



Mini Evaluation Board for Filterless Class-D Audio Amplifier

EVAL-SSM2301-MINI

FEATURES

DC power supply accepts 2.5 V to 5.5 V
Single-ended and differential input capability
Extremely small board size allows integration

GENERAL DESCRIPTION

The [SSM2301](#) is a single-chip, single-channel, Class-D audio amplifier. It is a fully integrated chip, which means that the application circuit requires a minimum of external components. It comes with a differential mode input port and a high efficiency H-bridge at the output. When compared to a half-bridge output stage, a full H-bridge enables direct coupling of the audio power signal to the loudspeaker, doubling the output voltage swing and eliminating the need for a large output coupling capacitor. Another benefit of a full H-bridge is an increase of the maximum output power by 4× when compared to a half bridge under the same load impedance. These benefits are particularly useful for low voltage, battery-powered portable electronics where energy and space are limited. The differential mode input stage allows for cancelling of common-mode noise leading to a superior CMRR.

Moreover, the part features a high efficiency, low noise output modulation scheme that does not require external LC output filters when attached to an inductive load. The modulation provides high efficiency even at low output power. Filterless operation also helps to decrease distortion due to nonlinearities of output LC filters, thereby providing a better sound quality and leading to savings in board space and overall cost.

This data sheet describes how to configure and use the SSM2301 mini evaluation board. It is recommended that this data sheet be read in conjunction with the SSM2301 data sheet, which provides more detailed information about the specifications, internal block diagrams, and application guidance for the amplifier IC.

EVALUATION BOARD DESCRIPTION

The SSM2301 mini evaluation board carries a complete application circuit for driving one loudspeaker. Figure 1 shows the top view of the PCB and Figure 2 shows the bottom view of the board. Figure 6 shows its layout. The bottom layer of the evaluation board is shown in Figure 7, and its mirrored version is shown in Figure 8. The schematic is shown in Figure 5. The bill of materials is given in Table 1.

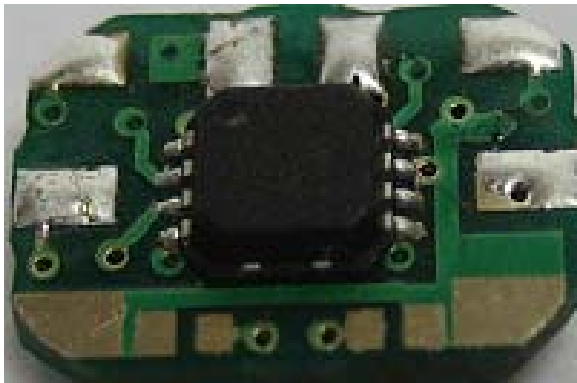


Figure 1. SSM2301 Mini Evaluation Board, Top View

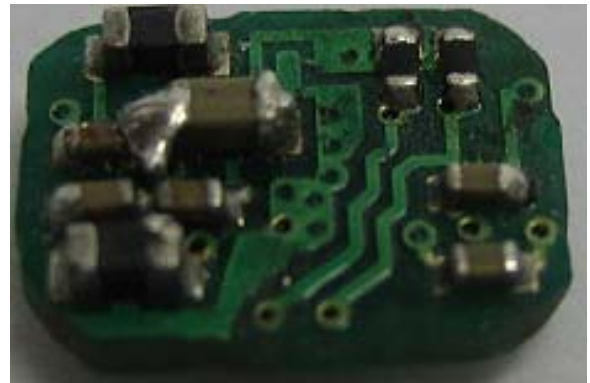


Figure 2. SSM2301 Mini Evaluation Board, Bottom View

Rev. 0

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REVISION HISTORY

7/08—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

Note that the SSM2301 mini evaluation board and layout guidelines were developed by Gang Liu of Analog Technologies, Inc., Sunnyvale, CA.

