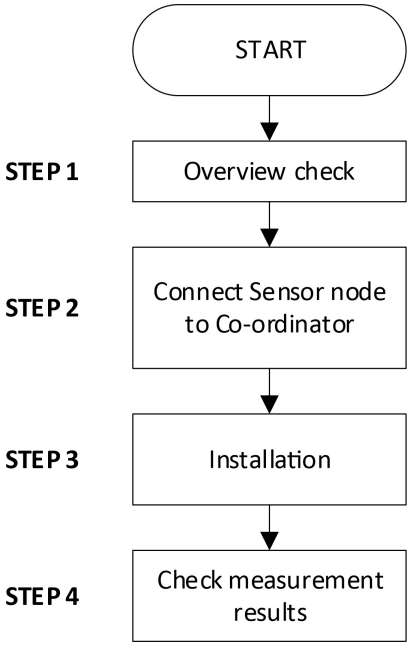
USER GUIDE FOR WIRELESS LIDAR PEOPLE COUNTER WS433-LPC

WS433-LPC-MN-EN-01	FEB-2022

This document is applied for the following products

SKU	WS433-LPC	**HW Ver.**	2.5	**FW Ver.**	6.01
Item Code	WS433-LPC-01	WIRELESS LIDAR PEOPLE COUNTER, 433MHZ, TYPE AA BATTERY 1.5VDC, IP5X			

0. Configuration Check List



Step 1: Overview check	
• Check cope of delivery • Make sure the device shows no signs of damage	Refer to **section 5** for details
Step 2: Connect Sensor node to Co-ordinator	
• Make sure that the battery is installed properly • Follow every steps Add sensors node to Co-ordinator WS433-CL or with iConnector integrated Co-ordinator	Refer to **section 6.3** for details
Step 3: Installation	
• Make sure compliance with manufacturer's recommendations • Make sure the correct measuring range	Refer to **section 6** and **section 7** for details
Step 4: Check measurement results	
• Check the reliability of the measurement compared with reality	

1. Functions Change Log

HW Ver.	FW Ver.	Release Date	Functions Change
1.1	5.00	FEB-2022	

2. Introduction

WS433-LPC is a sensor with built-in advanced Lidar sensor to detect and ranging people. It can count the people walk thru with accuracy higher than 95%. The sensor is not affected by temperature, humidity, RF noise and less affected by ambient light... 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 type AA battery. Typical Applications: People counter for public toilet, People counter for Store, shop, ...



