1.2W Audio Power Amplifier with Active-low Standby Mode

General Description

The SN4990A has been designed for demanding audio applications such as mobile phones and permits the reduction of the number of external components.

It is capable of delivering 1.2W of continuous RMS output power into an 8Ω load @ 5 V.

An externally-controlled standby mode reduces the supply current to less than 100nA. It also includes internal thermal shutdown protection.

The unity-gain stable amplifier can be configured by external gain setting resistors.

Features

- Operating from V_{CC} = 2.7 V to 5.5 V
- 1.2 W output power @ V_{CC} = 5 V, THD+N= 1%, f = 1 kHz, with 8Ω load
- Ultra-low consumption in standby mode (100 nA)
- 65 dB PSRR @ 217 Hz in grounded mode
- Near-zero pop & click
- Ultra-low distortion (0.03%)
- Unity gain stable
- UTQFN 9L (1.5mm x 1.5mm) Package

Applications

- Mobile Phones
- PDAs
- Portable Electronic Devices
- Notebook Computer

Typical Application Circuit

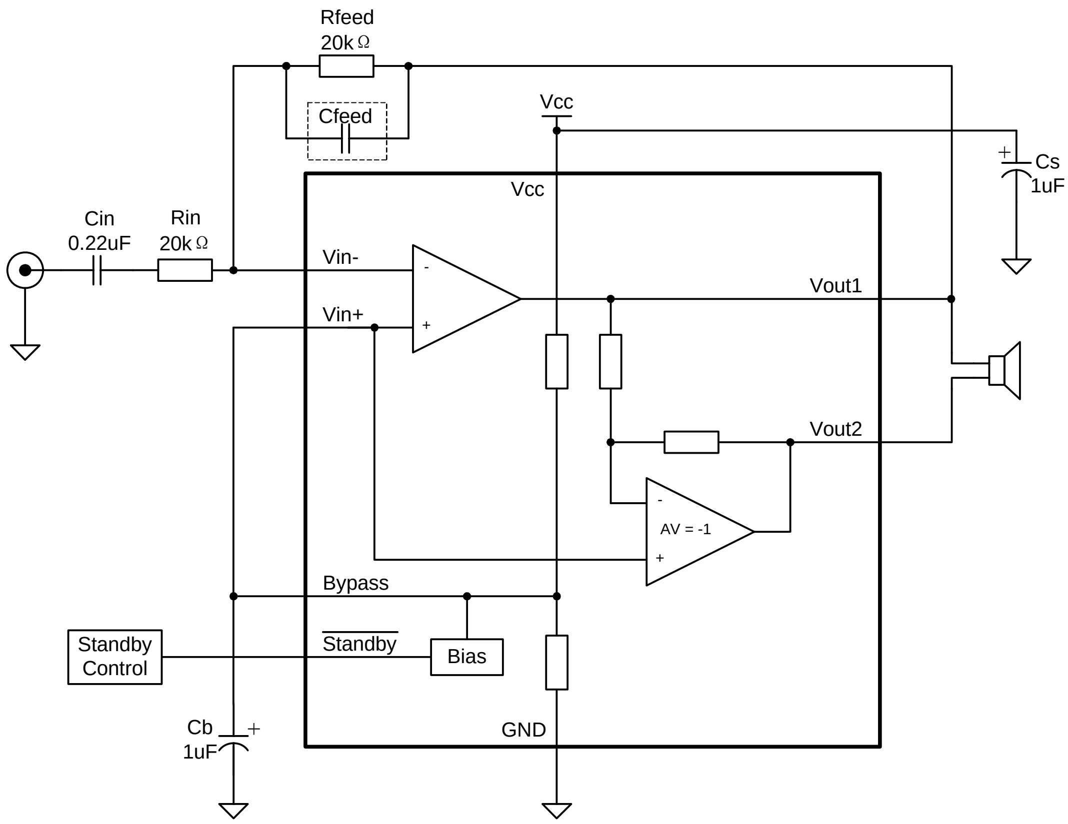
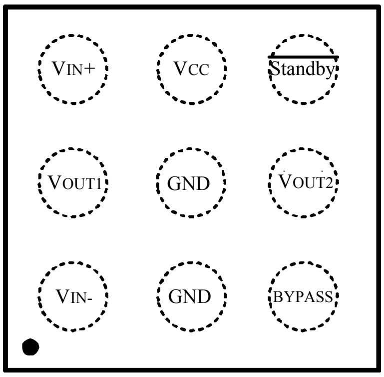


