Air Humidity, Temperature and Barometric Pressure Sensor Manual

The TBSHT05/TBSHTP05 is an air humidity, temperature and barometric pressure sensor with SDI-12 interface. The sensing elements are located on a PCB in the tip of the sensor. The acquisition circuit is completely over-moulded. Temperature measurement is carried out with a 0.1°C precision PT1000. Humidity measurement is based on a precision sensing element on a ceramic substrate. An additional MEMS chip measures barometric pressure. The sensor tip is protected with a replaceable filter.
Each sensor is individually factory-calibrated.
With dimensions of only 100mm x 16mm, the sensor can easily be fitted into many standard radiation shields.
While the TBSHT05 measures air humidity and air temperature, the TBSHTP05 measures air humidity, air temperature and barometric pressure.

TBSHT05/TBSHTP05 air humidity, air temperature and barometric pressure sensor

Features

- Air humidity, temperature and barometric pressure sensor
- SDI-12 Interface
- Temperature resolution: 0.01°C
- Temperature accuracy tolerance:
  -40°C to +85°C: ±0.1°C
  Air humidity resolution: 0.01% RH
- Air humidity accuracy tolerance:
  0% to 90%: typ. ±2%RH, max. ±2.5%RH
  90% to 100%: typ. ±2%RH, max. ±3.5%RH
- Barometric pressure range: 300-1100hPa (+9000 …-500m above sea level)
- Barometric pressure resolution: 0,02hPa
- Barometric pressure accuracy: ±1hPa
- Replacable PTFE filter cap, 10µm
- SDI-12 Standard V1.3
- Plug and Play
- 6 - 17V supply voltage
- Dimensions: 100 mm x 16 mm
- Operating Temperature Range:
  - 40°C … + 85°C
- Excellent price-performance ratio

Target Applications

- SDI-12 Sensor Networks

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1 Introduction

1.1 Product Features

TBSHT05/TBSHTP05 is based on a factory calibrated sensor chips, a low power controller and robust SDI-12 interface hardware:

- Measurement of air humidity, air temperature, barometric pressure (optional) and calculation of absolute air humidity, dew/frost point
- 5V, 1200 baud SDI-12 data interface with transient protection
- 6 - 17V, 10 mA/60µA sensor supply
- Sensor dimensions: 100 mm, Ø 16 mm
- Operating temperature range: -40°C … +85°C

1.2 Calibration

Each sensor is individually factory calibrated. No user calibration is required.

1.3 Placement

Don´t expose the sensor to direct sun or precipitation. Install it in a location with permanent shadow and protection from precipitation, inside a radiation shield or in an instrument shelter.

1.4 Installation

The TBSHT05/TBSHTP05 is compatible with any data logger or remote telemetry unit with SDI-12 interface. Refer to the data logger or RTU manual and to chapter 2 of this datasheet.

1.5 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.

Tekbox SDI-12 sensors have been installed in networks with cable lengths up to 200m and with up to 40 connected sensors.

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 V1.3 which dates from July 18th, 2005. The standard is available on the website of the SDI-12 Support Group.

More information on SDI-12 is presented in chapter 3.

2 Application Examples

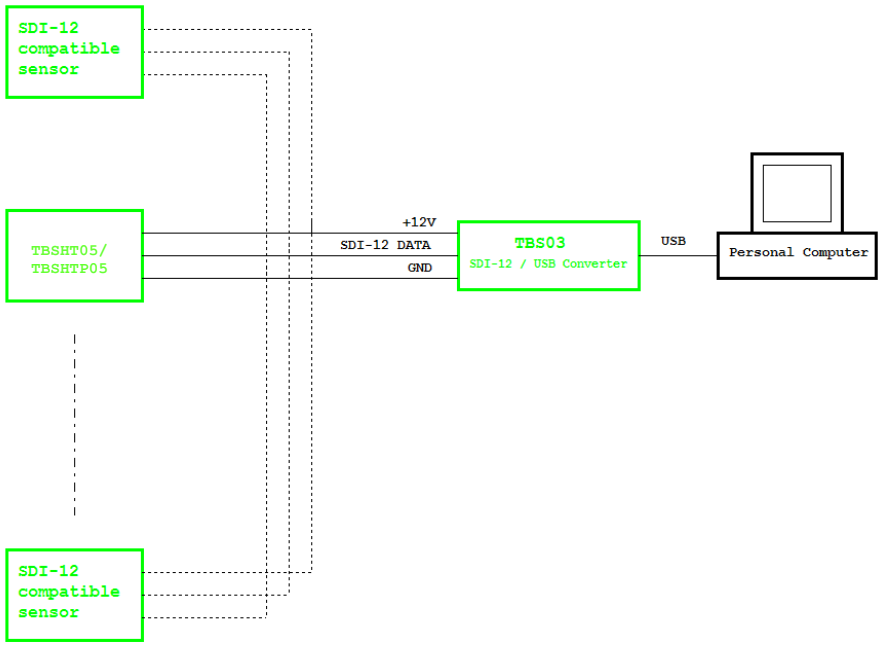

Figure 1 – TBSHT05/TBSHTP05 sensors connected to TBS03 SDI-12 to USB converter, setup for controlling / testing sensors and for PC based data recording

