TEKBOX
DIGITAL SOLUTIONS

SDI-12 Soil Temperature Sensor 3 depth levels

TBSST04 is a soil temperature sensor with SDI-12 interface. It allows measuring the temperature on 3 different depth levels (up to 3 meters for each segment). The product is available in 3 variants, with one, two or three temperature sensors that are based on Swiss made PT1000 with 0.1 ℃ accuracy.

The sensor is used to monitor the soil temperature and for specific applications like compost temperature monitoring where this parameter is critical to prevent sudden fire.

TBSST04 3 depth levels

TBSST04 single depth level

Features

- Soil and compost temperature sensor
- Measures temperatures on 3 levels.
- Each segment length: up to 3 m
- Probe length: up to 9 m
- Customizable probe length
- SDI-12 Standard V1.4
- 6 - 16V supply voltage
- Less than 80µA idle current
- Temperature accuracy: 0.1 ℃

- Temperature resolution: 3 digits
- Dimensions: 118x13x13 cm
- Weight: 2.1 kg
- Operating Temperature Range:
  - 40°C … + 80°C

Target Applications

- Soil temperature monitoring
- Compost temperature monitoring

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1   Introduction

The TBSST04 is a rugged soil temperature probe with SDI-12 interface.

It is made of high grade Pt1000 sensors and the electronic parts are mounted inside an UV resistant resin/glass fiber fabrics reinforced tubes. The interior of the tube is potted with silicon for enhanced durability.

2   Measurement

The TBSST04 outputs the temperature for 3 different depth levels.

Supported measurement commands:

aM!	aMC!	aC!	aCC!	**Temperature first depth level**
aM1!	aMC1!	aC1!	aCC1!	**Temperature second depth level**
aM2!	aMC2!	aC2!	aCC2!	**Temperature third depth level**
aM3!	aMC3!	aC3!	aCC3!	**Temperature for each depth level**

Supported SDI-12 v1.4 commands: metadata commands

aIM!	aIMC!	aIC!	aICC!	**Identify Measurement Commands**
aIM1!	aIMC1!	aIC1!	aICC1!	**Identify Measurement Commands**
aIM2!	aIMC2!	aIC2!	aICC2!	**Identify Measurement Commands**
aIM3!	aIMC3!	aIC3!	aICC3!	**Identify Measurement Commands**

aIM_001!	aIMC_001!	aIC_001!	aICC_001!	**Identify Measurement Parameter (1st)**
aIM1_001!	aIMC1_001!	aIC1_001!	aICC1_001!	**Identify Measurement Parameter (1st)**
aIM2_001!	aIMC2_001!	aIC2_001!	aICC2_001!	**Identify Measurement Parameter (1st)**
aIM3_001!	aIMC3_001!	aIC3_001!	aICC3_001!	**Identify Measurement Parameter (1st)**
aIM3_002!	aIMC3_002!	aIC3_002!	aICC3_002!	**Identify Measurement Parameter (2nd)**
aIM3_003!	aIMC3_003!	aIC3_003!	aICC3_003!	**Identify Measurement Parameter (3rd)**

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Extended SDI-12 commands:

aXSNnnnnnn!   **Set serial number**
where nnnnnn: 6 digits serial number

aX0n!   **Calibration at zero degree**
where: n=1,2,3 is the depth level index

aXTn,ff.ff!   **Calibration at ambient temperature**
where: n=1,2,3 is the depth level index,
ff.ff the ambient temperature

aXSTUF!   **Set temperature unit to degree Fahrenheit**

aXSTUC!   **Set temperature unit to degree Celcius**

3   Product Specification

- 3 high grade Pt1000 sensors
    - Extremely short response time
    - Low heat transfer, vibration resistant
    - Long term stability: maximum drift=0.03% after 1000h at 600℃
    - -200 / + 600℃
- UV resistant resin/glass fiber fabrics reinforced tube
    - 18 mm outer diameter
    - 3.5 mm wall thickness
    - Potted with silicon
- Segment length of the profile probe can be fully customized up to a maximum segment length of 3 meters (maximum probe size is 9 meters).
- SDI-12 Standard V1.4
- 6 - 16V supply voltage
- Temperature accuracy: 0.1 ℃
- Temperature resolution: 3 digits
- Operating Temperature Range: - 40°C … + 80°C
- Weight and dimensions: variable depending on the tube length.
    - For 1m probe and 1 depth level: 118x13x13 cm, 2.1 kg
- Current consumption: active 15mA; idle 80µA
- Standard cable length: 3m; any other length upon requirement

