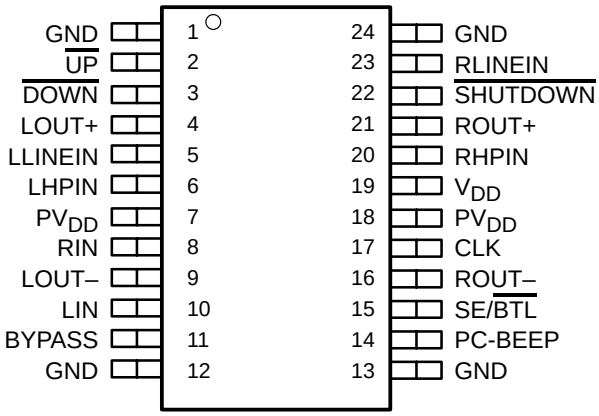
- **Compatible With PC 99 Desktop Line-Out Into 10-kΩ Load**
- **Compatible With PC 99 Portable Into 8-Ω Load**
- **Internal Gain Control, Which Eliminates External Gain-Setting Resistors**
- **Digital Volume Control From 20 dB to –40 dB**
- **2-W/Ch Output Power Into 3-Ω Load**
- **PC-Beep Input**
- **Depop Circuitry**
- **Stereo Input MUX**
- **Fully Differential Input**
- **Low Supply Current and Shutdown Current**
- **Surface-Mount Power Packaging 24-Pin TSSOP PowerPAD™**

PWP PACKAGE
(TOP VIEW)



description

The TPA0162 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-Ω loads. This device minimizes the number of external components needed, which simplifies the design and frees up board space for other features. When driving 1 W into 8-Ω speakers, the TPA0162 has less than 0.22% 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.

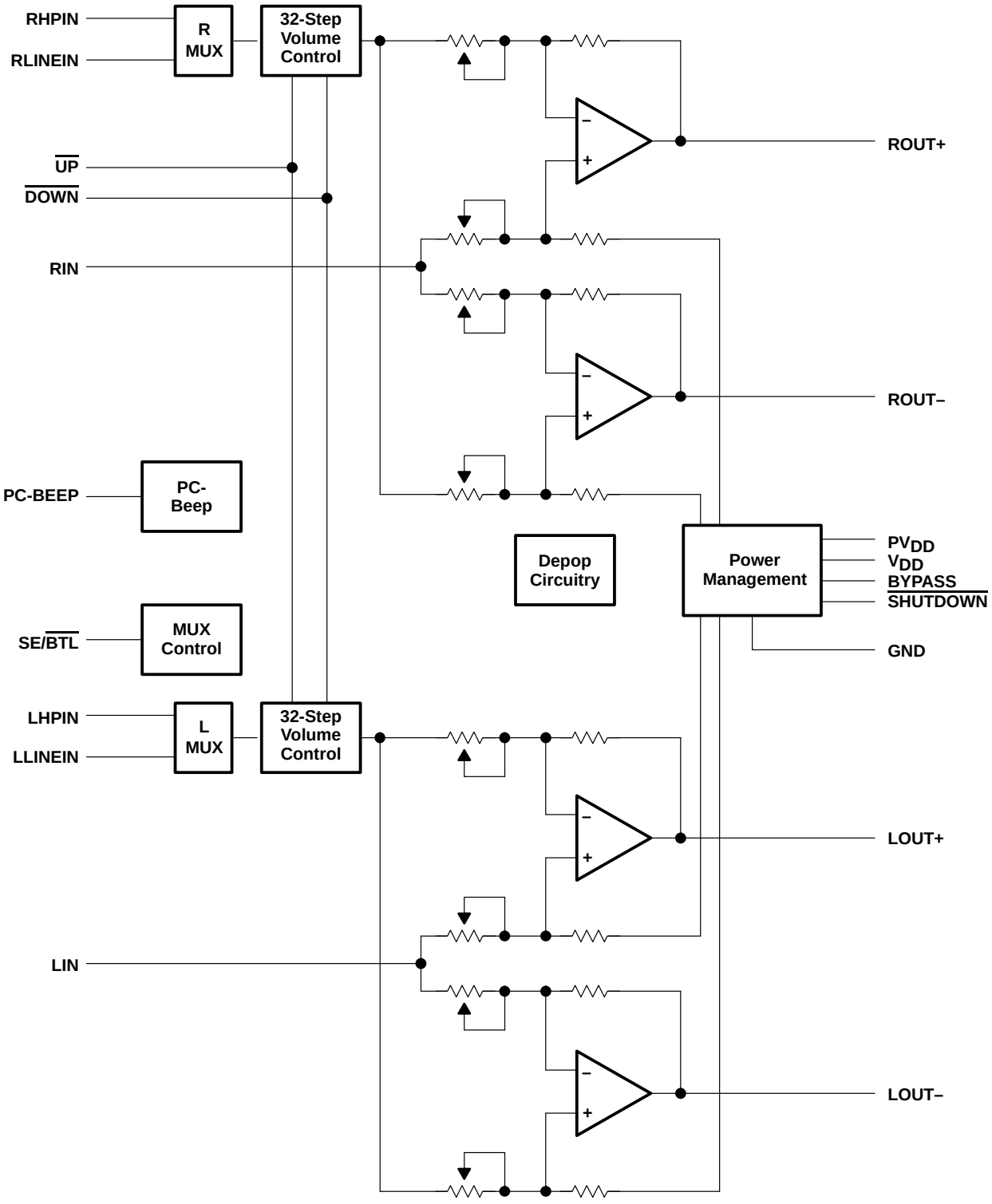
The overall gain of the amplifier is controlled digitally by the UP and DOWN terminals. At power up, the gain is set at the lowest level, –85 dB. It can then be adjusted to any of 31 discrete steps by pulling the voltage down at the desired pin to logic low. The gain is adjusted in the initial stage of the amplifier as opposed to the power output stage. As a result, the THD changes very little over all volume levels.

