GÜNTHER

ATEX

Assembly and operating instructions

Product group R7 - T8

Ex i – Intrinsic safety

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Temperature Measurement Technology

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ATEX Assembly and operating instructions – Product group R7 - T8

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1. General remarks

1.1 Introduction

These operating instructions contain fundamental information obligatory for installation, operation and maintenance of resistance thermometers series R7S, R7F, R7.1 R8S, R8F and thermocouples series T7, T7.1, T8.

- The document should be read thoroughly before installation and commissioning of the equipment by the installer, as well as by the personnel responsible for the unit.
- These operating instructions must be available and accessible at the site at all times.
- It must also be ensured that the temperature sensors are operated exclusively in the undamaged and clean condition.

The following sections contain important safety instructions, whose non-observance may lead to risks for humans and animals, things and objects.

1.2 Staff qualifications

The equipment may be operated only by qualified personnel that has been familiarised with installation, commissioning and operation of this product which was assembled and put into operation.

Qualified persons are those that due to their specialised training, know-how and experience and their knowledge of the relevant standards assess the work assigned to them and recognise possible dangers and hazards.

In the case of explosion-proof equipment, the staff must have appropriate education or training, or authorisation to work on explosion-protected equipment in explosion-hazard areas.

Dangers related to the failure to comply with safety instructions

Failure to comply with these safety instructions, foreseen applications or limiting values provided in the technical data of the unit may lead to dangers and damages of persons, environment or the installation.
In such a case damages claims against GÜNTHER GmbH Temperaturmesstechnik shall be excluded.

1.3 General

Temperature sensors are used to transform temperature at a measuring point into electric value (voltage, resistance). They are used, in conjunction with appropriate data processing instrumentation, for measuring, registration and control of temperatures in the range from -196 °C to +450 °C (thermocouples -40 °C to +800 °C).

Resistance thermometers and thermocouples R7S, R7F, R7.1, R8S, R8F, T7, T7.1 and T8 are used as intrinsically safe equipment for temperature measurement in liquid and gaseous media, as well as in zones at risk of dust explosion.

Resistance thermometers are equipped with Pt100, Pt500 or Pt1000 temperature sensors compliant with EN 60751 in the tolerance classes A, AA or B in two-, three-, or four-wire variants. Versions with two measuring circuits are also possible.

On request, thermocouple sensors may be equipped with T, J, K, E or N thermocouple according to DIN EN 60584-1 in tolerance classes 1 or 2, as a single or double measuring circuit.

They are certified for Ex ia explosion areas and according to the general concept, may be used in areas at risk of explosion in zone 0 in case of gas and in zone 20 in case of dust.

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When connecting to intrinsically safe circuits, the user must control the power of the respective electric device introduced in such a way, that the maximum surface heating according to the temperature class minus the safety margin is not exceeded !

In the description of R7S, R8S and T7, T8 only standard sensors are taken into account. The sensors of the R7F, R8F („fail save“) series are identical to the S-series in their construction, but in the measuring circuit there is a reed contact, which closes the circuit in the process connection using a magnetic field only after being placed in its target location.

1.4 Installation and operation

During installation relevant standards must be complied with, e.g. EN 60079-14 “Electrical equipment for potentially explosive atmospheres”.

- If the temperature sensor is mounted on parts of the unit that constitute a zone separator, the installation must be appropriately tight.
- Defective temperature sensors must not be used.
- Repairs must be performed only by appropriately authorised persons.
- Repairs may be done only using original spare parts from the original supplier, otherwise the requirements of the approval are not guaranteed.
- If a component of electrical unit which is of vital importance for the protection against explosion has been repaired, the unit may be put into operation again only after an expert has determined that its features vital for explosion protection comply with the requirements.

