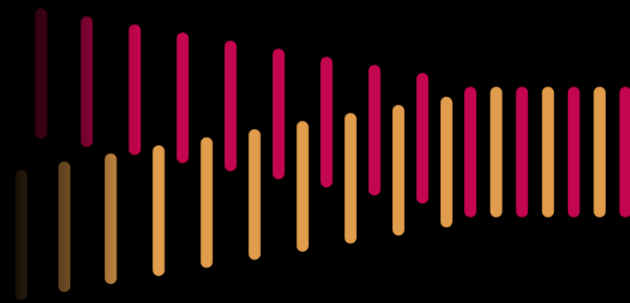




NEXTHERM

S E N S I N G

High Flux. High Value.

Specifications

Fast-response heat flux sensor

DHF Series

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List of Symbols

T	Temperature [°C]
U	Voltage, or electromotive force [mV]
Φ	Heat flux density [kW/m ²]

Introduction

DHF (Dynamic Heat Flux) Series sensors are designed to detect and measure heat flux associated with rapid phenomena, offering a response time of less than 5 milliseconds. These dynamic probes rely on the heating of a thin film—characterized by high thermal and electrical conductivity—deposited on the sensor's front face and coupled with a Type-K thermocouple. Consequently, DHF sensors function as both surface thermocouples and ultra-fast heat flux meters.

DHF heat fluxmeters feature a unique design developed by Nextherm Sensing, based on absolute temperature measurement at the front face of a ceramic substrate with known properties. When exposed to an external flux, the surface temperature rises rapidly—an effect amplified by the insulating nature of the ceramic. Advanced post-processing techniques are then used to get the instantaneous heat flux density from this sudden temperature rise.

The sensing element incorporates an electrical circuit that outputs a voltage (electromotive force) generated via the thermoelectric effect (Seebeck effect) within the thin-film thermocouple layer; this layer features a unique architecture with no equivalent on the market.

DHF heat flux meters are generally designed to measure total heat flux (i.e., the combination of radiative and convective heat transfer). A high-absorptivity surface treatment is applied to the sensing face to maximize signal amplitude. Nextherm Sensing has conducted extensive research to select and evaluate the best treatments in terms of performance and durability.

Compared to conventional bead thermocouples (including ultra-fine models with, for instance, hot junction smaller than 10 microns), DHF sensors demonstrate superior responsiveness regarding signal amplitude and rise time. This is due to their significantly larger exposed surface area and the presence of an insulating substrate. They can therefore effectively replace "conventional" thermocouples for rapid temperature measurement.

- Other advantages compared to conventional thermocouples include:
- Easier handling/mounting
- Greater robustness
- Perfect rigidity when subjected to a thermal event (e.g., a blast)



Fig. 1 Example of a DHF Series sensor: total heat flux with smooth-body interface.

Calibration

DHF heat flux sensors are calibrated using a high-power laser calibration bench. This proprietary calibration method developed by Nextherm Sensing offers several advantages over conventional blackbody-based calibration approaches:

- Extremely wide applicable heat flux range (from a few kW/m² to several MW/m²)
- Thermal cycling characterization
- Response time determination through controlled exposure duration
- Fast setup without warm-up phase
- Accurate power control
- Excellent source stability and uniformity

Unlike conventional approaches relying on secondary reference sensors calibrated against primary standards, Nextherm Sensing performs direct calibration, thereby avoiding cumulative uncertainty sources. Several power levels are applied to refine the calibration law and, when required, cover the full measurement range of the sensor.

Each sensor is calibrated over the heat flux range specified by the customer according to an internal calibration procedure. Upon request, accredited calibration can be performed through the French National Metrology Institute (LNE).

Nextherm Sensing recommends annual recalibration. During recalibration, the overall condition of the sensor, including the sensing surface, is inspected and refurbishment may be proposed if necessary.

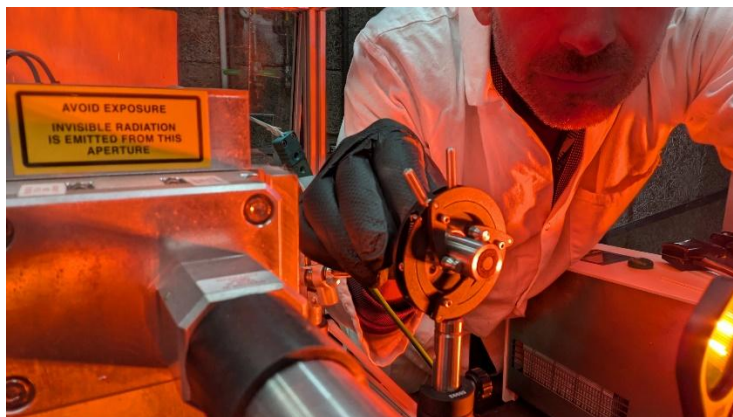


Fig.2 Laser-bench calibration is a unique approach developed by Nextherm Sensing

1. Measurement principle

DHF heat flux sensors rely on an indirect flux measurement principle: the sensor's surface temperature is measured and then used as an input for a calculation method (post-processing) to derive the instantaneous heat flux density.