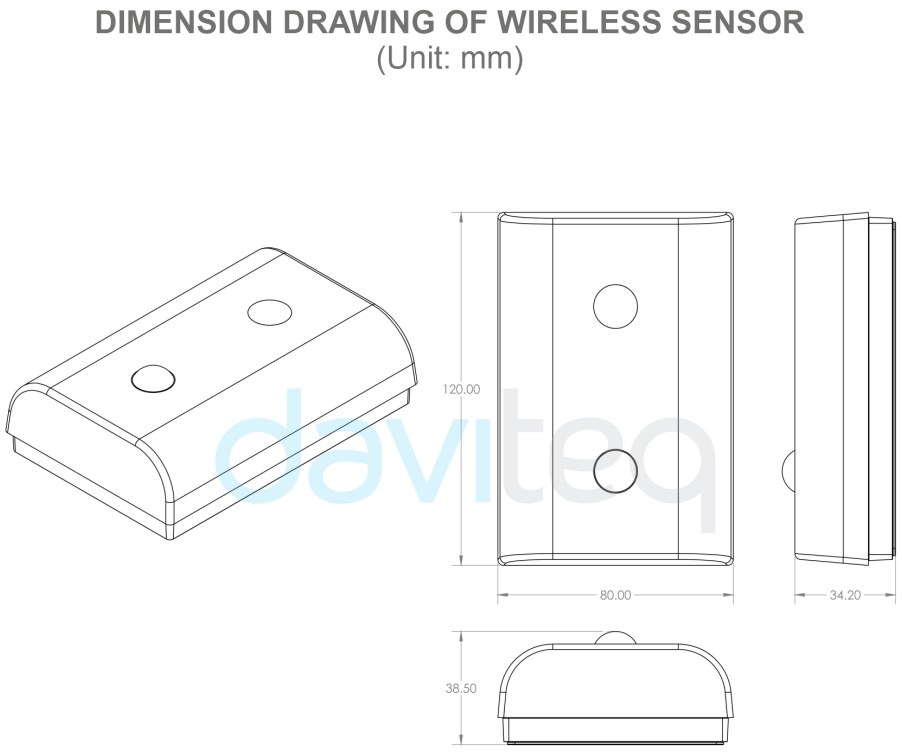
WS433-LPC-H1.PNG

3. Specification

SENSOR SPECIFICATION	
Sensor technology	Lidar
Detection range	max 4m
Detection cone	27 degree
Working temperature	-40 .. + 60 oC
Working humidity	0 .. 100% RH, non-condensing
WIRELESS SPECIFICATION	
Data speed	Up to 50kbps
Transmission distance, LOS	1000m
Antenna	Internal Antenna
Functions	Sending data in interval or when alarms occur
Battery	Battery AA Type 1.5VDC and 7..48VDC (AC adapter not included

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 Lithium Ultimate AA battery)
Housing/Protection	Self-extinguisher ABS, Dust and vapor protection
Mounting	Ceiling mount
Dimension	H120xW80xD45
Net weight	<150 grams

4. Dimensions



WS433-LPC-H6.PNG

5. Scope of delivery

1. Wireless sensor
2. Screws



6. Operation Principle

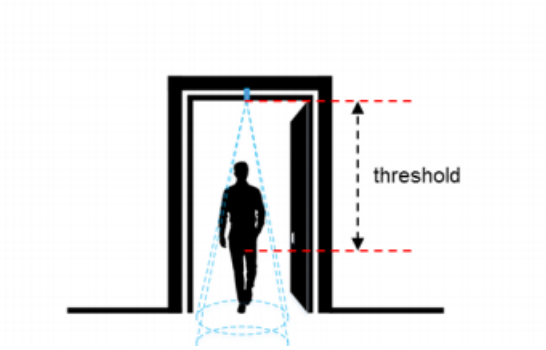
6.1 The principle of counting people

6.1.1 Overview

Counting people with the VL53L1X consists of using the multiple zones of the sensor receiving SPAD area, and of configuring it with two distinct fields of view (FoV), to alternatively get a ranging distance from them and consequently recognize the movements of a person. Using this method, the number of people occupying a meeting room, accessible from a reasonably narrow access, is known at all times by detecting the entrances and exits of the attendees.

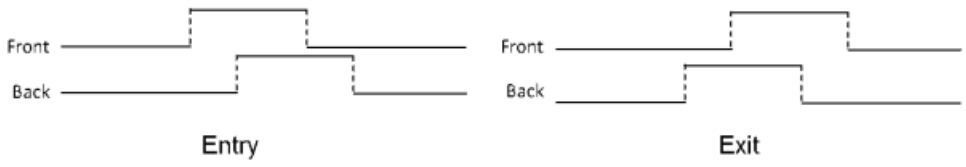
By measuring and analyzing the distances of targets within the FoVs of a front and back zone (see figure below and Figure 3. Front and back zones), a simple algorithm can detect the direction a person crosses the area under the two FoVs. This algorithm "understands" that someone is under one of the FoV as long as the distance measured by the sensor under this FoV is between 0 and a threshold value specified in mm.

Figure 1. **VL53L1X FoV divided in two subfields of view**



From a timing perspective, the sensor alternatively ranges on each of the two zones, for a very short period of time in milliseconds. It is possible to determine in which direction a person crosses the area, depending in which order this person has been detected in the two zones, as shown in the figure below.

Figure 2. **Person counting chronogram**



6.1.2 Algorithm description

The counting algorithm example relies on a list of states that have to occur in a certain order to detect if a person has crossed the specified area and in which direction this area has been crossed. These states are stored in a list and compared to two default lists of states that represent how the area is crossed in two different directions. When no-one is seen in either of the two zones, the list of states is reset.