1.5 Installation and connection instructions

- In general, the provisions of Regulation on the installation of electrical installations in areas at risk of explosion (BetrSichV) must be observed!
- When connecting the “associated equipment”, the electrical specifications listed in the examination certificate must observed.
- It is important to ensure that the prescribed allowable ambient temperature values are not exceeded.
- When installing a connecting cable, it must be ensured that the cable insulation is not in contact with parts that have higher surface temperatures than allowed under insulation resistance.
- Moreover, it needs to be guaranteed that the required protection level (IP-rate) for the whole temperature sensor is ensured:

Necessary for explosion protection type ⟨Ex⟩ ***II 1G Ex ia IIC T6-T1 Ga*** → at least IP20

Necessary for explosion protection type ⟨Ex⟩ ***II 1/2G Ex ia IIC T6-T1 Ga/Gb*** → at least IP20

Necessary for explosion protection type ⟨Ex⟩ ***II 1D Ex ia IIIC TX Da*** → at least IP6X

Necessary for explosion protection type ⟨Ex⟩ ***II 1/2 D Ex ia IIIC TX Da/Db*** → at least IP6X

Necessary for explosion protection type ⟨Ex⟩ ***II 2 G Ex ia IIC T6-T1 Gb*** → at least IP20

Necessary for explosion protection type ⟨Ex⟩ ***II 2 D Ex ia IIIC TX Db*** → protection rate IP6X

- Process connections include adjustable compression fittings or adjustable flanges. Pressure rings are made of metal or PTFE. Modified versions (thermal decoupling) should be used as process connections for temperature sensor in surface measurements.
- In case of zone separation (zone 0/zone 1 or zone 20/zone21) it is necessary to apply screw connections/flanges of the IP67 protection type according to DIN EN 60529.
  It is also possible to apply threaded connection or flanges as process connections.
  Process connections may also be optionally delivered with the temperature sensor.

2. Electrical and Thermal Characteristics

2.1 Electric limiting characteristics

Temperature sensor may be connected to the following max. values.

- Maximum values: U_i = 30 V/DC
  I_i = 101 mA
  P_i = 750 mW
- Insulation test: U = 500 V/AC measuring circuit/sheath and between measurement circuits by double circuits
- Capacity C_i of the applied mineral isolated cables for measuring inserts:

sheath-Ø 3.0 mm	C_i = 160 pF/m (core/core) C_i = 370 pF/m (core/sheath)
sheath-Ø 4.5 mm	C_i = 145 pF/m (core/core) C_i = 290 pF/m (core/sheath)
sheath-Ø 6.0 mm	C_i = 130 pF/m (core/core) C_i = 210 pF/m (core/sheath)
sheath-Ø >6.0 mm	C_i < 130 pF/m (core/core) C_i < 210 pF/m (core/sheath)

Capacities may as a rule be omitted, as the length of the connecting cables is strongly limited by the construction. They can, however, be very important by larger lengths.

- Inductivity: L_i = 5 µH (measurement resistance)
- Capacity of the connection wire/cable

  Most often used diameters include 0,22 mm²; 0,38 mm²; 0,50 mm² or 0,75 mm².
  Here the maximum value of capacity of cables is established.
  core/core → 110 pF/m
  core/sheath → 340 pF/m

2.2 Control of electrical connection values

The intrinsically safe supply of measuring inserts can be done by:

- An auxiliary, intrinsically safe equipment that is also certified as intrinsically safe and its intrinsically safe output values do not exceed the input values of the measuring insert.

For measuring inserts with 2 measuring circuits (double measuring circuit), the following rules apply:
They can be applied only in 2- or 3-wire connections. For measuring inserts with sheath diameter of 6.0 mm the required isolation distances between two measuring circuits in accordance with Table 5 of DIN EN 60079-11 for the 30 V voltage and protection class ia must be respected. Thus, both measuring circuits can be considered as isolated. For double-measuring inserts with sheath diameter of < 5.0 mm both measuring circuits must be considered as electrically connected, as due to the geometrical dimensions of the required isolation, distances according to the above table cannot be complied with. It should be noted that the voltage U_O, and current I_O must be added. The total power P_{O1} and P_{O2} may not exceed the P_i of temperature sensor.

