NEXTHERM

SENSING

High Flux. High Value.

Specifications

Inertia heat flux sensors

IHF Series

Table of Contents

List of Symbols

Cp	Heat capacity [J/(kg.K)]
K	Calibration coefficient [kg/m²]
T	Temperature [°C]
α, β, γ	Coefficients of the heat losses correction law
Φ	Heat flux density [kW/m²]

Introduction

IHF Series (Inertia Heat Flux) sensors enable heat flux measurement over a limited time or in cyclic mode. The sensor is not cooled and therefore cannot be used for continuous measurement or over significant periods.

IHF sensors are based on a unique design developed by Nextherm Sensing, using a method known as "calorimetric" or "inertial." Under the influence of an external heat flux, the temperature of a calorimetric element increases. This temporal temperature change, and therefore the stored energy, is proportional to the applied heat flux.

The sensing element is equipped with an electrical circuit that outputs a voltage (electromotive force) generated by the thermoelectric effect (Seebeck effect) of the internal circuit, which is converted into temperature. The sensor architecture is original and unique on the market. The recorded temperature signal is then post-processed to determine the instantaneous heat flux density collected on the front face of the sensor. The measurement range of IHF heat flux probes extends from low fluxes (a few kW/m²) to extreme fluxes (several MW/m²), depending on the heat capacity of the sensing element.

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

IHF heat flux seneors are available in three versions, depending on the flux component to be measured: total flux, convective flux, or radiative flux. In the latter case, a sapphire window (other types of glass are available as options) neutralizes the potential convective component. For radiative and total flux measurements, a very high-absorptivity surface treatment is applied to the sensing face. For convective flux measurements, the surface treatment is, conversely, very high-reflectivity, in order to reject as much incident radiation as possible. Nextherm Sensing has conducted extensive research to select and evaluate the best treatments (performance and durability).

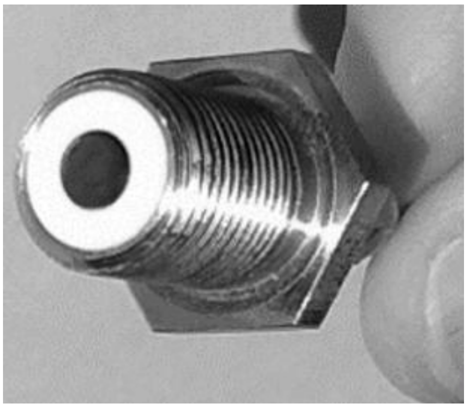

Fig.1 Example of IHF Series sensor: total fluxmeter with threaded mechanical interface

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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/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.

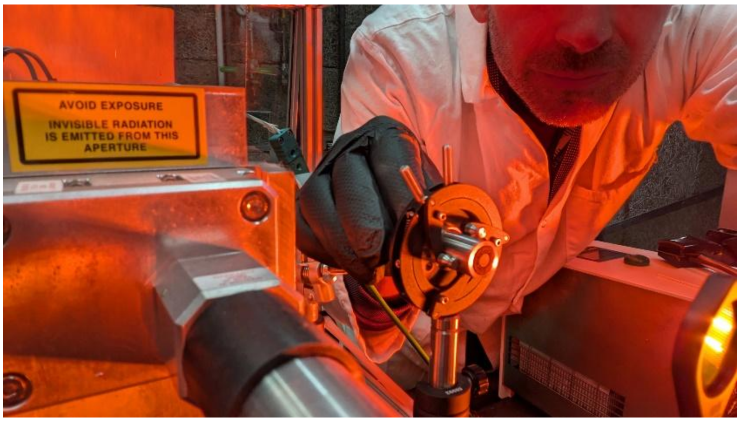

Fig.2 Laser-bench calibration is a unique approach developed by Nextherm Sensing

1. Measurement principle

IHF heat flux sensors provide an output signal analogous to temperature. They function exactly like type K thermocouples: their flat-pin connector must be plugged into a temperature recorder. This gives them numerous advantages over conventional heat flux meters: no intermediate voltage amplification, no EM interference related to low-voltage wiring, and increased ease of use (plug-and-play on a thermocouple module).

Our probes benefit from a patented design that incorporates through-flow temperature measurement—unlike conventional slug calorimeters—which is key to high accuracy.

