Ai-WB1-12F Specification

Version V1.1.0

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Document resume

Version	Date	Develop/revise content	Edition	Approve
V1.1.0	2022.6.20	First Edition	ChaoMei Deng	Ning Guan

Content

1. Product Overview

Ai-WB1-12F is a Wi-Fi&Bluetooth module developed by Shenzhen Ai-Thinker Technology Co., Ltd. The module is equipped with W800 chip as the core processor, supports Wi-Fi 802.11b/g/n protocol, and supports BT/BLE Dual-mode working mode, support BT/BLE4.2 protocol. W800 chip has built-in low-power 32-bit XT804 CPU, operating frequency 240MHz, built-in 2MB Flash, 288KB RAM and rich peripheral interfaces, including SDIO, PSRAM, SPI, UART, I2C, PWM, ADC, Touch sensor, Duplex I2S and GPIO Wait. It can be widely used in the Internet of Things (IoT), mobile devices, wearable electronic devices, smart home and other fields.
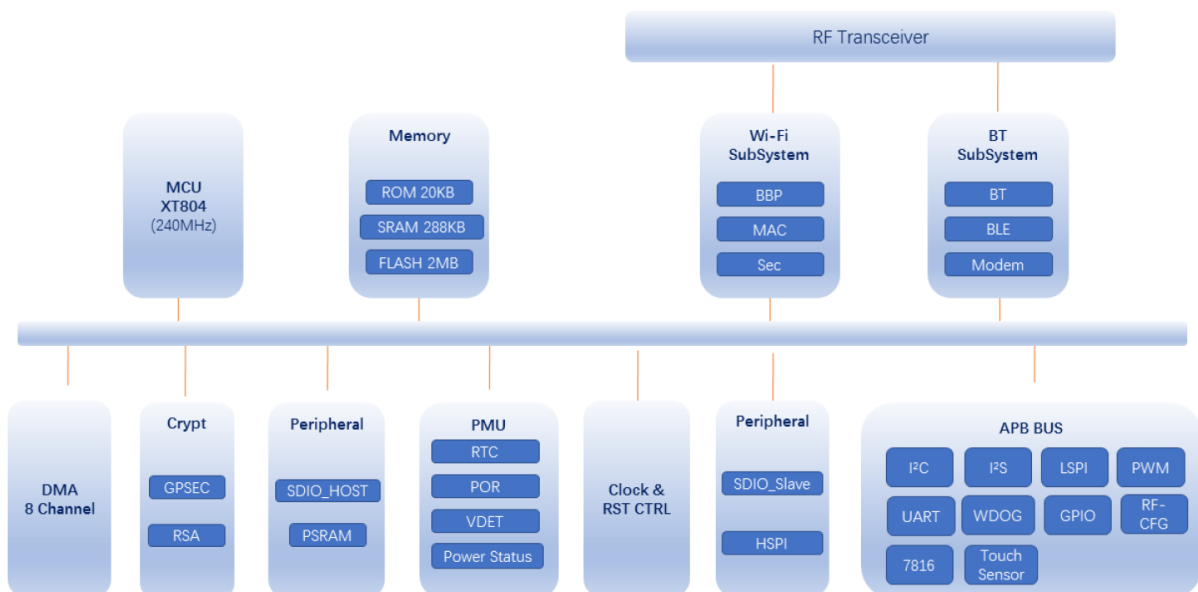
Figure 1 Main chip architecture diagram

1.1. Characteristic

■ The package is SMD-22

■ Support IEEE 802.11 b/g/n protocol

■ Wi-Fi Security Support Wi-Fi WMM/WMM-PS/WPA/WPA2 /WPS

■ Support 20/40MHz bandwidth, the highest rate is 150 Mbps

■ Support BT/BLE dual-mode working mode, support BT/BLE4.2 protocol

■ Support Station 、 Station＋SoftAP 、 SoftAP mode

■ Support 32-bit XT804 CPU，288KB RAM

■ The MCU has a built-in Tee security engine, and the code can distinguish between security events and non-security events

■ Integrated SASC/TIPC, memory and internal modules/interfaces can be configured with security attributes to prevent non-secure code access

■ Enable firmware signature mechanism for secure boot/upgrade

■ With firmware encryption function to enhance code security

■ Firmware encryption keys are distributed using asymmetric algorithms for enhanced key security

■ Hardware encryption module: RC4256, AES128, DES/3DES, SHA1/MD5, CRC32, 2048RSA, true random number generator

■ Support SDIO，PSRAM，SPI，UART，I2C，PWM，ADC，Touch senser，Duplex I2S and GPIO

■ Integrated Wi-Fi MAC/BB/RF/PA/LNA/Bluetooth

■ Support a variety of sleep modes, standby power consumption current 10μA

■ Universal AT instruction for quick start

■ Support secondary development, integrated Windows, Linux development environment

2. Main parameters

Table 1 Description of the main parameters

Model	Ai-WB1-12F
Package	SMD-22
Size	24.0*16.0*3.1(±0.2)mm
Antenna	on-board PCB antenna
Frequency	2400 ~ 2483.5MHz
Operating temperature	-40℃ ~ 85℃
Storage temperature	-40℃ ~ 125℃, < 90%RH
Power supply	Support voltage 3.0V ~ 3.6V，supply current ≥500mA
Interface	UART/GPIO/ADC/PWM/I2C/SPI/Touch senser/PSRAM/SDIO/Duplex I2S
IO	18
UART rate	Default 115200 bps
Security	Wi-Fi WMM/WMM-PS/WPA/WPA2 /WPS
Flash	Default 2MByte

2.1. Static electricity requirement

Ai-WB1-12F is an electrostatic sensitive device. Therefore, you need to take special precautions when carrying it.

