IT4992

2.3-Watt Low Noise Stereo Audio Power Amplifier

Feature

- 2.3V -5.5V operation range
- Output power
  - 2.3 W into 4Ω at 5V Supply at THD=10% (Typ.)
  - 1.35 W into 8Ω at 5V Supply at THD=1% (Typ.)
  - 450 mW into 8Ω at 3V Supply at THD=1% (Typ.)
  - 320 mW into 8Ω at 2.6V Supply at THD=1% (Typ.)
- Low quiescent current
  - 7mA Typical at VDD=5V
  - Shutdown current < 0.1uA
- High signal-to-noise ratio performance
  - Po=1W, f=1KHz, SNR=101 dB (A-weighting) at VDD=5V
- Ultra low noise (12u Vrms, A-weighting) and output offset voltage
- Thermal shutdown protection
- No output coupling capacitors, snubber networks or bootstrap capacitors required
- Unity-gain stable
- External gain configuration capability

Applications

- Mobile phones
- PDAs
- Portable electronic devices

General Description

The IT4992 is a dual bridge-connected audio power amplifiers, capable of delivering 1.35W of continuous average power to an 8 BTL with less than 1% distortion (THD+N) from a 5.0V power supply, and 320mW to an 8 BTL load from a 2.6V power supply. For the low current consumption applications, the SHDNB mode is supported to disable the IT4992 when it is idle. The current consumption can be further reduced to below 0.1uA. The IT4992 contains over temperature protection, preventing IT4992 from damages of temperature. For maximum flexibility, the IT4992 provides an externally controlled gain (with resistors), as well as an externally controlled turn-on time (with the bypass capacitor). The IT4992 is available in a 3mm×3mm QFN-16 package.

Typical Application Circuit

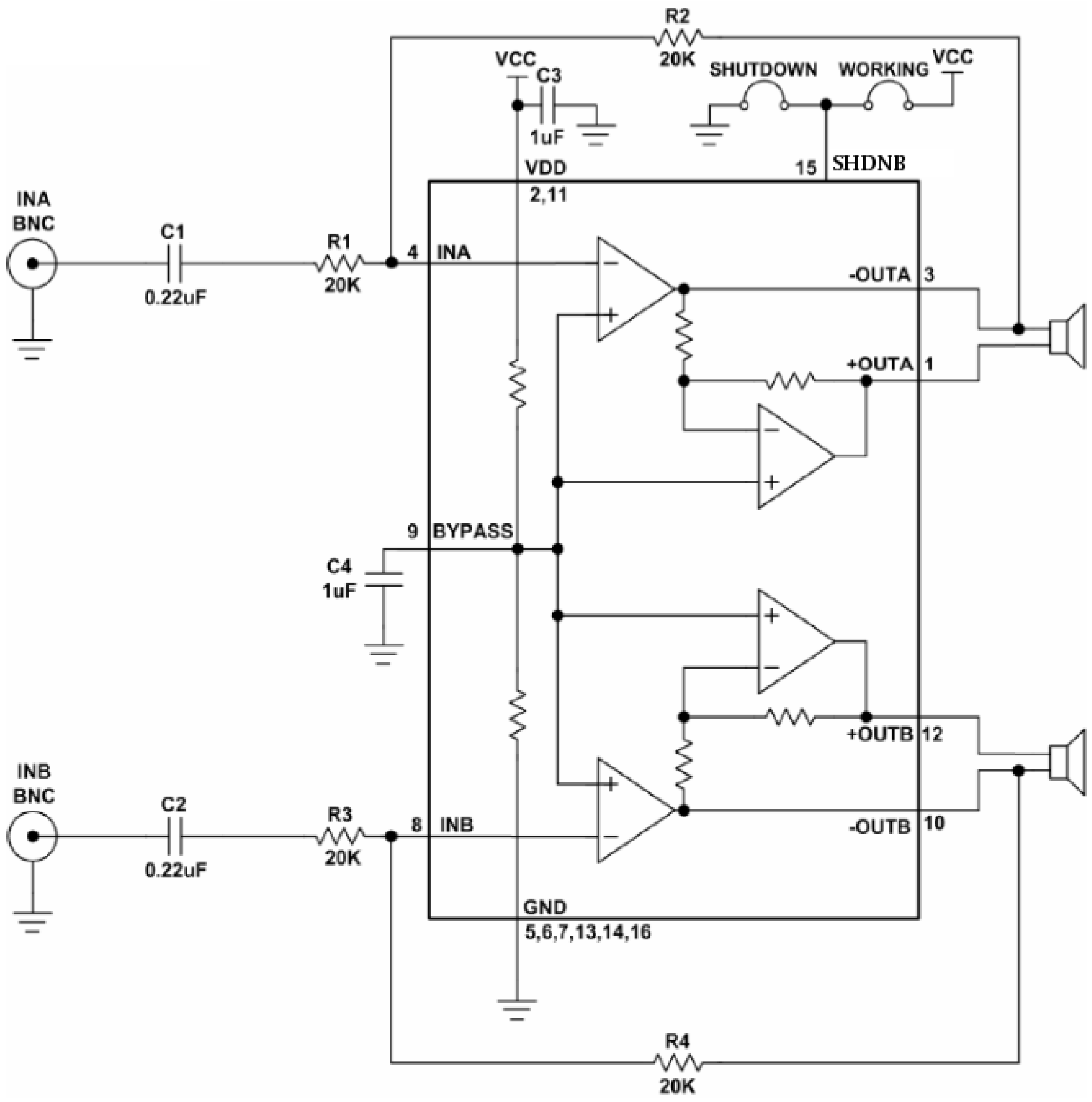


Figure1.

