USER GUIDE FOR WIRELESS CO2 SENSOR WITH HUMIDITY & TEMPERATURE WS433-CO2

WS433-CO2-MN-EN-01	JUN-2021

This document is applied for the following products

SKU	WS433-CO2	**HW Ver.**	2.5	**FW Ver.**	5.0
Item Code	WS433-CO2-01	WIRELESS CARBON DIOXIDE GAS SENSOR, 433MHZ, 0-40.000PPM, 2 X AA 1.5 VDC BATTERY, IP67			

1. Functions Change Log

HW Ver.	FW Ver.	Release Date	Functions Change
2.5	5.1	MAY-2021	Innitial FW

2. Introduction

WS433-CO2 sensor utilizes CMOSens® Technology for IR detection enables carbon dioxide measurements of the highest accuracy at a competitive price. Along with the NDIR measurement technology for detecting CO2 comes a best-in-class humidity and temperature sensor integrated on the same sensor module. Ambient humidity and temperature can be measured by special algorithm expertise through modelling and compensating of external heat sources without the need of any additional components. 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. The sensor can last up to 5 years with 2 x AA battery.



3. Specification

SENSOR SPECIFICATION	
CO2 Sensor technology	NDIR sensor
CO2 range/resolution/accuracy	0-40.000 ppm / 1ppm / (+/- 30ppm + 3% reading)
Repeatability	+/- 10ppm
Temperature Stability	+/- 2.5ppm / ℃ in range 0-50 ℃
Temperature range/resolution/accuracy	-40..+70 ℃ / 0.1 ℃ / ± 0.5 °C in range 0-50 ℃
Humidity range/resolution/accuracy	0-100%RH / 0.1%RH /+/- 3.0%RH in range 25-100% RH
Sensor Filter	316SS sintered filter
Sensor housing material / Rating	SS316/SS304 / for Indoor use
WIRELESS SPECIFICATION	
Data speed	Up to 50kbps
Transmission distance, LOS	1000m
Antenna	Internal Antenna
Battery	02 x AA 1.5-3.6VDC, up to 5 years operation, depends on the 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	-40oC..+60oC (with AA L91 Energizer)
Housing/Protection	Aluminum + Polycarbonate / IP67
Dimension	H180xW73xD42
Net weight	<400 grams

4. Operation Principle

4.1 Process of measurement

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.

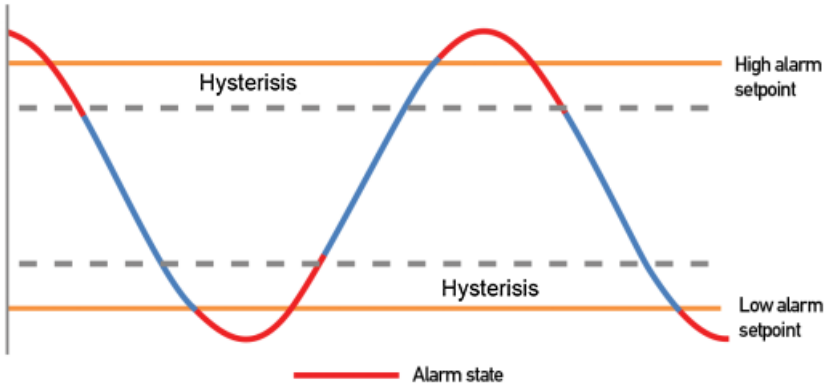
The measured value is the raw value of the sensor. The measured value can be scaled according to the following formula:

$$Y = aX + b$$

- **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.



Please note that the parameters below are for reference only

For example 1: At default **a1=1** and **b1=0**. We need to calibrate the sensor to a CO2 concentration of**50 ppm and 1000 ppm**. When putting the sensor in an environment with a CO2 concentration of**50 ppm and 1000 ppm**, we will have:

The raw **X1** value measured at **50 ppm (Y1 value)** CO2 is **70ppm**, and the value of**X2** value at **1000 ppm (Y2 value)** is **1100 ppm**. Then:

$$Y1 = aX1 + b \rightarrow \quad 50 \quad = a.70 + b$$
$$Y2 = aX2 + b \rightarrow 1000 = a.1100 + b$$

We solve the equation to get **a** and **b**. Then we configure parameters **a1** and **b1** into the sensor.

