

FHF05 series heat flux sensors

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

Do you want to measure heat flux? Start your search with heat flux sensors of the FHF05 series! Sensors are available in five different dimensions and sensitivities. They are flexible, have an integrated temperature sensor and have thermal spreaders to reduce thermal conductivity dependence. The rated temperature range is from -70 to $+120$ °C. FHF05 sensors measure heat flux from conduction, radiation and convection. Optionally, black BLK and gold GLD stickers are available to separate heat transport by radiation from that by convection. In case FHF05 sensors do not suit your needs, have a look at our other [heat flux sensor](#) models for special applications.

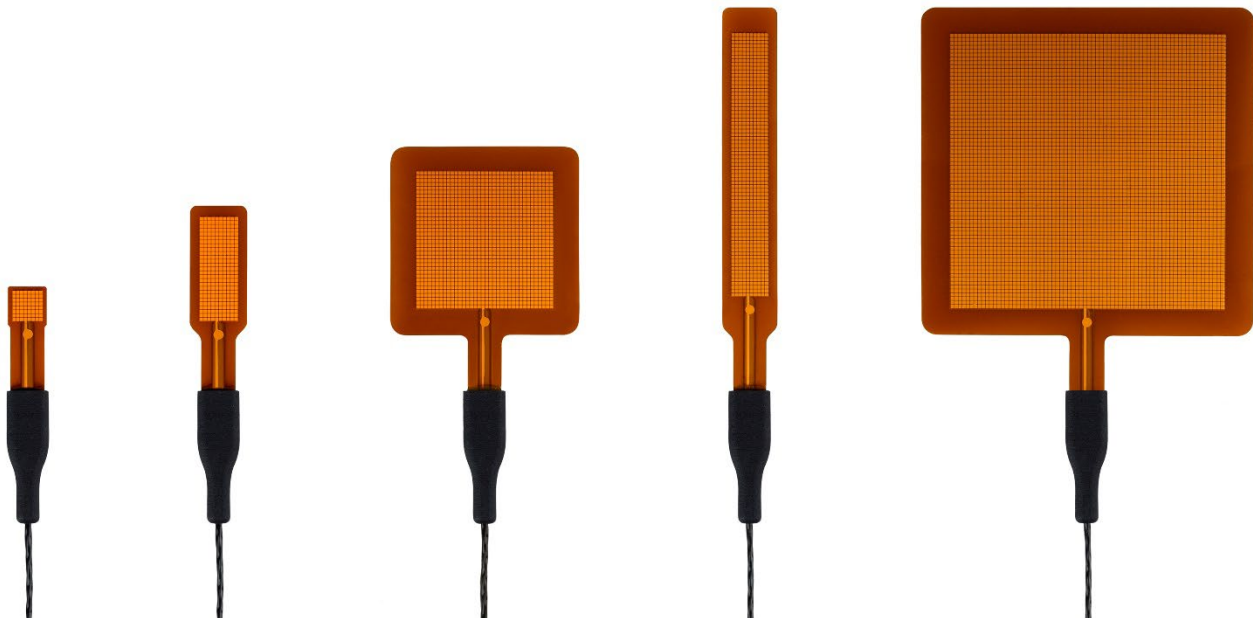


Figure 1 FHF05 series foil heat flux sensors with thermal spreaders: thin, flexible and versatile. Models are available in five different dimensions and sensitivities.

FHF05 series: covers most heat flux measurement applications

Sensors of the FHF05 series are suitable for general-purpose heat flux measurement. The range consists of sensor models of five different dimensions. Sensors with larger dimensions have a higher sensitivity and a larger area over which the heat flux is averaged.

Thin, flexible and versatile, FHF05 sensors measure heat flux through the object in which they are incorporated or on which they are 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 to provide a measurement of temperature. The thermopile and thermocouple sensors 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 the FHF05 sensors is independent of their environment. Many competing sensors do not have thermal spreaders so their sensitivity cannot be relied upon; it depends on the material on which they are mounted. The passive guard area around the FHF05 sensor reduces measurement errors due to edge effects and may also be used for mounting.

Using an FHF05 sensor 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 sensor output, a small voltage, by the sensitivity. The sensitivity is provided with the sensor on its certificate.

Robust and stable

Equipped with a potted cable connection block that prevents moisture from penetrating and may also serve as strain relief, FHF05 has proven to be very robust and stable.

