

User Manual
WAYV Air
FCC Version (Draft)



D00.02.06
August 17, 2020

Revision History:

Version Number	Date	Authors	Notes
D00.00.01	Sept 16, 2019	Muhua Luo	
D00.00.02	Sept 19, 2019	Hao Liu	Modify, supplement hardware related content
D00.01.01	Sept 26, 2019	Andrew Megaris	Translation and Technical Revision
D00.02.00	Mar 4, 2020	Zhenyu Hu	Initial draft for Wayv Air hardware ES2.0
D00.02.01	Mar 17, 2020	Zhenyu Hu	Add RS485 Hub in Section 6
D00.02.02	Mar 26, 2020	Zhenyu Hu	Add and test WiFi 'Station Mode'
D00.02.03	May 28, 2020	Zhenyu Hu	More description for Point-Cloud mode setup
D00.02.04	June 24, 2020	Zhenyu Hu	1. Add information of USB (RS-232) Version 2. Add software version information
D00.02.05	June 29, 2020	Zhenyu Hu	Add device Specs
D00.02.06	Aug 17, 2020	Zhenyu Hu	Add FCC verbiage and adjust text format

IMPORTANT NOTICE

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B device (commercial or industrial use), pursuant to Part 15 of FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communication. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his/her own expense.

NOTE:

- Only peripherals complying with FCC limits may be attached to this equipment. Operation with non-compliant peripherals or peripherals not recommended by Ainstein.
- Modification of this device may void the user's authority to operate the equipment
- Maintain 20cm of separation for the device during operation.

Firmware Version Information

Firmware/Software	The latest Version
Radar Application Firmware	<u>V2.0.29</u>
Radar Bootloader	<u>V2.0.10</u>
GUI Tool on Windows machine	<u>V1.0.1.6</u>

Note:

- The table only indicates the latest version of firmware/software for Wayv Air. For previous versions information, please contact Ainstein.
- We recommend to use the GUI tool to update the Radar Application Firmware and Radar Bootloader to achieve the better performance

1. Introduction

Wayv Air is a short-range radar that detects people indoors. It operates at 60GHz frequency band, and its detection range is up to 6 m. The small size and light weight make it feasible to be installed/mounted on ceiling or wall.

2. Specification

Specification

Operating Frequency	60.3 ~ 63.6 GHz
Swept Frequency	3.3 GHz
Azimuth Angle	120 Degree
Elevation Angle	120 Degree
Detection Range	Maximum 6m for People Detection
Data Refresh Rate	50ms
Machine Power	<5W
Machine Size	76.8mm*70.3mm*25.4mm(without cable and bracket)
Weight	Radar 84g, bracket + screw 64g
IP Rate	N/A
Operational Temperature Range	-20 °C ~ 50 °C

Note:


- All specs above are measured under the environment of 35 °C temperature, standard atmospheric pressure and humidity, without any Electromagnetic Interference (EMI).
- Operational Temperature Range indicates radar works properly in this range. If operating temperature goes beyond this range, radar might not be accurate and can suffer mechanical damage.

3. Software (GUI and API)

3.1 Software Path Requirement

The path of software (GUI) should only contain numbers and letters. DO NOT contain other characters or symbols.

3.2 Software Files and Structure

	icon	2/29/2020 10:04 AM	File folder	
	log	3/4/2020 11:18 AM	Text Document	0 KB
<input checked="" type="checkbox"/> 	vave	2/29/2020 10:03 AM	Application	102,116 KB

- Vave.exe
- icon folder; It contains icon image files, GUI is not able to work/display if this folder is missing.

3.3 API

We also provide API with source code for the end-users who would like to receive data from Wayv Air and do their own customized development. Please contact Ainstein to request it, NDA or other extra documents might be needed for this request.

4. Hardware

4.1 Cable for Power & Communication



- Power Supply: USB TYPE-C connector

- Voltage input
 - 5V~15V for RS-485 version
 - **Maximum** 5V for USB version
- Typ. 4W
- Four-pin at on the left-hand side is A

Pin #	Description
P1	GND
P2	<ul style="list-style-type: none"> ● RS-485 D- ● USB Data-
P3	<ul style="list-style-type: none"> ● RS485 D+ ● USB Data+
P4	Power



Note:

1. The default version of Wayv Air is RS-485. If you have the USB version, 'RS-485' represents 'Serial Port Communication' in the rest of the description in this document.
2. For USB version users, it is good to use the USB to USB-C cable, instead of the default cable in the above picture. Please make sure that the USB port for Wayv Air can support the current at least of 1 Amp.

4.2 Device Status LED and Interface Description



1. Status LED
 - System Booting: Magenta blink
 - Firmware Flash: Blue blink
 - Firmware Booting: Blue ON
 - Normal Operation: No Target -- Green blink; Target detected -- Magenta blink
2. Reset Button

Long press to restore factory settings

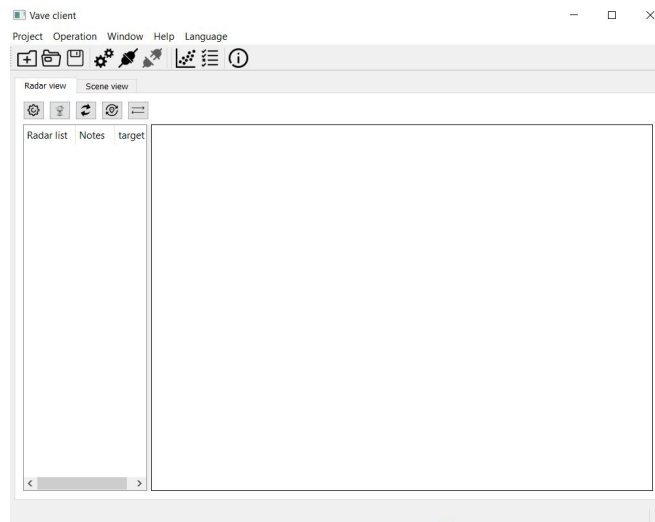
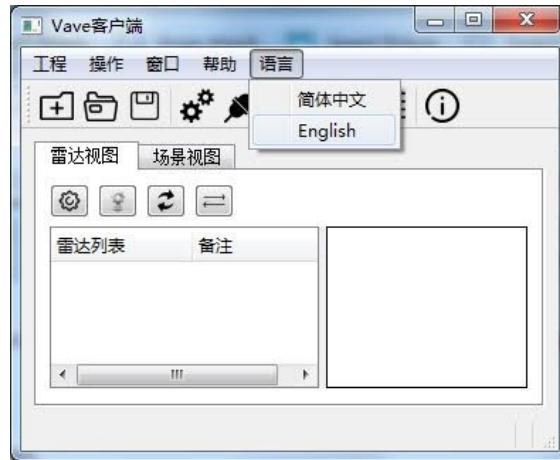
 - Wifi Name: Device serial #
 - Password: 12345678
 - Serial Port Communication Baud Rate: 115200
 - Serial Port Communication ID: 1
 - Initial Configuration: Default
3. USB Type-C Connector
 - Power supply
 - Serial Port Communication
4. Device ID: Serial Number on device (See it under QR code on the back panel of Wair Air)

