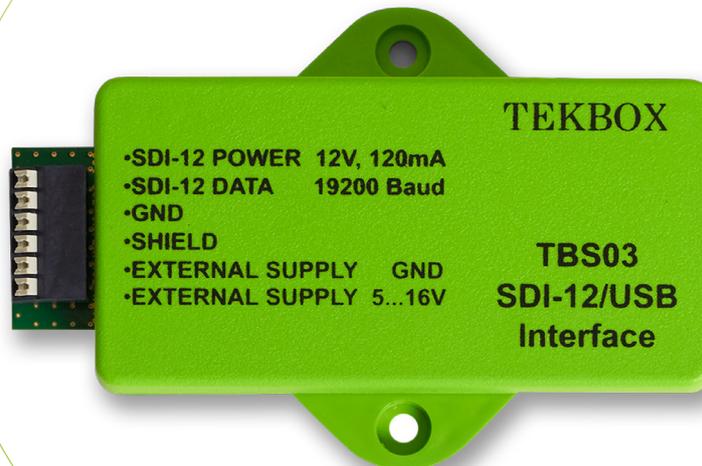


## SDI-12 / USB CONVERTER MANUAL



The TBS03 SDI-12/USB Converter is an Interface Box for connecting a PC to one or more sensors with a SDI-12 interface. The TBS03 connects to the PC USB interface and provides a SDI-12 compliant supply and data interface. The TBS03 is a versatile tool for everyone who designs sensors and data recorders or who installs, tests or maintains SDI-12 based data acquisition systems.

It is available in three variants – one option adds auto measurement and SDI-12 interface monitoring capability and another option adds test cases for SDI-12 protocol testing.

V1.3

TBS03

## FEATURES

- SDI-12 / USB Interface
- Transfer Mode
- Auto-measurement Mode
- SDI-12 Monitor Mode
- SDI-12 Tester Mode
- SDI-12 Standard V1.3
- Data rate: 19200 Baud
- Simple Driver Installation
- USB powered
- Provides 12V, 120mA sensor supply voltage
- Auxiliary power supply interface for higher current requirements
- Spring loaded terminal block
- Mini-USB-B connector
- Operating Temperature Range: -40°C - +85°C

## TARGET APPLICATIONS

- SDI-12 Data Recording
- SDI-12 Field Installations
- SDI-12 Interface Debugging
- SDI-12 Sensor Testing



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## 1. INTRODUCTION

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 meters of 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)  
www.sdi-12.org**

The latest standard is version V1.3 and 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 6.

TBS03 implements all functions for interfacing a SDI-12 sensor with a Personal Computer.

It is a plug and play solution for controlling or testing of SDI-12 compatible products.

### 1.1 PRODUCT FEATURES

**The TBS03 is based on a low power controller and robust SDI-12 interface hardware:**

- 5V, 1200 baud SDI-12 data interface with transient protection
- Mini USB-B connector
- Spring loaded terminal block for SDI-12 and auxiliary power
- Virtual COM Port data rate: 19200 baud
- 12V, 120mA sensor supply voltage
- Auxiliary power supply for higher sensor current requirements
- Basic version: Transfer mode; Option 01 adds SDI-12 auto measurement and SDI-12 interface monitoring capability; Option 02 adds test cases for SDI-12 sensor testing.
- Operating temperature range: -40 - +85°C

## 2. APPLICATION

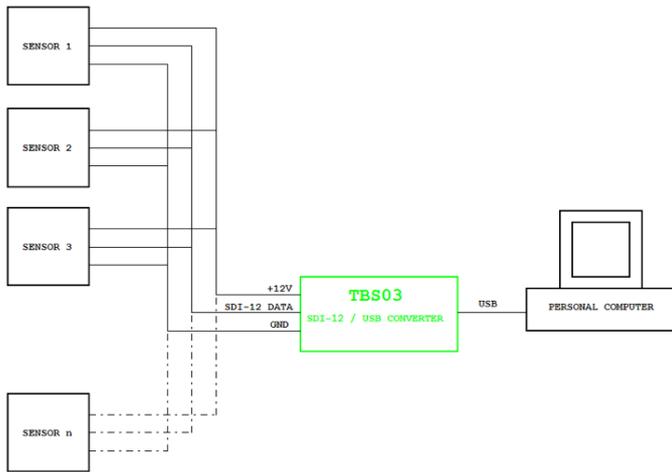


Figure 1 –TBS03 Application, standard setup for controlling / testing sensors and for PC based data recording

