EC-01G Specification

Version V2.0

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Document resume

Version	Date	Formulation / Revision	Make	Verify
V1.0	2021.05.25	First development	Nannan Yuan	Ning Guan
V2.0	2022.04.08	Updated version	Nannan Yuan	Ning Guan

CONTENT

1. Product overview

EC-01G is an NB+GPS module developed by Ai-Thinker. The main chip scheme adopted by the NB part is EC616S. The chip has an ultra-highly integrated NB-IoT SoC, supports ultra-low power consumption, and fully supports the 3GPP Rel14 NB-IoT standard. It is an ultra-high cost-effective NB-IoT chip.

It has the following characteristics：

- Integrated radio frequency transceiver, PA, radio frequency filter, antenna switch and power management.
- Excellent communication performance and stability in various wireless environments.
- Excellent power consumption performance in various modes (PSM, DRX, eDRX, connected state).
- Unique MCU mode, providing lower working current and shorter wake-up time.

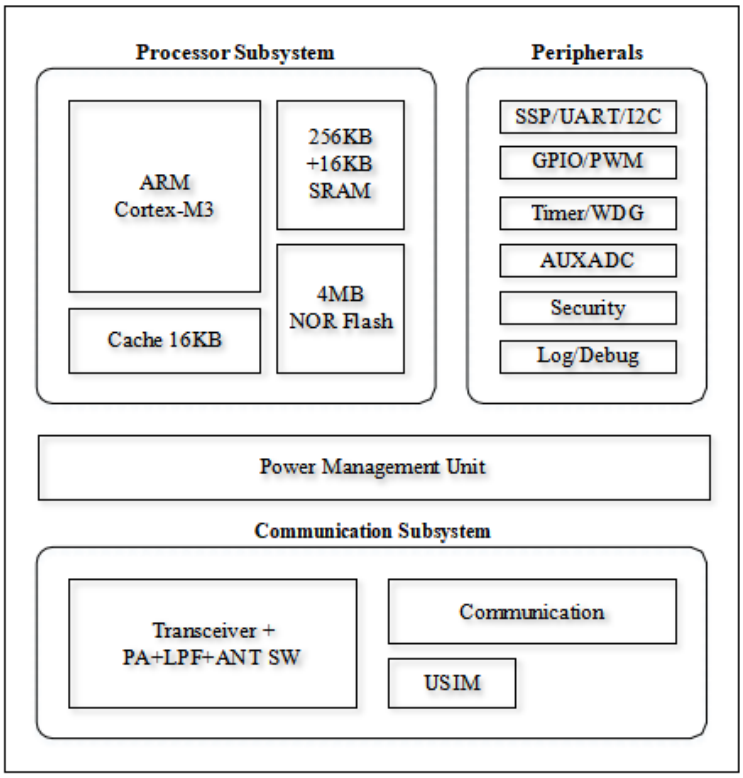

Figure　Chip architecture diagram

The main chip solution for GPS part of the EC-01G module is AT6558R. This chip is a high-performance BDS/GNSS multi-mode satellite navigation receiver SoC single chip, the chip integrated RF Front-End, digital base-band processor, 32-bit RISC CPU, power management function. The chip supports a variety of satellite navigation systems, including China's Beidou satellite navigation system BDS, the United States' GPS, and Russia's GLONASS, and can realize multi-system positioning.

It has the following characteristics（GPS）：

- Support BDS/GPS/GLONASS multi-system joint positioning and single-system independent positioning.
- With active antenna detection and protection.
- RTC and backup circuit power supply can be as low as 1.4V
- BDS/GPS dual-mode continuous operation.

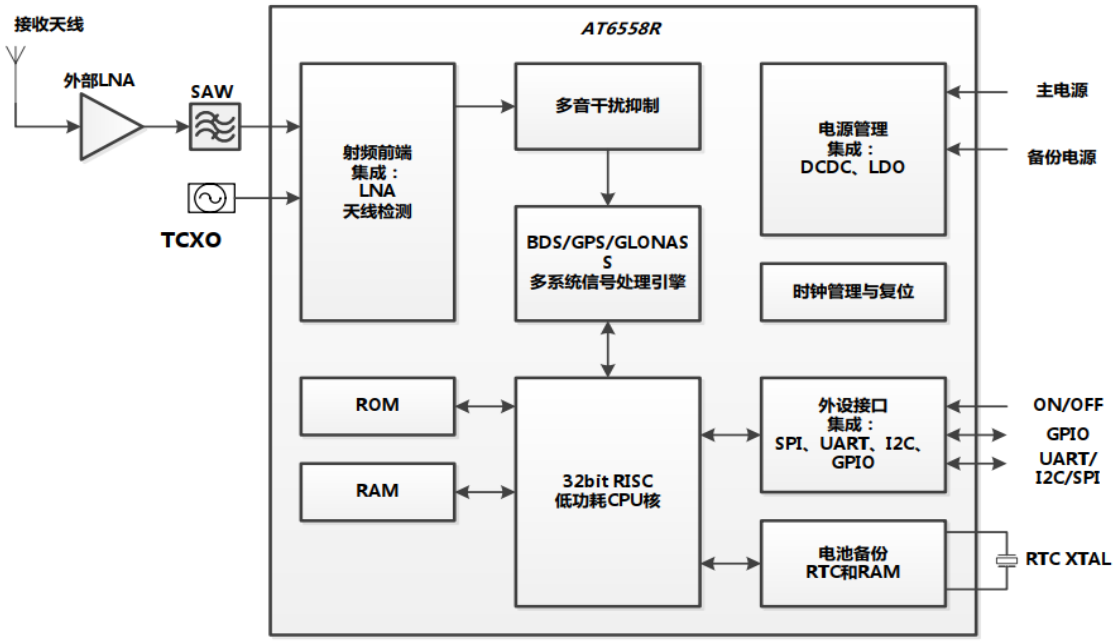

Figure 1 AT6558R chip architecture diagram

1.1. Features

- CPU：
- ✓ Cortex-M3, support MPU
- ✓ Configurable CPU frequency, up to 204MHz
- ✓ 8-channel DMA
- Memory：
- ✓ 4MB on-chip NOR flash
- ✓ 272KB on-wafer SRAM, divided into 256KB and 16KB