4   Calibration

TBSST04 is factory calibrated by inserting a 1kΩ resistor in lieu of Pt1000 sensor (which is equivalent to a zero degree Celcius calibration).

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However user calibration is also possible by setting the actual temperature for a given depth level based on a reference through aXTn,ff.ff! SDI-12 command.

Examples:

- aXT1,-03.546! => calibrates depth level 1 with temperature -3.546 degrees Celcius

- aXT3,+28.925! => calibrates depth level 3 with temperature +28.925 degrees Celcius

5   Installation

TBSST04 is compatible with any data logger or remote telemetry unit with SDI-12 interface (v1.3 or v1.4).

Refer to the data logger or RTU manual for further information.

6   SDI-12

SDI-12 is a standard for interfacing data recorders with microprocessor-based sensors. SDI-12 stands for serial/digital interface at 1200 baud. It can connect multiple sensors with a single data recorder on one cable. It supports up to 60 meter cable between a sensor and a data logger.

The SDI-12 standard is prepared by

SDI-12 Support Group
(Technical Committee)
165 East 500 South
River Heights, Utah
435-752-4200
435-752-1691 (FAX)
http://www.sdi-12.org

The latest standard is version V1.4 which dates from December 1[rst], 2017. The standard is available on the website of the SDI-12 Support Group.

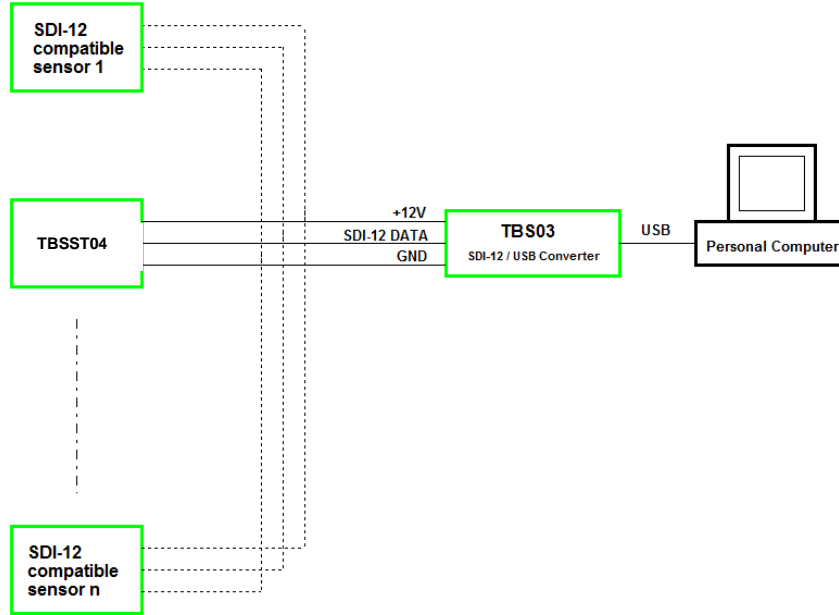SDI-12 Soil Temperature Sensor 3 depth levels

