IT4990

1.37-Watt Low Noise Audio Power Amplifier

Feature

- 2.3V -5.5V operation range
- Output power
  - 1.37 W into 8Ω at 5V Supply at THD=1% (Typ.)
  - 470 mW into 8Ω at 3V Supply at THD=1% (Typ.)
  - 340 mW into 8Ω at 2.6V Supply at THD=1% (Typ.)
- Low quiescent current
  - 2.5mA 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 IT4990 is an audio power amplifier designed for portable communication device applications such as mobile phone applications. The IT4990 is capable of delivering 1.37W of continuous average power to an 8Ω BTL load and with less than 1% distortion (THD+N) from a 5V power supply, and 470mW to a 8Ω BTL load from a 3V power supply. The IT4990 provides high quality output power while requiring few external components and minimal power consumption. It features a low-power shutdown mode, which is achieved by driving the SHDNB pin with logic low. For maximum flexibility, the IT4990 provides an externally controlled gain (with resistors), as well as an externally controlled turn-on time (with the bypass capacitor). The IT4990 is available in a 1.4mm×1.4mm WCSP package.

Typical Application Circuit

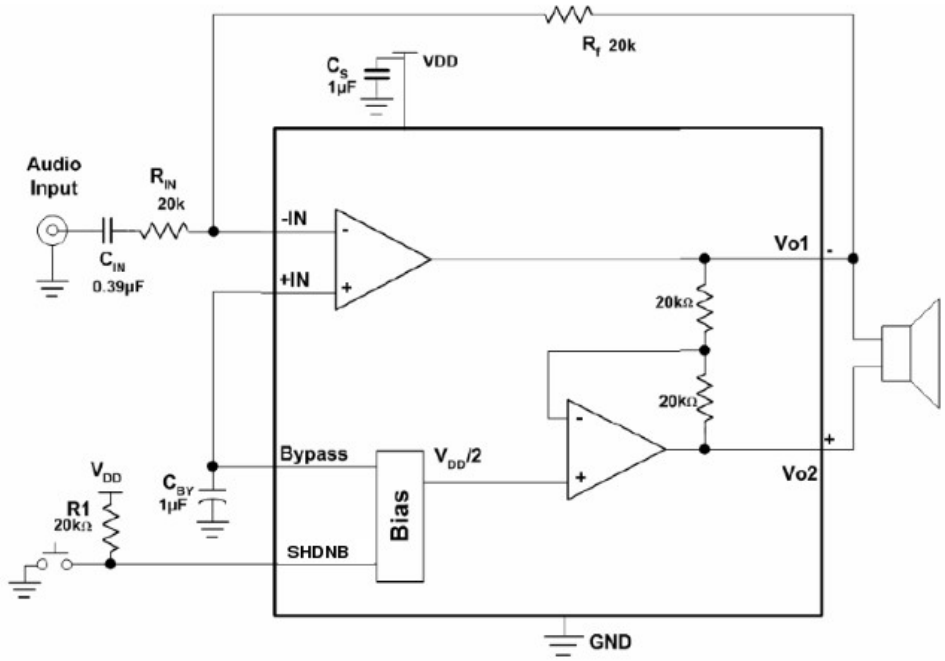


Figure1. Audio Amplifier with Single-ended Input

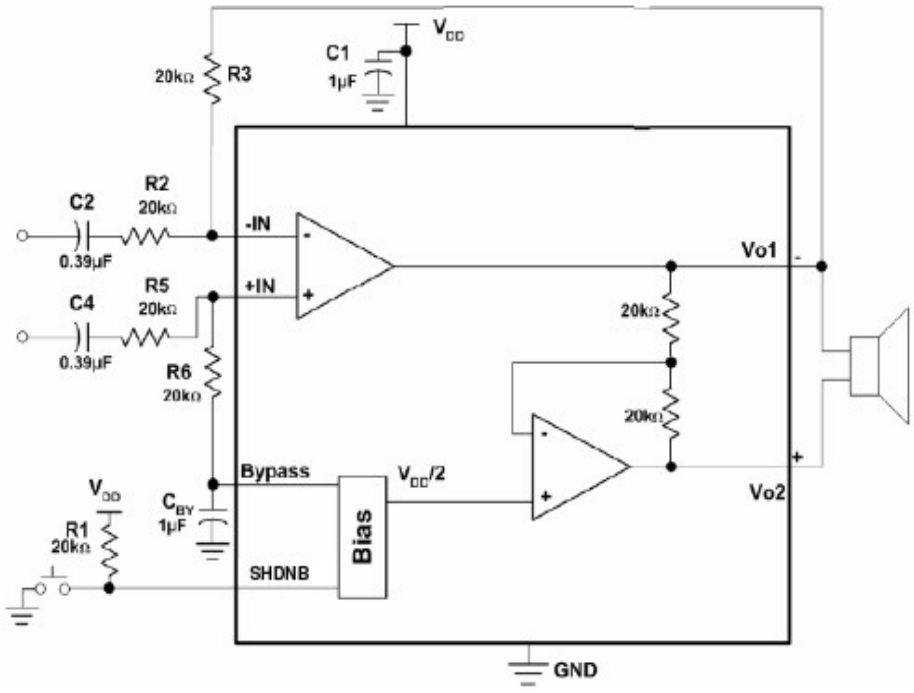


Figure2. Audio Amplifier with Differential Input

Pin Assignment

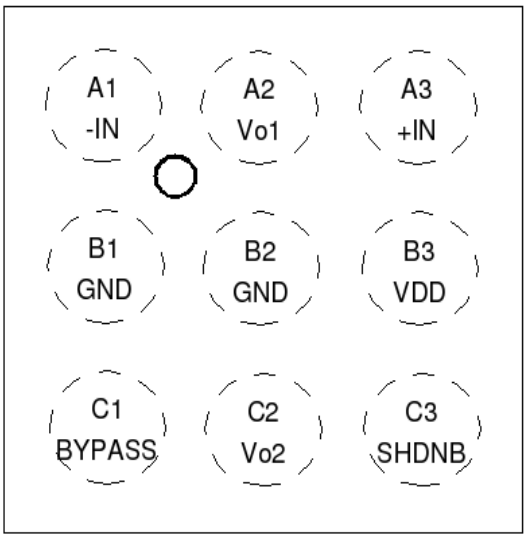


Figure3. WCSP-9 package 1.4mm*1.4mm (Top View)

Pin Description

Pin	Pin Name	Pin	I/O	Description
1	SHDNB	C3	I	The device enters in shutdown mode when a low level is applied on this pin
2	BYPASS	C1	I	Bypass capacitor pin which provides the common mode voltage
