



# Ra-08-P Specification

Version V1.0.0

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## Document resume

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## 1. Product overview

Ra-08-P is a high-power LoRa module designed and developed by Shenzhen Anxinke Technology Co., Ltd., which is used for ultra-long-distance spread spectrum communication. Its chip ASR6601 is a general-purpose LPWAN wireless communication SoC that integrates an RF transceiver, a modem, and a 32-bit RISC MCU. The MCU uses an ARM core and has an operating frequency of up to 48MHz. The Ra-08-P module supports LoRa modulation and traditional (G)FSK modulation under LPWAN use cases; at the same time, the transmitter also supports BPSK modulation and (G)MSK modulation, and the receiver supports (G)MSK modulation. Based on this technology, the module has built-in power amplifiers (PA) and low-noise amplifiers (LNA), with high sensitivity exceeding -137dBm, transmission power, long transmission distance, and high reliability. At the same time, compared with traditional modulation technologies, LoRa™ modulation technology also has obvious advantages in anti-blocking and selection, solving the problem that traditional design solutions cannot take into account distance, anti-interference and power consumption at the same time.

The Ra-08-P module provides ultra-long range and ultra-low power communication for LPWAN applications and can be widely used in scenarios such as smart meters, supply chain and logistics, home building automation, security systems, remote irrigation systems, etc.

## 1.1. Characteristic

- SMD-18 package
- Supported frequency bands: 410MHz-525MHz
- The operating voltage is 3.3V, Theoretical maximum transmit power
- High sensitivity: -137dBm @125Kz SF10
- Supported spreading factors SF5/SF6/SF7/SF8/SF9/SF10/SF11/SF12
- Embedded memory, 128KB FLASH, 16KB SRAM
- Support LoRa/ASK
- The antenna interface is compatible with various connection methods such as stamp hole/round hole and IPEX, supporting more solution selection.
- Support multiple sleep modes: deep sleep current as low as 17uA

## 2. Main parameters

**Table1 Description of main parameters**

<b>Module</b>	Ra-08-P
<b>Package</b>	SMD-18
<b>Size</b>	16.0*16.0*3.2( $\pm 0.2$ )mm
<b>Antenna</b>	Compatible with Half Hole Pad / Through Hole Pad / IPEX Sockets
<b>Frequency range</b>	410-525MHz
<b>Operating temperature</b>	-40 °C ~ 85 °C
<b>Storage environment</b>	-40 °C ~ 125 °C, < 90%RH
<b>Power supply range</b>	Supply voltage 2.8V ~ 3.6V, supply current >800mA
<b>Support interface</b>	UART/GPIO/ADC/DAC/I2C/I2S/SPI/PWM
<b>Number of IO ports</b>	IO2,IO4,IO5,IO8,IO9,IO11,IO14,IO15
<b>Serial port rate</b>	Support 110 ~ 4608000 bps, default 115200 bps
<b>Crystal frequency</b>	32MHz
<b>SPI Flash</b>	128KB
<b>Transport protocol</b>	LoRaWAN, LinkWAN

### 2.1. Static electricity requirement

Ra-08-P is electrostatic sensitive equipment, so special precautions should be taken during handling.



**Figure 2 ESD anti-static diagram**

Tip:

Ra-08-P modules are Electrostatic Sensitive Devices (ESD) and require special ESD precautions and should normally be applied to ESD sensitive components. Proper ESD handling and packaging procedures must be employed throughout the handling, shipping and operation of any application incorporating Ra-08-P modules. Do not damage the module by touching it with your hands or by soldering with a non-antistatic soldering iron.