7 Application Examples

Figure 1 – TBSST04 and other sensors with SDI-12 interface connected to TBS03 SDI-12 to USB converter; setup for controlling / testing sensors and for PC based data recording
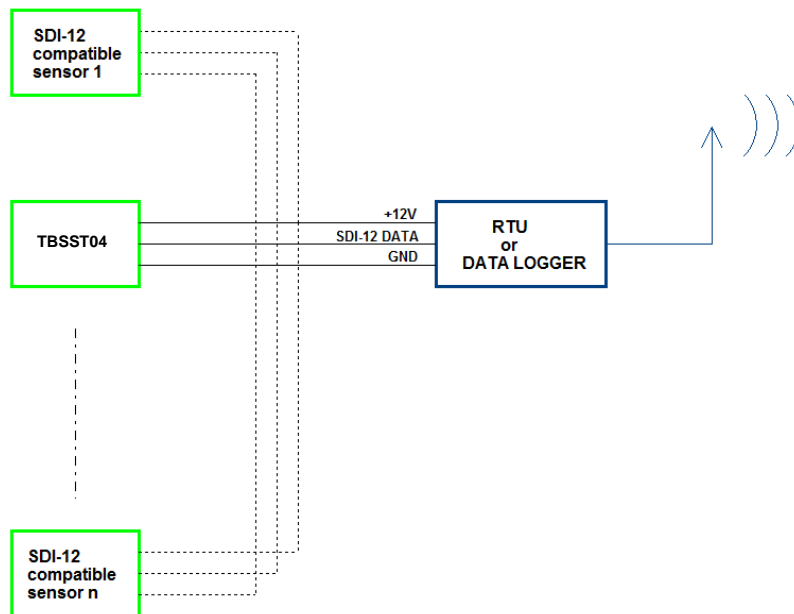

Figure 2 – TBSST04 and other sensors with SDI-12 interface connected to Remote Telemetry Unit or Data Recorder

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8   Functional description

The temperature can be measured on a specific depth level or reported for each level.

Below are examples of SDI-12 communication between a SDI-12 Recorder and TBSST04 to retrieve the measured temperature(s):

Measuring the temperature on a specific depth level

Ex. Measures temperature on the 2nd depth level:

SDI-12 Recorder	TBSST04
0M1!	00011
0D0!	0+23.876

Measuring the temperature on each depth level

Ex. Reports the temperature from each depth level

SDI-12 Recorder	TBSST04
0M3!	00033
0D0!	0+28.675+27.213+26.651

User can choose to report the temperature in degree Celcius or Fahrenheit by using extended SDI-12 commands aXSTUC!/aXSTUF!.

9   Supported SDI-12 v1.3 Commands

Following commands are supported by the TBSST04:

Command	Description	Response
a!	Acknowledge Active	a\<CR>\<LF>
aI!	Send Identification	014TEKBOXVNTBSST4v.vnnnnnn\<CR>\<LF> With nnnnnn representing the serial number and v.v representing the firmware version
aAb!	Change Address	b\<CR>\<LF> Changing the sensor address from a to b
?!	Address Query	a\<CR>\<LF>
aM!	Start Measurement Measures temperature – 1rst depth level	a0011\<CR>\<LF> Delay: (1) seconds and number of values (1)
aMC!	Start Measurement and request CRC Measures temperature – 1rst depth level and calculates CRC	a0011\<CR>\<LF> Delay: (1) second, number of values (1)
aC!	Start Concurrent Measurement	a00101\<CR>\<LF>

