UM402

433/470MHz Low power with long range

RF module with UART interface

UM402 is a highly integrated low-power half-`duplex RF transceiver module embedding high-speed low-power MCU and high-performance RF chip with LORA modem which is capable of achieving significant longer range than existing RF transceiver based on FSK or OOK modulation. UM402 module provides multiple channel choices, then users could modify the serial port rate, transmission power, radio frequency and other parameters online.

This module uses LoRa modem to improve the sensitivity up to -144.1dBm, significantly extending the transmission distance under a low power. So there is no need for repeater and complex communication infrastructure. Due to the transmission distance increasing, users could significantly reduce the usage of repeater, simplify the system design and reduce the production cost.

UM402 module's supplies the voltage 2.6-3.6 V with consuming only 13 mA at the receiving mode. UM402 module has four work modes and each one could be switched free. Under the power saving mode, the module consumption is only 1.3uA. The lithium battery with 3.6 V / 3.6 AH could work for several years, which is very suitable for a battery-powered system.

Apply

- Wireless water/heat/gas meter reading

- Wireless sensor

- Intelligent instrument and meter

- Intelligent lighting control

- Auto data collection

- Remote control and sensing

- Communication in highway and railway

- Smart building and security

- Robot control

- Power distribution network monitoring,

- Power system monitoring

- Wireless warehousing, logistics management

Feature

- Transmission distance > 5000 m

- Frequency 410MHz to 510MHz

- High sensitivity -144.1dBm@50.78bps

- Maximum transmission power 20dBm

- LoRa modem

- Low sleep current 1.3uA

- Receiving mode current 13mA

- Max current 120mA@20dBm

- Super small size 34.5mm*20mm*6mm

- Single needle interface

Catalog

1. General Introduction

UM402 is a new generation of multi-channel embedded RF transceiver module. It has multiple channels with 1 kHz step, and the biggest RF power is 100mw with small size (34.5 mm x 20 mm x 6.0 mm). The module has low power consumption being suitable for battery power supply system.

UM402 module uses the spread spectrum modulation and effective error correction coding. Reliable code also contains error detection ability at the same time, which could automatic filtering errors and false information, then realize the transparent connection. Under the same RF power, UM402 is nearly twice as far as the traditional module distance. So UM402 module is suitable for bad environment and long distance with the requirement of occasions.

1.1 Feature

- Support wireless awakening function which could low the average power.
- Provide four working modes could further reduce the power consumption; sleep current is 1.3uA, continuous receiving current is around 13 mA.
- Support on-line modification (by MCU) and local modification (using RFModuleManager) to modify module parameters.
- Up to 255 bytes in packet once.

1.2 Baud Rate and Sensitivity

When the air baud rate is：50.78，61.04，81.45，122.07，244.14，406.9，813.8，1464.84，1790.36，2604.17，3255.21，4557.29，5859.38，10416.67，18229.17，31250 bps , the corresponding sensitivity are：-144.1，-143.1，-141.8，-140，-137，-135，-132，-129.5， -128.5，-127，-126，-124.5，-123.5，-121，-118.5，-116 dBm.

2. Pin Definition

UM402 module has nine pins, specific definitions as the following table:

Pin	Name	Direction	State
1	GND	-	Ground, 0V
2	VCC	-	2.6~3.6V
3	SETA	Input（weak pull-up）	about 47kΩ pull-up resistor
4	RXD	Input（weak pull-up）	Pull up resistors UART input port, the TTL level, about 47kΩ
5	TXD	output	UART output, TTL level
6	AUX	output	Data input/output instruction
7	SETB	Input（pull-down）	About 4.7kΩ pull-down resistor
8	NC	-	Grounding/dangling
9	NC	-	Grounding/dangling

