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1 Introduction

This is a quick starting guide on how to interface a LoRaWAN TBSL1 with LORIoT infrastructure, which is Tekbox's recommended LoRaWAN services provider (<https://loriot.io/>).

1.1 Sensors configuration

The following configuration is deployed (can be used as a reference for other set up):

- 1 SDI-12 soil moisture and temperature probe with 7 cells (Probe 0)
 - SDI-12 addresses from '1' to '7'
 - SDI-12 command: M1!
- 1 SDI-12 wind vane sensor (TBSWV1; Probe 1)
 - SDI-12 address: '8'
 - SDI-12 commands: M!, M1!
- 1 SDI-12 wind speed sensor (TBSWS1; Probe 2)
 - SDI-12 address: '9'
 - SDI-12 command: M!
- 1 SDI-12 air temperature sensor (TBSHT02; Probe 3)
 - SDI-12 address: 'b'
 - SDI-12 command: M1!
- 2 analog sensors inputs
- 1 pulse sensor input

1.2 LoRaWAN settings

For this example LoRaWAN AS923 plan will be used with 8 frequencies ranging from 923MHz to 924.4MHz with an increment of 200kHz

It is therefore assumed from this point that:

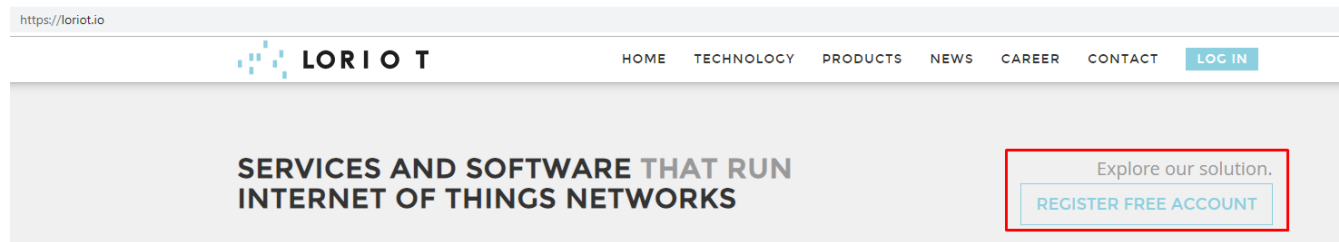
- Antenna fitted for 915MHz is used
- Gateway operating on 915MHz band is used (e.g. RisingHF RHF2S008 which provides easy integration with LORIoT LoRaWAN server).
- Gateway is correctly configured and attached to LORIoT LoRaWAN server operating on above plan and frequencies
- TBSL1 must be configured accordingly to match LORIoT LoRaWAN server configuration. In this example this means:
 - Class A
 - ADR off
 - ABP
 - AS923 plan as described above
 - EUI and ciphering keys as provided by LoRaWAN server

2 Prerequisites

2.1 LORIoT LoRaWAN server

User must register an account on LORIoT: <https://loriot.io/>

Register for a free account and then possibly upgrade for additional features:



Refer to [LoRaWAN configuration](#) for further instructions how to use LORIoT LoRaWAN server with TBSL1.

2.2 Antenna

Connect antenna internally and externally, ensure the right connector is used on LoRaWAN modem board depending on the frequency used.



Antenna connected externally



Antenna connected to LoRa modem high band connector

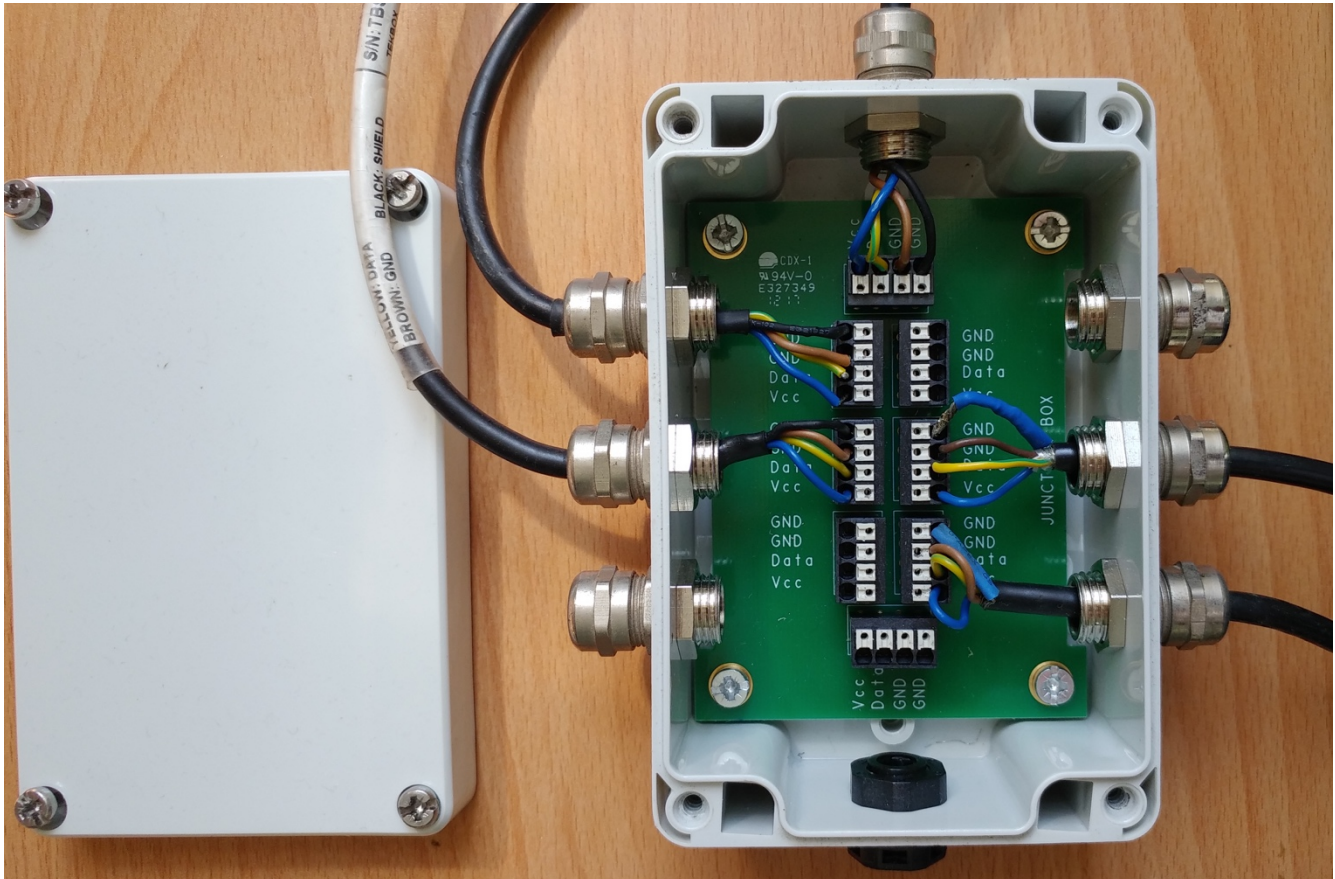
2.3 Sensors

Connect the sensors cable(s): one or both TBSL1 sensors connectors can be used depending on user's set up.



Sensors connectors

To deploy multiple SDI-12 sensors, Tekbox SDI-12 junction boxes can be used:



SDI-12 Junction box: upper connector plugged to TBSL1, others to SDI-12 sensors

CAUTION: both TBSL1 sensors connectors share the same electrical signals therefore

- **SDI-12 sensors can be freely connected to either connectors or both and also by using a junction box if required.**
- **TBSL1 supports only ONE pulse input: a pulse sensor can then be plugged to either connector, having one pulse input connected and the other left unused.**
- **TBSL1 supports 2 analog channels: each channel has an input on each connector. Therefore when a channel is connected to an analog sensor, the second one must be left unused.**

2.4 Battery

Connect a suitable battery inside the unit: 3.7V Li-Ion cell with at least 1500mAh capacity (refer to TBSL1 user manual), 10k NTC and protection circuit.



Li-Ion battery plugged

2.5 Solar panel

Refer to TBSL1 user manual for information related to solar panel required features.

Solar panel 5 pins connector must be modified as follows to allow for the unit to be supplied:



Then connect the solar panel on the TBSL1 5 pins connector.

TBSL1 is then fully fitted and starts operating as soon as the solar panel is connected.
Taking out the solar panel will switch off the platform.

2.6 TBSL1 configuration

The very first time TBSL1 is used, it starts up in console mode and is then ready to be configured.
Ensure that the PC used for configuration has ST virtual COM port driver installed (refer to www.st.com to download the driver).










A USB cable and TBSL1 configuration tool installed on the PC are required to proceed with the platform set up.

