USER GUIDE FOR SIGFOX TILT SENSOR WSSFC-AG

THIS IS **OBSOLETE** MANUAL

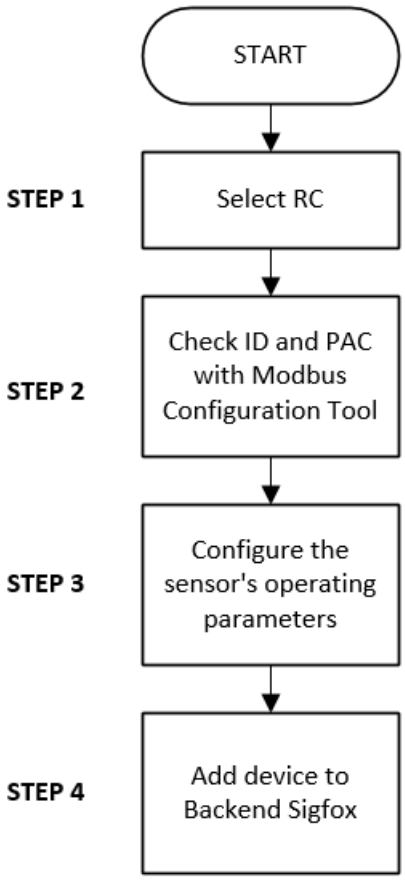
Please access https://www.iot.daviteq.com/wireless-sensors for updated manual

WSSFC-AG-MN-EN-01	FEB-2022

This document is applied for the following products

SKU	WSSFC-AG	**HW Ver.**	1.0	**FW Ver.**	1.02
Item Code	WSSFC-AG-9-01	Sigfox XYZ Tilt sensor, Internal antenna, Type AA battery 1.5VDC, IP67, RC2-RC3-RC4-RC5 zones			
	WSSFC-AG-8-01	Sigfox XYZ Tilt sensor, 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
1.0	1.02	DEC-2020	

2. Introduction

WSSFC-AG is a Sigfox Tilt Sensor, can be used to measure 3 tilt angles X, Y, Z of any object as Tower, Building, Tree, Electricity Tower, Telecom Tower, Bridges... The Tilt sensor utilises the combination of advanced Accelerometer and Gyro meter to deliver high accuracy and stable measurement of Tilt angle of 03 axis X,Y,Z. The Ultra-Low Power Power design and smart firmware allow the sensor to last up to 10 years with 02 x AA battery (depending on configuration). The sensor will transmit data in kilo-meters distance to Sigfox basestation. WSSFC-AG can support all regions of Sigfox network in over the World, RC1, RC2, RC3, RC4, RC5, RC6, RC7.



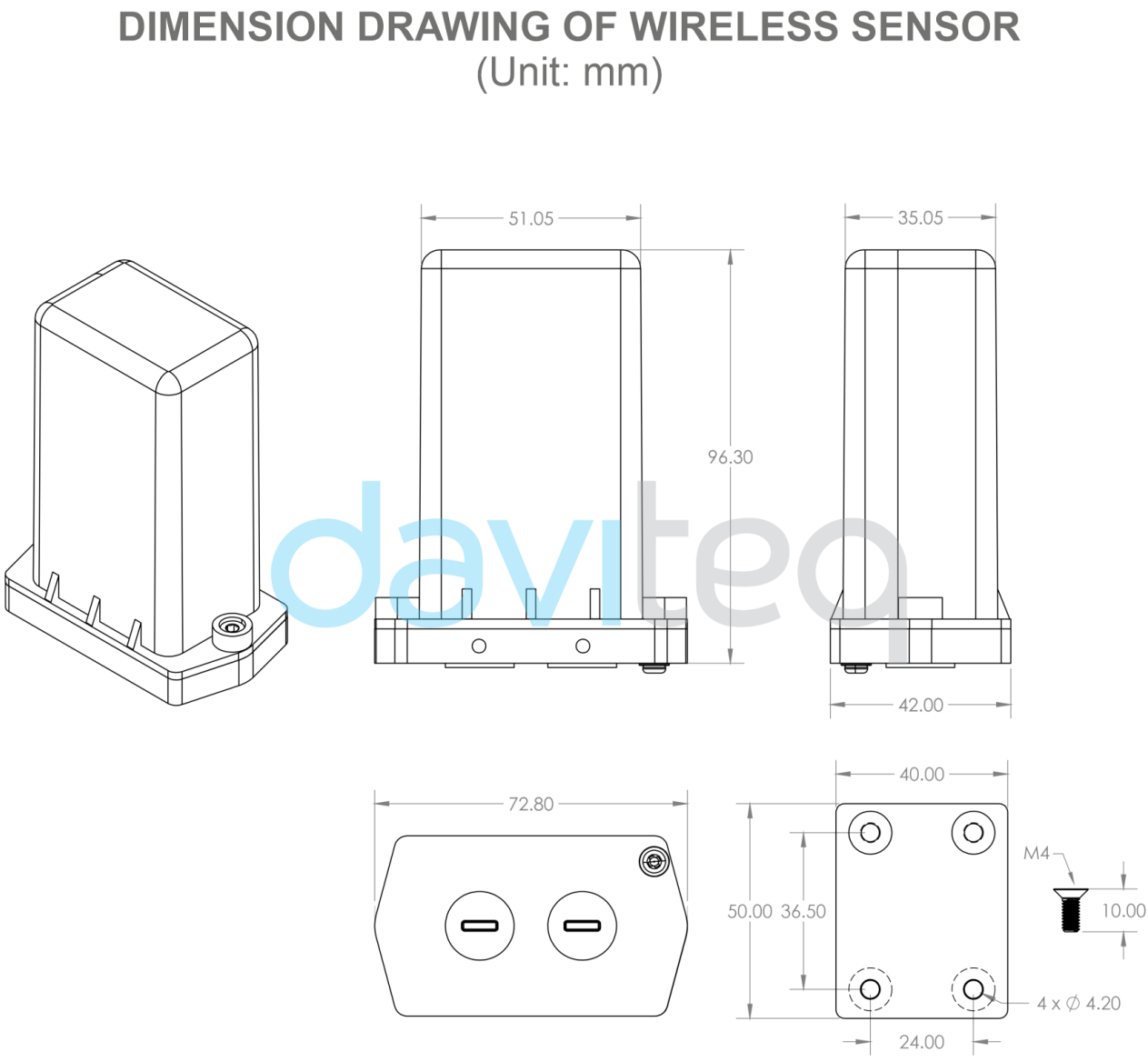
WSSFC-AG-H1.PNG

3. Specification

SENSORS SPECIFICATION:	
Tilt Sensor	Built-in advanced accelerometer and gyro meter to deliver tilt angle measurement of X, Y, Z

