AEROSENSE WAVE

Contactless Sleep Monitor

Development Guide

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V2.0

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Revision Table

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1. Product introduction

The AeroSense Wavve is a smart and contactless monitoring and early warning device. It is designed to monitor the sleep stages and to screen for high-hazardous risks during sleep via advanced radio frequency technology. The care givers will be alerted for risks such as prolonged bed-exit, abnormal breath/heart rate and many more. And it's all done without cameras, without wearables and without any button to push, for the best user experience and to minimize risk of cross contamination.

Radar type	FMCW
Frequency band	24GHz ISM band
Detection range	0.5-1.5m (1.64-4.92ft)
Effective field of view (horizontal)	60°
Effective field of view (vertical)	80°
System power	DC 5V/0.5A Max
Network connection	WiFi
Operating temprature	-10°C-50°C (14-131°F)
Dimensions	83*83*58mm (3.3*3.3*2.3in)
Weight of the unit (approx.)	80g

Figure 1 The specifications of the AeroSense Wavve

2. Functions and recommended testing tools

By constantly monitoring the user's bio-vital information as well as body movements whilst in bed, the functions of the AeroSense Wavve include real-time heart and breath monitoring, abnormal breath and heart alerts, sleep monitoring, night activity alerts, abnormal sleep alerts, etc., please see Table 1.

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Table 1 Functions of the Wavve: its definition, availability for different tools and recommended testing tools.

Function	Definition	APP/API	PC software /SDK	Recommended test tool
To get device version/ID	To get the device verison/ID.	√	√	APP/PC software
Bed-exit alert	To monitor if the user is in bed.	x	√	PC software
Oversleeping	To learn the user's sleep habit and get alerted if the user is still in bed beyond his normal schedule.	√	x	APP
Abnormal sleep	To get alerts if the user is still up past the set bedtime.	√	x	APP
Frequent night activity	Number of night activities at night (between the user goes to sleep and wakes up the next morning).	√	x	APP
Wandering (night)	To get an alert if the user is absent from the bed longer than expected at night. It covers the time after the user goes to sleep until the user wakes up the next morning.	√	x	APP
Real-time heart/breath rate	To monitor the user's real-time heart and breath rate	√	√	PC software
Abnormal breath/heart alert	To get alerts if the hear/breath rate is too high/low.	x	√	PC software
No breath/heart alert	To get alerts if there is no heart/breath detected when the user is in bed.	√	√	PC software
Body movement counter	To get the body movement counts of the user whist in-bed.	x	√	PC software
Turn-Over-Alert	To get alerts if the user has large scale movements such as turning over or sitting up in bed.	x	√	PC software
No-Turn-Over-Alert	To get alerts if during the set time, the user doesn't have large scale movements such as turning over or sitting up in bed.	x	√	PC software
Sleep report	Sleep report with sleep stages.	√	x	APP

- Availability of the functions depends on whether the algorithm is done by the radar or in the AeroSense cloud. Functions that request machine learning or data analysis are usually available only in the APP, such as the sleep report and night activity alerts. The developer can choose either the AeroSense Care APP or the PC software to test the product performance.
- Due to network latency, it is recommended to test certain functions using the PC software. Please refer to Table 1 for details.
- Please also note that when testing the device, the user can use either the APP or the PC software, but cannot use both at the same time.

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Table 2 Comparison of the APP and the PC software

	APP	PC software
Basics		
Network configuration	BlueTooth	BlueTooth
Connection interface	WiFi	WiFi/Bluetooth
Update	OTA	OTA
Remote data access	√	Within the same LAN
Device configuration		
Set the WiFi	√	√
Set the Server	Aerosense Server	√
Static IP	x	√
Working distance	x	√
Report interval	x	√
Reset	x	√