5. WiFi Mode Connection

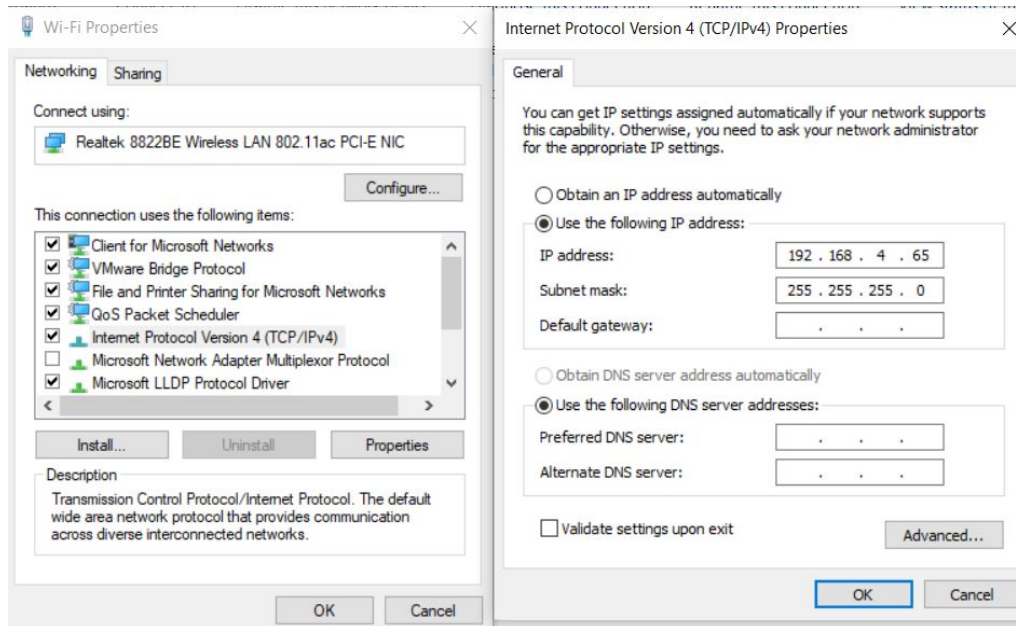
5.1 WiFi Connection for Single Device (AP Mode)


Wayv Air supports WiFi connection for single device (AP Mode), see following steps for AP Mode connection.

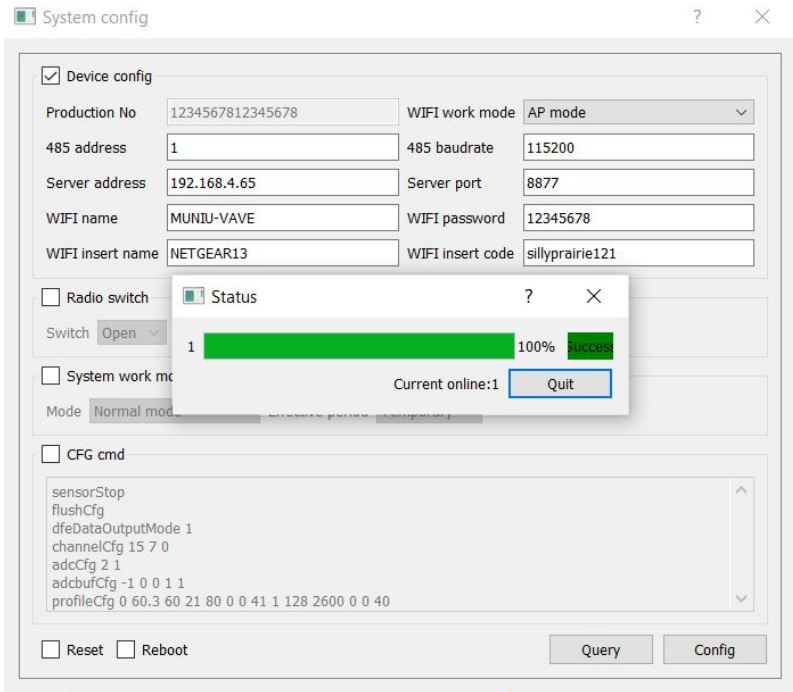
Note: To make sure WiFi connection between Wayv Air and host PC is functioning properly, please disable any anti-virus software and firewall on your host PC.




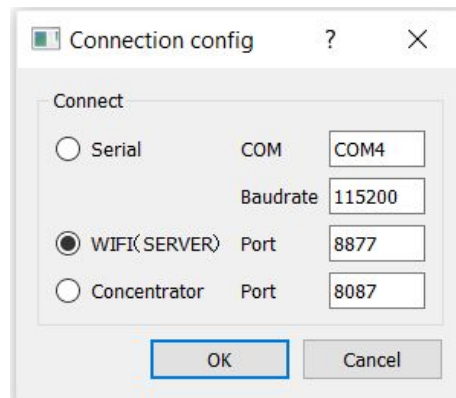
1. Power Wayv Air device on. Make WiFi connection between host PC and Wayv Air
 - Set IPV4 address of host PC as: **192.168.4.65**
 - Find WiFi name (Serial Number) of desired Wayv Air device
 - Connect Wayv Air device by typing password: **12345678**




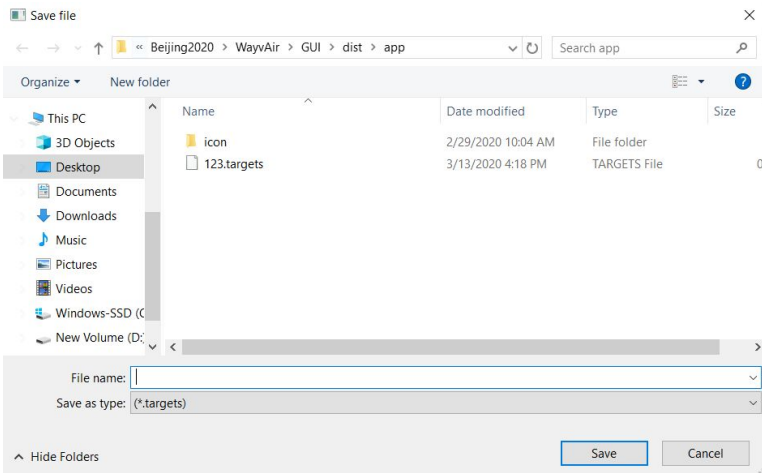
2. Make RS485 AP Mode connection to query/configure the 'WiFi work mode' and 'Server address' (For details of RS485 AP Mode connection, please refer to [Section 6.1](#))
 - 1) Wayv Air is in WiFi AP Mode by default, if the user never configured it to WiFi Station Mode. Skip all the rest of steps in 4 and jump to 5.
 - 2) After making RS485 AP Mode connection, click 'System Config'  icon; Click 'Query' button on the bottom to show current configuration information.
 - If the 'WiFi work mode' displays 'AP mode', and 'Server address' displays '192.168.4.65', close the 'System Config' window and jump to 5.
 - Otherwise, configure 'WiFi work mode' to 'AP mode', and 'Server address' to '192.168.4.65';