16KB instruction cache

- System
- ✓ Flexible configuration support 1.8/2.8/3.3V IO
- ✓ Clock source: 26MHz TCXO or DCXO, 32.768KHz crystal oscillator
- ✓ 1 external wake-up source (interrupt)
- ✓ Unique MCU mode, in this mode, the internal RC oscillator is used as the clock, and the power consumption is lower
- ✓ LOG port, UNILOG
- ✓ Debug port, SWD
- Peripherals
- ✓ 16 GPIO
- ✓ 3 UART, 2 SSP, 2 I2C
- ✓ 6 PWM, 6 Timers， 6 GPIO counter,1 WDG
- ✓ 32KHz RTC timer
- ✓ USIM, support Esim
- ✓ LPUART
- ✓ 4-channel 12-bit AUXADC
- ✓ Temperature sensor
- ✓ Battery voltage monitoring

- Low power consumption：
- ✓ Unique low-power architecture, 4-level sleep mode
- ✓ PSM: 800nA
- ✓ DRX (2.56s): typical value110uA
- ✓ RX: typical value10mA
- ✓ TX: typical value24mA
- Communication：
- ✓ Totally support 3GPP R14 NB-IoT
- ✓ Category NB2, 2-HARQ
- ✓ Multi-tone NPUSCH
- ✓ Anchor and non-anchor carrier
- ✓ In-band same/different PCI, guardband, standalone
- ✓ Multi-carrier paging, NPRACH
- ✓ Positioning: OTDOA & ECID
- ✓ ROHC, RAI, multiple-DRB, RRC connection re-establish
- ✓ SC-PTM (need SW upgrade)
- RF：
- ✓ Support frequency band: 3, 5, 8
- ✓ Chip integrated PA, support APT function
- ✓ Chip integrated RF transceiver filter and antenna switch
- ✓ Power rating 3
- Safety：
- ✓ Hardware encryption and decryption module(AES, SHA)
- ✓ Secure boot
- ✓ flash encryption
- ✓ True random number generator
- Application：
- ✓ Support open-CPU

- ✓ The software complies with the CMSIS architecture
- ✓ Support main cloud services
- ✓ IPv4, IPv6 and non-IP
- ✓ UDP, TCP
- ✓ DTLS, TLS, SSL
- ✓ MQTT, CoAP, HTTP(S)
- ✓ LWM2M
- ✓ Support FOTA
- ■ Voltage range：
- ✓ 3.3V to 4.5V

2. Main parameters

Table 1 Main parameter description

Model	EC-01G
Package	SMD-54
Size	19.2*18.8*2.8(±0.2)MM
Antenna	External antenna
Frequency range	Band3,Band5,Band8
Operating temperature	-40 ℃ ~ 85 ℃
Storage environment	-40 ℃ ~ 125 ℃ , < 90%RH
Power supply range	Supply voltage 3.3V ~ 4.5V, current ＞500mA
Support interface	SSP/UART/I2C/PWM/ADC/GPIO
Serial port rate	Support 110 ~ 4608000 bps ， default 9600 bps
Security	AES/SHA
Flash	4MB NOR flash

2.1. Electrical parameters

The EC-01G module is an electrostatic sensitive device, and special precautions must be taken when handling it.

Figure 2 ESD anti-static

2.2. Electrical characteristics

Table 2 Electrical characteristics table

Parameter		Condition	Min	Typical	Max	Unit
Voltage		VDD	3.3	3.3	4.5	V
I/O	V_{IL}/V_{IH}	-	-0.3/0.75VIO	-	0.25VIO/4.5	V
	V_{OL}/V_{OH}	-	N/0.8VIO	-	0.1VIO/N	V
	I_{MAX}	-	-	-	24	mA

2.3. NB RF performance

Table 3 NB RF performance

Band	Channel	1 Tone@11(15KHz)				12 Tone(15KHz)			
		Pout (dBm)	EVM RMS (%)	SEM Margin (dB)	ACLR Max (dBc)	Pout (dBm)	EVM RMS (%)	SEM Margin (dB)	ACLR Max (dBc)
3	1201	22.5	0.9	4.9	-39.5	20.5	7	6	-40.8
	1575	22.5	0.9	3.8	-39	20.5	7	6	-41

	1949	22.5	0.9	4	-39	20.5	7	5	-40.5
5	2401	22.6	0.9	8	-42	20.4	7	7	-43
	2525	22.6	0.9	9	-42	20.4	6	6	-42.5
	2649	22.6	0.9	8	-42	20.4	7	7	-42.8
8	3451	22.5	0.9	7.5	-42.5	20.5	6	4	-42.5
	3625	22.5	0.9	8.5	-42	20.4	6	3.5	-41
	3799	22.5	0.9	5	-42	20.4	7	4.5	-40.5

2.4. Power consumption

The following power consumption data is based on a 3.3V power supply, an ambient temperature of 25°C, and measured using an internal voltage regulator.

