

USER GUIDE FOR SIGFOX PIEZO-ELECTRIC 10KHZ VIBRATION SENSOR WSSFC-V1A

THIS IS OBSOLETE MANUAL

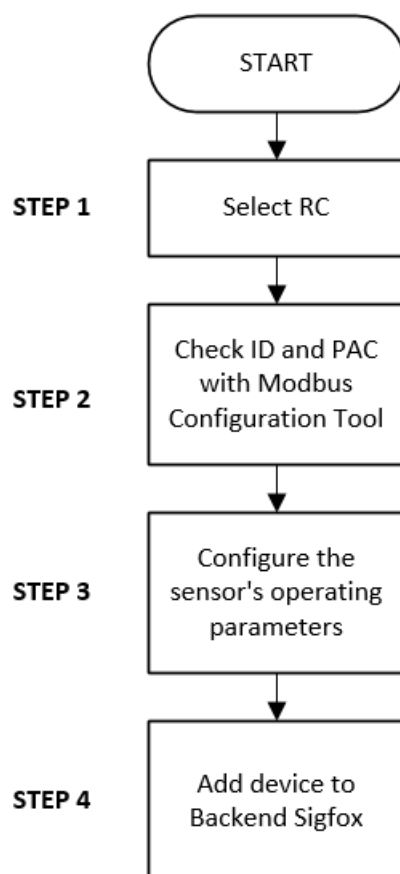
Please access <https://www.iot.daviteq.com/wireless-sensors> for updated manual

WSSFC-V1A-MN-EN-01	MAY-2021
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This document is applied for the following products

SKU	WSSFC-V1A	HW Ver.	1.1	FW Ver.	1.0
Item Code	WSSFC-V1A-9-01	SIGFOX PIEZO-ELECTRIC 10KHZ VIBRATION SENSOR, +/- 25G, INTERNAL ANTENNA, TYPE AA BATTERY 1.5VDC, IP67, RC2-RC3-RC4-RC5 ZONES			
	WSSFC-V1A-8-01	SIGFOX PIEZO-ELECTRIC 10KHZ VIBRATION SENSOR, +/- 25G, INTERNAL ANTENNA, TYPE AA BATTERY 1.5VDC, IP67, RC1-RC6-RC7 ZONES			

0. Configuration Check List



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 using button	Refer to the button configuration
STEP 2: Check ID and PAC	
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

WSSFC-V1A is a cost effective, Sigfox accelerometer single-axis vibration sensor designed for condition monitoring and preventive maintenance applications. The piezo-electric accelerometer is available in ranges $\pm 25g$ or $50g$ and features a flat frequency response up to $>10kHz$. Its accelerometer feature a stable piezo-ceramic crystal in shear mode with low power electronics, sealed in a fully hermetic package. The Piezo Electric technology incorporated in the WSSCF-V1A accelerometer has a proven track record for offering the reliable and long-term stable output required for condition monitoring applications. The accelerometer is designed and qualified for machine health monitoring and has superior Resolution, Dynamic Range and Bandwidth to MEMS devices. Beside that it can also measure the temperature at mounting point. With Ultra-low power design and smart firmware allow the complete Wireless and Sensor package run on 2 x AA battery up to 10 years. It can support all regions of Sigfox network in over the World, RC1, RC2, RC3, RC4, RC5, RC6, RC7.

