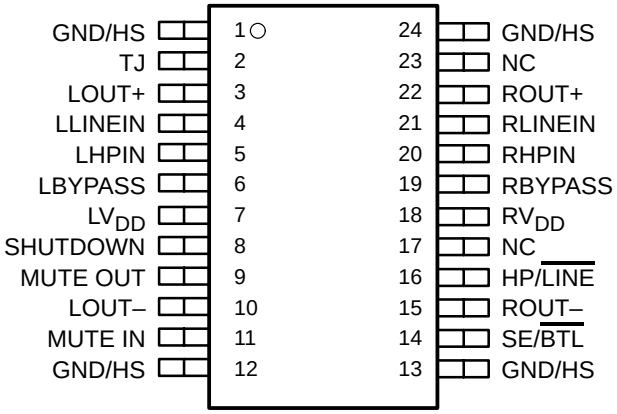
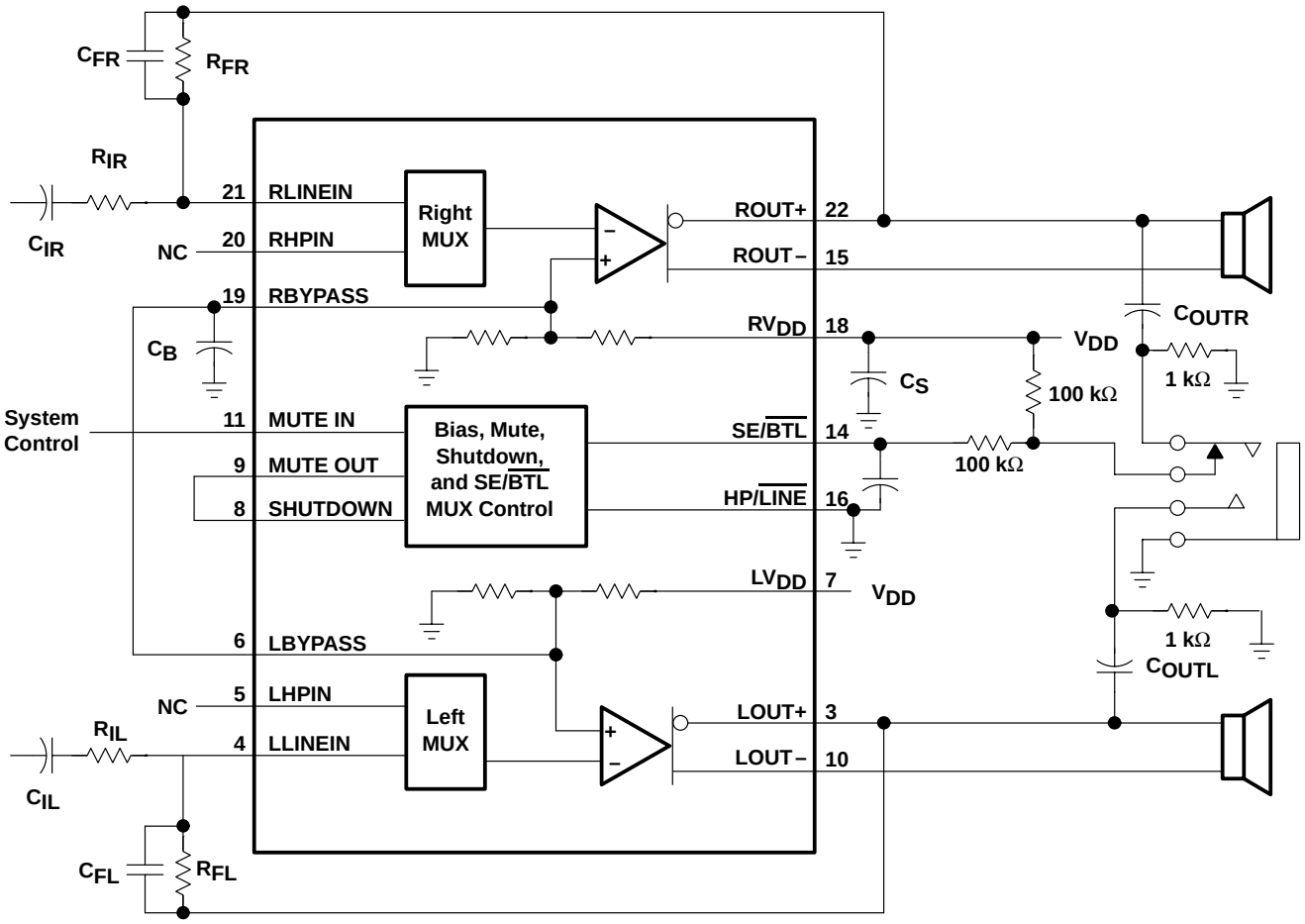
- **Integrated Depop Circuitry**
- **High Power with PC Power Supply**
  - **2 W/Ch at 5 V into a 3-Ω Load**
  - **800 mW/Ch at 3 V**
- **Fully Specified for Use With 3-Ω Loads**
- **Ultra-Low Distortion**
  - **0.05% THD+N at 2 W and 3-Ω Load**
- **Bridge-Tied Load (BTL) or Single-Ended (SE) Modes**
- **Stereo Input MUX**
- **Surface-Mount Power Package**
  24-Pin TSSOP PowerPAD™
- **Shutdown Control . . . I_{DD} = 5 μA**

