



Ai-WB3-12F Specification

Version V1.0.0

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Document resume

Version	Date	Develop/revise content	Edition	Approve
V1.0.0	2023.2.3	First Edition	JiYe Yang	NingGuan

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1. Product Overview

Ai-WB3-12F is a Wi-Fi&BLE module developed by Shenzhen Ai-Thinker Technology Co., Ltd. The module is equipped with LN882H chip as the core processor and supports Wi-Fi 802.11b/g/n protocol and BLE 5.1 protocol. The LN882H chip integrates the Cortex-M4F core, with a maximum frequency of 160MHz, built-in 296KB SRAM, 128KB ROM and rich peripheral interfaces, including SDIO/SPI/UART/I2C/PWM/ADC/DMA/SWD/GPIO, etc. It can be widely used in Internet of Things (IoT), mobile devices, wearable electronic devices, smart home and other fields.

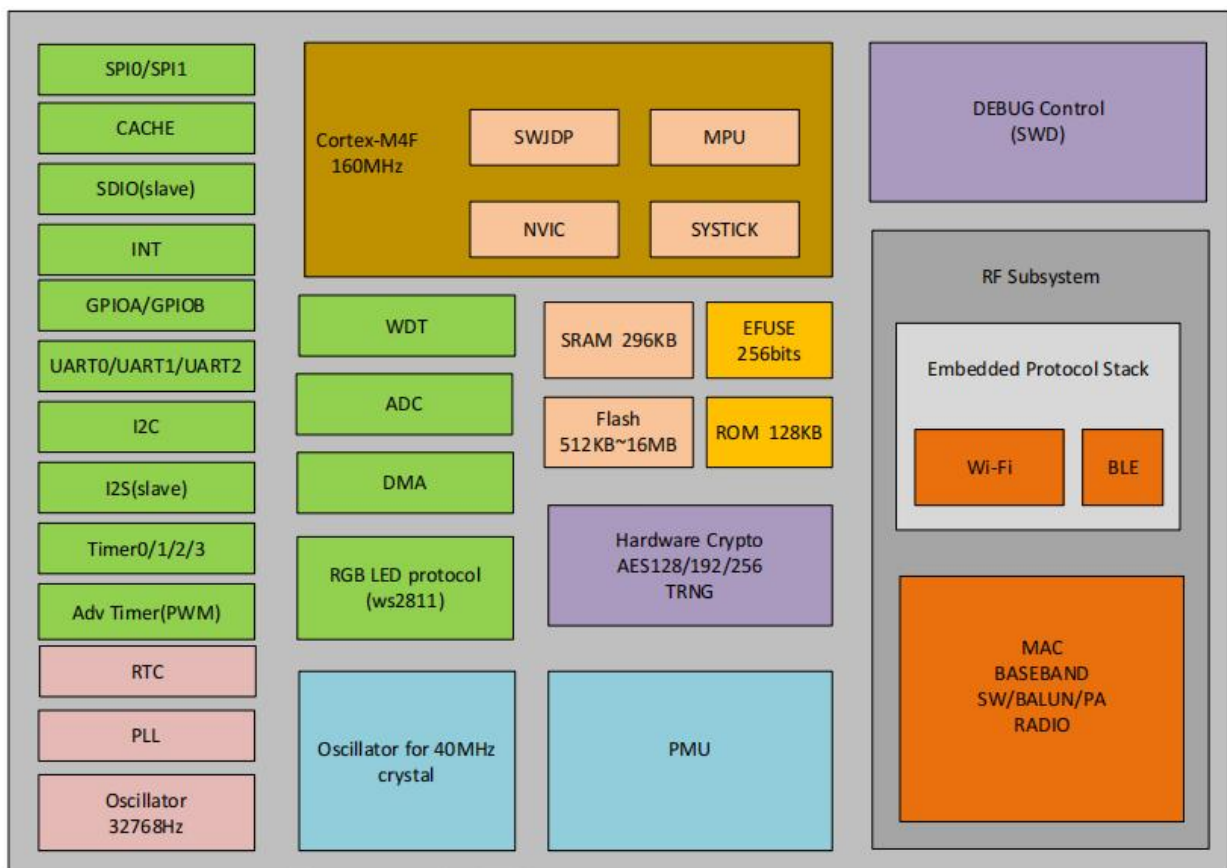


Figure 1 Main chip architecture diagram

1.1. Characteristic

- The package is SMD-22
- Support IEEE 802.11 b/g/n protocol
- Support BLE5.1
- Support long range (125Kbps, 500Kbps) and high data rate (2Mbps)
- Support 296KB SRAM / 128KB ROM
- Support SDIO/SPI/UART/I2C/PWM/ADC/DMA/SWD/GPIO port
- Supports multi-channel ADC and programmable amplifier for sound sensors
- Support RTC real-time clock and WDT watchdog
- Supports True Random Number Generator (TRNG)
- Support AES-128\AES-192\AES-256 hardware encryption
- Support 256 bits EFUSE
- Integrated CHKSUM accelerator to improve TCP/UDP transmission

2. Main parameters

Table 1 Description of the main parameters

Model	Ai-WB3-12F
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 2.7V ~ 3.6V, supply current ≥500mA
Interface	SDIO/SPI/UART/I2C/PWM/ADC/DMA/SWD/GPIO
IO	19
UART rate	Default 115200 bps
Security	AES-128\AES-192\AES-256 Hardware Encryption
Flash	Default 2MByte

