Ordering number : ENA1568A

SANYO Semiconductors
DATA SHEET

An ON Semiconductor Company

LV4985VH — Bi-CMOS IC For Portable Electronic Device Use 1.2W × 2ch BTL Power Amplifier

Overview

The LV4985VH has a 2-channel power circuit amplifier including an electronic volume control built in. It has a function for switching the headphone driver and also has a standby function to reduce the current drain. It is a power amplifier IC optimal for driving the speakers used in portable equipment and low power output equipment.

Applications

Portable DVD players, active speakers, compact LCD-TVs/LCD monitors, notebook PCs and more.

Features

- 2-cannels BTL power amplifier built-in : Standard output power = 1.2W (V_{CC} = 5V, R_L = 8Ω, THD = 10%)
  Output coupling capacitor is unnecessary because of differential output type.
- Volume function built-in (variable range: 69dB standard), DC voltage control system
- Mute function built-in (shared with VOL-min)
- Standby function built-in (three-value control ⇒ Shared with the second amplifier stop control pin) :
  Standard standby current = 0.01μA (V_{CC} = 5V)
- Second amplifier stop control function built-in (three-value control ⇒ Shared with the standby pin) :
  Headphone driver switch (for BTL/SE switch)
  Simple MUTE (Only BTL power amplifier path)
- Thermal protection circuit built-in
- Operation supply voltage range : V_{CC} = 4.5V to 5.5V
- Output phase compensation capacitor not necessary

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Specifications

Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V_{CC} max		6	V
Allowable power dissipation	Pd max	* Mounted on a specified board.*	1.45	W
Maximum junction temperature	Tj max		150	°C
Operating temperature	Topr		-20 to +75	°C
Storage temperature	Tstg		-40 to +150	°C

* Specified board (SANYO Semiconductor Evaluation board) : 50mm × 50mm × 1.6mm, glass epoxy both side.

Operating Conditions at Ta = 25°C

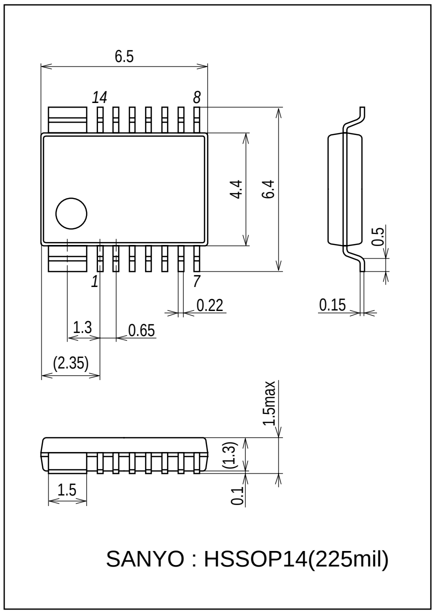
Parameter	Symbol	Conditions	Ratings	Unit
Recommended supply voltage	V_{CC}		5	V
Recommended load resistance	R_L		8 to 32	Ω
Allowable operating supply voltage range	V_{CC} op		4.5 to 5.5	V

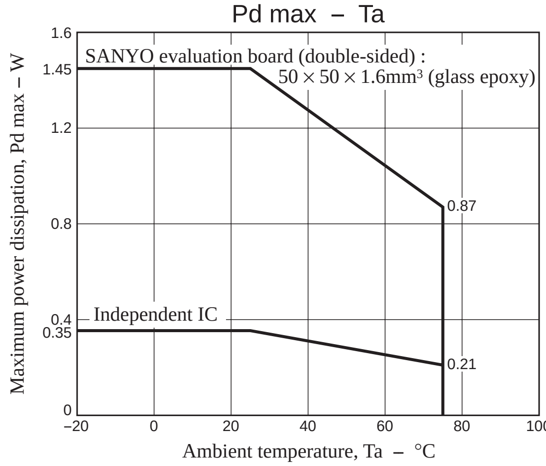
Electrical Characteristics at Ta = 25°C, V_{CC} = 5V, fin = 1kHz, R_L = 8Ω, V9 = 2.5V, V10 = 3V, pwr-amp-VG = 20.7dB

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Quiescent current drain	$I_{CCO}P$	No signal, no load		11.5	20	mA
Standby current drain	I_{STBY}	No signal, V9 = 0.3V		0.01	5	μA
Maximum output power	P_O max	THD = 10%	0.8	1.2		W
BTL voltage gain	VG	Vin = -30dBV	25.8	27.8	29.8	dB
Volume voltage gain	VGVOL	Vin = -30dBV, volume output pin		7.1		dB
Channel balance	CHBAL	Vin = -30dBV	-2	0	+2	dB
Total harmonic distortion	THD	Vin = -30dBV		0.4	1	%
Maximum output noise voltage	V_N max	Rg = 620Ω, 20 to 20kHz		0.7	1.4	mVrms
Minimum output noise voltage	V_N min	Rg = 620Ω, 20 to 20kHz		0.06		mVrms
Channel separation	CHsep	Vin = -20dBV, Rg = 620Ω	58	66		dB
Volume variable range	WVOL	Vin = -30dBV		69		dB
Mute attenuation level	ATTMT	Vin = -10dBV, V10 = 0.25V, 1kHz-BPF	-72	-82		dBV
Ripple rejection ratio	SVRR	Rg = 620Ω, fr = 100Hz, Vr = -20dBV		30		dB
Output DC offset voltage	VOS		-30		+30	mV
Reference voltage	VREF	Pin 6 voltage, Amplifier operation reference DC voltage source		2.5		V
Volume maximum control voltage	MXVOL	Pin 10 control voltage	2.8			V
Muting control voltage	VMT	Pin 10 control voltage	0		0.25	V
High level control voltage (pin 9)	V9CH	Full operating mode (BTL mode)	2.3		V_{CC}	V
Middle level control voltage (pin 9)	V9CM	Second amplifier non-operating mode (SE mode)	1.3		1.7	V
Low level control voltage (pin 9)	V9CL	Standby (shutdown) mode	0		0.3	V