The thermometer has to operate with a power-limiting circuit that limits Pmax. to 750 mW. When interconnecting intrinsically safe circuits in accordance with EN60079-14, the proof of intrinsic safety must be provided.
Two cases must be distinguished here:

- Simple intrinsically safe circuit with only one internal active and one passive, intrinsically safe unit, not requiring further care.
- More active units, which in normal operation or in the case of failure may provide energy into an intrinsically safe circuit. Simple intrinsically safe circuits can be verified by the responsible person by comparing the electrical connection from the relevant EC type-examination certificate.

The intrinsic safety of the interconnection must be observed
when the following conditions are met:

Intrinsically safe measuring insert series R0 or T0		Connected unit
U_i 30 V	≥	U_O
I_i 101 mA	≥	I_O
P_i 750 mW	≥	P_O

It needs to be checked whether the capacity C and the induction L may be ignored.
It depends on the length of the measuring insert or the length of the connecting cable.

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2.3 Thermal characteristics

In order to determine the max. permissable measuring temperature of a corresponding temperature class, the possible self-heating of a temperature sensor in case of error must be determined. For this, the power Po of the connected associated unit and the thermal resistance (self-heating error) R_{TH} of the sensor on the surface of the measuring tip must be known.

- P_O is shown on the type plate of the associated unit.
- Thermal resistance (losses) R_{TH} (for the calculation of the self-warming coefficient on the surface of the sensor)
  - sheath/tube-Ø 3.0 mm → 165 K/W
  - sheath/tube-Ø 5.0 mm → 110 K/W
  - sheath/tube-Ø ≥ 6.0 mm - 8.0 mm → 90 K/W

The maximum allowable surface temperature T_{OB} depends on the introduced power P_O of the associated intrinsically safe unit and the temperature class and can be established on the basis of the following information (see below). The inner capacity and inductivity are usually negligibly small.

Determining the maximum permissible medium temperature T_M for areas where explosive mixtures of air and gases, vapours or mists may occur, and requires the electrical equipment of category 1.

This requires that the thermal resistance R_{TH}, e.g. 100 K/W of the sensor must be known.
Temperature elevation is calculated using the introduced power e.g. P_O = 50 mW:

$\Delta T = P_O \times R_{TH}$

Example: ΔT = 0.05 W x 100 K/W = 5 K

Together with the permissible temperature of the respective temperature class and the existing surface temperature T_{OB} you can now determine if the sensor is permissible.

For zone 1 it is necessary to ensure a safety margin of 5 K for T3 - T6 and 10 K for T1 and T2.
T6: 85 °C - 5 K = 80 °C 80 °C - 5 K = 75 °C

The sensor may thus be applied in zone 1 and in temperature class T6 up to the medium temperature of T_M = 75 °C.

- R_{TH} : thermal resistance (self-heating) of the sensor
- T_M : max. temperature of the medium

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The following tables indicate the max. permissable media temperature for different measuring insert diameters or protection tube diameters at different levels of power supplied.

Error tolerance by power reduction (e.g upplying the sensor with “ib” power)	Temperature class	Max. medium temperature T_M in at the maximum power P_i on the sensor (reflects the P_o of the connected associated unit)			
Diameter of sheath measuring insert		Zone 1			
		$P_i \leq 25$ mW	$P_i \leq 100$ mW	$P_i \leq 250$ mW	$P_i \leq 750$ mW
3.0 mm	T1; +450 °C	+436 °C	+423 °C	+398 °C	+316 °C
	T2; +300 °C	+286 °C	+273 °C	+248 °C	+166 °C
	T3; +200 °C	+191 °C	+178 °C	+153 °C	+71 °C
	T4; +135 °C	+126 °C	+113 °C	+88 °C	+6 °C
	T5; +100 °C	+91 °C	+78 °C	+50 °C	-
	T6; +85 °C	+76 °C	+63 °C	+38 °C	-
4.5 mm - 5.0 mm	T1; +450 °C	+437 °C	+429 °C	+412 °C	+357 °C
	T2; +300 °C	+287 °C	+279 °C	+262 °C	+207 °C
	T3; +200 °C	+192 °C	+184 °C	+167 °C	+112 °C
	T4; +135 °C	+127 °C	+119 °C	+102 °C	+47 °C
	T5; +100 °C	+92 °C	+84 °C	+67 °C	+12 °C
	T6; +85 °C	+77 °C	+69 °C	+52 °C	-
6.0 mm - 8.0 mm	T1; +450 °C	+437 °C	+431 °C	+417 °C	+372 °C
	T2; +300 °C	+287 °C	+281 °C	+267 °C	+222 °C
	T3; +200 °C	+192 °C	+186 °C	+172 °C	+127 °C
	T4; +135 °C	+127 °C	+121 °C	+107 °C	+62 °C
	T5; +100 °C	+92 °C	+86 °C	+72 °C	+27 °C
	T6; +85 °C	+77 °C	+71 °C	+57 °C	+12 °C