3. Quick start

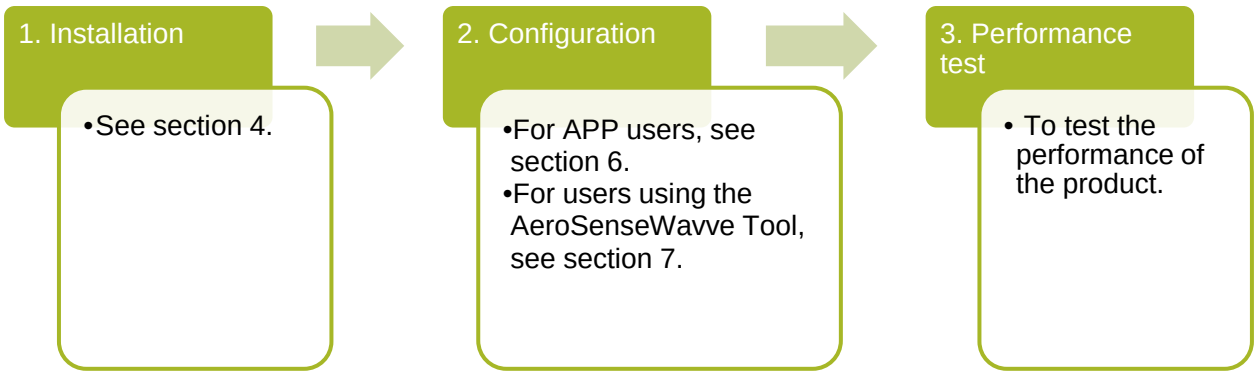


Figure 2 Quick start

Please install the device, setup the network and parameters and test the performance. During the test, please note that:

1) The device must be installed correctly, and the Wavve must face directly at the chest of the user.
2) Network latency may lead to incorrect display of results in the APP such as the real-time breath and heart rate value, the bed-occupancy status (in bed or not in bed) and abnormal breath/heart rate alerts. It is recommended to use the PC software to test these functions.

3) The Wavve supports only one user. Other people or pets within its field of view (FOV), about 2.5m around the radar, may interfere with the test accuracy or lead to false alerts.
4) It takes about 30-60s for the real-time bio-vital result to be stable and reliable enough. For better accuracy, the user shall lie motionless in bed, and breath steadily. Please do not talk nor move during the test.
5) If large movements are detected by the radar, for example if the user turns over in bed during the test, the result will not be accurate. Please wait for 30-60s after the user keeps motionless in bed.
6) It is recommended to compare the results of the radar to devices with medical device clearance. Results generated by smart bracelets or watches without the medical device clearance is not accurate.

4. Product installation

Please refer to the user manual for product installation.

It is recommended to install the Wavve on the wall above the head of the user, 1m away from the bed, as shown in Figure 3. The device shall be horizontally installed with the frond side facing directly toward the chest of the user. Otherwise, the result may not be accurate. Once the Wavve is correctly installed, the user can choose either the APP or the PC software to test the performance of the device.

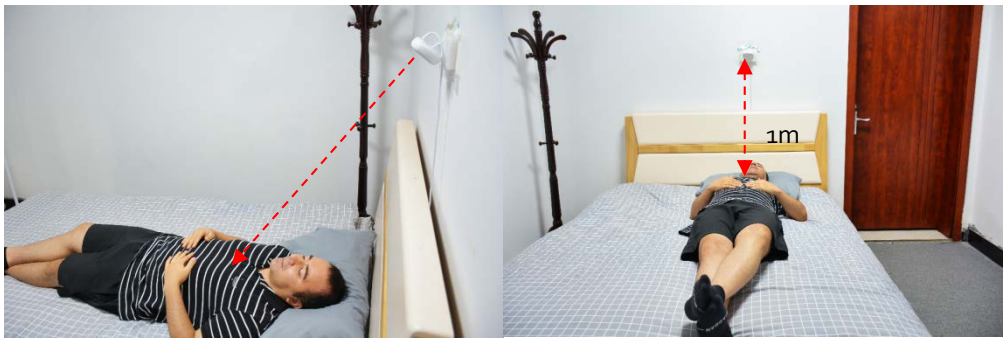


Figure 3 The Wavve installation

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5. Network configuration

Please use the configuration tools (APP or the PC software) to setup the device network. Figure 4 shows the network link and the configuration steps are illustrated in Figure 5.

