RAK7431
AT Command Manual

Version V1.1 | March, 2020

RAKwireless.com

Visit our website for more document.

Table of Contents

1 Overview

1.1 The Syntax of AT Command

The AT command must start with "**AT**" or "**at**" and end with <**CR**> <**LF**>.
At commands can be divided into:

- Reading command - read the configuration or status of the device, which is in the format of **AT+<*x*>**
- Write command - write/modify the device configuration, which is in the format of **AT+<*x*>=<*m*>:<*n*>**. The command name and parameters are separated by "**=**". If there are multiple parameters, the parameters are separated by "**:**"
- Test command - is the test command executable, which is in the format of **AT+<*x*>=?**

The response format of the command is usually:

Normal response with information	**<*Response*><CR><LF>OK<CR><LF>**
Normal response	**OK<CR><LF>**
Response When an error occurs	**ERROR <*Error code*> : <*Error packet*><CR><LF>**

Note: the at command is not case sensitive.

1.2 The Interface of AT Command

The at command interface of the device is USB interface. The baud rate is 115200, data bit is 8, stop bit is 1, no verification.

1.3 Common Errors

Error Code	Description
ERROR 1	Unsupported command
ERROR 2	Syntax error
ERROR 3	Storage failure
ERROR 4	System busy
ERROR 5	Parameter format / number error
ERROR 6	Insufficient resources
ERROR 7	Parameter out of valid range

2 LoRaWAN Commands

2.1 AT+DEVEUI

This command reads or modifies the LoRaWAN Device EUI of the device. After the EUI of the device is modified, it will take effect after restart.

Operation	AT Command	Response
Read	**AT+DEVEUI**	**<device_eui>** **OK**
Write	**AT+DEVEUI=<*device_eui*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*> : <packet>**
Test	**AT+DEVEUI=?**	**OK**

Parameters:

device_eui	Device EUI: Hexadecimal character, 16 bytes in length

2.2 AT+REGION

This command reads or modifies the working frequency band of the device, it will take effect after restart.

Operation	AT Command	Response
Read	**AT+REGION**	**<region>** **OK**
Write	**AT+REGION=<*region*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*>:<packet>**
Test	**AT+REGION=?**	**OK**

Parameters:

region	Supports frequency bands: EU433, CN470, RU864, IN865, EU868 US915, AU915, KR920, AS923

2.3 AT+JOINMODE

This command reads or modifies the LoRawan activation mode of the device, it will take effect after restart.

Operation	AT Command	Response
Read	**AT+JOINMODE**	**<mode>** **OK**
Write	**AT+JOINMODE=<*mode*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*>:<packet>**
Test	**AT+JOINMODE=?**	**OK**

Parameters:

mode	Supports activation mode: ABP or OTAA

2.4 AT+PUBLIC

This command reads or modifies the LoRawan public settings of the device. On by default. The modification will take effect after restart.

Operation	AT Command	Response
Read	**AT+PUBLIC**	**<x>** **OK**
Write	**AT+PUBLIC=<*x*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*>:<packet>**
Test	**AT+PUBLIC=?**	**OK**

Parameters:

x	Is it LoRawan public network: 0 no 1 yes

2.5 AT+CLASS

This command reads or modifies the LoRawan mode of the device. Effective immediately

after modification.

Operation	AT Command	Response
Read	**AT+CLASS**	**<class>** **OK**
Write	**AT+CLASS=<class>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*>:<packet>**
Test	**AT+CLASS=?**	**OK**

Parameters:

class	Supports parameters: A for Class A C for Class C

2.6 AT+APPEUI

The appeui parameter is valid when OTAA is activated. The modification will take effect after restart.

Operation	AT Command	Response
Read	**AT+APPEUI**	**<app_eui>** **OK**
Write	**AT+APPEUI=<*app_eui*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*>:<packet>**
Test	**AT+APPEUI=?**	**OK**

Parameters:

app_eui	Application EUI: Hexadecimal character, 16 bytes in length

2.7 AT+APPKEY

The appkey parameter is valid in OTAA activation mode. The modification will take effect after restart.

Operation	AT Command	Response
Read	**AT+APPKEY**	**<app_key>** **OK**

Write	**AT+APPKEY=<*region*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*>:<packet>**
Test	**AT+APPKEY=?**	**OK**

Parameters:

app_key	Application Key: Hexadecimal character, 32 bytes in length

2.8 AT+DEVADDR

The devaddr parameter is valid in ABP activation mode. The modification will take effect after restart.

Operation	AT Command	Response
Read	**AT+DEVADDR**	**<*devaddr*>** **OK**
Write	**AT+DEVADDR=<*devaddr*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*>:<packet>**
Test	**AT+DEVADDR=?**	**OK**

Parameters:

devaddr	Device Address Hexadecimal character, 8 bytes in length

2.9 AT+APPSKEY

The appskey parameter is valid in ABP activation mode. The modification will take effect after restart.

