

LM48310 Boomer® Audio Power Amplifier Series Ultra-Low EMI, Filterless, 2.6W, Mono, Class D Audio Power Amplifier with E²S

 Check for Samples: [LM48310](#)

FEATURES

- Passes FCC Class B Radiated Emissions with 20 inches of cable
- E²S System Reduces EMI while Preserving Audio Quality and Efficiency
- Output Short Circuit Protection with Auto-Recovery
- Stereo Class D operation
- No output filter required
- Internally Configured Gain (12dB)
- Synchronizable Oscillator for Multi-Channel operation

- Low power shutdown mode
- Minimum external components
- "Click and pop" suppression
- Micro-power shutdown
- Available in space-saving LLP package

APPLICATIONS

- Mobile phones
- PDAs
- Laptops

DESCRIPTION

The LM48310 is a single supply, high efficiency, mono, 2.6W, filterless switching audio amplifier. The LM48310 features National's Enhanced Emissions Suppression (E²S) system, that features a unique patent-pending ultra low EMI, spread spectrum, PWM architecture, that significantly reduces RF emissions while preserving audio quality and efficiency. The E²S system improves battery life, reduces external component count, board area consumption, system cost, and simplifying design.

The LM48310 is designed to meet the demands of portable multimedia devices. Operating from a single 5V supply, the device is capable of delivering 2.6W of continuous output power to a 4Ω load with less than 10% THD+N. Flexible power supply requirements allow operation from 2.4V to 5.5V. The LM48310 offers two logic selectable modulation schemes, fixed frequency mode, and an EMI suppressing spread spectrum mode. The E²S system includes an advanced, patent-pending edge rate control (ERC) architecture that further reduce emissions by minimizing the high frequency component of the device output, while maintaining high quality audio reproduction (THD+N = 0.03%) and high efficiency ($\eta = 88\%$). The LM48310 also features a SYNC_IN input and SYNC_OUT, which allows multiple devices to operate with the same switching frequency, eliminating beat frequencies and any other interference caused by clock intermodulation.

The LM48310 features high efficiency compared to conventional Class AB amplifiers, and other low EMI Class D amplifiers. When driving an 8Ω speaker from a 5V supply, the device operates with 88% efficiency at $P_O = 1W$. The gain of the LM48310 is internally set to 12dB, further reducing external component count. A low power shutdown mode reduces supply current consumption to 0.01μA.

Advanced output short circuit protection with auto-recovery prevents the device from being damaged during fault conditions. Superior click and pop suppression eliminates audible transients on power-up/down and during shutdown.

Table 1. Key Specifications

	VALUE	UNIT
Efficiency at 3.6V, 400mW into 8Ω	85% (typ)	
Efficiency at 5V, 1W into 8Ω	88% (typ)	
Quiescent Power Supply Current at 5V	3.2mA	
Power Output at $V_{DD} = 5V$, $R_L = 4\Omega$, THD+N ≤ 10%	2.6	W (typ)
Power Output at $V_{DD} = 5V$, $R_L = 8\Omega$, THD+N ≤ 10%	1.6	W (typ)



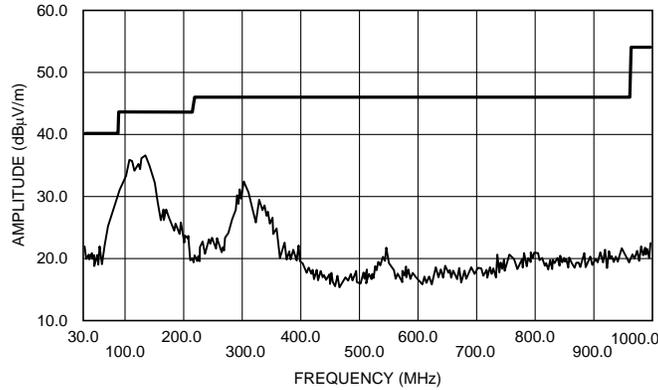
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Table 1. Key Specifications (continued)

Shutdown current	0.01µA (typ)	
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EMI Graph 20in of Speaker Cable



Typical Application

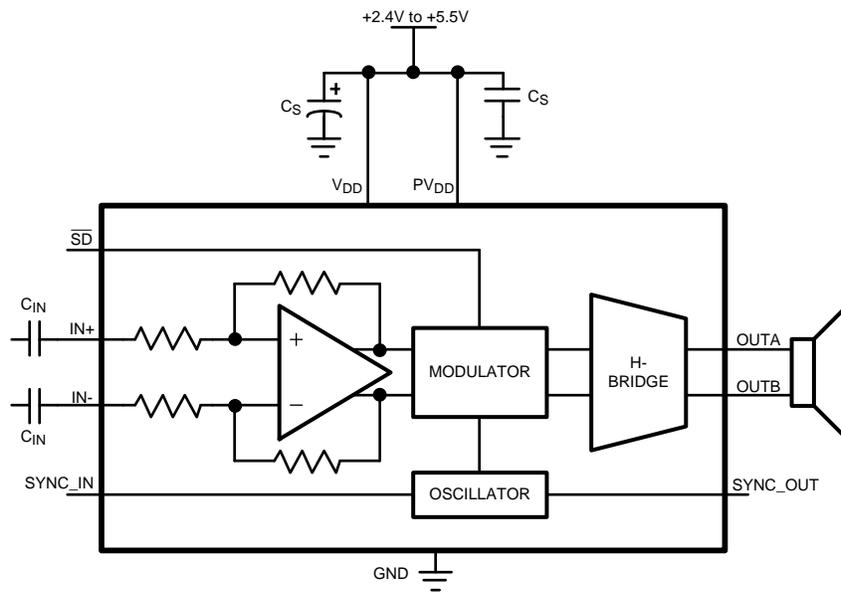


Figure 1. Typical Audio Amplifier Application Circuit

Connection Diagram

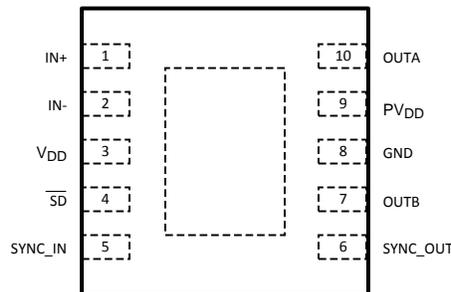


Figure 2. LLP Package (Top View)

Pin Functions

Pin Descriptions

Pin	Name	Description
1	IN+	Non-Inverting Input
2	IN-	Inverting Input
3	VDD	Power Supply
4	\overline{SD}	Active Low Shutdown Input. Connect to V_{DD} for normal operation.
5	SYNC_IN	Mode Select and External Oscillator Input. SYNC_IN = V_{DD} : Spread spectrum mode with $f_S = 300\text{kHz} \pm 30\%$ SYNC_IN = GND: Fixed frequency mode with $f_S = 300\text{kHz}$ SYNC_IN = Clocked: $f_S =$ external clock frequency
6	SYNC_OUT	Clock Output
7	OUTB	Inverting Output
8	GND	Ground
9	PVDD	H-Bridge Power Supply
10	OUTA	Non-Inverting Output