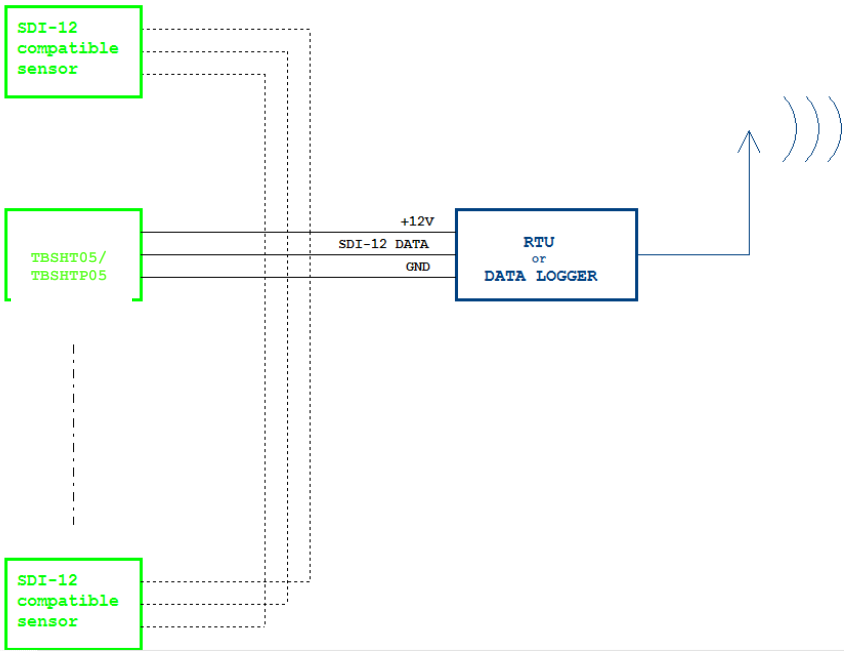

Figure 2 – TBSHT05/TBSHTP05 sensor(s) connected to Remote Telemetry Unit or Data Recorder

3 Functional Description

3.1 Overview

The SDI-12 standard defines a set of commands to configure sensors and to initiate measurements. Upon receiving specific commands, the sensor may carry out internal tasks, respond with information on conversion time or send measurement data.

SDI-12 commands are typically ASCII strings which are generated by the data recorder/controller firmware. The TBSHT05/TBSHTP05 can be connected to a TBS03 SDI-12 to USB converter and controlled by a PC application or hyper terminal. TBS03 converts the command strings to the logic levels and baud rate specified by the SDI-12 standard. Furthermore, TBS03 handles breaks, marks and all other details of the SDI-12 protocol.

Upon receiving data or status information originated by the TBSHT05/TBSHTP05, the TBS03 extracts the corresponding ASCII strings and sends them to the USB Virtual COM Port of the PC.

In remote applications, the TBSHT05/TBSHTP05 can be connected to a data logger, a data terminal or a Radio Telemetry Unit with a SDI-12 interface.

3.2 SDI-12 Basics

The SDI-12 is a serial data communication standard for interfacing multiple sensors with a data recorder. SDI-12 uses a shared bus with 3 wires: power (+12V), data, ground Data rate: 1200 baud. Each sensor at the bus gets a unique address which is in the range ASCII [0-9, a-z, A-Z]. The default address of every sensor is ASCII[0]. When setting up a SDI-12 sensor network, every sensor needs to be configured with a unique address. This can be done using the Change Address Command. A sensor can typically measure one or more parameters. Sensor manufacturers usually specify '*Extended Commands*' to configure or calibrate sensors. These commands are specified by the manufacturer, but they follow the command structure specified by SDI-12.

A typical recorder/sensor measurement sequence proceeds as follows:

1) The data recorder wakes all sensors on the SDI-12 bus with a break.
2) The recorder transmits a command to a specific, addressed sensor, instructing it to make a measurement.
3) The addressed sensor responds within 15.0 milliseconds, returning the maximum time until the measurement data will be ready and the number of data values it will return.
4) If the measurement is immediately available, the recorder transmits a command to the sensor instructing it to return the measurement result(s). If the measurement is not ready, the data recorder waits for the sensor to send a request to the recorder, which indicates that the data is ready. The recorder then transmits a command to get the data.
5) The sensor responds, returning one or more measurement results.

SDI-12 Command Structure:
Each SDI-12 command is an ASCII string with up to 5 characters, starting with the sensor address and terminated by a "**!**" character.

Example:
Send Identification Command **0I!**
0 is the sensor address (sensor zero). Upon receiving this command, the sensor will send an ASCII string containing sensor address, SDI-12 compatibility number, company name, sensor model number, sensor version number and sensor serial number.

The standard process to carry out a measurement is to send a measurement request upon which the sensor responds with the time that is required to carry out the measurement and the number of data items being returned. After waiting the time that the sensor requires to carry out the measurement, the data recorder sends a *"Read Command"* to get the measurement results.

Example:
Start Measurement Command **0M1!**
Sensor 0 might respond **00012** which means the measurement will take 1 second and deliver 2 values.
After min. 30 seconds, the data recorder can send the *"Read Data Command"* **0D0!** to which Sensor 0 might reply **0+67.75+17.23**. +67.53+17.23 is the two measurement results which may be 67.75% air humidity level and 17.23°C air temperature.

The response string of a sensor is always in ASCII format and may contain up to 40 or up to 80 characters, depending on the type of command. Out of 40 or 80 characters, the values part of the response string may contain up to 35 or 75 characters.

