



EC-01F Specification

Version V2.0

Copyright©2022

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.	4
1.1. Features.	5
2. Main parameters	7
2.1. Electrical parameters.	8
2.2. Electrical characteristics	8
2.3. NB RF performance	8
2.4. Power consumption.	9
3. Dimensions	10
4. PIN definition	11
5. Schematic diagram	13
6. Design guidance	14
6.1. Application circuit.	14
6.2. Power supply.	14
6.3. ESD electrostatic protection	15
6.4. Up / down power supply considerations	15
6.5. RESET pin application circuit.	16
6.6. WAKEUP pin application circuit	17
6.7. SIM card application circuit	18
6.8. Serial port level conversion circuit	19
7. Reflow soldering curve	20
8. Packaging	21
9. Contact us	21
Disclaimer and copyright notice	22
Notice.	22

1. Product overview

EC-01F is an NB 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.

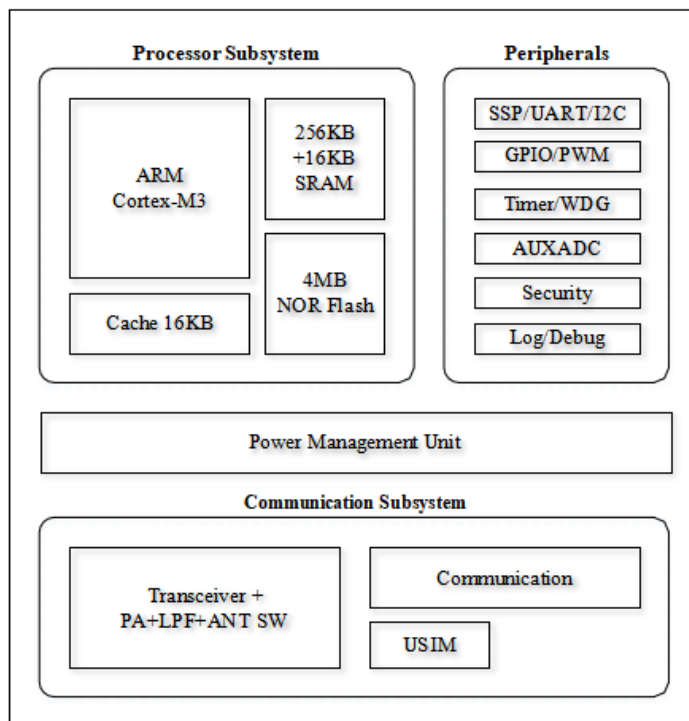


Figure Chip architecture diagram

1.1. Features

- CPU:
 - ✓ Cortex-M3, support MPU
 - ✓ Configurable CPU frequency, up to 204MHz
 - ✓ 8-channel DMA
- Memory:
 - ✓ 4MB NOR flash on chip
 - ✓ 272KB on-wafer SRAM, divided into 256KB and 16KB
 - ✓ 16KB instruction cache
- System:
 - ✓ Flexible configuration supports 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 Ports
 - ✓ 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 value 110uA
- ✓ RX: typical value 10mA
- ✓ TX: typical value 24mA
- 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
- Security:
 - ✓ 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 mainstream 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

List Main parameter description

Model	EC-01F
Package	SMD-44
Size	17.7*15.8*2.8(±0.2)MM
Antenna	External antenna
Frequency range	Band3,Band5,Band8
Operating temperature	-40°C~85°C
Storage environment	-40°C~125°C,<90%RH
Power supply range	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-01F module is an electrostatic sensitive device, and special precautions must be taken when handling it.



Figure ESD Anti-static

2. 2. Electrical characteristics

Table 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 NB RF performance table

Band	Channel	1 Tone@11(15KHz)				12 Tone(15KHz)			
		Pout (dBm)	EVMR MS (%)	SEMMa rgin(dB)	ACLRM ax (dBc)	Pout (dBm)	EVMR MS(%)	SEMMar gin(dB)	ACLRM ax (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 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

