USER GUIDE FOR WIRELESS ULTRASONIC LEVEL SENSOR WS433-ULC

WS433-ULC-MN-EN-01	MAR-2021

This document is applied for the following products

SKU	WS433-ULC	**HW Ver.**	2.5	**FW Ver.**	5.0
Item Code	WS433-ULC-01	Wireless Ultrasonic Level Sensor Sensor 433MHz, 6000mm range, type AA 1.5VDC battery, IP67			

1. Functions Change Log

HW Ver.	FW Ver.	Release Date	Functions Change
2.5	5.0	DEC-2019	• Change RF data rate by button

2. Introduction

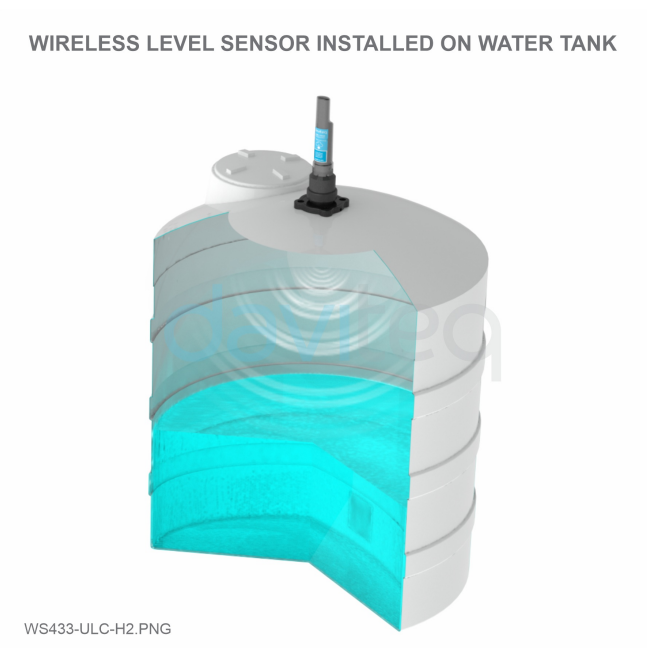
Wireless Ultrasonic Level Sensor is a combination of wireless sensor transmitter WS433-M12F and Ultrasonic level sensor, measure the level of liquid surface of water, oil ... This level sensor utilises the ultrasonic technology to measure the surface of liquid or solid, the principle is to measure the time of flight of the ultrasound pulse in the air environment. The wireless portion is Sub-GHz technology from Texas Instruments allows long range transmission at ultra-low power consumption. It will connect 2-way wirelessly to the wireless co-ordinator WS433-CL to send data and receiving the configuration. It can be configured the operation parameters like data sending interval, health check cycle...remotely from Globiots platform or via ModbusRTU software (thru the WS433-CL). Its default data rate is 50 kbps, can be switched to 625 bps to increase the communication range. It can last up to 10 years with a single AA battery. There are many applications such as monitoring of river water levels, water tanks, etc.

3. Specification

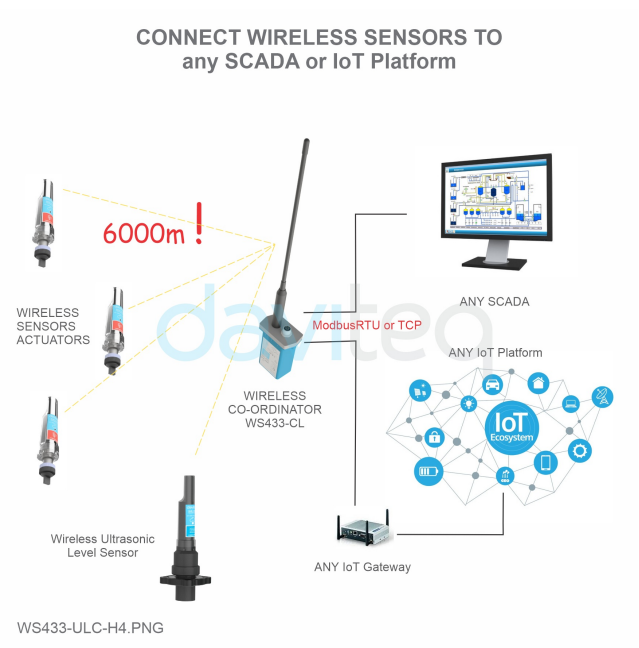
SENSORS SPECIFICATION:	
Sensor	Ultrasonic sensor
Measurement range	280 .. 7500 mm
Resolution	±5.0mm
Accuracy	±10 mm + S*0.3% (with S is the measured value)
Sensor sampling rate	configurable from 10s up to 3600s
Alarm setting	setting the alarm threshold for calculated value
WIRELESS TRANSMITTER SPECIFICATION:	
Data speed	Up to 50kbps
Tranmission distance, LOS	1000m
Antenna	Internal Antenna
Battery	01 x AA 1.5-3.6VDC, up to 10-year operation, depends on configuration
Frequency Band	ISM 433Mhz, Sub-GHz technology from Texas Instrument, USA
International Compliance	ETSI EN 300 220, EN 303 204 (Europe) FCC CFR47 Part15 (US), ARIB STD-T108 (Japan)
Vietnam Type Approval Certification	QCVN 73:2013/BTTTT, QCVN 96:2015/BTTTT (DAVITEQ B00122019)

Security Standard	AES-128
Operating temperature of PCB	-15°C..+60°C (with AA L91 Energizer)
Housing	Poly-carbonate, IP67
Product dimensions & weight	160x30x30mm, < 250g (without battery)
Box dimension & gross weight	190x50x50mm, < 300g