3.3 Sensor Identification

The air humidity temperature sensor interface will respond with a string of the following format when sending the *"Send Identification"* command **aI!**:

allccccccccmmmmmmmvvvxxxxxx<CR><LF>

Example: 013TEKBOXVNTSHTP51.0050011<CR><LF>

Where:	0	SDI-12 Sensor address
	13	SDI-12 version number, version 1.3
	TEKBOXVN	Company name
	TSHTP5	Model Name
	1.0	Firmware version 1.0
	050011	Serial number of TBSHT05/TBSHTP05

Remark about the model name field mmmmmm:

- For TBSHTP05: mmmmmm is TSHTP5
- For TBSHT05: mmmmmm is TBSHT5

3.4 Sensor Address

Each TBSHT05/TBSHTP05 is delivered with a default address of "0"

The TBSHT05/TBSHTP05 accepts SDI-12 addresses in the range "0" to "9", "A" to "Z" and "a" to "z". Setting the TBSHT05/TBSHTP05 address can be done using the "*Change Address Command*" **aAb!**.

Note:

- If the new address is invalid, the current address will be kept.

- The TBSHT05/TBSHTP05 will remain unresponsive for approximately 1 second while the new address is saved in the EEPROM memory.
- The TBSHT05/TBSHTP05 interface supports "**?**" as an address only for *"Acknowledge Active"* Command **a!**.

3.5 Measurement

The TBSHT05/TBSHTP05 sensor interface accepts the "*Start Measurement"* Command **aM!**, *"Additional Measurement"* Commands **aMn!** and *"Start Concurrent Measurement"* Command **aC!**, "*Additional Concurrent Measurement"* Commands **aCn!** for obtaining calibrated values from the probe.

The TBSHT05/TBSHTP05 sensor interface will not support the *"Continuous Measurement"* Command **aRn!** and *"Continuous Measurement and Request CRC"* Command **aRCn!**. The TBSHT05/TBSHTP05 sensor will respond with its address followed by <CR><LF> in response to this command.

The response to *"Start Measurement"* **aM!**, *"Additional Measurement"* Commands **aMn!** and *"Start Concurrent Measurement"* Command **aC!**, the *"Additional Concurrent Measurement"* Command **aCn!** reports how many sensor values will be sent. In order to receive the desired sensor values, the recorder needs to issue the corresponding *"Send Data"* Command(s) **aDn!**.

Note: The TBSHT05/TBSHTP05 sensor interface uses a format of "sign" followed by n digits (The n maximum is seven -7), followed by the decimal point, followed by m digits (The m maximum is one - 1) (+n.m) return readings.

3.6 Commands – Quick Reference

Measurement commands:

aM!	aMC!	aC!	aCC!	measure relative humidity [%]
aM1!	aMC1!	aC1!	aCC1!	measure relative humidity [%] / temperature [°C] or [F]
aM2!	aMC2!	aC2!	aCC2!	measure temperature [°C] or [F]
aM3!	aMC3!	aC3!	aCC3!	approximate calculation of dew point [°C] or [F] (*)
aM4!	aMC4!	aC4!	aCC4!	measure relative Humidity (%) / temperature / dew point [°C] or[F] (*)
aM5!	aMC5!	aC5!	aCC5!	approximate calculation of absolute humidity [g/m^3] (*)
aM6!	aMC6!	aC6!	aCC6!	estimate cloud base [m] (estimation; cannot replace a ceilometer measurement) (*)
aM7!	aMC7!	aC7!	aCC7!	rel.humidity/temperature/dew point/frost point/abs. humidity/estd. cloud base (*)
aM8!	aMC8!	aC8!	aCC8!	Pressure [Pa] and altitude[m] (*)

(*) TBSHTP05 only

Extended SDI-12 commands:

aXSNnnnnnn!	Set serial number (6 digits)
aXC!	temperature unit Celsius (default factory setting)
aXF!	temperature unit Fahrenheit

3.7 Measurement Examples

aM!, aC!,aMC!,aCC!: Measure Relative Humidity [%]

Command	Response	Comment
aM!	a0011<CR><LF>	
aD0!	a+hh.hh<CR><LF> Ex: 0+52.66<CR><LF>	

Value hh.hh: Relative Humidity

aM1!, aC1!, aMC1!, aCC1! Measure Relative Humidity [%] and Air Temperature [°C]

Command	Response	Comment
aM1!	a0012<CR><LF>	
aD0!	a+hh.hh+tt.ttt<CR><LF> Ex: 0+52.76+25.820<CR><LF>	The sign will change to – for negative temperatures

Value hh.hh: Relative Humidity Value tt.ttt: Air Temperature value

aM2!, aC2!, aMC2!, aCC2! : Measure Air Temperature [°C]

Command	Response	Comment
aM2!	a0011<CR><LF>	
aD0!	a+tt.ttt<CR><LF> Ex: 0+25.806<CR><LF>	The sign will change to – for negative temperatures

Value tt.ttt: Air Temperature value

aM3!, aC3!, aMC3!, aCC3! : Measure Dew Point

Command	Response	Comment
aM3!	a0011<CR><LF>	
aD0!	a+dd.dd<CR><LF> Ex: 0+15.28<CR><LF>	The sign will change to – for negative temperatures

The approximate calculations of dew point and absolute humidity are based on the measured values of air temperature and relative humidity and on the Magnus formula:

R_H: relative humidity [%] T: Temperature [°C] T_K: Temperature in Kelvin [K]

T_D: dew point temperature [°C] P_V: vapour pressure [hPa] P_{Vsat}: saturated vapour pressure [hPa]

C_E: estimated cloud base [m]

Parameters:

a = 7.5, b = 237.3 for T >= 0
a = 7.6, b = 240.7 for T < 0 above water (dew point)
a = 9.5, b = 265.5 for T < 0 above ice (ice point)

