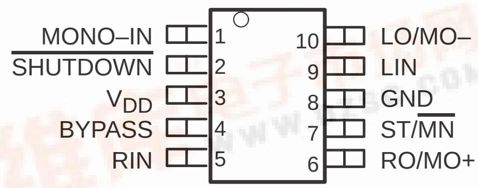
TPA0213
2-W MONO AUDIO POWER AMPLIFIER WITH HEADPHONE DRIVE

SLOS276B – JANUARY 2000 – REVISED MARCH 2000

- **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 2.5 V to 5.5 V**
- **Low Supply Current**
  - **4.2 mA Typical at 5 V**
  - **3.6 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**

DGQ PACKAGE (TOP VIEW)



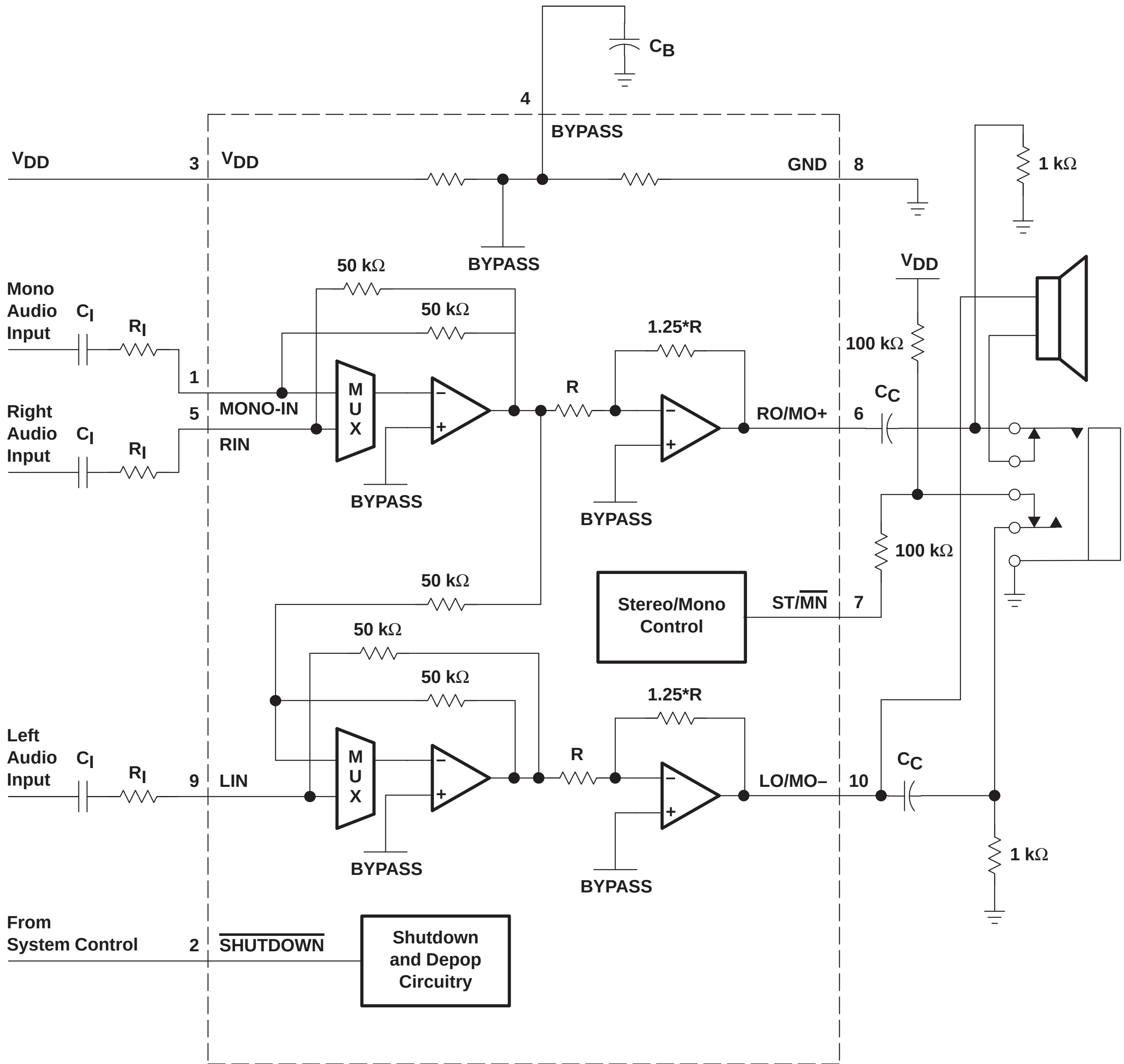
description

The TPA0213 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 TPA0213 can deliver 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 TPA0213 is available in the 10-pin thermally-enhanced MSOP package (DGQ) and operates over an ambient temperature range of –40°C to 85°C.

PowerPAD is a trademark of Texas Instruments Incorporated.


CB
4
BYPASS
VDD
3
VDD
GND
8
1 kΩ
BYPASS
50 kΩ
VDD
Mono Audio Input
CI
RI
50 kΩ
1.25*R
100 kΩ
1
MONO-IN
M U X
R
RO/MO+
6
CC
Right Audio Input
5
RIN
BYPASS
BYPASS
100 kΩ
50 kΩ
Stereo/Mono Control
ST/MN
7
50 kΩ
50 kΩ
1.25*R
Left Audio Input
9
LIN
LO/MO–
10
CC
1 kΩ
From System Control
2
SHUTDOWN
Shutdown and Depop Circuitry

AVAILABLE OPTIONS

T_A	PACKAGED DEVICES MSOP† (DGQ)	MSOP SYMBOLIZATION
–40°C to 85°C	TPA0213DGQ	AEH

† 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., TPA0213DGQR).

Terminal Functions

TERMINAL NAME	TERMINAL NO.	I/O	DESCRIPTION
MONO-IN	1	I	Mono input terminal
$\overline{\text{SHUTDOWN}}$	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-μF to 1-μF 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)§

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

