NEXTHERM
SENSING

High Flux. High Value.

Specifications

Heat flux sensor

GHF Series

Table of Contents

List of Symbols

S	Sensitivity [mV per kW/m²]
T	Temperature [°C]
U	Voltage or electromotive force (EMF) [mV]
Φ	Heat flux density [kW/m²]

Introduction

GHF (Gradient Heat Flux) series sensors enable the measurement of high (>kW/m²) to very high (>MW/m²) heat flux densities over a limited duration, involving energy accumulation within the (uncooled) sensor body.

GHF sensors feature a unique design developed by Nextherm Sensing, based on differential temperature measurement within a calorimetric element. When exposed to an external flux, a thermal gradient develops within the calorimetric element; this gradient is proportional to the applied flux.

The sensing element incorporates an electrical circuit that outputs a voltage (electromotive force) generated by the thermoelectric effect (Seebeck effect) of the internal assembly – an architecture that is unique and unrivaled on the market. This signal is proportional (linear) to the incident heat flux density.

Equipped with a sensing element made of a high-thermal-conductivity copper alloy, our sensors feature a robust, all-stainless-steel body capable of withstanding exposure to the harshest conditions.

GHF flux sensors are available in three versions, depending on the specific flux component to be measured: total flux, convective flux, or radiative flux. For radiative flux measurements, a sapphire window (with other glass types available as options) is used to block any potential convective component. For radiative and total flux measurements, the sensing face undergoes a surface treatment ensuring very high absorptivity. Conversely, for convective flux measurements, the surface treatment offers very high reflectivity to reject as much incident radiation as possible. Nextherm Sensing has conducted extensive research to select and evaluate the best treatments in terms of performance and durability.

As an option, GHF sensors can incorporate a Type K monitoring thermocouple to track the temperature of the sensing surface.

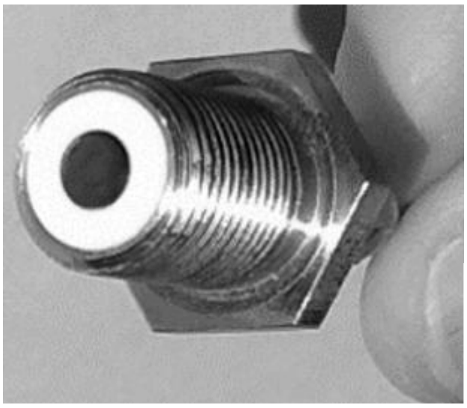

Fig.1 Example of GHF Series sensor: total heat flux version with threaded mounting

Calibration

GHF 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.

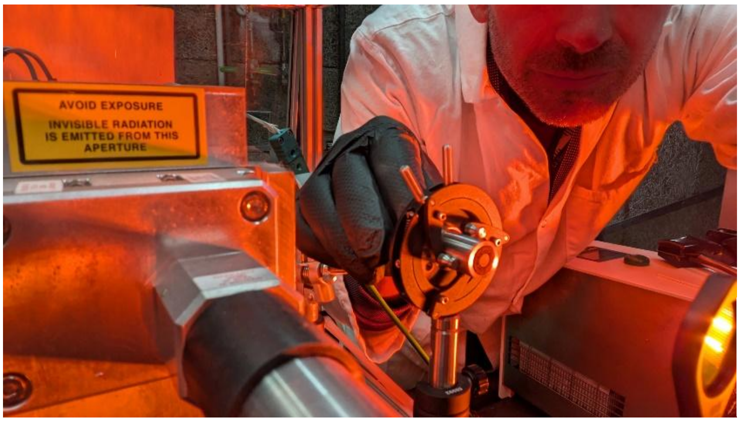

Fig.2 Laser-bench calibration is a unique approach developed by Nextherm Sensing

1. Measurement principle

GHF heat flux sensors operate on the principle of measuring the radial temperature gradient across the sensor's front face (sensing area): under the influence of a heat flux, a temperature profile rapidly develops across the front face, between its center and its periphery. A metallic (copper) thermal mass controls the temperature rise of the entire sensor for a limited duration (depending on the intensity of the absorbed flux):

