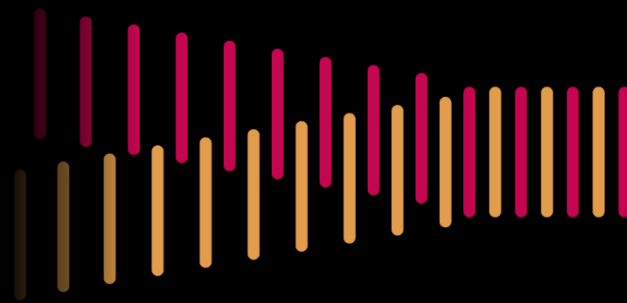




NEXTHERM

S E N S I N G

High Flux. High Value.

User Manual

Disk Thermocouple

Warnings



The sensor must not be powered. Applying a voltage greater than 12V to the wiring terminals can lead to irreversible damage to the sensor.



When following standard operating procedures, users should obtain their own copies of the standard. This manual provides only general operating guidelines.



Disassembling the sensor can lead to a loss of integrity of its metrological and mechanical functions and will void the manufacturer's warranty.



Nextherm Sensing performs traceable calibrations using its own procedures but is not an ISO 17025 accredited laboratory.

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Introduction

This document outlines the operating procedure for disk thermocouples. Its purpose is to define recommended mounting methods to ensure optimal thermal coupling, secure mechanical attachment, and reproducible dynamic response.

Disk thermocouples (Type K) are designed to be mounted directly onto a surface to measure its temperature at the point of contact—particularly when a standard thermocouple cannot be inserted into the material itself.

They are typically used in the following applications:

- On flat or slightly curved metal surfaces
- On moving parts or components that are difficult to drill
- In R&D thermal testing (fire resistance tests, prototypes, battery systems)
- For industrial thermal monitoring (fluid lines, hot-spot monitoring)

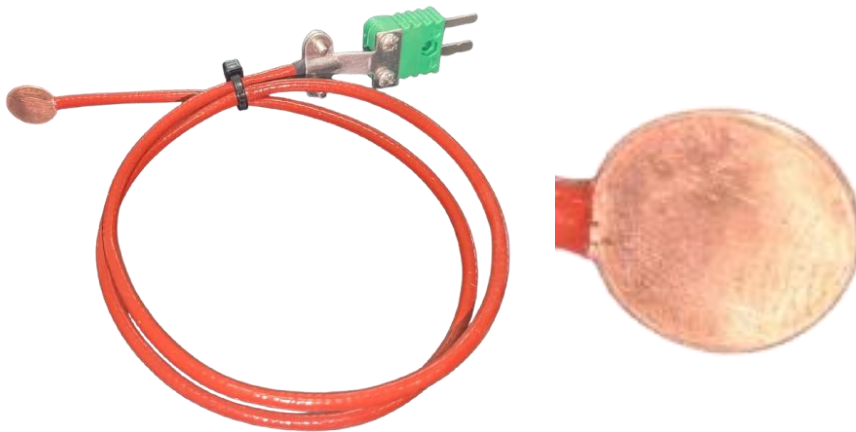


Fig.1 An example of disk thermocouple (copper disk)

Their advantages include:

- Very low thermal inertia (rapid response)
- Easy installation without machining
- High robustness in harsh environments

Nextherm Sensing offers standard models but also provides a custom design service (shape, thermocouple type) to meet your specific needs.

1. Sensor description

Disk thermocouples are available in standard versions with the following specifications:

- 12 mm diameter disk
- Type K thermocouple
- Paired 0.35 mm solid conductors
- 2.5 m lead length
- Glass fiber insulation (high-temperature silicone over-sheath optional)
- Termination with standard flat-pin connector (green plug)

Two disk versions are available:

 **Semi-rigid copper disks:** with a standard thickness of 0.2 mm, copper disks are suitable for use up to +650°C. They can be attached using refractory adhesive or cement. The Type K thermocouple is brazed to the back of the disk, with the +/- conductors positioned diametrically opposite each other. This arrangement allows for the measurement of the disk average temperature. Upon request, the thermocouple junction can be brazed to the center of the disk;

 **Flexible Kapton® (polyimide) disks:** with a thickness of 0.14 mm, polyimide disks are suitable for continuous use up to 260°C (300°C peak). The sensor's flexibility allows it to be bonded to curved surfaces (e.g., pipes). The thermocouple hot junction is encapsulated in the center of the disk, between two layers of polyimide.

