

BM20(BM23)SPKS1NBC

Bluetooth® Stereo Audio Module

Introduction

The BM2020 stereo audio module is a Bluetooth v5.0 (BDR/EDR) audio module for designers to add wireless audio and voice applications to their products. This Bluetooth SIG-certified module provides a complete wireless solution with Bluetooth stack, integrated antenna, and worldwide radio certifications in a compact surface mount package.

This stereo module contains a built-in Li-Ion charger and a digital audio interface (BM2020). It supports HSP, HFP, SPP, A2DP, and AVRCP profiles. Both AAC and SBC Codecs are supported for A2DP.

Note: The customers must connect their own external analog Codec/DSP/amplifier and MCU for audio output.

Figure 1. BM2020 Module

BM2020



Features

- Qualified for Bluetooth v5.0 Specification
 - HFP v1.6, HSP v1.1, A2DP v1.2, AVRCP v1.5, SPP v1.0, PBAP v1.0
 - Bluetooth Classic, Basic Rate/Enhanced Data Rate (BDR/EDR)
- On-Board Embedded Bluetooth Stack
- Easy to Configure with Windows Graphical User Interface (GUI) or Direct by Microcontroller Unit (MCU)
- Compact Surface Mount Module:
 - 29 x 15 x 2.5 mm
 - Castellated surface mount pads

- Integrated 3V and 1.8V Configurable Switching Regulator and LDO
- Built-in Lithium-ion Battery Charger (up to 350 mA)
- Built-in ADC for Battery Monitor and Voltage Sense
- Audio-In/Out
 - BM2020 supports analog audio output
- Transparent Universal Asynchronous Receiver/Transmitter (UART) Mode for Seamless Serial Data Over UART

Interface

- Integrated Crystal Oscillator and Matching Circuitry
- Secure AES128 Encryption

RF/Analog

- Frequency Spectrum: 2.402 GHz to 2.480 GHz
- Receive Sensitivity: -91 dB ($\pi/4$ DQPSK)
- Transmitter Output Power: +4 dBm (maximum) for Class 2

Audio processor

- Support 64 Kbps A-Law, μ -Law PCM format/Continuous Variable Slope Delta Modulation (CVSD) for SCO Channel Operation
- Noise Reduction (NR) and Acoustic Echo Cancellation (ACE)
- Sub-Band Coding (SBC) and Optional Advanced Audio Coding (AAC) Decoding
- Packet Loss Concealment (PLC)
- Four Languages (Chinese/ English/ Spanish/ French) Voice Prompts Support (20 events for each language) using the IS20XXS_UI tool
- Serial Copy Management System (SCMS-T) Content Protection

Audio Codec

- 20-Bit Digital-to-Analog Converter (DAC) and 16-bit Analog-to-Digital Converter (ADC) Codec
- 98 dB Signal-to-Noise ratio (SNR) DAC Playback

Peripherals

- One Line-in Port for External Audio Input
- Two LED Drivers
- One UART Interface
- Multiple I/O Pins for Control and Status
- High-Speed HCI-UART Interface (supports up to 921,600 bps)

Antenna

- PCB Antenna

Compliance

- Bluetooth Special Interest Group (SIG) Certified:
 - BM2020 QDID: 121137



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- BM2020 modules have been granted modular approval from various countries. For additional details, refer to [9. Certification Notices](#).
- RoHS Compliant

Operating Conditions

- Operating Voltage: 3.0V to 4.2V
- Temperature Range: -20°C to 70°C

Applications

- Bluetooth Sound Bar
- Bluetooth Stereo Speaker Phone

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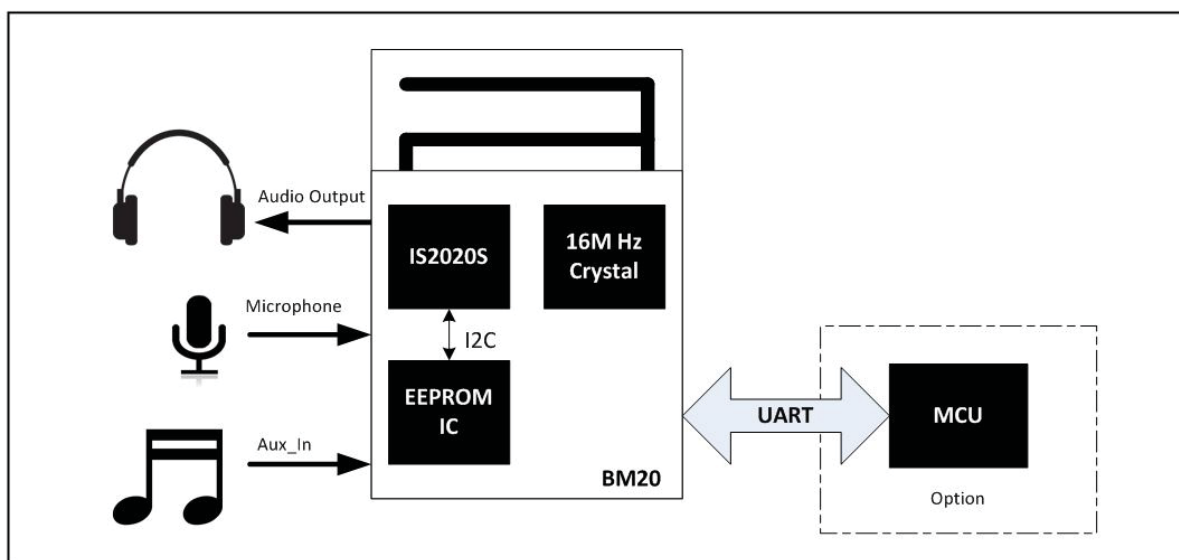
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1. Device Overview

The BM2020 stereo module is built around the IS2020S SoCs, respectively, which integrates the Bluetooth radio transceiver, a Power Management Unit (PMU), and a Digital Signal Processor (DSP).

The following figure illustrates a typical example of the BM2020 module that operates as an independent system or when connected to an MCU.

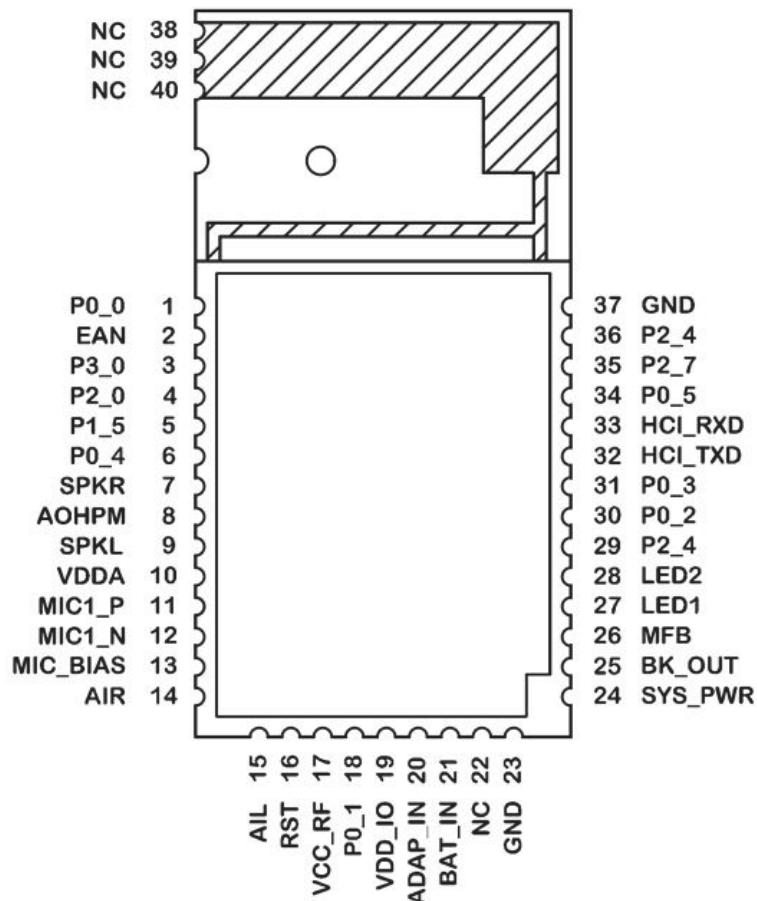
Figure 1-1. BM2020 Typical Application



1.1 Interface Description

The following figure illustrates the pin diagram of the BM2020 module.

Figure 1-3. BM2020 Module Pin Diagram



The following table provides the pin description of the BM20 module.

