



OPTITEMP TT 50 C/R Handbook

HART[®]-compatible, intelligent two-wire transmitter

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1.1 Intended use

TT 50 C

The TT 50 C is an intelligent, universal HART®-compatible 2-wire in-head transmitter for temperature, resistance or voltage measurements in an industrial environment.

The transmitter is optionally available in an intrinsically safe version for installation in potentially explosive areas. These devices are labeled with the "Ex" symbol (TT 50 C Ex) and are approved for use in zone 0, 1 and 2 and division 1 and 2.

All versions are intended for installation in a "B connection head" or larger according to DIN 43729.

TT 50 R

The TT 50 R is an intelligent, universal HART®-compatible 2-wire rail-mount transmitter for temperature, resistance or voltage measurements in an industrial environment.

All versions are intended for installation on a top-hat rail according to DIN 50022.

1.2 Certifications

1.2.1 EC directive compliance

CE marking



The device fulfils all applicable statutory requirements of the following EC directives:

- EMC Directive 2004/108/EC
- Devices for use in potentially explosive areas: ATEX Directive 94/9/EC

The manufacturer certifies successful testing of the product by applying the CE marking.

1.2.2 Ex approvals (TT 50 C Ex)

ATEX	II 1 G Ex ia IIC T4/T5/T6 T4: +85°C / +185°F, T5: +65°C / +149°F, T6: +50°C / +122°F	DEMKO 06 ATEX 141335X
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INFORMATION!

See also "Certificates" in the download area of the manufacturer's website.

1.3 Safety instructions from the manufacturer

1.3.1 Copyright and data protection

The contents of this document have been created with great care. Nevertheless, we provide no guarantee that the contents are correct, complete or up-to-date.

The contents and works in this document are subject to copyright. Contributions from third parties are identified as such. Reproduction, processing, dissemination and any type of use beyond what is permitted under copyright requires written authorisation from the respective author and/or the manufacturer.

The manufacturer tries always to observe the copyrights of others, and to draw on works created in-house or works in the public domain.

The collection of personal data (such as names, street addresses or e-mail addresses) in the manufacturer's documents is always on a voluntary basis whenever possible. Whenever feasible, it is always possible to make use of the offerings and services without providing any personal data.

We draw your attention to the fact that data transmission over the Internet (e.g. when communicating by e-mail) may involve gaps in security. It is not possible to protect such data completely against access by third parties.

We hereby expressly prohibit the use of the contact data published as part of our duty to publish an imprint for the purpose of sending us any advertising or informational materials that we have not expressly requested.

1.3.2 Disclaimer

The manufacturer will not be liable for any damage of any kind by using its product, including, but not limited to direct, indirect, incidental, punitive and consequential damages.

This disclaimer does not apply in case the manufacturer has acted on purpose or with gross negligence. In the event any applicable law does not allow such limitations on implied warranties or the exclusion of limitation of certain damages, you may, if such law applies to you, not be subject to some or all of the above disclaimer, exclusions or limitations.

Any product purchased from the manufacturer is warranted in accordance with the relevant product documentation and our Terms and Conditions of Sale.

The manufacturer reserves the right to alter the content of its documents, including this disclaimer in any way, at any time, for any reason, without prior notification, and will not be liable in any way for possible consequences of such changes.

1.3.3 Product liability and warranty

The operator shall bear responsibility for the suitability of the device for the specific purpose. The manufacturer accepts no liability for the consequences of misuse by the operator. Improper installation and operation of the devices (systems) will cause the warranty to be void. The respective "Standard Terms and Conditions" which form the basis for the sales contract shall also apply.

1.3.4 Information concerning the documentation

To prevent any injury to the user or damage to the device it is essential that you read the information in this document and observe applicable national standards, safety requirements and accident prevention regulations.

If this document is not in your native language and if you have any problems understanding the text, we advise you to contact your local office for assistance. The manufacturer can not accept responsibility for any damage or injury caused by misunderstanding of the information in this document.

This document is provided to help you establish operating conditions, which will permit safe and efficient use of this device. Special considerations and precautions are also described in the document, which appear in the form of underneath icons.

1.3.5 Warnings and symbols used

Safety warnings are indicated by the following symbols.



DANGER!

This information refers to the immediate danger when working with electricity.



DANGER!

This warning refers to the immediate danger of burns caused by heat or hot surfaces.



DANGER!

This warning refers to the immediate danger when using this device in a hazardous atmosphere.



DANGER!

These warnings must be observed without fail. Even partial disregard of this warning can lead to serious health problems and even death. There is also the risk of seriously damaging the device or parts of the operator's plant.



WARNING!

Disregarding this safety warning, even if only in part, poses the risk of serious health problems. There is also the risk of damaging the device or parts of the operator's plant.



CAUTION!

Disregarding these instructions can result in damage to the device or to parts of the operator's plant.



INFORMATION!

These instructions contain important information for the handling of the device.



LEGAL NOTICE!

This note contains information on statutory directives and standards.



• **HANDLING**

This symbol designates all instructions for actions to be carried out by the operator in the specified sequence.

➔ **RESULT**

This symbol refers to all important consequences of the previous actions.

1.4 Safety instructions for the operator



WARNING!

*In general, devices from the manufacturer may only be installed, commissioned, operated and maintained by properly trained and authorized personnel.
This document is provided to help you establish operating conditions, which will permit safe and efficient use of this device.*

2.1 Scope of delivery

The scope of delivery always consists of the transmitter and its documentation.

2.2 General description

The TT 50 transmitters are intelligent 2-wire universal transmitters with one channel.

The transmitters are intended for:

- Temperature measurements with resistance thermometers
- Temperature measurements with thermocouples
- Temperature difference measurements with resistance thermometers
- Measurements with potentiometers
- Voltage measurements in a range -10...+500 mV



INFORMATION!

*The **TT 50 C** is optionally available for operation in potentially explosive areas (zone 0, 1 and 2 and division 1 and 2).*

The **TT 50 C / TT 50 C Ex** are designed for installation in a "B connection head" according to DIN 43729 or larger.

The **TT 50 R** is designed for installation on a rail according to DIN 50022.

The 2-wire universal transmitters are HART[®] 5-compatible. Configuration of the transmitter is possible with:

- HART[®] 5 protocol via 4...20 mA output circuit
- HART[®] 5 hand held terminal
- The third part PC software with a FSK modem for HART[®] 5 communication
- PC configuration software (HartSoft) with HART[®] modem

To configure the transmitter using an IBM-compatible PC, the "HartSoft" software is required. The Windows-based "HartSoft" software can be used to access all functions of the transmitter. It is also used for configuration, calibration, display and documentation.

2.3 Nameplate

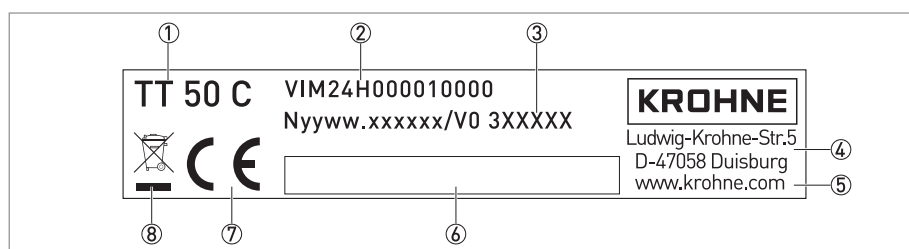


INFORMATION!

Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.

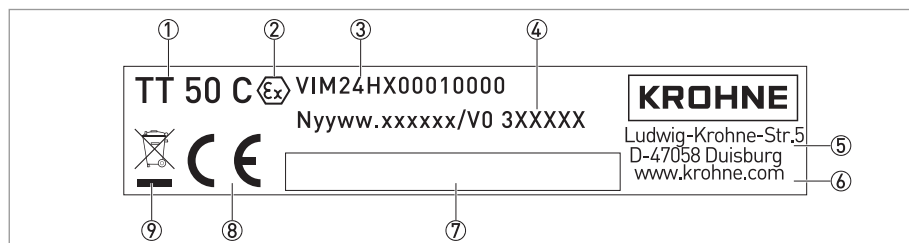
The transmitter can be identified by the information on the nameplates.

