HUKX

Sensor
Technology

Brochure

Foil heat flux sensors

FHF05 series

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Foil heat flux sensors

Five models covering the most common heat flux measurement applications

Looking to measure heat flux? Start your search with the FHF05 series! These heat flux sensors are available in five different dimensions and sensitivities to suit a wide range of applications. They are flexible, have an integrated temperature sensor, and feature 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. Optional black (BLK) and gold (GLD) stickers are available to separate heat transport by radiation from that by convection.
In case FHF05 sensors do not meet your specific requirements, explore our full range of heat flux sensor models for special applications.

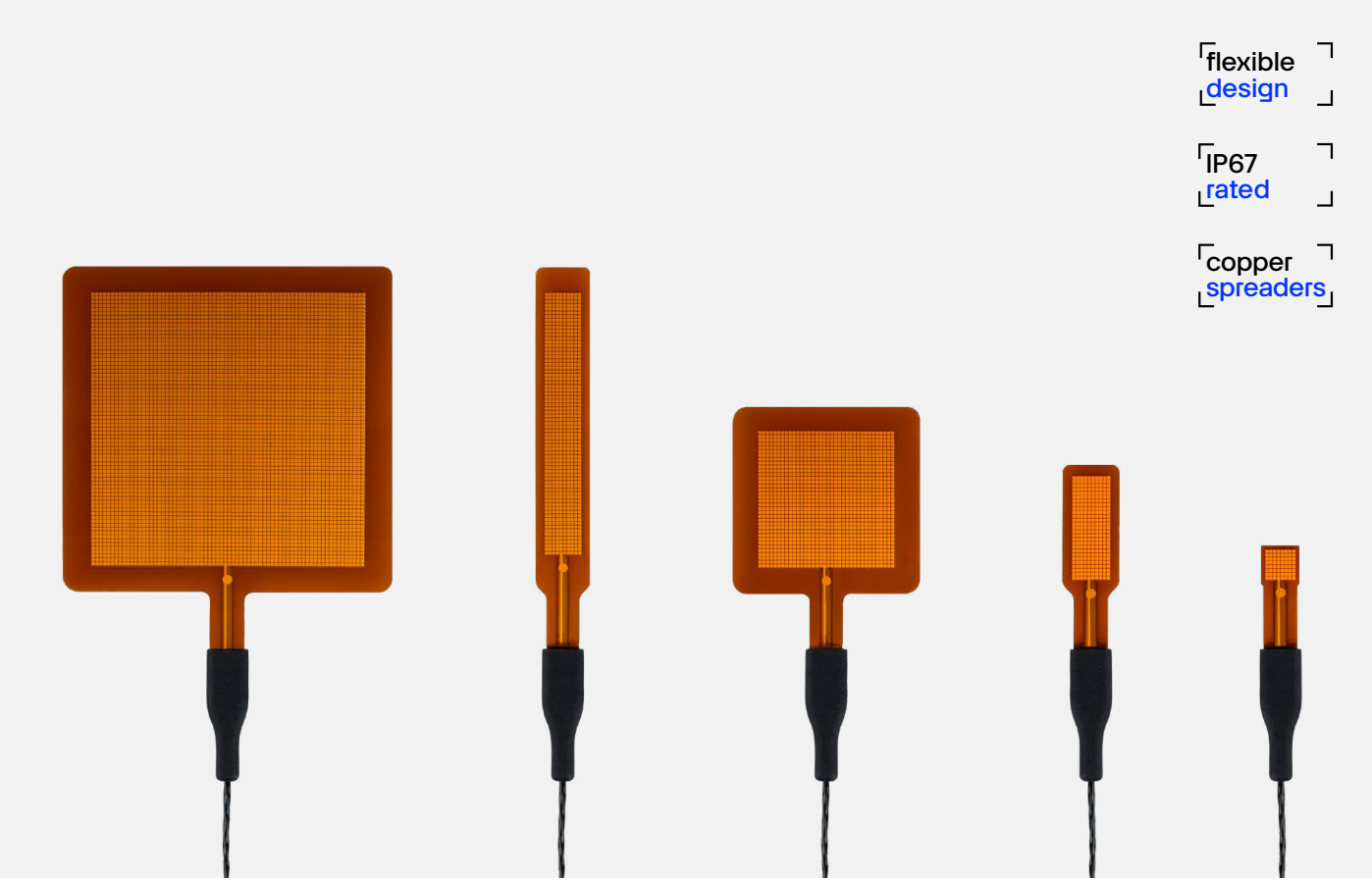

Figure 1 FHF05 series foil heat flux sensors with thermal spreaders: thin, flexible, and versatile. Models are available in five different dimensions and sensitivities.

