RTD temperature probes

Ex „i“ for use in areas with an explosion hazard (Ex areas)

Persons concerned:
Experienced professional electricians
as per EU Directive 1999/92/EC
and trained personnel

Operating Manual

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V1.00/EN/00404304

Contents

1 Equipment and intended application

RTD temperature probes from JUMO are used as intrinsically safe and/or flameproof equipment for temperature measurement in liquid and gaseous media, as well as for dusts. The thermometers consist of a protection fitting with various process connection options, a terminal head or a connecting cable, and an interchangeable measuring insert (depending on the type). All fittings in contact with the process media undergo a leakage test. The Pt100 temperature sensors mounted in the fittings are to EN 60751, in tolerance classes A or B, in a 2-, 3-, or 4-wire circuit (see Section 8). It is also possible to use these sensors with a higher reference value (Pt500; Pt1000; Pt2000; Pt5000). NTC sensors, such as KTY, or other PTC sensors may also be used. Versions with two or three measurement circuits can be provided. A transmitter can be integrated into the terminal head, for measurement transmission with a standard signal (e.g. 4 to 20 mA).

The thermometers fulfil the requirements for Explosion Group II in Categories 1 G and 1 D as well as 2 G and 2 D. They are thus suitable for use in areas with an explosion hazard: Zone 1 or Zone 2 with gas (**G**as) and Zone 21 or 22 with dust (**D**ust). Depending on the circumstances, it may be permissible for the probe stem to protrude into the Zone 0 or 20 area (zone separation).

The thermometer parameters that are specific to a given type can be found in the corresponding technical data sheet/detail drawing (see attachement) and/or on the label that is affixed to these operating instructions.

Depending on the measurement task and the application requirements, the RTD temperature probes are available with different terminal heads, a variety of process connections, matching pockets, with or without a interchangeable measuring insert, and with or without a fitted connecting cable.

RTD temperature probes with type Ex "i" protection are certified for connection to intrinsically safe circuits in Category **ib** (for use in Zones 1 and 2, with an isolator in Zone 0) and in Category **ia** (where the stem is in Zones 0, 1 or 2).

RTD temperature probes in flameproof enclosure (terminal head and cable gland) are also equipped with intrinsically safe measuring inserts for connection to intrinsically safe circuits.
When connecting up to circuits that are not intrinsically safe, the user must ensure that the power applied is limited in such a way that the maximum rise in surface temperature is no greater than that specified for the temperature class minus the safety reserve!
See also Section 5 “Technical data” of these operating instructions.

2 Marking

The designation for the RTD temperature probes used is marked on the terminal head or permanently attached nameplate. For every RTD temperature probe that is marked by an individual type designation (e.g. 90.2800.9101) there is a corresponding probe-specific drawing and data sheet. The appropriate marking ensures that all sensors are unambiguously identifiable and traceable. The probe-specific values can be found in the drawing, the technical data sheet and/or the label that is affixed to these operating instructions.

3 Safety notes

The technical data that are relevant to the use of the device in an area with an explosion hazard (**Ex** area) are presented in the detail drawing corresponding technical data sheet and/or the label that is affixed to these operating instructions.

Only operate RTD temperature probes according to their intended use and in a clean and undamaged state!

It is not permissible to make any alterations to the RTD temperature probes. In such a case, proper fault-free operation is no longer assured. The guarantee is also invalidated by any alterations. When exchanging measuring inserts, use only original JUMO replacement parts of the same type.

The national and international safety and accident prevention regulations must be followed for installing and working with RTD temperature probes. Furthermore, the operator of the plant or system is responsible for the observance of legal requirements. If lead extensions are used, the specified (length-dependent) limits for capacitance and inductance must be observed.

4 Conformance with standards

WARNING: This operating manual is only valid for the specified test certificate and the norms that are associated with it.