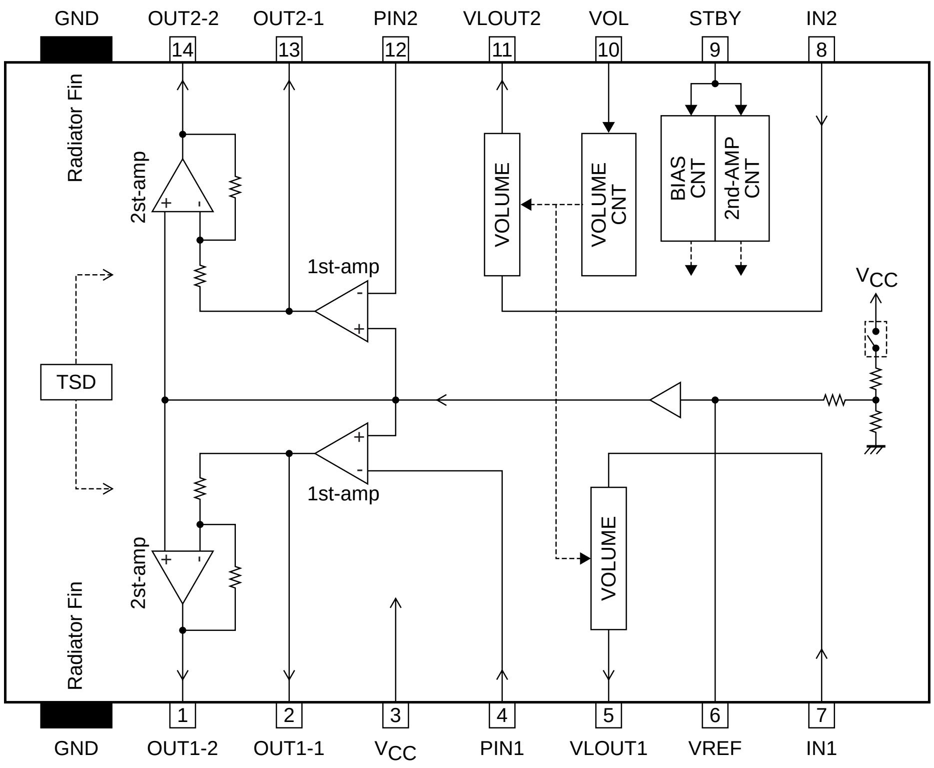
Package Dimensions

unit : mm (typ)
3313

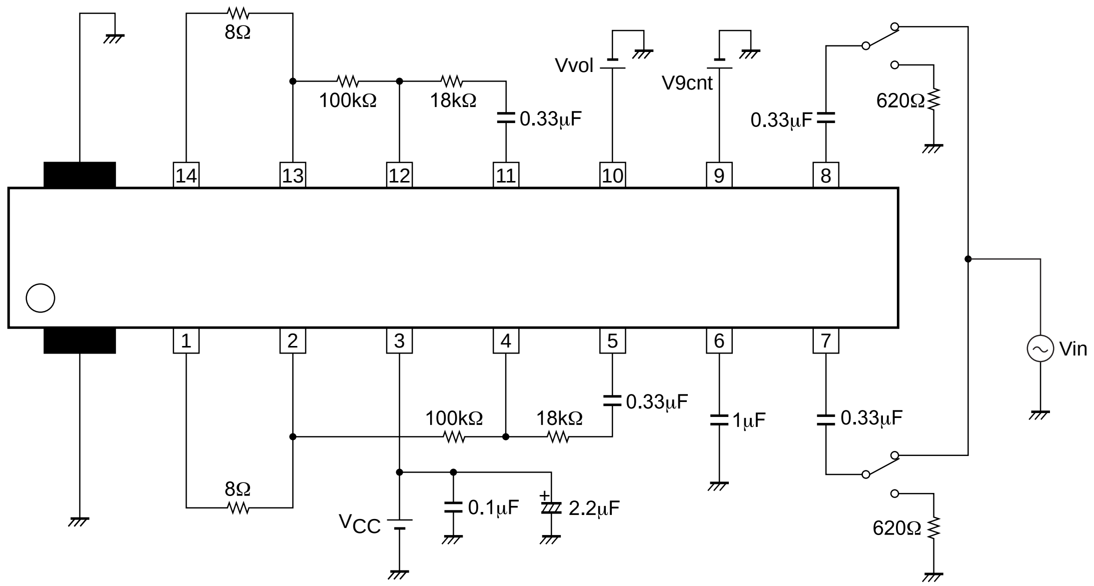




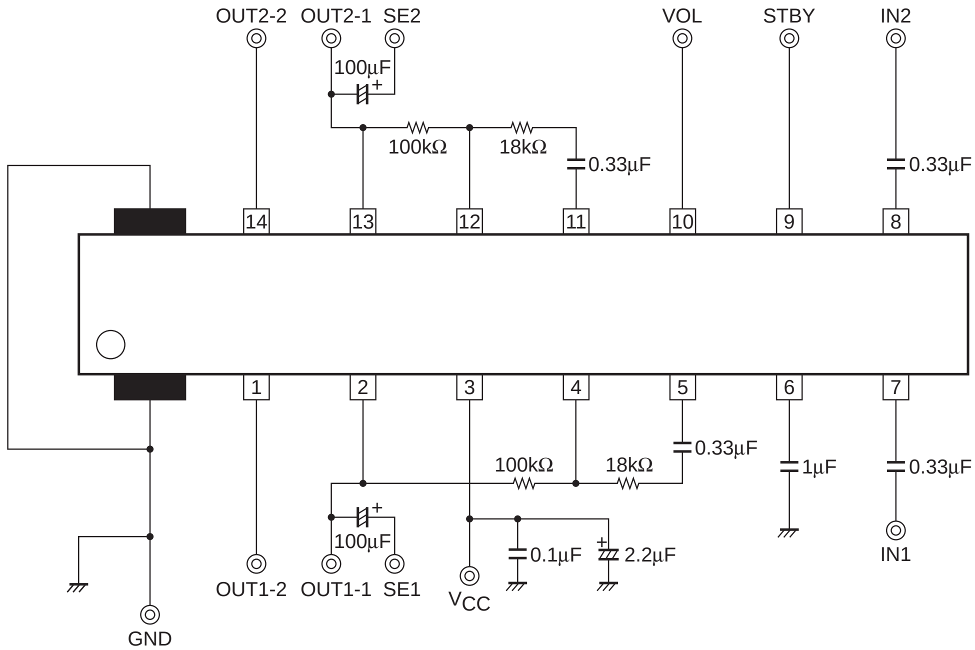
Block Diagram



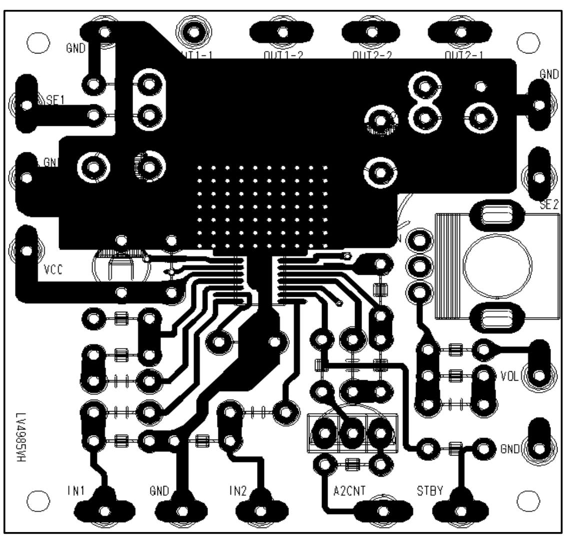
Test Circuit



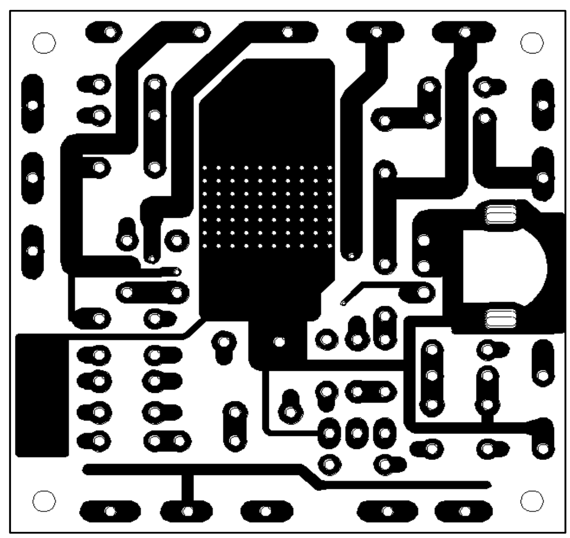
Evaluation Board Circuit



Evaluation Board Layout (50mm × 50mm × 1.6mm)