FHF05 series: versatile and suitable for most heat flux measurement applications

FHF05 series heat flux sensors are suitable for general-purpose heat flux measurement. The series consists of sensor models with five different dimensions and sensitivities. 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 (in W/m^2) either through the object in which they are incorporated or on which they are mounted. Each sensor contains a thermopile that measures the temperature difference across FHF05's flexible body, which directly translates to heat flux. An integrated Type T thermocouple provides additional temperature measurement. Both the thermopile and thermocouple are passive sensors and do not require external power.

Multiple small thermal spreaders form a conductive layer covering the sensor, reducing the thermal conductivity dependence of the measurement. With these incorporated spreaders, the sensitivity of the FHF05 sensors is independent of the thermal properties of their environment.

Many competing sensors do not have thermal spreaders, so their sensitivity cannot be relied upon since it varies depending 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 connects directly to commonly used data logging systems. The heat flux (in W/m^2) is calculated by dividing FHF05's output, a small voltage, by the sensitivity, which is provided on its certificate.

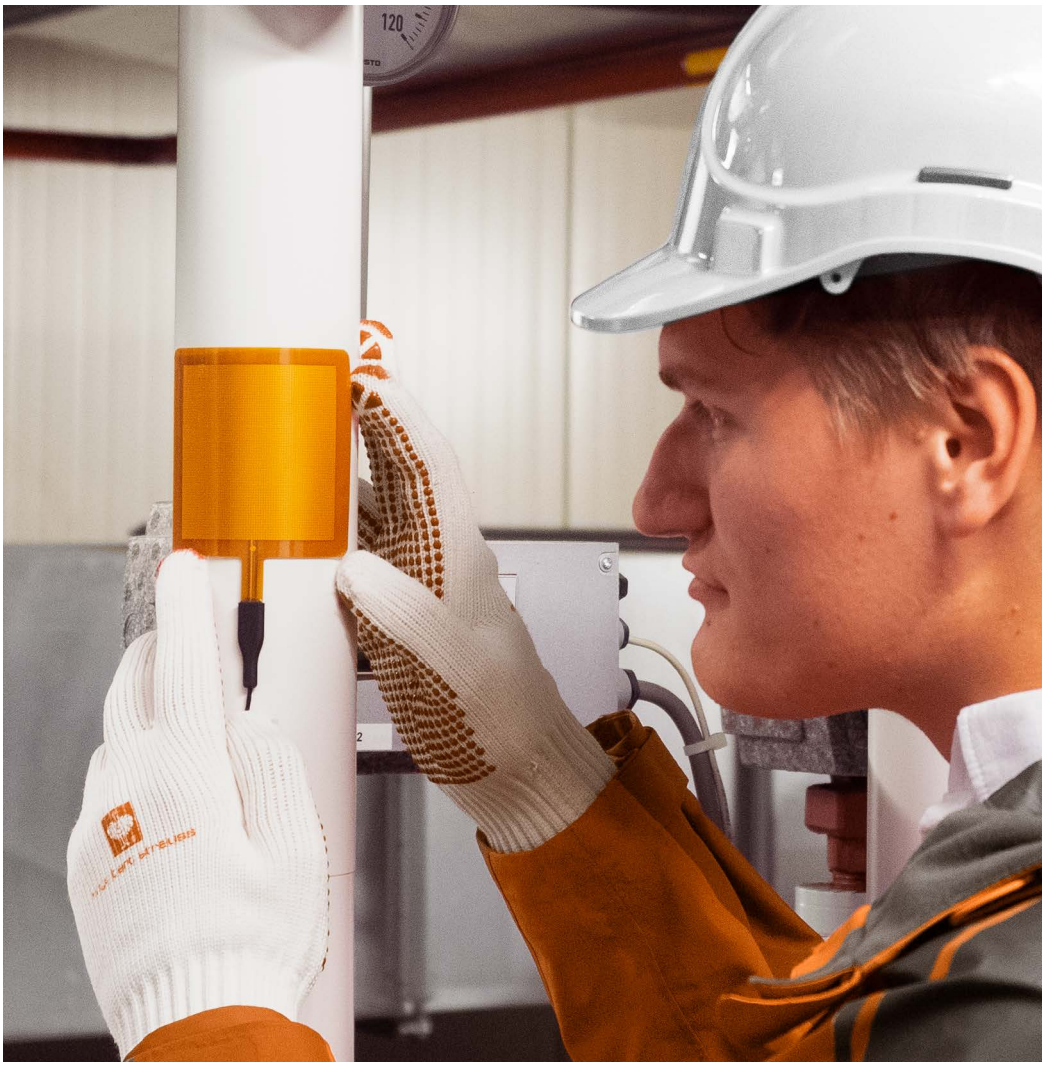

Figure 2 FHF05-85X85 being installed to measure heat flux on a pipe.

Robust and stable

FHF05 has proven to be very robust and stable. The instrument is equipped with a potted cable connection block that prevents moisture from entering and also serves as strain relief.

Unique features and benefits

– flexible (bending radius ≥ 7.5 x 10^{-3} m)
– low thermal resistance
– wide temperature range
– fast response time
– large guard area
– integrated Type T thermocouple
– robust design, including cable connection block for strain relief
– IP67 protection rating (essential for outdoor and humid environments)
– integrated thermal spreaders for low thermal conductivity dependence
