RF-WM-11AFB1 Ultra-Low-Power 2.4 GHz Wi-Fi Module

Version 1.0

Shenzhen RF-star Technology Co., Ltd.

Jan. 19th, 2020

Wi-Fi Module List

Chipset	Core	RAM (KB)	Tx Power (dBm)	Model	FLASH (Byte)	Antenna	Dimension (mm)	Distance (m)	Photo
CC3235S	M4	256	18	RF-WM-3235A1S	4M	PCB	20.5 × 25.0	100	
	M4	256	18	RF-WM-3235B1S	4M	Half-hole	20.5 × 17.5	100	
CC3235SF	M4	256	18	RF-WM-3235A1	4M + 1M embedded	PCB	20.5 × 25.0	100	
	M4	256	18	RF-WM-3235B1	4M + 1M embedded	Half-hole	20.5 × 17.5	100	
CC3200	M4	256	17	RF-WM-3200B1	1M	Chip	20 × 31	100	
				RF-WM-3200B1I	1M	IPEX	20 × 31	150	Contact Me
				RF-WM-3200B2	16M	Chip	20 × 31	100	
				RF-WM-3200B3	1M	Half-hole	20.5 × 17.5	100	
CC3220	M4	256	17	RF-WM-3220B1	4M	Chip / IPEX	20 × 31	100	
RTL8710AF	M3	512	17	RF-WM-10AFB1	1M	IPEX	20 × 23	100	
RTL8711AF	M3	512	17	RF-WM-11AFB1	1M	IPEX	20 × 23	100	

Note:

1. The communication distance is the longest distance obtained by testing the module's maximum transmission power in an open and interference-free environment in sunny weather.
2. Click the picture to buy modules.
3. All modules with PCB / Chip antenna and IPEX connector are dispatched with PCB / Chip antenna only by default. If IPEX connector is needed, pls check with me before quotation.

1 Device Overview

1.1 Description

RF-WM-11AFB1 is a PCB module based on Realtek Wi-Fi SoC RTL8711AF of Cortex™-M3 core at 83 MHz. This module has on-chip 512 KB RAM and 1 MB flash, a pin-out of peripherals of SDIO, SPI, UART, I²C, I²S, and GPIOs. It has integrated a 40 MHz crystal, an on-board PCB antenna, and an IPEX/ U.FL connector for connecting to an external antenna. It supports 2.4 GHz 802.11 b/g/n at 20 MHz channel bandwidth with 75 Mbps maximum data rate. The module comes with a pre-programmed serial interface data communication protocol and an AT commands set to minimizes users' effort to establish the data link to their existing MCUs or processors. It supports STA, AP, and STA + AP concurrent modes, advanced security features include Wi-Fi WEP, WPA, WPA2, and WPS2 with MD5, SHA-1, SHA2-256, DES, 3DES, and AES security engines.

1.2 Key Features

- General
  - CMOS MAC, baseband PHY, and RF in a single chip for 802.11b/g/n compatible WLAN
  - Complete 802.11n solution for 2.4 GHz band
  - 72.2 Mbps receive PHY rate and 72.2 Mbps transmit PHY rate using 20 MHz bandwidth
  - 150 Mbps receive PHY rate and 150 Mbps transmit PHY rate using 40 MHz bandwidth
  - Compatible with 802.11n specification
  - Backward compatible with 802.11b/g devices while operating in 802.11n mode
- Standards supported
  - 802.11b/g/n compatible WLAN
  - 802.11e QoS Enhancement (WMM)
  - 802.11i (WPA, WPA2). Open, shared key, and pair-wise key authentication services
  - Wi-Fi WPS support
  - Wi-Fi direct support
  - Light weight TCP/IP protocol
- WLAN MAC features
  - Frame aggregation for increased MAC efficiency (A-MSDU, A-MPDU)
  - Low latency immediate High-Throughput Block Acknowledgement (HT-BA)
  - Long NAV for media reservation with CF-End for NAV release
  - PHY-level spoofing to enhance legacy compatibility
  - Power saving mechanism
- WLAN PHY features
  - 802.11n OFDM
  - One Transmit and One Receive path (1T1R)
  - 20 MHz and 40 MHz bandwidth transmission
  - Short guard interval (400 ns)
  - DSSS with DBPSK and DQPSK, CCK modulation with long and short preamble
  - OFDM with BPSK, QPSK, 16QAM, and 640QAM modulation. Convolutional coding rate: 1/2, 2/3, 3/4, and 5/6
  - Maximum data rate 54 Mbps in 802.11g and 150 Mbps in 802.11n
  - Fast receiver Automation Gain Control (AGC)
  - On-chip ADC and DAC
- Peripheral interfaces
  - SDIO slave
  - Maximum 2 high speed UART interface with baud rate up to 4 MHz
  - 1 log UART with standard baud rate support

- Maximum 3 I²C interface
- I²S with 8/16/24/32/48/96/44.1/88.2 KHz sampling rate
- Maximum 2 PCM with 8/16 KHz sample rate
- Maximum 2 SPI supported with baud rate up to 20.8 MHz
- Support 4 PWM with configurable duration and suty cycle from 0 ~ 100%
- Support 4 external timer trigger event (ETE function) with configurable period in low power mode

1.3 Applications

- Cloud connectivity
- Home automation
- Home appliances
- Access control
- Security systems
- Smart energy
- Internet gateway
- Industrial control
- Smart plug
- Smart metering
- Wireless audio
- IP network sensor nodes

