

# USER GUIDE FOR ULTRASONIC LEVEL SENSOR FOR TRASH BIN WS433-ULA

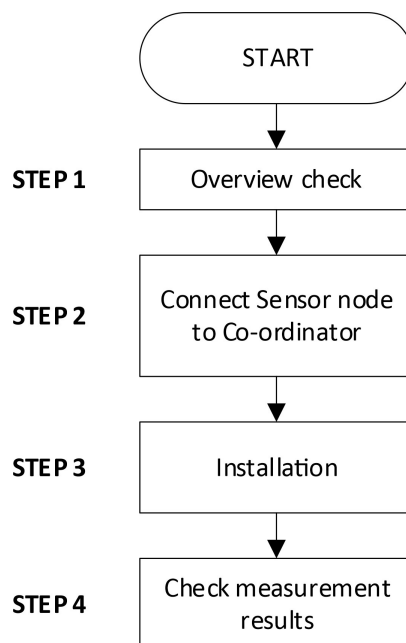
WS433-ULA-MN-EN-01

FEB-2022

*This document is applied for the following products*

|                  |              |  |     |                |      |
|------------------|--------------|--|-----|----------------|------|
| <b>SKU</b>       | WS433-ULA    | <b>HW Ver.</b>   | 2.5 | <b>FW Ver.</b> | 6.01 |
| <b>Item Code</b> | WS433-ULA-01 | Wireless Ultrasonic Level Sensor for Trash bin, Internal antenna, 4500mm range, Type AA battery 1.5VDC, IP67 |     |                |      |

## 0. Configuration Check List



|  |  |
|--|--|
| <b>Step 1: Overview check</b>  |  |
| <ul style="list-style-type: none"><li>• Check cope of delivery</li><li>• Make sure the device shows no signs of damage</li></ul>   | Refer to <a href="#">section 5</a> for details                               |
| <b>Step 2: Connect Sensor node to Co-ordinator</b>   |  |
| <ul style="list-style-type: none"><li>• Make sure that the battery is installed properly</li><li>• Follow every steps Add sensors node to Co-ordinator WS433-CL or with iConnector integrated Co-ordinator</li></ul> | Refer to <a href="#">section 6.4</a> for details                             |
| <b>Step 3: Installation</b>  |  |
| <ul style="list-style-type: none"><li>• Make sure compliance with manufacturer's recommendations</li><li>• Make sure the correct measuring range</li></ul>   | Refer to <a href="#">section 6</a> and <a href="#">section 7</a> for details |
| <b>Step 4: Check measurement results</b>   |  |
| <ul style="list-style-type: none"><li>• Check the reliability of the measurement compared with reality</li></ul>   |  |

# 1. Functions Change Log

| HW Ver. | FW Ver. | Release Date | Functions Change |
|---------|---------|--------------|------------------|
| 2.5     | 6.01    | FEB-2022     |                  |

## 2. Introduction

WS433-ULA is a ultrasonic level sensor to measure solid surface level in trash bin for waste management systems ... This level sensor uses ultrasonic technology to measure the solid surface of waste, the principle is to measure the time of flight of the ultrasound pulse in the air environment. The ultrasound pulse will be ejected from ultrasonic transducer, go thru the air and reach the solid surface of the waste, then reflected back to the ultrasonic transducer, the measuring circuit will measure the flight time of the pulse then calculated distance from the transducer to the surface. The sensor will connect wirelessly to the Wireless Coordinator WS433-CL then export the data to RS485 / modbusRTU and from there easily connect to any monitoring and control system. LOS distance from sensor to receiver is 1000m and can be extended by Extender. Typical applications include: Machine Health Monitoring, Predictive Maintenance Installations, Vibration Monitoring, Impact & Shock Monitoring, Bearing monitoring...

