AN-1922 LM48511 Evaluation Board

1 Introduction

To help the user investigate and evaluate the LM48511SQ performance and capabilities, a fully populated demonstration board was created. This board is shown in Figure 1. Connected to an external power supply ($3.0V \le V_{DD} \le 5.5V$) and a signal source, the LM48511SQ demonstration board easily exercises the amplifier's features.

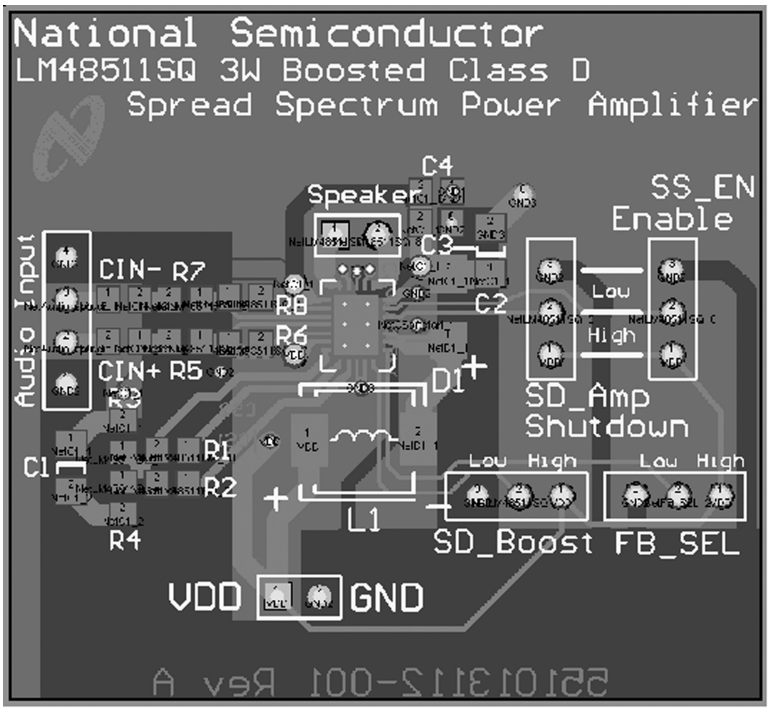


Figure 1. Typical LM48511SQ Demonstration Board

2 Quick Start Guide

Step 1. Apply a 3.0V to 5.5V power supply voltage to the VDD pin with respect to the ground (GND) pin.

Step 2. Set connectors SD_Amp, SS_En Enable, SD_Boost to High. Set FB_SEL to Low which boosts the regulator output voltage PV1 to about 7.6V.

Step 3. Apply a mono differential input signal into the Audio Input's two center pins of the 4-pin connector.

Step 4. Apply power. Make measurements.

3 General Description

The Texas Instruments 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.

4 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.

