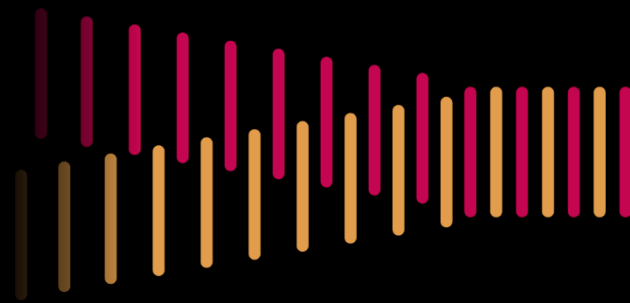




# NEXTHERM

## S E N S I N G

High Flux. High Value.

Specifications

Cooled heat flux sensor

# CHF Series

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# List of Symbols

|   |                                           |
|---|-------------------------------------------|
| S | Sensitivity [mV per kW/m <sup>2</sup> ]   |
| T | Temperature [°C]                          |
| U | Voltage or electromotive force (EMF) [mV] |
| Φ | Heat flux density [kW/m <sup>2</sup> ]    |

# Introduction

CHF Series (Cooled Heat Flux) sensors are designed for continuous measurement of high ( $> \text{kW/m}^2$ ) to extremely high ( $> \text{MW/m}^2$ ) heat flux densities thanks to an actively cooled body. Cooling is achieved either by tap water supply or by means of a closed-loop thermostatic circuit.

CHF sensors are based on a unique design developed by Nextherm Sensing, relying on differential temperature measurement within a calorimetric element. When exposed to an external heat flux, a thermal gradient develops inside the calorimetric element. This gradient is directly proportional to the applied heat flux, regardless of the cooling conditions (coolant flow rate and temperature).

The sensing element incorporates a proprietary thermoelectric circuit generating an output voltage (electromotive force) through the Seebeck effect. This unique architecture, unmatched on the market, delivers a signal linearly proportional to the incident heat flux density.

Featuring a high thermal conductivity copper-alloy sensing element and a fully stainless-steel housing, CHF sensors are robust and capable of withstanding the most demanding environments.

CHF heat flux sensors are available in three configurations depending on the heat flux component to be measured: total, convective or radiative heat flux. For radiative measurements, a sapphire window (other optical materials available upon request) eliminates the convective contribution. For total and radiative measurements, the sensing surface receives a high-absorptivity coating. Conversely, convective versions feature a highly reflective surface treatment to minimize incident radiation absorption. Nextherm Sensing has conducted extensive R&D work to identify, evaluate and qualify the most suitable surface treatments in terms of both performance and long-term durability.

As an option, CHF sensors can integrate a Type K monitoring thermocouple for sensing surface temperature monitoring.

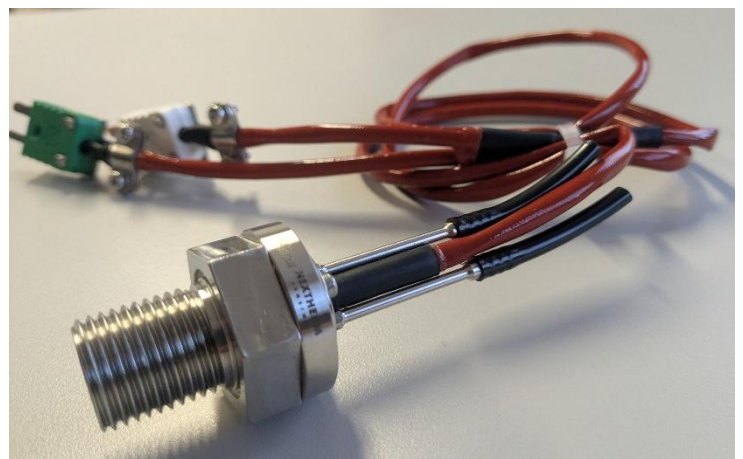
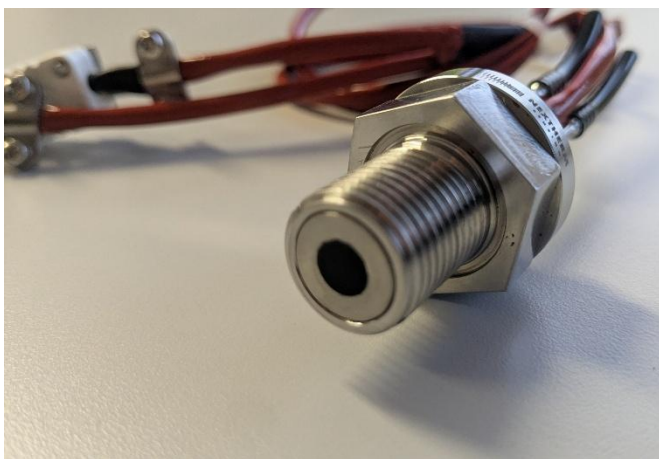