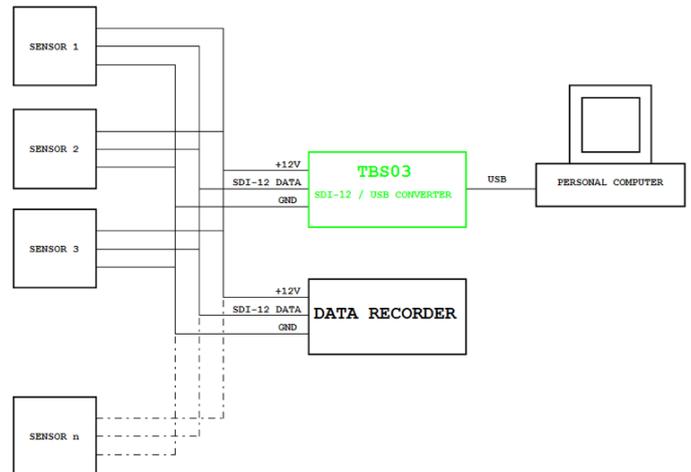


Figure 2 –TBS03 Application, standard setup for testing / monitoring SDI-12 based data recording installations

## 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 generated by the data recorder/controller firmware. The TBS03 can be controlled by a PC application or a hyper terminal and converts the command strings to the

logic levels and baud rate specified by the SDI-12 standard. Furthermore, the TBS03 handles breaks, marks and all other details of the SDI-12 protocol.

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

## 4. SDI-12 TRANSFER MODE

Transferring SDI-12 commands from USB-Interface to a SDI-12 Interface:



Figure 3 –TBS03 basic application; setup for transfer mode

This application is built based on a SDI-12 Recorder Protocol Stack Module. It receives commands from the USB Interface (e.g. user controlled via Hyper Terminal or via PC Application), and transfers the commands to the SDI Interface, waits for sensor response and transfers

the response (measurement results, etc.) back to the USB Interface where it can be accessed via Hyper Terminal or a PC Application. All standard SDI commands and the SDI scan bus command are supported. More details are described in section 7.1.

### 4.1. SDI-12 RECORDER – AUTO MEASUREMENT MODE<sup>1)</sup>

The User / PC Application can initialise an automatic periodic measurement of connected sensors. Upon sending an information configuration string, the TBS03 automatically starts to issue measurement commands.

Like SDI Transfer commands, this application sends measurement commands which are set up by the user, to the SDI-12 interface. After that, it automatically transfers collected measured data via USB interface.



Figure 4 –TBS03 application; setup for auto measurement mode

The auto measurement application uses “aDn!” Commands and transfers the data via the USB Interface. After each measurement, the next measurement command is started with a definable time interval inbetween consecutive measurements.

The maximum timer value is 4294967295ms. The maximum number of auto measurement commands is 9. More details are described in section 7.2.

1) requires option OTBS03-1 or OTBS03-2

## 4.2 SDI-12 RECORDER – AUTO MEASUREMENT MODE<sup>1)</sup>

In SDI-12 monitor mode, TBS03 monitors the data traffic between recorder and sensor(s). This feature is useful in setting up or debugging SDI-12 installations. More details are described in section 7.3.

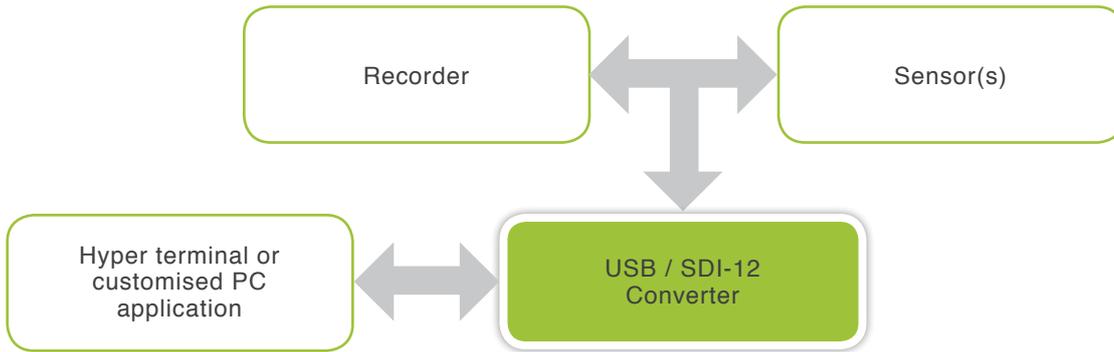


Figure 5 –TBS03 application; setup for monitor mode

2) requires option OTBS03-1 or OTBS03-2

## 4.3 SDI-12 TESTER MODE<sup>3)</sup>

The SDI-12 Tester function can be used to carry out various SDI-12 V1.3 compliance tests with connected sensors. More details are described in section 7.4.