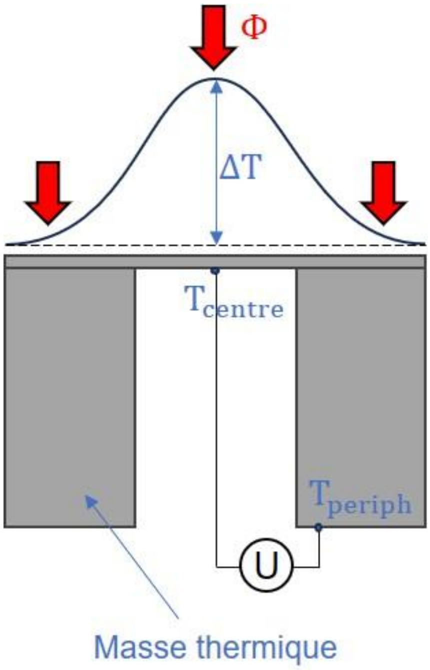

Fig.3 Schematic representation of heat flux measurement based on radial thermal gradient sensing

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/m²]
- S is the calibrated sensitivity of your sensor [V per W/m²]
- $\mathrm{U(t)}$ 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

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

2.1 Measurement ranges

GHF 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/m², please contact us.

Tab.1 Available GHF measurement ranges

GHF model	Maximum continuous heat flux density	Typical sensitivity	Typical full-scale output
GHF_250K	250 kW/m²	>20 µV per kW/m²	>5.0 mV
GHF_500K	500 kW/m²	>10 µV per kW/m²	>5.0 mV
GHF_1M	1 000 kW/m² (= 1 MW/m²)	>6 µV per kW/m²	>6.0 mV
GHF_5M	5 000 kW/m² (= 5 MW/m²)	>1 µV per kW/m²	>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:

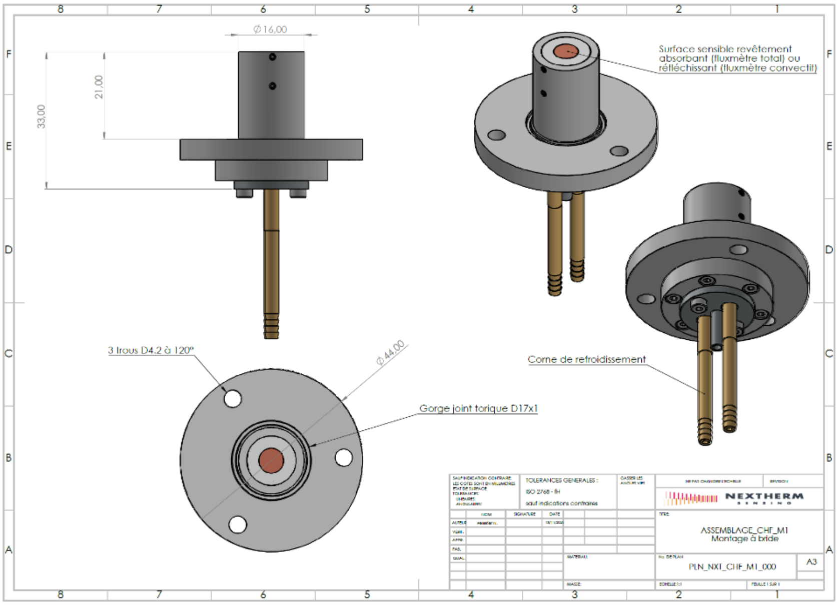

Fig.4 GHF heat flux sensor with three-hole flange-mounting interface at 120° (reference M1). The hole pattern differs from that of the CHF Series (cooled sensors, 3 holes at 120°) to prevent incorrect installation and damage.