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	Measures temperature – 1rst depth level	Delay: (1) second and number of values (01)
aCC!	Start Concurrent Measurement and request CRC Measures temperature – 1rst depth level and calculate CRC	a00101<CR><LF> Delay: (1) second, number of values (1)
aM1!	Start Measurement Measures temperature – 2nd depth level	a0011<CR><LF> Delay: (1) seconds and number of values (1)
aMC1!	Start Measurement and request CRC Measures temperature – 2nd depth level and calculates CRC	a0011<CR><LF> Delay: (1) second, number of values (1)
aC1!	Start Concurrent Measurement Measures temperature – 2nd depth level	a00101<CR><LF> Delay: (1) second and number of values (01)
aCC1!	Start Concurrent Measurement and request CRC Measures temperature – 2nd depth level and calculate CRC	a00101<CR><LF> Delay: (1) second, number of values (1)
aM2!	Start Measurement Measures temperature – 3rd depth level	a0011<CR><LF> Delay: (1) seconds and number of values (1)
aMC2!	Start Measurement and request CRC Measures temperature – 3rd depth level and calculates CRC	a0011<CR><LF> Delay: (1) second, number of values (1)
aC2!	Start Concurrent Measurement Measures temperature – 3rd depth level	a00101<CR><LF> Delay: (1) second and number of values (01)
aCC2!	Start Concurrent Measurement and request CRC Measures temperature – 3rd depth level and calculate CRC	a00101<CR><LF> Delay: (1) second, number of values (1)
aM3!	Start Measurement Measures temperature for the 3 depth levels	a0033<CR><LF> Delay: (3) seconds and number of values (3)
aMC3!	Start Measurement and request CRC Measures temperature for the 3 depth levels and calculates CRC	a0033<CR><LF> Delay: (3) seconds, number of values (3)
aC3!	Start Concurrent Measurement Measures temperature for the 3 depth levels	a00303<CR><LF> Delay: (3) seconds and number of values (03)
aCC3!	Start Concurrent Measurement and request CRC Measures temperature for the 3 depth levels and calculate CRC	a00303<CR><LF> Delay: (3) seconds, number of values (3)
aD0!	Get Measurement Result(s)	Upon issuing the aD0! Command, TBSST04 will send the measurement results.
aV!	Start Verification	a0000<CR><LF> Not supported
aRn! **aRCn!**	Continuous Measurement Continuous Measurement + CRC	a<CR><LF> Not supported

Table 1 – Standard SDI-12 v1.3 commands

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10 Supported SDI-12 v1.4 commands

Command	Description	Response
aIM!	aM! Identify Measurement Returns delay and number of parameters	a0011<CR><LF> Delay: (1) seconds and number of values (1)
aIMC!	aMC! Identify Measurement Returns delay and number of parameters	a0011<CR><LF> Delay: (1) second, number of values (1)
aIC!	aC! Identify Measurement Returns delay and number of parameters	a00101<CR><LF> Delay: (1) second and number of values (01)
aICC!	aCC! Identify Measurement Returns delay and number of parameters	a00101<CR><LF> Delay: (1) second, number of values (1)
aIM1!	aM1! Identify Measurement Returns delay and number of parameters	a0011<CR><LF> Delay: (1) seconds and number of values (1)
aIMC1!	aMC1! Identify Measurement Returns delay and number of parameters	a0011<CR><LF> Delay: (1) second, number of values (1)
aIC1!	aC1! Identify Measurement Returns delay and number of parameters	a00101<CR><LF> Delay: (1) second and number of values (01)
aICC1!	aCC1! Identify Measurement Returns delay and number of parameters	a00101<CR><LF> Delay: (1) second, number of values (1)
aIM2!	aM2! Identify Measurement Returns delay and number of parameters	a0011<CR><LF> Delay: (1) seconds and number of values (1)
aIMC2!	aMC2! Identify Measurement Returns delay and number of parameters	a0011<CR><LF> Delay: (1) second, number of values (1)
aIC2!	aC2! Identify Measurement Returns delay and number of parameters	a00101<CR><LF> Delay: (1) second and number of values (01)
aICC2!	aCC2! Identify Measurement Returns delay and number of parameters	a00101<CR><LF> Delay: (1) second, number of values (1)
aIM3!	aM3! Identify Measurement Returns delay and number of parameters	a0033<CR><LF> Delay: (3) seconds and number of values (3)
aIMC3!	aMC3! Identify Measurement Returns delay and number of parameters	a0033<CR><LF> Delay: (3) seconds, number of values (3)
aIC3!	aC3! Identify Measurement Returns delay and number of parameters	a00303<CR><LF> Delay: (3) seconds and number of values (03)
aICC3!	aCC3! Identify Measurement Returns delay and number of parameters	a00303<CR><LF> Delay: (3) seconds, number of values (3)
aIM_001!	aM! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,Temperature,Celcius;<CR><LF> (*)
aIMC_001!	aMC! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,Temperature,Celcius;ccc<CR><LF> Where ccc is the CRC

