Keywords: piezoelectric speaker, charge pump, stereo headphone driver, piezoelectric, charge pump doubler Dec 09, 2003

APPLICATION NOTE 2914

3V Supply Delivers 12VP-P to Piezoelectric Speaker

Abstract: A specialized IC (stereo headphone driver) with internal charge-pump doubler is harnessed to the task of driving a piezoelectric speaker from a 3V supply.

Low-profile piezoelectric speakers provide compact, quality sound for portable electronics devices. But they require voltage swings of $8V_{P-P}$, which exceeds the supply voltage typically available from conventional battery-driven amplifiers.

One solution is IC1 in **Figure 1**, which can be configured to drive a piezoelectric speaker with as much as $12V_{P-P}$, while operating from a single 3V supply.

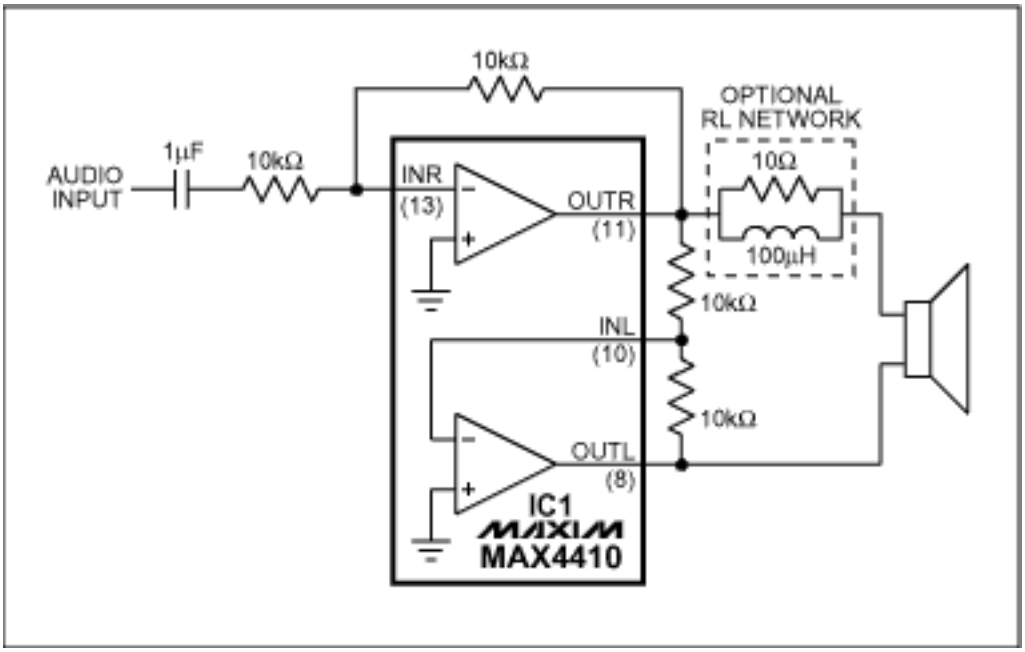

Figure 1. This bridge-tied-load (BTL) configuration multiplies the amplifiers' voltage-swing capability.

IC1 (the MAX4410) is a specialized device that combines a stereo headphone driver with an inverting charge pump that derives a negative -3V supply from the positive 3V supply. The internal ±3V supply allows each output of IC1 to swing $6V_{P-P}$. Configuring IC1 as a bridge-tied load driver (BTL) doubles the maximum swing at the load to $12V_{P-P}$.

In the BTL configuration, IC1's right channel serves as the master amplifier. It sets the gain of the device, drives one side of the speaker, and provides a signal to the left channel. Configured as a unity gain follower, the left channel inverts the output of the right channel and drives the other leg of the speaker. To ensure low distortion and good matching, set the left-channel gain using precision resistors.

The circuit was tested with a Panasonic WM-R57A piezoelectric speaker, yielding the THD+N curves shown in **Figures 2-3**. Note that THD+N increases as frequency increases in both graphs. Because the speaker appears to the amplifier as a capacitor, the speaker impedance decreases as frequency increases, drawing larger currents from the amplifier.