Pin Assignment

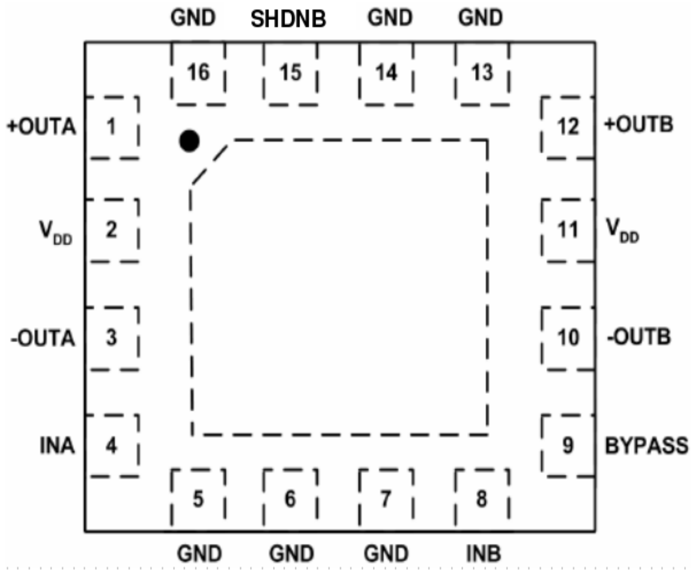


Figure2. QFN-16 package 3mm*3mm (Top View)

Pin Description

Pin	Pin Name	I/O	Description
1	+OUTA	O	Left channel positive output
2,11	V_{DD}		Analog VDD input supply
3	-OUTA	O	Left channel negative output
4	INA	I	Left channel input, receives the audio input signal
8	INA	I	Right channel input, receives the audio input signal
9	BYPASS		Bypass capacitor pin which provides the common mode voltage
10	-OUTB	O	Right channel negative output
12	+OUTB	O	Right channel positive output
15	SHDNB	I	Shutdown control, hold low for shutdown mode
5,7,13,14,16	GND		Ground connection for circuitry

Absolute Maximum Ratings

Supply Voltage.. 5.5 V

Input Voltage.. -0.3V to V_{DD}+0.3V

Maximum Junction Temperature...150 ℃

Storage Temperature Range.. -65 ℃~ 150 ℃

Recommended Operating Conditions

Supply Voltage.. 2.5V ~ 5V

Operating free-air temperature.. -40 ℃ ~ 85 ℃

Electrical Characteristics ,VDD=5V, T_A=25°C

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Quiescent current	VIN =0V, IO =0A		7	10	mA
Shutdown current	V_{SHDNB} =0V		0.1	1	uA
Shutdown Voltage Input High		1.1			V
Shutdown Voltage Input Low				0.9	V
Output Offset Voltage	VIN =0V		2	5	mV
Resistor Output GND			100		kΩ
Output Power (4Ω)	THD=10%, f=1kHz		2.3		W
Output Power (8Ω)	THD=1%, f=1kHz		1.35		W
Turn-on Time	1 F bypass capacitor		400		ms
Thermal Shutdown Temperature		120	150		℃
Total Harmonic Distortion + Noise	Po=1Wrms, RL=8 ,f=1kHz		0.05		%
Signal-to-Noise Ratio	Po=1Wrms, f=1kHz; None		99		dB
	Po=1Wrms, f=1kHz; A-weighting		101		
Output Noise Voltage	A-weighting		12		uVrms
Power Supply Rejection Ratio	Vripple=200mV sine p-p Input Terminated with to ground		54(f=217) 68(f=1K)		dB
Channel separation	f=1kHz, Cbypass=1 F		95		dB

Electrical Characteristics ,VDD=3V, T_A=25°C

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Quiescent Current	VIN =0V, IO =0A		5	7	mA
Shutdown Current	V_{SHDNB} =0V		0.1	1	uA
Shutdown Voltage Input High		1.2			V
Shutdown Voltage Input Low				0.4	V

Output Offset Voltage			2	5	mV
Resistor Output GND			100		kΩ
Output Power (8Ω)	THD=1%, f=1kHz		0.45		W
Turn-on Time			285		ms
Thermal Shutdown Temperature		120	150		℃
Total Harmonic Distortion + Noise	Po=0.25Wrms, RL=8, f=1kHz		0.07		%
Channel separation	f=1kHz, Cbypass=1 F		95		dB
Power Supply Rejection Ratio	Vripple=200mV sine p-p Input Terminated with to ground		57(f=217) 71(f=1K)		dB

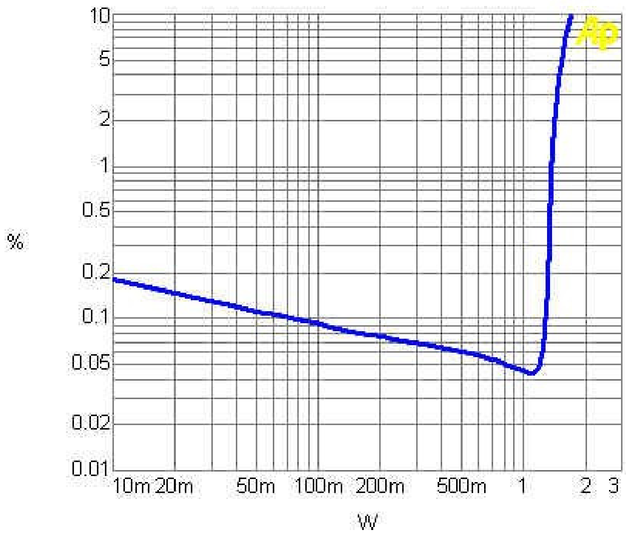
Electrical Characteristics ,VDD=2.6V, T_A=25°C