An internal input MUX allows two sets of stereo inputs to the amplifier. In notebook applications, where internal speakers are driven as BTL and the line outputs (often headphone drive) are required to be SE, the TPA0162 automatically switches into SE mode when the SE/$\overline{\text{BTL}}$ input is activated. This effectively reduces the gain by 6 dB.

The TPA0162 consumes only 20 mA of supply current during normal operation. A shutdown mode is included that reduces the supply current to less than 150 μA.

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 truly realized in multilayer PCB applications. This allows the TPA0162 to operate at full power into 8-Ω loads at ambient temperatures of 85°C.

functional block diagram



AVAILABLE OPTIONS

T_A	PACKAGED DEVICE
	TSSOP† (PWP)
–40°C to 85°C	TPA0162PWP

† 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., TPA0162PWPR).

Terminal Functions

TERMINAL NAME	TERMINAL NO.	I/O	DESCRIPTION
BYPASS	11		Tap to voltage divider for internal mid-supply bias generator
CLK	17	I	If a 47-nF capacitor is attached, the TPA0162 generates an internal clock. An external clock can override the internal clock input to this terminal.
$\overline{\text{DOWN}}$	3	I	A momentary pulse on this terminal decreases the volume level by 2 dB. Holding the terminal low for a period of time will step the amplifier through the volume levels at a rate determined by the capacitor on the CLK terminal.
GND	1, 12 13, 24		Ground connection for circuitry. Connected to thermal pad
LHPIN	6	I	Left-channel headphone input, selected when SE/$\overline{\text{BTL}}$ 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 negative input, selected when SE/$\overline{\text{BTL}}$ is held low
LOUT+	4	O	Left-channel positive output in $\overline{\text{BTL}}$ mode and positive in SE mode
LOUT–	9	O	Left-channel negative output in $\overline{\text{BTL}}$ 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.
PV_{DD}	7, 18	I	Power supply for output stage
RHPIN	20	I	Right channel headphone input, selected when SE/$\overline{\text{BTL}}$ 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/$\overline{\text{BTL}}$ is held low.
ROUT+	21	O	Right-channel positive output in $\overline{\text{BTL}}$ mode and positive in SE mode
ROUT–	16	O	Right-channel negative output in $\overline{\text{BTL}}$ mode and high impedance in SE mode
SE/$\overline{\text{BTL}}$	15	I	Input and output MUX control. When this terminal is held high, the LHPIN or RHPIN and SE output is selected. When this terminal is held low, the LLINEIN or RLINEIN and $\overline{\text{BTL}}$ output are selected.
$\overline{\text{SHUTDOWN}}$	22	I	When held low, this terminal places the entire device, except PC-BEEP detect circuitry, in shutdown mode.