§ 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	$T_A \leq 25°C$	DERATING FACTOR	$T_A = 70°C$	$T_A = 85°C$
DGQ	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
High-level input voltage, V_{IH}	ST/$\overline{\text{MN}}$	V_{DD} = 3 V	2.7		V
		V_{DD} = 5 V	4.5		
	$\overline{\text{SHUTDOWN}}$		2		
Low-level input voltage, V_{IL}	ST/$\overline{\text{MN}}$	V_{DD} = 3 V		1.65	V
		V_{DD} = 5 V		2.75	
	$\overline{\text{SHUTDOWN}}$			0.8	
Operating free-air temperature, T_A			–40	85	°C

electrical characteristics at specified free-air temperature, V_{DD} = 3 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$\|V_{OO}\|$	Output offset voltage (measured differentially)	V_{IO} = 0,	Gain = 8 dB			30	mV
PSRR	Power supply rejection ratio	V_{DD} = 2.9 V to 3.1 V,	BTL mode		65		dB
$\|I_{IH}\|$	High-level input current	V_{DD} = 3.3 V,	$V_I = V_{DD}$			1	µA
$\|I_{IL}\|$	Low-level input current	V_{DD} = 3.3 V,	V_I = 0			1	µA
Z_I	Input impedance				50		kΩ
I_{DD}	Supply current				3.6	5.5	mA
$I_{DD(SD)}$	Supply current, shutdown mode				1	10	µA

operating characteristics, V_{DD} = 3 V, T_A = 25°C, R_L = 4 Ω, f = 1 kHz (unless otherwise noted)

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 Ω		33		
THD + N	Total harmonic distortion plus noise	P_O = 500 mW,	f = 20 Hz to 20 kHz			0.2%		
B_{OM}	Maximum output power bandwidth	Gain = 8 dB,	THD = 2%			20		kHz
	Supply ripple rejection ratio	f = 1 kHz,	CB = 0.47 µF	BTL mode		52		dB
				SE mode		62		
V_n	Noise output voltage	CB = 0.47 µF,	f = 20 Hz to 20 kHz	BTL mode		42		μV_{RMS}
				SE mode		21		

