唯传科技
WINEXT
TECHNOLOGY

M300C LoRaWAN Transmission Module

User Manual

1. Description

1.1 Product Description

The M300C LoRaWAN module, meticulously crafted by Winext Technology utilizing ST's cutting-edge SOC LoRa chip, offers a highly efficient, energy-saving, stable, and easy-to-configure wireless communication solution for IoT industry. Its main features include exceptional long-range communication capabilities, ultra-low power consumption design, robust anti-interference performance, and a diverse range of interface options. Users can quickly customize and deploy applications with simple serial port configuration.

1.2 Features

Software Features：

- Integrated Standard LoRaWAN Communication Protocol, offers the option to customize private protocols and Winext Airnode protocol；
- AT Command Interaction for Configuration,Control of the module's peripheral interfaces can be set up with just a few or even a single command.
- Transparent Serial Port Data Transmission，Once configured in transparent transmission mode, data sent through the serial port can be directly transmitted to the cloud；
- Rich Peripheral Interfaces, including UART, SPI, I2C, GPIO, and ADC；
- Utilizing LoRa spread spectrum modulation technology, the module has extremely high sensitivity with a communication range of 1KM to 10KM；
- Low Power Consumption Serial Port，the module transmit and receive data normally in sleep mode without the need for wake-up operations.；
- Supports both serial port and wireless firmware upgrades;
- Supports adjustable serial port baud rates, output power, and a variety of communication speeds.

Hardware Features：

- SOC Chip: Equipped with the STM32WL chip, featuring an ARM Cortex-M4 core and an integrated SX1262 function；
- LoRa Spread Spectrum Modulation Technology，Rx sensitivity=-138dBm (BW = 125 kHz, SF = 12)；
- Built-in High-Efficiency PA，Lower power consumption，supports up to 22dBm output, and is configurable within the range of 0 to 22dBm；

- LoRa Communication Security: Supports 128/256-bit AES hardware encryption, PCROP read/write protection, and public key encryption using an elliptic curve encryption engine；
- Compliance with Global Regulatory Requirements：ETSI EN 300 220, EN 300 113, EN 301 166, FCC CFR 47 Part 15, 24, 90, 10，ARIB STD-T30, T-67, T-108, etc.；
- Support for Global Frequency Bands: Covers CN 470-510MHz, EU 863-870 MHz, US 902-928 MHz, and all major sub-GHz ISM frequency bands worldwide;
- Excellent Wireless Spurious Performance，Compared to SIP chips, it has lower in-band spurious emissions, higher adjacent channel suppression ratio, and less mutual interference, suitable for large-scale device communication;
- Ultra-Low Sleep Current: The operating current in sleep mode (with support for RTC mode) is as low as 3.0uA；
- Support for Scalable Dual-Core Design: Opens a full-function MCU for customer feature development；
- Compact Size with Industrial-Grade Design，offers good stability and reliability.

1.3 Product Specifications

Symbol	Description	Condition	Min.Value	Typical Value	Max.Value	Unit
VCC	Operating Voltage	-	1.8	3.3	3.6	V
T_{op}	Operating Temperature	-	-40	26	85	℃
I_{sleep}	Standby Current	Stop 2+RTC Low Power Mode	-	3.0	-	uA
I_{mcu}	MCU Operating Current		-	5.4	-	mA
I_{tx}	Transmission Current	RF Power=22dBm	-	118	-	mA
I_{rx}	Reception Current	MCU in Receive Mode	-	6.3	-	mA
Freq	Operating Frequency	Domestic Band	470	-	510	MHz
		International Band	863	-	870	MHz
			902	-	928	MHz
P_o	RF Output Power	Software Set RF Power=22dBm	-	22.0	-	dBm
RX Sensitivity	Receive Sensitivity	SF=12,BW=125KHz	-	-138	-	dBm
ACR	Adjacent Channel Rejection Ratio	SF=7	-	60	-	dB
		SF=12	-	72	-	dB
SIZE	Module Size	L*W	-	25*20.5	-	mm

1.4 Applications

- Smart Agriculture: Monitoring of water quality, carbon dioxide concentration, temperature, humidity, and pests to ensure optimal growing conditions；
- Environmental Monitoring: Real-time data transmission of temperature, wind speed, water level, flow rate, and sediment data；
- Smart Metering: Electricity consumption information for each household can be transmitted to the LoRa module every month. The LoRa module then sends the data to a remote control center through a gateway.

In addition, there are also extensive applications in fields such as smart parking, intelligent irrigation, and photovoltaic array monitoring.

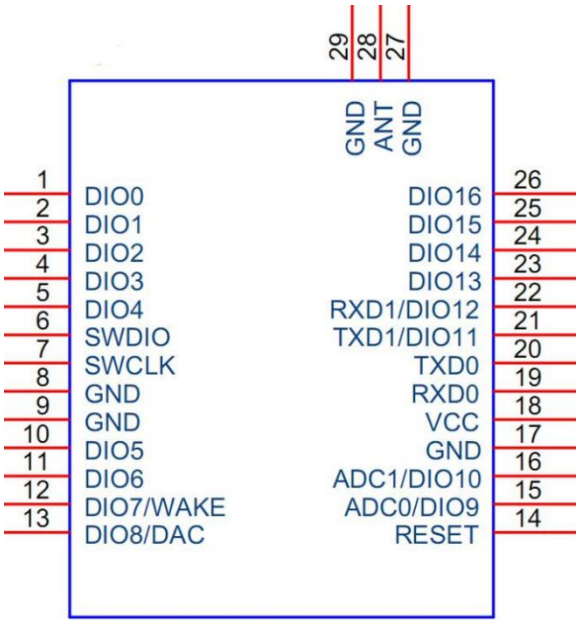
1.5 Glossary

Term	Abbreviation	Explanation
LoRa Wide Area Network	LoRaWAN	Long Range Wide Area Network
Over The Air Active	OTAA	Activation over the air
Active By Personalization	ABP	Activation by personalization
Spreading Factor	SF	Spreading factor
Band W idth	BW	Bandwidth
Coding Rate	CR	Coding rate
Preamble Length		Length of the preamble
Symbol		Symbol
Confirmed Message	CNF	A message that requires confirmation upon receipt
Unconfirmed Message	UCNF	A message that does not require confirmation
Point to Point	P2P	Point-to-point transmission

2. Hardware Architecture

2.1 Module Pin Interfaces

M300Cmodule offers a variety of peripheral interfaces, including SPI、UART、ADC、GPIO、I2C,etc.，as below：

