

---

---

**Bluetooth® 4.2 Stereo Audio SoC**

---

---

---

**Introduction**

---

The IS2062/64 products are part of the Bluetooth Dual Mode family of stereo audio System on Chip (SoC) devices.

- Flash-based devices:
  - The IS2062GM and IS2064GM SoCs are offered in LGA packages and contain in-package Flash, which allows for firmware updates.
- ROM-based devices:
  - The IS2064S and IS2064B natively supports Stereo Mode functionality in ROM. This allows for audio playback on two devices. Some Bluetooth parameters can be customized and stored in an internal EEPROM. These products are offered in QFN and BGA packages.

---

**Features**

---

- Qualified for Bluetooth v4.2 specification
- Bluetooth audio profiles:
  - A2DP 1.3
  - AVRCP 1.6
  - HFP 1.6
  - HSP 1.2
  - SPP 1.2
- Bluetooth Low Energy (BLE):
  - Generic access service
  - Device information service
  - Proprietary services for data communication
  - Apple Notification Center Service (ANCS)
- Supports 16 kHz High Definition (HD) voice
- Audio interfaces:
  - I<sup>2</sup>S digital output (IS2064GM and IS2064S/B)
  - Analog output
  - Auxiliary input
  - Microphone input
- Supports firmware upgrade (IS2062GM/64GM)
- Integrated battery charger (up to 350 mA)

## Baseband Features

- 16 MHz main clock input
- Built-in Flash memory for programming (8 Mbit) (IS2062GM/64GM)
- Built-in EEPROM
- Connects simultaneously to two hosts over HFP/A2DP and SPP/BLE
- Adaptive Frequency Hopping (AFH)

## Audio Codec

- Sub-band Coding (SBC) decoding and Advanced Audio Coding (AAC) decoding (IS2062GM/64GM)
- 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<sup>2</sup>S digital audio (IS2064GM and IS2064S/B)

## RF Features

- Transmit output power: +2 dBm
- Receive sensitivity: -90 dBm (2 Mbps Enhanced Data Rate (EDR))
- Combined Tx/Rx RF terminal simplifies external matching and reduces external antenna switches
- Tx/Rx RF switch for Class 2 or Class 3 applications
- Integrated synthesizer requires no external voltage-controlled oscillator (VCO), varactor diode, and resonator or loop filter
- Crystal oscillator with built-in digital trimming compensates for temperature or process variations

## DSP Audio Processing

- Includes a 32-bit DSP core
- Synchronous Connection-Oriented (SCO) channel operation
- 8/16 kHz noise suppression
- 8/16 kHz acoustic echo cancellation
- Modified Sub-Band Coding (MSBC) decoder for wide band speech
- Built-in High Definition Clean Audio (HCA) algorithms for both narrow band and wideband speech processing
- Packet Loss Concealment (PLC)
- Built-in audio effect algorithms to enhance audio streaming
- Serial Copy Management System (SCMS-T) content protection

## Package Details

**Table 1. PACKAGE DETAILS**

Parameter	IS2062GM	IS2064GM	IS2064S	IS2064B
Package type	LGA	LGA	QFN	BGA
Pin count	56	68	68	61

Parameter	IS2062GM	IS2064GM	IS2064S	IS2064B
Contact/Lead Pitch	0.4	0.4	0.4	0.5
Package size	7x7x1.0	8x8x1.0	8x8x0.9	5x5x0.9

**Note:** All dimensions are in millimeters (mm) unless specified.

## Peripherals

---

- UART interface for host MCU communication
- Full-speed USB 1.1 interface (IS2064GM and IS2064S)
- Built-in lithium-ion (Li-Ion) and lithium-polymer (Li-Po) battery charger (up to 350 mA)
- Integrated 1.8V and 3V configurable voltage regulators
- Built-in ADC for battery monitoring, voltage sensor and charger thermal protection
- Built-in under voltage protection (UVP)
- LED drivers: 2 (IS2062GM and IS2064B) and 3 (IS2064GM and IS2064S)

## Operating Condition

---

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

## Applications

---

- Headsets and headphones (IS2062GM and IS2064B)
- Portable speakers
- Earbuds and neckbands (IS2064B)

---

## Table of Contents

---

Introduction.....	1
Features.....	1
Baseband Features.....	2
Audio Codec.....	2
RF Features.....	2
DSP Audio Processing.....	2
Package Details.....	2
Peripherals.....	3
Operating Condition.....	3
Applications.....	3
1. Device Overview.....	6
1.1. Key Features.....	7
1.2. Pin Details.....	8
2. Audio.....	20
2.1. Digital Signal Processor.....	20
2.2. Codec.....	21
2.3. Auxiliary Port.....	23
2.4. Analog Speaker Output.....	23
3. Transceiver.....	25
3.1. Transmitter.....	25
3.2. Receiver.....	25
3.3. Synthesizer.....	25
3.4. Modem.....	25
3.5. Adaptive Frequency Hopping (AFH).....	25
4. Microcontroller.....	26
4.1. Memory.....	26
4.2. External Reset.....	26
4.3. Reference Clock.....	26
5. Power Management Unit.....	28
5.1. Charging a Battery.....	28
5.2. Voltage Monitoring.....	28
5.3. Low Dropout Regulator.....	28
5.4. Switching Regulator.....	29



---

---

5.5.	LED Driver.....	29
5.6.	Under Voltage Protection.....	29
5.7.	Ambient Detection.....	29
6.	Application Information.....	31
6.1.	Power Supply.....	31
6.2.	Host MCU Interface.....	31
6.3.	Configuration and Firmware Programming.....	37
6.4.	General Purpose I/O pins.....	37
6.5.	I <sup>2</sup> S Mode Application.....	38
7.	Antenna Placement Rule.....	40
8.	Electrical Characteristics.....	42
8.1.	Timing Specifications.....	47
9.	Packaging Information.....	50
9.1.	Package Marking Information.....	50
9.2.	Package Details.....	50
10.	Reflow Profile and Storage Condition.....	59
10.1.	Solder Reflow Recommendation.....	59
10.2.	Storage Condition.....	59
11.	Ordering Information.....	60
12.	Reference Circuit.....	61
13.	Document Revision History.....	84
	The Microchip Web Site.....	85
	Customer Change Notification Service.....	85
	Customer Support.....	85
	Microchip Devices Code Protection Feature.....	85
	Legal Notice.....	86
	Trademarks.....	86
	Quality Management System Certified by DNV.....	86
	Worldwide Sales and Service.....	88

## 1. Device Overview

The IS2062/64 SoC integrates:

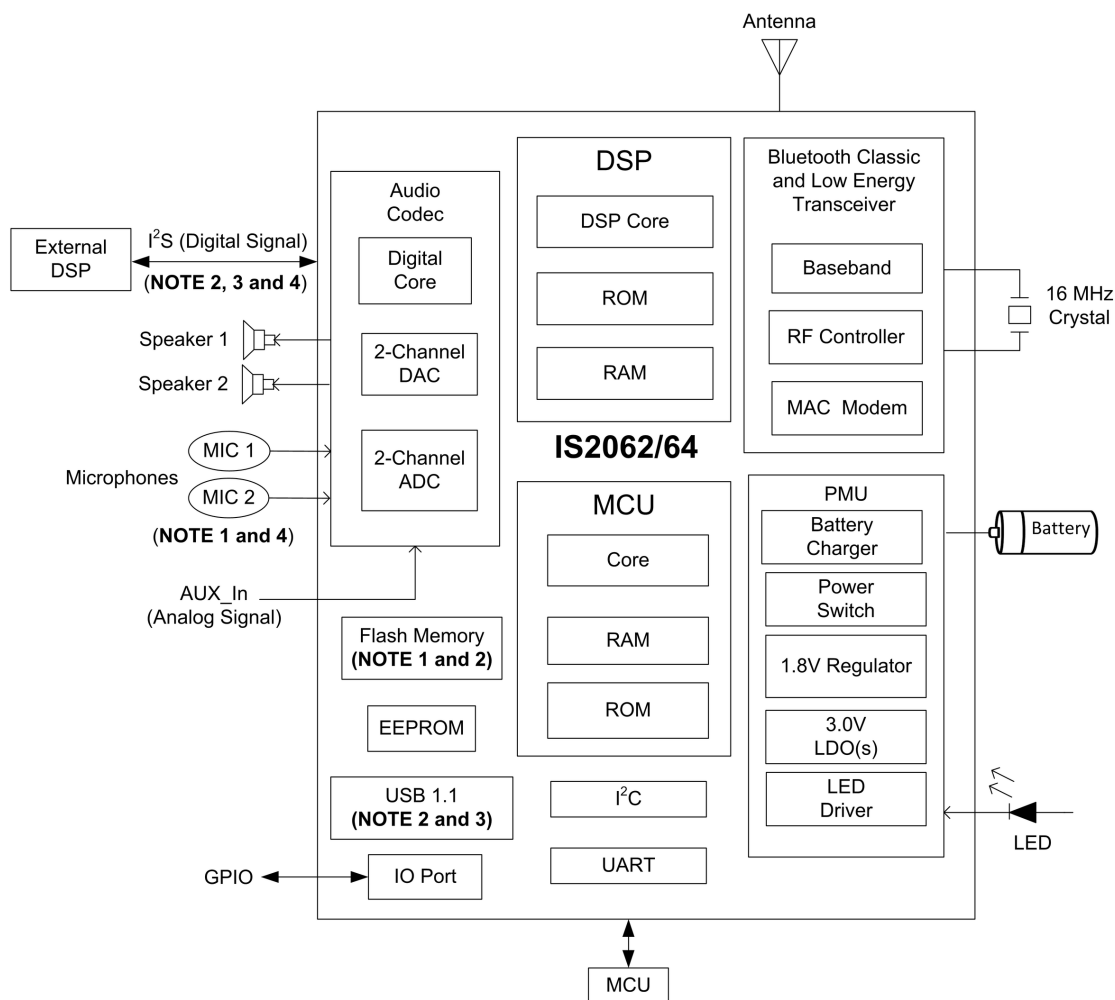
- Bluetooth 4.2 dual-mode radio transceiver
- Power Management Unit (PMU)
- Microcontroller (MCU)
- Audio codec
- Crystal oscillator
- 32-bit DSP
- Flash (IS2062GM/64GM)
- EEPROM

The IS2062/64 SoC is configured using an UI tool.

**Note:** The UI tool is a Windows<sup>®</sup> based configuration utility tool, which is available for download from the Microchip website at <http://www.microchip.com/wwwproducts/en/IS2062> and <http://www.microchip.com/wwwproducts/en/IS2064>.

The following figure illustrates the block diagram of the IS2062/64 SoC.

**Figure 1-1. BLOCK DIAGRAM OF IS2062/64 SOC**



**Note:**

1. IS2062GM.
2. IS2064GM.
3. IS2064S.
4. IS2064B.

## 1.1 Key Features

The following table provides the key features of the IS2062/64 family.

**Table 1-1. KEY FEATURES**

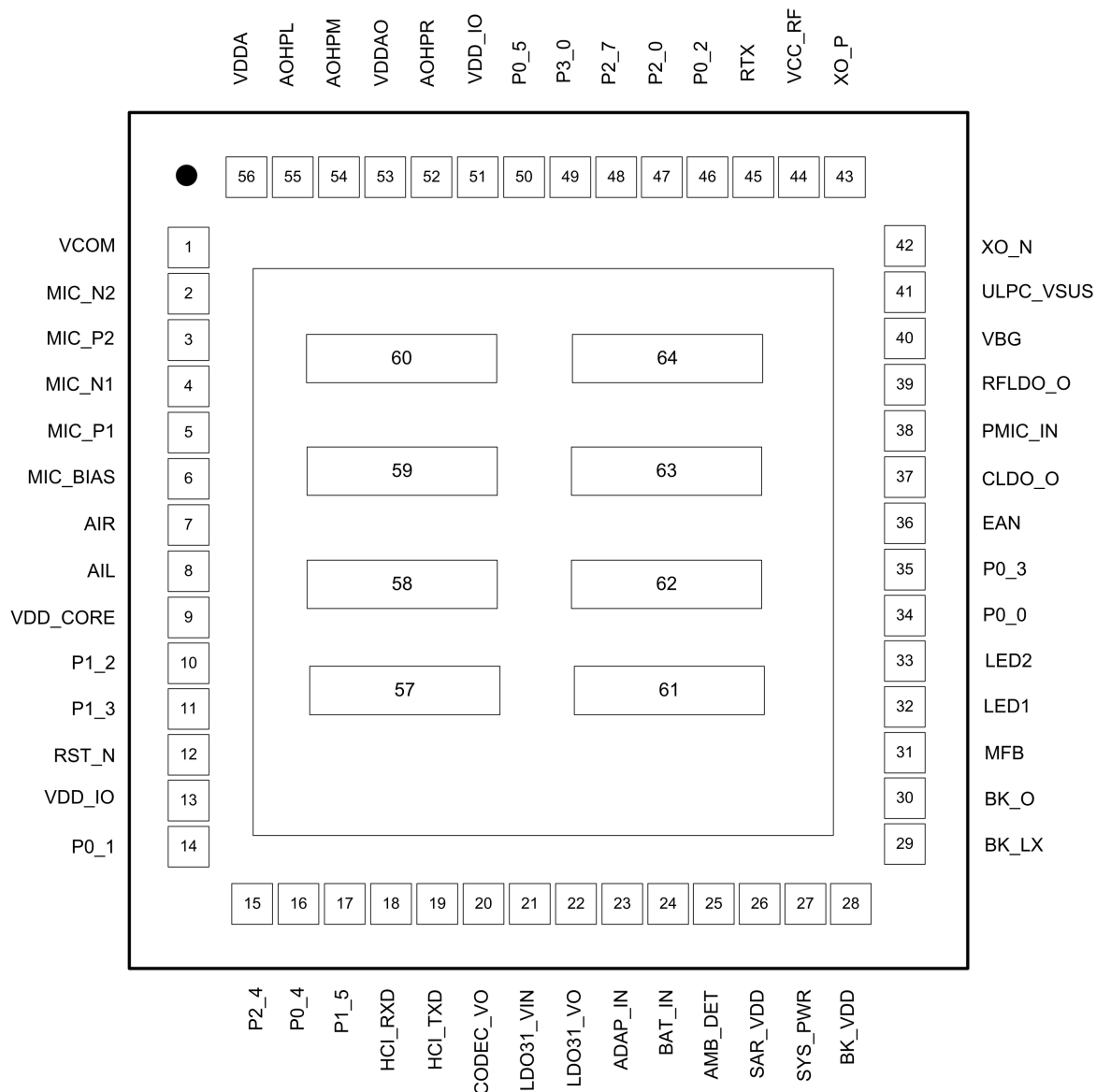
Feature	IS2062GM	IS2064GM	IS2064S	IS2064B
Application	Headset/Speaker	Speaker	Speaker	Headset
Flash/ROM	Flash	Flash	ROM	ROM
Stereo mode	Yes/ Programmable	Yes/ Programmable	Yes	Yes
Package	LGA	LGA	QFN	BGA
Pin/Ball count	56	68	68	61
Dimensions (mm)	7x7	8x8	8x8	5x5
Audio DAC output	2-channel	2-channel	2-channel	2-channel
DAC (single-ended) SNR at 2.8V (dB)	-98	-98	-98	-98
DAC (capless) SNR at 2.8V (dB)	-96	-96	-96	-96
ADC SNR at 2.8V (dB)	-92	-92	-92	-92
I <sup>2</sup> S digital output	No	Yes	Yes	Yes
Analog output	Yes	Yes	Yes	Yes
Analog Auxiliary-Input	Yes	Yes	Yes	Yes
Mono microphone	2	1	1	2
External audio amplifier interface	Yes	Yes	Yes	Yes
UART	Yes	Yes	Yes	Yes
Full-speed USB 1.1	No	Yes	Yes	No
LED driver	2	3	3	2
Integrated DC-DC step-down regulator	1	1	1	1
Integrated LDO regulator	2	2	2	2
DC 5V adaptor input	Yes	Yes	Yes	Yes

Feature	IS2062GM	IS2064GM	IS2064S	IS2064B
Battery charger (350 mA maximum)	Yes	Yes	Yes	Yes
ADC for charger thermal protection	Yes	Yes	Yes	Yes
Under Voltage Protection (UVP)	Yes	Yes	Yes	Yes
GPIO	10	15	15	10
EEPROM	128K	128K	256K	128K
Multitone	Yes	Yes	Yes	Yes
DSP functions (audio playback and voice call)	Yes	Yes	Yes	Yes
BLE	Yes	Yes	Yes	Yes
<b>Bluetooth profiles</b>				
A2DP	1.3	1.3	1.3	1.3
AVRCP	1.6	1.6	1.6	1.6
HFP	1.6	1.6	1.6	1.6
HSP	1.2	1.2	1.2	1.2
SPP	1.2	1.2	1.2	1.2

## 1.2 Pin Details

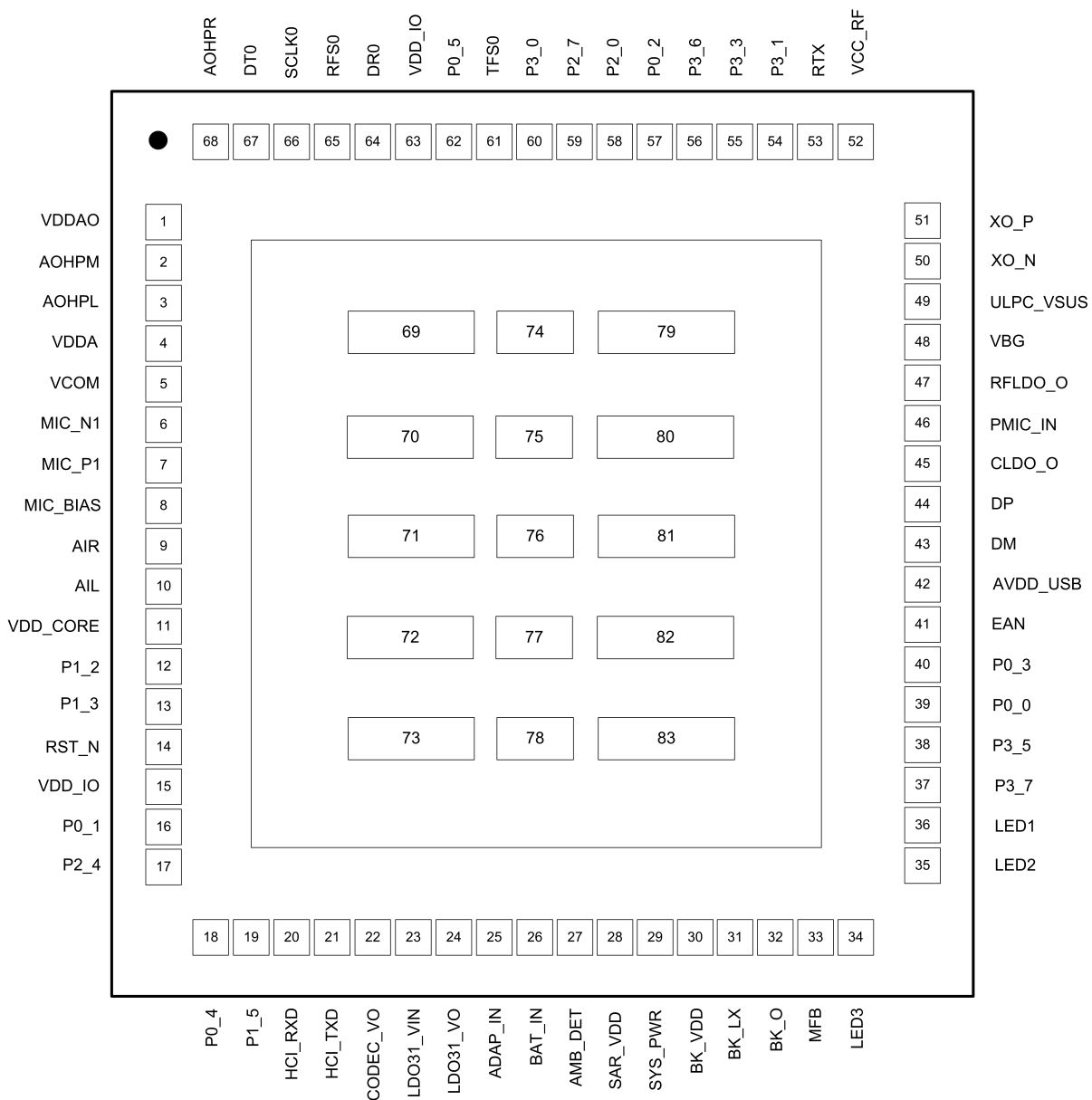
The following figure illustrates the pin diagram of the IS2062GM.

Figure 1-2. IS2062GM PIN DIAGRAM



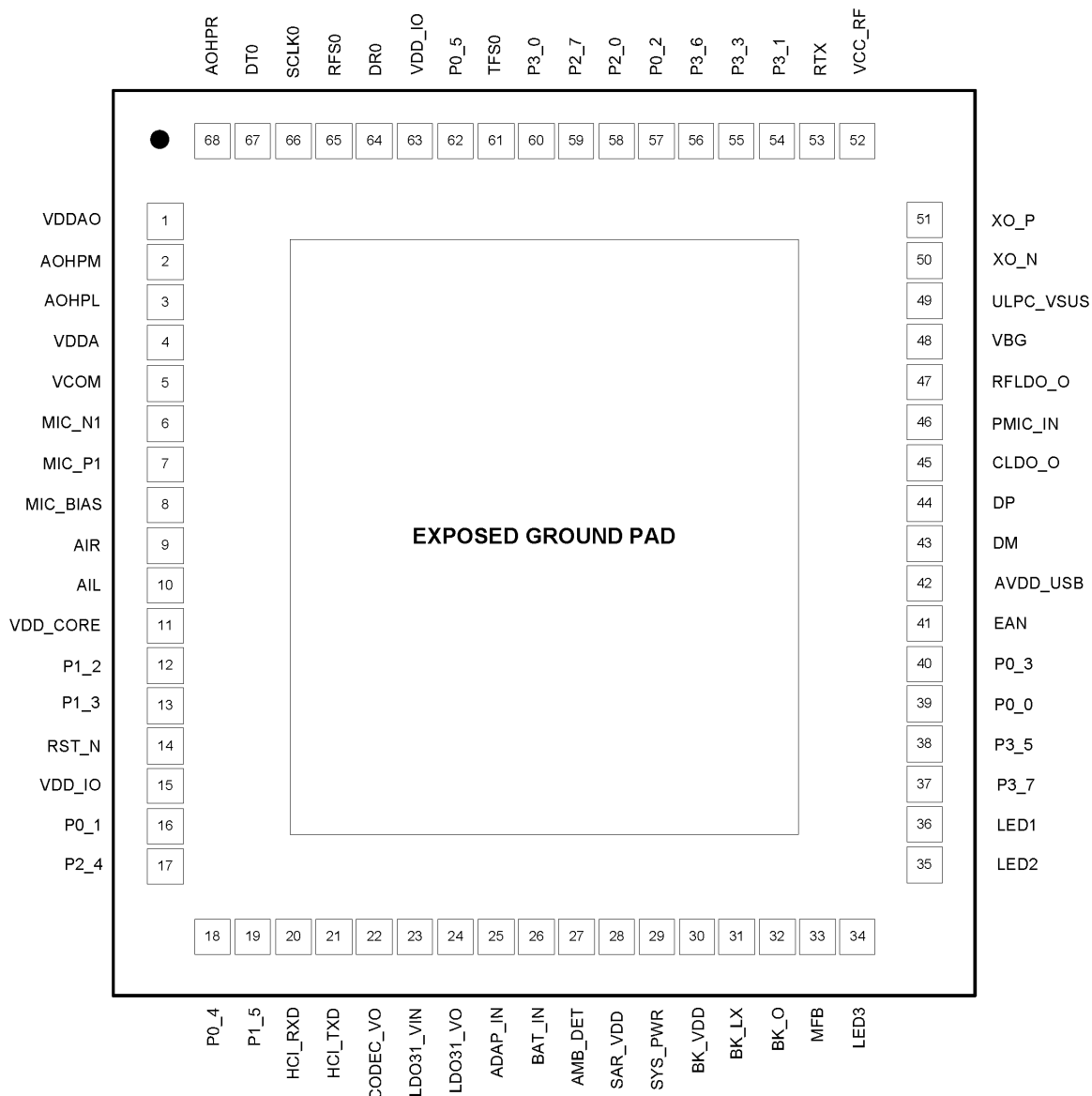
The following figure illustrates the pin diagram of the IS2064GM.

Figure 1-3. IS2064GM PIN DIAGRAM



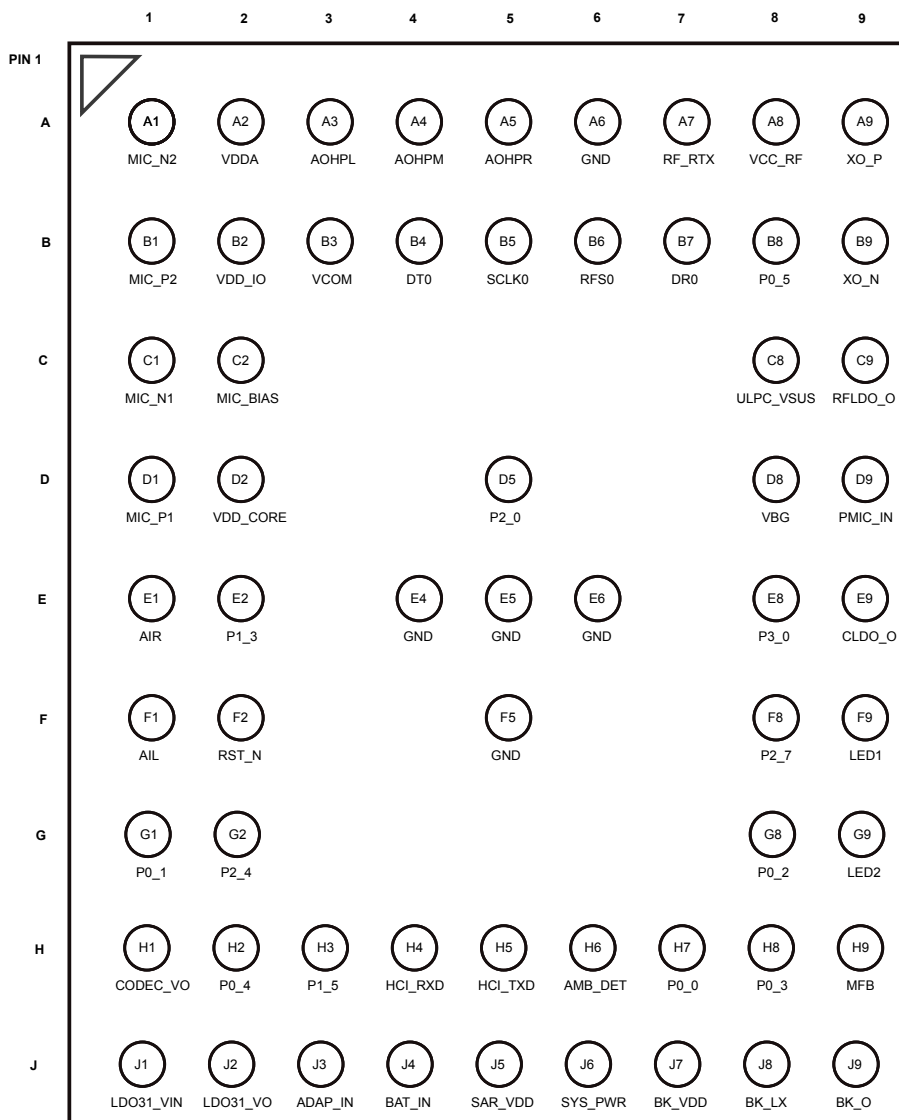
The following figure illustrates the pin diagram of the IS2064S.

Figure 1-4. IS2064S PIN DIAGRAM



The following figure illustrates the pin diagram of the IS2064B.

Figure 1-5. IS2064B PIN DIAGRAM



The following table provides the pin description of the IS2062GM, IS2064GM, IS2064S and IS2064B.

