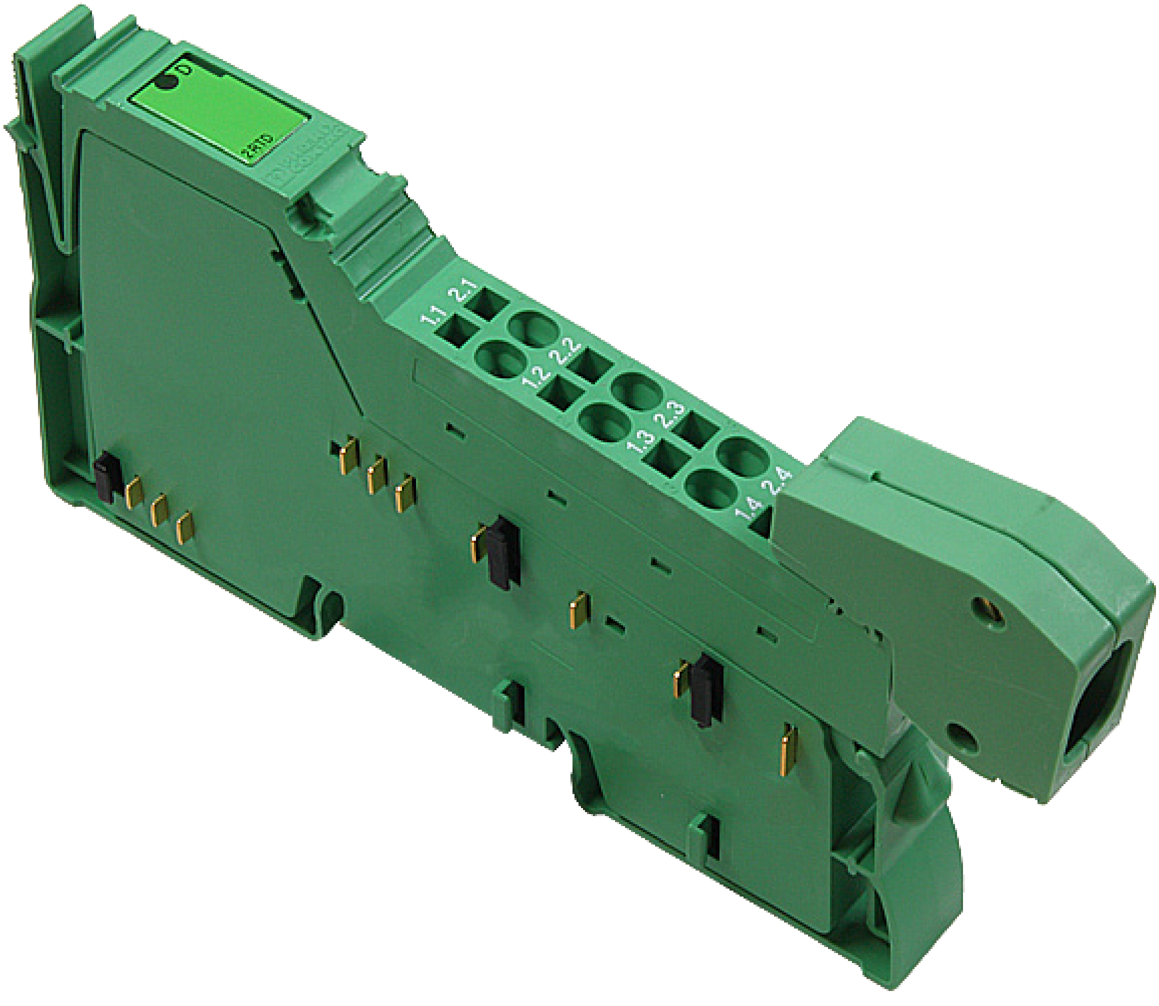
Inline terminal: 2 resistive temperature sensor inputs
ILT TEMP 2 RTD

Device description



SysMik® GmbH Dresden

Preliminary

This manual is intended to provide support for installation and usage of the device. The information is believed to be accurate and reliable. However, SysMik GmbH Dresden assumes no responsibility for possible mistakes and deviations in the technical specifications. SysMik GmbH Dresden reserves the right to make modifications in the interest of technical progress to improve our modules and software or to correct mistakes.

We are grateful to you for criticism and suggestions. Further information (device description, available software) can be found on our homepage www.sysmik.de. Please ask for latest information.