Figure 6 –TBS03 application; setup for SDI-12 tester mode

3) requires option OTBS03-2

## 4.4 POWER SUPPLY

The TBS03 derives its internal supply voltages from the USB power line. +12V SDI Power supply voltage is created by an internal step up converter. Due to the limited current capabilities of the USB interface, the 12V sensor supply output is limited to max. 120mA.

In case of higher sensor supply current requirements, the TBS03 provides connectivity to an external power supply at its terminal block.

Upon connection of an external supply voltage in the range of 10,5V – 16V, the internally generated sensor supply voltage gets disconnected and the external supply will be switched to the SDI-12 Power terminal of the TBS03. The supply path for the external voltage is internally protected with a 250mA polyfuse.

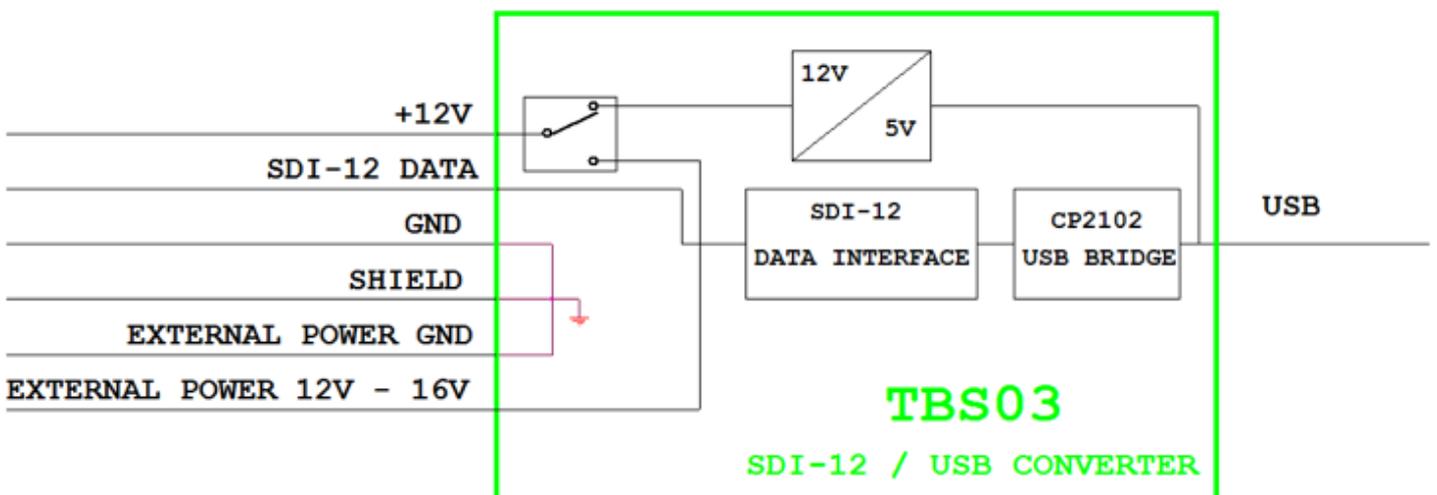


Figure 7 –TBS03 Block Diagram

## 5. TERMINAL BLOCK PIN ASSIGNMENT AND DESCRIPTION

### 5.1. PIN LIST

This table shows the pin names, their type (DIO-digital input/output, P-power), and the corresponding supply domain.

#	PIN NAME	TYPE	DOMAIN	DESCRIPTION
1	SDI-12 POWER	P	12V	SDI-12 Sensor Supply Voltage
2	SDI-12 DATA	DIO	5V	SDI-12 Data Interface
3	GND			Ground
4	SHIELD			Cable shield, Ground
5	EXTERNAL POWER GROUND			Ground
6	EXTERNAL POWER 12V – 16V	P		External Supply Voltage Input

Table 1 – Pin list

### 5.2. PIN DESCRIPTIONS

#### 5.2.1. SDI-12 POWER

12V sensor supply output. Maximum current: 120mA, if the TBS03 is supplied from USB. This output is protected against reverse current/voltage. Protected with a 500mA resettable fuse.

#### 5.2.2. SDI-12 SERIAL DATA INTERFACE – SDI-12\_DATA

Bi-directional serial data interface port. SDI-12\_DATA is low in idle state.

#### 5.2.3. GND

Ground.

#### 5.2.4. SHIELD

Connection for SDI-12 cable shield. Connected to Ground.