5 Operating Conditions

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

6 Application Circuit Schematic

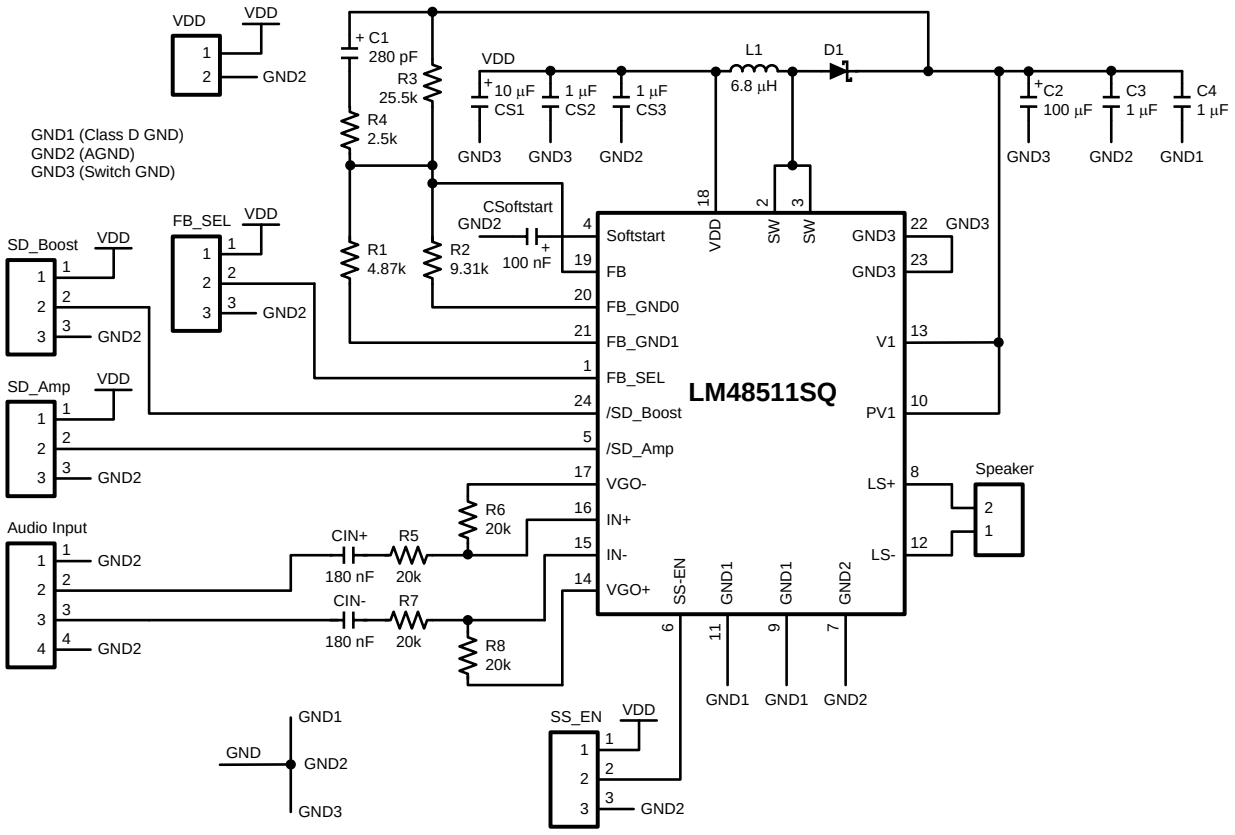


Figure 2. Typical LM48511 Audio Amplifier Application Circuit

7 Connections

Table 1. LM48511 Demonstration Board Connections

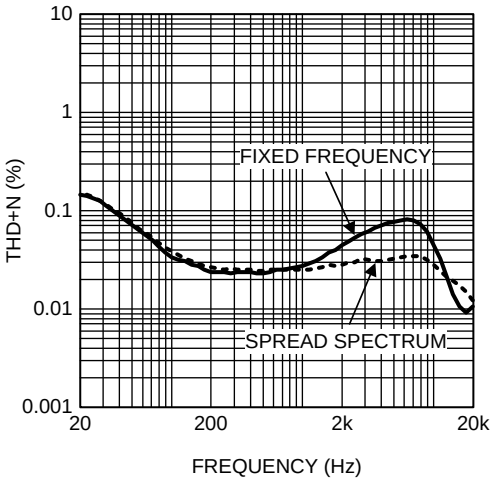
Designator	Function or Use
Supply Voltage (V_{DD})	The supply voltage operating range is from 3.0V to 5.5V, but the absolute maximum rating is 9V.
Audio Input	Connect a differential audio source to the two center pins of the Audio Input connector. For a single-ended audio source, connect one of the center pins to the adjacent center pin (GND) and connect the audio source to the remaining center pin.
Speaker (Audio Output)	Connect speaker load across the speaker connector.
SD_Amp	Set SD_AMP Low to disable the Class D amplifier. Set SD_AMP High to enable the Class D amplifier.
SS_EN Enable	Set SS_EN Low to enable Fixed frequency (FF) mode. Set SS_EN High to enable Spread Spectrum (SS) mode.
SD_Boost	Set SD_Boost Low to disable the boost regulator. Set SD_Boost High to enable the boost regulator.

Table 1. LM48511 Demonstration Board Connections (continued)

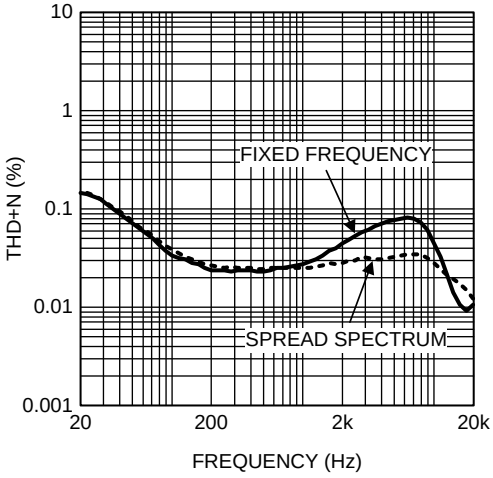
Designator	Function or Use
FB_SEL	Set the FB_SEL High for: PV1 = VFB {1 + [25.5kΩ / 4.87kΩ]} where V_{FB} = 1.23V
	Set the FB_SEL Low for: PV1 = VFB {1 + [25.5kΩ /9.31kΩ]} where V_{FB} = 1.23V

8 Typical Performance Characteristics

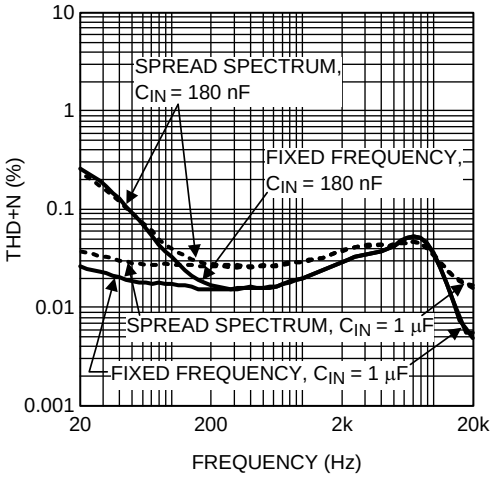
THD+N vs Frequency
V_{DD} = 5V, R_L = 8Ω
P_O = 2W, filter = 22kHz, PV_1 = 7.8V