2.1. Static electricity requirement

Ai-WB3-12F 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	2.7	3.3	3.6	V
I/O	VIL	-	-0.3	0	0.6	V
	VIH	-	VIO-0.6	VIO	VIO+0.3	V
	VOL	-	-0.45	0	0.45	V
	VOH	-	VIO-0.5	VIO	VIO+0.5	V

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 value	Max.	Unit
11n Mode HT20, PA output power	-	14	-	dBm
11g Mode, PA output power	-	16	-	dBm
11b Mode, PA output power	-	18	-	dBm
Receive Sensitivity				
Mode	Min.	Typical	Max.	Unit
11b, 1 Mbps	-	-95	-	dBm
11b, 11 Mbps	-	-88	-	dBm
11g, 6 Mbps	-	-91	-	dBm
11g, 54 Mbps	-	-74	-	dBm
11n, HT20 (MCS7)	-	-71	-	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 value	Max.	Unit
1Mbps	-	12	-	dBm
Receive Sensitivity				
Rate Mode	Min.	Typical value	Max.	Unit
1Mbps sensitivity@30.8%PER	-	-95	-	dBm

2.5. Power

The following power consumption data is based on a 3.3V power supply and an ambient temperature of 25° C.

- All POUT power for all emission modes is measured at the antenna interface.
- All emission data is based on 95% of the duty ratio, measured in continuous emission mode.

Table 5 Power consumption

Mode		Min.	AVG	Max.	Unit
Tx 802.11b, 11Mbps, POUT=+18dBm		-	260	-	mA
Tx 802.11g, 54Mbps, POUT =+16dBm		-	235	-	mA
Tx 802.11n, MCS7, POUT =+14dBm		-	225	-	mA
Rx 802.11b, packet length 1024 byte		-	90	-	mA
Rx 802.11g, packet length 1024 byte		-	90	-	mA
Rx 802.11n, packet length 1024 byte		-	90	-	mA
Sleep Mode	DTIM=1	-	11	-	mA
	DTIM=3	-	8	-	mA

3. Appearance Dimensions

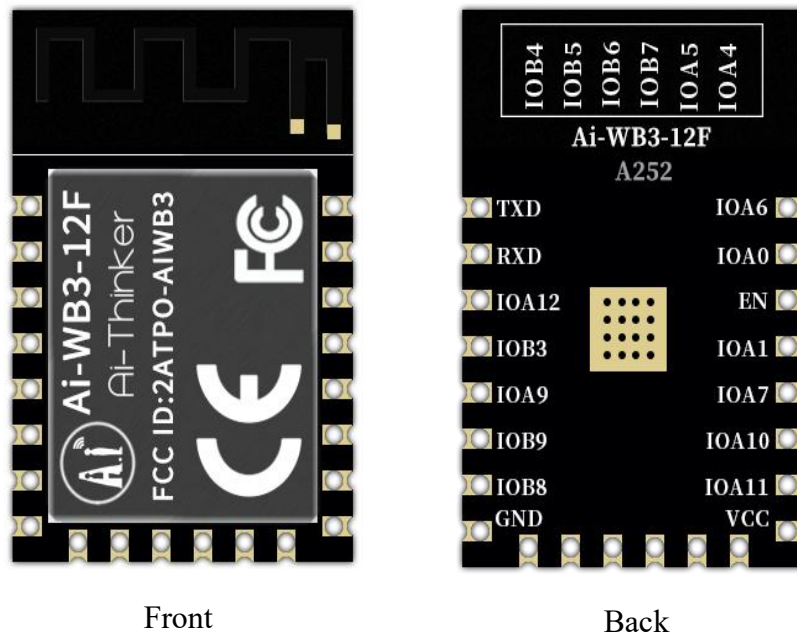


Figure 3 Appearance (the rendering is for reference only, the actual object shall prevail)

