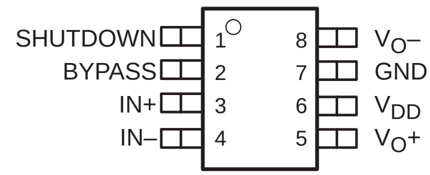
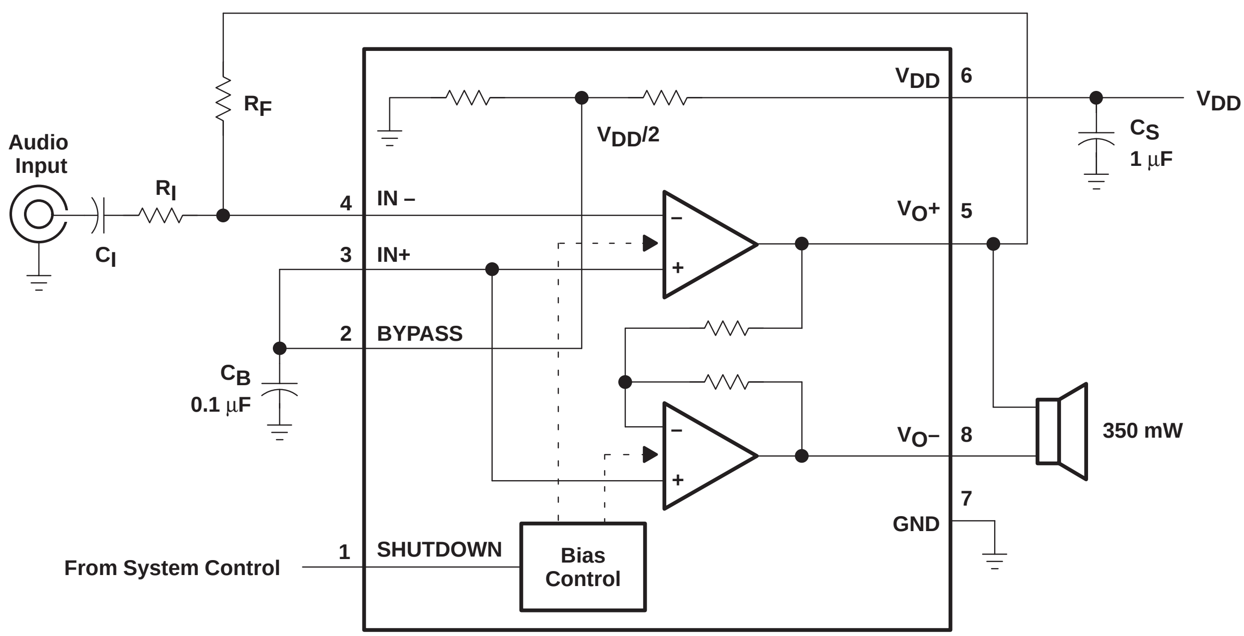
- **Fully Specified for 3.3-V and 5-V Operation**
- **Wide Power Supply Compatibility 2.5 V – 5.5 V**
- **Output Power for R_L = 8 Ω**
  - **350 mW at V_{DD} = 5 V, BTL**
  - **250 mW at V_{DD} = 3.3 V, BTL**
- **Ultra-Low Quiescent Current in Shutdown Mode . . . 0.15 μA**
- **Thermal and Short-Circuit Protection**
- **Surface-Mount Packaging**
  - **SOIC**
  - **PowerPAD™ MSOP**

D OR DGN PACKAGE
(TOP VIEW)



description

The TPA301 is a bridge-tied load (BTL) audio power amplifier developed especially for low-voltage applications where internal speakers are required. Operating with a 3.3-V supply, the TPA301 can deliver 250-mW of continuous power into a BTL 8-Ω load at less than 1% THD+N throughout voice band frequencies. Although this device is characterized out to 20 kHz, its operation was optimized for narrower band applications such as cellular communications. The BTL configuration eliminates the need for external coupling capacitors on the output in most applications, which is particularly important for small battery-powered equipment. This device features a shutdown mode for power-sensitive applications with a quiescent current of 0.15 μA during shutdown. The TPA301 is available in an 8-pin SOIC surface-mount package and the surface-mount PowerPAD MSOP, which reduces board space by 50% and height by 40%.



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AVAILABLE OPTIONS

T_A	PACKAGED DEVICES		MSOP Symbolization
	SMALL OUTLINE† (D)	MSOP† (DGN)	
–40°C to 85°C	TPA301D	TPA301DGN	AAA

† The D and DGN packages are available taped and reeled. To order a taped and reeled part, add the suffix R to the part number (e.g., TPA301DR).