Figure 1

Pin Configurations

Package	Top View
UTQFN 9L	

Pin Description

Pin	Function Description
V_{IN+}	Positive input of the first amplifier.
V_{OUT1}	Negative output of the SN4990A. Connected to the load and to the feedback resistor R_F.
V_{IN-}	Negative input of the first amplifier, receives the audio input signal. Connected to the feedback resistor R_F and to the input resistor Ri.
GND	Ground.
Bypass	Bypass capacitor pin which provides the common mode voltage (Vcc/2).
V_{OUT2}	Positive output of the SN4990A. Connected to the load.
$\overline{\text{Standby}}$	The device enters in shutdown mode when a low level is applied on this pin.
Vcc	Positive analog supply of the chip.

Ordering Information

Order Number	Package Type	Operating Temperature Range
SN4990AIF09E	UTQFN 9L	−40 °C to 85°C

SN4990A-------------- I F 09 E

Environmental Code
E: Lead Free

Pin Code
09: 9pins

ackage Type
F: UTQFN 9L (1.5mm*1.5mm)

Temperature Code
I: Industrial, -40°C to +85°C

Absolute Maximum Ratings (Notes 2)

- Supply Voltage ………………………………….. 6.0V
- Input Voltage ………………….. −0.3V to V_{CC} + 0.3V
- Thermal Resistance θ_{JA}(UTQFN9L) ……52.3°C/W
- Power Dissipation (Note 3) ..…… Internally Limited
- Storage Temperature …………... −65°C to +150°C
- Junction Temperature ……………………….… 150°C

Operating Ratings

Temperature Range

- T_{MIN} <T_A <T_{MAX} ……..……..…−40°C < T_A <85°C
- Supply Voltage ……………….…… 2.7V<V_{CC} <5.5V

Electrical Characteristics V_{CC}=5V (Notes1, 2)

The following specifications apply for Cin=0.22μF, Rin=Rfeed=20kΩ, Cb=1μF, unless otherwise specified. Limits apply for T_A= 25°C

Symbol	Parameter	Conditions		SN4990A Typical (Note 4)	SN4990A Limit (Notes 5)	Units (Limits)
I_{CC}	Quiescent Power Supply Current	V_{CC} = 0V, Io = 0A, No Load		4.8		mA (max)
I_{STBY}	Standby Current	V_{STBY} = GND, R_L=∞			1	μA(max)
V_{STBYH}	Shutdown Voltage Input High				1.4	V(min)
V_{STBYL}	Shutdown Voltage Input Low				0.4	V(max)
V_{OS}	Output Offset Voltage				30	mV (max)
Po	Output Power (8Ω)	THD+N = 1%; f = 1kHz		1.18		W
		THD+N = 10%; f = 1kHz		1.46		
T_{WU}	Wake-up time (Note 6)	Cb = 1μF		115		ms
THD+N	Total Harmonic Distortion+Noise (Note 6)	Po = 0.5Wrms; f = 1kHz		0.025		%
PSRR	Power Supply Rejection Ratio (Note 6)	Vripple p-p = 200mV Input Grounded	f = 217Hz	65		dB
			f = 1kHz	77		

Electrical Characteristics V_{CC}=3V (Notes1, 2)

The following specifications apply for Cin=0.22μF, Rin=Rfeed=20kΩ, Cb=1μF, unless otherwise specified. Limits apply for T_A= 25°C

Symbol	Parameter	Conditions	SN4990A Typical (Note 4)	SN4990A Limit (Notes 5)	Units (Limits)
I_{CC}	Quiescent Power Supply Current	V_{CC} = 0V, Io = 0A, No Load	3.8		mA(max)
I_{STBY}	Standby Current	V_{STBY} = GND, R_L =∞		1	μA(max)
Po	Output Power (8Ω)	THD+N = 1%; f = 1kHz	405		mW
		THD+N = 10%; f = 1kHz	502		
T_{WU}	Wake-up time (Note 6)	Cb = 1μF	102		ms
THD+N	Total Harmonic Distortion+Noise (Note 6)	Po = 0.3Wrms; f = 1kHz	0.027		%