The final set up should look like this:

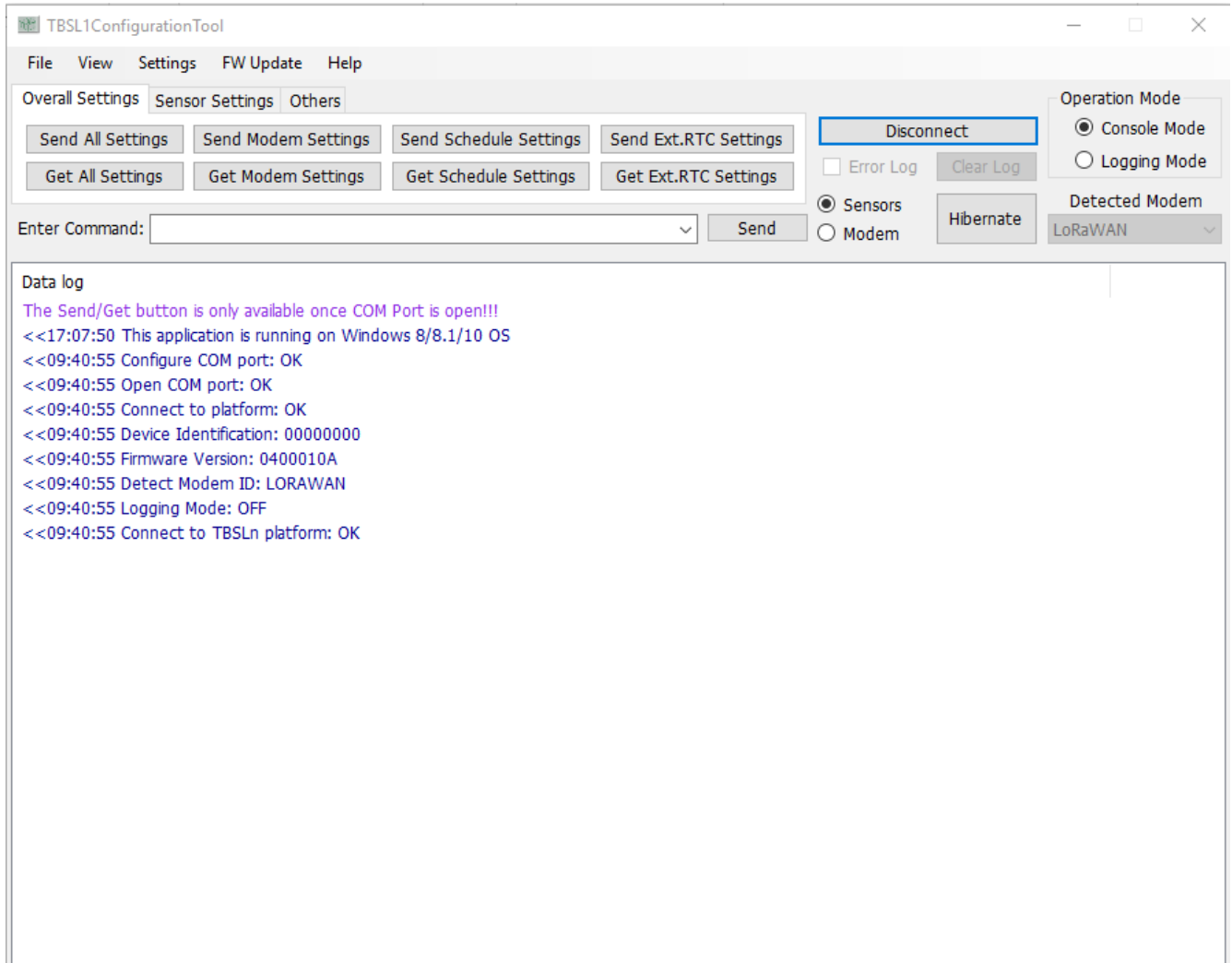


Then proceed with following steps:

- Open the PC application in Administrator mode

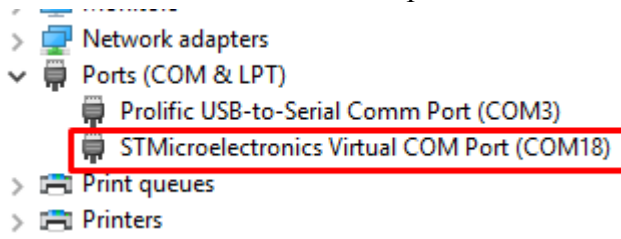
 JsonFile	9/15/2017 9:56 AM	File folder	
 Logs	9/15/2017 9:56 AM	File folder	
 Newtonsoft.Json.dll	3/23/2017 4:53 PM	Application extens...	478 KB
 TBSLnConfigurationTool	9/15/2017 9:08 AM	Application	463 KB
 TBSLnConfigurationTool	9/15/2017 9:08 AM	Program Debug D...	298 KB
 TBSLnConfigurationTool.vshost	9/15/2017 9:06 AM	Application	23 KB
 TBSLnConfigurationTool.vshost.exe.mani...	3/19/2017 4:00 AM	MANIFEST File	1 KB
 TBSLnConfigurationTool_User_Guide	9/14/2017 4:15 PM	Microsoft Word D...	898 KB
 TracerX-Logger.dll	3/23/2017 4:53 PM	Application extens...	136 KB

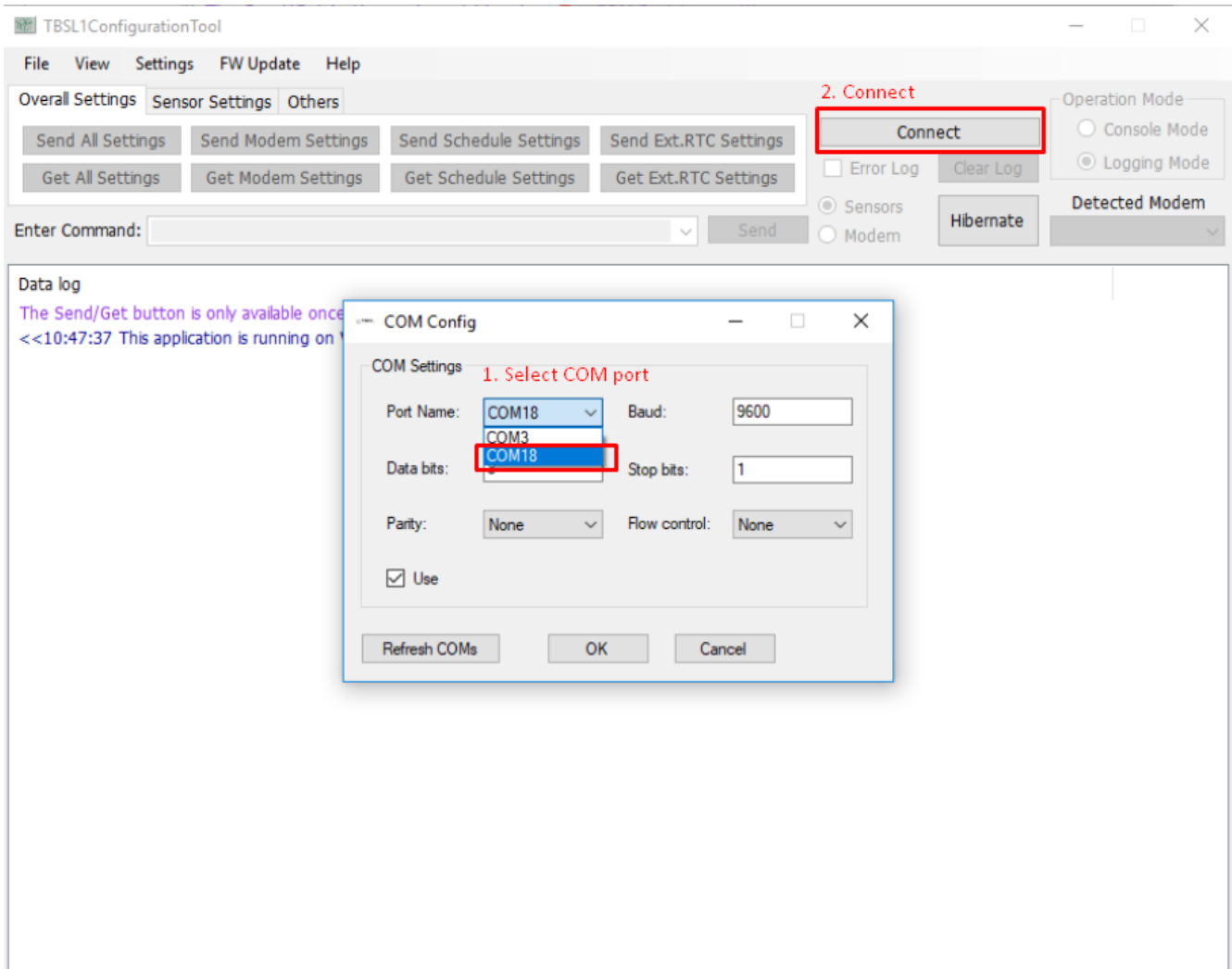
- Connect the USB cable between the PC and the TBSL1 USB connector.
- Wait about 10s until a USB serial COM port is enumerated on Windows Device Manager.
- The PC application will then:
 - Either autoconnect to the virtual serial COM port