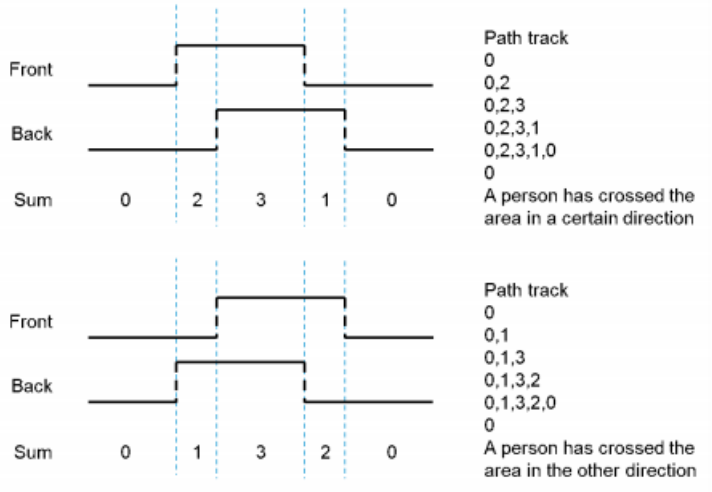
If we consider that a person detected in the front zone equals 2, and a person detected in the back zone equals 1, the algorithm adds the value of the two states and stores the result as soon as it changes.

Eventually, if the consecutive states in the list are 0, 1, 3, 2, 0 or 0, 2, 3, 1, 0 this means a person has been detected in one direction or the other, as described in Figure 4. List of status values.

Figure 3. **Front and back zones**



Figure 4. **List of status values**

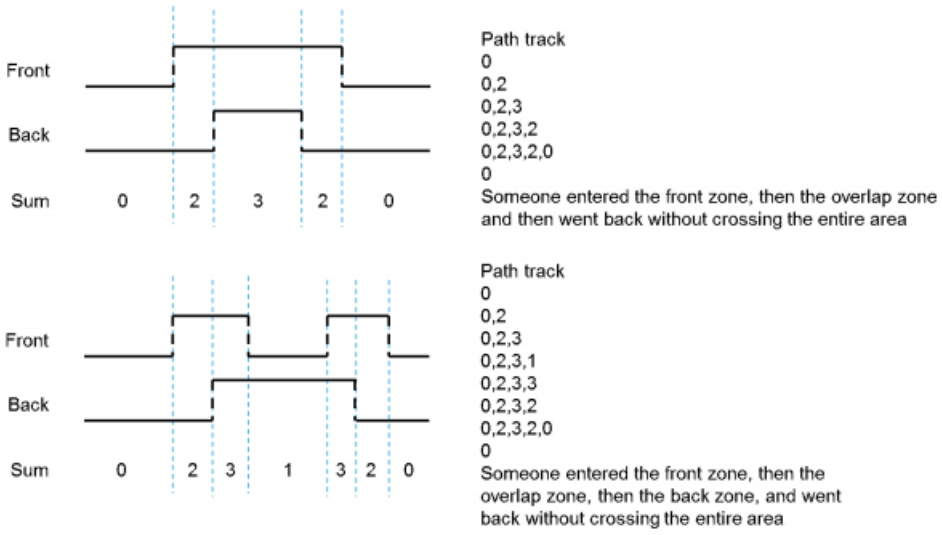


6.1.3 Hysteresis

The algorithm validates a crossing event only when a person has fully crossed the two zones. It does not validate the event when the person remains for a long time under the FoV or when the person decides to return from the place he came from.

This is illustrated in the figure below: the algorithm stops and the list of states is reset as soon as no-one is detected in any of the two FoVs.

