EC-01F Specification

Version V1.0
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Formulation / Revision / Abolition of CV

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

CONTENT

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).

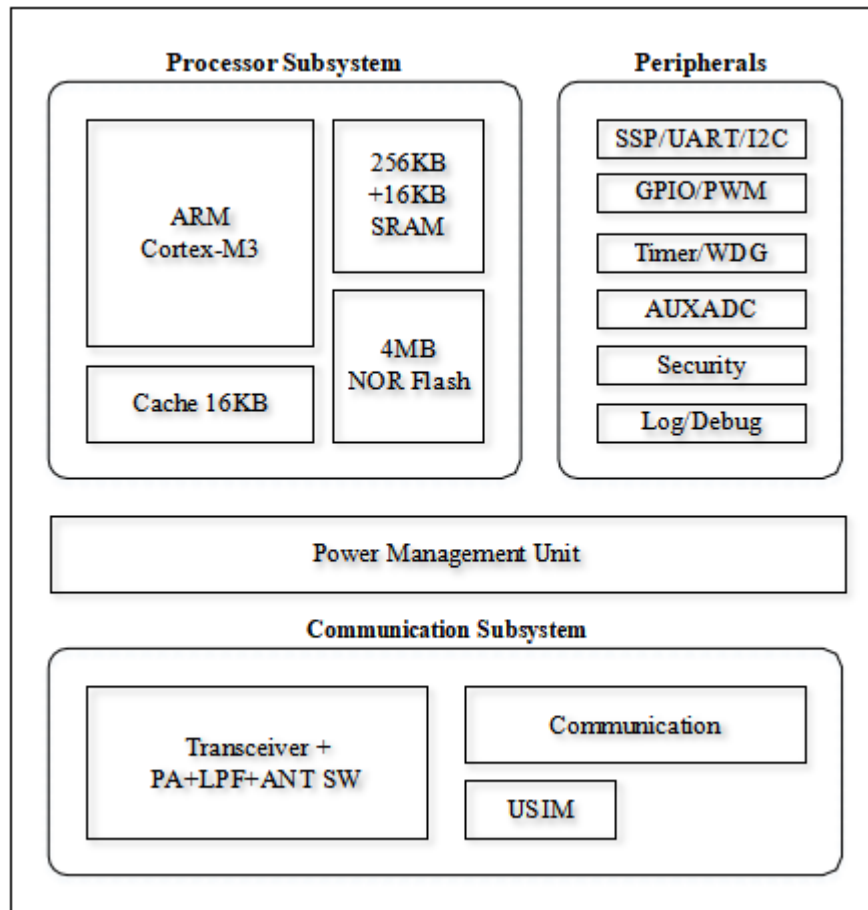■ Unique MCU mode, providing lower working current and shorter wake-up time.

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

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- ✓ 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 个 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 value 110uA

- ✓ RX: typical value10mA

- ✓ 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

- ■ 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 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
Side	17.7*15.8*2.8(±0.2)MM
Antenna	External antenna
Spectrum range	Band3,Band5,Band8
Operating temperature	-40□~85□
Storage environment	-40□~125□,<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
Safety	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.。

<div align="center">Fifure   **ESD Anti-static**</div>

2.2. **Electrical characteristics**

<div align="center">**List   electrical characteristics table**</div>

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**

<div align="center">**List   NB RF performance table**</div>

Band	Channel	1 Tone@11(15KHz)				12 Tone(15KHz)			
		Pout (dBm)	EVMRMS (%)	SEMMargin(dB)	ACLRMax (dBc)	Pout (dBm)	EVMRMS(%)	SEMMargin(dB)	ACLRMax (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

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	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.

List   power consumption table

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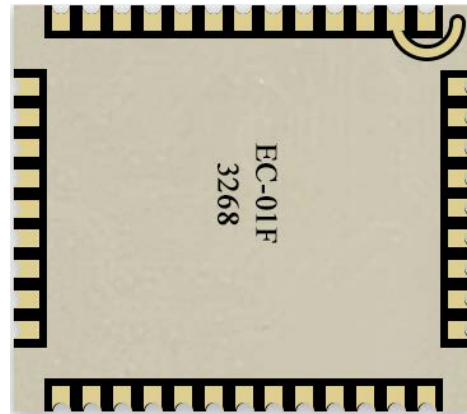
Figure 3 EC-01F appearance (The picture and silk screen are for reference only, the actual product shall prevail)