SysMik disclaims all warranties in case of improper use or disassembly and software modifications not described in this document or when using improper or faulty tools. Commissioning and operation of the device by qualified personnel only. All applicable regulations have to be observed.

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Contents

1 Description

Note: This device description is only valid in association with the IL SYS INST UM user manual or the Inline system manual of the specifically used bus system.

Make sure you always use the latest documentation – it can be downloaded at www.sysmik.de.

The terminal is designed for use within an -Inline station. This terminal provides an two-channel input module for resistive temperature sensors. This terminal supports platinum and nickel sensors according to the DIN standard and the SAMA guideline. In addition, sensors Cu10, Cu50, Cu53 as well as KTY81 and KTY84 are supported.

The measuring temperature is represented by 16-bit values in two process data words (one word per channel).

Features

- Two inputs for resistive temperature sensors
- Configuration of channels via the bus system
- Measured values can be represented in three different formats
- Connection of sensors in 2, 3, and 4-wire technology

2 Order information

Description	Type	Part No.	Pcs./Pkt.
Inline terminal with two resistive temperature sensor inputs, complete with accessories (connector and labeling field)	ILT TEMP 2 RTD	1225-100519-01-9	1

3 Technical data

General data	
Housing dimensions (width x height x depth)	12.2 mm x 120 mm x 66.6 mm
Weight	46 g (without connector); 67 g (with connector)
Operating mode	Process data mode with 2 words
Connection method for sensors	2, 3 and 4-wire technology
Ambient temperatures (operation)	-25 °C to +55 °C
Ambient temperature (storage/transport)	-25 °C to +85 °C
Permissible humidity (operation/storage/transport)	10 % to 95 %, according to DIN EN 61131-2
Permissible air pressure (operation/storage/transport)	70 kPa to 106 kPa (up to 3000 m above see level)
Degree of protection	IP20 according to IEC 60529
Class of protection	Class 3 according to EN 61131-2, IEC 61131-2
Connection data for Inline connectors	
Connection type	Spring-cage terminals
Conductor cross-section	0,2 mm² to 1,5 mm² (solid or stranded), AWG 24 - 16

Interface	
Local bus	Data routing

Power Consumption	
Communications power U_L	7.5 V
Current consumption at U_L	43 mA (typical), 60 mA (maximum)
I/O supply voltage U_{ANA}	24 V DC
Current consumption at U_{ANA}	11 mA (typical), 18 mA (maximum)
Total power consumption	587 mW (typical), 882 mW (maximum)

Supply of the Module Electronics and I/O Through the Bus Coupler/Power Terminal	
Connection method	Potential routing

Analog Inputs	
Number	Two inputs for resistive temperature sensors
Connection of the signals	2, 3 or 4-wire, shielded sensor cable
Sensor types that can be used	Pt, Ni, Cu, KTY
Characteristics standards	According to DIN/according to SAMA
Conversion time of the A/D converter	120 µs, typical
Process data update	Depending on the connection method
Both channels in 2-wire technology	20 ms
One channel in 2-wire technology/one channel in 4-wire technology	20 ms
Both channels in 3-wire technology	32 ms

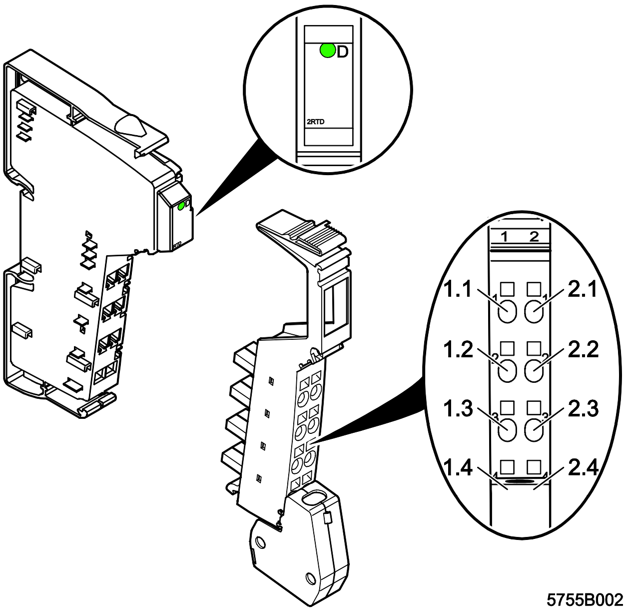
Safety equipment	none

Electrical Isolation	
Common Potentials	
24 V main voltage U_M, 24 V segment voltage U_S, and GND have the same potential. FE is a separate potential area.	
Separate Potentials in the Terminal	
Test Distance	**Test Distance**
7.5 V supply (bus logic) / 24 V analog supply (analog I/O)	7.5 V supply (bus logic) / 24 V analog supply (analog I/O)
7.5 V supply (bus logic) / functional earth ground	7.5 V supply (bus logic) / functional earth ground
24 V analog supply (analog I/O) / functional earth ground	24 V analog supply (analog I/O) / functional earth ground