NOTE 1: 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
$\|V_{OO}\|$	Output offset voltage (measured differentially)	V_{IO} = 0,	Gain = 8 dB			30	mV
PSRR	Power supply rejection ratio	V_{DD} = 4.9 V to 5.1 V,	BTL mode		62		dB
$\|I_{IH}\|$	High-level input current	V_{DD} = 5.5 V,	$V_I = V_{DD}$			1	µA
$\|I_{IL}\|$	Low-level input current	V_{DD} = 5.5 V,	V_I = 0			1	µA
Z_I	Input impedance				50		kΩ
I_{DD}	Supply current				4.2	6.3	mA
$I_{DD(SD)}$	Supply current, shutdown mode				1	10	µA

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, see Note 1	THD = 0.3%,	BTL mode			2		W
		THD = 0.1%,	SE mode,	R_L = 32 Ω		90		mW
THD + N	Total harmonic distortion plus noise	P_O = 1.5 W,	f = 20 Hz to 20 kHz			0.2%		
B_{OM}	Maximum output power bandwidth	Gain = 6 dB,	THD = 2%			20		kHz
	Supple ripple rejection ratio	f = 1 kHz,	CB = 0.47 µF	BTL mode		52		dB
				SE mode		62		
V_n	Noise output voltage	CB = 0.47 µF,	f = 20 Hz to 20 kHz	BTL mode		42		μV_{RMS}
				SE mode		21		