### WIRELESS ULTRASONIC LEVEL SENSOR FOR TRASH BIN WS433-ULA



WS433-ULA-H1.JPG

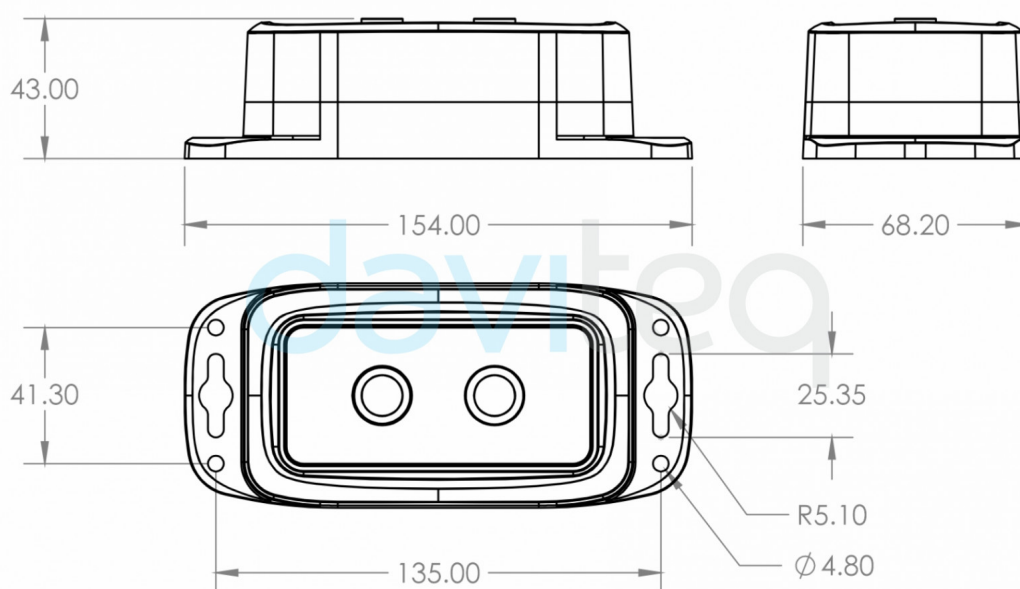
## 3. Specification

| SENSOR SPECIFICATION:      |   |
|----------------------------|---|
| Sensor                     | Ultrasonic sensor   |
| Measurement range          | 30 .. 1500 mm   |
| Resolution & accuracy      | 1.0mm, +/- 10 mm  |
| Sensor sampling rate       | configurable from 10s up to 3600s                                 |
| Alarm setting              | setting the alarm threshold for calculated value                  |
| WIRELESS SPECIFICATION:    |   |
| Data speed                 | Up to 50kbps  |
| Transmission distance, LOS | 1000m, internal Antenna   |
| Battery                    | 02 x AA 1.5VDC, 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        | -40°C..+60°C (with AA L91 Energizer)  |
| Housing                             | Poly-carbonate, IP67  |
| Installation method                 | Integrated with Sensor  |
| Product dimensions & weight         | 150x30x30mm, < 260g (without battery), with sensor                                |
| Box dimension & gross weight        | 190x50x50mm, < 300g   |

## 4. Dimensions

### DIMENSION DRAWINGS OF WIRELESS SENSOR (Unit: mm)



WS433-ULA-H7.JPG

## 5. Scope of delivery

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



## 6. Operation Principle

### 6.1 Process of measurement

**i** 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.

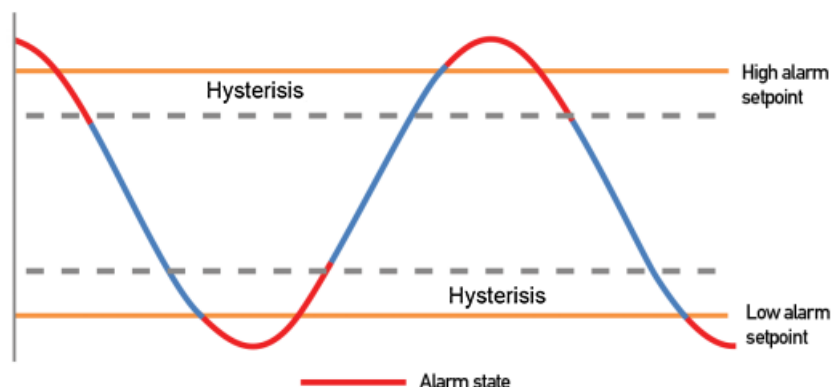
The measured value is the raw value of the sensor. The measured value can be scaled according to the following formula:

$$Y = aX + b$$

- **X:** the raw value from the sensor
- **Y:** the calculated value for parameter 1's value or parameter 2's value
- **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.



