LM48511 Evaluation Board User's Guide

National Semiconductor
Application Note 1922
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November 5, 2008

Quick Start Guide

Apply a 3.0V to 5.5V power supply voltage to the VDD pin with respect to the ground (GND) pin.

Set connectors SD_Amp, SS_En Enable, SD_Boost to High. Set FB_SEL to Low (FB_SEL0) which boosts the regulator output voltage PV1 to about 7.6V.

Apply a mono differential input signal into the Audio Input's two center pins of the 4-pin connector.

Apply power. Make measurements.

Introduction

To help the user investigate and evaluate the LM48511SQ performance and capabilities, a fully populated demonstration board was created. Please contact National Semiconductor Corporation's Audio Products Group for availability. This board is shown in Figure 1. Connected to an external power supply (3.0V ≤ VDD ≤ 5.5V) and a signal source, the LM48511SQ demonstration board easily exercises the amplifier's features.

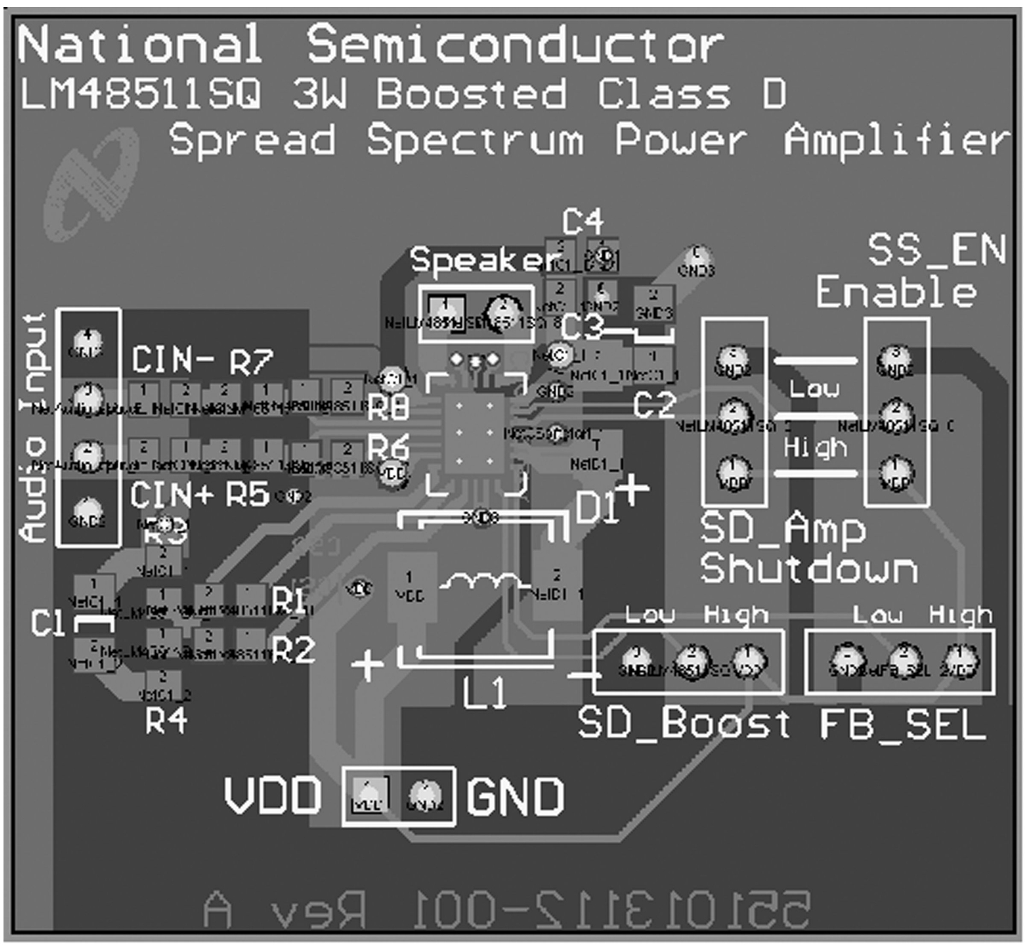

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FIGURE 1. Typical LM48511SQ Demonstration Board

General Description

The LM48511 integrates a boost converter with a high efficiency Class D audio power amplifier to provide 3W continuous power into an 8Ω speaker when operating from a 5V power supply. When operating from a 3V to 4V power supply, the LM48511 can be configured to drive 1 to 2.5W into an 8Ω load with less than 1% distortion (THD+N). The Class D amplifier features a low noise PWM architecture that eliminates the output filter, reducing external component count, board area consumption, system cost, and simplifying design. A selectable spread spectrum modulation scheme suppresses RF emissions, further reducing the need for output filters. The LM48511's switching regulator is a current-mode boost converter operating at a fixed frequency of 1MHz. Two selectable feedback networks allow the LM48511 regulator to dynamically switch between two different output voltages, improving efficiency by optimizing the amplifier's supply voltage based on battery voltage and output power requirements. The LM48511 is designed for use in portable devices, such as GPS, mobile phones, and MP3 players. The high, 80% efficiency at 5V, extends battery life when compared to boosted Class AB amplifiers. Independent regulator and amplifier shutdown controls optimize power savings by disabling the regulator when high output power is not required.

The gain of the LM48511 is set by external resistors, which allows independent gain control from multiple sources by summing the signals. Output short circuit and thermal overload protection prevent the device from damage during fault conditions. Superior click and pop suppression eliminates audible transients during power-up and shutdown.