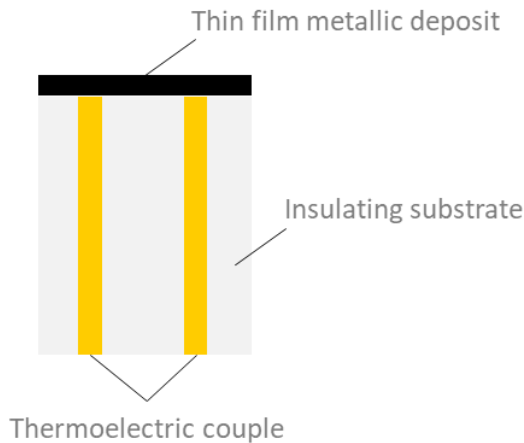


Fig. 3 Schematic diagram of heat flux measurement based on surface temperature readings.

DHF probes are therefore surface thermocouples: a thin conductive layer is deposited onto the surface of a highly insulating substrate:

- The substrate must withstand very high surface temperatures while exhibiting low thermal conductivity, allowing the surface temperature to rise rapidly. Materials are selected from machinable technical ceramics based on alumina (Al_2O_3), zirconia (ZrO_2), or hafnia (HfO_2);
- The thin conductive layer typically consists of a metal or alloy with a high melting point and excellent thermal conductivity;
- The thermocouple hot junction is connected to the thin layer by routing the wires through the insulating substrate. This indirect junction provides a temperature measurement averaged across the sensor's diameter.

Instantaneous heat flux can be derived from the temperature measurement using a theoretical approach based on solving the one-dimensional heat equation within the ceramic substrate. The substrate is treated as a semi-infinite medium with its rear face maintained at ambient temperature. Consequently, the following theoretical formula (based on the Abel inversion of the heat equation) can be applied:

$$\Phi(t) = \sqrt{\frac{\lambda \cdot \rho \cdot C_p}{\pi}} \cdot \int_0^t \frac{dT_s(\tau)/d\tau}{\sqrt{t-\tau}} \cdot d\tau$$

Where:

- $\Phi(t)$ is the instantaneous heat flux density [W/m²]
- λ , ρ et C_p are the ceramic substrate properties, respectively heat conductivity [W/(m.K)], density [kg/m³] and heat capacity [J/(kg.K)]
- T_s is the measured surface temperature [°C]

In practice, an iterative solution method is preferred to account for the temperature dependence of the substrate properties. For this reason, we recommend using our NexTest_DHF software, provided free of charge under MIT license with every sensor supplied (see procedure MO_NexTest_DHF_ENG_V2026 for further details).

2. Available versions

DHF heat flux sensors are available in a total flux version (other components upon special request) and with a single measurement range (an open scale extending from a few tens of kW/m² up to unlimited flux levels). Various mechanical interfaces are available, including a smooth-body version.

2.1 Mechanical interfaces

Depending on your application, several mechanical interfaces are available as standard offer. Custom interfaces can also be produced to meet your specific requirements. Standard interfaces come in smooth-body (reference M0), flanged (reference M1), or threaded (reference M2) versions, as shown in the following drawings:

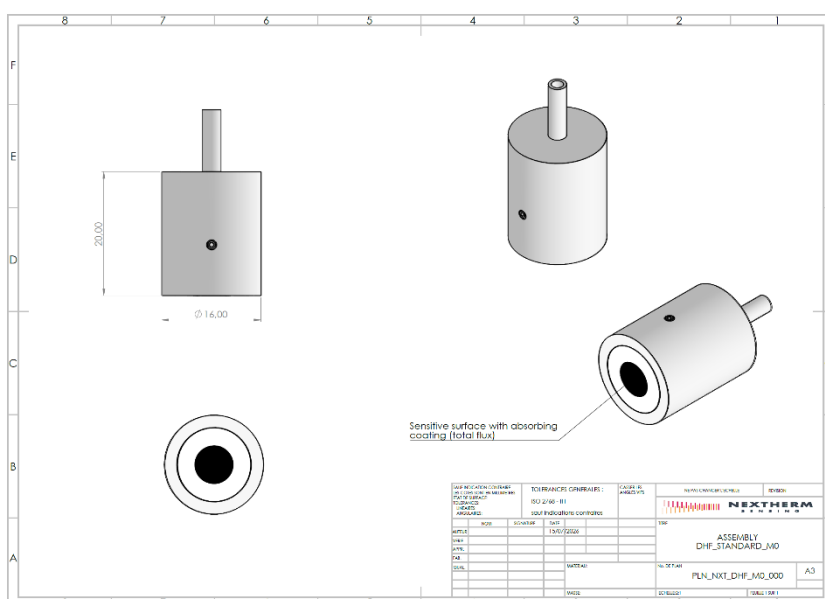


Fig. 4 Smooth-body DHF heat flux sensor (reference M0)

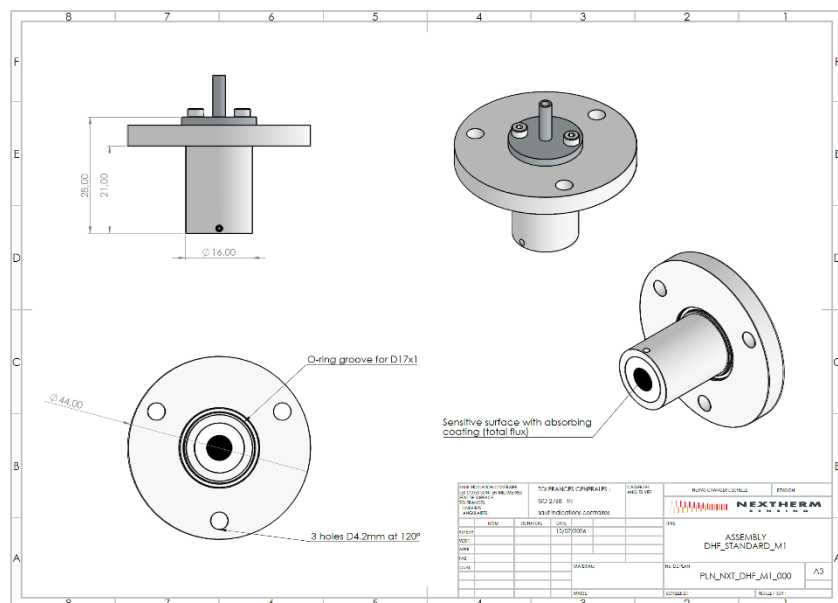


Fig. 5 DHF heat flux sensor with 3-hole, flange-mounting interface at 120° (reference M1)

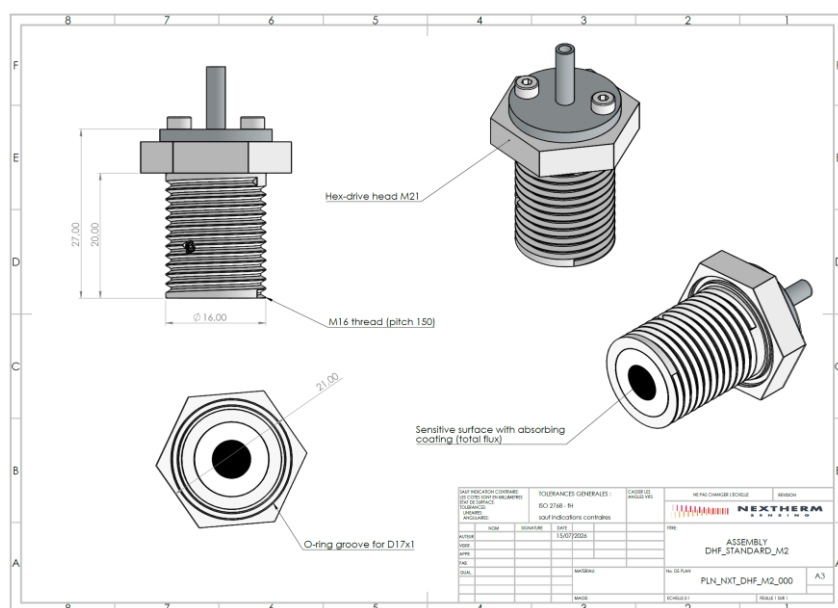


Fig. 6 DHF heat flux sensor with M16 threaded mechanical interface (reference M2)

2.2 Wiring and connectivity

DHF heat fluxmeters are supplied as standard with reinforced cabling featuring high-temperature sleeving (braided fiberglass structure with an inner silicone layer) and a Type K thermocouple connector with flat pins.