Fig.1 Example of CHF Series sensor: total heat flux version with threaded mounting

# Calibration

CHF 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/m<sup>2</sup> to several MW/m<sup>2</sup>)
- 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.

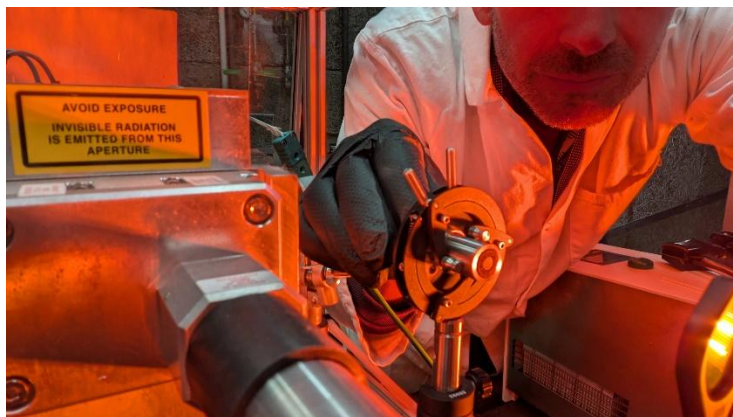


Fig.2 Laser-bench calibration is a unique approach developed by Nextherm Sensing

# 1. Measurement principle

CHF heat flux sensors operate by measuring the radial temperature gradient across the sensor front face (sensing area). When exposed to a heat flux, a temperature profile rapidly develops between the center and the periphery of the sensing surface. An internal water-cooling circuit maintains controlled operating temperature and enables continuous operation for process monitoring applications :

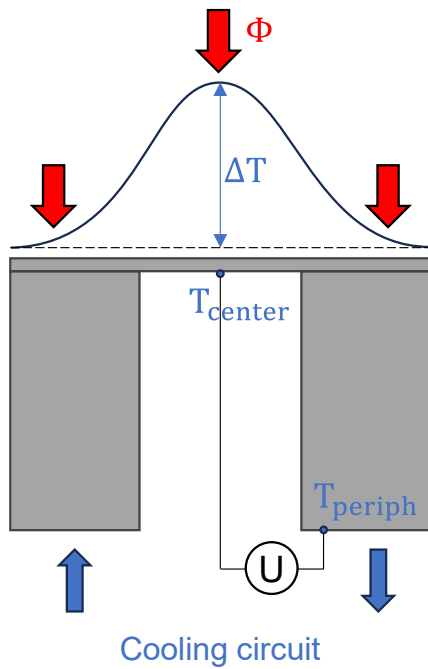


Fig.3 Schematic representation of heat flux measurement based on radial thermal gradient sensing

The output signal is a voltage (millivolts) directly proportional to the incident heat flux density:

$$\Phi(t) = \frac{U(t)}{S}$$

Where:

- $\Phi(t)$  is the instantaneous heat flux density [W/m<sup>2</sup>]
- $S$  is the calibrated sensitivity of your sensor [V per W/m<sup>2</sup>]
- $U(t)$  is the instantaneous output voltage [V]
- $t$  is time [s]

Heat flux density can therefore be calculated in real time using the above conversion equation.

