V1.4

User Guide TBS12

PC GUI for TBS12 configuration

Table of Contents

1 Introduction

SDI12-LoRa GUI is .NET-based utility program that can interface to SDI-12 LoRa module through UART (COM) connection. It can be used as a tool to set up operational parameters (time settings, SDI-12 commands, LoRaWan settings) and send commands to SDI-12 sensors or LoRaWan module on the board (TBS12) and display received responses on the GUI.

2 Hardware setup

Because UART (COM) pins on the TBS12 have TTL signal levels, so we need a mediate circuit to convert these signals to real COM or virtual USB-COM signals that can connect to PC.

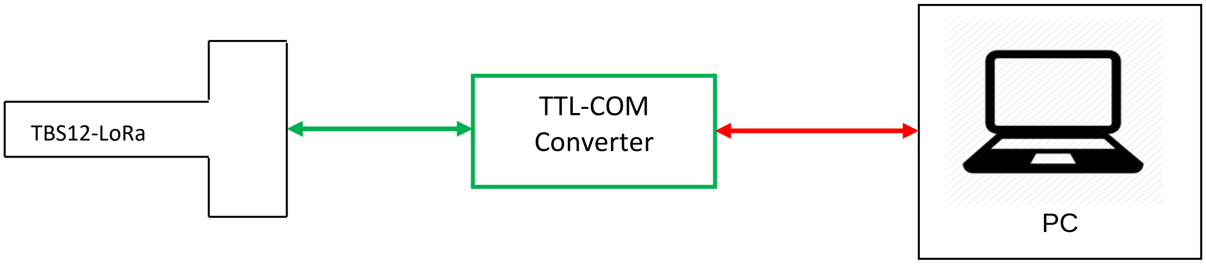


Fig1. Hardware Connection Diagram

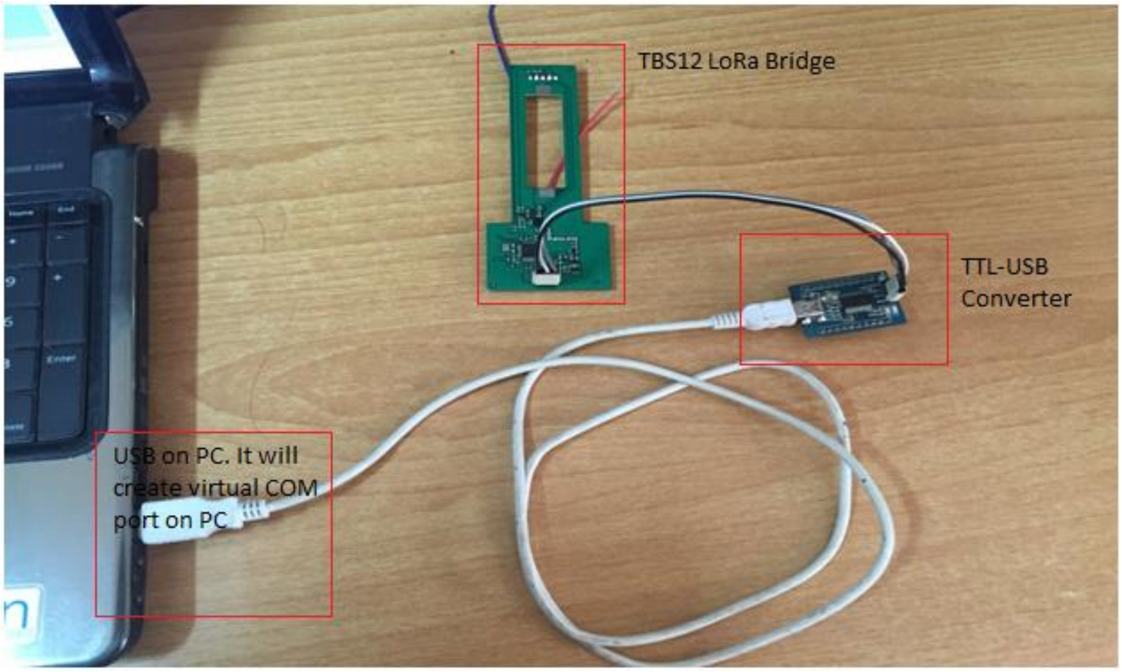
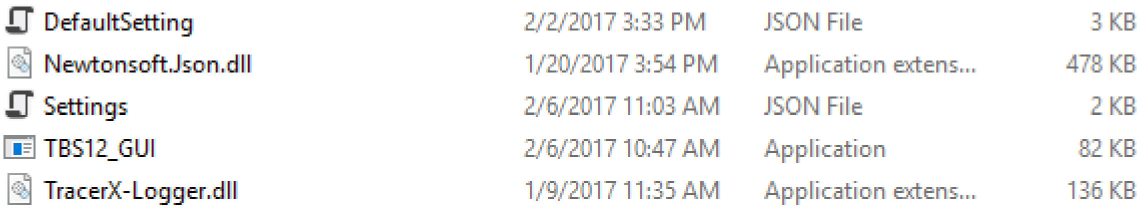


Fig2. Real Hardware Connection

3 Software dependencies and application's files

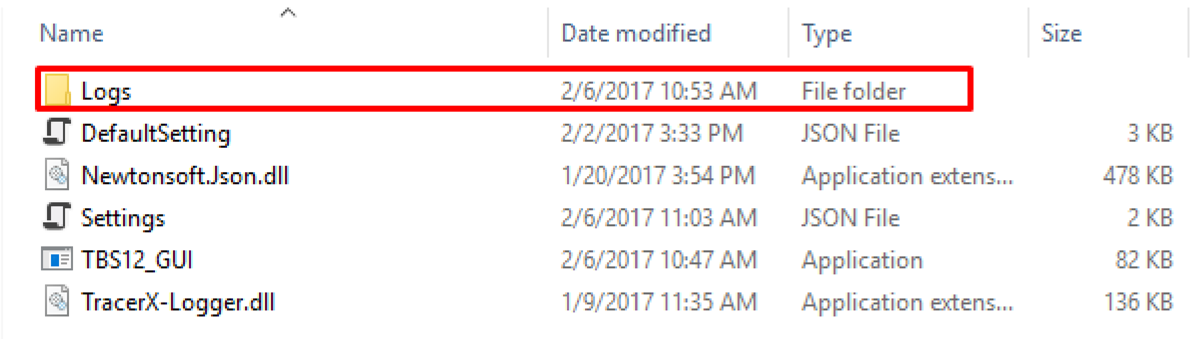
- SDI-12 LoRa GUI was .NET application developed in C# language with .NET Framework 4. So, to able to run the application, PC should install the required package - .NET Framework 4.
- Basically, the application consists of 4 files+1 optional default file. During operating, it will automatically create more "Log" directory at current application location to store logging information and errors as well.



