compatibility and the technical data.

2.2 Fundamental Safety Instructions

To prevent accidents, disruptions and damage as well as unacceptable adverse effects on the environment, those responsible for transport, installation, operation, maintenance and disposal of the product or parts of the product must ensure the following:

Personal protective equipment

Loosely worn or unsuitable clothing increases the danger of becoming trapped or caught up in rotating parts and the danger of getting caught on protruding parts. This results in danger to life and limb.

- All necessary devices and personal protective equipment required for the specific task, such as a hard hat, safety footwear, etc. must be worn. Observe the "Personal protective equipment" [▶Section 2.4, Page 16] section.
- Never wear damaged personal protective equipment.
- Never wear rings, necklaces or other jewelry.
- If you have long hair, wear a hairnet.

Work area

Untidy and poorly lit work areas can lead to accidents and malfunctions.

- Keep the work area clean and tidy.
- Make sure that the work area is well lit.
- The device, tools and installation materials must be clean and dry.
- Observe the applicable laws for accident prevention in the relevant country.

Contamination level

Moisture, dust, sweat and other conductive dirt may cause malfunctions in the device. To ensure contamination level II, observe the following information:

- Wear assembly gloves.
- Ensure that no dirt or moisture enters the device when it is open.
- Close up the device after installation.

Explosion protection

Highly flammable or explosive gases, vapors and dusts can cause serious explosions and fire.

- Do not install or operate the product in areas where a risk of explosion is present.

Safety markings

Warning signs and safety information plates are safety markings on the product. They are an important aspect of the safety concept. Safety markings are depicted and described in the chapter "Product description".

- Observe all safety markings on the product.
- Make sure all safety markings on the product remain intact and legible.
- Replace safety markings that are damaged or missing.

Ambient conditions

To ensure reliable and safe operation, the product must only be operated under the ambient conditions specified in the technical data.

- Observe the specified operating conditions and requirements for the installation location.

Modifications and conversions

Unauthorized or inappropriate changes to the product may lead to personal injury, material damage and operational faults.

- Only modify the product after consultation with Maschinenfabrik Reinhausen GmbH.

Spare parts

Spare parts not approved by Maschinenfabrik Reinhausen GmbH may lead to physical injury, damage to the product and malfunctions.

- Only use spare parts that have been approved by Maschinenfabrik Reinhausen GmbH.
- Contact Maschinenfabrik Reinhausen GmbH.

Working during operation

You must only operate the product when it is in a sound operational condition. Otherwise it poses a danger to life and limb.

- Regularly check the operational reliability of safety equipment.
- Perform the inspection tasks described in this technical document regularly.

2.3 Personnel qualification

The person responsible for assembly, commissioning, operation and inspection must have the following qualifications.

Electrically skilled person

The electrically skilled person has a technical qualification and therefore has the required knowledge and experience, and is also conversant with the applicable standards and regulations. The electrically skilled person is also proficient in the following:

- Can identify potential dangers independently and is able to avoid them.
- Is able to perform work on electrical systems.
- Is specially trained for the working environment in which (s)he works.
- Must satisfy the requirements of the applicable statutory regulations for accident prevention.

Technical Service

We strongly recommend having repairs and retrofitting carried out by our Technical Service department. This ensures that all work is performed correctly. If a repair is not carried out by our Technical Service department, please ensure that the personnel who carry out the maintenance are trained and authorized by Maschinenfabrik Reinhausen GmbH to carry out the work.

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2.4 Personal protective equipment

Personal protective equipment must be worn during work to minimize risks to health.

- Always wear the personal protective equipment required for the job at hand.
- Never wear damaged personal protective equipment.
- Observe information about personal protective equipment provided in the work area.

Protective clothing	Close-fitting work clothing with a low tearing strength, with tight sleeves and with no protruding parts. It mainly serves to protect the wearer against being caught by moving machine parts.
Safety shoes	To protect against falling heavy objects and slipping on slippery surfaces.
Safety glasses	To protect the eyes from flying parts and splashing liquids.
Visor	To protect the face from flying parts and splashing liquids or other dangerous substances.
Hard hat	To protect against falling and flying parts and materials.
Hearing protection	To protect against hearing damage.
Protective gloves	To protect against mechanical, thermal and electrical hazards.

Table 3: Personal protective equipment

3 IT security

Observe the following recommendations to operate the product securely:
- Ensure that only authorized personnel have access to the device.
- Ensure that the device is only operated by trained personnel who are familiar with IT security.
- Only use the device within an ESP (electronic security perimeter).
  - Do not connect the device to the Internet in an unprotected state.
  - Use mechanisms for vertical and horizontal network segmentation and security gateways (firewalls) at the transition points.
- Check regularly whether software updates are available for the device and perform the updates.

Due to the SCADA protocols used, the device does not have its own IT security mechanisms.
- To ensure adequate IT security, an upstream system must be operated with at least the following security measures:
  - Prevention of unauthorized access through the use of individual access.
  - Regularly checking of user accounts for permissions and access.

4 Product description

4.1 Scope of delivery

The product is packaged with protection against moisture and is delivered as follows:
- Pointer thermometer with temperature sensor
- Mounting brackets
- Technical documents

Optional:
- Cable connections:
  - Standard, WADI or offshore cable gland
  - 1/2" NPT adapters
  - PG16 adapters
- Cable connections for standard and TT versions:
  - Up to 3 x M20x1.5 und 1 x M16 for analog output
- Cable connections for TTM (Modbus) version:
  - 4 x M20, the two central cable glands with extension adapter
- Interfaces for analog signals and communication
  - TT version: 4...20 mA and/or 0...5 V DC analog output; further options on request
  - Pt100 version: Pt100 output
  - TTM version: RS485 for Modbus RTU, with Active 4...20 mA and/or 0...5 VDC analog output as an option

Please note the following:
- Check the shipment against the shipping documents for completeness
- Store the parts in a dry place until installation
- The product must remain in the packaging and may only be removed immediately before installation

4.2 Function description

The pointer thermometer measures the oil temperature or determines the winding temperature in power transformers, distribution transformers or reactors, depending on the version. The sensor of the pointer thermometer is located in the thermometer pocket mounted in the transformer tank. The measured value is displayed directly on the pointer thermometer or, as an option, on an analog or digital display using a signal converter.

Depending on the device version, the electrical temperature signal can be transmitted as follows:

- TT version: 4...20 mA and/or 0...5 V DC analog output (others on request)
- Pt100 version: Pt100 output
- TTM version: RS485 for Modbus RTU

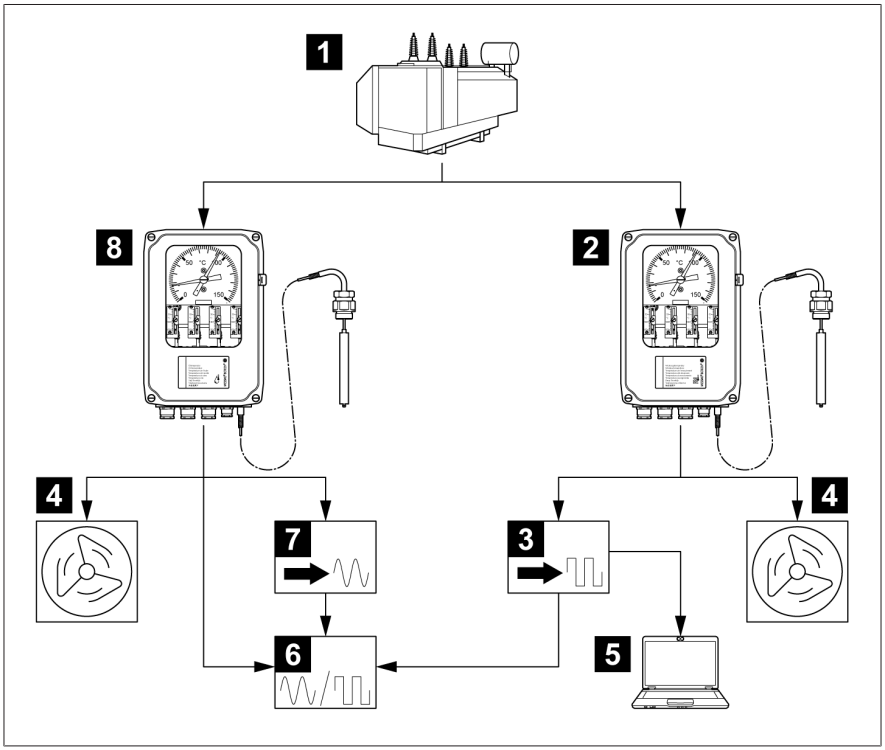


Figure 1: Example of temperature measurement and temperature display

1	Transformer	2	Pointer thermometer for winding temperature
3	Digital signal converter, alternative RS485 interface in the device	4	Transformer fan
5	SCADA	6	Digital display/analog display
7	Analog signal converter	8	Pointer thermometer for oil temperature

4.3 Design

4.3.1 Pointer thermometer

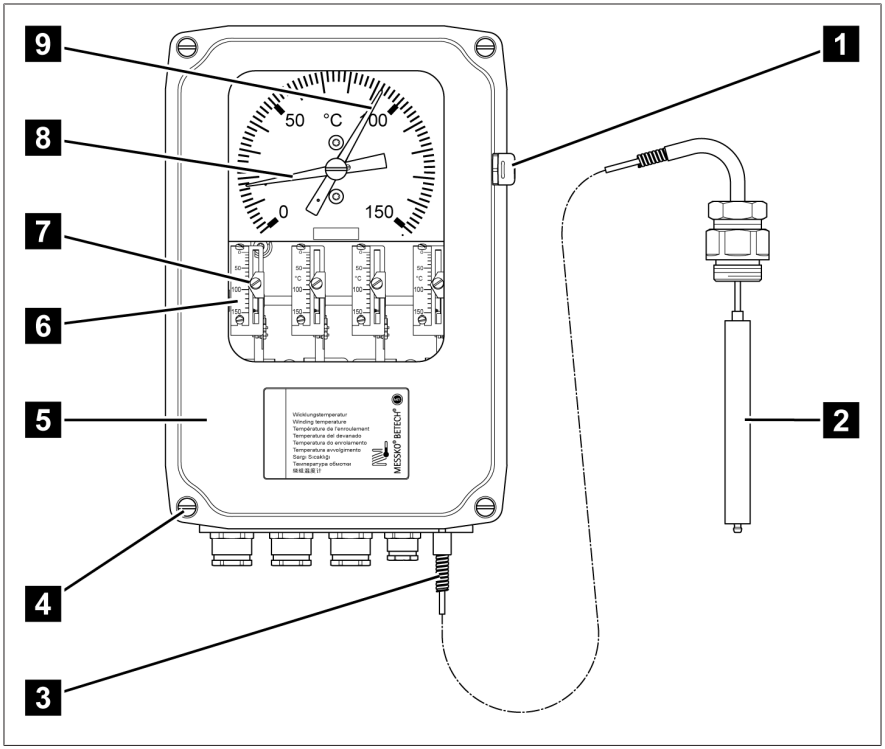


Figure 2: Pointer thermometer

1	Pressure equalization element	2	Temperature sensor
3	Capillary line with stainless steel protective tube	4	4 cover bolts
5	Housing cover	6	Switching point scale
7	Switching point configuration	8	Pointer
9	Drag hands		

NOTICE

Malfunctions

Changing the factory settings will result in the correct functionality being lost and the warranty becoming void.

› Do not adjust the screws on the dial or hands under any circumstances.

Connection with screw terminals (standard, TT)

The standard version and TT version are fitted with screw terminals.

You will find further details in the attached drawings.

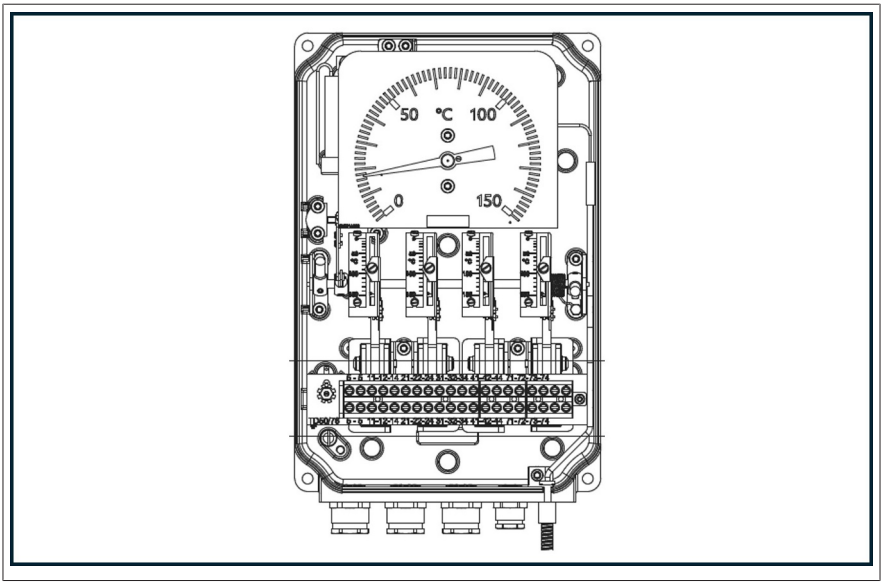


Figure 3: Standard and TT with screw terminals

Version with Push-in terminals (TTM)

The TTM version is fitted with Push-in terminals. At the same time, a larger number of terminals offers more combination options with 6 micro-switches with change-over contact.

You will find further details in the attached drawings.

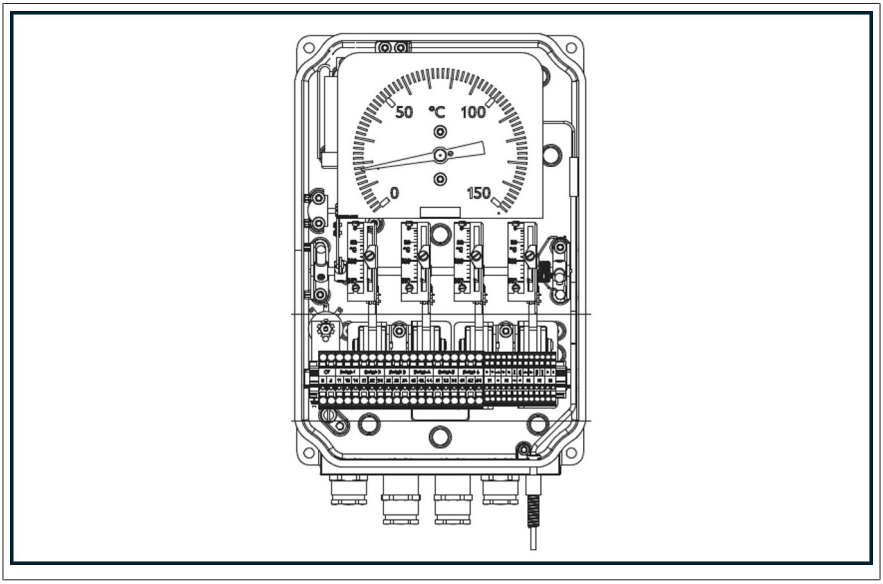


Figure 4: TTM with Push-in terminals

Mounting brackets

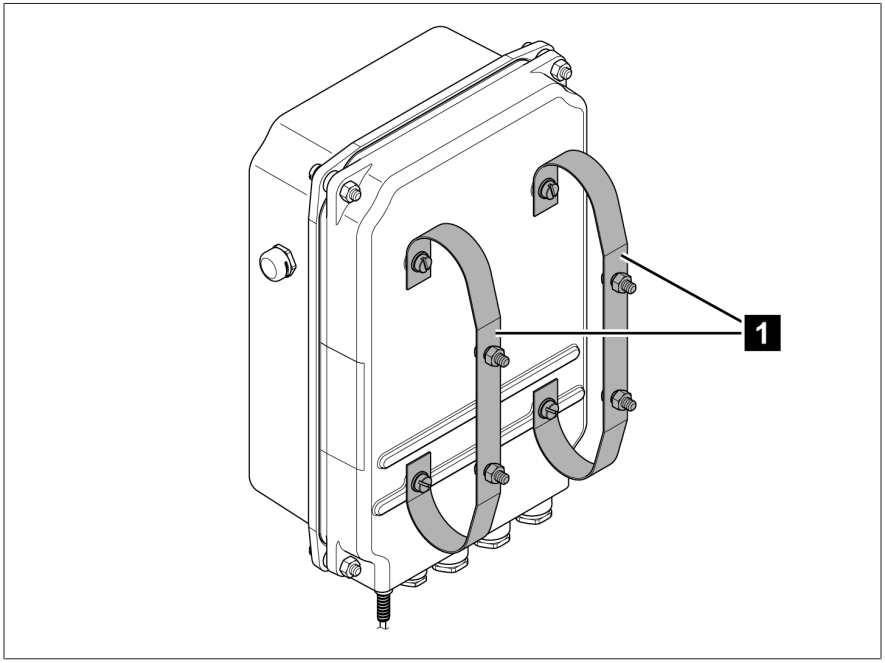


Figure 5: Mounting brackets

1	Mounting brackets		

4.3.2 Temperature sensor

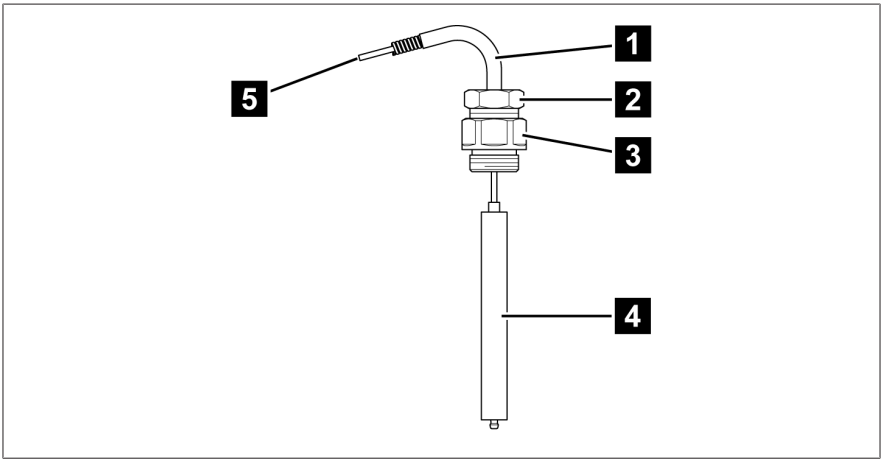


Figure 6: Example design of temperature sensor no. 2

1	Step protection	2	Small screw connection on temperature sensor
3	Large screw connection on temperature sensor	4	Temperature sensor
5	Capillary line with stainless steel protective tube		

Refer to the appendix [▶Section 12, Page 101] for dimensional information on all available temperature sensors.

4.4 Versions

The pointer thermometer is available in the following versions:

Oil temperature indicator (OTI)

- The temperature displayed is that of the oil temperature at the temperature sensor of the pointer thermometer.
- The mechanical measurement system functions independently and without a power source.

Winding temperature indicator (WTI)

- The temperature displayed is that of the winding temperature based on the oil temperature, secondary transformer current and the configured temperature difference.
- The secondary transformer current is proportional to the current in the winding.
- The secondary transformer current supplies a heating resistor in the mechanical pointer thermometer with power, thus causing a temperature increase corresponding to the transformer load compared to the actual oil temperature measured.
- The pointer thermometer with heating element is configured by adjusting the heating current.
- The version with heating element and integrated MRB110-1 or MRB110-2 balancing resistor is configured via the resistor.

Both versions (OTI and WTI) are available with up to 6 independently configurable micro-switches.

- The following applies for the standard version and the TT version:
  With devices with 5 or 6 micro-switches, there are limitations in terms of the number of change-over contacts; refer to the drawings in the appendix.
- With the TTM version, up to 6 change-over contacts are possible without limitation.

Optional versions

- TT version [▶Section 4.4.1, Page 26]
- Pt100 version [▶Section 4.4.2, Page 28]
- TTM version [▶Section 4.4.3, Page 28]

4.4.1 TT version (optional)

The pointer thermometer is equipped with a signal converter that signals the temperature value as an electrical signal (4...20 mA and/or 0...5 V DC). The signal converter requires a 24 V DC power supply.

The outputs are linear and proportional to the temperature displayed on the device. The same temperature value is displayed on the device and on the remote display.

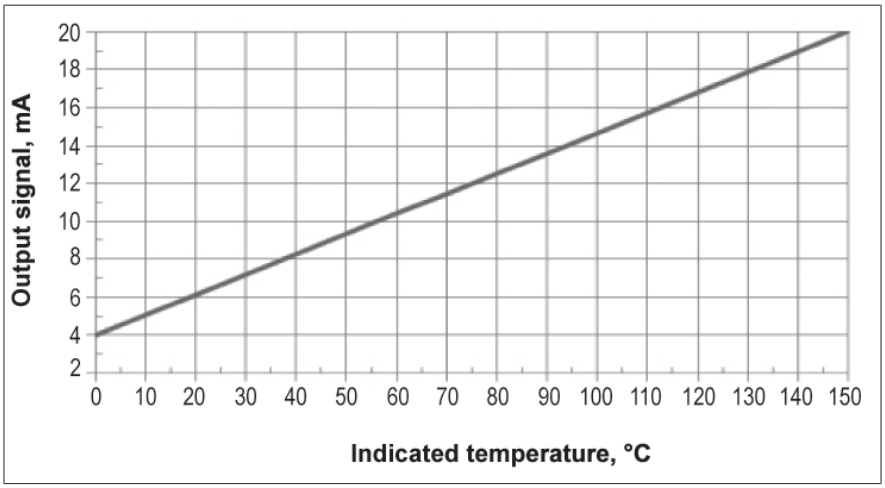


Figure 7: Example values for version with 4...20 mA analog output

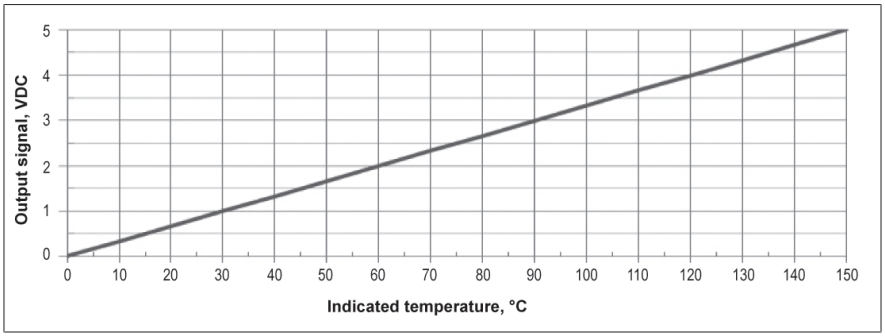


Figure 8: Example values for version with 0...5 V DC analog output

4.4.2 Pt100 version (optional)

The simulated Pt100 output is linear and proportional to the temperature displayed on the device. The same temperature value is displayed on the device and on the remote display.