Table 1-1. BM2020 Module Pin Description

Pin No.	Name	Pin type	Description
1	P0_0	I/O	I/O pin, default pull-high input (Note 1) - Slide switch detector, active-low - UART TX_IND, active-low
2	EAN	I	Embedded ROM/External Flash enable H: Embedded; L: External Flash
3	P3_0	I	I/O pin, default pull-high input (Note 1) Line-in Detector (default), active-low
4	P2_0	I	I/O pin, default pull-high input System Configuration, H: Application L: Base band (Test Mode)

.....continued

Pin No.	Name	Pin type	Description
5	P1_5	I/O	I/O pin, default pull-high input (Note 1) - NFC detection pin, active low - Out_Ind_0 - Slide Switch Detector, active low - Buzzer Signal Output
6	P0_4	I/O	I/O pin, default pull-high input (Note 1) - NFC detection pin, active low - Out_Ind_0
7	SPKR	O	Right-channel, analog headphone output
8	AOHPM	O	Headphone common mode output/sense input
9	SPKL	O	Left-channel, analog headphone output
10	VDDA	P	Positive power supply/reference voltage for Codec, no need to add power to this pin
11	MIC1_P	I	MIC 1 mono differential analog positive input
12	MIC1_N	I	MIC 1 mono differential analog negative input
13	MIC_BIAS	P	Electric microphone biasing voltage
14	AIR	I	Right-channel, single-ended analog input
15	AIL	I	Left-channel, single-ended analog input
16	RST	I	System Reset pin, Low: reset
17	VCC_RF	P	1.28V RF LDO output, no need to add power to this pin
18	P0_1	I/O	I/O pin, default pull-high input (Note 1) - FWD key, when Class 2 RF (default), active-low - Class 1 Tx Control signal of external RF T/R switch, active-high
19	VDD_IO	P	Power output, no need to add power to this pin
20	ADAP_IN	P	5V Power adapter input
21	BAT_IN	P	3.0V to 4.2V Li-Ion battery input
22	NC	-	No connection
23	GND	P	Ground pin
24	SYS_PWR	P	System power output BAT mode: 3.0 to 4.2V Adapter mode: 4.0V
25	BK_OUT	P	1.8V Buck output, no need to add power to this pin
26	MFB	I	- Power key in off mode - UART_RX_IND: MCU used to wake-up Bluetooth (Note 1)
27	LED1	I	LED driver 1
28	LED2	I	LED driver 2

.....continued			
Pin No.	Name	Pin type	Description
29	P2_4	I	I/O pin, default pull-high input System Configuration L: Boot Mode with P2_0 low combination
30	P0_2	I	I/O pin, default pull-high input (Note 1) Play/Pause key (default), active-low
31	P0_3	I/O	I/O pin, default pull-high input (Note 1) • REV key (default), active low • Buzzer Signal Output • Out_Ind_1 • Class1 Rx control signal of external RF T/R switch, active-high
32	HCI_TXD	O	HCI-UART data output
33	HCI_RXD	I	HCI-UART data input
34	P0_5	I	I/O pin, default pull-high input (Note 1) Volume down (default), active-low
35	P2_7	I	I/O pin, default pull-high input (Note 1) Volume up key (default), active-low
36	P2_4	I	I/O pin, default pull-high input System Configuration, L: Boot Mode with P2_0 low combination
37	GND	P	Ground pin
38	NC	-	No Connection
39	NC	-	No Connection
40	NC	-	No Connection

- I: Input pin
- O: Output pin
- I/O: Input/Output pin
- P: Power pin

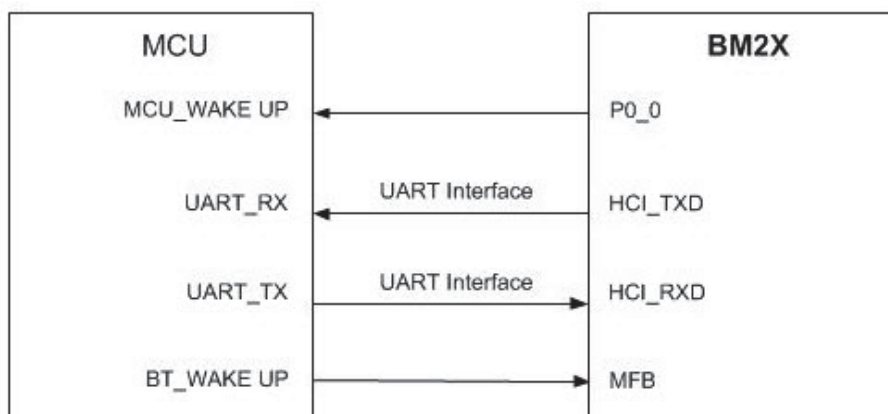
Note: All I/O pins can be configured using the IS20XXS_UI tool.

2. Application Information

2.1 Operation with External MCU

The BM2020 stereo module supports a UART command set to make an external MCU control the module. The following figure illustrates the interface between the BM2020 module and an external MCU.

Figure 2-1. Interface between MCU and BM20/23 Module

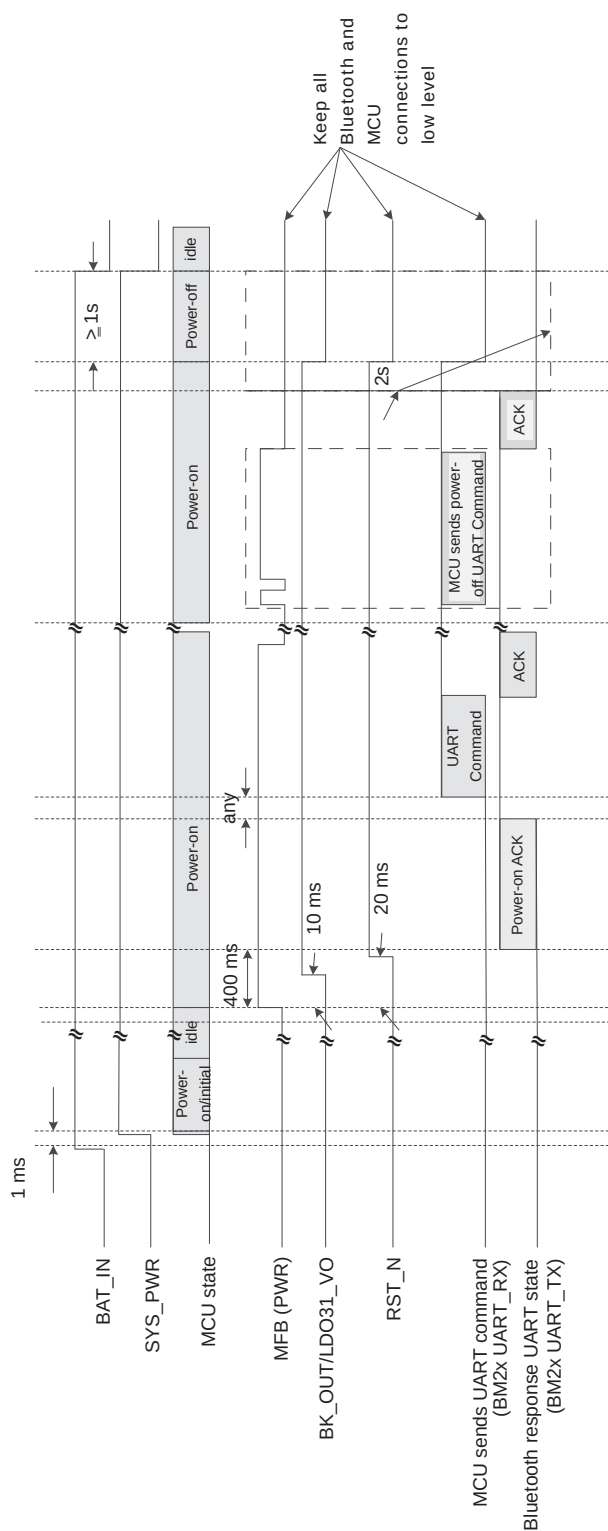


The MCU controls the module by the UART interface and wakes up the module by the PWR pin. The stereo module provides a wake-up MCU function that connects to P0_0 pin of the module.

Refer to the *UART Command Set* document for a list of functions the BM2020 module supports and how to use the UI tool to configure the UART and UART Command Set tool.

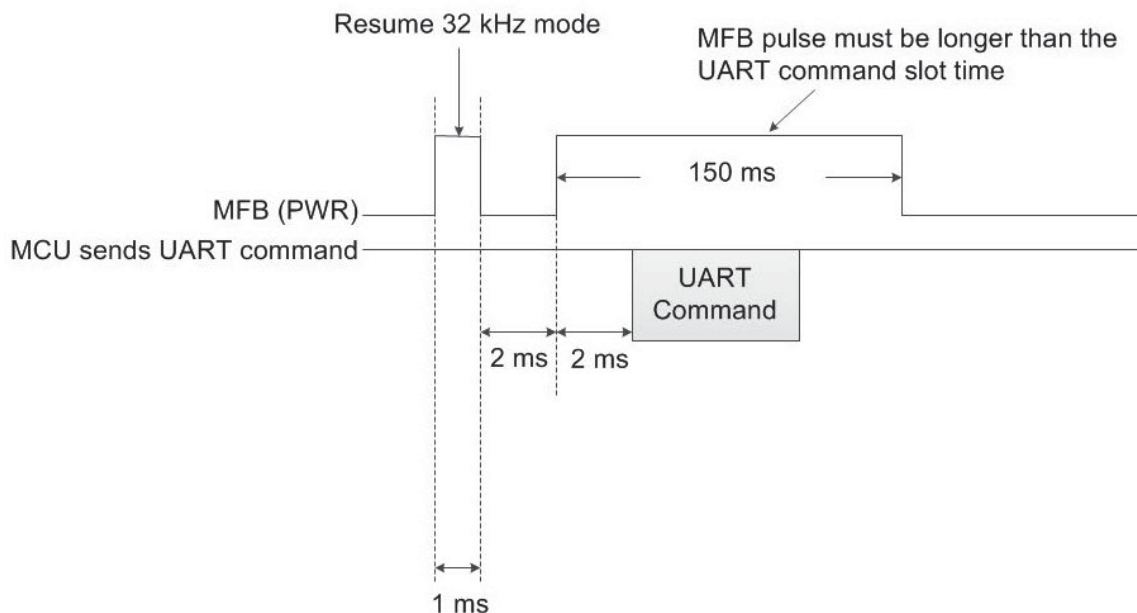
For a more detailed description, refer to the *UART_CommandSet_v154* document and the IS20XXS_UI tool. A UART control signal timing sequence is illustrated in the following figure.