Table 4 Power consumption table

Mode	Min	Average	Max	Unit
Connect_Tx_23dBm_1Tone(Band3 Channel 1575 1842.5MHz)	-	120	240	mA
Connect_Tx_23dBm_1Tone(Band5 Channel 2525 881.5MHz)	-	110	226	mA
Connect_Tx_23dBm_1Tone(Band8 Channel 2625 942.5MHz)	-	108	215	mA
Connect_Rx_Band3	-	10	40	mA
Connect_Rx_Band5	-	16	46	mA
Connect_Rx_Band8	-	10	40	mA
DRX (2.56s)	-		110	μA
PSM	-		<1	μA

3. Dimensions

Figure 3 EC-01G appearance(The picture and silk screen are for reference only, the actual product shall prevail）

Note: The two-dimensional code of the shielding cover is the SN/IMEI number of the product

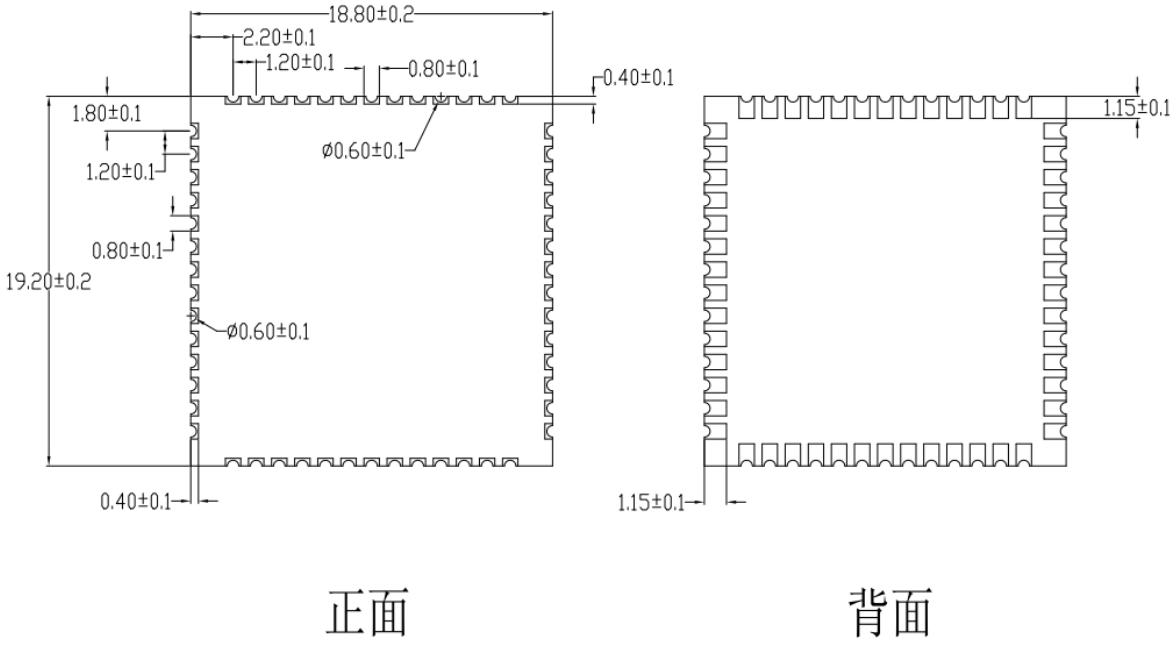

Figure 5 Module size

4. PIN definition

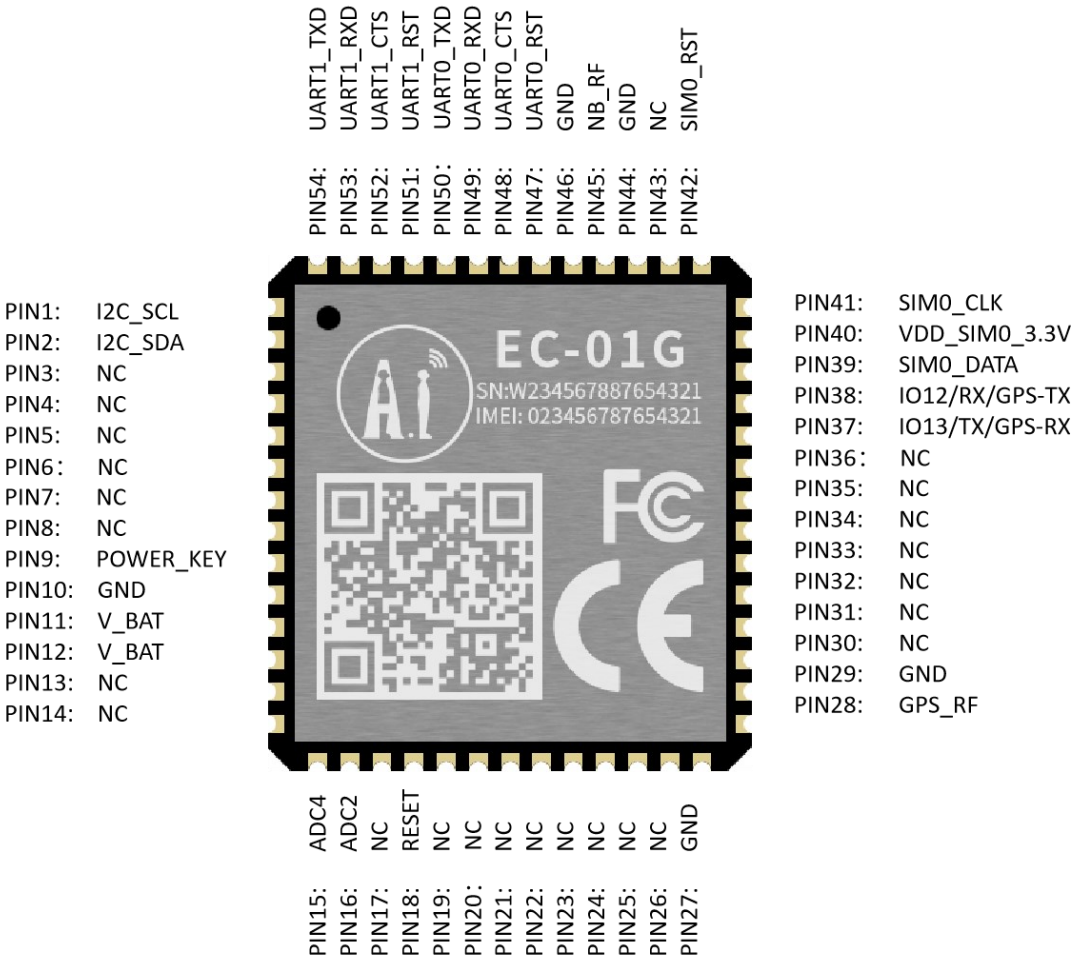

Figure 6 EC-01G PIN definition diagram(The picture and silk screen are for reference only, the actual product shall prevail)

The EC-01G module has a total of 54 interfaces. As shown in the pin diagram, the pin function definition table is the interface definition.