1.4 Functional Block Diagram

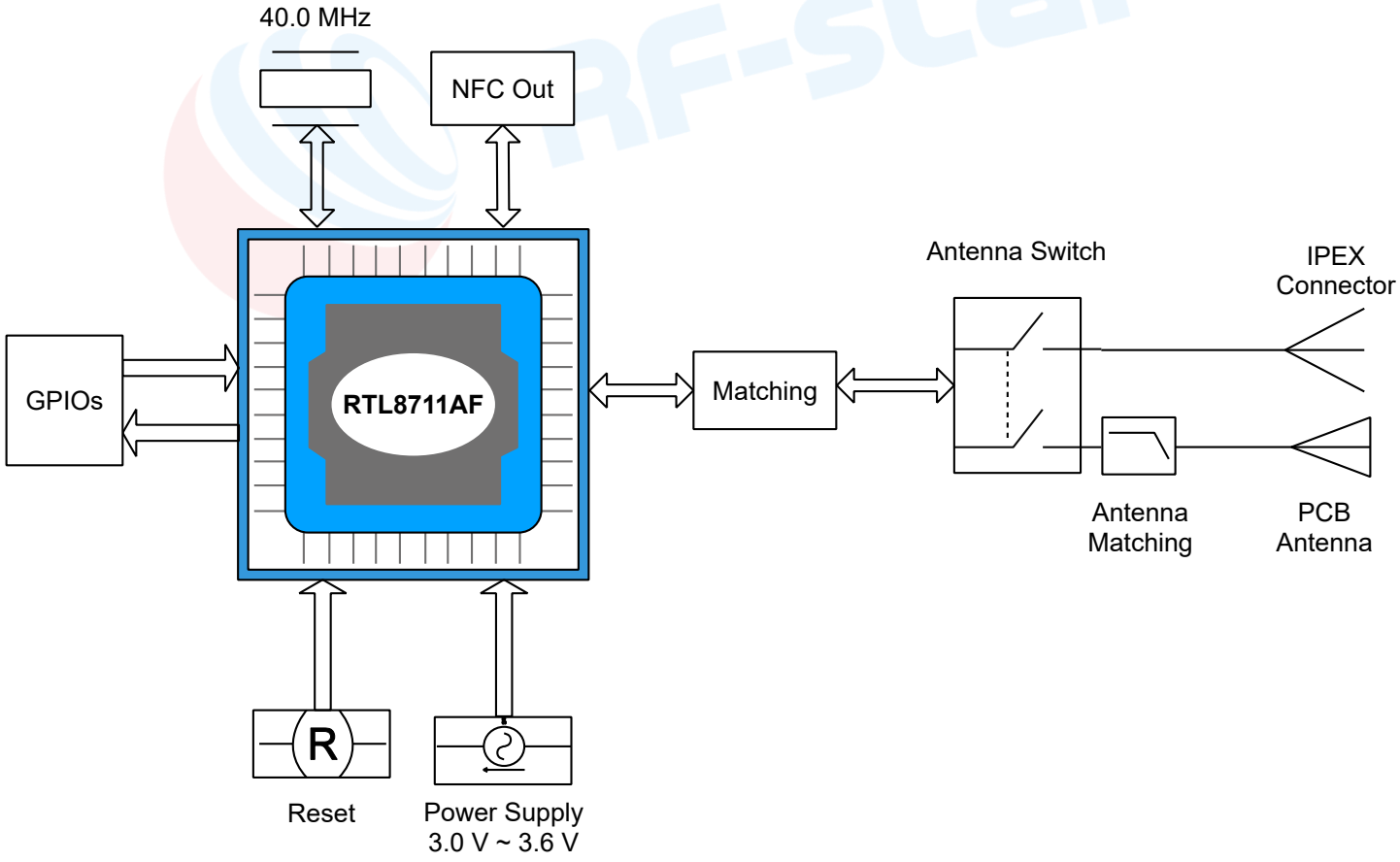

Figure 1. Functional Block Diagram of RF-WM-11AFB1

1.5 Part Number Conventions

The part numbers are of the form of RF-WM-11AFB1 where the fields are defined as follows:

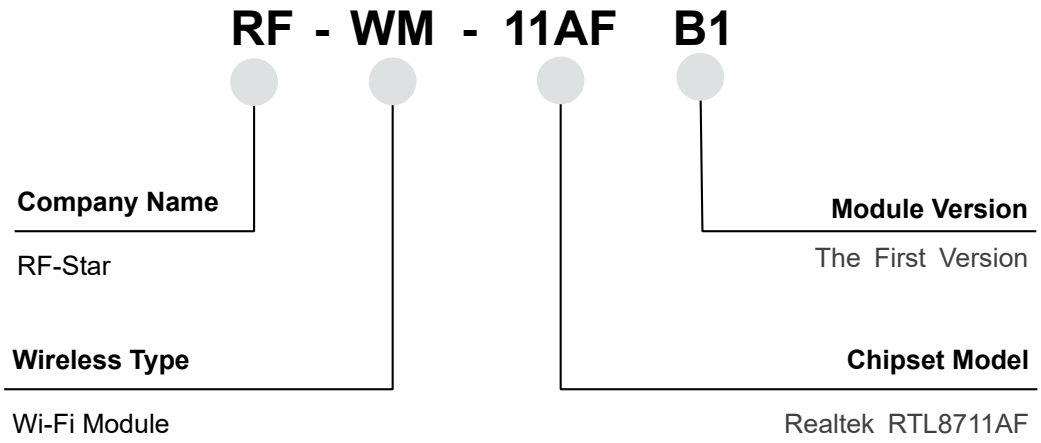

Figure 2. Part Number Conventions of RF-WM-11AFB1

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2 Module Configuration and Functions

2.1 Module Parameters

Table 1. Parameters of RF-WM-11AFB1

Chipset	Realtek RTL8711AF
Supply Power Voltage	3.0 V ~ 3.6 V, recommended to 3.3 V
Frequency	2.4 GHz
Crystal	40 MHz
Package	SMT Packaging
Dimension	23.0 mm x 20.0 mm x (2.4 ± 0.1) mm
Type of Antenna	PCB antenna / IPEX connector
Operating Temperature	-20 ℃ ~ +85 ℃
Storage Temperature	-40 ℃ ~ +125 ℃

