Sub-1GHz OOK/GFSK TRX Module

BM3603-0x-1

Revision: V1.00 Date: July 24, 2023

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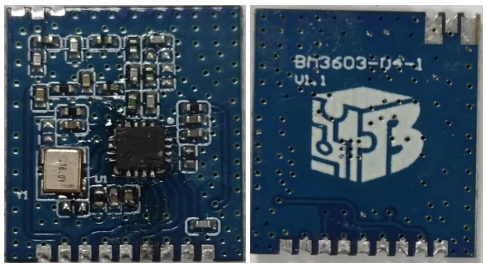
Features



- Operating voltage range: 1.8V~3.6V
- Frequency range: 315MHz~915MHz
- Modulation: OOK/GFSK
- Data rate:
  - OOK: 0.5kbps~20kbps
  - GFSK: 2kbps~250kbps
- TX output power: 0dBm~20dBm
- Operating current:
  - 0.4μA (Typ.) @ 3.3V, Deep Sleep mode
  - 5.8mA (Typ.) @ 3.3V, 433MHz RX 2kbps
  - 43.0mA (Typ.) @ 3.3V, 433MHz TX 13dBm
- RX sensitivity:
  - -120dBm (Typ.) @ 3.3V, 433MHz, 2kbps & BER=0.1%
  - -111dBm (Typ.) @ 3.3V, 433MHz, 50kbps & BER=0.1%
  - -103dBm (Typ.) @ 3.3V, 433MHz, 250kbps & BER=0.1%
- Maximum input power: 10dBm @ RF-in, BER<0.1%
- Interface: 12-pin stamp hole
- Size: 15.0mm(L)×18.5mm(W)×2.6mm(H)

General Description

The BM3603-0x-1 is a Sub-1GHz OOK/GFSK transceiver module designed based on the BC3603 device. This module can be used for wireless applications in the 315MHz, 433MHz, 470MHz, 868MHz and 915MHz ISM (Industrial, Scientific and Medical) bands. The external host MCU can access the module through a 3-wire or 4-wire SPI interface for wireless data communication.

Applications

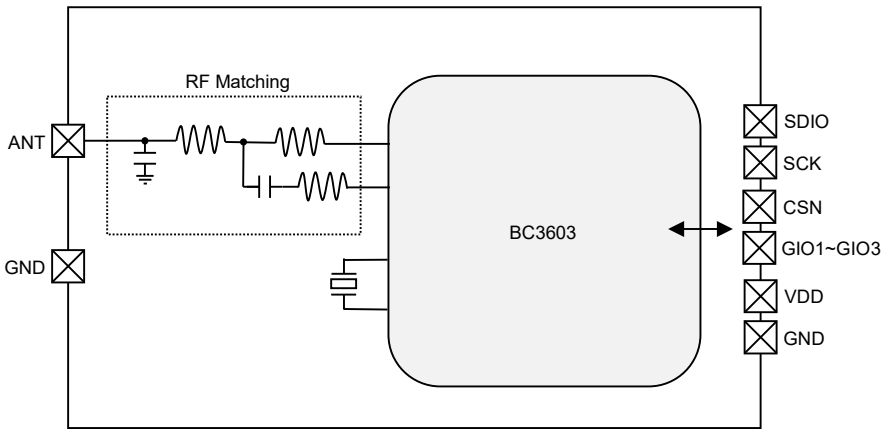
- Ceiling fans/lights
- Wireless switches
- Wireless doorbells
- Wireless smoke detectors

Selection Table

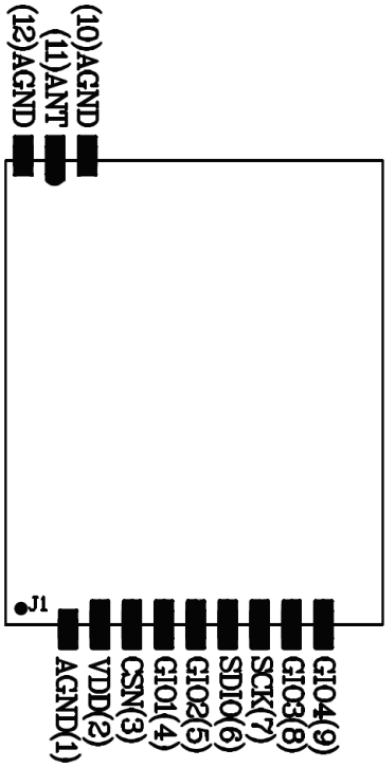
Part No.	Available Frequency Band	Optimal Operating Frequency	Supported Frequency Range
BM3603-03-1	315MHz	315MHZ	290MHz~349MHZ
BM3603-04-1	433MHz	433.92MHz	396.92MHz~471.92MHZ
BM3603-08-1	868MHz	868.35MHz	805.35MHz~923.35MHZ
BM3603-09-1	915MHz	915MHz	856MHZ~966MHz