Operation	AT Command	Response
Read	**AT+APPSKEY**	**<*appskey*>** **OK**
Write	**AT+APPSKEY=<*appskey*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*>:<packet>**
Test	**AT+APPSKEY=?**	**OK**

Parameters:

appskey	Application Session Key Hexadecimal character, 32 bytes in length

2.10 AT+NWKSKEY

The nwkskey parameter is valid in ABP activation mode. The modification will take effect after restart.

Operation	AT Command	Response
Read	**AT+NWKSKEY**	**<nwkskey>** **OK**
Write	**AT+NWKSKEY=<*nwkskey*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*>:<packet>**
Test	**AT+NWKSKEY=?**	**OK**

Parameters:

nwkskey	Network Session Key Hexadecimal character, 32 bytes in length

2.11 AT+ADR

Turn on / off the LoRawan dynamic rate adjustment function of the device, which is on by default. The modification will take effect immediately.

Operation	AT Command	Response
Read	**AT+ADR**	**<n>** **OK**
Write	**AT+ADR=<*n*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*>:<packet>**
Test	**AT+ADR=?**	**OK**

Parameters:

n	0	close ADR
	1	open ADR

2.12 AT+DATARATE

Read / modify the LoRawan DataRate setting of the device, which is valid when the ADR function is turned off. The modification will take effect immediately.

Operation	AT Command	Response
Read	**AT+DATARATE**	**<n>** **OK**
Write	**AT+DATARATE=<*n*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*>:<packet>**
Test	**AT+DATARATE=?**	**OK**

Parameters:

n	LoRaWAN DataRate 0 ~ 7

DataRate value range and default value are related to LoRawan region. Please refer to the **Appendix I: DataRate list of each region** in this document.

2.13 AT+CONFIRM

Turn on/off LoRawan packet confirmation function, which is set to be on by default. The modification will take effect immediately.

When the confirm function is enabled, the packet sent by the device will require the LoRa network server to send an ACK response. When RETRY=N (N!=1), if the device does not receive an ACK of a LoRawan packet, it will resend the packet until the ACK is received. The maximum number of times to send is n. About this, please refer to **2.14 AT+RETRY** chapter.

Operation	AT Command	Response
Read	**AT+CONFIRM**	**<n>** **OK**
Write	**AT+CONFIRM=<*n*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*>:<packet>**
Test	**AT+CONFIRM=?**	**OK**

Parameters:

n	0	close packet confirm function
	1	open packet confirm function

2.14 AT+RETRY

Set the maximum sending times of the same LoRawan message, which is valid when the confirm function is enabled. The default value is 3. The modification will take effect immediately.

When retry = n (n! = 1), if the device does not receive an ACK of a LoRawan message, it will resend the message until the ACK is received. The maximum number of times to send is n.

Operation	AT Command	Response
Read	**AT+RETRY**	**<n>** **OK**
Write	**AT+RETRY=<*n*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*>:<packet>**
Test	**AT+RETRY=?**	**OK**

Parameters:

n	Max resend times 1 ~ 8

2.15 AT+CHANNEL

Read / modify the LoRawan channel list of the device

When the LoRawan working frequency band of the device is cn470 / us915 / au915, the LoRawan channel of the device can be read / modified through this instruction. After modification, the start channel ID to the end channel ID in the instruction parameters are turned on, and other channels are turned off. The modification will take effect after restart.

When the LoRawan working frequency band of the device is eu433 / ru864 / in865 / eu868 / kr920 / as923, this instruction is read-only.

Operation	AT Command	Response
Read	**AT+CHANNEL**	**<id>:<freq>:<drmin>:<drmax>**

Operation	AT Command	Response
		… **OK**
Write (Only valid when Region is CN470 / US915 / AU915)	**AT+CHANNEL=<*startid*>:<*endid*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*>:<packet>**
Test	**AT+CHANNEL=?**	**OK**

Parameters:

id	Channel ID
freq	Center frequency of channel，unit: Hz
drmin	DataRate(Min)
drmax	DataRate(Max)
startid	Start channel ID
endid	Stop channel ID

2.16 AT+ADDCHANNEL

Add a LoRawan channel.

This instruction is valid when the working frequency band of LoRawan is eu433 / ru864 / eu868 / kr920 / as923. The modification shall take effect after restart.

Operation	AT Command	Response
Write	**AT+ADDCHANNEL=<*freq*>:<*drmin*>:<*drmax*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*>:<packet>**
Test	**AT+ADDCHANNEL=?**	**OK**

Parameters:

freq	Center frequency of channel，unit: Hz
drmin	DataRate(Min)
drmax	DataRate(Max)

2.17 AT+RMCHANNEL

Delete a LoRawan channel.
This instruction is valid when the working frequency band of LoRawan is eu433 / ru864 / eu868 / kr920 / as923. The modification shall take effect after restart.

