



AT60MF1T1RP32A

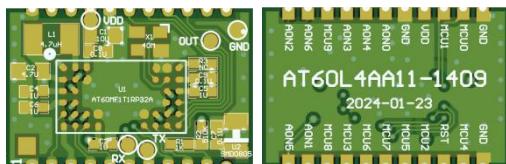
60GHz millimeter wave radar sensor

DS00011 V1.10 Date: 2024/04/25

Product data manual

product overview

The AT60MF1T1RP32A is a small-size module based on AT60MF1T1RP32A series chip launched by Gekong (Shanghai) Intelligent Technology Co., Ltd. for industrial and consumer markets, which is expected to provide the market with the best cost-effective solution with small size, low power consumption and high performance.



- ◆ Handler
 - ARM® Cortex-M0+core
 - The main frequency is up to 160MHz
 - 2 x 16KByte can be configured as I-Cache for SRAM
 - 192KByte SRAM(含 2 × 32KByte Retention SRAM)
- Accelerator
 - 1 × Up to 1024 point FFT arithmetic accelerator
 - 2×1D CA-CFAR pre-detector

Product feature

- ◆ radio
 - Operating frequency 59-64GHz
 - Built-in 1T1R antenna
 - The transmission power is adjustable and the maximum output is 11dBm
 - Built-in 0° /180° BPM phase shifter
 - Supports 5GHz continuous sweep frequency
 - NF 12dB@ maximum gain
 - Phase noise -90 DBC /Hz@1MHz
 - Built-in waveform generator supports 8 preset waveforms
 - 5Msps/10Msps 16bit real sampling ADC

Digital interface

- 1×UART
- ◆ 3×PWM、3×ADC、3×GPIO
- ◆ FLASH
 - Inner seal Quad-SPI 512KByte FLASH

Ordering information

Model	Power	Size
AT60MF1T1RP32A	3.3V	14×9 mm ²

Revision history

Version	Date	Reason
V1.00	2024/04/25	Create a document
V1.10	2024/04/25	Update module naming

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1. Product brief introduction

AT60MF1T1RP32A is a small-size module based on AT60MF1T1RP32A series chip (built-in 1T1R_AIP antenna) launched by Airtouch(Shanghai) Intelligent Technology Co., Ltd for industrial and consumer markets, which is expected to provide the market with the best cost-effective solution with small size, low power consumption and high performance.

The AT60MF1T1RP32A chip has a complete input-to-transmit link and ADC converter, and the transmitter has a 0° / 180° BPM phase shifter function, providing a maximum RF output power of 11dBm; The receiver channel can also be flexibly configured through the flexible combination of programmable gain and high-pass/low-pass filters, which can easily cope with different sweep slope application scenarios.

The AT60MF1T1RP32A chip supports a highly configurable waveform generator that supports up to eight different sweep waveform combinations, and the parameters of each sweep waveform can be flexibly configured. The use of composite waveform modes provides greater configuration flexibility in interference suppression and low power mode selection.

The AT60MF1T1RP32A chip has a built-in ARM® Cortex-M0+ core processor, supports SPI, I2C, UART and other communication interfaces, and consists of a complete SoC system through built-in FLASH, which supports low power mode and Memory Retention function.

The AT60MF1T1RP32A module can be widely used in smart home, security, gesture recognition, BSD and vital signs detection and other fields.

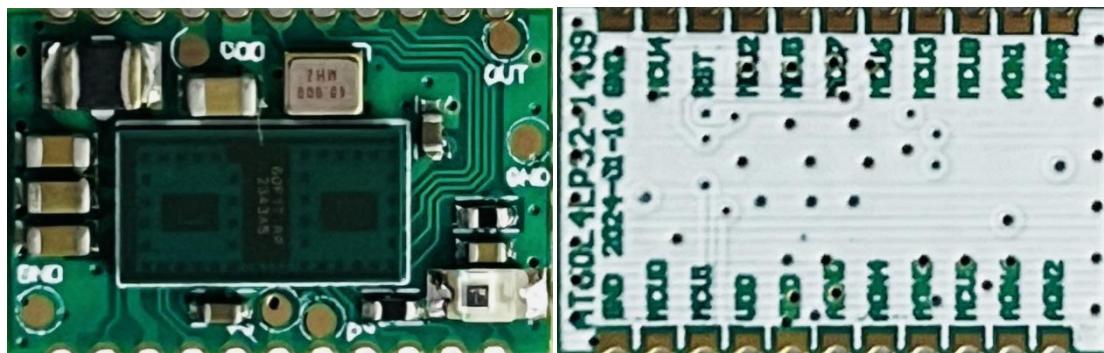


Figure 1.1 AT60MF1T1RP32A module

2. Main features

The AT60MF1T1RP32A module has the following features:

