



LAPP AUTOMAATIO EPIC Sensors Magnetic Temperature Sensor Type T-MAGN/W-MAGN User Guide

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LAPP AUTOMAATIO EPIC Sensors Magnetic Temperature Sensor Type T-MAGNW-MAGN



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Product description and intended use

Sensor types T-MAGN (thermocouple, TC) and W-MAGN (resistance, RTD) are magnetic temperature sensors with cable.

Sensors are intended for various industrial measuring applications. The construction allows quick and easy installation for surface temperature measurement on flat ferro-magnetic surfaces. Installation is carried out by a permanent magnet attached to sensor tip.

Sensor element protection tube material can be chosen, and element / cable length can be produced according to customer needs.

Measuring elements are rigid, non-bendable versions. Elements can be TC or RTD elements, standard versions are K-type thermocouple (for T-MAGN) and 4-wire Pt100 (for W-MAGN). Tailored versions are produced on request.

Wire and cable sheath materials can be chosen.

Also available as ATEX and IECEx approved protection type Ex i versions. Please see section Ex i data.

EPIC® SENSORS temperature sensors are measuring devices intended for professional use. They should be mounted by professionally capable installer who understands the installations surroundings. The worker should understand mechanical and electrical needs and safety instructions of the object installation. Suitable safety gear for each installation task must be used.

Temperatures, measuring

Allowed measuring temperature range for sensor tip, both RTD and TC, is:

- **With small magnet (Ø25 mm)** -50...+200 °C, depending on cable material
- **With large magnet (Ø60 mm)** -50...+350 °C, depending on cable material

NOTE!

The maximum temperature for the large permanent magnet (Ø60 mm) part is +500 °C, and it de-magnetizes (loses its magnetism) permanently in +860 °C temperature (Curie point).

The minimum temperature -50 °C is approximately the lowest working point to have magnetic force. Lower temperatures must be examined separately.

These values apply only for the magnet component, for the sensor allowed measuring values are given above.

Temperatures, ambient

Allowed maximum ambient temperature for wires or cable, according to cable type, is:

- SIL = silicone, max. +180 °C
- FEP = fluoropolymer, max. +205 °C
- GGD = glass silk cable/metal braid jacket, max. +350 °C
- FDF = FEP wire insulation/braid shield/FEP jacket, max. +205 °C
- SDS = silicone wire insulation/braid shield/silicone jacket, only available as 2 wire cable, max. +180 °C
- TDT = fluoropolymer wire insulation/braid shield/ fluoropolymer jacket, max. +205 °C
- FDS = FEP wire insulation/braid shield/silicone jacket, max. +180 °C
- FS = FEP wire insulation/silicone jacket, max. +180 °C

Make sure the process temperature is not too much for the cable.

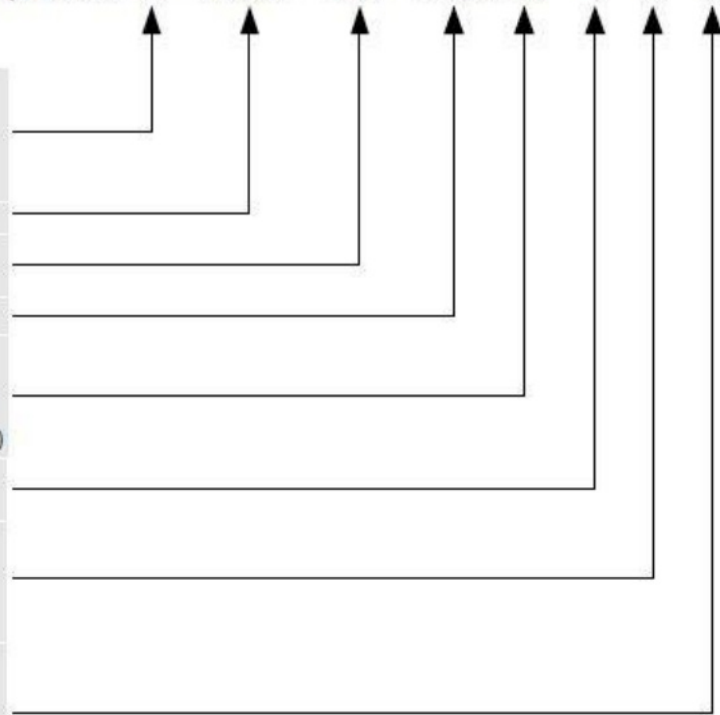
Temperatures, Ex i versions

For Ex i versions only (type designations -EXI-), specific temperature conditions apply according to the ATEX and IECEx certificates. For more details, please see section: Ex i data (only for types with Ex i approval).