Network configuration steps:

1) Plug in the Wavve. Press and hold the home button for 5s or until the LED indicator flashes blue.
2) Connect to the Wavve using the configuration tools via Bluetooth. Setup the server IP, port, and the router WiFi.
3) Once the network configuration is completed, the Bluetooth of the Wavve will be turned off, and the Wavve will automatically connect to the router WiFi and send data to the server IP and port.
4) If the setup is successful, the LED indicator will be constant blue for around 30s before automatically turned off.
5) To test the device performance using the AeroSense Care APP (see section 6) or the software AeroSenseWavve Tool (see section 7).

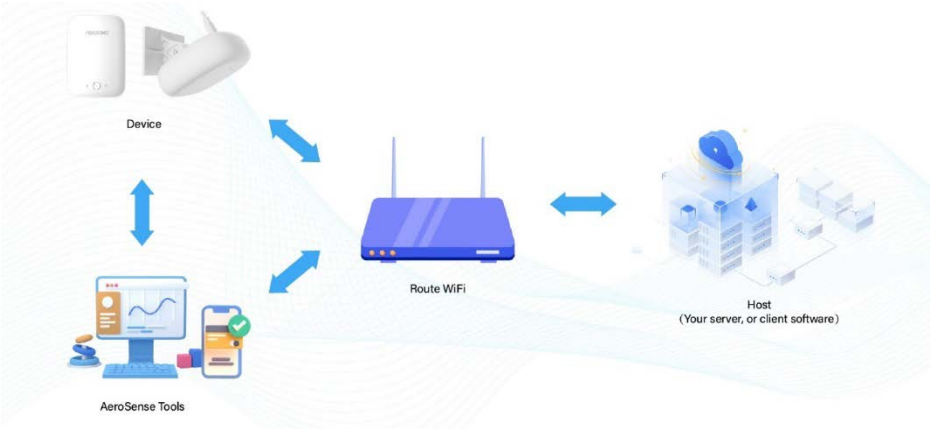


Figure 4 The network link of the AeroSense

- The AeroSense Assure/Wavve device

- Configuration Tool to setup the network (PC that supports Bluetooth to run the client software or APP that runs on Android)
- Network (router)
- Server (the company server or the client software that runs on a computer)

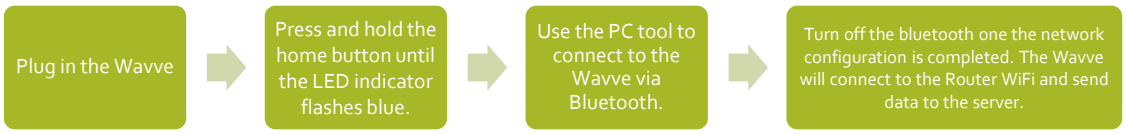


Figure 5 To setup the network

6. The AeroSense Care APP

Please download and install the AeroSense Care APP in IOS APP store or Google Play. It works on most phone models. If your phone is not compatible, please contact us. Once you've installed the APP, please follow the instructions in the APP to add the device and complete the configuration stages.

7. The AeroSenseWavve Tool PC software

Please use a computer that supports the Bluetooth, and with a system of Windows7 and above. The Bluetooth will allow the radar to transfer data directly to the software, without interference of the network or the firewall.

Please note that:

1) The curves shown on the software is an energy curve, instead of the frequency curve of the breath/heat.
2) For more fluent curve, please set the update interval to 50ms.
3) If the software is immediately off once you click the **startserver** software, please end the program **AerosenseWavve tool.exe** in the task management panel and restart the software.

4) If the connection is constantly off and the software is not showing any bio-vital data, it maybe due to the firewall of your computer. Please turn off the firewall and try again.