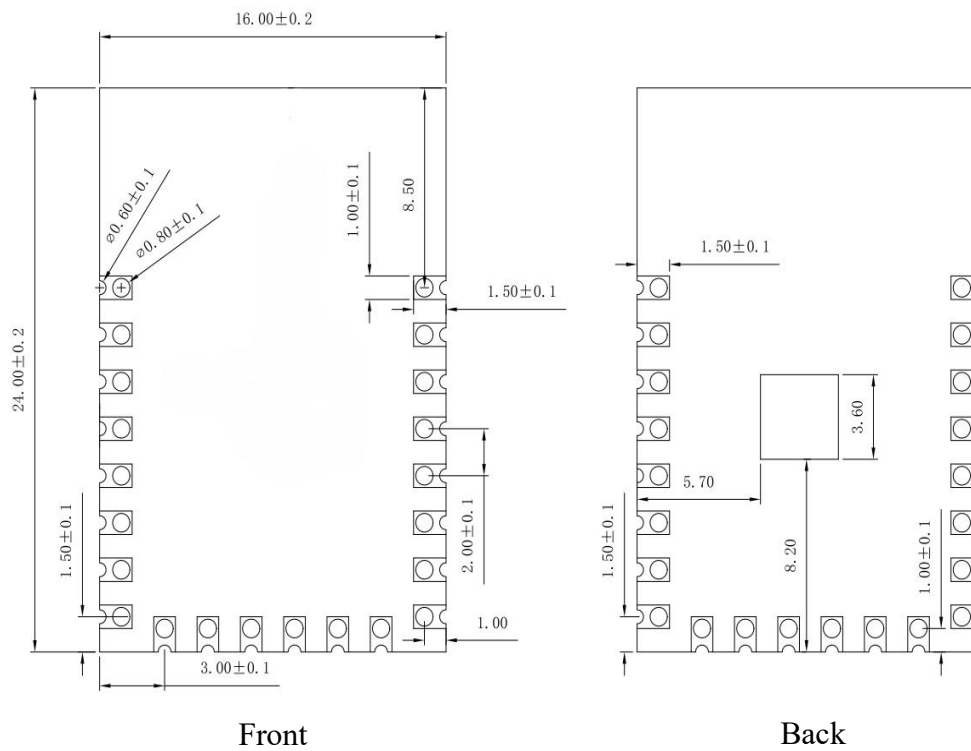


Figure 4 Dimension diagram (unit: mm)

4. Pin Definition

The Ai-WB3-12F module has a total of 22 pins, as shown in the schematic diagram of the pins, and the pin function definition table is the interface definition.

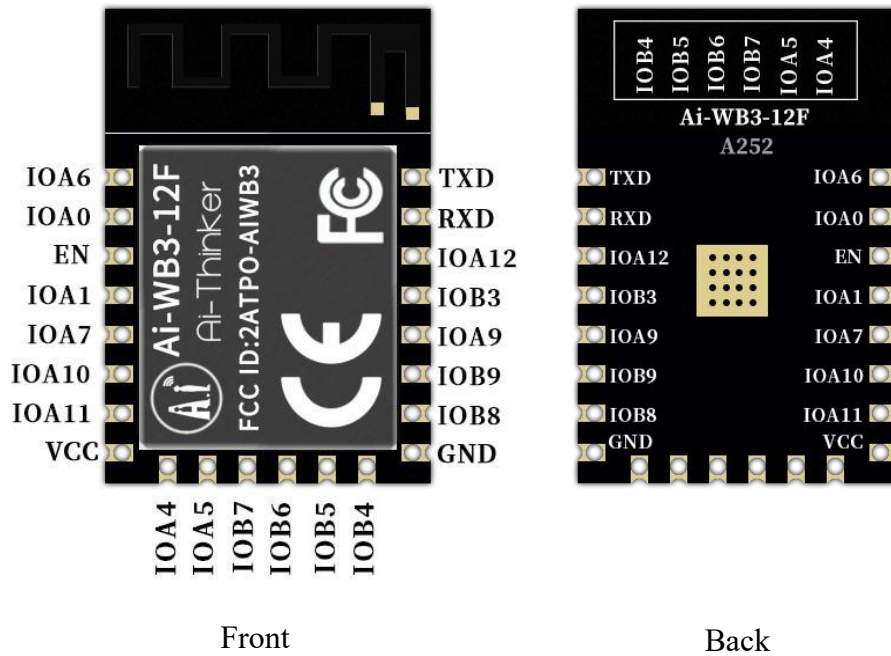


Figure 5 pin diagram

Table 6 Pin function definition table

No.	Name	Function Description
1	IOA6	GPIOA6/SDIO_IO2/I2S_SDI/EXT_INT/FULLMUX
2	IOA0	GPIOA0/ADC/EXT_INT/FULLMUX
3	EN	Default chip enable pin, active-high.
4	IOA1	GPIOA1/ADC/SWD/EXT_INT/FULLMUX
5	IOA7	GPIOA7/SDIO_IO3/EXT_INT/FULLMUX
6	IOA10	GPIOA10/SDIO_IO0/I2S_SDO/FULLMUX
7	IOA11	GPIOA11/SDIO_IO1/FULLMUX
8	VCC	3.3V power supply; the output current of the external power supply is recommended to be above 500mA
9	IOA4	GPIOA4/ADC/SWCK/FULLMUX
10	IOA5	GPIOA5/EXT_INT/FULLMUX
11	IOB7	GPIOB7/FULLMUX
12	IOB6	GPIOB6/FULLMUX
13	IOB5	GPIOB5/ADC/FULLMUX
14	IOB4	GPIOB4/ADC/FULLMUX
15	GND	Ground
16	IOB8	GPIOB8/FULLMUX
17	IOB9	GPIOB9/FULLMUX/EXT_INT
18	IOA9	GPIOA9/SDIO_CLK/I2S_SCLK/FLLMUX/BOOT_MODE
19	IOB3	GPIOB3/ADC/FULLMUX
20	IOA12	GPIOA12/FULLMUX
21	RXD	RXD/GPIOA3/EXT_INT/FULLMUX
22	TXD	TXD/GPIOA2/EXT_INT/FULLMUX

Note: 1. IOA9 is used as Bootstrap. When the power is low at the moment of power-on, the module enters the programming mode; when the power is high at the moment of power-on, the module starts normally. The module supports 1 master/slave I2C interface and 2 SPI interfaces, and any two pins with FULLMUX characteristics can be configured as I2C and SPI.