3. Product Size

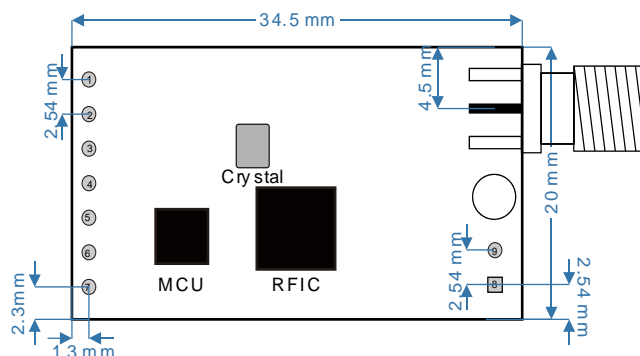
Figure 1：Product size

4. Working Mode

UM402 has four working modes:

- Mode 1 – normal
- Mode 2 – awaken
- Mode 3 – low power
- Model 4 – set

Mode 3 has two kinds of working condition (power saving & sleep). The four work modes are determined by the level of SETA and SETB.

4.1 Mode 1 – normal（SETA=0，SETB=0）

4.1.1 Mode 1-send

When the RXD pin of module getting the first byte, the AUX pin is set low, and module begins to judge SETB level; after receiving the last byte, module will wait 3 bytes time for a new byte coming in, if no, the module will set high AUX pin and send the preamble symbols synchronizing code and data.

In this mode, RF data contains normal length preamble symbols, so the receiving module must be in Mode 1 or Mode 2, which continue to receive status.

4.1.2 Mode 1-receive

The Serial port is open and the module is in continuous receiving mode. When receiving data from the current channel, module will set low AUX and immediately output data through the TXD pin. After the data is transferred, module will set high AUX pin.

Normal mode and timing as the figure 2:

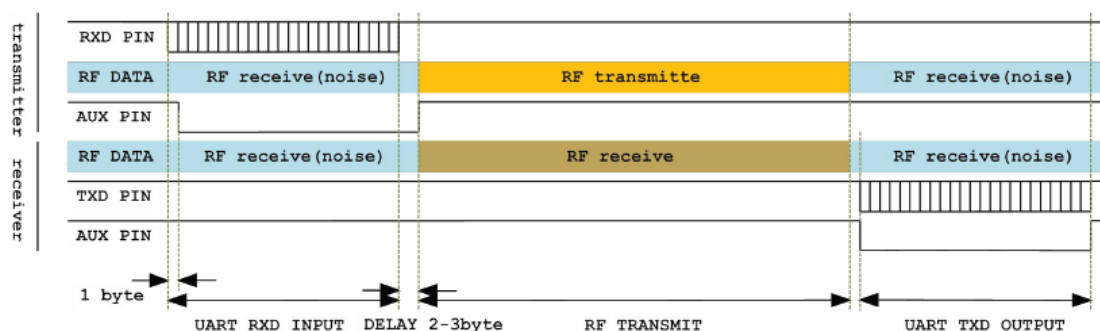Figure 2: sequence diagram under normal mode