R^* = 8314.3 J/(kmol*K) (molar gas constant)
m_w = 18.016 kg (molecular weight of water vapour)
A_H = absolute humidity in g water vapour per m^3 of air
Formulas:
P_{Vsat} = 6.1078 * 10^((a*T)/(b+T))
P_V = (R_H /100) * P_{Vsat}
T_D = (b * v)/(a-v) where v = log10(P_V / 6.1078)
T_K = T + 273.15
A_H = 10^5 * (m_w / R^*) * (P_V / T_K)
C_E = (T-T_D) * 120

aM4!, aC4!, aMC4!, aCC4! : Measure Relative Humidity [%], Air Temperature [°C] and Dew Point [°C]

Command	Response	Comment
aM4!	a0013<CR><LF>	
aD0!	a+hh.hh+tt.ttt+dd.dd<CR><LF> Ex: 0+52.25+25.806+15.27<CR><LF>	The sign will change to – for negative temperatures

Value hh.hh: Relative Humidity Value tt.ttt: Air Temperature Value dd.dd: Dew Point

aM5!, aC5!, aMC5!, aCC5! : approximate calculation of absolute humidity [g/m3]

Command	Response	Comment
aM5!	a0011<CR><LF>	
aD0!	a+www.ww<CR><LF> Ex: 0+12.51<CR><LF>	

Value www.ww: Absolute Humidity

aM6!, aC6!, aMC6!, aCC6! : estimate cloud base [m] (estimation; cannot replace a ceilometer measurement)

Command	Response	Comment
aM6!	a0011<CR><LF>	
aD0!	a+ccccc.cc<CR><LF> Ex: 0+1266.93<CR><LF>	

Value ccccc.cc: Estimate Cloud Base

aM7!, aC7!, aMC7!, aCC7! : Humidity,Temperature,DewPoint,FrostPoint,absolute humidity and estimate cloud

Command	Response	Comment
aM7!	a0016<CR><LF>	
aD0!	a+hh.hh+tt.ttt+dd.dd+ff.ff+www.ww+ccccc.cc<CR><LF>	The sign will change to – for

	Ex: 0+52.01+25.793+15.18+15.18+12.48+1274<CR><LF>	negative temperatures

Value hh.hh: Humidity Value tt.ttt: Air Temperature Value dd.dd: Dew Point
Value ff.ff: Frost Point Value www.ww: Absolute Humidity Value ccccc.cc: Estimate Cloud Base

aM8!, aC8!, aMC8!, aCC8! : Pressure [Pa] and absolute altitude[m]

Command	Response	Comment
aM8!	a0012<CR><LF>	
aD0!	a+pppppp.p+ll.ll<CR><LF> Ex: 0+100978.6+28.88<CR><LF>	The sign will change to – for negative value

Value pppppp.p: Pressure Value ll.ll: Absolute Altitude

3.8 Supported SDI-12 Commands

Following commands are supported by the TBSHT05/TBSHTP05:

Command	Description	Response
a!	Acknowledge Active	a<CR><LF>
aI!	Send Identification	013TEKBOXVNTSHTP5vvvxxxxxx<CR><LF> (TBSHTP05) 013TEKBOXVNTBSHT5vvvxxxxxx<CR><LF> (TBSHT05) Identification information
aAb!	Change Address	b<CR><LF> Changing the probe sensor address
?!	Address Query	a<CR><LF>
aM!	Start Measurement Measures relative humidity [%]	a0011<CR><LF> Delay (1) seconds and number of values (1)
aM1!	Additional Measurement Measures relative humidity [%] / temperature [°C] or [F]	a0012<CR><LF> Delay (1) seconds and number of values (2)
aM2!	Additional Measurement Measures temperature [°C] or [F]	a0011<CR><LF> Delay (1) seconds and number of values (1)
aM3!	Additional Measurement Approximate calculation of dew point [°C] or [F]	a0011<CR><LF> Delay (1) seconds and number of values (1)
aM4!	Additional Measurement Measures relative Humidity (%) / temperature / dew point [°C] or[F]	a0014<CR><LF> Delay (1) seconds and number of values (3)

aM5!	Additional Measurement Approximate calculation of absolute humidity [g/m^3]	a0011<CR><LF> Delay (1) seconds and number of values (1)
aM6!	Additional Measurement Estimates cloud base [m]	a0011<CR><LF> Delay (1) seconds and number of values (1)
aM7!	Additional Measurement Rel.humidity/temperature/dew point/frost point/abs. humidity/estimated cloud base	a0016<CR><LF> Delay (1) seconds and number of values (6)
aM8!	Additional Measurement Pressure [Pa] and altitude[m]	a0012<CR><LF> Delay (1) seconds and number of values (2)
aMC!	Start Measurement and Request CRC Measures relative humidity [%]	a0011<CR><LF> Delay (1) seconds and number of values (1)
aMC1!	Additional Measurement and Request CRC Measures relative humidity [%] / temperature [°C] or [F]	a0012<CR><LF> Delay (1) seconds and number of values (2)
aMC2!	Additional Measurement and Request CRC Measures temperature [°C] or [F]	a0011<CR><LF> Delay (1) seconds and number of values (1)
aMC3!	Additional Measurement and Request CRC Approximate calculation of dew point [°C] or [F]	a0011<CR><LF> Delay (1) seconds and number of values (1)
aMC4!	Additional Measurement and Request CRC Measures relative Humidity (%) / temperature / dew point [°C] or[F]	a0014<CR><LF> Delay (1) seconds and number of values (3)
aMC5!	Additional Measurement and Request CRC Approximate calculation of absolute humidity [g/m^3]	a0011<CR><LF> Delay (1) seconds and number of values (1)
aMC6!	Additional Measurement and Request CRC Estimates cloud base [m]	a0011<CR><LF> Delay (1) seconds and number of values (1)
aMC7!	Additional Measurement and Request CRC Rel.humidity/temperature/dew point/frost point/abs. humidity/estimated cloud base	a0016<CR><LF> Delay (1) seconds and number of values (6)
aMC8!	Additional Measurement and Request CRC Pressure [Pa] and altitude[m]	a0012<CR><LF> Delay (1) seconds and number of values (2)
aC!	Start Concurrent Measurement Measures relative humidity [%]	a0011<CR><LF> Delay (1) seconds and number of values (1)
aC1!	Additional Concurrent Measurement Measures relative humidity [%] /	a0012<CR><LF> Delay (1) seconds and number of values (2)