PWP PACKAGE
(TOP VIEW)





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description

The TPA0202 is a stereo audio power amplifier in a 24-pin TSSOP thermal package capable of delivering greater than 2 W of continuous RMS power per channel into 3-Ω loads. The TPA0202 simplifies design and frees up board space for other features. Full power distortion levels of less than 0.1% THD+N from a 5-V supply are typical. Low-voltage applications are also well served by the TPA0202 providing 800-mW per channel into 3-Ω loads with a 3.3-V supply voltage.

The TPA0202 has integrated depop circuitry that virtually eliminates transients that cause noise in the speakers during power up and when using the mute and shutdown modes.

Amplifier gain is externally configured by means of two resistors per input channel and does not require external compensation for settings of 2 to 20 in BTL mode (1 to 10 in SE mode). 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 (often headphone drive) outputs are required to be SE, the TPA0202 automatically switches into SE mode when the SE/$\overline{\text{BTL}}$ input is activated. Using the TPA0202 to drive line outputs up to 700 mW/channel into external 3-Ω loads is ideal for small non-powered external speakers in portable multimedia systems. The TPA0202 also features a shutdown function for power sensitive applications, holding the supply current at 5 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 readily realized in multilayer PCB applications. This allows the TPA0202 to operate at full power into 3-Ω loads at ambient temperature of up to 85°C with 300 CFM of forced-air cooling. Into 8-Ω loads, the operating ambient temperature increases to 100°C.

AVAILABLE OPTIONS

T_A	PACKAGE
	TSSOP‡ (PWP)
–40°C to 85°C	TPA0202PWP

‡ The PWP packages are available taped and reeled. To order a taped and reeled part, add the suffix R (e.g., TPA0202PWPR).

† See Texas Instruments document, *PowerPAD Thermally Enhanced Package Application Report* (Literature Number SLMA002) for more information on the PowerPAD package.

Terminal Functions

TERMINAL NAME	TERMINAL NO.	I/O	DESCRIPTION
GND/HS	1, 12, 13, 24		Ground connection for circuitry, directly connected to thermal pad
HP/$\overline{\text{LINE}}$	16	I	Input MUX control input, hold high to select LHP IN or RHP IN (5, 20), hold low to select LLINE IN or RLINE IN (4, 21)
LBYPASS	6		Tap to voltage divider for left channel internal mid-supply bias
LHP IN	5	I	Left channel headphone input, selected when HP/$\overline{\text{LINE}}$ terminal (16) is held high
LLINE IN	4	I	Left channel line input, selected when HP/$\overline{\text{LINE}}$ terminal (16) is held low
LOUT+	3	O	Left channel + output in BTL mode, + output in SE mode
LOUT–	10	O	Left channel – output in BTL mode, high-impedance state in SE mode
LV_{DD}	7	I	Supply voltage input for left channel and for primary bias circuits
MUTE IN	11	I	Mute all amplifiers, hold low for normal operation, hold high to mute
MUTE OUT	9	O	Follows MUTE IN terminal (11), provides buffered output
NC	17, 23		No internal connection
RBYPASS	19		Tap to voltage divider for right channel internal mid–supply bias
RHPIN	20	I	Right channel headphone input, selected when HP/$\overline{\text{LINE}}$ terminal (16) is held high
RLINEIN	21	I	Right channel line input, selected when HP/$\overline{\text{LINE}}$ terminal (16) is held low
ROUT+	22	O	Right channel + output in BTL mode, + output in SE mode
ROUT–	15	O	Right channel – output in BTL mode, high impedance state in SE mode
RV_{DD}	18	I	Supply voltage input for right channel
SE/$\overline{\text{BTL}}$	14	I	Hold low for BTL mode, hold high for SE mode
SHUTDOWN	8	I	Places entire IC in shutdown mode when held high, I_{DD} = 5 μA
TJ	2	O	Sources a current proportional to the junction temperature. This terminal should be left unconnected during normal operation. For more information, see the *junction temperature measurement* section of this document.