Operation	AT Command	Response
Write	**AT+RMCHANNEL=*<freq>*:*<drmin>*:*<drmax>***	When the modification is successful: **OK** When modification fails: **ERROR *<code>*:<packet>**
Test	**AT+RMCHANNEL=?**	**OK**

Parameters:

freq	Center frequency of channel，unit: Hz
drmin	DataRate(Min)
drmax	DataRate(Max)

2.18 AT+CHANMASK

Read the currently configured LoRawan channel mask. The LoRawan channel mask is determined by the currently open channel. This instruction is read-only.

Operation	AT Command	Response
Read	**AT+CHANMAS**	**<chanmsk>** **OK**
Test	**AT+CHANMASK=?**	**OK**

Parameters:

chanmask	Channel mask: Hexadecimal string, right to left corresponding channel ID from low to high

2.19 AT+TXPOWER

The txpower parameter is valid when the ADR function is turned off. The modification will take effect immediately.

Operation	AT Command	Response

Operation	AT Command	Response
Read	**AT+TXPOWER**	**<txpwr>** **OK**
Write	**AT+TXPOWER=<*txpwr*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*>:<packet>**
Test	**AT+TXPOWER=?**	**OK**

Parameters:

txpwr	Transmit power(dBm, floating point) The value range is 0 ~ maxeirp, and the effective step size is 2dbm, that is, txpwr = maxeirp – 2 * n, and N is an integer greater than or equal to 0 Maxeirp is related to LoRawan working frequency band

2.20 AT+LPTP

Lptp is a Rak private LoRawan message splitting protocol, which can send data with length exceeding the maximum available load into multiple messages. It needs to be used with LoRa network server supporting this protocol. Off by default. The modification will take effect immediately.

Operation	AT Command	Response
Read	**AT+LPTP**	**<x>** **OK**
Write	**AT+LPTP=<*x*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*>:<packet>**
Test	**AT+LPTP=?**	**OK**

Parameters:

x	0	close LPTP
	1	open LPTP

3 Data Interface Commands

3.1 AT+BAUDRATE

Read or modify the baud rate of the device's data serial port, and the modification will take effect after restarting.

Operation	AT Command	Response
Read	**AT+BAUDRATE**	**<baudrate>** **OK**
Write	**AT+BAUDRATE=<*baudrate*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*> : <message>**
Test	**AT+BAUDRATE=?**	**OK**

Parameters:

baudrate	Baudrate of data serial port: 2400 4800 9600 14400 19200 38400 57600 115200

3.2 AT+DATABIT

Read or modify the serial data bit of the device, and the modification will take effect after restart.

Operation	AT Command	Response
Read	**AT+BAUDRATE**	**<databit>** **OK**
Write	**AT+BAUDRATE=<*databit*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*> : <message>**
Test	**AT+BAUDRATE=?**	**OK**

Parameters:	
databit	Data bit of data serial port: 7 7bit 8 8bit

3.3 AT+STOPBIT

Read or modify the data serial port stop bit of the device, and the modification will take effect after restart.

Operation	AT Command	Response
Read	**AT+STOPBIT**	**<stopbit>** **OK**
Write	**AT+STOPBIT=<*stopbit*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*> : <message>**
Test	**AT+STOPBIT=?**	**OK**

Parameters:	
stopbit	1 1bit 1.5 1.5bit 2 2bit

3.4 AT+PARITY

Read or modify the data serial port check bit of the device, and the modification will take effect after restart.

Operation	AT Command	Response
Read	**AT+PARITY**	**<parity>** **OK**
Write	**AT+PARITY=<*parity*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*> : <message>**
Test	**AT+PARITY=?**	**OK**

Parameters:	
parity	NONE No check EVEN Even parity check ODD Odd parity check

3.5 AT+DTUMODE

Read / modify the operating mode of the device data interface. Data interface supports two modes: P2P and MODBUS. The modification will take effect immediately.

Operation	AT Command	Response
Read	**AT+DTUMODE**	**<mode>** **OK**
Write	**AT+DTUMODE=<*mode*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*> : <message>**
Test	**AT+DTUMODE=?**	**OK**

Parameters:

mode	**P2P**	Point to point mode
	MODBUS	Modbus mode

3.6 AT+MODBUSTIMEOUT

Read / modify the Modbus instruction timeout of the device. It is valid when the data interface is in MODBUS mode.

Operation	AT Command	Response
Read	**AT+MODBUSTIMEOUT**	**<n>** **OK**
Write	**AT+MODBUSTIMEOUT=<*n*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*> : <message>**
Test	**AT+MODBUSTIMEOUT=?**	**OK**

Parameters:

n	Modbus timeout in ms

3.7 AT+TRANSPARENT

When the data serial port of the device works in MODBUS mode, the data encapsulation format can be divided into two types: transparent transmission / non transparent transmission.

In transparent mode, the response data (received data) of Modbus execution instruction will be directly forwarded to the server through lorawan.

In the non transparent mode, the response data (received data) of Modbus execution instructions will be encapsulated in the message header according to the predetermined protocol, and then transmitted to the server through lorawan. Please refer to Appendix II: MODBUS Data Encapsulation Protocol

The device works in non transparent mode by default and takes effect immediately after modification.