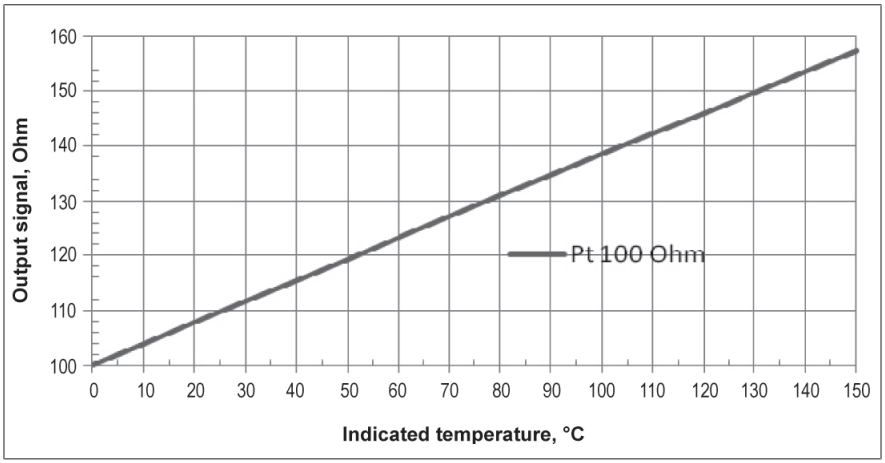


Figure 9: Example values for version with Pt100 analog output

Temperature [°C]	Resistance value [Ohm]
0	100.00
25	109.73
50	119.40
100	138.50
150	157.31

Table 4: Example Pt100 analog output values

4.4.3 TTM version (optional)

The pointer thermometer transmits the measured temperature via an active analog output (4...20 mA or 0...5 V DC) and via an RS485 interface for Modbus RTU.

> The device needs a 24 VDC power supply for this. This is also the case even if you only connect the analog output.
> Please note the limited number of cable glands on the device.

Depending on the application, only 1...2 cable glands are available on the device for wiring the micro-switches:

Cable gland	1 Modbus cable + analog signal	2 Modbus cable	2 Modbus cable + analog signal
M20	Micro-switches	Micro-switches	Micro-switches
M20	Micro-switches	Micro-switches	Modbus
M20	Modbus	Modbus	Modbus
M16	Analog signal	Modbus	Analog signal

Table 5: Cable gland assignment

4.5 Nameplate

The nameplate is on the right-hand side on the housing base.

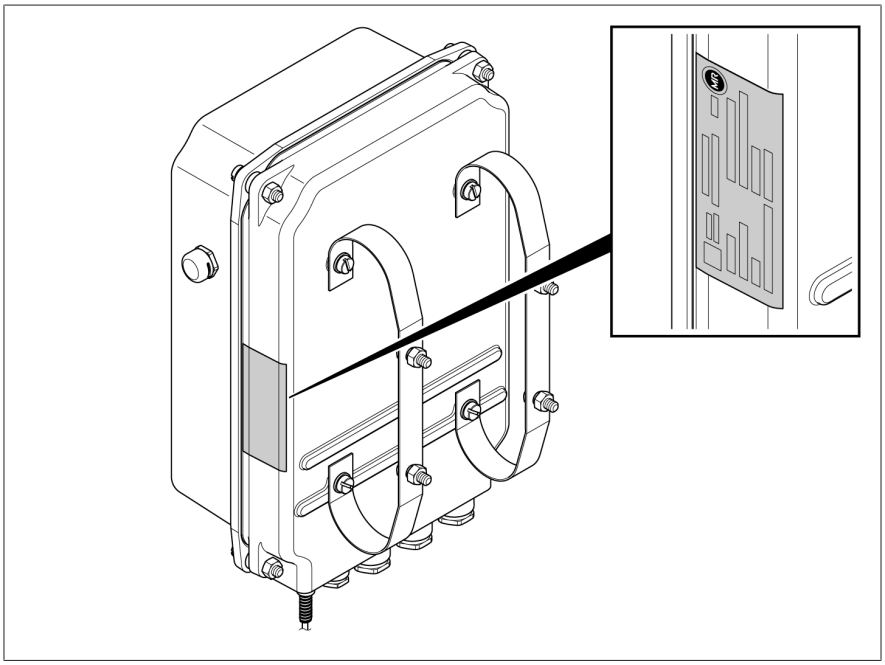


Figure 10: Nameplate

5 Packaging, transport and storage

5.1 Purpose

The packaging is designed to protect the packaged product during transport, loading, unloading and during periods of storage in such a way that no detrimental changes occur. The packaging must protect the goods against permitted transport stresses such as vibration, knocks and moisture (rain, snow, condensation).

The packaging also prevents the packaged goods from moving impermissibly within the packaging.

5.2 Suitability, structure and production

The goods are packaged in a sturdy cardboard box or solid wooden crate. These ensure that the shipment is secure when in the intended transportation position and that none of its parts touch the loading surface of the means of transport or touch the ground after unloading.

Inlays inside the box or crate stabilize the goods, preventing impermissible changes of position and protecting them from vibration.

5.3 Markings

The packaging bears a signature with instructions for safe transport and correct storage. The following symbols apply to the shipment of non-hazardous goods. Adherence to these symbols is mandatory.

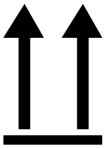
 Protect against moisture	 Top	 Fragile	 Attach lifting gear here	 Center of mass

Table 6: Shipping pictograms

5.4 Transportation, receipt and handling of shipments

In addition to vibrations, jolts must also be expected during transportation. To prevent possible damage, avoid dropping, tipping, knocking over and colliding with the product.

If the packaging tips over or falls, damage is to be expected regardless of the weight.

Every delivered shipment must be checked for the following by the recipient before acceptance (acknowledgment of receipt):
- Completeness based on the delivery slip
- External damage of any type.

The checks must take place after unloading when the cartons or transport container can be accessed from all sides.

Visible damage

If external transport damage is found upon receipt of the shipment, proceed as follows:

- Immediately record the transport damage found in the shipping documents and have this countersigned by the carrier.
- In the event of severe damage, total loss or high damage costs, immediately notify the sales department at Maschinenfabrik Reinhausen GmbH and the relevant insurance company.
- After identifying damage, do not modify the condition of the shipment further and retain the packaging material until an inspection decision has been made by the transport company or the insurance company.
- Record the details of the damage immediately on site together with the carrier involved. This is essential for any claim for damages.
- If possible, photograph damage to packaging and packaged goods. This also applies to signs of corrosion on the packaged goods due to moisture inside the packaging (rain, snow, condensation).
- Be absolutely sure to also check the sealed packaging.

Hidden damage

When damage is not determined until unpacking after receipt of the shipment (hidden damage), proceed as follows:

- Make the party responsible for the damage liable as soon as possible by telephone and in writing, and prepare a damage report.
- Observe the time periods applicable to such actions in the respective country. Inquire about these in good time.

With hidden damage, it is very hard to make the transportation company (or other responsible party) liable. Any insurance claims for such damage can only be successful if relevant provisions are expressly included in the insurance terms and conditions.

5.5 Storage of shipments

When selecting and setting up the storage location, ensure the following:
- Store the product and accessories in the original packaging until installation.
- Protect stored goods against moisture (rain, flooding, water from melting snow and ice), dirt, pests such as rats, mice, termites etc. and against unauthorized access.
- Store crates and boxes on pallets, timber beams or planks as protection against ground moisture and for improved ventilation.
- Ensure that the foundation has sufficient load-bearing capacity.
- Keep entrance paths clear.
- Check the stored goods at regular intervals. Also take appropriate action after storms, heavy rain or snow etc.

5.6 Further transport

Use the original product packaging for further transport.

If you transport the product to the final installation site in a mounted state, observe the following information in order to protect the product against mechanical damage due to external influences.

Transport packaging requirements
- Select packaging suitable for the duration of transport or storage, taking the climatic conditions into consideration.
- Ensure that the packaging protects the product against transport stress such as shaking, vibrations and impacts.
- Ensure that the packaging protects the product against moisture such as rain, snow and condensation.
- Ensure that the packaging allows for sufficient air circulation in order to prevent the formation of condensation.

6 Installation and commissioning

This chapter describes how to correctly mount and connect the device. Observe the following hazard notices prior to opening the device:

⚠ DANGER

Electric shock!
Risk of fatal injury due to electrical voltage. Always observe the following safety regulations when working in or on electrical equipment.

- Disconnect the equipment.
- Lock the equipment to prevent an unintentional restart.
- Make sure all poles are de-energized.
- Ground and short-circuit.
- Cover or cordon off adjacent energized parts.

⚠ CAUTION

Damage to the device
The measurement system is hermetically sealed. If you cut the capillary line, the measurement system will be destroyed.

- Never cut the capillary line.

NOTICE

Damage to the device!
Electrostatic discharge can lead to damage to the device.

- Take precautionary measures to prevent the build-up of electrostatic charges on work surfaces and personnel.

NOTICE

Damage to the device!

If you kink the capillary line or use the capillary line to carry the device, the device can become damaged and display incorrect measured values as a result.

- Carefully remove the device from the packaging.
- Never use the capillary line to carry the device.
- Do not damage the capillary line or sensor.
- Unroll the capillary line without bending or kinking it.
- Observe the minimum bending radius of 25 mm.

6.1 Transporting in the installed state

If transportation of the entire assembled unit is necessary between mounting the device onto the transformer / oil conservator and commissioning it, please also refer to the information on further transport [▶Section 5.6, Page 34].

NOTICE

Damage to the device

The device can become damaged during transport due to unsuitable packaging.

- Use suitable packaging for transporting the device in the installed state.
- Protect the device against mechanical damage.
- Prevent the ingress of rain water.
- Ensure sufficient air ventilation without the formation of condensation.

6.2 Checking measured temperature values

Before attaching the pointer thermometer, you can check the accuracy of the display with a reference measurement. The pointer thermometer for oil temperature is calibrated at the factory.

i The gradient for the pointer thermometer for winding temperature is not preset at the factory. Contact your representative at Maschinenfabrik Reinhausen GmbH if you want the gradient to be preset.

✓ Only perform a reference measurement in moving liquid baths. We recommend using the MESSKO® MZT1650S calibration bath.

✓ The temperature of the liquid bath must remain constant for 15 minutes.

✓ Use an additional, calibrated glass thermometer to perform the reference measurement.

1. Immerse the temperature sensor of the pointer thermometer and a calibrated glass thermometer in the liquid bath for approx. 15 minutes.
2. Compare the measured temperature values of the pointer thermometer and glass thermometer with each other.

» If the measured temperature values deviate from each other significantly (maximum permitted deviation ±3 °C), contact the service department of Maschinenfabrik Reinhausen GmbH [▶Section 2.3, Page 14].

6.3 Mounting the pointer thermometer

6.3.1 Attaching the pointer thermometer to the transformer

When attaching the thermometer to the transformer, note the following information:

– Ensure that the pointer thermometer is mounted vertically.

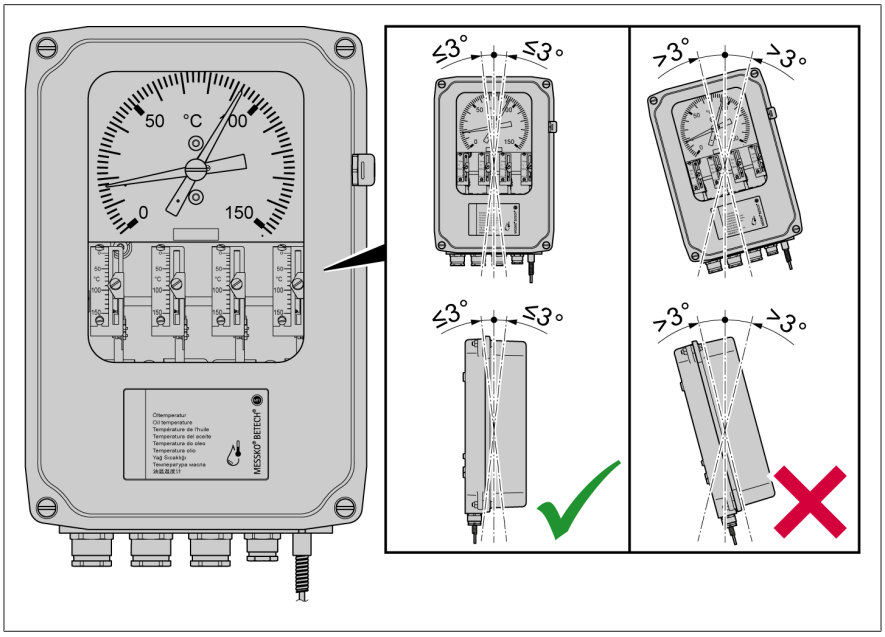


Figure 11: Mounting position

– Ensure that the pointer thermometer is not subjected to any vibrations at the installation location.
– Comply with EMC standards [▶Section 6.4.1.1, Page 45].
– Observe the dimensions in the dimensional drawings in the appendix.

6.3.1.1 Attaching the mounting brackets to the device

To attach the mounting brackets to the device, proceed as follows:

1. Use the 4 M6x8 screws included in the delivery to attach the two mounting brackets to the device via the predrilled holes on the device rear.

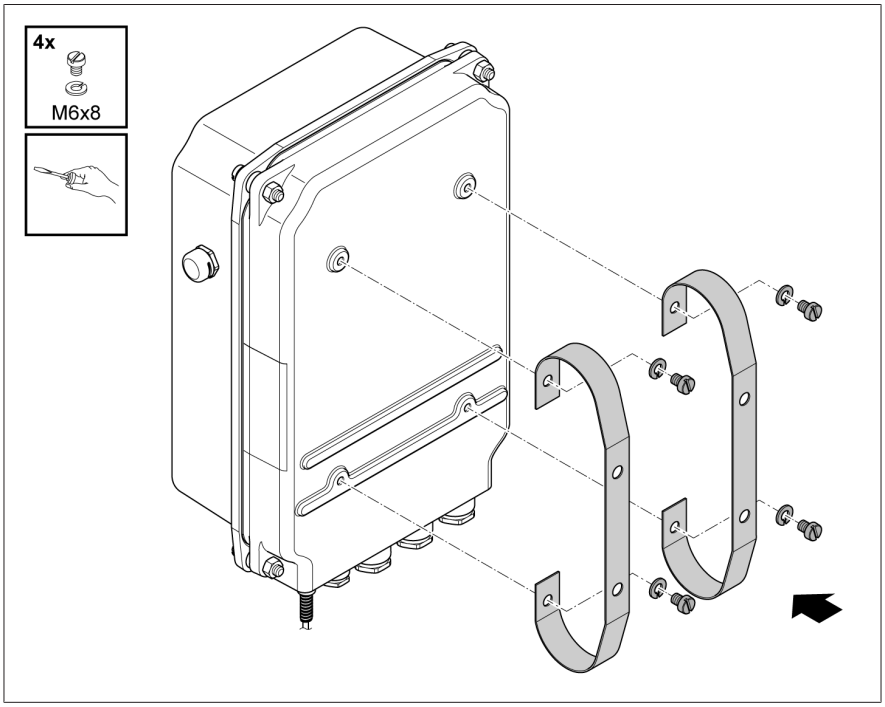


Figure 12: Attaching the mounting brackets

6.3.1.2 Attaching the pointer thermometer via mounting brackets

1. Drill four holes as shown below into a suitable bracket on the outside of the transformer, on the control cabinet mounting plate or on another suitable structure.

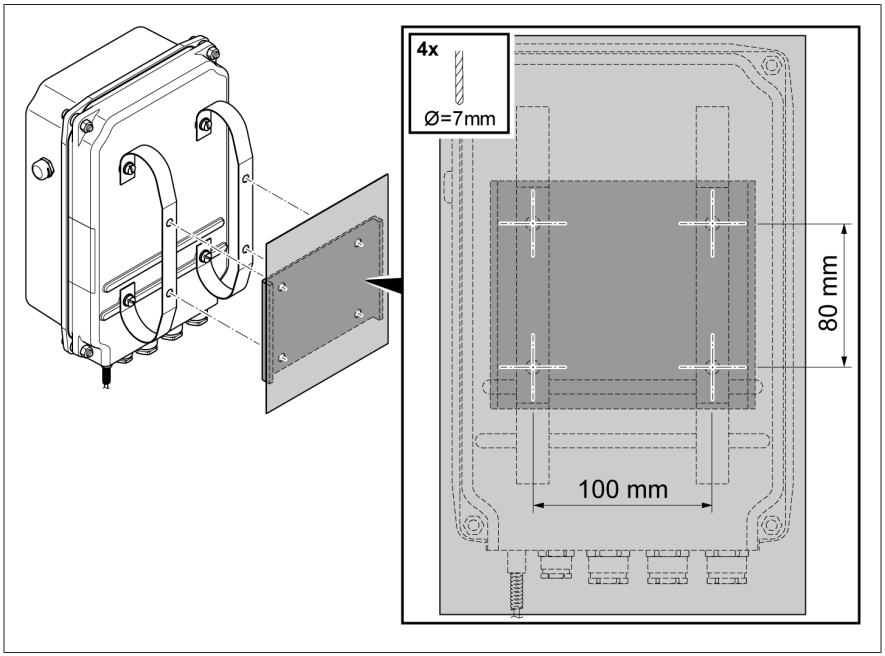


Figure 13: Drill holes

2. Attach the pointer thermometer to the transformer via the mounting brackets.

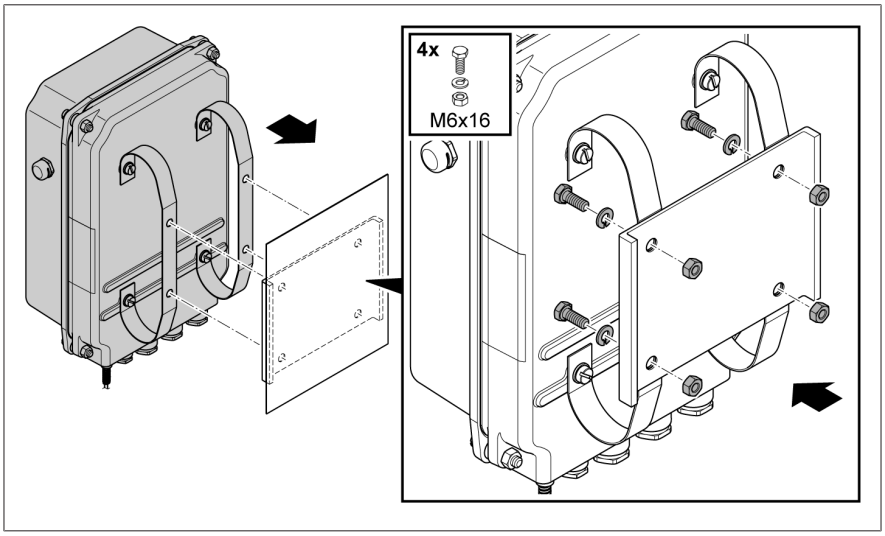


Figure 14: Attaching the pointer thermometer via mounting brackets

6.3.2 Securing the capillary line

When securing the capillary line, note the following information:

NOTICE

Damage to the device!

A capillary line bending radius that is too narrow can lead to a loss of device function.

› Ensure compliance with the minimum bending radius of 25 mm (0.98″).

– Attach the capillary line to the transformer so that it cannot be damaged during transport or operation due to factors such as impact, scuffing, pressure, vibrations or crushing.

Proceed as follows:
1. Route the capillary line to the transformer and secure it with cable ties.
2. Wind up any excess capillary line with a minimum winding diameter of 200 mm (7.87″).

6.3.3 Inserting the temperature sensor

The following steps describe how to install temperature sensor no. 2. Refer to the drawings in the appendix for wrench sizes for the other available versions of the temperature sensor.

1. Fill 85% of the transformer thermometer pocket with oil.

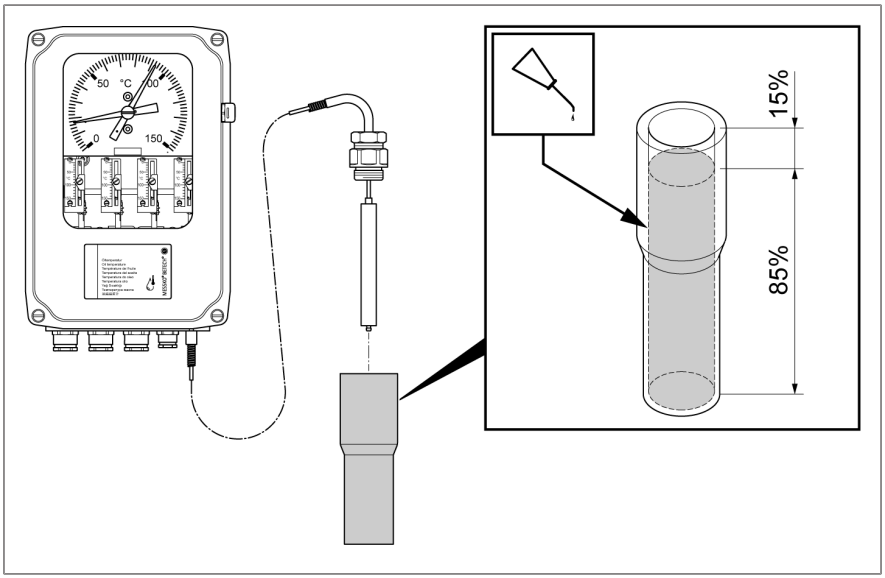


Figure 15: Filling the thermometer pocket

2. Unscrew the large screw connection on the temperature sensor from the small screw connection.

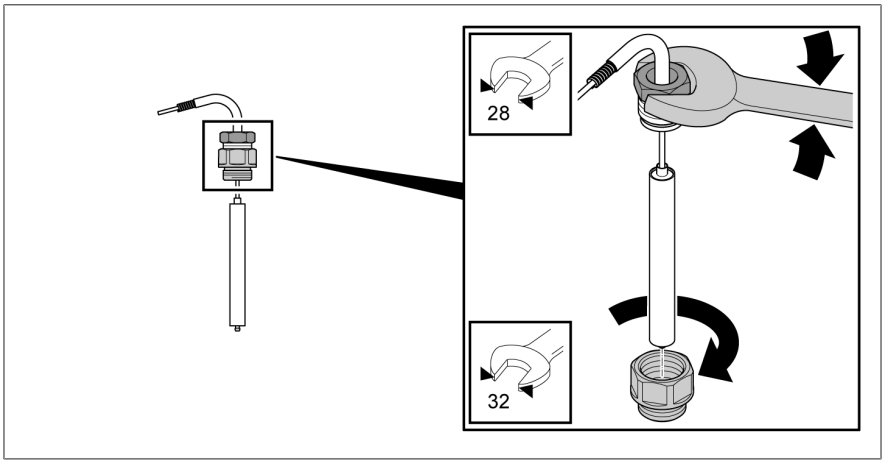


Figure 16: Unscrewing the large screw connection

3. Insert the large screw connection into the transformer thermometer pocket along with the gasket (gasket not included in the scope of delivery) and secure it.

