E77-400/900M22S

STM32WLE5 400/900MHz LoRaWAN wireless module

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Content

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1 Product Overview

1.1Introduction

E77-400/900M22S series products are standard LoraWan node modules designed and produced by Chengdu Yibaite Electronic Technology Co., Ltd. E77-400M22S works in the frequency band 410~510 MHZ , E77-900M22S works in the frequency band 868~930 MHZ, E77- 400M22S supports Lo Ra W AN 1.0.3 EU433/CN470 standard , E77-900M22S supports Lo Ra W AN 1.0.4 EU868/US915/AU915/AS923/IN865/KR920/RU864 standard, and supports CLASS - A/CLASS-C nodes Type, supports ABP/OTAA two network access methods. At the same time, the module has a variety of low-power modes. The external communication interface uses standard UART. Users can access the standard LoRaWAN network through simple configuration through AT commands. It is the current Excellent choice for IoT applications.

E77-400M22S

E77-900M22S

1.2 Features

- Under ideal conditions, using transparent transmission protocol , the communication distance can reach 5.6 km;
- Under ideal conditions, using Lo Ra W AN standard firmware, the communication distance can reach 3.5 km;
- The maximum transmit power is 21.5dBm , multi-level software adjustable;
- E77-400M22S supports the global license-free ISM 433/470MHz frequency band;
- E77-900M22S supports the global license - free ISM 868/915 MHz frequency band;
- E77-400M22S supports Lo Ra W AN 1.0.3 EU433/CN470 standard;
- E77-900M22S supports Lo Ra W AN 1.0.4 EU868/US915/AU915/AS923/IN865/KR920/RU864 standard;
- E77-400/900M22S supports two device types: Class A and Class C;
- ~12SF spreading factors launched to support dense networks ;
- Supports 1.8 ~ 3.6 V power supply, and any power supply greater than 3.3 V can ensure the best performance;
- The external crystal oscillator uses 32.768KHz, 32MHz high-precision industrial-grade crystal oscillator;
- 14.0*20.0*2.7mm small size patch package, conducive to system integration development;
- Industrial grade standard design, supports long-term use at -40~+85℃;
- Optional dual antennas (IPEX/stamp hole) facilitate user secondary development and integration;

1.3 Application scenarios

- Smart home and industrial sensors, etc.;
- Security systems, positioning systems;
- Wireless remote control, drone;
- wireless game remote;
- healthcare products;
- Wireless voice, wireless headphones;
- Automotive industry applications.

2 Specifications

2.1 RF parameters

2.2 Hardware parameters

RF parameters	Parameter value	Remark
E77-400M22S Working frequency	410 ~ 510 MHz	Support ISM frequency band
E77-900M22S Working frequency	850 ~ 930 MHz	
Transmit power	0 ~ 21.5dBm	The software is adjustable and requires users to develop settings by themselves.
Receive sensitivity	-118dBm	GFSK, airspeed 1.2 kbps
Spreading factor	5 ~ 12	——
Measured distance	3.5km	LoRaWAN protocol, clear and open environment, antenna gain 3.5dBi, height 2m
	5.6 km	Transparent transmission protocol (see demo routine for details), clear and open environment, antenna gain 3.5dBi, height 2m

Hardware parameters	Parameter value	Remark
IC full name	STM32WLE5CCU6	——
Kernel	Cortex-M4	——
FLASH	256 KB	——
RAM	64 KB	——
Crystal frequency	32MHz /32.768KHz	External temperature compensated crystal oscillator
Size	14*20mm	——
Antenna form	IPEX/stamp hole	Equivalent impedance is about 50 Ω
Communication Interface	UART	The factory comes with LoRaWAN protocol firmware
	UART, SPI, I² C, GPIO, ADC	Users need to develop their own settings
Packaging method	patch stamp hole	——

2.3 Electrical parameters

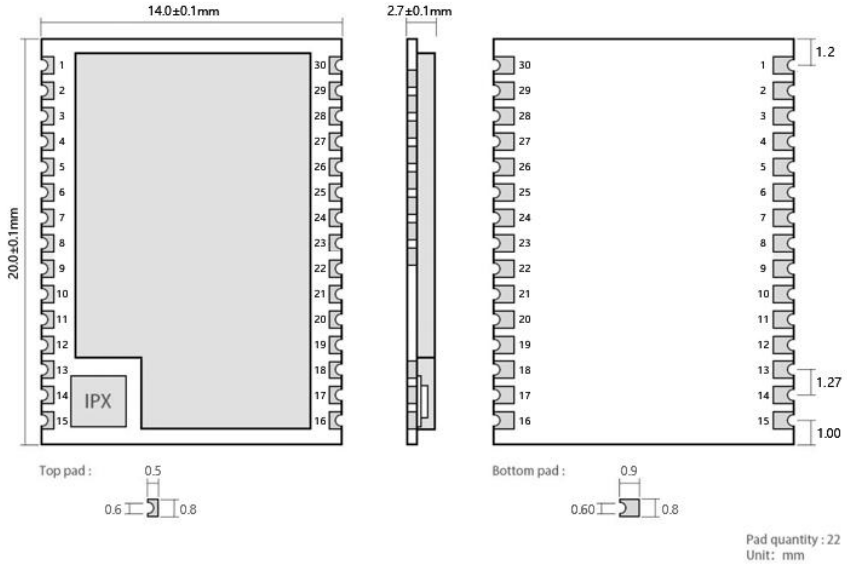
Electrical parameters	minimum value	Typical value	maximum value	unit	condition
voltage	1.8	3.3	3.6	V	≥3.3V guarantees output power Exceeding 3.6 V will permanently burn the module
Communication level	-	3.3	-	V	It is recommended to add level conversion when using 5.0 V TTL
Emission current	-	128	-	mA	Instantaneous power consumption
receive current	-	14	-	mA	——
E77-900M22S Sleep current	-	3	-	μA	Software shutdown
E77-400M22S Sleep current	-	2	-	μA	
Operating temperature	-40	20	85	℃	——
Working humidity	10	60	90	%	——
Storage temperature	-40	20	125	℃	——

2.4 Parameter description

- When designing the power supply circuit for the module, it is often recommended to reserve more than 30% margin, so that the whole machine can work stably for a long time;
- The current required at the moment of emission is relatively large, but because the emission time is extremely short, the total energy consumed may be smaller;
- When customers use an external antenna, the different impedance matching degrees between the antenna and the module at different frequencies will affect the emission current to varying degrees;
- The current consumed when the RF chip is in a pure receiving state is called receiving current. Some RF chips with communication protocols or developers have loaded some self-developed protocols on the whole machine, which may cause the tested receiving current to be too large;
- The shutdown current is often much smaller than the current consumed by the power supply part of the whole machine when it is no-load, so there is no need to be too demanding;
- Since the material itself has certain errors, a single LRC component has an error of ±0.1%. However, if multiple LRC components are used in the entire RF circuit, errors will accumulate, resulting in differences in the transmitting current and receiving current of different modules;
- Reducing the transmit power can reduce power consumption to a certain extent, but due to many reasons, reducing the transmit power will reduce the efficiency of the internal PA.