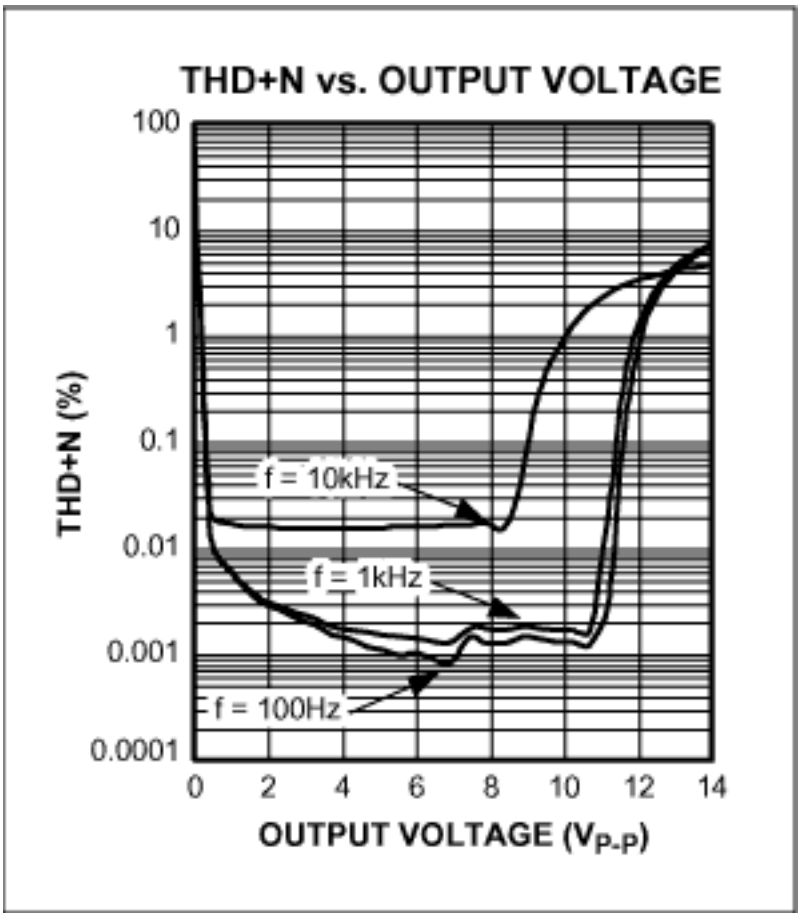

Figure 2. THD+N vs. output voltage for the Figure 1 circuit.