2.2 Module Pin Diagram

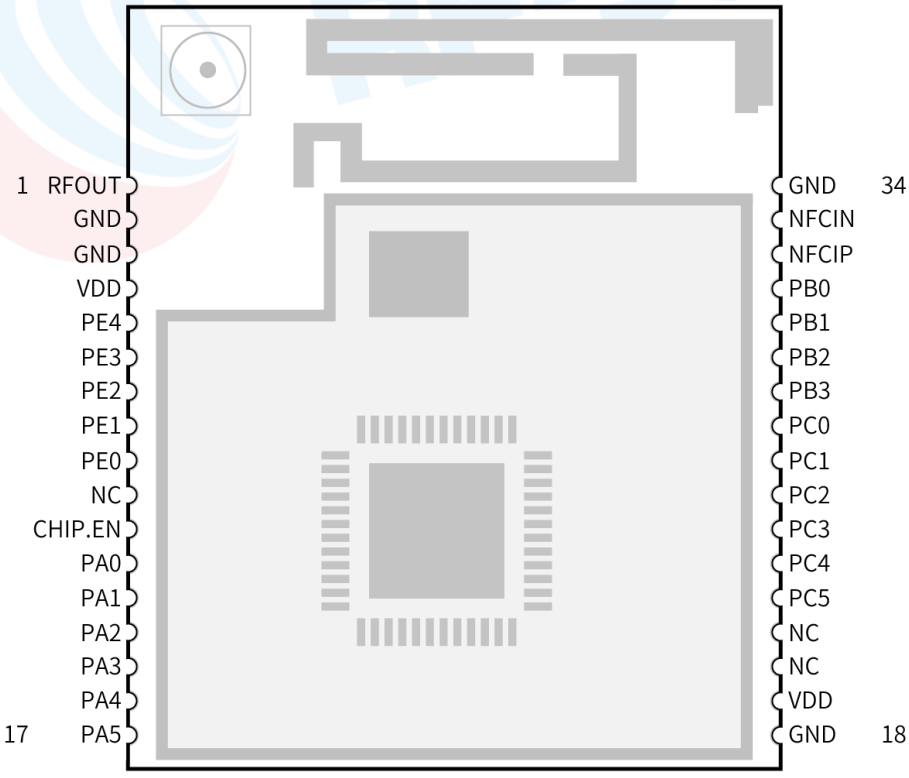


Figure 3. Pin Diagram of RF-WM-11AFB1

2.3 Pin Functions

Table 2. Pin Functions of RF-WM-11AFB1

Pin	Name	Description
1	RFOUT	RF signal output pin
2	GND	Ground
3	GND	Ground
4	VDD	3.3 V power supply
5	GPIO_E4	GPIO pin, the MUX function can be referred to pin multiplexing table.
6	GPIO_E3	GPIO pin, the MUX function can be referred to pin multiplexing table.
7	GPIO_E2	GPIO pin, the MUX function can be referred to pin multiplexing table.
8	GPIO_E1	GPIO pin, the MUX function can be referred to pin multiplexing table.
9	GPIO_E0	GPIO pin, the MUX function can be referred to pin multiplexing table.
10	NC	None connect
11	CHIP_EN	Chip enable pin, can be used for reset.
12	GPIO_A0	GPIO pin, the MUX function can be referred to pin multiplexing table.
13	GPIO_A1	GPIO pin, the MUX function can be referred to pin multiplexing table.
14	GPIO_A2	GPIO pin, the MUX function can be referred to pin multiplexing table.
15	GPIO_A3	GPIO pin, the MUX function can be referred to pin multiplexing table.
16	GPIO_A4	GPIO pin, the MUX function can be referred to pin multiplexing table.
17	GPIO_A5	GPIO pin, the MUX function can be referred to pin multiplexing table.
18	GND	Ground
19	VDD	3.3 V power supply
20	NC	None connect
21	NC	None connect
22	GPIO_C5	GPIO pin, the MUX function can be referred to pin multiplexing table.
23	GPIO_C4	GPIO pin, the MUX function can be referred to pin multiplexing table.
24	GPIO_C3	GPIO pin, the MUX function can be referred to pin multiplexing table.
25	GPIO_C2	GPIO pin, the MUX function can be referred to pin multiplexing table.
26	GPIO_C1	GPIO pin, the MUX function can be referred to pin multiplexing table.

27	GPIO_C0	GPIO pin, the MUX function can be referred to pin multiplexing table.
28	GPIO_B3	GPIO pin, the MUX function can be referred to pin multiplexing table.
29	GPIO_B2	GPIO pin, the MUX function can be referred to pin multiplexing table.
30	GPIO_B1	GPIO pin, the MUX function can be referred to pin multiplexing table.
31	GPIO_B0	GPIO pin, the MUX function can be referred to pin multiplexing table.
32	NFCIP	NFC differential signal input
33	NFCIN	NFC differential signal input
34	GND	Ground

2.4 Pin Multiplexing

Table 3. Pin Multiplexing of RF-WM-11AFB1

Pin name	JTAG	SDIO	UART Group	I2C Group	SPI Group	I2S Group	PCM Group	WI_LED	PWM	ETE	WKDT	GPIO INT	Default State	SCHMT
GPIO_A0		SD_D2	UART2_IN		SPI1_MISO							GPIO_INT	PH	O
GPIO_A1		SD_D3	UART2_CTS		SPI1_MOSI							GPIO_INT	HI	
GPIO_A2		SD_CMD	UART2_RTS		SPI1_CLK								PH	O
GPIO_A3		SD_CLK											PH	O
GPIO_A4		SD_D0	UART2_OUT		SPI1_CS								PH	
GPIO_A5		SD_D1									D_SBY0		PH	
GPIO_B0			UART_LOG_OUT							ETE0			HI	
GPIO_B1			UART_LOG_IN					WL_LED0		ETE1	D_SLP0		PH	
GPIO_B2				I2C3_SCL						ETE2			HI	O
GPIO_B3				I2C3_SDA						ETE3		GPIO_INT	PH	
GPIO_C0			UART0_IN		SPI0_CS0	I2S1_WS	PCM1_SYNC		PWM0	ETE0			HI	
GPIO_C1			UART0_CTS		SPI0_CLK	I2S1_CLK	PCM1_CLK		PWM1	ETE1		GPIO_INT	HI	O
GPIO_C2			UART0_RTS		SPI0_MOSI	I2S1_SD_TX	PCM1_OUT		PWM2	ETE2			HI	
GPIO_C3			UART0_OUT		SPI0_MISO	I2S1_MCK	PCM1_IN		PWM3	ETE3		GPIO_INT	HI	O
GPIO_C4				I2C1_SDA	SPI0_CS1	I2S1_SD_RX						GPIO_INT	HI	
GPIO_C5				I2C1_SCL	SPI0_CS2							GPIO_INT	HI	O
GPIO_E0	JTAG_TRST		UART0_OUT	I2C2_SCL	SPI0_CS0		PCM0_SYNC		PWM0				PH	O
GPIO_E1	JTAG_TDI		UART0_RTS	I2C2_SDA	SPI0_CLK		PCM0_CLK		PWM1			GPIO_INT	PH	O
GPIO_E2	JTAG_TDO		UART0_CTS	I2C3_SCL	SPI0_MOSI		PCM0_OUT		PWM2			GPIO_INT	PH	O
GPIO_E3	JTAG_TMS		UART0_IN	I2C3_SDA	SPI0_MISO		PCM0_IN		PWM3			GPIO_INT	PH	O
GPIO_E4	JTAG_CLK				SPI0_CS1								PH	O