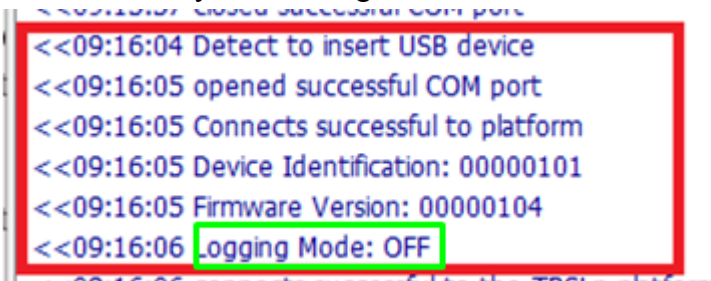
- Or will require manual connection by configuring the COM port from “Settings>COM port Configuration” PC application menu and clicking then on “Connection” button.

First check that the virtual COM port is mounted by Windows, then select it in the tool:





- TBSL1 is then switched to console mode (indicated by the comment “Logging Mode: OFF” and is therefore ready to be configured.



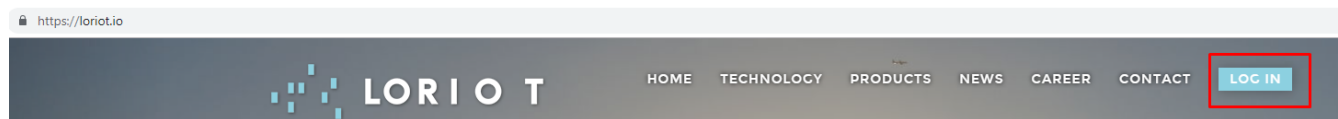
3 Configure TBSL1

3.1 LoRaWAN configuration


In this example and as described in the introduction, following LoRaWAN configuration is used:

- Class A
- ABP
- AS923
- ADR off
- No ACK





Login to your LORIoT account:




Pick the desired LoRaWAN server based on your geographical location (this is an important step to reduce network latencies) and enter your credentials:









EUROPE & AFRICA

Server	Location
 EU1	Frankfurt, Germany
 EU2	New Amsterdam, Netherlands
 EU3	New Madrid, Spain
 AF1	Cape Town, South Africa






ASIA / PACIFIC

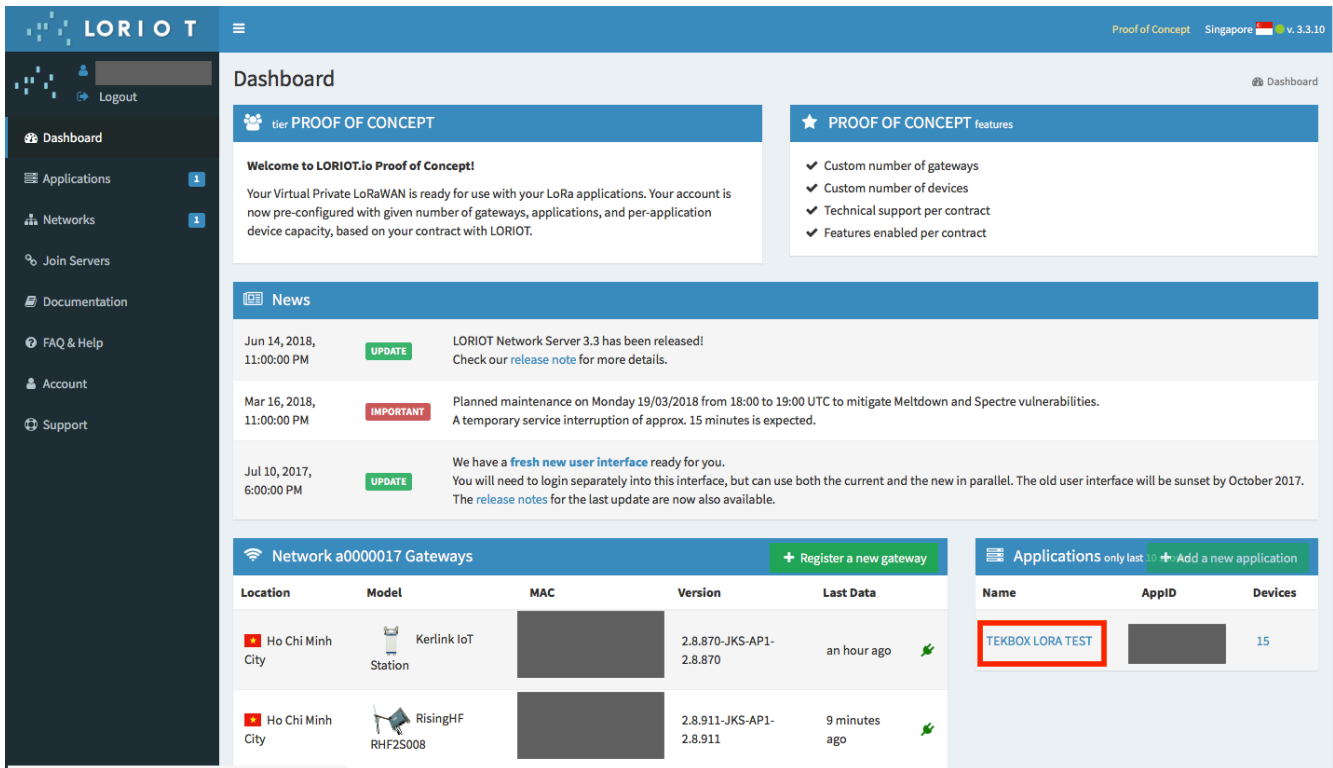
Server	Location
 AP1	Singapore
 AU1	Sydney, Australia
 CN1	Shenzhen, China
 AP2	New Tokyo, Japan
 AP3	New Mumbai, India



AMERICAS

Server	Location
 US1	California, USA
 US2	New New York, USA
 SA1	Sao Paulo, Brazil

Choose your LoRaWAN application to access your nodes:

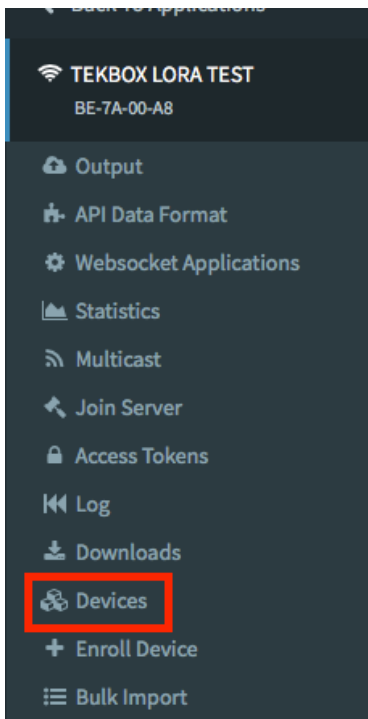


The screenshot shows the LORIoT dashboard interface. On the left is a navigation menu with options like Dashboard, Applications, Networks, Join Servers, Documentation, FAQ & Help, Account, and Support. The main content area is titled 'Dashboard' and includes a 'Welcome to LORIoT.io Proof of Concept!' message, a 'News' section with updates from June 2018, and two tables. The 'Network a0000017 Gateways' table lists two gateways in Ho Chi Minh City. The 'Applications' table lists one application named 'TEKBOX LORA TEST' with 15 devices. A red box highlights the 'TEKBOX LORA TEST' application name in the table.