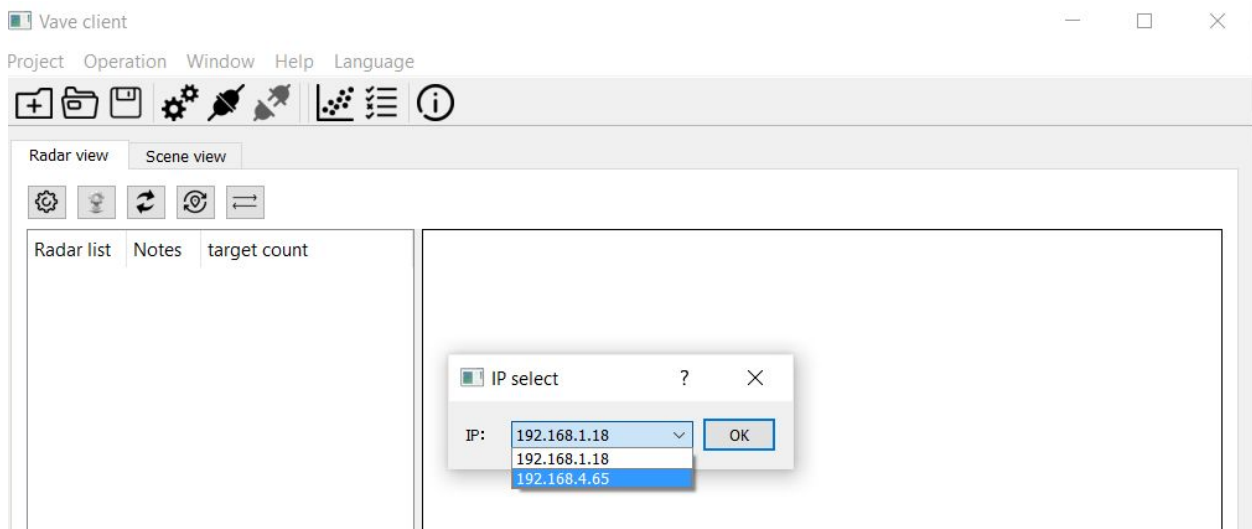
- Click 'Connection config'  icon, select 'WIFI' in 'Connection config' panel, port number 8877, then click 'OK' button



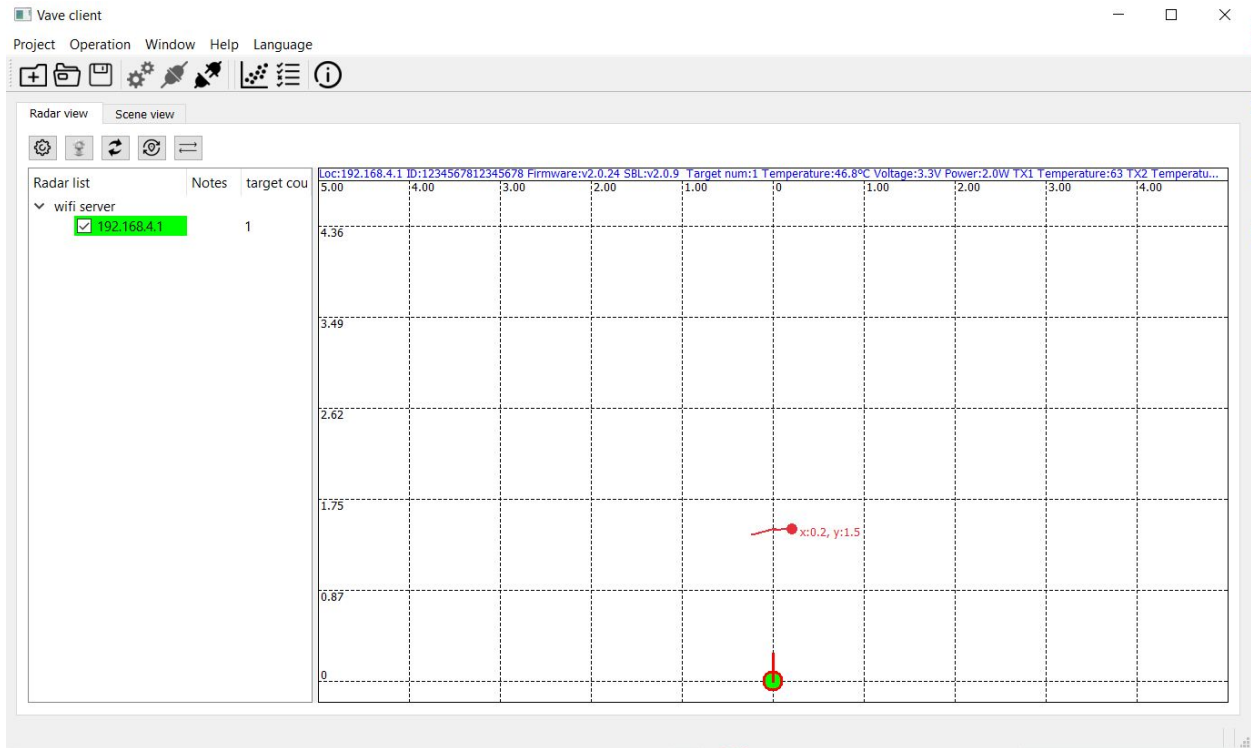
- Click 'Connect'  icon. GUI will pop up a 'Save File' window, select the path and type the name you prefer to save the data, click 'Save' button; Or you can click 'Cancel' to skip it.



- If your host PC has multiple network adapters, please select the one with IP address of **192.168.4.65**, this is the WiFi Adapter on your host PC you have set in step 3 above.



- After selecting the proper IP, Wayv Air will be able to connect to the host PC and display the object(s), like the following figure.



When the host PC and Wayv Air device make connections successfully, information of Wayv Air will be displayed in blue message, including Device ID, Temperature, Target number, etc.

