

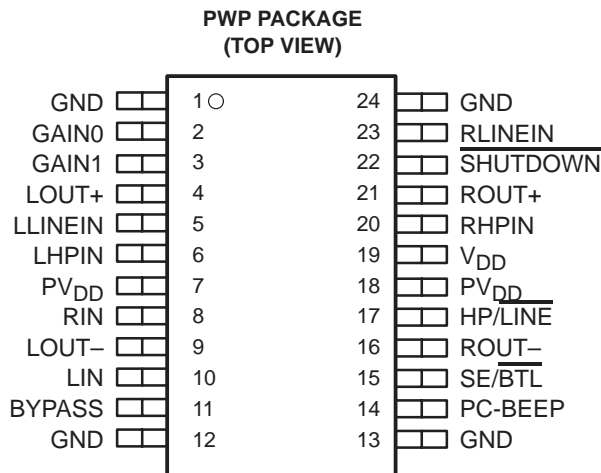
# TPA0312

## 2-W STEREO AUDIO POWER AMPLIFIER

### WITH FOUR SELECTABLE GAIN SETTINGS AND MUX CONTROL

SLOS335–DECEMBER 2000

- Compatible With PC 99 Desktop Line-Out Into 10-k $\Omega$  Load
- Internal Gain Control, Which Eliminates External Gain-Setting Resistors
- 2-W/Ch Output Power Into 3- $\Omega$  Load
- Input MUX Select Terminal
- PC-Beep Input
- Depop Circuitry
- Stereo Input MUX
- Fully Differential Input
- Low Supply Current and Shutdown Current
- Surface-Mount Power Packaging 24-Pin TSSOP PowerPAD™



#### description

The TPA0312 is a stereo audio power amplifier in a 24-pin TSSOP thermally enhanced package capable of delivering 2 W of continuous RMS power per channel into 3- $\Omega$  loads. This device minimizes the number of external components needed, simplifying the design, and freeing up board space for other features. When driving 1 W into 8- $\Omega$  speakers, the TPA0312 has less than 0.8% THD+N across its specified frequency range.

Included within this device is integrated depop circuitry that virtually eliminates transients that cause noise in the speakers.

Amplifier gain is internally configured and controlled by way of two terminals (GAIN0 and GAIN1). BTL gain settings of 6 dB, 10 dB, 15.6 dB, and 21.6 dB (inverting) are provided, while SE gain is always configured as 4.1 dB (inverting) for headphone drive. An internal input MUX allows two sets of stereo inputs to the amplifier. The HP/LINE terminal allows the user to select which MUX input is active, regardless of whether the amplifier is in SE or BTL mode. In notebook applications, where internal speakers are driven as BTL and the line outputs (often headphone drive) are required to be SE, the TPA0312 automatically switches into SE mode when the SE/BTL input is activated, and this reduces the gain to 4.1 dB.

The TPA0312 consumes only 6 mA of supply current during normal operation. A miserly shutdown mode reduces the supply current to less than 150  $\mu$ A.

The PowerPAD™ package (PWP) delivers a level of thermal performance that was previously achievable only in TO-220-type packages. Thermal impedances of approximately 35°C/W are readily realized in multilayer PCB applications. This allows the TPA0312 to operate at full power into 8- $\Omega$  loads at an ambient temperature of 85°C.