Figure 2 ESD preventive measures

2.2. Electrical characteristics

Table 2 Electrical characteristics table

Parameters		Condition	Min.	Typical value	Max.	Unit
Voltage Supply		VDD	3.0	3.3	3.6	V
I/O	VIL	-	0.3	-	0.8	V
	VIH	-	2.0	-	VDD+0.3	V
	VOL	-	-		0.4	V
	VOH	-	2.4		-	V
	IMAX	-	-	-	24	mA

2.3. Wi-Fi RF Performance

Table 3 Wi-Fi RF performance table

Description	Typical value			Unit
Frequency range	2400 ~ 2483.5MHz			MHz
Output Power				
Mode	Min.	Typical	Max.	Unit
11n Mode HT20，PA output power	-	12	-	dBm
11g Mode, PA output power	-	13	-	dBm
11b Mode, PA output power	-	18	-	dBm
Receive Sensitivity				
Mode	Min.	Typical	Max.	Unit
11b，1 Mbps	-	-95	-	dBm
11b，11 Mbps	-	-85	-	dBm
11g，6 Mbps	-	-89	-	dBm
11g，54 Mbps	-	-72	-	dBm
11n，HT20 (MCS7)	-	-69	-	dBm

2.4. BLE RF Performance

Table 4 BLE RF performance table

Description	Typical value			Unit
Frequency range	2400 ~ 2483.5MHz			MHz
Output Power				
Rate Mode	**Min.**	**Typical**	**Max.**	**Unit**
1Mbps	-	4	6	dBm
Receive Sensitivity				
Rate Mode	**Min.**	**Typical**	**Max.**	**Unit**
1Mbps sensitivity@30.8%PER	-	-92	-	dBm

2.5. Power

The following power consumption figures are based on a 3.3V supply, 25°C ambient temperature, and are measured using the internal voltage regulator.

■ All measurements are made at the antenna interface with filters

■ All transmit data is based on 100% duty cycle, measured in continuous transmit mode.

Table 5 Power consumption

Mode	Min.	AVG	Max.	Unit
Tx 802.11b，11Mbps，POUT=+19dBm	-	348	-	mA
Tx 802.11g，54Mbps，POUT =+15dBm	-	190	-	mA
Tx 802.11n，MCS7，POUT =+12dBm	-	190	-	mA
Rx 802.11b，packet length 1024 byte	-	96	-	mA
Rx 802.11g，packet length 1024 byte	-	96	-	mA
Rx 802.11n，packet length 1024 byte SRAM retention	-	96	-	mA
Deep-Sleep	-	10	-	µA

3. Appearance Dimensions
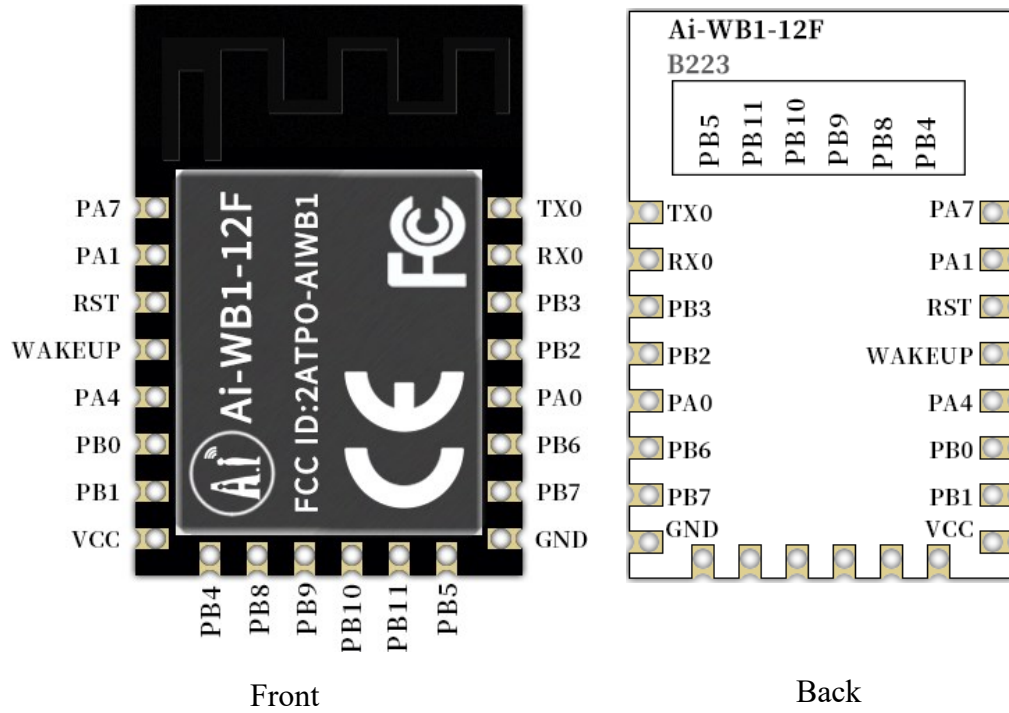

Front   Back
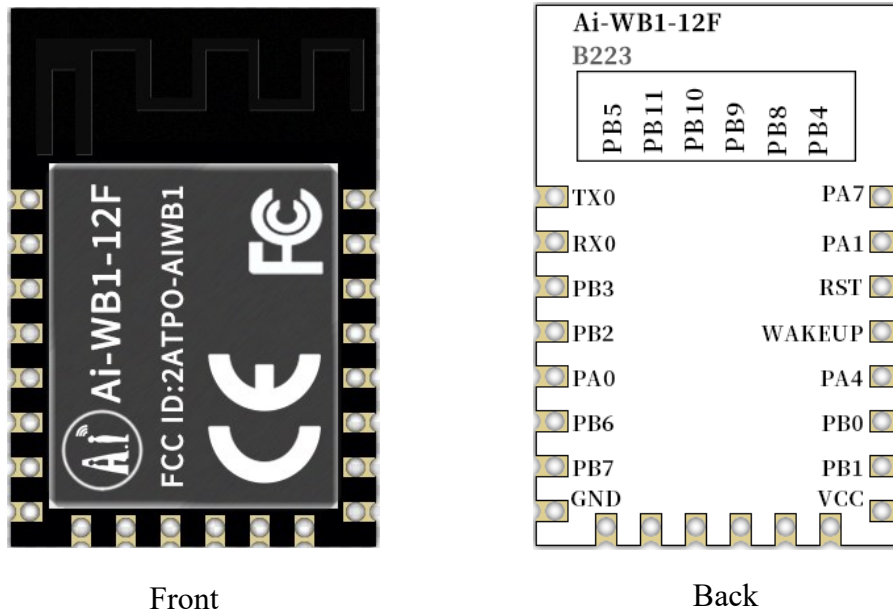
Figure 3 Appearance diagram (pictures is for reference only,subject to physical objects)

