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# Product Technical Specification

## BC127, BC127-HD, BC127-EXT



**SIERRA**  
WIRELESS®

41110693  
Rev 1

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## Revision History

Revision number	Release date	Changes
1	March 2, 2017	Initial conversion to SWI template.



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# >> 1: Introduction

The BC127/BC127-HD/BC-127EXT is a highly flexible, low power, small form factor Bluetooth Audio module. The BC127, BC127HD, and BC127-EXT are Bluetooth Version 4.2 Certified.

The model comes preloaded with Sierra Wireless Melody software, and is ideal for developers who want to quickly and cost effectively integrate Bluetooth functionality into their products.



Figure 1-1: BC127

Note: this is an example image and does not represent the label used on commercial shipments.

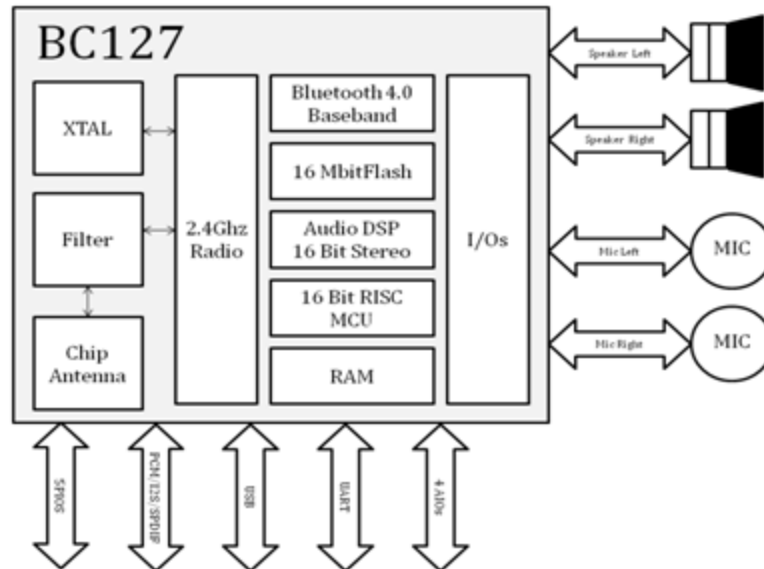


Figure 1-2: BC127 Flow Diagram

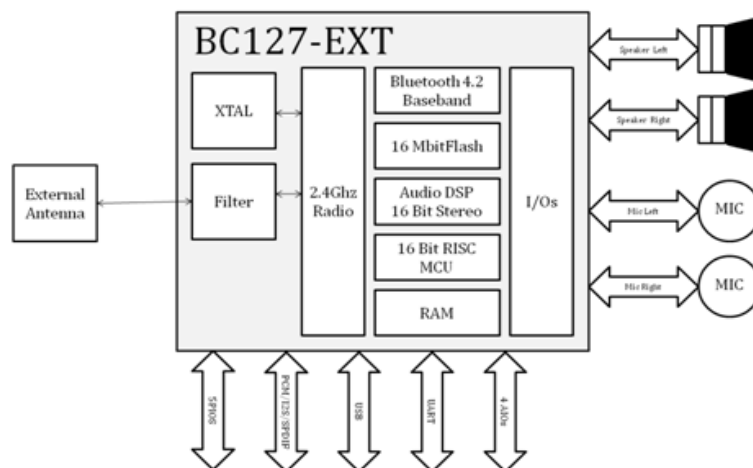


Figure 1-3: BC127-EXT Flow Diagram

## Applications

- Wireless Speakers, Docks and Headsets
- SmartPhone Controlled Audio Systems
- Automotive Infotainment Systems
- Medical Devices
- High Quality Audio Streaming
- Gaming Accessories and MP3 Players

## Key Specifications

- Bluetooth Certified 4.2 Audio module
- Dual Mode: Bluetooth and Bluetooth Low Energy (BLE)
- Backwards compatible with 1.1, 2.0, 2.1 + EDR and 3.0
- Embedded Bluetooth Protocol Stack
- Supports HFP, A2DP, AVRCP, PBAP and SPP
- Supports IAP1/IAP2 profiles for connection to iOS devices
- Simple UART and GPIO interface for command and control
- Can connect to external codecs with I2S, PCM, SPDIF interface
- Includes aptX-HD™ license and algorithm<sup>1</sup>
- Small form factor (11.8mm x 18mm x 3.2mm)

1. Only on BC127-HD



## General Specifications

**Table 1-1: General Specifications**

Specification	Description
<b>Bluetooth Standard</b>	Bluetooth 4.2 Class 2
<b>Interfaces</b>	UART, AIO, GPIO, USB, SPI, Audio In, Mic In, PCM, I2S, SPDIF, I2C
<b>Size</b>	11.8mm x 18mm x 3.2mm
<b>Weight</b>	1.1g

## RF Specifications

**Table 1-2: RF Specifications**

Specification	Description
<b>Frequency Band</b>	2,402 MHz to 2,480 MHz
<b>Modulation</b>	8 DPSK, PI/4 DQPSK, GFSK
<b>Maximum Data Rate</b>	3Mbps (typical 1.6Mbps)
<b>Operating Range</b>	20m to 30m
<b>RF Sensitivity</b>	0.1% BER at -88dBm
<b>Transmit Power</b>	BER/EDR Class2 < 4dBm, BLE < 10dBm

## Audio Specifications

**Table 1-3: Audio Specifications**

Specification	Description
<b>DAC resolution</b>	16 bits
<b>DAC Output Sample Rate</b>	8 KHz to 90 KHz
<b>DAC SNR</b>	96dB
<b>Stereo Separation</b>	-87.7dB