DefaultSetting	2/2/2017 3:33 PM	JSON File	3 KB
Newtonsoft.Json.dll	1/20/2017 3:54 PM	Application extens...	478 KB
Settings	2/6/2017 11:03 AM	JSON File	2 KB
TBS12_GUI	2/6/2017 10:47 AM	Application	82 KB
TracerX-Logger.dll	1/9/2017 11:35 AM	Application extens...	136 KB

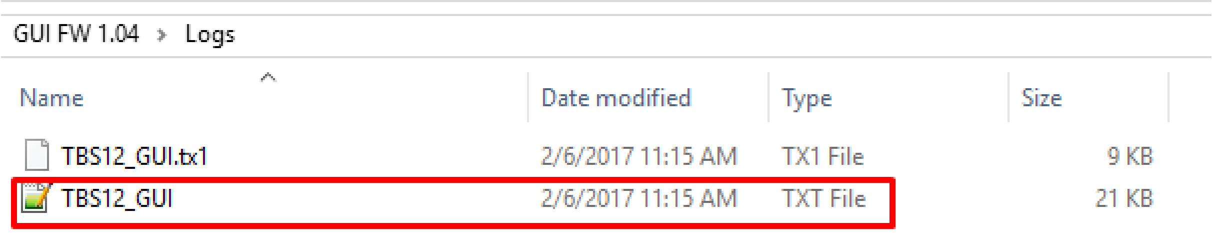
Fig3. Initial Application Files

+ TBS12-GUI.exe – main application file. To run the application, we execute this file.
+ TraceX-Logger.dll – DLL file to support logging functions.
+ Newtonsoft.Json.dll – DLL to support JSON format.
+ Settings.json – JSON file which is used to hold all parameters of the application.
+ Default.json – optional; used to restore default settings.



Name	Date modified	Type	Size
Logs	2/6/2017 10:53 AM	File folder	
DefaultSetting	2/2/2017 3:33 PM	JSON File	3 KB
Newtonsoft.Json.dll	1/20/2017 3:54 PM	Application extens...	478 KB
Settings	2/6/2017 11:03 AM	JSON File	2 KB
TBS12_GUI	2/6/2017 10:47 AM	Application	82 KB
TracerX-Logger.dll	1/9/2017 11:35 AM	Application extens...	136 KB

Fig4. Directory Structure when Application Running



GUI FW 1.04 › Logs

Name	Date modified	Type	Size
TBS12_GUI.tx1	2/6/2017 11:15 AM	TX1 File	9 KB
TBS12_GUI	2/6/2017 11:15 AM	TXT File	21 KB

Fig5. Log File

4 Functional Description

To open the GUI application, execute file TBS12-GUI.exe in the directory where the application files are located.