Location	Model	MAC	Version	Last Data
Ho Chi Minh City	Kerlink IoT Station	[REDACTED]	2.8.870-JKS-AP1-2.8.870	an hour ago
Ho Chi Minh City	RisingHF RHFZ5008	[REDACTED]	2.8.911-JKS-AP1-2.8.911	9 minutes ago

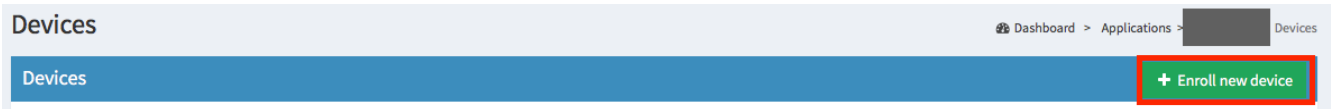
Name	AppID	Devices
TEKBOX LORA TEST	[REDACTED]	15

Access your devices (through 'Device' or 'Manage devices'):

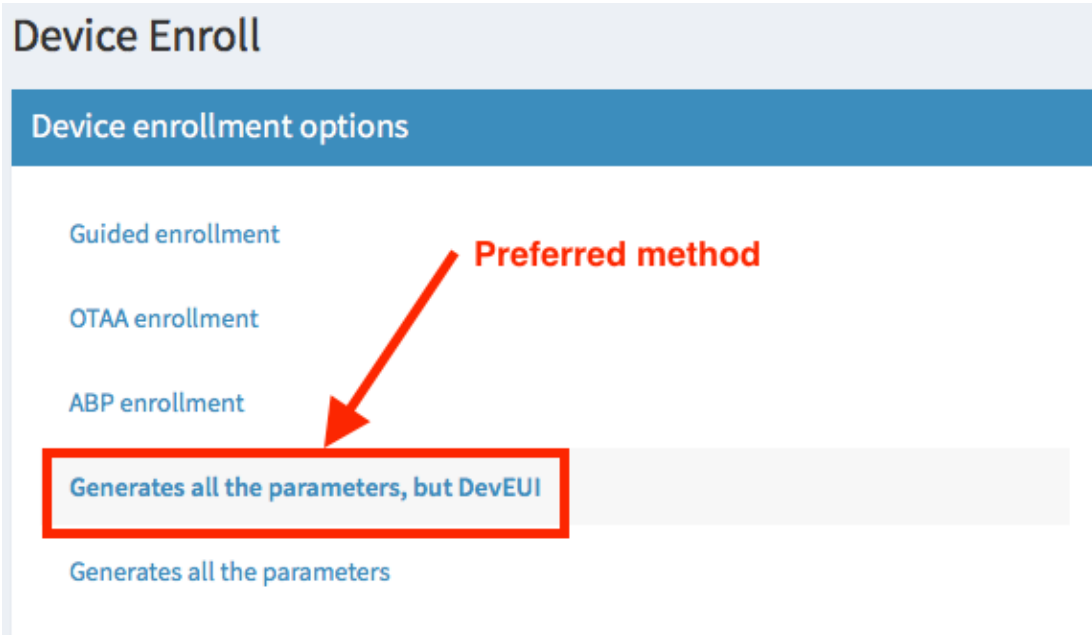


The screenshot shows a dark-themed application menu for 'TEKBOX LORA TEST'. The menu items include Output, API Data Format, Websocket Applications, Statistics, Multicast, Join Server, Access Tokens, Log, Downloads, Devices (highlighted with a red box), Enroll Device, and Bulk Import.

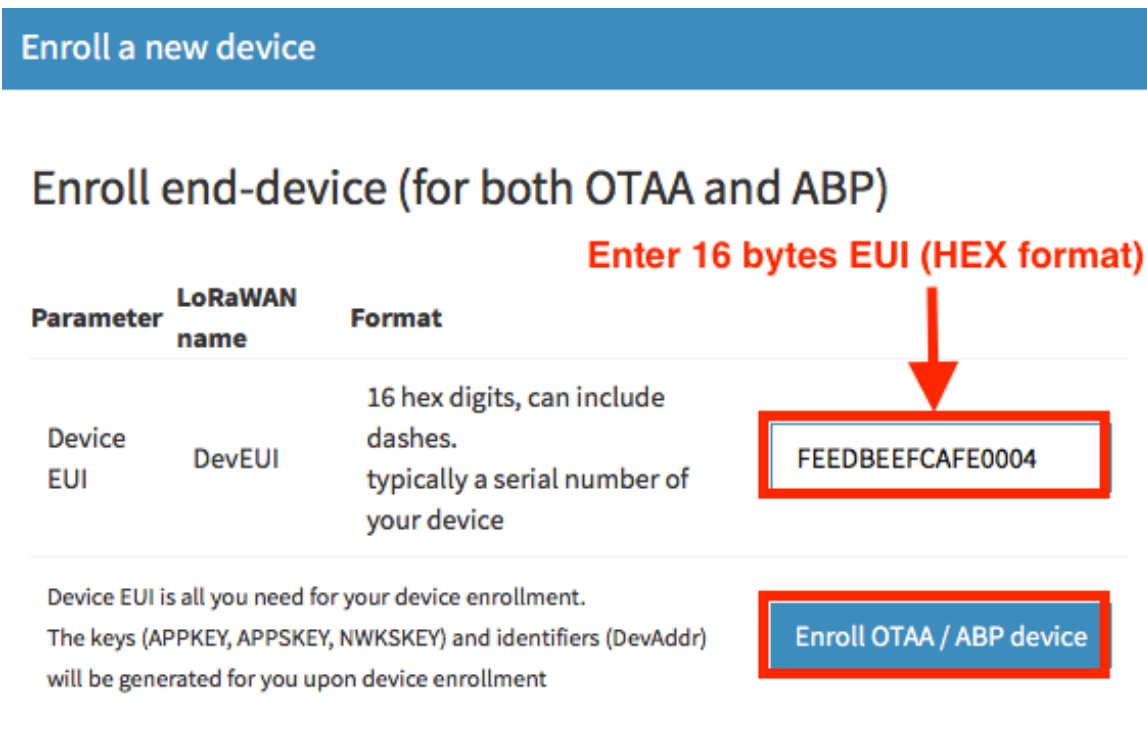
Create a new node (preferred method: user should enroll a new device using his own EUI):



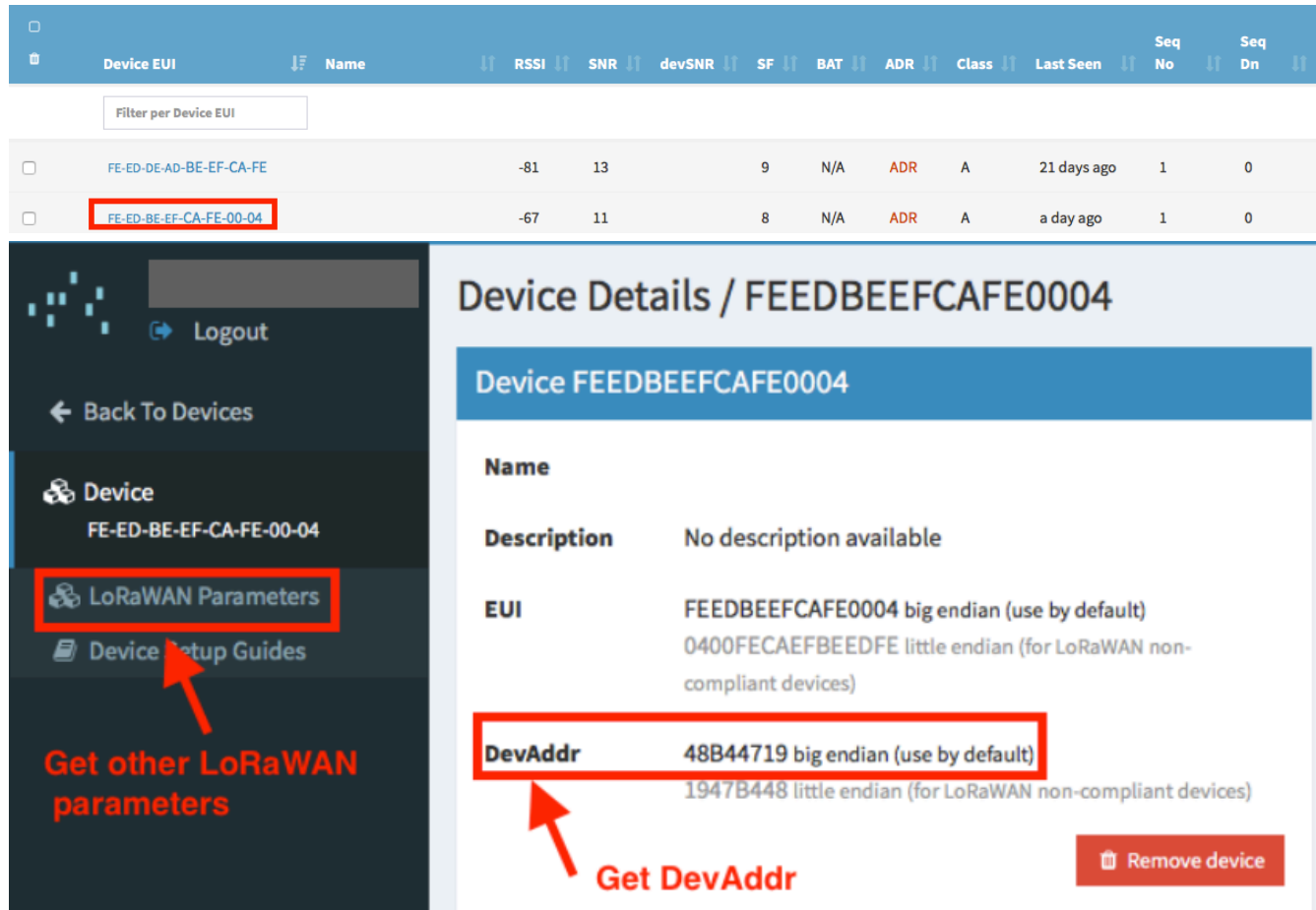
then



Enter EUI:



Access the node's IDs and ciphering keys:



The screenshot shows a web interface for managing LoRaWAN devices. At the top, there is a table with columns for Device EUI, Name, RSSI, SNR, devSNR, SF, BAT, ADR, Class, Last Seen, Seq No, and Seq Dn. Two devices are listed, with the second one, FE-ED-BE-EF-CA-FE-00-04, highlighted with a red box. Below the table, there is a sidebar on the left with a 'Logout' button and a 'Back To Devices' link. The sidebar contains a 'Device' section with the EUI FE-ED-BE-EF-CA-FE-00-04, and a 'LoRaWAN Parameters' section which is highlighted with a red box. An arrow points from the text 'Get other LoRaWAN parameters' to this section. The main content area shows 'Device Details / FEEDBEEFCAFE0004'. It includes a 'Device FEEDBEEFCAFE0004' header and a list of parameters: Name, Description (No description available), EUI (FEEDBEEFCAFE0004 big endian (use by default) and 0400FECAEFBEEEDFE little endian (for LoRaWAN non-compliant devices)), and DevAddr (48B44719 big endian (use by default) and 1947B448 little endian (for LoRaWAN non-compliant devices)). The DevAddr value is highlighted with a red box, and an arrow points from the text 'Get DevAddr' to it. A 'Remove device' button is located at the bottom right of the details view.

Device EUI	Name	RSSI	SNR	devSNR	SF	BAT	ADR	Class	Last Seen	Seq No	Seq Dn
FE-ED-DE-AD-BE-EF-CA-FE		-81	13		9	N/A	ADR	A	21 days ago	1	0
FE-ED-BE-EF-CA-FE-00-04		-67	11		8	N/A	ADR	A	a day ago	1	0

Device Details / FEEDBEEFCAFE0004

Device FEEDBEEFCAFE0004

Name

Description No description available

EUI FEEDBEEFCAFE0004 big endian (use by default)
0400FECAEFBEEEDFE little endian (for LoRaWAN non-compliant devices)

DevAddr 48B44719 big endian (use by default)
1947B448 little endian (for LoRaWAN non-compliant devices)

Remove device

LoRaWAN Parameters


LoRaWAN AES128 Keys

AppKey

Application Key (Device Key)



6860C4CB27F6910F006B23BF67BA69C3

 Remove appkey

If you want to enable over-the-air join, add or derive the device's application key.

NwkSKey

Network Session Key




0AE06AE693032ABBEA4B593A9C8E693F

AppSKey

Application Session Key



1CACD690390382D348D25003886D02AB

 Remove appskey





NOTE: When copy-pasting an AES128 key, use it as it is. It is a cryptographic key without the notion of endianness

See the [device guides](#) for personalized, device specific configuration commands

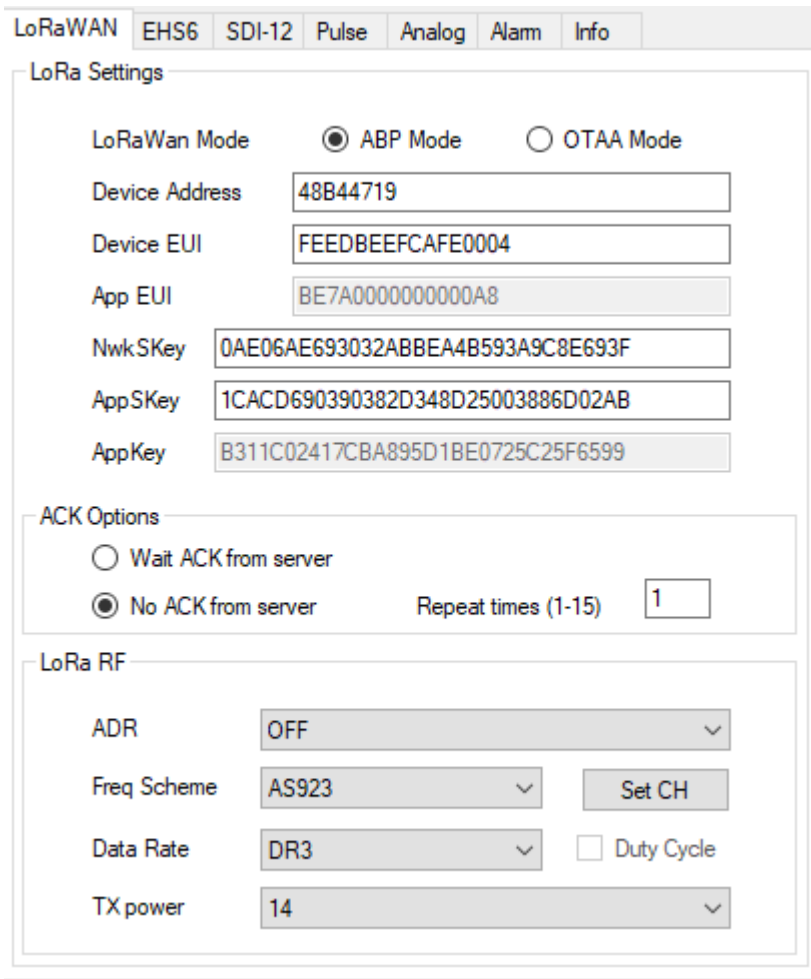
In our example, ABP configuration is used therefore the user needs to configure TBSL1 LoRaWAN modem with DevEUI, DevAddr, NwkSkey and AppSkey.

Would the user wants to activate his node by OTAA, then DevEUI, AppEUI and AppKey should be used instead.

Check that other LoRaWAN parameters are correct (Class, duty cycle, etc...):

LoRaWAN Device Parameters		
Class LoRaWAN device class	Class A	
RX Window LoRaWAN Receive Window preference	RX1	
ADR Adaptive Data Rate	disabled Only the end-device can enable / disable ADR	
Duty cycle	No limitation	

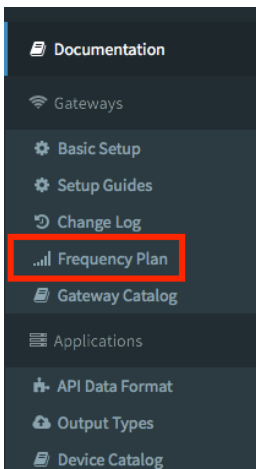
Those LoRaWAN settings needs then to be input in the TBSL1 configuration tool:

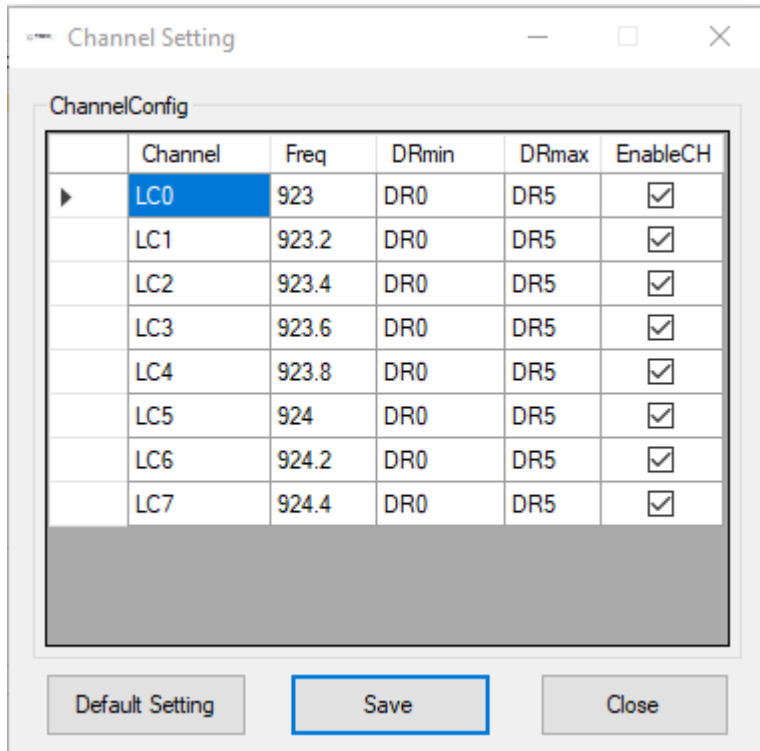


The screenshot shows the configuration tool interface with the following sections:

- LoRa Settings:**
 - LoRaWan Mode: ABP Mode, OTAA Mode
 - Device Address: 48B44719
 - Device EUI: FEEDBEEFCAFE0004
 - App EUI: BE7A0000000000A8
 - NwkSKey: 0AE06AE693032ABBEA4B593A9C8E693F
 - AppSKey: 1CACD690390382D348D25003886D02AB
 - AppKey: B311C02417CBA895D1BE0725C25F6599
- ACK Options:**
 - Wait ACK from server
 - No ACK from server
 - Repeat times (1-15): 1
- LoRa RF:**
 - ADR: OFF
 - Freq Scheme: AS923 (Set CH button)
 - Data Rate: DR3 (Duty Cycle checkbox)
 - TX power: 14

Ensure that right frequencies are defined by clicking on “Set CH” and cross-check with LORIOT AS923 plan accessible from the dashboard:





3.2 SDI-12 sensors configuration

4 SDI-12 probes are defined in this example with the configuration described in the introduction. Measurement intervals are set to 15 minutes for each probe.

Probe 0:

LoRaWAN EHS6 SDI-12 Pulse Analog Alarm Info

SDI Settings

Number of Probes:

SDI-12 Probes ID:

Number of Command: in probe

Measure Interval: minutes

Warm Up Delay second ranges: 0 - > 30

SDI Sensor Setting

	Ordinal	Description	Measurement Command
▶	0	S1	1M1!
	1	S2	2M1!
	2	S3	3M1!
	3	S4	4M1!
	4	S5	5M1!
	5	S6	6M1!
	6	S7	7M1!

Probe 1:

LoRaWAN EHS6 SDI-12 Pulse Analog Alarm Info

SDI Settings

Number of Probes:

SDI-12 Probes ID:

Number of Command: in probe

Measure Interval: minutes

Warm Up Delay second ranges: 0 - > 30

SDI Sensor Setting

	Ordinal	Description	Measurement Command
▶	0	WD	8M!
	1	WT	8M1!

Probe 2:

LoRaWAN | EHS6 | SDI-12 | Pulse | Analog | Alarm | Info

SDI Settings

Number of Probes:

SDI-12 Probes ID:

Number of Command: in probe

Measure Interval: minutes

Warm Up Delay second ranges: 0 - > 30

SDI Sensor Setting

	Ordinal	Description	Measurement Command
▶	0	WS	9M!

Probe 3:

LoRaWAN | EHS6 | SDI-12 | Pulse | Analog | Alarm | Info

SDI Settings

Number of Probes:

SDI-12 Probes ID:

Number of Command: in probe

Measure Interval: minutes

Warm Up Delay second ranges: 0 - > 30

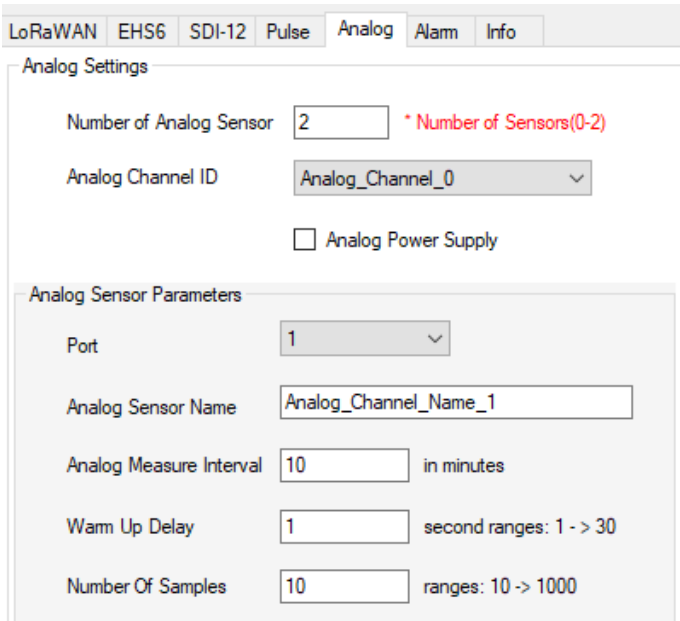
SDI Sensor Setting

	Ordinal	Description	Measurement Command
▶	0	Air HT	bM1!

3.3 Analog sensors configuration

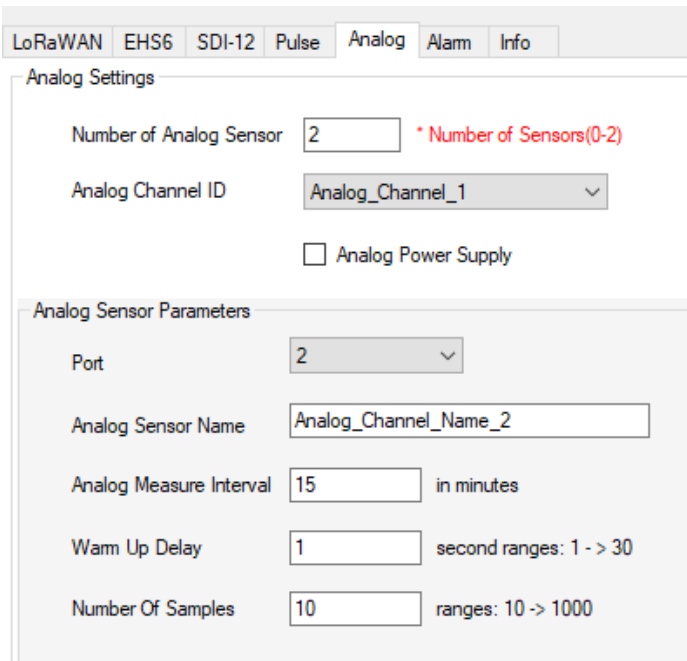
2 analog channels are configured with 10 and 15 minutes measurement intervals:

Channel 0:



The screenshot shows the 'Analog Settings' configuration page for Channel 0. The 'Analog Settings' section includes a 'Number of Analog Sensor' field set to 2, with a red asterisk and the text '* Number of Sensors(0-2)'. Below it is a dropdown menu for 'Analog Channel ID' set to 'Analog_Channel_0' and an unchecked checkbox for 'Analog Power Supply'. The 'Analog Sensor Parameters' section includes a 'Port' dropdown set to 1, an 'Analog Sensor Name' text field containing 'Analog_Channel_Name_1', an 'Analog Measure Interval' field set to 10 with the unit 'in minutes', a 'Warm Up Delay' field set to 1 with the unit 'second ranges: 1 - > 30', and a 'Number Of Samples' field set to 10 with the unit 'ranges: 10 -> 1000'.

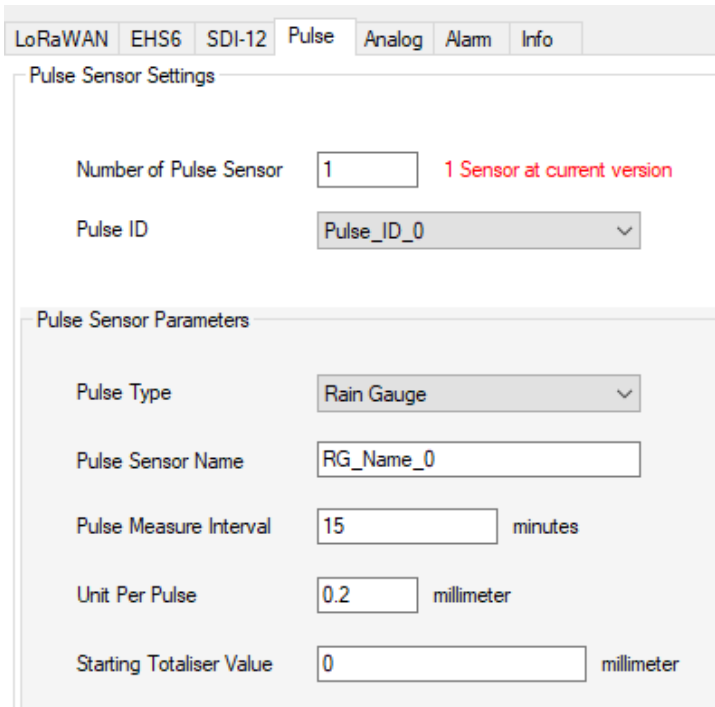
Channel 1:



The screenshot shows the 'Analog Settings' configuration page for Channel 1. The 'Analog Settings' section includes a 'Number of Analog Sensor' field set to 2, with a red asterisk and the text '* Number of Sensors(0-2)'. Below it is a dropdown menu for 'Analog Channel ID' set to 'Analog_Channel_1' and an unchecked checkbox for 'Analog Power Supply'. The 'Analog Sensor Parameters' section includes a 'Port' dropdown set to 2, an 'Analog Sensor Name' text field containing 'Analog_Channel_Name_2', an 'Analog Measure Interval' field set to 15 with the unit 'in minutes', a 'Warm Up Delay' field set to 1 with the unit 'second ranges: 1 - > 30', and a 'Number Of Samples' field set to 10 with the unit 'ranges: 10 -> 1000'.