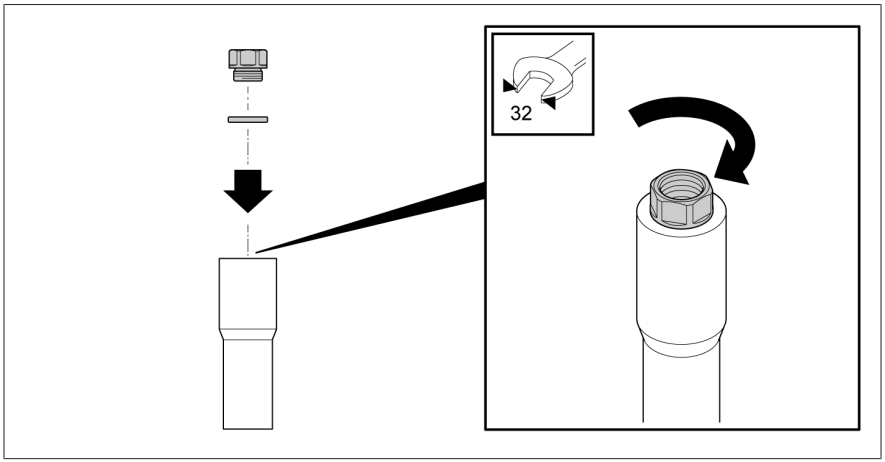


Figure 17: Securing the large screw connection

4. Insert the temperature sensor into the large screw connection and turn it to the desired position together with the capillary line. Tighten the small screw connection on the thermometer sensor.

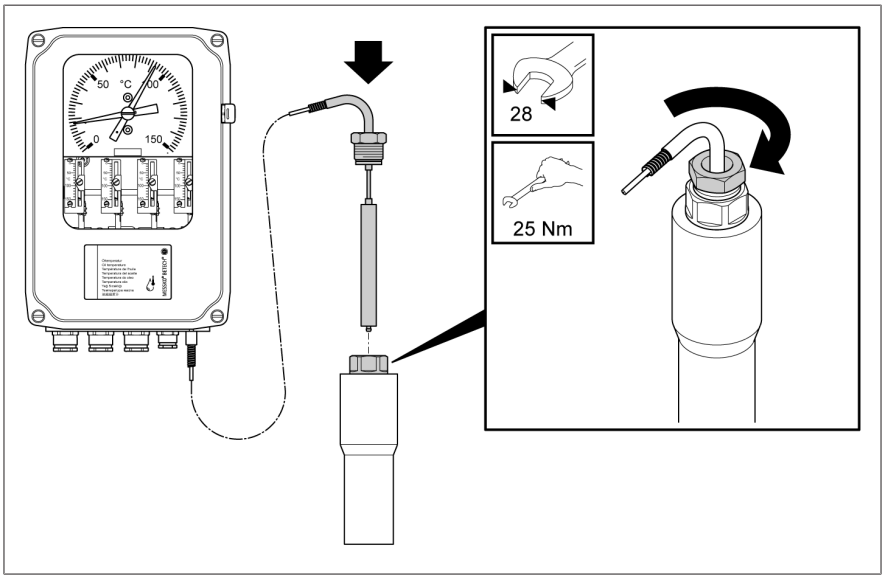


Figure 18: Inserting and securing the temperature sensor

6.4 Electrical connection

This chapter describes how to connect the device correctly. Note the connection diagrams provided. Observe the following hazard notices prior to opening the device:

⚠ DANGER

Electric shock!

Risk of fatal injury due to electrical voltage. Always observe the following safety regulations when working in or on electrical equipment.

- Disconnect the equipment.
- Lock the equipment to prevent an unintentional restart.
- Make sure all poles are de-energized.
- Ground and short-circuit.
- Cover or cordon off adjacent energized parts.

NOTICE

Damage to the device!

Electrostatic discharge can lead to damage to the device.

- Take precautionary measures to prevent the build-up of electrostatic charges on work surfaces and personnel.

6.4.1 Preparation

Observe the following information for the electrical connection.

6.4.1.1 Electromagnetic compatibility

The device has been developed in accordance with the applicable EMC standards. The following points must be noted in order to maintain the EMC standards.

6.4.1.1.1 Wiring requirement of installation site

Note the following when selecting the installation site:

- The system's overvoltage protection must be effective.
- The system's ground connection must comply with all technical regulations.
- Separate system parts must be joined by a potential equalization.

6.4.1.1.2 Wiring requirement of operating site

Note the following when wiring the operating site:

- Do not route lines which cause interference (e.g. supply lines) and lines susceptible to interference (e.g. signal lines) in the same cable duct.
- Maintain a distance of more than 100 mm (3.94″) between lines which cause interference and those which are susceptible to interference.
- Never connect the device with a multi-wire collective pipe.
- Use shielded cables for signal transmission.

6.4.1.2 Safeguarding the power circuits

You may only connect the device to circuits with an external overcurrent protective device and an all-pole isolating device so that the equipment can be fully de-energized if required.

Suitable equipment includes isolating devices in accordance with IEC 60947-1 and IEC 60947-3 (e.g. circuit breakers). Observe the properties of the relevant circuits (voltage, maximum currents) when selecting the circuit breaker type. In addition, observe the following:

- It must be easy for the operator to access the isolating device.
- The isolating device must be labeled for the device and the circuits to be isolated.
- The isolating device may not be a part of the power line.
- The isolating device may not interrupt the main protective conductor.

Miniature circuit breaker

You must protect the mains circuits (supply voltage, main switching contacts) with a miniature circuit breaker. The miniature circuit breaker must have the following properties:

- Rated current: 16 A
- Triggering characteristic: C

Conductor cross-section

For all mains circuits, you must use a conductor cross-section that is appropriate for the miniature circuit breaker you have selected.

6.4.1.3 Cable recommendation

Please note the following recommendation from the manufacturer when wiring the device:

- Due to the intrinsic heating of the devices, the connection cables used for the winding temperature indicator version (WTI) must have a temperature resistance that is 40 K higher than the operating temperature. Example: At an ambient temperature of +80 °C, the temperature resistance must be at least +120 °C.
- Due to the intrinsic heating of the devices, the connection cables used for the oil temperature indicator version (OTI) must have a temperature resistance that is 25 K higher than the operating temperature. Example: At an ambient temperature of +80 °C, the temperature resistance must be at least +105 °C.
- The cables used must be flame-resistant in accordance with IEC 60332-1-2 or UL 2556 VW-1.
- If both low voltage and extra-low voltage are connected in the device, it must be ensured that the circuits for extra-low voltage and for low voltage in the connection area and in the cable are separated from each other with double insulation.
- Devices with a plug connection may be connected via the device plug to either only extra-low-voltage circuits or only low-voltage circuits.
- It must be possible to apply a nominal voltage of at least 300 V to all below-listed connection cables. Rigid and flexible cables can be used.

Analog output

We recommend a shielded cable. Connect the shield in the control cabinet and route it to the device without interruption. We recommend EMC cable glands for shielding the device.

Modbus RTU

We recommend a shielded twisted pair cable. A shielded twisted pair cable is recommended. To optimize the number of cables and the cable glands, it may be advantageous to run Modbus and the 24 V supply in the same cable. Connect the shield to the Modbus master (e.g. in the control cabinet) and route it to the device without interruption. We recommend EMC cable glands for shielding the device.

Cable recommendations for the standard and TT versions

Cable	Terminals	Conductor cross-section
Protective conductor	⏚	≥ all other conductors
Balancing resistor	5 - 5	1.5...4 mm²/ 16...12 AWG
Micro-switches	11, 12, 14; 21, 22, 24; 31, 32, 33, 34; 41, 42, 43, 44; 51, 52, 53, 54; 61, 62, 63, 64	1.5...4 mm²/ 16...12 AWG
Power supply and analog outputs	71, 72, 73, 74	1.5...4 mm²/ 16...12 AWG

Table 7: Standard and TT versions: connection cable recommendation

Cable recommendations for the TTM version

Cable	Terminals	Conductor cross-section
Protective conductor	⏚	≥ all other conductors
Balancing resistor	5 - 5	Single-wire or finely-stranded conductor with ferrule **without** plastic collar: 1.5...4 mm²/ 16...12 AWG
		Finely-stranded conductor with ferrule **with** plastic collar: 1.5...2.5 mm²/ 16...14 AWG

Cable	Terminals	Conductor cross-section
Micro-switches	11, 12, 14; 21, 22, 24; 31, 32, 33, 34; 41, 42, 43, 44; 51, 52, 53, 54; 61, 62, 63, 64	Single-wire or finely-stranded conductor with ferrule **without** plastic collar: 1.5...4 mm^2/ 16...12 AWG
		Finely-stranded conductor with ferrule **with** plastic collar: 1.5...2.5 mm^2/ 16...14 AWG
Power supply, analog outputs and Modbus for TTM version	71, 72, 73, 74, 75, 76, 77, 78	Single-wire or finely-stranded conductor with ferrule **without** plastic collar: 0.2...1.5 mm^2/ 24...16 AWG
		Finely-stranded conductor with ferrule **with** plastic collar: 0.2...1 mm^2/ 24...18 AWG

Table 8: TTM version: connection cable recommendation

6.4.2 Opening the housing

1. Unscrew the 4 bolts (standard version M5; offshore version M6) on the housing cover and remove the housing cover.

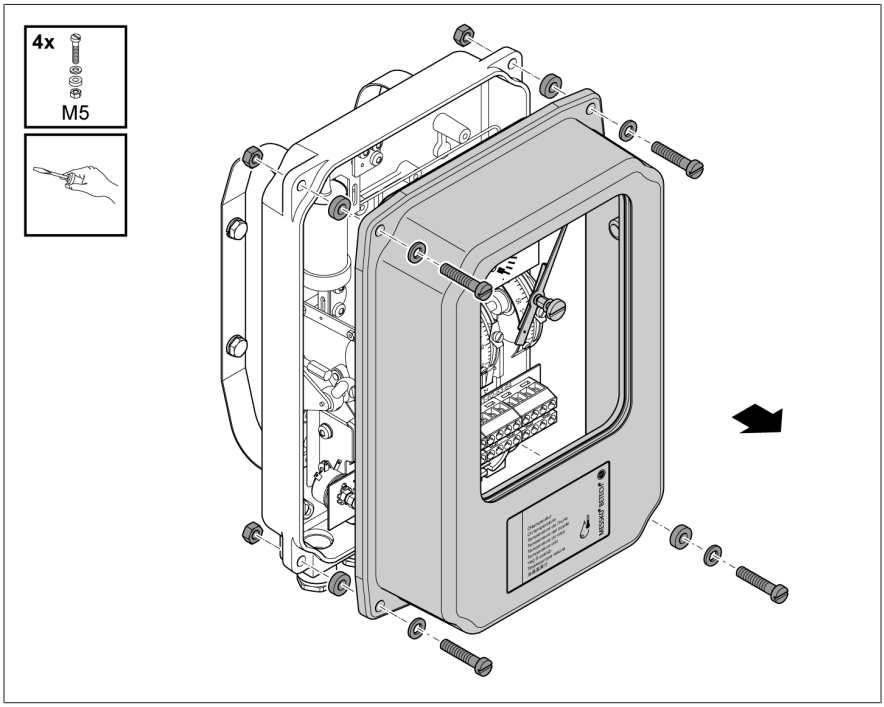


Figure 19: Opening the housing (standard version)

Connection terminals

The standard version and TT version are fitted with screw terminals.

The TTM version is fitted with Push-in terminals.

With the Push-in terminals, the conductors can be inserted without tools.
You need a bladed screwdriver to remove the conductors:
We recommend a 3.5 x 0.5 mm bladed screwdriver for the large terminals.
For the small terminals, we recommend 2.5 x 0.4 mm bladed screwdriver.

You will find further details in the attached drawings.

6.4.3 Preparing the cables

To ensure that you prepare the cablers properly, please pay particular attention to the installation instructions of the cable manufacturers and connection material manufacturers.
The following illustrates an example of a connection cable with protective conductor.

1. Note cable recommendation.
2. Route the connection cables without tension and attach them so that neither the device nor the cable gland is subjected to mechanical stress.
3. Remove approx. 160 mm (6.3″) of the jacket from the cable of the respective connection lines, strip approx. 6 mm (0.24″) of the insulation from the wires and seal with ferrules.

4. Ensure that the cable for the protective conductor is 50 mm longer and equip the conductor with an M5 ring cable lug.

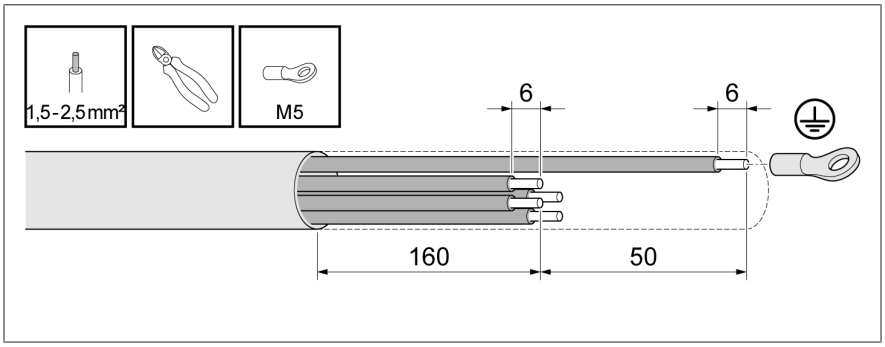


Figure 20: Stripping the cable jacket and wire insulation (example)

6.4.3.1 Standard cable gland

1. *NOTICE!* If the cable gland is not used, equip it with a sealing plug or replace the entire cable gland with a dummy plug in order to ensure the IP degree of protection.
2. Remove the protective cap in the outer nut.

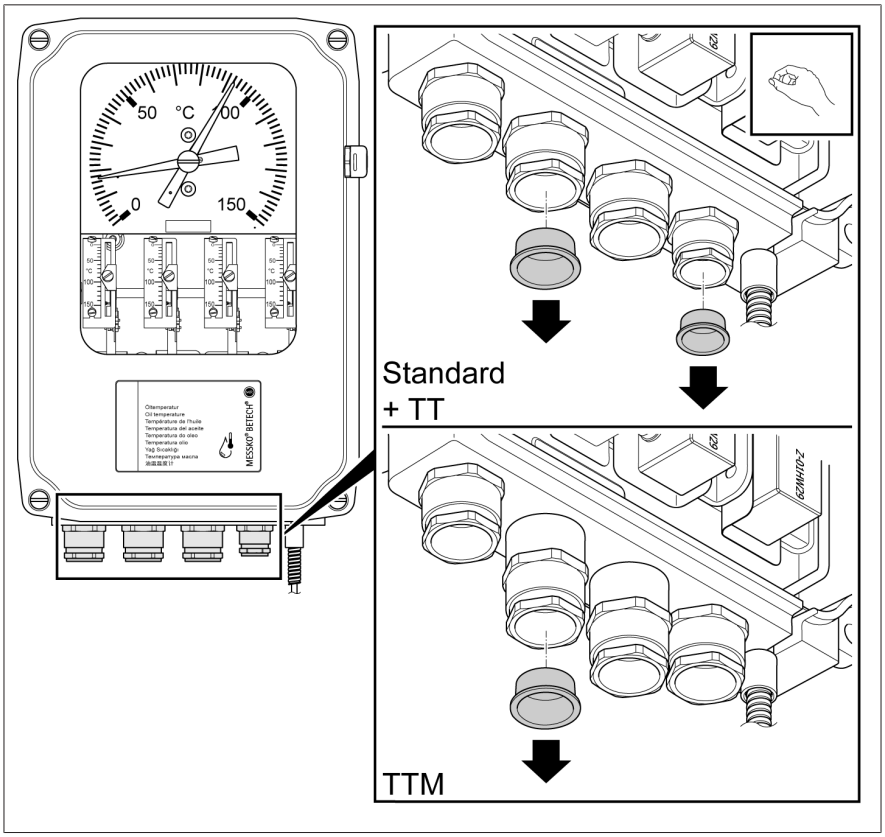


Figure 21: Removing the protective cap – standard cable gland

3. Note the clamping ranges.

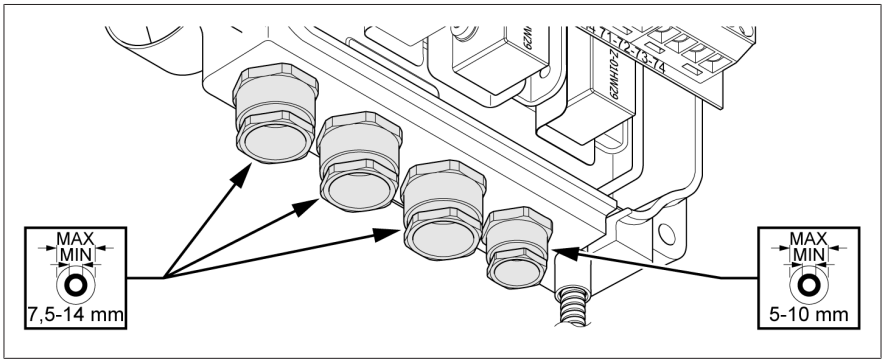


Figure 22: Clamping ranges – standard cable gland

4. Loosen the outer nut, route a sufficient length of connection cable through the cable gland and tighten the outer nut.

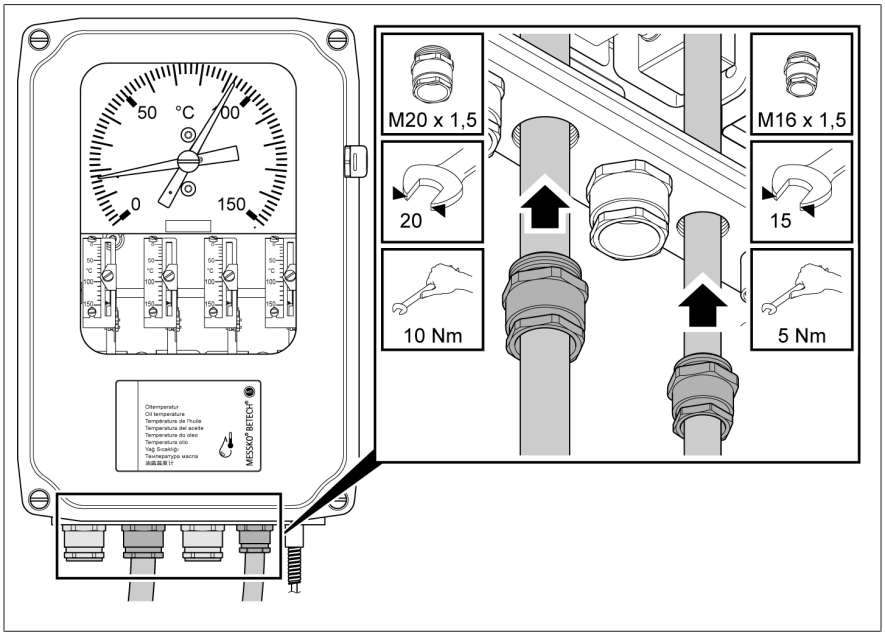


Figure 23: Cable gland – standard cable gland

6.4.3.2 PG16 adapter

1. *NOTICE!* If the adapter is not used, equip it with a sealing plug to ensure the IP degree of protection.
2. Remove the protective cap.

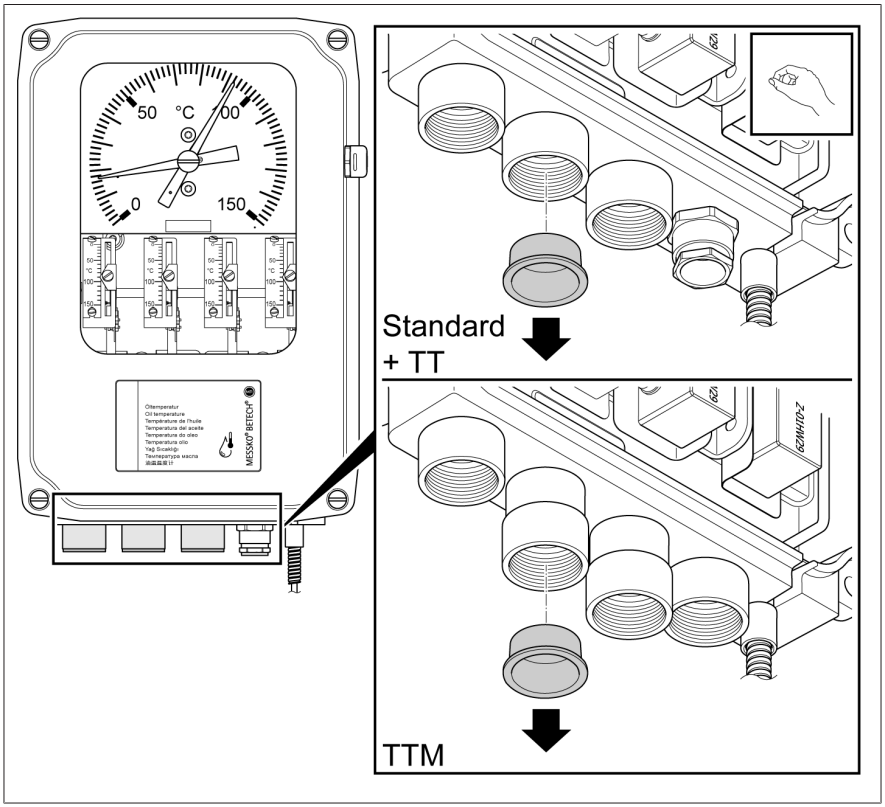


Figure 24: Removing the protective cap – PG16 adapter

3. Screw a cable conduit or cable tube with a PG16 external thread into the adapter correctly and tightly. Feed through a sufficient length of cable.

6.4.3.3 1/2″ NPT adapter

1. *NOTICE!* If the adapter is not used, equip it with a sealing plug to ensure the IP degree of protection.
2. Remove the protective cap.

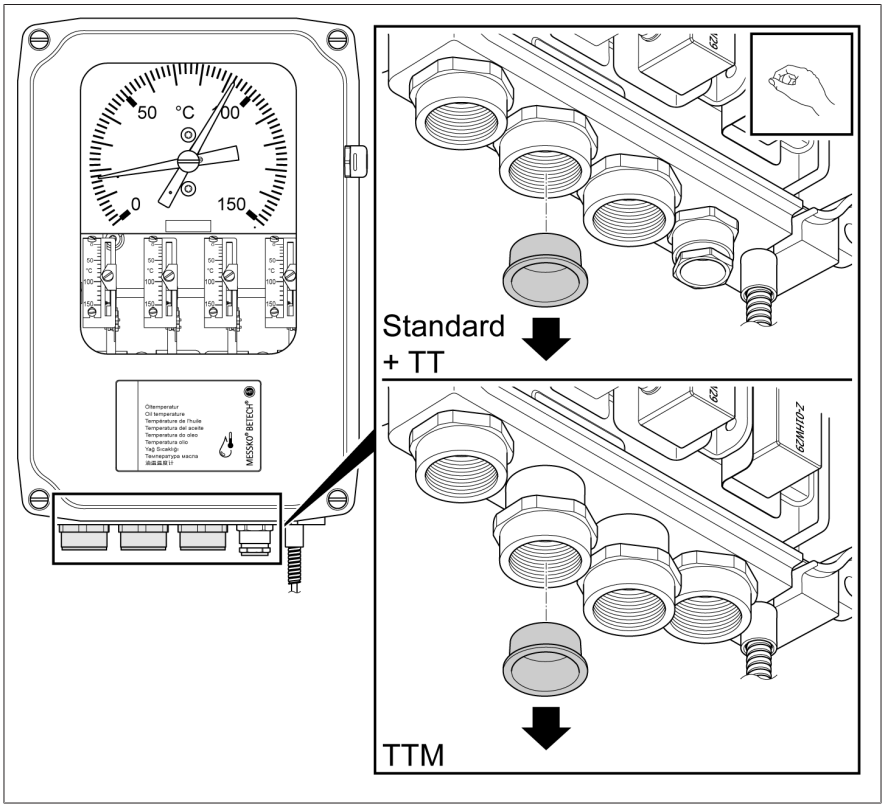


Figure 25: Removing the protective cap – 1/2″ NPT adapter

3. Screw a cable conduit or cable tube with an external thread of 1/2″ 14NPT into the adapter correctly and tightly. Feed through a sufficient length of cable.