The proprietary design of our sensors differentiates them from competing products through their high robustness (operation under pressure or vacuum), high sensitivity, short response time and wide measurable heat flux range.

Another remarkable feature of Nextherm Sensing sensors is their compact size (16mm) compared to competing sensors, most of which are only available in a 1-inch (25.4mm) front face diameter. This compactness makes them less intrusive to the phenomena being characterized (see section dedicated to available mechanical interfaces).

As an option, front-face temperature can be measured through a second wiring (Type K thermocouple with flat-pin connector). This measurement may be useful for monitoring the proper operation of the cooling system.

## 2. Available versions

CHF sensors are available in a wide range of configuration, including measurement range, mechanical interface and heat flux component.

### 2.1 Measurement ranges

CHF Series heat flux sensors are available in four measurement ranges. The range is defined by the full-scale heat flux density. Depending on the selected range, both the geometry (internal dimensions) and the material of the sensing element differ in order to optimize sensitivity and thermal resistance (see Table 1). The sensor full-scale may be exceeded without signal saturation or sensor damage. However, operation above 150% of full scale is not recommended. For heat fluxes over 5 MW/m<sup>2</sup>, please contact us.

Tab.1 Available CHF measurement ranges

| CHF model | Maximum continuous heat flux density             | Typical sensitivity          | Typical full-scale output |
|-----------|--------------------------------------------------|------------------------------|---------------------------|
| CHF_250K  | 250 kW/m <sup>2</sup>                            | >20 µV per kW/m <sup>2</sup> | >5.0 mV                   |
| CHF_500K  | 500 kW/m <sup>2</sup>                            | >10 µV per kW/m <sup>2</sup> | >5.0 mV                   |
| CHF_1M    | 1 000 kW/m <sup>2</sup> (= 1 MW/m <sup>2</sup> ) | >6 µV per kW/m <sup>2</sup>  | >6.0 mV                   |
| CHF_5M    | 5 000 kW/m <sup>2</sup> (= 5 MW/m <sup>2</sup> ) | >1 µV per kW/m <sup>2</sup>  | >5.0 mV                   |

## 2.2 Mechanical interfaces

Several standard mechanical interfaces are available depending on the intended application. Custom interface can also be manufactured to meet specific requirements. As standard, the available interfaces are either flange-mounted (reference M1) or threaded (reference M2), as illustrated on the drawings below:

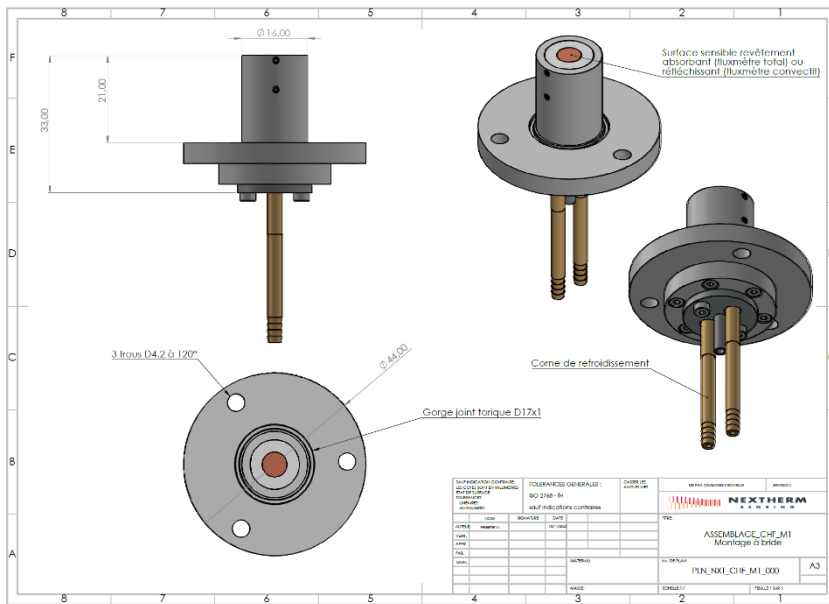


Fig.4 CHF heat flux sensor with three-hole flange-mounting interface at  $120^\circ$  (reference M1)