**Note:** The conventions used in the below table are indicated as follows:

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



Table 1-2. PIN DESCRIPTION

IS2062GM Pin No	IS2064GM and IS2064S Pin No	IS2064B Ball No	Pin Type	Pin Name	Description
53	1	—	P	VDDAO	Power supply (3.0V to 3.6V) dedicated to codec output amplifiers; connect to CODEC_VO pin
54	2	A4	O	AOHPM	Headphone common mode output/sense input
55	3	A3	O	AOHPL	Left channel, analog headphone output
56	4	A2	P	VDDA	Analog reference voltage. Do not connect, for internal use only
1	5	B3	P	VCOM	Internal biasing voltage for codec, connect a 4.7 $\mu$ F capacitor to ground
4	6	C1	I	MIC_N1	MIC1 mono differential analog negative input
5	7	D1	I	MIC_P1	MIC1 mono differential analog positive input
2	—	A1	I	MIC_N2	MIC2 mono differential analog negative input
3	—	B1	I	MIC_P2	MIC2 mono differential analog positive input
6	8	C2	P	MIC_BIAS	Electric microphone biasing voltage
7	9	E1	I	AIR	Right channel, single-ended analog input
8	10	F1	I	AIL	Left channel, single-ended analog input
9	11	D2	P	VDD_CORE	Core 1.2V power input; connect to CLDO_O pin; connect to GND through a 1 $\mu$ F (X5R/X7R) capacitor
10	12	—	O	P1_2	I <sup>2</sup> C SCL (Internal EEPROM clock), do not connect
11	13	E2	I/O	P1_3	I <sup>2</sup> C SDA (Internal EEPROM data) requires external 4.7 kOhm pull-up resistor
12	14	F2	I	RST_N	System Reset (active-low)
13	15	B2	P	VDD_IO	I/O power supply input (3.0V to 3.6V); connect to LDO31_VO;

IS2062GM Pin No	IS2064GM and IS2064S Pin No	IS2064B Ball No	Pin Type	Pin Name	Description
					connect to GND through a 1 $\mu$ F (X5R/X7R) capacitor
14	16	G1	I/O	P0_1	Configurable control or indication pin (Internally pulled-up, if configured as an input) <ul style="list-style-type: none"> <li>FWD key when Class 2 RF (default), active-low</li> <li>Class 1 Tx control signal for external RF Tx/Rx switch, active-high</li> </ul>
15	17	G2	I/O	P2_4	For IS2062GM/64GM (Flash variant): External address bus negative, System configuration pin along with the P2_0 and EAN pins can be used to set the SoC in any one of the following three modes: <ul style="list-style-type: none"> <li>Application mode (for normal operation)</li> <li>Test mode (to change EEPROM values), and</li> <li>Write Flash mode (to load a new firmware into the SoC), see <a href="#">Table 6-1</a></li> </ul> For IS2064S/B (ROM variant): Do not connect this pin
16	18	H2	I/O	P0_4	Configurable control or indication pin (Internally pulled-up, if configured as an input) <ul style="list-style-type: none"> <li>Out_Ind_1</li> </ul>
17	19	H3	I	P1_5	Configurable control or indication pin (Internally pulled-up, if configured as an input) <ul style="list-style-type: none"> <li>Slide switch detector, active-high</li> <li>Out_Ind_1</li> <li>Master/Slave mode control</li> </ul>
18	20	H4	O	HCI_RXD	HCI UART data input
19	21	H5	I	HCI_TXD	HCI UART data output
20	22	H1	P	CODEC_VO	LDO output for codec power

IS2062GM Pin No	IS2064GM and IS2064S Pin No	IS2064B Ball No	Pin Type	Pin Name	Description
21	23	J1	P	LDO31_VIN	LDO input, connect to SYS_PWR
22	24	J2	I	LDO31_VO	3V LDO output for VDD_IO power, do not calibrate
23	25	J3	P	ADAP_IN	5V power adapter input, used to charge the battery in case of Li-Ion battery power applications
24	26	J4	P	BAT_IN	Power Supply input. Voltage range: 3.2V to 4.2V. Source can either be a Li-Ion battery or any other power rail on the host board
25	27	H6	P	AMB_DET	Analog input for ambient temperature detection
26	28	J5	P	SAR_VDD	SAR 1.8V input; connect to BK_O pin
27	29	J6	P	SYS_PWR	System power output derived from the ADAP_IN or BAT_IN. Do not connect, for internal use only
28	30	J7	I	BK_VDD	1.8V buck VDD power input; connect to SYS_PWR pin
29	31	J8	I	BK_LX	1.8V buck regulator feedback path
30	32	J9	I	BK_O	1.8V buck regulator output. Do not connect to other devices. For internal use only
31	33	H9	P	MFB	<ul style="list-style-type: none"> <li>Multi-Function Button and power-on key</li> <li>UART RX_IND, active-high (used by host MCU to wake-up the Bluetooth system)</li> </ul>
—	34	—	P	LED3	LED driver 3
33	35	G9	P	LED2	LED driver 2
32	36	F9	P	LED1	LED driver 1
—	37	—	P	P3_7	Configurable control or indication pin (Internally pulled-up, if configured as an input) <ul style="list-style-type: none"> <li>UART TX_IND, active-low (used by Bluetooth system to wake-up the host MCU)</li> </ul>

IS2062GM Pin No	IS2064GM and IS2064S Pin No	IS2064B Ball No	Pin Type	Pin Name	Description
—	38	—	P	P3_5	Configurable control or indication pin (Internally pulled-up, if configured as an input)
34	39	H7	I/O	P0_0	Configurable control or indication pin (Internally pulled-up, if configured as an input) <ul style="list-style-type: none"> <li>Slide switch detector, active-high</li> </ul>
35	40	H8	I/O	P0_3	Configurable control or indication pin (Internally pulled-up, if configured as an input) <ul style="list-style-type: none"> <li>REV key (default), active-low</li> <li>Buzzer signal output</li> <li>Out_Ind_2</li> <li>Class 1 Rx control signal of external RF T/R switch, active-high</li> </ul>
36	41	—	I/O	EAN	For IS2062GM/64GM (Flash variant): External address-bus negative System configuration pin along with the P2_0 and P2_4 pins can be used to set the SoC in any one of the following three modes: <ul style="list-style-type: none"> <li>Application mode (for normal operation)</li> <li>Test mode (to change EEPROM values), and</li> <li>Write Flash mode (to load a new firmware into the SoC), see <a href="#">Table 6-1</a></li> </ul> For IS2064S/B (ROM variant): Do not connect for this pin
—	42	—	P	AVDD_USB	USB power input; connect to LDO31_VO pin
—	43	—	I/O	DM	Differential data-minus USB
—	44	—	I/O	DP	Differential data-plus USB
37	45	E9	P	CLDO_O	1.2V core LDO output for internal use only. Connect to GND through a 1 $\mu$ F capacitor

IS2062GM Pin No	IS2064GM and IS2064S Pin No	IS2064B Ball No	Pin Type	Pin Name	Description
38	46	D9	P	PMIC_IN	1.8V power input for internal blocks; connect to BK_O
39	47	C9	P	RFLDO_O	1.28V RF LDO output for internal use only. Connect to GND through a 1 $\mu$ F capacitor
40	48	D8	P	VBG	Bandgap output reference for decoupling interference, connect to GND through a 1 $\mu$ F capacitor
41	49	C8	P	ULPC_VSUS	ULPC 1.2V output power, maximum loading 1 mA, connect to GND through a 1 $\mu$ F capacitor
42	50	B9	I	XO_N	16 MHz crystal input negative
43	51	A9	I	XO_P	16 MHz crystal input positive
44	52	A8	P	VCC_RF	RF power input (1.28V) for both synthesizer and Tx/Rx block, connect to RFLDO_O
45	53	A7	I/O	RTX/ RF_RTX	RF path (transmit/receive)
—	54	—	I/O	P3_1	Configurable control or indication pin (Internally pulled-up, if configured as an input) <ul style="list-style-type: none"> <li>REV key when Class 1 RF (default), active-low</li> </ul>
—	55	—	I/O	P3_3	Configurable control or indication pin (Internally pulled-up, if configured as an input) <ul style="list-style-type: none"> <li>FWD key when Class 1 RF (default), active-low</li> </ul>
—	56	—	I/O	P3_6	Configurable control or indication pin (Internally pulled-up, if configured as an input) <ul style="list-style-type: none"> <li>Master/Slave mode control</li> </ul>
46	57	G8	I/O	P0_2	Configurable control or indication pin (Internally pulled-up, if configured as an input) <ul style="list-style-type: none"> <li>Play/Pause key (default)</li> </ul>
47	58	D5	I/O	P2_0	For IS2062GM/64GM (Flash variant):

IS2062GM Pin No	IS2064GM and IS2064S Pin No	IS2064B Ball No	Pin Type	Pin Name	Description
					<p>External address-bus negative System configuration pin along with the P2_4 and EAN pins can be used to set the SoC in any one of the following three modes:</p> <ul style="list-style-type: none"> <li>• Application mode (for normal operation)</li> <li>• Test mode (to change EEPROM values), and</li> <li>• Write Flash mode (to load a new firmware into the SoC), see <a href="#">Table 6-1</a></li> </ul> <p>For IS2064S/B (ROM variant): Do not connect for this pin</p>
48	59	F8	I/O	P2_7	<p>Configurable control or indication pin (Internally pulled-up, if configured as an input)</p> <ul style="list-style-type: none"> <li>• Volume up key (default), active-low</li> </ul>
49	60	E8	I/O	P3_0	<p>Configurable control or indication pin (Internally pulled-up, if configured as an input)</p> <ul style="list-style-type: none"> <li>• Auxiliary input detector, active-low</li> </ul>
—	61	—	I/O	TFS0	I <sup>2</sup> S interface: left/right clock
50	62	B8	I/O	P0_5	<p>Configurable control or indication pin (Internally pulled-up, if configured as an input)</p> <ul style="list-style-type: none"> <li>• Volume down key (default), active-low</li> </ul>
51	63	B2	P	VDD_IO	I/O power supply input (3V to 3.6V); connect to LDO31_VO pin, connect to GND through a 1 $\mu$ F (X5R/X7R) capacitor
—	64	B7	I/O	DR0	I <sup>2</sup> S interface: digital left/right data
—	65	B6	I/O	RFS0	I <sup>2</sup> S interface: left/right clock
—	66	B5	I/O	SCLK0	I <sup>2</sup> S interface: bit clock
—	67	B4	I/O	DT0	I <sup>2</sup> S interface: digital left/right data

IS2062GM Pin No	IS2064GM and IS2064S Pin No	IS2064B Ball No	Pin Type	Pin Name	Description
52	68	A5	O	AOHPR	Right-channel, analog headphone output
57-64	69-83	—	P	EP	Exposed pads, Used as ground (GND) pins
—	—	A6, E4, E5, E6, F5	P	GND	Ground reference

**Note:** All I/O pins are configured using UI tool, a Windows® based utility.

## 2. Audio

The input and output audio signals have different stages and each stage is programmed to vary the gain response characteristics. 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 are used at both positive and negative sides of the input. Internally, this analog signal is converted to 16-bit, 8/16 kHz linear PCM data.

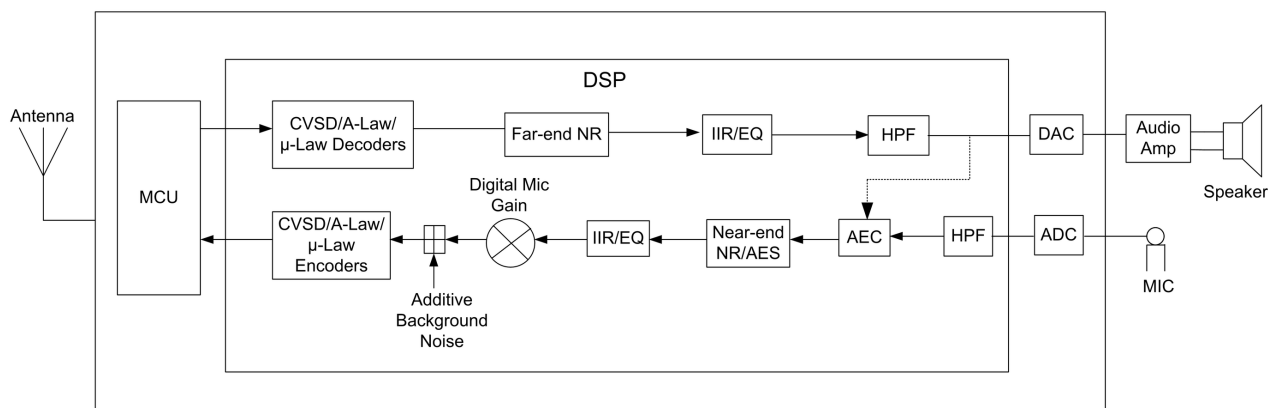
### 2.1 Digital Signal Processor

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 built-in. 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.

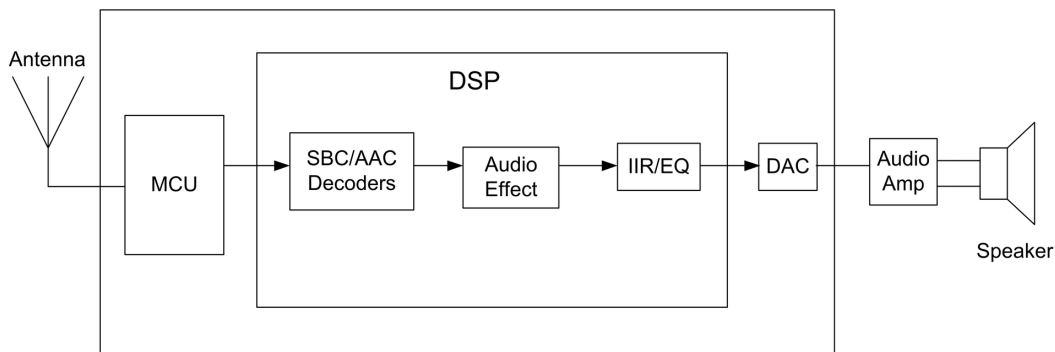
The embedded noise reduction algorithm helps to extract clean speech signals from the noisy inputs captured by microphones and improves mutual understanding in communication. The advanced audio features, such as multi-band dynamic range control, parametric multi-band equalizer, audio widening and virtual bass are built-in. The audio effect algorithms improve the user's audio listening experience in terms of better quality audio after audio signal processing.

The following figures illustrate the processing flow of speaker phone applications for speech and audio signal processing.

**Figure 2-1. SPEECH PROCESSING**



**Figure 2-2. AUDIO PROCESSING**





The DSP parameters such as EQ, Speaker Gain, Mic Gain, Sound Effect etc. are configured 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" are available for download from the Microchip website at <http://www.microchip.com/wwwproducts/en/IS2062> and <http://www.microchip.com/wwwproducts/en/IS2064>.

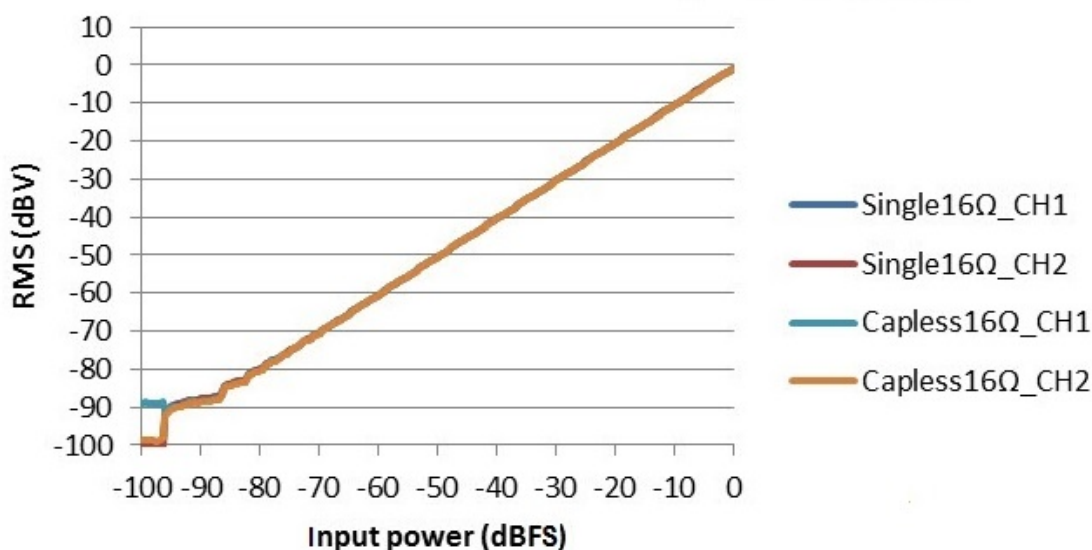
## 2.2 Codec

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

**Note:** The internal codec supports 16-bit resolution. 24-bit I<sup>2</sup>S port requirements are met by adding trailing zeros in LSBs.

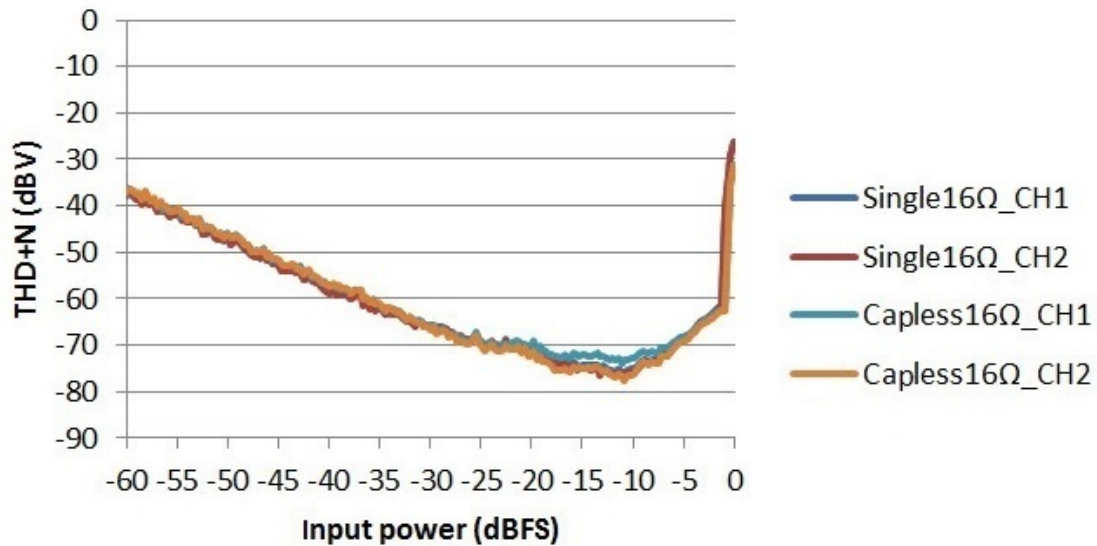
The following figures illustrate the dynamic range and frequency response of the codec.

**Figure 2-3. CODEC DAC DYNAMIC RANGE**



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

Figure 2-5. CODEC DAC FREQUENCY RESPONSE (CAPLESS MODE)

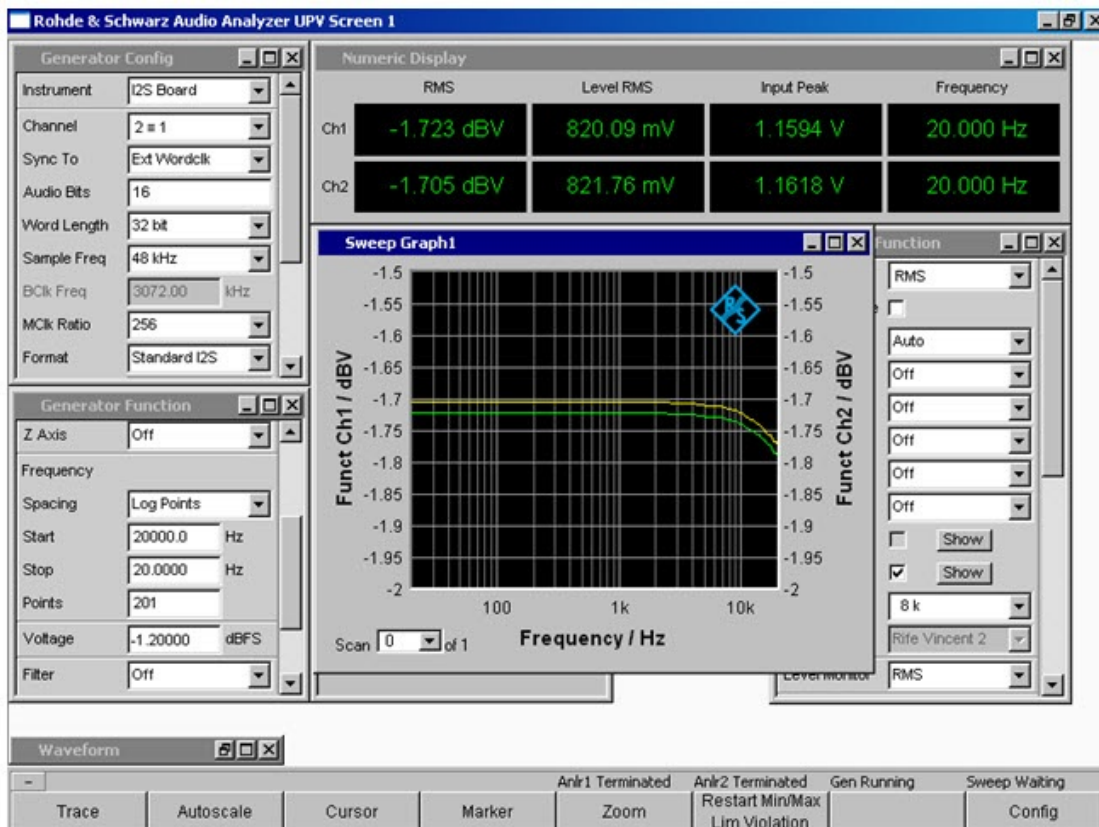
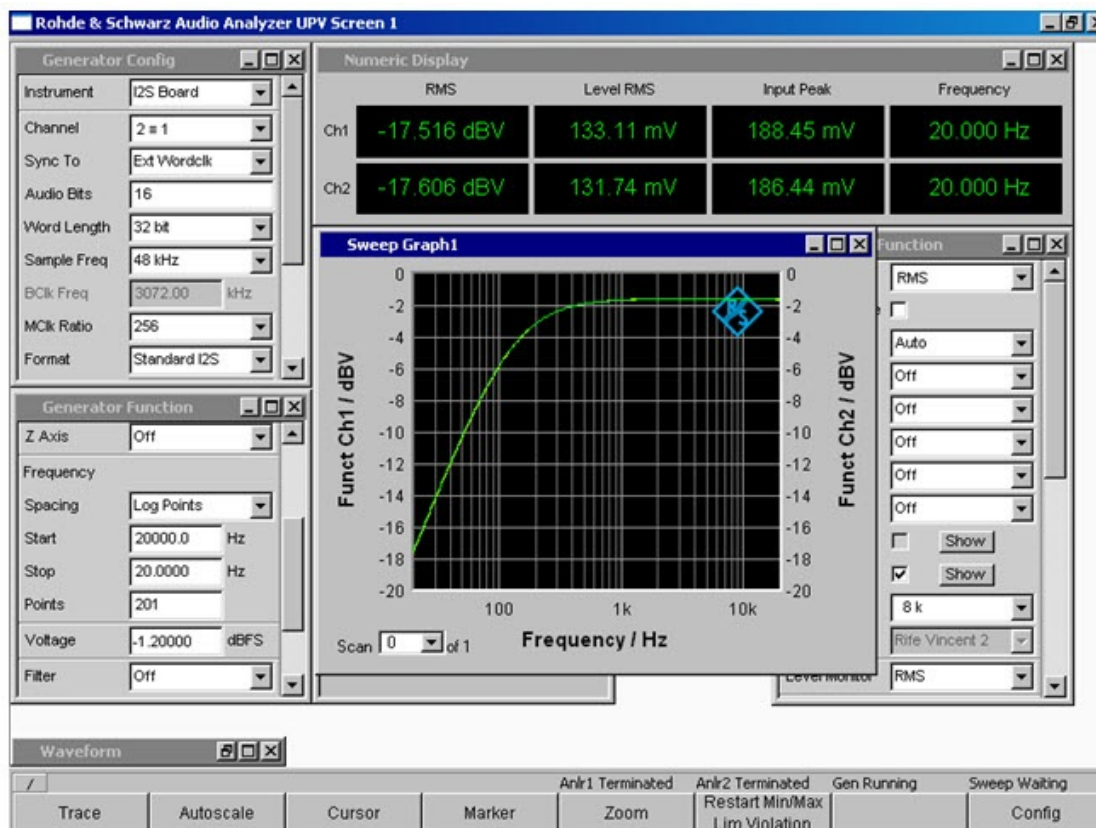


Figure 2-6. CODEC DAC FREQUENCY RESPONSE (SINGLE-ENDED MODE)



**Note:** The DAC frequency response corresponds to single-ended mode with a 47  $\mu$ F DC block capacitor.

## 2.3 Auxiliary Port

The IS2062/64 SoC supports one analog (line-in) signal from the external audio source. The analog signal is processed by the DSP to generate different sound effects (multi-band dynamic range compression, and audio widening), which are configured using the DSP tool.

## 2.4 Analog Speaker Output

The IS2062/64 SoC supports the following 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

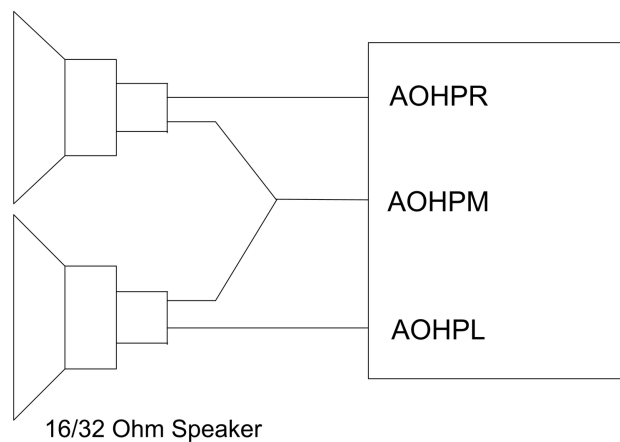
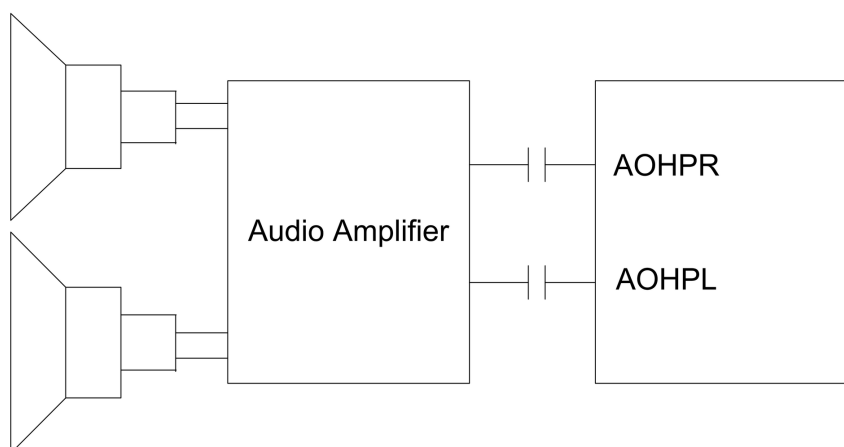


Figure 2-8. ANALOG SPEAKER OUTPUT SINGLE-ENDED MODE



### 3. Transceiver

The IS2062/64 SoC is designed and optimized for Bluetooth 2.4 GHz systems. It contains a complete radio frequency transmitter/receiver section. An internal synthesizer generates a stable clock to synchronize with another device.

#### 3.1 Transmitter

The internal Power Amplifier (PA) has a maximum output power of +4 dBm. This is applied to Class 2 or Class 3 radios, without an external RF PA. The transmitter directly performs the IQ conversion to minimize the frequency drift.

#### 3.2 Receiver

The Low-Noise Amplifier (LNA) operates with TR-combined mode for the single port application. It saves the pin on the package without having an external Tx/Rx switch.

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

The image rejection filter is used to reject the image frequency for the low-IF architecture, and it also 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. The VCO inside, with a tunable internal LC tank, can reduce any 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 is 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 EDR specifications.

For Bluetooth 2.0 and above specifications, EDR is 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 represent 2-bit or 3-bit. This is achieved by using two different modulations,  $\pi/4$  DQPSK and 8 DPSK.

#### 3.5 Adaptive Frequency Hopping (AFH)

The IS2062/64 SoC has an AFH function to avoid RF interference. It has an algorithm to check the nearby interference and to choose the clear channel for transceiver Bluetooth signal.

## 4. Microcontroller

A microcontroller is built into the SoC to execute the Bluetooth protocols. It operates from 16 MHz to higher frequencies, where the firmware dynamically adjusts the trade-off between the computing power and the power consumption. In the ROM version, the MCU firmware is hard-wired to minimize power consumption for the firmware execution and to save the external Flash cost.

### 4.1 Memory

There are sufficient ROM and RAM to fulfill the processor requirements, in which a synchronous single port RAM interface is used. The register bank, dedicated single port memory and Flash memory are connected to the processor bus. The processor coordinates with all link control procedures and the data movement happens using a set of pointer registers.

