Contents

1. Introduction

This document briefly explains how to set up a TBSMP01 to carry out volumetric soil moisture measurements using the TBS03 USB to SDI-12 converter. The TBS03 interfaces to a PC with Docklight V1.9 used as terminal program.
It is assumed that the user is familiar with the basics of the SDI-12 protocol.
Instead of the TBS03, any other SDI-12 converter or data logger can be used.
Communication with the probe is based on ASCII commands, so any serial terminal software can be used.

2. Set up

Step 1)
Install Docklight V1.9 or any other serial terminal software on your computer.

Download link for Docklight V1.9:
http://www.docklight.de/download_en.htm

Step 2)
Connect the TBSMP02 soil moisture probe to the TBS03 SDI-12 to USB converter according to figure 1.
The probe comes with default address 0, so unless the address is not changed, all SDI-12 commands start with 0. The measured result later on will depend on where the probe is placed – on the desk, in water or in soil.

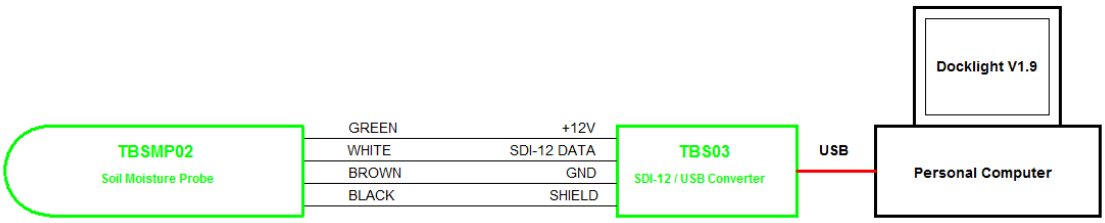

Figure 1 – hardware set up

Step 3)
Open the Hardware Manager on your computer and determine the COM port number assigned to the TBS03.
Set up COM port in Docklight V1.9

Baud rate	19200
Databits	8
Parity	none
Stopbits	1
Handshake	none

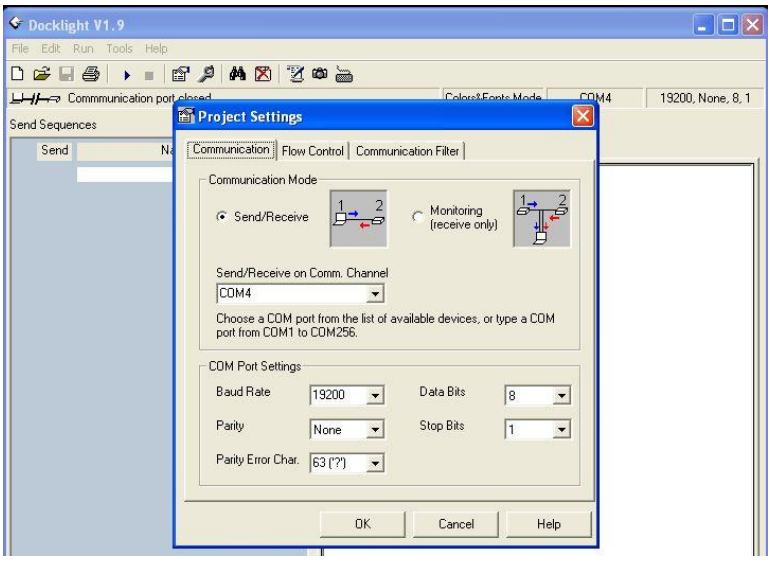

Figure 2 – COM port set up

2.1 Set up SDI-12 commands in Docklight V1.9

In order to avoid repeated entering of ASCII commands, Docklight V1.9 has a feature to define buttons which upon pressing send defined ASCII strings. Each string has to be terminated with *r n*, representing carriage return/line feed.

