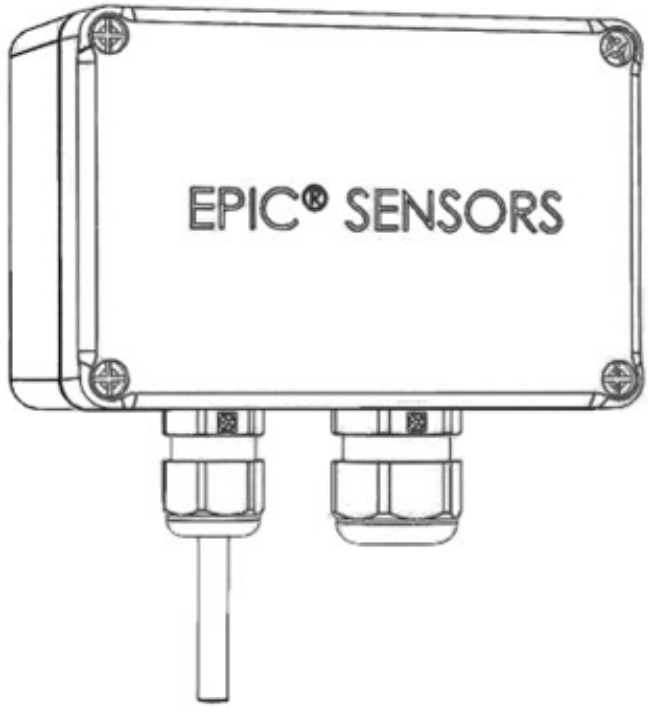
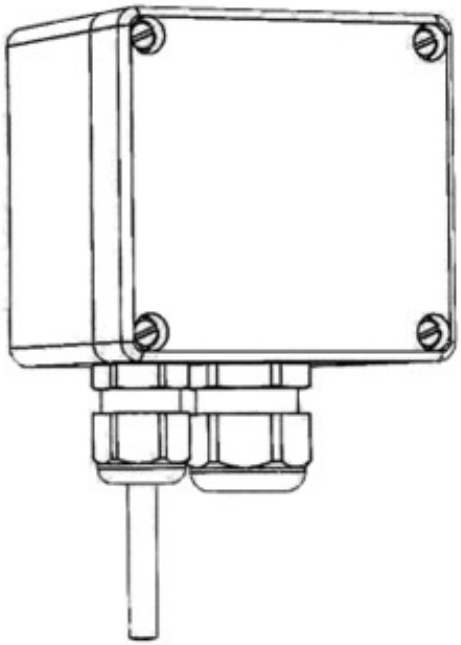
EPIC® SENSORS

Indoor / Outdoor resistance Temperature Sensor
Type: W-K-F / W-M-F

EN, Installation Instructions and User Manual
Manual 6





Lapp Automation Ltd.
Äyritie 18
FI-01510 Vantaa, Finland

lapp.fi

Technical sales:
Tel: +358 (0)20 764 6410

Open orders:
Phone: +358 (0)20 764 6420

Domicile
Vantaa

Business ID: 1107293-1
VAT: FI11072931

Table of contents-

General information

All components are carefully monitored for quality and compliance with standards. Our quality assurance is standardized according to ISO-9001, ISO-14001 and ISO-45001 certificates.

This manual contains important information for using the product. Particular attention should be paid to operating temperatures and environmental requirements.

Product description and intended use

Sensor types W-K-F and W-M-F are indoor / outdoor resistance thermometers (RTD), that are available with plastic or metallic rectangular junction box. Protection rating of both enclosures is IP65.

The sensor is intended to be installed on a wall, or other flat surface. The temperature measurement is implemented with Pt100 sensing element. Typical measuring temperature range for plastic enclosure is: -20 … +80 °C, and for metallic enclosure: -40 … +100 °C.

This type of sensor does have a replaceable sensor element within, it can be easilly replaced if broken. Temperature transmitter can be included in the junction box, to convert the measured temperature response from sensing element to mA current signal. The mA current signal is more resilient to any electromagnetic interference than the direct response, or voltage signal.

The sensor is also available in ATEX and IECEx approved versions with Ex d and/or Ex i protection classes designed for explosive atmospheres.

EPIC® SENSORS temperature sensors are measuring devices for professional use. The user who performs the installation of the unit must be professionally qualified to perform installations in the environment of the intallation site. The installer must have an understanding of the general and local requirements for mechanical and electrical installation, as well as the occupational safety instructions to be followed at the installation site. The work must be carried out using protective equipment appropriate to the task and the possession of a permit to work at the site must be ensured.

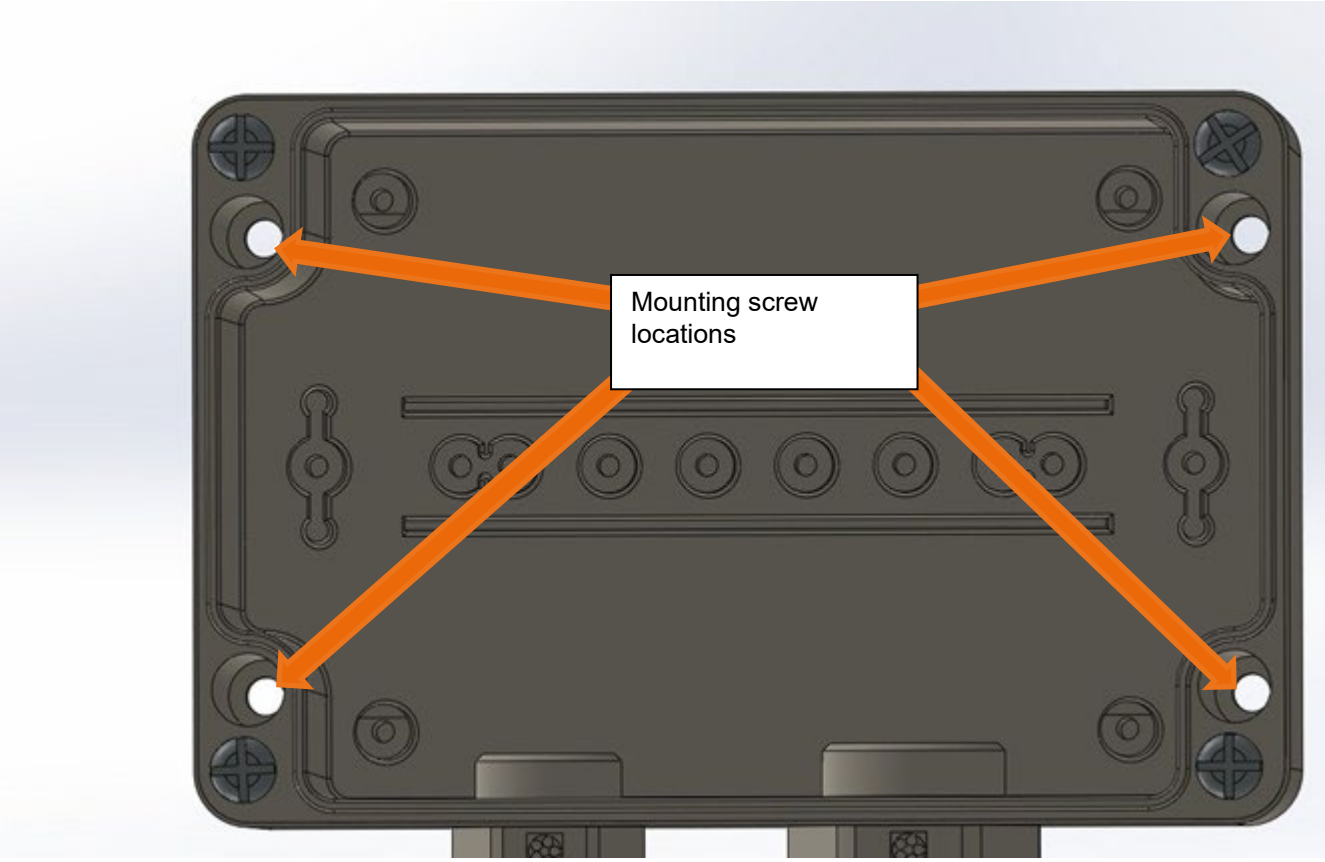
Plastic enclosure (type W-K-F)

Environment temperature range for sensor with plastic enclosure is: -20…+80 °C. Limiting factor for environment temperature range is the temperature tolerance of the plastic materials in enclosure and gable glands. For this reason the sensor with plastic housing is mostly suitable for monitoring indoor room temperatures. Sensor typically has two SKINTOP® cable glands, with M16x1 and M20x1,5 threads.

Smaller cable gland is holding the measuring element W-CABLE-6/60-150/SIL-4-A, which is W-CABLE -type of temperature sensor. This W-CABLE sensor can be separately ordered and delivered. Cable glands can be opened and also changed if necessary. Bigger cable gland is reserved for cable, and it is suitable for cables with diameter of Ø8 – Ø13 mm.

