WF88 MQTT Application Note

Amp'ed RF Technology, Inc.

WF88 MQTT Application Note

1. Mesh Network to MQTT Broker

We build a Mesh network so that STA node can connect to the MQTT Broker through a Gateway.

1.1. Network topology diagram

As shown in the network topology diagram in Figure 1-1. If MQTT Broker supports IPV6, the entire network should be configured using IPV6. If MQTT Broker only supports IPV4, the entire network may be configured using IPV4.

The Gate needs to be in the same network segment as the router. STA and Gate first establish normal Mesh communication, and they must be in the same network segment as well. Ensure that PC, Gate and STA can access MQTT Broker normally. Since the MQTT Broker in the figure is on the Internet, the PC, Gate and STA need to be able to access the Internet normally. *Note: a public Broker cannot usually support a ping.* Use the "ping 8.8.8.8" (Google DNS) command to test on the PC, Gate and STA to confirm that the Internet can be accessed.


Figure 1-1. Network topology diagram

1.2. Gate Configuration

Use the WF88 configuration tool to configure the parameters of Gate.

(1) Start the WF88 configuration tool, as shown in Figure 1-2.

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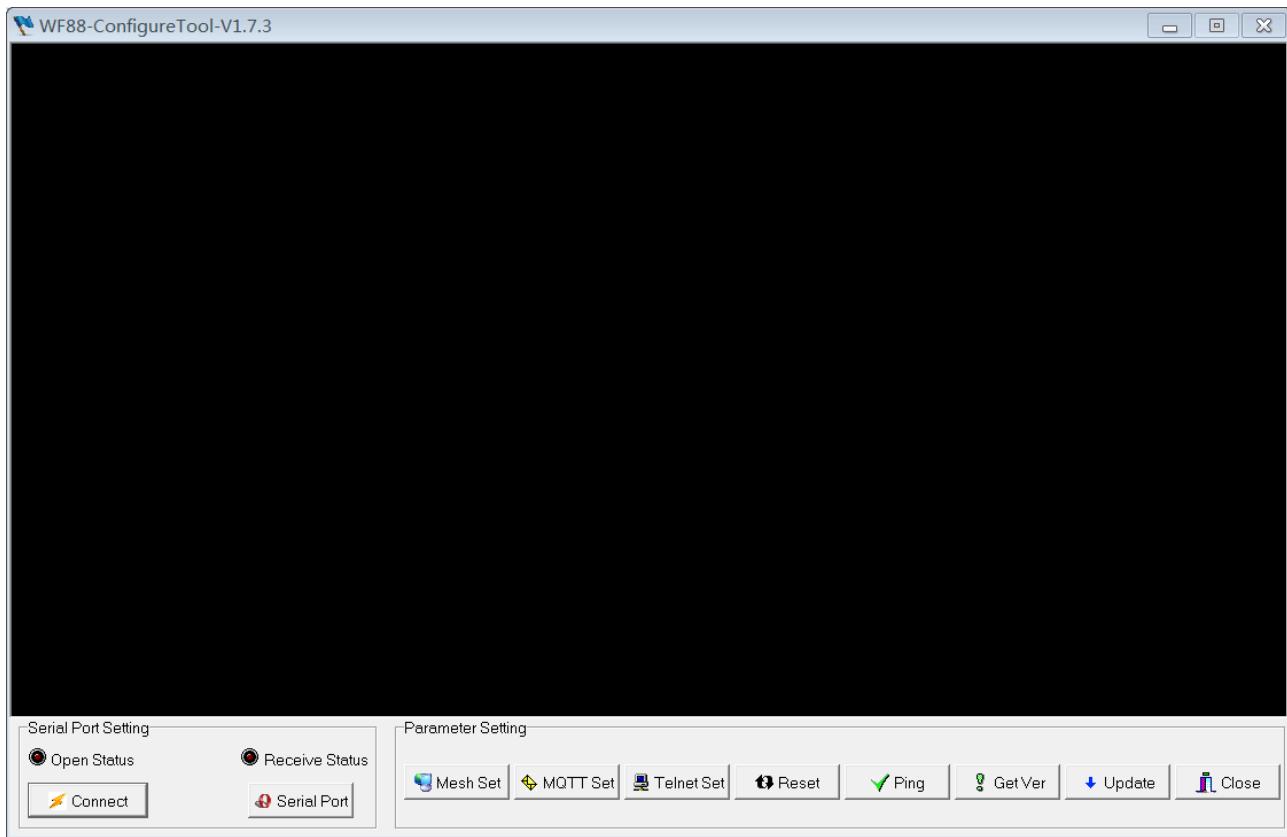
Figure 1-2. WF88 configuration tool

(2) Clicking the "Serial Port" button will bring up the "Setup" dialog box. Select the serial port number of the PC connected to the WF88 debugging serial port from the "Port" drop-down list as shown in Figure 1-3.
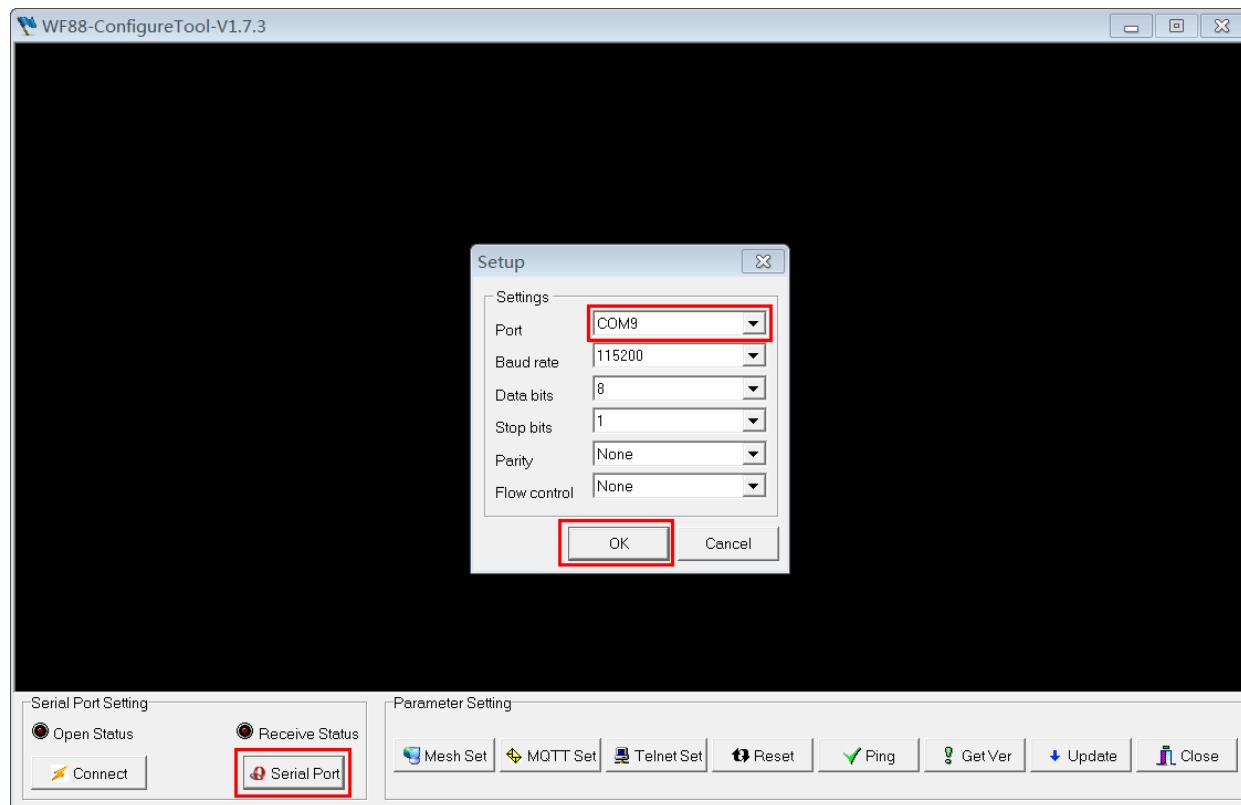

Figure 1-3. The serial port configuration.

(3) Click the "Connect" button to open the serial port, as shown in Figure 1-4.
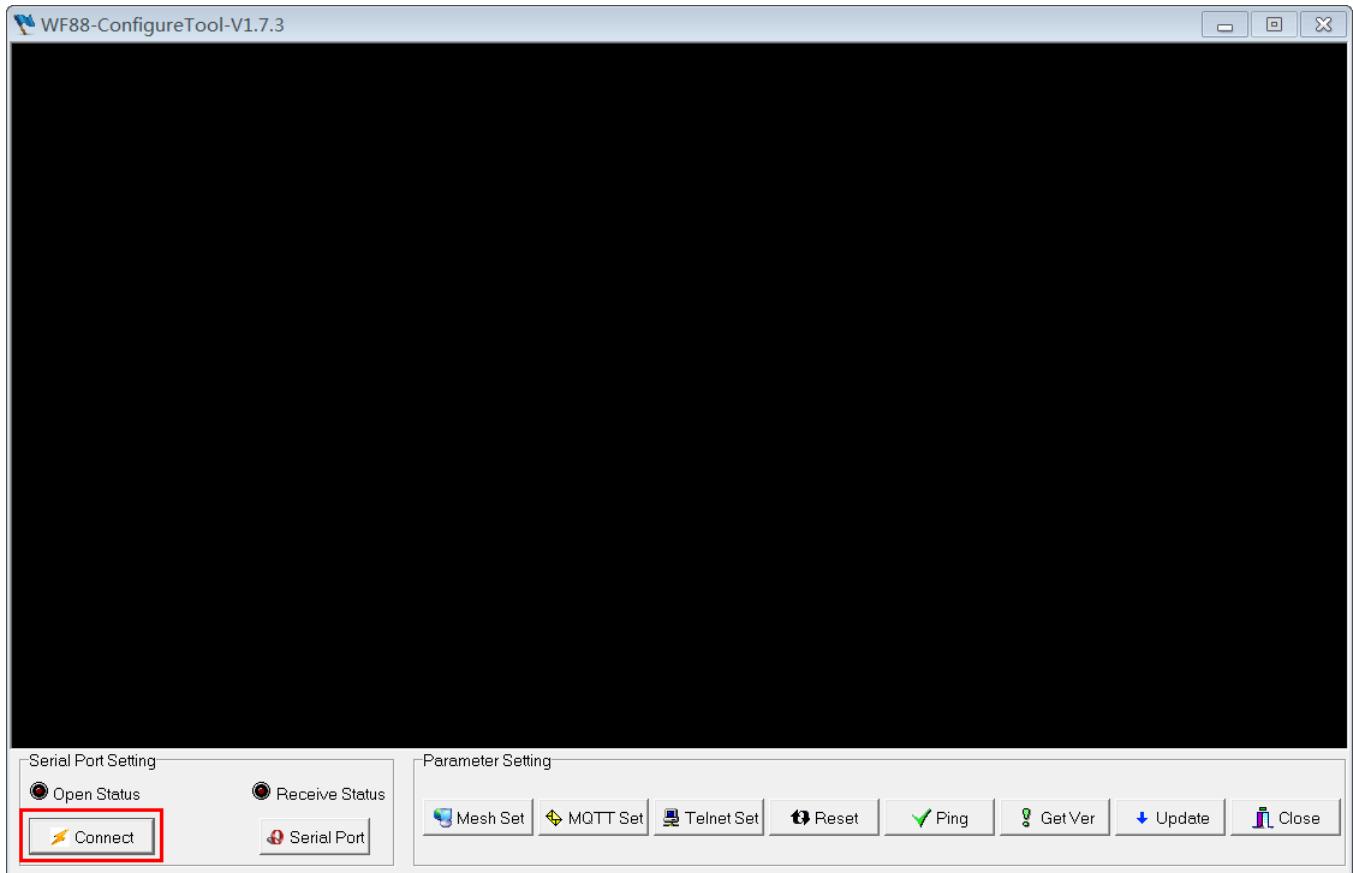
Figure 1-4. Open the serial port

(4) Click the "Mesh Set" button to bring up the "Mesh Set" dialog box. Select "Gate (Connect to Mesh)" from the "Node Type" drop-down list. Enter the Mesh name and corresponding password in the "Mesh Name" and "Password" editing boxes. Select "2.4G" from the "Band" drop-down list. Select "India" from the "Country" drop-down list. Select "6" from the "Channel" drop-down list. Select the corresponding IP version based on the user's network support in the "IP Version" drop-down list, and enter the IP address in the corresponding IP version below. Finally, click the "Save" button. As shown in Figure 1-5 and Figure 1-6.
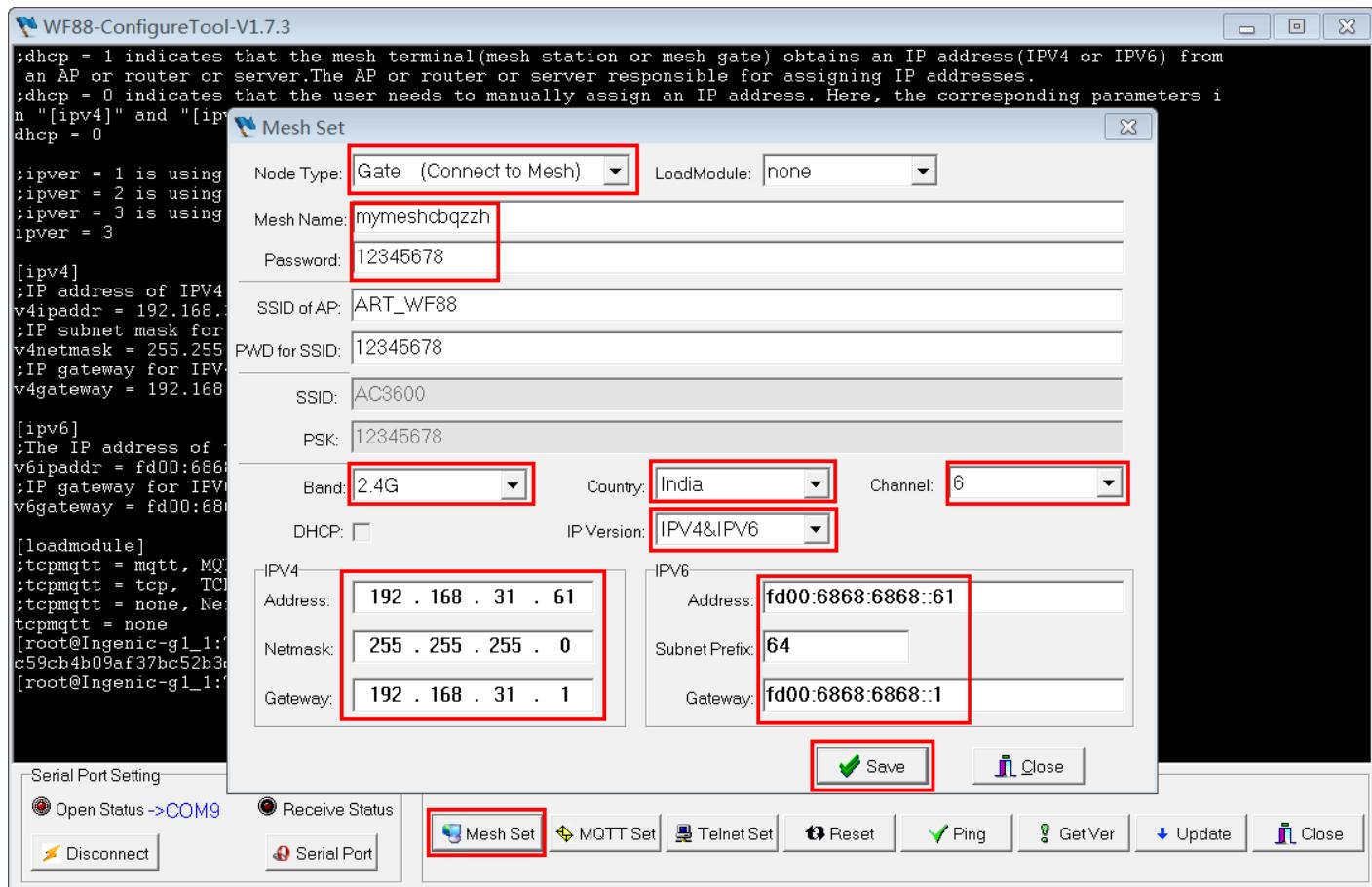
Figure 1-5. Mesh Set configuration for Gate
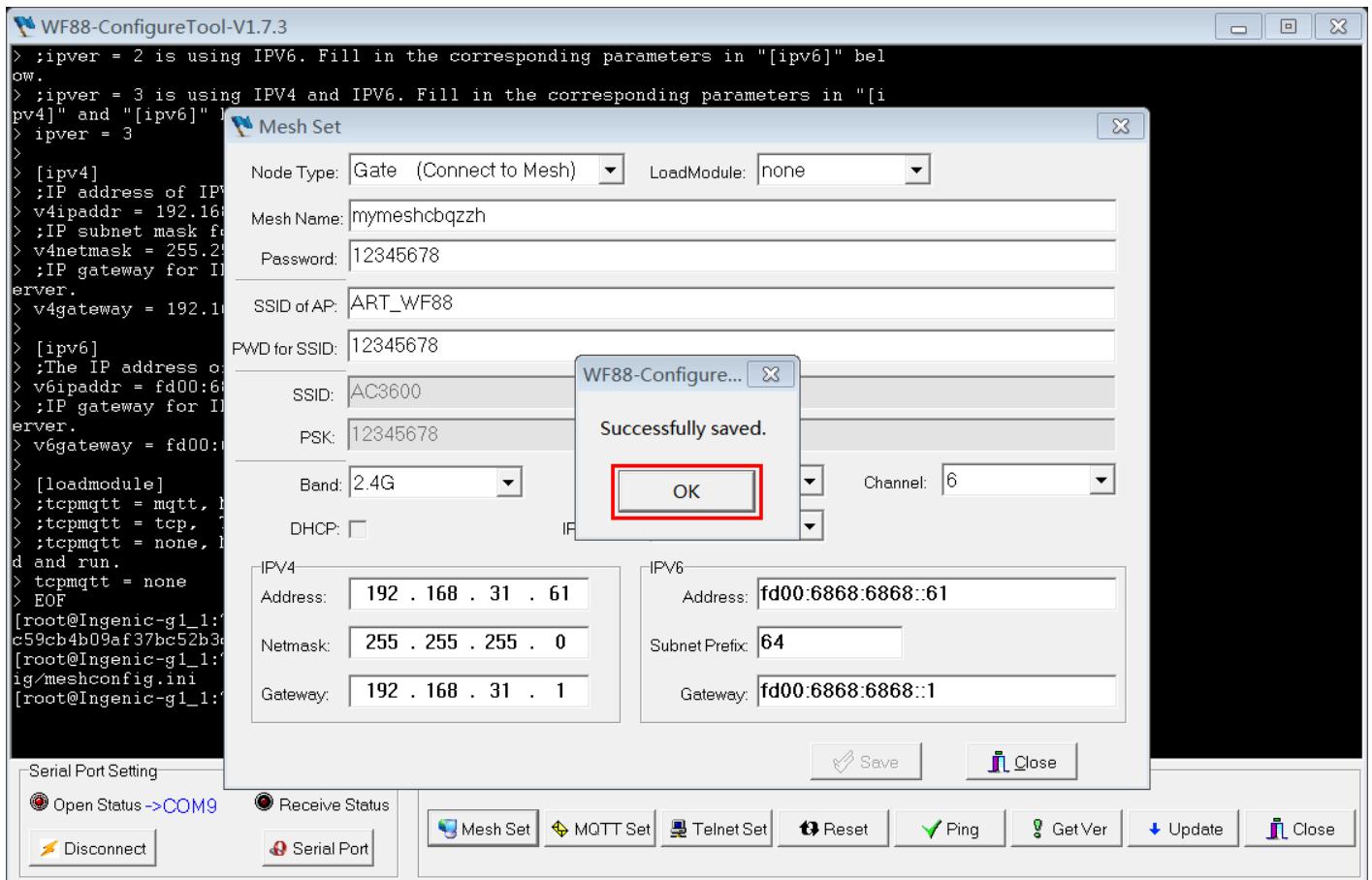
Figure 1-6. Successfully saved