$\overline{\text{UP}}$	2	I	A momentary pulse on this terminal increases the volume level by 2 dB. Holding the terminal low for a period of time will step the amplifier through the volume levels at a rate determined by the capacitor on the CLK terminal.
V_{DD}	19	I	Analog V_{DD} input supply. This terminal needs to be isolated from PV_{DD} to achieve highest performance.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

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

† 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	$T_A \le 25°C$	DERATING FACTOR	$T_A = 70°C$	$T_A = 85°C$
PWP	2.7 W‡	21.8 mW/°C	1.7 W	1.4 W

‡ 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/$\overline{\text{BTL}}$	4		V
	$\overline{\text{SHUTDOWN}}$	2		
	$\overline{\text{UP}}$, $\overline{\text{DOWN}}$	0.5		
Low-level input voltage, V_{IL}	SE/$\overline{\text{BTL}}$		3	V
	$\overline{\text{SHUTDOWN}}$		0.8	
	$\overline{\text{UP}}$, $\overline{\text{DOWN}}$		4	
Operating free-air temperature, T_A		–40	85	°C

electrical characteristics at specified free-air temperature, V_{DD} = 5 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$\|V_{OO}\|$	Output offset voltage (measured differentially)	V_I = 0 V, A_V = 2 V/V			25	mV
PSRR	Power supply rejection ratio	V_{DD} = 4.9 V to 5.1 V		67		dB
$\|I_{IH}\|$	High-level input current	V_{DD} = 5.5 V, V_I = V_{DD}			900	nA
$\|I_{IL}\|$	Low-level input current	V_{DD} = 5.5 V, V_I = 0 V			900	nA
I_{DD}	Supply current	BTL mode		20		mA
		SE mode		10		
$I_{DD(SD)}$	Supply current, shutdown mode			150	300	μA

operating characteristics, V_{DD} = 5 V, T_A = 25°C, R_L = 4 Ω, Gain = 2 V/V, BTL mode (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
P_O	Output power	THD = 1%, f = 1 kHz			2		W
THD+N	Total harmonic distortion plus noise	P_O = 1 W, f = 20 Hz to 15 kHz			0.22%		
B_{OM}	Maximum output power bandwidth	THD = 5%			>15		kHz
	Supply ripple rejection ratio	f = 1 kHz, $C_{(BYP)}$ = 0.47 μF	BTL mode		65		dB
			SE mode		60		
V_n	Noise output voltage	$C_{(BYP)}$ = 0.47 μF, f = 20 Hz to 20 kHz	BTL mode		17		μV_{RMS}
			SE mode		44		

TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
THD+N	Total harmonic distortion plus noise	vs Output power	1, 4, 6, 8, 10
		vs Voltage gain	2
		vs Frequency	3, 5, 7, 9, 11
		vs Output voltage	12
V_n	Output noise voltage	vs Bandwidth	13
	Supply ripple rejection ratio	vs Frequency	14, 15
	Crosstalk	vs Frequency	16, 17, 18
	Shutdown attenuation	vs Frequency	19
SNR	Signal-to-noise ratio	vs Bandwidth	20
	Closed loop response		21, 22
P_O	Output power	vs Load resistance	23, 24
P_D	Power dissipation	vs Output power	25, 26
		vs Ambient temperature	27
Z_i	Input impedance	vs Gain	28