6.4.3.4 WADI cable gland (brass) and offshore cable gland (stainless steel)

The WADI cable gland and offshore cable gland differ only in the material. The WADI cable gland is made of brass and the offshore cable gland is made of stainless steel.

1. *NOTICE!* If the cable gland is not used, equip it with a sealing plug or replace the entire cable gland with a dummy plug in order to ensure the IP degree of protection.
2. Remove the protective cap in the union nut.

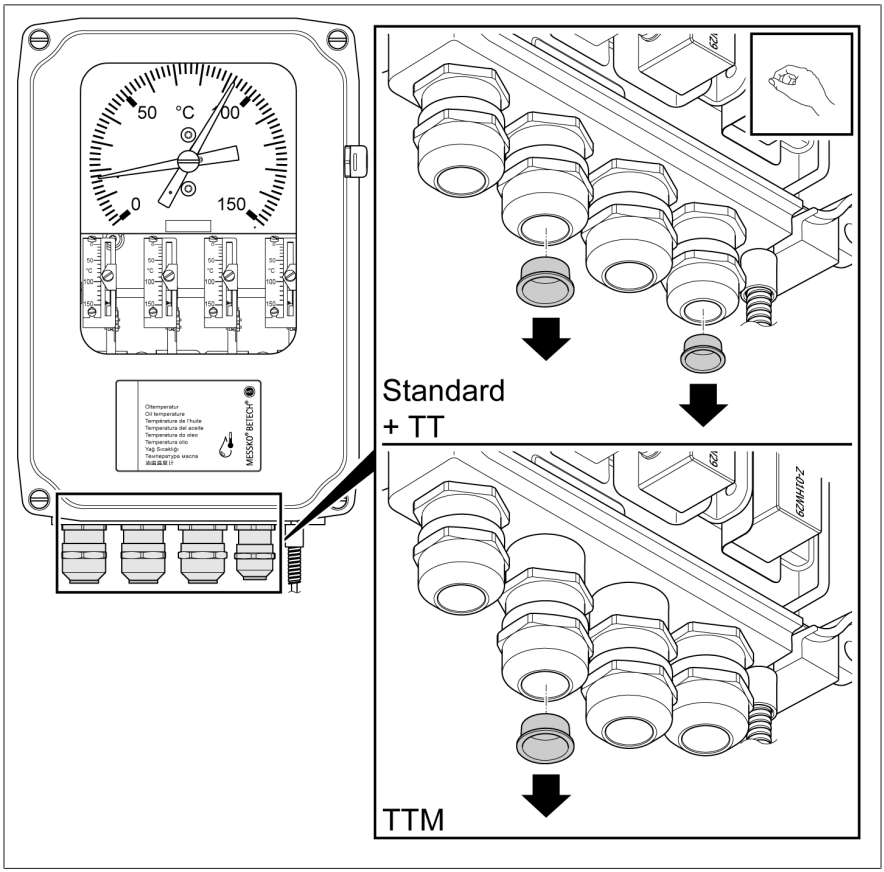


Figure 26: Removing the protective cap – WADI/Offshore

3. Note the clamping ranges.

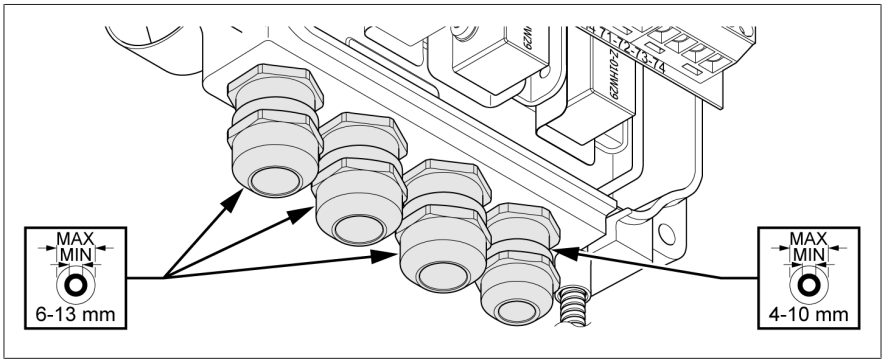


Figure 27: Clamping ranges – WADI/Offshore

4. Loosen the union nut, route a sufficient length of connection cable through the cable gland and tighten the union nut.

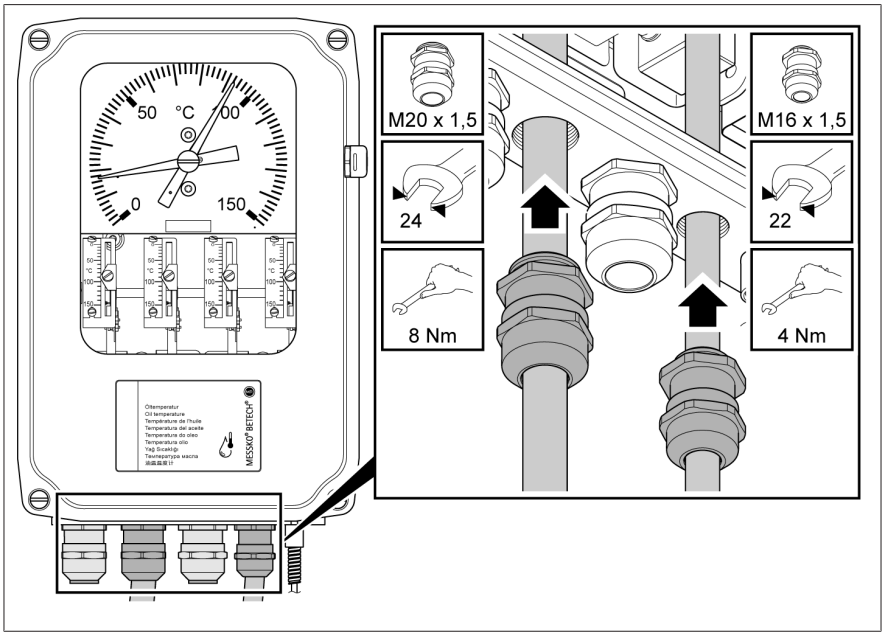


Figure 28: Cable gland – WADI/Offshore

6.4.4 Protective conductor connection

To connect the protective conductor to the pointer thermometer, proceed as follows:

1. Equip the protective conductor (PE) with a forked cable lug or ring cable lug (M5) and secure it to the protective conductor screw on the pointer thermometer.

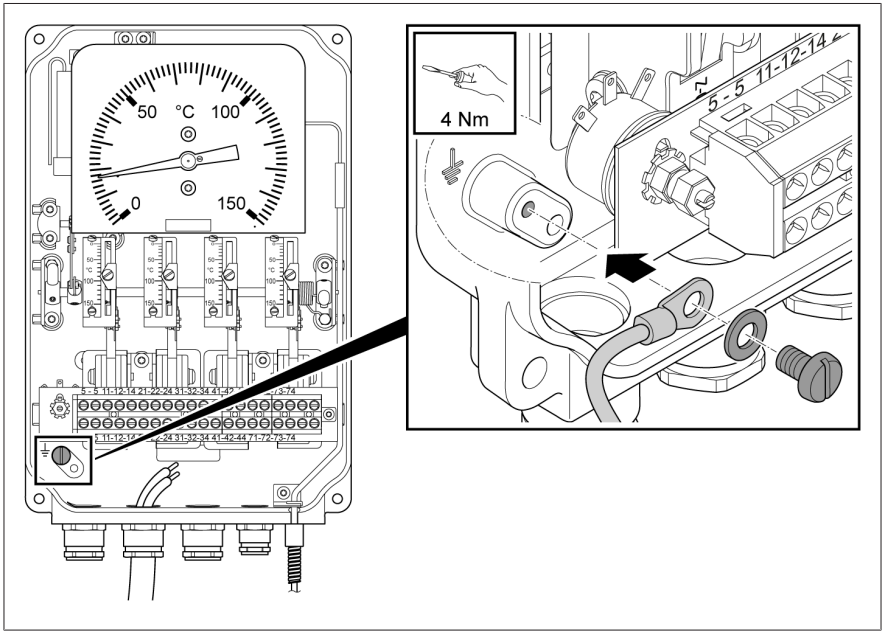


Figure 29: Connecting the protective conductor to the pointer thermometer

6.4.5 Connecting the micro-switches

⚠ WARNING

Electric shock!

When a dangerous electrical voltage is applied to one of these main switching contacts, the neighboring relay contacts must not be operated with protective extra-low voltage.

To connect the micro-switches, proceed as follows:

1. Connect the wires to the terminal strip in accordance with the connection diagram (see appendix).

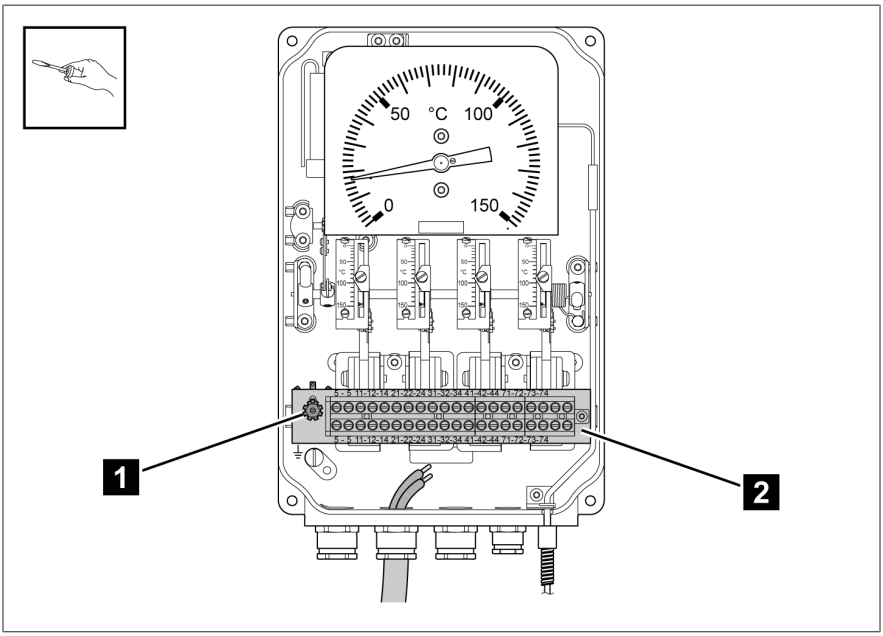


Figure 30: Connecting the micro-switches

1	Balancing resistor	2	Terminal strip

6.4.6 Setting the micro-switches

The micro-switches can be set independently of each other and can be set to every desired temperature on the scale.

1. Loosen the setting screw on the orange pointer on one micro-switch.

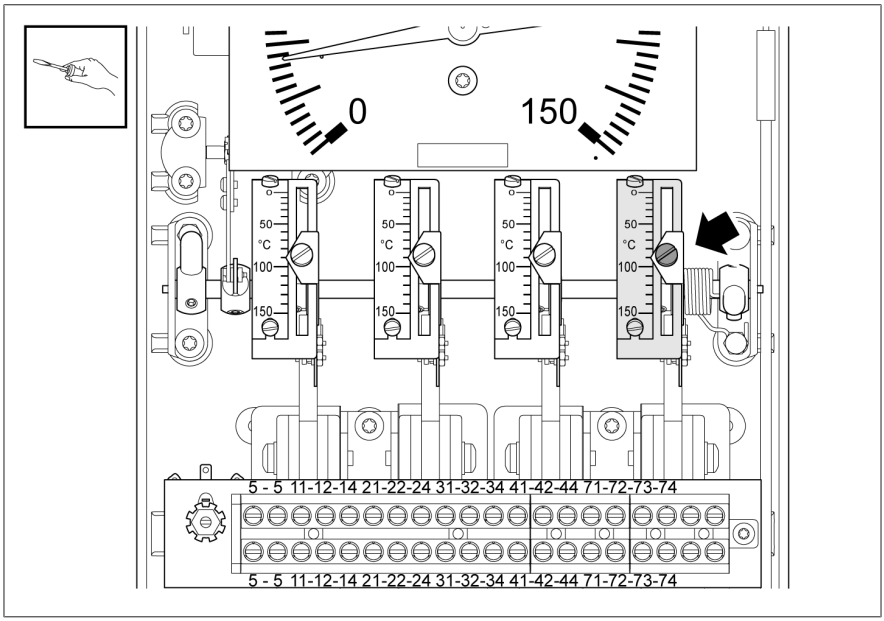


Figure 31: Loosening the setting screw on the pointer

2. Hold the setting screw in place. While doing so, turn the scale by hand until the orange pointer is pointing to the desired temperature on the scale.

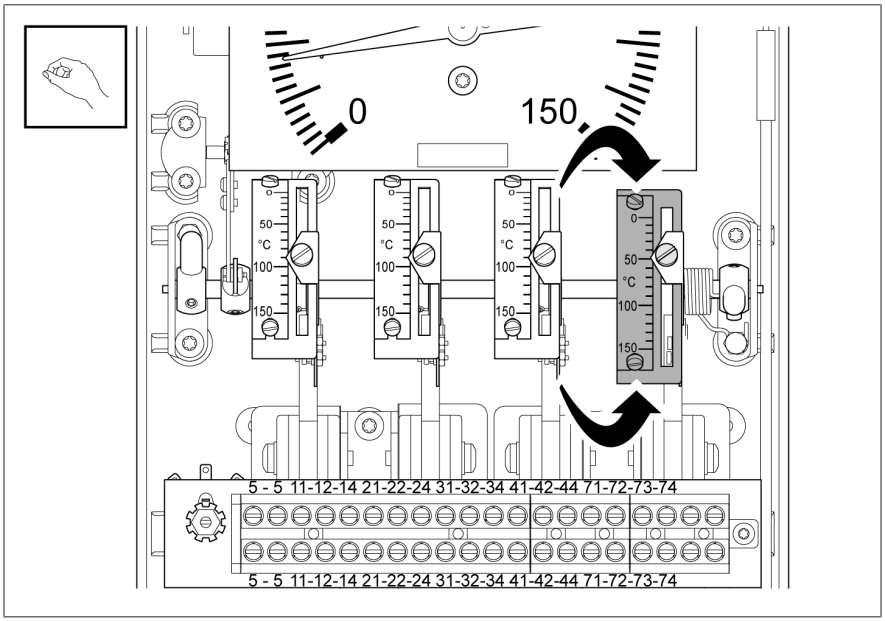


Figure 32: Turning the scale

3. Tighten the setting screw at this position with max. 3 Nm.
4. Follow these instructions precisely for the other micro-switches.

6.4.7 Checking the micro-switches

1. Hold the device in a vertical position.
2. *NOTICE!* Changing the calibration by turning the shaft towards the lower temperatures. Note the direction of rotation. Using the levers on the sides of the shaft, turn the scales attached to it in the direction of the higher temperatures.

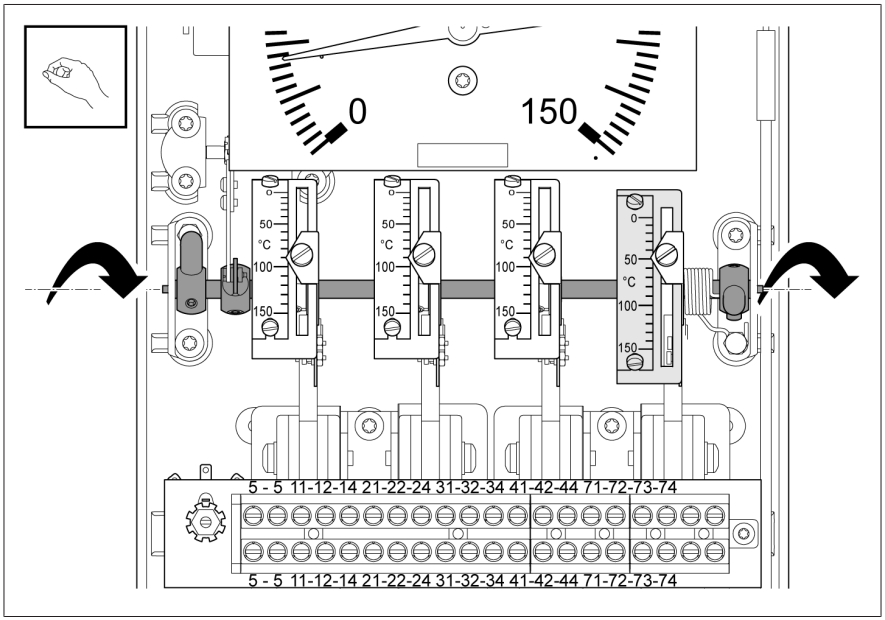


Figure 33: Turning the shaft using the levers

3. Check that the orange pointer moves in the same direction and that the micro-switch switches at the set temperature.
4. If the micro-switch does not switch, set the micro-switch again.

6.4.8 Connecting the analog sensor (TT, TTM)

The pointer thermometer is equipped with a passive sensor that converts the temperature value into an electrical signal (4...20 mA and/or 0...5 V DC). The sensor has a 3-conductor design.

We recommend a shielded cable. Connect the shield in the control cabinet and route it to the device without interruption. We recommend EMC cable glands for shielding the device.

1. Connect the conductors to the terminal strip in accordance with the connection diagram.
2. When doing so, insert the individual conductors into the front opening of the Push-in terminal up to the stop.
3. If a conductor needs to be removed, use a 2.5 x 0.4 mm bladed screwdriver to open the Push-in terminal.

NOTICE

Damage to the device with 2 analog outputs 4...20 mA und 0...5 V DC

› If only the voltage output is used, permanently short-circuit the 4...20 mm output.

Dielectric test

NOTICE

Damage to the device

Observe the following notes regarding performing the dielectric test:

› Prior to starting the dielectric test, short-circuit the terminals in accordance with the following table.
› Remove the bridges from the terminal strip after the dielectric test.
› If, with the version with 2 analog outputs, only the 0...5 V DC output is used, the bridge in terminals 71 and 72 must remain in place.

Version	Short-circuiting terminals for the dielectric test
TT with 4...20 mA analog output	71, 72, 73
TT with 4...20 mA and 0...5 V DC analog output	71, 72, 73, 74
TT with 0...5 V DC analog output	71, 73, 74
TT with Pt100 analog sensor	71, 72, 73

Version	Short-circuiting terminals for the dielectric test
TTM with 4...20 mA analog output	71, 72, 73, 75
TTM with 4...20 mA and 0...5 V DC analog output	71, 72, 73, 74, 75
TTM with 0...5 V DC analog output	71, 73, 74, 75

Table 9: Terminals short-circuited during the dielectric test

6.4.9 Connecting Modbus (TTM)

The pointer thermometer is equipped with a Modbus RTU (RS-485) interface that digitally transmits the temperature value. The interface has a half-duplex design.

> **i** You can loop through the RS485 connection to the next device (daisy-chain) via the terminal bar.
> If the device is the only bus device or the last bus device, insert a terminating resistor (120 Ω, 0.5 W) into the second terminal strip between "A" and "B".

We recommend a shielded twisted pair cable for the Modbus connection. Connect the shield to the Modbus master (e.g. in the control cabinet) and route it to the device without interruption. We recommend EMC cable glands for shielding the device.

1. Connect the conductors to the terminal strip in accordance with the connection diagram.
2. When doing so, insert the individual conductors into the front opening of the Push-in terminal up to the stop.
3. If a conductor needs to be removed, use a 2.5 x 0.4 mm bladed screwdriver to open the Push-in terminal.

6.5 Configuring Modbus (type TTM)

You can change the Modbus configuration settings if the factory settings are not suitable for your application. You will need a configuration tool for this, such as the "MR Modbus Client", which you can download from the MR Download Center.

You will also need a USB-RS485 adapter.

To adjust the Modbus configuration, proceed as follows:
1. Install the MR Modbus Client (admin rights are not needed for this).
2. Connect the device and PC to the RS485 bus.
3. Select the device from the list.
4. Check the communication settings (Modbus address, baud rate, etc.) and make changes where necessary to connect to the device. It is also possible to change the Modbus address if several devices with the same address are already connected to the bus (e.g., MTO, MT-ST, BETECH, TFMR).
   » You can now make the desired configuration settings in accordance with your application.
   » Any changes to the communication settings (Modbus address, baud rate, etc.) will become effective after approximately five seconds.
5. If necessary, update the settings in the MR Modbus Client.
6. You can also use the MR Modbus Client to read out further available data, such as the measured values.

For more information (e.g. register content), see section Modbus RTU [▶Section 10.5, Page 87] technical data.

Modbus baud rate setting

The transmission speed (baud rate) of the Modbus interface can be set to the following values: 4800, 9600, 19200, 38400, 57600, 115200 baud.

Modbus baud rate	
Delivery state (factory setting)	19200 Bd
Maximum value	115200 Bd
Minimum value	4800 Bd

Setting the Modbus address

The following values are available for the Modbus address:

Modbus address	
Delivery state (factory setting) oil temperature indicator OTI	51
Delivery state (factory setting) winding temperature indicator WTI	52
Maximum value	247
Minimum value	1

> Issuing the same network address twice will lead to malfunctions.

Parity

For data transmission, the parity is determined as follows:

Parity	
Delivery state (factory setting)	Even
Optional	Odd / none

Ensure that the same Modbus settings are made in your SCADA system.

Terminating resistor

This is a 120 ohm resistor that is connected between A+ and B-.

The terminating resistor can be activated if the device is the only device in the Modbus network or it is the last device in the Modbus network.