7.1 The PC software and navigation



Figure 6 The AeroSenseWavve Tool (PC Software)

1) The connection status of the device (connected or disconnect) is shown in panel 1A.
2) The real-time breath and heart data is shown in panel 1B. It shows the real-time breath rate (**Breathing BPM**) and heart rate (**HeartBeating BPM**), the energy curves and the data confidence. The result will usually be stable and reliable enough within 30-60s. **Signal** shows the current signal strength. **Confidence High/Confidence Low** indicates the confidence of the current breath/heart rate data. The stabler is the target, the higher the confidence.
3) 1C is the Body movement counter. It shows the total number of movements of the user whilst he is in bed. The developer can use this figure to develop functions such as pressure ulcer alerts.
4) 1D shows whether the user is **In bed** or **out of bed**. It can be used to develop functions such as bed-exit alert.

5) The panel 1E is to setup the configuration parameters. **Bluetooth**: Bluetooth and network settings; **Configuration**: to setup the device parameters; **Vital sign**: to setup the alert parameters; **Movement detection**: to setup the body movement detection; **OTA**: for software update; **Admin**: for authorized personnel only.
6) The alerts are shown in panel 1F. Click **Clear** to clear the alert history.

7.2 Network configuration and parameter settings

7.2.1. Bluetooth and network configurations (the Bluetooth panel)

Please correctly install the device and plug it in.

1) Enable the Bluetooth on your computer. Double click to run the **AeroSenseWavveTool.exe** software.
2) Plug in the AeroSense Wavve. Press and hold the home button on the back of the device for 5s until the LED indicator flashes blue.
3) Click **Scan** in the Bluetooth setting panel, as shown in Figure 7A-1, to search for the Bluetooth device.
4) Select the AeroSense Wavve device in the drop down list as shown in Figure 7A-2, and click **Connect** (Figure 7A-3). Wait until the status is **Connected** (Figure 7B).
5) Wait until the progress bar underneath is completely green and the Bluetooth configuration is completed. The device will transfer data via Bluetooth directly. (If the connection is failed or jammed, please restart the software, reboot the device and connect again.)



Figure 7 Bluetooth settings

7.2.2. Device parameter configuration (the Configuration panel)

Once the device is successfully connected to the network, you can then set up the device parameters in this panel.

1) **Work Range** is the distance between the radar to the chest of the user. It should be set between 0.6m~3.0m. The radar will detect targets within a distance of 1.5m by default.
2) **Upload Interval** is the refresh rate, unit: ms. It is recommended to change the upload interval to 50ms if the user wants the curve to be more fluent.
3) Turn on (set at 1) or off (set at 0) the **Body Movement** detection.
4) The **AeroSenseID**: to get the RadarID.
5) **Firmware Version** is the radar firmware version. If it is 0.0.0.0, please click **Reboot AeroSense** to restart the device and shows the firmware version.
6) Click **RebootAeroSense** to reboot the device.
7) Click **ResetParameters** to reset the parameters.



Figure 8 Device parameter configuration

7.2.3. Alert settings (Vital sign)

Once the device is successfully connected to the AeroSenseWavve Tool software, the user can set up the alert parameters in the panel **Vital sign**.

1) **No Breathing Alert Timer**: the time threshold to trigger the **No-Breath-Alert.** Only when the detected respiratory rate remains 0 during the set time will the alert be triggered. It should be set between 30-86400s. When set at 0, the **No-Breath-Alert** function is OFF.

