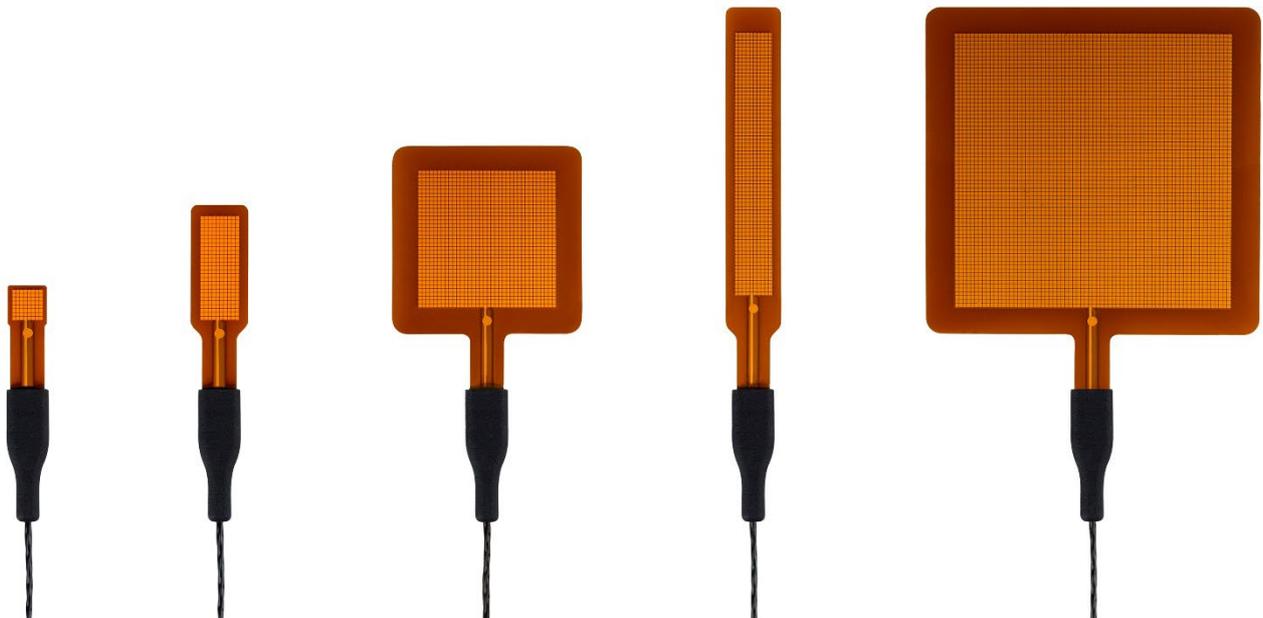


## FHF05 series - heat flux sensors

Five models covering the most common heat flux measurement applications; new, patented technology, flexible, with temperature sensor

*FHF05 is the product range to start looking if you consider measuring heat flux. Models are available in five different dimensions and sensitivities. All FHF05's are flexible, have an integrated temperature sensor and have thermal spreaders to reduce thermal conductivity dependence. Rated temperature range is from  $-70$  to  $+120$  °C. FHF05 measures heat flux from conduction, radiation and convection. Optionally, black BLK and gold GLD stickers are available for all five models to separately determine heat transport by radiation and convection. In case the FHF05 series does not match your needs, have a look at other [heat flux sensor models for special applications](#).*



**Figure 1** FHF05 series foil heat flux sensors with thermal spreaders: thin, flexible and versatile. Models are available in five different dimensions and sensitivities.

### FHF05 series: covers most heat flux measurement applications

Sensors of the FHF05 series are suitable for general-purpose heat flux measurement. The range is available in five different dimensions. Larger dimensions mean a higher sensitivity and a larger area over which the heat flux is averaged.

They are thin, flexible and versatile. FHF05 measures heat flux through the object in which it is incorporated or on which it is mounted, in  $W/m^2$ . The sensor in FHF05 is a thermopile. This thermopile measures the temperature difference across FHF05's flexible body. A type T thermocouple is integrated as well. The thermopile and thermocouple are passive sensors; they do not require power.