#### Status bytes of sensor Node

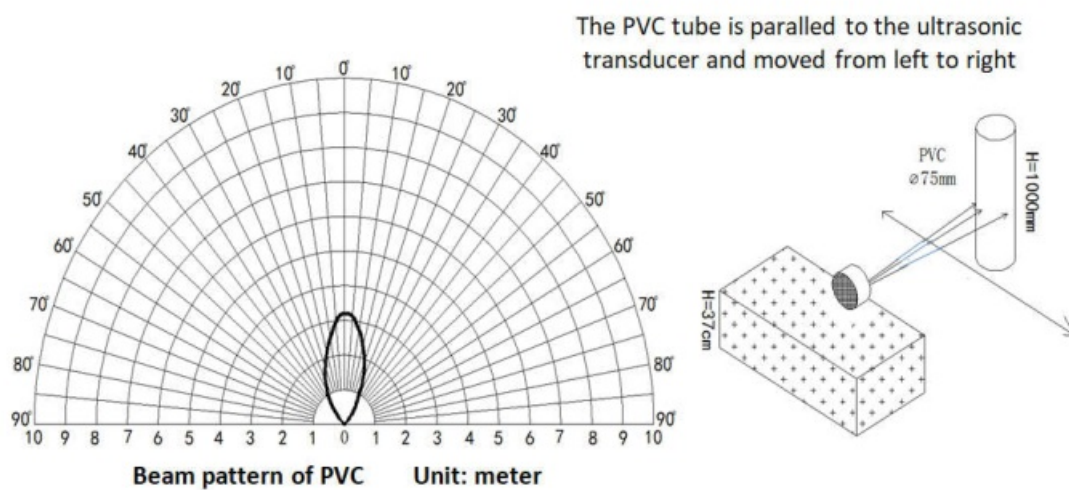
- Hi-Byte is error code

| 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   |

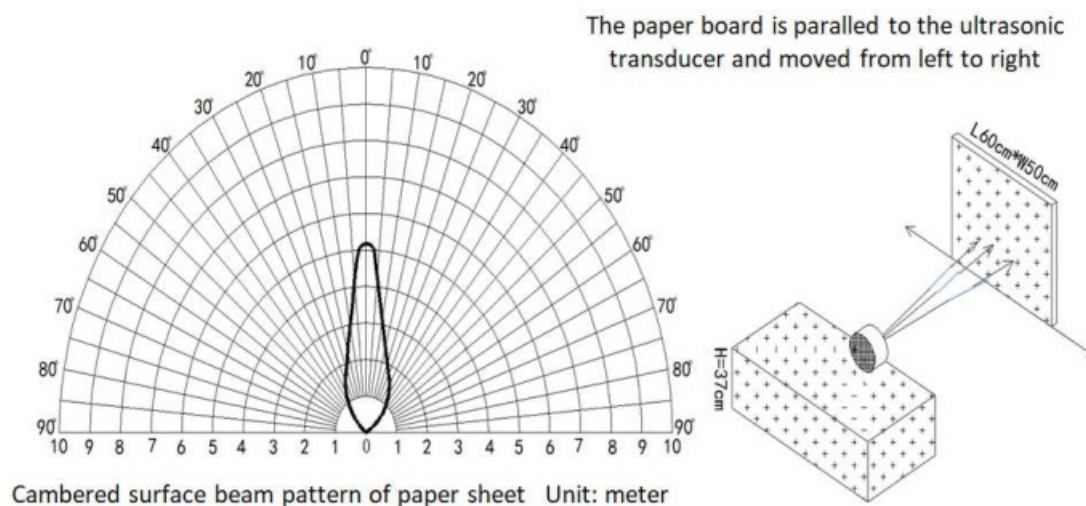
- Lo-Byte is sensor type

| 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   |

## 6.2 The Effective Detection Range



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



## 6.3 Range of measurement

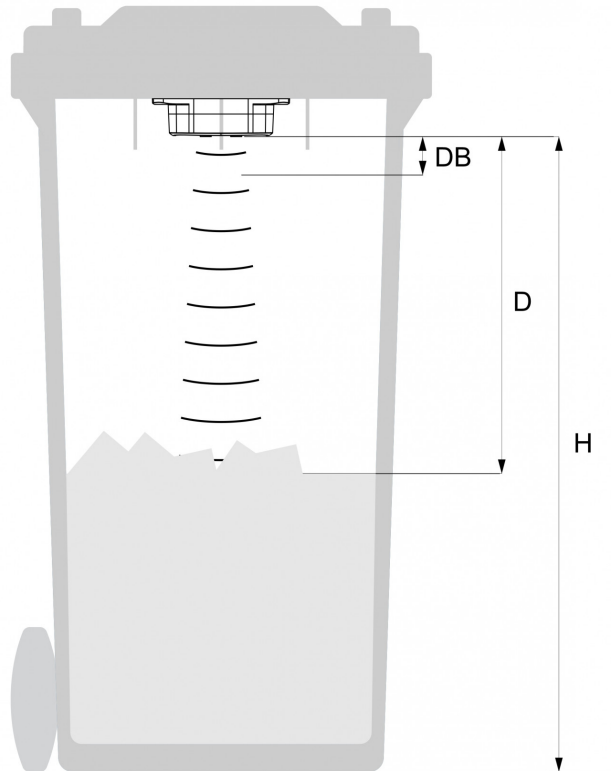


Figure – Ultrasonic Level Transmitter

- **DB:** Dead band **0..30 mm** (This is a short range in front of the ultrasonic sensor can not measure distances)
- **H:** Maximum measuring distance **4500mm** ( with flat object)
- **D:** Distance

## 6.4 Add sensors node to Co-ordinator WS433-CL

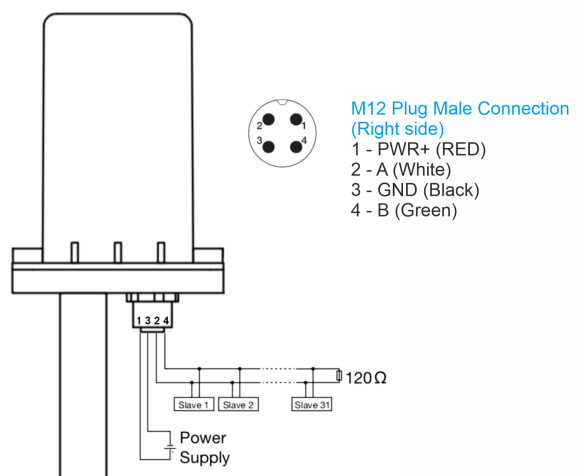
### 6.4.1 Add Sensor Node ID automatically

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



WS433-CL-H12.PNG

PIN ASSIGNMENT & WIRING



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-ordinators **successfully**.
- Buzzer plays **2 peep** sounds, LED blink 2 times, that this Node ID is **already registered**.