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

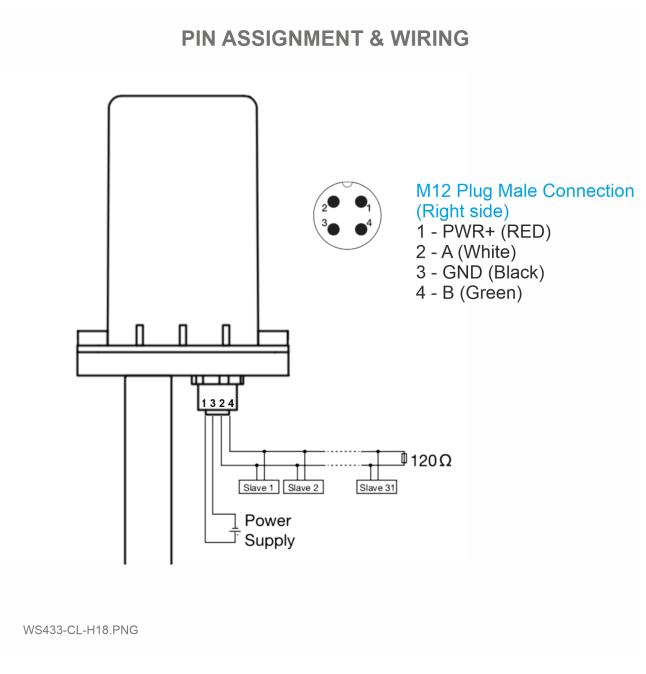
> ⚠ **if a1 and b1 in sensor are different from a1=1 and b1=0 then write down a1 and b1 numbers in excel template configuration file**

> ℹ Refer to **Section 4.4** for more details.

4.2 Add sensors node to Co-ordinator WS433-CL

4.2.1 Add Sensor Node ID automatically





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.**

> 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 resgisters**

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

https://filerun.daviteq.com/wl/?id=WBbGm89AToHWyvIyMOc780N1KmjfUr3Y

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

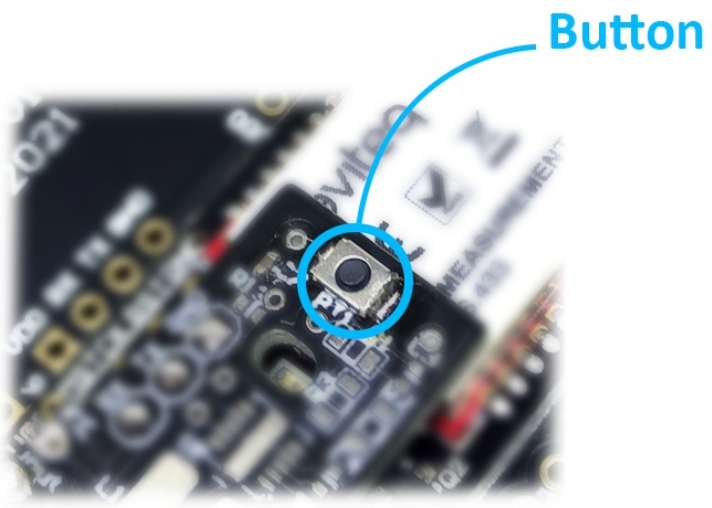
In case the sensor need to be added to WS433-CL-04 (1) has been installed in a high position, the sensor cannot be brought close to WS433-CL-04 (1). For more details:

