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## Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

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## Bluetooth® 4.1 Stereo Audio Module

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### Features:

- Complete, Fully Certified, Embedded 2.4 GHz Bluetooth® Version 4.1 Module
- Bluetooth Classic (BDR/EDR)
- Bluetooth SIG Certified
- Onboard embedded Bluetooth Stack
- Transparent UART mode for seamless serial data over UART interface
- Easy to configure with Windows GUI or direct by MCU
- Compact surface mount module: 29 x 15 x 2.5 mm<sup>3</sup>
- Castellated surface mount pads for easy and reliable host PCB mounting
- Environmentally friendly, RoHS compliant
- Perfect for Portable Battery Operated Devices
- Internal Battery Regulator Circuitry
- Worldwide regulatory certifications
- Audio-In / Out
- BM23 support digital audio I<sup>2</sup>S format.
- BM20 support analog audio output.

### Operational:

- Operating voltage: 3.0V to 4.2V
- Temperature range: -20C to 70°C
- Simple, UART interface
- Integrated crystal, internal voltage regulator, and matching circuitry
- Multiple I/O pins for control and status

### RF/Analog:

- Frequency: 2.402 to 2.480 GHz
- Receive Sensitivity: -91 dBm ( $\pi/4$  DQPSK)
- Power Output: class 2 / +4dBm max.
- Connection Distance: >10m (free space and no interference)

### Audio processor

- Support 64 kb/s A-Law or  $\mu$ -Law PCM format, or CVSD (Continuous Variable Slope Delta Modulation) for SCO channel operation.
- Noise suppression
- Echo suppression
- SBC and optional AAC decoding
- Packet loss concealment

- Build-in four languages (Chinese/ English/ Spanish/ French) voice prompts and 20 events for each one (This function can be set up in "IS20XXS\_UI" tool.)
- Support SCMS-T

### Audio Codec

- 20 bit DAC and 16 bit ADC codec
- 98dB SNR DAC playback

### Peripherals

- Built-in Lithium-ion battery charger (up to 350mA)
- Integrate 3V, 1.8V configurable switching regulator and LDO
- Built-in ADC for battery monitor and voltage sense.
- A line-in port for external audio input
- Two LED drivers

### Flexible HCI interface

- High speed HCI-UART (Universal Asynchronous Receiver Transmitter) interface (up to 921600bps)

### MAC/Baseband/Higher Layer:

- Secure AES128 encryption
- Bluetooth profiles
  - HFP v1.6
  - HSP v1.1
  - A2DP v1.2
  - AVRCP v1.5
  - SPP v1.0
  - PBAP v1.0

### Antenna:

- Printed Antenna

### Compliance:

- Bluetooth SIG QDID
- Module certified for the United States (FCC) and Canada (IC), Korea (LCC), Taiwan (NCC), Japan (MIC) and China(SRRC)

Figure 1:



**General Description:**

Stereo module is a fully-certified Bluetooth® Version 4.1 (BDR/EDR) module for designers who want to add Bluetooth® 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, 29x15x2.5 mm<sup>3</sup>.

This stereo module built-in Li-Ion charger and BM23 contain a digital audio interface. It supports HSP, HFP, SPP, A2DP, and AVRCP profiles. Both AAC and SBC codecs are supported for A2DP. Note that the customer must connect their own external analog CODEC/DSP/amplifier and MCU for audio output.

**Applications:**

- Bluetooth sound bar
- Bluetooth stereo speaker phone

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### Abbreviations List:

**HFP:** Hands-free Profile

**AVRCP:** Audio Video Remote Control Profile

**A2DP:** Advanced Audio Distribution Profile

**PBAP:** Phone Book Access Profile

**HSP:** Headset Profile

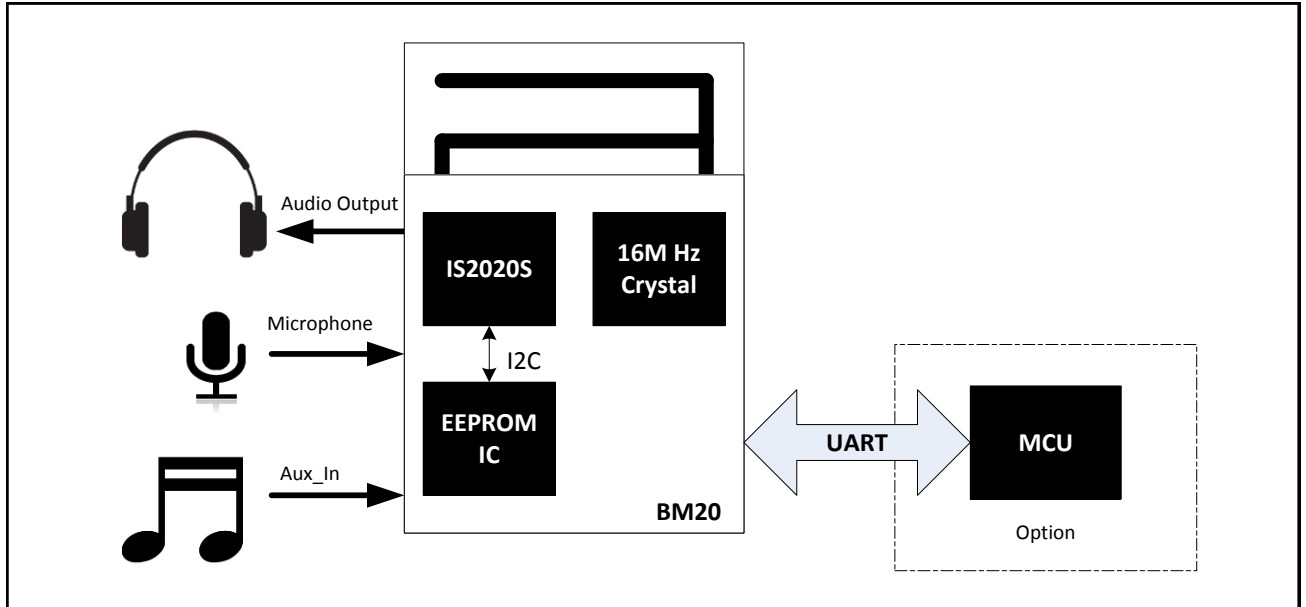
**SPP:** Serial Port Profile

## 1. DEVICE OVERVIEW

The stereo module series include BM20 and BM23. The chip integrates Bluetooth 4.1 radio transceiver, PMU and DSP. Figure 1-1 and 1-2 shows the application block diagram.

