Keywords: audio, autoshutdown, cell-phone power, speaker amplifiers, window comparators

APPLICATION NOTE 3612

AutoShutdown™ for Speaker Amplifier Conserves Cell-Phone Power

Sep 16, 2005

Abstract: This circuit conserves battery power by automatically shutting down the speaker driver when no audio signal is present, thus conserving cell-phone power.

This design idea appeared in the April 18, 2005 issue of *EE Times*.

The AutoShutdown circuit of **Figure 1** exploits the transient nature of cell-phone conversations. When the circuit detects a lull in conversation, it places the speaker amplifier in a low-power shutdown state that conserves battery life and extends talk time. When conversation picks up again, the speaker amplifier quickly turns on to avoid loss of audio information.

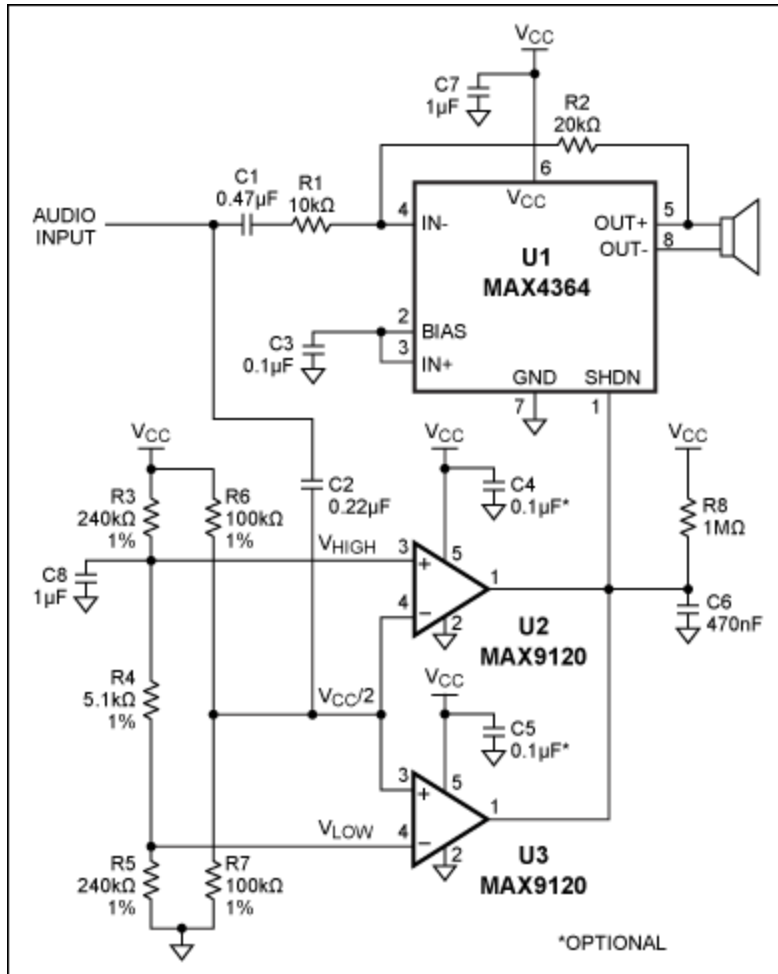Attend this brief webcast by Maxim on TechOnline

Figure 1. This circuit conserves battery power by automatically shutting down the speaker driver when no audio signal is present.

Cell-phone batteries supply current to power-hungry circuits such as the RF power amplifier and, in speakerphone mode, the class AB speaker amplifier. An ideal speaker amplifier draws 353mARMS from the battery when driving 8Ω at 1W. However, with no signal present, it still draws milliamps of supply current. For that reason, most speaker-driver ICs include a shutdown mode that reduces supply current when the driver is not in use.

As a result, the quiescent operating and shutdown currents can differ dramatically. Speaker amplifier U1 of Figure 1, for instance, draws 7mA typical when no signal is applied. Forcing U1 into shutdown reduces that quiescent supply current to a paltry 10nA. In Figure 1, the total supply current drops from approximately 7mA to 22µA when the audio input dips below a preset level for a defined time interval.

A window comparator (U2 or U3) compares the input signal with a preset reference voltage proportional to V_{CC}. R6 and R7 bias the input signal to the middle of the comparator's window, which is $V_{CC}/2$. R3-R5 set the window comparator reference, in which the high and low thresholds are:

$$V_{HIGH} = \frac{V_{CC} \times (R4 + R5)}{R3 + R4 + R5}, \quad V_{LOW} = \frac{V_{CC} \times R5}{R3 + R4 + R5}.$$

Setting the difference in thresholds (V_{HIGH} - V_{LOW}) sufficiently large ensures that noise cannot turn on

the speaker amplifier.