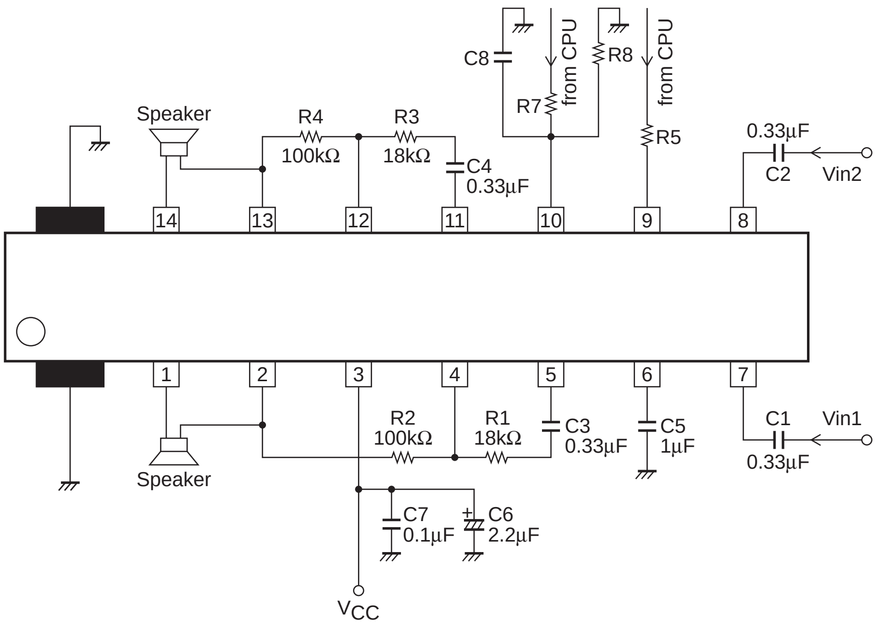
Top Layer



Bottom Layer

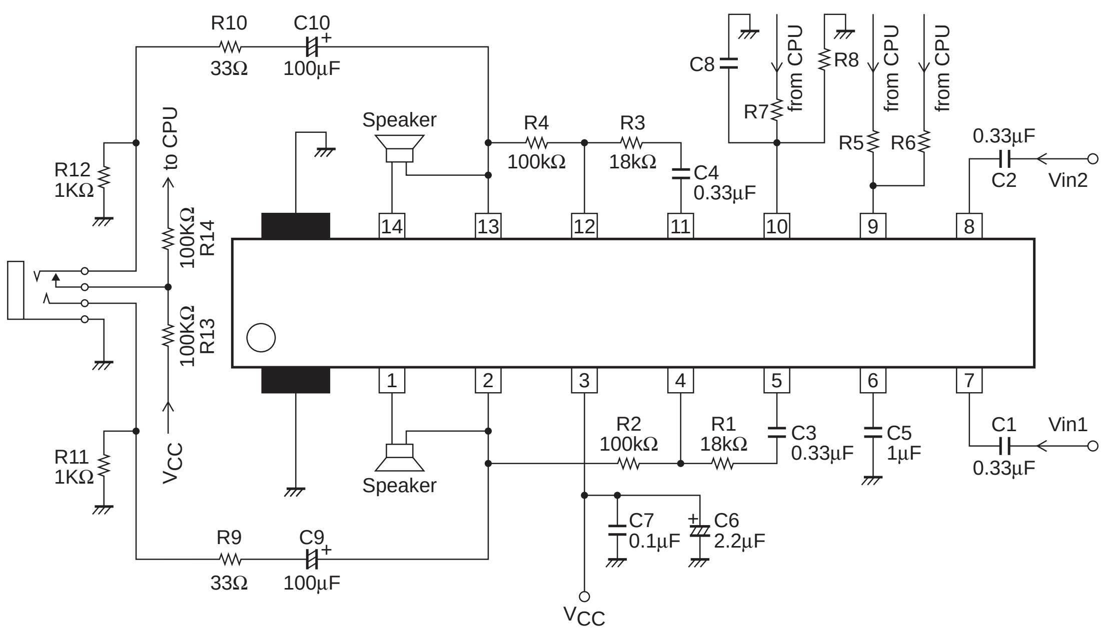
Application Circuit Example 1

(BTL mode only)

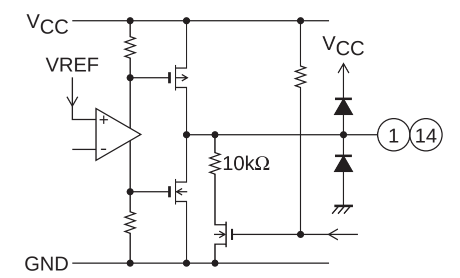
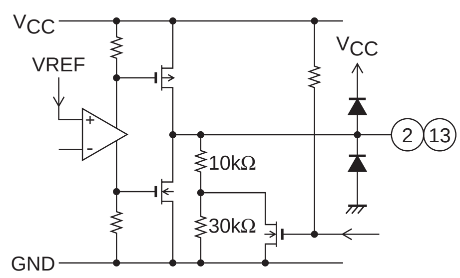
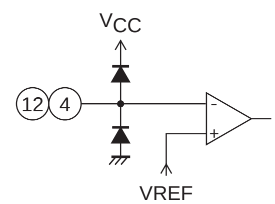
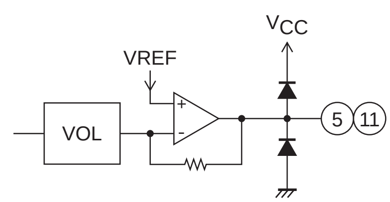
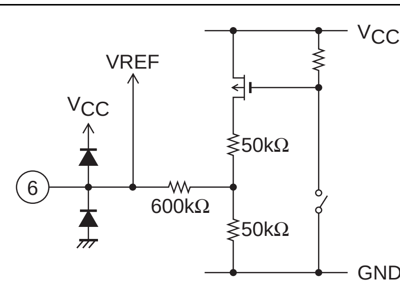
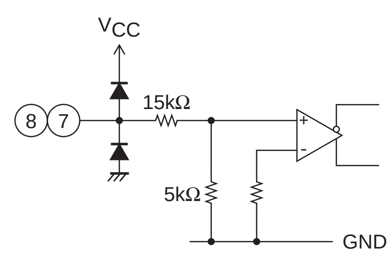


Application Circuit Example 2

(BTL mode/SE mode changeover)



Pin Functions

Pin No.	Pin Name	Pin Voltage V_{CC} = 5V	Description	Equivalent Circuit
1 14	OUT1-2 OUT2-2	2.49	Power amplifier 2nd output pin.	
2 13	OUT1-1 OUT2-1	2.49	Power amplifier 1st output pin.	
3	V_{CC}	5.0	Power supply pin.	
4 12	PIN1 PIN2	2.49	Power amplifier input pin.	
5 11	VLOUT1 VLOUT2	2.49	Volume output pin.	
6	VREF	2.49	Ripple filter pin. (for filtering capacitor connection)	
7 8	IN1 IN2	0	Input pin.	

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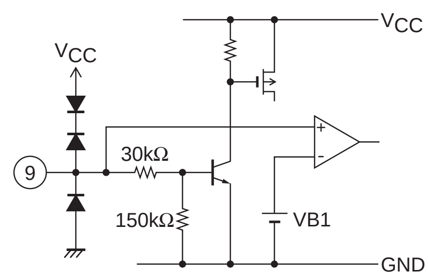
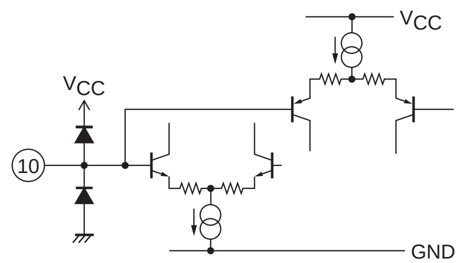
Pin No.	Pin Name	Pin Voltage V_{CC} = 5V	Description	Equivalent Circuit
9	STBY	External apply	Standby/2nd amplifier stop control pin. 0 to 0.3V ⇒ Standby mode 1.3 to 1.7V ⇒ SE mode 2.3 to V_{CC} ⇒ BTL mode	
10	VOL	External apply	Volume control pin.	