3 Mechanical Dimensions and Pin Definitions

3.1 Dimensional drawing



3.2 Pin definition

Pin number	Pin name	Pin direction	Pin usage
1	PB3	input Output	TX_LED, transmit data indication pin, output high level when transmission is completed
2	PB4	input Output	RX_LED, receive data indication pin, output high level after receiving
3	PB5	input Output	LINK_LED, network access status indicator pin, outputs high level if network access is successful
4	PB6	input Output	USART1_TX (the built-in firmware is not used, reserved)
5	PB7	input Output	USART1_RX (comes with firmware, not used, reserved)
6	PB8	input Output	Configurable general-purpose IO port (see STM32WLE5CCU6 manual for details)
7	PA0	input Output	Soft boot pin, pull it low continuously for 1s after power on to enter IAP upgrade mode.
8	PA1	input Output	Configurable general-purpose IO port (see STM32WLE5CCU6 manual for details)
9	PA2	input Output	LP_ USART 2 _TX (AT command serial port transmission pin)
10	PA3	input Output	LP_ USART 2 _RX (AT command serial port receiving pin)

11	PA4	input Output	Configurable general-purpose IO port (see STM32WLE5CCU6 manual for details)
12	PA5	input Output	Configurable general-purpose IO port (see STM32WLE5CCU6 manual for details)
13	GND	input Output	Ground wire, connected to the power reference ground
14	ANT	input Output	Antenna interface, stamp hole (50 Ω characteristic impedance)
15	GND	input Output	Ground wire, connected to the power reference ground
16	PA8	input Output	Configurable general-purpose IO port (see STM32WLE5CCU6 manual for details)
17	NRST	enter	Chip reset trigger input pin, active low level (built-in 0.1uF ceramic capacitor)
18	PA9	input Output	Configurable general-purpose IO port (see STM32WLE5CCU6 manual for details)
19	PA12	input Output	Configurable general-purpose IO port (see STM32WLE5CCU6 manual for details)
20	PA11	input Output	Configurable general-purpose IO port (see STM32WLE5CCU6 manual for details)
twenty one	PA10	input Output	Configurable general-purpose IO port (see STM32WLE5CCU6 manual for details)
twenty two	PB12	input Output	Configurable general-purpose IO port (see STM32WLE5CCU6 manual for details)
twenty three	PB2	input Output	Configurable general-purpose IO port (see STM32WLE5CCU6 manual for details)
twenty four	PB0	input Output	Configurable general-purpose IO port (see STM32WLE5CCU6 manual for details)
25	PA15	input Output	Configurable general-purpose IO port (see STM32WLE5CCU6 manual for details)
26	PC13	input Output	Configurable general-purpose IO port (see STM32WLE5CCU6 manual for details)
27	GND	output	Ground wire, connected to the power reference ground
28	VDD	enter	Power supply, ranging from 1.8 to 3.6 V (it is recommended to add external ceramic filter capacitors)
29	SWDIO	enter	Program download
30	SWCLK	enter	Program download

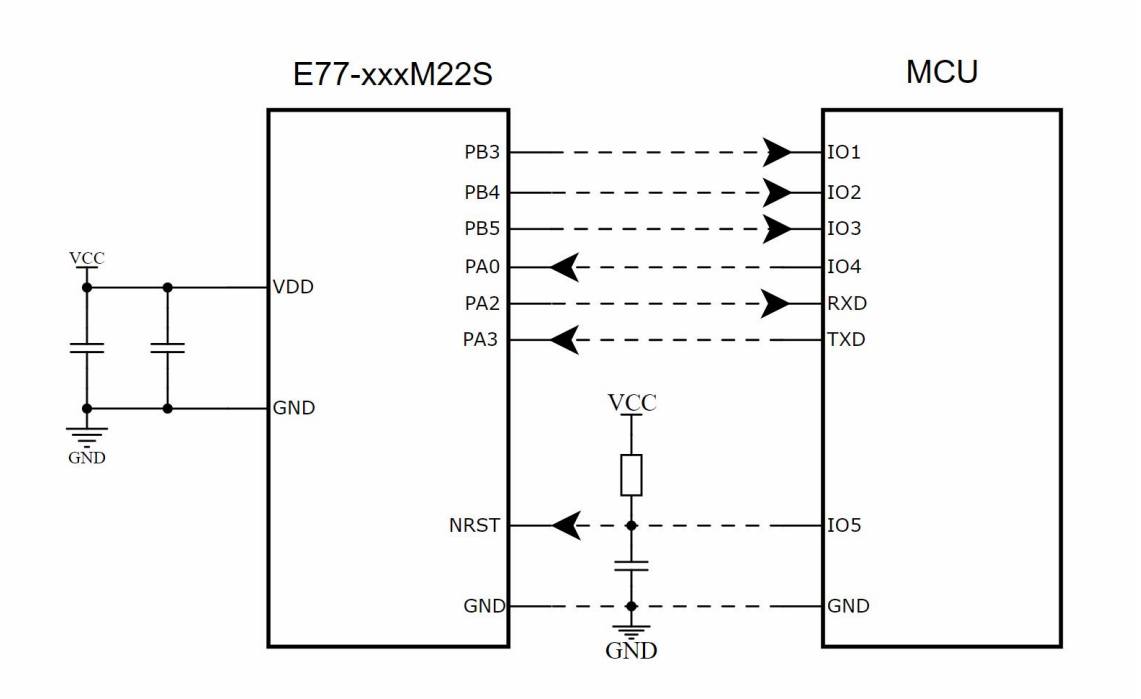
*The pins in red font are the pins used by the LoRaWAN firmware that comes with the module;

Note 1: The PA6 and PA7 pins are used as internal control radio frequency switches in the module, PA6 = RF_TXEN, PA7 = RF_RXEN, RF_TXEN=1 RF_RXEN=0 is the sending channel, RF_TXEN=0 RF_RXEN=1 is the receiving channel

Note 2: The PC14-OSC32_IN and PC15-OSC32_OUT pins have been connected to a 32.768KHz crystal oscillator inside the module for users to choose during secondary development.

Note 3: The OSC_IN and OSC_OUT pins have been connected to a 32MHz crystal oscillator inside the module for users to choose during secondary development.

3.3 Recommended connection diagram



*Only applicable to LoRaWAN firmware applications that come with the module before delivery. Users need to define pin functions by themselves for secondary development.

4 Terms and Definitions

4.1LoRa

LoRa is one of the LPWAN communication technologies. Its full name is Long Range Radio, which means "long range radio" in Chinese;

The company currently leading this technology is the foreign S emtech company;

LoRa's main ISM brand is in the global free frequency bands: 433MHz, 470MHz, 868MHz, 915MHz, etc.

Features: Low power consumption, long distance, low cost.

4.2 LoRaWAN

The LoRa Alliance is an open, non-profit organization led by Semtech in March 2015. The alliance released a low-power wide area network standard based on an open source MAC layer protocol: the LoRaWAN protocol standard.

Network topology: star structure

Network composition: LoRa module, gateway (Gateway or base station), Server (including Network Server, Network control, Application

Server).

LoRaWAN divides LoRa nodes into three categories: A/B/C:

- Bidirectional transmission terminal (Class A):

Class A terminals will be followed by two short downlink reception windows after each uplink to achieve two-way transmission. The terminal arranges transmission time slots based on its own communication needs, with small changes based on random time (ie, ALOHA protocol). This Class A operation provides the lowest power end system for applications, requiring only

The server's downlink transmission is performed within a short period of time after the terminal's uplink transmission. Downstream transmissions performed by the server at any other time have to wait for the terminal's next upstream transmission.