The post-processing of this measurement provides the time evolution of the heat flux density observed by the sensor. On some measurement systems, the heat flux can be calculated in near real-time. If not, don't worry: our NexTest_IHF software is provided free of charge, under a MIT license, with every sensor purchased (see the MO_NexTest_IHF_V2026 operating procedure for more details). Once your measurement is complete, you will have a file containing the time and temperature signal at a given sampling frequency. The flux density can then be obtained by applying the calorimetric principle:

$$\Phi(t) = K.Cp(T).\frac{dT}{dt}$$

where:

- $\Phi(t)$ is the instantaneous heat flux density [W/m²]
- K is the calibration coefficient of your sensor [kg/m²]
- $\mathrm{Cp(T)}$ is the heat capacity of the sensitive element, given as a function of temperature [J/(kg.K)]
- T is the temperature of the sensor [°C]
- t is time [s]

An inertial heat flow meter should ideally be insulated. To provide the most accurate heat flux measurement possible, deviations from ideal conditions are accounted for by introducing a correction term, representative of heat losses:

$$\Phi_C(t) = \Phi(t) + \Phi_{ploss}(T)$$

where:

- $\Phi_C(t)$ is the instantaneous corrected heat flux density [W/m²]
- $\Phi_{loss}(T)$ is the corrective heat flux accounting for heat losses, calculated as a function of temperature [W/m²] :

$$\Phi_{loss}(T[°C]) = \alpha.T^2 + \beta.T + \gamma \quad [W/m^2]$$

Heat losses are thus considered to be linked to the temperature of the calorimetric element. The compensation law is strictly valid only over the temperature range covered during calibration (approximately 500°C), but can be extrapolated beyond that.

2. Available versions

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

2.1 Measurement ranges

The IHF Series heat fluxmeters are available in three measurement ranges. The range is defined by the full-scale calorimetric capacity of the sensing element: this is the maximum amount of energy the sensor can store until it reaches its maximum operating temperature. To maintain a significant safety margin, we set this limit at 500°C. Capacities are therefore calculated up to this limit, but can exceed it (safety factor 1.5).

Tab.1 IHF measurement range available

IHF model	Calorimetric capacity	Heat-flux versus duration capacity (Examples)
IHF-13	13 MJ/m²	50kW/m² during 140 seconds 2200 kW/m² during 16 seconds
IHF-16	16 MJ/m²	50 kW/m² during 180 seconds 2200 kW/m² during 20 seconds
IHF-20	20 MJ/m²	50 kW/m² during 210 seconds 2200 kW/m² during 24 seconds

IHF sensors are now also available in a "slim" version in the form of small discs, giving them a very low response time (<10ms) for dynamic applications (e.g., fireball, plasma arc, etc.):

Tab.2 Additional range for measuring rapid phenomena

IHF model	Calorimetric capacity	Heat-flux versus duration capacity (Examples)
IHF-SLIM	0,16 MJ/m²	50 kW/m² during 2 seconds 2200 kW/m² during 0,2 seconds

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:

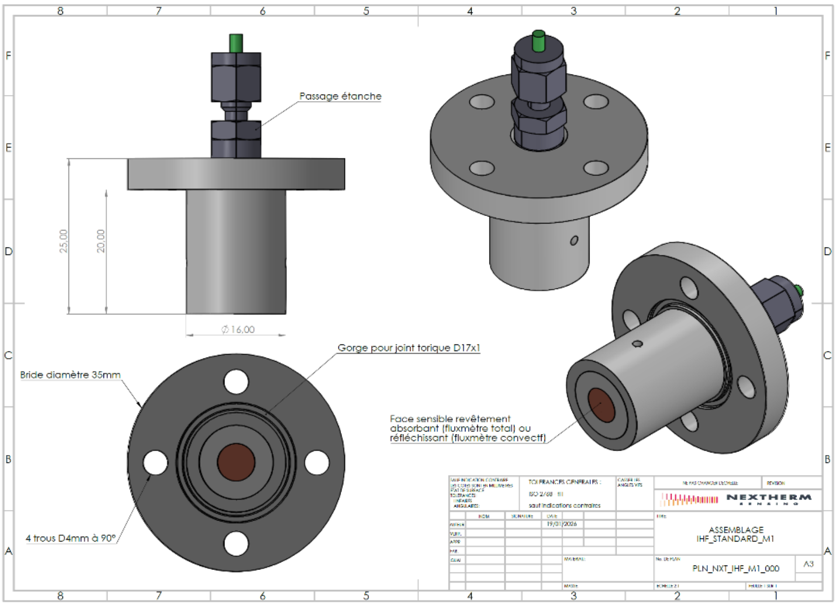

Fig.3 CHF heat flux sensor with four-hole flange-mounting interface at 90° (reference M1)