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		(**)
aIC_001!	aC! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,Temperature,Celcius;<CR><LF> (*)
aICC_001!	aCC! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,Temperature,Celcius;ccc<CR><LF> Where ccc is the CRC (**)
aIM1_001!	aM1! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,Temperature,Celcius;<CR><LF> (*)
aIMC1_001!	aMC1! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,Temperature,Celcius;ccc<CR><LF> Where ccc is the CRC (**)
aIC1_001!	aC1! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,Temperature,Celcius;<CR><LF> (*)
aICC1_001!	aCC1! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,Temperature,Celcius;ccc<CR><LF> Where ccc is the CRC (**)
aIM2_001!	aM2! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,Temperature,Celcius;<CR><LF> (*)
aIMC2_001!	aMC2! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,Temperature,Celcius;ccc<CR><LF> Where ccc is the CRC (**)
aIC2_001!	aC2! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,Temperature,Celcius;<CR><LF> (*)
aICC2_001!	aCC2! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,Temperature,Celcius;ccc<CR><LF> Where ccc is the CRC (**)
aIM3_001!	aM3! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,Temperature,Celcius;<CR><LF> (*)
aIMC3_001!	aMC3! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,Temperature,Celcius;ccc<CR><LF> Where ccc is the CRC (**)
aIC3_001!	aC3! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,Temperature,Celcius;<CR><LF> (*)
aICC3_001!	aCC3! Identify Measurement Parameters (1rst) Returns parameter's identification and unit	a,Temperature,Celcius;ccc<CR><LF> Where ccc is the CRC (**)
aIM3_002!	aM3! Identify Measurement	a,Temperature,Celcius;<CR><LF>

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	Parameters (2nd) Returns parameter's identification and unit	(*)
aIMC3_002!	aMC3! Identify Measurement Parameters (2nd) Returns parameter's identification and unit	a,Temperature,Celcius;ccc<CR><LF> Where ccc is the CRC (**)
aIC3_002!	aC3! Identify Measurement Parameters (2nd) Returns parameter's identification and unit	a,Temperature,Celcius;<CR><LF> (*)
aICC3_002!	aCC3! Identify Measurement Parameters (2nd) Returns parameter's identification and unit	a,Temperature,Celcius;ccc<CR><LF> Where ccc is the CRC (**)
aIM3_003!	aM3! Identify Measurement Parameters (3rd) Returns parameter's identification and unit	a,Temperature,Celcius;<CR><LF> (*)
aIMC3_003!	aMC3! Identify Measurement Parameters (3rd) Returns parameter's identification and unit	a,Temperature,Celcius;ccc<CR><LF> Where ccc is the CRC (**)
aIC3_003!	aC3! Identify Measurement Parameters (3rd) Returns parameter's identification and unit	a,Temperature,Celcius;<CR><LF> (*)
aICC3_003!	aCC3! Identify Measurement Parameters (3rd) Returns parameter's identification and unit	a,Temperature,Celcius;ccc<CR><LF> Where ccc is the CRC (**)

(*) Or a,Temperature,Fahrenheit;<CR><LF>

(**)Or a,Temperature,Fahrenheit;ccc<CR><LF>

Table 2 – Standard SDI-12 v1.4 commands

11 Supported Extended Commands

| Command	Description	Response
aXSNnnnnnn!	Set 6 digits serial number nnnnnn	aX_OK<CR><LF>
aX0n!	Temperature calibration at zero degree Celcius. N=1,2,3 is the depth level. Used for factory calibration using a 1kΩ resistor.	aX_OK<CR><LF>
aXTn,ff.ff!	Temperature calibration (user settings) where: n=1,2,3 is the depth level ff.ff: is the temperature in floating format (9 digits maximum including sign and decimal point)	aX_OK<CR><LF>
aXSTUF!	Set temperature unit to degree Fahrenheit	aX_OK<CR><LF>

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aXSTUC!	Set temperature unit to degree Celcius	aX_OK<CR><LF>

Table 3 – Extended SDI-12 Commands

12 Mechanical Dimensions

TBSST04 is available as a 1m probe in 3 variants based on the number of integrated PT1000 sensors (1 to 3).