**Figure 2** FHF05-85X85 being installed to measure heat flux on a pipe

Multiple small thermal spreaders, which form a conductive layer covering the sensor, help reduce the thermal conductivity dependence of the measurement. With its incorporated spreaders, the sensitivity of FHF05 is independent of its environment. Many competing sensors do not have thermal spreaders. The passive guard area around the sensor reduces measurement errors due to edge effects and is also used for mounting.

Using FHF05 is easy. It can be connected directly to commonly used data logging systems. The heat flux in  $W/m^2$  is calculated by dividing the FHF05 output, a small voltage, by the sensitivity. The sensitivity is provided with FHF05 on its certificate.

### Unique features and benefits

- flexible (bending radius  $\geq 7.5 \times 10^{-3}$  m)
- low thermal resistance
- wide temperature range
- fast response time
- large guard area
- integrated type T thermocouple
- robustness, including connection block, for strain relief
- IP protection class: IP67 (essential for outdoor application)
- integrated thermal spreaders for low thermal conductivity dependence

### FHF05 series specifications

Measurand	heat flux
Measurand	temperature
Temperature sensor	type T thermocouple*
Thermal spreaders	included
Rated bending radius	$\geq 7.5 \times 10^{-3}$ m
Rated load on cable	$\leq 1.6$ kg
Outer dimensions (w x b) foil with guard	$(10 \times 10) \times 10^{-3}$ m $(15 \times 30) \times 10^{-3}$ m $(50 \times 50) \times 10^{-3}$ m $(15 \times 85) \times 10^{-3}$ m $(85 \times 85) \times 10^{-3}$ m
Sensor thermal resistance	$11 \times 10^{-4}$ K/(W/m <sup>2</sup> )
Sensor thickness	$0.4 \times 10^{-3}$ m
Uncertainty of calibration	$\pm 5\%$ (k = 2)
Measurement range	$(-10 \text{ to } 10) \times 10^3$ W/m <sup>2</sup>
Sensitivity (nominal) per model	
10X10:	$1 \times 10^{-6}$ V/(W/m <sup>2</sup> )
15X30:	$3 \times 10^{-6}$ V/(W/m <sup>2</sup> )
50X50:	$13 \times 10^{-6}$ V/(W/m <sup>2</sup> )
15X85:	$7 \times 10^{-6}$ V/(W/m <sup>2</sup> )
85X85:	$50 \times 10^{-6}$ V/(W/m <sup>2</sup> )
Assymetry	$< 2\%$
Rated temperature range	
continuous use:	-70 to +120 °C
short intervals:	-160 to +150 °C*
IP protection class	IP67***
Standard cable length	2 m
Options	5 or 10 m cable length separate cable without cable BLK black sticker GLD gold sticker

\* temperature measurement uncertainty: 5 % of value in °C. For details, refer to user manual.

\*\* when measuring at temperatures of -160 °C, contact Hukseflux.

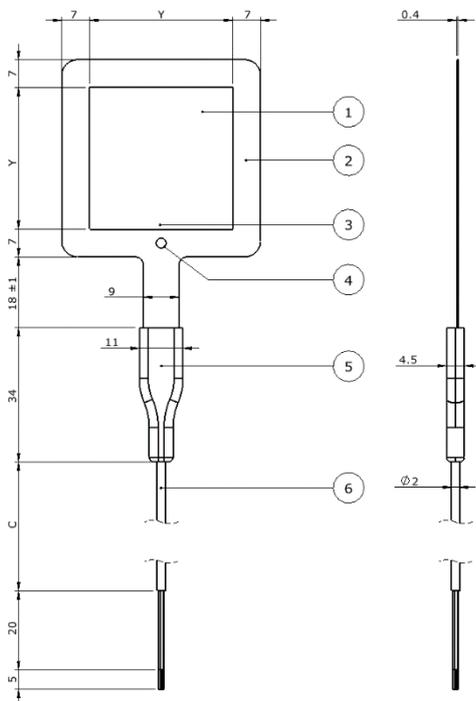
\*\*\* sensor is not suitable for continuous exposure to water.