SIGFOX PIEZO-ELECTRIC 10KHZ VIBRATION SENSOR WSSFC-V1A



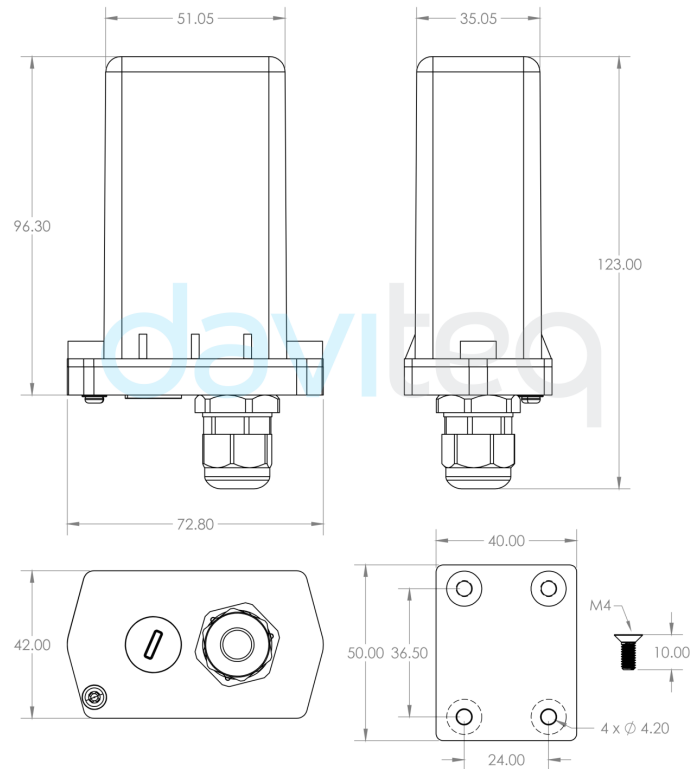
WSSFC-V1A-H1.PNG

3. Specification

SENSOR SPECIFICATION	
Sensor technology	Hermetically Sealed, Piezo-Ceramic Crystal, Shear Mode
Acceleration Range and Shock Limit (g)	±25 or 50, 10,000
Frequency Response and Resonant Frequency (Hz)	2-10000, >30000
Non-Linearity, Transverse Sensitivity	±2%FSO, < 5%
Temperature measuring and operating range, accuracy & resolution (°C)	-40.. +85, +/- 0.5, 0.125
Sensor Material, mousing protection and mounting	304SUS, IP67, M6 Screw
<i>*Notes</i>	<i>All above values are typical at +24°C, 80Hz</i>
Connector	M12-M 4-pin, Coding A
Extended cable (optional)	2m cable with M12-F and M12-M at two ends
SIGFOX SPECIFICATION	
Sigfox zones	select RC2-RC3-RC4-RC5 or RC1-RC6-RC7
Antenna	Internal Antenna 2 dbi
Configuration	via offline USB cable (PC software is supplied at free)
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	-40oC..+60oC (using Energizer Lithium Ultimate AA battery)
Dimensions	H106xW73xD42
Net-weight	190 grams
Housing	Aluminum+Polycarbonate, IP67
Mounting	Wall mount bracket

4. Dimensions

DIMENSION DRAWING OF WIRELESS SENSOR (Unit: mm)



WSSFC-V1A-H3.PNG

5. 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;

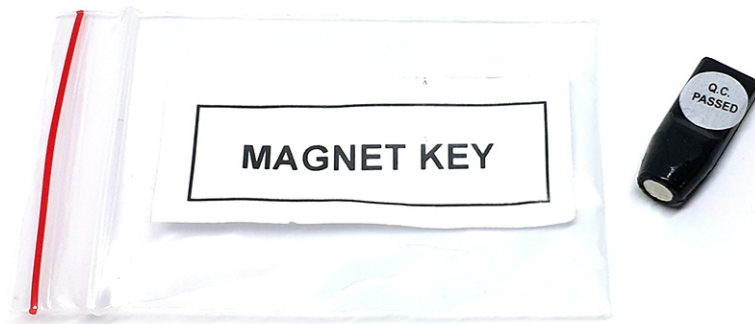
NOTE:



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

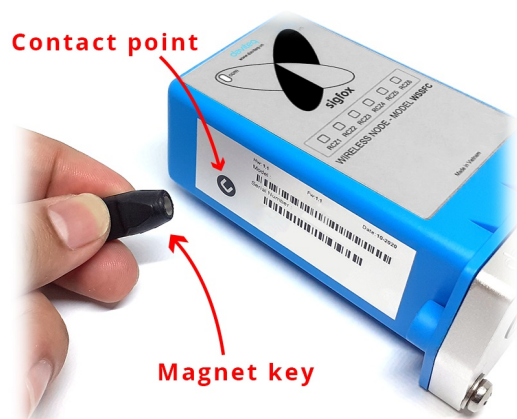
2. When the sending time interval is reached, it will send data to Base station immediately, regardless of value;

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.



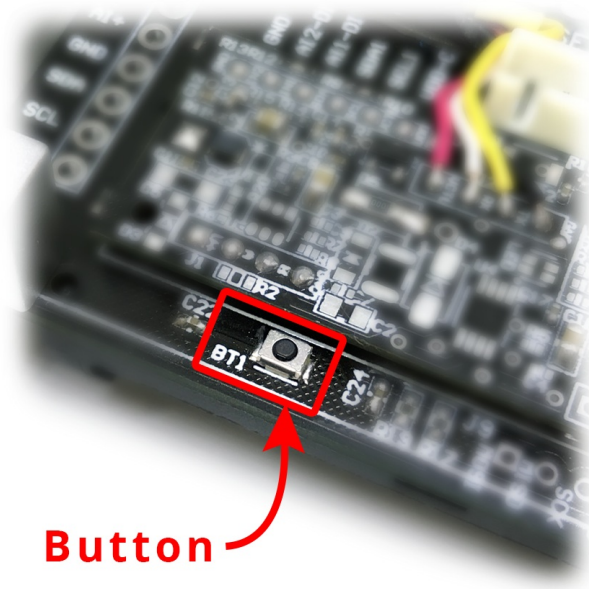
5.1 LED meaning

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



5.2 Button Function



i the push button can only be used for the first **60 seconds** after powering up.

5.2.1 Menu configuration

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

We use the button to enter the menus as follows:

5.2.1.1 tx_repeat

Press and hold the button **2s** -> When the **Red LED** is on, it means entering the **tx_repeat** configuration menu. Then release to configure it.

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

5.2.1.1 downlink_flag

Press and hold the button **5s** -> When the **Green LED** is on, it means entering the **downlink_flag** configuration menu. Then release to configure it.

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

5.2.1.1 radio configuration

Press and hold the button **10s** -> **Blue LED** is on, it means entering the **Radio Configuration** menu. Then release to configure it.

Press to configure. After pressing if the **Blue LED** blinks **once**, it is **Radio Configuration = 1**. After pressing 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**.

5.2.2 Exit the menu:

There are 3 ways to exit the menu:

- Press and 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)).

5.3 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.

