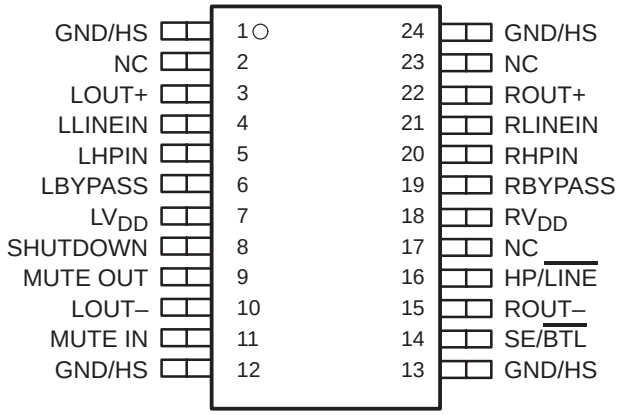
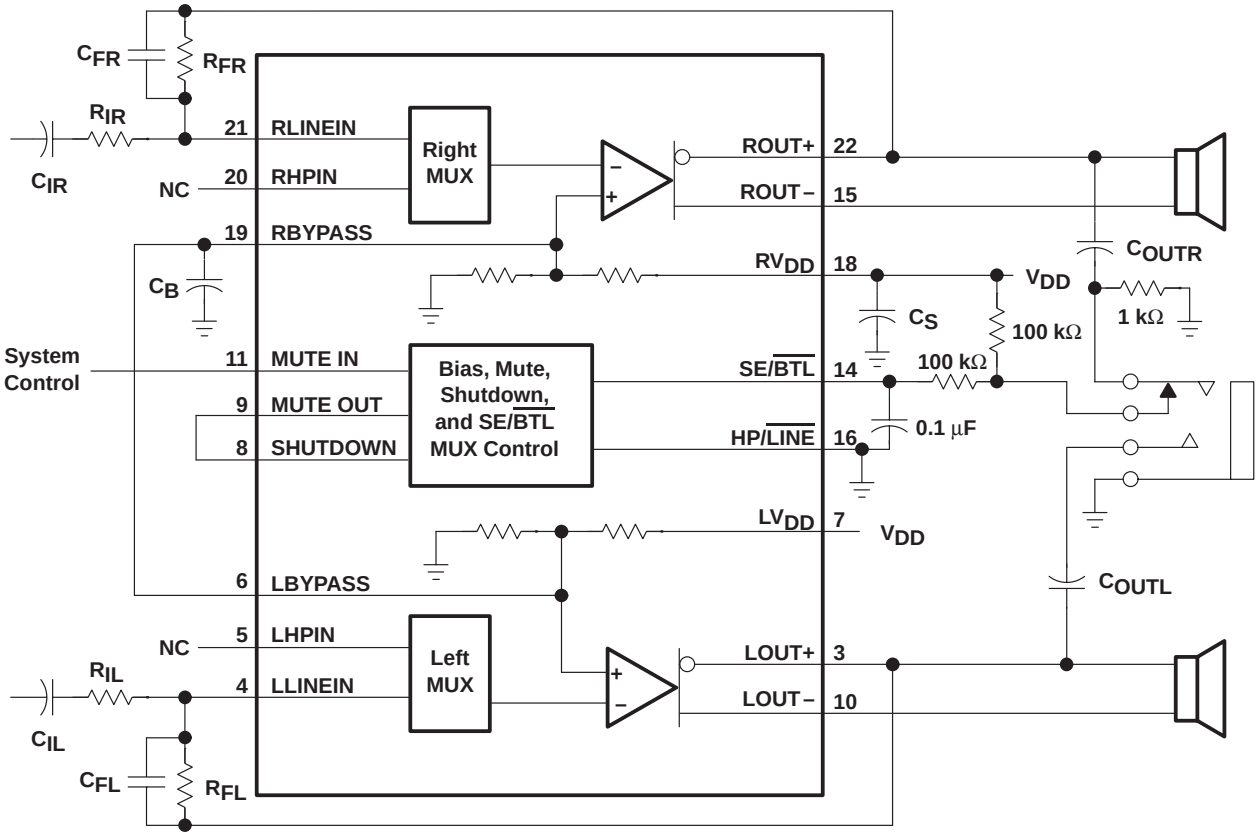
- **High Power with PC Power Supply**
  - **1.5 W/Ch at 5 V**
  - **600 mW/Ch at 3 V**
- **Ultra-Low Distortion**
  < 0.05% THD+N at 1.5 W and 4-Ω Load
- **Bridge-Tied Load (BTL) or Single Ended (SE) Modes**
- **Stereo Input MUX**
- **Surface-Mount Power Package**
  24-Pin TSSOP PowerPAD™
- **Shutdown Control . . . I_{DD} < 10 μA**