Please contact us for custom requirements (disk thickness and diameter, conductor type, connector type, etc.).

This document outlines best practices for:

- Surface preparation;
- Attachment: bonding, cementing, or brazing where applicable;
- Wire positioning and securing;
- Post-installation inspection.

2. Inspection upon delivery

2.1 Package content

Upon receipt of your disk thermocouple, please check that:

-  The sensor surface is flat and free of defects (scratches, dents, etc.)
-  The wiring is intact and fitted with its flat-pin connector
-  The label attached to the wiring is present

2.2 Quick check of the instrumentation

A quick check of the sensor can be performed by connecting it to a tester (multimeter or thermocouple reader):

1. Check the electrical continuity (beep) of the "flux" signal output wiring.
- 2.
3. Test the sensor's response to excitation by briefly exposing it (for a few seconds at most) to a heat source (e.g., a heat gun). The response should manifest as a (positive) rise in the voltage or temperature signal.

3. Implementation principles

The mounting method directly influences the quality of the measurement, particularly:

-  contact thermal resistance;
-  response time;
-  the measured temperature;
-  resistance to thermal cycling;
-  repeatability between installations.

For dynamic and heat flux measurements, the mounting must be considered an integral part of the measurement system.

3.1 Thermal coupling

Heat transfer can be represented as:

"Surface" → "interface" → "pad" → "thermocouple"

The thermal resistance of the interface is approximately:

$$R_{th} = \frac{e}{\lambda A}$$

with:

-  e : interface thickness
-  λ : thermal conductivity of the fastening material ;
-  A : area of contact.

The temperature difference associated with this resistance can be estimated by:

$$\Delta T = \Phi \cdot R_{th}$$

where Φ is the heat flux crossing the surface.

It is therefore advisable to aim for an interface that is thin, continuous, and homogeneous, with no contact defects.

A bonding layer that is too thick or contains voids can increase thermal resistance and slow down the sensor's response.

3.2 Fundamental principles

Regardless of the method used:

1. the surface must be clean;
2. the disk must be in perfect contact with the surface;
3. the interface thickness must be minimal;
4. bubbles and contact defects must be avoided;
5. the wires must not exert stress on the disk;
6. the bonding material must be compatible with the operating temperature;
7. the process must be reproducible from one assembly to the next.

4. Selection of mounting method

The choice depends primarily on the operating temperature, the required dynamic response, thermal cycling, and any need for disassembly.

The table below provides an overview of recommended mounting methods, distinguishing between them in terms of:

-  Transmission of dynamic phenomena;
-  Thermal performance;
-  Level of implementation difficulty.

Method	Copper disk	Polyimide disk	Dynamics	Thermal resistance	Difficulty	Recommendation
Epoxy adhesive	✓	✓	★★★	★★	★★★★★	Recommended
HT epoxy adhesive	✓	✓	★★★	★★★★	★★★★	According to temperature
Ceramic cement	✓	X /not recommended	★★★	★★★★★	★★★★	Copper only
Soft soldering	✓*	X	★★★★★	★★	★★★	Specific case
HT brazing °	✓*	X	★★★★★	★★★★★	★	Required qualification
Mechanical fastening	✓	✓	★★★★	★★★★★	★★★	According on geometry

* only if the material and metallization of the disk allow for soldering.

In general, the following is recommended:

 Copper pad:

1. Thin-bond adhesive for general use;
2. High-temperature bonding;
3. Brazing for high-dynamic or severe-duty applications.

 Polyimide pad:

1. Bonding with a compatible adhesive;
2. Mechanical fastening where possible.

5. Surface preparation

Surface preparation is common to the various fastening methods.

5.1 Cleaning

The measurement area must be:

clean – dry – flat – free of grease and contaminants.

Recommended procedure:

1. remove dust and particles;
2. degrease the area;
3. lightly sand, if necessary;
4. remove sanding residue;
5. perform a final cleaning;
6. allow to dry completely.

The solvent used must be compatible with the substrate and the mounting material.

5.2 Mechanical preparation

When necessary, light sanding allows for:

- removing an oxidized or contaminated surface layer;
- improving adhesion;
- reducing flatness irregularities.