- Bidirectional transmission terminal demarcating reception time slots (Class B):

Class B terminals will have more receive slots. In addition to the random receiving window of Class A, Class B equipment will also open other receiving windows at designated times. In order for the terminal to open the receiving window at the specified time, the terminal needs to receive a time synchronized beacon (Beacon) from the gateway. This allows the server to know when the terminal is listening.

- Bidirectional transmission terminal that maximizes receive time slots (Class C):

The Class C terminal basically keeps the receiving window open and only closes it briefly when sending. Class C terminals consume more power than Class A and Class B, but at the same time, the delay from the server to the terminal is also the shortest.

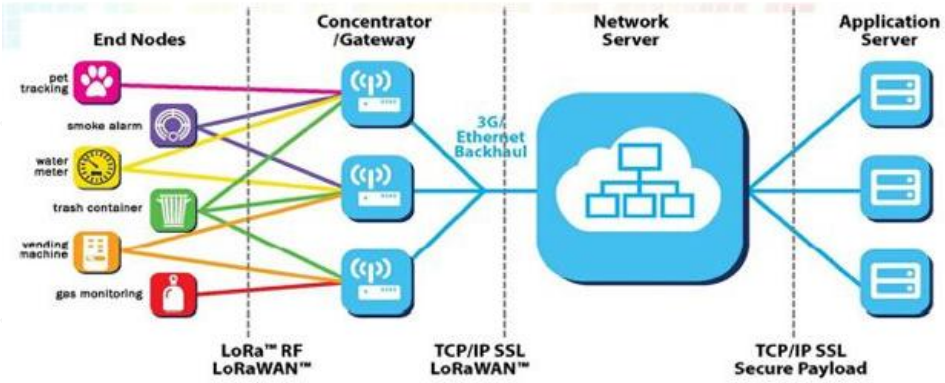
Note: E77-400/900M22S supports two device types: Class A and Class C;

4.3 ADR

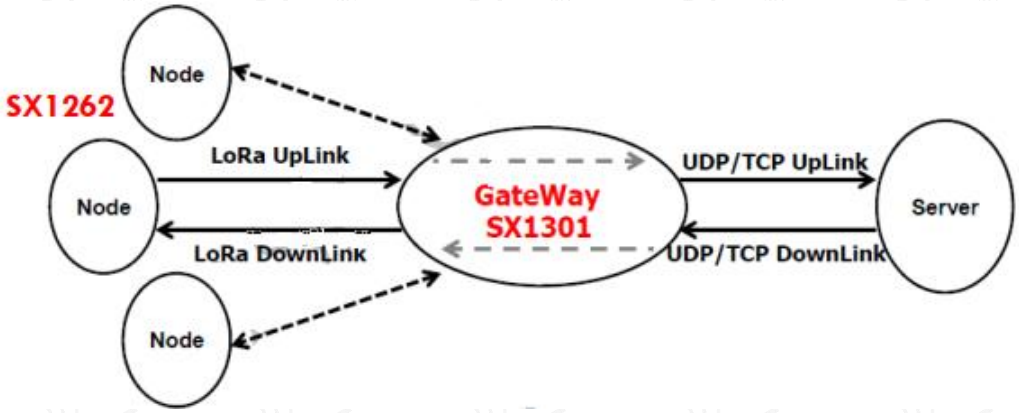
ADR is called Adaptive Data Rate in Chinese. In the loraWan network system, in order to maximize the battery life

and overall network capacity of the terminal device, the LoRaWAN network server manages the data rate and RF output of each terminal device separately through the adaptive data rate (ADR) algorithm. Through ADR technology, In the LORAWAN system, the server automatically updates and sets the node's rate based on the node's signal reception capability. If the distance is far, the rate is low, and if the distance is close, the rate is high. This greatly improves the effective bandwidth and load capacity of the network in practical applications.

5 LoraWan application model diagram



The complete LoraWan network system consists of: nodes, gateways, Lora NetWork Server, and application servers. The nodes are generally designed by LORA chips; the gateway is designed by SX1301 provided by semtech; the Lora NetWork Server currently has open source loraserver or commercial TTN (The ThingsNetwork), users can build it by themselves; the application server is designed and developed by users, mainly used for exchanging application data with Lora NetWork Server.



6 Access Demonstration

This demonstration kit is: E77-900M22S as the node, E890 as the gateway to access the free TTN (TheThingsNetwork) test server for communication testing; the serial port uses pins 9 and 10, LP_USART2_TX serial port, baud rate 9600bps 8N1

The corresponding settings for the node-side OTAA access mode are as follows:

AT+RESTORE //Restore default configuration

AT+REGION=5 //eu868 frequency band

AT+CDEVEUI=70B3D57ED0063EC9 //Set deveui

AT+CAPPEUI=0000000 0 00000000 //Set appeui

AT+CAPPKEY=2000000000000000000000000000000001 //Set appkey

AT+ C JOIN=1 :0 //otaa joins the network, automatically joins the network without powering on

On TTN, the gateway information is as follows:

The gateway data looks like this:

TTN node data records are as follows:

AT+SEND=3:1: 1: 112233 //Send data parameter 1: port number parameter 2: maximum number of retransmissions parameter 3: ack response parameter 4: hex data

Node serial port:

Note: For TTN creation equipment and corresponding configuration process, please refer to "LORAWAN Node + Gateway TTN Server Configuration Tutorial"

7 AT Commands

7.1 Instruction format

<CMD>[op][para1, para2, para3,…]<CR><LF>

: command prefix

CMD: control command

[op]: Instruction operator. Can be the following:

- ✓ "=": Indicates parameter settings.
- ✓ "?": Indicates the parameters of the query setting command .
- ✓ "": Indicates execution of instructions.
- ✓ "=?": Indicates the current value of the query parameter.

[para-n]: Indicates the set parameter value, or specifies the parameter to be queried.

<CR><LF>: carriage return and line feed, ASCII 0x0D 0x0A

7.2 AT command set

instruction	Description (general command)
AT	test instructions
AT+VER	Read lorawan version related information
AT+FWCODE	Read software code
AT+DEVTYPE	Read device model
AT+LOGLEVEL	Set log level
AT+UART	Set the serial port baud rate and parity bit
AT+IAP	IAP upgrade
AT+LTIME	Get local time
AT+RESTORE	Restore default parameters
AT+CSAVE	Save current parameters
AT+RST	command reset
AT+BAT	Check battery power
AT+REGION	Set regional options
AT+CCLASS	Set device type
AT+DUTYCYCLE	Set whether to enable duty cycle
AT+CTXP	Set transmit power
AT+CAPPEUI	Set up APPEUI (used for OTAA network access)
AT+CDEVEUI	Set up DEVEUI (used for OTAA network access)
AT+CAPPKEY	Set up APPKEY (used for OTAA network access)
AT+CNWKSKEY	Set NWKSKEY (used by ABP to access the network)
AT+CAPPSKEY	Set APPSKEY (used by ABP to access the network)
AT+CDEVADDR	Set DEVADDR (used by ABP to access the network)
AT+CJOIN	Access the network
AT+SEND	send data
AT+CNWKID	Set port number
AT+LINKC	Query link status
AT+CFREQBANDMASK	Set channel mask
AT+CADR	Set airspeed adaptation
AT+CDATARETE	Set airspeed
AT+CJN1DL	Set the network access rx1 time
AT+CJN2DL	Set the network access rx2 time
AT+CRX1DL	Set rx1 time
AT+CRX2DL	Set rx2 time
AT+CRX2FQ	Set rx2 receiving frequency