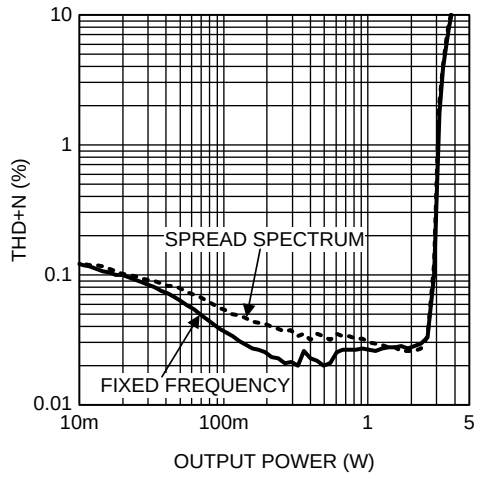
THD+N vs Frequency
V_{DD} = 3.6V, R_L = 8Ω
P_O = 500mW, filter = 22kHz, PV_1 = 4.8V



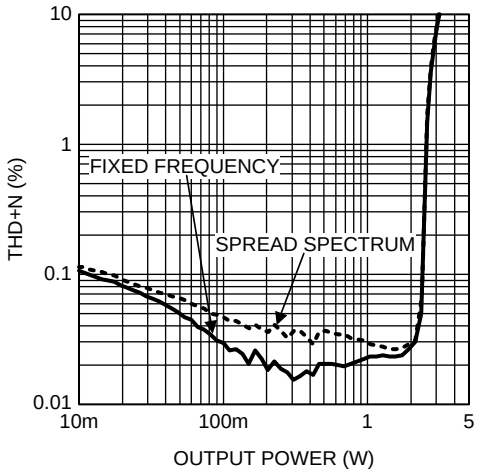
THD+N vs Frequency
V_{DD} = 3V, R_L = 8Ω
P_O = 1.5W, filter = 22kHz, PV_1 = 7V



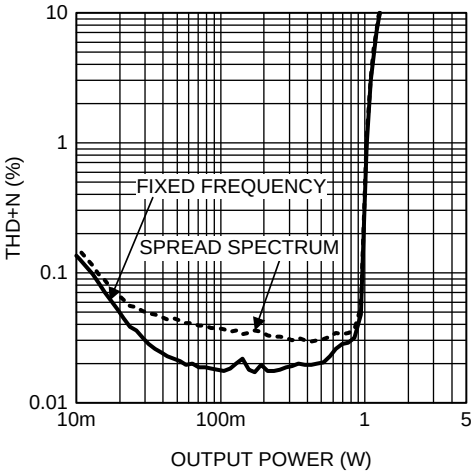
THD+N vs Output Power
V_{DD} = 5V, R_L = 8Ω
P_O = 1.5W, f = 1kHz, filter = 22kHz, PV_1 = 7.8V



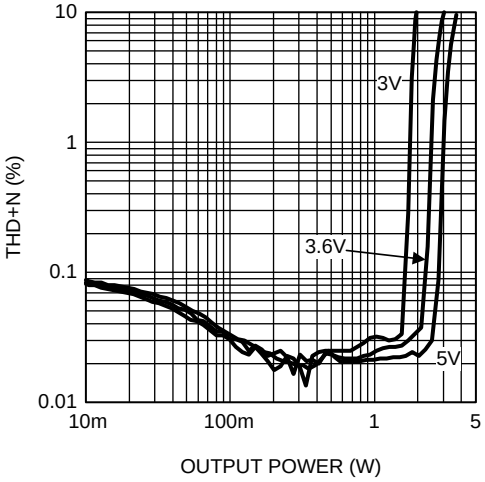
THD+N vs Output Power
V_{DD} = 3.6V, R_L = 8Ω
f = 1kHz, filter = 22kHz, PV_1 = 7V



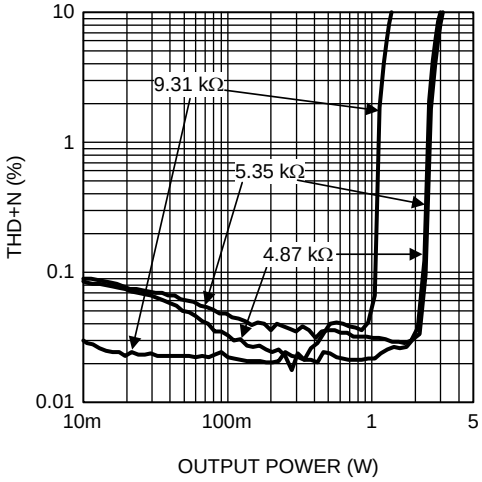
THD+N vs Output Power
V_{DD} = 3V, R_L = 8Ω
f = 1kHz, filter = 22kHz, PV_1 = 4.8V



