AN-1680 LM49250 Evaluation Board

1 Introduction

The LM49250 evaluation board is a fully-integrated audio subsystem designed for stereo cell phone applications. The LM49250 combines 2.5W stereo Class D speaker drivers with stereo ground referenced headphone drivers, a class AB earpiece driver, TI 3D enhancement, volume control and input mixer into a single device. The filterless class D amplifiers deliver 1.19W/channel into an 8 Ω load with <1% THD+N from a 5 V supply.

The LM49250 features a new circuit technology that utilizes a charge pump to generate a negative supply voltage. This allows the outputs to be biased about ground, thereby eliminating output-coupling capacitors typically used with normal single-ended loads. To supply the required voltage level to the ground referenced amplifier, an LDO has been integrated. For improved noise immunity, the LM49250 features fully differential left, right and mono inputs. The three inputs can be mixed/multiplexed to either the loudspeaker, headphone or earpiece amplifiers. The left and right differential inputs can be used as separate single-ended inputs, mixing multiple stereo audio sources. The mixer, volume control, and device mode select are controlled through an I2C compatible interface.

Output short circuit and thermal overload protection prevent the device from being damaged during fault conditions. Superior click and pop suppression eliminates audible transients on power-up/down and during shutdown.

The LM49250 evaluation board (shown in Figure 1) allows the user to easily evaluate the performance and characteristics of the LM49250 device. It provides connectors for audio inputs, audio outputs, I^2C control, power supply, and shutdown control.

2 Quick Start

The following procedures are needed to begin the

1. Connect a shunt across the center pin (I^2C VDD) and the VDD pin of J9 (I^2CVDD = VDD).
2. Connect a shunt across the center RESET pin and the “+” terminal of J4 (I2C reset pin).
3. Connect a 4Ω or 8Ω speaker across the “+” and “-” pins of J2 (left loudspeaker output) and J3 (right loudspeaker output).
4. Connect stereo headphones to the headphone jack (U2).
5. Connect a 16Ω or 32Ω speaker across the “+” and “-” pins of J1 (earpiece output).
6. Connect a 3.6V power supply to the VDD pin of J8, and the power supply ground source to the GND pin of J8.
7. Apply a positive audio signal source to the “+” terminals of J5 (right input), J6 (left input), and J7 (mono input), and a negative audio signal source to the “-” terminals of J5 (right input), J6 (left input), and J7 (mono input).
8. Connect the USB interface card to a PC with the USB cable. Connect cable attached to USB interface card to the I^2C interface jumper (J10)on demo board.
9. Open LM49250 I^2C interface software.
10. Turn on the power supply and audio source.
11. In the LM49250 I^2C interface software (see Figure 2) select:
    - “ON” for Earpiece, Left Loudspeaker, Right Loudspeaker, Left Headphone, and Right Headphone
    - Mode “2” for Loudspeaker Output Mode, Headphone Output Mode, and Earpiece Output Mode

12. Select Chip Power to “ON” to enable the device.
13. Adjust the Left, Right, and Mono Volume Control to obtain the desired output level.

Table 1. Operating Conditions

• Temperature Range	$-40°C \le T_A \le +85°C$
• Supply Voltage	($V_{DD} = V_{DD(LS)} = V_{DD(CP)}$)
	$2.7V \le V_{DD} \le 5.5V$
• I^2C Supply Voltage	$1.7V \le I^2CV_{DD} \le 5.5V$
	$I^2CV_{DD} \le V_{DD}$