3.4 Pulse sensor

1 pulse sensor for rain gauge application:

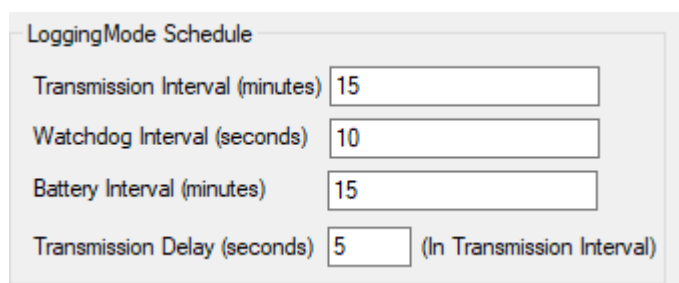


The screenshot shows a configuration interface for a pulse sensor. At the top, there are tabs for 'LoRaWAN', 'EHS6', 'SDI-12', 'Pulse', 'Analog', 'Alarm', and 'Info'. The 'Pulse' tab is selected. Below the tabs, there are two main sections: 'Pulse Sensor Settings' and 'Pulse Sensor Parameters'. In the 'Pulse Sensor Settings' section, 'Number of Pulse Sensor' is set to 1 with a red note '1 Sensor at current version', and 'Pulse ID' is set to 'Pulse_ID_0'. In the 'Pulse Sensor Parameters' section, 'Pulse Type' is 'Rain Gauge', 'Pulse Sensor Name' is 'RG_Name_0', 'Pulse Measure Interval' is 15 minutes, 'Unit Per Pulse' is 0.2 millimeter, and 'Starting Totaliser Value' is 0 millimeter.

3.5 Reporting intervals

Following intervals need then to be configured:

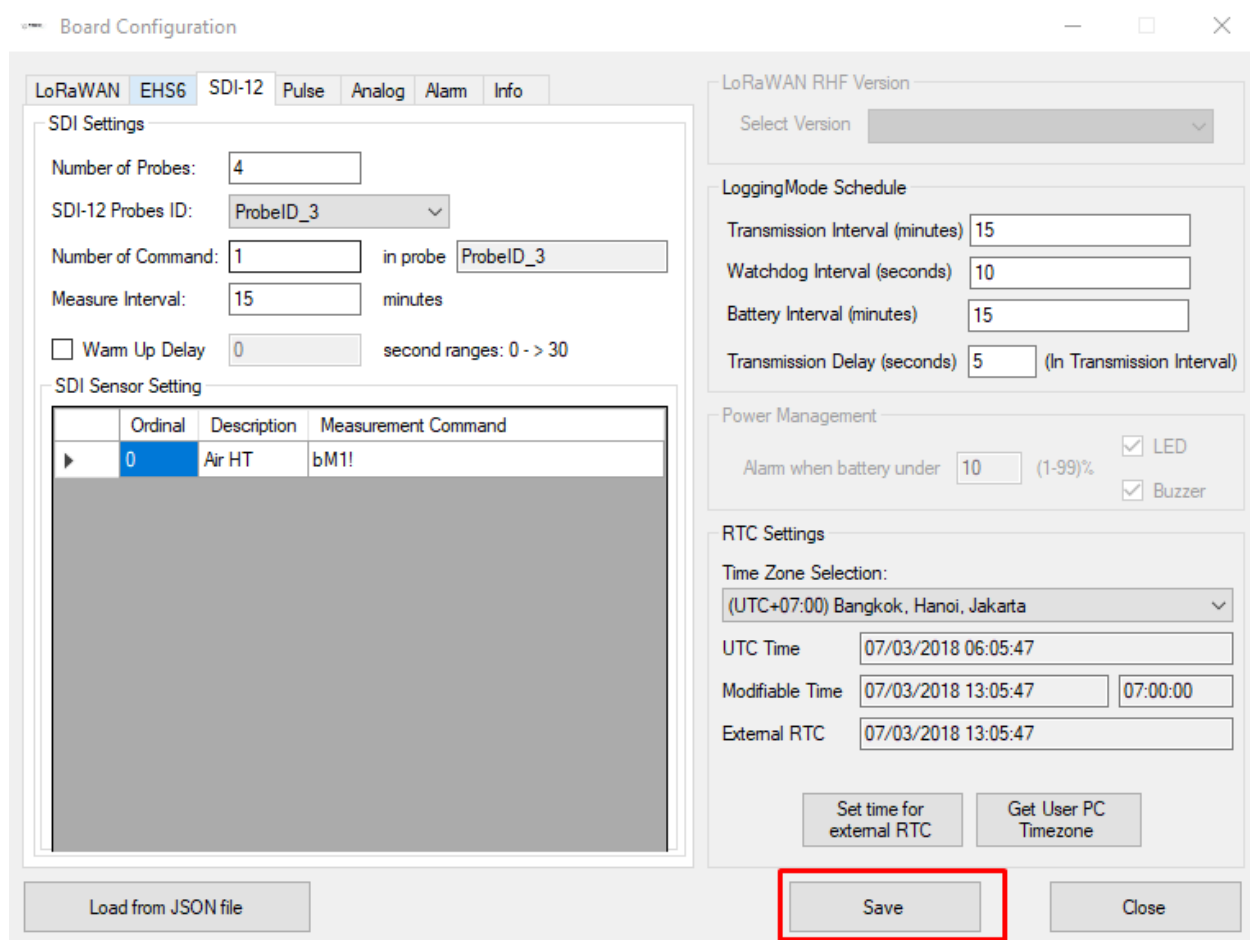
- Transmission
- Battery level reporting
- Transmission delay



The screenshot shows the 'LoggingMode Schedule' configuration interface. It contains four rows of configuration fields: 'Transmission Interval (minutes)' set to 15, 'Watchdog Interval (seconds)' set to 10, 'Battery Interval (minutes)' set to 15, and 'Transmission Delay (seconds)' set to 5 with the note '(In Transmission Interval)'.

3.6 Save configuration

From whatever tab, click on the ‘Save’ button to save the configuration:



The screenshot shows the 'Board Configuration' window with several tabs: LoRaWAN, EHS6, SDI-12, Pulse, Analog, Alarm, and Info. The 'SDI-12' tab is active, displaying 'SDI Settings' and 'SDI Sensor Setting'.

SDI Settings:

- Number of Probes: 4
- SDI-12 Probes ID: ProbeID_3
- Number of Command: 1 in probe ProbeID_3
- Measure Interval: 15 minutes
- Warm Up Delay: 0 second ranges: 0 - > 30

SDI Sensor Setting:

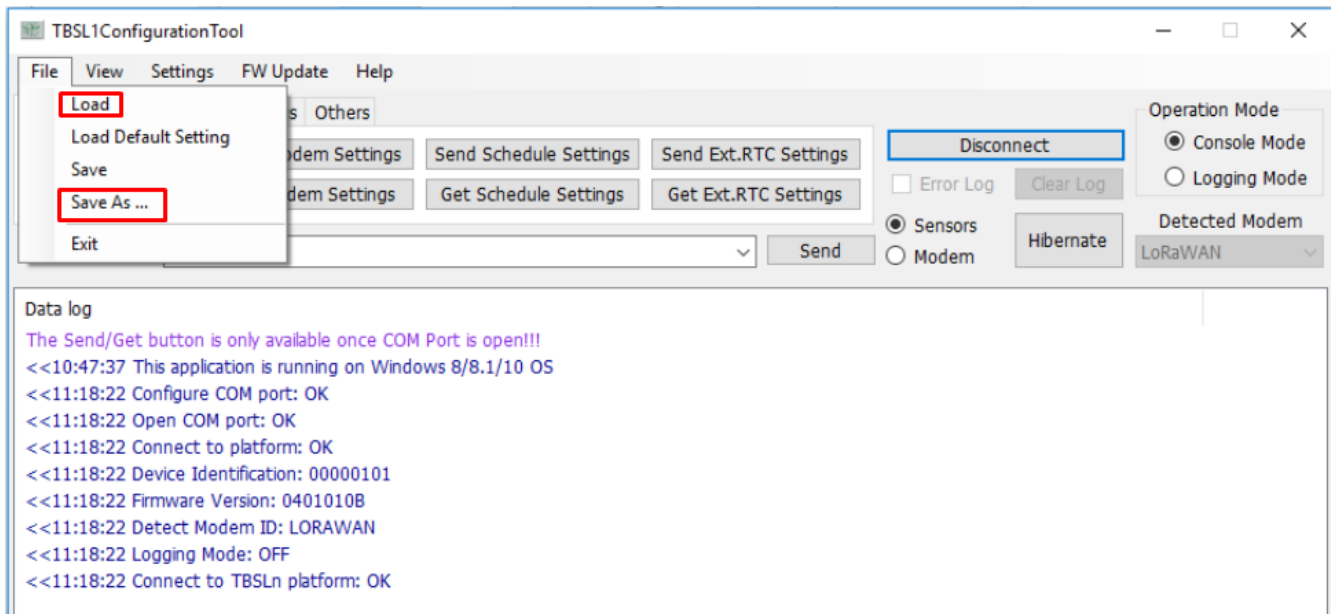
Ordinal	Description	Measurement Command
0	Air HT	bM1!