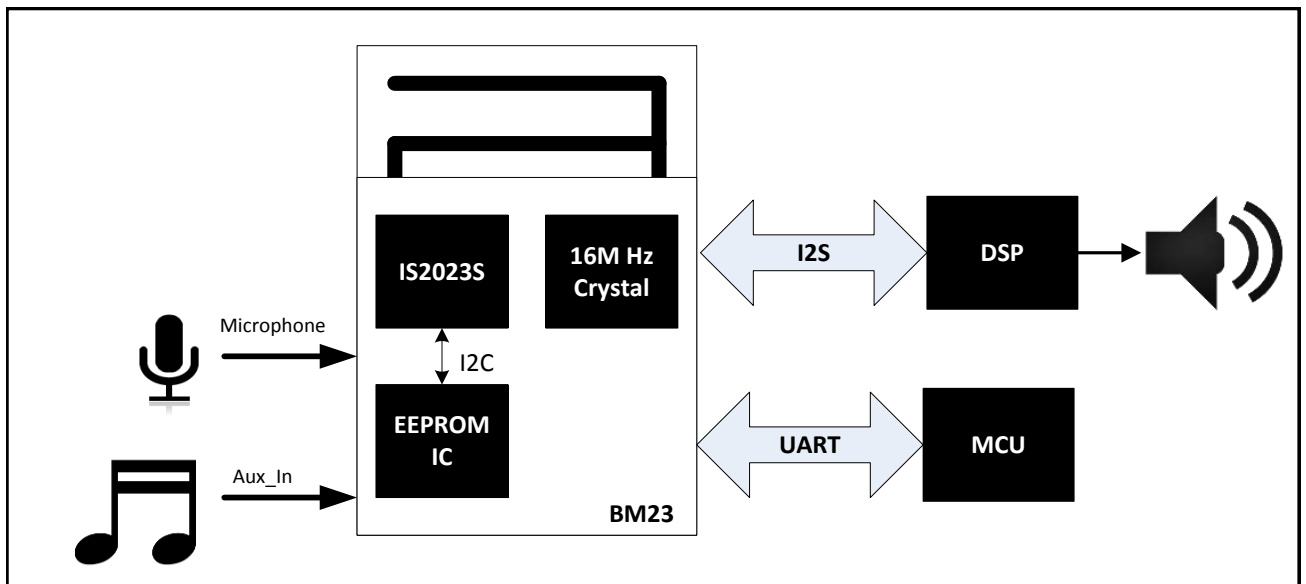
### FIGURE 1-1: BM20 Typical Application

The following depicts an example of BM20 module operate as an independent system or connected to an MCU.



### FIGURE 1-2: BM23 Typical Application

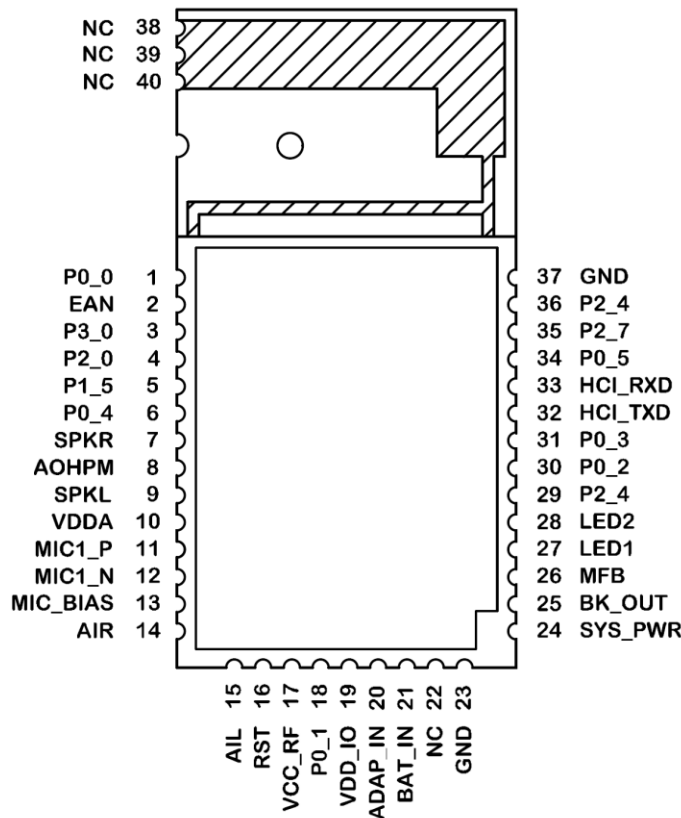
The following depicts an example of BM23 module connected to an MCU, external DSP/CODEC.



## 1.1. INTERFACE DESCRIPTION

BM20 pin diagram is shown in Figure 1-3. The pin descriptions are shown in Table 1-1

**FIGURE 1-3: BM20 PIN DIAGRAM**



**TABLE 1-1: BM20 PIN DESCRIPTION**

Pin No.	Pin type	Name	Description
1	I/O	P0_0	IO pin, default pull-high input (Note 1) 1. Slide Switch Detector, active low. 2. UART TX_IND, active low.
2	I	EAN	Embedded ROM/External Flash enable H: Embedded; L: External Flash
3	I	P3_0	IO pin, default pull-high input (Note 1) Line-in Detector (default), active low.
4	I	P2_0	IO pin, default pull-high input System Configuration, H: Application L: Baseband (IBDK Mode)
5	I/O	P1_5	IO pin, default pull-high input (Note 1) 1. NFC detection pin, active low. 2. Out_Ind_0 3. Slide Switch Detector, active low. 4. Buzzer Signal Output
6	I/O	P0_4	IO pin, default pull-high input. (Note 1) 1. NFC detection pin, active low. 2. Out_Ind_0
7	O	SPKR	R-channel analog headphone output
8	O	AOHPM	Headphone common mode output/sense input.



# Stereo Module

Pin No.	Pin type	Name	Description
9	O	SPKL	L-channel analog headphone output
10	P	VDDA	Positive power supply/reference voltage for CODEC, no need to add power to this pin.
11	I	MIC1_P	Mic 1 mono differential analog positive input
12	I	MIC1_N	Mic 1 mono differential analog negative input
13	P	MIC_BIAS	Electric microphone biasing voltage
14	I	AIR	R-channel single-ended analog inputs
15	I	AIL	L-channel single-ended analog inputs
16	I	RST	System Reset Pin, Low: reset
17	P	VCC_RF	1.28V RF LDO output, no need to add power to this pin.
18	I/O	P0_1	IO pin, default pull-high input (Note 1) 1. FWD key when class 2 RF (default), active low. 2. Class1 TX Control signal of external RF T/R switch, active high.
19	P	VDD_IO	Power output , no need to add power to this pin
20	P	ADAP_IN	5V Power adaptor input
21	P	BAT_IN	3.0V~4.2V Li-Ion battery input
22	-	NC	No Connection
23	P	GND	Ground Pin
24	P	SYS_PWR	System Power Output BAT mode: 3.0~4.2V Adapter mode: 4.0V
25	P	BK_OUT	1.8V buck output, no need to add power to this pin
26	I	MFB	1. Power key when in off mode 2. UART_RX_IND: MCU use to wakeup BT (Note 1)
27	I	LED1	LED Driver 1
28	I	LED2	LED Driver 2
29	I	P2_4	IO pin, default pull-high input System Configuration, L: Boot Mode with P2_0 low combination
30	I	P0_2	IO pin, default pull-high input (Note 1) Play/Pause key (default), active low.
31	I/O	P0_3	IO pin, default pull-high input (Note 1) 1. REV key (default), active low. 2. Buzzer Signal Output 3. Out_Ind_1 4. Class1 RX Control signal of external RF T/R switch, active high.
32	O	HCI_TXD	HCI-UART TX data
33	I	HCI_RXD	HCI-UART RX data
34	I	P0_5	IO pin, default pull-high input (Note 1) Volume down (default), active low.
35	I	P2_7	IO pin, default pull-high input (Note 1) Volume up key (default), active low.

