

## Evaluation Board for **SSM2932** High Efficiency Class-G Headphone Amplifier

### PACKAGE CONTENTS

**EVAL-SSM2932Z** evaluation board

### OTHER SUPPORTING DOCUMENTATION

**SSM2932** data sheet

### GENERAL DESCRIPTION

The **SSM2932** is a stereo headphone amplifier capable of delivering 50 mW continuous output power per channel into 16  $\Omega$  single-ended loads at the 1% THD + N threshold. The stereo headphone drivers are highly efficient, true ground-referenced Class-G technology.

The **SSM2932** incorporates a gain control pin that selects between 0 dB and 6 dB. The ground-referenced output scheme eliminates the need for large dc-blocking capacitors, reducing system BOM cost and board area. The Class-G amplifier is

fine-tuned to maximize battery life, a critical task in portable applications. The device maximizes battery life by modulating the amplifier power supply rail to match the output demand without consuming excessive supply current, thus reducing power dissipation during typical audio playback.

The **SSM2932** is specified over the industrial temperature range ( $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ). It has output short-circuit protection along with ESD protection to 8 kV using a human body model. It is available in 16-ball 1.6 mm  $\times$  1.6 mm wafer level chip scale package (WLCSP).

### EVALUATION BOARD OVERVIEW

The **SSM2932** evaluation board carries a complete application circuit for driving a headphone. Figure 1 shows the top view of the evaluation board, and Figure 2 shows the bottom view.

### DIGITAL PICTURE OF THE EVALUATION BOARD

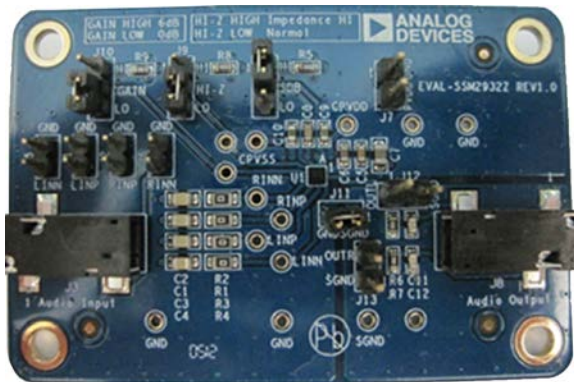


Figure 1. **SSM2932** Evaluation Board Top View



Figure 2. **SSM2932** Evaluation Board Bottom View

**TABLE OF CONTENTS**

Package Contents.....	1	Output Configuration.....	3
Other Supporting Documentation.....	1	Ground Sense.....	3
General Description.....	1	Power Supply Configuration.....	3
Evaluation Board Overview.....	1	Passive Component Selection.....	4
Digital Picture of the Evaluation Board.....	1	Input Gain Resistors.....	4
Revision History.....	2	Input Coupling Capacitors.....	4
Setting Up the Evaluation Board.....	3	Charge Pump Flying Capacitor.....	4
Input Configuration.....	3	Evaluation Board Schematic and Artwork.....	5
Shutdown Mode.....	3	Ordering Information.....	7
Gain Configuration.....	3	Bill of Materials.....	7
High Output Impedance.....	3		

**REVISION HISTORY**

**6/12—Revision 0: Initial Version**

## SETTING UP THE EVALUATION BOARD

### INPUT CONFIGURATION

Four of the 2-pin headers (J1, J2, J5, and J6) feed the stereo differential audio signal into the board (see Figure 1). If the input audio signal is a single-ended stereo audio input, an audio jack, J3, (3.5 mm) can be used. To configure the board for single-ended stereo audio input, connect LINP and RINP to ground by inserting jumpers across J1 and J2. Audio signals are then connected to J5 (LINN) and J6 (RINN) or via a 3.5 mm jack to J3.

### SHUTDOWN MODE

Shutdown of the [SSM2932](#) amplifier is controlled by the  $\overline{\text{SD}}$  (J4) pin. If a logic low is applied to the pin by inserting a jumper from the center pin of J4 to GND (low), the amplifier becomes inactive and draws only minimal current from the supply. To activate the amplifier, insert a jumper across the center pin of J4 to PVDD (high).