Figure 2-2. Power ON/OFF Sequence



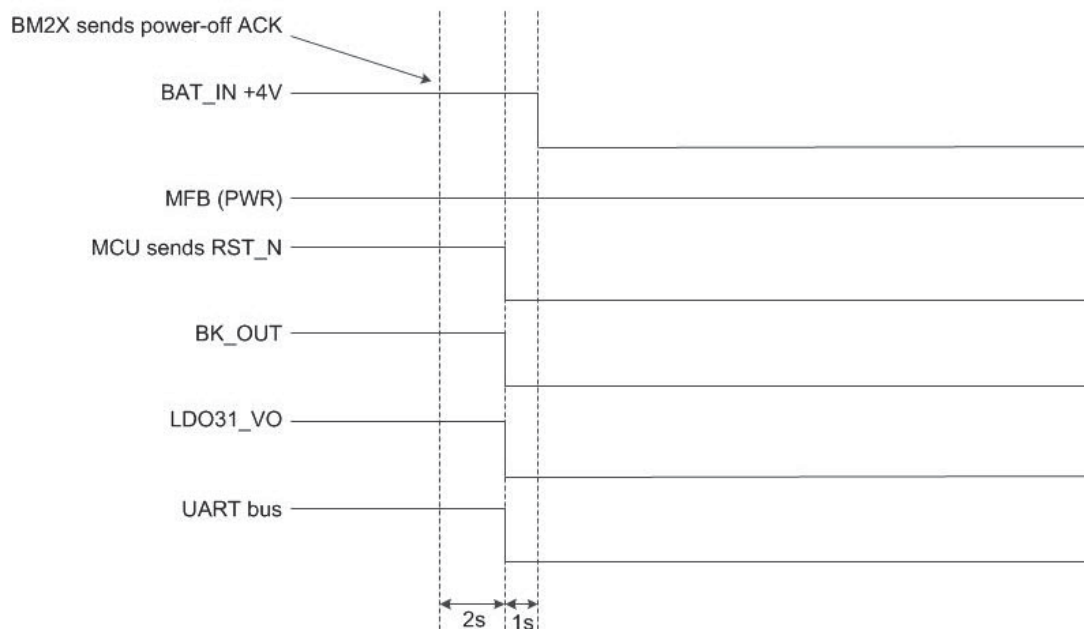
A timing sequence of Rx indication after power-on is illustrated in the following figure.

Figure 2-3. Timing Sequence of Rx Indication After Power-On



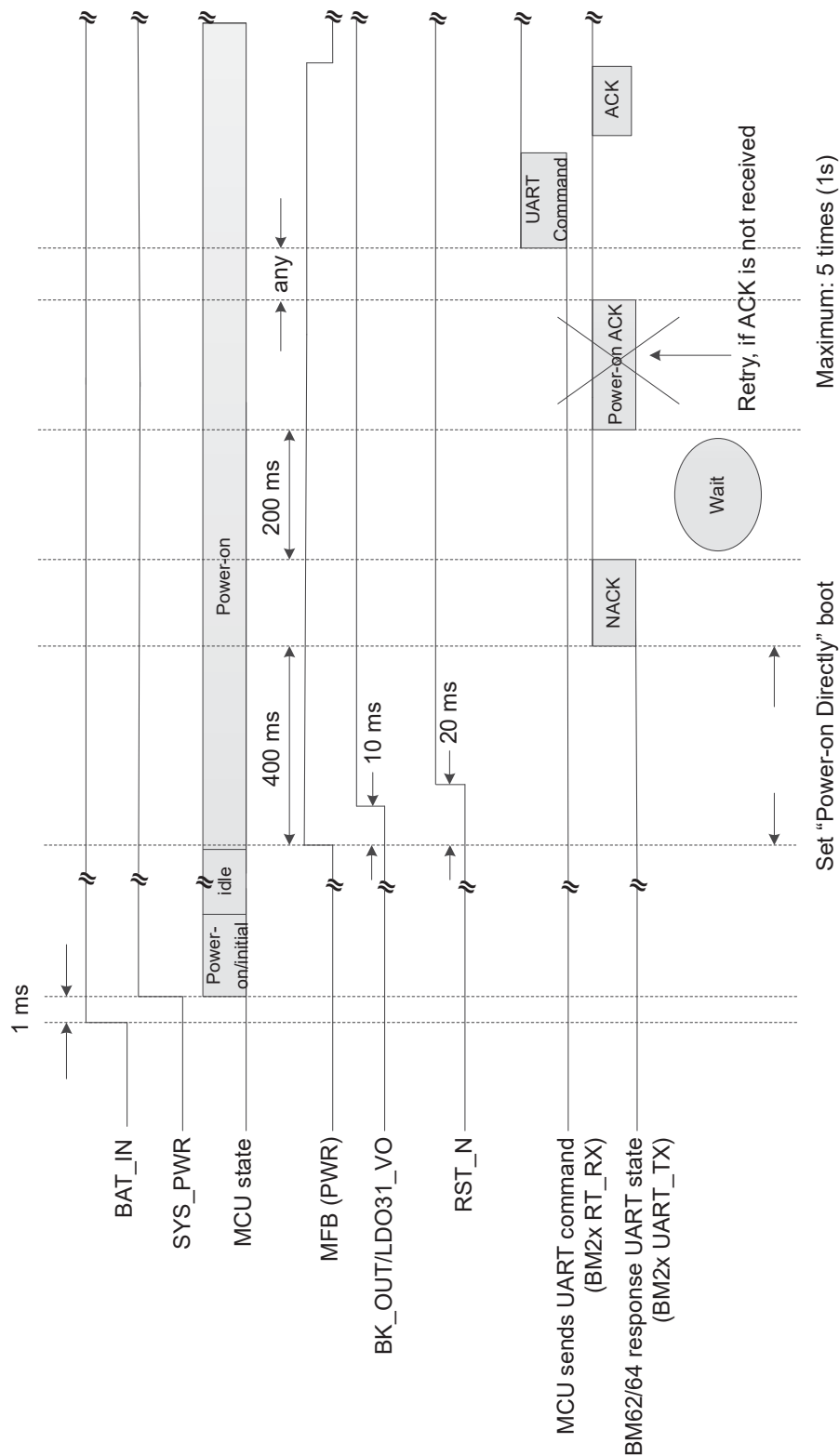
A timing sequence of Rx indication after power-off is illustrated in the following figure.

Figure 2-4. Timing Sequence of Rx Indication After Power-Off



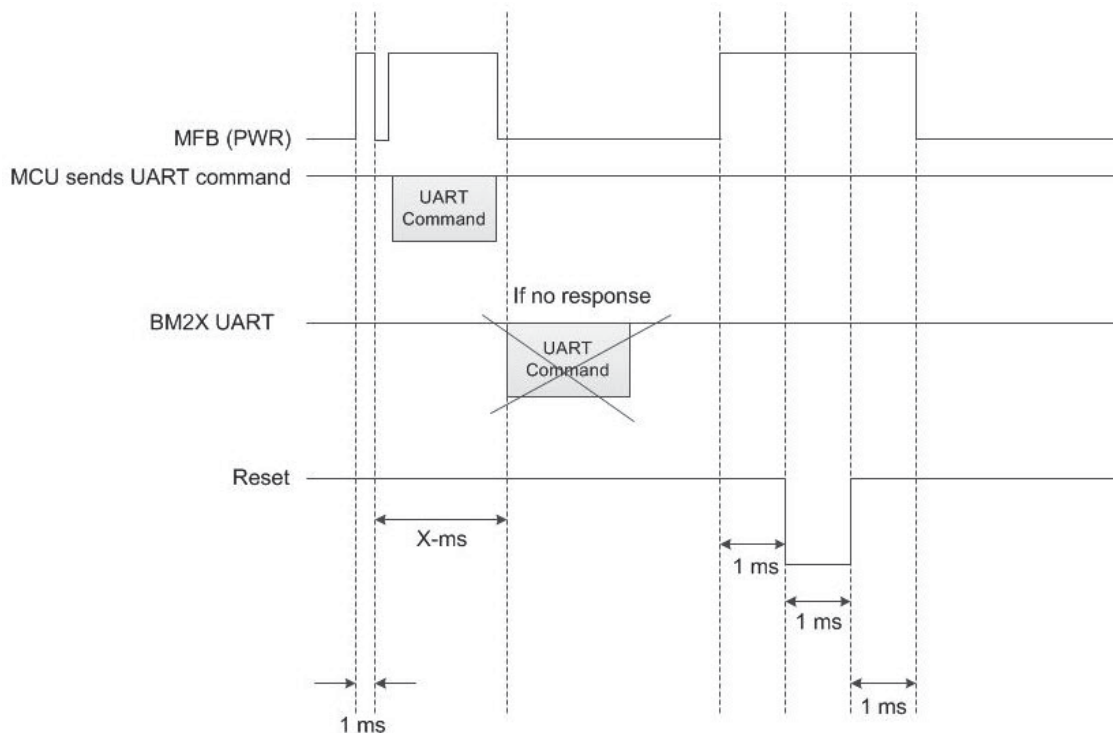
A timing sequence of power-on (Nack) is illustrated in the following figure.