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

正面   背面
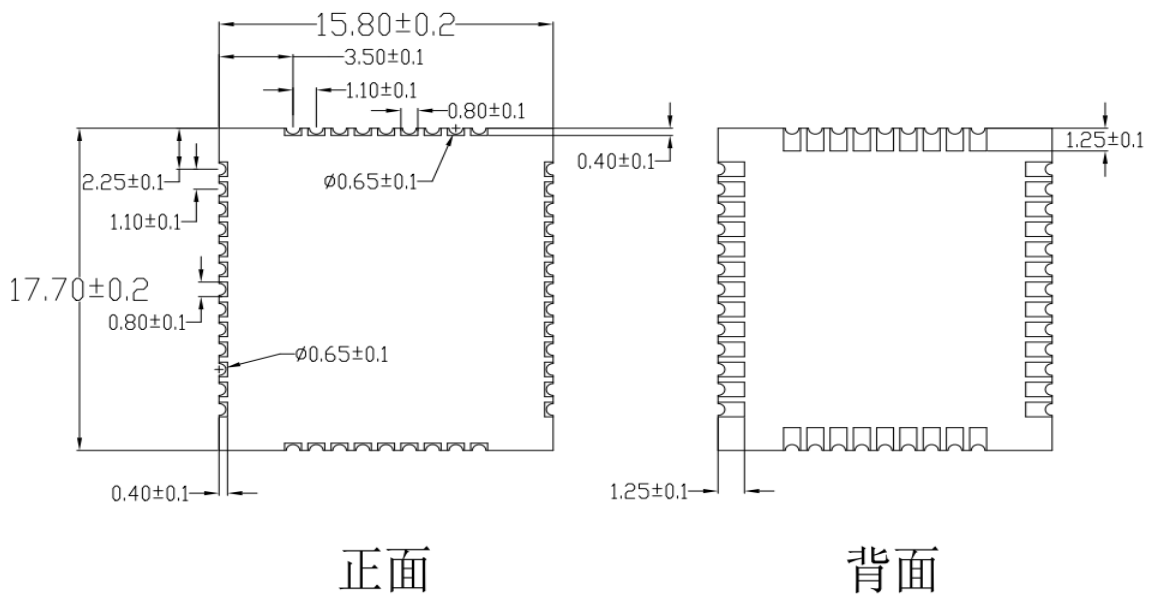
Figure 4 Module size chart

4. PIN definition
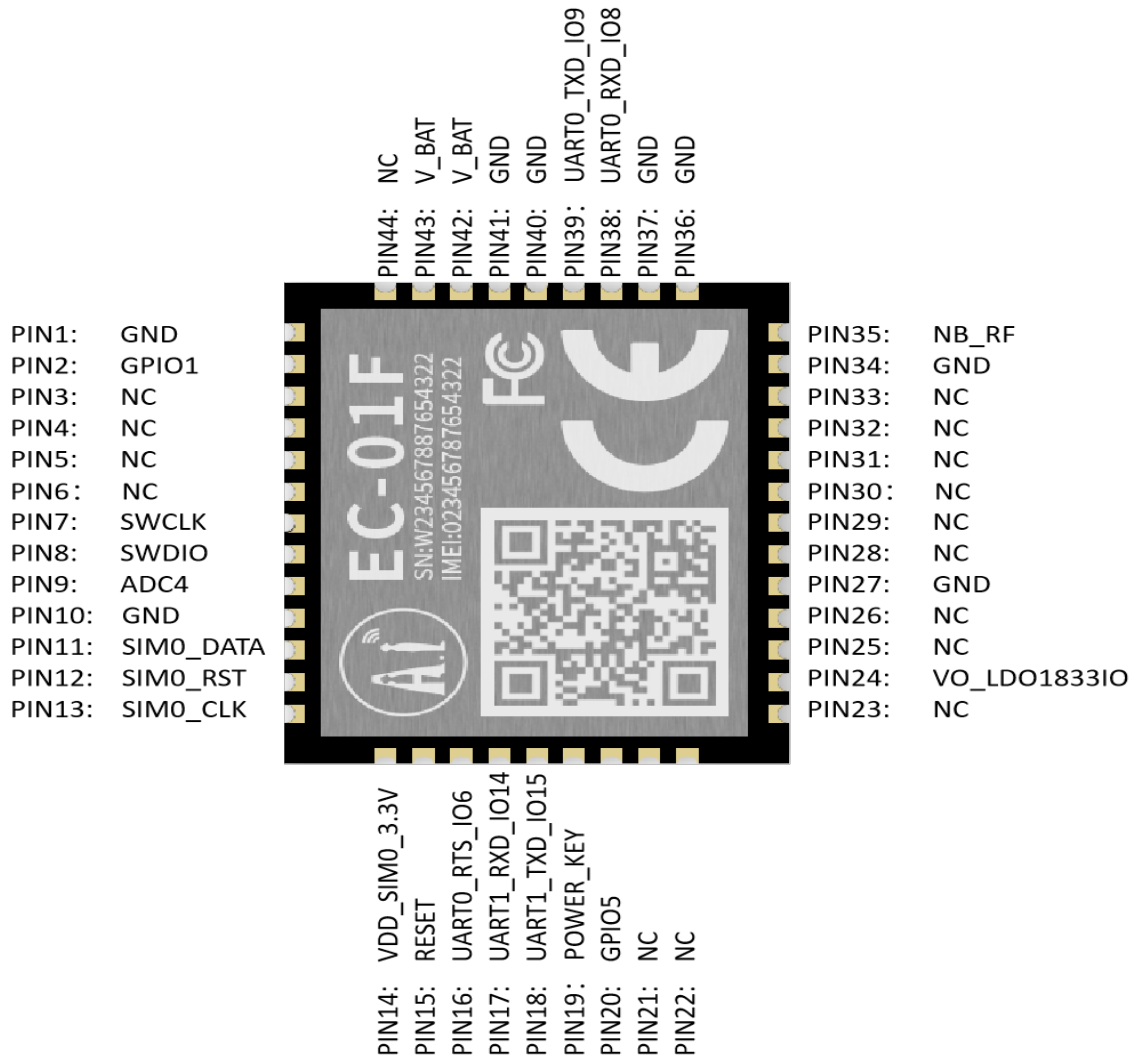
Figure 5 EC-01F Pin diagram(The picture and silk screen are for reference only,