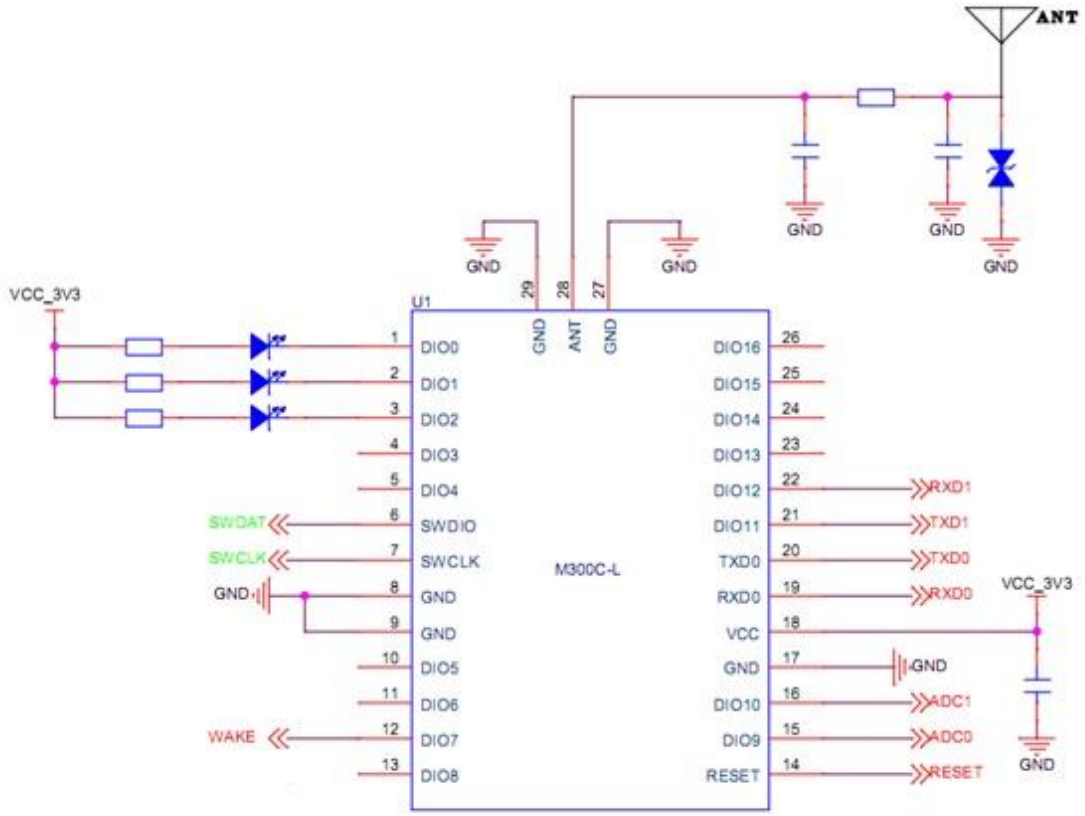


M300C module pin interface

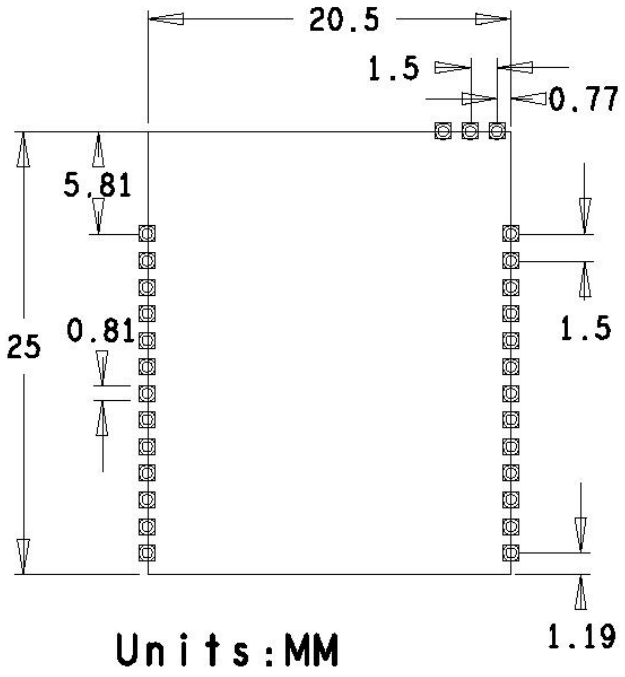
M300C Pin Description

No.	Name	Additional Function	Description
1	DIO0	LED Indicator	Digital IO pin 0，can be used as an LED indicator
2	DIO1	LED Indicator	Digital IO pin 1，can be used as an LED indicator
3	DIO2	LED Indicator	Digital IO pin 2，can be used as an LED indicator
4	DIO3	LED Indicator	Digital IO pin 3，can be used as an LED indicator
5	DIO4	LED Indicator	Digital IO pin 4，can be used as an LED indicator
6	SWDAT		Programming download port
7	SWCLK		Programming download port
8	GND		Ground
9	GND		Ground
10	DIO5	LED Indicator	Digital IO pin 5，can be used as an LED indicator
11	DIO6	LED Indicator	Digital IO pin 6，can be used as an LED indicator
12	DIO7	WAKE	Digital IO pin 7，module wake-up pin，triggered by low-level signal
13	DIO8	DAC	Digital IO pin 8，can be used for DAC output
14	RESET		Reset，triggered by low-level signal
15	DIO9	ADC0	Digital IO pin 9，can be used for DAC input
16	DIO10	ADC1	Digital IO pin 10，can be used for DAC input
17	GND		Ground
18	VCC		Power supply，3.3V with a 10uF capacitor placed nearby
19	RXD0		UART 0 data input
20	TXD0		UART 0 data output
21	DIO11	TXD1	Digital IO pin 11, can be used as data output for UART 1
22	DIO12	RXD1	Digital IO pin 12, can be used as data input for UART 1（Before receiving data on serial port1，the WAKE pin must be pulled low to wake up the M300C module）
23	DIO13		Digital IO pin 13
24	DIO14		Digital IO pin 14
25	DIO15		Digital IO pin 15
26	DIO16		Digital IO pin 16
27	GND		Ground
28	ANT		Antenna port, connected with a 50-ohm microstrip line, and an external PI matching circuit is used for antenna matching.
29	GND		Ground

2.2 Application Schematic



2.3 Dimension



2.4 Image of M300C Module

3. Function Description

The M300C module supports two operational modes: AT Command mode for basic configuration and Transparent Transmission mode for direct data relay to the cloud. It offers two data transmission methods: P2P mode, which facilitates direct node-to-node communication for module upgrades and configurations, and LORAWAN mode, which enables data transmission to the cloud. Configuration can be performed not only through the UART serial port but also remotely via server-issued AT commands.

3.1 Operating Mode

The M300C module features 2 working modes: AT command mode and Transparent Transmission mode. In AT Command mode , parameters are configured by sending AT commands via the serial port. In Transparent Transmission mode, sensor data from User can be transparently transmitted to the cloud. Transitions between these modes can be achieved through command execution.

3.1.1 AT Command Mode

AT commands enable the querying and setting of all module parameters. They facilitate the transmission and reception of wireless data and allow for the inspection of the status and outcomes of data exchanges.
To transition to Transparent Transmission mode from AT Command mode, input the command”AT+ENTERTRANS ”

3.1.2 Transparent Transmission Mode

In Transparent Transmission mode, data received by the module’s serial port is sent out wirelessly directly. Conversely,data received wirelessly by the module is sent out through the serial port directly. In this mode, when the module receives data from the user’s serial port, it need to packetize the serial data. The module checks the time interval between consecutive bytes. A frame is concluded when this

interval exceeds a set threshold, or data reception continues until it surpasses a specified packet byte limit.The default frame termination interval is set at 20ms between two serial bytes. Parameter settings are not possible in Transparent mode,; switching to AT Command mode is required for configuration. To exit Transparent Transmission mode and enter AT Command mode, input the sequence"+++".

3.2 Communication Mode

The module offers 2 modes of communication: LoRaWAN for cloud connectivity and P2P for direct node-to-node communication, with the latter mode dedicated to upgrade and configuration tasks.

3.2.1 LoRaWAN Communication

LoRaWAN is a standard for low-power wide-area networks (LPWANs) established by the LoRa Alliance. The architecture of a LoRa network is a classic star topology, with the LoRa gateway serving as a transparent transmission relay between end devices and cloud service platforms. Communication between the gateway and the cloud platform is conducted through the standard TCP/IP protocol. End nodes communicate in a single hop with one or more gateways, and all nodes engage in two-way communication with the gateways. LoRaWAN networks classify end nodes into three categories—Classes A, B, and C—based on the specific applications.