Operation	AT Command	Response
Read	**AT+TRANSPARENT**	**<n>** **OK**
Write	**AT+TRANSPARENT=<*n*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*> : <message>**
Test	**AT+TRANSPARENT=?**	**OK**

Parameters:

n	Whether to turn on the transparent transmission mode 0 close 1 open

3.8 AT+MODBUSRETRY

When the data serial port of the device works in MODBUS mode, the number of retries when a MODBUS instruction does not get the response from the node. No retransmission by default. The modification will take effect immediately.

Operation	AT Command	Response
Read	**AT+MODBUSRETRY**	**<n>** **OK**
Write	**AT+MODBUSRETRY=<*n*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*> : <message>**
Test	**AT+MODBUSRETRY=?**	**OK**

Parameters:

n	Retry frequency

	0 No retry 1 ~ 8 Max retries

3.9 AT+ENABLEPOLL

When the data serial port of the device works in MODBUS mode, it supports timing polling function.

Timed polling function means that the device will perform a polling operation every other period of time (polling cycle). During polling, the device will send the pre added MODBUS instructions in turn and forward the corresponding response data to the server through lorawan network.

The device turns on timed polling by default. The modification shall take effect after restart.

Operation	AT Command	Response
Read	**AT+ENABLEPOLL**	**<n>** **OK**
Write	**AT+ENABLEPOLL=<*n*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*> : <message>**
Test	**AT+ENABLEPOLL=?**	**OK**

Parameters:

n	Enable scheduled polling or not 0 close 1 open

3.10 AT+POLLPERIOD

Sets / reads the cycle of scheduled polling.

The device turns on timed polling by default. The modification takes effect after the next polling cycle takes effect or restarts.

Operation	AT Command	Response
Read	**AT+POLLPERIOD**	**<n>** **OK**
Write	**AT+POLLPERIOD=<*n*>**	When the modification is successful: **OK** When modification fails:

Operation	AT Command	Response
		ERROR <*code*> : <message>
Test	**AT+POLLPERIOD=?**	**OK**

Parameters:

n	Polling cycle in seconds

3.11 AT+ADDPOLL

Add a polling instruction.

Up to 32 polling instructions are supported. It will take effect after the next polling cycle or restart.

Operation	AT Command	Response
Write	**AT+ADDPOLL=<*n*>:<*xxxx*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*> : <message>**
Test	**AT+ADDPOLL=?**	**OK**

Parameters:

n	Polling instruction ID, value range 1 ~ 127
xxxx	Polling instruction content, hexadecimal string, maximum instruction length 128 bytes

3.12 AT+RMPOLL

Delete a polling instruction. It takes effect after the next polling cycle or restart after deletion.

Operation	AT Command	Response
Write	**AT+RMPOLL=<*n*>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*> : <message>**
Test	**AT+RMPOLL=?**	**OK**

Parameters:

n	Polling instruction ID, value range 1 ~ 127

3.13 AT+POLLTASK

Query the list of scheduled polling instructions.

Operation	AT Command	Response
Read	**AT+POLLTASK**	When it is successful: **<n>:<xxxx>** … **OK** When modification fails: **ERROR <*code*> : <message>**
Test	**AT+POLLTASK=?**	**OK**

Parameters:

n	Polling instruction ID, value range 1 ~ 127
xxxx	Instruction content, hexadecimal string

4 System Related Commands

4.1 AT+VERSION

Read the firmware version of the device.

Operation	AT Command	Response
Read	**AT+VERSION**	When the read is successful **<a>.<b>.<cccc>** **OK** When reading fails **ERROR <*code*>:<packet>**

Parameters:

a.b.cccc	Firmware Version, such as“1.1.0050”

4.2 AT+SYSLOGLVL

Read or set the system log level.

The module turns off system log output by default. The user can modify the log output level through this command. Effective immediately after modification.

Operation	AT Command	Response
Read	**AT+SYSLOGLVL**	**<level>** **OK**
Write	**AT+SYSLOGLVL=<level>**	**OK**
Test	**AT+SYSLOGLVL=?**	**OK**

Parameters:

level	Output log level 0 : does not output any logs 1~6 : log with output level less than or equal to the value

4.3 AT+ECHO

Turns echo of the at command line interface on / off. Echo is turned off by default. It takes effect immediately after modification and automatically turns off echo after restart.

Operation	AT Command	Response
Write	**AT+ECHO=<n>**	When the modification is successful: **OK** When modification fails: **ERROR <*code*>:<packet>**

Parameters:

n	0	close
	1	open

4.4 AT+BOOT

The device supports switching to the boot mode. In the boot mode, the dedicated upgrade software can be used for online firmware upgrade.

Operation	AT Command	Response
Write	**AT+BOOT**	**<BOOT MODE>**

4.5 AT+RESTART

Reboot the device.