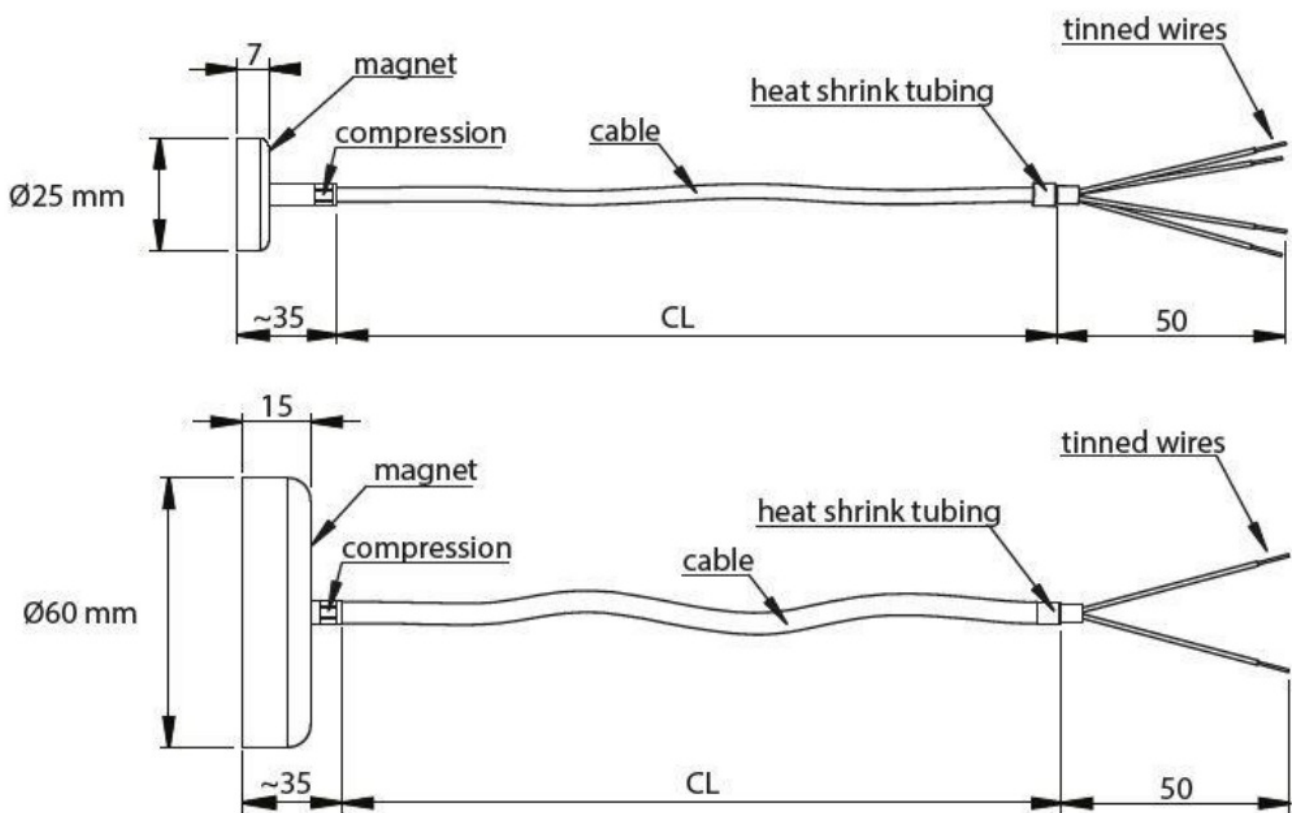
Code key

Example code: W — MAGN — D25 — 5000 / SIL — 4 — A — X

| | |
|--|--|
| W | = Pt100 resistance thermometer |
| 2xW | = 2 x Pt100 resistance thermometer |
| T | = thermocouple |
| 2xT | = 2 x thermocouple |
| MAGN | = magnetic sensor (constant in code) |
| D25 | = magnet diameter |
| D60 | |
| 5000 | = cable length, CL [mm] |
| SIL, FEP, GGD, FDF, TDT, SDS, FDS, FS | = cable material (for more information, look technical data on first page of the datasheet) |
| 4,3,2 | = Pt100 wire count |
| K,N,J | = thermocouple type |
| A,B | = Pt100 accuracy class, (class A as standard delivery) |
| 1,2,3 | = thermocouple accuracy class, (class 1 as standard delivery) |
| EXI | = Ex i certified sensor |
| X | = additional details on the text line |



Dimensional drawing



Technical Data

| | |
|--|---|
| Materials | AISI 316L, max. temperature +250 °C, temporarily +350 °C, other materials on request |
| Dimensions | Small magnet, external Ø 25 mm / height 7 mm, other dimensions on request Large magnet, external Ø 60 mm / height 15 mm, other dimensions on request |
| Cable materials | SIL = silicone, max. + 180°C FEP = fluoropolymer, max. +205 °C GGD = glass silk cable/metal braid jacket, max. +350 °C FOF = FEP wire insulation/braid shield/FEP jacket, max. +205 °C SDS = silicone wire