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Quiescent Current	VIN =0V, IO =0A		4.5	6	mA
Shutdown Current	V_{SHDNB} =0V		0.1	1	uA
Output Power (8Ω)	THD=1%, f=1kHz		0.32		W
Total Harmonic Distortion + Noise	Po=0.15Wrms, RL=8, f=1kHz		0.08		%
Power Supply Rejection Ratio	Vripple=200mV sine p-p Input Terminated to ground		57(f=217) 72(f=1K)		dB

Typical Operating Characteristics

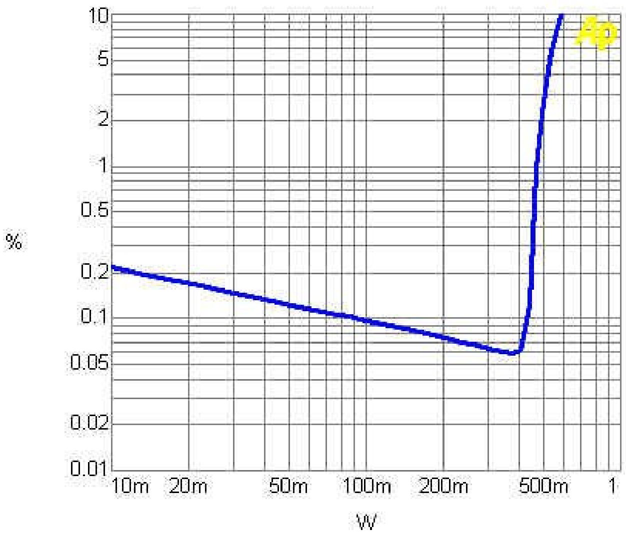
THD+N vs Output Power

VDD=5V, RL=8ohm, f=1KHz



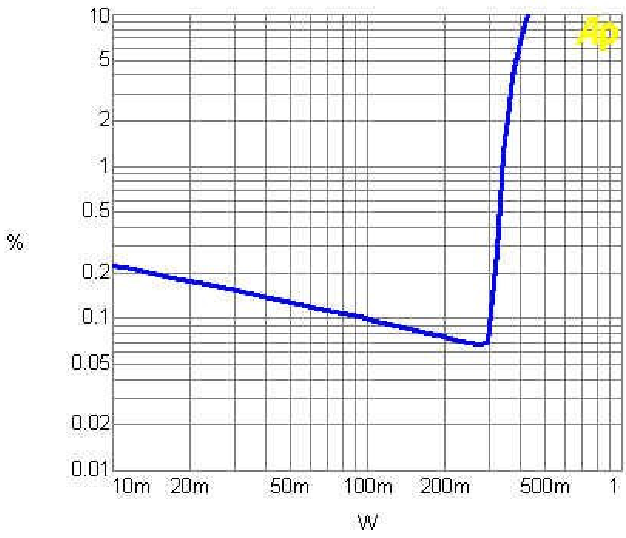
THD+N vs Output Power

VDD=3V, RL=8ohm, f=1KHz



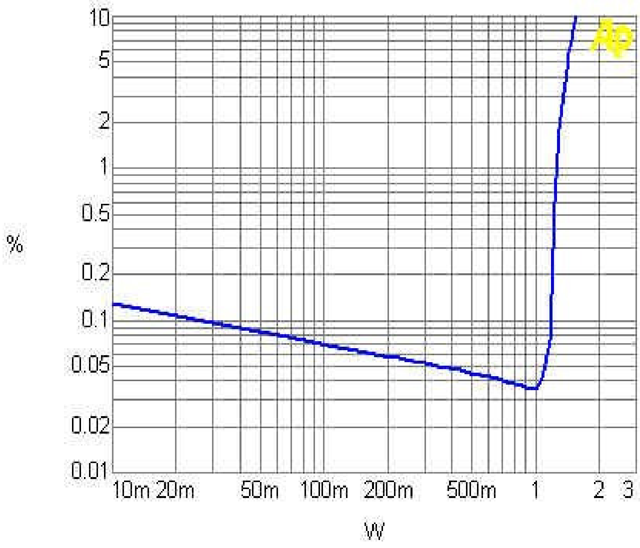
THD+N vs Output Power

VDD=2.6V, RL=8ohm, f=1KHz



THD+N vs Output Power

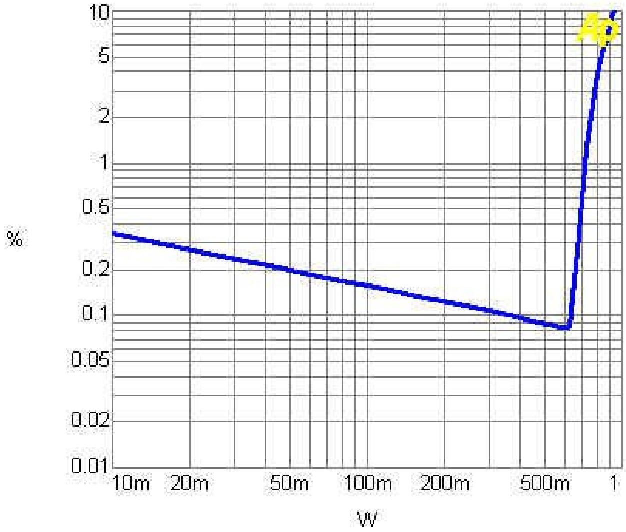
VDD=5V, RL=4ohm, f=1KHz



Typical Operating Characteristics (continued)