The terminating resistor can be activated by actuating the DIP switch, as illustrated in the figure below:

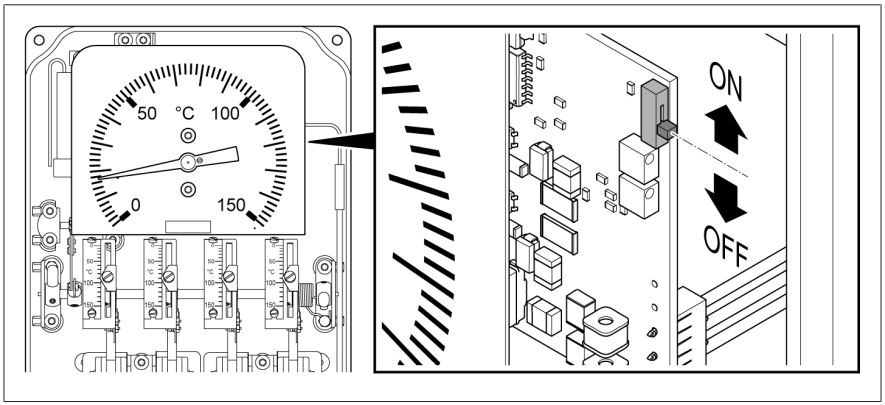


Figure 34: Modbus terminating resistor

6.6 Closing the housing

1. Put the housing cover into position on the device and affix it using the 4 bolts (torque 1 Nm).

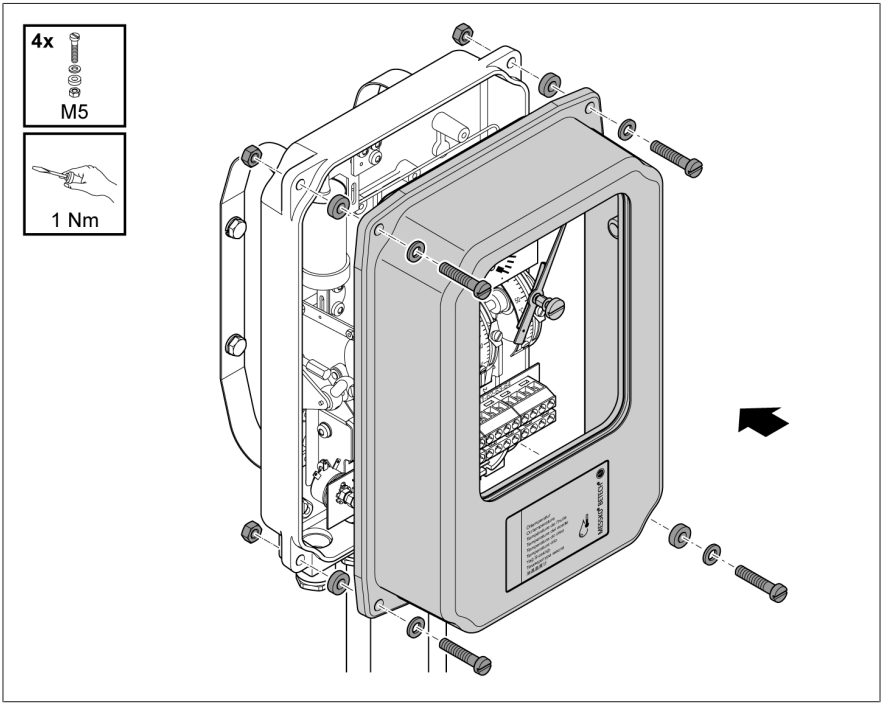


Figure 35: Closing the housing (standard version)

6.7 Setting temperature gradients (winding temperature)

6.7.1 Gradient setting by heating current

Gradient

The gradient is the temperature difference above the oil temperature for the pointer thermometer for winding temperature. The pointer thermometer for winding temperature displays a thermal image of the winding temperature on the transformer.

Calculating the gradient

You can determine the gradient using the graphs or tables, or you can calculate it using the following equation:

$G = K \times I_h^2$
where
G = gradient (°C)
I_h = heating current (A)
K = constant (depending on temperature sensor type)

Temperature sensor types	Measuring ranges		
	A: 0...+150 °C C: -20...+130 °C	E: 0...+160 °C	G: -40...+160 °C
1; 2; 2F; 5; 8; 22; 27	22	23.5	29
6	24.5	26	32.5
9; 10	24	25.5	32

Table 10: Determining constant K

	Gradient °C (or K) above the oil temperature												
	8	10	12	14	16	18	20	22	24	26	28	30	32
I_h	0.60	0.67	0.74	0.80	0.85	0.90	0.95	1.00	1.04	1.09	1.13	1.17	1.21

Table 11: Determining the gradient [1]

1 Only applies for temperature sensor types 1; 2; 2F; 5; 8; 22; 27 and for the measuring ranges A (0...+150 °C) and C (-20...+130 °C)

I_h = heating current in A, ±5 %

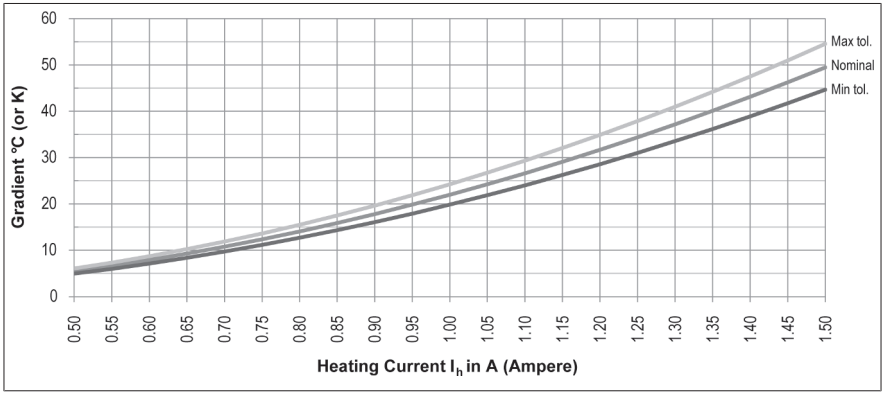


Figure 36: Determining the gradient [1]

Technical data

- Nominal secondary transformer current: 2 A
- Max. heating current I_h = 2.3 A continuous
- Max. heating current I_h = 10 A for 5 seconds
- Thermal time constant: 9 minutes

The gradients are displayed for an oil temperature of 60 °C.

Verifying the gradient settings

To verify the gradient (temperature difference), proceed as follows:

✓ The housing cover is affixed to the device.

✓ Make sure that the temperature on the temperature sensor remains constant during the setting process.

1. Immerse the temperature sensor of the pointer thermometer in the oil bath or water bath.
2. Feed a constant current source (AC or DC) that equates to the desired temperature difference into the WTI heating element.
3. Read off the temperature displayed after 45 minutes.

» The gradient is the difference between the temperature read off and the starting temperature of the bath.

6.7.2 Setting the gradient via balancing resistor

> You can find an overview of all the diagrams for the different probe types and measuring ranges in the chapter „Resistance value setting curves“ [▶Section 11, Page 91].

1. Determine the necessary gradient in °C (or K) from the heat run test.
2. Check CT current (in amps) at 100% load.
3. Use the setting curve to determine at which point the curve of the determined CT current and the determined gradient cross.
   » The total resistance value of the terminals 5 - 5 is the resistance value (in ohms) on the y axis at this point.

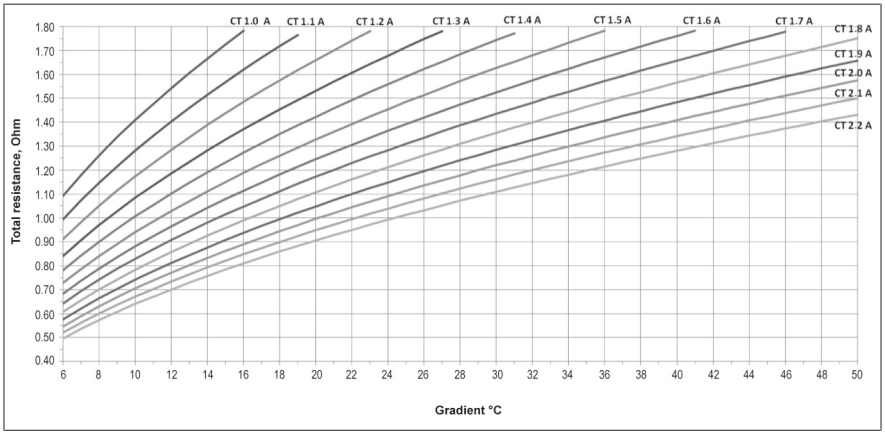


Figure 37: Example of a resistance value setting curve [2]

4. Connect an ohmmeter to the terminals 5 - 5.
5. Adjust the MRB110-1 or MRB110-2 balancing resistor until the determined resistance value is reached.
6. Tighten the locknut when this value is reached.

2 Only applies for temperature sensor types 1; 2; 2F; 5; 8; 22; 27 and for the measuring ranges A (0...+150 °C) and C (-20...+130 °C)

Verifying the gradient settings

✓ The housing cover is affixed to the device.

1. Connect a constant current source (AC or DC) that is the same as the CT current at 100% load to the terminals 5 - 5.
2. Read off the temperature displayed after 45 minutes.

If adjustments to the gradient need to be made, proceed as follows:

› To reach a higher gradient, adjust in the direction of a higher resistance value.

OR

› To reach a lower gradient, adjust in the direction of a lower resistance value.

7 Maintenance, inspection and care

Maintenance

The device is maintenance-free.

Inspection and care

Depending on the conditions of use of the device and the national regulations in the respective country of use, the transformer manufacturers can specify different inspection intervals.

› Observe the inspection intervals defined in CIGRE Publication No. 445 "Guide for Transformer Maintenance" or the inspection intervals specified by the transformer manufacturer.

Check and clean the device as part of each transformer inspection as follows:

1. Use only a damp towel and mild cleaning agent to clean the housing of the device when needed.
2. Ensure that the ventilation is free of dirt and deposits.
3. Check the device for external damage and contamination.

In the event of questions or irregularities, contact the Technical Service department:

Maschinenfabrik Reinhausen GmbH
MR Service & Complaint
Falkensteinstrasse 8
93059 Regensburg
Germany

service@reinhausen.com

8 Fault elimination

This section describes how to eliminate operating faults.

If a solution for a fault cannot be found, contact the manufacturer:

Maschinenfabrik Reinhausen GmbH
MR Service & Complaint
Falkensteinstrasse 8
93059 Regensburg
Germany
service@reinhausen.com
complaint@reinhausen.com

Please have the following data ready:
- Serial number
- Software version

Questionnaire for preparation

1. Has there previously been a problem with this device?
2. Have you previously contacted Maschinenfabrik Reinhausen GmbH about this issue? If yes, then who was the contact?
3. When did the error first occur? Is there a correlation with events such as thunderstorms, lightning surge testing in the transformer station, transformer disconnection/reconnection after short circuit or ground fault, etc.?
4. Is the error constant or sporadic? Is there a correlation with other events/conditions, such as extreme ambient temperatures?
5. Is there an error in the transmission of the analog signal or in the Modbus transmission?

   - Are you using shielded lines?
   - Are you using a twisted pair line?
   - Is the cable shielding attached on both sides?
   - What is the cable length?
   - Which receiver do you use as a receiver?
   - Which analog signal is being used (4...20 mA, 0...10 mA, 0...5 mA, 0...5 V, Pt100)?

- What is the load resistance?
- Modbus: Are there other devices on the Modbus?
- TTM version: Please tell us the value of the status register.

Checking the plausibility of the measured values

If the device is working but not reporting plausible values, check, document and compare the following:

- Measured value via analog output
- Measured value via Modbus RTU interface
- Measured value via pointer on the scale
- Actual physical measured value (measured or estimated).

Calculating the target current of the analog output

The following calculation example for a 4...20 mA analog signal can be converted for use in the same way with other analog signals.

> I_{target} = 4 mA + 16 mA * [(current measured value scale – $scale_{min}$) / ($scale_{max}$ – $scale_{min}$)]

Calculation example for the oil temperature indicator:

- Scale of -20...+140 °C; the indicator points to 60 °C

  => I_{target}
  = 4 mA + 16 mA * [(60 °C – -20 °C)/(140 °C – -20 °C)]
  = 4 mA + 16 mA * 0.5
  = 12 mA

8.1 General malfunctions (TT and TTM versions)

Characteristic/detail	Cause	Remedy
Analog output: no function	Power supply not present	– Check the cabling – Check the supply (18... 30 VDC) – Check the analog output receiver (loop in multimeter) – Check the Modbus receiver (supply, configuration)
Modbus: no function		

Table 12: General faults

8.2 Analog signal malfunctions (TT and TTM versions)

Characteristic/detail	Cause	Remedy
The receiver does not measure any loop current	– Conductor break, open terminal point – Short circuit – Power supply not present – Device defective	– Loop in multimeter and measure – Check the cabling – Check the device supply (18... 30 VDC)
The receiver measures a loop current that is too low	– A part of the current is running through a parallel path – Load resistance too high – Supply voltage too low – Device defective	– Loop in multimeter and measure – Check the cabling – Check the receiver (load resistance)
The receiver measures a loop current that is too high	– A part of the current is being fed-in externally – Device defective	– Disconnect the analog output on the terminals and measure using a multimeter. – Contact MR if necessary

Table 13: Analog signal malfunctions

8.3 Modbus communication malfunctions (type TTM)

Characteristic/detail	Cause	Remedy
No communication possible (continuous)	Power supply not present	– Check cables – Check device supply (18... 30 VDC)
	– RS485 lines A, B not connected or interrupted – Short-circuit A, B – Ground fault A and/or B – RS485 connections swapped	Info: A+ = D0 = D+; B- = D1 = D- – Check wiring – Take a voltage measurement with a multimeter if necessary (A+ against B-; A+ against Com; B- against Com) – Reconnect A+, B- if necessary
	– Modbus address incorrect – Modbus address assigned multiple times – Baud rate – Parity	Info: For factory settings, see section Modbus RTU [▶ Section 10.5, Page 87] – Check parameters (device and master) – Change parameters if necessary; see section Modbus RTU [▶ Section 10.5, Page 87]
	– Device defective	– Contact MR
No communication possible (sporadic)	– Modbus address assigned multiple times	– Check parameters (device and master) – Change parameters if necessary; see section Modbus RTU [▶ Section 10.5, Page 87]
	– Device defective	– Contact MR

Table 14: Modbus communication malfunction

8.4 Self-diagnostic/device status (TTM version)

The device checks its own functionality cyclically (self-diagnostic).

In Modbus input register 0 (data type: UINT16), the device reports a corresponding status via status bits. Multiple bits can also be set at the same time.

Status "0" means that the device has not detected any error.

All error will reset once the error is no longer occurring. An acknowledgement is not needed.

Status bit value/characteristic/detail	Cause	Remedy
0: no error detected	-	-
4: Current not within measuring range	– Extremely low or extremely high oil temperatures – Extremely high CT current – Extremely high gradient (with winding temperature indicator)	– Are the oil temperatures/CT currents/gradients actually extremely low or high? Compare the reported temperature with the pointer position
	– Current loop is open (continuous load resistance) because you do not want to use the current loop at all – Interruption of the current loop	– If you are not using the analog output, connect a resistor (470 Ohm ±20%/0.5 W) as load resistance. If necessary, you can use a wire bridge. – Check wiring as per supplied connection diagram: loop open? Parallel paths? Current leaks?
4: Current not within measuring range	– Load resistance too high	– Take the maximum conductor length and conductor cross-section into consideration
	– Supply voltage too low	– Check the supply voltage

Status bit value/characteristic/detail	Cause	Remedy
	– Extremely high ambient temperatures and/or CT currents (with winding temperature indicator)	– Check compliance with the limit values
	– Electromagnetic interferences	– Signal line: do not route adjacent to interference-inducing conductors – Use shielded twisted-pair cable, shield on both sides wherever possible
	– Moisture in the device	– Check for moisture/creep inside the device
	– Device defective	– Contact MR
All other status bit values: internal error	– Device defective	– Contact MR

Table 15: Status codes

9 Disposal

Observe the national disposal regulations in the country of use.

9.1 SVHC information in accordance with the REACH regulation

This product complies with the provisions of European Regulation 1907/2006/EC dated December 18, 2006 on the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH).

The following components of the product contain > 0.1% [w/w] of the SVHC substance lead (CAS no. 7439-92-1):

- Aluminum alloy
- Brass alloy
- Standard parts with a low property class

10 Technical data

10.1 Ambient conditions

Permissible ambient conditions	Standard version, TT version	TTM version
Location of use	Indoors and outdoors, tropic-proof Optional arctic version	Indoors and outdoors, tropic-proof
Operating temperature	-40...+70 °C	-40...+70 °C
Storage temperature	-40...+80 °C	-40...+80 °C
Ambient air temperature	-40...+70 °C (optional: arctic version to -60 °C)	-40...+70 °C
Insulating fluid temperature	Measuring range ±20%	
Relative humidity	Fog-free up to 80%	
Installation altitude[1)]	4,000 m above mean sea level	
Degree of protection	IP55 in accordance with IEC 60529	
Protection class	1	
Overvoltage category	III	
Contamination level	2 (within the device)	

10.2 Technical data

Measuring ranges (further measuring ranges on request)	Display accuracy
0...+150 °C	±3 K (optional ±2 K or ±1.5 K) in the range of 20...130 °C
-20...+130 °C	±3 K (optional ±2 K or ±1.5 K) in the range of 0...110 °C
0...+160 °C	±3 K (optional ±2 K or ±1.5 K) in the range of 20...140 °C
-40...+160 °C	±3 K in the range of -20...+140 °C

Basic materials	
Housing	Aluminum, RAL 7033 or RAL 7038 coating Other colors on request
Inspection window	Standard: Laminated safety glass with UV filter (optional: UV-stabilized polycarbonate)
Sensor screw connection	Quadratic 4-hole flange; G3/4″; G1″; 7/8″-14UNF; other screw connections on request
Cable gland	
– Standard, TT version	Up to 3 x M20x1.5 und 1 x M16 for analog output
– TTM version	4 x M20x1.5, the two central cable glands with extension adapter

Dimensions and weight	
Dimensions	See dimensional drawings in the appendix
Weight	approx. 4 kg

10.3 Micro-switches

Micro-switch technical data	Standard: SPDT[1)]	Option: MBO[2)] SPDT[1)]	Option: Gold SPDT[1)]
Quantity	2...6		
Contact type	Change-over contact, normally open contact		
Switching hysteresis	12 K ±2 K; others on request		
Miniature circuit breaker fuse protection	16 A, Type C	10 A, Type C	-[3)]
Rated insulation voltage in accordance with IEC 60076-22-1			
– Terminals to ground	2,500 V AC/ 1 min	2,500 V AC/ 1 min	2,500 V AC/ 1 min
– Between open terminals	1,500 V AC/1 min	1,500 V AC/1 min	600 V AC/1 min
Lightning impulse withstand voltage in accordance with IEC 60076-22-1			
– Terminals to ground	2,000 V	2,000 V	2,000 V
– Between open terminals	1,500 V	1,500 V	600 V
Contact material	Silver alloy	Silver alloy	Silver, gold-plated

Table 16: Micro-switch technical data

[1)] SPDT = Single Pole, Double Throw
[2)] MBO = Magnetic Blowout
[3)] Fuse protection must be determined by a qualified electrician on a case-by-case basis.

Utilization category in accordance with IEC 60947-5-1

Utilization categories in accordance with IEC 60947-5-1	Typical application
AC-12 (50/60 Hz)	Regulation of resistive load and semi-conductor load resistance with disconnection via optocoupler
AC-15 (50/60 Hz)	Regulation of electromagnetic load resistance with AC voltage
DC-12	Regulation of resistive load and semi-conductor load resistance with disconnection via optocoupler
DC-13	Regulation of electromagnets with DC voltage

Table 17: **Explanation of utilization categories in accordance with IEC 60947-5-1**

Utilization categories in accordance with IEC 60947-5-1	Rating/nominal operation					
	Standard: SPDT[1)]		Option: MBO[2)] SPDT[1)]		Option: Gold SPDT[1)]	
	U_N	I_N	U_N	I_N	U_N	I_N
AC-12 (50/60 Hz)	250 V	15 A	250 V	3 A	125 V	0.1 A
	-	-	125 V	10 A	-	-
AC-15 (50/60 Hz)	250 V	15 A	250 V	2 A	-	-
	125 V	15 A	125 V	7.5 A	-	-
	-	-	30 V	10 A	-	-
DC-12	250 V	0.3 A	250 V	3 A	5 V	0.1 A
	125 V	0.75 A	125 V	10 A	30 V	0.1 A
DC-13	250 V	0.2 A	250 V	2 A		
	125 V	0.4 A	125 V	7.5 A		
			30 V	10 A		

Table 18: **Utilization category in accordance with IEC 60947-5-1**

[1)] SPDT = Single Pole, Double Throw
[2)] MBO = Magnetic Blowout

Switching capacity in accordance with IEC 60076-22-1

Micro-switch version	U_N	Switching capacity in accordance with IEC 60076-22-1
Standard: SPDT[1)] Option: MBO[2)] SPDT[1)]	230 V AC	Making capacity: 250 VA, cos φ > 0.4
		Breaking capacity: 60 VA, cos φ > 0.4
	24...220 V DC	Making capacity: 130 W, L/R = 7 ms
		Breaking capacity: 25 W, L/R = 7 ms
Option: Gold SPDT[1)3)]	125 V AC	Max. 12.5 VA, resistive load
	24...220 V DC	Max. 2.4 VA, resistive load

Table 19: Switching capacity in accordance with IEC 60076-22-1

[1)] SPDT = Single Pole, Double Throw
[2)] MBO = Magnetic Blowout
[3)] Switching higher loads will destroy the gold plating.

10.4 Interfaces

Passive Pt100 analog output (TT version)	
Rated insulation voltage	Terminals to ground: 500 V DC/1 min

Active analog output (TT + TTM versions)	
Supply voltage	18...30 VDC unregulated, max. 10% residual ripple, protected against polarity reversal
Output signal	4...20 mA; 0...10 mA; 0...5 mA; 0...5 V DC
Maximum current consumption	40 mA (at 24 V DC)
Analog signal load resistance	Current loop: max. 500 ohms Voltage signal: min. 5,000 ohms
Rated insulation voltage	Terminals to ground: 500 V DC/1 min
Repetition accuracy	≤ ±0.1% from the end value

RS485 interface for Modbus RTU (TTM version)	
Supply voltage	18...30 VDC unregulated, max. 10% residual ripple, protected against polarity reversal
Standard	EIA/TIA-485
Protocol	Modbus RTU
Wiring	2-wire; half-duplex
Terminal designation	Polarity: A+ = D+; B- = D-; COM = common ground Expected voltage between A+ and B- in the idle state: >+200 mV
Rated insulation voltage	Terminals to ground: 500 V DC/1 min

10.5 Modbus RTU

Factory settings

Device version	Modbus address	Baud rate	Parity
MESSKO® BETECH® OTI	51	19200	EVEN
MESSKO® BETECH® WTI L1	52	19200	EVEN
MESSKO® BETECH® WTI L2	53	19200	EVEN
MESSKO® BETECH® WTI L3	54	19200	EVEN

Table 20: Modbus RTU factory settings

Input register

Function code "04" to read the information.