(5) Click the "Reset" button to restart, as shown in Figure 1-7.
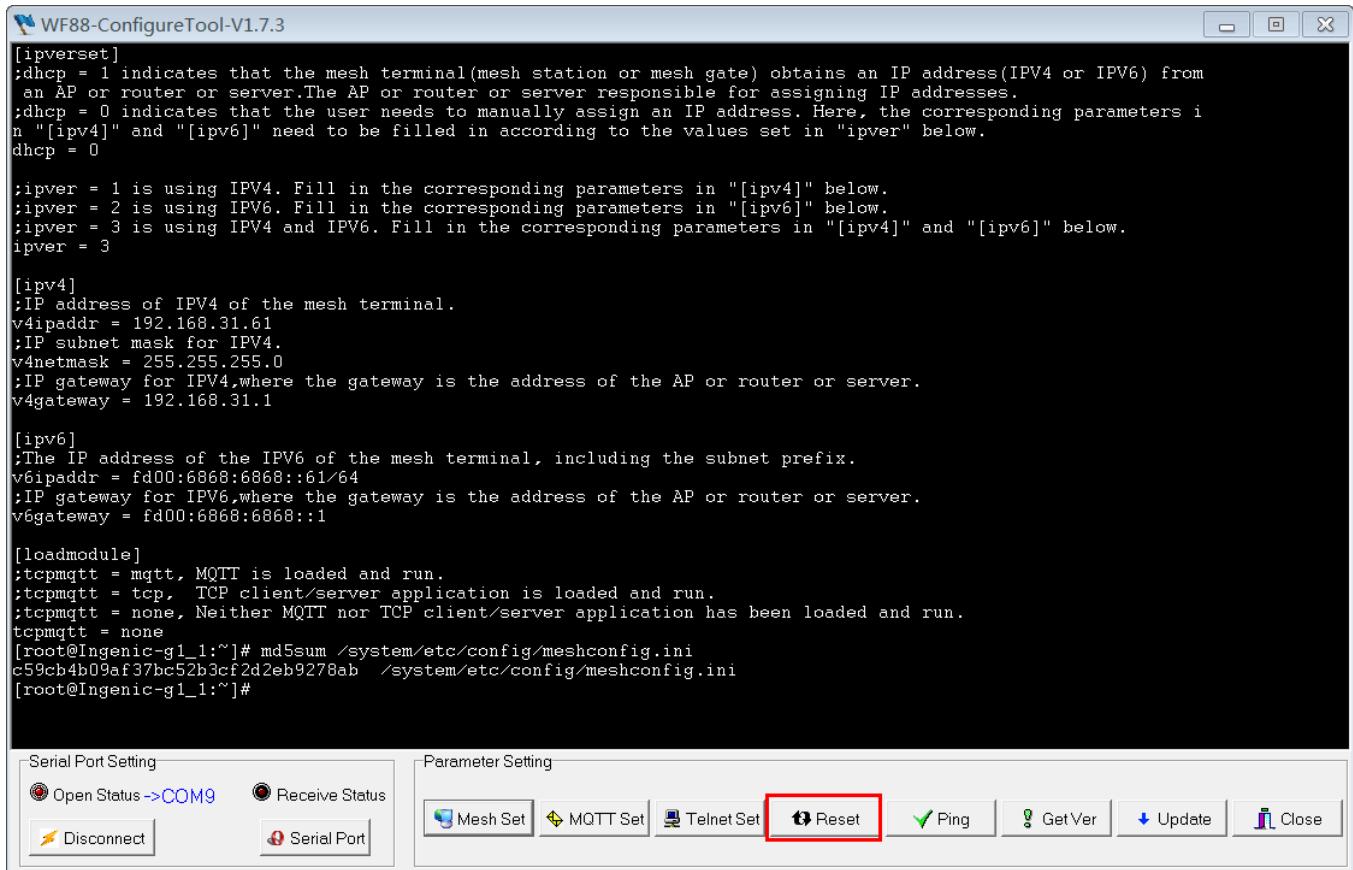
Figure 1-7. Reset

(6) After the system restarts, clicking the "Ping" button will bring up the "Ping Test" dialog box. Enter the IP address to be tested in the "PingIP" editing. If MQTT Broker accepts the ping command, it can directly ping its IP address. If the MQTT Broker does not accept the ping command and is still on the Internet, you can ping the 8.8.8.8 IP address as shown in Figure 1-8. The ping test indicates if Gate can access the network.
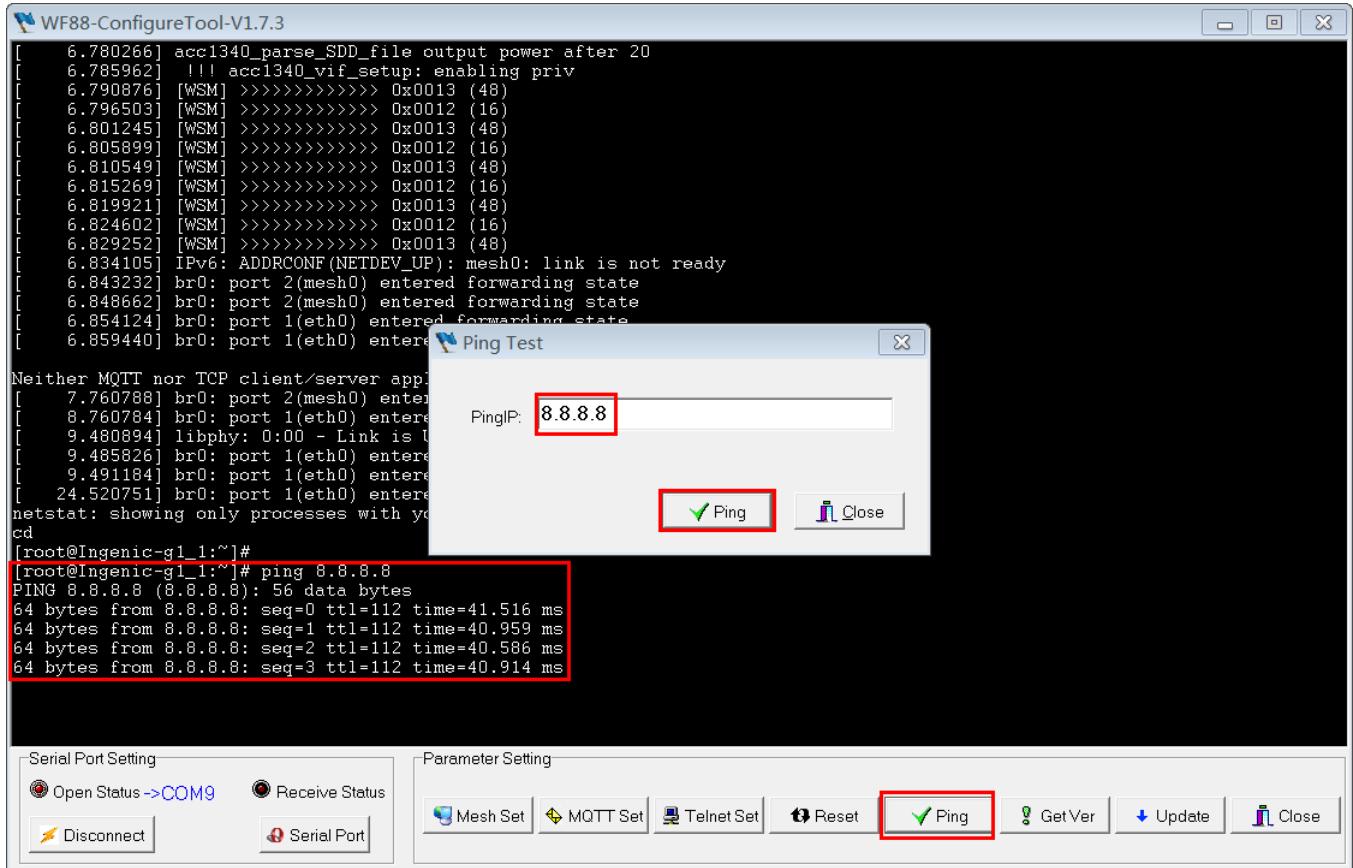
Figure 1-8. Ping Test

(7) The setting of Gate is completed.

1.3. Configure the parameters of STA

Use the WF88 configuration tool to configure the parameters of STA next. (identical steps to above are skipped)

Click the "Mesh Set" button to bring up the "Mesh Set" dialog box. Select "Station (Connect to Mesh)" from the "Node Type" drop-down list. Select "MQTT" from the "LoadModule" drop-down list. Enter the Mesh name and corresponding password in the "Mesh Name" and "Password" editing boxes. Select "2.4G" from the "Band" drop-down list. Select "India" from the "Country" drop-down list. Select "6" from the "Channel" drop-down list. Select the corresponding IP version based on the user's network support in the "IP Version" drop-down list, and enter the IP address in the corresponding IP version below. *The settings for "Mesh Name", "Password", "Band", "Country", "Channel", and "IP Version" must be consistent with those in Gate*. Finally, click the "Save" button. As shown in Figure 1-9.
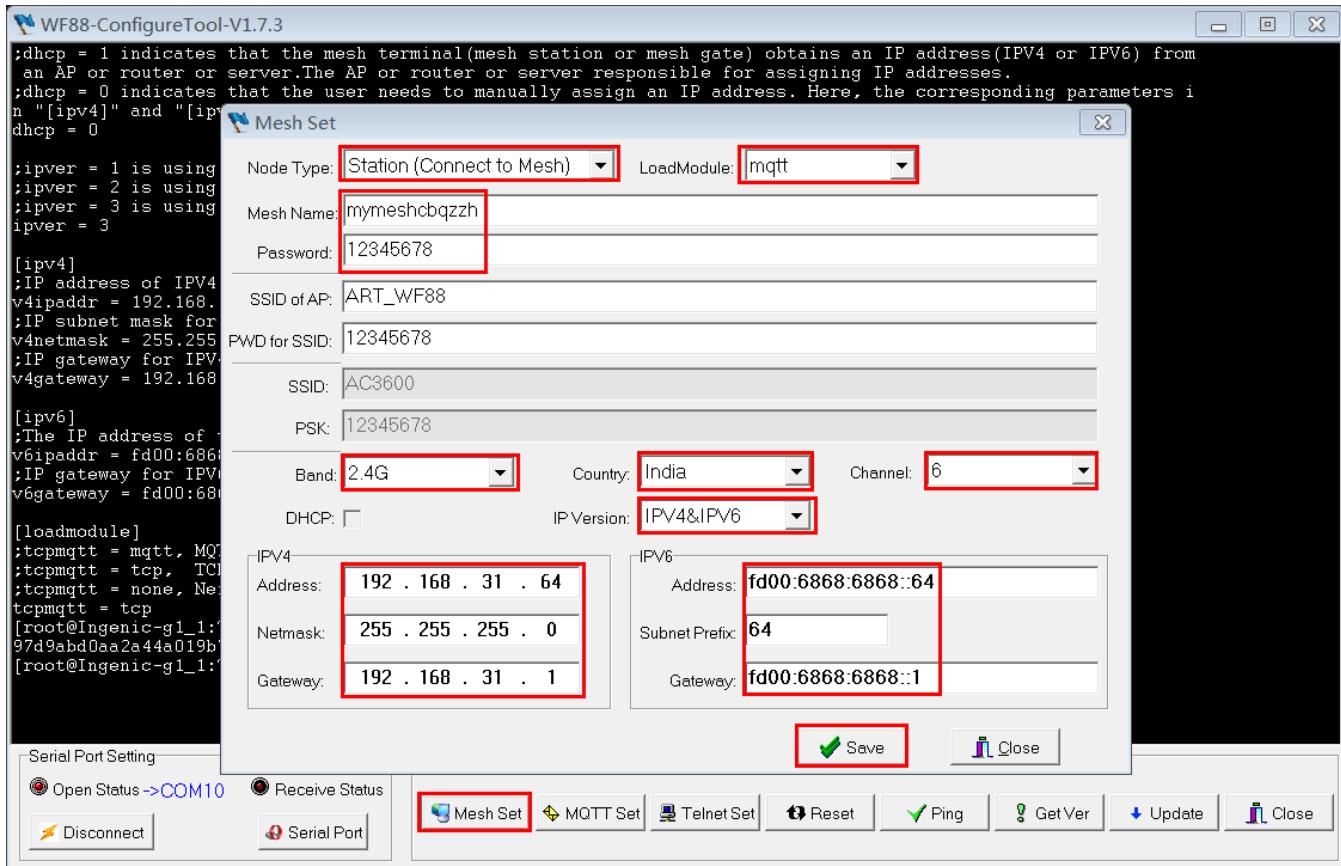
Figure 1-9. Mesh Set configuration for STA

(1) Click the "MQTT Set" button to bring up the "MQTT Set" dialog box. Select "TCP" from the "Protocol" drop-down list. Enter the IP address "44.232.241.40" of the MQTT Broker in the "ServerIP" editing box. STA itself supports accessing MQTT Broker for IPV6. Enter the port "1883" of MQTT Broker in the "RemotePortNum" editing box. Other options can be set to default values. Finally, click the "Save" button. As shown in Figure 1-10.