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

4.3 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

4.4 Configuration

First, you need to prepare



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

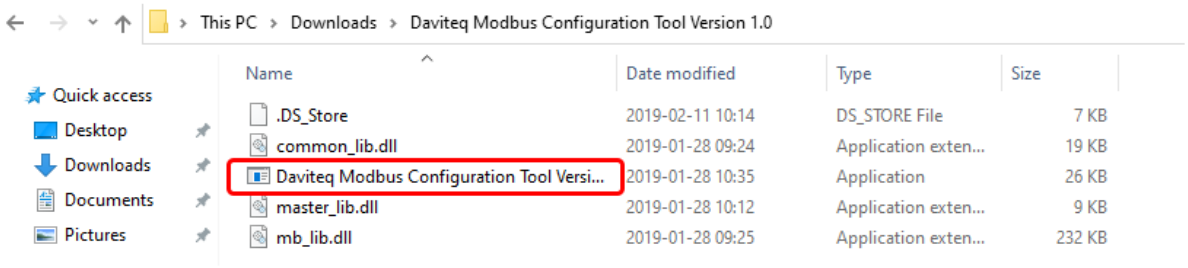
- You can download Daviteq Modbus Configuration Tool with the following link:

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

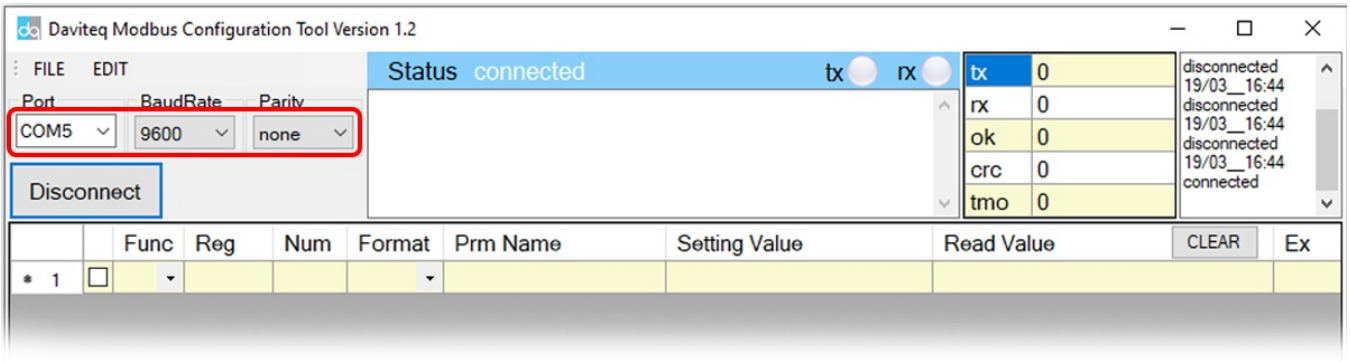
Template File: https://filerun.daviteq.com/wl/?id=ItFaeQgtCmXN98J7GaPdeZvKK5eS1Dd1

How to use the Modbus configuration software

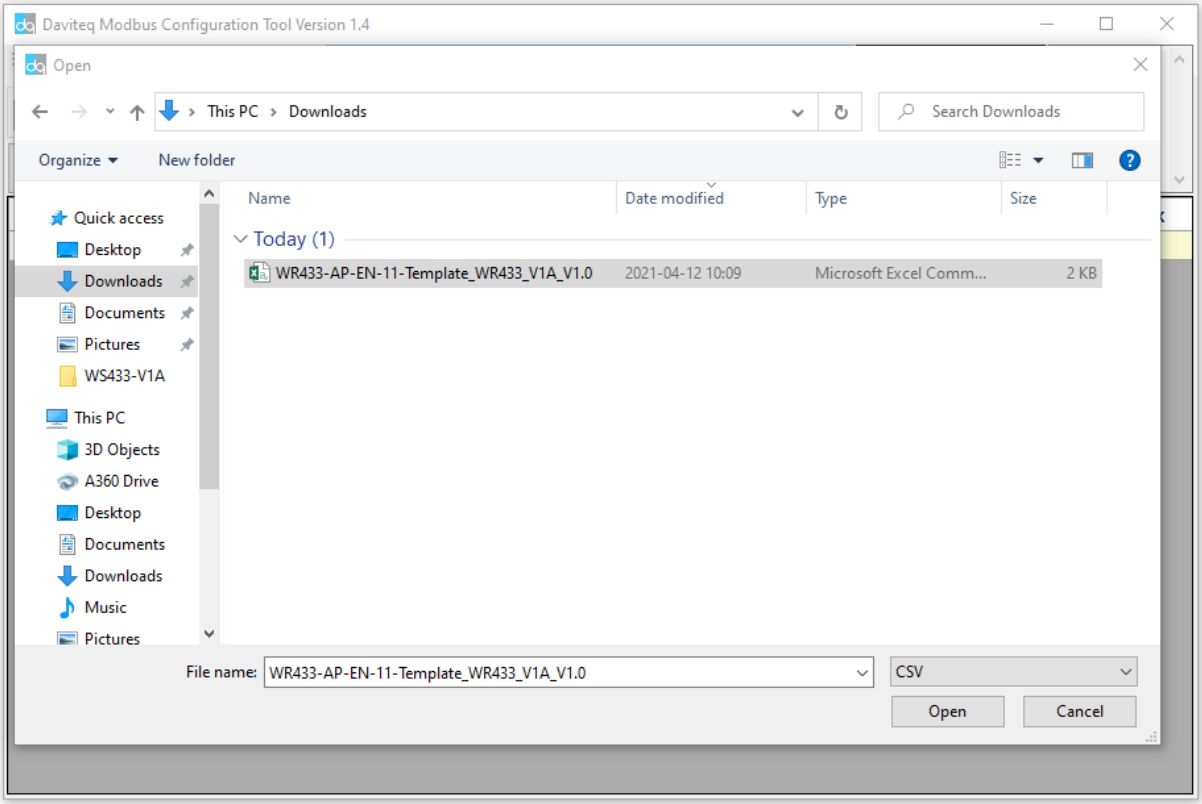
- Unzip file and run file application "Daviteq Modbus Configuration Tool Version"