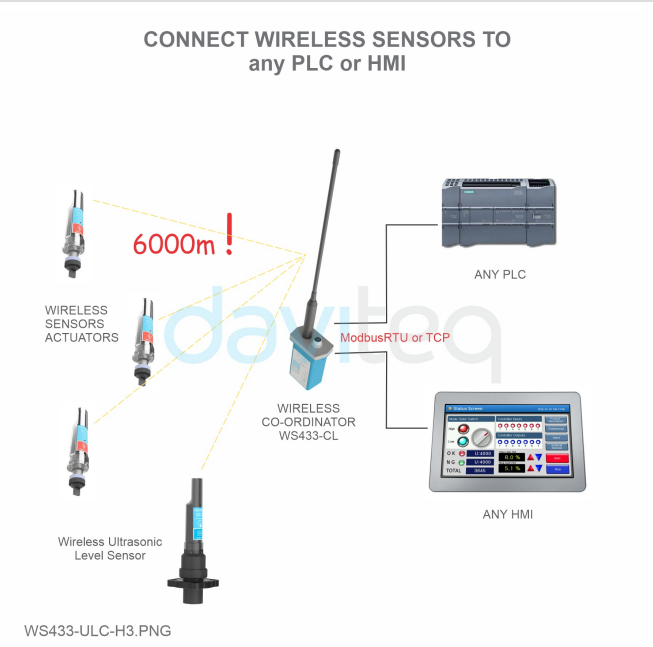
4. Typical Applications



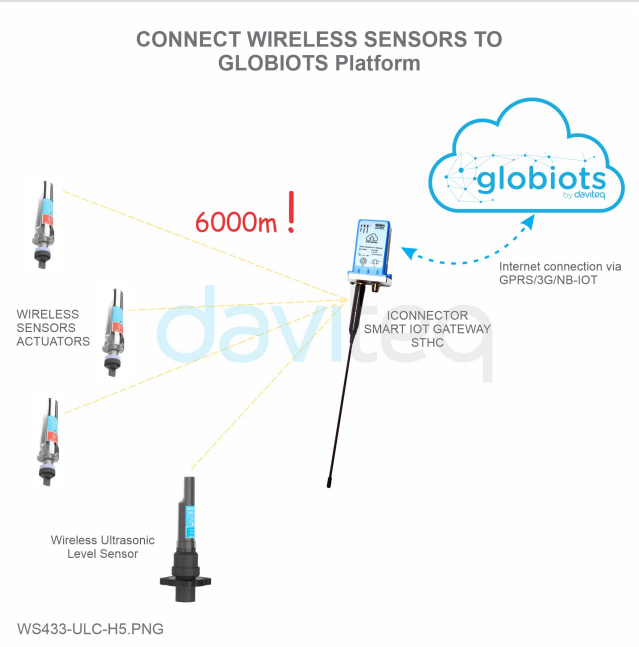
WS433-ULC-H2.PNG



WS433-ULC-H4.PNG



WS433-ULC-H3.PNG



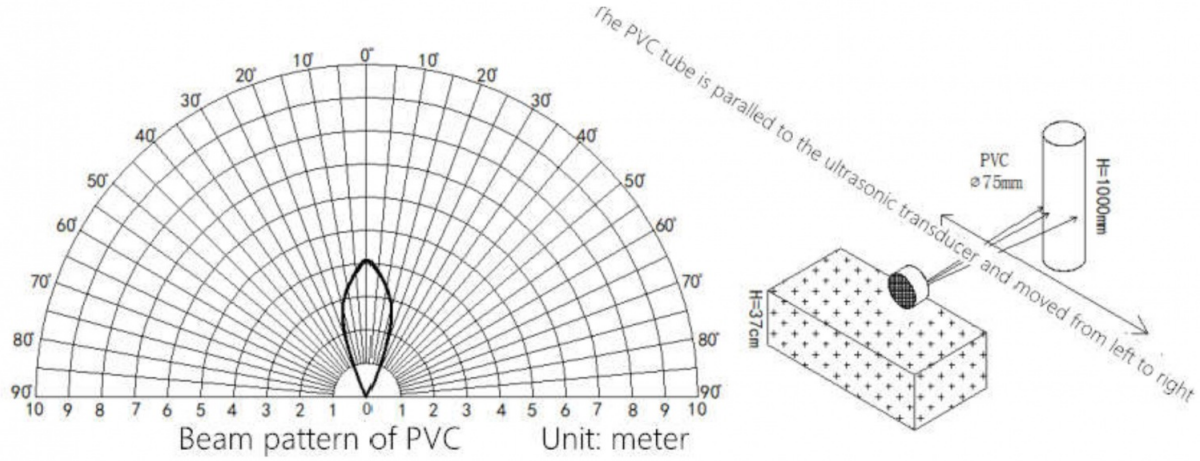
WS433-ULC-H5.PNG

5. Operation Principle

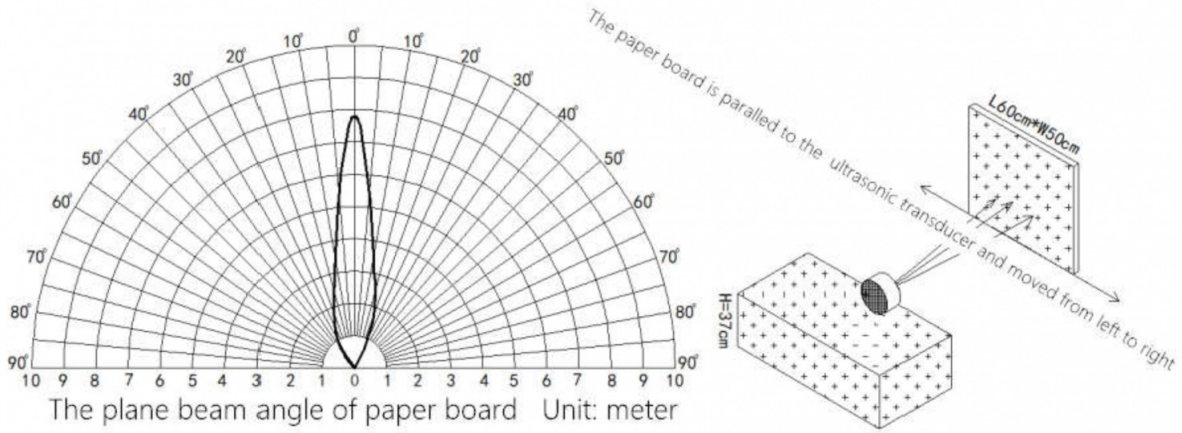
5.1 The Effective Detection Range

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:



5.2 Process of measurement

5.2.1 Measurement principle of Wireless Sensor

> When the sensor sampling time interval is reached, For example**2 minutes**, the 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.

For example: the measurement time is 200mS, after this time, the node will read the value of sensor, node will switch OFF power supply to external sensor to save energy.

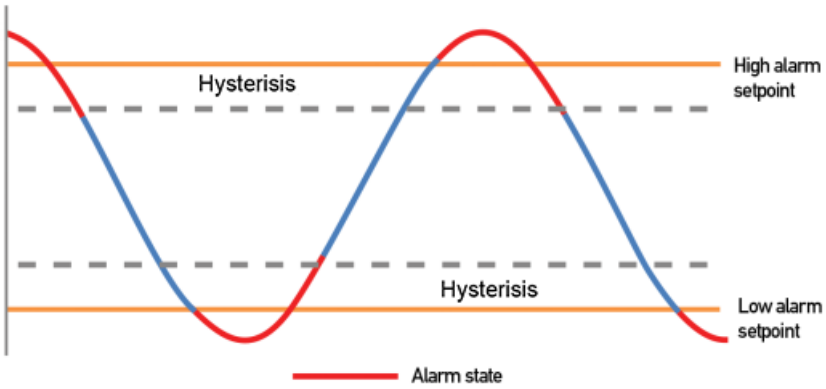
The measured value is the raw value of the sensor. The measured value can be scaled according to the following formula:

$$Y = aX + b$$

- **X:** the raw value from the sensor
- **Y:** the calculated value will be sent to LoRaWAN Gateway 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.



5.2.2 Calibration

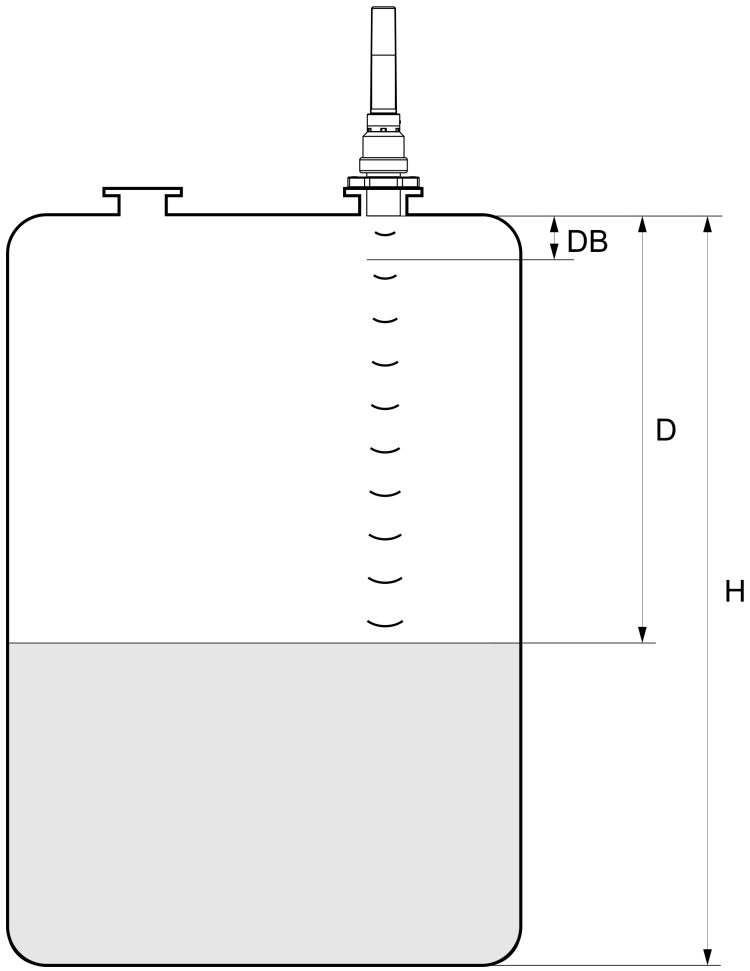


Figure – Ultrasonic Level Transmitter Calibration

- **DB:** Dead band **0..280 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: Water tank with maximum height to be measured **3000mm** (**H**) and Dead band (**DB**) is **280 mm**, then:

$$a = \frac{1000}{\mathrm{DB} - \mathrm{H}} = \frac{1000}{280 - 3000} = -0.3676$$

$$b = \frac{1000.\mathrm{H}}{\mathrm{H} - \mathrm{DB}} = \frac{1000.3000}{3000 - 280} = 1102.9412$$

From here we can look up the water 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 (‰)
280	1000
500	919
1000	735
1500	552
2000	368
2500	184
3000	0

Use the offline configuration tool to configure sigfox sensor. Write in the sensor the parameters **a** and **b**.