Operating Conditions

- Temperature Range $T_{MIN} \leq T_A \leq T_{MAX}$ — $-40°C \leq T_A \leq +85°C$
- Supply Voltage (V_{DD}) — $3.0V \leq V_{DD} \leq \pm 5.5V$
- Amplifier Voltage (PV1, V1) — $4.8V \leq PV_1 \leq \pm 8.0V$

Board Features

The LM48511SQ 3W, Ultra-Low EMI, Filterless, Mono, Class D Audio Power Amplifier with Spread Spectrum demonstration board has all of the necessary connections using 0.100" headers connectors to apply the power supply voltage, audio input signals, and audio output (speaker). The amplified audio signal is only available on the audio output header.

Schematic

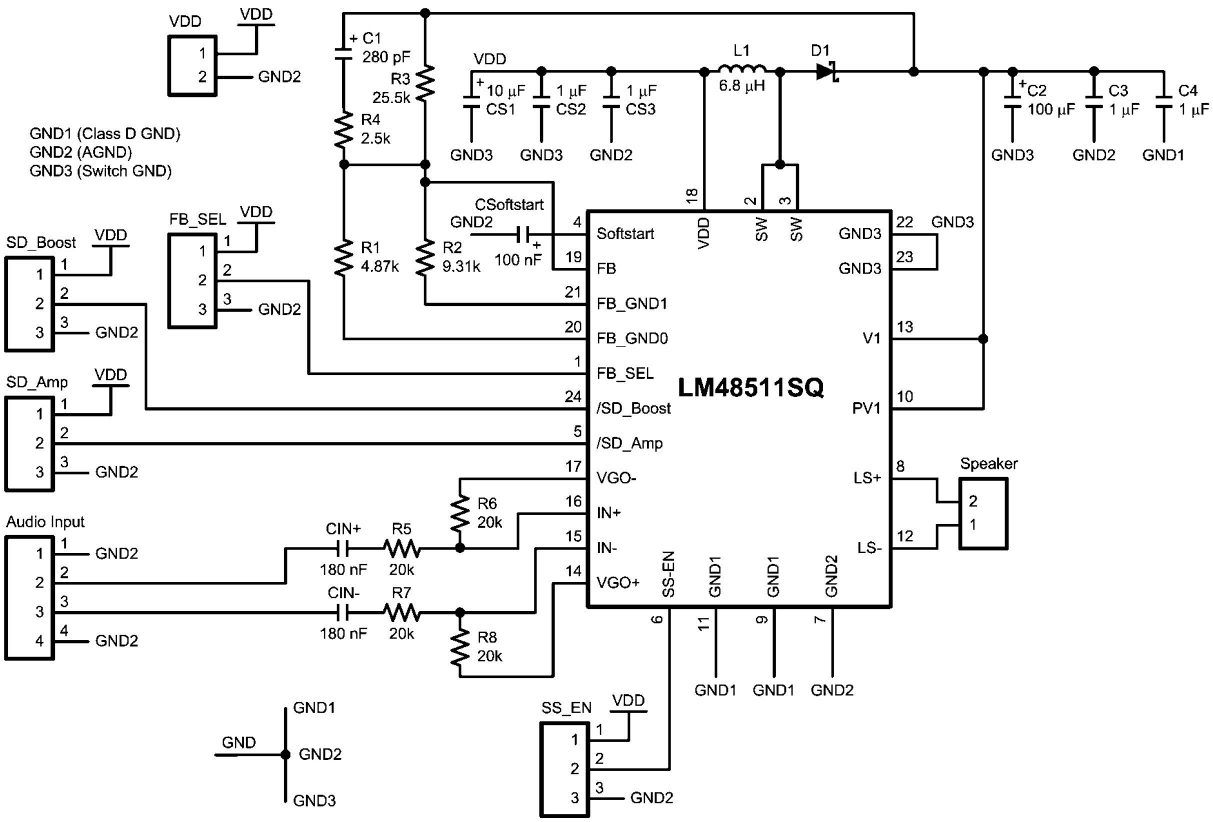

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FIGURE 2. Typical LM48511 Audio Amplifier Application Circuit

Connections

TABLE 1. LME49600 Demonstration Board Connections

Designator	Function or Use
Supply Voltage (VDD)	The supply voltage operating range is from 3.0V to 5.5V, but the absolute maximum rating is 9V.
Audio Input	The two center pins of the 4 pin connector on the left above are used as differential inputs into the LM48511, or two single-ended inputs when one center pin and an outer ground pin are paired.
Speaker (Audio Output)	The differential output for an 8Ω or 4Ω speaker.
SD_Amp	If SD_Amp is set LOW, the independent internal audio amplifier is disabled, and when set HIGH the amplifier is enabled.
SS_EN Enable	If SS_EN Enable is set LOW, the spread spectrum function is disabled, and when set HIGH the spread spectrum is enabled.
SD_Boost	If SD_Boost is set low, the independent regulator is disabled, and when set HIGH, the regulator is enabled.
FB_SEL	When LOW (FB_SEL0), the regulator output voltage PV1 is as follows: PV1 = VFB {1 + [25.5kΩ / 4.87kΩ]} where V_{FB} = 1.23V
	When LOW (FB_SEL1), the regulator output voltage PV1 is as follows: PV1 = VFB {1 + [25.5kΩ /9.31kΩ] } where V_{FB} = 1.23V

PCB Layout Guidelines

This section provides general practical guidelines for PCB layouts that use various power and ground traces. Designers should note that these are only "rule-of-thumb" recommendations and the actual results are predicated on the final layout.

POWER AND GROUND CIRCUITS

Star trace routing techniques can have a major positive impact on low-level signal performance. Star trace routing refers to using individual traces that radiate from a signal point to feed power and ground to each circuit or even device.