#### 5.2.5. EXTERNAL POWER GND

Ground terminal for the connection of an external power supply.

#### 5.2.6. EXTERNAL POWER 12V-16V

In case of sensors with a current requirement > 120mA, or in case of sensors with high inrush current, the internal 12V supply will not be sufficient. The external power terminal provides connectivity for an external power supply. As soon as an external voltage > 5V gets connected to this terminal, it will be automatically switched to the SDI-12 power terminal.

## 6. ELECTRICAL CHARACTERISTICS

### 6.1. ABSOLUTE MAXIMUM RATINGS

Stress above the limits listed in the following table may cause permanent failure. Exposure to absolute ratings for extended time periods may affect device reliability. The limiting values are in accordance with the Absolute Maximum Rating System (IEC 134). All voltages are referenced to ground.

SYMBOL	PARAMETER	CONDITIONS	MIN	MAX	UNIT
	SDI-12 DATA	-	-0.5	7	V
	SDI-12 POWER		-	500 <sup>(1)</sup>	MA
VEXT	EXTERNAL POWER 12V-16V		-	17	V
VES	ELECTROSTATIC HANDLING <sup>(2)</sup> & <sup>(3)</sup>		-	2000	V

Table 2 - Absolute maximum ratings

<sup>(1)</sup> Internal polyfuse: 250mA; trip time at 500mA: 3s

<sup>(2)</sup> Tested according to MIL883C Method 3015.6 (Standardized Human Body Model: 100 pF, 1500Ω, 3 pulses, protection related to substrate).

<sup>(3)</sup> Static and dynamic latch-up values are valid at room temperature.

## 6.2. ELECTRICAL SPECIFICATIONS

Temperature TA = 20°C, USB powered, unless otherwise stated

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
SDI-12 DATA TERMINAL						
VIL	INPUT LOW VOLTAGE LEVEL		-0.5	0	1	V
VIH	INPUT HIGH VOLTAGE LEVEL		3.5	5	5.5	V
VOH	OUTPUT LOW VOLTAGE LEVEL		-0.5	0	1	V
VOL	OUTPUT HIGH VOLTAGE LEVEL		3.5	5	5.5	V
SDI-12 POWER TERMINAL						
V_SDI_PI	SENSOR SUPPLY VOLTAGE		11.5	12	12.5	V
I_SDI_PI	SENSOR SUPPLY CURRENT				120	MA
V_SDI_PE	SENSOR SUPPLY VOLTAGE	EXTERNALLY POWERED	5	12	16	V
I_SDI_PE	SENSOR SUPPLY CURRENT	EXTERNALLY POWERED			250	MA
OPERATING TEMPERATURE RANGE			-40 to +85			°C

Table 3 - Electrical Specifications

## 7. SDI-12 BASICS

SDI-12 is a serial data communication standard for interfacing multiple sensors with a data recorder. The 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 are 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 0!

0 is the sensor address (sensor zero). Upon receiving this command, the sensor will send an ASCII string containing sensor address, a 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 00302 which means the measurement will take 30 seconds and deliver two values.

After min. 30 seconds, the data recorder can send the Read Data Command "0D0!" to which Sensor 0 might reply 0+27+1050. +27+1050 is the two measurement results which may be 27°C and 1050 milibar.

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.

## 8. SETTING UP TBS03

### 8.1. REQUIREMENTS

#### 8.1.1. USER INTERFACE

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

#### 8.1.2. HARDWARE INTERFACE

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

#### 8.1.3. 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 have to restart.
- 4) Upon restart after successful driver installation – and not before-, connect TBS03 to the USB interface of the PC.
- 5) Wait until you get the notification, that new hardware is installed and ready to use.



## 9. OPERATION

### 9.1. SDI-12 / USB CONVERTER TRANSFER MODE

Every mode of the 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 initialisation 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>)

TBS03 will respond with ACK<CR><LF>

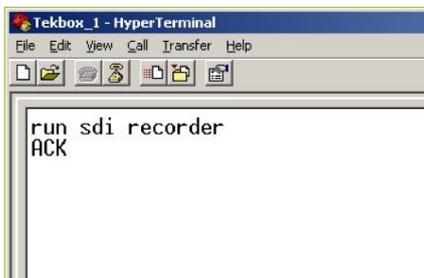


Figure 8 –TBS03 Transfer mode initialization using Windows Hyper Terminal

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

The following screenshots show how to communicate with a sensor. The TBS03 is connected to an ADCON GPS Compass Sensor, Model A516. When using a TBS03 for controlling any sensor, first read the corresponding sensor manual with respect to available SDI-12 commands and presentation of data.