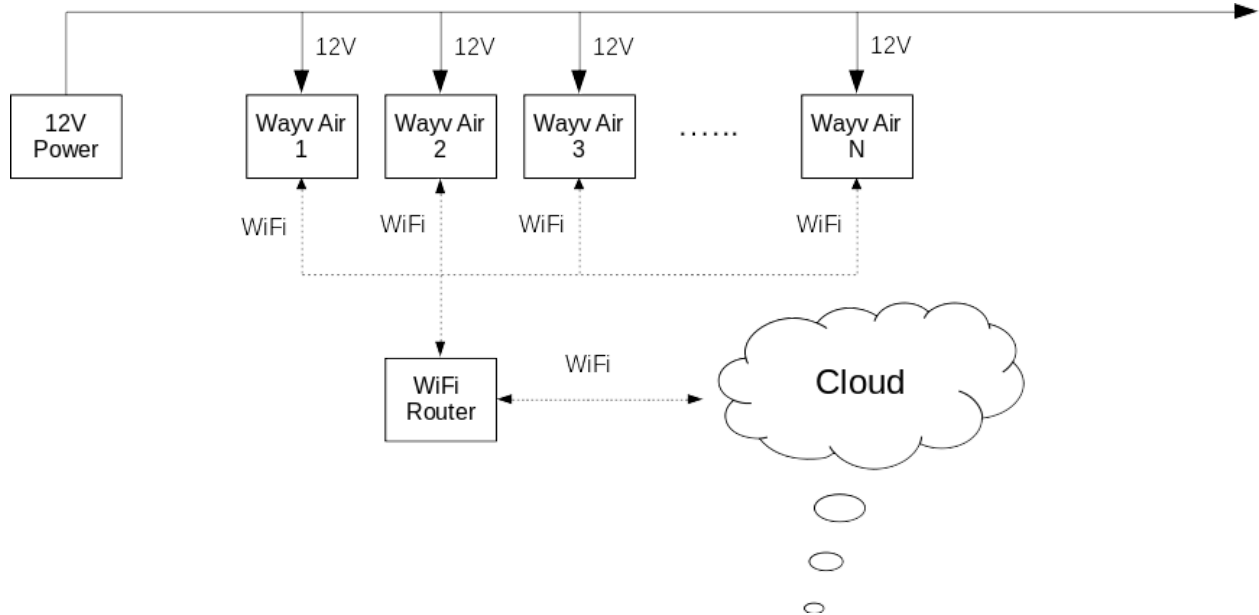
- Loc: Device IP address
- ID: Device identification number
- Firmware: Firmware version
- SBL: Bootloader version
- Target num: Current detected target(s)
- TX1, TX2, TX3, PM: Device temperature

Loc:192.168.4.1	ID:1234567812345678	Firmware:v2.0.24	SBL:v2.0.9	Target num:1	Temperature:47.8°C	Voltage:3.3V	Power:3.6W	TX1 Temperature:64	TX2 Temperatu...
5.00	4.00	3.00	2.00	1.00	0	1.00	2.00	3.00	4.00
4.36									

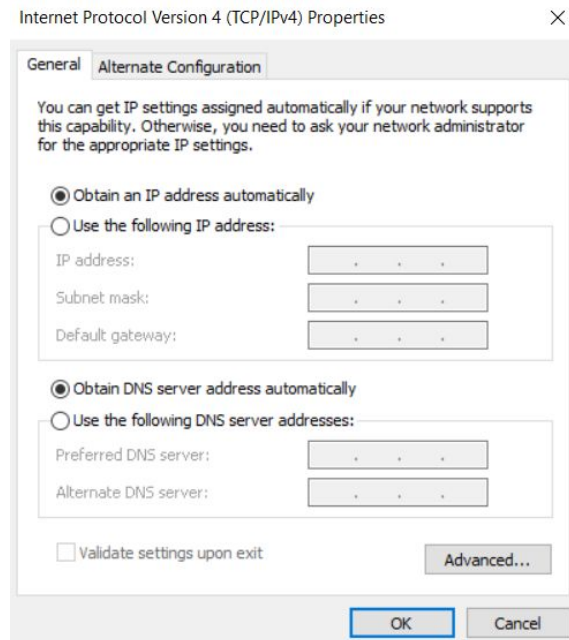
5.2 WiFi Cascading Connection (Station Mode)


Multiple Wayv Air devices can be connected to the host PC (or other DSC -- Data Service Center) via local WiFi network, then downstream/upstream data.

This cascading connection is suitable for the scenarios that require simple, quick, and small-scale deployment. Please make sure the local WiFi network is able to cover all Wayv Air devices in this case.



1. Set IPV4 address “Obtain an IP address automatically”



2. Find your host PC WLAN IP address.
 - a. Windows OS: “ipconfig” in cmd
 - b. Linux OS: “ifconfig -a” in terminal
3. In GUI, click ‘System Config’  icon; Click ‘Query’ button on the bottom to show current configuration information

System config

Device config

Production No	0300AK3206080004	WIFI work mode	AP mode
485 address	1	485 baudrate	115200
Server address	192.168.4.65	Server port	8877
WIFI name	0300AK3206080004	WIFI password	12345678
WIFI insert name	MuNiuTech	WIFI insert code	aerotenna

Radio switch
Switch: Open Effective period: Temporary

System work mode
Mode: Normal mode Effective period: Temporary

CFG cmd

```
sensorStop
flushCfg
dfeDataOutputMode 1
channelCfg 15 7 0
adcCfg 2 1
adcbufCfg -1 0 0 1 1
profileCfg 0 60.3 60 21 80 0 0 41 1 128 2600 0 0 40
```

Reset Reboot Close WIFI Query Config

4. Set 'WiFi insert name' and 'WiFi insert code' as exactly the same as name and password of current local network.
5. Set 'Server address' as the host PC's WLAN IP address (IPv4).
6. Set 'WiFi work mode' as 'Station mode'.
7. Click the 'Config' button on the bottom to complete this configuration, then reconnect WiFi.

System config

Device config

Production No	0300AK3206080004	WIFI work mode	Station mode
485 address	1	485 baudrate	115200
Server address	192.168.1.50	Server port	8877
WIFI name	0300AK3206080004	WIFI password	12345678
WIFI insert name	Ainstein	WIFI insert code	@!nste!n

Radio switch
Switch: Open Effective period: Temporary

System work mode
Mode: Normal mode Effective period: Temporary

CFG cmd

```
sensorStop
flushCfg
dfeDataOutputMode 1
channelCfg 15 7 0
adcCfg 2 1
adcbufCfg -1 0 0 1 1
profileCfg 0 60.3 60 21 80 0 0 41 1 128 2600 0 0 40
```

Reset Reboot Close WIFI Query Config

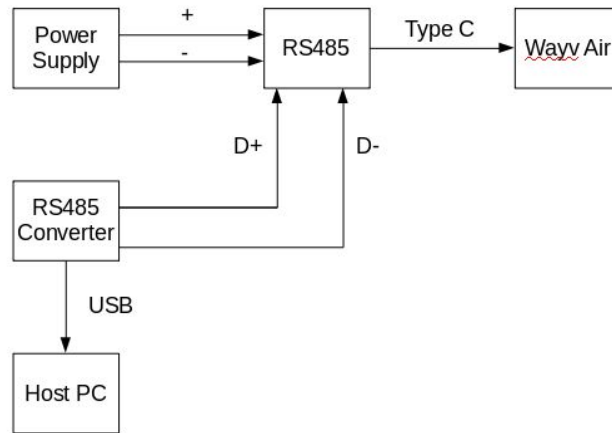
8. After WiFi cascading configured and connected successfully (Station Mode), the GUI will show the same Result/Widget as AP Mode, that is track of objects.