> ⚠ **if a1 and b1 in sensor are different from a1=1 and b1=0 then write down a1 and b1 numbers in excel template configuration file**

> ℹ Refer to **Section 5.5** for more details.

Status bytes of sensor Node

- Hi-Byte is error code

Error code	Description
0	No error
1	Just exchange the sensor module but node has not been reset ==> please take out the battery for 20s then install it again to reset node to recognize the new sensor module
2	Error, sensor port M12F shorted to GND
3	Error, sensor port M12F shorted to Vcc
4	Error, sensor port M12F shorted each other

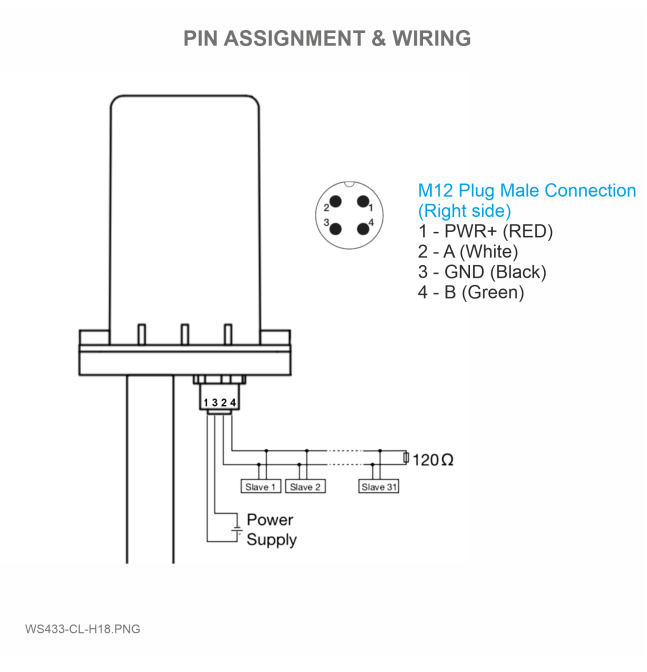
- Lo-Byte is sensor type

Error code	Description
0	No error
1	Just exchange the sensor module but node has not been reset ==> please take out the battery for 20s then install it again to reset node to recognize the new sensor module
2	Error, sensor port M12F shorted to GND
3	Error, sensor port M12F shorted to Vcc
4	Error, sensor port M12F shorted each other

5.3 Add sensors node to Co-ordinator WS433-CL

5.3.1 Add Sensor Node ID automatically

WS433-CL-H12.PNG



WS433-CL-H18.PNG

Step 1: After supplying power the Co-ordinator via M12 connector, the Node ID must be registered within the first 5 minutes, up to 40 WS.

Step 2: Bring the wireless sensor closer to the Co-ordinator's antenna then take off the wireless sensor battery, wait for 5s then insert the battery again. If:

- Buzzer plays **1 peep** sound, LED blink 1 time, that means registering Node ID on Co-ordinator **successfully.**
- Buzzer plays **2 peep** sounds, LED blink 2 times, that this Node ID is **already registered.**

> If you do not hear the "Peep" sound, please disconnect the power the co-ordinator, wait a few minute and try again.

Node id added in this way will be written to the **smallest node_id_n** address which is = **0.**

Set **Rssi_threshold** (see **RF MODE CONFIG** (in the **Modbus Memmap of WS433-CL**), default **-25**): The case if Co-ordinator is on high position and need to add node sensor. We set the sensor as close as possible and set the **Rssi_threshold** to **-80**, **-90** or **-100** to increase the sensitivity to allow WS433-CL-04 can add sensors at a longer distance. After that, perform 2 steps of adding sensors and then reset Rssi_threshold = -25.

Enb_auto_add_sensors configuration (see **RF MODE CONFIG** (in the **Modbus Memmap of WS433-CL**)): In case you do not want to turn off the power WS433-CL, you can set **Enb_auto_add_sensors = 1**, this way we have 5 minutes to add nodes (add up to 40 nodes) . After 5 minutes **Enb_auto_add_sensors** will automatically **= 0.**

> **Memmap resgisters**
>
> You can download Modbus Memmap of WS433-CL with the following link:
>
> **https://filerun.daviteq.com/wl/?id=WBbGm89AToHWyvIyMOc780N1KmjfUr3Y**

5.2.2 Add sensor node into WS433-CL-04 (1) through intermediate WS433-CL-04 (2) and Modbus

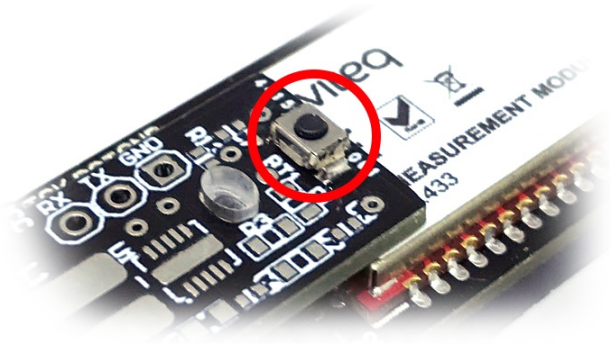
> **In case the sensor need to be added to WS433-CL-04 (1) has been installed in a high position, the sensor cannot be brought close to WS433-CL-04 (1). For more details:**

http://www.daviteq.com/en/manuals/books/long-range-wireless-co-ordinator-ws433-cl/page/user-guide-for-long-range-wireless-co-ordinator-ws433-cl

5.4 Button Function

Open the cover of sensor then use the push button to set the data transfer speed for the first 30 seconds when the battery is first installed, after 30 seconds the push button function does not work.