# Stereo Module

Pin No.	Pin type	Name	Description
36	I	P2_4	IO pin, default pull-high input System Configuration, L: Boot Mode with P2_0 low combination
37	P	GND	Ground Pin
38	-	NC	No Connection
39	-	NC	No Connection
40	-	NC	No Connection

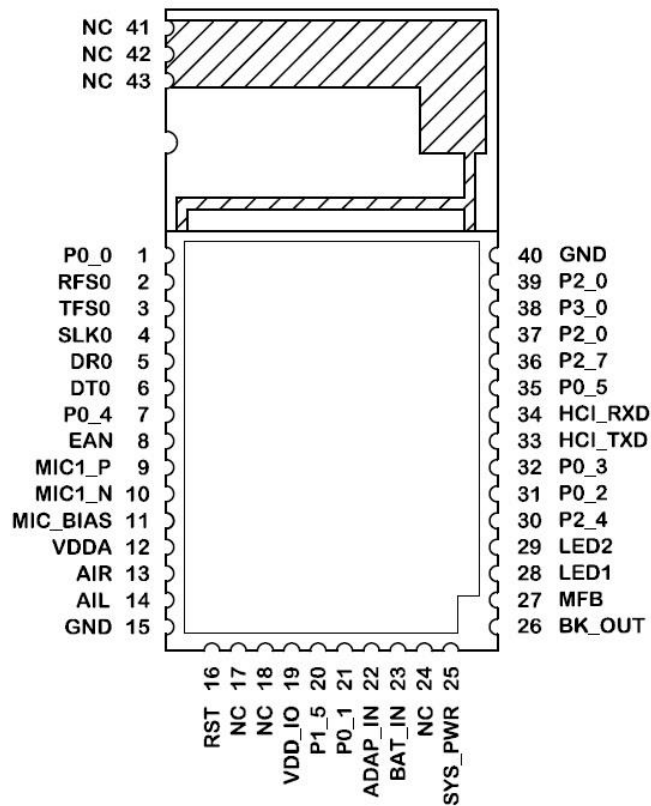
- \* I: signal input pin
- \* O: signal output pin
- \* I/O: signal input/output pin
- \* P: power pin

Note 1: These button or functions can be setup by “IS20XXS\_UI” tool.

# Stereo Module

BM23 pin diagram is shown in Figure 1-4. The pin descriptions are shown in Table 1-2

**FIGURE 1-4: BM23 PIN DIAGRAM**



**TABLE 1-2: BM23 PIN DESCRIPTION**

Pin No.	Pin Type	Name	Description
1	I/O	PO_0	IO pin, default pull-high input (Note 1) UART TX_IND
2	I/O	RFS0	I <sup>2</sup> S interface: DAC Left/Right Clock
3	I/O	TFS0	I <sup>2</sup> S interface: ADC Left/Right Clock
4	I/O	SLK0	I <sup>2</sup> S interface: Bit Clock
5	I	DR0	I <sup>2</sup> S interface: DAC Digital Left/Right Data
6	O	DT0	I <sup>2</sup> S interface: ADC Digital Left/Right Data
7	I/O	PO_4	IO pin, default pull-high input
8	I	EAN	Embedded ROM/External Flash enable High: ROM mode; Low: External Flash mode
9	I	MIC1_P	Mic 1 mono differential analog positive input
10	I	MIC1_N	Mic 1 mono differential analog negative input
11	P	MIC_BIAS	Power output, microphone biasing voltage
12	P	VDDA	Power output, reserve for external cap to fine tune audio frequency
13	I	AIR	Stereo analog line in, R-channel
14	I	AIL	Stereo analog line in, L-channel

# Stereo Module

Pin No.	I/O	Name	Description
15	P	GND	Ground
16	I	RST_N	System Reset Pin, active when rising edge.
17	--	NC	--
18	--	NC	--
19	P	VDDIO	Power output, VDDIO pin, no need to add power to this pin
20	I/O	P1_5	IO pin, default pull-high input
21	I/O	P0_1	IO pin, default pull-high input
22	P	ADAP_IN	5V power adaptor input
23	P	BAT_IN	3.3~4.2V Li-ion battery input
24	--	NC	--
25	P	SYS_PWR	System Power Output BAT mode: 3.3~4.2V Adapter mode: 4.0V
26	P	BK_OUT	Power output, 1v8 pin, no need to add power to this pin
27	P	MFB	1. Power key when in off mode 2. UART_RX_IND: MCU use to wakeup BT
28	P	LED1	LED Driver 1, 4mA max
29	P	LED2	LED Driver 2, 4mA max
30	I	P2_4	IO pin, default pull-high input System Configuration, L: Boot Mode with P2_0 low combination
31	I/O	P0_2	IO pin, default pull-high input
32	I/O	P0_3	IO pin, default pull-high input
33	O	HCI_TXD	HCI-UART TX data
34	I	HCI_RXD	HCI-UART RX data
35	I/O	P0_5	IO pin, default pull-high input
36	I/O	P2_7	IO pin, default pull-high input
37	I/O	P2_0	IO pin, default pull-high input
38	I/O	P3_0	IO pin, default pull-high input
39	I	P2_0	IO pin, default pull-high input System Configuration, H: Application L: Baseband(IBDK Mode)
40	P	GND	Ground.
41	--	NC	--
42	--	NC	--
43	--	NC	--

- \* I: signal input pin
- \* O: signal output pin
- \* I/O: signal input/output pin
- \* P: power pin

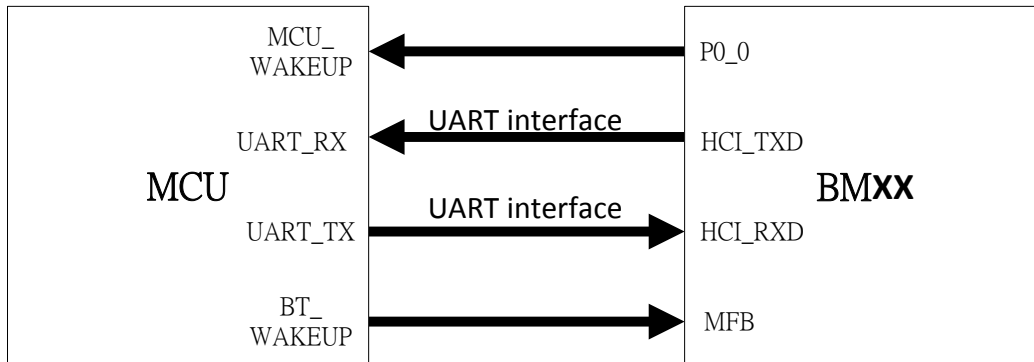
Note 1: These button or functions can be setup by "IS20XXS\_UI" tool.

## 2. APPLICATION INFORMATION

### 2.1. OPERATION WITH EXTERNAL MCU

Stereo module support UART command set to make an external MCU to control module. Here is the connection interface between BMXX and MCU.