In WiFi cascading connection (Station Mode), Radar is the Client and sends data to the Server with designated IP address, and Radar itself is in the same network with the Server.

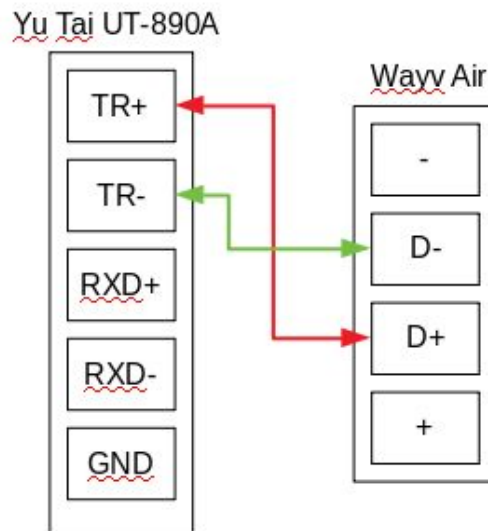
6. RS485 Mode Connection


6.1 RS485 Connection for Single Device (AP Mode)

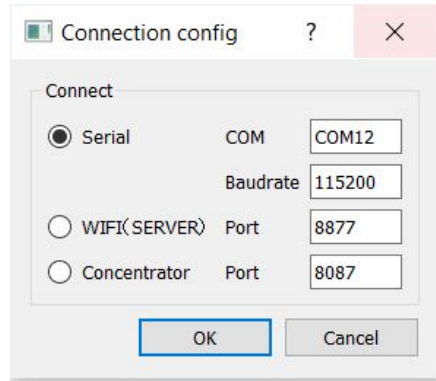
In RS485 AP mode, the hardware connection is shown as below, the 'Converter Module' is RS485-to-USB, we recommend to use Yu Tai UT-890A.




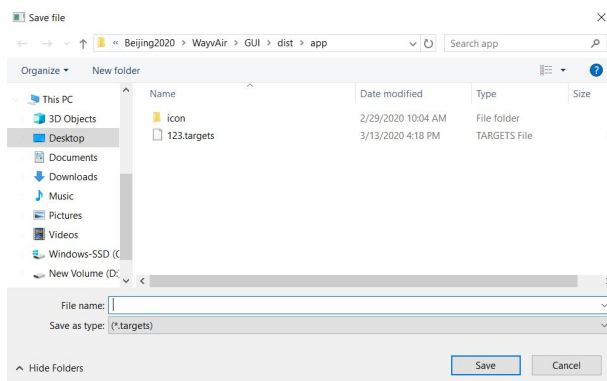
1. Hardware connect Wayv Air and host PC via Yu Tai UT-890A



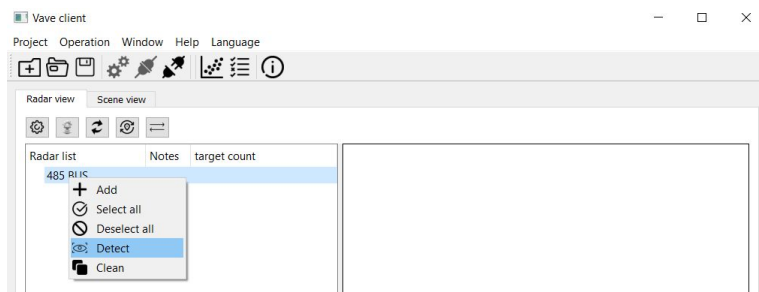
2. Click 'Connection config'  icon, select proper COM port and baud rate, then click 'OK'



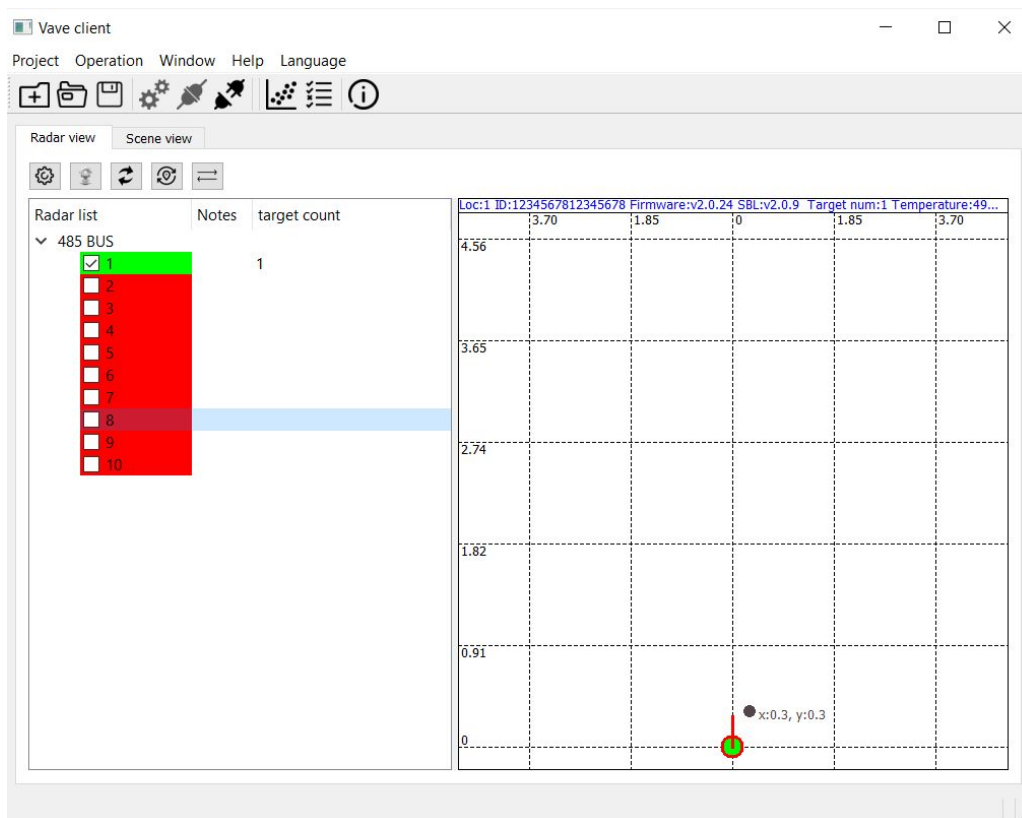
2. Click 'Connect'  icon, GUI will pop up a 'Save File' window, select the path and type the name you prefer to save the data, click 'Save' button; Or you can click 'Cancel' to skip it.



3. Right click '485 BUS', select 'Detect'. GUI will automatically connect all units on RS485 bus.



4. Device number highlighted in Green is the active unit(s), highlighted in Red is the inactive unit(s). Uncheck all inactive unit(s). Then GUI will display the object(s), like the following figure.