Step 1)

Define following buttons / SDI-12 command strings in Docklight V1.9:

Initialize TBS03	run sdi recorder
Identify	0I!rn
Select Soil Type 3	0XGS3!rn
Polynomial Calibration	0XSC1!rn
Measure soil moisture	0M!rn
Measure temperature	0M2!rn
Get meas. result	0D0!rn

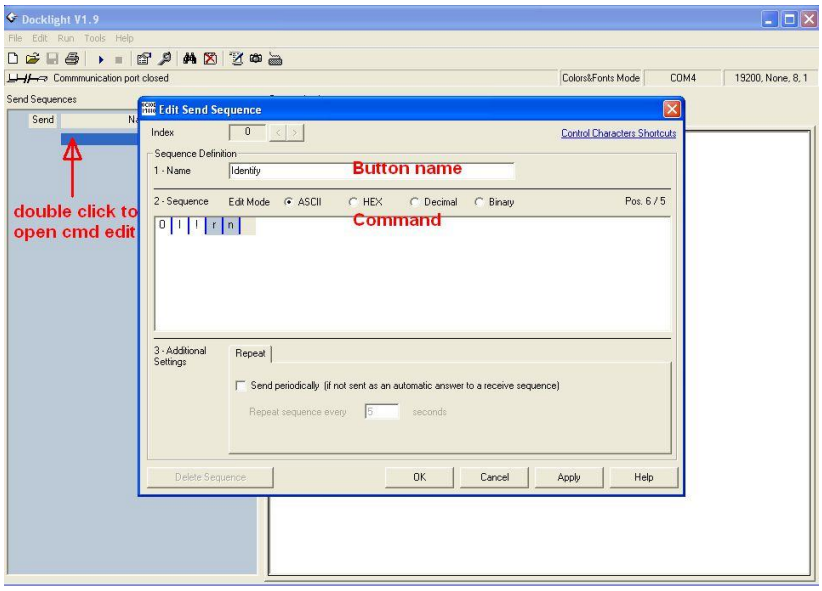

Figure 3 – define buttons / SDI-12 commands

Step 2)

Connect to PC:

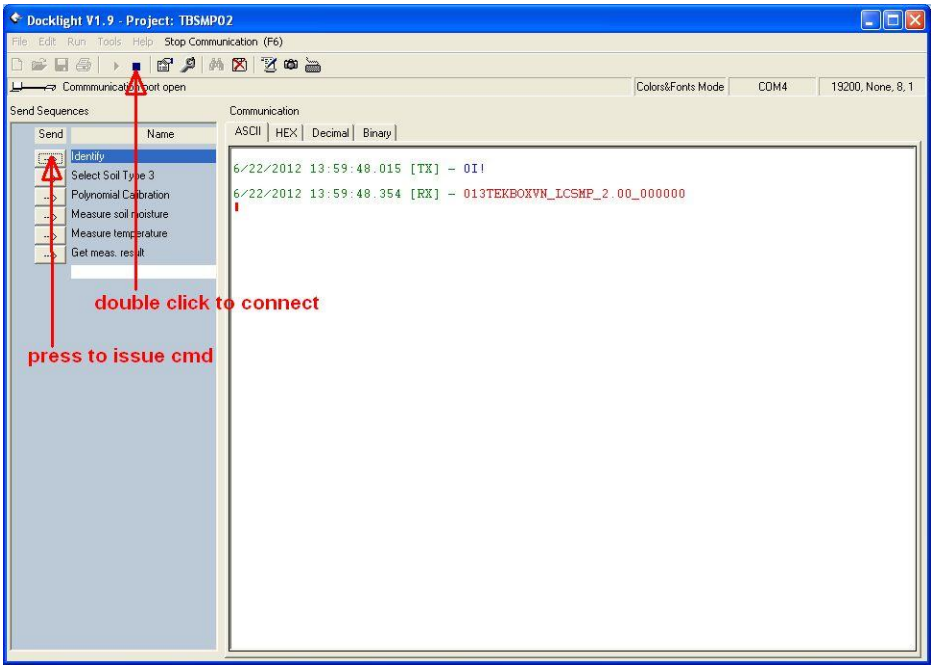

Figure 4 – connect to PC

3. Verify the set up

Send following ASCII string (non SDI-12 related) to initialize the TBS03:
run sdi recorder
Send following command to verify that the setup is working correctly:
0I!
The probe will respond with its ID:
013TEKBOXVN_LCSMP_2.00_000000

4. Volumetric soil moisture measurement

The TBSMP02 is factory calibrated to air/water and 3 soil types and comes with default settings suitable for most applications.

- Soil type 0: air/water calibration; not soil specific – air = 0%, water = 100%
- Soil type 1: sand
- Soil type 2: Potting soil
- Soil type 3: 50% sand + 50% Potting soil

Calibration of the TBSMP02 in other soil types is subject of the TBSMP02 calibration manual.