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

TYPICAL CHARACTERISTICS

TOTAL HARMONIC DISTORTION + NOISE vs OUTPUT POWER

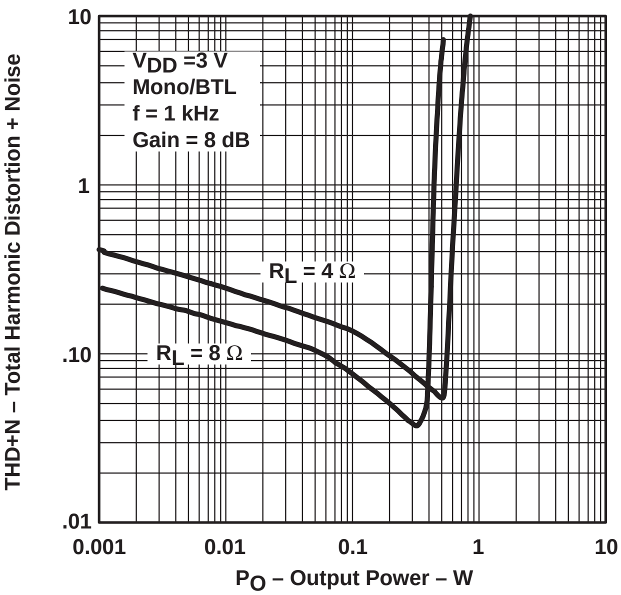


Figure 1

TOTAL HARMONIC DISTORTION + NOISE vs FREQUENCY

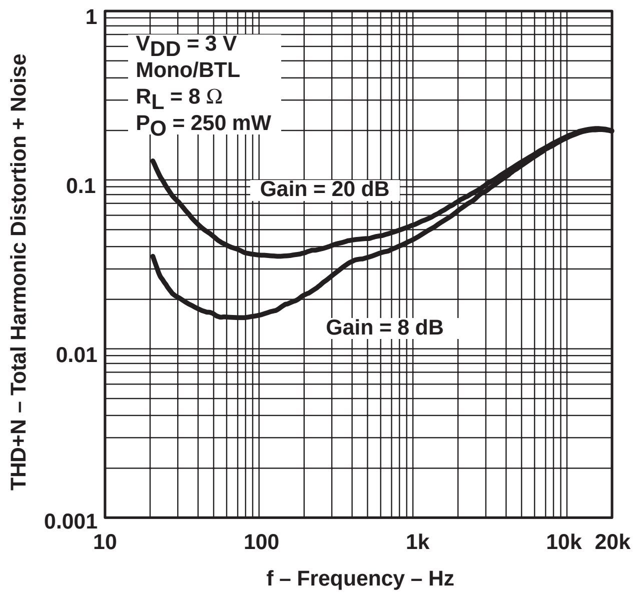


Figure 2

TOTAL HARMONIC DISTORTION + NOISE vs OUTPUT POWER

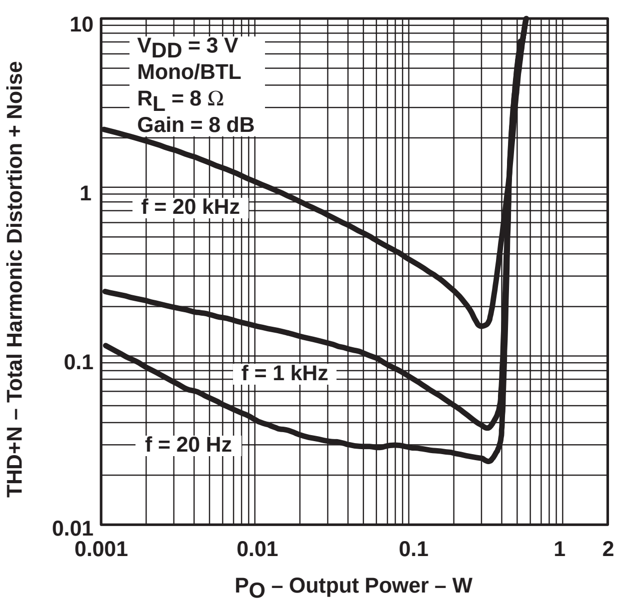


Figure 3