insulation/braid shield/silicone jacket. only available as 2 wire cable, max. +180 °C TDT = fluoropolymer wire insulation/braid shield/fluoropolymer jacket, max. +205 °C FOS = FEP wire insulation/braid shield/ silicone jacket, max. +180 °C FS = FEP wire insulations/silicone jacket, max. +180 °C |
| Tolerances Pt 100 (IEC 60751) | A tolerance $\pm 0.15 + 0.002 \times t$, operating temperature -100...+450 °C B tolerance $\pm 0.3 + 0.005 \times t$, operating temperature -196 ...+600 °C B 1/3 DIN, tolerance $\pm 1/3 \times (0.3 + 0.005 \times t)$, operating temperature -196...+600 °C B 1/ 10 DIN, tolerance $\pm 1/ 10 \times (0.3 + 0.005 \times t)$, operating temperature -196...+600 °C |
| Tolerances thermocouple (IEC 60584) | Type J tolerance class 1 = -40. – 375 °C ± 1.5 °C, 376. – 750 °C $\pm 0.004 \times t$ Type K and N tolerance class 1 = -40... 375 °C ± 0.5 °C, 375 1000 °C $\pm 0.004 \times t$ |
| Temperature range Pt100 | -50...+350 °C for large magnet, depending on cable material -50 ... +200°C for small magnet, depending on cable material |
| Temperature range thermocouple | -50...+350 °C for large magnet, depending on cable material -50 ... +200 °C for small magnet, depending on cable material |
| Approvals | ATEX, IECEx, METROLOGICAL PATTERN APPROVAL |
| Quality certificate | ISO 9001:2015 and ISO 14001:2015 issued by ONV |