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Absolute Maximum Ratings ⁽¹⁾ ⁽²⁾

Supply Voltage	6.0V
Storage Temperature	-65°C to +150°C
Input Voltage	-0.3V to $V_{DD} + 0.3V$
Power Dissipation ⁽³⁾	Internally Limited
ESD Rating ⁽⁴⁾	2000V
ESD Rating ⁽⁵⁾	200V
Junction Temperature	150°C
Thermal Resistance	
θ_{JC}	8.2°C/W
θ_{JA}	49.2°C/W

- (1) "Absolute Maximum Ratings" indicate limits beyond which damage to the device may occur, including inoperability and degradation of device reliability and/or performance. Functional operation of the device and/or non-degradation at the *Absolute Maximum Ratings* or other conditions beyond those indicated in the *Recommended Operating Conditions* is not implied. The *Recommended Operating Conditions* indicate conditions at which the device is functional and the device should not be operated beyond such conditions. All voltages are measured with respect to the ground pin, unless otherwise specified.
- (2) The *Electrical Characteristics* tables list guaranteed specifications under the listed *Recommended Operating Conditions* except as otherwise modified or specified by the *Electrical Characteristics Conditions* and/or Notes. Typical specifications are estimations only and are not guaranteed.
- (3) The maximum power dissipation must be derated at elevated temperatures and is dictated by T_{JMAX} , θ_{JA} , and the ambient temperature, T_A . The maximum allowable power dissipation is $P_{DMAX} = (T_{JMAX} - T_A) / \theta_{JA}$ or the number given in *Absolute Maximum Ratings*, whichever is lower.
- (4) Human body model, applicable std. JESD22-A114C.
- (5) Machine model, applicable std. JESD22-A115-A.

Operating Ratings ⁽¹⁾ ⁽²⁾

Temperature Range	
$T_{MIN} \leq T_A \leq T_{MAX}$	$-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$

- (1) "Absolute Maximum Ratings" indicate limits beyond which damage to the device may occur, including inoperability and degradation of device reliability and/or performance. Functional operation of the device and/or non-degradation at the *Absolute Maximum Ratings* or other conditions beyond those indicated in the *Recommended Operating Conditions* is not implied. The *Recommended Operating Conditions* indicate conditions at which the device is functional and the device should not be operated beyond such conditions. All voltages are measured with respect to the ground pin, unless otherwise specified.
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Operating Ratings ⁽¹⁾ ⁽²⁾ (continued)

Supply Voltage	$2.4V \leq V_{DD} \leq 5.5V$
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Electrical Characteristics $V_{DD} = PV_{DD} = 5V$

(1)(2)

 The following specifications apply for $A_V = 12\text{dB}$, ($R_L = 8\Omega$, $\text{SYNC_IN} = V_{DD}$ (Spread Spectrum mode), $f = 1\text{kHz}$, unless otherwise specified. Limits apply for $T_A = 25^\circ\text{C}$.

Symbol	Parameter	Conditions	LM48310		Units (Limits)
			Typical	Limit	
			(3)	(4)(2)	
V_{OS}	Differential Output Offset Voltage	$V_{IN} = 0$	1	3	mV (max)
I_{DD}	Quiescent Power Supply Current	$V_{IN} = 0, R_L = \infty$ $V_{DD} = 3.6V$	2.7	3.9	mA (max)
		$V_{IN} = 0, R_L = \infty$ $V_{DD} = 5V$	3.2	4.4	mA (max)
I_{DD}	Quiescent Power Supply Current	$V_{IN} = 0, V_{DD} = 3.6V$	2.7		mA
		$V_{IN} = 0, V_{DD} = 5V$	3.2		mA
I_{SD}	Shutdown Current	$\overline{SD} = \text{GND}$	0.01	1.0	μA
V_{IH}	Logic Input High Voltage	\overline{SD} input, $V_{DD} = 3.6V$		1.4	V (min)
V_{IL}	Logic Input Low Voltage	\overline{SD} input, $V_{DD} = 3.6V$		0.4	V (max)
T_{WU}	Wake Up Time		7.5		ms
f_{SW}	Switching Frequency	$\text{SYNC_IN} = V_{DD}$ (Spread Spectrum)	300±30		kHz
		$\text{SYNC_IN} = \text{GND}$ (Fixed Frequency)	300		kHz
		$\text{SYNC_IN} = \text{External Clock}$ Minimum Frequency	200		kHz
		$\text{SYNC_IN} = \text{External Clock}$ Maximum Frequency	1000		kHz
A_V	Gain		12	11 13	dB (min) dB (max)
R_{IN}	Input Resistance		20	17	k Ω (min)
P_O	Output Power	$R_L = 4\Omega$, THD = 10% $f = 1\text{kHz}$, 22kHz BW $V_{DD} = 5V$ $V_{DD} = 3.6V$ $V_{DD} = 2.5V$	2.6 1.3 555		W W mW
		$R_L = 8\Omega$, THD = 10% (max) $f = 1\text{kHz}$, 22kHz BW $V_{DD} = 5V$ $V_{DD} = 3.6V$ $V_{DD} = 2.5V$	1.6 800 354		W mW mW
		$R_L = 4\Omega$, THD = 1% (max) $f = 1\text{kHz}$, 22kHz BW $V_{DD} = 5V$ $V_{DD} = 3.6V$ $V_{DD} = 2.5V$	2.1 1 446		W W mW
		$R_L = 8\Omega$, THD = 1% (max) $f = 1\text{kHz}$, 22kHz BW $V_{DD} = 5V$ $V_{DD} = 3.6V$ $V_{DD} = 2.5V$	1.3 640 286	1.1	W (min) mW mW
THD+N	Total Harmonic Distortion + Noise	$P_O = 200\text{mW}$, $R_L = 8\Omega$, $f = 1\text{kHz}$	0.03		% (max)
		$P_O = 100\text{mW}$, $R_L = 8\Omega$, $f = 1\text{kHz}$	0.03		%

- (1) The *Electrical Characteristics* tables list guaranteed specifications under the listed *Recommended Operating Conditions* except as otherwise modified or specified by the *Electrical Characteristics Conditions* and/or Notes. Typical specifications are estimations only and are not guaranteed.
- (2) R_L is a resistive load in series with two inductors to simulate an actual speaker load. For $R_L = 8\Omega$, the load is $15\mu\text{H} + 8\Omega + 15\mu\text{H}$. For $R_L = 4\Omega$, the load is $15\mu\text{H} + 4\Omega + 15\mu\text{H}$.
- (3) Typical values represent most likely parametric norms at $T_A = +25^\circ\text{C}$, and at the *Recommended Operation Conditions* at the time of product characterization and are not guaranteed.
- (4) Datasheet min/max specification limits are guaranteed by test or statistical analysis.