Table 5 Pin function definition table

No.	Name	Function description
1	I2C_SCL	GPIO3
2	I2C_SDA	GPIO2
3-8	NC	Not connected
9	POWER_KEY	WAKEUP
10	GND	Ground
11	V_BAT	Power input
12	V_BAT	Power input
13-14	NC	Not connected
15	ADC4	ADC Channel AIO4
16	ADC2	ADC Channel AIO2
17	NC	Not connected
18	RESET	RESETn
19-26	NC	Not connected
27	GND	Ground
28	GPS_RF	GPS RF Front-end
29	GND	Ground
30-36	NC	Not connected
37	IO13/TX	UART1_TXD
38	IO12/RX	UART1_RXD
39	SIM0_DATA	USIM_UIO/SIM card IO

40	VDD_SIM0_3.3V	VO_LDOSIM Output of LDO SIM 1.8V/3.3V
41	SIM0_CLK	USIM_UCLK/SIM card clock
42	SIM0_RST	USIM_URSTn/SIM card reset
43	NC	Not connected
44	GND	Ground
45	NB_RF	NB RF Front-end
46	GND	Ground
47	UART0_RST	GPIO6/UART0_RSTn
48	UART0_CTS	GPIO7/UART0_CTSn
49	UART0_RXD	GPIO8/UART0_RXD
50	UART0_TXD	GPIO9/UART0_TXD
51	UART1_RST	GPIO10/UART1_RSTn
52	UART1_CTS	GPIO11/UART1_CTSn
53	UART1_RXD	GPIO14/UART1_RXD
54	UART1_TXD	GPIO15/UART1_TXD

