BM63

Bluetooth® 4.2 Stereo Audio Module

Features

- Qualified for Bluetooth v4.2 specifications
- Supports HFP 1.6, HSP 1.2, A2DP 1.3, SPP 1.2 and AVRCP 1.6
- Supports Bluetooth 4.2 dual-mode (BDR/EDR/ BLE) specifications (FW dependent)
- Stand-alone module with on-board PCB antenna and Bluetooth stack
- Supports high resolution up to 24-bit, 96 kHz audio data format
- Supports to connect two hosts with HFP/A2DP profiles simultaneously
- Supports to connect one host with SPP/BTLE
- Transparent UART mode for seamless serial data over UART interface
- Easy to configure with Windows® GUI or directly by external MCU
- Supports firmware field upgrade
- Supports one microphone
- Castellated surface mount pads for easy and reliable host PCB mounting
- RoHS compliant
- Ideal for portable battery operated devices
- Internal battery regulator circuitry

DSP Audio Processing

- Supports 64 kbps A-Law, μ-Law PCM format/ Continuous Variable Slope Delta (CVSD) modulation for SCO channel operation
- Supports 8/16 kHz noise suppression
- Supports 8/16 kHz echo cancellation
- Supports Modified Sub-Band Coding (MSBC) decoder for wide band speech
- Built-in High Definition Clean Audio (HCA) algorithms for both narrow band and wide band speech processing
- Packet loss concealment (PLC)
- Built-in audio effect algorithms to enhance audio streaming
- Supports Serial Copy Management System (SCMS-T) content protection

FIGURE 1: BM63 MODULE

Audio Codec

- Sub-band Coding (SBC) and optional Advanced Audio Coding (AAC) decoding
- 20-bit digital-to-analog converter (DAC) with 98 dB SNR
- 16-bit analog-to-digital converter (ADC) with 92 dB SNR
- Supports up to 24-bit, 96 kHz I^2S digital audio

Peripherals

- Built-in lithium-ion and lithium-polymer battery charger (up to 350 mA)
- Integrated 1.8V and 3V configurable switching regulator and low-dropout (LDO) regulator
- Built-in ADC for battery voltage sense
- An AUX-In port for external audio input
- Three LED drivers
- Multiple I/O pins for control and status

RF/Analog

- Frequency spectrum: 2.402 GHz to 2.480 GHz
- Receive sensitivity: -90 dBm (2 Mbps EDR)
- Class 2 output power (+2 dBm typical)

HCI Interface

- High-speed HCI-UART interface (supports up to 921,600 bps)

MAC/Baseband Processor

- Supports Bluetooth 4.2 dual-mode (FW dependent)
  - BDR/EDR transport for audio, voice and SPP data exchange
  - BLE transport for proprietary transparent service and Apple Notification Center Service (ANCS) data exchange

Operating Condition

- Operating voltage: 3.2V to 4.2V
- Operating temperature: -20°C to +70°C

Compliance

- Bluetooth SIG QDID: 83345

Applications

- Soundbar and Subwoofer (FW dependent)
- Bluetooth portable speaker phone
- Multi-speaker (FW dependent)

Description

The BM63 module is a fully qualified Bluetooth v4.2 dual-mode (BDR/EDR/BLE) module for designers to add wireless audio and voice applications to their products. The BM63 module is a Bluetooth Special Interest Group (SIG) certified module that provides a complete wireless solution with a Bluetooth stack and an integrated PCB antenna in a compact surface-mount package.

The BM63 module has an integrated lithium-ion and lithium-polymer battery charger, and a digital audio interface. The module supports HSP, HFP, SPP, A2DP and AVRCP profiles, and AAC and SBC codecs.

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NOTES:

1.0 DEVICE OVERVIEW

The BM63 module is built around Microchip Technology IS2063 SoC. The IS2063 SoC integrates the Bluetooth 4.2 dual-mode radio transceiver, Power Management Unit (PMU), crystal and DSP. Users can configure the BM63 module by using the UI tool and DSP tool, a Windows-based utility.

Note: The UI and DSP tools are available for download from the Microchip web site at: www.microchip.com/BM63.

Figure 1-1 illustrates a typical example of the BM63 module which is connected to an external MCU and a DSP/codec.

FIGURE 1-1: APPLICATION USING BM63 MODULE

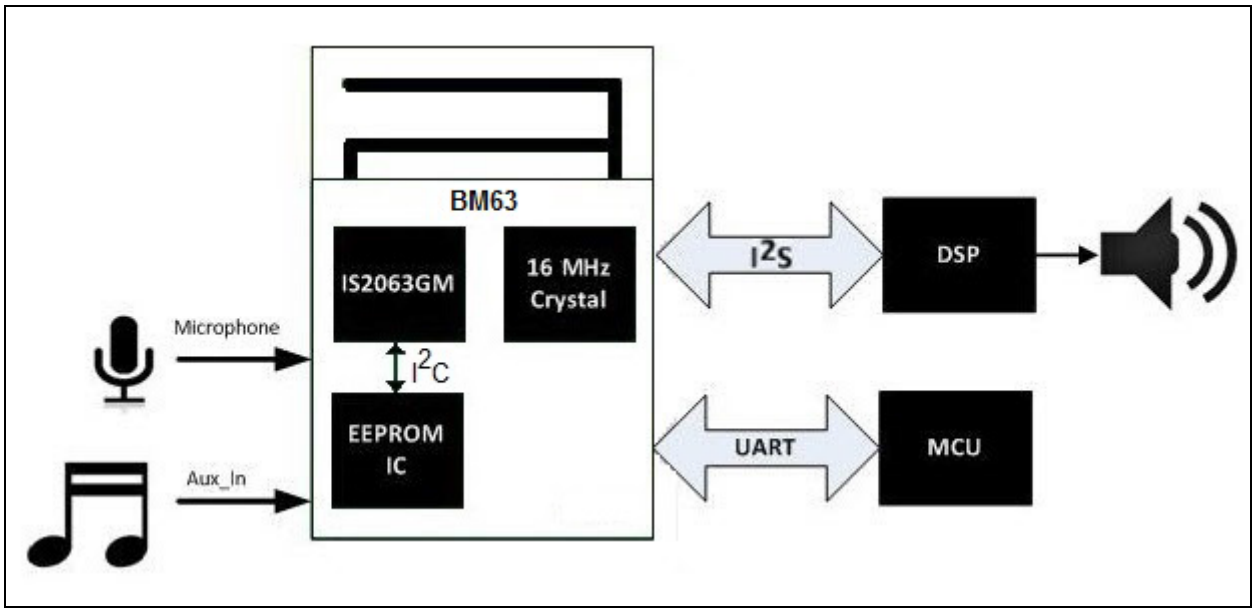


Figure 1-2 illustrates the Soundbar and Subwoofer applications using the BM63 module.

FIGURE 1-2: SOUNDBAR AND SUBWOOFER APPLICATIONS USING BM63 MODULE

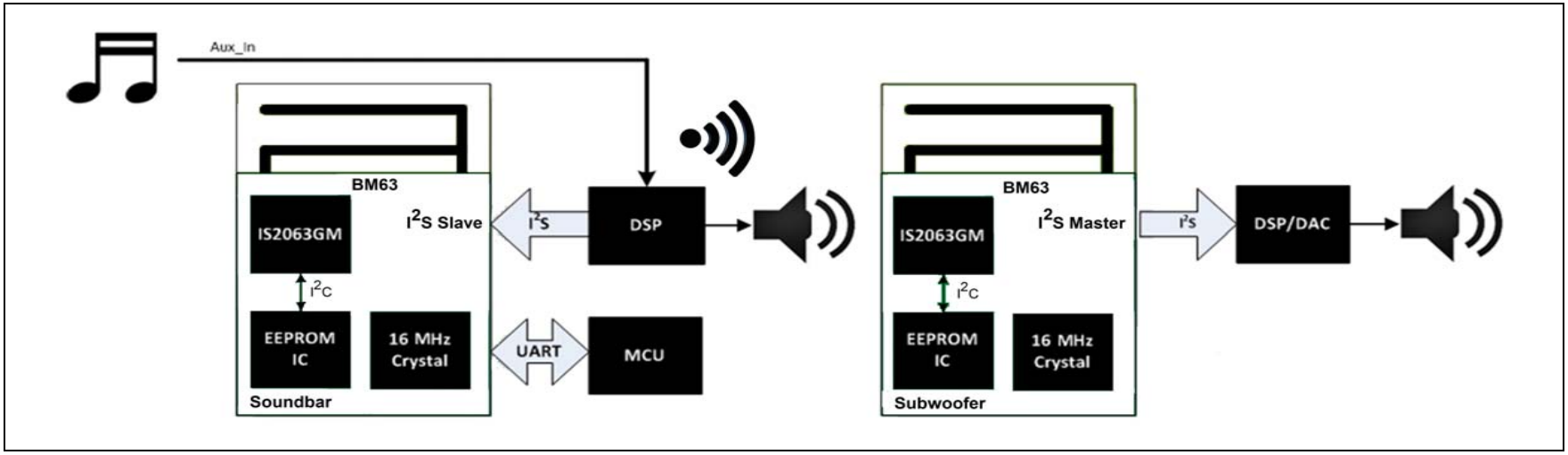


Figure 1-3 illustrates the Soundbar and Subwoofer applications using the BM63 module and smartphone.

FIGURE 1-3: SOUNDBAR AND SUBWOOFER APPLICATIONS USING BM63 MODULE AND SMARTPHONE

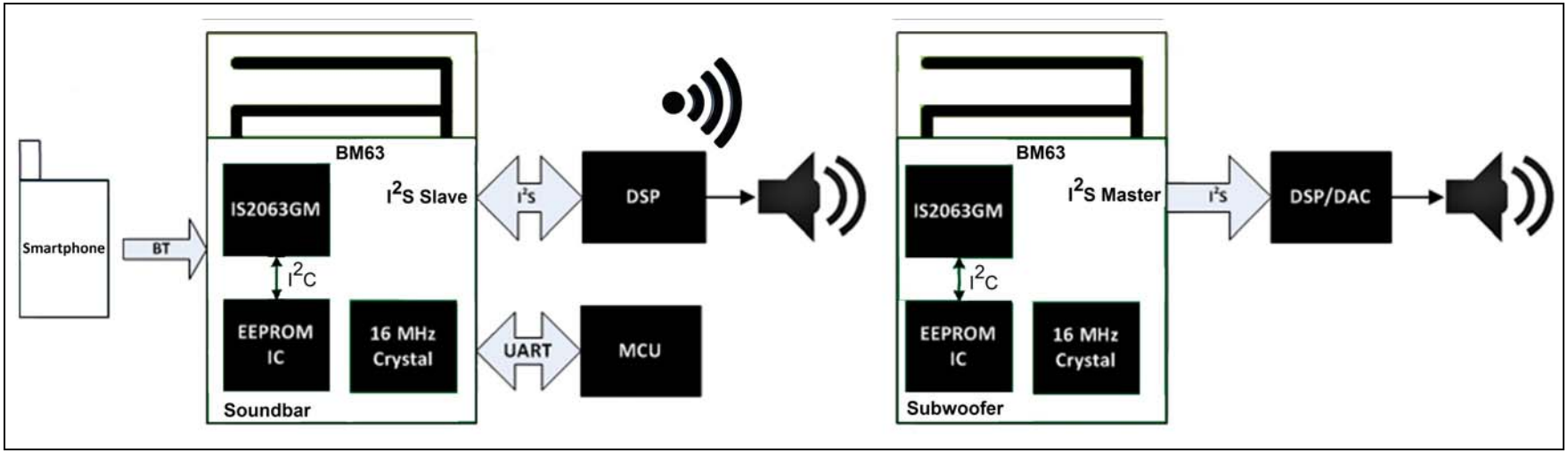


Figure 1-4 illustrates the Multi-speaker application using the BM63 module.

FIGURE 1-4: MULTI-SPEAKER APPLICATION USING BM63 MODULE

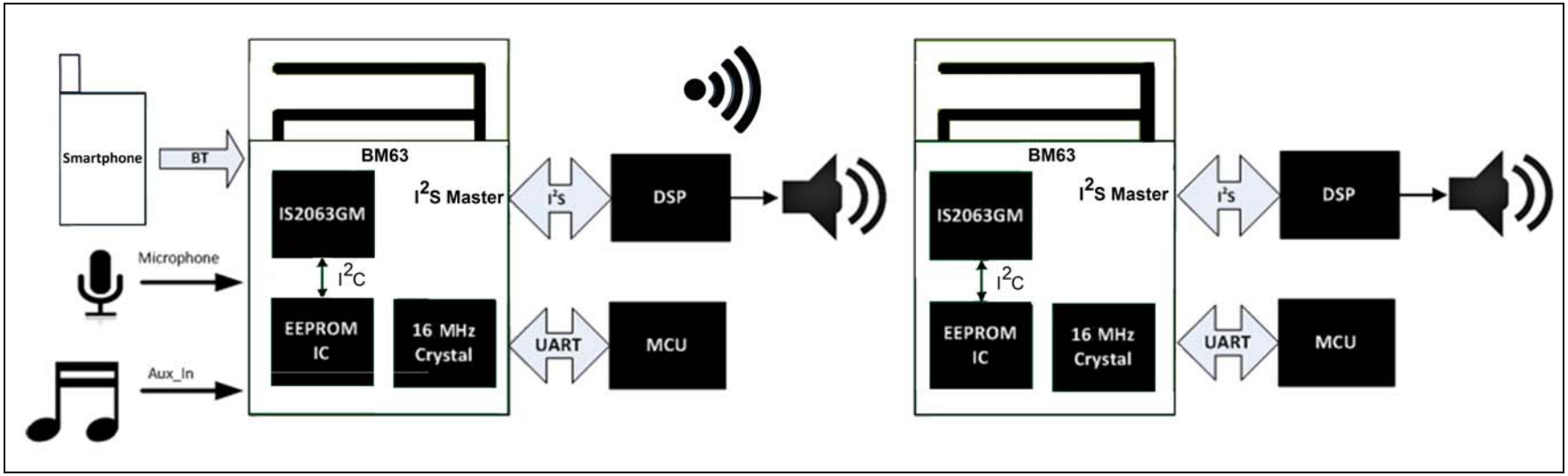


Table 1-1 provides the key features of the BM63 module.

TABLE 1-1: BM63 KEY FEATURES

Feature	BM63
Application	Multi-speaker/Soundbar/Subwoofer
Stereo/mono	Stereo
Pin count	48
Dimensions (mm^2)	15 x 32
PCB antenna	Yes
Tx power (typical)	2 dBm
Audio DAC output	2 Channel
DAC (single-ended) SNR at 2.8V (dB)	-98
DAC (capless) SNR at 2.8V (dB)	-98
ADC SNR at 2.8V (dB)	-92
I^2S digital interface	Yes
Analog AUX-In	Yes
Mono MIC	1
External audio amplifier interface	Yes
UART	Yes
USB	Yes
LED driver	3
Internal DC-DC step down regulator	Yes
DC 5V adapter input	Yes
Battery charger (350 mA max)	Yes
ADC for thermal charger protection	No
Undervoltage protection (UVP)	No
GPIO	15
Button support	6
NFC (triggered by external NFC)	Yes
EEPROM	Yes
Voice prompt (FW dependent)	8K Sampling Rate, stored in EEPROM with approximately 800 bytes/second
Multi-tone	Yes
DSP sound effect	Yes
BLE	Yes
Bluetooth profiles	
HFP	1.6
AVRCP	1.6
A2DP	1.3
HSP	1.2
SPP	1.2

Figure 1-5 illustrates the pin diagram of the BM63 module.

