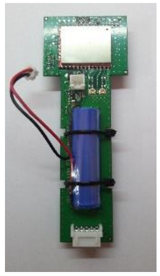
V1.11

Datasheet TBS12SMP/TBS12S/TBS12B

LoRaWAN RTU for SDI-12 sensors

The TBS12 SDI-12 / LoRaWAN module brings LoRa wireless connectivity to SDI-12 sensors. The head embeds a low power LoRaWAN certified modem, with dual antennas connectors to operate on low (434MHz/470MHz) and high (868MHz/915MHz) ISM bands. It also integrates a fully SDI-12 compatible data logger, that sends configurable SDI-12 commands to the sensors and transmits the measurements over LoRa. Though primarily designed for Tekbox TBSSPP1 (Soil moisture and temperature sensor), TBS12 variants are available to interface with any SDI-12 compliant sensor and with optional solar panel support. It offers low current consumption, small footprint and easy integration with SDI-12 sensors.
The head empowers the long range capability of LoRa, along with flexible configuration.
The TBS12 has been engineered specifically for applications where cost, performance, time to market and ease of integration are prime considerations.



Features

- LoRaWAN 1.02 Class A - ABP
- SDI-12 Standard V1.3
- Selectable frequency schemes: EU, US, AU, AS, CN, Custom
- Easy configuration with PC tool through TBS12's UART port
- Low quiescent current
- 3.6V (200mA or more) battery powered
- Exists in 3.6V and 12V versions for SDI-12 sensors
- More than 15km range with clear line of sight
- Configurable measurements and transmission intervals.
- Internal data storage
- Solar panel support
- Operating Temperature Range: -40°C - +85°C

Target Applications

- Any usual agricultural application (eg crop yield optimization, precision irrigation, etc…) where deploying SDI-12 cables is an issue.
- Acts as a range extender for SDI-12 (up to 15km instead of 60m)
- SDI-12 sensors network capacity increase (thousands of nodes can be deployed with only one gateway).

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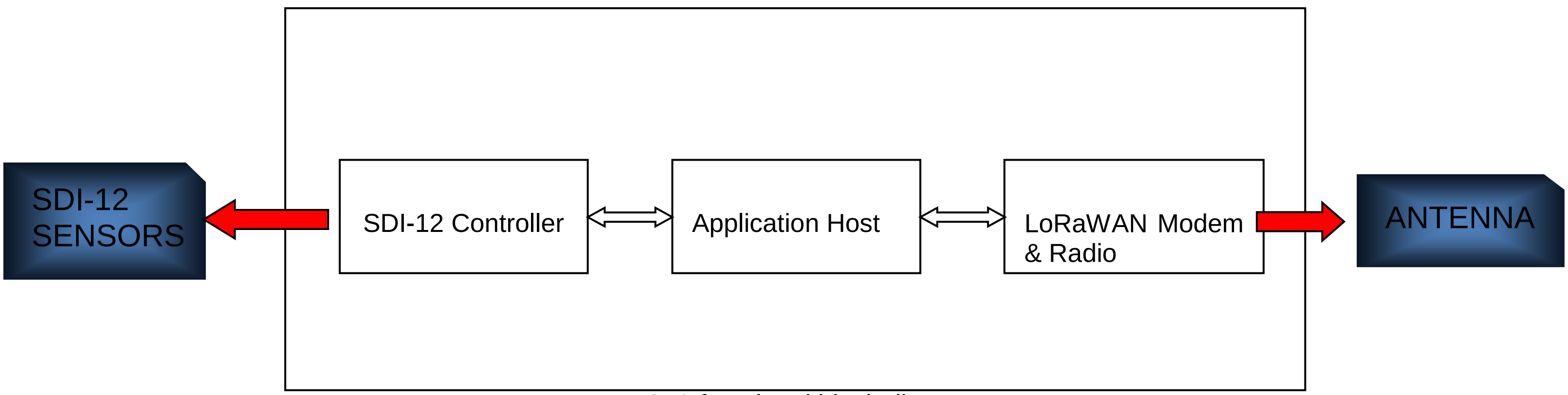
1 Introduction

1.1 Module overview

The TBS12 module implements three main components:

- A SDI-12 controller, used to control SDI-12 sensors and send back measurements to internal host
- A LoRaWAN modem, used to transmit the SDI-12 measurements to the remote application server over LoRa.
- An application host, that controls:
    - SDI-12 commands configuration
    - SDI-12 measurements
    - LoRaWAN transmission
    - Measurement and transmission intervals
    - Measurements storage
    - Power management



TBS12 functional block diagram

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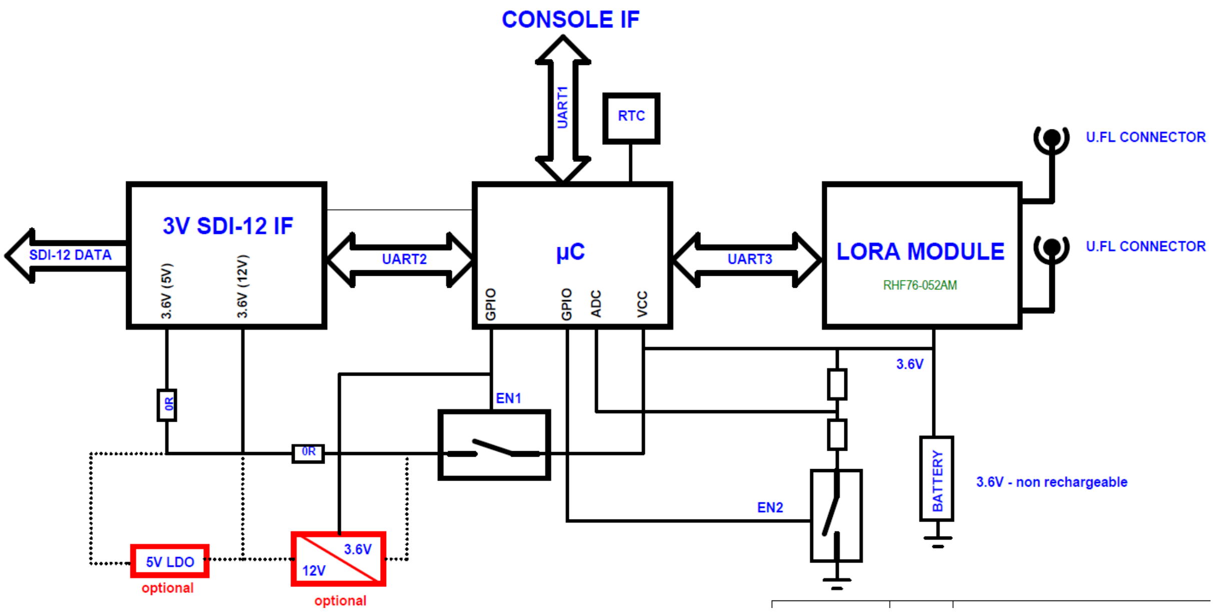

1.2 Variants overview

It exists in 3 variants:

- TBS12SMP (Soil Moisture Probe)
  - LoRaWAN head for Tekbox SDI-12 soil moisture and temperature cells
- TBS12B
  - LoRaWAN RTU for SDI-12 sensors, powered by batteries
- TBS12S
  - LoRaWAN RTU for SDI-12 sensors powered by rechargeable battery and solar panel

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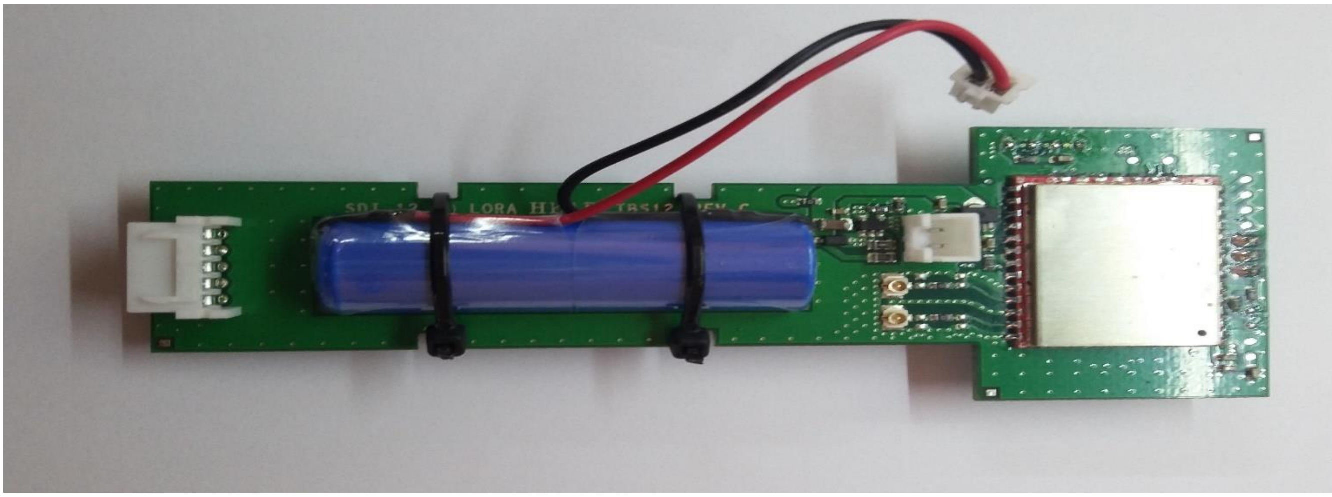
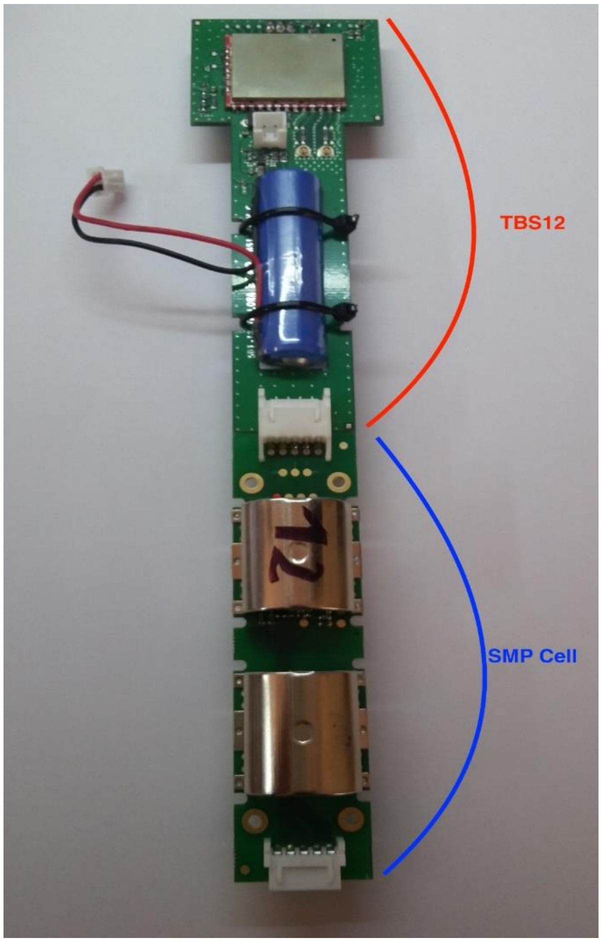
1.2.1 TBS12SMP variant



TBS12SMP: LoRaWAN head powered by a 3.6V battery (Soil moisture and temperature variant)

TBS12SMP connected to a 12V TBSSPP1 Soil Moisture Probe:



Following pictures show an example of TBS12SMP mounting: the LoRaWAN head is connected to TBSSPP1 soil moisture probes and is fitted with an external antenna.