Measurement range	± 90° of XYZ
Repeatibility	± 0.25°
Sensor sampling rate	1Hz max
Alarm setting	setting the alarm threshold for each angle
Sigfox SPECIFICATION:	
Sigfox zones	select RC2-RC3-RC4-RC5 or RC1-RC6-RC7
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	-40°C..+60°C (using Energizer Lithium Ultimate AA battery)
Dimensions	H97xW73xD42
Net-weight	250 grams
Housing	Polycarbonate & POM plastic, IP67

4. Dimensions



WSSFC-AG-H6.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 1 minute 30 seconds later the device will send the first data packet and at the same time wait for the downlink packet from the Base Station.

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

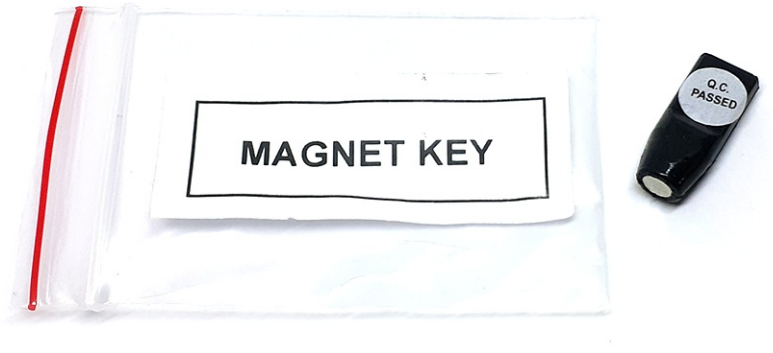
1. When the sensor sampling time interval is reached, the Sigfox node will read the data from Input or sensor and performing the calculation. After that it will check calculated value with alarm thresholds. If the calculated was out off the threshold values (Lo or Hi), called alarm, and the number of 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.



REED SWITCHS FUNCTIONS (activated by magnet):

EVENT	PRE-CONDITION	ACTION	LED STATUS	ACTIVITIES	POST-CONDITION
FORCE_DATA	Any state	Move Magnet Key to contact point of REED SWITCH. Led blink **SKY BLUE**, move Magnet Key away.	Blink **SKY BLUE**	See FW specs	Back to previous state
PARAMETERS_UPDATE	Any state	Move Magnet Key to contact point of REED SWITCH. Led blink **SKY BLUE**, hold Magnet Key **5s**. Led blink **PURPLE**, move Magnet Key away.	Blink **PURPLE**	See FW specs	Back to previous state

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**5s**. if shorter than **5s**, there will be no data sending.





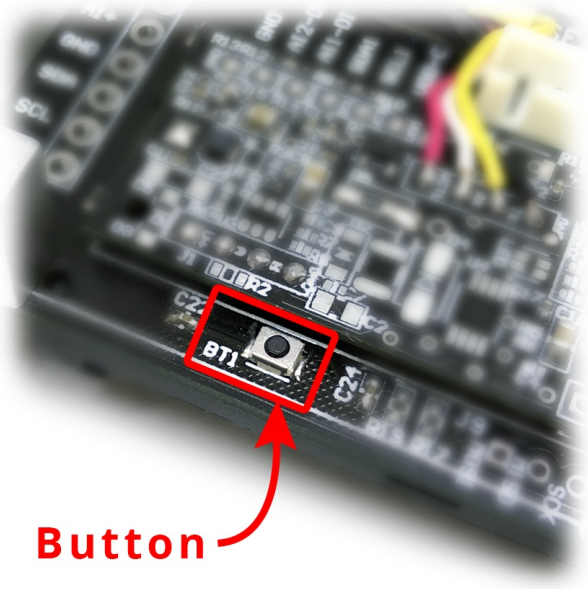
5.1 LED meaning

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



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).

5.2.1.2 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).

5.2.1.3 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.

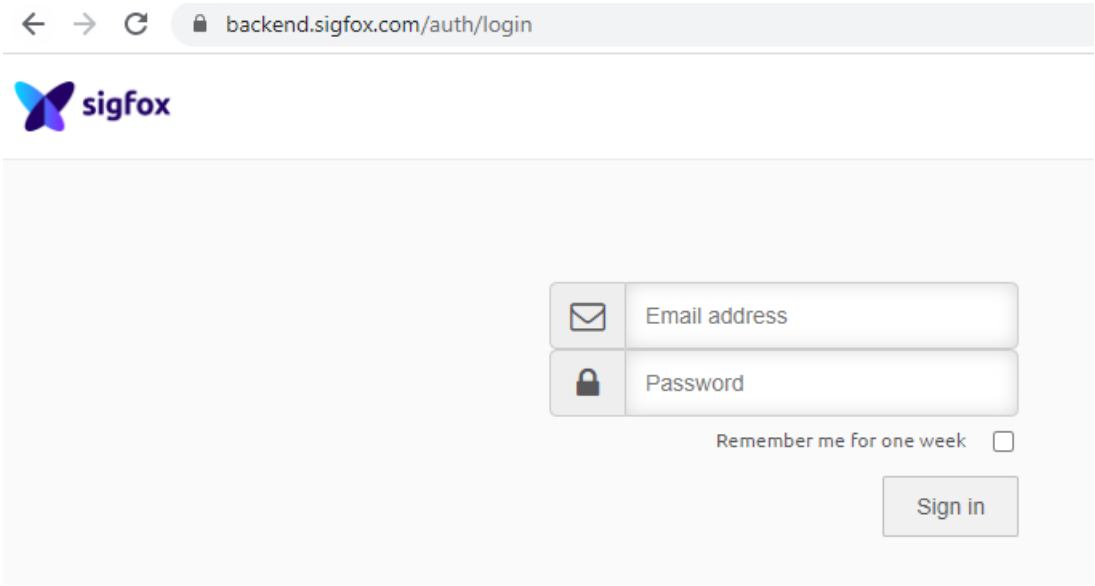
Sigfox's high limit EIRP recommendation is included in each column although regulations sometimes allow for more radiated power than the Sigfox recommendation.