## 2.2. Electrical characteristics

Table 2 Table of Electrical Characteristics

Parameter	Name		Min. value	Typical value	Max. value	Un	Note
Operating Temperature	TOPR		-40	25	85	°C	
Supply voltage	VDD		2.8	3.3	3.6	V	≥3.3V Guaranteed
Power consumption	Sleep Mode	Consumption 1	-	17	-	uA	DeepSleep
		Consumption 2	-	7	-	mA	standby mode
	Full-load mode (TX:29dBm)		-	700	-	mA	DC-DC Mode
	Reception mode (RX:SF7)		-	16	-	mA	DC-DC Mode

## 2.3. Digital port characteristics

Table 3 Digital Ports

Interface	Name	Min. value	Typical value	Max. value	Unit
IO Level	VIO	2.8	3.3	3.6	V
Input logic level low	VIL	-	-	0.2	V
Input logic level high	VIH	0.8	-	-	V
Output logic level low	VOL	-	-	0.1	V
Output logic level high	VOH	0.9	-	-	V



## 2.4. RF parameters

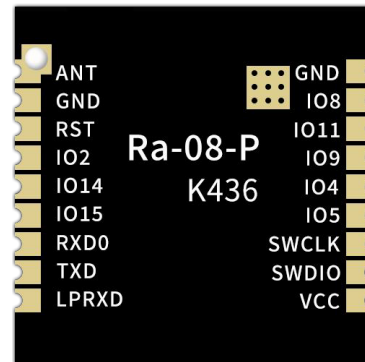
**Table 4 RF parameters**

Output power					
Mode	RF Band	Min.	Typical	Max.	Unit
Transmit power	433MHz	-	+29	-	dBm
Transmit power	470MHz	-	+29	-	dBm
Transmit power	490MHz	-	+29	-	dBm
Transmit power	510MHz	-	+29	-	dBm
Receiving sensitivity Modulation bandwidth 125kHz					
Mode		Min.	Typical	Max.	Unit
SF7		-	-127	-	dBm
SF8		-	-130	-	dBm
SF9		-	-134	-	dBm
SF10		-	-137	-	dBm

### 3. Appearance Dimensions

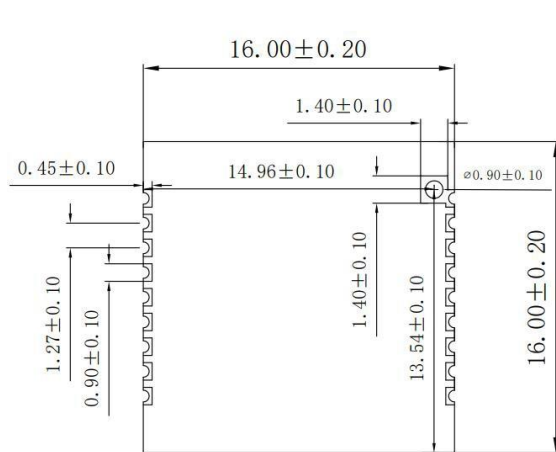


Front

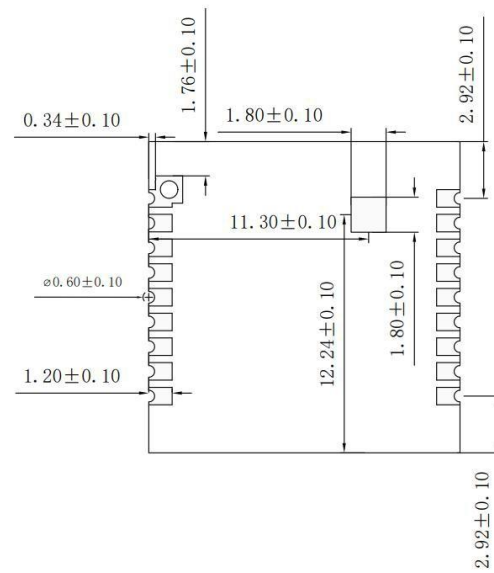


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**Figure 3 Exterior view (Rendering for reference only, subject to physical condition)**