– sensor foil only: may be used in vacuum environments

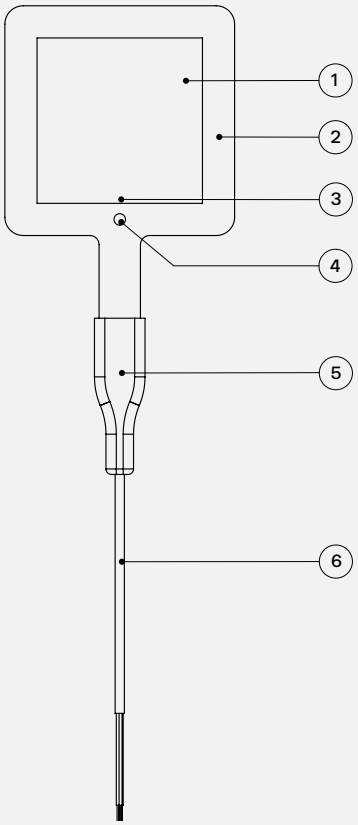

Figure 3 FHF05 heat flux sensor:
1. sensing area with thermal spreaders
2. passive guard
3. Type T thermocouple
4. dot indicating front side
5. cable connection block
6. cable, standard length is 2 m

Figure 4 The thin and flexible FHF05-15X85 can be easily mounted on a curved surface, like a pipe or tube.

Suggested use

FHF05 series 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 use, battery thermal management
– 15X85: wrapped around a pipe
– 85X85: low heat fluxes, insulation performance testing, use with low accuracy data loggers and amplifiers

Calibration

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

Working with heat flux sensors

Refer to the user manual for detailed directions

Installation

There are various ways to install a heat flux sensor. For more information, see our application note on how to install a heat flux sensor.

Options

– with 5 or 10 m cable lengths
– separate cable in 2, 5, or 10 m lengths
– sensor foil only (without wiring and without connection block)
– LI19 hand-held read-out unit/data logger
NOTE: LI19 measures heat flux only.
– BLK sticker for all models
(to measure both radiative and convective heat flux)
– GLD sticker for all models
(to measure convective heat flux only)
– BLK and GLD stickers can also be ordered pre-applied at the factory

Figure 6 Model FHF05-50X50 with BLK and GLD stickers for measuring insulation losses of a thermos.

BLK and GLD sticker series

Want to study energy transport/heat flux in more detail? Hukx helps take your measurement to the next level! Order FHF05 series with radiation-absorbing black and radiation-reflecting gold stickers. You can then use one sensor to measure convective + radiative flux and the other to measure convective flux only. Subtract the two measurements to obtain radiative flux.

Stickers are available for every sensor dimension. For instructions, see the BLK – GLD sticker series user manual and installation video.