### 4.2 External Reset

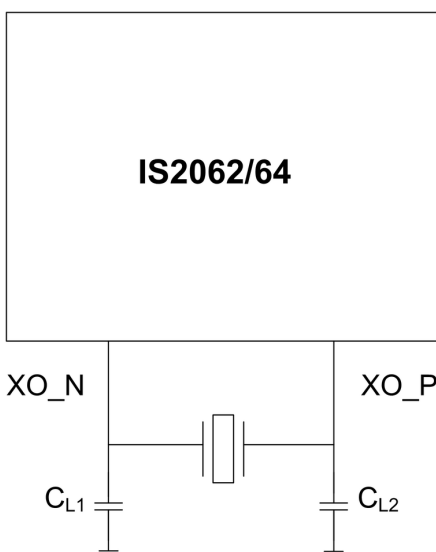
The IS2062/64 SoC provides a Watchdog Timer (WDT) to reset the SoC. It has an integrated Power-on Reset (POR) circuit that resets all circuits to a known Power-on state. This action is also driven by an external Reset signal, which is used to control the device externally by forcing it into a POR state. The RST\_N signal input is active-low and no connection is required in most of the applications.

### 4.3 Reference Clock

The IS2062/64 SoC is composed of an integrated crystal oscillation function that uses a 16 MHz $\pm$ 10 ppm external crystal and two specified loading capacitors to provide a high quality system reference timer source. This feature is typically used to remove the initial tolerance frequency errors, which are associated with the crystal and its equivalent loading capacitance in the mass production. Frequency trim is achieved by adjusting the crystal loading capacitance through the on-chip trim capacitors ( $C_{trim}$ ).

The value of trimming capacitance is 200 fF ( $200 \times 10^{-15}$  F) per LSb at 5-bit word and the overall adjustable clock frequency is  $\pm 40$  kHz (based on the crystal with load capacitance,  $C_L$  spec = 9 pF). The following figure illustrates the crystal connection of the IS2062/64 SoC with two capacitors.

**Figure 4-1. CRYSTAL CONNECTION**



**Note:**

1.  $C_{trim} = 200 \text{ fF} * (1 \text{ to } 31)$ ;  $C_{int} = 3 \text{ pF}$ .
2.  $C_L = [C_{L1} \times C_{L2}] / (C_{L1} + C_{L2}) + (C_{trim} / 2) + C_{int}$  (set trim value as 16, then  $C_{trim} = 3.2 \text{ pF}$ ).
3. For a 16 MHz crystal, in which  $C_L = 9 \text{ pF}$ , then the  $C_{L1} = C_{L2} = 9.1 \text{ pF}$ .
4. For  $C_L$  selection, refer to the data sheet of the crystal.

## 5. Power Management Unit

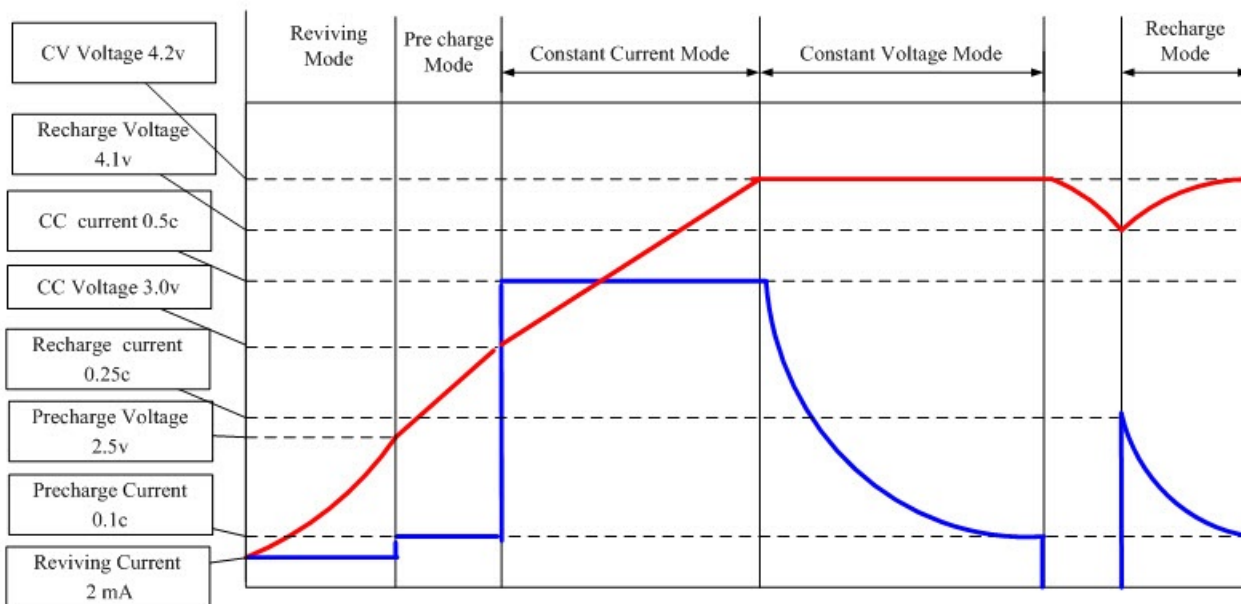
The IS2062/64 SoC has an integrated Power Management Unit (PMU). The main features of the PMU are a lithium-ion and lithium-polymer battery charger, and a voltage regulator. The power switch is used to exchange the power source between a battery and an adaptor. Also, the PMU provides current to the LED drivers.

### 5.1 Charging a Battery

The IS2062/64 SoC has a built-in battery charger, which is optimized with lithium-ion and lithium-polymer batteries. The battery charger includes a current sensor for charging control, user programmable current regulator, and high accuracy voltage regulator.

The charging current parameters are configured by using the UI tool. An adapter is plugged in to activate the charging circuit. Reviving, pre-charging, constant current and constant voltage modes and re-charging functions are included. The maximum charging current is 350 mA. The following figure illustrates the charging curve of a battery.

**Figure 5-1. BATTERY CHARGING CURVE**



### 5.2 Voltage Monitoring

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

### 5.3 Low Dropout Regulator

A built-in Low Dropout (LDO) Regulator is used to convert the battery or adaptor power for power supply. It also integrates the hardware architecture to control the power-on/off procedure. The built-in programmable LDOs provide power for codec and digital I/O pads. Also, it is used to buffer the high input voltage from battery or adapter. This LDO requires 1  $\mu$ F bypass capacitor.



## 5.4 Switching Regulator

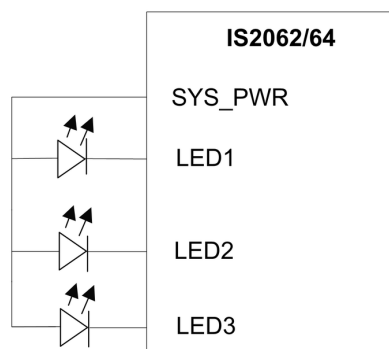
The built-in programmable output voltage regulator converts the battery voltage to RF and baseband core power supply. This converter has a high conversion efficiency and a fast transient response.

## 5.5 LED Driver

The IS2062GM and IS2064B have two LED drivers, and the IS2064GM and IS2064S have three LED drivers to control the LEDs. The LED drivers provide enough sink current (16-step control and 0.35 mA for each step) and the LED is connected directly to the IS2062/64 SoC. The LED settings are configured using the UI tool.

The following figure illustrates the LED driver in the IS2062/64 SoC.

**Figure 5-2. LED DRIVER**



## 5.6 Under Voltage Protection

When the voltage of SYS\_PWR pin drops below the voltage level of 2.9V, the system shuts down automatically.

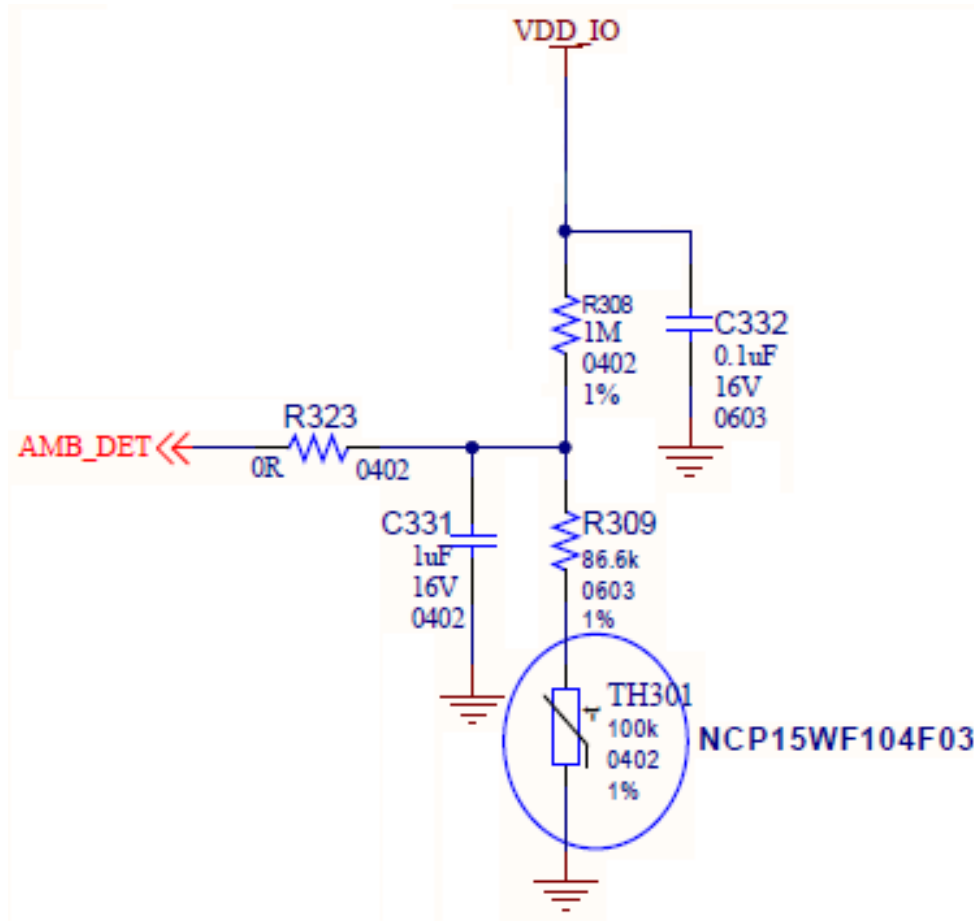
## 5.7 Ambient Detection

The IS2062/64 SoC contains a built-in ADC for charger thermal protection.

The following figure illustrates the suggested circuit and thermistor, Murata NCP15WF104F. The charger thermal protection avoids battery charge in the restricted temperature range. The upper and lower limits for temperature values are configured by using the UI tool.

**Note:** The thermistor must be placed close to the battery in the user application for accurate temperature measurements and to enable the thermal shutdown feature.

Figure 5-3. AMBIENT TEMPERATURE DETECTOR



## 6. Application Information

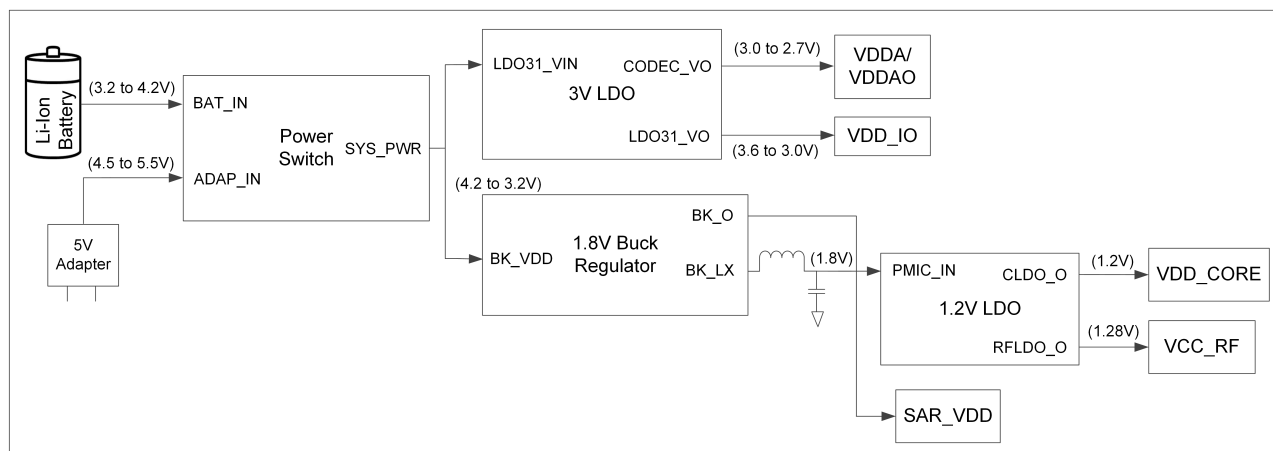
This section describes the power supply connection, host MCU UART interface, and various modes in detail.

### 6.1 Power Supply

The following figure illustrates the connection from the BAT\_IN pin to various other voltage supply pins of the IS2062/64 SoC.

The IS2062/64 SoC is powered through the BAT\_IN input pin. The external 5V power adapter can be connected to ADAP\_IN in order to charge the battery.

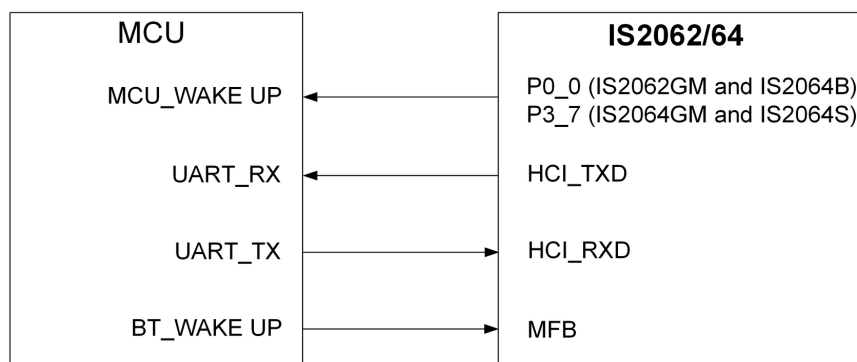
**Figure 6-1. POWER TREE DIAGRAM**



### 6.2 Host MCU Interface

The following figure illustrates the UART interface between the IS2062/64 SoC and an external MCU.

**Figure 6-2. HOST MCU INTERFACE OVER UART**



The MCU controls the IS2062/64 SoC over the UART interface and wakes up the SoC using the MFB, P0\_0 (IS2062GM and IS2064B) and P3\_7 (IS2064GM and IS2064S) pins.

Refer to the "*UART\_CommandSet*" document for a list of functions that the IS2062/64 SoC supports and how to use the UI tool to set up the system using the UART command.

**Note:** The "*UART\_CommandSet*" document is available for download from the Microchip website at <http://www.microchip.com/wwwproducts/en/IS2062> and <http://www.microchip.com/wwwproducts/en/IS2064>.

The following figures illustrate the various UART control signal timing sequences.

Figure 6-3. POWER-ON/OFF SEQUENCE

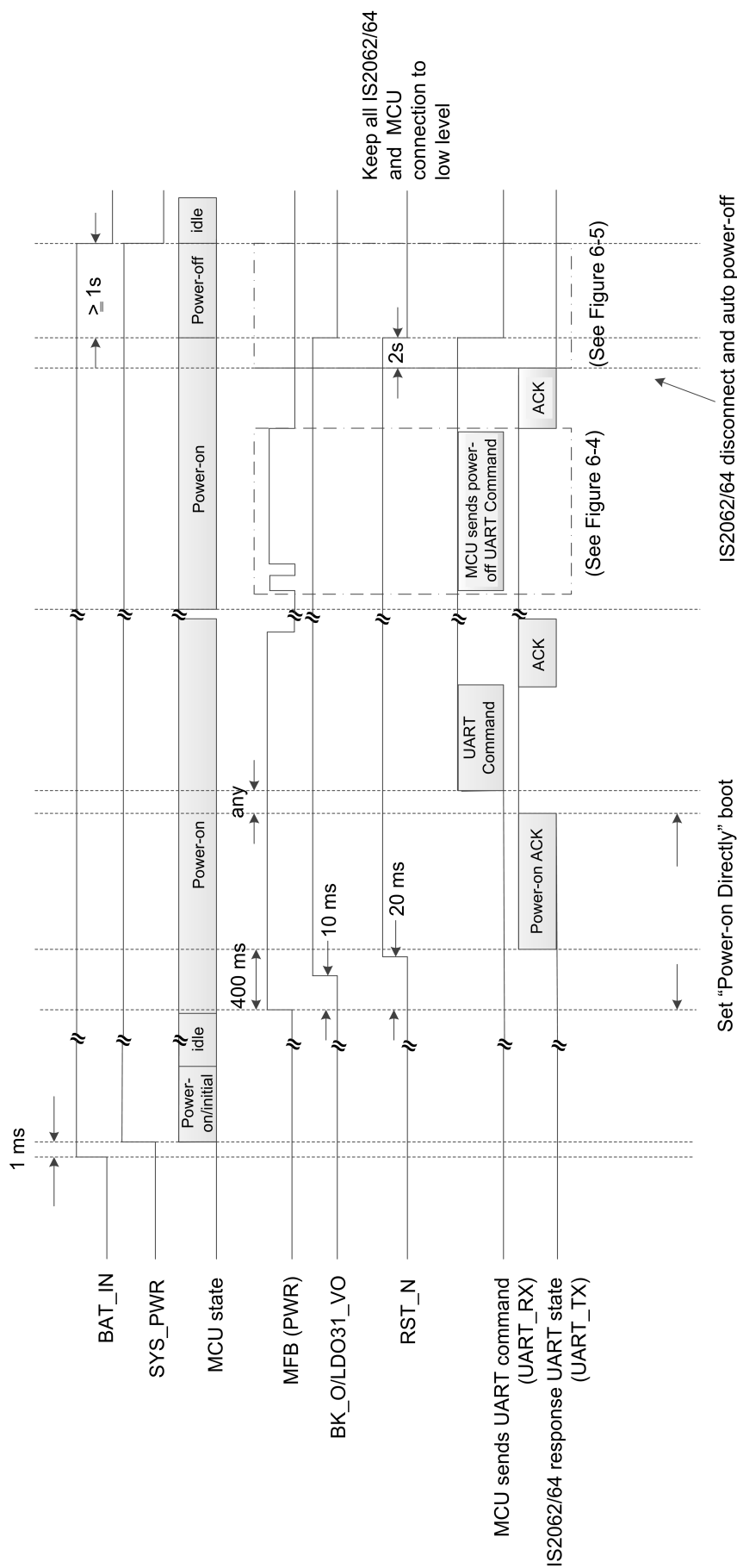


Figure 6-4. TIMING SEQUENCE OF RX INDICATION AFTER POWER-ON

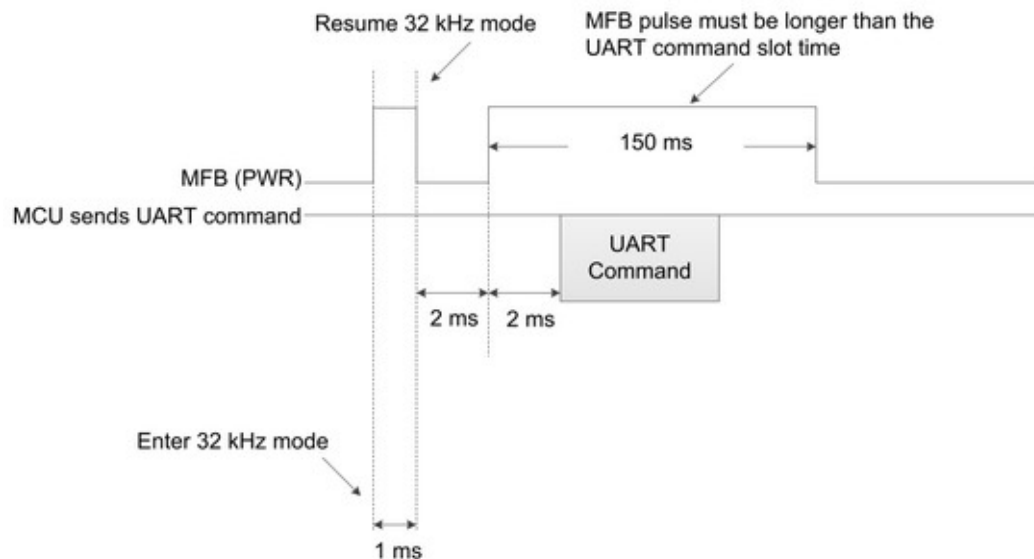
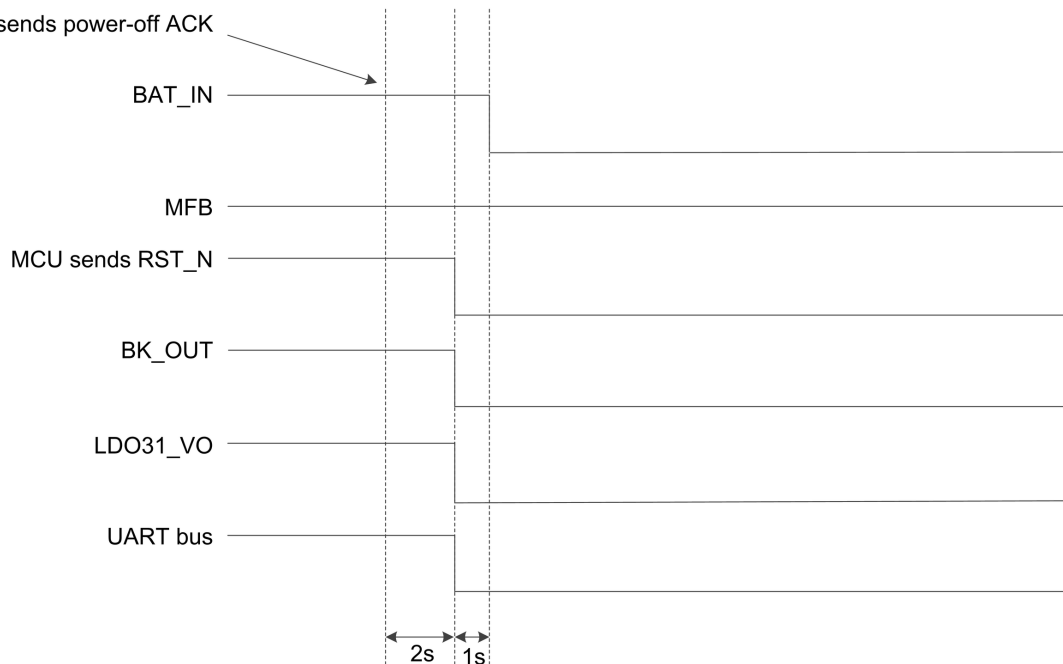


Figure 6-5. TIMING SEQUENCE OF POWER-OFF

**Note:**

1. EEPROM clock = 100 kHz.
2. For a byte wire,  $0.01 \text{ ms} \times 32 \text{ clock} \times 2 = 640 \mu\text{s}$ .
3. It is recommended to have ramp-down time more than 640  $\mu\text{s}$  during the power-off sequence to ensure safe operation of the device.

Figure 6-6. TIMING SEQUENCE OF POWER-ON (NACK)

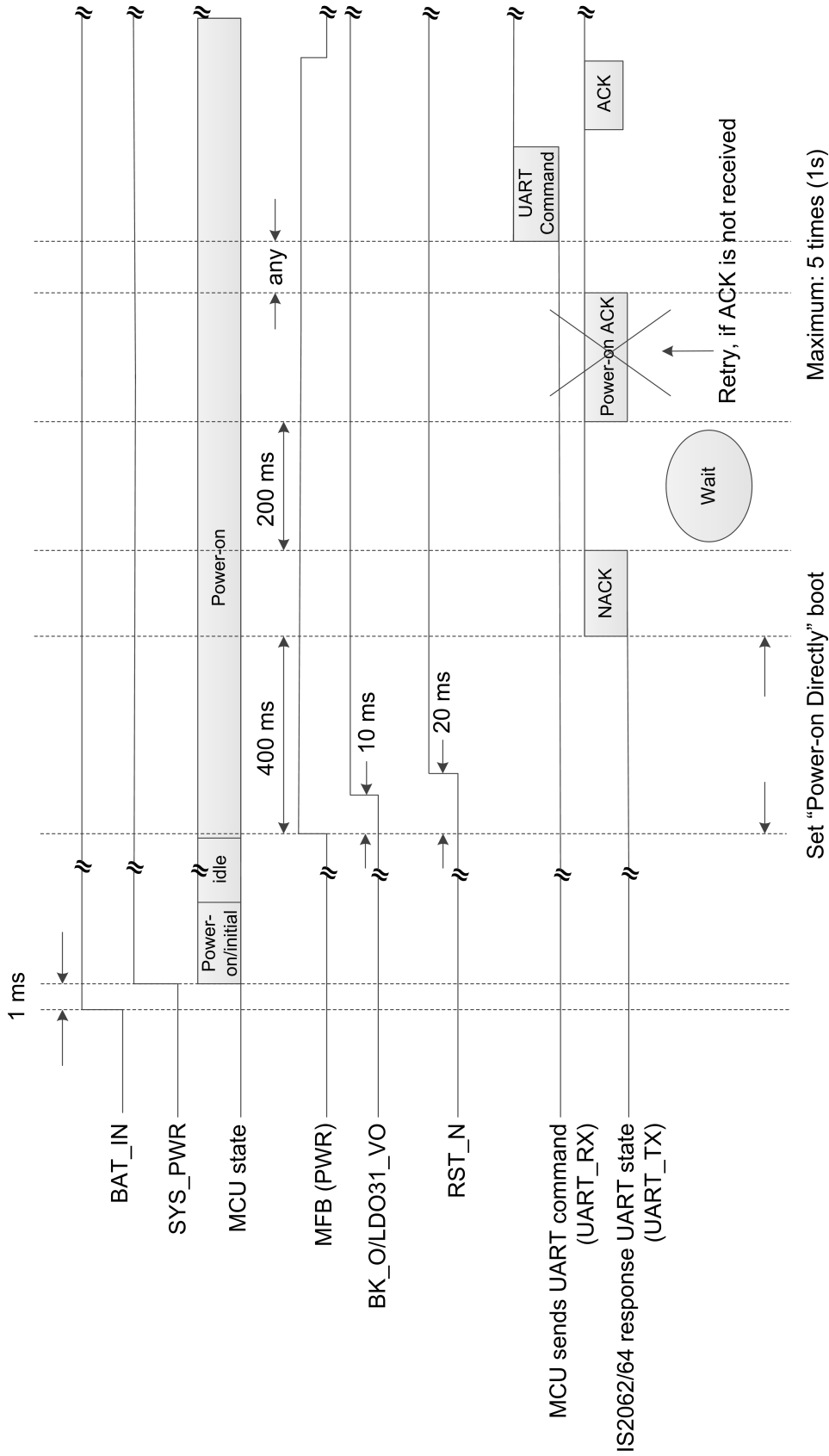
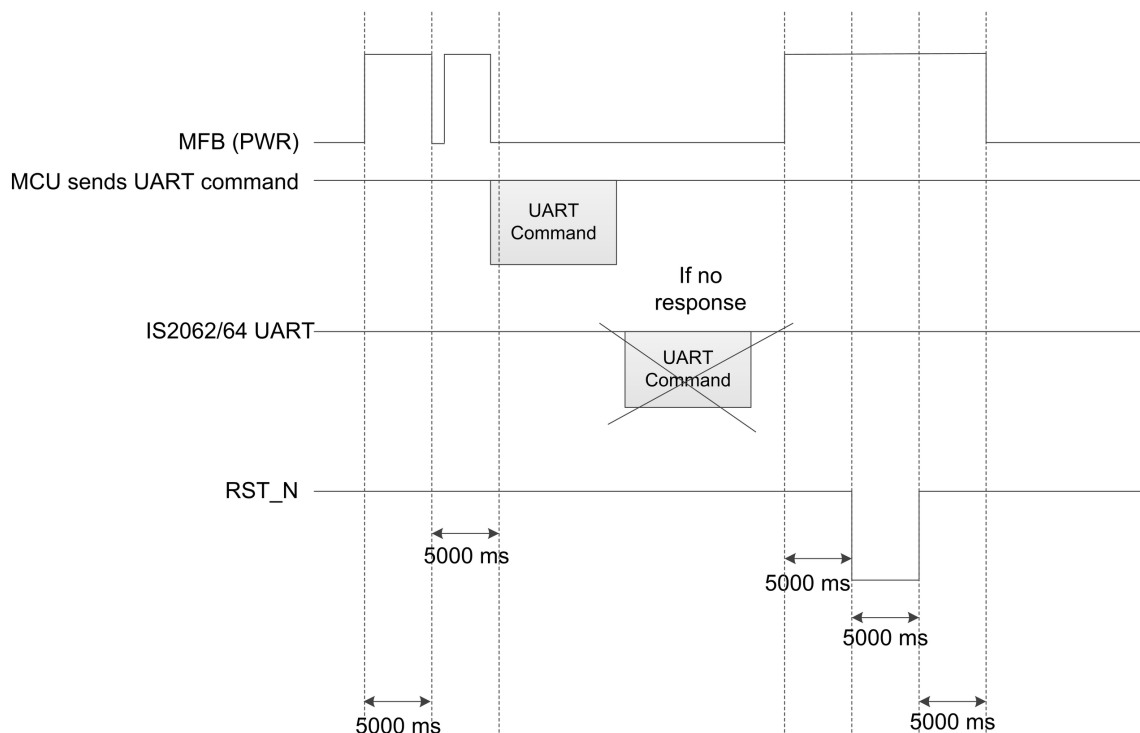
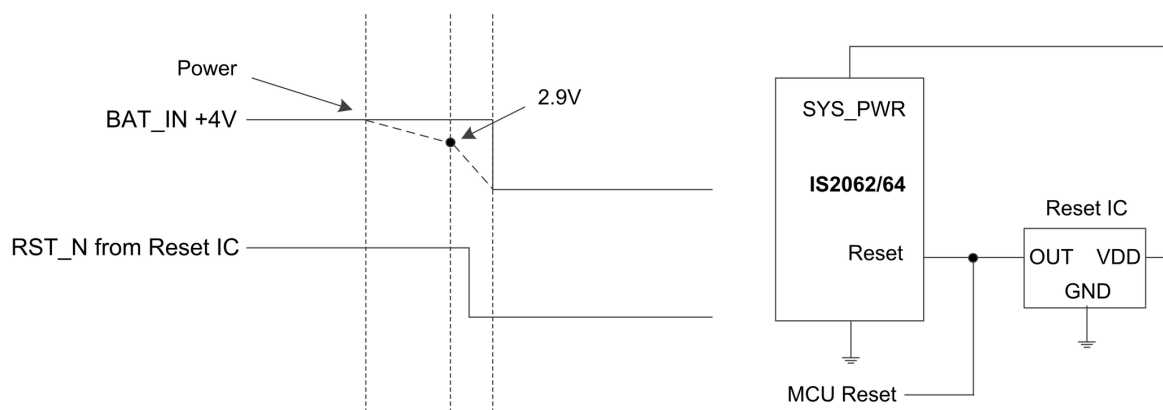


Figure 6-7. RESET TIMING SEQUENCE IN CASE OF NO RESPONSE FROM SoC TO HOST MCU



**Note:** The MCU sends the UART command again, when SoC is not responding to its first UART command. If the SoC is not responding to the second UART command within 5 secs, then the MCU forces the system to reset.