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2) **Abnormal Breath Timer**: the time threshold to trigger the **Abnormal-Breath-Alerts**, either too fast or too slow. Only when the detected respiratory rate remains abnormal during the set time will the alert be triggered. It should be set between 30-86400 (unit:s).
3) **Low Breath-Rate Alert Thresh**: the respiratory rate threshold to trigger the **Low Breath-Rate Alert.** For example, if the **Low Breath-Rate Alert Thresh** is set at 6, and the **Abnormal Breath Timer** is set at 60, the **Low Breath-Rate Alert** will be triggered if the detected respiratory rate is constantly below 6 over 60s. When set at 0, the function is OFF.
4) **High Breath-Rate Alert Thresh**: the respiratory rate threshold to trigger the **Low Breath-Rate Alert.** For example, if the **Low Breath-Rate Alert Thresh** is set at 30, and the **Abnormal Breath Timer** is set at 60, the **Low Breath-Rate Alert** will be triggered if the detected respiratory rate is constantly above 60 over 60s. When set at 0, the function is OFF.
5) **No Heart-beating Alert Timer**: the time threshold to trigger the **No-Heart-Alert.** Only when the detected heart rate remains 0 during the set time will the alert be triggered. It should be set between 30-86400s. When set at 0, the **No-Heart-Alert** function is OFF.
6) **Abnormal HeartBeat Timer**: the time threshold to trigger the **Abnormal-Heart-Alerts**, either too fast or too slow. Only when the detected heart rate remains abnormal during the set time will the alert be triggered. It should be set between 30-86400 (unit:s).
7) **Low Heart-Rate Alert Thresh**: the respiratory rate threshold to trigger the **Low Heart-Rate Alert.** For example, if the **Low Heart-Rate Alert Thresh** is set at 50, and the **Abnormal HeartBeat Timer** is set at 60, the **Low Heart-Rate Alert** will be triggered if the detected heart rate is constantly below 50 over 60s. When set at 0, the function is OFF.
8) **High Heart-Rate Alert Thresh**: the respiratory rate threshold to trigger the **High Heart-Rate Alert.** For example, if the **High Heart-Rate Alert Thresh** is set at 90, and the **Abnormal HeartBeat Timer** is set at 60, the **Low Heart-Rate Alert** will be triggered if the detected heart rate is constantly above 90 over 60s. When set at 0, the function is OFF.

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Figure 9 The Vital Sign panel

7.2.4. Bed-Exit and Body Movement Detection (Movement Detection)

1) Bed Exit Timer: the time threshold to trigger the bed-exit alert. Only when the user leaves the bed and no other moving targets detected within the set time frame will the alert be triggered. It should be set between 30-86400 (unit:s). When set at 0, the function is OFF.
2) Turns Over In Bed Timer: When set at 0, the function is OFF; 1, turns over in bed alert; 2: Sit-up alert; 3: Turn Over In Bed and Sit-Up Alert.



Figure 10 The Movement Detection panel

7.2.5. The Admin panel

The Admin panel in Figure 11 is for authorized personnel ONLY. Please do not edit anything without authorization from the factory.



Figure 11 The Admin panel

8. Software upgrade

The AeroSense Wavve is composed of a radar board and a communication board, using different firmwares.

For OTA upgrade, the device has to be correctly connected to the AeroSenseWavve Tool, and it shows **connected** as seen in Figure 6-1A.

8.1 Radar firmware upgrade

The current radar firmware version is shown in Figure 8, Firmware version. 2.1.70.0 in the Figure.

To upgrade the radar firmware, please **choose** the correct software (.bin), and click upgrade, as shown in the OTA panel in Figure 12. It will read **Upgrade Succeed** if the update is successful. If it fails (**Upgrade failed**), please click the **upgrade** again to do the update.



Figure 12 Radar firmware upgrade (OTA)

8.2 Communication board firmware upgrade

Generally speaking, you don't need to upgrade the firmware of the communication board. If you have to, please see the steps below.

Click the BLE in the Bluetooth Panel in the AeroSenseWavve Tool software to get the current version of the communication board, as seen in Figure 7.

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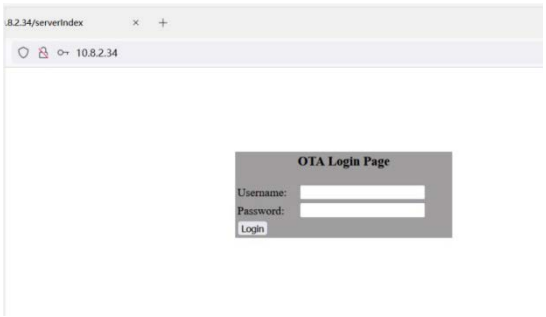
Write down the TCP client IP shown on the top right corner of the AeroSense Wavve Tool, as shown in Figure 13 (10.8.2.30 in this Figure). Please note that the number in the end is the port, not the IP.