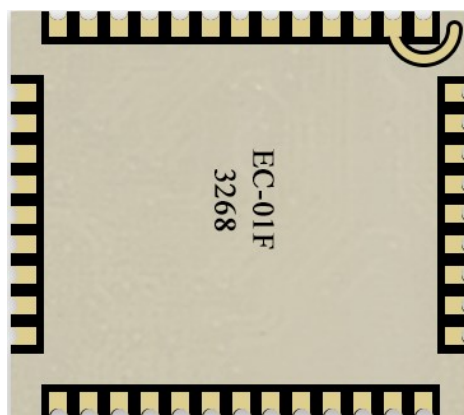


Figure 3
EC-01F
appearan
ce (The
picture
and silk

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

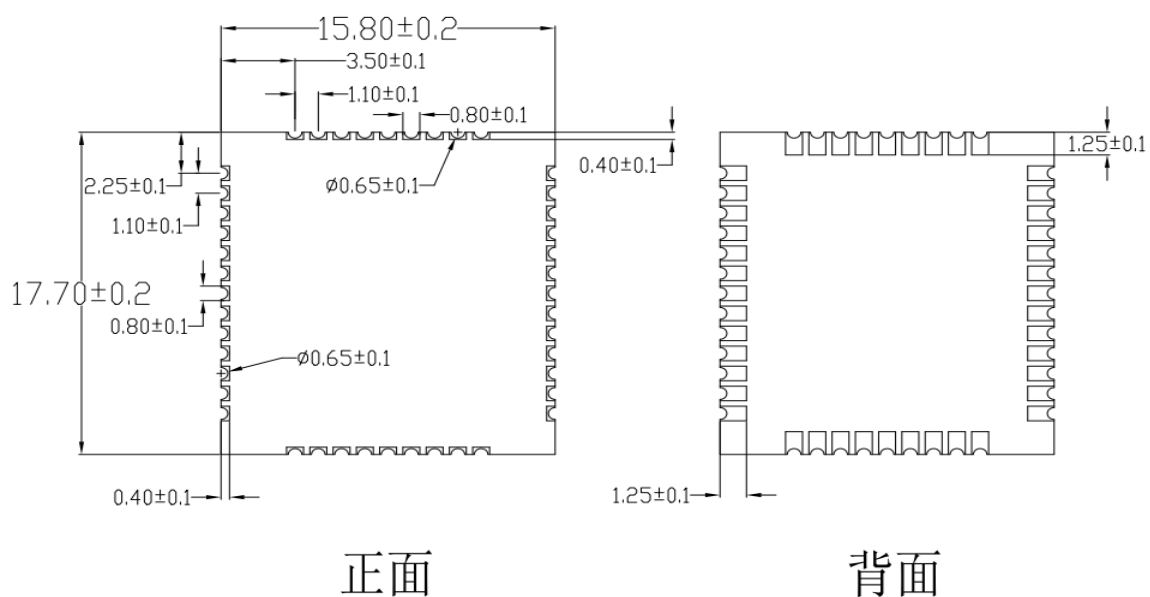


Figure 4 module dimensions

4. PIN definition

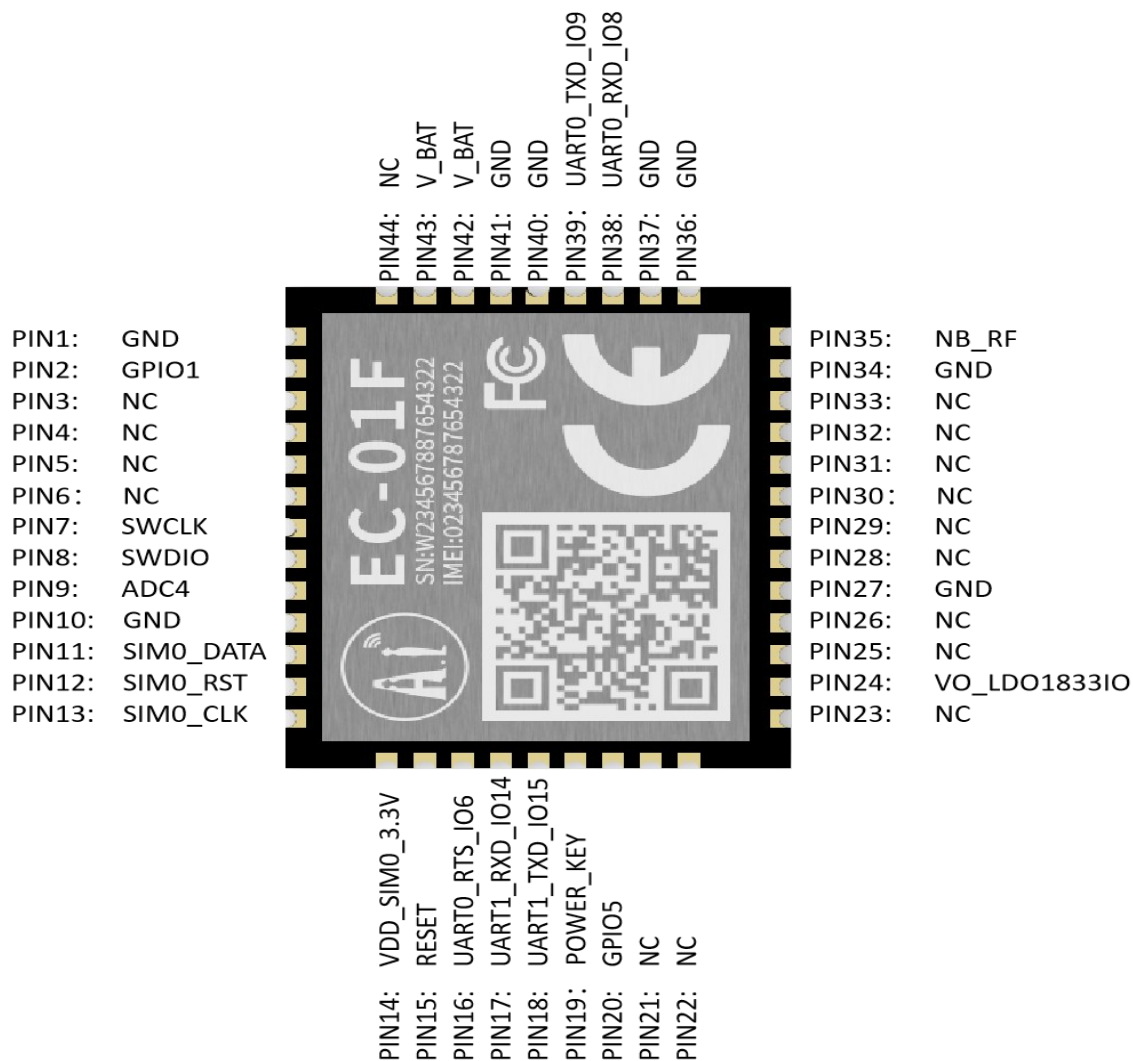


Figure 5 EC-01F Pin diagram(The picture and silk screen are for reference only, the actual product shall prevail)

The EC-01F module has 44 interfaces. As shown in the pin diagram, the pin function definition table is the interface definition.

Table 5 Pin function definition table

Pin No.	Name	Function description
1	GND	Ground
2	GPIO1	GPIO1
3-6	NC	Not connected
7	SWCLK	SWCLK/Serial Wire Debug Clock
8	SWDIO	SWDIO/Serial Wire Debug Data
9	ADC4	AIO4/ADC Channel
10	GND	Ground
11	SIM0_DATA	USIM_UIO/SIM Card IO
12	SIM0_RST	USIM_URSTn/SIM Card reset
13	SIM0_CLK	USIM_UCLK/SIM Card clock
14	VDD_SIM0_3.3V	VO_LDOSIM/Output of LDO_SIM,1.8V/3.3V
15	RESET	RESETn
16	UART0_RTS_IO6	GPIO6/UART0_RSTn
17	UART1_RXD_IO14	GPIO14/UART1_RXD
18	UART1_TXD_IO15	GPIO15/UART1_TXD
19	POWER_KEY	WAKEUP
20	GPIO5	GPIO5
21-23	NC	Not connected
24	VO_LDO_1833IO	VO_LDO_33IO
25-26	NC	Not connected

27	GND	Ground
28-33	NC	Not connected
34	GND	Ground
35	NB_RF	NB RF Front-end
36-37	GND	Ground
38	UART0_RXD_IO8	GPIO8/UART0_RXD
39	UART0_TXD_IO9	GPIO9/UART0_TXD
40-41	GND	Ground
42-43	V_BAT	Power input
44	NC	Not connected