FIGURE 1-5: BM63 MODULE PIN DIAGRAM

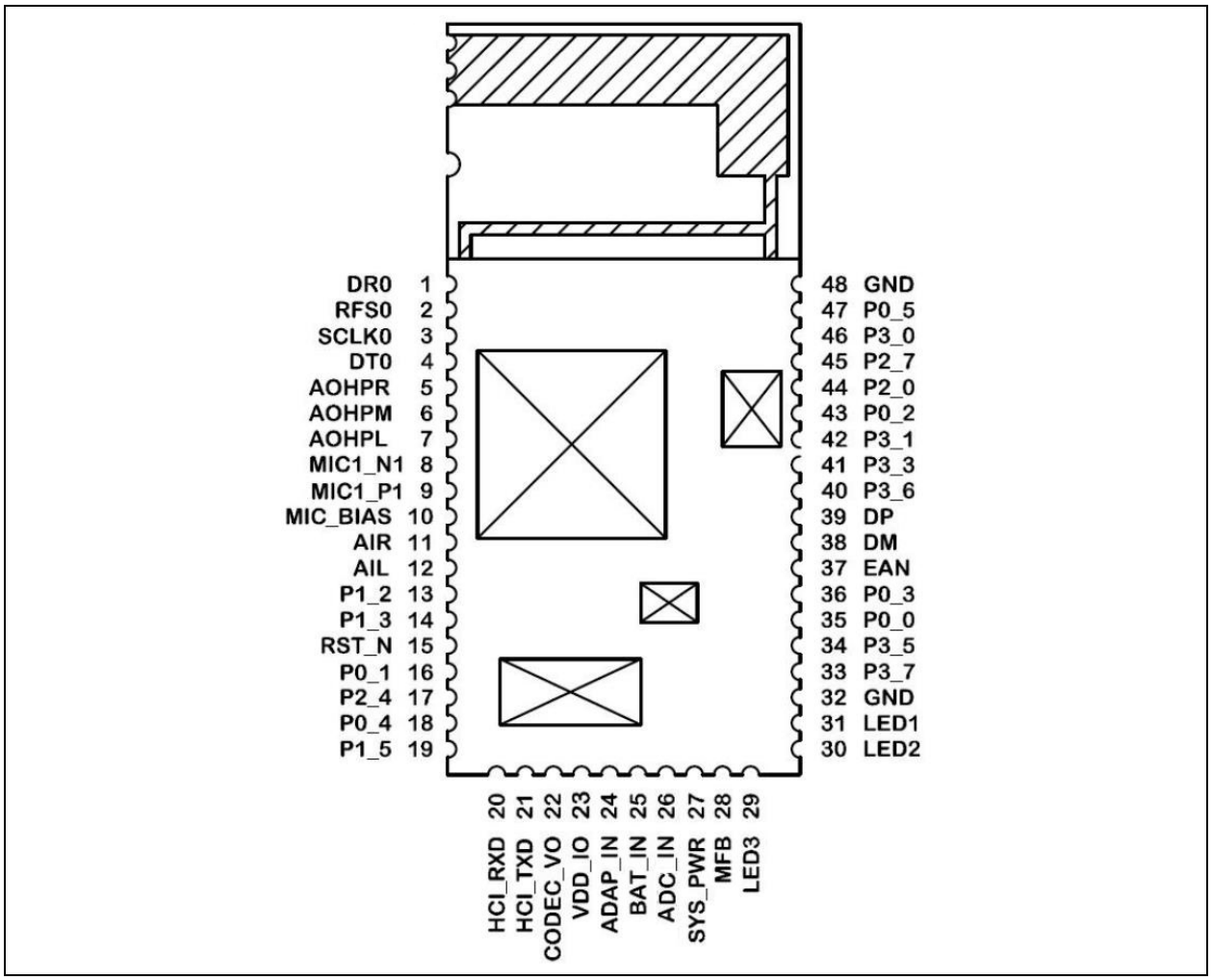


Table 1-2 provides the pin description of the BM63 module.

TABLE 1-2: BM63 MODULE PIN DESCRIPTION

Pin No	Pin Type	Name	Description
1	I	DR0	I^2S interface: digital left/right data
2	I/O	RFS0	I^2S interface: left/right clock
3	I/O	SCLK0	I^2S interface: bit clock
4	O	DT0	I^2S interface: digital left/right data
5	O	AOHPR	Right-channel, analog headphone output
6	O	AOHPM	Headphone common mode output/sense input
7	O	AOHPL	Left-channel, analog headphone output
8	I	MIC_N1	MIC1 mono differential analog negative input
9	I	MIC_P1	MIC1 mono differential analog positive input
10	P	MIC_BIAS	Electric microphone biasing voltage
11	I	AIR	Right-channel, single-ended analog input
12	I	AIL	Left-channel, single-ended analog input
13	I/O	P1_2	EEPROM clock SCL
14	I/O	P1_3	EEPROM data SDA
15	I	RST_N	System Reset (active-low)
16	I/O	P0_1	Configurable control or indication pin (Internally pulled-up if configured as an input) • FWD key when Class 2 RF (default), active-low • Class 1 Tx control signal for external RF Tx/Rx switch, active-high
17	I/O	P2_4	System configuration pin along with P2_0 and EAN pins used to set the module in any one of these modes: • Application mode (for normal operation) • Test mode (to change EEPROM values) • Write Flash mode (to load a new firmware into the module), refer to Table 5-1
18	I/O	P0_4	Configurable control or indication pin (Internally pulled-up if configured as an input) • NFC detection pin, active-low • Out_Ind_1
19	I/O	P1_5	Configurable control or indication pin (Internally pulled-up if configured as an input) • NFC detection pin, active-low • Slide switch detector, active-high • Out_Ind_1 • Multi-SPK Master/Slave mode control (FW dependent)
20	I	HCI_RXD	HCI-UART data input
21	O	HCI_TXD	HCI-UART data output
22	P	CODEC_VO	Power supply/reference voltage for codec. Do not connect, for internal use only
23	P	VDD_IO	I/O positive supply. Do not connect, for internal use only
24	P	ADAP_IN	5V power adapter input

TABLE 1-2: BM63 MODULE PIN DESCRIPTION (CONTINUED)

Pin No	Pin Type	Name	Description
25	P	BAT_IN	Battery input. Voltage range: 3.2V to 4.2V. When an external power supply is connected to the ADAP_IN pin, the BAT_IN pin can be left open if battery is not connected.
26	P	ADC_IN	Analog input
27	P	SYS_PWR	System power output derived from ADAP_IN or BAT_IN
28	I	MFB	• Multi-Function Button and power-on key • UART RX_IND, active-high (used by host MCU to wakeup the Bluetooth system)
29	I	LED3	LED driver 3
30	I	LED2	LED driver 2
31	I	LED1	LED driver 1
32	P	GND	Ground reference
33	I/O	P3_7	Configurable control or indication pin (Internally pulled-up if configured as an input) UART TX_IND, active-low (used by Bluetooth system to wakeup the host MCU)
34	I/O	P3_5	Configurable control or indication pin (Internally pulled-up, if configured as an input) • Slide switch detector, active-high
35	I/O	P0_0	Configurable control or indication pin (Internally pulled-up if configured as an input) • Slide switch detector, active-high, Out_Ind_0
36	I/O	P0_3	Configurable control or indication pin (Internally pulled-up if configured as an input) • REV key (default), active-low • Buzzer signal output • Out_Ind_2 • Class 1 Rx Control signal of external RF Tx/Rx switch, active-high
37	I	EAN	External address bus negative; must be pulled-down with 4.7 kOhm to GND System configuration pin along with P2_0 and P2_4 pins, used to set the module in any one of these modes: • Application mode (for normal operation) • Test mode (to change EEPROM values) • Write Flash mode (to load a new firmware into the module), refer to Table 5-1
38	I/O	DM	Differential data-minus USB
39	I/O	DP	Differential data-plus USB
40	I/O	P3_6	Configurable control or indication pin (Internally pulled-up if configured as an input) Multi-SPK Master/Slave mode control (FW dependent)
41	I/O	P3_3	Configurable control or indication pin (Internally pulled-up if configured as an input) FWD key (default), active-low
42	I/O	P3_1	Configurable control or indication pin (Internally pulled-up if configured as an input) REV key (default), active-low

TABLE 1-2: BM63 MODULE PIN DESCRIPTION (CONTINUED)

Pin No	Pin Type	Name	Description
43	I/O	P0_2	Configurable control or indication pin (Internally pulled-up if configured as an input) Play/Pause key (default)
44	I/O	P2_0	System configuration pin along with P2_4 and EAN pins used to set the module in one of these modes: • Application mode (for normal operation) • Test mode (to change EEPROM values) • Write Flash mode (to load a new firmware into the module), refer to Table 5-1 • Pulse/PWM signal output
45	I/O	P2_7	Configurable control or indication pin (Internally pulled-up if configured as an input) Volume-up key (default), active-low
46	I/O	P3_0	Configurable control or indication pin (Internally pulled-up if configured as an input) AUX-In detector, active-low
47	I/O	P0_5	Configurable control or indication pin (Internally pulled-up if configured as an input) Volume-down key (default), active-low
48	P	GND	Ground reference

Legend: I= Input pin O= Output pin I/O= Input/Output pin P= Power pin

Note: All I/O pins can be configured using the UI tool, a Windows utility.

2.0 AUDIO

The input and output audios have different stages and each stage can be programmed to vary the characteristics of the gain response. For microphones, both single-ended inputs and differential inputs are supported. To maintain a high quality signal, a stable bias voltage source to the condenser microphone's FET is provided. The DC blocking capacitors can be used at both positive and negative sides of a input. Internally, this analog signal is converted to 16-bit, 8/16 kHz linear PCM data.

2.1 Digital Signal Processor

A Digital Signal Processor (DSP) is used to perform speech and audio processing. The advanced speech features, such as acoustic echo cancellation and noise reduction are inbuilt. To reduce nonlinear distortion and to help echo cancellation, an outgoing signal level to the speaker is monitored and adjusted to avoid saturation of speaker output or microphone input. Adaptive filtering is also applied to track the echo path impulse in response to provide echo free and full-duplex user experience.

The embedded noise reduction algorithm helps to extract clean speech signals from the noisy input captured by the microphones, and improves mutual understanding in communication.

The advanced audio features, such as multi-band dynamic range control, parametric multi-band equalizer, audio widening and virtual bass are inbuilt. The audio effect algorithms improve the user's audio listening experience in terms of better audio quality after audio signal processing.

Figure 2-1 and Figure 2-2 illustrate the processing flow of speaker-phone applications for speech and audio signal processing.

FIGURE 2-1: SPEECH SIGNAL PROCESSING

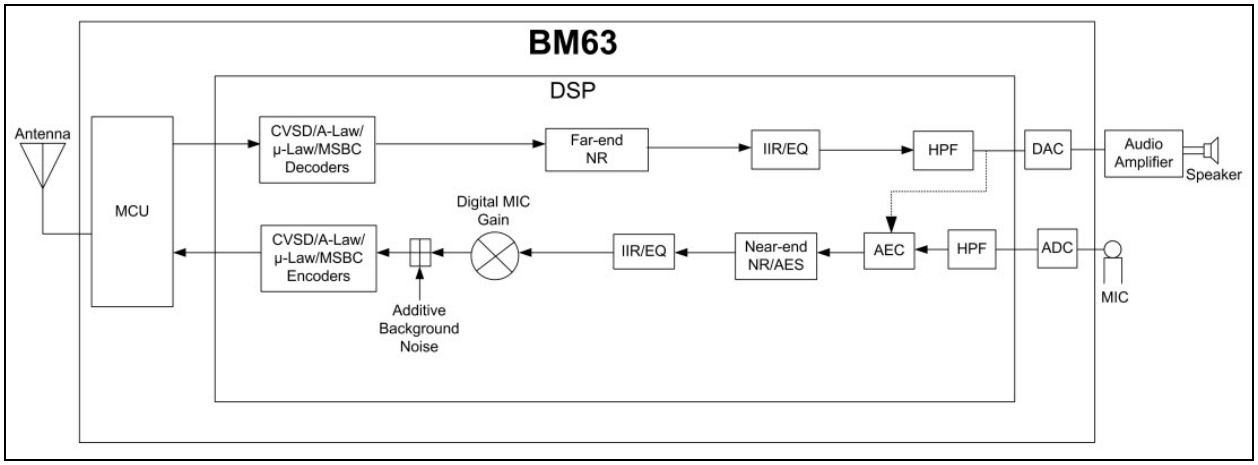
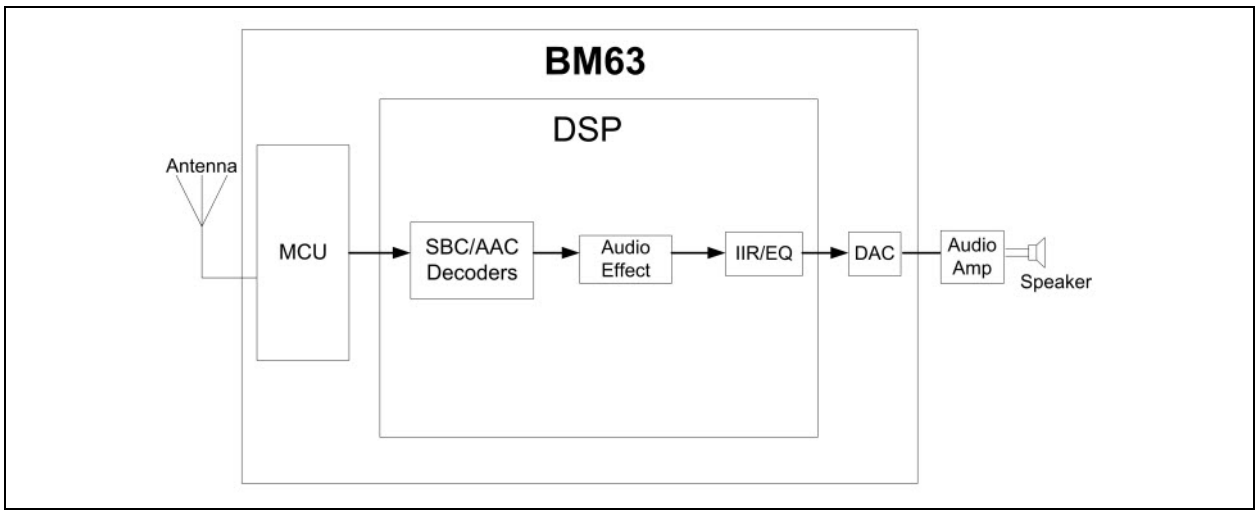


FIGURE 2-2: AUDIO SIGNAL PROCESSING



Users can configure DSP parameters using the DSP tool. For additional information on the DSP tool, refer to the "*IS206X DSP Application Note*".

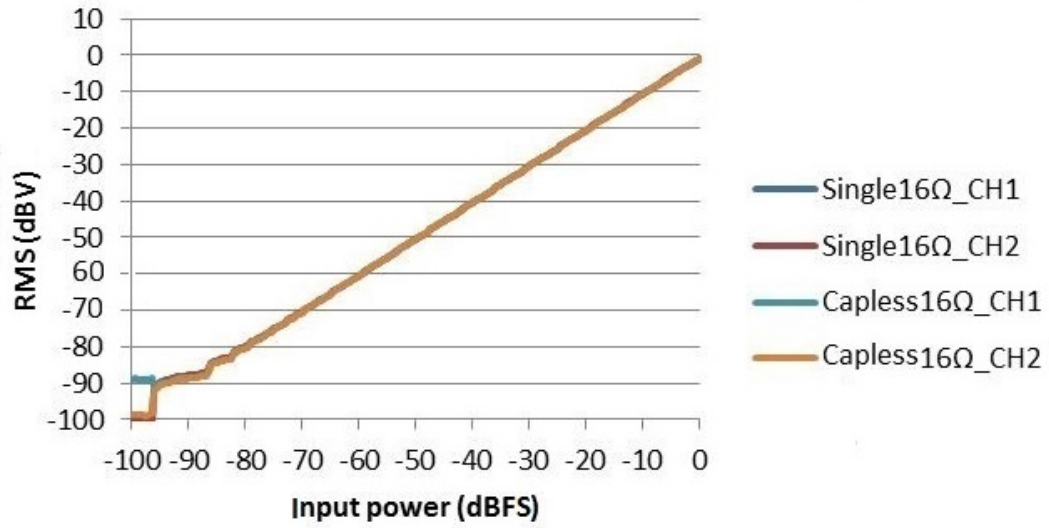
Note:	The DSP tool and "*IS206X DSP Application Note*" document, are available for download from the Microchip web site at: www.microchip.com/BM63.

2.2 Codec

The built-in codec has a high signal-to-noise ratio (SNR) performance and it consists of an ADC, a DAC and an additional analog circuitry.

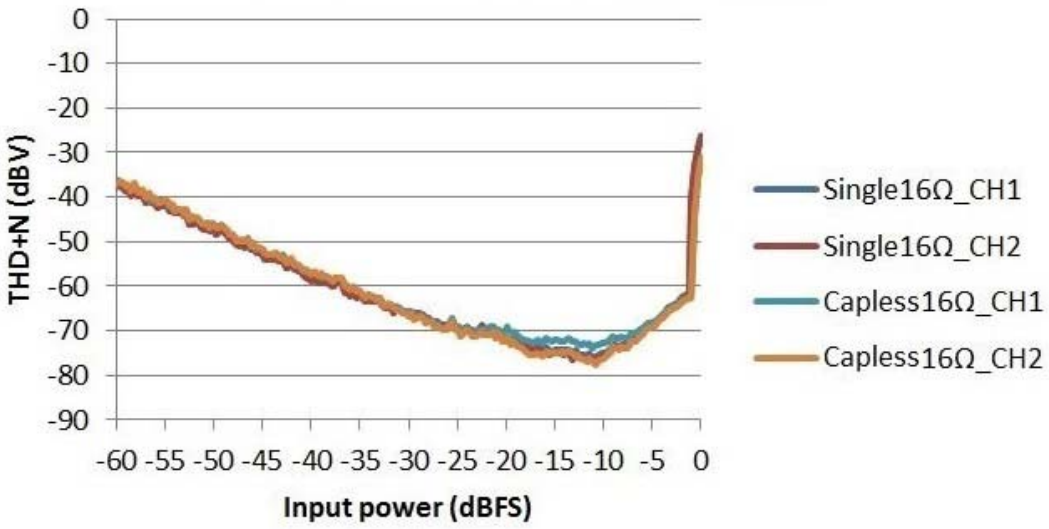
Figure 2-3 through Figure 2-6 illustrate the dynamic range and frequency response of the codec.

FIGURE 2-3: CODEC DAC DYNAMIC RANGE



Note: The data corresponds to the 16 Ohm load with 2.8V operating voltage at +25°C room temperature.

FIGURE 2-4: CODEC DAC THD+N VERSUS INPUT POWER



Note: The data corresponds to the 16 Ohm load with 2.8V operating voltage at +25°C room temperature.