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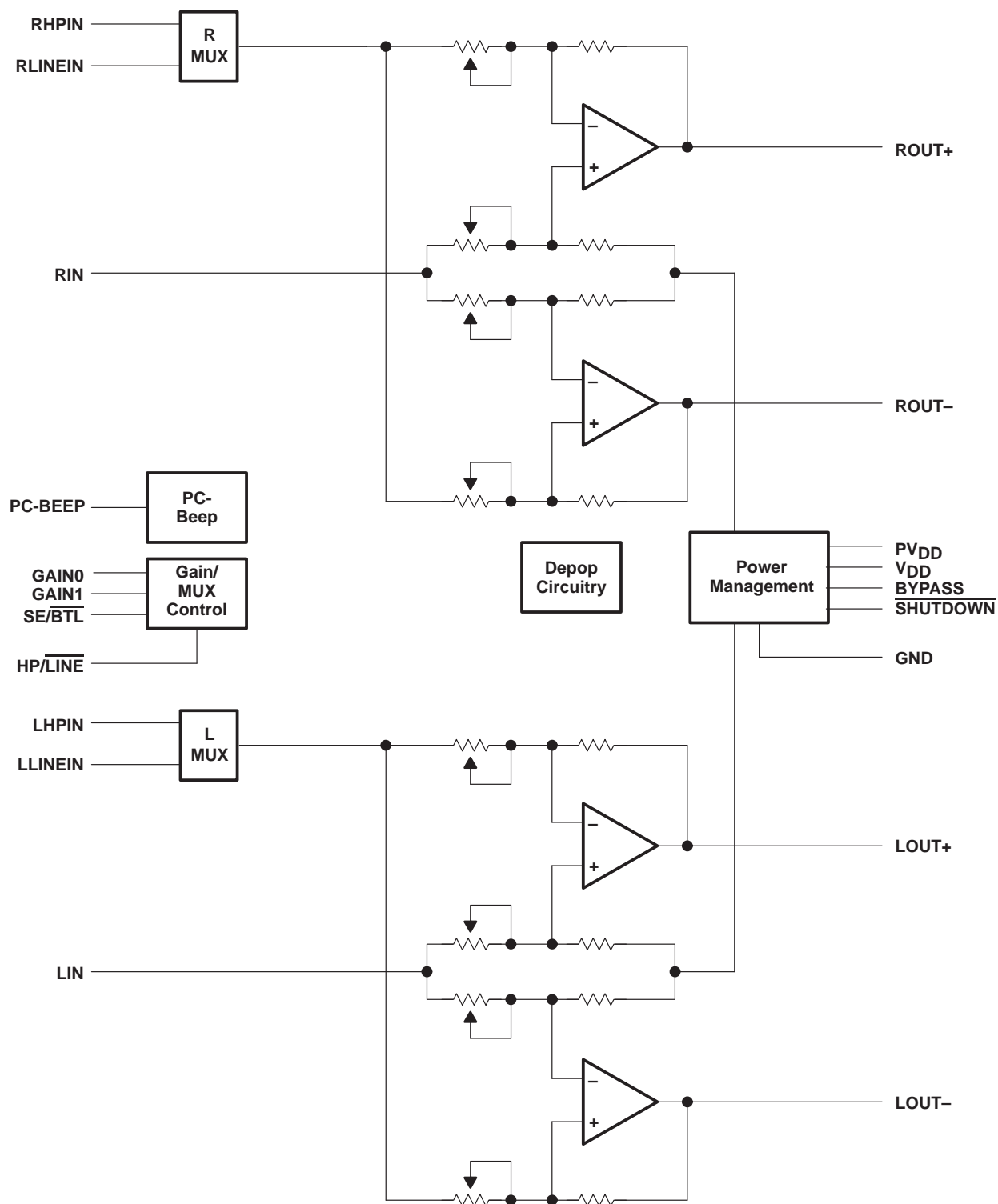
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#### functional block diagram



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## AVAILABLE OPTIONS

T <sub>A</sub>	PACKAGED DEVICE
	TSSOP† (PWP)
–40°C to 85°C	TPA0312PWP

† The PWP package is available taped and reeled. To order a taped and reeled part, add the suffix R to the part number (e.g., TPA0312PWPR).

## Terminal Functions

TERMINAL NAME	NO.	I/O	DESCRIPTION
BYPASS	11		Tap to voltage divider for internal mid-supply bias generator
GAIN0	2	I	Bit 0 of gain control
GAIN1	3	I	Bit 1 of gain control
GND	1, 12, 13, 24		Ground connection for circuitry. Connected to the thermal pad.
LHPIN	6	I	Left channel headphone input, selected when SE/BTL is held high
LIN	10	I	Common left input for fully differential input. AC ground for single-ended inputs.
LLINEIN	5	I	Left channel line input, selected when SE/BTL is held low
LOUT+	4	O	Left channel positive output in BTL mode and positive output in SE mode
LOUT–	9	O	Left channel negative output in BTL mode and high-impedance in SE mode
PC-BEEP	14	I	The input for PC Beep mode. PC-BEEP is enabled when a > 1-V (peak-to-peak) square wave is input to PC-BEEP or PCB ENABLE is high.
HP/LINE	17	I	HP/LINE is the input MUX control input. When the HP/LINE terminal is held high, the headphone inputs (LHPIN or RHPIN [6, 20]) are active. When the HP/LINE terminal is held low, the line BTL inputs (LLINEIN or RLINEIN [5, 23]) are active.
PVDD	7, 18	I	Power supply for output stage
RHPIN	20	I	Right channel headphone input, selected when SE/BTL is held high
RIN	8	I	Common right input for fully differential input. AC ground for single-ended inputs.
RLINEIN	23	I	Right channel line input, selected when SE/BTL is held low
ROUT+	21	O	Right channel positive output in BTL mode and positive output in SE mode
ROUT–	16	O	Right channel negative output in BTL mode and high-impedance in SE mode
SHUTDOWN	22	I	Places entire IC in shutdown mode when held low, except PC-BEEP remains active
SE/BTL	15	I	Hold SE/BTL low for BTL mode and hold high for SE mode.
VDD	19	I	Analog VDD input supply. This terminal needs to be isolated from PVDD to achieve highest performance.