2.3.1 Example of a nameplate for an in-head transmitter (Non-Ex)

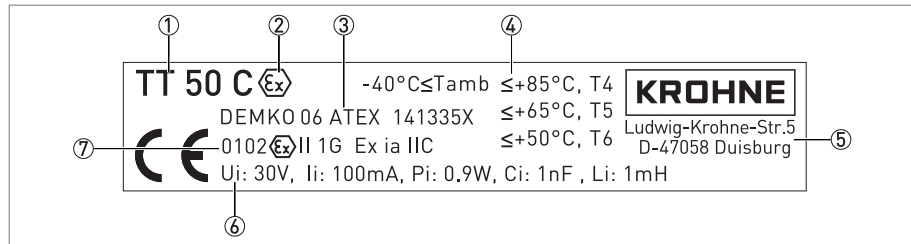


- ① Product name
- ② Part number
- ③ Year and week of manufacturing / batch number
- ④ Manufacturer and address
- ⑤ Website of manufacturer
- ⑥ Space for configuration data sticker
- ⑦ CE marking (EC conformity)
- ⑧ WEEE dustbin symbol

2.3.2 Example of namplates for an in-head transmitter (Ex)

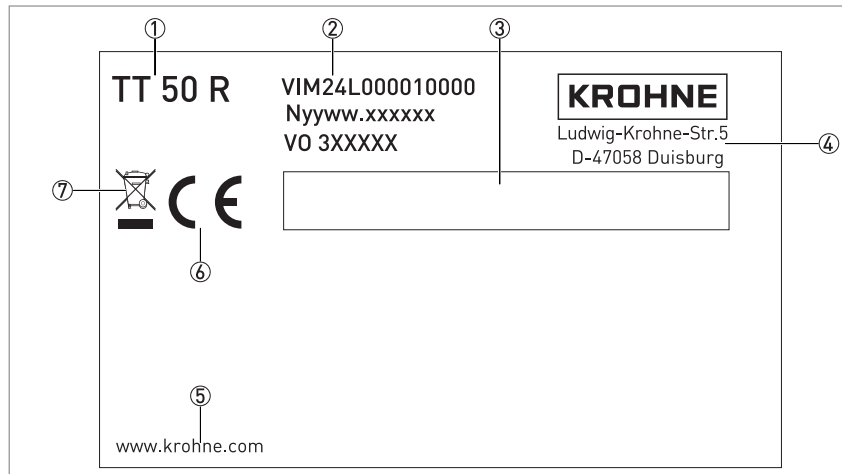


- ① Product name
- ② Symbol for Ex-approval
- ③ Part number
- ④ Year and week of manufacturing / batch number
- ⑤ Manufacturer and address
- ⑥ Website of manufacturer
- ⑦ Space for configuration data sticker
- ⑧ CE marking (EC conformity)
- ⑨ WEEE dustbin symbol



- ① Product name
- ② Symbol for Ex-approval
- ③ ATEX approval
- ④ Temperature classes
- ⑤ Manufacturer and address
- ⑥ Ex-relevant electrical data
- ⑦ Supplementary Ex-data

2.3.3 Nameplate for rail-mount transmitter



- ① Product name
- ② Top down: part number, year and week of manufacturing, batch number
- ③ Space for configuration data sticker
- ④ Manufacturer and address
- ⑤ Website of manufacturer
- ⑥ CE marking (EC conformity)
- ⑦ WEEE dustbin symbol

3.1 Notes on installation

**INFORMATION!**

Inspect the cartons carefully for damage or signs of rough handling. Report damage to the carrier and to the local office of the manufacturer.

**INFORMATION!**

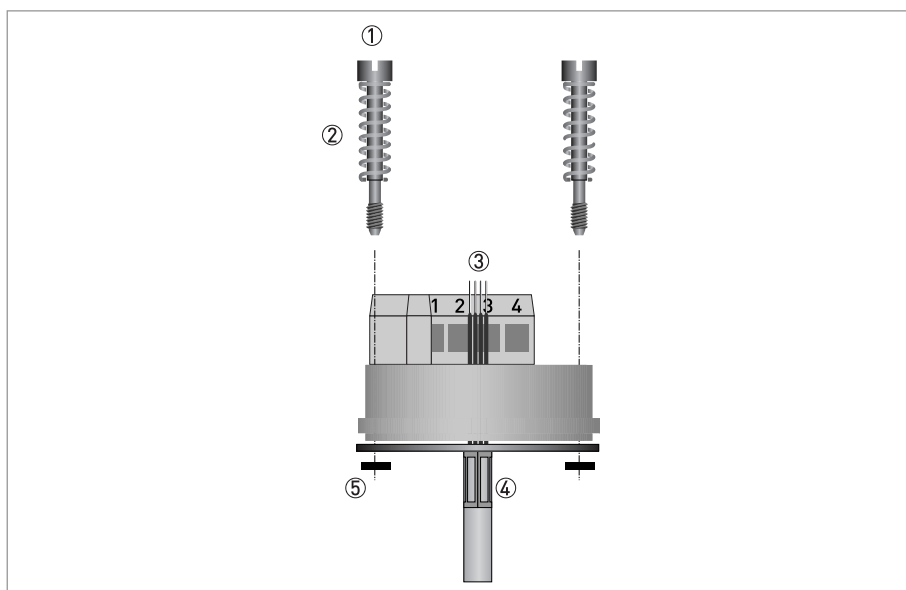
Check the packing list to check if you received completely all that you ordered.

**INFORMATION!**

Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.

3.2 In-head transmitter

These transmitters are intended for installation in DIN B connection heads or larger. The large $\varnothing 7$ mm / 0.28" center hole facilitates the electrical connection of the measurement sensor and the installation. For detailed information refer to the chapter "Dimensions and weights".



- ① Screw M4
- ② Spring
- ③ Sensor connection cables
- ④ Protection tube
- ⑤ Lock washer

**DANGER!**

Never install or operate the TT 50 C in potentially explosive areas, it might cause an explosion that can result in fatal injuries! Only use the TT 50 C Ex in potentially explosive areas!

The Ex transmitter can be installed in potentially hazardous areas zone 0, 1 and 2. It must be supplied by an intrinsically safe power supply unit or Zener barrier placed outside of the potentially explosive zone.

The Ex transmitter must be installed in a housing with the protection rating IP20 or better according to EN 60529 / IEC 60529.

**CAUTION!**

The TT 50 C / TT 50 C Ex temperature transmitter has been developed for an ambient temperature of -40...+85°C / -40...+185°F. Please also note that the ambient temperature is also dependent on the temperature category. For detailed information refer to Ex data of the ambient temperature.

The process temperature is also transferred to the transmitter housing via the protective tube. If the process temperature is close to or exceeds the maximum specified ambient temperature of the transmitter, then the temperature in the transmitter housing can rise above the maximum permissible ambient temperature. Always check that the ambient temperature does not exceed the permissible range!

One way to decrease heat transfer via the protective tube is to make the protective tube longer or in general to install the transmitter farther away from the heat source. The same safety measures can be taken if the temperature is below the specified minimum temperature.

**CAUTION!**

The TT 50 C Ex may only be installed in a light metal housing, whose magnesium component does not exceed 6%.

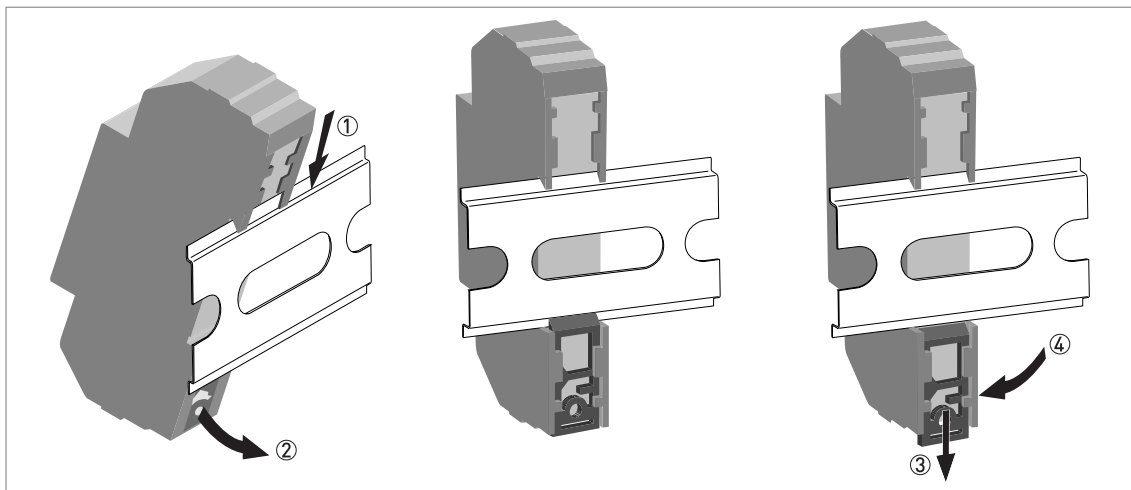
3.3 Rail-mount transmitter



DANGER!

