Temperature

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Soil Temperature Sensor (T-Soil)

User Manual

Version 2020

1. Introduction

Thank you for purchasing the Ecomatik Soil Temperature (T-Soil). The T-Soil sensor is a robust and highly precise soil probe for the continuous measurements of soil, or water temperature.

This manual is written to help you install and operate your T-Soil sensor without difficulty and to achieve the most desirable results. Please read it carefully before installing the sensor, and refer back to it if you should have any difficulty with the sensor in the future.

The T-Soil is the sensor part of the measuring system. This means that the T-Soil sensor must be installed into the soil or underwater, and connected to a data logger for continuous data recording. The T-Soil sensor is compatible with a range of available data loggers.

2. Product Description

As shown below, a standard version of the T-Soil sensor consists of:

- 1x Sensor with pluggable 5 m cable. The cable length can be extended up to max. 50 m.

T-Soil sensor

The sensor can be ordered in standard configuration, or with cable extension:

- Standard cable length: 5 m
- Optional extensions instead of the standard 5 m length are 10 m, 15 m, 20m

3. Installation & Safety Information

Important!

Please avoid any tension between the sensor, sensor cable and data logger. The installation must be strain relieved on both sides, sensor and data logger. Pay attention to connect the sensor wires correctly to the data logger. Wrong connections will provide wrong readings.

Installation

1. Dig a small hole in the ground to the desired installation depth of the sensor.
2. Insert the sensor into the installation hole and carefully insert the metal tip 1-2 cm into the wall at the bottom of the installation hole.

3. Put about 30 cm of additional cable in the installation hole, so that the sensor is free of any pulling force.
4. Refill the installation hole with the excavated material.
5. Strain relieve the sensor cable coming out of the soil as close as possible to the installation position, e.g. on a peg firmly hammered into the ground.

You need further assistance?

In case you need further assistance for installation, please do not hesitate to contact us.

4. Wiring and Logger Configuration

The T-Soil sensor is compatible with our DL 18 data logger (ordered with stereo plug), as well as with a wide range of other available data loggers, e.g. CR1000(ordered with bare cable ends). However, note that suitable loggers have to provide a precise and stable, switched (sensor should only be powered 100ms before and during measurements) excitation voltage (V_{ex}) of usually 2500 mV.

Connecting the sensor with bare cable ends, e.g. to a CR1000 logger:

The sensor can be connected either in differential (wiring diagram a), or in single-ended (wiring diagram b) mode.

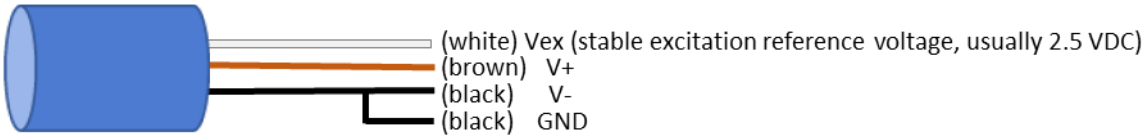

Figure A: Differential wiring

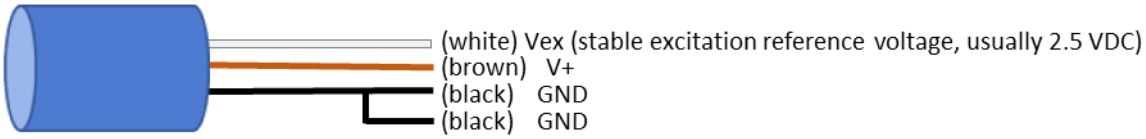

Figure B: Single-ended wiring

Wiring Examples:

Campbell Data Logger (CR1000)

This section describes how to connect the T-Soil sensor to the widely used Campbell data logger CR1000. If you use another data logger, contact us in case you need further assistance. The T-Soil sensor can be connected in differential voltage as well as in single-ended voltage mode, measurement range must be set to 2500 mV. One CR1000 can record up to eight T-Soil sensors in differential mode, or sixteen T-Soil sensors in single-ended mode.

Differential Voltage Mode T-Soil sensor

Connection			
Cable Color			Input Port
1st T-Soil sensor	$V_{T\text{-}Soil}$	White	Vx1
		Brown	1H
		Black	1L and Signal Ground
Program Syntax (exemplifying one sensor, with conversion of raw voltage signal in °C) *VoltDiff(T_Soil,1,mV2500,2,True,0,_50Hz,1,0)* *T_Soil=(2500-T_Soil)/T_Air*20000* *T_Soil=1/(0,001130756+0,000233897*LN(T_Soil)+0,000000088*LN(T_Soil)^3)-273.15*			

DL 18 data logger

Ordered with stereo plug connector, the T-Soil is compatible with our DL 18 data logger. Each T-Soil sensor requires one of the four channels of the DL 18. For further information on DL 18 configuration for T-Soil sensors, please refer to our DL18 manual.

Configured correctly, sensor signals will be stored in V. Values in °C can be calculated from stored measurement values as described in the following section (Excel program for data calculation available on request).

5. Manual Data Calculation

In case that the used logger does not support complex conversion procedures of the raw measurement values, stored values have to be converted manually after data download from the logger (e.g. DL 18 logger).

The following function applies to convert the analog output signal of the T-Soil sensor from V into Ω:

$R_{ntc}=(V_{ex}-V_{out})/V_{out}*20000$

where:

R_{ntc}: NTC sensor resistance in Ω corresponding to the respective mV measurement signal

V_{ex}: excitation Voltage in V (e.g. for DL 18 logger V_{ex} = 2.5 V)

V_{out}: measured sensor output signal in V, ranging between 0 and V_{ex}

The following function applies to convert the analog output signal from Ω into °C:

T (°C)= 1/(a + b(Ln R_{ntc}) + c(Ln R_{ntc})^3)-273.15 (Steinhart-Hart equation)

where:

T: temperature in °C R_{ntc}: sensor resistance in Ω at temperature T

a: coefficient = 1.13075635 E-03

b: coefficient = 2.33896902 E-04

c: coefficient = 8.82996895 E-08

6. Technical Specifications

Name	T-Soil
Application	Soil temperature
Range of the sensor	-40 to 70°C
Accuracy	+/- 0.2 °C
Resolution	Theoretically infinite, depends on data logger
Size and weight	Cylindric, length 50 mm, diameter 6mm, 5g (only sensor tip without cable)
Output signal type	Within below specified operating conditions: voltage between 333 to 2300 mV, when supplying the sensor with 2500 mV
Power supply	Excitation voltage Vex usually switched 2500 mV, power up 100ms max. Power consumption negligible.
Operating conditions	Temperature: -40 to 70 °C