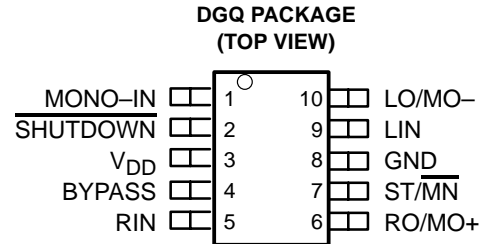


# TPA0223

## 2-W MONO AUDIO POWER AMPLIFIER WITH HEADPHONE DRIVE

SLOS277B – JANUARY 2000 – REVISED APRIL 2001

- Ideal for Notebook Computers, PDAs, and Other Small Portable Audio Devices
- 2 W Into 4-Ω From 5-V Supply
- 0.6 W Into 4-Ω From 3-V Supply
- Stereo Head Phone Drive
- Separate Inputs for the Mono (BTL) Signal and Stereo (SE) Left/Right Signals
- Wide Power Supply Compatibility  
3 V to 5 V
- Meets PC99 Desktop Specs (Target)
- Low Supply Current
  - 11 mA Typical at 5 V
  - 10 mA Typical at 3 V
- Shutdown Control . . . 1 μA Typical
- Shutdown Pin Is TTL Compatible
- –40°C to 85°C Operating Temperature Range
- Space-Saving, Thermally-Enhanced MSOP Packaging



### description

The TPA0223 is a 2-W mono bridge-tied-load (BTL) amplifier designed to drive speakers with as low as 4-Ω impedance. The amplifier can be reconfigured on-the-fly to drive two stereo single-ended (SE) signals into head phones. This makes the device ideal for use in small notebook computers, PDAs, digital personal audio players, anyplace a mono speaker and stereo head phones are required. From a 5-V supply, the TPA0223 can delivery 2-W of power into a 4-Ω speaker.

The gain of the input stage is set by the user-selected input resistor and a 50-kΩ internal feedback resistor ( $A_V = -R_F/R_I$ ). The power stage is internally configured with a gain of –1.25 V/V in SE mode, and –2.5 V/V in BTL mode. Thus, the overall gain of the amplifier is 62.5 kΩ/  $R_I$  in SE mode and 125 kΩ/  $R_I$  in BTL mode. The input terminals, high-impedance CMOS inputs, can be used as summing nodes.

The TPA0223 is available in the 10-pin thermally-enhanced MSOP package (DGQ) and operates over an ambient temperature range of –40°C to 85°C.