Figure 2-5. Timing Sequence of Power-On (Nack)



If the module is hanged, the reset timing sequence must be as illustrated in the following figure.

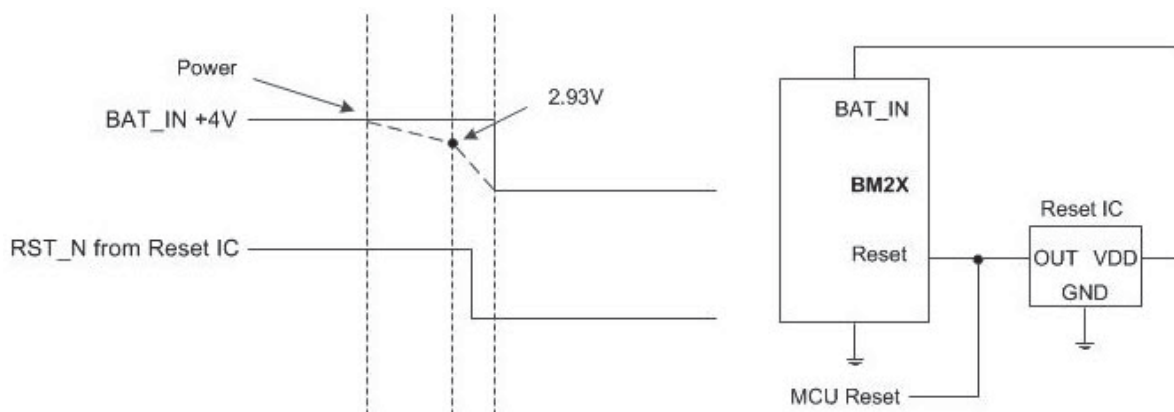
Figure 2-6. Reset Timing Sequence if Module is Hanged



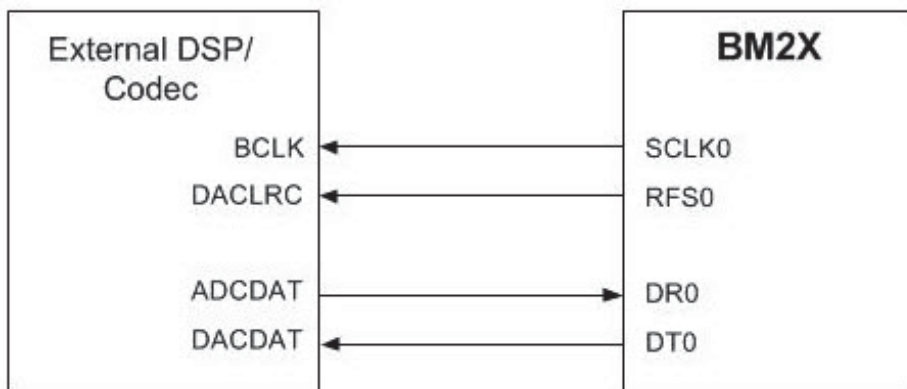
If the MCU sends a UART Command and Bluetooth does not respond within X-ms, then the MCU sends a reset signal to BT to perform the hardware reset.

A timing sequence of power drop protection is illustrated in the following figure.

Figure 2-7. Timing Sequence of Power Drop Protection

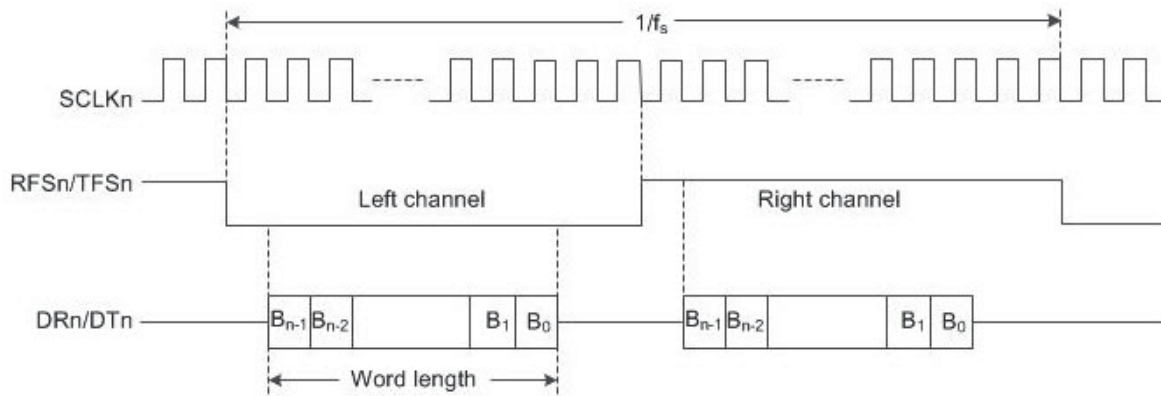


If the Bluetooth BAT uses an adapter that translates voltage by LDO, it is recommended to use "Reset IC" to avoid power-off suddenly. The Rest IC output pin must be "Open Drain" with a delay time ≤ 10 ms and the recommended part is TCM809SVNB713 or G691L263T73.



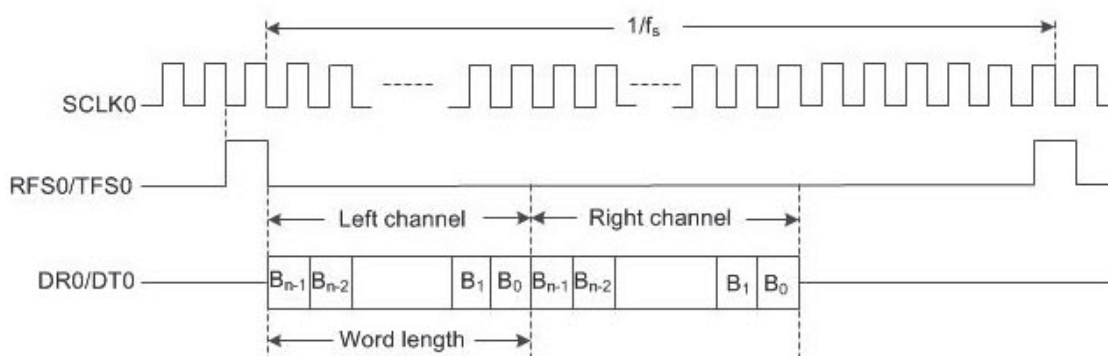
The Slave mode reference connection is shown in the following figure.

Figure 2-8. Timing for I²S Modes (both Master and Slave)



The following figures illustrate the timing diagram in the PCM modes.

Figure 2-9. Timing Diagram for PCM Modes (Master/Slave)



2.3 RESET (RST_N)

RST is the module reset pin, which is in Active-Low state. To reset the module, the RST_N pin must hold LOW for at least 63 ns.

2.4 Status LED (LED1, LED2)

The status LED provides the following status indications:

- Standby
- Inquiry
- Link
- Link Back
- Low Battery
- Page
- Battery Charging

Note: Each LED flashing sequence and brightness status indications are configurable by the UI tool.

2.5 External Configuration

The BM2020 stereo module can be configured and the firmware programmed using an external configuration and programming tool available from our company. It is recommended to include a pin header on the main PCB for development.

3. Electrical Characteristics

The following table provides the absolute maximum specification conditions of the BM20/23 module.

Table 3-1. Absolute Maximum Specification

Symbol	Parameter	Min.	Max.	Unit
BAT_IN	Input voltage for battery	0	4.3	V
ADAP_IN	Input voltage for adapter	0	7.0	V
T _{STORE}	Storage temperature	-65	+150	°C
T _{OPERATION}	Operation temperature	-20	+70	°C

The following table provides the recommended operating condition of the BM20/23 module.

Table 3-2. Recommended Operating Condition

Symbol	Parameter	Min.	Typical	Max.	Unit
BAT_IN	Input voltage for battery	3	3.7	4.2	V
ADAP_IN	Input voltage for adapter	4.5	5	5.5	V
T _{OPERATION}	Operation temperature	-20	+25	+70	°C

Note: The absolute and recommended operating condition tables reflect typical usage for device.

⚠ CAUTION Stresses listed under Absolute Maximum Ratings cause permanent damage to the device. This is a stress rating only. The functional operation of the device at those or any other conditions and those indicated in the operation listings of this specification, is not implied. Exposure to maximum rating conditions for extended periods affects the device reliability.

The parameters of the I/O and reset level are shown in the following table.

Table 3-3. I/O and Reset Level

Parameter	Min.	Typ.	Max.	Units
I/O supply voltage (VDD_IO)	2.7	-	3.3	V
I/O Voltage Levels				
V _{IL} input logic levels low	-0.3	-	0.8	V
V _{IH} input logic levels high	2.0	-	3.6	V
V _{OL} output logic levels low	-	-	0.4	V
V _{OH} output logic levels high	2.4	-	-	V
RESET				
V _{TH,RES} threshold voltage	-	1.6	-	V

Note:

1. VDD_IO voltage is programmable by EEPROM parameters.
2. These parameters are characterized but not tested in manufacturing.

The parameters of the battery charger are shown in the following table.