Never install or operate the TT 50 C in potentially explosive areas, it might cause an explosion that can result in fatal injuries!

The rail-mount transmitter is intended for installation on a rail according to DIN 50022.



- ① Hook the upper groove of the transmitter onto the rail.
- ② Press the lower part of the transmitter against the rail.
- ➡ When you hear a "click" from the snap fastener, the transmitter is fixed onto the rail (drawing in the centre).
- ③ To remove the transmitter, use a small screwdriver to push the snap fastener downwards.
- ④ Carefully move the lower part of the transmitter in the forward direction and then upwards.

4.1 Safety instructions

**DANGER!**

All work on the electrical connections may only be carried out with the power disconnected. Take note of the voltage data on the nameplate!

**DANGER!**

Observe the national regulations for electrical installations!

**DANGER!**

The transmitter is protected against polarity reversal. No damage will occur to the device if the polarity of the supply voltage is switched. The output will then indicate 0 mA.

**DANGER!**

Always observe the corresponding chapters and the instructions in this manual when connecting devices with an Ex certificate!

Never install or operate the TT 50 C in potentially explosive areas, it might cause an explosion that can result in fatal injuries!

For the operation in potentially explosive areas the manufacturer offers the TT 50 C Ex. You may only connect this transmitter to sensors that meet the requirements for "simple equipment" in EN 60079-11:2007, section 5.7.

**WARNING!**

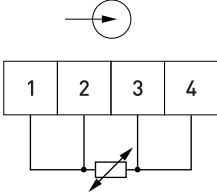
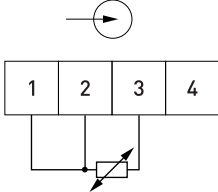
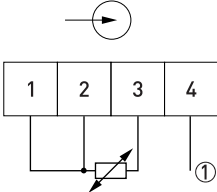
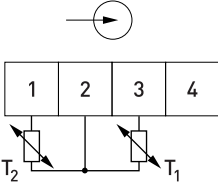
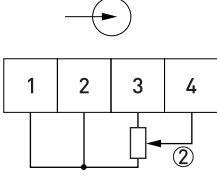
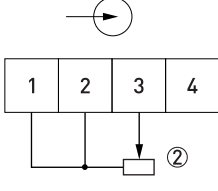
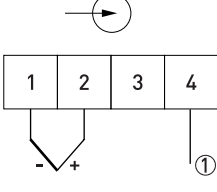
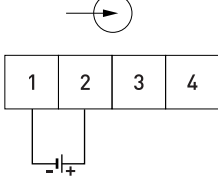
Observe without fail the local occupational health and safety regulations. Any work done on the electrical components of the measuring device may only be carried out by properly trained specialists.

**INFORMATION!**

Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.

4.2 Electrical connections (in-head and rail-mount)

The input and output signals and the power supply must be connected in accordance with the following illustrations. The in-head transmitter is easy to install with the connection head installation kit. To avoid measuring errors, all cables must be connected properly and the screws tightened correctly.

<p>Pt10...1000, Ni100, Ni1000, 4-wire connection</p> 	<p>Pt10...1000, Ni100, Ni1000, 3-wire connection</p> 
<p>Pt100 "SmartSense", 3-wire connection</p> 	<p>Pt100, temperature difference, $T_1 > T_2$</p> 
<p>Potentiometer, 4-wire connection</p> 	<p>Potentiometer, 3-wire connection</p> 
<p>Thermocouple</p> 	<p>Voltage</p> 

- ① SmartSense wire
- ② Maximum input

4.3 Connection diagram of in-head transmitter



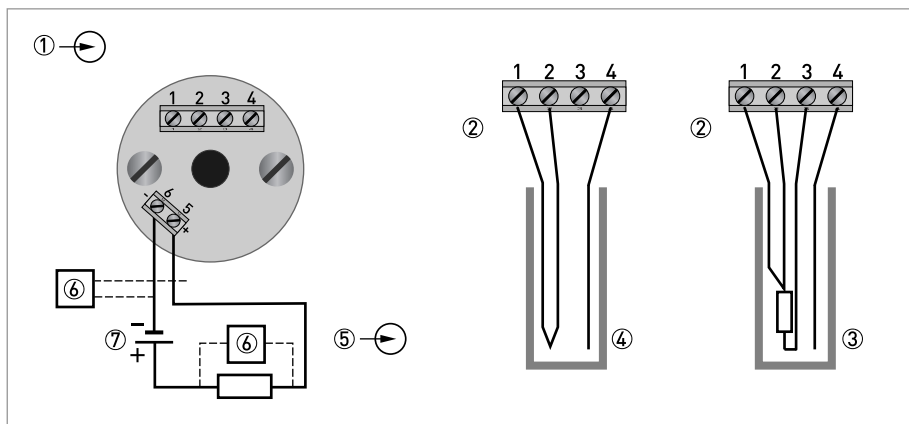
DANGER!

Never install or operate this transmitter in potentially explosive areas, it might cause an explosion that can result in fatal injuries!



DANGER!

To enable HART[®] communication, the output circuit must have an output load of at least 250 Ω.



- ① Input
- ② SmartSense temperature sensor
- ③ Pt100 3-wire connection
- ④ Thermocouple
- ⑤ Output
- ⑥ Modem
- ⑦ Voltage supply 10...42 VDC



INFORMATION!

The HART[®] modem is connected parallel to the output load or parallel to the output of the transmitter.

4.4 Connection diagram of in-head transmitter (Ex)

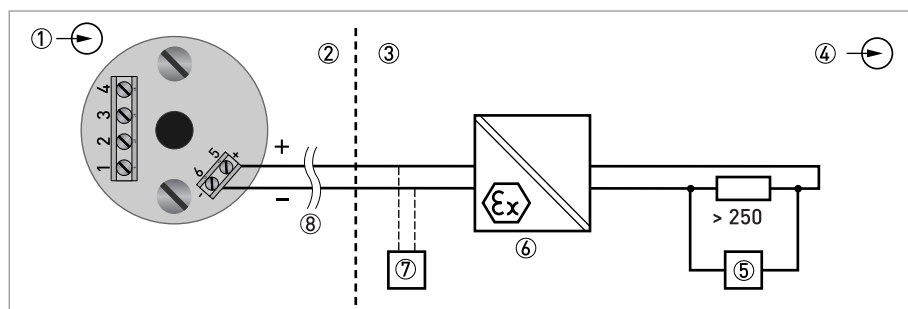
**DANGER!**

The Ex transmitter can be installed in potentially explosive areas of zone 0, 1 and 2. It may only be connected to sensors that meet the requirements for "simple equipment" in EN 60079-11:2007, section 5.7. During operations in potentially explosive areas always regard the relevant safety instructions and especially the following items:

- The transmitter must be supplied by an intrinsically safe power supply unit or Zener barrier placed outside of the potentially explosive area.
- The output parameters of the Ex approved Zener barrier or voltage supply and the output parameters of the Ex approved HART unit or modem have to be less or equal than the input parameters of the transmitter (i.e. U_i , I_i , P_i , L_i , C_i).
- Only use an Ex approved HART[®] modem.
- Observe the maximum cable length of the output circuit to ensure reliable HART[®] communication with this transmitter (on page 19).

**DANGER!**

To enable HART[®] communication, the output circuit must have an output load of at least 250 Ω .



- ① Input
- ② Potentially explosive area
- ③ Safe area
- ④ Output
- ⑤ Modem
- ⑥ Zener barrier or voltage supply 12...30 VDC (intrinsically safe)
- ⑦ Modem, Ex-approved
- ⑧ See section "Cable length"

**INFORMATION!**

The HART[®] modem is connected parallel to the output load or parallel to the output of the transmitter.

