

# ML601

Embedded low power consumption LoRa module manual

0V1

Date	Author	Version	Note
June 21 <sup>st</sup> ,2021	Yebing Wang	V0.1	First edition, modules' definition of hardware and request of function.

# 1 Introduction

**1.1** The ASR6601 is a LoRa soc chip. The interior is implemented by core of Cortex M4 with software core of Semtech's LoRa transceiver SX1262 . The module can achieve 868(for EU)/915Mhz frequency band communication. The module implements the LoRa device with CLASS A,B,C protocol, DTU and various private protocols. Class A,B,C protocol is nonstandard Lorawan protocol and is only suitable for our gateway. The MCU inside the module is powerful, with 48Mhz master frequency and 16kbytes Sram,128k flash, making a big leap in performance from the previous ASR6505. In order to reduce the cost of hardware, the Open MCU scheme can be used directly inside by user without expand MCU.

The module's maximum receiving sensitivity is up to - 140dBm, maximum transmit power up to 14dBm@868MHz(for EU) Band / 94dBuV/m@3m@915MHz Band.

## 1.2 Main feature:

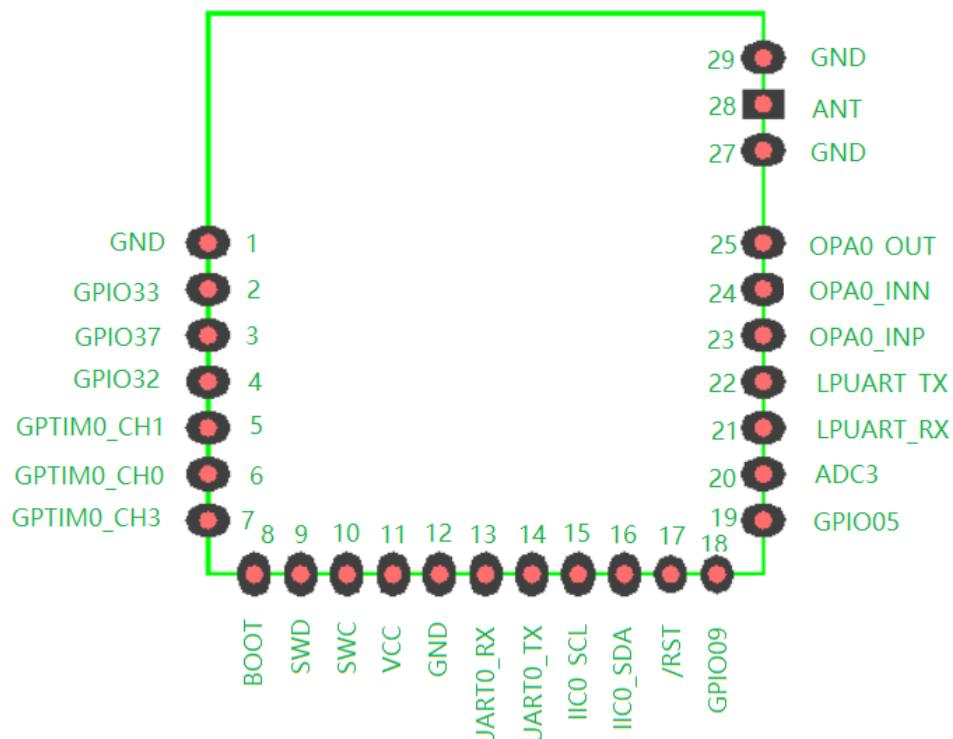
- Maximum reception sensitivity is up to -148dBm
- Maximum launch power is 14dBm@868MHz(for EU) Band / 94dBuV/m@3m@915MHz Band.
- Maximum transmission speed: 62.5kbps
- Minimum dormant current: 2uA
- Maximum master frequency: 48Mhz
- 16kbytes Sram, 128k Flash

# 2. Basic parameters of the module

Classify	Parameter	Value
Wireless	Launch power	
		14dBm@868MHz(for EU) Band
		94dBuV/m@3m@915MHz Band.
	Receive sensitivity	-124dbm@SF7(5470bps)
		-127dbm@SF8(3125bps)
		-129.5dbm@SF9(1760bps)
Hardware	Data interface	UART /SPI/IIC/PWM/IO&etc.
	Power range	3~3.6V
	Current	120mA
	dormant current	2uA
	Temperature	-20~85
	Size	18.2x18x2.5mm
Software	Networking protocol	CLASS A, B, C, DTU & private protocol
	Encryption type	AES128
	User configuration	AT instruction

### 3 Hardware introduction

#### 3.1 Outline of module



#### Notes for Hardware design:

1. Try to supply the module using separate power supplies with low noise LDO such as SGM2033.
2. The supply current of module must be  $>120\text{mA}$ , not include the rest system current.