TBS03:                    Entering 0I! <CR><LF> will respond with the sensor ID:  
Sensor response: 013ADCON A516 023000034<CR><LF>

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 use of several TBS03 in parallel on a single PC or Laptop.

### 8.2. HARDWARE

- Connect the USB / SDI-12 Converter to PC via USB port.
- Connect the TBS03 SDI-12 data interface to the sensor SDI-12 data Interface.
- Supply the sensor with external power if the connected sensor(s) have a current consumption >120mA.

#### 8.2.1. 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

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 9 –TBS03 Transfer mode, sensor response on ID command 0I!

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

Sensor response: 00012 <CR><LF>

Which means that the sensor will be able to deliver two values after an acquisition time of 1 second.

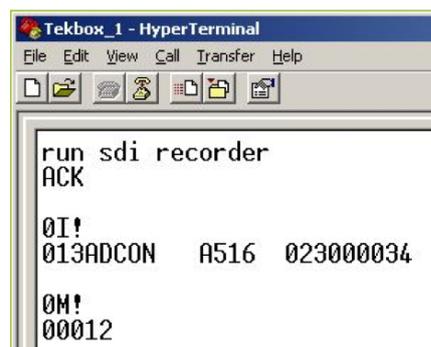


Figure 10 –TBS03 Transfer mode, sensor response on Start Measurement command 0M!

TBS03:            Entering 0D0! <CR><LF> will respond with:  
 Sensor response: 0+1+247 <CR><LF>  
 Where 1 means that the sensor is in calibrated state and 247 is the  
 compass heading of 247°

```

Tekbox_1 - HyperTerminal
File Edit View Call Transfer Help

run sdi recorder
ACK
0I!
013ADCON A516 023000034
0M!
00012
0D0!
0+1+247
  
```

**Figure 11 –TBS03 Transfer mode, sensor response on Send Data command 0D!**  
 Other SDI commands will work similarly.

## 9.2. AUTO-MEASUREMENT MODE

Auto-measurement mode is only available on a 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. After that, it automatically collects measured data by sending aDn! commands and transfers the data via a USB Interface.

Then, the next measurement command is started with a user defined time interval inbetween consecutive measurements.

The maximum timer value is 4294967295ms. The maximum number of 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 USING AN ADCON GPS COMPASS SENSOR, MODEL A516:

TBS03: Entering run auto 0M! 2000<CR><LF> will respond with periodically measured compass heading values. The time interval between two consecutive measurements is 2000ms:

```

Tekbox_1 - HyperTerminal
File Edit View Call Transfer Help

run auto 0M! 2000
ACK
0M!: 0+1+236
0M!: 0+1+236
0M!: 0+1+254
0M!: 0+1+260
0M!: 0+1+267
0M!: 0+1+274
0M!: 0+1+282
0M!: 0+1+287
0M!: 0+1+292
0M!: 0+1+298

Tekbox_1 - HyperTerminal
File Edit View Call Transfer Help

0M!: 0+1+330
0M!: 0+1+335
0M!: 0+1+342
0M!: 0+1+348
0M!: 0+1+355
0M!: 0+1+1
0M!: 0+1+5
0M!: 0+1+16
0M!: 0+1+24
0M!: 0+1+29
stop
ACK
  
```

**Figure 12 –TBS03 auto-measurement mode, periodical measurement of compass sensor heading**

### EXAMPLE USING AN ADCON GPS COMPASS SENSOR, MODEL A516:

TBS03: Entering run auto 0M! 1000 0M4! 1000 0M3! 1500<CR><LF> will respond with periodically measured compass heading values, longitude, latitude, altitude, HDOP, PDOP, VDOP and number of satellites in fix. The time intervals between the measurement commands 0M!, 0M4! and 0M3! are 1000ms. After each measurement sequence there is a 1500ms break.

```

Tekbox_1 - HyperTerminal
File Edit View Call Transfer Help

run auto 0M! 1000 0M4! 1000 0M3! 1500
ACK
0M!: 0+0+176
0M4!: 0+0+10+0.811776+1+106+0.667263+3+7.7
0M3!: 0+1+3+1.8+2.5+6
0M!: 0+0+176
0M4!: 0+0+10+0.811776+1+106+0.667263+3+7.7
0M3!: 0+1+3+1.8+2.5+6
0M!: 0+0+176
0M4!: 0+0+10+0.811776+1+106+0.667263+3+7.7
  