"UART0 BaudRate" represents the communication rate of the UART0 interface of WF88.

The port number of MQTT Broker corresponds to Protocol (tcp/ssl), which means that when using "tcp" protocol, there is a corresponding port number; when using "ssl" protocol, it will correspond to another port number.

"UserName" and "PassWord" indicate that MQTT Broker requires a username and password to establish a connection.

"SubTopic" represents topic the client subscriptions to, with a default value of "SToC"; "PubTopic" represents topic the client publishes to, with the default value being "CToS"; "KeepAliveInterval" refers to the time interval in seconds during which MQTT client sends keep alive messages to MQTT Broker; "QoS" refers to quality of service, with a default value of "0"; "ClientId" represents the ID of the MQTT client.

"OpenCert" and "OpenKey" indicate that MQTT Broker requires a client certificate and client private key to

establish a connection.

The five options of "UserName", "PassWord", "OpenCert", 'OpenKey", and "OpenCA" need to be filled in according to the protocol and access requirements of MQTT Broker. If necessary, they should be filled in according to the requirements. Otherwise, they can be left blank by default.


Figure 1-10. MQTT Set configuration for STA

(2) Click the "Reset" button to restart.

(3) After the system restarts, we will see a prompt message similar to "mesh0: mesh link with 00:80:e1:2f: 58:26 established", indicating that the Mesh network has been successfully established. As shown in Figure 1-11.

Figure 1-11. Mesh network has been successfully established

(4) A prompt message "Device Setup complete." indicates that the MQTT connection has been successfully established, as shown in Figure 1-12.

Figure 1-12. MQTT connection has been successfully established

(5) If we don't see similar prompt messages, you can test whether the network communication is correct from the STA. Clicking the "Ping" button will bring up the "Ping Test" dialog box. Enter the IP address to be tested in the "PingIP" editing. First, test communication with Gate. Input "192.168.31.61" for testing. As shown in Figure 1-13, ping test of the Gate indicates connectivity with the STA.

If MQTT Broker accepts the ping command, the STA can directly ping its IP address. If the MQTT Broker does not support the ping command and is still on the Internet, you can ping the 8.8.8.8 IP address. As shown in Figure 1-14, ping test indicates if STA can access the network or Broker.
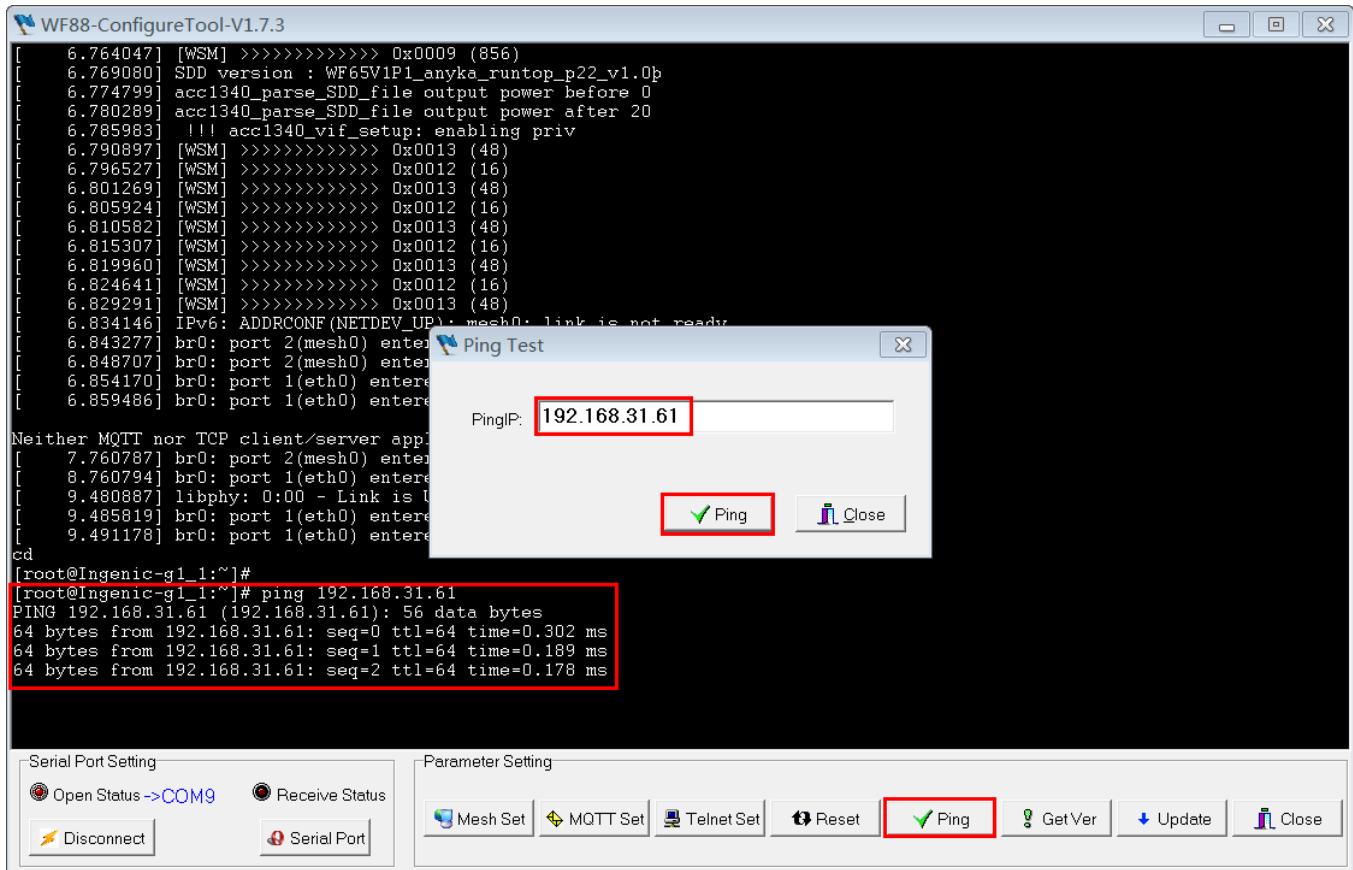
Figure 1-13. Ping test Gate
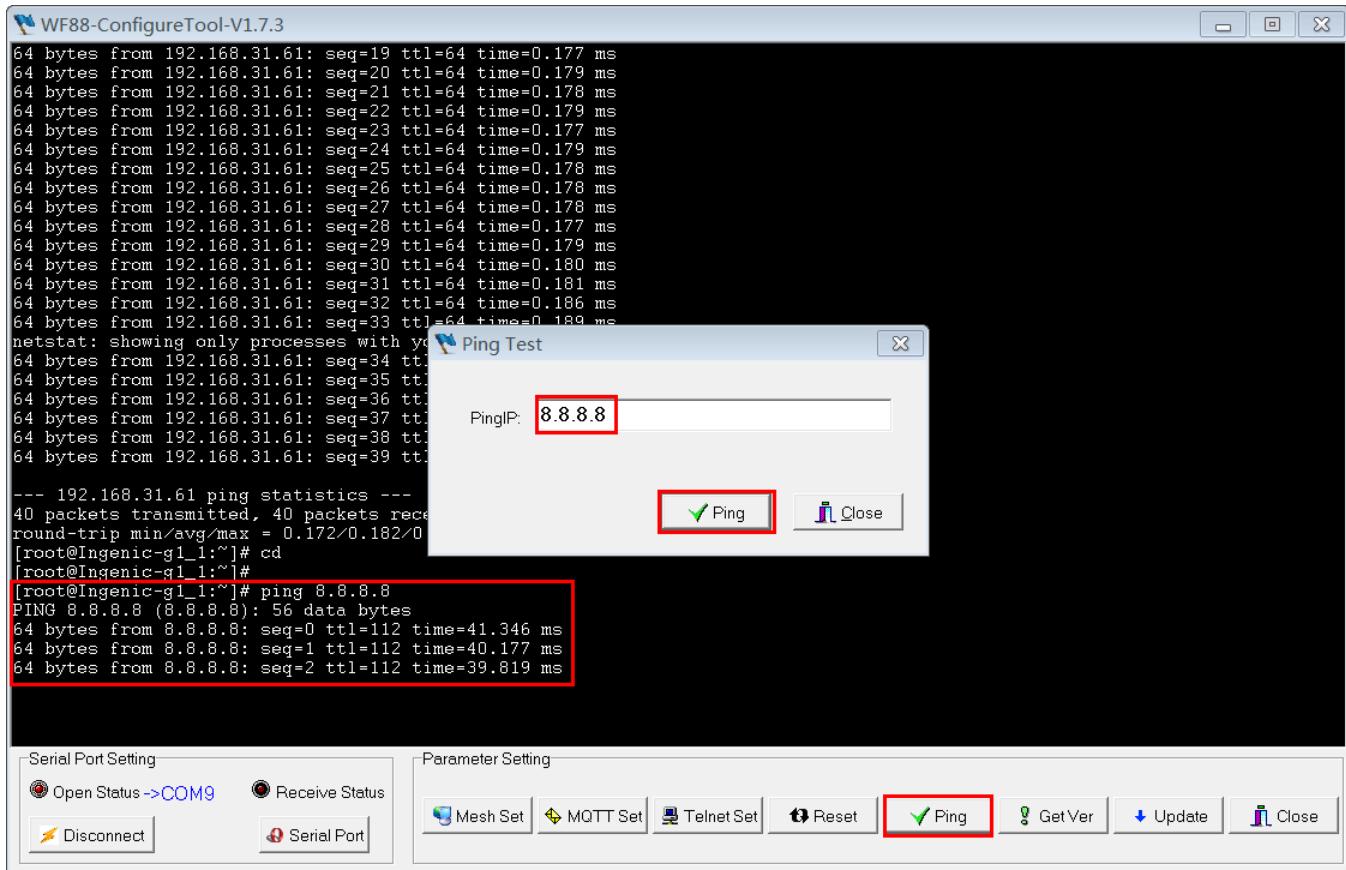
Figure 1-14. Ping test

(8) The setting of STA is completed.

1.4. MQTT Broker and Client Tool

Use the **mqttfx-1.7.1-windows-x64.exe** as the client the "**broker.emqx.io**" website for this example. This is a public Broker test site. Note that this test site does not support Username & Password for login authorization.

(1) Running **MQTT.fx** will bring up its main interface, and clicking on the blue gear icon will bring up the "Edit Connection Profile" dialog box, as shown in Figure 1-15.
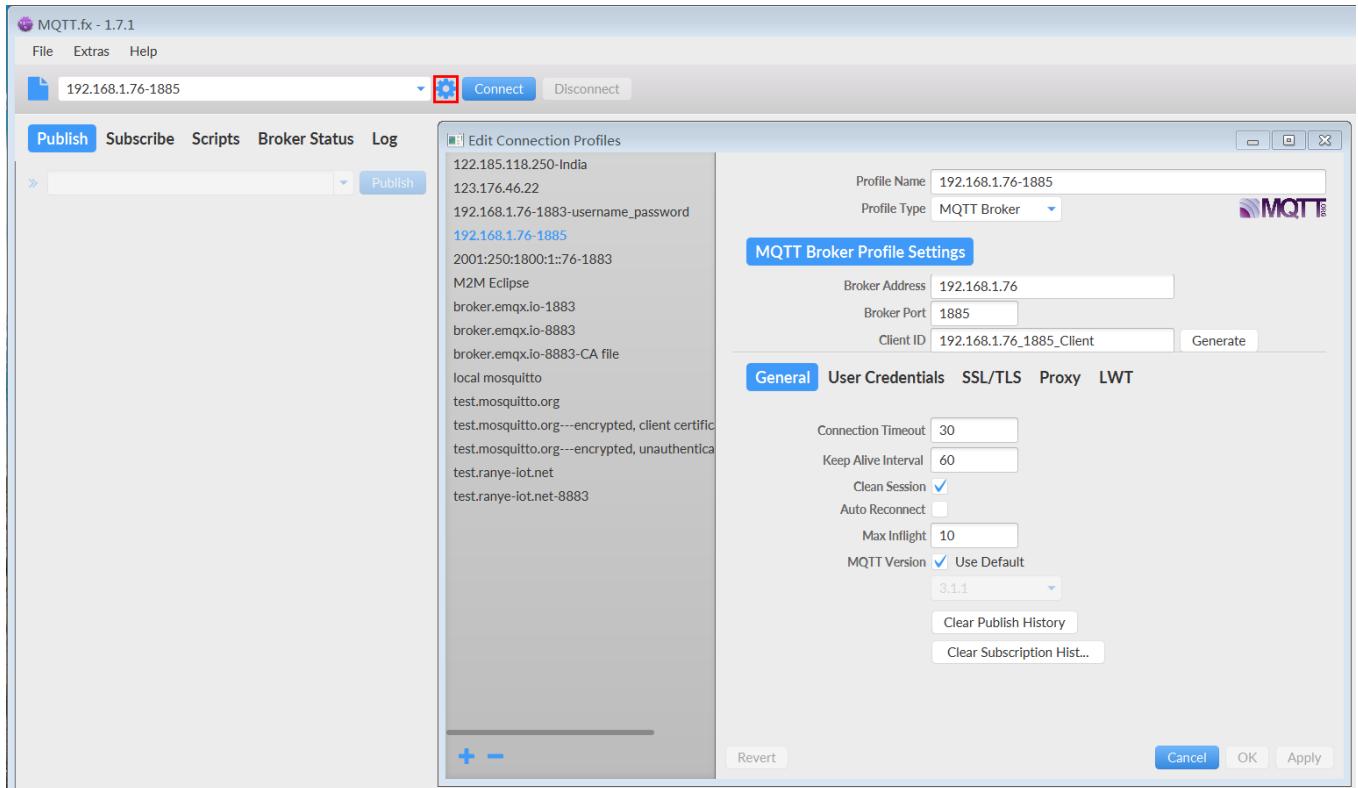
Figure 1-15. Edit Connection Profile