However, the surface must not exhibit excessive roughness that could create areas of poor contact.

5.3 Coatings & paints

Where possible, the disk should be attached directly to the material whose temperature is to be measured.

A paint, coating or intermediate layer provides additional thermal resistance.

When the coating is part of the system studied, the measurement must naturally be carried out on it.

6. Installation of the copper disk

6.1 Bonding

Bonding is the standard method for common applications:

1. Prepare the surface: clean and degrease the mounting area.
2. Prepare the disk: clean the side intended to contact the surface.
3. Apply the adhesive: apply a minimal amount sufficient to cover the contact area.
4. Position the disk: press the disk onto the surface without moving it unnecessarily.
5. Apply light pressure: maintain uniform pressure during the initial setting phase.
6. Remove excess: remove any adhesive that squeezes out around the disk.
7. Cure: follow the curing cycle recommended by the adhesive manufacturer.
8. Ensure mechanical strain relief for the wires: the wires must be supported independently of the disk when necessary.

6.2 Choice of adhesive

The choice must be based on:

- Maximum temperature;
- Duration of exposure;
- Thermal cycles;
- Environment;
- Need for electrical insulation;
- Nature of the substrate.

Potential options include:

- Epoxy;
- Thermally conductive epoxy;
- High-temperature epoxy;
- Flexible adhesives for applications subject to deformation or thermal cycling.

The adhesive's permissible temperature rating must always be verified in its technical documentation.

6.3 Cement bonding

Cement bonding with an inorganic material is preferred when the operating temperature exceeds the limits of organic adhesives. The procedure is as follows:

1. prepare and clean the surface;
2. clean the face of the gauge;
3. prepare the cement according to the manufacturer's recommendations;
4. apply a layer as thin as possible;
5. position the gauge;
6. apply light, uniform pressure;
7. remove excess material;
8. observe the drying time;
9. carry out the recommended curing cycle.

Points to note: ceramic cements are generally more rigid and brittle than organic adhesives. Therefore, the following should be avoided:

- thick layers;
- stress concentrations;
- mechanical shocks;
- stress on the lead wires during drying;
- rapid temperature changes (a gradual temperature rise is required).

The cement must be selected based on the substrate, the gauge, and the operating temperature.

6.4 Brazing

Brazing is a suitable choice when minimal interfacial thermal resistance and excellent mechanical strength are required. Its advantages include:

- very thin interface layer;
- excellent thermal conductivity;
- very good mechanical strength;
- excellent thermal cycling performance (following process qualification);
- very good process repeatability when properly controlled.

However, brazing has certain limitations:

- high process temperature;
- risk of thermocouple degradation or alteration;
- thermomechanical stresses;
- difficulty of disassembly;
- requirement for process qualification.

Depending on the chip design and the substrate, various alloy families may be considered:

- Sn-Ag-Cu solders for low-temperature applications;
- Ag-Cu solders;
- Ag-Cu-Ti active solders, when required for specific interfaces.

The selection process must take into account:

- melting temperature;
- operating temperature;
- materials involved;
- brazing atmosphere;
- metallurgical compatibility;
- coefficient of thermal expansion;
- impact of the brazing cycle on the thermocouple.

Any brazing process intended for industrial use must first be qualified using the actual assembly.

7. Installation of polyimide disk

7.1 Principle

The polyimide disk is primarily intended for applications requiring:

- low thickness;
- low mass;
- flexibility;
- adaptation to slightly irregular surfaces;
- simple implementation by gluing.

The preferred fixing method is gluing.

7.2 Gluing

The procedure is as follows:

1. clean and degrease the surface;
2. clean the face of the disk;
3. apply a very thin layer of adhesive;
4. position the disk without creases or ripples;
5. apply uniform pressure;
6. remove excess material;
7. hold the disk in place during curing;
8. adhere to the manufacturer's curing cycle;
9. ensure mechanical strain relief for the wires.

The choice must take into account:

- maximum temperature;
- nature of the substrate;
- adhesion to polyimide;
- thermal cycling;
- rigidity after curing.

For applications subject to thermal cycling or significant differences in expansion, an adhesive that retains some flexibility may be preferable to a very rigid one.