Figure 5. **Hysteresis principle**



6.1.4 Ranging on the floor to determine the threshold

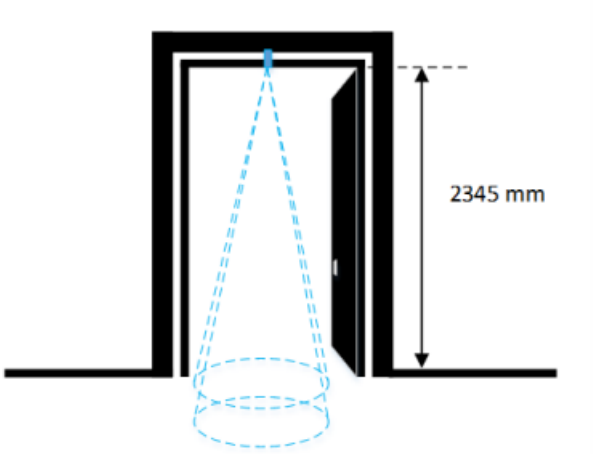
Reliability of the algorithm relies on the accuracy of the setup which detects the distance between the sensor and the floor. This can be ensured only if nothing (e.g. no obstacle or static object) blocks the front and back FoVs. To assess if a setup is reliable, a significant number of distances can be measured with the sensor. Then, a histogram diagram can be established to confirm that the sensor is correctly set up and that no target is within its FoVs.

A threshold needs to be defined, which is achieved after having ranged on the flooring material over a significant number of samples. In fact, the threshold should be chosen so that all the measured distances (when ranging the floor) are greater than this threshold. We recommend that at installation of the application, an autocalibration routine is launched to calculate the threshold. This is because flooring material can be different in many locations.

Figure 6. People counting at 2345 mm distance from the floor. The distance between the sensor and the floor is 2345 mm, and as the minimum distance measured by the sensor is 2290 mm, the threshold is thus less than 2290 mm.

Note: This calibration should be performed in the worst ambient light conditions, to maximize the jitter and obtain a threshold that is relevant to all possible ambient lighting conditions the counting setup is exposed to.

Figure 6 **People counting at 2345 mm distance from the floor**



6.2 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

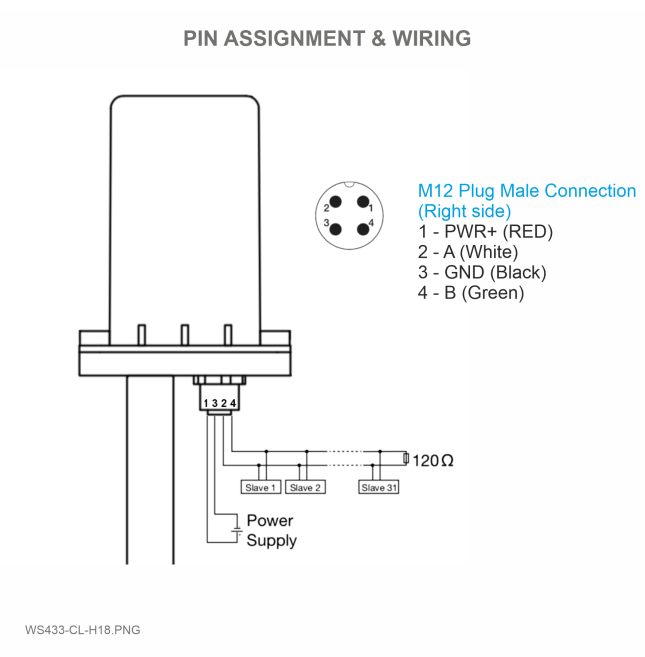
- Lo-Byte is sensor type

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

6.3 Add sensors node to Co-ordinator WS433-CL

6.3.1 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.**

> 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=BKEaUzdArkoc0Hc7nfpRShdPVToVrqQZ**

6.3.2 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

6.4 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.
> 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