(2) In the "Edit Connection Profiles" dialog box, click the blue plus sign ("+") icon in the bottom right corner to create a new profile. Enter the name of the configuration file in the "Profile Name" edit box. Enter the MQTT Broker domain name "broker.emqx.io" in the "Broker Address" edit box. The default "Broker Port" is 1883. Clicking the "Generate" button will generate a Client ID. Select the "Auto Reconnect" checkbox. Finally, click the "OK" button to complete the configuration. As shown in Figure 1-16.
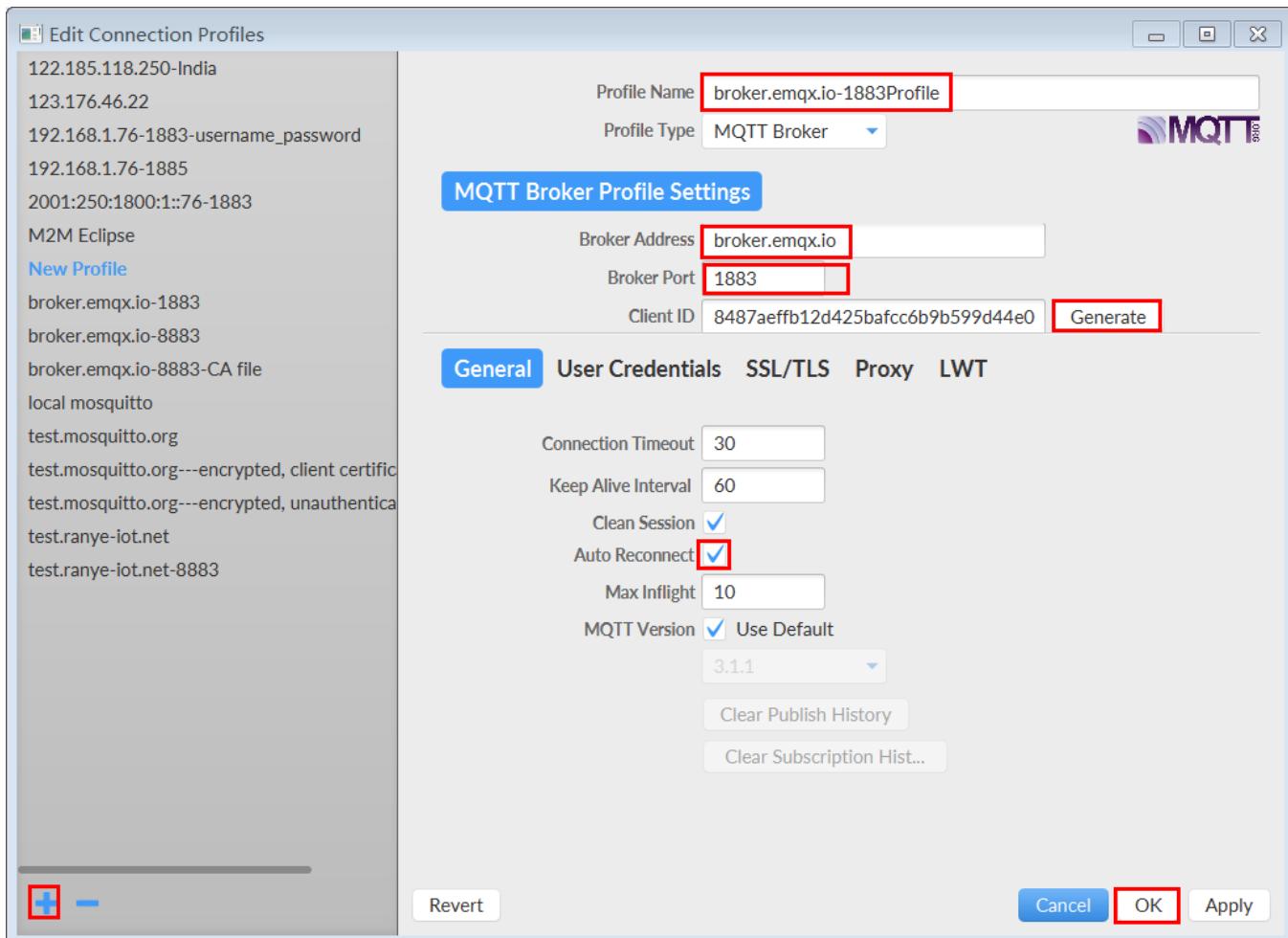
Figure 1-16. Create a new profile

(3) Click the "Connect" button to successfully establish a connection with MQTT Broker, and a green circle will appear in the upper right corner of the window. As shown in Figure 1-17.
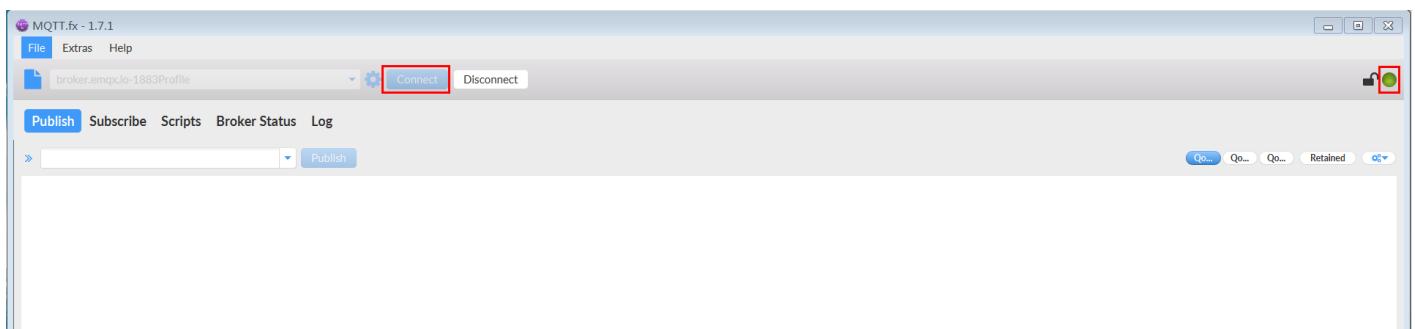

Figure 1-17. Connect to MQTT Broker

(4) Use a serial debugging term tool to connect to the UART0 port of WF88.

(5) Publish data to WF88, click on the "Publish" tab, then enter "T00:80:E1:17:CE:20/StoC" in the editing box

below, and enter "Publish a test." as the content to be sent. Finally, click the "Publish" button. It should receive the corresponding content in the serial term tool of the STA. As shown in Figure 1-18 and 1-19.

Format for: T + MAC address/Topic, for which T is fixed to character, the MAC address is WF88's own MAC. Topic is defined in the "SubTopic" of the "MQTT Set" dialog box.
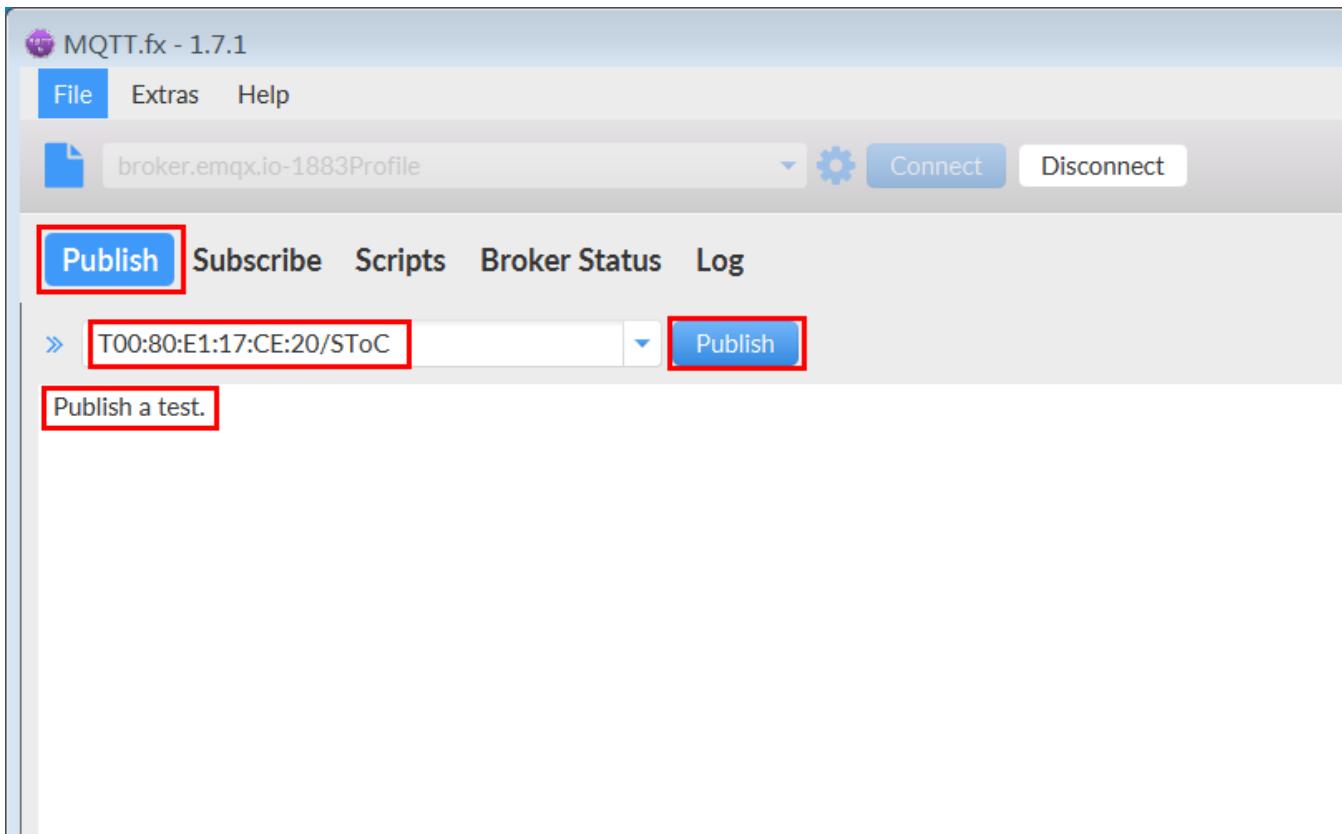

Figure 1-18. Publish data to WF88
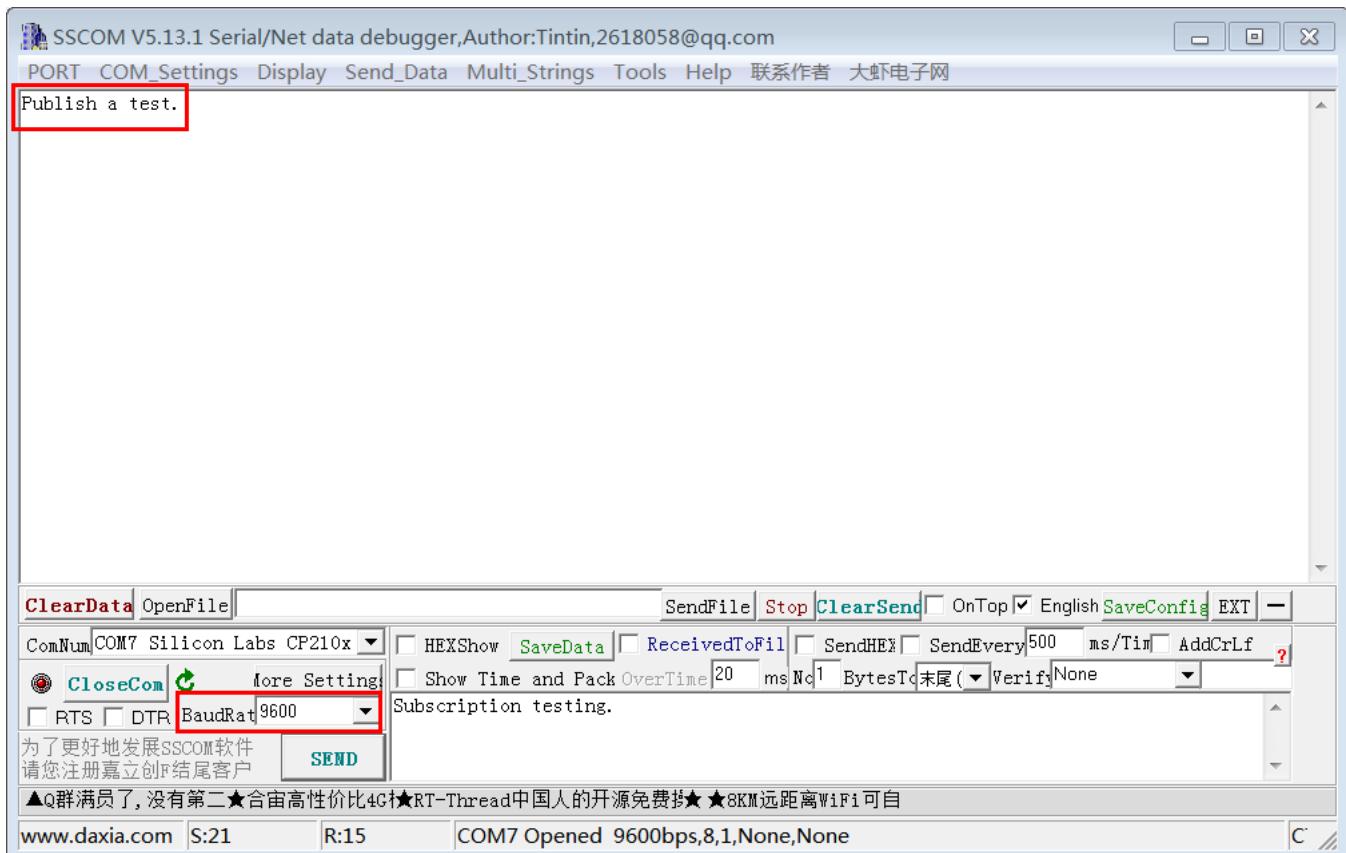
Figure 1-19. Receive a published message

(6) To subscribe to data from WF88, click on the "Subscribe" tab, then enter "T00:80:E1:17:CE:20/CToS" in the edit box below, and click the "Subscribe" button. Send "Subscription testing." through the serial port debugging software. MQTT.fx can receive the content from the WF88 STA. As shown in Figure 1-20 and 1-21.

Format for: T + MAC address/Topic, for which T is fixed to character, the MAC address is WF88's own MAC. Topic is defined in the "PubTopic" of the "MQTT Set" dialog box.
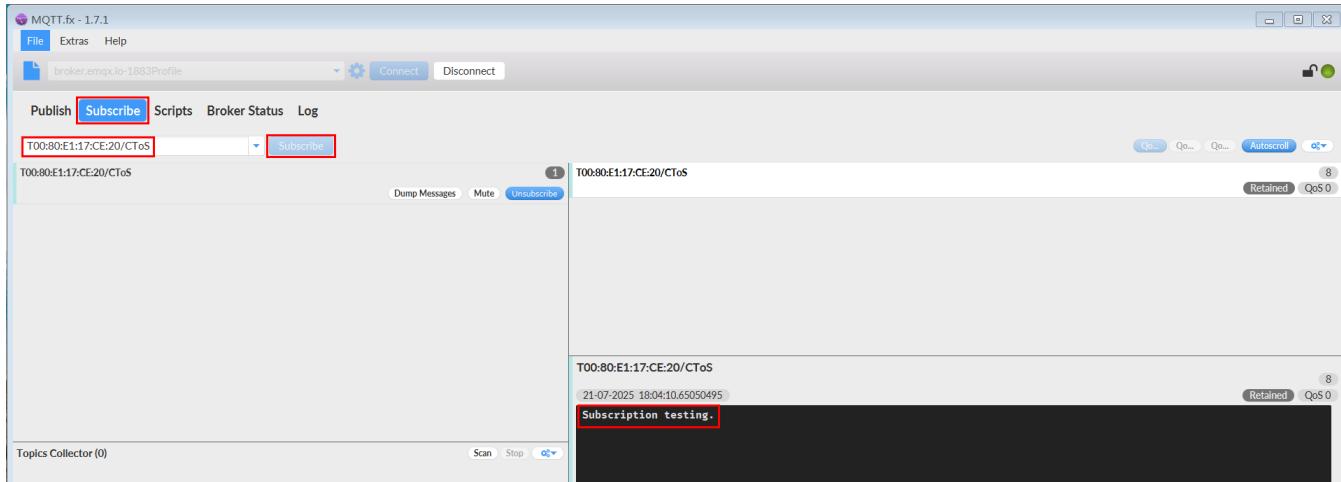
Figure 1-20. Subscribe to data from WF88
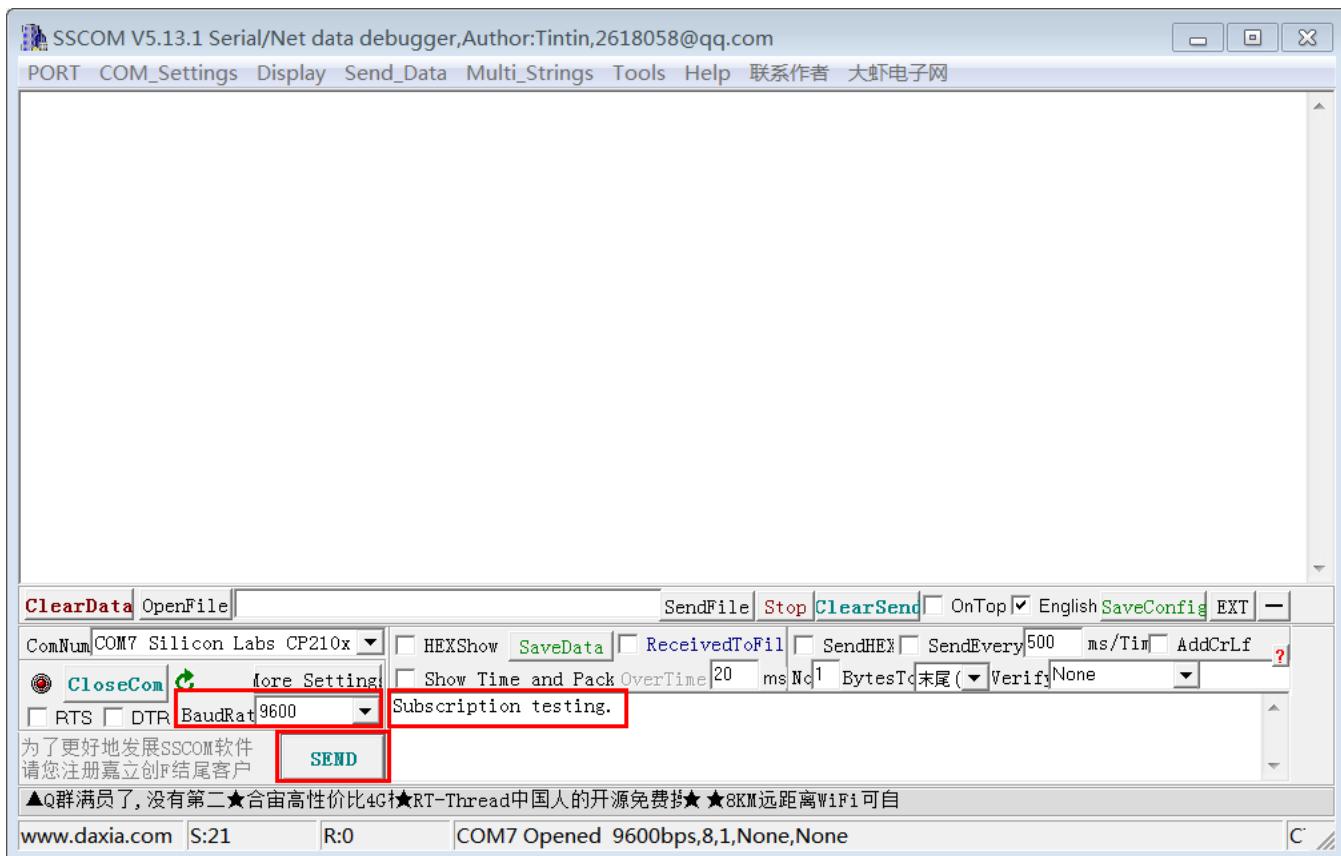
Figure 1-21. Send a message to MQTT.fx

2. Connect to MQTT Broker through AP using STA mode

Set up a Wi-Fi network so that node can connect to AP in STA mode (without mesh) and access MQTT Broker through the network.