Materials

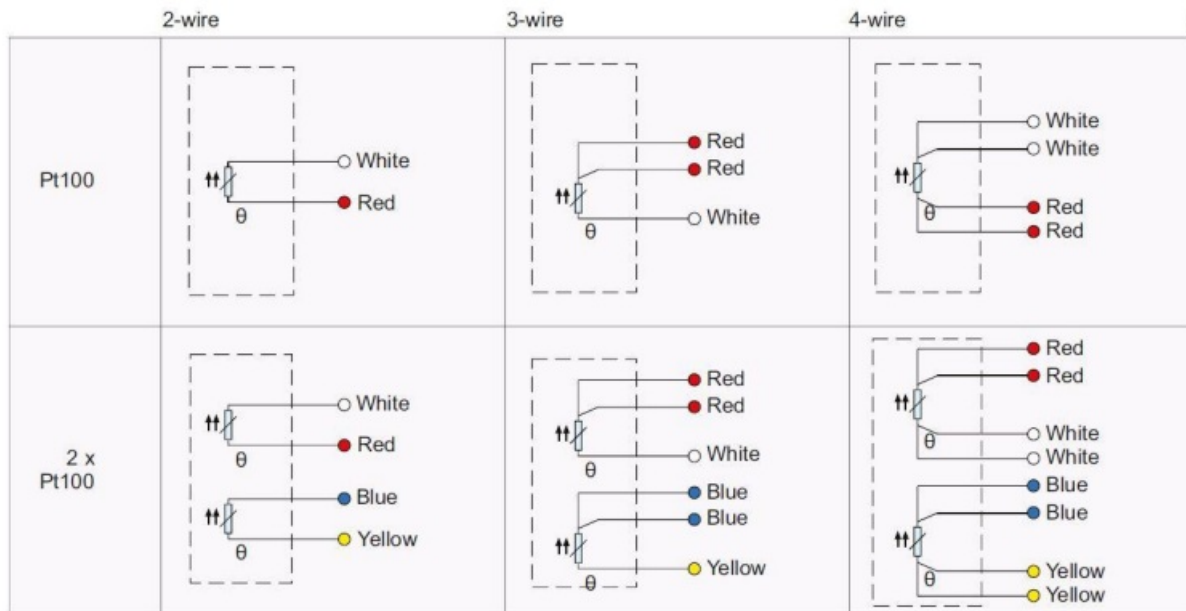
These are the standard materials of components for the sensor types T-MAGN / W-MAGN.

- **Cable/wires** please see Technical data
- **Heat shrink tube** Irradiated Modified Polyolefin (max +125 °C), only on request, not used as standard
- **Sensor element** AISI 316L
- **Magnet cover** Zinc-plated Steel
- **Magnet** Ø25 mm: Hard-Ferrite (max. +200 °C) Ø60 mm: Aluminum-Nickel-Cobalt (max. +500 °C)

Other materials can be used on request.

Pt100; connection wiring

Image below: These are the connection colors of Pt100 resistor connections, according to standard EN 60751.



Pt100; measuring current

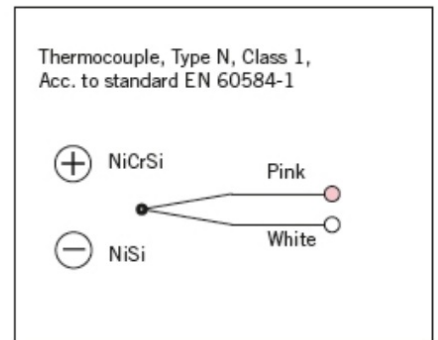
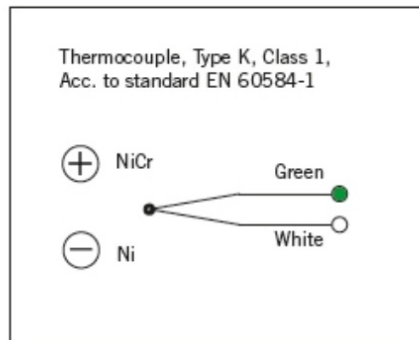
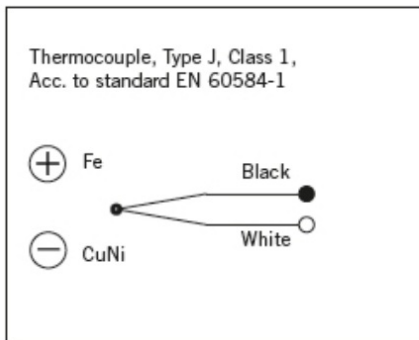
The highest allowed measuring current for Pt100 measuring resistors depends on resistor type and brand. Normally the recommended maximum values are;

- **Pt100** 1 mA
- **Pt500** 0,5 mA
- **Pt1000** 0,3 mA.

Do not use higher measuring current. It will lead to false measurement values and might even destroy the resistor. Above listed values are normal measuring current values. For Ex i certified sensor types, type designation -EXI-, higher values (worst case) are used for the self-heating calculation for safety reasons. For further details and calculation examples, please see ANNEX A.

TC; connection wiring

Image below: These are the connection colors of TC types J, K and N.