5. Schematic

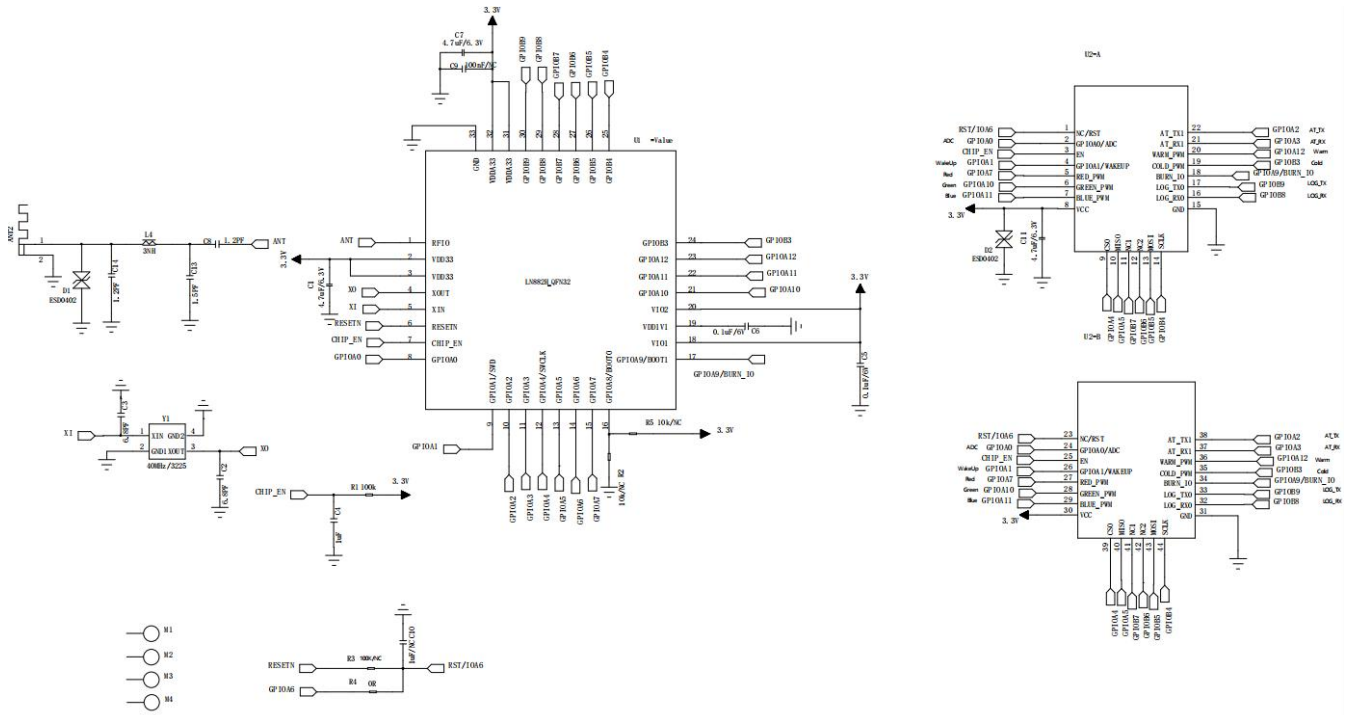


Figure 6 Module schematic

6. Antenna parameters

6.1. Schematic diagram of the antenna test prototype

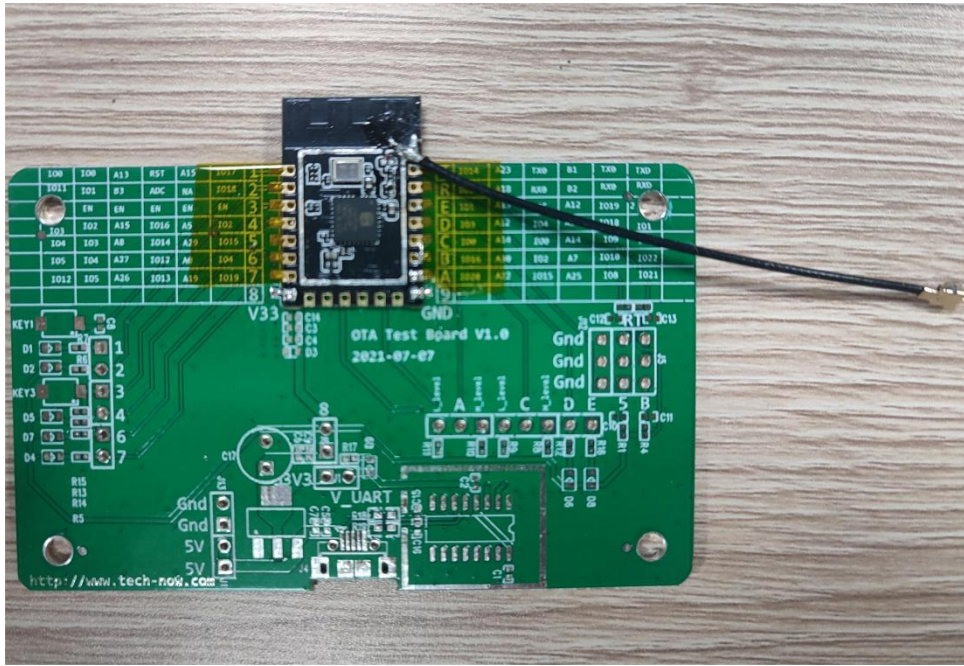


Figure 7 Schematic diagram of the antenna test prototype