5. Schematic diagram

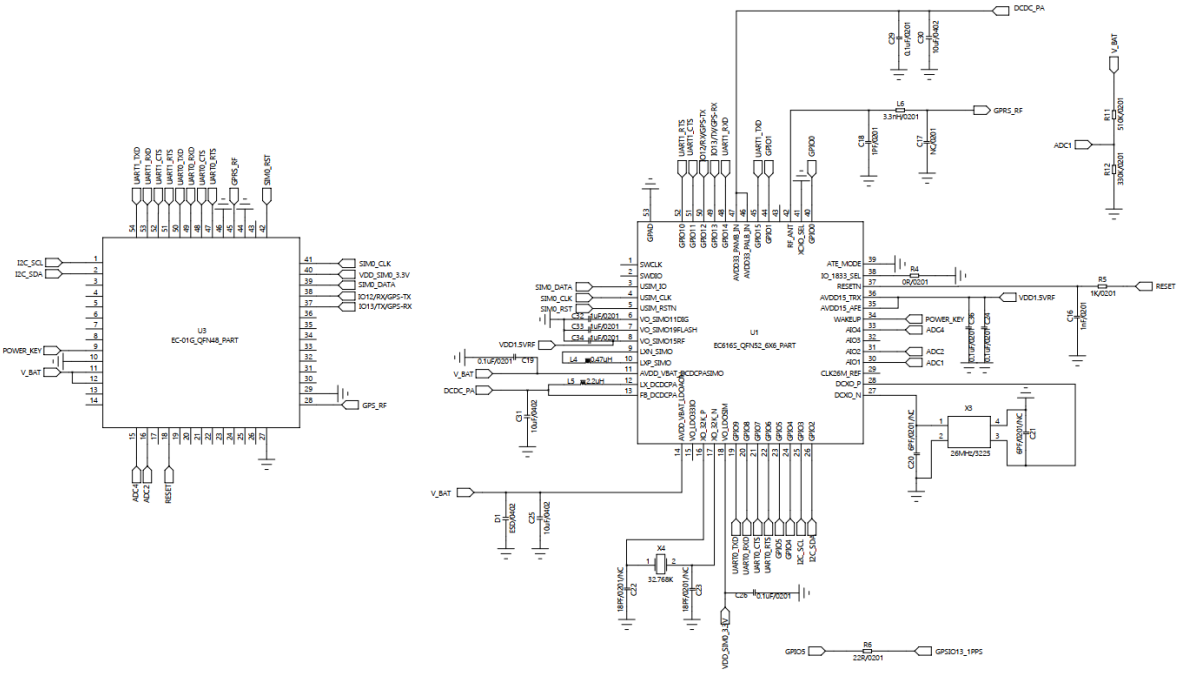

Figure 7 Module schematic diagram NB part

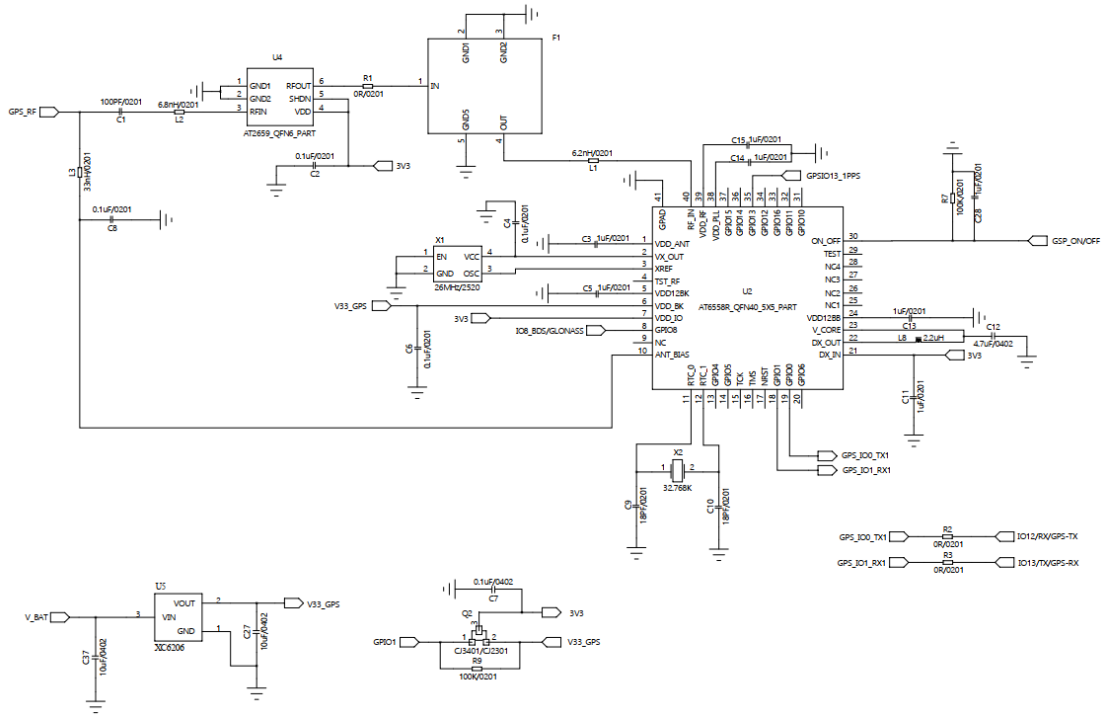

Figure 8 Module schematic diagram GPS part

6. Design guidance

6.1. Application circuit

It is recommended to add an anti-static protection IC to the power input.

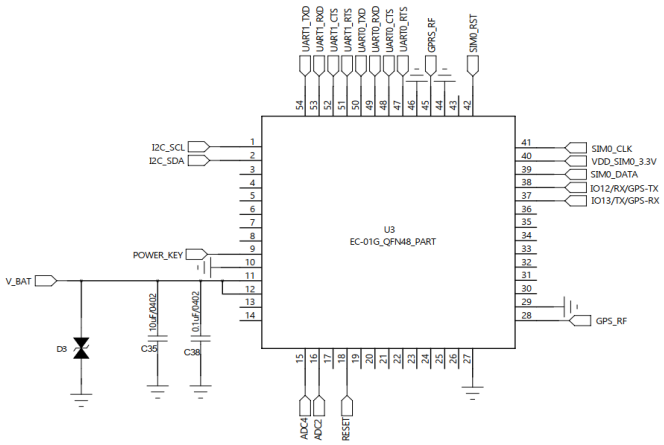

Figure 9 Application circuit schematic

6.2. Power supply

- Recommended 3.3V-4.5V voltage, peak current above 500mA.
- It is recommended to use LDO for power supply; if using DC-DC, it is recommended that the ripple be controlled within 50mV.
- For the DC-DC power supply circuit, it is recommended to reserve a place for the dynamic response capacitor to optimize the output ripple when the load changes greatly.
- It is recommended to add ESD devices for the 3.3V-4.5V power interface.

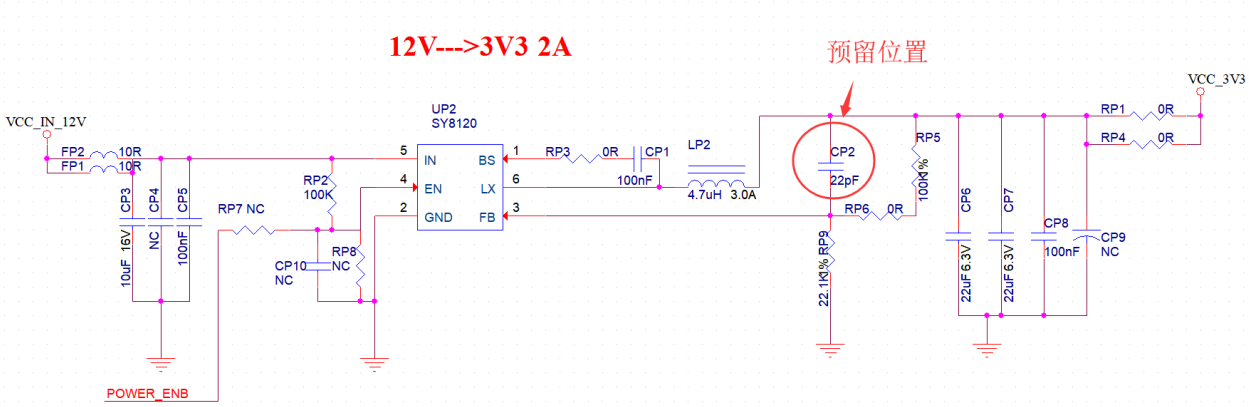

Figure 10 Recommended power supply circuit

6.3. ESD electrostatic protection

1）Vulnerable to electrostatic damage pins : V_BAT, NB_RF, RESET, POWER_KEY(WAKEUP).

2）Electrostatic protection components have been added to the internal design circuit of V_BAT module. The user main board can supply the module selectively according to their own needs. It is recommended to reserve the position of TVS pipe.

3) NB_RF RF interface, electrostatic protection components have been added to the internal design circuit of the module.It is strongly recommended that the TVS pipe position can be selectively added according to the actual situation.

Note: The selection of the NB_RF interface TVS device requires a capacitance saving of less than 0.1pF. Excessive junction capacitance can affect the RF performance.

4) RESET, POWER_KEY(WAKEUP) , if there is contact with the outside environment (such as external keys), TVS devices must also be added. If the circuit is only connected to the MCU, there is no contact with the outside environment risk can not be added.

