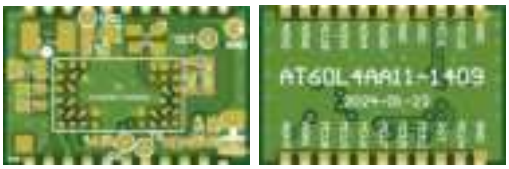
AT60MF1T1RP32A

60GHz millimeter wave radar sensor

DS00011 V1.10Date: 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.



————————————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

◆ 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

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

Contents

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.

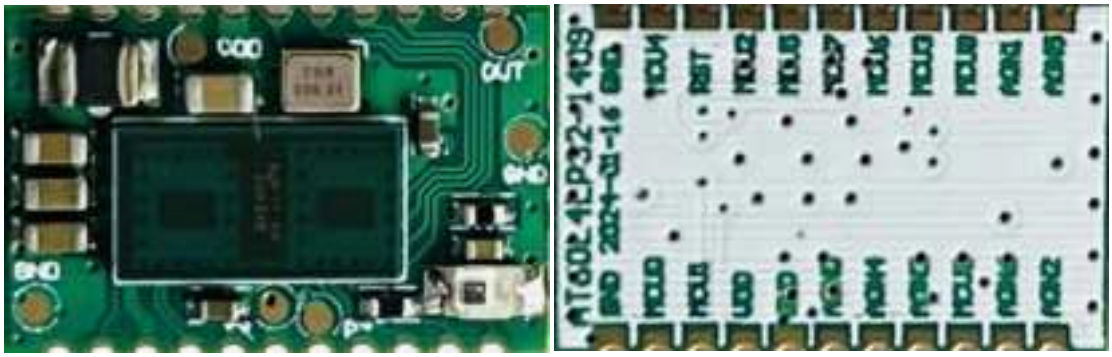


Figure 1.1 AT60MF1T1RP32A module

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.

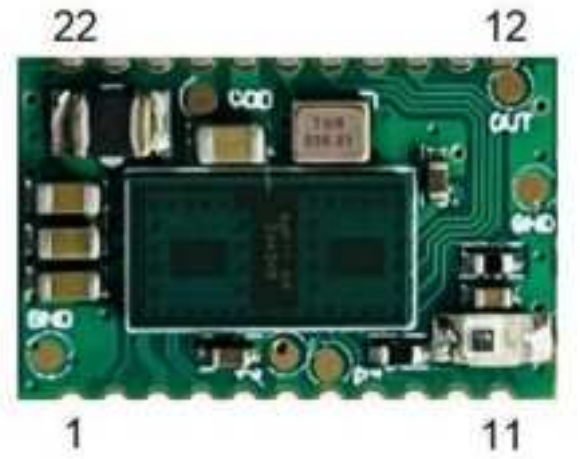


Figure 3.1 Module pin definition

Table 3.1 Module pin definition and description

Pin	symbol	property	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

13	A6	I/O	A6 / SPI_D3 / SWD	SPI D3 bit Indicates pin 3 of the SPI interface data. SWD indicates the debug pin	L
14	M9	I/O	M9	Multifunctional foot	H
15	A3	I/O	A3 / I2C_SCL	Can be used as I2C interface clock signal pin	H
16	A4	I/O	A4 / I2C_SDA	Can be used as I2C interface clock data pin	H
17	A0	I/O	A0 / PWM0 / ADC1	Can be used as interrupt input pin	L
18	GND	P	Module grounding pin	Work gnd	
19	VDD	P	Module power supply pin	DC 3.3V ±0.15V (typical)*	
20	M1	I/O	M1 / SPI_CS	SPI CS bit Indicates the SPI interface chip selection pin	H
21	M0	I/O	M0 / SPI_CLK	SPI CLK bit Indicates the clock pin of the SPI interface	L
22	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.

