Mono 1.5 W/Stereo 250 mW Power Amplifier

SSM2250

FEATURES

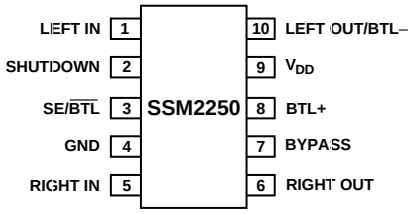
Part of SoundMax® Audio Solution for Desktop Computers
Mono 1.5 W Differential or Stereo 250 mW Output
Single-Supply Operation: 2.7 V to 6 V
Low Shutdown Current = 60 μA
PC 99 Compliant
Low Distortion: 0.2% THD at 1.5 W
Wide Bandwidth: 4 MHz
Unity-Gain Stable

APPLICATIONS

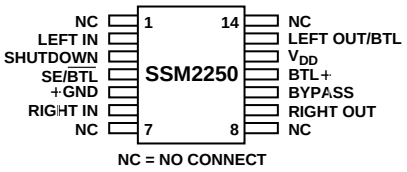
Desktop, Portable or Palmtop Computers
Sound Cards
Communication Headsets
2-Way Communications
Handheld Games

PIN CONFIGURATIONS

10-Lead MSOP
(RM Suffix)



14-Lead TSSOP
(RU Suffix)



NC = NO CONNECT

GENERAL DESCRIPTION

The SSM2250 is intended for use in desktop computers that have basic audio functions. It is also ideal for any audio system that needs to provide both an internal monaural speaker and a stereo line or headphone output. Combined with an AC'97 Codec it provides a PC audio system that meets the PC 99 requirements. The SSM2250 is compact and requires a minimum of external components.

The SSM2250 features an audio amplifier capable of delivering 1.5 W of low distortion power into a mono 4 Ω bridged-tied load (BTL) or 2 × 90 mW into stereo 32 Ω single-ended load (SE) headphones. Both amplifiers provide rail-to-rail outputs for maximum dynamic range from a single supply. The balanced output provides maximum output from 5 V supply and eliminates the need for a coupling capacitor.

The SSM2250 can automatically switch between an internal mono speaker and external headphones. The device can run from a single supply, ranging from 2.7 V to 6 V, with an active supply current of 9 mA typical. The ability to shut down the amplifiers, (60 μA shutdown current) makes the SSM2250 an ideal speaker amplifier for battery-powered applications.

The SSM2250 is specified over the industrial (–40°C to +85°C) temperature range. It is available in 14-lead TSSOP and 10-lead MSOP surface mount packages.

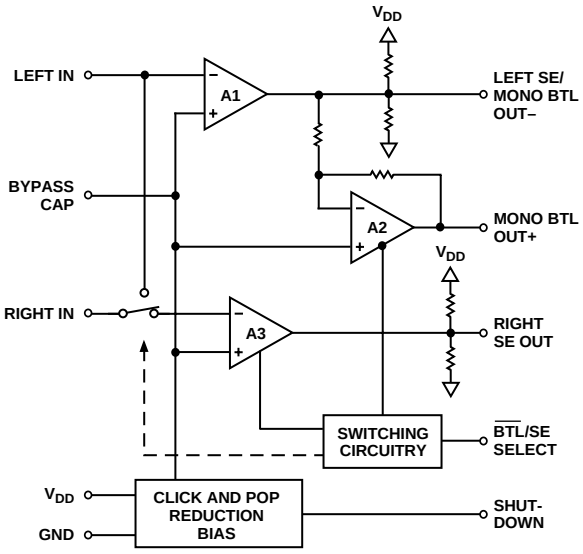


Figure 1. Functional Block Diagram

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One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106, U.S.A.
Tel: 781/329-4700 World Wide Web Site: http://www.analog.com
Fax: 781/326-8703