Usage Note

1. Input coupling capacitor (C1 and C2)
   C1 (C2) is an input coupling capacitor that is used to cut the DC component. The input coupling capacitor C1 (C2) and the input resisters of 20kΩ (15kΩ + 5kΩ) make up a high-pass filter, attenuating the bass frequency. Therefore, the capacitance value must be selected with due consideration of the cut-off frequency.
   The cut-off frequencies are expressed by the following formulas.
   1ch ⇒ $fc1 = 1/(2\pi \times C1 \times 20000)$
   2ch ⇒ $fc2 = 1/(2\pi \times C2 \times 20000)$
   This capacitor affects the pop noise at startup. Note with care that increasing the capacitance value lengthens the charging time of the capacitor, which will make the pop noise louder.

2. Input coupling capacitors (C3 and C4) in the power amplifier block
   C3 (C4) is an input coupling capacitor that is used to cut the DC component. The input coupling capacitor C3 (C4) and the input resistor R1 (R3) make up a high-pass filter, attenuating the bass frequency. Therefore, the capacitance value must be selected with due consideration of the cut-off frequency.
   The cut-off frequencies are expressed by the following formulas.
   1ch ⇒ $fc3 = 1/(2\pi \times C3 \times R1)$
   2ch ⇒ $fc4 = 1/(2\pi \times C4 \times R3)$
   This capacitor affects the pop noise at startup. Note with care that increasing the capacitance value lengthens the charging time of the capacitor, which will make the pop noise louder.

3. BTL voltage gain of the power amplifier block
   The voltage gain of the first amplifier is determined by the ratio between the resistors R1 and R2 (R3 and R4).
   1ch ⇒ $Vg1 = 20 \times \log(R2/R1)$ ⋯ unit : dB
   2ch ⇒ $Vg2 = 20 \times \log(R4/R3)$ ⋯ unit : dB
   Therefore, the BTL voltage gain of the power amplifier block is expressed by the following formulas.
   1ch ⇒ $VgBTL1 = 6 + 20 \times \log(R2/R1)$ ⋯ unit : dB
   2ch ⇒ $VgBTL2 = 6 + 20 \times \log(R4/R3)$ ⋯ unit : dB
   The BTL voltage gain of the power amplifier block must be set in the range of 0 to 26dB.

4. pin 6 capacitor (C5)

This capacitor is a ripple filter capacitor. The internal resistors (600kΩ + 50kΩ) and C5 make up a low-pass filter that is used to reduce the power supply ripple component and increase the ripple rejection ratio.
Note that inside the IC, the rising-transient-response-characteristic of the pin 6 voltage (reference voltage) is used to activate the automatic pop noise reduction circuit. Therefore, when reducing the C5 capacitance value to increase the voltage rise speed, the design should take into account that the pop noise increases during voltage rise.

5. Power supply line capacitor (C6 and C7)

The bypass capacitor C7 is used to remove the high frequency component that cannot be eliminated by the power supply capacitor C6 (chemical capacitor). Place the bypass capacitor C7 as near to the IC as possible, and use a ceramic capacitor with good high frequency characteristics.
When using a stabilized power supply, these capacitors can also be combined into a single 2.2μF ceramic capacitor.
Note that when the power supply line is relatively unstable, the power supply capacitor C6 capacitance value must be increased.

6. Load capacitance

When connecting a capacitor between the output pin and ground to suppress electromagnetic radiation or other purposes, the effects of this capacitor may cause the power amplifier phase margin to be reduced, resulting in oscillation. When adding this capacitor, care should be taken for the capacitance value.

Recommended capacitance value : 1000pF to 0.1μF

7. Headphone drive

When also using the BTL amplifier's first amplifier as the headphone amplifier, it is recommended to adjust the level by inserting series resistors R9 (R10) to the signal line as shown in Application Circuit Example-2.
Note that this series resistor, the headphone load resistance and the output coupling capacitors C9 (C10) make up a high-pass filter, so this should be taken into account in the design. The cut-off frequencies are expressed by the following formulas.

1ch $\Rightarrow$ $fc5 = 1/ (2\pi \times C9 \times (R9 + R_L))$

2ch $\Rightarrow$ $fc6 = 1/ (2\pi \times C10 \times (R10 + R_L))$

8. Standby pin (pin 9)

As shown in Figure1, by controlling the standby pin, the mode changeover can be made between standby mode, single-ended (SE) operating mode, and BTL operating mode.

State	Pin 9 voltage	Port A	Port B
Standby mode	0V to 0.3V	Low	Low
SE operating mode	1.3V to 1.7V	High	Low
BTL operating mode	2.3V to V_{CC}	High	High

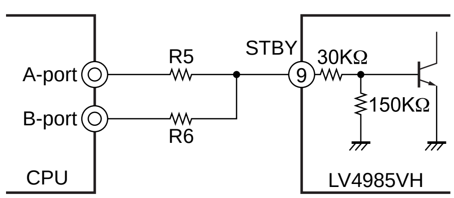


Fig. 1

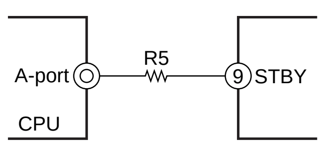


Fig. 2

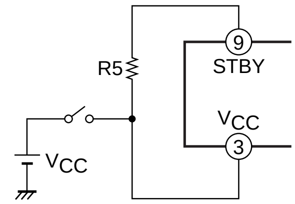


Fig. 3

When not using the single-ended operating mode, a direct control is possible by connecting the standby pin to the CPU output port. However, it is recommended to insert a series resistor R5 (1kΩ or more) as shown in Figure 2 in case the pin is affected by the digital noise from CPU.
In addition, when not using the standby mode, the pin 9 can also be used interlocked with the power supply as shown in Figure 3. Since there exists an internal current limiting resistor (30kΩ), the series resistor R5 can be eliminated, but the current I9 expressed by the following formula flows through the pin 9, so this should be taken into account in the design.

Pin 9 inflow current (unit : A) : $I9 = 4.7 \times 10^{-6} + (V_{CC} - 0.7)/(R5 + 30000)$

9. Electronic volume control (pin 10 control)

By changing voltage applied to the pin 10, the voltage gain of the built-in VCA(variable control amplifier) is varied. Since the ripple component of applied voltage is generated, a stabilized power source must be used.
When controlling the amplifier using the PWM signal from the CPU, use a resistor and capacitor for DC conversion as shown in Figure 4 and adjust the voltage gain by changing the pulse width of PWM signal. In this case, the frequency of PWM signal used must be higher than audio frequency band.

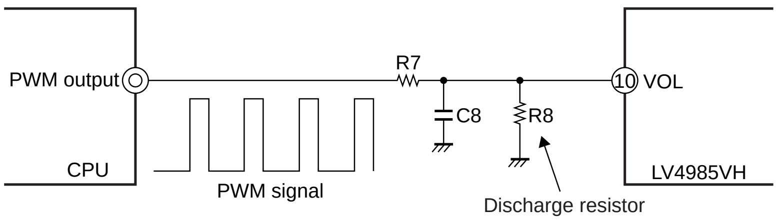


Fig. 4

10. Thermal protection circuit

The IC has a built-in thermal protection circuit that can reduce the risk of breakdown or degradation when the IC becomes abnormally hot for some reason. When the internal chip junction temperature Tj rises to approximately 170°C, this protective circuit operates to cut off the power supply to the power amplifier block and stop signal output. Operation recovers automatically when the chip temperature drops to approximately 130°C.
Note that this circuit cannot always prevent breakdown or degradation, so sufficient care should be taken for using the IC. When the chip becomes abnormally hot, immediately turn off the power and determine the cause.