### 3.2 The definition of pin

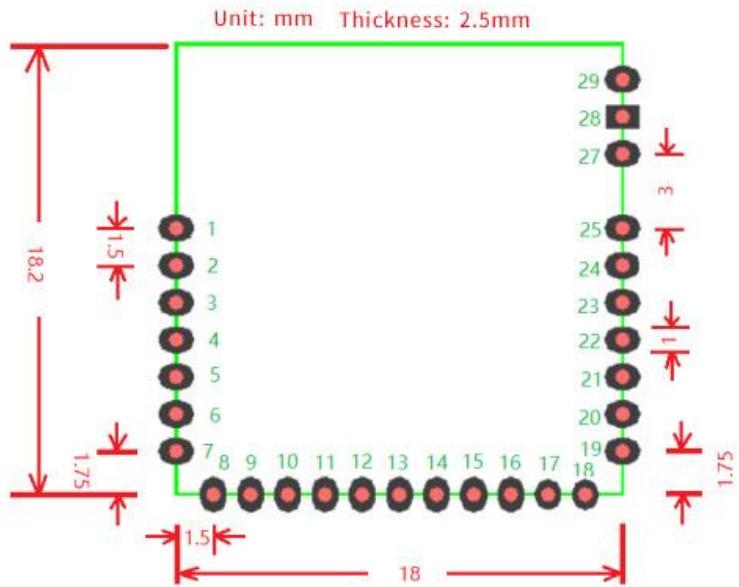
Pin number	Name	Type	Description
1	GND	Power	System GND
2	GPIO33	O	<p>This IO function is high output at module wake up and IO low during hibernation. For 9V battery power supply cases, for low power consumption. Power is supplied by LDO when the module is dormant and by DCDC when the module wakes up.</p> <p><b>External LED, usually high, put low when lighting.</b></p>
3	GPIO37	I	<p>1. For the external MCU to wake up LoRa module. (Usually high level, when the module needs to wake up, the MCU output 1ms pulse (low level effective) to the module. All mode pull down low levels above 2S recovery port rate default);</p> <p>2. For the external MCU tells Lora is ready to receive AT instructions;</p>
4	GPIO32	O	<p>1. To wake up external MCU.</p> <p>2. Use to tell the Mcu,Lora module has been awakened to accept AT instructions; Lower wireless data, finish sending, and hibernation</p>
5	GPTIM0_CH1 SPI0_CS GPIO01	IO	<p>PWM output</p> <p>SPI chip selection</p> <p>IO</p>
6	GPTIM0_CH0 SPI0_CLK GPIO00	IO	<p>PWM output</p> <p>SPI clock</p> <p>IO</p>
7	GPTIM0_CH3 SPI0_RX GPIO03	IO	<p>PWM output</p> <p>SPI input</p> <p>IO</p>
8	BOOT GPTIM0_CH2 SPI0_TX GPIO02	IO	<p>Choose BOOT (<b>internal pull-down</b>) .</p> <p>PWM output</p> <p>SPI output</p> <p>IO</p>
9	SWD GPIO06	IO	<p>Simulator debugging SWD (<b>pull-up</b>)</p> <p>IO</p>

10	SWC GPIO07	O	Simulator (pull-down) <b>IO</b>	debugging	SWC
11	VCC	O	Power input 3.3V, Maximum peak current150mA.		
12	GND	Power	System GND		
13	UART0_RX GPIO16	IO	Serial port 0 receive <b>IO-download-print</b>		
14	UART0_TX GPIO17	IO	Serial port 0 send <b>IO-download-print</b>		
15	IIC0_SCL GPIO14	IO	IIC0 clk IO		
16	IIC0_SDA GPIO15	IO	IIC0 DATA IO		
17	/RST	O	System reset, low effectiveness		
18	GPIO09 GPTIM1_CH1	O	IO PWM output		
19	GPIO5 ADC2	IO/A	IO ADC CH2		
20	ADC3 GPIO04	A/IO	ADC CH3 IO		
21	LPUART_RX GPIO60	IO	Low Power UART RX IO-AT interactive		
22	LPUART_TX GPIO47	IO	Low Power UART TX IO		
23	OPA0_INP GPIO45	A/IO	Operational amplifier 0, positive enter point IO		
24	OPA0_INN GPIO44	A/IO	Operational amplifier 0, negative enter point IO		
25	OPA0_OUT GPIO10	A/IO	Operational amplifier 0, output point IO		
27	GND	Power	System GND		
28	ANT	RF	Antenna wire		
29	GND	Power	System grounding line		

Note : I –Input, O-Output, A-Analog

Module has various functions and support various software. The functions are chosen by this protocol are marked by red.