SSM2250–SPECIFICATIONS

ELECTRICAL CHARACTERISTICS (V_S = 5.0 V, V_{CM} = 2.5 V, T_A = 25°C unless otherwise noted)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
DEVICE CHARACTERISTICS						
Output Offset Voltage	V_{OS}	BTL Mode; A_V = 2; BTL+ to BTL–		4	100	mV
Large Signal Voltage Gain	A_{VO}	R_L = 2 kΩ		2		V/mV
Output Power	P_{OUT}	SE Mode: R_L = 32 Ω, THD < 1%		90		mW
		BTL Mode: R_L = 8 Ω, THD < 1%		1,000		mW
Output Impedance	Z_{OUT}			0.1		Ω
SHUTDOWN INPUT						
Input Voltage High	V_{IH}	I_S < 100 µA	2.0			V
Input Voltage Low	V_{IL}	I_S > 1 mA			0.8	V
POWER SUPPLY						
Supply Current	I_S	BTL Mode		6.4		mA
		SE Mode		6.4		mA
Supply Current/Amplifier	I_S			60		µA
DYNAMIC PERFORMANCE						
Slew Rate	SR	R_L = 100 kΩ, C_L = 50 pF		4		V/µs
Gain Bandwidth Product	GBP			4		MHz
Phase Margin	Φo			84		Degrees
NOISE PERFORMANCE						
Voltage Noise Density	e_n	f = 1 kHz		45		nV/√Hz

Specifications subject to change without notice.

ELECTRICAL CHARACTERISTICS (V_S = 2.7 V, V_{CM} = 1.35 V, T_A = 25°C unless otherwise noted)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
DEVICE CHARACTERISTICS						
Output Offset Voltage	V_{OS}	BTL Mode; A_V = 2; BTL+ to BTL–		4	100	mV
Large Signal Voltage Gain	A_{VO}	R_L = 2 kΩ		2		V/mV
Output Power	P_{OUT}	SE Mode: R_L = 32 Ω, THD < 1%		25		mW
		BTL Mode: R_L = 8 Ω, THD < 1%		300		mW
Output Impedance	Z_{OUT}			0.1		Ω
SHUTDOWN INPUT						
Input Voltage High	V_{IH}	I_S < 100 µA	2.0			V
Input Voltage Low	V_{IL}	I_S > 1 mA			0.8	V
POWER SUPPLY						
Supply Current	I_S	BTL Mode		6.4		mA
		SE Mode		6.4		mA
Supply Current/Amplifier	I_S			32		µA
DYNAMIC PERFORMANCE						
Slew Rate	SR	R_L = 100 kΩ, C_L = 50 pF		4		V/µs
Gain Bandwidth Product	GBP			4		MHz
Phase Margin	Φo			84		Degrees
NOISE PERFORMANCE						
Voltage Noise Density	e_n	f = 1 kHz		45		nV/√Hz

Specifications subject to change without notice.

ABSOLUTE MAXIMUM RATINGS[1]

Supply Voltage . . . . . 6 V
Differential Input Voltage[2] . . . . . ±5 V
Common-Mode Input Voltage . . . . . ±6 V
ESD Susceptibility . . . . . 2000 V
Storage Temperature Range
RM, RU Packages . . . . . –65°C to +150°C
Operating Temperature Range
SSM2250 . . . . . –40°C to +85°C
Junction Temperature Range
RM, RU Packages . . . . . –65°C to +165°C
Lead Temperature Range (Soldering, 60 sec) . . . . . 300°C

NOTES
[1]Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those listed in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
[2]Differential Input Voltage or $\pm V_S$, whichever is lower.

Package Type	θ_{JA}[1]	θ_{JC}	Unit
10-Lead MSOP (RM)	200	44	°C/W
14-Lead TSSOP (RU)	180	35	°C/W

NOTE
[1]θ_{JA} is specified for worst-case conditions, i.e., θ_{JA} is specified for device soldered in circuit board for surface mount packages.

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
SSM2250RM	–40°C to +85°C	10-Lead MSOP	RM-10
SSM2250RU	–40°C to +85°C	14-Lead TSSOP	RU-14

CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although the SSM2250 features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

PRODUCT OVERVIEW

The SSM2250 is a low distortion power amplifier that can drive a set of stereo headphones or a single 8 Ω loudspeaker. It contains three rail-to-rail output op amps, click and pop reduction biasing, and all necessary switching circuitry. In SE (Single-Ended) Mode, the device automatically mutes the internal 8 Ω speaker. In BTL (Bridge-Tied Load) Mode, the internal speaker is activated.

The SSM2250 can operate from a 2.7 V to 5.5 V single supply. The rail-to-rail outputs can be driven to within 400 mV of either supply rail while supplying a sustained output current of 350 mA into 8 Ω. The device is unity-gain stable and requires no external compensation capacitors. The SSM2250 can be configured for gains of up to 40 dB.

TYPICAL APPLICATION

In SE Mode, the device operates similar to a high current output, dual op amp. A1 and A3 are independent amplifiers with a gain of –R2/R1. The outputs of A1 and A3 are used to drive the external headphones plugged into the headphone jack. Amplifier A2 is shut down to a high output impedance state. This prevents current from flowing through the 8 Ω internal speaker, thereby muting it.

