

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 °C 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 °C

- 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

SDI-12 Soil Temperature Sensor 3 depth levels

Contents

1	INTRODUCTION	3
2	MEASUREMENT	3
3	PRODUCT SPECIFICATION	4
4	CALIBRATION	4
5	INSTALLATION	5
6	SDI-12	5
7	APPLICATION EXAMPLES	6
8	FUNCTIONAL DESCRIPTION	7
9	SUPPORTED SDI-12 V1.3 COMMANDS	7
10	SUPPORTED SDI-12 V1.4 COMMANDS	9
11	SUPPORTED EXTENDED COMMANDS	11
12	MECHANICAL DIMENSIONS	12
13	CABLE CONNECTION	14
14	ORDERING INFORMATION	15
15	HISTORY	15

Tables

Table 1 – Standard SDI-12 v1.3 commands	9
Table 2 – Standard SDI-12 v1.4 commands	11
Table 3 – Extended SDI-12 Commands	12
Table 4 – Cable Connection	14
Table 5 – Ordering Information	15
Table 6 – History	15

Figures

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	6
Figure 2 – TBSST04 and other sensors with SDI-12 interface connected to Remote Telemetry Unit or Data Recorder	6

SDI-12 Soil Temperature Sensor 3 depth levels

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)

SDI-12 Soil Temperature Sensor 3 depth levels

Extended SDI-12 commands:

aXSNnnnnnn! where nnnnnn: 6 digits serial number	Set serial number
aX0n! where: n=1,2,3 is the depth level index	Calibration at zero degree
aXTn,ff.ff! where: n=1,2,3 is the depth level index, ff.ff the ambient temperature	Calibration at 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°C
 - -200 / + 600 °C
- 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 °C
- 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).

SDI-12 Soil Temperature Sensor 3 depth levels

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 1st, 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

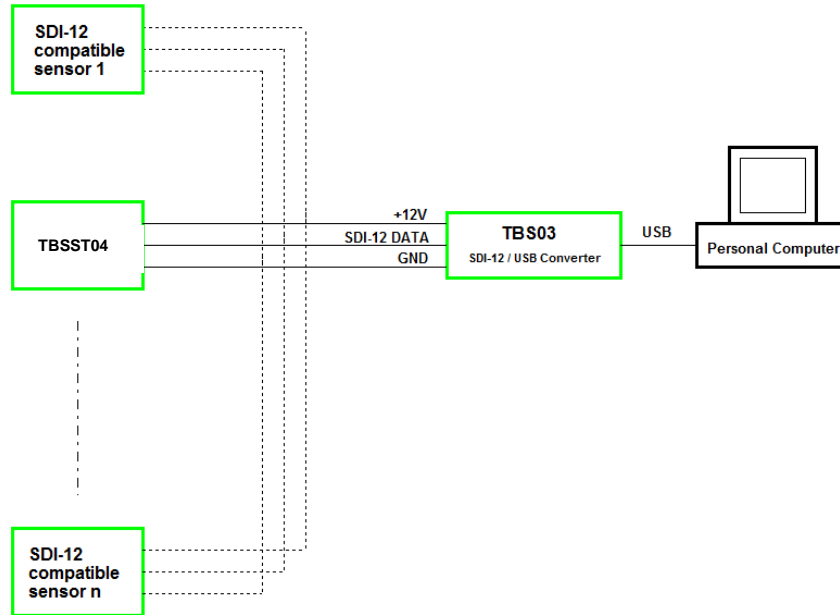


Figure 1 – TBSST04 and other sensors with SDI-12 interface connected to TBS03 SDI-12 to USB converter; setup for controlling / testing sensors and for PC based data recording

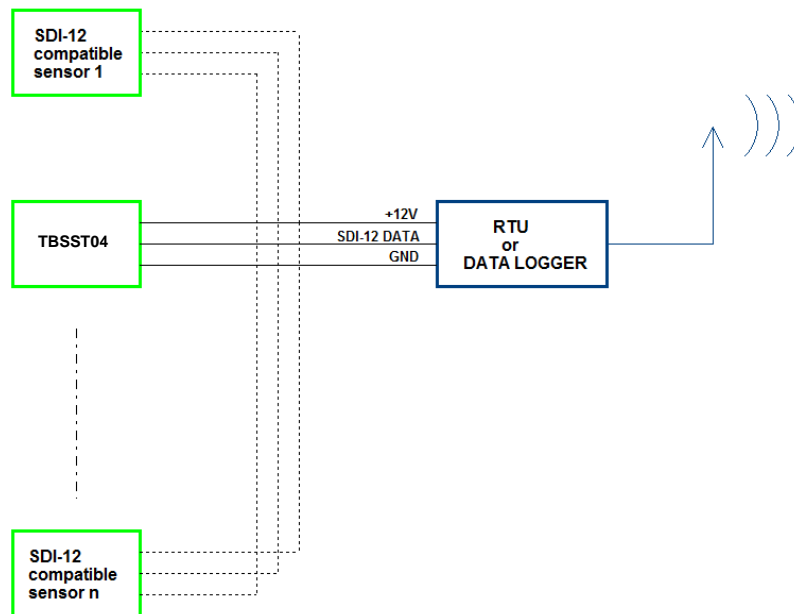


Figure 2 – TBSST04 and other sensors with SDI-12 interface connected to Remote Telemetry Unit or Data Recorder