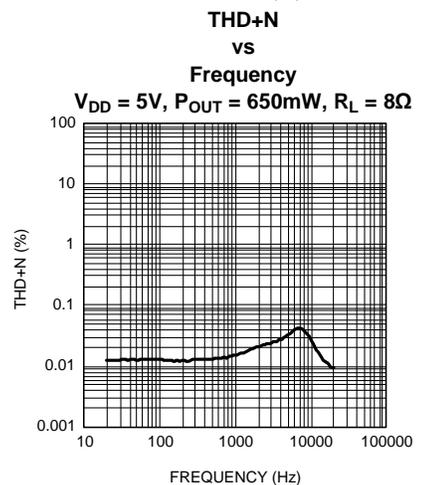
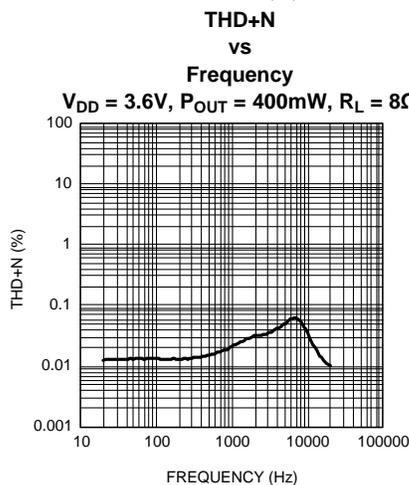
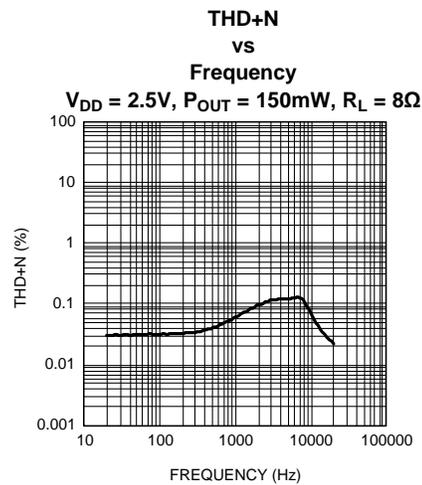
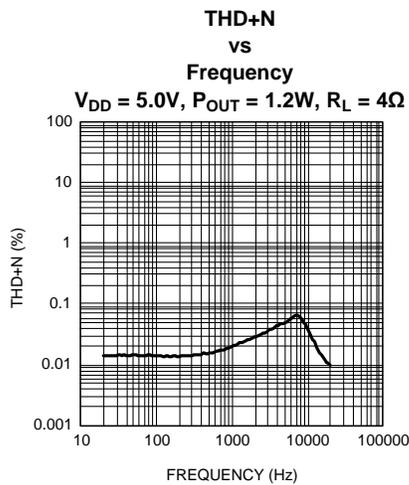
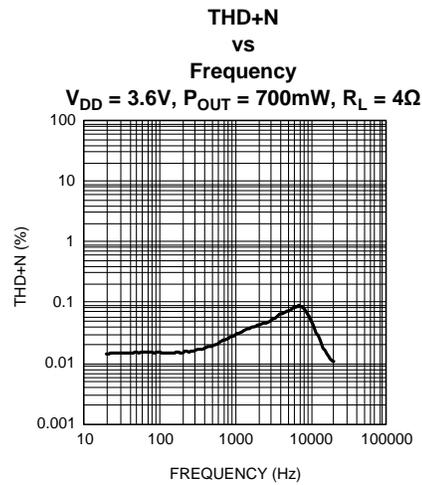
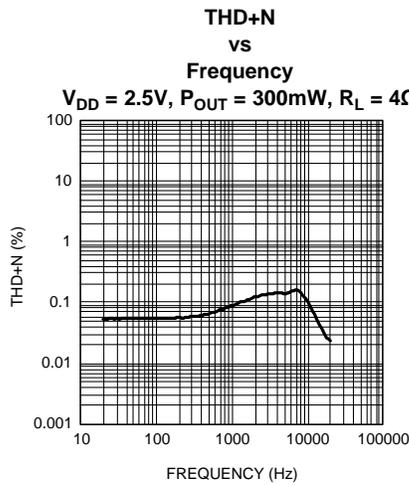
Electrical Characteristics $V_{DD} = PV_{DD} = 5V$ (continued)