(1) 3.6V Battery is connected to TBS12SMP, the mounted TBS12/TBSSPP1 is inserted in a plastic pole and antenna cable is installed.

(2) Antenna is screwed to the pole

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1.2.2 TBS12B variant

TBS12B: front view and rear view with fixture

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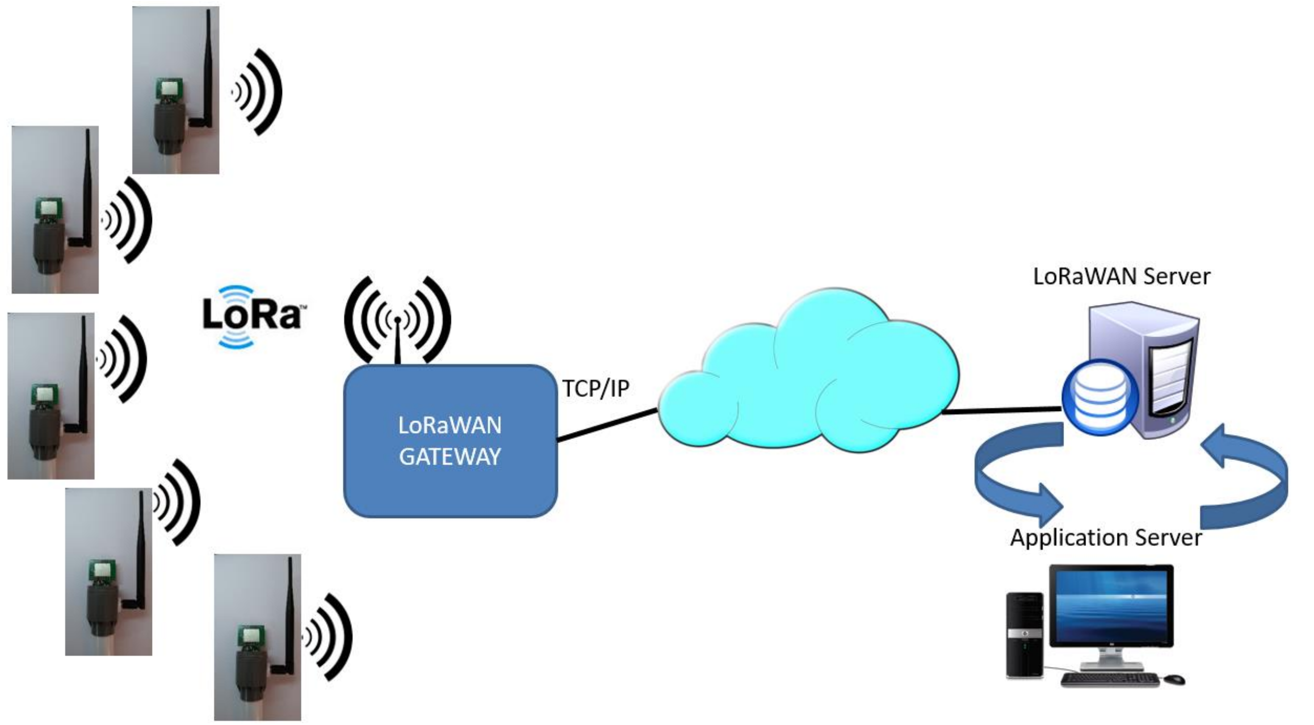
1.2.3 TBS12S variant

TBS12S front view and rear view with fixture

1.3 System overview

TBS12 integrates within a typical LoRaWAN ecosystem: each TBS12 LoRaWAN Head is seen as a unique end node within a LoRaWAN private network (ie including at least one LoRaWAN gateway and a LoRaWAN server).

Following schematic shows a typical TBS12 deployment:



TBS12 in a private LoRaWAN network

Before being used, TBS12 must go through a configuration and provisioning phase to initialize system, SDI-12 and LoRaWAN parameters.
Device configuration is achieved by connecting TBS12 to a PC and running the configuration tool provided along with this product. Further details pertaining to TBS12 configuration are found in configuration chapter.

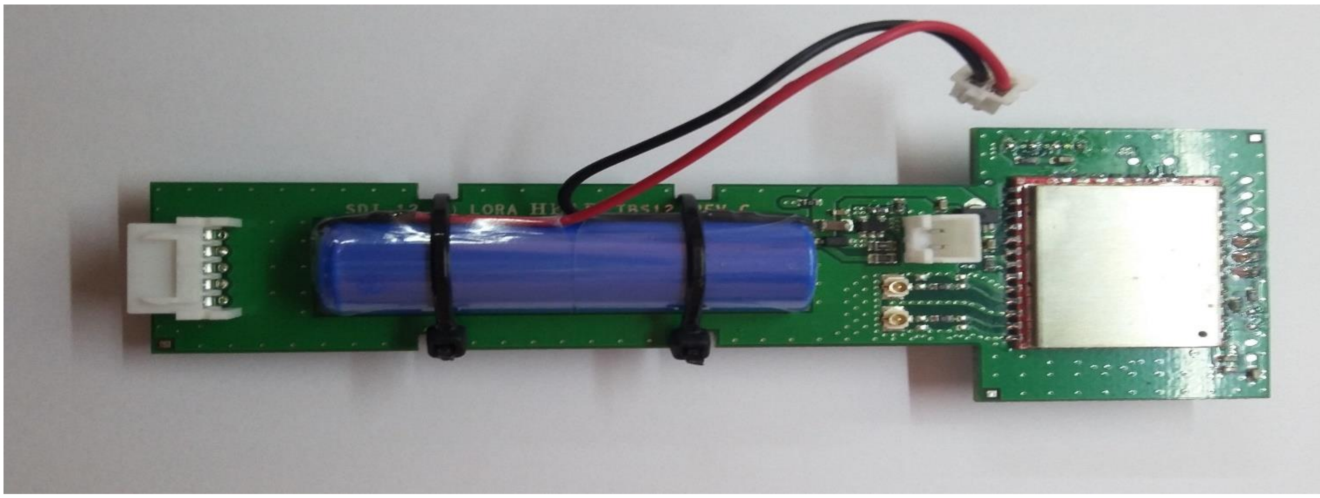
1.4 Product Features

The TBS12 is based on a low power controller and LoRaWAN modem, and a robust SDI-12 interface hardware.

1.4.1 HW features

- 3.6V or 12V (depending on TBS12 product version), 1200 baud SDI-12 data interface with transient protection
- PC UART interface: data rate 9600 baud, 8 bits data, no parity, 1 stop bit, no handshake
- 3.3V PC UART control interface (to be used along with TBS12 Configuration Tool)

- Power supply: battery powered, refer to Power Supplies section for further information.
- Dual antenna connector: low (434MHz/470MHz) and high (868MHz/915MHz) bands
- Operating temperature range: -40 - +85°C
- Available in 3 variants:
    - Soil moisture and temperature to LoRaWAN (TBS12SMP)



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- SDI-12 sensors to LoRaWAN (TBS12B)

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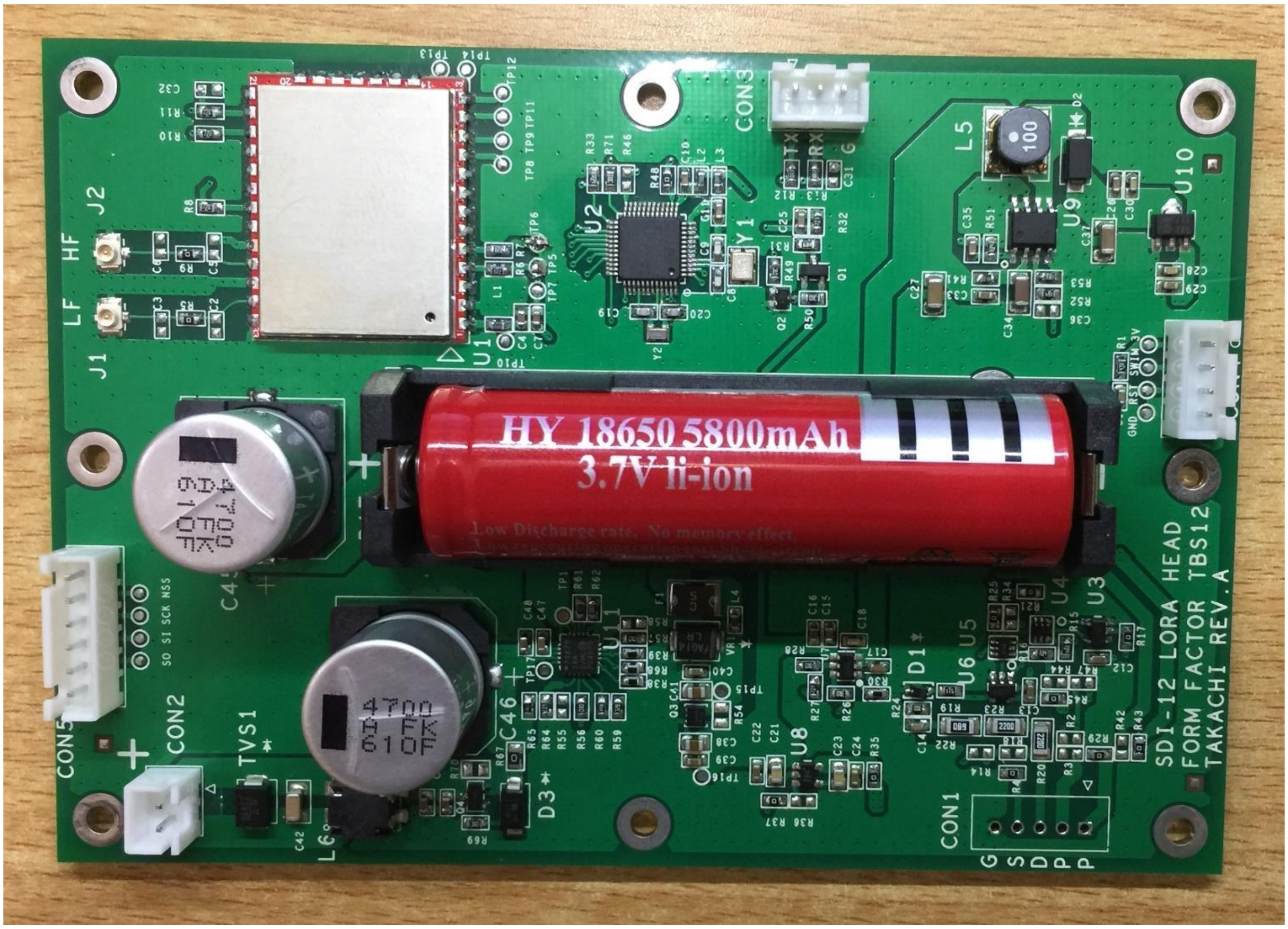
- SDI-12 sensors to LoRaWAN + solar panel support (TBS12S - TAKACHI form factor)