Test certificate: SEV 15 ATEX 0118	IECEx SEV 15.0006
EN 60079-0:2012 + A11:2013	IEC 60079-0:2011, mod. + Cor.:2012 + Cor.:2013
EN 60079-1:2014	IEC 60079-1:2014
EN 60079-11:2012	IEC 60079-11:2011 + Cor.:2012
EN 60079-26:2015	IEC 60079-26:2014
EN 60079-31:2014	IEC 60079-31:2013
Test certificate: SEV 13 ATEX 0197	IECEx SEV 13.0010
EN 60079-0:2012 + A11:2013	IEC 60079-0:2011 (Edition: 6.0)
EN 60079-11:2012	IEC 60079-11:2011 (Edition: 6.0)
EN 60079-26:2007	IEC 60079-26:2006 (Edition: 2)

Table 1: Conformance with Standards

The JUMO quality management system to EN ISO 9001 is the basis for conformance with the directive 94/9/EG up to April 20, 2016, directive 2014/34/EU as of April 20, 2016.
The RTD temperature probes have been developed, manufactured and tested in accordance with the state of the art and in conformity with the applicable standards and regulations.

5 Technical data, explanation and case study

CAUTION: for specific data, see the attached technical data sheet/detail drawing and/or the label that is affixed to these operating instructions

5.1 Intrinsically safe connection, type Ex "i" protection

The equipment used in areas with an explosion hazard only contains intrinsically safe circuits. A circuit is intrinsically safe if, both in normal operation and in the event of a fault, a short-circuit of the circuit does not produce a spark capable of causing ignition, and the current flowing through the equipment does not heat any part of the surface above the level specified for the temperature class (see also EN 60079-11).

In order for a circuit to be designated as intrinsically safe, every individual device included in the circuit must be designed to be intrinsically safe. Furthermore, it is necessary to test that the complete circuit configuration of the (individually) intrinsically safe devices forms, as a whole, an intrinsically safe circuit. **The fact that a circuit is assembled from devices that are (individually) intrinsically safe, does not guarantee that the circuit as a whole is intrinsically safe.**

For instance, the sensing element in a RTD temperature probes carries a current during measurement. This produces internal heating of the element, and, as a result, an increase in the temperature on the surface of the protective fitting. So it is necessary to ensure that the limits of the given temperature class are not exceeded.

Temperature class	Max. surface temperature for the equipment[1]	Ignition temperature of the flammable materials
T1	450 °C	> 450 °C
T2	300 °C	> 300 < 450 °C
T3	200 °C	> 200 < 300 °C
T4	135 °C	> 135 < 200 °C
T5	100 °C	> 100 < 135 °C
T6	85 °C	> 85 < 100 °C

Table 2: Temperature classes

The surface heating itself is influenced by the design of the temperature probe, by the ambient conditions (thermal coupling with the medium being measured) and the power that is applied. The self-heating of the thermometer is characterized by the thermowell constant SK (in °C/W), which represents the increase in surface temperature (in still air) above the ambient temperature as a function of the applied power. The thermowell constant SK is determined by JUMO, and can be found in the attached data sheet/on the affixed label. The user must determine whether the thermometer is suitable for the measurement application and the connected equipment under the given conditions. The maximum permissible measured temperature at the probe tip can be found from the following equation: $\mathbf{T_S = T_K - P_i \times SK}$

T_S Maximum permissible temperature at the probe tip
T_K Maximum permissible surface temperature, depending on the temperature class (as in the table, reduced by the safety reserve)
P_i Power in the certified intrinsically safe circuit
SK Thermowell constant (see technical data sheet)

The following diagram illustrates an example of self-heating of the probe surface of a RTD temperature probe, as a function of the applied power and thus the temperature arising within the probe. (Self-heating is independent of the protection type, and also applies to the flameproof enclosure!)