the actual product shall prevail)

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

List 5 Pin function definition table

No.	Name	Function description
1	GND	Grounded

27	GND	Grounded
28-33	NC	Empty
34	GND	Grounded
35	NB_RF	NB RF port
36-37	GND	Grounded
38	UART0_RXD_IO8	GPIO8/UART0_RXD
39	UART0_TXD_IO9	GPIO9/UART0_TXD
40-41	GND	Grounded
42-43	V_BAT	Power input
44	NC	Empty

5. Schematic diagram
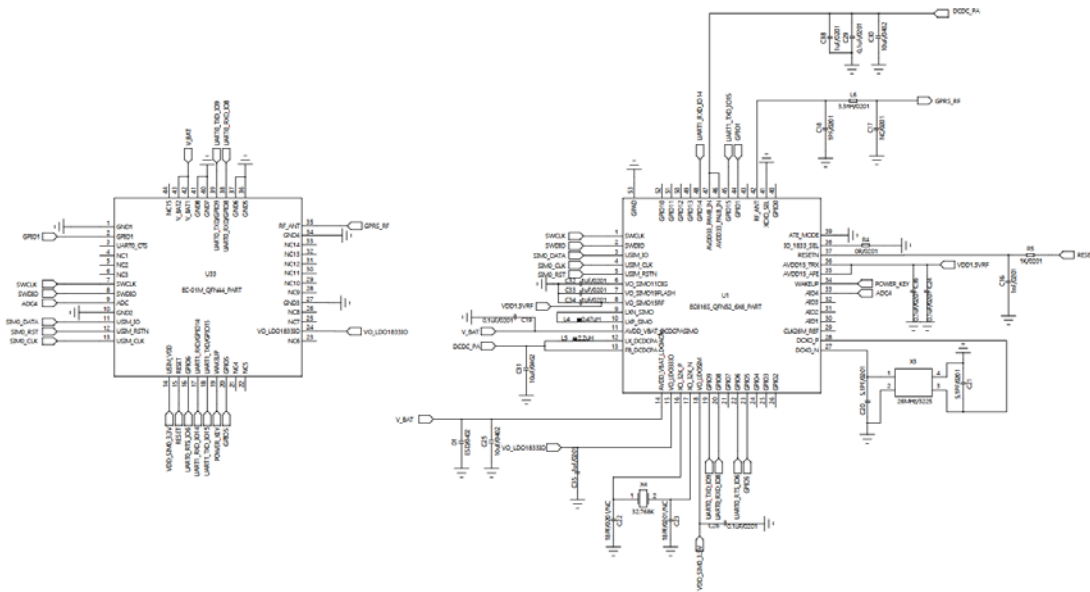