TOTAL HARMONIC DISTORTION + NOISE vs FREQUENCY

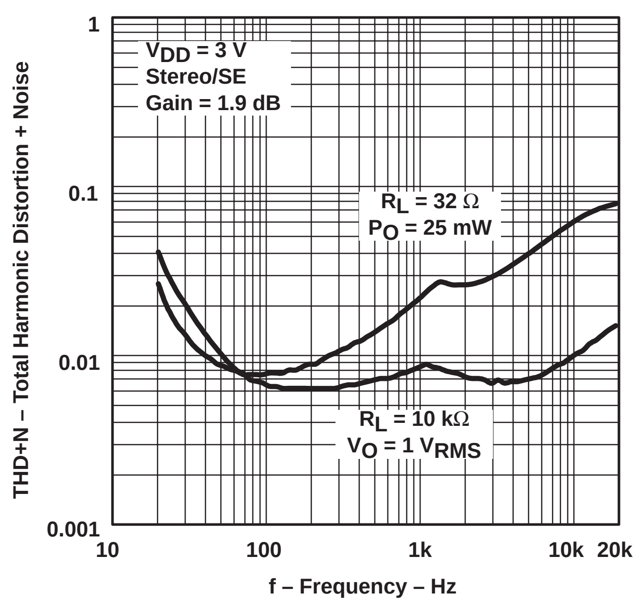


Figure 4

TYPICAL CHARACTERISTICS

TOTAL HARMONIC DISTORTION + NOISE
vs
OUTPUT POWER

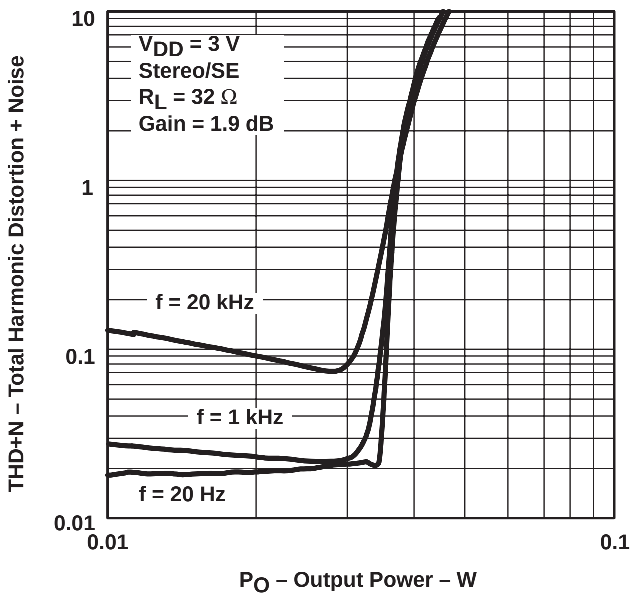


Figure 5

TOTAL HARMONIC DISTORTION + NOISE
vs
OUTPUT POWER

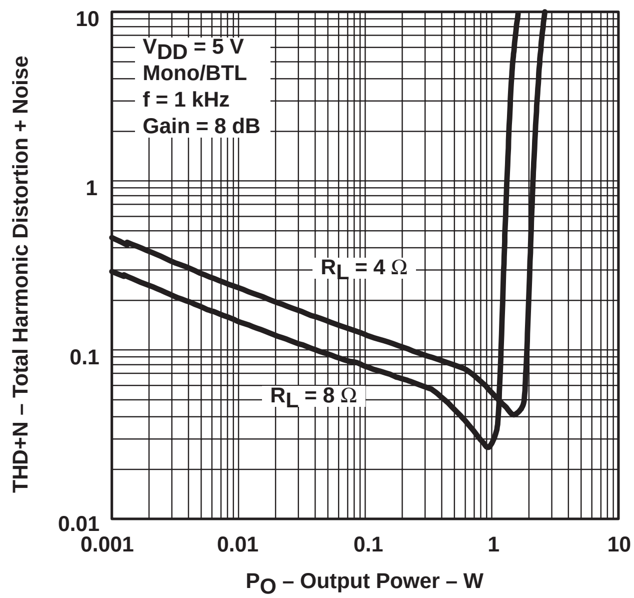


Figure 6

TOTAL HARMONIC DISTORTION + NOISE
vs
FREQUENCY

