Ordering number : EN5504

Monolithic Linear IC

LA4905

17-W, 2-Channel BTL AF High-Efficiency Power Amplifier for Car Stereo Systems

Overview

The LA4905 is a BTL 2-channel power amplifier IC for use in car audio systems. Increases in the number of external components are held to a minimum by adopting both a signal-following type switching scheme in the amplifier's output stage power supply, and a newly-developed nonlinear amplifier that has nonlinear characteristics in the signal system. The power dissipation (thermal loss) in the actual operating range has been reduced to about 1/2 that of earlier class B amplifier ICs. This contributes significantly to miniaturization of the heat sink and to reduction of heating within the set.

Features

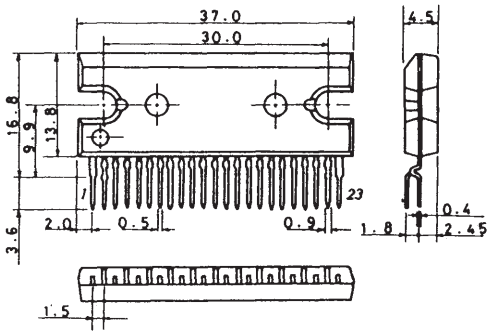
- Power dissipation reduced by 50% (When average music power is measured, and when compared to earlier Sanyo products.)
- The number of required signal follower circuits has been reduced to a single circuit for two channels, allowing the number of external components to be reduced.
- The output is a pure analog signal: no switching noise is output to the output lines.
- Operates on an 8 to 18-V single-voltage power supply.
- Full complement of built-in protection circuits (shorting to the power supply, shorting to ground, overvoltage, and thermal protection)
- Built-in standby switch

Package Dimensions

unit: mm

3160-SIP23HZ

[LC4905]



SANYO: SIP23HZ

Specifications

Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V_{CC} max1	No input, t = 1 minute	24	V
	V_{CC} max2		18	V
Maximum output current	I_O Peak	(Per channel)	4.5	A
Allowable power dissipation	Pd max	With an arbitrarily large heat sink	37.5	W
Operating temperature	Topr		–35 to +85	°C
Storage temperature	Tstg		–40 to +150	°C

Notes: 1. Set VCC and RL in the range where Pd max does not exceed 37.5 W.
2. The overvoltage protection circuit operates when VCC is 20 V or higher.

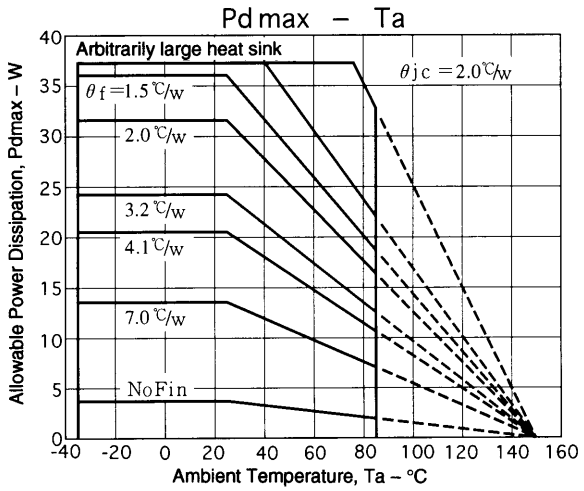
Operating Conditions at Ta = 25°C

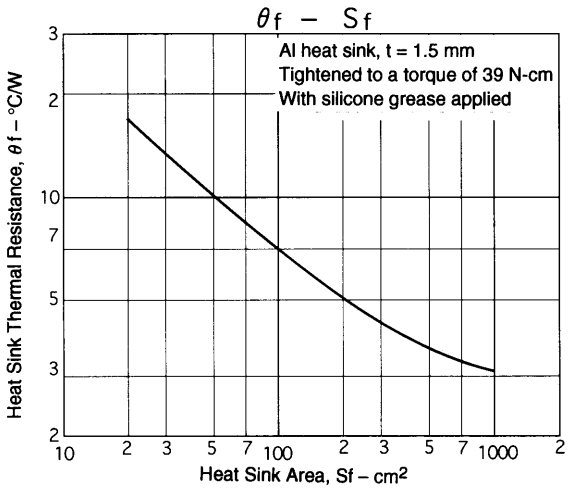
Parameter	Symbol	Conditions	Ratings	Unit
Recommended supply voltage	V_{CC}		13.2	V
Allowable operating supply voltage range	V_{CC} op		8 to 18	V
Recommended load resistance	R_L		4	Ω
Recommended load resistance range	R_L op		2 to 4	Ω

Notes: Set VCC and RL in the range where Pd max does not exceed 37.5 W.

