



Enhancing Battery Life and Audio Performance in Mobile Devices

By Bill Hermann, Principal Member of the Technical Staff; Matthew Mowdy, Senior Member of the Technical Staff; and Brandon Xu, Executive Business Manager; Mobile Audio

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Abstract

Even small, mobile electronic devices are now expected to deliver high-quality audio while still providing long battery life. Given their tiny form factor, however, this is a tall order to meet from a design standpoint. After all, the smaller the device, the smaller the battery and, therefore, less capacity. This paper examines technologies that enable designers to integrate high-quality audio and long battery life into portable products like hearables and Bluetooth® headphones.

Introduction

Delivering a Rich Audio Experience



Mobile device users expect high-quality, long-lasting performance

Whether they're wearing wireless headphones or earbuds, listeners want the sound coming from their devices to transport them to another place. Sound that is open and rich with a high level of clarity can provide this audio experience. What's more, listeners don't want the interruption of having to frequently recharge their portable devices. In short, they expect lasting, high-quality audio performance while they're on-the-go.

From a design standpoint, it's challenging to deliver on both criterion in a tiny portable device. Some products offer great audio quality, but the sound isn't loud enough when the user is in a noisy environment. Other products provide loud sound, but once the user moves to a quiet space, the distortion of the sound becomes noticeable. And power consumption? That can be a mixed bag.

This paper compares two audio solutions available for development of small, portable electronics with audio. The paper highlights a solution that achieves the balance of great audio performance with low power consumption in mobile electronics.

Single-Chip Versus Codec-Based Solution

One available option is to use a single-chip solution (or system-on-chip (SoC)) plus discrete components for the Bluetooth device.

This approach delivers generally good audio performance based on the signal-to-noise ratio and power consumption. The chip, which supports 16-bit audio, includes a hardware codec. It also runs a software compression algorithm over the Bluetooth link, which, based on the operating system run on the source, can deliver better audio performance compared to standard audio compression. This solution typically draws 15mA or more from a single-cell battery (this measurement is based on a Lithium-ion battery; for different battery types, the current draw would scale with voltage proportional to the power needed).

The other available solution consists of a specialized, low-power audio codec, a power management IC (PMIC) based on a single-input, multiple-output (SIMO) architecture, and a Bluetooth chip. This solution was designed to deliver an excellent power/performance ratio, drawing as low as 8mA from a battery. This represents a power savings of about 40% relative to the single-chip solution previously discussed, making it an ideal solution for mid-range applications.

In the audio codec, each block, from the microphone inputs to the headphone outputs, has been designed for high audio quality at the lowest possible power. The sound comes through loud and clear, without distortion. The codec features a variety of filters and controls that enhance sound quality:

- A seven-band parametric equalizer allows you to tune the audio response of your design; for example, you could boost the bass or adjust the treble
- A DC-blocking filter removes any offset from the audio signal
- A lowpass filter removes high-frequency, inaudible noise and signals
- Digital volume control allows upward and downward adjustment of the audio amplitude. Analog volume control is also available. The analog and digital volume controls together allow you to set up the optimal gain structure based on your desired full-scale level and the sensitivity of your headphone speakers (or coils or drivers).
- Dynamic range control smooths out peak audio volume for a consistent listening experience