Note: PH = Pull-High, HI = High-Impedance

3 Specifications

3.1 Recommended Operating Conditions

Functional operation does not guarantee performance beyond the limits of the conditional parameter values in the table below. Long-term work beyond this limit will affect the reliability of the module more or less.

Table 4. Recommended Operating Conditions of RF-WM-11AFB1

Items	Condition	Min.	Typ.	Max.	Unit
Operating Supply Voltage	Battery Mode	3.0	3.3	3.6	V
Operating Temperature	/	-20	+25	+85	℃
Environmental Hot Pendulum	/	-20		+20	℃/min

3.2 Handling Ratings

Table 5. Handling Ratings of RF-WM-11AFB1

Items	Condition	Min.	Typ.	Max.	Unit
Storage Temperature	Tstg	-55	+25	+125	℃
Human Body Model	HBM		4000		V
Moisture Sensitivity Level			2		
Charged Device Model			750		V

3.3 RF Parameters

3.3.1 RF Configuration

Wireless Mode	Transmission Rate (Modulation)	Tx Power (Typical)	Rx Sensitivity (Typical)
IEEE802.11 B	11 Mbps @ CCK	17.0 dBm	-82 dBm
IEEE802.11 G	54 Mbps @ OFDM	13.5 dBm	-69 dBm
IEEE802.11 N	HT20 @ MCS7	13.5 dBm	-66 dBm
IEEE802.11 N	HT40 @ MCS7	13.5 dBm	-63 dBm

3.3.2 Transmission Distance

The transmission distance test was conducted in the outdoor open area, and two RF-WM-11AFB1 modules were marked as A0 and B0 respectively. And the simultaneous bidirectional communication test was conducted under the modules with external rod antenna and PCB antenna. The test results are as follows:

Test conditions:

1. Outside and open air
2. Transmission distance: 100 meters
3. Data packet: 100 bytes

Wi-Fi Module		UDP Socket Communication				TCP Socket Communication			
		Sending Packet	Receiving Packet	Number of Packet Loss	Packet Loss Rate	Sending Packet	Receiving Packet	Number of Packet Loss	Packet Loss Rate
PCB Antenna	A0→B0	1000	1000	0	0%	1000	1000	0	0%
	A0←B0	1000	1000	0	0%	1000	1000	0	0%
External Antenna	A0→B0	1000	1000	0	0%	1000	1000	0	0%
	A0←B0	1000	1000	0	0%	1000	1000	0	0%

4 Application, Implementation, and Layout

4.1 Module Photos

Figure 4. Photos of RF-WM-11AFB1

4.2 Recommended PCB Footprint

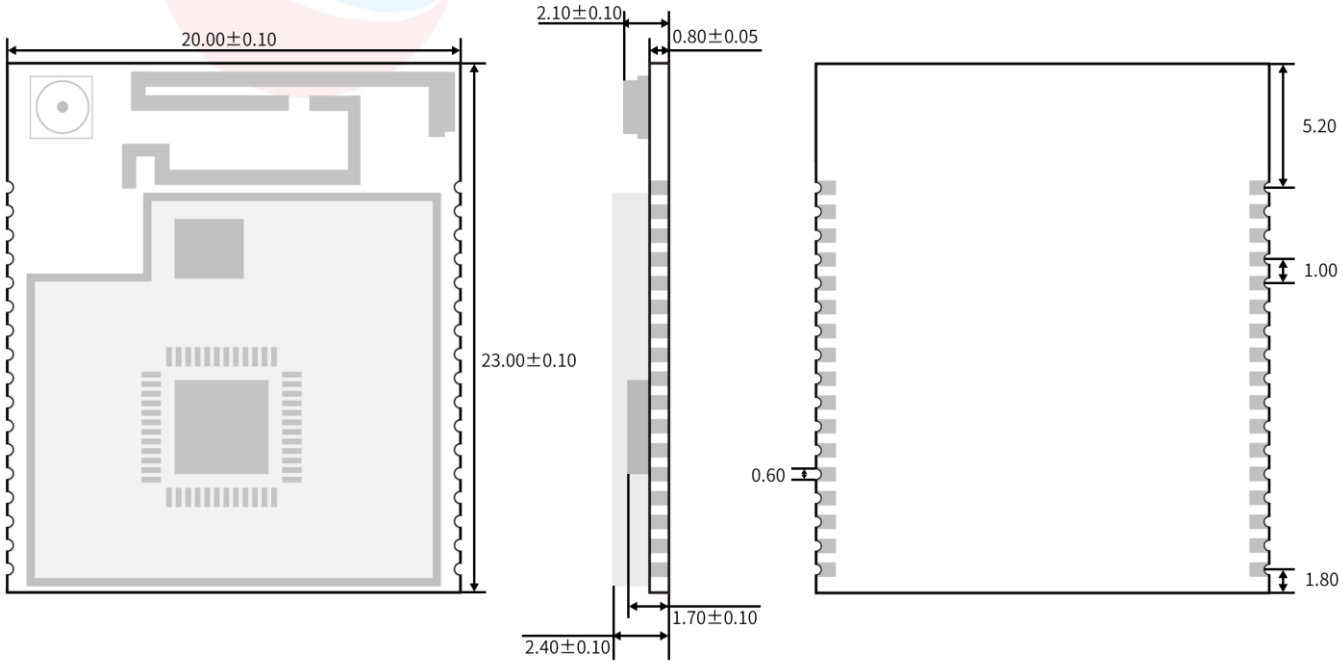


Figure 5. Recommended PCB Footprint of RF-WM-11AFB1 (mm)

