IHF Series

Inertia High Heat Flux Sensors

IHF sensors are dedicated to the measurement of high heat flux. They are based on a physical principal called "inertia" or "capacitive" measurement. In practice, they are made of a calorimetric sensitive element (pure, oxygen-free, copper block) with well-known thermal properties (computed as a function of temperature). Their very robust design offer an unparalleled resistance in the most hostile applications, whether in the presence of impinging flame, soot, acids, high pressure or vacuum. IHF fluxmeters are available in radiative, convective and total flux versions.

Figure 1 *IHF heat flux sensors are available in a wide variety of mechanical interfaces. They works at unprecedented high flux levels (>20MW/m²), without competitive equivalent.*

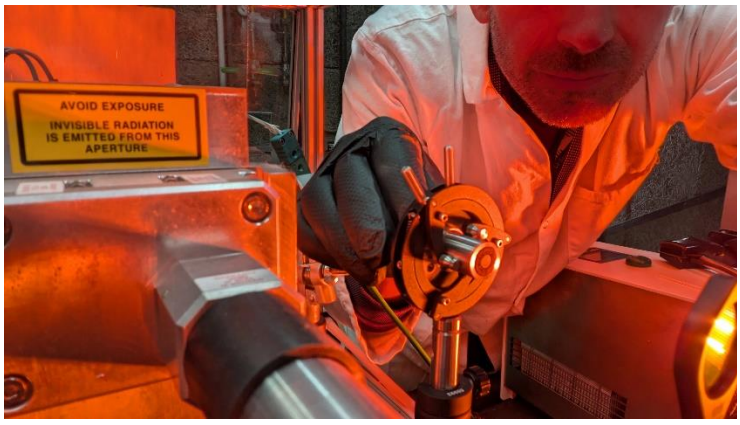


Figure 2 *IHF sensor at work on our laser calibration test bench. NexTherm Sensing is the only heat flux sensor provider that uses laser as stable and accurate calibration source.*

Introduction

IHF probes measure heat flux up to 20MW/m² over limited duration. Indeed, there are built around a sensitive core which, when submitted to a heat flux, which sees it temperature increase up to a maximal allowable level (around 900°C). From this temperature rise, heat flux is then computed by applying a mathematical post-processing, based on the calorimetric principle.

With open detector, IHF is able to measure either convective or total heat flux according to the surface finish (gold or nickel black thin layer). With a window above the detector, IHF provides an accurate radiative flux measurement. See options.

IHF technology & advantages

IHF sensors generate an output directly in temperature (°C), in the same way as a Type K thermocouple.

This brings many advantages over usual fluxmeters:

- No dedicated voltage amplification
- No EM interference due to low voltage wiring
- Ease-of-use (plug-and-play on any thermocouple module)

Our probes benefit from a patented design, which integrates a fully transversal temperature measurement – unlike usual slug calorimeters –, which is the key to high precision.

IHF heat flux probes are available in four standard versions: IHF-70, 280, 1400 and 1400-E. See table on next page.

Standard IHF sensors

IHF heat flux sensors are available in four standard versions, according to both heat flux level and measurement duration. All versions are given a maximal error of 5%FS. The following table gives the duration versus flux (assumed constant) envelope for each model, along with the 63% response time.

Standard model	Heat capacity	Typical duration vs flux envelope	Rise time (63%)
IHF-70	70 Joule	10 seconds under 250 kW/m²	<15ms
IHF-280	280 Joule	10 seconds under 1 MW/m²	<0.1s
IHF-1400	1400 Joule	10 seconds under 5 MW/m² 50 seconds under 1 MW/m²	<0.2s
IHF-1400E *	1400 Joule	10 seconds under 20 MW/m² 200 seconds under 1 MW/m²	<0.4s
** Extended duration version obtained by advanced sensitive element geometry*			