*Module features cannot be ensured under the supported frequency range, so the above optimal operating frequencies are recommended.
*Products are available from Best Modules

Block Diagram



Pin Assignment



Pin Description

Pin	Function	Type	Description
1	AGND	PWR	Negative power supply, ground
2	VDD	PWR	Positive power supply
3	CSN	DI	SPI chip select input, low active
4	GIO1	DI/DO	Multi-function I/O 1
5	GIO2	DI/DO	Multi-function I/O 2
6	SDIO	DI/DO	SPI data input/output
7	SCK	DI	SPI clock input
8	GIO3	DI/DO	Multi-function I/O 3
9	GIO4	DI/DO	Multi-function I/O 4
10	AGND	PWR	Negative power supply, ground
11	ANT	AI	Antenna input
12	AGND	PWR	Negative power supply, ground

Legend: DI=digital input; DO=digital output; AI=analog input; PWR=power

Technical Specifications

Absolute Maximum Ratings

Supply Voltage ..... V_{SS}-0.3V~V_{SS}+3.6V

Digital Input Voltage ..... V_{SS}-0.3V~V_{DD}+0.3V

Storage Temperature..... -60℃~150℃

Operating (Ambient) Temperature ..... -40℃~85℃

ESD HBM ..... >±2kV

Note: The devices are ESD sensitive. HBM (Human Body Mode) is based on MIL-STD-883.

D.C. Electrical Characteristics

Ta=25°C, V_{DD}=3.3V, f_{XTAL}=16MHz, GFSK modulation with matching circuit and low/high pass filter
RF output is powered byV_{DD} (3.3V), unless otherwise specified

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
T_{OP}	Operating Temperature	—	-40	—	85	°C
V_{DD}	Supply Voltage	—	1.8	3.3	3.6	V
Current Consumption						
$I_{DeepSleep}$	Deep Sleep Mode Current Consumption	—	—	0.4	1.0	μA
I_{IL}	Idle Mode Current Consumption	LIRC on, X'tal off	—	1.6	—	μA
$I_{LightSleep}$	Light Sleep Mode Current Consumption	X'tal on	—	0.6	—	mA
$I_{Standby}$	Standby Mode Current Consumption @ 315/433MHz	X'tal on, Synthesizer on	—	3.9	—	mA
	Standby Mode Current Consumption @ 868/915MHz		—	3.9	—	

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{RX}/I_{TX}	315MHz Band Current Consumption	RX mode @ 2kbps	—	6	—	mA
		RX mode @ 250kbps	—	6.6	—	
		TX mode @ 0dBm P_{OUT}	—	17	—	
		TX mode @ 10dBm P_{OUT}	—	30	—	
		TX mode @ 13dBm P_{OUT}	—	43	—	
		TX mode @ 19dBm P_{OUT}	—	74	—	
	433MHz Band Current Consumption	RX mode @ 2kbps	—	6	—	mA
		RX mode @ 250kbps	—	6.6	—	
		TX mode @ 0dBm P_{OUT}	—	19	—	
		TX mode @ 10dBm P_{OUT}	—	33	—	
		TX mode @ 13dBm P_{OUT}	—	43	—	
		TX mode @ 19dBm P_{OUT}	—	71	—	
	868MHz Band Current Consumption	RX mode @ 2kbps	—	6.8	—	mA
		RX mode @ 250kbps	—	7.5	—	
		TX mode @ 0dBm P_{OUT}	—	19	—	
		TX mode @ 10dBm P_{OUT}	—	35	—	
		TX mode @ 13dBm P_{OUT}	—	47	—	
		TX mode @ 19dBm P_{OUT}	—	88	—	
	915MHz Band Current Consumption	RX mode @ 2kbps	—	6.6	—	mA
		RX mode @ 250kbps	—	7.4	—	
		TX mode @ 0dBm P_{OUT}	—	19	—	
		TX mode @ 10dBm P_{OUT}	—	36	—	
		TX mode @ 13dBm P_{OUT}	—	46	—	
		TX mode @ 19dBm P_{OUT}	—	86	—	