2.1. Network topology diagram

As shown in the network topology diagram in Figure 2-1. If MQTT Broker supports IPV6, the entire network should be configured using IPV6. If MQTT Broker only supports IPV4, the entire network may be configured using IPV4.

The Gate needs to be in the same network segment as the router. STA and Gate first establish normal Mesh communication, and they must be in the same network segment as well. Ensure that PC, Gate and STA can access MQTT Broker normally. Since the MQTT Broker in the figure is on the Internet, the PC, Gate and STA need to be able to access the Internet normally. *Note: a public Broker cannot usually support a ping.* Use the "ping 8.8.8.8" (Google DNS) command to test on the PC, Gate and STA to confirm that the Internet can be accessed.

Figure 2-1. Network topology diagram

2.2. STA Configuration

Use the WF88 configuration tool to configure the parameters of STA.

(1) Start the WF88 configuration tool, as shown in Figure 2-2.
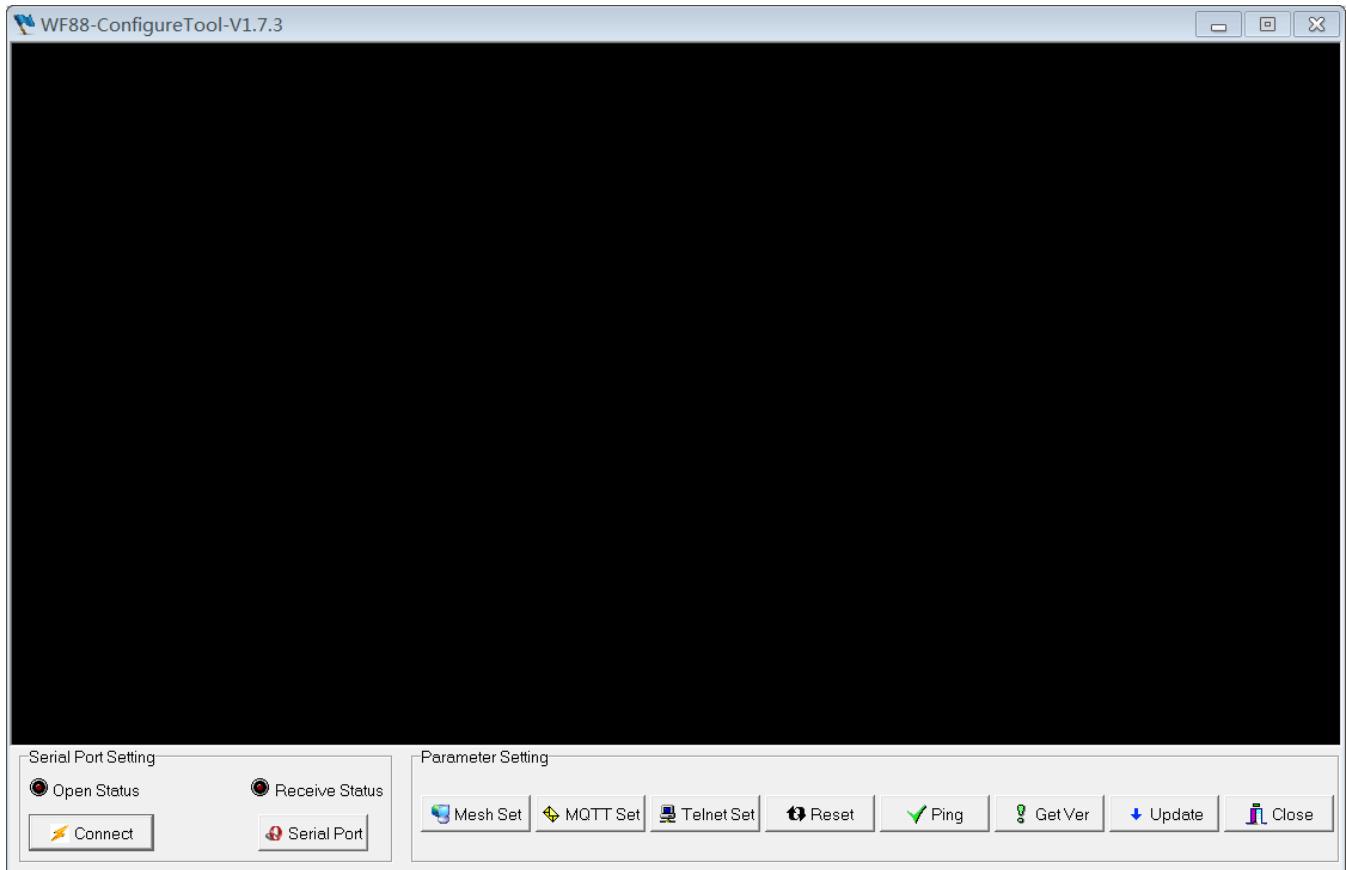
Figure 2-2. WF88 configuration tool

(2) Clicking the "Serial Port" button will bring up the "Setup" dialog box. Select the serial port number of the PC connected to the WF88 debugging serial port from the "Port" drop-down list as shown in Figure 2-3.
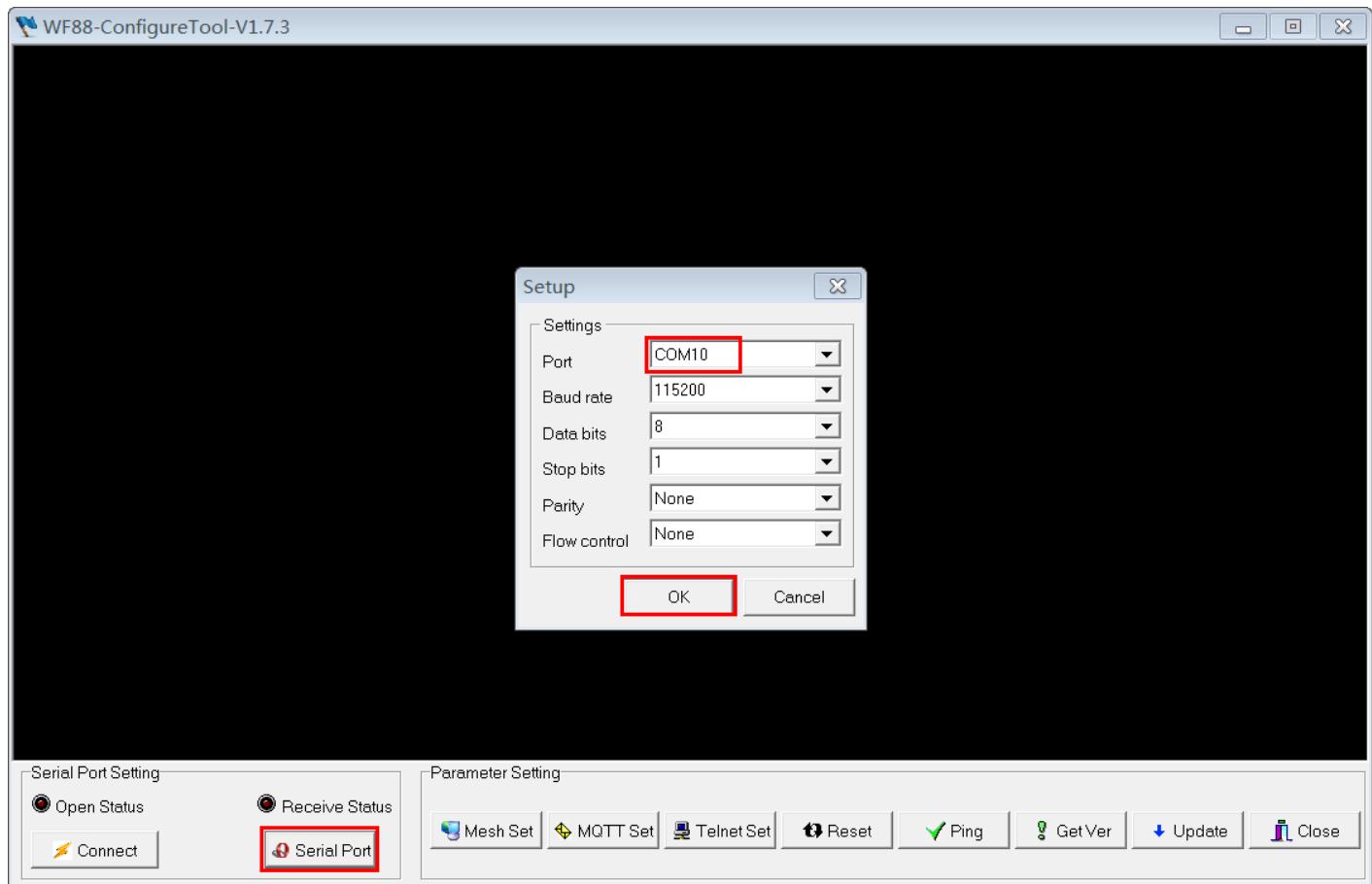
Figure 2-3. The serial port configuration

(3) Click the "Connect" button to open the serial port, as shown in Figure 2-4.
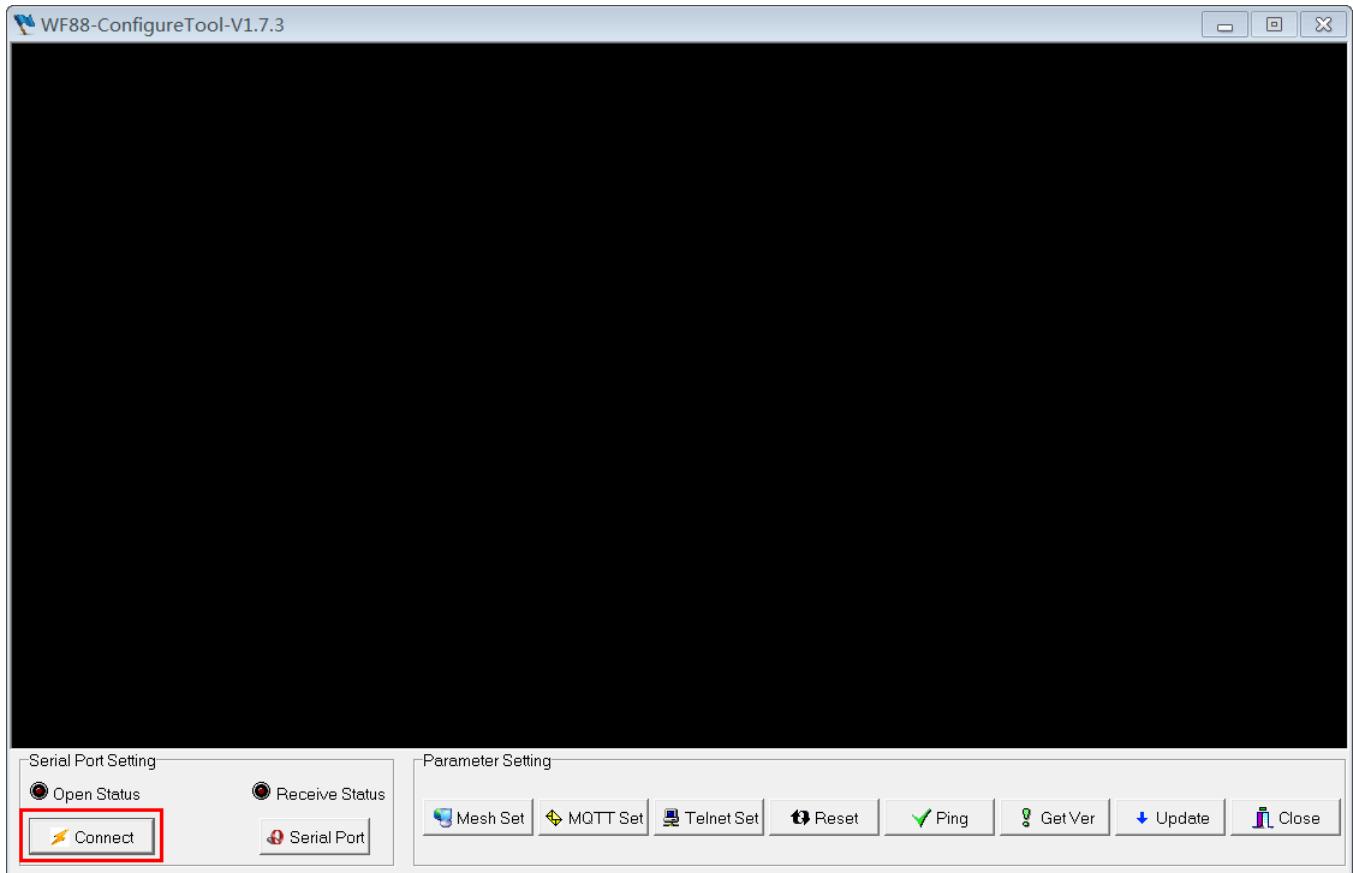
Figure 2-4. Open the serial port