Table 3-4. Battery Charger

Parameter		Min	Typical	Max	Unit
ADAP_IN input voltage		4.5	5.0	5.5	V
Supply current to charger only		-	3	4.5	mA
Maximum battery Fast charge current Note: ENX2=0	Headroom > 0.7V (ADAP_IN=5V)	170	200	240	mA
	Headroom = 0.3V (ADAP_IN=4.5V)	160	180	240	mA
Maximum battery Fast charge current Note: ENX2=1	Headroom > 0.7V (ADAP_IN=5V)	330	350	420	mA
	Headroom = 0.3V (ADAP_IN=4.5V)	180	220	270	mA
Trickle charge voltage threshold		-	3	-	V
Battery charge termination current, (% of fast charge current)		-	10	-	%

Note:

1. Headroom = VADAP_IN – VBAT
2. ENX2 is not allowed to be enabled, when VADAP_IN – VBAT > 2V
3. These parameters are characterized but not tested in manufacturing

The parameters of the LED driver are shown in the following table.

Table 3-5. LED driver

Parameter	Min	Typical	Max	Unit
Open-drain voltage	-	-	3.6	V
Programmable current range	0	-	5.25	mA
Intensity control	-	16	-	Step
Current step	-	0.35	-	mA
Power down open-drain current	-	-	1	μA
Shutdown current	-	-	1	μA

Note:

1. Test condition: SAR_VDD = 1.8V, temperature = 25 °C.
2. These parameters are characterized but not tested in manufacturing.

The parameters of the audio Codec ADC are provided in the following table.

T= 25°C, V_{dd} = 3.0V, 1 kHz sine wave input, Bandwidth = 20 Hz to 20 kHz.

Table 3-6. Audio Codec ADC

Parameter (Condition)	Min.	Typ.	Max.	Unit
Resolution	-	-	16	Bits
Output sample rate	8	-	48	kHz

.....continued				
Parameter (Condition)	Min.	Typ.	Max.	Unit
Signal-to-Noise Ratio Note: 1 (SNR at MIC or Line-in mode)		88	-	dB
Digital gain	-54		4.85	dB
Digital gain resolution	-	2 to 6	-	dB
MIC boost gain	-	20	-	dB
Analog gain	-	-	60	dB
Analog gain resolution	-	2.0	-	dB
Input full-scale at maximum gain (differential)	-	4	-	mV rms
Input full-scale at minimum gain (differential)	-	800	-	mV rms
3 dB bandwidth	-	20	-	kHz
Microphone mode (input impedance)	-	24	-	kOhm
THD+N (microphone input) at 30 mV/rms input	-	0.02	-	%

Note:

- $f_{in} = 1$ kHz, B/W = 20 Hz to 20 kHz, A-weighted, THD+N < 1%, 150 mV_{pp} input.
- These parameters are characterized but not tested in manufacturing.

The parameters of the audio Codec DAC are provided in the following table.

T = 25°C, V_{dd} = 3.0V, 1 kHz sine wave input, Bandwidth = 20 Hz to 20 kHz

Table 3-7. Audio Codec DAC

Parameter	Min.	Typ.	Max.	Unit
Over-sampling rate	-	128	-	f _s
Resolution	16	-	20	Bits
Output sample rate	8	-	48	kHz
Signal-to-Noise Ratio (Note: 1) (SNR at Capless mode) for 48 kHz	-	96	-	dB
Signal-to-Noise Ratio (Note: 1) (SNR at Single-Ended mode) for 48 kHz	-	98	-	dB
Digital gain	-54	-	4.85	dB
Digital gain resolution	-	2 to 6	-	dB
Analog gain	-28	-	3	dB
Analog gain resolution	-	1	-	dB
Output voltage full-scale swing (AVDD=2.8V) (Note: 3)	-	742.5	-	mV/rms
Maximum output power (16 Ohm load)	-	34.5	-	mW

.....continued

Parameter	Min.	Typ.	Max.	Unit
Maximum output power (32 Ohm load)	-	17.2	-	mW
Allowed load (Resistive)	8	16	O.C.	Ω
Allowed load (Capacitive)	-	-	500	pF
THD+N (16 Ohm load)	-	-	0.05	%
Signal-to-Noise Ratio (SNR at 16 Ohm load)	-	-	96	dB

Note:

1. $f_{in} = 1$ kHz, B/W = 20 Hz to 20 kHz, A-weighted, THD+N < 0.01%, 0 dBFS signal, Load = 100 kOhm.
2. These parameters are characterized but not tested in manufacturing.
3. V_{dd} and AVDD are generated by internal LDO.

The parameters of the transmitter section for BDR and EDR are shown in the following table.

Test condition: VCC_RF = 1.28V, temperature = 25°C.

Table 3-8. Transmitter section for BDR and EDR

Parameter	Min.	Typ.	Max.	Bluetooth specifications	Unit
Maximum RF transmit power (BM20)	-	-	-	-6 to 4	dB
Maximum RF transmit power (BM23)	-	2	-	-6 to 4	-
EDR/BDR Relative transmit power	-4	-1.2	1	-4 to 1	dB

Note: The RF Transmit power is calibrated during production using MP Tool software and MT8852 Bluetooth Test equipment.

The parameters of the receiver section for BDR and EDR are shown in the following table.

Test condition: VCC_RF = 1.28V, temperature = 25°C.

Table 3-9. Receiver Section for BDR and EDR

Parameters	Modulation	Min.	Typ.	Max.	Bluetooth Specification	Unit
Sensitivity at 0.1% BER	GFSK	-	-90	-	≤ -70	dBm
Sensitivity at 0.01% BER	$\pi/4$ DQPSK	-	-91	-	≤ -70	dBm
	8DPSK	-	-82	-	≤ -70	dBm

Note: These parameters are characterized but not tested in manufacturing.

The parameters of system current consumption of analog audio output are shown in the following table.

Test condition: BAT_IN = 3.8V, link with HTC EYE cell phone; distance between cell phone and EVB is 30 cm.

Table 3-10. System Current Consumption of Analog Audio Output

System Status	Typ.	Max.	Unit
System off mode	2	5	μA
Standby mode	0.8	-	mA
Linked mode	0.4	-	mA
SCO link	7.8	-	mA
A2DP link ($V_{p-p} = 200$ mV; 1k tone signal)	10.7	-	mA

Note: Use BM2020 EVB as a test platform.

The parameters of system current consumption of digital audio output are shown in the following table.

Test condition: BAT_IN = 3.8V, link with HTC M8 cell phone; distance between cell phone and EVB is 30 cm; I²S signal link with YAMAHA YDA174 EVB.

Table 3-11. System Current Consumption of Digital Audio Output

System status	Typ	Max	Unit
System Off mode	2	5	μA
Standby mode	0.4	-	mA
Linked mode	0.4	-	mA
SCO link	9.3	-	mA
A2DP link (1k tone signal)	11.7	-	mA

4. Printed Antenna Information

4.1 Module Radiation Pattern

The stereo module contains a PCB printed antenna. The PCB printed antenna radiation pattern is illustrated in the following figure.

Figure 4-1. Antenna Keep Out Area Examples

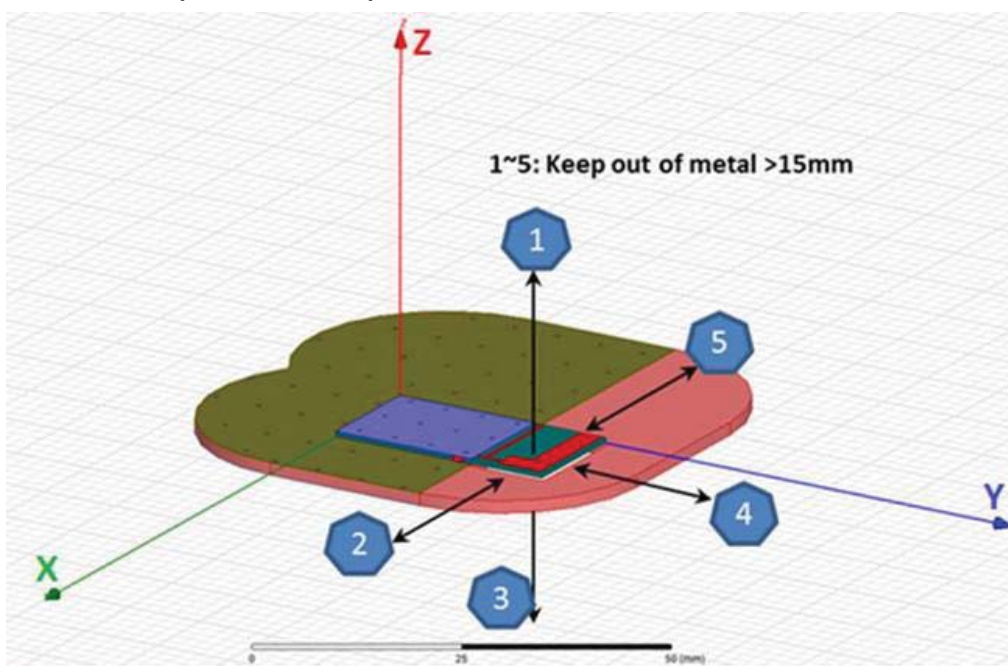
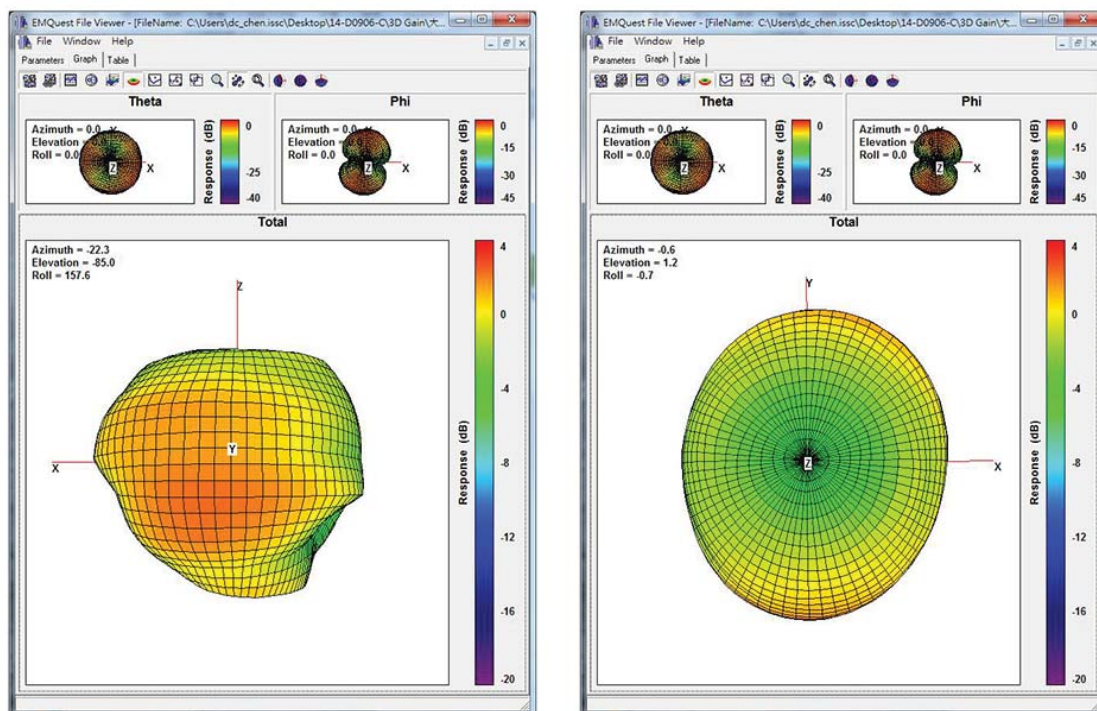