11. Short-circuit between pins

Turning on the power supply with the short-circuit between terminals leads to the deterioration and destruction of IC. When fixing the IC to the substrate, please check that the solder is not short-circuited between the terminals before turning on the power.

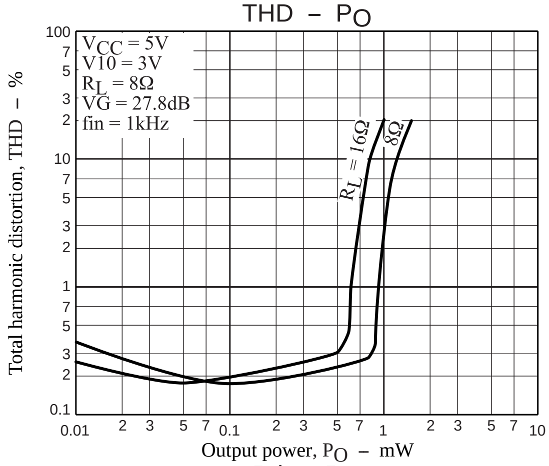
12. Load Short-circuit

Leaving the IC in the load short-circuit for many hours leads to the deterioration and destruction of the IC. The load must not be short-circuited absolutely.

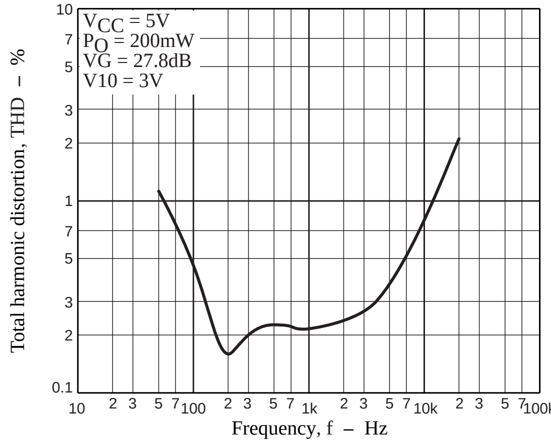
13. Maximum rating

When the rated value used is just below to the absolute maximum ratings value, there is a possibility to exceed the maximum rating value with slight extrusion variable. Also, it can be a destructive accident.
Please use within the absolute maximum ratings with sufficient variation margin of supply voltage.
In addition, the package of this IC has low thermal radiation characteristics, so secure sufficient thermal radiation by providing a copper foil land on the printed circuit board near the heat sink.