Note 1: *All voltages are measured with respect to the ground pin, unless otherwise specified.*
Note 2: *Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the Operating Ratings. Specifications are not guaranteed for parameters where no limit is given, however, the typical value is a good indication of device performance.*
Note 3: *The maximum power dissipation must be derated at elevated temperatures and is dictated by T_{JMAX}, θ_{JA}, and the ambient temperature T_A. The maximum allowable power dissipation is $P_{DMAX} = (T_{JMAX}-T_A)/\theta_{JA}$ or the number given in Absolute Maximum Ratings, whichever is lower. For the SN4990A, see power derating curves for additional information.*
Note 4: *Typicals are measured at 25°C and represent the parametric norm.*
Note 5: *Datasheet min/max specification limits are guaranteed by design, test, or statistical analysis.*
Note 6: *No production tested, and guaranteed by design.*

Typical Performance Characteristic

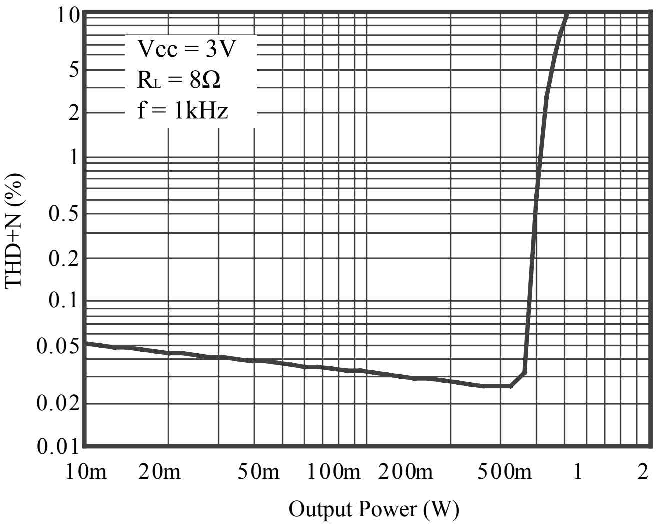


Figure 2. THD+N vs. Output Power

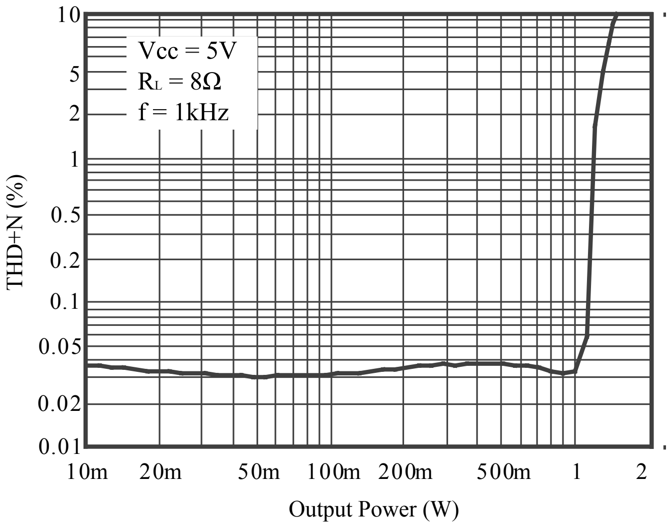


Figure 3. THD+N vs. Output Power

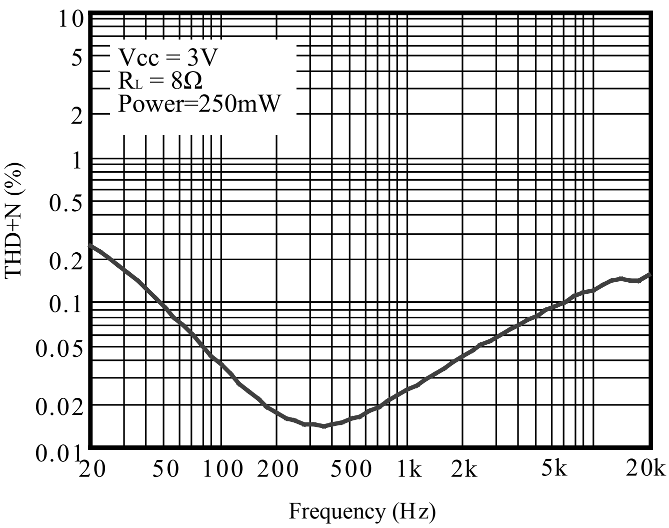


Figure 4 .THD+N vs. Frequency

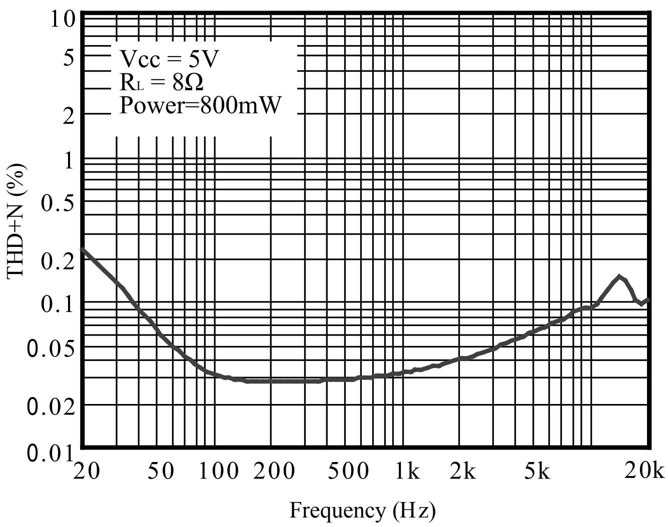


Figure 5. THD+N vs. Frequency

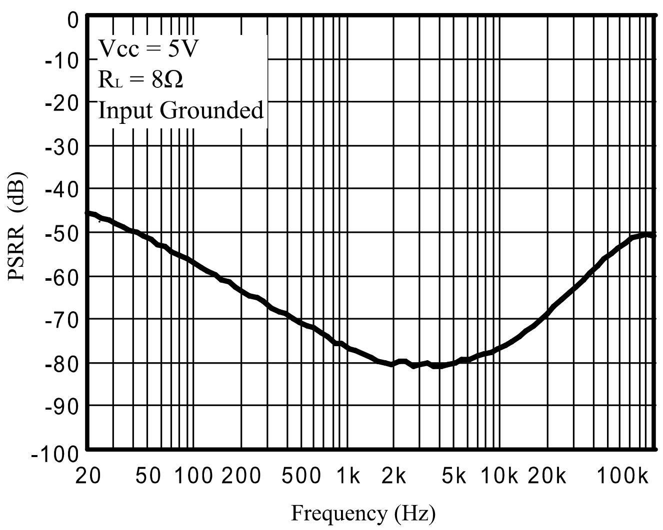


Figure 6 .PSRR vs. Frequency

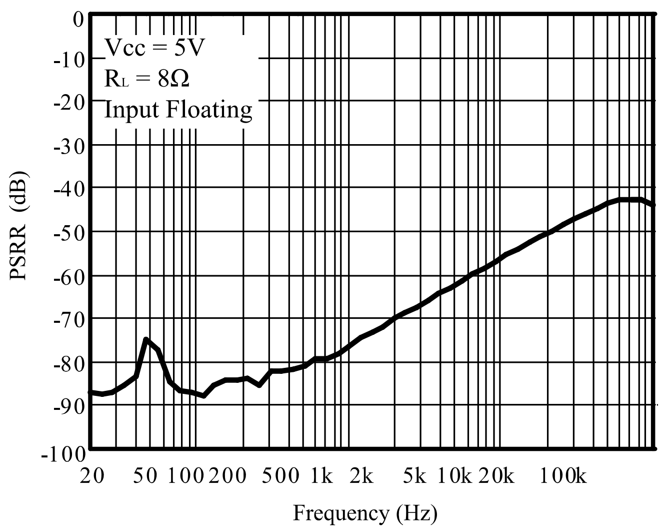


Figure 7. PSRR vs. Frequency

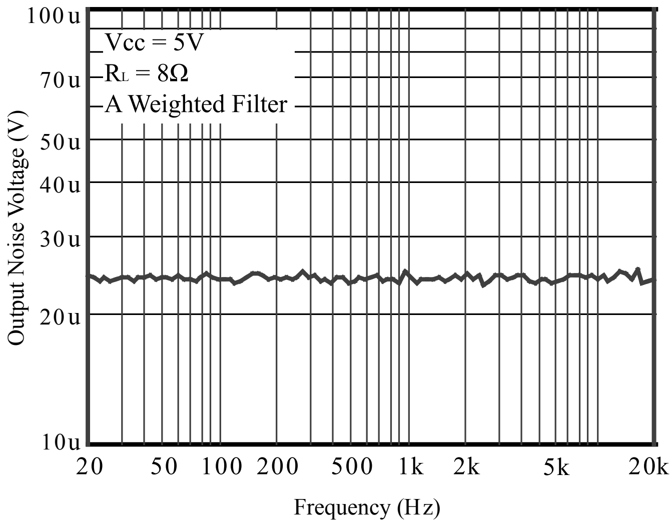


Figure 8. Noise Floor