7.3 AT command description

command character	Command type	Command format	response
AT(Test)	Execute instructions	AT	OK
	Example	AT OK	
	illustrate	Test whether the AT command is normal	
command character	Command type	Command format	response
VER (read protocol related information)	test command	AT+VER?	AT+VER Get the FW version
	Query command	AT+VER= ?	APPLICATION_VERSION: <version> L2_SPEC_VERSION: <version> RP_SPEC_VERSION: <version>
	Parameter Description	APPLICATION_VERSION: sdk version number L2_SPEC_VERSION: lorawan version RP_SPEC_VERSION: lorawan region version	
	Return value description		
	Example	AT+ VER= ? APPLICATION_VERSION: V1.3.0 L2_SPEC_VERSION: V1.0.4 RP_SPEC_VERSION: V2-1.0.1 OK	
	Precautions	-	
command character	Command type	Command format	response
FWCODE (read software code)	test command	AT+FWCODE?	AT+FWCODE Get firmware code OK
	Query command	AT+ FWCODE= ?	FWCODE = <code> OK
	Parameter Description	<code> : software coding	
	Return value description		
	Example	AT+ FWCODE= ?	

		FWCODE= 748 3-1-10 OK	
	Precautions	-	
command character	Command type	Command format	response
DEVTYPE (read device model)	test command	AT+DEVTYPE?	AT+DEVTYPE Get Device type
	Query command	AT+ DEVTYPE= ?	DEVTYPE = <type> OK
	Parameter Description	<type> : device model	
	Return value description		
	Example	AT+ DEVTYPE= ? DEVTYPE = E77-400M 22S OK	
	Precautions	-	
command character	Command type	Command format	response
LOGLEVEL (Set log level)	test command	AT+LOGLEVEL?	AT+LOGLEVEL=<Level><CR>. Set the log Verbose Level=[0:Off , 1 : On] OK
	Query command	AT+LOGLEVEL=?	<Level> OK
	Set command	AT+LOGLEVEL =<Level>	OK
	Parameter Description	<Level> : log level Range: 0-1, 0 is off, 1 is on	
	Return value description		
	Example	AT+LOGLEVEL= 1 OK AT+LOGLEVEL=? 1 OK	
	Precautions	The default level is 0, which will not be saved when power off.	
command character	Command type	Command format	response
UART (Set baud	test command	AT+UART?	AT+UART=<baud> : <parity>. Get or Set Uart baud and parity

rate)			OK
	Query command	AT+UART=?	<baud> : <parity> OK
	Set command	AT+UART= <baud> : <parity>	OK
	Parameter Description	<baud> : baud rate [0-2] 0 : 2400 1:4800 2:9600 <parity> : Check digit [0-2] 0 : 8N1 1:8E1 2:8O1	
	Return value description		
	Example	AT+UART=2:0 OK AT+UART=? 2:0 OK	
	Precautions	Valid after powering on again	
command character	Command type	Command format	response
IAP (Online upgrade)	test command	AT+ IAP?	AT+IAP IAP Upgrade OK
	Excuting an order	AT+IAP	AT+IAP=OK
	Parameter Description	-	
	Return value description		
	Example	AT+ IAP AT+IAP = OK C C C	
	Precautions	User IAP upgrade does not need to execute this command, use our package to upgrade the upper level opportunity to send	
command character	Command type	Command format	response
LTIME (get local time)	test command	AT+LTIME?	AT+LTIME Get the local time in UTC format OK
	Query command	AT+ LTIME= ?	LTIME:<h><m><s> on day/month/year/ OK

	Parameter Description	h: hour m: minutes s: seconds	
	Return value description		
	Example	AT+ LTIME = ? LTIME:00h00m00s on 01/01/1970 OK	
	Precautions	Each power-on starts from January 1, 1970, 00h00m00s	
command character	Command type	Command format	response
RESTORE (restore default configuration)	test command	AT+ RESTORE?	AT+RESTORE: Restore EEPROM Factory Settings OK
	Excuting an order	AT+ RESTORE	OK
	Parameter Description	-	
	Return value description		
	Example	AT+ RESTORE OK	
	Precautions	-	
command character	Command type	Command format	response
CSAVE (save parameters)	test command	AT+CSAVE?	AT+CSAVE: Store current context to EEPROM OK
	Excuting an order	AT+CSAVE	NVM DATA STORED OK
	Parameter Description	-	
	Return value description		
	Example	AT+CSAVE NVM DATA STORED OK	
	Precautions	-	
command character	Command type	Command format	response
AT+RST (restart module)	test command	AT+ RST ?	AT+ RST Trig a MCU reset OK

	Set command	AT+ RST	OK
	Parameter Description	-	
	Return value description		
	Example	AT+ RST OK	
	Precautions	After receiving the command, the communication module replies OK and then restarts the communication module. No further follow-up will be received until the restart is complete. AT command.	
command character	Command type	Command format	response
BAT (battery power)	test command	AT+BAT?	AT+BAT Get the battery Level in mV OK
	Query command	AT+BAT=?	<value>
	Parameter Description	<value>: Current power supply voltage, unit mv	
	Return value description		
	Example	AT+BAT=? 3300 OK	
	Precautions	-	
command character	Command type	Command format	response
REGION (Set working frequency band)	test command	AT+ REGOIN ?	AT+REGION=<BandID><CR>. Get or Set the Active Region BandID=[0:AS923, 1:AU915, 2:CN470, 4:EU433, 5:EU868, 6:KR920, 7:IN865, 8: US915, 9:RU864] OK
	Query command	AT+ REGION= ?	<region> OK
	Set command	AT+ REGION=<region>	OK
	Parameter Description	<region> ： Regional standards	

	Return value description	0:AS923 1:AU915 2:CN470 4:EU433 5:EU868 6:KR920 7:IN865 8:US915 9:RU864	
	Example	AT+REGION=? 5:EU868 OK AT+REGION=5 OK	
	Precautions	It needs to be set before Join , and finally use AT+RESTORE to restore the default configuration before switching regions.	
command character	Command type	Command format	response
CCLASS (Set Class)	test command	AT+CCLASS?	AT+CCLASS=<Class><CR>. Get or Set the Device Class=[A, C] OK
	Query command	AT+CCLASS = ?	+CCLASS:<class> OK
	Set command	AT+CCLASS=<class>	OK
	Parameter Description	<class>: A, Class A mode, receiving only opens a window after sending C, Class C mode, reception is always on	
	Return value description		
	Example	AT+CCLASS= C :+EVT:SWITCH_TO_CLASS_C OK //Not connected to the network AT+CCLASS=C AT_NO_NETWORK_JOINED	
	Precautions	The network access is all CLASS A. If you want to switch to CLASS C, you need to execute it after accessing the network, otherwise an error will be reported.	