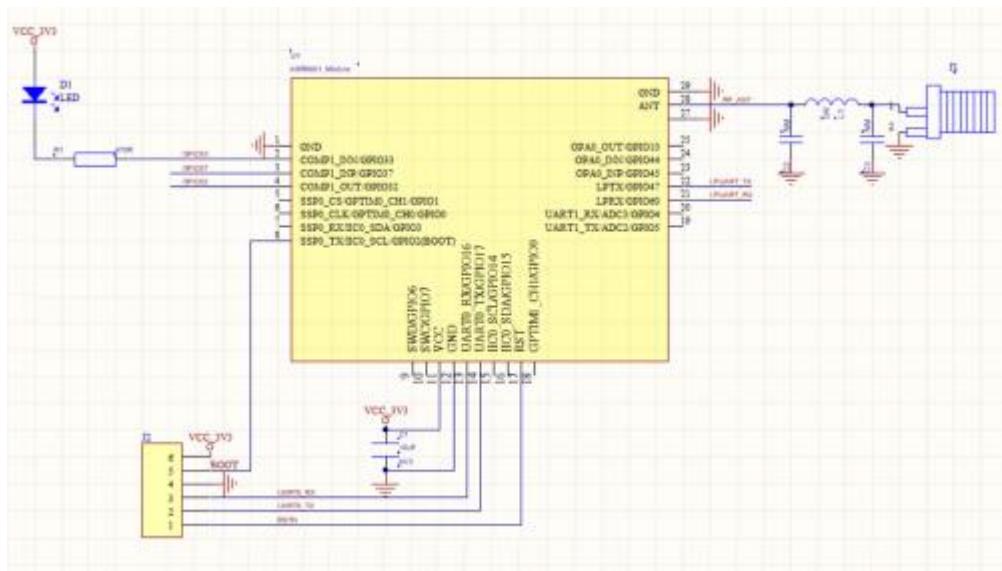
### 3.3 Hardware size



### 3.4 Electrical character

Parameter	Condition	Minimum	Normal	Maximum	Unit
Working voltage		3	3.3	3.6	V
Working current	Continuous send		120		mA
dormant current	RTC work		2		uA

### 3.5 Reference design



## 4. Parameter of function.

- 4.1 Support wireless transmission
- 4.2 Changeable serial port rate and test bit
- 4.3 Support for transmission data encryption and decryption
- 4.4 Support for frequency and rate setting
- 4.5 Support the selective preservation of setting parameters. The MCU control module does not need to be saved, and it is used separately as a transmission module
- 4.6 Support the use of external MCU control modules and independent modules
- 4.7 The serial port port rate, Lora rate, Lora frequency, and secret key within the same transmission combination need to be consistent, and the inconsistency will lead to anomalies
- 4.8 LED lamp (GPIO33) flash at 2S frequency
- 4.9 Pull GPIO32 down when sending data, sent and dormant
- 4.10 Export "AT + START\r\n", until it receives this command
- Directive configuration and data transfer
- 4.11 Recovery default serial port port rate is 38400, no verification function

## 5. Regional division of FLASH

**Internal Flash has a total of 128kbytes,page in size of 4k.**

Region	Range of region	Byte	Note
DTU routine are	0x0800_0000~0x0801_EFFF	124K	DTU routine are
INFO	0x0801_F000~0x0801_FFFF	4K	Store some user information

## 6. Usage of module

Module use can be controlled by an external MCU and as independent modules using two, with an arbitrary combination of port rate and rate, the packet length transmission supports a maximum of 1K (1023Byte) byte data.

### 6.1 External MCU control

The default GPIO32 of the power is high, the GPIO32 is pulled down during the data transmission process, and the GPIO32 is high, which can be determined here whether the broken module is dead, the timeout should be greater than 5.26S (sending 1 K bytes at SF9,2400 baud rate).

6.2 When the transmission data is greater than 1K, the 1K data is sent first to continue to send the remaining data when the GPIO32 is restored to high, so that the circular transmission is sent.