Operation	AT Command	Response

Operation	AT Command	Response
Write	**AT+RESTART**	**Null**

4.6 AT+FACTORY

Restore the device to the factory condition. This operation will last for about 60s. Please do not cut off the power supply of the device before the device automatically restarts.

Operation	AT Command	Response
Write	**AT+FACTORY**	**Null**

4.7 AT+SYSTIME

Operation	AT Command	Response
Write	**AT+SYSTIME**	**<time>** **OK**

Parameters:

time	Time stamp in UNIX format, in seconds

4.8 AT+DATETIME

Operation	AT Command	Response
Write	**AT+DATETIME**	**<datetime>** **OK**

Parameters:

datetime	Date / Time in YYYY/MM/DD hh:mm:ss

4.9 AT+SYSINFO

Operation	AT Command	Response
Write	**AT+SYSINFO**	**<model>** **<sn>** **<version>** **<vendor>** **<copyright>** **OK**

Parameters:	
model	Model info
sn	Product sn info
version	Firmware version
vendor	Manufacturer info
copyright	Copyright info

5 Event Notification

When the working state of the module changes, an event notification will be output through the at command line interface.
The event notification format is:
EVENT:[EVENT_ID]:[EVENT_MSG]:<ADDITION_INFO>

Event	Description
EVENT_ID	Event ID
EVENT_MSG	Event name
ADDITION_INFO	Additional information - Optional Some events need to output additional information. Multiple additional information is separated by ":"

The module supports the following event notifications:

ID	EVENT_MSG	Description
0	STARTUP	System startup complete
1	JOIN_NETWORK	LoRaWAN network activation successful
2	LEAVE_NETWORK	LoRaWAN activation failure
5	SYSTEM_WAKEUP	System wakeup
6	RESTART	System restart

5.1 STARTUP Event

Appears after module system initialization.
Message format:
EVENT:0:STARTUP
No additional information.

5.2 JOIN_NETWORK Event

Lorawan network activation succeeded. It appears after OTAA activation succeeded / ABP activation completed.
Message format:
EVENT:1:JOIN_NETWORK
No additional information.

5.3 LORA_LEAVE_NETWORK Event

In OTAA activation mode, if 8 consecutive uplink LoRaWAN Confirmed packet do not receive a response, LORA_LEAVE_NETWORK event will be triggered. After the LORA_LEAVE_NETWORK event is triggered, the module will stop sending LoRaWAN message and start OTAA activation again.
Message format:
EVENT:2:LEAVE_NETWORK
No additional information.

5.4 SYSTEM_WAKEUP Event

A module in a low-power running state is triggered when it is awakened by the input of the at command line interface. After wakeup, the module will no longer enter the low-power mode. If you want the module to enter low power mode again, should enter AT command:
AT+SLEEP\r\n
Message format:
EVENT:5:SYSTEM_WAKEUP

5.5 RESTART Event

Triggered before the module restarts.
Message format:
EVENT:6:RESTART

6 Low Power Operation and Wakeup

The module supports low power mode operation. When lorawan operation mode is set to class A, the module automatically enters into low power operation mode.
The module can be waked up at any time when it runs in low power mode.

- Wakeup by system internal
  When the module system needs to perform tasks such as sending / receiving, it will

wake up automatically. Automatically resume to low power operation after task completion.

- Wakeup by at command line interface

  Any instruction sent through at command line interface can wake up the module. After wakeup, the SYSTEM_WAKEUP event is triggered, and the low power mode is no longer entered, so that the user can use the at command line to modify the module configuration info. When the module needs to enter the low power mode again, you need to enter the command through the at command line interface: **AT+SLEEP\r\n**

- Wakeup by data interface

  When the module is running in low power mode, the module will be wakeup when sending data directly to the data serial port. However, due to the time delayed for the module to wake up, the first few bytes of data will be lost. Therefore, 6 wakeup bytes need to be added before the data to be sent. After receiving the data, the module will automatically delete the extra wakeup bytes and forward only the data to be sent.

  The contents of wakeup bytes can be set through the **AT+WAKEUPBYTE** command, and the default value is 0xAA

- Wakeup by WAKEUP pin

  The module provides a wakeup input pin. When the pin input is high, the module will wake up automatically. When the input power is low, the module will automatically enter into low power mode.

7 Appendix I: DataRate of Each Region

7.1 EU868/EU433/AS923/RU864 DataRate

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

7.2 CN470/KR920 DataRate

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

7.3 US915 DataRate

DataRate	Configuration	Indicative physical bit rate [bit/s]
0	LoRa: SF10 / 125kHz	980
1	LoRa: SF9 / 125kHz	1760
2	LoRa: SF8 / 125kHz	3125
3	LoRa: SF7 / 125kHz	5470
4	LoRa: SF8 / 500kHz	12500
5…7	RFU	

8	LoRa: SF12/500kHz	980
9	LoRa: SF11/500kHz	1760
10	LoRa: SF10/500kHz	3900
11	LoRa: SF9/500kHz	7000
12	LoRa: SF8/500kHz	12500
13	LoRa: SF7/500kHz	21900
14…15	RFU	

7.4 AU915 DataRate

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

7.5 IN865 DataRate

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

8 Appendix II: Modbus Data Encapsulation Protocol

This chapter describes the definition of Modbus message encapsulation format.