1.4.2 LoRaWAN features

- LoRaWAN Class A
- Device activation: ABP / OTAA
- Frequency plans: EU868, EU433, US915, AU915, AU915OLD, AS923, CN470, CN779; configurable frequencies and data rates.
- Uplink communication – selectable confirmed or unconfirmed messages, repeat feature
- Reconfigurable LoRaWAN parameters: identifiers (DevAddr, DevEUI) and security keys (NwkSKey, AppSKey, AppKey)

1.4.3 System features

- Fully configurable set of SDI-12 commands to be executed (up to 40 Measurement/Data commands pairs)
- Programmable measurement and transmission intervals (from 1 minute to 24 hours)
- Configurable battery information reporting interval
- Configurable transmission delay: allow to stagger the transmission of multiple TBS12 units deployed in the same vicinity, contributing then to reduce the collision rate.
- 2 modes of operation while connected to TBS12 PC application:
  - Logging mode: TBS12 operates normally but outputs debug information to the PC tool
  - Console mode: TBS12 is in configuration mode, its system, SDI-12 and LoRaWAN parameters can be checked and updated. Moreover, it is possible to directly access connected SDI-12 sensors and LoRaWAN modem by sending any supported SDI-12 commands/LoRaWAN modem AT command (this is an advanced diagnosis feature).

1.5 Technical references

1.5.1 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 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)
http://www.sdi-12.org

The latest standard is version V1.3 and dates from July 18th, 2005. The standard is available on the web site of the SDI-12 Support Group. More information on SDI-12 is presented in chapter 6.

1.5.2 LoRaWAN

LoRaWAN is a MAC layer radio protocol for LoRa (technology owned by Semtech, www.semtech.com) developed and maintained by LoRa Alliance:

www.lora-alliance.org

LoRa™ Alliance

2400 Camino Ramon, #375

San Ramon, CA 94583

Phone: +1 925-275-6611

Fax: +1 925-275-6691

"**LoRaWAN™** is a Low Power Wide Area Network (LPWAN) specification intended for wireless battery operated Things in a regional, national or global network. LoRaWAN targets key requirements of Internet of Things such as secure bi-directional communication, mobility and localization services. The LoRaWAN specification provides seamless interoperability among smart Things without the need of complex local installations and gives back the freedom to the user, developer, businesses enabling the roll out of Internet of Things."

Further details available on LoRa Alliance website (https://www.lora-alliance.org/What-Is-LoRa/Technology).

2 TBS12 connectivity

TBS12 provides following connectivity:

- 1 UART to control SDI-12 sensor
- 1 UART port for PC connection
- 1 SWIM port for FW update and connection to an emulator
- 1 slot for battery (form factor is variant dependant)
- 1 port for solar panel (TBS12S only – embedded on the housing)
- 2 internal antenna connectors (low and high LoRaWAN frequencies) linked to external antenna.

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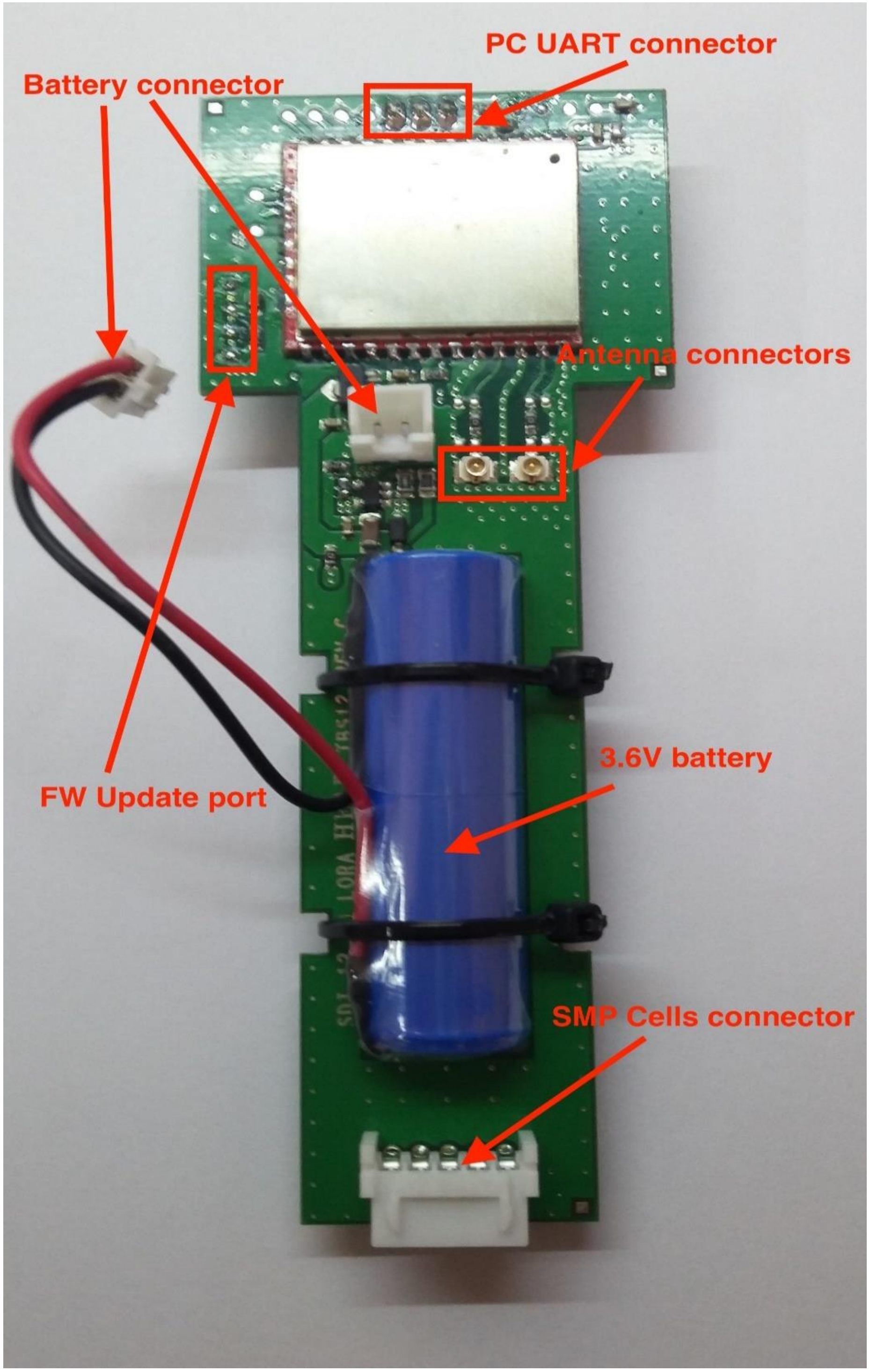
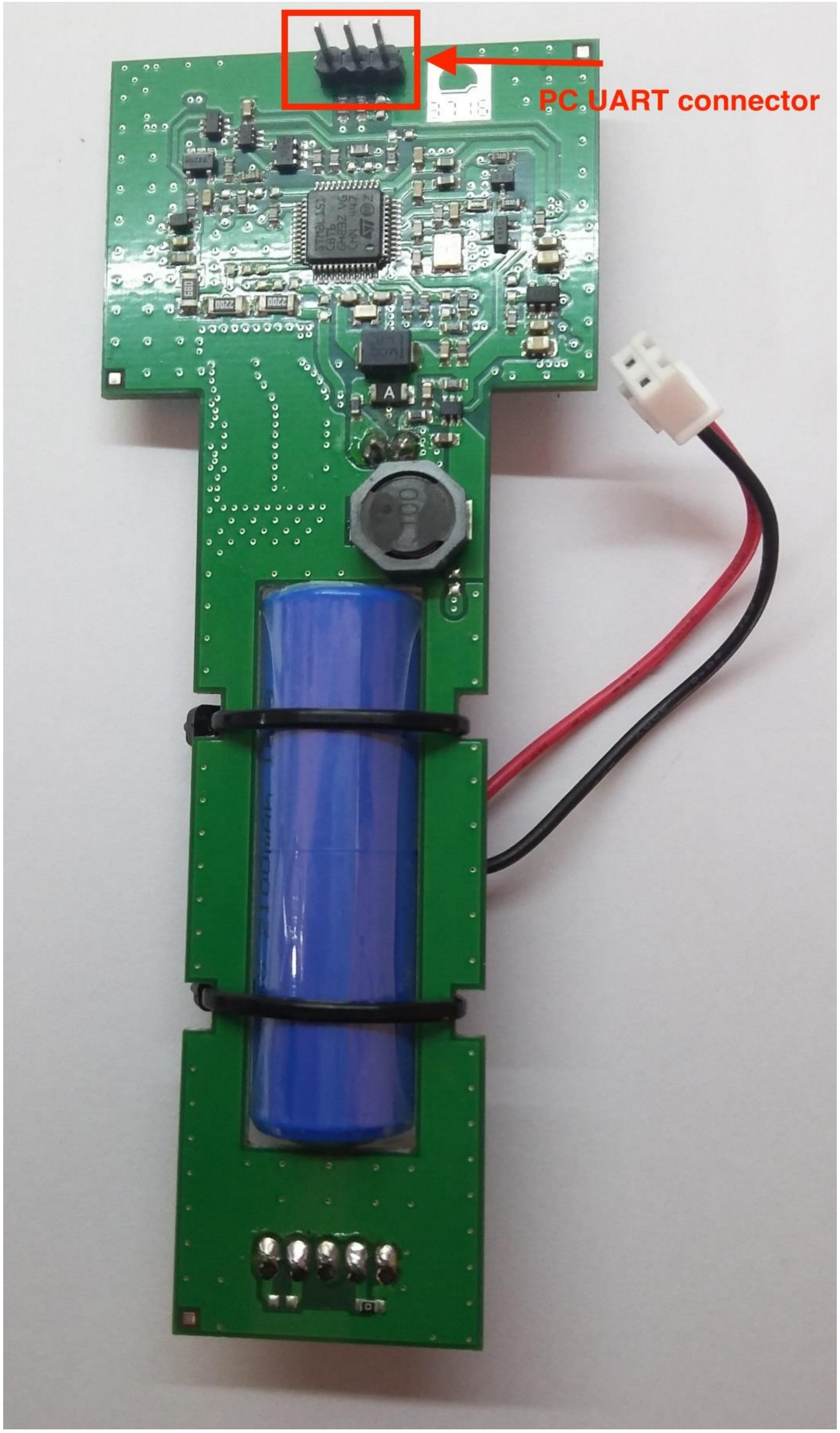
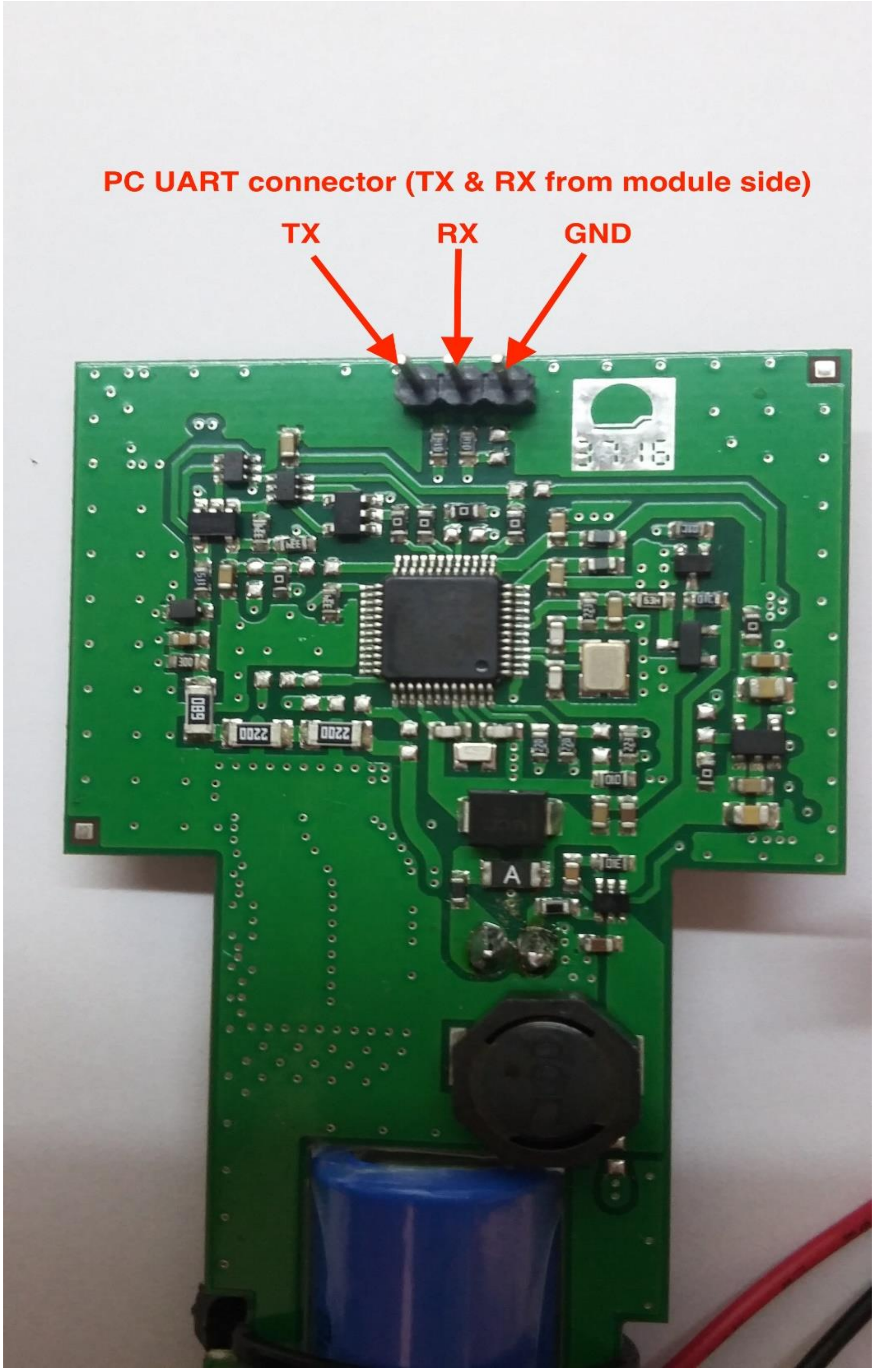
2.1 TBS12SMP connectivity details