3	+IN	A3	I	Positive input of the first amplifier, receives the common mode voltage
4	-IN	A1	I	Negative input of the first amplifier, receives the audio input signal. Connected to the feedback resistor R_f and to the input resistor R_{in}
5	V_{O1}	A2	O	Negative output of the IT4990. Connected to the load and to the feedback resistor R_f
6	V_{DD}	B3	I	Analog VDD input supply
7	GND	B1/ B2		Ground connection for circuitry
8	V_{O2}	C2	O	Positive output of the IT4990

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, No load			2.2	3.2	mA
	VIN =0V, IO =0A, 8Ω load			2.5	3.5	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				10		kΩ
Output Power (8Ω)	THD=1%, f=1kHz			1.37		W
Wake-Up Time				400		ms
Thermal Shutdown Temperature			120	150		℃
Total Harmonic Distortion + Noise	Po=1Wrms, f=1kHz			0.047		%
Signal-to-Noise Ratio	Po=1Wrms, f=1kHz	None		99		dB
		A-weighting		101		
Output Noise Voltage	None			18		uVrms
	A-weighting			12		
Power Supply Rejection Ratio	Vripple=200mV sine p-p Input Terminated with to ground			54(f=217) 68(f=1K)		dB

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

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Quiescent Current	VIN =0V, IO =0A, No load		2.1	3.1	mA
	VIN =0V, IO =0A, 8Ω load		2.2	3.2	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			10		kΩ
Output Power (8Ω)	THD=1%, f=1kHz		0.47		W
Wake-Up Time			285		ms
Thermal Shutdown Temperature		120	150		℃
Total Harmonic Distortion + Noise	Po=0.25Wrms, f=1kHz		0.07		%
Power Supply Rejection Ratio	Vripple=200mV sine p-p Input Terminated with to ground		57(f=217) 71(f=1K)		dB

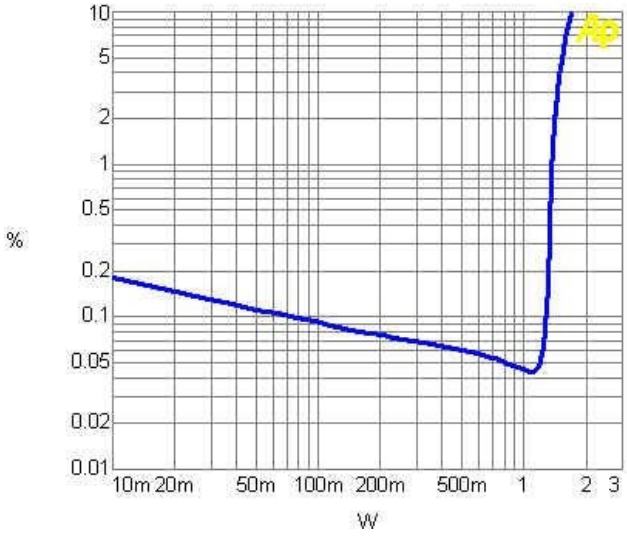
Electrical Characteristics ,VDD=2.6V, T_A=25°C