AUX pin could help users set the packets' interval lowest time. After RXD pin receiving data, AUX pin will be set low, and only set high again at the beginning of the RF transmission. Users are able to send next packet via RXD pin again, and the module will send the second packet after transmitting of the first packet.
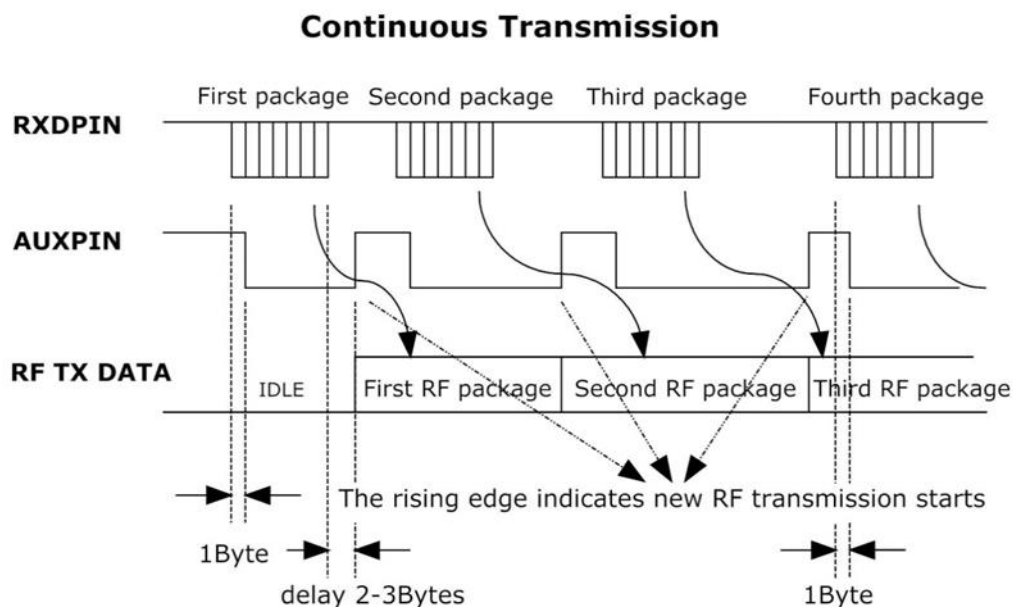
Sequence is shown as figure 3.

Continuous Transmission

Figure 3: normal mode for multiple packet sending sequence

4.2 Mode 2 – awaken （SETA=0，SETB=1）

4.2.1 Mode 2 -send

When the RXD pin of module get the first byte, the AUX is set low, and the module begins to judge SETB level; after receiving the last byte, the module will wait 2-3 bytes time for a new byte coming in, if no, the module will set high AUX pin and send the preamble symbols synchronizing code and data.

`In this mode RF data has a long preamble symbol, so the receiving module must be in Mode 1, Mode 2 or Mode 3.

4.2.1 Mode 2-receive

The serial port is open and the module is continuous receiving mode, when receiving data from the current channel, module will set low AUX and immediately output data through the TXD pin. After the data is transferred, module will set high AUX pin.

4.3 Mode 3 - low power（SETA=1，SETB=0）

Status of SETA and the SETB determine the module in the low power mode. Function of bit5 makes module work in the state of power saving or sleep mode (see section 6.2).

4.3.1 Power Saving

The serial port is closed and RF receiver will be wakeup periodically to search preamble symbol. Module will sleep again for the next wakeup cycle if no finding preamble symbol; otherwise receiver will wait for the synchronous code to receive all data. Once receiving RF data, module will set low AUX pin to wake up MCU, after a certain amount of time (delay time could be set, default is 5ms), module open the serial port and output data. After the serial port finishing output, serial port is closed and AUX pin is set high .The mode of receiving diagram is shown as figure 4.
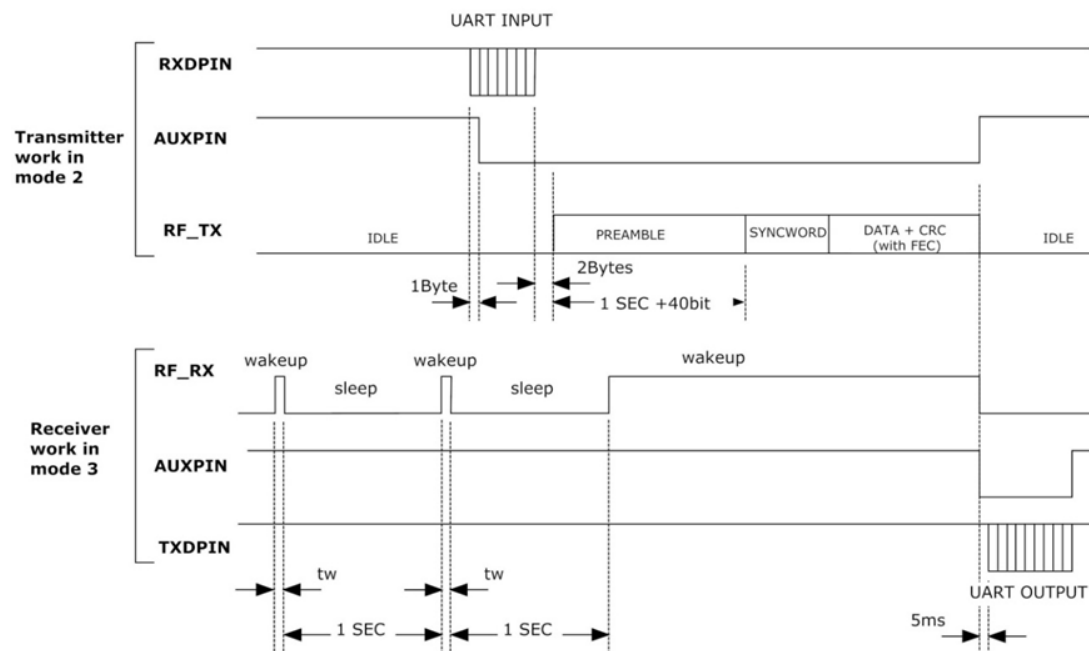