**FIGURE 2-1: INTERFACE BETWEEN MCU AND BMXX MODULE**



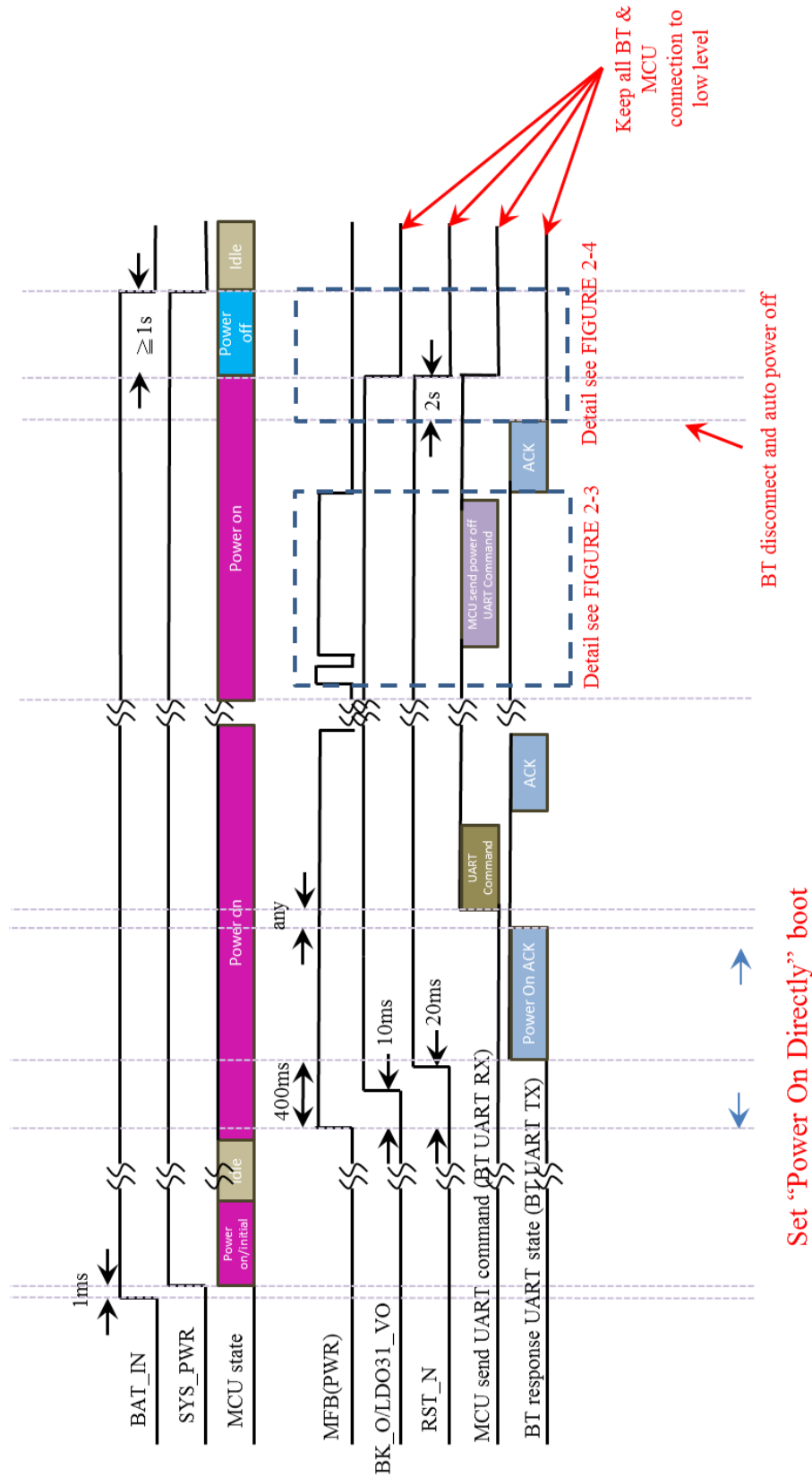
MCU can control module by UART interface and wakeup module by PWR pin. Stereo module provide wakeup MCU function by connect to P0\_0 pin of module.

“UART Command Set” document provide all function which module support and UI tool will help you to set up your system support UART command.

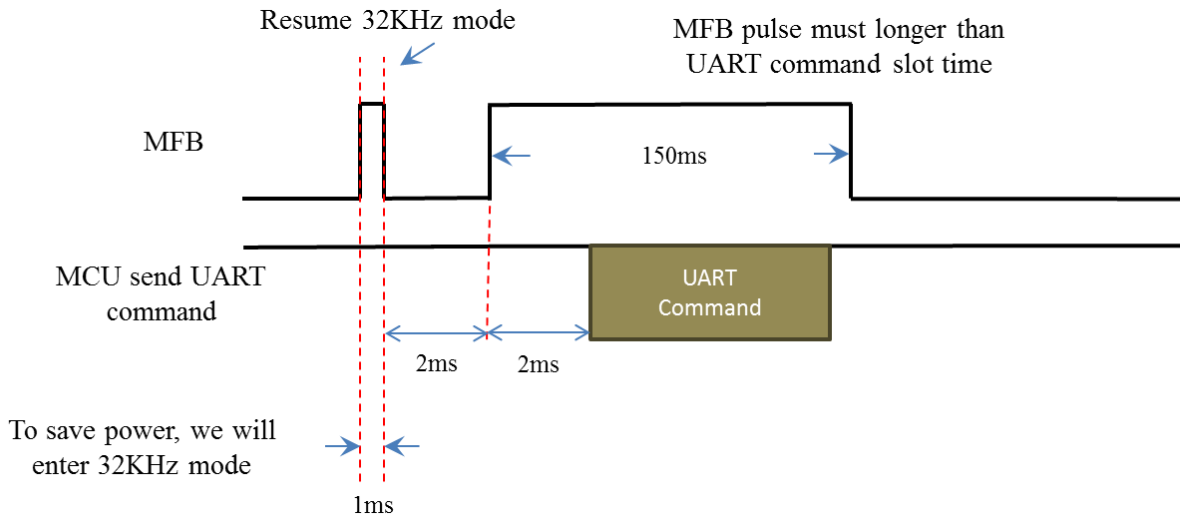
For more detail description, please reference “UART\_CommandSet\_v154” document and “IS20XXS\_UI” tool.

Here are some suggestions of UART control signal timing sequence:

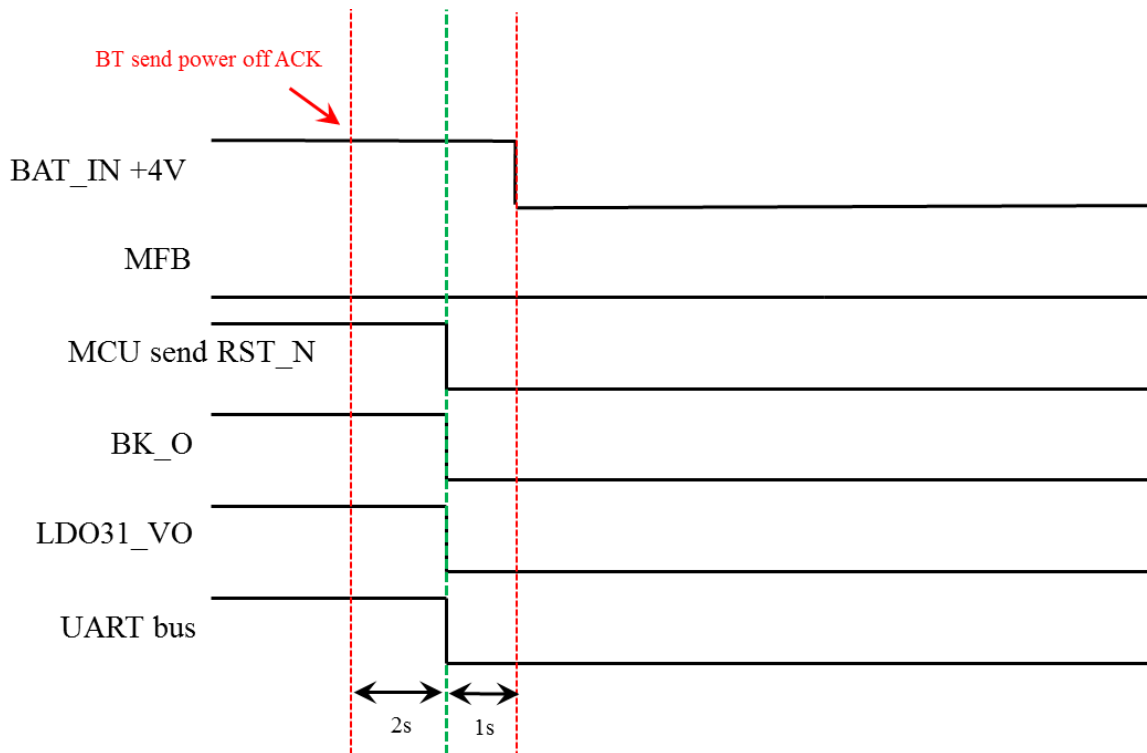
**FIGURE 2-2: POWER ON/OFF SEQUENCE**



**FIGURE 2-3: TIMING SEQUENCE OF RX INDICATION AFTER POWER ON**



**FIGURE 2-4: TIMING SEQUENCE OF POWER OFF**

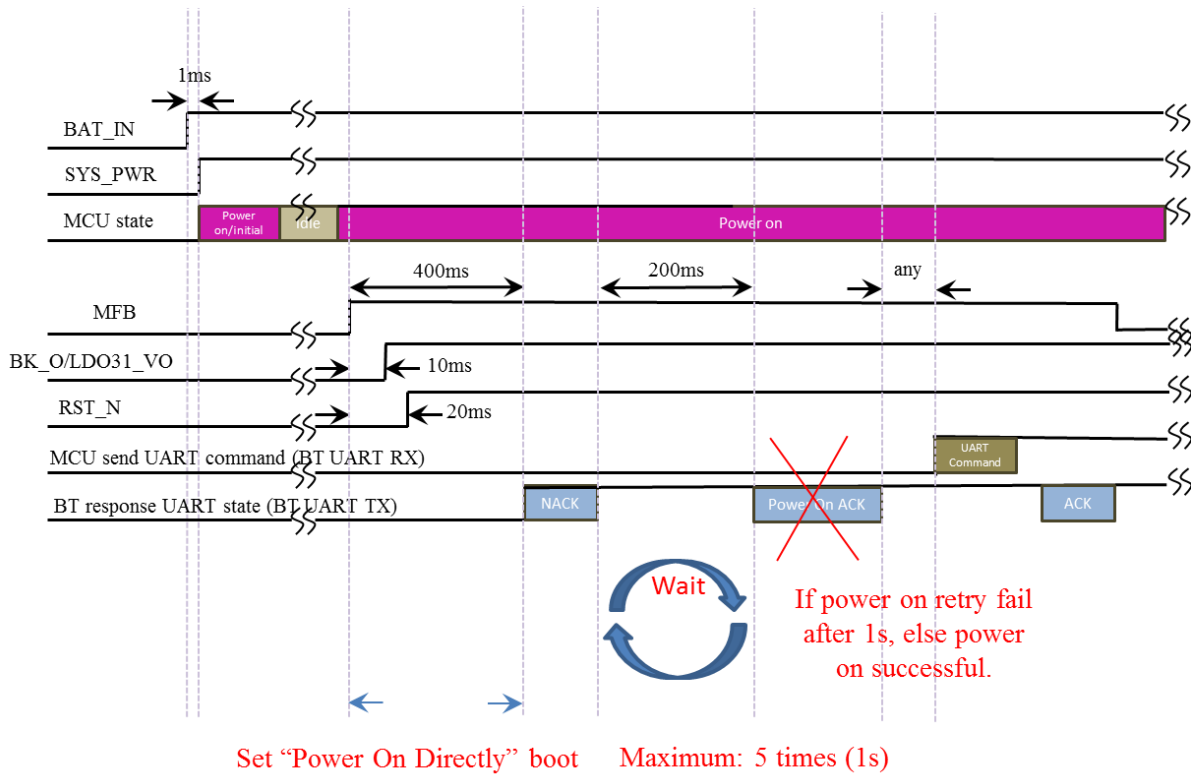


EEPROM clock= 100KHz

For a byte write,  $0.01ms * 32clock * 2 = 640us$

If power drop faster than 640us, some issue may occurs, but the possibility is low

**FIGURE 2-5: TIMING SEQUENCE OF POWER ON (NACK)**



**FIGURE 2-6: RESET TIMING SEQUENCE IF MODULE HANGS UP**

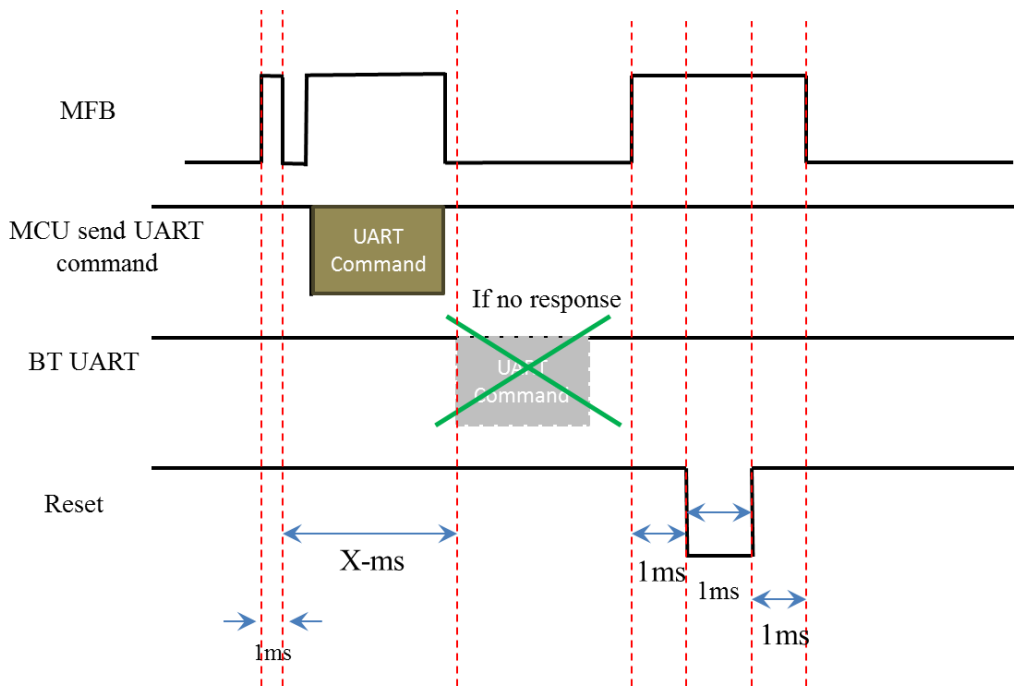
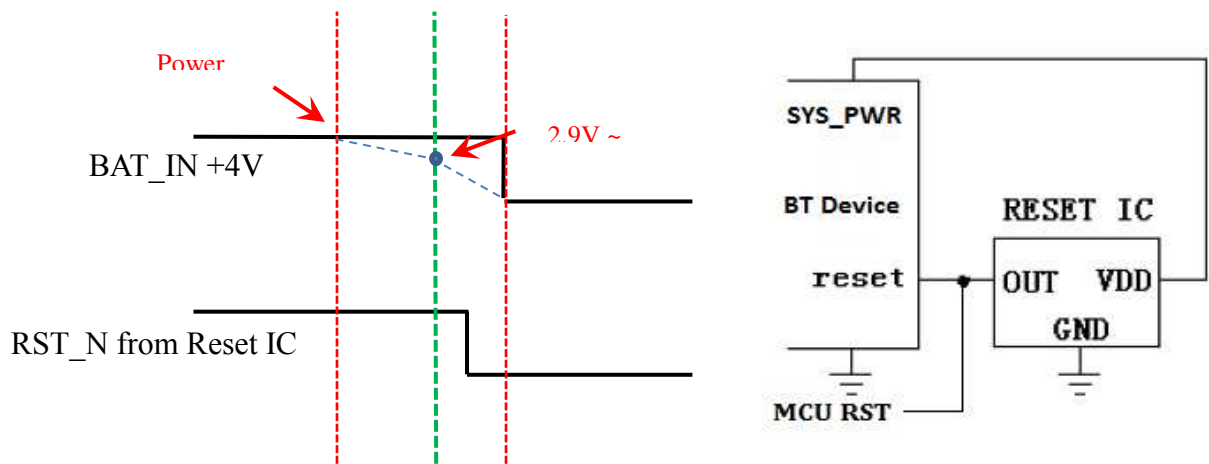