TC; non-grounded or grounded types

Normally the thermocouple sensors are non-grounded, which means the protective tube / MI cable sheath is not connected to the thermo material hot junction, where two materials are welded together.

In special applications also grounded types are used.

NOTE! Non-grounded and grounded sensors cannot be connected to same circuits, make sure you are using the right type.

NOTE! Grounded TCs are not allowed for Ex i certified sensor types

Image below: Non-grounded and grounded structures in comparison.

Non-grounded TC





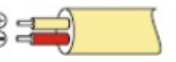



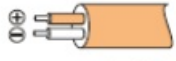
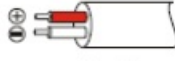







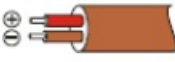
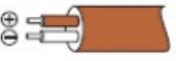



Thermo material hot junction
and protective tube / MI cable
sheath are galvanically
isolated from each other.

Grounded TC



Thermo material hot junction
has galvanic connection with
protective tube / MI cable
sheath.

TC; thermocouple cable standards (color table)

| New standards: | IEC 60584-3 | DIN EN 60584 | ISA MC 96.1 |
|-----------------------------------|--|--|--|
| Thermo Type | IEC 584 | DIN 43714 | ANSI MC 96.1 |
| NiCr-Ni / K KCA: Fe-CuNi |  + green/ - white Jacket: green |  + red/ - green Jacket: green |  + yellow/ - red Jacket: yellow |
| Fe-CuNi / L | |  + red/ - blue Jacket: blue | |
| Fe-CuNi / J |  + black/ - white Jacket: black | |  + white/ - red Jacket: black |
| Pt10Rh-Pt / S SCA: E-Cu/A-Cu |  + orange/ - white Jacket: orange |  + red/ - white Jacket: white |  + black/ - red Jacket: green |
| Pt13Rh-Pt / R RCA: E-Cu/A-Cu |  + orange/ - white Jacket: orange |  + red/ - white Jacket: white |  + black/ - red Jacket: green |
| Pt30Rh-Pt6Rh / B BC: S-Cu/E-Cu |  + grey/ - white Jacket: grey | |  + grey/ - red Jacket: grey |
| NiCrosil-Nisil / N NC: Cu-CuNi |  + pink/ - white Jacket: pink | | |
| Cu-CuNi / U | |  + red/ - brown Jacket: brown | |
| Cu-CuNi / T |  + brown/ - white Jacket: brown | | |
| NiCr-CuNi / E |  + purple/ - white Jacket: purple |  + red/ - purple Jacket: purple |  + purple/ - red Jacket: purple |

Installation Instructions

Before any installation, make sure the target process/machinery and site are safe to work!
Make sure the cable type matches the temperature and chemical requirements of the site.

Installation phases:

- Install the sensor magnet on a plane ferro-magnetic surface.
- Make sure there is no excess bending force loading the cable.
- Mount extra strain relief, e.g. cable tie, for cable, if necessary.

Type label of standard versions

Each sensor has a type label attached to. It is a moisture and wear proof industrial grade sticker, with black text on white label. This label has printed information as presented below.

- Image below: Example of a standard sensor type label.



Manufacturer contact information.
For some sensor types, this part
may also be printed on a separate
label for practical reasons.

Trade name
Type code
Product number
Serial number with production date
CE-mark (RoHS) | Serial number
as QR code

Serial number information

Serial number S/N is always printed on type label in the following form: yymmdd-xxxxxxx-x:

- **yymmdd** production date, e.g. “210131” = 31.1.2021
- **-xxxxxxx** production order, e.g. “1234567”
- **-x** sequential ID number within this production order, e.g. “1”

Ex i data (only for types with Ex i approval)

This sensor type is available also with ATEX and IECEx Ex i approvals. Assembly consists of a temperature sensor for magnet installation, with cable for connection (sensor type designation -EXI-). All relevant Ex data is given below.

Ex i – Special Conditions for Use

There are special specifications and conditions for use defined in certificates. These include e.g. Ex data, allowed ambient temperatures, and self-heating calculation with examples. These are presented in Annex A: Specification and special conditions for use – Ex i approved EPIC®SENSORS temperature sensors.