- Radio

- Operating frequency 59-64GHz
- Built-in 1T1R antenna
- The transmission power is adjustable and the maximum output is 11dBm
- Built-in 0° /180° BPM phase shifter
- Supports 5GHz continuous sweep frequency
- Phase noise -90 DBC /Hz@1MHz
- Built-in waveform generator supports 8 preset waveforms
- 5Msps/10Msps 16bit real sampling ADC

- Handler

- ARM® Cortex-M0+kernel
- The main frequency is up to 160MHz
- 2×16KByte can be configured as I-Cache for SRAM
- 192KByte SRAM(contain 2×32KByte Retention SRAM)

- Accelerator

- 1×Up to 1024 point FFT arithmetic accelerator
- 2×1D CA-CFAR predetector

- Port

- 1×UART
- ◆ 3×PWM、3×ADC、3×GPIO

- FLASH

- Internal Quad-SPI 512KByte FLASH

3. Pin definition

AT60MF1T1RP32A radar module reserved 22PIN (11 x 2 double row semicircular holes, spacing 1.1mm). Figure 3.1 shows the module pin definition diagram, and Table 3.1 shows the pin definition and description.

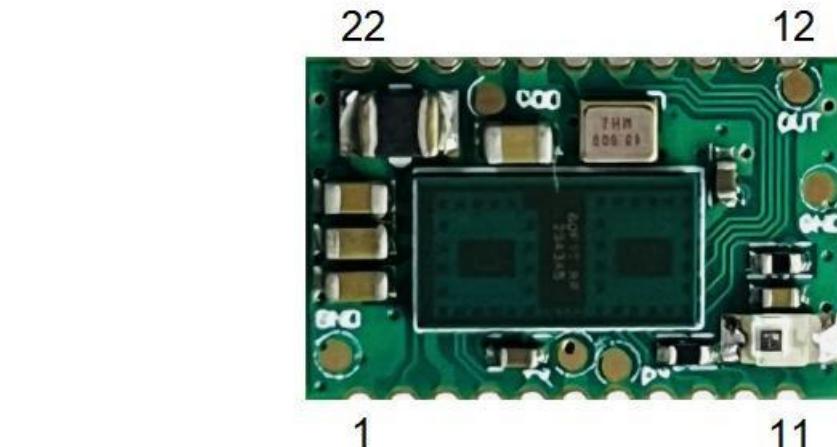


Figure 3.1 Module pin definition
Table 3.1 Module pin definition and description

Pin	symbol	prop erty	Pin definition	describe	original state
1	GND	P	Module grounding pin	Work gnd	
2	M4	I/O	M4 / PWM3 / ADC2	Multifunctional foot	L
3	RST	I	Reset foot	Hardware reset function pin, low level reset	
4	M2	I/O	M2 / SPI_D0	SPI D0 bit Indicates pin 0 of the SPI interface data	L
5	M5	I/O	M5 / PWM4 / ADC2	Multifunctional foot	L
6	M7	I/O	M7 / Radar_RX	UART_Rx foot (Download port)	H
7	M6	I/O	M6 / Radar_TX	UART_Tx foot (Download port)	H
8	M3	I/O	M3 / SPI_D1	SPI D1 bit Indicates pin 1 of the SPI interface	L
9	M8	I/O	M8	Multifunctional foot	H
10	A1	I/O	A1 / PWM1 / ADC1	Multifunctional foot	L
11	A5	I/O	A5 / SPI_D2 / SWC	SPI D2 bit Indicates data pin 2 of the SPI interface. SWC indicates the debug pin	
12	A2	O	Module output pin	Can PWM output	L