### GAIN CONFIGURATION

The [SSM2932](#) amplifier gain can be set to either 0 dB or 6 dB by applying a logic level to the GAIN pin, as shown in Table 1. J10 is used to configure the [SSM2932](#) amplifier gain to 6 dB and to insert a jumper across the center pin of J10 and PVDD (high). To configure the [SSM2932](#) amplifier gain to 0 dB, insert a jumper across the center pin of J10 and GND (low).

**Table 1. Amplifier Gain**

Amplifier Gain	GAIN Pin Logic Level
0 dB	Low ( $\leq 0.5\text{ V}$ )
6 dB	High ( $\geq 1.2\text{ V}$ )

### HIGH OUTPUT IMPEDANCE

The [SSM2932](#) has a HI-Z control pin that mutes the amplifier and sets the output to a high impedance. If both HI-Z and  $\overline{\text{SD}}$  are set to PVDD (high), the amplifier remains in a high-impedance mode. This feature allows the headphone output jack to be shared for other functions such as video output or data transmission. J9 is used to configure the [SSM2932](#) amplifier gain to high impedance output mode and to insert a jumper across the center pin of J9 and PVDD (high). To configure the [SSM2932](#) amplifier output to normal operational mode, insert a jumper across the center pin of J9 and GND (low).

### OUTPUT CONFIGURATION

The output connector, J8 can be connected to a set of headphones with a minimum impedance of 16  $\Omega$ . J8 is a standard 3.5 mm 3-terminal connector (left, right, and ground). Alternatively, for direct access to the outputs, the user can connect test loads to J12 (OUTL) and J13 (OUTR) for testing on an audio analyzer.

### GROUND SENSE

SGND is a headphone ground sense pin and must be connected directly to the common headphone jack. When the headphone jack is connected to a device or board, there is ground difference between the headphone jack's ground pin and audio amplifier. SGND is used to detect this ground difference, which reduces audible noise due to ground loop currents. This also reduces output offset voltage and turn-on pop noise. On the board, SGND is connected to the board GND by placing a jumper across J11.

### POWER SUPPLY CONFIGURATION

An external power supply connected to PVDD is required for the [SSM2932](#) to operate. PVDD and GND must be connected by the 2-pin header, J7.

Be sure to connect the dc power supplies with correct polarity and voltage. PVDD must be connected to a supply voltage in the acceptable range, between 2.5 V and 3.6 V. Reverse polarity or overvoltage may damage the board permanently.

## PASSIVE COMPONENT SELECTION

### INPUT GAIN RESISTORS

If the desired gain of the amplifier is lower than the default 6 dB or 0 dB gain settings, a series resistor can be placed in the input signal path. This creates a voltage divider with the 18 k $\Omega$  input resistance on each input pin, allowing an arbitrary reduction of the input signal. Note that input signal attenuation directly reduces SNR performance; therefore, large values compared to the built-in input resistance should be avoided. These components are populated with 0  $\Omega$  values on the evaluation board (R1, R2, R3, R4).

### INPUT COUPLING CAPACITORS

The input coupling capacitors, C1, C2, C3, and C4, should be large enough to couple the low frequency signal components in the incoming signal but small enough to reject unnecessary extremely low frequency signals. For music signals, the cutoff frequency is typically between 20 Hz and 30 Hz. The value of the input capacitor is calculated by

$$C = 1/(2\pi R_{IN} f_c)$$

where:

$R_{IN} = 18 \text{ k}\Omega + (R1, R2 \text{ or } R3, R4)$ .

$f_c$  is the desired cutoff frequency.

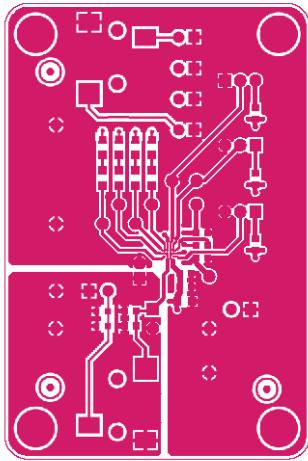
### CHARGE PUMP FLYING CAPACITOR

The headphone amplifier uses Class-G architecture and generates the required power supplies with a built-in charge pump, using a flying capacitor connected across CF1 and CF2, C8. The value of C8 is recommended to be 1.0  $\mu\text{F}$ , X7R ceramic capacitor for optimal charge pump operation.