**i** 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 registers

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

<https://filerun.daviteq.com/wl/?id=BKEaUzdArkoc0Hc7nfpRShdPVTtoVrqQZ>

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

**i** 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>

## 6.5 Magnet Function

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



Get the magnet close to the magnet mark  on the label . Then

- Buzzer beep **1 time** => Release the magnet to set Data rate **RF50kbps**
- Buzzer beep **2 times** => Release the magnet to set Data rate **RF625bps**
- Buzzer beep **3 times** => Release the magnet to reset RF parameters (frequency, RF output power, data rate), if held for more than 30 seconds then the magnet function does not work.

#### Reset default WS433:

**i** Frequency: 433.92 MHz

## 6.6 Configuration

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.

**i** 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

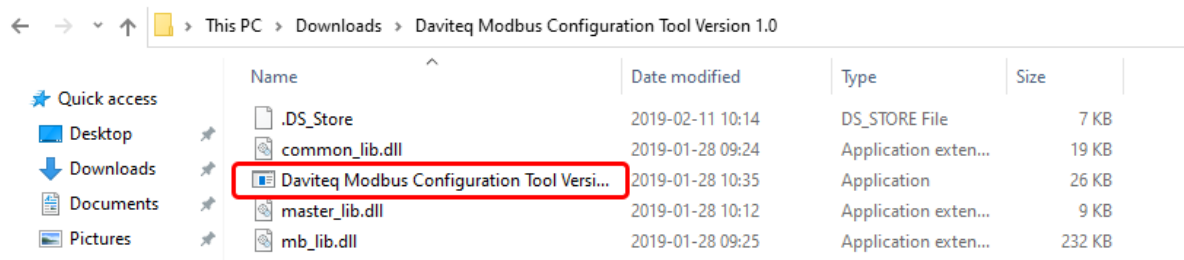
- You can download Daviteq Modbus Configuration Tool with the following link:

<https://filerun.daviteq.com/wl/?id=yDOJE5d6kqFIGNVVIMdFg19Aad6aw0Hs>

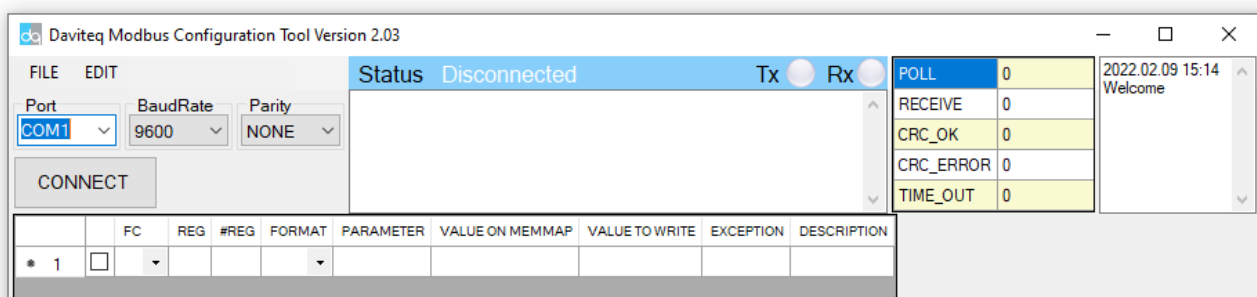
**Template File:** <https://filerun.daviteq.com/wl/?id=BOfpTe7woBFbNULuHqsLhIJI4GmZ33fi>