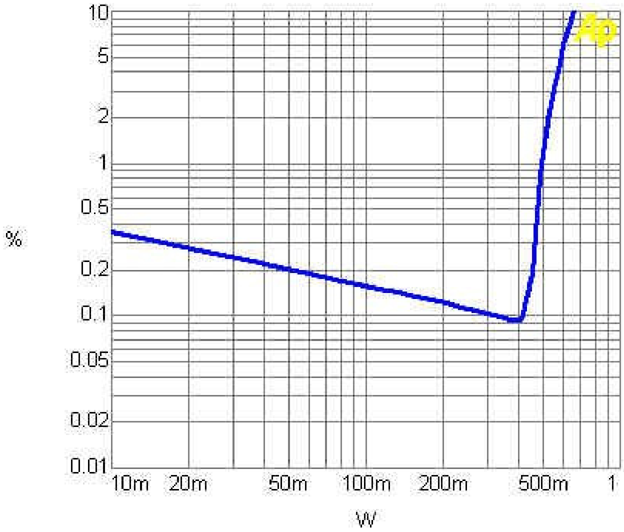
THD+N vs Output Power

VDD=3V, RL=4ohm, f=1KHz



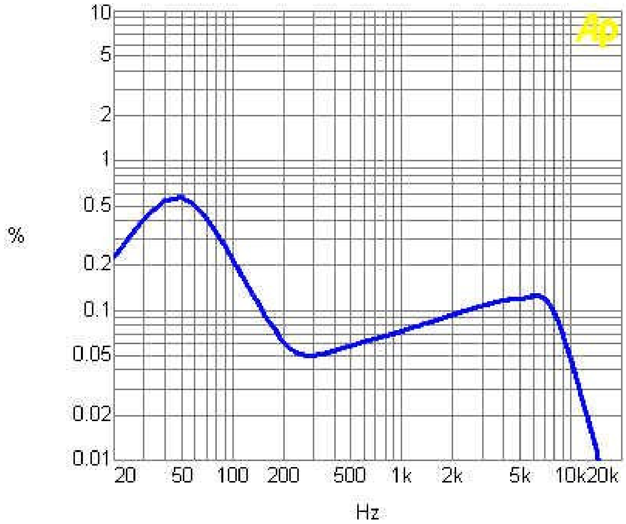
THD+N vs Output Power

VDD=2.6V, RL=4ohm, f=1KHz



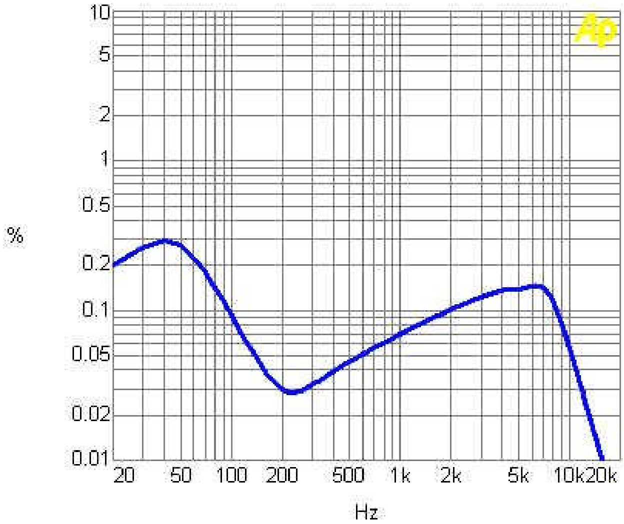
THD+N vs Frequency

VDD=5V, RL=8ohm, Po=500mW



THD+N vs Frequency

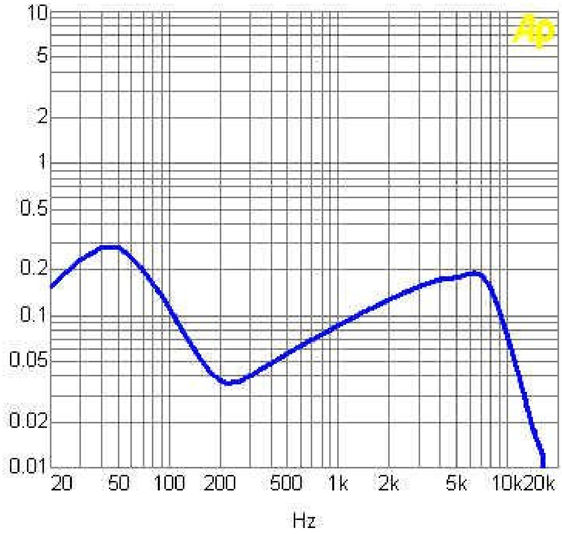
VDD=3V, RL=8ohm, Po=250mW



Typical Operating Characteristics (continued)