The maximum permissible temperature of the polyimide, the adhesive, and the entire assembly must be verified before use.

8. Common best practices

The mounting interface must be as thin as possible while ensuring continuous contact.

An excessive amount of mounting material increases thermal resistance and can degrade dynamic response.

Avoid bubbles and contact defects. Contact defects can:

- increase thermal resistance locally;
- slow down the response;
- create variation between sensors;
- cause an unstable response during thermal cycling.

The sensor disk must be pressed down fully and evenly.

The leads must be positioned to limit:

- mechanical stress on the disk;
- parasitic thermal conduction;
- unnecessary exposure to a steep thermal gradient.

Where necessary, create a strain relief zone near the sensor. The lead securing method must not transmit significant force to the disk.

9. Impact on performance

9.1 Dynamic response

The response of a thermocouple can be approximated by:

$$T(t) = T_{\infty} + (T_0 - T_{\infty})e^{-t/\tau}$$

The time constant τ depends in particular on:

- the mass of the disk;
- its geometry;
- the thermal resistance of the interface;
- the thickness of the interface;
- the thermal properties of the substrate;
- heat exchange with the environment.

To maximize speed, the following should be combined:

low-mass disk + thin interface + good thermal contact + limitation of parasitic thermal paths.

9.2 Influence of the main variables

The table below summarizes the influence of the key variables on the performance of measurement using a wafer thermocouple:

Variable	Influence on measurement
Adhesive thickness $\uparrow$	Thermal resistance $\uparrow$; slower response
Adhesive conductivity $\uparrow$	Thermal resistance $\downarrow$
Contact area $\uparrow$	Thermal resistance $\downarrow$
Bubbles / voids	Local thermal resistance $\uparrow$; dispersion
Disk mass $\uparrow$	Thermal inertia $\uparrow$
Stress on wires	Risk of detachment / drift
Poor surface preparation	Adhesion and repeatability $\downarrow$
Non-homogeneous interface	Non-reproducible response
Significant thermal cycling	Risk of cracking / detachment

9.3 Selection guide table

The following table provides a guide for selecting the best process based on your environment:

Application	Copper disk	Polyimide disk
Standard mounting	Thin epoxy	Compatible adhesive
High-speed application	Very thin interface / brazing	Very thin adhesive
High-speed application	High-temp epoxy	Compatible adhesive
High temperature	High-temp epoxy	Depends on construction
Very high temperature	Specialized cement / brazing	Generally unsuitable
Severe thermal cycling	Cement or qualified brazing	Flexible adhesive
High vibration	Brazing / mechanical fastening	Bonding + mechanical retention
Dismantling required	Adhesive / mechanical fastening	Adhesive / mechanical fastening
Dismantling required	Cement / brazing	Adhesive

UE declaration of conformity



We,

Nextherm Sensing SAS
Registered office: 70 Chemin de Cantalauze
31220 Martres-Tolosane
France

In accordance with the requirements of the following directive:

2011/65/EU Restriction of the use of certain hazardous substances in electrical and electronic equipment

We hereby declare under our sole responsibility that:

Product model: TC-TK-0.35-CU & TC-TK-0.35-PI
Product type: Disk thermocouple
Brand: Nextherm Sensing

complies with the following applicable European Union harmonization legislation:

Directive 2011/65/EU of the European Parliament and of the Council on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS), including Amendment **(EU) 2015/863**.

Product conformity has been assessed based on internal production controls. The product is designed for use under normal operating conditions in accordance with its technical documentation.



Nicolas Pelletier
Chief Executive Officer
Martres-Tolosane, 29/09/2026

About Nextherm Sensing

Nextherm Sensing is an innovative French company with roots in aerospace Research, specializing in heat flux measurement. Founded in 2022, it offers a wide range of sensors to address a diverse array of academic and industrial challenges.

Attentive to your needs and application constraints, we provide end-to-end support throughout the sensor selection process, from user training and the provision of analysis tools to after-sales service. We also offer a unique recalibration service based on a high-precision laser source.

Founded by two passionate researchers, Nextherm Sensing has innovation and continuous improvement in its DNA. That's why we dedicate a significant portion of our resources to developing new, increasingly robust and high-performing products.

Find us at www.nextherm-sensing.com
Or contact us directly at contact@nextherm-sensing.com