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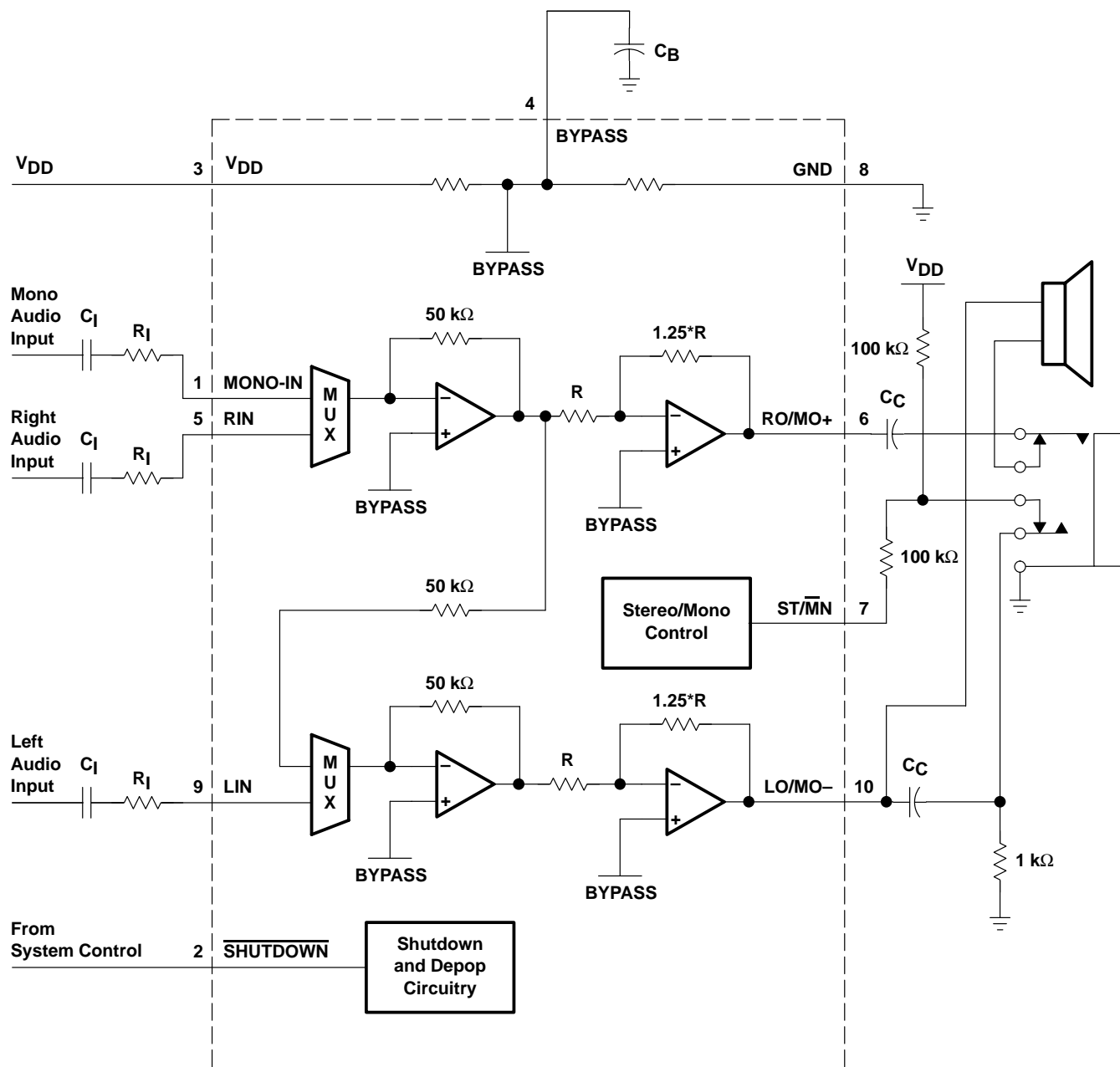
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### AVAILABLE OPTIONS

T <sub>A</sub>	PACKAGED DEVICES	MSOP SYMBOLIZATION
	MSOP† (DGQ)	
–40°C to 85°C	TPA0223DGQ	AEI

† The DGQ package are available taped and reeled. To order a taped and reeled part, add the suffix R to the part number (e.g., TPA0223DGQR).

### Terminal Functions

TERMINAL NAME	NO.	I/O	DESCRIPTION
MONO-IN	1	I	Mono input terminal
SHUTDOWN	2	I	$\overline{\text{SHUTDOWN}}$ places the entire device in shutdown mode when held low. TTL compatible input.
$V_{DD}$	3	I	$V_{DD}$ is the supply voltage terminal.
BYPASS	4	I	BYPASS is the tap to the voltage divider for internal mid-supply bias. This terminal should be connected to a 0.1- $\mu\text{F}$ to 1- $\mu\text{F}$ capacitor.
RIN	5	I	Right-channel input terminal
RO/MO+	6	O	Right-output in SE mode and mono positive output in BTL mode
ST/ $\overline{\text{MN}}$	7	I	Selects between stereo and mono mode. When held high, the amplifier is in SE stereo mode, while held low, the amplifier is in BTL mono mode.
GND	8		Ground terminal
LIN	9	I	Left-channel input terminal
LO/MO–	10	O	Left-output in SE mode and mono negative output in BTL mode.