FIGURE 2-5: CODEC DAC FREQUENCY RESPONSE (CAPLESS MODE)

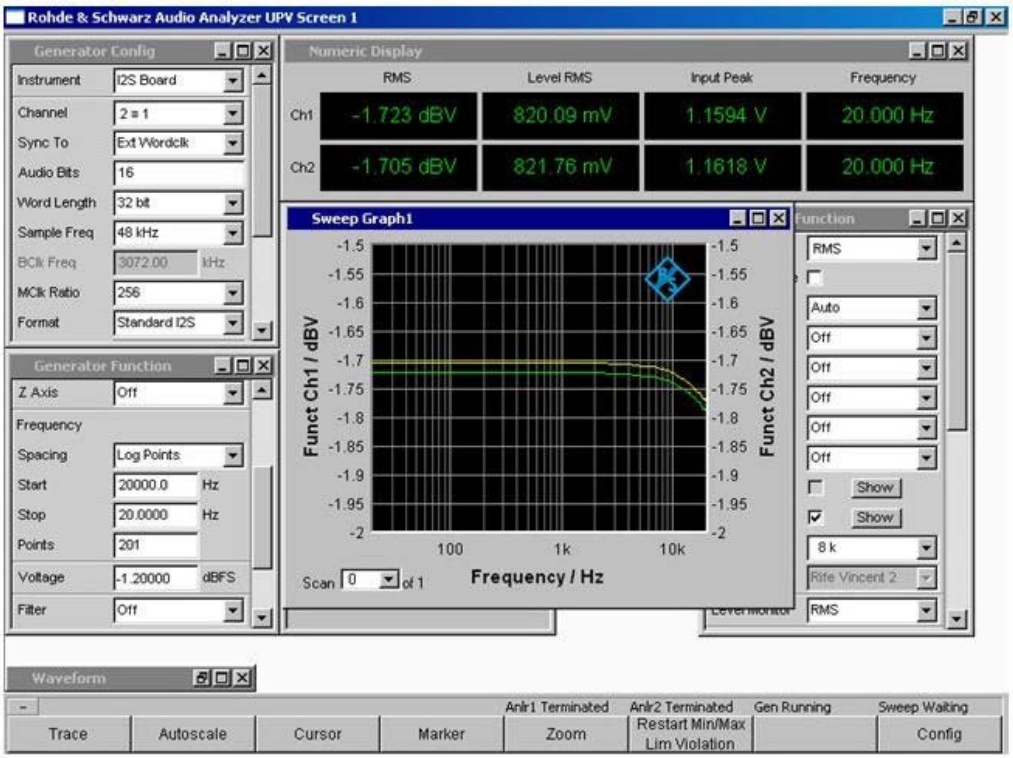
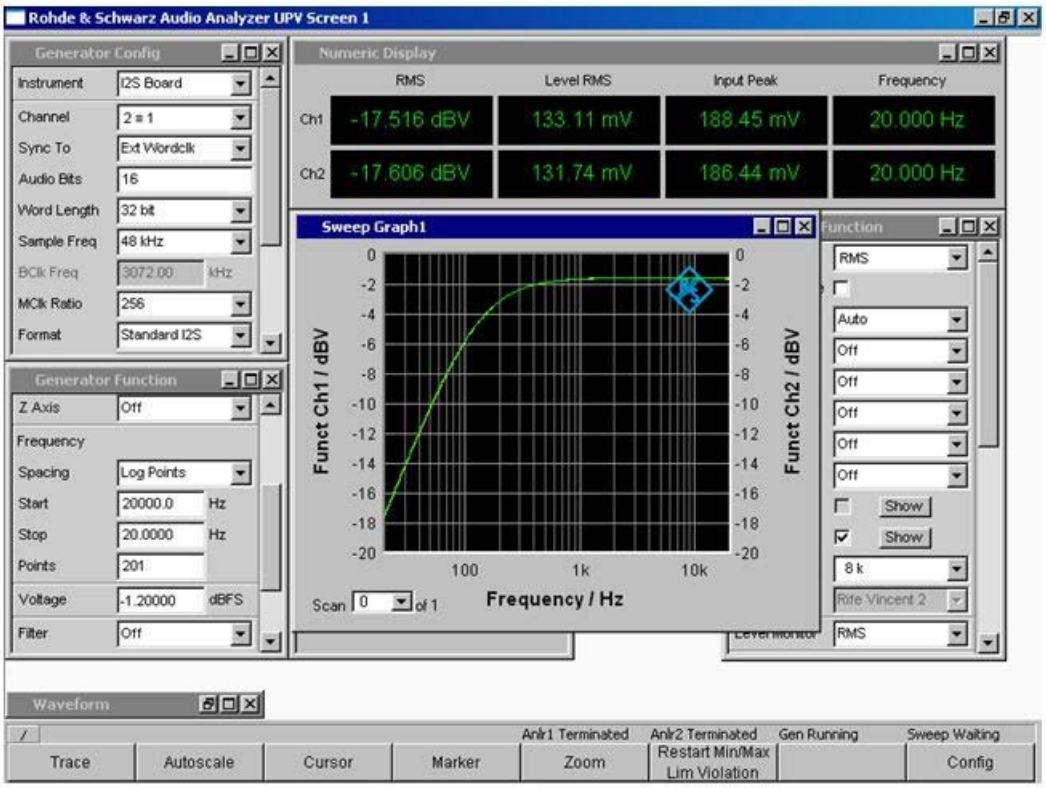


FIGURE 2-6: CODEC DAC FREQUENCY RESPONSE (SINGLE-ENDED MODE)



Note: The DAC frequency response corresponds to single-ended mode with a 47 µF DC block capacitor.

2.3 Auxiliary Port

The BM63 module supports analog (line-in) signals from the external audio source. The analog (line-in) signal can be processed by the DSP to generate different sound effects (Multi-band dynamic range compression and audio widening), which can be configured by using the DSP tool.

2.4 Analog Speaker Output

The BM63 module supports the following analog speaker output modes:

- Capless mode – Recommended for headphone applications in which capless output connection helps to save the BOM cost by avoiding a large DC blocking capacitor. Figure 2-7 illustrates the analog speaker output capless mode
- Single-ended mode – Used for driving an external audio amplifier where a DC blocking capacitor is required. Figure 2-8 illustrates the analog speaker output single-ended mode

FIGURE 2-7: ANALOG SPEAKER OUTPUT CAPLESS MODE

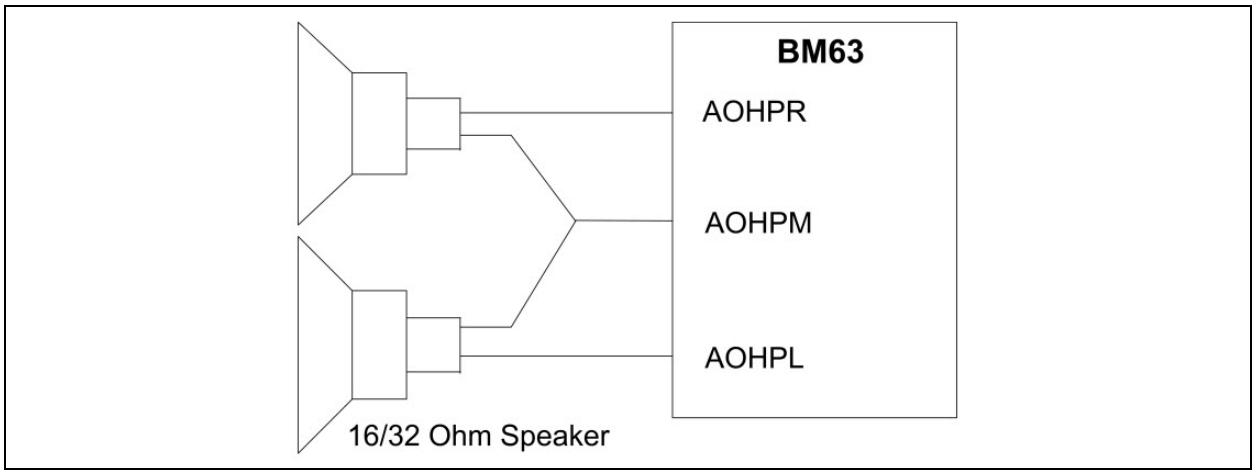
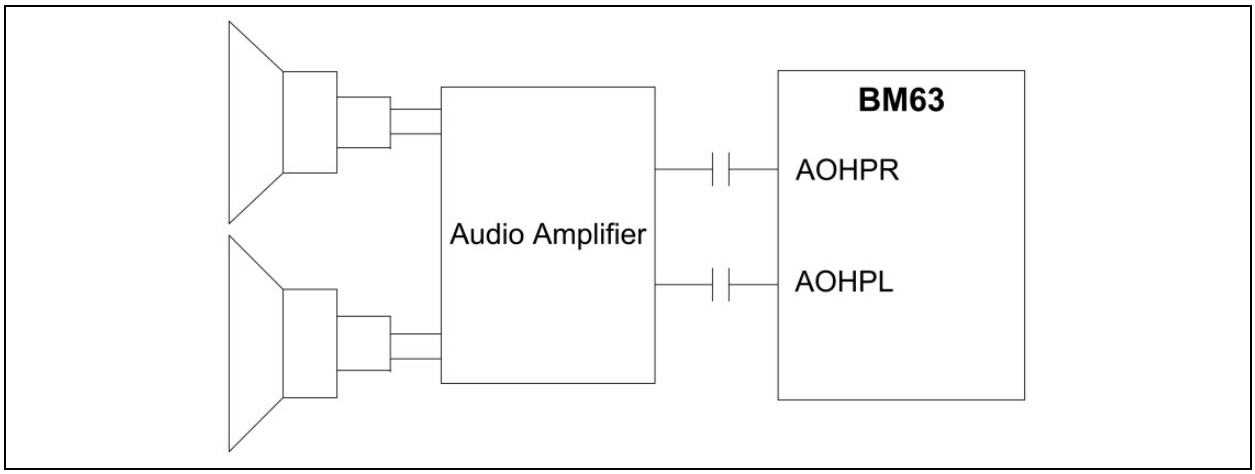


FIGURE 2-8: ANALOG SPEAKER OUTPUT SINGLE-ENDED MODE



3.0 TRANSCEIVER

The BM63 module is designed and optimized for Bluetooth 2.4 GHz system. It contains a complete radio frequency transmitter/receiver section. An internal synthesizer generates a stable clock for synchronizing with another device.

3.1 Transmitter

The internal power amplifier (PA) has a maximum output power of +4 dBm. This is applied for Class 2 or Class 3 radios without an external RF PA.

The transmitter performs the IQ conversion to minimize the frequency drift.

3.2 Receiver

The low-noise amplifier (LNA) operates with TR-combined mode for single port application. It can save a pin on the package without having an external Tx/Rx switch.

The ADC can sample the input analog signal and convert it into a digital signal for demodulator analysis. A channel filter has been integrated into receiver channel before the ADC, which is used to reduce the external component count and increase the anti-interference capability.

The image rejection filter is used to reject the image frequency for low-IF architecture. This filter for low-IF architecture is intended to reduce external Band Pass Filter (BPF) component for a super heterodyne architecture.

The Received Signal Strength Indicator (RSSI) signal feedback to the processor is used to control the RF output power to make a good trade-off for effective distance and current consumption.

3.3 Synthesizer

A synthesizer generates a clock for radio transceiver operation. There is a VCO inside, with a tunable internal LC tank that can reduce variation for components. A crystal oscillator with an internal digital trimming circuit provides a stable clock for the synthesizer.

3.4 Modem

For Bluetooth 1.2 specification and below, 1 Mbps was the standard data rate based on the Gaussian Frequency Shift Keying (GFSK) modulation scheme. This basic rate modem meets Basic Data Rate (BDR) requirements of Bluetooth 2.0 with Enhanced Data Rate (EDR) specifications.

For Bluetooth 2.0 and above specifications, EDR has been introduced to provide the data rates of 1/2/3 Mbps. For baseband, both BDR and EDR utilize the same 1 MHz symbol rate and 1.6 kHz slot rate. For BDR, symbol 1 represents 1-bit. However, each symbol in the payload part of EDR packets represents 2/3 bits. This is achieved by using two different modulations, π/4 DQPSK and 8 DPSK.

3.5 Adaptive Frequency Hopping (AFH)

The BM63 module has an AFH function to avoid RF interference. It has an algorithm to check the nearby interference and to choose clear channel for transceiver Bluetooth signal.

NOTES:

4.0 POWER MANAGEMENT UNIT

The on-chip Power Management Unit (PMU) has two main features: lithium-ion and lithium-polymer battery charger, and voltage regulator. A power switch is used to switch over the power source between the battery and an adapter. Also, the PMU provides current to drive three LEDs.

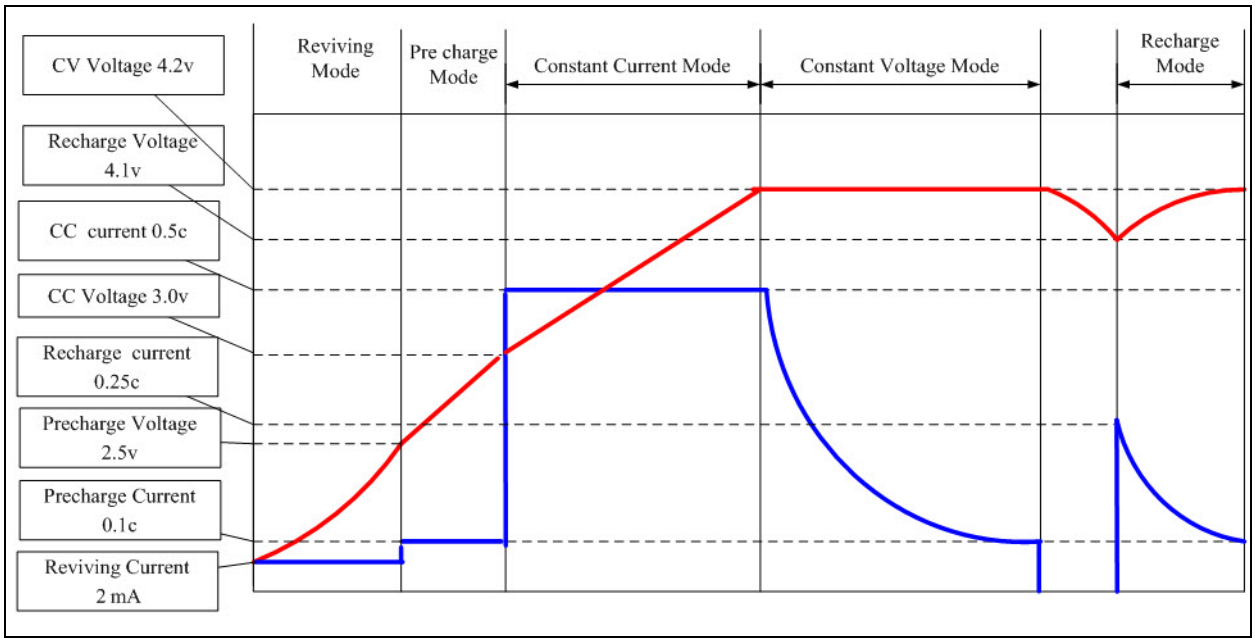
4.1 Charging a Battery

The BM63 module has a built-in battery charger which is optimized for lithium-ion and lithium-polymer batteries.

The battery charger includes a current sensor for charging control, user programmable current regulation and high accuracy voltage regulation.

The charging current parameters are configured by the UI tool. Reviving, pre-charging, constant current and constant voltage modes and re-charging functions are included. The maximum charging current is 350 mA. Figure 4-1 illustrates the charging curve of a battery.

FIGURE 4-1: BATTERY CHARGING CURVE



4.2 Voltage Monitoring

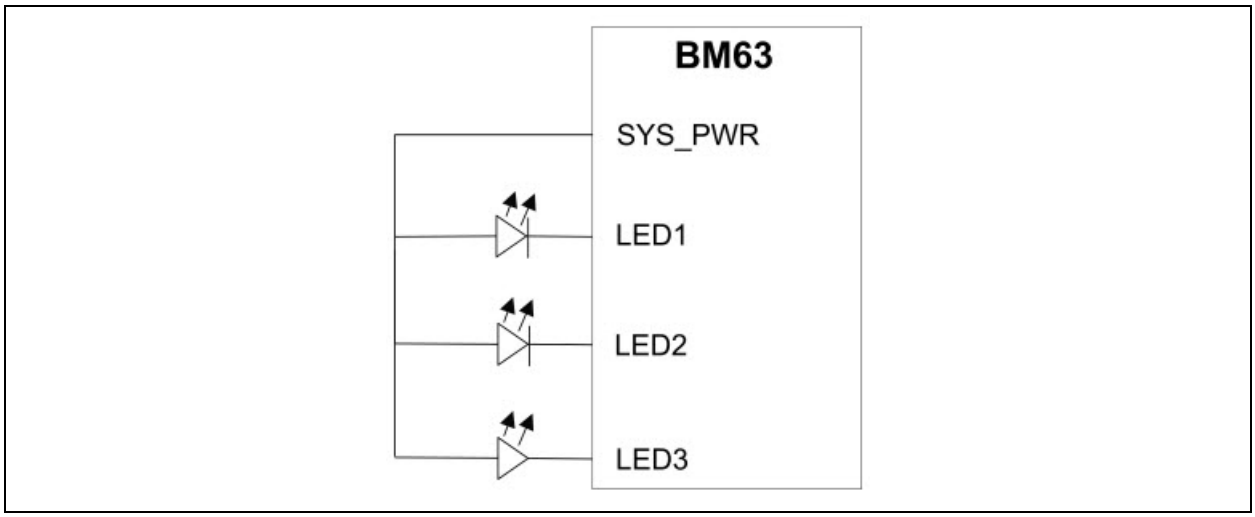
A 10-bit successive approximation register ADC (SAR ADC) provides a dedicated channel for battery voltage level detection. The warning level can be programmed by using the UI tool. The ADC provides a granular resolution to enable the external MCU to take control over the charging process.