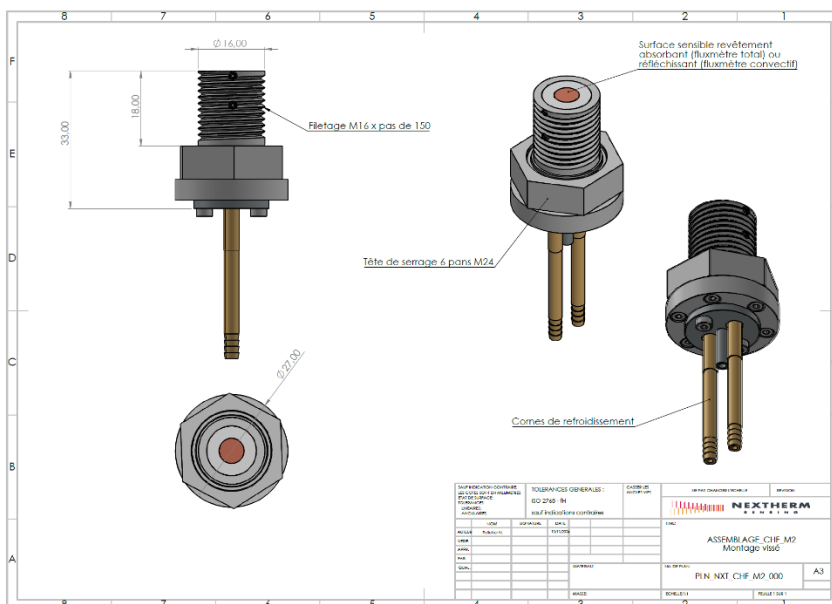


Fig.5 CHF heat flux sensor with M16 threaded mounting interface (reference M2)

## 2.3 Wiring and connectivity

CHF heat flux sensors are supplied as standard with reinforced cabling protected by high-temperature sheath consisting of braided fiberglass insulation with an outer silicon jacket. The voltage output is provided through a copper flat-pin connector.

As an option, a flat-pin-to-BNC adapter can be supplied to facilitate connection to the user's voltage acquisition system.

An optional temperature output may also be integrated into the sensor. It uses a Type K thermocouple with chromel-alumel flat-pin connector and enables monitoring of the sensor front-face temperature.

## 2.4 Heat flux components

CHF sensors can be configured to measure different heat flux components:

- ✦ In the convective version, the sensing element features a reflective surface finish (emissivity < 0.05) in order to suppress any radiative contribution from the incident heat flux
- ✦ In the radiative version (radiometer), the sensing element is isolated from the environment being characterized by means of an optical window, thereby eliminating the convective component of the incident heat flux. The window transmissivity is measured in the laboratory over a wide spectral range. In this configuration, the sensing element features an absorptive surface finish (emissivity > 0.90), which is also characterized in the laboratory over a broad wavelength range
- ✦ In the total version, the sensing element receives the same absorptive surface finish as the radiometer configuration but remains directly exposed to the environment in order to simultaneously capture both radiative and convective heat flux components. When convection is negligible, this configuration can also be used as a windowless radiometer with a wide field of view.

