USER GUIDE FOR SIGFOX ULTRASONIC LEVEL SENSOR FOR TRASH BIN WSSFC-ULA

THIS IS **OBSOLETE** MANUAL

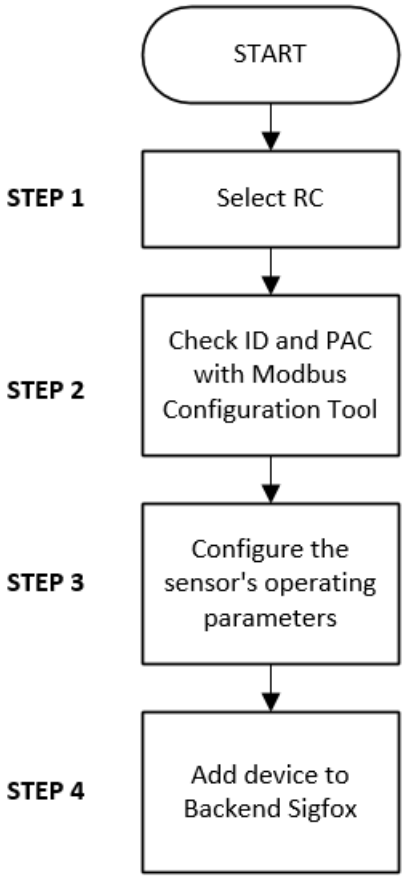
Please access https://www.iot.daviteq.com/wireless-sensors for updated manual

WSSFC-ULA -MN-EN-01	DEC-2020

This document is applied for the following products

SKU	WSSFC-ULA	**HW Ver.**	1.1	**FW Ver.**	1.0
Item Code	WSSFC-ULA-8-01	Sigfox Ultrasonic Level Sensor for Trash bin, Internal antenna, 4500mm range, Type AA battery 1.5VDC, IP67, RC1 zone			
	WSSFC-ULA-9-01	Sigfox Ultrasonic Level Sensor for Trash bin, Internal antenna, 4500mm range, Type AA battery 1.5VDC, IP67, RC2-RC4 zones			

0. Configuration Check List



Step 1: Overview check	
• Check cope of delivery • Make sure the device shows no signs of damage	Refer to **section 5** for details
STEP 1: Select RC	
1. Select RC zone **using Modbus Configuration Cable**	RC zones selection 1, 2, 4 is RCZ1, RCZ2, RCZ4 (refer to register address **270**)
2. Select RC zone	**Refer here**
Use Modbus Configuration Cable to read the ID and PAC values	Refer to register address 8 and 10 (DEC)
STEP 3: Configure the sensor's operating parameters	
Configure parameters like cycle send data, alarm, a, b,...	Refer to the configuration section **using the Modbus Configuration Cable**
STEP 4: Add device to Backend Sigfox	
refer to section 5.4 for details	

1. Functions Change Log

HW Ver.	FW Ver.	Release Date	Functions Change
1.1	1.0	DEC-2020	

2. Introduction

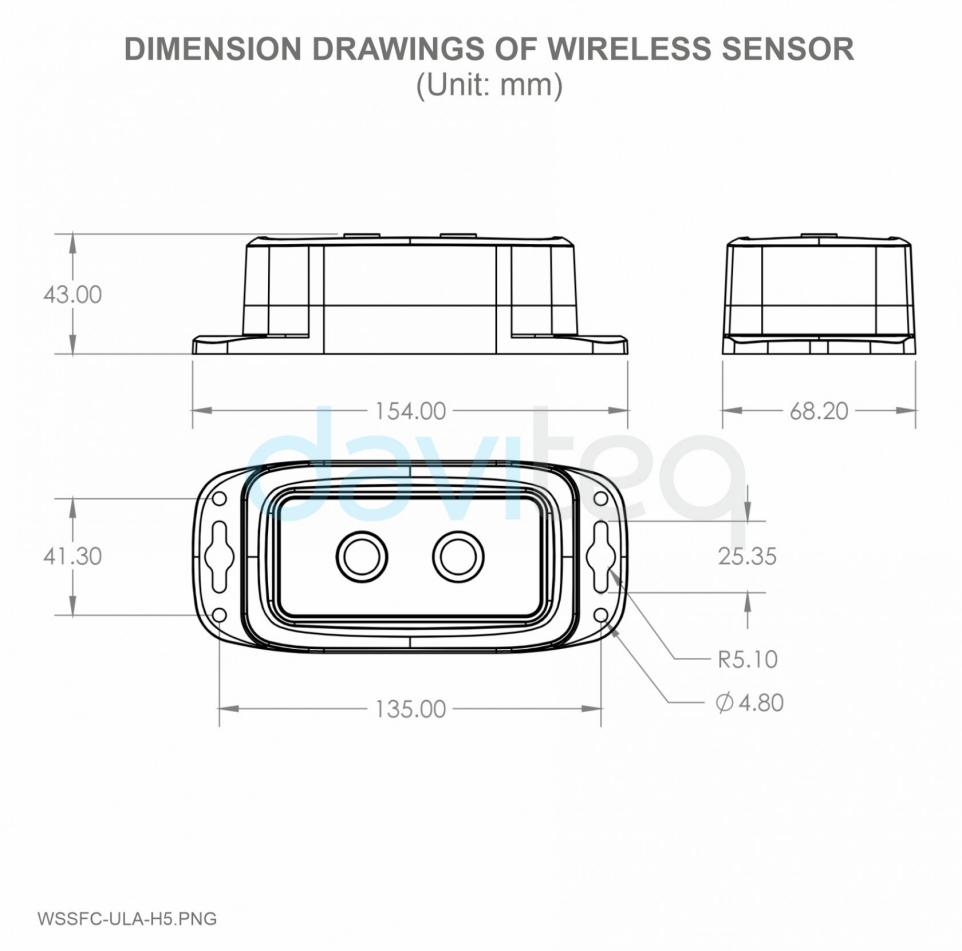
The WSSFC-ULA is a Sub-GHz wireless sensor that uses ultrasonic technology to measure trash bin levels. With advanced digital signal processing technology, the sensor can eliminate unwanted reflected ultrasonic waves. The sensor can be used for trash cans with openable lids where the measured value is not affected during the opening and closing. The sensor is designed for IP68 Standard, which can be used both indoors and outdoors. With Ultra-low Power design and smart firmware allow the sensor can last up to 10 years with 02 x AA-type batteries (depends on configuration). WSSFC-ULA can support all regions of Sigfox network in over the World, RC1, RC2, RC4.
The sensor is used to monitor the level of garbage in the trash cans in Office buildings, Hospitals, Schools, Factories... and also for public trash cans of Smart City.



3. Specification

Sensor SPECIFICATION:	
Measurement technology	Dual ultrasonic sensor
Measuring range	30 .. 4500 mm
Resolution & Accuracy	1.0mm, +/- 10mm
Sampling and transmission rates	Configurable from 30 seconds to 3600 seconds
Working temperature	-15 .. +60°C
Working humidity	0 .. 95% RH, non condensing
Sigfox SPECIFICATION:	
Sigfox zones	select RC2-RC4 or RC1
Antenna	Internal Antenna 2dbi
Battery	02 x AA Type 1.5VDC, working time up to 10 years (depends on configuration)
RF Module complies to	CE, FCC, ARIB
Working temperature	-15°C..+60°C (with AA L91 Energizer)
Dimensions	H180xW50xD40
Net-weight	250 grams
Housing	Poly-carbonate, IP68

4. Dimensions



5. Scope of delivery

1. Sigfox ultrasonic level sensor
2. Magnet key
3. BTP1- PARTSKIT-ULA



6. Operation Principle

Upon power on, the Sigfox node has **60 seconds** to wait for **off-line** configuration (via **cable** with **ModbusRTU** protocol).

After that, Sigfox node will send the first message to Base station.