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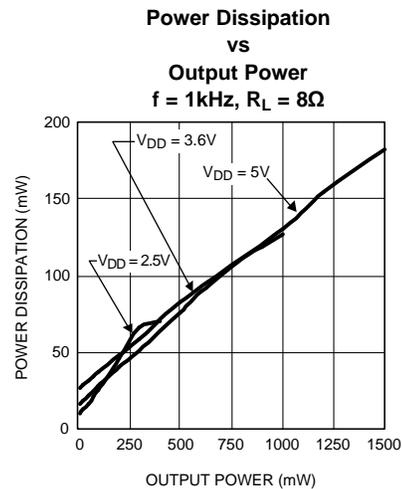
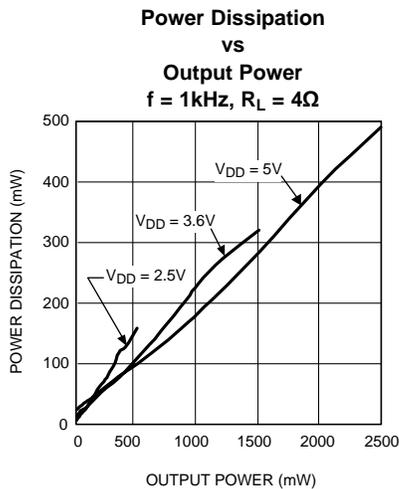
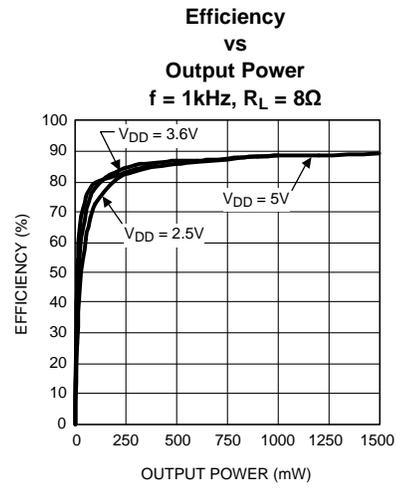
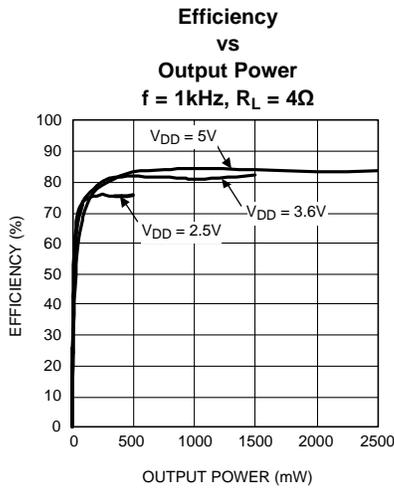
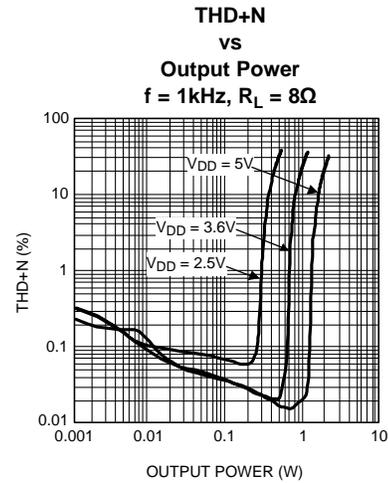
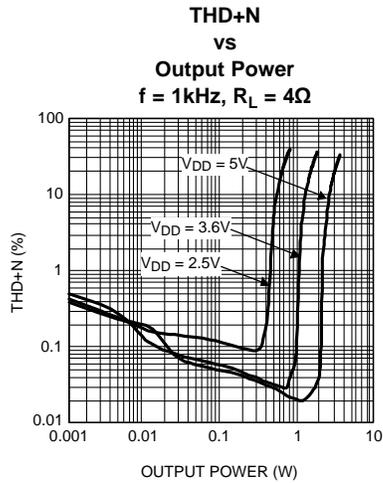
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Symbol	Parameter	Conditions	LM48310		Units (Limits)
			Typical	Limit	
			(3)	(4) (2)	
PSRR	Power Supply Rejection Ratio (Input Referred)	$V_{\text{RIPPLE}} = 200\text{mV}_{\text{P-P}}$ Sine, $f_{\text{RIPPLE}} = 217\text{Hz}$, Inputs AC GND, $C_{\text{IN}} = 1\mu\text{F}$, Input referred	82		dB
		$V_{\text{RIPPLE}} = 200\text{mV}_{\text{P-P}}$ Sine, $f_{\text{RIPPLE}} = 1\text{kHz}$, Inputs AC GND, $C_{\text{IN}} = 1\mu\text{F}$, Input referred	80		dB
CMRR	Common Mode Rejection Ratio	$V_{\text{RIPPLE}} = 1\text{V}_{\text{P-P}}$ $f_{\text{RIPPLE}} = 217\text{Hz}$	70		dB
η	Efficiency	$V_{\text{DD}} = 5\text{V}$, $P_{\text{OUT}} = 1\text{W}$ $R_L = 8\Omega$, $f = 1\text{kHz}$	88		%
		$V_{\text{DD}} = 3.6\text{V}$, $P_{\text{OUT}} = 400\text{mW}$ $R_L = 8\Omega$, $f = 1\text{kHz}$	85		%
SNR	Signal to Noise Ratio	$V_{\text{DD}} = 5\text{V}$, $P_O = 1\text{W}$, Fixed Frequency Mode	97		dB
		$V_{\text{DD}} = 5\text{V}$, $P_O = 1\text{W}$, Spread Spectrum Mode	97		dB
ϵ_{OS}	Output Noise	Input referred, Fixed Frequency Mode, A-weighted Filter	14		μV
		Input referred, Spread Spectrum Mode, Unweighted	28		μV

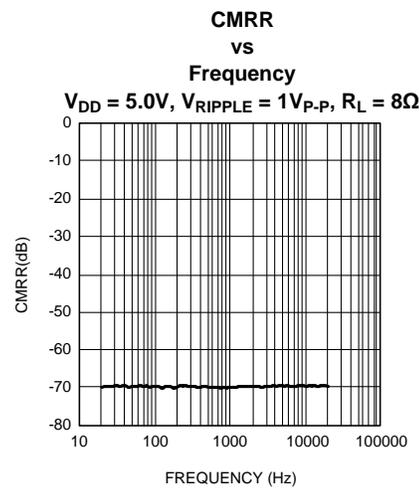
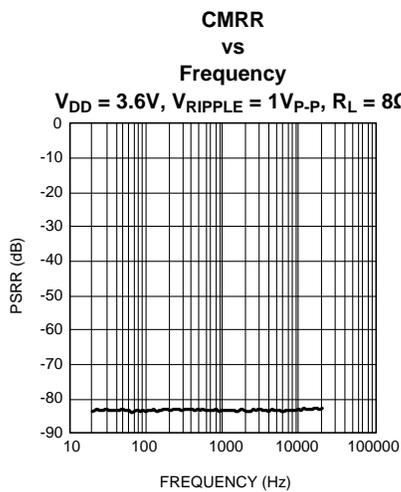
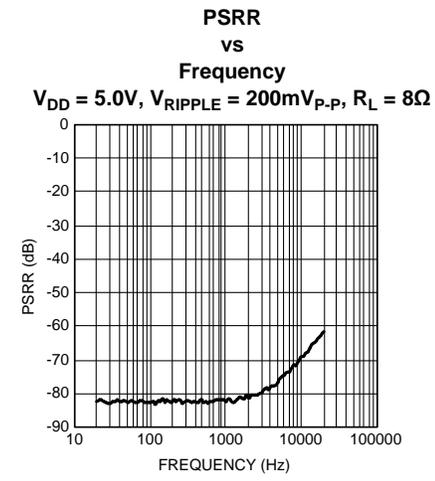
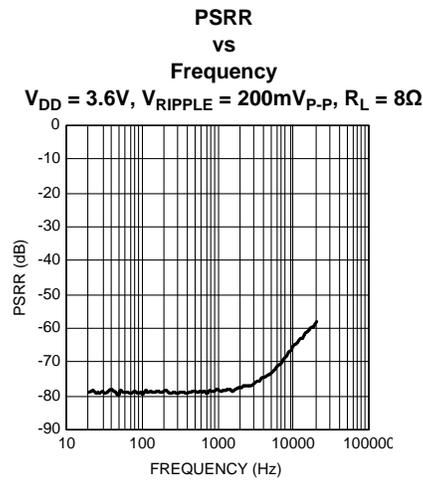
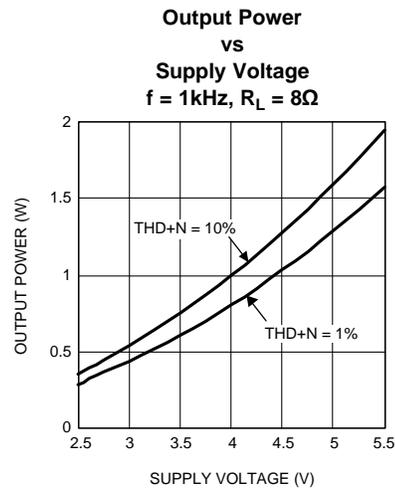
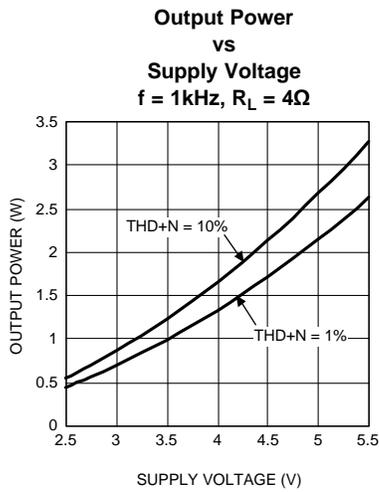
TYPICAL PERFORMANCE CHARACTERISTICS