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Quiescent Current	VIN =0V, IO =0A, No load		2.1	3.1	mA
Shutdown Current	V_{SHDNB} =0V		0.1	1	uA
Output Power (8Ω)	THD=1%, f=1kHz		0.34		W
Total Harmonic Distortion + Noise	Po=0.15Wrms, f=1kHz		0.085		%
Power Supply Rejection Ratio	Vripple=200mV sine p-p Input Terminated to ground		57(f=217) 72(f=1K)		dB

Typical Operating Characteristics

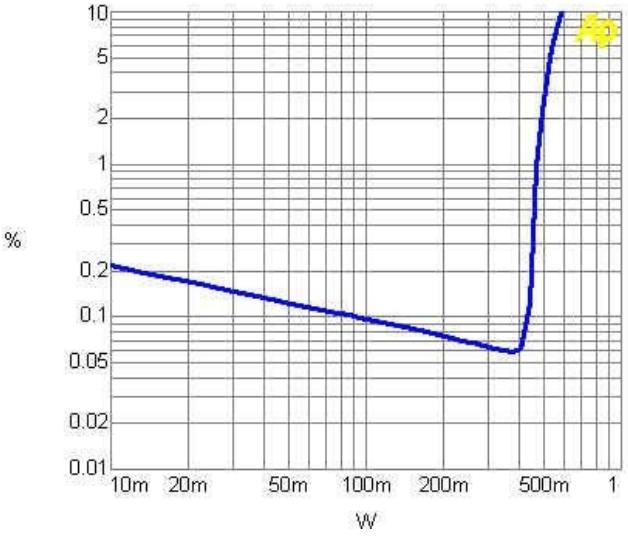
THD+N vs Output Power

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



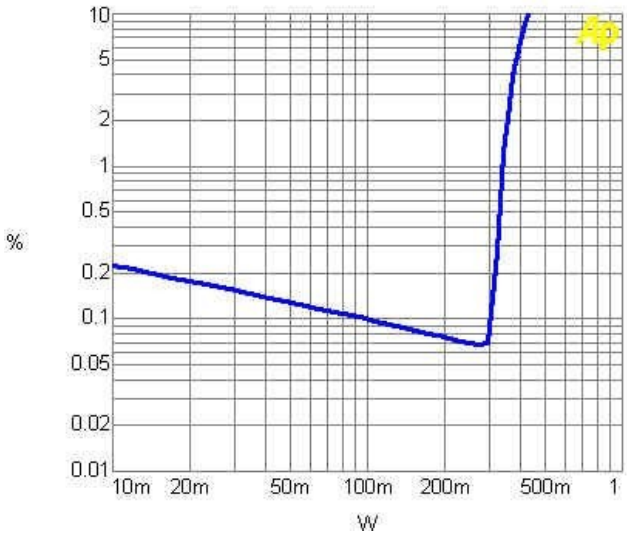
THD+N vs Output Power

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



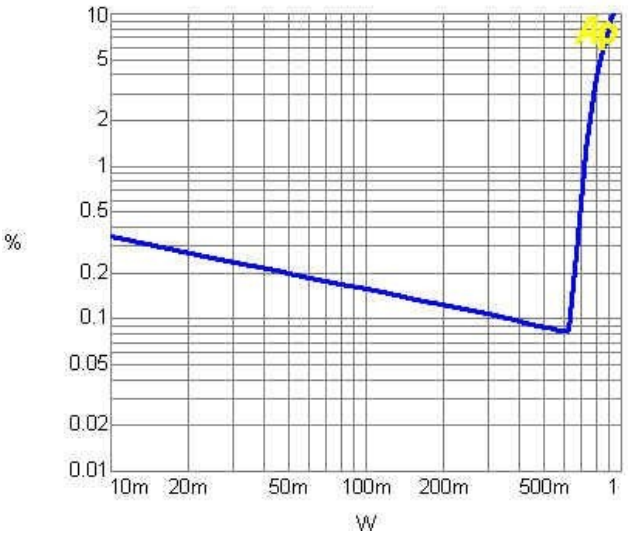
THD+N vs Output Power

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



THD+N vs Output Power

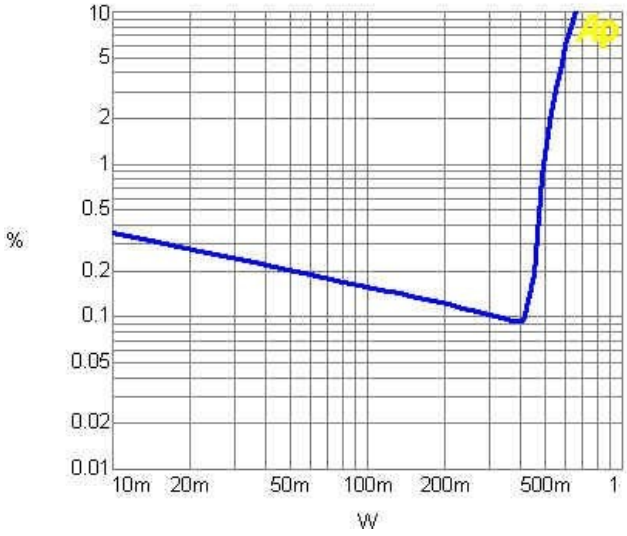
VDD=3V, RL=4ohm, f=1KHz



Typical Operating Characteristics (continued)