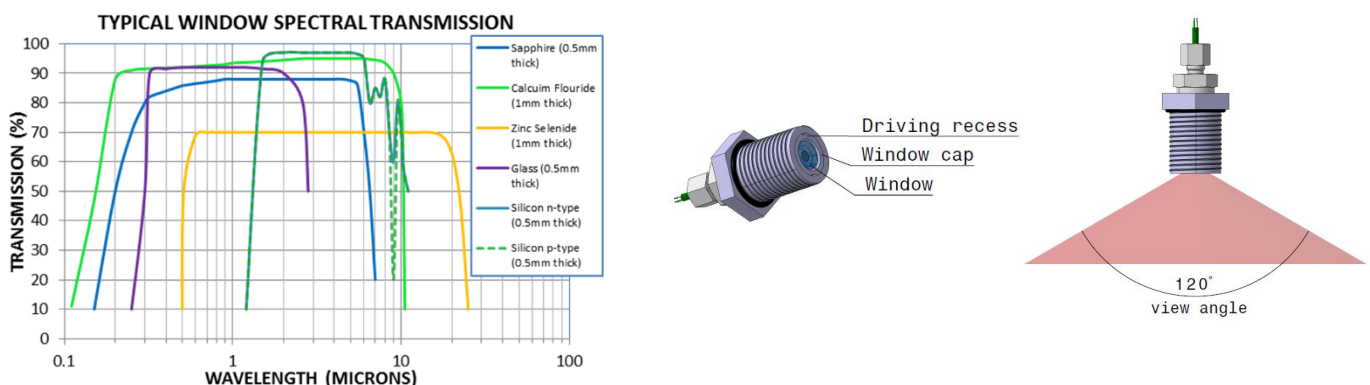


Fig.6 Radiative heat flux sensor: transmission spectrum to be considered and sensor configuration

NexTherm Sensing masters advanced optical solutions (glasses and surface treatments) for monitoring specific spectral bands (e.g. near-IR, far-IR, etc.). As standard, radiative sensors are provided with sapphire window. Contac us for any specific requirements.

Tab.2 Glass grades for radiative heat flux sensors

| Grade                                     | Full transmission range   | Efficient transmission range<br>(for 1mm thickness) | Melting point |
|-------------------------------------------|---------------------------|-----------------------------------------------------|---------------|
| Sapphire ( $\text{Al}_2\text{O}_3$ )      | 0.22 to 5.5 $\mu\text{m}$ | 85% @ [0.22,4.2] $\mu\text{m}$                      | 2040°C        |
| KRS-5 ( $\text{TiBr}_{42}\text{I}_{58}$ ) | 0.6 to 40 $\mu\text{m}$   | 65-71% @ [0.6,30] $\mu\text{m}$                     | 414.5°C       |
| Calcium fluoride<br>( $\text{CaF}_2$ )    | 0.13 to 10 $\mu\text{m}$  | 90-95% @ [0.2,7.0] $\mu\text{m}$                    | 1360°C        |
| N-BK7<br>(borosilicate)                   | 0.35 to 2.5 $\mu\text{m}$ | 90% @ [0.35,2.1] $\mu\text{m}$                      | 557°C         |
| Quartz (fused<br>$\text{SiO}_2$ )         | 0.18 to 3.5 $\mu\text{m}$ | 92% @ [0.5,3.4] $\mu\text{m}$                       | 1710°C        |
| Zinc selenide<br>( $\text{ZnSe}$ )        | 0.55 to 15 $\mu\text{m}$  | 70% [1.1,15] $\mu\text{m}$                          | 1525°C        |

## 3. Specifications

The sensors of the CHF Series measure a heat flux density collected over a sensing surface, expressed in  $\text{W}/\text{m}^2$ ,  $\text{kW}/\text{m}^2$  or  $\text{MW}/\text{m}^2$  (calibration certificates are provided in  $\text{kW}/\text{m}^2$ ).

Our heat flux sensors are passive (they require no electrical power supply) and have been miniaturized as much as possible to demonstrate low intrusiveness and to minimize disturbance to the thermal source itself. They can also be more easily integrated into systems such as engines, reactors, industrial lines, etc., compared to bulkier competing products.

At Nextherm Sensing, the selection of the flux range is very straightforward, as we can cover a wide range of requirements (from  $\text{kW}/\text{m}^2$  to  $\text{MW}/\text{m}^2$ ) with only a few models.

The CHF sensors are designed for continuous operation, without thermal drift.

The table on the following page summarizes the technical specifications of the CHF heat flux sensors.