SDI-12 Soil Temperature Sensor 3 depth levels

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>
a!	Send Identification	a14TEKBOXVNTBSST4rv<h><nnnnnn><ffffff><CR><LF> With: <a>: SDI-12 address <h>: HW revision (one letter) <nnnnnn>: serial number (6 digits) <ffffff>: firmware version (7 digits) Example: 014TEKBOXVNTBSST4rvA1234560F00100<CR><LF>
aAb!	Change Address	b<CR><LF> Changing the sensor address from a to b
?!	Address Query	a<CR><LF>
aM!	Start Measurement	a0011<CR><LF>

SDI-12 Soil Temperature Sensor 3 depth levels

	Measures temperature – 1rst depth level	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 Measures temperature – 1rst depth level	a00101<CR><LF> 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>

SDI-12 Soil Temperature Sensor 3 depth levels

		Not supported
aRn! aRCn!	Continuous Measurement Continuous Measurement + CRC	a<CR><LF> Not supported

Table 1 – Standard SDI-12 v1.3 commands

10 Supported SDI-12 v1.4 commands

Command	Description	Response
aM!	aM! Identify Measurement Returns delay and number of parameters	a0011<CR><LF> Delay: (1) seconds and number of values (1)
aMC!	aMC! Identify Measurement Returns delay and number of parameters	a0011<CR><LF> Delay: (1) second, number of values (1)
aC!	aC! Identify Measurement Returns delay and number of parameters	a00101<CR><LF> Delay: (1) second and number of values (01)
aCC!	aCC! Identify Measurement Returns delay and number of parameters	a00101<CR><LF> Delay: (1) second, number of values (1)
aM1!	aM1! Identify Measurement Returns delay and number of parameters	a0011<CR><LF> Delay: (1) seconds and number of values (1)
aMC1!	aMC1! Identify Measurement Returns delay and number of parameters	a0011<CR><LF> Delay: (1) second, number of values (1)
aC1!	aC1! Identify Measurement Returns delay and number of parameters	a00101<CR><LF> Delay: (1) second and number of values (01)
aCC1!	aCC1! Identify Measurement Returns delay and number of parameters	a00101<CR><LF> Delay: (1) second, number of values (1)
aM2!	aM2! Identify Measurement Returns delay and number of parameters	a0011<CR><LF> Delay: (1) seconds and number of values (1)
aMC2!	aMC2! Identify Measurement Returns delay and number of parameters	a0011<CR><LF> Delay: (1) second, number of values (1)
aC2!	aC2! Identify Measurement Returns delay and number of parameters	a00101<CR><LF> Delay: (1) second and number of values (01)
aCC2!	aCC2! Identify Measurement Returns delay and number of parameters	a00101<CR><LF> Delay: (1) second, number of values (1)
aM3!	aM3! Identify Measurement Returns delay and number of parameters	a0033<CR><LF> Delay: (3) seconds and number of values (3)
aMC3!	aMC3! Identify Measurement Returns delay and number of parameters	a0033<CR><LF> Delay: (3) seconds, number of values (3)
aC3!	aC3! Identify Measurement Returns delay and number of parameters	a00303<CR><LF> Delay: (3) seconds and number of values (03)
aCC3!	aCC3! Identify Measurement Returns delay and number of parameters	a00303<CR><LF>

SDI-12 Soil Temperature Sensor 3 depth levels

		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 (**)
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	a, Temperature, Celcius; <CR><LF>

SDI-12 Soil Temperature Sensor 3 depth levels

	Parameters (1rst) Returns parameter's identification and unit	(*)
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 Parameters (2nd) Returns parameter's identification and unit	a, Temperature, Celcius; <CR><LF> (*)
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>