Front

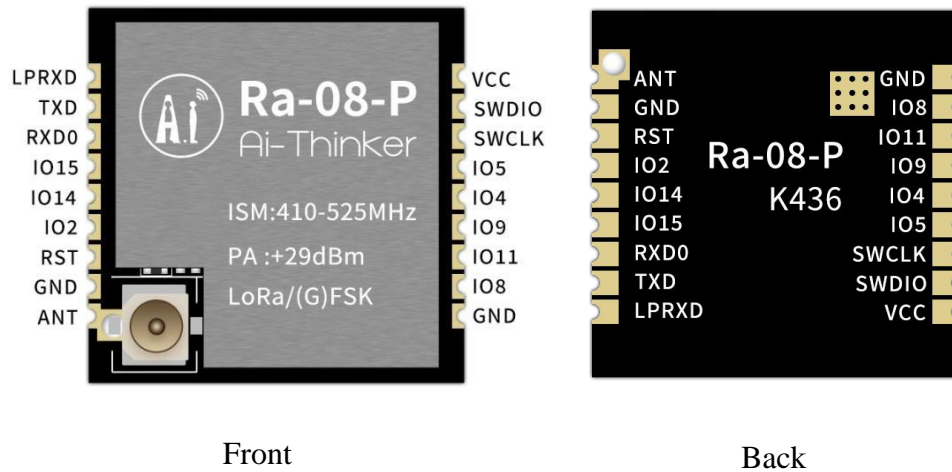


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**Figure 4 Dimensional drawing (unit: mm)**

## 4. Pin Definition

Ra-08-P module connects 19 pins as shown in the pin diagram, and the pin function definition table is the interface definition.



### Figure 5 Pin diagram

**Table 5 Definition table of pin functions**

No.	Name	Function
1, 17	GND	Ground
2	IO8	GPIO8/ADC_IN1
3	IO11	GPIO11/ADC_IN0
4	IO9	GPIO9/DAC_OUT
5	IO4	GPIO4/SSP1_CLK
6	IO5	GPIO5/SSP1_NSS
7	SWCLK	GPIO7/SWD_CLK
8	SWDIO	GPIO6/SWD_DATA
9	VCC	3.3V supply, recommended supply current >800mA.
10	LPRXD	GPIO60/LPUART-RX, Communication serial port.
11	TXD	GPIO17/UART TX
12	RXD0	GPIO16/UART RX, Burning a serial port.
13	IO15	GPIO15/I2C_SDA
14	IO14	GPIO14/I2C_SCL
15	IO2	GPIO2/BOOT
16	RST	RSTN_IN External reset, active low.
18	ANT	Antenna Interface
EPAD	GND	Grounding, need to be reliable grounding, conducive to heat dissipation.

**Table 6 Module start-up mode description.**

System boot mode			
Pin	Default	SPI boot mode	Download boot mode
IO2	下拉	0	1

Note: Some pins have been internally pulled-up, refer to the schematic.

## 5. Design Guidance

### 5.1. Application circuit

Attention:

- IO2 is the boot control pin, low in normal operation mode, high in burn firmware mode.  
The chip is internally low by default.
- U0RX is the burning serial port and LPRXD is the communication serial port, please choose by yourself according to your requirement.
- The module cannot transmit unloaded, the ANT pin must be connected to a load/antenna to transmit, otherwise it will result in burning the FEM chip.
- The output power of the module ASR6601 chip should be strictly controlled within 5dBm, and the input power is too large which will lead to burn the FEM chip.