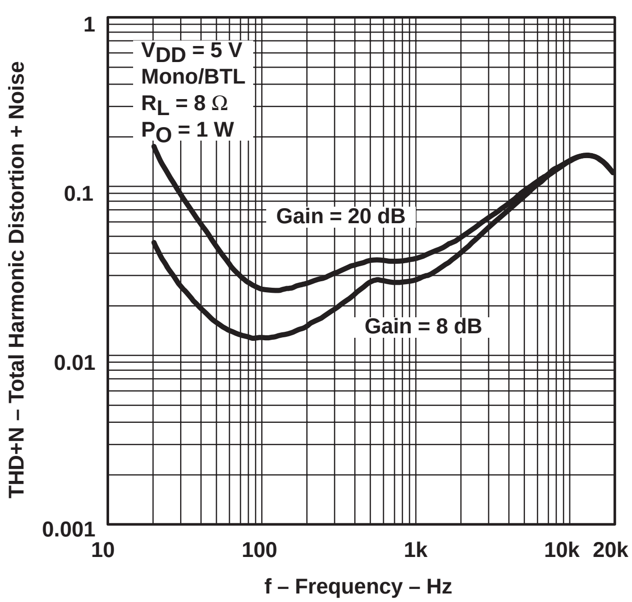


Figure 7

TOTAL HARMONIC DISTORTION + NOISE
vs
OUTPUT POWER

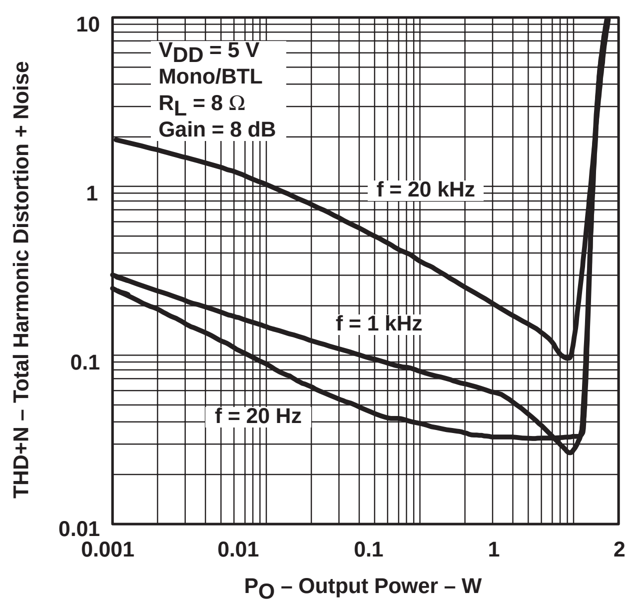


Figure 8

TYPICAL CHARACTERISTICS

TOTAL HARMONIC DISTORTION + NOISE vs FREQUENCY

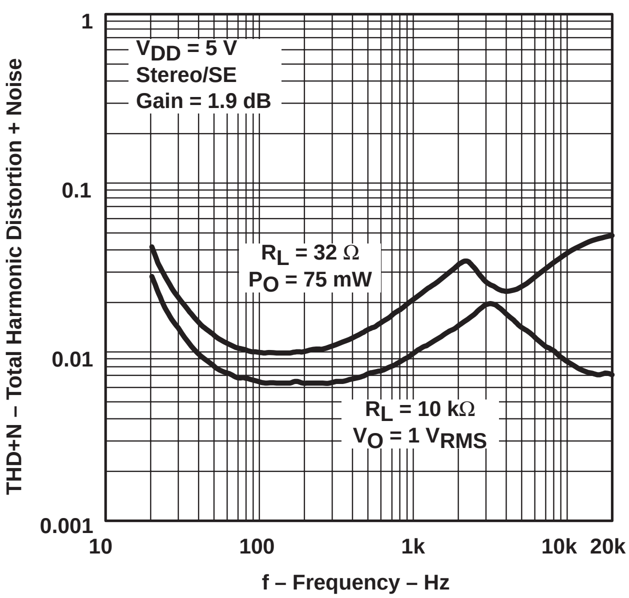


Figure 9

TOTAL HARMONIC DISTORTION + NOISE vs OUTPUT POWER

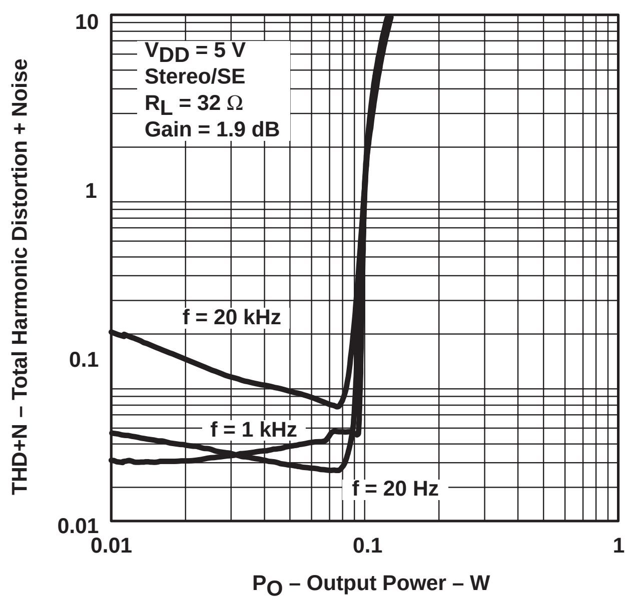


Figure 10

OUTPUT NOISE VOLTAGE vs FREQUENCY