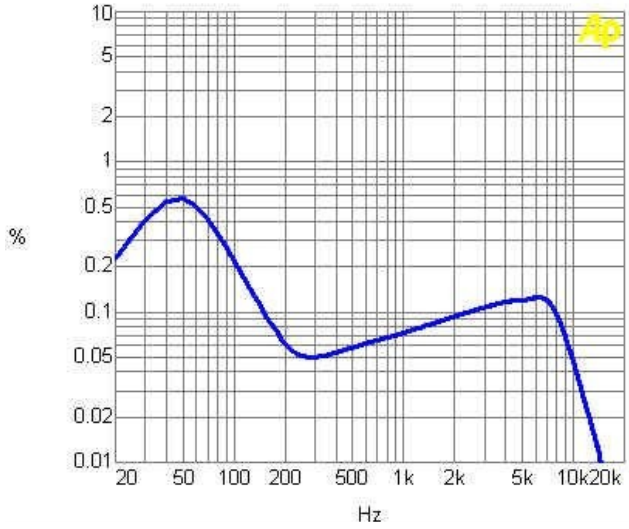
THD+N vs Output Power

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



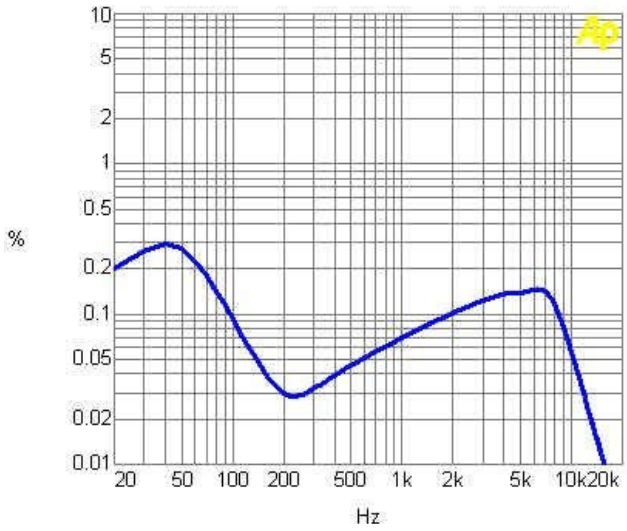
THD+N vs Frequency

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



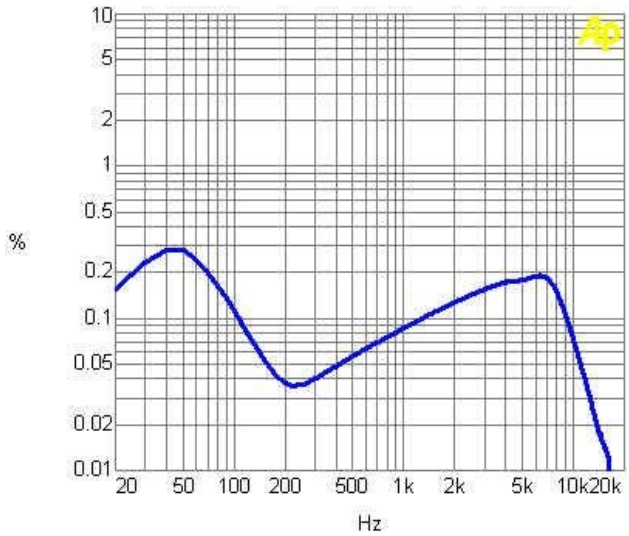
THD+N vs Frequency

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



THD+N vs Frequency

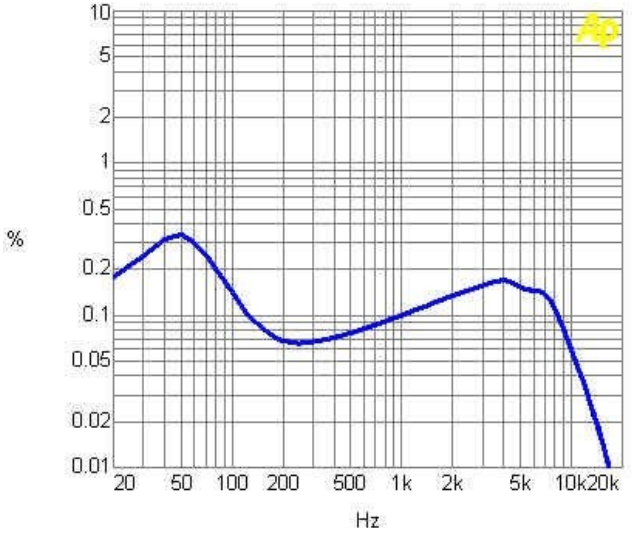
VDD=2.6V, RL=8ohm, Po=150mW



Typical Operating Characteristics (continued)