4.3 Antenna

RF-WM-11AFB1 module is integrated the IPEX version 1 antenna seat, the specification of antenna seat is as follow:

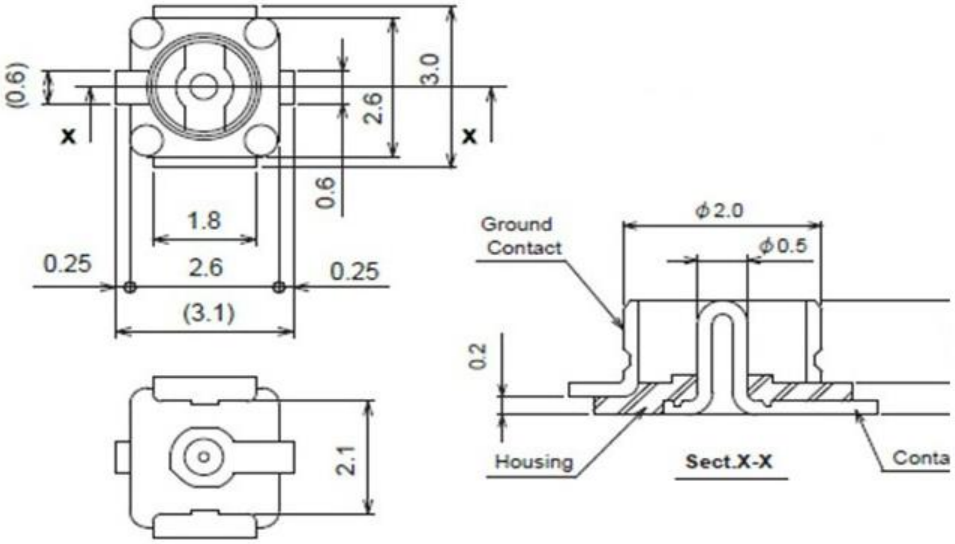


Figure 6. Specification of Antenna Seat

The specification of IPEX wire end is as follow:

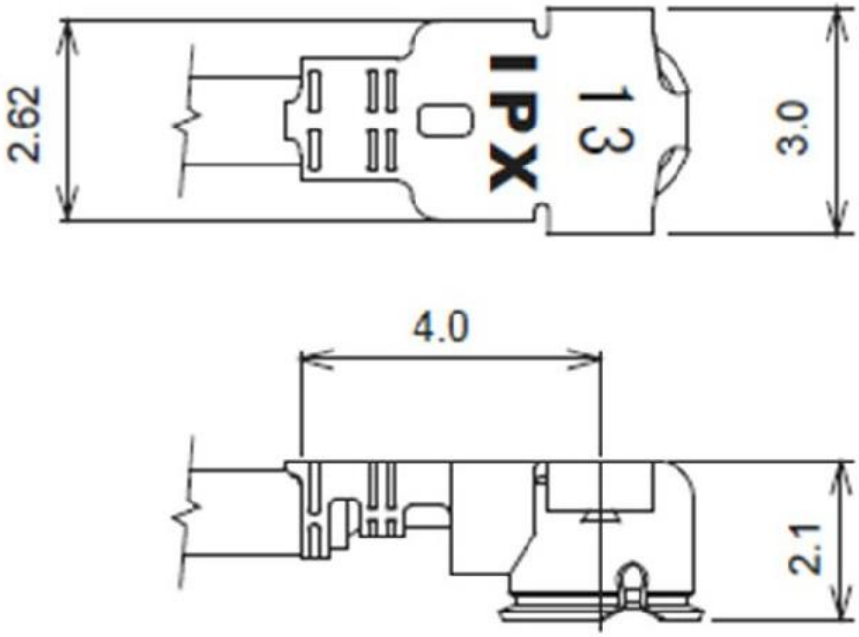


Figure 7. Specification of IPEX Wire

4.4 Schematic Diagram

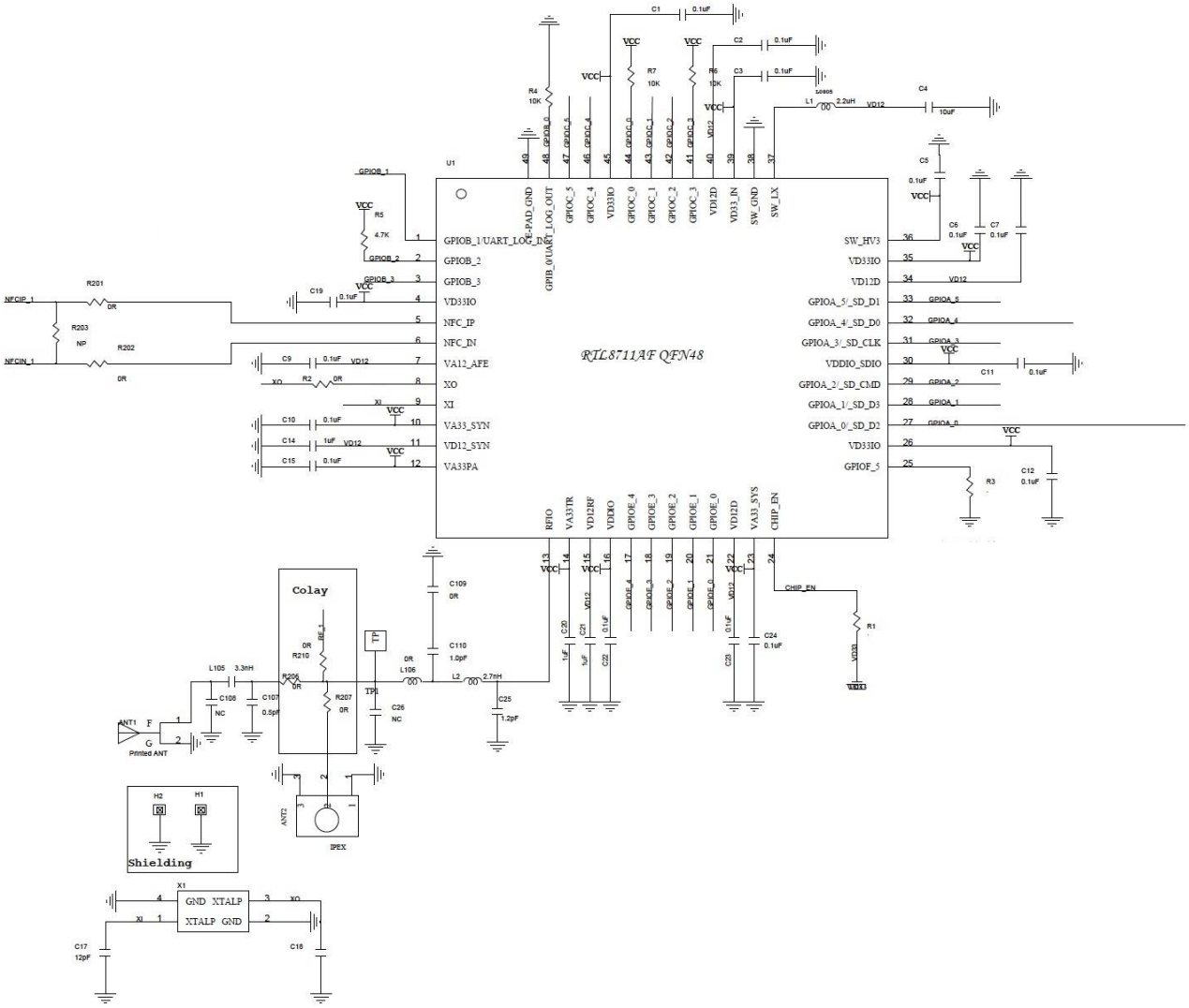


Figure 8. Schematic Diagram of RF-WM-11AFB1

4.5 Download and Debug Interface

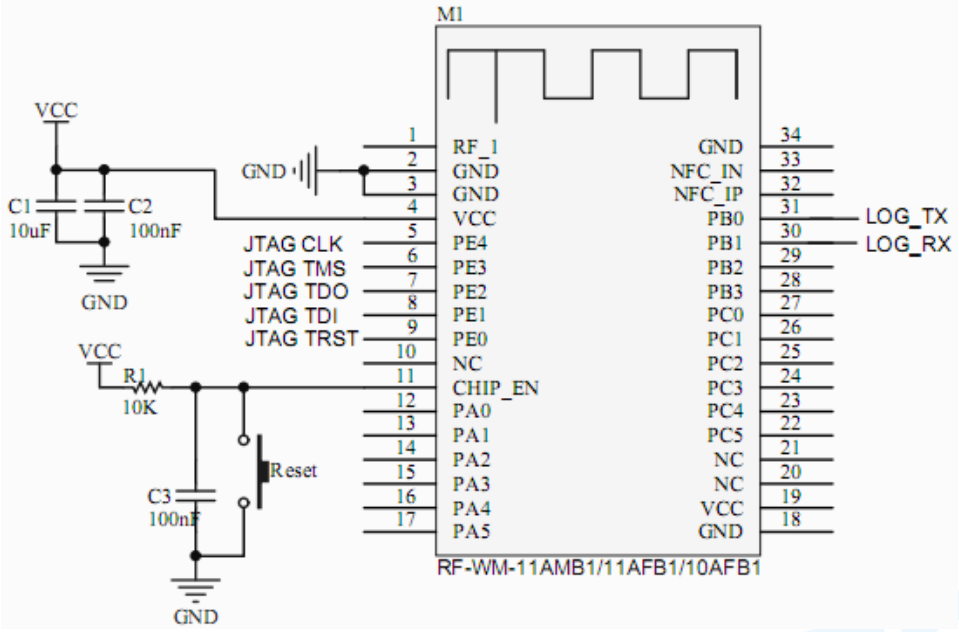


Figure 9. Download and Debug Interface of RF-WM-11AFB1

Regarding the download and debugging methods of the module, please cooperate with the RF-DK-871xB1 development board provided by RF-star. For related information, please refer to the "RF-DK-871xB1 development board user manual".

4.6 Basic Operation of Hardware Design

1. It is recommended to offer the module with a DC stabilized power supply, a tiny power supply ripple coefficient and the reliable ground. Please pay attention to the correct connection between the positive and negative poles of the power supply. Otherwise, the reverse connection may cause permanent damage to the module;
2. Please ensure the supply voltage is between the recommended values. The module will be permanently damaged if the voltage exceeds the maximum value. Please ensure the stable power supply and no frequently fluctuated voltage.
3. When designing the power supply circuit for the module, it is recommended to reserve more than 30% of the margin, which is beneficial to the long-term stable operation of the whole machine. The module should be far away from the power electromagnetic, transformer, high-frequency wiring and other parts with large electromagnetic interference.
4. The bottom of module should avoid high-frequency digital routing, high-frequency analog routing and power routing. If it has to route the wire on the bottom of module, for example, it is assumed that the module is soldered to the Top Layer, the copper must be spread on the connection part of the top layer and the module, and be close to the digital part of module and routed in the Bottom Layer (all copper is well grounded).
5. Assuming that the module is soldered or placed in the Top Layer, it is also wrong to randomly route the Bottom Layer or other layers, which will affect the spurs and receiving sensitivity of the module to some degrees;

6. Assuming that there are devices with large electromagnetic interference around the module, which will greatly affect the module performance. It is recommended to stay away from the module according to the strength of the interference. If circumstances permit, appropriate isolation and shielding can be done.
7. Assuming that there are routings of large electromagnetic interference around the module (high-frequency digital, high-frequency analog, power routings), which will also greatly affect the module performance. It is recommended to stay away from the module according to the strength of the interference. If circumstances permit, appropriate isolation and shielding can be done.
8. It is recommended to stay away from the devices whose TTL protocol is the same 2.4 GHz physical layer.
9. The antenna installation structure has a great influence on the module performance. It is necessary to ensure the antenna is exposed and preferably vertically upward. When the module is installed inside of the case, a high-quality antenna extension wire can be used to extend the antenna to the outside of the case.
10. The antenna must not be installed inside the metal case, which will cause the transmission distance to be greatly weakened.
11. The recommendation of antenna layout.