4.5 Connection diagram of rail-mount transmitter



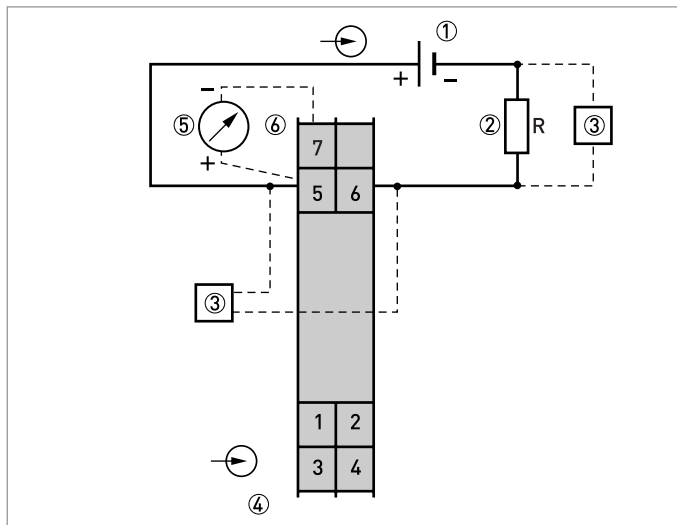
DANGER!

Neither operate this transmitter in potentially explosive areas, nor connect it to a sensor located in a potentially explosive area! Otherwise the transmitter might cause an explosion that can result in fatal injuries!



DANGER!

To enable HART[®] communication, the output circuit must have an output load of at least 250 Ω.



- ① Voltage supply 11...42 VDC
- ② R_{Load}
- ③ Modem
- ④ Input
- ⑤ Measuring device
- ⑥ Test circuit



INFORMATION!

The HART[®] modem is connected parallel to the output load or parallel to the output of the transmitter.

4.6 Cable length

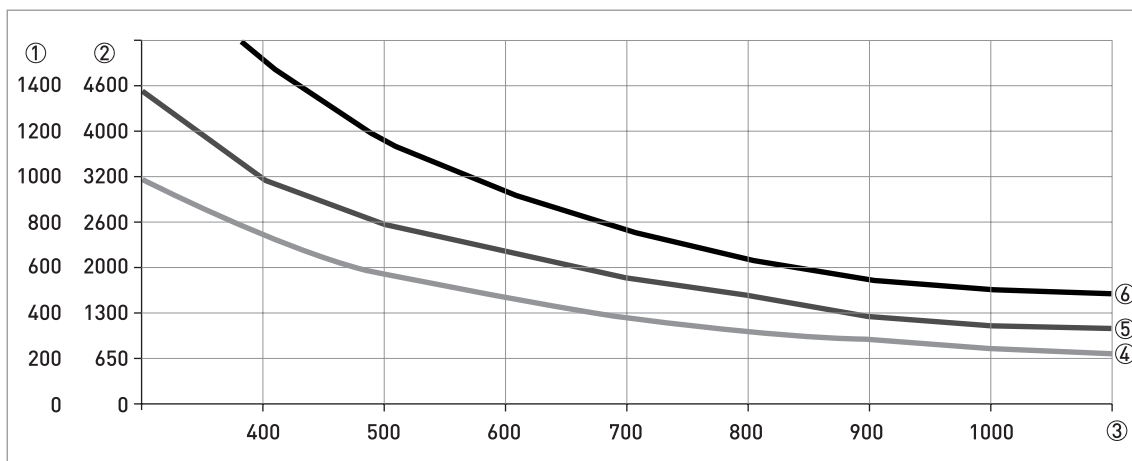
In order to ensure reliable HART[®] communication, the maximum cable length of the output circuit must be observed.



DANGER!

In the Ex version, please note that the maximum cable length is determined by a resistance, an inductance and a capacitance of the cable. The total capacitance and inductance of the cable must be within the limits for the transmitter described in the Ex certificate.

To calculate the maximum cable length for the output circuit, determine the total resistance of the output loop (load resistance + approximate cable resistance). Find out the capacitance of the cable being used. In the following tables you can find the maximum cable length based on the typical values for 1 mm² cables. CN is the abbreviation for "Capacitance Number" which is multiple of 5000 pF present in the device.



- ① Cable length [m]
- ② Cable length [ft]
- ③ Load resistance and cable resistance
- ④ 200 pF per m/ft
- ⑤ 150 pF per m/ft
- ⑥ 100 pF per m/ft

For multiple connections (multidrop mode), the following formula shall be used:

$$L = [(65 \times 10^6) / (R \times C)] \times (C_n \times 5000 + 10000) / C$$

with

L: cable length [m or ft]

R: load resistance (incl. the resistance of any Zener barrier) + cable resistance [Ω]

C: cable capacitance [pF/m or pF/ft]

Cn: number of transmitters in the loop

5.1 HART[®] networks



DANGER!

Only connect an Ex approved HART[®] modem located in a safe area to a transmitter in a potentially explosive area.



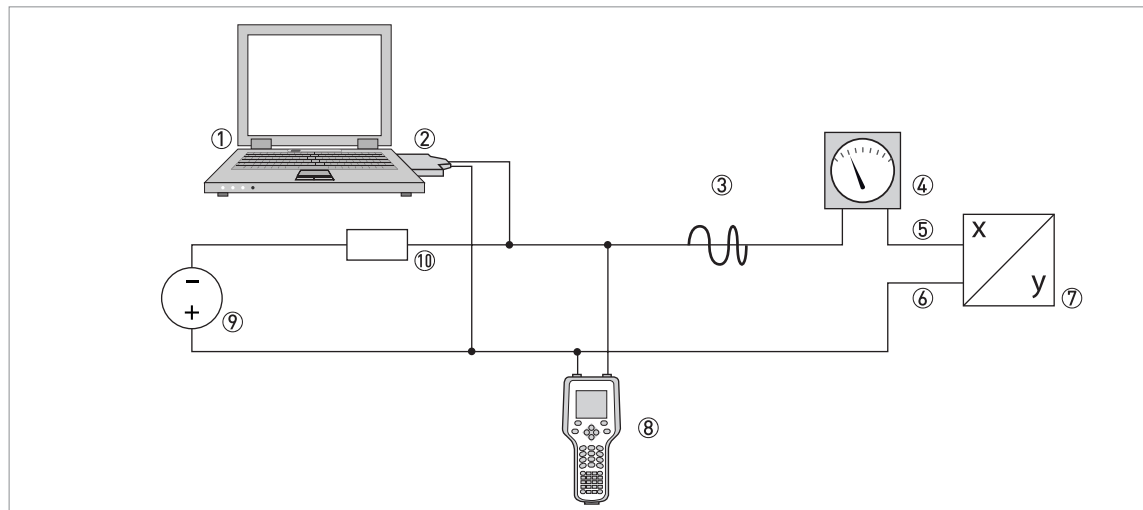
CAUTION!

In order to ensure reliable HART[®] communication with this transmitter, the loop resistance must be at least 250 Ω!

5.1.1 Point-to-point connection analog / digital mode

Point-to-point connection between the transmitter and the HART[®] master.

The current output of the device may be active or passive.