FHF05 series specifications

| | |
|--|---|
| Measurand | heat flux |
| Measurand | temperature |
| Temperature sensor | type T thermocouple, IEC 60584-1 class 2* |
| Thermal spreaders | included |
| Rated bending radius | $\geq 7.5 \times 10^{-3}$ m |
| Rated load on cable | ≤ 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 | 11×10^{-4} K/(W/m ²) |
| Sensor thickness | 0.4×10^{-3} m |
| Uncertainty of calibration | $\pm 5\%$ (k = 2) |
| Measurement range | $(-10 \text{ to } 10) \times 10^3$ W/m ² |
| Sensitivity (nominal) per model | |
| 10X10: | 1×10^{-6} V/(W/m ²) |
| 15X30: | 3×10^{-6} V/(W/m ²) |
| 50X50: | 13×10^{-6} V/(W/m ²) |
| 15X85: | 7×10^{-6} V/(W/m ²) |
| 85X85: | 50×10^{-6} V/(W/m ²) |
| Asymmetry | < 2 % |
| Rated operating 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: ± 1 or $0.0075 \times T$ °C.

For details, see the user manual.

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

*** see appendix on long-term use under condensing, wet and underwater conditions.

**** sensor foil only (without cable and cable connection block) may be used in vacuum.



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

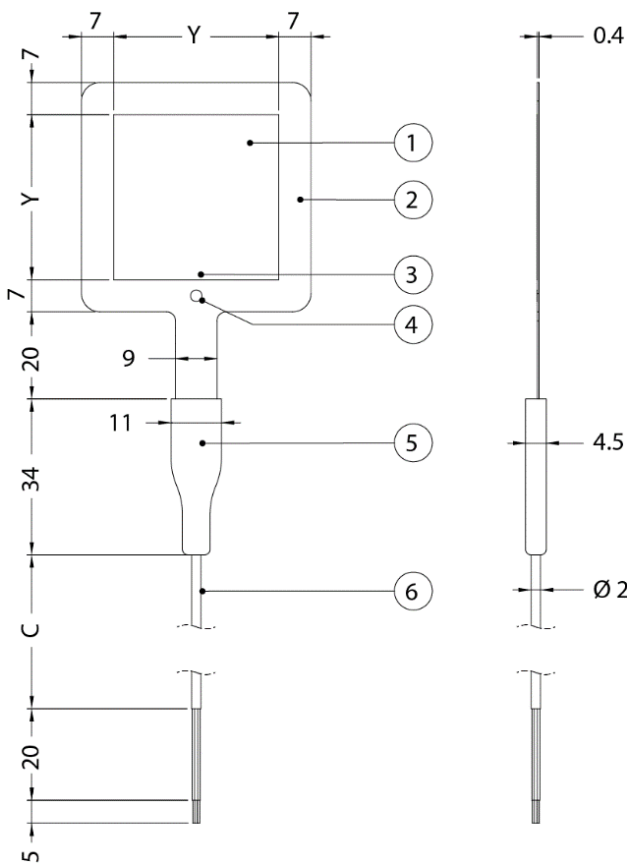


Figure 4 FHF05-10X10, -50X50 or -85X85 heat flux sensor: (1) sensing area with thermal spreaders, (2) passive guard, (3) type T thermocouple, (4) dot indicating front side, (5) cable connection block, (6) cable, standard length C is 2 m. The size of Y = 8, 36 or 70. All dimensions in $\times 10^{-3}$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