The comparators' open-drain outputs connect to U1's SHDN input. When the peak-to-peak value of the audio input is outside the window set by R3-R5, the open-drain outputs turn on alternately, maintaining V_{SHDN} at ground as shown in **Figure 2**. When the audio signal is within the window, both outputs turn off. C6 and pullup resistor R8 then cause V_{SHDN} to slowly rise to U1's shutdown threshold.
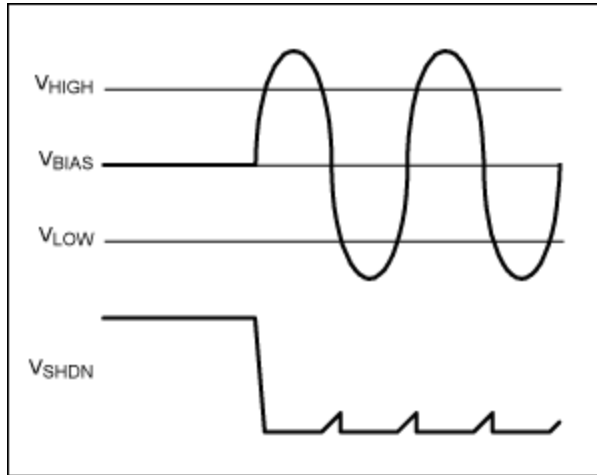

Figure 2. The shutdown signal in Figure 1 (V_{SHDN}) is driven low when the input exceeds preset levels. The large time constant created by C6 and R8 prevents excessive gating of the audio signal.

Waking up from shutdown is much quicker, because C6 discharges directly to ground through one of the open-drain comparator outputs. A quick turn-on ensures that no audio information is lost (**Figure 3**).
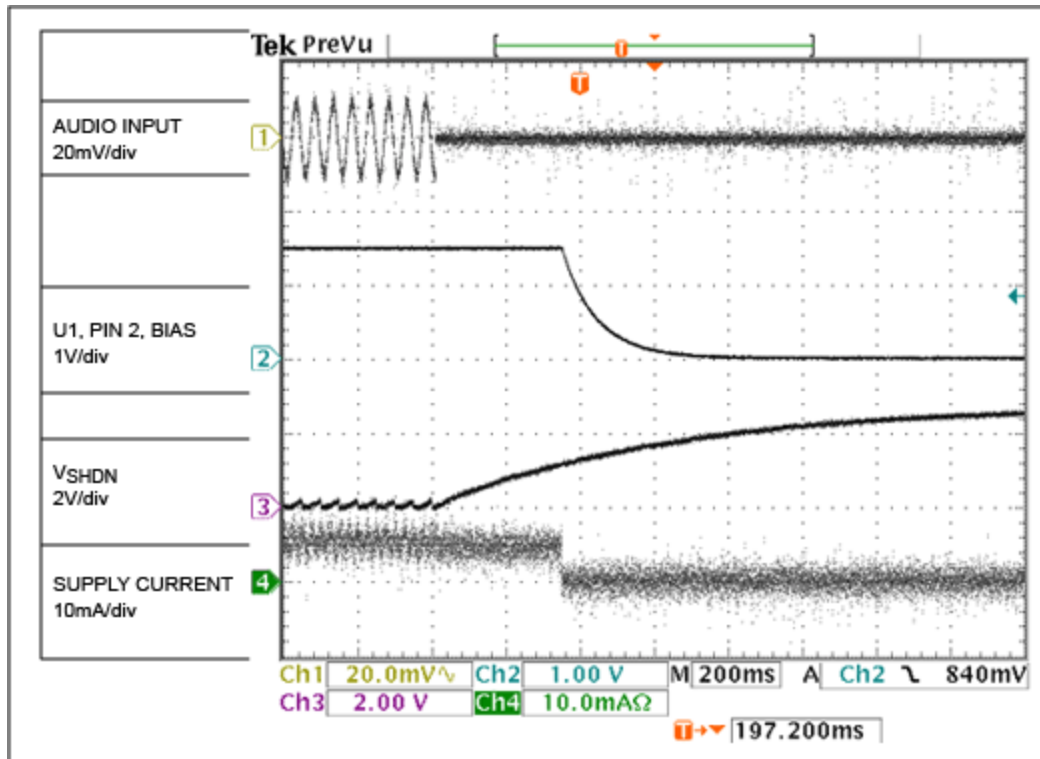
Figure 3. The speaker amplifier in Figure 1 shuts down quickly when the input signal is removed.

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