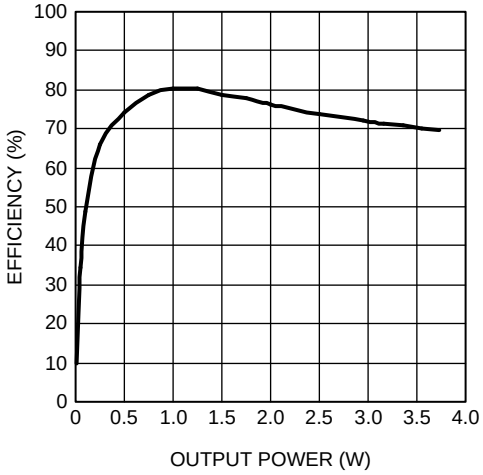
THD+N vs Output Power
V_{DD} = 3V, 3.6V, 5V, R_L = 8Ω
f = 1kHz, filter = 22kHz, R_1 = 4.87kΩ, FF



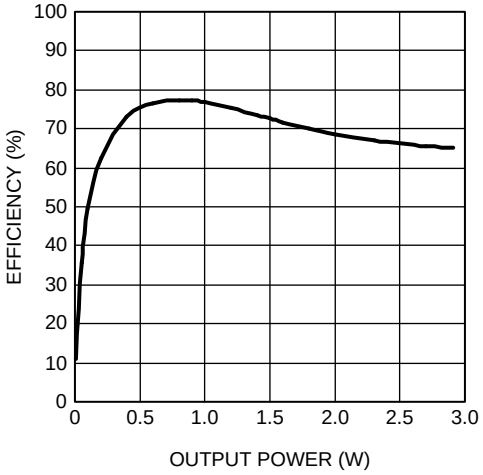
THD+N vs Output Power
V_{DD} = 3.6V, R_L = 8Ω
filter = 22kHz, PV_1 = 7.8V, PV_1 = 7V, PV_1 = 4.8V, FF



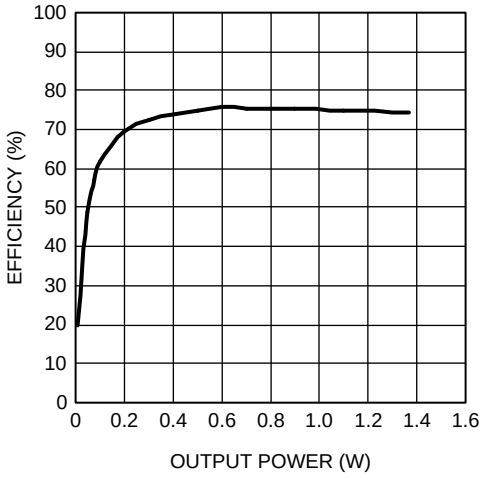
Boost Amplifier vs Output Power
V_{DD} = 5V, R_L = 8Ω
f = 1kHz, PV_1 = 7.8V



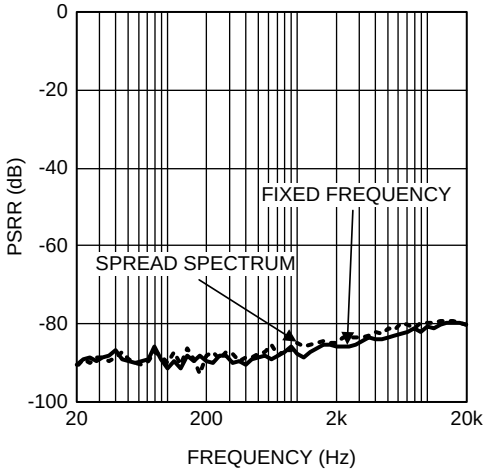
Boost Amplifier vs Output Power
V_{DD} = 3.6V, R_L = 8Ω
f = 1kHz, PV_1 = 7V



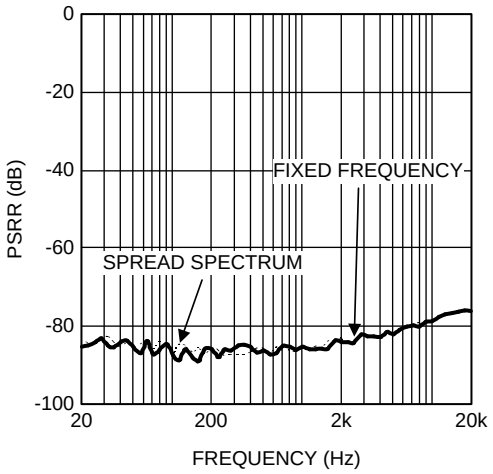
Boost Amplifier vs Output Power
V_{DD} = 3V, R_L = 8Ω
f = 1kHz, PV_1 = 4.8V



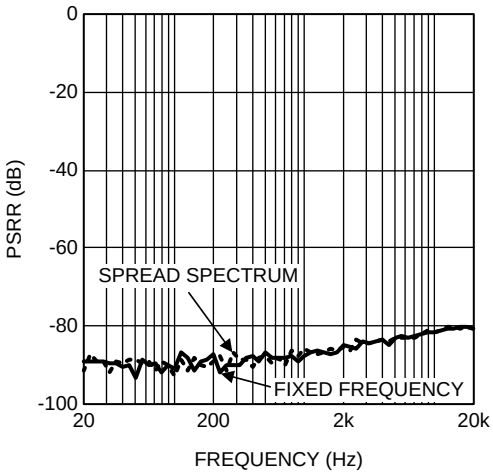
PSRR vs Frequency
V_{DD} = 5V, R_L = 8Ω
V_{RIPPLE} = 200mV_{PP}, PV_1 = 7.8V