Class	Description
A	Class A end devices support two-way communication with low power consumption. They send data first and then receive data, alternating between sending and receiving. End devices can only receive data from the cloud service center after sending data themselves, and data transmission is not restricted by data reception.
B	Class B end devices feature two-way communication with reception slots. Like Class A, they send first and then receive, but differ in that after each transmission, they activate reception windows at certain time intervals to receive multiple data packets.
C	Class C end devices offer two-way communication with the maximum reception slots. They close the reception window only during transmission, allowing for nearly continuous data reception. They consume more power than Class A and B but have lower latency in interaction with the cloud service center.

4. AT Command

Module configuration is performed by entering AT commands via the serial port, with 4 primary types of AT commands available：

AT+X=? **for querying command，X is for the command code**

AT+X=P **for setting command，X is for the command code, P is for parameter.**

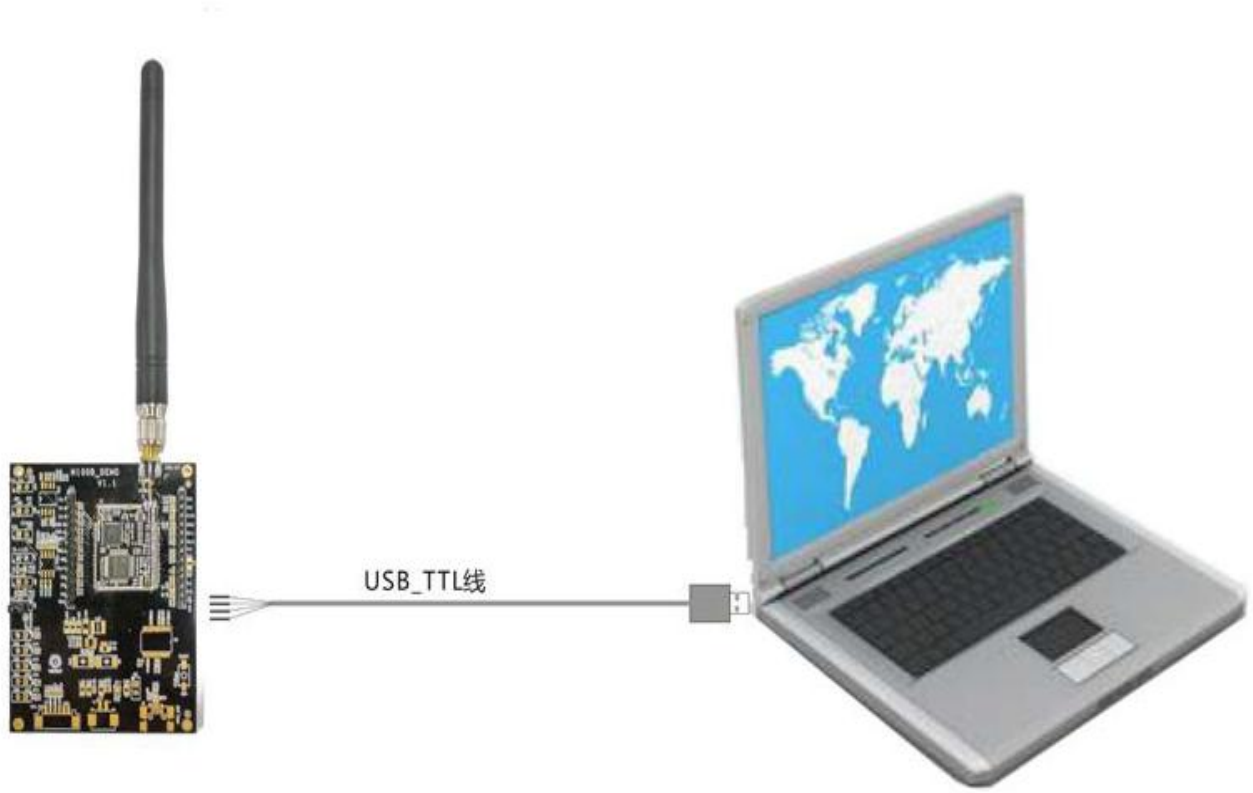
AT+X **to execute the command**

^X:P **for reporting command, P is for parameter**

Query commands, configuration commands,and execution commands are all initiated by the the user who inputs AT commands,and the module responds accordingly.Report commands are issued by module itself,usually to indicate a change in status or the occurrence of an event.Users can also set the module to prevent it from automatically sending out report commands,instead relying on query commands to check for status changes or the occurrence of events. For a detailed explanation of AT commands, please refer to the" M300C AT Command Manual".

4.1 Serial AT Command

AT commands of module can be executed via the local serial port, the connection be below:



To communicate with the module,users simply need to connect to the UART interface of the DEMO board using serial communication software.

4.2 Remote AT Command

Remote AT commands can be sent to the module via the LoRaWAN server, enabling the execution of the vast majority of the module's AT commands. However, some AT commands that generate excessively long return data cannot be sent in a single LoRaWAN packet, resulting in only 'OK\r\n' being returned. The FPort for these remote LoRaWAN AT commands is consistently set to 220. The content of the remote LoRaWAN AT command consists of an address field, which includes the address type and the destination node address, and a command field, which comprises one or more AT command characters. The "\r" or "\r\n" of the last AT command may be omitted, but intermediate "\r"or "\r\n" between commands must not be omitted.

Address Field		Command Field		
Address Type	Address	Command 0	…	Command n

Address Type	Description
0xFF	No address included
0x01	16-byte DEVEUI in big-endian format, with the high address first
0x02	4-byte DEVADDR in little-endian format, with the low address first

Example：

Sending the LoRaWAN remote AT command “AT+STATUS=?\r” to a node without an address.
FF 41 54 2B 53 54 41 54 55 53 3D 3F
Sending the LoRaWAN remote AT command ”AT+STATUS=?\r”and”AT+DEVADDR=?\r” to a node without an address.
FF 41 54 2B 53 54 41 54 55 53 3D 3F 0D 41 54 2B 44 45 56 41 44 44 52 3D 3F
Sending the LoRaWAN remote AT command ”AT+STATUS=?\r” to a node with the DEVADDR of 0x07578093.
02 93 80 57 07 41 54 2B 53 54 41 54 55 53 3D 3F
Sending the LoRaWAN remote AT command ”AT+STATUS=?\r”and ”AT+DEVADDR=?\r” to a node with DEVEUI of FFFFFF1000000C8C
01 FF FF FF 10 00 00 0C 8C 41 54 2B 53 54 41 54 55 53 3D 3F 0D 41 54 2B 44 45 56 41 44 44 52 3D 3F

5. Usage Method of M300C

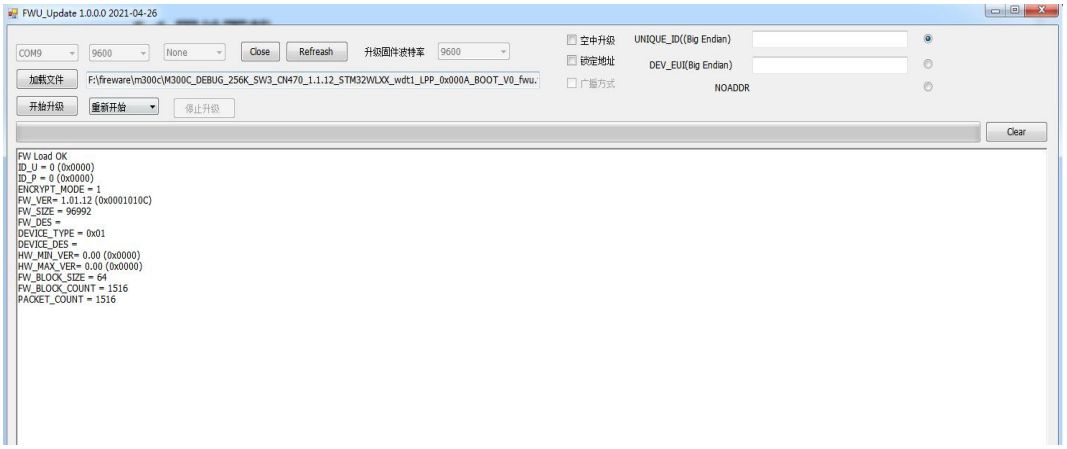
The M300C utilizes a serial port for inputting AT commands to interact with users,offering a user-friendly communication approach. Basic operations like serial data pass-through and IO port control can be easily executed with simple command instructions.

