Inductor Selection for the TAS2552 Boosted Class-D Amplifier

AIP Audio

ABSTRACT

TAS2552 boosted class-D amplifier contains a DC/DC converter which requires a properly sized inductor for optimal performance. This application report explains how to choose an inductor for the TAS2552.

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TAS2552 Boost Converter

The boost converter inside the TAS2552 creates 8.5 V from a 3.0-V to 5.5-V input voltage on the VBAT terminal. This boosted voltage supplies the class-D output stage enabling up to 4 W of power into an 8-Ohm load.

Setting bit D6 in register 2 enables the boost converter. Setting bit D5 in register 2 enables auto pass through mode, which configures the boost converter for class-G mode, automatically turning the boost on or off, depending on the signal level. The threshold and the deactivation delay for auto pass through mode is configurable in register 20. For details, see 7.5.22 in the TAS2552 data sheet.

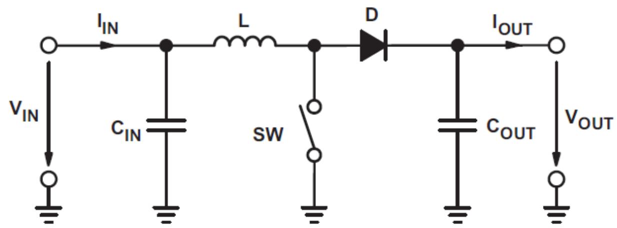

Figure 1. Boost Converter Circuit

Figure 1 shows the equivalent circuit of the TAS2552 Boost Converter. The boost converter requires external passive components for proper operation: The input capacitor C_{IN}, the boost inductor L and the output capacitor C_{OUT}.

The TAS2552's internal logic controls the duty cycle of SW. When SW is closed, the current through L increases which builds a magnetic field and stores energy in the inductor. When SW opens, the (decreasing) current through the inductor charges the capacitor C_{OUT}. The diode prevents discharging the capacitor when SW is closed. The voltage across C_{OUT} is a function of the input voltage and the duty cycle (assuming ideal components).

The switch and diode are internal to the TAS2552, C_{OUT} attenuates ripple on the output and should be a low ESR (X5R or better dielectric material) ceramic capacitor (10 μF, 16 V). The capacitor must maintain its 10-μF specification at the boost voltage (8.5 V for the TAS2552).

Boost Inductor and Input Capacitor Selection

The boost inductor and the input capacitor determine the maximum output current and the stability of the boost converter.

The size of the inductor has a direct effect on the maximum output current because of the relationship between ripple current and inductance. Higher inductance has lower ripple current.

Ripple current ΔI_L is the amount the current through the inductor changes for each switching cycle. The inductor must be able to handle a total current of $I_{max} + \Delta I_L / 2$ without saturating. Due to parasitic capacitor ESR, the ripple current will also produce a ripple voltage. The ripple current is a parameter with the following trade-offs:

- Low ripple current = high inductance, low ripple voltage
- High ripple current = high saturation current, high ripple voltage

For the TAS2552, a ripple current of 20% of the maximum current is a good estimate for a balanced trade-off between inductance and saturation current.

$\Delta I_L = 0.2 \times I_{max}$

Example:

$I_{max} = 3\text{ A}$, $\Delta I_L = 0.2 \times 3\text{ A} = 600\text{ mA}$

The inductance is a function of input voltage, output voltage, switching frequency and ripple current:

$L = V_{IN} \times (V_{OUT} – V_{IN}) / (\Delta I_L \times fs \times V_{OUT})$

fs for the TAS2552 is 1.75 MHz; therefore,

$L = 3.0\text{ V} \times (8.5\text{ V} – 3.0\text{ V}) / (0.6\text{ A} \times 1.75\text{ MHz} \times 8.5\text{ V}) = 1.9\ \mu\text{H}$

The input capacitor is required to stabilize the boost converter by supplying peak currents. Like the output capacitor, a low ESR ceramic capacitor (X5R or better) should be used. To ensure stability, the product of the boost inductor and the input capacitor, $L \times C_{IN}$, must be greater than 10e-12 s^2.