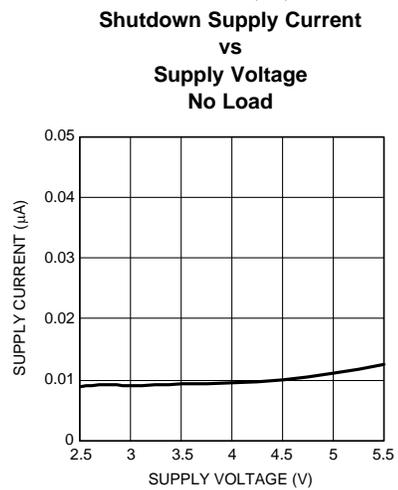
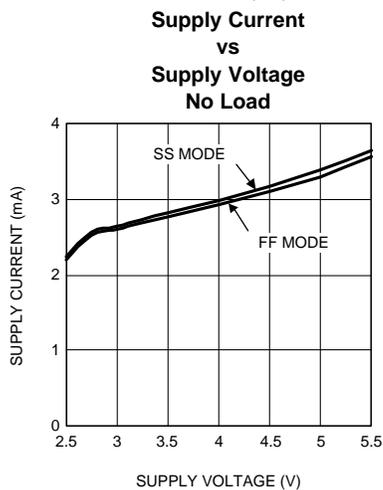
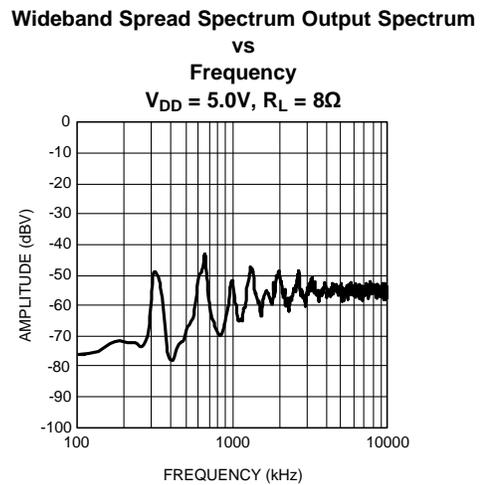
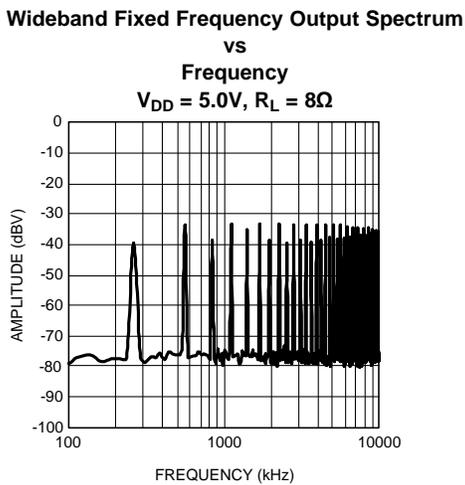
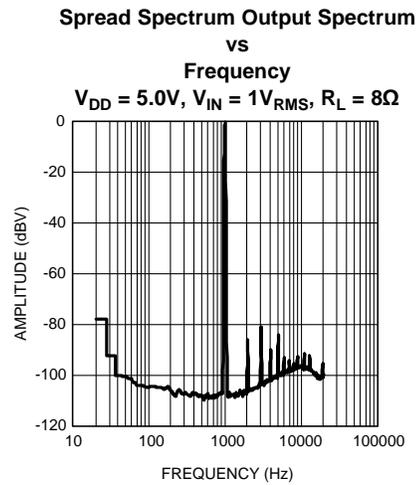
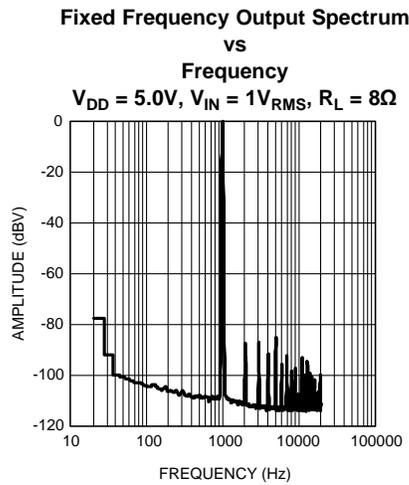
TYPICAL PERFORMANCE CHARACTERISTICS (continued)



TYPICAL PERFORMANCE CHARACTERISTICS (continued)



TYPICAL PERFORMANCE CHARACTERISTICS (continued)



Application Information

GENERAL AMPLIFIER FUNCTION

The LM48310 mono Class D audio power amplifier features a filterless modulation scheme that reduces external component count, conserving board space and reducing system cost. With no signal applied, the outputs (V_{OUTA} and V_{OUTB}) switch between V_{DD} and GND with a 50% duty cycle, in phase, causing the two outputs to cancel. This cancellation results in no net voltage across the speaker, thus there is no current to the load in the idle state.

With the input signal applied, the duty cycle (pulse width) of the LM48310 outputs changes. For increasing output voltage, the duty cycle of V_{OUTA} increases, while the duty cycle of V_{OUTB} decreases. For decreasing output voltages, the converse occurs. The difference between the two pulse widths yields the differential output voltage.

ENHANCED EMISSIONS SUPPRESSION SYSTEM (E²S)

The LM48310 features National's patent-pending E²S system that reduces EMI, while maintaining high quality audio reproduction and efficiency. The E²S system features a synchronizable oscillator with selectable spread spectrum, and advanced edge rate control (ERC). The LM48310 ERC greatly reduces the high frequency components of the output square waves by controlling the output rise and fall times, slowing the transitions to reduce RF emissions, while maximizing THD+N and efficiency performance. The overall result of the E²S system is a filterless Class D amplifier that passes FCC Class B radiated emissions standards with 20in of twisted pair cable, with excellent 0.03% THD+N and high 88% efficiency.