6.2. Antenna S parameter

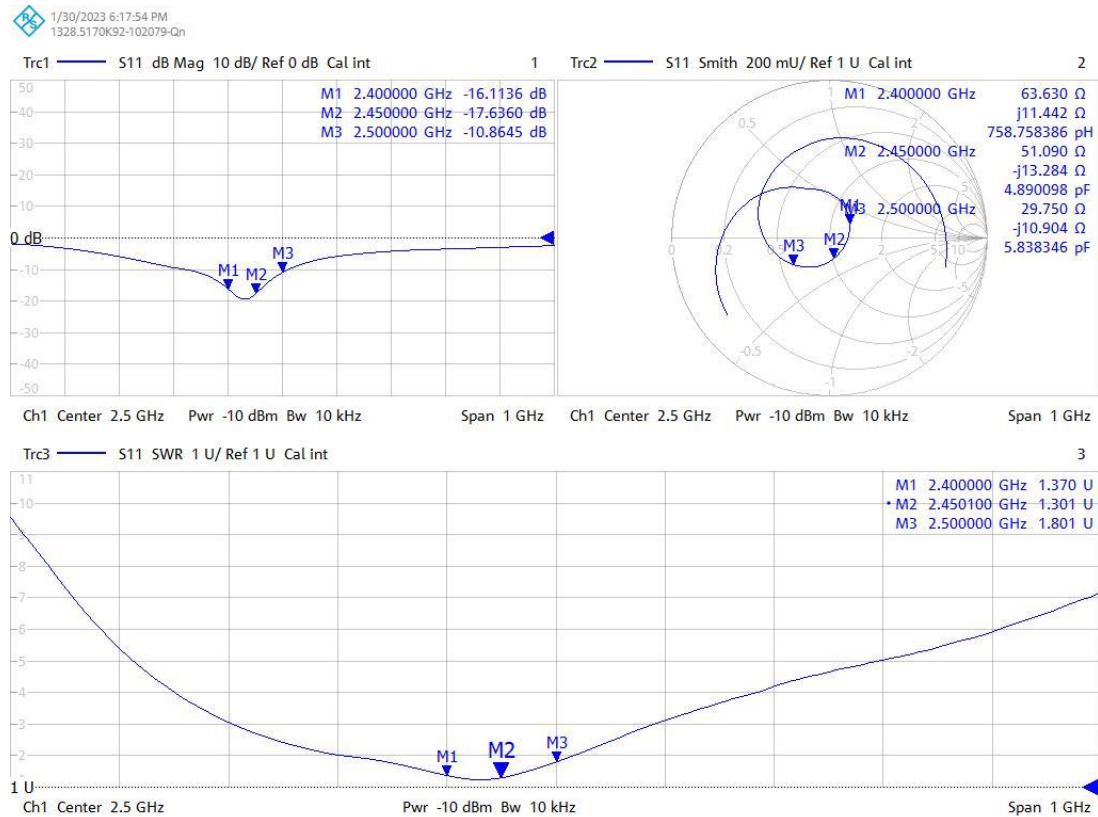


Figure 8 Antenna S parameters

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)	1.31	1.29	1.16	1.06	1.09	1.17	1.26	1.42	1.33	1.22	1.18
Efficiency (%)	59.9	60.6	60.1	59.8	60.8	60.8	61.8	62.3	60.2	58.8	59.7