## Electric Specifications

**Table 1-4: Electrical Specifications**

Specification	Description
<b>Supply Voltage</b>	3.3V to 4.7 V DC (supports Li-ion battery voltage range)
<b>Typical Current</b>	15mA (music streaming)
<b>Typical Current Idle</b>	<1mA (connectable)
<b>Operating Temperature</b>	-40°C to 85°C
<b>Storage Temperature</b>	-40°C to 105°C

## Product Models

**Table 1-5: Model Names**

Models	Description
<b>BC127</b>	Class2 Bluetooth 4.2 Module with integrated chip antenna
<b>BC127-EXT</b>	Class2 Bluetooth 4.2 Module with external antenna connection
<b>BC127-HD</b>	Class2 Bluetooth 4.2 Module with integrated chip antenna & support for aptX HD <sup>®</sup> audio
<b>BC127-HD-EXT</b>	Class2 Bluetooth 4.2 Module with external antenna connection & support for aptX HD <sup>®</sup> audio

BC127/BC127-HD/BC127-EXT modules are shipped flashed with the latest Melody firmware production build. Customers need to confirm at order with distributors that they will receive the firmware build they require. For volume orders (1k quantities), the BC127/BC127-HD/BC127-EXT can be shipped flashed with custom firmware.



## Placement Considerations

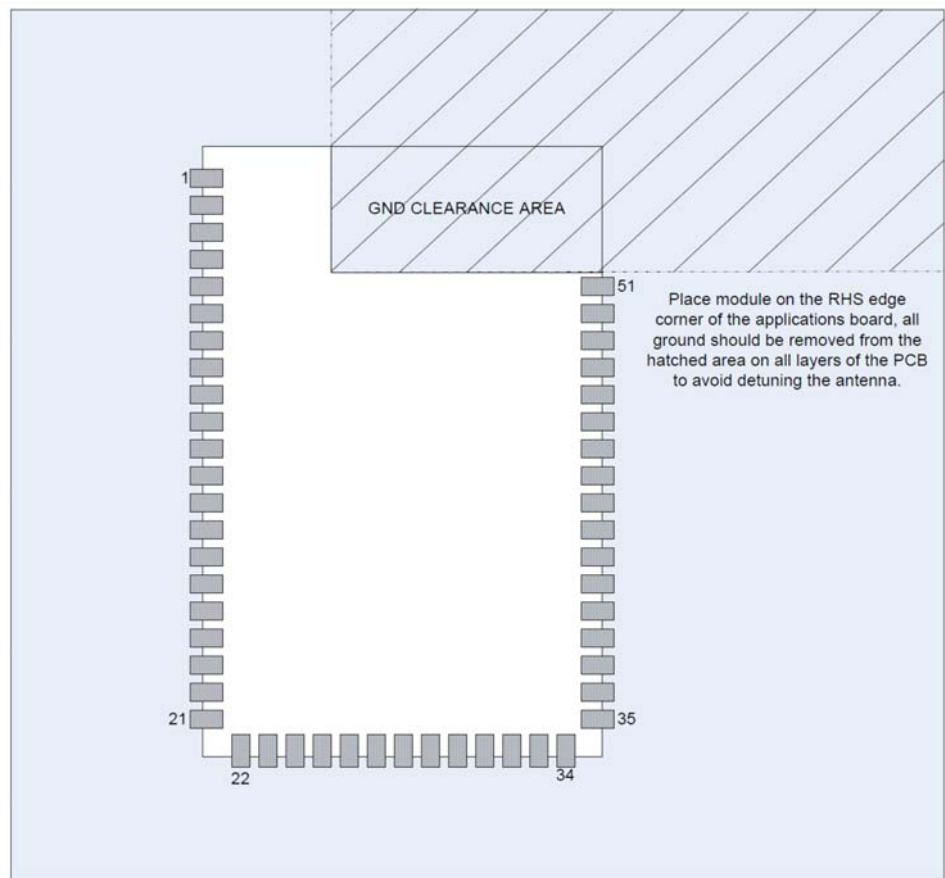


Figure 2-2: Placement Layout

## 3: Audio Circuit

The Audio circuit consists of:

- two independent 16-bit high-quality ADC channels:
  - Programmable as either microphone or line input
  - Programmable as either stereo or dual-mono input
  - Multiplexed with two of the digital microphone inputs
  - Each channel is independently configurable to be either single-ended or fully differential
  - Each channel has an analog and digital programmable gain stage
- A dual differential class A-B output stage. If a single ended audio output is required, use an external differential to single-ended converter.

The main features of the interface are:

- Stereo and mono analog input for voice band and audio band
- Stereo and mono analog output for voice band and audio band
- Support for stereo digital audio bus standards such as I2S
- Support for IEC-60958 standard stereo digital audio bus standards (e.g. SPDIF and AES3)
- Support for PCM including PCM master codecs that require an external system clock

The analog audio diagram is shown in [Figure 3-1](#):