Figure 13 The TCP Client IP

In your web browser, enter the Tcp Client IP, for example 10.8.2.30, as seen in Figure 14. Enter the username and password (both **admin)**, and **Login**. (For versions before 0.0.4.4, please contact tech support to get the username and password.)

As seen in Figure 15, in the web page, click **Browse** to choose the correct firmware (.bin), and click **update**. Wait until the progress shows 100%. Wait for another 5s before you close the browser to make sure the transfer is completed. Please note that the name of the software is in the format of **Aerosense_Wavve_OTA. Release 0.0.4.X. bin**. Please choose the right software and do not misuse the radar firmware.



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Figure 14 Upgrade the communication board-user name and password

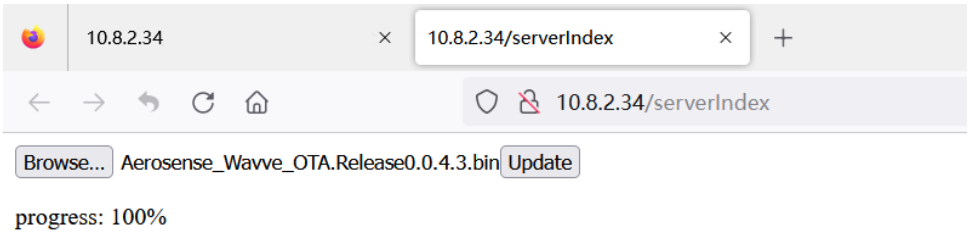


Figure 15 Upgrade the communication board

9. Support

Please contact support@ax-end.com for any help or more information.

Appendix I: Setup the network using the AeroSense Tool for Android

If your computer doesn't support Bluetooth, please use the Android Tool to complete the network configuration. See steps below.

1) Please scan the code below to download and install the AeroSense Tool in your Android phone.



Figure 16 To download the network configuration tool using an Android phone

2) Plug in the AeroSense Wavve. Press and hold the Home button until the LED indicators flash blue. It will take about 3-5 seconds. Enable 'Location' and 'Bluetooth' in your Android phone.
3) In the AeroSense Tool APP, select **Wavve** (Figure 17A).
4) Click '**SCAN BLUETOOTH**". Wait until it shows **Connecting**!, as shown in Figure 17B. If you cannot see this message, press and hold Home button for about 3 seconds to reset the device, until the LED flash blue. Repeat Step 3 and Step 4.
5) As shown in Figure 17C, enter the name and password of your Wifi network. Click **SET WIFI**. If it's successful, you will see a pop up message (**Setting success)**, as shown in Figure 17C.
6) As shown in Figure 17D, enter the server IP and port (8899), and click **SET SERVER**. If it's successful, you will see a pop up message (**Setting success)**, as shown in Figure 17D.
7) Turn off **Bluetooth** in your phone. In a few seconds, the LED indicator on the device will be constant blue, indicating successful network configuration. You can then use the PC software to test the performance of the device.
8) If the LED keeps flashing blue, please check whether the Bluetooth in your phone is still on.

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9) When the LED is red, the device is connecting to the server. Please turn on the server by clicking **Start Server** as shown in Figure 18, and the LED will be blue indicating a successful connection.

