

STP01

Soil temperature profile sensor with self-test

STP01 accurately measures the temperature profile of the soil at 5 depths close to its surface. It is used for scientific grade surface energy balance measurements. The sensor is buried and usually cannot be taken to the laboratory for calibration. The on-line self-test using the incorporated heating wire offers a solution to verify STP01's measurement stability.



Figure 1 STP01 soil temperature profile sensor is applied in many large scale networks.



Figure 2 STP01 is often used in meteorological surface energy flux measurement stations

Introduction

STP01 soil temperature profile sensor offers an accurate temperature difference measurement at five measurement locations at 0.02 , 0.05, 0.1, 0.2 and 0.5 m below the soil surface. It also has a well specified and fixed distance between the measurement locations. STP01 contains 5 matched thermocouples, at locations A to E in figure 5, and one reference temperature sensor (Pt100 type) at location E at 0.5 m depth. By having the reference temperature measurement in the sensor and only measuring differential thermocouple voltages (relative to the reference at 0.5 m), the uncertainty of the temperature difference measurement is very low: ± 0.02 °C is attainable. Simple copper-conductor signal wire is used in STP01's cable. As an extra, a heating wire is incorporated in STP01. Analysis of the temperature change during the heating interval serves as a self-test. Soil temperature sensors are preferably left in the soil for as long as possible, so that the soil properties become representative of natural conditions. Using self-testing, the user no longer needs to take sensors to the laboratory to verify their stable performance. The result is a much improved accuracy & quality assurance of the measurement relative to measurements with conventional sensor types.

Suggested use

- high accuracy, scientific grade measurement of the soil energy balance, with a high level of data quality assurance

Reference users

The Centre for Ecology and Hydrology (CEH) of the UK included NR01, STP01 and HFP01SC in its new (2014) measurement network.

NOTE: the fact that a sensor is used in a network does not constitute a formal endorsement by the network owner.

STP01 advantages

- high accuracy, scientific measurement of soil energy balance, with a high level of data quality assurance
- high accuracy K/m temperature gradient measurement by accurate positioning of the thermocouple joints (± 0.001 m), and accurate temperature difference measurement (± 0.05 K)
- high accuracy and stability of the relative distance between sensors (± 0.0005 m)
- thin, 0.6×10^{-3} m thickness, construction which leaves the soil structure intact
- simple copper-core signal wire; no special connectors needed
- self-test saves servicing time

Measurement and control

Requirements for data acquisition and control are:

- for temperature measurement: four millivolt measurements, one Pt100 measurement
- for the optional self-test: one heater voltage measurement
- for the optional self-test: one relay with 12 VDC nominal output, switching the heater current on and off

Self-testing

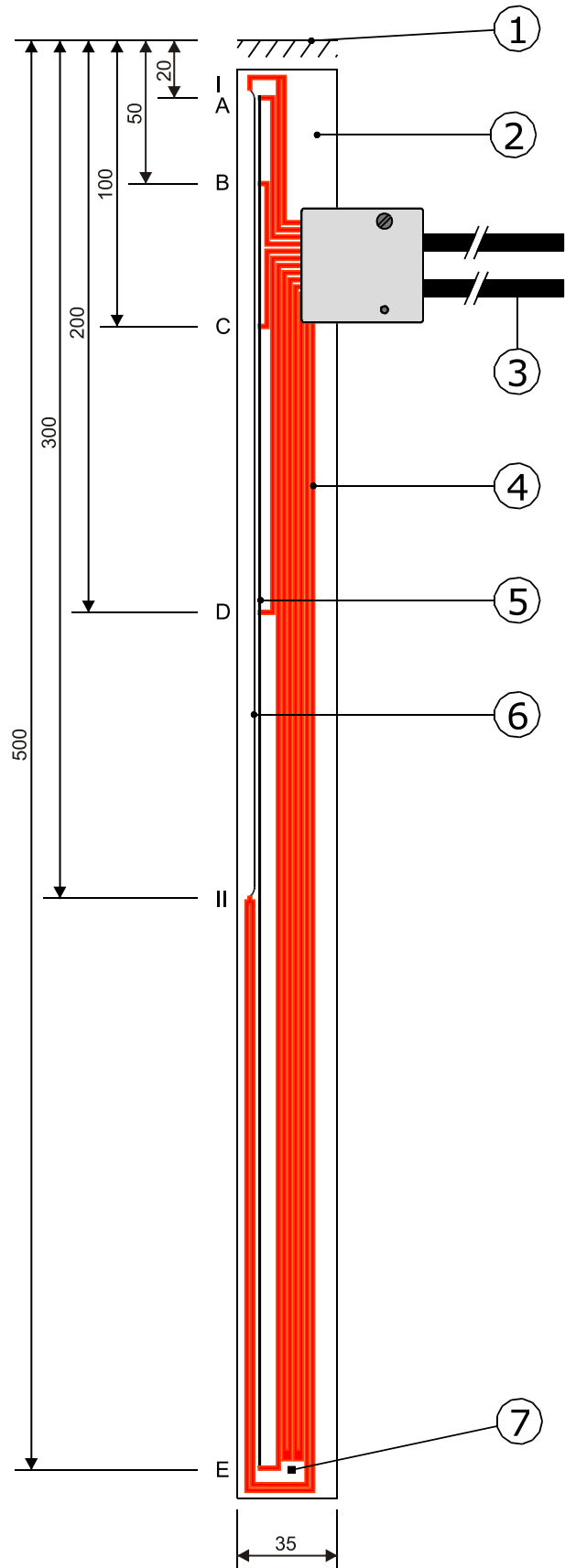
When activating the heater for a self-test, this will lead to a local increase in temperature at the sensors at 0.02, 0.05, 0.1 and 0.2 m depth. The STP01 stability is monitored by analysis of yearly patterns of this step-response.