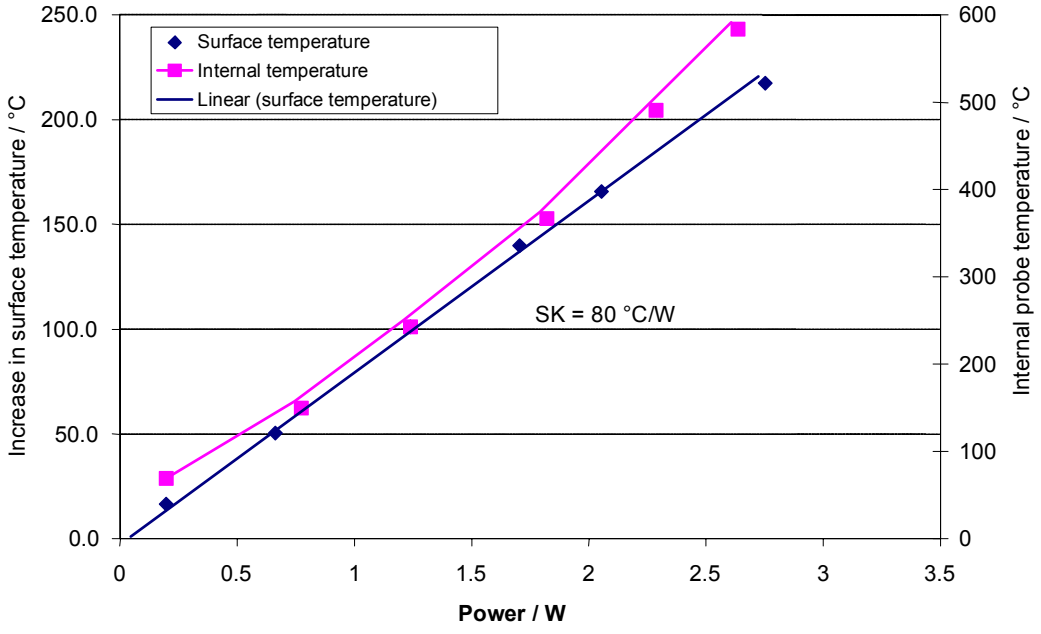

Figure 1 : Self-heating of a Pt100 RTD temperature probe

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[1] **Explanation**
The following safety reserves **must also be complied with:**
Category 1: according to EN 1127-1:2011 Item 6.4.2 (hot surfaces): the temperature of any and all surfaces of equipment ... used in Zone 0 ... that can come into contact with a potentially explosive atmosphere ... must not exceed ... 80 % of the ignition temperature!
⇨ Temperature class minus 20 %!
An additional reduction must be applied: 10 °C for temperature classes T1 and T2, 5 °C for classes T3 – T6.
Category 2: an additional safety reserve (reduction) must be applied: 10 °C for temperature classes T1 and T2, 5 °C for classes T3 – T6.

Example 1

A thermometer is to be used in temperature class T4 (maximum temperature 135 °C, safety reduction of the limit: 5 °C).

Thermowell constant SK = 80 °C/W

Maximum power in the circuit P = 0.5 W

TS = 130 °C – 0.5 W × 80 °C/W
TS = 130 °C – 40 °C = 90 °C

So the maximum temperature (the medium temperature being measured) on the probe tip must not exceed 90 °C, since in the event of a fault it is possible that the limit for the temperature class will be exceeded. **DANGER OF EXPLOSION!**

Example 2

The same thermometer is to be used in the same application as above, but this time using the JUMO transmitter dTRANS T01, which has a considerably lower maximum power, this permitting a substantial increase of the maximum temperature being measured, and so a wider range of applications.

Thermowell constant SK = 80 °C/W

Maximum power in the circuit P = 0.011 W (JUMO transmitter, Type 707015)

TS = 130 °C – 0.011 W × 80 °C/W
TS = 130 °C – 0.88 °C = 129.12 °C

So the maximum temperature (the medium temperature being measured) on the probe tip must not exceed 129.12 °C, since in the event of a fault it is possible that the limit for the temperature class will be exceeded. **DANGER OF EXPLOSION!**

If a transmitter is to be used in a thermometer that has a terminal head, then the permissible operating limits for the transmitter must also be taken into account. The transmitter is hermetically sealed into the terminal head. The ambient temperature and the heat conducted through the protective fittings from the medium being measured both contribute to a rise in surface temperature and the temperature within the terminal head.