#### How to use the Modbus configuration software

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

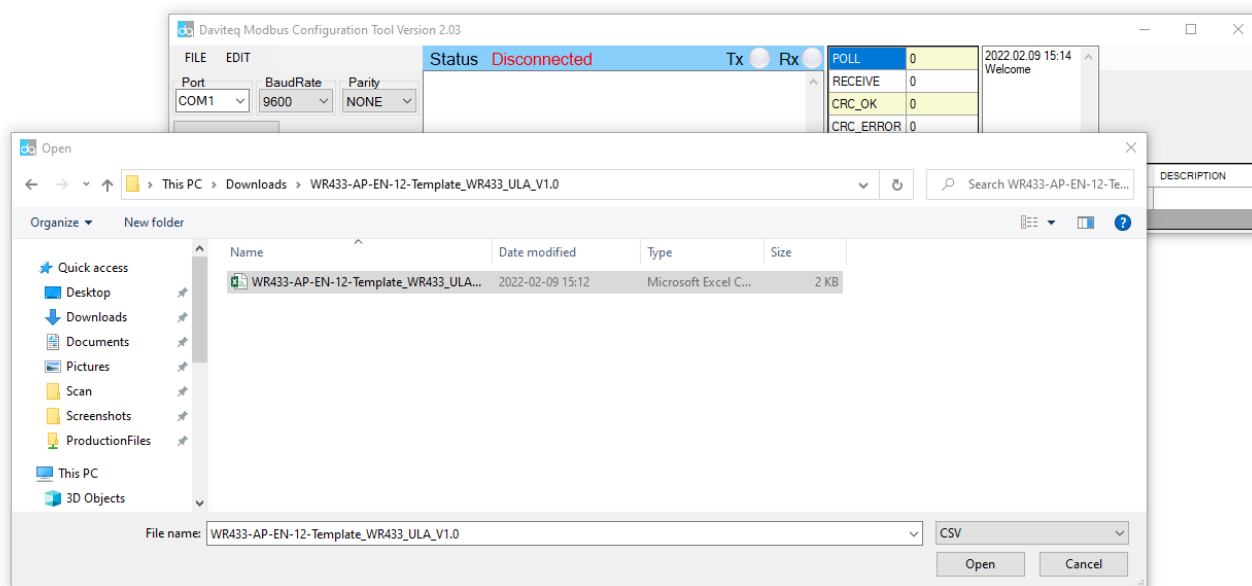


- Choose **COM Port** (the Port which is USB cable plugged in)
- Set the **BaudRate: 9600, Parity: none**



- Click "**Connect**" until 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 **MENUEFILE / Import New / => select the **template file**.**



**Step 3:** Configure parameters of the sensor.

### Memmap registers

- 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-ULA** 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

### 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) | mm          |         | float  | Read     | Value from ultrasonic level sensor. This value is parameter 1 of a wireless sensor node               |
| 4                    |                       | 1             | 2         | Status bytes of sensor Node              |             |         | uint16 | Read     | Hi-Byte is error code, Lo-Byte is sensor type   |

|   |    |   |   |   |            |     |        |              |  |
|---|----|---|---|---|------------|-----|--------|--------------|--|
| 4 |    | 2 | 4 | Distance value of sensor Node (parameter 2) | mm         |     | float  | Read         | Value from ultrasonic level sensor. This value is parameter 2 of a wireless sensor node  |
| 4 |    | 1 | 2 | Logic status of parameters                  |            |     | uint16 | Read         | Hi-Byte is Logic status of parameter 1, Lo-Byte is Logic status of parameter 2   |
| 3 |    | 1 | 2 | Data status of Node                         | 0-9, 99    |     | byte   | Read         | 0-9: Interval updated data<br>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 |
| 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 | Co-ordinator id                             |            | 0   | uint32 | Read / Write | Configure the ID number of Co-ordinator that wireless sensor want to connect to the Co-ordinator when only adding the sensor manually  |

|   |    |   |   |                 |                        |        |        |              |   |
|---|----|---|---|-----------------|------------------------|--------|--------|--------------|---|
| 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                                  |
| 3 | 16 | 1 | 2 | Tx power        | -10,10,15              | 15     | int16  | Read / Write | Configure the RF power of wireless sensor by Co-ordinator, only for advanced users<br>+ 15 <=> tx power = 15dBm<br>+ 10 <=> tx power = 10dBm<br>+ -10 <=> tx power = -10dBm |
| 3 | 16 | 1 | 2 | Data rate RF    | 0-1                    | 0      | uint16 | Read / Write | Configure the air data rate of wireless sensor by Co-ordinator, only for advanced users<br>+ 0 <=> data rate RF at 50kbps<br>+ 1 <=> data rate RF at 625bps                 |
| 3 | 16 | 2 | 4 | a1              |                        | 1      | float  | Read / Write | Scale value of parameter_1 = (a1 * Raw sensor value of parameter_1) + b1. For sensor value scale  |
| 3 | 16 | 2 | 4 | b1              |                        | 0      | float  | Read / Write | Scale value of parameter_1 = (a1 * Raw sensor value of parameter_1) + b1. For sensor value scale  |
| 3 | 16 | 2 | 4 | a2              |                        | 1      | float  | Read / Write | Scale value of parameter_2 = (a2 * Raw sensor value of parameter_2) + b2. For sensor value scale  |