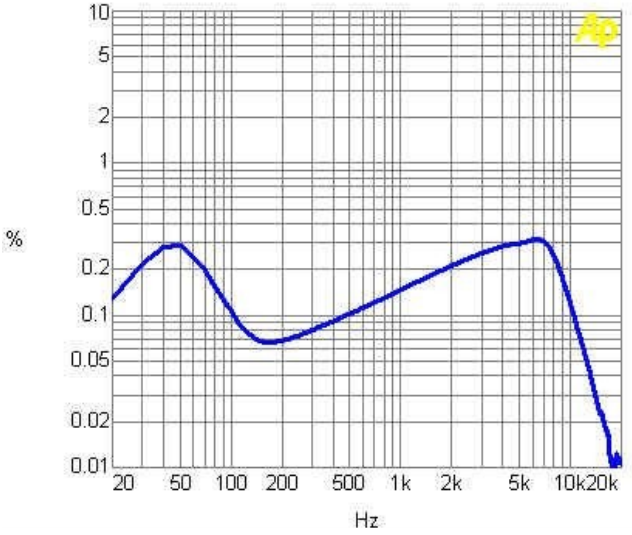
THD+N vs Frequency

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



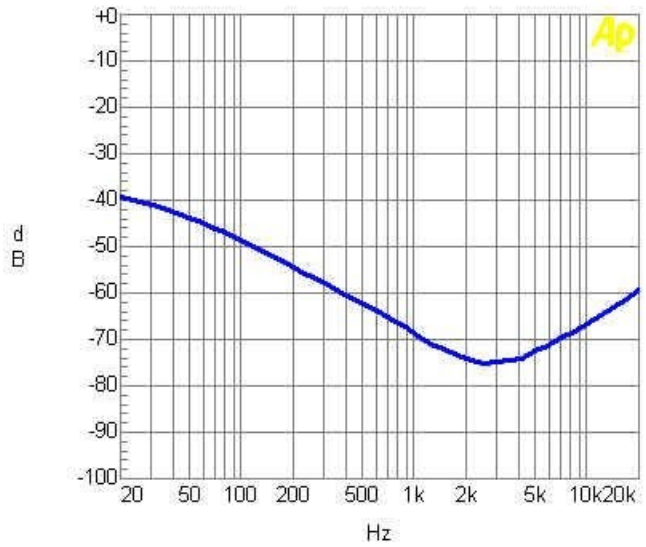
THD+N vs Frequency

VDD=2.6V, RL=4ohm, Po=140mW



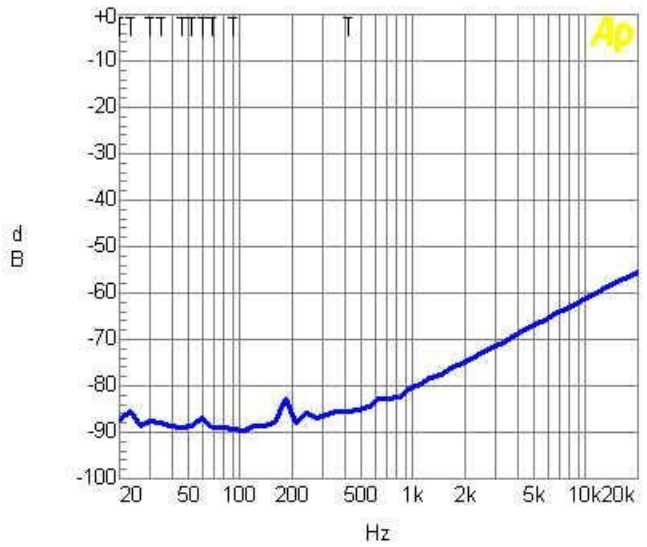
PSRR vs Frequency

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



PSRR vs Frequency

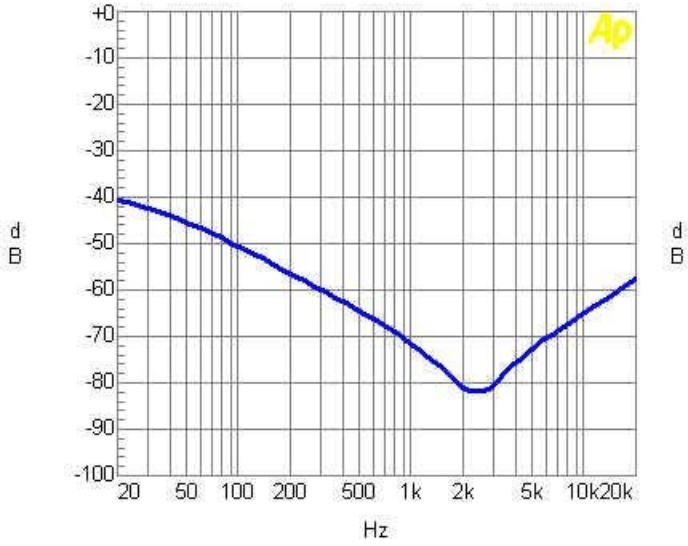
VDD=5V, RL=8ohm, input floating



Typical Operating Characteristics (continued)