Front

Back
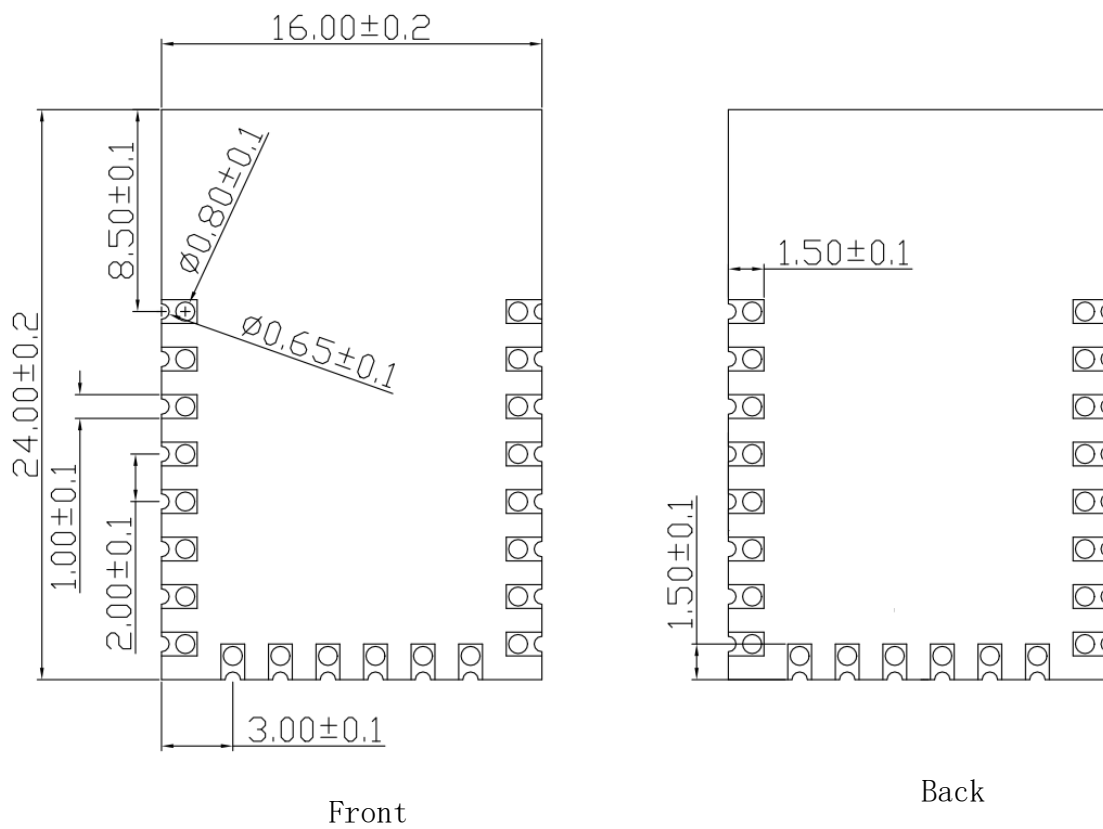
Figure 4 Dimension diagram

4. Pin Definition

Ai-WB1-12F module has a total of 22 pins, as shown in the pin diagram, the pin function definition table is the interface definition.

Figure 5 Schematic diagram of module pins

Table 6 Pin function definition table

| No.	Name	Function
1	PA7	PWM4/LSPI_MOSI/I2S_MCK/I2S_DI/Touch0/GPIO
2	PA1	JTAG_CK/I2C_SCL/PWM3/I2S_LRCK/ADC0
3	RST	As a chip enable, active low
4	WAKE	Wakeup function
5	PA4	JTAG_SWO/I2C_SDA/PWM4/I2S_BCK/ADC1
6	PB0	PWM0/LSPI_MISO/UART3_TX/PSRAM_CK/Touch3/GPIO
7	PB1	PWM1/LSPI_CLK/UART3_RX/PSRAM_CS/Touch4/GPIO
8	VCC	3.3V power supply; the output current of the external power supply is recommended to be above 500mA
9	PB4	LSPI_CS/UART2_RTS/UART4_TX/PSRAM_D2/Touch7/GPIO
10	PB8	I2S_BCK/MMC_D0/PWM_BREAK/SDIO_D0/Touch11/GPIO
11	PB9	I2S_LRCK/MMC_D1/HSPI_CS/SDIO_D1/Touch12/GPIO
12	PB10	I2S_DI/MMC_D2/HSPI_DI/SDIO_D2/GPIO
13	PB11	I2S_DO/MMC_D3/HSPI_DO/SDIO_D3/GPIO
14	PB5	LSPI_MOSI/UART2_CTS/UART4_RX/PSARM_D3/Touch8/GPIO
15	GND	Ground
16	PB7	UART1_RX/MMC_CMD/HSPI_INT/SDIO_CMD/Touch10/GPIO
17	PB6	UART1_TX/MMC_CLK/HSPI_CK/SDIO_CK/Touch9/GPIO
18	PA0	I2S_MCLK/LSPI_CS/PWM2/I2S_DO/BOOTMODE
19	PB2	PWM2/LSPI_CK/UART2_TX/PSRAM_D0/Touch5/GPIO
20	PB3	PWM3/LSPI_MISO/UART2_RX/PSRAM_D1/Touch6/GPIO
21	RX0	UART0_RX/PWM1/UART1_CTS/I2C_SCL
22	TX0	UART0_TX/PWM0/UART1_RTS/I2C_SDA