command character	Command type	Command format	response
DUTYCYCLE (Set duty cycle)	test command	AT+DUTYCYCLE?	AT+DUTYCYCLE=<DutyCycle><CR>. Get or Set the ETSI DutyCycle=[0:disable, 1:enable] - Only for testing
	Query command	AT+DUTYCYCLE = ?	<DutyCycle> OK
	Set command	AT+DUTYCYCLE == <DutyCycle>	OK
	Parameter Description	<DutyCycle> 0: Turn off ETSI duty cycle 1: Turn on ETSI duty cycle	
	Return value description		
	Example	AT+DUTYCYCLE =0 OK	
	Precautions	After DCS is turned on, the data sending frequency complies with the lorawan protocol standard, and the duty cycle is generally 1%. After sending one packet of data at low airspeed, it will take a long time to send the next packet.	
command character	Command type	Command format	response
CTXP (Set transmit power)	test command	AT+CTXP?	+CTXP: " value " OK
	Query command	AT+CTXP = ?	+CTXP:<value> OK
	Set command	AT+CTXP=<value>	OK
	Parameter Description	<value>: It is the sending power. The factory value is 0. Different regional standards have different maximum powers.	
	Return value description	0-17dBm 1-15dBm 2-13dBm 3-11dBm 4-9dBm 5-7dBm 6-5dBm 7-3dBm	
	Example	AT+CTXP=1 OK	
	Notice	The power here is the standard of cn470, which varies in different regions. See Appendix 2.	
command	Command	Command format	response

character	type		
CAPPEUI (**Set up AppEUI**)	test command	AT+CAPPEUI?	AT+CAPPEUI=<XXXXXXXXXXXXXXXX><CR>. Get or Set the App Eui
	Query command	AT+CAPPEUI = ?	<appeui> OK
	Set command	AT+CAPPEUI = <appeui>	OK
	Parameter Description	<appeui> : NodeAppEUI Length 8 bytes, format hexadecimal	
	Return value description		
	Example	AT+CAPPEUI=AABBCCDD00112233 OK	
	Precautions	Parameters are automatically saved after connecting to the network	
command character	Command type	Command format	response
CDEVEUI (Set up DEVEUI)	test command	AT+CDEVEUI?	AT+CDEVEUI=<XXXXXXXXXXXXXXXX><CR>. Get or Set the Device EUI OK
	Query command	AT+CDEVEUI = ?	+CDEVEUI : <deveui> OK
	Set command	AT+CDEVEUI = <deveui>	OK
	Parameter Description	<deveui> : Node DevEUI Length 8 bytes, format hexadecimal	
	Return value description		
	Example	AT+CDEVEUI? +CDEVEUI=AABBCCDD00112233 OK	
	Precautions	After connecting to the network, the current parameters will be automatically saved.	
command character	Command type	Command format	response
CAPPKEY (**Set AppKey**)	test command	AT+CAPPKEY?	AT+CAPPKEY=<XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX><CR>: Get or Set the Application Key OK
	Query command	AT+CAPPKEY = ?	<APPKEY> OK
	Set command	AT+CAPPKEY = <APPKEY>	OK

	Parameter Description	<APPKEY> : Node A PPKEY Length 16 bytes, format hexadecimal	
	Return value description		
	Example	AT+CAPPKEY= 20000000000000000000000000000001 OK	
	Precautions	After connecting to the network, the current parameters will be automatically saved.	
command character	Command type	Command format	response
CDEVADDR (**Set DevAddr**)	test command	AT+CDEVADDR?	AT+CDEVADDR=<XX : XX : XX : XX><CR>. Get or Set the Device address OK
	Query command	AT+CDEVADDR = ?	+CDEVADDR:< DEVADDR > OK
	Set command	AT+CDEVADDR =< DEVADDR >	OK
	Parameter Description	<DEVADDR> : Node DevAddr Length 4 bytes, format hexadecimal	
	Return value description		
	Example	AT+CDEVADDR=00 : 11 : 22 : 33 OK	
	Precautions	Used when ABP is used, the current parameters will be automatically saved after connecting to the network.	
command character	Command type	Command format	response
CAPPSKEY (Set **AppSKey**)	test command	AT+CAPPSKEY?	AT+CAPPSKEY=<XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX><CR>: Get or Set the Application Session Key OK OK
	Query command	AT+CAPPSKEY =?	<appkey> OK
	Set command	AT+CAPPSKEY = =< appskey >	OK
	Parameter Description	<appskey> : node AppSKey Length 16 bytes, format hexadecimal	
	Return value		

	description		
	Example	AT+CAPPSKEY= 20000000000000000000000000000001 OK	
	Precautions	Used when ABP is used, the current parameters will be automatically saved after connecting to the network.	
command character	Command type	Command format	response
CNWKSKEY (**Set NwkSKey**)	test command	AT+CNWKSKEY?	AT+CNWKSKEY=<XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX><CR>: Get or Set the Network Session Key OK
	Query command	AT+CNWKSKEY = ?	<nwkskey> OK
	Set command	AT+CNWKSKEY=< nwkskey >	OK
	Parameter Description	<nwkskey> : Node NwkSKey Length 16 bytes, format hexadecimal	
	Return value description		
	Example	AT+CNWKSKEY= 20000000000000000000000000000001 OK	
	Precautions	Used when ABP is used, the current parameters will be automatically saved after connecting to the network.	
command character	Command type	Command format	response
CNWKID (Set network ID)	test command	AT+CNWKID?	AT+CNWKID=<NwkID><CR>. Get or Set the Network ID=[0..127] OK
	Query command	AT+CNWKID = ?	<nwkid> OK
	Set command	AT+CNWKID =<nwkid>	OK
	Parameter Description	<nwkid>: network ID	
	Return value description		
	Example	AT+CNWKID = ? 0 OK	
	Precautions	No need to set	
command	Command	Command format	response

character	type		
CFREQBAND MASK (set mask)	test command	AT+CFREQBANDMASK?	AT+CFREQBANDMASK Set channel frequency band mask
	Query command	AT+CFREQBANDMASK = ?	<mask 0 > :<mask1>: <mask 2 > :<mask3>: <mask 4 > :<mask5> OK
	Set command	AT+CFREQBANDMASK =<mask 0 > :<mask1>: <mask 2 > :<mask3>: <mask 4 > :<mask5>	OK
	Parameter Description	<mask>: Mask of frequency points where the network may work. One mask represents 16 channels , and mask0 represents the lower 16 channels. For details, please refer to the LoRaWAN access specification. Only cn470, au915, us915 need to be set	
	Return value description		
	Example	AT+CFREQBANDMASK= 0007 : 0000 : 0000 : 0000 : 0000 : 0000 OK	
command character	Command type	Command format	response
CJOIN (Set Join)	test command	AT+CJOI N ?	AT+CJOIN=<Mode>:<autojoin><CR>. Join network with Mode=[0:ABP, 1:OTAA] OK
	Set command	AT+CJOIN= <mode>:<auto_join>	If the input is legal, first return OK, and then start automatic authentication. right, returns the authentication result. +EVT:JOINED Authentication successful +EVT:JOIN FAILED Authentication failed
	Parameter Description	<mode>:Network access mode 0:ABP mode. This mode does not actually require access to the network. Executing this command only switches the local state. 1: OTAA mode, over-the-air network access <auto_join>: Whether to automatically join the network after power on	
	Return value description		
	Example	AT+CJOIN=1：0 OK +EVT:JOINED	
command character	Command type	Command format	response
SEND (**send data**)	test command	AT+ SEND ?	AT+SEND=<Port>:<Ack>:<Payload><CR>. Send binary data with the application Port=[1..199] and Ack=[0:unconfirmed, 1:confirmed] OK
	Set	AT+SEND=<Port>:	+EVT:SEND_CONFIRMED