- 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-CO2** 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	CO2 value of sensor Node	400..40000 ppm		float	Read	CO2 value from Wireless sensor
4		1	2	Status bytes of sensor Node			uint16	Read	Hi-Byte is error code, Lo-Byte is sensor type
4		2	4	Humidity value of sensor Node	0..100%RH		float	Read	Humidity value from Wireless CO2 sensor
4		2	4	Temperature value of sensor Node	-40..+70°C		float	Read	Temperature value of 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)	900	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)	1800	uint16	Read/Write	Every time interval of Cycle_healths sensor node will absolutely send data to co-ordinator regardless any condition **(Recommend : 900 seconds)**
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	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

4.5 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 shorted to GND
3	Error, sensor port shorted to Vcc
4	Error, sensor port 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 shorted to GND
3	Error, sensor port shorted to Vcc
4	Error, sensor port shorted each other

5. Battery Life Estimation

We can estimate the battery life with the following conditions:

> Battery capacity of 2 x 1.5VDC : **3000mAh**
>
> Battery performance: **90%**
>
> Data rate: **50kbps**
>
> Temperature: **25°C**

Cycle_wakeup	**Estimated battery life**
900 second (15 minutes)	2.89 year
600 second (10 minutes)	2 year
300 second (5 minutes)	1 year