Optionally, these stickers can be ordered pre-applied on FHF05 series sensors.

Suitable electronics

The combined measurement of heat flux and temperature provides a complete picture of the system's thermal behavior. Heat flux sensors produce 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 visualization. To learn more, view our application notes on sensor amplification or FHF sensors with Hioki data loggers.

Select your FHF model

FHF05 series sensors are available in 5 different sizes. The following 5-step guide helps you choose the right sensor and electronics for your application and environment. Selecting the right sensor–electronics combination helps reduce total system costs.

Sensors with larger dimensions have:
– a higher sensitivity
– a larger area over which the heat flux is averaged
– a higher price

Step 1

Familiarize yourself with heat flux measurement. Visit the Hukx YouTube channel:

– quick intro to heat flux (3 min)
– online course (40 min)
– separating radiation and convection (2 min)

Step 2

Verify that FHF05 series sensors are suitable for your heat flux measurement application and environment:
– Check if the heat flux is between -10 to +10 x 10^3 W/m^2.
– Confirm that the rated temperature range is below 120 °C.
– Verify other specifications in the user manual.

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

Step 3

Determine which 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 compatible:
– Estimate the output range of the heat flux sensor(s) in [x 10^{-6} V] using the sensitivities in the specifications table.
NOTE: Microvolt output range = heat flux range in [W/m²] x sensitivity in [x 10^{-6} V/(W/m²)].
– Check if your electronics accept analog voltage input.
– Confirm that the microvolt voltage measurement accuracy of your instruments is better than 1 % of the sensor output range. This ensures that the electronics are not the limiting factor in measurement accuracy. If your electronics lack sufficient accuracy, consider a larger sensor or connect the sensors in series to create a higher sensitivity.
– Verify 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 Hukx to review your measurement setup:

– Share your application details with us for feedback. Please include: the purpose of the measurement, heat flux source, heat flux sink, expected heat flux and temperature ranges, electronic devices used, and a sketch of the setup with specifications and dimensions.
– Consider alternatives: FHF05 series sensors may not be the best fit. We supply a wide range of heat flux sensor models optimized for various applications.

See also: FHF05SC

FHF05SC series are self-calibrating versions of the standard FHF05 models, paired with an HTR02 series heater. These 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
– Hukx offers a complete product range of heat flux sensors with the highest quality for any budget

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.

FHF05 series specifications

measurand	heat flux
measurand	temperature
temperature sensor	Type T thermocouple, IEC 60584-1 Class 2*
thermal spreaders	included
rated bending radius	≥ 7.5 x 10^{-3} m
rated load on cable	≤ 1.6 kg
outer dimensions (w x b) foil with guard	(10 x 10) x 10^{-3} m (15 x 30) x 10^{-3} m (50 x 50) x 10^{-3} m (15 x 85) x 10^{-3} m (85 x 85) x 10^{-3} m
sensor thermal resistance	11 x 10^{-4} K/(W/m^2)
sensor thickness	0.4 x 10^{-3} m
uncertainty of calibration	± 5 % (k = 2)
measurement range	(-10 to 10) x 10^{3} W/m^2
sensitivity (nominal) per model 10X10: 15X30: 50X50: 15X85: 85X85:	 1 x 10^{-6} V/(W/m^2) 3 x 10^{-6} V/(W/m^2) 13 x 10^{-6} V/(W/m^2) 7 x 10^{-6} V/(W/m^2) 50 x 10^{-6} V/(W/m^2)

asymmetry	< 2 %
rated operating temperature range continuous use: short intervals:	 -70 to +120 °C -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

* The temperature measurement uncertainty is ± 1 or 0.0075 × T °C. For details, see the user manual.

** When measuring at temperatures of -160 °C, contact Hukx.

*** 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 environments.

About Hukx

Hukx is the leading innovator in solar radiation and heat flux sensor technology. We are proud to set the standard in high-accuracy measurement, and to be working at the heart of the energy transition.

Customers worldwide rely on our bestselling pyranometers and heat flux sensors. From sensor design and selection to supply and recalibration, we support you across the entire lifecycle.

Hukx is headquartered in the Netherlands, with locally owned representative sales offices in the USA, Brazil, India, China, Southeast Asia, and Japan.

Let us help you select the best sensor for your application.
Get in touch with our experts today via: info@hukx.com

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