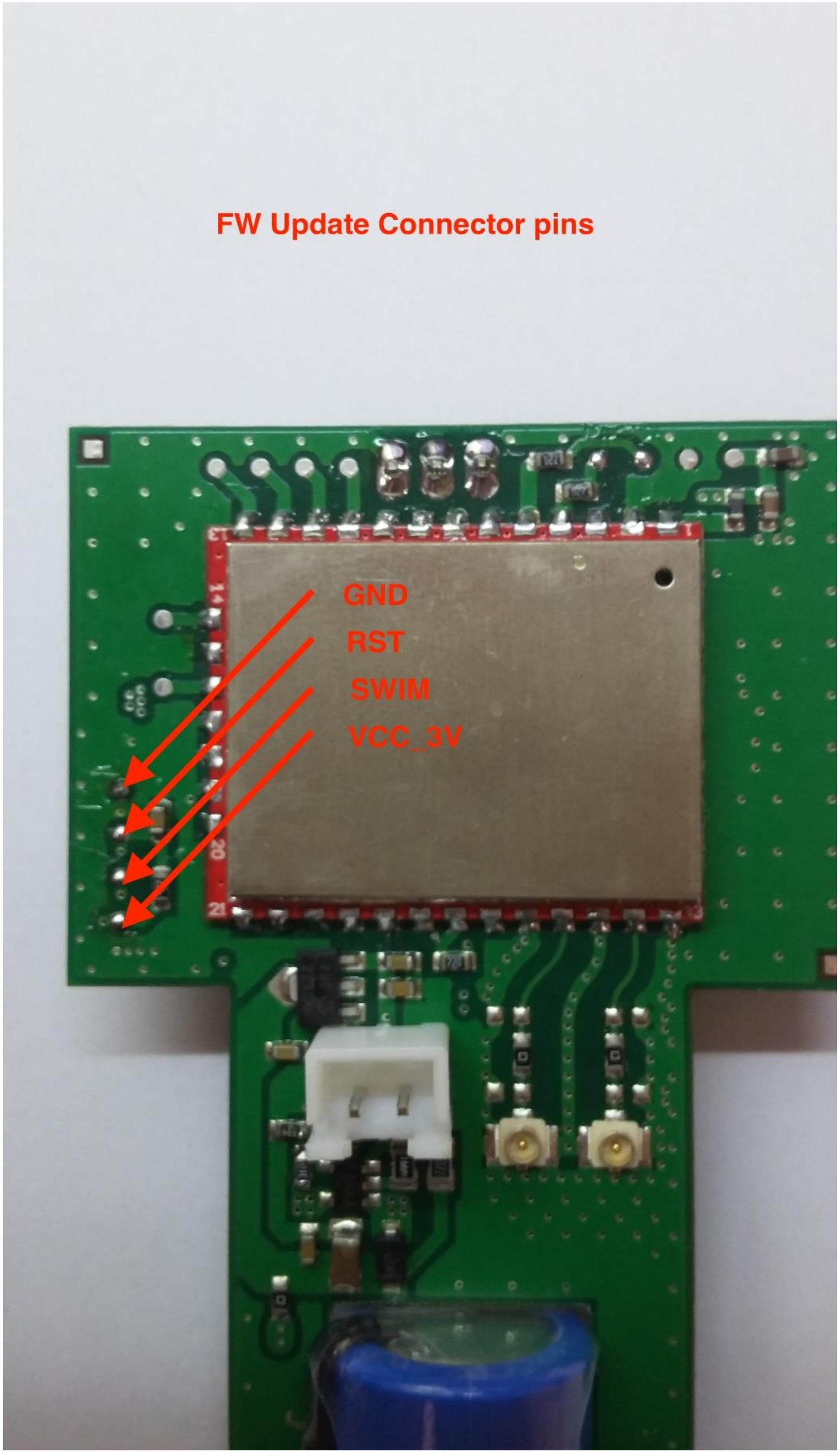
TBS12SMP – Front view



TBS12SMP – Rear view



PC UART connector – pins description



SWIM connector – pins description

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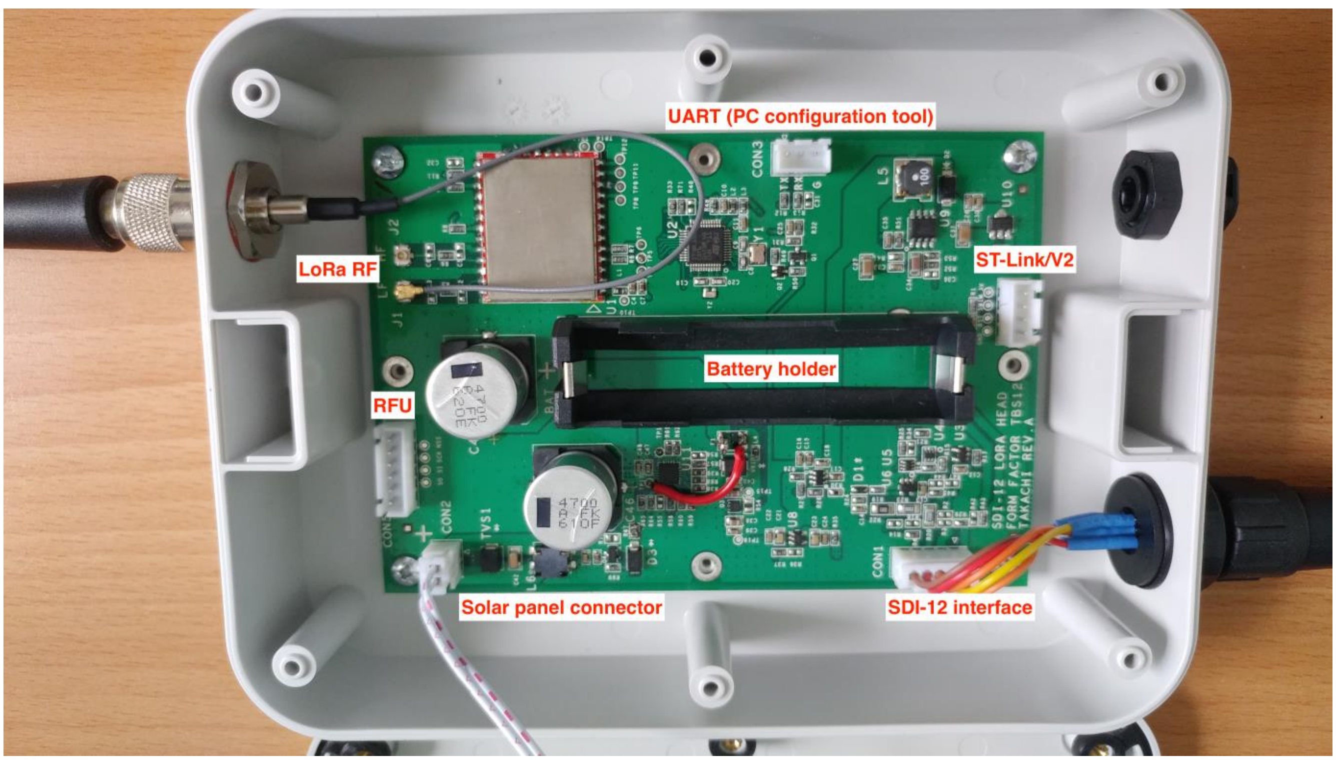
2.2 TBS12S connectivity

TBS12S – Housing closed



TBS12S – Lid open

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2.3 TBS12B connectivity

3 Functional Description

3.1 Interface function

3.1.1 SDI-12

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 TBS12 is connected to the TX output of the data recorder controller UART and converts the command strings to the logic levels and baud rate specified by the SDI-12 standard. Furthermore, the TBS12 module handles breaks, marks and all other details of the SDI-12 protocol.

Upon receiving data or status information originated by a Sensor, the TBS12 extracts the corresponding ASCII strings and presents it to the RX input of the data recorder controller UART.

3.1.2 LoRa modem and radio

TBS12 embeds a LoRaWAN compatible modem and a dual band LoRa radio.

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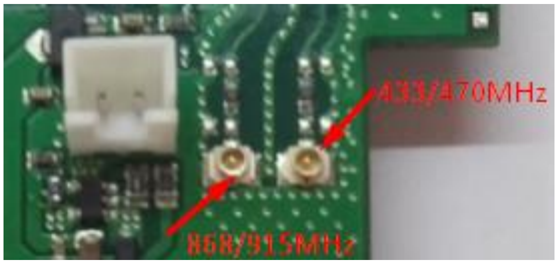
Depending on the frequency plan that is used (country specific), either low or high ISM band will be needed. It is therefore crucial to connect the antenna to the right connector:



As LoRaWAN uses free ISM bands, useable frequencies are subject to local regulation, and TBS12 must be configured accordingly:

- To use supported LoRaWAN frequency plans for countries where this has been defined
- To use custom plans for other countries

Refer to latest LoRaWAN specification on www.lora-alliance.org

TBS12 must be then used along with a LoRaWAN gateway that operates on the same frequency band: for example, if TBS12 is deployed in Europe, both TBS12 and gateway must be configured to use EU868 frequency plan.