|   |    |   |   |                |   |   |       |              |   |
|---|----|---|---|----------------|---|---|-------|--------------|---|
| 3 | 16 | 2 | 4 | b2             |   | 0 | float | Read / Write | Scale value of parameter_2 = (a2 * Raw sensor value of parameter_2) + b2. For sensor value scale  |
| 3 | 16 | 2 | 4 | Delta_1        |   | 0 | float | Read / Write | Delta value, this is the threshold to allow sending data to co-ordinator when the new value of parameter 1 is changed from the last value a delta value which is higher than the threshold. |
| 3 | 16 | 2 | 4 | High_threshold |    | 0 | float | Read / Write | High threshold value for parameter 1  |
| 3 | 16 | 2 | 4 | Low_threshold  |  | 0 | float | Read / Write | Low threshold value for parameter 1   |
| 3 | 16 | 2 | 4 | High_threshold |  | 0 | float | Read / Write | High threshold value for parameter 2  |
| 3 | 16 | 2 | 4 | Low_threshold  |  | 0 | float | Read / Write | Low threshold value for parameter 2   |
| 3 | 16 | 1 | 2 | Num_of_samp    |  |   | float | Read / Write | Number of sampling times  |

## 7. Installation

### 7.1 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:

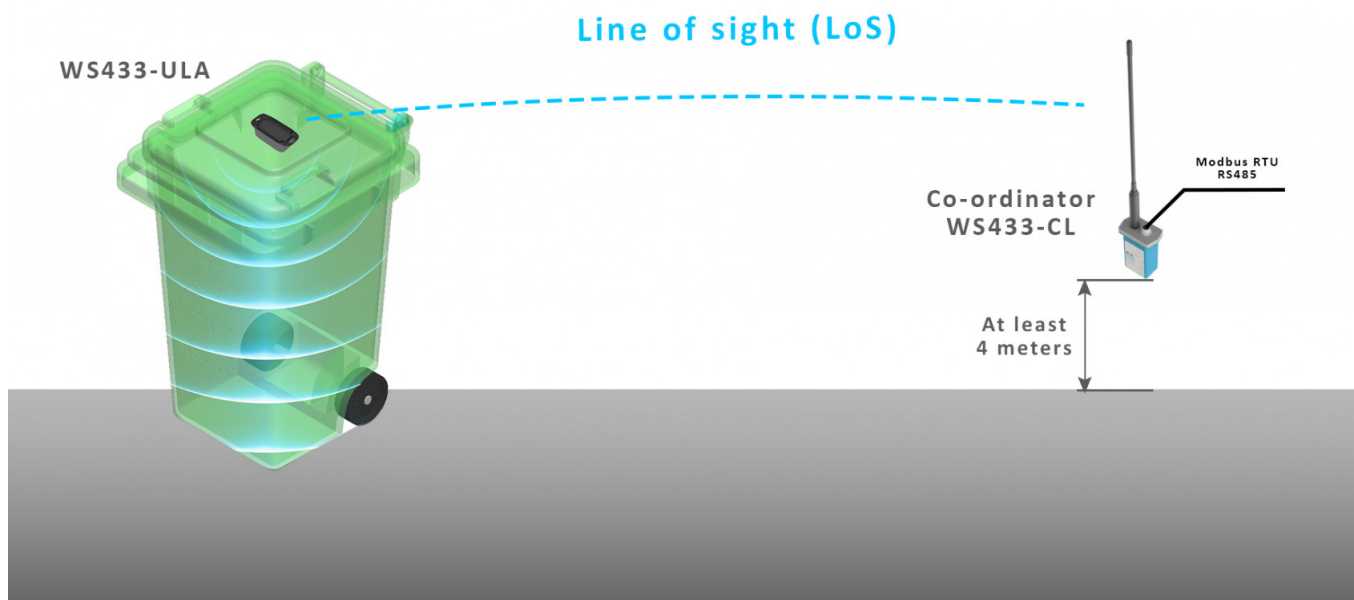


**DO NOT** cover the Wireless sensor or its antenna inside a completed metallic box or housing, because the RF signal can not pass through the metallic material.

