



RF-BM-4044B2 Bluetooth Low Energy Module

Version 1.1

Shenzhen RF-star Technology Co., Ltd.

Aug. 02, 2018

1 Device Overview

1.1 Description

RF-BM-4044B2 module is designed based on CC2640R2FRSM Bluetooth Smart BT 5.0 System-on-Chip, fully supports the single mode Bluetooth Low Energy operation. The module contains a 32-bit ARM Cortex™-M3 processor, with the working frequency at 48.0 MHz which is the same as the main processor. The module has rich peripherals function libraries, and a unique ultra-low power sensor controller, which is fit for connecting the external sensors in the sleep mode and/or acquiring analog and digital data independently.

1.2 Key Features

- RF
 - 2.4 GHz RF transceiver compatible with Bluetooth low energy 4.2 and specification
 - Excellent receiver sensitivity (-97 dBm for BLE)
 - Programmable output power up to +2 dBm
 - Signal-ended or differential RF interface
- Microcontroller
 - Powerful ARM® Cortex®-M3
 - EEMBC CoreMark® Score: 142
 - Up to 48-MHz Clock Speed
 - 275 KB of Nonvolatile Memory Including 128 KB of In-System Programmable Flash
 - Up to 28 KB of System SRAM, of Which 20 KB is Ultra-Low Leakage SRAM
 - 8 KB of SRAM for Cache or System RAM Use
 - 2-Pin cJTAG and JTAG Debugging
 - Supports Over-The-Air Upgrade (OTA)
- Ultra-Low Power Sensor Controller
 - 16-Bit Architecture
 - 2 KB of Ultra-Low Leakage SRAM for Code and Data
- Peripherals
 - 12 Bit ADC, 200 ksamples/s, 8 Channel
- Analog
 - MUX
 - Continuous Time Comparator
 - Ultra-Low-Power Analog Comparator
 - Programmable Current Source
 - UART
 - 2× SSI (SPI, MICROWIRE, TI)
 - I2C
 - I2S
 - Real-Time Clock (RTC)
 - AES-128 Security Module
 - True Random Number Generator (TRNG)
- Low Power
 - Wide Supply Voltage Range: 1.8 V to 3.8 V
 - Active-Mode RX: 5.9 mA
 - Active-Mode TX at 0 dBm: 6.1 mA
 - Active-Mode MCU: 61 μA/MHz
 - Active-Mode MCU: 48.5 CoreMark/mA
 - Active-Mode Sensor Controller: 0.4 mA + 8.2 μA/MHz
 - Standby: 1.1 μA (RTC Running and RAM/CPU Retention)
 - Shutdown: 100 nA (Wake Up on External Events)

1.3 Applications

- Smart toys
- Fitness equipment
- Environmental sensor nodes
- Passive key-less entry (PKE)

- Smart door locks
- Phone accessories
- Health-care equipment
- Smart lighting
- Energy harvesting
- Thermometer
- Human input devices
- Sports equipment



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2 Module Configuration and Functions

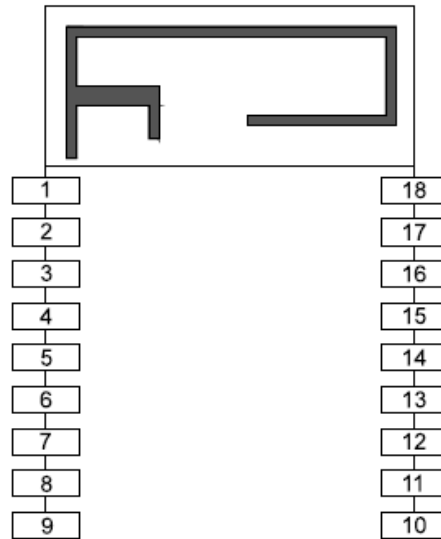
2.1 Module Parameters

Table 1. The Parameters of RF-BM-4044B2

Chipset	CC2640R2FRSM
Supply Power Voltage	1.8 V ~ 3.8 V, recommended to 3.3 V
Frequency	2402 MHz ~ 2480 MHz
Maximum Transmit Power	-21.0 dBm ~ +2.5 dBm
Receiving Sensitivity	-97 dBm
GPIO	10
Crystal	24 MHz
RAM	20 KB
Flash	128 KB
Package	SMT Packaging
Frequency Error	±20 kHz
Dimension	16.6 mm x 11.2 mm x 1.7 mm
Type of Antenna	PCB Antenna
Operating Temperature	-40 °C ~ +85 °C
Storage Temperature	-40 °C ~ +125 °C

2.2 Module Pin Diagram

Figure 2. The Pin Diagram of RF-BM-4044B2



3.3 Pin Functions

Table 2. The Pin Diagram of RF-BM-4044B2

Pin	Name	Chip Pin	Pin Type	Description
1	GND	GND	Power	GND
2	VDDZ	VCC	Power	Power supply 1.8 V ~ 3.8 V, Recommend 3.3 V
3	TMSC	TMSC	JTAG	JTAG: TMSC
4	TCKC	TCKC	JTAG	JTAG: TCKC
5	RES_N	REST	REST	Reset after power on. No need for external RC circuit.
6	P06	P06	I/O	
7	P09	P09	I/O	Programmable I/O
8	GND	GND	GND	GND
9	GND	GND	GND	GND
10	P08	P0.8	I/O	
11	P07	P0.7	I/O	
12	P05	P0.5	I/O	
13	P04	P0.4	I/O	
14	P03/BRTS	P0.3	I/O	
15	P02/BCTS	P0.2	I/O	
16	P01/TX	P0.1	I/O	