Table 1 *IHF Standard models*

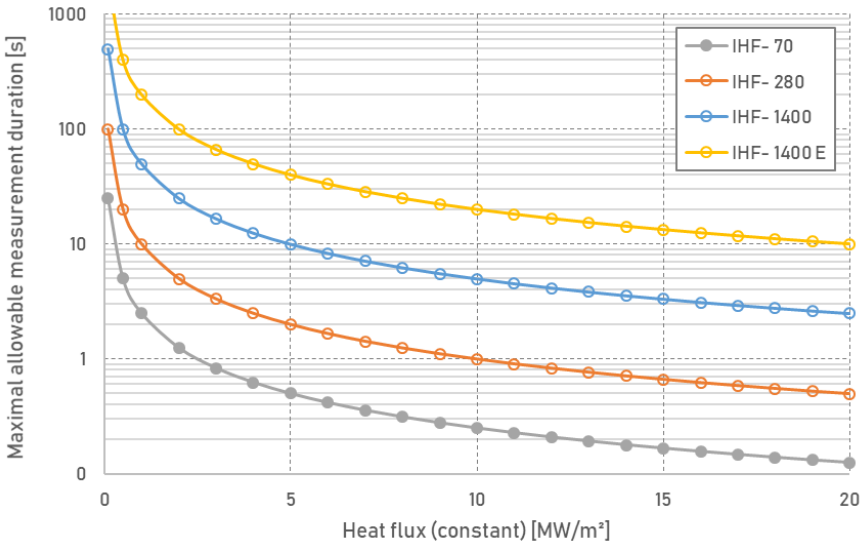


Figure 3 *Duration versus flux envelope of the four standard IHF sensors*

IHF-70 sensor is designed for transient measurement of highly dynamic phenomena, such as ignition, flame propagation, detonation, etc. due to very thin sensitive element, which limits nevertheless its usage for long-duration measurement.

IHF-280 and IHF-1400 are the most used sensors of our standard IHF series due to their high versatility, from fast high flux events to quasi-steady low flux process.

IHF-1400E is an extended version of the IHF-1400 offering impressive long duration measurement.

For higher flux or measurement duration (in other words, above the IHF-1400E curve), choose the **cooled CHF series**.

Different variations according to your application

- In their convection-type version, the sensitive element of the sensor is made of a highly reflecting gold layer (emissivity <0.05) in order to suppress as far as possible radiative contribution.
- In their radiation-type version (radiometers), the sensitive element of the sensor is isolated from the external environment by the means of a window, so as to suppress any convective contribution. Window transmissivity in characterized in our laboratory over a large spectrum. In that case, the sensitive element is made of a highly absorbing black surface (emissivity >0.90), also spectrally characterized.
- In their total-type version, the sensitive element is analogous to the radiation-type version, but is directly exposed to the external environment so as to catch combined radiative-convective heat

transfers. If convection can be neglected in your application, this version can be turned into a large view angle radiometer.

OPTIONS

MECHANICAL INTERFACE

NexTherm Sensing heat fluxmeters can be integrated in various housings. Tailored interfaces can also be designed to answer you special needs (miniature support, lateral lead wire routing, adhesive mounting, etc.). Baseline support material is stainless steel 316L. Other materials on request. Every unit is delivered with a Thermolok® seal glang (Thermocoax type MG20) for lead wire leak-tightness.