LAYOUT HELPFUL HINTS:

1. Avoid routing traces under the inductor.
2. Use three separate grounds that eventually connect to one point:
   a. Signal or quiet ground (GND2)
   b. Ground for the LM48511 device (GND1)
   c. SW (GND3)(switch ground)
      i. This trace for the switch ground carries the heaviest current (3A) and therefore is the nosiest. Make this trace as wide and short as possible and keep at a distance from the quiet ground and device ground. Give distance priority to the quiet ground.

Bill Of Materials

Designator	Description	Footprint	Quantity	Value
Cf1	CHIP CAPACITOR GENERIC	CAP 0805	1	470pF
CINA	CHIP CAPACITOR GENERIC	CAP 1210	1	1µF
CINB	CHIP CAPACITOR GENERIC	CAP 1210	1	1µF
Co	CHIP CAPACITOR GENERIC	CAP 1210	1	10µF
Cs1	CHIP CAPACITOR GENERIC	CAP 1210	1	2.2µF
Cs2	CHIP CAPACITOR GENERIC	CAP 1210	1	4.7µF
D1	SCHOTTKY DIODE	DIODE MBR0520 IR	1	
L1		IND_COILCRAFT-DO1813P	1	4.7µH
R1	CHIP RESISTOR GENERIC	RES 0805	1	41.2K
R2	CHIP RESISTOR GENERIC	RES 0805	1	13.3K
RINA	CHIP RESISTOR GENERIC	RES 0805	1	150K
RINB	CHIP RESISTOR GENERIC	RES 0805	1	150K

Demonstration Board PCB Layout

Figures 3 through 8 shows the different layers used to create the LM48511SQ demonstration board. Figure 3 is the silkscreen that shows component locations on the board's top surface. Figure 4 is the metal Top Layer. Figure 5 is the metal Midlayer 1. Figure 6 is the metal Midlayer 2. Figure 7 is the metal Bottom Layer. Figure 8 is the silkscreen that shows component locations on the board bottom.