3.2 Power Supplies

TBS12 power supply depends on the variant:

- Soil moisture & temperature cells (TBS12):
  - 3.6V non rechargeable battery (e.g. PulsesPlus™ series from Tadiran)
- SDI-12 sensors (TBS12B):
  - 3*1.5V DCELL
- SDI-12 sensors + solar panel (TBS12S)
  - 3.7V Li-Ion rechargeable
  - Capacity: 2000-3000 mAh
  - Size must fit the battery holder 0.72" Dia * 2.56'' H (18.2mm * 65.0mm)

Depending on the mounting configuration, cable binders can be used to tie the battery to the PCB.

3.3 System

TBS12 acts like a mini-RTU (Remote Telemetry Unit): it is designed to trigger SDI-12 measurements on a regular basis, and transmit the measurements over LoRa to application server on defined time interval.

SDI-12 measurements are stored in TBS12 internal memory until they're transmitted.

All of these parameters are configurable.

3.3.1 Time intervals

Three different time intervals are defined in the system:

- Measurement interval
  - Period in minutes to perform SDI-12 measurements and store data into internal memory.
- Transmission interval
  - Period in minutes to transmit measurements stored in TBS12 internal memory over LoRa
- Monitoring interval
  - Period in minutes to transmit monitoring information (eg battery level) over LoRa to the application server. This must be a multiple of the Transmission Interval.

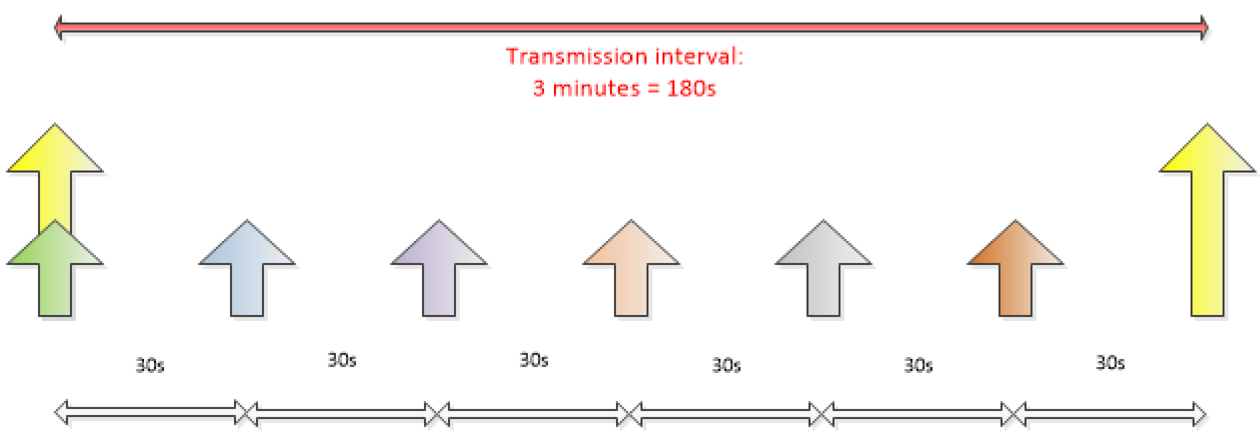
These parameters are configured with the TBS12 Configuration Tool.

Intervals are set in minutes from 1min to 1440 minutes (ie 24 hours).

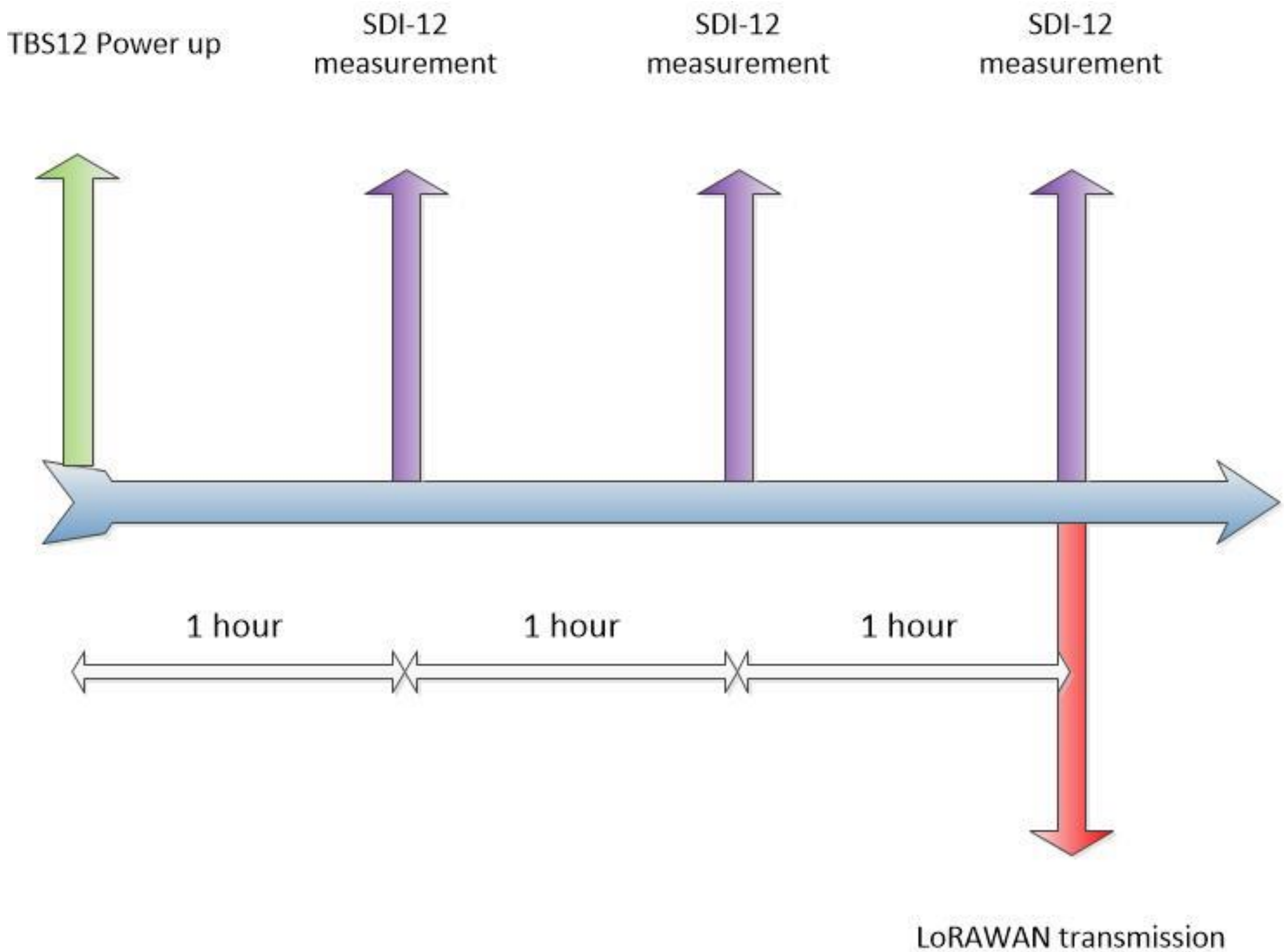
A transmission delay can be set in case multiple TBS12 are deployed in the same area. Having several TBS12 sending data at the same time will result in numerous packets collisions, therefore staggering the transmission of each units over the transmission interval will help reducing this effect.