FIGURE 2-7: TIMING SEQUENCE OF POWER DROP PROTECTION



If BT's BAT use adaptor translates voltage by LDO, we recommend use "Reset IC" to avoid power off suddenly. Rest IC spec output pin must be "Open Drain" \ delay time  $\leq 10\text{ms}$

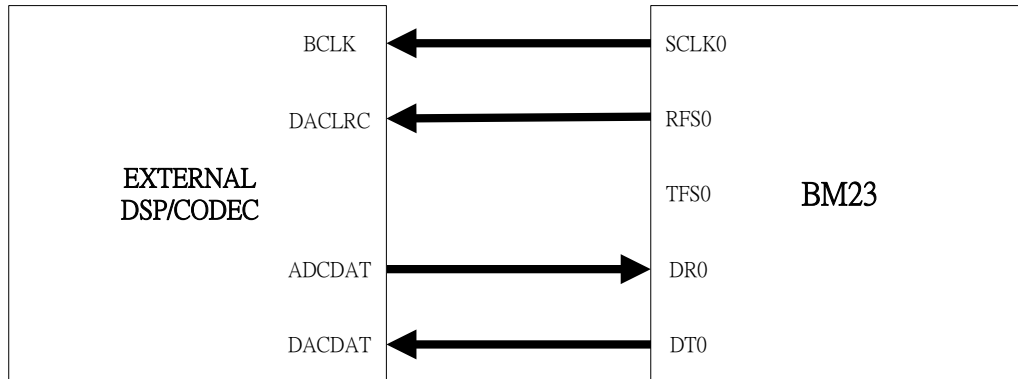
**Recommend part: TCM809SVNB713 or G691L263T73**

## 2.2. I<sup>2</sup>S Signal Application for BM23

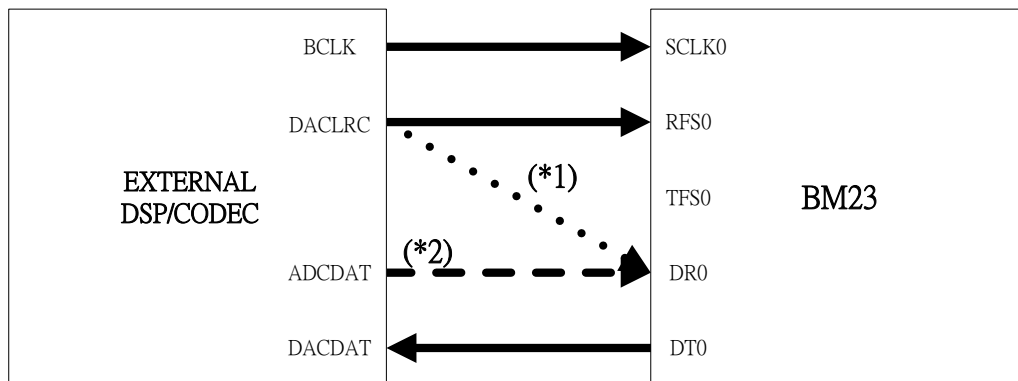
BM23 support I<sup>2</sup>S digital audio signal interface to connect your external CODEC/DSP. It provide 8k Hz, 44.1k Hz and 48k Hz sampling rate; it also support 16 bits and 24bits data format. The I<sup>2</sup>S setting can be set up by UI and DSP tools.

The external CODEC/DSP needs to be connected to SLK0, RFS0, TFS0, DR0, and DT0 (pins 4, 2, 3, 5, and 6 respectively). The I<sup>2</sup>S signal connection between BM23 and external DSP as below:

**FIGURE 2-9: MASTER MODE REFERENCE CONNECTION**



**FIGURE 2-10: SLAVE MODE REFERENCE CONNECTION**



Note 1: For 002 version chip or module, system should connect line 1 in slave mode figure.

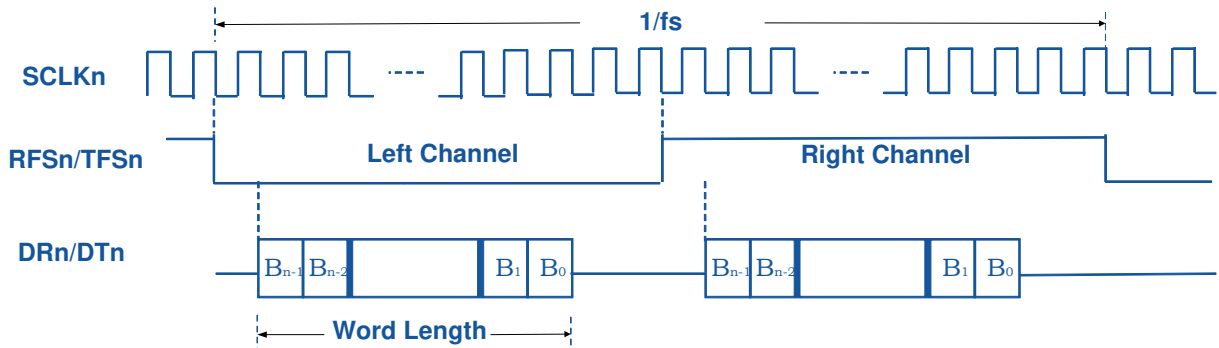
And, system not support ADC signal from external DSP/CODEC.

Note 2: For other version chip or module, system should connect line 2 in slave mode figure.