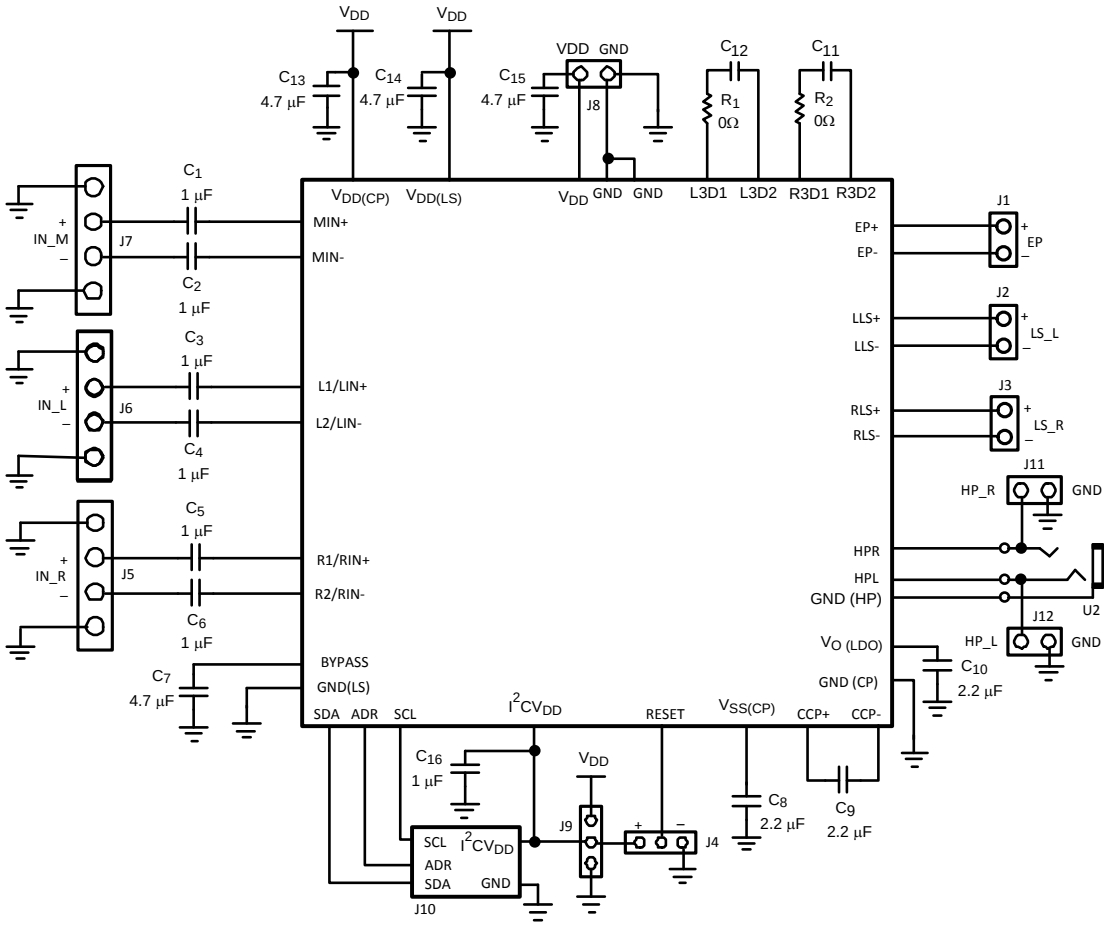

Figure 1. Evaluation Board Schematic

Table 2. Board Connectors

Designator	Label	Function
J1	EP	Mono BTL earpiece audio output
J2	LS_L	Left loudspeaker class D audio output
J3	LS_R	Right loudspeaker class D audio output
J4	RESET	I^2C Reset Pin - For normal operation short the center RESET pin to the “+” pin. To reset the PWR_ON bit in the shutdown control register short the center RESET pin to the “-” terminal.
J5	IN_R	Right, single ended or differential, audio input terminal

Table 2. Board Connectors (continued)

Designator	Label	Function
J6	IN_L	Left, single ended or differential, audio input terminal
J7	IN_M	Mono differential audio input terminal
J8	V_{DD} GND	Power Supply Connection
J9	I^2CV_{DD}	If a separate I^2C power supply voltage is used: Connect the positive voltage source to the center I^2CV_{DD} terminal and the ground source to the pin on J9 labeled GND. If a separate I^2C power supply is not used: Connect the center I^2CV_{DD} to the pin on J9 labeled V_{DD}.
J10		I^2C signal terminals. Pin 1 is for the SCL signal, pin 2 is for the ADR signal, pin 3 is for the SDA signal, pin 4 is for I^2C V_{DD}, and pin 5 is ground (as labeled on the evaluation board).
J11	HP_R	Right ground referenced headphone output terminal
J12	HP_L	Left ground referenced headphone output terminal