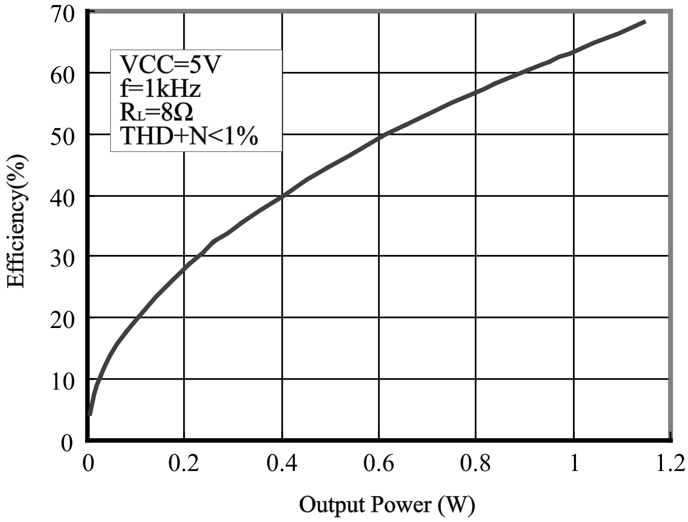


Figure 9 Efficiency vs. Output Power

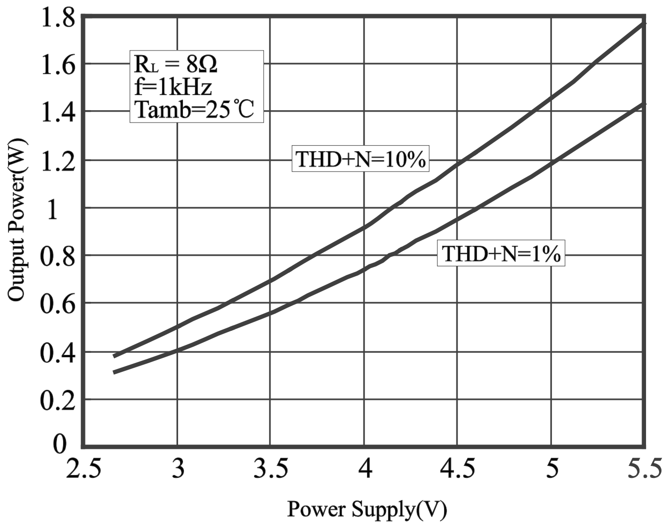


Figure 10. Output Power vs. Power Supply

Application Information

BTL configuration principle

The SN4990A is a monolithic power amplifier with a BTL output type. BTL (bridge tied load) means that each end of the load is connected to two single-ended output amplifiers. Thus, we have:

Single-ended output 1 = Vout1 = Vout (V)
Single ended output 2 = Vout2 = −Vout (V)
and Vout1 - Vout2 = 2Vout (V)

The output power is:

$$P_{out} = \frac{(2V_{out_{RMS}})^2}{R_L}$$

For the same power supply voltage, the output power in BTL configuration is four times higher than the output power in single ended configuration.