4.3 LED Driver

Three dedicated LED drivers control the LEDs. They provide enough sink current (16 step control and 0.35 mA for each step), thus LEDs can be connected with the BM63 module. The LED settings can be configured using the UI tool.

Figure 4-2 illustrates the LED drivers in the BM63 module.

FIGURE 4-2: LED DRIVER



4.4 Under Voltage Protection

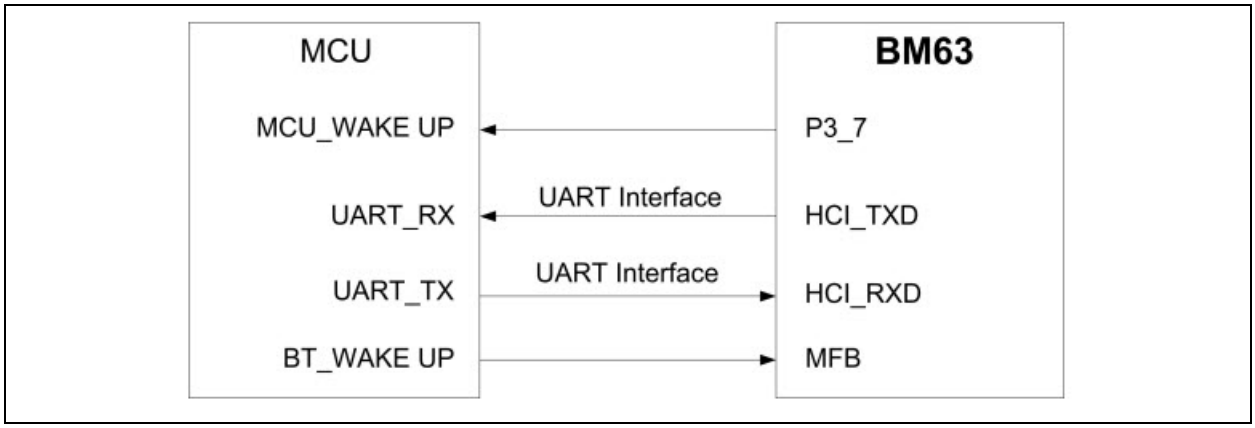
When the voltage of the SYS_PWR pin drops below the voltage level of 2.9V, the system will shutdown automatically.

5.0 APPLICATION INFORMATION

5.1 Host MCU Interface

The BM63 module supports UART commands. The UART commands enable an external MCU to control the BM63 module. Figure 5-1 illustrates the UART interface between the BM63 module and an external MCU.

FIGURE 5-1: HOST MCU INTERFACE OVER UART



An external MCU can control the BM63 module over the UART interface and wakeup the module with the MFB and P3_7 pins.

Refer to the *"UART_CommandSet"* document for a list of functions the BM63 module supports and how to use the UI tool to configure the UART and UART Command Set tool.

Note:	The UART Command set tool (SPKCommandSetTool v160.xx) and *"UART_CommandSet"* document are available for download from the Microchip web site at: www.microchip.com/BM63.

Figure 5-2 through Figure 5-6 illustrate the timing sequences of various UART control signals.

FIGURE 5-2: POWER-ON/OFF SEQUENCE

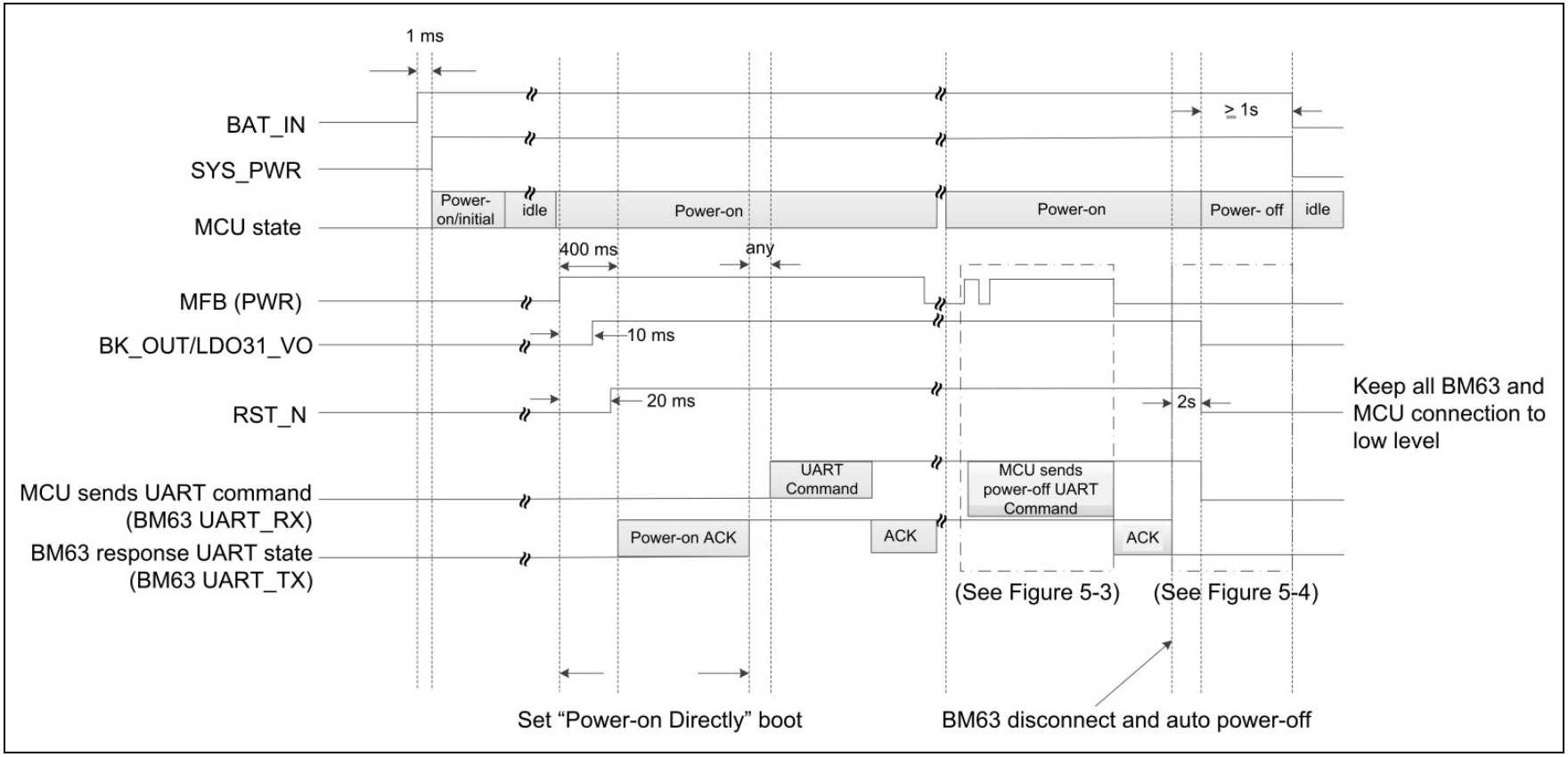


FIGURE 5-3: TIMING SEQUENCE OF RX INDICATION AFTER POWER-ON STATE

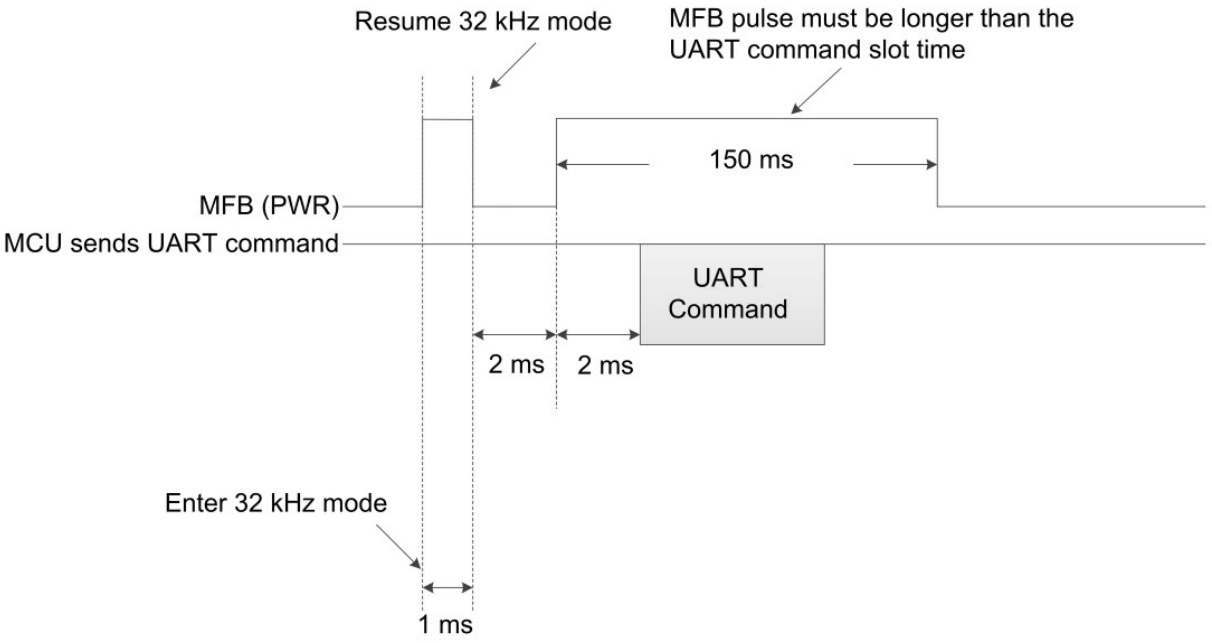
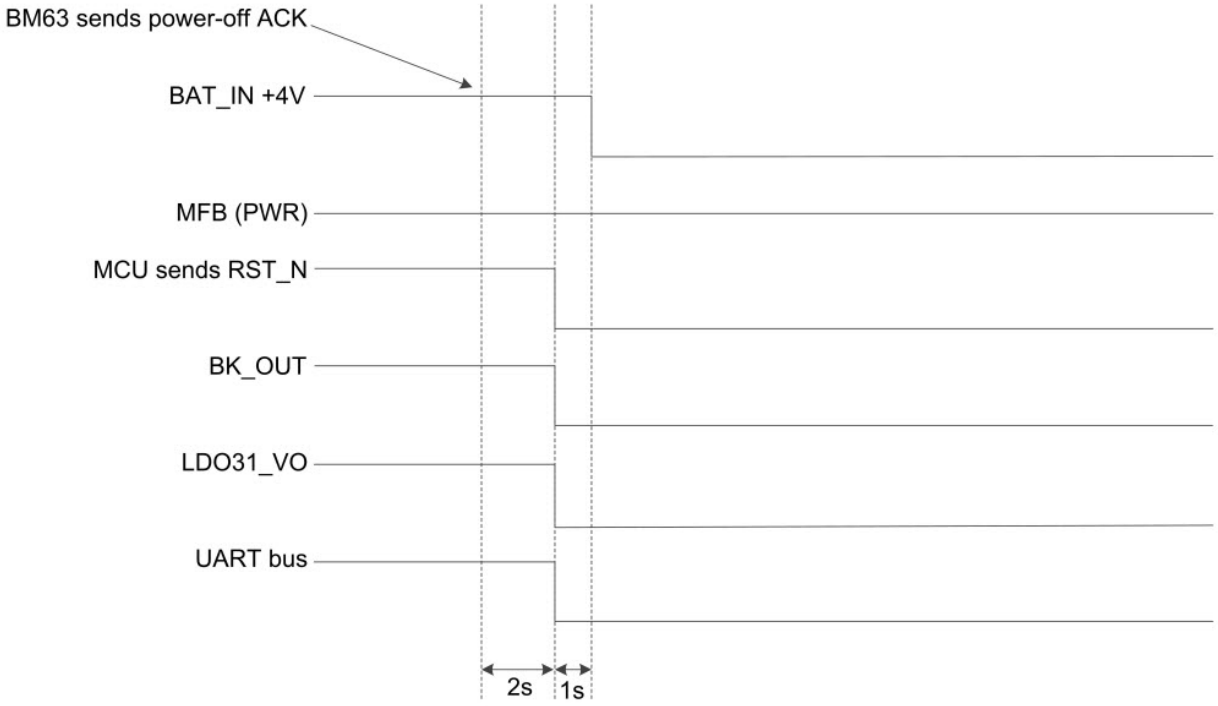


FIGURE 5-4: TIMING SEQUENCE OF POWER-OFF STATE



Note 1: EEPROM clock = 100 kHz.

2: For a byte write: 0.01 ms x 32 clock x 2 = 640 µs.

3: It is recommended to have a ramp-down time more than 640 µs during the power-off sequence to ensure safe operation of the device.

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

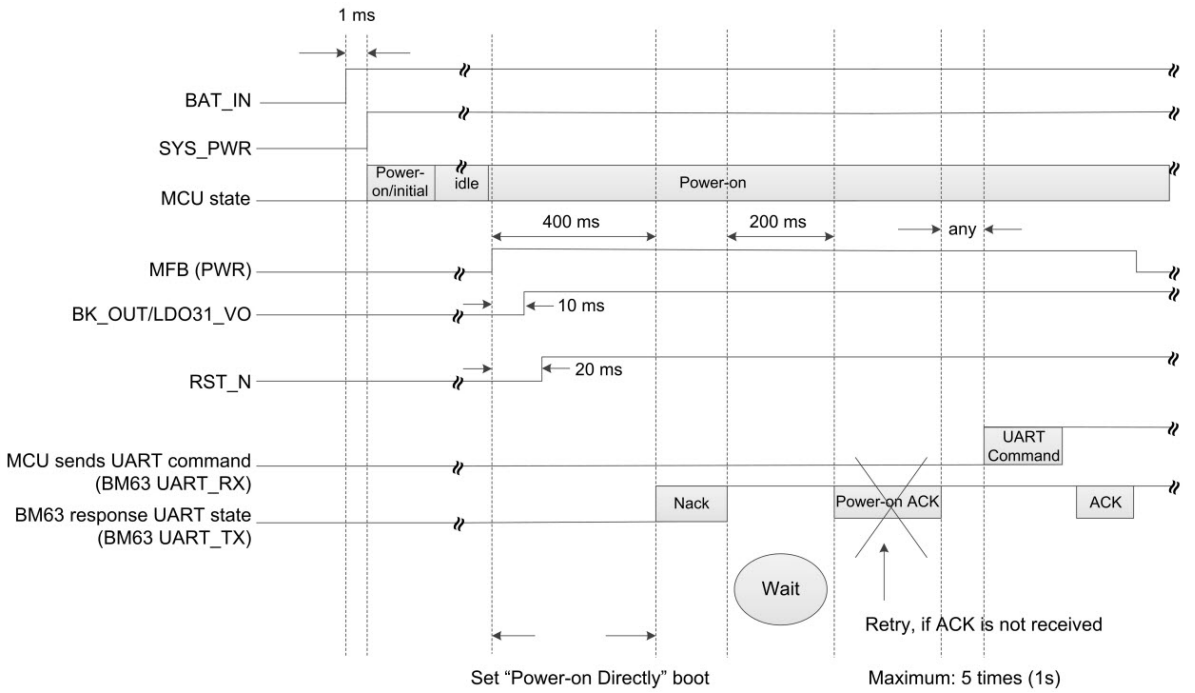
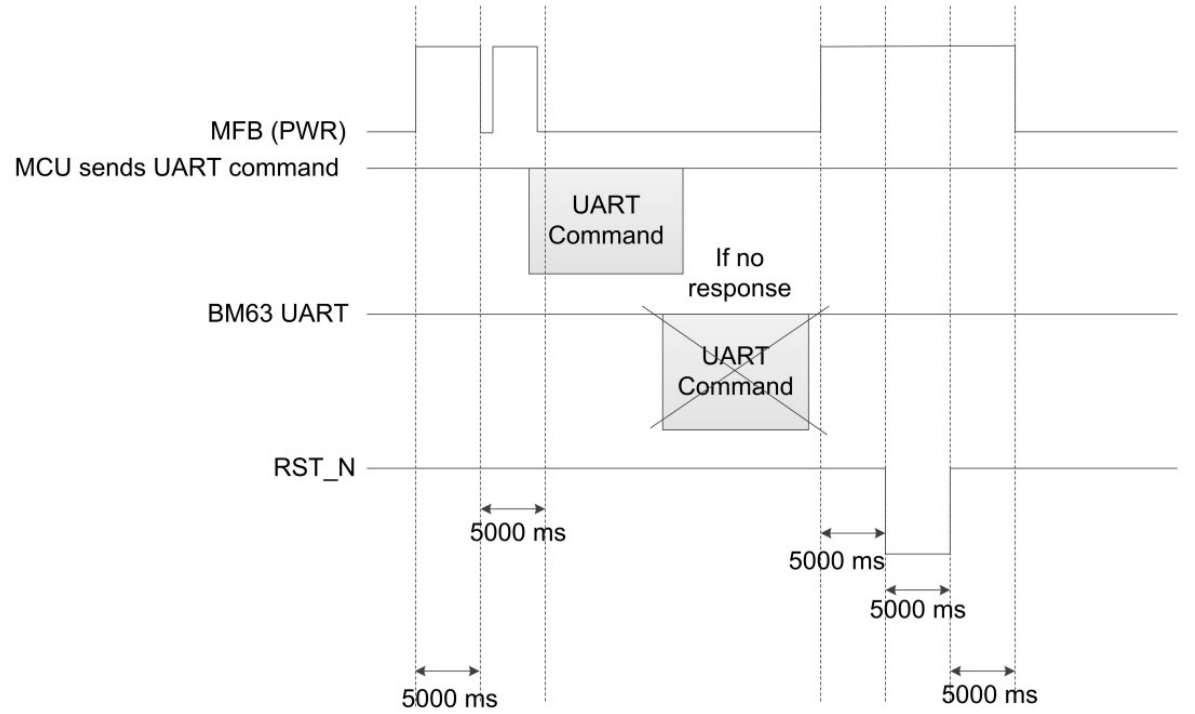


FIGURE 5-6: RESET TIMING SEQUENCE IN CASE OF NO RESPONSE FROM MODULE TO HOST MCU



Note: When the host MCU sends a UART command and the BM63 module does not respond, the MCU resends the UART command. If the BM63 module does not respond within 5 secs, the MCU will force the system to Reset.