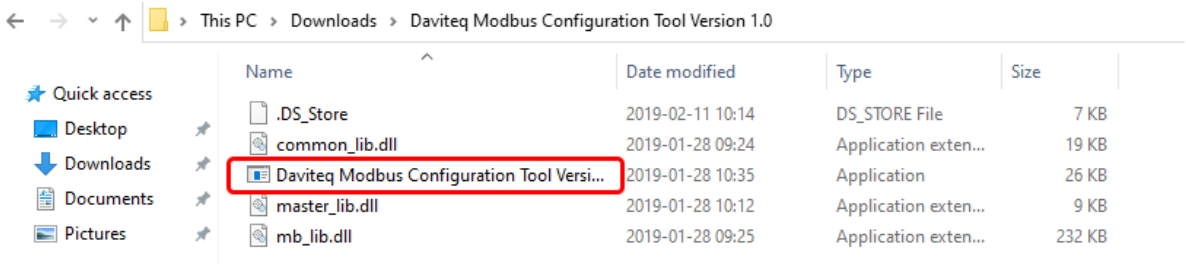
- You can download Daviteq Modbus Configuration Tool with the following link:

https://filerun.daviteq.com/wl/?id=yDOjE5d6kqFlGNVVlMdFg19Aad6aw0Hs

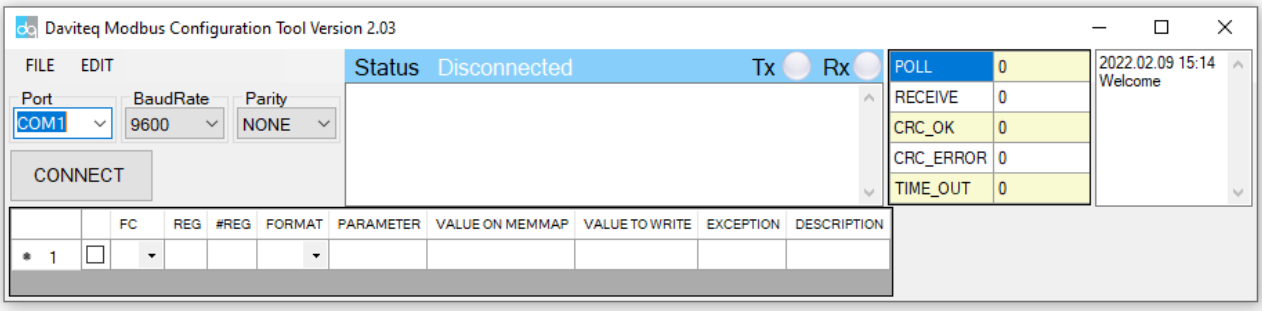
Template File: https://filerun.daviteq.com/wl/?id=xYEknMN8AhRLTmf73fXh9SWf0Ryp1QMa