5.1 Firmware Download

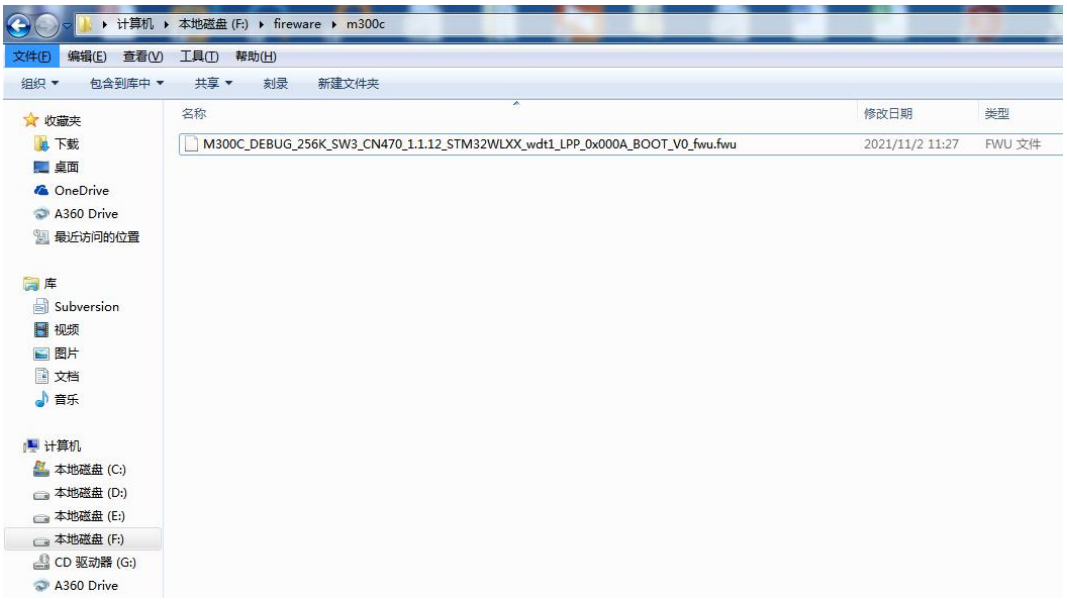
The Module comes with the latest firmware pre-installed,there are 3 methods available for upgrading to new software versions: over-the-air (OTA) download, serial port download, and JLink download.

The following introduces the firmware download via the serial port:

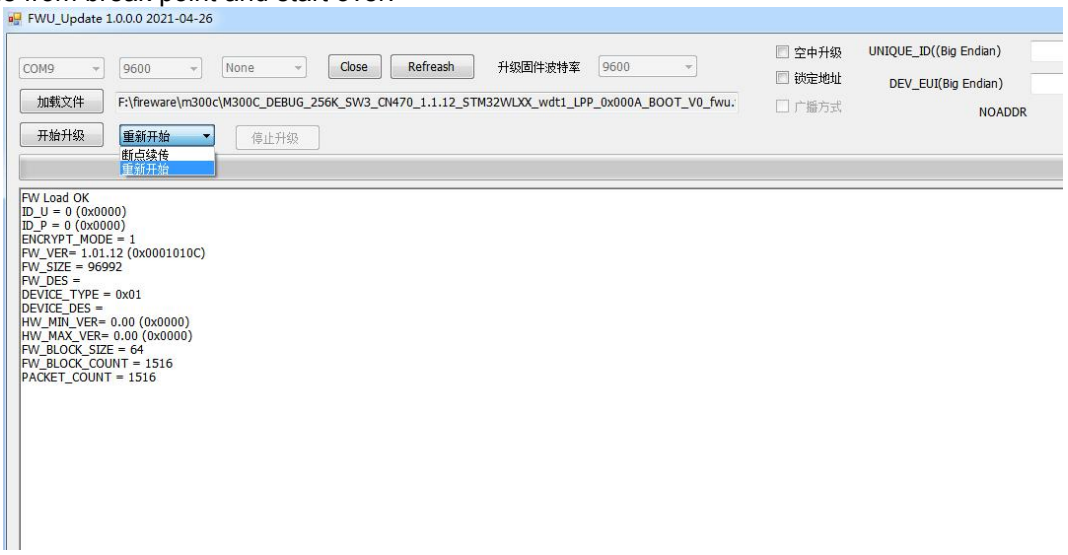
Click on the firmware download software.



Click to load the file, select the software firmware that needs to be downloaded.

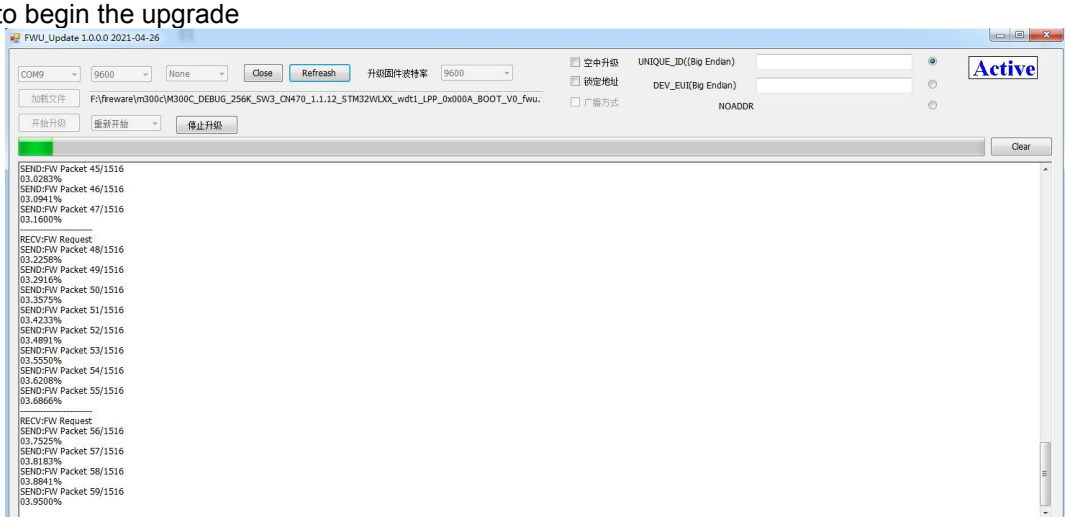


Click to load the file, choose the serial port upgrade method; there are two upgrade methods available: resume from break point and start over.