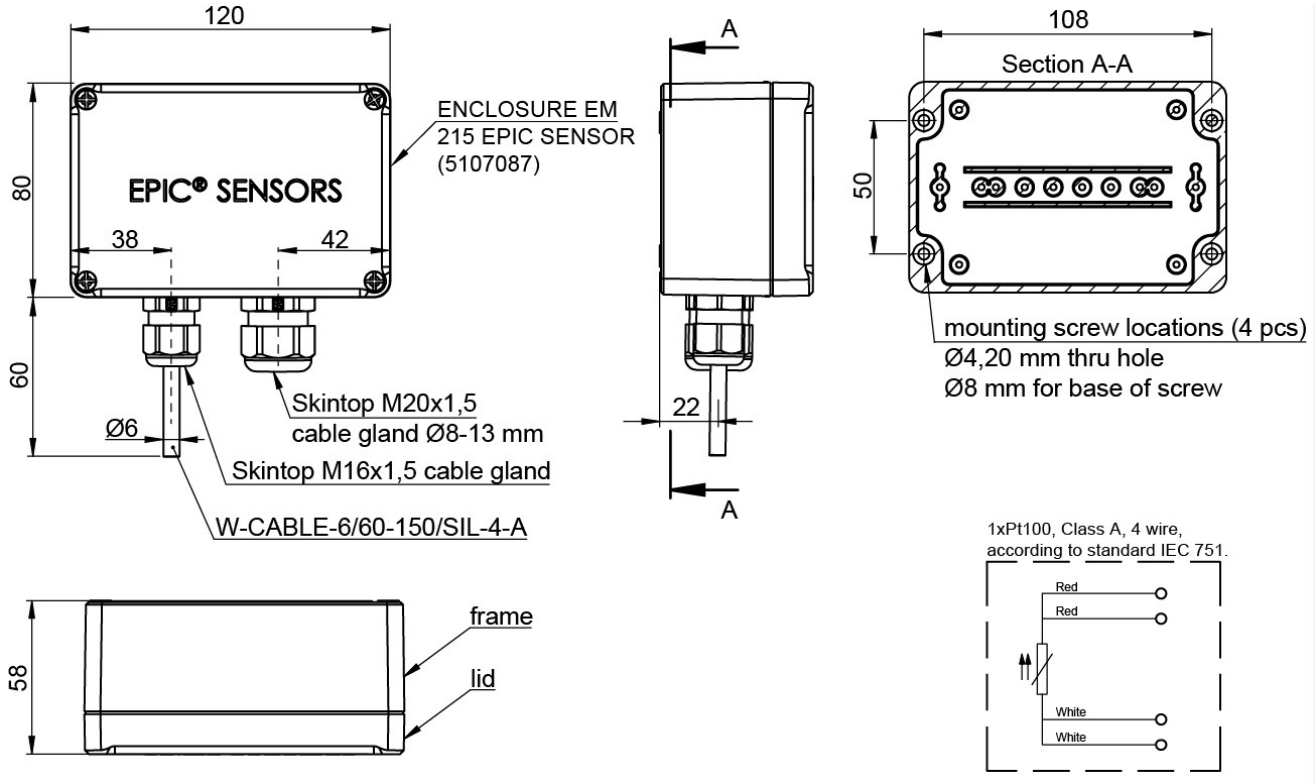
Color of the enclosure is light grey and the IP-classification is IP65. There is sealant in between the lid and the enclosure, to prevent any moisture entering. Lid will attach to the enclosure with four coarse threaded stainless steel screws (AISI 314 / EN1.4301).

To attach the enclosure to wall, four mounting screws is needed. Picture below will illustrate the location of the attachment. Note that the installation should locate outside the lid gasket. Holes for the mounting screws are Ø4,2 mm and there is Ø8 mm space for the base of each screw. It is not recommended to use mounting screws exceeding these dimensions. Plastic enclosure material thickness between the base of the intallation screw and the wall is 4 mm.



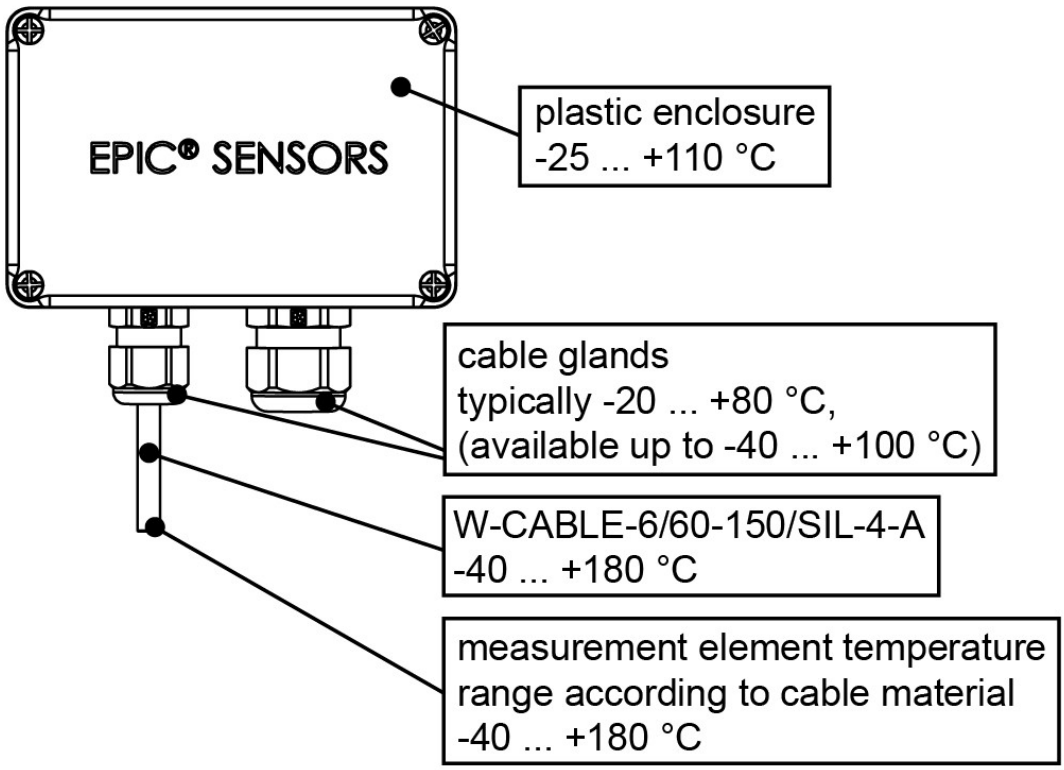
Dimensional drawing

Dimensions of the product with plastic enclosure is presented as follows:



Temperature tolerance

Picture below will show temperature range for each part of the product with plastic enclosure:



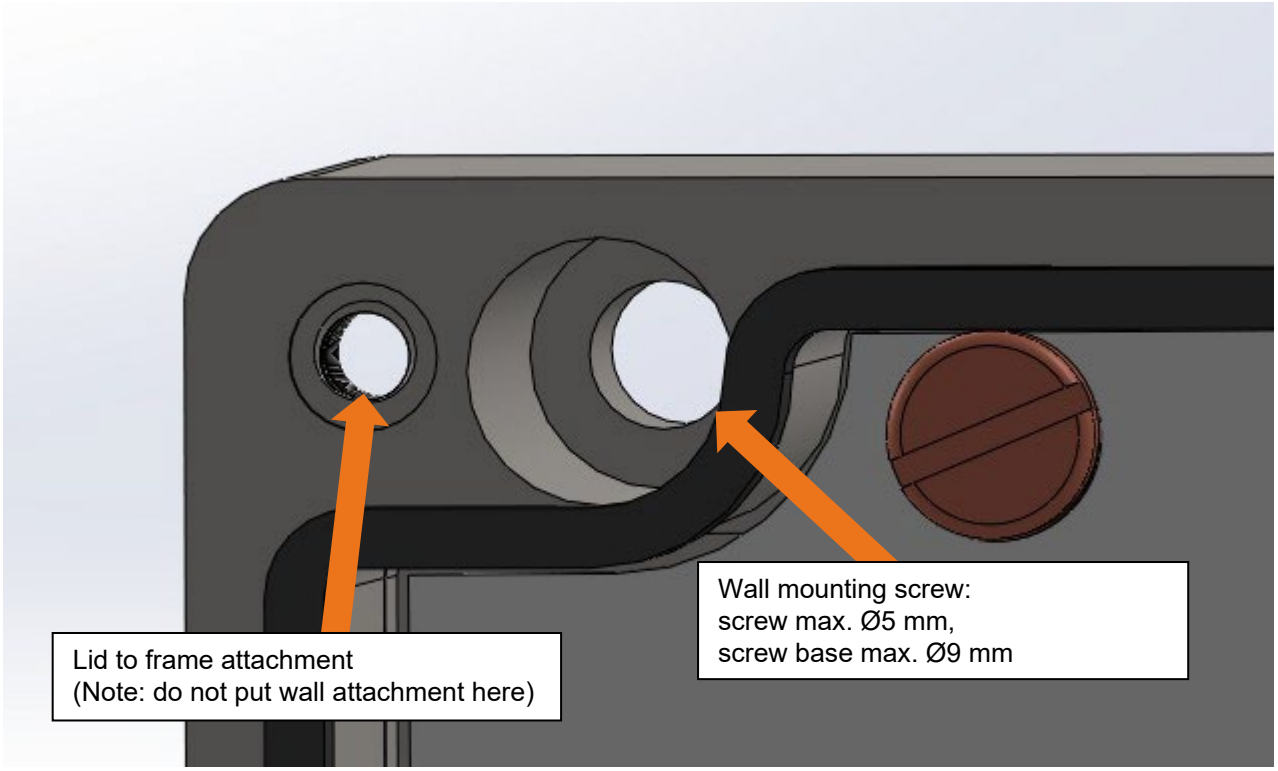
Metallic enclosure (type W-M-F)

Temperature range of the product with metallic enclosure is within range -40…+100 °C. Limiting factor for the temperature is the temperature tolerance of the cable glands. Product with metallic enclosure is mainly suited for outdoors environment. Enclosure is typically mounted with two SKINTOP® cable glands made of brass. They are attached to the enclosure with M16x1,5 and M20x1,5 threads.

Smaller cable gland is holding the measuring element W-CABLE-6/60-150/SIL-4-A, which is W-CABLE -type of temperature sensor. This W-CABLE sensor can be separately ordered and delivered. Cable glands can be opened and also changed if necessary. Bigger cable gland is reserved for cable, and it is suitable for cables with diameter of Ø8 – Ø13 mm.

Color of the enclosure is dark grey and the IP-classification is IP65. Material of the enclosure is aluminium. There is sealant in between the lid and the enclosure, to prevent any moisture entering. Lid will attach to the enclosure with four screws, located at the each corner of the lid.