5. Schematic
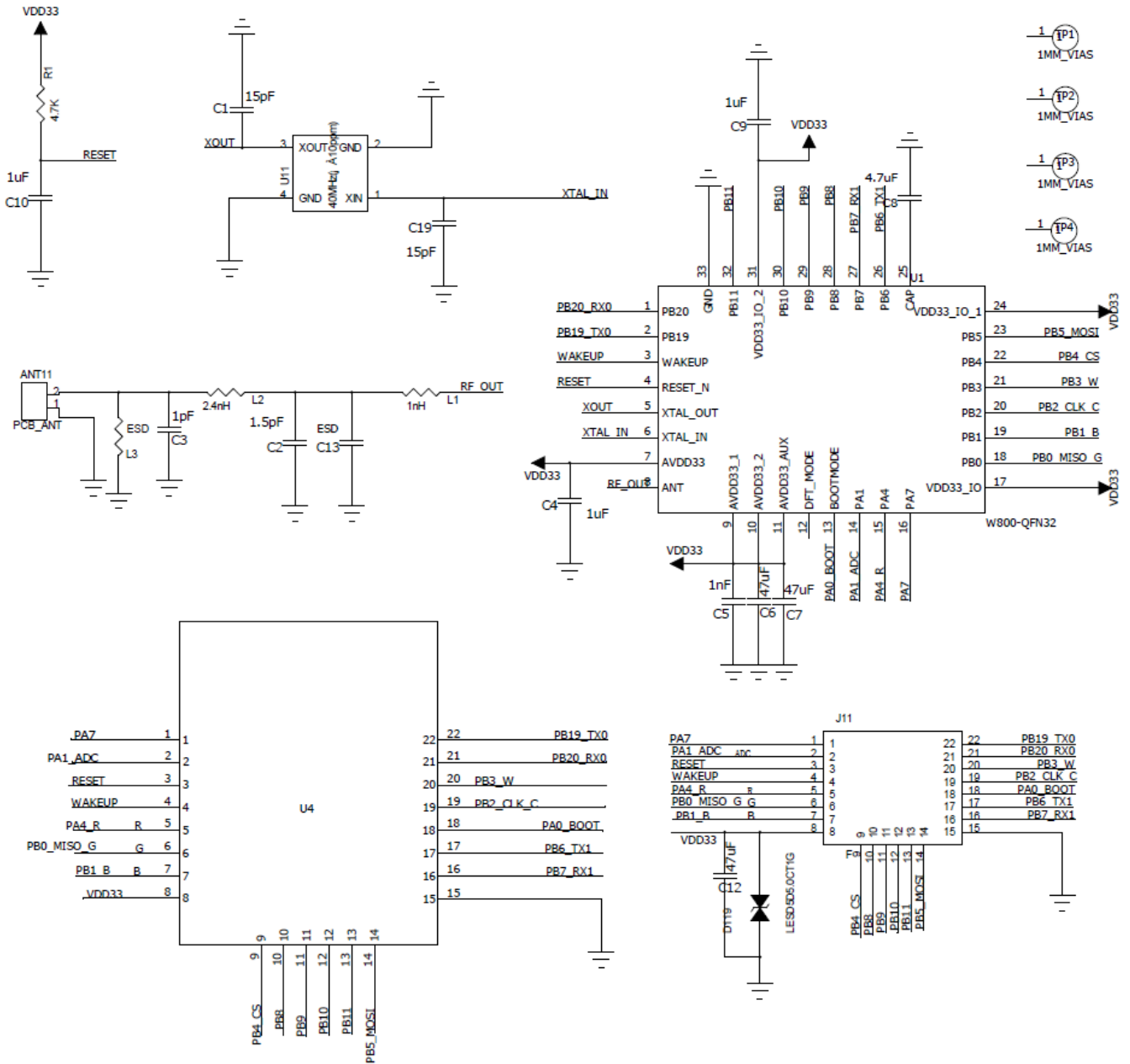
Figure 6 Schematic

6. Antenna parameters

6.1. Schematic diagram of the antenna test prototype
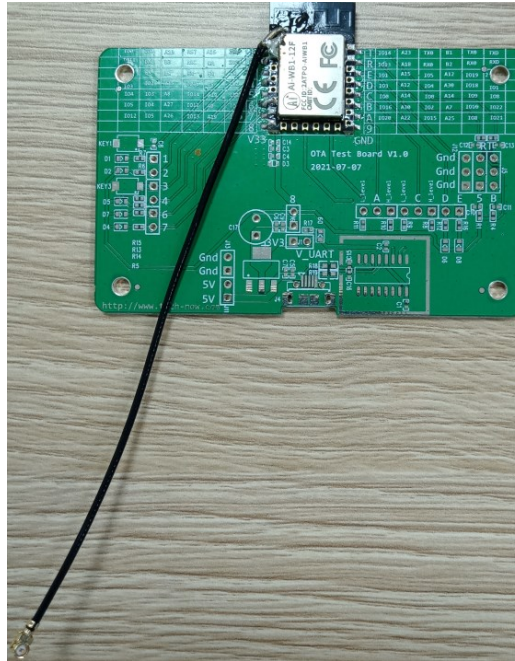
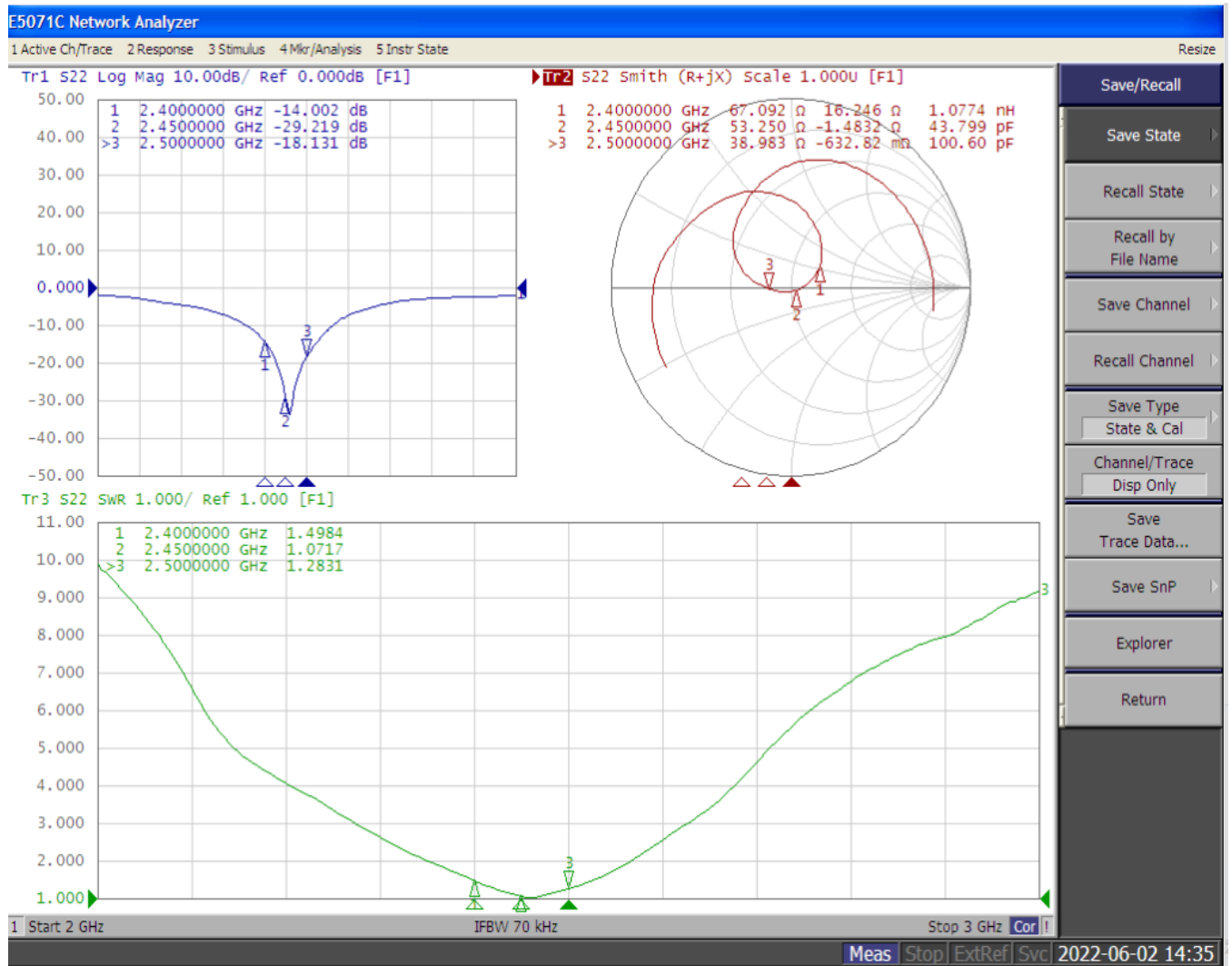**Figure 7 Schematic diagram of the antenna test prototype**