5.2 I²S Mode Application

The BM63 module provides an I²S digital audio output interface to connect with an external codec/DSP. It provides 8, 16, 44.1, 48, 88.2 and 96 kHz sampling rates for 16-bit and 24-bit data formats. The I²S setting can be configured using the UI and DSP tools.

Figure 5-7 and Figure 5-8 illustrate the I²S signal connection between the BM63 module and an external DSP. Use the DSP tool to configure the BM63 module as a Master/Slave.

For additional information on timing specifications, refer to **8.2 "Timing specifications"**.

FIGURE 5-7: BM63 MODULE IN I²S MASTER MODE

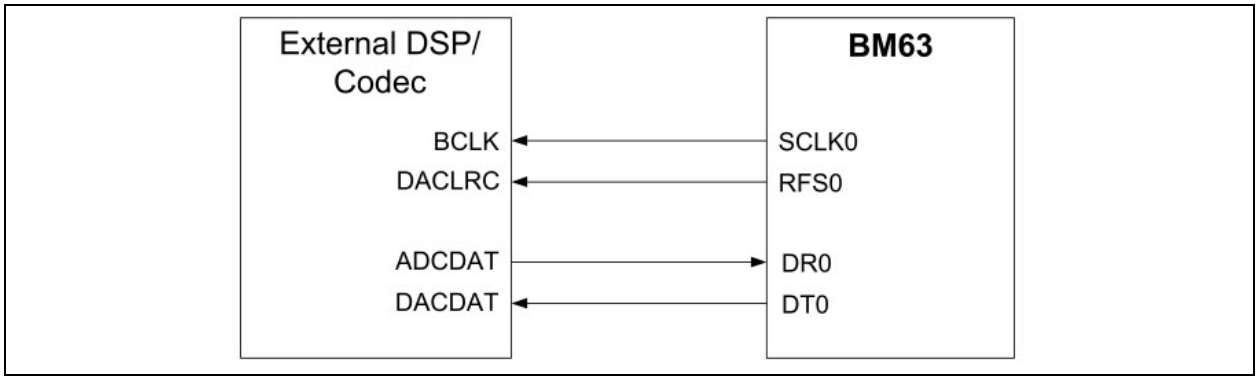
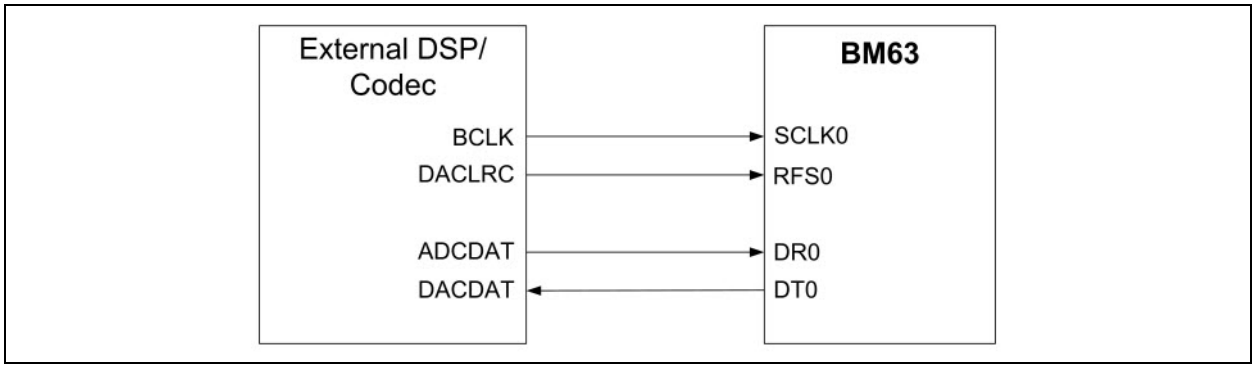


FIGURE 5-8: BM63 MODULE IN I²S SLAVE MODE



5.3 Reset

The BM63 module provides a watchdog timer (WDT) to reset the chip. It has an integrated Power-on Reset (POR) circuit that resets all circuits to a known Power-on state. This action can be driven by an external Reset signal which is used to control the device externally by forcing it into a POR state. The RST_N signal input is active-low and no connection is required in most of the applications.

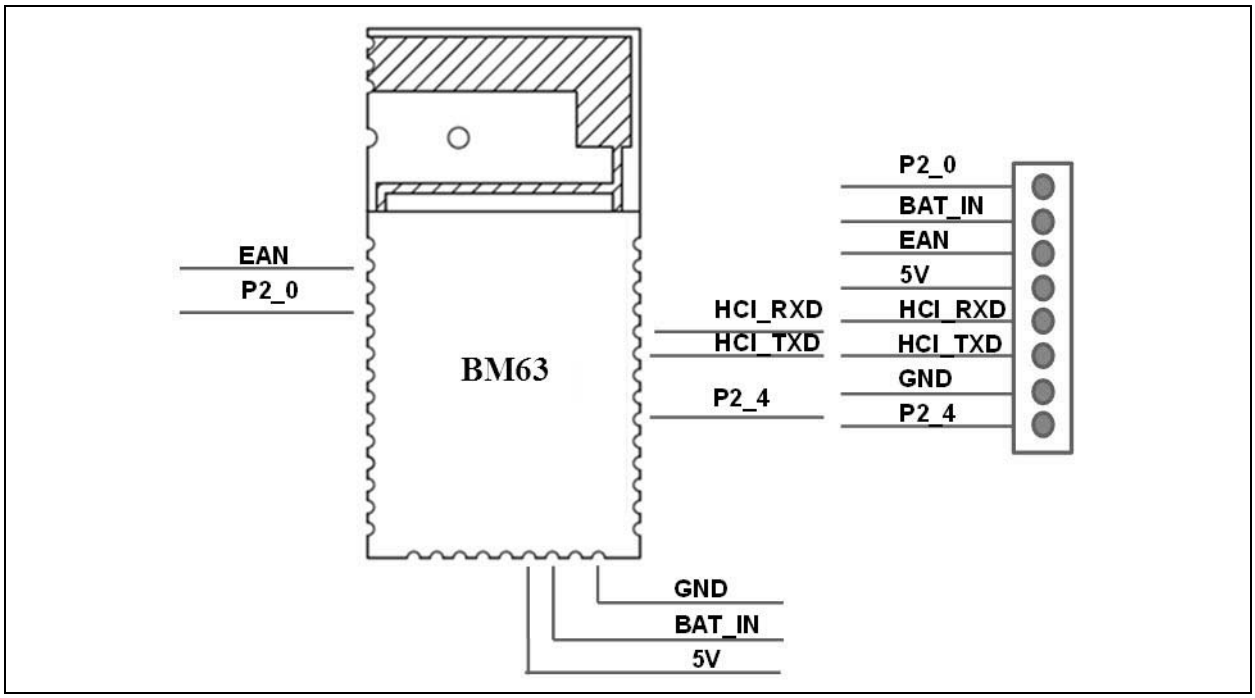
5.4 External Configuration and Programming

The BM63 module can be configured by using an external configuration tool (EEPROM tool) and the firmware is programmed by using a programming tool (Flash tool).

Note:	The EEPROM and Flash tools are available for download from the Microchip web site at: www.microchip.com/BM63.

Figure 5-9 illustrates the configuration and firmware programming interface on the BM63 module. It is recommended to include a header pin on the main PCB for development.

FIGURE 5-9: EXTERNAL PROGRAMMING HEADER CONNECTIONS



Configuration and firmware programming modes are entered according to the system configuration I/O pins. The P2_0, P2_4 and EAN pins have internal pull up.

Table 5-1 provides the system configuration settings.

TABLE 5-1: SYSTEM CONFIGURATION I/O PINSETTINGS

Pins			Operating Mode
P2_0	P2_4	EAN	
High	High	Low (Flash), High (ROM)	APP mode (Normal operation)
Low	High	Low (Flash), High (ROM)	Test mode (Write EEPROM)
Low	Low	High	Write Flash

5.5 Reference Circuit

Figure 5-10 through Figure 5-14 illustrate the BM63 module reference circuit for a stereo headset applications.

FIGURE 5-10: BM63 REFERENCE CIRCUIT FOR STEREO HEADSET APPLICATIONS

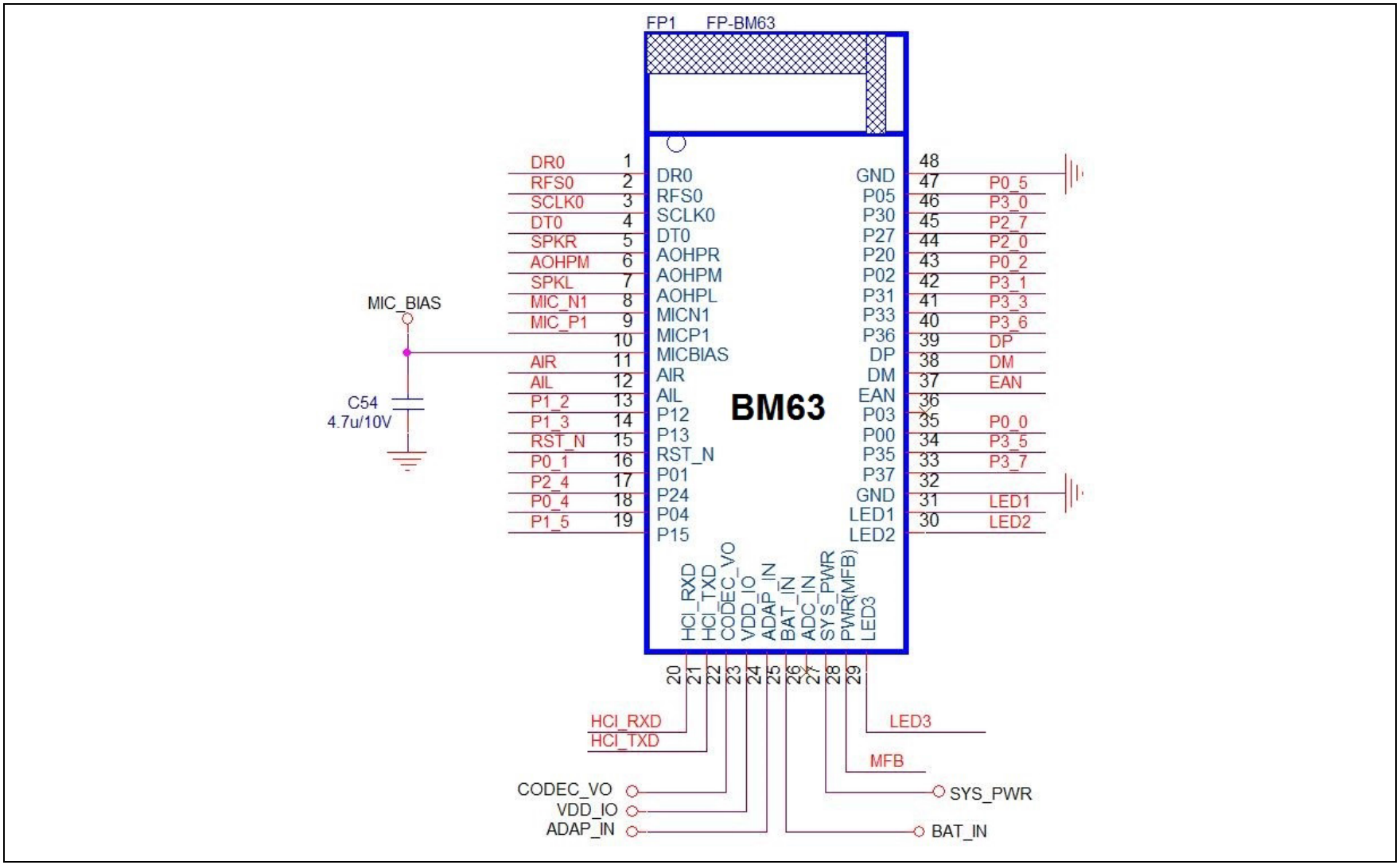
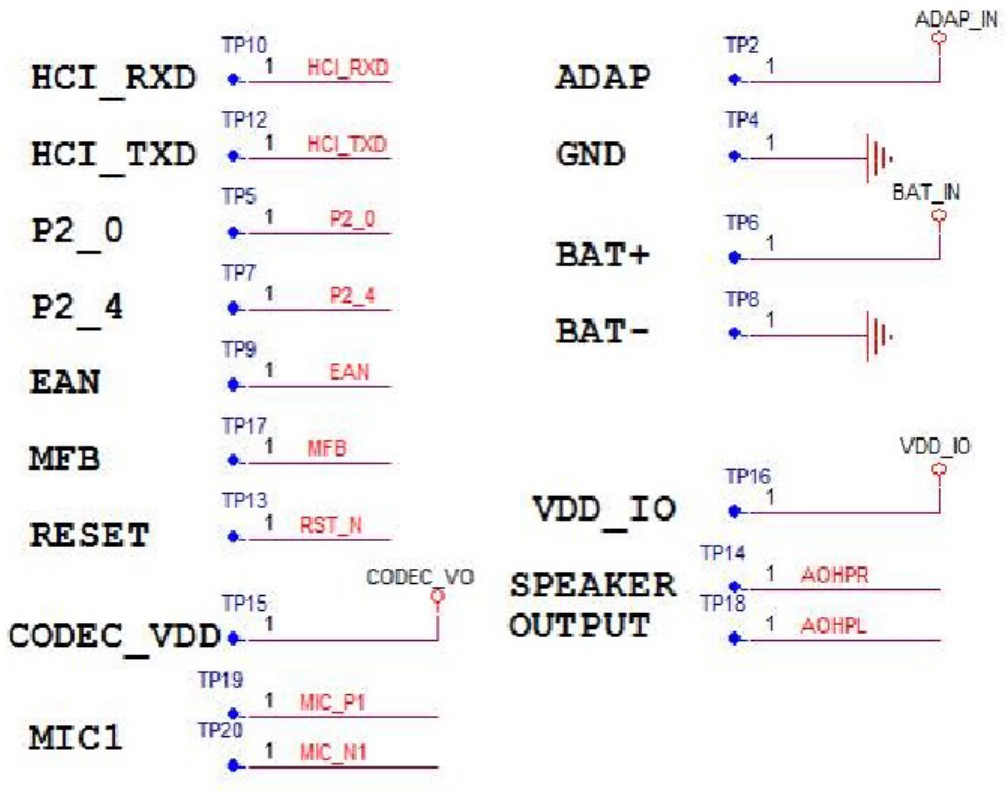


FIGURE 5-11: BM63 REFERENCE CIRCUIT FOR STEREO HEADSET APPLICATIONS



GPIO Description

MFB	UART_RX_IND; MFB
P0_2	PLAY/PAUSE
P2_7	VOL+
P0_5	VOL-
P3_1	REV
P3_3	FWD
P0_0	SLDIE SWITCH
P0_4	AMP_EN/NFC
P3_0	AUX IN Detection
P3_7	UART_TX_IND
P1_5	AMP_EN/SLIDE_SWITCH
	Multi-SPK Master/Slave mode control
P3_6	Multi-SPK Master/Slave mode control
P2_0	System Configuration
EAN	System Configuration

