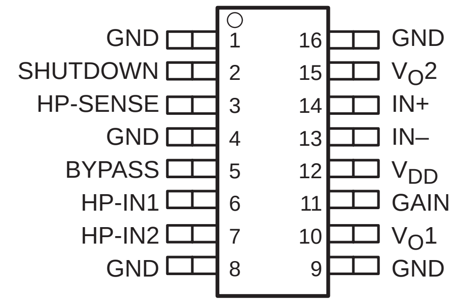
TPA4860
1-W MONO AUDIO POWER AMPLIFIER

- **1-W BTL Output (5 V, 0.2 % THD+N)**
- **3.3-V and 5-V Operation**
- **No Output Coupling Capacitors Required**
- **Shutdown Control (I_{DD} = 0.6 μA)**
- **Headphone Interface Logic**
- **Uncompensated Gains of 2 to 20 (BTL Mode)**
- **Surface-Mount Packaging**
- **Thermal and Short-Circuit Protection**
- **High Power Supply Rejection (56-dB at 1 kHz)**
- **LM4860 Drop-In Compatible**

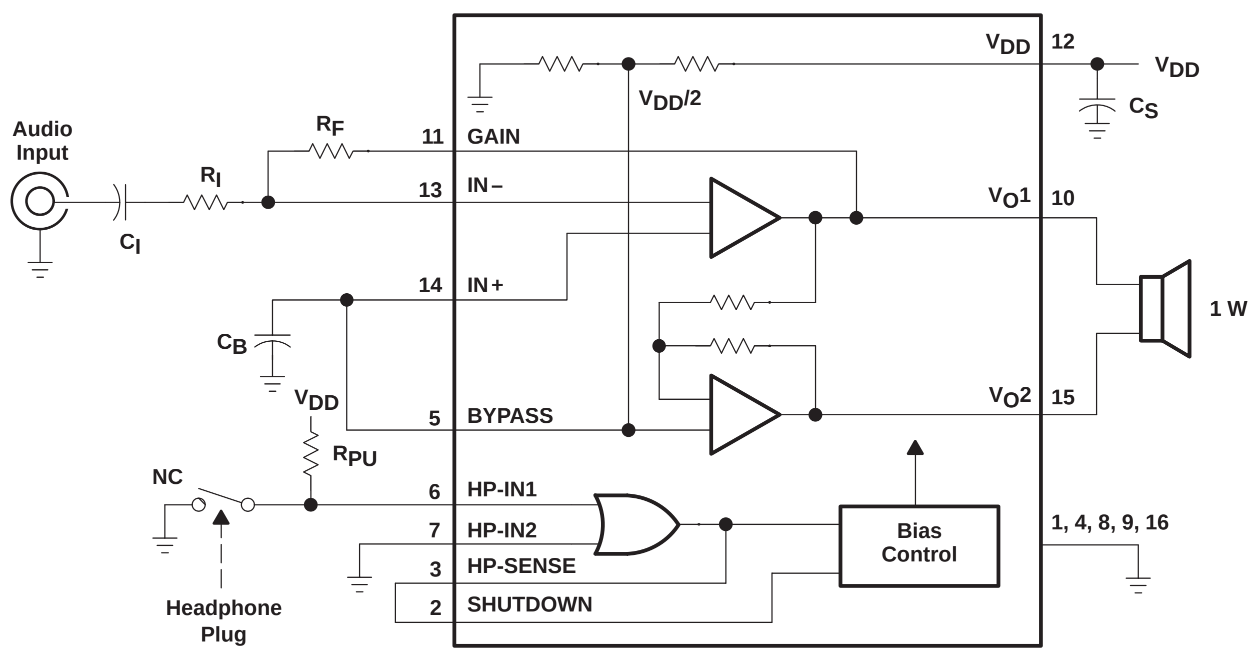
D PACKAGE
(TOP VIEW)



description

The TPA4860 is a bridge-tied load (BTL) audio power amplifier capable of delivering 1 W of continuous average power into an 8-Ω load at 0.4 % THD+N from a 5-V power supply in voiceband frequencies (f < 5 kHz). A BTL configuration eliminates the need for external coupling capacitors on the output in most applications. Gain is externally configured by means of two resistors and does not require compensation for settings of 2 to 20. Features of this amplifier are a shutdown function for power-sensitive applications as well as headphone interface logic that mutes the output when the speaker drive is not required. Internal thermal and short-circuit protection increases device reliability. It also includes headphone interface logic circuitry to facilitate headphone applications. The amplifier is available in a 16-pin SOIC surface-mount package that reduces board space and facilitates automated assembly.