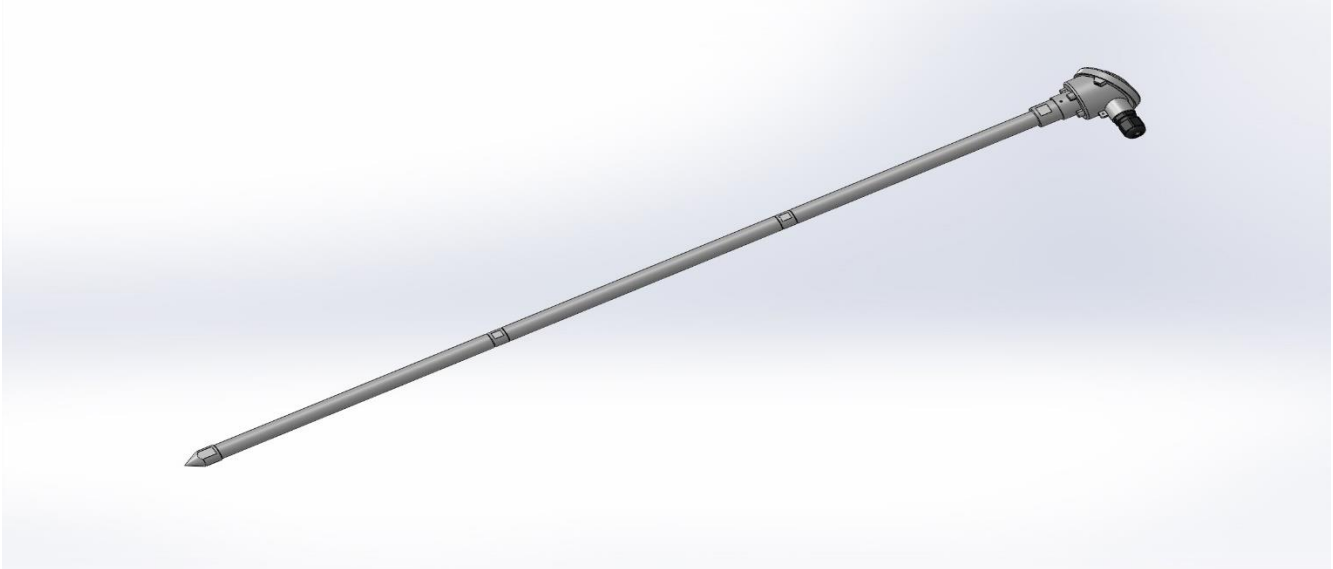- TBSST04 with 1 PT1000 sensor (segment length: 1m)
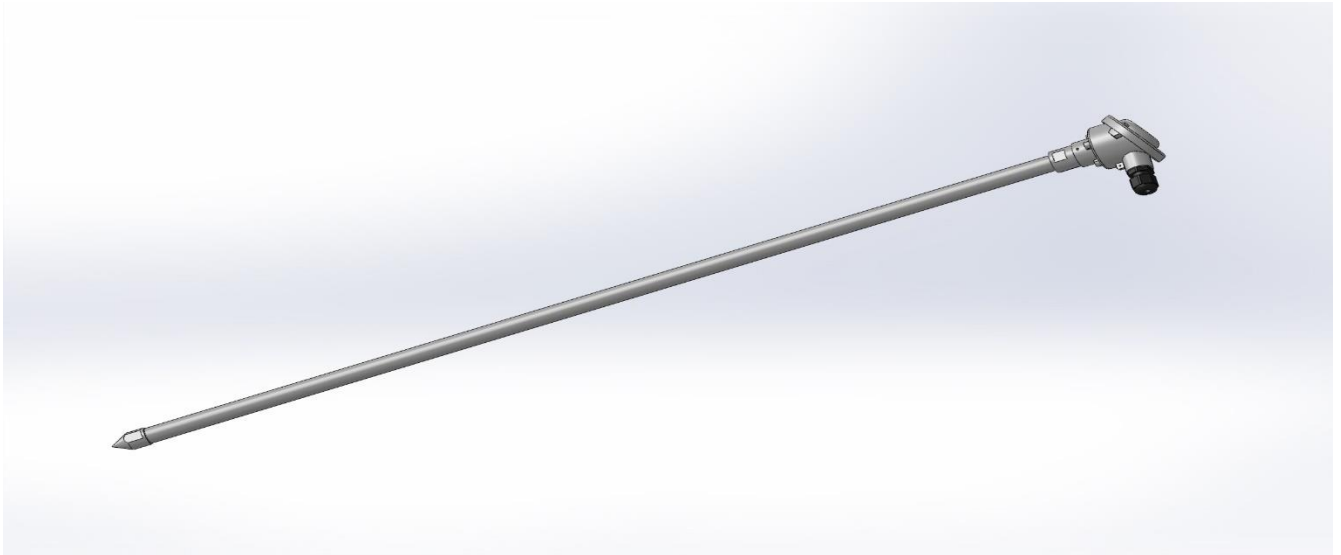
- TBSST04 with 2 PT1000 sensors (segment length: 50cm)