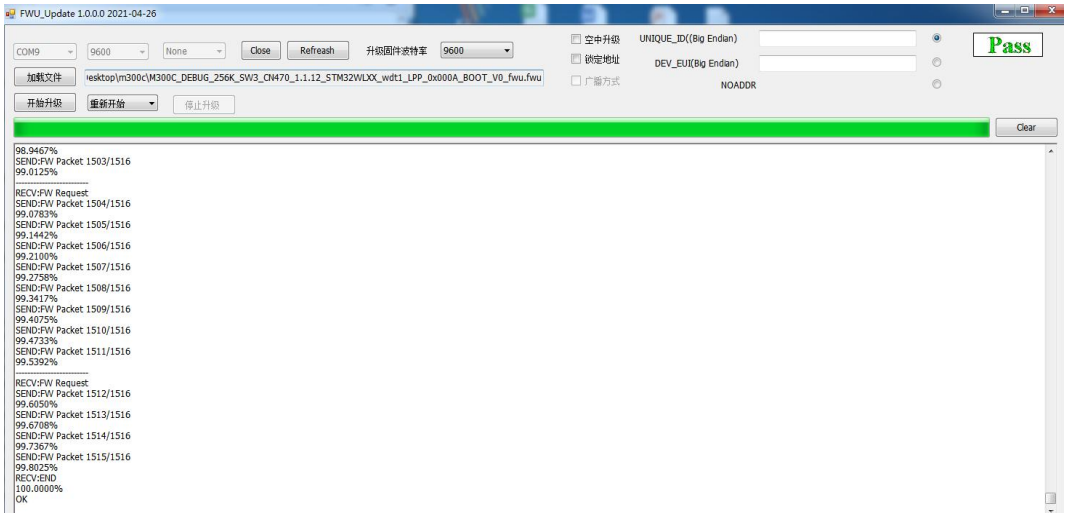


Here, the selection is to start over.

Click to begin the upgrade

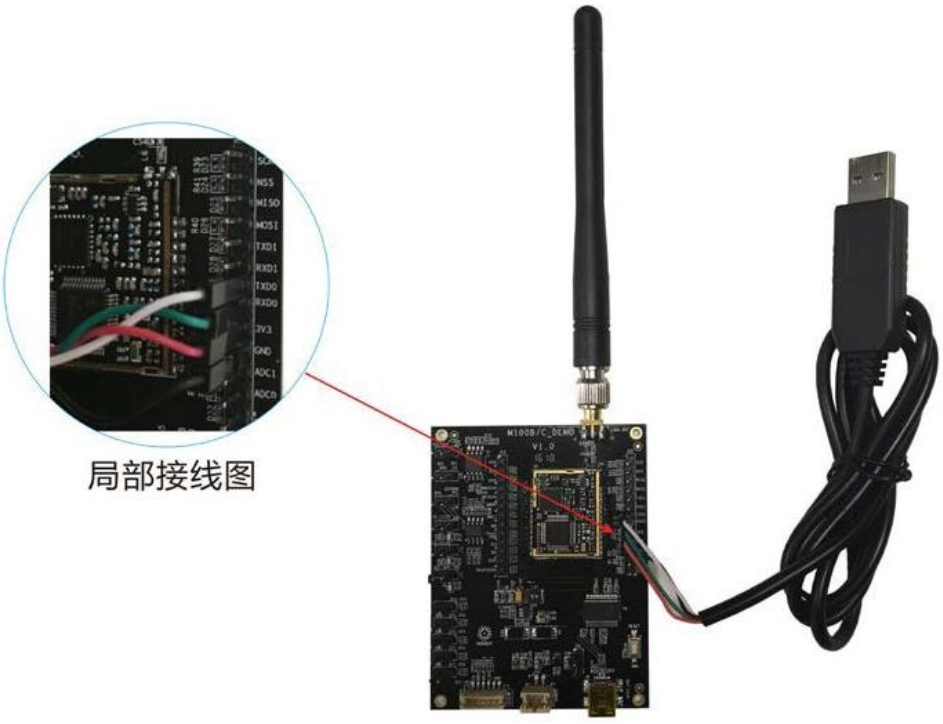


A successful upgrade will display PASS in the upper right corner.