FIXED FREQUENCY MODE (SYNC_IN = GND)

The LM48310 features two modulations schemes, a fixed frequency mode and a spread spectrum mode. Select the fixed frequency mode by setting SYNC_IN = GND. In fixed frequency mode, the amplifier output switch at a constant 300kHz. In fixed frequency mode, the output spectrum consists of the fundamental and its associated harmonics (see *Typical Performance Characteristics*).

SPREAD SPECTRUM MODE (SYNC_IN = V_{DD})

The logic selectable spread spectrum mode eliminates the need for output filters, ferrite beads or chokes. In spread spectrum mode, the switching frequency varies randomly by 30% about a 300kHz center frequency, reducing the wideband spectral content, improving EMI emissions radiated by the speaker and associated cables and traces. Where a fixed frequency class D exhibits large amounts of spectral energy at multiples of the switching frequency, the spread spectrum architecture of the LM48310 spreads that energy over a larger bandwidth (See *Typical Performance Characteristics*). The cycle-to-cycle variation of the switching period does not affect the audio reproduction, efficiency, or PSRR. Set SYNC_IN = V_{DD} for spread spectrum mode.

EXTERNAL CLOCK MODE (SYNC_IN = CLOCK)

Connecting a clock signal to SYNC_IN synchronizes the LM48310 oscillator to an external clock, moving the output spectral components out of a sensitive frequency band, and minimizing audible beat frequencies when multiple LM48310s are used in a single system. The LM48310 accepts an external clock frequency between 200kHz and 1MHz. The LM48310 can be synchronized to a spread spectrum clock, allowing multiple LM48310s to be synchronized in spread spectrum mode (see SYNC_OUT section).

SYNC_OUT

SYNC_OUT is a clock output for synchronizing external devices. The SYNC_OUT signal is identical in frequency and duty cycle of the amplifier's switching frequency. When the LM48310 is in fixed frequency mode, SYNC_OUT is a fixed, 300kHz clock. When the LM48310 is in spread spectrum mode, SYNC_OUT is an identical spread spectrum clock. When the LM48310 is driven by an external clock, SYNC_OUT is identical to the external clock. If unused, leave SYNC_OUT floating.

Multiple LM48310s can be synchronized to a single clock. In Figure 2, device U1 is the master, providing a spread spectrum clock to the slave device (U2). This configuration synchronizes the switching frequencies of the two devices, eliminating any audible beat frequencies. Because SYNC_OUT has no audio content, there is minimal THD+N degradation or crosstalk between the devices, Figure 3-5.

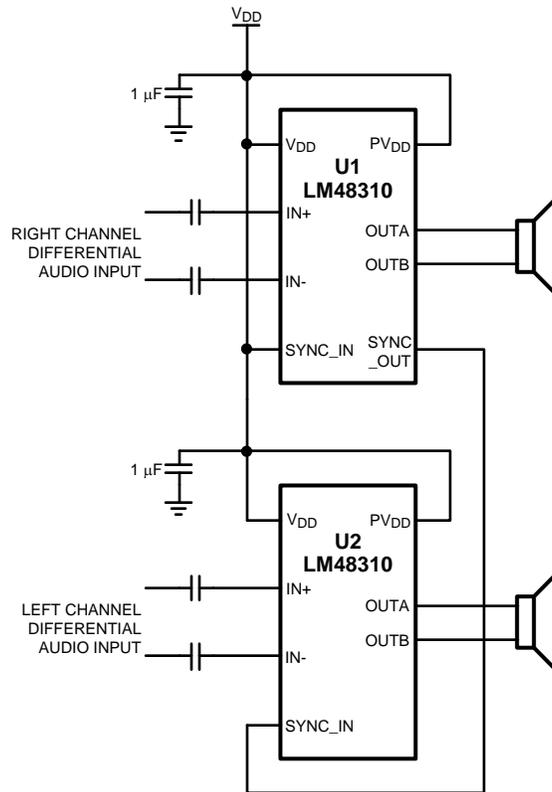


Figure 3. Cascaded LM48310

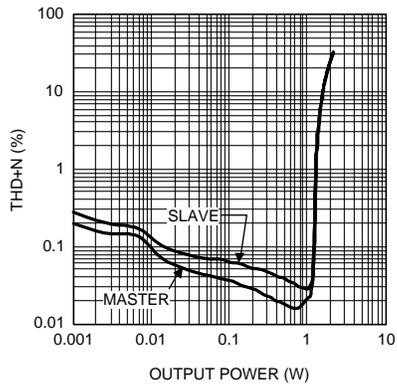


Figure 4. THD+N vs Output Power

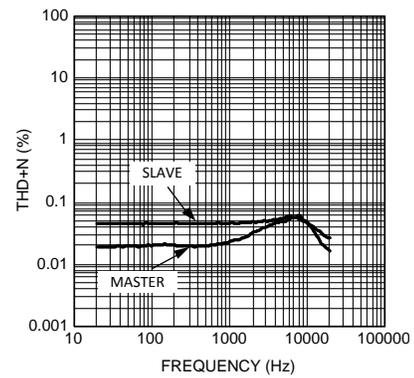


Figure 5. THD+N vs Frequency

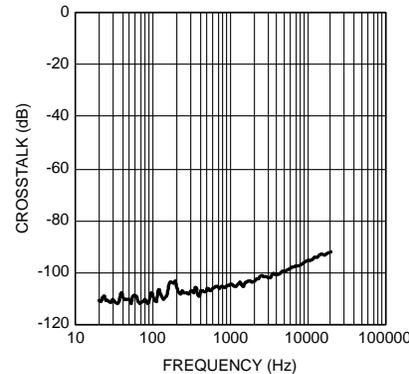


Figure 6. Crosstalk vs Frequency

DIFFERENTIAL AMPLIFIER EXPLANATION

As logic supplies continue to shrink, system designers are increasingly turning to differential analog signal handling to preserve signal to noise ratios with restricted voltage signs. The LM48310 features a fully differential speaker amplifier. A differential amplifier amplifies the difference between the two input signals. Traditional audio power amplifiers have typically offered only single-ended inputs resulting in a 6dB reduction of SNR relative to differential inputs. The LM48310 also offers the possibility of DC input coupling which eliminates the input coupling capacitors. A major benefit of the fully differential amplifier is the improved common mode rejection ratio (CMRR) over single ended input amplifiers. The increased CMRR of the differential amplifier reduces sensitivity to ground offset related noise injection, especially important in noisy systems.

POWER DISSIPATION AND EFFICIENCY

The major benefit of a Class D amplifier is increased efficiency versus a Class AB. The efficiency of the LM48310 is attributed to the region of operation of the transistors in the output stage. The Class D output stage acts as current steering switches, consuming negligible amounts of power compared to their Class AB counterparts. Most of the power loss associated with the output stage is due to the IR loss of the MOSFET on-resistance, along with switching losses due to gate charge.