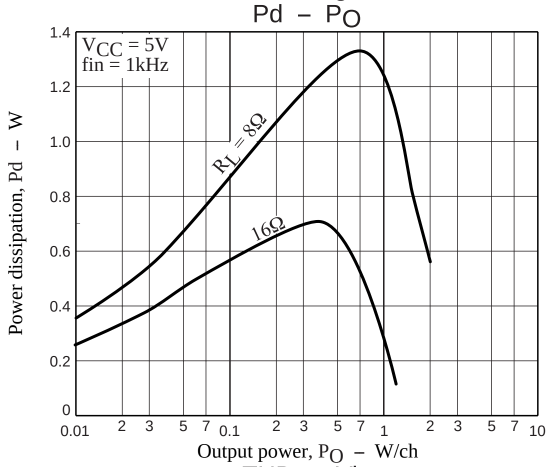
THD – PO



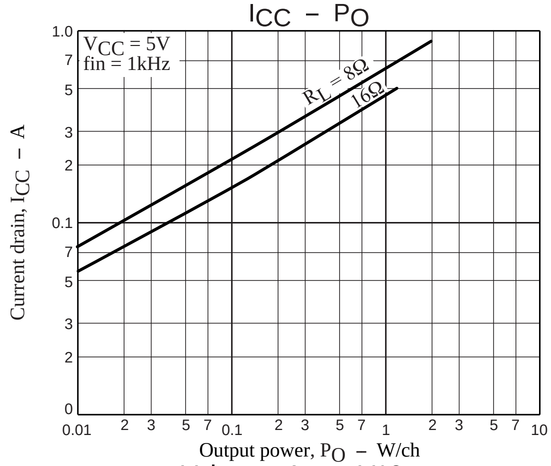
THD – f



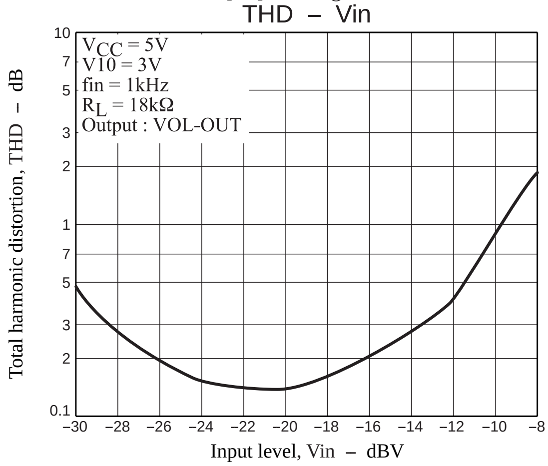
Pd – PO



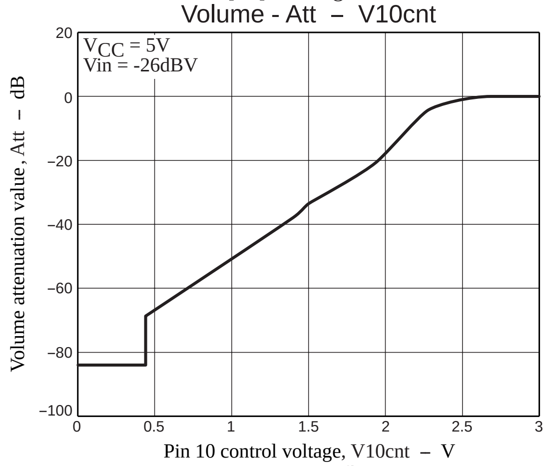
ICC – PO



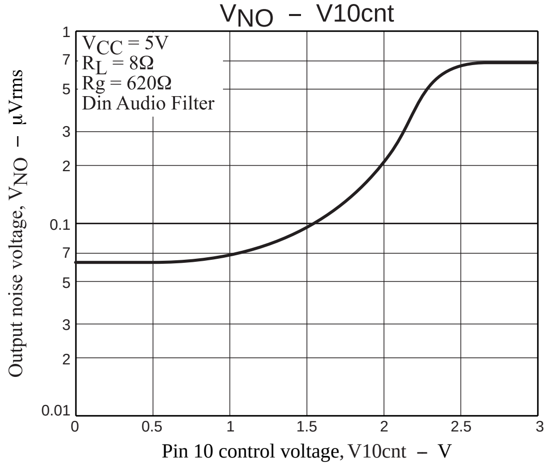
THD – Vin



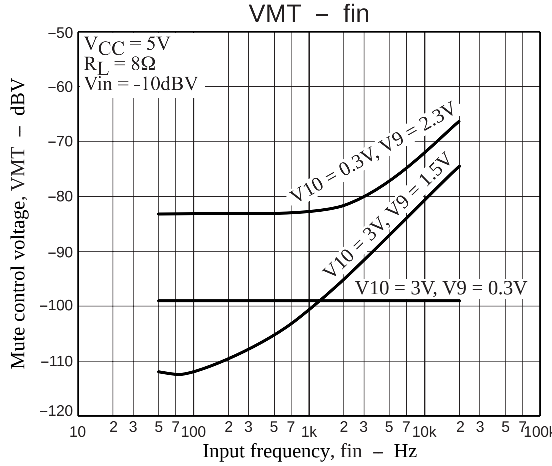
Volume - Att – V10cnt



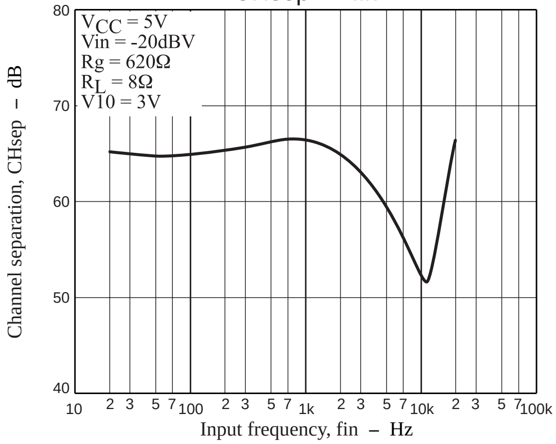
VNO – V10cnt



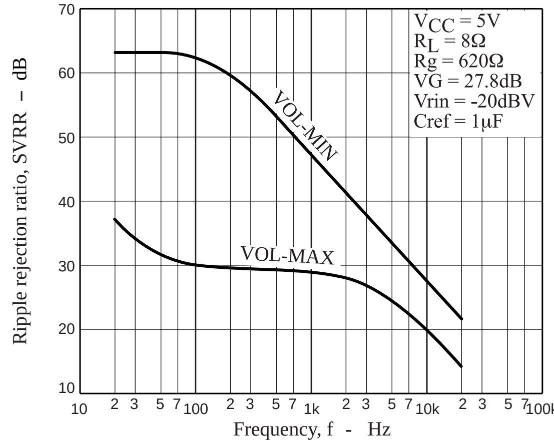
VMT – fin



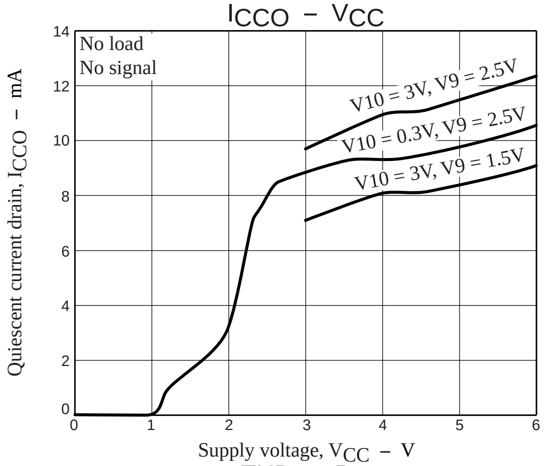
CHsep – fin



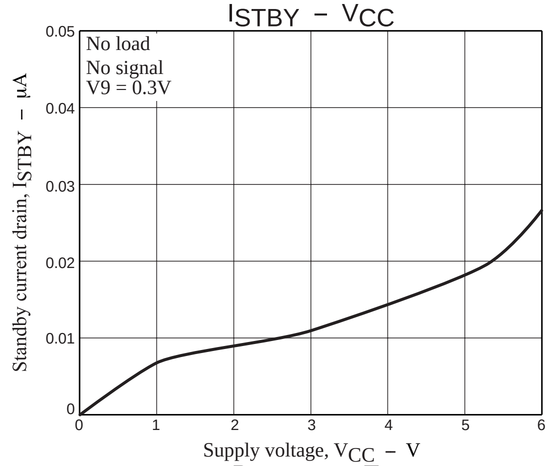
SVRR – f



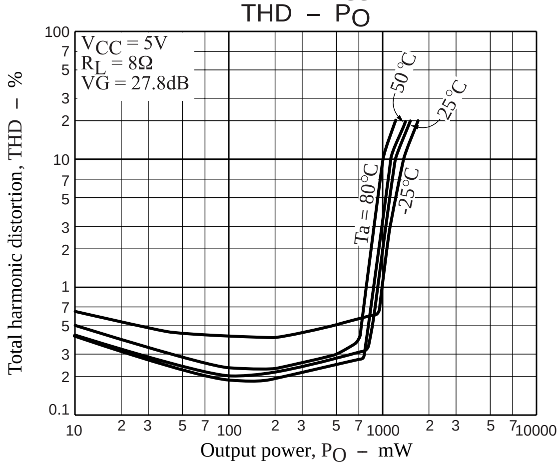
ICCO – VCC



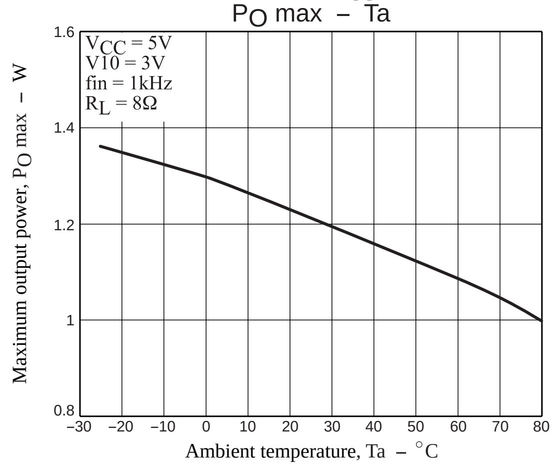
ISTBY – VCC



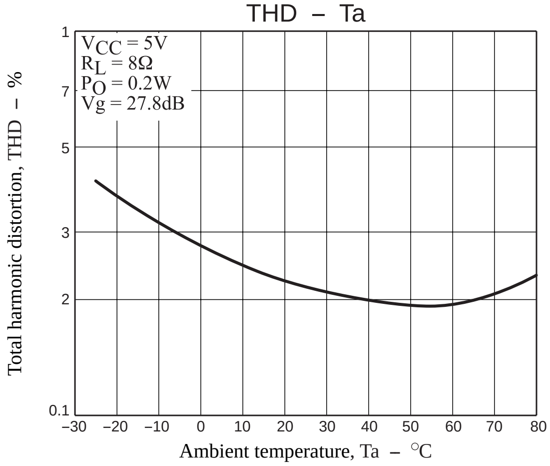
THD – PO



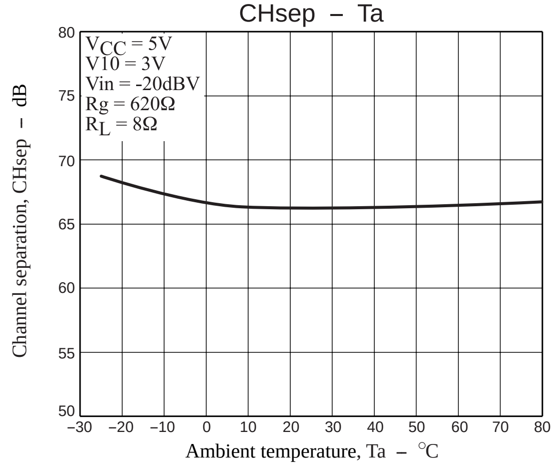
PO max – Ta



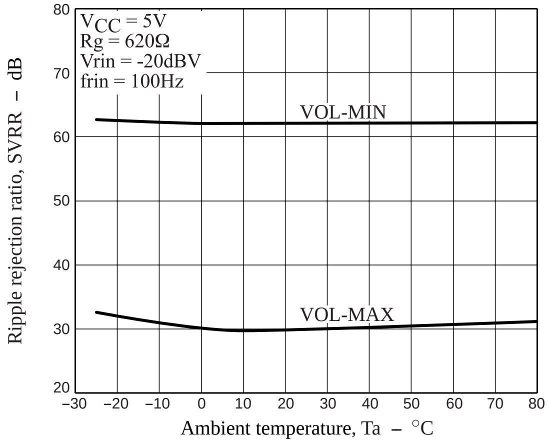
THD – Ta



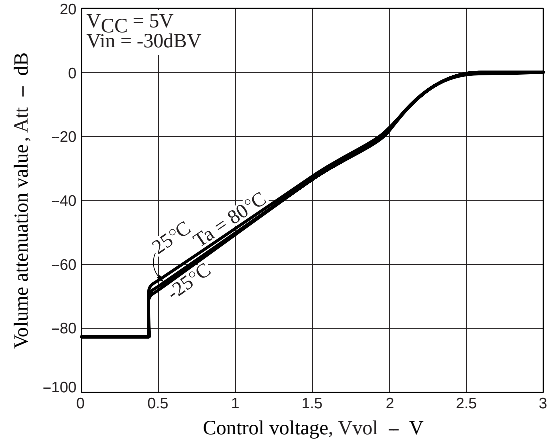
CHsep – Ta