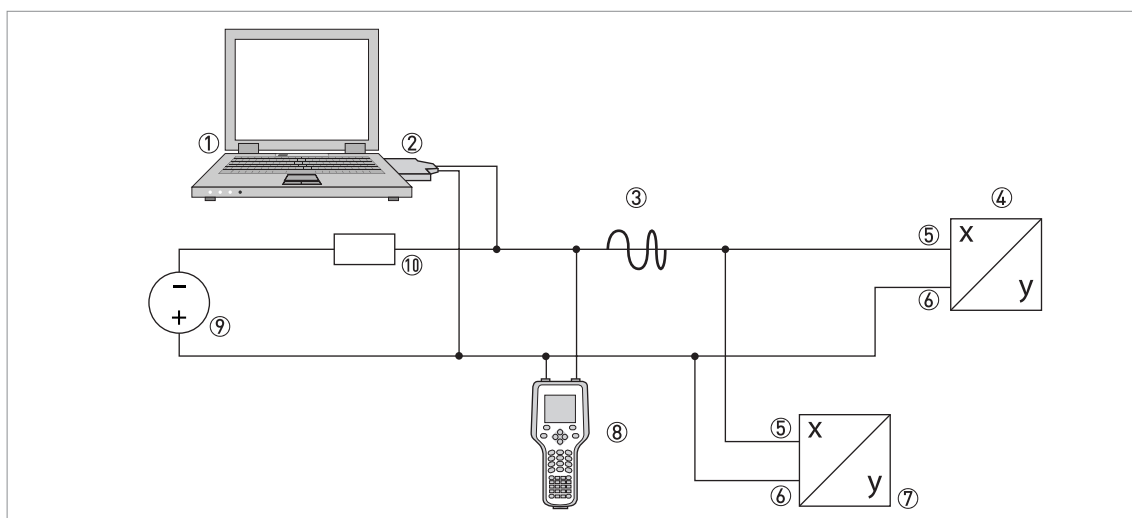
- ① Primary Master
- ② HART[®] modem
- ③ HART[®] signal
- ④ Analog indicator
- ⑤ Terminal 5
- ⑥ Terminal 6
- ⑦ Device with address = 0 and passive or active current output
- ⑧ Secondary Master
- ⑨ Power supply for devices (slaves) with passive current output
- ⑩ Load $\geq 250 \Omega$ (Ohm)

5.1.2 Multi-drop connection (2-wire connection)

As a multipoint connection (Multidrop) with up to 15 devices in parallel (this transmitter or other HART[®] devices).

The current outputs of the devices must be passive!

Burst mode is not supported.



- ① Primary master
- ② HART[®] modem
- ③ HART[®] signal
- ④ Other HART[®] devices or this transmitter (refer also to ⑦)
- ⑤ Terminal 5
- ⑥ Terminal 6
- ⑦ Device with address > 0 and passive current output, connection of max. 15 devices (slaves)
- ⑧ Secondary Master
- ⑨ Power supply for devices (slaves) with passive current output
- ⑩ Load $\geq 250 \Omega$ (Ohm)

5.2 Factory settings for configuration



DANGER!

Only connect an Ex approved HART[®] modem located in a safe area to a transmitter in a potentially explosive area.

The transmitter are delivered with either a factory settings or configured according to customers' specifications.

Menu	Parameter	Factory settings
Device Root menu		
-> Sensor	Type of sensor 1	RTD Pt100 $\alpha=0.003850$
	Number of wires	3
	PV Lower range value	0
	PV Upper range value	100
	Digital units	°C
	Lock code	Unlocked
	Isolation resistance monitoring	Off
	Sensor break (Off/Down scale/Up scale)	Up scale
	Sensor short circuit (Off/Down scale/Up scale)	Off
	Span	0...+100°C / +32...+212°F

5.3 Configuration of transmitter

The transmitters can be configured by means of:

1. The PC with the help a HART-modem ("VIATOR") and the software "HartSoft".
2. A hand held communicator (secondary master) such as the field communicators FC 375 or FC 475 (Emerson)
3. EDD enabled device management softwares/systems (primary master) such as:
 - PDM - Process Device Manager (Siemens)
 - AMS - Asset Management Solutions (Emerson)

5.3.1 Configuration with PC and HART[®]-modem

Configuration with the PC requires a HART[®]-modem for connection to a USB-interface and the software "HartSoft". Therefore all models of the TT 50 series are HART[®]-compatible.



INFORMATION!

If you need "HartSoft", contact the manufacturer (the software is for free). The manual is available in the download area of the manufacturer's website.

5.3.2 Configuration with a hand held communicator FC375/FC475

The Field communicators FC375/FC475 are hand held communicators from Emerson Process Management for configuring HART[®] and Foundation Fieldbus devices. To be able to configure the transmitter with the FC375/FC475 you need a Device Description (DD) file.

The transmitter DD has to be installed on the FC375/FC475, otherwise the user will work with the transmitter as generic device losing opportunity to control all features of the transmitter. For installing DD on the FC375/FC475 the "Easy Upgrade Programming Utility" is needed and the FC375/FC475 must have a system card with "Easy Upgrade" option (see details in the "375/475 Field Communicator User's Manual").

The transmitter DD for FC375/FC475 can also be downloaded from our website. For information about installing, follow the instructions in the attached "readme.txt" file.

For proper connection of the transmitter with the hand held communicator refer to *Connection diagram of in-head transmitter* on page 17 and refer to *Connection diagram of rail-mount transmitter* on page 19.

To configure the transmitter for potentially explosive areas refer to *Connection diagram of in-head transmitter (Ex)* on page 18.

5.3.3 Device management software

The transmitter can be configured via the PC software as AMS (Asset Management System) and Simatic PDM.

Asset Management Solutions Device Manager (AMS)

The AMS is a PC application from Emerson Process Management for configuring and managing HART® and Foundation Fieldbus devices. For adaptation to different devices AMS uses Device Descriptions (DD).

The transmitter DD has to be installed on the AMS system and a so called "Installation Kit HART AMS" is needed (available as download on the internet). For installing the DD with the installation kit refer to the "AMS Intelligent Device Manager Books Online" section "Basic AMS Functionality /Device Configurations / Installing Device Types / Procedures /Install device types from media". Please read also the "readme.txt", which is also contained in the installation kit.

The transmitter DD for AMS can also be downloaded from our website. For information about installing, follow the instructions in the attached "readme.txt" file.

AMS supports the "EDDL Process Variables Root Menu", the "Diagnostic Root Menu" and the "Device Root Menu" for online access to the device.

Process Device Manager (PDM)

The Simatic PDM is a PC application from Siemens for configuring HART® and PROFIBUS devices. For adaptation to different devices Simatic PDM uses Device Descriptions (DD).

The transmitter DD has to be installed on the PDM System and a so called "Device Install HART PDM" is needed (available as download on the internet).

For installing the DD on PDM refer to the "PDM Manual" section 13:"Integrating Devices".Please read also the "readme.txt", which is also contained in the "Device Install".

The transmitter DD for PDM can also be downloaded from our website. For information about installing, follow the instructions in the attached "readme.txt" file.

PDM supports the "EDDL Process Variables Root Menu", the "Diagnostic Root Menu" and the "Device Root Menu" for online access to the device. Furthermore it supports the "Offline Root Menu" for offline configuration.

5.4 Factory calibration of transmitter

The transmitters are delivered with a factory configuration Pt100 ($\alpha=0.00385$), 3-wire connection 0...+100°C / +32...+212°F or configured according to customer's requirements. For detailed information refer to *Factory settings for configuration* on page 23.



INFORMATION!

Should you for any reason require the re-calibration, send the transmitter back to the factory!

6.1 Spare parts availability

The manufacturer adheres to the basic principle that functionally adequate spare parts for each device or each important accessory part will be kept available for a period of 3 years after delivery of the last production run for the device.

This regulation only applies to spare parts which are subject to wear and tear under normal operating conditions.

6.2 Availability of services

The manufacturer offers a range of services to support the customer after expiration of the warranty. These include repair, technical support and training.



INFORMATION!

For more precise information, please contact your local representative.

6.3 Returning the device to the manufacturer

6.3.1 General information

This device has been carefully manufactured and tested. If installed and operated in accordance with these operating instructions, it will rarely present any problems.



CAUTION!

Should you nevertheless need to return a device for inspection or repair, please pay strict attention to the following points:

- *Due to statutory regulations on environmental protection and safeguarding the health and safety of our personnel, manufacturer may only handle, test and repair returned devices that have been in contact with products without risk to personnel and environment.*
- *This means that the manufacturer can only service this device if it is accompanied by the following certificate (see next section) confirming that the device is safe to handle.*



CAUTION!

If the device has been operated with toxic, caustic, flammable or water-endangering products, you are kindly requested:

- *to check and ensure, if necessary by rinsing or neutralizing, that all cavities are free from such dangerous substances,*
- *to enclose a certificate with the device confirming that is safe to handle and stating the product used.*

6.3.2 Form (for copying) to accompany a returned device

Company:		Address:	
Department:		Name:	
Tel. no.:		Fax no.:	
Manufacturer's order no. or serial no.:			
The device has been operated with the following medium:			
This medium is:	water-hazardous		
	toxic		
	caustic		
	flammable		
	We checked that all cavities in the device are free from such substances.		
	We have flushed out and neutralized all cavities in the device.		
We hereby confirm that there is no risk to persons or the environment through any residual media contained in the device when it is returned.			
Date:		Signature:	
Stamp:			

6.4 Disposal



CAUTION!