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

‡ Please 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	NOM	MAX	UNIT
Supply Voltage, V_{DD}			3	5	5.5	V
Operating free-air temperature, T_A	V_{DD} = 5 V, 250 mW/ch average power,	4-Ω stereo BTL drive, with proper PCB design	–40		85	°C
	V_{DD} = 5 V, 2 W/ch average power,	3-Ω stereo BTL drive, with proper PCB design and 300 CFM forced-air cooling	–40		85	
Common mode input voltage, V_{ICM}	V_{DD} = 5 V		1.25		4.5	V
	V_{DD} = 3.3 V		1.25		2.7	

dc electrical characteristics, T_A = 25°C

PARAMETER		TEST CONDITIONS			TYP†	MAX	UNIT
I_{DD}	Supply current	V_{DD} = 5 V	Stereo BTL		19	30	mA
			Stereo SE		9	18	mA
			Mono BTL		9	18	mA
			Mono SE		3	10	mA
		V_{DD} = 3.3 V	Stereo BTL		13	20	mA
			Stereo SE		5	10	mA
			Mono BTL		5	10	mA
			Mono SE		3	6	mA
V_{OO}	Output offset voltage (measured differentially)	V_{DD} = 5 V,	Gain = 2,	See Note 1	5	25	mV
$I_{DD(MUTE)}$	Supply current in mute mode	V_{DD} = 5 V			1.5		mA
$I_{DD(SD)}$	I_{DD} in shutdown	V_{DD} = 5 V			5	20	μA

NOTE 1: At 3 V < V_{DD} < 5 V the dc output voltage is approximately $V_{DD}/2$.

ac operating characteristics, V_{DD} = 5 V, T_A = 25°C, R_L = 3 Ω (unless otherwise noted)

PARAMETER		TEST CONDITIONS			TYP	MAX	UNIT
P_O	Output power (each channel) see Note 2	THD = 0.2%,	BTL,	See Figure 3	2		W
		THD = 1%,	BTL,	See Figure 3	2.2		
THD+N	Total harmonic distortion plus noise	P_o = 2W,	f = 20 – 20 kHz,	See Figure 5	200		m%
		V_I = 1 V,	R_L = 10 kΩ,	A_V = 1 V/V	100		m%
B_{OM}	Maximum output power bandwidth	A_V = 10 V/V	THD < 1 %,	See Figure 5	>20		kHz
	Phase margin	R_L = 4 Ω,	Open Loop,	See Figure 43	85°		
	Supply ripple rejection ratio	f = 1 kHz,	See Figure 37		80		dB
		f = 20 – 20 kHz,	See Figure 37		60		
	Mute attenuation				85		dB
	Channel-to-channel output separation	f = 1 kHz,	See Figure 39		85		dB
	Line/HP input separation				100		dB
	BTL attenuation in SE mode				100		dB
Z_I	Input impedance				2		MΩ
	Signal-to-noise ratio	P_o = 500 mW,	BTL		95		dB
V_n	Output noise voltage	See Figure 35			21		μV(rms)

NOTE 2: Output power is measured at the output terminals of the IC at 1 kHz.

ac operating characteristics, V_{DD} = 3.3 V, T_A = 25°C, R_L = 3 Ω

PARAMETER		TEST CONDITIONS			TYP	MAX	UNIT
P_O	Output power (each channel) see Note 2	THD = 0.2%,	BTL,	See Figure 10	800		mW
		THD = 1%,	BTL,	See Figure 10	900		
THD+N	Total harmonic distortion plus noise	P_o = 800 mW,	f = 20 – 20 kHz,	See Figure 11	350		m%
		V_I = 1 V,	R_L = 10 kΩ,	A_V = 1 V/V	200		m%
B_{OM}	Maximum output power bandwidth	A_V = 10 V/V	THD < 1 %,	See Figure 11	>20		kHz
	Phase margin	R_L = 4 Ω,	Open Loop,	See Figure 44	85°		
	Supply ripple rejection ratio	f = 1 kHz,	See Figure 37		70		dB
		f = 20 – 20 kHz,	See Figure 37		55		
	Mute attenuation				85		dB
	Channel-to-channel output separation	f = 1 kHz,	See Figure 40		85		dB
	Line/HP input separation				100		dB
	BTL attenuation in SE mode				100		dB
Z_I	Input impedance				2		MΩ
	Signal-to-noise ratio	P_o = 500 mW,	BTL		95		dB
V_n	Output noise voltage	See Figure 37			21		μV(rms)