Gain in a typical application schematic

The typical application schematic is shown in Figure 1 on page 1.

In the flat region (no Cin effect), the output voltage of the first stage is (in Volts):

$$V_{out1} = (-V_{in})\frac{R_{feed}}{R_{in}}$$

For the second stage: $V_{out2} = -V_{out1}$ (V)

The differential output voltage is (in Volts):

$$V_{out2} - V_{out1} = 2V_{in}\frac{R_{feed}}{R_{in}}$$

The differential gain named gain (G_v) for more convenient usage is:

$$G_v = \frac{V_{out2} - V_{out1}}{V_{in}} = 2V_{in}\frac{R_{feed}}{R_{in}}$$

$V_{out}2$ is in phase with V_{in} and V_{out1} is phased 180° with V_{in}. This means that the positive terminal of the loudspeaker should be connected to V_{out2} and the negative to V_{out1}.

Low and high frequency response

In the low frequency region, C_{in} starts to have an effect. C_{in} forms with R_{in} a high-pass filter with a −3dB cut-off frequency. F_{CL} is in Hz.

$$F_{CL} = \frac{1}{2\pi R_{in} C_{in}}$$

In the high frequency region, you can limit the bandwidth by adding a capacitor (C_{feed}) in parallel with R_{feed}. It forms a low-pass filter with a −3dB cut-off frequency. F_{CH} is in Hz.

$$F_{CH} = \frac{1}{2\pi R_{feed} C_{feed}}$$

Decoupling of the circuit

Two capacitors are needed to correctly bypass the SN4990A: a power supply bypass capacitor C_s and a bias voltage bypass capacitor C_b.

C_s has particular influence on the THD+N in the high frequency region (above 7kHz) and an indirect influence on power supply disturbances. With a value for C_s of 1µF, you can expect THD+N levels similar to those shown in the datasheet.

In the high frequency region, if C_s is lower than 1µF, it increases THD+N and disturbances on the power supply rail are less filtered.

On the other hand, if C_s is higher than 1µF, those disturbances on the power supply rail are more filtered.

C_b has an influence on THD+N at lower frequencies, but its function is critical to the final result of PSRR (with input grounded and in the lower frequency region).

If C_b is lower than 1µF, THD+N increases at lower frequencies and PSRR worsens.

If C_b is higher than 1µF, the benefit on THD+N at lower frequencies is small, but the benefit to PSRR is substantial.

Note that C_{in} has a non-negligible effect on PSRR at lower frequencies. The lower the value of C_{in}, the higher the PSRR is.

Wake-up time (t_{WU})

When the standby is released to put the device ON, the bypass capacitor C_b will not be charged immediately. As C_b is directly linked to the bias of the amplifier, the bias will not work properly until the C_b voltage is correct. The time to reach this voltage is called wake-up time or t_{WU} and specified in the electrical characteristics table with C_b = 1µF.

Pop performance

Pop performance is intimately linked with the size of the input capacitor C_{in} and the bias voltage bypass capacitor C_b.

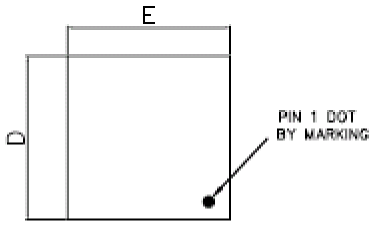
The size of C_{in} is dependent on the lower cut-off frequency and PSRR values requested. The size of C_b is dependent on THD+N and PSRR values requested at lower frequencies.

Moreover, C_b determines the speed with which the amplifier turns ON.

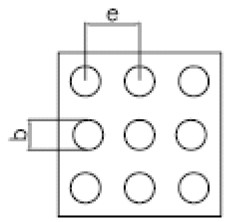
Package information

UTQFN 9L

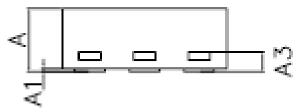
Top View



Bottom View



Side View



Symbol	Dimension (mm)		
	MIN	**NOM**	**MAX**
A	0.50	0.55	0.60
A1	0.00	–	0.05
A3	0.15 REF		
D	1.45	1.50	1.55
E	1.45	1.50	1.55
b	D0.25	D0.275	D0.30
e	0.50BSC		