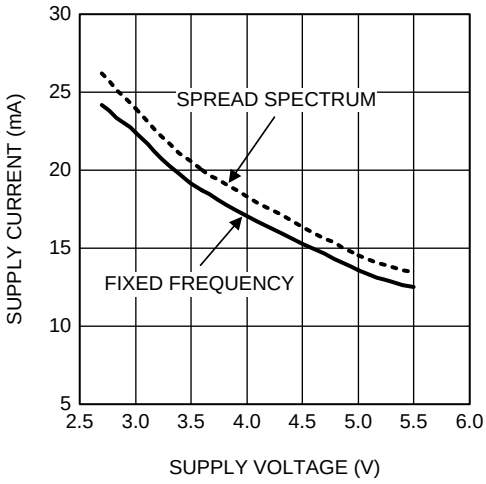
PSRR vs Frequency
V_{DD} = 3.6V, R_L = 8Ω
V_{RIPPLE} = 200mV_{PP}, PV_1 = 7V



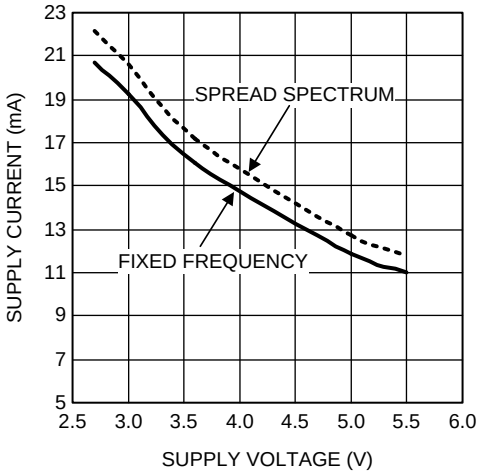
PSRR vs Frequency
V_{DD} = 3V, R_L = 8Ω
V_{RIPPLE} = 200mV_{PP}, PV_1 = 4.8V



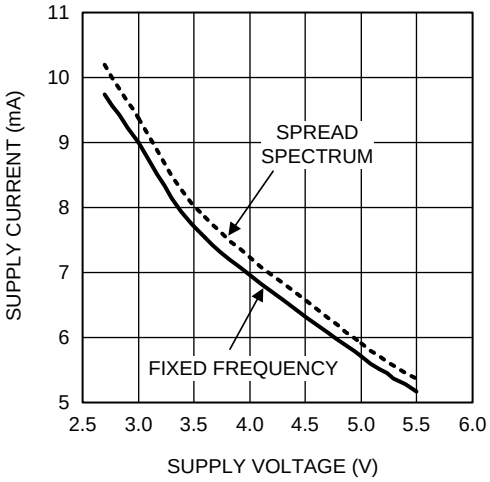
Supply Current vs Supply Voltage
PV_1 = 7.8V



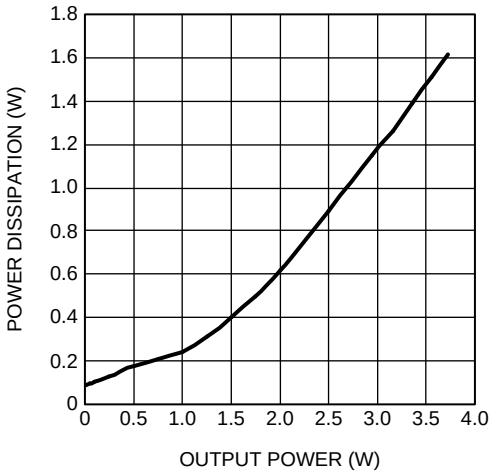
Supply Current vs Supply Voltage
PV_1 = 7V



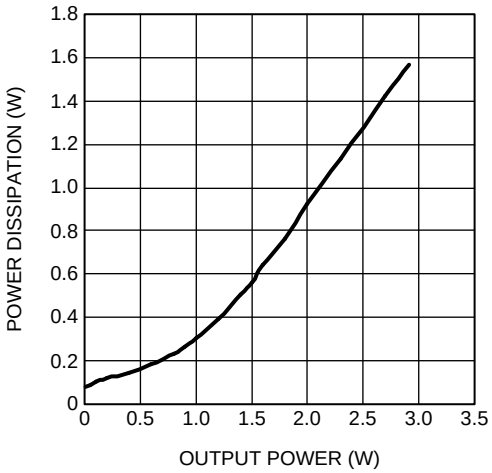
Supply Current vs Supply Voltage
PV_1 = 4.8V