(4) Click the "Mesh Set" button to bring up the "Mesh Set" dialog box. Select "Station (Connect to AP)" from the "Node Type" drop-down list. Select "MQTT" from the "LoadModule" drop-down list. Enter the SSID and password of the AP you want to connect to in the "SSID" and "PSK" editing boxes respectively, and select the "DHCP" checkbox. Finally, click the "Save" button. As shown in Figure 2-5 and Figure 2-6.
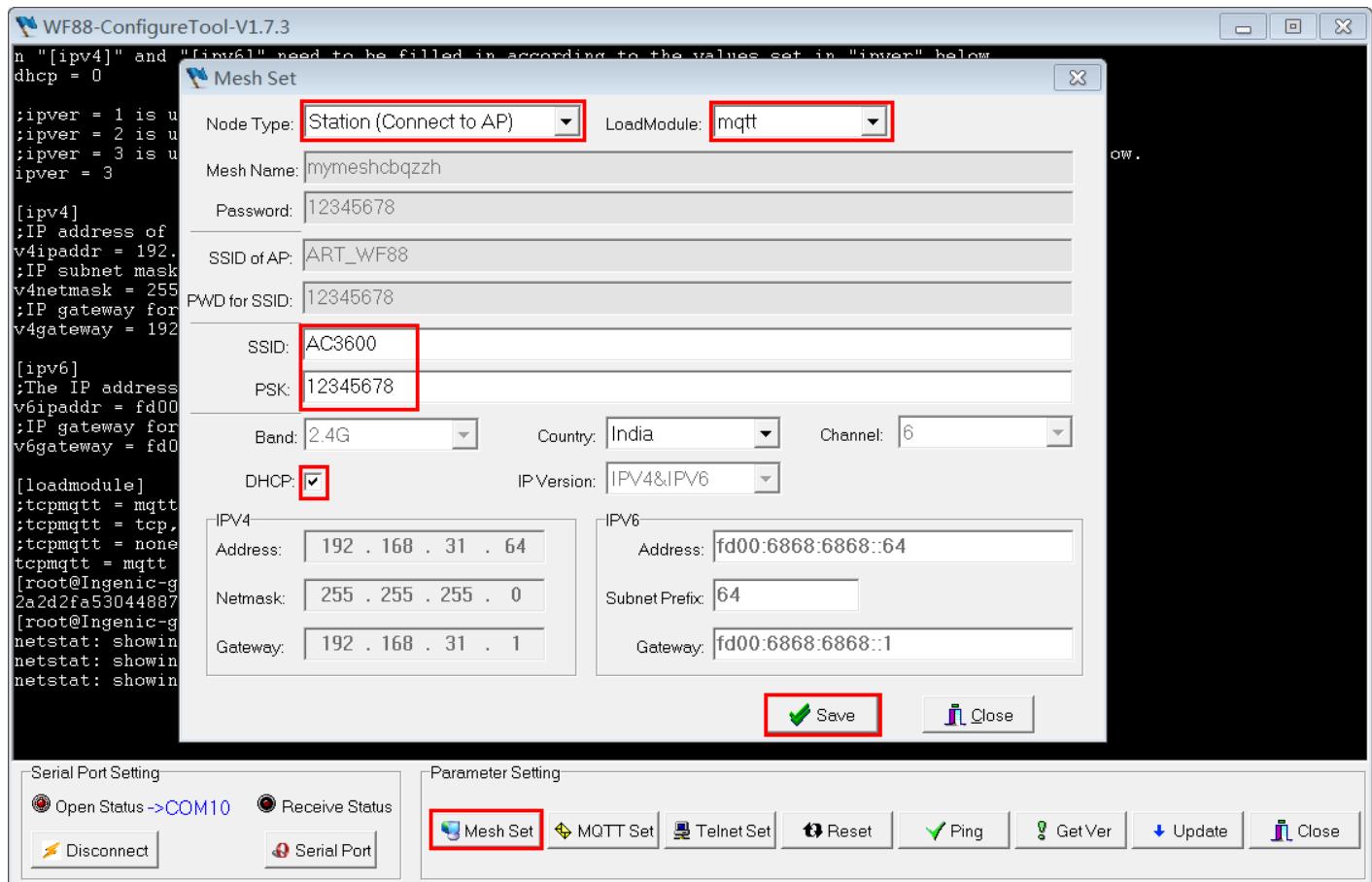
Figure 2-5. Wi-Fi configuration for STA
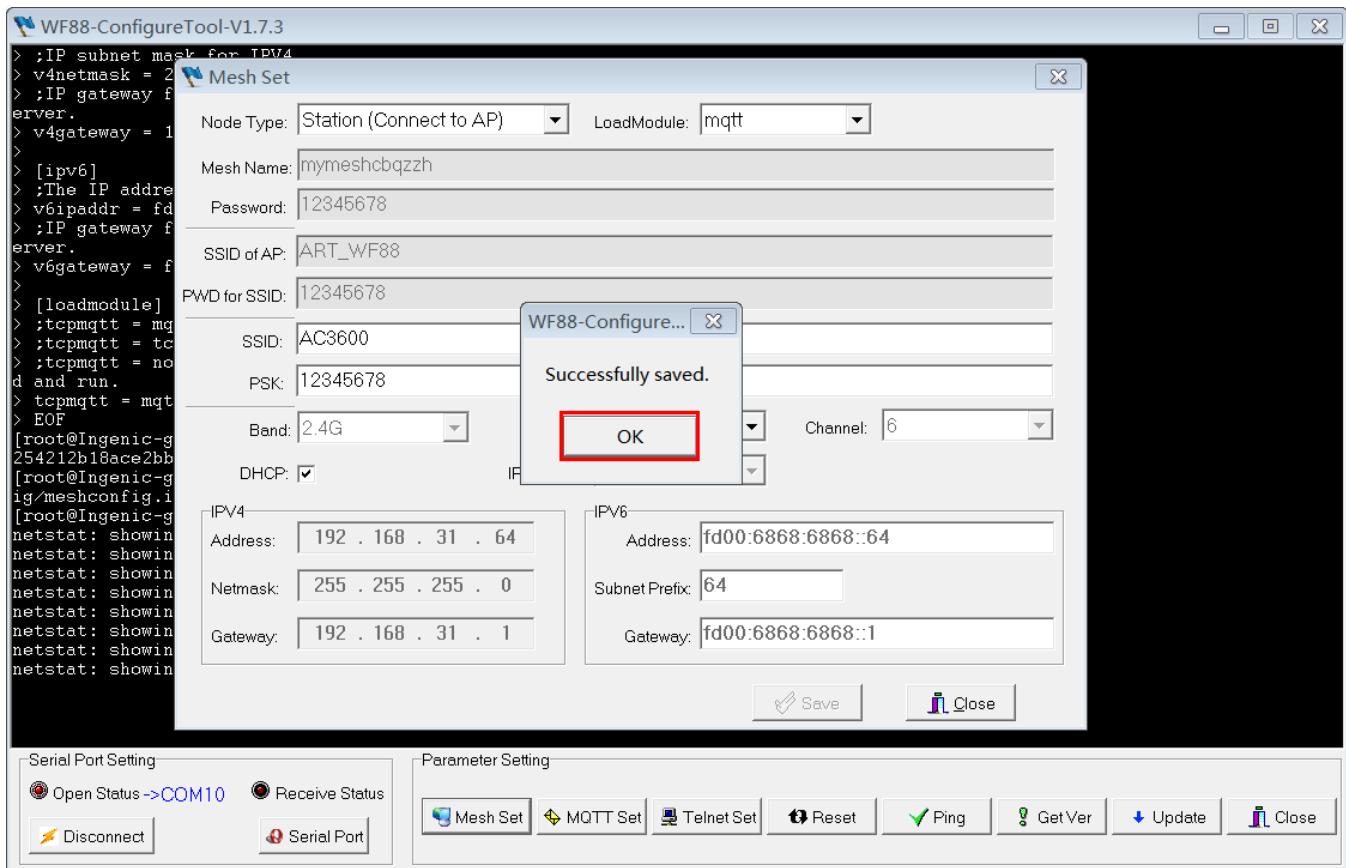
Figure 2-6. Successfully saved

(5) Click the "MQTT Set" button to bring up the "MQTT Set" dialog box. Select "TCP" from the "Protocol" drop-down list. Enter the IP address "44.232.241.40" of MQTT Broker in the "ServerIP" editing box. STA itself supports accessing MQTT Broker for IPV6. Enter the port "1883" of MQTT Broker in the "RemotePortNum" editing box. Other options can be set to default values. Finally, click the "Save" button. As shown in Figure 2-7.

"UART0 BaudRate" represents the communication rate of the UART0 interface of WF88.

The port number of MQTT Broker corresponds to Protocol (tcp/ssl), which means that when using "tcp" protocol, there is a corresponding port number; when using "ssl" protocol, it will correspond to another port number.

"UserName" and "PassWord" indicate that MQTT Broker requires a username and password to establish a connection.

"SubTopic" represents topic the client subscriptions to, with a default value of "SToC"; "PubTopic" represents topic the client publishes to, with the default value being "CToS"; "KeepAliveInterval" refers to the time interval in seconds during which MQTT client sends keep alive messages to MQTT Broker; "QoS" refers to quality of service, with a default value of "0"; "ClientId" represents the ID of the MQTT client.

"OpenCert" and "OpenKey" indicate that MQTT Broker requires a client certificate and client private key to establish a connection.

The five options of "UserName", "PassWord", "OpenCert", "OpenKey", and "OpenCA" need to be filled in according to the protocol and access requirements of MQTT Broker. If necessary, they should be filled in according to the requirements. Otherwise, they can be left blank by default.


Figure 2-7. MQTT Set configuration for STA

(6) Click the "Reset" button to restart.

(7) After the system restarts, a prompt message similar to "Connection to 88:c3:97:ce:b0:c5 completed" and "Sending select for 192.168.31.159" indicates that the WF88 has successfully established a connection with the AP and obtained an IP address. As shown in Figure 2-8.
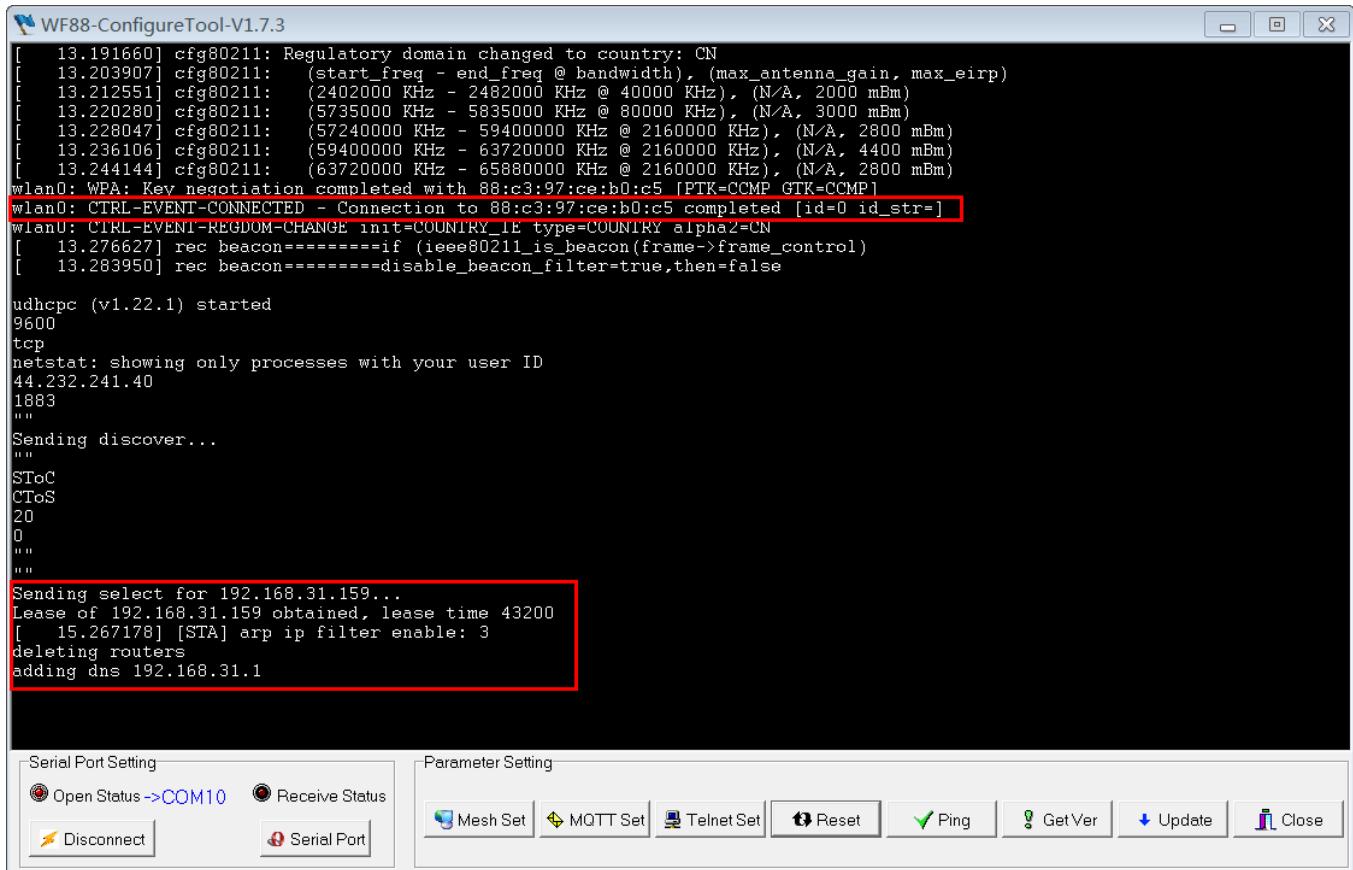
Figure 2-8. Successfully established a connection with the AP

(6) Next, a prompt message "Device Setup complete." indicates that the MQTT connection has been successfully established, as shown in Figure 2-9.
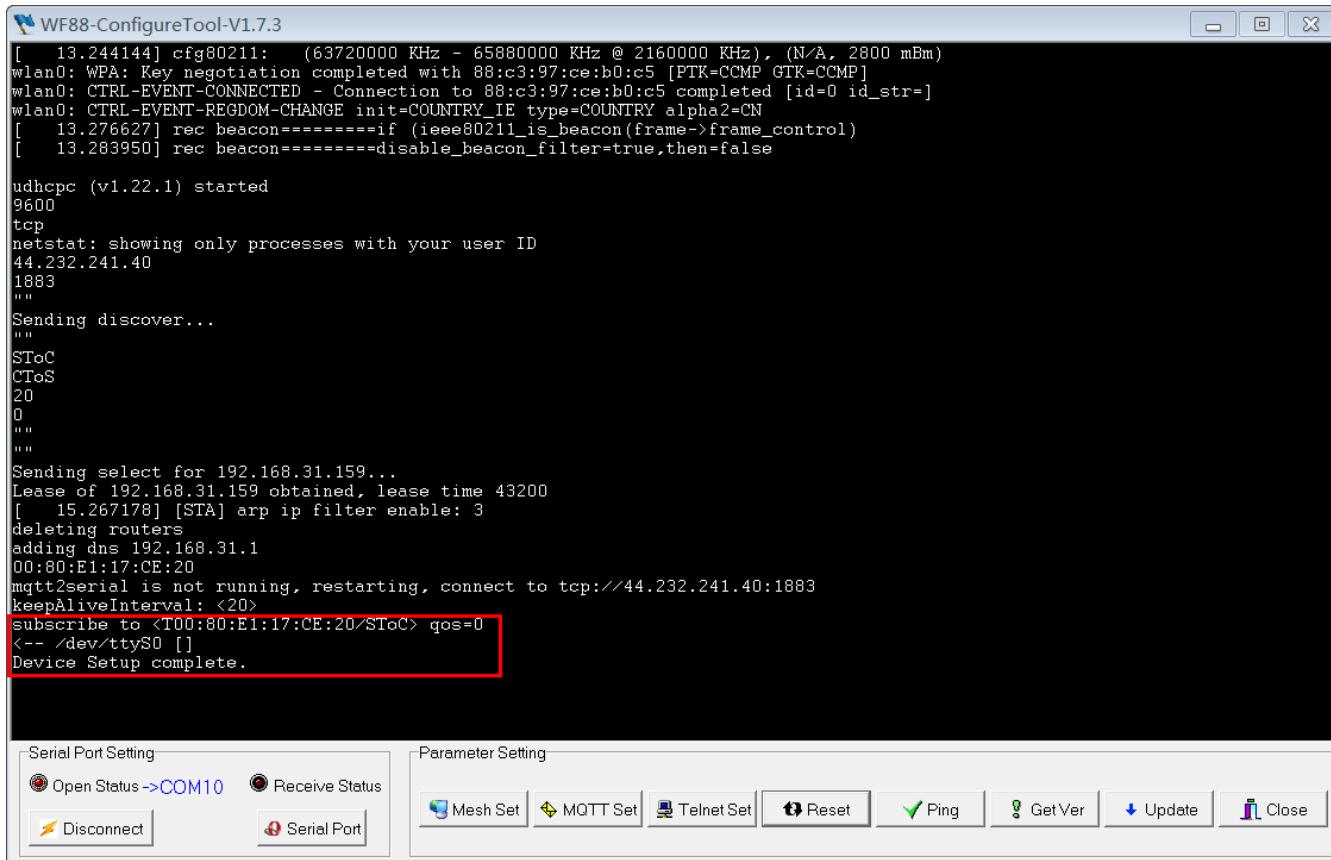
Figure 2-9. MQTT connection has been successfully established

