CHF Series

Cooled Heat Flux Sensors

CHF sensors are dedicated to the measurement of medium to high heat flux over long duration, including continuous thermal monitoring. They are derived from the IHF series and are characterized by an optimized circulation cooling system integrated in the sensor body. Featuring a robust design like their big brother IHF, CHF sensors can be implemented in very hostile environments. CHF fluxmeters are available in radiative, convective and total flux versions.

Figure 1 *CHF heat flux sensors are very compact despite their cooling structure. They are able to work in continuous mode at high flux levels (>MW/m²), without any degradation.*

Figure 2 *CHF are very easy to implement into your application, whether you are working in lab or on industrial equipment. They can be cooled by either tap water or thermostatic bath.*

Introduction

CHF probes are characterized by their capability to provide continuous heat flux measurement, up to several MW/m². They are a very interesting option for industrial thermal monitoring, but also where usual IHF sensors reach their duration limit (see IHF series for more information).

A single configuration can cover a wide range of heat flux measurement needs, from "low" intensities (some kW/m²) up to ultra-high flux (>MW/m²).

- In their convection-type version, the sensitive element of the sensor is made of a highly reflecting surface treatment (emissivity <0.05) in order to suppress any 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 surface treatment (emissivity >0.90), also spectrally characterized.

- In their total-type version, the sensitive element is analogous to the radiation-type version, but 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 field of view radiometer.

CHF sensors are liquid-cooled by an internal heat exchanger fed either by tap water or by a remote thermostatic circulating bath (thermocryostat) connected by two insulated flexible hoses. Internal exchanger allows the backside of the sensor to be perfectly maintained at a set-point temperature, even for the most elevated heat flux (>MW/m²). Length of flexible hoses can be adapted to your application. Their thermal insulation is achieved by a multilayer sheath made of a silicon-coated fiberglass core.

CHF sensors are equipped with fast connectors for easy dismounting of the cooling circuit.

NexTherm Sensing recommends the use of LAUDA® LOOP circulation thermostat devices for their compactness, flexibility and reliability. With its cooling output of 120W at 20°C, the LOOP L100 model is a cost-effective solution using a low consumption Peltier cooling unit.

OPTIONS

MECHANICAL INTERFACE

CHF fluxmeters can be integrated in various housings. Tailored interfaces can also be designed to answer you special needs. Baseline support material is stainless steel 316L. Other materials on request. Every unit is delivered with a rigid metal outlet filled with a resin potting for lead wire leak-tightness.

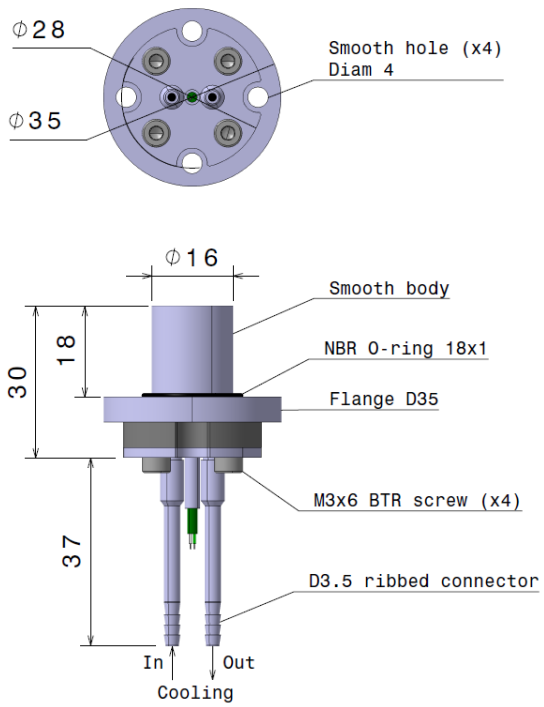
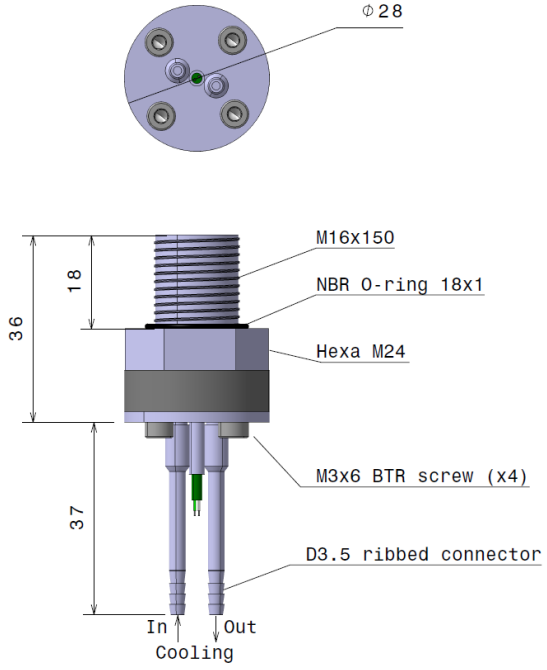
Flange mounting	Thread mounting
	