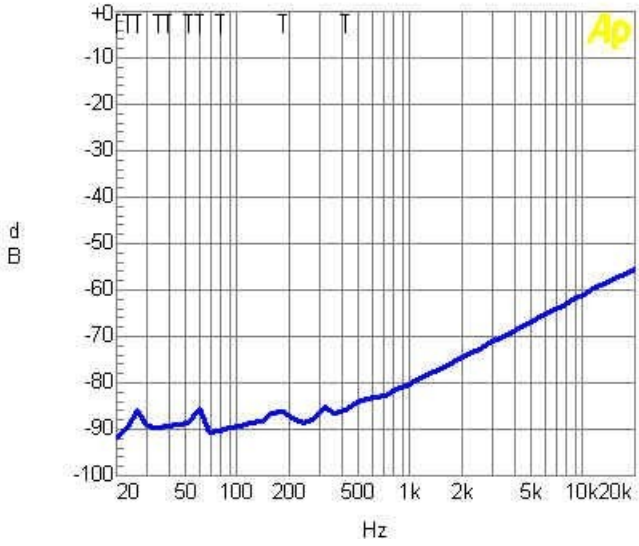
PSRR vs Frequency

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



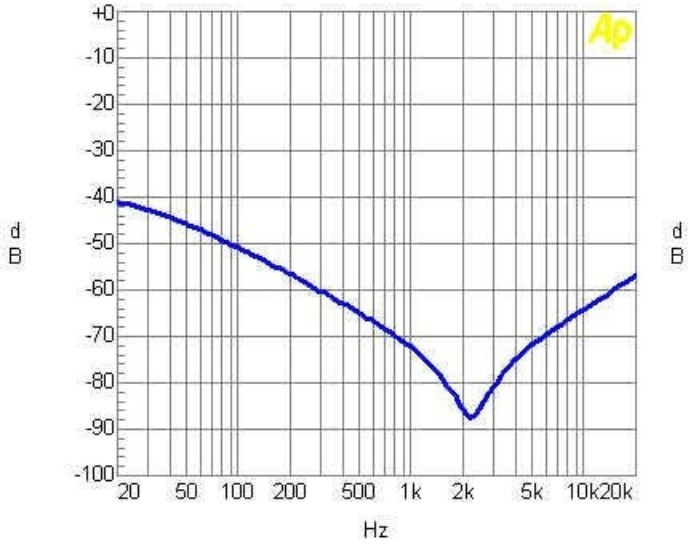
PSRR vs Frequency

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



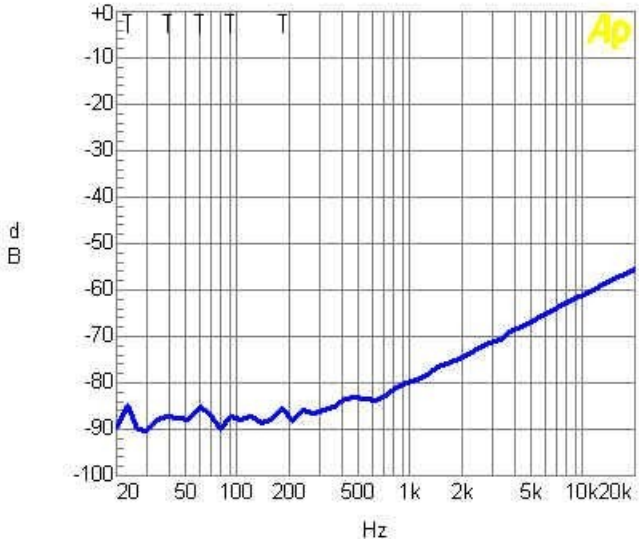
PSRR vs Frequency

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



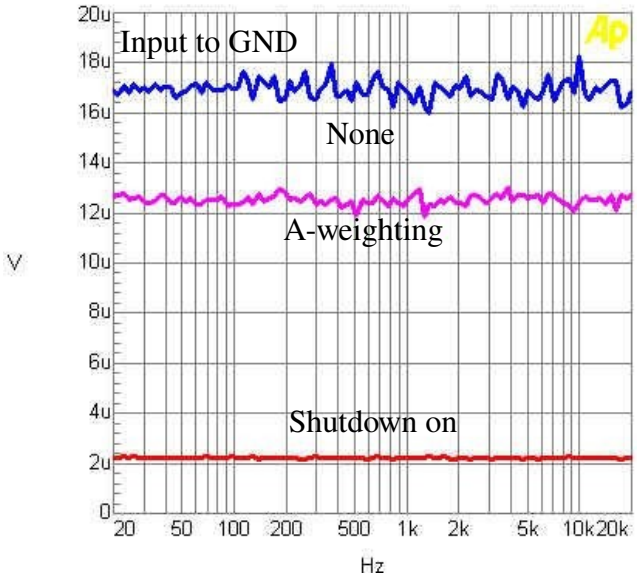