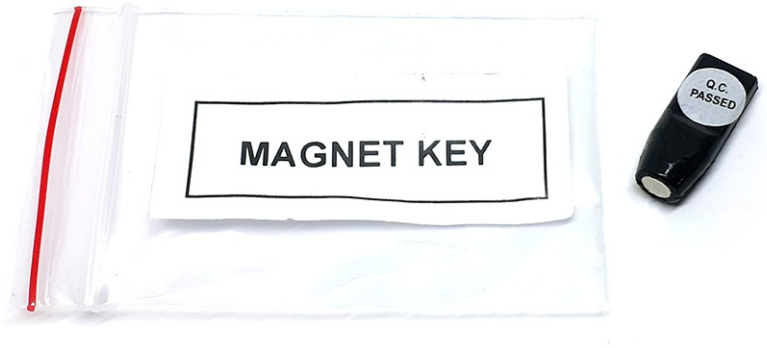
Then during the operation, there are 03 cases of sending data to base station:

1. When the sensor sampling time interval is reached, the Sigfox node will read the data from Input or sensor and performing the calculation. After that it will check calculated value with alarm thresholds. If the calculated was out off the threshold values (Lo or Hi), called alarm, and the number of times of alarm did not pass the limit of number of alarms, then it will send data to Base station immediately;

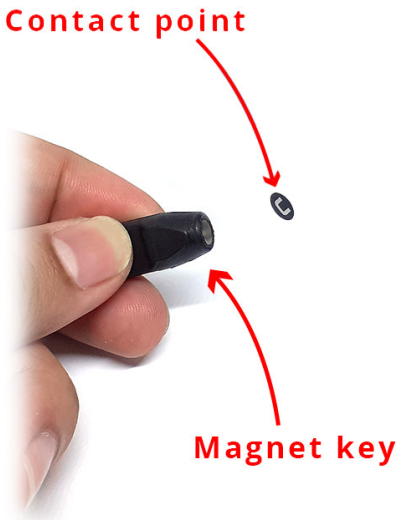
> ⚠ **NOTE:**
>
> Once sending the data to base station by this alarm event, the timer of sending time interval will be reset;

2. When the sending time interval is reached, it will send data to Base station immediately, regardless of value;

3. By using the magnet key, the Sigfox node can be triggered to send data to base station immediately. There will be a beep sound from the buzzer meaning the data has been sent.



> ⚠ **NOTE:**
>
> Once sending the data to base station by the magnet key, the timer of sending time interval will be reset;
>
> The shortest time interval between the two manual triggers is 15s. if shorter than 15s, there will be no data sending and you will not hear the beep sound.



6.1 LED meaning

Whenever the data is sent to base station, the LED will lit with color codes as below:

- **RC1:** RED colour
- **RC2:** GREEN colour
- **RC4:** BLUE colour



6.2 Magnet Key Function

> the magnet key can only be used for the first **60 seconds** after powering up.

6.2.1 Menu configuration

There are 3 configuration menus: **tx_repeat**, **downlink_flag**, **radio configuration**.

We use the magnet key to enter the menus as follows:

6.2.1.1 tx_repeat

Hold the magnet key **2s** -> When the **Red LED** is on, it means entering the **tx_repeat** configuration menu. Then release to configure it.

Light touch to configure. After touching if the **Red LED** flashes **once**, **tx_repeat = 0** (send 1 time). After touching if the **Red LED** blinks **twice**, it is **tx_repeat = 1** (send 3 times).

6.2.1.1 downlink_flag

Hold the magnet key **5s** -> When the **Green LED** is on, it means entering the **downlink_flag** configuration menu. Then release to configure it.

Light touch to configure. After touching if the **Green LED** flashes **once**, it is **downlink_flag = 0** (downlink is not allowed). After touching if the **Red LED** blinks **twice**, it is **downlink_flag = 1** (downlink is allowed).

6.2.1.1 radio configuration

Hold the magnet key **10s** -> **Blue LED** is on, it means entering the **Radio Configuration** menu. Then release to configure it.

Light touch to configure. After touching if the **Blue LED** blinks **once**, it is **Radio Configuration = 1**. After touching if the **Blue LED** flashes **twice**, it is **Radio Configuration = 2**. After pressing if the **Blue LED** flashes **4 times**, it is **Radio Configuration = 4.**

6.2.2 Exit the menu:

There are 3 ways to exit the menu:

- Hold for 3s, the LED turns off to exit the menu;
- Wait 30 seconds, then exit the menu;
- Take out the battery, it all starts over (outside the menu)).

6.3 RC technical details

The RF transmit power will be automatically set as the max value as allowed by the Zone.

Sigfox Radio Configuration (RC) defines the radio parameters in which the device shall operate: Sigfox operating frequencies, output power, spectrum access mechanism, throughput, coexistence with other radio technologies, etc.

Each radio configuration includes 4 uplink classes: 0u, 1u, 2u, and 3u.

The Sigfox network globally works within the ranges from 862 to 928 MHz. But not all RCs require such a wide range of operation.

	RC1	RC2	RC4
Uplink center frequency (MHz)	868.130	902.200	920.800
Downlink center frequency (MHz)	869.525	905.200	922.300
Uplink data rate (bit/s)	100	600	600
Downlink data rate (bit/s)	600	600	600
Sigfox recommended EIRP (dBm)	16	24	24
Specifics	Duty cycle 1% *	Frequency hopping **	Frequency hopping **

* **Duty cycle** is 1% of the time per hour (36 seconds). For an 8 to 12 bytes payload, this means 6 messages per hour, 140 per day.

** **Frequency hopping**: The device broadcasts each message 3 times on 3 different frequencies. Maximum On time 400 ms per channel. No new emission before 20 s.

*** **Listen Before Talk**: Devices must verify that the Sigfox-operated 200 kHz channel is free of any signal stronger than −80 dBm before transmitting.

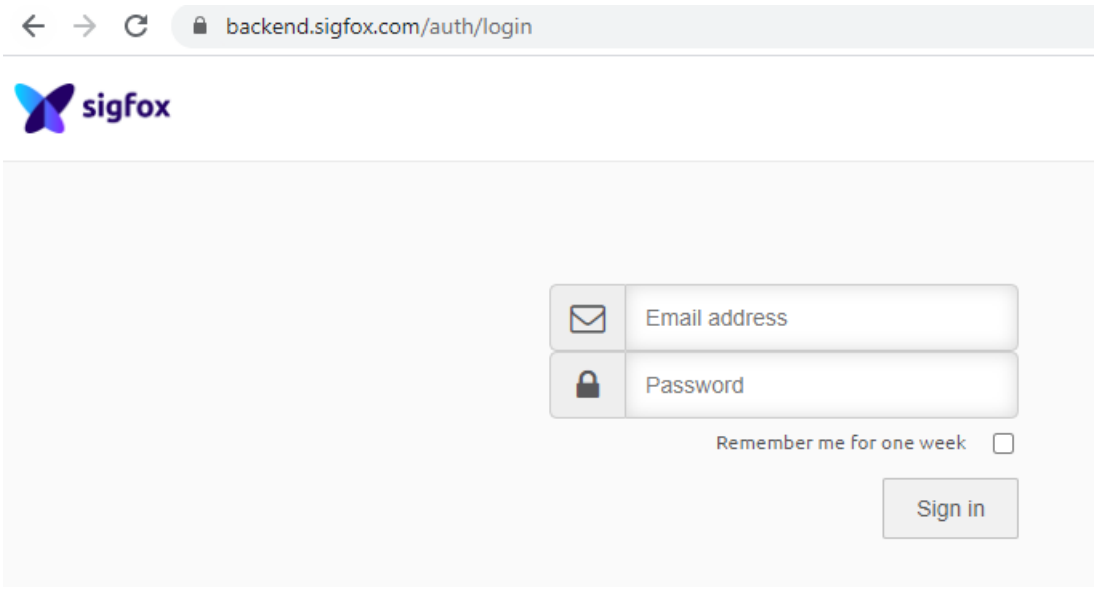
Sigfox's high limit EIRP recommendation is included in each column although regulations sometimes allow for more radiated power than the Sigfox recommendation.