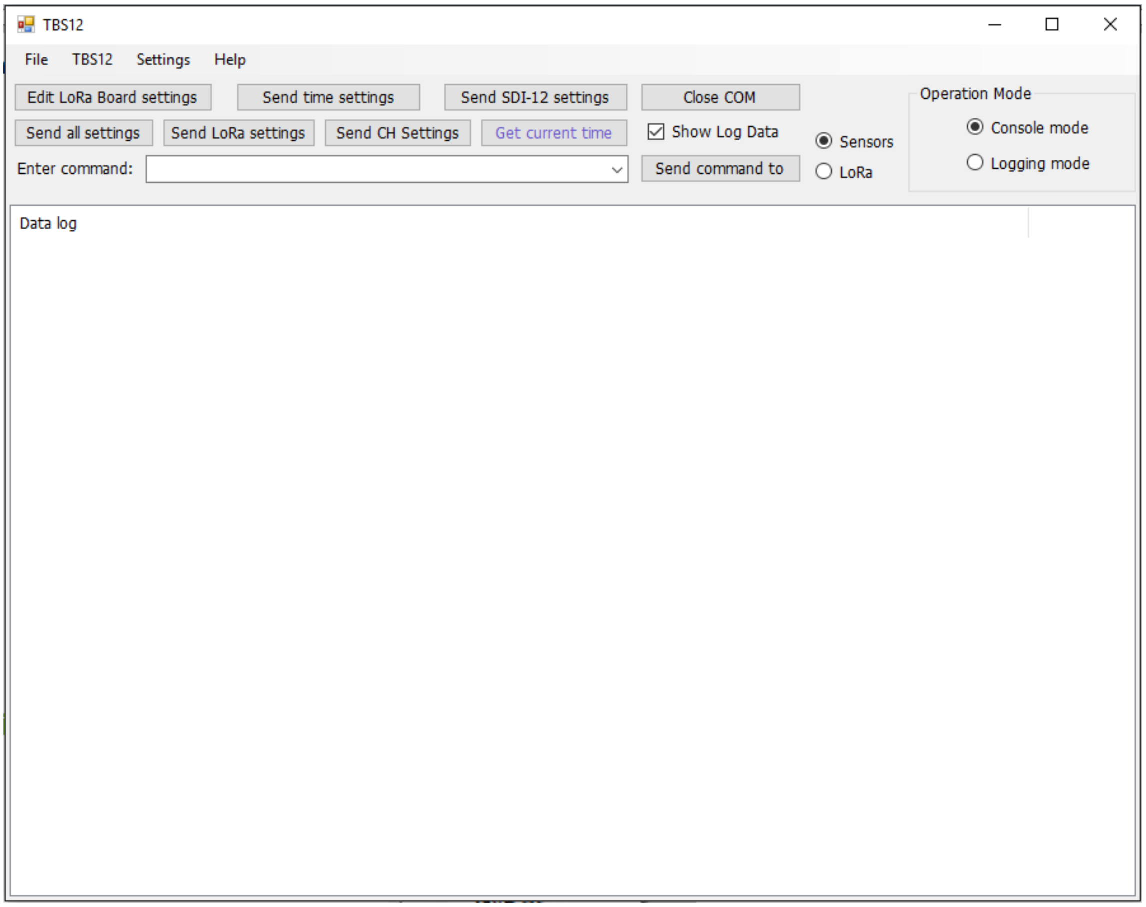


Fig6. Main Application Screen

4.1 File Menu

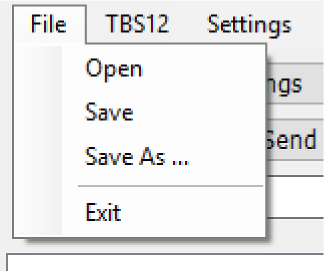


Fig7. File Menu

- **"Open" item:** this item allows user to load setting from JSON file. After clicking on this item, a file dialog window will be open for user to choose suitable JSON file.

- **"Save" item**: this item allows user to save setting to default JSON file "Settings.JSON". The settings stored in "Settings.JSON" file usually are the newest settings user had set, it will be loaded each time the GUI starts up.
- **"Save As …" item**: this item allows user to save setting to any JSON file they want to.
- **"Exit" item**: Stop and quit the application.

4.2 TBS12 Menu

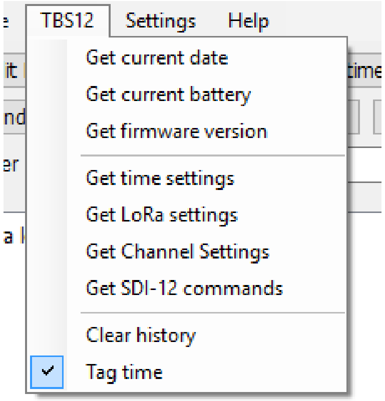
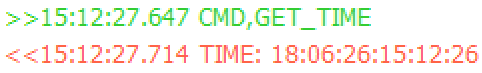


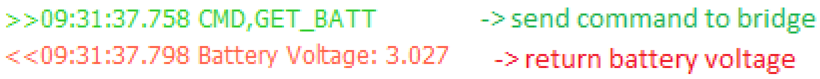
Fig8. TBS12 Menu

- "Get current date" item: When the TBS12 operates in console mode, this item permits to get the board's current time. It is displayed as below on GUI when this item is clicked. The time response from the TBS12 has format ***YY:MM:dd:HH:mm:ss (year month day hour minute second).***



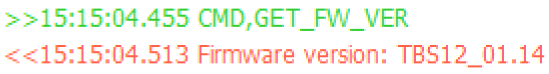
```
>>15:12:27.647 CMD,GET_TIME
<<15:12:27.714 TIME: 18:06:26:15:12:26
```

- "Get current battery" item: When the TBS12 operates in console mode, this item permits to get the battery voltage. It is displayed as below on GUI when this item is clicked.



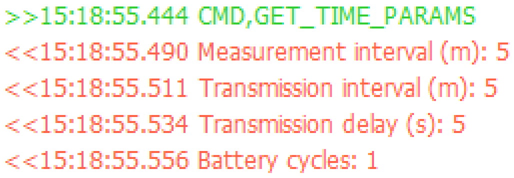
```
>>09:31:37.758 CMD,GET_BATT              -> send command to bridge
<<09:31:37.798 Battery Voltage: 3.027     -> return battery voltage
```

- "Get firmware version" item: When the TBS12 operates in console mode, this item permits to get the version of current firmware. The firmware version string has format "TBS12_xx.yy".



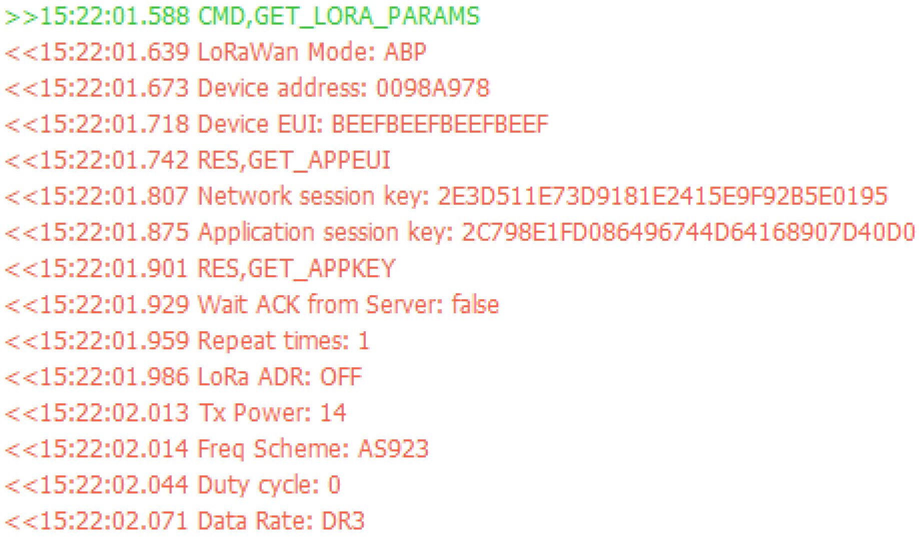
```
>>15:15:04.455 CMD,GET_FW_VER
<<15:15:04.513 Firmware version: TBS12_01.14
```

- "Get schedule settings" item: When the TBS12 operates in console mode, this item permits to get the current intervals settings on TBS12: measurement interval, transmission interval, transmission delay and battery sending cycle. Four time parameters are returned to the GUI when this item is clicked.



