Product Specification

Product Name: RBF Chip

Product Model: RB4331/RB8681/RB9151

Revision History

Specification		Sect.	Update Description	By
Rev.	Date			
1.0	2025-04-03		New version release	Arvin

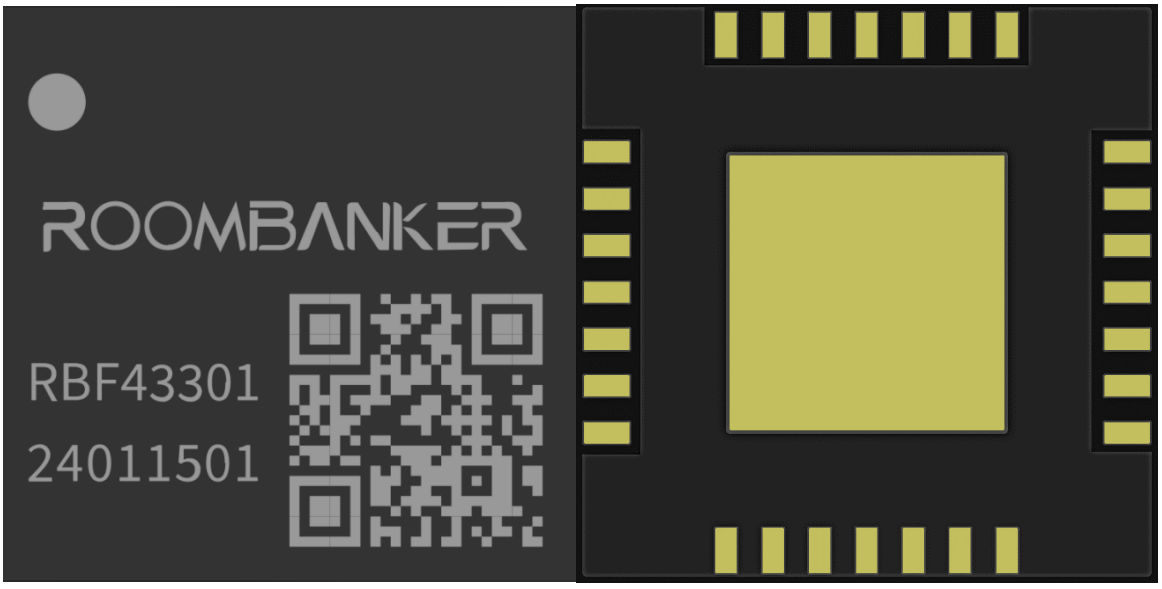
Approvals

Organization	Name	Title	Date

1. Introduction

1.1. Key Features

- Low Power Wireless System-on-Chip
- Sub-GHz 433/868/915 MHz models are available
- Integrated 39MHz & 32.768kHZ Clock
- Fully integrated RF matching and Antenna
- DC/DC converter with loading circuit
- TX power up to +20 dBm
- High Performance 32-bit 78 MHz ARM Cortex®-M33
- 512 kB Flash program memory and 64 kB RAM data memory
- 21 configurable GPIOs
- Interfaces ADC, ACMP, VDAC, SPI, I2C, UART, PWM, PDM and other interface
- Power supply 1.71 to 3.8V
- Packaging: LGA 10 x 10 x 1.72 mm
- Operating temperature range: -40 ºC to 85 ºC