6. Installation

6.1 Installation location

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

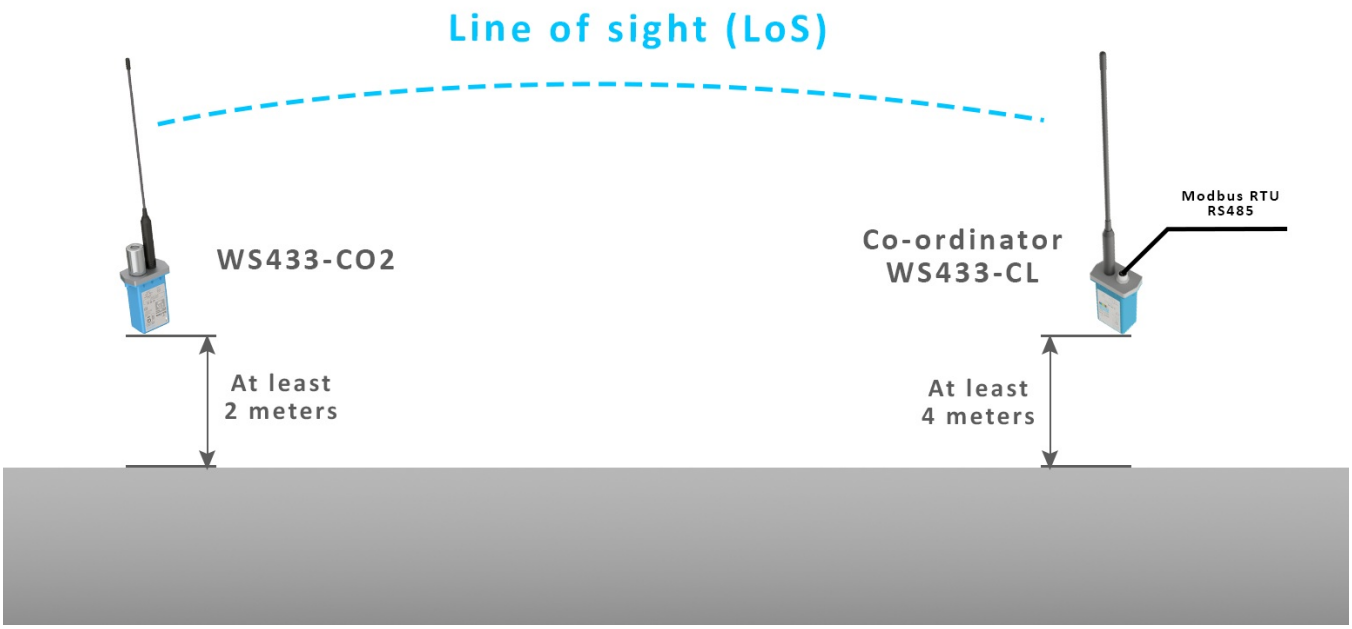
To maximize the distance of transmission, the ideal condition is Line-of-sight (LOS) between the Wireless sensor and Gateway. In real life, there may be no LOS condition. However, the two modules still communicate each other, but the distance will be reduced significantly.

> **ATTENTION:**
>
> ⚠ **DO NOT** cover the Wireless sensor or its antenna inside a completed metallic box or housing, because the RF

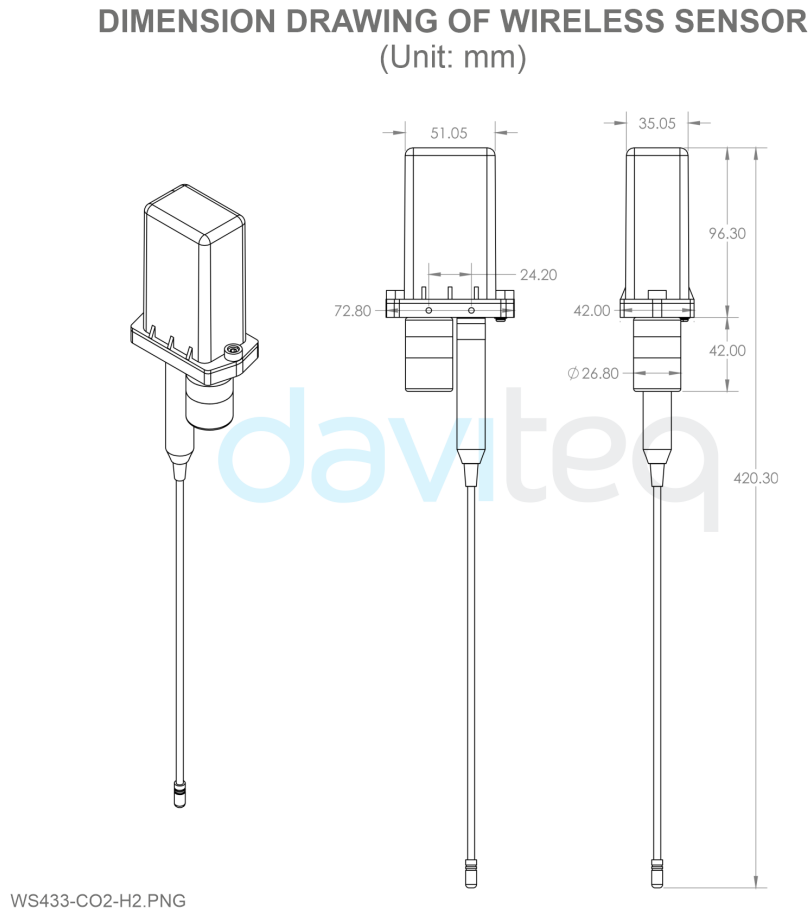
signal can not pass through the metallic material.