Figure 6 Module schematic

6. Design guide

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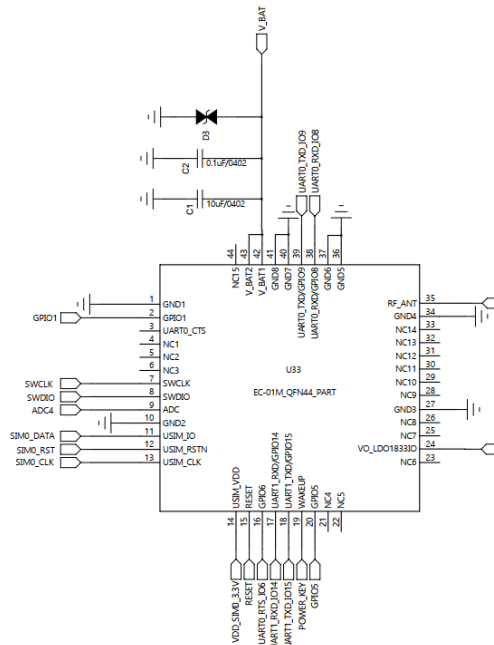
It is recommended to add an anti-static protection IC to the power input.

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.
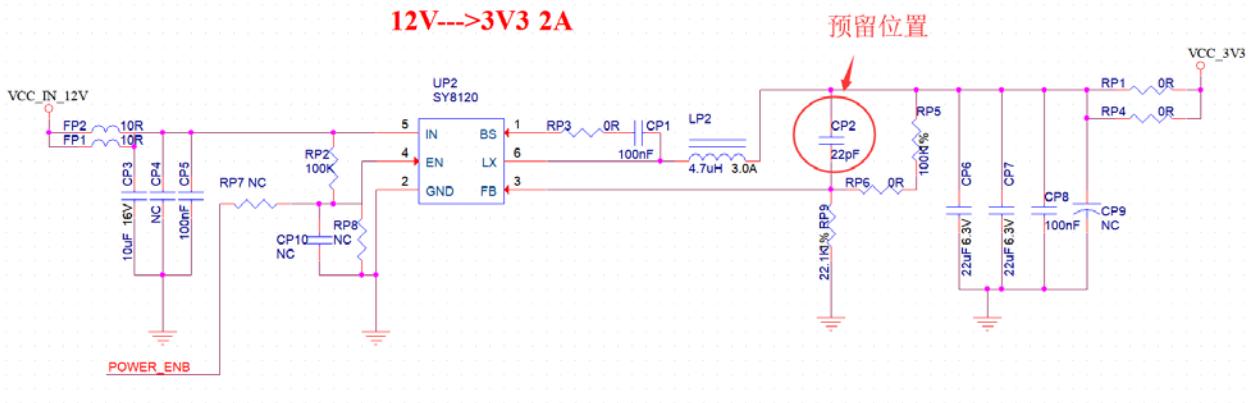
Figure 8 Recommended power supply circuit
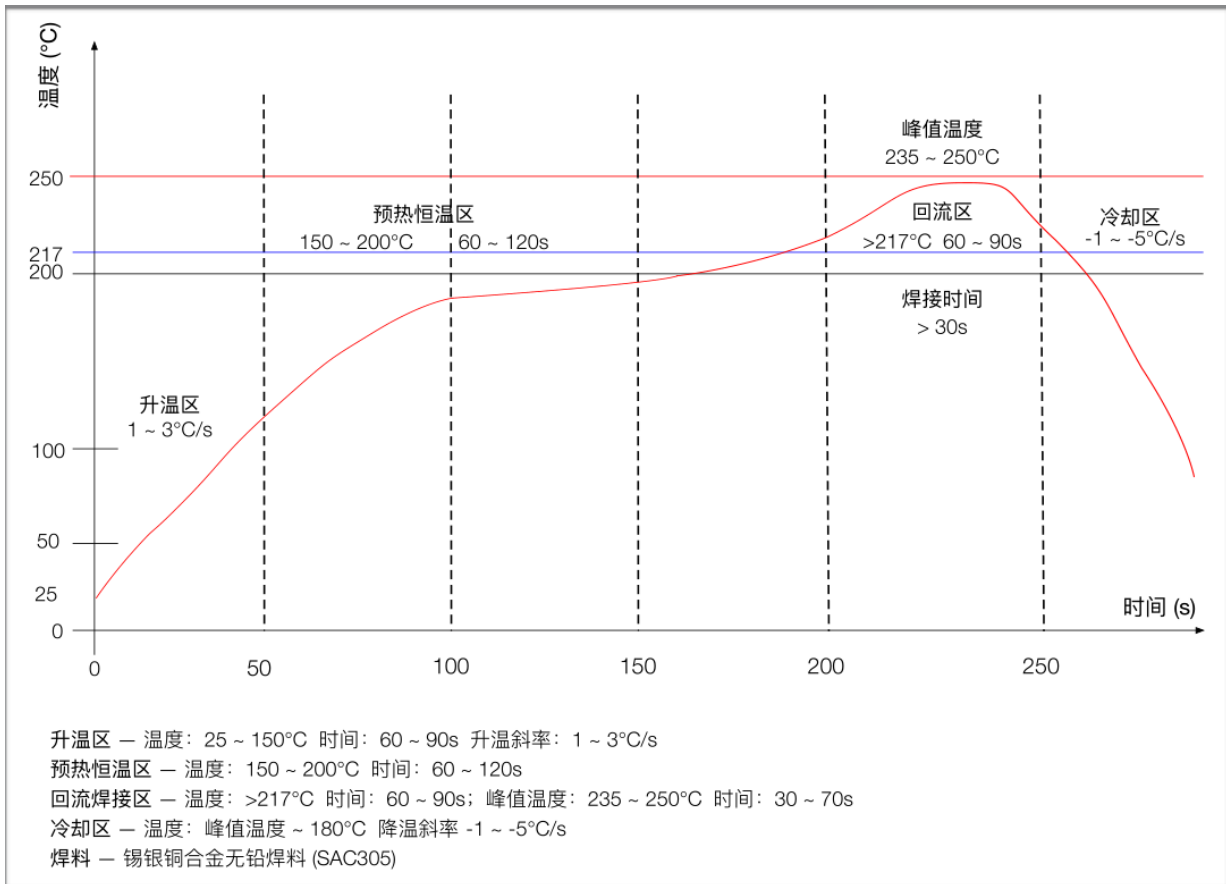
7. Reflow soldering curve