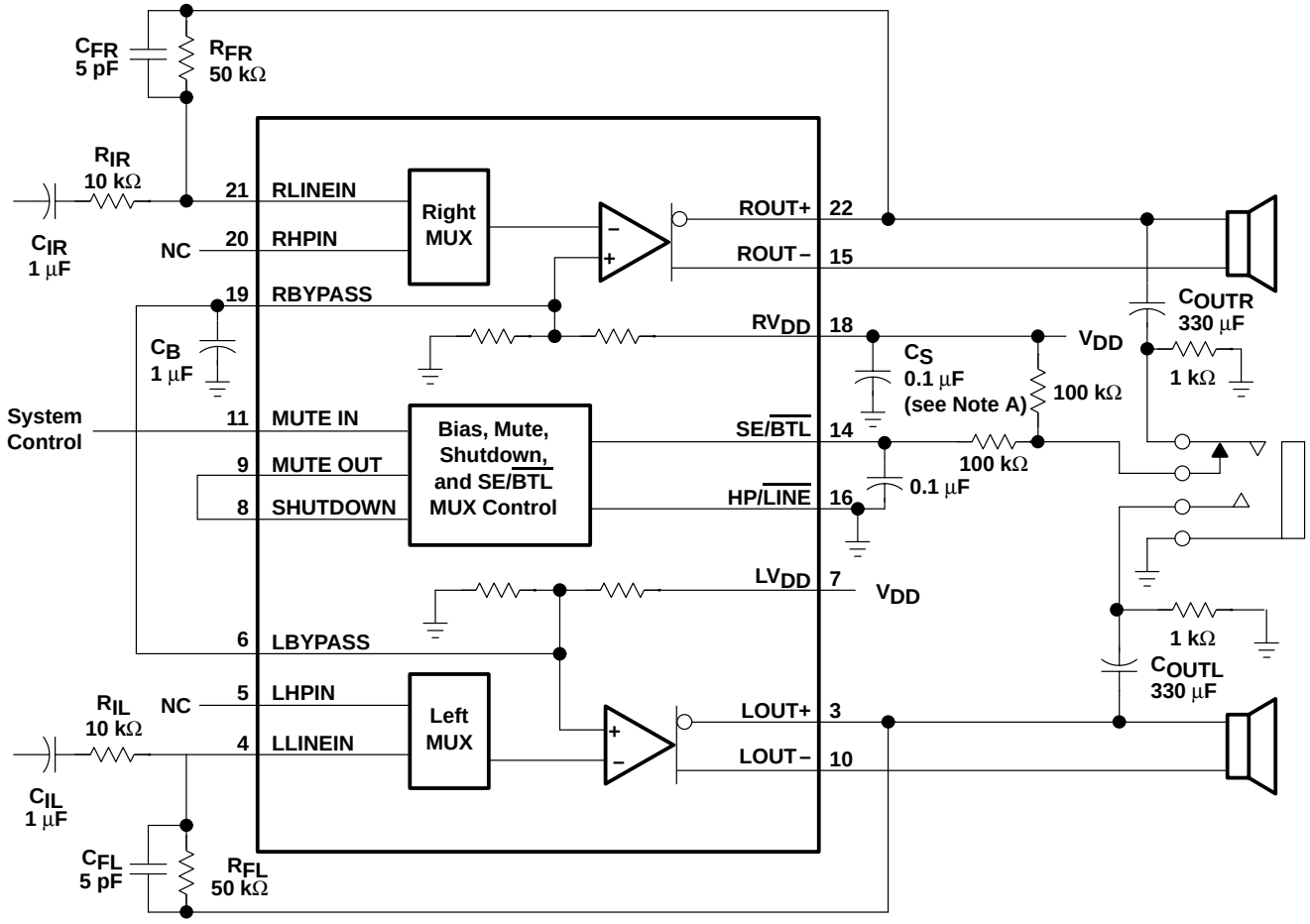
NOTE 2: Output power is measured at the output terminals of the IC at 1 kHz.