Since each actual permissible medium temperature depends on the max. output power P_O of the associated unit, it can be determined according to the above example. The specific self- warming error of the corresponding sheath diameter or protection tube diameter is provided above in the „Thermal Characteristics“ section.

Temperature classes / max. permissible surface temperatures

- For zone 1 temperature class minus safety margin of 5 K for T3 - T6 and 10 K for T2 and T1.
- For zone 0 temperature class minus 20% and additionally safety margin of 5 K for T3 - T6 and 10 K for T1 and T2.

Temperature class	Max. surface temperature In Zone 0	Max. surface temperature In Zone 1
T1; +450 °C	+350 °C	+440 °C
T2; +300 °C	+230 °C	+290 °C
T3; +200 °C	+155 °C	+195 °C
T4; +135 °C	+103 °C	+130 °C
T5; +100 °C	+75 °C	+95 °C
T6; +85 °C	+63 °C	+80 °C

For thermocouples the maximum permissible surface temperature may be calculated as the temperature of the respective temperature class minus safety margin.

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Limiting temperatures in Ex areas because of dust without dust deposits

- The surface temperature must not exceed 2/3 of the ignition temperature in °C of the respective dust-air mixture.
- If there is dust deposition of glow dischargeable dust with layer thickness of up to 5 mm, the maximum surface temperature must not exceed glow temperature of the respective dust minus 75 K.

The established temperature rise at the ambient temperature of 20 °C.

The following three tables present the temperature rise of sensor surface depending on the capacity loss in K, which can come into contact with the dust.

Protective tube diameter 3.0 mm - 4.4 mm				
Power	25 mW	100 mW	250 mW	750 mW
Temperature	+10 K	+20 K	+35 K	+110 K

Protective tube diameter 4.5 mm - 5.9 mm				
Power	25 mW	100 mW	250 mW	750 mW
Temperature	+5 K	+15 K	+30 K	+65 K

Protective tube diameter ≥ 6.0 mm				
Power	25 mW	100 mW	250 mW	750 mW
Temperature	+5 K	+10 K	+20 K	+50 K

- In case of layer thickness exceeding 5 mm, it is necessary to apply an additional reduction of surface temperature. Table 4 of EN 60079-11 must be applied here (Maximum allowable power dissipation at full dust overfill).

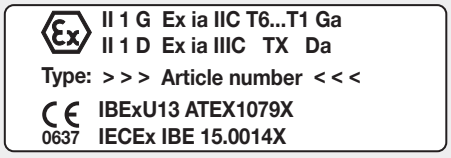
Important note:

The operator must make sure that the epoxy resin input points do not exceed the maximum allowable temperature of 150 °C. In the case of sensors of the R7.1 and T7.1 (bajonett sensors) series this is also the maximum measurement temperature, as the measuring tip is closed hermetically with epoxy resin.