Table 3. Evaluation Board Bill of Materials

Designator	Part Description	Manufacturer	Part Number
C1 – C6	Ceramic capacitor 1µF 16V X7R 1206 10%	muRata	GRM319R71C105KC11D
C7, C13, C14, C15	Ceramic capacitor 2.2µF 16V X5R 0805	muRata	GRM21BR61C225KA88L
C8, C9, C10	Ceramic capacitor 2.2µF 16V X5R 0805	muRata	GRM21BR61C225KA88L
C11, C12	Ceramic capacitor 68nF 16V X7R 0805	muRata	GRM188R71C683KA01D
C16	Ceramic capacitor 1µF 16V X7R 0805	muRata	GRM21BR71C105KA01L
R1, R2	Resistor 0W 1/8W 5% 0805 SMD		

3 I²C Software Interface

The LM49250 evaluation board is controlled through an I^2C compatible USB interface. The LM49250 I^2C interface software provides a user friendly interface to easily evaluate the functionality of the device. Each button corresponds to bits in an I^2C command byte. For detailed I^2C information, see the LM49250 data sheet.

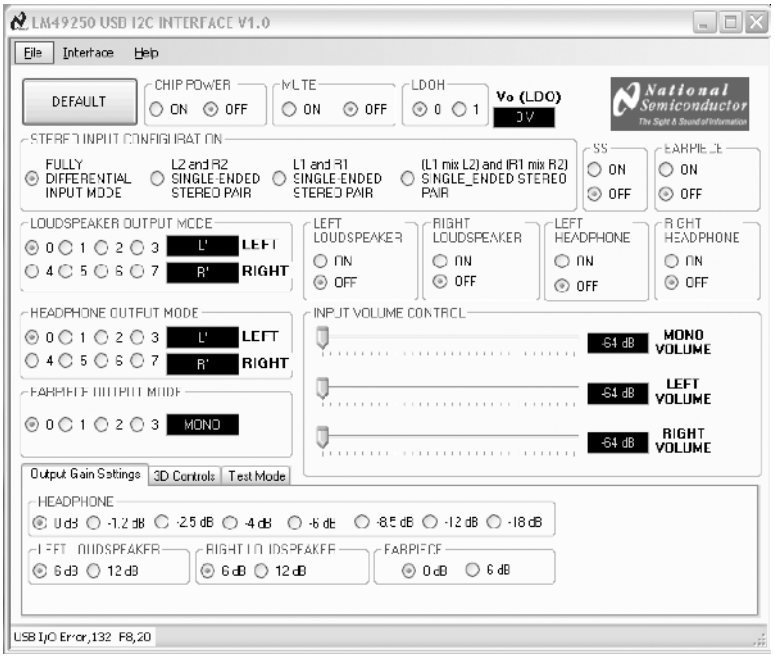

Figure 2. LM49250 I²C Software Interface

4 Default

The DEFAULT button sets the LM49250 and the interface software to its default state. In the default state all output amplifiers, spread spectrum, and 3D controls are off, all output modes are set to 0, the fully differential input mode is selected, all input gains are set to -64dB, right and left loudspeaker output gain is 6dB, and headphone and earpiece output gain are set to 0dB. Each time the power supply to the device is cycled, the interface must be reset to its default state.

5 Chip Power

The Chip Power button enables or disables the entire device. Even if an individual amplifier channel is enabled, the device will not output any audio if the Chip Power button is set to “OFF”.

6 LDOH

The LDOH button enables and disables the internal LDO. The LDO is used to drive the ground referenced headphone amplifiers. This allows the speaker and headphone amplifiers to operate from separate power supplies. The separate power supplies allow the speaker amplifiers to operate from a higher voltage for maximum headroom, while the headphone amplifiers operate from a lower voltage, improving power dissipation.

If the LDO and the Chip Power is enabled, 2.25V will be seen at the VO(LDO) pin. However, if the LDO is disabled but either headphone output is enabled, 2.25V will be seen at the VO(LDO) pin (see Table 3).

Table 4. LDO Disabling Options

LDOH	HPR_ON/HPL_ON	PWR_ON	$V_{O(LDO)}$ (V)
0	0	X	0
0	1	1	2.25
1	X	0	VDD
1	1	0	2.25
0	1	0	

7 Spread Spectrum

The LM49250 features a filterless spread spectrum modulation scheme. The switching frequency varies which reduces the wideband spectral content. This improves EMI emissions radiated by the speaker and associated cables and traces. The spread spectrum function can be turned on and off through the “SS” section of the interface software.