6.4. Antenna pattern

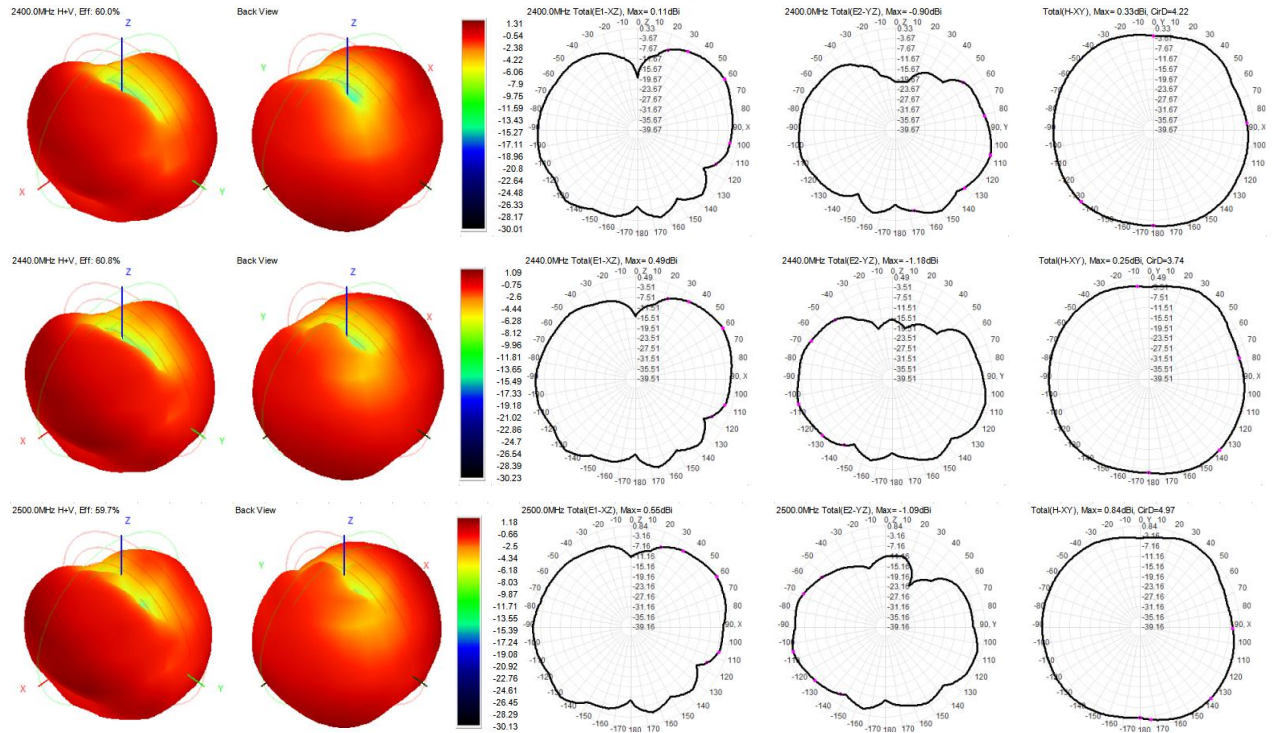


Figure 9 Antenna pattern

7. Design Guidance

7.1. Application Guide Circuit

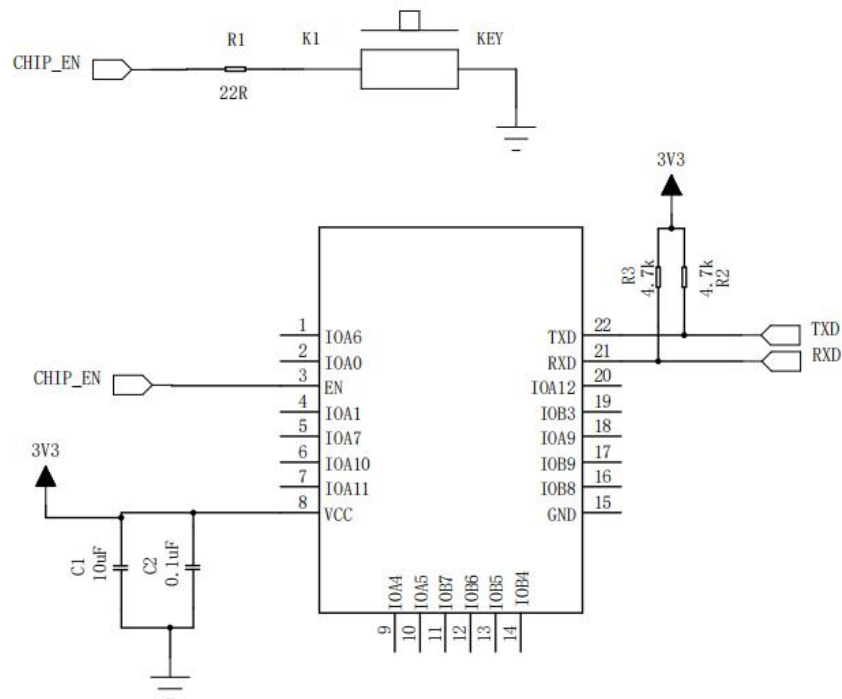


Figure 10 Application circuit diagram

- If the I/O port is used as PWM, it is recommended to reserve 4.7K pull-down resistance around the module. In particular, the application of the lamp control side prevents the flash phenomenon at the moment of power-on startup.

7.2. Recommend PCB footprint size

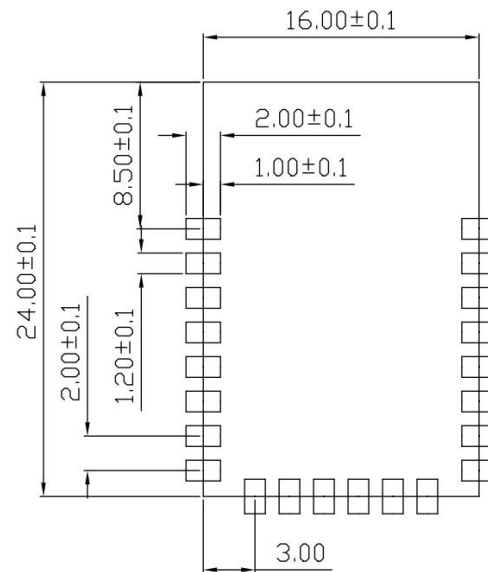


Figure 11 Recommend PCB footprint size(unit:mm)

7.3. Antenna layout requirements

- For the installation position on the motherboard, the following two methods are recommended:

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

Solution 2: Put the module on the edge of the motherboard, and hollow out an area on the edge of the motherboard where the antenna is.

- 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.

