The TBSHTP03 is an air humidity, temperature and barometric pressure sensor with SDI-12 interface. The sensing elements are located on a replaceable 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.

**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: 0.04% RH
- Air humidity accuracy tolerance:
  - 0% to 80%: typ. ±1.8%RH, max. ±2%RH
  - 80% to 100%: typ. ±3%RH, max. ±4%RH
- Barometric pressure range: 300-1100hPa (+9000 ... -500m above sea level)
- Barometric pressure resolution: 0.02hPa
- Barometric pressure accuracy: ±1hPa
- 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
TBSHTP03 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 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 TBSHTP03 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 – TBSHTP03 sensors connected to TBS03 SDI-12 to USB converter, setup for controlling / testing sensors and for PC based data recording

Figure 2 – TBSHTP03 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 TBSHTP03 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 TBSHTP03, the TBS03 extracts the corresponding ASCII strings and sends them to the USB Virtual COM Port of the PC.

In remote applications, the TBSHTP03 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 all!

```
allccccccccmmmmmmvvvxxxxxxxxxxx<CR><LF>
```

Example: 013TEKBOXVN_TBSHTP3_V0.10_000001 <CR><LF>

Where:
- 0         SDI-12 Sensor address
- 13        SDI-12 version number, version 1.3
- TEKBOXVN  Company name
- TBSHTP3   Model Name
- V0.10     Firmware version 0.10
- 000001    Serial number of TBSHTP03

### 3.4 Sensor Address

Each TBSHTP03 is delivered with a default address of “0”
The TBSHTP03 accepts SDI-12 addresses in the range “0” to “9”, “A” to “Z” and “a” to “z”. Setting the TBSHTP03 address can be done using the “Change Address Command” aAb!

Note:
- If the new address is invalid, the current address will be kept.
- The TBSHTP03 will remain unresponsive for approximately 1 second while the new address is saved in the EEPROM memory.
- The TBSHTP03 interface supports “?” as an address only for “Acknowledge Active” Command a!.
3.5 Measurement

The TBSHTP03 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 TBSHTP03 sensor interface will not support the “Continuous Measurement” Command aRn! and “Continuous Measurement and Request CRC” Command aRCn!. The TBSHTP03 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 TBSHTP03 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 / frost point [°C] or [F]
aM4! aMC4! aC4! aCC4! measure relative Humidity (%) / temperature / dew point (frost point) [°C] or[F]
aM5! aMC5! aC5! aCC5! approximate calculation of absolute humidity [g/m²]
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]

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!: Measure Relative Humidity [%]

<table>
<thead>
<tr>
<th>Command</th>
<th>Response</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>aM!</td>
<td>a0011&lt;CR&gt;&lt;LF&gt;</td>
<td></td>
</tr>
<tr>
<td>aD0!</td>
<td>a+9.25&lt;CR&gt;&lt;LF&gt;</td>
<td></td>
</tr>
<tr>
<td>aC!</td>
<td>a00101&lt;CR&gt;&lt;LF&gt;</td>
<td></td>
</tr>
<tr>
<td>aD0!</td>
<td>a+9.25&lt;CR&gt;&lt;LF&gt;</td>
<td></td>
</tr>
</tbody>
</table>

The value +9.25 is the relative humidity in [%]. The relative humidity is represented by up to 2 digits before and by two digits after the decimal point. (max. value 99.99)
aM1!, aC1! Measure Relative Humidity [%] and Air Temperature [°C]
### Command, Response, Comment

<table>
<thead>
<tr>
<th>Command</th>
<th>Response</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>aM1!</td>
<td>a0012&lt;CR&gt;&lt;LF&gt;</td>
<td></td>
</tr>
<tr>
<td>aD0l</td>
<td>a+hh.hh+tt.tt&lt;CR&gt;&lt;LF&gt;</td>
<td>The sign will change to – for negative temperatures</td>
</tr>
</tbody>
</table>

Value nn.nn: Relative Humidity  
Value mm.mm: Air Temperature value

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

<table>
<thead>
<tr>
<th>Command</th>
<th>Response</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>aM2!</td>
<td>a0011&lt;CR&gt;&lt;LF&gt;</td>
<td></td>
</tr>
<tr>
<td>aD0l</td>
<td>a+tt.tt&lt;CR&gt;&lt;LF&gt;</td>
<td>The sign will change to – for negative temperatures</td>
</tr>
</tbody>
</table>