### 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, $T_A$ (see Table 3)	–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	$T_A = 70^\circ\text{C}$	$T_A = 85^\circ\text{C}$
DGQ	2.14 W <sup>‡</sup>	17.1 mW/°C	1.37 W	1.11 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 <sub>DD</sub>			2.5	5.5	V
High-level input voltage, V <sub>IH</sub>	ST/ $\overline{\text{MN}}$	V <sub>DD</sub> = 3 V	2.7		V
		V <sub>DD</sub> = 5 V	4.5		
	SHUTDOWN		2		
Low-level input voltage, V <sub>IL</sub>	ST/ $\overline{\text{MN}}$	V <sub>DD</sub> = 3 V		1.65	V
		V <sub>DD</sub> = 5 V		2.75	
	SHUTDOWN			0.8	
Operating free-air temperature, T <sub>A</sub>			−40	85	°C

# TPA0223

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**electrical characteristics at specified free-air temperature,  $V_{DD} = 3\text{ V}$ ,  $T_A = 25^\circ\text{C}$  (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$ V_{OO} $ Output offset voltage (measured differentially)				30	mV
$I_{DD}$ Supply current			10	13	mA
$I_{DD(SD)}$ Supply current, shutdown mode			1	10	$\mu\text{A}$

**operating characteristics,  $V_{DD} = 3\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $R_L = 4\ \Omega$**

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$P_O$ Output power, see Note 1	THD = 1%, BTL mode		660		mW
	THD = 0.1%, SE mode, $R_L = 32\ \Omega$		33		
THD + N Total harmonic distortion plus noise	$P_O = 500\text{ mW}$ , $f = 20\text{ Hz to } 20\text{ kHz}$		0.3%		
BOM Maximum output power bandwidth	Gain = 2, THD = 2%		20		kHz

NOTE 1: Output power is measured at the output terminals of the device at  $f = 1\text{ kHz}$ .

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

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$ V_{OO} $ Output offset voltage (measured differentially)				30	mV
$I_{DD}$ Supply current			11	15	mA
$I_{DD(SD)}$ Supply current, shutdown mode			1	10	$\mu\text{A}$

**operating characteristics,  $V_{DD} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $R_L = 4\ \Omega$**

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$P_O$ Output power, see Note 1	THD = 1%, BTL mode		2		W
	THD = 0.1%, SE mode, $R_L = 32\ \Omega$		95		mW
THD + N Total harmonic distortion plus noise	$P_O = 1\text{ W}$ , $f = 20\text{ Hz to } 20\text{ kHz}$		0.2%		
BOM Maximum output power bandwidth	Gain = 2.5, THD = 2%		20		kHz

NOTE 1: Output power is measured at the output terminals of the device at  $f = 1\text{ kHz}$ .

## TYPICAL CHARACTERISTICS

### Table of Graphs

		FIGURE
Supply ripple rejection ratio	vs Frequency	1, 2
$I_{DD}$ Supply current	vs Supply voltage	3
$P_O$ Output power	vs Supply voltage	4, 5
	vs Load resistance	6, 7
THD+N Total harmonic distortion plus noise	vs Frequency	8, 9, 10, 11
	vs Output power	12, 13, 14, 15, 16, 17
$V_n$ Output noise voltage	vs Frequency	18, 19
Closed loop response		20, 21