升温区 — 温度：25 ~ 150°C 时间：60 ~ 90s 升温斜率：1 ~ 3°C/s
预热恒温区 — 温度：150 ~ 200°C 时间：60 ~ 120s
回流焊接区 — 温度：>217°C 时间：60 ~ 90s；峰值温度：235 ~ 250°C 时间：30 ~ 70s
冷却区 — 温度：峰值温度 ~ 180°C 降温斜率 -1 ~ -5°C/s
焊料 — 锡银铜合金无铅焊料 (SAC305)

Figure 9 reflow soldering curve

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8. Packaging

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

Figure 10 tape package

9. Contact us

Website：https://www.ai-thinker.com

Development DOCS：https://docs.ai-thinker.com

Forum：http://bbs.ai-thinker.com

Sample order：https://ai-thinker.en.alibaba.com/

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Gushu, Xixiang, Baoan District, Shenzhen China 518126

Tel：0755-29162996

antenna or transmitter.

The availability of some specific channels and/or operational frequency bands are country dependent and are firmware programmed at the factory to match the intended destination.

The firmware setting is not accessible by the end user.

The final end product must be labelled in a visible area with the following:

"Contains Transmitter Module 2ATPO-EC-01"

Requirement per KDB996369 D03

2.2 List of applicable FCC rules

List the FCC rules that are applicable to the modular transmitter. These are the rules that specifically establish the bands of operation, the power, spurious emissions, and operating fundamental frequencies. DO NOT list compliance to unintentional-radiator rules (Part 15 Subpart B) since that is not a condition of a module grant that is extended to a host manufacturer. See also Section 2.10 below concerning the need to notify host manufacturers that further testing is required.3

Explanation: This module meets the requirements of FCC part 15C (15.247).it Specifically identified Conducted output power, Effective Radiated Power of Transmitter(EIRP), peak-to-average ratio, 99% & 26dB Occupied Bandwidth, Band Edge at antenna terminals, Spurious emissions at antenna terminals, Field strength of spurious radiation, Frequency stability.