- Press and hold the button for 2 seconds => LED blinks once => Release the button to set Data rate RF 50kbps
- Press and hold the button for 5 seconds => LED blinks twice => Release the button to set Data rate RF 625bps
- Press and hold the button for 10 seconds => LED blinks 3 times => Release the button to reset RF parameters (frequency, RF output power, data rate), if held for more than 30 seconds then the button function does not work.



Reset default WS433:

Frequency: 433.92 MHz
RF transmit power: 15 dBm
RF data rate: 50 kbps

5.5 Configuration

5.5.1 Configuration Offline

First, you need to prepare

Computer

RS485
Configuration Cable

Power Adapter 12-24VDC

WS433-CL-H9.PNG

> **Num of Node** will indicate the number of nodes managed by WS433-CL.
> Every time a node is **added**, the Num of Node will **increase** by 1.
> Every time a node is **deleted**, the Num of Node is **reduced** by 1.
> Writing Num of Node = 0 will **delete all** 40 node ids to 0.
> If you want to delete a node id, then write it = 0 with the **Write** function is **16** and the **Read** function is **3**.

Step 1: Connect Antenna, RS485 - configuration cable and power supply co-ordinator

INSTALL ANTENNA

WS433-CL-H10.PNG

CONNECT CO-ORDINATOR TO RS485 - CONFIGURATION CABLE via M12 CONNECTOR

WS433-CL-H12.PNG

SUPPLY POWER 12-24VDC

WS433-CL-H11.PNG

CONNECT RS485 - CONFIGURATION
TO COMPUTER via USB

WS433-CL-H13.PNG

Step 2: Open Modbus tool on PC

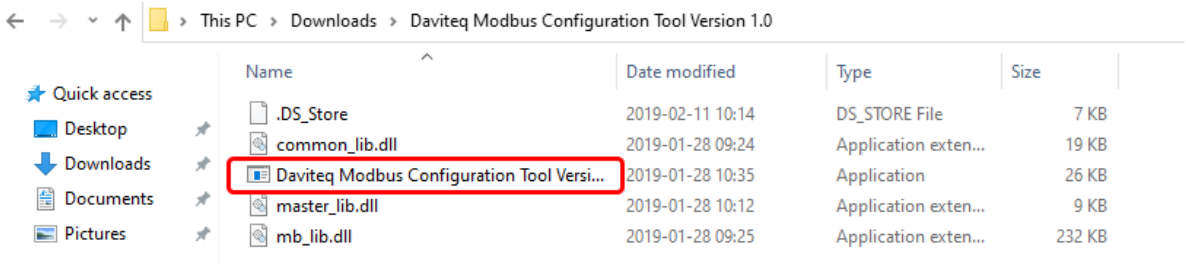
- You can download Daviteq Modbus Configuration Tool with the following link:

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

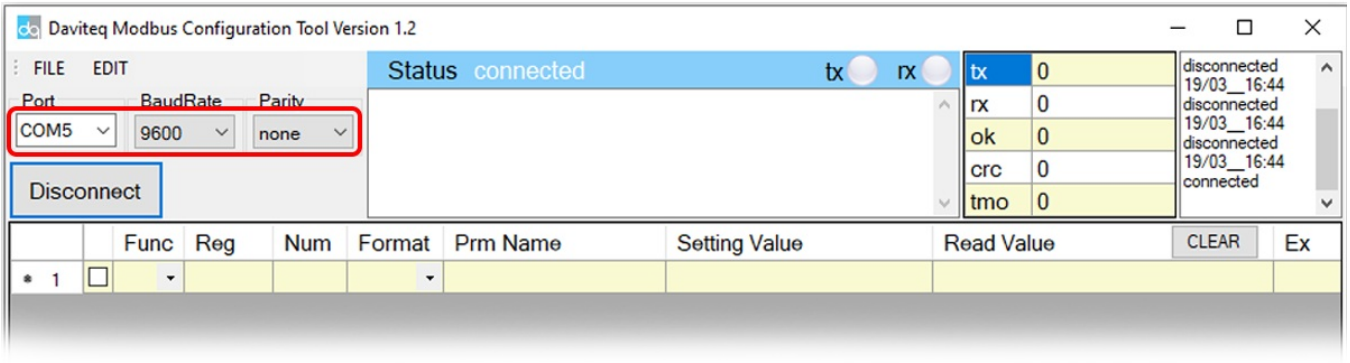
Template File: https://filerun.daviteq.com/wl/?id=hgrjOg3wwvyrvAZ54p8iZiFpDyXTcnec