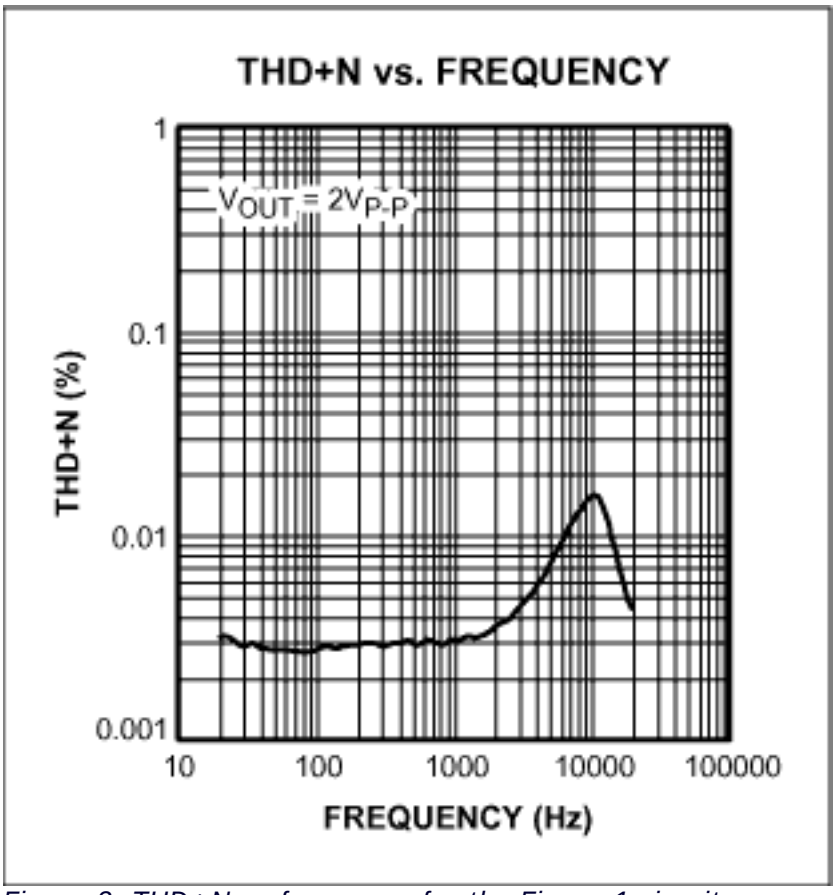

Figure 3. THD+N vs frequency for the Figure 1 circuit.

IC1 remains stable with the speaker shown (**Figure 4**), but a speaker with different characteristics might cause instability. In that case, you can isolate the speaker's capacitance from the amplifier by adding a simple inductor/resistor network in series with the speaker (shown within the dotted lines on Figure 1). The network maintains stability by maintaining a minimum high-frequency load of about 10Ω at the device output.

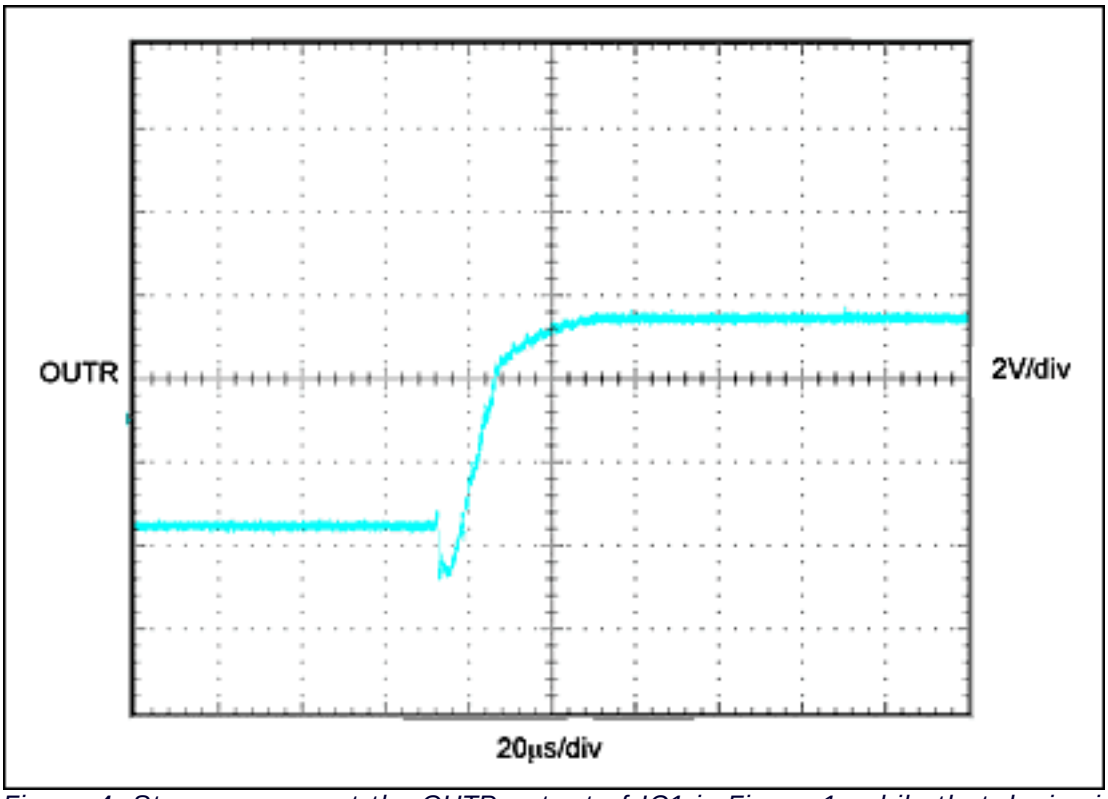

Figure 4. Step response at the OUTR output of IC1 in Figure 1, while that device is driving a WM-R57A piezoelectric speaker.

This former design idea was published in the October 16, 2003 issue of *EDN* magazine.

Application Note 2914: http://www.maxim-ic.com/an2914

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