Step 1)
Select soil type:
In order to configure the probe for soil type 3, send following SDI-12 command:
0XGS3! 0 is the probe address; 3 refers to soil type 3

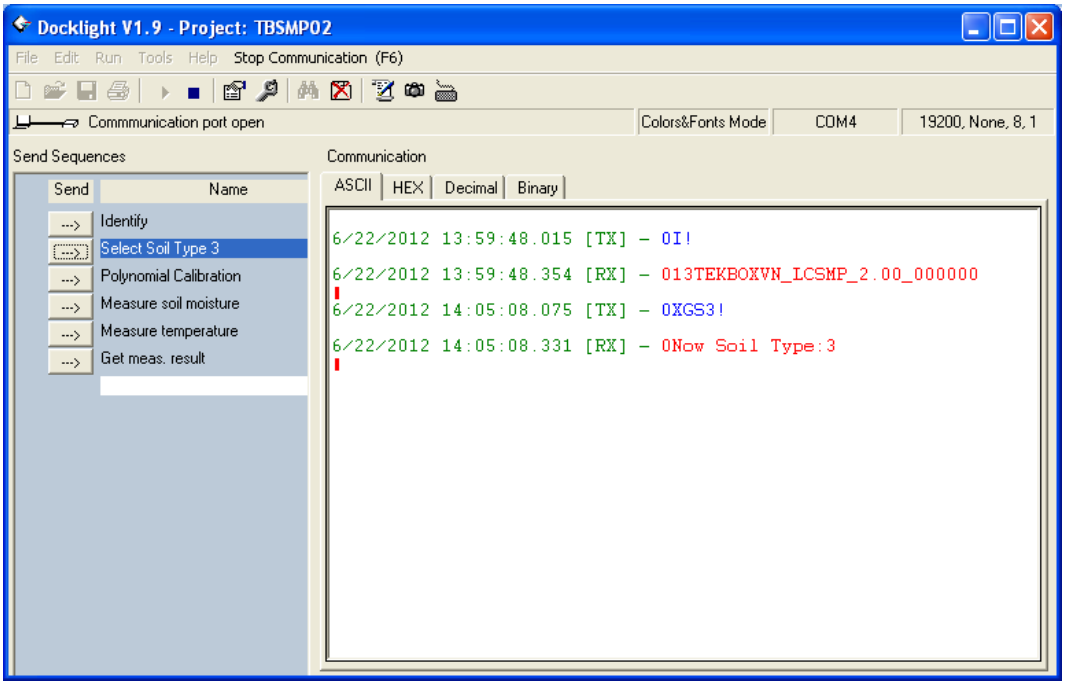

Figure 5 – configure the probe for soil type 3

Step 2)
Select calibration method:
The TBSMP02 supports 2 methods – Min/Max and polynomial calibration. Min/Max is a linear approximation; Polynomial calibration gives better accuracy in soil types with high organic content.
In order to select polynomial calibration, send following SDI-12 command:
0XSC1! 0 is the probe address; 1 refers to polynomial calibration (0 for Min/Max calibration; in case of soil type 0, the probe will automatically select air water calibration without need for an additional command)

Step 3)
Measure volumetric soil moisture:
Step 1 and step 2 provided the configuration commands for soil type 3 and polynomial calibration. The configuration is stored in the non volatile memory of the probe, so the configuration commands do not need to be repeated unless any change of the configuration is intended.