1 3	A6	I/O	A6 / SPI_D3 / SWD	SPI D3 bit Indicates pin 3 of the SPI interface data. SWD indicates the debug pin	L
1 4	M9	I/O	M9	Multifunctional foot	H
1 5	A3	I/O	A3 / I2C_SCL	Can be used as I2C interface clock signal pin	H
1 6	A4	I/O	A4 / I2C_SDA	Can be used as I2C interface clock data pin	H
1 7	A0	I/O	A0 / PWM0 / ADC1	Can be used as interrupt input pin	L
1 8	GND	P	Module grounding pin	Work gnd	
1 9	VDD	P	Module power supply pin	DC 3.3V ±0.15V (typical)*	
2 0	M1	I/O	M1 / SPI_CS	SPI CS bit Indicates the SPI interface chip selection pin	H
2 1	M0	I/O	M0 / SPI_CLK	SPI CLK bit Indicates the clock pin of the SPI interface	L
2 2	GND	P	Module grounding pin	Work gnd	

*Power supply limit voltage +5.5V, exceeding or equal to the upper voltage will damage the chip, seriously damage the chip.

4. Schematic

The typical application schematic diagram of AT60MF1T1RP32A module is shown in Figure 4.1. If you need more detailed design information, please contact our business department.

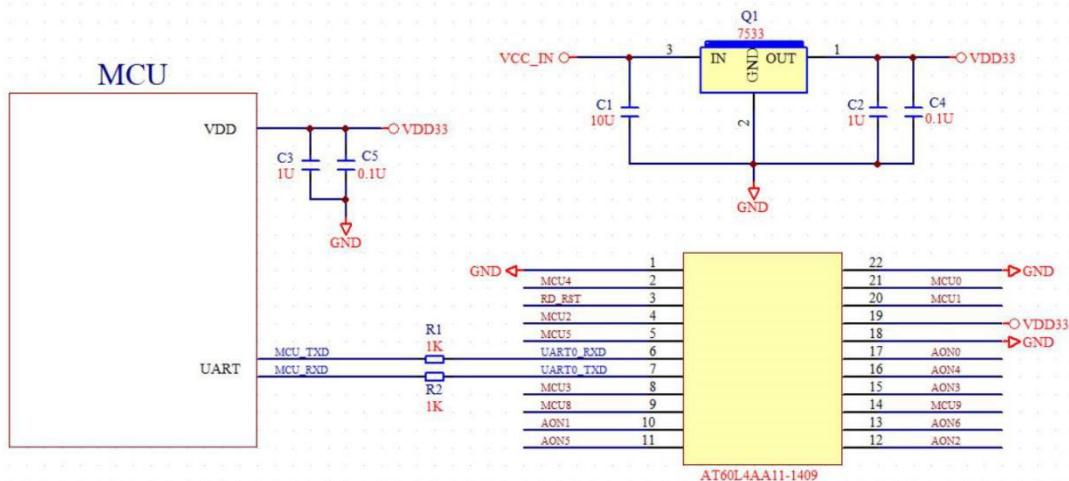


Figure 4.1 Schematic diagram of typical application of modules

5. Electrical characteristics

5.1 Recommended Working Parameters

Table 5.1 lists the main parameters of the AT60MF1T1RP32A module.

Table 5.1 Main parameters of the AT60MF1T1RP32A module

Parameter	Symbol	Min	Typical	Max	Unit	Remarks/Test conditions
Working voltage	V _{CC}	3.0	3.3	4.2	V	—
Working current	I _{CC}	0.33	11	—	mA	Low power mode
Working current	I _{CC}	—	80	—	mA	Non-low power mode

5.2 Absolute Maximum rated parameters

The absolute maximum rating is a condition that must not be exceeded, even for an instant, otherwise it may lead to reduced IC performance or even permanent damage. Table 5.2 shows the absolute maximum rated parameters of the AT60MF1T1RP32A module.

Table 5.2 Absolute maximum rated parameters of the AT60MF1T1RP32A module

Parameter	Symbol	Min	Typical	Max	Unit	Remarks/Test conditions
Working voltage	V _{CC}	3.0	—	5.5	V	—
I/O direct voltage	V _{IO}	0	3.3	3.6	V	—
RF input power	P _{RF}	—	—	0	dBm	RXRF
Operating temperature	T _A	-30	—	85	°C	Ambient air temperature
Storage temperature	T _{STG}	-40	—	150	°C	—

5.3 RF Performance Parameters

Table 5.3 lists main performance parameters of the RFtransmitter of the AT60MF1T1RP32A module. Table 5.3 Main performance parameters of the RF transmitter.