How to use the Modbus configuration software

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

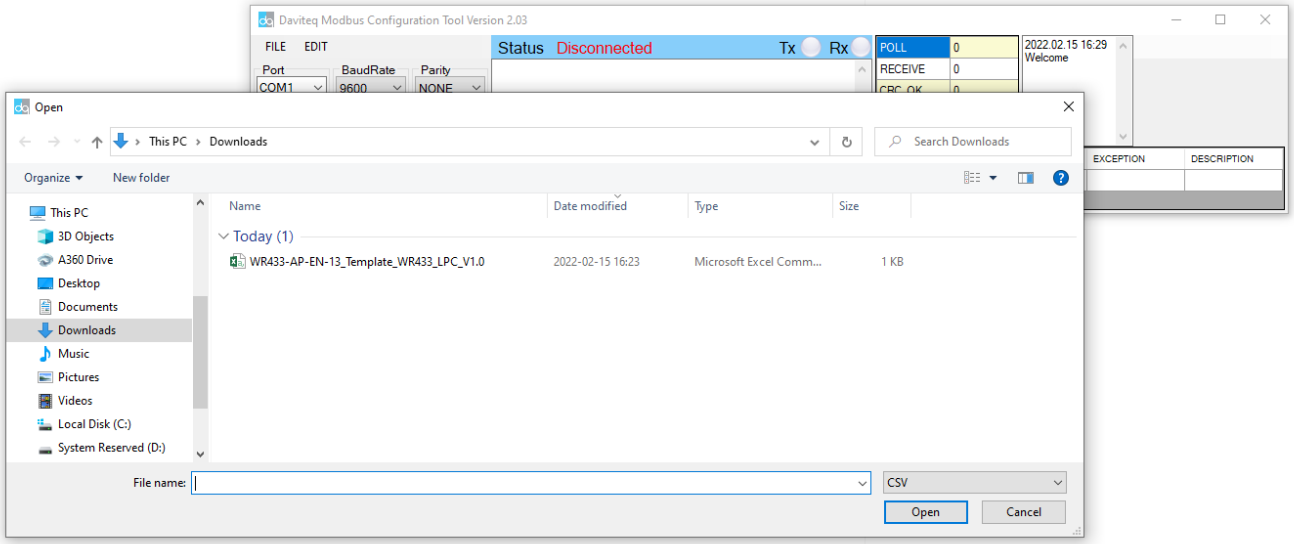


- Choose **COM Port** (the Port which is USB cable plugged in)
- Set the **BaudRate: 9600**, **Parity: none**



- 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-LPC** 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		1	2	NRC_People_I			uint16	Read	Non-resettable counter
4		1	2	NRC_People_C			uint16	Read	Non-resettable counter
4		1	2	Status bytes of sensor Node			uint16	Read	Hi-Byte is error code, Lo-Byte is sensor type
4		1	2	RC_People_In			uint16	Read	Reset to 0 after sending to Coordinator

4		1	2	RC_People_Ou			uint16	Read	Reset to 0 after sending to Coordinator
4		1	2	Dist_front_zor			int16	Read	Distance of front zone
4		1	2	Dist_back_zor			int16	Read	Distance of back zone
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
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 + 15 <=> tx power = 15dBm + 10 <=> tx power = 10dBm + -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 + 0 <=> data rate RF at 50kbps + 1 <=> data rate RF at 625bps
3	16	1	2	Count_thresh		20	uint16	Read / Write	Threshold count on how many people send Coordinator
3	16	1	2	Dist_threshol		1600	uint16	Read / Write	Threshold setting for laser sensor to distinguish between when people are present and when no one is standing under the sensor The laser sensor will measure the distance value from the sensor (ceiling) to the floor. + When there are people, the measured laser sensor value < Dist_threshol + When there is no person, the measured laser sensor value > Dist_threshol
3	16	1	2	Dist_hys		100	uint16	Read / Write	Hysteresis of Dist_threshol
3	16	1	2	Inter_meas_p		48	uint16	Read / Write	The sampling time of the sensor laser