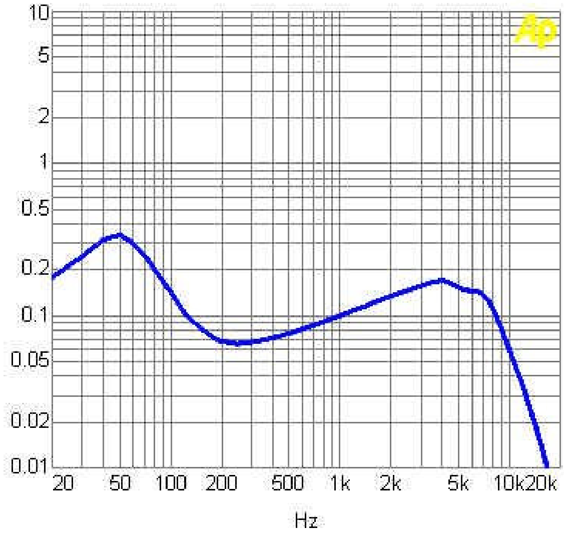
THD+N vs Frequency

VDD=2.6V, RL=8ohm, Po=150mW



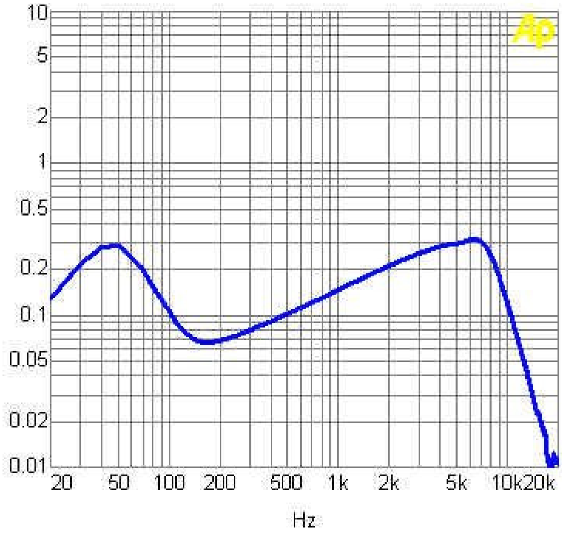
THD+N vs Frequency

VDD=3V, RL=4ohm, Po=500mW



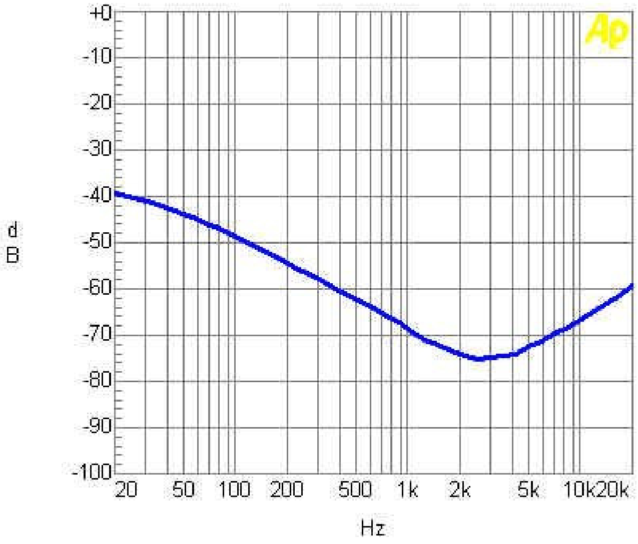
HD+N vs Frequency

VDD=2.6V, RL=4ohm, Po=150mW



PSRR vs Frequency

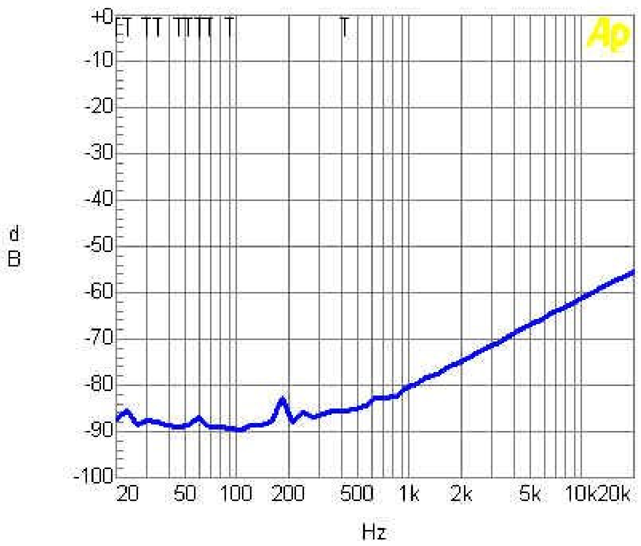
VDD=5V, RL=8ohm, input ground



Typical Operating Characteristics (continued)