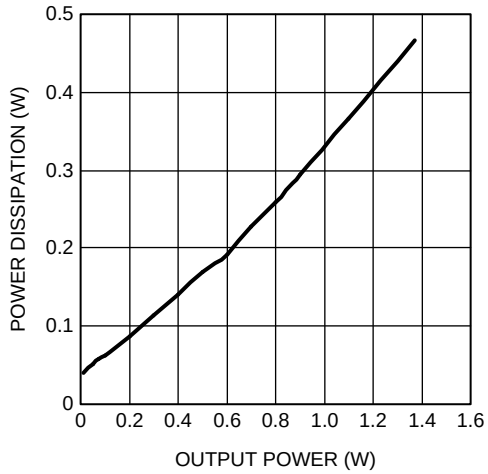
Power Dissipation vs Output Power
V_{DD} = 5V, R_L = 8Ω
PV_1 = 7.8V, FF



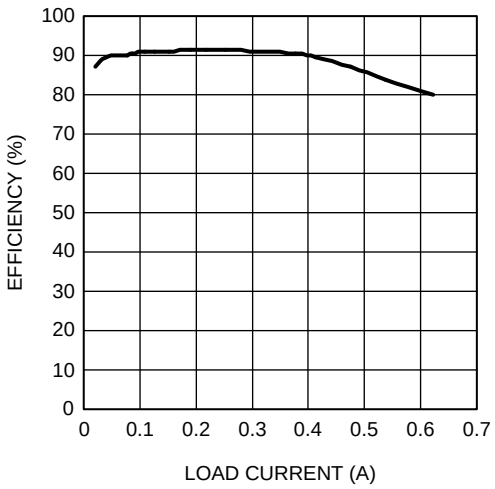
Power Dissipation vs Output Power
V_{DD} = 3.6V, R_L = 8Ω
PV_1 = 7V, FF



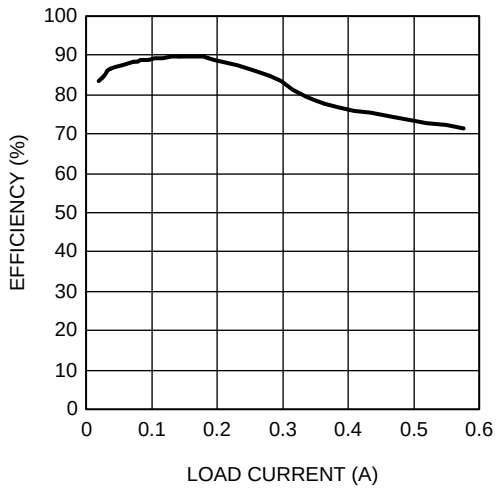
Power Dissipation vs Output Power
V_{DD} = 3V, R_L = 8Ω
PV_1 = 4.8V, FF



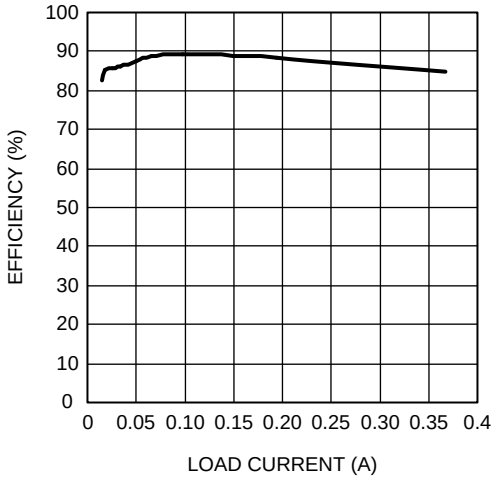
Boost Converter Efficiency vs $I_{LOAD(DC)}$ V_{DD} = 5V, PV_1 = 7.8V



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



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



9 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.

9.1 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.

9.2 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). 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.

10 Bill Of Materials

Designator	Description	Footprint	Qty	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

11 Demonstration Board PCB Layout

Figure 3 through Figure 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.