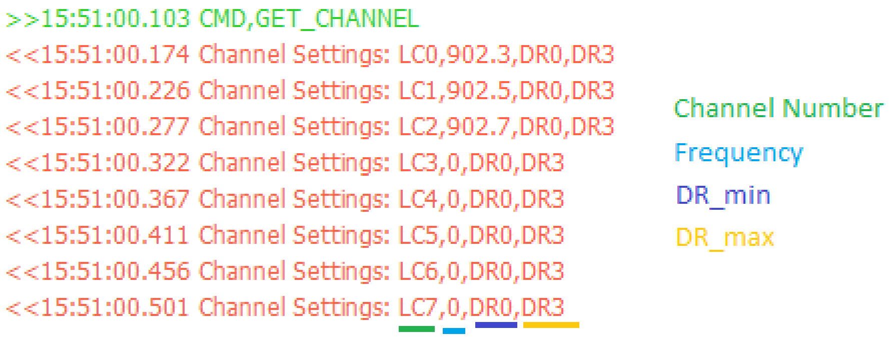
```
>>15:18:55.444 CMD,GET_TIME_PARAMS
<<15:18:55.490 Measurement interval (m): 5
<<15:18:55.511 Transmission interval (m): 5
<<15:18:55.534 Transmission delay (s): 5
<<15:18:55.556 Battery cycles: 1
```

- "Get LoRa settings" item: When the TBS12 operates in console mode, this item permits to get current LoRa settings on the TBS12. We will see 12 parameters on GUI when we click on this item



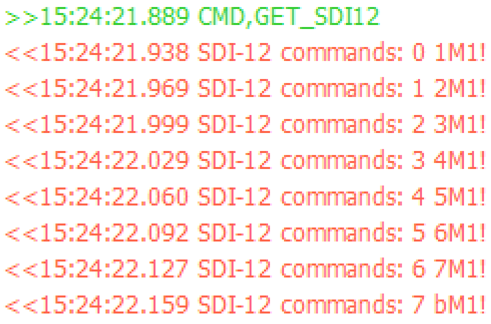
```
>>15:22:01.588 CMD,GET_LORA_PARAMS
<<15:22:01.639 LoRaWan Mode: ABP
<<15:22:01.673 Device address: 0098A978
<<15:22:01.718 Device EUI: BEEFBEEFBEEFBEEF
<<15:22:01.742 RES,GET_APPEUI
<<15:22:01.807 Network session key: 2E3D511E73D9181E2415E9F92B5E0195
<<15:22:01.875 Application session key: 2C798E1FD086496744D64168907D40D0
<<15:22:01.901 RES,GET_APPKEY
<<15:22:01.929 Wait ACK from Server: false
<<15:22:01.959 Repeat times: 1
<<15:22:01.986 LoRa ADR: OFF
<<15:22:02.013 Tx Power: 14
<<15:22:02.014 Freq Scheme: AS923
<<15:22:02.044 Duty cycle: 0
<<15:22:02.071 Data Rate: DR3
```

- "Get Channel Settings" item: When the TBS12 operates in console mode, this item permits to get current Channel settings on the TBS12. All settings for 8 channels (even disabled channel) are displayed on the GUI when this item is clicked (Note: when frequency is set to 0, it means corresponding channel is disabled).



```
>>15:51:00.103 CMD,GET_CHANNEL
<<15:51:00.174 Channel Settings: LC0,902.3,DR0,DR3
<<15:51:00.226 Channel Settings: LC1,902.5,DR0,DR3
<<15:51:00.277 Channel Settings: LC2,902.7,DR0,DR3
<<15:51:00.322 Channel Settings: LC3,0,DR0,DR3
<<15:51:00.367 Channel Settings: LC4,0,DR0,DR3
<<15:51:00.411 Channel Settings: LC5,0,DR0,DR3
<<15:51:00.456 Channel Settings: LC6,0,DR0,DR3
<<15:51:00.501 Channel Settings: LC7,0,DR0,DR3
```

- "Get SDI-12 commands" item: When the TBS12 operates in console mode, this item permits to get SDI-12 command list on the TBS12. SDI-12 commands list is displayed on GUI when this item is clicked. Each line displays command index and SDI-12 command.



```
>>15:24:21.889 CMD,GET_SDI12
<<15:24:21.938 SDI-12 commands: 0 1M1!
<<15:24:21.969 SDI-12 commands: 1 2M1!
<<15:24:21.999 SDI-12 commands: 2 3M1!
<<15:24:22.029 SDI-12 commands: 3 4M1!
<<15:24:22.060 SDI-12 commands: 4 5M1!
<<15:24:22.092 SDI-12 commands: 5 6M1!
<<15:24:22.127 SDI-12 commands: 6 7M1!
<<15:24:22.159 SDI-12 commands: 7 bM1!
```

- "Clear history" item: Clear all information that was displayed on Data log window.
- "Tag time" item: Start-up state of this item was selected. When the item is selected, the application will tag PC's current time to every data that it sends/receives to/from the TBS12. This feature is useful when we need to calculate time stamps for commands.