APPLICATION INFORMATION

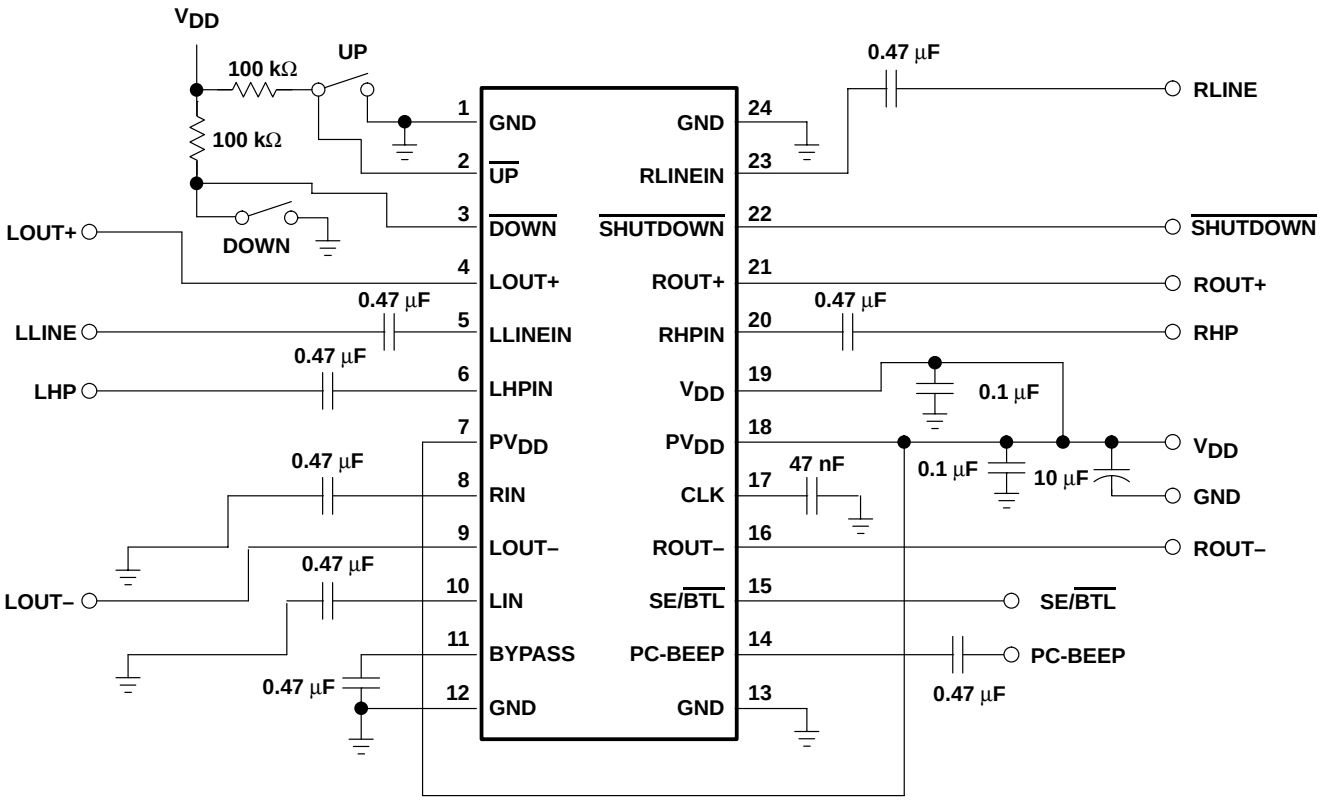