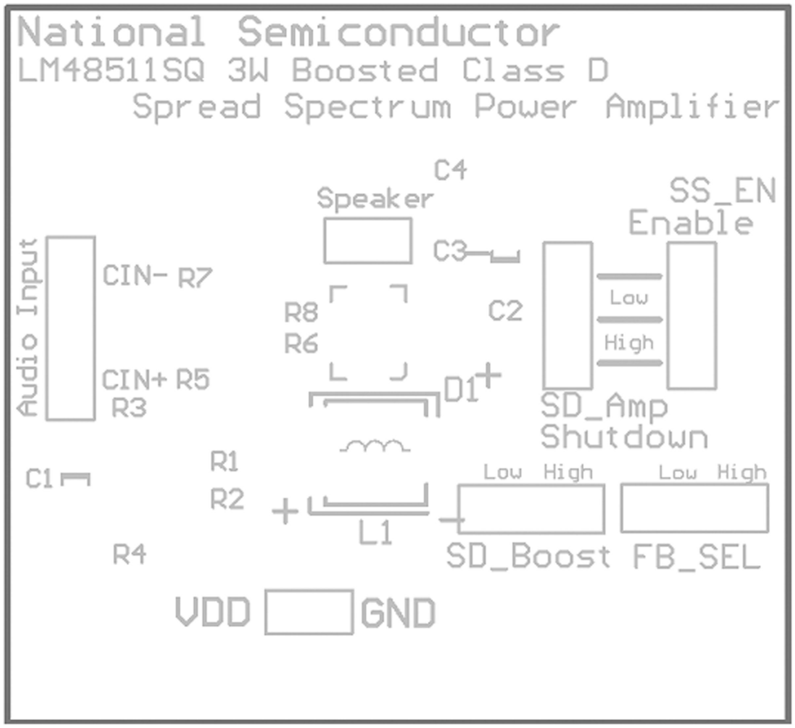

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FIGURE 3. Top Silkscreen

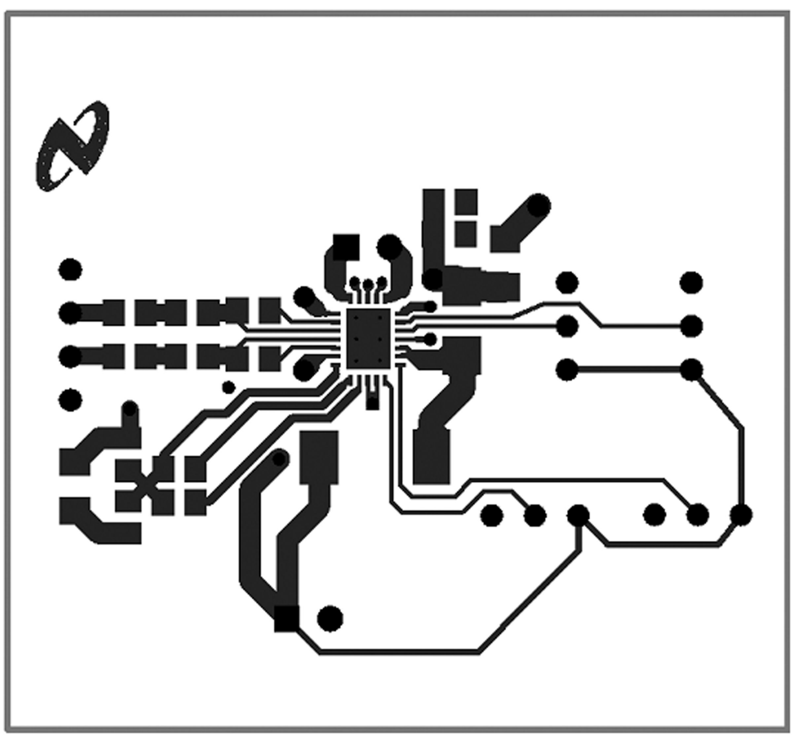

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FIGURE 4. Top Layer

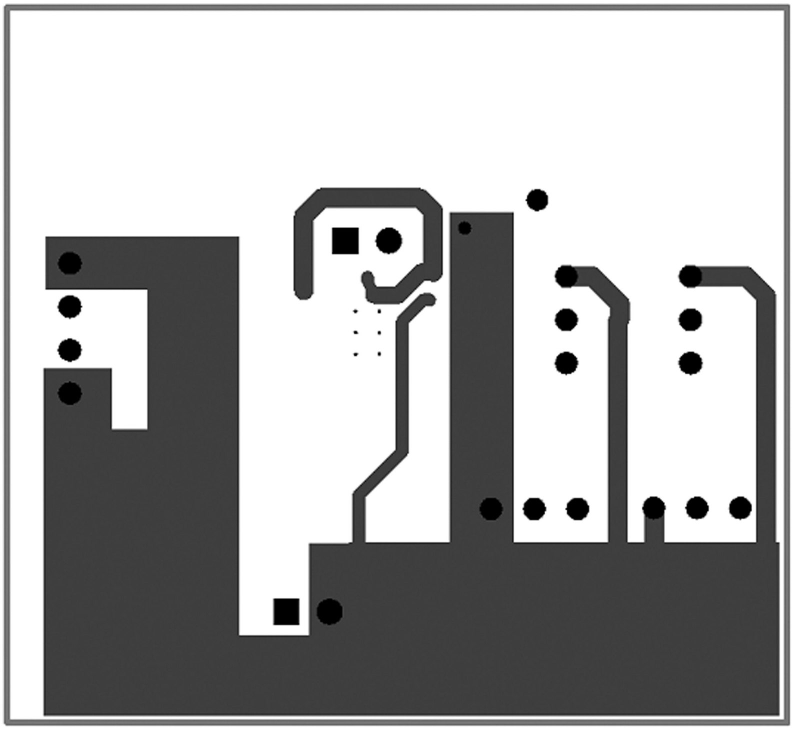

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FIGURE 5. Mid Layer 1

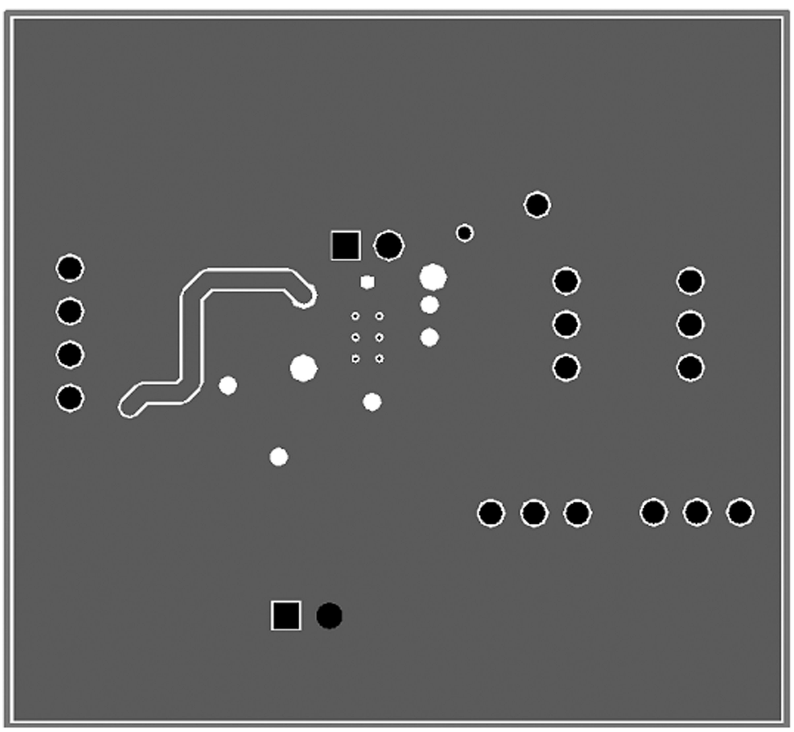

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FIGURE 6. Mid Layer 2

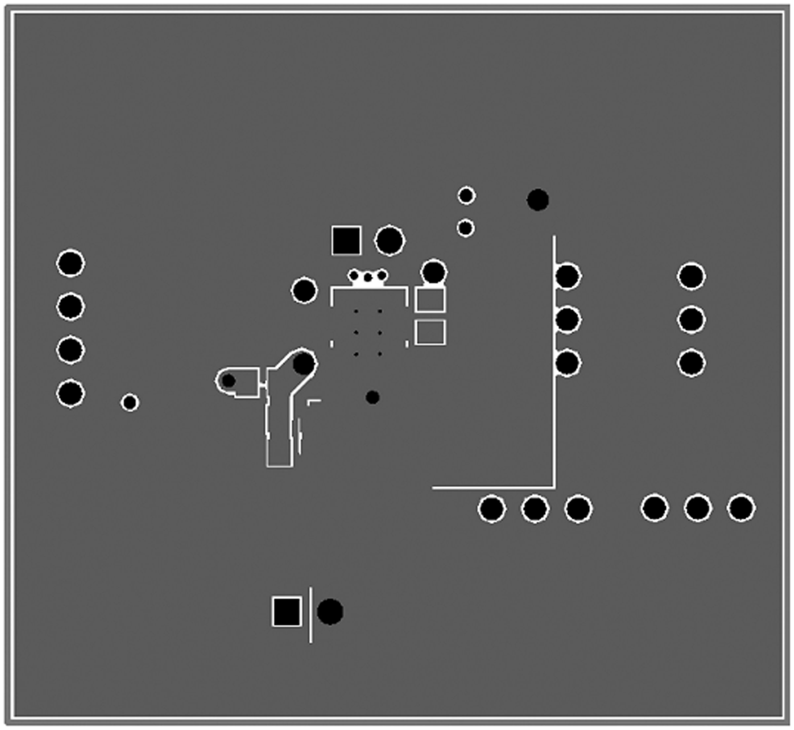

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FIGURE 7. Bottom Layer

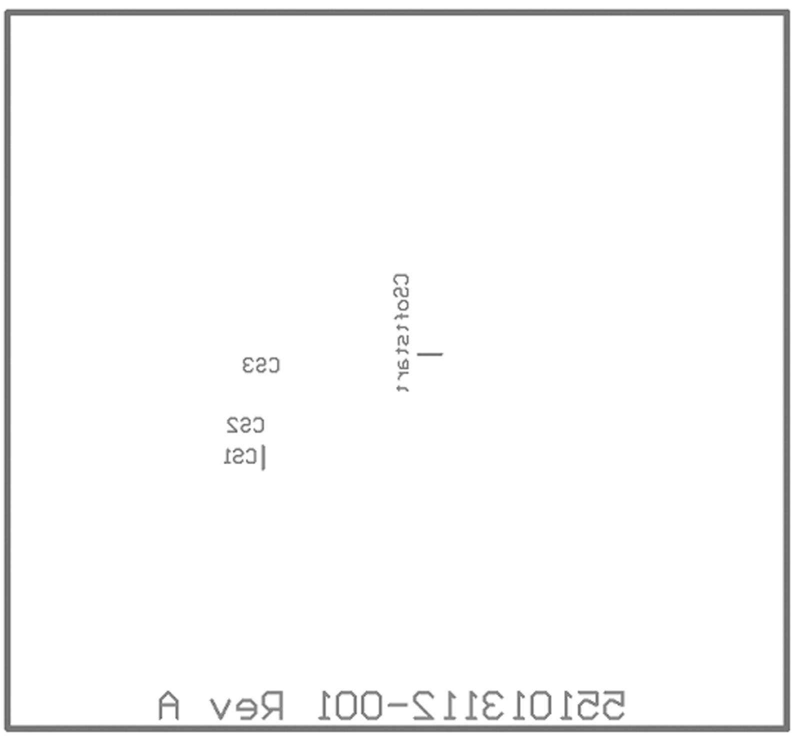