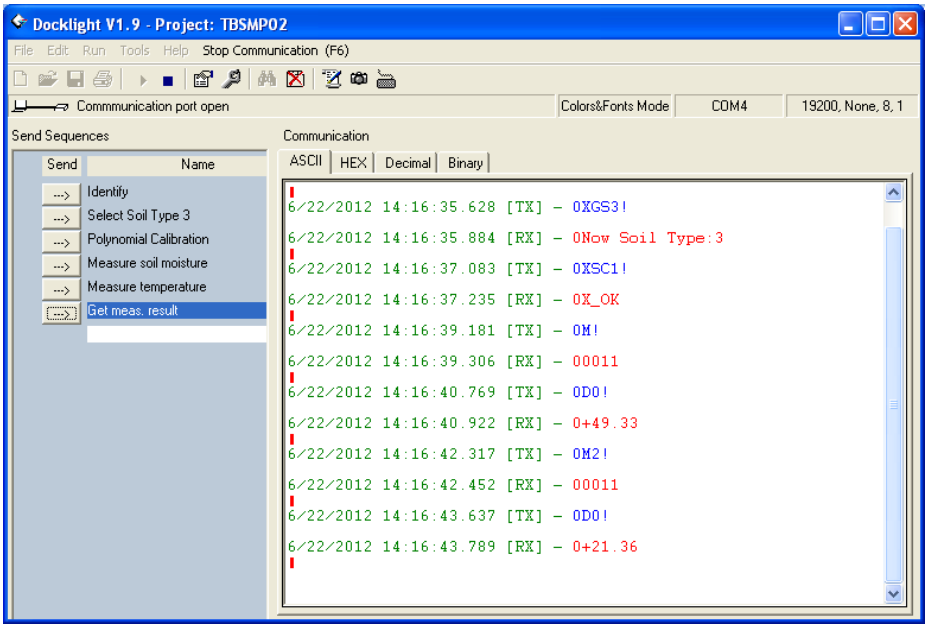

Figure 6 – configure the probe to use polynomial calibration

Send 0M! to initiate measurement of volumetric soil moisture.
The probe will respond with 00011, which means one measurement result will be available for query after 1 second.
Send 0D0! to query the measurement result.
The probe will respond with 49.33 (49.33%volumetric soil moisture). The result will depend on the setup of the probe.
Send 0M2! and 0D0! to measure temperature.

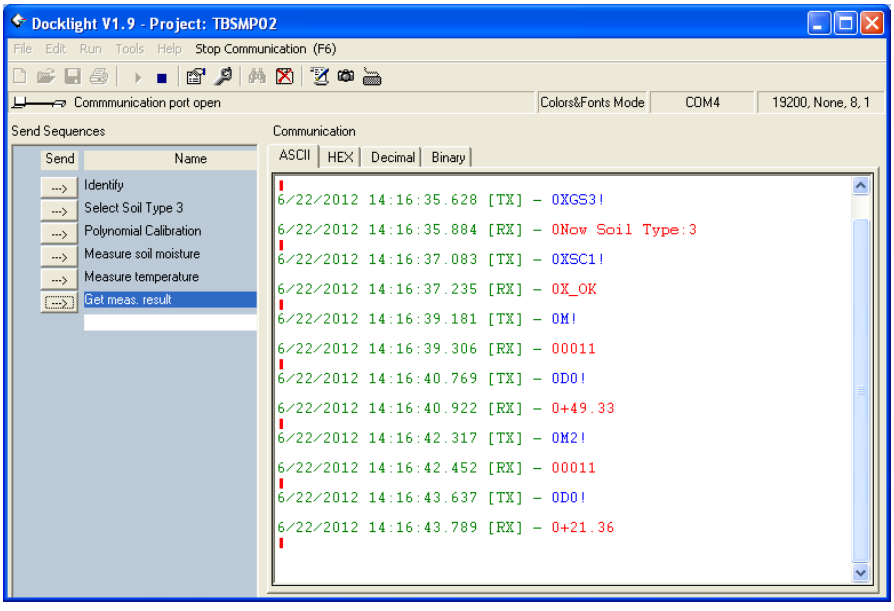

Figure 7 – measure volumetric soil moisture and temperature

5. Command overview

5.1 Supported Standard SDI-12 Commands

Following standard SDI-12 commands are supported by the soil moisture probe:
a represents the sensor address, **<CR>** represents carriage return and **<LF>** represents line feed.

Command	Description	Response
a!	Acknowledge Active	**a<CR><LF>**
aI!	Send Identification	**allccccccccmmmmmmvvvxxxxxxxxxxxxx<CR><LF>** Identification information
aAb!	Change Address	**b<CR><LF>** Changing the probe sensor address
?!	Address Query	**a<CR><LF>**
aM!	Start Measurement	**atttn<CR><LF>** Delay (ttt) in seconds and number of values (n) up to 9
aMn!	Additional Measurement	**atttn<CR><LF>** Delay (ttt) in seconds and number of values (n) up to 9 A response of a0000<CR><LF> is provided indicating the additional measurement are not supported in sensor
aMC!	Start Measurement and Request CRC	**a0000<CR><LF>** Supported
aMCn!	Additional Measurement and Request CRC	**a0000<CR><LF>** Supported
aC!	Start Concurrent Measurement	**atttnn<CR><LF>** Delay (ttt) in seconds and number of values (nn) up to 20
aCn!	Additional Concurrent Measurement	**a0000<CR><LF>** Not supported
aCC!	Start Concurrent Measurement and Request CRC	**a0000<CR><LF>** Not supported
aCCn!	Additional Concurrent Measurement and Request CRC	**a0000<CR><LF>** Not supported
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

For more details refer to the official SDI-12 standard which can be downloaded from:

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 V1.3 and dates from July 18th 2005.