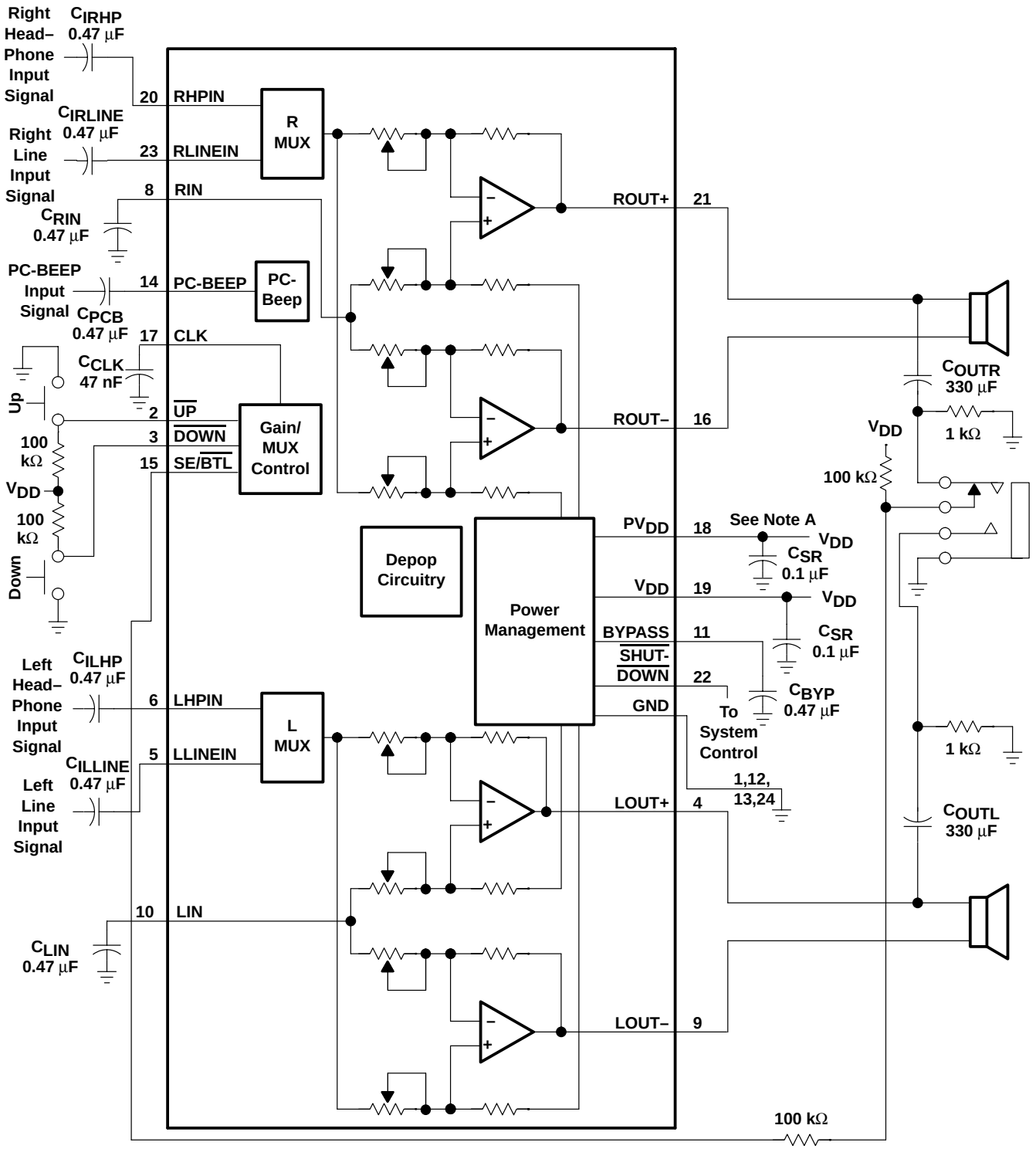