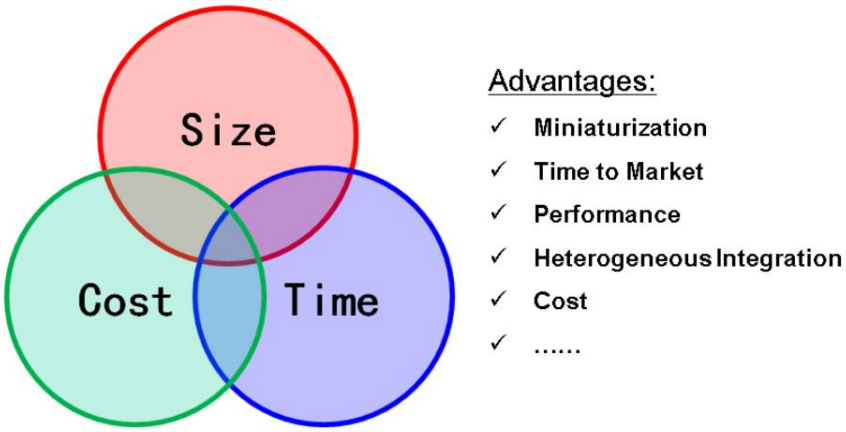


1.2. Product Feature Summary

- Low-power CE/RED certified chip with ultra-low energy consumption, enabling easy battery operation.
- Communication range of up to 3.5 kilometers (in open space), supporting star network configurations with a capacity of up to 10,000 devices.
- Utilizes advanced technologies such as FHSS, TDMA, and AES-CCM+ encryption for

secure and reliable data transmission.

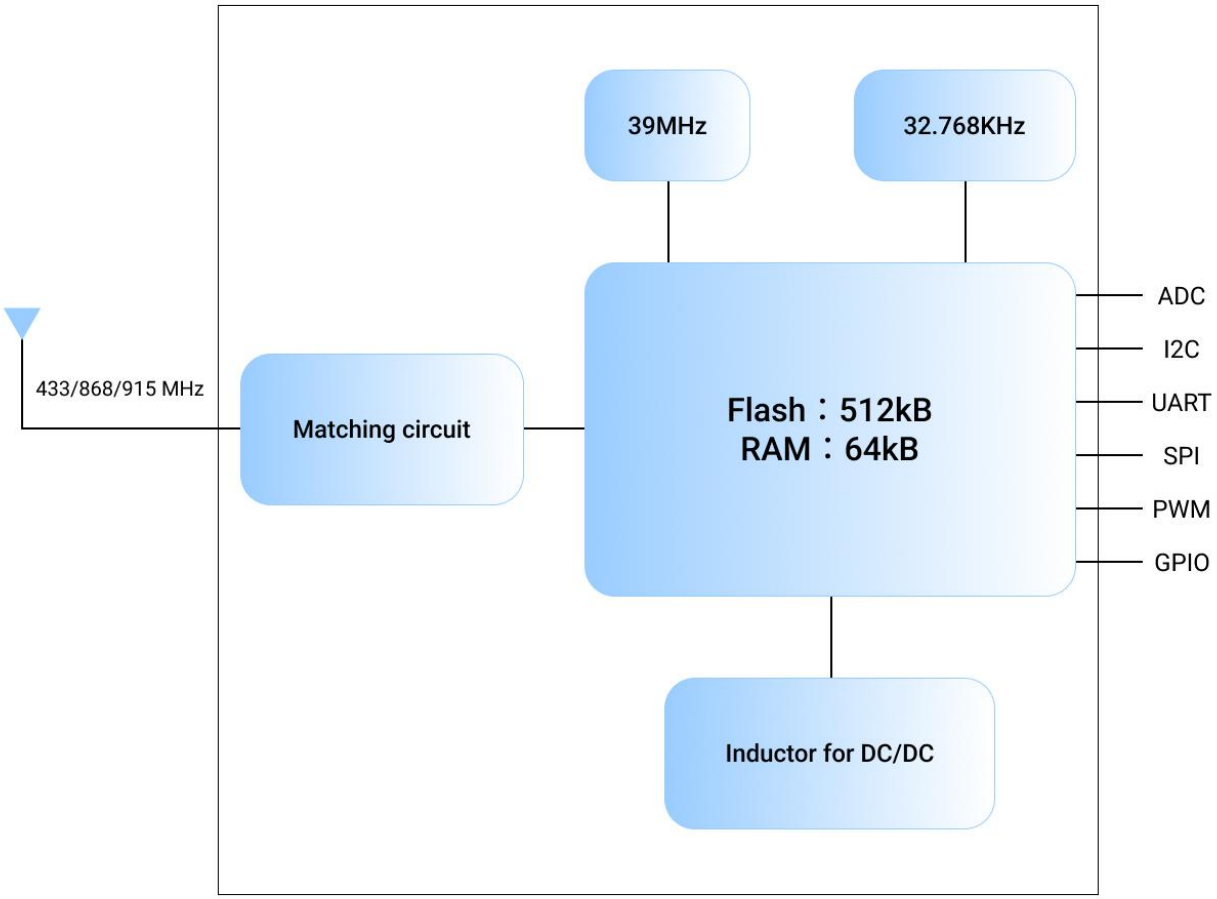
- Low-code development with a packaged protocol stack and user-friendly API accelerates the production process.
- OTA multicast technology allows simultaneous firmware updates to multiple devices.
- High RF integration enables the use of external antennas, reducing the need for in-house development.
- Low PCB layer count minimizes manufacturing costs.