Sigfox's recommendation is set to comply with the Sigfox technological approach of:

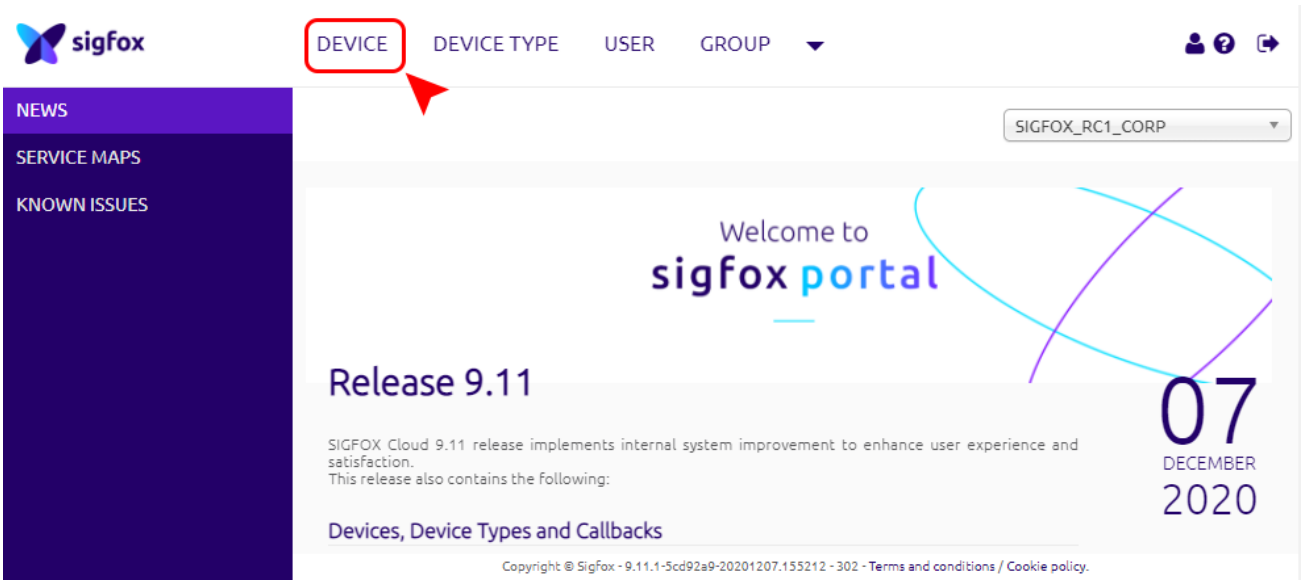
- Low current consumption
- Balanced link budget between uplink and downlink communication

6.4 Add a device to the Backend Sigfox

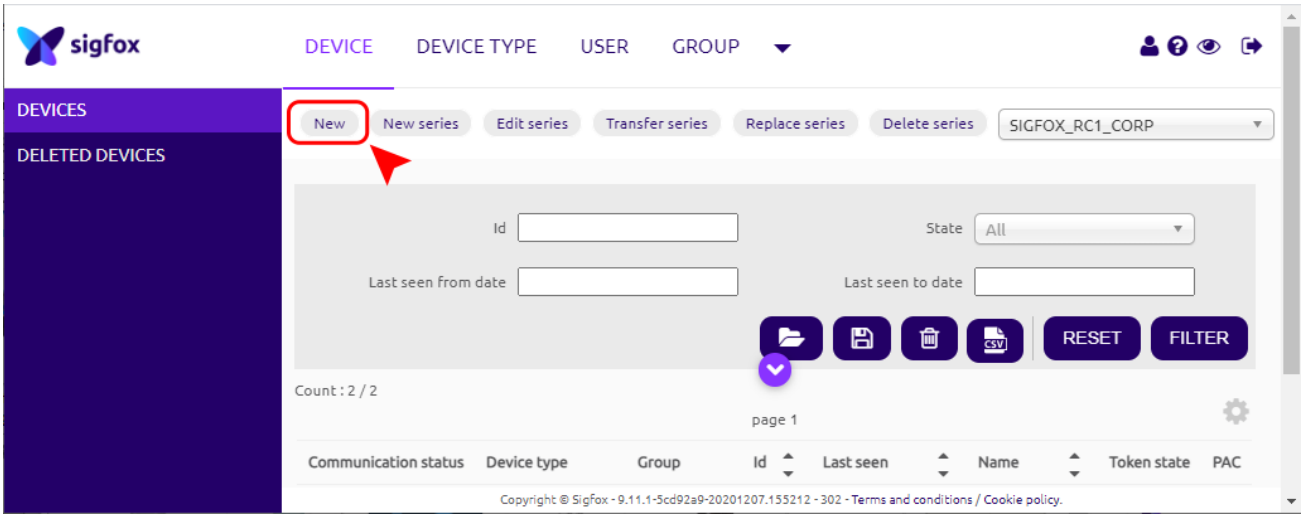
Step 1: Log in to the sigfox backend website