Error Messages to the Higher-Level Control or Computer System	
Failure of the internal voltage supply	Yes
Failure of or insufficient communications power U_L	Yes, I/O error message sent to the bus coupler

4 Local diagnostic and status indicators / Terminal point assignment

Functional identification: green



5755B002

Local diagnostic and status indicators

Designation	Color	Meaning
D	green	Diagnostics

Terminal point assignment for 2/3-wire termination:

Terminal point	Signal	Assignment
1.1	**I_1+**	RTD of sensor 1
1.2	**I_1-**	Constant current supply
1.3	**U_1-**	Measuring input of sensor 1
2.3	**U_2-**	Measuring input of sensor 2
2.1	**I_2+**	RTD of sensor 2
2.2	**I_2-**	Constant current supply
1.4, 2.4	**Shield**	Shield connection (channel 1 and 2)

Terminal point assignment for 4-wire termination on channel 1 and 2-wire termination on channel 2:

Terminal point	Signal	Assignment
1.1	**I_1+**	RTD of sensor 1
1.2	**I_1-**	Constant current supply
1.3	**U_1-**	Measuring input of sensor 1
2.3	**U_1+**	Measuring input of sensor 2
2.1	**I_2+**	RTD of sensor 2
2.2	**I_2-**	Constant current supply
1.4, 2.4	**Shield**	Shield connection (channel 1 and 2)

Fig. 1: local diagnostic and status indicators and terminal point assignment

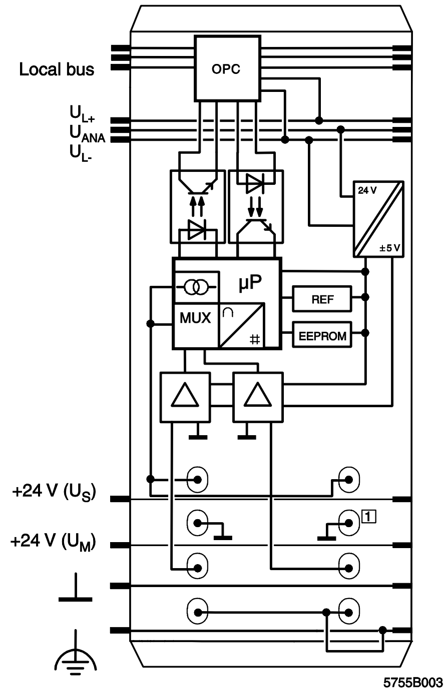
Safety note:

WARNING: During configuration, ensure that no isolating voltage is specified between the analog inputs and the local bus. During thermistor detection this, for example, means that the user has to provide signals with **safe isolation**, if applicable.

Installation instruction:

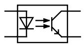
High current flowing through potential jumpers U_M and U_S leads to a temperature rise in the potential jumpers and inside the terminal. To keep the current flowing through the potential jumpers of the analog terminals as low as possible, always place the analog terminals after all the other terminals at the end of the main circuit (sequence of the Inline terminals: see also IL SYS INST UM E user manual or the Inline system manual for your bus system).

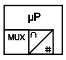
5 Internal circuit diagram



Key:

 Protocol chip

 Optocoupler

 Mikroprocessor with multiplexer and analog/digital converter

 Electrically erasable programmable read-only memory

 DC/DC converter with electrical isolation

 Reference voltage

 Amplifier

Fig. 2: Internal wiring oft terminal points

Note: Other symbols used are explained in the IL SYS INST UM E user manual or in the Inline system manual for your bus system.