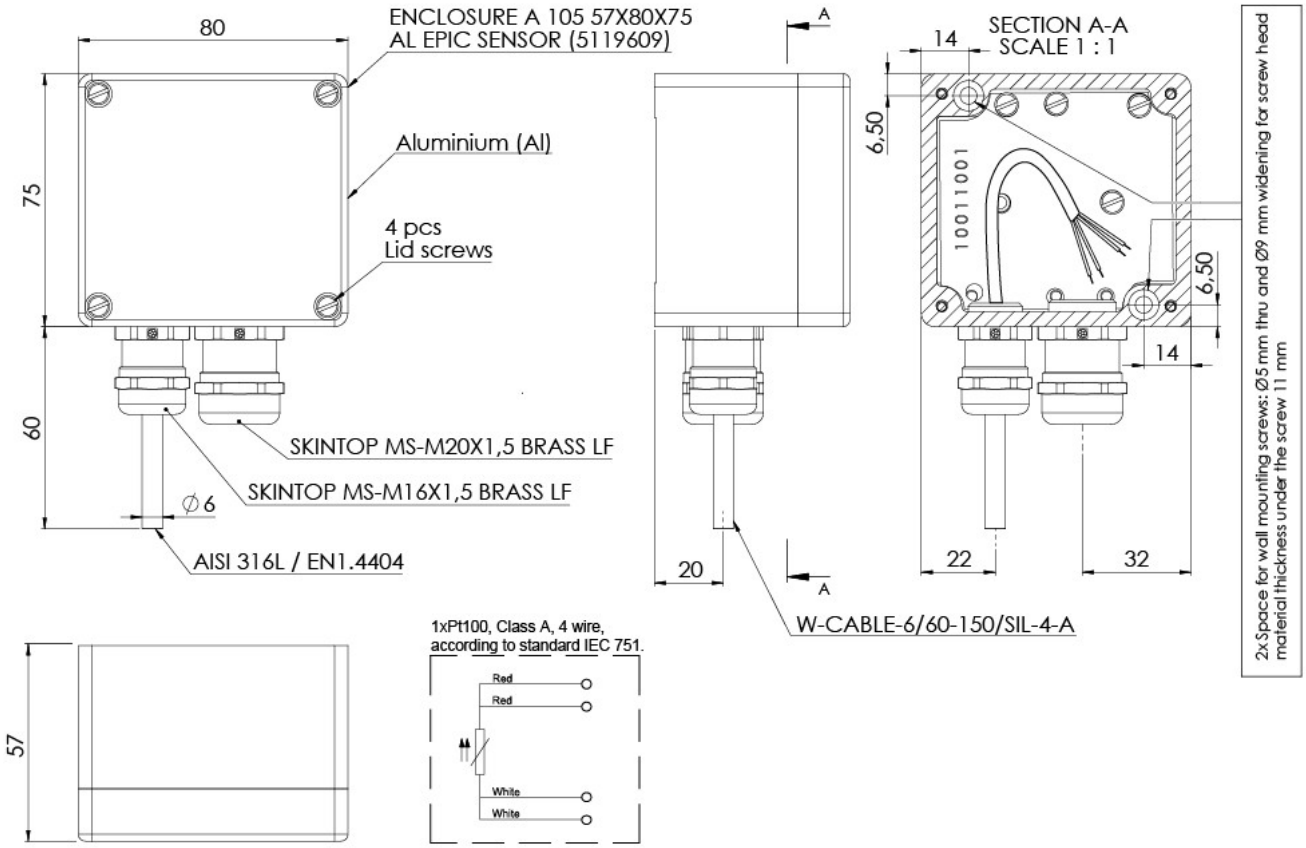
To attach the enclosure to wall, two mounting screws is needed. Picture below will illustrate the location of the holes for wall attachment. Note that the installation of mounting screws, should always be locate outside the lid gasket, for the IP-rating to stay valid. Holes for the mounting screws are Ø5 mm and there is Ø9 mm space for the base of each screw. It is not recommended to use mounting screws exceeding these dimensions. The aluminium enclosure material thickness between the base of the mounting screw and the wall is 11 mm.



Product with metallic enclosure is available as Ex i -certified version.

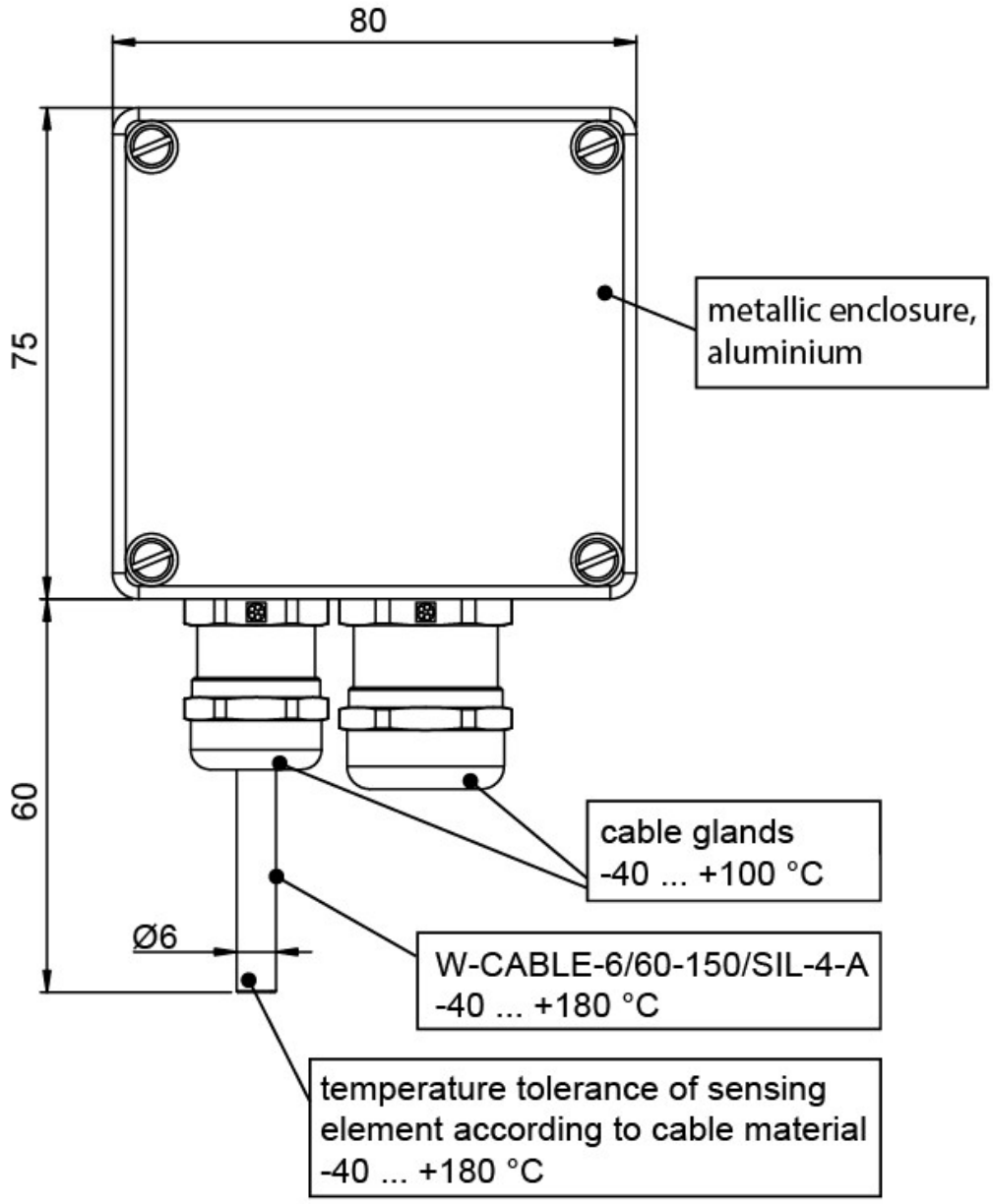
Dimensional drawing

Following picture will present the dimensions of the product with metallic enclosure:



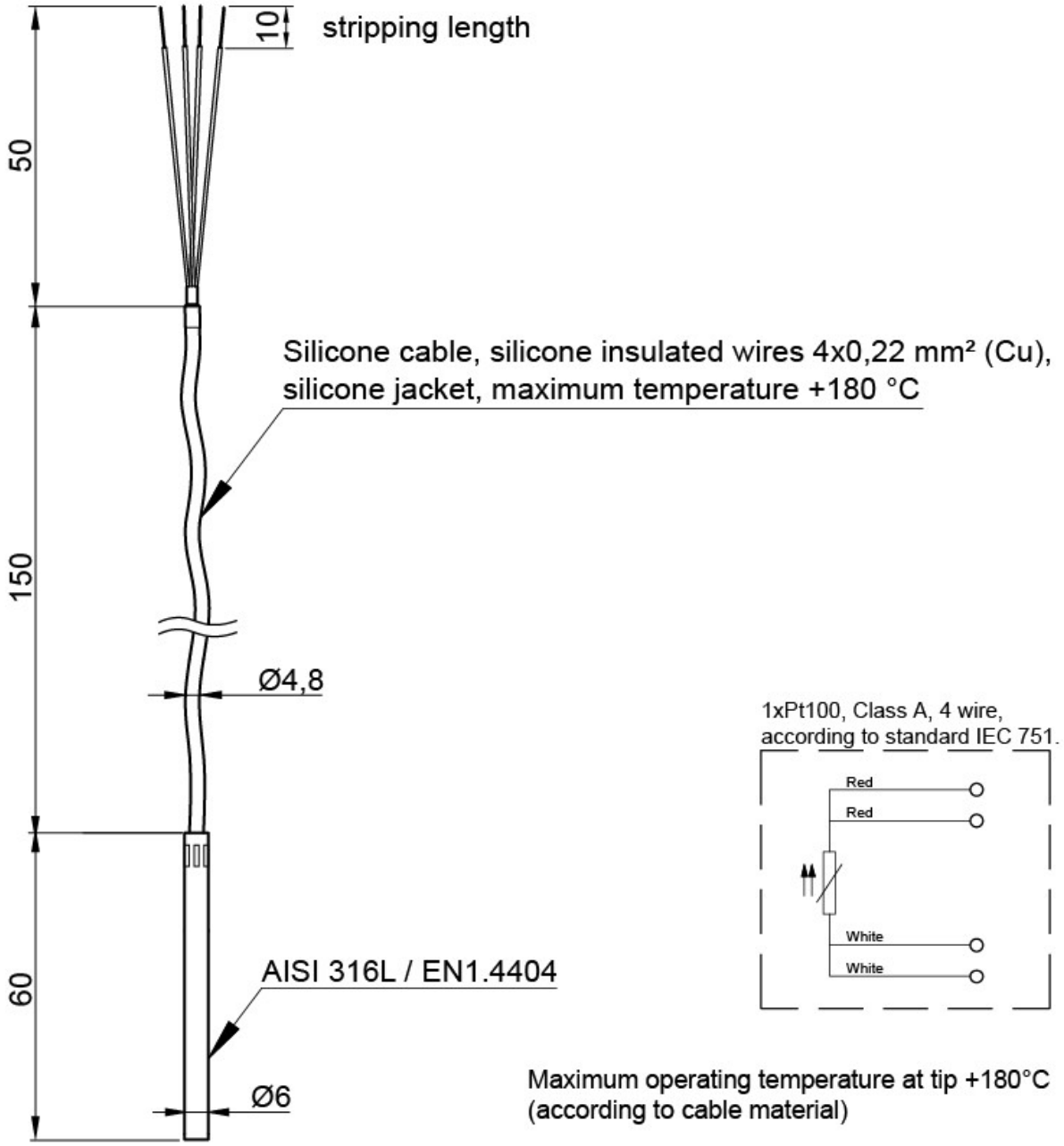
Temperature tolerance

Picture below will show temperature range for each part of the product with metallic enclosure:



Sensor element (W-CABLE-6/60-150/SIL-4-A)

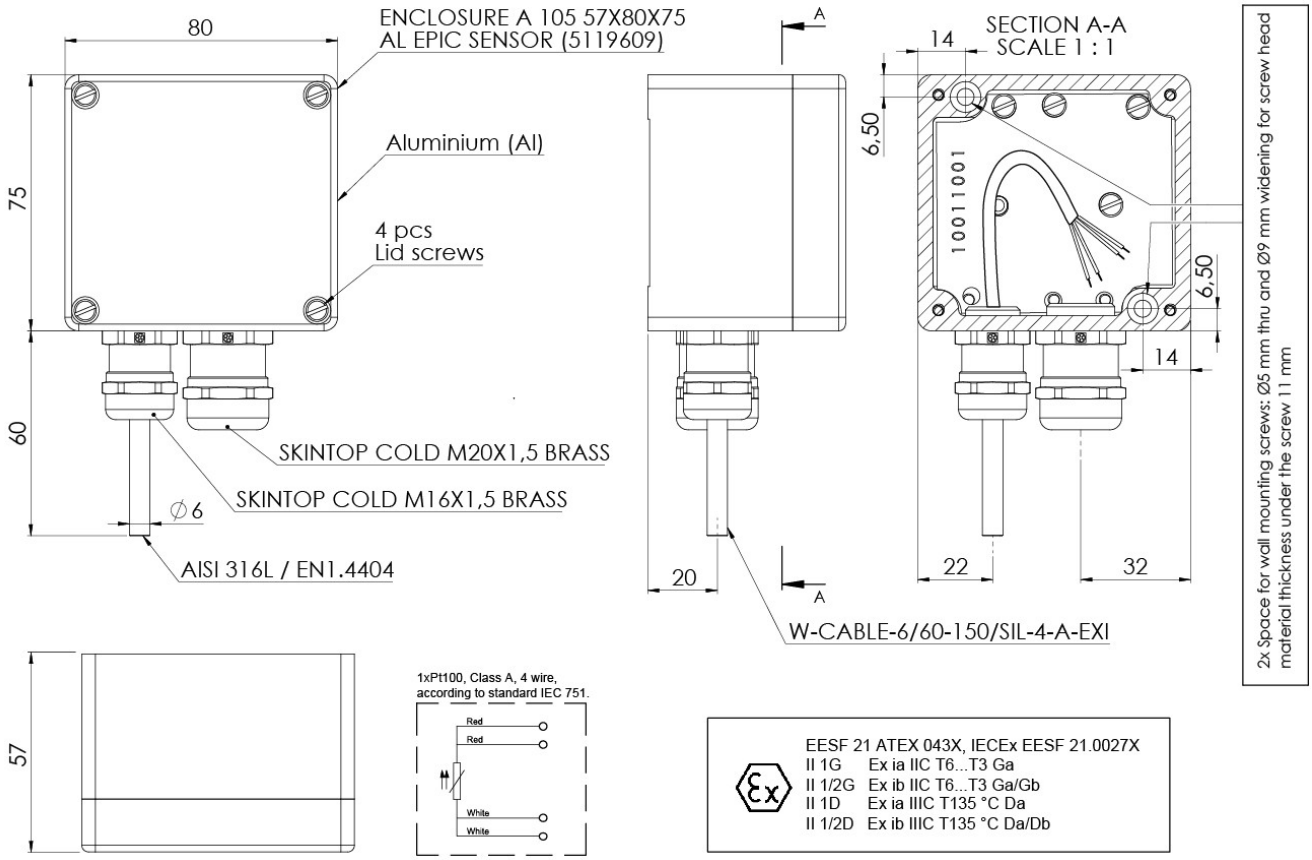
Following picture will show the sensing element W-CABLE-6/60-150/SIL-4-A. Please note that the sensor element is intended for conventional use, and it does not meet the requirements of Ex zones. For Ex zones, special versions of the sensor element are available. W-CABLE-6/60-150/SIL-4-A sensor element will fit into both, plastic and metallic enclosure:



Please note: sensor element is available as separate part, and if required different versions can be manufactured, i. e. cable length can be easilly customized. Please contact our sales for more information.

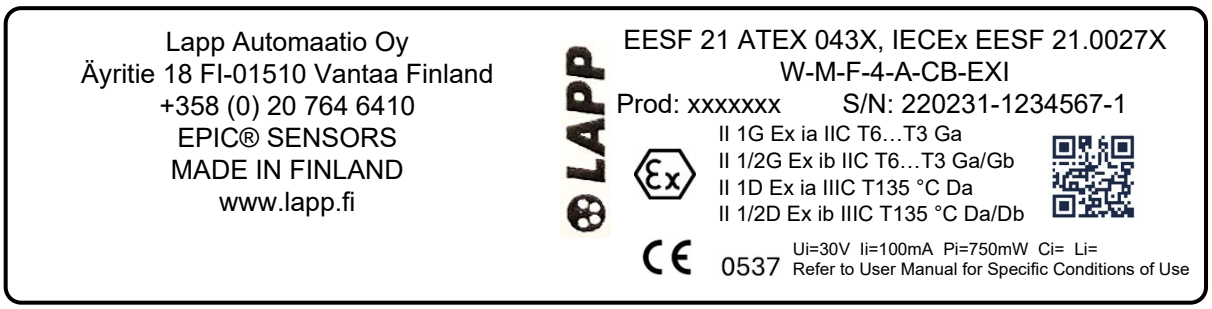
Ex i -certified sensor (type W-M-F … -EXI)

Product version with the metallic enclosure is available as Ex i -certified, it can be used as part in intrinsically safe circuits. Dimensions of Ex i -certified product are the same as non-certified, difference is that all components are Ex i -certified, and for that reason they might have different product names and numbers. Picture below will display the dimensions and components of Ex i -certified product:



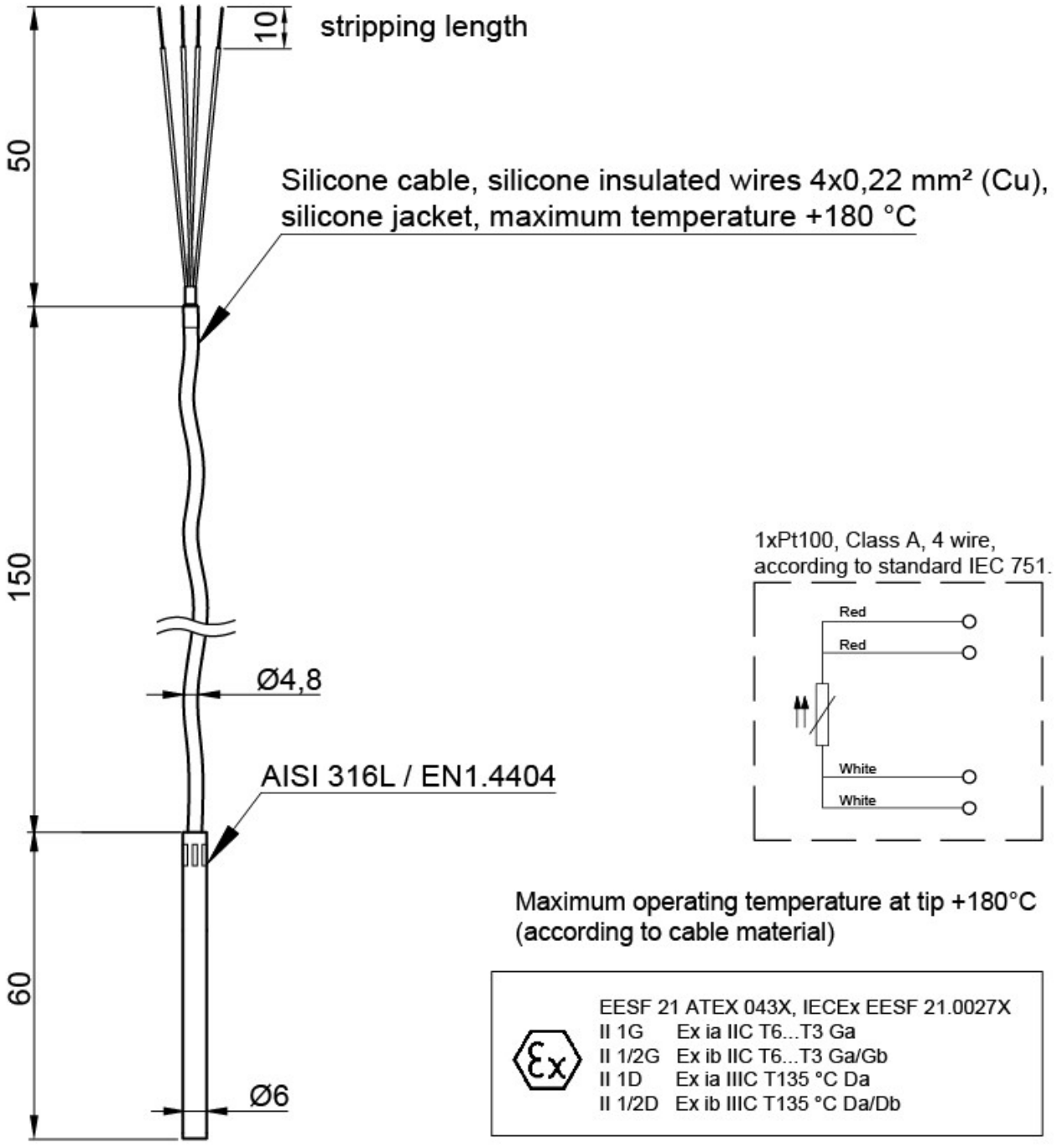
Note that product specific dimensional drawing is always supplied with the Ex i -certified product. This drawing is decleration that the structure of the product will meet the Ex i requirements. Mechanical changes to the product or the drawing should never be carried out without the manufacturer. In some cases the dimensional drawing can include demanding requirements on how to use the product correctly.