SDI-12 Soil Temperature Sensor 3 depth levels

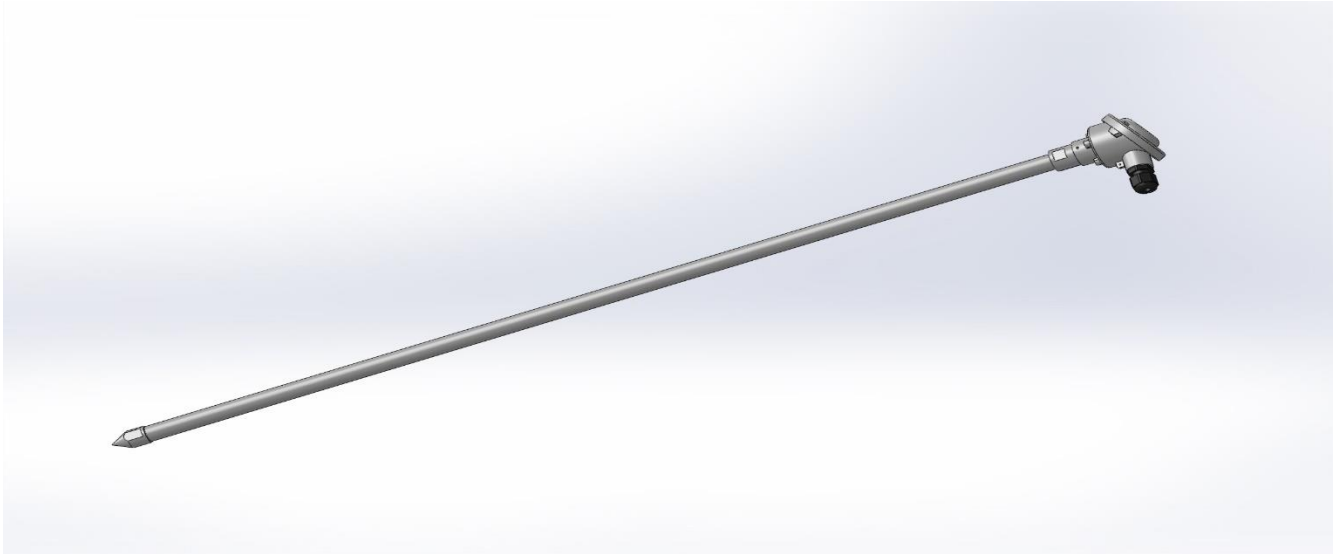
aXTn,ff.ff!	Temperature calibration (user settings) where: n=1,2,3 is the depth level ff.ff: is the temperature in floating format (9 digits maximum including sign and decimal point)	aX_OK<CR><LF>
aXSTUF!	Set temperature unit to degree Fahrenheit	aX_OK<CR><LF>
aXSTUC!	Set temperature unit to degree Celcius	aX_OK<CR><LF>

Table 3 – Extended SDI-12 Commands

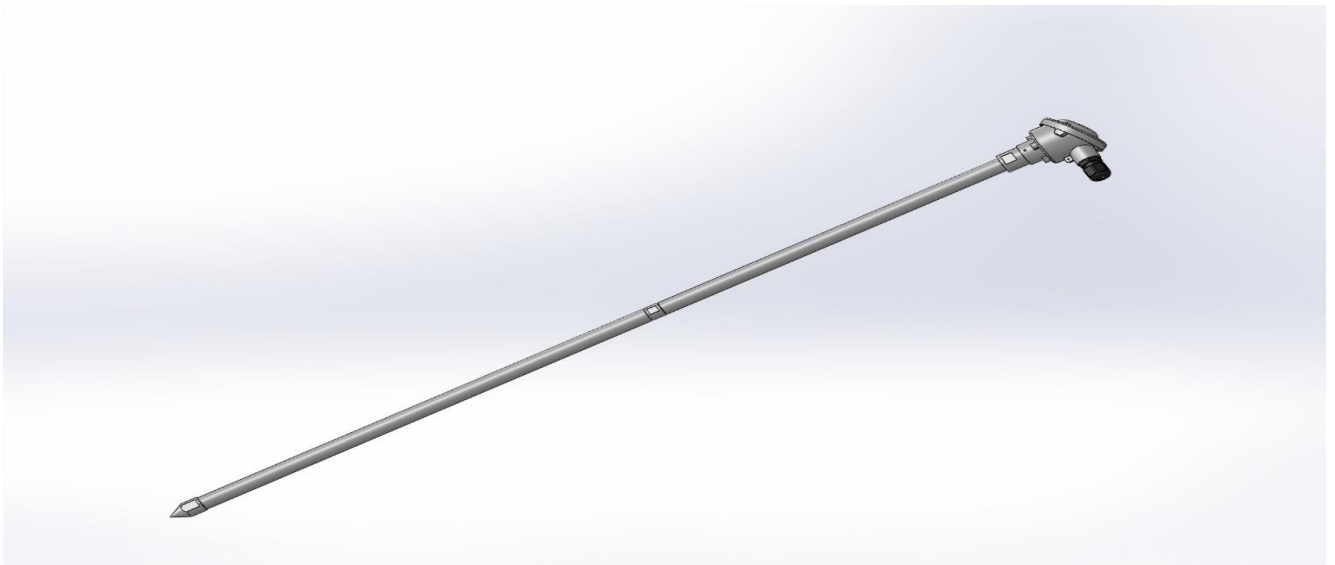
12 Mechanical Dimensions

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)