1.3. Typical Application

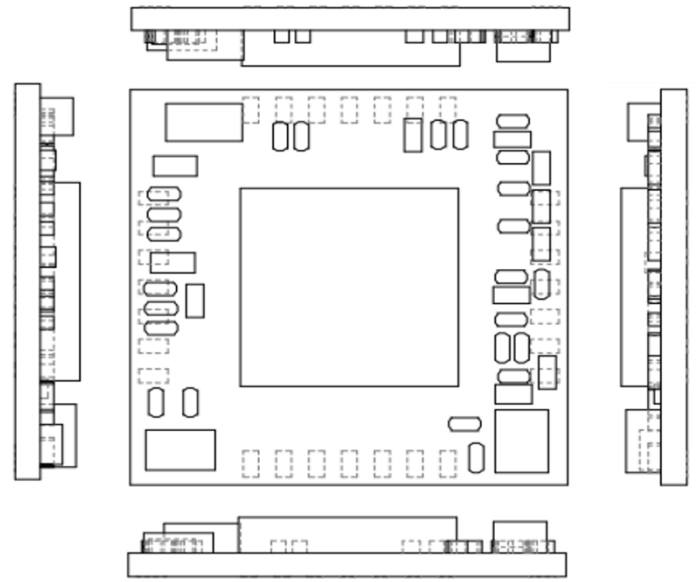
- Wireless Meter Reading System (Water meter, gas meter, heat meter, electricity meter)
- Wireless Security System in House/Villa, Office, Retail and other SMB scenarios
- Electric Vehicles and Charging Points
- Smart Apartment (Express Cabinet, Smart Lock, etc)
- Industrial Automation