Figure 6-8. TIMING SEQUENCE OF POWER DROP PROTECTION

**Note:**

1. It is recommended to connect the battery on a BAT\_IN pin of the SoC for power supply.
2. If an external power source or a power adapter is utilized to provide the power to the SoC (ADAP\_IN), use a voltage supervisor IC.
3. The Reset IC output pin must be "Open drain" with delay time of  $\leq 10$  ms, and the recommended part is G691L293T73.



### 6.3 Configuration and Firmware Programming

Configuration and Firmware programming modes are entered according to the system configuration I/O pins. The following table provides the system configuration settings. The P2\_0 and P2\_4 pins have internal pull-up.

**Table 6-1. SYSTEM CONFIGURATION SETTINGS**

P2_0	P2_4	EAN	Operating mode
High	High	Low (Flash) High (ROM)	Application mode (normal operation)
Low	High	Low (Flash) High (ROM)	Test mode (write EEPROM)
Low	Low	High	Test mode (write Flash) (only for IS2062GM/64GM)

### 6.4 General Purpose I/O pins

The following table provides the details of various functions that are mapped to the I/O pins of IS2062/64 SoC and these I/Os are configured by using the UI tool.

**Note:** The MFB pin must be configured as the power-on/off key and the remaining pins are configured for any one of the default functions, as provided in the following table.

**Table 6-2. I/O PIN CONFIGURATION**

S.No	Pin Name	IS2062GM and IS2064B	IS2064GM and IS2064S
1	MFB	Button 0 UART_RX_IND	Button 0 UART_RX_IND
2	P0_0	UART_TX_IND Slide Switch	UART_TX_IND Slide Switch
3	P0_1	Button 4 (FWD) CLASS1 TX	Button 4 (FWD) CLASS1 TX
4	P0_2	Button 1 (Play/Pause)	Button 1 (Play/Pause)
5	P0_3	Button 5 (REV) Buzzer Output Ind.1 CLASS1 RX	Button 5 (REV) Buzzer Output Ind.1 CLASS1 RX
6	P0_4	Output Ind.0	Output Ind.0

S.No	Pin Name	IS2062GM and IS2064B	IS2064GM and IS2064S
		External Amplifier Enable	External Amplifier Enable
7	P0_5	Button 3 (VOL-)	Button 3 (VOL-)
8	P1_5	Output Ind.0 Slider Switch External Amplifier Enable Twin Role setting1	Output Ind.0 Slider Switch External Amplifier Enable Twin Role setting1
9	P2_0	System Configuration Buzzer	System Configuration Buzzer
10	P2_7	Button 2 (VOL+)	Button 2 (VOL+)
11	P3_0	Aux-in detect	Aux-in detect
12	P3_1	—	Button 5
13	P3_3	—	Button 4 (FWD)
14	P3_6	—	Twin Role setting 2
15	P3_7	—	UART_TX_IND LED3

## 6.5 I<sup>2</sup>S Mode Application

The IS2064GM and IS2064S/B SoC provide an I<sup>2</sup>S digital audio output interface to connect with the external codec or DSP. It provides 8, 16, 44.1, 48, 88.2 and 96 kHz sampling rates for 16-bit and 24-bit data formats. The I<sup>2</sup>S setting are configured by using the UI and DSP tools.

**Note:** The UI and DSP tools are available for download from the Microchip website at <http://www.microchip.com/wwwproducts/en/IS2062> and <http://www.microchip.com/wwwproducts/en/IS2064>.

The external codec or DSP interfaces with IS2062/64 over these pins: SCLK0, RFS0, DR0, and DT0. The following figures illustrate the I<sup>2</sup>S signal connection between the IS2064GM and IS2064S/B SoC and an external DSP. Use the DSP tool to configure the IS2064GM and IS2064S/B SoC as Master/Slave. For additional information on timing specifications, refer to [Timing Specifications](#).

**Figure 6-9. I<sup>2</sup>S MASTER MODE**

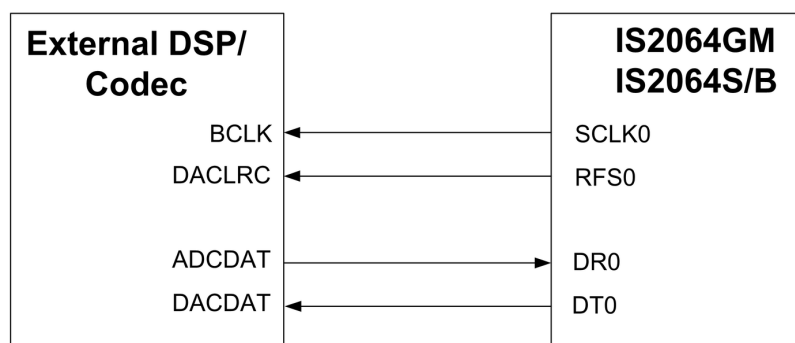
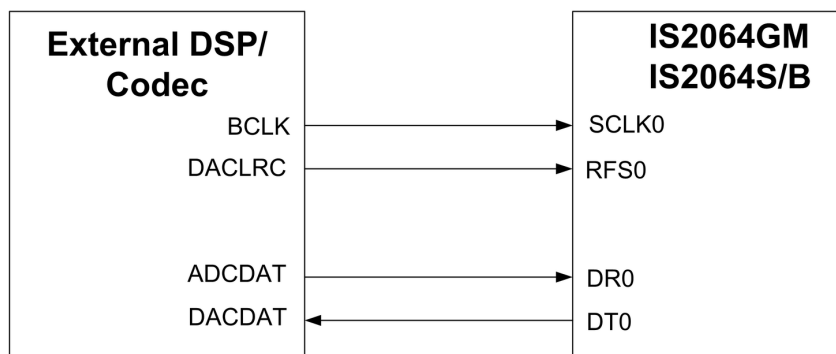


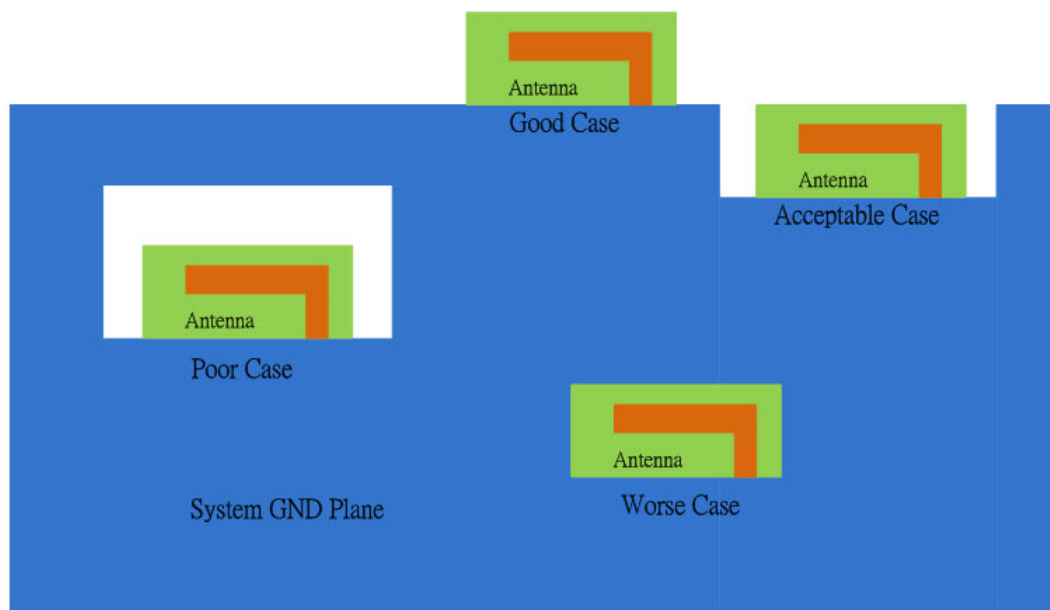
Figure 6-10. I<sup>2</sup>S SLAVE MODE

## 7. Antenna Placement Rule

For Bluetooth enabled products, the antenna placement affects the overall performance. The antenna requires free space to radiate RF signals and it must not be surrounded by the GND plane.

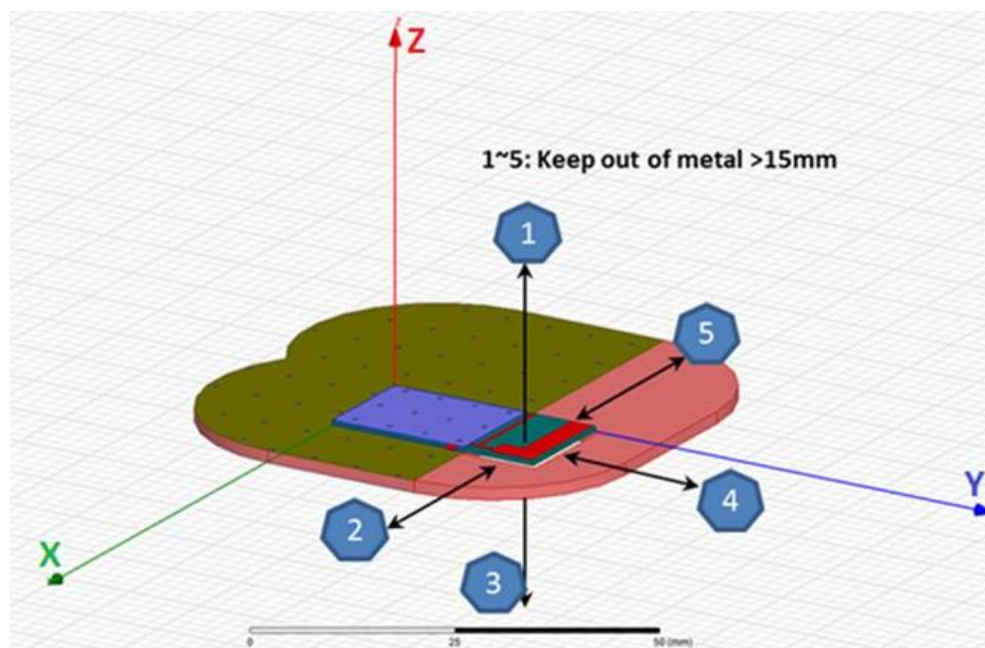
The following figure illustrates a typical example of the good and poor antenna placement on the main application board with the GND plane.

**Figure 7-1. ANTENNA PLACEMENT EXAMPLES**



The following figure illustrates the keep out area recommended for the PCB antenna.

**Figure 7-2. KEEP OUT AREA RECOMMENDED FOR PCB ANTENNA**



**Note:** For additional information on the antenna placement, refer to the antenna specific data sheet from the antenna manufacturer.

## 8. Electrical Characteristics

This section provides an overview of the IS2062/64 SoC electrical characteristics. Additional information to be provided in future revisions of this document, once it is available.

**Table 8-1. ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Min.	Max.	Unit
Ambient temperature under bias	—	-20	+70	°C
Storage temperature	—	-65	+150	°C
Digital core supply voltage	VDD_CORE	0	1.35	V
RF supply voltage	VCC_RF	0	1.35	V
SAR ADC supply voltage	SAR_VDD	0	2.1	V
Codec supply voltage	VDDA/VDDAO	0	3.3	V
I/O supply voltage	VDD_IO	0	3.6	V
Buck supply voltage	BK_VDD	0	4.3	V
Supply voltage	LDO31_VIN	0	4.3	V
Battery input voltage	BAT_IN	0	4.3	V
Adapter input voltage	ADAP_IN	0	7.0	V

**Note:** Stresses listed on the preceding table 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 are not implied. Exposure to maximum rating conditions for extended periods affects device reliability.

The following tables provide the recommended operating conditions and the electrical specifications of the IS2062/64 SoC.

**Table 8-2. RECOMMENDED OPERATING CONDITION**

Parameter	Symbol	Min.	Typ.	Max.	Unit
Digital core supply voltage	VDD_CORE	1.14	1.2	1.26	V
RF supply voltage	VCC_RF	1.22	1.28	1.34	V
SAR ADC supply voltage	SAR_VDD	1.62	1.8	1.98	V
Codec supply voltage	VDDA/ VDDAO	1.8	2.8	3.0	V
I/O supply voltage	VDD_IO	3.0	3.3	—	V
Buck supply voltage	BK_VDD	3	3.8	4.25	V
Supply voltage	LDO31_VIN	3	3.8	4.25	V
Input voltage for battery	BAT_IN	3.2	3.8	4.25	V
Input voltage for adaptor	ADAP_IN	4.5	5	5.5	V
Operation temperature	T <sub>OPERATION</sub>	-20	+25	+70	°C

**Note:** The PMU output powers, BK\_O, CODEC\_VO, RFLDO\_O, and CLDO\_O are programmed through the EEPROM parameters.

**Table 8-3. BUCK REGULATOR**

Parameter	Min.	Typ.	Max.	Unit
Input Voltage	3.0	3.8	4.25	V
Output Voltage ( $I_{load} = 70$ mA and $V_{in} = 4$ V)	1.7	1.8	2.05	V
Output Voltage Accuracy	—	±5	—	%
Output Voltage Adjustable Step	—	50	—	mV/Step
Output Adjustment Range	-0.1	—	+0.25	V
Average Load Current ( $I_{LOAD}$ )	120	—	—	mA
Conversion Efficiency (BAT = 3.8V and $I_{load} = 50$ mA)	—	88 <sup>(1)</sup>	—	%
Quiescent Current (PFM)	—	—	40	µA
Output Current (peak)	200	—	—	mA
Shutdown Current	—	—	<1	µA

**Note:**

1. Test condition: Temperature +25°C and wired inductor 10 µH.
2. These parameters are characterized, but not tested on the manufactured device.

**Table 8-4. LOW DROP REGULATOR**

Parameter	Min.	Typ.	Max.	Unit
Input Voltage	3.0	3.8	4.25	V
Output Voltage	CODEC_VO	—	2.8	V
	LDO31_VO	—	3.3	
Output Accuracy ( $V_{IN} = 3.7$ V, $I_{LOAD} = 100$ mA and +27°C)	—	±5	—	%
Output current (average)	—	—	100	mA
Drop-out voltage ( $I_{load} =$ maximum output current)	—	—	300	mV
Quiescent Current (excluding load and $I_{load} < 1$ mA)	—	45	—	µA
Shutdown Current	—	—	<1	µA

**Note:**

1. Test condition: Temperature +25°C.
2. These parameters are characterized, but not tested on manufactured device.

**Table 8-5. BATTERY CHARGER**

Parameter		Min.	Typ.	Max.	Unit
Input Voltage (ADAP_IN)		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) ( <b>Note 2</b> )	—	175	—	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 on manufactured device.

**Table 8-6. 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	$\mu$ A
Shutdown Current	—	—	1	$\mu$ A

**Note:**

1. Test condition: BK\_O = 1.8V with temperature +25°C.
2. These parameters are characterized, but not tested on manufactured device.

**Table 8-7. AUDIO CODEC DIGITAL TO ANALOG CONVERTER**

Parameter (Condition)	Min.	Typ.	Max.	Unit
Output Sampling Rate	—	128	—	$f_s$
Resolution	16	—	20	Bit
Output Sample Rate	8	—	48	kHz
Signal-to-Noise Ratio ( <b>Note 2</b> ) (SNR @capless mode) for 48 kHz	—	96	—	dB
Signal-to-Noise Ratio ( <b>Note 2</b> ) (SNR @single-ended mode) for 48 kHz	—	98	—	dB
Digital Gain	-54	—	4.85	dB



Parameter (Condition)		Min.	Typ.	Max.	Unit
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 3)		—	0.05	—	%
Signal-to-Noise Ratio (SNR @ 16 Ohm load) (Note 4)		—	98	—	dB

**Note:**

1.  $T = +25^{\circ}\text{C}$ ,  $V_{DD} = 2.8\text{V}$ , 1 kHz sine wave input, Bandwidth = 20 Hz to 20 kHz.
2.  $f_{in} = 1\text{ kHz}$ , B/W = 20 HZ to 20 kHz, A-weighted, THD+N < 0.01%, 0 dBFS signal, Load = 100 kOhm.
3.  $f_{in} = 1\text{ kHz}$ , B/W = 20 HZ to 20 kHz, A-weighted, -1 dBFS signal, Load = 16 Ohm.
4.  $f_{in} = 1\text{ kHz}$ , B/W = 20 HZ to 20 kHz, A-weighted, THD+N < 0.05%, 0 dBFS signal, Load = 16 Ohm.
5. These parameters are characterized, but not tested on manufactured device.

**Table 8-8. AUDIO CODEC ANALOG TO DIGITAL CONVERTER**

Parameter (Condition)		Min.	Typ.	Max.	Unit
Resolution		—	—	16	Bit
Output Sample Rate		8	—	48	kHz
Signal-to-Noise Ratio (Note 2) (SNR @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 mVrms input		—	0.02	—	%

**Note:**

1.  $T = +25^{\circ}\text{C}$ ,  $V_{DD} = 2.8\text{V}$ , 1 kHz sine wave input, Bandwidth = 20 Hz to 20 kHz

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

**Table 8-9. TRANSMITTER SECTION FOR BDR AND EDR**

Parameter	Min.	Typ.	Max.	Bluetooth specification	Unit
Transmit power	—	2 <sup>(3)</sup>	4	-6 to 4	dBm
EDR/BDR relative transmit power	-4	-1.8	1	-4 to 1	dB

**Note:**

- The RF Transmit power is modulation value.
- The RF Transmit power is calibrated during production using the MP tool software and MT8852 Bluetooth test equipment.
- Test condition: VCC\_RF = 1.28V, temperature +25°C.

**Table 8-10. RECEIVER SECTION FOR BDR AND EDR**

Parameter	Packet Type	Min.	Typ.	Max.	Bluetooth specification	Unit
Sensitivity at 0.1% BER	GFSK	—	-89	—	≤-70	dBm
Sensitivity at 0.01% BER	π/4 DQPSK	—	-93	—	≤-70	dBm
	8 DPSK	—	-86	—	≤-70	dBm

**Note:**

- Test condition: VCC\_RF = 1.28V, temperature +25°C.
- These parameters are characterized, but not tested on manufactured device.

**Table 8-11. IS2062GM SYSTEM CURRENT CONSUMPTION**

System Status	Typ.	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:**

- Standby mode: Power-on without Bluetooth link; Link mode: With Bluetooth link in low-power mode.

- Current consumption values are considered with the BM62 EVB as a test platform, BAT\_IN = 3.8V. The distance between smart phone and EVB is 30 cm and the speaker is without loading.

**Table 8-12. IS2064S/B SYSTEM CURRENT CONSUMPTION**

Modes	Condition	Role	Packet Type	IS2064B	IS2064S	Unit
Default UI (1 kHz tone, without LEDs)	Standalone BT mode, with default UI table	Master		10.3	10.1	mA
SCO/eSCO connection (mute at both far end and near end)	Mono audio codec output	Master	HV3	10.6	11	mA
			2EV3	9.3	10.7	mA
			3EV3	NS	NS	mA
		Slave	HV3	12.8	14.7	mA
			2EV3	13.6	14.7	mA
			3EV3	NS	NS	mA
A2DP connection (1 kHz tone, mute, no load)	Internal Codec, Android Slave	Master	DH5	11.4	11.1	mA
			2DH5	10.7	10.1	mA
	Internal Codec, iOS Master	Slave	DH5	10.3	9.7	mA
			2DH5	10.3	9.7	mA
Sniff mode (linked to smartphone, BLE off)	Connection established, but no activity (system idle)	Master		423	427	μA
		Slave		423	427	μA
Inquiry Scan (discoverable by smartphone)	With LEDs			3.8	3.8	mA
	Without LEDs			1.1	1.2	mA
System-off	3.8V at BAT_IN			18	20	μA

**Note:**

- NS = Not Supported.
- The measurements are taken on the IS2064S-114 and IS2064B-114 Validation Platform.
- The distance between the DUT and the smartphone is 20 cm.
- iOS version 10.3.2 and Android version 5.1.1.
- BAT\_IN = 3.8V.
- The current consumption values reflect the average current consumption.

**8.1 Timing Specifications**

The following figures illustrate the timing diagram of the IS2062/64 SoC in I<sup>2</sup>S and PCM modes.

Figure 8-1. TIMING DIAGRAM FOR I<sup>2</sup>S MODES (MASTER/SLAVE)

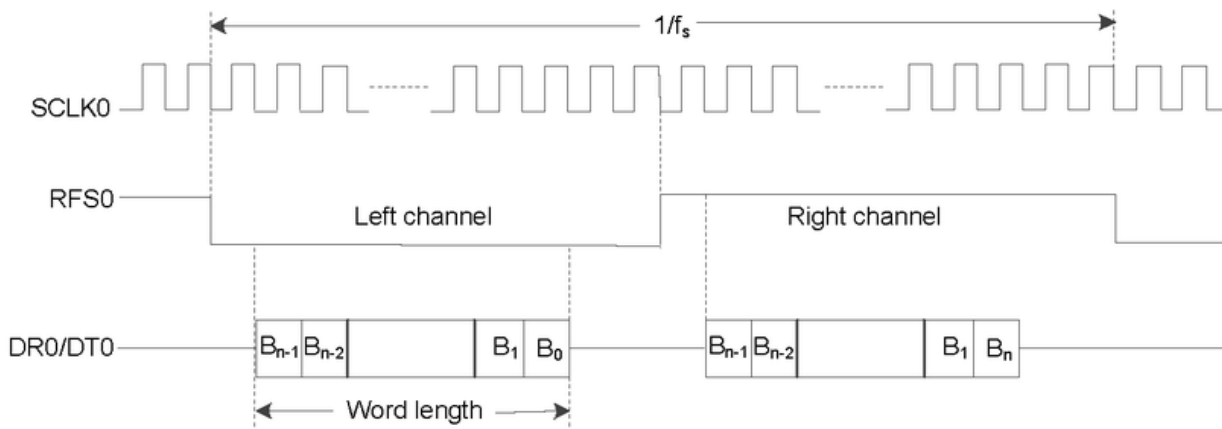
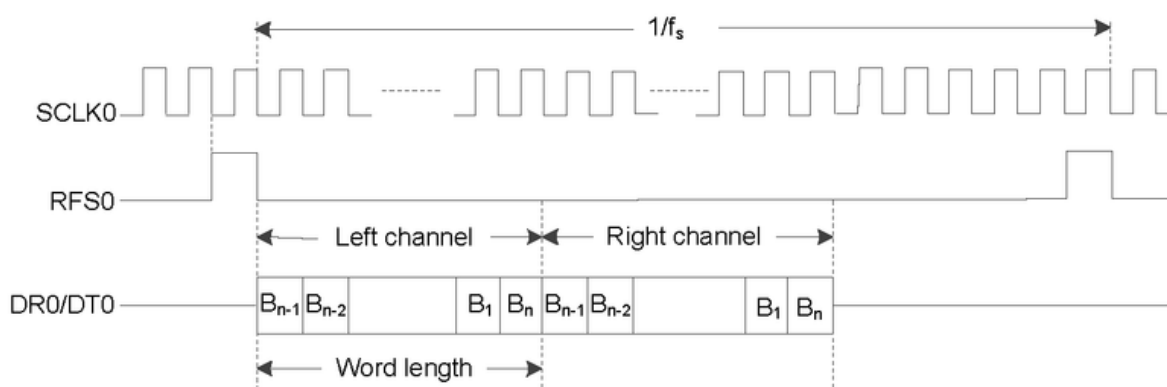


Figure 8-2. TIMING DIAGRAM FOR PCM MODES (MASTER/SLAVE)

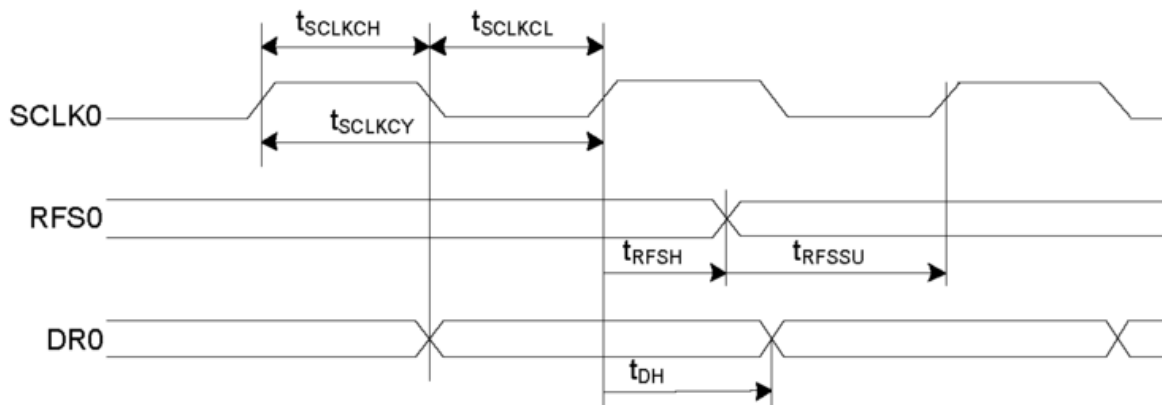


**Note:**

1.  $f_s$ : 8, 16, 32, 44.1, 48, 88.2 and 96 kHz.
2. SCLK0:  $64 \times f_s / 256 \times f_s$ .
3. Word length: 16-bit and 24-bit.

The following figure illustrates the audio interface timing diagram.

Figure 8-3. AUDIO INTERFACE TIMING



The following table provides the timing specifications of the audio interface.