6.4. Up / down power supply considerations

1）After the NB chip is powered on, the RESET and BOOT inputs can be automatically started. The start-up sequence is shown in the figure below

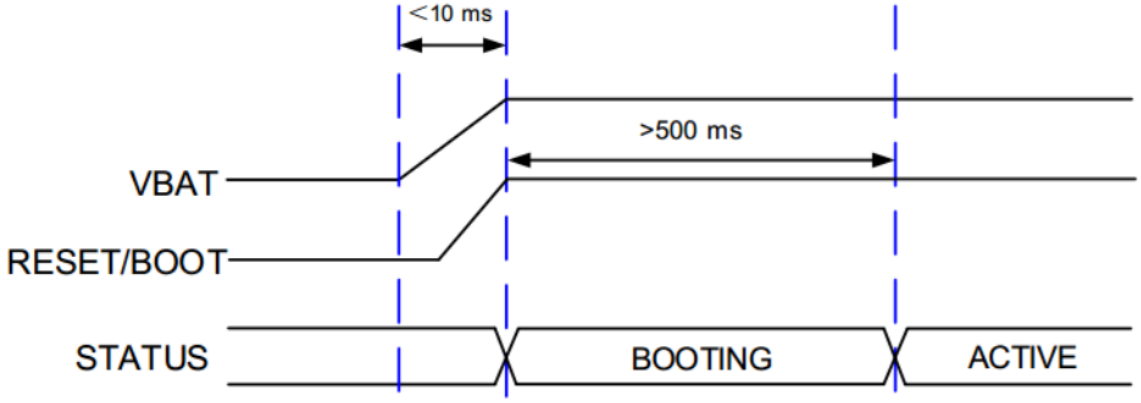

Figure 11 NB chip power on electric timing diagram

2）Need attention：

① After V_BAT is cut off, its voltage is lower than 0.7V. The specific discharge time should be evaluated according to the actual circuit test, and leave enough margin to avoid abnormal start-up when powered on again.

② V_BAT power on time needs to be within 10ms.

③ It is recommended that the MCU keep the RESET control pin. After the module is abnormal, we can control module reset to exit the abnormal state.

④ After V_BAT power-on, RESET and BOOT automatically rise to high level due to internal pull-up.

6.5. RESET pin application circuit

1）The internal pull-up resistor of NB chip RESET pin is very weak and vulnerable to be interference and abnormal reset, which needs to add RC filter circuit to the RESET pin.The circuit has been added inside the module that the customer can omit.

2）If the external MCU GPIO is connected to the RESET pin of the module via a triode (as shown in Figure 10), the leakage current in the triode cut-off state is required to be less than 0.5uA. The reason is that the internal drag resistance of the RESET pin is very weak, and the leakage may pull the RESET pin below 1.2V. The NB chip work normally for its RESET pin high level need guaranteed to be above 1.2V.

3）There are two solutions under the premise that the triode leakage current cannot be

guaranteed.

① Use a MOS tube instead of the triode, most MOS leakage current is small.

② The pull-up circuit is reserved on the circuit (as shown in FIG. 10). The voltage range of VCC is 1.8V-3.6V and need often open. Do not use the electricity from the NB module.

4）Module V_BAT will force the hibernation protection at power supply below 2.2V, which requires external RESET pin (or power circuits completely discharged and then power on) to resume normal operation. In the application of OpenCPU, it is necessary to replace the triode partial circuit with a circuit that monitors the low voltage detection of the VBAT voltage (it is recommended to use a detection chip with a low voltage below 2.4V output).

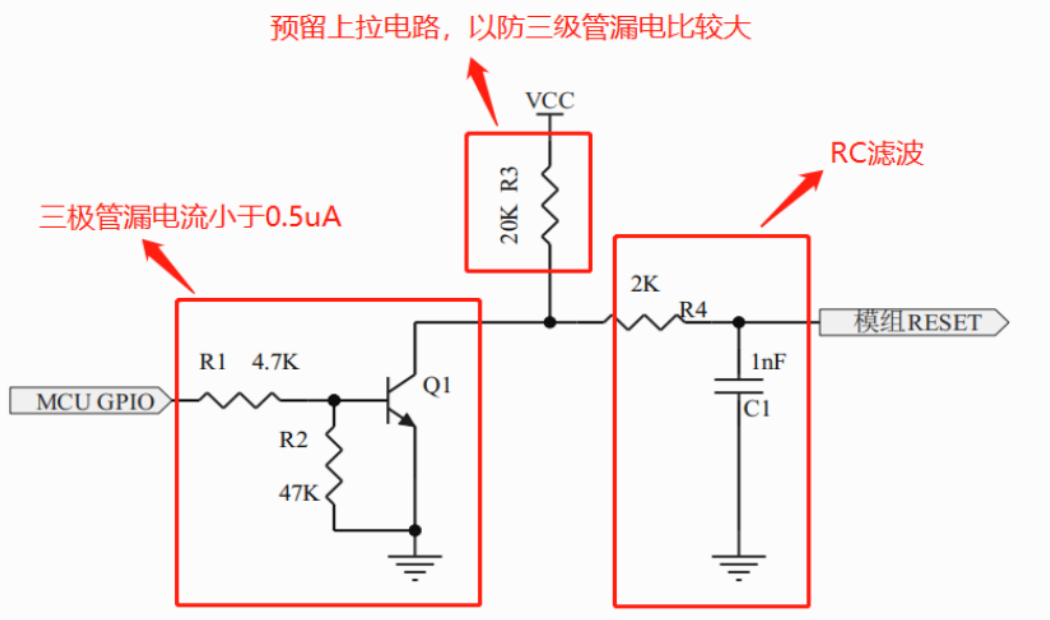

Figure 12 The Reset pin reference circuit

6.6. WAKEUP pin application circuit

1）The pull-up resistor of the WAKEUP pin of the NB chip is very weak and tolerant to interference. To avoid abnormal wake up of the module in the dormant state, add RC filter circuit in the WAKEUP pin(as shown in Figure 11). No this RC circuit exists inside the module,

so the peripheral circuit of the user motherboard must be added.

2）If the external MCU GPIO is connected to the WAKEUP pin of the module through triode (as shown in Figure 11), the leakage current of the triode cut-off state is required to be less than 0.5uA, because the internal pull-up of WAKEUP is weak and the WAKEUP pin below 1.2V. It is possible that the NB chip can not be awakened by the WAKEUP pin in a dormant state.