PSRR vs Frequency

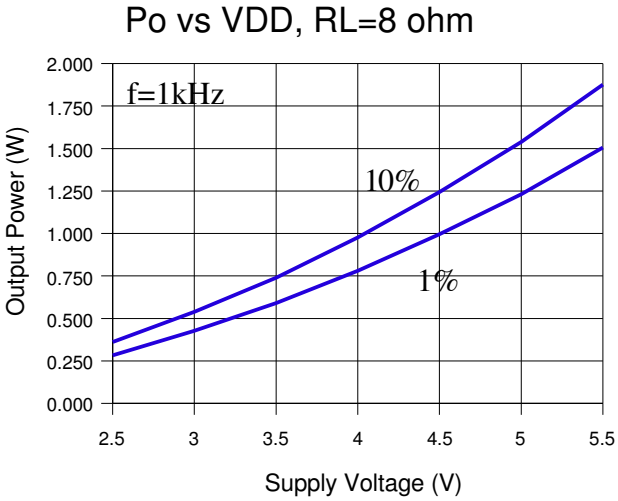
VDD=2.6V, RL=8ohm, input ground

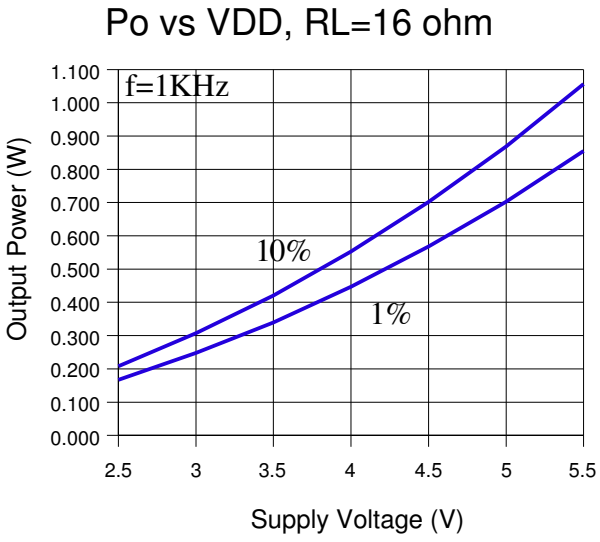


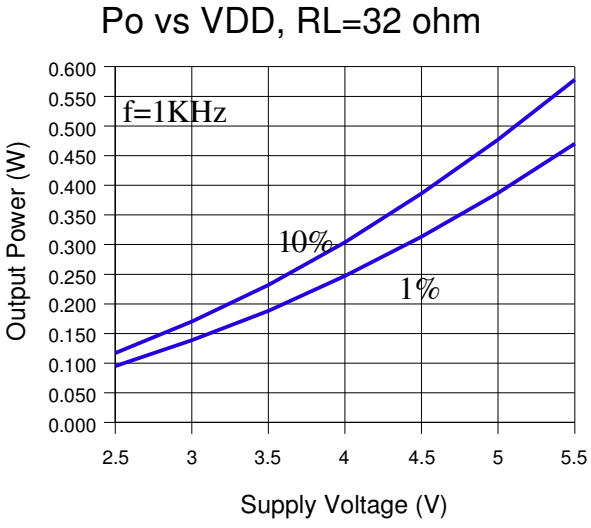
Typical Operating Characteristics (continued)

Noise Floor, 5V, 8ohm



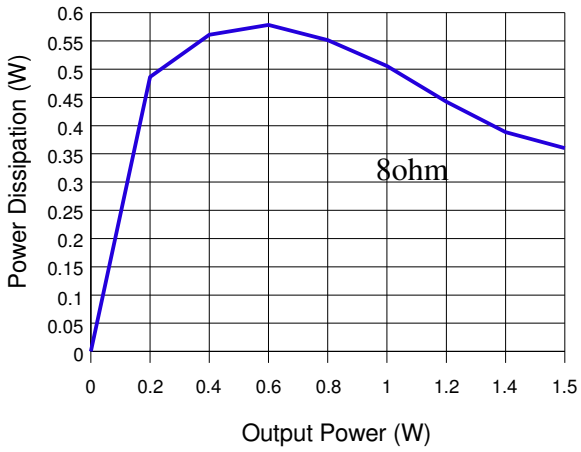




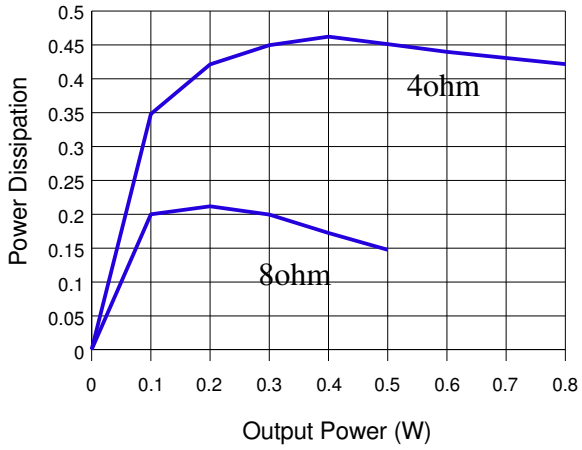


Typical Operating Characteristics (continued)