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

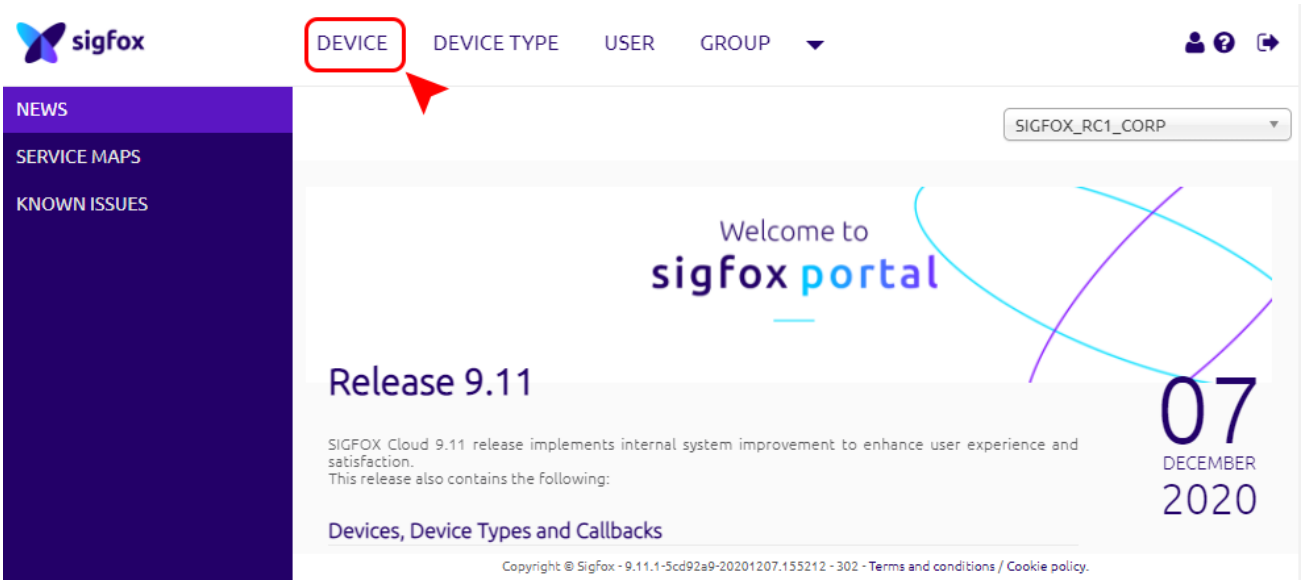
- Low current consumption
- Balanced link budget between uplink and downlink communication

5.4 Add a device to the Backend Sigfox

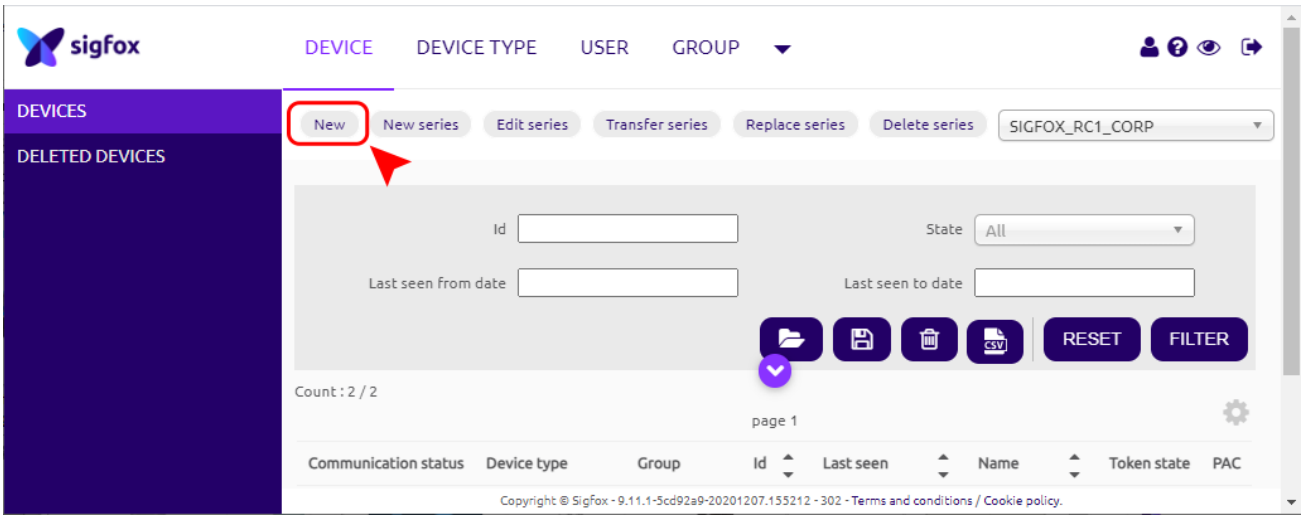
Step 1: Log in to the sigfox backend website