Disposal must be carried out in accordance with legislation applicable in your country.

7.1 Measuring principles

The kind of the measuring principle depends on the measuring insert that you combine with the transmitter. In matters of the thermometer type the manufacturer offers two different measuring inserts, either with a resistance thermometer or with a thermocouple. For more information refer to the handbook of the measuring inserts or the handbook of the industrial thermometers.

7.1.1 Resistance thermometer

The measuring insert with a resistance thermometer features a temperature-sensitive sensor made from a platinum RTD, whose value at 0°C / +32°F is 100 Ω. That is where the name "Pt100" comes from.

It is generally valid that the electric resistance of metals increases according to a mathematical function as the temperature rises. This effect is taken advantage of by resistance thermometers to measure temperature. The "Pt100" thermometer features a measuring resistance with defined characteristics, standardised in IEC 60751. The same is true for the tolerances. The average temperature coefficient of a Pt100 is $3.85 \times 10^{-3} \text{ K}^{-1}$ in the range from 0...+100°C / +32...+212°F.

During operation, a constant current $I (\leq 1 \text{ mA})$ flows through the Pt100 RTD, which brings about a voltage drop U . The resistance R is calculated using Ohm's Law ($R=U/I$). As the voltage drop U at 0°C / +32°F is 100 mV, the resulting resistance of the Pt100 thermometer is 100 Ω (100 mV / 1 mA = 100 Ω).

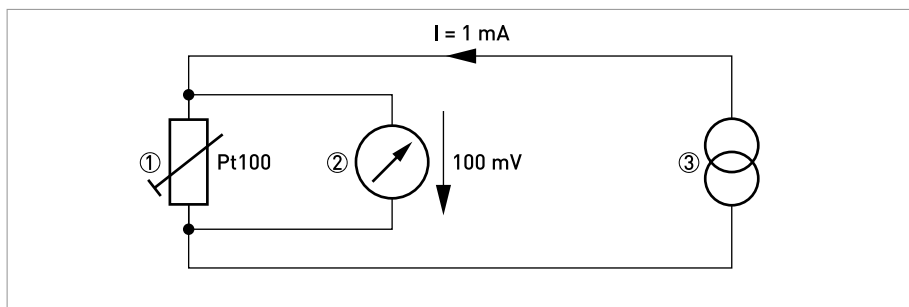


Figure 7-1: Pt100 resistance thermometer in 4 wire connection at 0°C / +32°F, schematic.

- ① Pt100 RTD
- ② Voltage meter
- ③ Current source

7.1.2 Thermocouples

The thermocouple features two electric conductors made from different metals, connected at one end. Each free end is connected to a compensation cable which is then connected to a millivolt meter. This circuitry forms a "thermal circuit". The point at which the two electric conductors connect is called the measuring point (hot junction) and the point at which the compensation cables connect to the conductors of the millivolt meter is called the reference junction (cold junction).

If the measuring point of this thermal circuit is heated up, a small electrical voltage (thermal voltage) can be measured. If, however, the measuring point and the reference junction are at the same temperature, no thermoelectric voltage is generated. The degree of thermoelectric voltage, also known as electromotive force (EMF), depends on the thermocouple material and the extent of the temperature difference between the measuring point and the reference junction. It can be measured using the millivolt meter with no auxiliary power.

Simply put, the thermocouple behaves like a battery, the voltage of which also increases as the temperature rises.



INFORMATION!

The characteristic curves and tolerances of commercially available thermocouples are standardised in IEC 60584.

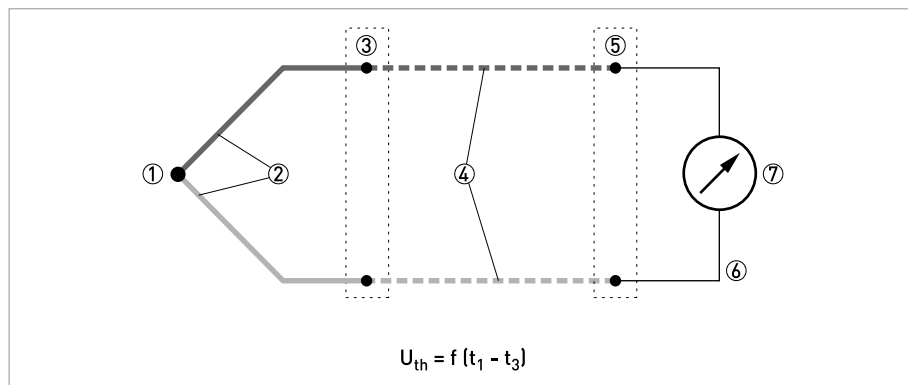


Figure 7-2: Thermocouple measuring circuit, schematic.

- ① Measuring point t_1 (hot junction)
- ② Thermocouple
- ③ Transition junction t_2
- ④ Compensation cable / extension cable
- ⑤ Reference junction t_3 (cold junction)
- ⑥ Copper conductor
- ⑦ Voltage meter U_{th}

7.2 Technical data



INFORMATION!

- The following data is provided for general applications. If you require data that is more relevant to your specific application, please contact us or your local representative.
- Additional information (certificates, special tools, software,...) and complete product documentation can be downloaded free of charge from the website (Download Center).

Measuring system

Application range	Temperature, resistance or voltage measurements of solids, liquids and gases in industrial environment.
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Design

Versions	
TT 50 C	In-head transmitter which is intended for installation in a "B connection head" or larger according to DIN 43729. This transmitter is optionally available in an intrinsically safe version for installation in potentially explosive areas (TT 50 C Ex).
TT 50 R	Rail-mount transmitter which is intended for installation on a top-hat rail according to DIN 50022 / EN 60715.
Features	
HART® 5 compliance	The transmitter are fully compliant with the HART® 5 protocol. HART® 5 offers the possibility to receive diagnostic information such as sensor errors or sensor conditions.
Sensor isolation monitoring	The isolation resistance of thermocouples and RTD's as well as the cabling between sensor and transmitter is being monitored. If the isolation is below a user-defined level, this will be indicated in ConSoft and with a diagnostic HART® message, and the output signal can be forced upscale or downscale. This feature requires an extra lead inside the thermocouple or RTD.
Customized linearization	For resistance and mV inputs, the 50-point customized linearization can provide a correct process value, in a choice of engineering units, for a sensor with non-linear input/output relation.
Sensor break monitoring	User-definable output: 3.6...22.8 mA.

Measuring accuracy

Accuracy	RTD and thermocouple: for detailed information refer to <i>RTD and T/C accuracy table</i> on page 38.
	Resistance: $\pm 0.1 \Omega$ or $\pm 0.1\%$ of span
	Voltage: $\pm 20 \mu\text{V}$ or $\pm 0.1\%$ of span
Temperature influence	RTD and thermocouple: for detailed information refer to <i>RTD and T/C accuracy table</i> on page 38.
	Resistance: $\pm 0.01\%$ of span per °C or °F
	Voltage: $\pm 0.01\%$ of span per °C or °F

Cold Junction Compensation (CJC)	In-head transmitter:
	Celsius: $\pm 0.5^{\circ}\text{C}$ within ambient temperature $-40\dots+85^{\circ}\text{C}$
	Fahrenheit: $\pm 0.9^{\circ}\text{F}$ within ambient temperature $-40\dots+185^{\circ}\text{F}$
	Rail-mount transmitter:
	Celsius: $\pm 0.5^{\circ}\text{C}$ within ambient temperature $-20\dots+70^{\circ}\text{C}$
	Fahrenheit: $\pm 0.9^{\circ}\text{F}$ within ambient temperature $-4\dots+158^{\circ}\text{F}$
Temperature influence CJC	$\pm 0.02^{\circ}\text{C}$ per $^{\circ}\text{C}$ / $\pm 0.02^{\circ}\text{F}$ per $^{\circ}\text{F}$
Sensor wire influence	RTD and resistance, 2-wire: adjustable wire resistance compensation.
	RTD and resistance, 3-wire: negligible, with equal wire resistance.
	RTD and resistance, 4-wire: negligible.
	Thermocouple and voltage: negligible.
Supply voltage influence	Negligible
Long-term drift	$\pm 0.1\%$ of span per year