5.2 Supported Extended Commands

Command	Description	Response
aXSTnn.mm!	Set the soil type coefficient ; nn.mm : 00.00 to 99.99. The soil type coefficient (nn.mm) is represented as: 01.00 to 99.99; depending on the soil type, the moisture levels are divided by this coefficient. Default value is 01.00; "n.m" is always in 4 digits format. [a] is the sensor address Application: by default, the soil type coefficient is set to "1". Changing the soil type coefficient can be used, if any scaling of the soil moisture level value is required. It is however recommended to make a soil specific calibration instead.	**aX_OK<CR><LF>**
aXCA!	Soil Moisture Air Calibration [a] is the sensor address Application: by default, the sensor is already calibrated to air. Placing the sensor in air and then sending the **aXCA!** command triggers a re-calibration	**aX_OK<CR><LF>**
aXCW!	Soil Moisture Water Calibration [a] is the sensor address Application: by default, the sensor is already calibrated to water. Placing the sensor in water and then sending the **aXCW!** command triggers a re-calibration	**aX_OK<CR><LF>**
aXCTsnn.nn!	Soil Temperature Calibration [a] is the sensor address s:sign nn.nn : 00.00 ->±99.99 example : 0XCT+01.00! , add 1 degree Celsius to measured value Application : temperature calibration; factory calibrated by default	**aX_OK<CR><LF>**
aXSAnn!	Set number of samples for averaging Max value nn = 10 [a] is the sensor address Application: averaging; default value is "1"	**aX_OK<CR><LF>**
aXSPnn!	Set number of samples for gliding average Max value nn = 10 [a] is the sensor address Application: gliding averaging; default value is "0"	**aX_OK<CR><LF>**
aXSD!	Restore all parameters to default values 1. Sensor address: 0 2. Soil scaling coefficient: 1 3. Temperature unit: Celsius 4. Temperature offset: 0 5. Soil type: 0; air/water calibration 6. Polynomial coefficients: a = 0; b = 0; c = 1; d = 0 7. Calibration method: Min-max To restore default parameters for soil type 1, 2, 3, refer to Table 3	**aX_OK<CR><LF>**
aXSMt,dry,sat, max!	Set parameters for Min/Max calibration [a] is the sensor address [t],1...9 is the number assigned to the soil type [dry] is the value of dry soil measured in air/water calibrated mode [sat] is the value of saturated soil measured in air/water calibrated mode [max] is the real volumetric value of saturated soil (volume of water required to reach saturation/volume of dry soil) 4 digits per coefficient; the decimal point may be at any position	**aX_OK <CR><LF>**
aXSSt,a,b,c,d!	Set coefficients for polynomial calibration: ax^3+bx^2+cx+d [a] is the sensor address [t],1...9 is the number assigned to the soil type [a, b, c, d] are the polynomial coefficients max. 7 digits for a, b; max. 5 digits for c, d; the decimal point may be at	**aX_OK <CR><LF>**

	any position	
aXGSt!	Select soil type for measurement [a] is the sensor address [t],1...9 is the number assigned to the soil type (see associated numbers below) The TBSMP02 will store all calibration parameters of each soil type in the EEPROM; before measurement, initialize the soil type (once). **Soil Type** **Associated number** Default 0 - not soil specific; uses air/water calibration only Sand 1 Potting soil 2 50% mineral / 50%organic 3 User defined 4…..9	**aNow Soil Type:t <CR><LF>**
aXSCn!	Set calibration method [a] is the sensor address [n] = 0: Min/Max calibration [n] = 1: polynomial calibration The TBSMP02 will store the calibration method setting in the EEPROM; before measurement, initialize the calibration method (once).	**an<CR><LF>**
aXGA!	Query number of samples for set for averaging	**an<CR><LF>**
aXGP!	Query number of samples for set for gliding average	**an<CR><LF>**
aXGT!	Query soil type	**an.m<CR><LF>**
aXGCT!	Query temperature calibration offset	**asn.m<CR><LF>**

Table 2 – Extended SDI-12 Commands

6. HISTORY

Version	Date	Author	Changes
V 1.0	20.06.2012	Nguyen Phu Thinh	Creation of the document