## 7 AT instruction

(Note: Sending the command needs to return the line and return the AT command to return the line)

### 7.1, Enter into AT instruction mode

Serial port	Format	Note
Send	+++	The start and end byte of a frame must be with a ending with three consecutive '+'+"r\n", send a character 'a' between <b>10ms to 1s</b>
Send	a	The 'a' must end with the frame start byte + "\r\n" and if the '+' character is not received in module 1S, the '+' is issued as a data transmission
Return	AT+ENAT=OK	Enter into command mode

### 7.2, Set the serial port rate

Note: After this step, the serial port returns OK or ERR,MCU according to the previous port rate and check bit to synchronously initialize the corresponding port rate and check bit after receiving the successful set up command.

Serial port	Format	Note
Send	AT+BAUD=9600,0	2400、4800、9600、14400、19200、 <b>38400</b> (default)、 <b>57600</b> 、 <b>115200</b> optional 0-No check bit (default) 1-Check odd 2-Check even
Return	AT+BAUD=OK	Correct return
Return	AT+BAUD=ERR	Wrong return
Send	AT+BAUD=?	Inquiry
Return	AT+BAUD=9600,0	

### 7.3, Set the Lora frequency interval

Serial port	Format	Note
Send	AT+FREQ=4400	470Mhz span: 4300~5100 868Mhz(for EU) span: 8600~9200 Default; <b>4400</b>
Return	AT+FREQ=OK	Correct return
Return	AT+FREQ=ERR	Wrong return
Send	AT+FREQ=?	Inquiry
Return	AT+FREQ=4400	

#### 7.4, Set the Lora rate

Serial port	Format	Note
Send	AT+RATE=7	7(5470bps) /8(3125bps) /9(1760bps)optional Default : 7
	AT+RATE=OK	Correct return
Return	AT+RATE=ERR	Wrong return
Send	AT+RATE=?	Inquiry
Return	AT+RATE=7	

#### 7.5, Set the working mode

Serial port	Format	Note
Send	AT+WORKMODE=1	After sending the data in dormant mode
Return	AT+WORKMODE=2	Post the data delay dormancy mode
Send	AT+WORKMODE=3	No dormant mode (default)
	AT+WORKMODE=OK	Correct return
Return	AT+WORKMODE=ERR	Wrong return
Send	AT+WORKMODE=?	Inquiry
Return	AT+WORKMODE=1	

#### 7.6, Set the Lora packet length

Serial port	Format	Note
Send	AT+LORALENTH=240	Set the lora data per packet (32~240)
	AT+LORALENTH=OK	Correct return
Return	AT+LORALENTH=ERR	Wrong return
Send	AT+WORKMODE=?	Inquiry
Return	AT+WORKMODE=240	

## 7.7, Set up the key

Fixed 16 bytes and 16 decimal numbers (16 characters) with the encryption key to resolve the data correctly. Query is not supported.

Serial port	Format	Note
Send	AT+DATAKEY=Qqert,91234567890	Support for numbers, English, and English characters. Default: All 0
Return	AT+DATAKEY=OK	Correct return
	AT+DATAKEY=ERR	Wrong return
Send	AT+DATAKEY=?	Inquiry
Return	AT+DATAKEY=ERR	

## 7.8, Save the parameters set above

Note: Perform this command to save the previously set AT instruction parameters.

Serial port	Format	Note
Send	AT+SAVE	Save the above set AT instruction parameters
Return	AT+SAVE=OK	

## 7.9, clear the above set parameters- -the restart takes effect

Note: restore default except the above setting AT instruction parameters.

Serial port	Format	Note
Send	AT+RESTORE	Clear the above set AT instruction parameters to restore the default values
Return	AT+RESTORE=OK	

## 7.10, Exit the AT instruction mode

Note: This step indicates that the setting is complete and the module receives the instruction into transmission mode. The setting was not complete midway, and the previous setting was also successful.

Serial port	Format	Note
Send	AT+EXAT	Exit the at instruction mode
Return	AT+EXAT=OK	

**Note: The parameters configured through the AT instruction will not be automatically saved, the configured parameters after power again will restore the default, need to be saved through AT + SAVE.**

## **8. Restores the default serial port rate 38400 and no checked**

**GPIO37 pin holding low level above 2S can restore the default serial port rate and return to AT + BAUD=38400,0 + return line.**

**Please take attention that changes or modification not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.**

**This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.**

The module is limited to OEM installation ONLY

The OEM integrator is responsible for ensuring that the end-user has no manual instruction to remove or install module.

When the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: "Contains FCC ID: 2AZ6I-ML601" and the information should be also contained in the devices' user manual.