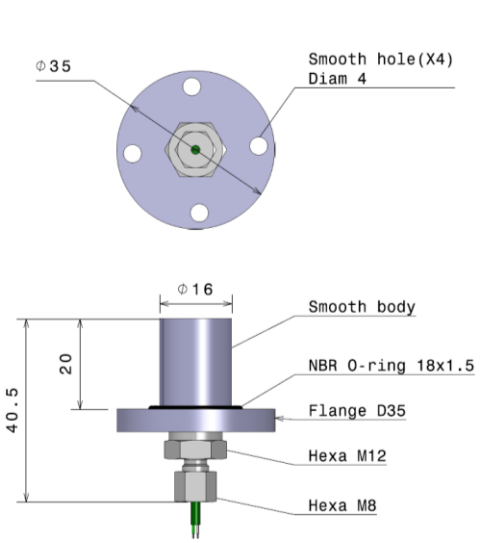
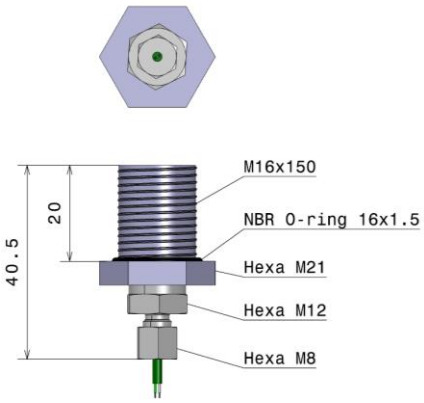
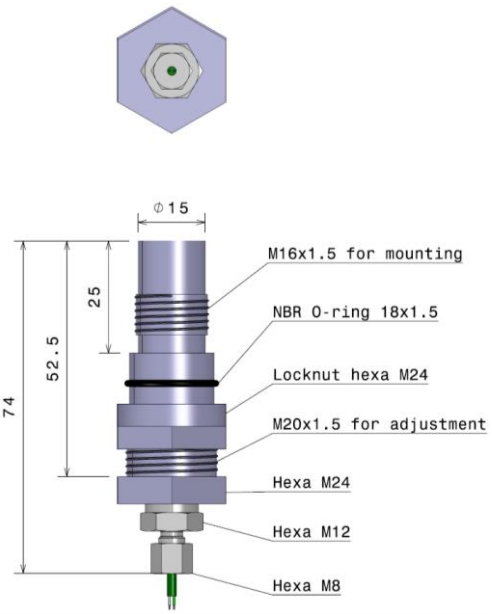
Flange mounting	Thread mounting	Fine thread mounting
		
Very simple mounting method, by screwing four points of a flat flange. Sealing by NBR (nitrile) O-ring (copper and graphite flat-ring also available). Other flange shape and smooth hole diameter on request.	Hexagonal head bolt-type fastening. Sealing by NBR (nitrile) O-ring (copper and graphite flat-ring also available). Other diameter, length and thread pitch on request.	Fine adjustment of the depth by a locknut, allowing a perfect flush-mounting of the measuring surface. Peripheral NBR (nitrile) O-ring seal.
Mounting reference : M1	Mounting reference : M2	Mounting reference : M3

Table 2 *IHF Standard mechanical interfaces*

ELECTRICAL INTERFACE

In standard version, inertia heat flux sensors are equipped with type K (chromel-alumel) thermocouple lead wires (0.5mm diameter). Baseline finish is silicon sheathing with glass silk insulation (reference W4), which constitutes a good compromise between thermomechanical resistance (480°C) and flexibility. Standard wire length is 1 meter. Miniature type K connector with flat plug (reference C1) completes the baseline version. See table below.

On request, other cable finishes are possible (*e.g.*: ceramic or metallic rigid sheath, multi-pair bundles, etc..), as well as other type K connectors (*e.g.*:, panel mounting, cable gland, ...).

Lead wire type	View	Reference
PFA insulation, SS braid shielding		W1
Glass fiber insulation, SS braid shielding		W2
Fire-proof Mica-PR / low smoke composite		W3
Standard glass silk insulation (480°C)		W4
High temperature glass silk insulation (800°C)		W5
Ultra-high temperature ceramic fiber insulation (1400°C)		W6

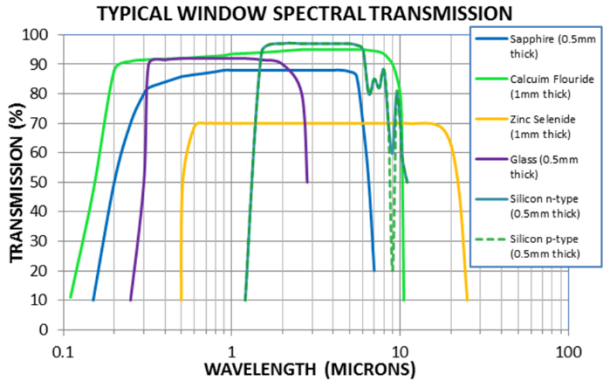
Table 3 *Available lead wire variations*