6 Electrical isolation

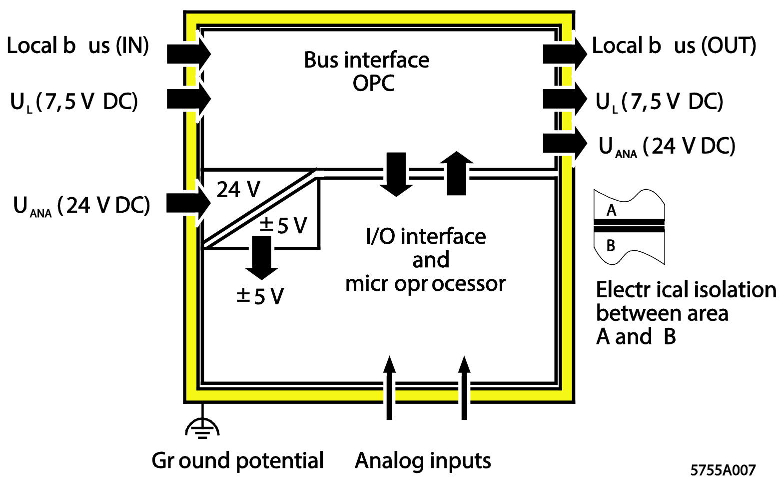


Fig. 3: Electrical isolation of the individual function areas

7 Connection notes

Connection oft the resistance sensors:

In 4-wire technology a sensor can only be connected to channel 1. In this case the sensor can only be connected to channel 2 using 2-wire technology.

Shield connection:

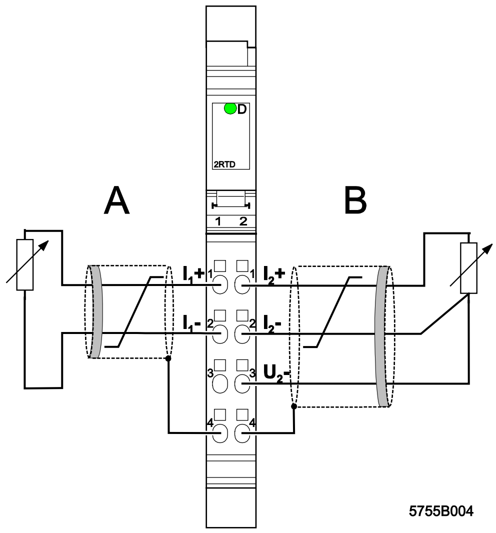
The Connection examples show how to connect the shield.

- Connect the shielding to the Inline terminal using the shield connection clamp. The clamp connects the shield directly to FE on the terminal side. Additional wiring is not necessary.
- Isolate the shield at the sensor.

Sensor connection in 4-wire technology:
Always connect temperature shunts using shielded, twisted-pair cables.

8 Connection examples

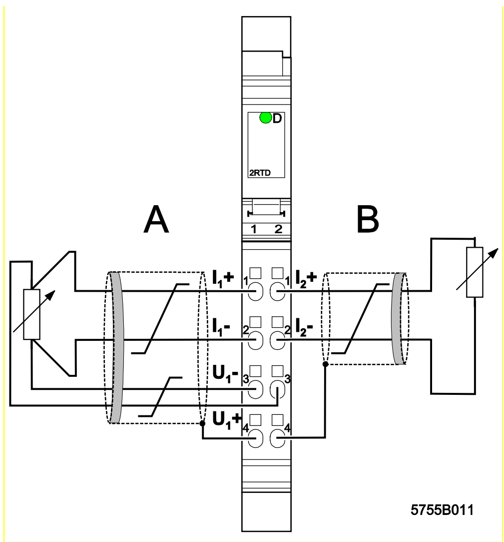
Connection of passive sensors



A Channel 1; 2- wire technology

B Channel 2; 3- wire technology

Fig. 4: Connection of sensors in 2 and 3-wire technology with shield connection



A Channel 1; 4-wire technology

B Channel 2; 2-wire technology

Fig. 5: Connection of sensors in 4 and 2-wire technology with shield connection

> ⚠ When connecting the shield at the terminal you must insulate the shield on the sensor side (shown in gray in Figure 4 and Figure 5).
>
> Use a connector with shield connection when installing the sensors. Figure 4 shows the connection schematically (without shield connector).