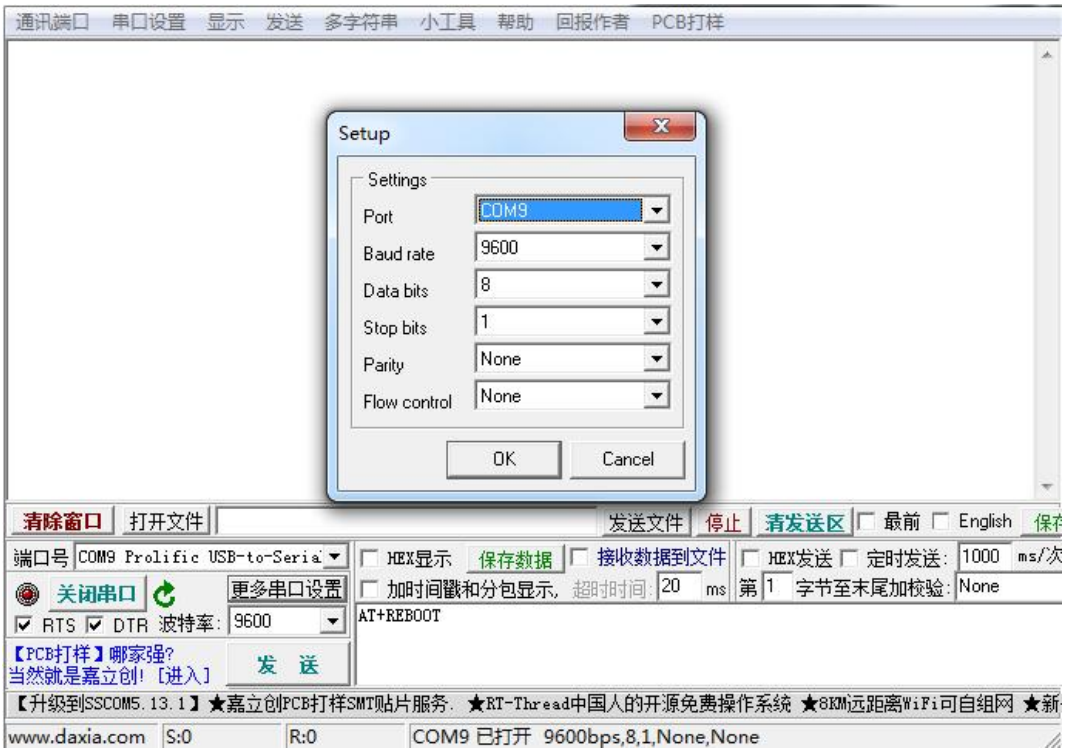


5.2 Basic AT Command Usage

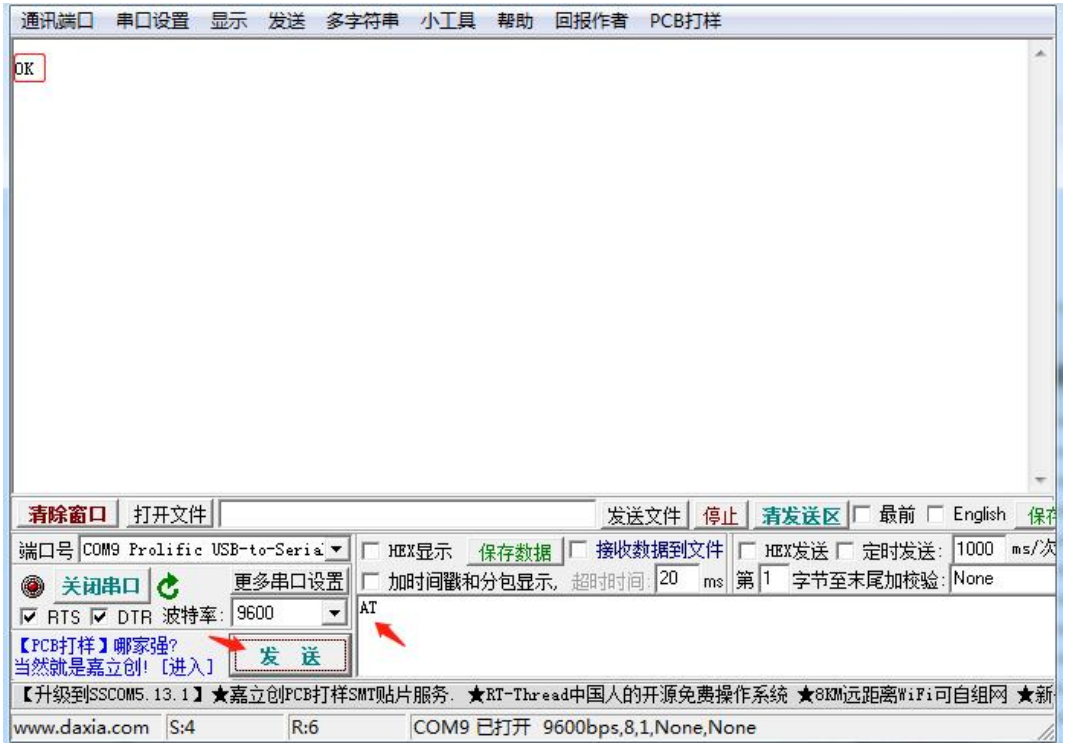
The connection method for the development board's serial port is illustrated in the figure below. The white, green, red, and black wires of the USB-TTL serial cable correspond, in order, to the serial port's TX, RX, power, and ground, respectively, and are connected to the TXD0, RXD0, 3V3, and GND on the development board.



The development board's default serial port settings are a baud rate of 9600, 8 data bits, 1 stop bit, no parity bit, and no flow control. Open the serial terminal software and configure the appropriate settings.



Entering an AT test command and getting an 'OK' response signifies that the AT is available at the moment, as shown in the figure below:



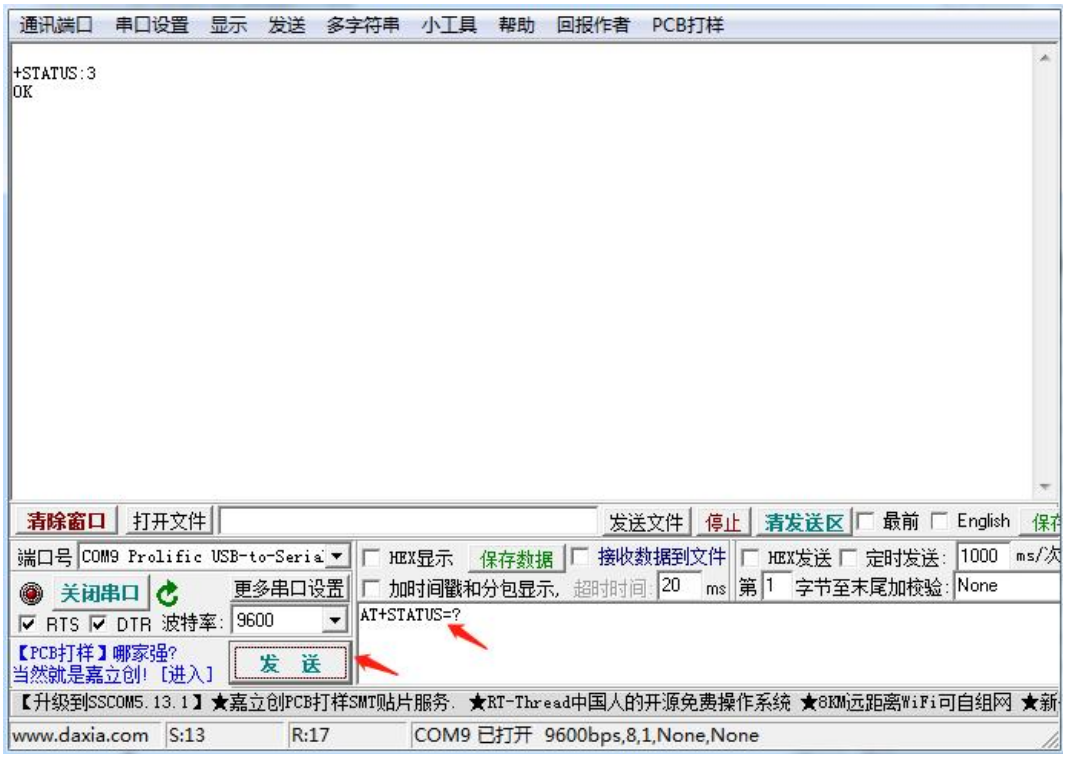
Query the current module version information:

Type the command : AT+DEVINFO=? to retrieve and display the manufacturer's relevant information, as below:

Winext Technology , Add: Room606,6th Floor, BuildingB#, Oufeiguang Headquarters R&D Center,Fenghuang Street, Guangming District, Shenzhen. Tel: 0755-23990916

This command shows the current module name as M300C, firmware version 1.1.1, hardware version 0.0, LoRaWAN version 1.0.2, and the frequency band CN470.

The query for the current network registration status returns a value where '3' means the module is already registered to the network. For details, please refer to the AT Command Manual regarding the section on the AT+STATUS=? command.



5.3 LORAWAN Nework Access

LoRa module need to be registered to a network before transmitting data. There are two methods of network registration for LoRa: OTAA (Over-The-Air Activation) and ABP (Activation By Personalization). These methods can be set and queried through the AT command AT+ACTIVEMODE. The default factory setting is for OTAA mode .

5.3.1 Inquire about the network joining method

Input “AT+ACTIVEMODE=?” through the serial port to check the network joining method. A return value of 0 signifies OTAA joining, while a return value of 1 indicates ABP joining. As depicted in the following illustration, a return value of 0 means that the current network joining method is OTAA.

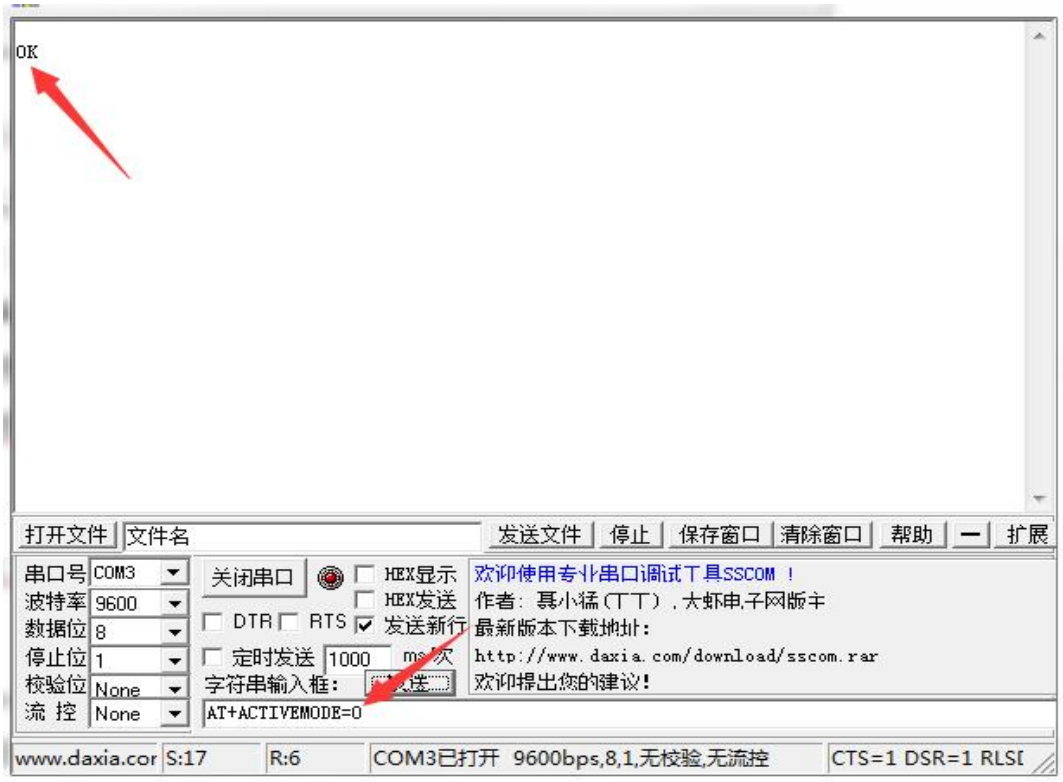
5.3.2 Setting the Network Joining Method