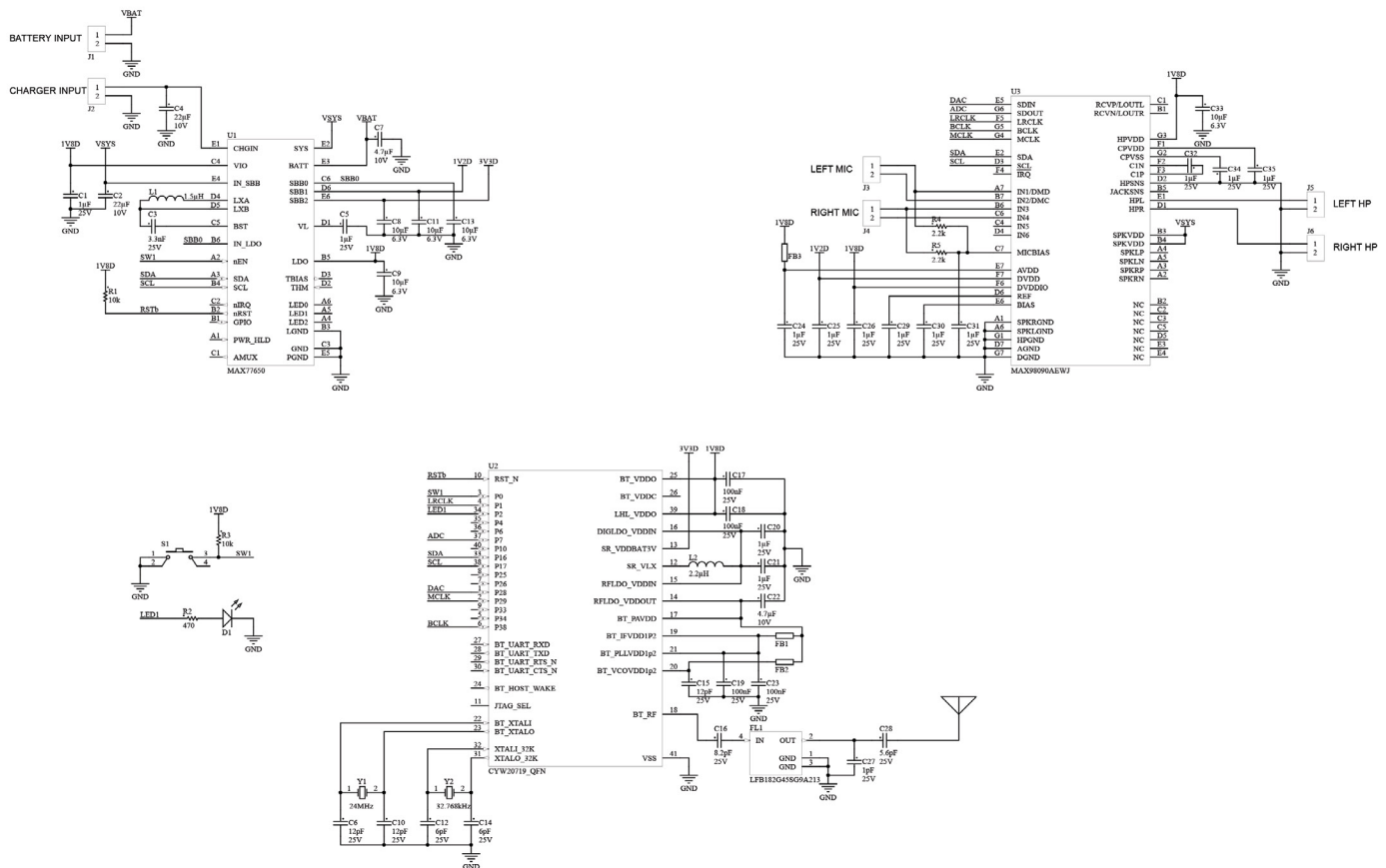


Figure 1. Mobile audio design reference schematic.



*Highly integrated
solution delivers
excellent power/
performance for
mobile audio
products*

The small form factor of mobile electronics typically means that the devices are powered by lithium-ion batteries. Due to its SIMO architecture and its low quiescent current, the PMIC (a buck-boost converter) helps to extend battery life while reducing power dissipation. The SIMO PMIC essentially provides the same functionality of traditional power management solutions in less than half the space. Traditional multiple switching-regulator topologies call for a separate inductor for each switching regulator. Inductors are large and costly and, therefore, not very practical for small electronics. A buck-boost converter based on the SIMO architecture can regulate up to three output voltages over wide output voltage ranges via a single inductor. A thoughtful design approach is required when using a SIMO, as this architecture does have tradeoffs to consider. For example, since a single inductor is providing buckets of energy to alternate outputs, the output voltage ripple will tend to be higher. Since a SIMO is heavily loaded, it becomes time-limited, so there can be a delay in servicing each channel, further increasing output voltage ripple. Larger output caps can offset these sources of output voltage ripple while preserving a net footprint/BOM advantage.