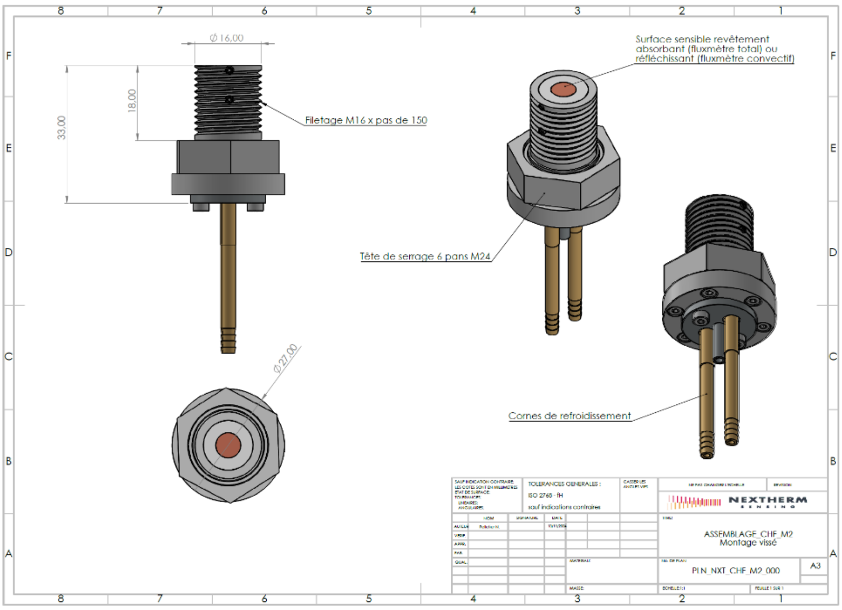

Fig.5 GHF heat flux sensor with M16 threaded mounting interface (reference M2)

2.3 Wiring and connectivity

GHF 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 inf the sensor front-face temperature.

2.4 Heat flux components

GHF 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 if 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 avec 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 filed of view.

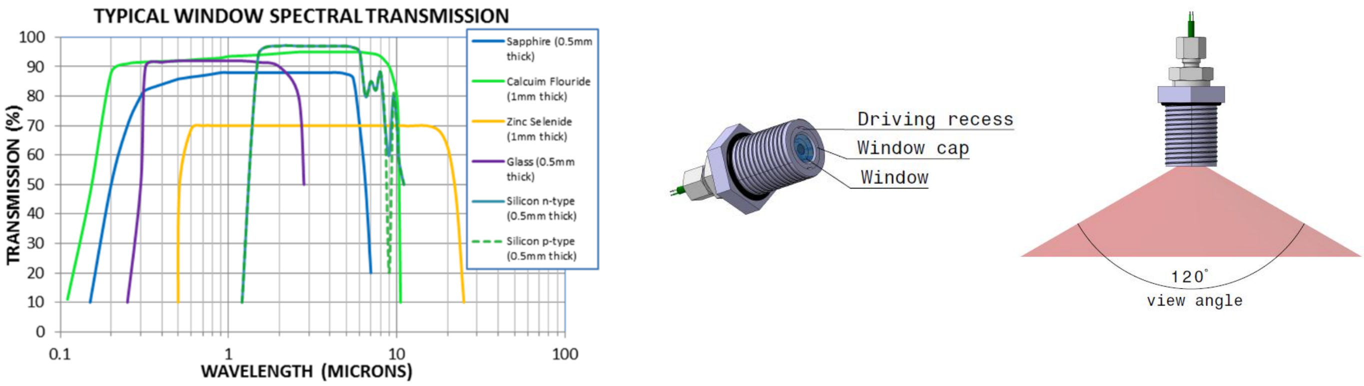

Fig.6 Radiative heat flux sensor: transmission spectrum to be considered and sensor configuration

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 (for 1mm thickness)	Melting point
Sapphire (Al_2O_3)	0.22 to 5.5 µm	85% @ [0.22,4.2] µm	2040°C
KRS-5 ($TiBr_{42}I_{58}$)	0.6 to 40 µm	65-71% @ [0.6,30] µm	414.5°C
Calcium fluoride (CaF_2)	0.13 to 10 µm	90-95% @ [0.2,7.0] µm	1360°C
N-BK7 (borosilicate)	0.35 to 2.5 µm	90% @ [0.35,2.1] µm	557°C
Quartz (fused SiO_2)	0.18 to 3.5 µm	92% @ [0.5,3.4] µm	1710°C
Zinc selenide (ZnSe)	0.55 to 15 µm	70% [1.1,15] µm	1525°C

3. Specifications

The sensors of the GHF Series measure a heat flux density collected over a sensing surface, expressed in W/m², kW/m² or MW/m² (calibration certificates are provided in kW/m²).