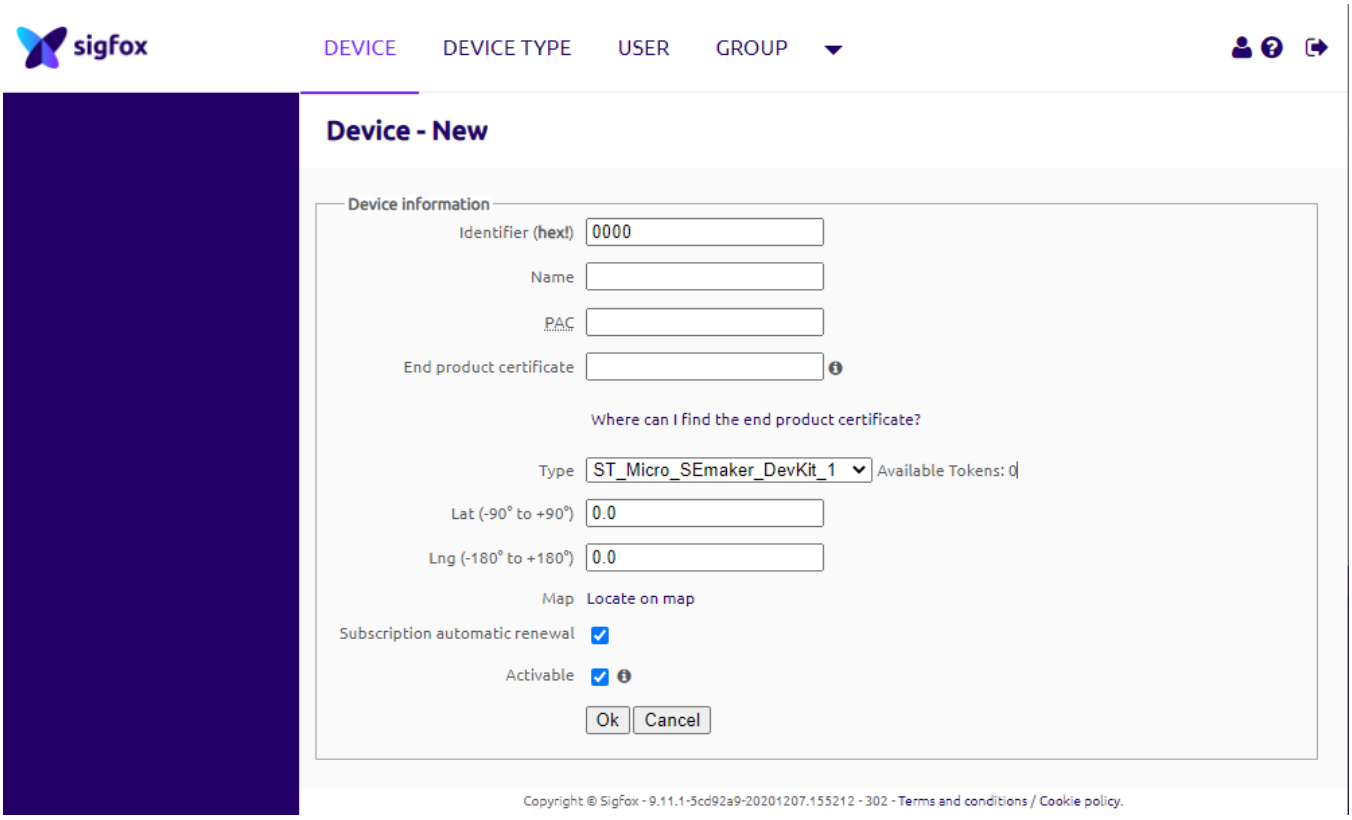
Step 2: Click on Device



Step 3: Click New → Select a group

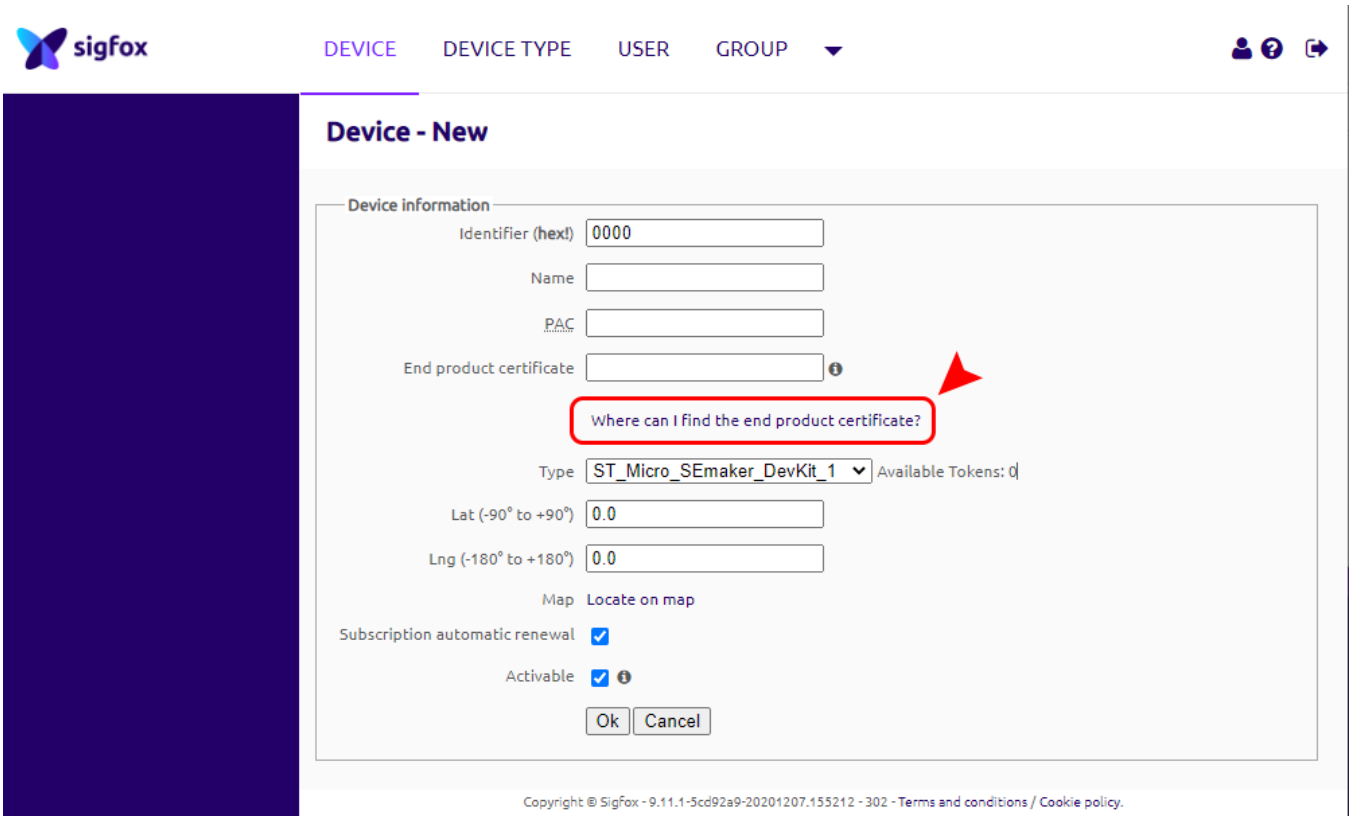


Step 4: Fill in the required information

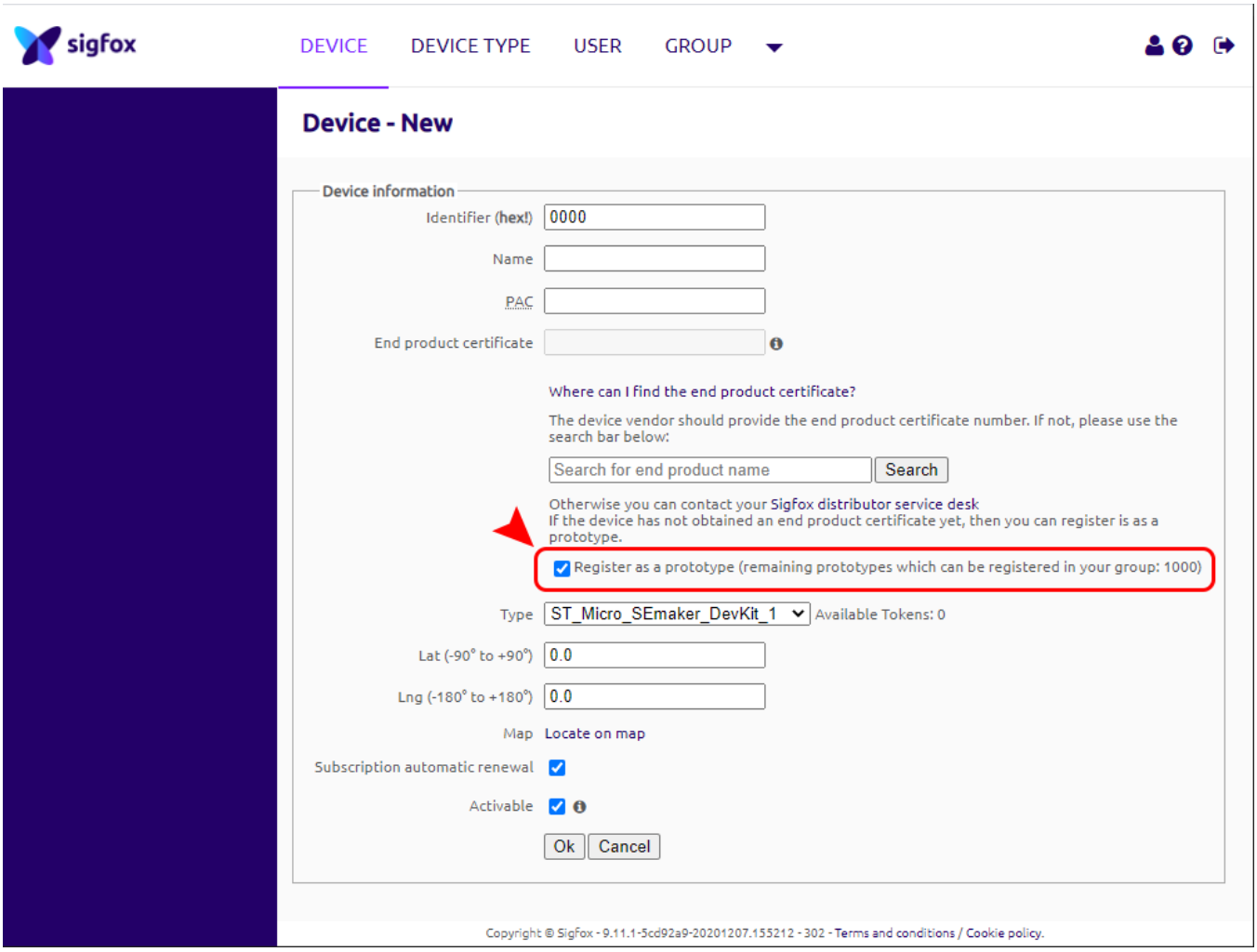


Note: Some of our products may not have end product certification in time, to add the product to Backend Sigfox please follow the steps below.

Click on the text as shown below



Check the box as shown below to register as a prototype



5.5 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:

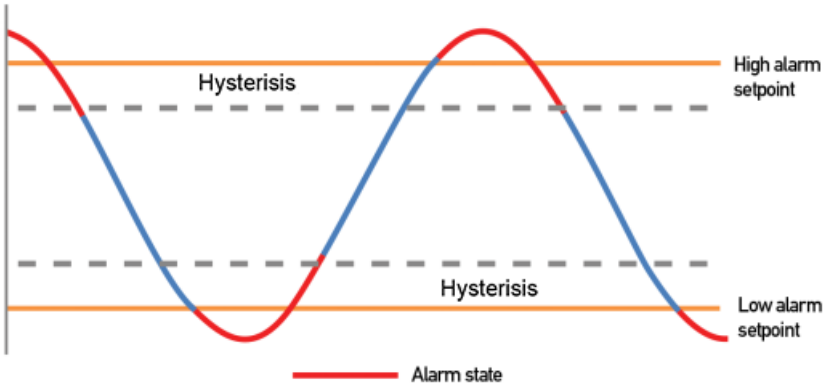
$$Y = aX + b$$

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.