17	P00/RX	P0.0	I/O	
18	NC	-	-	

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 3. Recommended Operating Conditions of RF-BM-4044B2

Items	Condition	Min.	Typ.	Max.	Unit
Operating Supply Voltage	Battery Mode	1.8	3.3	3.8	V
Operating Temperature	/	-25	25	75	C°
Environmental Hot Pendulum	/	-20		+20	C°/min

Notes :

- (1) The operating temperature is limited to the change of crystal's frequency;
- (2) To ensure the RF performance, the ripple wave on the source must be less than ± 200 mV.

3.2 Power Consumption

Table 4. The Table of Power Consumption

When measured on the RF-BM-4044B2 reference design with T A = 25 C°, V BAT = 3.3 V with DC/DC enabled unless otherwise noted.

Test Item	Average Current	Test Condition
Power consumption on sleep	0.1 μ A	EN is in high level.
Broadcast	60 μ A	Broadcast interval: 200 ms.
Connection	70 μ A	Connection interval: 100 ms
Module receives UART data and transmits to APP	180 μ A	(20 bytes, 10 time/s) Connection interval: 100 ms
Module receives APP data and transmits to MCU	160 μ A	(20 bytes, 10 time/s) Connection interval: 100 ms

3.2 RF Test

When measured on the RF-BM-4044B2 reference design with T A = 25 C°, V BAT = 3.3 V with DC/DC, channel of 39th (2442 MHz) enabled unless otherwise noted.

Table 5. The Table of Power Consumption

Test Item	Parameter	Test Value	Unit
Transmitter	Power	5 (Max.)	dBm
	Frequency Error	±20	KHz
	Radiation (30 m ~ 1 G)	-36	dBm
	Radiation (1 G ~ 12.75 G)	-30	dBm
Receiver	Sensitivity (8% PER)	-93	dBm