Validity of the measured value stored in the INPUT register addresses 1...3:
It can be seen via the DISC register address with address 0 (Boolean) whether the measured value is invalid (0) or valid (1). We recommend evaluating this register address alongside the measured value query.
Device status:
The INPUT register address 0 indicates the device status (0: the device self-diagnostic has confirmed that the device is running without errors). We recommend querying the device status either parallel to the measured values or when needed (e.g. during troubleshooting, fault elimination).
See section "Fault elimination" [▶Section 8, Page 75] for details.

Address	Data type	Designation
0	UINT16	Device status [▶Section 8.4, Page 79]
1, 2	FLOAT32	Measured value (temperature in °C) with decimal places; Oil temperature or winding temperature
3	SINT16	Measured value (temperature in °C) as an integer; Oil temperature or winding temperature
4...16	-	Reserved for future use
17	UINT16	Firmware version major
18	UINT16	Firmware version minor
19	UINT16	Firmware version patch

Table 21: Input register

With FLOAT parameters, the MSB (Most Significant Bit) is stored in the lower address and the LSB (Least Significant Bit) in the higher address.

Configuration via holding register

Each address must be unique in the BUS system. Therefore, for example, when using two identical devices (same default address!), configure them to different addresses before commissioning!

Use function code "03" to read the information and function code "06/16" to write the information.

Address	Data type	Designation	Setting option
0	UINT16	Modbus address	1...247 51[1] MESSKO® BETECH® OTI 52[1] MESSKO® BETECH® WTI L1 53[1] MESSKO® BETECH® WTI L2 54[1] MESSKO® BETECH® WTI L3
1	UINT16	Modbus baud rate	0: 4800 1: 9600 2: 19200[1] 3: 38400 4: 57600 5: 115200
2	UINT16	Modbus parity	0: None 1: Even[1] 2: Odd
3	UINT16	Modbus number of stop bits	1: One stop bit[2] Can only be read.
4...72	-	Reserved	-
73...79[3]	STRING	Serial number	7-digit, 1 number per register in ASCII-format[2]
100...109	STRING	Serial number	7-digit, 2 ASCII characters per register, little-endian[2]
110...119	STRING	Date of manufacture	2 ASCII characters per register, little-endian[2]
120...129	STRING	Firmware version	
130...139	STRING	Sensor manufacturer	
140...149	STRING	Sensor designation	

Table 22: Holding register

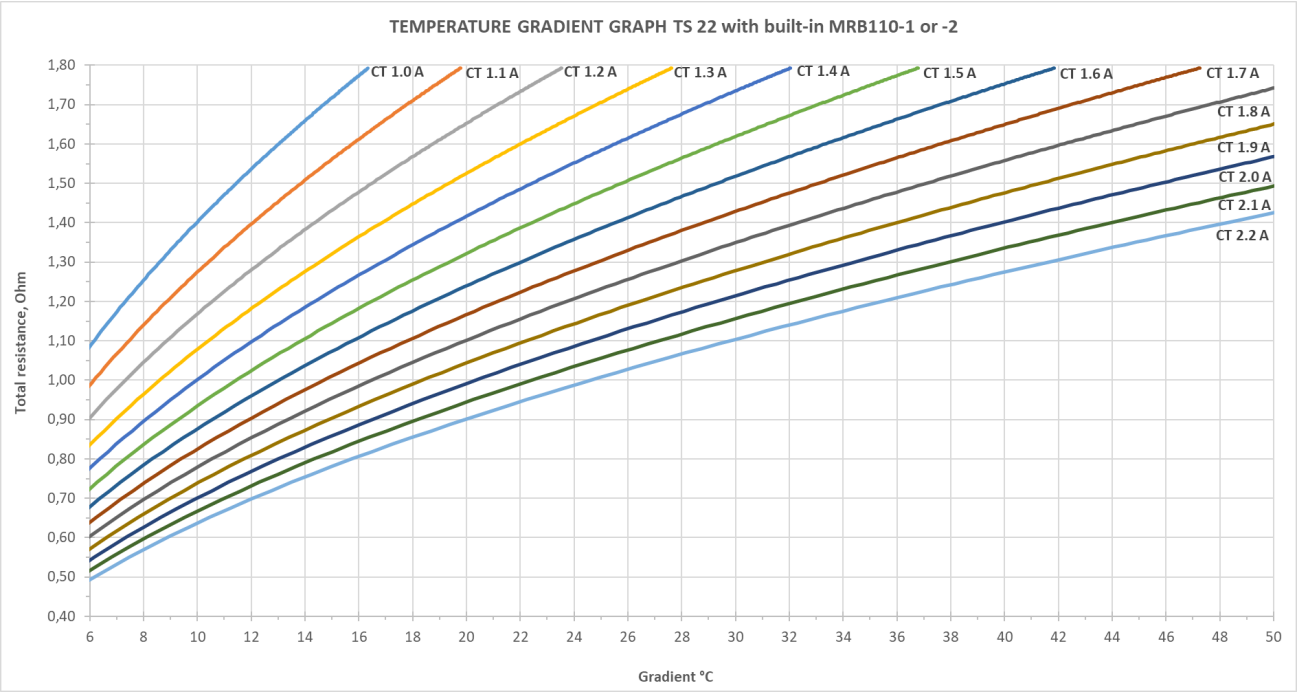
[1] Delivery condition/default settings
[2] Cannot be overwritten by the user.

Validity of the measured value via DISC register

Use function code "02" to read the information from DISC register address 0.

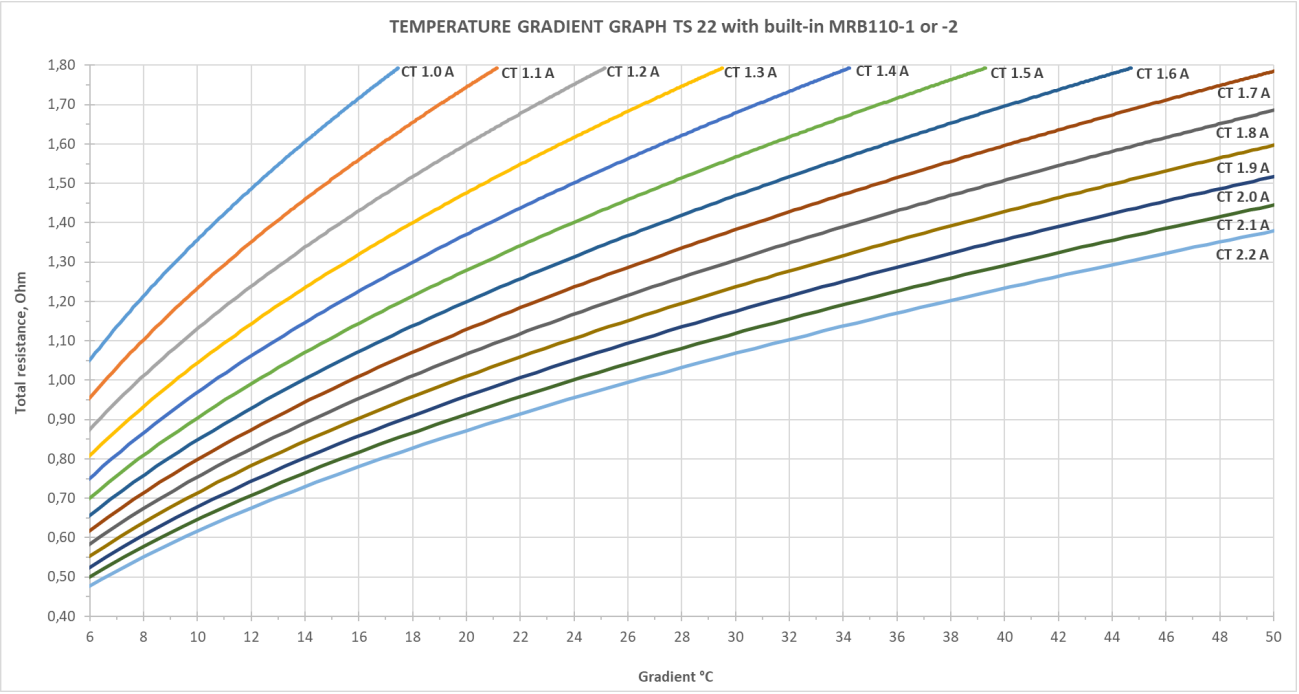
Address	Data type	Designation
0	BOOL	Validity of the measured value (input register 1...3): 0: Invalid 1: Valid

11 Resistance value setting curves



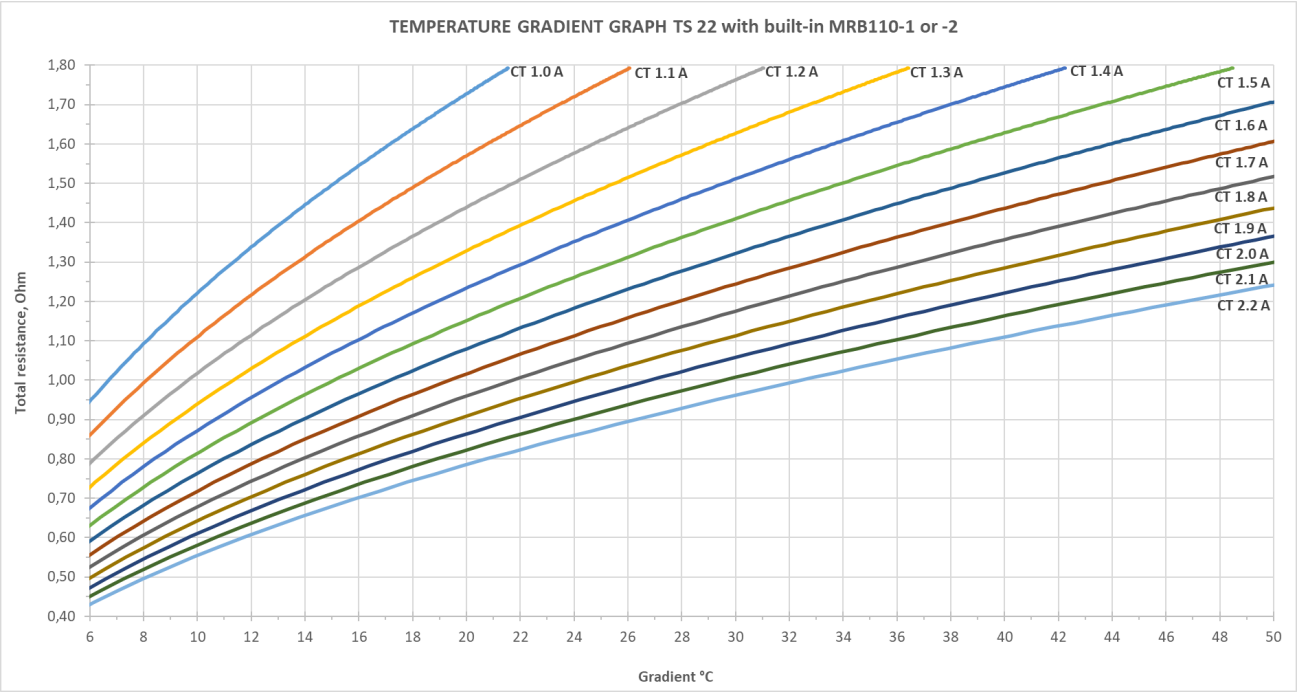
gilt nur für die Temperaturfühlertypen 1; 2; 2F; 5; 8; 22; 27 sowie für die Messbereiche
A (0...+150 °C) und C (-20...+130 °C)

Valid for MESSKO BETECH measuring range A (0...+150 °C) and C (-20...+130 °C)
and for bulb types 1, 2, 2F, 5, 8, 22 and 27



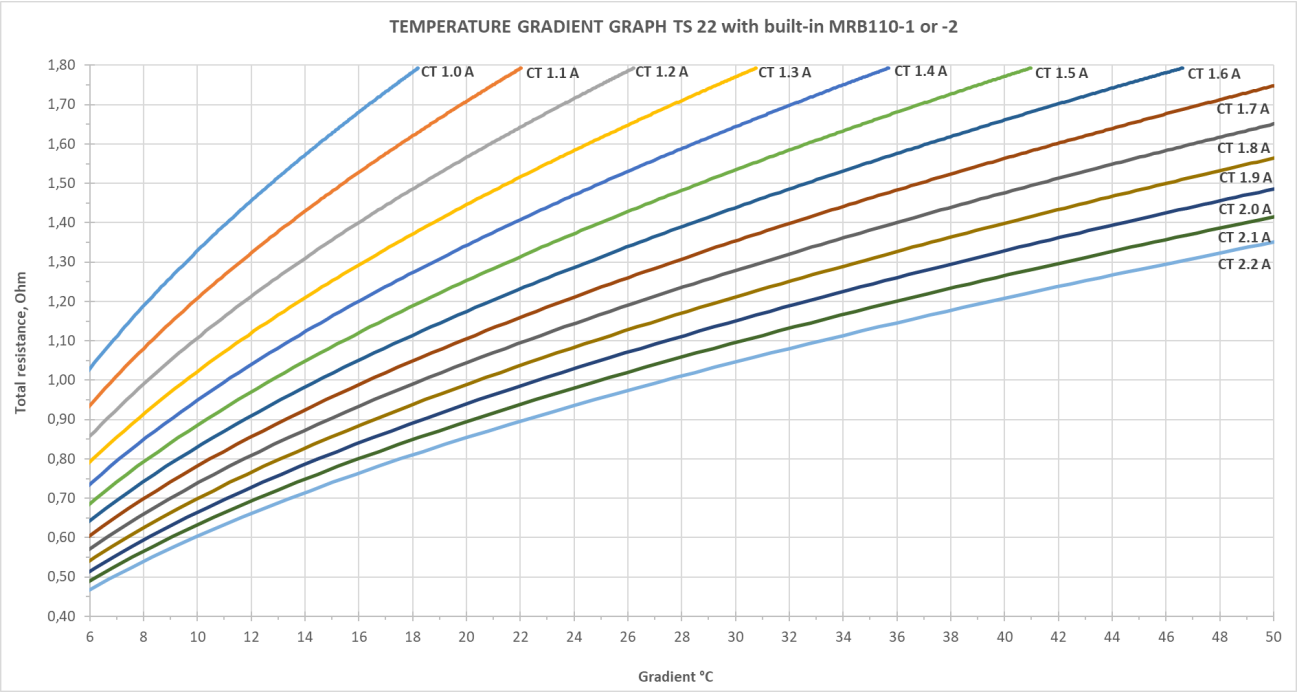
gilt nur für die Temperaturfühlertypen 1; 2; 2F; 5; 8; 22; 27 sowie für die Messbereiche
E (0...+160 °C)

Valid for MESSKO BETECH measuring range E (0...+160 °C)
and for bulb types 1, 2, 2F, 5, 8, 22 and 27



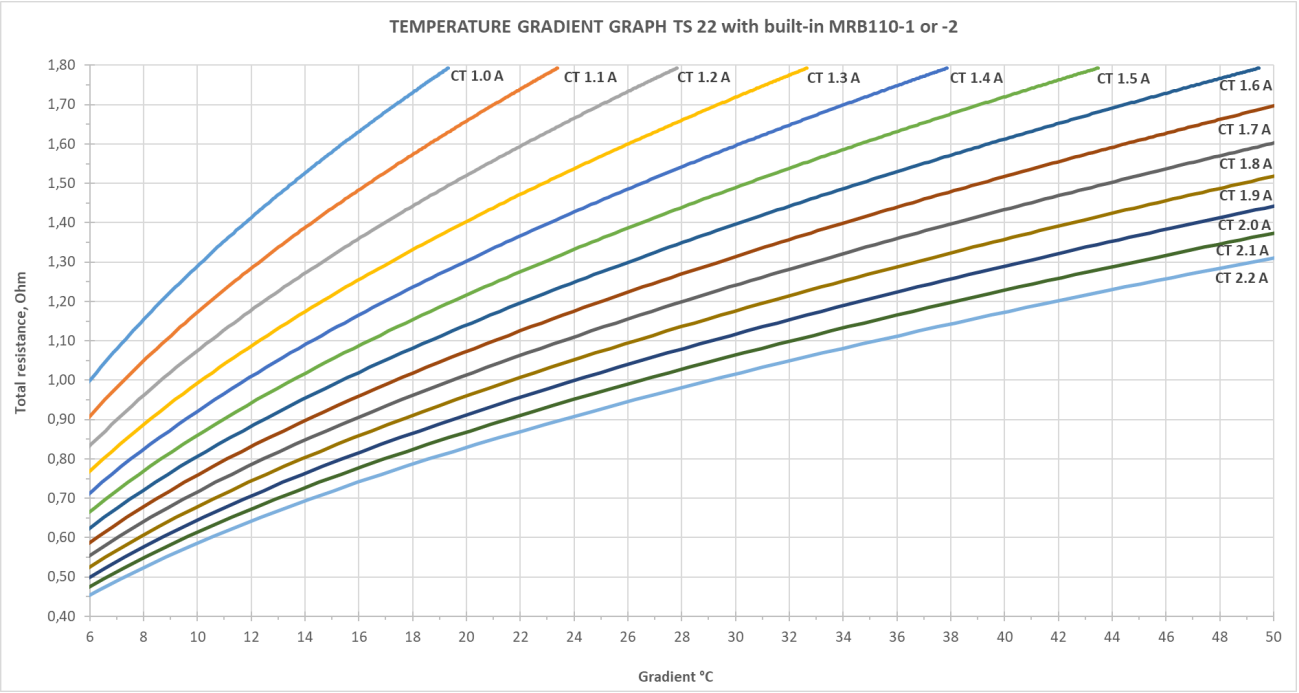
gilt nur für die Temperaturfühlertypen 1; 2; 2F; 5; 8; 22; 27 sowie für die Messbereiche
H (0...+200 °C)

Valid for MESSKO BETECH measuring range H (0...+200 °C)
and for bulb types 1, 2, 2F, 5, 8, 22 and 27



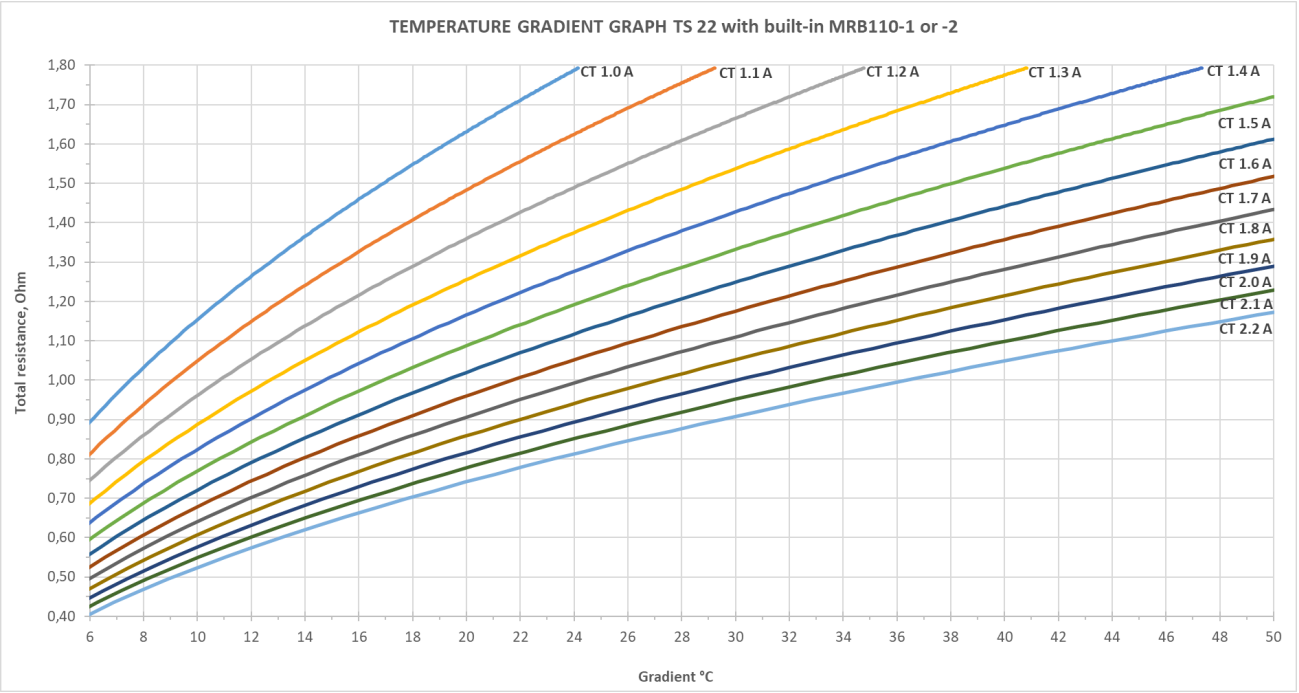
gilt nur für die Temperaturfühlertypen 6 sowie für die Messbereiche
A (0...+150 °C) und C (-20...+130 °C)

Valid for MESSKO BETECH measuring range A (0...+150 °C) and C (-20...+130 °C)
and for bulb types 6



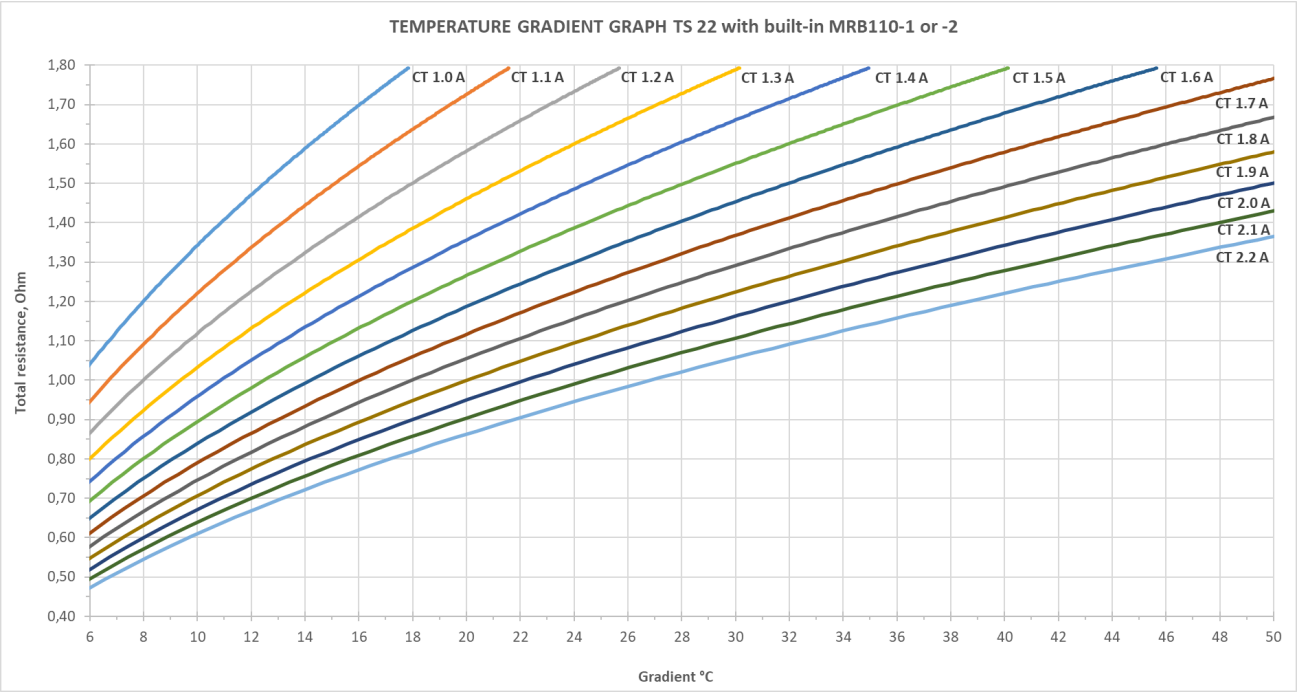
gilt nur für die Temperaturfühlertypen 6 sowie für die Messbereiche
E (0...+160 °C)