RF Electrical Characteristics

Ta=25°C, V_{DD}=3.3V, f_{XTAL}=16MHz, GFSK modulation with matching circuit and low/high pass filter
RF output is powered byV_{DD} (3.3V), unless otherwise specified

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
RF Characteristics						
f_{RF}	RF Frequency Band	315MHz band	—	315	—	MHz
		433MHz band	—	433.92	—	
		470~510MHz band	—	490	—	
		868MHz band	—	868.3	—	
		915MHz band	—	915	—	
DR	Data Rate	OOK modulation	0.5	—	20	kbps
		GFSK modulation	2	—	250	
Transmitter						
P_{OUT}	TX Output Power	433MHz band	0	—	20	dBm
		868MHz band	0	—	20	
$t_{ST,TX}$	TX Settling Time	Light Sleep mode to TX mode	—	120	—	μs
S.E.$_{TX}$	TX Spurious Emission (POUT=10dBm)	f<1GHz	—	—	-36	dBm
		47MHz<f<74MHz	—	—	-54	
		87.5MHz<f<118MHz				
		174MHz<f<230MHz				
		470MHz<f<862MHz				
		2nd, 3rd Harmonic	—	—	-30	

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Receiver						
$t_{ST,RX}$	RX Settling Time	Light Sleep mode to RX mode	—	150	—	μs
P_{Sens}	315MHz RX Sensitivity @ BER=0.1%	2kbps (f_{DEV}=8kHz)	—	-119	—	dBm
		10kbps (f_{DEV}=40kHz)	—	-112	—	
		50kbps (f_{DEV}=18.75kHz)	—	-110	—	
		125kbps (f_{DEV}=46.875kHz)	—	-106	—	
		250kbps (f_{DEV}=93.75kHz)	—	-103	—	
	433MHz RX Sensitivity @ BER=0.1%	2kbps (f_{DEV}=8kHz)	—	-120	—	dBm
		10kbps (f_{DEV}=40kHz)	—	-113	—	
		50kbps (f_{DEV}=18.75kHz)	—	-111	—	
		125kbps (f_{DEV}=46.875kHz)	—	-106	—	
		250kbps (f_{DEV}=93.75kHz)	—	-103	—	
	868MHz RX Sensitivity @ BER=0.1%	2kbps (f_{DEV}=8kHz)	—	-119	—	dBm
		10kbps (f_{DEV}=40kHz)	—	-112	—	
		50kbps (f_{DEV}=18.75kHz)	—	-109	—	
		125kbps (f_{DEV}=46.875kHz)	—	-105	—	
		250kbps (f_{DEV}=93.75kHz)	—	-102	—	
	915MHz RX Sensitivity @ BER=0.1%	2kbps (f_{DEV}=8kHz)	—	-119	—	dBm
		10kbps (f_{DEV}=40kHz)	—	-112	—	
		50kbps (f_{DEV}=18.75kHz)	—	-109	—	
		125kbps (f_{DEV}=46.875kHz)	—	-105	—	
		250kbps (f_{DEV}=93.75kHz)	—	-102	—	
$P_{IN,max}$	Maximum Input Power @ BER<0.1%	—	—	—	10	dBm

Functional Description

TX/RX FIFO Mode (DIR_EN=0)