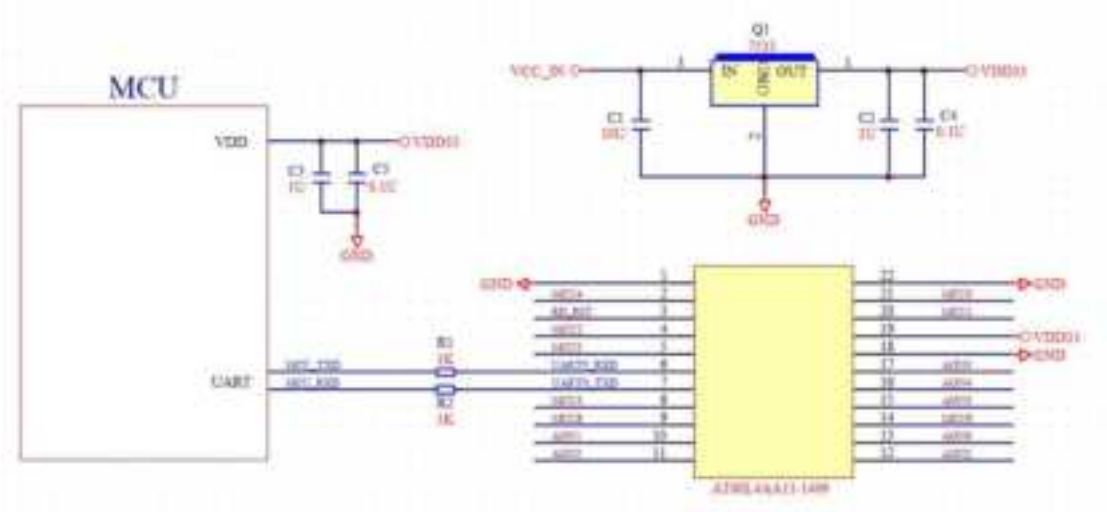


Figure 4.1 Schematic diagram of typical application of modules

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	Vcc	3.0	3.3	4.2	V	—
Working current	Icc	0.33	11	—	mA	Low power mode
Working current	Icc	—	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	Vcc	3.0	—	5.5	V	—
I/O direct voltage	VIO	0	3.3	3.6	V	—
RF input power	PRF	—	—	0	dBm	RXRF
Operating temperature	TA	-30	—	85	℃	Ambient air temperature
Storage temperature	TSTG	-40	—	150	℃	—

5.3 RF Performance Parameters

Table 5.3 lists main performance parameters of the RFtransmitter of the AT60MF1T1RP32Amodule. Table 5.3 Main performance parameters of the RF transmitter.

Parameter	Symbol	Min	Typical	Max	Unit	Remarks/Test conditions
RF port impedance	ZTX	—	50	—	Ω	PA_OUT
Output power	PRFOUT	—	10	11	dBm	—

Frequency range	FRF	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	Symbol	Min	Typical	Max	Unit	Remarks/Test conditions
RF port impedance	ZRX	—	50	—	Ω	RXRF
P1dB	—	—	10	—	dBm	—
Frequency range	FRF	59	—	64	GHz	—
Gain margin	GRX	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.