### DECOUPLING CAPACITORS FOR CPVDD AND CPVSS

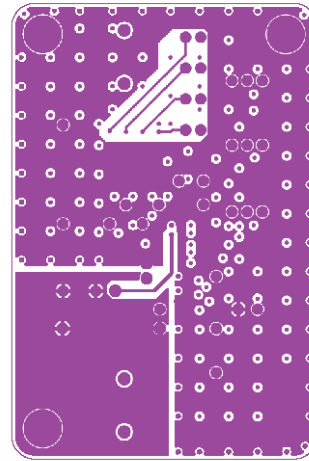
The charge pump within [SSM2932](#) generates CPVDD (positive) and CPVSS (negative) voltage rails for headphone amplifier headphone operation. C9 and C10 serve as a reservoir for the amplifier. For best audio performance, it is recommended that 2.2  $\mu\text{F}$ , X7R ceramic decoupling capacitors be used for CPVDD and CPVSS.





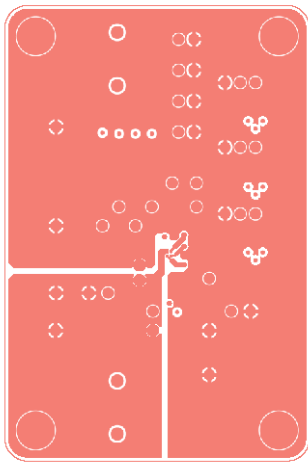
10502-004

Figure 4. Top Layer Copper



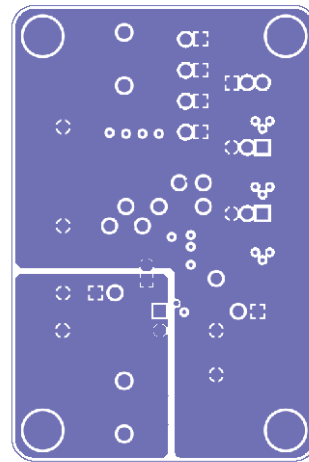
10502-006

Figure 6. Third Layer Copper—VDD Plane



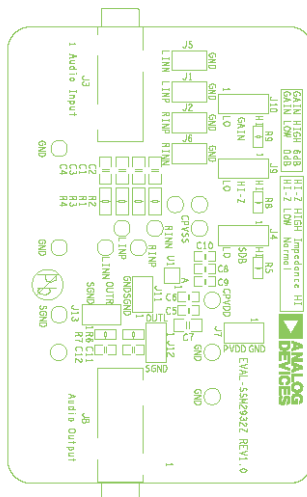
10502-005

Figure 5. Second Layer Copper—GND Plane



10502-007

Figure 7. Bottom Layer Copper



800-2090

Figure 8. Top Silkscreen

**ORDERING INFORMATION****BILL OF MATERIALS**

Table 2.

Qty	Reference Designator	Description	Supplier/Part No.
1	U1	IC, <a href="#">SSM2932</a>	Analog Devices/SSM2932CBZ
4	C1, C2, C3, C4	Capacitor, ceramic 1.0 $\mu$ F, 25 V, X7R, 080	Taiyo Yuden/TMK212B7105KG-T
2	C5, C8	Capacitor, ceramic 1.0 $\mu$ F, 25 V, X7R, 0603	Taiyo Yuden/TMK107B7105KA-T
1	C6	Capacitor, ceramic 0.1 $\mu$ F, 16 V, X7R, 0603	KEMET/C0603C104J4RACTU
1	C7	Capacitor, ceramic 10 $\mu$ F, 16 V, X5R, 0805	KEMET/C0805C106K4PACTU
2	C9, C10	Capacitor, ceramic 2.2 $\mu$ F, 25 V, X5R, 0603	Taiyo Yuden/TMK107ABJ225KA-T
2	C20, C23	Capacitor, ceramic, 150 pF, 25 V, X7R, 0603	AVX/06033C151KAT2A
2	J3, J10	Audio jack 3.5 mm stereo SMD	CUI Inc./SJ-3523-SMT
4	R6, R7, R8, R9	Resistor, 0.0 $\Omega$ , 1/8 W, 0805	Panasonic/ECG/ERJ-6GEY0R00V
5	R1, R2, R3, R4, R5	Resistor, 100 k $\Omega$ , 1/10 W, 1%, 0603	Vishay/CRCW0603100KFKEA
1	J8	Connector, header, 2-position, 0.100" single gold	Samtec/TSW-202
3	J4, J11, J12	Connector, header, 3-position, 2 mm single gold	Samtec/TMM-103
5	J1, J2, J5, J6, J13	Connector, header, 2-position, 2 mm single gold	Samtec/TMM-102