The self-heating and heat conduction from outside, via the protective fittings, have been determined for the worst case of a measured temperature of 300 °C and the maximum power dissipation of the transmitter of 750 mW. In such a situation, the temperature of the terminal head is 18 °C higher than the ambient temperature.

It is necessary to take account of the ambient temperature conditions prevailing in the application, and to check that the transmitter is being operated within its specifications and thus does not itself present an explosion hazard.

The values specified in the type examination certificate for the transmitter that is used must be observed and adhered to.

Transmitter example:

Temperature measurement in class T4, max. 135 °C, ambient temperature of the terminal head 40 °C, temperature rise in head 18 °C. The resulting maximum temperature in the terminal head is 40 °C + 18 °C = 58 °C. The transmitter used is a JUMO dTRANS T01, according to data sheet 707010 in “II1G”, and its maximum ambient temperature when used in class T4 is 60 °C. Since 58 °C < 60 °C, this transmitter can be operated inside the terminal head for temperature class T4 with these ambient condition.

5.2 General information on the types of protection

When using different protection types, the self-heating behavior of the equipment to EN 60079-0 must generally also be specified, for classification in the appropriate temperature class.

5.3 Flameproof enclosure, Ex "d" protection

The components that could ignite a potentially explosive atmosphere are arranged within a flameproof enclosure (here: terminal head with cable gland) that is capable of containing the internal pressure caused by an explosion of an explosive mixture inside, and prevents the explosion from being propagated to the potentially explosive atmosphere surrounding the enclosure. The underlying principle is safe containment in the event of an explosion.

It is not mandatory to connect the versions in flameproof enclosure to intrinsically safe circuits, however, it must always be ensured that the rise in temperature of the thermometer remains limited, as was described in detail in Section 5.1. and demonstrated by the case studies.

The temperature classes and safety reserves apply equally to both protection types, and the temperature development in the terminal head (if used with a built-in transmitter) must also be taken into account.

For operation in Zone 0 (G) or 20 (D), type "d" protection “Flameproof enclosure” is by no means sufficient by itself!

In a potentially explosive atmosphere the terminal head and/or connection terminals must not be opened when voltage flows if the ignition protection class "intrinsically safe" (Ex "i") is not also applied.

5.4 Use in areas with an explosion hazard caused by dust

Dust explosion protection: safe limitation of energy
Type of protection "protection type intrinsic safety"

For the safe limitation of the energy fed to the sensing element – also in the event of a fault of the supply unit – using a circuit with "intrinsic safety" protection is highly appropriate. The protection type "protection type intrinsic safety" means that, in the area with an explosion hazard caused by dust, the only criterion is the characteristic of safe limitation of electrical variables in the intrinsically safe equipment by means of the associated intrinsically safe devices. Head-mounted transmitters in Category 1G or 2G are included in the "Protection through enclosure" type of protection inside the terminal head. The associated intrinsically safe device, that has to be positioned outside the hazardous area, need not meet the requirements of Category 1D or 2D. The category markings for equipment requirements in areas with an explosion hazard caused by gas 1G or 2G are therefore sufficient for the intrinsically safe equipment or associated intrinsically safe devices.

The following temperature values must be taken into account for applications in areas with a dust explosion hazard:

Applicable to all zones:
The surface temperature of the equipment must not rise to a level that could ignite swirling dust or dust deposits on the equipment. This is achieved through the following regulations:

No dust deposit
The surface temperature must not exceed $^{2}/_{3}$ of the ignition temperature (in °C) for the corresponding dust-air mixture.

With dust deposit
Surfaces on which a dangerous accumulation of smolderable dust cannot be prevented must not have a temperature that is higher than 75 °C below the smoldering temperature of the dust concerned. If layers thicker than 5 mm occur, a further reduction of the surface temperature must be applied.