Ex i certificates and Ex markings

| Certificate – Number | Issued by | Applicable area | Marking |
|------------------------------------|---|-----------------|---|
| ATEX – EESF 21 ATEX 043X | Eurofins Electric & Electronics Finland Oy, Finland, Notified Body Nr 0537 | Europe | Ex II 1G Ex ia IIC T6...T3 Ga Ex II 1/2G Ex ib IIC T6...T3 Ga/Gb Ex II 1D Ex ia IIIC T135 °C Da Ex II 1/2D Ex ib IIIC T135 °C Da/Db |
| IECEX – IECEX EESF 21.0027X | Eurofins Electric & Electronics Finland Oy, Finland, Notified Body Nr 0537 | Global | Ex ia IIC T6...T3 Ga Ex ib IIC T6...T3 Ga/Gb Ex ia IIIC T135 °C Da Ex ib IIIC T135 °C Da/Db |

Note! Name change of the Notified Body Nr 0537:

- **Until 31.3.2022, the name was:** Eurofins Expert Services Oy
- **As of 1.4.2022, the name is:** Eurofins Electric & Electronics Finland Oy.

Ex i type label

For ATEX and IECEX Ex i approved versions there is more information on the label, according to applicable standards.

- Image below: Example of an ATEX and IECEX Ex i approved sensor type label.



Manufacturer contact information.
For some sensor types, this part may also be printed on a separate label for practical reasons.

Trade name
Type code
Product number
Serial number with production date
CE-mark (RoHS)
Serial number as QR code

EU Declaration of Conformity

The EU Declaration of Conformity, declaring products' conformance to the European Directives, is delivered with products or sent on request

Manufacturer contact information

Manufacturer HQ main office:
Lapp Automaatio Oy

Street address Martinkyläntie 52
Postal address FI-01720 Vantaa, Finland

Production site and logistics:

Lapp Automaatio Oy

Street address Varastokatu 10

Postal address FI-05800 Hyvinkää, Finland

Phone (sales) +358 20 764 6410

Email epicsensors.fi.lav@lapp.com

Https www.epicsensors.com

Document history

| Version / date | Author(s) | Description |
|----------------|-----------|--------------------------------|
| 20220822 | LAPP/JuPi | Telephone number update |
| 20220815 | LAPP/JuPi | Material name text corrections |
| 20220408 | LAPP/JuPi | Minor text corrections |
| 20220401 | LAPP/JuPi | Original version |

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ANNEX A – Specification and special conditions for use – Ex i approved EPIC® SENSORS temperature sensors

Ex data for RTD (resistance temperature sensor) and TC (Thermocouple temperature sensor)

Sensor Ex data, maximum interface values, without transmitter or / and display.

Table 1. Sensor Ex data.

| Electrical values | For Group IIC | For Group IIIC |
|-------------------|---------------|---|
| Voltage U_i | 30 V | 30 V |
| Current I_i | 100 mA | 100 mA |
| Power P_i | 750 mW | 550 mW @ $T_a +100\text{ }^{\circ}\text{C}$ |
| | | 650 mW @ $T_a +70\text{ }^{\circ}\text{C}$ |
| | | 750 mW @ $T_a +40\text{ }^{\circ}\text{C}$ |
| Capacitance C_i | Negligible, * | Negligible, * |
| Inductance L_i | Negligible, * | Negligible, * |

* For sensors with long cable part, the parameters C_i and L_i must be included in the calculation. Following values per meter can be used according to EN 60079-14:

$C_{\text{cable}} = 200\text{ pF/m}$ and $L_{\text{cable}} = 1\text{ }\mu\text{H/m}$.

Allowed ambient temperatures – Ex i temperature class, without transmitter and/or display.