## 5.2. Recommend PCB footprint size

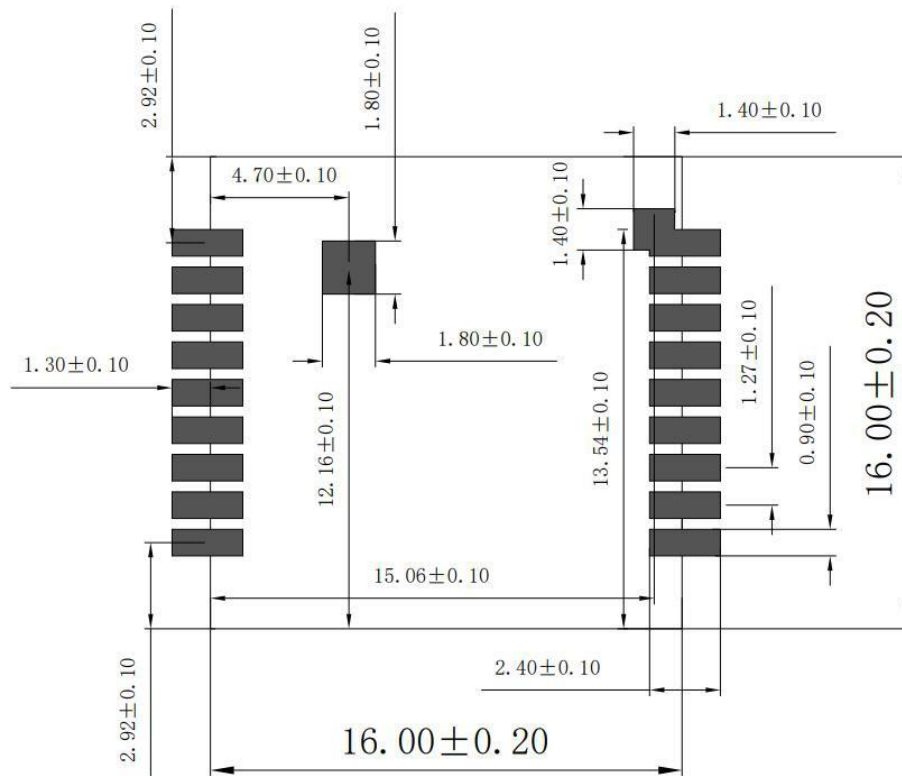


Figure 8 Recommended PCB package size diagram (unit: mm)

## 5.3. Antenna installation

- The Ra-08-P requires an external antenna for use, and the module has half-hole pads to lead to the motherboard.
- For optimal antenna performance, the antenna should be mounted away from metal parts.
- Antenna mounting structure has a great influence on the module performance, make sure the antenna is exposed, preferably vertically upwards. When the module is installed inside the case, you can use a good quality antenna extension cable to extend the antenna to the outside of the case.
- The antenna should never be mounted inside a metal case, as this will result in a significant weakening of the transmission range.

## 5.4. Power supply

- Recommends 3.3V voltage and 1A+ peak current.
- Recommends the use of LDO power supply; if using DC-DC it is recommended that the ripple is controlled within 100mV.
- The DC-DC power supply circuit recommends reserving the location of a dynamic response capacitor, which can optimise the output ripple when the load varies greatly.
- Additional ESD devices are recommended for the 3.3V power interface.
- When designing the power supply circuit for the module, it is recommended to keep more than 30% of the power supply current, so that the whole machine is conducive to long-term stable operation.
- Please pay attention to the correct connection of the positive and negative terminals of the power supply, such as reverse connection may lead to permanent damage to the module.

## 5.5. GPIO level conversion.

- There are some IO ports leading out of the periphery of the module, if you need to use it, it is recommended to connect 10-100 ohm resistors in series on the IO ports. This will suppress overshoot and make the levels smoother on both sides. It is helpful for both EMI and ESD.
- The pull-up and pull-down of the special IO ports should be referred to the usage instructions in the datasheet, and the start-up configuration of the module will be affected here.
- The IO port of the module is 3.3V, if the IO port level of the master control and the module do not match, you need to add a level conversion circuit.
- If the IO port is directly connected to a peripheral interface, or a terminal such as a row of pins, it is recommended to reserve an ESD device in the IO port alignment near the terminal.