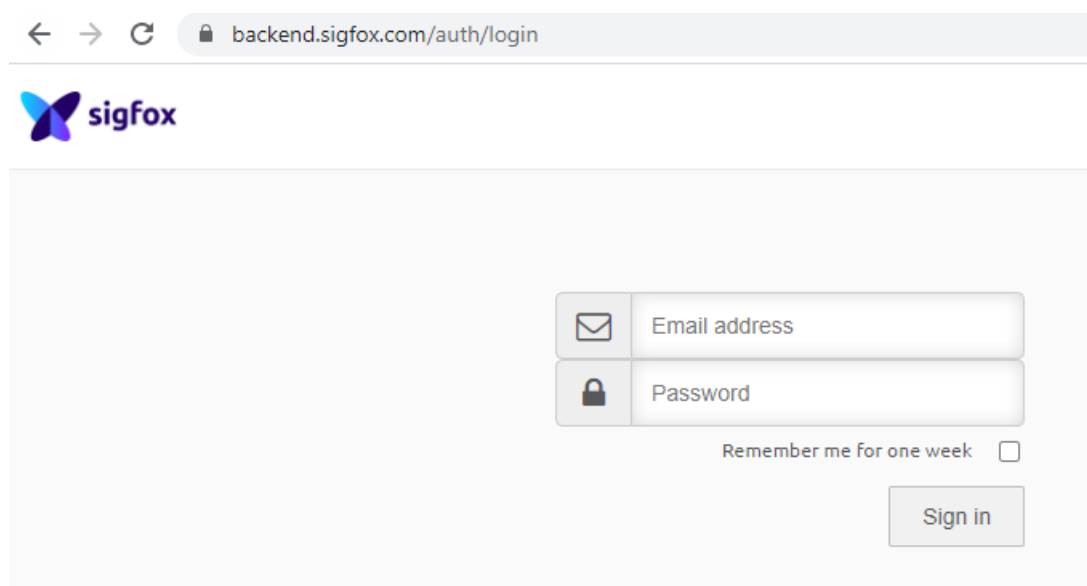
Sigfox's high limit EIRP recommendation is included in each column although regulations sometimes allow for more radiated power than the Sigfox recommendation.