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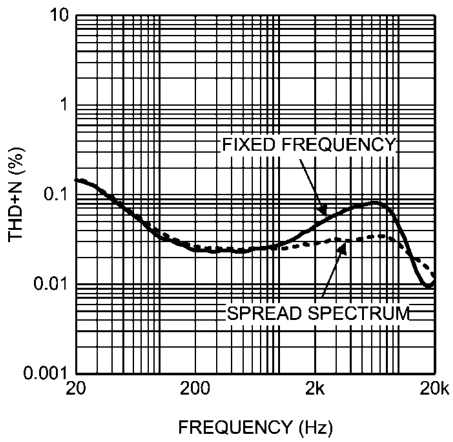
FIGURE 8. Bottom Overlay

Typical Performance Characteristics

THD+N vs Frequency
V_{DD} = 5V, R_L = 8Ω
P_O = 2W, filter = 22kHz, PV_1 = 7.8V



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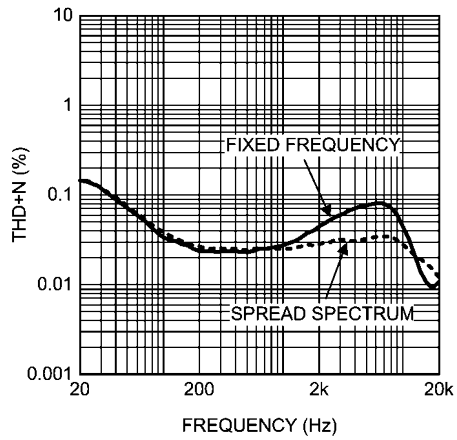
THD+N vs Frequency
V_{DD} = 3.6V, R_L = 8Ω
P_O = 500mW, filter = 22kHz, PV_1 = 4.8V



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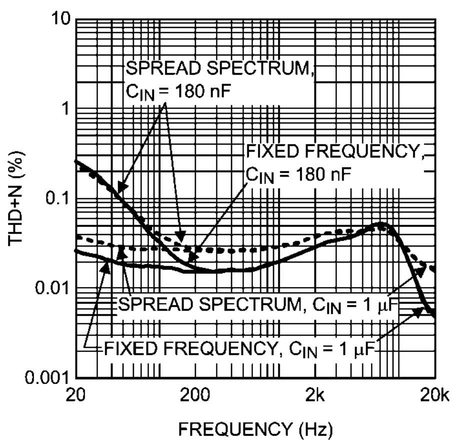
THD+N vs Frequency
V_{DD} = 3V, R_L = 8Ω
P_O = 1.5W, filter = 22kHz, PV_1 = 7V