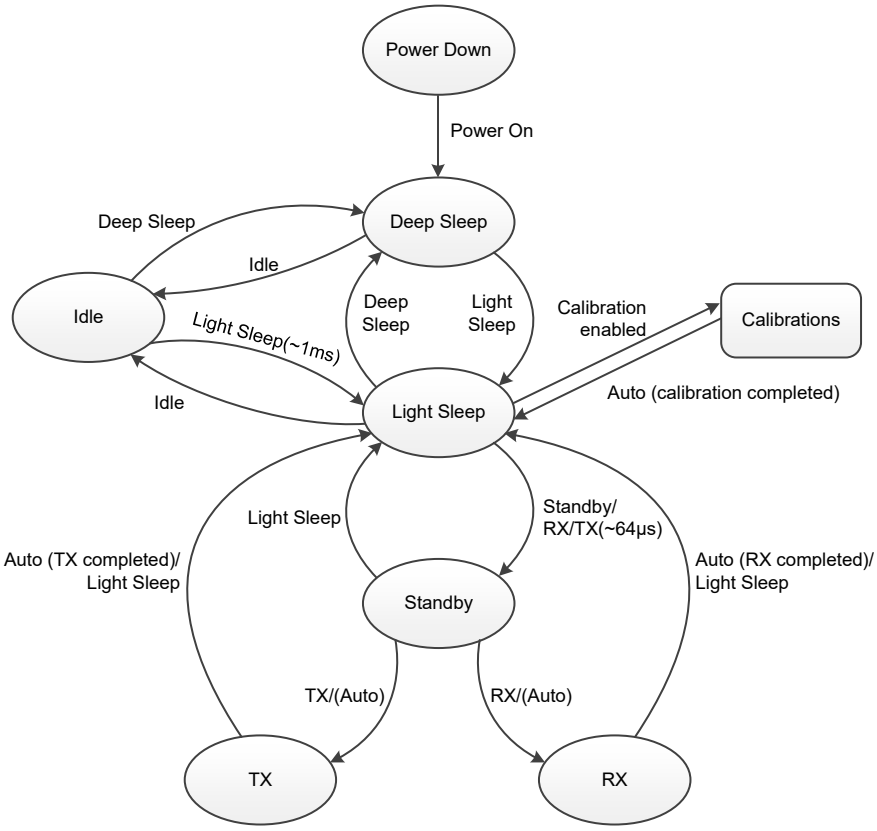
If the DIR_EN bit is cleared to 0, the device mode transactions are implemented by strobe command from the host MCU and the TX/RX data are derived from the packet handling hardware.

Initially, the BC3603 is in the Power Down mode. After the device completes the internal power on reset, it will enter the Deep Sleep mode and wait for further strobe commands from the host MCU. If the Light Sleep command is received, the device will enable the internal LDO, oscillate the XO and enter the Light Sleep mode. In this state, the host MCU can have the BC3603 execute calibration process if necessary. For normal TRX operations, the host MCU can issue an RX or TX command to the BC3603.

After receiving the TX or RX command, the device will first enter the Standby mode which lasts a certain period known as TX/RX settling time. After the settling time has escaped, the device will finally enter the RX or TX mode. The device will stay in the TX/RX sate until the TX/RX event is completed, after which the device will return to the Light Sleep mode automatically.

For low power periodical wireless transmission, the device supports low power Idle mode where the LIRC and wake-up timer are turned on. By appropriate timer setting and issuing the Idle mode command, the device will turn off the LDO and XO and enter the Idle mode.

The wake-up timer starts to count after ATR_EN is set to “1”. The device stays in the Idle mode until the timer expires and then an IRQ will be asserted on the GIO to wake up the host MCU. Then the host MCU can have the device enter the Light Sleep mode and continue to execute normal TX/RX operations. After the TX/RX event is completed, the host MCU can issue the Idle command to have the device return to the Idle mode again.



FIFO Mode State Diagram

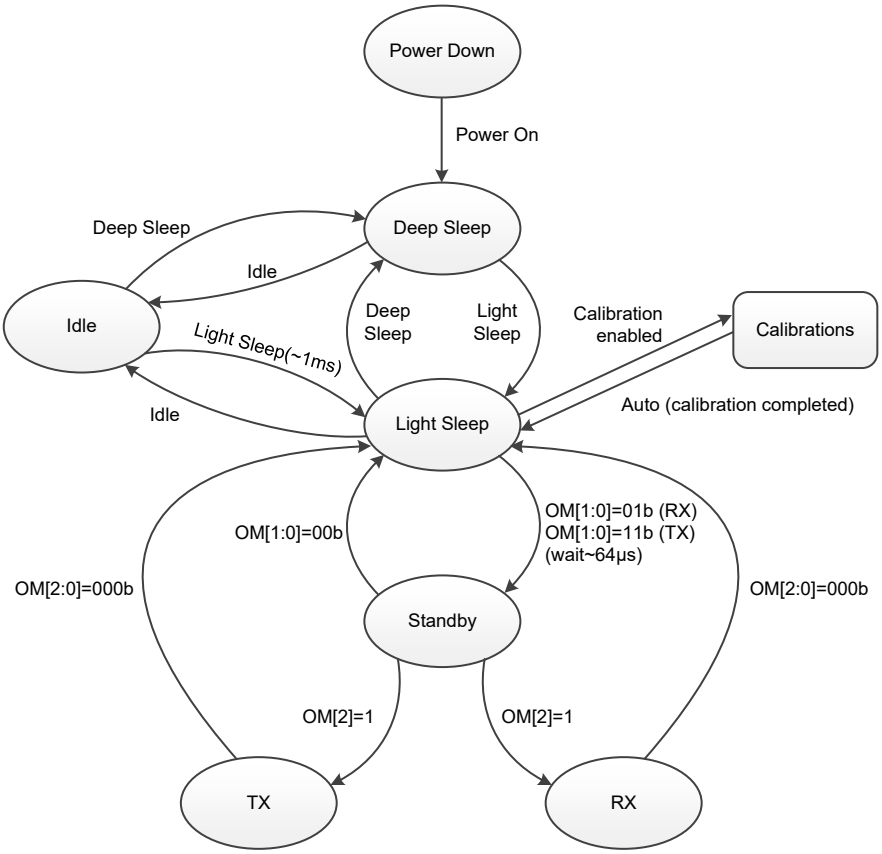
TX/RX Direct Mode (DIR_EN=1)