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


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


5.4 Add a device to the Backend Sigfox


Step 1: Log in to the sigfox backend website



← → ↻ 🔒 backend.sigfox.com/auth/login



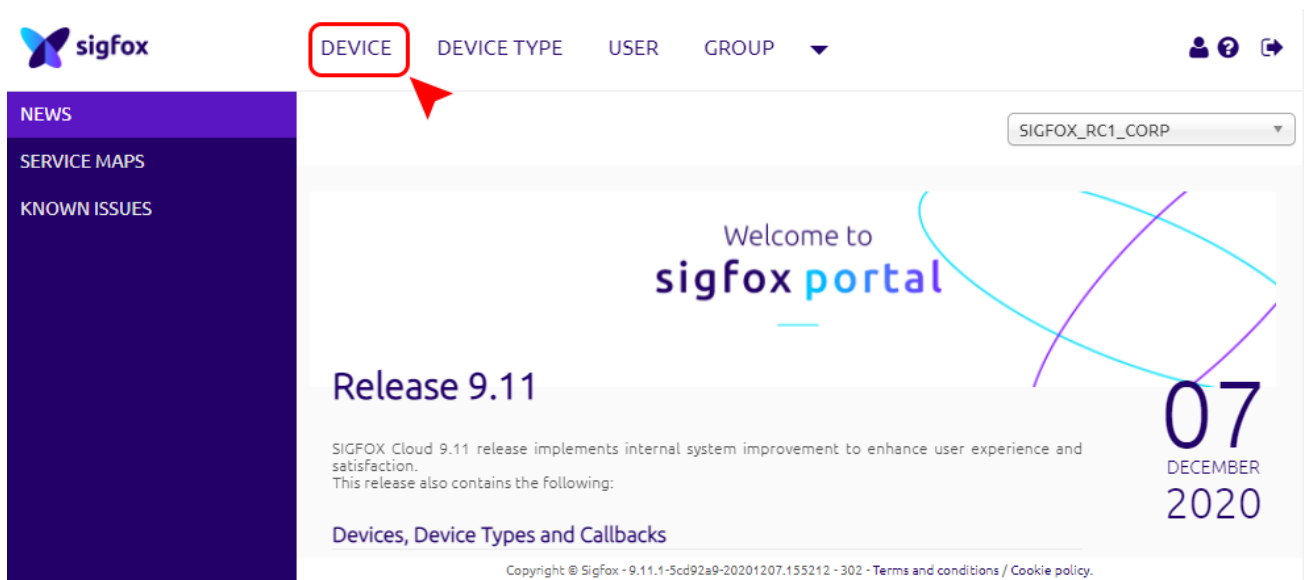
 Email address

 Password

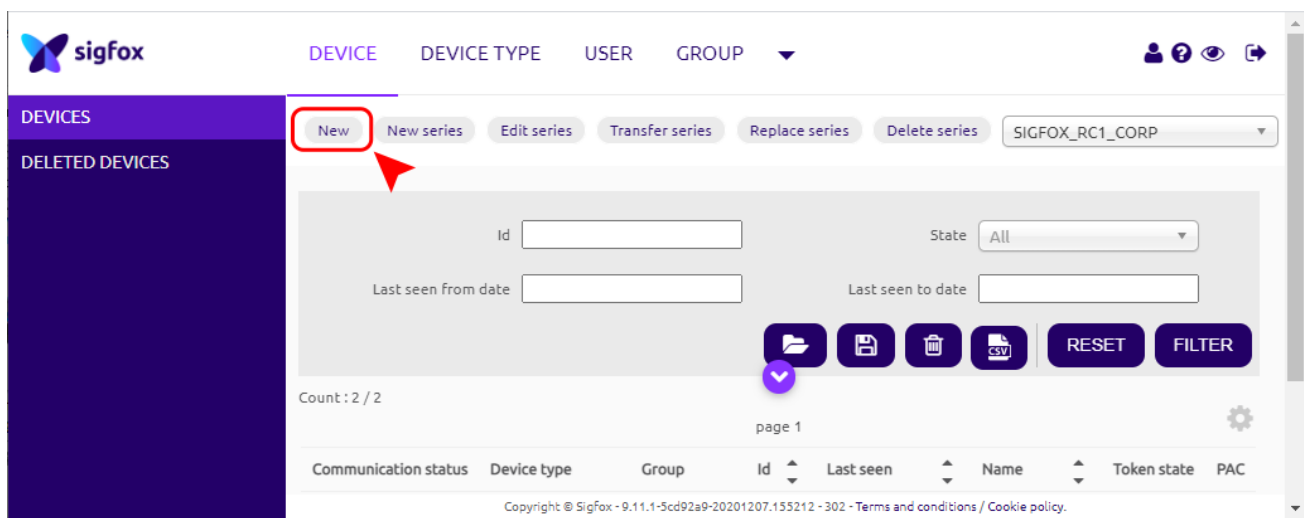
Remember me for one week ☐

Sign in

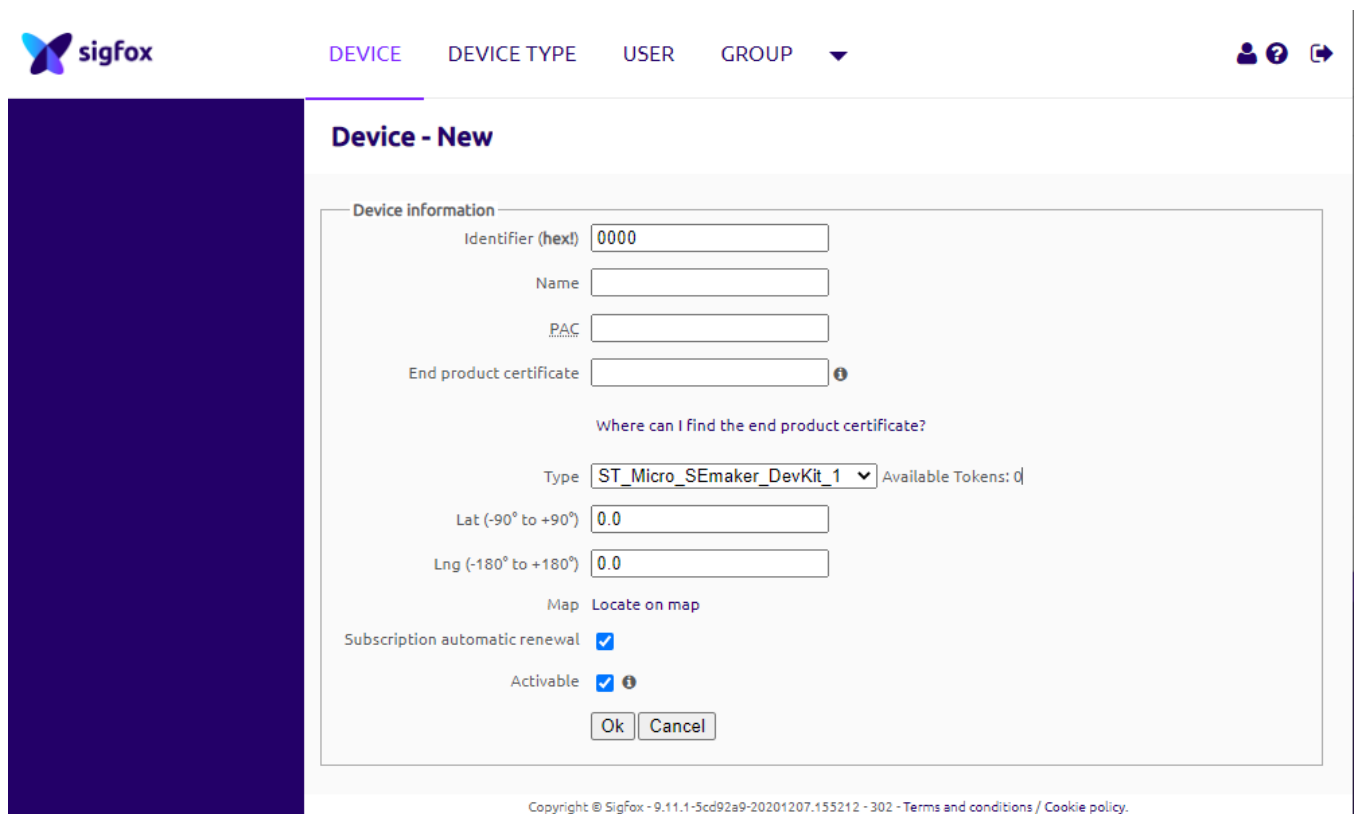
Step 2: Click on Device



Step 3: Click New → Select a group

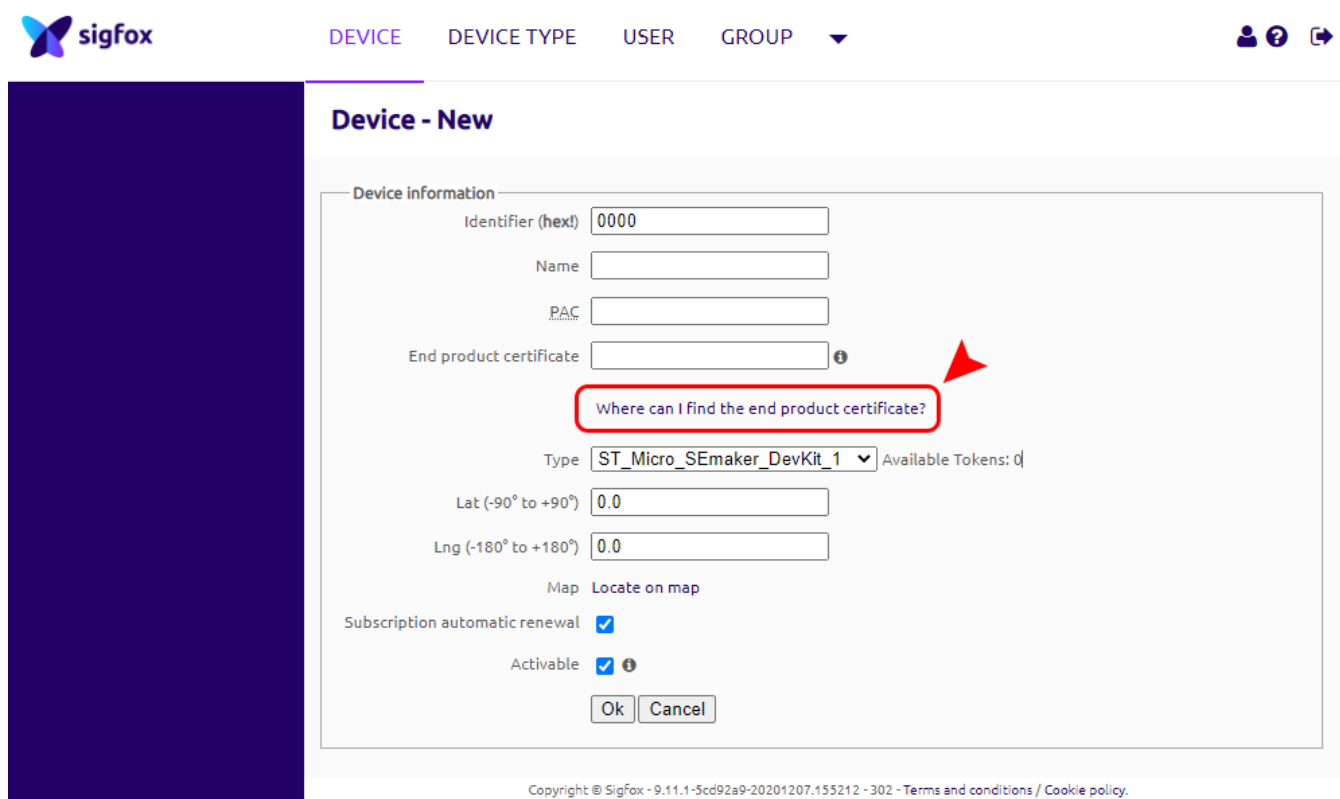


Step 4: Fill in the required information



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



The screenshot shows the 'Device - New' form in the Sigfox backend. The form is titled 'Device - New' and contains several input fields and checkboxes. The 'End product certificate' field is highlighted with a red box, and a red arrow points to it. The text 'Where can I find the end product certificate?' is written inside the red box. The form also includes fields for Identifier (hex!), Name, PAC, Type, Lat, and Lng, as well as checkboxes for Subscription automatic renewal and Activable. The 'Ok' and 'Cancel' buttons are at the bottom of the form.

Device information

Identifier (hex!)

Name

PAC

End product certificate **Where can I find the end product certificate?**

Type Available Tokens: 0

Lat (-90° to +90°)

Lng (-180° to +180°)

Map [Locate on map](#)

Subscription automatic renewal ☒

Activable ☒ **i**

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Check the box as shown below to register as a prototype

Device - New

Device information

Identifier (hex)

Name

PAC

End product certificate

Where can I find the end product certificate?

The device vendor should provide the end product certificate number. If not, please use the search bar below:

Otherwise you can contact your [Sigfox distributor service desk](#)
If the device has not obtained an end product certificate yet, then you can register as a prototype.

☒ Register as a prototype (remaining prototypes which can be registered in your group: 1000)

Type Available Tokens: 0

Lat (-90° to +90°)

Lng (-180° to +180°)

Map [Locate on map](#)

Subscription automatic renewal ☒

Activable ☒

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5.5 Measurement principle of Sigfox Vibration Sensor

When the time interval is reached, for example 30 minutes, the Sigfox node will wake up and switch ON the power supply to supply the energy to vibration sensor module to start the measurement. Depends on the type and characteristic of external sensor, the sensor will take a certain time to finish the measurement.