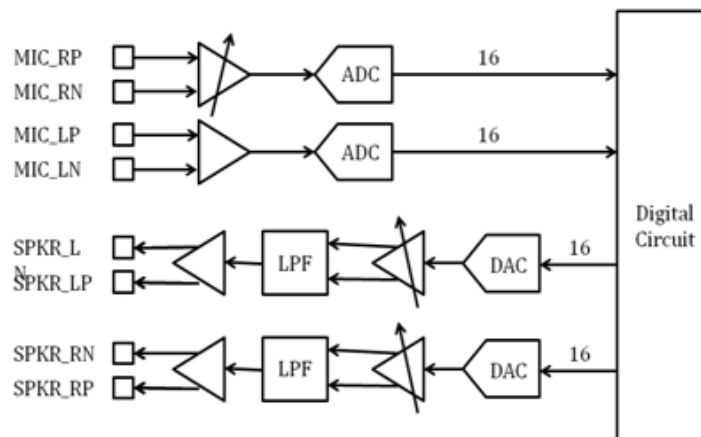


Figure 3-1: Audio Diagram

## Pin Descriptions

**Table 3-1: Pin Descriptions for the BC127/BC127-HD/BC127EXT**

No	Pin Name	Pin Type	Pin Description
1	GND	GND	Common Ground
2	GND	GND	Common Ground
3	GND	GND	Common Ground
4	GND	GND	Common Ground
5	PIO_6/ PCM2_SYNC	Bi-directional	Programmable I/O (PCM2_SYNC or I2S_S)
6	PIO_7/ PCM2_CLK	Bi-directional	Programmable I/O (PCM2_CLK or I2S_CLK)
7	CAP_SENSE_1	Analog Input	Capacitive Touch Sense Input
8	CAP_SENSE_4	Analog Input	Capacitive Touch Sense Input
9	CAP_SENSE_3	Analog Input	Capacitive Touch Sense Input
10	CAP_SENSE_2	Analog Input	Capacitive Touch Sense Input
11	GND	GND	Common Ground
12	AIO_1	Bi-directional	Analog programmable input/output line
13	SPKR_LN	Audio output	Speaker output negative, left
14	SPKR_LP	Audio output	Speaker output positive, left
15	SPKR_RN	Audio output	Speaker output negative, right
16	SPKR_RP	Audio output	Speaker output positive, right
17	MIC_BIAS_A	Analog Input	Microphone bias
18	MIC_RN	Analog Input	Microphone input negative, right
19	MIC_RP	Analog Input	Microphone input positive, right
20	MIC_LN	Analog Input	Microphone input negative, left
21	MIC_LP	Analog Input	Microphone input positive, left
22	GND	GND	Common Ground
23	PIO_0	Bi-directional	Programmable input/output line
24	PIO_1	Bi-directional	Programmable input/output line
25	PIO_5/ PCM2_OUT	Bi-directional	Programmable I/O (PCM2_OUT or I2S_OUT)
26	PIO_4/ PCM2_IN	Bi-directional	Programmable I/O (PCM2_IN or I2S_IN)
27	GND	GND	Common Ground



**Table 3-1: Pin Descriptions for the BC127/BC127-HD/BC127EXT**

No	Pin Name	Pin Type	Pin Description
28	VREGEN	Analogue	Take High to Enable Switch-Mode Regulator
29	CHG_EXT	Charger input	External battery charger control
30	VCHG	Charger input	Battery Charger Input
31	VBAT_SENSE	Battery Sense	Battery Charger Sense
32	VBAT	Battery terminal +ve	Battery Positive
33	VDD_PADS	Supply	Positive Supply input
34	3V3_USB	Supply	Positive Supply output
35	USB_N	Bi-directional	USB data negative
36	USB_P	Bi-directional	USB data positive
37	LED_0	Open drain output	LED Driver
38	LED_1	Open drain output	LED Driver
39	LED_2	Open drain output	LED Driver
40	UART_CTS	Bi-directional	UART Clear to Send
41	UART_TX	Bi-directional	UART TX Data
42	UART_RX	Bi-directional	UART RX Data
43	UART_RTS	Bi-directional	UART request to send, active low
44	RST#	Reset Input with Pull-Up	Reset if low for more than 5ms
45	SPI_PCM#	Input	Select PCM/SPI
46	PCM1_SYNC	Bi-directional	Synchronous data sync
47	PCM1_CLK	Bi-directional	Synchronous data clock
48	PCM1_OUT	CMOS output	Synchronous data output
49	PCM1_IN	CMOS input	Synchronous data input
50	PIO_2	Bi-directional	Programmable input/output line
51	PIO_3	Bi-directional	Programmable input/output line

**Table 3-2: Additional Pins on the BC127-EXT**

No	Pin Name	Pin Type	Pin Description
52	GND	GND	Common Ground

**Table 3-2: Additional Pins on the BC127-EXT**

No	Pin Name	Pin Type	Pin Description
53	BT RF	BT RF	BT RF
54	GND	GND	Common Ground

## Notes

- PIO\_X are bidirectional with weak pull down
- Reset Input is with strong pull-up
- USB data positive with selectable internal 1.5k $\Omega$  pull up resistor
- UART are bidirectional with weak pull up
- PCM\_OUT, IN, SYNC, and CLK can be used as SPI\_MISO, MOSI, CSB, and CLK respectively. SPI-PCM# high switches SPI/PCM lines to SPI, low switches to PCM/PIO use

