Hukseflux
Thermal Sensors

FTN01

FIELD THERMAL NEEDLE SYSTEM FOR THERMAL RESISTIVITY/ CONDUCTIVITY MEASUREMENT

The FTN01 Field Thermal Needle System allows performing fast, on-site measurements of the thermal resistivity or conductivity of soils, in particular around the typical depth of burial of high voltage cables. FTN01 is designed with a focus on robustness and saving time, while still offering sufficient accuracy for typical field measurements. The sensor is a Non-Steady-State Probe (NSSP), TP09, which is mounted at the tip of the Lance LN01. The system is operated using a hand-held Control and Readout Unit CRU01.

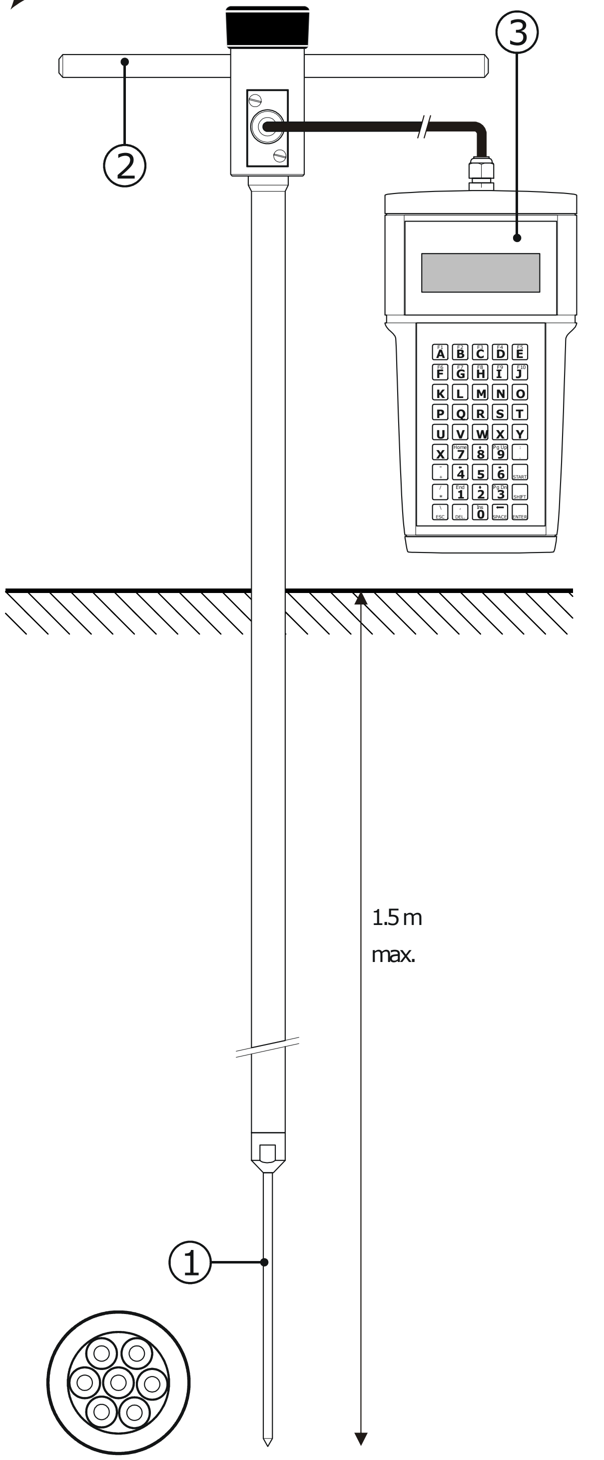

Figure 1 *FTN01 in operation. The Non-Steady-State Probe TP09 (1), mounted at the tip of the Lance, LN01 (2), is inserted into the soil. The user performs control and read out of the experiment from the CRU01 (3), using its keyboard and LCD. The CRU01 contains a rechargeable battery pack for powering the TP09. The measurement result is immediately generated.*

INTRODUCTION

The measurement method is based on the so-called Non-Steady-State Probe (NSSP) technique, which uses a probe (also called thermal properties sensor or thermal needle) in which both a heating wire and a temperature sensor are incorporated. The probe is inserted into the soil. From the response to a heating step the thermal resistivity (or the inverse value, the conductivity) of the soil can be calculated. The measurement with FTN complies with the IEEE Guide for Soil Thermal Resistivity Measurements (IEEE Standard 442-1981) as well as with ASTM D 5334-00 Standard Test Method for Determination of Thermal Conductivity of Soil and Soft Rock. The main application of FTN is route surveying for high voltage electric power cables and for heated pipelines.