Table 8-13. AUDIO INTERFACE TIMING SPECIFICATIONS

Parameter	Symbol	Min.	Typ.	Max.	Unit
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 =  $256 f_s$

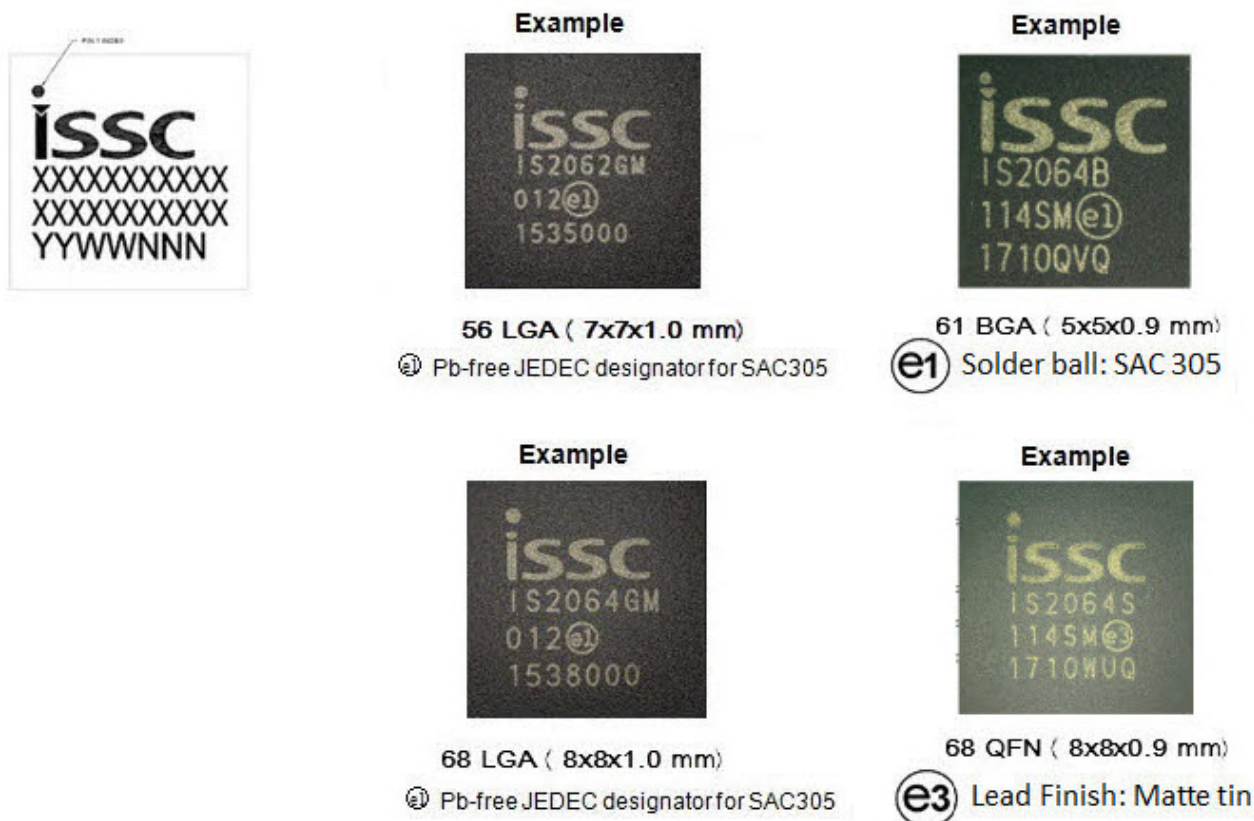
## 9. Packaging Information

This section provide the details on package marking information, package details and footprint dimensions of the IS2062/64 SoC.

### 9.1 Package Marking Information

The following figures illustrate the package marking information of the IS2062GM, IS2064GM, IS2064S and IS2064B.

Figure 9-1. PACKAGE MARKING INFORMATION



#### Legend:

XXX: Chip serial number version and

(e1) Pb-free JEDEC designator for SAC305

YY: Year code (last 2 digits of calendar year)

WW: Week code (week of January 1 is week "01")

NNN: Alphanumeric traceability code

#### Note:

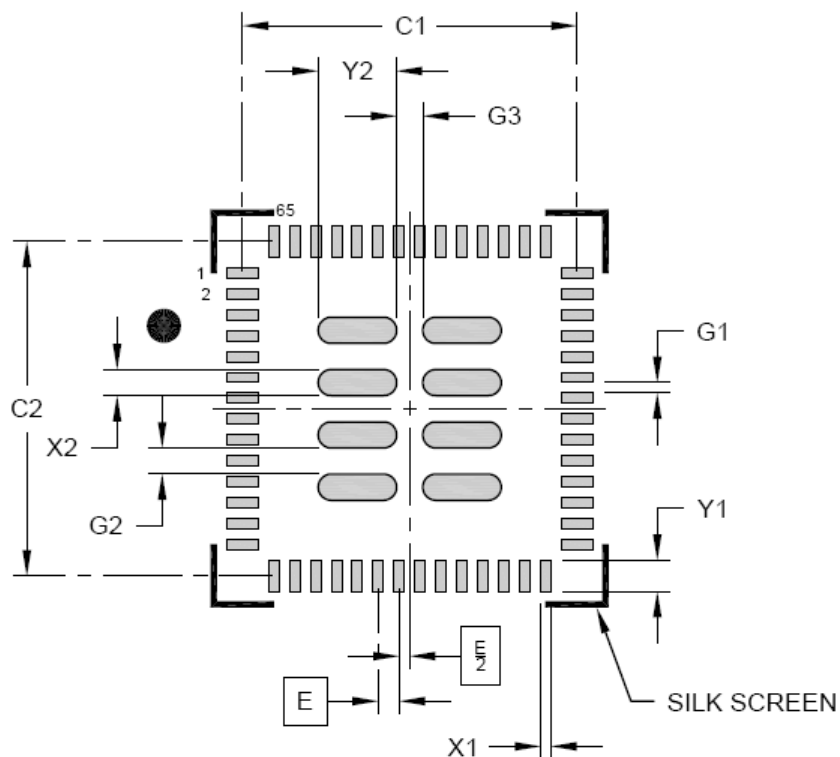
(1) SAC305 is the pre-solder version. Customer need to take care solder paste before screen printing.

## 9.2 Package Details

### 9.2.1 56-Lead Land Grid Array (VZ) - 7x7x1 mm Body (LGA)

The following figure illustrates the footprint dimensions of the IS2062GM SoC.

Figure 9-2. IS2062GM FOOTPRINT DIMENSIONS



## RECOMMENDED LAND PATTERN

Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Contact Pitch	E	0.40 BSC		
Center Pad Width (X8)	X2			0.50
Center Pad Length (X8)	Y2			1.50
Contact Pad Spacing	C1		6.40	
Contact Pad Spacing	C2		6.40	
Contact Pad Width (X56)	X1			0.20
Contact Pad Length (X56)	Y1			0.60
Contact Pad to Pad (X52)	G1	0.20		
Center Pads Clearance (X6)	G2		0.50	
Center Pads Clearance X4	G3		0.50	

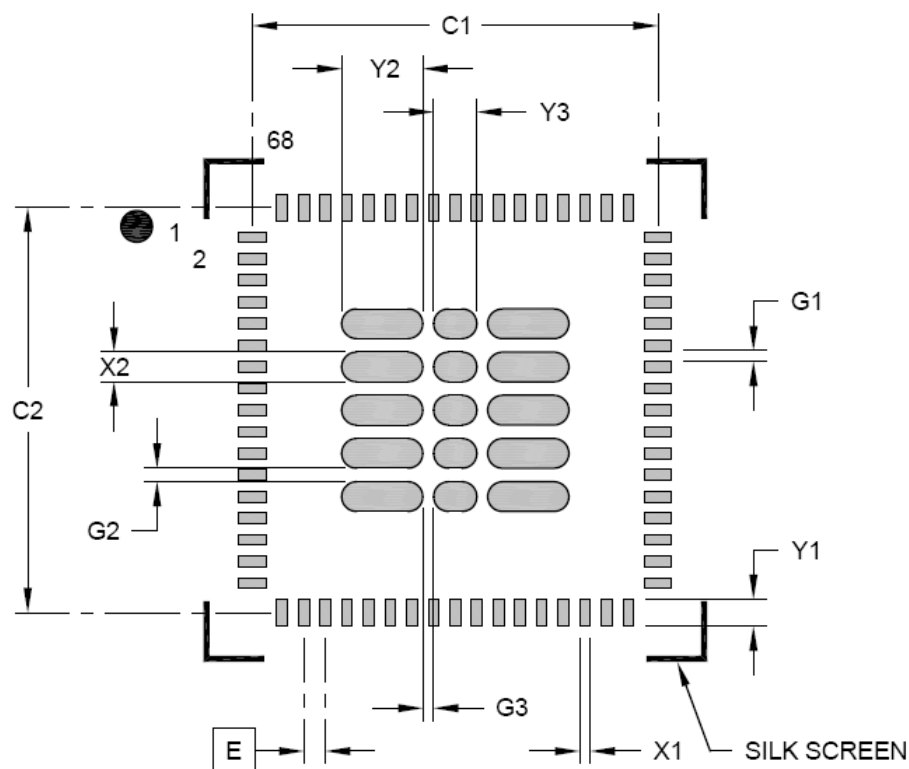
**Note:**

1. Dimensioning and tolerance per ASME Y14.5M
  - BSC: Basic Dimension. Theoretically exact value shown without tolerances.
2. For best soldering results, thermal vias if used, must be filled or tinned to avoid solder loss during reflow process.
3. For the most current package drawings, see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>.

**9.2.2 68-Lead Land Grid Array (VZ) - 8x8x1 mm Body (LGA)**

The following figure illustrates the footprint dimensions of the IS2064GM SoC.

Figure 9-3. IS2064GM FOOTPRINT DIMENSIONS



## RECOMMENDED LAND PATTERN

Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Contact Pitch	E	0.40 BSC		
Center Pad Width (X10)	X2			0.55
Center Pad Length (X10)	Y2			1.50
Center Pad Length (X5)	Y3			0.80
Contact Pad Spacing	C1		7.50	
Contact Pad Spacing	C2		7.50	
Contact Pad Width (X68)	X1			0.20
Contact Pad Length (X68)	Y1			0.50
Contact Pad to Pad (X68)	G1	0.20		
Center Pads Clearance (X12)	G2	0.20		
Center Pads Clearance (X10)	G3	0.20		

**Note:**

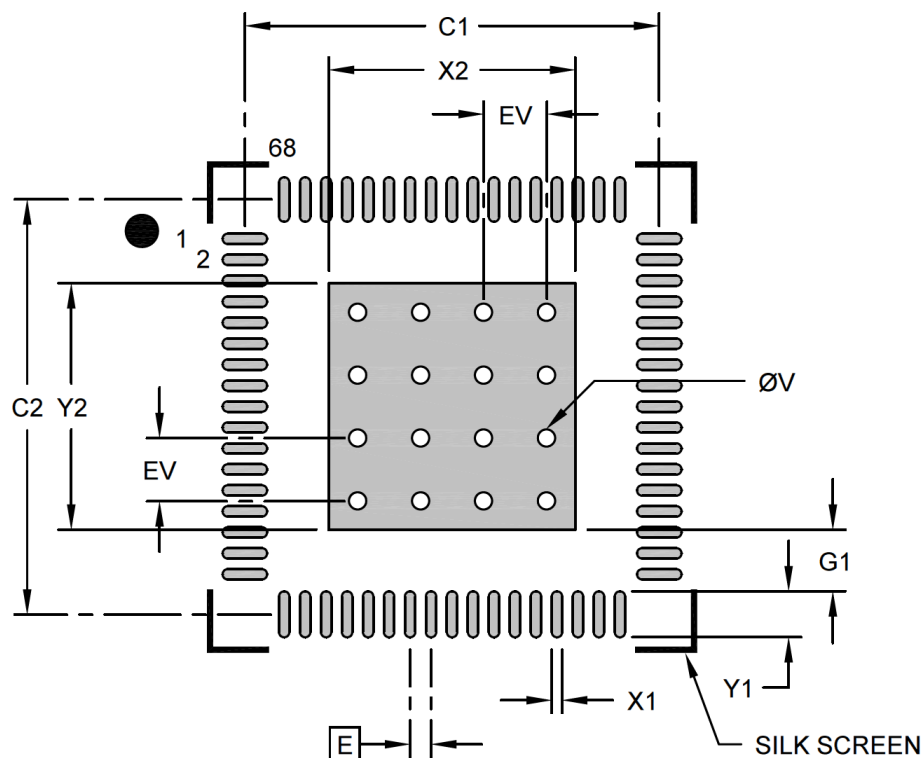
- Dimensioning and tolerance per ASME Y14.5M
  - BSC: Basic Dimension. Theoretically exact value shown without tolerances.
- For best soldering results, thermal vias if used, must be filled or tinned to avoid solder loss during reflow process.
- For the most current package drawings, see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>.

**9.2.3 68-Lead Very Thin Plastic Quad Flat, No Lead Package (VZ) - 8x8x0.9 mm Body (VQFN)**

The following figure illustrates the footprint dimensions of the IS2064S SoC.



Figure 9-4. IS2064S FOOTPRINT DIMENSIONS



## RECOMMENDED LAND PATTERN

Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Contact Pitch	E	0.40 BSC		
Optional Center Pad Width	X2			4.70
Optional Center Pad Length	Y2			4.70
Contact Pad Spacing	C1		7.90	
Contact Pad Spacing	C2		7.90	
Contact Pad Width (X68)	X1			0.20
Contact Pad Length (X68)	Y1			0.85
Contact Pad to Center Pad (X68)	G1	0.20		
Thermal Via Diameter	V		0.33	
Thermal Via Pitch	EV		1.20	

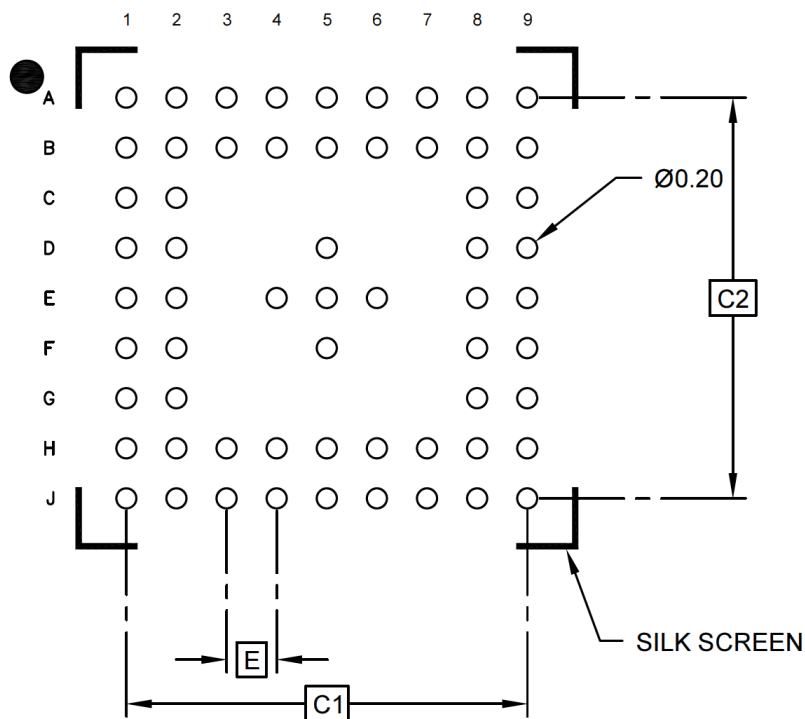
**Note:**

1. Dimensioning and tolerance per ASME Y14.5M
  - BSC: Basic Dimension. Theoretically exact value shown without tolerances.
2. For best soldering results, thermal vias if used, must be filled or tinned to avoid solder loss during reflow process.
3. For the most current package drawings, see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>.

**9.2.4 61-Ball Very Thin Fine Pitch Ball Grid Array (5HX) - 5x5x0.9 mm Body (VFPGA)**

The following figure illustrates the footprint dimensions of the IS2064B SoC.

Figure 9-5. IS2064B FOOTPRINT DIMENSIONS



RECOMMENDED LAND PATTERN

Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Contact Pitch	E	0.50 BSC		
Contact Pad Spacing	C1		4.00	
Contact Pad Spacing	C2		4.00	
Contact Pad Diameter (X61)	X1			0.20

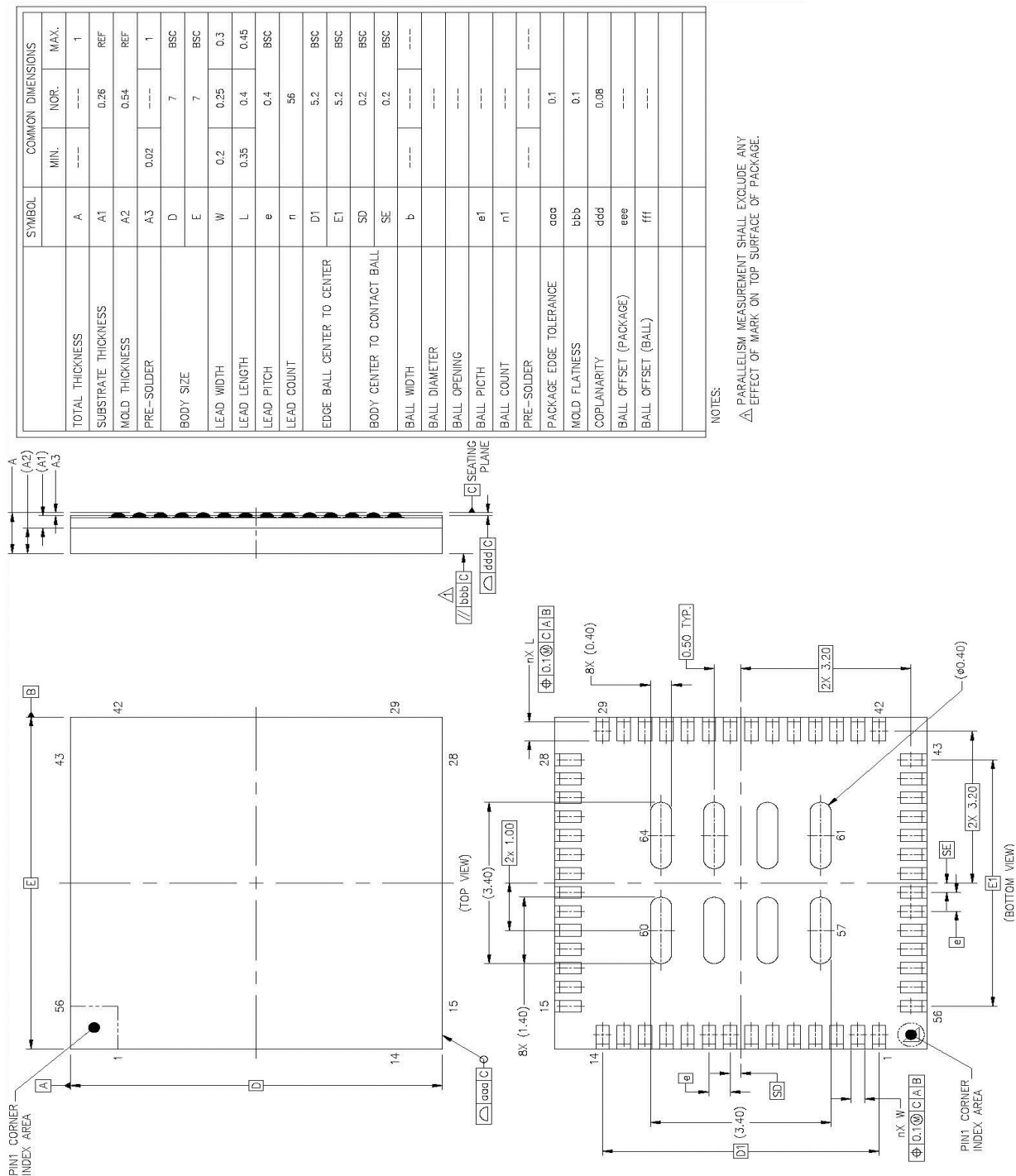
Note:

1. Dimensioning and tolerance per ASME Y14.5M
  - BSC: Basic Dimension. Theoretically exact value shown without tolerances.
2. For the most current package drawings, see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>.

9.2.5 IS2062GM-SAC305

The following figure illustrates the package details of the IS2062GM-SAC305.

Figure 9-6. IS2062GM-SAC305 PACKAGE DETAILS



**Note:** For the most current package drawings, see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>.

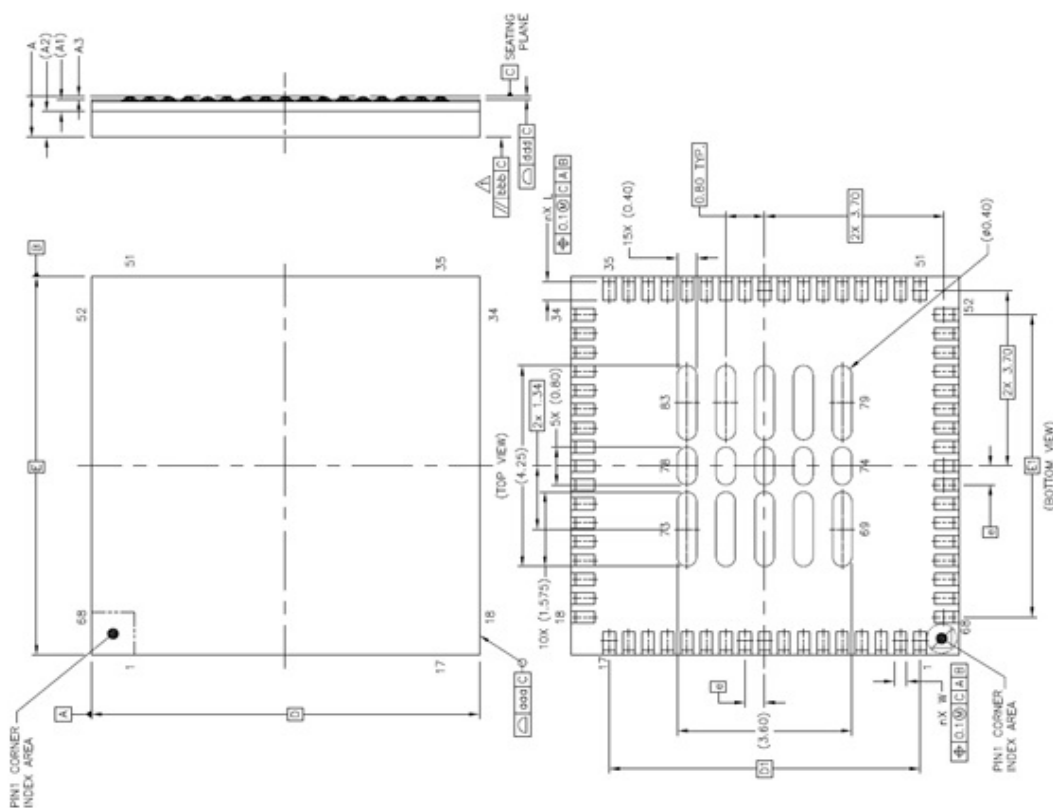
9.2.6 IS2064GM-SAC305

The following figure illustrates the package details of the IS2064GM-SAC305.

Figure 9-7. IS2064GM-SAC305 PACKAGE DETAILS

	SYMBOL	COMMON DIMENSIONS		
		MIN.	NDR.	MAX.
TOTAL THICKNESS	A	---	---	1
SUBSTRATE THICKNESS	A1	0.26		REF
MOLD THICKNESS	A2	0.54		REF
BODY SIZE	D	B		BSC
	E	B		BSC
LEAD WIDTH	W	0.2	0.25	0.3
LEAD LENGTH	L	0.35	0.4	0.45
LEAD PITCH	ø	0.4		BSC
LEAD COUNT	n		68	
EDGE BALL CENTER TO CENTER	D1		6.4	BSC
	E1		6.4	BSC
	SD			BSC
BODY CENTER TO CONTACT BALL	SE			BSC
BALL WIDTH	b	---	---	---
BALL DIAMETER				
BALL OPENING				
BALL PITCH	e1			
BALL COUNT	n1			
PRE-SOLDER	A3	0.02		0.1
PACKAGE EDGE TOLERANCE	aaa			0.1
MOLD FLATNESS	bbb			0.1
COPLANARITY	ddd			0.08
BALL OFFSET (PACKAGE)	eee			---
BALL OFFSET (BALL)	fff			---

NOTES:  
 ▲ PARALLELISM MEASUREMENT SHALL EXCLUDE ANY EFFECT OF MARK ON TOP SURFACE OF PACKAGE.



**Note:** For the most current package drawings, see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>.

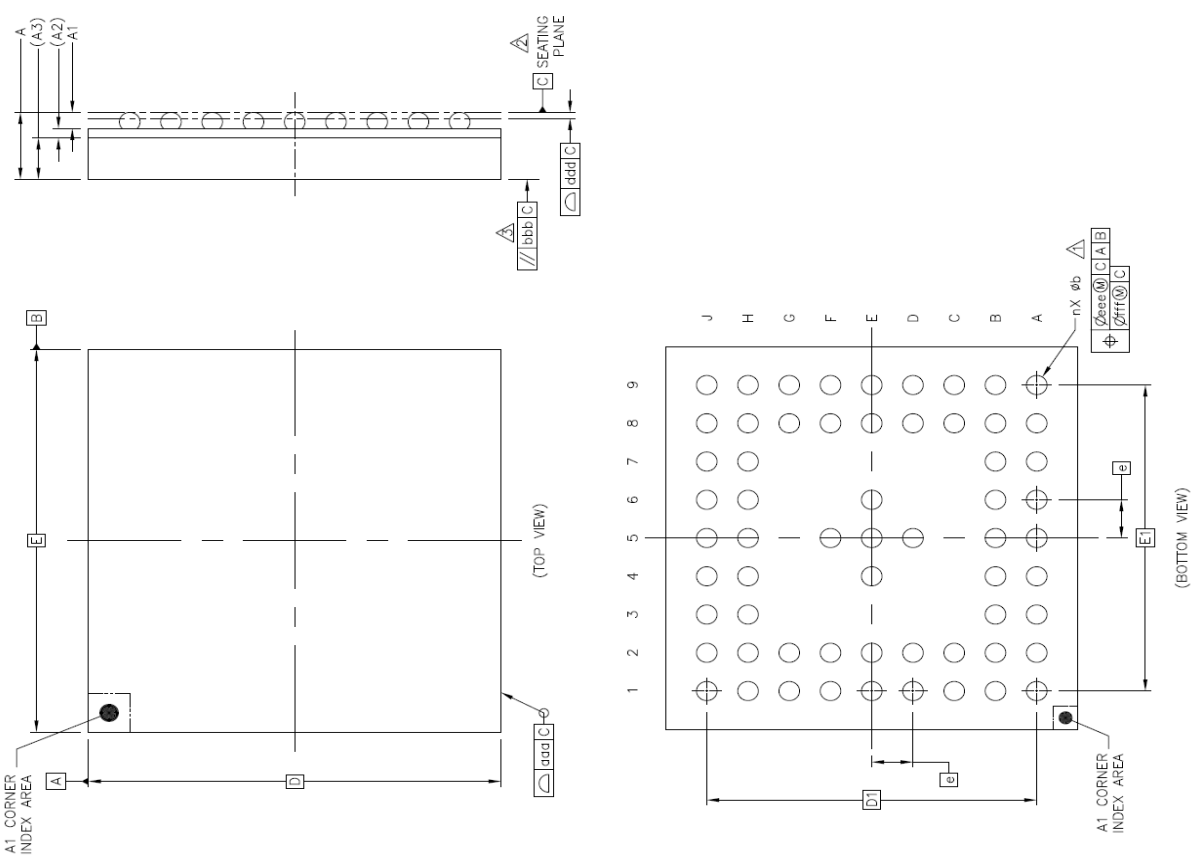
9.2.7 IS2064S-QFN

The following figure illustrates the package details of the IS2064S-QFN.

Figure 9-8. IS2064S-QFN PACKAGE DETAILS

	SYMBOL	COMMON DIMENSIONS		
		MIN.	NOR.	MAX.
TOTAL THICKNESS	A	---	---	0.9
STAND OFF	A1	0.11	---	0.21
SUBSTRATE THICKNESS	A2	0.125	REF	REF
MOLD THICKNESS	A3	0.54	REF	REF
BODY SIZE	D	5	BSC	BSC
	E	5	BSC	BSC
BALL DIAMETER		0.25		
BALL OPENING		0.25		
BALL WIDTH	b	0.2	---	0.3
BALL PITCH	e	0.5	BSC	BSC
BALL COUNT	n	61		
EDGE BALL CENTER TO CENTER	D1	4	BSC	BSC
	E1	4	BSC	BSC
BODY CENTER TO CONTACT BALL	SD	---	BSC	BSC
	SE	---	BSC	BSC
PACKAGE EDGE TOLERANCE	aaa	0.1		
MOLD FLATNESS	bbb	0.2		
COPLANARITY	ddd	0.08		
BALL OFFSET (PACKAGE)	eee	0.15		
BALL OFFSET (BALL)	fff	0.08		

- NOTES:
- △ DIMENSION b IS MEASURED AT THE MAXIMUM SOLDER BALL DIAMETER, PARALLEL TO DATUM PLANE C.
  - △ DATUM C (SEATING PLANE) IS DEFINED BY THE SPHERICAL CROWNS OF THE SOLDER BALLS.
  - △ PARALLELISM MEASUREMENT SHALL EXCLUDE ANY EFFECT OF MARK ON TOP SURFACE OF PACKAGE.