8 Input Audio Signal Selection

The LM49250 has a single mono differential input and left and right stereo inputs that can be configured for both single-ended and differential audio signals. The stereo input configurations can be set in the “STEREO INPUT CONFIGURATION” portion of the software interface.

- Select “FULLY DIFFERENTIAL INPUT MODE” to configure the left and right inputs for differential operation.
- Select “L2 and R2 SINGLE-ENDED STEREO PAIR” to configure the device to accept single ended audio inputs connected to L2 and R2.
- Select “L1 and R1 SINGLE-ENDED STEREO PAIR” to configure the device to accept single ended audio inputs connected to L1 and R2.
- Select “(L1 mix L2) and (R1 mix R2) SINGLE ENDED STEREO PAIR” to configure the device to accept two single ended stereo sources, connected to both input pairs.

9 Volume Control and Gain Setting

Each channel of the LM49250 has two separate gain stages. Each input stage (mono, left and right) features a 32 step volume control that can be configured through the “INPUT VOLUME CONTROL” section of the interface software. The output gain settings can be set under the “Output Gain Settings” tab in the interface software. The loudspeaker output gain for the left and right channels are set independently, while the headphone gain is the same for both left and right channels.

The earpiece output stage has two gain settings, 0dB and 6dB. Each loud speaker output stage has two gain settings, 6dB and 12dB. The headphone output stage has 8 gain settings, 0dB, -1.2dB, -2.5dB, -4dB, -6dB, -8.5dB, -12dB and -18dB. In single-ended input mode with only one stereo signal applied, the loudspeaker and headphone output stage gain settings are increased by 6dB. The total gain for a given signal path can be calculated by adding the input volume control gain to the output gain setting.