	command	<Nbtarns>: <Ack>:<Payload><CR>	+EVT:RX_1, PORT 0, DR 3, RSSI -49, SNR 10 AT_NO_NETWORK_JOINED AT_DUTYCYCLE_RESTRICTED
	Parameter Description	<Port> : port number <Nbtarns>: When there is ACK, the maximum number of retransmissions <Ack> : Whether to enable response <Payload> : Hexadecimal data, two digits are one byte	
	Return value description		
	Example	AT+SEND=3:1:112233 :+EVT:SEND_CONFIRMED +EVT:RX_1, PORT 0, DR 3, RSSI -47, SNR 11	
	Precautions	Connect to the network first, then send data	
command character	Command type	Command format	response
CADR (Set rate adaptive)	test command	AT+CADR?	AT+CADR=<ADR><CR>. Get or Set the Adaptive Data Rate setting ADR=[0:off, 1:on] OK
	Query command	AT+CADR=?	+CADR: <value> OK
	Set command	AT+CADR=<value>	OK
	Parameter Description	<value>: as follows: 0: turn off ADR 1: Turn on ADR	
	Return value description		
	Example		
	Precautions	Enabled by default	
command character	Command type	Command format	response
CDATARATE (**Set communication rate**)	test command	AT+CATARATE?	+CATARATE: " value " OK
	Query command	AT+CATARATE = ?	+CATARATE:<value> OK
	Set command	AT+CATARATE =<value>	OK
	Parameter Description	<value>: as follows: Rate value, factory value is, value range: 0 - SF12, BW125	
	Return		

	value description	1 - SF11, BW125 2 - SF10, BW125 3 - SF9, BW125 4 - SF8, BW125 5-SF7, BW125	
	Example	AT+CATARATE=1 OK	
	Precautions	It needs to be set before sending data. It will become invalid after enabling ADR . That is, you need to set AT+CADR=0 before configuring the rate. The airspeed value range may be different in different regions. See Appendix 1.	
command character	Command type	Command format	response
LINK C (**verify network connection**)	test command	AT+LINK C ?	AT+LINKC. Piggyback a Link Check Request to the next uplink
	Excuting an order	AT+LINK C	OK
	Parameter Description	-	
	Return value description		
	Example	AT+LINK C OK	
	Precautions	After executing this command, the server will send a response message after the next uplink.	
command character	Command type	Command format	response
CJN1DL (Set the network access rx1 window delay)	test command	AT+CJN1DL?	AT+CJN1DL= <Delay> <CR>. Get or Set the Join Accept Delay between the end of the Tx and the Join Rx Window 1 in ms
	Query command	AT+CJN1DL?	<Delay> OK
	Set command	AT+CJN1DL=<Delay>	OK
	Parameter Description	<Delay> Gets or sets the Join-Accept Delay (milliseconds) between the end of Tx and Join-Rx window 1	
	Return value description		
	Example	AT+CJN1DL= 1000	
	Notice		
command	Command	Command format	response

character	type		
CJN2DL (Set the network access rx2 window delay)	test command	AT+CJN2DL?	AT+CJN 2 DL=<Delay><CR>. Get or Set the Join Accept Delay between the end of the Tx and the Join Rx Window 2 in ms
	Query command	AT+CJN2DL?	<Delay> OK
	Set command	AT+CJN 2 DL=<Delay>	OK
	Parameter Description	<Delay> Gets or sets the Join-Accept Delay (milliseconds) between the end of Tx and Join-Rx window 2	
	Return value description		
	Example	AT+CJN 2 DL= 2000	
	Notice	Rx2_delay=rx1_delay+1000 ms	
command character	Command type	Command format	response
CRX1DL (set rx1 window delay)	test command	AT+ CRX1DL ?	AT+CRX1DL=<Delay><CR>. Get or Set the delay between the end of the Tx and the Rx Window 1 in ms
	Query command	AT+ CRX1DL ?	<Delay> OK
	Set command	AT+ CRX1DL =<Delay>	OK
	Parameter Description	<Delay> Gets or sets the delay between the end of Tx and Rx window 1, in ms	
	Return value description		
	Example	AT+CJN 2 DL= 2000	
	Notice	There is no need to set it up. If it is set up on the server, the module will automatically synchronize.	
command character	Command type	Command format	response
CRX2DL (set rx2 window delay)	test command	AT+ CRX2DL ?	AT+CRX1DL=<Delay><CR>. Get or Set the delay between the end of the Tx and the Rx Window 2 in ms
	Query command	AT+ CRX2DL ?	<Delay> OK
	Set command	AT+ CRX2DL =<Delay>	OK

	Parameter Description	<Delay> Gets or sets the delay between the end of Tx and Rx window 2, in ms	
	Return value description		
	Example	AT+CJN 2 DL= 3000	
	Notice	There is no need to set it. If it is set on the server, the module will automatically synchronize. Rx2_delay=rx1_delay+1000 ms	
command character	Command type	Command format	response
CRX2FQ (Set receive window 2 frequency)	test command	AT+ CRX2FQ ?	AT+CRX2FQ=<Freq><CR>. Get or Set the Rx2 window Freq in Hz OK
	Query command	AT+ CRX2FQ ?	<Freq> OK
	Set command	AT+ CRX2FQ= <Freq>	
	Parameter Description	<Freq> , the second receiving window frequency	
	Return value description		
	Example	AT+ CRX2FQ= 869525000	
	Precautions	Generally, there is no need to set it. It will be changed automatically when switching regions. If it does not match the server and gateway after modification, communication will not be possible.	