	temperature [°C] or [F]	
aC2!	Additional Concurrent Measurement Measures temperature [°C] or [F]	a0011<CR><LF> Delay (1) seconds and number of values (1)
aC3!	Additional Concurrent Measurement Approximate calculation of dew point [°C] or [F]	a0011<CR><LF> Delay (1) seconds and number of values (1)
aC4!	Additional Concurrent Measurement Measures relative Humidity (%) / temperature / dew point [°C] or[F]	a0014<CR><LF> Delay (1) seconds and number of values (3)
aC5!	Additional Concurrent Measurement Approximate calculation of absolute humidity [g/m^3]	a0011<CR><LF> Delay (1) seconds and number of values (1)
aC6!	Additional Concurrent Measurement Estimates cloud base [m]	a0011<CR><LF> Delay (1) seconds and number of values (1)
aC7!	Additional Concurrent Measurement Rel.humidity/temperature/dew point/frost point/abs. humidity/estimated cloud base	a0016<CR><LF> Delay (1) seconds and number of values (6)
aC8!	Additional Concurrent Measurement Pressure [Pa] and altitude[m]	a0012<CR><LF> Delay (1) seconds and number of values (2)
aCC!	Start Concurrent Measurement and Request CRC Measures relative humidity [%]	a0011<CR><LF> Delay (1) seconds and number of values (1)
aCC1!	Additional Concurrent Measurement and Request CRC Measures relative humidity [%] / temperature [°C] or [F]	a0012<CR><LF> Delay (1) seconds and number of values (2)
aCC2!	Additional Concurrent Measurement and Request CRC Measures temperature [°C] or [F]	a0011<CR><LF> Delay (1) seconds and number of values (1)
aCC3!	Additional Concurrent Measurement and Request CRC Approximate calculation of dew point [°C] or [F]	a0011<CR><LF> Delay (1) seconds and number of values (1)
aCC4!	Additional Concurrent Measurement and Request CRC Measures relative Humidity (%) / temperature / dew point [°C] or[F]	a0014<CR><LF> Delay (1) seconds and number of values (3)
aCC5!	Additional Concurrent Measurement and Request CRC Approximate calculation of absolute humidity [g/m^3]	a0011<CR><LF> Delay (1) seconds and number of values (1)

aCC6!	Additional Concurrent Measurement and Request CRC Estimates cloud base [m]	a0011<CR><LF> Delay (1) seconds and number of values (1)
aCC7!	Additional Concurrent Measurement and Request CRC Rel.humidity/temperature/dew point/frost point/abs. humidity/estimated cloud base	a0016<CR><LF> Delay (1) seconds and number of values (6)
aCC8!	Additional Concurrent Measurement and Request CRC Pressure [Pa] and altitude[m]	a0012<CR><LF> Delay (1) seconds and number of values (2)
aV!	Start Verification	a0000<CR><LF> Not supported
aRn!	Continuous Measurement	a<CR><LF> Not supported
aRCn!	Continuous Measurement and Request CRC	a<CRC><CR><LF> Not supported

Table 1 – Standard SDI-12 commands

3.9 Supported Extended Commands

Command	Description	Response
aXSNnnnnnn!	Set serial number (6 digits)	aX_OK<CR><LF>
aXC!	temperature unit Celsius (default factory setting)	aX_OK<CR><LF>
aXF!	temperature unit Fahrenheit	aX_OK<CR><LF>

Table 2 – Extended SDI-12 Commands

4 Application Example

This chapter is a practical guide on how to set up a TBSHT05/TBSHTP05 , interface it to a PC with a TBS03 SDI-12 to USB converter and carry out measurements.

4.1 Setting up TBSHT05/TBSHTP05 together with TBS03

4.1.1 Requirements

User Interface

Any hyper terminal (e.g.: Windows Hyper Terminal, Terminal V1.9B, RealTerm) or specific application software (e.g. LabVIEW VI)

Hardware Interface

PC or laptop with USB interface and mini USB-B cable (USB cable supplied with TBS03)

4.1.2 Driver

Silicon Labs CP210x driver must be installed on PC (on CD supplied with TBS03 or download from Silicon Labs)

Do not connect TBS03 to the PC, when starting the CP2102 driver installation process!

1) Start the driver installation executable

2) Follow the installation instructions step by step until the driver installation process is finished

3) The system may need to restart

4) Upon restart after successful driver installation (and not before), connect the TBS03 to the USB interface of the PC

5) Wait until you get the notification, that the new hardware has been installed and is ready to use.

Some terminal programs need manual COM port set up.

Open the hardware manager to check the COM port number assigned to the Silicon Labs USB bridge.

Every TBS03 device is serialized with an individual number. This enables the use of several TBS03's in parallel on a single PC or Laptop.

4.2 Hardware

- Connect the USB / SDI-12 Converter to PC via USB port.
- Connect the TBSHT05/TBSHTP05 SDI-12 interface to the TBS03 SDI-12 data Interface.

