Umweltanalytische
Produkte GmbH

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 accurate Swiss made PT1000.
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 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:

aXSTUn!   **Set temperature unit**

aXGTU!   **Get temperature unit**

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℃
    - Accuracy: 0.1℃
- 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 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 delivered factory calibrated and ready to use.

However, in case it is required to adjust the probe measurement results depending on the test environment, it is possible to proceed with a custom calibration following these steps:

1. Reset TBSST04 parameters: aXRSTDC!
2. Set the number of TBSST04 depth levels to be calibrated: aXSLVNBn!
    a. Example: aXSLVNB2! for a 2 levels probe
3. Perform desired temperature measurements with TBSST04 and compare with a reference to generate the required polynomial coefficients *a, b, c, d* for each depth level.
4. Apply the polynomial correction for the depth level index *n*: aXSPOLCn,a,b,c,d!

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a. Example: 0XSPOLC1,0,0,1.234,-0.324! for the 2nd depth level

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 and is available on the website of the SDI-12 Support Group.

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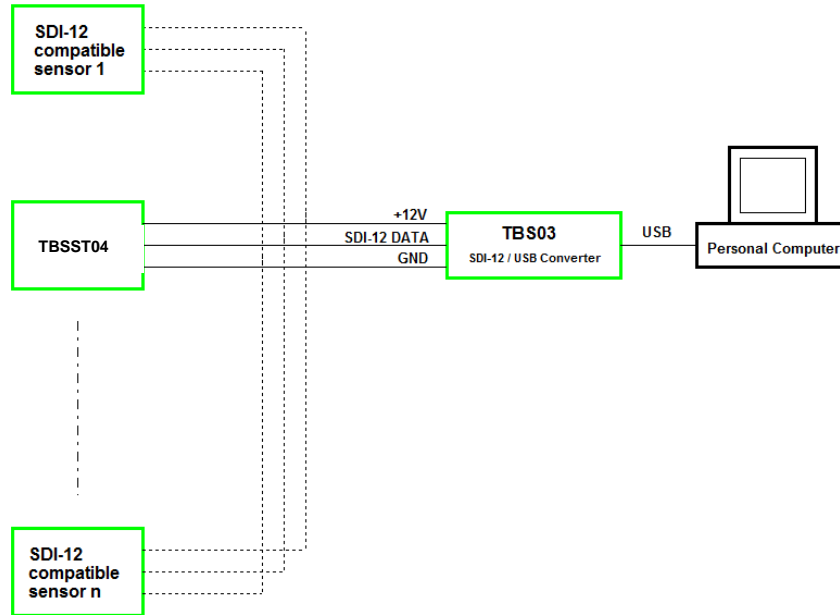
7 Application Examples

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
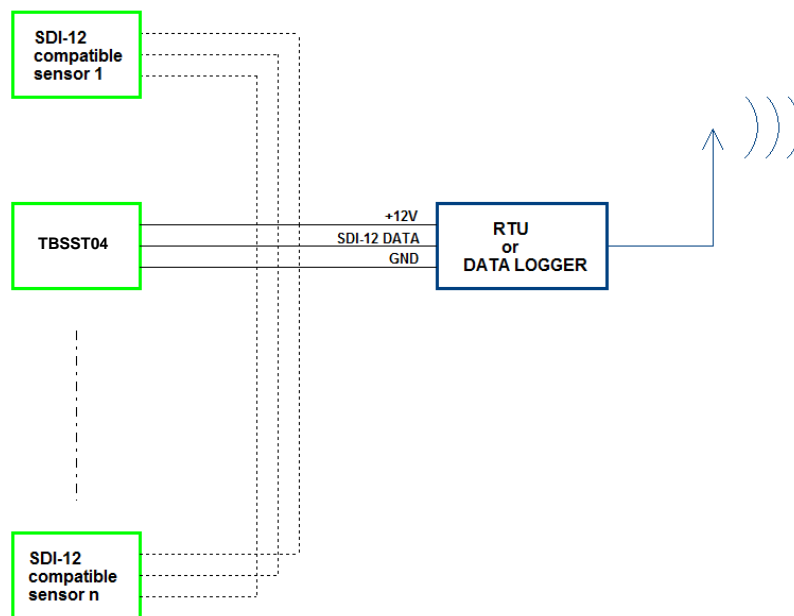

Figure 2 – TBSST04 and other sensors with SDI-12 interface connected to Remote Telemetry Unit or Data Recorder

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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 an SDI-12 Recorder and TBSST04 to retrieve the measured temperature(s). This TBSST04 has 3 different depth levels.