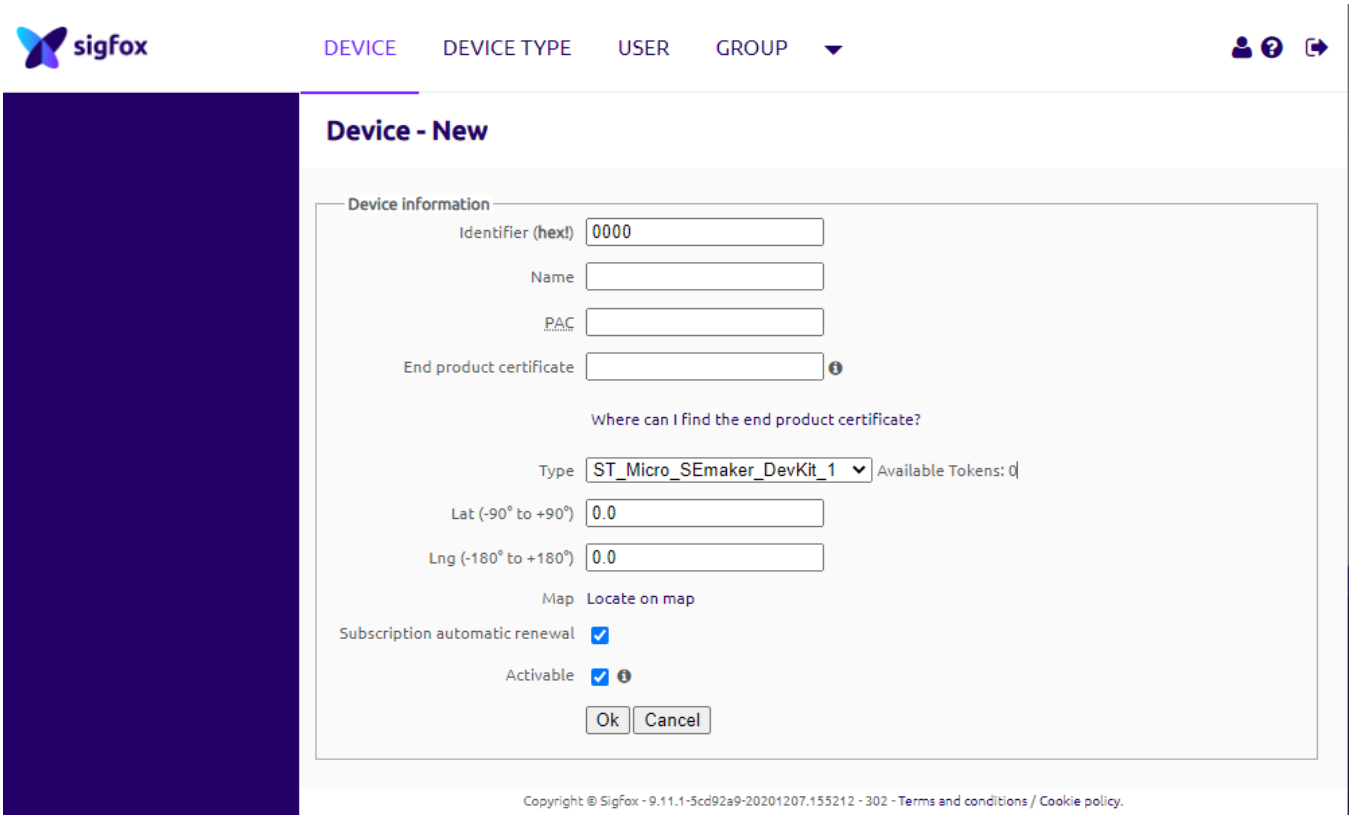
Step 2: Click on Device



Step 3: Click New → Select a group

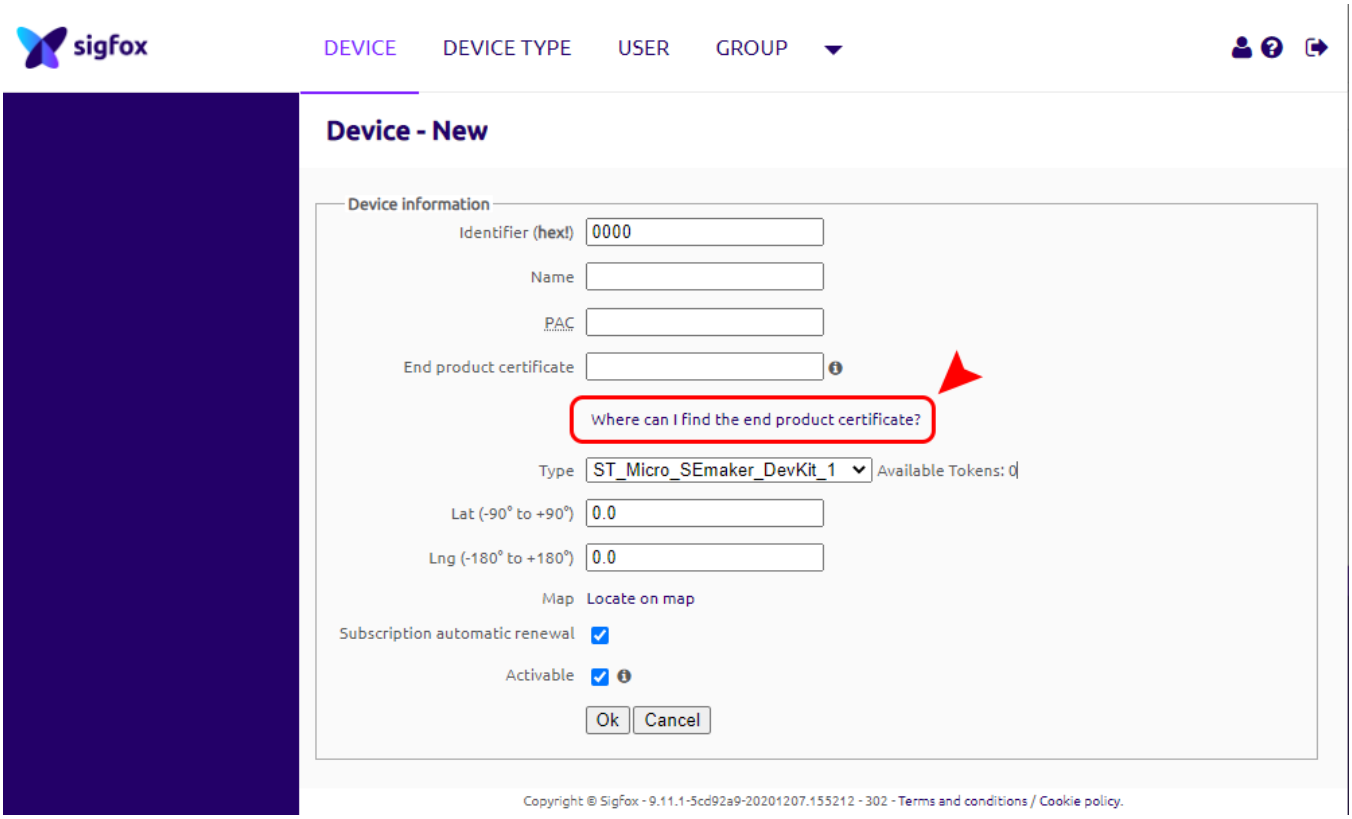


Step 4: Fill in the required information

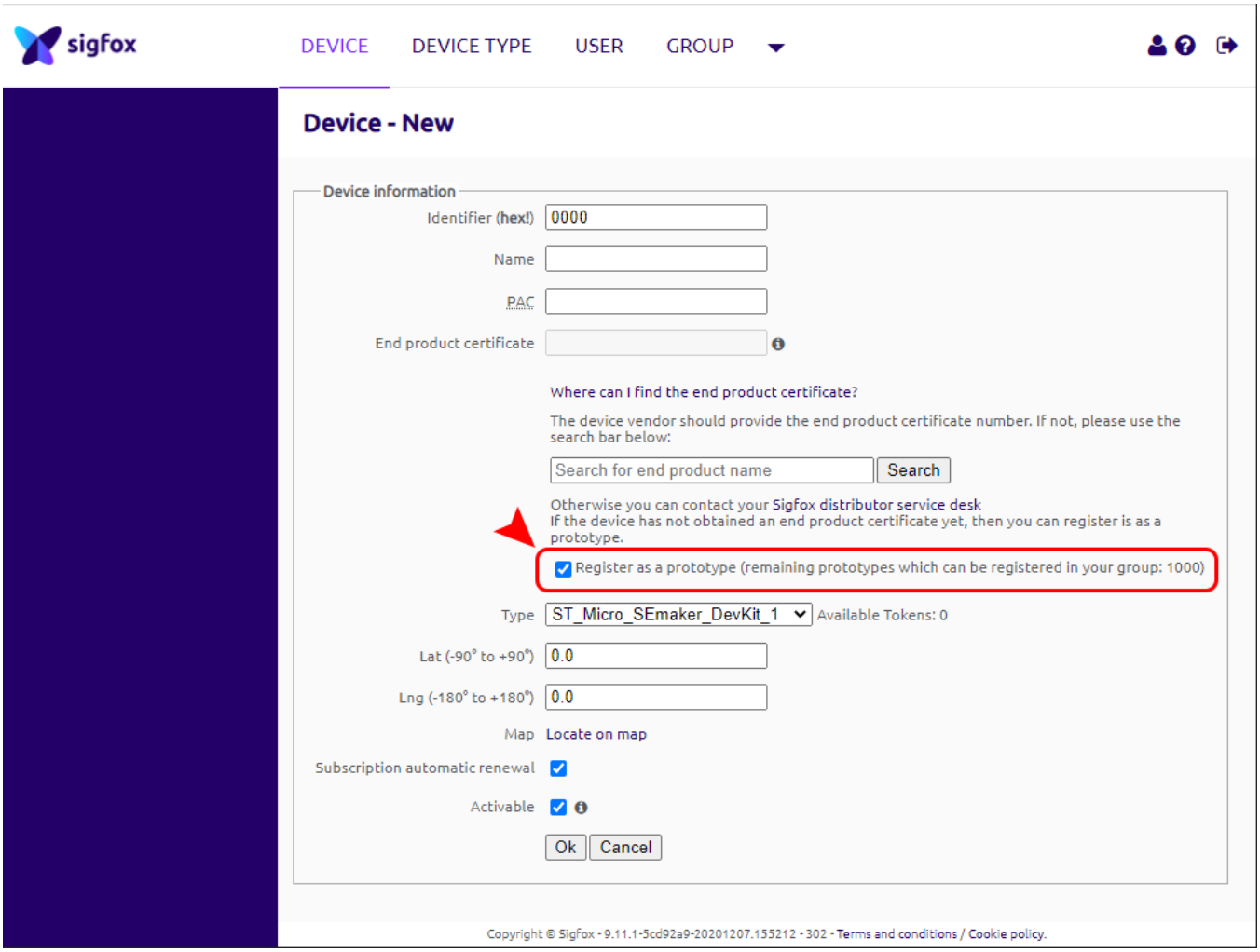


Note: Some of our products may not have end product certification in time, to add the product to Backend Sigfox please follow the steps below.