7. Installation

7.1 Installation location

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

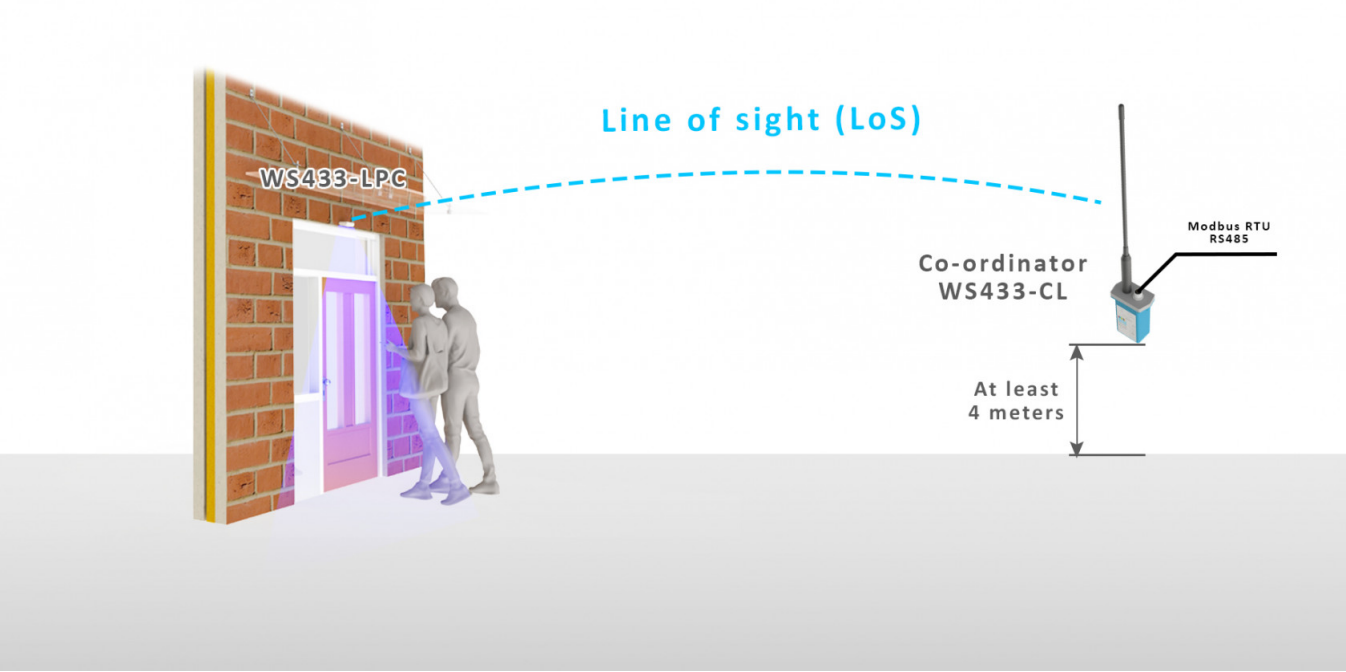
To maximize the distance of transmission, the ideal condition is Line-of-sight (LOS) between the Wireless sensor and Gateway. In real life, there may be no LOS condition. However, the two modules still communicate each other, but the distance will be reduced significantly.

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-LPC clearly visible.



7.2 Mounting

Installation method: Mount to the ceiling

Locate the mounting position at the entrance where people pass by, and out of direct sunlight

The direction of the triangle is the direction of counting people entering as specified in the payload

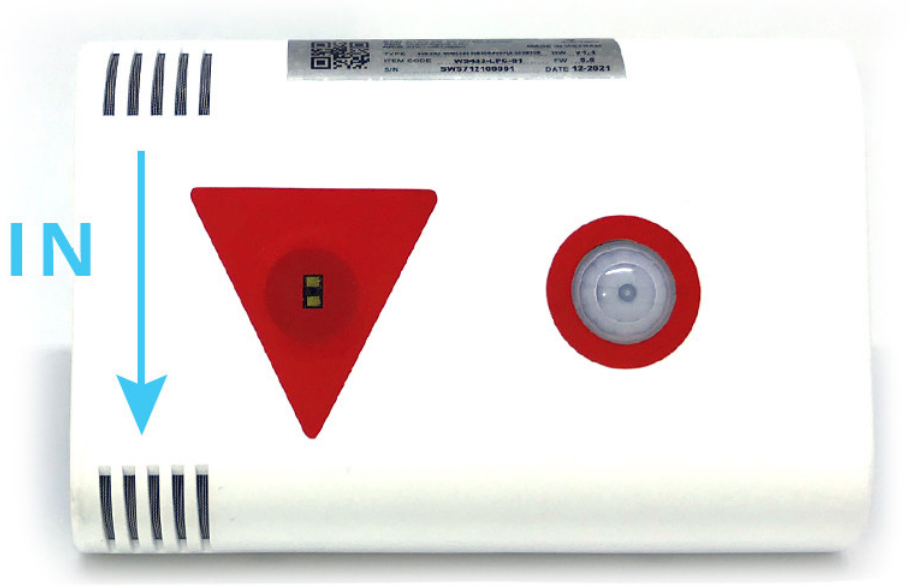
Determine the correct orientation to install the bottom cover to the ceiling in the correct direction

WARNING:

Avoid placing hands or heavy objects on the laser sensor surface or the PIR sensor surface, as this may cause damage to the device;