6.2. Antenna S parameter

Figure 8 Antenna S parameters

6.3. Antenna Gain and Efficiency

Table 7 Antenna Gain and efficiency

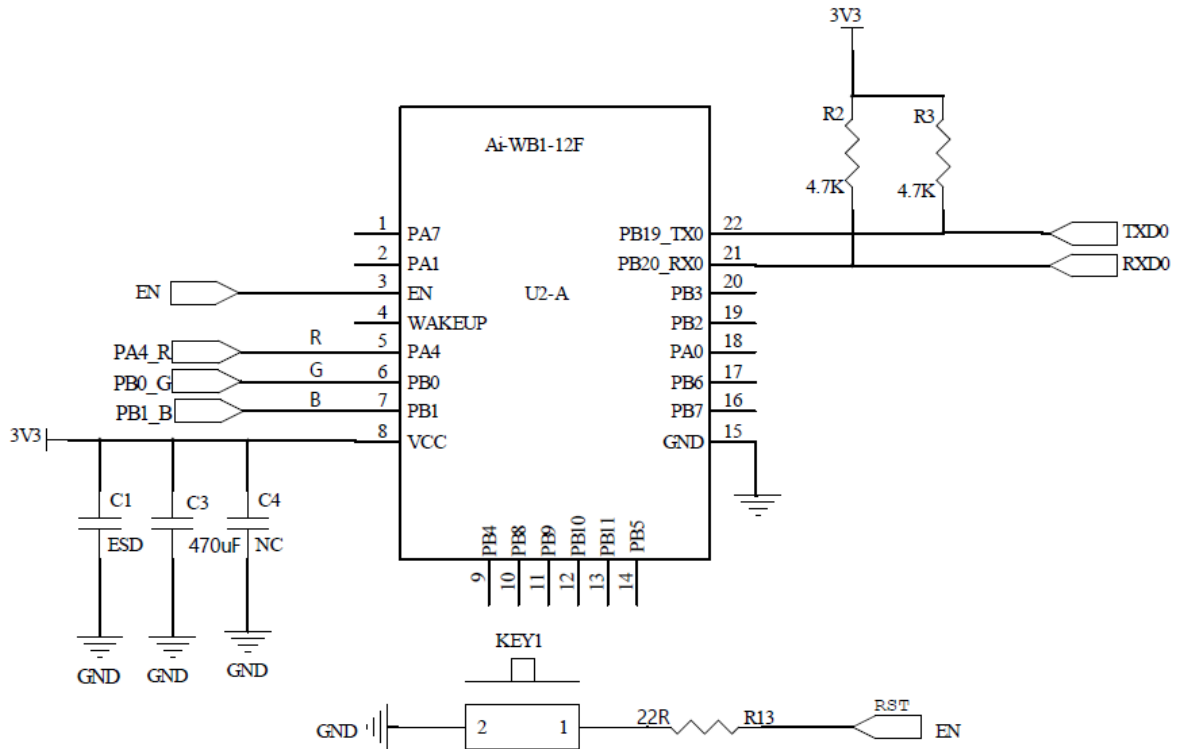| Frequency ID	1	2	3	4	5	6	7	8	9	10	11
Frequency(MHz)	2400	2410	2420	2430	2440	2450	2460	2470	2480	2490	2500
Gain (dBi)	1.63	1.49	1.61	1.90	2.09	2.22	2.15	2.04	1.80	1.78	1.60
Efficiency (%)	54.1	54.57	56.92	58.90	61.35	63.54	63.64	62.99	61.33	60.62	59.16