How to use the Modbus configuration software

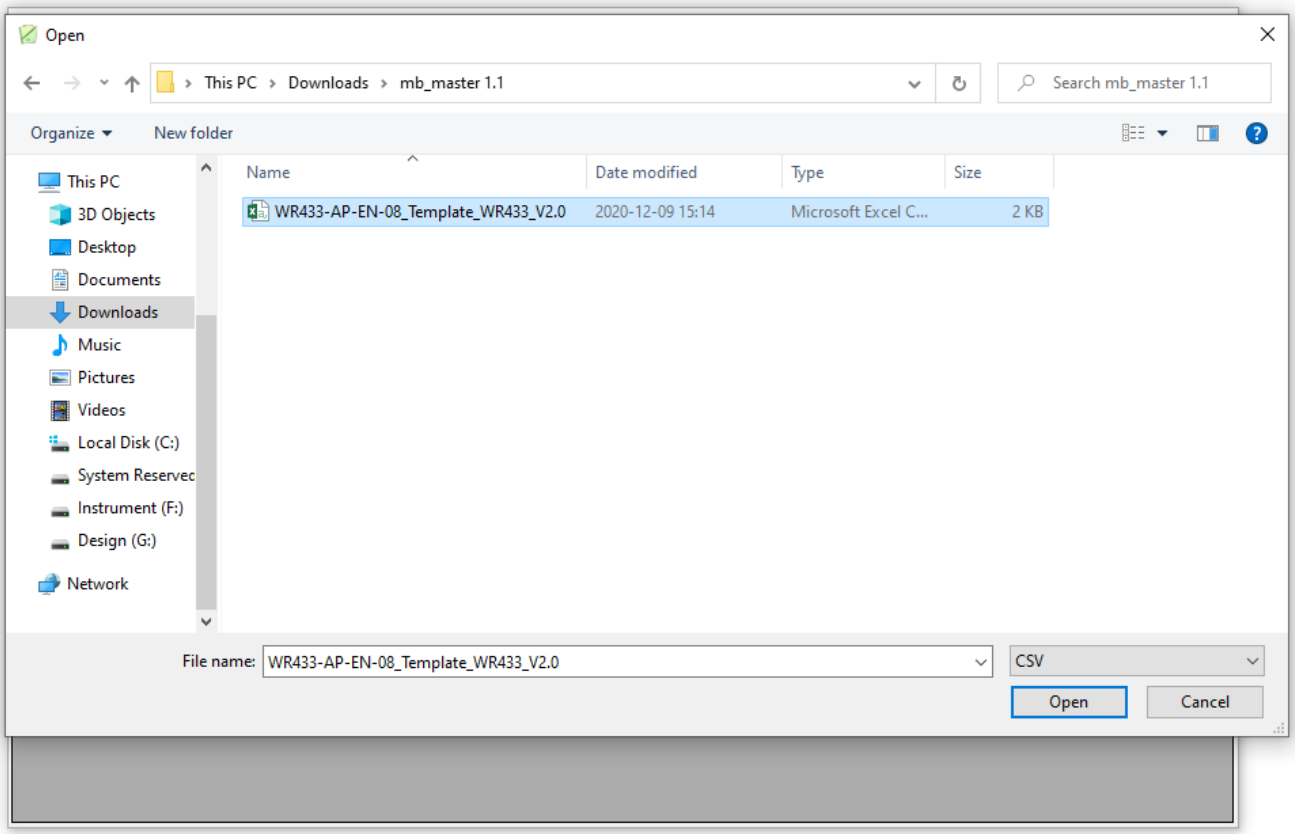
- Unzip file and run file application "Daviteq Modbus Configuration Tool Version"



- Choose **COM Port** (the Port which is USB cable plugged in)
- Set the **BaudRate: 9600**, **Parity: none**



- Click " **Connect** " untill the Status displays "**disconnected**" to "**connected**". It means the WS433-CL-04 is being connected with computer;
- Next, we need to import the configuration file for WS433-CL-04 by importing the csv file: Go to MENU**FILE / Import New / =>** select the **template file**.



Step 3: Configure parameters of the sensor.

Memmap resgisters

You can download Modbus Memmap of WS433-CL with the following link:

https://filerun.daviteq.com/wl/?id=BKEaUzdArkoc0Hc7nfpRShdPVToVrqQZ

In the memmap file, refer to the **Memmap of WS433-ULB & ULC** sheet to configure the sensor's operating parameters accordingly.

The reference memmap addresses are based on the order of the sensors added in the Memmap file above

5.5.2 Typical sensor parameters:

Function Code (Read)	Function Code (Write)	# of register	Byte Size	Description	Value Range	Default	Format	Property	Explanation
4		1	2	%Battery of sensor Node	10,30,60,99		uint16	Read	Battery level, only 04 levels: 10%, 30%, 60% and 99% (full). When 10% ==> Need to replace the battery

4		2	4	Level value of sensor Node (parameter 1)			float	Read	Value from ultrasonic level sensor. This value is parameter 1 of a wireless sensor node
4		2	4	Distance value of sensor Node (parameter 2)			float	Read	Value from ultrasonic level sensor. This value is parameter 2 of a wireless sensor node
3		1	2	Data status of Node	0-9, 99		byte	Read	0-9: Interval updated data 99: Disconnected
3		1	2	RF Signal strength of Node	0-4		byte	Read	From 0 to 4 with 0 is being lost connection RF and 4 is the strongest RF
3	16	1	2	Cycle_wakeup	1-3600(s)	120	uint16	Read/Write	Every time interval of Cycle_wakeup sensor node would ONLY send data to co-ordinator if the new measured value was changed more than the Delta value of the last measured value. Default Cycle_wakeup is 120 seconds **(Recommend : 900 seconds)**
3	16	1	2	Cycle_healths	60-7200(s)	600	uint16	Read/Write	Every time interval of Cycle_healths sensor node will absolutely send data to co-ordinator regardless any condition
3	16	2	4	Radio frequency	433.05-434.79, 433 Mhz	433.92	float	Read/Write	Configure the operating frequency of wireless sensor by Co-ordinator, should be configured from 433.05-434.79 MHz, only for advanced users