Click on the text as shown below

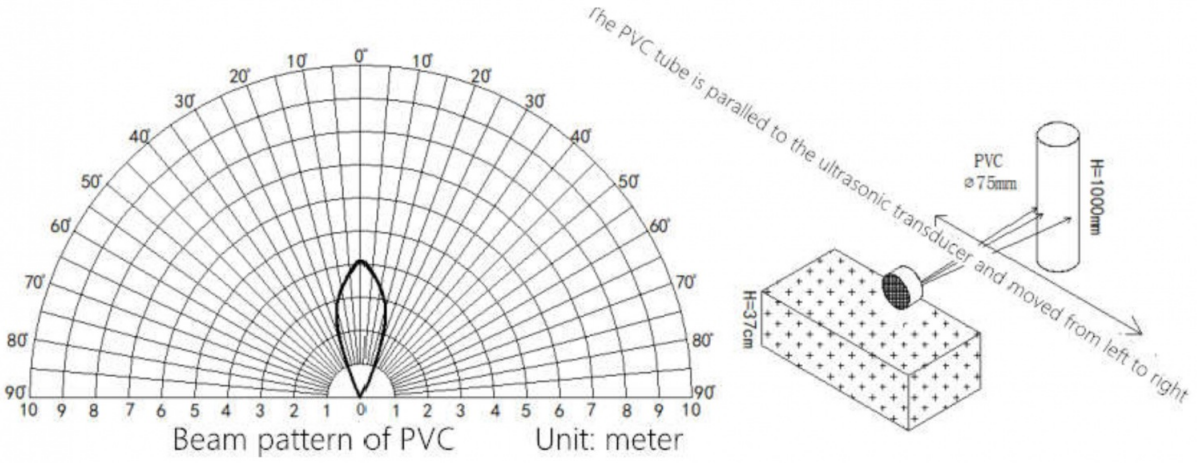


Check the box as shown below to register as a prototype

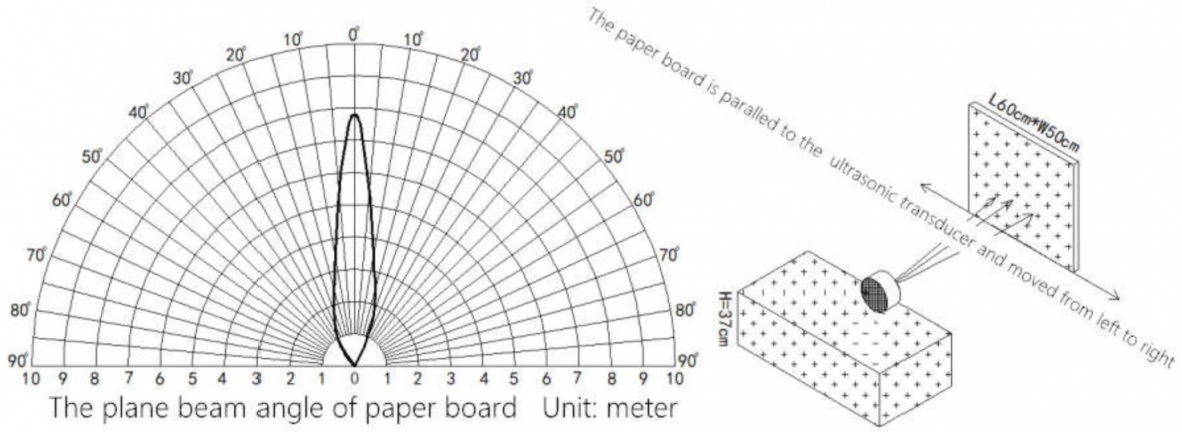


6.5 The Effective Detection Range

(1) The tested object is the white cylindrical tube, material is PVC, height is 100cm, diameter is 7.5cm:



(2) The tested object is the corrugated case, perpendicular to 0° axle wire, length is 60cm, width is 50cm:



6.6 Process of measurement

6.6.1 Measurement principle of Sigfox Sensor

When the sensor sampling time interval is reached, for example 2 minutes, the Sigfox node will wake up and switch ON the power supply to supply the energy to external sensor to start the measurement. Depends on the type and characteristic of external sensor, the sensor will take a certain time to finish the measurement.

Once reading the value, it can be scaled to any engineering value by the following formula:

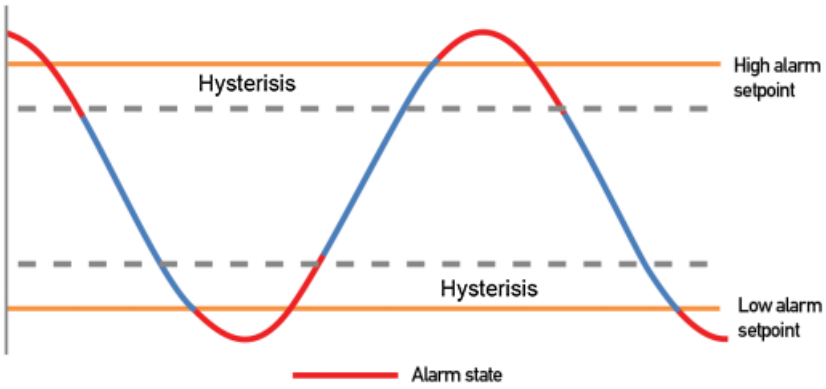
$$Y = aX + b$$

Where:

- X: the raw value from sensor
- Y: the calculated value will be sent to Sigfox base station in the payload data.
- a: constant (default value is 1)
- b: constant (default value is 0)

So, if there is no user setting for **a** and **b** ==> **Y** = **X**

The **Y** value will be compared with Lo and Hi threshold. Please refer below the graph of alarm processing.



6.6.2 Calibration

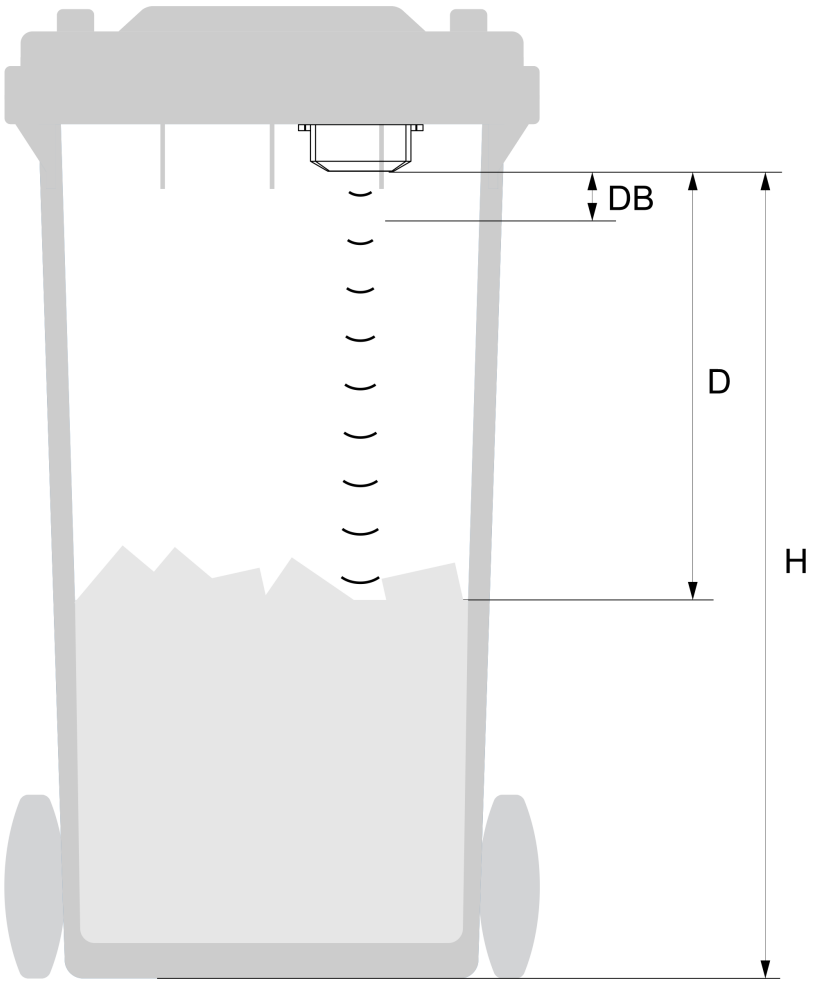


Figure – Ultrasonic Level Transmitter Calibration

- **DB:** Dead band **0..300 mm** (This is a short range in front of the ultrasonic sensor can not measure distances)
- **H:** Maximum measuring distance (Span)
- **D:** Distance

$$a = \frac{1000}{\mathrm{DB} - \mathrm{H}} \; ; \; b = \frac{1000.\mathrm{H}}{\mathrm{H} - \mathrm{DB}}$$

For example: Trash bin with maximum height to be measured **1200mm** (**H**) and the maximum height to measure is **300mm** (Recommended to install the lowest point that should be larger than the **Deadband 300mm**), then:

$$a = \frac{1000}{\mathrm{DB} - \mathrm{H}} = \frac{1000}{300 - 1200} = -1.111$$

$$b = \frac{1000.\mathrm{H}}{\mathrm{H} - \mathrm{DB}} = \frac{1000.1200}{1200 - 300} = 1333.333$$

From here we can look up the trash level corresponding to the measured distance of the sensor by the formula**Y = aX + b**.

Where: **X** is the measured distance (mm) and**Y** is the level (‰)

Distance (mm)	Level (‰)
300	1000
400	889
500	778
600	667
700	556
800	445
900	333
1000	222
1100	111
1200	0

Use the offline configuration tool to configure sigfox sensor. Write in the sensor the parameters**a1** and **b1**.

Refer to **Resigter table** for more details.

6.7 Payload Data

The following is the format of payload data will be sent to Sigfox server. Length is 4 bytes.