## APPLICATION INFORMATION

### ST/MN (stereo/mono) operation (continued)

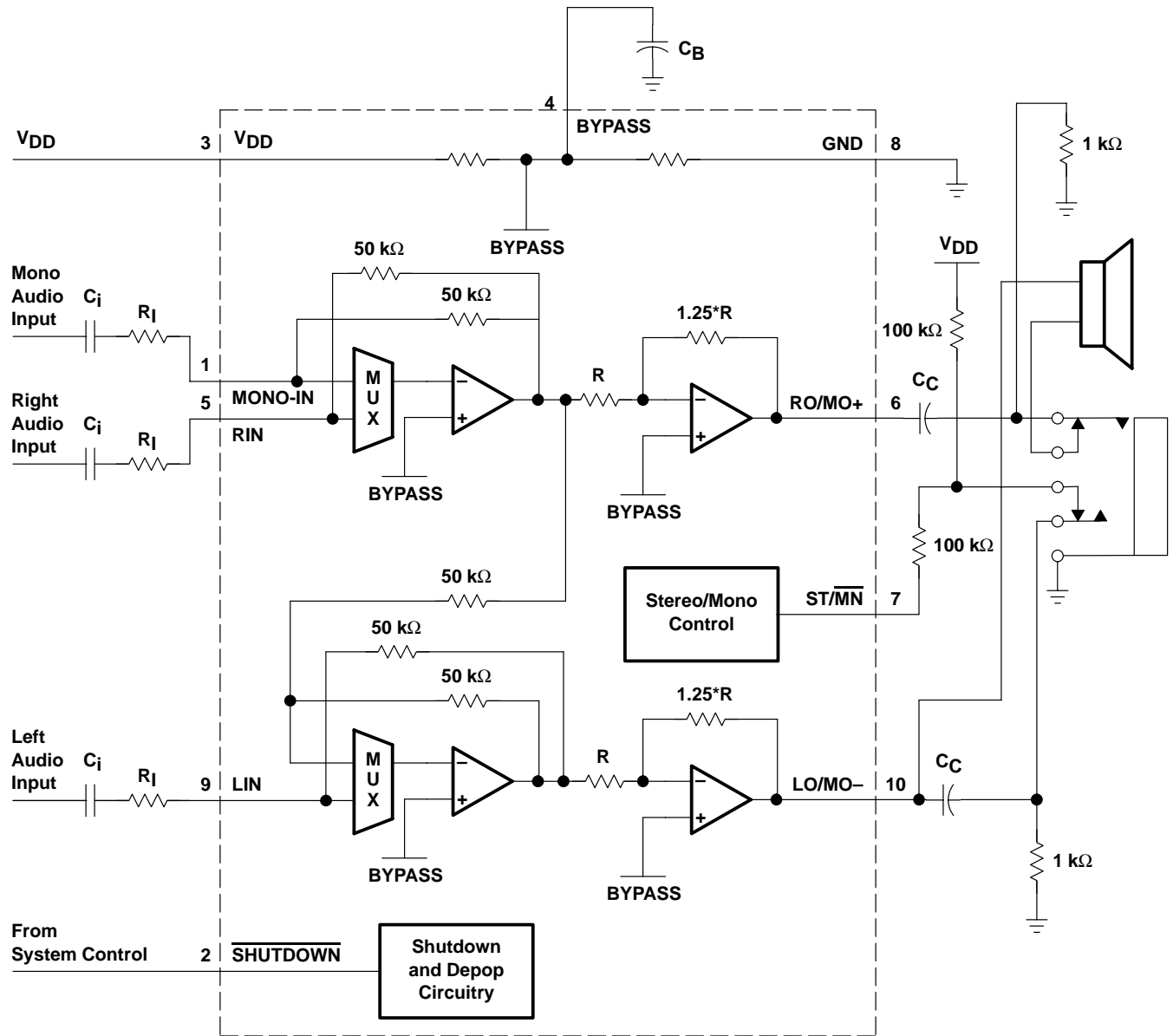


Figure 25. TPA0223 Resistor Divider Network Circuit

Using a readily available 1/8-in. (3.5 mm) stereo headphone jack, the control switch is closed when no plug is inserted. When closed, the 100-kΩ/1-kΩ divider pulls the ST/MN input low. When a plug is inserted, the 1-kΩ resistor is disconnected and the ST/MN input is pulled high. The mono speaker is also physically disconnected from the RO/MO+ output so that no sound is heard from the speaker while the headphones are inserted.