3）There are two solutions under the premise that the triode leakage current cannot be guaranteed.

① With a MOS tube instead of the triode, most MOS leakage current is small.

② The pull-up circuit is reserved on the circuit (as shown in Figure 11). The voltage range of VCC is 1.8V~3.6V and often open. Do not use the electricity from the NB module.

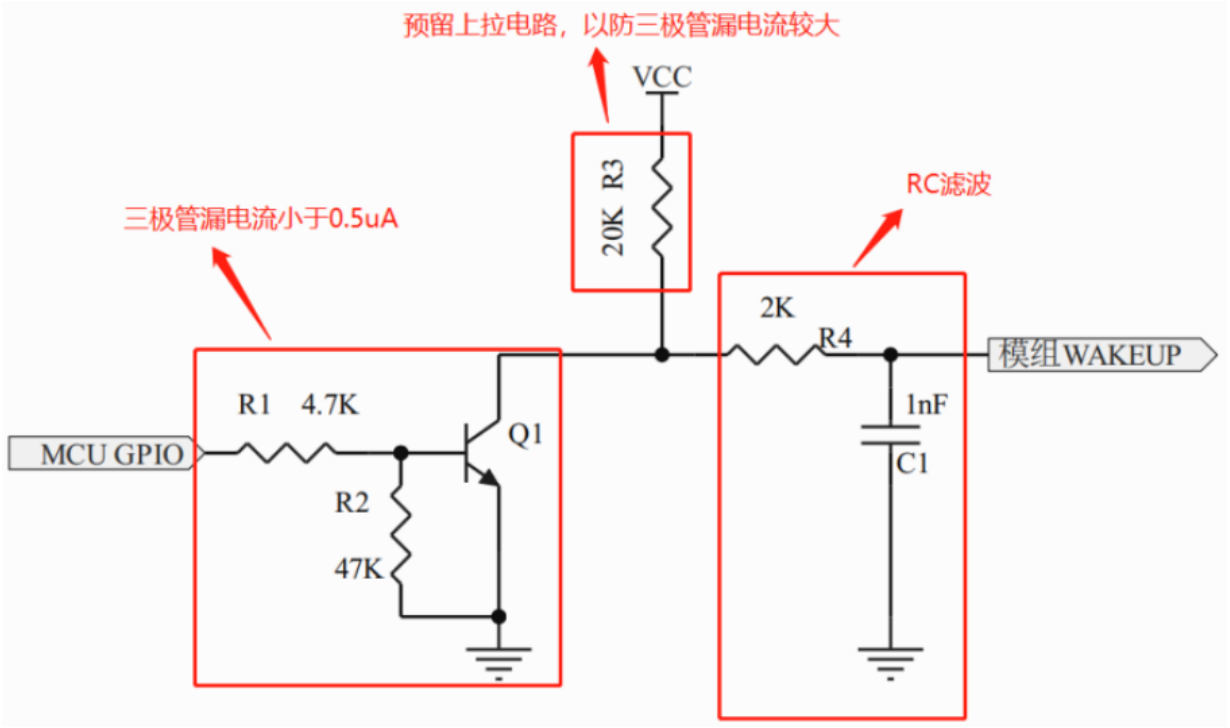

Figure 13 The WAKEUP pin reference circuit

6.7. SIM card application circuit

1）The SIM DATA pin is recommended to add a typical value of 20K pull-up resistor, without adding the pull-up resistor may have a risk that some SIM cards can not be correctly identified, and affecting the communication.The reference circuit is shown in Figure 14.

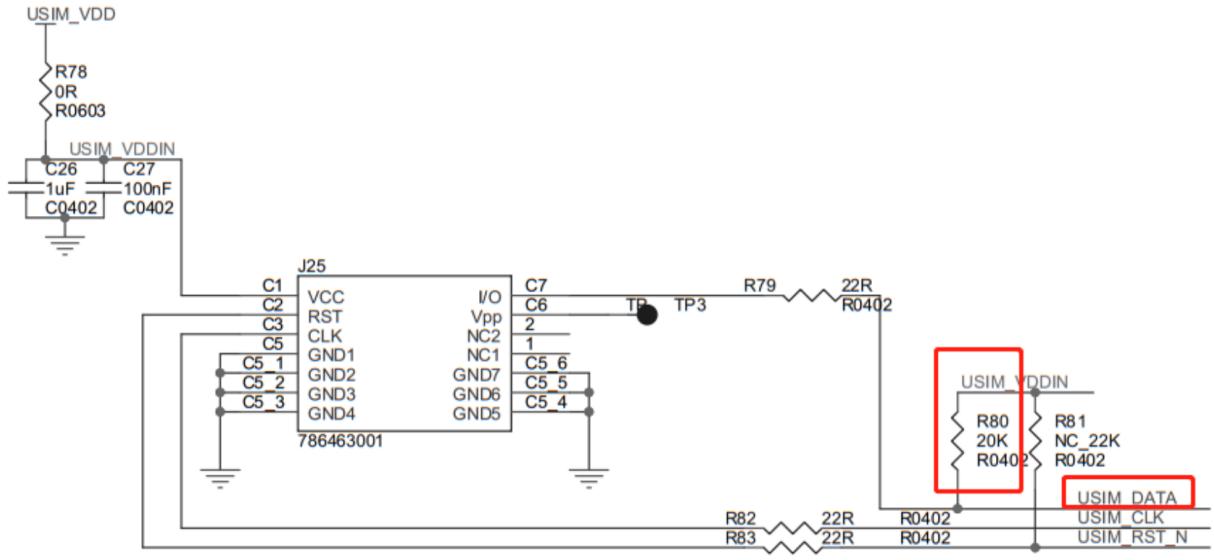

Figure 14 The SIM card reference circuit

6.8. Serial port level conversion circuit

1）If the user connects the AT serial port RXD with WAKEUP outside the module, and the WAKEUP also enables the wake up function (the RXD of module serial port 1 itself has WAKEUP function), then the module RXD cannot use the triode level conversion circuit, otherwise there will be abnormal wake up and dormancy.The RXD pin of NB chip has an anti-inverted design, and the MCU TXD voltage range can be solved by the RXD direct connection with the module (shown in Figure 13) within 1.8~3.6V.