(7) If not, test the network communication. Clicking the "Ping" button will bring up the "Ping Test" dialog box. Enter the IP address to be tested in the "PingIP" editing. First, test the communication with AP. Input "192.168.31.1" for testing. As shown in Figure 2-10, ping test AP indicates if STA can access it normally. If MQTT Broker accepts the ping command, it can directly ping its IP address. If the MQTT Broker does not accept the ping command and is still on the Internet, use ping the 8.8.8.8 IP address. As shown in Figure 2-11, ping test indicates if STA can access the network.
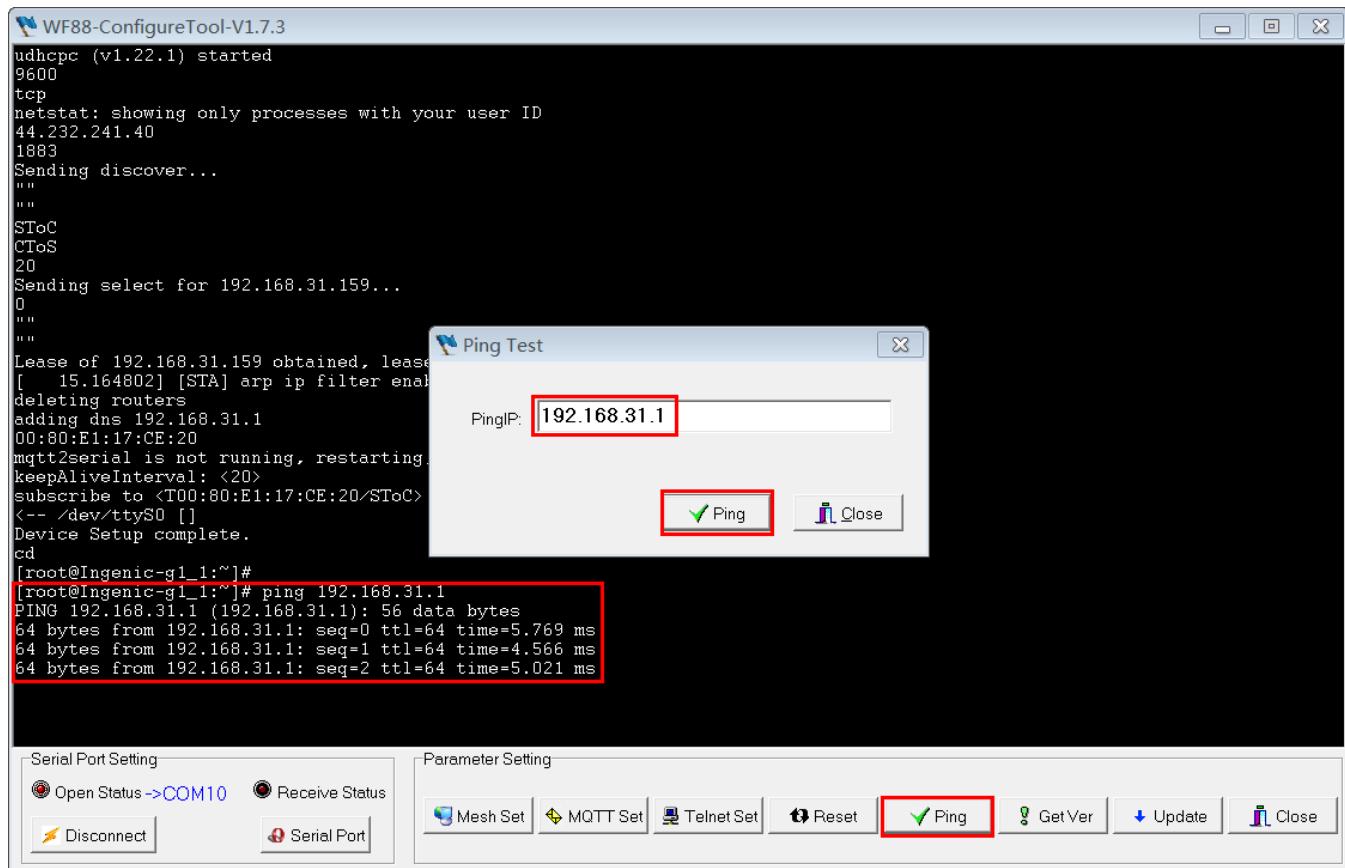
Figure 2-10. Ping test AP
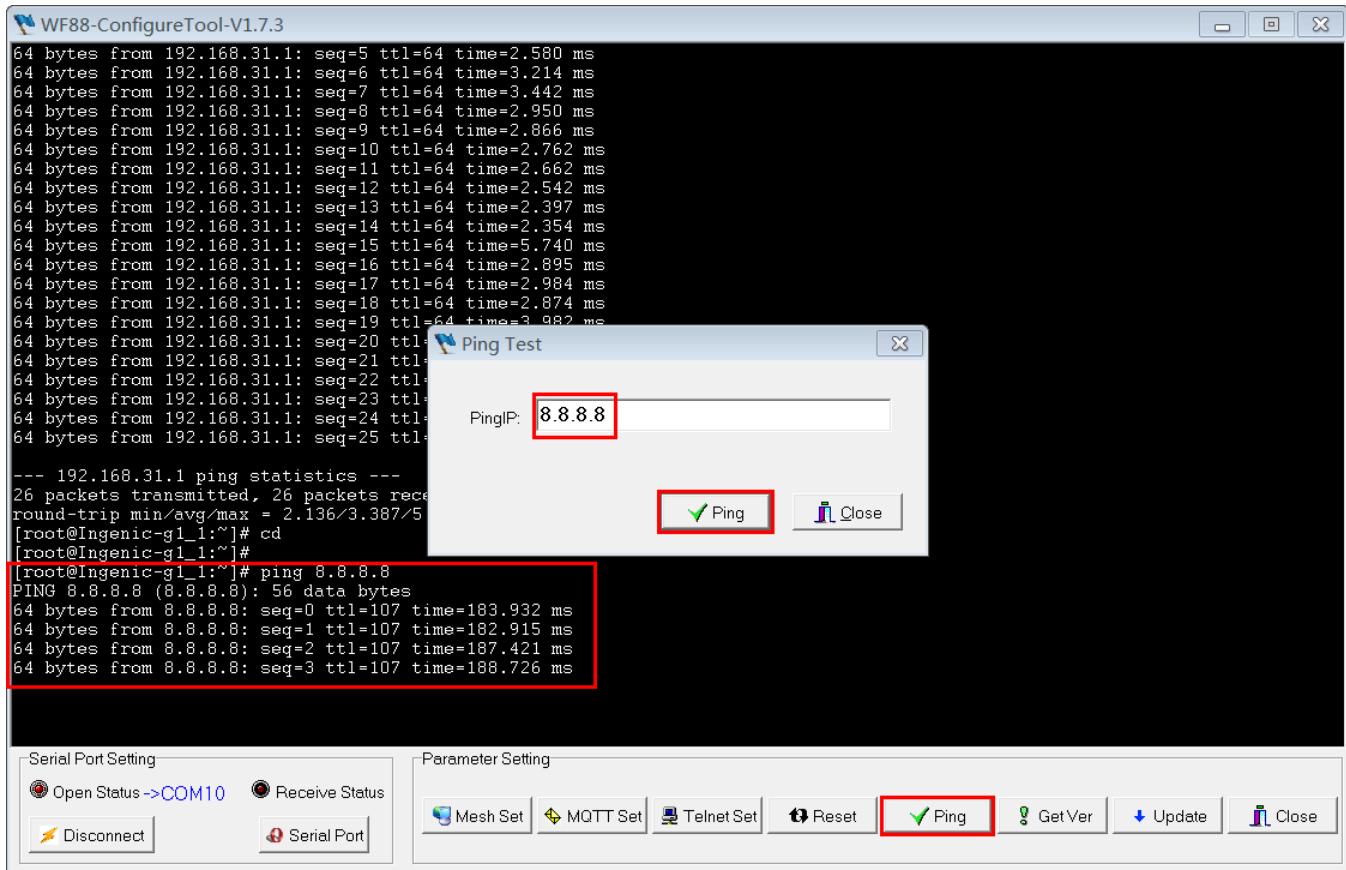
Figure 2-11. Ping test

(9) The setting of STA is completed.

2.3. MQTT Broker and Client Tool

Please refer to the "1.4 MQTT Broker and Client Tool" chapter above.

3. MQTT protocol and corresponding certificate settings

3.1. Support domain name settings

In the "MQTT Set" settings dialog box, the "ServerIP" editing box supports setting domain name and IP addresses in IPV4 and IPV6 formats, as shown in Figure 3-1.
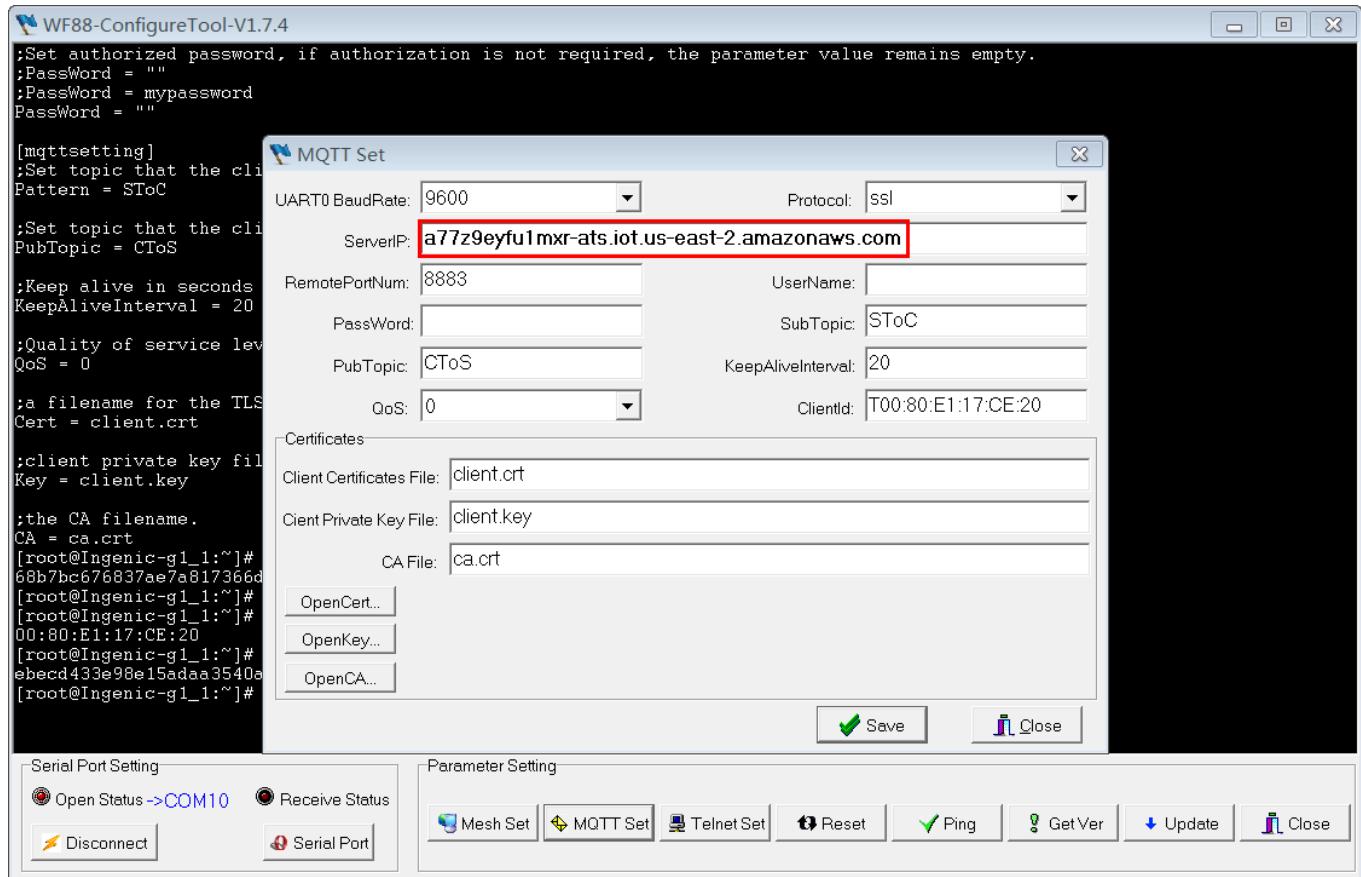
Figure 3-1. MQTT domain name and IP address settings.

3.2. TCP protocol settings

When selecting the "tcp" protocol, all parameters within the "Certificates" group cannot be set and will turn into dark gray. That is to say, there is no need to set up certificates for the "tcp" protocol. In addition, if the certificate parameters were previously set and now changed to the "tcp" protocol, the set certificate parameters will become invalid and MQTT will no longer read them. As shown in Figure 3-2.
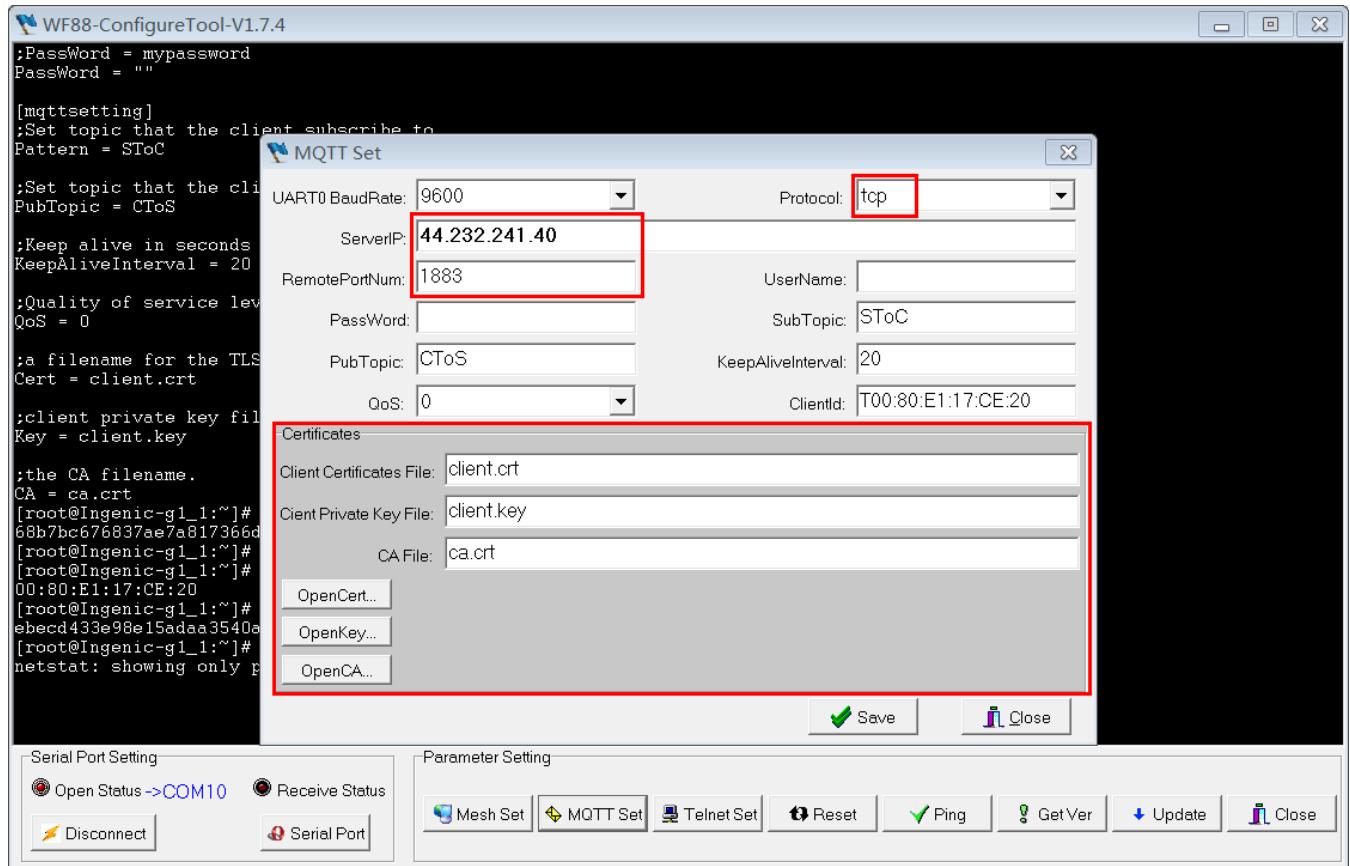
Figure 3-2. TCP protocol settings

3.3. SSL protocol settings

When selecting the "ssl" protocol, all parameters within the "Certificates" group will become adjustable. For the "ssl" protocol, we support four types of authentication.