Tab.3 List of specifications for the CHF Series heat flux sensors

| CHF Series specifications         |                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sensor type                       | Cooled heat flux sensor (total, convective or radiative)                                                                                                                                                                                                                                                                   |
| Measured quantity                 | Heat flux density [W/m <sup>2</sup> ]<br>Option : front-face temperature [°C]                                                                                                                                                                                                                                              |
| Measurand                         | Voltage (electromotive force) [mV]                                                                                                                                                                                                                                                                                         |
| Sensor technology                 | Thermal gradient heat flux sensor                                                                                                                                                                                                                                                                                          |
| Rated measurement ranges          | Four ranges available:<br>250 kW/m <sup>2</sup> , 500 kW/m <sup>2</sup> , 1 000 kW/m <sup>2</sup> (1MW/m <sup>2</sup> ) and<br>5 000 kW/m <sup>2</sup> (5 MW/m <sup>2</sup> )                                                                                                                                              |
| Measurement range limit           | +150% of rated measurement range                                                                                                                                                                                                                                                                                           |
| Sensing area diameter             | 6 mm (4mm for CHF_5M)                                                                                                                                                                                                                                                                                                      |
| Output signal                     | Voltage [mV]                                                                                                                                                                                                                                                                                                               |
| Typical sensitivity               | <ul style="list-style-type: none"> <li>250 kW/m<sup>2</sup> range: &gt;20 µV per kW/m<sup>2</sup></li> <li>500 kW/m<sup>2</sup> range: &gt;10 µV per kW/m<sup>2</sup></li> <li>1 000 kW/m<sup>2</sup> range: &gt;6 µV per kW/m<sup>2</sup></li> <li>5 000 kW/m<sup>2</sup> range: &gt;1 µV per kW/m<sup>2</sup></li> </ul> |
| Conversion law                    | $\Phi(t) = \frac{U(t)}{S}$                                                                                                                                                                                                                                                                                                 |
| Required readout                  | <ul style="list-style-type: none"> <li>1 x voltage channel for heat flux</li> <li>Option : 1 x thermocouple (Type K) channel for control temperature</li> </ul>                                                                                                                                                            |
| Rated operating temperature range | <ul style="list-style-type: none"> <li>-30 to +500 °C (sensor, front face)</li> <li>-30 to +250 °C (sensor body)</li> <li>-30 to +250 °C (cable and connector)</li> </ul>                                                                                                                                                  |
| Use in vacuum                     | Suitable for use in primary (~10 <sup>-3</sup> bar) and secondary (~10 <sup>-6</sup> bar) vacuum. Sensor can show outgassing                                                                                                                                                                                               |
| Use under pressure                | Maximum pressure in operation: 30 bar abs (limited to 10 bar abs for 250kW/m <sup>2</sup> range)                                                                                                                                                                                                                           |
| Non-linearity                     | Measured on full-scale range by calibration: <2%                                                                                                                                                                                                                                                                           |
| Sensing area emissivity           | <ul style="list-style-type: none"> <li>Radiative and total sensor: <math>\epsilon &gt; 0.90^*</math></li> <li>Convective sensor: <math>\epsilon &lt; 0.05</math></li> </ul> <p>* <i>Spectral emissivity curve provided</i></p>                                                                                             |
| Full field of view                | <ul style="list-style-type: none"> <li>Convective and total sensor: 180° (no window)</li> <li>Radiative sensor: 120° (with window)</li> </ul>                                                                                                                                                                              |
| Response time                     | <200ms (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-lined fiberglass braided sheath                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Sensor marking                  | Serial number on label on the wiring + engraving on sensor                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Gross weight                    | <0.2 kg standard cable included                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Water cooling</b>            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Cooling method                  | Tap water or thermostatic circulating bath                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Maximum cooling pressure        | 10 bar                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Cooling flow rate               | 0.5 to 1 L/min (30 to 60 L/hr)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Recommended cooling temperature | 10 to 30°C<br>No influence of the cooling temperature on the heat flux output                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Recommended cooling tube        | We recommend the use of silicone or polyethylene tube (ID 3mm x OD 6mm) to be compatible with the convoluted metal tube of the sensor (D3.4mm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Use without cooling             | CHF sensors can operate without cooling for a limited time provided the control temperature is monitored and kept below 400°C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Use in testing</b>           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Recommended applications        | <ul style="list-style-type: none"> <li>• Fire reaction testing: Flammability of construction products using a radiant heat source, flame spread, heat release, smoke production, mass loss rate, full chamber testing for surface products, scale model testing, determination of thermal and fire reaction parameters of materials, products, and assemblies using an intermediate-scale calorimeter (ICAL)</li> <li>• Fire reaction testing of facades - Intermediate and large scales</li> <li>• Fire reaction testing of floor coverings - Determination of fire behavior using a Radiant heat source</li> <li>• Test method for determining the flame penetration resistance of cargo compartment linings</li> <li>• Standardized test method for oxyacetylene ablation testing of thermal insulation materials</li> </ul> |