Although the gains of A1 and A3 can be set independently, it is recommended that the feedback and feedforward resistor around both amplifiers be equal. This will prevent one channel from becoming louder than the other.

In BTL mode, the current into the Right In pin is directed to the input of A1. This effectively sums the Left and Right In audio signals. The A2 amplifier is activated and configured with a fixed gain of $A_V = –1$. This produces a balanced output configuration that drives the internal speaker. Because the BTL output voltages swing opposite to each other, the gain to the speaker in BTL mode is twice the gain of SE mode. The voltage across the internal speaker can be written:

$$V_{SPEAKER} = \left(V_{LEFT} + V_{RIGHT}\right) \times 2 \times \frac{R2}{R1} \qquad (1)$$

The bridged output configuration offers the advantage of a more efficient power transfer from the input to the speaker. Because both outputs are symmetric, the dc voltage bias across the 8 Ω internal speaker is zero. This eliminates the need for a coupling capacitor at the output. In BTL mode, the A3 amplifier is shut down to conserve power.

In BTL Mode, the SSM2250 can achieve 1 W continuous output into 8 Ω at ambient temperatures up to 40°C. The power derating curve shown in Figure 15 should be observed for proper operation at higher ambient temperatures. For a standard 14-lead TSSOP package, typical junction-to-ambient temperature thermal resistance (θ_{JA}) is 180°C/W on a 2-layer board, and 140°C/W on a 4-layer board.

Internal Speaker/External Headphones Automatic Switching

Pin 4 on the SSM2250 controls the switching between BTL and SE Modes. Logic low to Pin 4 activates BTL Mode, while logic high activates SE Mode. The configuration shown in Figure 12 provides the appropriate logic voltages to Pin 4, muting the internal speaker when headphones are plugged into the jack.

A stereo headphone jack with a normalizing pin is required for the application. With no plug inserted, a mechanical spring connects the normalizing pin to the output pin in the jack. Once a plug is inserted, this connection is broken.

Referring to Figure 12, Pin 4 of the SSM2250 is connected to the normalizing pin for the right channel output. This is the pin in the headphone jack that will hit the ring on the headphone plug. A 100 kΩ pull-up resistor to 5 V is also connected at this point.

With a headphone plug inserted, the normalizing pin disconnects from the output pin, and Pin 4 is pulled up to 5 V, activating SE Mode on the SSM2250. This mutes the internal speaker while driving the stereo headphones.

Once the headphone plug is removed, the normalizing pin connects to the output pin. This drives the voltage at Pin 4 to 50 mV, as this point is pulled low by the 1 kΩ resistor now connected to the node. The SSM2250 goes into BTL mode, deactivating the right SE amplifier to prevent the occurrence of any false mode switching.

It is important to connect Pin 4 and the 100 kΩ pull up resistor to the normalizing pin for the right output in the headphone jack. Connecting them to the left output normalizing pin will result in improper operation from the device. The normalizing pin to the left output in the headphone jack should be left open.

Coupling Capacitors

Output coupling capacitors are not required to drive the internal speaker from the BTL outputs. However, coupling capacitors are required between the amplifier's SE outputs and the headphone jack to drive external headphones. This prevents dc current from flowing through the headphone speakers, whose resistances are typically on the order of 80 Ω.

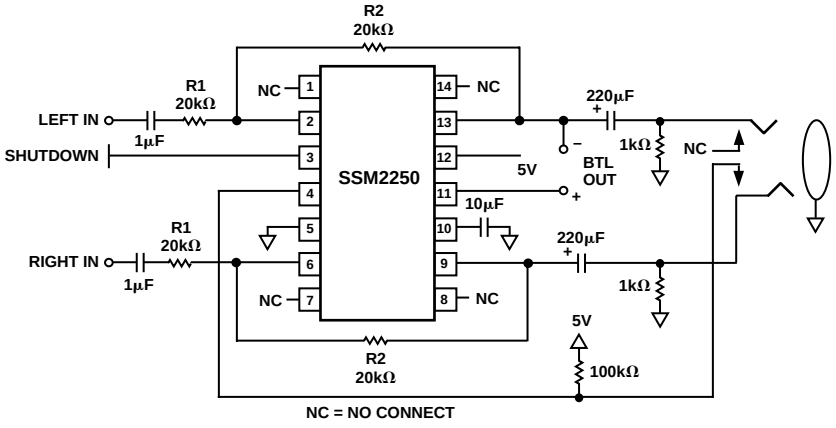

Figure 12. Typical Application

The AD1881 is an AC'97 Ver. 2.1 audio codec available from Analog Devices. The stereo output from the AD1881 is coupled into the SSM2250, which is used to drive a mono internal speaker and stereo headphones. The internal speaker switching is controlled by the SSM2250 through the normalizing pin on the headphone jack. The AD1881 controls the shutdown pin on the SSM2250, and is activated through the power management software drivers installed on the computer.