# 4: Hardware Design Guidelines

## BC127/BC127-HD with a Battery

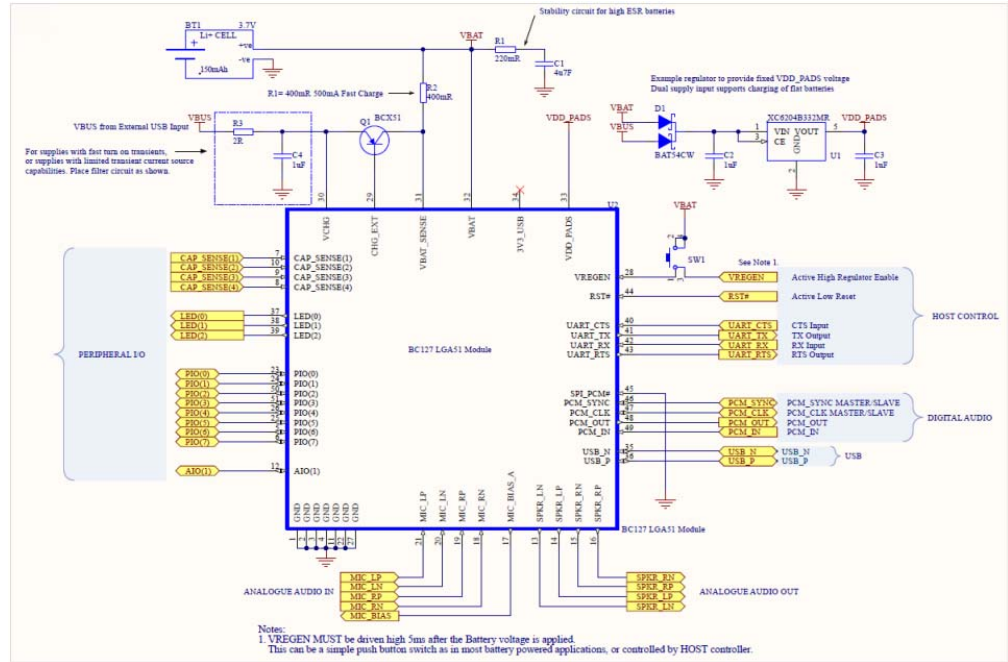


Figure 4-1: Hardware Design

**Note 1.** VREGEN should be driven high 5ms after VBAT is applied to boot the module.

Referring to the figure above, a Li-ion battery is connected to VBAT and VBUS from an external USB source is connected to VCHG. It is assumed that the VBUS supply is not connected permanently but periodically.

Table 4-1: Pin Voltages

Net	Min	Typ	Max
VCHG	3.1V*/4.75V	5V	5.75V
VBAT_SENSE	2.8V	3.7V	4.25V
VBAT	2.8V	3.7V	4.25V
VDD_PADS	1.7V	3.3V	3.6V
VREGEN	2.8V	3.7V	4.25V

\*This is the minimum voltage allowed to enable the module in the boot modes described below.

**VCHG** is the input to the battery charger regulator.

**VBAT\_SENSE** is the input to the Battery sensor circuitry.

**VBAT** is the main supply input to the internal switch mode and LDO regulators and is the supply domain for VREGEN.

**VDD\_PADS** is the supply to all the I/O domains for PIO, UART, PCM, LED and RST#.

## Boot Modes

The module will boot automatically whenever a voltage greater than 3.1V is applied to VCHG (for example, when a USB source is plugged in).

The module does not support a soft start supply configuration, for fast transient supply sources or supply sources with limited sourcing current use a filter (see R3/C4 in the main schematic above) to slow the rising edge of the supply voltage at turn on. A large inrush current at turn on can cause a dipping of the supply voltage applied to the module, in turn causing the module to lock out, adding the filter as shown keeps the input supply voltage rise monotonic and avoids lock out.

## Charging and Battery

In this configuration an external pass transistor is connected between VCHG, VBAT\_SENSE, and CHG\_EXT to support an external fast charge configuration. VBAT\_SENSE is connected to VBAT via a 400mR resistor.

The charging current is by default 150mA. It can be configured by UART command to be between 0 and 200mA. Please refer to the Melody Manual for configuration.

R1 and C1 in the main schematic diagram form a RC snubber circuit that is designed to maintain stability over a wide range of Battery ESRs. The maximum ESR of the battery should not exceed  $1\Omega$ .

The external VBUS voltage connected to VCHG is used to supply the current to charge the battery. Typically this comes from an external USB source.

In the above circuit VDD\_PADS is supplied by a regulated voltage from VBAT, in the case of batteries that are flat or discharged, the absence of a voltage on VDD\_PADS will halt the booting of the module. Therefore to ensure that a voltage is available on VDD\_PADS to support discharged batteries, the following circuit is required. This circuit combines the VBAT and VCHG inputs to generate the supply for VDD\_PADS.

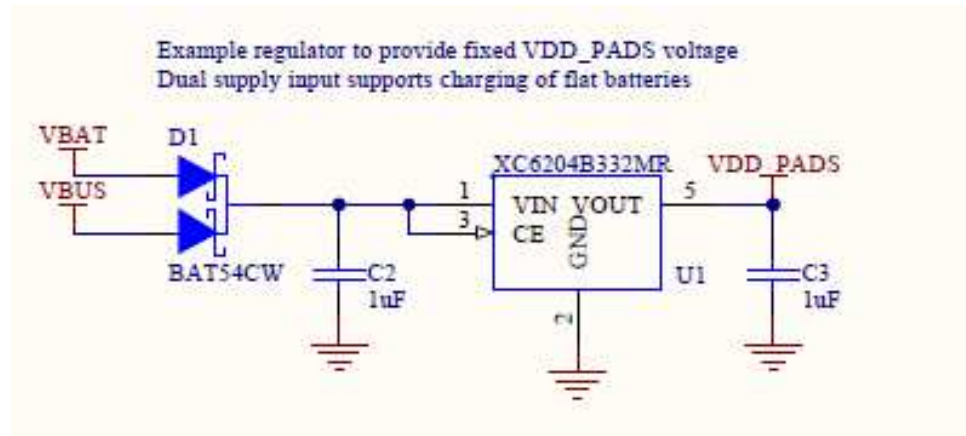


Figure 4-2: Circuit to Support Discharged Battery Starting

If the voltage of the battery is below 2.9V, the charger will enter 'trickle charge mode', when in this mode, the battery is charged at a current of a few milliamps in order to safely charge deeply discharged batteries. Once the voltage of the battery reaches anything above 2.9 V, fast charging mode will be used. In this mode, the battery is charged at the current configured by the user in the battery configuration settings, provided that there is enough headroom between the charger's input voltage and the voltage of the battery.