5. Schematic diagram

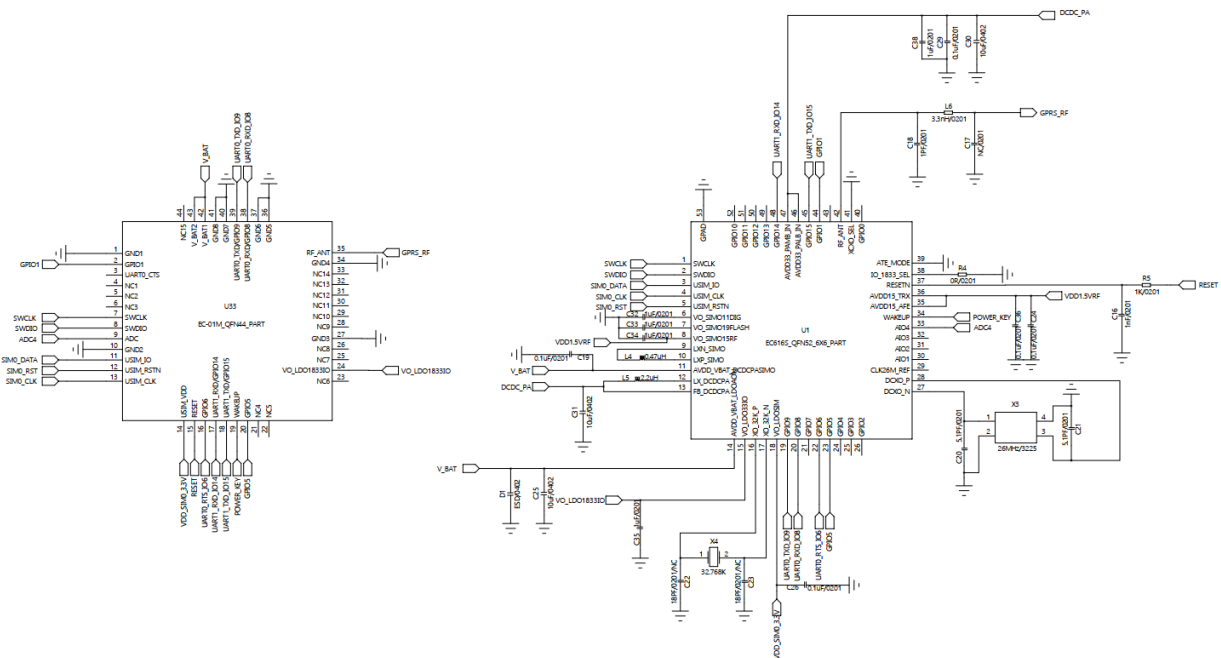


Figure 6 Module schematic

6. Design guidance

6. 1. Application circuit

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

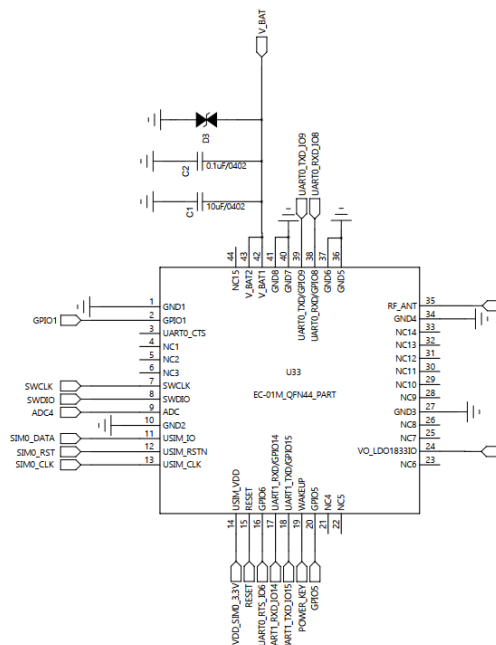


Figure 7 Application circuit schematic

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.