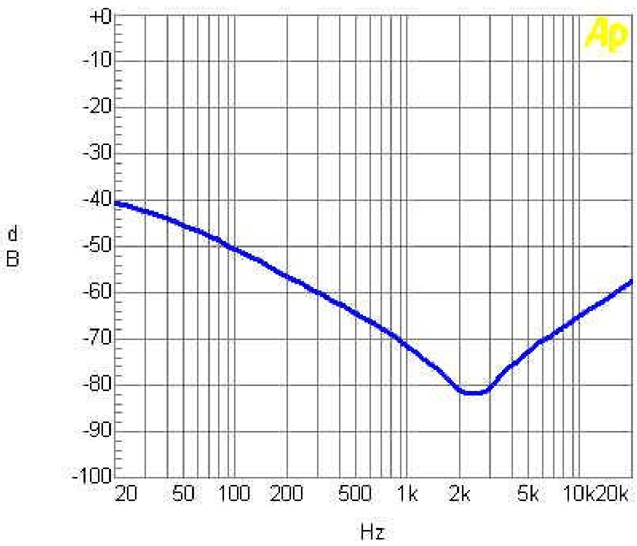
PSRR vs Frequency

VDD=5V, RL=8ohm, input floating



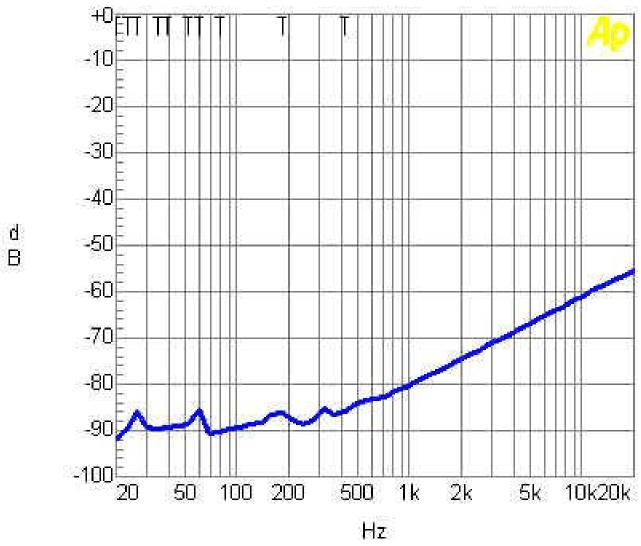
PSRR vs Frequency

VDD=3V, RL=8ohm, input ground



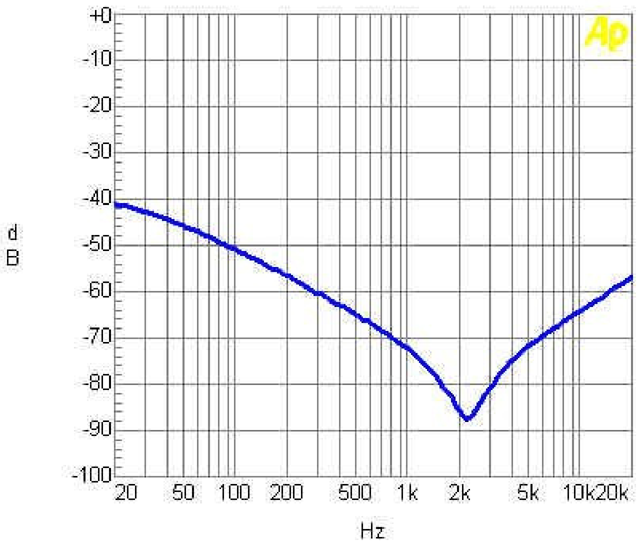
PSRR vs Frequency

VDD=3V, RL=8ohm, floating



PSRR vs Frequency

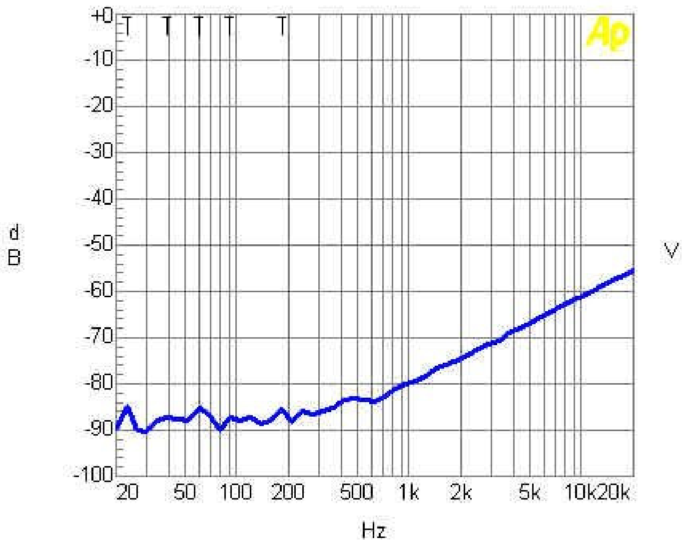
VDD=2.6V, RL=8ohm, input ground



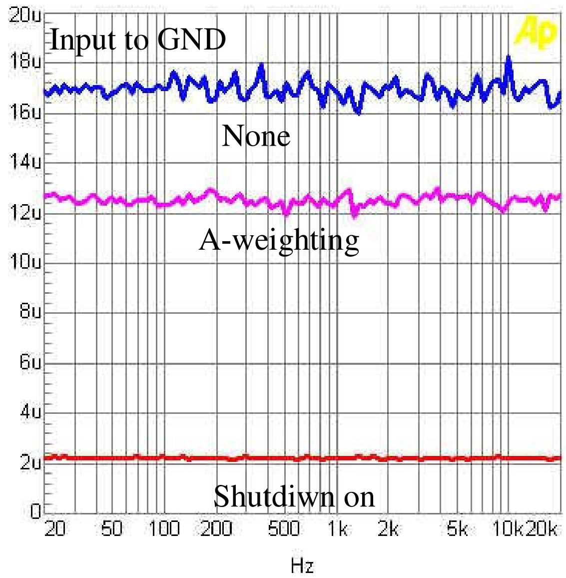
Typical Operating Characteristics (continued)