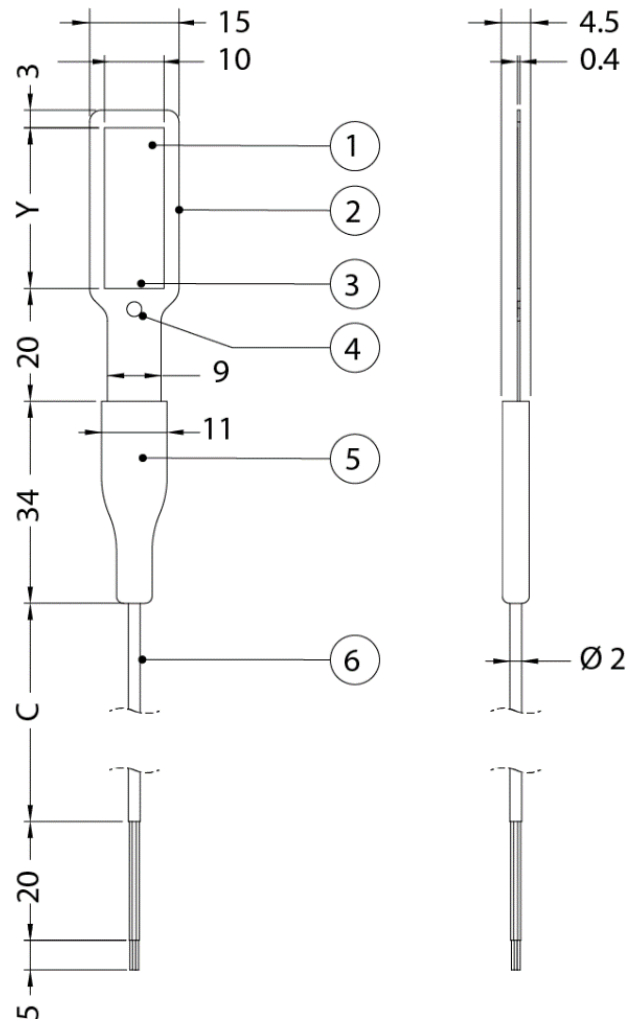


Figure 5 FHF05-15X30 or -15X85 heat flux sensor: (1) sensing area with thermal spreaders, (2) passive guard, (3) type T thermocouple, (4) dot indicating front side, (5) cable connection block, (6) cable, standard length is 2 m. The size of Y1 = 27 or 71. All dimensions in $\times 10^{-3}$ m.

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 cable connection block, for strain relief
- IP protection class: IP67 (essential for outdoor application and in humid environments)
- integrated thermal spreaders for low thermal conductivity dependence
- sensor foil only: may be used in vacuum

Suggested use

FHF05 sensors can be used for general-purpose heat flux measurement, and are often applied as part of a larger test- or measuring system.

Typical applications per model

- 10X10: high power microchips
- 15X30: 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 data loggers & amplifiers



Figure 6 Model FHF05-50X50 with BLK and 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

See the user manual for detailed directions.

Installation

There are many possibilities for installing a heat flux sensor. See also our application note on [how to install a heat flux sensor](#).

Options

- with 5 or 10 metres cable length
- separate cable in 2, 5 or 10 metres length
- without wiring, without connection block (sensor foil only)
- LI19 hand-held read-out unit / data logger
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 stickers can also be ordered pre-applied at the factory

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. There are stickers for every sensor dimension. See the BLK - GLD sticker series user manual and installation video for instructions.

Optionally, these stickers can be ordered pre-applied on FHF sensors.

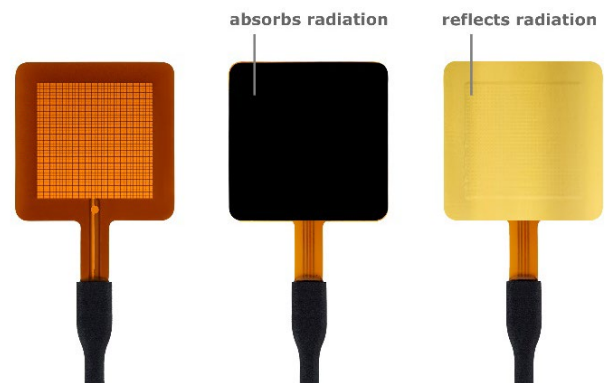


Figure 7 FHF05-50X50 with BLK-50X50 and GLD-50X50 stickers.



Figure 8 Model 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 a full picture of the thermal behaviour of a system. Heat flux sensors have a small millivolt signal output and are often combined with thermocouples as part of a larger test- or measuring system. We have several preferred solutions for amplification, data logging and data visualisation. See our application notes on [sensor amplification](#) or [FHF sensors with Hioki data loggers](#).

See also: FHF05SC

[FHF05SC series](#), are self-calibrating versions of the standard FHF05 models, combined with a [HTR02 series](#) heater. FHF05SC sensors are used when the highest level of quality assurance is required and for long-term heat flux measurement. The self-calibrating sensor is available in two models -50X50 and -85X85.