The BC127/BC127-HD will stop charging when the voltage at VBAT\_SENSE reaches 4.2V. The BC127/BC127-HD will shut down when the battery voltage reaches 2.9V indicating that the battery is depleted.

## BC127-EXT for Extended Range

The BC127-EXT (BC128 in the schematics in [Figure 4-3](#) below) supports the same supply and control configurations as the BC127. The BC127-EXT supports an external 50 Ohm RF port for use in larger area applications to connect to an external antenna with a greater gain than the internal module antenna for extended range.

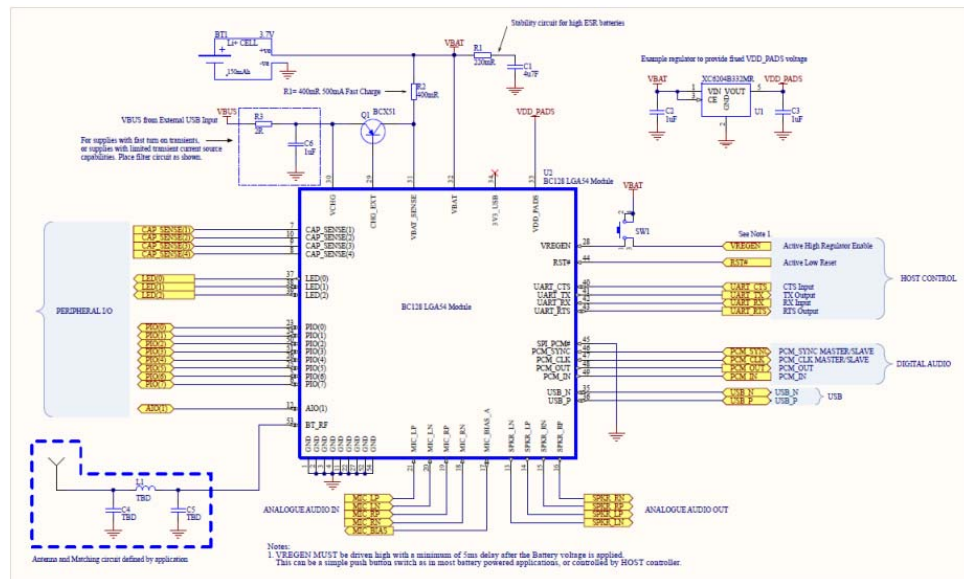


Figure 4-3: BC128 for Extended Range

## Role of VREG

Once the module is booted, VREGEN acts like a standard PIO. The function of VREGEN can be configured.

Please refer to the Melody Manual for the VREGEN function once the module is booted.

## ESD protection

The module has no supplementary ESD protection other than that provided by the IC within the module. The Bluetooth IC ESD protection is limited to:

- Human Body Model Contact Discharge per ANSI/ESDA/JEDEC JS-001 Class 2 - 2kV (all pins except CHG\_EXT; CHG\_EXT rated at 1kV)
- Machine Model Contact Discharge per JEDEC/EIA JESD22-A115 200V (all pins)
- Charged Device Model Contact Discharge per JEDEC/EIA JESD22-C101 Class II - 200V (all pins)

Sierra Wireless recommends adding supplementary ESD protection to externally available interfaces in the end application.



## Role of VREG

Once the module is booted, VREGEN acts like a standard PIO. The function of VREGEN can be configured. Please refer to the Melody Manual for the VREGEN function once the module is booted.

## Connection Microphones

A stereo microphone example schematic is shown in [Figure 4-4](#):