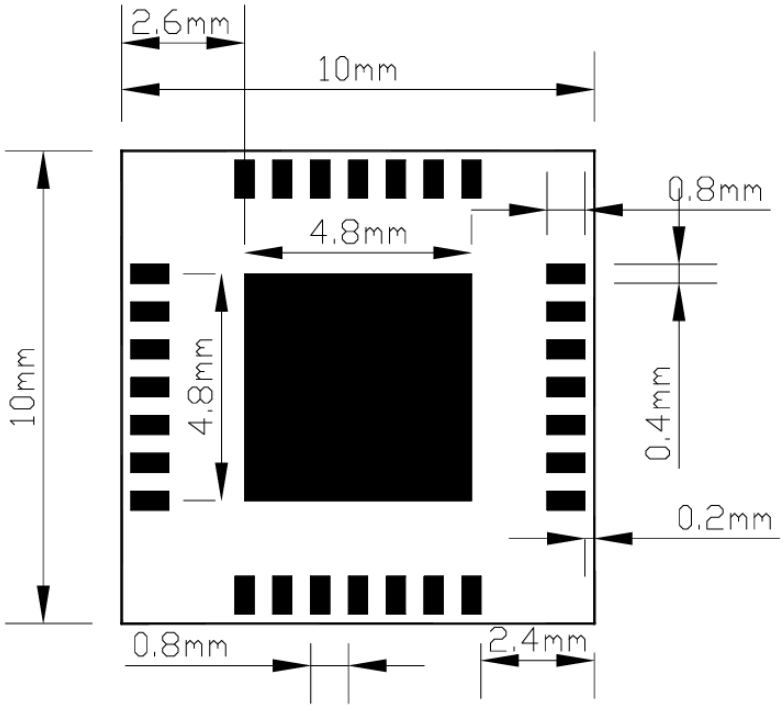
1.4. Block Diagram



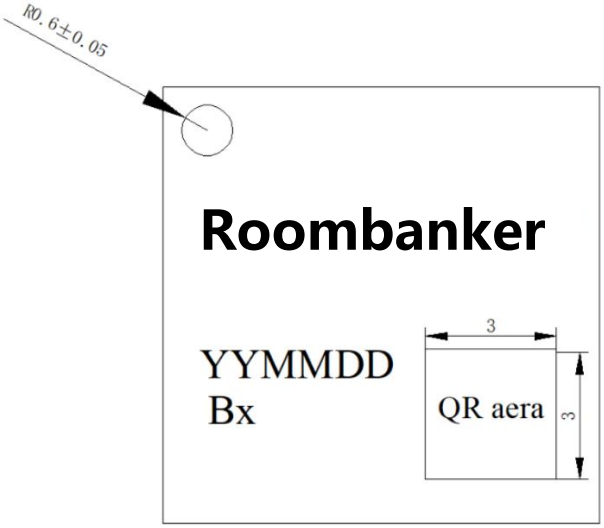
2. Product Detail

2.1. Component Layout, External Dimensions and Pad Design





2.2. Mark Specification Range

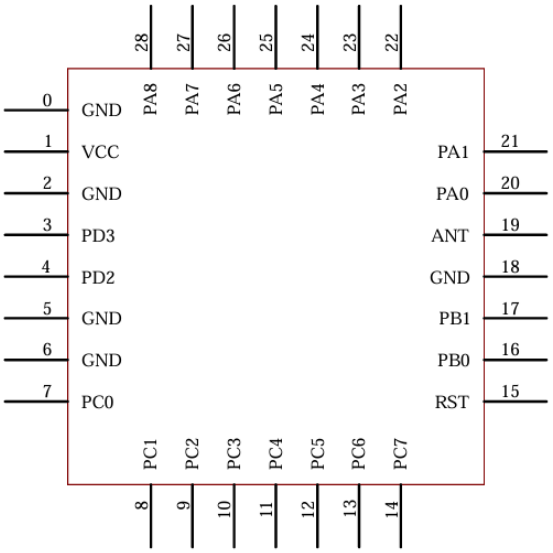


Code	Bx	YY	MM	DD
Explanation	Production batch	Year	Month	Day
Code - printing	B1	24	06	27