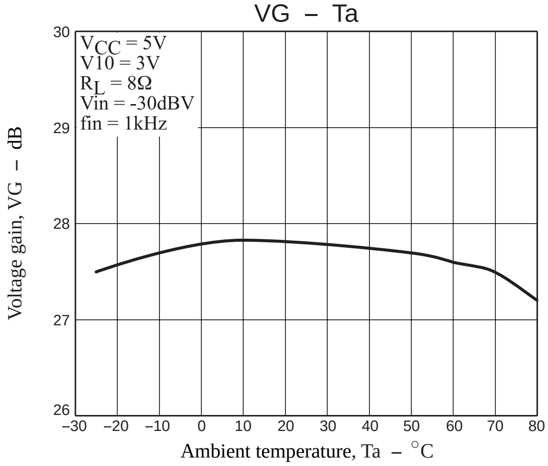
SVRR – Ta



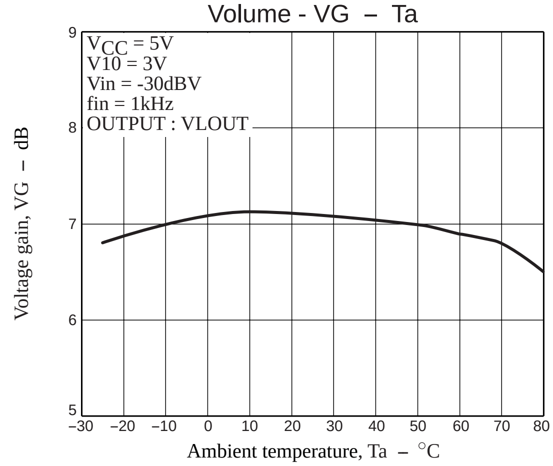
Volume - Att – Vvol



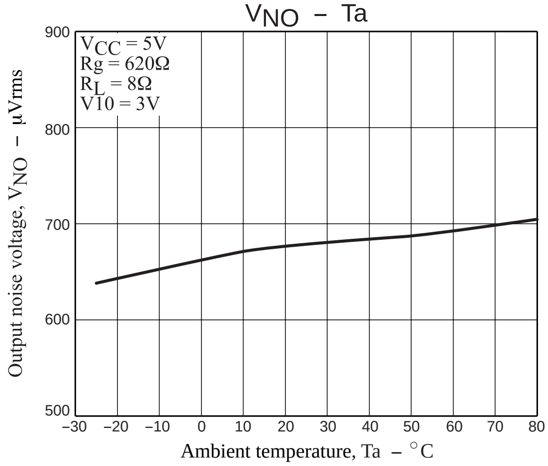
VG – Ta



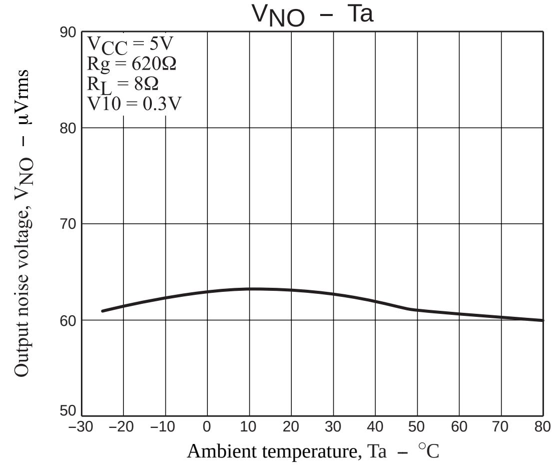
Volume - VG – Ta



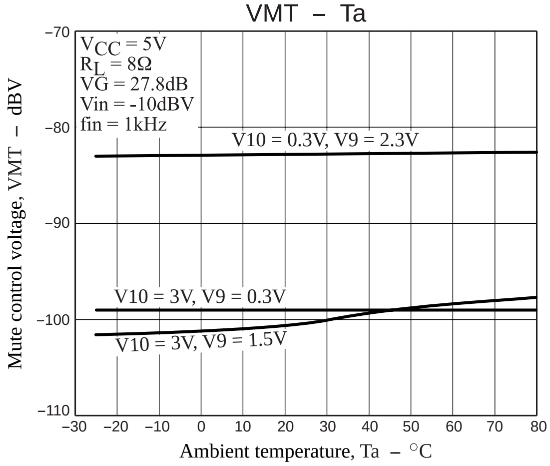
V_{NO} – Ta



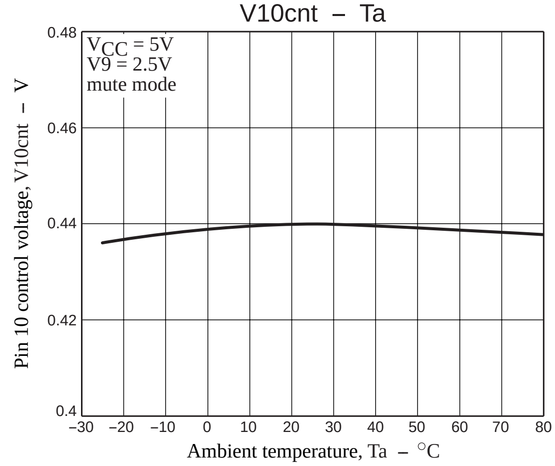
V_{NO} – Ta

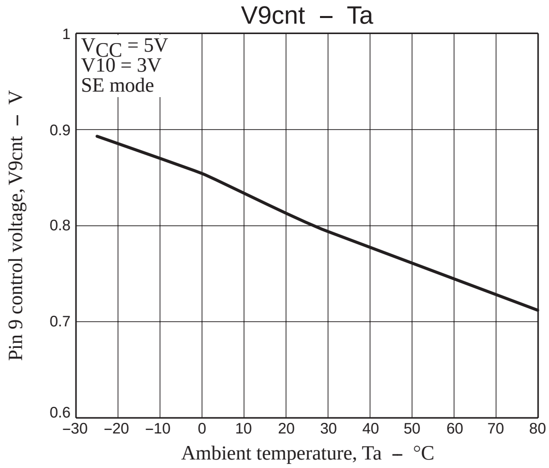


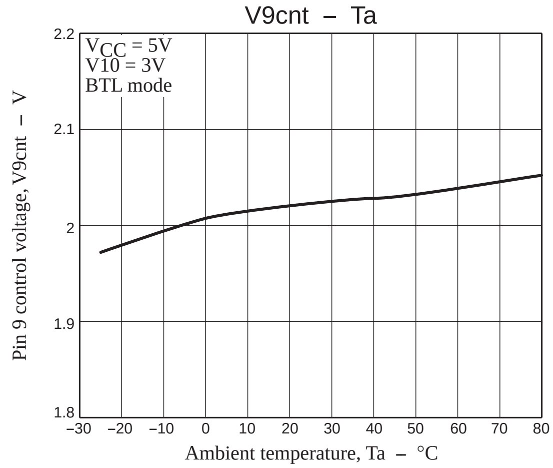
VMT – Ta

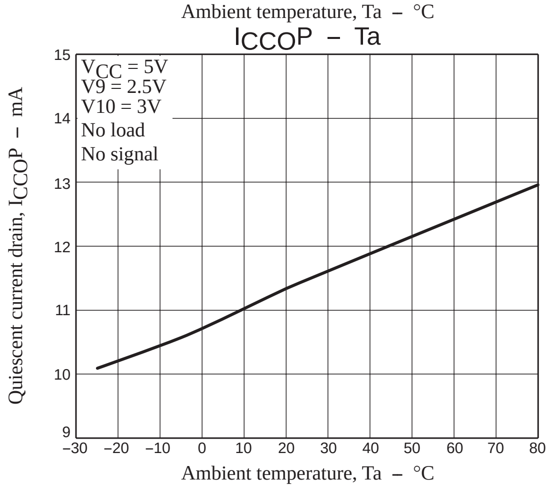


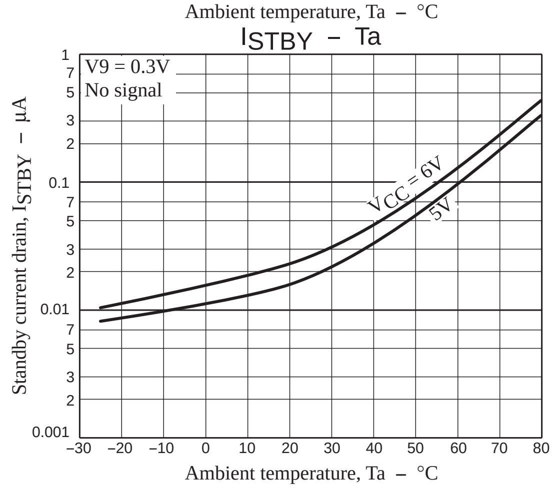
V10cnt – Ta




V9cnt – Ta
VCC = 5V
V10 = 3V
SE mode
Pin 9 control voltage, V9cnt – V
1
0.9
0.8
0.7
0.6
–30 –20 –10 0 10 20 30 40 50 60 70 80
Ambient temperature, Ta – °C

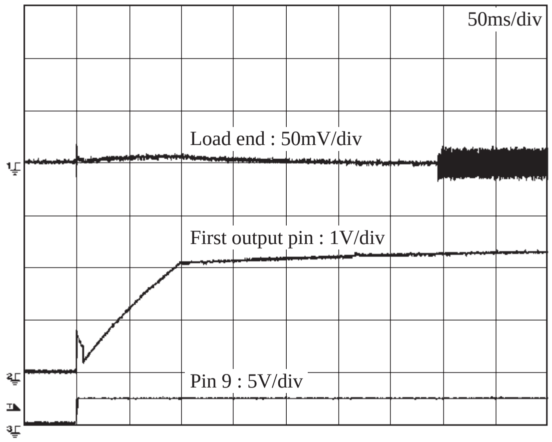

V9cnt – Ta
VCC = 5V
V10 = 3V
BTL mode
Pin 9 control voltage, V9cnt – V
2.2
2.1
2
1.9
1.8
–30 –20 –10 0 10 20 30 40 50 60 70 80
Ambient temperature, Ta – °C


ICCOP – Ta