PWP PACKAGE
(TOP VIEW)





description

The TPA0102 is a stereo audio power amplifier in a 24-pin TSSOP thermal package capable of delivering greater than 1.5 W of continuous RMS power per channel into 4-Ω loads. This device functionality provides a very efficient upgrade path from the TPA4860 and TPA4861 mono amplifiers where three separate devices are required for stereo applications: two for speaker drive, plus a third for headphone drive. The TPA0102 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. This provides significant improvement in fidelity for speech and music over the popular TPA4860/61 series. Low-voltage applications are also well served by the TPA0102 providing 600-mW per channel into 4-Ω loads with a 3.3-V supply voltage.

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 TPA0102 automatically switches into SE mode when the SE/$\overline{\text{BTL}}$ input is activated. Using the TPA0102 to drive line outputs up to 500 mW/channel into external 4 Ω loads is ideal for small non-powered external speakers in portable multimedia systems. The TPA0102 also features a shutdown function for power sensitive applications, holding the supply current below 5 μA. In speakerphone or other monaural applications, the TPA0102 is configured through the power supply terminals to activate only half of the amplifier which reduces supply current by approximately one-half over stereo applications.

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 TPA0102 to operate at full power into 4-Ω loads at ambient temperature of up to 55°C. Into 8-Ω loads, the operating ambient temperature increases to 100°C.

AVAILABLE OPTIONS

T_A	PACKAGE
	TSSOP (PWP)
40°C to 85°C	TPA0102PWP

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 L/RHPIN (5, 20), hold low to select L/RLINEIN (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	2, 17, 23		No internal connection
RBYPASS	19		Tap to voltage divider for right channel internal mid–supply bias
RHP IN	20	I	Right channel headphone input, selected when HP/$\overline{\text{LINE}}$ terminal (16) is held high
RLINE IN	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, $I_{DD} < 1\ \mu A$