FIGURE 5-12: BM63 REFERENCE CIRCUIT FOR STEREO HEADSET APPLICATIONS

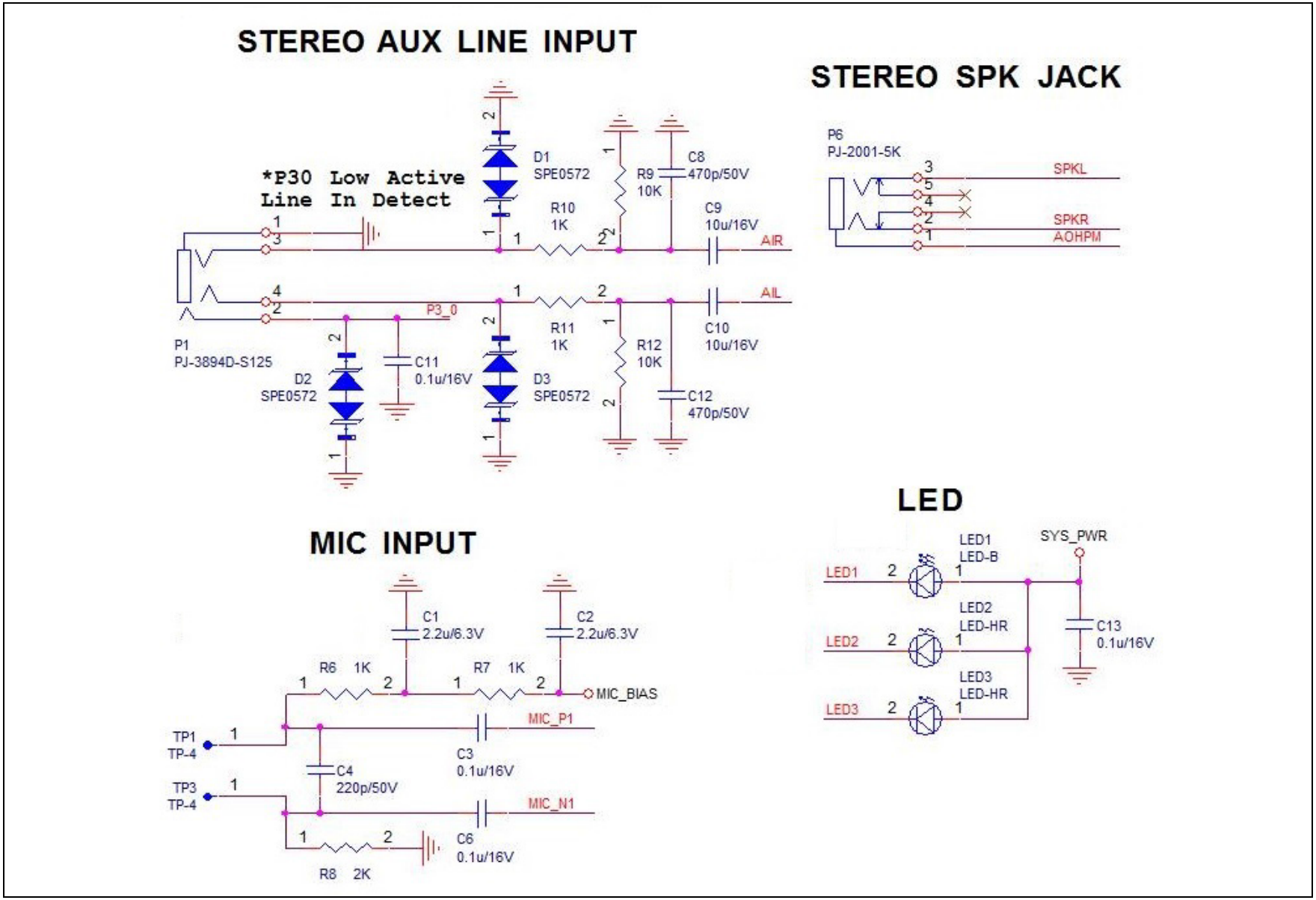


FIGURE 5-13: BM63 REFERENCE CIRCUIT FOR STEREO HEADSET APPLICATIONS

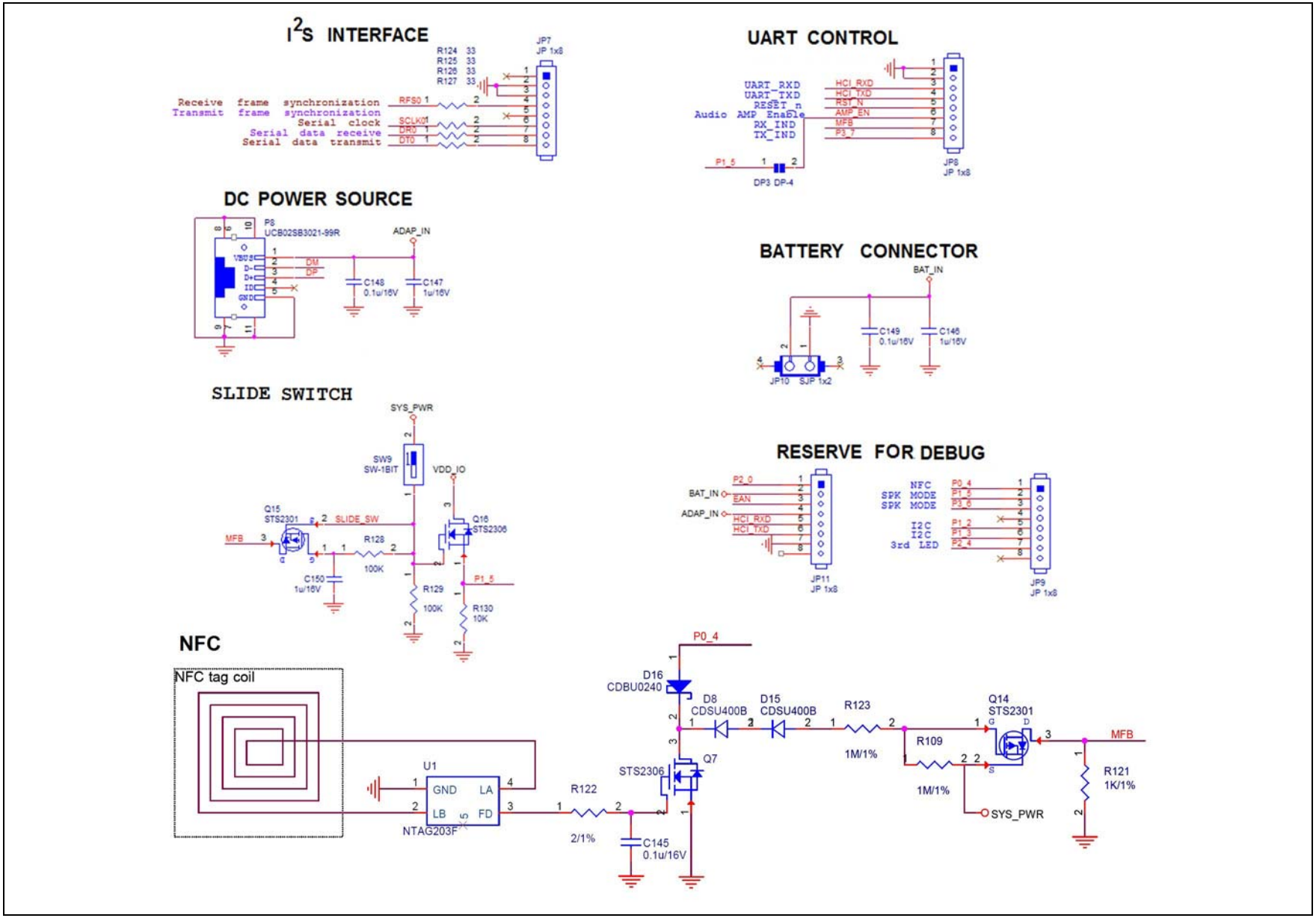
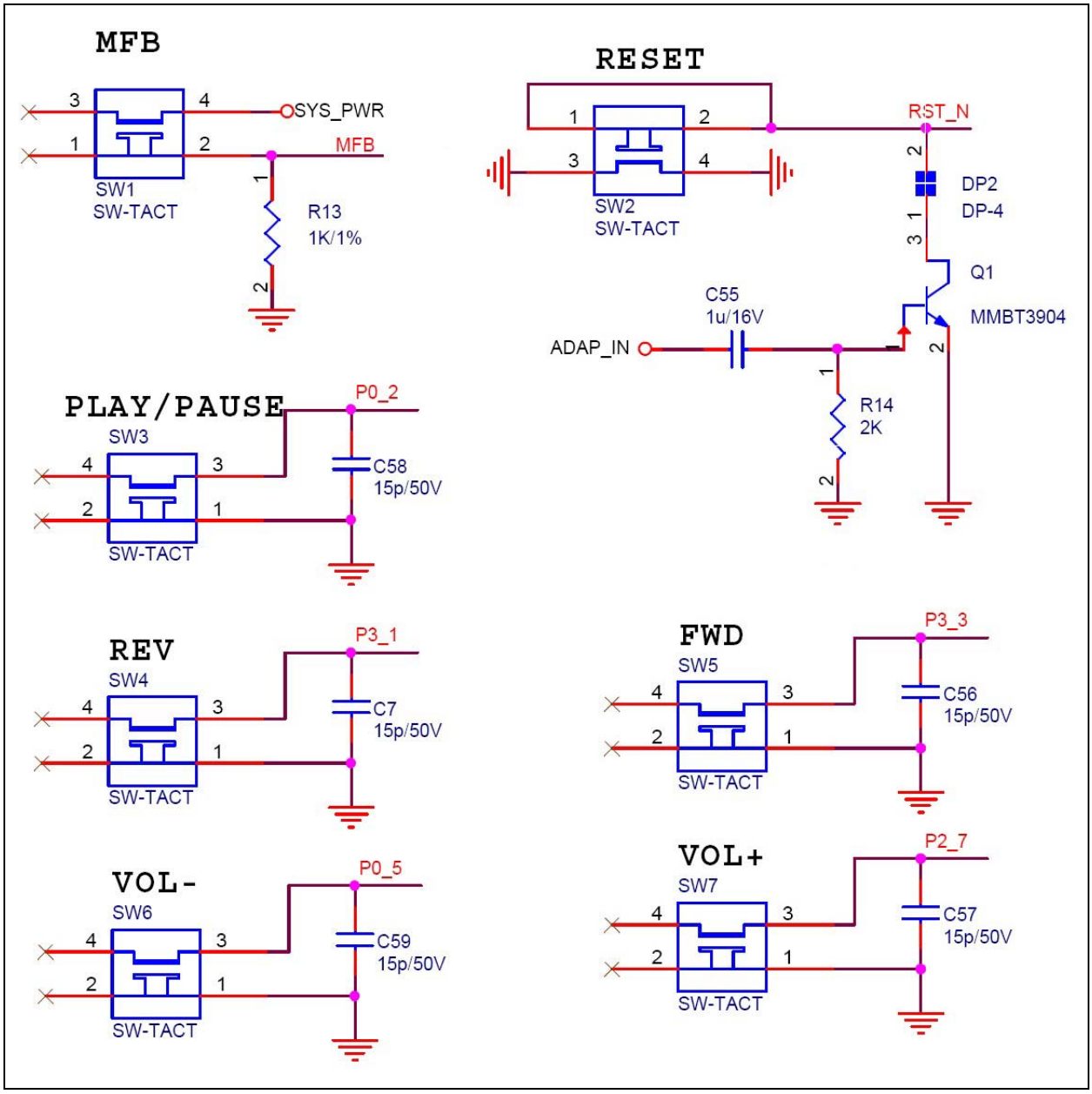


FIGURE 5-14: BM63 REFERENCE CIRCUIT FOR STEREO HEADSET APPLICATIONS



NOTES:

6.0 PRINTED ANTENNA INFORMATION

6.1 Antenna Radiation Pattern

The BM63 module is integrated with one PCB printed antenna, see Figure 6-1.

FIGURE 6-1: RECOMMENDED KEEPOUT AREA FOR PCB ANTENNA

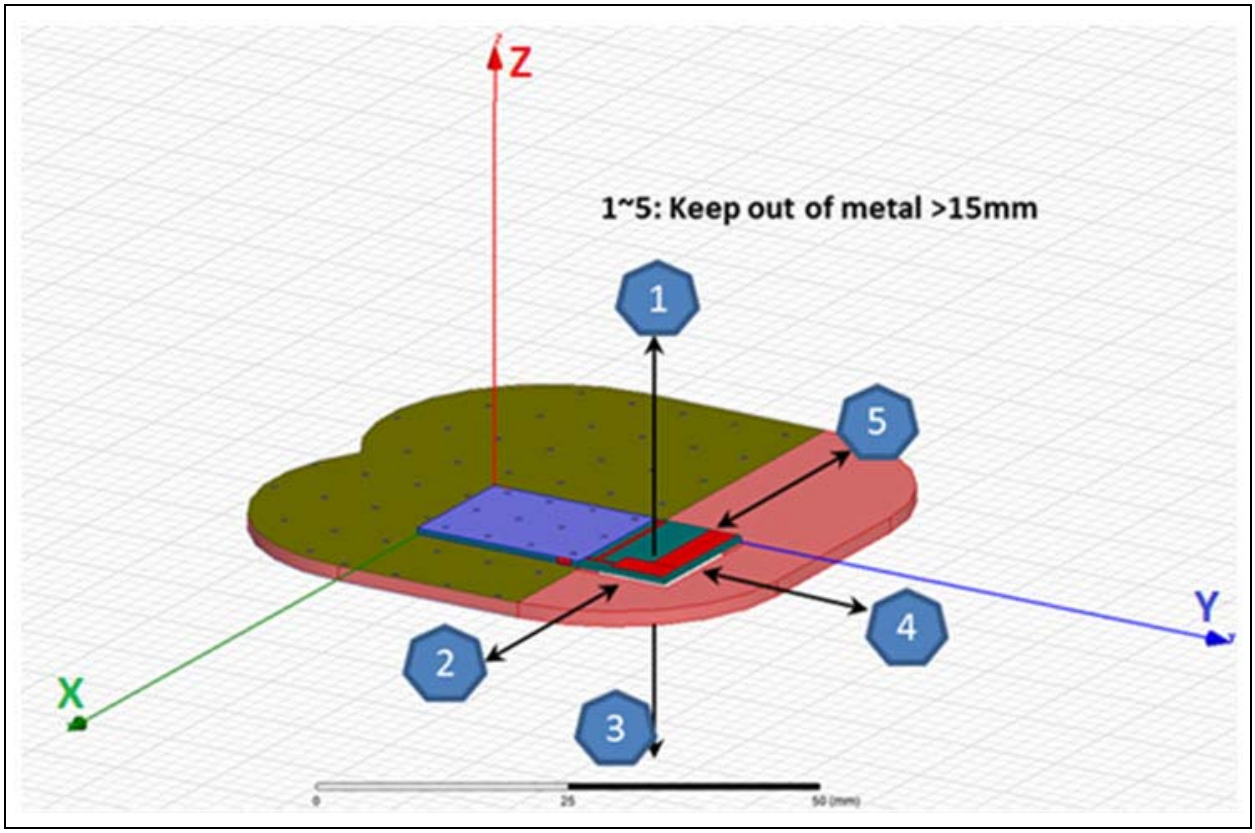


Figure 6-2 illustrates the 3D radiation pattern of the PCB printed antenna at 2441 MHz.

FIGURE 6-2: PCB ANTENNA 3D RADIATION PATTERN AT 2441 MHZ

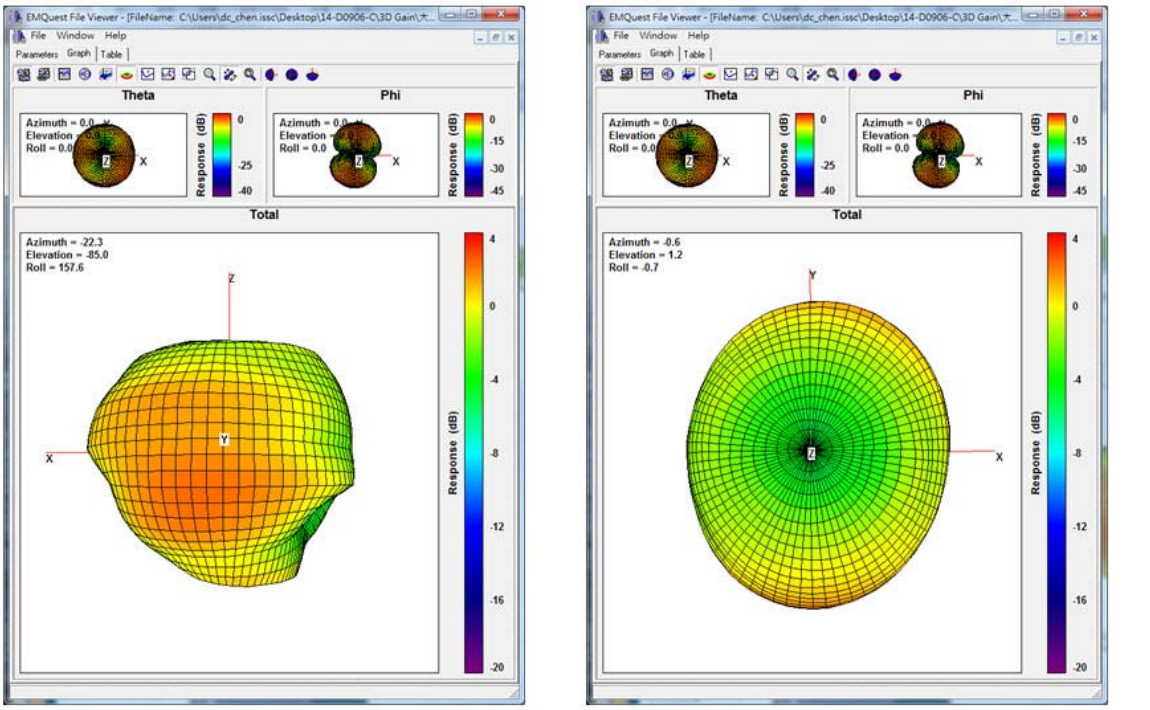


Table 6-1 provides the PCB Antenna characteristics of BM63 module.