3. Specifications

DHF Series sensors measure the heat flux density collected by a sensing surface, expressed in W/m^2 , kW/m^2 , or MW/m^2 (calibration certificates are provided in kW/m^2).

Our heat flux sensors are passive (requiring no external power supply) and have been miniaturized as much as possible to ensure minimal intrusiveness and to minimize disturbance to the heat source itself. Furthermore, unlike bulkier competing products, they can be easily integrated into systems such as engines, reactors, and industrial production lines.

DHF sensors are designed for short-duration operation; the specific duration depends on the incident heat flux but is typically less than one second.

The following table outlines the technical specifications of the DHF heat flux sensors.

Tab.1 List of specifications for DHF Series sensors

DHF Series specifications	
Sensor type	Total, dynamic heat flux sensor
Measured quantity	Heat flux density [W/m^2]
Measurand	Voltage (electromotive force, type K) [mV]
Sensor technology	Surface temperature heat flux sensor
Rated measurement ranges	Unique (from a few tens of kW/m^2 to $>100 \text{ MW/m}^2$)
Measurement range limit	None
Sensing area diameter	6 mm
Output signal	Voltage (mV)
Typical sensitivity	Time-dependant: $S(t) \approx 0.67 \cdot \sqrt{t} \text{ [}^\circ\text{C per kW/m}^2\text{]}$

Conversion law	$\Phi(t) = \sqrt{\frac{\lambda \cdot \rho \cdot C_P}{\pi}} \cdot \int_0^t \frac{dT_s(\tau)/d\tau}{\sqrt{t-\tau}} \cdot d\tau$ Preferred NexTest_DHF post-processing
Required readout	1 x thermocouple (Type K) channel
Rated operating temperature range	-30 to +1000 °C (sensor, front face) -30 to +250 °C (sensor body) -30 to +250 °C (cable and connector)
Use in vacuum	Suitable for use in primary (~10 ⁻³ bar) and secondary (~10 ⁻⁶ bar) vacuum. Sensor can show outgassing
Use under pressure	Maximum pressure in operation: 30 bar abs
Non-linearity	Measured on full-scale range by calibration: <2%
Sensing area emissivity	Total sensor: $\epsilon > 0.90^*$ <i>* Spectral emissivity curve provided</i>
Full field of view	Total sensor: 180° (no window)
Response time	<5ms (measured by laser stimulation)
Typical sensor resistance	<500Ω. Does not influence signal under standard high-input-impedance acquisition conditions
Required power supply	0 W (passive sensor)
Standard cable length	1m00
Standard cable finish	High-temperature silicone-coated glass fiber braided sleeving
Sensor marking	Serial number on label on the wiring + engraving on sensor
Gross weight	<0.2 kg standard cable included
Cooling	
Cooling method	Uncooled sensor. Limited exposure time.
Maximum surface temperature	Temperature must not exceed 1000°C.

Use in testing	•Pyrotechnic tests (ignition, deflagration, etc.) •Detection of rapid thermal events (e.g., flame front passage)
Recommended applications	
Installation and use	Academic Research, R&D, and industry Systems exposed to high heat fluxes for periods ranging from several seconds to several hours. Connected to user-supplied data acquisition equipment. Regular inspection of the sensor surface, body, wiring, and cooling hose. Continuous monitoring of sensor temperature and water supply. No special requirements for immunity, emissions, or chemical resistance.
Typical conditions of use	
Repair of the sensitive surface	It is possible to restore the surface finish if damaged. Recalibration is highly recommended
Calibration	
Calibration certificate	Supplied with each sensor, including test conditions
Calibration method	Laser bench calibration according to internal procedure. Minimum 3 power levels distributed across the calibration range.
Calibration accreditation	Nextherm Sensing is not accredited. Certified calibration is available through LNE or equivalent
Calibration uncertainty	<5% (k=2)
Calibration frequency	Minimum: annual (no calibration alteration during prolonged storage) Recommended: after each measurement campaign
Measurement accuracy	
Uncertainty of measurement	Statements regarding overall measurement uncertainty can only be made on a case-by-case basis.
Versions & Options	
Measurement range	Single (10kW/m ² to >100MW/m ²)

4. Product reference

To order a standard DHF Series heat flux sensor, please use the following reference:

DHF-MM

With the corresponding codes:

 **MM** : mechanical mounting type (M0 : smoothed-body, M1 : flange, M2 : threaded)

For any other configuration, please contact us.

Sales contact



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UE declaration of conformity



We,

Nexttherm 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: DHF
Product type: Fast-response heat flux sensor
Brand: Nexttherm 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