5.6 Configuration Parameters

Parameter	Description	Possible values	Default value	Length (in bits)
LED_BUZZER_ENABLE	Enable/Disable LEDs and Buzzersinteractions for action not triggered by the reed switch	0b0 = LEDs and Buzzers are OFF 0b1 = LEDs and Buzzers are ON	0b1 = LEDs and Buzzers are ON	**1**
HEARTBEAT_PERIOD	Period of time to send HEARTBEAT event	0b000 = every 1h 0b001 = every 6h 0b010 = every 12h 0b011 = every 24h (1 day) 0b100 = every 48h (2 days) 0b101 = every 72h (3 days) 0b110 = every 120h (5 days) 0b111 = every 240h (10 days)	0b011 = every 24h (1 day)	**3**
MEASURE_PERIOD	Period of time to measure sensor	0b0000 = every 1s 0b0001 = every 2s 0b0010 = every 5s 0b0011 = every 10s 0b0100 = every 20s 0b0101 = every 30s 0b0110 = every 1min 0b0111 = every 2min 0b1000 = every 5min 0b1001 = every 10min 0b1010 = every 20min 0b1011 = every 30min 0b1100 = every 1h 0b1101 = every 2h 0b1110 = every 3h 0b1111 = every 6h	0b1001 = every 10min	**4**
TX_REPEAT	Sigfox TX repeat	0b0 = Send RF 1 time 0b1 = Send RF 3 time	0b1 = Send RF 3 time	**1**
CYCLIC_DATA_PERIOD	Period of time to send CYCLIC_DATA event	0b000 = every 10min 0b001 = every 30min 0b010 = every 1h 0b011 = every 2h 0b100 = every 3h 0b101 = every 6h 0b110 = every 12h 0b111 = every 24h	0b000 = every 10min	**3**

DEVICE_RESET	Once this parameter is set, the device shall restart once after having received the Downlink.	0b1010 = 0xA = force device reset others = do nothing	0b0000 = do nothing	**4**
DOWNLINK_TYPE	Downlink type	4-bit unsigned integer See Sigfox Downlink tab	0b0000	**4**

5.7 Payload Data

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

5.7.1 Payload Fields

Data name	Description	Encoding or Possible values	Length (in bits)
EVENT_ID	Unique ID identifying the device event	4-bit unsigned integer 0 = START_UP 1 = HEARTBEAT 2 = PARAMETERS_UPDATE 3 = FORCE_DATA 4 = CYCLIC_DATA 5 = ALARM	**4**
HW_VERSION	Indicate HW version	4-bit unsigned integer 1..15	**4**
FW_VERSION	Indicate FW version	8-bit unsigned integer 1..255	**8**
LATEST_SIGFOX_DOWNLINK	Latest received and valid sigfox downlink frame = Current configuration	64-bit encoded field See Sigfox Downlink tab	**64**
HW_ERROR	HW error	0b0 = no error 0b1 = error	**1**
BATTERY_LEVEL	Battery level	2-bit unsigned integer 0..3	**2**
X_TILT_VALUE_X10	X Tilt value	16-bit signed integer X_TILT_VALUE = X_TILT_VALUE_X10 / 10 Range: -90.0 to 90.0	**16**
Y_TILT_VALUE_X10	Y Tilt value	16-bit signed integer Y_TILT_VALUE = Y_TILT_VALUE_X10 / 10 Range: -90.0 to 90.0	**16**
Z_TILT_VALUE_X10	Z Tilt value	16-bit signed integer Z_TILT_VALUE = Z_TILT_VALUE_X10 / 10 Range: -90.0 to 90.0	**16**

5.7.2 Sigfox Uplink Frame Format

Size					
	START_UP	*(led blink **WHITE**)*			
	Payload	**EVENT_ID**	**HW_VERSION**	**FW_VERSION**	**LATEST_SIGFOX_DOWNLINK**
10.0	**bits**	**4**	**4**	**8**	**64**
	Value	*0b0000 = 0*	*yes*	*yes*	*yes*
	HEARTBEAT	*(led blink **GREEN**)*			
	Payload	**EVENT_ID**	**HW_VERSION**	**FW_VERSION**	**LATEST_SIGFOX_DOWNLINK**

10.0	**bits**	**4**	**4**	**8**	**64**	
	Value	*0b0001 = 1*	*yes*	*yes*	*yes*	
	PARAMETERS_UPDAT	*(led blink **PURPLE**)*				
	Payload	**EVENT_ID**	**HW_VERSION**	**FW_VERSION**	**LATEST_SIGFOX_ DOWNLINK**	
10.0	**bits**	**4**	**4**	**8**	**64**	
	Value	*0b0010 = 2*	*yes*	*yes*	*yes*	

	FORCE_DATA	(led blink **SKY BLUE**)							
	Payload	**EVENT_ID**	**HW_ERROR**	**reserved**	**BATTERY_LE**	**reserved**	**X_TILT_VALU**	**Y_TILT_VALU**	**Z_TILT_VALU**
8.0	**bits**	**4**	**1**	**5**	**2**	**4**	**16**	**16**	**16**
	Value	0b0011 = 3	yes	zeros	yes	zeros	yes	yes	yes
	CYCLIC_DATA	*(led blink **SKY BLUE**)*							
	Payload	**EVENT_ID**	**HW_ERROR**	**reserved**	**BATTERY_LE**	**reserved**	**X_TILT_VALU**	**Y_TILT_VALU**	**Z_TILT_VALU**
8.0	**bits**	**4**	**1**	**5**	**2**	**4**	**16**	**16**	**16**
	Value	*0b0100 = 4*	*yes*	*zeros*	*yes*	*zeros*	*yes*	*yes*	*yes*

5.7.3 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**!!!

