

TP01

THERMAL PROPERTIES SENSOR

The TP01 is a sensor for the long-term monitoring of soil thermal conductivity, thermal diffusivity and heat capacity.

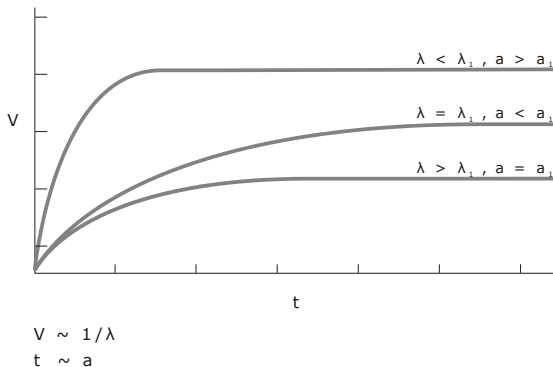
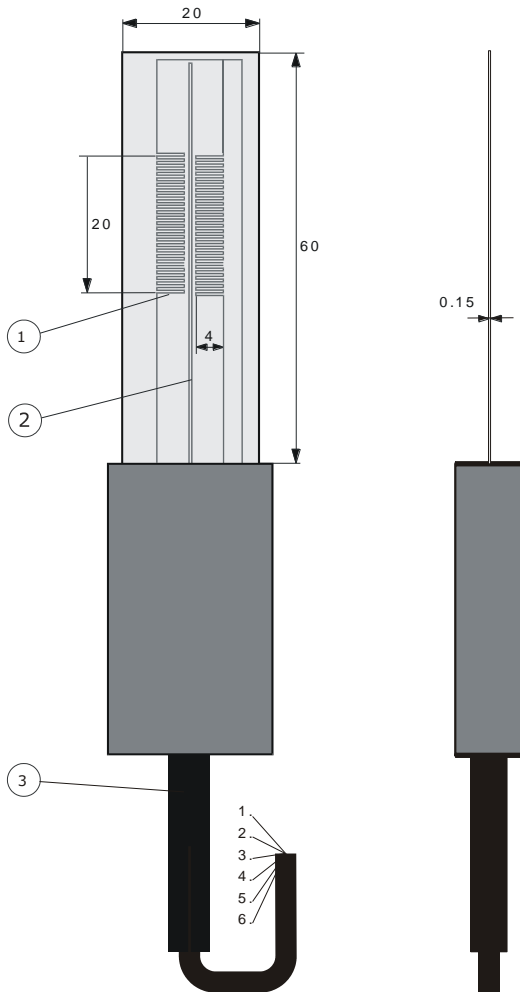


Figure 1 above: TP01 sensor: thermopiles (1), heating wire (2), cable (3). Dimensions in mm. below: graphs in different soil types: signal amplitude varies with $1/\lambda$, signal response time varies with a . All dimensions are in mm.

TP01 is designed for long term (permanent) installation in soils. It covers the the thermal conductivity (λ) range of 0.3 to 5 W/m.K, which is sufficient for most anorganic soil types. The core of TP01 is a differential temperature sensor (2 thermopiles) (1) measuring the radial differential temperature with record breaking sensitivity. The sensor performs a temperature measurement around a heating wire (2). Both heating wire and sensor are incorporated in a very thin plastic foil. The low thermal mass makes it suitable for estimating thermal diffusivity (a). Dividing λ by the thermal diffusivity, a , gives the volumetric heat capacity C_v , which varies with water content. The thermopile signal minus the initial offset ($U - U_0$) when heating with power Q depends on λ and a of the medium.

$$U - U_0 = (E_\lambda Q / \lambda) F(a t)$$

E_λ is a calibration constant, t is time, F is a function that equals 1 for large at . By looking at the steady state signal amplitude λ can be determined. C_v and a can be found by looking at the 63% response time for F . The detection of changes in C_v (and water content) is the strong point of TP01; the resolution is much better than the accuracy. The product manual can be obtained via e-mail. Programs for use with the Campbell Scientific CR10X and CR1000 are available. Hukseflux has a broad product range of sensors for thermal conductivity measurement; please consult the product catalogue. See also needle type probes: TP02 and TP08.

SUGGESTED USE

Scientific study of the heat storage as part of the surface energy balance
Redundancy for soil moisture content

TP01 SPECIFICATIONS

Temperature range:	-30 to +80 °C
Sensor thickness (nominal):	0.15 mm
Required readout:	2 diff voltage channels 1 V , 5 mV range
Voltage input (nominal):	1-2 VDC
Typical heating cycle duration:	± 3 min at 0.05 W
Range λ :	0.3 to 5 W/m.K
Measurement accuracy λ :	+/- 5%
Measurement accuracy a :	+/- 20 %
Measurement accuracy C_v :	λ / a
Measurement resolution C_v :	10%
Heating power / m (nominal):	0.8 W/m