Valid for MESSKO BETECH measuring range E (0...+160 °C)
and for bulb types 6



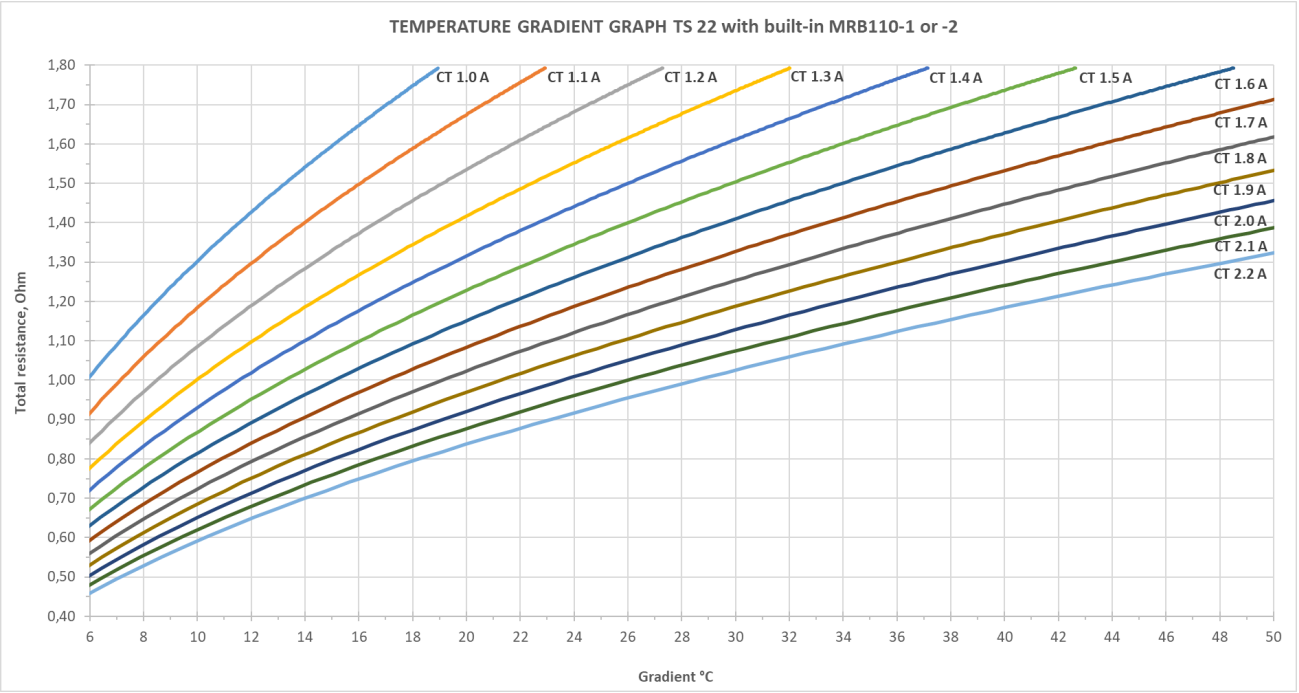
gilt nur für die Temperaturfühlertypen 6 sowie für die Messbereiche
H (0...+200 °C)

Valid for MESSKO BETECH measuring range H (0...+200 °C)
and for bulb types 6



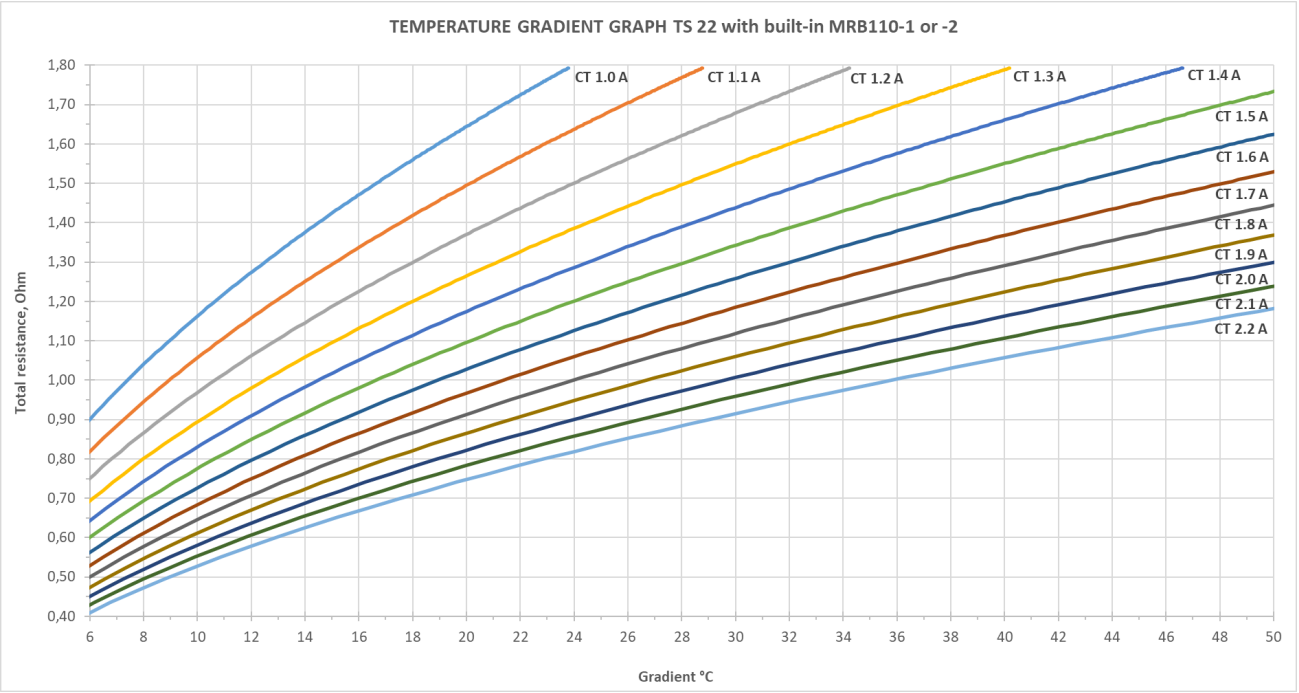
gilt nur für die Temperaturfühlertypen 9 und 10 sowie für die Messbereiche
A (0...+150 °C) und C (-20...+130 °C)

Valid for MESSKO BETECH measuring range A (0...+150 °C) and C (-20...+130 °C)
and for bulb types 9 and 10



gilt nur für die Temperaturfühlertypen 9 und 10 sowie für die Messbereiche
E (0...+160 °C)

Valid for MESSKO BETECH measuring range E (0...+160 °C)
and for bulb types 9 and 10



gilt nur für die Temperaturfühlertypen 9 und 10 sowie für die Messbereiche
H (0...+200 °C)

Valid for MESSKO BETECH measuring range H (0...+200 °C)
and for bulb types 9 and 10

12 Appendix

	DATE	NAME	DOCUMENT NO.	
DFTR.	26.07.2023	SCHAEFERB	SED 9167569 000 01	
CHKD.	26.07.2023	KISTNERM	CHANGE NO.	SCALE
STAND.	26.07.2023	KLEYN	1123770	1:3

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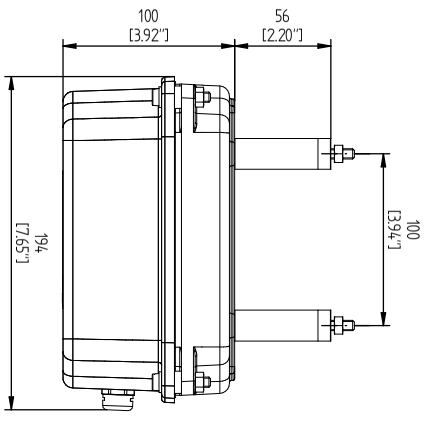
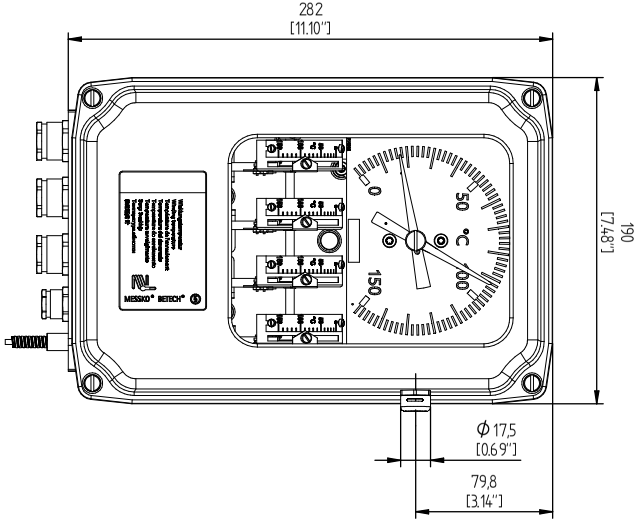
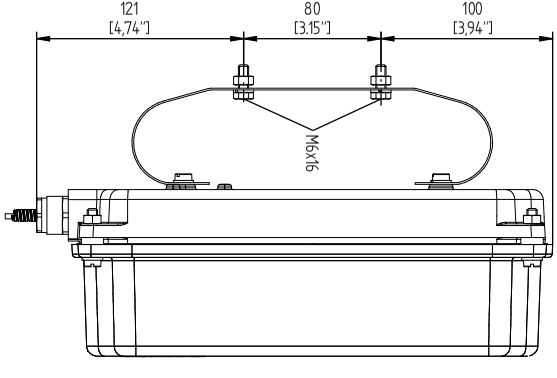
DIMENSION IN mm EXCEPT AS NOTED







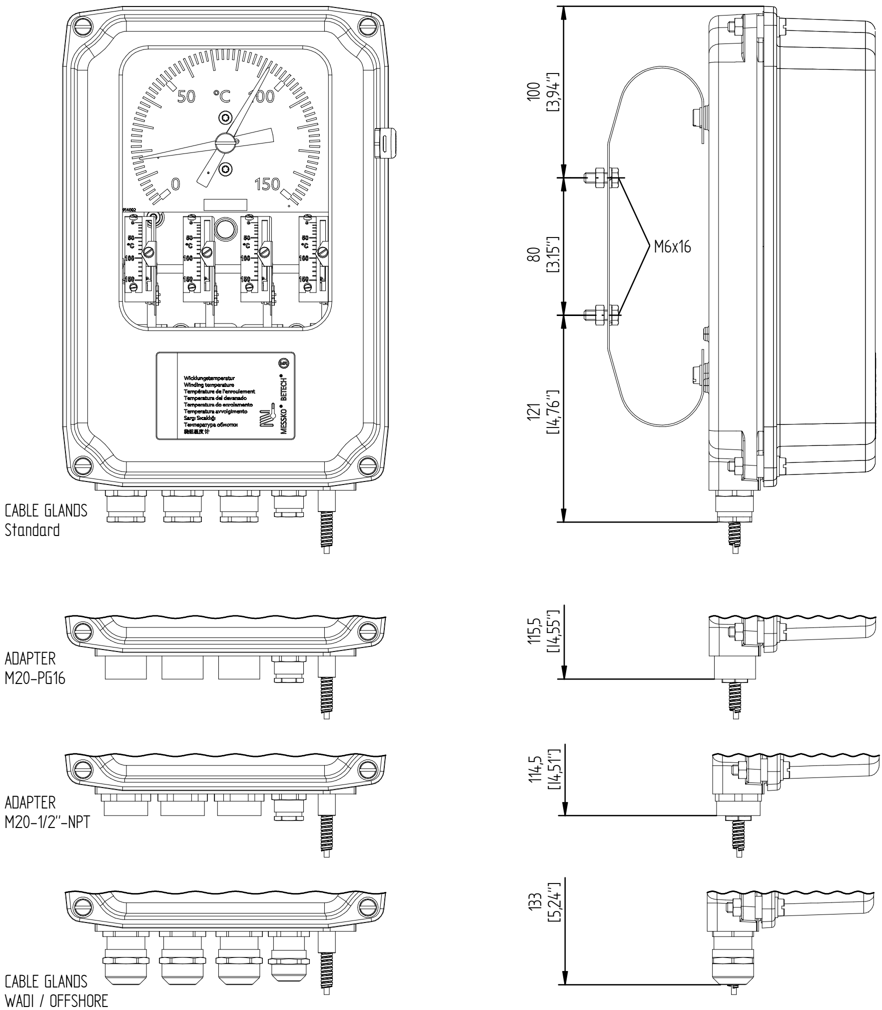
TRANSFORMER ACCESSORIES
BETECH POINTER THERMOMETER
638-0TI/4/1/2/6m/TT

SERIAL NUMBER

MATERIAL NUMBER
10173871 0M

SHEET
1 / 1

A4



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CHKD.	26.07.2023	KISTNERM	CHANGE NO.	SCALE
STAND.	26.07.2023	KLEYN	1123770	1:3

DIMENSION IN mm EXCEPT AS NOTED

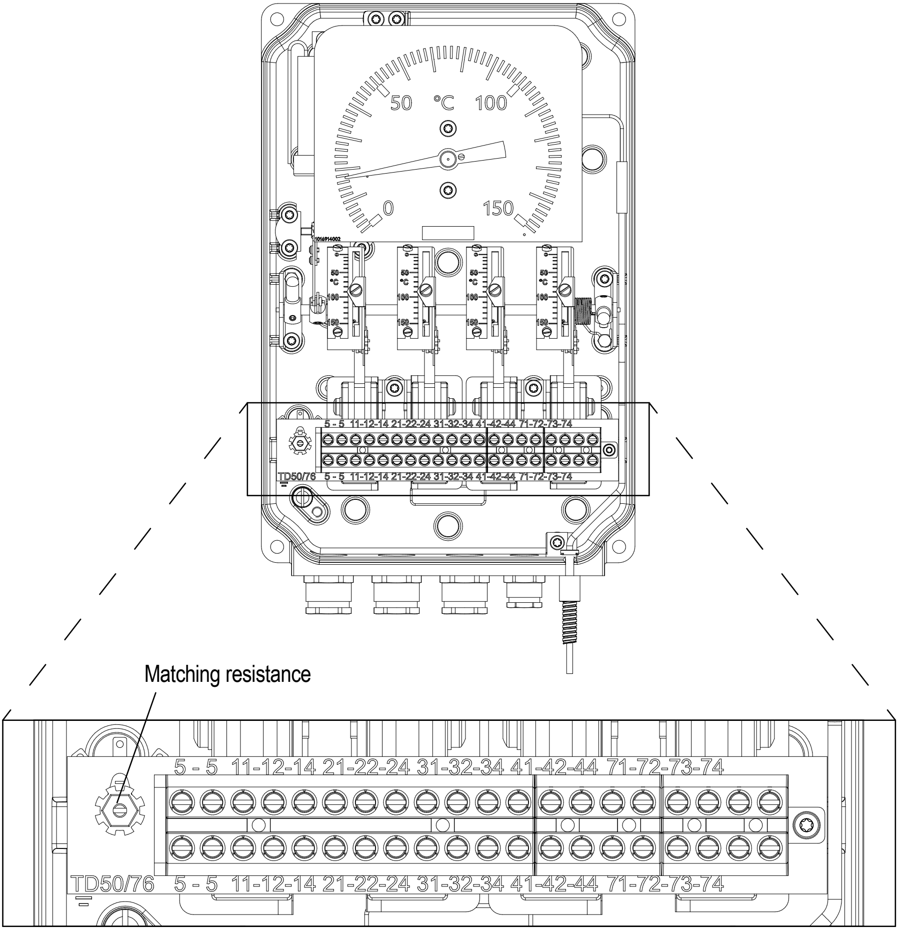
TRANSFORMER ACCESSORIES
BETECH POINTER THERMOMETER
CABLE GLANDS

SERIAL NUMBER

MATERIAL NUMBER 101738720M

SHEET 1/ 1

A4



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CHKD.	26.07.2023	KISTNERM	CHANGE NO.	SCALE
STAND.	26.07.2023	KLEYN	1123770	1:2,5

DIMENSION IN mm EXCEPT AS NOTED

TRANSFORMER ACCESSORIES
BETECH POINTER THERMOMETER
CONNECTION TERMINALS

SERIAL NUMBER	
MATERIAL NUMBER	SHEET
101740040M	1/ 1

A4

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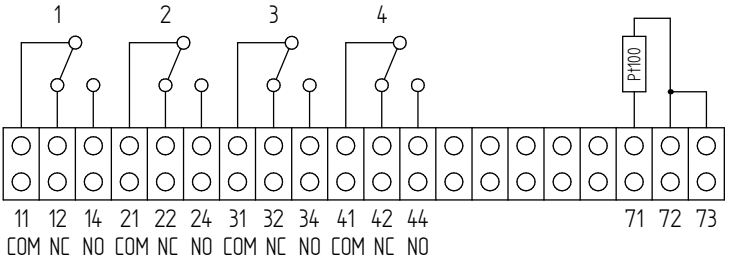
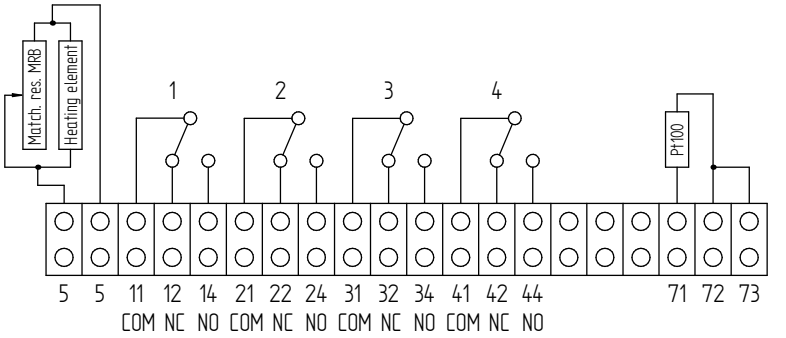
Wiring Diagram Example: OTI with 4 switches + Pt100



Wiring Diagram Example: WTI with 4 switches and MRB110 + Pt100



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CHKD	14.12.2022	SCHAEFERB	CHANGE NO.	SCALE
STAND.	15.12.2022	KLEYN	1118823	-

DIMENSION IN mm EXCEPT AS NOTED

TRANSFORMER ACCESSORIES
BETECH POINTER THERMOMETER
WIRING DIAGRAM EXAMPLE OTI / WTI 4 SWITCHES

SERIAL NUMBER

MATERIAL NUMBER 101742510M

SHEET 1 / 1

A4

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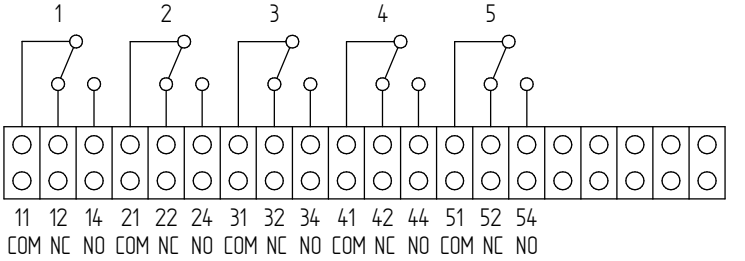
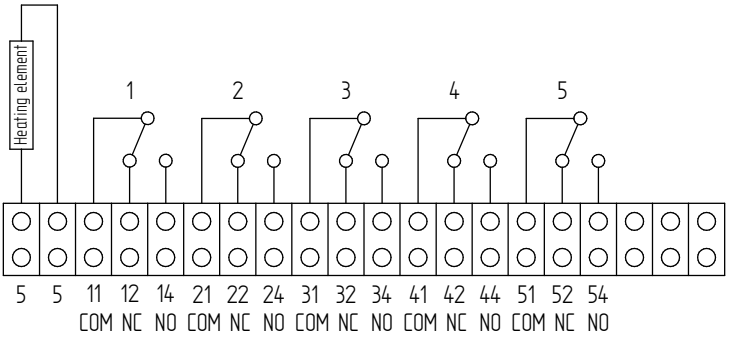
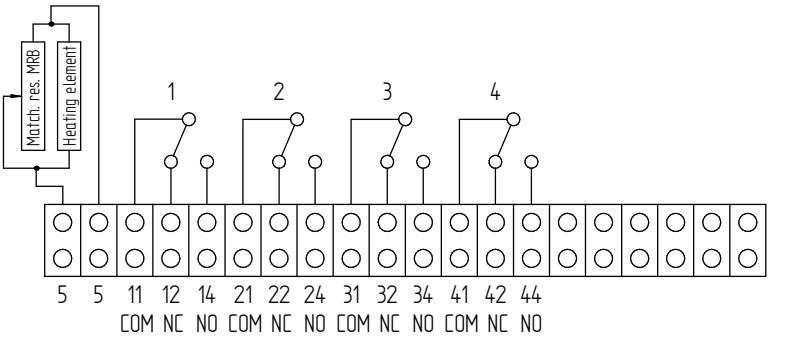
Wiring Diagram: OTI with 5 switches



Wiring Diagram: WTI with 5 switches



Wiring Diagram: WTI with 4 switches and MRB110



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CHKD	14.12.2022	SCHAEFERB	CHANGE NO.	SCALE
STAND.	15.12.2022	KLEYN	1118823	-