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#### absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>

Supply voltage, $V_{DD}$	6 V
Input voltage, $V_I$	–0.3 V to $V_{DD} + 0.3$ V
Continuous total power dissipation	internally limited (see Dissipation Rating Table)
Operating free-air temperature range, $T_A$	–40°C to 85°C
Operating junction temperature range, $T_J$	–40°C to 150°C
Storage temperature range, $T_{stg}$	–65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°C

<sup>†</sup> Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25^\circ\text{C}$	DERATING FACTOR	$T_A = 70^\circ\text{C}$	$T_A = 85^\circ\text{C}$
PWP	2.7 W <sup>‡</sup>	21.8 mW/°C	1.7 W	1.4 W

<sup>‡</sup> See the Texas Instruments document, *PowerPAD™ Thermally Enhanced Package Application Report* (literature number SLMA002), for more information on the PowerPAD™ package. The thermal data was measured on a PCB layout based on the information in the section entitled *Texas Instruments Recommended Board for PowerPAD™* on page 33 of the before mentioned document.

#### recommended operating conditions

		MIN	MAX	UNIT
Supply voltage, $V_{DD}$		4.5	5.5	V
High-level input voltage, $V_{IH}$	SE/BTL, HP/LINE	4		V
	SHUTDOWN	2		
Low-level input voltage, $V_{IL}$	SE/BTL, HP/LINE		3	V
	SHUTDOWN		0.8	
Operating free-air temperature, $T_A$		–40	85	°C

#### electrical characteristics at specified free-air temperature, $V_{DD} = 5$ V, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$ V_{OO} $ Output offset voltage (measured differentially)	$V_I = 0$ , $A_V = -2$ V/V			25	mV
PSRR Power supply rejection ratio	$V_{DD} = 4$ V to 5 V		77		dB
$ I_{IH} $ High-level input current	$V_{DD} = 5.5$ V, $V_I = V_{DD}$			1	μA
$ I_{IL} $ Low-level input current	$V_{DD} = 5.5$ V, $V_I = 0$ V			1	μA
$I_{DD}$ Supply current	BTL mode		6	10	mA
	SE mode		3	5	
$I_{DD(SD)}$ Supply current, shutdown mode			150	300	μA



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operating characteristics,  $V_{DD} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $R_L = 8\ \Omega$ , Gain =  $-2\text{ V/V}$ , BTL mode

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$P_O$	Output power	THD = 1%, $R_L = 4\ \Omega$ $f = 1\text{ kHz}$ ,		1.9		W
THD + N	Total harmonic distortion plus noise	$P_O = 1\text{ W}$ , $f = 20\text{ Hz to }15\text{ kHz}$		0.75%		
BOM	Maximum output power bandwidth	THD = 5%		>15		kHz
	Supply ripple rejection ratio	$f = 1\text{ kHz}$ , $C_B = 0.47\ \mu\text{F}$ BTL mode		68		dB
SNR	Signal-to-noise ratio			105		dB
$V_n$	Noise output voltage	$C_B = 0.47\ \mu\text{F}$ , BTL mode		16		$\mu\text{V}_{\text{RMS}}$
		$f = 20\text{ Hz to }20\text{ kHz}$ SE mode		30		
$Z_I$	Input impedance		See Table 1			