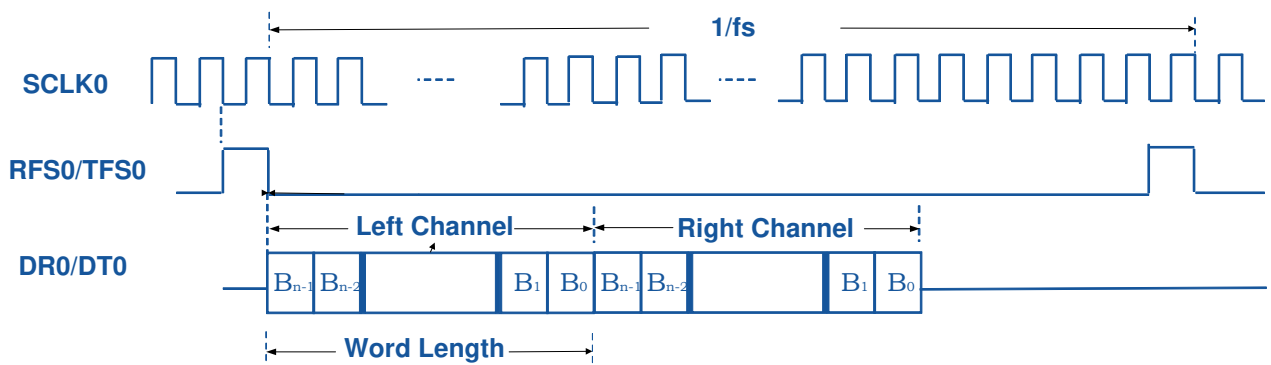
About “Mast” or “Slave” mode setting, you can use “DSP Configuration Tool” to set up system.

The clock and data timing as below:

**FIGURE 2-11: TIMING FOR I<sup>2</sup>S MODES (both master and slave)**



**FIGURE 2-12: TIMING FOR PCM MODES (both master and slave)**



## 2.3. RESET (RST\_N)

RST is module reset pin which is active LOW. To reset the module, the RST\_N must hold LOW for at least 63ns.

## 2.4. STATUS LED (LED1, LED2)

The status LED provide below status indication:

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

Each status indication LED flashing sequence and brightness is configurable by UI tool.

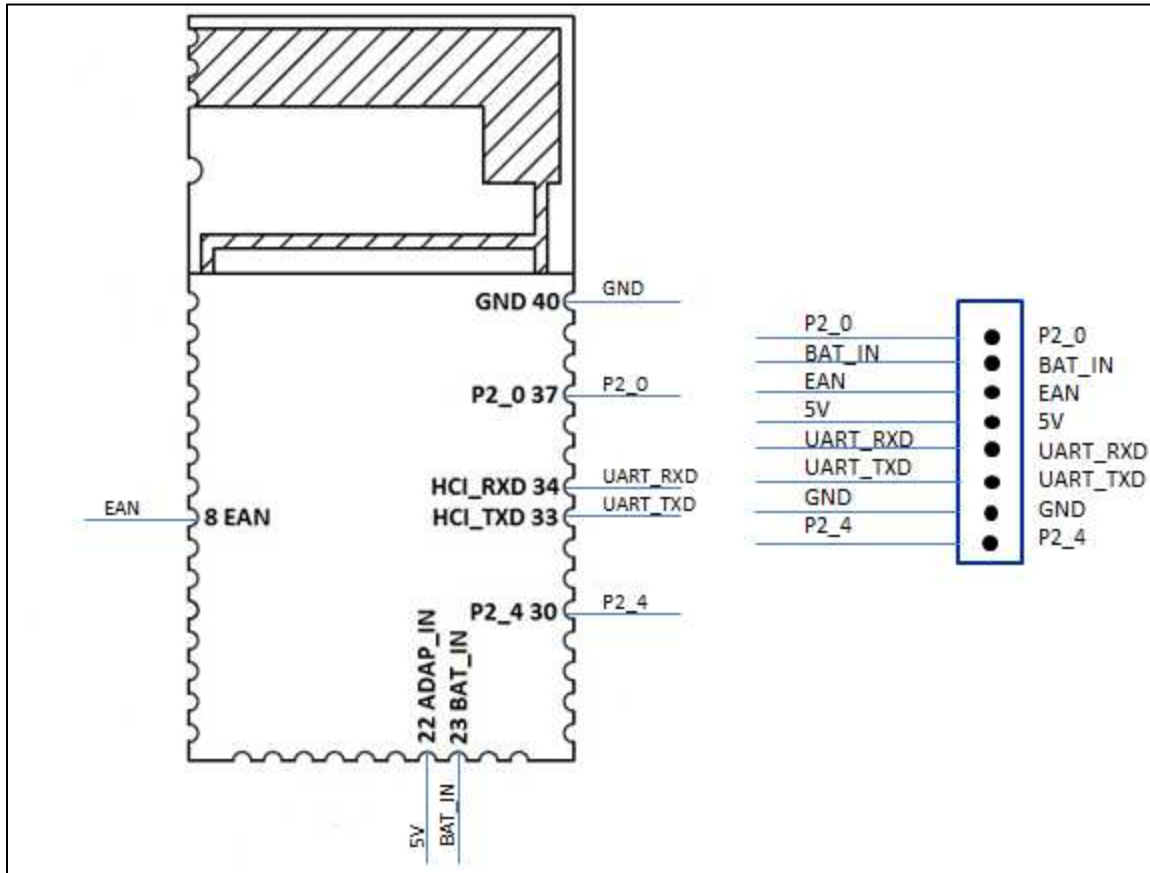
## 2.5. EXTERNAL CONFIGURATION

Stereo module can be configured and firmware programmed using an external configuration and programming tool available from Microchip. Figure 2-7 shows the configuration and firmware programming interface on BM23. It is recommended to include a pin header on the main PCB for development.

Configuration and firmware programming modes are entered accordingly to the system configuration I/O pins as shown in Table 2-1. Pin P20, P24 and EAN pin have internal pull-up.

**FIGURE 2-13: EXTERNAL PROGRAMMING HEADER CONNECTIONS**

(Here is the interface connect example of the BM23)



**TABLE 2-1: SYSTEM CONFIGURATION SETTINGS**

P20	P24	EAN	Operational Mode
High	High	High	APP mode (Normal operation)
Low	High	High	Test mode (Write EEPROM)
Low	Low	High	Write Flash (Firmware programming if flash build-in in chip)

## 3. ELECTRICAL CHARACTERISTICS

**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 adaptor	0	7.0	V
T <sub>STORE</sub>	Storage temperature	-65	+150	°C
T <sub>OPERATION</sub>	Operation temperature	-20	+70	°C

**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 adaptor	4.5	5	5.5	V
T <sub>OPERATION</sub>	Operation temperature	-20	+25	+70	°C

Note:

Absolute and Recommended operating condition tables reflect typical usage for device.

**TABLE 3-3: I/O AND RESET LEVEL**

Parameter	Min.	Typ.	Max.	Units
I/O Supply Voltage (VDD IO)	2.7	3.0	3.3	V
<b>I/O Voltage Levels</b>				
V <sub>IL</sub> input logic levels low	-0.3		0.8	V
V <sub>IH</sub> input logic levels high	2.0		3.6	V
V <sub>OL</sub> output logic levels low			0.4	V
V <sub>OH</sub> output logic levels high	2.4			V
<b>RESET</b>				
V <sub>TH,RES</sub> 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.

# Stereo Module

**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 =  $V_{ADAP\_IN} - V_{BAT}$
- (2) ENX2 is not allowed to be enabled when  $V_{ADAP\_IN} - V_{BAT} > 2V$
- (3) These parameters are characterized but not tested in manufacturing.