Message Command	Message Sequence Number	Data Length	Data
DTU_CMD	MSER	MDATA_LEN	MDATA
1Byte	2Byte	2Byte	nByte

DTU_CMD:

MSER: Message Sequence Number

DTU report message activly - DTU incremental cycle count.

Platform query message - consistent with the sequence number of the message issued by the platform.

8.1 Message Command DTU_CMD Definition

Data Bits	BIT7	BIT6	BIT5	BIT4	BIT3	BIT2	BIT1	BIT0
Definition	DIR	STATUS	RESERVED	Message TYPE				
Description	0: DownLink 1: UpLink	0: Success 1: Fail	0: Reserved	0x00: Reserved 0x01: Scheduled polling task data 0x02: Transparent instruction / data 0x03: Add scheduled polling task list 0x04: Remove scheduled polling task list 0x05: Read scheduled polling task list 0x06: Read LoRa configuration 0x07: Set LoRa configuration 0x08: Read DTU configuration 0x09: Set DTU configuration 0x1D: Initialize LoRa configuration 0x1E: Initialize DTU configuration 0x1F: System restart				

Bit7 direction: the message sent by the platform to DTU is a downlink message. This is 0. The message sent by DTU to the platform is an uplink message. This is 1.

Bit6 status: result of DTU executing instruction / task - status 0 for success and status 1 for failure.

8.2 Message Type Definition

8.2.1 Data for Scheduled Polling Task

The scheduled polling task list data message is responsible for sending the data read when the scheduled task list is executed to the platform. This message needs to be sent whether the execution is successful or not. When the execution fails, the status flag position 1 in the DTU CMD command word is set, and the data length is 0. When the execution is successful, the status flag position 0 in the DTU? CMD command word.

Execution success message format:

DTU_CMD	MSER	MDATA_LEN	MDATA	
0x81	2Byte	2Byte	TASK_ID	DATA
			1Byte	nByte

Execution failure message format:

DTU_CMD	MSER	MDATA_LEN	MDATA	
0xC1	2Byte	2Byte	TASK_ID	ERROR_CODE
			1Byte	1Byte

TASK_ID: task list ID.
DATA: data. When the scheduled task list fails to execute, the data length is 0.

8.2.2 Transparent Instruction / Data Message

The transparent transmission instructions and the execution results of the instructions issued by the platform are transmitted through this message.

This message needs to be sent whether or not the instruction is executed successfully. When the execution fails, the status flag position 1 in the DTU CMD command word is set, and the data length is 0. When the execution is successful, the status flag position 0 in the DTU? CMD command word.

Format of downlink instruction message:

DTU_CMD	MSER	MDATA_LEN	MDATA
0x02	2Byte	2Byte	DATA
			nByte

Uplink data message format when execution successful:

DTU_CMD	MSER	MDATA_LEN	MDATA
0x82	2Byte	2Byte	DATA

			nByte

Uplink data message format when execution failed:

DTU_CMD	MSER	MDATA_LEN	MDATA
0xC2	2Byte	2Byte	ERROR_CODE
			1Byte

DATA: Instruction content / data
ERROR_CODE: error code

8.2.3 Add Scheduled Polling Task List message

DTU timing task list and execution result are added to the platform and transmitted through this message

This message needs to be sent to the platform whether or not the scheduled task list is added successfully. Position 1 of the status flag in the DTU CMD command word when execution fails. When the execution is successful, the status flag position 0 in the DTU? CMD command word.

Format of downlink instruction message:

DTU_CMD	MSER	MDATA_LEN	MDATA	
0x03	2Byte	2Byte	TASK_ID	DATA
			1Byte	nByte

Uplink data message format when execution successful:

DTU_CMD	MSER	MDATA_LEN	MDATA
0x83	2Byte	2Byte	TASK_ID
			1Byte

Uplink data message format when execution failed:

DTU_CMD	MSER	MDATA_LEN	MDATA	
0xC3	2Byte	2Byte	TASK_ID	ERROR_CODE
			1Byte	1Byte

TASK_ID: Task list id
DATA: Task list content
ERROR_CODE: error code

8.2.4 Remove Scheduled Polling Task List

The platform removes the DTU timing task list and the execution results are transmitted through this message

This message needs to be sent to the platform whether or not the scheduled task list is successfully removed. Position 1 of the status flag in the DTU CMD command word when execution fails. When the execution is successful, the status flag position 0 in the DTU? CMD command word.

Note: if the specified task list ID is not found in the DTU, it will be regarded as successful execution.