For more information on the AD1881, the data sheet can be downloaded from the Analog Devices web site at **http://www.analog.com.**

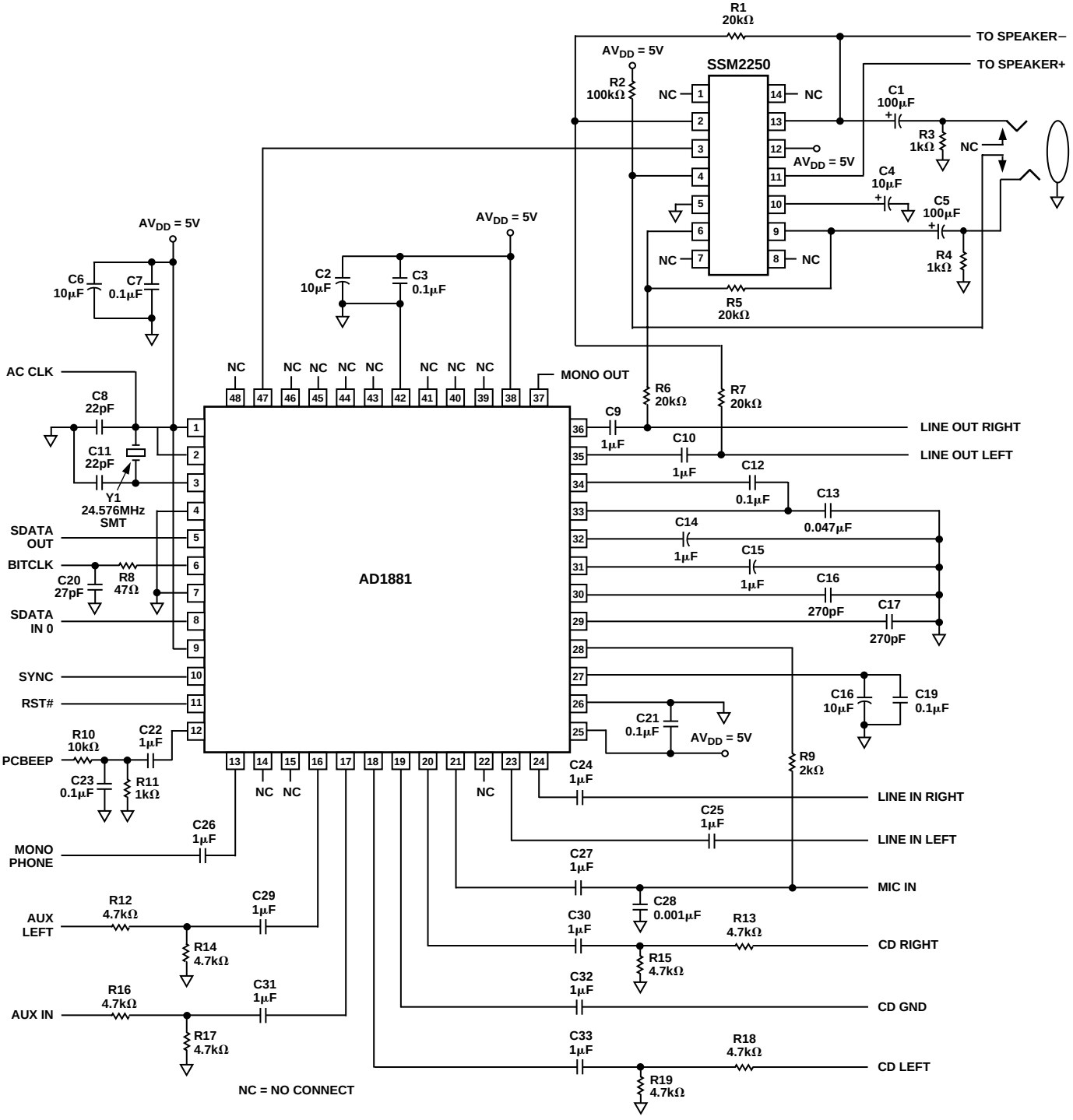

Figure 18. PC 99 Compliant Audio System Reference Design