Figure 4: Power saving mode work diagram

4.3.1 Sleep

The serial port is closed and the module will be wakeup periodically to clear the watch dog. Under this working mode, RF parts will sleep and set low MCU main clock frequency.

4.4 Model 4 - Set （SETA=1，SETB=1）

Under this mode, users could read or set the module parameters (see chapter 6).

5. Application Form

5.1 Hardware Interface

Four modes of module by SETA and SETB setting high and low could be switched freely. Diagram of the connection between module and MCU is shown as figure 5.
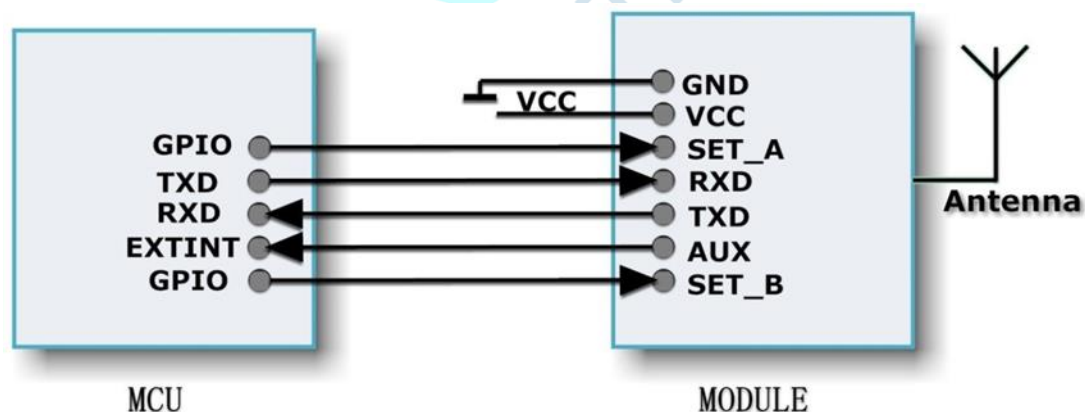

Figure 5: under the module and machine connection diagram

5.1 The Workflow of Normal and Awaken Mode

After configuring out SETA = 0 and SETB = 0, the module will be in the normal mode (Mode 1); users could directly connect SETA and SETB of each module to GND pin (saving two IO pins of MCU).

After configuring out SETA = 0 and SETB = 1, the module will be in the awaken mode (Mode 2); users could directly connect SETA to GND, or connect SETB to VCC (saving two IO pins of MCU).

In this mode, the module will work in half-duplex communication mode, which could be the transmitter or receiver. The communication could work, only if parameters of transmitter and receiver would be setting the same.

When getting data from RXD pin, the module will set low AUX pin and automatically switch to the RF mode. If in the awaken mode, the module will transmit a longer preamble symbol to wake up the module of the power saving mode.