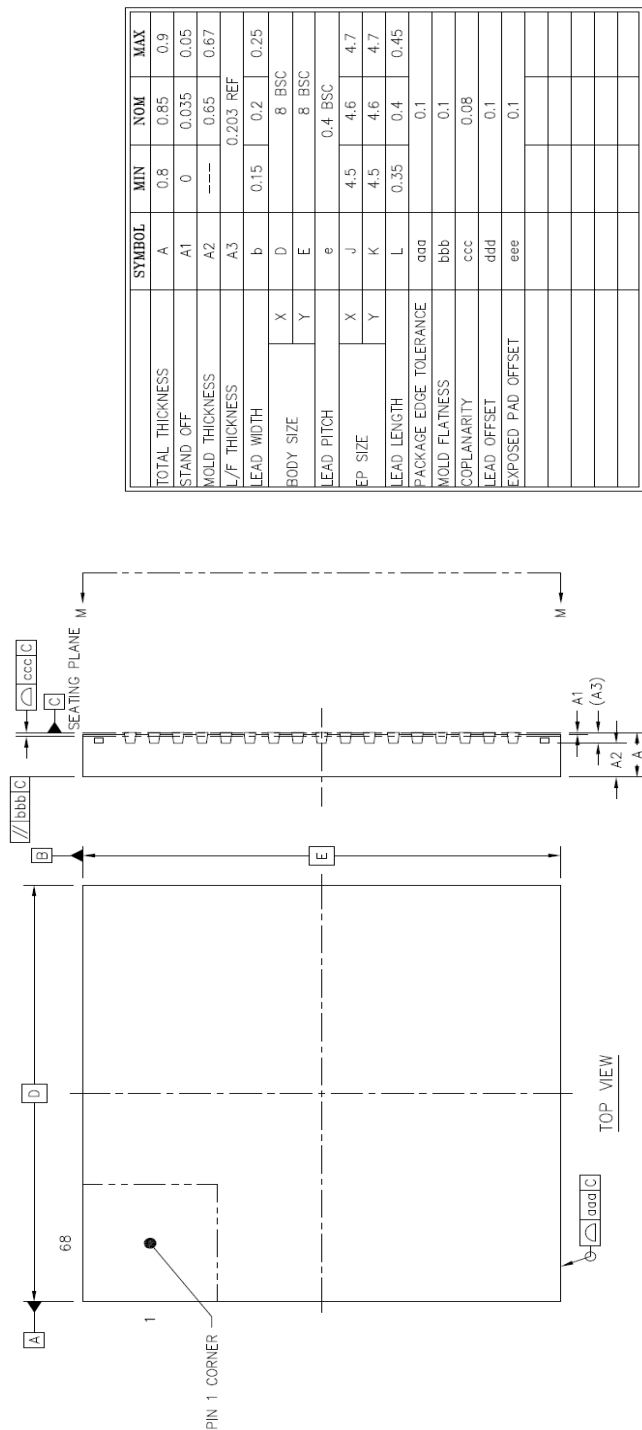


**Note:** For the most current package drawings, see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>.

9.2.8 IS2064B-BGA

The following figure illustrates the package details of the IS2064B-BGA.

Figure 9-9. IS2064B-BGA PACKAGE DETAILS



	SYMBOL	MIN	NOM	MAX
TOTAL THICKNESS	A	0.8	0.85	0.9
STAND OFF	A1	0	0.035	0.05
MOLD THICKNESS	A2	---	0.65	0.67
L/F THICKNESS	A3	0.203 REF		
LEAD WIDTH	b	0.15	0.2	0.25
BODY SIZE	X	8 BSC		
	Y	8 BSC		
LEAD PITCH	e	0.4 BSC		
EP SIZE	X	J	4.5	4.6
	Y	K	4.5	4.6
LEAD LENGTH	L	0.35	0.4	0.45
PACKAGE EDGE TOLERANCE	aaa	0.1		
MOLD FLATNESS	bbb	0.1		
COPLANARITY	ccc	0.08		
LEAD OFFSET	ddd	0.1		
EXPOSED PAD OFFSET	eee	0.1		

NOTES  
 1.0 COPLANARITY APPLIES TO LEADS, CORNER LEADS AND DIE ATTACH PAD.

**Note:** For the most current package drawings, see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>.

## 10. Reflow Profile and Storage Condition

This section describes about the Solder Reflow Recommendation and Storage Condition of the IS2062GM/64GM SoC.

### 10.1 Solder Reflow Recommendation

Refer to Microchip Technology Application Note "AN233 Solder Reflow Recommendation" (DS00000233) for the soldering reflow recommendations from the Microchip website: <http://ww1.microchip.com/downloads/en/appnotes/00233d.pdf>.

### 10.2 Storage Condition

Users must follow these specific storage conditions for the IS2062/64 SoC.

- Calculated shelf life in the sealed bag: 24 months at <40°C and <90% Relative Humidity (RH)
- Once the bag is opened, devices that are subjected to reflow solder or other high temperature process must be mounted within 168 hours of factory conditions, that is <30°C /60% RH

The following figure illustrates the IS2062/64 SoC bag label details.

**Figure 10-1. STORAGE CONDITIONS**



1. Calculated shelf life in sealed bag : **24** months at < 40°C and <90% relative humidity ( RH )
2. Peak package body temperature: \_\_\_\_\_ °C  
If blank, see adjacent bar code label
3. After bag is opened, devices that will be subjected to reflow solder or other high temperature process must be
  - a) Mounted within: **168** hours of factory conditions  
If blank, see adjacent bar code label  
≤30°C/60% RH, or
  - b) Stored per J-STD-033
4. Devices require bake, before mounting, if:
  - a) Humidity Indicator Card reads > 10% for level 2a - 5a devices or > 60% for level 2 devices when read at 23± 5°C
  - b) 3a or 3b are not met.
5. If baking is required, refer to IPC/JEDEC J-STD-033 for bake procedure.

Bag Seal Date: \_\_\_\_\_  
If blank, see adjacent bar code label

Note: Level and body temperature defined by IPC/JEDEC J-STD-020

## 11. Ordering Information

The following table provides the ordering information of the IS2062/64 SoC.

**Table 11-1. ORDERING INFORMATION**

Device	Description	Package	Part Number
IS2062GM	Bluetooth 4.2, Flash SoC, 2 microphones, Analog output	7x7x1.0 mm, 56-LGA package	IS2062GM-012
IS2064GM	Bluetooth 4.2, Flash SoC, 1 microphone, Analog and I <sup>2</sup> S output	8x8x1.0 mm, 68-LGA package	IS2064GM-012
IS2064S	Bluetooth 4.2, ROM SoC Stereo mode, 1 microphone, Analog and I <sup>2</sup> S output	8x8x0.9 mm, 68-QFN package	IS2064S-114SM
IS2064B	Bluetooth 4.2, ROM SoC Stereo mode, 2 microphone, Analog and I <sup>2</sup> S output	5x5x0.9 mm, 61-BGA package	IS2064B-114SM

**Note:** The IS2062/64 SoC is purchased through a Microchip representative. Go to <http://www.microchip.com/> for ordering information.



## **12. Reference Circuit**

This section provides the reference schematics of IS2062GM, IS2064GM, IS2064S and IS2064B used in stereo headset application.

The following figures illustrate the IS2062GM reference schematics for the stereo headset application.

Figure 12-1. IS2062GM REFERENCE CIRCUIT FOR STEREO HEADSET

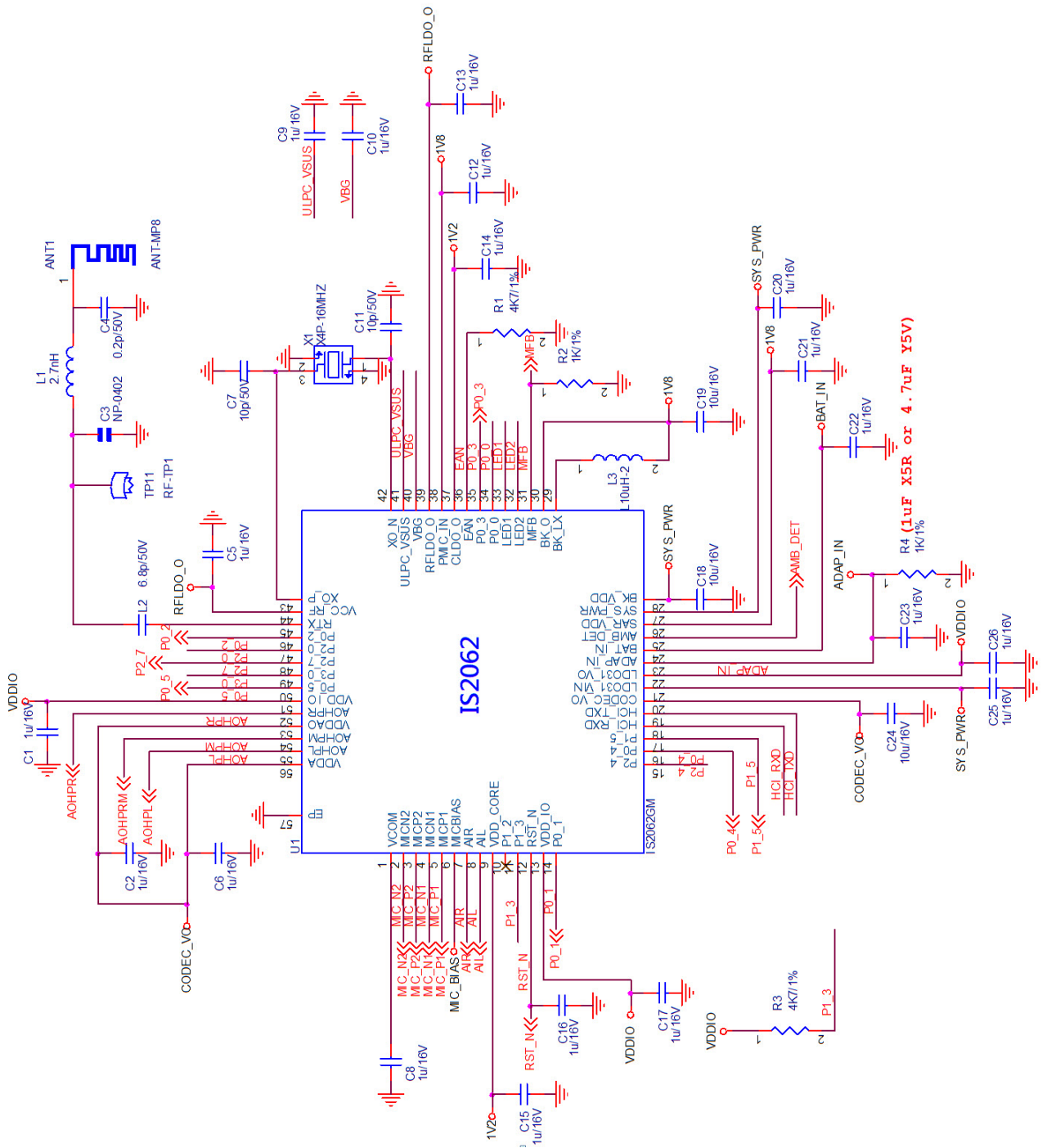


Figure 12-2. IS2062GM REFERENCE CIRCUIT FOR STEREO HEADSET

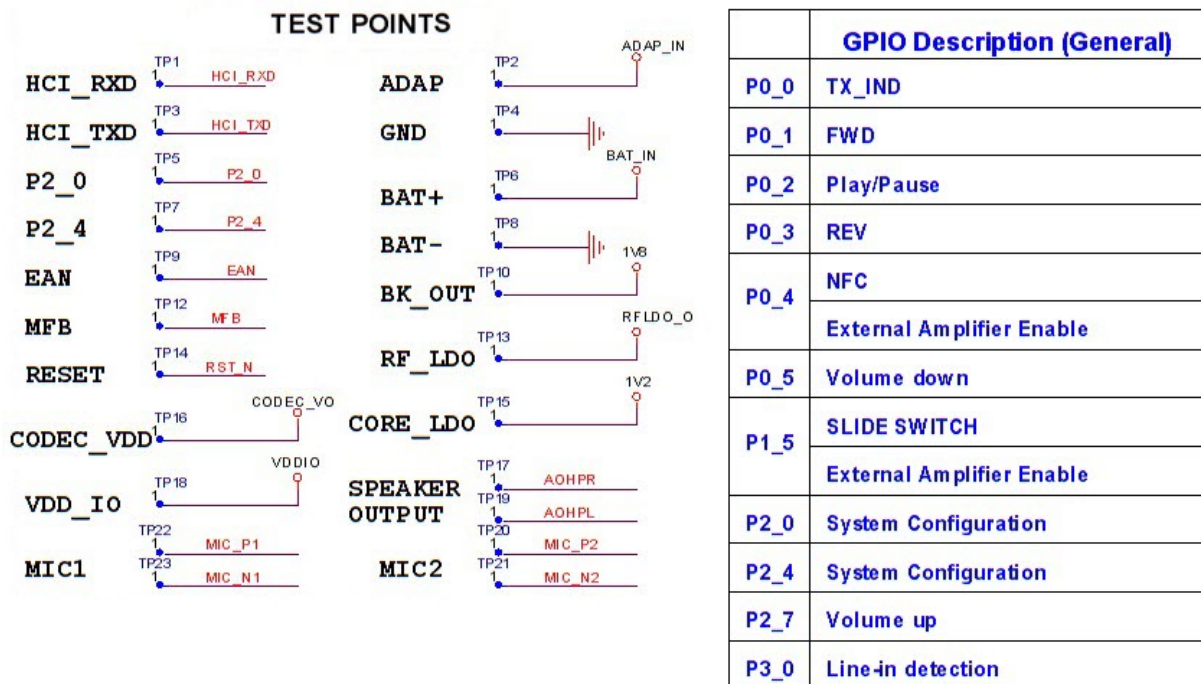
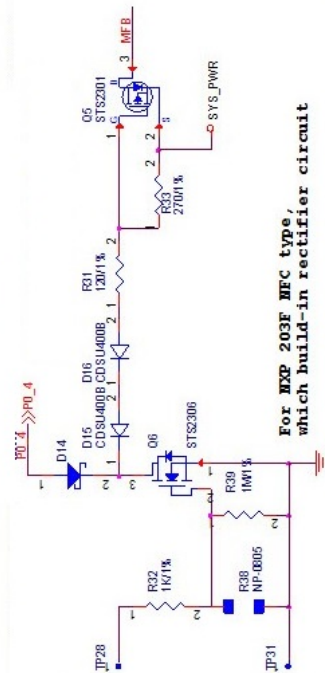
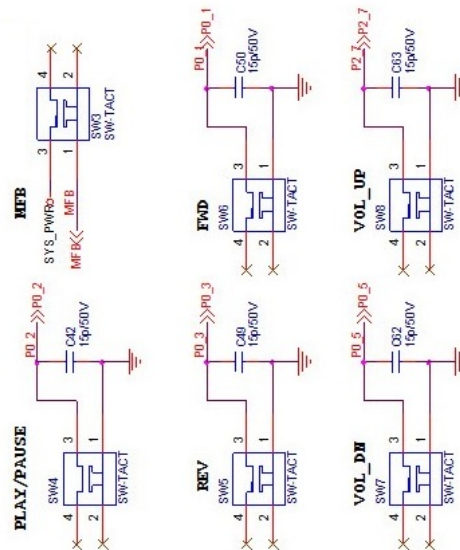


Figure 12-3. IS2062GM REFERENCE CIRCUIT FOR STEREO HEADSET

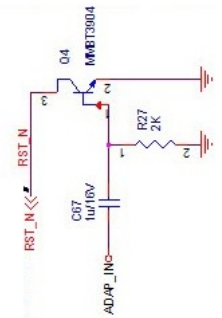
**NFC(OPTIONAL)**



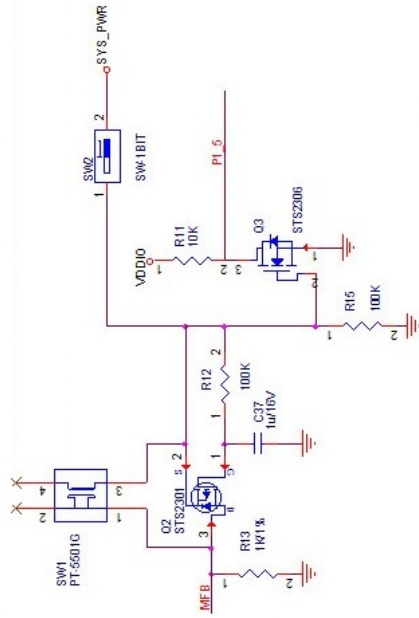
**SWITCH**



**Reset (OPTIONAL)**



**SLIDE SWITCH(OPTIONAL)**



**AMB DET**

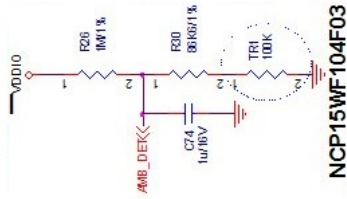
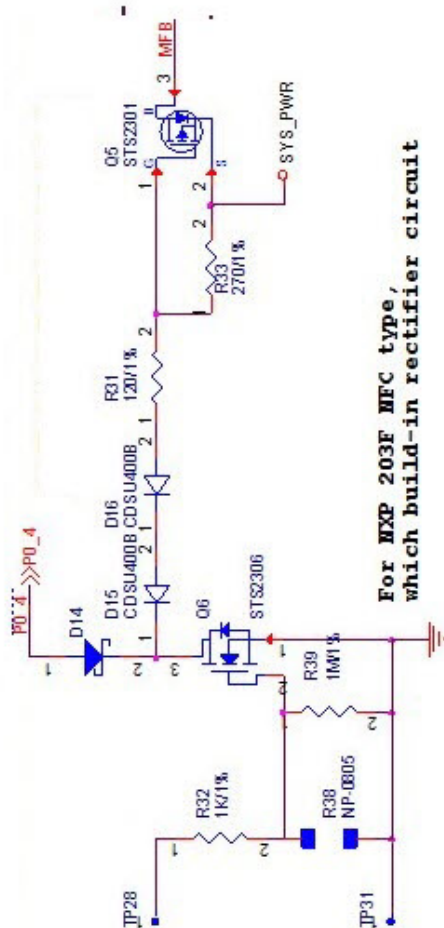


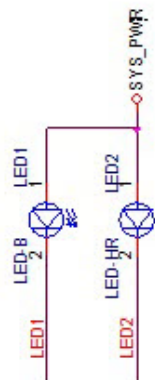
Figure 12-4. IS2062GM REFERENCE CIRCUIT FOR STEREO HEADSET

**NFC (OPTIONAL)**

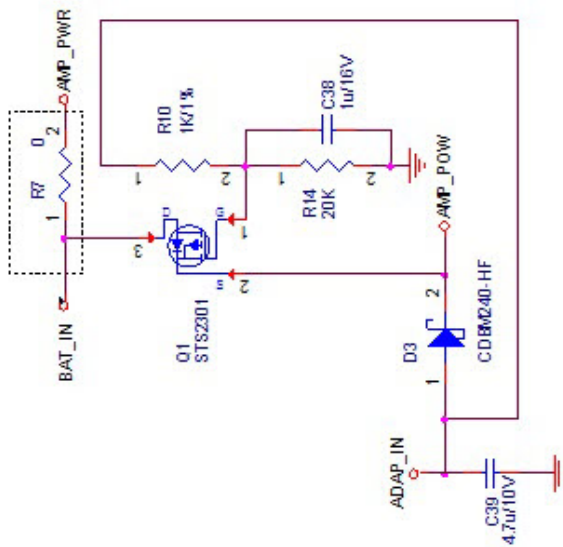


For MXP 203F NFC type,  
which build-in rectifier circuit

**LED**



**EXT POWER TREE (OPTIONAL)**



**Reset IC (OPTIONAL)**

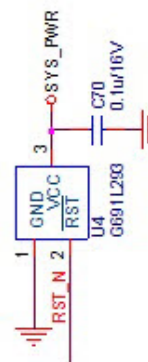


Figure 12-5. IS2062GM REFERENCE CIRCUIT FOR STEREO HEADSET

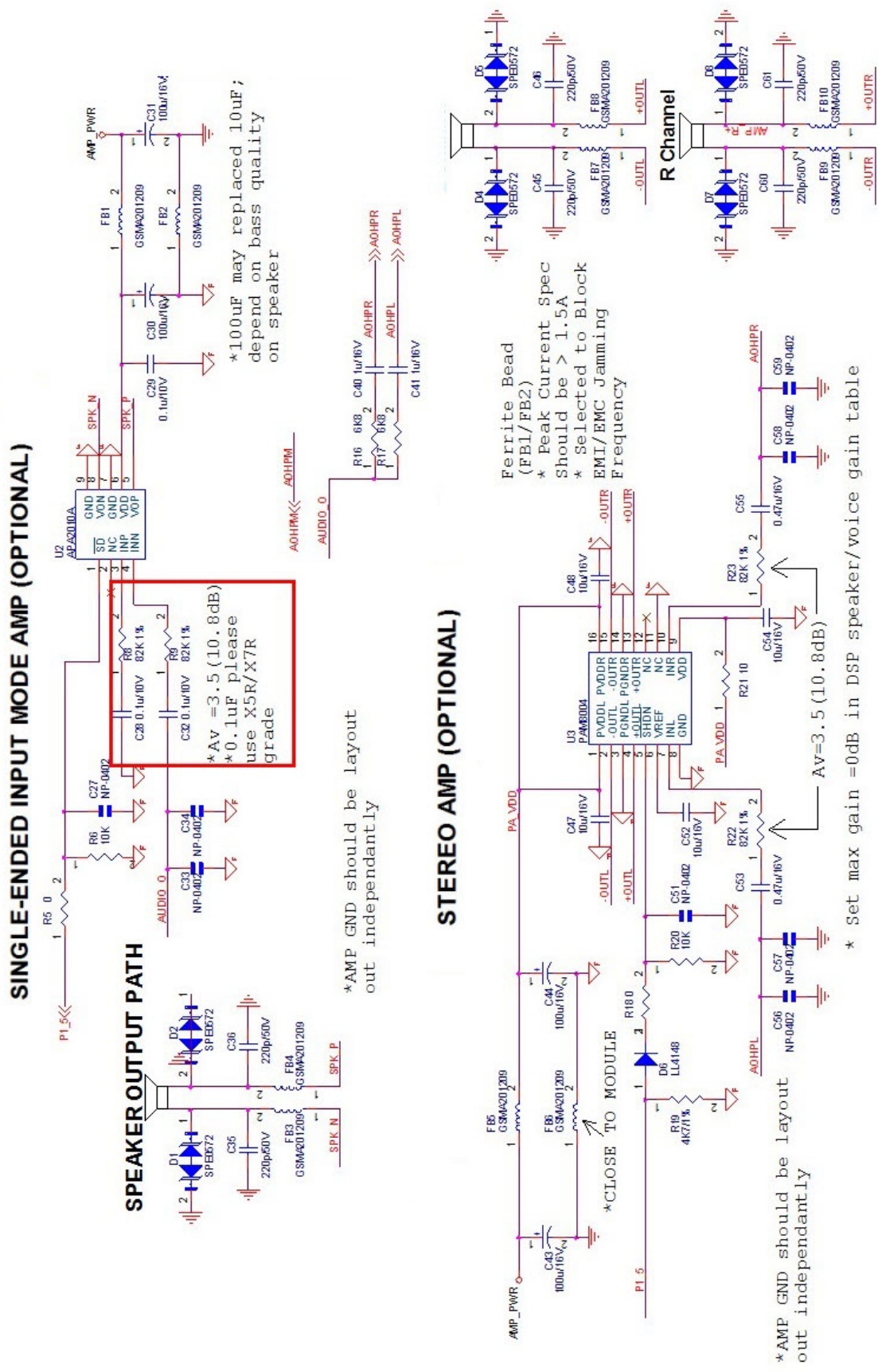
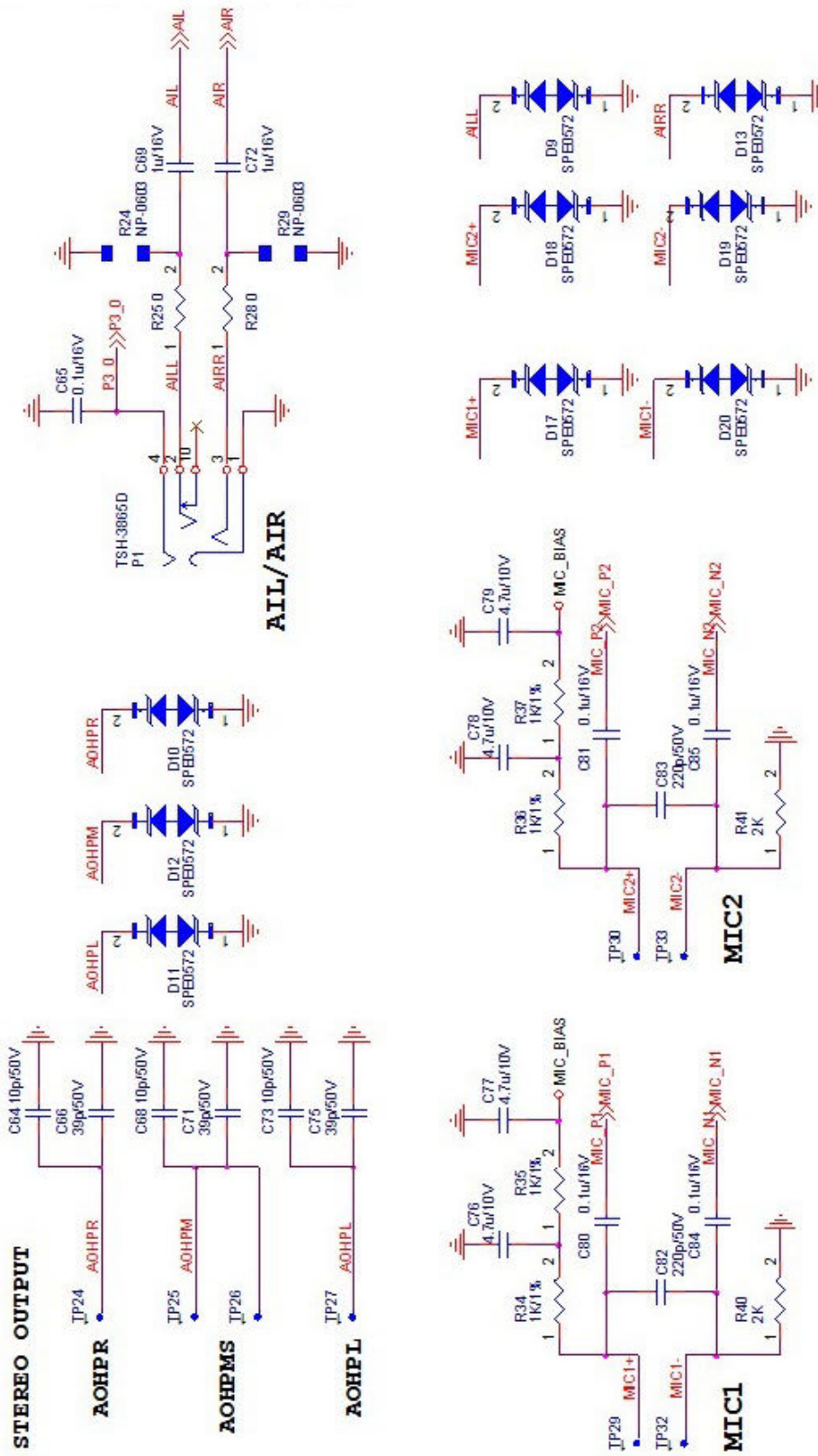




Figure 12-6. IS2062GM REFERENCE CIRCUIT FOR STEREO HEADSET

AUDIO MICROPHONE/SPEAKER OUTPUT



Note: All ESD diodes in this schematics are reserved for the testing.

The following figures illustrate the IS2064GM reference schematics for the stereo headset application.