NOTE:

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



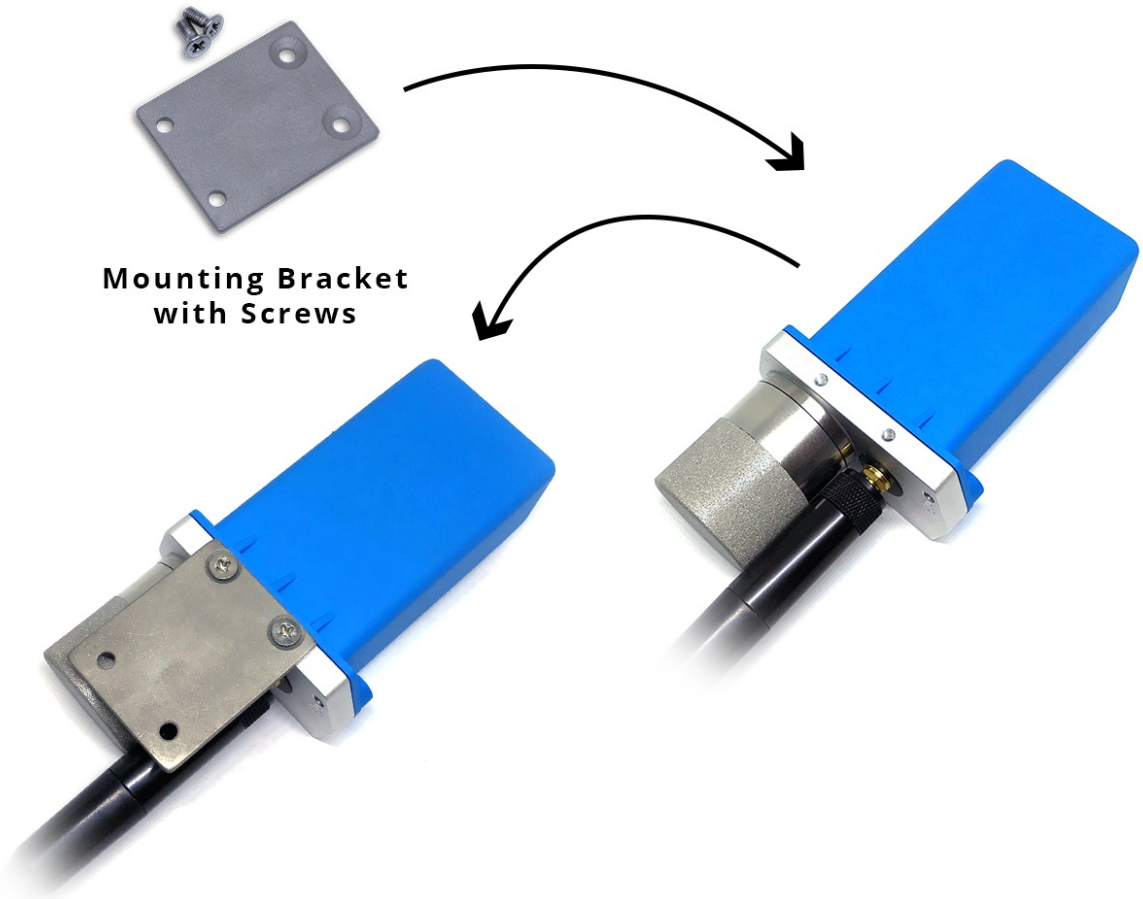
6.2 Dimensions



6.2 Antenna Installation



6.3 Bracket mounting



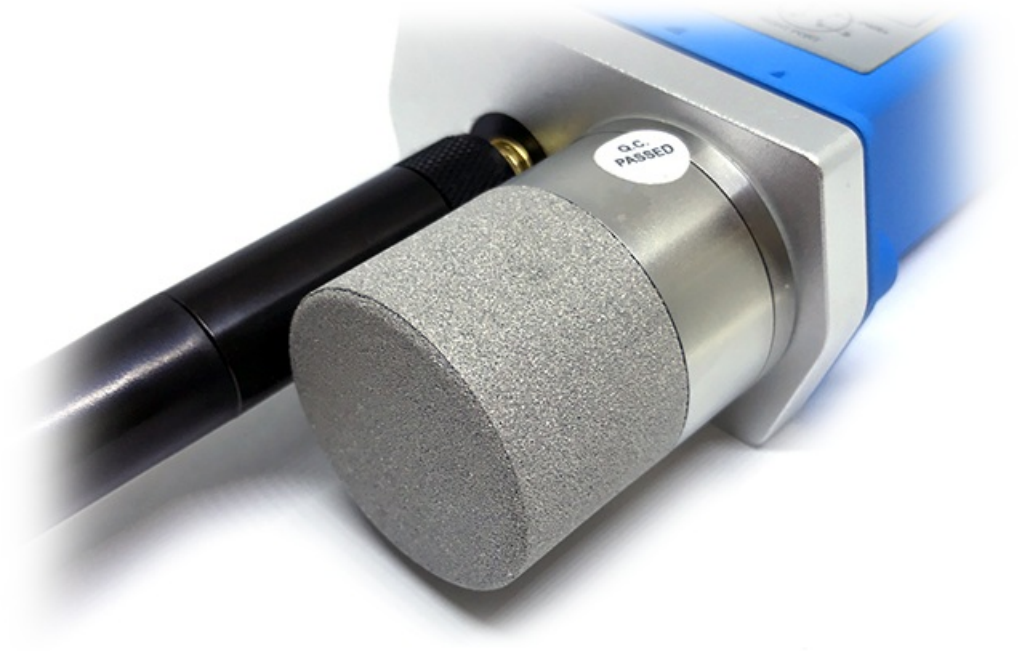
6.4 Filter

> ⚠ **WARNINGS:**

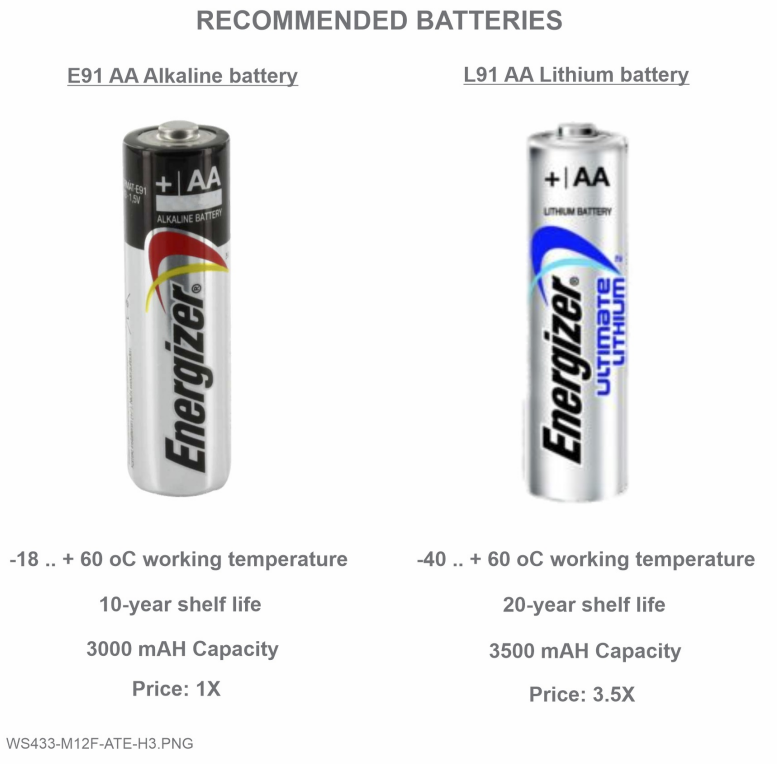
⚠ **Please make sure that the operating ambient temperature is right for the sensor.**

⚠ **Prepare the professional tools for installation. The inappropriate tools may cause damage to the sensor.**

⚠ **Please avoid contaminating the sensor's filter to ensure accurate measurement**