PARAMETER MEASUREMENT INFORMATION

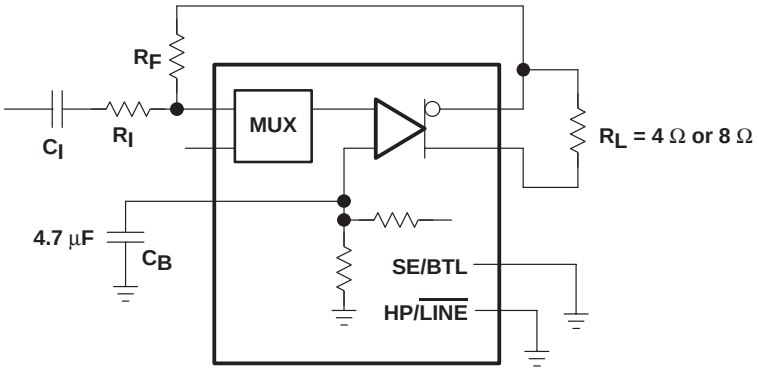


Figure 1. BTL Test Circuit

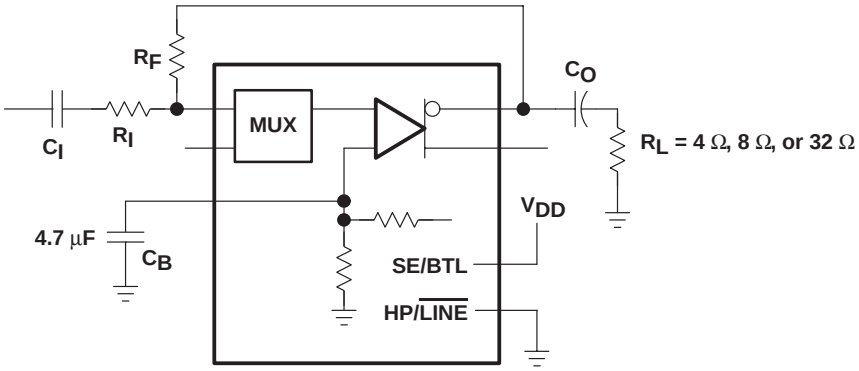


Figure 2. SE Test Circuit

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, 1.5 W/ch average power,	4-Ω stereo BTL drive, With proper PCB design	–40		55	
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	25	mA
			Stereo SE		9	15	mA
			Mono BTL		9	15	mA
			Mono SE		3	10	mA
		V_{DD} = 3.3 V	Stereo BTL		13	20	mA
			Stereo SE		3	10	mA
			Mono BTL		3	10	mA
			Mono SE		3	10	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			800		µA
$I_{DD(SD)}$	I_{DD} in shutdown	V_{DD} = 5 V			5	15	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 = 4 Ω

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
P_O	Output power (each channel) see Note 2	THD = 0.2%,	BTL		1.25		W
		THD = 1%,	BTL		1.5		
		THD = 0.2%,	SE		500		mW
		THD = 1%,	SE		600		
THD+N	Total harmonic distortion plus noise	P_O = 1 W,	f = 20 to 20 kHz		200		m%
B_{OM}	Maximum output power bandwidth	G = 10,	THD < 5 %		>20		kHz
	Phase margin	BTL			72°		
		Open Load			71°		
		SE			52°		
	Power supply ripple rejection	f = 1 kHz			75		dB
		f = 20 – 20 kHz,			60		
	Mute attenuation				85		dB
	Channel-to-channel output separation	f = 1 kHz			65		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				25		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 = 4 Ω

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
P_O	Output power (each channel) see Note 2	THD = 0.2%	BTL		600		mW
		THD = 1%	BTL		750		
		THD = 0.2%,	SE		200		
		THD = 1%,	SE		250		
THD+N	Total harmonic distortion plus noise	P_O = 600 mW,	f = 20 to 20 kHz		250		m%
B_{OM}	Maximum output power bandwidth	G = 10,	THD < 5 %		>20		kHz
	Phase margin	BTL			92°		
		Open Load			70°		
		SE			57°		
	Power supply ripple rejection	f = 1 kHz			70		dB
		f = 20 – 20 kHz			55		
	Mute attenuation				85		dB
	Channel-to-channel output separation	f = 1 kHz			65		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				25		μV(rms)

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

THERMAL INFORMATION

The thermally enhanced PWP package is based on the 24-pin TSSOP, but includes a thermal pad (see Figure 58) to provide an effective thermal contact between the IC and the PWB.

Traditionally, surface mount and power have been mutually exclusive terms. A variety of scaled-down TO-220-type packages have leads formed as gull wings to make them applicable for surface-mount applications. These packages, however, have only two shortcomings: they do not address the very low profile requirements (<2 mm) of many of today's advanced systems, and they do not offer a terminal-count high enough to accommodate increasing integration. On the other hand, traditional low-power surface-mount packages require power-dissipation derating that severely limits the usable range of many high-performance analog circuits.

The PowerPAD package (thermally enhanced TSSOP) combines fine-pitch surface-mount technology with thermal performance comparable to much larger power packages.

The PowerPAD package is designed to optimize the heat transfer to the PWB. Because of the very small size and limited mass of a TSSOP package, thermal enhancement is achieved by improving the thermal conduction paths that remove heat from the component. The thermal pad is formed using a patented lead-frame design and manufacturing technique to provide a direct connection to the heat-generating IC. When this pad is soldered or otherwise thermally coupled to an external heat dissipator, high power dissipation in the ultra-thin, fine-pitch, surface-mount package can be reliably achieved.