Other Settings:

- LoRaWAN RHF Version: Select Version
- LoggingMode Schedule:
 - Transmission Interval (minutes): 15
 - Watchdog Interval (seconds): 10
 - Battery Interval (minutes): 15
 - Transmission Delay (seconds): 5 (In Transmission Interval)
- Power Management:
 - Alarm when battery under: 10 (1-99)%
 - LED
 - Buzzer
- RTC Settings:
 - Time Zone Selection: (UTC+07:00) Bangkok, Hanoi, Jakarta
 - UTC Time: 07/03/2018 06:05:47
 - Modifiable Time: 07/03/2018 13:05:47 | 07:00:00
 - External RTC: 07/03/2018 13:05:47

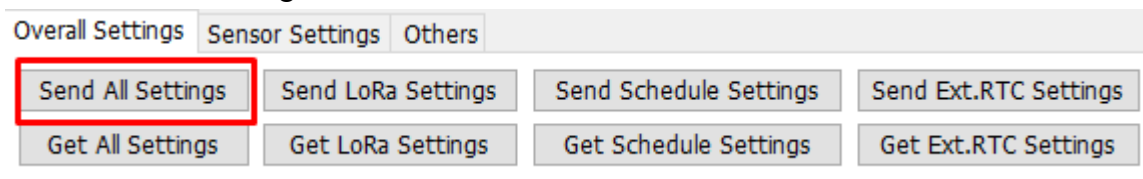
Buttons at the bottom: Load from JSON file, **Save** (highlighted with a red box), Close.

Current configuration can be saved into a JSON file and reloaded later through the ‘File’ menu:

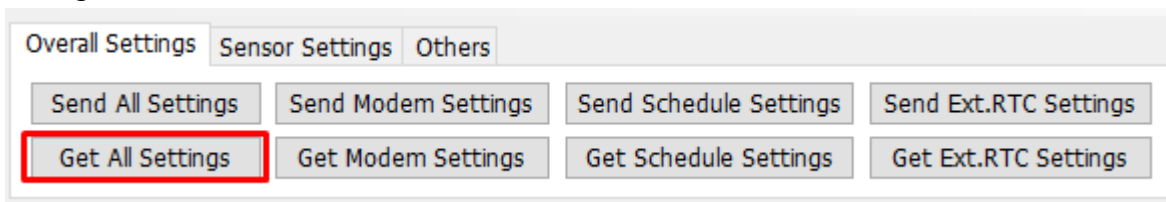


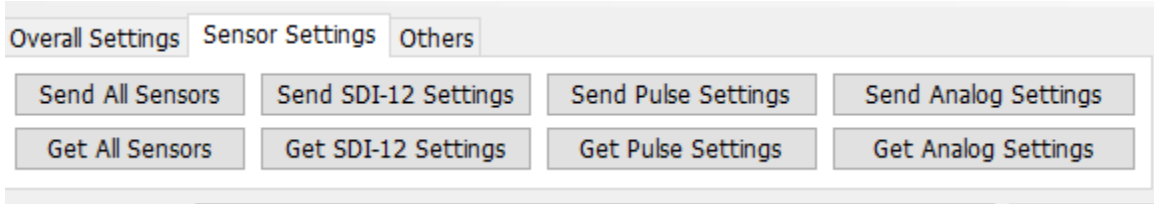
4 Platform activation

If platform default configuration has been modified, it is required to click on “Send All Settings” button (OR sub-category settings button depending on what has been changed): this will update the internal TBSL1 configuration.



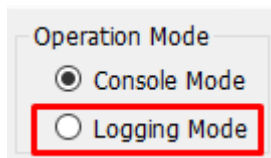
Configuration can be checked likewise through the ‘Get All Settings’ button or any sub-category get settings button.





Set and get parameters for specific sensors categories

To turn the platform to operating mode, it just requires to click on “Logging Mode” button and wait for the confirmation.



From this point, the PC application can be closed or left open, and the USB cable is no longer required. TBSL1 starts logging measurements and transmitting them based on various programmed intervals. Any further change to TBSL1 configuration requires to switch back to console mode by clicking to “Console Mode” button (note: the switch will only happen when the platform is not in sleep mode or at power up).

Alternatively if the unit has to be stored on shelves or left unattended for a while until it is deployed on the field, the following steps should be followed in order to save the battery:

- Click on ‘Send All Settings’
- Click on ‘Hibernate’ → this makes TBSL1 enter into hibernation mode
- Then 2 options to restart the platform in active mode (logging):
 - If TBSL1 is left hibernating, then swipe a magnet over the reed switch and it will automatically restart in logging mode
 - Unplug the solar panel and the platform will be shutdown. When plugging back the solar panel, TBSL1 will automatically restart in logging mode.

5 Data format

Several reporting messages are transmitted by TBSL1:

- Common data message
 - Ex: **C00004AC10400010f0fR -53**
 - Fields:
 - **C:** common data message
 - **00004AC1:** device ID to be read as “00004AC1”

- **0400010f**: FW version to be read as “04.00.01.0F”
 - **0**: Reserved for future use, systematically set to zero.
 - **f**: total number of connected sensors, to be read as “15”
 - **-53**: RSSI, to be read as “-53”
- Battery report message
 - Ex: **PB16:10:27:02:45:00 4.100**
 - Fields:
 - **P**: parameters report message
 - **B**: battery
 - **16:10:27:02:45:00** time stamp, 2016 October 27th 02:45:00AM (HH:MM:SS)
 - **<space>**
 - **4.100**: battery voltage in V.
 - Pulses report message
 - Ex: **PP16:10:27:02:45:000 12004**
 - Fields:
 - **P**: parameters report message
 - **P**: pulse sensor
 - **16:10:27:02:45:00** time stamp, 2016 October 27th 02:45:00AM (HH:MM:SS)
 - **0**: pulse sensor ID
 - **<space>**
 - **12004**: pulse count
 - Analog report message
 - Ex: **PA16:10:29:14:30:001 0.235532 3.454323 5.454323**
 - Fields:
 - **P**: parameters report message
 - **A**: analog sensor
 - **16:10:29:14:30:00** time stamp, 2016 October 29th 14:30:00 (ie 2:30:00 PM, HH:MM:SS)
 - **<space>**
 - **0.235532**: minimum measured analog value
 - **<space>**
 - **3.454323**: average of analog measured values
 - **<space>**
 - **5.454323**: maximum measured value

- SDI-12 report message
 - o Ex: **PS16:10:29:02:30:000204 -12.20003 +2.322432 -4.433332 -9.110423**
 - o Fields:
 - **P:** parameters report message
 - **S:** SDI-12 sensor
 - **16:10:29:02:30:00** time stamp, 2016 October 29th 02:30:00AM (HH:MM:SS)
 - **0:** SDI-12 sensor ID
 - **2:** SDI-12 sub-sensor ID
 - **04:** 4 measurements returned by the sensor
 - **<space>**
 - **-12.20003 +2.322432 -4.433332 -9.110423:** 4 measurements values returned by SDI-12 sensor and separated by a <space> delimiter.

Refer to TBSL1-N datasheet for further description of each message format.

6 History

Version	Date	Author	Changes
V1.0	15/09/2017	Philippe Hervieu	Creation
V1.1	03/07/2018	Philippe Hervieu	Update vs FW/GUI 04.00.01.0B
V1.2	20/11/2018	Philippe Hervieu	Instructions to use TBSL1 with LorIoT LoRaWAN server