4.3 Settings Menu

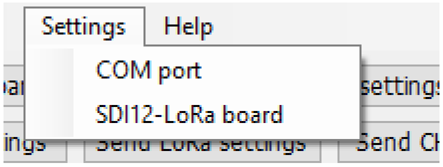
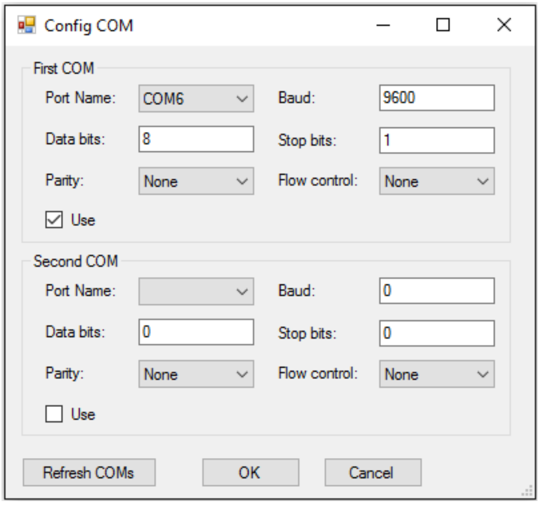


Fig9. Settings Menu

- "COM port" item: The item is used to configure settings of COM port that interfaces with the board. When clicked, the application will open new COM settings window such as:



Config COM

First COM

Port Name: COM6
Baud: 9600
Data bits: 8
Stop bits: 1
Parity: None
Flow control: None
☑ Use

Second COM

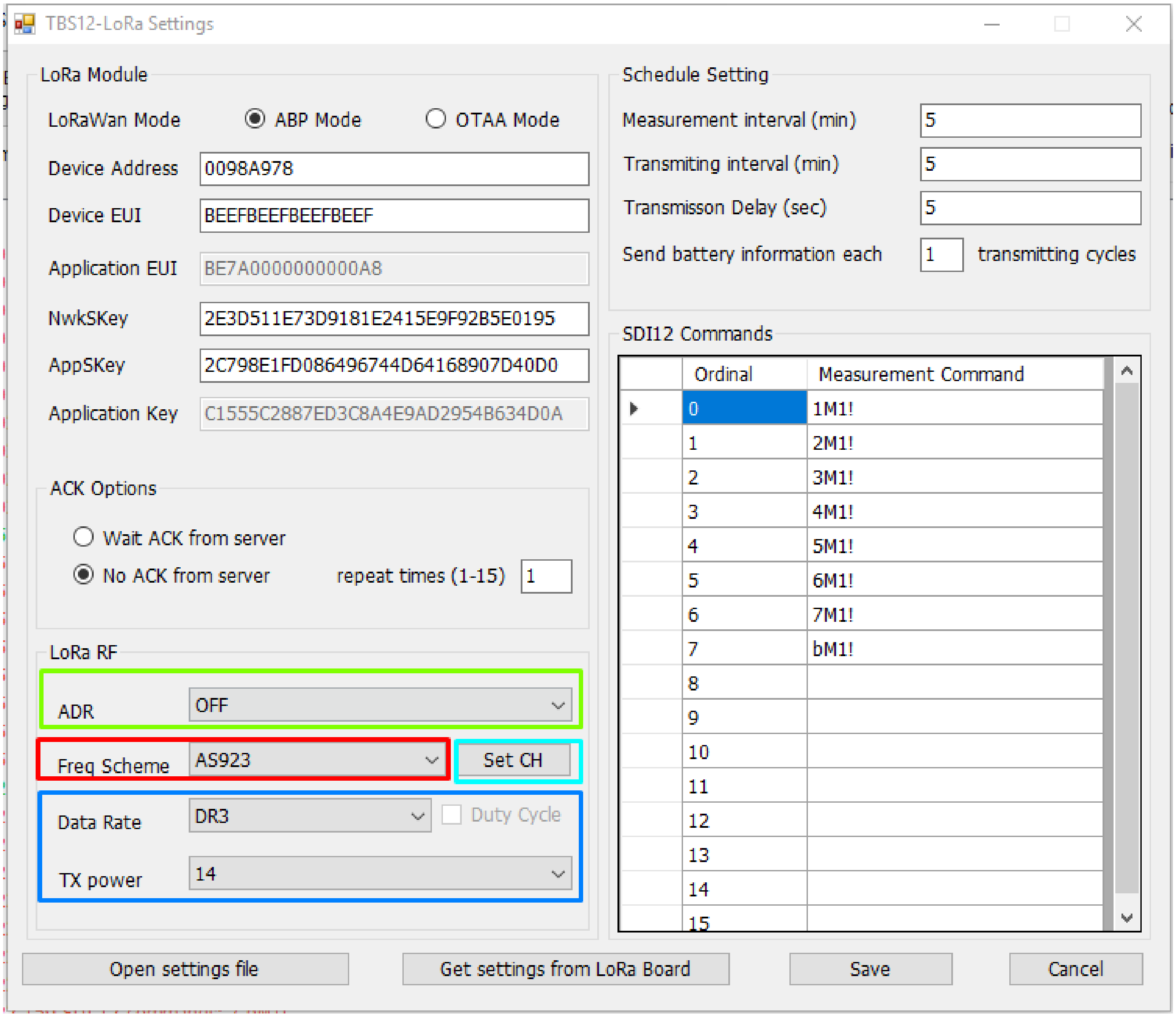
Port Name:
Baud: 0
Data bits: 0
Stop bits: 0
Parity: None
Flow control: None
☐ Use

Fig10. COM Settings

We must choose a correct COM port from “Port Name” drop-list. If the COM/USB cable is plugged on the PC after opening the window, “Refresh COMs” button can be used to refresh the drop-list. The remaining settings should be kept as default values unless it is needed these changes match with new firmware parameters on the board. You choose “OK” button if you accept and want to save selected values. The new settings will be updated and written the appropriate section in the Settings.JSON file.