Figure 29. Typical TPA0162 Application Circuit

selection of components

Figure 30 and Figure 31 are schematic diagrams of typical notebook computer application circuits.

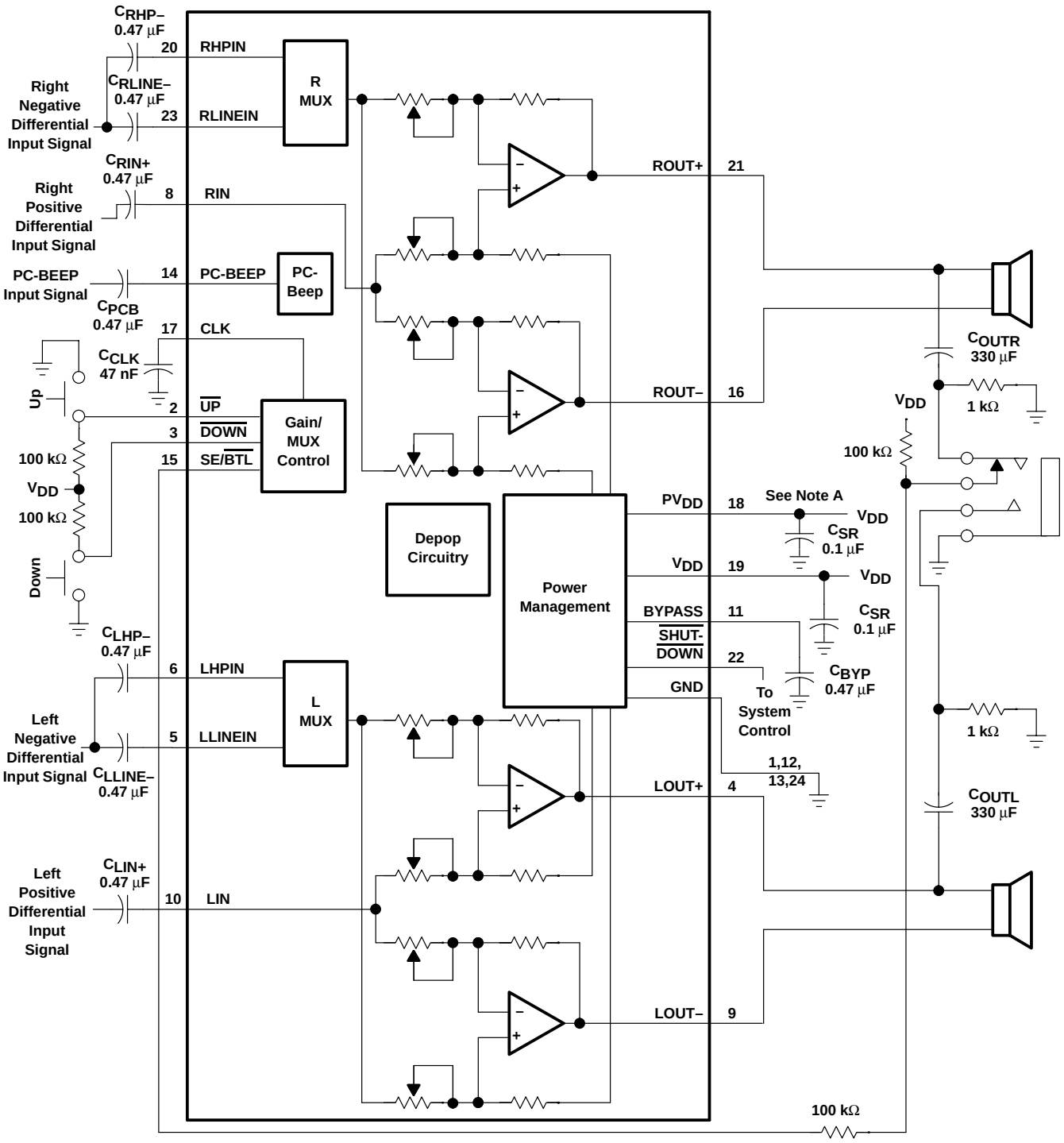
APPLICATION INFORMATION



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 30. Typical TPA0162 Application Circuit Using Single-Ended Inputs and Input MUX

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 31. Typical TPA0162 Application Circuit Using Differential Inputs