To achieve the rated performance of 1% THD at 4-W output power, TI recommends a 2.2-µH, 3.5-A boost inductor with a 22-µF, 16-V, X5R ceramic input capacitor. The capacitor must maintain its 22-µF specification over the V_{IN} range.

Boost Inductor and THD+N

If the application requires a small size inductor, THD+N performance will deteriorate as shown in Figure 2: THD+N vs. output power for a 2.2-μH, 3-A and a 1-μH, 3-A inductor, VBAT = 3.6 V, boost = enabled, auto-pass-through = disabled, 8-Ohm load, digital input signal (1kHz sine wave):

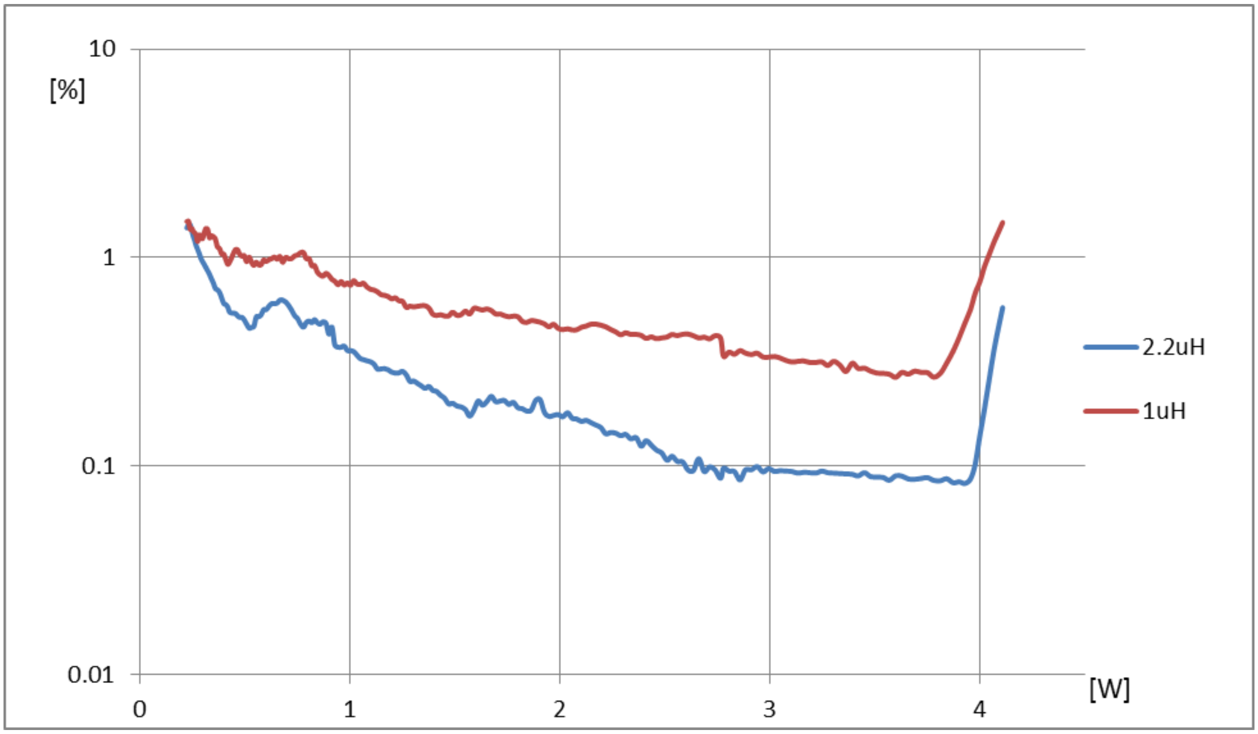

Figure 2. THD+N vs. Output Power

For best performance, a 2.2-μH inductor is recommended for the TAS2552.

Revision History

Changes from Original (April 2014) to A Revision **Page**

- Added *best performance* comment after Figure 2. 4

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