## NOTES

**ESD Caution**

**ESD (electrostatic discharge) sensitive device.** Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

**Legal Terms and Conditions**

By using the evaluation board discussed herein (together with any tools, components documentation or support materials, the "Evaluation Board"), you are agreeing to be bound by the terms and conditions set forth below ("Agreement") unless you have purchased the Evaluation Board, in which case the Analog Devices Standard Terms and Conditions of Sale shall govern. Do not use the Evaluation Board until you have read and agreed to the Agreement. Your use of the Evaluation Board shall signify your acceptance of the Agreement. This Agreement is made by and between you ("Customer") and Analog Devices, Inc. ("ADI"), with its principal place of business at One Technology Way, Norwood, MA 02062, USA. Subject to the terms and conditions of the Agreement, ADI hereby grants to Customer a free, limited, personal, temporary, non-exclusive, non-sublicensable, non-transferable license to use the Evaluation Board FOR EVALUATION PURPOSES ONLY. Customer understands and agrees that the Evaluation Board is provided for the sole and exclusive purpose referenced above, and agrees not to use the Evaluation Board for any other purpose. Furthermore, the license granted is expressly made subject to the following additional limitations: Customer shall not (i) rent, lease, display, sell, transfer, assign, sublicense, or distribute the Evaluation Board; and (ii) permit any Third Party to access the Evaluation Board. As used herein, the term "Third Party" includes any entity other than ADI, Customer, their employees, affiliates and in-house consultants. The Evaluation Board is NOT sold to Customer; all rights not expressly granted herein, including ownership of the Evaluation Board, are reserved by ADI. CONFIDENTIALITY. This Agreement and the Evaluation Board shall all be considered the confidential and proprietary information of ADI. Customer may not disclose or transfer any portion of the Evaluation Board to any other party for any reason. Upon discontinuation of use of the Evaluation Board or termination of this Agreement, Customer agrees to promptly return the Evaluation Board to ADI. ADDITIONAL RESTRICTIONS. Customer may not disassemble, decompile or reverse engineer chips on the Evaluation Board. Customer shall inform ADI of any occurred damages or any modifications or alterations it makes to the Evaluation Board, including but not limited to soldering or any other activity that affects the material content of the Evaluation Board. Modifications to the Evaluation Board must comply with applicable law, including but not limited to the RoHS Directive. TERMINATION. ADI may terminate this Agreement at any time upon giving written notice to Customer. Customer agrees to return to ADI the Evaluation Board at that time. LIMITATION OF LIABILITY. THE EVALUATION BOARD PROVIDED HEREUNDER IS PROVIDED "AS IS" AND ADI MAKES NO WARRANTIES OR REPRESENTATIONS OF ANY KIND WITH RESPECT TO IT. ADI SPECIFICALLY DISCLAIMS ANY REPRESENTATIONS, ENDORSEMENTS, GUARANTEES, OR WARRANTIES, EXPRESS OR IMPLIED, RELATED TO THE EVALUATION BOARD INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, TITLE, FITNESS FOR A PARTICULAR PURPOSE OR NONINFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. IN NO EVENT WILL ADI AND ITS LICENSORS BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES RESULTING FROM CUSTOMER'S POSSESSION OR USE OF THE EVALUATION BOARD, INCLUDING BUT NOT LIMITED TO LOST PROFITS, DELAY COSTS, LABOR COSTS OR LOSS OF GOODWILL. ADI'S TOTAL LIABILITY FROM ANY AND ALL CAUSES SHALL BE LIMITED TO THE AMOUNT OF ONE HUNDRED US DOLLARS (\$100.00). EXPORT. Customer agrees that it will not directly or indirectly export the Evaluation Board to another country, and that it will comply with all applicable United States federal laws and regulations relating to exports. GOVERNING LAW. This Agreement shall be governed by and construed in accordance with the substantive laws of the Commonwealth of Massachusetts (excluding conflict of law rules). Any legal action regarding this Agreement will be heard in the state or federal courts having jurisdiction in Suffolk County, Massachusetts, and Customer hereby submits to the personal jurisdiction and venue of such courts. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement and is expressly disclaimed.