Format of downlink instruction message:

DTU_CMD	MSER	MDATA_LEN	MDATA
0x04	2Byte	2Byte	TASK_ID
			1Byte

Message format when execution successful:

DTU_CMD	MSER	MDATA_LEN	MDATA
0x84	2Byte	2Byte	TASK_ID
			1Byte

Message format when execution failed:

DTU_CMD	MSER	MDATA_LEN	MDATA	
0xC4	2Byte	2Byte	TASK_ID	ERROR_CODE
			1Byte	1Byte

TASK_ID: Task list id
ERROR_CODE: error code

8.2.5 Read the Scheduled Polling Task List

The platform reads the DTU timing task list and transmits the execution result through this message

This message needs to be sent to the platform whether or not the scheduled task list is read successfully. When the execution fails, the status flag position 1 in the DTU CMD command word and the data content are empty. When the execution is successful, the status flag position 0 in the DTU? CMD command word.
Format of downlink instruction message:

DTU_CMD	MSER	MDATA_LEN	MDATA
0x05	2Byte	2Byte	TASK_ID
			1Byte

Uplink data message format when execution successful:

DTU_CMD	MSER	MDATA_LEN	MDATA	
0x85	2Byte	2Byte	TASK_ID	DATA
			1Byte	nByte

Uplink data message format when execution failed:

DTU_CMD	MSER	MDATA_LEN	MDATA	
0xC5	2Byte	2Byte	TASK_ID	ERROR_CODE
			1Byte	1Byte

TASK_ID: Task list id
DATA: Task list content
ERROR_CODE: error code

8.2.6 Read LoRa Configuration

The platform reads the Lora configuration and transmits the result through this message. Platform read message fdata is empty.

This message needs to be sent to the platform whether the Lora configuration is read successfully or not. When the execution fails, the status flag position 1 in the DTU CMD command word and the data content are empty. When the execution is successful, the status flag position 0 in the DTU? CMD command word.

Format of downlink instruction message:

DTU_CMD	MSER	MDATA_LEN	MDATA
0x06	2Byte	2Byte	0Byte

Uplink data message format when execution successful:

DTU_CMD	MSER	MDATA_LEN	MDATA					
0x86	2Byte	2Byte	DATARATE	TXPWR	CONFIRM	RETRY	ADR	DUTYCYCLE
			1Byte	1Byte	1Byte	1Byt	1Byte	1Byte

Uplink data message format when execution failed:

DTU_CMD	MSER	MDATA_LEN	MDATA
0xC6	2Byte	2Byte	ERROR_CODE

			1Byte

DATARATE: rate (0 – 5)
TXPOWER: transmit power (0 - 20)
COMFIRM: Whether to turn on ack. 0 - off, 1 - on
RETRY: Maximum retransmission times when ack is on (0 ~ 15)
ADR: Whether to turn on dynamic rate adjustment (ADR) 0 - off, 1 - on
DUTYCYCLE: Is duty cycle limit on 0-off, 1-on

8.2.7 Set LoRa Configuration

The platform reads the Lora configuration and transmits the result through this message. Platform read message fdata is empty.

This message needs to be sent to the platform whether the Lora configuration is read successfully or not. When the execution fails, the status flag position 1 in the DTU CMD command word and the data content are empty. When the execution is successful, the status flag position 0 in the DTU? CMD command word.

Format of downlink instruction message:

DTU_CMD	MSER	MDATA_LEN	MDATA					
0x07	2Byte	2Byte	DATARATE	TXPWR	CONFIRM	RETRY	ADR	DUTYCYCLE
			1Byte	1Byte	1Byte	1Byt	1Byte	1Byte

Uplink data message format when execution successful:

DTU_CMD	MSER	MDATA_LEN	MDATA
0x87	2Byte	2Byte	0Byte

Uplink data message format when execution failed:

DTU_CMD	MSER	MDATA_LEN	MDATA
0xC7	2Byte	2Byte	ERROR_CODE
			1Byte

DATARATE: rate (0 – 5)
TXPOWER: transmit power (0 - 20)
COMFIRM: Whether to turn on ack. 0 - off, 1 - on
RETRY: Maximum retransmission times when ack is on (0 ~ 15)
ADR_ENABLE: Whether to turn on dynamic rate adjustment (ADR) 0 - off, 1 - on
DUTYCYCLE_ENABLE: Is duty cycle limit on 0-off, 1-on

8.2.8 Read DTU Configuration

The DTU configuration and results read by the platform are transmitted through this message. Platform read message fdata is empty.

This message needs to be sent to the platform whether the DTU configuration is read successfully or not. When the execution fails, the status flag position 1 in the DTU CMD command word and the data content are empty. When the execution is successful, the status flag position 0 in the DTU? CMD command word.