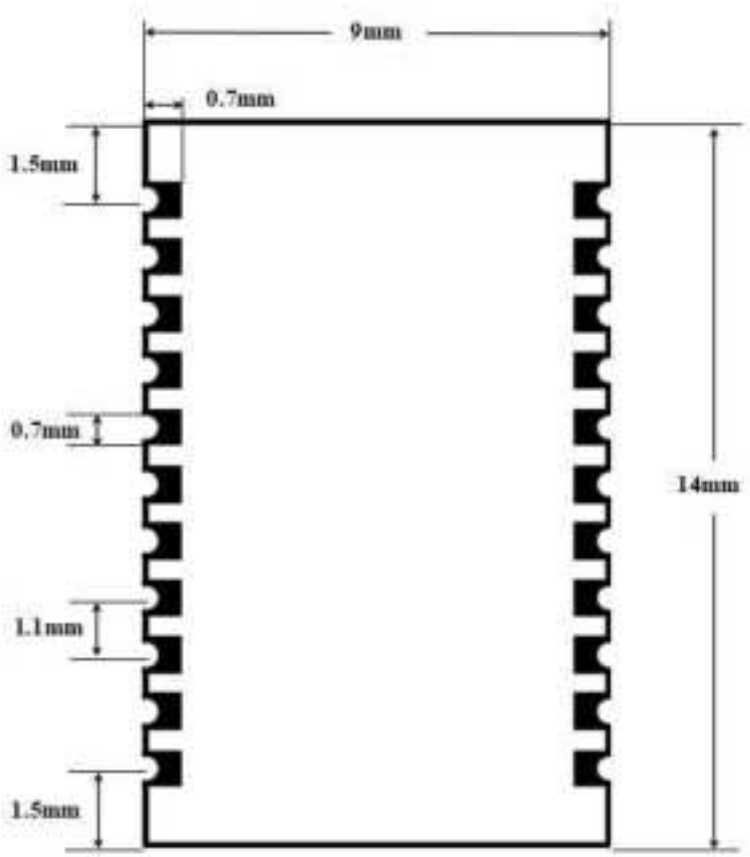


Figure 7.1 Schematic diagram of module dimensions

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:

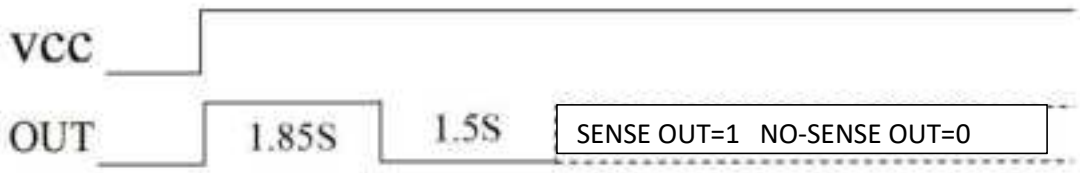


Figure 8.1 Timing diagram of module power-on

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)

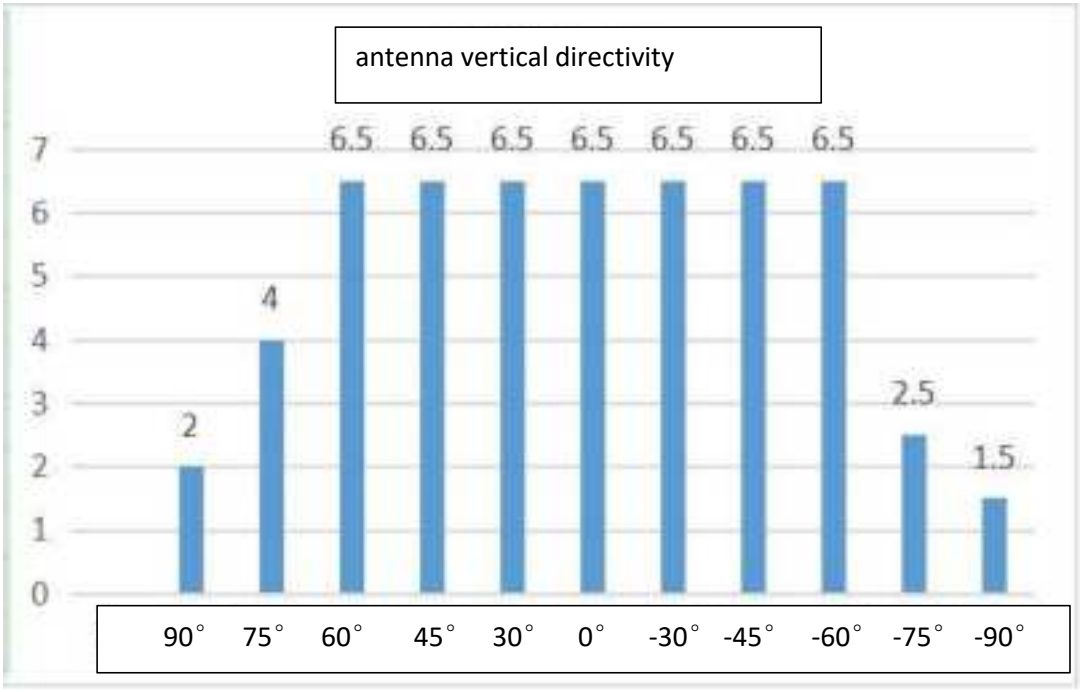


Figure 9.1 Schematic diagram of module detection range

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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