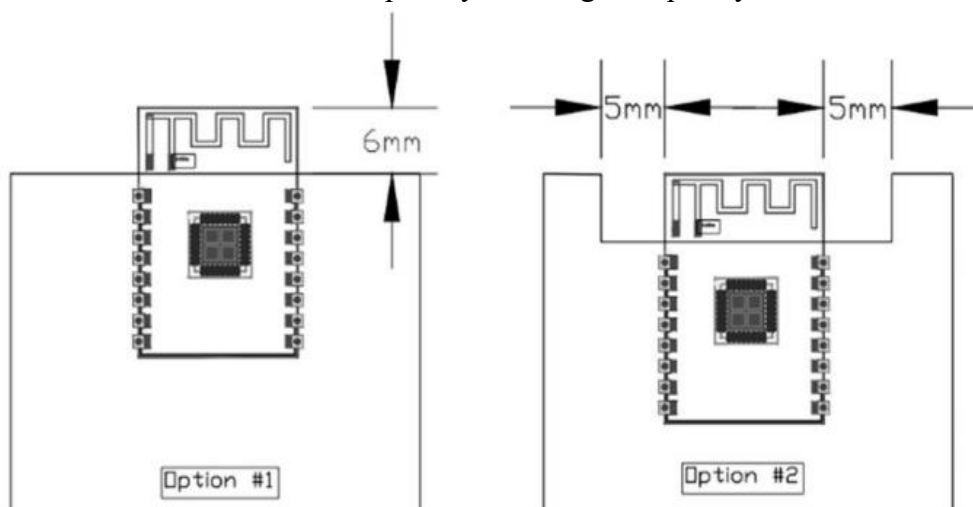


Figure 12 Antenna layout diagram

7.4. Power supply

- Recommended 3.3V voltage, peak current above 500mA.
- It is recommended to use LDO power supply; if using DC-DC, it is recommended to control the ripple 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

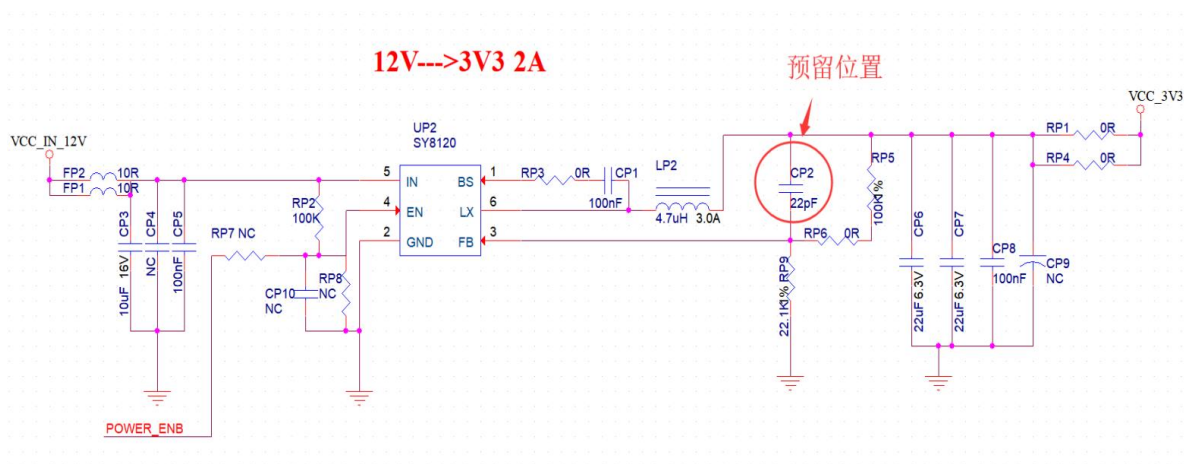


Figure 13 DC-DC step-down circuit diagram

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 ports. This can suppress overshoot and make the levels on both sides more stable. Helpful for both EMI and ESD.
- For the pull-up and pull-down of the special IO port, please refer to the instructions in 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 do not match, a level conversion circuit needs to be added.
- If the IO port is directly connected to the peripheral interface, or terminals such as pin headers, it is recommended to reserve an ESD device near the IO port wiring near the terminal.

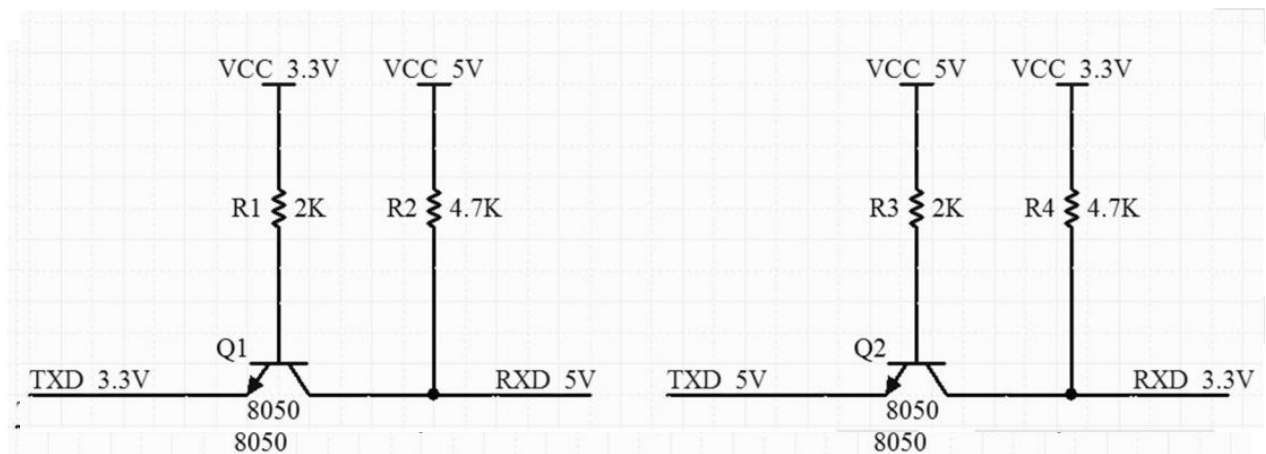


Figure 14 Level convert circuit

8. Storage conditions

Products sealed in moisture-proof bags should be stored in a non-condensing atmosphere at $<40^{\circ}\text{C}/90\%\text{RH}$.