Connection of a potentiometer

1)
Connection and direct %-evaluation of a 2-kΩ potentiometer at channel 1 in 2-wire technology

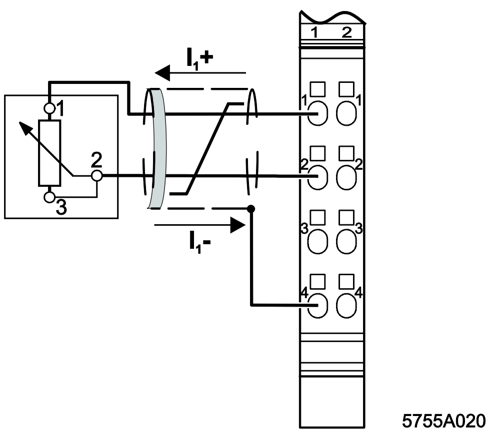


Fig. 6: Connection of a potentiometers at channel 1 in 2-wire technology with shield connection

2)
Connection and direct %-evaluation of a 2-kΩ potentiometer at channel 1 in 3-wire technology

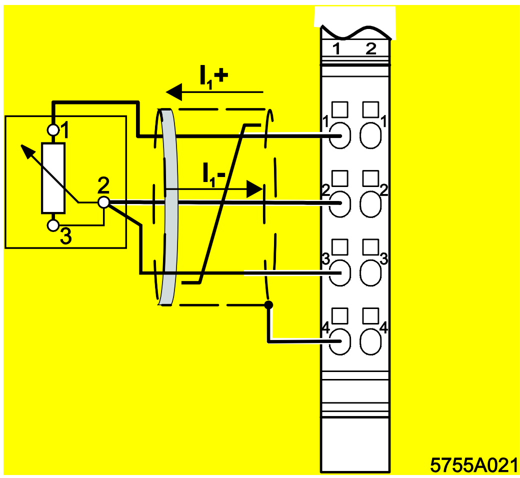


Fig. 7: Connection of a potentiometers at channel 1 in 3-wire technology with shield connection

9 Measuring ranges

9.1 Measuring Ranges Depending on the Resolution (Format IB Standard)

Resolution (Bit 7 and 6)	Temperature sensors
00	-273 °C up to +3276,8 °C resolution: 0,1 °C
01	-273 °C up to +327,68 °C resolution: 0,01 °C
10	-459 °F up to +3276.8 °F resolution ung: 0,1 °F
11	-459 °F up to +327.68 °F resolution: 0,01 °F

Temperature values can be converted from °C to °F according to the following formula:

$$T\,[°F] = T\,[°C] \times \frac{9}{5} + 32$$

Where:

T [°F] … Temperature in °F

T [°C] … Temperature in °C

9.2 Input measuring values

No.	Input	Sensor type		Measuring range (Software-supported)	
				Lower limit	Upper limit
0	Temperature sensors	Pt R_0 10 Ω to 3000 Ω	acc. to DIN	-200 °C	+850 °C
1		Pt R_0 10 Ω to 3000 Ω	acc. to SAMA	-200 °C	+850 °C
2		Ni R_0 10 Ω to 3000 Ω	acc. to DIN	-60 °C	+180 °C
3		Ni R_0 10 Ω to 3000 Ω	acc. to SAMA	-60 °C	+180 °C
4		Cu10		-70 °C	+500 °C
5		Cu50		-50 °C	+200 °C
6		Cu53		-50 °C	+180 °C
7		Ni1000 L+G		-50 °C	+160 °C
8		Ni500 (Viessmann)		-60 °C	+250 °C
9		KTY81-110		-55 °C	+150 °C
10		KTY84		-40 °C	+300 °C
11	Reserved				
12					
13	Relative potentiometer range			0 %	4 kΩ / R_0 x 100 % (max. 400 %)
14	Linear resistance measuring range			0 Ω	400 Ω
15				0 Ω	4000 Ω

10 Measuring errors

10.1 Systematic measuring errors during temperature measurement using resistance thermometers

When measuring temperatures using resistance thermometers, systematic measuring errors are often the cause of incorrectly measured results.

There are three possibilities of connecting sensors: 2, 3, and 4-wire technology.