6. Installation

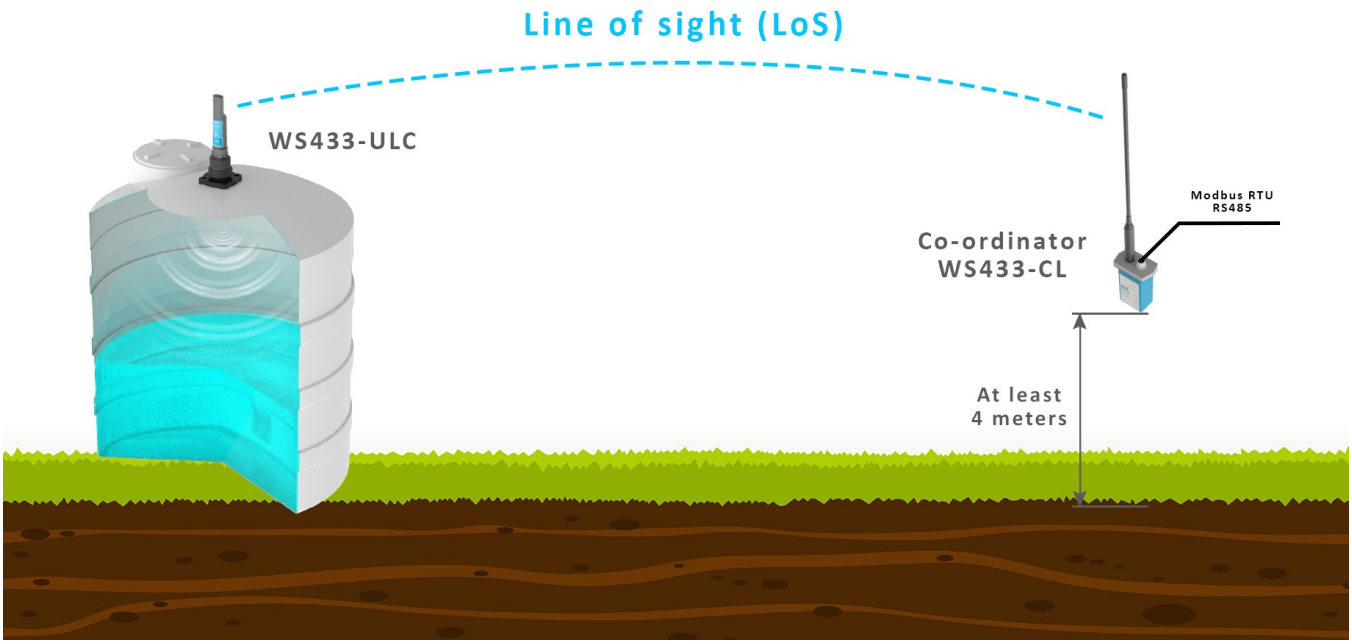
6.1 Installation location

Wireless sensor utilize the ultra-low power 433Mhz RF signal to transmit/receive data with Wireless co-ordinator.

To maximize the distance of transmission, the ideal condition is Line-of-sight (LOS) between the Wireless sensor and Gateway. In real life, there may be no LOS condition. However, the two modules still communicate each other, but the distance will be reduced significantly.

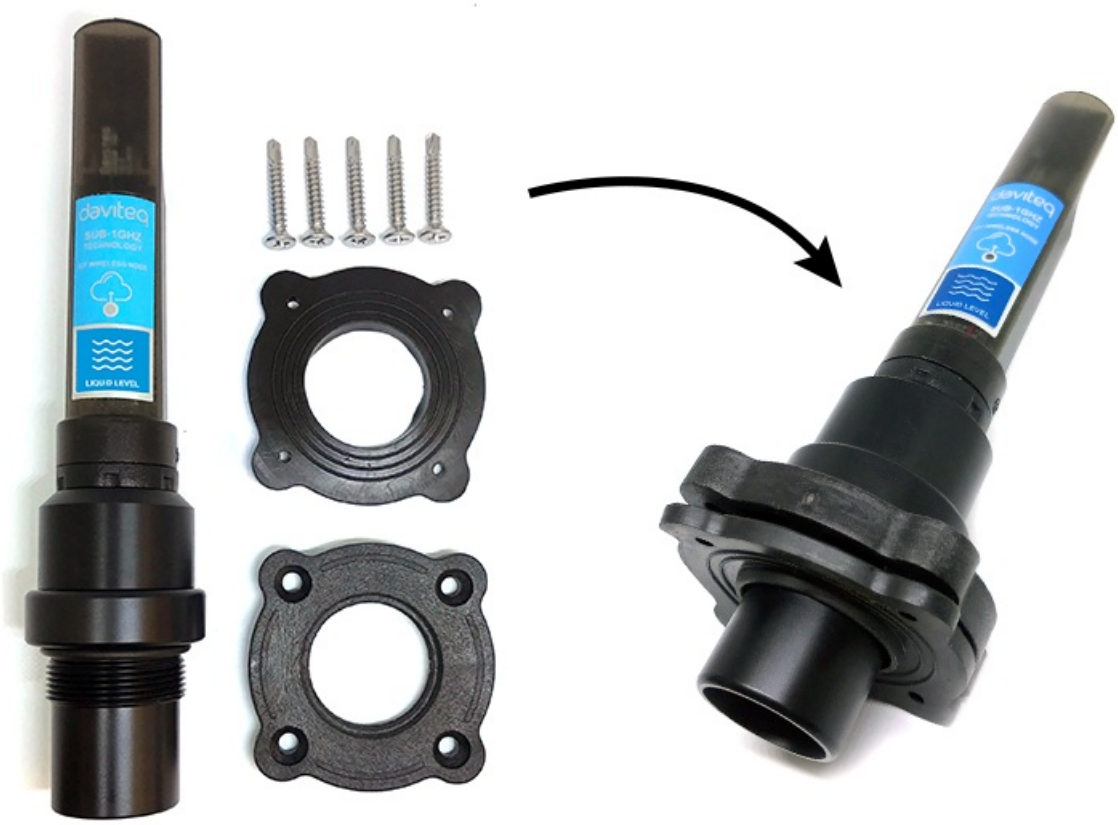
> **ATTENTION:**
>
> **DO NOT** cover the Wireless sensor or its antenna inside a completed metallic box or housing, because the RF signal can not pass through the metallic material.