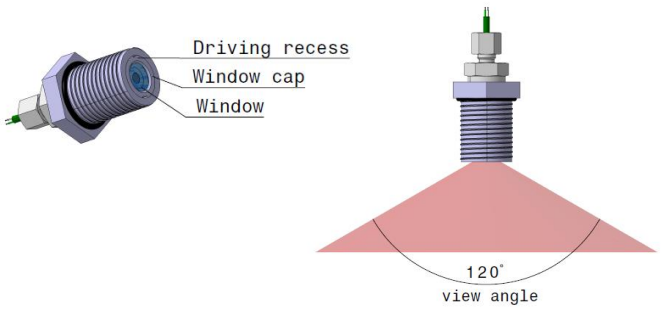
Connector type	View	Reference
Miniature plastic body, flat plugs, standard temperature (220°C)		C1
Miniature ceramic body (cast alumina), flat plugs, high temperature (650°C)		C2
Flat plugs, cable gland reinforcement		C3

Table 4 *Available connector variations*

Special windows

NexTherm Sensing masters advanced optical solution (glasses and surface treatments) allowing to target peculiar spectral band (*e.g.* near IR, far IR, singular wave length filtering).





Window material	Full transmission range	Recommended range (for a 2mm 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

Table 4 *Sapphire, quartz, ZnSe, … As many glass types allowing to target specific radiative bands in your application © Infrared Materials*

In addition to these various substrates, custom coatings can be envisaged to obtain interferential narrow bandpass filters with very high optical density (up to 4) in the rejection band, along with a better than 91% transmission in the pass region.

View restriction: Note that the integration of a window generates a reduction of the sensitive element view angle (ideally a hemispherical field of 180°).

Calibration

Sensor temperature accuracy is determined in a thermostatic bath, with a reference temperature sensor (PT-100 probe). Note that real temperature accuracy in your application depends on your overall hardware configuration (wiring, signal conditioning, DAQ performance).

Heat flux calibration is then carried out on our dedicated laser test bench. It is based on a continuous, high stability, CO_2 laser source (400W), generating a beam with an adjustable diameter (typically 10mm). Laser beam is shaped by a specific optical arrangement to obtain a spatially uniform heat flux density. Power control is monitored though two calibrated power-meters (one in-line and one on a 0.5% power pick-up).

Data acquisition & post-processing: the NexTest™ tool

Measurement is now an easy task thanks to our proprietary analysis tool called NexTest™, powered by National Instrument LabView®. In three steps, you will be able to register you sensor, run measurement and post-process it. Measurements are immediately available as both raw data and graphics. Advanced analysis can be carried out to get signals numerically filtered, when your process is highly instable for example.

NexTherm also offers a field suitcase equipped with a cutting-edge data acquisition system (16 channels, 24 bit, 20kHz per channel, 1 microsecond synchronization, 8 Go RAM, 256Go SSD, Windows 10 OS, possible external triggering, Gig-Ethernet communication interface).

Ordering

For standard model ordering, please use the following referencing:

IHF-C-M-W-C-F

with the corresponding coding:

- C : heat capacity level (70,280,1400,1400E)
- M : mounting type (flange M1, thread M2, fine thread M3)
- W : wire type (W1 to W6)
- C : connector type (C1 to C3)
- F : sensor finishing (TF : total flux, CF: convective flux)

Example: for a convective flux (CF) sensor of 280 Joule heat capacity with a standard flange mounting (M1), glass fiber insulated lead wire (W2) and standard connector (C1):

⇨ *IHF-280-M1-W2-C1-CF*

For other configurations (including window selection for radiometers), please contact us.

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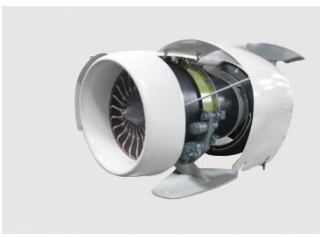

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