    The inverted-F antenna position on PCB is free space electromagnetic radiation. The location and layout of antenna is a key factor to increase the data rate and transmission range.

    Therefore, the layout of the module antenna location and routing is recommended as follows:

    (1) Place the antenna on the edge (corner) of the PCB.

    (2) Make sure that there is no signal line or copper foil in each layer below the antenna.

    (3) It is the best to hollow out the antenna position in the following figure so as to ensure that S11 of the module is minimally affected.

    (4) The impedance of external IPEX interface is 50 Ω.

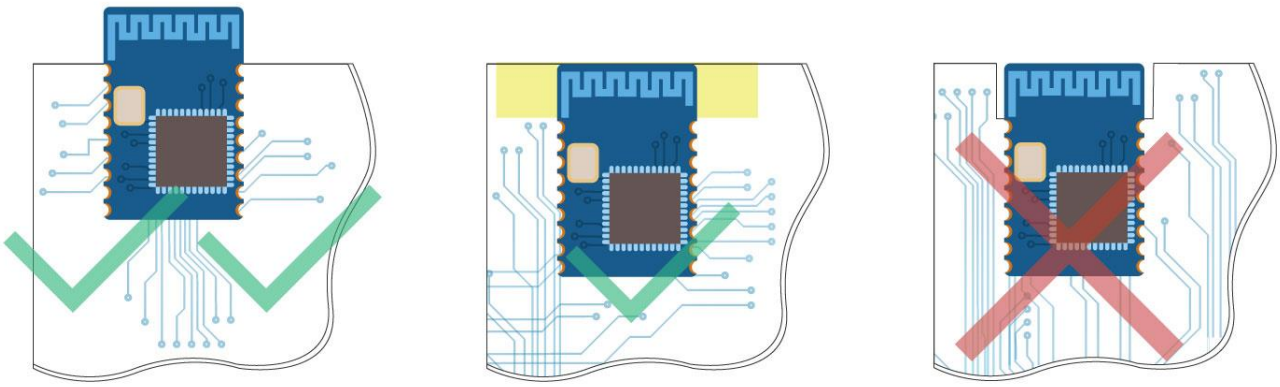


Figure 10. Recommendation of Antenna Layout

Note: The hollow-out position is based on the antenna used.

4.7 Trouble Shooting

4.7.1 Unsatisfactory Transmission Distance

1. When there is a linear communication obstacle, the communication distance will be correspondingly weakened. Temperature, humidity, and co-channel interference will lead to an increase in communication packet loss rate. The performances of ground absorption and reflection of radio waves will be poor, when the module is tested close to the ground.
2. Seawater has a strong ability to absorb radio waves, so the test results by seaside are poor.
3. The signal attenuation will be very obvious, if there is a metal near the antenna or the module is placed inside of the metal shell.
4. The incorrect power register set or the high data rate in an open air may shorten the communication distance. The higher the data rate, the closer the distance.
5. The low voltage of the power supply is lower than the recommended value at ambient temperature, and the lower the voltage, the smaller the power is.
6. The unmatchable antennas and module or the poor quality of antenna will affect the communication distance.

4.7.2 Vulnerable Module

1. Please ensure the supply voltage is between the recommended values. The module will be permanently damaged if the voltage exceeds the maximum value. Please ensure the stable power supply and no frequently fluctuated voltage.
2. Please ensure the anti-static installation and the electrostatic sensitivity of high-frequency devices.
3. Due to some humidity sensitive components, please ensure the suitable humidity during installation and application. If there is no special demand, it is not recommended to use at too high or too low temperature.

4.7.3 High Bit Error Rate

1. There are co-channel signal interferences nearby. It is recommended to be away from the interference sources or modify the frequency and channel to avoid interferences.
2. The unsatisfactory power supply may also cause garbled. It is necessary to ensure the power supply reliability.
3. If the extension wire or feeder wire is of poor quality or too long, the bit error rate will be high.

4.8 Electrostatics Discharge Warnings

The module will be damaged for the discharge of static. RF-star suggest that all modules should follow the 3 precautions below:

1. According to the anti-static measures, bare hands are not allowed to touch modules.

2. Modules must be placed in anti- static areas.
3. Take the anti-static circuitry (when inputting HV or VHF) into consideration in product design.

   Static may result in the degradation in performance of module, even causing the failure.

4.9 Soldering and Reflow Condition

1. Heating method: Conventional Convection or IR/convection.
2. Solder paste composition: Sn96.5 / Ag3.0 / Cu0.5
3. Allowable reflow soldering times: 2 times based on the following reflow soldering profile.
4. Temperature profile: Reflow soldering shall be done according to the following temperature profile.
5. Peak temperature: 245 ℃.