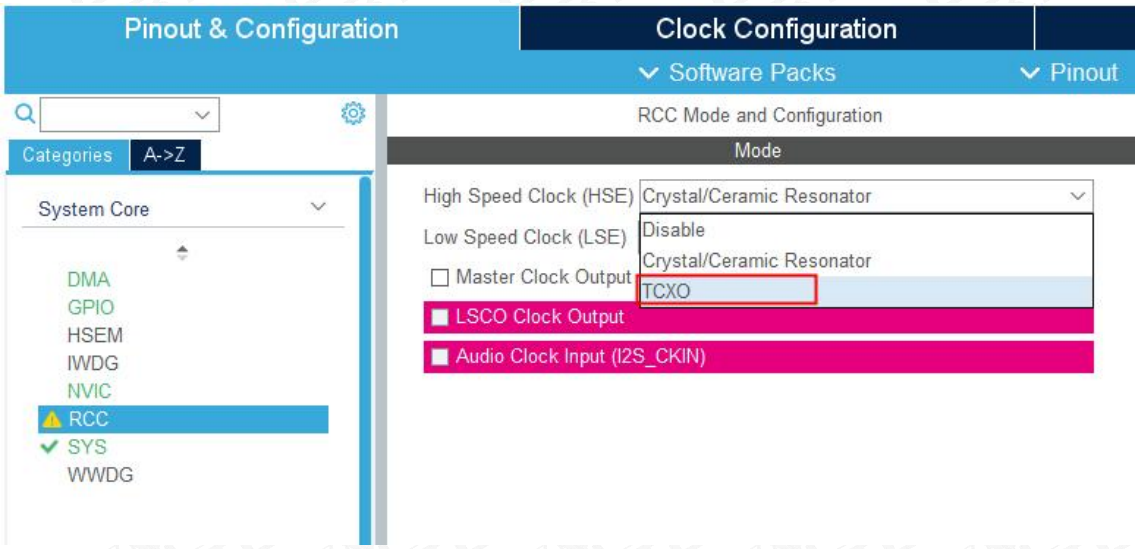
8 Secondary Development

- Please refer to the E77-400M22S DEMO routine provided by Chengdu Yibyte official website. This routine only demonstrates simple transceiver functions in LoRa ™ modulation and demodulation mode ;
- LoRaWAN ™ development, please download and refer to the instructions in the stm32cubewl library file of ST Company, and use the stm32cubemx software to generate the protocol stack project of the relevant development platform ;
- When developing LoRaWAN ™, when using the passive crystal oscillator version module, please use software to adjust the internal load capacitance of the crystal oscillator. Recommended value: XTAL_DEFAULT_CAP_VALUE = 0x0B;
- There is no need to adjust the crystal load capacitance when using the active crystal oscillator version module. Modules with sn codes starting from xxxxx are all active crystal oscillator versions.

  There are two points where the active crystal oscillator needs to be modified:

  ①In the BSP_RADIO_IsTCXO() function in stm32wlxx_nucleo_radio.c,change return RADIO_CONF_TCXO_NOT_SUPPORTED to return RADIO_CONF_TCXO_SUPPORTED;

  ② Select TCXO for the external clock when configuring stm32cubemx



- PA6 and PA7 pins are used as internal control radio frequency switches in the module. PA6 = RF_TXEN, PA7 = RF_RXEN, RF_TXEN=1 RF_RXEN=0 is the sending channel, RF_TXEN=0 RF_RXEN=1 is the receiving channel; RF_TXEN and RF_RXEN cannot be high at the same time. flat or low level ;
- How to distinguish hardware versions:

The E77-400M22S module includes an active crystal oscillator version and a passive crystal oscillator version. Users can distinguish them according to the production batch number of the module SN code. The production batch number ≥3202995 is the active crystal oscillator version module (user-customized passive Except for the crystal oscillator version), the rest are passive crystal oscillator versions.

SN code description: S3202995S00001, 3202995 is the production batch, and 00001 is the production serial number.

Example:

1. The user's module production batch is 3202996, 3202996≥3202995, and the module with production batch 3202996 is an active crystal oscillator module;

2. The user's module production batch is 3202994, 3202994 < 3202995, and the module with production batch 3202994 is a passive crystal oscillator module.

The E77-900M22S module includes an active crystal oscillator version and a passive crystal oscillator version. Users can distinguish them according to the production batch number of the module SN code. The production batch number ≥3202996 is the active crystal oscillator version module (user-customized passive Except for the crystal oscillator version), the rest are passive crystal oscillator versions.

SN code description: S3202996S00001, 3202996 is the production batch, and 00001 is the production serial number.

Example:

1. The user's module production batch is 3202997, 3202997≥3202996, and the module with production batch 3202997 is an active crystal oscillator module;

2. The user's module production batch is 3202995, 3202995 < 3202996, and the module with production batch 3202995 is a passive crystal oscillator module.

9 Data Rates of Each Frequency Band

EU433/EU868/RU864/AS923 :

data rate	Configuration	Represents physical data rate [bit/s]
0	LoRa: SF12 / 125 kHz	250
1	LoRa: SF11 / 125 kHz	440
2	LoRa: SF10 / 125 kHz	980
3	LoRa: SF9 / 125 kHz	1760
4	LoRa: SF8 / 125 kHz	3125
5	LoRa: SF7 / 125 kHz	5470
6	LoRa: SF7 / 250 kHz	11000
7	FSK: 50kbps	50000
8~15	RFU	

CN470/KR920 :

data rate	Configuration	Represents physical data rate [bit/s]
0	LoRa: SF12 / 125 kHz	250
1	LoRa: SF11 / 125 kHz	440
2	LoRa: SF10 / 125 kHz	980
3	LoRa: SF9 / 125 kHz	1760
4	LoRa: SF8 / 125 kHz	3125
5	LoRa: SF7 / 125 kHz	5470
6 ~ 15	RFU	

data rate	Configuration	Represents physical data rate [bit/s]
0	LoRa: SF10 / 125 kHz	980
1	LoRa: SF9 / 125 kHz	1760
2	LoRa: SF8 / 125 kHz	3125
3	LoRa: SF7 / 125 kHz	5470
4	LoRa: SF8 / 500 kHz	12500
5~7	RFU	
8	LoRa: SF12 / 500 kHz	980
9	LoRa: SF11 / 500 kHz	1760
10	LoRa: SF10 / 500 kHz	3900
11	LoRa: SF9 / 500 kHz	7000
12	LoRa: SF8 / 500 kHz	12500
13	LoRa: SF7 / 500 kHz	21900
14 ~ 15	RFU	

US915:

0-4 is upward, 8-13 is downward

AU915:

0-6 up, 8-12 down

data rate	Configuration	Represents physical data rate [bit/s]
0	LoRa: SF12 / 125 kHz	250
1	LoRa: SF11 / 125 kHz	440
2	LoRa: SF10 / 125 kHz	980
3	LoRa: SF9 / 125 kHz	1760
4	LoRa: SF8 / 125 kHz	3125
5	LoRa: SF7 / 125 kHz	5470
6	LoRa: SF8 / 500 kHz	12500
7	RFU	RFU
8	LoRa: SF12 / 500 kHz	980
9	LoRa: SF11 / 500 kHz	1760
10	LoRa: SF10 / 500 kHz	3900
11	LoRa: SF9 / 500 kHz	7000
12	LoRa: SF8 / 500 kHz	12500

IN865:

data rate	Configuration	Represents physical data rate [bit/s]
0	LoRa: SF12 / 125 kHz	250
1	LoRa: SF11 / 125 kHz	440
2	LoRa: SF10 / 125 kHz	980
3	LoRa: SF9 / 125 kHz	1760
4	LoRa: SF8 / 125 kHz	3125
5	LoRa: SF7 / 125 kHz	5470
6	RFU	RFU
7	FSK: 50 kbps	50000
8~15	RFU	RFU

10 Maximum power of each frequency band

Note: The actual power will be 2.15dbm less than the set value. This is because the lorawan protocol includes the antenna gain.

EU868 :

By default, the maximum MaxEIRP is +16dBm.

Transmit power	Configuration
0	MaxEIRP
1	MaxEIRP-2dB
2	MaxEIRP-4dB
3	MaxEIRP - 6 dB
4	MaxEIRP - 8 dB
5	MaxEIRP-10dB
6	MaxEIRP - 12 dB
7	MaxEIRP - 14 dB

US915:

Transmit power	Configuration
0	30dBm-2*TXpower
1	28dBm
2	26dBm
3~9	-
10	10 dBm
11 ~ 15	RFU

The agreement stipulates that the maximum power of the module is 22dbm

AU915 :

By default, the maximum MaxEIRP is +30dBm.

Transmit power	Configuration
0	MaxEIRP
1~10	MaxEIRP-2*TXPower
11~10	RFU

The agreement stipulates that the maximum power of the module is 22dBm

KR920 :

By default, the maximum MaxEIRP is +14dBm.