Mark accuracy：20um~40um

Mark depth：±50um

2.3. Pin Definition

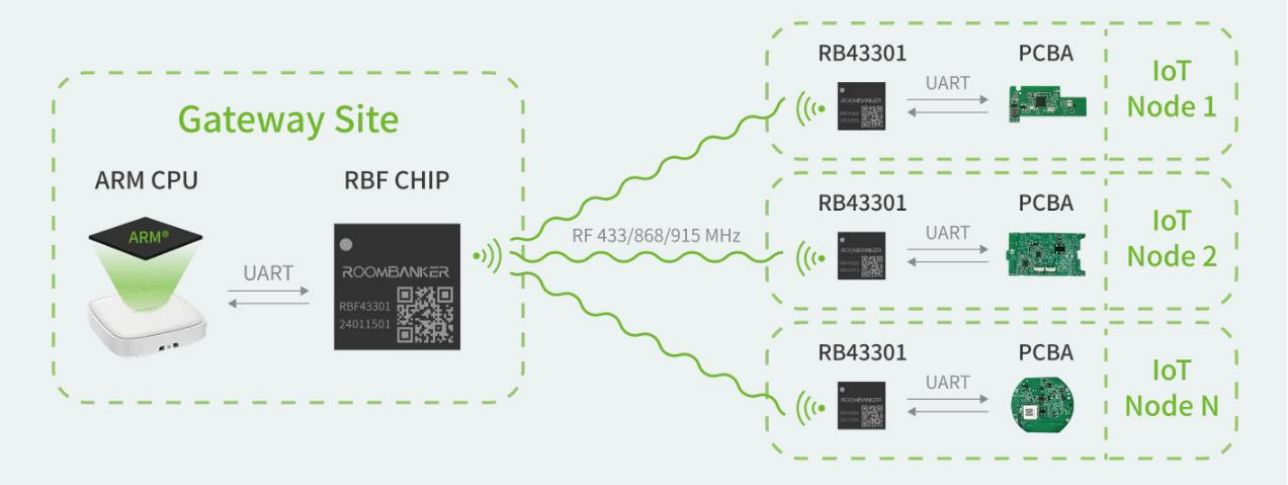


Pin number	symbol	IO type	function
1	GND	P	Chip power reference ground
2	VCC	P	Power supply pins of the chip (typical supply voltage: 3.3V)
3	PD3	I/O	general I/O (Configurable features)
4	PD2	I/O	general I/O (Configurable features)
5	GND	P	Chip power reference ground
6	GND	P	Chip power reference ground
7	PC0	I/O	general I/O (Configurable features)
8	PC1	I/O	general I/O (Configurable features)
9	PC2	I/O	general I/O (Configurable features)
10	PC3	I/O	general I/O (Configurable features)
11	PC4	I/O	general I/O (Configurable features)
12	PC5	I/O	general I/O (Configurable features)
13	PC6	I/O	general I/O (Configurable features)
14	PC7	I/O	general I/O (Configurable features)
15	RST	I	Chip hardware reset pin, default high level, effective when pulled low
16	PB0	I/O	general I/O (Configurable features)

17	PB1	I/O	general I/O （Configurable features）
18	GND	P	Chip power reference ground
19	ANT	I/O	RF transmitting and receiving pi
20	PA0	I/O	general I/O （Configurable features）
21	PA1	I/O	general I/O （Configurable features）
22	PA2	I/O	general I/O （Configurable features）
23	PA3	I/O	general I/O （Configurable features）
24	PA4	I/O	general I/O （Configurable features）
25	PA5	I/O	general I/O （Configurable features）
26	PA6	I/O	general I/O （Configurable features）
27	PA7	I/O	general I/O （Configurable features）
28	PA8	I/O	general I/O （Configurable features）

GPIO	Alternate Functions
PA00	IADC0.VREFP
PA01	GPIO.SWCLK
PA02	GPIO.SWDIO
PA03	GPIO.SWV，GPIO.TDO，GPIO.TRACEDATA0，LESENSE.EN_0
PA04	GPIO.TDI，GPIO.TRACECLK，LESENSE.EN_1
PA05	GPIO.TRACEDATA1，GPIO.EM4WU0，LESENSE.EN_2
PA06	GPIO.TRACEDATA2
PA07	GPIO.TRACEDATA3
PB00	VDAC0.CH0_MAIN_OUT
PB01	GPIO.EM4WU3，VDAC0.CH1_MAIN_OUT
GPIO	Alternate Functions
PC0	GPIO.EM4WU6
PC05	GPIO.EM4WU7
PC0	GPIO.EM4WU8，GPIO.THMSW_EN
PD02	GPIO.EM4WU9