Terminal Functions

TERMINAL NAME	TERMINAL NO.	I/O	DESCRIPTION
BYPASS	2	I	BYPASS is the tap to the voltage divider for internal mid-supply bias. This terminal should be connected to a 0.1-µF to 1-µF capacitor when used as an audio amplifier.
GND	7		GND is the ground connection.
IN–	4	I	IN– is the inverting input. IN– is typically used as the audio input terminal.
IN+	3	I	IN+ is the noninverting input. IN+ is typically tied to the BYPASS terminal.
SHUTDOWN	1	I	SHUTDOWN places the entire device in shutdown mode when held high (I_{DD} < 1 µA).
V_{DD}	6		V_{DD} is the supply voltage terminal.
V_O+	5	O	V_O+ is the positive BTL output.
V_O–	8	O	V_O– is the negative BTL output.

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	$T_A = 70°C$	$T_A = 85°C$
D	725 mW	5.8 mW/°C	464 mW	377 mW
DGN	2.14 W§	17.1 mW/°C	1.37 W	1.11 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	MAX	UNIT
Supply voltage, V_{DD}	2.5	5.5	V
Operating free-air temperature, T_A	–40	85	°C

electrical characteristics at specified free-air temperature, V_{DD} = 3.3 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{OD}	Differential output voltage	See Note 1		5	20	mV
PSRR	Power supply rejection ratio	V_{DD} = 3.2 V to 3.4 V		85		dB
$I_{DD(q)}$	Supply current (see Figure 3)	BTL mode		0.7	1.5	mA
$I_{DD(sd)}$	Supply current, shutdown mode (see Figure 4)			0.15	5	µA

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		MIN	TYP	MAX	UNIT
P_O	Output power, see Note 2	THD = 0.5%,	See Figure 9		250		mW
THD + N	Total harmonic distortion plus noise	P_O = 250 mW, Gain = 2,	f = 20 Hz to 4 kHz, See Figure 7		1.3%		
	Maximum output power bandwidth	Gain = 2, See Figure 7	THD = 3%,		10		kHz
B_1	Unity-gain bandwidth	Open Loop,	See Figure 15		1.4		MHz
	Supply ripple rejection ratio	f = 1 kHz, See Figure 2	C_B = 1 µF,		71		dB
V_n	Noise output voltage	Gain = 1, R_L = 32 Ω,	C_B = 0.1 µF, See Figure 19		15		µV(rms)

NOTE 2: Output power is measured at the output terminals of the device at f = 1 kHz.

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_{OD}	Differential output voltage			5	20	mV
PSRR	Power supply rejection ratio	V_{DD} = 4.9 V to 5.1 V		78		dB
$I_{DD(q)}$	Quiescent current (see Figure 3)			0.7	1.5	mA
$I_{DD(sd)}$	Quiescent current, shutdown mode (see Figure 4)			0.15	5	µA

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

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
P_O	Output power	THD = 0.5%,	See Figure 13		700		mW
THD + N	Total harmonic distortion plus noise	P_O = 250 mW, Gain = 2,	f = 20 Hz to 4 kHz, See Figure 11		1%		
	Maximum output power bandwidth	Gain = 2, See Figure 11	THD = 2%,		10		kHz
B_1	Unity-gain bandwidth	Open Loop,	See Figure 16		1.4		MHz
	Supply ripple rejection ratio	f = 1 kHz, See Figure 2	C_B = 1 µF,		65		dB
V_n	Noise output voltage	Gain = 1, R_L = 32 Ω,	C_B = 0.1 µF, See Figure 20		15		µV(rms)