With vibration sensor, here are the 8 measurement values:

- Acceleration Peak (m/s²)
- Acceleration RMS (m/s²)
- Velocity Peak (mm/s)
- Velocity RMS (mm/s)
- Displacement Peak-Peak (um)
- Displacement RMS (um)
- Base vibration frequency (Hz)
- Temperature (oC)

Because the Payload of Sigfox sensor is limited by 12 bytes, we use the first 02 bytes for Sensor information and status, the rest 10 bytes will store measurement value. With above 8 measurement values, we have to device it into 03 datagrams. Each datagram will be sent each time.

Values to be sent in Datagram 1:

- Velocity RMS (mm/s)
- Acceleration Peak (mm/s)
- Frequency (Hz)

Values to be sent in Datagram 2:

- Velocity Peak (mm/s)
- Acceleration RMS (m/s²)
- Temperature (°C) (Real Temperature value = Temperature value / 10)

Values to be sent in Datagram 3:

- Displacement Peak-Peak (um)
- Displacement RMS (um)
- Frequency (Hz)



User can configure the Sigfox node to send any number of datagram, but minimum is Datagram 1. The configuration can be done offline via cable & software OR via downlink.

5.6 Payload Data

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

5.6.1 Payload for uplink 12 bytes

Sensor type (1 byte)	Status + Datagram (1 byte)	Parameter 1 (4 bytes)	Parameter 2 (4 bytes)	Parameter 2 (2 bytes)
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Meaning of Data in the Payload

Data	Size	Bit	Format	Meaning
Sensor type	1 byte	all	UInt8	Sensor type: <ul style="list-style-type: none"> • 0x10 means Sigfox V1A • 0xFF means no sensor.
Status: battery level	2 bits	Bit 7 and 6		Battery capacity in 04 levels <ul style="list-style-type: none"> • 11: battery level 4 (99%) • 10: battery level 3 (60%) • 01: battery level 2 (30%) • 00: battery level 1 (10%)
Status: error	2 bits	Bit 5 and 4		Node status <ul style="list-style-type: none"> • 01: error • 00: no error
Datagram	4 bits	Bit 3 to 0		Datagram <ul style="list-style-type: none"> 000 : Datagram 1 001 : Datagram 2 010 : Datagram 3
Parameter 1	4 bytes	all	Float	Datagram 1 : Velocity RMS (mm/s) Datagram 2 : Velocity Peak (mm/s) Datagram 3 : Displacement Peak-Peak (um)
Parameter 2	4 bytes	all	Float	Datagram 1 : Acceleration Peak (mm/s) Datagram 2 : Acceleration RMS (m/s ²) Datagram 3 : Displacement RMS (um)

Parameter 3	2 bytes	all	Datagram 1 : uint16; Datagram 2 : int16; Datagram 3 : uint16	Datagram 1 : Frequency (Hz) Datagram 2 : Temperature (°C) Real Temperature value = Temperature value / 10 Datagram 3 : Frequency (Hz)
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5.6.2 Payload for Downlink, length is 8 bytes.

⚠ The Sigfox node is only able to receive max 04 downlinks a day, each downlink will be waiting in every 06 hours.

User can set the down link data in Sigfox back-end system in advance, whenever the Sigfox node connected to base stations and with downlink waiting is enable at that time (one time in 6 hours), the downlink data will be loaded to Sigfox node.

The downlink data can be any configuration parameter.

⚠ Please pay attention when send downlink data. If there was a mistake in sending wrong data, it would cause the Sigfox node not working properly and user need to configure it by **offline cable!!!**

Downlink payload format:

Prm_adr (1 byte)	Prm_len (1 byte)	Prm_value (6 bytes)
------------------	------------------	---------------------

Examples of Downlink data to configure the Sigfox node:

Prm_name	Prm_adr	Prm_len	Comment
cycle_send_data	0x12	0x04	to configure the interval time of data sending, in seconds.
Enb_datagram	0x44	0x02	to configure which datagram to be sent.

Explain for Enb_datagram:

- bit 0 = 1: enable datagram 1
- bit 0 = 0: disable datagram 1
- bit 1 = 1: enable datagram 2
- bit 1 = 0: disable datagram 2
- bit 2 = 1: enable datagram 3
- bit 2 = 0: disable datagram 3

Some examples of Enb_datagram:

Enb_datagram = 0x0000 ==> **Only datagram 1 will be sent.**

Enb_datagram = 0x07 = 0b00000111 ==> **Enable 3 datagrams**

- At 1st cycle_send_data , Sigfox V1A will send datagram 1
- At 2nd cycle_send_data , Sigfox V1A will send datagram 2
- At 3rd cycle_send_data , Sigfox V1A will send datagram 3
- At 4th cycle_send_data , Sigfox V1A will send datagram 1 and so on.

Enb_datagram = 0x05 = 0b00000101 ==> **Enable datagram 1 and 3, disable datagram 2**

- At 1st cycle_send_data , Sigfox V1A will send datagram 1
- At 2nd cycle_send_data , Sigfox V1A will send datagram 3
- At 3rd cycle_send_data , Sigfox V1A will send datagram 1
- At 4th cycle_send_data , Sigfox V1A will send datagram 3 and so on.