Datalogger compatibility

Sensors made by Hukseflux are designed for compatibility with the most commonly used datalogger models. For many models we have example programs and wiring diagrams available.

Figure 3 STP01 layout and dimensions

- 1 soil surface
 - 2 sensor foil (0.6×10^{-3} m thickness, 2.5×10^{-3} m at Pt 100)
 - 3 2 x cable 5 m (see options)
 - 4 copper leads
 - 5 T type thermocouple wire
 - 6 CuNi heater wire
 - 7 Pt100 reference temperature sensor (4-wire connection)
- I and II: connection points of the heating wire (4-wire connection)
A, B, C, D and E: thermocouple type T joints
Dimensions in $\times 10^{-3}$ m.



Experimental use: soil thermal conductivity measurement

The step response of the temperature during the self-test can be used to measure the soil thermal conductivity at 3 depths; 0.05, 0.1 and 0.2 m. For more background on this measurement method, see the manual of model TP02 thermal needle. The possibility to perform this thermal conductivity measurement is an option, with an unspecified measurement accuracy.

Installation

For ease of installation with a minimum of disturbance of the local soil, Hukseflux offers IT01 insertion tool.



Figure 3 IT01 insertion tool is hammered down into the soil. After retracting it leaves a slit in which STP01 may be inserted



Figure 4 STP01 is often used in combination with HFP01SC self-calibrating heat flux sensor, shown in the picture

See also

- model TP01 soil thermal properties sensor
- soil heat flux sensors HFP01 and HFP01SC
- view our complete product range of surface energy flux measurement products
- view our range of radiometers

STP01 specifications

Measurand	temperature at 5 depths from 0 to 0.5 m
Temperature sensors	matched thermocouples type T
Uncertainty of temperature difference measurement	1.5 % of measured value plus measurement system uncertainty in $\times 10^{-6}$ V/40
Uncertainty of relative position	± 0.001 m
Rated operating environment	surrounded by soil
On-line functionality testing	self-test using the incorporated heater
Reference temperature sensor	Pt100, IEC 751:1983 class B
Sensor foil thickness	0.6×10^{-3} m 2.5×10^{-3} m at Pt100
Measurement depths	0.02, 0.05, 0.1, 0.2 and 0.5 m
Measurement range	-30 to +70 °C
Standard cable length (2 cables)	5 m (see options)
IP protection class	IP67
Optional non-traceable measurand	thermal conductivity at 3 depths

Heater specifications

Heater resistance (nominal)	200 Ω
Heater rated power supply	9 to 15 VDC
Power consumption daily average	0.005 W
Interval between self-tests	24 hr
Self-test duration	600 s
Order code	STP01/ cable length in m

Options

- longer cable (2 x), in multiples of 5 m, cable lengths above 20 m in multiples of 10 m
- insertion tool IT01

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. Hukseflux sensors, systems and services are offered worldwide via our office in Delft, the Netherlands and local distributors.

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