If the DIR_EN bit is set to 1, TX data is derived directly from the host MCU to BC3603 and RX data is sent directly from the BC3603 to the host MCU. In order to simplify the data bit clock synchronization between the BC3603 and the host MCU, the BC3603 outputs the TBCLK/RCLK from GIO3 by setting GIO3S[3:0]. Both TBCLK and RBCLK are in 50/50 duty cycle.

In the transmitting mode, the host MCU outputs bit data at the rising edge of the TBCLK signal and the BC3603 samples the TX bit data at the falling edge of the TBCLK signal. In the receiving mode, the host MCU receives data at the rising edge of the RBCLK signal and the BC3603 outputs bit data at the falling edge of the RBCLK signal. The host MCU can select GIO1 or GIO2 for the TX/RX bit data transmission by setting GIO1S[2:0] or GIO2S[2:0].

For TX operations in the direct mode, the host MCU needs to set the OM[1:0] bits, i.e. RTX_SEL and SX_EN, to 11b to select the TX mode and have the BC3603 enter standby mode first, then set the OM[2] bit, RTX_EN, to 1 to have the BC3603 start to transmit the TX data. As long as the host MCU sets OM[2:0] to 000b, the BC3603 will return to the Light Sleep mode.

For RX operations in the direct mode, the host MCU needs to set OM[1:0] to 01b first, then set OM[2] to 1 to have the BC3603 start to receive data from the air. After the BC3603 receives the matched SYNCWORD code, it will output the RBCLK clock, receive data bit (payload part) and then transmit to the host MCU. In direct mode, the transmission data length has no limit.



Direct Mode State Diagram

Interface

SPI Communication Format

The BC3603 communicates with a host MCU via a 3-wire SPI interface (CSN, SCK, SDIO) or a 4-wire SPI interface (SDO from GIO1 or GIO2) with a data rate up to 4Mbps. An SPI transmission is an (8+8×n) bits sequence which consists of an 8-bit command and n×8 bits of data, where n can be 0 or any natural number. If the number n is greater than the address boundary, the address will return to zero. The host MCU should pull the CSN (SPI chip select) pin low in order to access the BC3603. Using the SPI interface, user can access the control registers and issue Strobe commands. When writing data to the RF chip, the SPI data will be latched into the registers at the rising edge of the SCK signal. When reading data from the RF chip registers, the bit data will be transferred at the falling edge of the SCK signal after the target register address has been input.

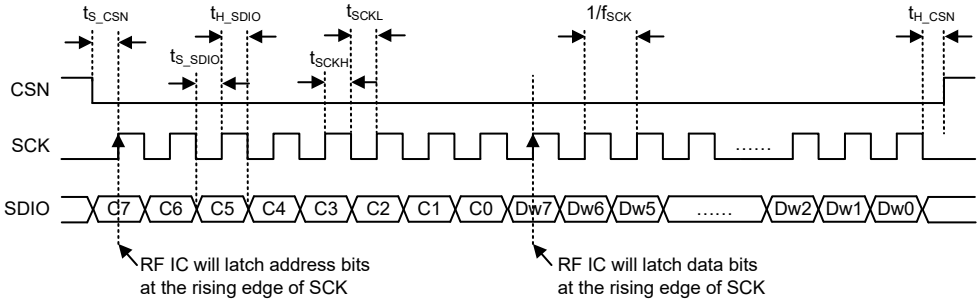
Command (8 bits)								Data (8 bits)							
C7	C6	C5	C4	C3	C2	C1	C0	D7	D6	D5	D4	D3	D2	D1	D0