6. 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

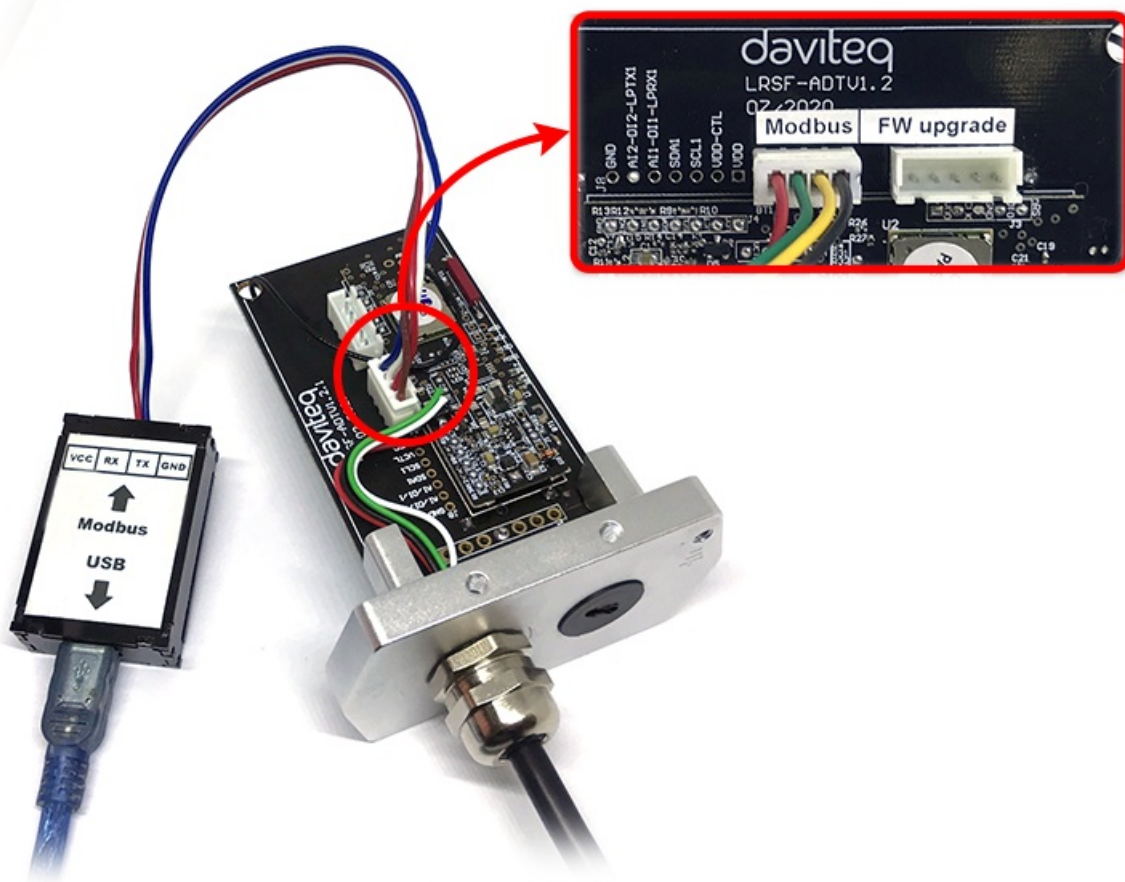
Step 2: Plug the configuration cable to Computer via **USB** port;



Step 3: Open the housing;



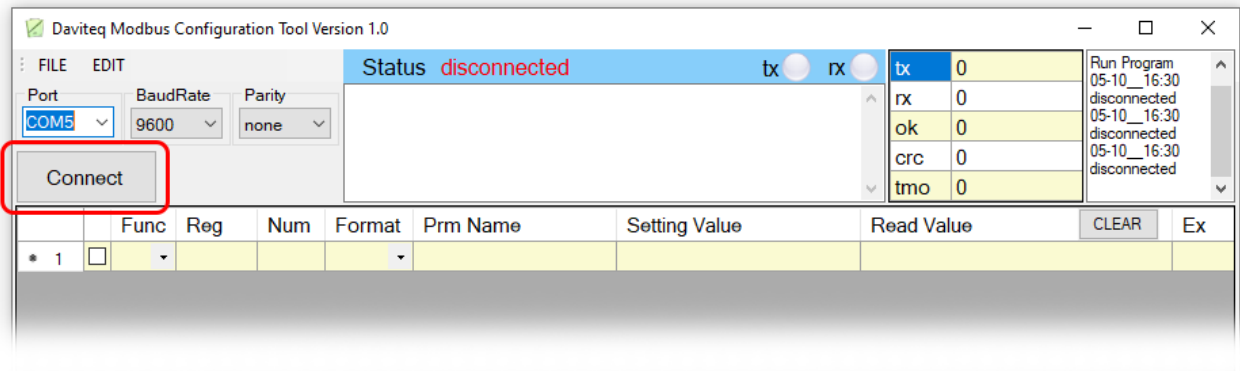
Step 4: Plug the connector to the configuration port;



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.csv (in the link below). Then click **Connect**;



CONFIGURATION TEMPLATE FILE FOR SIGFOX WSSFC-V1A.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			string	Read	
6	6	3	2	hardware version			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
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
270	10E	3	16	1	Radio Configuration	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_flag	0-1	0	uint16	Read/Write	1: enable Downlink, 0: disable Downlink (Fw v1.0 hasn't got Downlink function)
274	112	3	16	2	cycle_send		900	uint32	Read/Write	Data sending cycle, in seconds
278	116	3	16	1	alarm_limit		44	uint16	Read/Write	Limit number of alarm sending in 24h
280	118	3	16	2	sensor1: sampling_rate		120	uint32	Read/Write	Sensor/Input 1 sampling rate, in seconds
282	11A	3	16	2	sensor1: calc_time		100	uint32	Read/Write	Measurement time of sensor/input 1, in ms
324	144	3	16	1	enb_datagram		0x0001	hex	Read/Write	bit 0 = 1: enb datagram 1 bit 0 = 0: dis datagram 1 bit 1 = 1: enb datagram 2 bit 1 = 0: dis datagram 2 bit 2 = 1: enb datagram 3 bit 2 = 0: dis datagram 3 enb_datagram = 0x0000: emb datagram 1