TABLE 6-1: BM63 PCB ANTENNA CHARACTERISTICS

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

6.2 Module Placement Guidelines

For Bluetooth-enabled products, the antenna placement affects the overall performance of the system. The antenna requires free space to radiate RF signals and it must not be surrounded by the ground plane. Microchip recommends that the area underneath the antenna on the host PCB must not contain copper on the top, inner, or bottom layers, as illustrated in Figure 6-1.

A low-impedance ground plane will ensure the best radio performance (best range, lowest noise). The ground plane can be extended beyond the minimum recommendation, as required for the main PCB EMC noise reduction. For the best range performance, keep all external metal at least 15 mm away from the on-board PCB trace antenna.

Figure 6-3 and Figure 6-4 illustrate the examples of good and poor placement of the BM63 module on a host board with GND plane.

FIGURE 6-3: BM63 MODULE PLACEMENT GUIDELINES

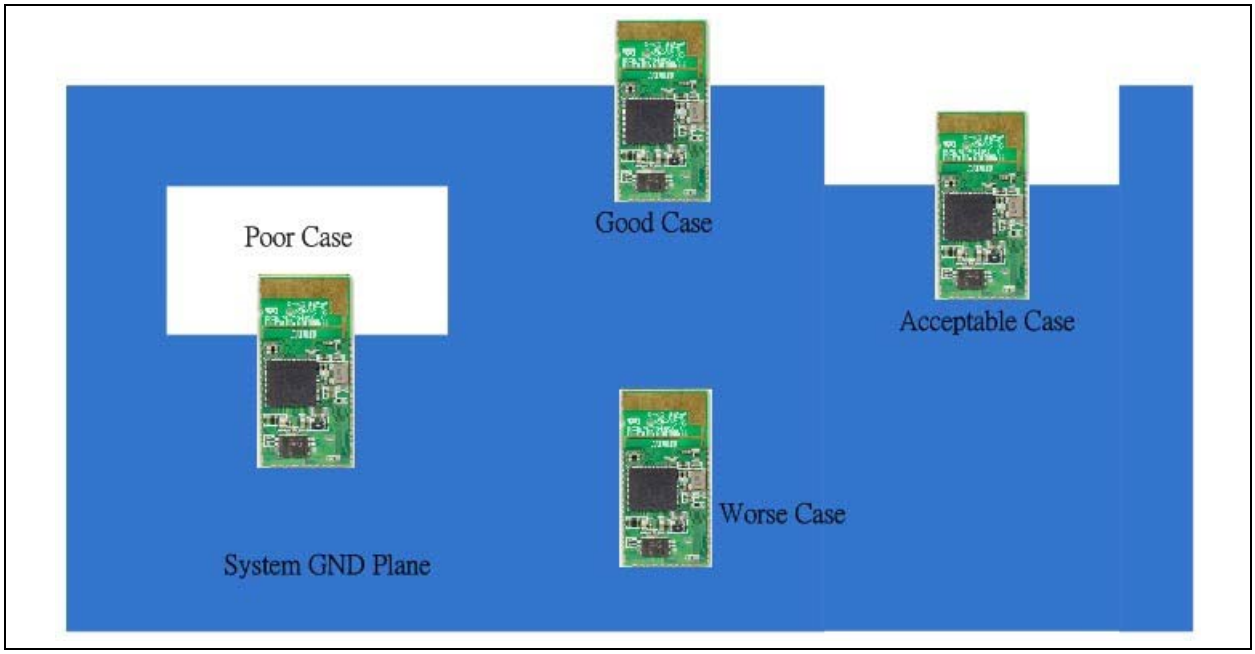
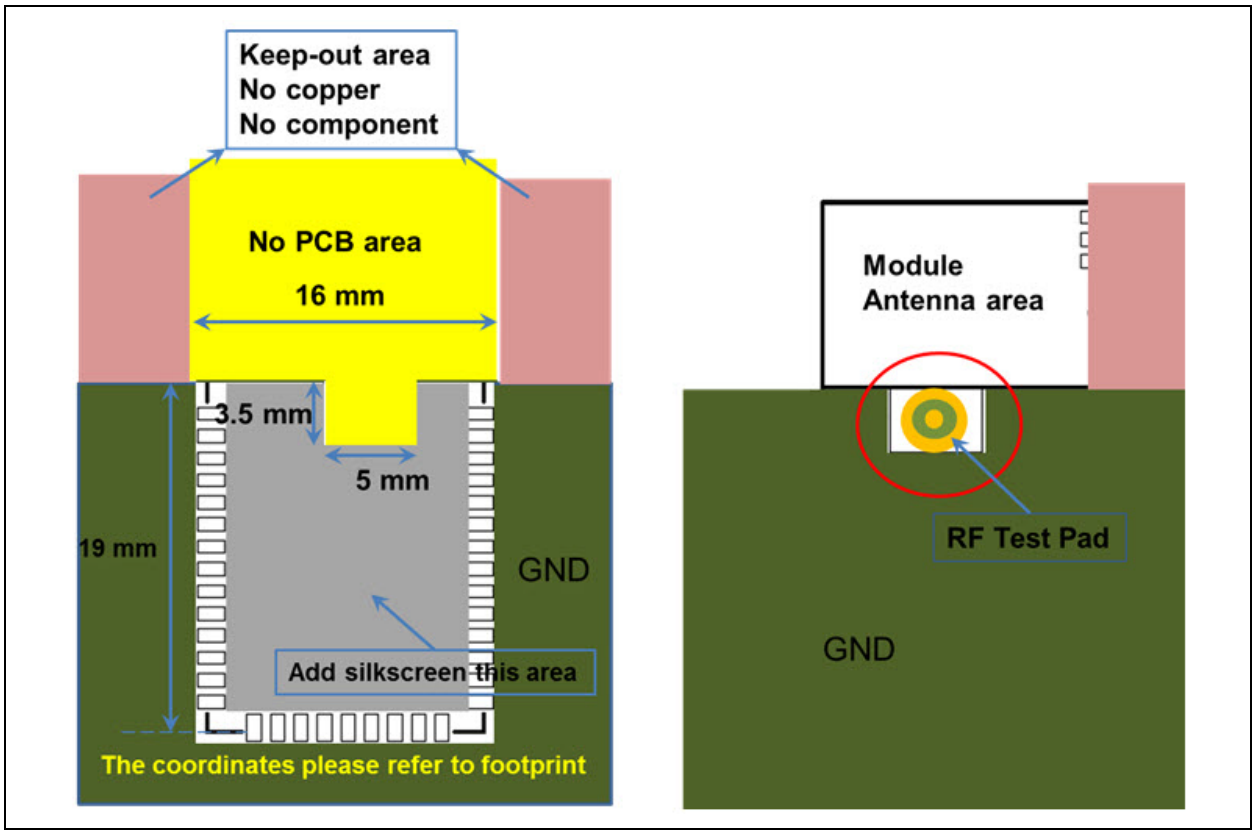


FIGURE 6-4: GND PLANE ON MAIN APPLICATION BOARD

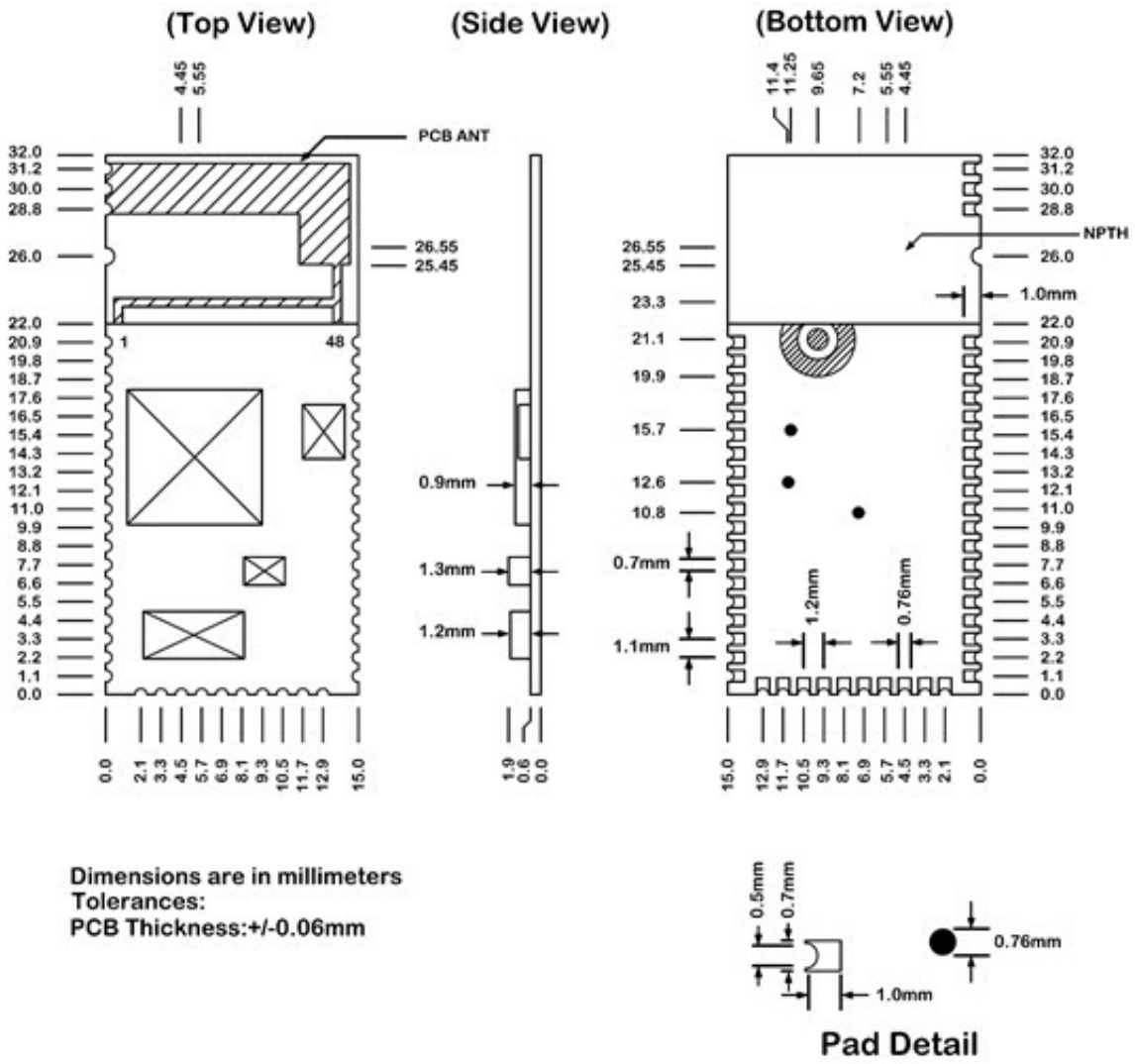


NOTES:

7.0 PHYSICAL DIMENSIONS

Figure 7-1 illustrates the PCB dimensions of the BM63 module.

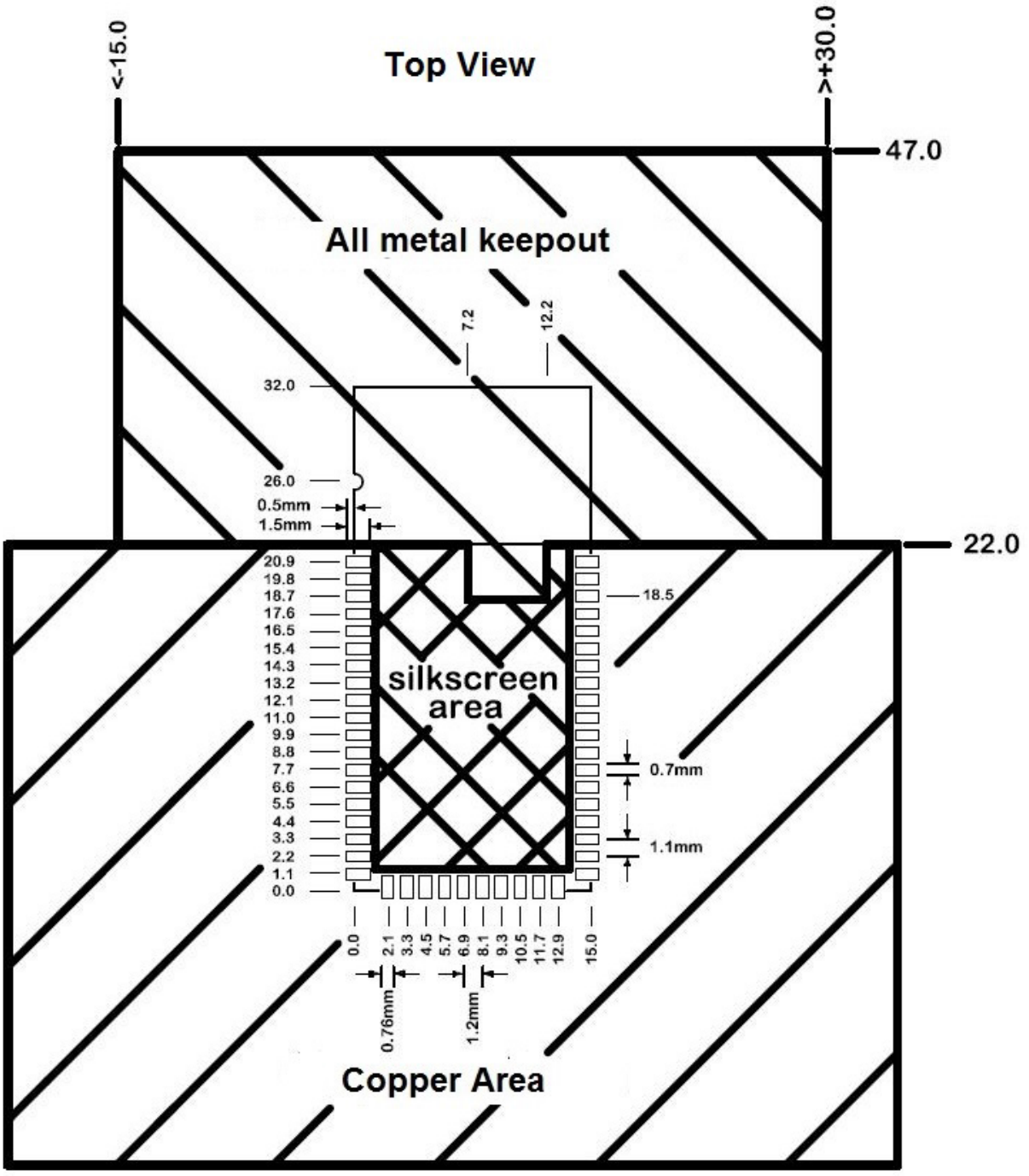
FIGURE 7-1: BM63 MODULE PCB DIMENSIONS



Note: PCB dimensions: X: 15.0 mm, Y: 32.0 mm and tolerances: 0.25 mm

Figure 7-2 illustrates the recommended PCB footprint of the BM63 module

FIGURE 7-2: RECOMMENDED BM63 MODULE PCB FOOTPRINT



Note 1: The keep-out area is reserved to keep the RF test point away from GND plane.

2: All metal keep-out is used to isolate the PCB antenna.

8.0 ELECTRICAL CHARACTERISTICS

This section provides an overview of the BM63 module electrical characteristics. Additional information will be provided in future revisions of this document as it becomes available.

Absolute maximum ratings for the BM63 module are listed below. Exposure to these maximum rating conditions for extended periods may affect device reliability. Functional operation of the device at these or any other conditions, above the parameters indicated in the operation listings of this specification, is not implied.

8.1 Absolute Maximum Ratings

Ambient temperature under bias.....-20°C to +70°C
Storage temperature .....-40°C to +125°C
Voltage on V_{DD} with respect to V_{SS} ..... -0.3V to +3.6V
Maximum output current sink by any I/O pin.....12 mA
Maximum output current sourced by any I/O pin.....12 mA

Note:	Stresses listed under **"Absolute Maximum Ratings"** may 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 may affect device reliability.

Table 8-1 through Table 8-10 provide the recommended operating conditions and the electrical specifications of the BM63 module.