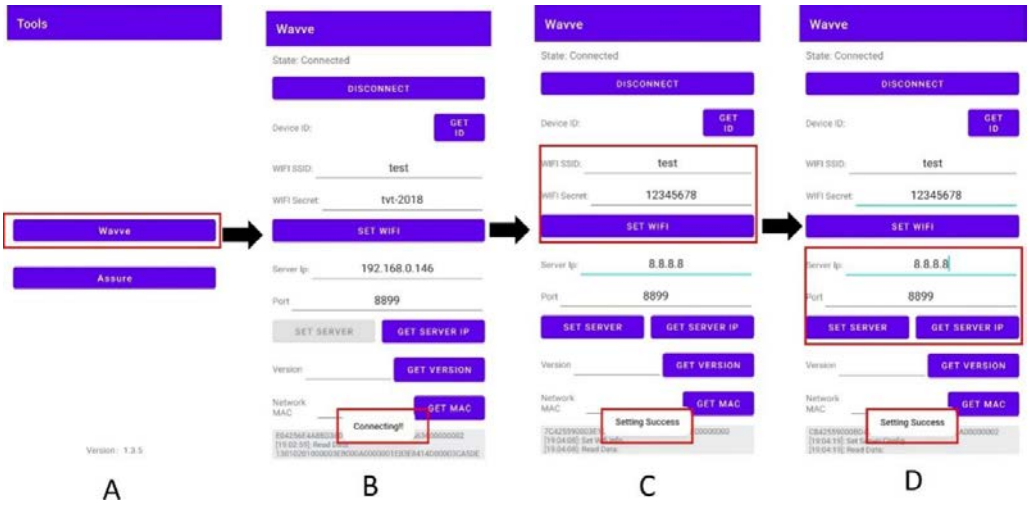


Figure 17 Network configuration using the AeroSense Tool in Android

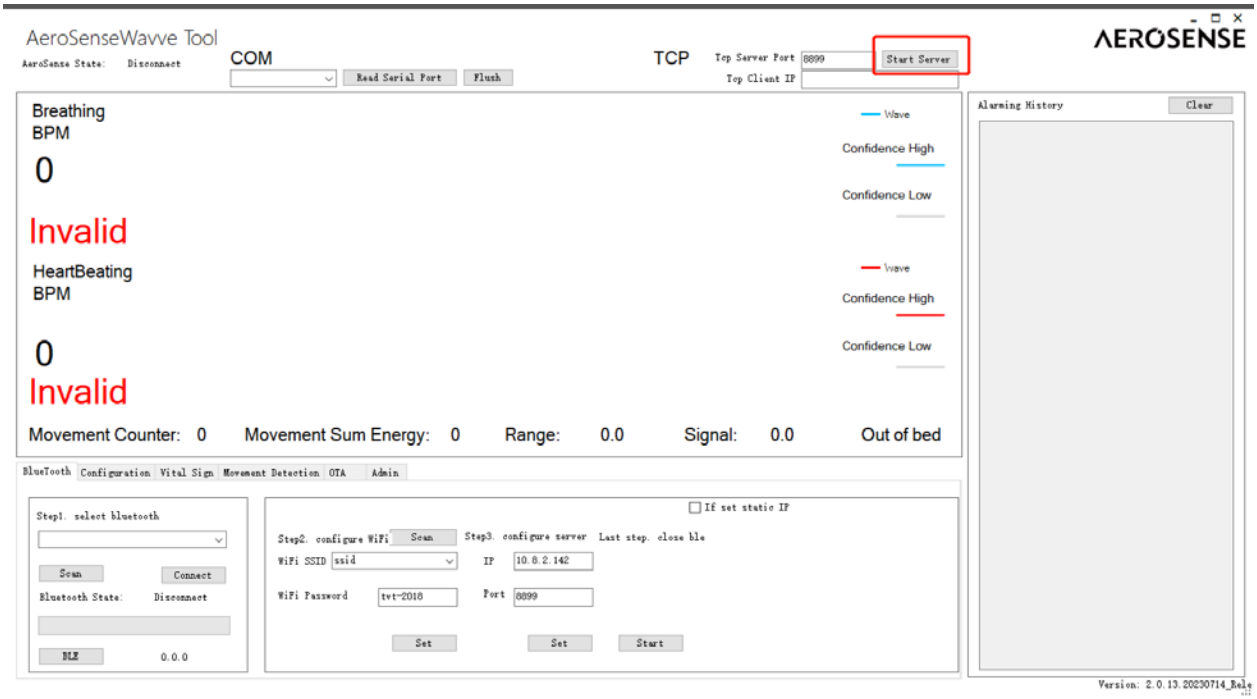


Figure 18 Start Server in the AeroSenseWavve Tool

Appendix II: To use the WiFi to transfer data in the AeroSenseWavve Tool

When using the AeroSenseWavve Tool, it is recommended to use the Bluetooth to transfer data to avoid delay due to network latency or fire wall. If you need to transfer data using WiFi, please see steps below.