Ex i -certified product can be recognized from the product name, that always ends with suffix -EXI. Product name is displayed in the product type plate, where is also the information of standardization facility, certificate information and information of applicable zone classification. Picture below will show the type plate of Ex i sensor according to the ATEX- and IECEx -certificates:



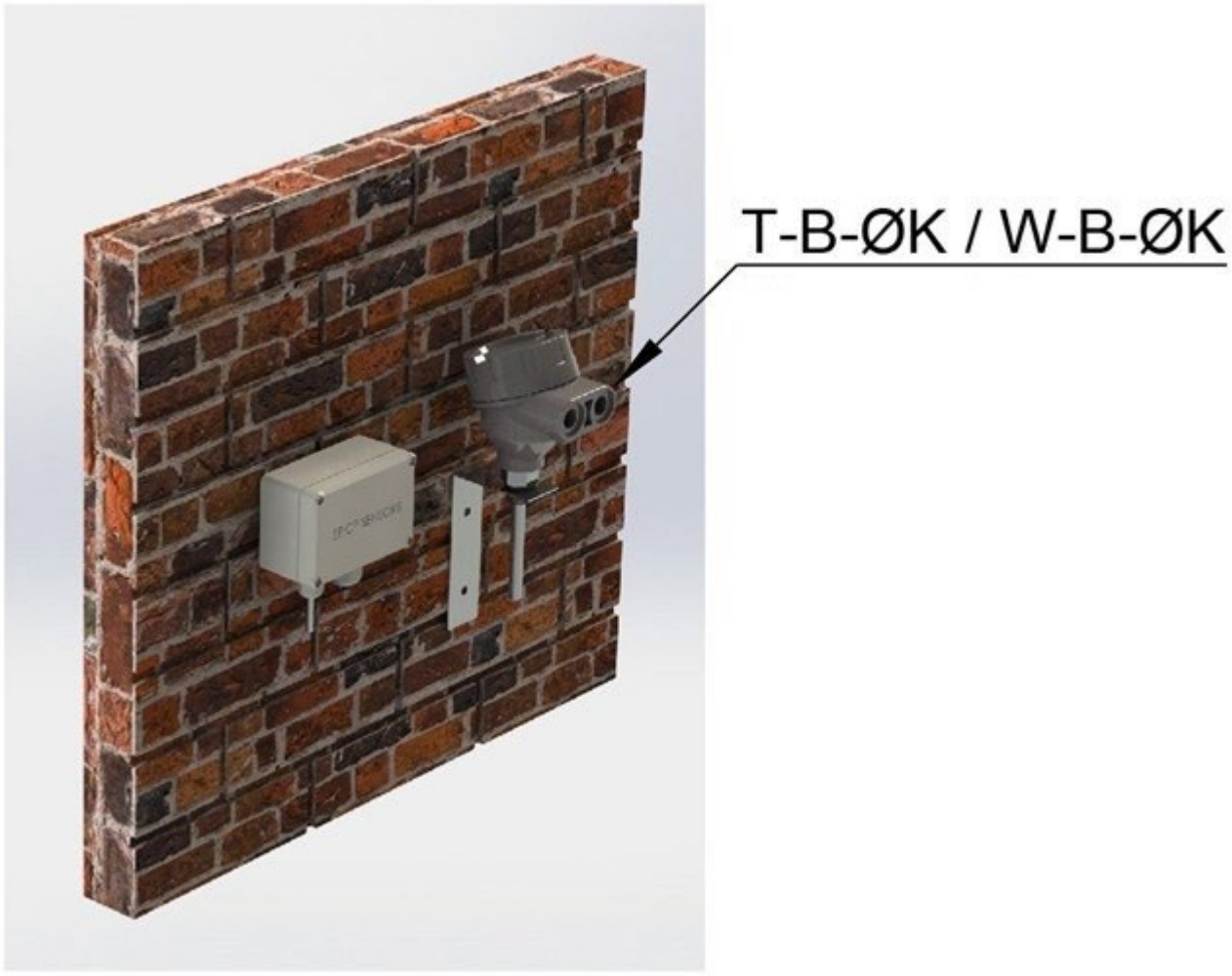
Sensor element (W-CABLE-6/60-150/SIL-4-A-EXI)

Picture below will display the sensor element W-CABLE-6/60-150/SIL-4-A-EXI. Please note that this sensor element is intended to be used in Ex i -certified product, and in intrinsically safe circuits, and so it might contain different components than the normal version:



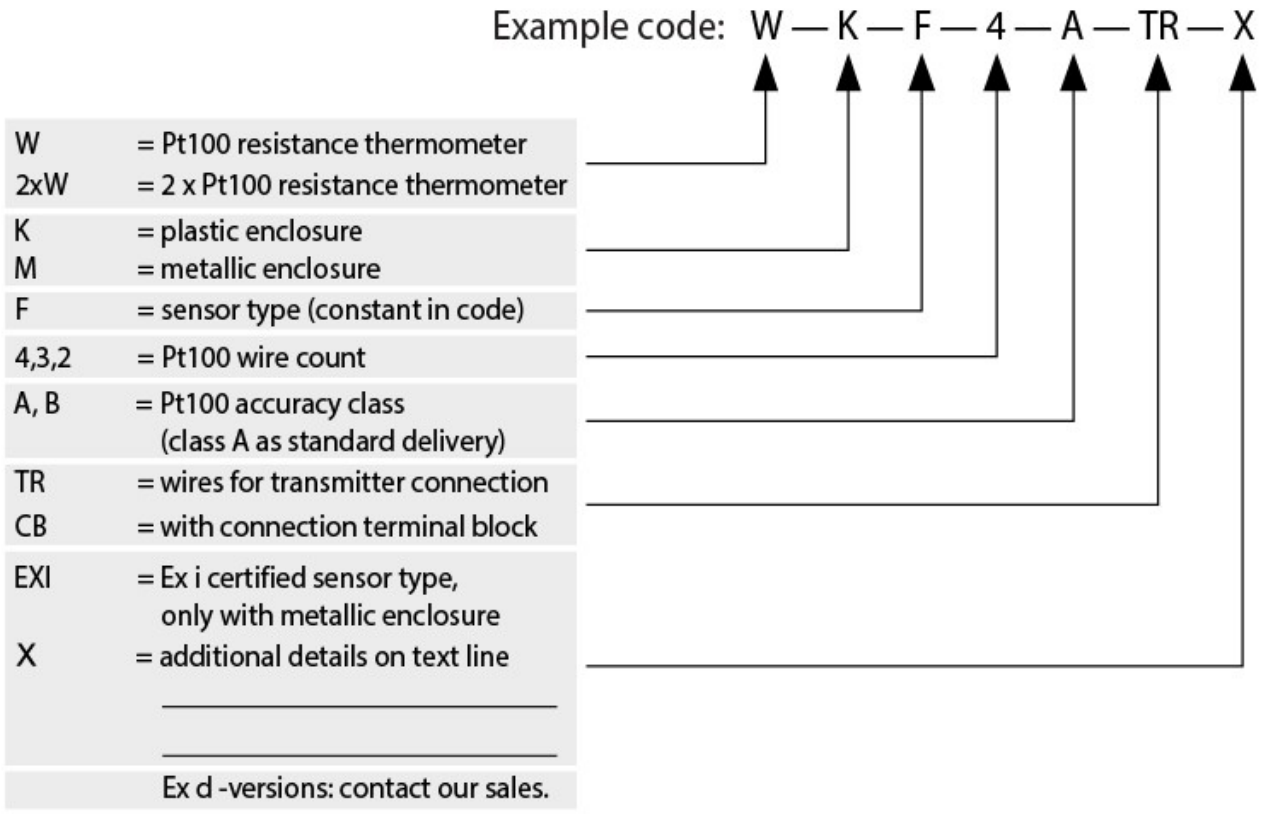
Ex d -certified sensor

Product type W-K-F / W-M-F, described in this manual, does not have Ex d -certified sensor. Instead it is recommended to use threaded temperature sensor without neck pipe. Threaded temperature sensor without neck pipe is available with wall mounting kit and it is Ex d -approved. More information can be found in the manual of sensor type T-B-ØK / W-B-ØK.