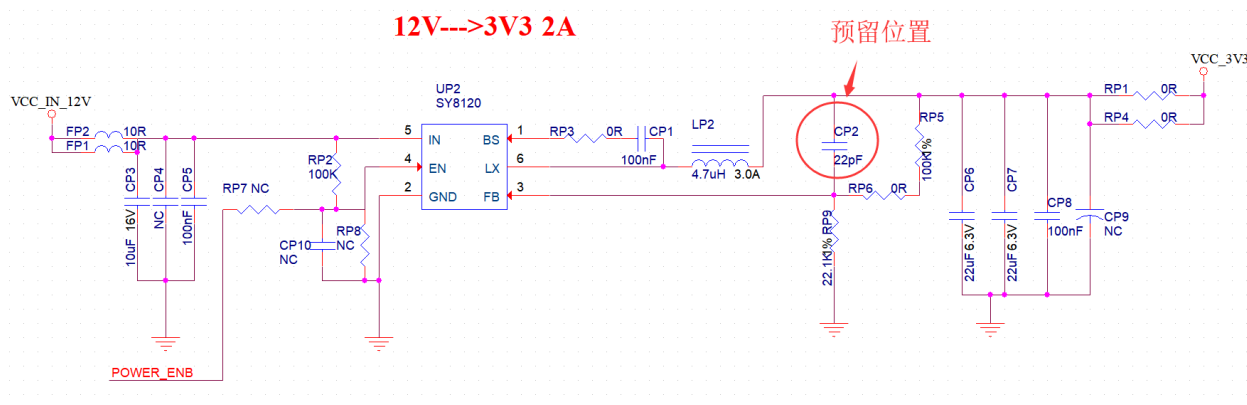


Figure 8 Recommended power supply circuit

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

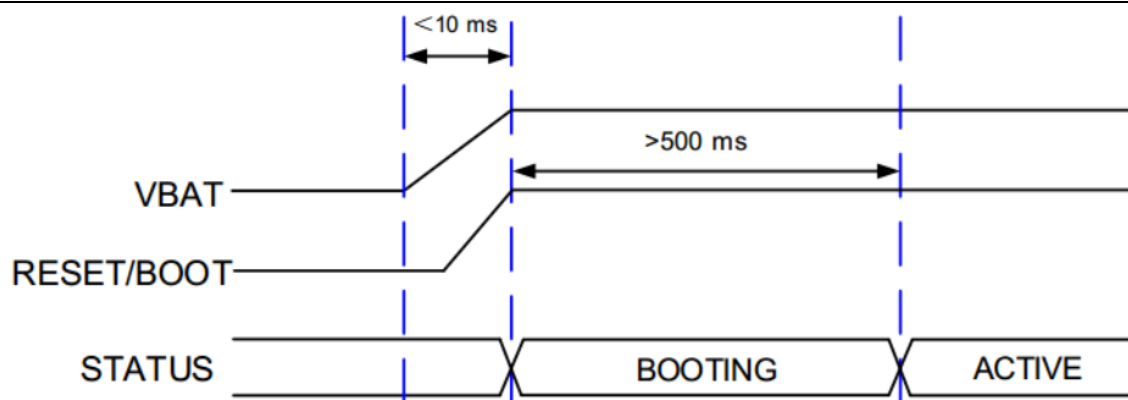


Figure 9 NB chip power on electric timing diagram

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).