4-Wire technology

4-wire technology is the most precise way of measuring (see Fig.8)

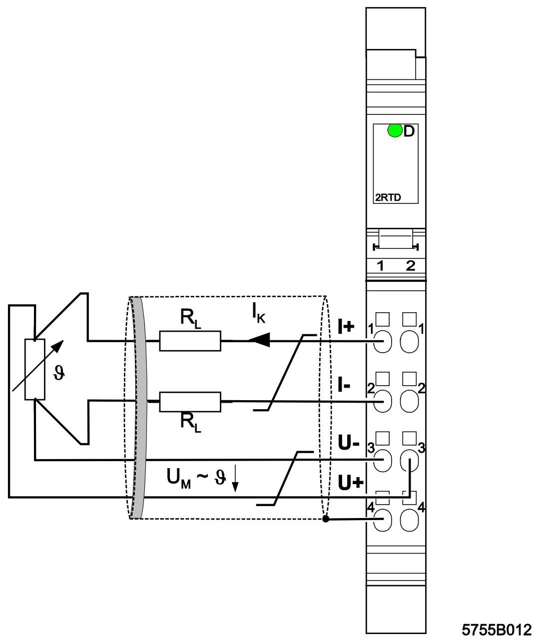


Fig. 8: Connection of resistance thermometers in 4-wire technology

When using the 4-wire technology, a constant current is sent through the sensor via cables I+ and I-. With the other two cables U+ and U-, the temperature-related voltage is tapped and measured at the sensor. The cable resistances do not influence the measurement.

3-Wire technology

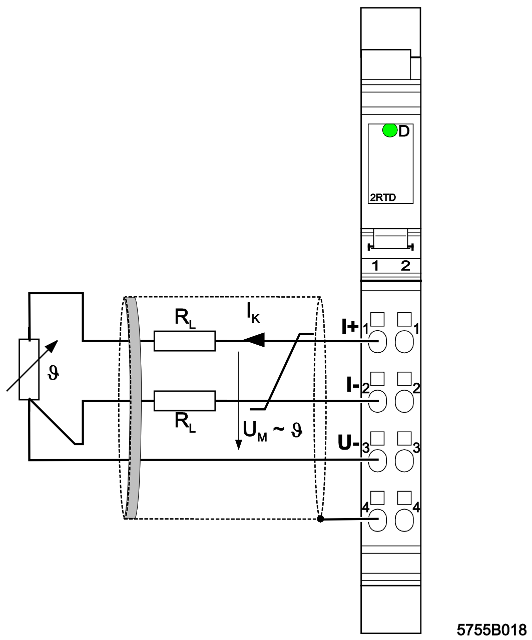
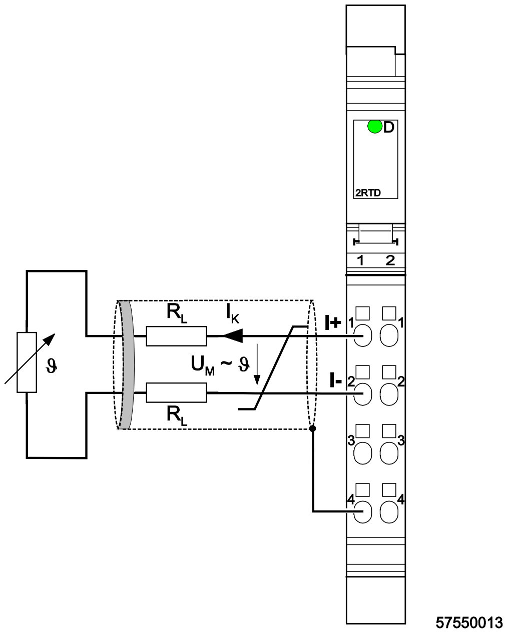


Fig. 9: Connection of resistance thermometers in 3-wire technology

In 3-wire technology the effect of the cable resistance on the measured result within the terminal is eliminated or minimized by multiple measuring of the temperature-related voltage and corresponding calculations. The quality of the results is almost as good as when using the 4-wire technology shown in Fig. 8. However, the 4-wire technology provides better results in environments subject to heavy noise.

2-Wire technology



2-wire technology is the most cost-effective connection method. The U+ and U- cables are no longer needed. Temperature-related voltage is not directly measured at the sensor and therefore not falsified by the two cable resistances R_L (Fig. 10).

The measuring errors that occur may lead to the entire measurement to become useless (diagrams in Fig. 11 to Fig. 13). However, these diagrams show at which points of the measurement system measures can be taken to minimize these errors.