Once the receiver getting RF data from the RF transmitter, the module will set low AUX pin and output it through the serial port. At the end of data output through the UART, the module will set high AUX pin, and set back into the RF receive mode.
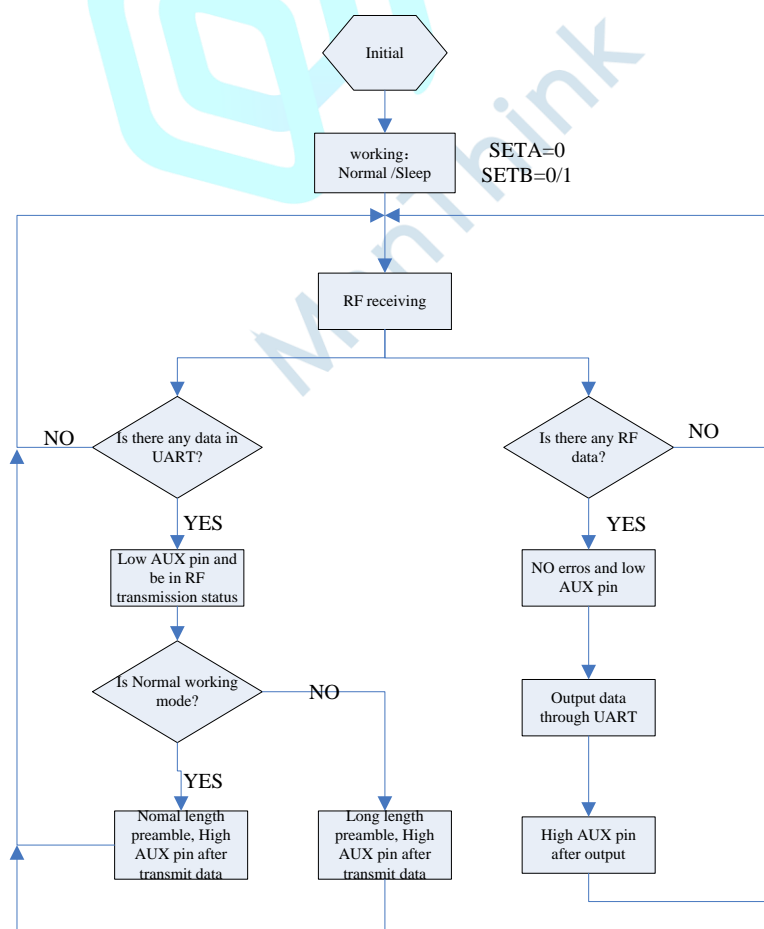
The working process is shown as figure 6.

Figure 6: normal/awaken model work process

5.2 Application of Power Saving Mode

When transmitting data, SETA is low level, and level of SETB determines the length of preamble symbols to wake up the module of power saving. When receiving, if module enables the function of RSSI, the module will increase a byte for RSSI in output packet data. The receiving intensity is expressed as:

RSSI [dBm] =RSS I_value -137 [dBm]

5.3 Sleep Mode

The sleep mode could be set by modifying the function bit of parameters, during the sleep mode, SETA and SETB must keep the status. Module could quickly switch from sleep to awaken which time is just 20us. It means that in sleep working mode, users could send data to the module only 20us after setting low SETA pin through the UART. In the process of receiving or transmitting, even the module is set to mode 3 or 4, and then the module should complete the receiving or sending before being modified into a new working mode.

Sleep mode has the lowest power consumption.