6.4. Antenna pattern
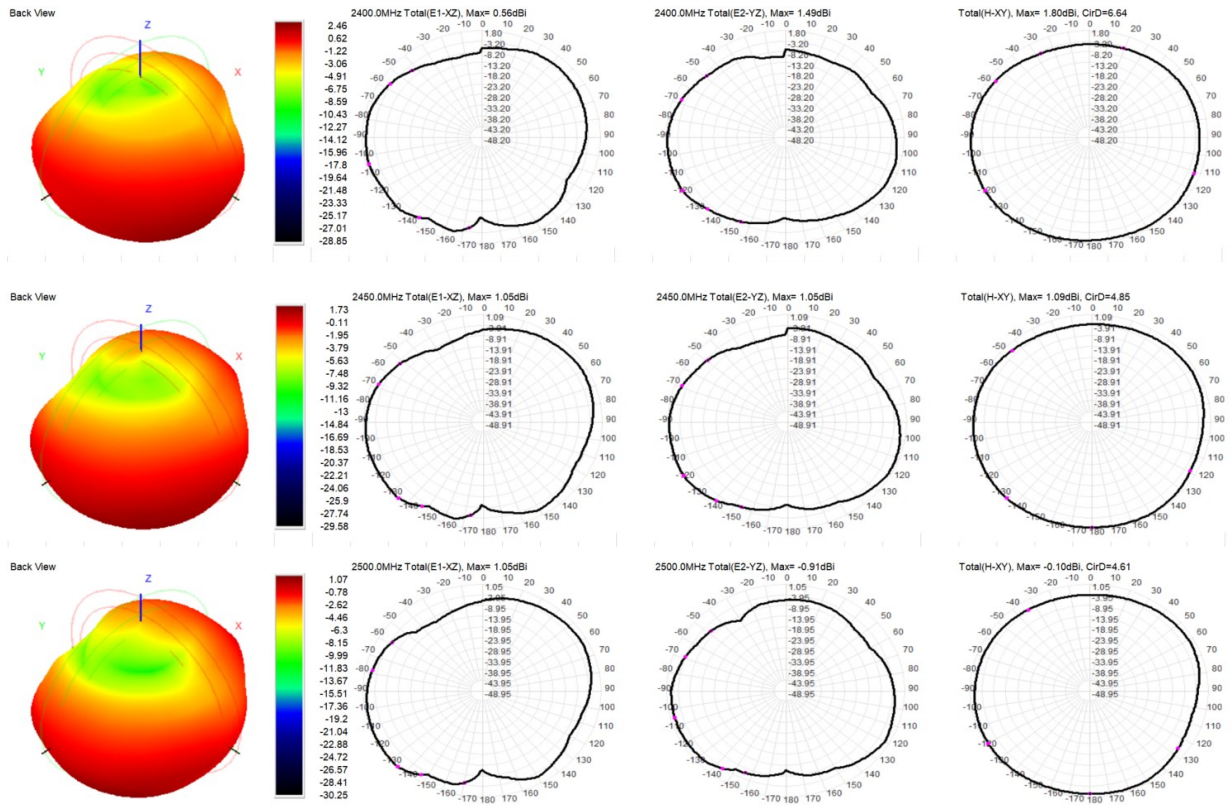
Figure 9 Antenna pattern

7. Design Guidance

7.1. Application Guidance Circuit

Figure 10 Application circuit diagram

■ If the IO port is used as PWM, it is recommended to reserve a 4.7K pull-down resistor on the periphery of the module. Especially in the application of light control, it can prevent the flashing light phenomenon at the moment of power-on start.

■ For power input, a 470uF capacitor needs to be added next to the VCC pin and placed close to the VCC pin, otherwise it will affect the RF EVM and other performance.

7.2. Recommended PCB package size
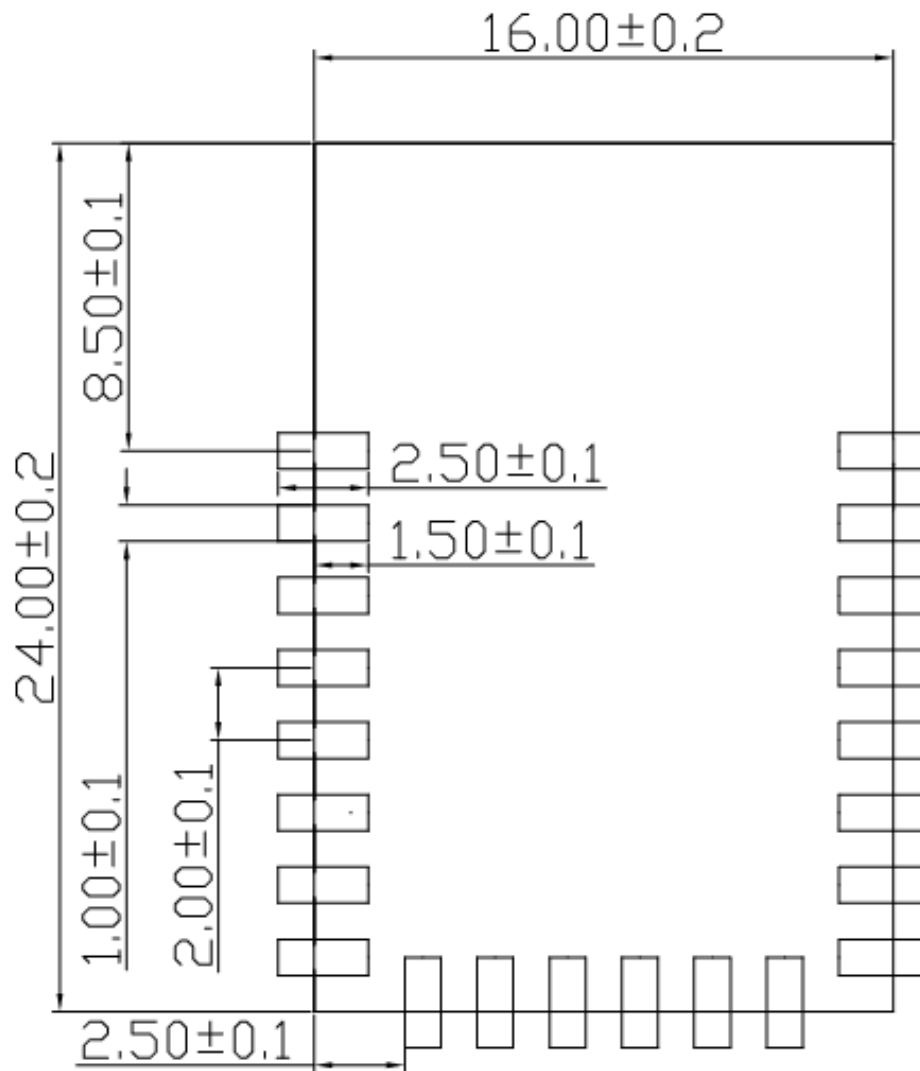
Figure 11 Recommended PCB package size (top view)

7.3. Antenna Layout Requirements

■ In the installation position on the motherboard, the following two methods are recommended:

Option 1: Put the module on the edge of the motherboard, and the antenna area extends out of the edge of the motherboard.

Option 2: Put the module on the edge of the motherboard, and hollow out an area on the edge of the motherboard at the antenna position.

■ In order to meet the performance of the on-board antenna, it is forbidden to place metal parts around the antenna and keep away from high-frequency devices.
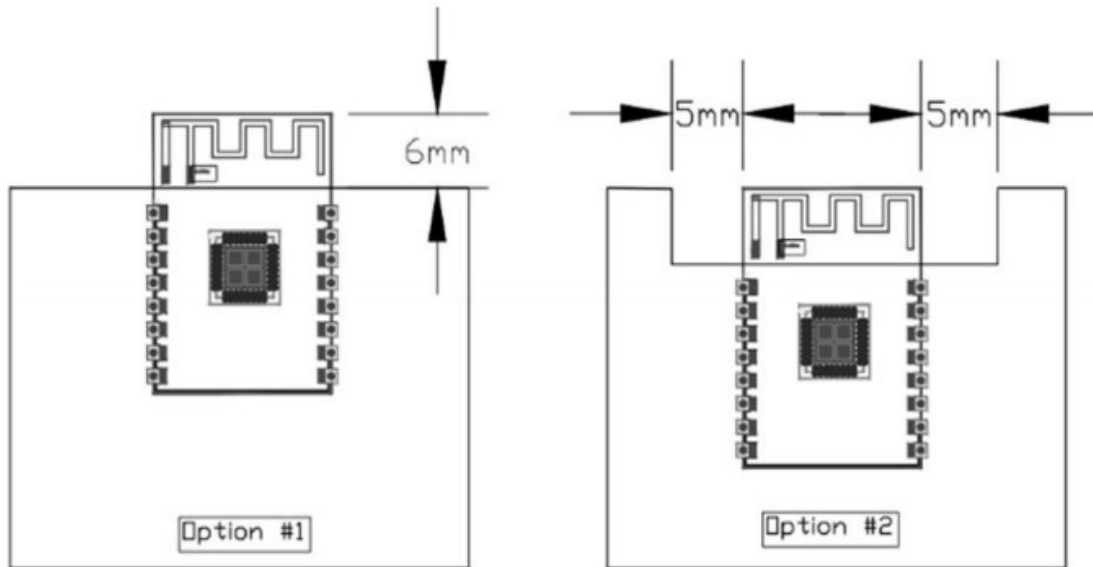
Figure 12 Schematic diagram of antenna layout

7.4. Power supply

■ Recommended 3.3V voltage, peak current above 500mA.