Bild 10: Connection of resistance thermometers in 2-wire technology

10.2 Systematic errors during temperature measurement using 2-wire technology

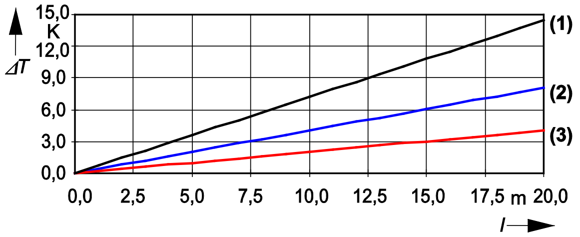


Fig. 11: Systematic temperature measuring error ΔT depending on the cable length l

Curves depending on the cable cross section A

(1) Temperature measuring error for A = 0,14 mm²

(2) Temperature measuring error for A = 0,25 mm²

(3) Temperature measuring error for A = 0,50 mm²

(Measuring error valid for:
copper cable χ = 57 m/Ωmm^2, T_A= 25°C and
Pt100 sensor)

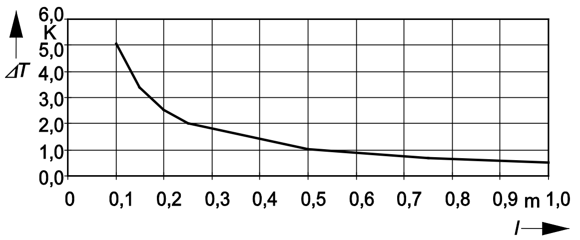


Fig. 12: Systematic temperature measuring error ΔT depending on the cable cross section A

(Measuring error valid for:
copper cable χ = 57 m/Ωmm^2,
T_A= 25°C, l = 5 m and
Pt100 sensor)

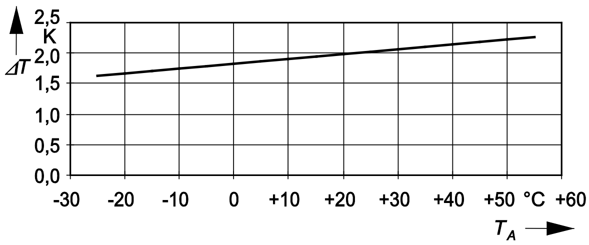


Fig. 13: Systematic temperature measuring error ΔT depending on the cable temperature T_A

Measuring error valid for:
copper cable χ = 57 m/Ωmm2,
l = 5 m, A = 0.25 mm2, and
Pt100 sensor)

All diagrams show that the increase in cable resistance causes the measuring error.

A considerable improvement is made through the use of Pt1000 sensors. Due to the 10-fold higher temperature coefficient α (α = 0.385 Ω/K for Pt100 to α = 3.85 Ω/K for Pt1000) the effect of the cable resistance on the measurement is decreased by factor 10. All errors in the diagrams above would be reduced by factor 10.

Diagram 1 clearly shows the effect of the cable length on the cable resistance and therefore on the measuring error. The solution is to use the shortest possible sensor cables.

Diagram 2 shows the influence of the cable diameter on the cable resistance. It can be seen that cables with a cross section of less than 0.5 mm^2 cause errors to increase exponentially.

Diagram 3 shows the effect of the ambient temperature on the cable resistance. This parameter does not play a great role and can hardly be influenced but it is mentioned here for the sake of completeness.

The formula to calculate the cable resistance is as follows:

$$R_L = R_{L20} \times (1 + 0.0043 \frac{1}{K} \times T_A)$$

$$R_L = \frac{l}{\chi \times A} \times (1 + 0.0043 \frac{1}{K} \times T_A)$$

Where:

R_L	Cable resistance in Ω
R_{L20}	Cable resistance at 20 °C in Ω
l	Cable length in m
χ	Specific electrical resistance of copperin $\Omega mm^2/m$
A	Cable cross-section in mm^2
0,0043 1/K	Temperature coefficient for Kupfer
T_A	Ambient temperature (cable temperature) in °C

Since there are two cable resistances in the measuring system (forward and return), the value must be doubled.

The absolute measuring error in Kelvin [K] is provided for platinum sensors according to DIN using the average temperature coefficient α (α = 0.385 Ω/K for Pt100; α = 3.85 Ω/K for Pt1000).

11 Tolerance and temperature response

α: Medium sensitivity to calculate the tolerance values.

x: Additional error when the connection is made using 2-wire technology (see Systematic errors during temperature measurement using 2-wire technology).