APPLICATION INFORMATION

For example, if the 5-V supply is replaced with a 3.3-V supply (TPA0202 has a maximum recommended V_{DD} of 5.5 V) in the calculations of Table 1, then efficiency at 0.5 W would rise from 44% to 67% and internal power dissipation would fall from 0.62 W to 0.25 W at 5 V. Then for a stereo 0.5-W system from a 3.3-V supply, the maximum draw would only be 1.5 W as compared to 2.24 W from 5 V. In other words, use the efficiency analysis to choose the correct supply voltage and speaker impedance for the application.

selection of components

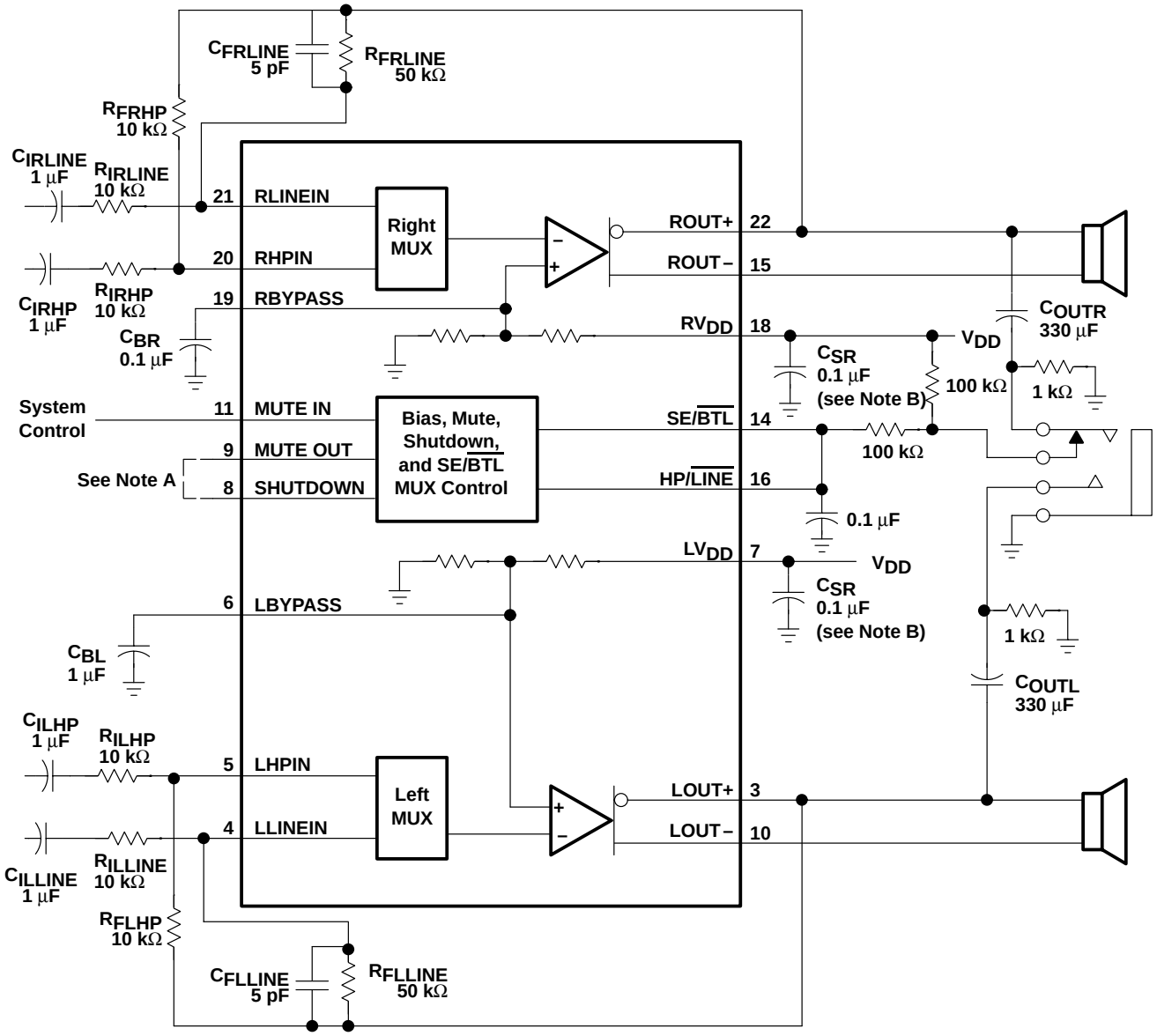
Figure 62 and Figure 63 are a schematic diagrams of a typical notebook computer application circuits.



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 aluminum electrolytic capacitor of 10 μF or greater should be placed near the audio power amplifier.

Figure 62. TPA0202 Minimum Configuration Application Circuit

APPLICATION INFORMATION



NOTES: A. This connection is for ultra-low current in shutdown mode.
B. A 0.1 μF ceramic capacitor should be placed as close as possible to the IC. For filtering lower-frequency noise signals, a larger aluminum electrolytic capacitor of 10 μF or greater should be placed near the audio power amplifier.

Figure 63. TPA0202 Full Configuration Application Circuit