The staggering delay should be carefully chosen so there's no overlap with the next transmission interval.

Following sequence shows 6 TBS12 units transmitting their data on a 30s slot basis spread over a 6 minutes transmission interval:



Below diagram shows how TBS12 operates with a 1 hour measurement interval and 3 hours transmission interval:



Note: it is strongly recommended to use same interval for both measurements and transmission (e.g. each 15 minutes) to ensure smooth operation of the RTU.

3.3.2 Communication outage

The TBS12 is able to handle 2 different situations related to communication outage:

(1) Some stored measurements have not been transmitted because of empty battery
(2) Data is not received by the server because of radio transmission issue, gateway is down, LoRaWAN server outage, etc…

Situation (1) is automatically handled by TBS12: when the device is repowered (ie battery has been replaced), upon the first transmission interval it will transmit the measurements that have not been previously sent.

Situation (2) is handled by TBS12 only if the device has been configured to use confirmed messages as per LoRaWAN standard: in this case, whenever a packet of data is sent by TBS12, the LoRaWAN server must sent back an acknowledge to confirm the packet has been successfully received.

Would this acknowledge not be received, transmission is aborted. The packet will be retransmitted upon the next transmission interval, along with subsequent data packets stored in internal memory.

Up to 1Kb of data is stored into TBS12 internal memory before being overwritten: depending on the programmed measurement and transmission intervals, and the volume of SDI-12 measurements to be stored (cf Data format), it is possible to assess the maximum outage time without loosing data.

3.3.3 Data format

Each measurement stored in internal memory is time stamped, and one packet of data corresponds to one sensor.
As an example, if 5 SDI-12 TBSSPP1 sensors are connected to TBS12, 5 packets of data are stored in memory upon each measurement interval.

TBS12SMP/TBS12B/TBS12S returns 2 types of messages:

- Measurement message
- Battery reporting message

Measurement message
This message is a string formatted as follows:
PSYY:MM:DD:HH:MM:SS:0<CMD_Index><Nb_values> Value1 Value2 … ValueN
Where:

- <PS>: packet header for SDI-12 parameters
- <YY:MM:DD> is the date with <YY> being the last 2 digits of the year, <MM> the month number and <DD> the date. For example, <18:06:01> is the 1rst of June 2018.
- <HH:MM:SS> is the time represented as hours/minutes/seconds, eg 16:25:00.
    - Note: time is 24h format (ie no AM/PM representation)
- <0>: delimiter.
- <CMD_Index>: index of the SDI-12 commands that is executed. It corresponds to the index of the SDI-12 command programmed with the GUI.
- <Nb_values>: number of measurements returned by the SDI-12 sensor
- <Value1>… <ValueN>: SDI-12 measurements formatted as per SDI-12 standard (pd.d).

Example:
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

Battery measurement message
This message is a string formatted as follows:
PBYY:MM:DD:HH:MM:SS <Battery_voltage>Where:

- <PB>: packet header for battery voltage parameter

- <YY:MM:DD> is the date with <YY> being the last 2 digits of the year, <MM> the month number and <DD> the date. For example, <18:06:01> is the 1rst of June 2018.
- <HH:MM:SS> is the time represented as hours/minutes/seconds, eg 16:25:00.
    - Note: time is 24h format (ie no AM/PM representation)
- <0>: separator.
- <Battery_voltage>: battery voltage in V coded over 5 digit including the decimal separator.

Example:
PB18:06:01:17:00:00 3.600
- Time stamp: 1rst of June 2018 (date) 17:00:00 (time)
- Battery voltage: 3.6V

4 TBS12 configuration

Before being used, TBS12 must be configured:
- With ad hoc LoRaWAN ID and ciphering keys to operate on the selected LoRaWAN service provider.
- With LoRa frequencies and data rates corresponding to the area where the head is deployed (subject to loca regulation and as per LoRaWAN standard)
- With optional LoRaWAN parameters like ADR, confirmed/unconfirmed messages, …
- With measurement and transmission intervals

TBS12 configuration is achieved through a PC application that accesses the device through its external UART port.
When TBS12 is connected to PC application, its internal date and time are automatically updated. TBS12 is designed so it can't operate until its date and time have been set through the PC application.

A maximum of 16 SDI-12 commands can be programmed.

Refer to the TBS12 PC configuration tool user guide for further information.

5 Electrical Characteristics

Current consumption in sleep mode:

- TBS12/TBS12B: 5-7 µA
- TBS12S: 35 µA

Current consumption while performing SDI-12 measurements and transmitting data over LoRa depends on the kind of SDI-12 sensor(s) on one side, and on the measurement/transmission intervals on the other side.

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6 Power Management strategy

TBS12 integrates automatic power management feature. When the device neither measures nor transmits, the MCU goes to deep sleep mode, SDI-12 HW stage is disabled and LoRaWAN modem is in ultra low power mode.

Following screenshot mirrors the current consumption in a typical TBS12 operating sequence, where measurement and transmission intervals occur at the same time: the platform wakes up from sleep mode, then performs SDI-12 measurements, and finally transmit all measurements stored since last transmission over LoRa.

7 Mechanical Specifications

7.1 With soil moisture and temperature cells support (TBS12)

TBS12 dimensions:

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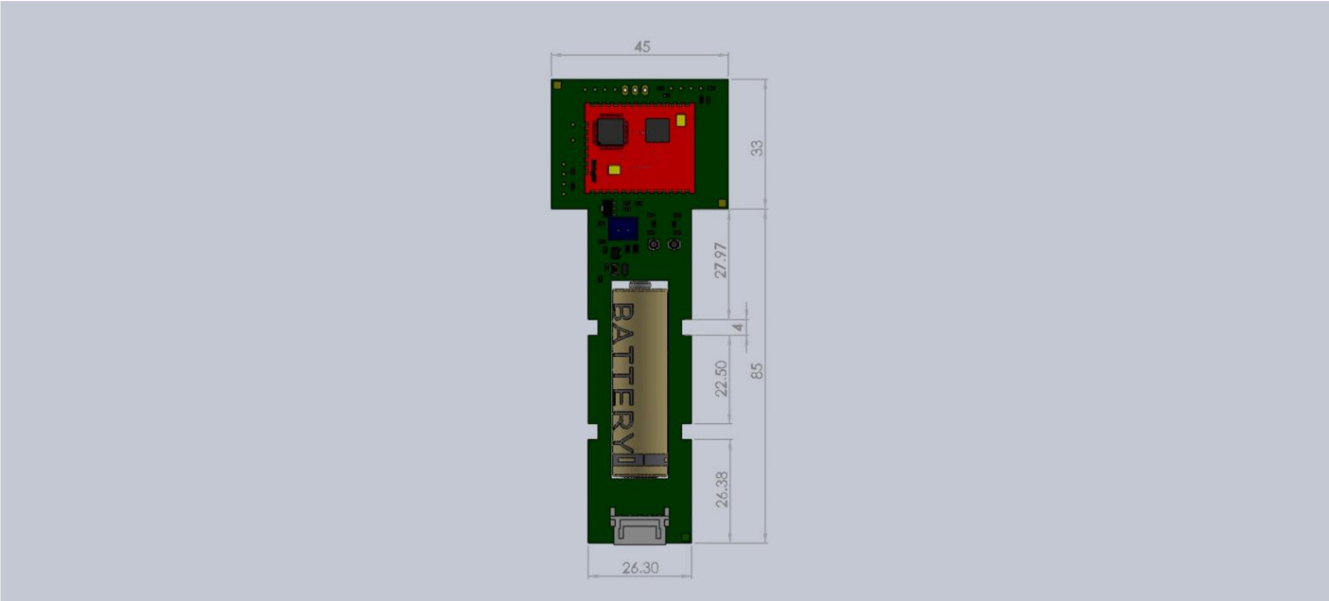
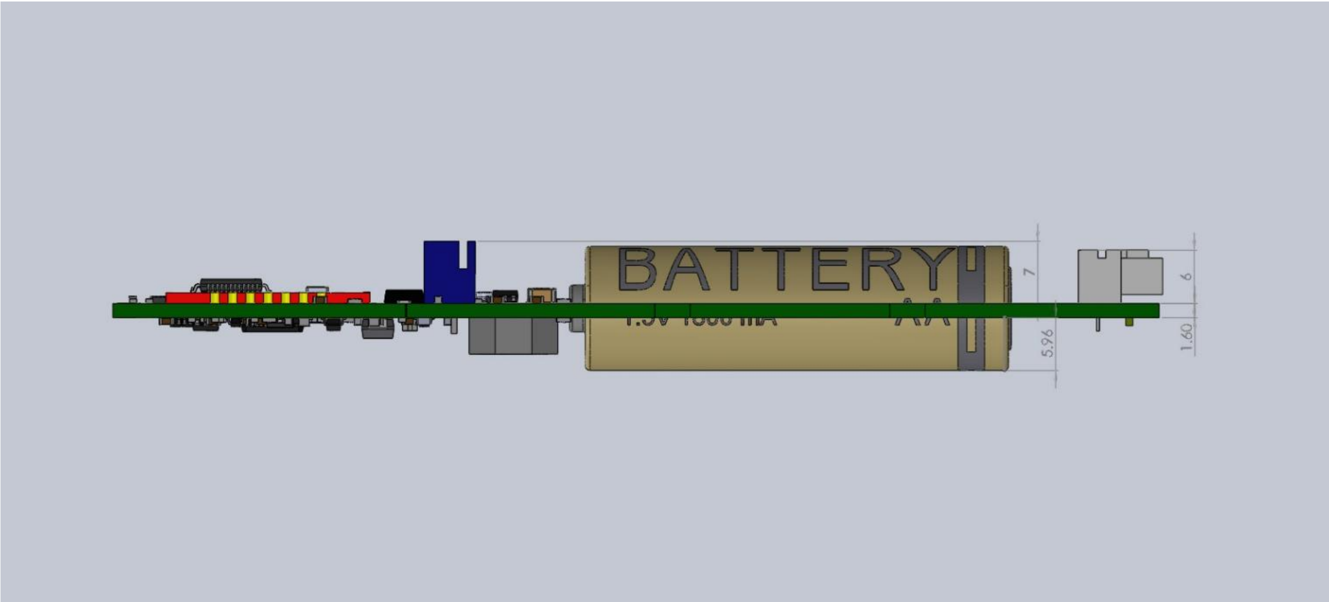
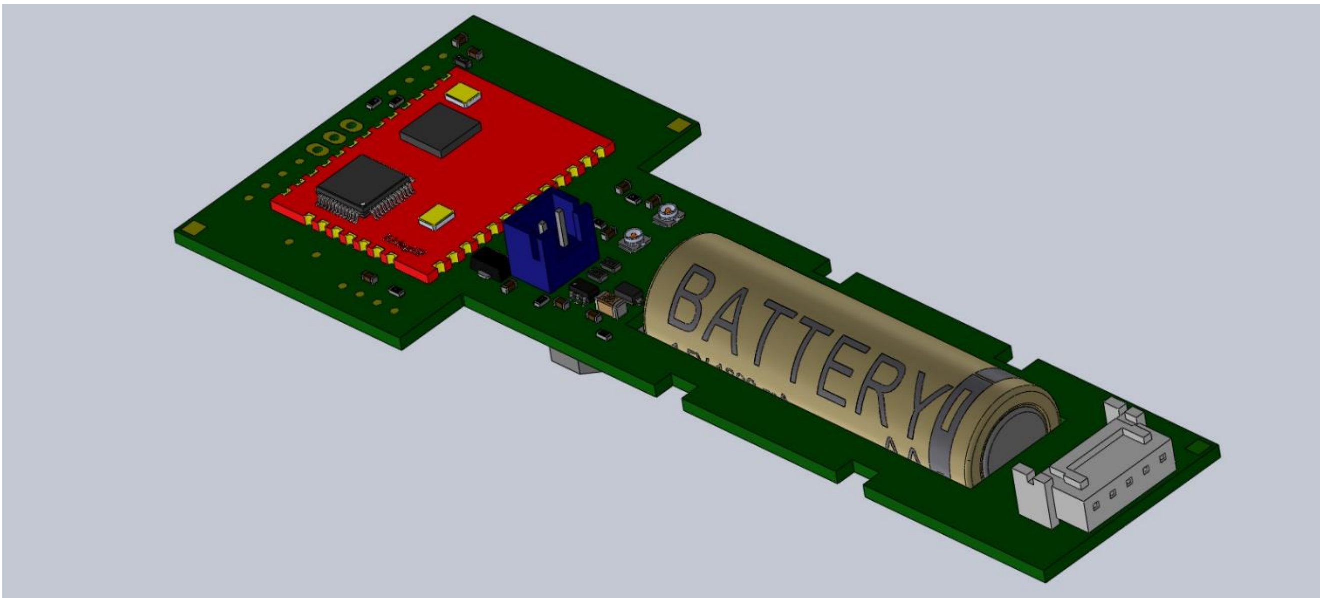
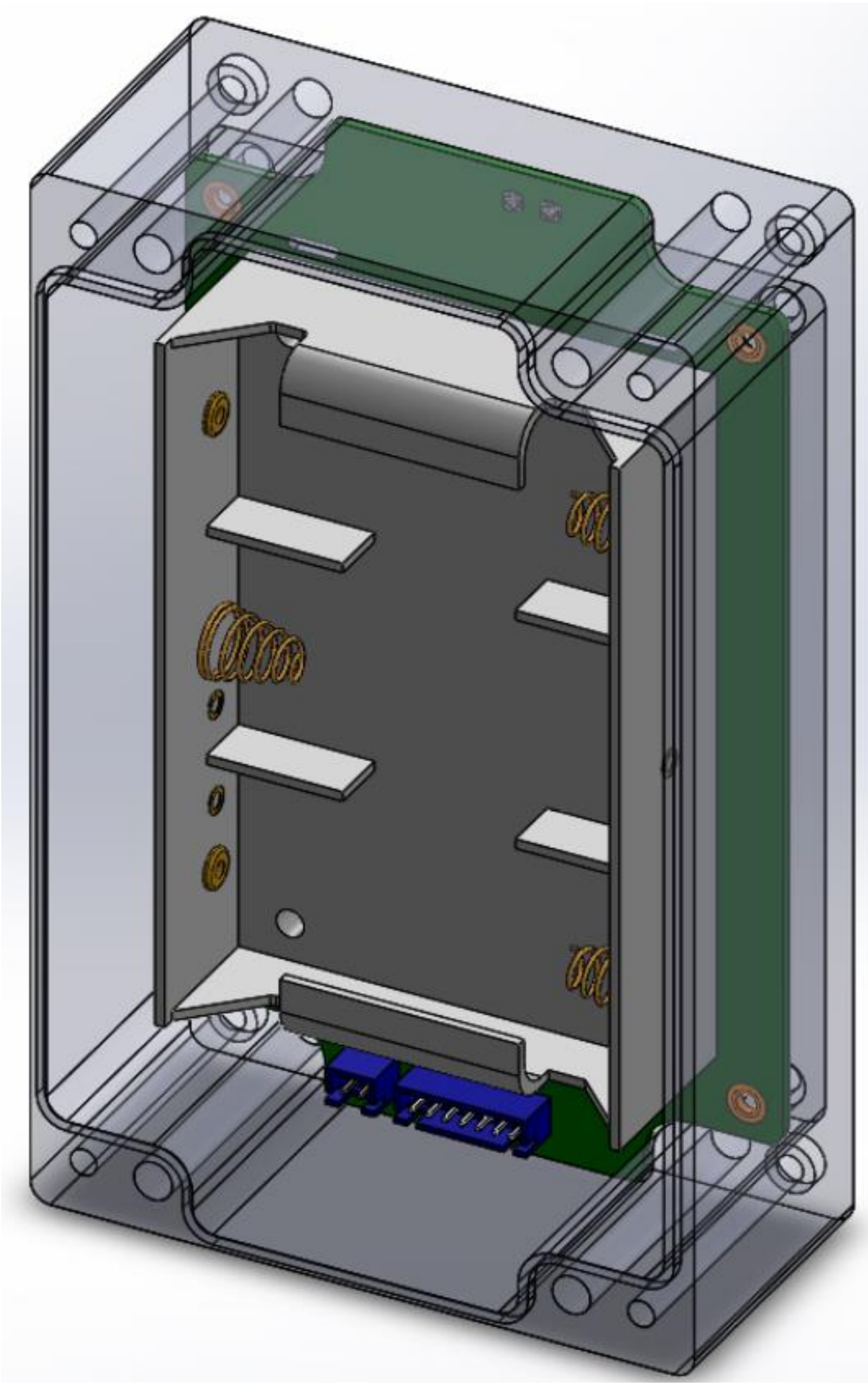

45
33
27.97
4
85
22.50
26.38
26.30
BATTERY


BATTERY
7
6
5.96
1.60



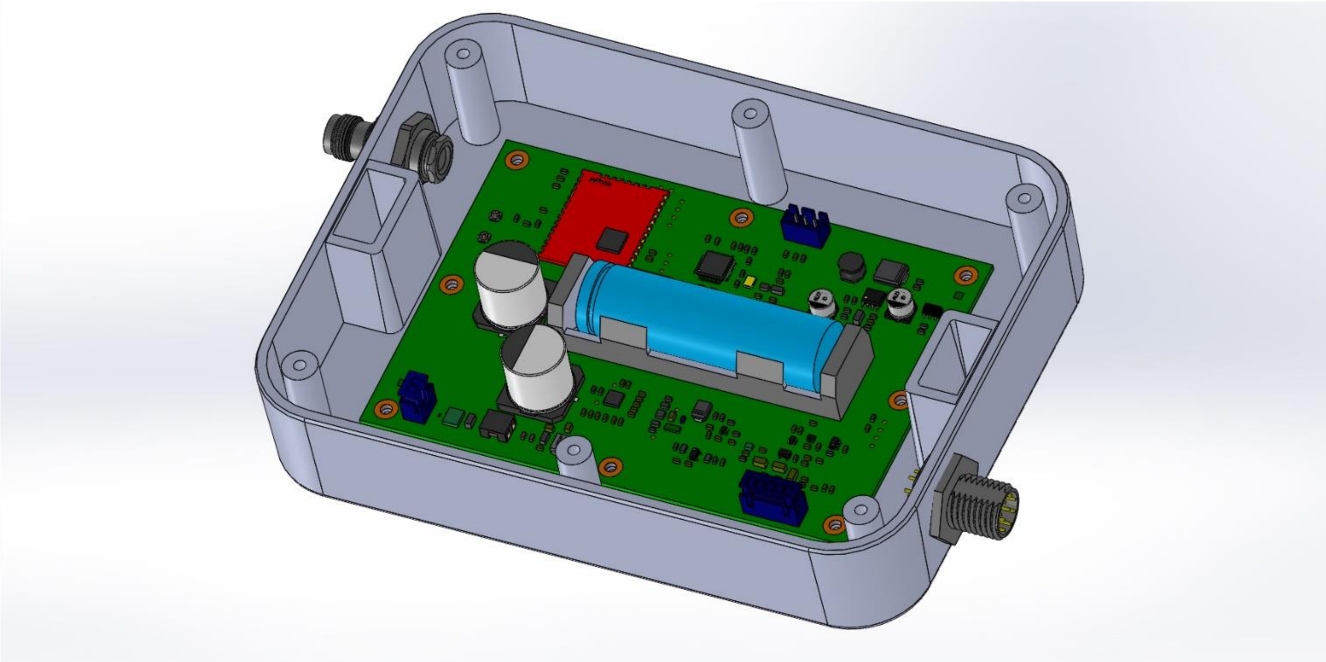
7.2 With SDI-12 compliant sensors support (TBS12B)

Delivered within its IP67 grade housing.