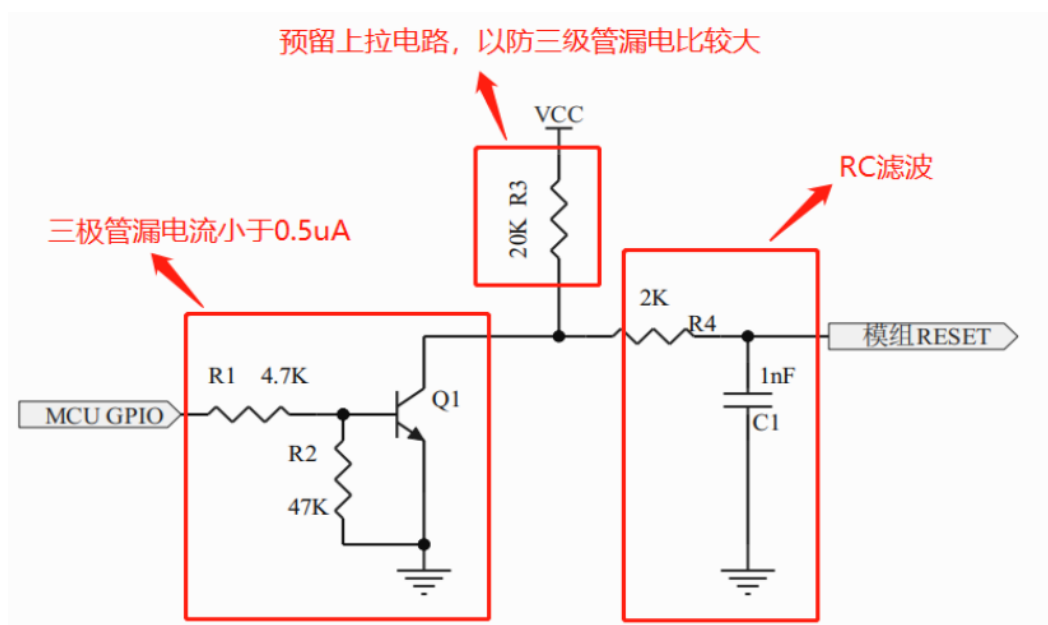


Figure 10 The Reset pin reference circuit

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.

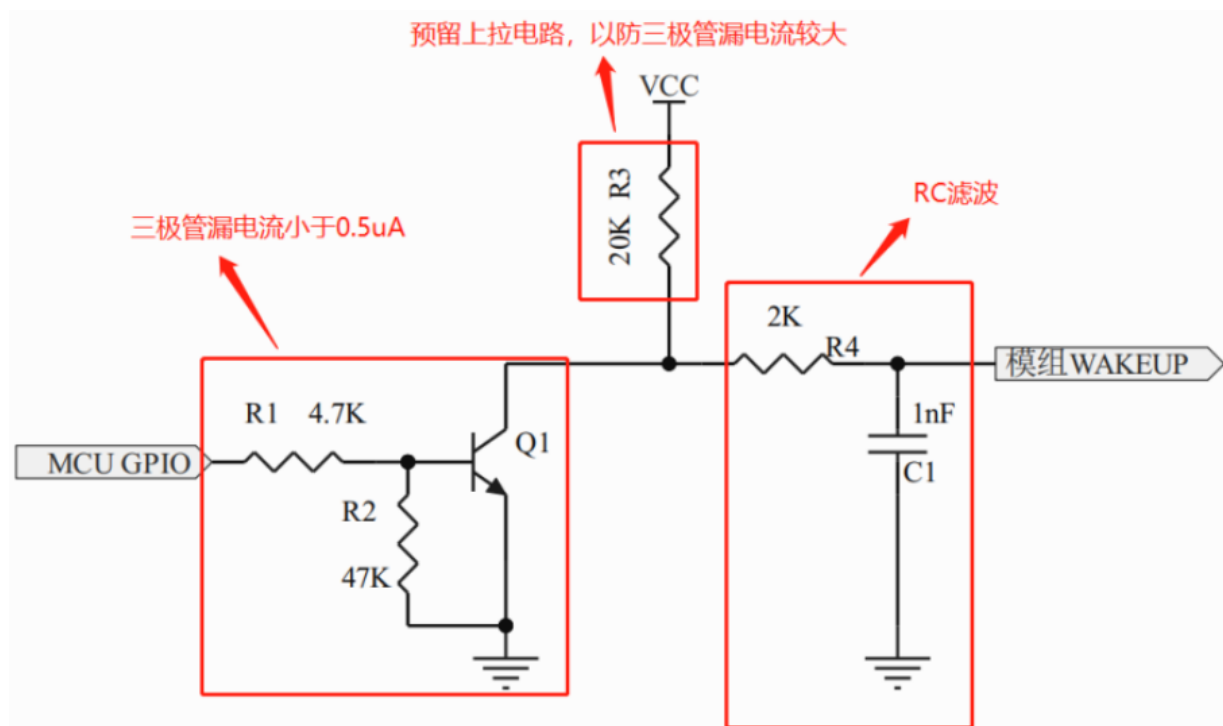


Figure 11 The WAKEUP pin reference circuit

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 12.