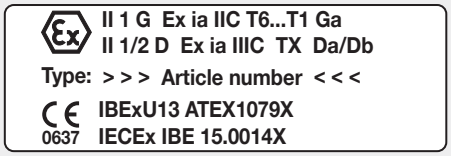
3. Types of protection and coding of individual series

Product group: R5-T6 (R7; T7; R8; T8) (Label / Heat shrink tubing)

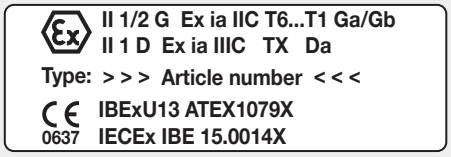
ATEX categories 1/1



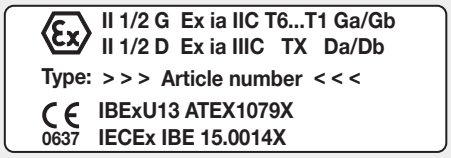
ATEX categories 1/12



ATEX categories 12/1



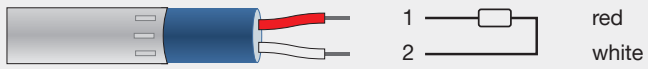
ATEX categories 12/12



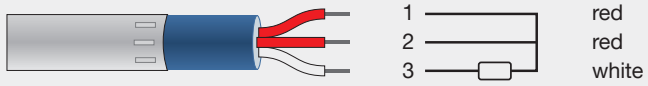
4. Connection options

4.1 Cable sensors – Resistance thermometers (Colour coding according to DIN EN 60751)

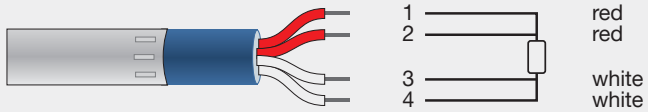
1x Pt100 2-wire connection



1x Pt100 3-wire connection



1x Pt100 4-wire connection



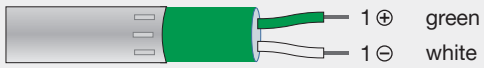
2x Pt100 2-wire connection

2x Pt100 3-wire connection

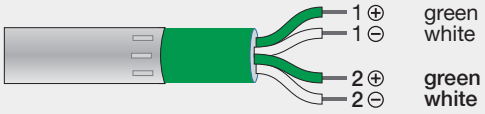
Depending on the connecting cable used, deviations in the conductor colours are possible, if the measuring circuits remain clearly assignable.

4.2 Cable sensors - Thermocouples (Colour coding acc. to DIN EN 60584)

1x NiCr-Ni (Type K)

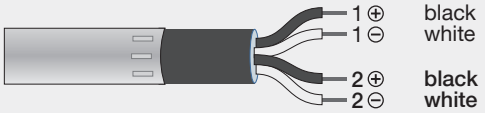


2x NiCr-Ni (Type K)

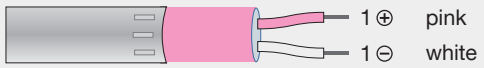


1x Fe-CuNi (Type J)

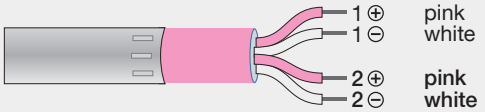
2x Fe-CuNi (Type J)



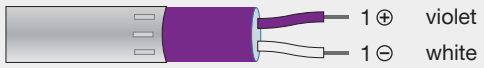
1x NiCrSi-NiSi (Type N)



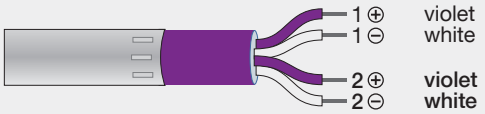
2x NiCrSi-NiSi (Type N)



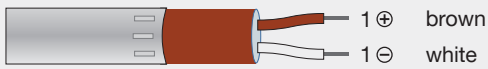
1x NiCr-CuNi (Type E)



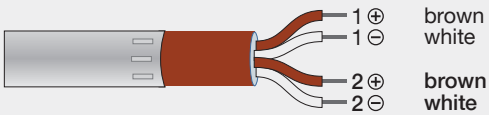
2x NiCr-CuNi (Type E)



1x Cu-CuNi (Type T)



2x Cu-CuNi (Type T)



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