- “SDI12-LoRa board” item: The item is used to configure settings for SDI-12 part and LoRaWan module on the board. When clicked, the application will open a new SDI12-LoRa window such as:

PC GUI for TBS12 configuration



LoRa Module

LoRaWan Mode ● ABP Mode ○ OTAA Mode

Device Address: 0098A978

Device EUI: BEEFBEEFBEEFBEEF

Application EUI: BE7A0000000000A8

NwkSKey: 2E3D511E73D9181E2415E9F92B5E0195

AppSKey: 2C798E1FD086496744D64168907D40D0

Application Key: C1555C2887ED3C8A4E9AD2954B634D0A

ACK Options

○ Wait ACK from server

● No ACK from server repeat times (1-15) 1

LoRa RF

ADR: OFF

Freq Scheme: AS923

Data Rate: DR3 □ Duty Cycle

TX power: 14

Schedule Setting

Measurement interval (min): 5

Transmiting interval (min): 5

Transmisson Delay (sec): 5

Send battery information each 1 transmitting cycles

SDI12 Commands

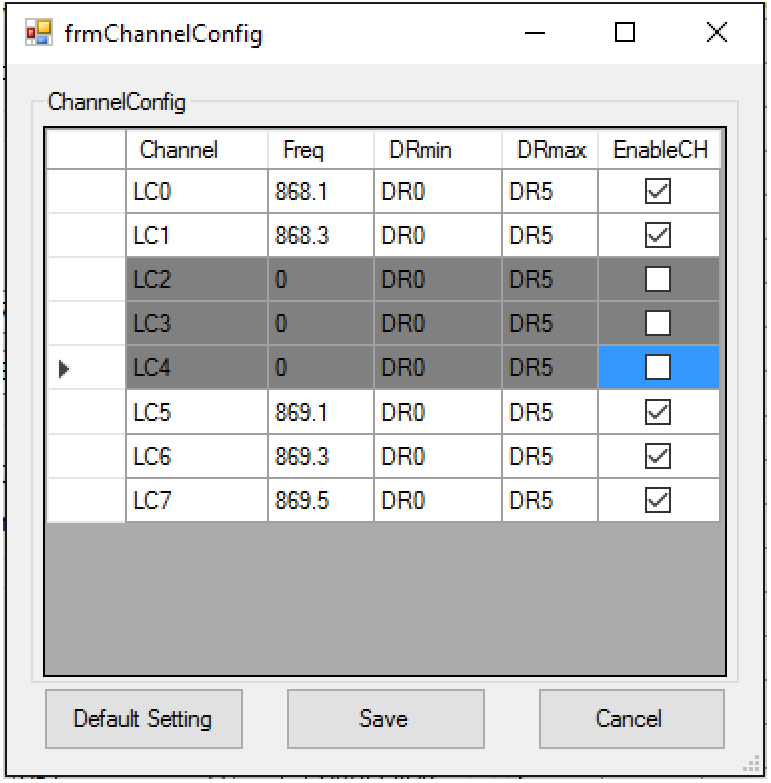
Ordinal	Measurement Command
0	1M1!
1	2M1!
2	3M1!
3	4M1!
4	5M1!
5	6M1!
6	7M1!
7	bM1!
8	
9	
10	
11	
12	
13	
14	
15	

Fig11. SDI-12 And LoRa Settings

On this window, we can setup settings for time (measurement, transmission, battery sending cycle), settings for LoRaWan module and maximum 16 SDI-12 commands. Any SDI-12 command can be deleted by selecting the command and pressing "Del" key. Click"Save" button to save selected values. The new settings will be updated and written the appropriate sections in the Settings.JSON file. Parameters for setting LoRa Radio Frequency:

- "ADR" item: This item is for setting ADR of LoRa, user can choose between "ON" and "OFF".
- "Freq Scheme" item: this item is option for choosing datarate scheme, depend on region of user. It only supports EU868, US915 and AU920 at the moment. Other region might be supported in the future.

- "Data Rate" item: this item is for setting DR of LoRa, this available options changing depend on which "Freq Scheme" is chose. Ex: In EU868, "Data Rate" will be available between DR0 - DR5.
- "Duty Cycle" item: this option will only be available in EU868.
- "TX power" item: these item values also depend on which "Freq Scheme" is chose.
- "Set CH" item: This item used to configure settings for 8 channel. The screen will be like:



	Channel	Freq	DRmin	DRmax	EnableCH
	LC0	868.1	DR0	DR5	☑
	LC1	868.3	DR0	DR5	☑
	LC2	0	DR0	DR5	☐
	LC3	0	DR0	DR5	☐
▶	LC4	0	DR0	DR5	☐
	LC5	869.1	DR0	DR5	☑
	LC6	869.3	DR0	DR5	☑
	LC7	869.5	DR0	DR5	☑

On this window, default channel setting is displayed: user can only enable/disable channels or set frequencies and channel numbers. DRmin and DRmax can't be edited. User can disable channel by unchecking EnableCH or deleting the Frequency. After disabling a channel, user can only enable it again by clicking on EnableCH and setting the frequency.

- "Default Settings" button: this button will set all the setting back to current.
- "Save" button: after finish configure channel, click "Save" button to save user setting. To save on JSON file, user must also click "Save" button on TBS-12 LoRa Settings screen.
- "Cancel" button: click this if user does not want to save their setting. This button does not affect the configuration on TBS-12 LoRa Settings screen.

4.4 Help Menu.

This menu was empty now; it is intended for use in the future.