6. Parameter Configuration

6.1 Module Parameter Configuration

Parameter	No. of bytes	Address	State
Module type	1	0	Read-only
Firmware version	1	1	Read-only
Frequency	3	2~4	Unit KHz，such as 433.920 MHz with 0x06, 0x9f, 0x00
Air baud rate （bps）	1	5	50.78, 61.04, 81.45, 122.07, 244.14, 406.9, 813.8, 1464.84, 1790.36, 2604.17, 3255.21, 4557.29, 5859.38, 10416.67, 18229.17,

			31250. Corresponding register parameters from 0x00 to 0x0f; under the 31.2 kbps, module only supports fixed length frame mode.
Transmission power	1	6	Setting range from -1 ~ 20 dBm, output power = register values - 2; such as register values of 10, the corresponding transmission power 8 dBm.
Serial port Baud rate	1	7	1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200bps are represented as 0x00，0x01，0x02，0x03，0x04，0x05，0x06，0x07.
Serial port check	1	8	0x00 is none, 0x01 is odd-parity check, and 0 x02 is even-parity check.
Wake cycle	1	9	Setting range from 1 ~ 100, awaken cycle = register values * 50ms, such as register values 40, the wake cycle 2000ms.
Trigger delay	1	10	Setting range from 1 ~ 200, trigger delay = register values * 5ms. Such as register values is 40, the trigger delay is for 200ms, and the wireless pin AUX output is low level after waking up, data will be sent back to the MCU 200ms after receive
Carrier detection timeout	1	11	This parameter is meaningful, if carrier detect module function is enable. Range from 1 ~ 200, the carrier detection timeout = register values * 100ms .Such as register values is 40, then the carrier detection timeout for 4000ms .

Wireless packet length	1	12	Range from 1~ 255; sending wireless data length by module; being effective only in the fixed length frame mode.
Hardware address	2	13~14	If enabling hardware address, packets whose address is inconsistent with module will be discarded. Address format example :register is set to 0x03, 0x01, the hardware address 0x301 = 769
Function byte	1	15	[7:6]：Retain [0]：Fixed length of the frame mode [1]：RSSI [2]：Carrier detect [3]：Hardware address [4]：Send the source address is effective [5]: Low power mode selection（see 6.2）

6.2 Low Power Consumption Mode Selection

When bit5 of function byte is 1, the module will work in power saving mode; when bit5 is set to 0, the module will work in sleep mode.

6.3 Fixed Length Frame and No-Fixed Length Frame

● Packet length definition: packets according to the set of different parameter could contain the target address information, the application data and the source address information. The total length of the three kinds of information data makes up the packet length. UM402 module's max packet length is 255 bytes.

● Module supports fixed length frame and no-fixed length frame. Under the fixed length frame mode, no header information in the packet make the transmission more efficiently (37.5 kbps baud rate only supports fixed length fame mode). Under the fixed length frame mode, users should set the length of packet. If the length of packet is less than settings, module will append 0 symbols; else if the

length of packet is longer than settings, module will send the fixed length data only.

6.4 Packet Format and Function Byte Description

● Send

The target address (2 bytes)	Data

■ When the hardware address is enabling, the first two sending bytes of the packet must be the target hardware address. If the hardware address is 0, the frame is a broadcast frame. The receiver will check RF packet with its address, if not match, the packet will be discard.

■ When sending the source address is enabling, the module automatically add the hardware address. The maximum length of application data is :

Packet length (if no-fixed length, the value is 255) - 4;

If the hardware address is enabling and sending the source address is disabling, the maximum length of the application data is:

Packet length (if no-fixed length, the value is 255) - 4;

■ If hardware address is enabling, the maximum length of the application data is:

Packet length (if no-fixed length, the value is 255).

● Receive

Source address (2 bytes)	Date	RSSI（1 byte）

When the hardware address is enabling, the receiver will check the receiving data with module's hardware address, and packet will be discard if the address doesn't match. If sending the source address is enabling, the first two bytes of receiving are regard as the sender's address.

Note：Only the hardware address is enabling, sending source address function could be meaningful.

When the RSSI detection is effective, each last packet's byte is the RSSI value.