Where a combination of swirling and deposited dust occurs, the lower of the values derived above must be applied.

Note
In this case, "surface" means the exterior surface of the equipment, see also 60079-14.

The ignition or smoldering temperature of the dust or dust-air mixture that is present must be defined or determined by the operator of the plant or system!

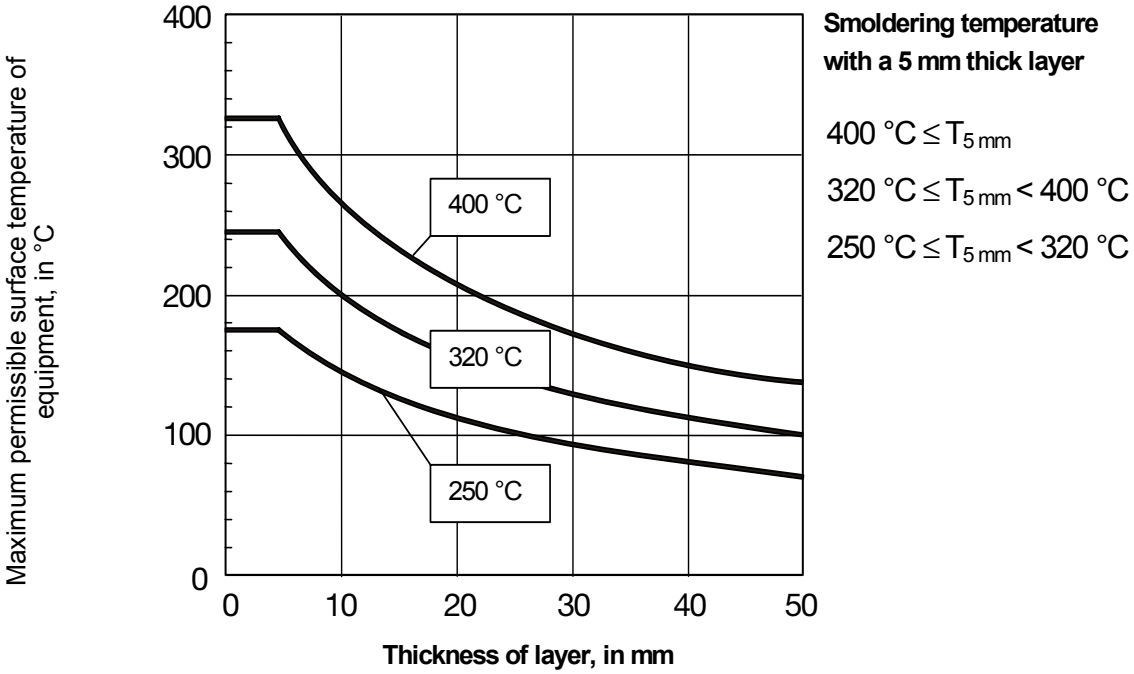


Figure 2: **Reduction of the maximum permissible surface temperature with increasing thickness of the dust layer**

6 Installation

The valid European and national regulations must be observed for installation and operation. The generally accepted state of the art and these operating instructions must be applied.

RTD temperature probes from JUMO are used to measure temperature within areas with an explosion hazard, containing flammable or non-flammable materials, gases, air-gas mixtures or potentially explosive dusts. In the case of equipment with type Ex "i" protection, the supply of power and evaluation are performed by certified intrinsically safe circuits.

The RTD temperature probes are mounted by means of the process connection on site. The RTD temperature probe may need to be built into an additional screw-in or weld-in pocket, depending on the process connection. If a thread is provided as a process connection, then the entire thread length of the RTD temperature probe must be in contact.

The feed wire of the RTD temperature probe must be fixed in position when mounted to containers or pipelines that contain potentially explosive gas/air mixtures (zone 0, 1G or EPL Ga) or dust (zone 20, 1D or EPL Da).