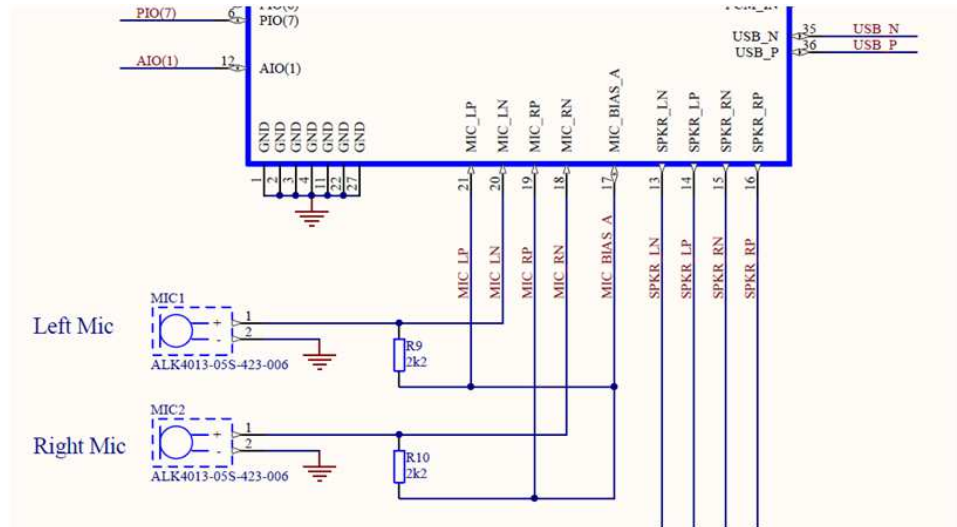


Figure 4-4: Stereo Microphone Example Schematic

## Mono Microphone Example Schematic

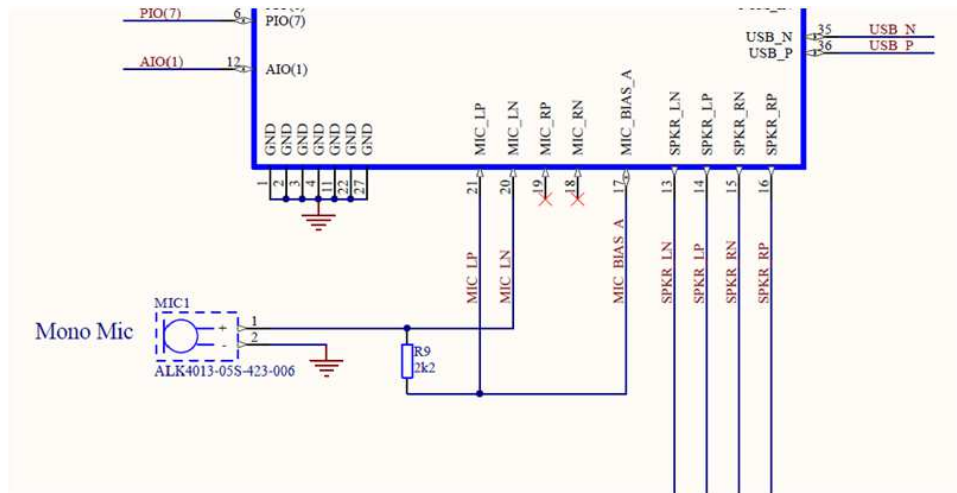


Figure 4-5: Mono Microphone Example Schematic

The left channel is used for mono operation, leave the right channel unconnected. For dual mono operation the right channel forms the auxiliary channel; connect as per stereo example schematic.

By default mic bias will go high for a hands-free and for a music connection. The behavior of Mic Bias can be configured. Please refer to the Melody UART manual for configuration options.

Mic bias is 2.6V and can source up to 2.8mA of current. Melody fixes it at a certain voltage. Please refer to the manual. The microphone input goes into a buffer stage so its input resistance is high.

## Connecting Speakers

The analogue output is not AC coupled. The analogue output circuit comprises a DAC, a buffer with gainsetting, a low-pass filter, and a class AB output stage amplifier. The output is available as a differential signal between SPKR\_LN and SPKR\_LP for the left channel, and between SPKR\_RN and SPKR\_RP for the right channel. The amplifiers expect a load impedance of 16 to 32 Ohms. Peak voltage output depends on the gain setting though one should expect nothing more than a peak to peak voltage of 1.5V with a DC offset of around 1.2V at maximum gain.

## External Amplifier Support

On the BC127/BC127-HD/BC127-EXT (non MFI builds), PIO3 goes high when an audio link is active. That PIO can be used for turning ON and OFF an external amplifier.

The BC127/BC127-HD/BC127-EXT is designed to provide direct speaker drive however in the case where higher audio power is required, the BC127/BC127-HD/BC127-EXT can drive an external amplifier.

The BC127/BC127-HD/BC127-EXT speaker outputs are DC coupled to the Bluetooth IC internal to the module. The speaker outputs are referenced to 1.8V. Sierra Wireless recommends connecting the BC127/BC127-HD/BC127-EXT to an external amplifier in a differential configuration for enhanced noise immunity. In this configuration common mode noise is rejected by the amplifier configuration. In many applications supply noise can significantly degrade audio performance so supplying filtering and layout grounding is essential to gain best performance in audio applications. This is especially important in USB powered applications or where a USB source is used to charge a battery powered applications, USB supplies vary significantly with noise levels and supply stability. Good grounding and isolation of noise ground currents is essential for superior audio applications.

In addition to steady state noise levels from USB supplies, the plugging and unplugging of USB chargers can cause large supply transients that ripple through the supply chain to cause clicking and popping in the audio domain. Sierra Wireless recommends following good noise immunity pcb design practices, ground isolation, short residual current return paths and the use of ferrite bead and large decoupling capacitors on USB supply connections.

An example USB supply configuration is shown [Figure 4-6](#):

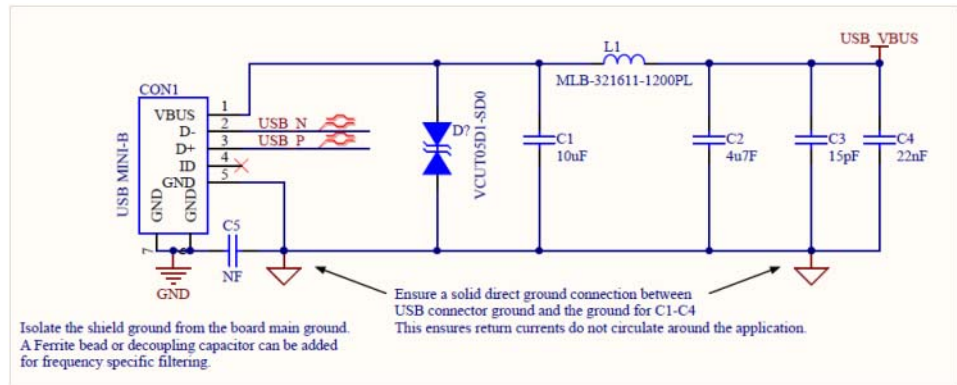


Figure 4-6: Example USB Supply Configuration

The BC127/BC127-HD/BC127-EXT Discovery Board and the BC127/BC127-HD/BC127-EXT Development Board use an external amplifier for audio application demonstration purposes. For superior audio performance always follow the design and layout guidelines provided by the amplifier manufacturer.