6.2 RS485 Cascading Connection (Station Mode)

In RS485 Station mode, all Wayv Air units should be powered by an external 12V power supply. We recommend to use 'RVV2*1.5' cable for both power supply and RS485 communications.

For details of this connection, refer to the [Section 7](#) (RS485 Hub).

7. RS485 Hub

Note: RS485 Hub is not included in Wayv Air; It is a separate accessory for users who require RS485 cascading connection. For details, please contact Ainstein.

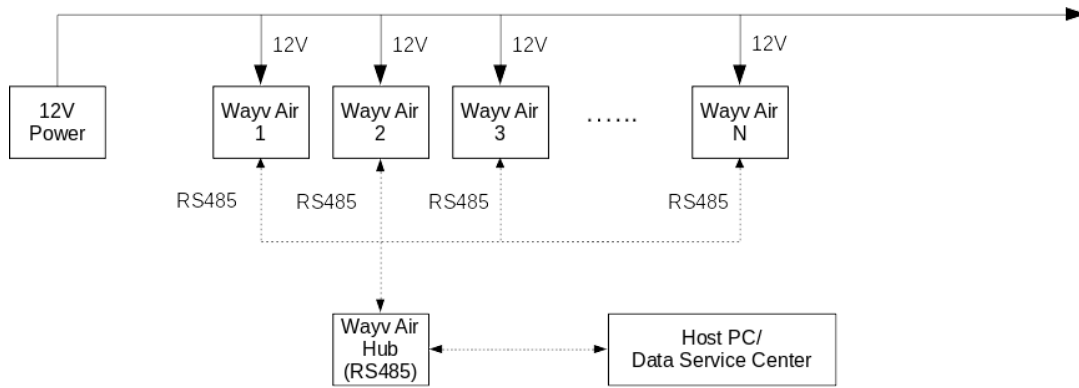
As the below figure shows, all Wayv Air units are connected to 12V power supply by 'RVV2*1.5' power cable, and connected to RS485 hub by 'RVV2*1.5' communication cable. RS485 hub can support up to input/output ports, and it can support up to 8 Wayv Air units operating simultaneously.

We also recommend the cable length for every single Wayv Air unit is no greater than

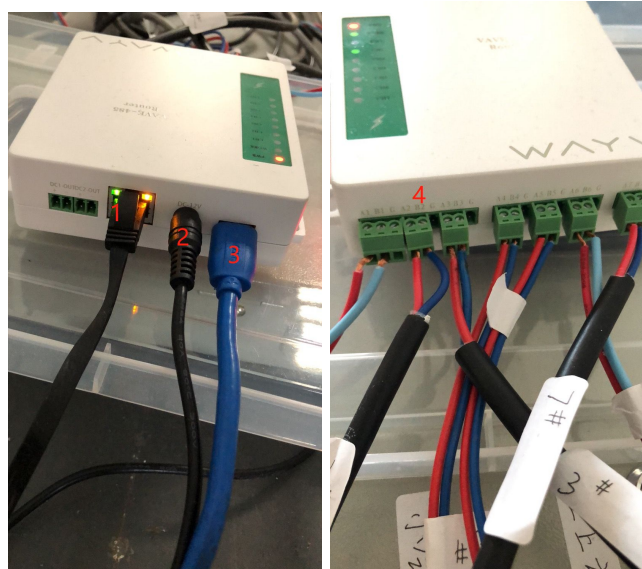
100m to make sure data transmission robustness for

RS485 link.

The interface between RS485 hub and DSC (Data Service Center) is Ethernet cable or USB cable.



7.1 RS485 Hub Hardware




- 1) Ethernet Port
- 2) Power Supply Port
- 3) USB Port
- 4) RS485 port(s) for multiple Wayv Air unit(s)

7.2 RS485 Hub Setup and Connection

RS485 Hub will be only used for users who need RS485 Station Mode connection, we prepare a separate document to describe the details of RS485 Hub setup and connection. Please contact Ainstein for this document if you require it.

8. CFG Setting

In the GUI tool, there is a CFG module that can support dynamic configuration of Wayv Air. Here are some brief steps to do so.

1. Click 'System config'  icon
2. Find and check 'CFG cmd' and type proper commands, then click 'Config' button to enable

The screenshot shows the 'System config' window with the following settings:


- Device config
 - Production No: 1234567812345678
 - 485 address: 1
 - Server address: 192.168.4.65
 - WIFI name: MUNIU-VAVE
 - WIFI insert name: MuNiuTech
 - WIFI work mode: Station mode
 - 485 baudrate: 115200
 - Server port: 8877
 - WIFI password: 12345678
 - WIFI insert code: aerotenna
- Radio switch
 - Switch: Open
 - Effective period: Temporary
- System work mode
 - Mode: Normal mode
 - Effective period: Temporary
- CFG cmd
 - sensorStop
 - flushCfg
 - dfeDataOutputMode 1
 - channelCfg 15 7 0
 - adcCfg 2 1
 - adcbuFCfg -1 0 0 1 1
 - profileCfg 0 60.3 60 21 80 0 0 41 1 128 2600 0 0 40

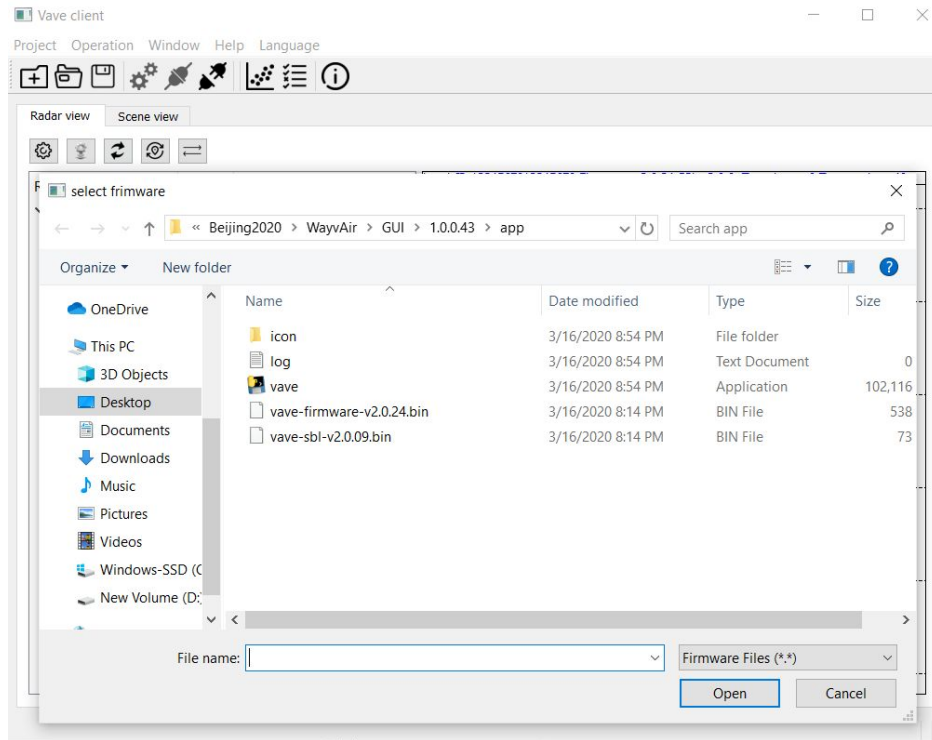
Buttons at the bottom: Reset, Reboot, Query, Config

These commands are designed for tuning Wayv Air's specs, including sensitivity, scenario size etc.. For more details, please contact Ainstein Ai for technical support.