2）Serial port TXD and RXD should be far away from WAKEUP and RESET, and WAKEUP and RESET routing are recommended.The internal and peripheral circuits of the module should adopt such wiring rules.

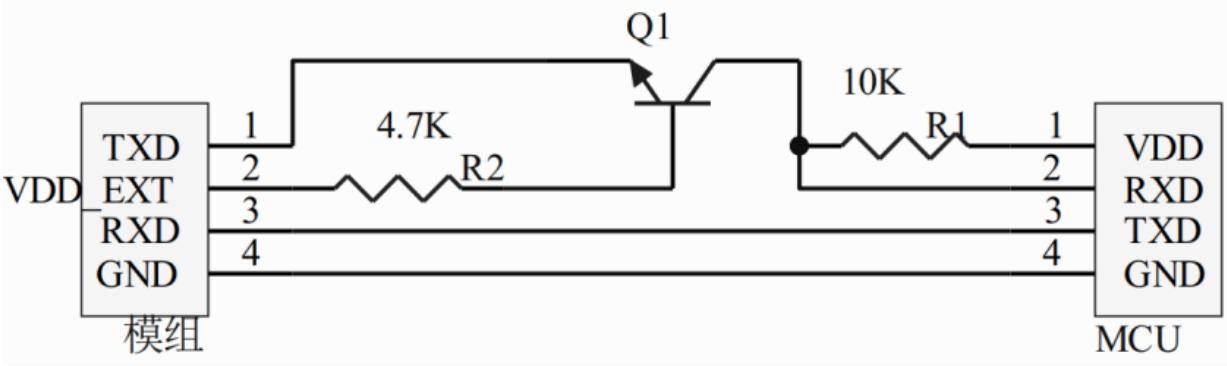

Figure 15 Serial port level conversion reference circuit

7. Reflow soldering curve

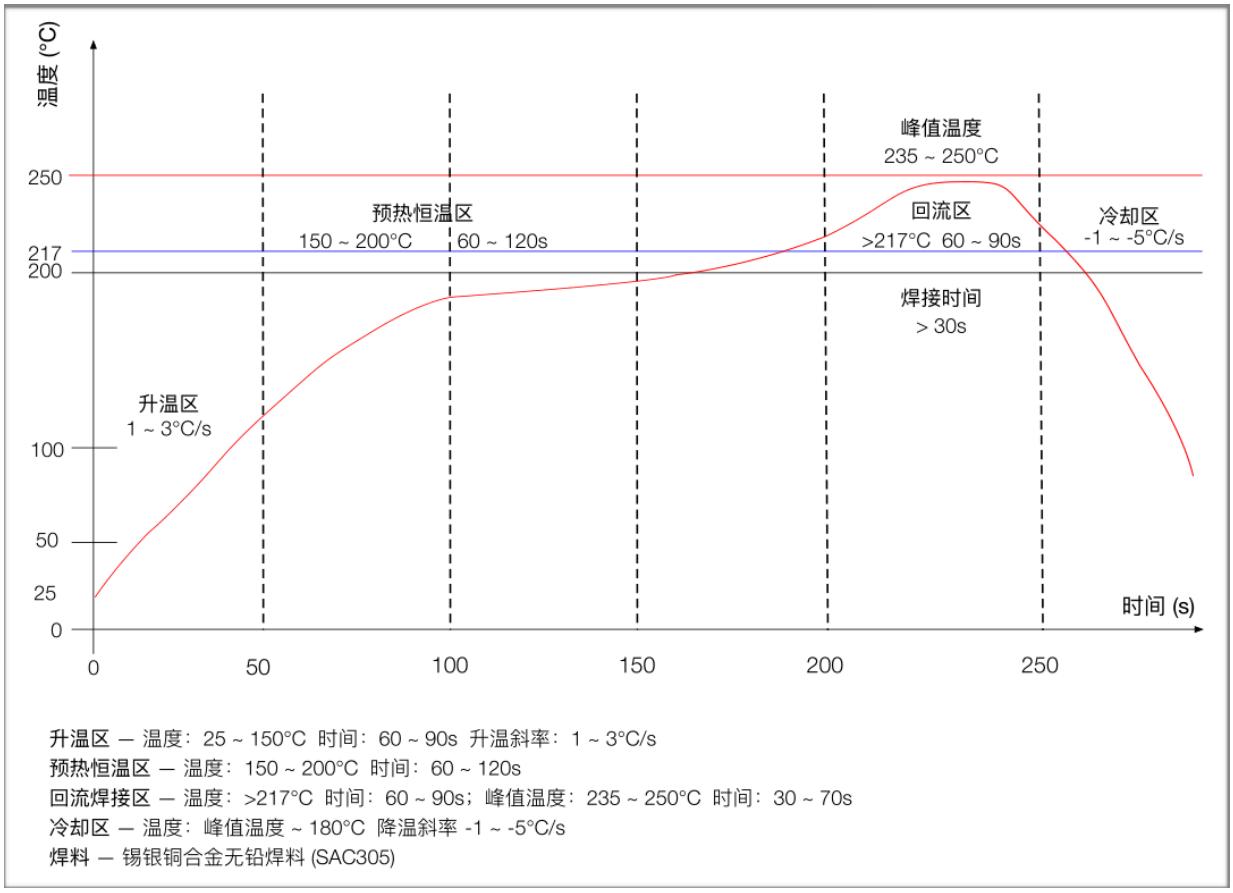

Figure 16 Reflow soldering curve

8. Packaging

As shown in the figure below, the default packaging of EC-01G is taping.

Figure 15 Tape package

9. Contact us

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