**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	$\mu A$
Shutdown Current			1	$\mu A$

Note:

- (1) Test condition: SAR\_VDD=1.8V, temperature=25 °C.
- (2) These parameters are characterized but not tested in manufacturing.

# Stereo Module

**Table 3-6: AUDIO CODEC ANALOGUE TO DIGITAL CONVERTER**

T= 25°C, V <sub>dd</sub> =3.0V, 1KHz sine wave input, Bandwidth = 20Hz~20KHz				
Parameter (Condition)	Min.	Typ.	Max.	Unit
Resolution			16	Bits
Output Sample Rate	8		48	KHz
Signal to Noise Ratio <b>Note: 1</b> (SNR @MIC or Line-in mode)		88		dB
Digital Gain	-54		4.85	dB
Digital Gain Resolution		2~6		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
3dB bandwidth		20		KHz
Microphone mode (input impedance)		24		KΩ
THD+N (microphone input) @30mVrms input		0.02		%

Note:

- (1) f<sub>in</sub>=1KHz, B/W=20~20KHz, A-weighted, THD+N < 1%, 150mV<sub>pp</sub> input
- (2) These parameters are characterized but not tested in manufacturing.

# Stereo Module

**Table 3-7: AUDIO CODEC DIGITAL TO ANALOGUE CONVERTER**

T= 25°C, V <sub>dd</sub> =3.0V, 1KHz sine wave input, Bandwidth = 20Hz~20KHz					
Parameter (Condition)	Min.	Typ.	Max.	Unit	
Over-sampling rate		128		$f_s$	
Resolution	16		20	Bits	
Output Sample Rate	8		48	KHz	
Signal to Noise Ratio <b>Note: 1</b> (SNR @cap-less mode) for 48kHz		96		dB	
Signal to Noise Ratio <b>Note: 1</b> (SNR @single-end mode) for 48kHz		98		dB	
Digital Gain	-54		4.85	dB	
Digital Gain Resolution		2~6		dB	
Analog Gain	-28		3	dB	
Analog Gain Resolution		1		dB	
Output Voltage Full-scale Swing (AVDD=2.8V) <b>Note:3</b>		742.5		mV rms	
Maximum Output Power (16Ω load)		34.5		mW	
Maximum Output Power (32Ω load)		17.2		mW	
Allowed Load	Resistive	8	16	O.C.	Ω
	Capacitive			500	pF
THD+N (16Ω load)			0.05	%	
Signal to Noise Ratio (SNR @ 16Ω load)			96	dB	

Note:

- (1)  $f_{in}$ =1KHz, BW=20~20KHz, A-weighted, THD+N < 0.01%, 0dBFS signal, Load=100KΩ
- (2) These parameters are characterized but not tested in manufacturing.
- (3) V<sub>dd</sub>, AVDD are generated by internal LDO

**Table 3-8: TRANSMITTER SECTION FOR BDR AND EDR**

Parameter	Min	Typ	Max	Bluetooth specification	Unit
Maximum RF transmit power(BM20)				-6 to 4	dBm
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.

Test condition: VCC\_RF= 1.28V, temperature=25 °C.



**Table 3-9: RECEIVER SECTION FOR BDR AND EDR**

	Modulation	Min	Typ	Max	Bluetooth specification	Unit
Sensitivity at 0.1% BER	GFSK		-90		≤-70	dBm
Sensitivity at 0.01% BER	π/4 DQPSK		-91		≤-70	dBm
	8DPSK		-82		≤-70	dBm

Note:

- (1) Test condition: VCC\_RF= 1.28V, temperature=25 °C.
- (2) These parameters are characterized but not tested in manufacturing.

**Table 3-10: SYSTEM CURRENT CONSUMPTION OF ANALOG AUDIO OUTPUT**

System Status	Typ.	Max.	Unit
System Off Mode	2	5	uA
Standby Mode	0.8		mA
Linked Mode	0.4		mA
SCO Link	7.8		mA
A2DP Link (V <sub>pp</sub> =200mV; 1k tone signal)	10.7		mA

Note: Use BM20 EVB as test platform.

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

**Table 3-11: SYSTEM CURRENT CONSUMPTION OF DIGITAL AUDIO OUTPUT(I<sup>2</sup>S)**

System Status	Typ.	Max.	Unit
System Off Mode	2	5	uA
Standby Mode	0.4		mA
Linked Mode	0.4		mA
SCO Link	9.3		mA
A2DP Link (1k tone signal)	11.7		mA

Note: Use BM23 EVB as test platform

Test condition: BAT\_IN= 3.8V, link with HTC M8 cell phone; distance between cell phone and EVB: 30cm;  
I<sup>2</sup>S signal link with YAMAHA YDA174 EVB

## 4. PRINTED ANTENNA INFORMATION

### 4.1. MODULE RADIATION PATTERN

The stereo module contains a PCB printed antenna. The PCB printed antenna radiation pattern is shown in Figure 4-2.

FIGURE 4-1: ANTENNA KEEP OUT AREA EXAMPLES

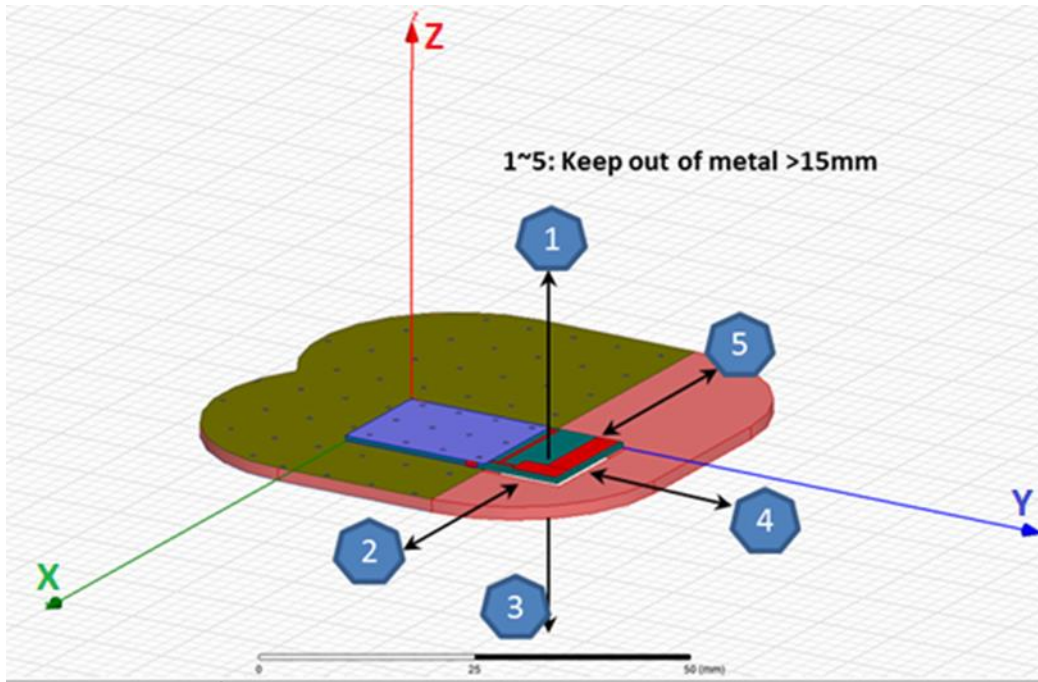


FIGURE 4-2: ANTENNA 3D RADIATION PATTERN @2441 MHz