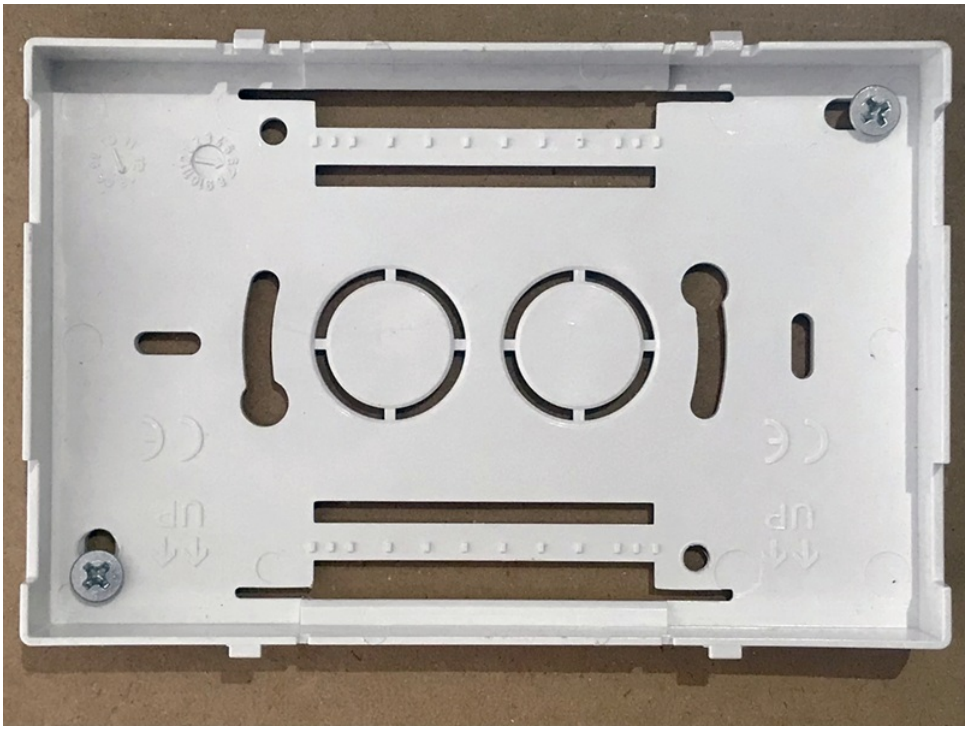
Periodically use a clean cloth moistened with 70 degrees of alcohol to wipe the surface of the 2 sensors to keep the sensor clean and accurate.

Step 1: Determine the direction of people entering the room of the sensor



Step 2: Mount the bottom housing of the sensor to the ceiling by fasten the 2 screws to the ceiling located at the 2 diagonal corners of the bottom cover.

- Use the 2 screws that are included to be used to attach the sensor to surfaces such as: **Wood, composite plastic.**
- If the ceiling surface is made of plaster, it is recommended to use a special **insert** so that the device can firmly adhere to the ceiling surface. **Avoid dropping the device.**



Step 3: Attach the top and bottom housings (note the 2 reed joint)

- Fit the main body to the bottom cover in the correct direction: the **2 reed joints** on the bottom cover should fit into the main body on the side labeled with the device.
- Make sure that the main body is fully engaged with the bottom cover, then release the hand.



7.3 Battery installation



Steps for battery installation:

Step 1: Using flat head screws to push into 2 reed joints



Step 2: Open the housing, then insert 06 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 **(Please note the 2 reed joint)**



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
No.11 Street 2G, Nam Hung Vuong Res., An Lac Ward, Binh Tan Dist., Ho Chi Minh City, Vietnam.
Tel: +84-28-6268.2523/4 (ext.122)
Email: info@daviteq.com | www.daviteq.com

Distributor in **Australia** and **New Zealand**

Templogger Pty Ltd
Tel: 1800 LOGGER
Email: contact@templogger.net

Revision #4
★ Created Mon, Feb 14, 2022 8:57 PM by Kiệt Anh Nguyễn
Updated Tue, Feb 15, 2022 2:53 AM by Kiệt Anh Nguyễn