SPI Command Format

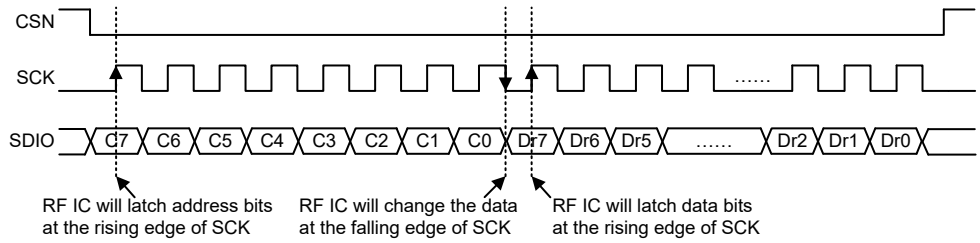
Two kinds of command are defined. One is 1-byte command only, named CmdO, and the other is 1-byte command followed by n-byte data, named CmdD.

C7	C6	C5	C4	C3	C2	C1	C0	Description	CmdO	CmdD
0	1	A5	A4	A3	A2	A1	A0	Write to control registers		√
1	1	A5	A4	A3	A2	A1	A0	Read from control registers		√
0	0	1	x	x	x	B1	B0	Set register bank	√	
0	0	0	1	x	x	x	0	Write SYNCWORD command		√
1	0	0	1	x	x	x	0	Read SYNCWORD command		√
0	0	0	1	x	x	x	1	TX FIFO write command		√
1	0	0	1	x	x	x	1	RX FIFO read command		√
1	0	0	1	1	1	1	1	Read Chip ID command		√
0	0	0	0	1	0	0	0	Software reset command	√	
0	0	0	0	1	0	0	1	TX FIFO address pointer reset command	√	
1	0	0	0	1	0	0	1	RX FIFO address pointer reset command	√	
0	0	0	0	1	0	1	0	Deep Sleep mode	√	
0	0	0	0	1	0	1	1	Idle mode	√	
0	0	0	0	1	1	0	0	Light Sleep mode	√	
0	0	0	0	1	1	0	1	Standby mode	√	
0	0	0	0	1	1	1	0	TX mode	√	
1	0	0	0	1	1	1	0	RX mode	√	

SPI Timings



3-Wire SPI Interface Write 1-byte Data Operation

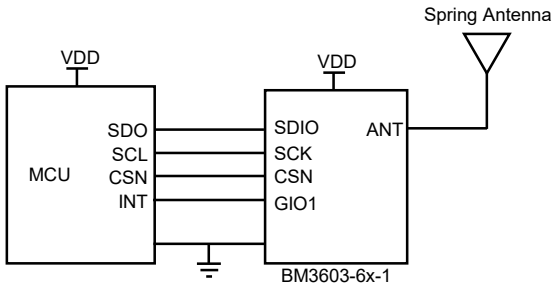


3-Wire SPI Interface Read 1-byte Data Operation

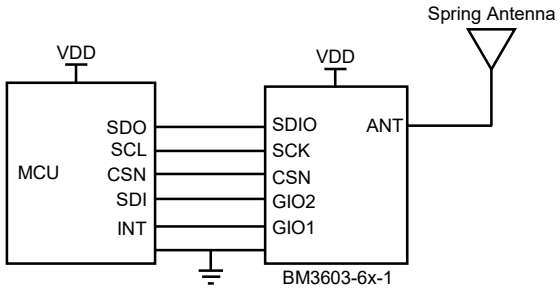
*Products are available from Best Modules