DIMENSION IN mm EXCEPT AS NOTED

TRANSFORMER ACCESSORIES
BETECH POINTER THERMOMETER
WIRING DIAGRAM /OTI 5 SWITCHESWTI 4 SWITCHES + MRB110

SERIAL NUMBER

MATERIAL NUMBER 101742490M

SHEET 1 / 1

A4

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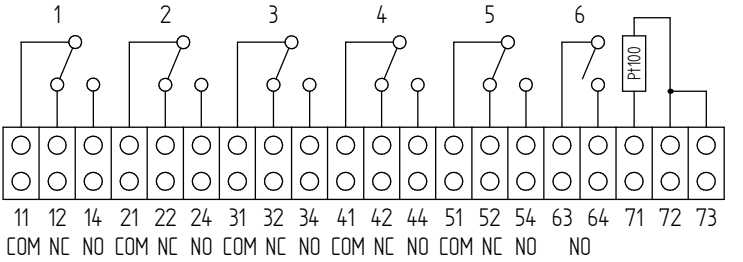
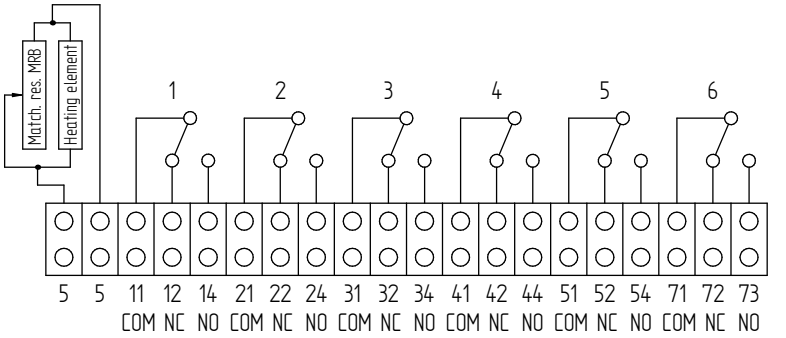
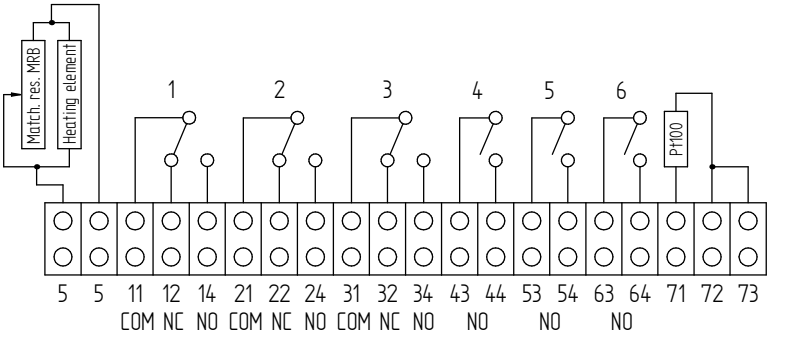
Wiring Diagram: OTI with 6 switches and Pt100



Wiring Diagram: WTI with 6 switches and MRB110



Wiring Diagram: WTI with 6 switches and MRB110 + Pt100



	DATE	NAME	DOCUMENT NO.	
DFTR.	19.01.2023	KISTNERM	SED 10098840 000 00	
CHKD	19.01.2023	SCHAEFFERB	CHANGE NO.	SCALE
STAND.	23.01.2023	WANNINGER	1118823	-

DIMENSION IN mm EXCEPT AS NOTED

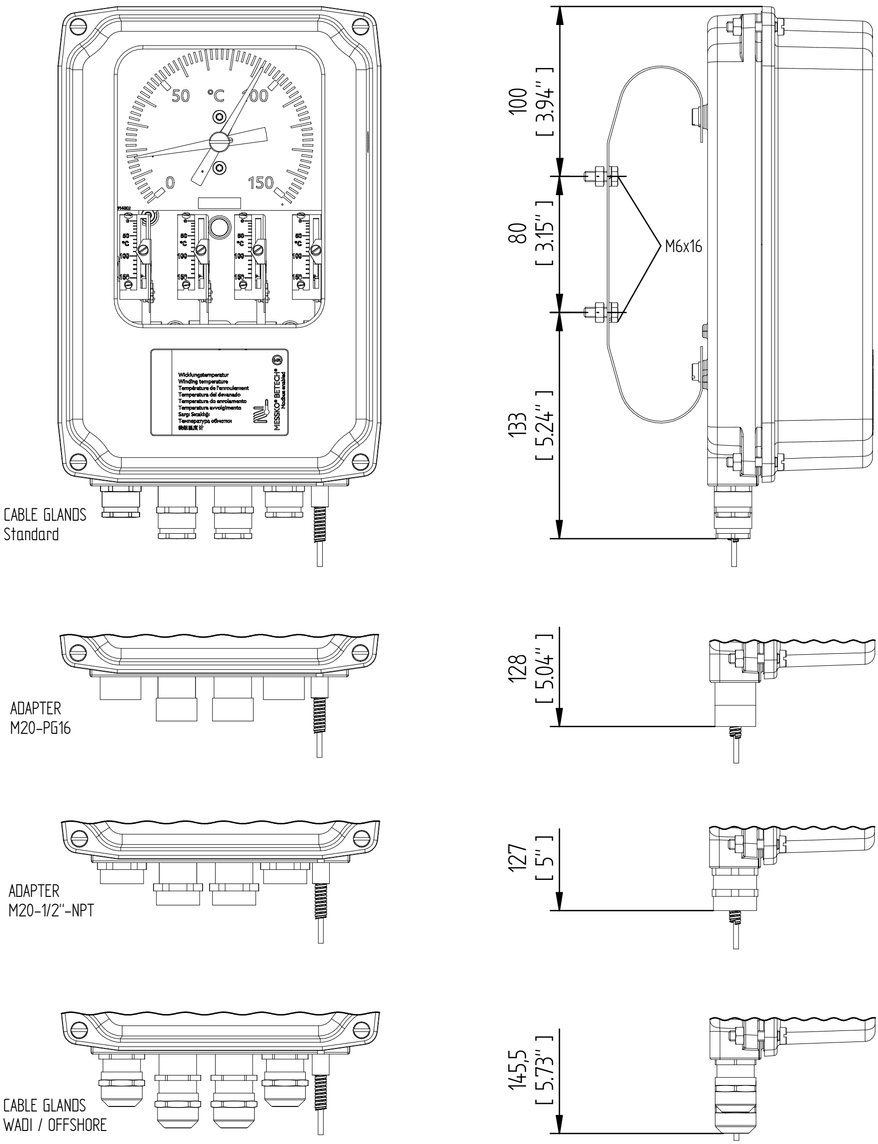
TRANSFORMER ACCESSORIES
BETECH POINTER THERMOMETER
WIRING DIAGRAM/OTI 6 SWITCHES + MRB110 + PT100

SERIAL NUMBER

MATERIAL NUMBER 101748590M

SHEET 1 / 1

A4



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	DATE	NAME	DOCUMENT NO.	
DFTR.	29.10.2024	ALALIM	SED 11598669 000 00	
CHKD.	29.10.2024	SCHAEFERB	CHANGE NO.	SCALE
STAND.	30.10.2024	KLEYN	1132492	1:3

DIMENSION IN mm EXCEPT AS NOTED

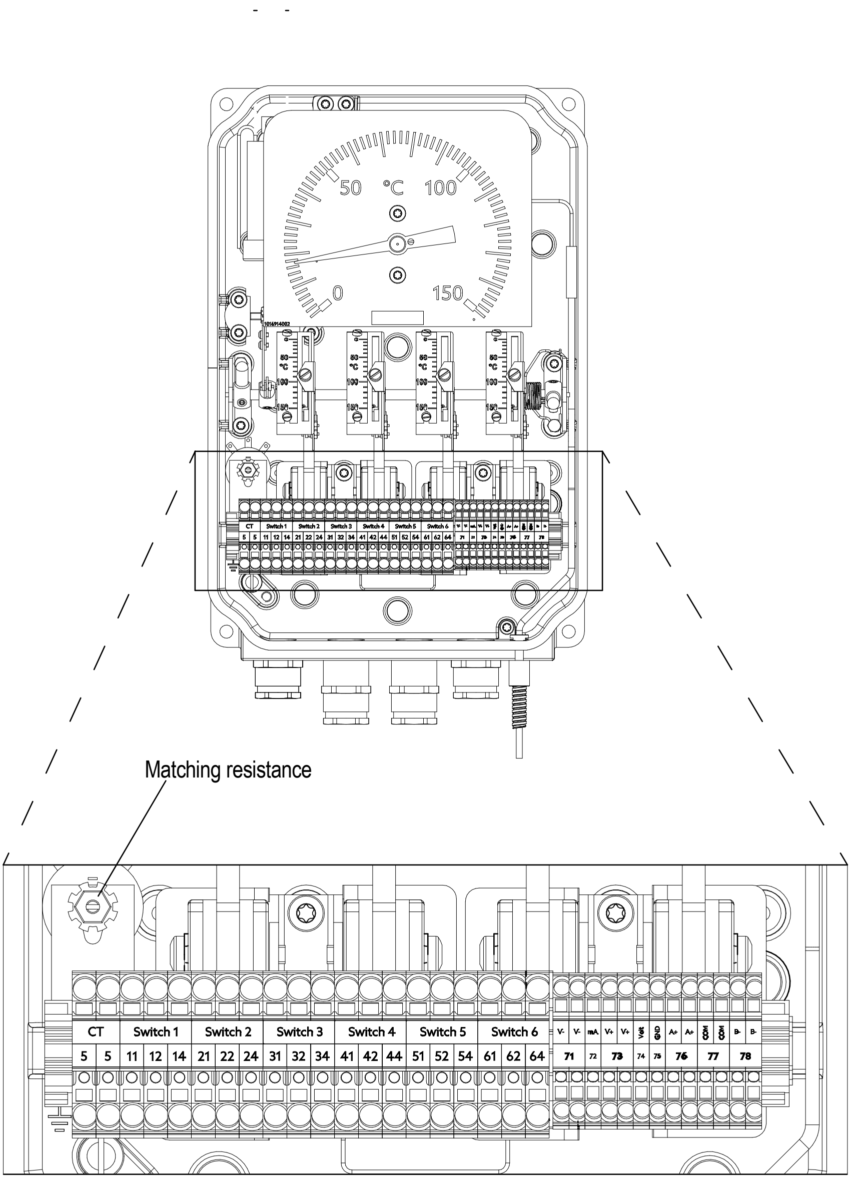
TRANSFORMER ACCESSORIES
BETECH POINTER THERMOMETER
CABLE GLANDS MODBUS

SERIAL NUMBER

MATERIAL NUMBER 101855680M

SHEET 1/ 1

A4



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	DATE	NAME	DOCUMENT NO.
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CHKD.	28.10.2024	SCHAEFERB	CHANGE NO. / SCALE
STAND.	29.10.2024	KLEYN	1132492

DIMENSION IN mm EXCEPT AS NOTED

MR

TRANSFORMER ACCESSORIES
BETECH POINTER THERMOMETER
CONNECTION TERMINALS MODBUS

SERIAL NUMBER

MATERIAL NUMBER 101854450M

SHEET 1/ 1

A4

11415184

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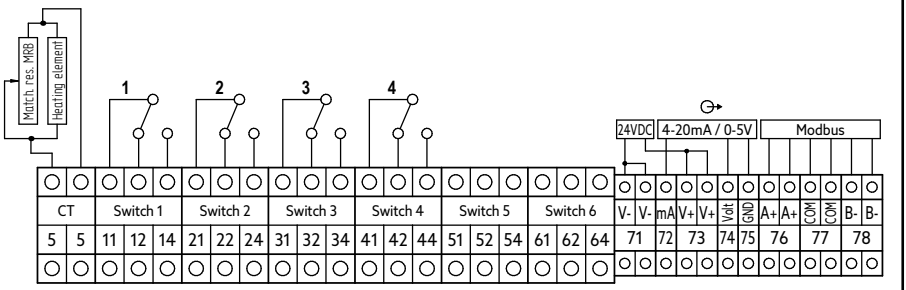
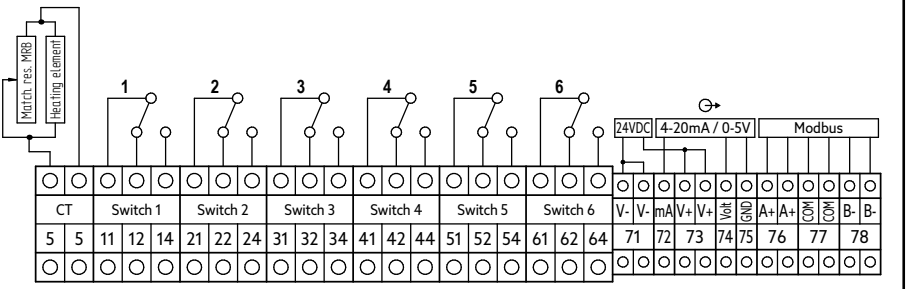
Wiring Diagram Example: WTI with 4 switches and MRB110 + 4-20 mA + 0-5 V + MODBUS



Wiring Diagram: WTI with 6 switches and MRB110 + 4-20 mA + 0-5 V + MODBUS



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CHKD.	29.10.2024	SCHAEFFERB	CHANGE NO.	SCALE
STAND.	30.10.2024	KLEYN	1132492	-

DIMENSION IN mm EXCEPT AS NOTED

TRANSFORMER ACCESSORIES
BETECH POINTER THERMOMETER
WIRING DIAGRAM/ WTI 4/6 SWITCHES + MRB110 + MODBUS

SERIAL NUMBER

MATERIAL NUMBER 101856250M

SHEET 1 / 1

A4

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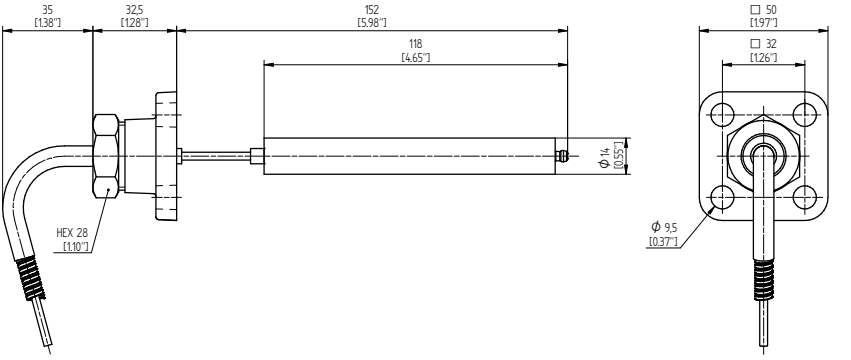
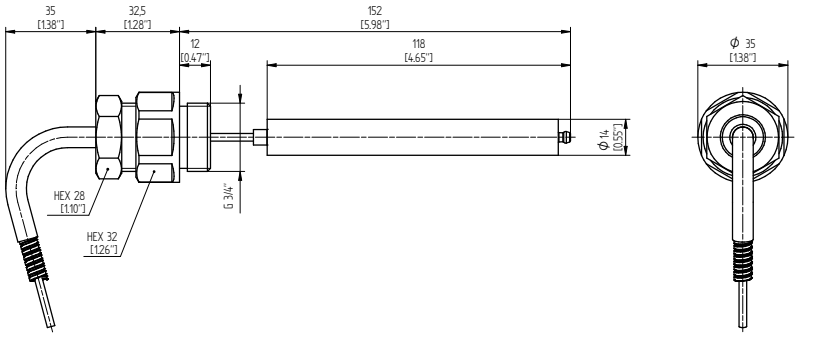
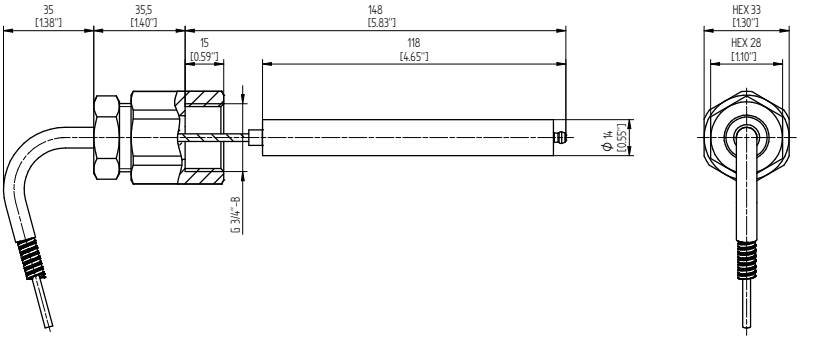
Dimensions bulb no. 1



Dimensions bulb no. 2



Dimensions bulb no. 2F



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CHKD	14.12.2022	SCHAEFFERB	CHANGE NO.	SCALE
STAND.	15.12.2022	KLEYN	1118823	1:2

DIMENSION IN mm EXCEPT AS NOTED

MR

TRANSFORMER ACCESSORIES
BETECH POINTER THERMOMETER
DIMENSIONS BULB NO. 1, 2, 2F

SERIAL NUMBER

MATERIAL NUMBER 101740210M

SHEET 1 / 1

A4

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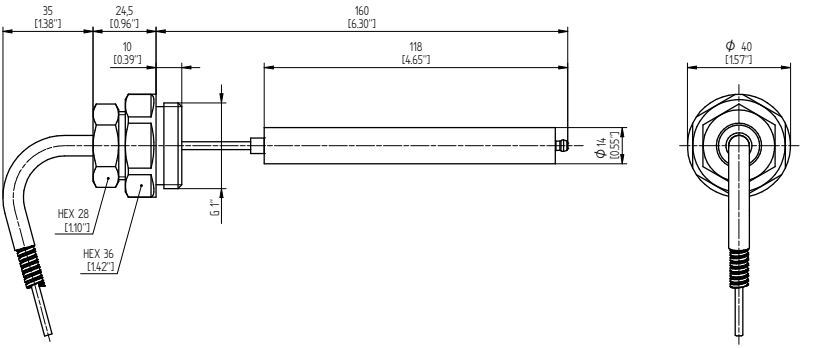
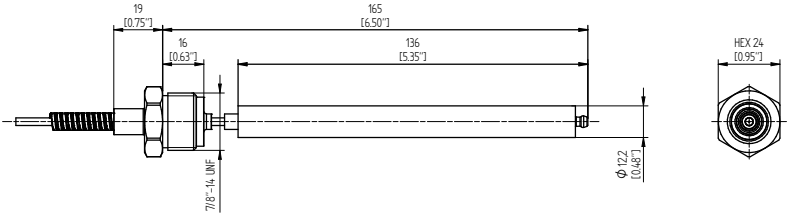
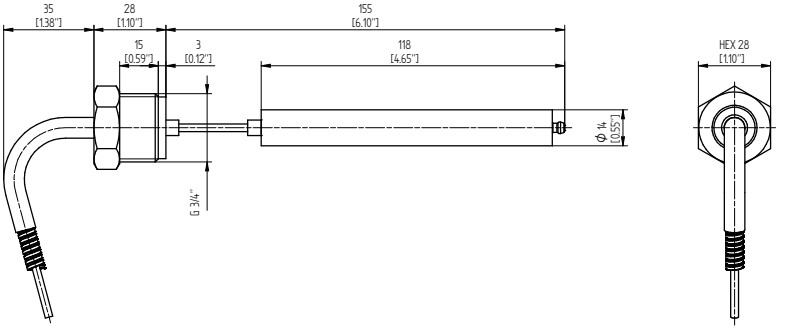
Dimensions bulb no. 5



Dimensions bulb no. 6



Dimensions bulb no. 8



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CHKD	14.12.2022	SCHAEFFERB	CHANGE NO.	SCALE
STAND	15.12.2022	KLEYN	1118823	1:2

DIMENSION IN mm EXCEPT AS NOTED

TRANSFORMER ACCESSORIES
BETECH POINTER THERMOMETER
DIMENSIONS BULB NO. 5, 6, 8

SERIAL NUMBER

MATERIAL NUMBER 101740250M

SHEET 1 / 1

A4

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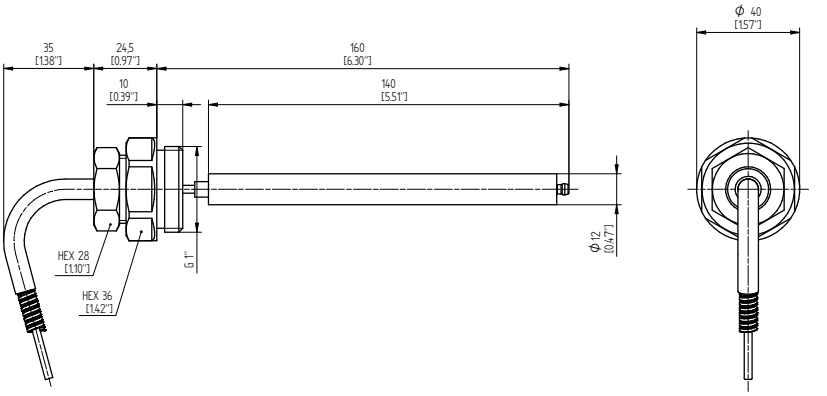
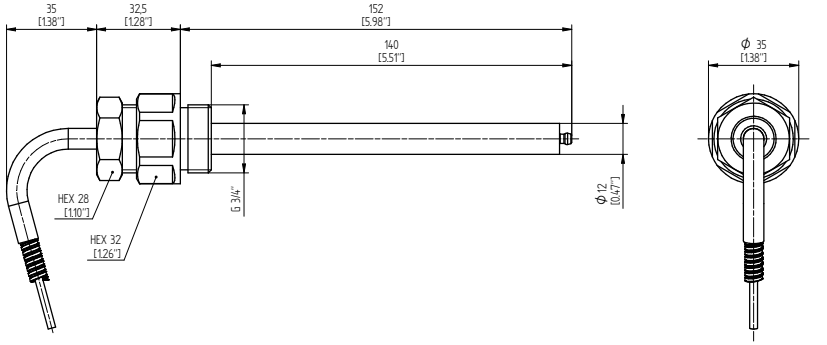
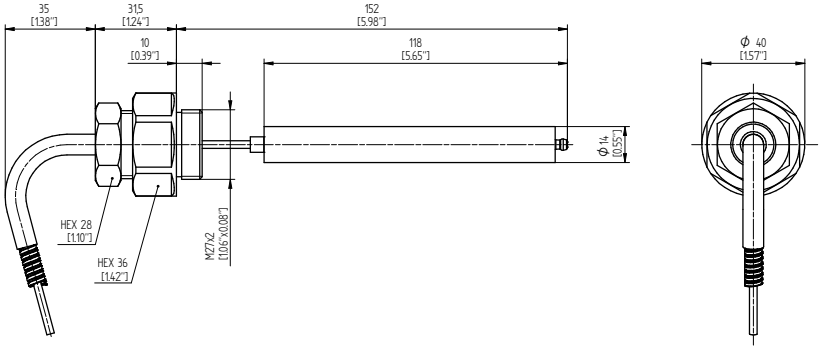
Dimensions bulb no. 9



Dimensions bulb no. 10



Dimensions bulb no. 27



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CHKD	14.12.2022	SCHAEFFERB	CHANGE NO.	SCALE
STAND.	15.12.2022	KLEYN	1118823	1:2

DIMENSION IN mm EXCEPT AS NOTED

MR

TRANSFORMER ACCESSORIES
BETECH POINTER THERMOMETER
DIMENSIONS BULB NO. 9, 10, 27

SERIAL NUMBER

MATERIAL NUMBER 101740280M

SHEET 1 / 1

A4

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Intel-Hex-Parser

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Modbus-Stack

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Glossary

Ambient air temperature
Permissible temperature of the air in the surroundings of the equipment in operation on which the device is installed.

EMC
Electromagnetic compatibility

Insulating fluid temperature
Permissible temperature of the insulating fluid in the product or directly on the product.

Operating temperature
Permissible temperature in the immediate surroundings of the device during operation taking ambient influences, for example due to the equipment and installation location, into consideration.

SCADA
Technical processes are monitored and controlled using a computer system (Supervisory Control and Data Acquisition)

Storage temperature
Permissible temperature for storing the device in an unmounted state or in a mounted state so long as the device is not in operation.

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