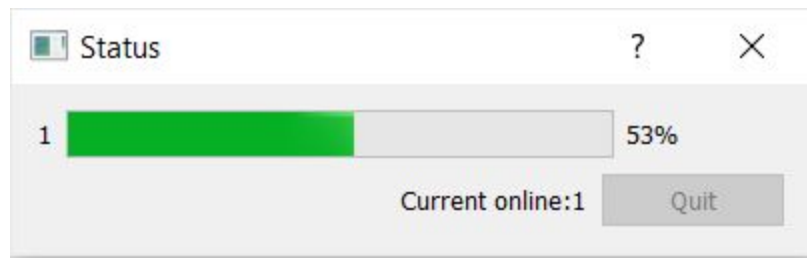
9. Firmware Update

The GUI tool supports firmware update for Wayv Air.

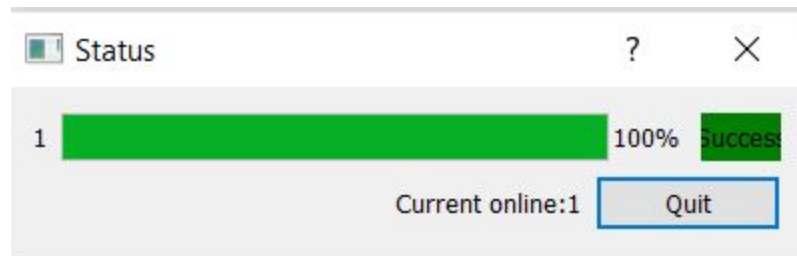
1. Click 'Firmware update'  icon, it will pop up the following window



2. Select the proper vave-firmware-version.bin file, then click 'Open'. The update process will begin.
Note: NOT vave-sbl.bin file.




3. When the process bar achieves 100% and shows 'Success', click the 'Quit' button to quit and complete the firmware update process. The Wayv Air should automatically reboot with the new firmware.



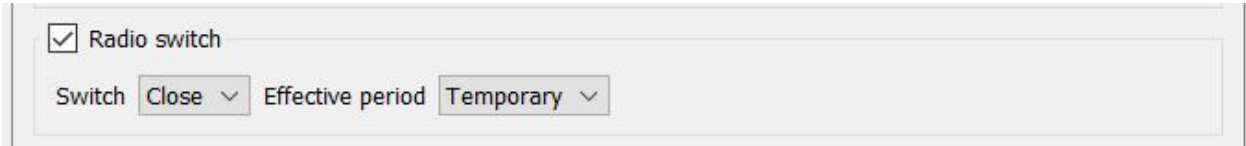
10. Parameter Query and Change

The GUI tool supports parameter query and change for Wayv Air.

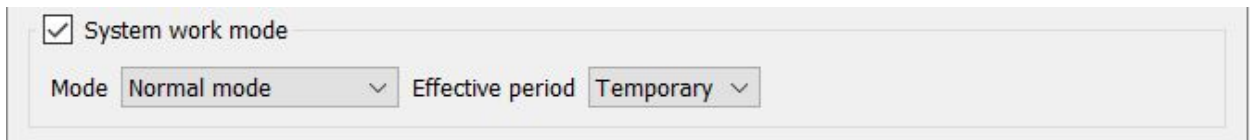
1. Click 'System config'  icon, check corresponding boxes and click 'Query' on the bottom, then it will show current parameter
2. Change parameter(s), then click 'Config' on the bottom to complete

Here is the description of all parameter boxes:

- Production No: The Serial Number of Wayv Air device
- WiFi work mode: User can select either 'AP Mode' or 'Station Mode'
- 485 address: Address of RS485
- 485 baud rate: The default baud rate of RS485 is 115200
- Server address: The IP address of WiFi server that Wayv Air connecting, default is '192.168.4.65'
- Server port: The port number of WiFi server that Wayv Air is connecting
- WiFi name: WiFi name in AP Mode
- WiFi password: WiFi password in AP Mode
- WiFi insert name: WiFi name in Station Mode
- WiFi insert code: WiFi password in Station Mode
- Radio switch: User can select shutdown RF temporarily or permanently. When RF is shutting down, Wayv Air will stop working and no target will be displayed on GUI window



- System work mode: There are three modes -- Normal mode, Points cloud mode, Production line mode




- Normal mode: Display track of targets
- Points cloud mode: User need to set baud rate to 921600, GUI will display target's point and cloud in three-dimension space (See [Section 11](#) for more details)
- Production line mode: This mode for internal test purposes ONLY. No access to the end-users.

11. Point and Cloud Display

Note: ONLY the device with high-speed RS485 chip can support this point and cloud feature. Please contact Ainstein if this feature is needed.

The GUI supports targets' point and cloud display under High-Speed hardware with RS485 AP mode connection (WiFi connection doesn't support it).

To enable it:

1. First we need to know the baud rate on the radar device. Usually, the radar device's RS485 baud rate is configured to either 115200 b/s or 926100 b/s. To verify it, we can try to set baud rate in 'Connection Config' as either 115200 b/s or 921600 b/s, then follow the steps in [Section 6.1](#) till connection is successful.
 - a. If the connection works on '115200' in 'Connection config', click 'System config'  icon and configure '485 baudrate' to '921600', then reconnect the Wayv Air unit with the 921600 baud rate. (Yes, you need to reconnect radar because radar MCU's UART has been configured to the new baud rate, and you need to set the baud rate on host machine same as it)

System config

Device config
Production No: 0300AK3201190073 WIFI work mode: AP mode
485 address: 1 485 baudrate: 921600
Server address: 192.168.4.65 Server port: 8877
WIFI name: 0300AK3201190073 WIFI password: 12345678
WIFI insert name: MuNiuTech WIFI insert code: aerotenna

Radio switch
Switch: Open Effective period: Temporary

System work mode
Mode: Normal mode Effective period: Temporary

CFG cmd

```
sensorStop  
flushCfg  
dfeDataOutputMode 1  
channelCfg 15 7 0  
adcCfg 2 1  
adcbufCfg -1 0 0 1 1  
profileCfg 0 60.3 60 21 80 0 0 41 1 128 2600 0 0 40  
chirpCfg 0 0 0 0 0 0 0 1  
chirpCfg 1 1 0 0 0 0 0 2  
chirpCfg 2 2 0 0 0 0 0 4  
frameCfg 0 2 64 0 50 1 0  
lowPower 0 0  
cfarCfg -1 0 0 8 4 4 0 6800  
cfarCfg -1 1 0 4 2 3 0 6800
```

Reset Reboot Close WIFI

Connection config

Connect


Serial COM: COM3 Baudrate: 921600

WIFI(SERVER) Port: 8877

Concentrator Port: 8087

- b. If the connection works on '921600' in 'Connection config', go to step 2 in the following.