Code key

The code key can be used to read the product structure according to the product name. The image below shows the code key for the sensor type:



Technical information

Enclosure	Plastic enclosure dimensions 120x80x58 mm (W x H x D), Metal enclosure dimensions 80x75x58 mm (W x H x D) Other enclosures on request
Tolerances Pt100 (IEC 60751)	AA tolerance ±0.1 + 0.0017 x t, operating temperature -50...+250 °C A tolerance ±0.15 + 0.002 x t, operating temperature -100...+450 °C B tolerance ±0.3 + 0.005 x t, operating temperature -196...+600 °C B 1/3 DIN, 0.1 °C +0.5%, B1/10 DIN 0.03 °C +0.5%, operating temperature -196...+250 °C
Temperature range Pt100	-40...+80 °C, other measurement ranges on request
Approvals	ATEX, IECEx
Quality certificate	ISO 9001:2015, ISO 14001:2015 and ISO 45001:2018 issued by DNV
IP rating	IP65, higher IP rating on request

Materials

Component	Material
W-CABLE-6/60-150/SIL-4-A	stainless steel (EN1.4404 / AISI 316), silicone cable
W-CABLE-6/60-150/SIL-4-A-EXI	stainless steel (EN1.4404 / AISI 316), silicone cable
Plastic enclosure	ABS, UV-stabilized polycarbonate and chloroprene rubber
Metallic enclosure	aluminum (Al)
SKINTOP® cable gland M16x1,5	polyamide and chloroprene rubber
SKINTOP® cable gland M20x1,5	polyamide and chloroprene rubber
SKINTOP KR-M16X1,5 ATEX BLUE PA	frame: specific polyamide sealing: specific elastomer o-ring gasket: nitrile rubber
SKINTOP K-M20X1,5 ATEX BLUE PA	frame: specific polyamide sealing: specific elastomer o-ring gasket: nitrile rubber
SKINTOP MS-M16X1,5 BRASS LF	frame: nickel plated brass internal: polyamide sealing: chloroprene rubber o-ring gasket: nitrile rubber
SKINTOP MS-M20X1,5 BRASS LF	frame: nickel plated brass internal: polyamide sealing: chloroprene rubber o-ring gasket: nitrile rubber
Measurement element	RTD (Pt100), other materials on request

Calibration

Measuring element of the temperature sensor can be calibrated to customer specified temperature range. To specify the calibration area: two points on a temperature scale are needed. Calibration can also be done by a third party, typically accredited testing laboratory. Calibration should be done as liquid bath calibration, where the sensor tip is dipped to a constant temperature flowing liquid, typically silicone oil. Equipment to perform the calibration should be regularly calibrated for the best results.

Typical calibration intervals are:

- Pt100 resistance sensor: 12-24 months
- Thermocouple sensor: 12 months
- Re-calibration is recommended for sensors that has been stored for over than 3 years.

Calibration interval must be evaluated according to the process and possible risk involved. Always think what is the risk involved when the temperature sensor is going out of calibration. For example, in pharmaceutical industry where medicine is manufactured calibrations must be done on regular basis to minimize this risk. If process requires precision from the temperature, the calibration is then recommended to be done in short intervals.

Measuring element will age in use, and this ageing is not always linear with time. Ageing is faster in cyclic processes where the change in temperature is big in short duration of time. This ageing can be seen in the calibration, since it is possible to compare the calibration results to the initial calibration results of the sensor.

Measurement error and tolerance

Tolerance and measurement error of thermocouples, and any calculus related to them, is presented in standards: IEC 60584, DIN 43710 and ANSI MC96.1. Thermoelement accuracy class is typically 1.

Standard IEC 60751 has information about measurement error of Pt100 resistance sensor. In Pt100 resistance sensor some measurement error is often caused by the small resistance of the wires or cable in use. It is necessary to eliminate this small constant resistance if very accurate temperature reading is needed.

Insulation resistance

Insulation resistance of the measuring elementi is always inspected during the manufacturing. The insulation resistance is measured from the internal measuring loop to the external metal parts of the element. If multiple measuring loops are present, insulation resistance of each loop is measured and deemed to be sufficient. Insulation resistance should be ≥ 500 MΩ in room temperature in operational condition. Insulation resistance can be measured by using insulation resistance tester intended for this use. Always use tester that is calibrated.

Connecting cable to the sensor

Note: The connection head contains live parts, make sure that it is possible to open the connection head.

Note: It is recommended to use SKINTOP® cable glands to achieve improved protection rating of the sensor unit.

Note: When sensor is Pt100 resistor based, always use Copper (Cu) cable.

Note: When using thermoelement sensor without temperature transmitter, always use the same thermoelement material in the extension cable as in the measuring thermoelement.

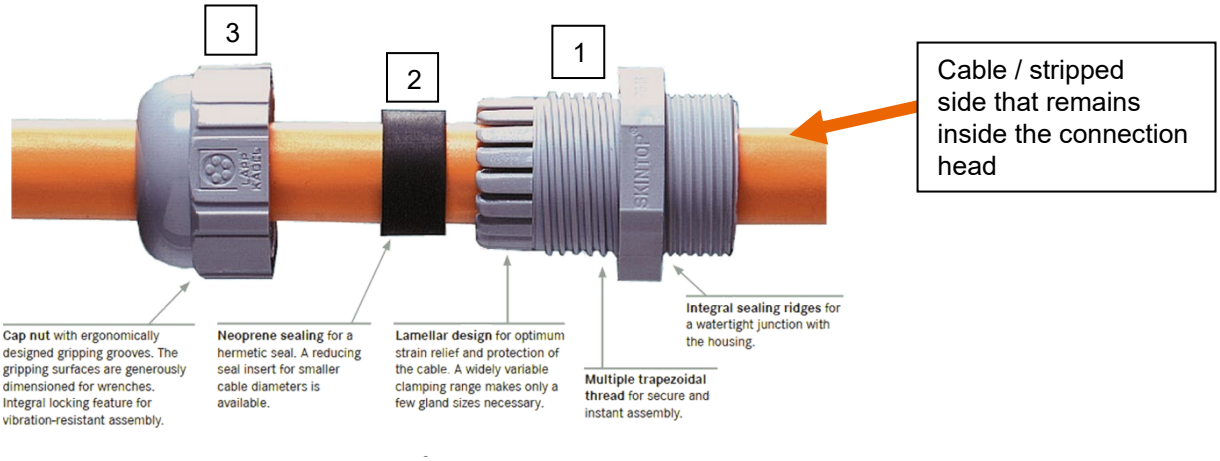
Note: When using thermoelement sensor with temperature transmitter always use Copper (Cu) cable.

Steps to connect the cable to sensor unit:

1) Strip the cable to be connected. It is recommended to strip 50 – 70 millimeters of wires with insulation from the cable jacket. Similarly it is recommended to strip around 10 mm of each conductor to be visible for the connection. Simplified as 50 mm insulated wire with 10 mm of bare conductor at the end.

2) Depending on the cable and connection head in use, attach ground ring terminal to the ground of the cable. In case of EXD connection head, ground wire can be connected without the ground ring terminal.

3) Losen the cable gland parts and bring them over the cable in the order of the picture below. During the transport the cable gland is typically attached to the sensor unit, where it can be detached from. If cable gland is delivered as separate part, there can be internal lock nut with it. Internal lock nut is not used with the connection head and can be discarded. All required parts are shown in the picture below:



4) Take the parts of the cable gland in the order of the picture into the cable entry thread of the connection head and tighten them in place. Part 2 should be positioned between cable jacket and the forks of the part 1 as a sealant. Tightening is performed by rotating part 3 to part 1. Tightening torques are mentioned in the cable gland datasheet if information is available.

   Note: when taking the stripped cable end into the connection head, leave enough space for the transmitter. Transmitters are typically around Ø45 mm.

5) Test the cable gland functionality by pulling the cable. Cable should not slide off from the cable gland. If this happen, see that the cable gland parts are in correct order and add tension.

6) A) If Pt100 sensor is in use with ceramic block, then always use copper (Cu) cable. Ceramic block has terminals that can be rotated to open and close, for more information see section „RTD; resistance temperature sensor connections“. Connection is typically one cable conductor to one Pt100 wire terminal with Pt100 wire.

   B) If Pt100 sensor is in use with temperature transmitter, see the temperature transmitter datasheet for correct connection. Most datasheets can be found online from the manufacturer. Use copper (Cu) cable with temperature transmitter.

   C) If you are using ceramic terminal block and thermocouple; connection is done by connecting the positive wire of the extension cable under the positive wire of the thermocouple, and similarly negative wire is connected to the negative wire. Ceramic block has terminals that can be rotated to open and close, for more information see section „TC; thermocouple connection“.

   Note: Use only same type of thermocouple and extension cable: i.e. K-type sensor will need K-type extension cable, where the conductor core material is the same. Try to set wires in the connection so that they are in direct contact with each other. Any other medium, in between the wires, can cause measurement error to occur.

   Note: Never use copper (Cu) cable as extension cable for thermocouple sensor with ceramic block.

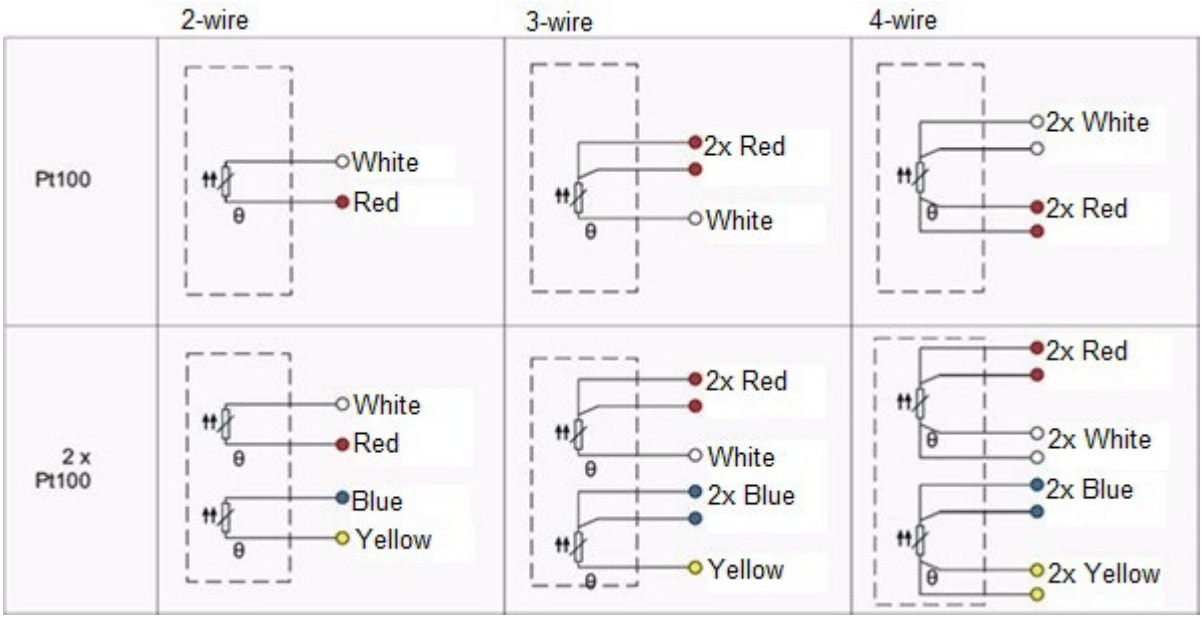
   D) If you are using thermocouple sensor with temperature transmitter, see the temperature transmitter datasheet for correct connection. Use copper (Cu) cable in the connection.