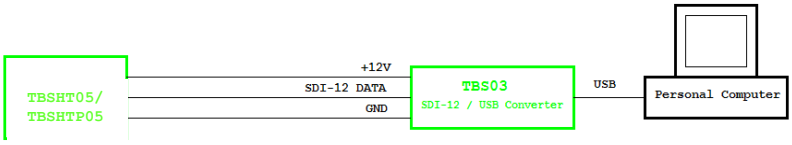

Figure 3 – Setup

4.2.1 Setting up the HyperTerminal application

- Open the hardware manager to check the COM port number assigned to the Silicon Labs USB bridge.
- Start the Windows HyperTerminal application.
- Connect to the COM Port assigned to the SDI-12 USB converter.
- Set the COM speed to 19200, 8 Bits, No Parity, 1 Stop Bit, No Handshake.
- In Settings, click "ASCII Setup" and activate "Send line ends with line feed" and "Echo typed characters locally".

4.3 Operation

4.3.1 SDI-12 / USB converter transfer mode

Every mode of TBS03 needs to be initialized with an ASCII string. Upon reception, the TBS03 will switch into the initialized mode and remain in this mode until the device receives an initialization string for another mode or the device gets disconnected. At the start up time, *"Transfer Mode"* is the default mode.

Transfer Mode initialisation:

In Windows hyper terminal, enter ***run sdi recorder*** and press the enter key (or <CR><LF>)

The TBS03 will respond with *ACK<CR><LF>*

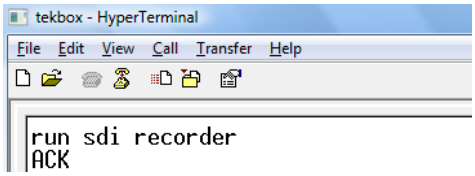

Figure 4 –TBS03 Transfer mode initialization using Windows Hyper Terminal

The TBS03 is now in transfer mode and ready to transfer commands to the sensor and respond data to the PC.

The following screenshots show how to communicate with the TBSHT05/TBSHTP05.

TBS03: Entering ***0I!*** <CR><LF> will respond with the sensor ID:

TBSHT05/TBSHTP05 response: 013TEKBOXVN_TBSHT05/TBSHTP05_V0.10_000001 *<CR><LF>*

Upon sending the ID command **0I!**, the sensor responds with SDI-12 compatibility level, Manufacturer name, Model name, Firmware release number and serial number

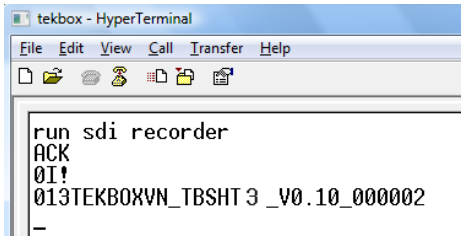

*Figure 5 – TBSHT03 (TBSHT05/TBSHTP05), sensor response to ID command **0I!***

TBS03: Entering ***0M!*** <CR><LF> will respond with:

TBSHT05/TBSHTP05 response: *00011 <CR><LF>*

which means that the sensor will be able to deliver 1 value after an acquisition time of 1 second

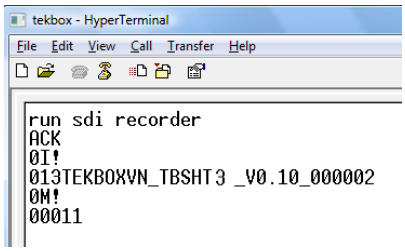

*Figure 6 – TBSHT03 (TBSHT05/TBSHTP05) response to Start Measurement command **0M!***

TBS03: Entering ***0D0!*** <CR><LF> will respond with:
Sensor response: *0+71.89 <CR><LF>*
where 71.89 is the measured air humidity level of 71.89%

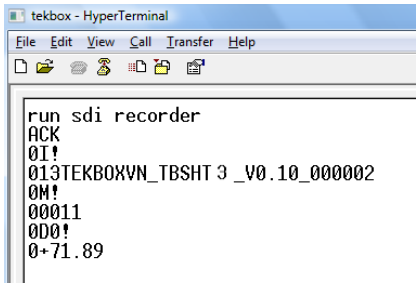

*Figure 7 – TBSHT03 (TBSHT05/TBSHTP05) response to Send Data command **0D!***

TBS03: Entering ***0M1!*** <CR><LF> will respond with:
TBSHT05/TBSHTP05 response: *00012 <CR><LF>*
which means that the sensor will be able to deliver 2 values after an acquisition time of 1 second
TBS03: Entering ***0D0!*** <CR><LF> will respond with:
Sensor response: *0+71.73+30.04 <CR><LF>*
where 71.73 is the measured air humidity level of 71.73% and 30.04 is the air temperature of 30.04°C

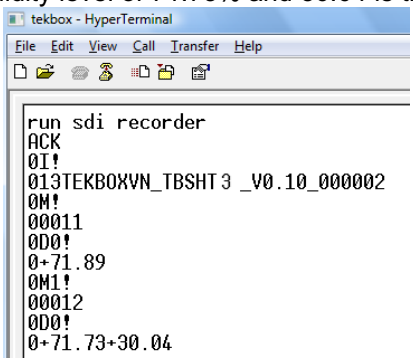

*Figure 8 –TBSHT03 (TBSHT05/TBSHTP05) response to commands **0M1!** and **0D!***

Other SDI commands will work similarly.