Table 6. Temperature Table of Soldering and Reflow

Profile Feature	Sn-Pb Assembly	Pb-Free Assembly
Solder Paste	Sn63 / Pb37	Sn96.5 / Ag3.0 / Cu0.5
Min. Preheating Temperature (T_{min})	100 ℃	150 ℃
Max. Preheating Temperature (T_{max})	150 ℃	200 ℃
Preheating Time (T_{min} to T_{max}) (t_1)	60 s ~ 120 s	60 s ~ 120 s
Average Ascend Rate (T_{max} to T_P)	Max. 3 ℃/s	Max. 3 ℃/s
Liquid Temperature (T_L)	183 ℃	217 ℃
Time above Liquidus (t_L)	60 s ~ 90 s	30 s ~ 90 s
Peak Temperature (T_p)	220 ℃ ~ 235 ℃	230 ℃ ~ 250 ℃
Average Descend Rate (T_p to T_{max})	Max. 6 ℃/s	Max. 6 ℃/s
Time from 25 ℃ to Peak Temperature (t_2)	Max. 6 minutes	Max. 8 minutes
Time of Soldering Zone (t_P)	20±10 s	20±10 s

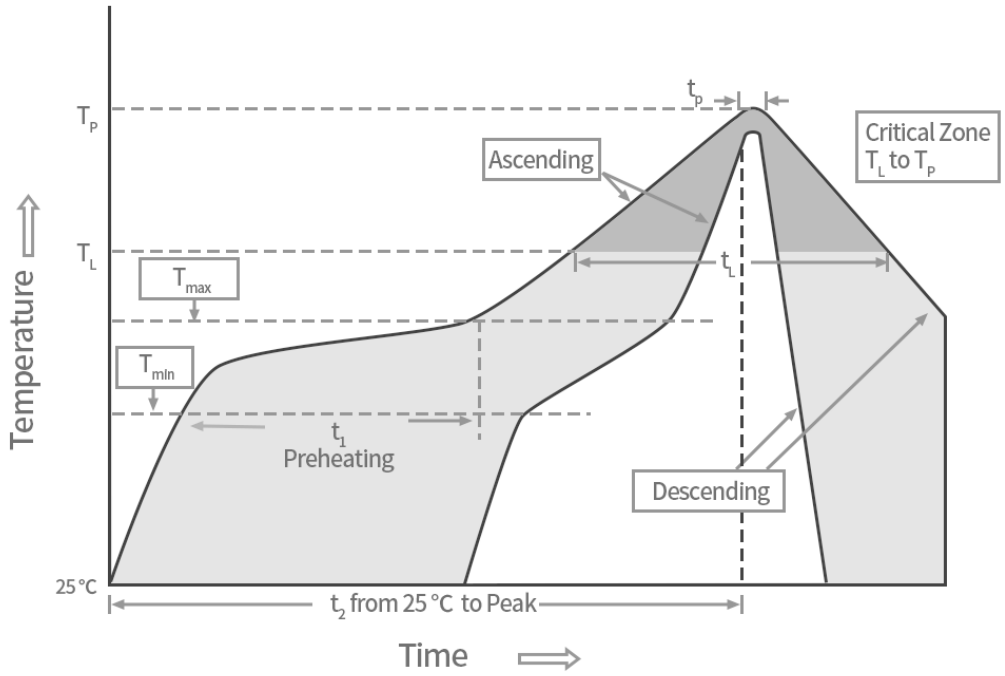


Figure 11. Recommended Reflow for Lead Free Solder

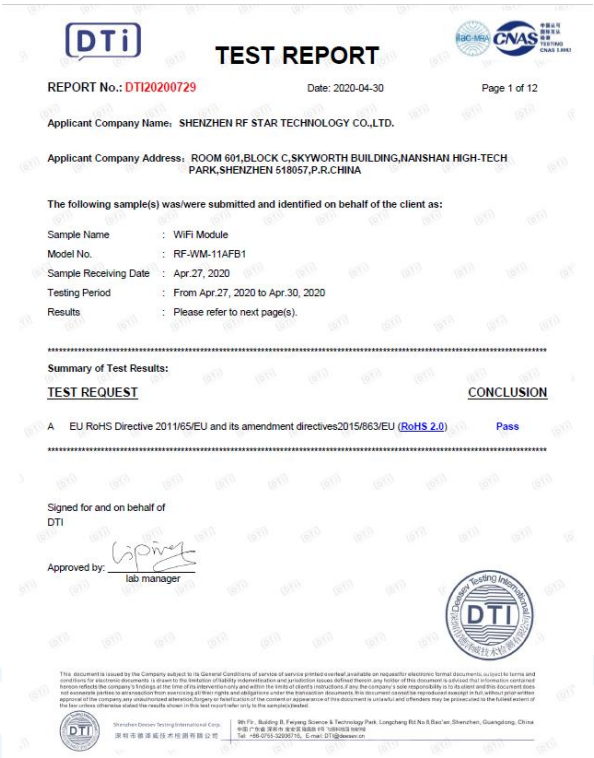
4.10 Optional Packaging

Figure 12. Optional Packaging Mode

Note: Default tray packaging.

5 Certificates

5.1 RoHS



DTi

TEST REPORT

REPORT No.: DTI20200729 Date: 2020-04-30 Page 1 of 12

Applicant Company Name: SHENZHEN RF STAR TECHNOLOGY CO.,LTD.

Applicant Company Address: ROOM 601,BLOCK C,SKYWORTH BUILDING,NANSHAN HIGH-TECH PARK,SHENZHEN 518057,P.R.CHINA

The following sample(s) was/were submitted and identified on behalf of the client as:

Sample Name	:	WiFi Module
Model No.	:	RF-WM-11AFB1
Sample Receiving Date	:	Apr.27, 2020
Testing Period	:	From Apr.27, 2020 to Apr.30, 2020
Results	:	Please refer to next page(s).

****

Summary of Test Results:

TEST REQUEST		CONCLUSION
A	EU RoHS Directive 2011/65/EU and its amendment directives2015/863/EU (RoHS 2.0)	Pass

****

Signed for and on behalf of DTI

Approved by: lab manager

Figure 13. RoHS Certificate

6 Revision History

Date	Version No.	Description	Author
2016.08.01	V1.0	The initial version is released.	Aroo Wang
2020.01.19	V1.0	Add Wi-Fi module list.	Sunny Li

Note:

1. The document will be optimized and updated from time to time. Before using this document, please make sure it is the latest version.
2. To obtain the latest document, please download it from the official website: www.szrfstar.com.

7 Contact Us

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