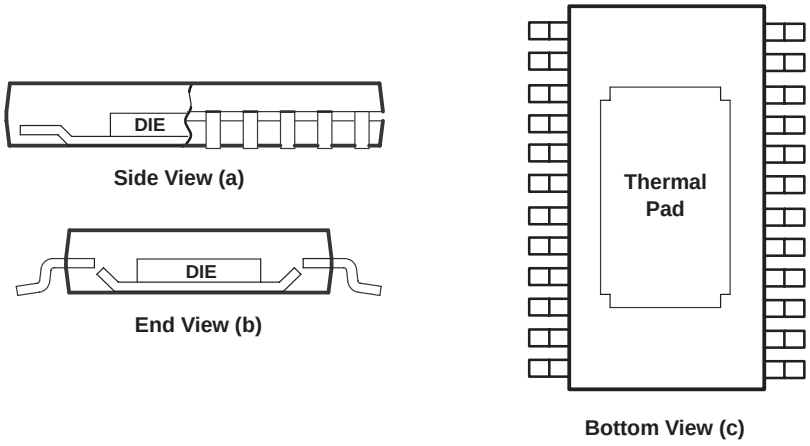


Figure 58. Views of Thermally Enhanced PWP Package

APPLICATION INFORMATION

For example, if the 5-V supply is replaced with a 3.3-V supply (TPA0102 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 chose 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.