Operating conditions

Temperature	
In-head transmitter	Operating and storage temperature:
	Standard version: $-40\dots+85^{\circ}\text{C}$ / $-40\dots+185^{\circ}\text{F}$
	Intrinsically safe version: for detailed information refer to <i>Temperature data for potentially explosive areas</i> on page 37.
Rail-mount transmitter	Storage temperature:
	$-40\dots+85^{\circ}\text{C}$ / $-40\dots+185^{\circ}\text{F}$
	Operating temperature:
	$-20\dots+70^{\circ}\text{C}$ / $-4\dots+158^{\circ}\text{F}$
Humidity	5...95% RH (non-condensing)
Protection category	
In-head transmitter	Housing: IP50
	Terminals: IP10
Rail-mount transmitter	Housing: IP20
	Terminals: IP00

Installation conditions

Mounting	In-head transmitter: DIN B-head or larger, DIN-rail (with adapter).
	Rail-mount transmitter: rail acc. to DIN 50022 / EN 60715, 35 mm / 1.38".
	For detailed information refer to chapter "Installation".
Weight	In-head transmitter: 50 g / 0.11 lb
	Rail-mount transmitter: 70 g / 0.15 lb
Dimensions	For detailed information refer to <i>Dimensions</i> on page 34.

Materials

Housing and flammability acc. to UL	In-head transmitter: PC + ABS (V0), polyamide (V2)
	Rail-mount transmitter: PC + glassfibre (V0)

Electrical connections

Power supply	In-head transmitter: 10...42 VDC
	Rail-mount transmitter: 11...42 VDC
	Intrinsically safe version: 12...30 VDC at maximum of 100 mA and 0.9 W.
Isolation	1500 VAC, 1 min
Connection	Single/stranded wires: max. 1.5 mm ² / AWG 16

Inputs / Outputs

Input - RTD	
Pt100 (IEC 60751, $\alpha=0.00385$)	-200...+1000°C / -328...+1832°F
Pt100 (JIS C 1604-8, $\alpha=0.003916$)	
PT X ($10 \leq X \leq 1000$) (IEC 60751, $\alpha=0.00385$)	Corresponding to max. 2000 Ω
Ni100 (DIN 43760, $\alpha=0.006180$)	-60...+250°C / -76...+482°F
Ni1000 (DIN 43760, $\alpha=0.006180$)	-60...+150°C / -76...302°F
Sensor current	Circa 400 μ A
Maximum sensor wire resistance	25 Ω /wire
Input - resistance / potentiometer	
Range, resistance	0...2000 Ω
Range, potentiometer	0...2000 Ω
Minimum span	10 Ω
Customized linearization	Up to 50 points
Sensor current	Circa 400 μ A
Maximum sensor wire resistance	25 Ω /wire
Input - thermocouples	
T/C type B - Pt30Rh-Pt6Rh (IEC 60584)	+400...+1800°C / +752...+3272°F
T/C type E - NiCr-CuNi (IEC 60584)	-200...+1000°C / -328...+1832°F
T/C type J - Fe-CuNi (IEC 60584)	
T/C type K - NiCr-Ni (IEC 60584)	-200...+1350°C / -328...+2442°F
T/C type L - Fe-CuNi (DIN 43710)	-200...+900°C / -328...+1652°F
T/C type U - Cu-CuNi (DIN 43710)	-200...+600°C / -328...+1112°F
T/C type N - NiCrSi-NiSi (IEC 60584)	-100...+1300°C / -148...+2372°F
T/C type R - Pt13Rh-Pt (IEC 60584)	-50...+1750°C / -58...+3182°F
T/C type S - Pt10Rh-Pt (IEC 60584)	
T/C type T - Cu-CuNi (IEC 60584)	-200...+400°C / -328...+752°F
Input impedance	>10 M Ω
Cold Junction Compensation (CJC)	Internal, external (Pt100) or fixed

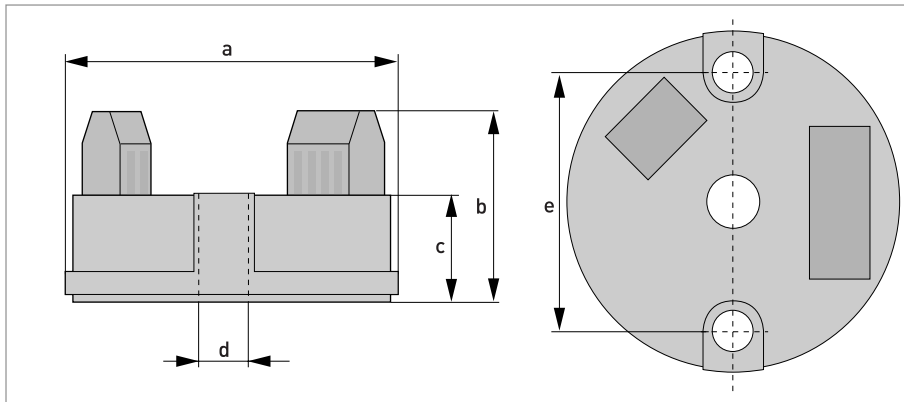
Input - voltage	
Range	-10...+500 mV
Minimum span	2 mV
Customized linearization	Up to 50 points
Input impedance	>10 MΩ
Maximum wire loop resistance	500 Ω
Output	
Output signal	4...20 mA, 20...4 mA or customized
	Temperature linear for RTD & T/C
HART® protocol	HART® 5
Adjustable output filtering	0...10 s (time constant)
Permissible load	Note: Communication according to HART® always requires a resistance greater than 250 Ω! For TT 50 C Ex and TT 50 R a greater load than the below-mentioned is allowed with a higher supply voltage, see output load diagram.
	TT 50 C: 610 Ω at 24 VDC and 23 mA
	TT 50 C Ex: 520 Ω at 24 VDC and 23 mA
	TT 50 R: 565 Ω at 24 VDC and 23 mA.
Configuration	
HartSoft	The PC configuration software "HartSoft" is a versatile and user-friendly tool for transmitter configuration, loop check-up and sensor diagnostics. It runs on Windows 2000, XP and Vista.
Alternatives	Hand held communicator, e.g. FC375/FC475 (Emerson)
	Management systems, e.g. AMS (Emerson) and PDM (Siemens)
	EDD enabled systems

Approvals and certifications

CE	The device fulfils the statutory requirements of the EC directives. The manufacturer certifies that these requirements have been met by applying the CE marking.
Intrinsically safe version	ATEX: II 1 G Ex ia IIC T4/T5/T6
Electromagnetic compatibility	Directive: 2004/108/EC.
	Harmonized standards: EN 61326-1:2006.

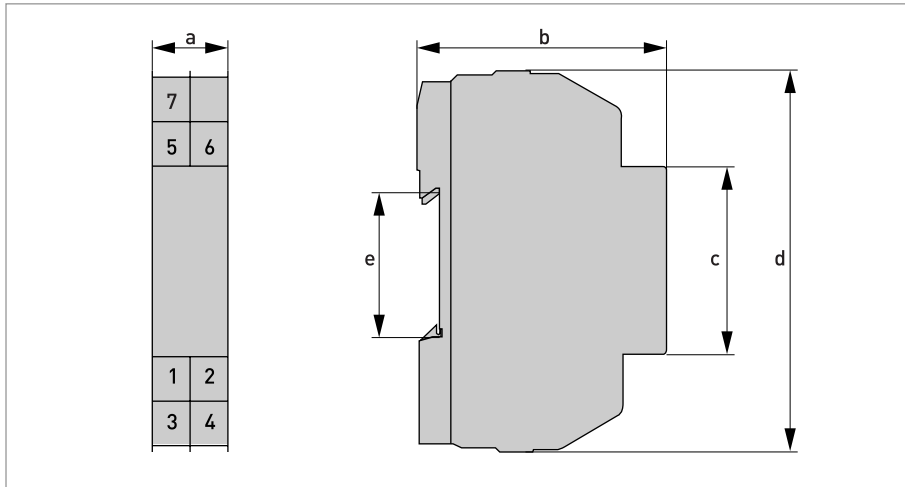
7.3 Dimensions

In-head transmitter (Non-Ex and Ex)