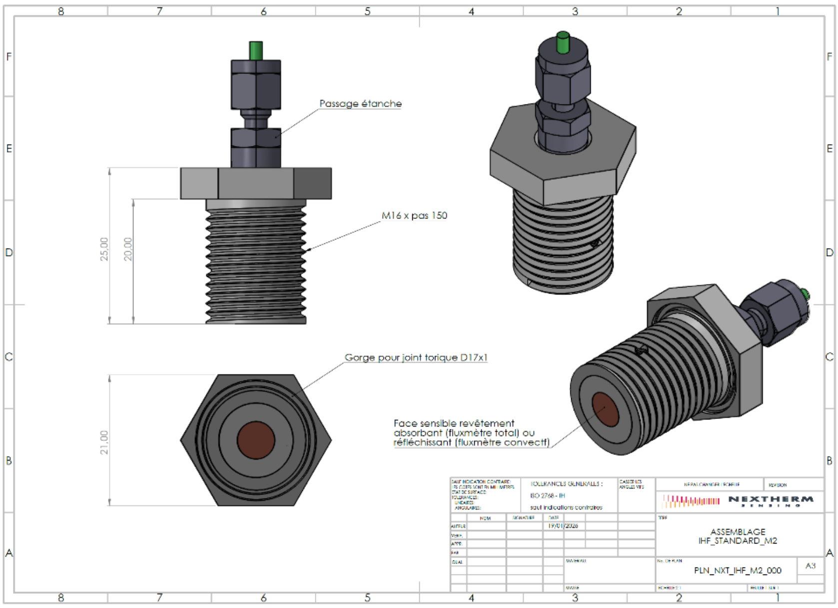

Fig.4 CHF heat flux sensor with M16 threaded mounting interface (reference M2)

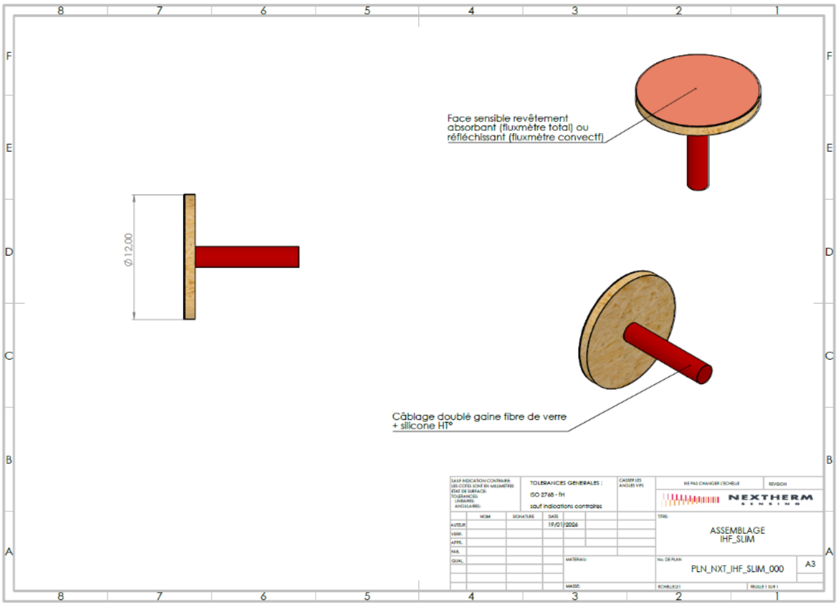

Fig.5 IHF "SLIM" free-standing disc

2.3 Wiring and connectivity

The IHF heat flux sensors in the 13, 16, and 20 MJ/m² ranges are supplied as standard with reinforced stainless steel braided wiring and a high-temperature (480°C) type K thermocouple connector with flat pins. Optionally, they can be lined with a high-temperature sheath (braided fiberglass sheath lined with silicone), offering continuous resistance up to 1000°C.

The IHF heat flux sensors in the 0.16 MJ/m² range are supplied as standard with fiberglass wiring lined with a high-temperature sheath (braided fiberglass sheath lined with silicone). This configuration reduces the wiring load to prevent any risk of it being pulled out at the base of the sensor.

2.4 Heat flux components

IHF 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.

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.