Actual value is: RSSI [dBm] = -137 + RSSI_value [dBm]

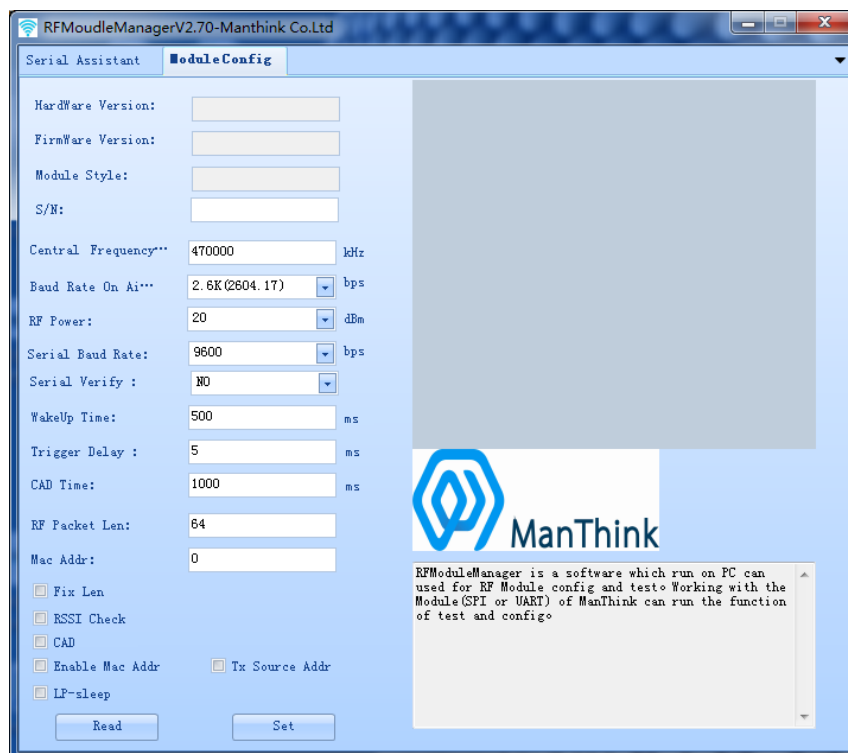## 6.5 Using RFModuleManager Tool Configuration

Figure 9: UART module configuration tool

There are two ways to modify parameters of module which include UART, Radio-Frequency, Air-Baud-Rate and RF Power. Users could use RFModuleManager to modify parameters on PC by UART/TTL to RS232 conversion board. When commutating with module on set working mode, baud rate of serial must be set to 9600bps. The software is shown as figure 9. The connection is shown as figure 10.
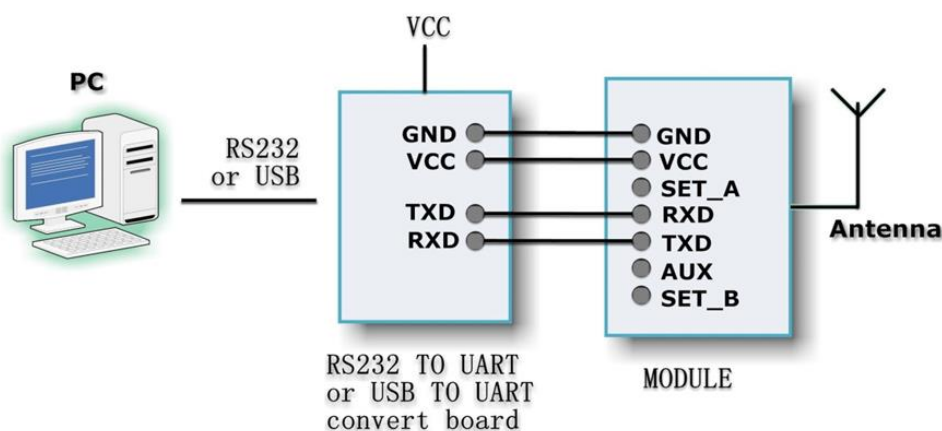

Figure 10: configuration diagram

6.6 Online Configuration

Online Settings also works through UART/TTL (4, 5 Pin). The module will work normally after the module is powered on 500ms later. Before parameters setting, users must switch (such as Mode 1, 2, 3) to Mode 4. About 10ms later, parameters could be set through UART. Under the Mode 4, the baud rate of UART is 9600bps.