4.5 Command buttons.

On main screen, we have some buttons for sending parameters to the TBS12

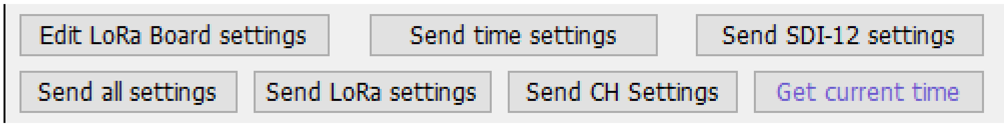
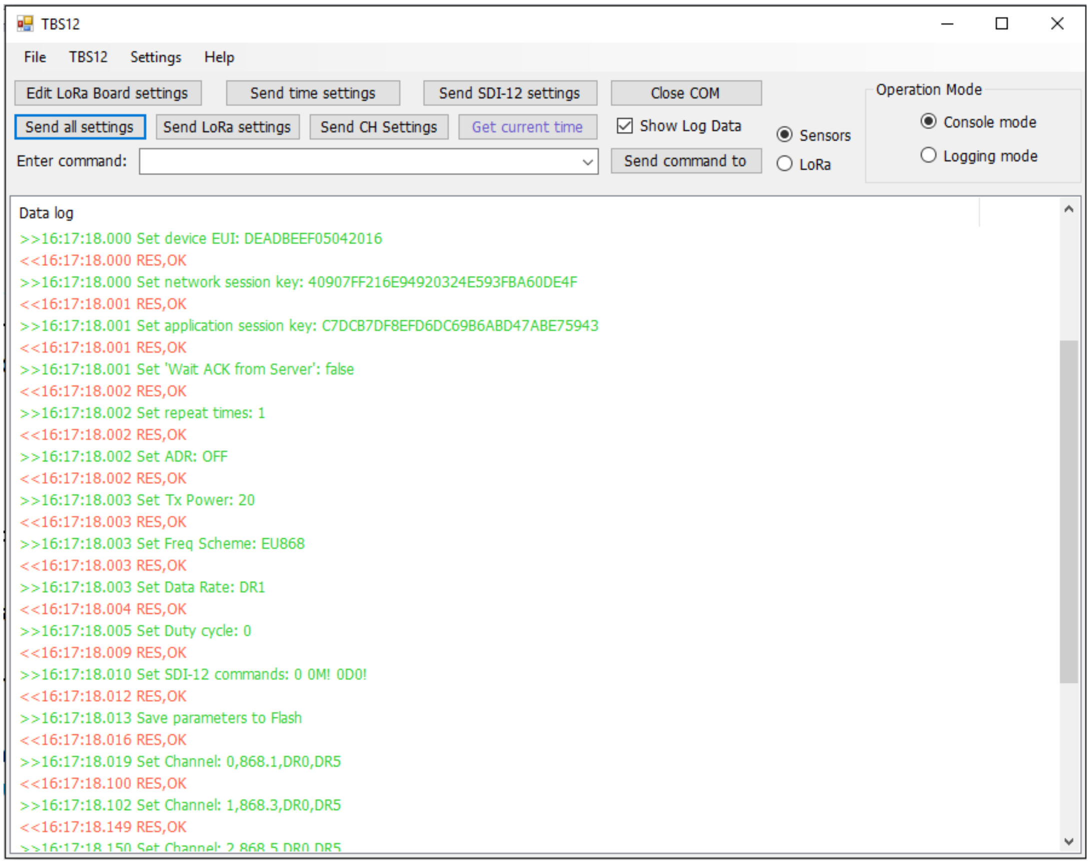


Fig12. Command buttons

- "Send all settings" button: When the TBS12 operates in console mode, this button is used to send all parameters and channel settings to the TBS12. The contents on GUI were basically self-explanation. Note: After clicked "Send all settings" the application will be delay for about 3 seconds. This delay is required for sending data.



```
>>16:17:18.000 Set device EUI: DEADBEEF05042016
<<16:17:18.000 RES,OK
>>16:17:18.000 Set network session key: 40907FF216E94920324E593FBA60DE4F
<<16:17:18.001 RES,OK
>>16:17:18.001 Set application session key: C7DCB7DF8EFD6DC69B6ABD47ABE75943
<<16:17:18.001 RES,OK
>>16:17:18.001 Set 'Wait ACK from Server': false
<<16:17:18.002 RES,OK
>>16:17:18.002 Set repeat times: 1
<<16:17:18.002 RES,OK
>>16:17:18.002 Set ADR: OFF
<<16:17:18.002 RES,OK
>>16:17:18.003 Set Tx Power: 20
<<16:17:18.003 RES,OK
>>16:17:18.003 Set Freq Scheme: EU868
<<16:17:18.003 RES,OK
>>16:17:18.003 Set Data Rate: DR1
<<16:17:18.004 RES,OK
>>16:17:18.005 Set Duty cycle: 0
<<16:17:18.009 RES,OK
>>16:17:18.010 Set SDI-12 commands: 0 0M! 0D0!
<<16:17:18.012 RES,OK
>>16:17:18.013 Save parameters to Flash
<<16:17:18.016 RES,OK
>>16:17:18.019 Set Channel: 0,868.1,DR0,DR5
<<16:17:18.100 RES,OK
>>16:17:18.102 Set Channel: 1,868.3,DR0,DR5
<<16:17:18.149 RES,OK
>>16:17:18.150 Set Channel: 2,868.5,DR0,DR5
```

- "Send LoRa settings" button: When the TBS12 operates in console mode, this button is used to send only LoRa parameters to the TBS12.
- "Send CH Settings" button: When the TBS12 operates in console mode, this button is used to send only Channel Settings to the TBS12.

- "Send time settings" button: When the TBS12 operates in console mode, this button is used to send only timing parameters to the TBS12.
- "Send SDI-12 commands" button: When the TBS12 operates in console mode, this button is used to send only SDI-12 commands to the TBS12.
- "Get current time" button: When the TBS12 operates in console mode, this button is used to get current time on the TBS12.

4.6 Open Connection and Send Command

To interface with the board, first we must open COM port with settings that have already setup in "4.2 section" and then click "Open COM" button.

Once the application has opened the COM port connection, we can interface with the board. When power-up, the board will send a specified command ("PING" command) to PC and wait for the response from the application. If the application have started and opened the COM port, it should answer with an "OK" response and the board will go to the "***console***" mode, after the date and time are automatically programmed into the unit. In this console mode, the board doesn't perform any measurement/transmission operations. It only receives the commands from the application, executes the commands on sensor/LoRa module and send responses to the application.

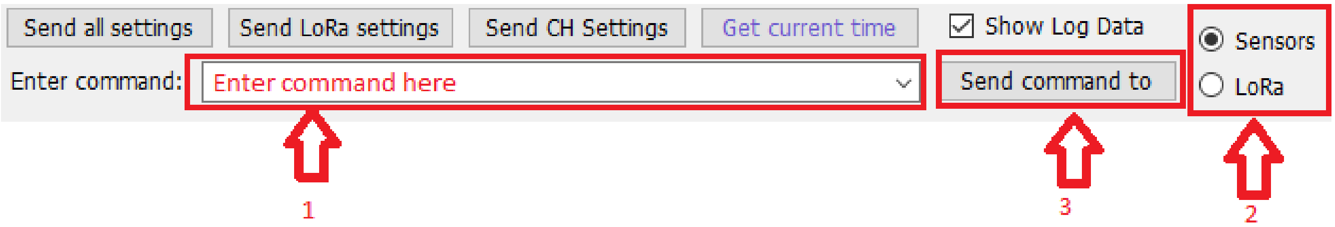


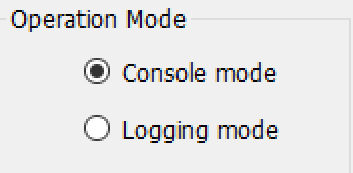
Fig13. Send Command

The steps need to follow to send any command to the board.