Metallic connector housings must be grounded via the connecting cables, for equipotential bonding.
Non-metallic connector housings must not exceed the max. surface area specified by EN 60079-0.
The screw-in or weld-in pocket can also serve to separate zones, and is made from steel, stainless steel, Hastelloy, etc. with a minimum wall thickness of 1 mm.
Devices which are installed in the separating wall between an area requiring EPL Da and an area that is less endangered are indicated on the nameplate with both EPLs, but they are separated with a hyphen (e.g. Ex d IIC T6 Da/Db or Ex ia/d IIB T4 Da/Db).
The hyphen between the equipment protection level in connection with ignition protection type Ex "ia" indicates that the sensor may be inserted into zone 0 without a separator.
The hyphen Da/Db in the version with the ignition protection type "ib" indicates an existing separator. As a result, the fitting can only protrude into zone 0 with a separator.

Norm EN 60079-14 "Explosive atmospheres - Part 14: Electrical installations design, selection and erection" needs to be observed!

Equipment for potentially explosive areas which contain hybrid mixtures has to be especially checked for this use. Hybrid mixtures are potentially explosive mixtures out of combustible gases, vapors, or mists with combustible dust. The operator bears the responsibility of checking if the equipment is suitable for such uses.

Caution:
In all cases, zoning is the responsibility of the plant/system operator, and not of the manufacturer/supplier of the equipment!

Zone separation			
Gases, mists, vapors	**Dusts**	**Potentially explosive atmosphere present**	**Guide values**
Zone 0	Zone 20	continually, long-term, or frequently	> 1000 hours/year
Zone 1	Zone 21	occasionally	10 to 1000 hours/year
Zone 2	Zone 22	infrequently, short-term	< 10 hours/year

Table 3: Zone separation

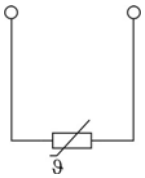
7 Maintenance

The valid European and national regulations must be observed for maintenance, servicing and testing. During maintenance, all parts must be tested that are relevant for the Ex (explosion protection) rating.

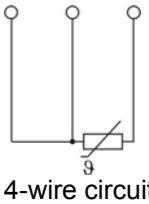
In addition, thermometers with a plastic terminal head as well as all plastic components (e.g. connectors and the like) must only be cleaned with a damp cloth, to avoid building up an electrostatic charge.

8 Connection circuits for RTD temperature probes
(applies to both head-mounted and cable-connected RTDs from JUMO)

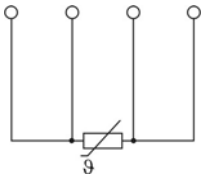
2-wire circuit



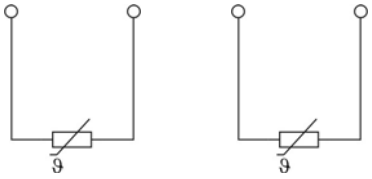
3-wire circuit



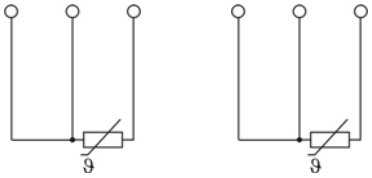
4-wire circuit



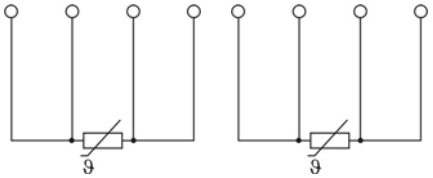
2 × 2-wire circuit



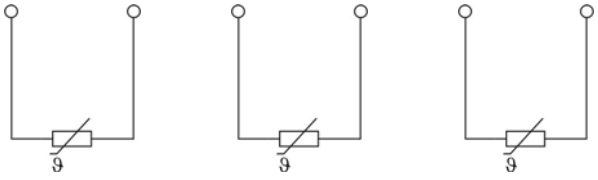
2 × 3-wire circuit



2 × 4-wire circuit



3 × 2-wire circuit



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