Transmit power	Configuration
0	MaxEIRP
1	MaxEIRP-2dB
2	MaxEIRP-4dB
3	MaxEIRP - 6 dB

4	MaxEIRP - 8 dB
5	MaxEIRP-10dB
6	MaxEIRP - 12 dB
7	MaxEIRP - 14 dB

AS923:

By default, the maximum MaxEIRP is +16dBm.

Transmit power	Configuration
0	MaxEIRP
1	MaxEIRP-2dB
2	MaxEIRP-4dB
3	MaxEIRP - 6 dB
4	MaxEIRP - 8 dB
5	MaxEIRP-10dB
6	MaxEIRP - 12 dB
7	MaxEIRP - 14 dB
8~15	RFU

IN865:

By default, the maximum MaxEIRP is +30dBm.

Transmit power	Configuration
0	MaxEIRP
1	MaxEIRP-2dB
2	MaxEIRP-4dB
3	MaxEIRP - 6 dB
4	MaxEIRP - 8 dB
5	MaxEIRP-10dB
6	MaxEIRP - 12 dB
7	MaxEIRP - 14 dB
8	MaxEIRP - 16 dB
9	MaxEIRP - 18 dB
10	MaxEIRP-20dB
11 ~ 15	RFU

The agreement stipulates that the maximum power of the module is 22dBm

RU864 :

By default, the maximum MaxEIRP is +16dBm.

Transmit power	Configuration
0	MaxEIRP
1	MaxEIRP-2dB
2	MaxEIRP-4dB
3	MaxEIRP - 6 dB

4	MaxEIRP - 8 dB
5	MaxEIRP-10dB
6	MaxEIRP - 12 dB
7	MaxEIRP - 14 dB

CN470 :

By default, the maximum MaxEIRP is +19.15 dBm.

Transmit power	Configuration
0	MaxEIRP
1	MaxEIRP 2 dB
2	MaxEIRP 4 dB
3	MaxEIRP 6 dB
4	MaxEIRP 8 dB
5	MaxEIRP-10dB
6	MaxEIRP - 12 dB
7	MaxEIRP - 14 dB
8~15	RFU

EU433 :

By default, the maximum MaxEIRP is +12.15 dBm.

Transmit power	Configuration
0	MaxEIRP
1	MaxEIRP-2dB
2	MaxEIRP-4dB
3	MaxEIRP - 6 dB
4	MaxEIRP - 8 dB
5	MaxEIRP-10dB
6 ~ 15	RFU

11 Maximum transmission load of each frequency band

Note: M in the table below represents the length of the message with MAC header, N represents the maximum length of data sent without MAC header.

EU868:

data rate	M	N
0	59	51
1	59	51
2	59	51
3	123	115
4	250	242
5	250	242
6	250	242
7	250	242
8~15	-	-

US915:

data rate	M	N
0	19	11
1	61	53
2	133	125
3	250	242
4	250	242
5~7	Not Defined	Not Defined
8	61	53
9	137	129
10	250	242
11	250	242
12	250	242
13	250	242
14 ~ 15	Not Defined	Not Defined

AU915 :

data rate	M	N
0	59	51
1	59	51
2	59	51
3	123	115
4	250	242
5	250	242

6	250	242
7	Not Defined	Not Defined
8	61	53
9	137	129
10	250	242
11	250	242
12	250	242
13	250	242
14 ~ 15	Not Defined	Not Defined

KR920:

data rate	M	N
0	59	51
1	59	51
2	59	51
3	123	115
4	250	242
5	250	242
6 ~ 15	Not Defined	Not Defined

AS923:

data rate	Upstream MAC payload size (M)		Downstream MAC payload size (N)	
	UplinkDwellTime = 0	UplinkDwellTime = 1	DownlinkDwellTime = 0	DownlinkDwellTime = 1
0	59	N/A	59	N/A
1	59	N/A	59	N/A
2	59	19	59	19
3	123	61	123	61
4	250	133	250	133
5	250	250	250	250
6	250	250	250	250
7	250	250	250	250
8	RFU		RFU	

IN865:

data rate	M	N
0	59	51
1	59	51
2	59	51
3	123	115
4	250	242
5	250	242

6	250	242
7	250	242
8~15	-	-

RU864:

data rate	M	N
0	59	51
1	59	51
2	59	51
3	123	115
4	230	222
5	230	222
6	230	222
7	230	222
8~15	-	-

CN470:

data rate	M	N
0	59	51
1	59	51
2	59	51
3	123	115
4	250	242
5	250	242
6 ~ 15	-	-

EU433:

data rate	M	N
0	59	51
1	59	51
2	59	51
3	123	115
4	250	242
5	250	242
6	250	242
7	250	242
8~15	-	-

12 Frequently Asked Questions

12.1 The communication distance is very close

- When there are straight-line communication obstacles, the communication distance will be correspondingly attenuated.
- Temperature, humidity, and co-channel interference will cause the communication packet loss rate to increase.
- The ground absorbs and reflects radio waves, and the test effect is poor when close to the ground.
- Seawater has a strong ability to absorb radio waves, so the test results at the seaside are poor.
- If there are metal objects near the antenna, or if it is placed in a metal case, the signal attenuation will be very serious.
- The power register setting is wrong and the air rate is set too high (the higher the air rate, the closer the distance).
- The low voltage of the power supply at room temperature is lower than the recommended value. The lower the voltage, the smaller the power generated.
- There is a poor match between the antenna and the module or there is a problem with the quality of the antenna itself.

12.2 Modules are easily damaged

- Please check the power supply to ensure it is within the recommended value. If it exceeds the maximum value, it will cause permanent damage to the module.
- Please check the stability of the power supply. The voltage cannot fluctuate greatly and frequently.
- Please ensure anti-static operation during installation and use, as high-frequency devices are sensitive to static electricity.
- Please ensure that the humidity during installation and use should not be too high, as some components are humidity sensitive.
- If there are no special needs, it is not recommended to use it at too high or too low temperature.

12.3 Network access failed

- When accessing the OTAA network, please check whether the three parameters of APPKEY, DEVKEY, and DEVEUI are the same as the server settings. Check whether the node frequency band, gateway frequency band, and server settings are the same;
- If this module has successfully connected to the network and changed the APPKEY, DEVKEY, and DEVEUI parameters to re-enter the network as a new node, you need to use AT+RESTORE to reset the parameters and then set them;
- When using ABP communication, the server will record the fcnt (frame count) of the module each time it is uploaded. If it is less than the previous value, communication will not be possible. The module will not save each fcnt, which will cause great damage to the flash. When using TTN, you need to reset the MAC parameters every time. When using chirpstack, you need to check the ignore frame technology;
- When otaa connects to the network, it shows devnoce to small. This only appears in version 1.0.4. The devnoce of each network connection will be incremented by one. This module will record it, but if the module restores the

default parameters, the devnonce of the corresponding server needs to be set to 0 manually. ;

Important statement

- Ebyte reserves the right of final interpretation and modification of all contents in this manual.
- Due to the continuous improvement of product hardware and software, this manual may be changed without prior notice. The latest version of the manual shall prevail.
- Users of this product need to go to the official website to pay attention to product updates so that users can obtain the latest information on this product in a timely manner.

Revise history

Version	Revision date	Revision Notes	Maintenance man
1.0	2024-04-16	Merged manuals and added AT commands	Bin
1.1	2024-05-11	Content revision	Bin

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