PSRR vs Frequency

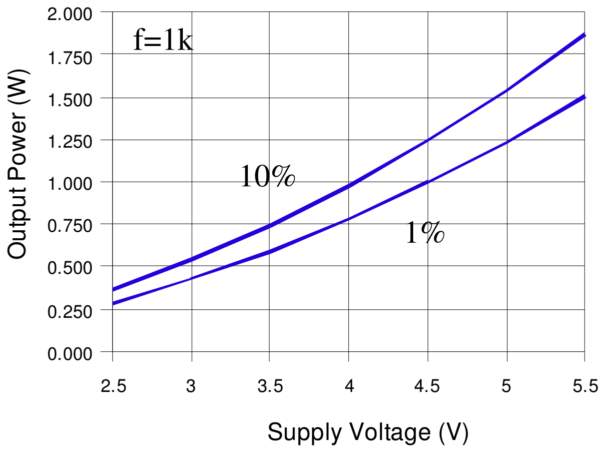
VDD=2.6V, RL=8ohm, input floating



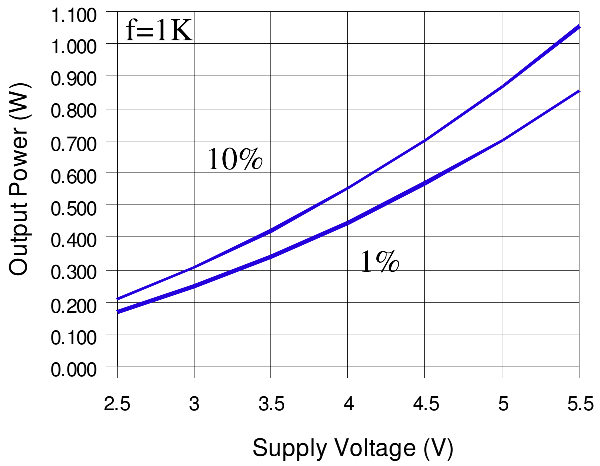
Noise Floor, 5V, 8ohm



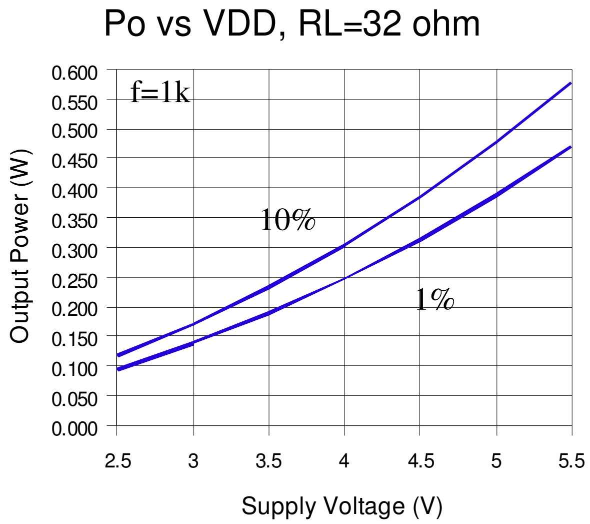
Po vs VDD, RL=8 ohm

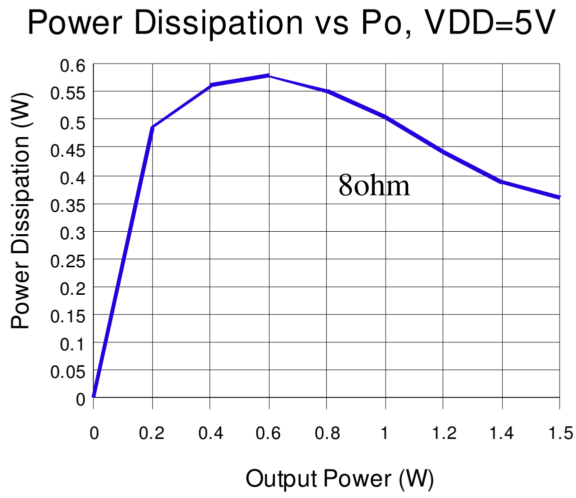


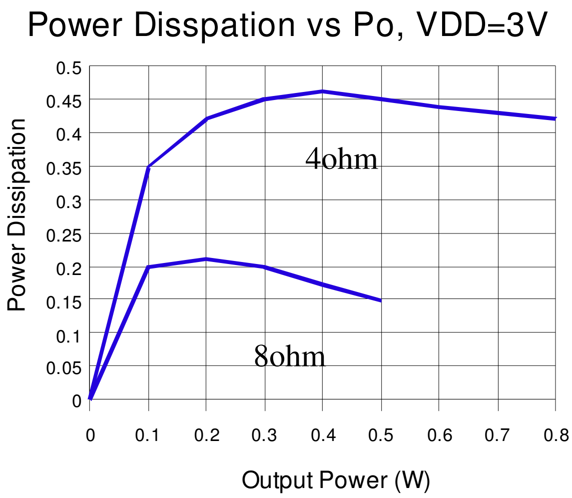
Po vs VDD, RL=16 ohm

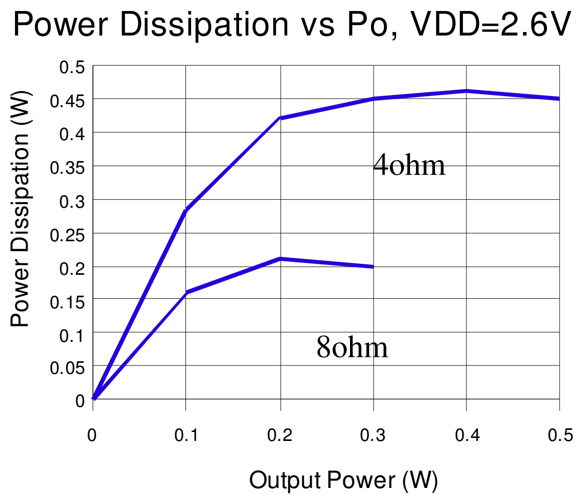


Typical Operating Characteristics (continued)









Application Information

Bridged Configuration Explanation

The structure of the IT4992 is basically composed of two pairs of power amplifiers, forming a two channel (channel A and channel B) stereo amplifier;(Though the following discusses channel A, it applies equally to channel B) the first one is externally configurable with gain-setting resistors R_{in} and R_f (the closed-loop gain is fixed by the ratios of theses resistors) and the second is internally fixed in an inverting unity-gain configuration by two resistors of 20kΩ. So the load is driven differentially through -OUTA and -OUTA outputs. This configuration eliminates the need for an output coupling capacitor.

The Bridge amplifier presents two major advantages:

- The possible output power is four times larger (the output swing is doubled) as compared to single-ended amplifier under the same conditions.
- Output pins (-OUTA and -OUTA) are biased at the same potential $V_{DD}/2$, this eliminates the need for an output coupling capacitor required with a single-ended amplifier configuration.

The differential closed loop-gain of the amplifier is given by $Av=2*(R_f/R_{in})$

Power Dissipation

Power dissipation is a major concern when designing a successful amplifier, whether the amplifier is bridged or single-ended. A direct consequence of the increased power delivered to the load by a bridge amplifier is an increase in internal power dissipation. Since the IT4992 has two operational amplifiers in one package, the maximum internal power dissipation is 4 times that of a single-ended amplifier. The maximum power dissipation for a given application can be derived from the power dissipation graphs of from equation1.

$$P_{DMAX}=4*(V_{DD}^2/(2\ {}^2R_L)) \quad \text{------(1)}$$

It is critical that the maximum junction temperature T_{JMAX} of 150°C is not exceeded. T_{JMAX} can be determine from the power de-rating curves by using P_{DMAX} and the PC board foil area. By adding additional copper foil, the thermal resistance of the application can be reduced, resulting in higher P_{DMAX}. Additional copper foil can be added to any of the leads connected to the IT4992. If T_{JMAX} still exceeds 150°C, then additional changes must be made. These changes can include reduced supply voltage, higher load impedance, or reduced ambient temperature. Internal power dissipation is a function of output power.