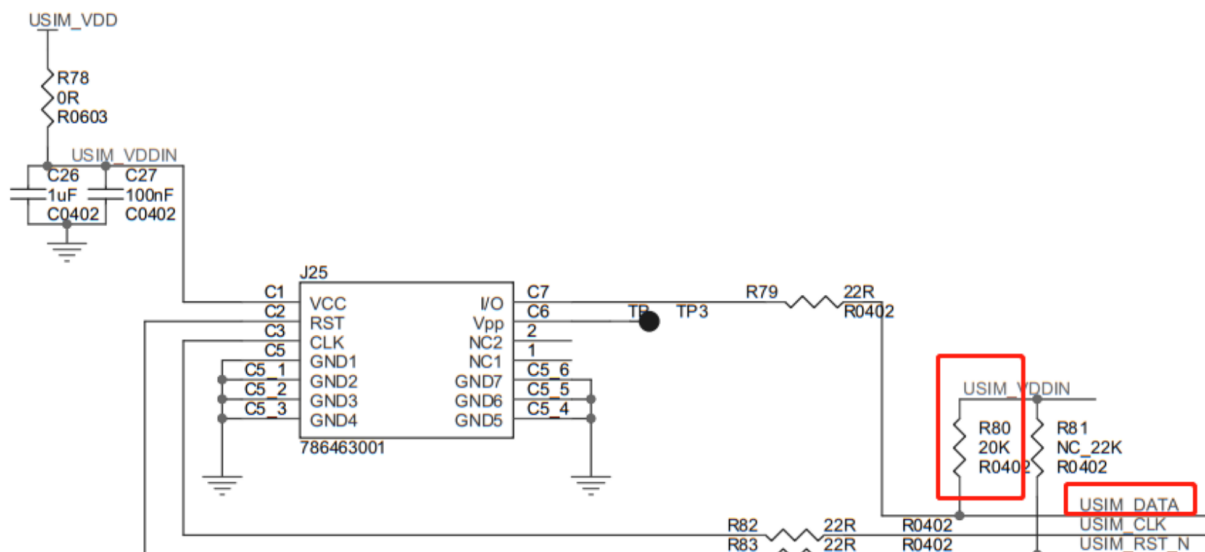


Figure 12 The SIM card reference circuit

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.