SHUTDOWN FUNCTION

The LM48310 features a low current shutdown mode. Set $\overline{SD} = GND$ to disable the amplifier and reduce supply current to 0.01 μ A.

Switch \overline{SD} between GND and V_{DD} for minimum current consumption is shutdown. The LM48310 may be disabled with shutdown voltages in between GND and V_{DD} , the idle current will be greater than the typical 0.1 μ A value.

The LM48310 shutdown input has an internal pulldown resistor. The purpose of this resistor is to eliminate any unwanted state changes when \overline{SD} is floating. To minimize shutdown current, \overline{SD} should be driven to GND or left floating. If \overline{SD} is not driven to GND or floating, an increase in shutdown supply current will be noticed.

AUDIO AMPLIFIER POWER SUPPLY BYPASSING/FILTERING

Proper power supply bypassing is critical for low noise performance and high PSRR. Place the supply bypass capacitors as close to the device as possible. Typical applications employ a voltage regulator with 10 μ F and 0.1 μ F bypass capacitors that increase supply stability. These capacitors do not eliminate the need for bypassing of the LM48310 supply pins. A 1 μ F capacitor is recommended.

AUDIO AMPLIFIER INPUT CAPACITOR SELECTION

Input capacitors may be required for some applications, or when the audio source is single-ended. Input capacitors block the DC component of the audio signal, eliminating any conflict between the DC component of the audio source and the bias voltage of the LM48310. The input capacitors create a high-pass filter with the input resistors R_{IN} . The -3dB point of the high pass filter is found using Equation (1) below.

$$f = 1 / 2\pi R_{IN} C_{IN} \quad (1)$$

Where R_{IN} is the value of the input resistor given in the *Electrical Characteristics* table.

The input capacitors can also be used to remove low frequency content from the audio signal. Small speakers cannot reproduce, and may even be damaged by low frequencies. High pass filtering the audio signal helps protect the speakers. When the LM48310 is using a single-ended source, power supply noise on the ground is seen as an input signal. Setting the high-pass filter point above the power supply noise frequencies, 217Hz in a GSM phone, for example, filters out the noise such that it is not amplified and heard on the output. Capacitors with a tolerance of 10% or better are recommended for impedance matching and improved CMRR and PSRR.

AUDIO AMPLIFIER GAIN

The gain of the LM48310 is internally set to 12dB. The gain can be reduced by adding additional input resistance (Figure 6). In this configuration, the gain of the device is given by:

$$A_V = 2 \times [R_F / (R_{INEXT} + R_{IN})] \quad (2)$$

Where R_F is 40k Ω , R_{IN} is 20k Ω , and R_{INEXT} is the value of the additional external resistor.

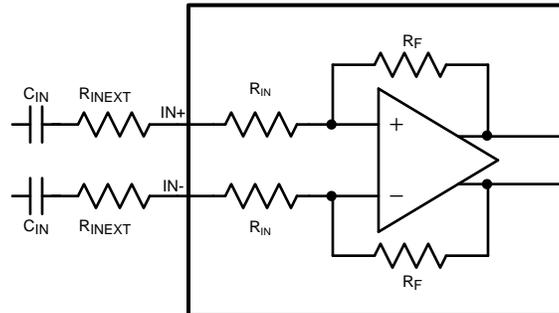


Figure 7. Reduced Gain Configuration

SINGLE-ENDED AUDIO AMPLIFIER CONFIGURATION

The LM48310 is compatible with single-ended sources. When configured for single-ended inputs, input capacitors must be used to block DC component at the input of the device. Figure 7 shows the typical single-ended applications circuit.

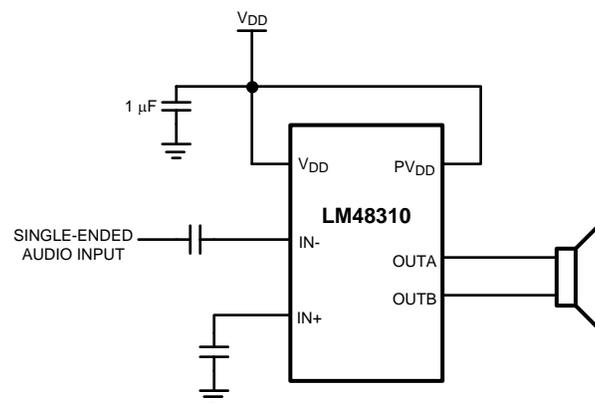


Figure 8. Single-Ended Input Configuration

PCB LAYOUT GUIDELINES

As output power increases, interconnect resistance (PCB traces and wires) between the amplifier, load and power supply create a voltage drop. The voltage loss due to the traces between the LM48310 and the load results in lower output power and decreased efficiency. Higher trace resistance between the supply and the LM48310 has the same effect as a poorly regulated supply, increasing ripple on the supply line, and reducing peak output power. The effects of residual trace resistance increases as output current increases due to higher output power, decreased load impedance or both. To maintain the highest output voltage swing and corresponding peak output power, the PCB traces that connect the output pins to the load and the supply pins to the power supply should be as wide as possible to minimize trace resistance.

The use of power and ground planes will give the best THD+N performance. In addition to reducing trace resistance, the use of power planes creates parasitic capacitors that help to filter the power supply line.

The inductive nature of the transducer load can also result in overshoot on one of both edges, clamped by the parasitic diodes to GND and V_{DD} in each case. From an EMI standpoint, this is an aggressive waveform that can radiate or conduct to other components in the system and cause interference. It is essential to keep the power and output traces short and well shielded if possible. Use of ground planes beads and micro-strip layout techniques are all useful in preventing unwanted interference.

As the distance from the LM48310 and the speaker increases, the amount of EMI radiation increases due to the output wires or traces acting as antennas become more efficient with length. Ferrite chip inductors placed close to the LM48310 outputs may be needed to reduce EMI radiation.