■ It is recommended to use LDO for power supply; if DC-DC is used, it is recommended that the ripple be controlled within 30mV.

■ It is recommended to reserve the position of the dynamic response capacitor for the DC-DC power supply circuit, which can optimize the output ripple when the load changes greatly.

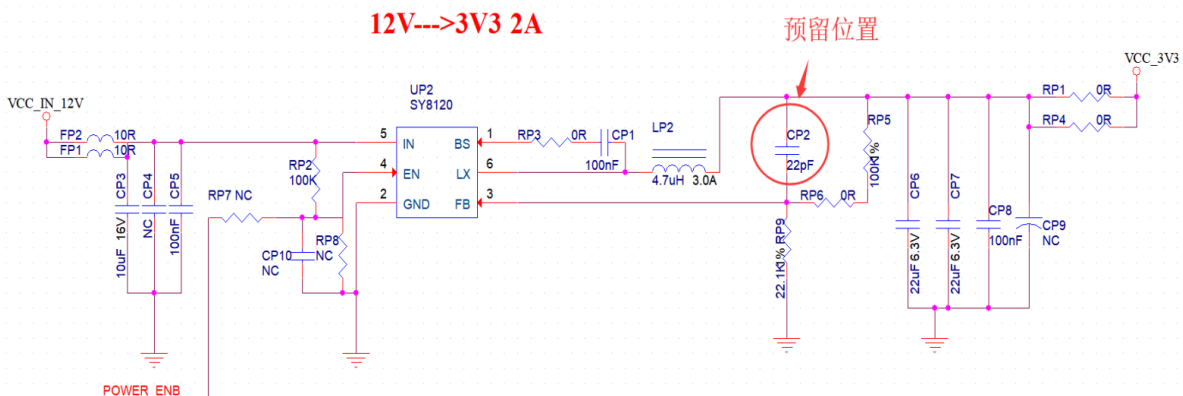■ It is recommended to add ESD devices to the 3.3V power interface.

Figure 13 DC-DC step-down circuit diagram

7.5. GPIO

■ There are some IO ports on the periphery of the module. If you need to use it, it is recommended to connect a 10-100 ohm resistor in series with the IO port. This suppresses overshoot and makes the level on both sides smoother. Helps with both EMI and ESD.

■ For the up-down and down-down of the special IO port, please refer to the instruction manual of the specification, which will affect the startup configuration of the module.

■ The IO port of the module is 3.3V. If the level of the main control and the IO port of the module does not match, a level conversion circuit needs to be added.

■ If the IO port is directly connected to a peripheral interface, or a terminal such as a pin header, it is recommended to reserve an ESD device near the terminal of the IO port trace.
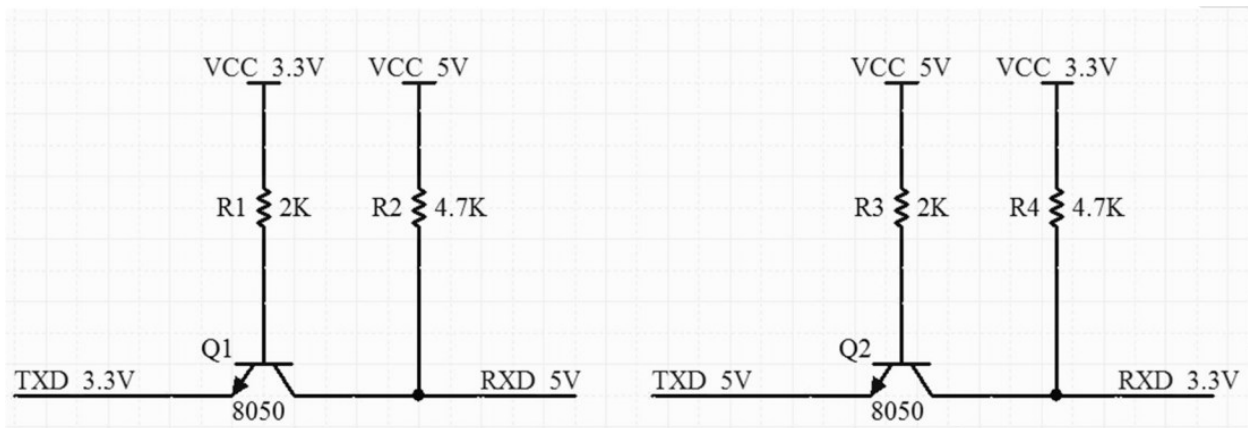
Figure 14 Level convert circuit
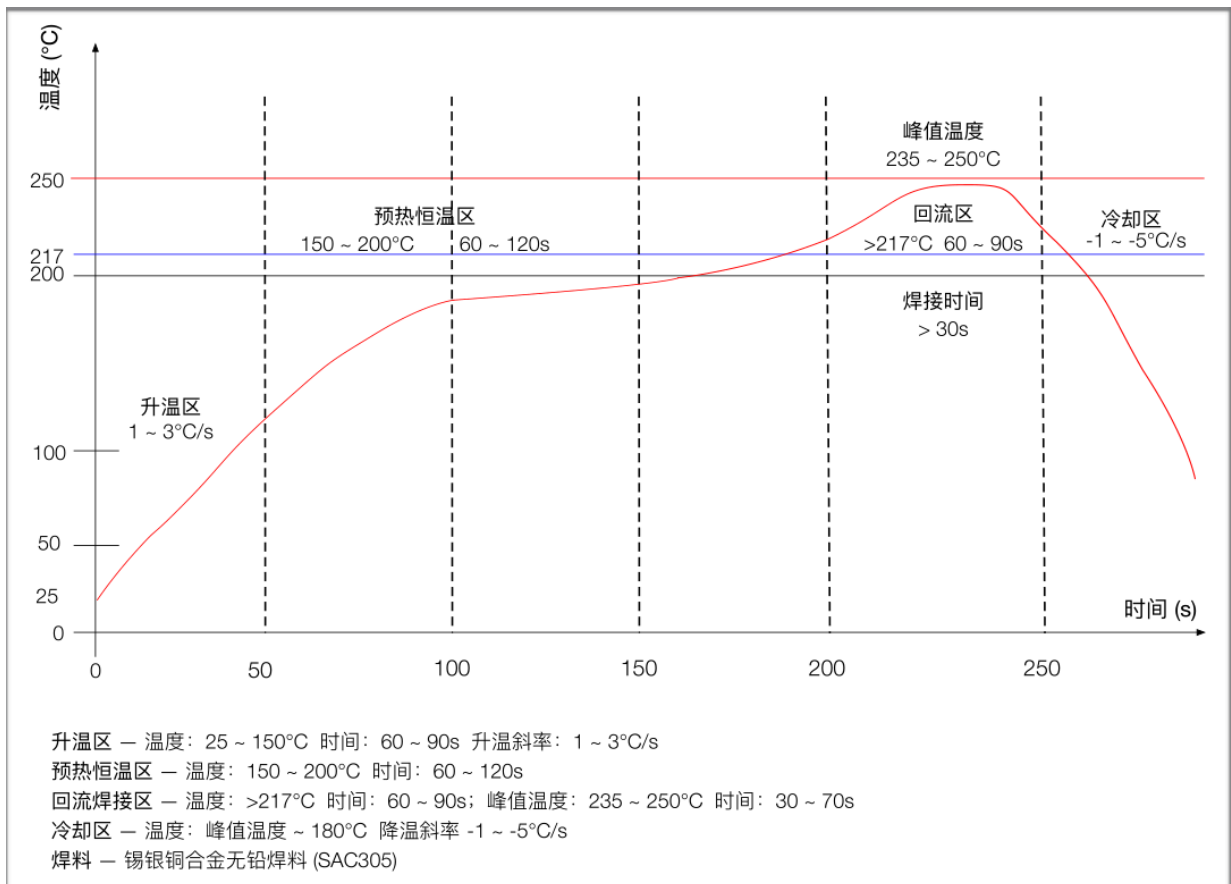
8. Storage conditions