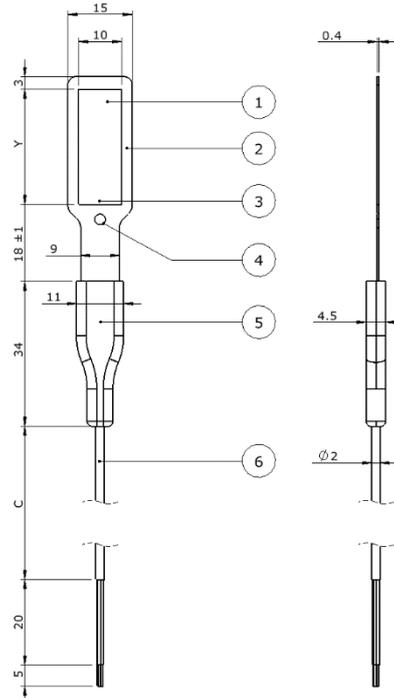
**Figure 3** FHF05-15X85, thin and flexible, can be easily mounted on a curved surface like a pipe or tube

### Robust and stable

Equipped with a connection block, which may serve as strain relief, and with potted protective covers on both sides so that moisture does not penetrate, FHF05 has proven to be very robust and stable.



**Figure 4** FHF05-10X10, 50X50 or 85X85 heat flux sensor: (1) sensing area with thermal spreaders, (2) passive guard, (3) type T thermocouple, (4) dot indicating front side, (5) connection block, (6) cable, standard length C is 2 m. The size of Y can be 8, 36 or 70. All dimensions in  $\times 10^{-3}$  m.



**Figure 5** FHF05-15X30 or 15X85 heat flux sensor: (1) sensing area with thermal spreaders, (2) passive guard, (3) type T thermocouple, (4) dot indicating front side, (5) connection block, (6) cable, standard length is 2 m. The size of Y can be 27 or 70. All dimensions in  $\times 10^{-3}$  m.

### BLK and GLD sticker series

Would you like to study energy transport / heat flux in detail? Hukseflux helps taking your measurement to the next level: order FHF05 with radiation-absorbing black and radiation-reflecting gold stickers. You can then measure convective + radiative flux with one, and convective flux only with the other. Subtract the 2 measurements and you have radiative flux. BLK – GLD stickers can be applied by the user to the sensor. There are stickers for every sensor dimension. Optionally, they can be ordered pre-applied. See the BLK – GLD sticker series user manual and installation video for instructions.



**Figure 6** FHF05-50X50 with BLK-50X50 and GLD-50X50 stickers

## Suggested use

FHF05 series have sensors for general-purpose heat flux measurement, often applied as part of a larger test- or measuring system. **FHF05SC series** on the other hand, is a self-calibrating version of the standard model FHF05, combined with a **HTR02 series** heater. FHF05SC series is used when the highest level of quality assurance is required and for long-term heat flux measurement. The self-calibrating sensor is available in a 50X50 and 85X85 model.

## Typical applications per model

- 10X10: high power microchips
- 10X15: high heat flux in ovens
- 50X50: general purpose, battery thermal management
- 15X85: wrapped around a pipe
- 85X85: low heat fluxes, insulation performance testing, low accuracy dataloggers & amplifiers



**Figure 7** FHF05-50X50 with BLK GLD stickers for measuring insulation losses of a thermos.

## Calibration

FHF05 calibration is traceable to international standards. The factory calibration method follows the recommended practice of ASTM C1130 - 21.

## Working with heat flux sensors

When used under conditions that differ from the calibration reference conditions, the FHF05 sensitivity to heat flux may be different than stated on its certificate. See the user manual for suggested solutions. See also our application note [how to install a heat flux sensor](#).