7) Insulate any cable conductors that will remain un-used within the connection head. This can be done with insulation sleeve or tape.

8) After cable has been connected: close the lid of the connection head.

RTD; resistance temperature sensor connections

Picture below will show IEC 751, international standard, Pt-100 connections and wire color codes:



Note: customer specific color codes and wiring is available on request.

RTD; measurement current

Maximum measurement current for Pt100 temperature sensor is depending on the manufacturer of the sensing element.

Generally allowable measurement currents are (Note: this is the maximum current by the manufacturer):

- Pt100 <1 mA
- Pt500 0,5 mA
- Pt1000 0,3 mA

Do not use measurement current above this limit, since it can destroy the sensing element.

Values presented above are normal values. Different values are used in Ex i certified sensor types for safety reasons. This is due to the fact that in Ex i sensor or sensing element the self heating is considered to be relevant. For more information of Ex i measurement current values, please see: Appendix A.

Response time

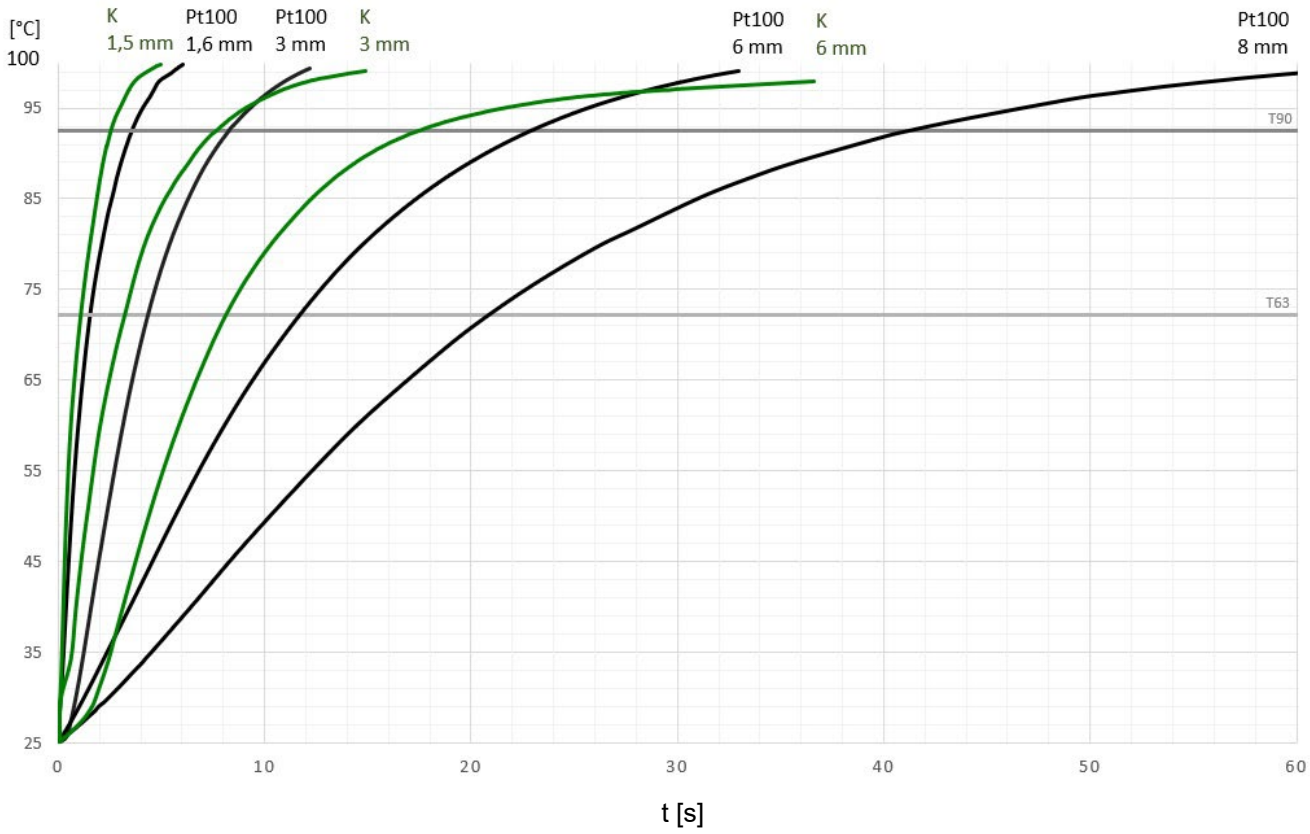
Response time of temperature sensor is highly depending on the structure around the sensing point and materials in use. Air around the measuring point will act as insulator and slow the response time. Ceramic thermowells, which contain lots of air, will typically slow the response time significantly. Any non-protected measuring element that is directly in contact with the medium to be measured, is fastest in response, but mechanical and chemical durability is lesser. Non-protected measuring elements can not be used in all cases for this reason.

Response time has two different values: T63 [s] and T90 [s]. The T63 time is the time it takes for the sensor to reach 63% of the final temperature and similarly the T90 time is the time it takes for the sensor to reach 90% of the final temperature. Response of temperature sensor is changing exponentially as function of time. This means that measuring the final temperature to a degree will take long time and is not practical in most of the cases. Knowing the T63 or T90 response time of the sensor is sometimes helpful, since this information with a few points of temperature measures, can be sufficient to calculate the current approximate temperature in the target under measurement.

Table below will show response times of different elements:

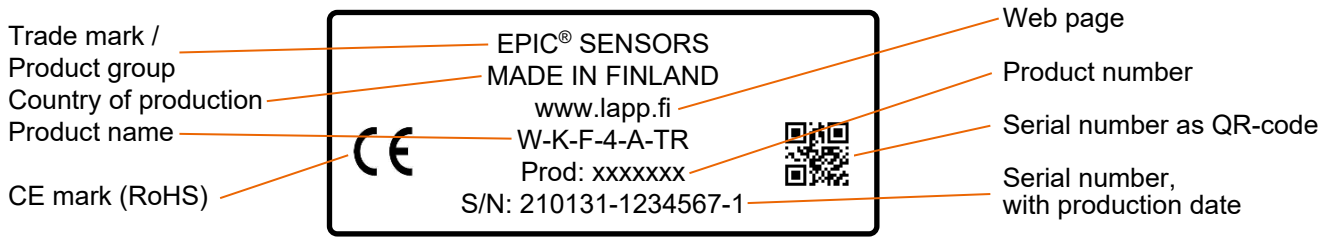
Sensor	Response time T63 [s]	Response time T90 [s]
Pt100, 1.6 mm element	1,7	3,6
Pt100, 3 mm element	4,2	8,2
Pt100, 6 mm element	13,7	24,7
Pt100, 8 mm element	27,6	47,5
Thermocouple, Type K, 1.5 mm element	1,1	2,4
Thermocouple, Type K, 3 mm element	3,1	7,5
Thermocouple, Type K, 6 mm element	8,2	17,2
Thermowell 6 mm, Pt100, 3 mm element	29,7	62,3
Thermowell 9 mm, Pt100, 6 mm element	39,9	75,3
Thermowell 11 mm, Pt100, 6 mm element	58,8	112,2
Thermowell D1, Pt100, 6 mm element	86,3	153,6
W-Cable sensor, Pt100, 6/60 mm tip	11,2	21,2
Margin of error: ±0,2 [s] These measurement are done by dipping the sensor element to a silicone oil bath, which is precisely temperature controlled. Flow of the silicone oil is constant during the measurements. Initial measurement temperature is +25 [°C] and temperature of silicone oil bath is +100 [°C].		

Chart below will show the response time for some Pt100 elements and K-type thermocouple elements:



Type plate

Each sensor has individual type plate attached. Picture below will show example of information found on sensor type plate:



Sensors with EAC EMC approval, that are transported to Eurasian Economic Union area, have their own type of type plate. Below picture will show type plate of EAC EMC approved product, with sensor (*) and transmitter (**).