If the command is correct, module will reply and automatically reset initialization again. If the command is incorrect, the module will not reply, but still cause a reset initialization.

6.5.1 Configuration Command

Module settings adopt HEX code; baud rate is 9600bps; configure command have two formats as below:

● Read the setting command: 0XFF, 0x56, 0xae, 0x35, 0xa9, 0x55, 0xf0, the starting address, the number of bytes

Reply: 0x24, parameter data

■ Example 1: read all parameters command, the starting address 0, number of bytes is 16.

0XFF, 0X56, 0xae, 0x35, 0xa9, 0x55, 0xf0, 0x00 , 0x10

Reply: 0cx24, module type, version number, frequency, air rate, transmission power, rate of serial port, serial port check mode, wake up of time, trigger delay, carrier detect time, RF packet length, hardware address, function byte.

■ Example 2: read the frequency command:

0XFF, 0x56, 0xae, 0x35, 0xa9, 0x55, 0xf0, 0x02, 0x03

Reply: 0x24, frequency (3 bytes)

● Write setting command: 0XFF, 0x56, 0xae, 0x35, 0xa9, 0x55, 0x90, the starting address, the number of bytes, parameter data

Reply: 0 x24, set the parameter data

■ Example 1: set all parameters, the starting address 2, the number of bytes 14.

0xFF，0x56，0xAE，0x35，0xA9，0x55，0x90，0x02，0x0E, frequency, air rate, transmission power, rate of serial port, serial port check mode, wake up of time, trigger delay, carrier sensing time, RF packet length, hardware address, function byte.

Reply: 0x24, frequency, air rate, transmission power, rate of serial port, serial port check mode, wake up of time, trigger delay, carrier sensing time, RF packet length, hardware address, function byte.

■ Example 2: set the frequency parameter, 0XFF, 0x56, 0xAE, 0x35, 0xA9, 0x55, 0x90, 0x02, 0x03, frequency (3 bytes).

Reply: 0x24, frequency (3 bytes)

7. Electrical Parameter

Radio Frequency	410~510MHz
Step Frequency	1kHz
Transmission Power	5~20dBm,
Receiving Sensitivity	-144.1dBm@50.78bps, -121dBm@12.5kbps
Air Transfer Rate	300bps~31.2kbps
Interface Baud Rate	1200 – 115200bps
Interface Detection Way	8N1/8E1/8O1
Interface Buffer Space	Double 255Bytes
Working Humidity	10%～90% (no condensation)
Working Temperature	-45℃~85℃
The power Supply	2.6~ 3.6V
Transmission Current (typical)	120mA@100mW
Harmonic Suppression	≤1GHz：<-36dBm, ＞1GHz：<-30dBm
CAD/ Receives Current(typical)	13mA
Sleep Current(typical)	1.3uA
Size	34.5mm x 20.0mm x 6.0mm
Antenna Impedance	50Ω

8. Other

8.1 Common Problem

No Communication Between g Modules	1. Different parameters between two modules, such as: baud rate
	2. Different radio frequency or air baud rate
	3. Different product series
	4. Abnormal power supply
	5. Module Damaged
	6. Module mode setting error
	7. Out of communication range or incorrect antenna connection
Close Transmission Distance	1. Over voltage range
	2. Too big power supply ripple
	3. Incorrect antenna connection or type
	4. Too closed between antenna and metal surface or too small area with module grounding
	5. Terrible condition, such as dense buildings

8.2 Contact

For more support, please contact with Beijing Manthink technology co., Ltd:

Contact number：010-56229170

E-mail：info@manthink.cn

Address：Room601 Ronghua International Building No.5, Ronghua South Road No.10, Beijing Economic-Technological Development Area (BDA)