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**Page 4/6. For Hukseflux Thermal Sensors go to [www.hukseflux.com](http://www.hukseflux.com) or e-mail us: [info@hukseflux.com](mailto:info@hukseflux.com)**

## Options

- with 5 or 10 metres cable length
- separate cable in 2, 5 or 10 metres length
- without wiring, without connection block
- **LI19** hand-held read-out unit / datalogger  
*NOTE: LI19 measures heat flux only*
- BLK sticker for all models (to measure radiative as well as convective heat flux)
- GLD sticker for all models (to measure convective heat flux only)
- BLK - GLD sticker series can also be ordered pre-applied at the factory



**Figure 8** FHF05-15X30 with GLD- 15X30 being installed to measure heat flux on a computer processor. The sensor is mounted on a well-prepared flat surface.

## Suitable electronics

The combined measurement of heat flux and temperature offers you a full picture of the thermal behaviour of a system. Heat flux sensor output is a small millivolt signal. Often heat flux sensors are combined with thermocouples. **We have several preferred solutions for amplification, data logging and data visualisation.**

### See also

- model **FHF05SC series** for a self-calibrating version of FHF05-50X50 or 85X85
- model **HFP01** for increased sensitivity (also consider putting two or more FHF05s in series)
- heater **HTR02 series**, for calibration and verification of performance of FHF-type sensors
- **BLK - GLD sticker series** to separate radiative and convective heat fluxes
- Hukseflux offers a complete variety of **heat flux sensors** with the highest quality for any budget

### About Hukseflux

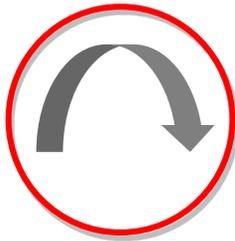
Hukseflux is the leading expert in measurement of energy transfer. We design and manufacture sensors and measuring systems that support the energy transition. We are market leaders in solar radiation- and heat flux measurement.

Customers are served through the main office in the Netherlands, and locally owned representations in the USA, Brazil, India, China, South East Asia and Japan.

Interested in this product?  
E-mail us at: [info@hukseflux.com](mailto:info@hukseflux.com)

# FHF05 series outperforms competing models: how?

FHF05 series are Hukseflux' standard models for thin, flexible and versatile heat flux sensors. With its small footprint, FHF05 10X10 is the most economical one.



**Flexible**

FHF05 series may be bent to a radius of 7.5 mm.

**Large-area**

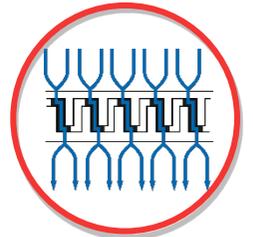
Larger is better: FHF05 85X85's sensitive area of 70 x 70 mm offers good averaging, leading to increased sensitivity. FHF05 series have a thermal guard around the sensitive area. The guard can also be used for mounting the sensor without disturbing the sensitive area.

Sensitive area with thermal spreaders reducing thermal conductivity dependence

**Sensitivity independent of environment:**

**Thermal spreader included**

Unlike many competing sensors, FHF05 series sensors have thermal spreaders, i.e. conductive layers covering the sensor. These layers help reduce the thermal conductivity dependence of the measurement. By employing spreaders, the sensitivity of FHF05 series becomes independent of its environment.



Corrosion-proof plastic cover protecting the thermal spreader

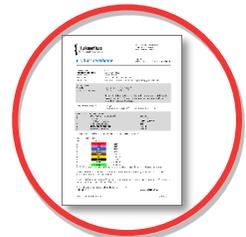
Thermocouple type T included

Durable waterproof wires with potted connection block, may be used as strain relief, temperature resistant up to 120 °C

BLK and GLD stickers series matching FHF05 series to measure radiative and convective heat flux separately

**Best paperwork**

Hukseflux has the paperwork covered; all FHF05 series sensors are provided with formally traceable calibration certificates. We calibrate in accordance with ASTM. C1130 - 21.



**Stable: waterproof (IP67), corrosion-proof**

FHF05 series sensor connection is potted, and waterproof. Its protection class is IP67. Competing sensors often have wire connections with open contact to the environment. This is a large potential source of damage, as well as a starting point for measurement errors, corrosion, and sensor instability.

5 sizes, covering most heat flux applications. Larger dimensions mean a higher sensitivity and a larger area over which the heat flux is averaged

**FHF05-50X50**

