



## STP01

### SOIL TEMPERATURE PROFILE (& THERMAL CONDUCTIVITY\*) SENSOR WITH SELF-TEST

The STP01 is a sensor for very accurate measurement of temperature versus depth (also called "temperature gradient") in the soil. A heating wire offers the possibility of self-testing, increasing the level of quality assurance. An experimental option is to determine soil thermal conductivity as a function of depth.

#### INTRODUCTION

The measurement of soil temperature profiles has many applications, particularly in determining soil energy balance. STP01 contains 5 thermocouples, tc, (at 2, 5, 10, 20 and 50 cm depth, A to E) and one reference Pt100 temperature sensor (at 50 cm, E). The key item in the design is the central copper-nickel (CuNi) wire (5). By having the reference tc junction in the sensor and only measuring differential tc voltages (relative to the reference tc junction at 50 cm), the gradient accuracy is record breaking (down to +/- 0.02 degrees C) and cabling can be simple all copper (Cu) wire. As an extra, there is a heating wire incorporated (6) from I to II. The reaction of the tc's to sudden heating (tc pulse response) is a test for sensor performance in the inaccessible environment.

Figure 1 Layout of STP01

- 1 soil surface
- 2 sensor foil (0.6 mm thickness, 2.5 at Pt 100)
- 3 cables (5 m), extendable
- 4 copper leads
- 5 constantan wire for thermocouples
- 6 constantan wire for heater
- 7 Pt 100 (4 wire connection)
- I and II: end of heating wire (2 times 2 wire connection) A, B, C, D and E: tc junctions

#### Wiring schedule:

- 1 heater power
- 2 heater measure
- 3 thermocouple 2 cm
- 4 thermocouple 5 cm
- 5 thermocouple 10 cm
- 6 thermocouple 20 cm
- 7 thermocouple 50 cm
- 8 Pt100 +
- 9 Pt100 +
- 10 Pt100 -
- 11 Pt100 -
- 12 heater power
- 13 heater measure

All dimensions are in mm.

## STP01 ADVANTAGES

The STP01 has several advantages over existing designs:

- high accuracy gradient measurement by accurate positioning of the tc joints (+/- 1mm), and measurement of tc voltage relative to the junction at 50 cm (+/- 0.02 K is achievable)
- high accuracy and stability of the relative distance between sensors (+/- 0.5 mm)
- thin, 0.6 mm only, (non disturbing) construction (contrary to conventional stick designs) does not disturb the thermal flow pattern
- sensor to logger cabling is all copper; easily extendable.
- easy quality assurance & servicing: self-test is possible by heating and looking at the pulse response, saving servicing time.

## \*EXPERIMENTAL USE: SOIL THERMAL CONDUCTIVITY MEASUREMENT

When using the heater, the tc pulse response can be used to calculate soil thermal conductivity at 3 depths; 5, 10 and 20 cm. The well established thermal needle or non-steady-state probe technique is applicable. For more theory on this method, see ask for the Hukseflux TP02 manual. ( $T = A \cdot \ln(t) + B$ , with T temperature, t time, A a function of geometry, power and thermal conductivity). The possibility to perform this measurement is an experimental option and the measurement accuracy is not specified by Hukseflux.

## DATA ACQUISITION AND CONTROL

Solutions for measurement and control: See the STP01 manual or inquire at Hukseflux. Example programs for Campbell Scientific CR10X and CR1000 are available.

## MANUALS

The STP01 manual is available free of charge as a PDF file via e-mail.

## SUGGESTED USE

- scientific grade measurement of soil temperature
- soil temperature gradient measurement
- energy balance & heat flux determination

## STP01 SPECIFICATIONS

### SENSOR SPECIFICATIONS

Thermocouples, tc:	Cu-CuNi, type T
Temperature range:	-30 to +70 °C
Depths below soil surface:	20, 50, 100, 200 & 500 +/- 1 mm
Reference junction:	Pt100 DIN class B
Thickness (nominal):	0.6 mm (2.5 at Pt100)
Required readout:	4 diff volt, 1 common ground, Pt100-4 or 3 wire

### HEATER SPECIFICATIONS

Resistance (nominal):	200 Ω
Voltage input	9-15 VDC
Duration of the self test:	± 10 min at 0.3 Watt
Average power consumption	0.05 Watt
Required readout:	1 diff volt
Self-test recommendation:	once every 3 hours, at least every 24 hours

### OPTIONS

Extended cable x meter (added to the standard length of 5 m)  
Insertion tool IT01  
See also model ST01