7. Installation

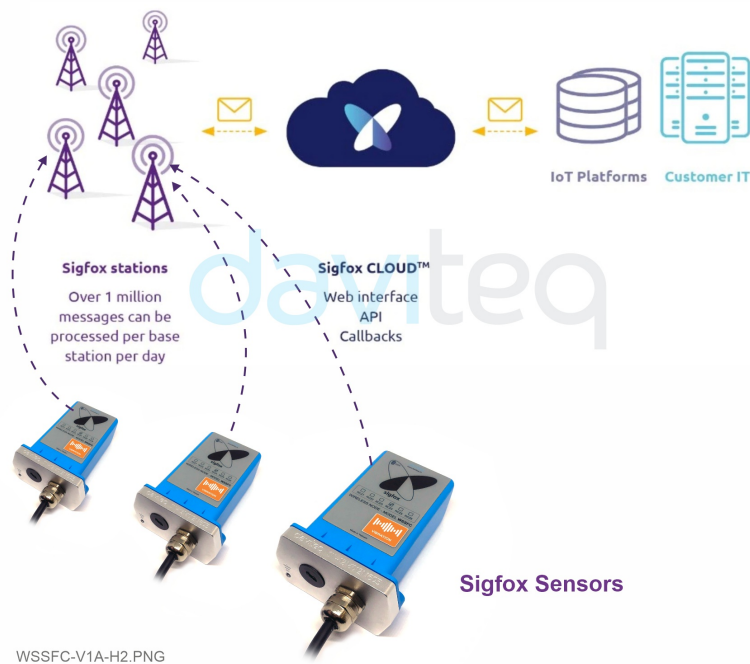
7.1 Locate the good place for Radio signal

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.

SYSTEM ARCHITECTURE



7.2 Process mounting

WARNING:

- ⚠ The sensor should be mounted on an oil-free and grease-free surface as close to the source of vibration as possible.
- ⚠ For best results, the sensor should be mounted via a drill hole and have an **M6x1.0** threaded hole (an adapter can be used) attached directly to the housing.
- Please make sure that the operating ambient temperature is within the specification of sensor.
- ⚠ Prepare the professional tools for installation. The inappropriate tools may cause damage to the sensor.

- ⚠ **DANGER:** Do not twist the upper part of sensor, only screwing the sensor by using the HEX wrench with the lower HEX part of sensor.



7.3 Battery installation

RECOMMENDED BATTERIES FOR SIGFOX SENSOR

E91 AA Alkaline battery



-18 .. + 60 oC working temperature

10-year shelf life

3000 mAh Capacity

Price: 1X

L91 AA Lithium battery



-40 .. + 60 oC working temperature

20-year shelf life

3500 mAh Capacity

Price: 3.5X

WSSFC-ULC-H7.PNG

Steps for battery installation:

Step 1: Using L hex key to unscrew M4 screws at the side of the housing and carefully pull out the top plastic housing in the vertical direction



Step 2: 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 by L hex key

ATTENTION:

When reinstalling the cover, pay attention to put the PCB edge into the middle slot of the box inside as shown below)



8. Troubleshooting

No.	Phenomena	Reason	Solutions
1	Node does not send RF to base station periodically, LED does not blink	<ul style="list-style-type: none"> No power supply or battery ran out Configuration sending cycle is incorrect 	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> The alarm configuration is incorrect Running out of the number of alarms set for the day 	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Magnetic switch has malfunctioned Or place the Magnet key not right position 	<ul style="list-style-type: none"> Locate the correct position for magnet key 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	<ul style="list-style-type: none"> Out of the number of RF packages of uplink per day (140 packages / day) 	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> LED malfunction 	<ul style="list-style-type: none"> Contact manufacturer

6	The measurement values from sensor do not change, keep constant values for long time	<ul style="list-style-type: none"> • Sensor got failure • Sensor cable broken • Sensor connector is not connected firmly 	<ul style="list-style-type: none"> • Check sensor cable and connector • If the issue is still exist, please contact manufacturer for warranty or replace new sensor
7	The node does not send RF and the RF module is hot	<ul style="list-style-type: none"> • Insert the battery in the wrong direction • Electronics got problem 	<ul style="list-style-type: none"> • Check battery polarity
8	RSSI is weak and often loses data	<ul style="list-style-type: none"> • Distance between Node and Base station is far or there are many obstructions • Connection to Antenna problem 	<ul style="list-style-type: none"> • Check location of Sigfox node and distance to base station • Check the antenna connector in the PCB

9. Support contacts

Manufacturer



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🔄 Revision #12

★ Created Sun, May 16, 2021 7:35 PM by [Kiệt Anh Nguyễn](#)

✍ Updated Wed, Jan 24, 2024 6:57 AM by [Phi Hoang Tran](#)