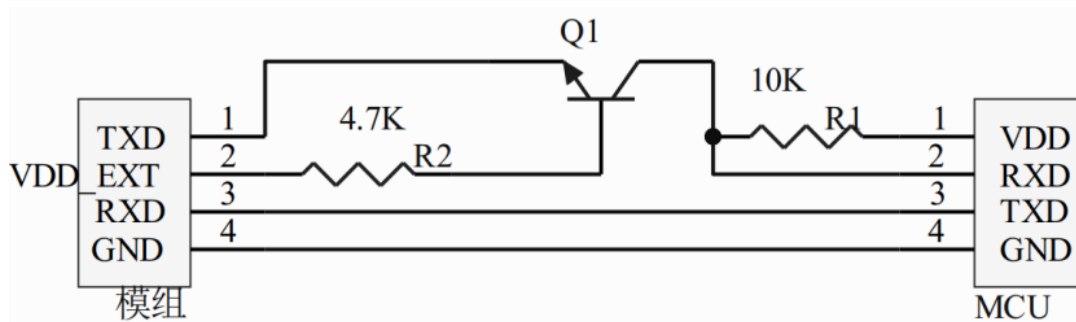


Figure 13 Serial port level conversion reference circuit

7. Reflow soldering curve

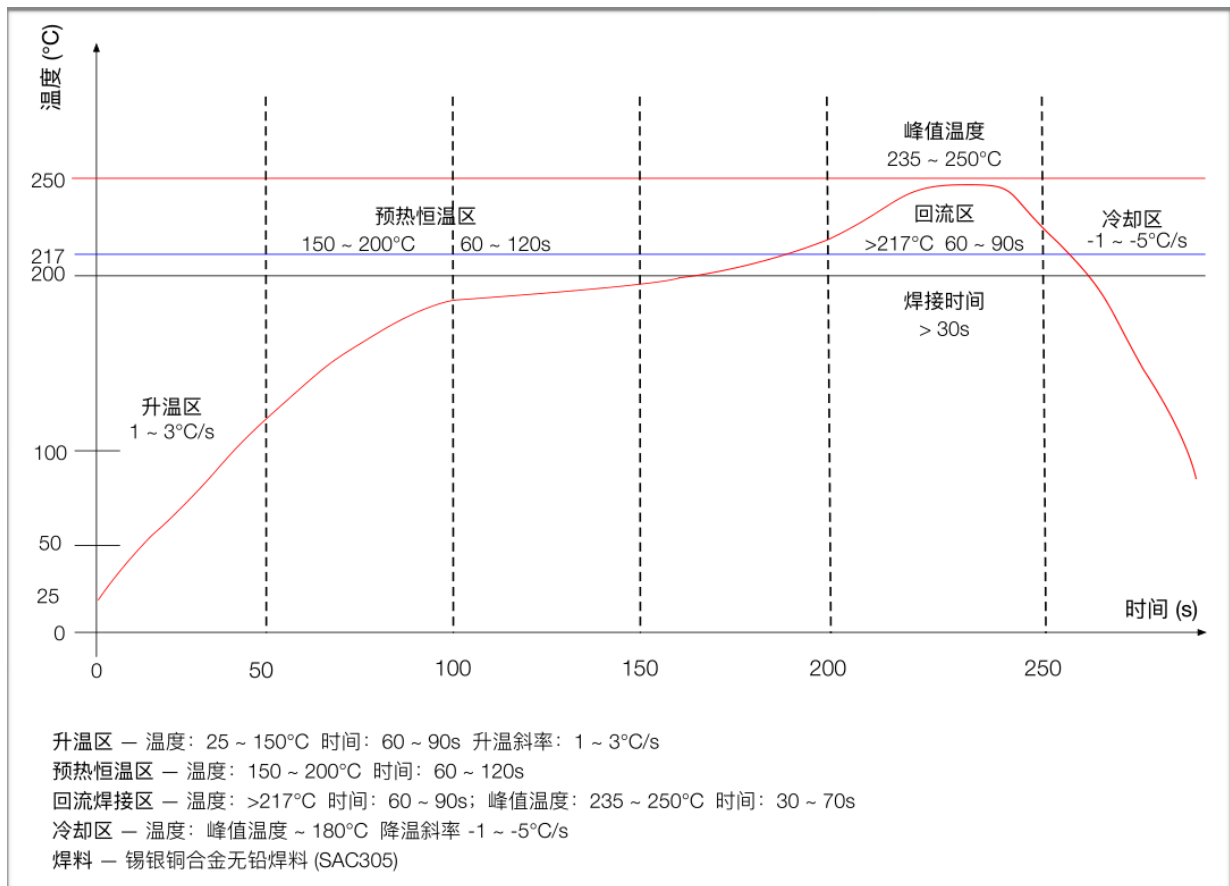


Figure 14 Reflow soldering curve

8. Packaging

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



Figure 15 Tape package

9. Contact us

[Ai-Thinker official website](#)

[Office forum](#)

[Develop DOCS](#)

[LinkedIn](#)

[Tmall shop](#)

[Taobao shop](#)

[Alibaba shop](#)

[Technical support email: support@aithinker.com](#)

[Domestic business cooperation: sales@aithinker.com](#)

[Overseas business cooperation: overseas@aithinker.com](#)

Company Address: Room 403,408-410, Block C, Huafeng Smart Innovation Port, Gushu 2nd Road, Xixiang, Baoan District, Shenzhen.

Tel: +86-0755-29162996



Wechat mini program



Wechat official account

Disclaimer and copyright notice

The information in this article, including the URL address for reference, is subject to change without notice.

The document is provided "as is" without any guarantee responsibility, including any guarantee for merchantability, suitability for a specific purpose, or non-infringement, and any guarantee mentioned elsewhere in any proposal, specification or sample. This document does not bear any responsibility, including the responsibility for infringement of any patent rights arising from the use of the information in this document. This document does not grant any license for the use of intellectual property rights in estoppel or other ways, whether express or implied.

The test data obtained in the article are all obtained from Ai-Thinker's laboratory tests, and the actual results may vary slightly.

All brand names, trademarks and registered trademarks mentioned in this article are the property of their respective owners, and it is hereby declared.

The final interpretation right belongs to Shenzhen Ai-Thinker Technology Co., Ltd.

Notice

Due to product version upgrades or other reasons, the contents of this manual may be changed.

Shenzhen Ai-Thinker Technology Co., Ltd. reserves the right to modify the contents of this manual without any notice or prompt.

This manual is only used as a guide. Shenzhen Ai-Thinker Technology Co., Ltd. makes every effort to provide accurate information in this manual. However, Shenzhen Ai-Thinker Technology Co., Ltd. does not guarantee that the contents of the manual are completely free of errors. All statements and information in this manual And the suggestion does not constitute any express or implied guarantee.