4.3.2 Auto-measurement mode

Auto-measurement mode is only available on TBS03 with option OTBS03-1 or option OTBS03-2

Like SDI Transfer commands, this application sends measurement commands which are set up by the user, to the SDI-12 / USB interface. Then, it automatically collects measured data by sending aDn! commands and transfers the data via USB Interface. After that, the next measurement command is started with a user defined time interval in between consecutive measurements. The maximum timer value is 4294967295ms. The maximum number of different SDI-12 measurement commands in an auto measurement string is 9. Auto-measurement mode is stopped by sending *stop* <CR><LF>

Syntax: run *auto <measurement command 1> <timer value 1> ... <measurement command n> <timer value n>*

Example of controlling a TBSHT05/TBSHTP05 in auto measurement mode:

TBS03: Entering ***run auto 0M4!*** **10000**<CR><LF> will respond with periodically measured temperature, humidity and dew point (frost point) values. The time interval between two consecutive measurements is 1000ms:

```
run auto 0M4! 1000
ACK

0M4!: 0+71.96+30.08+24.45
0M4!: 0+71.92+30.09+24.46
0M4!: 0+71.89+30.10+24.46
0M4!: 0+71.86+30.10+24.45
0M4!: 0+71.83+30.11+24.46
0M4!: 0+71.80+30.12+24.46
0M4!: 0+71.76+30.13+24.46
0M4!: 0+71.73+30.15+24.46
0M4!: 0+71.67+30.15+24.45
0M4!: 0+71.67+30.15+24.45
.
.
.
0M4!: 0+71.64+30.16+24.45
0M4!: 0+71.60+30.17+24.45
0M4!: 0+71.60+30.17+24.45
stop
ACK
```

5 Tools for TBS03

The TBS03 can be controlled using hyper terminals or customized PC application software. National Instruments, for example, offers a LabView SDI-12 API which could be used for designing customized applications for TBS03.

When using Hyper Terminal programs, take care that the representation of <CR><LF> may be different for different programs.

Windows Hyper Terminal requires activatation of “Send line ends with line feed” in ASCII setup and thereafter pressing the ENTER-key results in <CR><LF>

Many Hyper Terminal programs require \n at the end of each SDI-12 string – e.g. *0M!\n or run sdi recorder\n*

Terminal v1.9b – 20080315β – by Br@y ++ requires adding $0D$0A for <CR><LF>. This tool offers user defined macros for frequently used commands - a convenient feature when working with TBS03.

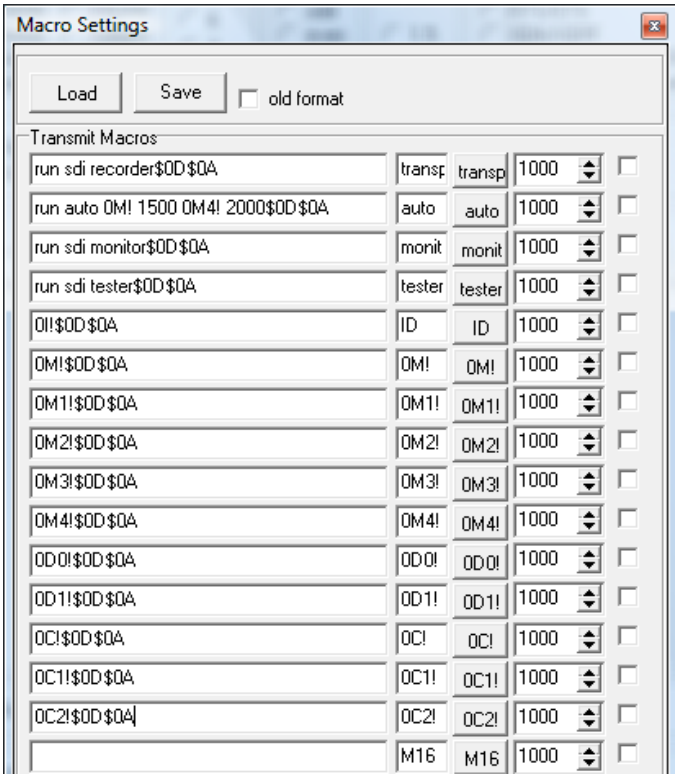

Figure 9 – Terminal v1.9b, defining Macros for mode initialization and SDI-12 commands

When manually entering commands in Terminal v1.9b, tick the CR=CR+LF and +CR box.