2.4. Topology & Usage



3. Specification

3.1. Technical Specification

Technical Specification			
Model	**RB4331**	**RB8681**	**RB9151**
Hardware			
Frequency Band	433.12MHz~435.12 MHz	863 MHz ~ 870 MHz	902 MHz ~ 928 MHz
Antenna Option	U.FL, RF pad		
RAM	64 KB	64 KB	64 KB
Flash	512 KB	512 KB	512 KB
Performance			
RF Data Rate	2 kbps ~ 100 kbps		
Transmit Range (Open Area)	Up to 3.5 km with -1.92 dBi antenna		
Transmit Power	Max. 20dBm		
Receiver Sensitivity	-110.7 dBm @50kbps(2GFSK), BER<0.1%	-113.3 dBm @38.4kbps(2GFSK), BER<0.1%	-96.9 dBm @2Mbps(2GFSK), BER<0.1%
Spectrum Utilization	FHSS		
Modulation	FSK Narrowband / DSSS Spreading		
Feature			
Digital I/O	21-ch Digital I/O		
Analog Input	21-ch Analog Inputs		
Networking Topology	Star Connection		
Encryption	AES-CCM+Random Number Key		
Image Transmit	Support		
OTA	Multicast OTA, Background Upgrading		
Power			
Supply Voltage	1.7 V ~ 3.8V		
Transmit Current	Max 76.8 mA(20dBm)	Max 90.6 mA(20dBm)	Max 92 mA(20dBm)
Receive Current	6.7@ (2-GFSK, 100kbps)	6.3@ (2-GFSK, 38.4kbps)	8.5@ (2-GFSK, 2 Mbps)

Sleep Current	< 2 μA
General	
Dimension	10 mm (W) × 10 mm (H) × 1.72 mm (D)
Weight	1.8g
Operating Temperature	-40 °C ~ 85 °C
Storage Temperature	-40℃ ~ 125℃
Regulatory Approval	
ETSI (Europe)	CE/RED
RoHS	Compliant

3.2. Absolute Maximum Ratings

Parameter	Test Condition	Min	Typ	Max	Unit
Storage temperature range		-50	-	+150	℃
Voltage on any supply pin		-0.3	-	3.8	V
Total current into VDD power lines	Source	-	-	200	mA
Total current into VSS ground lines	Sink	-	-	200	mA
Current per I/O pin	Sink	-	-	50	mA
	Source	-	-	50	mA
Current for all I/O pins	Sink	-	-	200	mA
	Source	-	-	200	mA

3.3. General Operating Conditions

Parameter	Test Condition	Min	Typ	Max	Unit
Operating ambient tempera ture range		-40	-	+85	℃

VDD supply Voltage		1.71	3.3	3.8	V
IOVDD operating supply voltage		1.71	3.3	3.8	V

3.4. Power Consumption

Parameter	Test Condition	Min	Typ	Max	Unit
Current consumption in receive mode	f = 915 MHz, 2-GFSK, 2 Mbps	-	8.5	-	mA
	f = 868 MHz, 2-GFSK, 38.4 kbps	-	6.3	-	mA
	f = 433 MHz, 2-GFSK, 100 kbps	-	6.7	-	mA
Current consumption in transmit mode, EM1	f = 915 MHz, CW, 20 dBm PA, +20 dBm output power	-	92	-	mA
	f = 869.5 MHz, CW, 20 dBm PA, +20 dBm output power	-	90.6	-	mA
	f = 433 MHz, CW, 20 dBm PA, +20 dBm output power	-	76.8	-	mA
Current consumption for retained RAM bank in EM2 or EM3		-	0.1	-	μA

3.5. Clock Sources

Internal High Frequency Clock for RF Stability: 39 MHz Crystal Frequency Tolerance

Parameters	Test Condition	Min	Typ	Max	Unit
Crystal frequency		39.000000			MHz
Equivalent Series Resistance		-		30	Ω
Load Capacitance		12			pF
Shunt Capacitance		-	-	3	pF
Frequency Tolerance	At 25℃±3℃	-8	-	8	
Frequency Stability	Over Operating Temp.Range(Ref.to 25℃)	-10	-	10	ppm

Internal Low Frequency Clock for BLE Synchronization: 32.768 kHz Crystal Frequency Tolerance

Parameters	Test Condition	Min	Typ	Max	Unit
Crystal frequency		32.768000			KHz z
Equivalent Series		-		80	KΩ

Resistance					
Load Capacitance		12.5			pF
Shunt Capacitance		-	1.15	-	pF
Frequency Tolerance	At 25℃±3℃	-10	-	10	

4. QA Requirement

Information Description	Standard(Yes) Custom(No)
ESD Testing	Yes
RF Antenna Analysis	Yes
Environmental Testing	Yes
Reliability Testing	Yes
Certification	FCC, CE, RoHS

5. Sub-GHz RF Transceiver Characteristics

5.1. 915 MHz Band +20 dBm RF Characteristics

Conditions: 25ºC, VCC=3.3V, RF center frequency 915 MHz.