Sensor type (1 byte)	Status (1 byte)	1 st - Parameter (2 bytes)	2nd - Parameter (2 bytes)

Meaning of Data in the Payload

Data	Size (byte)	Bit	Format	Meaning
Sensor type	1	all	Uint8	Sensor type = 0x0E means ULA sensor
Status: battery level	1	Bit 7 and 6	Uint8	Battery capacity in 04 levels • 11: battery level 4 (99%) • 10: battery level 3 (60%) • 01: battery level 2 (30%) • 00: battery level 1 (10%)

Status: error		Bit 5 and 4		Node status • 01: error • 00: no error
Status: alarm 1		Bit 3 and 2		Alarm status of 1st - Parameter (Y1 value) • 11 : Hi alarm • 01 : Lo alarm • 00 : No alarm
Status: alarm 2		Bit 1 and 0		Alarm status of 2nd - Parameter (Y2 value) • 11 : Hi alarm • 01 : Lo alarm • 00 : No alarm
1st - Parameter	2	all	Uint16	Y1 value: Level (**x 0.1%**) Y1 is calculated based on Y2 value by the formula: Y1 = Y2*__a1__+__b1__
2nd - parameter	2	all	Uint16	Y2 value: Distance(mm)

7. Offline configuration

Using the configuration cable to connect to the sensor as below picture.



Serial port configuration on computer: **9600** baud, **None** parity, **1** stop bit.

Reading data by **Function 3.**

Writing data by **Function 16**.

During connection with Modbus configuration tool, the Sigfox node will send all data in realtime: Battery, Battery level, Vref, Button status, reed switch status, PCB temperature, Measured value, alarm status.

Step to configure & check data:

NOTE:

The Modbus configuration can be done in the first **60s** after power up the Sigfox node. After 60s, if user can not finish the configuration, user need to reset the power of Sigfox node again, by removing battery in at least 15s.

Step 1: Install the Modbus Configurator Software in the link below

https://filerun.daviteq.com/wl/?id=qK0PGNbY1g1fuxTqbFW9SXtEvCw7bpc6

How to use the Modbus configuration software

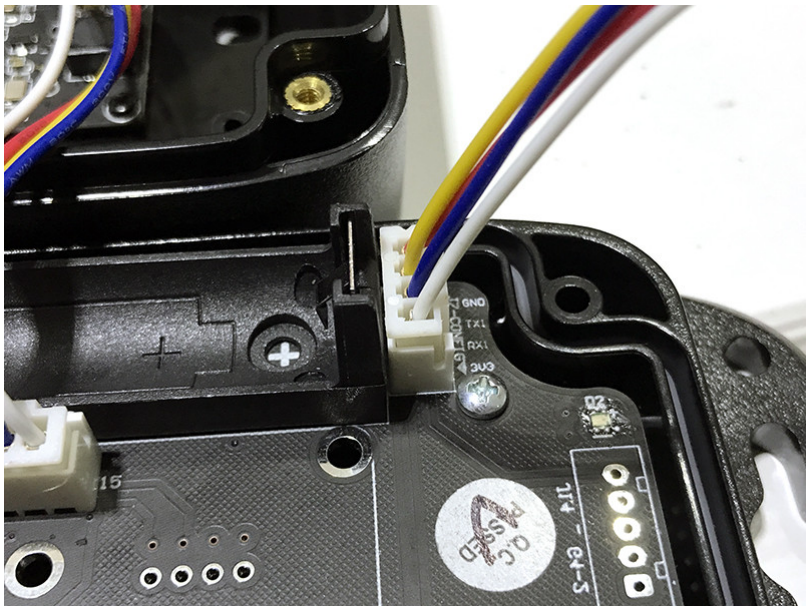
Step 2: Plug the configuration cable to Computer via **USB** port;



Step 3: Open the housing with phillips screwdriver to unscrew M3 screws at the side of the housing

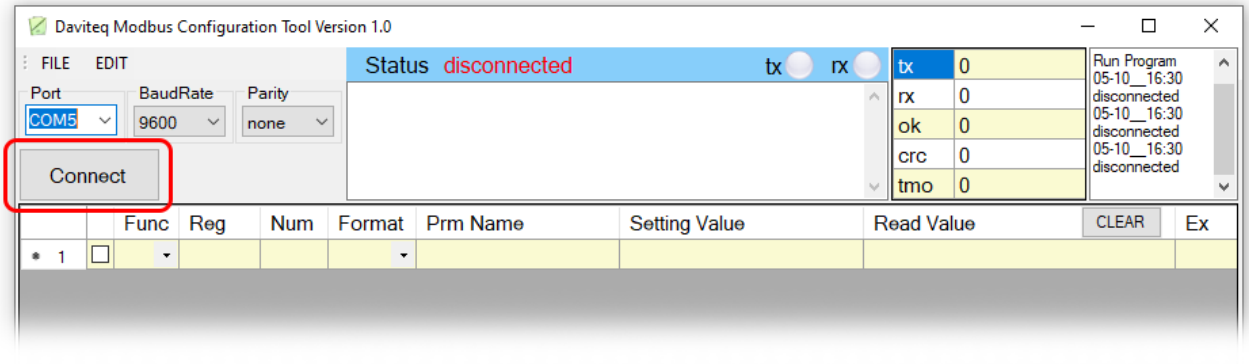


Step 4: Plug the connector to the configuration port;



Step 5: Import the configuration file by importing the csv file: Go to MENU:**FILE / Import New /** => select the file with name CONFIGURATION TEMPLATE FILE FOR SIGFOX WSSFC-ULA.csv (in the link below). Then click **Connect**;

CONFIGURATION TEMPLATE FILE FOR SIGFOX WSSFC-ULA.csv



Here is the table of Data will be read by Modbus tool

Modbus Register (Decimal)	Modbus Register (Hex)	Function Code	# of Registers	Description	Range	Default	Format	Property	Comment
0	0	3	2	device info			string	Read	Product name
2	2	3	4	firmware version		1.0	string	Read	
6	6	3	2	hardware version		1.0	string	Read	
8	8	3	2	device ID			hex	Read	Product ID
10	A	3	4	device PAC			hex	Read	Product PAC
14	E	3	1	sen_type	1-255		uint16	Read	Sensor or Input Type
15	F	3	1	batt level	0-3		uint16	Read	Battery level

16	10	3	1	err_status	0-1		uint16	Read	Sensor error code
17	11	3	1	prm1 alm_status	0-2		uint16	Read	Alarm status of 1st parameter
18	12	3	1	prm2 alm_status	0-2		uint16	Read	Alarm status of 1st parameter
19	13	3	2	prm1 value			float	Read	1st calculated value
21	15	3	2	prm2 value			float	Read	2nd calculated value
23	17	3	1	batt %	10%, 30%, 60%, 99%		uint16	Read	Battery %
24	18	3	2	batt volt	0-3.67 vdc		float	Read	Battery Voltage
26	1A	3	2	temp	oC		float	Read	RF module temperature
28	1C	3	1	vref	0-3.67 vdc		uint16	Read	Vref of RF Module
29	1D	3	1	btn1 status	0-1		uint16	Read	Button status, 0: released, 1: pressed
30	1E	3	1	btn2 status	0-1		uint16	Read	Reedswitch status, 0: opened, 1: closed

Here is the table for Configuration:

Modbus Register (Decimal)	Modbus Register (Hex)	Function Code (Read)	Function Code (Write)	# of Registers	Description	Range	Default	Format	Property	Comment
256	100	3	16	1	modbus address	1-247	1	uint16	Read/ Write	Modbus address of device
270	10E	3	16	1	Radio Configuratio	1-6	4	uint16	Read/ Write	RC zones selection 1, 2 ,4 is RCZ1, RCZ2, RCZ4
271	10F	3	16	1	tx_power		20	int16	Read/ Write	RF Tx power
272	110	3	16	1	tx_repeat	0-1	1	uint16	Read/ Write	Number of repeat, 0: 1 time, 1: 3 repeats
273	111	3	16	1	downlink_fla	0-1	1	uint16	Read/ Write	1: enable Downlink, 0: disable Downlink (Fw v1.0 hasn't got Downlink function)