|                                 |                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                 | <ul style="list-style-type: none"> <li>• Combustion bench tests (turbomachinery, rocket engines, hydrogen reactors, etc.)</li> <li>• Green energy (solar concentrators, etc.)</li> </ul>                                                                                                                                                                                                                  |
| <b>Installation and use</b>     | Academic Research, R&D, and industry                                                                                                                                                                                                                                                                                                                                                                      |
| Typical conditions of use       | <p>Systems exposed to high heat fluxes for periods ranging from several seconds to several hours.</p> <p>Connected to user-supplied data acquisition equipment.</p> <p>Regular inspection of the sensor surface, body, wiring, and cooling hose.</p> <p>Continuous monitoring of sensor temperature and water supply.</p> <p>No special requirements for immunity, emissions, or chemical resistance.</p> |
| Repair of the sensitive surface | It is possible to restore the surface finish if damaged. Recalibration is highly recommended                                                                                                                                                                                                                                                                                                              |
| <b>Calibration</b>              |                                                                                                                                                                                                                                                                                                                                                                                                           |
| 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           | <p>Minimum: annual (no calibration alteration during prolonged storage)</p> <p>Recommended: after each measurement campaign</p>                                                                                                                                                                                                                                                                           |
| <b>Measurement accuracy</b>     |                                                                                                                                                                                                                                                                                                                                                                                                           |
| Uncertainty of measurement      | Statements regarding overall measurement uncertainty can only be made on a case-by-case basis.                                                                                                                                                                                                                                                                                                            |
| <b>Versions &amp; Options</b>   |                                                                                                                                                                                                                                                                                                                                                                                                           |
| Measurement range               | 250, 500, 1 000 et 5 000 kW/m <sup>2</sup> . More on request                                                                                                                                                                                                                                                                                                                                              |
| Radiative flux option           | 1mm-thickness sapphire window without anti-reflective coating. 85% light transmission over the range [0.2-4.2] $\mu$ m                                                                                                                                                                                                                                                                                    |
| Thermocouple to coaxial cable   | Thermocouple (flat plugs) to coaxial (BNC) converter                                                                                                                                                                                                                                                                                                                                                      |

## 4. Product reference

To order a standard CHF Series heat flux meter, please use the following reference:

### CHF-GG-FF-MM-OPTION

With the corresponding codes:

-  **GG** : heat flux range (250, 500, 1 000, 10 000 kW/m<sup>2</sup>)
-  **FF** : heat flux component (TF : total flux, CF : convective flux, RF : radiative flux)
-  **MM** : mechanical mounting type (M1 : flange, M2 : threaded)
-  **OPTION : TC** : Control temperature option

*Example: For a total flux (TF) sensor with a measuring range of 500 kW/m<sup>2</sup> and a flange mounting (M1), with an optional temperature control output:*

⇒ CHF-500-TF-M1-TC

For any other configuration, please contact us.

## Sales contact

 Nextherm Sensing  
Pépinère d'Entreprises  
70 Chemin de Cantalauze  
31220 Martres-Tolosane, France

 [contact@nexttherm-sensing.com](mailto:contact@nexttherm-sensing.com)

 +33 (0)6.45.13.04.71

## 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: CHF  
Product type: Cooled 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](http://www.nextherm-sensing.com)

Or contact us directly at [contact@nextherm-sensing.com](mailto:contact@nextherm-sensing.com)