TABLE 8-1: RECOMMENDED OPERATING CONDITION

Symbol	Parameter	Min.	Typ.	Max.	Unit
BAT_IN	Input voltage for battery	3.2	3.8	4.2	V
ADAP_IN	Input voltage for adapter	4.5	5	5.5	V
$T_{OPERATION}$	Operation temperature	-20	+25	+70	ºC

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

TABLE 8-2: I/O AND RESET LEVEL

Parameter	Min.	Typ.	Max.	Unit
I/O Supply Voltage (VDD_IO)	3.0	3.3	3.6	V
I/O Voltage Levels				
V_{IL} input logic levels low	0	–	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
RST_N				
Threshold voltage	–	0.8	–	V

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

TABLE 8-3: BATTERY CHARGER

Parameter		Min.	Typ.	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	Headroom > 0.7V (ADAP_IN = 5V)	–	350	–	mA
	Headroom = 0.3V to 0.7V (ADAP_IN = 4.5V)	–	175(2)	–	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: When $V_{ADAP\_IN} – V_{BAT} > 2V$, the maximum fast charge current is 175 mA for thermal protection.

3: These parameters are characterized, but not tested in manufacturing.

TABLE 8-4: LED DRIVER

Parameter	Min.	Typ.	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: BK_OUT = 1.8V with +25ºC temperature.

2: These parameters are characterized, but not tested in manufacturing.

TABLE 8-5: AUDIO CODEC ANALOG TO DIGITAL CONVERTER

T = 25^{o}C, V_{DD} = 2.8V, 1 kHz sine wave input, Bandwidth = 20 Hz to 20 kHz				
Parameter (Condition)	**Min.**	**Typ.**	**Max.**	**Unit**
Resolution	–	–	16	Bit
Output Sample Rate	8	–	48	kHz
Signal to Noise Ratio **(Note 1)** (SNR at MIC or Line-in mode)	–	92	–	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 1: f_{IN} = 1 kHz, B/W = 20 Hz to 20 kHz, A-weighted, THD+N < 1%, 150 mV_{PP} input.

2: These parameters are characterized, but not tested in manufacturing.

TABLE 8-6: AUDIO CODEC DIGITAL TO ANALOG CONVERTER

T = 25°C, VDD = 2.8V, 1 kHz sine wave input, Bandwidth = 20 Hz to 20 kHz					
Parameter (Condition)		**Min.**	**Typ.**	**Max.**	**Unit**
Over-sampling rate		–	128	–	f_s
Resolution		16	–	20	Bit
Output Sample Rate		8	–	48	kHz
Signal to Noise Ratio **(Note 1)** (SNR at capless mode) for 48 kHz		–	98	–	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)		495	742.5	–	mV/rms
Maximum Output Power (16 Ohm load)		–	34.5	–	mW
Maximum Output Power (32 Ohm load)		–	17.2	–	mW
Allowed Load	Resistive	–	16	O.C.	Ohm
	Capacitive	–	–	500	pF
THD+N (16 Ohm load) **(Note 2)**		–	0.05	–	%
Signal to Noise Ratio (SNR at 16 Ohm load) **(Note 3)**		–	98	–	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: f_{IN} = 1 kHz, B/W = 20 Hz to 20 kHz, A-weighted, -1 dBFS signal, Load = 16 Ohm

3: f_{IN} = 1 kHz, B/W = 20 Hz to 20 kHz, A-weighted, THD+N < 0.05%, 0 dBFS signal, Load = 16 Ohm

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

TABLE 8-7: TRANSMITTER SECTION FOR BDR AND EDR

Parameter	**Min.**	**Typ.**	**Max.**	**Bluetooth specification**	**Unit**
RF transmit power	–	2	–	-6 to 4	dBm
EDR/BDR Relative transmit power	-4	-1.8	1	-4 to 1	dB

Note 1: The RF Tx power is modulation value.

2: The RF Transmit power is calibrated during the production by using the MP tool software and MT8852 Bluetooth Test equipment.

3: Test condition: VCC_RF = 1.28V, temperature +25ºC.

TABLE 8-8: RECEIVER SECTION FOR BDR AND EDR

	Modulation	Min.	Typ.	Max.	Bluetooth specification	Unit
Sensitivity at 0.1% BER	GFSK	–	-89	–	≤-70	dBm
Sensitivity at 0.01% BER	π/4 DQPSK	–	-90	–	≤-70	dBm
	8 DPSK	–	-83	–	≤-70	dBm

Note 1: Test condition: VCC_RF = 1.28V with temperature +25ºC.

2: These parameters are characterized, but not tested in manufacturing.

TABLE 8-9: BM63 SYSTEM CURRENT CONSUMPTION

System Status	Typ.(1)	Max.	Unit
System-Off mode	–	10	μA
Stop advertising (Samsung S5 (SM-G900I)/Android™ 4.4.2)			
Standby mode	0.57	–	mA
Link mode	0.5	–	mA
ESCO link	15.1	–	mA
A2DP link	14.3	–	mA
Stop advertising (iPhone® 6/iOS 8.4)			
Standby mode	0.6	–	mA
Link mode	0.6	–	mA
SCO link	15.3	–	mA
A2DP link	15.4	–	mA

Note 1: The measurement data corresponds to Firmware v1.0.

2: Mode definition:
Standby mode: Power-on without Bluetooth link;
Link mode: With Bluetooth link in Low-power mode.

3: The current consumption values are measured with the BM63 EVB as a test platform, with BAT_IN = 3.8V. The distance between the smartphone and BM63 EVB is 30 cm, and the speaker is without loading.

8.2 Timing specifications

Figure 8-1 and Figure 8-2 illustrate the timing diagram of the BM63 module in I^2S and PCM modes.

FIGURE 8-1: TIMING DIAGRAM FOR I^2S MODES (MASTER/SLAVE)

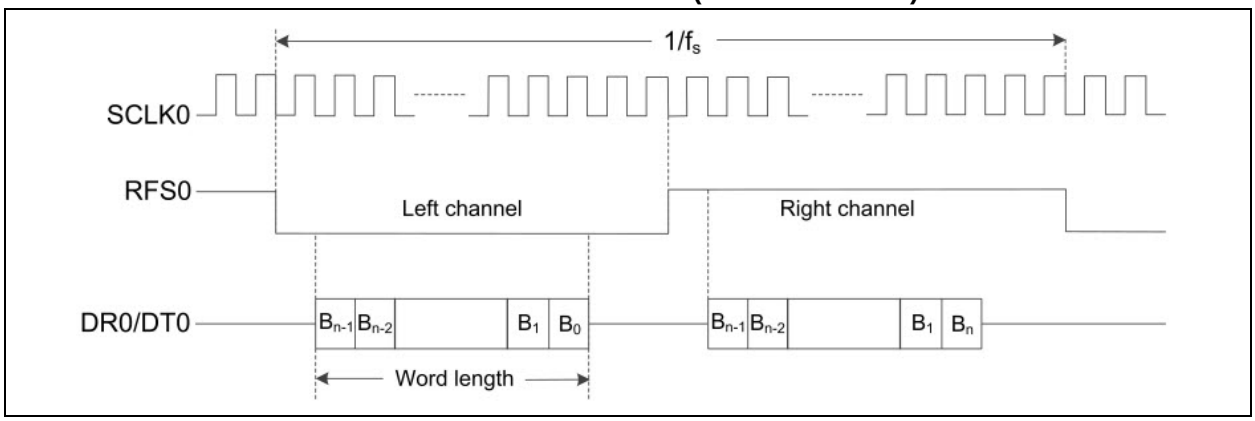
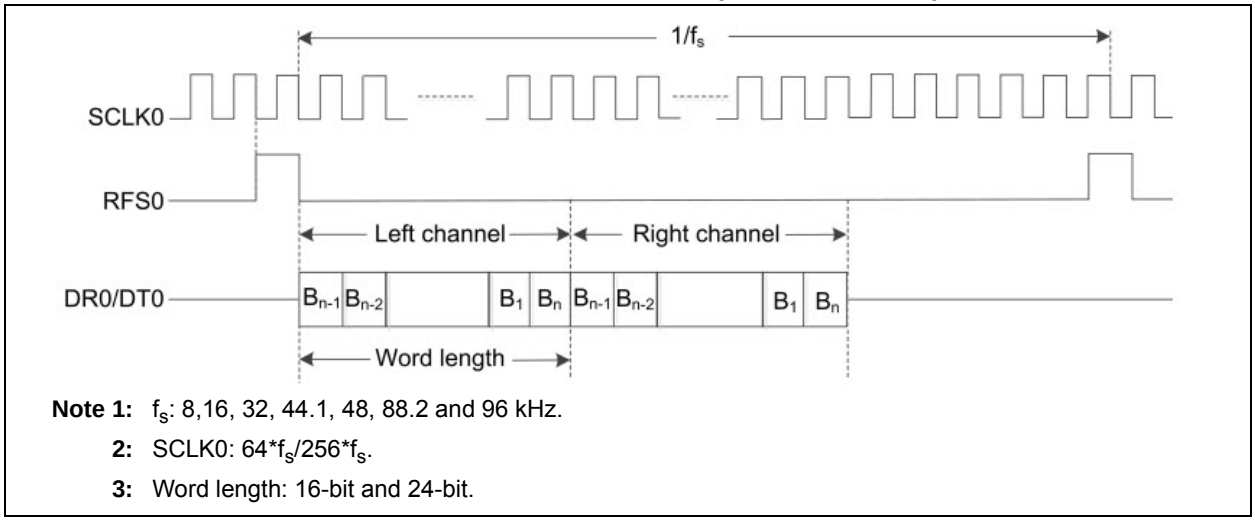


FIGURE 8-2: TIMING DIAGRAM FOR PCM MODES (MASTER/SLAVE)



Note 1: f_s: 8,16, 32, 44.1, 48, 88.2 and 96 kHz.

2: SCLK0: $64*f_s/256*f_s$.

3: Word length: 16-bit and 24-bit.

Figure 8-3 illustrates the timing diagram of the audio interface.

FIGURE 8-3: AUDIO INTERFACE TIMING DIAGRAM

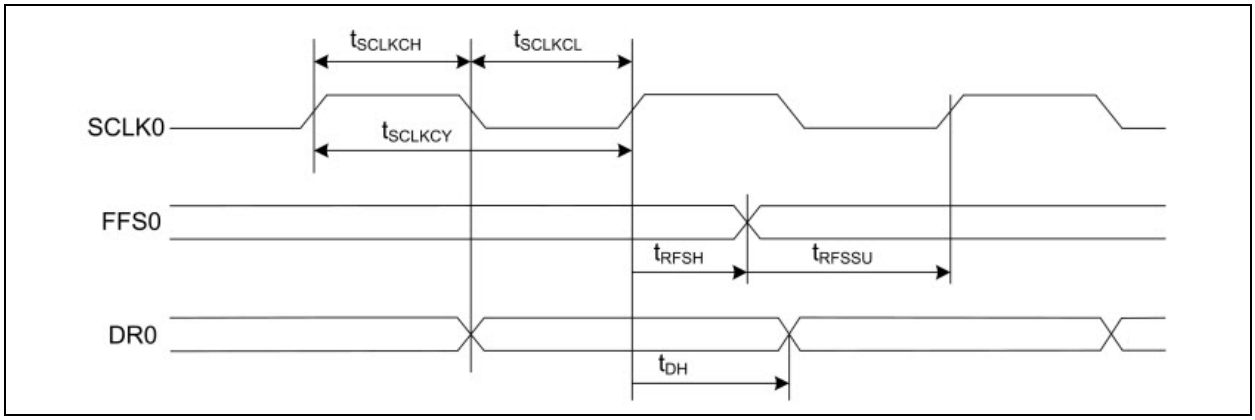


Table 8-10 provides the timing specifications of the audio interface.

TABLE 8-10: AUDIO INTERFACE TIMING SPECIFICATIONS

Parameter	Symbol	Min.	Typ.	Max.	Units
SCLK0 duty ratio	d_{SCLK}	–	50	–	%
SCLK0 cycle time	t_{SCLKCY}	50	–	–	ns
SCLK0 pulse width high	t_{SCLKCH}	20	–	–	ns
SCLK0 pulse width low	t_{SCLKCL}	20	–	–	ns
RFS0 Setup time to SCLK0 rising edge	t_{RFSSU}	10	–	–	ns
RFS0 hold time from SCLK0 rising edge	t_{RFSH}	10	–	–	ns
DR0 hold time from SCLK0 rising edge	t_{DH}	10	–	–	ns

Note: Test Conditions: Slave mode, f_s = 48 kHz, 24-bit data and SCLK0 period = 256 f_s.

NOTES:

9.0 SOLDERING RECOMMENDATIONS

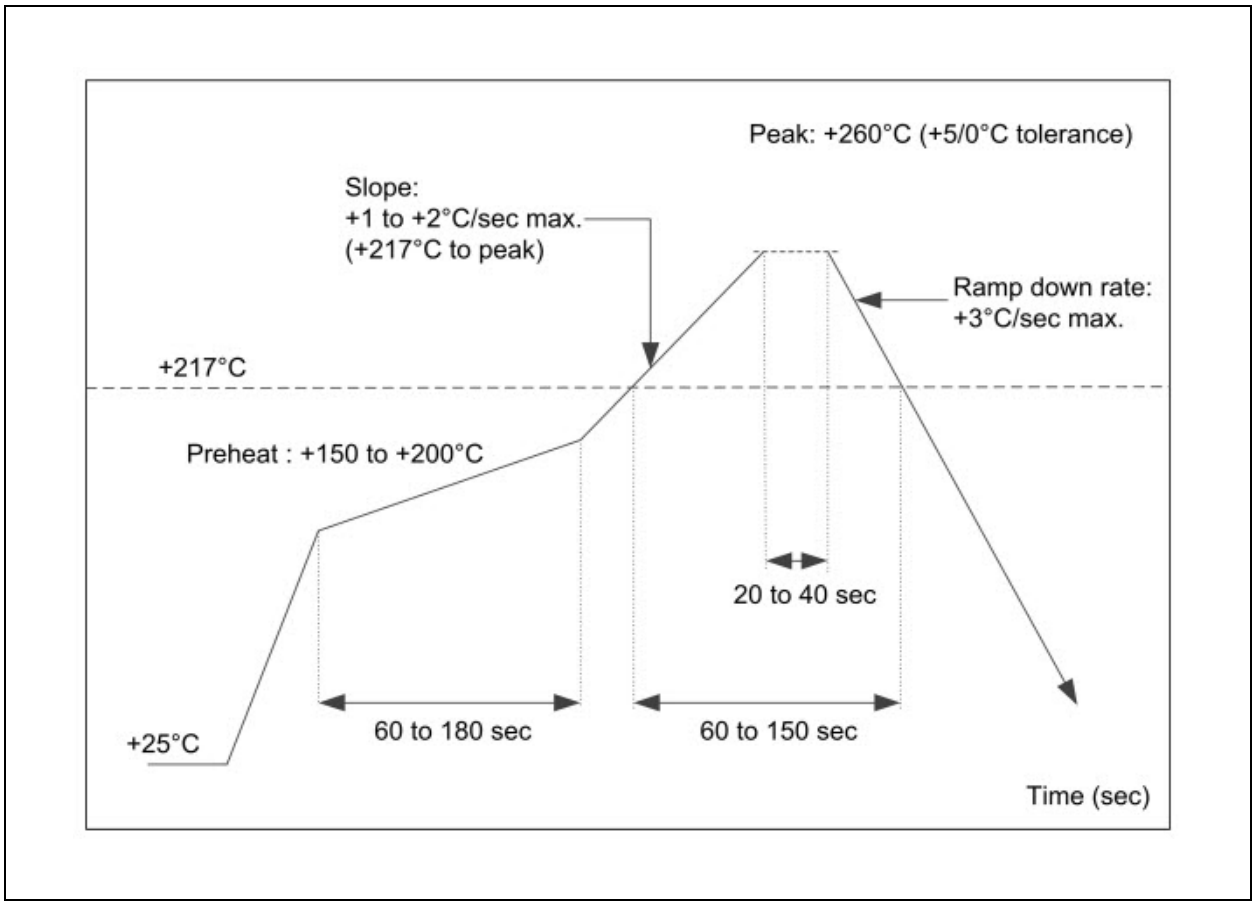
The BM63 module is assembled using a standard lead-free reflow profile, IPC/JEDEC J-STD-020. The BM63 module can be soldered to the main PCB using a standard leaded and lead-free solder reflow profiles.

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

- Refer to the *"AN233 Solder Reflow Recommendation"* (DS00233) document for the soldering reflow recommendations
- The peak temperature (T_P) must not exceed +260ºC
- 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.

Figure 9-1 illustrates the reflow profile of the BM63 module.

FIGURE 9-1: REFLOW PROFILE



NOTES:

10.0 ORDERING INFORMATION

Table 10-1 provides the ordering information of the BM63 module.

TABLE 10-1: BM63 MODULE ORDERING INFORMATION

Module	Microchip IC	Description	Part No
BM63	IS2063GM	Bluetooth 4.2 Stereo Audio with BLE, I^2S, Flash, Class 2, no shield, built-in antenna	BM63SPKA1MC2

Note: The BM63 module can be purchased through a Microchip representative. Go to Microchip website www.microchip.com for the current pricing and a list of distributors for the product.

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (June 2016)

This is the initial released version of this document.

Revision B (January 2017)

This revision includes the following changes and minor updates to text and formatting which were incorporated throughout the document.

TABLE B-1: MAJOR SECTION UPDATES

Section	Update Description
1.0 "Device Overview"	Added USB and updated the voice prompt details in Table 1-1. Updated Table 1-2 with correct pin descriptions.
7.0 "Physical Dimensions"	Added Note to Figure 7-2.

NOTES:

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