typical application circuit



AVAILABLE OPTIONS

T_A	PACKAGED DEVICE SMALL OUTLINE (D)
–40°C to 85°C	TPA4860D

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
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	$T_A = 70°C$	$T_A = 85°C$
D	1250 mW	10 mW/°C	800 mW	650 mW

recommended operating conditions

		MIN	MAX	UNIT
Supply voltage, V_{DD}		2.7	5.5	V
Common-mode input voltage, V_{IC}	V_{DD} = 3.3 V	1.25	2.7	V
	V_{DD} = 5 V	1.25	4.5	V
Operating free-air temperature, T_A		–40	85	°C

electrical characteristics at specified free-air temperature range, V_{DD} = 3.3 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	TPA4860			UNIT
			MIN	TYP	MAX	
V_{OO}	Output offset voltage (measured differentially)	See Note 1		5	20	mV
	Supply ripple rejection ratio	V_{DD} = 3.2 V to 3.4 V		75		dB
I_{DD}	Quiescent current			2.5		mA
$I_{DD(M)}$	Quiescent current, mute mode			750		µA
$I_{DD(SD)}$	Quiescent current, shutdown mode			0.6		µA
V_{IH}	High-level input voltage (HP-IN)			1.7		V
V_{IL}	Low-level input voltage (HP-IN)			1.7		V
V_{OH}	High-level output voltage (HP-SENSE)	I_O = 100 µA	2.5	2.8		V
V_{OL}	Low-level output voltage (HP-SENSE)	I_O = –100 µA		0.2	0.8	V

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

operating characteristics, V_{DD} = 3.3 V, T_A = 25°C, R_L = 8 Ω

PARAMETER			TEST CONDITIONS	TPA4860			UNIT
				MIN	TYP	MAX	
P_O	Output power, see Note 2		THD = 0.2%, f = 1 kHz, A_V = 2		350		mW
			THD = 2%, f = 1 kHz, A_V = 2		500		mW
B_{OM}	Maximum output power bandwidth		Gain = 10, THD = 2%		20		kHz
B_1	Unity-gain bandwidth		Open Loop		1.5		MHz
	Supply ripple rejection ratio	BTL	f = 1 kHz		56		dB
		SE	f = 1 kHz		30		dB
V_n	Noise output voltage, see Note 3		Gain = 2		20		µV

NOTES: 2. Output power is measured at the output terminals of the device.
3. Noise voltage is measured in a bandwidth of 20 Hz to 20 kHz.

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

PARAMETER		TEST CONDITIONS	TPA4860 MIN	TPA4860 TYP	TPA4860 MAX	UNIT
V_{OO}	Output offset voltage	See Note 1		5	20	mV
	Supply ripple rejection ratio	V_{DD} = 4.9 V to 5.1 V		70		dB
I_{DD}	Supply current			3.5		mA
$I_{DD(M)}$	Supply current, mute			750		µA
$I_{DD(SD)}$	Supply current, shutdown			0.6		µA
V_{IH}	High-level input voltage (HP-IN)			2.5		V
V_{IL}	Low-level input voltage (HP-IN)			2.5		V
V_{OH}	High-level output voltage (HP-SENSE)	I_O = 500 µA	2.5	2.8		V
V_{OL}	Low-level output voltage (HP-SENSE)	I_O = –500 µA		0.2	0.8	V

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

operating characteristic, V_{DD} = 5 V, T_A = 25°C, R_L = 8 Ω

PARAMETER			TEST CONDITIONS	TPA4860 MIN	TPA4860 TYP	TPA4860 MAX	UNIT
P_O	Output power, see Note 2		THD = 0.2%, f = 1 kHz, A_V = 2		1000		mW
			THD = 2%, f = 1 kHz, A_V = 2		1100		mW
B_{OM}	Maximum output power bandwidth		Gain = 10, THD = 2%		20		kHz
B_1	Unity-gain bandwidth		Open Loop		1.5		MHz
	Supply ripple rejection ratio	BTL	f = 1 kHz		56		dB
		SE	f = 1 kHz		30		dB
V_n	Noise output voltage, see Note 3		Gain = 2		20		µV

NOTES: 2. Output power is measured at the output terminals of the device.
3. Noise voltage is measured in a bandwidth of 20 Hz to 20 kHz.

TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
V_{OO}	Output offset voltage	Distribution	1,2
I_{DD}	Supply current distribution	vs Free-air temperature	3,4
THD+N	Total harmonic distortion plus noise	vs Frequency	5,6,7,8,9, 10,11,15, 16,17,18
		vs Output power	12,13,14, 19,20,21
I_{DD}	Supply current	vs Supply voltage	22
V_n	Output noise voltage	vs Frequency	23,24
	Maximum package power dissipation	vs Free-air temperature	25
	Power dissipation	vs Output power	26,27
	Maximum output power	vs Free-air temperature	28
	Output power	vs Load Resistance	29
		vs Supply Voltage	30
	Open loop frequency response	vs Frequency	31
	Supply ripple rejection ratio	vs Frequency	32,33

APPLICATION INFORMATION

selection of components

Figure 37 is a schematic diagram of a typical notebook computer application circuit.

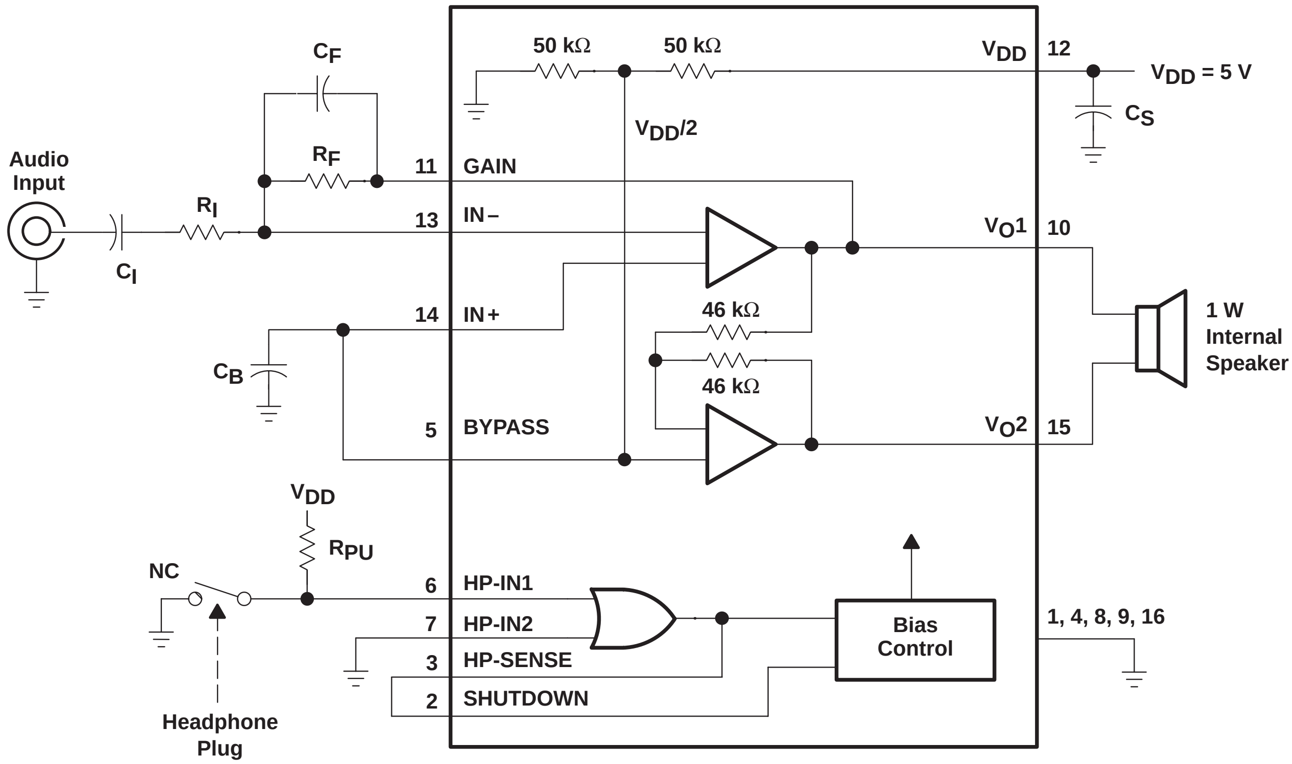


Figure 37. TPA4860 Typical Notebook Computer Application Circuit

gain setting resistors, R_F and R_I

The gain for the TPA4860 is set by resistors R_F and R_I according to equation 5.