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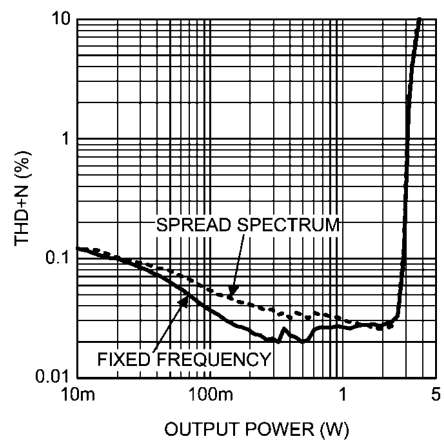
THD+N vs Output Power
V_{DD} = 5V, R_L = 8Ω
P_O = 1.5W, f = 1kHz, filter = 22kHz, PV_1 = 7.8V



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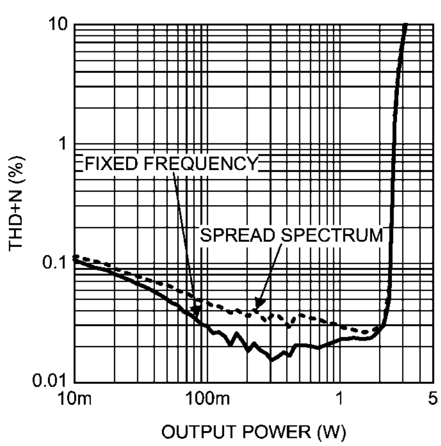
THD+N vs Output Power
V_{DD} = 3.6V, R_L = 8Ω
f = 1kHz, filter = 22kHz, PV_1 = 7V



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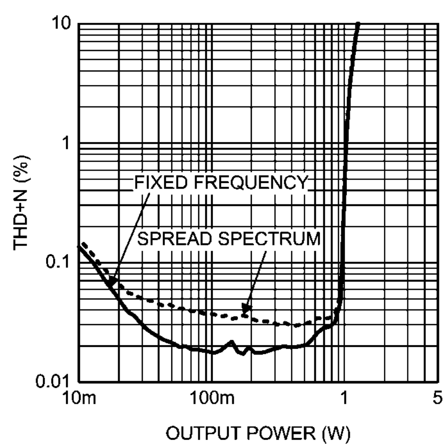
THD+N vs Output Power
V_{DD} = 3V, R_L = 8Ω
f = 1kHz, filter = 22kHz, PV_1 = 4.8V



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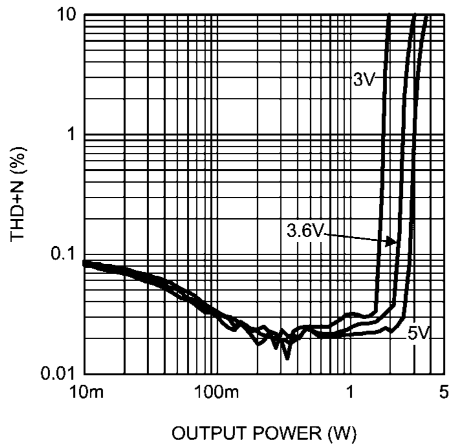
THD+N vs Output Power
V_{DD} = 3V, 3.6V, 5V, R_L = 8Ω
f = 1kHz, filter = 22kHz, R_1 = 4.87kΩ, FF



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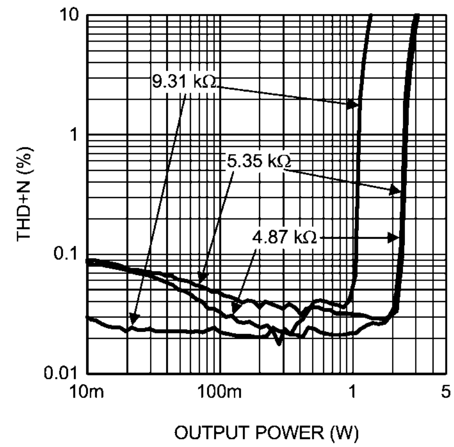
THD+N vs Output Power
V_{DD} = 3.6V, R_L = 8Ω
filter = 22kHz, PV_1 = 7.8V, PV_1 = 7V, PV_1 = 4.8V, FF



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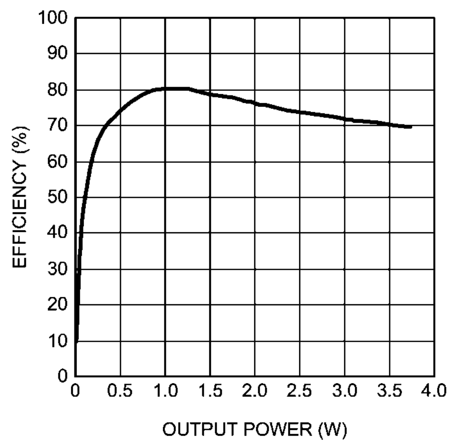
Boost Amplifier vs Output Power
V_{DD} = 5V, R_L = 8Ω
f = 1kHz, PV_1 = 7.8V



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Boost Amplifier vs Output Power
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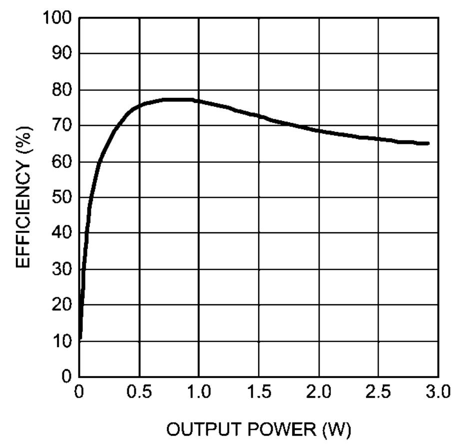
f = 1kHz, PV_1 = 7V