> **NOTE:**
>
> Integrated WS433-CL / iConnector Coordinator The coordinator must be placed at least**4 meters** above the ground and the WS433-ULC clearly visible.



6.2 Process mounting

> **WARNINGS:**
>
> **1.** Please make sure the fluid is suitable with the wetted materials of the sensor. Please refer sensor specification;
> **2.** Please make sure that the operating ambient temperature is right for the sensor. Please refer to the sensor's specifications;
> **3**. Prepare the professional tools for installation. The inappropriate tools may cause damage to the sensor.



6.3 Battery installation

Steps for battery installation:

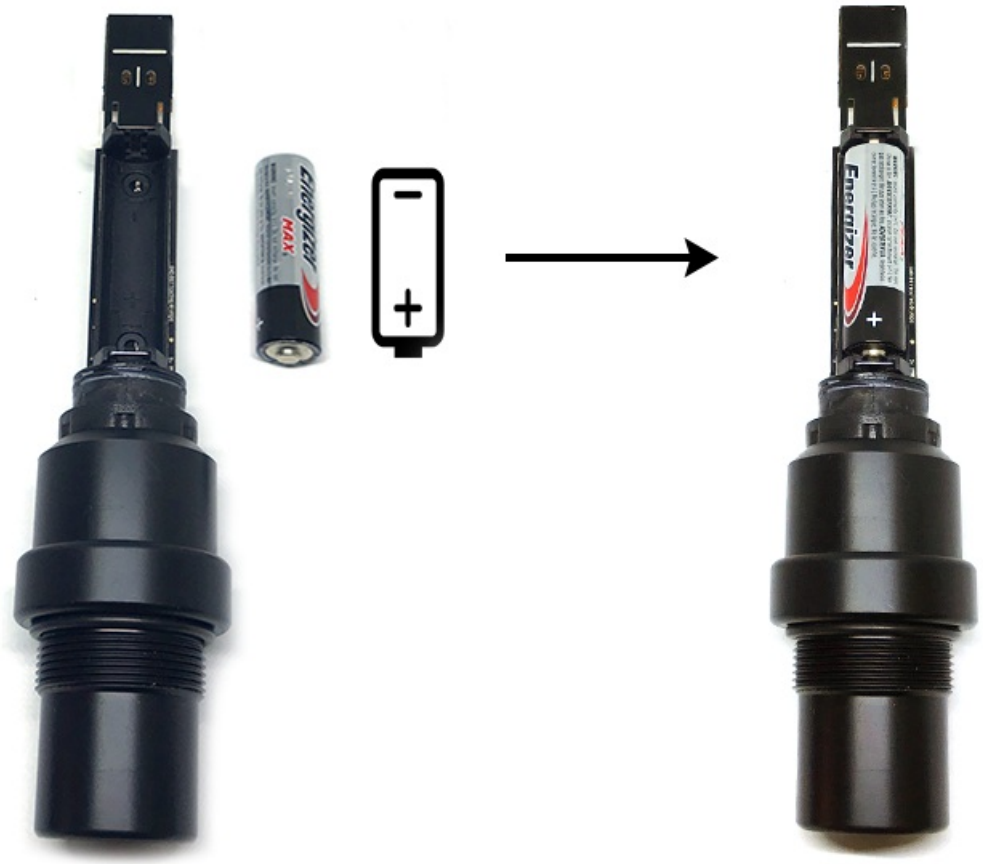
Step 1: Using Philips screw driver to unscrew M2 screw at the side of housing.

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

> **ATTENTION:**

Because of O-ring, it requires to have much pulling force at the beginning, therefore please do it carefully to avoid the damage of circuit board which is very thin (1.00mm);

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



Step 3: Insert the top plastic housing and locking by M2 screw

7. Troubleshooting

No.	Phenomena	Reason	Solutions
1	The status LED of wireless sensor doesn't light up	• No power supply • Configuration function of the LED is not correct	• Check that the battery is empty or not installed correctly • Reconfigure the led light function exactly as instructed
2	Wireless sensor not connected to co-ordinator	• No power supply • The configuration function of the RF data rate is incorrect	• Check that the battery is empty or not installed correctly • Reconfigure the RF data rate with the button according to the instructions

8. Support contacts

Manufacturer

Daviteq Technologies Inc
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