OTAA Joining

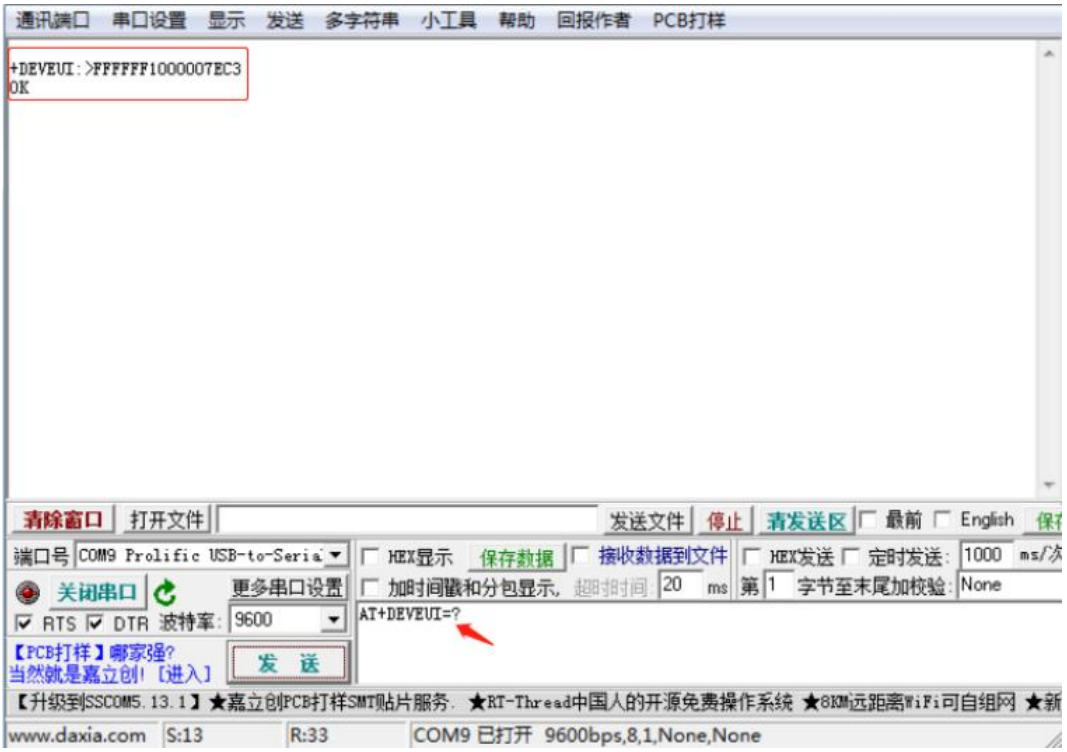
1）Configure the current node to join the network using the OTAA method

The node comes with a pre-configured default OTAA joining mode, along with communication parameters such as DEVEUI, APPEUI, and APPKEY. On the LoRaWAN platform, nodes must be manually or in batches added with information recorded, ensuring that the node's DEVEUI, APPEUI, APPKEY, and other parameters match those of the module from the factory. Once powered on, the module will request to join the network via the LoRaWAN gateway.

The example below demonstrates setting the joining mode to OTAA by inputting the command AT+ACTIVEMODE=0 through the serial port. A response of 'OK' signifies that the setting has been successfully applied.



2） Use the AT+DEVEUI command to query the current node's DEVEUI. The APPKEY, which is an application key, is preset at the factory, and users are only allowed to modify it, not to query its value.



ABP Joining

1）M300C module parameter “AT+ACTIVEMODE=？” returns a value of 1，indicating the ABP joining method, The joining method is set to ABP by using the command : AT+ACTIVEMODE=1 .

ABP(Active By Personalization) is the manual network joining procedure for LoRaWAN ,which requires the configuration of parameters: DEVEUI,APPSKEY and NWKSKEY.
The cloud service platform needs to create a new node with DEVEUI,APPSKEY and NWKSKEY consistent with the module, and then the module transmit data normally.

Parameters	Query Command	Setting Command
ACTIVEMODE	AT+ ACTIVEMODE=?	AT+ ACTIVEMODE=1
DEVEUI	AT+DEVEUI=？	AT+DEVEUI=<deveui>
APPEUI	AT+APPEUI=?	AT+APPEUI=<appeui>
APPKEY	AT+APPKEY=?	AT+APPKEY=<appkey>

Note: M300C comes with a unique and non-repeating DEVEUI,which normally no longer needs to be set.

5.4 Transmitting CONFIRM Data Packets via Command

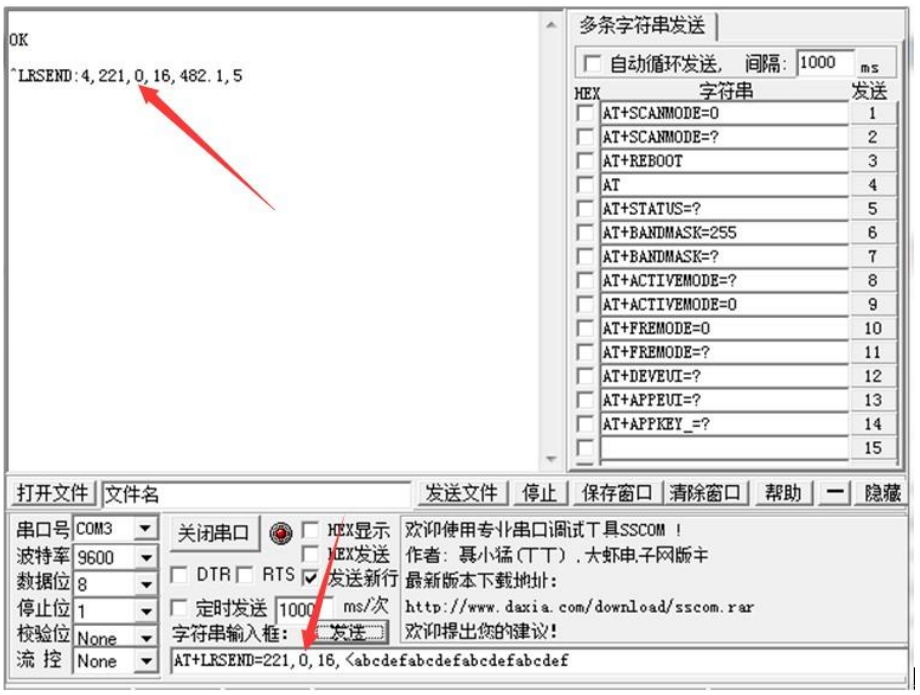
The M300C module utilizes the AT+LRSEND“ command to transmit data, the usage of this command is as follows:
AT+LRSEND=<port>,<confirm>,<len>,<data>.
<port> is for port number,
<confirm>signifies the requirement for a gateway confirmation,

<len> represents the length of the data packet;
<data>is the actual data being sent.
For sending a confirmed message, the parameter is set to 1.
For instance, to upload the string '01234567890123456789' to the cloud, follow the process illustrated in the accompanying figure. Upon sending the confirm packet '01234567890123456789' via the serial port, an ACK confirmation message will be received in response.