#### NOTE:



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



## 7.2 Mounting

### 7.2.1 Installation method

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

#### **WARNING:**

- 1 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 WS433-CL

**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

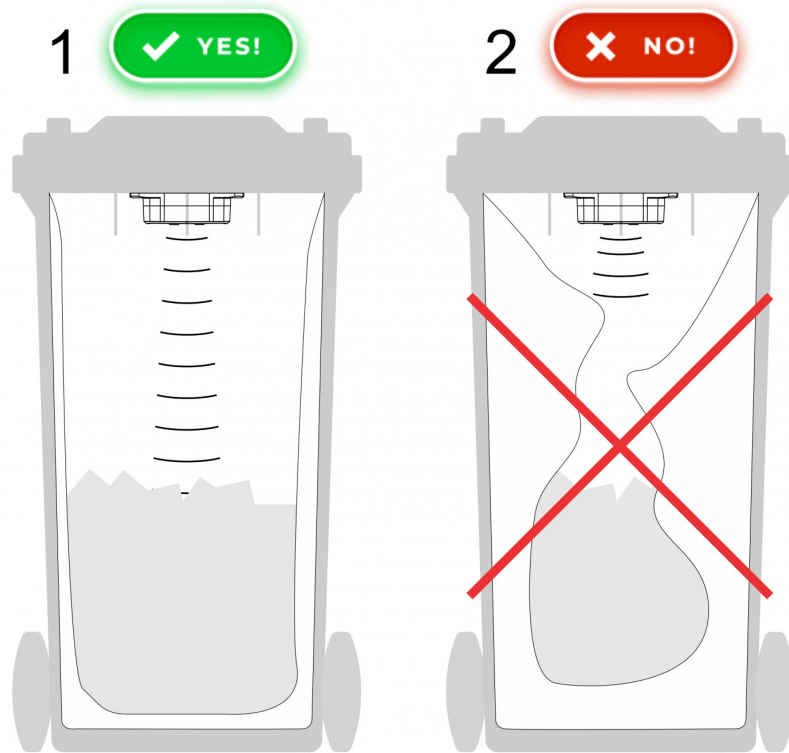




## 7.2.2 Installation conditions

Align the sensor so that it is vertical to the solid surface<sup>(1)</sup>

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



## 7.3 Battery installation

*Steps for battery installation:*

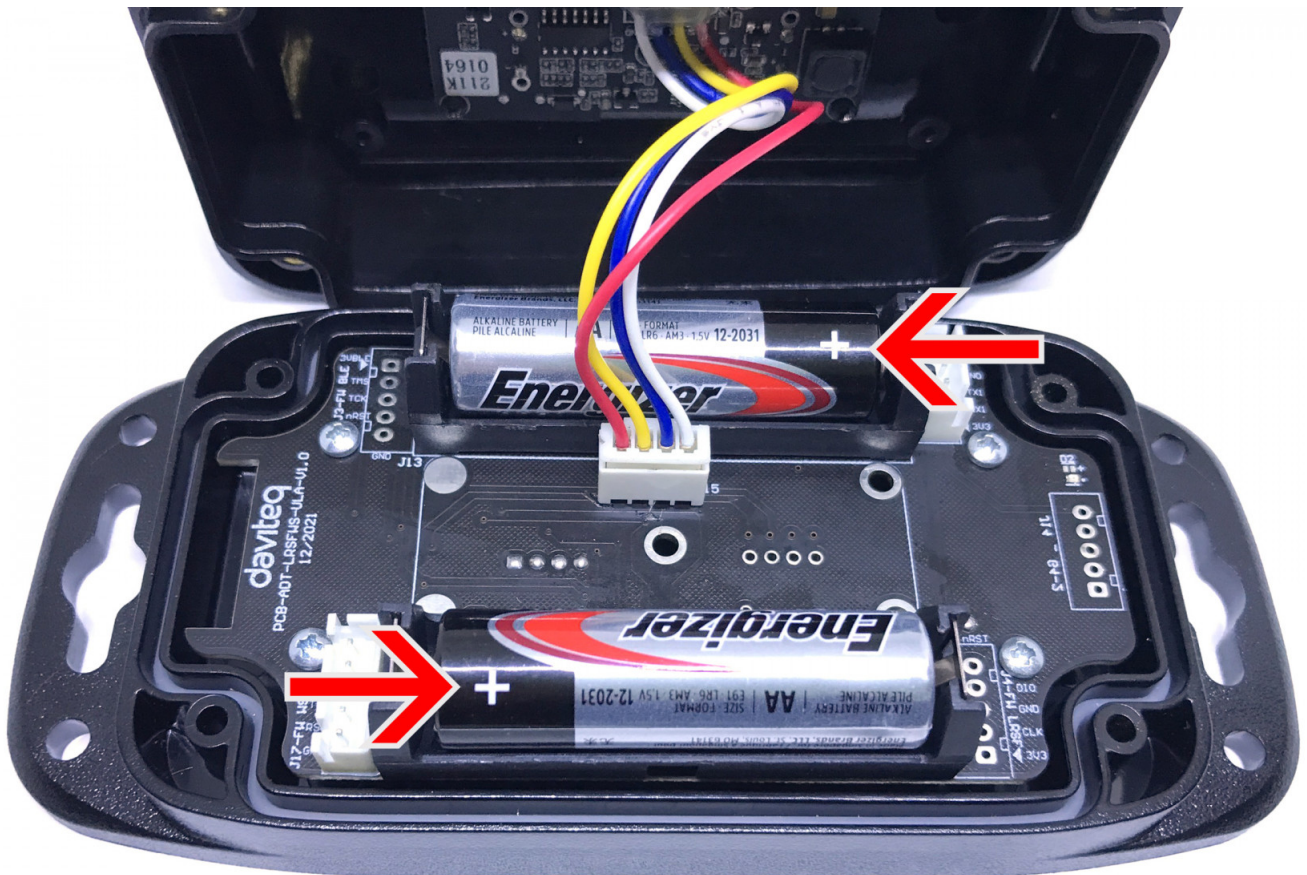
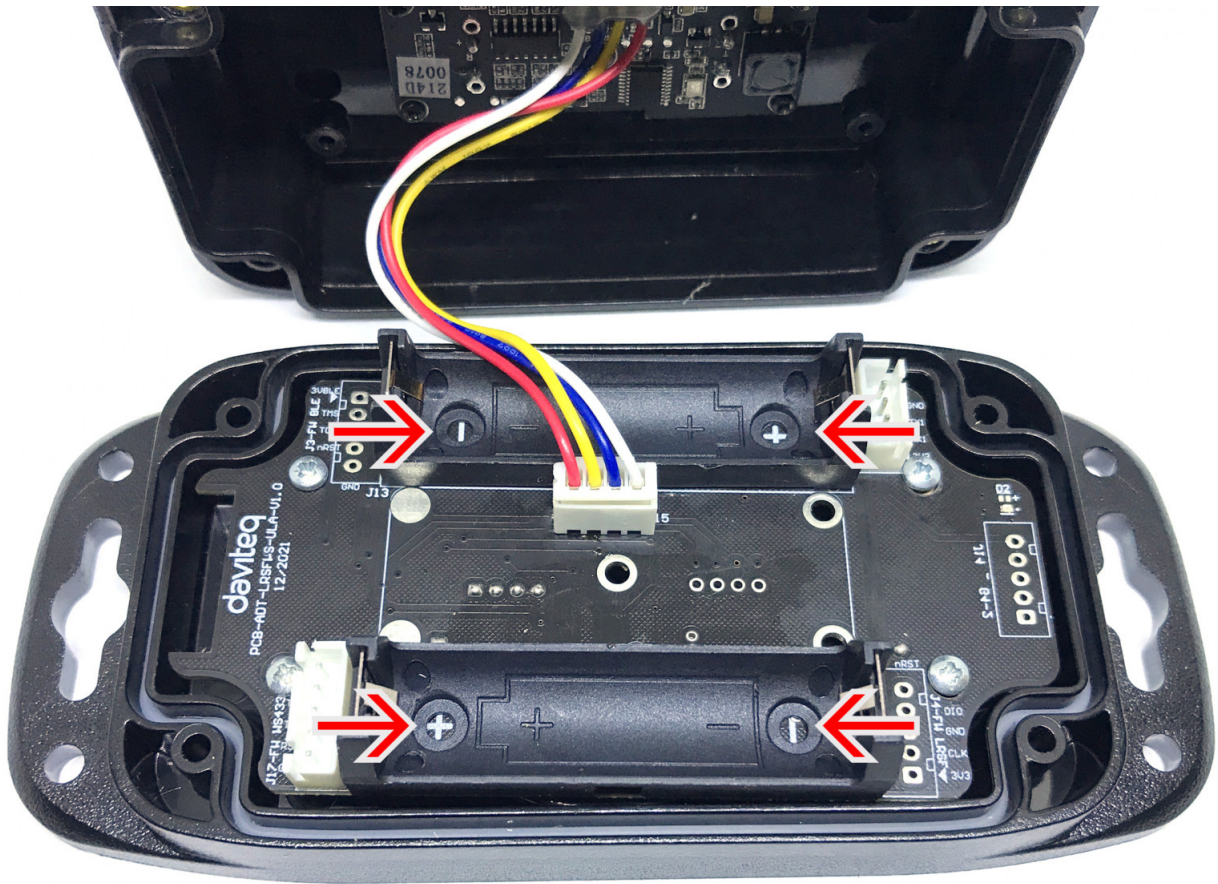
**Step 1:** Using Philips screw driver to unscrew 4 screws under the housing.