```

**Figure 13 –TBS03 auto-measurement mode, periodical measurement using 3 measurement commands**

### 9.3. SDI-12 MONITOR MODE

The SDI-12 monitor mode is only available on a TBS03 with option OTBS03-1 or option OTBS03-2

In SDI-12 monitor mode, the TBS03 is connected in parallel to a data recorder and sensor(s) and monitors the data on the SDI-12 interface. SDI-12 monitor mode is initialized by entering run sdi monitor<CR><LF>

#### EXAMPLE:

COMMAND	EXPECTED RESPONSE	EXPLANATION
RUN SDI MONITOR	ACK	START MONITOR MODE
	0C! 000206 0D0! 0+20.34+30.12+30.23+30.23+30.23+45.23 0C! 000206 0D0! 0+20.34+30.12+30.23+30.23+30.23+45.23	DATA TRAFFIC ON SDI-12 INTERFACE
STOP	ACK	STOP MONITOR MODE

Table 4 – SDI-12 Monitor Mode

### 9.4. SDI-12 TESTER

THIS APPLICATION RUNS TEST CASES TO CHECK SDI-12 PROTOCOL V 1.3 COMPLIANCE OF SENSORS. THE SDI-12 / USB CONVERTER CAN TEST:

- All SDI-12 commands (With the exception of: extended SDI-12 commands);
- If sensors correctly respond to a break (from 6.5ms to 26.656 ms );
- If sensors are able to wake up within 100 milliseconds after a break;
- If sensors are able to respond within 15 milliseconds after receiving the last byte of a valid command;
- If sensors are able to return to low power standby mode;
- If sensors are able to reset receiving a command process when a mark is detected during reception of a command;
- If sensors are able to reset upon receipt of an invalid address or a break while processing a measurement command;
- If sensors are able to continue concurrent measurements and to abort concurrent measurements.

#### EXAMPLE:

COMMAND	RESPONSE	EXPLANATION
RUN SDI TESTER	Press: '1': Break Timing Test '2': Low Power Standby Mode Test '3': Response Time Test. '4': Continuous concurrent measurement test '5': SDI-12 Commands Test. "abort 0M!": Aborting Measurements Test "abort 0C!": Aborting Concurrent Measurement Test "continue 0C!": Continue Concurrent Measurements Test 'h' or '?' : help instruction.	Help / Start various test cases

## EXAMPLE (CONTINUED):

COMMAND	RESPONSE	EXPLANATION
1	Break Timing 6.0ms: No Response Break Timing 6.1ms: No Response Break Timing 6.2ms: No Response Break Timing 6.3ms: No Response Break Timing 6.4ms: Response Break Timing 6.5ms: Response Break Timing 6.6ms: Response Break Timing 6.7ms: Response ... Break Timing 27.1ms: Response Break Timing 27.2ms: Response Break Timing 27.3ms: Response Break Timing 27.4ms: Response Break Timing 27.5ms: No Response Break Timing Testing Finish	Break Timing function Check
2	Low power standby mode test: success	Low power standby function check
3	Response Timing 0: success	Response Timing function check
4	Timing distance between two commands 100ms: Response Timing distance between two commands 99ms: Response Timing distance between two commands 98ms: Response ... Timing distance between two commands 2ms: Response Timing distance between two commands 1ms: Response Continuous Operation Test finished	Continuous Operation Test
5	Address Query: Response Acknowledge Active: Response Send Identification: Response Change Address: Response Start Measurement: Response 0M1!: Response ... Start Measurement and Request CRC : Response ... Start Concurrent Measurement: Response ... Start Concurrent Measurement and Request CRC : Response ... 0R0!: Response ... 0D0!: Response ... SDI-12 Commands Test Finished	SDI-12 Commands Test

## EXAMPLE (CONTINUED):

COMMAND	RESPONSE	EXPLANATION
abort 0M!	Break after 1ms measurement: Passed Break after 101ms measurement: Passed . . Break after 701ms measurement: Passed Break after 801ms measurement: Passed Break after 901ms measurement: Passed 0M!: Aborting Measurements Test finished	Continuous Operation Test
continue 0C!	Break after 1ms measurement: Continue concurrent measurement passed Break after 101ms measurement: Continue concurrent measurement passed ... Break after 801ms measurement: Continue concurrent measurement passed Break after 901ms measurement: Continue concurrent measurement passed	Continue function check