Authentication Type	Client Certificate	Client Private Key	CA Certificate	Security Typical	Application Scenarios
No verification	×	×	×	Minimum	Testing environment
Unidirectional verification	×	×	✓	Medium	Public IoT devices
Client only verification	✓	✓	×	Medium to high	Closed system
Two way verification	✓	✓	✓	Highest	Security sensitive scenario

Choose the verification type based on the actual application scenario, and click the corresponding "OpenCert", "OpenKey", and "OpenCA" buttons to open a dialog box and select the corresponding certificate file. Note that the total length of the file names of all certificate files (including the main file name,

extension name, and symbol ".") cannot exceed 13 characters.

To delete a certificate, delete the corresponding certificate file name in the "Client Certificates File", "Client Private Key File", "CA File" editing boxes, and then save it. As shown in Figure 3-3.
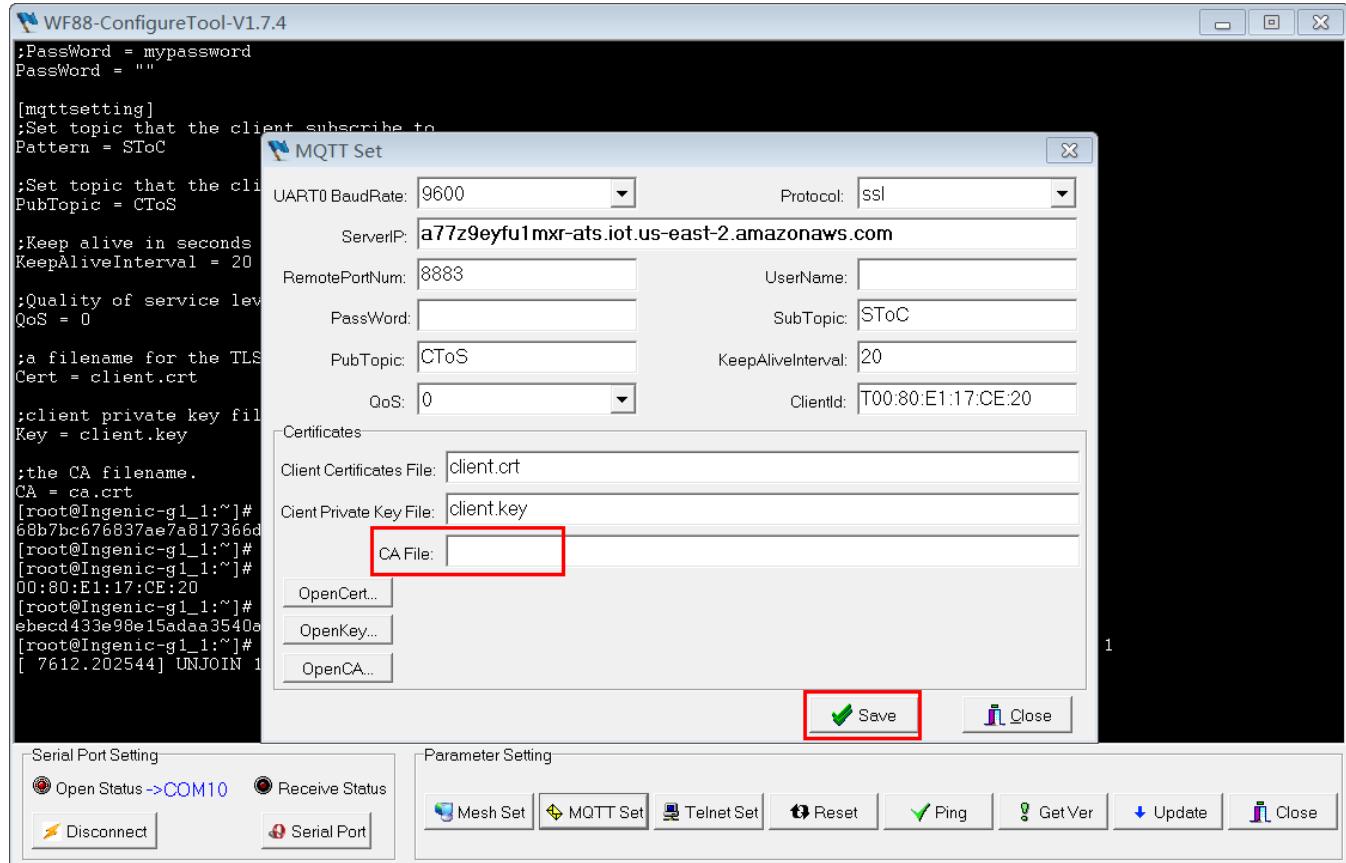
Figure 3-3. Delete the certificate.

4. Troubleshooting guide

4.1. Mesh network not working

Q: There is no network connection between STAs in Mesh or between STA and Gate.

A: Use the WF88 configuration tool to check. The settings for "Mesh Name", "Password", "Band", "Country", "Channel", and "IP Version" must be consistent with those in STA/Gate.

STA and Gate or STA and STA first need to establish normal Mesh communication, and they both need to be in the same network segment.

It can be tested through the ping command, for example, if the IP address of the tested device is "192.168.31.1", "ping 192.168.31.1" can be used for testing.

4.2. Mesh network is normal, unable to access the Internet

Q: The mesh network is normal, but WF88 cannot access the Internet.

A: First, check whether the Gate can access the Internet normally. If it cannot be accessed normally, use the ping command on Gate to confirm whether the IP address of the router connected to Gate can be pinged. If it can be pinged, check whether the router can access the Internet normally. Otherwise, it is necessary to check whether the Ethernet cable connection of Gate is normal and whether the parameter configuration of Gate is correct. We can refer to the configuration in section "1.2. Configure the parameters of Gate".

4.3. How to confirm if the MQTT function of WF88 is enabled?

Q: How to confirm if the MQTT function of WF88 is enabled?

A: Use the WF88 configuration tool to check. Refer to the configuration in section "1.3.Configure the parameters of STA". Confirm that "MQTT" is selected in the "LoadModule" drop-down list.

4.4. How to confirm that MQTT process is running?

Q: How to confirm that MQTT process is running?

A: First confirm whether MQTT is enabled by asking "3.3 How to confirm if the MQTT function of WF88 is enabled?". If enabled, use the WF88 configuration tool. After WF88 completes startup, a prompt message like "MQTT Client: <T00:80:E1:17:CE:20> Failed to connect", indicates that MQTT has been enabled and cannot connect to the MQTT Broker, as shown in Figure 3-1. A prompt message such as "Device Setup complete.", indicates a successful connection to MQTT Broker, as shown in Figure 3-2.
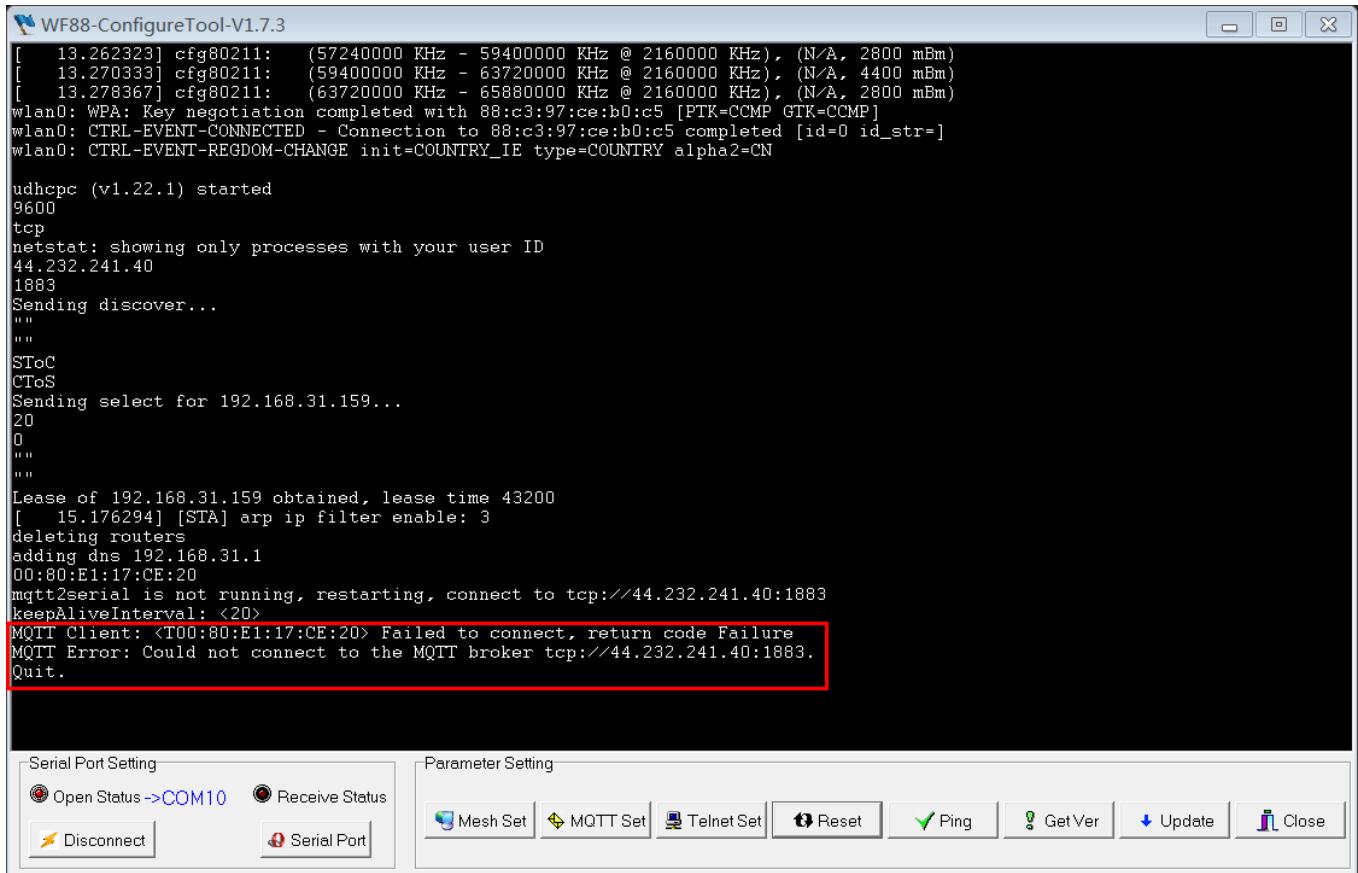
Figure 4-1. MQTT Client Failed to connect
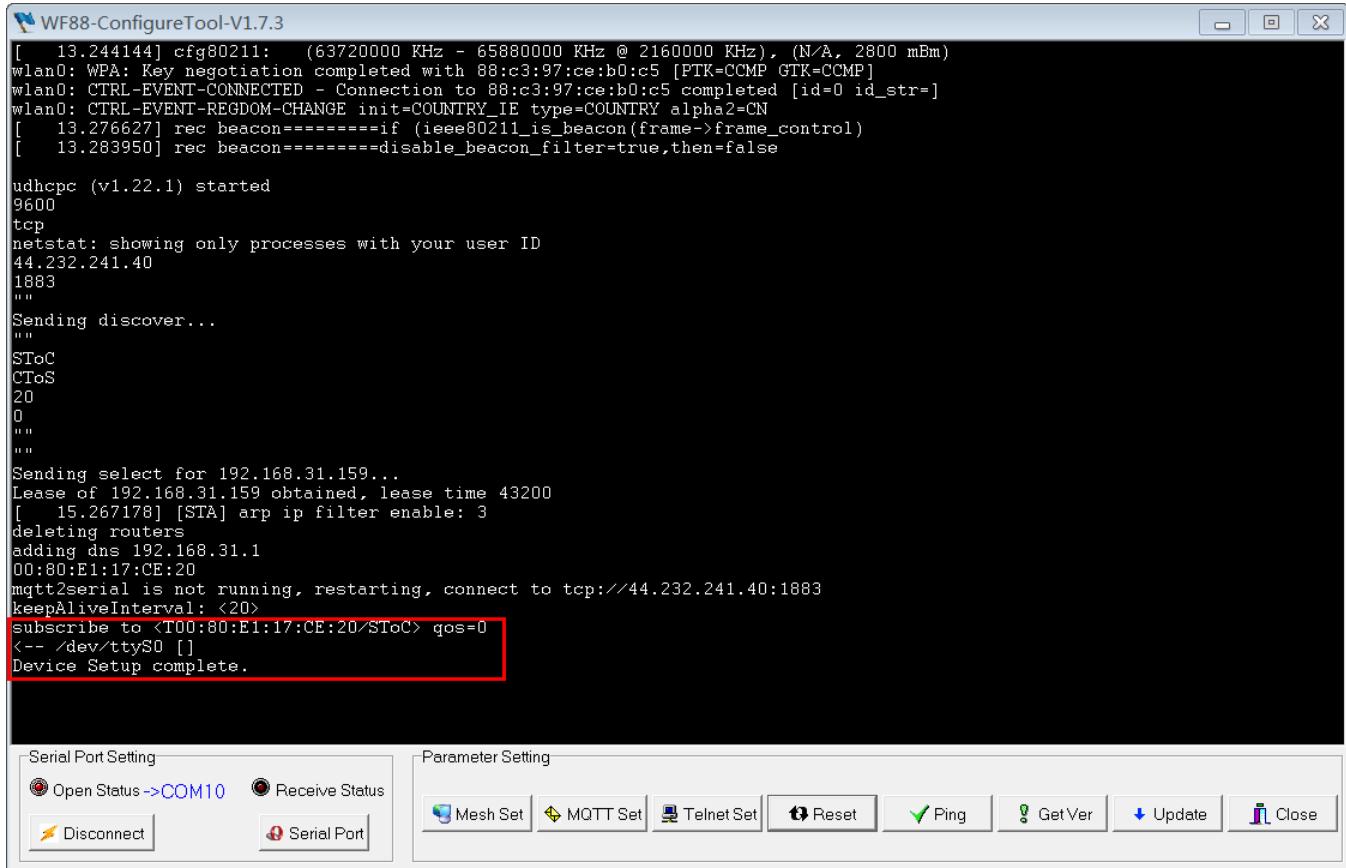
Figure 4-2. MQTT connection has been successfully established

4.5. How to check the connection status of MQTT's TCP port?

Q: How to confirm the connection status of MQTT's TCP port?

A: Use a serial port debugging tool to input the "netstat" command into the WF88 debugging serial port. If noted that the MQTT port configured has already established a connection, it means that the TCP port connection is successful. If the connection information of the configured port cannot be seen, it means that the TCP port has not established a connection, as shown in Figure 3-3.
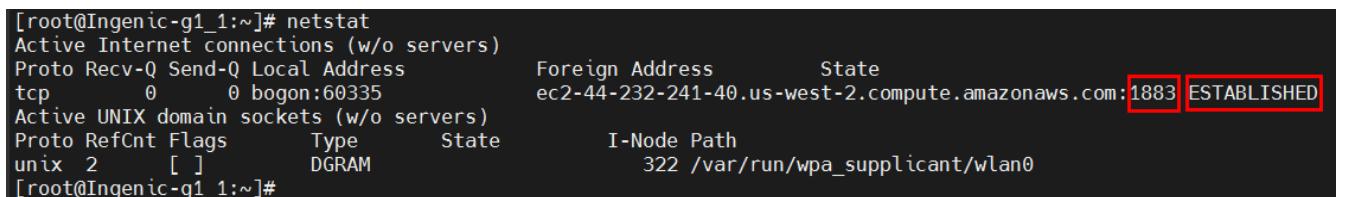
Figure 4-3. The connection status of MQTT's TCP port

4.6. How to review MQTT broker logs for connection attempts or errors?

Q: How to review MQTT broker logs for connection attempts or errors?

A: In MQTT.fx software, click on the "Log" tab and observe the log information, as shown in Figure 3-4.

Figure 4-4. Log information

4.7. How to review local IP address information?

Q: How to review local IP address information?

A: Use a serial port debugging tool to input the "ifconfig" command into the WF88 debugging serial port, as shown in Figure 3-5.

Figure 4-5. IP address information

4.8. How to review Routing Information?

Q: How to review Routing Information?

A: Use a serial port debugging tool to input the "ip route show" command into the WF88 debugging serial port, as shown in Figure 3-6.

Figure 4-6. Routing Information