See also

- model [FHF06](#) for application up to 250 °C.
- model [HFP01](#) (used on walls and in soils as a lower cost alternative to FHF05 85X85)
- heaters of the [HTR02 series](#), for verification of performance of FHF-type sensors
- [BLK - GLD sticker series](#) to separate radiative and convective heat fluxes
- Hukseflux offers a complete product range of [heat flux sensors](#) with the highest quality for any budget

Select your FHF model

FHF05 sensors are available in 5 different sizes. The following text helps you select the right sensor for your application and the right electronics. Selecting the right electronics - sensor combination helps reduce total system costs. Sensors with larger dimensions have

- a higher sensitivity and
- a larger area over which the heat flux is averaged and also
- a higher price.

Step 1

Familiarise yourself with heat flux measurement. Visit the Hukseflux [YouTube](#) channel:

- [quick intro to heat flux](#) (3 min);
- [online course](#) (40 min);
- [separating radiation and convection](#) (2 min).

Step 2

Verify that FHF05 sensors is suitable for your heat flux measurement application and environment:

- check if the heat flux is between -10 to +10 x 10³ W/m²;
- verify that the rated temperature range is below 120 °C;
- verify other specifications in the [manual](#).

Step 3

Verify what FHF05 model / size and optional black and gold stickers may be used:

- decide if you need a minimum sensor size;
- see which model fits in the available space;
- check if you want to separate radiation and convection; if so, consider BLK and GLD stickers.

Step 4

Verify that your electronics are suitable:

- estimate the output range of the heat flux sensor(s) in [x 10⁻⁶ V] using the sensitivities in the specifications table: microvolt output range = heat flux range in [W/m²] x sensitivity in [x 10⁻⁶ V/(W/m²)]
- check if your electronics accept analogue voltage input
- check if the microvolt voltage measurement accuracy of your instruments is better than 1 % of the output range, to ensure electronics are not the limiting factor in measurement accuracy. If your electronics' accuracy is insufficient, you may choose a larger sensor

or put sensors electrically in series to create a higher sensitivity

- make sure that your electronics accept type T thermocouples. If not, consider whether a temperature measurement is needed or if a separate temperature sensor can be added.

Step 5

Ask Hukseflux to check your choices

- ask for our input / suggestions. Send all information and specifications of your application to Hukseflux. This includes: the purpose of the measurement, heat flux source, heat flux sink, expected heat flux and temperature ranges, electronic devices used, sketch of the setup indicating specifications and dimensions;
- consider alternatives: the FHF sensors may not be the best option: we can supply many different sensor models optimised for a wide range of applications.

About Hukseflux

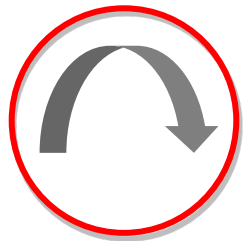
Hukseflux is the leading expert in measurement of energy transfer. We design and manufacture sensors and measuring systems that support the energy transition. We are market leaders in solar radiation- and heat flux measurement.

Customers are served through our headquarters in the Netherlands, and locally owned representative sales offices in the USA, Brazil, India, China, Southeast Asia and Japan.

Interested in this product?
E-mail us at: info@hukseflux.com

FHF05 sensors outperform competing models: how?

FHF05 sensors are Hukseflux' standard models for thin, flexible and versatile heat flux sensors.



Flexible

FHF05 sensors are extremely flexible and may be bent to a radius of 7.5 mm.

Flexible, robust plastic cover protecting the FHF sensors

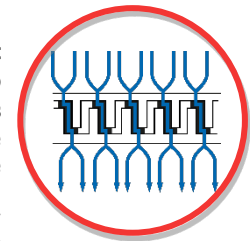
For measuring temperature: Thermocouple type T included

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

Sensitivity you can rely on:
Sensitive area with thermal spreaders reducing thermal conductivity

Sensitivity independent of environment, thanks to thermal spreaders

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



5 sizes, covering most heat flux and temperature measurement applications. Sensors with larger dimensions have a higher sensitivity and a larger area over which the heat flux is averaged



Stable: waterproof (IP67), corrosion-proof

The cable connection of FHF05 sensors is potted and waterproof, and its protection class is IP67. Competing sensors often have wire connections that are open to the environment, which is a large potential source of damage and a starting point for measurement errors, corrosion, and sensor instability.