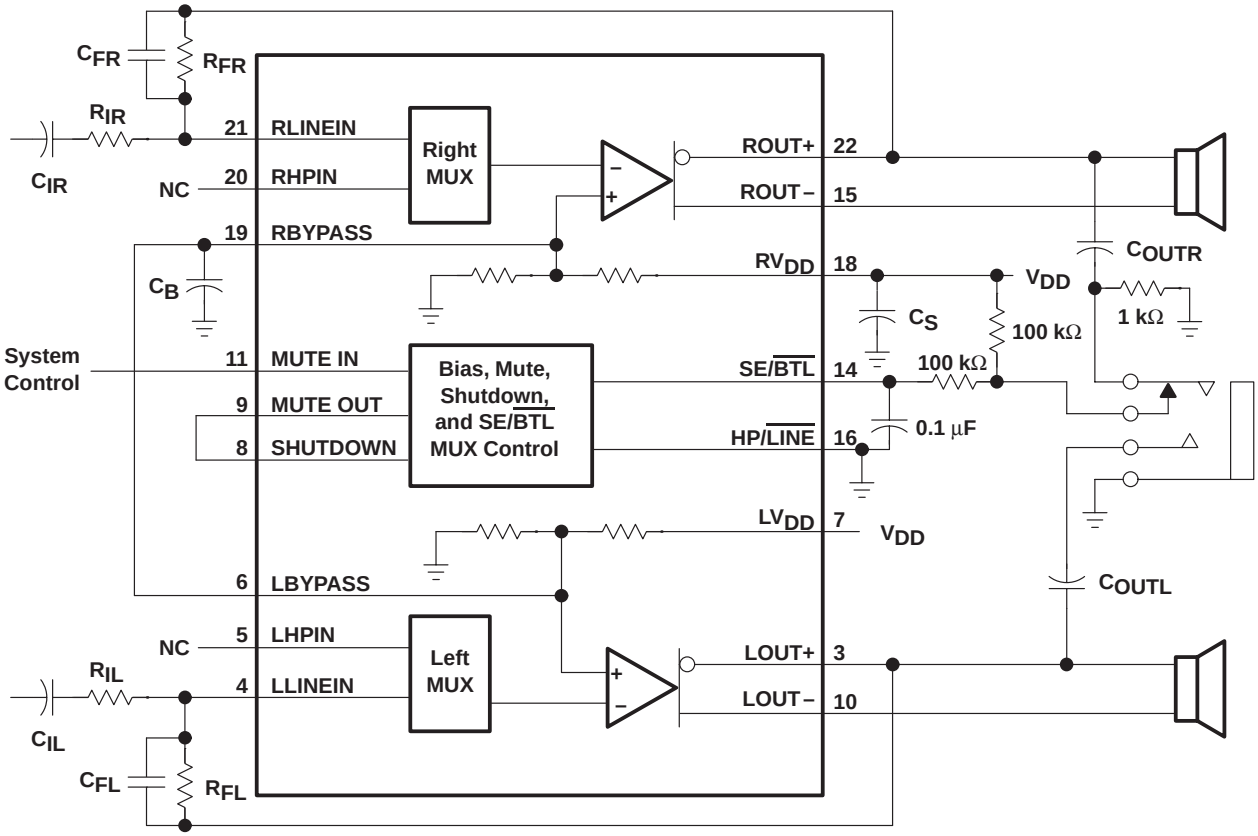
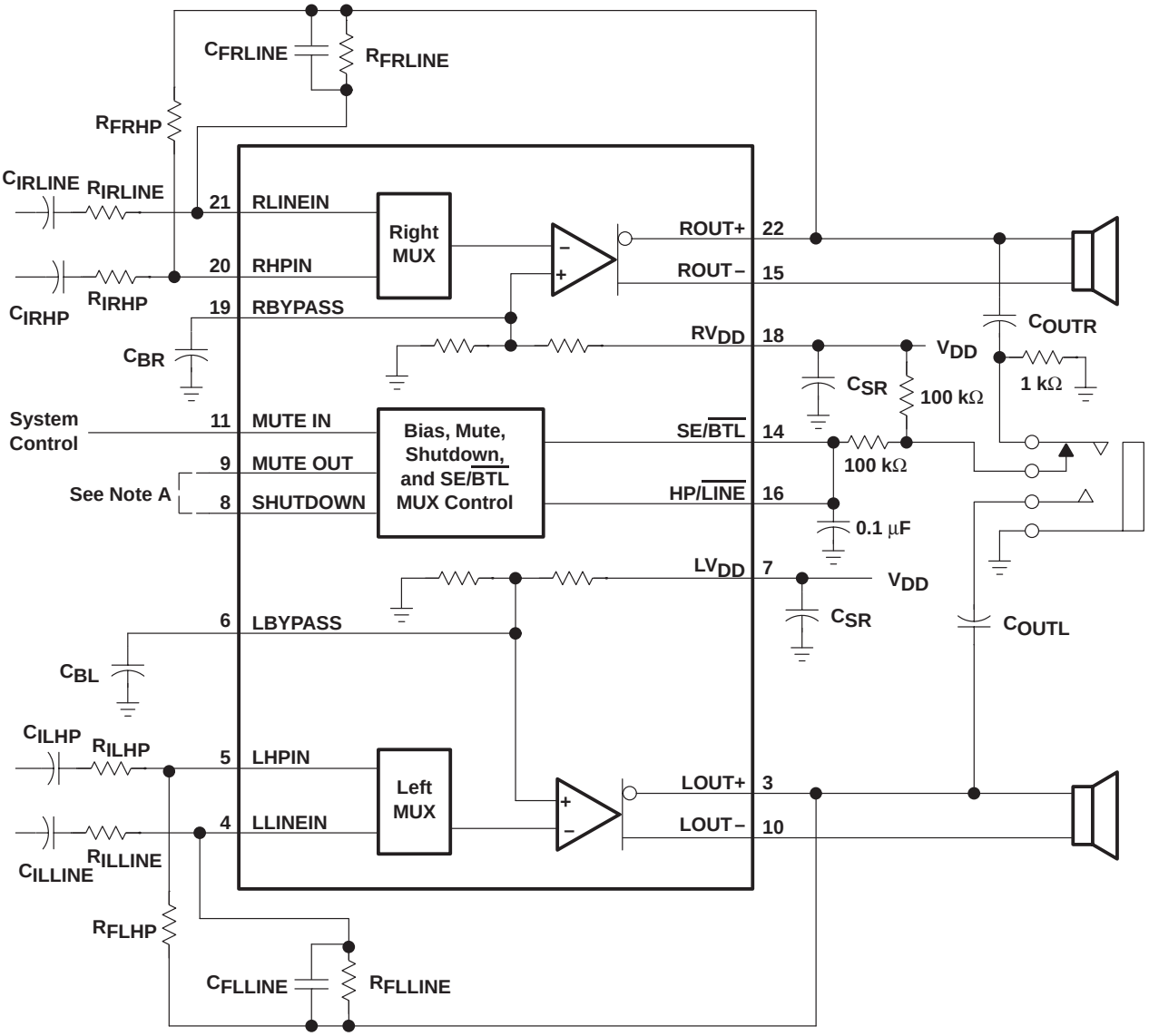


Figure 62. TPA0102 Minimum Configuration Application Circuit

APPLICATION INFORMATION



NOTE A: This connection is for ultralow current in shutdown mode.

Figure 63. TPA0102 Full Configuration Application Circuit

gain setting resistors, R_F and R_I

The gain for each audio input of the TPA0102 is set by resistors R_F and R_I according to equation 5 for BTL mode.

$$\text{BTL Gain} = -2\left(\frac{R_F}{R_I}\right) \quad (5)$$