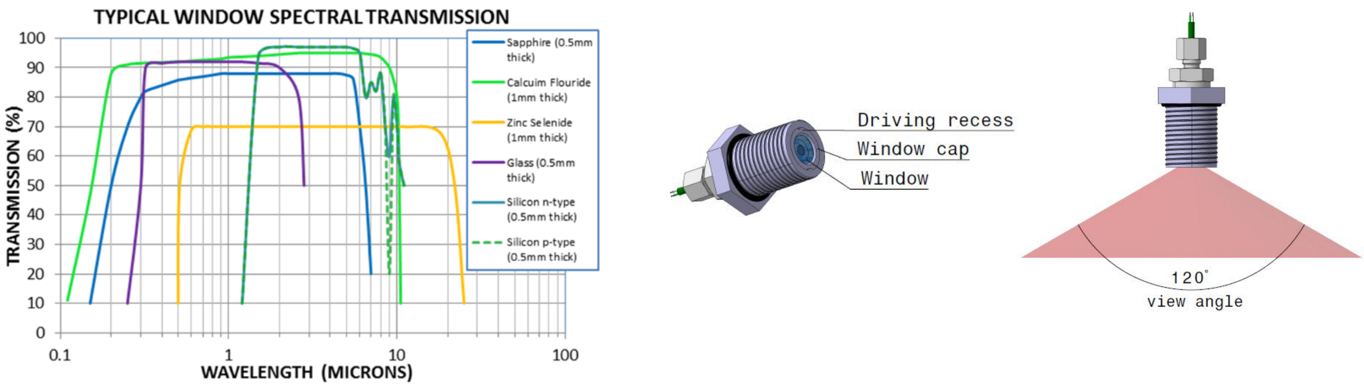

Fig.6 Radiative heat flux sensor: transmission spectrum to be considered and sensor configuration

Tab.3 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. Custom design

Nextherm Sensing distinguishes itself from the competition by offering a design office service to meet your specific needs. We are able to design unique solutions to adapt to your environment.

Fig.7 Illustrations of custom-made solutions (long bodies with 8-hole flange and miniature bodies for gluing). The cables are shown here doubled with high-temperature silicone sheathing.

4. Specifications

The IHF Series sensors measure the heat flux density collected by a sensitive surface, measured in W/m², kW/m², or MW/m² (calibration certificates are provided in kW/m²). Our heat flux meters are passive (they do not require a power supply) and have been miniaturized as much as possible to be as non-intrusive as possible and minimize interference with the heat source itself. They can also be more easily integrated into systems such as engines, reactors, and industrial lines, unlike larger competing products.

At Nextherm Sensing, choosing the right heat flux range is very simple, as we can cover a wide range of needs (kW/m² to MW/m²) with just a few models. IHF sensors are designed to accumulate a fixed amount of energy until they reach their maximum operating temperature (we recommend not exceeding 500°C).

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

Tab.3 Liste des spécifications des fluxmètres de la Série IHF

CHF Series specifications	
Sensor type	Heat flux sensor (total, convective or radiative)
Measured quantity	Heat flux density [W/m²]
Measurand	Temperature (electromotive force, type K) [°C]
Sensor technology	Inertia heat flux sensor
Rated measurement ranges	10 kW/m² to 2 000 kW/m² (more on demand)
Temperature limit	500°C
Sensing area diameter	6 mm
Output signal	Temperature (converted from electromotive force) [°C]
Conversion law	$\Phi(t) = K.Cp(T).\frac{dT}{dt} + \alpha.T^2 + \beta.T + \gamma$
Required readout	1 x thermocouple (Type K) channel
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
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	<10Ω. Does not influence signal under standard high-input-impedance acquisition conditions
Required power supply	0 W (passive sensor)

Standard cable length	1m50
Standard cable finish	Stainless steel braided sheath
Sensor marking	Serial number on label on the wiring + engraving on sensor
Gross weight	<0.2 kg standard cable included
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, determination of thermal and fire reaction parameters of materials, products, and assemblies using an intermediate-scale calorimeter (ICAL) • 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 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.
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

Calorimetric capacity	13, 16 and 20 MJ/m^2. Fast version 0.16 MJ/m^2
Radiative flux option	1mm-thickness sapphire window without anti-reflective coating. 85% light transmission over the range [0.2-4.2] µm

1. Product reference

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

IHF-GG-FF-MM-OPTION

With the corresponding codes:

- **GG** : calorimetric capacity range (0.16, 13, 16, 20 MJ/m²)
- **FF** : heat flux component (TF : total flux, CF : convective flux, RF : radiative flux)
- **MM** : mechanical mounting type (M1 : flange, M2 : threaded)
- **OPTION : SG** : option silicone oversleeve

Example: for a total flux (TF) sensor with a measuring capacity of 16 MJ/m² and a flange mounting (M1), with an optional silicone oversleeve:

⇨ *IHF-16-TF-M1-SG*

To order a fast IHF Series flux probe, please use the following reference:

IHF-0.16-FF

With the corresponding codes:

- **FF** : heat flux component (TF : total flux, CF : convective flux, RF : radiative flux)

Example : for a fast IHF in total flux version (TF) :

⇨ *IHF-0.16-TF*

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:	IHF
Product type:	Inertia 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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We reserve the right to change the specifications without prior notice.