Figure 4-2. PCB Antenna 3D Radiation Pattern at 2441 MHZ



The following table provides the details of BM2X PCB Antenna characteristics.

Table 4-1. BM2x PCB Antenna Characteristics

Parameter	Values
Frequency	2400 MHz to 2480 MHz
Peak Gain	1.927 dBi
Efficiency	73.41%

4.2 Module Placement Rules

On the main PCB, the areas under the antenna should not contain any top, inner layer, or bottom copper as shown in the below figure. A low-impedance ground plane will ensure the best radio performance (best range, lowest noise). The ground plane can be extended beyond the minimum recommended as needed for the main PCB EMC noise reduction. For the best range performance, keep all external metal at least 15 mm away from the ceramic chip antenna.

Figure 4-3. Module Placement Examples

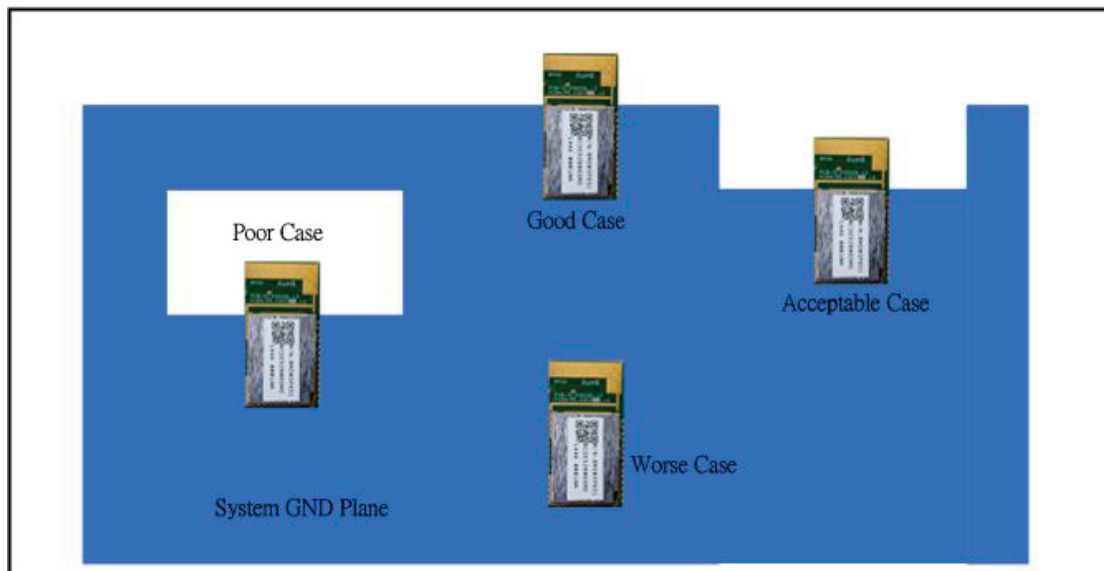
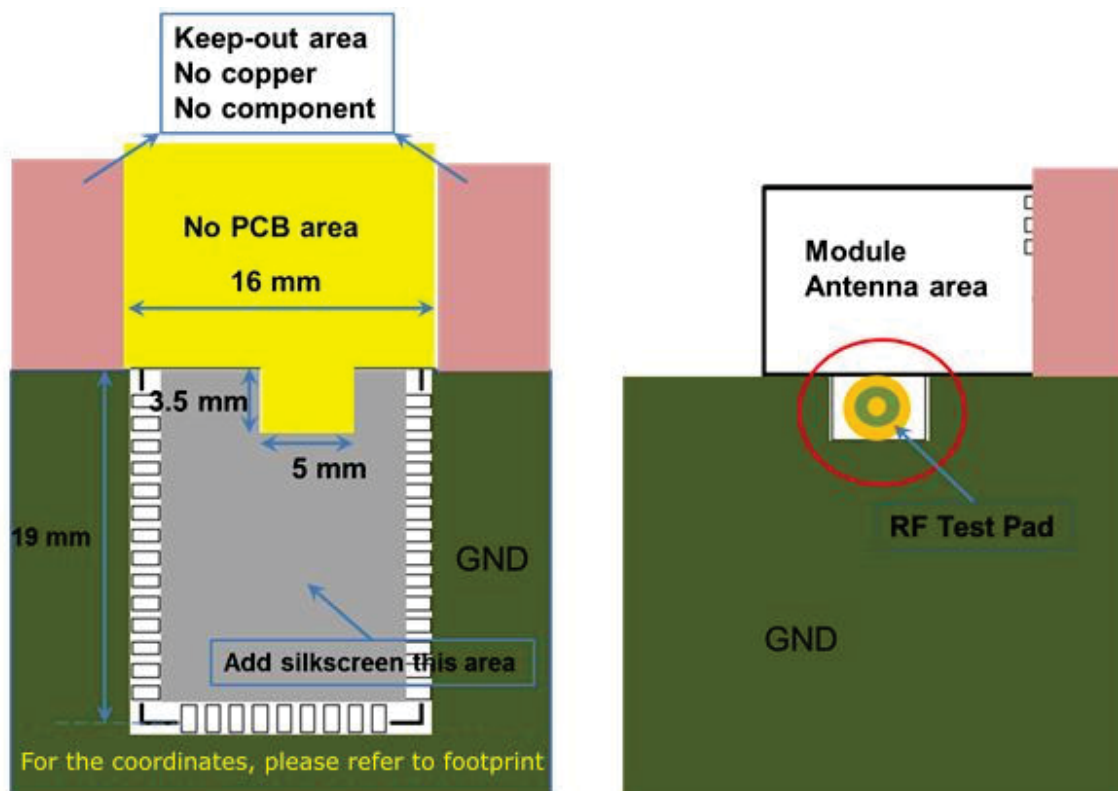


Figure 4-4. GND Plane on Main Application Board



5. Reference Circuit

This section provides the reference schematics of BM20 and BM23 modules.

5.1 BM2020 Reference Circuit

The following figures illustrate the reference schematics of the BM20 module.