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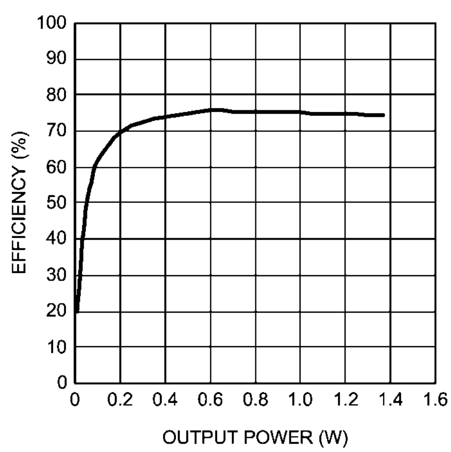
Boost Amplifier vs Output Power
V_{DD} = 3V, R_L = 8Ω
f = 1kHz, PV_1 = 4.8V



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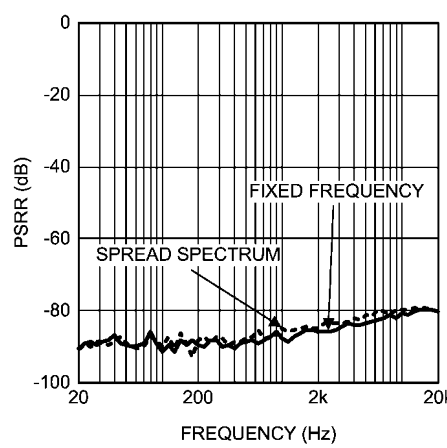
PSRR vs Frequency
V_{DD} = 5V, R_L = 8Ω
V_{RIPPLE} = 200mV_{PP}, PV_1 = 7.8V



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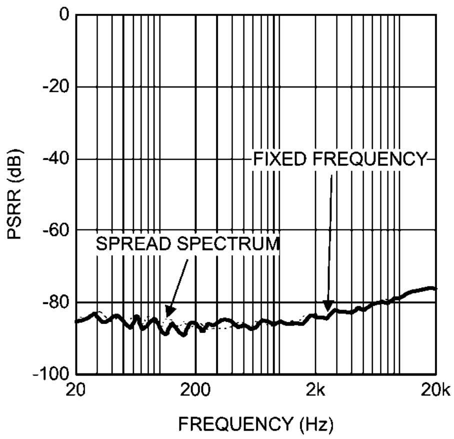
PSRR vs Frequency
V_{DD} = 3.6V, R_L = 8Ω
V_{RIPPLE} = 200mV_{PP}, PV_1 = 7V



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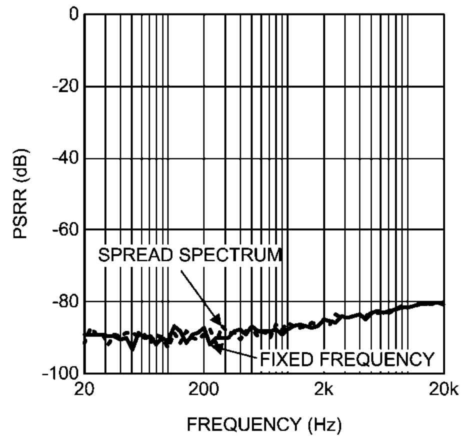
PSRR vs Frequency
V_{DD} = 3V, R_L = 8Ω
V_{RIPPLE} = 200mV_{PP}, PV_1 = 4.8V



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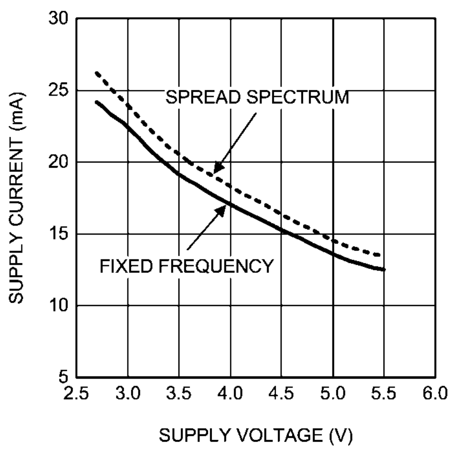
Supply Current vs Supply Voltage
PV_1 = 7.8V



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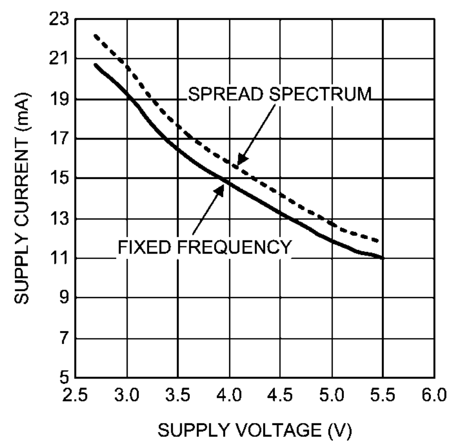
Supply Current vs Supply Voltage
PV_1 = 7V



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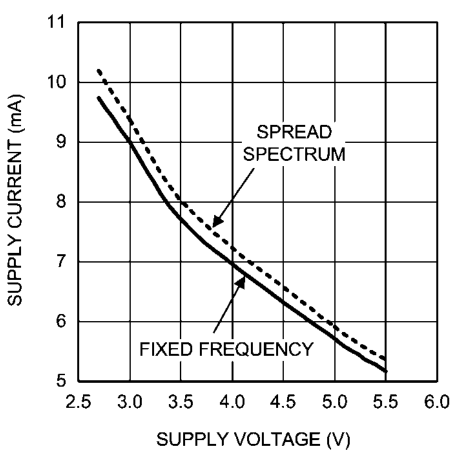
Supply Current vs Supply Voltage
PV_1 = 4.8V