274	112	3	16	2	cycle_send_		3600	uint32	Read/ Write	Data sending cycle, in seconds
276	114	3	16	2	spare					Spare for future
278	116	3	16	1	alarm_limit		0	uint16	Read/ Write	Limit number of alarm sending in 24h
279	117	3	16	1	spare					Spare for future
280	118	3	16	2	sensor1: sampling_ra		120	uint32	Read/ Write	Sensor/Input 1 sampling rate, in seconds
282	11A	3	16	2	sensor1: calc_time		500	uint32	Read/ Write	Measuremer time of sensor/input 1, in ms
288	120	3	16	2	prm1: a		1	float	Read/ Write	Constant a for scaling measured value 1
290	122	3	16	2	prm1: b		0	float	Read/ Write	Constant b for scaling measured value 1
294	126	3	16	2	prm1: High threshold		100000	float	Read/ Write	Hi Threshold for calculated value 1
296	128	3	16	2	prm1: High Hysteresis		10000	float	Read/ Write	Hysterisis for Hi for calculated value 1
298	12A	3	16	2	prm1: Low threshold		0	float	Read/ Write	Lo Threshold for calculated value 1
300	12C	3	16	2	prm1: Low Hysteresis		10000	float	Read/Write	Hysterisis for Lo for calculated value 1
302	12E	3	16	2	prm1: High cut		100000	float	Read/ Write	High cut value for calculated value 1
304	130	3	16	2	prm1: Low cut		0	float	Read/ Write	Low cut value for calculated value 1
306	132	3	16	2	prm2: a		1	float	Read/ Write	Constant a for scaling measured value 2

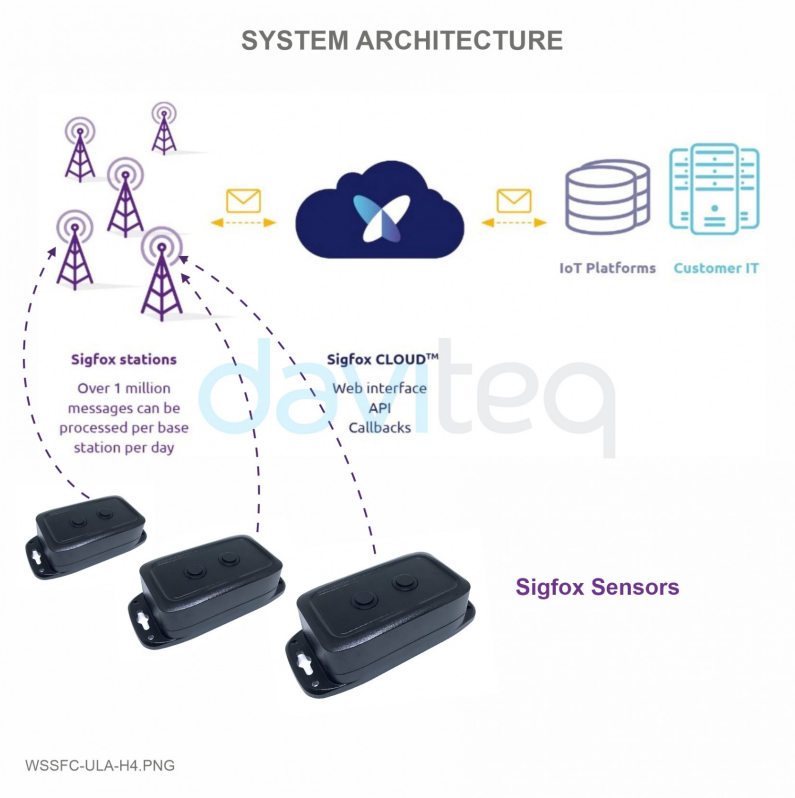
308	134	3	16	2	prm2: b		0	float	Read/ Write	Constant b for scaling measured value 2
312	138	3	16	2	prm2: High threshold		100000	float	Read/ Write	Hi Threshold for calculated value 2
314	13A	3	16	2	prm2: High Hysteresis		10000	float	Read/ Write	Hysterisis for Hi for calculated value 2
316	13C	3	16	2	prm2: Low threshold		0	float	Read/ Write	Lo Threshold for calculated value 2
318	13E	3	16	2	prm2: Low Hysteresis		10000	float	Read/ Write	Hysterisis for Lo for calculated value 2
320	140	3	16	2	prm2: High cut		100000	float	Read/ Write	High cut value for calculated value 2
322	142	3	16	2	prm2: Low cut		0	float	Read/ Write	Low cut value for calculated value 2

8. Installation

8.1 Locate the good place for Radio signal

To maximize the distance of transmission, the ideal condition is Line-of-sight (LOS) between the Sigfox sensor and Base station. In real life, there may be no LOS condition. However, the Sigfox sensor still communicate with Base station, but the distance will be reduced significantly.

> **ATTENTION:**
>
> ⚠ **DO NOT** install the Sigfox sensor or its antenna inside a completed**metallic** box or housing, because RF signal can not pass through metallic wall. The housing is made from Non-metallic materials like plastic, glass, wood, leather, concrete, cement...is acceptable.



8.2 Mounting

8.2.1 Installation method

Mounting the sensor under the bottom and at the center of the trash bin lid

WARNING:

Avoid causing strong impact on the 2 probes on the sensor;

DO NOT install the sensor in complete metal trash bin because the signal can't transmit to the Gateway

Step 1: Determine the center of the trash bin

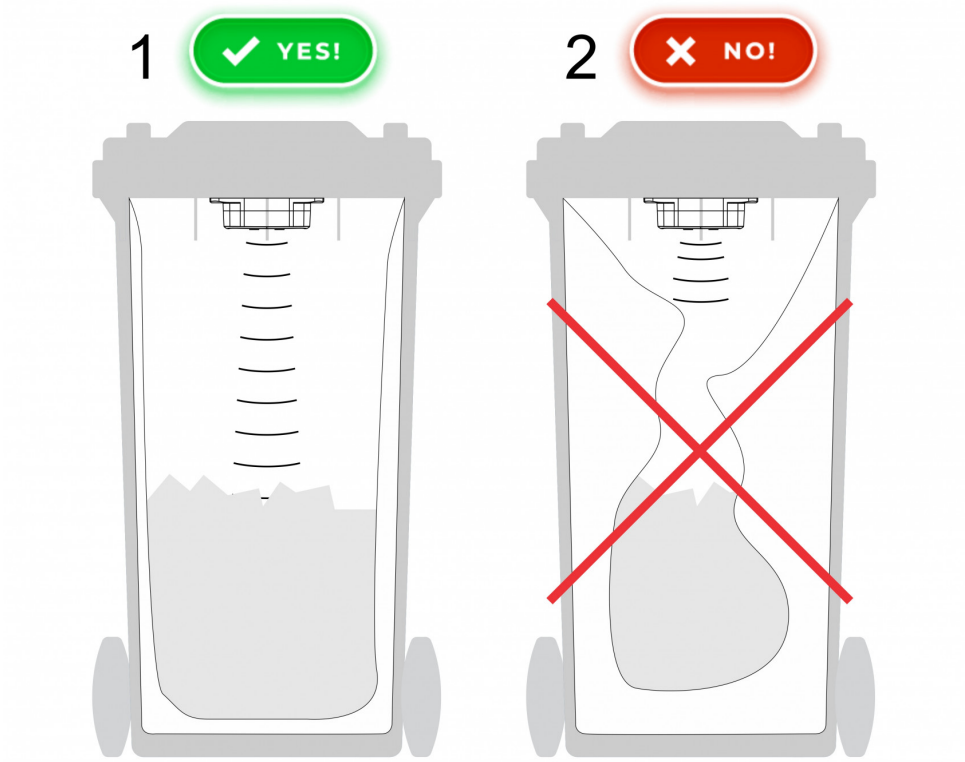
Step 2: Mounting the sensor under the trash bin lid by fasten the 4 screws that are included



8.2.2 Installation conditions

Align the sensor so that it is vertical to the solid surface**(1)**

When installing, do not let the plastic bag inflate too much to block the path of the sensor**(2)**



8.3 Battery installation



ENERGIZER L91 (recommended battery)