7.3 With SDI-12 compliant sensors and solar panel support (TBS12S – Takachi form factor)

Delivered within its IP67 grade housing.



8 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 typically can 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 indicatesthat 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:

Factory 4, F5, Lot I-3B-1 | Saigon Hi-Tech Park | Tan Phu Ward, District 9 | Ho Chi Minh City | Tel +84 (83)5471340
E-mail office@tekbox.com| www.tekbox.com

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, 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 2 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.
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9 LoRaWAN network basics

9.1 Overview

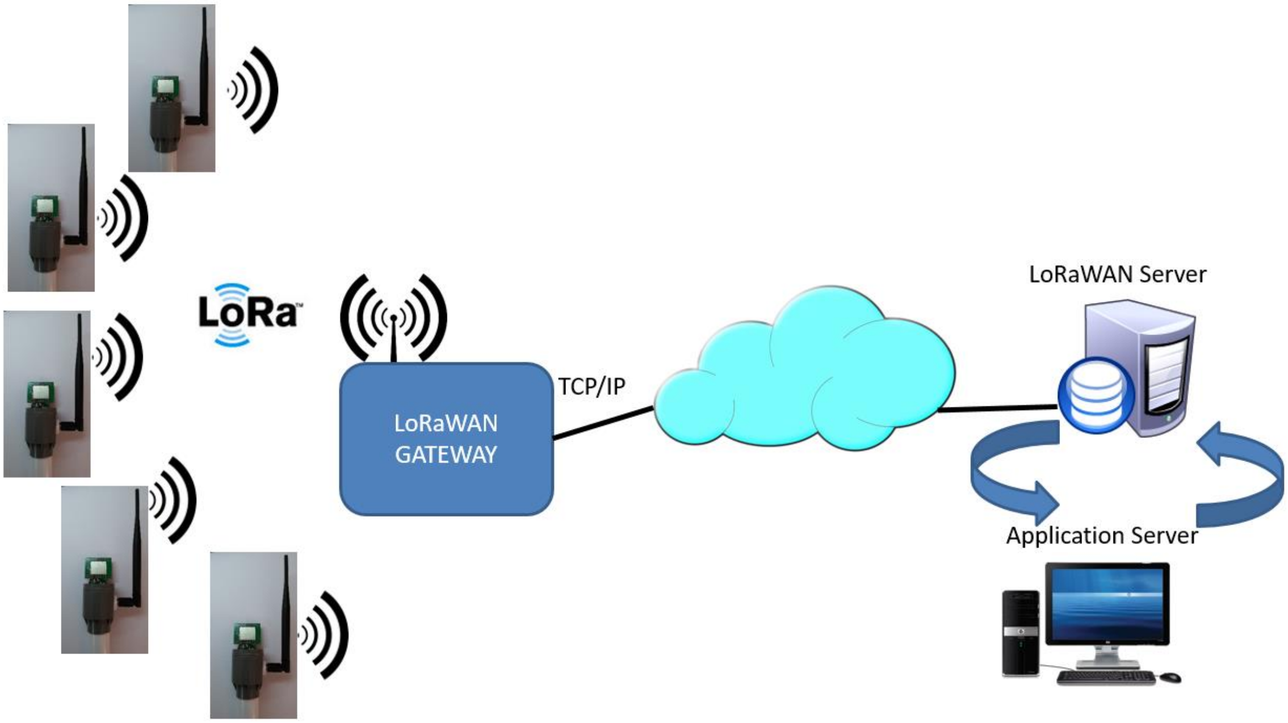
This section provides the TBS12 user a basic understanding of LoRaWAN key features, so TBS12 can be integrated smoothly in such ecosystem.

LoRa Alliance describes a LoRaWAN network as follows:
"

LoRaWAN network architecture is typically laid out in a star-of-stars topology in which **gateways** is a transparent bridge relaying messages between **end-devices** and a central **network server** in the backend. Gateways are connected to the network server via standard IP connections while end-devices use single-hop wireless communication to one or many gateways. All end-point communication is generally bi-directional, but also supports operation such as multicast enabling software upgrade over the air or other mass distribution messages to reduce the on air communication time.
Communication between end-devices and gateways is spread out on different **frequency channels** and **data rates**. The selection of the data rate is a trade-off between communication range and message duration. Due to the spread spectrum technology, communications with different data rates do not interfere with each other and create a set of "virtual" channels increasing the capacity of the gateway. LoRaWAN data rates range from 0.3 kbps to 50 kbps. To maximize both battery life of the end-devices and overall network capacity, the LoRaWAN network server is managing the data rate and RF output for each end-device individually by means of an **adaptive data rate** (ADR) scheme.

"

This leads then to a network where each TBS12 is a unique end node communicating with a gateway as highlighted in below schematics:



Several components are involved in the LoRaWAN network:

- End nodes: this is any end-user device integrating a LoRaWAN modem and communicating with a LoRaWAN gateway. With respect to this, TBS12 is a end node.
- Gateway: it acts as a packet forwarder between end nodes and LoRaWAN server. It communicates through LoRa radio with end nodes, and through a TCP/IP connection with LoRaWAN server (depending on the gateway capability, this can be achieved with an Ethernet, wifi or cellular connection). One gateway can accommodate thousands of end nodes, and typical range is 2km in urban areas and around 15km in rural areas with clear line of sight.
- LoRaWAN server: this is a service provided by a 3rd party company (hence the user needs to subscribe to such service). As LoRaWAN packets are encrypted, the LoRaWAN server proceeds with deciphering of LoRaWAN packets and make them available to user's application server through various communication protocols (this is totally dependant on the LoRaWAN service provider, but HTTPS, WebSocket and REST are widely used protocols besides direct integration with IoT platforms like Microsoft Azure or AWS IoT). An API is then provided to access deciphered data, device EUI and other radio parameters (usually in JSON or XML format).

9.2 Integrating TBS12 in a LoRaWAN ecosystem

To build a private network of TBS12, it is first required to choose a LoRaWAN gateway (eg www.kerlink.com, www.multitech.com, …) and a LoRaWAN services provider (eg www.loriot.io, …).

TBS12 is compatible with any LoRaWAN certified gateway and network service provider.

This choice is dependant on several criteria:

- Geographic area where the sensors will be deployed: this determines the LoRaWAN frequency plan to be used. The gateway must then have required HW to support these frequencies (eg 868MHz, 915MHz, etc…)
- Gateway connectivity: depending on where the gateway will be installed, next options need to be considered,
  - Indoor / outdoor model
  - Connectivity: Ethernet, cellular, wifi
- The LoRaWAN service provider:
  - Needs to support the chosen gateway (because it will be programmed to access the selected LoRaWAN service provider)
  - Must support the frequency plans required by the user
  - Must support the LoRaWAN features required by the user (eg LoRaWAN downlink, Class C, OTAA, etc…)
  - Provides a suitable interface for the user so the application server can collect deciphered data (eg JSON/XML API reachable through Websocket, REST, etc…)
  - Must be ideally located in the same region where end nodes are deployed, to avoid latenties (eg end nodes in Vietnam, LoRaWAN server in Singapore but not in Germany)
  - Support of multiple applications/accounts, scalability of the server, …
  - Pricing model: subscription based, billing per gateway and end nodes, etc…

The next step is to activate each end node so they are identified and can communicate with the LoRaWAN network.

LoRaWAN standard defines 2 ways of activating end nodes:

- Activation By Personalization (ABP): with this configuration, the end node is bound to a specific LoRaWAN network. This mode is supported by default in TBS12, and can be compared to a smartphone that is SIM-locked to a specific cellular network.
- Over the Air Activation (OTAA): this configuration is optional on TBS12. It gives the end node the "roaming" capability, ie the end node is not bound to a specific network, and can be re-activated on different LoRaWAN network through OTAA procedure.

Both activation modes require following identifiers & keys configuration:

Mode	ID/EUI	Key
ABP	DevAddr	NwkSKey, AppSKey
OTAA	AppEUI, DevEUI	AppKey

Note: the generation of DevAddr in ABP mode is dependant on the LoRaWAN service provider. It can be any random value generated by the user, or can be generated from EUI (or other mean) by the LoRaWAN service provider.

Good practice is to define an EUI for an end node, whether it is activated by ABP or OTAA.

9.3 Deploying TBS12 on the field

When fitted into a housing, TBS12's antenna should be external for better performances.
It is key having the gateway installed as high as possible to get increased communication range.

10 Environmental Specifications

Symbol	Parameter	Conditions	Min	Max	Unit
T_A	Operating Ambient Temperature Range		-40	+85	°C
T_{STG}	Storage Temperature Range		-40	+85	°C
	Humidity level	Ta=60°C; no condensation	-	95	% R.H

Table 1 – Environmental Specifications

11 ESD Safety

The TBS12 is a static-sensitive electronic device. Do not operate or store near strong electrostatic fields. Follow guidelines as per EIA/JESD22-A115-A.

12 RoHS Compliance

TBS12 modules are compliant with the European Union Directive 2002/95/EC Restriction on the Use of Hazardous Substances (RoHS). All designated products have Pb-free terminals.

13 Ordering Information

Part Number	Description
TBS12	LoRaWAN Head for SDI-12 Stackable Soil Moisture Probes (TBSSPP1)
TBS12B	LoRaWAN Head for SDI-12 sensors
TBS12S	LoRaWAN Head for SDI-12 sensors + solar panel support

Contact: sales@tekbox.net

14 History

Version	Date	Author	Changes
V1.0	02.11.2016	Philippe Hervieu	Creation of the document

V1.1	03.11.2016	Philippe Hervieu	Remove soldering profile and packaging chapters / Update power management, Electrical specifications and Mechanical Specification sections.
V1.2	06.02.2017	Philippe Hervieu	Battery information updated
V1.3	06.02.2017	Philippe Hervieu	Details about date and time programming in the unit
V1.4	03.08.2017	Philippe Hervieu	Update current consumption in sleep mode
V1.5	02.10.2017	Philippe Hervieu	Add Tekbox/Takachi variants descriptions
V1.6	10.04.2018	Philippe Hervieu	Update products names
V1.7	01.06.2018	Philippe Hervieu	Update power consumption section and messages format
V1.8	25.06.2018	Philippe Hervieu	Add TBS12S connectivity
V1.9	24.08.2018	Philippe Hervieu	Update TBS12 variants
V1.10	02.10.2018	Philippe Hervieu	Update configuration section.
V1.11	18.10.2018	Philippe Hervieu	Recommendation about using same measurement and transmission intervals.