6.4 Battery installation



Steps for battery installation:

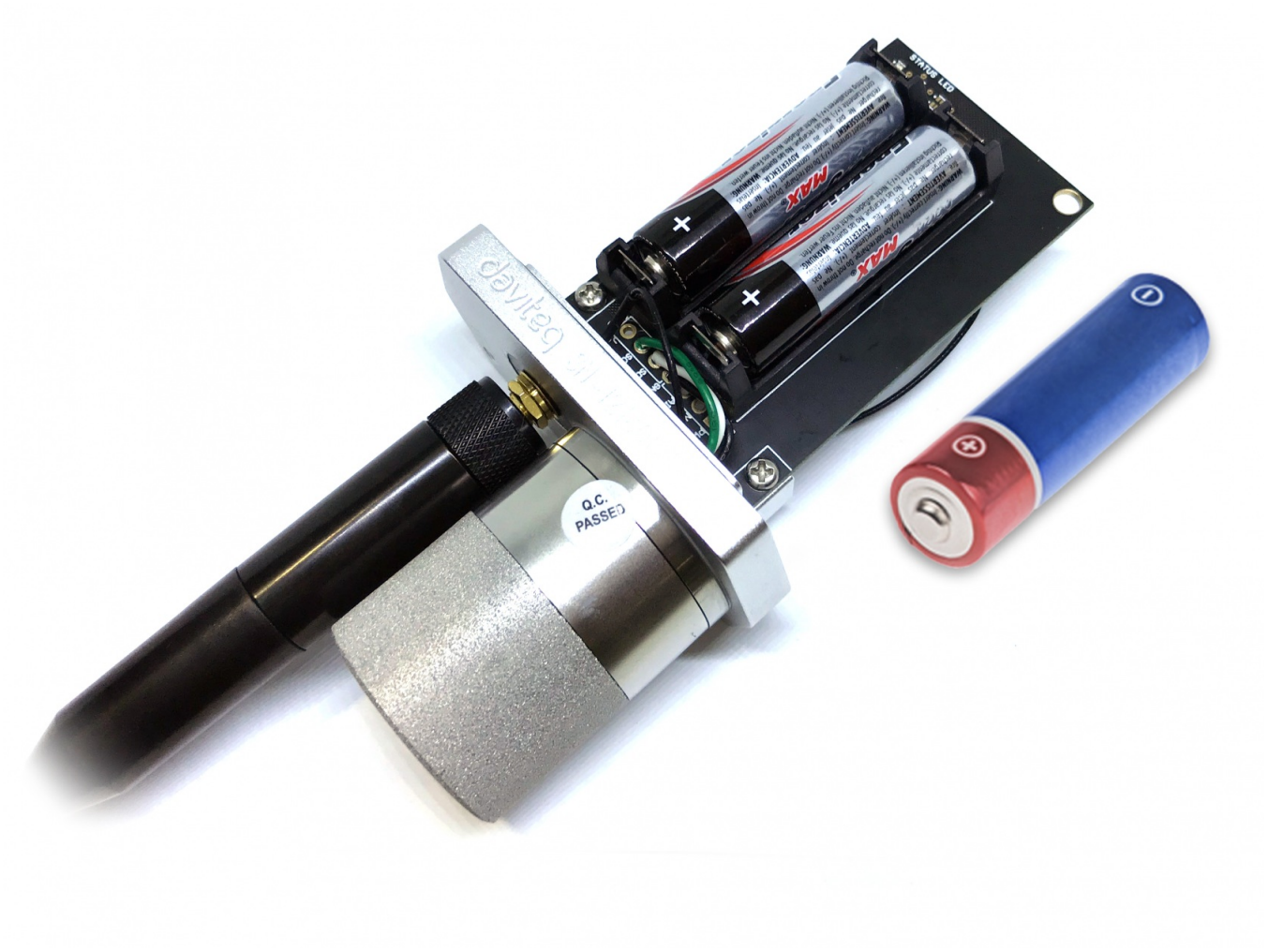
Step 1: Using L hex key to unscrew M4 screws at the side of the housing and carefully pull out the top plastic housing

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)



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

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