Figure 12-7. IS2064GM REFERENCE CIRCUIT FOR STEREO HEADSET

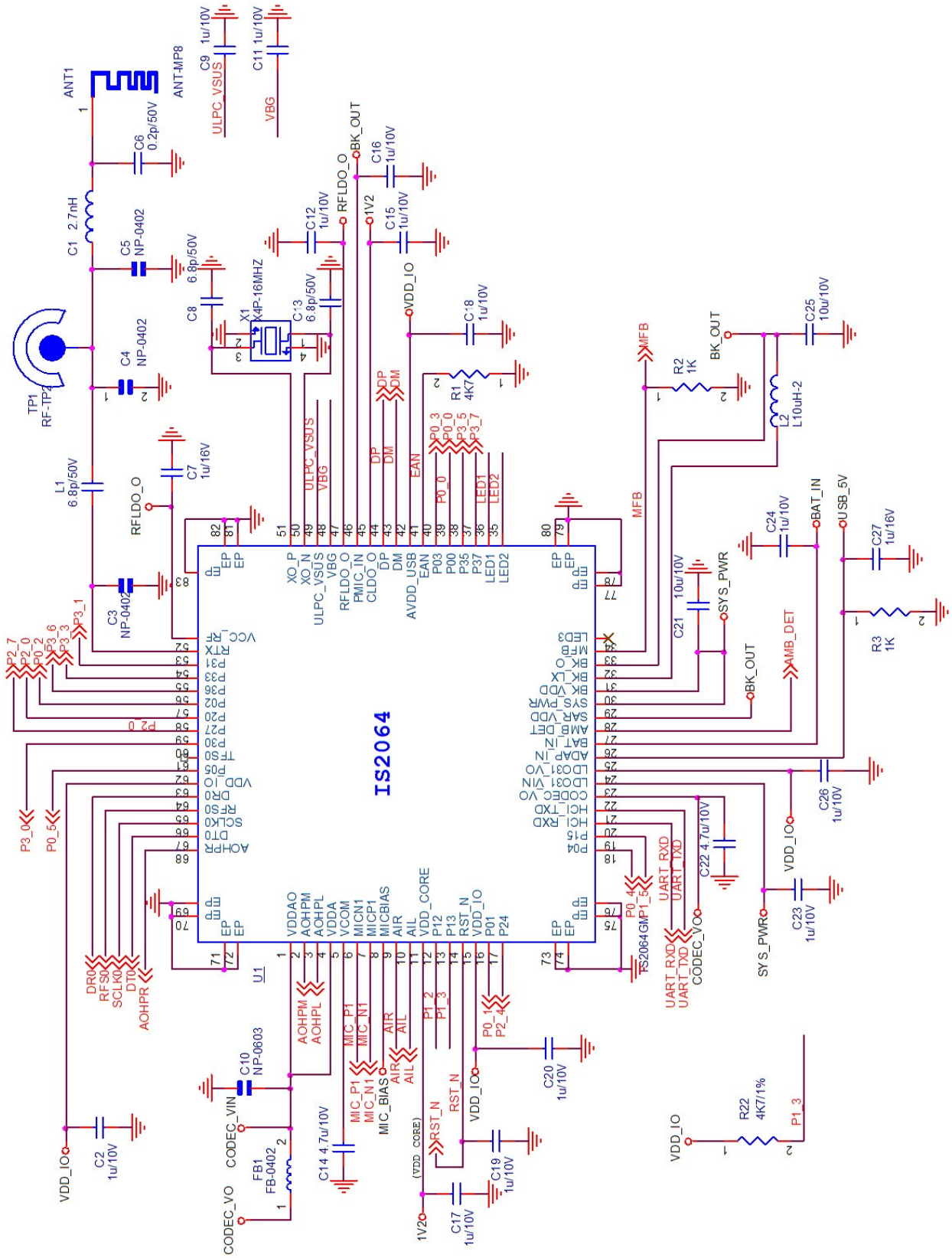
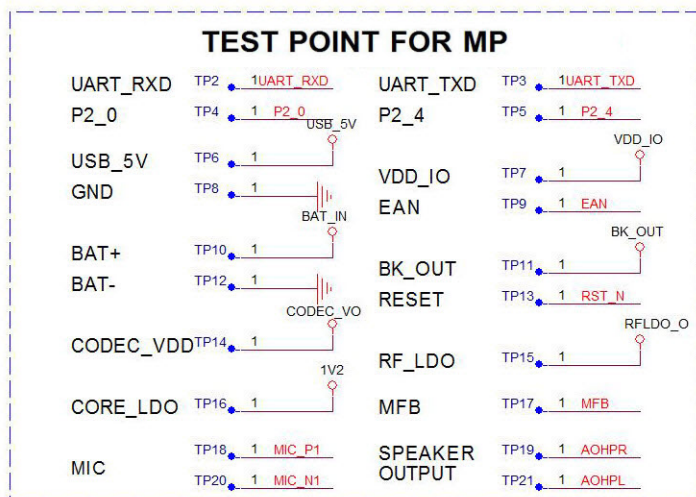


Figure 12-8. IS2064GM REFERENCE CIRCUIT FOR STEREO HEADSET



**GPIO DESCRIPTION**

MFB	UART_RX_IND; MFB
P0_0	SLIDE SWITCH
P0_2	PLAY/PAUSE
P0_4	AMP_EN/NFC
P0_5	VOL-
P2_7	VOL+
P3_0	AUX IN Detection
P3_7	UART_TX_IND
P1_5	AMP_EN/SLIDE SWITCH
	Single/Double setting
P3_6	Single/Double setting
P2_0	System Configuration
EAN	System Configuration

Figure 12-9. IS2064GM REFERENCE CIRCUIT FOR STEREO HEADSET

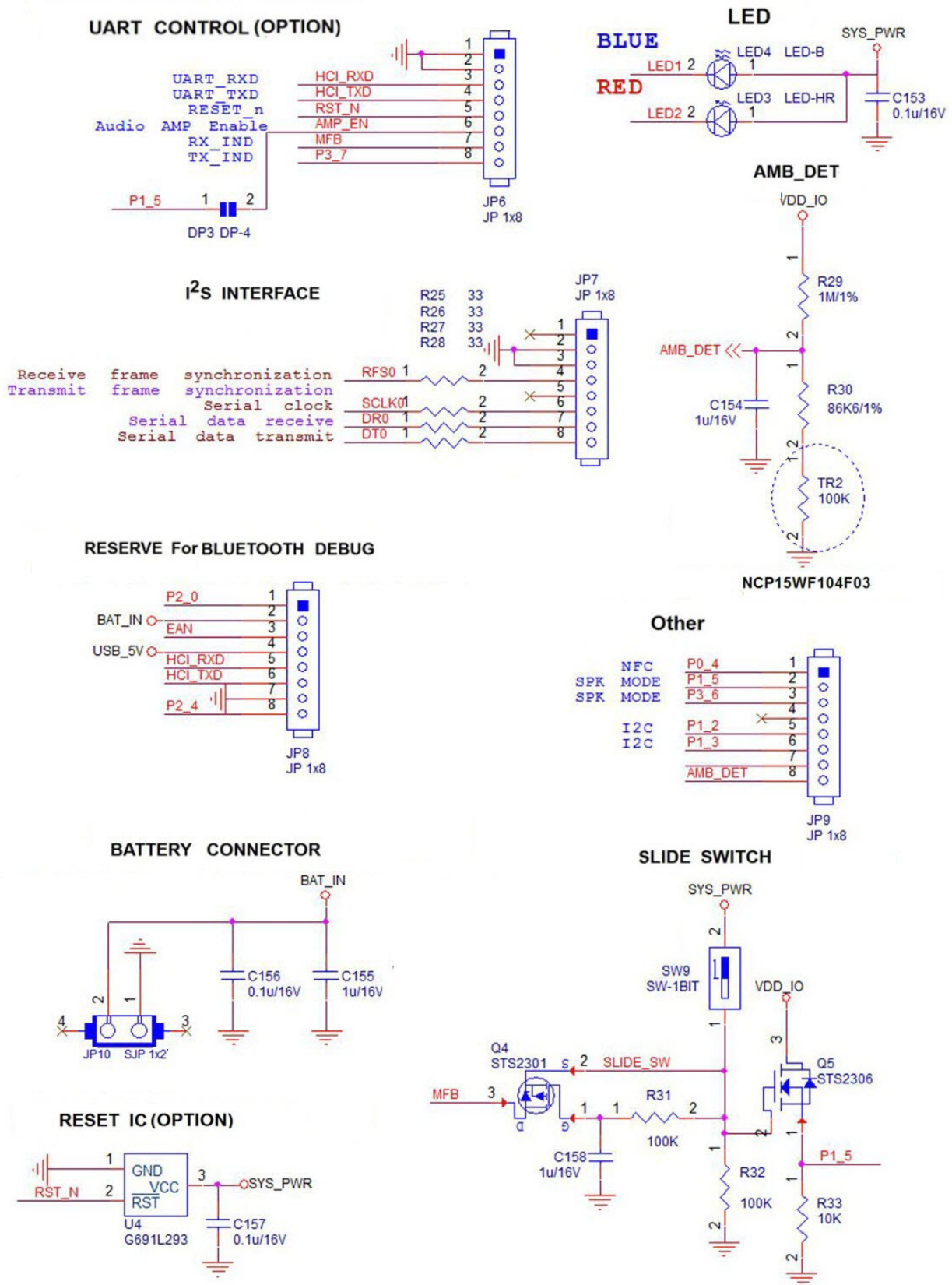
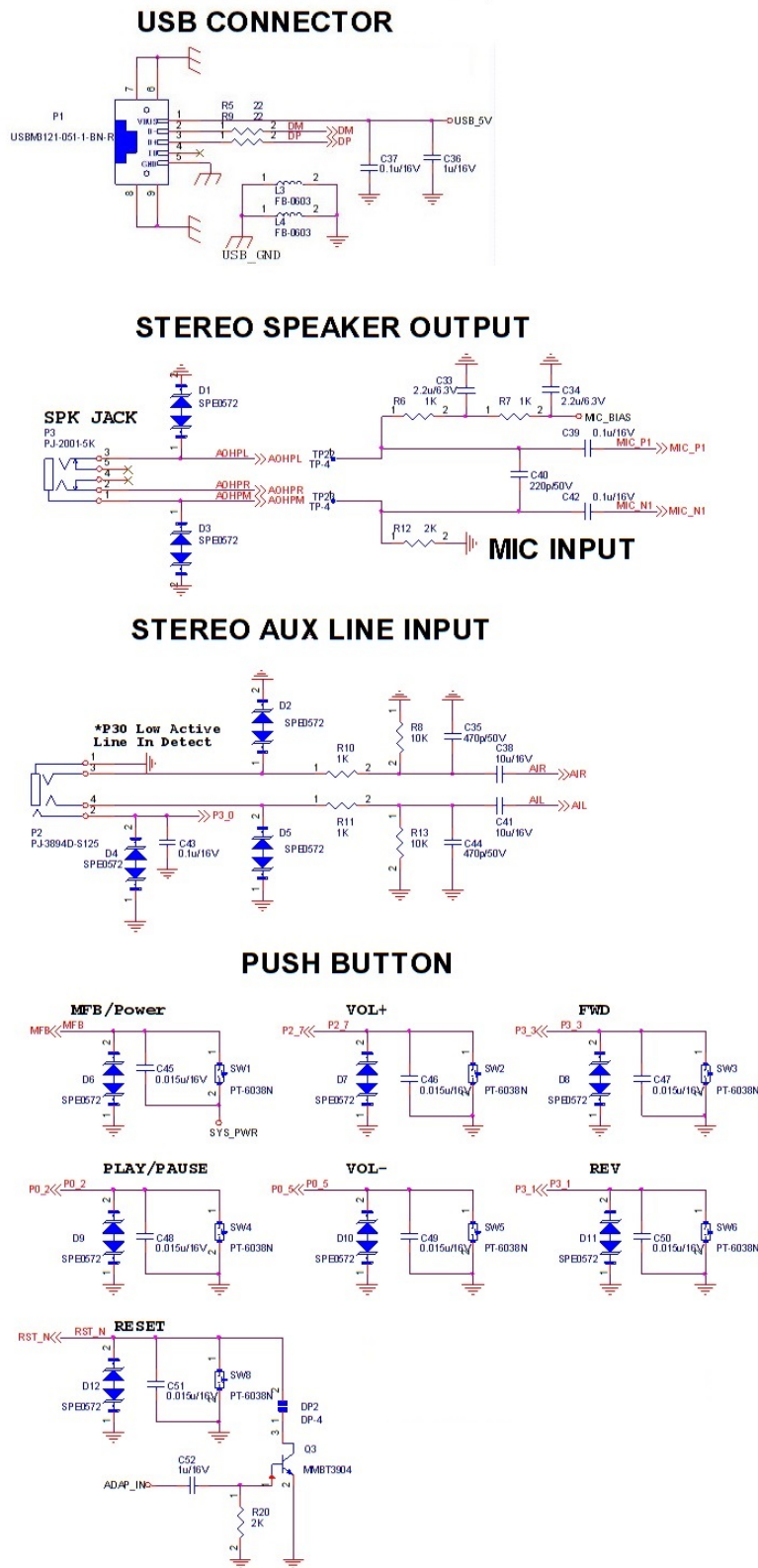


Figure 12-10. IS2064GM REFERENCE CIRCUIT FOR STEREO HEADSET



**Note:** All ESD diodes in this schematics are reserved for the testing.

The following figures illustrate the IS2064S reference schematics for a stereo headset application.

Figure 12-11. IS2064S REFERENCE CIRCUIT FOR STEREO HEADSET

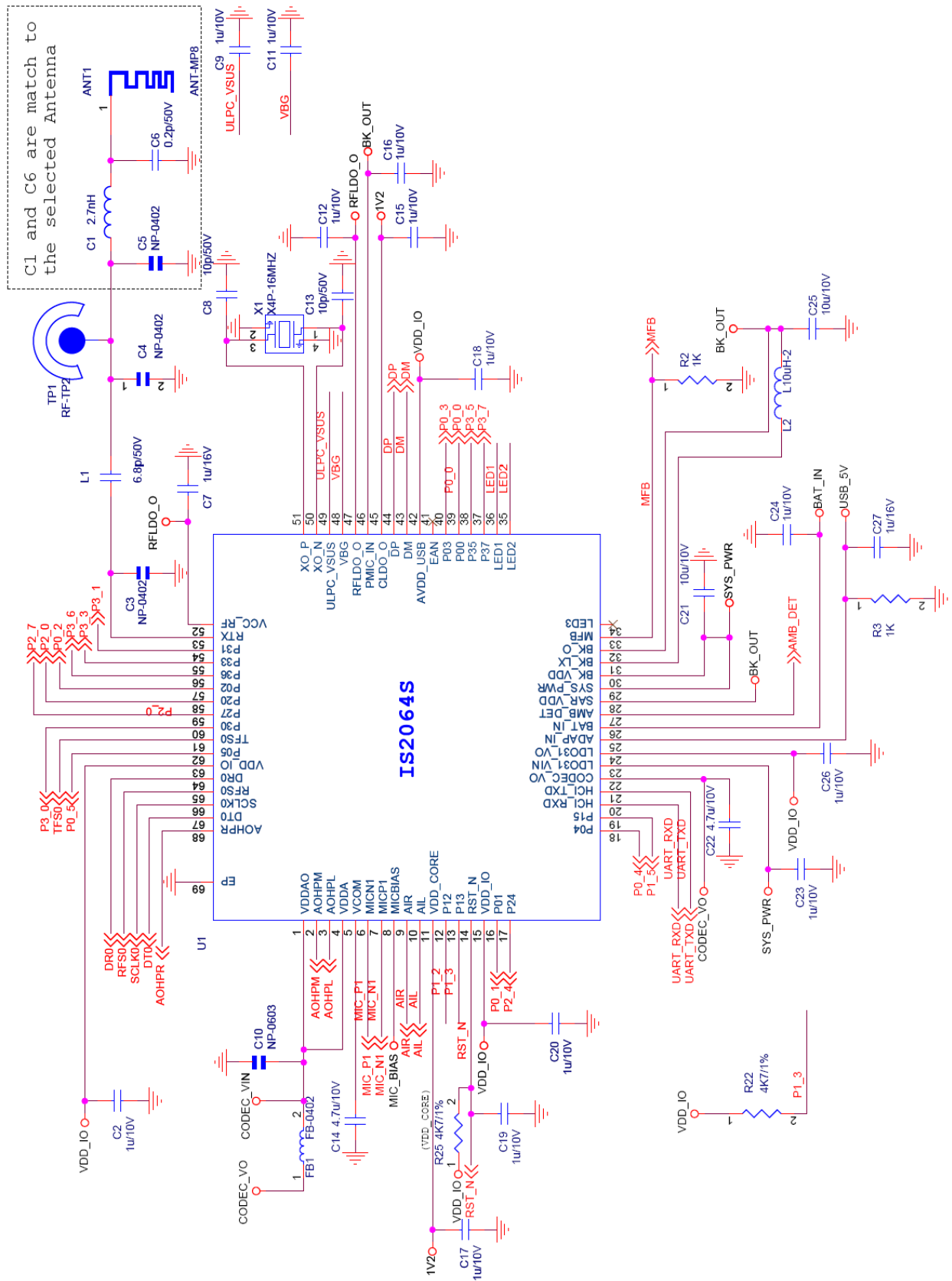


Figure 12-12. IS2064S REFERENCE CIRCUIT FOR STEREO HEADSET

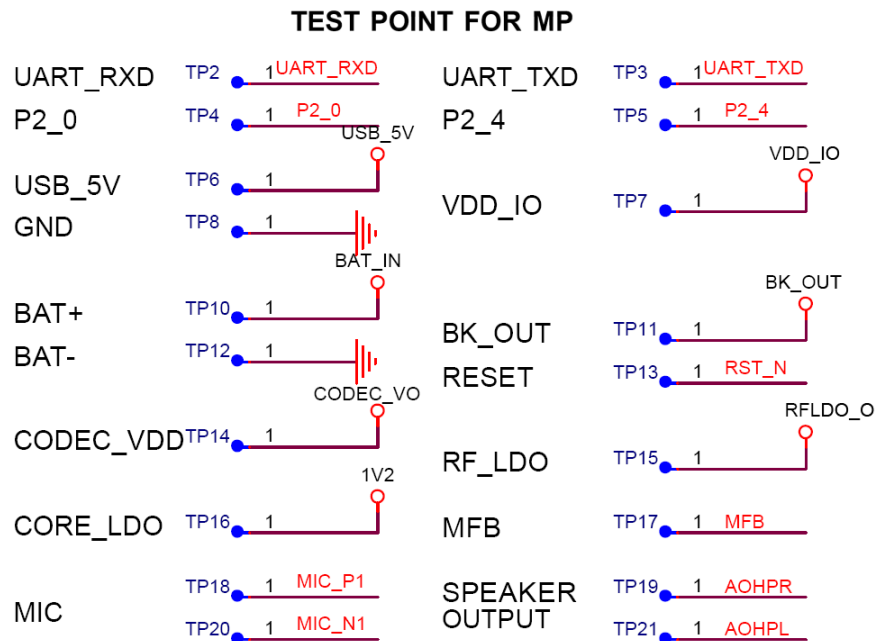




Figure 12-13. IS2064S REFERENCE CIRCUIT FOR STEREO HEADSET

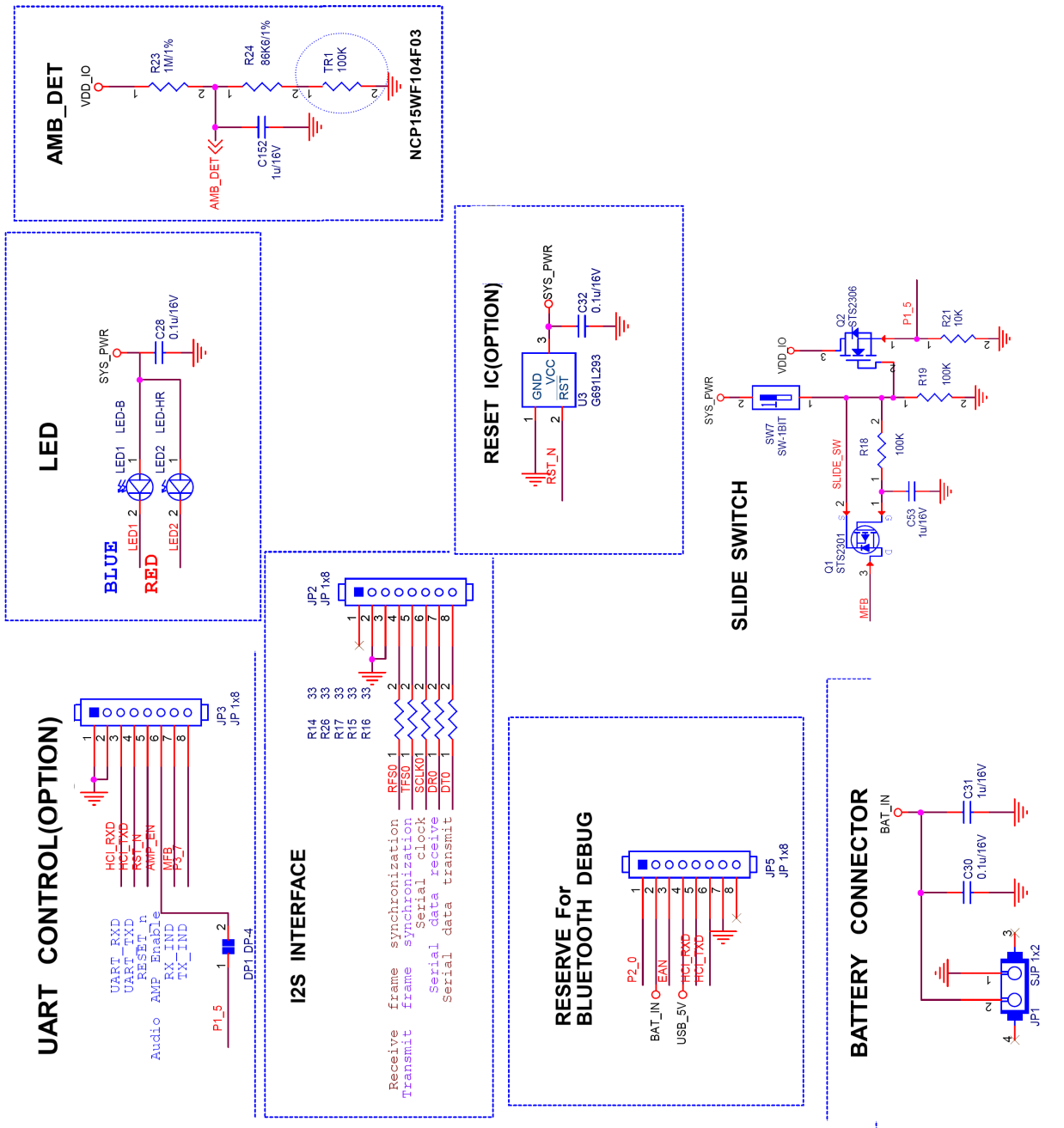
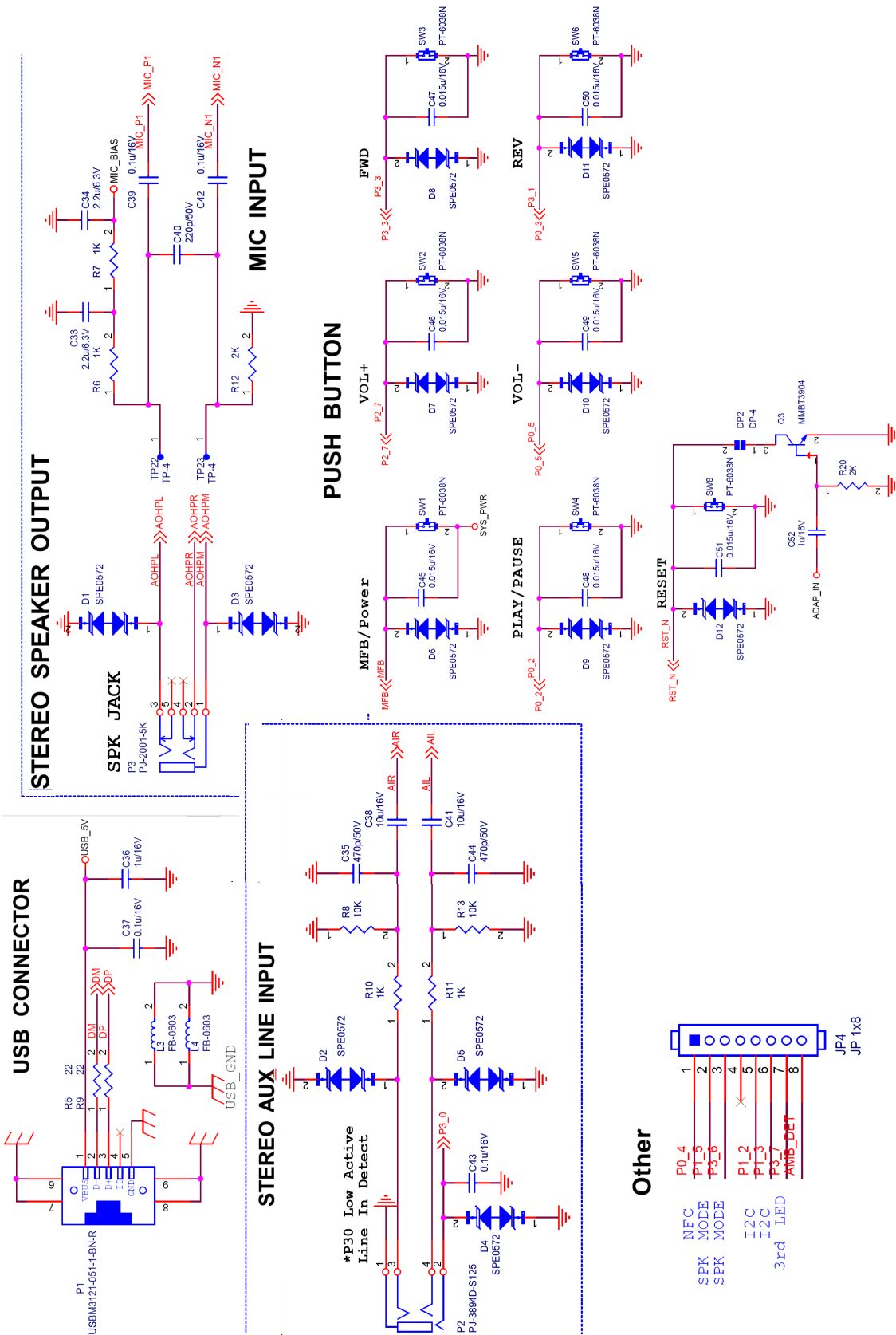


Figure 12-14. IS2064S REFERENCE CIRCUIT FOR STEREO HEADSET



**Note:** All EDS diodes in this schematics are reserved for testing and can be removed, if ESD is passed without adding it.



The following figures illustrates the IS2064B reference schematics for the stereo headset application.