VCC = 5V
V9 = 2.5V
V10 = 3V
No load
No signal
Quiescent current drain, ICCOP – mA
15
14
13
12
11
10
9
–30 –20 –10 0 10 20 30 40 50 60 70 80
Ambient temperature, Ta – °C

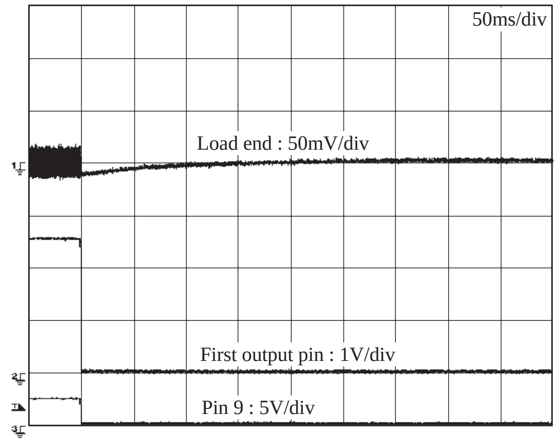

ISTBY – Ta
V9 = 0.3V
No signal
VCC = 6V
5V
Standby current drain, ISTBY – µA
1
7
5
3
2
0.1
7
5
3
2
0.01
7
5
3
2
0.001
–30 –20 –10 0 10 20 30 40 50 60 70 80
Ambient temperature, Ta – °C

• **Transient response characteristics** (volume max. setting)

Rising (V9 ⇒ high) characteristics

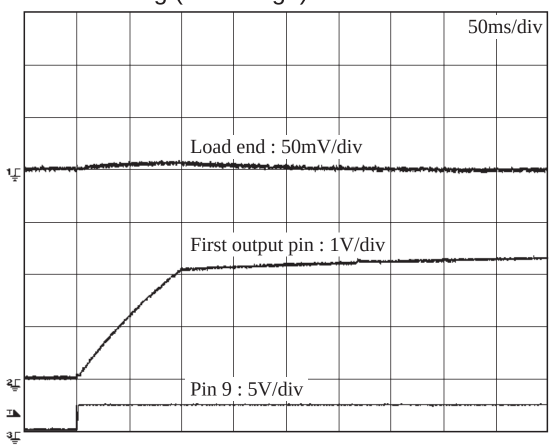


Falling (V9 ⇒ low) characteristics

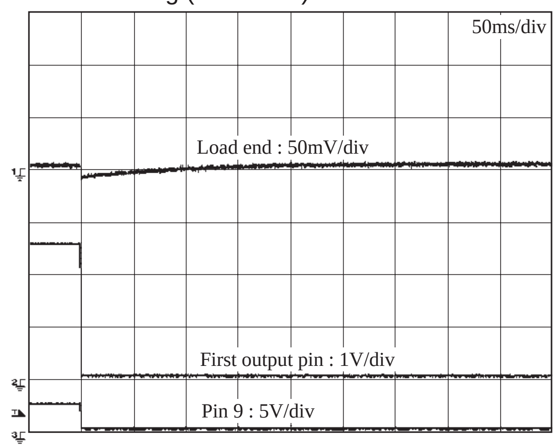


• **Transient response characteristics** (volume mute. setting)

Rising (V9 ⇒ high) characteristics



Falling (V9 ⇒ low) characteristics



This catalog provides information as of December, 2009. Specifications and information herein are subject to change without notice.