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 kW/m² to MW/m²) with only a few models.

GHF sensors are sized to operate for a limited duration, determined by the sensor's maximum thermal capacity (the energy that can be stored within the sensor in a system considered to be perfectly adiabatic).

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

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

GHF Series specifications	
Sensor type	Non-cooled heat flux sensor (total, convective or radiative)
Measured quantity	Heat flux density [W/m²] Option : front-face temperature [°C]
Measurand	Voltage (electromotive force) [mV]
Sensor technology	Thermal gradient heat flux sensor
Rated measurement ranges	Four ranges available: 250 kW/m², 500 kW/m²,1 000 kW/m² (1MW/m²) and 5 000 kW/m² (5 MW/m²)
Measurement range limit	+150% of rated measurement range
Sensing area diameter	6 mm (4mm for GHF_5M)
Output signal	Voltage [mV]
Typical sensitivity	• 250 kW/m² range: >20 µV per kW/m² • 500 kW/m² range: >10 µV per kW/m² • 1 000 kW/m² range: >6 µV per kW/m² • 5 000 kW/m² range: >1 µV per kW/m²
Conversion law	$\Phi(t) = \frac{U(t)}{S}$
Required readout	• 1 x voltage channel for heat flux • Option : 1 x thermocouple (Type K) channel for control temperature
Rated operating temperature range	• -30 to +500 °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 (limited to 10 bar abs for 250kW/m² range)
Non-linearity	Measured on full-scale range by calibration: <2%
Sensing area emissivity	• Radiative and total sensor: $\epsilon > 0.90$* • Convective sensor: $\epsilon < 0.05$ * *Spectral emissivity curve provided*
Full field of view	• Convective and total sensor: 180° (no window) • Radiative sensor: 120° (with window)
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
Water cooling	
Cooling method	Non-cooled sensor. Limited exposure time.
Thermal capacity of the sensor	Approx. 1350 Joule in adiabatic assembly conditions
Recommended maximum measurement duration (until the front face reaches 400°C)	• 250 kW/m² range: 60 s • 500 kW/m² range: 30 s • 1 000 kW/m² range: 20 s • 5 000 kW/m² range: 5 s
Maximum front-face temperature	Control temperature must be monitored and maintained below 400°C.
Use in testing Recommended applications	• 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, • Fire reaction testing of facades - Intermediate and large scales • Fire reaction testing of floor coverings - Determination of fire behavior using a Radiant heat source • Test method for determining the flame penetration resistance of cargo compartment linings • Standardized test method for oxyacetylene ablation testing of thermal insulation materials • Combustion bench tests (turbomachinery, rocket engines, hydrogen reactors, etc.) • Green energy (solar concentrators, etc.)

Installation and use Typical conditions of use	Academic Research, R&D, and industry Systems exposed to high heat fluxes for short periods Connected to user-supplied data acquisition equipment. Regular inspection of the sensor surface, body and wiring. Continuous monitoring of sensor temperature. No special requirements for immunity, emissions, or chemical resistance.
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	250, 500, 1 000 et 5 000 kW/m². More on request
Radiative flux option	1mm-thickness sapphire window without anti-reflective coating. 85% light transmission over the range [0.2-4.2] µm
Thermocouple to coaxial cable	Thermocouple (flat plugs) to coaxial (BNC) converter

4. Product reference

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

GHF-GG-FF-MM-OPTION

With the corresponding codes:

- **GG** : heat flux range (250, 500, 1 000, 10 000 kW/m²)
- **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/m² and a flange mounting (M1), with an optional temperature control output:

⇨ *GHF-500-TF-M1-TC*

For any other configuration, please contact us.

Sales contact

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UE declaration of conformity

CE

We,

Nextherm Sensing SAS
Registered office: 6 Impasse Louis Bentajou
31410 Longages
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:	GHF
Product type:	Non-cooled heat flux sensor
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
Longages, le 15 Janvier 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

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