Proper Selection of External Components

The IT4992 is unity-gain stable and requires no external components besides gain-setting

resistors, and
input coupling capacitor and proper bypassing capacitor in the typical application.

Gain-Setting Resistor Selection (R$_{in}$ and R$_f$)

R_{in} and R_f set the closed-loop gain of the amplifier. In order to optimize device and system performance, the IT4992 should be used in low gain configurations. The low gain configuration minimizes THD + noise values and maximizes the signal to noise ratio, and the amplifier can still be used without running into the bandwidth limitations. Low gain configurations require large input signals to obtain a given output power. Input signals equal to or greater than 1Vrms are available from sources such as audio codes. A closed loop gain in the range from 2 to 5 is recommended to optimize overall system performance. An input resistor (R_{in}) value of 20kΩ is realistic in most of applications, and does not require the use of a too large capacitor C_{in}.

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Bypass Capacitors (C$_{BYPASS}$)

The bypass capacitor Cbypass provides half-supply filtering and determines how fast the IT4992 turns on. This capacitor is a critical component to minimize the turn-on pop. A 1.0µF bypass capacitor value (Cin=＜ 0.39µF) should produce clickless and popless shutdown transitions. The amplifier is still functional with a 0.1µF capacitor value but is more susceptible to pop and click noise. Thus, a 1.0µF bypassing capacitor is recommended.

Input Capacitor (C$_{in}$)

The input coupling capacitor blocks the DC voltage at the amplifier input terminal. This capacitor creates a high-pass filter with Rin, the cut-off frequency is given by

$$f_c=1/(2\quad R_{in}*C_{in})$$

The size of the capacitor must be large enough to couple in low frequencies without severe attenuation. However a large input coupling capacitor requires more time to reach its quiescent DC voltage ($V_{DD}/2$) and can increase the turn-on pops. An input capacitor value between 0.1µF and 0.39µF performs well in many applications (with R_{in}=22kΩ).

Power Supply Bypassing Capacitor (C$_S$)

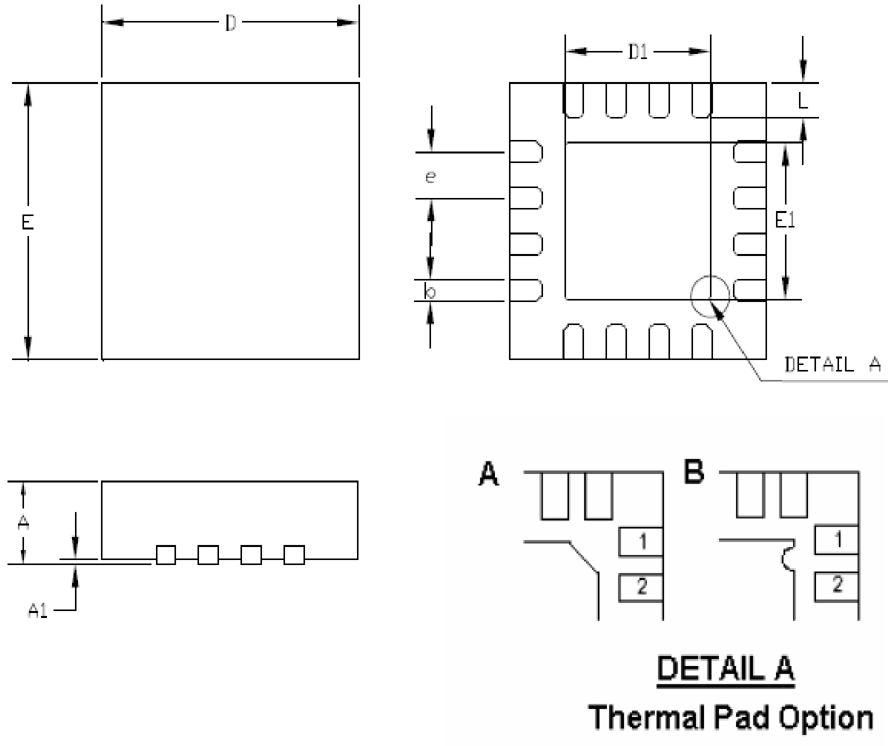
As with any amplifier, proper supply bypassing is critical for low noise performance and high power supply rejection. The capacitor location on both the bypass and power supply pins should be as close to the device is possible.

Thermal Pad Considerations

The thermal pad must be connected to ground. The package with thermal pad of the IT4992 requires special attention on thermal design. If the thermal design issues are not properly addressed, the IT4992 will go into thermal shutdown when driving a heavy load. The thermal pad on the bottom of the IT4992 should be soldered down to a copper pad on the circuit board. Heat can be conducted away from the thermal pad through the copper plane to ambient. If the copper plane is not on the top surface of the circuit board, 8 to 10 vias of 13 mil or smaller in diameter should be used to thermally couple the thermal pad to the bottom plane. For good thermal conduction, the vias must be plated through and solder filled. The copper plane used to conduct heat away from the thermal pad should be as large as practical. If the ambient temperature is higher than 25℃,a larger copper plane or forced-air cooling will be required to keep the IT4992 junction temperature below the thermal shutdown temperature (150℃). In higher ambient temperature, higher airflow rate and/or larger copper area will be required to keep the IC out of thermal shutdown.

Package Information

TQFN-16 (3mm×3mm)



SYMBOLS	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	0.70	0.80	0.028	0.031
A1	0.00	0.05	0.000	0.002
b	0.18	0.30	0.007	0.012
E	2.90	3.10	0.114	0.122
D	2.90	3.10	0.114	0.122
D1	1.70		0.067	
E1	1.70		0.067	
e	0.50		0.020	
L	0.30	0.50	0.012	0.020