Typical measuring tolerances at 25°C							
	α at 100 °C	2-Wire technology		3-Wire technology		4-Wire technology	
		relative [%]	absolute	relative [%]	absolute	relative [%]	absolute
Temperature sensors							
Pt100	0,385 Ω/K	±0,03 + x	±0,26 K + x	±0,03	±0,26 K	±0,02	±0,2 K
Pt1000	3,85 Ω/K	±0,04 + x	±0,31 K + x	±0,04	±0,31 K	±0,03	±0,26 K
Ni100	0,617 Ω/K	±0,09 + x	±0,16 K + x	±0,09	±0,16 K	±0,07	±0,12 K
Ni1000	6,17 Ω/K	±0,11 + x	±0,2 K + x	±0,11	±0,2 K	±0,09	±0,16 K
Cu50	0,213 Ω/K	±0,24 + x	±0,47 K + x	±0,24	±0,47 K	±0,18	±0,35 K
Ni1000 L+G	5,6 Ω/K	±0,13 + x	±0,21 K + x	±0,13	±0,21 K	±0,11	±0,18 K
Ni500 Viessmann	2,8 Ω/K	±0,17 + x	±0,43 K + x	±0,17	±0,43 K	±0,14	±0,36 K
KTY81-110	10,7 Ω/K	±0,07 + x	±0,11 K + x	±0,07	±0,11 K	±0,06	±0,09 K
KTY84	6,2 Ω/K	±0,06 + x	±0,19 K + x	±0,06	±0,19 K	±0,05	±0,16 K
Linear resistance							
0 Ω bis 400 Ω		±0,025 + x	±100 mΩ + x	±0,025	±100 mΩ	±0,019	±75 mΩ
0 Ω bis 4 kΩ		±0,03 + x	±1,2 Ω + x	±0,03	±1,2 Ω	±0,025	±1 Ω

Maximum measuring tolerances at 25°C							
	α at 100 °C	2-Wire technology		3-Wire technology		4-Wire technology	
		relative [%]	absolute	relative [%]	absolute	relative [%]	absolute
Temperature sensors							
Pt100	0,385 Ω/K	±0,12 + x	±1,04 K + x	±0,12 %	±1,04 K	±0,10 %	±0,83 K
Pt1000	3,85 Ω/K	±0,15 + x	±1,3 K + x	±0,15 %	±1,3 K	±0,12 %	±1,04 K
Ni100	0,617 Ω/K	±0,36 + x	±0,65 K + x	±0,36 %	±0,65 K	±0,29 %	±0,52 K
Ni1000	6,17 Ω/K	±0,45 + x	±0,81 K + x	±0,45 %	±0,81 K	±0,36 %	±0,65 K
Cu50	0,213 Ω/K	±0,47 + x	±0,94 K + x	±0,47 %	±0,94 K	±0,38 %	±0,75 K
Ni1000 L+G	5,6 Ω/K	±0,56 + x	±0,89 K + x	±0,56 %	±0,89 K	±0,44 %	±0,71 K
Ni500 Viessmann	2,8 Ω/K	±0,72 + x	±1,79 K + x	±0,72 %	±1,79 K	±0,57 %	±1,43 K
KTY81-110	10,7 Ω/K	±0,31 + x	±0,47 K + x	±0,31 %	±0,47 K	±0,25 %	±0,37 K
KTY84	6,2 Ω/K	±0,27 + x	±0,81 K + x	±0,27 %	±0,81 K	±0,22 %	±0,65 K
Linear resistance							
0 Ω bis 400 Ω		±0,10 + x	±400 mΩ + x	±0,10 %	±400 mΩ	±0,08 %	±320 mΩ
0 Ω bis 4 kΩ		±0,13 + x	±5 Ω + x	±0,13 %	±5 Ω	±0,10 %	±4 Ω

All errors indicated as a **percentage** are related to the positive measuring range final value. The **maximum** tolerances contain the theoretical maximum possible tolerances. The data refers to nominal operation (installation on horizontal mounting rail, U_S = +24 V). Please also observe the values for temperature drift and the tolerances under EMI influences.

Temperature response at -25 °C to +55 °C		
	typical	**maximum**
2, 3, 4-wire technology	±12 ppm/°C	±45 ppm/°C

Additional tolerances influenced by electromagnetic fields		
Type of Electromagnetic Interference	**Typical Deviation From the Measuring Range Final Value**	**Criterion**
Electromagnetic fields; field strength 10 V/m according to EN 61000-4-3 / IEC 61000-4-3	< ±1,51 %	A
Conducted interference Class 3 (test voltage 10 V) according to EN 61000-4-6 / IEC 61000-4-6	< ±0,92 %	A
Fast transients (burst) Class 3 according to EN 61000-4-4 / IEC 61000-4-4	< ±0,24 %	A