4 Application, Implementation, and Layout

4.1 Module Photos

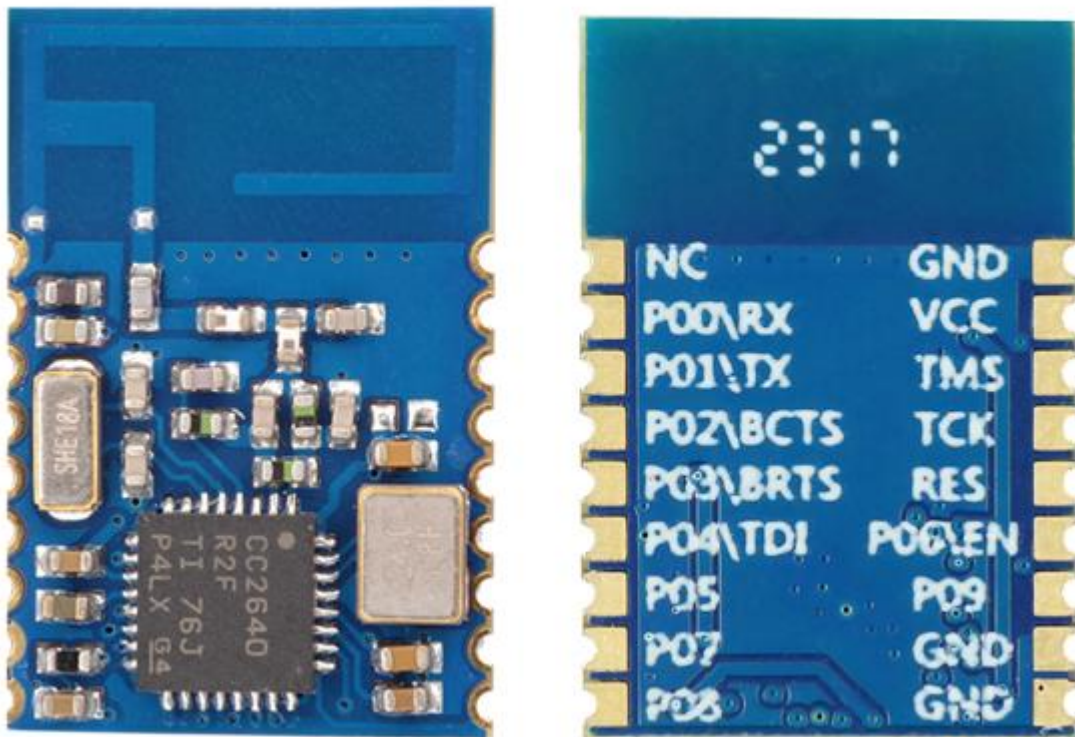


Figure 3. The Photos of RF-BM-4044B2

4.2 Recommended PCB Footprint

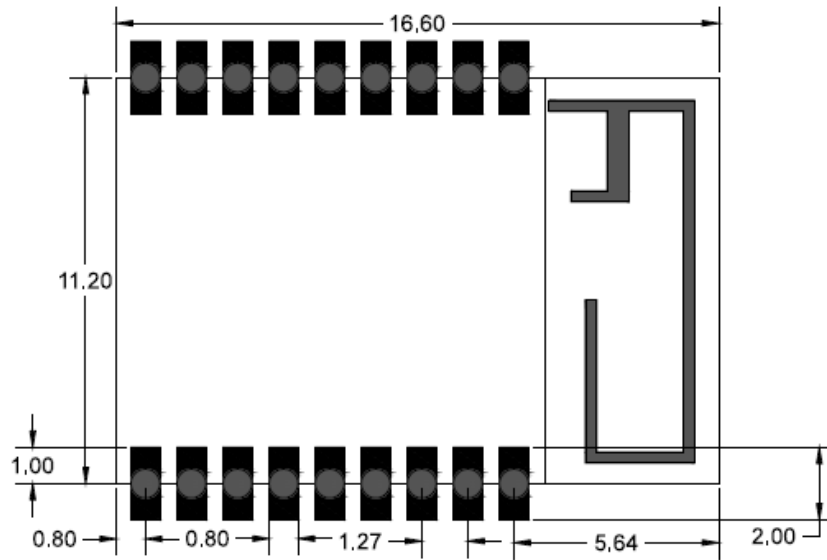


Figure 4. The Top View of RF-BM-4044B2 (mm)





4.4 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, for example: USB 3.0;
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.

4.5 Trouble Shooting

4.5.1 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.

4.5.2 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.

4.5.3 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.

4.6 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.

4.7 Soldering and Reflow Condition

1. Heating method: Conventional Convection or IR/convection.
2. Temperature measurement: Thermocouple $d = 0.1 \text{ mm}$ to 0.2 mm CA (K) or CC (T) at soldering portion or equivalent methods.
3. Solder paste composition: Sn/3.0 Ag/0.5 Cu
4. Allowable reflow soldering times: 2 times based on the following reflow soldering profile.
5. Temperature profile: Reflow soldering shall be done according to the following temperature profile.
6. Peak temperature: $245 \text{ }^{\circ}\text{C}$.

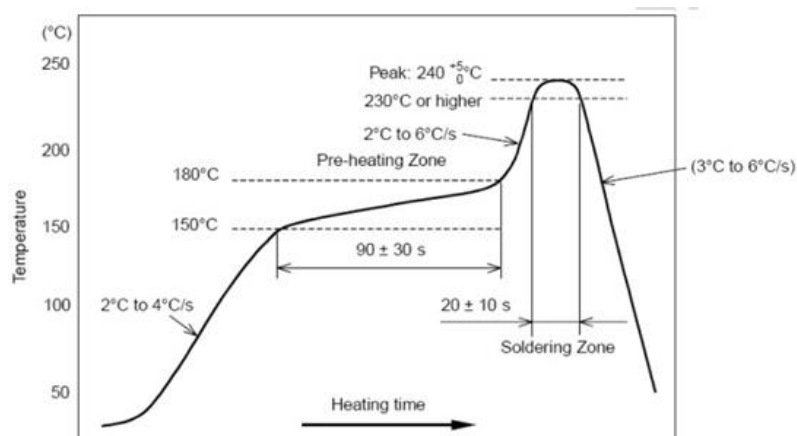


Figure 6. Recommended Reflow for Lead Free Solder

5 Certification

5.1 FCC warnings

FCC Statement

FCC standards: FCC CFR Title 47 Part 15 Subpart C Section 15.247
Integral PCB antenna with antenna gain 0dBi

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.

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

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.

We will retain control over the final installation of the modular such that compliance of the end product is assured. In such cases, an operating condition on the limit modular approval for the module must be only approved for use when installed in devices produced by a specific manufacturer. If any hardware modify or RF control software modify will be made by host manufacturer, C2PC or new certificate should be apply to get approval, if those change and modification made by host manufacturer not expressly approved by the party responsible for compliance, then it is illegal.

FCC Radiation Exposure Statement

The modular can be installed or integrated in mobile or fix devices only. This modular cannot be installed in any portable device.

This modular complies with FCC RF 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.

If the FCC 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. This exterior label can use wording such as the following: "Contains Transmitter Module FCC ID: 2ABN2-BM4044B2 Or Contains FCC ID: 2ABN2-BM4044B2"

When the module is installed inside another device, the user manual of the host must contain below warning statements;

1. 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.
 - (2) This device must accept any interference received, including interference that may cause undesired operation.
- 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.

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

The devices must be installed and used in strict accordance with the manufacturer's instructions as described in the user documentation that comes with the product.

Any company of the host device which install this modular with limit modular approval should perform the test of radiated & conducted emission and spurious emission, etc. according to FCC part 15C : 15.247 and 15.209 & 15.207, 15B Class B requirement, Only if the test result comply with FCC part 15C : 15.247 and 15.209 & 15.207, 15B Class B requirement, then the host can be sold legally.