#### aM3!, aC3!: Measure Dew Point

<table>
<thead>
<tr>
<th>Command</th>
<th>Response</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>aM3!</td>
<td>a0011&lt;CR&gt;&lt;LF&gt;</td>
<td></td>
</tr>
<tr>
<td>aD0l</td>
<td>a+dd.dd&lt;CR&gt;&lt;LF&gt;</td>
<td>The sign will change to – for negative temperatures</td>
</tr>
</tbody>
</table>

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

- RH: relative humidity [%]
- T: Temperature [°C]
- TK: Temperature in Kelvin [K]
- TD: dew point temperature [°C]
- PV: vapour pressure [hPa]
- PVsat: saturated vapour pressure [hPa]
- CE: 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)
- mw = 18.016 kg (molecular weight of water vapour)
- AH = absolute humidity in g water vapour per m³ of air

**Formulas:**

- PVsat = 6.1078 * 10^((a*T)/(b+T))
- PV = (RH/100) * PVsat
- TD = (b * v)/(a-v) where v = log10(PV / 6.1078)
- TK = T + 273.15
- AH = 10^5 * (mw / R') * (PV / TK)
- CE = (T-TD) * 120

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

<table>
<thead>
<tr>
<th>Command</th>
<th>Response</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>aM4!</td>
<td>a0013&lt;CR&gt;&lt;LF&gt;</td>
<td></td>
</tr>
<tr>
<td>aD0l</td>
<td>a+hh.hh+tt.tt+dd.dd&lt;CR&gt;&lt;LF&gt;</td>
<td>The sign will change to – for negative temperatures</td>
</tr>
</tbody>
</table>

#### aM5!, aC5!: approximate calculation of absolute humidity [g/m³]
### 3.8 Supported SDI-12 Commands

Following commands are supported by the TBSHTP03:

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>a!</td>
<td>Acknowledge Active</td>
<td>a&lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td>all</td>
<td>Send Identification</td>
<td>allccccccalllllllllllllllllllllllll&lt;CR&gt;&lt;LF&gt; Identification information</td>
</tr>
<tr>
<td>aAb!</td>
<td>Change Address</td>
<td>b&lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td>?!</td>
<td>Address Query</td>
<td>a&lt;CR&gt;&lt;LF&gt;</td>
</tr>
</tbody>
</table>

Example:

```
OM8!
00012
0DO!
0+100813.64+42.66
```
### 3.9 Supported Extended Commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>aXSNnnnnnnn!</td>
<td>Set serial number (6 digits)</td>
<td>aX_OK&lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td>aXC!</td>
<td>temperature unit Celsius (default factory setting)</td>
<td>aX_OK&lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td>aXF!</td>
<td>temperature unit Fahrenheit</td>
<td>aX_OK&lt;CR&gt;&lt;LF&gt;</td>
</tr>
</tbody>
</table>

Table 2 – Extended SDI-12 Commands
4 Application Example

This chapter is a practical guide on how to set up a TBSHTP03, interface it to a PC with a TBS03 SDI-12 to USB converter and carry out measurements.

4.1 Setting up TBSHTP03 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 TBSHTP03 SDI-12 interface to the TBS03 SDI-12 data Interface.
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>

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 TBSHTP03.

TBS03: Entering 0I! <CR><LF> will respond with the sensor ID:
TBSHTP03 response: 013TEKBOXVN_TBSHTP03_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

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 TBSHTP03.

TBS03: Entering 0M! <CR><LF> will respond with:
TBSHTP03 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 (TBSHTP03) 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 (TBSHTP03) response to Send Data command 0D!

TBS03: Entering 0M1! <CR><LF> will respond with:
TBSHTP03 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 (TBSHTP03) 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 TBSHTP03 in auto measurement mode:

TBS03: Entering run auto 0M4! 1000<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+30.11+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 activation 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.

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>.