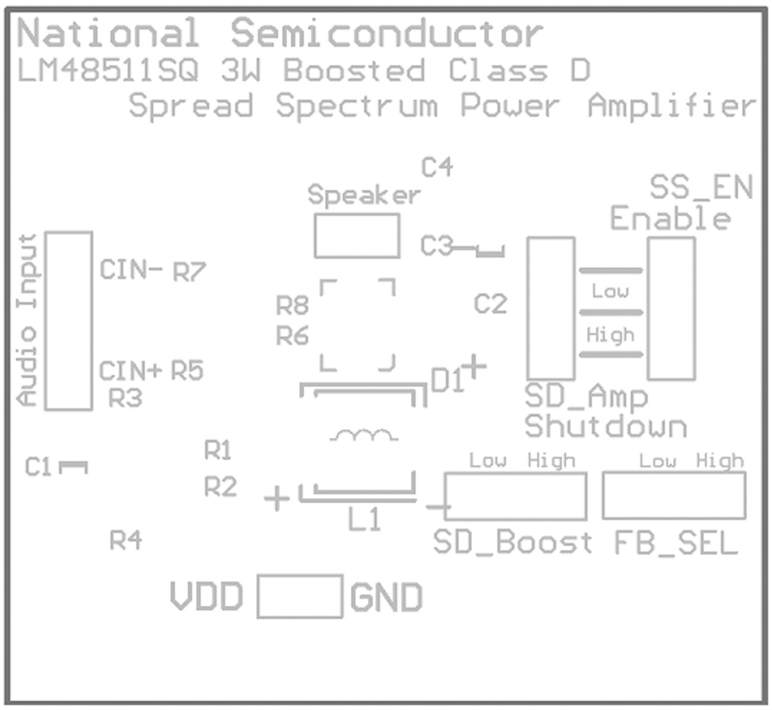


Figure 3. Top Silkscreen

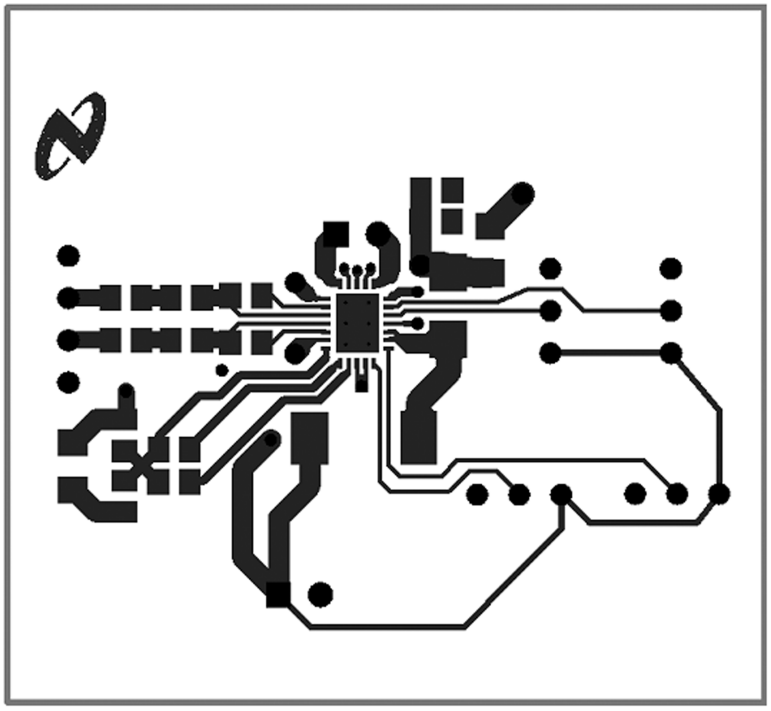


Figure 4. Top Layer

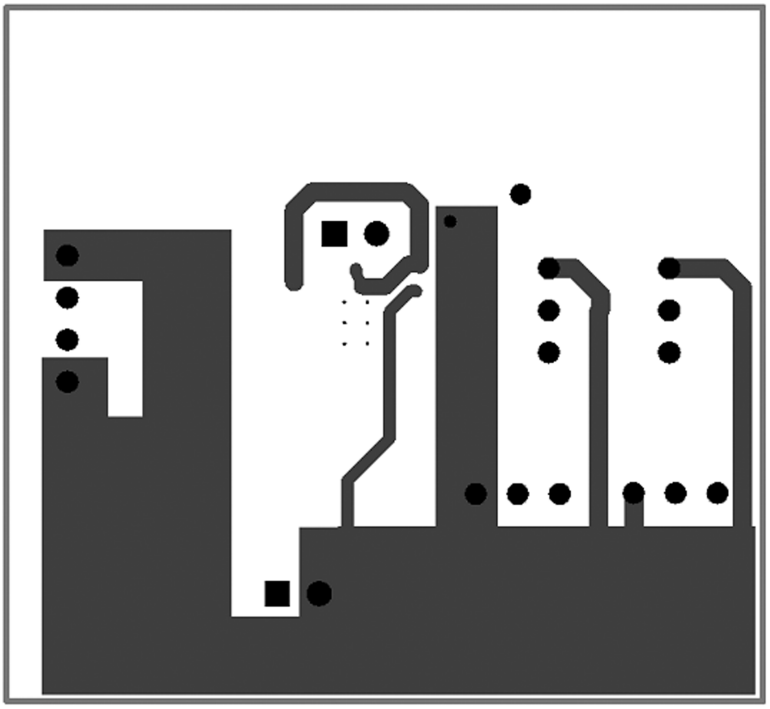


Figure 5. Mid Layer 1

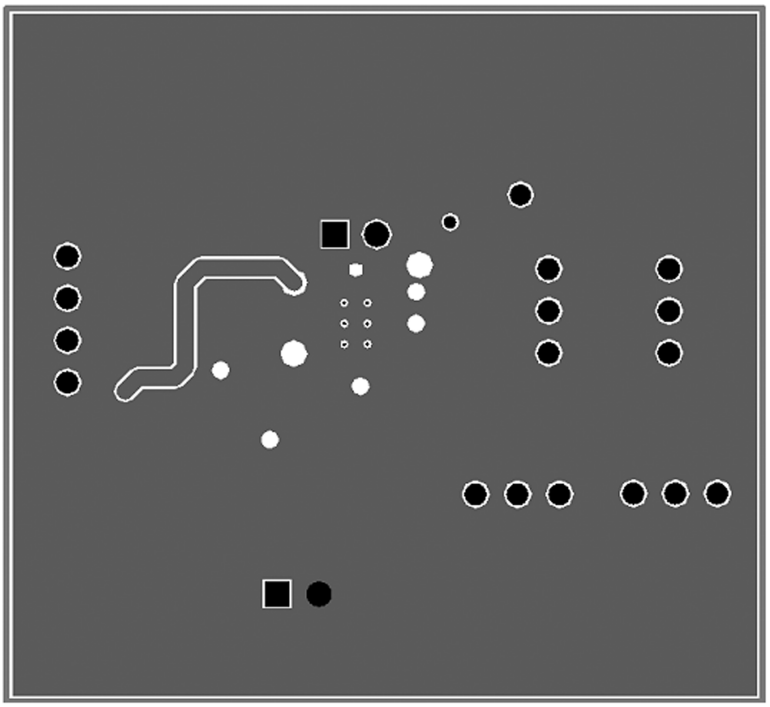


Figure 6. Mid Layer 2

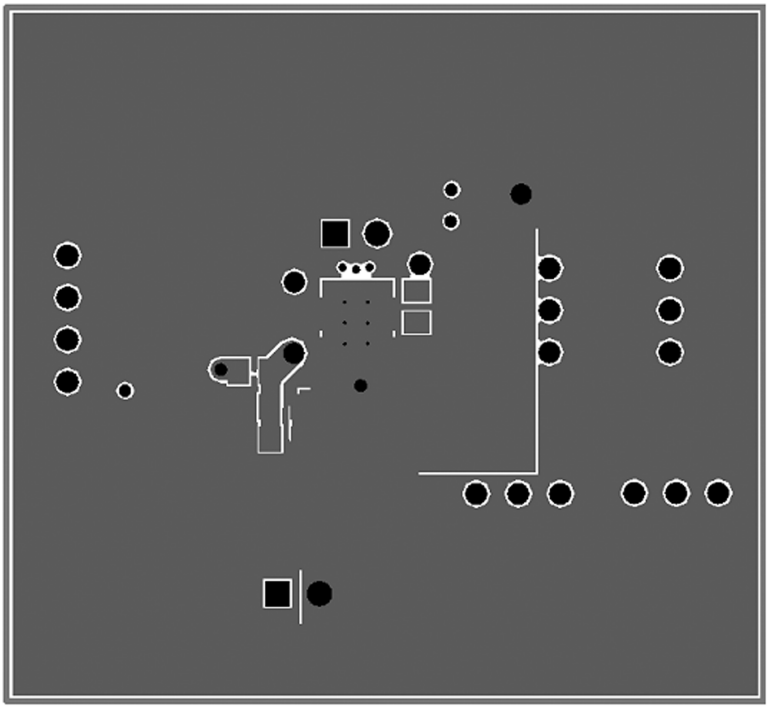


Figure 7. Bottom Layer

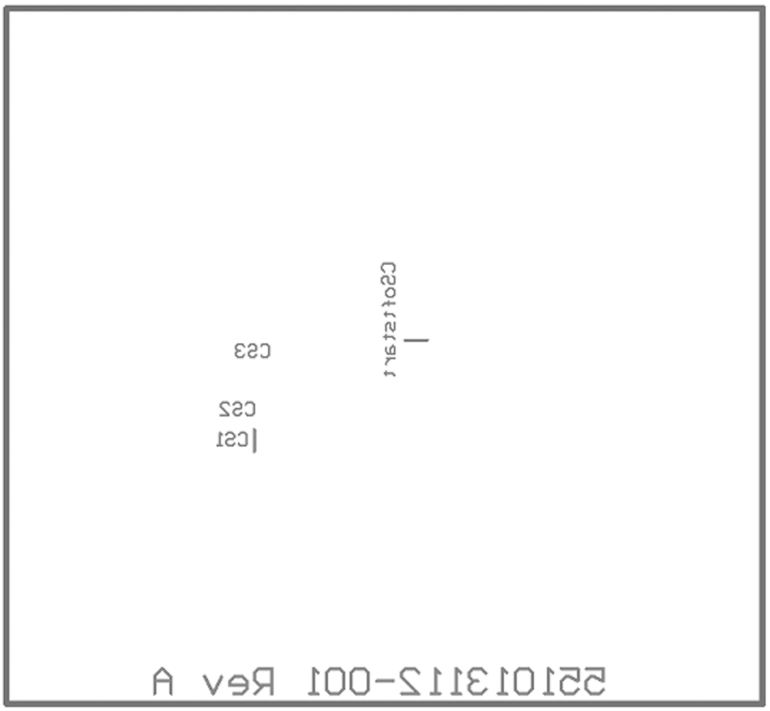


Figure 8. Bottom Overlay

12 Revision History

Rev	Date	Description
1.0	11/05/08	Initial release.
1.01	08/05/11	Changed the title of Table 1 from LME49600 to LM48511.
1.02	10/18/12	Edited Table 1 (Demonstration Board Connections). Edited Figure 2 (Typical LM48511 Audio Amplifier Circuit).

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