The SSM2301 mini evaluation board features the SSM2301 filterless Class-D amplifier, designed to drive a BTL mono loudspeaker in portable audio applications. The SSM2301 mini evaluation board operates from a dc power supply that can provide 2.5 V to 5.5 V. The audio input source is amplified to drive 1.4 W into an 8 Ω loudspeaker at 5.0 V supply. The SSM2301 mini evaluation board accepts differential or single-ended input signals.

On the left of the SSM2301 mini evaluation board layout, there are three input audio signals: IN+, IN–, and GND (see Figure 6). The mini evaluation board takes audio signals by using IN+ and IN– to receive audio signals from common appliances, such as DVD players, personal computers, and TVs. When the input signal is sensed in single-ended mode, the audio single signal is transmitted from IN+ into the IC. At the same time, short circuit the negative input node to neighborhood ground (see the schematic in Figure 5). Some appliances may have strong ground noise; using the IN+ as the input may allow this noise to be converted into an audible hissing sound at the output. When this happens, a differential mode connection is needed and the ground noise interference can be cancelled.

When the input signal is sensed in differential mode, IN+ and IN– can be used. Figure 3 shows such a connection: the ground on the signal source appliance is sensed by a dedicated cable wire in addition to the ground connection wire.

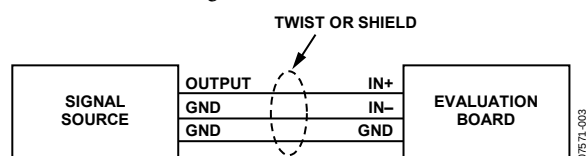


Figure 3. Cancelling Ground Noise by Differential Input Mode

There is a ground soldering pad on the lower left corner of the mini evaluation board; it can be used for connecting with the ground of the signal source.

On the lower center side of the mini evaluation board are solder pads, LP1 and LP2.

LP1 is for the shut-down function: short circuit to shut down the amplifier and open circuit to turn it on.

LP2 is for controlling the gain: short circuit the GAIN pin to ground, to set the amplifier to a lower gain, 6 dB; open circuit to set to a higher gain, 12 dB.

There are two solder pads in the upper center edge area of the mini evaluation board for connecting the power supply voltages.

The output ports are located on the right side of the board and marked with labels. The output ports can be connected with soldering pads on the right edge of the board (see Figure 6).

WHAT TO TEST

- Electromagnetic interference (EMI). Connect wires for the speakers in the same length as for the actual application situation and execute the EMI test.
- Signal-to-noise ratio.
- Output noise. Make sure to use an A-weighted filter to filter the output before the measurement meter.
- Maximum output power.
- Efficiency.

COMPONENT SELECTIONS

Selecting the right components is the key to achieving the performance required at the cost budgeted. The bill of materials of the SSM2301 mini evaluation board is shown in Table 1.

Input Coupling Capacitor Selection

The capacitors, C1 and C2, should be large enough to couple the low frequency signal components in the incoming signal and should be small enough to filter out unnecessary low frequency signals. For music signals, the cutoff frequency is often chosen between 20 Hz to 50 Hz. The value of the input capacitor is calculated by

$$C = 1/(2\pi R f_c)$$

where:

$R = 150 \text{ k}\Omega$.

f_c is the cutoff frequency.

Output Beads—B1 and B2

B1 and B2 are necessary components for filtering out the EMIs caused at the switching output node when the speaker cable length is greater than 8 cm.

The penalty for use of ferrite beads for EMI filtering is slightly worse noise and distortion performance at the system level. Make sure that these beads have enough current conducting capability while providing sufficient EMI attenuation. The current rating needed for an 8 Ω load is about 600 mA, and impedance at 100 MHz need to be $\geq 220 \Omega$. In addition, the lower the DCR (dc resistance) of these beads, the better for minimizing their power consumption. The recommended bead is the BLM18EG221SN1 from Murata with 220 Ω impedance, 2000 mA maximum current, 1.6 mm $\times$ 0.8 mm $\times$ 0.8 mm size, and 0.05 Ω DCR.