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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is</td>
<td>Supply current</td>
<td>Active mode</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>mA</td>
</tr>
<tr>
<td>Is</td>
<td>Supply current</td>
<td>Sleep mode</td>
<td>50</td>
<td>60</td>
<td>70</td>
<td>µA</td>
</tr>
<tr>
<td>Vs</td>
<td>Supply voltage</td>
<td></td>
<td>6</td>
<td>12</td>
<td>17</td>
<td>V</td>
</tr>
<tr>
<td>tm</td>
<td>Measurement Time</td>
<td>Time in active mode per measurement</td>
<td></td>
<td></td>
<td>700</td>
<td>ms</td>
</tr>
<tr>
<td>RH_range</td>
<td>Relative humidity measurement range</td>
<td></td>
<td>0</td>
<td>100</td>
<td>%RH</td>
<td></td>
</tr>
<tr>
<td>RH_res</td>
<td>Relative humidity resolution</td>
<td></td>
<td>0.01</td>
<td></td>
<td>%RH</td>
<td></td>
</tr>
<tr>
<td>RH_tol</td>
<td>Relative humidity accuracy tolerance</td>
<td></td>
<td>±1.8</td>
<td></td>
<td>%RH</td>
<td>see fig. 13</td>
</tr>
<tr>
<td>RH_h</td>
<td>Relative humidity hysteresis</td>
<td></td>
<td>±1</td>
<td></td>
<td>%RH</td>
<td></td>
</tr>
<tr>
<td>RH_rep</td>
<td>Relative humidity reproducibility</td>
<td></td>
<td>±0.2</td>
<td></td>
<td>%RH</td>
<td></td>
</tr>
<tr>
<td>RH_drift</td>
<td>Relative humidity long term drift @25°C</td>
<td></td>
<td>&lt;0.5</td>
<td></td>
<td>%RH / year</td>
<td></td>
</tr>
<tr>
<td>T_range</td>
<td>Temperature measurement range</td>
<td></td>
<td>-40</td>
<td>+85</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>T_res</td>
<td>Temperature resolution</td>
<td></td>
<td>0.01</td>
<td></td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>T_tol</td>
<td>Temperature accuracy tolerance</td>
<td></td>
<td>±0.1</td>
<td>±0.12</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>T_res</td>
<td>Temperature long term drift</td>
<td></td>
<td>&lt;0.04</td>
<td></td>
<td>°C / year</td>
<td></td>
</tr>
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</table>

Table 3 – Technical specifications ATRH sensor

![Graph showing typical and maximal tolerance at 25°C for relative humidity](image)

Figure 11 – RH, typical and maximum tolerance at 25°C
### Table 4 – Technical specifications pressure sensor

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

#### 7 Environmental Specifications

<table>
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<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>$T_A$</td>
<td>Operating Ambient Temperature Range</td>
<td></td>
<td>-40</td>
<td>+85</td>
<td>°C</td>
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<tr>
<td>$T_{STG}$</td>
<td>Storage Temperature Range</td>
<td></td>
<td>-50</td>
<td>+90</td>
<td>°C</td>
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<td>humidity level</td>
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<td></td>
<td>0</td>
<td>100</td>
<td>%</td>
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#### 8 Cable Connection

<table>
<thead>
<tr>
<th>Cable Colour</th>
<th>Signal Assignment</th>
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</thead>
<tbody>
<tr>
<td>Red</td>
<td>SDI-12 Power</td>
</tr>
<tr>
<td>White</td>
<td>SDI-12 Data</td>
</tr>
<tr>
<td>Blue</td>
<td>GND</td>
</tr>
<tr>
<td>Black</td>
<td>Shield (GND)</td>
</tr>
</tbody>
</table>

Table 6 – Cable Connection
9 Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>TBSHT03</td>
<td>Air Humidity, Temperature, Barometric Pressure sensor, SDI-12 Interface 4-wire PU cable (SDI-12 Power, SDI-12 Data, GND, Shield), cable length: 3m, other length upon order</td>
</tr>
<tr>
<td>TBSHTP03-SB</td>
<td>Sensor board replacement</td>
</tr>
<tr>
<td>TBSHTP03-FL</td>
<td>Filter replacement</td>
</tr>
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</table>

Table 7 – Ordering Information

10 History

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Author</th>
<th>Changes</th>
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<tbody>
<tr>
<td>V1.0</td>
<td>5.04.2015</td>
<td>Mayerhofer</td>
<td>Creation of the document</td>
</tr>
</tbody>
</table>

Table 8 – History