Parameter	Test Condition	Min	Typ	Max	Unit
RF test frequency range		902		928	MHz
Maximum TX Power	PAVDD = 3.3V, 20 dBm devices, +20 dBm match	17.7	20	21.4	dBm
Minimum active TX Powe		-	-20.6	-	dBm
Max usable input level, 0.1% BER	Desired is reference 2 Mbps 2GFSK signal	-	-	10	dBm
Sensitivity	Desired is reference 4.8 kbps OOK signal, PER<20%	-	-113.1	-	dBm
	Desired is reference 50 kbps 2FSK signal, Δf = ± 25 kHz, PER<10%	-	-110.1	-	dBm
	Desired is reference 50 kbps 2FSK signal, Δf = ± 25 kHz, PER	-	-114.2	-	dBm
	Desired is reference 150 kbps 2FSK signal, Δf = ± 37.5 kHz, PER<10%	-	-107.5	-	dBm
	Desired is reference 2 Mbps 2GFSK signal, Δf = ± 500 kHz, BER<0.1%	-	-96.9	-	dBm
	Desired is reference 4.8 kbps O QPSK signal, spreading factor=8, PER<1%	-	-125.8	-	dBm
	Desired is reference 250 kbps O QPSK DSSS signal, PER<1%	-	-103.5	-	dBm
	Desired is reference 120 kbps OOK signal8, PER<20%	-	-102.6	-	dBm

5.2. 868 MHz Band +20 dBm RF Characteristics

Conditions: 25ºC, VCC=3.3V, RF center frequency 868 MHz.

Parameter	Test Condition	Min	Typ	Max	Unit
RF test frequency range		868		869.9	MHz
Maximum TX Power	PAVDD = 3.3V, 20 dBm devices, +20 dBm match	18.4	20.3	21.5	dBm
Minimum active TX Powe		-	-20.4	-	dBm
Max usable input level, 0.1% BER	Desired is reference 500 kbps 2GMSK signal	-	-	10	dBm
Sensitivity	Desired is reference 2.4 kbps 2GFSK	-	-125.3	-	dBm

	signal, Δf = ± 1.2 kHz, BER<0.1%				
	Desired is reference 38.4 kbps 2GFSK signal, Δf = ± 20 kHz, BER<0.1%	-	-113.3	-	dBm
	Desired is reference 50 kbps 2FSK signal, Δf = ± 12.5 kHz, PER<10%	-	-111.5	-	dBm
	Desired is reference 100 kbps 2FSK signal, Δf = ± 25 kHz, PER<10%	-	-109.2	-	dBm
	Desired is reference 500 kbps 2GMSK signal, Δf = ± 125 kHz1, BER<0.1%	-	-103.2	-	dBm
	Desired is reference 100 kbps O QPSK DSSS signal, PER<1%	-	--110.9	-	dBm

5.3. 433 MHz Band +20 dBm RF Characteristics

Conditions: 25ºC, VCC=3.3V, RF center frequency 433 MHz.

Parameter	Test Condition	Min	Typ	Max	Unit
RF test frequency range		433.12		434.72	MHz
Maximum TX Power	PAVDD = 3.3V, 20 dBm devices, +20 dBm match	17.6	19.8	21.1	dBm
Minimum active TX Powe		-	-20.3	-	dBm
Max usable input level, 0.1% BER	Desired is reference 100 kbps 2GFSK signal, BER<0.1%l	-	-	10	dBm
Sensitivity	Desired is reference 2.4 kbps 2GFSK signal, Δf = ± 1.2 kHz, BER<0.1%	-	-126.9	-	dBm
	Desired is reference 4.8 kbps OOK signal, PER<20%	-	-114.2	-	dBm
	Desired is reference 100 kbps 2GFSK signal, Δf = ± 50 kHz, BER<0.1%	-	-110.7	-	dBm
	Desired is reference 50 kbps 2GFSK signal, Δf = ± 25 kHz, BER<0.1%	-	-113.8	-	dBm
	Desired is reference 50 kbps 4GFSK signal, Δfo = ± 25 kHz, Δfi = ± 8.33 kHz, PER<1%	-	-112.1	-	dBm
	Desired is reference 460 MHz 4.8 kbps 2FSK signal, Δf = ± 2.4 kHz, PER<10%	-	-122.5	-	dBm