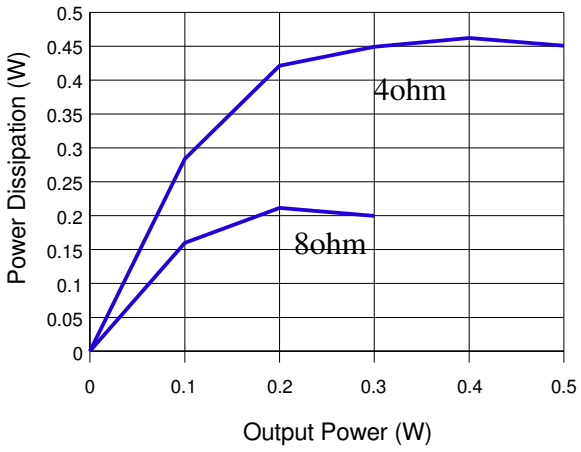
Power Dissipation vs Po, VDD=5V



Power Disspation vs Po, VDD=3V



Power Dissipation vs Po, VDD=2.6V



Application Information

Bridged Configuration Explanation

The structure of the IT4990 is basically composed of two identical internal power amplifiers; 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 Vo1 and Vo2 outputs. This configuration eliminates the need for an output coupling capacitor.

The differential-ended 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 (Vo1 and Vo2) 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 IT4990 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.

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

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 IT4990. 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 IT4990 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 IT4990 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 IT4990 turns on. This capacitor is a critical component to minimize the turn-on pop. A 1.0 μF bypass capacitor value (Cin=< 0.39 μF) should produce clickless and popless shutdown transitions. The amplifier is still functional with a 0.1 μF capacitor value but is more susceptible to pop and click noise. Thus, a 1.0 μF 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

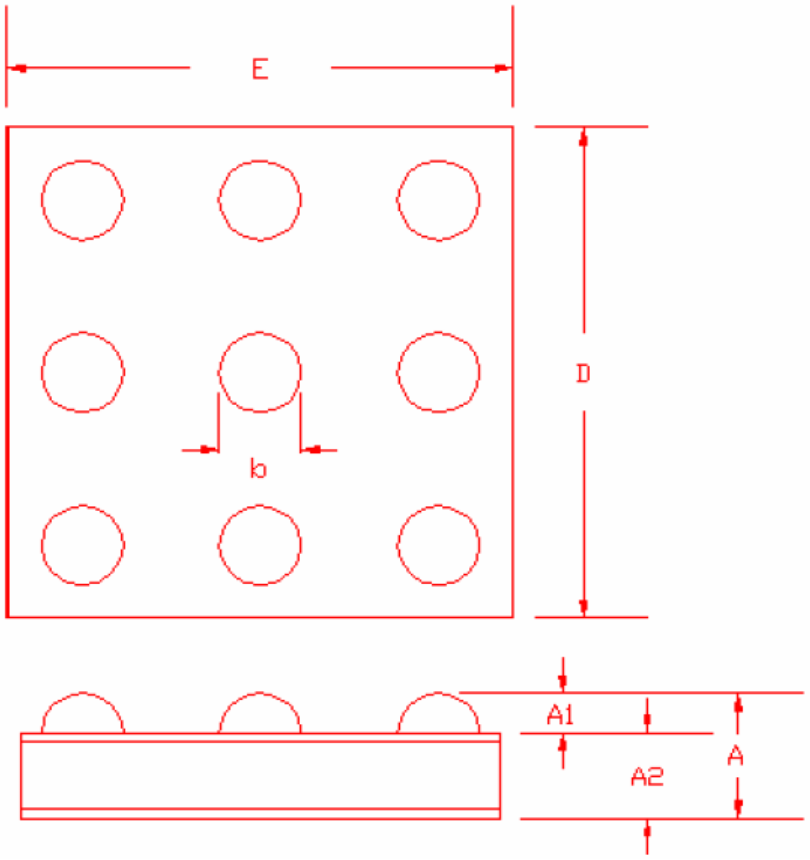
$$f_c=1/(2\pi *R_{in}*C_{in})$$

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 0.1 μFand 0.39 μF 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.

Package Information



SYMBOL	DIMENSION(mm)		
	MIN	NOM	MAX
A	0.550	0.600	0.650
A1	0.140	0.160	0.180
A2	0.391	0.440	0.490
B	0.230	0.250	0.270
E	1.350	1.400	1.450
D	1.350	1.400	1.450
MIN. Ball pitch: 0.500			