Always use a high quality audio amplifier ideally with click and pop suppression circuits built in. These amplifiers use noise suppression and soft start techniques to filter supply noise and transients as well as minimising ground loop currents and DC offsets that can cause degraded audio effects. Some amplifiers even employ ground sensing and suppression techniques to minimise and remove noise coupling to the audio path.

In the example amplifier circuit below, the amplifier audio ground is connected to the main ground via a single “star” point at the audio output jack. This is suitable for connection to headphones where noise from an external source is not expected. This circuit is used on the BC127/BC127-HD/BC127-EXT Development Board.

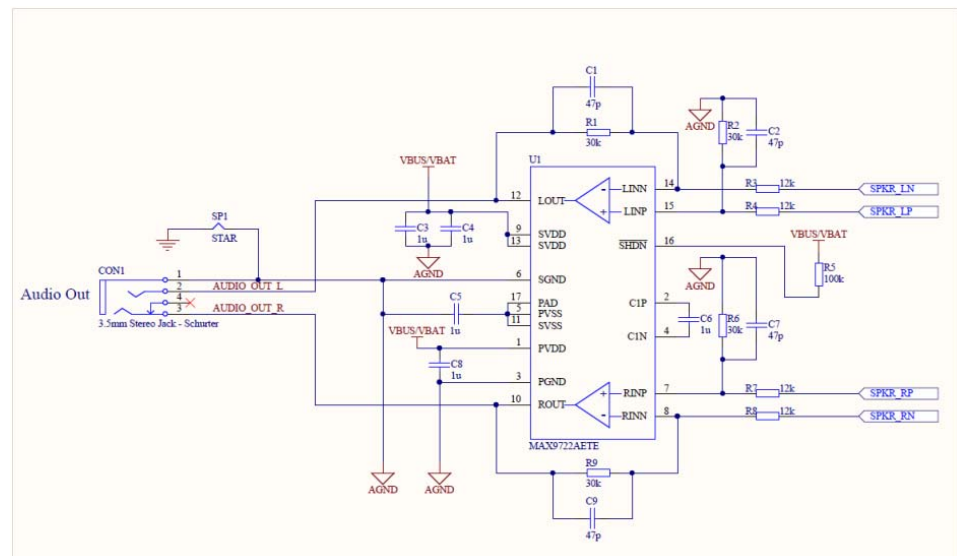


Figure 4-7: Example External Audio Amplifier Connection Suitable for Connecting to External Headphones

No two audio amplifiers are the same so it is important to ensure that you follow the design recommendations provided by the supplier of the amplifier.

When connecting to external devices such as laptops in a “line In” configuration, there is a possibility that the sleeve of the audio cable can carry noise derived from the laptop. Also external devices connected through the audio cable sleeve can have different ground potentials which causes currents to flow through the sleeve ground. In this case it is important to isolate the sleeve ground from the audio amplifier to avoid the noise coupling to the amplifier and degrading the signal source. In this case add a filter circuit or ferrite bead connecting the sleeve ground to the ground on the application board as shown in [Figure 4-7](#) below.

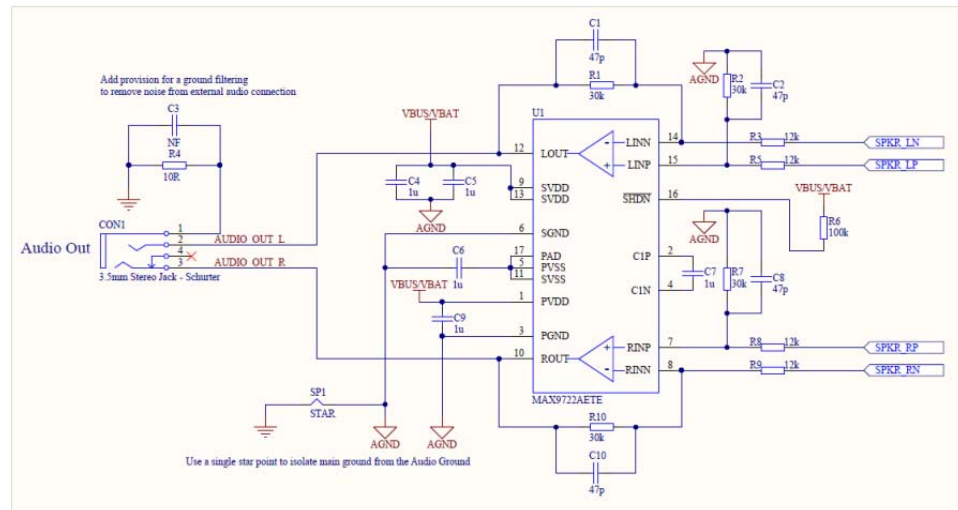


Figure 4-8: Isolating the Sleeve Ground from the Amplifier

Some amplifiers do not support “capless” operation and require AC coupling on the input and output of the amplifier. Series capacitance can introduce clicks and pops during turn off and turn on as voltage transients occur across the capacitors causing audible spikes on the audio output.

Choice of capacitors used in these configurations is important; avoid using ceramic capacitors as these tend to have high voltage coefficients. Use low voltage coefficients capacitors such as tantalum or electrolytic capacitors to reduce low frequency distortion effects.

In differential mode the tolerance of the source and feedback resistors which set the gain of an amplifier is important. 1% resistors give a 40dB CMRR whereas 0.1% resistors give a 60dB CMRR. Use 0.1% resistor arrays for even better performance.

The BC127/BC127-HD/BC127-EXT can be used to drive amplifiers in a single ended format. Simply terminate the +ve differential outputs directly to the audio ground. An example of a single ended connection is shown below.