Confirm data received by cloud server

5.5 Transmitting UNCONFIRM Data Packets via Command

Sending UNCONFIRM data packets does not elicit an ACK confirmation from the server. It is important to note that a value of 0 at the third position indicates the UNCONFIRM message type. The process of sending an UNCONFIRM packet is essentially the same as sending a CONFIRM packet, with the only difference being that the parameter in the transmission argument is set to 0, as illustrated in the figure below:

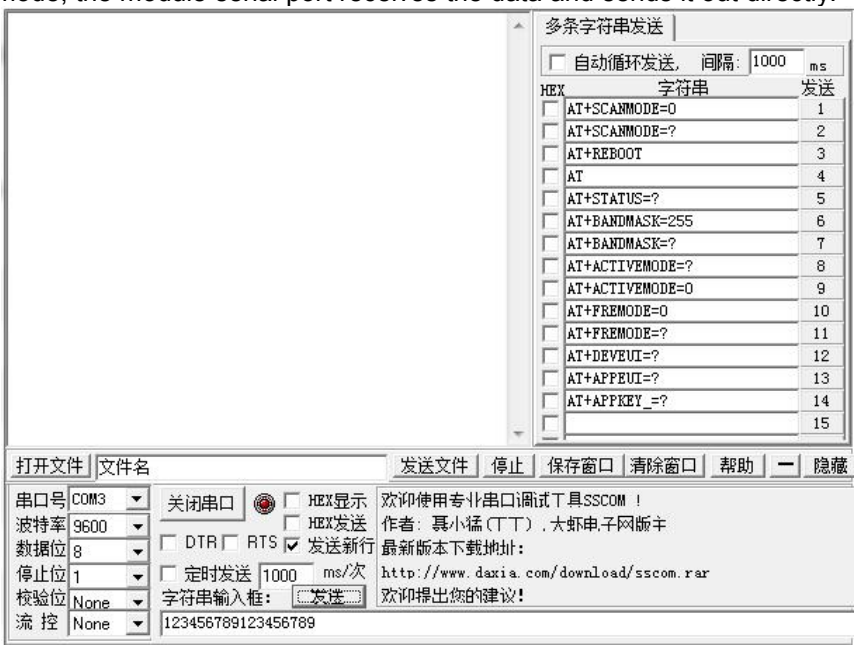


Since the packet being sent is an unconfirm packet, the server does Not return an acknowledgment packet.

Fcnt	Fport	Rssi	Lo Ra S N R	Time	Gateway Count	Data
4	221	-18	0	2018-03-16 14:55:01	2	ab cd ef ab cd ef ab cd ef ab cd ef 00 00 00 00
3	221	-22	0	2018-03-16 14:54:39	2	01 23 45 67 89 01 23 45 67 89 00 00 00 00 00 00
2	221	-19	0	2018-03-16 14:53:58	2	01 23 45 67 89 01 23 45 67 89 00 00 00 00 00 00
1	221	-19	0	2018-03-16 14:50:12	2	01 23 45 67 89 01 23 45 67 89 00 00 00 00 00 00
0	221	-24	0	2018-03-16 14:45:14	2	bf 12 d0 de d9 0c 75 f9 83 87 a3 85 f2 9f 15 3e
10	221	-25	0	2018-03-16 14:38:26	2	01 23 45 67 89 0a bc de f0 12 34 56 78 90 ab cd

5.6 Data Transmission in Transparent mode.

In transparent mode, the module serial port receives the data and sends it out directly.



The data received by the cloud consists of ASSII code values.

Fcnt	Fport	Rssi	Lo Ra S N R	Time	Gateway Count	Data
10	219	-18	0	2018-03-16 15:49:04	3	31 32 33 34 35 36 37 38 39 31 32 33 34 35 36 37 38 39 0d 0a
9	219	-17	0	2018-03-16 15:48:54	5	41 54 0d 0a
8	219	-17	0	2018-03-16 15:48:51	3	41 54 0d 0a
7	219	-17	0	2018-03-16 15:48:48	4	41 54 0d 0a
6	219	-16	0	2018-03-16 15:48:45	4	0a

*Notes：

1）In practical applications, LoRaWAN should not transmit data too frequently. If the module's serial port receives data it may result in data loss.

2）AT commands are not usable when entering transparent transmission mode.

5.7 IO Indicator

TThe M300C features three IO indicators:DIOSLEEP,DIORFTX and DIOLRRECV, corresponding functions are described as below:

IO Indicator	Description	AT Command	AT Command Parameters
DIOSLEEP	The IO pin level indicates whether the module is in sleep mode.	AT+DIOSLEEP=? AT+DIOSLEEP=<en>,<pol>,<sel>	<en>:Whether the IO indicator function is enabled; 0:Disabled; 1:Enabled; <pol>:IO indicator polarity， 0:Low level indicates the corresponding state,high level indicates not in the corresponding state; 1:High level indicates the state,low level indicates not in the state. <sel>:IO selection，0～6 corresponds to DIO0～DIO6
DIORFTX	Indicates if the module is in wireless transmission mode through the IO pin	AT+DIORFTX=? AT+DIORFTX=<en>,<pol>,<sel>	
DIOLRRECV	Indicates if the module has received data from LORAWAN through the IO pin level.	AT+DIOLRRECV=? AT+DIOLRRECV=<en>,<pol>,<sel>	

For example：

*The command “AT+DIOSLEEP=1,1,0” enables the DIOSLEEP IO indicator,where a high level signifies sleep state, a low level signifies wake-up state,and DIO0 is selected as indicator for DIOSLEEP.

*The command “AT+DIORFTX=1,0,1” enables the DIORFTX IO indicator, where a low level signifies wireless transmission state, a high level signifies not in wireless transmission state, and DIO1 is selected as the indicator for DIORFTX.

*The command AT+DIOLRRECV=1,0,2 enables the DIOLRRECV IO indicator, where a low level indicates that LORAWAN has received data, a high level indicates that LORAWAN has not received data or that the received data has been output through the serial port, and DIO2 is selected as the indicator for DIOLRRECV.

A single DIO cannot be used for multiple IO indicator functions. DIOLRRECV can commonly serve as the wake-up IO for the M300C module to control the MCU's wake-up.

5.8 Serial Ports and Wake-up

The M300C is equipped with two serial ports, UART0 and UART1. UART0 is a low-power serial port that can receive data while in sleep mode. UART1 is not a low-power serial port and cannot receive data during sleep. UART1 can only accept data after the M300C module has been awakened. The wake-up pin for the M300C is DIO7, which triggers wake-up with a low level and allows the module to sleep with a high level.

Both UART0 and UART1 can be used separately as either an AT command port or a transparent transmission port. The settings for the serial ports are as follows:

UART0:

UART0MODE=0	UART0MODE=1	UART0MODE=2
AT commands	Transparent transmission	Not Used (Serial Port Still Enabled)

UART1

UART1EN=1, UART1MODE=0	UART1EN=1, UART1MODE=1	UART1EN=1, UART1MODE=2	UART1EN=0, UART1MODE=X
AT commands	Transparent transmission	Not Used (Serial Port Still Enabled)	Not Used (Serial Port Disabled)

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