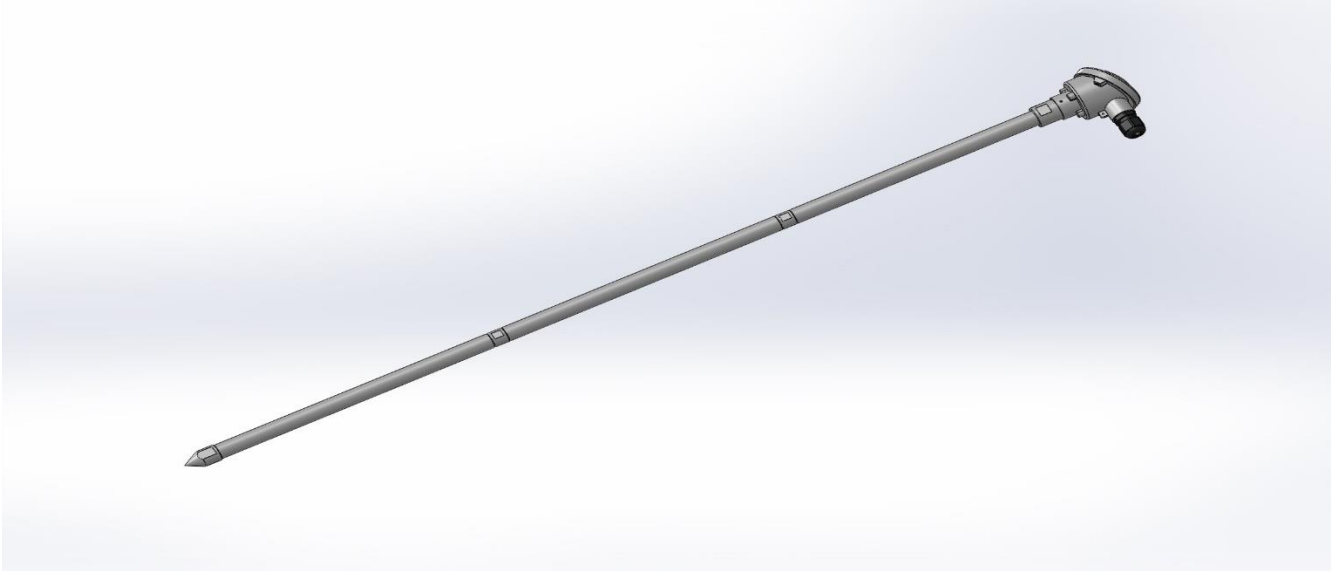


- TBSST04 with 2 PT1000 sensors (segment length: 50cm)



SDI-12 Soil Temperature Sensor 3 depth levels

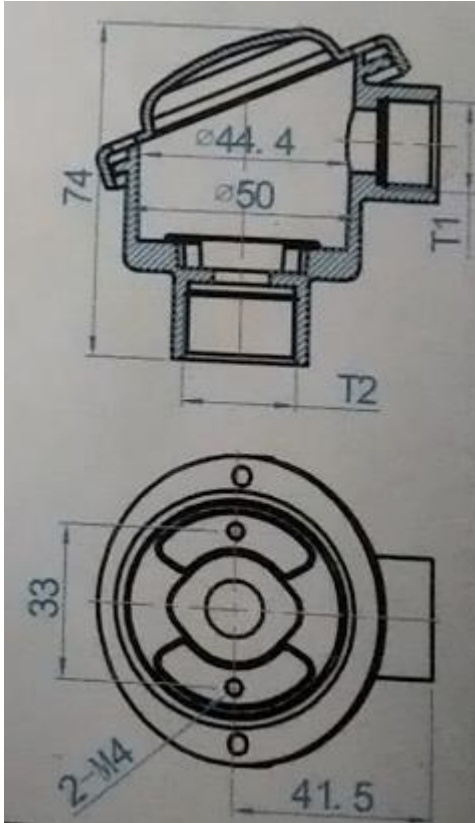
- TBSST04 with 3 PT1000 sensors (segment length: 33cm)



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



SDI-12 Soil Temperature Sensor 3 depth levels



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

SDI-12 Soil Temperature Sensor 3 depth levels

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	Correction: 13 Cable Connection
V1.9	30.03.2021	Philippe Hervieu	Update SDI-12 response to all!

Table 6 – History