Products sealed in moisture-proof bags should be stored in a non-condensing atmosphere <40°C/90%RH.

The module's moisture sensitivity level MSL is level 3.

the vacuum bag is unpacked, it must be used within 168 hours at 25±5℃/60%RH, otherwise it will need to be baked before going online again.

9. Reflow welding curve diagram

Figure 15 Reflow welding diagram

10. Product related models

Table 8 Product related model list

Model	Power Supply	Package	Size	Antenna
Ai-WB1-12F	3.0V ~ 3.6V，I≥500mA	SMD-22	24.0*16.0*3.1(±0.2)mm	on-board PCB antenna
Ai-WB1-32S	3.0V ~ 3.6V，I≥500mA	SMD-38	25.5*18.0*3.1(±0.2)mm	Default onboard PCB antenna/compatible IPEX interface
Ai-WB1-12F-Kit	3.3V or 5V, I>500mA	DIP-30	25.41*55.19(±0.2)mm	on-board PCB antenna
Ai-WB1-32S-Kit	3.3V or 5V, I>500mA	DIP-38	25.4*55.78(±0.2)mm	on-board PCB antenna
Product related information：https://docs.ai-thinker.com				

11. Product Packaging Information

Ai-WB1-12F module is packaged in a tape, 800pcs/reel.As shown in the below image:

Figure 16 Package and packing diagram

12. Contact us

Ai-Thinker official website   Office forum   Develop DOCS

LinkedIn   Tmall shop   Taobao shop   Alibaba shop

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FCC WARNING

FCC Caution: Any changes or modifications not expressly
approved by the party responsible for compliance could void the user's
authority to operate this 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.

This device and its antenna(s) must not be co-located or operating in conjunction
with any other antenna or transmitter.

15.105 Information to the user.

(b) For a Class B digital device or peripheral, the instructions furnished the
user shall include the following or similar statement, placed in a prominent
location in the text of the manual:

Note: This equipment has been tested and found to comply
with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules.
These limits are designed to provide reasonable protection against harmful
interference in a residential installation. This equipment generates, uses and
can radiate radio frequency energy and, if not installed and used in
accordance with the instructions, may cause harmful interference to radio
communications. However, there is no guarantee that interference will not
occur in a particular installation. If this equipment does cause harmful
interference to radio or television reception, which can be determined by
turning the equipment off and on, the user is encouraged to try to correct the
interference by one or more of the following measures:

—Reorient or relocate the receiving antenna.

—Increase the separation between the equipment and receiver.

—Connect the equipment into an outlet on a circuit different from that to which
the receiver is connected.

—Consult the dealer or an experienced radio/TV technician for help.

This equipment complies with FCC radiation exposure limits set forth for an uncon-
trolled environment. This equipment should be installed and operated with minimum
distance 20
cm between the radiator and your body.

Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an
uncontrolled environment.

This transmitter must not be co-located or operating in conjunction with any other

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-AIWB1"

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 AC Power Line Conducted Emission, Radiated Spurious emissions, Band edge and RF Conducted Spurious Emissions, Conducted Peak Output Power, Bandwidth, Power Spectral Density, Antenna Requirement.

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 product antenna uses an irreplaceable antenna with a gain of 1dBi

2.4 Single Modular

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

A Single Modular 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 Single Modular 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.

2.5 Trace antenna designs

For a modular transmitter with trace antenna designs, see the guidance in Question 11 of KDB Publication 996369 D02 FAQ – Modules for Micro-Strip Antennas and traces. The integration information shall include for the TCB review the integration instructions for the following aspects: layout of trace design, parts list (BOM), antenna, connectors, and isolation requirements.

a) Information that includes permitted variances (e.g., trace boundary limits, thickness, length, width, shape(s), dielectric constant, and impedance as applicable for each type of antenna); b) Each design shall be considered a different type (e.g., antenna length in multiple(s) of frequency, the wavelength, and antenna shape (traces in phase) can affect antenna gain and must be considered); c) The parameters shall be provided in a manner permitting host manufacturers to design the printed circuit (PC) board layout; d) Appropriate parts by manufacturer and specifications; e) Test procedures for design verification; and f) Production test procedures for ensuring compliance

The module grantee shall provide a notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify the module grantee that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the grantee, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application

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: The module complies with FCC radiofrequency radiation exposure limits for uncontrolled environments. The device is installed and operated with a distance of more than 20 cm between the radiator and your body." This module follows FCC statement design, FCC ID :2ATPO-AIWB1

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 product antenna uses an irreplaceable antenna with a gain of 1dBi

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-AIWB1

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: Ningde lingyang Electronic 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.