Parameter	Symbol	Min	Typical	Max	Unit	Remarks/Test conditions
RF port impedance	Z _{TX}	—	50	—	Ω	PA_OUT
Output power	P _{RFOUT}	—	10	11	dBm	—

Frequency range	F _{RF}	59	—	64	GHz	—
Phase shifter	—	—	1	—	1bit	180°
Phase shifter mean square error	—	—	1.5	—	°	—

Table 5.4 lists the main performance parameters of the RF receiver of the AT60MF1T1RP32A module.

Table 5.4 RF receiving performance parameters

Parameter	Sym bol	Min	Typical	Max	Unit	Remarks/Test conditions
RF port impedance	Z _{RX}	—	50	—	Ω	RXRF
P1dB	—	—	10	—	dBm	—
Frequency range	F _{RF}	59	—	64	GHz	—
Gain margin	G _{RX}	22	—	56	dB	—
RX NF	NF	—	12	—	dB	—
High-pass filter	HPF	43.75/87.5/175/350/700			kHz	—
LOW-pass filter	LPF	1000/2000			kHz	—

6. List of key components

Description	Designator	Footprint	Comment	Quantity
SMD-crystal oscillator	X1	2016	40MHz CL=8pF ±15ppm	1
SMD-inductor	L1	2016	4.7uH±20% DCR≤200mΩ IDC≥1A	1

7. Module size

The following figure 7.1 is the specification and size diagram of the module. The length and width of the module are 14 mm * 9 mm, and the PCB thickness is 1.0mm.

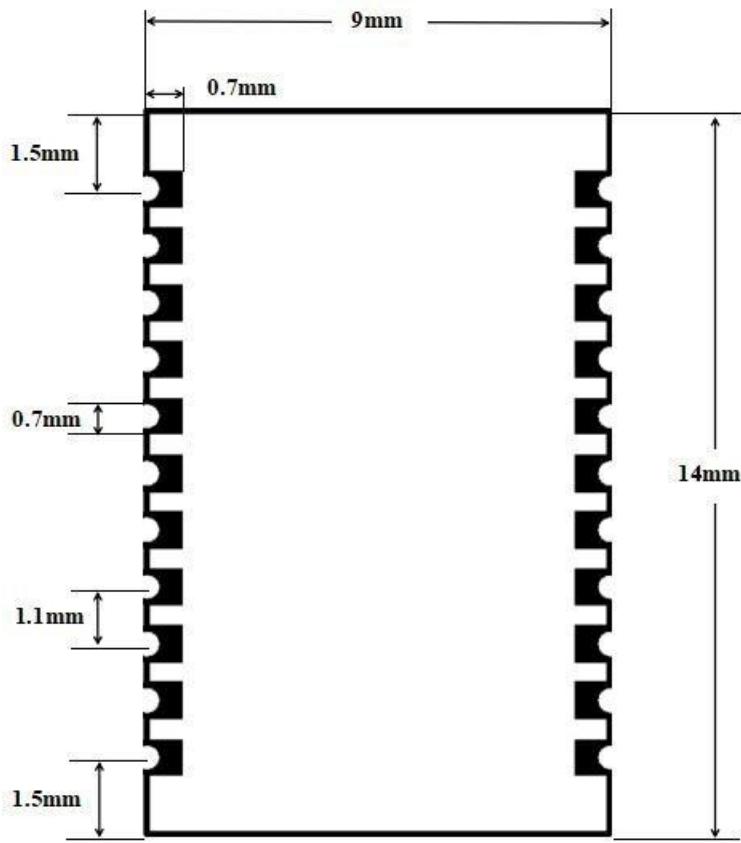


Figure 7.1 Schematic diagram of module dimensions

8. Power-on sequence

After the module is powered on, the OUT pin outputs high level after a delay of 4ms, low level after a delay of 1.85S, and enters normal induction mode after a low level delay of 1.5S (where the first 0.5S is the software initialization time). The following figure 8.1 is the sequence diagram of the control signal after the module is powered on:

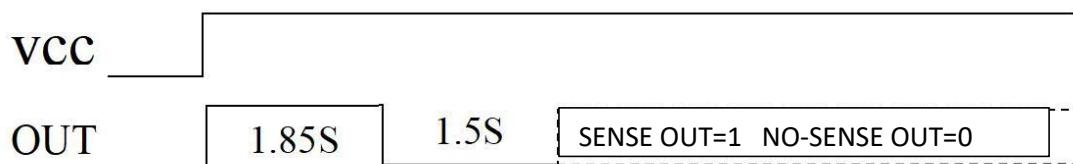


Figure 8.1 Timing diagram of module power-on

9. Schematic diagram of detection range

The sensitivity of the radar sensor can be configured by modifying the software parameters. The forward limit sensing distance is about 12 meters, and the actual sensing distance can be adjusted according to the needs. Radar ranging data diagram of the following typical scene (outdoor open field, with a distance of 8 meters). If the sensitivity is set higher, the detection range will be larger accordingly. Figure 9.1 below records the distance data detected by human movement at different angles (the distance tested by different field environments will be biased).

(Unit: meter)

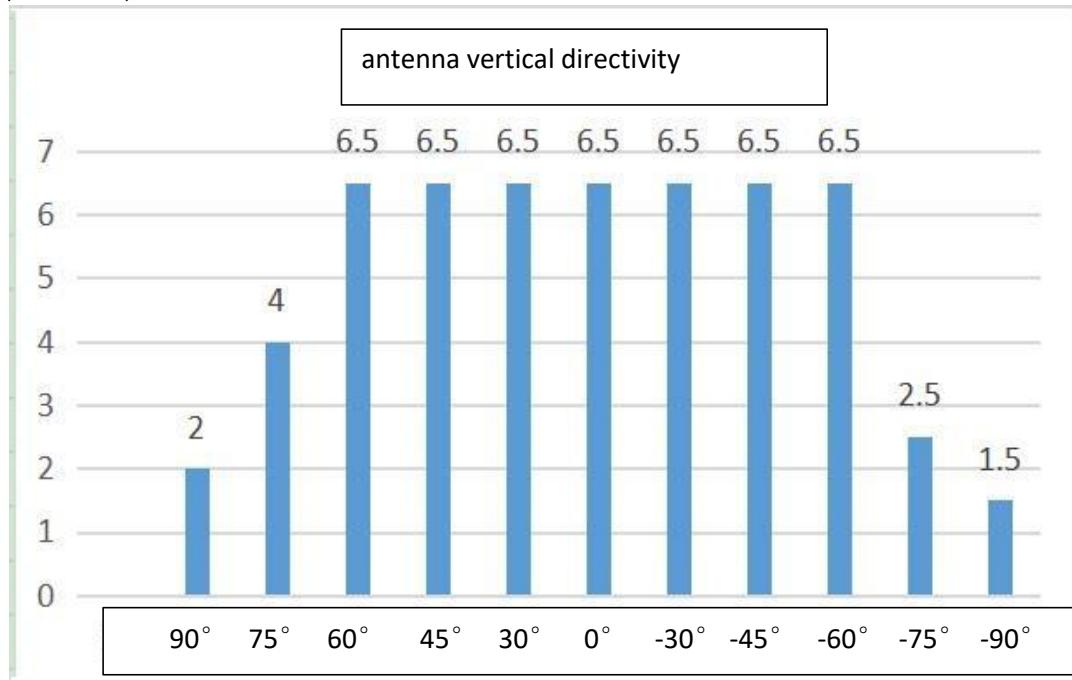


Figure 9.1 Schematic diagram of module detection range

10. Precautions

- When installing the antenna, avoid metal shells or components on the front of the antenna to prevent signals from being shielded. Shielding materials such as plastic or glass are allowed. However, the shielding materials should not be close to the front of the antenna.

For example: 1.5mm thick PC (polycarbonate) material, the distance between the 60G module antenna surface needs to be an integer multiple of 2.5mm,

For example, 2.5mm / 5.0mm / 7.5mm.

- Try to avoid pointing the radar antenna directly towards large metal equipment or pipes.
- When installing multiple radar modules, ensure that the antennas of each radar module are parallel to each other as far as possible, avoid direct irradiation between the antennas, and maintain a spacing of more than 1m between the modules.
- The radar sensor should avoid facing the AC drive power supply and stay away from the rectifier bridge of the drive power supply as far as possible, so as not to interfere with the radar signal with the power frequency.