Table 5 – SDI-12 Tester Mode

## 10. 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.

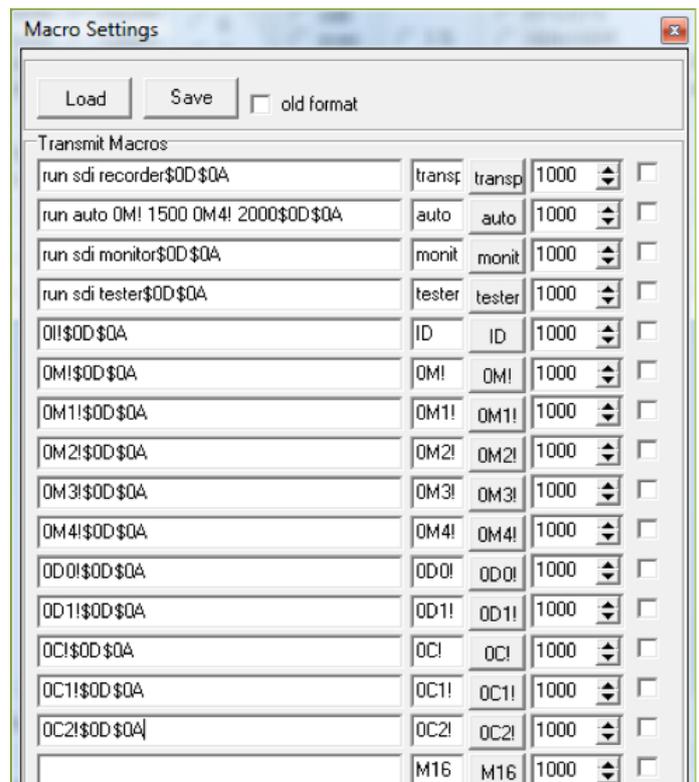


Figure 14 – Terminal v1.9b, defining Macros for mode initialization and SDI-12 commands