	Dimensions	
	[mm]	["]
a	44	1.73
b	26	1.02
c	16	0.63
d	7	0.28
e	33	1.30

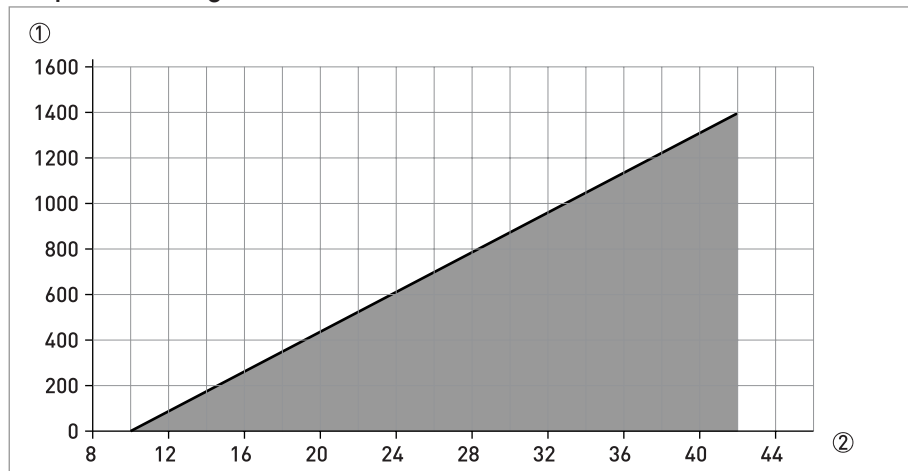
Rail-mount transmitter



	Dimensions	
	[mm]	["]
a	17.5	0.69
b	58	2.28
c	45	1.77
d	90	3.54
e	35	1.38

7.4 Output load diagrams

Output load diagram TT 50 C



- ① R: total output load in Ω
 ② U: supply voltage in VDC

Formula for the maximum permissible output load of the TT 50 C:
 permissible $R_{Load} [\Omega] = (U-10)/0.023$

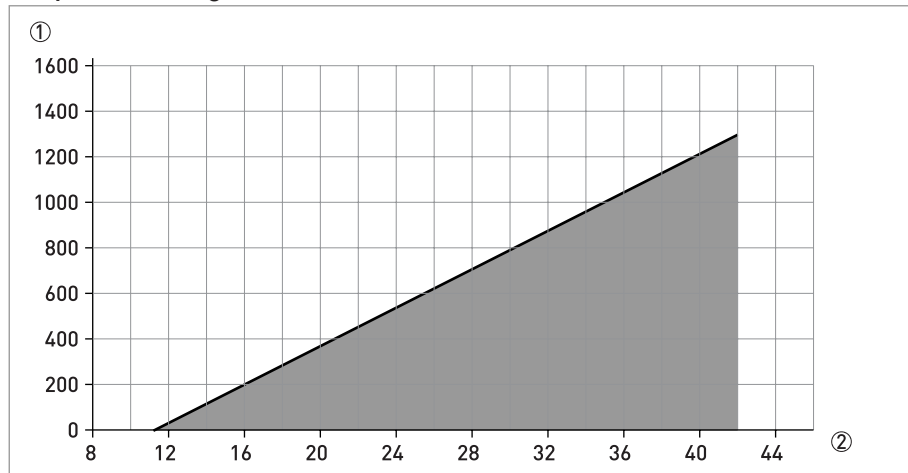
Output load diagram TT 50 C Ex



- ① R: total output load in Ω
 ② U: supply voltage in VDC

Formula for the maximum permissible output load of the TT 50 C Ex:
 permissible $R_{Load} [\Omega] = (U-12)/0.023$

Output load diagram TT 50 R



- ① R: total output load in Ω
 ② U: supply voltage in VDC

Formula for the maximum permissible output load of the TT 50 R:
 permissible $R_{Load} [\Omega] = (U-11)/0.023$

7.5 Temperature data for potentially explosive areas

In-head transmitter (Ex-version)

Temperature class	Ambient temperature T_a
T6	$-40^{\circ}\text{C} \leq T_a \leq +50^{\circ}\text{C}$ / $-40^{\circ}\text{F} \leq T_a \leq +122^{\circ}\text{F}$
T5	$-40^{\circ}\text{C} \leq T_a \leq +65^{\circ}\text{C}$ / $-40^{\circ}\text{F} \leq T_a \leq +149^{\circ}\text{F}$
T4	$-40^{\circ}\text{C} \leq T_a \leq +85^{\circ}\text{C}$ / $-40^{\circ}\text{F} \leq T_a \leq +185^{\circ}\text{F}$

7.6 Electrical data for outputs and inputs

In-head transmitter (Ex-version)

Output (supply)		Input (sensor)	
Max. voltage to transmitter	$U_i = 30 \text{ VDC}$	Max. voltage from transmitter	$U_o = 30 \text{ VDC}$
Max. current to transmitter	$I_i = 100 \text{ mA}$	Max. current from transmitter	$I_o = 25 \text{ mA}$
Max. power to transmitter	$P_i = 900 \text{ mW}$	Max. power from transmitter	$P_o = 190 \text{ mW}$
Internal inductance	$L_i = 1 \text{ mH}$	Max. inductance (input loop)	$L_o = 19 \text{ mH}$
Internal capacitance	$C_i = 1 \text{ nF}$	Max. capacitance (input loop)	$C_o = 31 \text{ nF}$

7.7 RTD and T/C accuracy table

**INFORMATION!**

- Conformance level 95% (2σ)
- CJC = Cold Junction Compensation

Accuracies in °C

Input type	Temp. range	Min. span	Accuracy	Temp. influence (Dev. from ref. temp. 20°C)
	[°C]		[°C]	
RTD Pt100	-200...+1000	10	$\pm 0.2^\circ\text{C}$ or $\pm 0.1\%$ of span	$\pm 0.01\%$ of span per °C
RTD Ni100	-60...+250	10	$\pm 0.2^\circ\text{C}$ or $\pm 0.1\%$ of span	$\pm 0.01\%$ of span per °C
T/C type J	-200...+1000	50	$\pm 0.3^\circ\text{C}$ or $\pm 0.1\%$ of span ①	$\pm 0.01\%$ of span per °C
T/C type K	-200...+1350	50	$\pm 0.5^\circ\text{C}$ or $\pm 0.1\%$ of span ①	$\pm 0.01\%$ of span per °C
T/C type S	-50...+1750	300	$\pm 2.0^\circ\text{C}$ or $\pm 0.1\%$ of span ①	$\pm 0.01\%$ of span per °C
T/C type B	+400...+1800	700	$\pm 2.0^\circ\text{C}$ or $\pm 0.1\%$ of span ①	$\pm 0.01\%$ of span per °C

① CJC error is not included

Accuracies in °F

Input type	Temp. range	Min. span	Accuracy	Temp. influence (Dev. from ref. temp. 68°F)
	[°F]		[°F]	
RTD Pt100	-328...+1832	50	$\pm 0.4^\circ\text{F}$ or $\pm 0.1\%$ of span	$\pm 0.006\%$ of span per °C
RTD Ni100	-76...+482	50	$\pm 0.4^\circ\text{F}$ or $\pm 0.1\%$ of span	$\pm 0.006\%$ of span per °C
T/C type J	-328...+1832	122	$\pm 0.5^\circ\text{F}$ or $\pm 0.1\%$ of span ①	$\pm 0.006\%$ of span per °C
T/C type K	-328...+2462	122	$\pm 0.9^\circ\text{F}$ or $\pm 0.1\%$ of span ①	$\pm 0.006\%$ of span per °C
T/C type S	-58...+3182	572	$\pm 3.6^\circ\text{F}$ or $\pm 0.1\%$ of span ①	$\pm 0.006\%$ of span per °C
T/C type B	+752...+3272	1292	$\pm 3.6^\circ\text{F}$ or $\pm 0.1\%$ of span ①	$\pm 0.006\%$ of span per °C

① CJC error is not included





KROHNE product overview

- Electromagnetic flowmeters
- Variable area flowmeters
- Ultrasonic flowmeters
- Mass flowmeters
- Vortex flowmeters
- Flow controllers
- Level meters
- Temperature meters
- Pressure meters
- Analysis products
- Measuring systems for the oil and gas industry
- Measuring systems for sea-going tankers

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