## TYPICAL CHARACTERISTICS

Table of Graphs

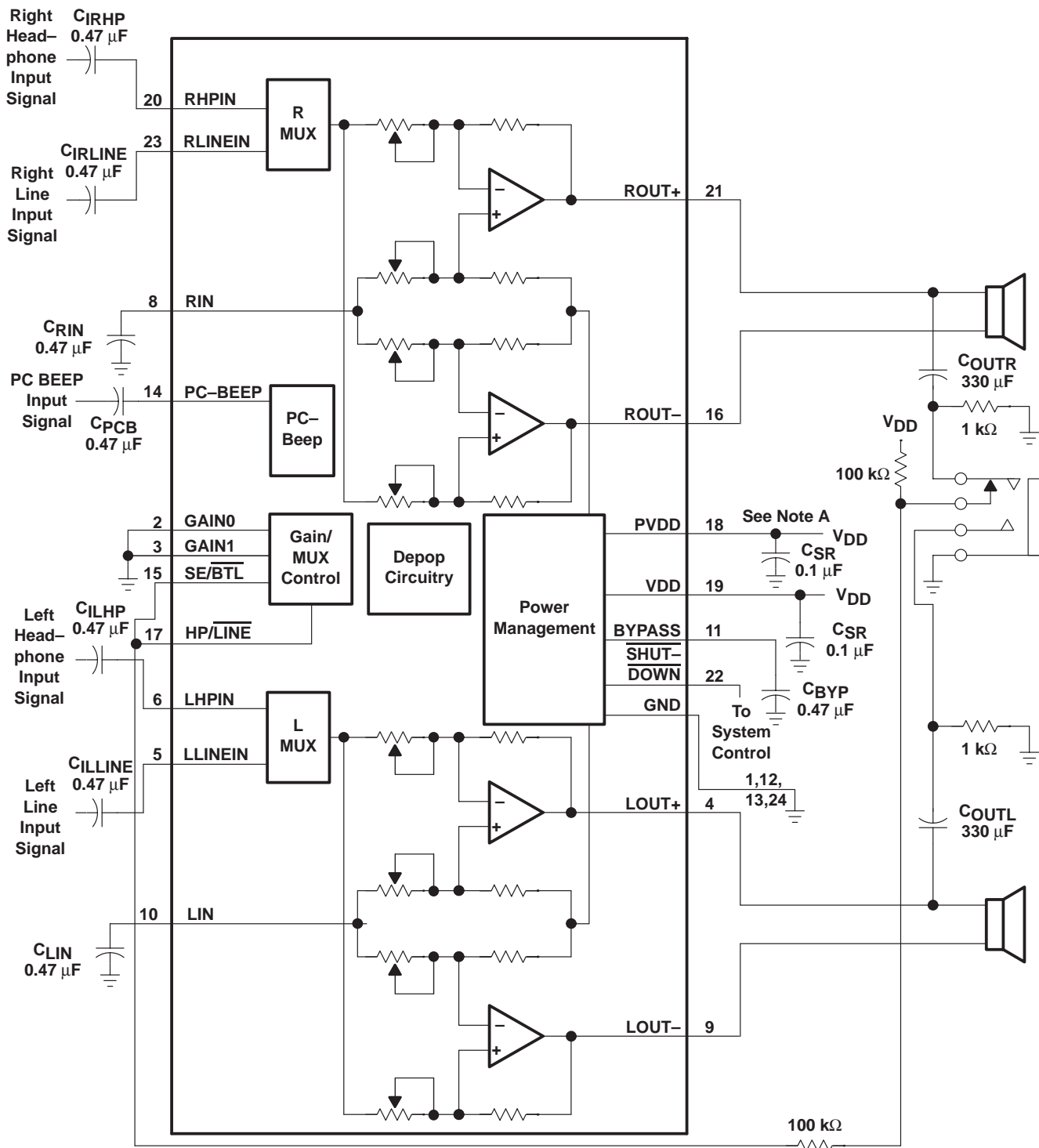
		FIGURE
THD+N	Total harmonic distortion plus noise	vs Output power
		1, 4–6, 9–11, 14–16, 18
		vs Frequency
		2, 3, 7, 8, 12, 13, 17, 19
		vs Output voltage
		20
$V_n$	Output noise voltage	vs Bandwidth
		21
	Supply ripple rejection ratio	vs Frequency
		22, 23
	Crosstalk	vs Frequency
		24, 25
	Shutdown attenuation	vs Frequency
		26
SNR	Signal-to-noise ratio	vs Frequency
		27
	Closed loop response	
		28–30
$P_O$	Output power	vs Load resistance
		31, 32
$P_D$	Power dissipation	vs Output power
		33, 34
		vs Ambient temperature
		35



## APPLICATION INFORMATION

### selection of components

Figure 37 and Figure 38 are schematic diagrams of typical notebook computer application circuits.



NOTE A: A 0.1  $\mu\text{F}$  ceramic capacitor should be placed as close as possible to the IC. For filtering lower-frequency noise signals, a larger electrolytic capacitor of 10  $\mu\text{F}$  or greater should be placed near the audio power amplifier.