1. Type the command that you want to send (make sure that syntax of command was correct)
2. Choose where the command will be send to (SDI-12 sensor or LoRa module).
3. Click "Send command to" button.

On the Data log area, we will see "transmit command string" was prefixed with ">>" string and "receive command string" was prefixed with "<<" string. Moreover, if "Tag time" item was selected, we will see "time stamp" information the Data log area for each data row.

4.7 User-manual for Operation Mode



Operation Mode

● Console mode

○ Logging mode

Fig14. Switch Mode

Normally, the application always stays in **"Console"** mode. In this mode, the board will be waiting to receive/transmit data from/to the application. All the setting sent from the application at this time will only be saved in the board memory; they are not set to the board yet. When user clicked on **"Logging mode"** button, the application will send a command to the board; tell it to go to **"Logging"** mode. In **"Logging"** mode, the board will self-configure the settings which saved in the memory. After that, the board will go to sleep. From here onwards, user had two options:

- First, switch to **"Console"** mode by click on **"Console mode"** button, clicking **"Console mode"** button send a command to the board. Whenever the board wakes up, it will receive that command and switch to **"Console"** mode.
- Second, stay in **"Logging"** mode. In this state, after wakes up, the board will start the routine of *measure data -> go to sleep -> wake up -> measure again and/or transmit data -> go to sleep again and go on*. The time between each sleep and wake up depend on the Interval settings in the application.

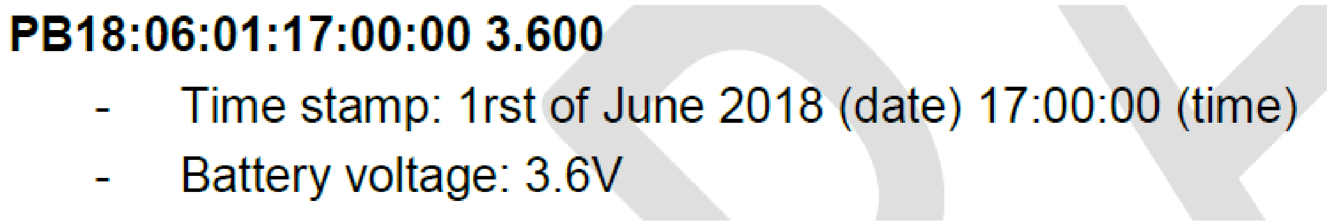
Note: even if user clicks "Console mode" button at the moment the board still self-configure the settings or measure/transmit data to server, the board will only switch back to "Console mode" button after it wakes up.

4.8 Data format

As of today, we have two kinds of data to send to server. First is battery voltage and other is sensor data. The following is format of these two data kinds (refer to User Manual for further information):

4.8.1 Battery data format

Data format for battery consists of a header ("PB"), a timestamp and battery voltage.

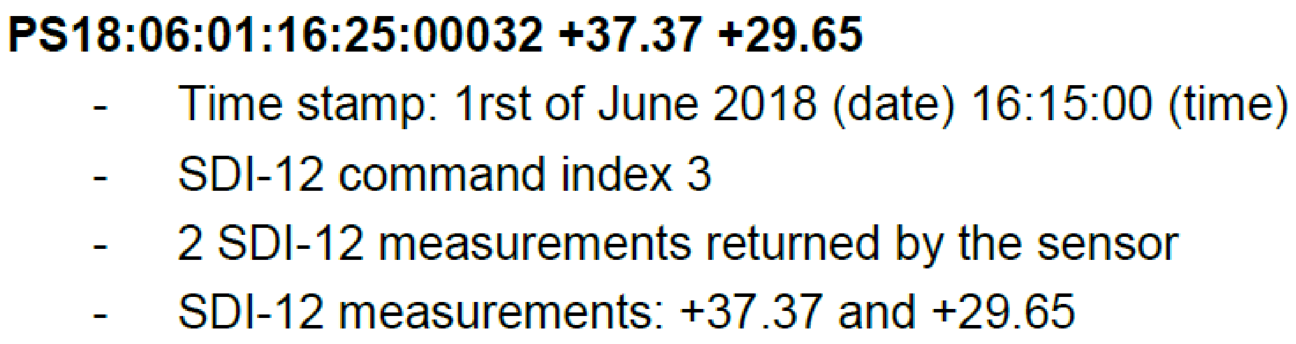


PB18:06:01:17:00:00 3.600

- Time stamp: 1rst of June 2018 (date) 17:00:00 (time)
- Battery voltage: 3.6V

4.8.2 Measurements data format

Data format for sensor's measurement value consists of a header ("PS"), a timestamp, the index of executed SDI-12 sensor command and measurement value(s).



PS18:06:01:16:25:00032 +37.37 +29.65

- Time stamp: 1rst of June 2018 (date) 16:15:00 (time)
- SDI-12 command index 3
- 2 SDI-12 measurements returned by the sensor
- SDI-12 measurements: +37.37 and +29.65

5 History

Version	Date	Author	Changes
V1.0	2016	Tuan Anh Dinh	Creation of the document
V1.1	2017	Philippe Hervieu	Update document following changes in GUI
V1.2	10.04.2018	Philippe Hervieu	Update number of supported SDI-12 commands.
V1.3	04.06.2018	Philippe Hervieu	Update frame format
V1.4	26.06.2018	Philippe Hervieu	Update SDI-12 related screenshots+comments