6. Hardware Design Considerations

6.1. The RBF chips of model 915/868/433 MHz have built-in RF chip matching circuits, eliminating the need for external placement of chip matching devices and saving board space.

6.2. The RBF chips of model 15/868/433MHZ have all integrated peripheral chips such as 39M crystal oscillator and 32.768K crystal oscillator.

6.3. The chip should not be placed in a casing made of metal. If a metal casing must be used, the antenna must be led out.

6.4 For the products that require installation of this chip, some metal components such as screws and inductors should be kept as far away as possible from the RF antenna part of the chip.

6.5. On the antenna of the chip, try not to place other components to avoid interference with the wireless performance.

6.6. The chip should be placed as close as possible to the edge or corner of the main board, and the PCB under the antenna part of the chip should be annotated and hollowed out with the keep out layer if it is not possible to hollow out. If copper plating or wiring is not allowed under the antenna, it will affect the RF performance.

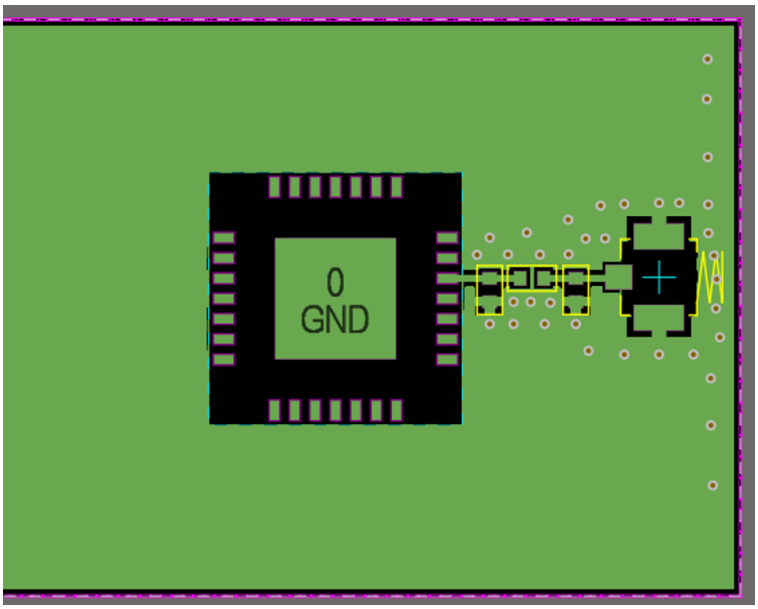
6.7. Please pay attention to check the pin diagrams and the IO connected to them. Please pay attention to the IO mode and status.

6.8. GND must be well grounded.

6.9. It is recommended to use magnetic beads or inductors for filtering of the input power supply.

7. Antenna layout suggestion

For RBF series chips, the internal integrated chip matching, customers only need to build an antenna matching circuit based on the external antenna.
For RBF series chip antenna design, it is recommended to reserve antenna matching devices. Because the RBF series chip frequency is 433MHz/868MHz/915MHz, the onboard antenna size is too large, it is not recommended to use the onboard antenna.
When using IPEX technology (external antenna), it is necessary to pay attention to the need for 50 Ohm matching in the RF output part, and it is recommended to cover the RF output part in the PCB layout by connecting holes to the ground to prevent unnecessary losses during the transmission of RF on the PCB board. And the RF part needs to be kept at a distance of more than 10mm from some interference sources, and the general layout needs to avoid any electrical components.



8. Package Information

Packing Type	Tape Reel
Packing Quantity	2000 pcs / tape