11. Disclaimer

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The Company reserves the right to modify the content of the document or software without notice to the reader, and the company does not assume any responsibility for any effects arising from the use of the software.

Antenna used

Antenna Type	Brand/ manufacturer	Model No.	Max. Antenna Gain
Integrated Patch Antenna	Airtouch (Shanghai) Intelligent Technology Co., Ltd	AT60MF1T1RP32A	5dBi

Notice to Host Product Manufacturer

Notice to Host manufacturer when installing our Limited Module and intend to use Contains FCC ID: 2AVK2AT60MF1T1RP32A

Limited module procedure

The module doesn't have its own RF shielding, The host should provide the RF shielding to the modular, which belong to Limited module.

Standard requires: Clear and specific instructions describing the conditions, limitations and procedures for third parties to use and/or integrate the module into a host device (see Comprehensive integration instructions below).

Supply example as follows: Installation Notes:

- (1). Power supply for the limited module with FCC ID: 2AVK2AT60MF1T1RP32A is DC 3.3V, when you use product with this module design, the power supply cannot exceed this value.
- (2). When connect the module to the host device, the host device must be powered off.
- (3). Make sure the module pins correctly installed.
- (4). Make sure that the module does not allow users to replace or demolish.

The host product will need to evaluate according to FCC Part 15 Subpart C 15.255 for 59–64GHz Radar:

- (1). Maximum EIRP of channel 59–64GHz.
- (2). Radiated spurious emissions and band edge on channel 59 and 64GHz with the other co-located transmitters.

RF Exposure evaluation for the simultaneous transmission of the co-located transmitters. The host product shall be evaluation for ensuring the continuous compliance for the FCC rules that apply to the host product. Additional guidance for testing host products is provided in KDB Publication 996369 D02 and D04. This module was tested as a subsystem and its certification does not cover the FCC Part 15 Subpart B (unintentional radiator) rule requirement applicable to final host. The host will still need to be reassessed for compliance to this portion of rule requirements. For the host product is not installed according to this guide, the module certification will be invalid, and a new grant certification will be required for the host product.

Contact Information:

Company Name: Airtouch (Shanghai) Intelligent Technology Co., Ltd

Address: 11th Floor, Building 4, Lane 388, Shengrong Road, Pudong New District, Shanghai, China

Contact Email: lingjun.huang@airtouching.com

Contact Phone: +86 021-61461038

FCC&IC regulatory compliance statement

§ 15.19 Statement

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.

§ 15.21 Information to user

Warning: changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

RF Exposure compliance statement

This Module complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Labelling Instruction for Host Product Integrator

Please notice that if the FCC and IC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. For FCC, this exterior label should follow "Contains FCC ID: 2AVK2AT60MF1T1RP32A".

In accordance with FCC KDB guidance 784748 Labeling Guidelines.

§ 15.19 Labelling requirements shall be complied on end user device.

Labelling rules for special device, please refer to § 2.925, § 15.19 (a) (5) and relevant KDB publications. For E-label, please refer to § 2.935.

Installation Notice to Host Product Manufacturer

The OEM integrator is responsible for ensuring that the end-user has no manual instruction to remove or install module.

The module is limited to installation in mobile application, a separate approval is required for all other operating configurations, including portable configurations with respect to § 2.1093 and difference antenna configurations.

Antenna Change Notice to Host manufacturer

If you desire to increase antenna gain and either change antenna type or use same antenna type certified, a Class II permissive change application is required to be filed by us, or you (host manufacturer) can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application.

FCC other Parts, Part 15B Compliance Requirements for Host product manufacturer
This modular transmitter is only FCC authorized for the specific rule parts listed on our grant, 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.

Host manufacturer in any case shall ensure host product which is installed and operating with the module is in compliant with Part 15B requirements.

Please note that For a Class B or Class A digital device or peripheral, the instructions furnished the user manual of the end-user product shall include statement set out in § 15.105 Information to the user or such similar statement and place it in a prominent location in the text of host product manual.

Original texts as following:

For Class B

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.

For Class A

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

This equipment used on satellites, and aircraft are prohibited.