## External Speaker Connections

In some versions of the BC127/BC128, the speaker lines SPKR\_LN, SPKR\_LP, SPKR\_RN & SPKR\_RP were internally DC blocked by 100nF capacitors on the module. This limited the low frequency response of the audio output. A new BC127 (V4 and above still to be released) will have these capacitors removed. So external series capacitors are now required on the four audio output lines mentioned above.

Select the capacitor values based on the low frequency response you wish to achieve in your application. 1uF would be a typical suggested value.

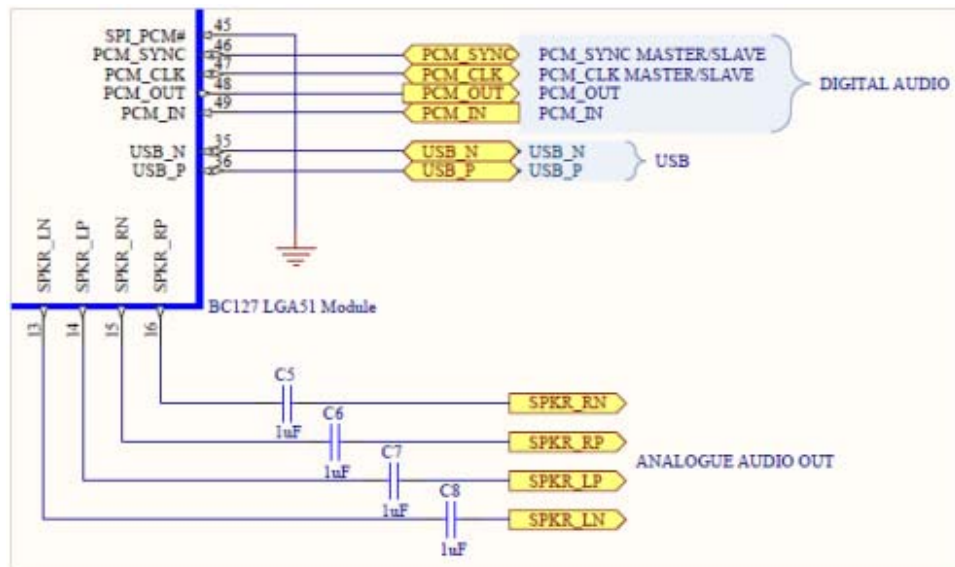


Figure 4-9: External Series Capacitance Required for Speaker Output Connects

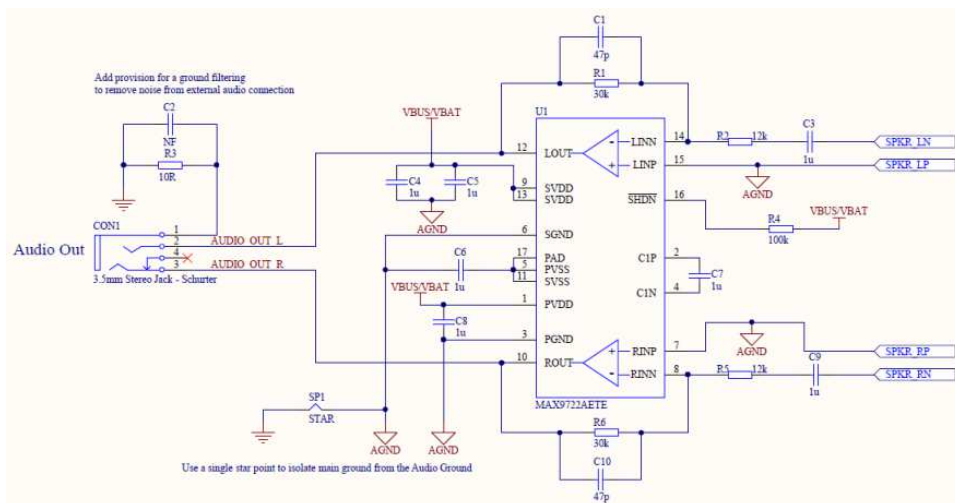


Figure 4-10: Isolation

## GPIO and UART

The BC127/BC127-HD/BC127-EXT is controlled by GPIOs. This can be configured. If GPIO control is not used, these GPIOs should be left floating. The UART by default does not use RTS/CTS flow control. If the users do not expect to use it, these lines should be left floating.

## Digital Pin States on Reset or After Power Up

The following table shows the Digital Pin States on Reset or after power up.

**Table 4-2: Digital Pin States on Reset or after Power up**

Pin Name/Group	I/O Type	State after Power Up or Reset
USB_DP	Digital bi-directional	N/A
USB_DN	Digital bi-directional	N/A
UART_RX	Digital bi-directional with PU	Strong PU
UART_TX	Digital bi-directional with PU	Weak PU
UART_CTS	Digital bi-directional with PD	Weak PD
UART_RTS	Digital bi-directional with PU	Weak PU
SPI_CS#	Digital input with PU	Strong PU
SPI_CLK	Digital input with PD	Weak PD
SPI_MISO	Digital tri-state output with PD	Weak PD
SPI_MOSI	Digital input with PD	Weak PD
SPI_PCM#	Digital bi-directional with PD	Strong PD
PCM_IN	Digital bi-directional with PD	Weak PD
PCM_OUT	Digital bi-directional with PD	Weak PD
PCM_SYNC	Digital bi-directional with PD	Weak PD
PCM_CLK	Digital bi-directional with PD	Weak PD
RST#	Digital input with PU	Strong PU
PIO[7:0]	Digital bi-directional with PD	Weak PD

PD = Pull Down, PU = Pull Up