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

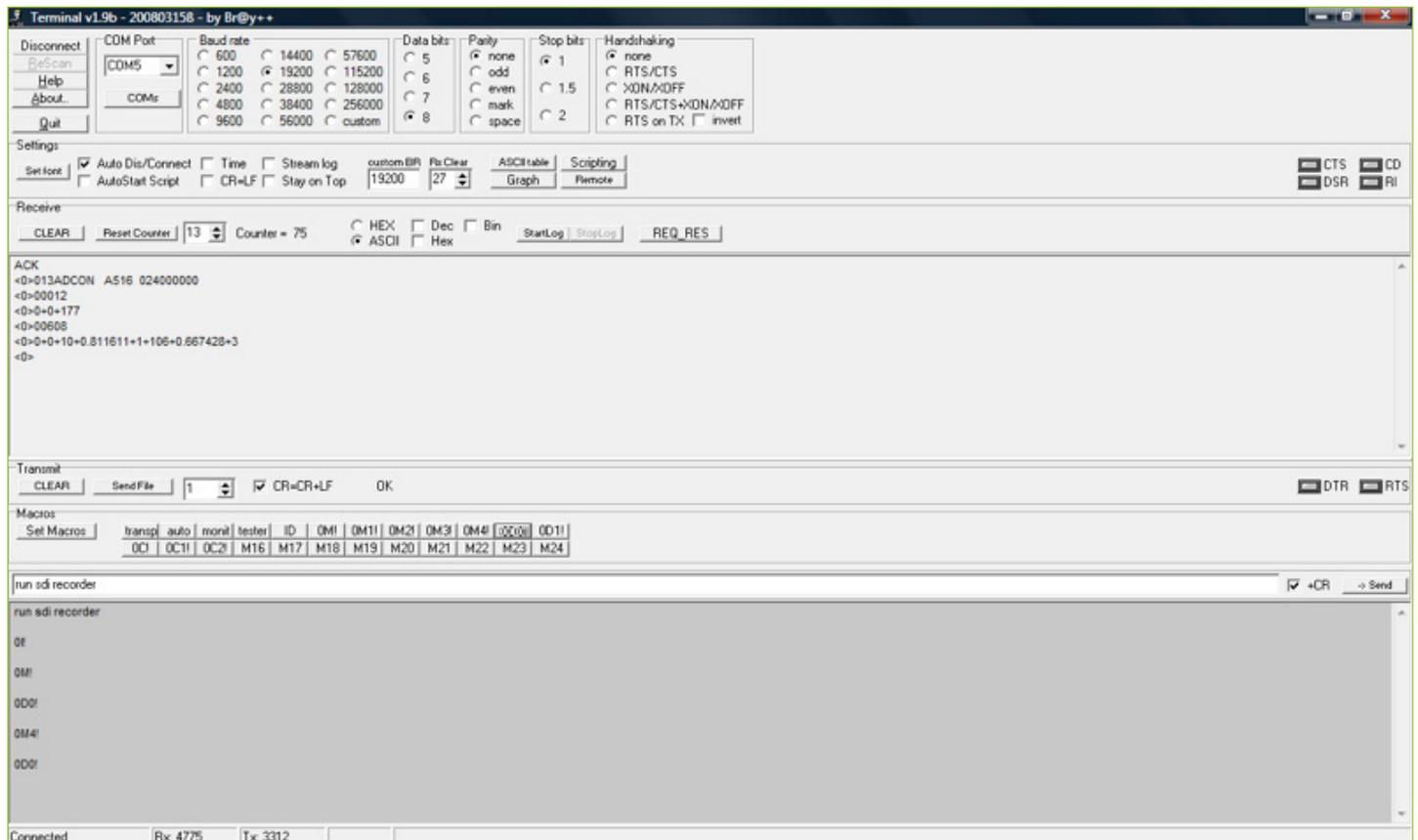


Figure 15 –Example set up of Terminal v1.9b

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

Tekbox offers a free customizable terminal program, SDI-12 Commander Lite. Sensors can be arranged in Tabs and SDI-12 commands can be assigned to buttons. SDI-12 Commander Lite and the corresponding manual can be downloaded from the Tekbox website.

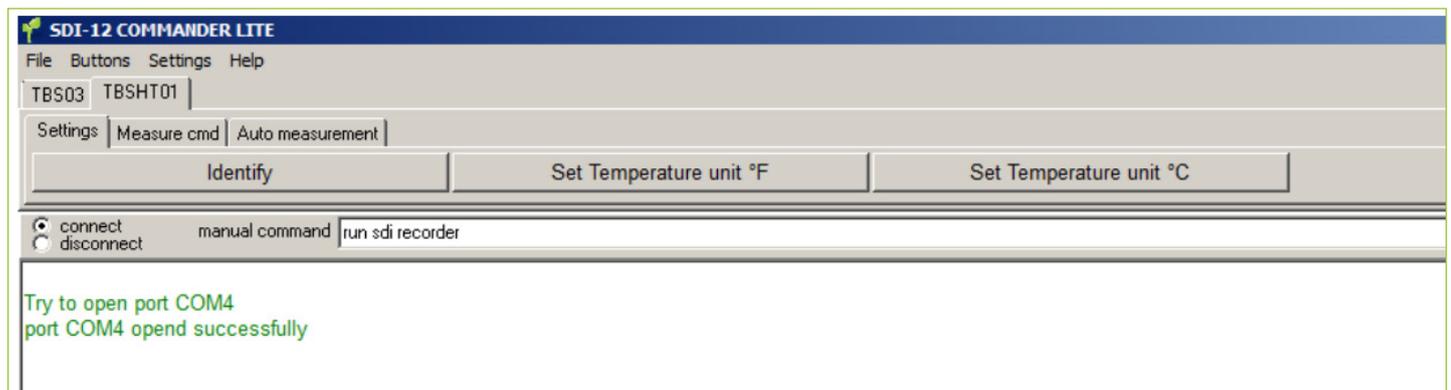


Figure 16 – example configuration of SDI-12 Commander Lite

## 11. ENVIRONMENTAL SPECIFICATIONS

SYMBOL	PARAMETER	CONDITIONS	MIN	MAX	UNIT
TA	OPERATING AMBIENT TEMPERATURE RANGE		-40	+85	°C
TSTG	STORAGE TEMPERATURE RANGE		-40	+85	°C
	HUMIDITY LEVEL	TA=60°C NO CONDENSATION	-	95	% R.H

Table 6 - Environmental Specifications

## 12. ORDERING INFORMATION

PART NUMBER	DESCRIPTION
TBS03	SDI-12 / USB converter, Transfer Mode
TBS03/OTBS03-1	SDI-12 / USB CONVERTER, TRANSFER MODE, AUTO-MEASUREMENT MODE, SDI-12 MONITOR MODE
TBS03/OTBS03-2	SDI-12 / USB CONVERTER, TRANSFER MODE, AUTO-MEASUREMENT MODE, SDI-12 MONITOR MODE, SDI-12 TESTER MODE

*Table 7 – Ordering Information*

## 13. HISTORY

VERSION	DATE	AUTHOR	CHANGES
V1.0	14.03.2010	L.T.THANG	CREATION OF THE DOCUMENT
V1.1	05.03.2010	ANH NGUYEN	UPDATE
V1.2	19.01.2010	MAYERHOFER	UPDATE
V1.3	19.02.2010	MAYERHOFER	UPDATE

*Table 8 – History*