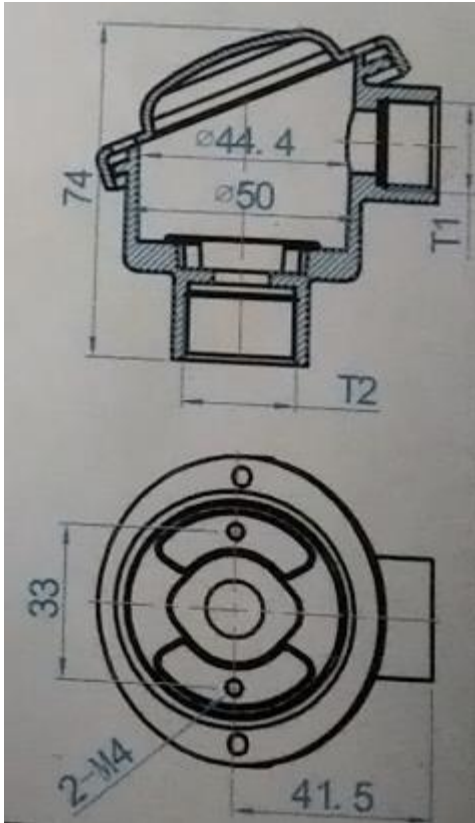# SDI-12 Soil Temperature Sensor 3 depth levels

- TBSST04 with 3 PT1000 sensors (segment length: 33cm)

- UV resistant resin/glass fiber fabrics reinforced tube
  - 18 mm outer diameter
  - 3.5 mm wall thickness
- Aluminium housing:

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With:
T1 = M20 * 1.5
T2 = M20 * 1.5

13 Cable Connection

Cable Colour	Signal Assignment
Blue	SDI-12 Power
Yellow	SDI-12 Data
Brown	GND
Black	Shield (GND)

Table 4 – Cable Connection

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14 Ordering Information

Part Number	Description
TBSST04_1	1 level soil temperature sensor – probe length: 1m
TBSST04_2	2 levels soil temperature sensor – probe length: 1m
TBSST04_3	3 levels soil temperature sensor – probe length: 1m
Custom (please contact Tekbox' sales)	Segment length: maximum 3m Probe length: maximum 9m

Please mention in your order, if you require a different cable length.

Table 5 – Ordering Information

15 History

Version	Date	Author	Changes
V1.0	11.12.2019	Philippe Hervieu	Creation of the document
V1.1	12.12.2019	Philippe Hervieu	Update SDI-12 v1.4 commands with CRC
V1.2	24.12.2019	Philippe Hervieu	Mechanical information and supported temperature range
V1.3	17.01.2020	Philippe Hervieu	Add pictures
V1.4	13.02.2020	Philippe Hervieu	Temperature accuracy/resolution added
V1.5	17.02.2020	Philippe Hervieu	Dimensions and weight added.
V1.6	24.02.2020	Philippe Hervieu	Mechanical dimensions and ordering information updated
V1.7	16.03.2020	Philippe Hervieu	Update MC/CC responses
V1.8	22.06.2020	Hoa Hoang	Corection: 13 Cable Connection

Table 6 – History