Very simple mounting method, by screwing four points of a flat flange. Sealing by NBR (nitrile) O-ring (copper and graphite flat-ring also available). Other flange shape and smooth hole diameter on request.	Hexagonal head bolt-type fastening. Sealing by NBR (nitrile) O-ring (copper and graphite flat-ring also available). Other diameter, length and thread pitch on request.
Mounting reference : M1	Mounting reference : M2

Table 1 *CHF Standard mechanical interfaces*

ELECTRICAL INTERFACE

In standard version, CHF 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.

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

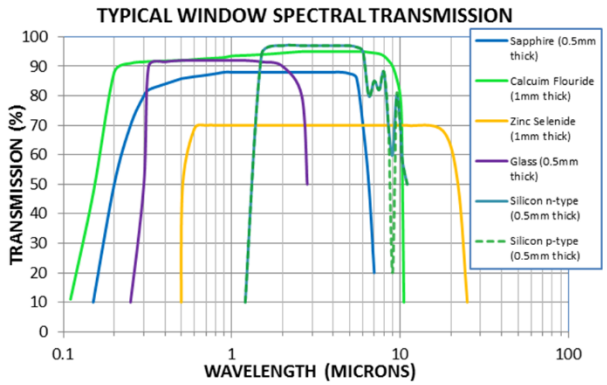
Table 2 *Available lead wire variations*

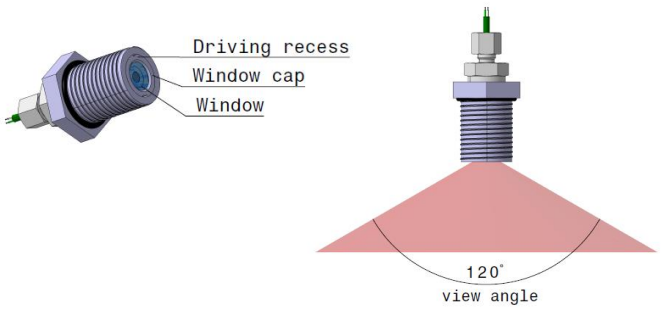
Connector type	View	Reference
Miniature plastic body, flat plugs, standard temperature (220°C)		C1
Miniature ceramic body (cast alumina), flat plugs, high temperature (650°C)		C2
Flat plugs, cable gland reinforcement		C3

Table 3 *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 5 *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:

CHF-M-W-C-F

with the corresponding coding:

- C : heat capacity level (70,280,1400,1400E)
- M : mounting type (flange M1, thread M2)
- 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 with a standard flange mounting (M1), glass fiber insulated lead wire (W2) and standard connector (C1):

⇨ *CHF-M1-W2-C1-CF*

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

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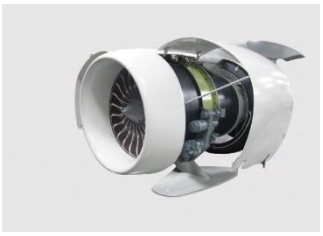

Turbomachines

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