2.3 Summarize the specific operational use conditions

Describe use conditions that are applicable to the modular transmitter, including for example any limits on antennas, etc. For example, if point-to-point antennas are used that require reduction in power or compensation for cable loss, then this information must be in the instructions. If the use condition limitations extend to professional users, then instructions must state that this information also extends to the host manufacturer's instruction manual. In addition, certain information may also be needed, such as peak gain per frequency band and minimum gain, specifically for master devices in 5 GHz DFS bands.

Explanation: The gain of each antenna is no more than 1 dBi.

2.4 Limited module procedures

If a modular transmitter is approved as a "limited module," then the module manufacturer isresponsible for approving the host environment that the limited module is used with. The manufacturer of a limited module must describe, both in the filing and in the installation instructions, the alternative means that the limited module manufacturer uses to verify that the host meets the necessary requirements to satisfy the module limiting conditions.

A limited module manufacturer has the flexibility to define its alternative method to address the conditions that limit the initial approval, such as: shielding, minimum signaling amplitude, buffered modulation/data inputs, or power supply regulation. The alternative method could include that the limited

module manufacturer reviews detailed test data or host designs prior to giving the host manufacturer approval.

This limited module procedure is also applicable for RF exposure evaluation when it is necessary to demonstrate compliance in a specific host. The module manufacturer must state how control of the product into which the modular transmitter will be installed will be maintained such that full compliance of the product is always ensured. For additional hosts other than the specific host originally granted with a limited

module, a Class II permissive change is required on the module grant to register the additional host as a specific host also approved with the module.

Explanation: The module is a single module.

2.6 RF exposure considerations

It is essential for module grantees to clearly and explicitly state the RF exposure conditions that permit a host product manufacturer to use the module. Two types of instructions are required for RF exposure information: (1) to the host product manufacturer, to define the application conditions (mobile, portable – xx cm from a person's body); and (2) additional text needed for the host product manufacturer to provide to end users in their end-product manuals. If RF exposure statements and use conditions are not provided, then the host product manufacturer is required to take responsibility of the module through a change in FCC ID (new application).

Explanation: This module complies with FCC RF radiation exposure limits set forth for an uncontrolled environment, This equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body." This module is designed to comply with the FCC statement, FCC ID is: 2ATPO-EC-01

2.7 Antennas

A list of antennas included in the application for certification must be provided in the instructions. For modular transmitters approved as limited modules, all applicable professional installer instructions must be included as part of the information to the host product manufacturer. The antenna list shall also identify the antenna types (monopole, PIFA, dipole, etc. (note that for example an "omni-directional antenna" is not considered to be a specific "antenna type")).

For situations where the host product manufacturer is responsible for an external connector, for example with an RF pin and antenna trace design, the integration instructions shall inform the installer that unique antenna connector must be used on the Part 15 authorized transmitters used in the host product.

The module manufacturers shall provide a list of acceptable unique connectors.

Explanation: The gain of each antenna is no more than 1 dBi.

2.8 Label and compliance information

Grantees are responsible for the continued compliance of their modules to the FCC rules. This

includes advising host product manufacturers that they need to provide a physical or e-label stating "Contains FCC ID" with their finished product. See Guidelines for Labeling and User Information for RF Devices – KDB Publication 784748.

Explanation: The host system using this module, should have label in a visible area indicated the following texts: "Contains FCC ID: 2ATPO-EC-01.

2.9 Information on test modes and additional testing requirements5

Additional guidance for testing host products is given in KDB Publication 996369 D04 Module Integration Guide. Test modes should take into consideration different operational conditions for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product.

The grantee should provide information on how to configure test modes for host product evaluation for different operational conditions for a stand-alone modular transmitter in a host, versus with multiple, simultaneously transmitting modules or other transmitters in a host.

Grantees can increase the utility of their modular transmitters by providing special means, modes, or instructions that simulates or characterizes a connection by enabling a transmitter. This can greatly simplify a host manufacturer's determination that a module as installed in a host complies with FCC requirements.

Explanation: Shenzhen Ai-Thinker Technology Co., Ltd. can increase the utility of our modular transmitters by providing instructions that simulates or characterizes a connection by enabling a transmitter.

2.10 Additional testing, Part 15 Subpart B disclaimer

The grantee should include a statement that the modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product

as being Part 15
Subpart B compliant (when it also contains unintentional-radiator digital circuity), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

Explanation: The module without unintentional-radiator digital circuity, so the module does not require an evaluation by FCC Part 15 Subpart B. The host shoule be evaluated by the FCC Subpart B.