Serial number

Serial number S/N is always printed to type plate in form of yymmdd-xxxxxxx-x:

- yymmdd date of production, i.e. “210131” = 31.1.2021
- -xxxxxxx production order, i.e. “1234567”
- -x running number of production order, i.e. “1”

Ex i -approved sensor

Special conditions for safe use of Ex i approved sensor

ATEX and IECEx certificates have technical information and special conditions of use for Ex i products. Part of this information is the allowable ambient temperatures. Any information related, special conditions of use and calculus of self heating is presented in appendix: **Appendix A – Technical information and special conditions of use - Ex i certified EPIC® SENSORS temperature sensors.**

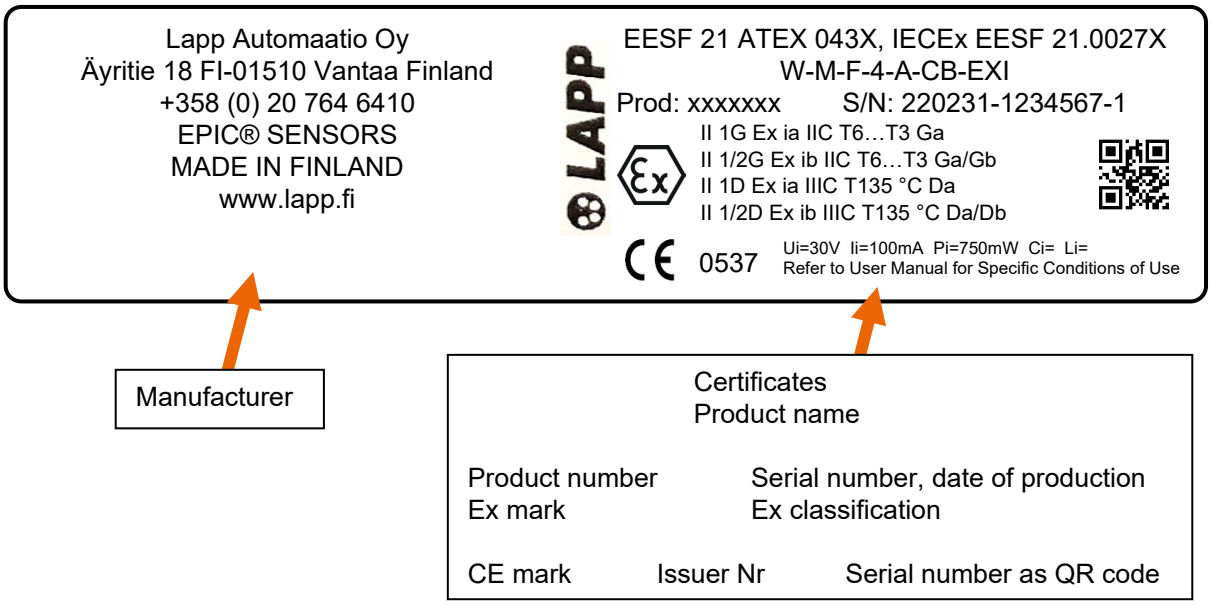
Note: Drawing of Ex i approved sensor is supplied with the product. This drawing is decleration of compatibility of the product according to the current ATEX and IECEx certificates and it will show the sensor structure. Changes to the sensor structure is not allowed. In some cases the drawing can include instructions on „how to correctly use the sensor“ and these instructions should not be ignored.

Ex i approval and Ex marking

Certificate	Issuer	Economic zone	Marking
ATEX EESF 21 ATEX 043X	Eurofins Electric & Electronics Finland Oy, Notified body (NANDO) 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, Notified body (NANDO) 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

Type plate of Ex i approved sensor

ATEX and IECEx certified Ex i approved sensors have information on the type plate according to the complying classification. Picture below is an example of a type plate of Ex i approved sensor:



Transportation, packaging and storage

Packaged goods can be transported in weatherproof closed containers on wheels, by rails, or by sea and air routes. Ambient temperature during the transportation should be between -20 … +60 °C and relative air humidity in the package should be less than 80 %.

Package of goods must not be under pressure during the transportation and sudden stops or falls of movement during the loading and unloading must be avoided. Always attach the package during the transportation with sutable load bearing cargo straps.

Inspect the shipment of goods immidiately upon receiving. Any breach and damage in the container and goods must be written to transporting courier's waybill. If seaworthy packaging is needed for transportation, please mention this to our sensor sales team. Products and packaking can be photographed and documented in prior sending the shipment.

Storage conditions: temperature between -20 … +80 °C, relative humidity between 35 … 85% (no condensing allowed).

Maintenance and cleaning

In general temperature sensors are maintenance free. In certain cases sensor can be transported to our premices for maintenance, repair or calibration. Note: Never use third party for repairs, only manufacturer has the „know how" on how to repair. Unqulified repair work can lead to unit with safety issues.

Before sending the sensor, please remove any process residue. Use adequate safety gear during the cleaning. Fill maintenance letter found on our company webpage and put it into the same box of shipment as the sensor unit to be returned. Mention separately if the sensor unit has been in touch with dangerous or hazardous materials, like strong acidic or strong alkaline solutions. Use antistatic packing materials around the sensor unit. Sensors do need to be shipped to production and logistics address. Please find chapter „Manufacturer's addresses".

Recycling and returns

Returns are accepted only if warrantry conditions or other contract term allows.

Always consider the possible process residue in the sensor unit when recycling. Sensor units are processed as electronic and electrical equipment waste, but in case of hazardous process residue, please recycle the sensor unit as hazardous waste material. Use appropriate local waste disposal and recycling facility.

EU declaration of conformity

EU declaration of confirmity can be submitted with the sensor unit. Sensor product specific certificates are available for download from company web page.

Manufacturer's addresses

Main office:

	Lapp Automaatio Oy
Street	Äyritie 18
Postal code, City	01510 Vantaa

Production and logistics:
(address used for returns)

	Lapp Automaatio Oy
Street	Varastokatu 10
Postal code, City	05800 Hyvinkää

Tel. (sales)	020 764 6410
e-mail	sales.fi.lav@lapp.com
www	https://www.lapp.fi/

Document version

Version / YYYYMMDD	Author(s)	Change description
20250801	TeMa	Update
20241007	VeTe	Specification of various technical information and updates of Ex product guides.
20230707	VeTe	Adding of Ex i and Ex d certified sensor unit grounding and other small changes.
20220822	JuPi	Phone number change
20220401	JuPi	Original

Lapp Automaatio Oy is not responsible from any direct, undirect, contemporary or incidental damages or losses, that have been caused by the wrong interpretation of the user of this manual. User must always have competent professional understanding of operation and use the latest version of this manual.

Appendix A – Technical information and special conditions of use - Ex i certified EPIC® SENSORS temperature sensors

Ex data for RTD (resistance) and TC (thermocouple) temperature sensors

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

Electrical values	for group IIC	for group IIIC
Voltage Ui	30 V	30 V
Current Ii	100 mA	100 mA
Power Pi	750 mW	550 mW @ Ta +100 °C
		650 mW @ Ta +70 °C
		750 mW @ Ta +40 °C
Capasitance Ci	Insignificant, *	Insignificant, *
Inductance Li	Insignificant, *	Insignificant, *

Table 1. Sensor Ex data.

* For sensor with long cable, the parameters Ci and Li must be included in the calculation.
Following values per meter can be used according to EN 60079-14:
Ccable = 200 pF/m ja Lcable = 1 µH/m.

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

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

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

Note!
The temperatures above are for sensors without cable 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, i. e. for the durability and the temperatures above.
For EPL Ga group IIC the aluminium parts in the connection heads are subjected to sparking by impacts or fiction.
For group IIIC the maximum input power Pi shall be observed.
When the sensor is mounted to boundary layer in between different zones, refer to IEC 60079-26 section 6 to ensure boundary layer is not compromised.

Appendix A – Technical information and special conditions of use - Ex i certified 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 of self-heating of the sensor tip or the thermowell tip

When the sensor tip is located in environment where the temperature is within T6…T3, it is needed to consider the self-heating of the sensor. Self-heating is of particularly significant 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.

	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 (i.e. B-6K, B-9K, B-6, B-9, A-15, A-22, F-11, etc.)	185	140	55	50	13	5
With solid material thermowell (i.e. D-Dx, A-Ø-U)	65	50	20	20	5	1

Table 3. Thermal resistance based on Test report 211126

Note!
If the measuring device for RTD sensor is using measuring current > 1 mA, the maximum surface temperature of the sensor tip should be calculated and taken to account. Please see next page.

If sensor type has multiple sensing elements 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 Ex i circuits).

Appendix A – Technical information and special conditions of use - Ex i certified EPIC® SENSORS temperature sensors

Calculation of the maximum temperature:

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

Tmax= Po × Rth + MT

(Tmax) = Maximum temperature = maximum temperature at the surface of the sensor tip
(Po) = Maximum operating power of the sensor (see the transmitter certificate)
(Rth) = Thermal resistance (K/W, Taulukko 3.)
(MT) = Temperature of the medium under measurement.

Calculation of the maximum permessible temperature at the tip of the sensor:

Example 1 – Calculation for RTD sensor tip with thermowell

Sensor is used in Zone 0
RTD sensor type: W-M-9K ... (RTD sensor with transmitter mounted).
Sensor with thermowell, thermowell diameter Ø 9 mm.
Temperature of medium under measurement (MT) is 120 °C
Components are 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 (Po) which is feeding the sensor and Rth-value of used sensor type. (See the Table 3.)

Supplied power by PR 5437 D is (Po) = 23,3 mW (from the transmitter Ex-certificate)
Temperature class T4 (135 °C) must not be exceeded.
Thermal resistance (Rth) for the sensor is = 55 K/W (from Table 3).
Self-heating is 0.0233 W * 55 K/W = 1,28 K
Maximum temperature (Tmax) is MT + self-heating: 120 °C + 1,28 °C = 121,28 °C
The result in this example shows that, the self-heating at the sensor tip is insignificant.
The safety margin for (T6 to T3) is 5 °C and that must be subtracted from 135 °C; this means that temperature of sensor tip up to 130 °C, with self-heating included, 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 is used in Zone 1
RTD sensor type: W-M-6/303 ... (RTD sensor with cable, no transmitter mounted)
Sensor without thermowell, diameter of measuring tip/element Ø 6 mm.
Temperature of medium under measurement (MT) is 40 °C
Components are PR electronics isolated barrier/transmitter PR 9113 D.
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 (Po) which is feeding the sensor and Rth-value of used sensor type. (See the Table 3.)

Supplied power by PR 9113D is (Po) = 40,0 mW (from the transmitter Ex-certificate)
Temperature class T3 (200 °C) must not be exceeded.
Thermal resistance (Rth) for the sensor is = 100 K/W (from Table 3).
Self-heating is 0.040 W * 100 K/W = 4,00 K
Maximum temperature (Tmax) is MT + self-heating: 40 °C + 4,00 °C = 44,00 °C
The result in this example shows that, the self-heating at the sensor tip is insignificant.
The safety margin for (T6 to T3) is 5 °C and that must be subtracted from 200 °C; this means that temperature of sensor tip up to 195 °C, with self-heating included, would be acceptable. In this example the temperature of class T3 is not exceeded.

Appendix A – Technical information and special conditions of use - Ex i certified EPIC® SENSORS temperature sensors

Additional information for Group II devices: (according 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 Appendix A is an instructional document on specifications.
For original regulatory data on specific conditions, always refer to ATEX and IECEx certificates:

EESF 21 ATEX 043X
IECEx EESF 21.0027X