In general a NSSP consists of a heating wire, representing a perfect line source, and a temperature sensor capable of measuring the temperature at this source. The probe is inserted into the soil that is investigated. The NSSP principle relies on a unique property of a line source: after a short transient period the temperature rise, ΔT, only depends on heater power, Q, and medium thermal conductivity, λ:

$$\Delta T = (Q / 4 \pi \lambda) (\ln t + B)$$

With ΔT in K, Q in W/m, λ in W/mK, t the time in s and B a constant. By measuring the heater power, and tracing the temperature in time (for FTN typically during 5 minutes), λ can be calculated.

FTN DESIGN

Suitability for field surveys: FTN01's primary focus has been on the capability to perform field measurements. This implies that it is able to perform measurements without external power source and that the system is sufficiently robust to survive manual insertion into most common soils. The system runs as a stand-alone unit, powered by the batteries in the CRU. Recharging can be done by a 12VDC source or a car battery using the CA01 car adapter, or on 220/110 VAC using the WSA01 wall socket adapter.

Saving time: Many cables and pipelines are buried at a depth of around 1.5 m. The long lance, LN01, 1.5 m, serves to avoid the necessity to dig a large access hole. In general a small-diameter hole is drilled to a depth just above the required depth of measurement (generally using a ground drill). After this the lance LN01 is inserted. The probe TP09 itself (17 cm long at the tip of LN01) is then brought down (hammered or by manual force) into the undisturbed soil.

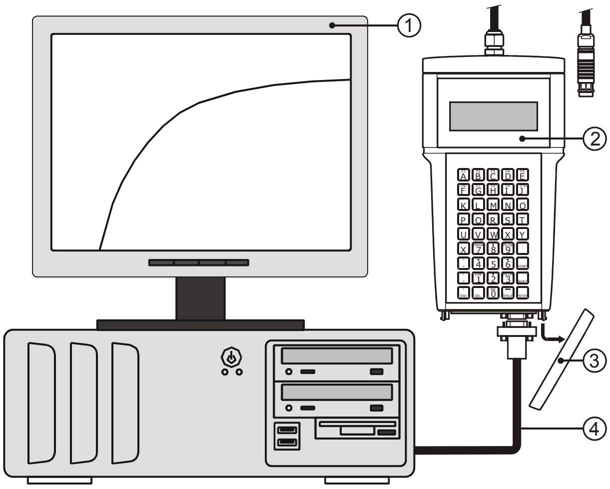

Figure 2 *For additional quality insurance, the data of the measurements can be stored and downloaded to the PC, and reviewed using the CRU01 software (1). The CRU (2) can be connected to the PC by removing a cover (3) and using a RS232 connection (4). Visual data review is required by ASTM. The PC is not included.*

Automatic processing: CRU01 automatically processes the measurement data, and gives both an end-result and a quality indication of the measurement. CRU01 can archive 30 measurements. In case of review, the end result is preferably checked and recalculated by analysis of the measured data in a spreadsheet (like EXCEL) or a mathematical program.

Local calibration: verification of the stability of the total system can be done by repeated testing in glycerol. This test can also be performed in the field.

NEW!

For high accuracy calibration CRC Calibration Reference Cylinders are available.

SUGGESTED USE

- Route surveys
- Studies of soils and soft rock

MORE INFORMATION / OPTIONS

Alternative designs: Hukseflux is specialised in NSSP design. Alternative models, for instance for laboratory use, are available at Hukseflux.
It is suggested to also consult the brochures of complementary systems MTN and TNS, as well as TPSYS, which is more accurate but has less robust needles.

FTN01 SPECIFICATIONS

Test method:	ASTM D 5334-00 and IEEE Standard 442-1981
Data analysis:	First analysis by CRU, second review of stored data on PC (as required by ASTM)
Range (λ):	0.1 to 6 W/m.K (all known soils)
Temperature range TP:	-30 to +80 °C
Temperature range CRU:	0 to +50 °C
Accuracy (@ 20 °C):	+/- (6% + 0.04) W/mK
Measurement cycle duration:	300 s (typical)
Power requirements:	Recharging: 12V, 2 Watt (max) normally from a car battery.
Data storage:	>30 measurements
Length LN, TP:	1.5m, 0.17m
CE certification:	Complies with CE directives
Software:	Included, new software can be downloaded through RS232
Data communication:	RS232 serial port
ISO requirements:	Suitable for use by ISO certified labs