Output Shunting Capacitors—C3 and C4

The C3 and C4 capacitors filter out lower frequency EMIs of up to 250 MHz. Use small size (0402) multilayer ceramic capacitors that are made of X7R or COG (NPO) materials. The higher the value of these capacitors, the lower the residual EMI level at the output, and the higher the quiescent current at the power supply. Using 500 pF to 1 nF capacitors is recommended.

LAYOUT GUIDELINES

1. Place at least nine vias on the thermal solder pad of the amplifier for proper conduction of heat to the opposite side of the board. The outer diameter of the vias should be 0.5 mm and the inner diameter should be 0.25 mm to 0.3 mm. Use a PCB area of at least 2 cm² equivalent area on the opposite side of the layer of the amplifier chip as a heat sink. Also, extend the ground pad (for the thermal pad) as much as possible on the amplifier side of the PCB as a heat sink (see Figure 4). If internal layers are available, allocate a certain area as a heat sink; make sure to connect the vias conducting the heat to the internal layers.

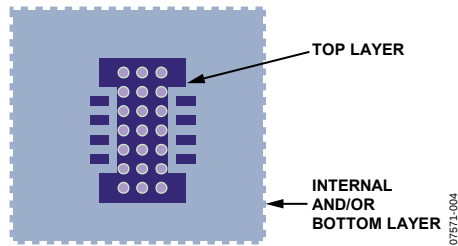
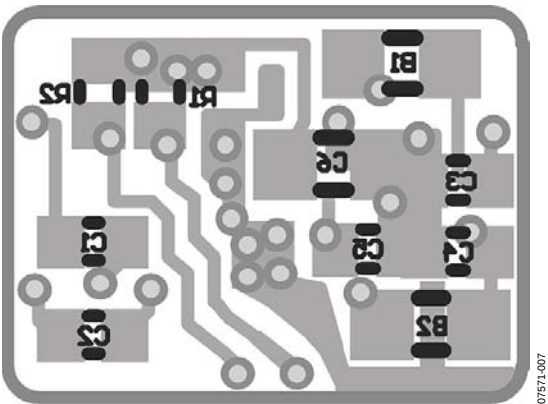
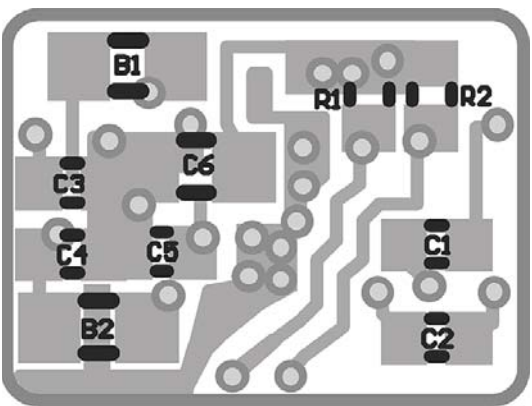
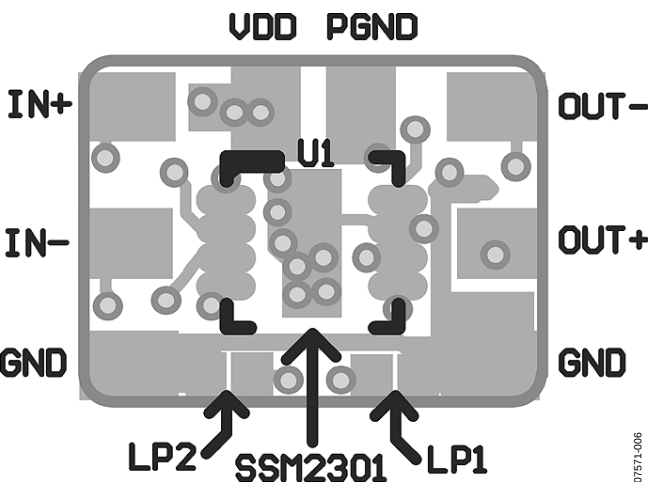
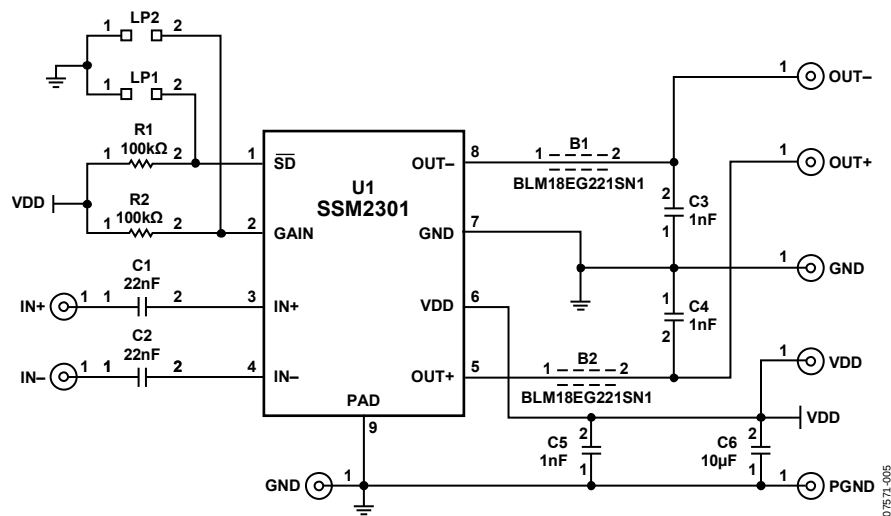