Application Circuits

3-Wire SPI Mode

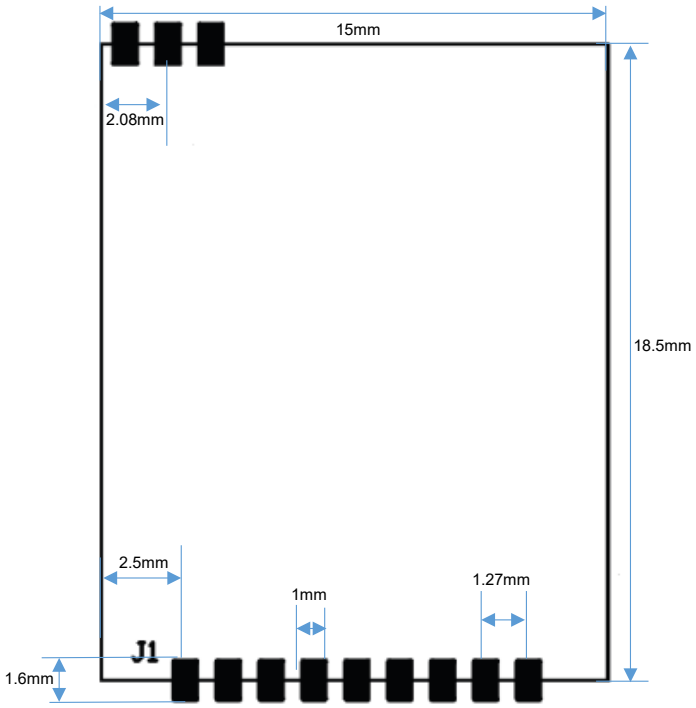


4-Wire SPI Mode



Layout Description

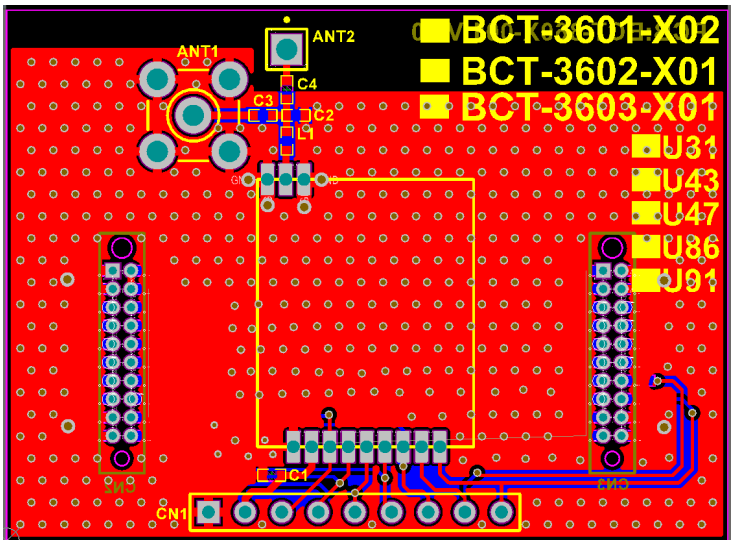
PCB Footprint



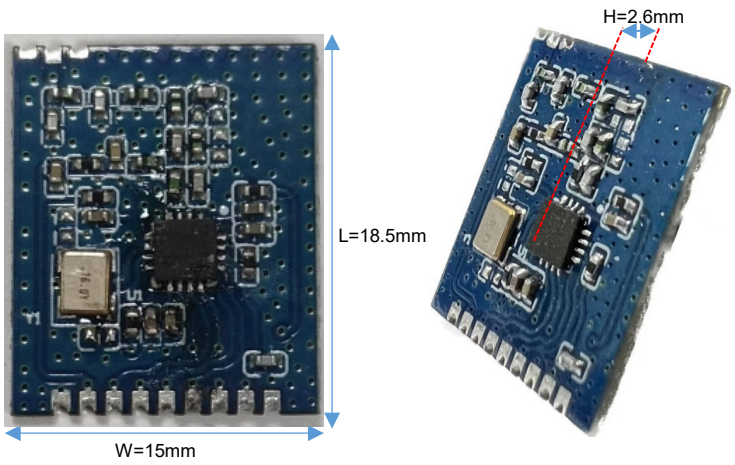
Layout Guidelines

1. Provide a stable power supply and add appropriate filter capacitors.
2. Keep away from DC-DC circuits as much as possible.
3. Reserve a π type matching circuit for the antenna.
4. During module application, ensure that the antenna is as far away from any metal objects as possible within a space of 1cm.

Layout Example



Dimensions



Reference Information

Modification History

Date	Author	Issue	Modification Information
2023.02.28	Zahi	V1.00	First version

Relevant Document

BC3603 Example Program

Buy Online

Best Modules

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