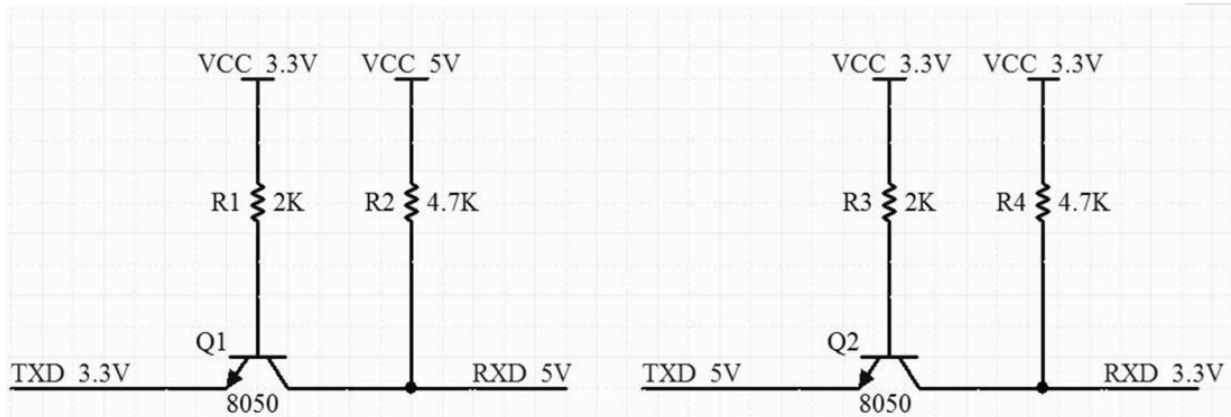


Figure 10 Level conversion circuit

## 5.6. Software writing

- The maximum input power of FEM chip can not exceed +5dBm, in order to avoid burning the FEM chip, users need to strictly configure the output power of ASR6601, recommended 3dBm.
- This module is an ASR6601+ peripheral circuit and the user can follow the ASR6601 chip manual exactly.



## 6. Frequently Asked Questions

### 6.1. Factors affecting transmission distance

- When there is a straight-line communication barrier, the communication distance is attenuated accordingly.
- Temperature, humidity, and co-frequency interference, can lead to increased communication packet loss.
- The ground absorbs and reflects radio waves and is less effective when tested close to the ground.
- Seawater has a very strong ability to absorb radio waves, so the results of the seaside test are poor.
- Signal attenuation can be very severe when there are metal objects near the antenna, or when it is placed in a metal case.
- The power register is set incorrectly, the air rate is set too high (the higher the air rate, the closer the distance).
- The low voltage of the power supply at room temperature is lower than the recommended value, and the lower the voltage, the lower the generating power.
- Using an antenna that is poorly matched to the module or the quality of the antenna itself.

### 6.2. Modules usage precautions

- Check the power supply to ensure that it is between the recommended supply voltages, exceeding the maximum value can cause permanent damage to the module.
- Check the stability of the power supply, the voltage should not fluctuate significantly and frequently.
- Ensure that the process of installation and use of anti-static operation, high-frequency devices electrostatic sensitivity.
- Ensure that the process of installation and use should not be too high humidity, some components are humidity sensitive devices.
- It is not recommended to use it at too high or too low a temperature if there is no special need.

### 6.3. Factors causing interference with the module

- There is co-channel signal interference in the vicinity, stay away from the interference source or modify the frequency or channel to avoid the interference.
- The clock waveform on SPI is not standard, check whether there is interference on the SPI line, and the SPI bus alignment should not be too long.
- Unsatisfactory power supply may also cause garbled code, be sure to ensure the reliability of the power supply.
- Poor quality or too long extension cables and feeder cables can also cause high BER.

## 7. Storage condition

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

The moisture sensitivity class 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 will need to be baked before it can be put on line a second time.