Designator	Quantity	Description
C1	1	10 μ F \pm 10% 16V 500 Ω Tantalum Capacitor (B Case) AVX TPSB106K016R0500
C2, C3	2	1 μ F \pm 10% 16V X7R Ceramic Capacitor (603) Panasonic ECJ-1VB1C105K
C4, C5	2	1 μ F \pm 10% 16V X7R Ceramic Capacitor (1206) Panasonic ECJ-3YB1C105K
C6	1	Not Installed Ceramic Capacitor (603)
R1	1	0 Ω \pm 1% resistor (603)
JP1 — JP2	2	3 Pin Headers
LM48310SDL	1	LM48310SD (10-pin LLP)

LM48310 Demo Board Schematic

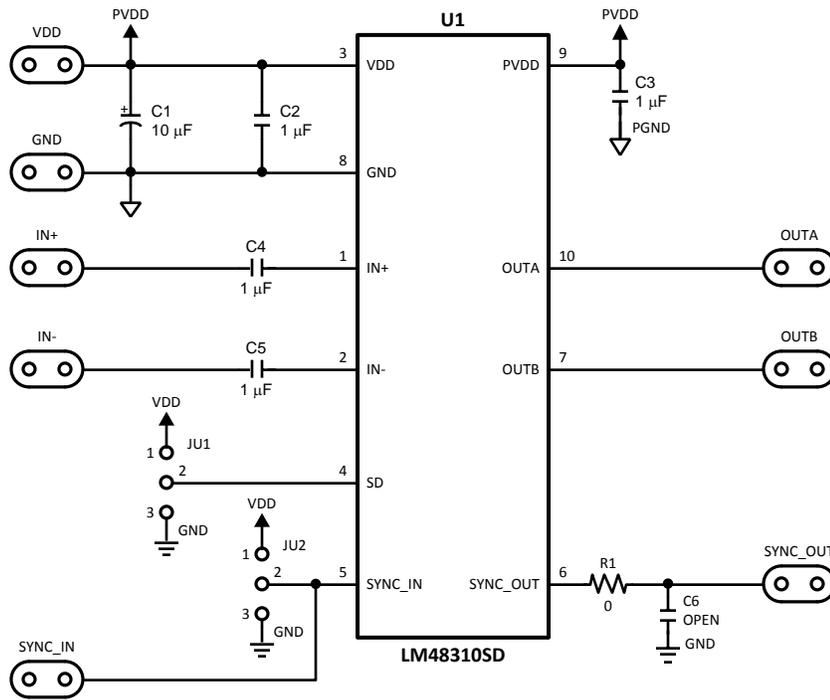


Figure 9. LM48310 DEMO BOARD SCHEMATIC

Demo Boards

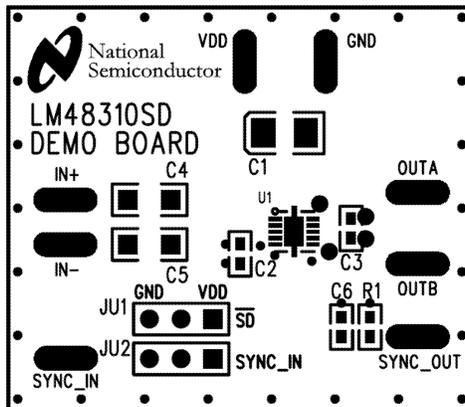


Figure 10. Top Silkscreen

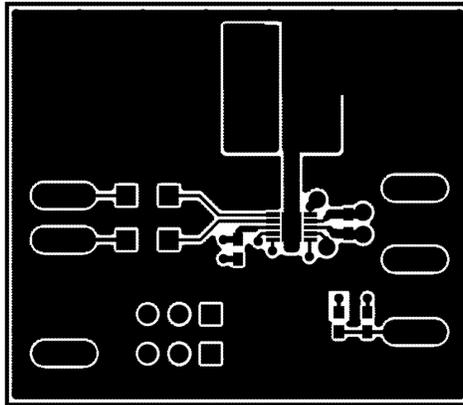


Figure 11. Top Layer

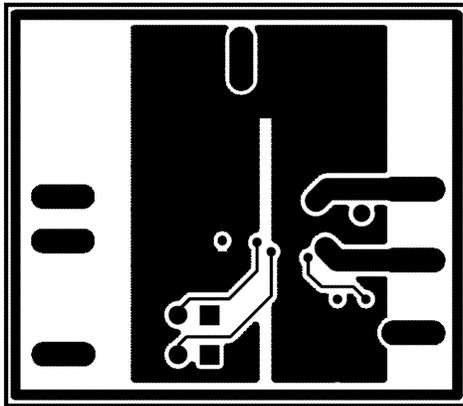


Figure 12. Layer 2 (GND)

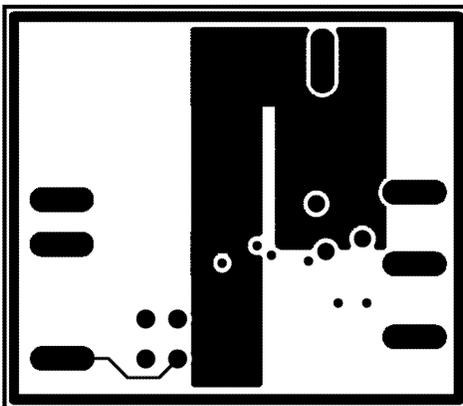


Figure 13. Layer 3 (V_{DD})

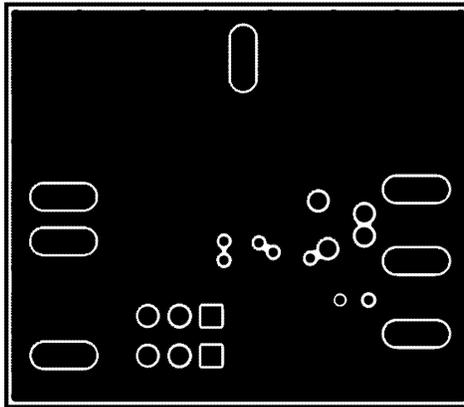


Figure 14. Bottom Layer

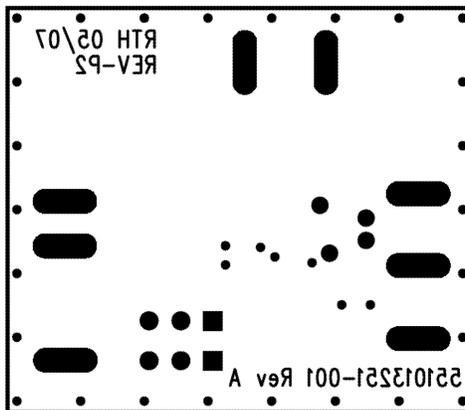


Figure 15. Bottom Silkscreen

Revision History

Rev	Date	Description
1.0	11/13/07	Initial release.
1.01	02/26/08	Fixed few typos (Pin Description table).
1.02	03/04/08	Text edits under SHUTDOWN FUNCTION (Application Information section).
1.03	06/24/09	Text edits.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
LM48310SD/NOPB	ACTIVE	SON	DSC	10	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	G18	Samples
LM48310SDX/NOPB	ACTIVE	SON	DSC	10	4500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	G18	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

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Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) Only one of markings shown within the brackets will appear on the physical device.

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TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM48310SD/NOPB	SON	DSC	10	1000	178.0	12.4	3.3	3.3	1.0	8.0	12.0	Q1
LM48310SDX/NOPB	SON	DSC	10	4500	330.0	12.4	3.3	3.3	1.0	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM48310SD/NOPB	SON	DSC	10	1000	203.0	190.0	41.0
LM48310SDX/NOPB	SON	DSC	10	4500	349.0	337.0	45.0

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