Table 2. Ex i temperature classes and allowed ambient temperature ranges

| Marking, Gas Group IIC | Temperature class | Ambient temperature |
|---|-------------------|---------------------|
| II 1G Ex ia IIC T6 Ga II 1/2G Ex ib IIC T6-T3 Ga/Gb | T6 | -40...+80 °C |
| II 1G Ex ia IIC T5 Ga II 1/2G Ex ib IIC T6-T3 Ga/Gb | T5 | -40...+95 °C |
| II 1G Ex ia IIC T4-T3 Ga II 1/2G Ex ib IIC T6-T3 Ga/Gb | T4-T3 | -40...+100 °C |
| | | |
| Marking, Dust Group IIIC | Power Pi | Ambient temperature |
| II 1D Ex ia IIIC T135 °C Da II 1/2D Ex ib IIIC T135 °C Da/Db | 750 mW | -40...+40 °C |
| II 1D Ex ia IIIC T135 °C Da II 1/2D Ex ib IIIC T135 °C Da/Db | 650 mW | -40...+70 °C |
| II 1D Ex ia IIIC T135 °C Da II 1/2D Ex ib IIIC T135 °C Da/Db | 550 mW | -40...+100 °C |

Note!

The temperatures above are without gable glands.

The compatibility of cable glands must be according to the application specifications.

If the transmitter and/or display will be inside the transmitter housing, the specific Ex requirements of the transmitter and/or display installation must be noted.

The used materials must comply the needs of application, e.g., abrasion, and the temperatures above.

For EPL Ga Group IIC the aluminium parts in connection heads are subject to sparking by impacts or friction.

For Group IIIC the maximum input power Pi shall be observed.

When the sensors are mounted across boundary between different Zones, refer to standard IEC 60079-26 section 6, for ensuring the boundary wall between different hazardous areas.

ANNEX A – Specification and special conditions for use – Ex i approved EPIC® SENSORS temperature sensors

Considering sensor self-heating

Self-heating of the sensor tip shall be considered in respect with Temperature Classification and associated ambient temperature range and manufacturer's instructions for calculating tip surface temperature according to thermal resistances stated in the instructions shall be observed.

Allowed ambient temperature range of sensor head or process connection for Groups IIC and IIIC with different temperature classes are listed in Table 2. For Group IIIC the maximum input power Pi shall be observed.

The process temperature shall not adversely affect ambient temperature range assigned for Temperature Classification.

Calculation for self-heating of the sensor at the tip of sensor or the thermowell tip

When the sensor-tip is located at environment where the temperature is within T6...T3, it is needed to

consider the self-heating of the sensor. Self-heating is of particular significance when measuring low temperatures.

The self-heating at the sensor tip or thermowell tip depends on the sensor type (RTD/TC), the diameter of sensor and structure of sensor. It is also needed to consider the Ex i values for the transmitter. The table 3. shows the Rth values for different type of sensors structure.

Table 3. Thermal resistance based on Test report 211126

| | Thermal resistance Rth [°C / W] | | | | | |
|--|---------------------------------|-----------|----------|-------------------|-----------|----------|
| Sensor type | Resistance thermometer (RTD) | | | Thermocouple (TC) | | |
| Measuring insert diameter | < 3 mm | 3...<6 mm | 6...8 mm | < 3 mm | 3...<6 mm | 6...8 mm |
| Without thermowell | 350 | 250 | 100 | 100 | 25 | 10 |
| With thermowell made from tube material (e.g. B-6k, B-9K, B-6, B-9, A-15, A-22, F-11, etc) | 185 | 140 | 55 | 50 | 13 | 5 |
| With thermowell – solid material (e.g. D-Dx, A-Ø-U) | 65 | 50 | 20 | 20 | 5 | 1 |

Note!

If the measuring device for RTD-measuring is using measuring current > 1 mA, the maximum surface temperature of the temperature sensor tip should be calculated and taken to account. Please see next page. If sensor type has multiple sensing elements included, and those are used simultaneously, note that the maximum power for all sensing elements should not be more than the allowed total power Pi. Maximum power must be limited to 750 mW. This must be guaranteed by process owner. (Not applicable for Multi-point temperature sensor types T-MP / W-MP or T-MPT / W-MPT with segregated Exi circuits).

ANNEX A – Specification and special conditions for use – Ex i approved EPIC® SENSORS temperature sensors

Calculation for maximum temperature:

The self-heating of the sensor tip can be calculated from formula:

$$T_{max} = P_o \times R_{th} + MT$$

(**Tmax**) = Maximum temperature = surface temperature at the sensor tip

(**Po**) = Maximum feeding power for the sensor (see the transmitter certificate)

(**Rth**) = Thermal resistance (K/W, Table 3.)