**Figure 37. Typical TPA0312 Application Circuit Using Single-Ended Inputs and Input MUX**

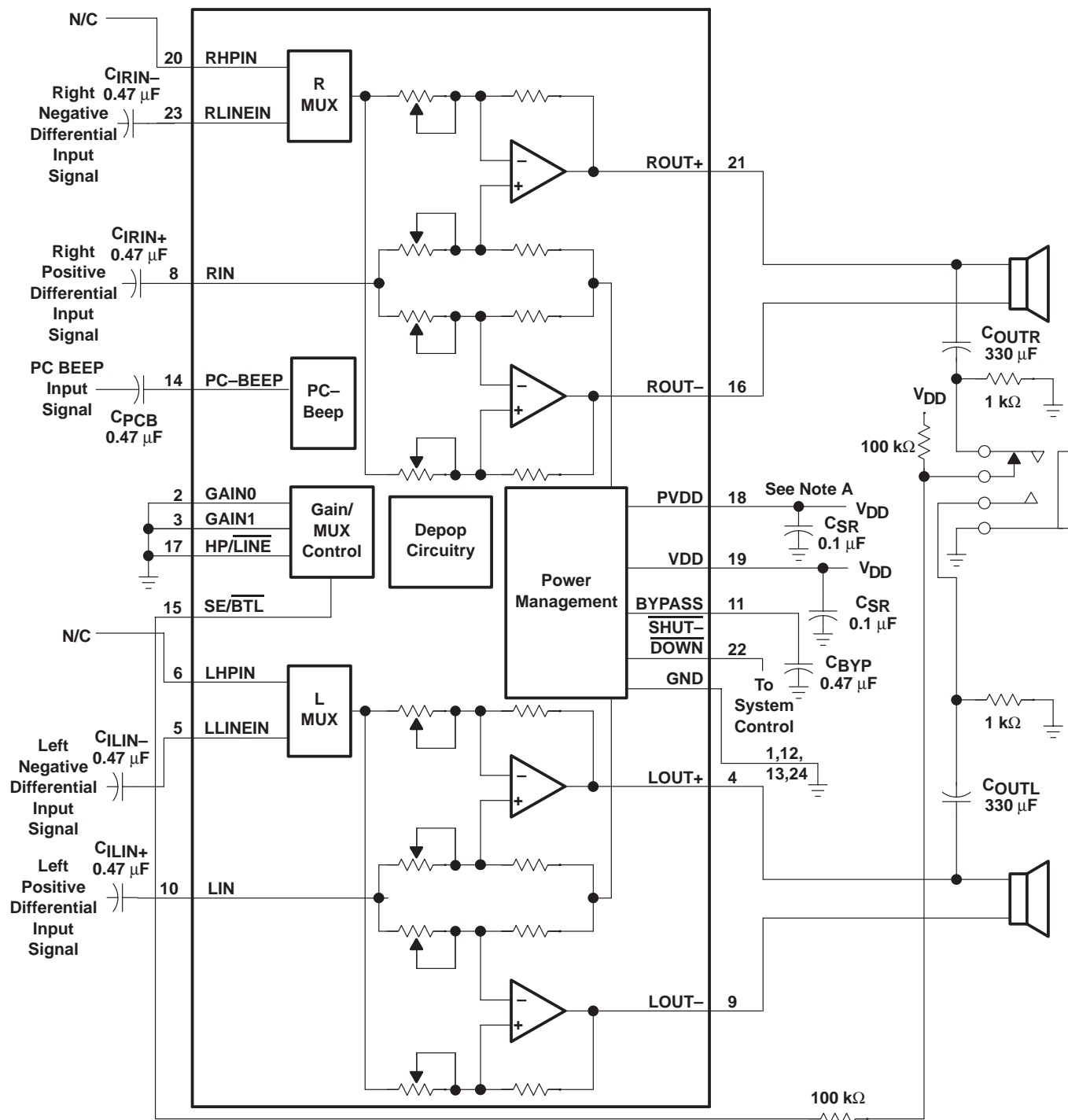
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#### APPLICATION INFORMATION



NOTE A: A 0.1 μF ceramic capacitor should be placed as close as possible to the IC. For filtering lower frequency noise signals, a larger electrolytic capacitor of 10 μF or greater should be placed near the audio power amplifier.

Figure 38. Typical TPA0312 Application Circuit Using Differential Inputs