PARAMETER MEASUREMENT INFORMATION

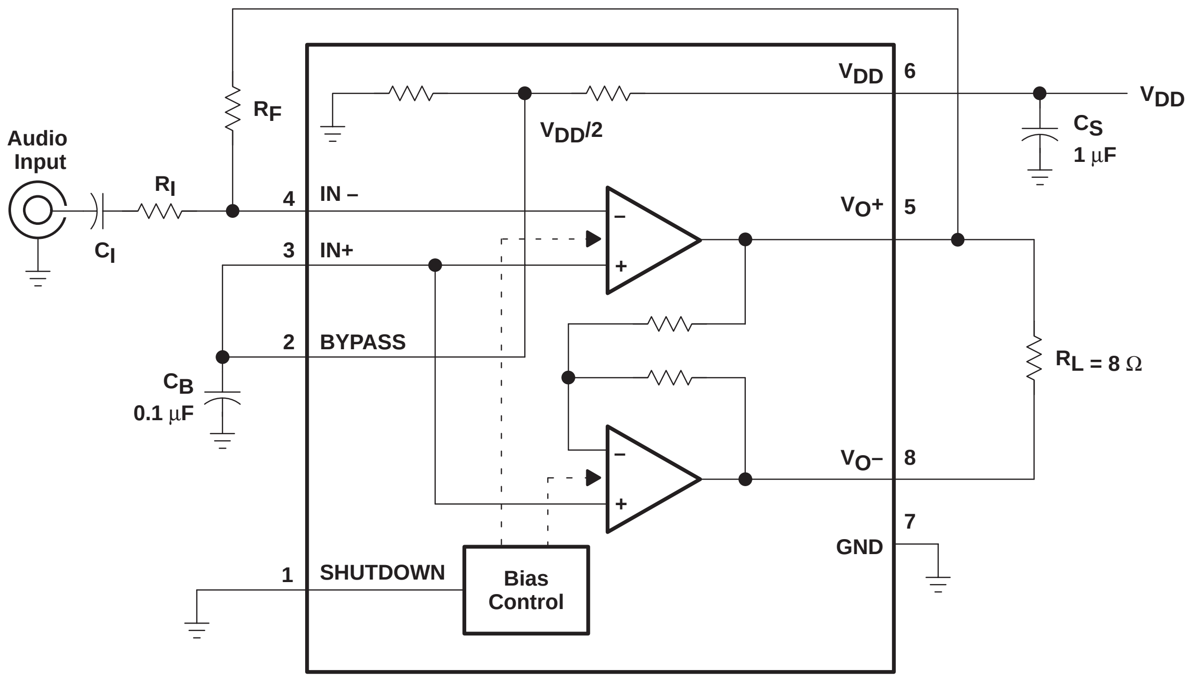

Figure 1. Test Circuit

TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
k_{SVR}	Supply voltage rejection ratio	vs Frequency	2
I_{DD}	Supply current	vs Supply voltage	3, 4
P_O	Output power	vs Supply voltage	5
		vs Load resistance	6
THD + N	Total harmonic distortion plus noise	vs Frequency	7, 8, 11, 12
		vs Output power	9, 10, 13, 14
	Open loop gain and phase	vs Frequency	15, 16
	Closed loop gain and phase	vs Frequency	17, 18
V_n	Output noise voltage	vs Frequency	19, 20
P_D	Power dissipation	vs Output power	21, 22

APPLICATION INFORMATION

application schematic

Figure 26 is a schematic diagram of a typical handheld audio application circuit, configured for a gain of –10 V/V.

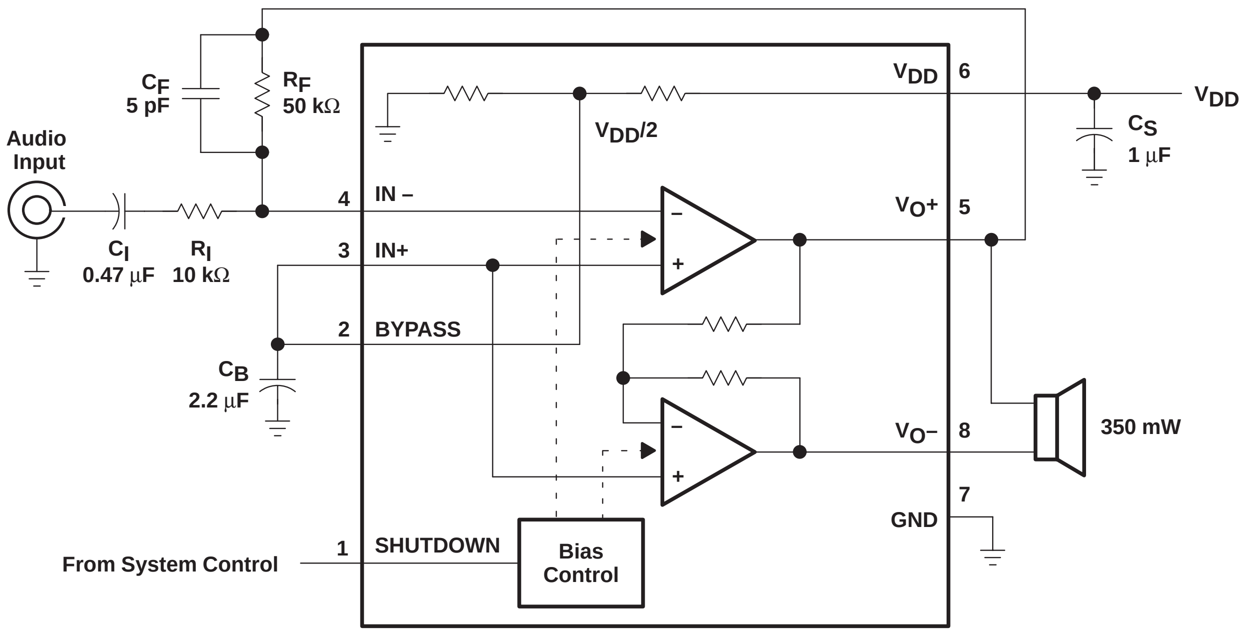

Figure 26. TPA301 Application Circuit

The following sections discuss the selection of the components used in Figure 26.

component selection

gain setting resistors, R_F and R_I

The gain for each audio input of the TPA301 is set by resistors R_F and R_I according to equation 5 for BTL mode.

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

BTL mode operation brings about the factor 2 in the gain equation due to the inverting amplifier mirroring the voltage swing across the load. Given that the TPA301 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 are required for proper start-up 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.

$$\text{Effective Impedance} = \frac{R_F R_I}{R_F + R_I} \quad (6)$$