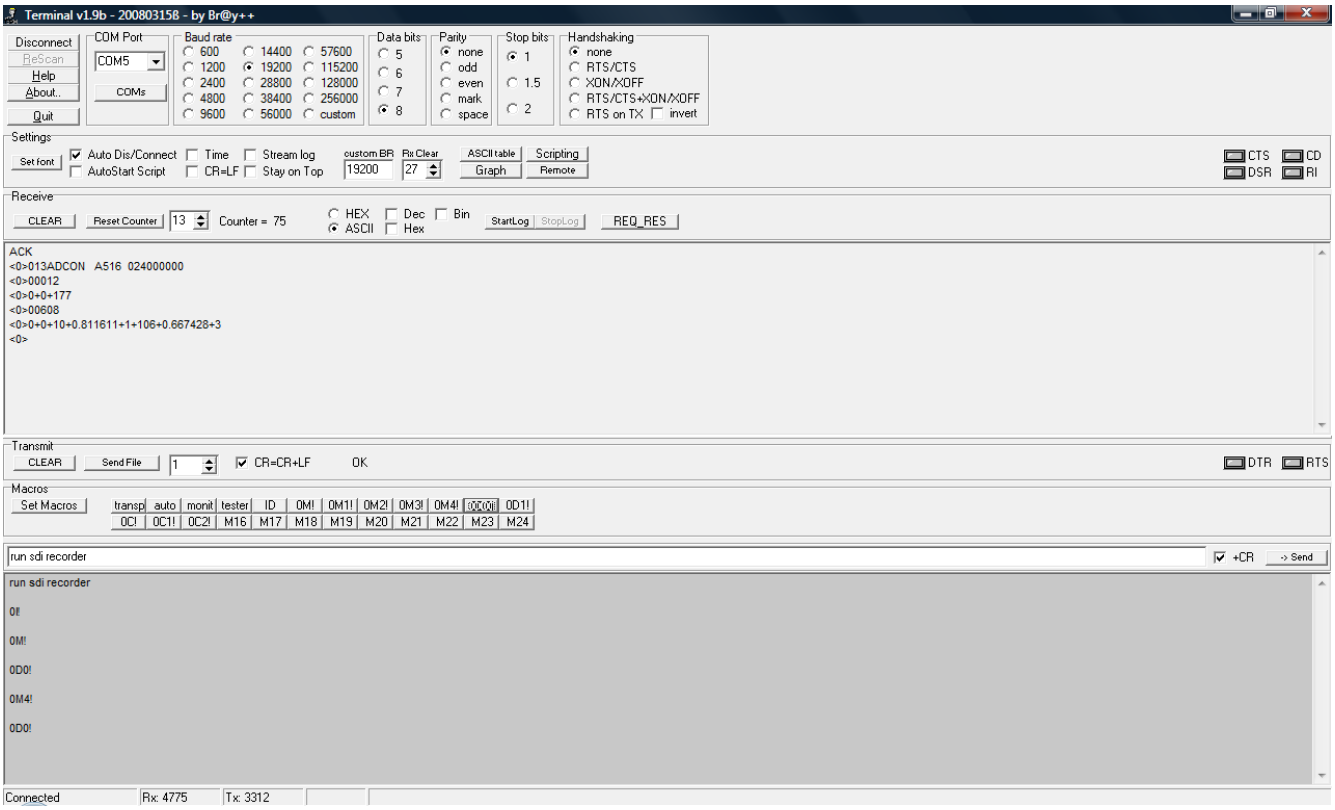

Figure 10 – Example set up of Terminal v1.9b

The above mentioned Hyper Terminal Programs are just examples to highlight that using such tools requires to take care of their way to handle <CR><LF>.

6 Technical Specifications

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Is	Supply current	Active mode	8	9	10	mA
Is	Supply current	Sleep mode	50	60	70	µA
Vs	Supply voltage		6	12	17	V
tm	Measurement Time	Time in active mode per measurement			700	ms
RH_{range}	Relative humidity measurement range		0		100	%RH
RH_{res}	Relative humidity resolution			0.01		%RH
RH_{tol}	Relative humidity accuracy tolerance			±2	see fig. 11	%RH
RH_h	Relative humidity hysteresis @ 25°C			±0.8		%RH
RH_{rep}	Relative humidity repeatability			±0.15		%RH
RH_{drift}	Relative humidity long term drift @25°C			<0.25		%RH / year
T_{range}	Temperature measurement range		-40		+85	°C
T_{res}	Temperature resolution			0.01		°C
T_{tol}	Temperature accuracy tolerance			±0.1	±0.12	°C
T_{res}	Temperature long term drift			<0.04		°C / year

Table 3 – Technical specifications ATRH sensor

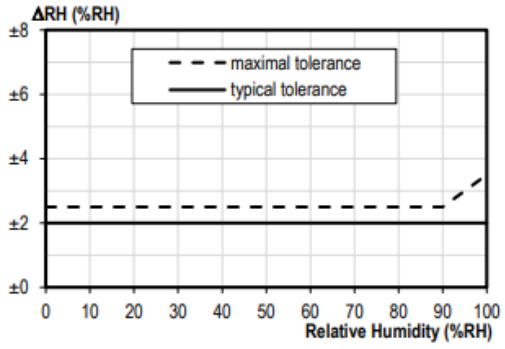

Figure 11 – RH, typical and maximum tolerance at 25°C

Parameter	Conditions	Min	Typ	Max	Unit
Barometric pressure range		300 9000	-	1100 -500	hPa m
Relative pressure accuracy	950 . . . 1050 hPa @ 25 °C		±0.12 ±1		hPa m
	700 … 900hPa 25 . . . 40 °C		±0.12 ±1		hPa m
Absolute pressure accuracy	300 . . . 1100 hPa 0 . . . +65 °C	-4	-1±1	+2	hPa
	300 . . . 1100 hPa -20 . . . 0 °C	-6	-1±1	+4.5	hPa
RMS noise			0.03 0.25		hPa m

Table 4 – Technical specifications pressure sensor

7 Environmental Specifications

Symbol	Parameter	Conditions	Min	Max	Unit
T_A	Operating Ambient Temperature Range		-40	+85	°C
T_{STG}	Storage Temperature Range		-50	+90	°C
	humidity level		0	100	%

Table 5 - Environmental Specifications

8 Cable Connection

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

Table 6 – Cable Connection

9 Ordering Information

Part Number	Description
TBSHT05	Air Humidity, Temperature, SDI-12 Interface
TBSHTP05	Air Humidity, Temperature, Barometric Pressure sensor, SDI-12 Interface
ATRH_FIL	Replacement filter cap, PTFE, 10µm pore diameter

Table 7 – Ordering Information

10 History

Version	Date	Author	Changes
V1.0	5.04.2015	Mayerhofer	Creation of the document
V1.1	20.12.2019	Mayerhofer	Table 4 update
V1.2	18.03.2020	Mayerhofer	Update from TBSHT(P)03 to new version TBSHT(P)05

Table 8 – History