(**MT**) = Medium temperature.

Calculate the maximum possible temperature at the tip of sensor:

Example 1 – Calculation for RTD-sensor tip with thermowell

Sensor used at Zone 0

RTD sensor type: W-M-9K . . . (RTD-sensor with head-mounted transmitter).

Sensor with thermowell, diameter of Ø 9 mm.

Medium temperature (MT) is 120 °C

Measuring is made with PR electronics head mounted transmitter 5437D and isolated barrier PR 9106 B.

Maximum temperature (Tmax) can be calculated by adding the temperature of the medium that you are

measuring and the self-heating. The self-heating of the sensor tip can be calculated from the Maximum power (P_o) which is feeding the sensor and R_{th} -value of used sensor type. (See the Table 3.)

Supplied power by PR 5437 D is (P_o) = 23,3 mW (from the transmitter Ex-certificate)

Temperature class T4 (135 °C) must not be exceeded.

Thermal resistance (R_{th}) for the sensor is = 55 K/W (from Table 3).

Self-heating is $0.0233 \text{ W} \cdot 55 \text{ K/W} = 1,28 \text{ K}$

Maximum temperature (T_{max}) is $MT + \text{self-heating}$: $120 \text{ °C} + 1,28 \text{ °C} = 121,28 \text{ °C}$

The result in this example shows that, the self-heating at the sensor tip is negligible.

The safety margin for (T_6 to T_3) is 5 °C and that must be subtracted from 135 °C; means that up to 130 °C would be acceptable. In this example the temperature of class T4 is not exceeded.

Example 2 – Calculation for RTD-sensor tip without the thermowell.

Sensor used at Zone 1

RTD sensor type: W-M-6/303 . . . (RTD-sensor with cable, without head-mounted transmitter)

Sensor without thermowell, diameter of Ø 6 mm.

Medium temperature (MT) is 40 °C

Measuring is made with rail-mounted PR electronics PR 9113D isolated transmitter/barrier.

Maximum temperature (T_{max}) can be calculated by adding the temperature of the medium that you are measuring and the self-heating. The self-heating of the sensor tip can be calculated from the Maximum power (P_o) which is feeding the sensor and R_{th} -value of used sensor type. (See the Table 3.)

Supplied power by PR 9113D is (P_o) = 40,0 mW (from the transmitter Ex-certificate)

Temperature class T3 (200 °C) must not be exceeded.

Thermal resistance (R_{th}) for the sensor is = 100 K/W (from Table 3).

Self-heating is $0.040 \text{ W} \cdot 100 \text{ K/W} = 4,00 \text{ K}$

Maximum temperature (T_{max}) is $MT + \text{self-heating}$: $40 \text{ °C} + 4,00 \text{ °C} = 44,00 \text{ °C}$

The result in this example shows that, the self-heating at the sensor tip is negligible.

The safety margin for (T_6 to T_3) is 5 °C and that must be subtracted from 200 °C; means that up to 195 °C would be acceptable. In this example the temperature of class T3 is not exceeded.

ANNEX A – Specification and special conditions for use – Ex i approved EPIC® SENSORS temperature sensors

Additional information for Group II devices: (acc. to EN IEC 60079-0: 2019 section: 5.3.2.2 and 26.5.1)

- Temperature class for T3 = 200 °C
- Temperature class for T4 = 135 °C
- Safety margin for T3 to T6 = 5 K
- Safety margin for T1 to T2 = 10 K.

Note!

This ANNEX is an instructional document on specifications.

For original regulatory data on specific conditions for use, always refer to ATEX and IECEx certificates:

EESF 21 ATEX 043X

IECEx EESF 21.0027X



EPIC Sensors Magnetic Temperature Sensor Type T-MAGN W-MAGN, EPIC Sensors Magnetic Temperature Sensor Type T-MAGN, W-MAGN, EPIC Sensors Magnetic Temperature Sensor, Temperature Sensor, Type T-MAGN W-MAGN, T-MAGN, W-MAGN

Manuals+,