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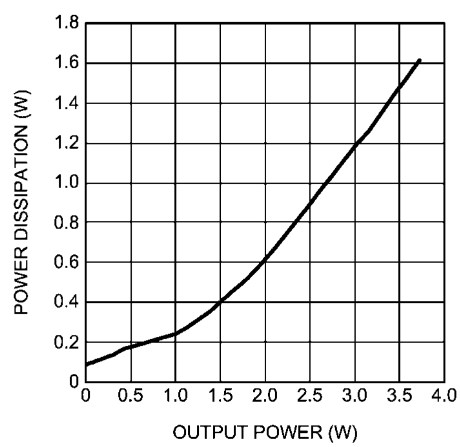
Power Dissipation vs Output Power
V_{DD} = 5V, R_L = 8Ω
PV_1 = 7.8V, FF



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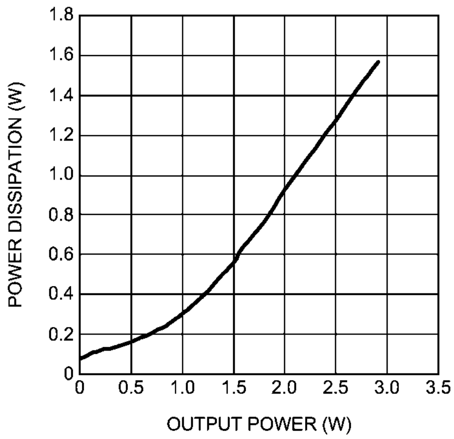
Power Dissipation vs Output Power
V_{DD} = 3.6V, R_L = 8Ω
PV_1 = 7V, FF



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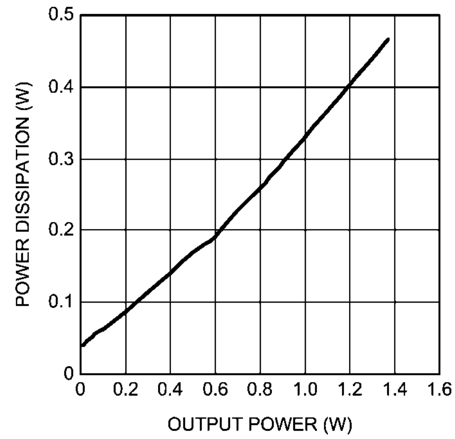
Power Dissipation vs Output Power
V_{DD} = 3V, R_L = 8Ω
PV_1 = 4.8V, FF



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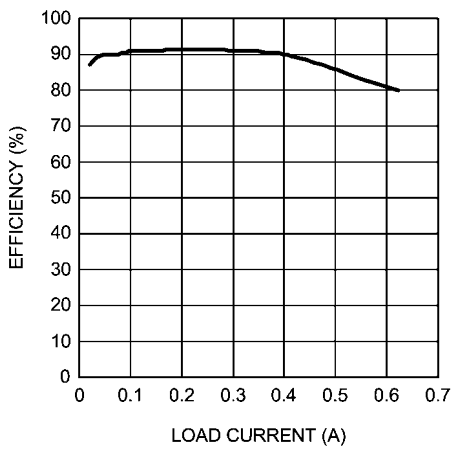
Boost Converter Efficiency vs $I_{LOAD(DC)}$
V_{DD} = 5V, PV_1 = 7.8V



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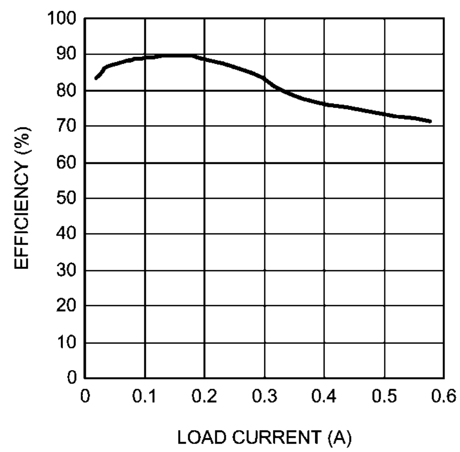
Boost Converter Efficiency vs $I_{LOAD(DC)}$
V_{DD} = 3.6V, PV_1 =7V



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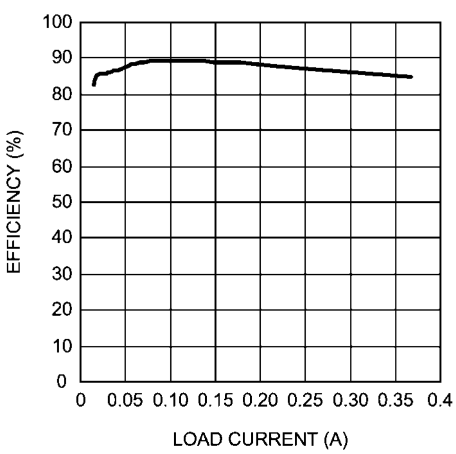
Boost Converter Efficiency vs $I_{LOAD(DC)}$
V_{DD} = 3V, PV_1 = 4.8V



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Revision History

Rev	Date	Description
1.0	11/05/08	Initial release.

Notes

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Power Management	www.national.com/power	Green Compliance	www.national.com/quality/green
Switching Regulators	www.national.com/switchers	Distributors	www.national.com/contacts
LDOs	www.national.com/ldo	Quality and Reliability	www.national.com/quality
LED Lighting	www.national.com/led	Feedback/Support	www.national.com/feedback
Voltage Reference	www.national.com/vref	Design Made Easy	www.national.com/easy
PowerWise® Solutions	www.national.com/powerwise	Solutions	www.national.com/solutions
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