HFP01SC

Self-calibrating heat flux sensor™

HFP01SC self-calibrating heat flux sensor™ is a heat flux sensor for use in the soil. It offers the best available accuracy and quality assurance of the measurement. The on-line self-test verifies the stable performance and good thermal contact of sensors that are buried and cannot be visually inspected and taken to the laboratory for recalibration. The self-test also includes self-calibration which compensates for measurement errors caused by the thermal conductivity of the surrounding soil (which varies with soil moisture content), for sensor non-stability and for temperature dependence.

Figure 1 *HFP01SC self-calibrating heat flux sensor. The opposite side has a blue coloured cover.*

Figure 2 *HFP01SC is used in soil heat flux measurements in high-accuracy surface energy flux experiments*

Introduction

HFP01SC measures soil heat flux in W/m^2. It is used when the highest level of quality assurance and a high measurement accuracy are required. In essence, HFP01SC is a combination of a heat flux sensor and a film heater. The heat flux sensor output is a voltage signal that is proportional heat flux through the sensor. At a regular interval the film heater is activated to perform a self-test (see figure 4). The self-test results in a verification of sensor contact to the soil and in a new sensitivity that is valid for the circumstances at that moment. The latter is called self-calibration. Implicitly also cable connection, data acquisition and data processing are tested. The result is a much improved accuracy & quality assurance of the measurement relative to measurements with conventional sensors such as model HFP01.
Soil heat flux sensors are preferably left in the soil for as long as possible, so that the soil properties become representative of the local conditions. Using self-testing, the user no longer needs to take sensors to the laboratory to verify their stable performance. A typical measurement location is equipped with 2 or more sensors for good spatial averaging.

Unique features and benefits

- low thermal resistance
- large guard area (required by the ISO 9869 standard)
- low electrical resistance (low pickup of electrical noise)
- high sensitivity (good signal to noise ratio in low-flux environments)
- robustness, including a strong cable (essential for permanently installed sensors)
- IP protection class: IP67 (essential for outdoor application)
- incorporated film heater for self-testing

Suggested use

- high-accuracy scientific measurement of soil heat flux, with a high level of data quality assurance

Measurement and control

Requirements for data acquisition and control:

- for heat flux: one millivolt measurement
- for heater current: one current measurement (or voltage over a current sensing resistor)
- for switching the heater current on and off: one relay with 12 VDC nominal output

Calibration

HFP01SC calibration is traceable to international standards. The factory calibration method follows the recommended practice of ASTM C1130.

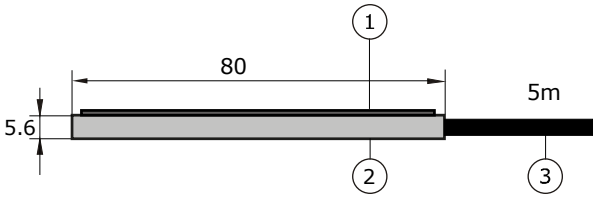

Figure 3 *HFP01SC self-calibrating heat flux plate: (1) film heater, (2) heat flux sensor plus passive guard, (3) 2 x cable, standard length is 5 m (optionally longer cable). Total sensor thickness including heater and covers is 5.6 x 10^{-3} m (6 x 10^{-3} m at cable exit from sensor). Dimensions in x 10^{-3} m.*

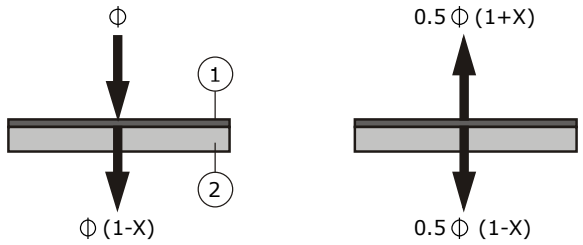

Figure 4 *Explanation of the self-calibration: on the left, the heat flux sensor (2) measures a soil heat flux Φ. This flux is subject to a measurement error - X, the deflection error which depends on the thermal conductivity of the soil compared to that of the sensor and its thermal contact to the soil. On the right, during the self-test the film heater (1) is switched on to generate a known electrically generated heat flux. As a first approximation, the division of the total heat flux between downward flux through the sensor and upward flux contains the same (1-X) term that also characterises the deflection error. The signal level during the self-test, multiplied by 2, is used for self-calibration. The newly measured sensitivity compensates for the deflection error, and also for temperature dependence of the sensitivity and non-stability of the sensor.*

HFP01SC specifications

Measurand	heat flux
On-line functionality testing	self-test including self-calibration
Sensing area	8 x 10^{-4} m^2
Sensor thermal resistance	81 x 10^{-4} K/(W/m^2)
Measurement range	-2000 to 2000 W/m^2
Sensitivity (nominal)	60 x 10^{-6} V/(W/m^2)
Rated operating temperature range	-30 to +70 °C
IP protection class	IP67
Film heater resistance	100 Ω ± 10 %
Film heater rated power supply	9 to 15 VDC
Interval between self-tests	6 hr
Heating interval duration	180 s
Power consumption daily average	0.02 W
Standard cable length	2 x 5 m
Options	longer cable length (10, 15, 20, 30, 40 m)

Options

- longer cable (2 x), in multiples of 5 m, cable lengths above 20 m in multiples of 10 m

See also

- in case a less accurate measurement is sufficient, consider model HFP01
- view our complete range of heat flux sensors

About Hukseflux

Hukseflux Thermal Sensors offers measurement solutions for the most challenging applications. We design and supply sensors as well as test & measuring systems, and offer related services such as engineering and consultancy. With our laboratory facilities, we provide testing services including material characterisation and calibration. Our main area of expertise is measurement of heat transfer and thermal quantities such as solar radiation, heat flux and thermal conductivity. Hukseflux is ISO 9001:2008 certified. Hukseflux sensors, systems and services are offered worldwide via our office in Delft, the Netherlands and local distributors.

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