**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**



## RECOMMENDED BATTERIES

E91 AA Alkaline battery



-18 .. + 60 oC working temperature

10-year shelf life

3000 mAh Capacity

Price: 1X

WS433-M12F-ATE-H3.PNG

L91 AA Lithium battery



-40 .. + 60 oC working temperature

20-year shelf life

3500 mAh Capacity

Price: 3.5X

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

## 7. Troubleshooting

| No. | Phenomena  | Reason   | Solutions  |
|-----|--|--|--|
| 1   | The status LED of wireless sensor doesn't light up | <ul style="list-style-type: none"> <li>No power supply</li> <li>Configuration function of the LED is not correct</li> </ul>            | <ul style="list-style-type: none"> <li>Check that the battery is empty or not installed correctly</li> <li>Reconfigure the led light function exactly as instructed</li> </ul>                   |
| 2   | Wireless sensor not connected to co-ordinator      | <ul style="list-style-type: none"> <li>No power supply</li> <li>The configuration function of the RF data rate is incorrect</li> </ul> | <ul style="list-style-type: none"> <li>Check that the battery is empty or not installed correctly</li> <li>Reconfigure the RF data rate with the button according to the instructions</li> </ul> |

## 8. Support contacts

Manufacturer

**daviteq**

**Daviteq Technologies Inc**

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