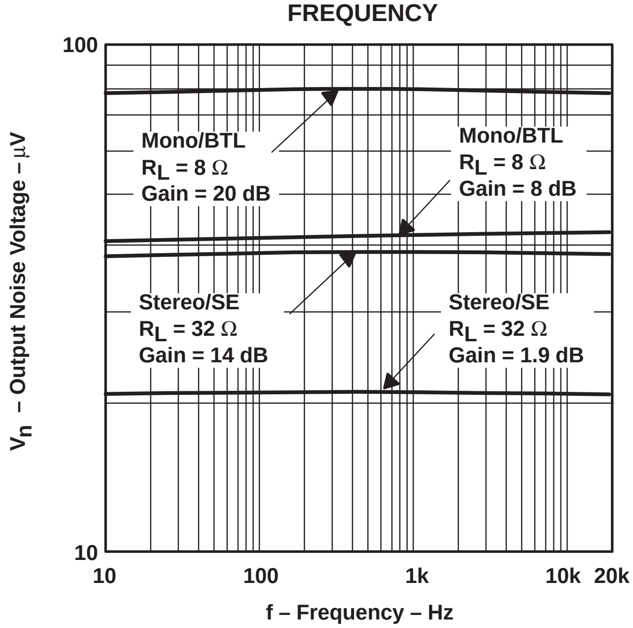


Figure 11

POWER SUPPLY REJECTION RATIO vs FREQUENCY

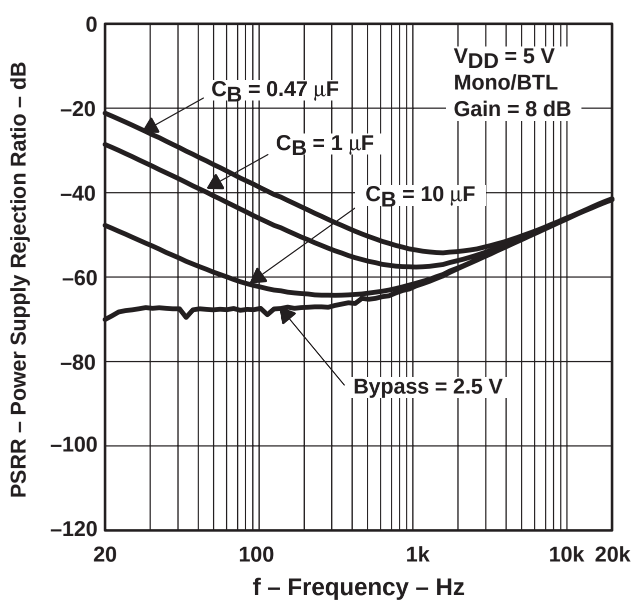


Figure 12

TYPICAL CHARACTERISTICS

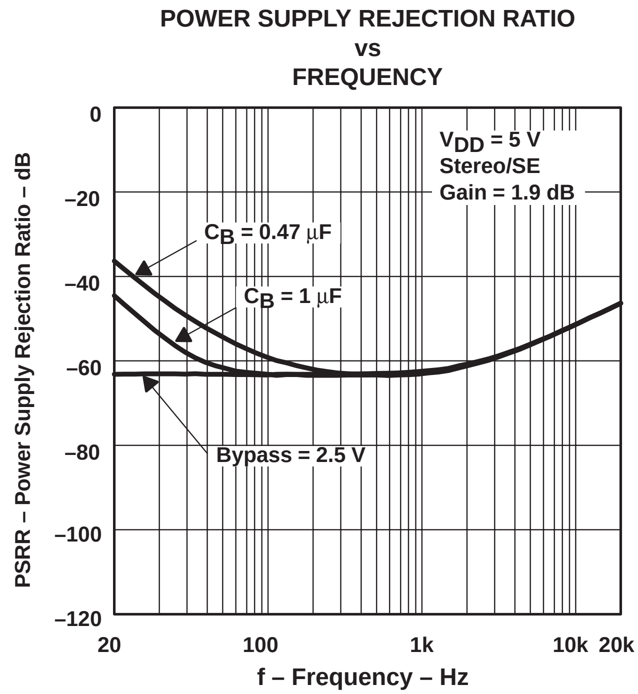
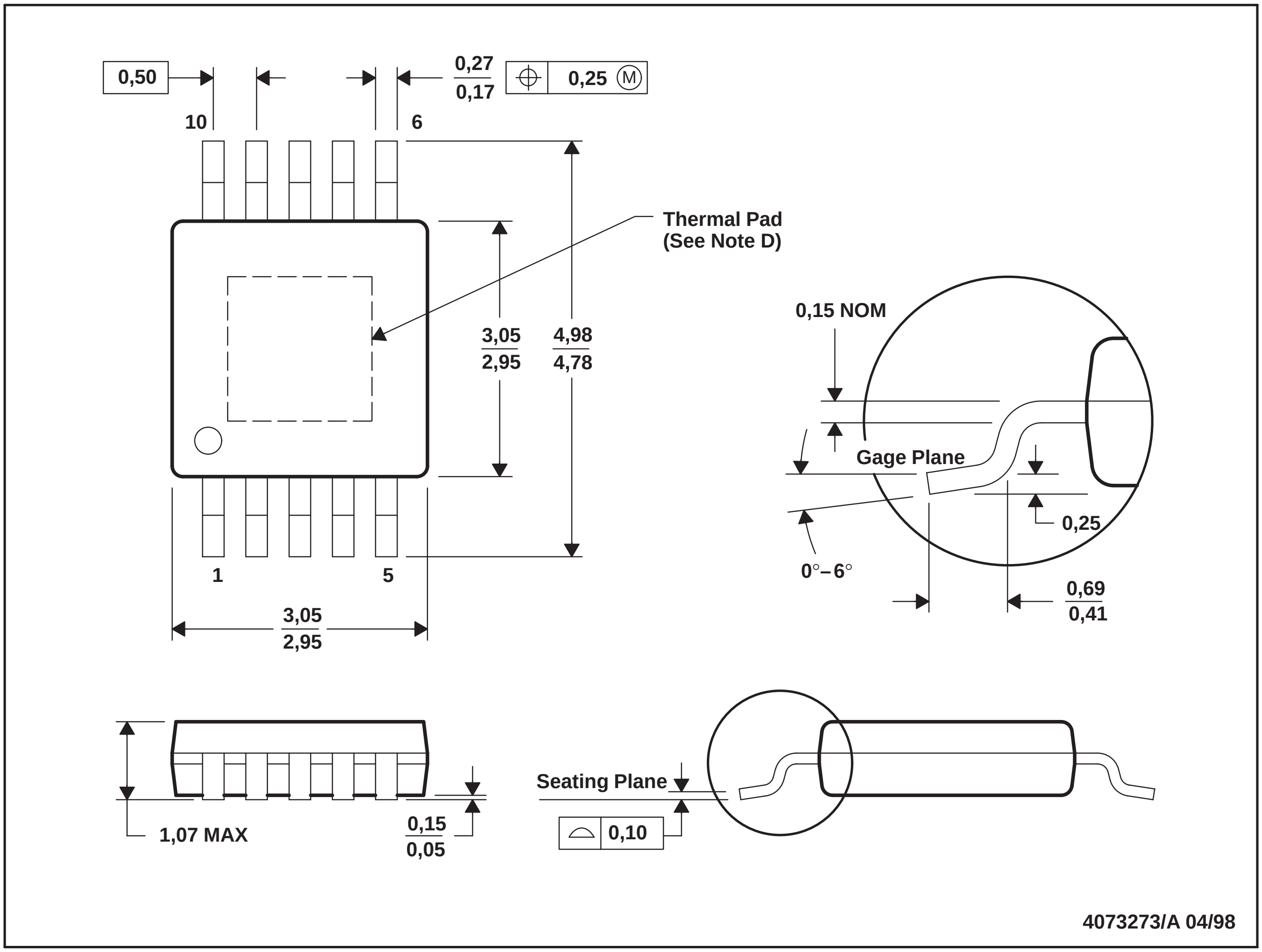


Figure 13

MECHANICAL DATA

DGQ (S-PDSO-G10) **PowerPAD™ PLASTIC SMALL-OUTLINE PACKAGE**



NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion.
D. The package thermal performance may be enhanced by bonding the thermal pad to an external thermal plane. This pad is electrically and thermally connected to the backside of the die and possibly selected leads. The dimension of the thermal pad is 1.40 mm (height as illustrated) × 1.80 (width as illustrated) mm (maximum). The pad is centered on the bottom of the package.