Figure 4. Heat Sink Layout

2. Place the EMI filtering beads, B1 and B2 as close to the amplifier chip as possible.
3. Place the decoupling capacitors for the beads, C3 and C4, as close to the amplifier chip as possible, and connect all their ground terminals together as close as possible. Do not rely on PCB tracks or ground planes for connecting their ground terminals together.
4. The 1 nF capacitor and the ferrite bead can block the EMI for up to 250 MHz. To eliminate EMI higher than 250 MHz, place a low value small size capacitor, such as a 100 pF, 0402 size capacitor, in parallel with the 1 nF decoupling capacitor. Place this small capacitor a small distance away from the 1 nF capacitor and use the PCB connection track as an inductor to form a PI shape low-pass filter.
5. If implementing a PCB track PI filter, the input PCB track and the output PCB track connection to the decoupling capacitor should not be connected.
6. Place the decoupling capacitor for the power supply, C5 and C6, as close to the amplifier chip as possible, and connect its ground terminal directly to the IC ground pins.

EVALUATION BOARD SCHEMATIC AND ARTWORK



EVAL-SSM2301-MINI

ORDERING INFORMATION

BILL OF MATERIALS

Table 1.

Qty	Designator	Description	Supplier	Supplier Part No.
2	R1, R2	Resistor, 100 k Ω , 1/16 W, 0.5%, 0402 SMD	Digi-Key	RR05P100DTR-ND
2	C1, C2	Capacitor, ceramic, 22 nF, 50 V, X7R 0402	Digi-Key	490-3884-2-ND
3	C3, C4, C5	Capacitor, ceramic, 1 nF, 5%, 50 V, X7R 0402	Digi-Key	478-3661-2-ND
1	C6	Capacitor, ceramic, 10 μ F, 6.3 V, X5R 0603	Digi-Key	PCC2395TR-ND
2	B1, B2	Filter chip 220 Ω , 2 A, 0603	Digi-Key	490-3992-2-ND
1	U1	Filterless, high efficiency, mono, 1.4 W, Class-D audio amplifier	Analog Devices	SSM2301CPZ-REEL7

ORDERING GUIDE

Model	Description
SSM2301-MINI-EVALZ ¹	Evaluation Board with DIP Switch

¹ Z = RoHS Compliant Part.

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.

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