Figure 12-15. IS2064B REFERENCE CIRCUIT FOR STEREO HEADSET

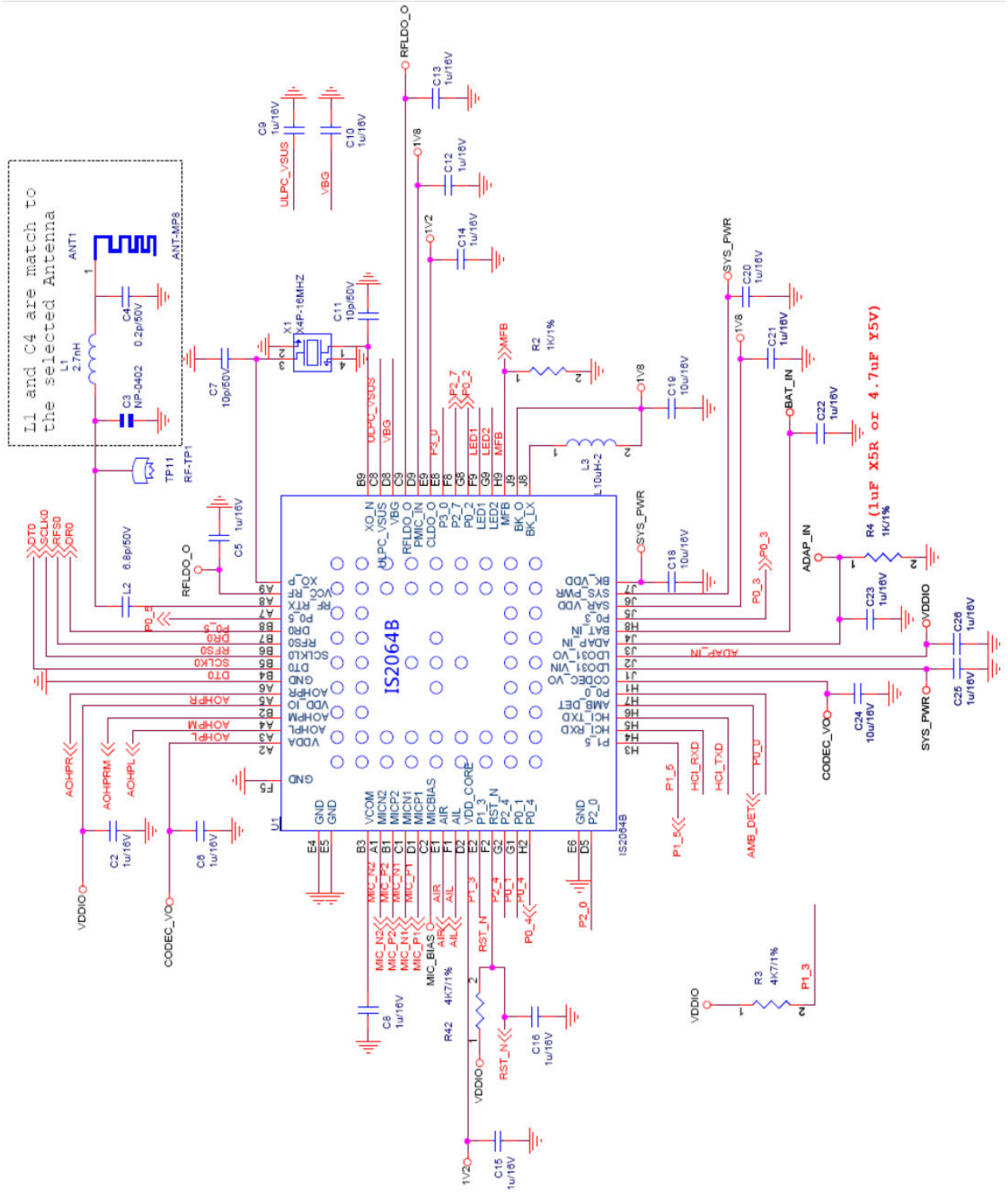


Figure 12-16. IS2064B REFERENCE CIRCUIT FOR STEREO HEADSET

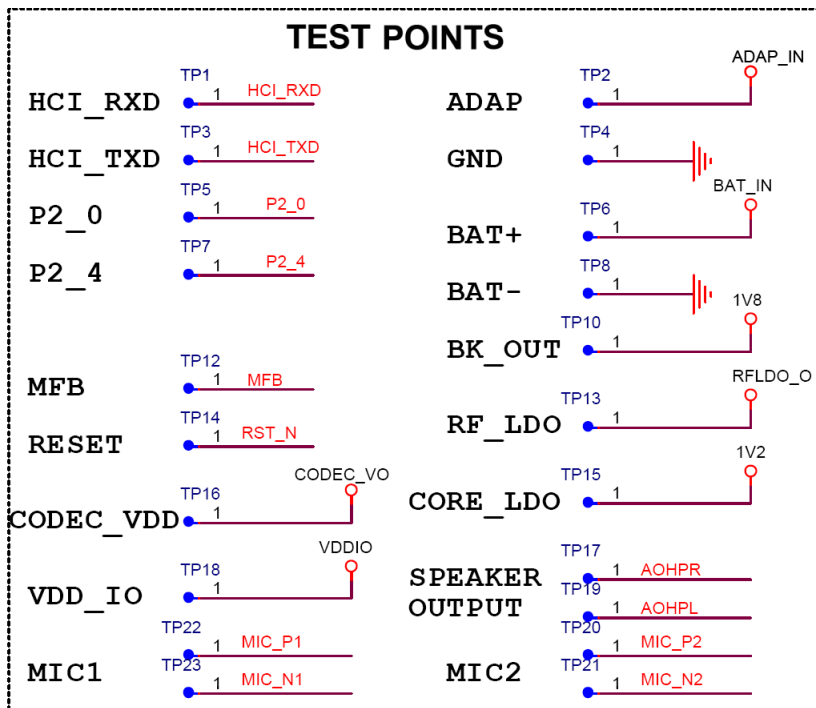


Figure 12-17. IS2064B REFERENCE CIRCUIT FOR STEREO HEADSET

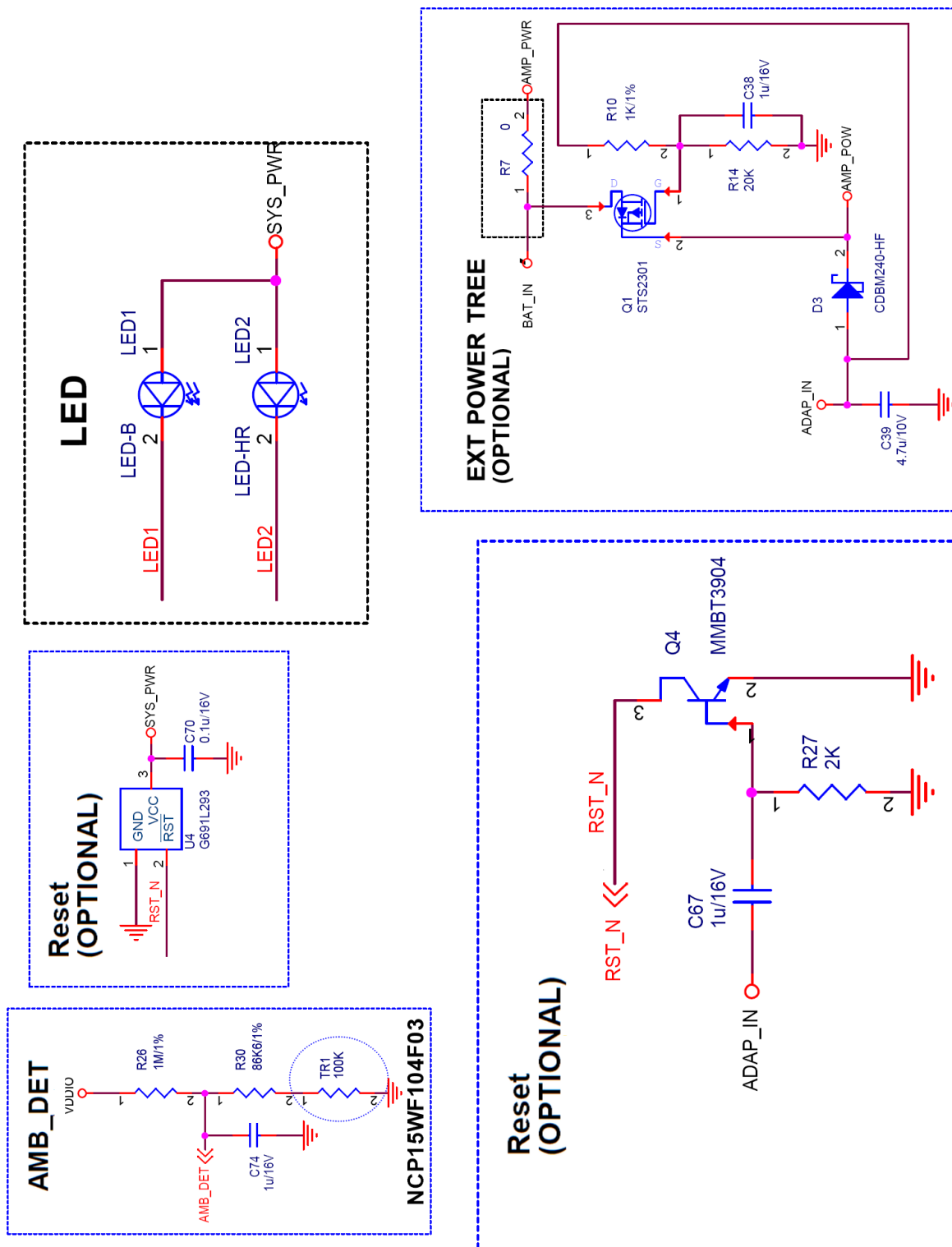
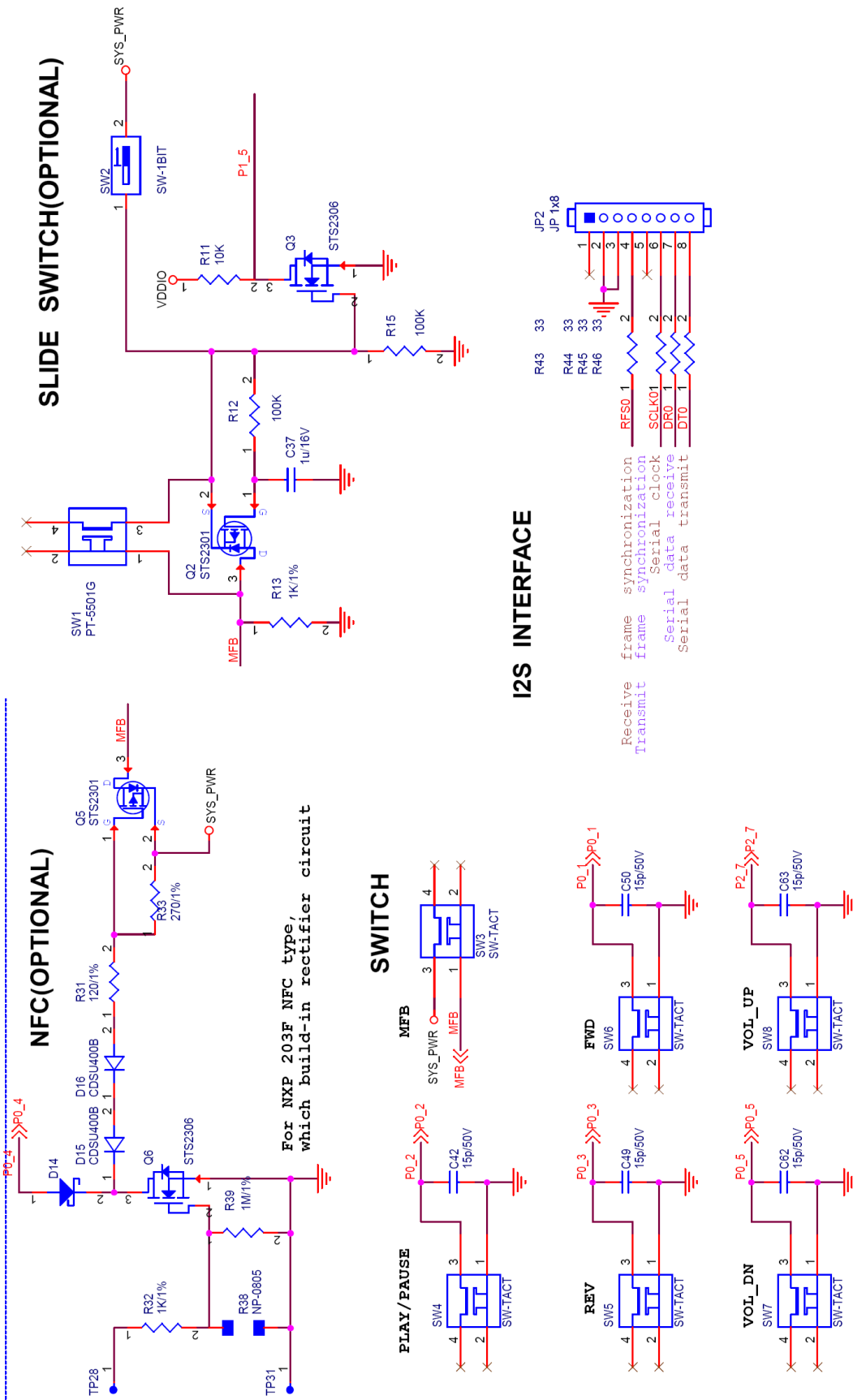


Figure 12-18. IS2064B REFERENCE CIRCUIT FOR STEREO HEADSET



For NXP 203F NFC type,  
which build-in rectifier circuit

Figure 12-19. IS2064B REFERENCE CIRCUIT FOR STEREO HEADSET

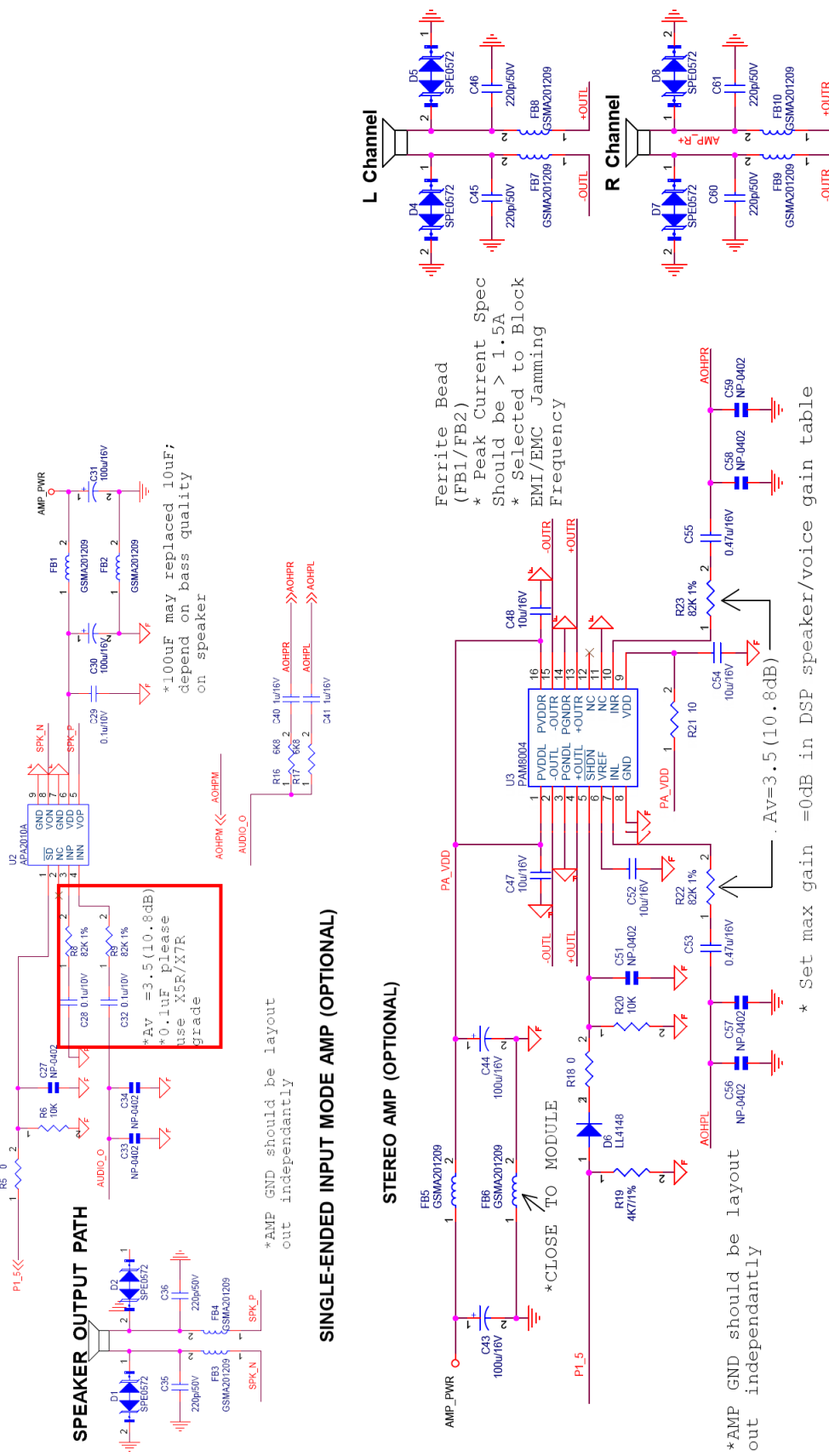
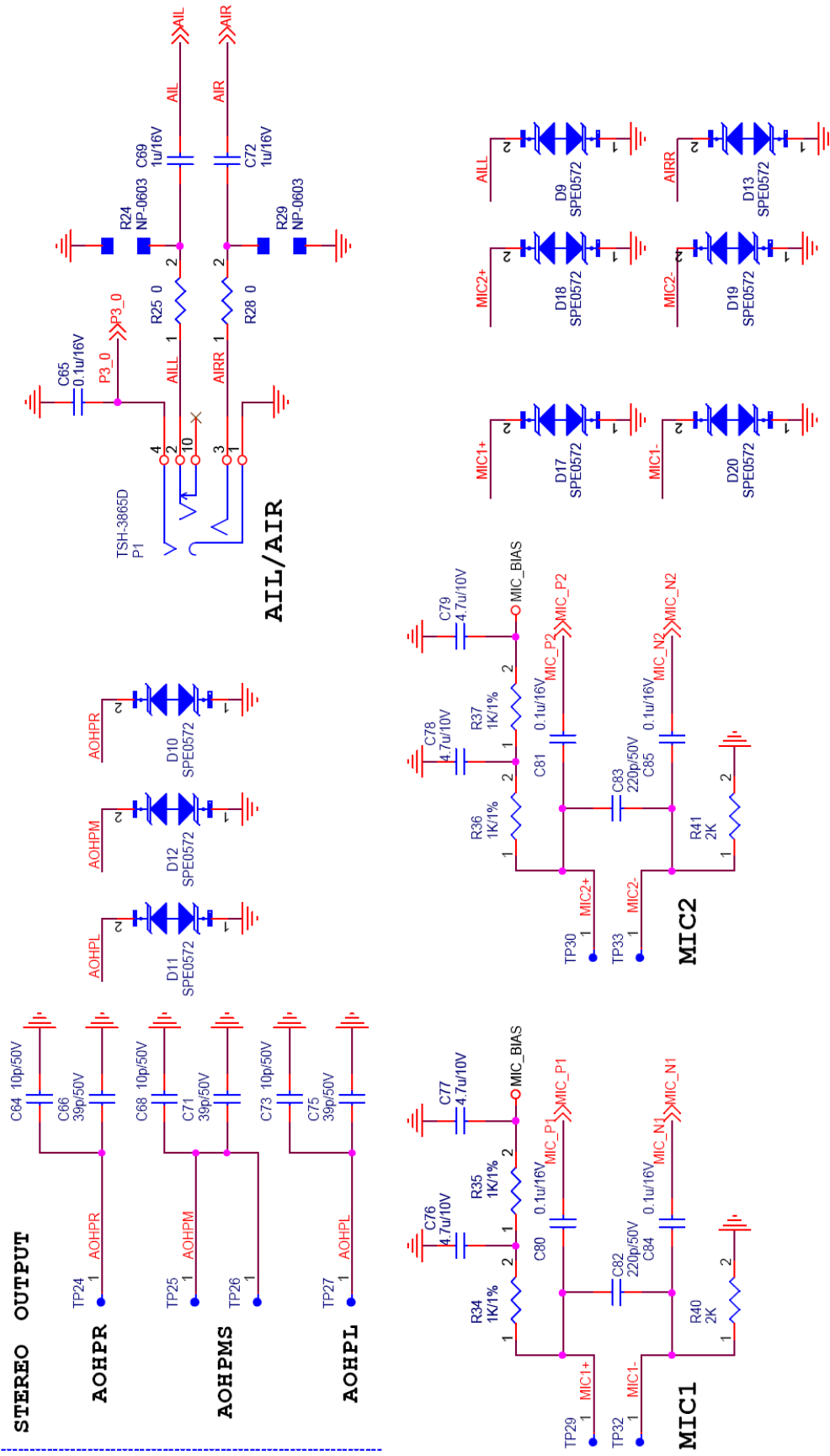


Figure 12-20. IS2064B REFERENCE CIRCUIT FOR STEREO HEADSET

**AUDIO MICROPHONE/SPEAKER OUTPUT**



**Note:** All ESD diodes in this schematics are reserved for testing and can be removed, if ESD is passed without adding it.

## 13. Document Revision History

### Revision A (May 2016)

This is the initial released version of this document.

### Revision B (December 2016)

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

**Table 13-1. MAJOR SECTION UPDATES**

Section	Changes
<a href="#">Audio Codec</a>	Updated the I <sup>2</sup> S digital audio applicability.
<a href="#">Peripherals</a>	Updated the USB version details.
<a href="#">Device Overview</a>	Updated <a href="#">Figure 1-1</a> and <a href="#">Figure 1-2</a> . Added “USB” details and updated “Customized voice prompt” details in Table 1-1.  Updated Table 1-1 through Table 1-3.
<a href="#">Codec</a>	Added a note for internal codec support and addition of trailing zeros.
<a href="#">Application Information</a>	Added Note 2 for usage of BAT_IN or ADAP_IN pins. Updated <a href="#">Figure 6-1</a> .  Updated Table 6-4 and deleted Table 6-5.
<a href="#">Reference Circuit</a>	Updated <a href="#">Figure 12-8</a> and <a href="#">Figure 12-9</a> .

### Revision C (July 2017)

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

**Table 13-2. MAJOR SECTION UPDATES**

Section	Changes
<b>Document</b>	<ul style="list-style-type: none"> <li>Added ROM variant information of IS2062/64 family.</li> <li>Updated the document as per latest template.</li> </ul>



---

## The Microchip Web Site

Microchip provides online support via our web site at <http://www.microchip.com/>. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQ), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

## Customer Change Notification Service

Microchip's customer notification service helps keep customers current on Microchip products. Subscribers will receive e-mail notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, access the Microchip web site at <http://www.microchip.com/>. Under "Support", click on "Customer Change Notification" and follow the registration instructions.

## Customer Support

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or Field Application Engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at: <http://www.microchip.com/support>

## Microchip Devices Code Protection Feature

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a

---

violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

## Legal Notice

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE.

Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

## Trademarks

The Microchip name and logo, the Microchip logo, AnyRate, AVR, AVR logo, AVR Freaks, BeaconThings, BitCloud, CryptoMemory, CryptoRF, dsPIC, FlashFlex, flexPWR, Heldo, JukeBlox, KeeLoq, KeeLoq logo, Klear, LANCheck, LINK MD, maXStylus, maXTouch, MediaLB, megaAVR, MOST, MOST logo, MPLAB, OptoLyzer, PIC, picoPower, PICSTART, PIC32 logo, Prochip Designer, QTouch, RightTouch, SAM-BA, SpyNIC, SST, SST Logo, SuperFlash, tinyAVR, UNI/O, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

ClockWorks, The Embedded Control Solutions Company, EtherSynch, Hyper Speed Control, HyperLight Load, IntelliMOS, mTouch, Precision Edge, and Quiet-Wire are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, BodyCom, chipKIT, chipKIT logo, CodeGuard, CryptoAuthentication, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, EtherGREEN, In-Circuit Serial Programming, ICSP, Inter-Chip Connectivity, JitterBlocker, KlearNet, KlearNet logo, Mindi, MiWi, motorBench, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICkit, PICtail, PureSilicon, QMatrix, RightTouch logo, REAL ICE, Ripple Blocker, SAM-ICE, Serial Quad I/O, SMART-I.S., SQI, SuperSwitcher, SuperSwitcher II, Total Endurance, TSHARC, USBCheck, VariSense, ViewSpan, WiperLock, Wireless DNA, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

Silicon Storage Technology is a registered trademark of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2017, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

ISBN: 978-1-5224-2019-4

Quality Management System Certified by DNV

**ISO/TS 16949**

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC<sup>®</sup> MCUs and dsPIC<sup>®</sup> DSCs, KEELOQ<sup>®</sup> code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

## Worldwide Sales and Service

AMERICAS	ASIA/PACIFIC	ASIA/PACIFIC	EUROPE
<p><b>Corporate Office</b> 2355 West Chandler Blvd. Chandler, AZ 85224-6199 Tel: 480-792-7200 Fax: 480-792-7277 Technical Support: <a href="http://www.microchip.com/support">http://www.microchip.com/support</a> Web Address: <a href="http://www.microchip.com">www.microchip.com</a></p> <p><b>Atlanta</b> Duluth, GA Tel: 678-957-9614 Fax: 678-957-1455</p> <p><b>Austin, TX</b> Tel: 512-257-3370</p> <p><b>Boston</b> Westborough, MA Tel: 774-760-0087 Fax: 774-760-0088</p> <p><b>Chicago</b> Itasca, IL Tel: 630-285-0071 Fax: 630-285-0075</p> <p><b>Dallas</b> Addison, TX Tel: 972-818-7423 Fax: 972-818-2924</p> <p><b>Detroit</b> Novi, MI Tel: 248-848-4000</p> <p><b>Houston, TX</b> Tel: 281-894-5983</p> <p><b>Indianapolis</b> Noblesville, IN Tel: 317-773-8323 Fax: 317-773-5453 Tel: 317-536-2380</p> <p><b>Los Angeles</b> Mission Viejo, CA Tel: 949-462-9523 Fax: 949-462-9608 Tel: 951-273-7800</p> <p><b>Raleigh, NC</b> Tel: 919-844-7510</p> <p><b>New York, NY</b> Tel: 631-435-6000</p> <p><b>San Jose, CA</b> Tel: 408-735-9110 Tel: 408-436-4270</p> <p><b>Canada - Toronto</b> Tel: 905-695-1980 Fax: 905-695-2078</p>	<p><b>Asia Pacific Office</b> Suites 3707-14, 37th Floor Tower 6, The Gateway Harbour City, Kowloon</p> <p><b>Hong Kong</b> Tel: 852-2943-5100 Fax: 852-2401-3431</p> <p><b>Australia - Sydney</b> Tel: 61-2-9868-6733 Fax: 61-2-9868-6755</p> <p><b>China - Beijing</b> Tel: 86-10-8569-7000 Fax: 86-10-8528-2104</p> <p><b>China - Chengdu</b> Tel: 86-28-8665-5511 Fax: 86-28-8665-7889</p> <p><b>China - Chongqing</b> Tel: 86-23-8980-9588 Fax: 86-23-8980-9500</p> <p><b>China - Dongguan</b> Tel: 86-769-8702-9880</p> <p><b>China - Guangzhou</b> Tel: 86-20-8755-8029</p> <p><b>China - Hangzhou</b> Tel: 86-571-8792-8115 Fax: 86-571-8792-8116</p> <p><b>China - Hong Kong SAR</b> Tel: 852-2943-5100 Fax: 852-2401-3431</p> <p><b>China - Nanjing</b> Tel: 86-25-8473-2460 Fax: 86-25-8473-2470</p> <p><b>China - Qingdao</b> Tel: 86-532-8502-7355 Fax: 86-532-8502-7205</p> <p><b>China - Shanghai</b> Tel: 86-21-3326-8000 Fax: 86-21-3326-8021</p> <p><b>China - Shenyang</b> Tel: 86-24-2334-2829 Fax: 86-24-2334-2393</p> <p><b>China - Shenzhen</b> Tel: 86-755-8864-2200 Fax: 86-755-8203-1760</p> <p><b>China - Wuhan</b> Tel: 86-27-5980-5300 Fax: 86-27-5980-5118</p> <p><b>China - Xian</b> Tel: 86-29-8833-7252 Fax: 86-29-8833-7256</p>	<p><b>China - Xiamen</b> Tel: 86-592-2388138 Fax: 86-592-2388130</p> <p><b>China - Zhuhai</b> Tel: 86-756-3210040 Fax: 86-756-3210049</p> <p><b>India - Bangalore</b> Tel: 91-80-3090-4444 Fax: 91-80-3090-4123</p> <p><b>India - New Delhi</b> Tel: 91-11-4160-8631 Fax: 91-11-4160-8632</p> <p><b>India - Pune</b> Tel: 91-20-3019-1500</p> <p><b>Japan - Osaka</b> Tel: 81-6-6152-7160 Fax: 81-6-6152-9310</p> <p><b>Japan - Tokyo</b> Tel: 81-3-6880-3770 Fax: 81-3-6880-3771</p> <p><b>Korea - Daegu</b> Tel: 82-53-744-4301 Fax: 82-53-744-4302</p> <p><b>Korea - Seoul</b> Tel: 82-2-554-7200 Fax: 82-2-558-5932 or 82-2-558-5934</p> <p><b>Malaysia - Kuala Lumpur</b> Tel: 60-3-6201-9857 Fax: 60-3-6201-9859</p> <p><b>Malaysia - Penang</b> Tel: 60-4-227-8870 Fax: 60-4-227-4068</p> <p><b>Philippines - Manila</b> Tel: 63-2-634-9065 Fax: 63-2-634-9069</p> <p><b>Singapore</b> Tel: 65-6334-8870 Fax: 65-6334-8850</p> <p><b>Taiwan - Hsin Chu</b> Tel: 886-3-5778-366 Fax: 886-3-5770-955</p> <p><b>Taiwan - Kaohsiung</b> Tel: 886-7-213-7830</p> <p><b>Taiwan - Taipei</b> Tel: 886-2-2508-8600 Fax: 886-2-2508-0102</p> <p><b>Thailand - Bangkok</b> Tel: 66-2-694-1351 Fax: 66-2-694-1350</p>	<p><b>Austria - Wels</b> Tel: 43-7242-2244-39 Fax: 43-7242-2244-393</p> <p><b>Denmark - Copenhagen</b> Tel: 45-4450-2828 Fax: 45-4485-2829</p> <p><b>Finland - Espoo</b> Tel: 358-9-4520-820</p> <p><b>France - Paris</b> Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79</p> <p><b>France - Saint Cloud</b> Tel: 33-1-30-60-70-00</p> <p><b>Germany - Garching</b> Tel: 49-8931-9700</p> <p><b>Germany - Haan</b> Tel: 49-2129-3766400</p> <p><b>Germany - Heilbronn</b> Tel: 49-7131-67-3636</p> <p><b>Germany - Karlsruhe</b> Tel: 49-721-625370</p> <p><b>Germany - Munich</b> Tel: 49-89-627-144-0 Fax: 49-89-627-144-44</p> <p><b>Germany - Rosenheim</b> Tel: 49-8031-354-560</p> <p><b>Israel - Ra'anana</b> Tel: 972-9-744-7705</p> <p><b>Italy - Milan</b> Tel: 39-0331-742611 Fax: 39-0331-466781</p> <p><b>Italy - Padova</b> Tel: 39-049-7625286</p> <p><b>Netherlands - Drunen</b> Tel: 31-416-690399 Fax: 31-416-690340</p> <p><b>Norway - Trondheim</b> Tel: 47-7289-7561</p> <p><b>Poland - Warsaw</b> Tel: 48-22-3325737</p> <p><b>Romania - Bucharest</b> Tel: 40-21-407-87-50</p> <p><b>Spain - Madrid</b> Tel: 34-91-708-08-90 Fax: 34-91-708-08-91</p> <p><b>Sweden - Gothenberg</b> Tel: 46-31-704-60-40</p> <p><b>Sweden - Stockholm</b> Tel: 46-8-5090-4654</p> <p><b>UK - Wokingham</b> Tel: 44-118-921-5800 Fax: 44-118-921-5820</p>