Size									
	DOWNLINK_ = 0								
	Payload	**reserved**	**LED_BUZZER**	**HEARTBEAT_**	**MEASURE_PI**	**TX_ REPEAT**	**CYCLIC_DAT**	**DEVICE_RES**	**DOWNLINK_**
8.0	**bits**	**44**	**1**	**3**	**4**	**1**	**3**	**4**	**4**

	Value	*zeros*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*0b0000 = 0*

	DOWNLINK_TYPE = 5					
	Payload	**PRM_ADDRESS**	**PRM_LENGTH**	**PRM_VALUE**	**reserved**	**DOWNLINK_TYPE**
8.0	**bits**	**8**	**8**	**16**	**28**	**4**
	Value	*yes*	*0x02 = 2*	*yes*	*zeros*	*0b0101 = 5*
	Payload	**PRM_ADDRESS**	**PRM_LENGTH**	**PRM_VALUE**	**reserved**	**DOWNLINK_TYPE**
8.0	**bits**	**8**	**8**	**32**	**12**	**4**
	Value	*yes*	*0x04 = 4*	*yes*	*zeros*	*0b0101 = 5*

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

ℹ **How to use the Modbus configuration software**

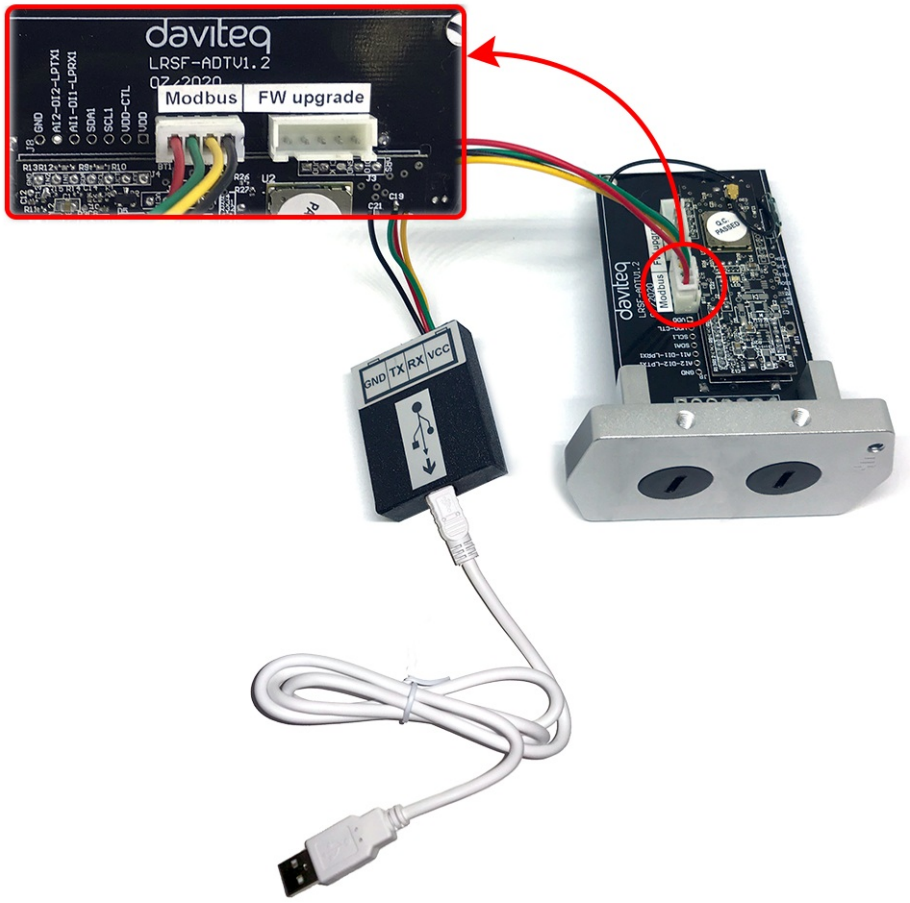
Step 2: Plug the configuration cable to Computer via **USB** port;



Step 3: Open the housing;

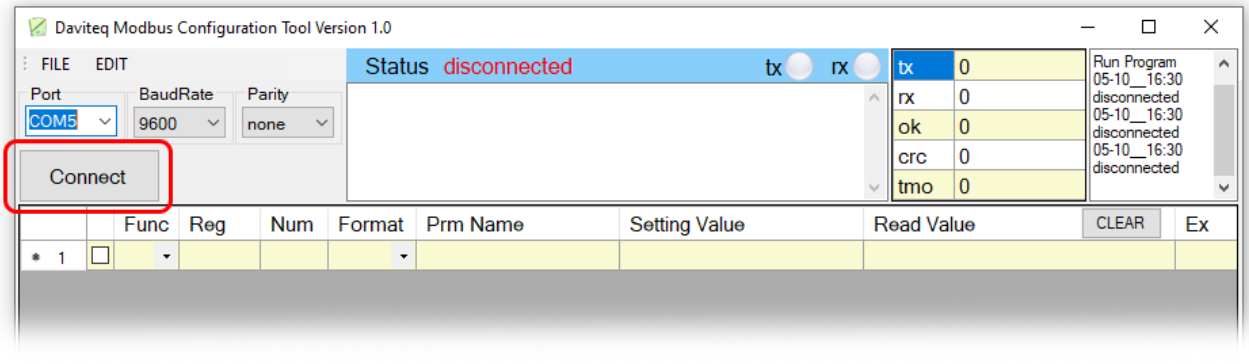


Step 4: Plug the connector to the configuration port;



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-AG.csv



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

Modbus Register (Dec)	Modbus Register (Hex)	Function Code (Read)	Function Code (Write)	# of Registers	Description	Range	Default	Format	Property	Comment
2	2	3		4	FW_VERSION			string	Read	
6	6	3		2	HW_VERSIO			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	SENSOR_TYP	1-255		uint16	Read	Sensor or Input Type

Here is the table for Configuration:

Modbus Register (Dec)	Modbus Register (Hex)	Function Code (Read)	Function Code (Write)	# of Registers	Description	Range	Default	Format	Property	Comment
270	10E	3	16	4	CURRENT_C			hex	Read / Write	
274	112	3	16	1	SERVER_CO			uint16	Read / Write	0: Send to Sigfox Network 1: Send to Dongle
276	114	3	16	1	RADIO_CONI	1, 2, 4	4	uint16	Read / Write	RC zones selection 1, 2 ,4 is RCZ1, RCZ2, RCZ4
277	115	3	16	1	TX_POWER		20	int16	Read / Write	RF Tx power
286	11E	3	16	2	SENSOR_BO		200	uint32	Read / Write	Boot time of sensor/input in ms

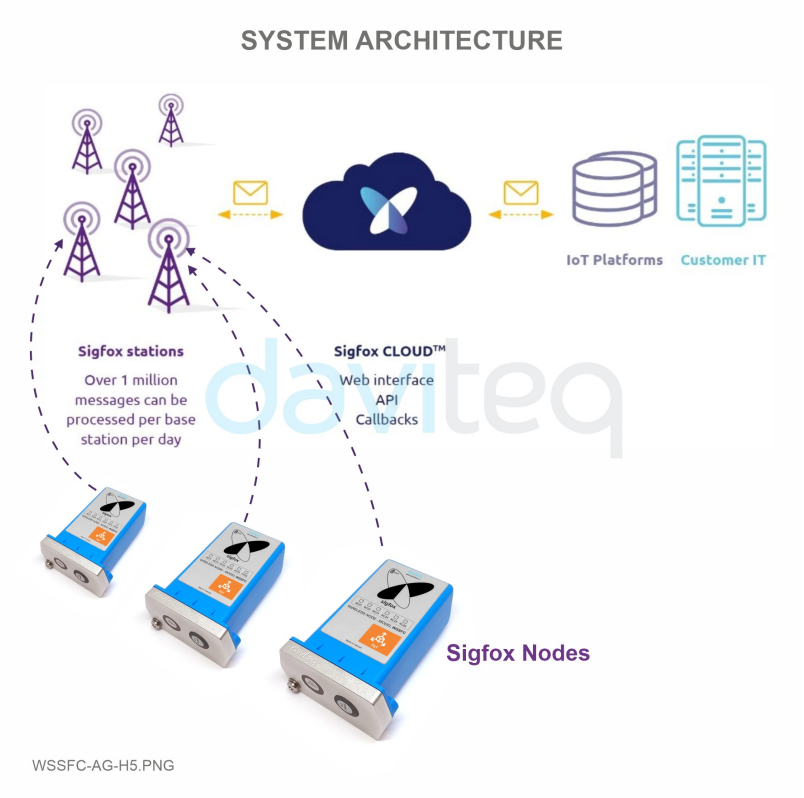
7. Installation

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.

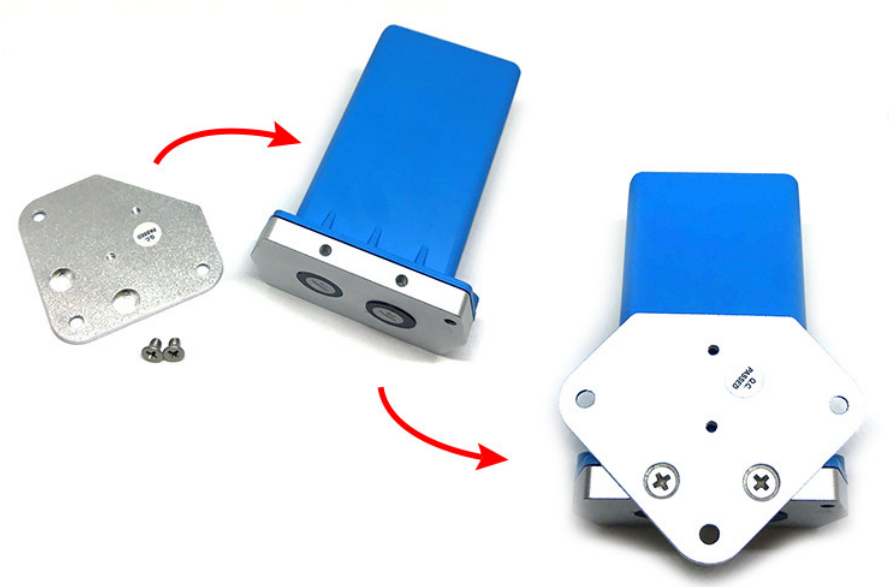
ATTENTION:

⚠ **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.



7.2 Process mounting

7.2.1 Bracket installation



7.2.2 Site Installation

> ⚠ **WARNING:**
>
> ⚠ The sensor must be securely fixed on the tilt angle measurement area.
>
> ⚠ The sensor only measures 3 axes from -90 degrees to 90 degrees
>
> ⚠ It is recommended to make a standard angle of 90 degrees for the sensor to achieve the best measurement results

TILT SENSOR FOR CRANE MONITORING



WSSFC-AG-H4.PNG

TILT SENSOR INSTALLED ON THE TREE



WSSFC-AG-H3.PNG

7.3 Battery installation

RECOMMENDED BATTERIES FOR SIGFOX SENSOR

E91 AA Alkaline battery	L91 AA Lithium battery
	
-18 .. + 60 oC working temperature	-40 .. + 60 oC working temperature
10-year shelf life	20-year shelf life
3000 mAH Capacity	3500 mAH Capacity
Price: 1X	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	• No power supply or battery ran out • 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 • Or place the Magnet key not right position	• 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	• Out of the number of RF packages of uplink 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	• Contact manufacturer

6	The measurement values from sensor do not change, keep constant values for long time	• Sensor got failure • Sensor cable broken • Sensor connector is not connected firmly	• 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	• Insert the battery in the wrong direction • Electronics got problem	• Check battery polarity
8	RSSI is weak and often loses data	• Distance between Node and Base station is far or there are many obstructions • Connection to Antenna problem	• 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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