Figure 5-1. BM2020 Reference Circuit

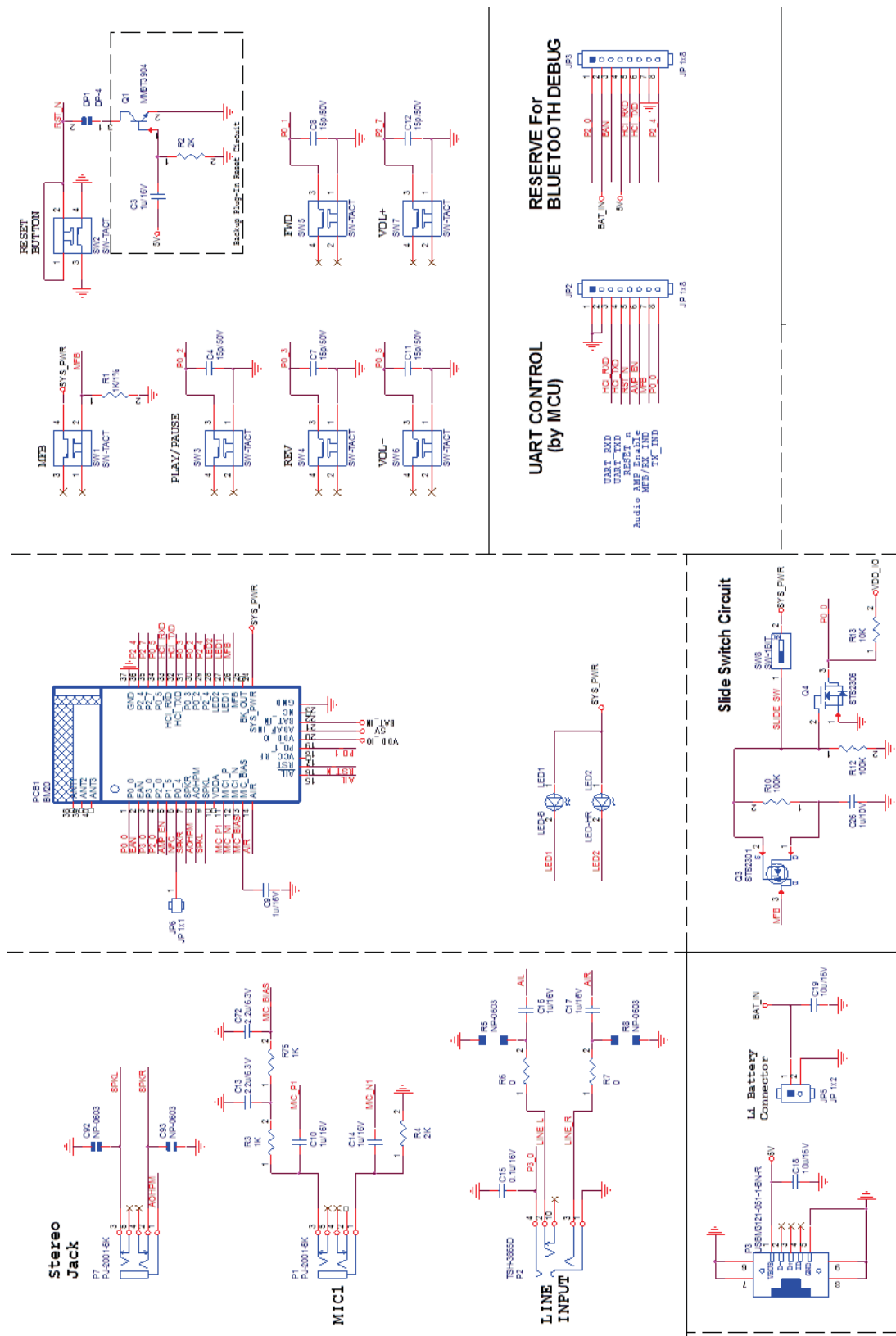
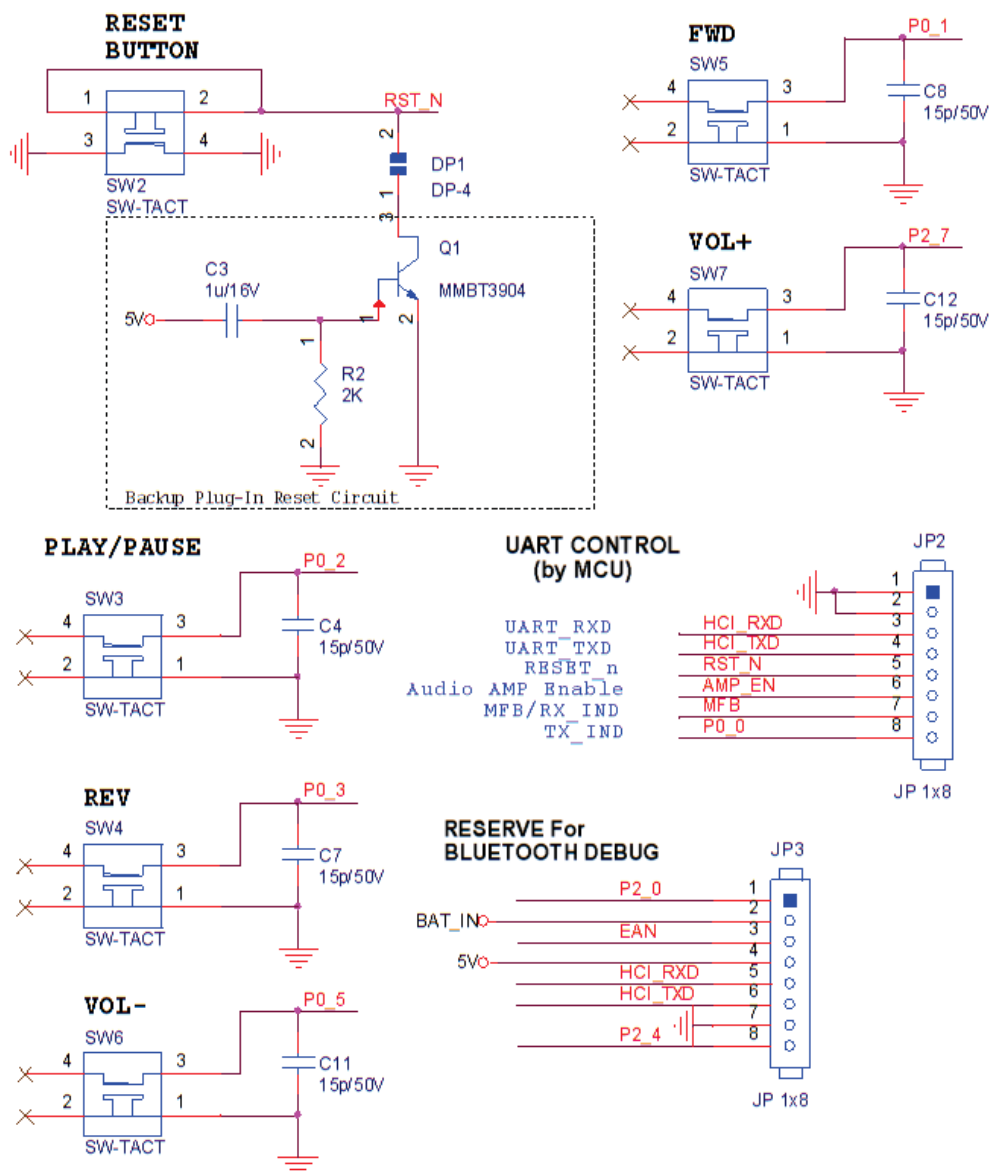


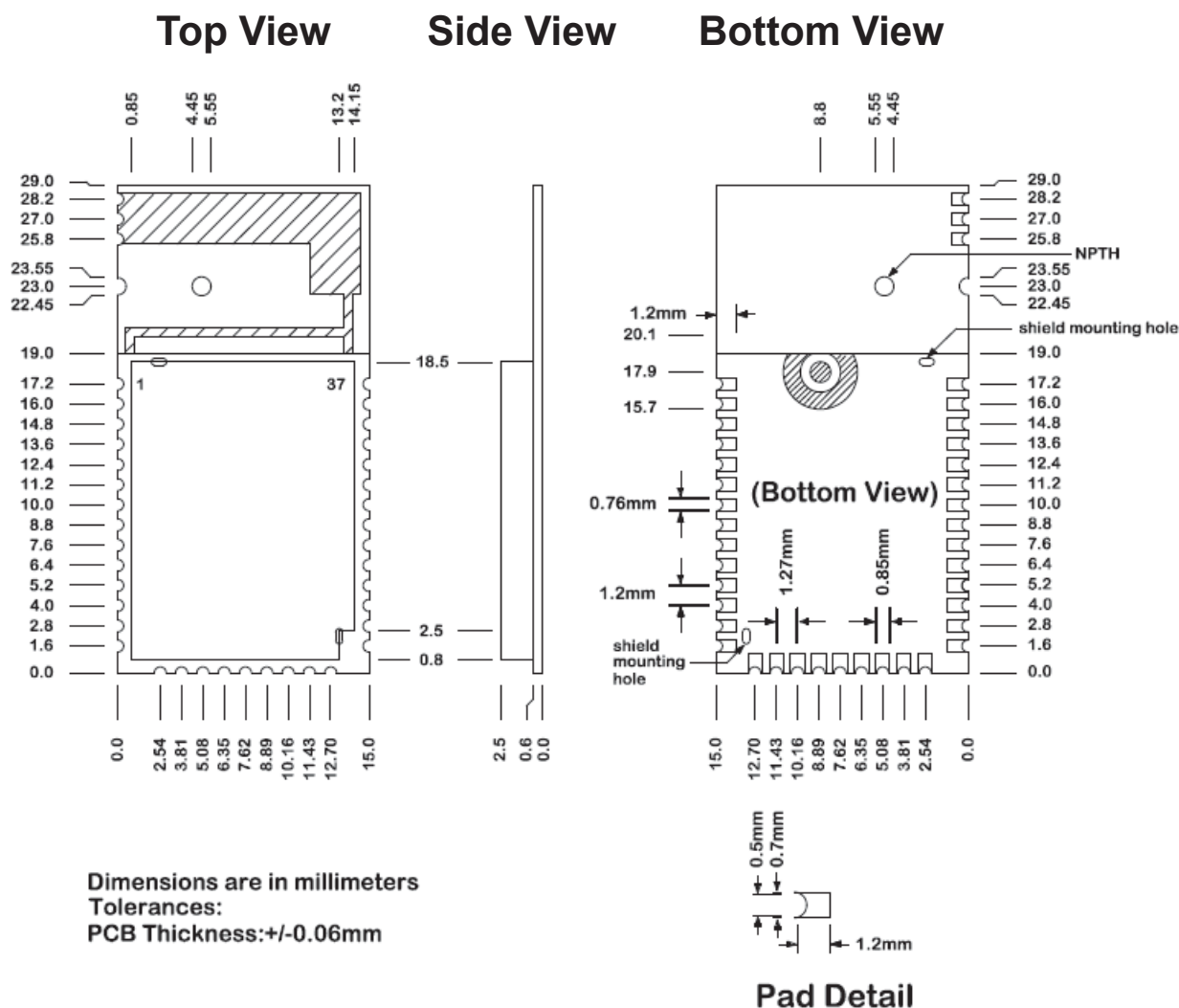
Figure 5-2. BM2020 Reference Circuit



6. Physical Dimensions

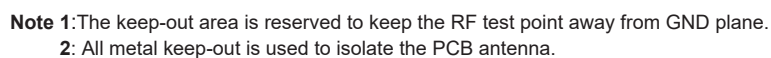
The following figure shows the PCB dimension of BM2020 module.