## 8. Reflow welding curve diagram

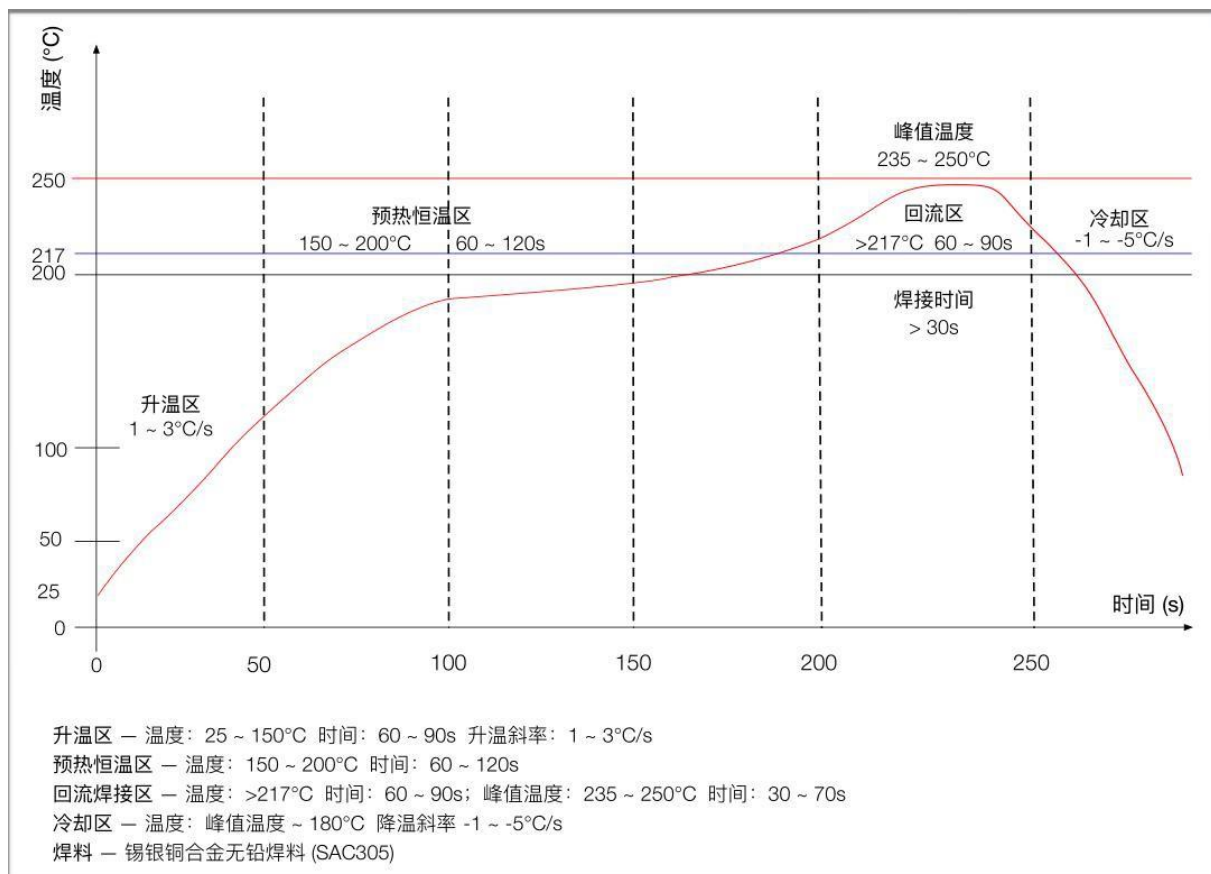


Figure 11 Reflow welding curve

## 9. Product packaging information

Ra-08-p is packaged in braided tape, 750pcs/tray. As shown in the picture below:



Figure 12 Packing braid

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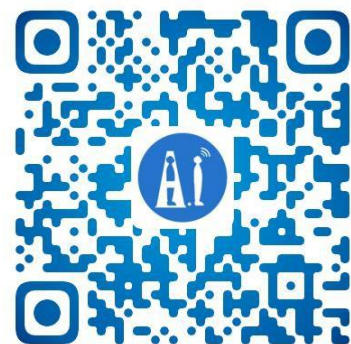
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Technology Co., Ltd. does not guarantee that the contents of the manual are completely free of errors. All statements and information in this manual. And the suggestion does not constitute any express or implied guarantee.

## 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 20cm 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-RA08P”

## **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.<sup>3</sup>

**Explanation:** This module meets the requirements of FCC part 15C (15.231). It specifically identified AC Power Line Conducted Emission, Radiated Spurious emissions, Bandwidth, Dwell Time, 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.

**Explanation:** The product antenna uses an Glue stick antenna with a gain of 1dBi

### **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-RA08P

## 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-RA08P

## **2.9 Information on test modes and additional testing requirements<sup>5</sup>**

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.