1) Please complete the Bluetooth setting.
2) In the AeroSenseWavve Tool, the **Bluetooth** panel, enter the **WiFi SSID/WiFi Password** in **Step2. Configure**, as seen in Figure 19. Alternatively, click **Scan** and select the correct WiFi network in the drop-down list. Enter the correct password and click **SET**. Wait until you see the **Write succeed** message in the right window. See Figure 19.
3) See Figure 20. Enter the **IP** and **Port** (8899) in **Step3. configure server**. Click **SET**. Wait until you see the **Write succeed** message in the right window.
4) Turn off Bluetooth in your computer. Alternatively, you can click Start in Step3. configure server, see Figure 21.
5) The device will access the network using dynamic IP by default. If you want to use static IP, please click the **If set static IP** in the **Bluetooth** panel. In Step4 (Optional). configure static ip, enter the static IP paraments.

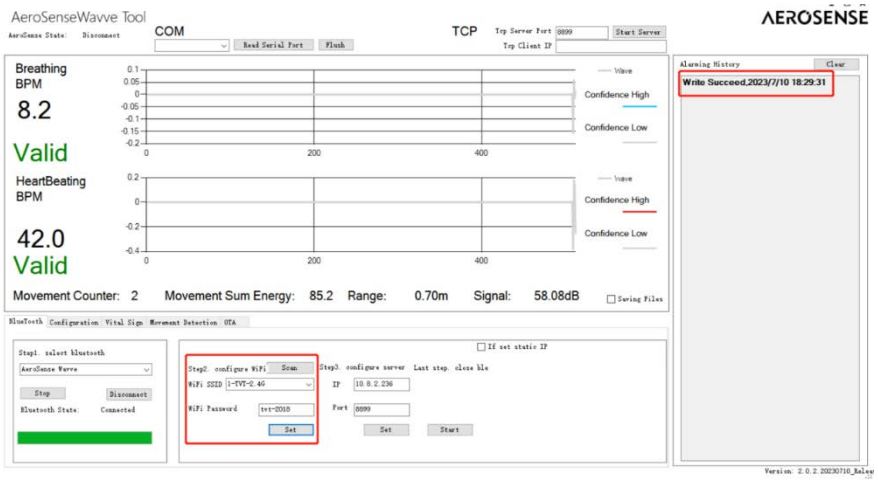


Figure 19 To set the WiFi network

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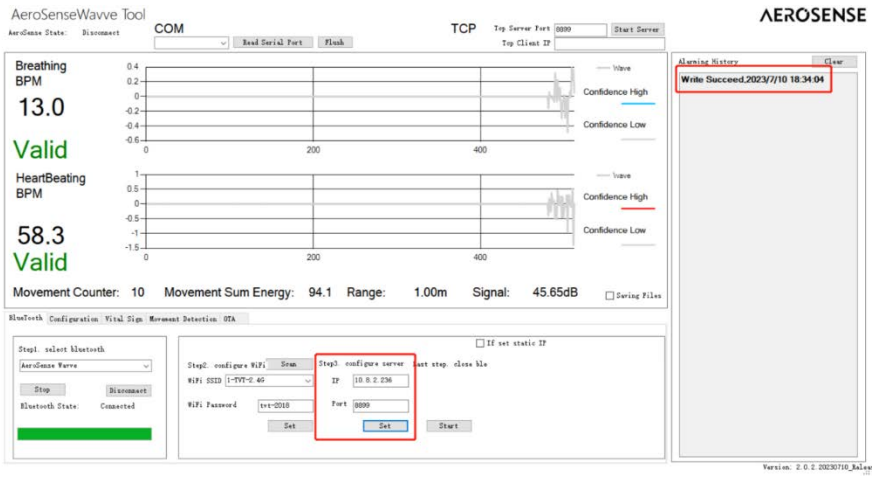


Figure 20 Set up the server



Figure 21 To turn off the Bluetooth



Figure 22 To set the WiFi and server

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