Note: If the RS485 connection doesn't work in either 115200 b/s or 921600 b/s, try to press and hold the 'Reset' button, then use 115200 b/s in 'Connection Config'.

2. Once RS485 connection is successful, click 'System config'  icon, then click 'Query' to see the current parameters.
 - a. Change the 'Points cloud' in 'System work mode'
 - b. Click 'Config' button to complete the configuration

System config
? X

Device config

Production No	<input type="text" value="0300AK3201190073"/>	WIFI work mode	<input type="text" value="AP mode"/>
485 address	<input type="text" value="1"/>	485 baudrate	<input type="text" value="921600"/>
Server address	<input type="text" value="192.168.4.65"/>	Server port	<input type="text" value="8877"/>
WIFI name	<input type="text" value="0300AK3201190073"/>	WIFI password	<input type="text" value="12345678"/>
WIFI insert name	<input type="text" value="MuNiuTech"/>	WIFI insert code	<input type="text" value="aerotenna"/>

Radio switch

Switch Effective period

System work mode


Mode Effective period

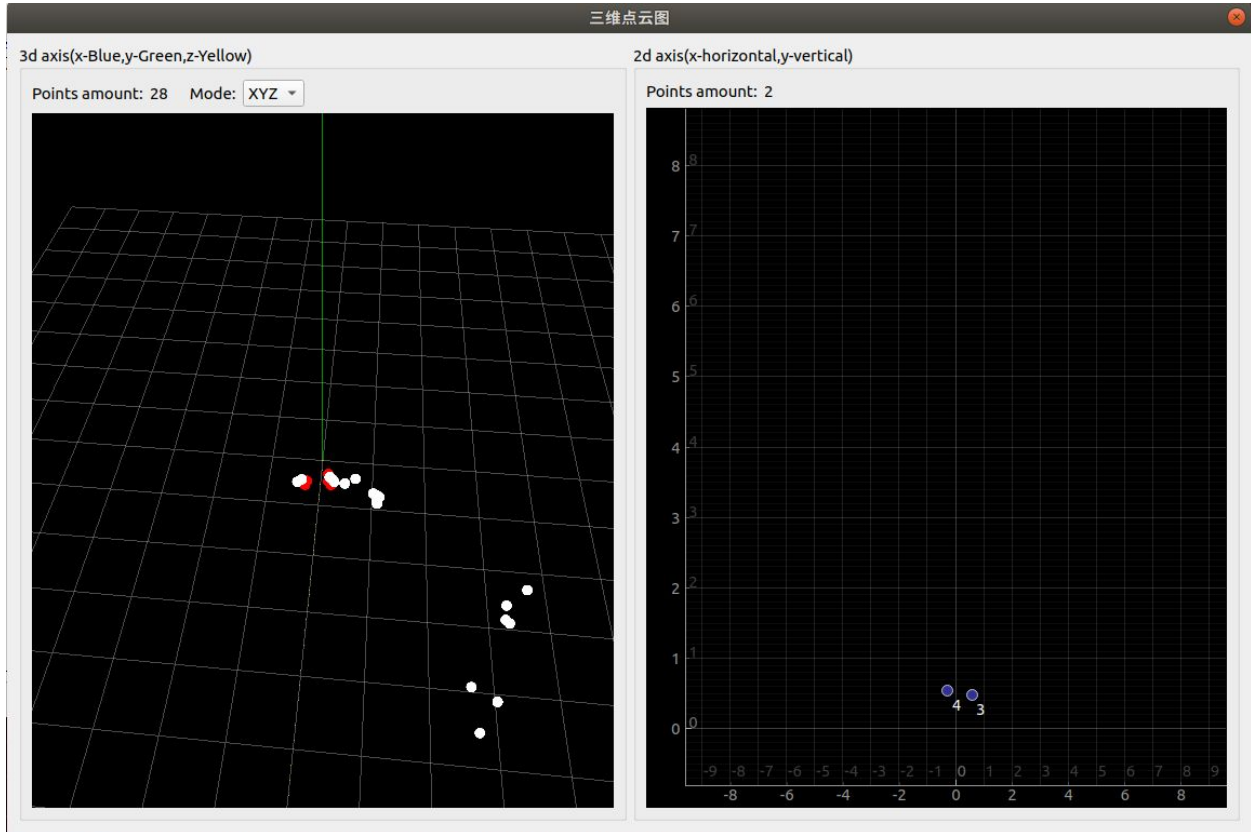
CFG cmd

```

sensorStop
flushCfg
dfeDataOutputMode 1
channelCfg 15 7 0
adcCfg 2 1
adcbufCfg -1 0 0 1 1
profileCfg 0 60.3 60 21 80 0 0 41 1 128 2600 0 0 40
chirpCfg 0 0 0 0 0 0 1
chirpCfg 1 1 0 0 0 0 2
chirpCfg 2 2 0 0 0 0 4
frameCfg 0 2 64 0 50 1 0
lowPower 0 0
cfarCfg -1 0 0 8 4 4 0 6800
cfarCfg -1 1 0 4 2 3 0 6800
          
```

Reset Reboot Close WIFI

3. In main window, click  to open the point and cloud display window. The left figure in the window is a three-dimensional figure, the right figure in the window is a two-dimensional figure.



Note: ONLY Wayv Air hardware with high-speed RS485 interface hardware can support point and cloud display. Please specify 'Require high-speed RS485 interface' when ordering or contact us before shipment.

12. Reset

Wayv Air provides two methods to reset the device:

1. In GUI, type 'restoreConf' in CFG (See details of CFG in [Section 8](#)). After device rebooting, confirm all WiFi parameters are reset to the default values.
2. Keep pressing the button till the LED turns green, then release the button and wait for the reset process to complete, this process usually takes about 30 seconds. After device rebooting, green LED flashes if there is no object, and confirms all WiFi parameters are reset to the default values.

After reset, all information/parameters/setting will be reset to the default, including:

- WiFi name: Device Serial Number
- WiFi password: 12345678
- RS485 baud rate: 115200
- RS485 ID: 1

13. Disconnect Wayv Air

Click  to disconnect Wayv Air in the GUI.



2029 Becker Dr
Lawrence, KS 66047

Contact Us:

ADDRESS:

2029 Becker Drive,
Lawrence, KS 66047 USA

EMAIL:

Hi@ainstein.ai

PHONE:

785-856-0460