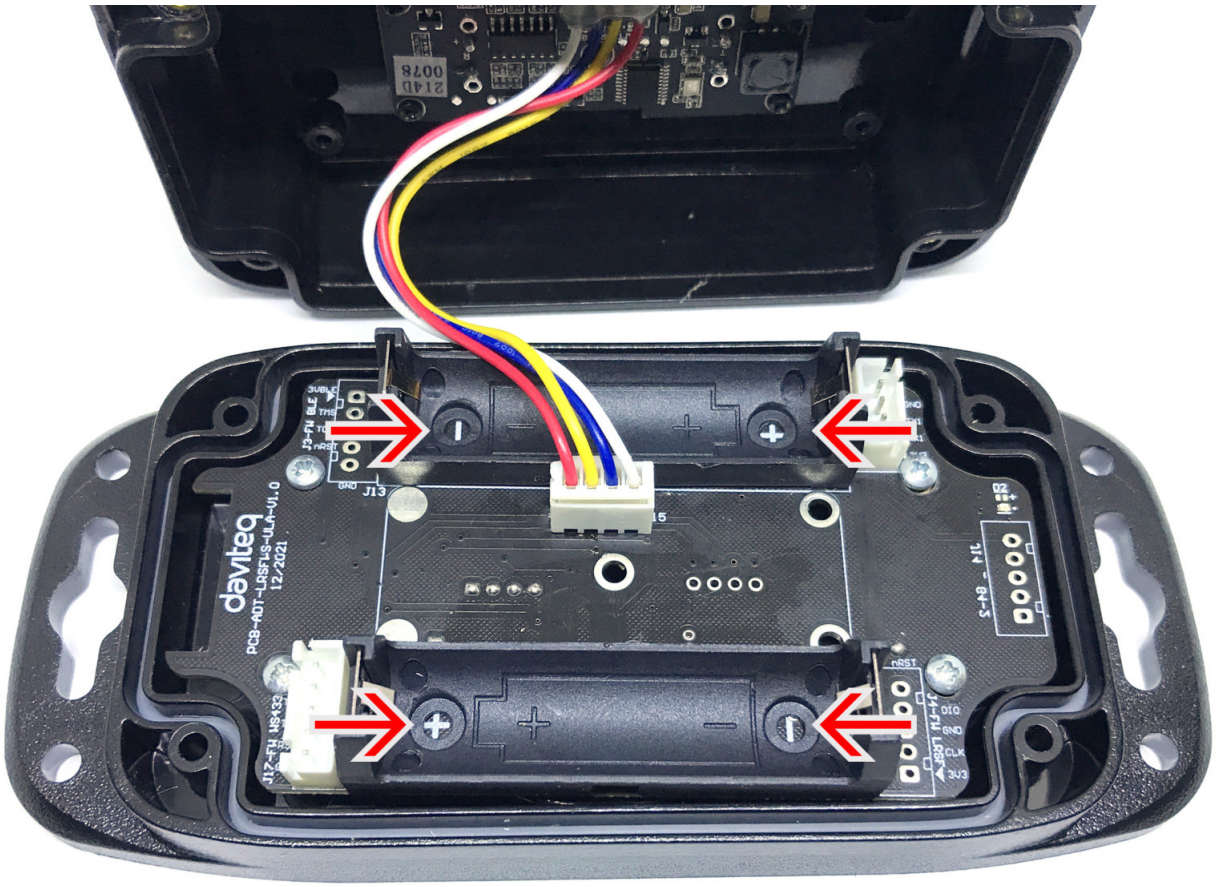
Steps for battery installation:

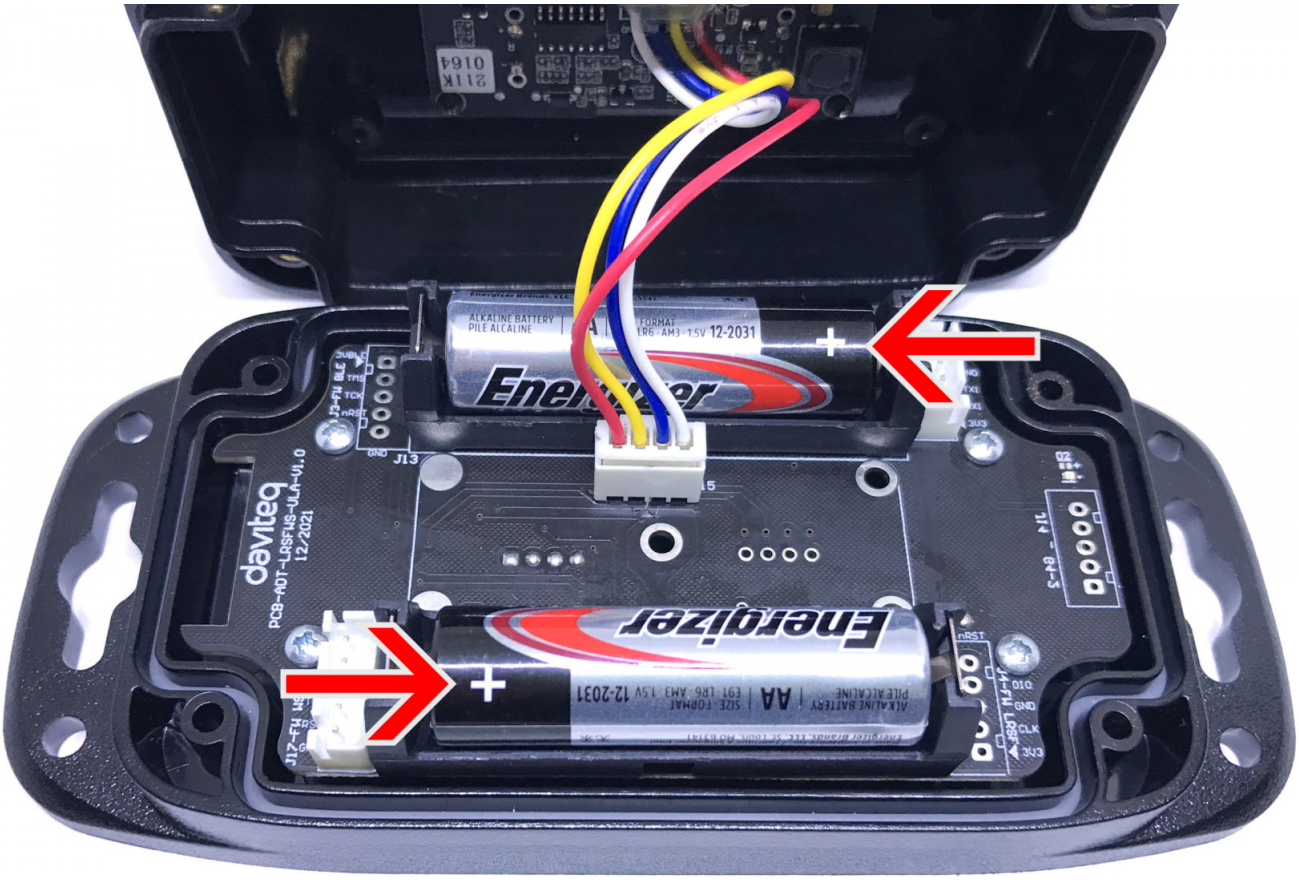
Step 1: Using Philips screw driver to unscrew 4 screws under the housing.



Step 2: Pull out the cover then insert 02 x AA 1.5VDC battery, please take note the poles of the battery.

ATTENTION: REVERSED POLARITY OF BATTERIES IN 10 SECONDS CAN DAMAGE THE SENSOR CIRCUIT !





Step 3: Insert the top plastic housing and locking the cover

9. Troubleshooting

No.	Phenomena	Reason	Solutions
1	Node does not send RF to base station periodically, LED does not blink	• No power supply • Configuration sending cycle is incorrect	• Check that the battery is empty or not installed correctly • Check the power supply • Check the send cycle configuration
2	Node does not send RF to base station according to the alarm, LED does not blink	• The alarm configuration is incorrect • Running out of the number of alarms set for the day	• Check alarm configuration • Check the configuration for the maximum number of alarms per day
3	Node does not send RF to base station when activated by the magnetic switch, LED does not blink	• Magnetic switch has malfunctioned	• Read the status of the magnetic switch via modbus (when powering or attaching the battery) to see if the magnetic switch is working.
4	Node has blinked LED when sending RF but the base station cannot received	• Out of the number of RF packages per day (140 packages / day)	• Check on the base station whether the event message exceeds the number of RF packets
5	Node has sent RF but the LED does not blink	• LED malfunction • LED welding is not good	• Check LED condition and LED weld
6	The value of the sensor is 0	• No pressure • Lost connection with the sensor	• Check pipe pressure • Check sensor connection
7	The node does not send RF and the RF module is hot	• Insert the battery in the opposite direction • Short circuit	Warranty or replacement
8	RSSI is weak and often loses data	• Distance between Node and Gateway is far or there are many obstructions • Connection to Antenna problem	• Check Antenna position • Install Node in a well ventilated location

10. Support contacts

Manufacturer

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