Figure 6-1. BM2020 Module PCB dimension



PCB dimension:

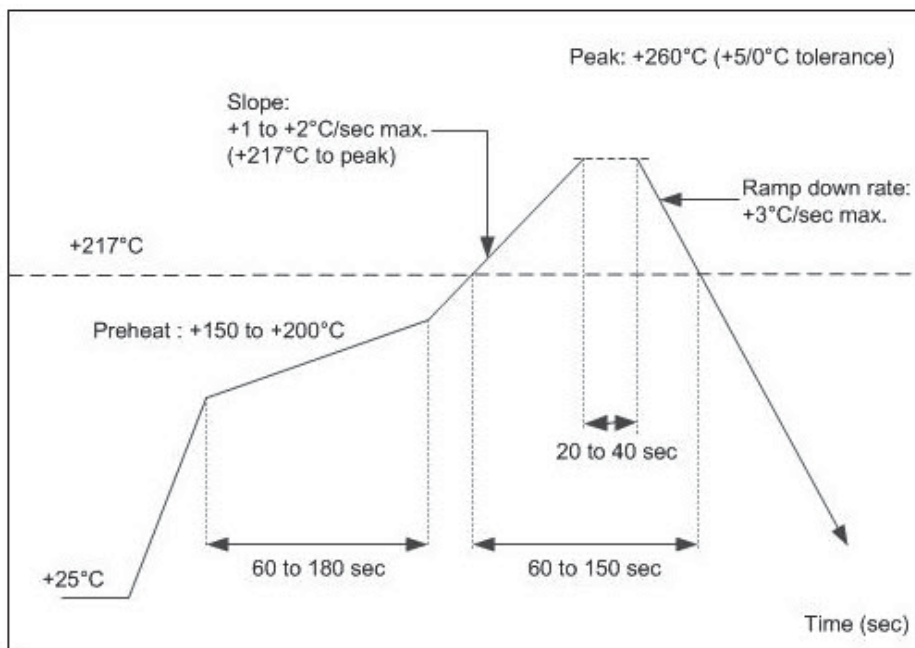
- X: 15.0 mm
- Y: 29.0 mm
- Tolerances: 0.25 mm



7. Reflow Profile

The following figure illustrates the reflow profile of the BM2020 module.

Figure 7-1. Reflow Profile



7.1 Soldering Recommendations

The BM2020 module is assembled using a standard lead-free reflow profile IPC/JEDEC J-STD-020. The BM2020 module can be soldered to the main PCB using standard leaded and lead-free solder reflow profiles.

To avoid the damage to the module, follow these recommendations:

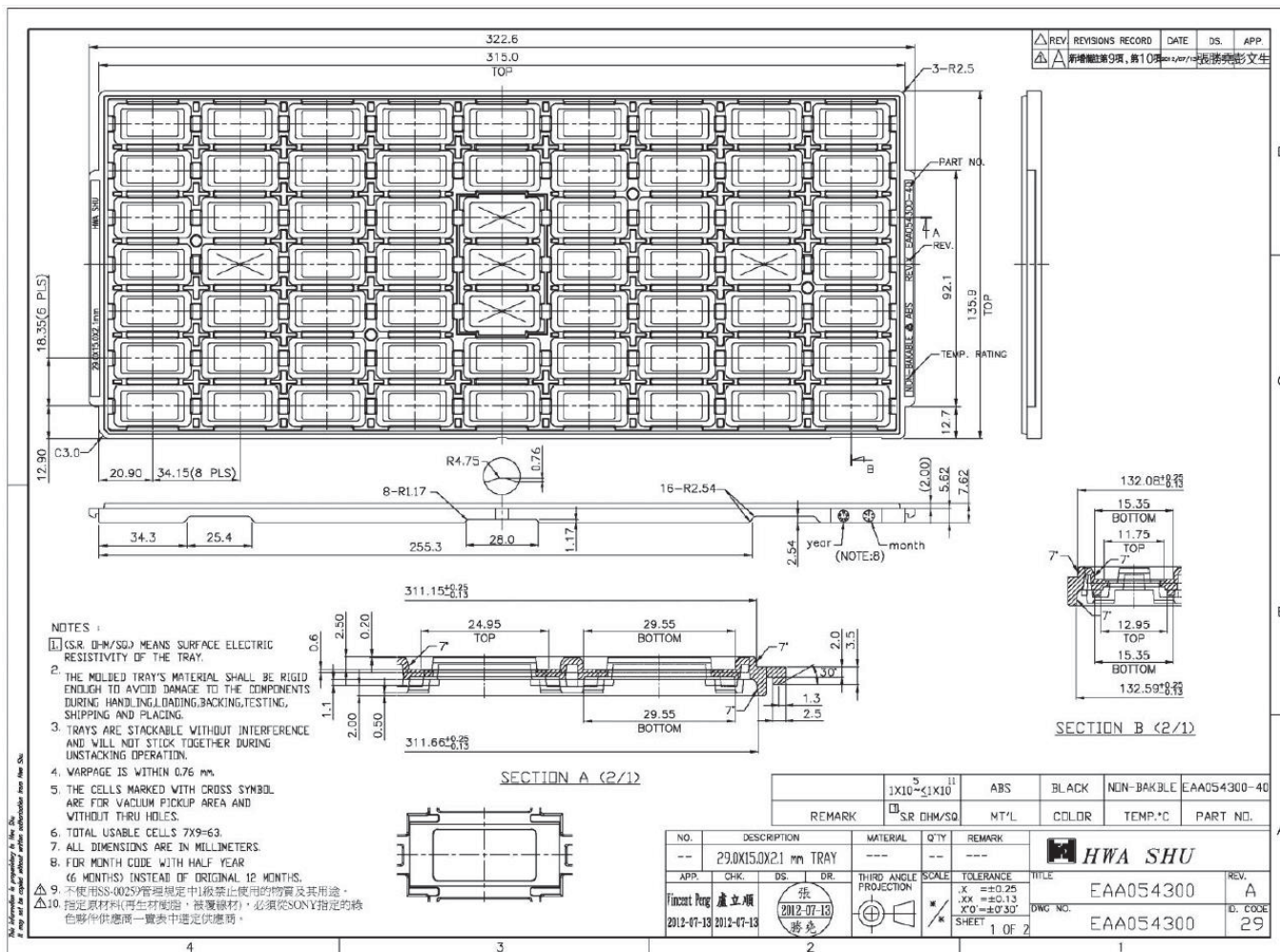
- Do not exceed peak temperature (T_P) of +250°C
- Refer to the Solder Paste data sheet for specific reflow profile recommendations
- Use no-clean flux solder paste
- Do not wash the module, as moisture can be trapped under the shield
- Use only one flow. If the PCB requires multiple flows, apply the module on the final flow

7.2 Packing and Storage Information

The module is packaged into trays of sixty-three (63) modules in a 7 x 9 format (see the following figure). These trays are then sealed into bags. 10 sealed bags are then placed in a box of 630 pieces with a dimension of 36 x 16 x 9.5 cm³.

The shelf life of each module in a sealed bag is 12 months at <40°C and <90% relative humidity. After a bag is opened, devices that will be subjected to reflow solder or other high temperature processes must be mounted within 168 hours (7 days) at factory conditions of <30°C and <60% relative humidity.

Figure 7-2. Packing and Storage Information



8. Ordering Information

The following table provides the ordering information of the BM2020 module.

Part Number	Description
HTC-BM2020	Bluetooth 5.0 BDR/EDR, Class 2 Surface Mount module with integrated antenna ,But no shield case.



深圳市龙华区龙华街道油松路天汇大厦B932
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9. Document Revision History

Table 9-1. Document Revision History

Revision	Date	Section	Description
V1.1	08/2019	Document	Removed "Preliminary" from document footer.
V1.0	08/2019	Document	Initial release.

FCC Requirement(FCC warning - Module)

RF exposure considerations

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.

RF Exposure - This device is only authorized for use in a mobile application. At least 20 cm of separation distance between the module and the user's body must be maintained at all times.

A label must be affixed to the outside of final commercial product with the following statements:

This device contains FCC ID: 2AZVH-BM20SPKS1NBC

Consistent with §2.909(a), the following text must be included within the user's manual or operator instruction guide for the final commercial product

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.

This device is only authorized for use in a mobile application. At least 20 cm of separation distance between the module and the user's body must be maintained at all times.

The final host / module combination may also need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device. The FCC Part 15 Statement shall be included in the user manual of final commercial product if applicable. CAUTION: Any changes or modifications not expressly approved could void the user's authority to operate the equipment.

Model No.: BM20SPKS1NBC-C001AA

FCC ID: 2AZVH-BM20SPKS1NBC