Reference Design for Fast Prototyping

Maxim has a new reference design featuring the [MAX98090 audio codec](#), the [MAX77650 SIMO buck-boost converter](#), and the Cypress CYW20721 enhanced low-power, BR/EDR/BLE Bluetooth 5.0 wireless SoC device. The reference schematic in Figure 1 can be used to prototype mobile audio designs. There are also evaluation kits available for each of these components.

The combination of the audio codec and the SIMO PMIC support the low power and compact size requirements of applications such as hearables, wearables, and Bluetooth headphones. Compared to the single-chip solution, this integrated offering delivers 102dB dynamic range stereo digital-to-analog converter (DAC) to headphone versus 96dB. From a power standpoint, designs created using the MAX98090 plus the Cypress CYW20721 BT/BLE SoC with WASSTM chip will consume as low as 8mA, which has up to 40% current consumption savings. FlexSound® DSP technology in the record and playback paths of the codec includes digital gain and filtering, a biquad filter (record), dynamic range control (playback), and a seven-band parametric equalizer (playback).

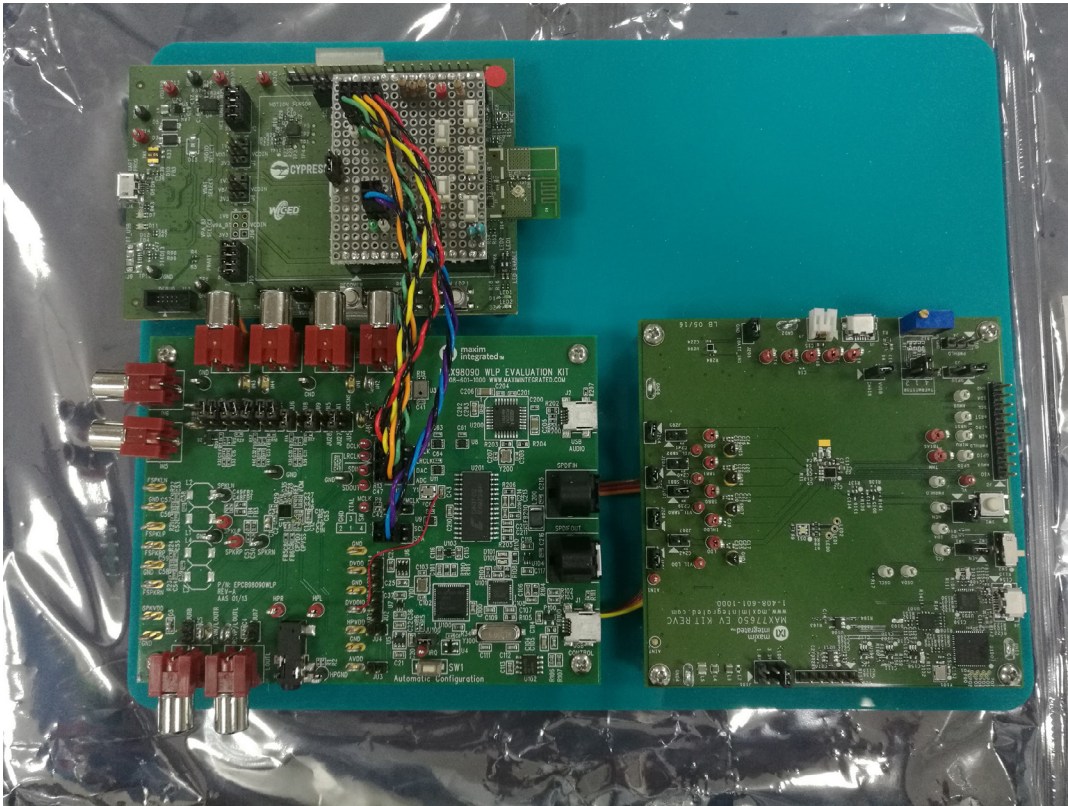


Figure 2. Mobile audio reference design setup.

Summary

To differentiate your mobile audio design, the product must deliver high-quality sound with long battery life. This paper examined two approaches for achieving these objectives, and highlighted how an integrated solution with a low-power audio codec and a SIMO PMIC can effectively achieve this balance.

Learn More

Learn more about [Maxim's Mobile technologies](#) from resources including application notes and technical videos.

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