Format of downlink instruction message:

DTU_CMD	MSER	MDATA_LEN	MDATA
0x08	2Byte	2Byte	0Byte

Uplink data message format when execution successful:

DTU_CMD	MSER	MDATA_LEN	MDATA				
0x88	2Byte	2Byte	POLL ENABLE	POLL PERIOD	BUS TIMEOUT	RETRY	RS485
			1Byte	4Byte	1Byte	1Byte	1Byte

Uplink data message format when execution failed:

DTU_CMD	MSER	MDATA_LEN	MDATA
0xC8	2Byte	2Byte	ERROR_CODE
			1Byte

POLL ENABLE: enables scheduled polling. 0-off, 1-on
POLL PERIOD: polling period, in seconds
BUS TIMEOUT: bus timeout. The unit is seconds.
RETRY: number of retries after bus timeout. 0 - turn off retry function
RS485: 485 bus parameters

Definition	BIT7	BIT6	BIT5	BIT4	BIT3	BIT2	BIT1	BIT0
	Baudrate			Data Bit	Stop Bit		Check Code	
Details	0: 2400 1: 4800 2: 9600 3: 14400 4: 19200 5: 38400 6: 57600 7: 115200			0: 8bit 1: 9bit	0: 1bit 1: 1.5bit 2: 2bit		0: NONE 1: EVEN 2: ODD	

8.2.9 Set DTU Configuration

DTU configuration and results of platform settings are transmitted through this message. Set the result message fdata to null.

This message needs to be sent to the platform whether the DTU configuration is read successfully or not. When the execution fails, the status flag position 1 in the DTU CMD command word and the data content are empty. When the execution is successful, the status flag position 0 in the DTU? CMD command word.

Format of downlink instruction message:

DTU_CMD	MSER	MDATA_LEN	MDATA				
0x09	2Byte	2Byte	POLL ENABLE	POLL PERIOD	BUS TIMEOUT	RETRY	RS485
			1Byte	4Byte	1Byte	1Byte	1Byte

Uplink data message format when execution successful:

DTU_CMD	MSER	MDATA_LEN	MDATA
0x89	2Byte	2Byte	0Byte

Uplink data message format when execution failed:

DTU_CMD	MSER	MDATA_LEN	MDATA
0xC9	2Byte	2Byte	ERROR_CODE
			1Byte

POLL ENABLE: enables scheduled polling. 0-off, 1-on
POLL PERIOD: polling period, in seconds
BUS TIMEOUT: bus timeout. The unit is seconds.
RETRY: number of retries after bus timeout. 0 - turn off retry function
RS485: 485 bus parameters

Definition	BIT7	BIT6	BIT5	BIT4	BIT3	BIT2	BIT1	BIT0
	Baudrate			Data Bit	Stop Bit		Check Code	
Details	0: 2400 1: 4800 2: 9600 3: 14400 4: 19200 5: 38400 6: 57600 7: 115200			0: 7bit 1: 8bit	0: 1bit 1: 1.5bit 2: 2bit		0: NONE 1: EVEN 2: ODD	

8.2.10 Initialize LoRa Configuration

Lora configuration and results of platform initial call are transmitted through this message. Message fdata is empty.

This message needs to be sent to the platform whether the DTU configuration is read successfully or not. If the execution fails, set the status flag position 1 in the DTU CMD command word. If the execution succeeds, set the status flag position 0 in the DTU CMD command word.

Format of downlink instruction message:

DTU_CMD	MSER	MDATA_LEN	MDATA
0x1D	2Byte	2Byte	0Byte

Uplink data message format when execution successful:

DTU_CMD	MSER	MDATA_LEN	MDATA
0x9D	2Byte	2Byte	0Byte

Uplink data message format when execution failed:

DTU_CMD	MSER	MDATA_LEN	MDATA
0xDD	2Byte	2Byte	ERROR_CODE
			1Byte

Initial value of LoRa configuration

DATARATE	0 – DR_0
TXPOWER	19 – 19dBm
CONFIRM	1 – open
RETRY	3 – retransmission 3 times
ADR_ENABLE	1 – open
DUTYCYCLE_ENABLE	0 – close

8.2.11 Initialize DTU Configuration

Lora configuration and results of platform initial call are transmitted through this message. Message fdata is empty.

This message needs to be sent to the platform whether the DTU configuration is read successfully or not. If the execution fails, set the status flag position 1 in the DTU CMD command word. If the execution succeeds, set the status flag position 0 in the DTU CMD command word.

Format of downlink instruction message:

DTU_CMD	MSER	MDATA_LEN	MDATA
0x1E	2Byte	2Byte	0Byte

Uplink data message format when execution successful:

DTU_CMD	MSER	MDATA_LEN	MDATA
0x9E	2Byte	2Byte	0Byte

Uplink data message format when execution failed:

DTU_CMD	MSER	MDATA_LEN	MDATA
0xDE	2Byte	2Byte	ERROR_CODE
			1Byte

Initial value of DTU

POLL_ENABLE	1 (opened)	
POLL_PERIOD	3600 (seconds)	
BUS TIMEOU	1000 (milliseconds)	
RS485	0xE0	Baud rate: 115200 Data bits: 8 Stop bit: 1 Check code: NONE

9 Revision History

Revision	Description	Date
1.0	Create first version	2020-01-02
1.1	Add 5, 6 chapter	2020-03-13

10 Document Summary

Prepared by	Checked by	Approved by
Yutao	Penn	