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

BTL mode operation brings about the factor of 2 in the gain equation due to the inverting amplifier mirroring the voltage swing across the load. Given that the TPA4860 is a MOS amplifier, the input impedance is very high, consequently input leakage currents are not generally a concern although noise in the circuit increases as the value of R_F increases. In addition, a certain range of R_F values is required for proper startup operation of the amplifier. Taken together it is recommended that the effective impedance seen by the inverting node of the amplifier be set between 5 kΩ and 20 kΩ. The effective impedance is calculated in equation 6.

$$\text{Effective Impedance} = \frac{R_F R_I}{R_F + R_I} \tag{6}$$

As an example, consider an input resistance of 10 kΩ and a feedback resistor of 50 kΩ. The gain of the amplifier would be –10 and the effective impedance at the inverting terminal would be 8.3 kΩ, which is well within the recommended range.

APPLICATION INFORMATION

midrail bypass capacitor, C_B

The midrail bypass capacitor, C_B, serves several important functions. During start-up or recovery from shutdown mode, C_B determines the rate at which the amplifier starts up. This helps to push the start-up pop noise into the subaudible range (so low it can not be heard). The second function is to reduce noise produced by the power supply caused by coupling into the output drive signal. This noise is from the midrail generation circuit internal to the amplifier. The capacitor is fed from a 25-kΩ source inside the amplifier. To keep the start-up pop as low as possible, the relationship shown in equation 10 should be maintained.

$$\frac{1}{\left(C_B \times 25\ \text{k}\Omega\right)} \leq \frac{1}{\left(C_I R_I\right)} \tag{10}$$

As an example, consider a circuit where C_B is 0.1 µF, C_I is 0.22 µF and R_I is 10 kΩ. Inserting these values into the equation 9 we get: $400 \leq 454$ which satisfies the rule. Bypass capacitor, C_B, values of 0.1 µF to 1 µF ceramic or tantalum low-ESR capacitors are recommended for the best THD and noise performance.

single-ended operation

Figure 38 is a schematic diagram of the recommended SE configuration. In SE mode configurations, the load should be driven from the primary amplifier output (OUT1, terminal 10).

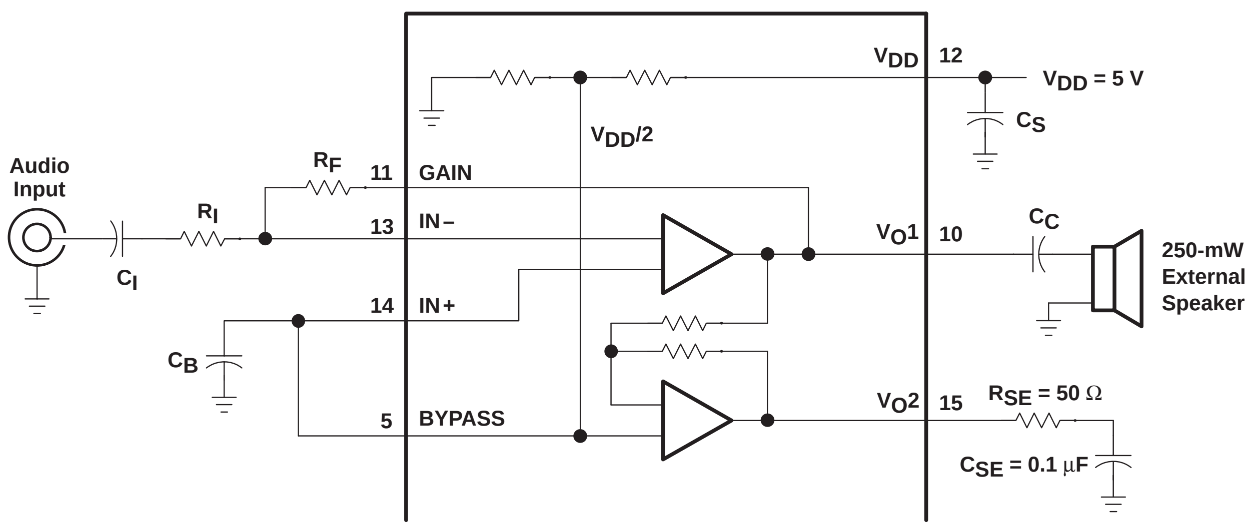


Figure 38. Singled-Ended Mode

Gain is set by the R_F and R_I resistors and is shown in equation 11. Since the inverting amplifier is not used to mirror the voltage swing on the load, the factor of 2 is not included.

$$\text{Gain} = -\left(\frac{R_F}{R_I}\right) \tag{11}$$

The phase margin of the inverting amplifier into an open circuit is not adequate to ensure stability, so a termination load should be connected to V_O2. This consists of a 50-Ω resistor in series with a 0.1-µF capacitor to ground. It is important to avoid oscillation of the inverting output to minimize noise and power dissipation.