10 Demonstration Board Layout

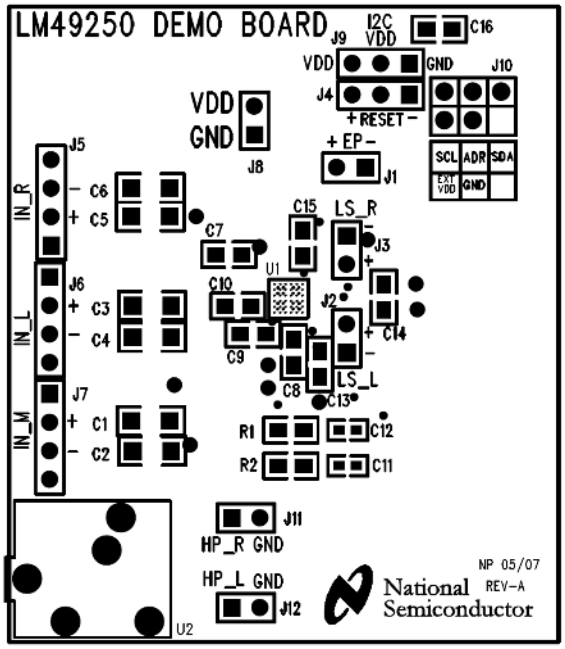

Figure 3. Top Silkscreen

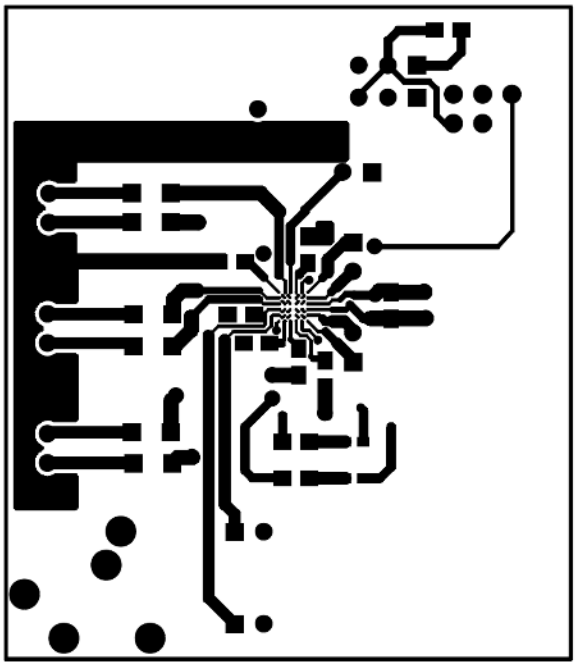

Figure 4. Top Layer

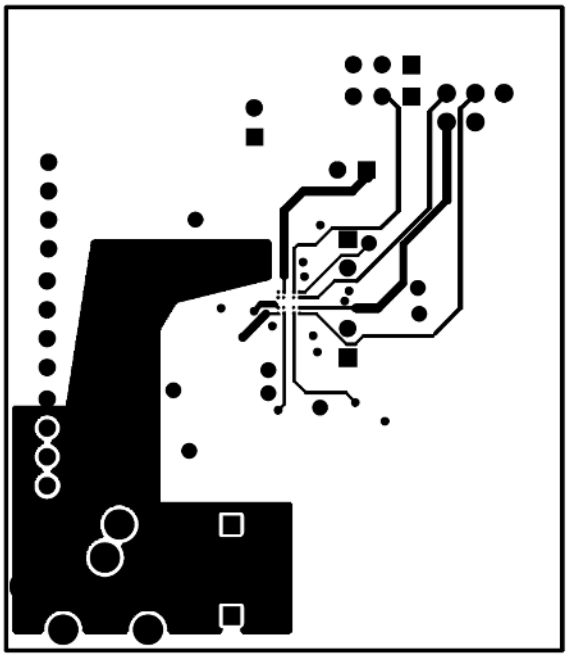

Figure 5. Layer 2

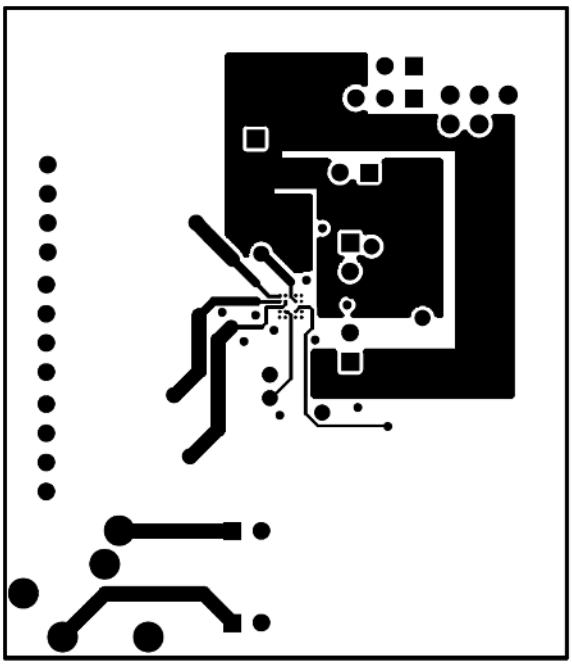

Figure 6. Layer 3

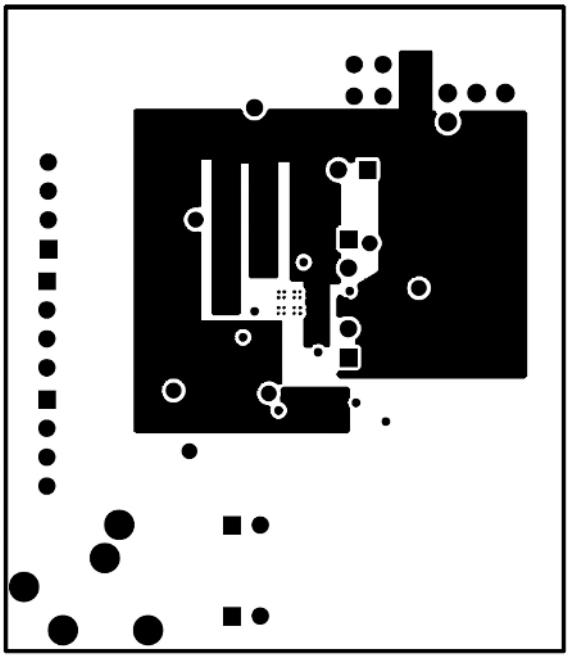

Figure 7. Bottom Layer

11 Revision History

Rev	Date	Description
1.0	03/09/10	Initial WEB released.

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