The moisture sensitivity level MSL of the module is 3.

After the vacuum bag is unpacked, it must be used within 168 hours at $25 \pm 5^{\circ}\text{C}/60\%\text{RH}$, otherwise it needs to be baked before it can be put online again.

9. Reflow welding curve diagram

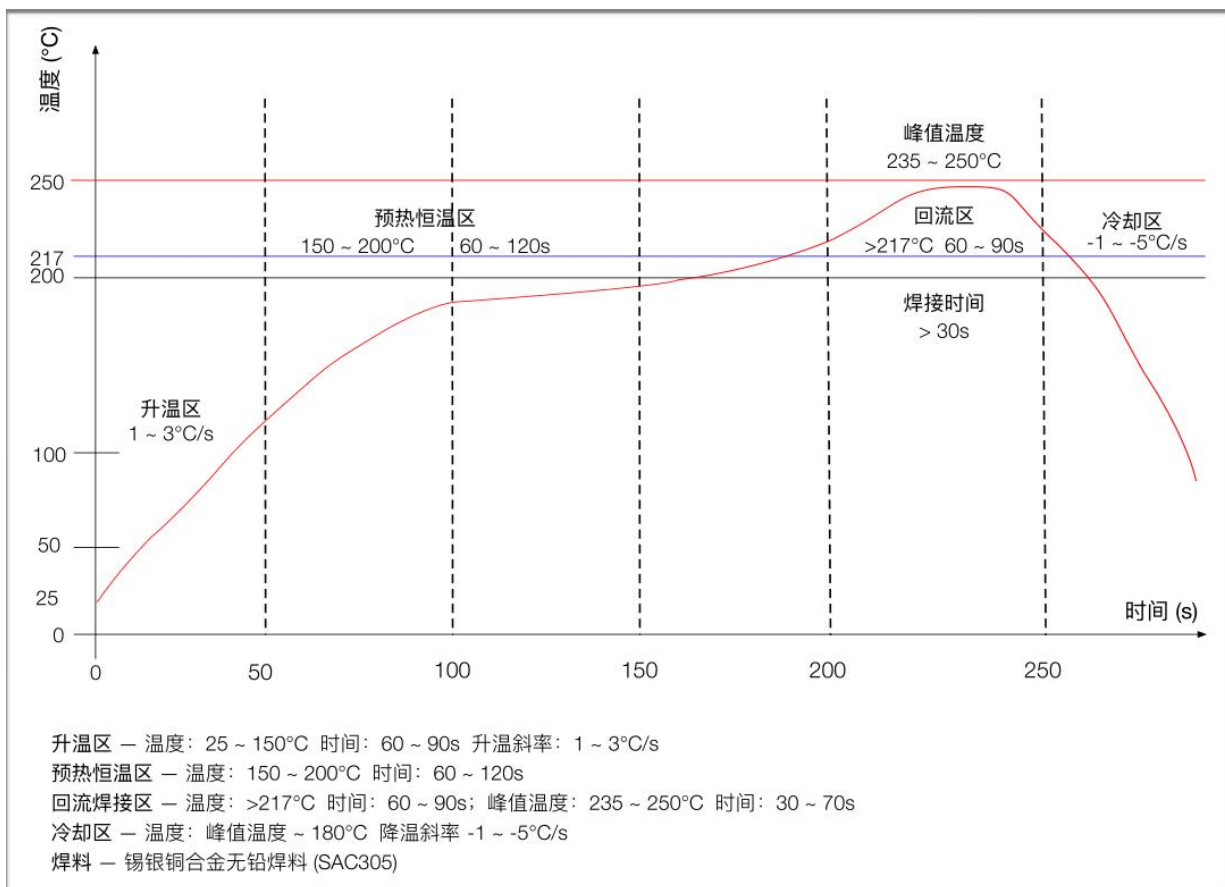


Figure 15 Reflow welding diagram

10.Product Packaging Information

Ai-WB3-12F module was packaged in a tape, 800pcs/reel.As shown in the below image:



Figure 16 Package and packing diagram

11.Contact us

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

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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.

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 uncontrolled 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 “FCC ID:2ATPO-AIWB3”

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 **WIFI:1.26dBi ,BT:1.42dBi**

2.4 Single Modular

If a modular transmitter is approved as a "Single Modular," then the module manufacturer is responsible 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-AIWB3

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 WIFI:1.26dBi ,BT:1.42dBi

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-AIWB3

2.9 Information on test modes and additional testing requirements

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 circuitry), 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 circuitry, so the module does not require an evaluation by FCC Part 15 Subpart B. The host should be evaluated by the FCC Subpart B.