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 aXSTUn!.

TBSST04 supports up to three depth levels that are indexed from 0 to 2:
- Index 0: upper depth level (closest to the ground)
- Index 1: mid depth level
- Index 2: lower depth level (deepest from the ground)

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	a14TEKBOXVNTBSST4rv\<h>\<nnnnnn>\<fffffff>\<CR>\<LF>
		With:
		   o \<a>: SDI-12 address
		   o \<h>: HW revision (one letter)
		   o \<nnnnnn>: serial number (6 digits)
		   o \<fffffff>: firmware version (7 digits)
		Example:
		014TEKBOXVNTBSST4rvA1234560F00101\<CR>\<LF>

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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) second 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) second 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) second 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 all depth levels	a001n<CR><LF> Delay: (1) second and number of values (n) Where n is the number of TBSST04 levels (1 to 3).
aMC3!	Start Measurement and request CRC Measures temperature for all depth levels and calculates CRC	a001n<CR><LF> Delay: (1) second and number of values (n) Where n is the number of TBSST04 levels (1 to 3).
aC3!	Start Concurrent Measurement Measures temperature for all depth levels	a0010n<CR><LF> Delay: (1) second and number of values (n) Where n is the number of TBSST04 levels (1 to 3).

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aCC3!	Start Concurrent Measurement and request CRC Measures temperature for all depth levels and calculate CRC	a0010n<CR><LF> Delay: (1) second and number of values (n) Where n is the number of TBSST04 levels (1 to 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> a<CRC><CR><LF>

(*) Or a0000<CR><LF>/a00000<CR><LF> respectively for aM(C)x!/aC(C)x! if TBSST04 does not have this depth level available.

Table 1 – Standard SDI-12 v1.3 commands

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	a001n<CR><LF>

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	Returns delay and number of parameters	Delay: (1) second and number of values (n) Where n is the number of TBSST04 levels (1 to 3).
aIMC3!	aMC3! Identify Measurement Returns delay and number of parameters	a001n\<CR>\<LF> Delay: (1) second and number of values (n) Where n is the number of TBSST04 levels (1 to 3).
aIC3!	aC3! Identify Measurement Returns delay and number of parameters	a0010n\<CR>\<LF> Delay: (1) second and number of values (n) Where n is the number of TBSST04 levels (1 to 3).
aICC3!	aCC3! Identify Measurement Returns delay and number of parameters	a0010n\<CR>\<LF> Delay: (1) second and number of values (n) Where n is the number of TBSST04 levels (1 to 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; \<CRC>\<CR>\<LF> (**)
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; \<CRC>\<CR>\<LF> (**)
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; \<CRC>\<CR>\<LF> (**) (****)
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; \<CRC>\<CR>\<LF> (**) (****)
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; \<CRC>\<CR>\<LF> (**) (****)
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)	a,Temperature,Celcius; \<CRC>\<CR>\<LF>

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	Returns parameter's identification and unit	(**) (****)
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; <CRC><CR><LF> (**)
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; <CRC><CR><LF> (**)
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; <CRC><CR><LF> (**) (****)
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; <CRC><CR><LF> (**) (****)
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; <CRC><CR><LF> (**) (****)
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; <CRC><CR><LF> (**) (****)

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

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

(***) Or a0000<CR><LF>/a00000<CR><LF> respectively for aM(C)x!/aC(C)x! if TBSST04 does not have this depth level available.

(****) Or a<CR><LF>/a<CRC><CR><LF> respectively for aMx!/aCx! and aMCx!/aCCx! if TBSST04 does not have this depth level available.

Table 2 – Standard SDI-12 v1.4 commands

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11 Supported Extended Commands

11.1 Setting temperature unit

Command	Description	Response
aXSTUn!	Set temperature unit <n>: Celcius (C) or Fahrenheit (F)	aX_OK<CR><LF>
aXGTU!	Get temperature unit	an<CR><LF> <n>: ○ C for Celcius ○ F for Fahrenheit

Table 3 – Extended SDI-12 Commands: temperature unit

12 Cable Connection

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

Table 5 – Cable Connection

M12 connector SDI-12 to GP2 logger wiring connections - using logger power

Wire colour		GP2 terminal		M12 plug pins
Black		SDI-12 DATA	SDI-12 Data	4
Blue		GND	Sensor ground / power return	3
White		12V	Sensor power	2