Operating Characteristics at Ta = 25°C, V_{CC} = 13.2 V, R_L = 4 Ω, f = 1 kHz, Rg = 600 Ω, in the recommended circuit

Parameter	Symbol	Conditions	min	typ	max	Unit
Quiescent current	Icco	R_L = ∞, V_{IN} = 0	80	110	150	mA
Standby current	Ist			0	10	μA
Voltage gain	VG	V_O = 0 dBm	38	40	42	dB
Total harmonic distortion	THD	P_O = 1W, LPF = 30 kHz		0.07	0.2	%
Output power 1	P_O1	THD = 10%, R_L = 4 Ω	14	17		W
	P_O2	THD = 10%, R_L = 2 Ω		25		W
Output noise voltage	V_{NO}	Rg = 0, BPF = 20 Hz to 20 kHz		0.15	0.3	mVrms
Ripple rejection ratio	SVRR	Rg = 0, V_{CCR} = 0 dBm, BPF = 20 Hz to 20 kHz	60	70		dB
Channel separation	CHsep	Rg = 10 kΩ, V_O = 0 dBm, BPF = 20 Hz to 20 kHz	45	55		dB
Input resistance	Ri		21	30	39	kΩ
Output offset voltage	VN offset	Rg = 0	–300		+300	mV
Standby on voltage	V_{STH}	AMP = on, applied through a 10 kΩ resistor	3		V_{CC}	V





LA4905 High-Efficiency Technology

(1) Signal-following switching scheme

The LA4905 adopts a switching regulator scheme in the power supply applied to the amplifier output stage. The LA4905 power dissipation is reduced significantly by having the output voltage of the switching regulator follow the input signal. Furthermore, in combination with the nonlinear amplifier scheme described below, the LA4905 design reduces the number of switching regulators to merely one circuit even though it is a BTL 2-channel amplifier. (See Figure 1.)

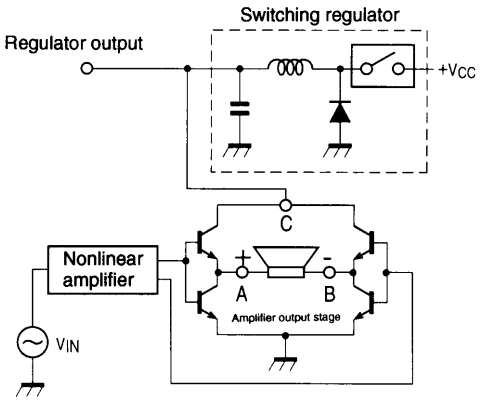


Figure 1 Overview Block Diagram

(2) Nonlinear amplifier

The LA4905 adopts a nonlinear amplifier that has the nonlinear characteristics shown in Figure 2 in the amplifier signal system. This scheme does not use the center point voltage of 1/2 VCC used in normal amplifiers, but instead uses a voltage about 2 V lower. This allows the design to dispense with the lower side switching regulator.

This nonlinear amplifier has a structure based on a differential amplifier that has symmetric negative feedback circuits. Although the BTL output stage positive and negative phase output waveform is a half-wave waveform that is expanded and compressed as shown in Figure 3, the combined output waveform at the negative load terminal is identical to that output by earlier products.

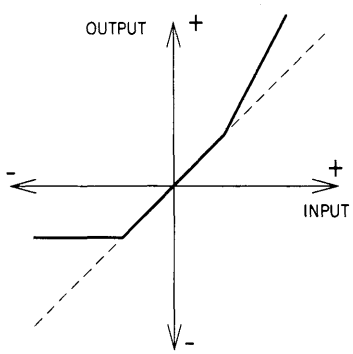


Figure 2 Nonlinear Amplifier Input/Output Characteristics

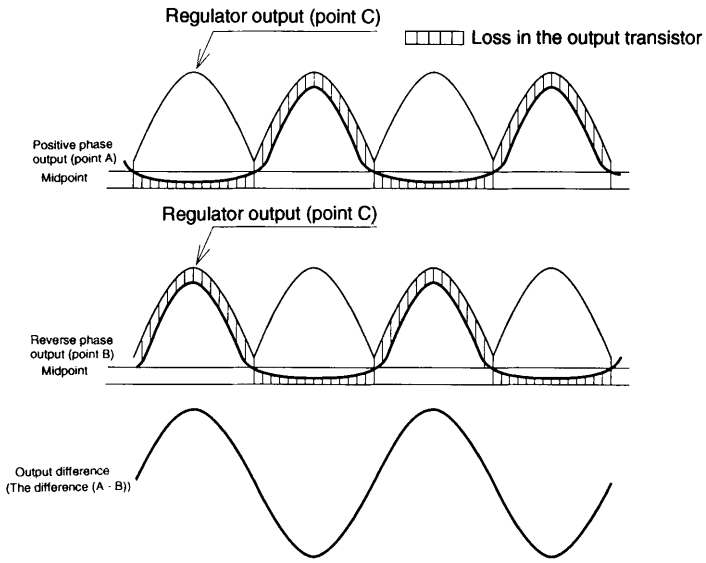


Figure 3 Output Waveforms

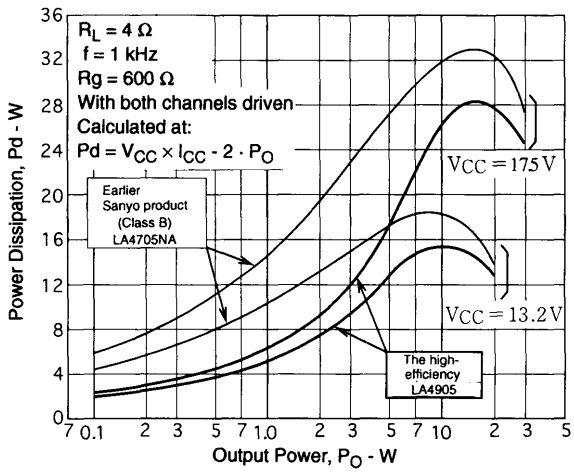
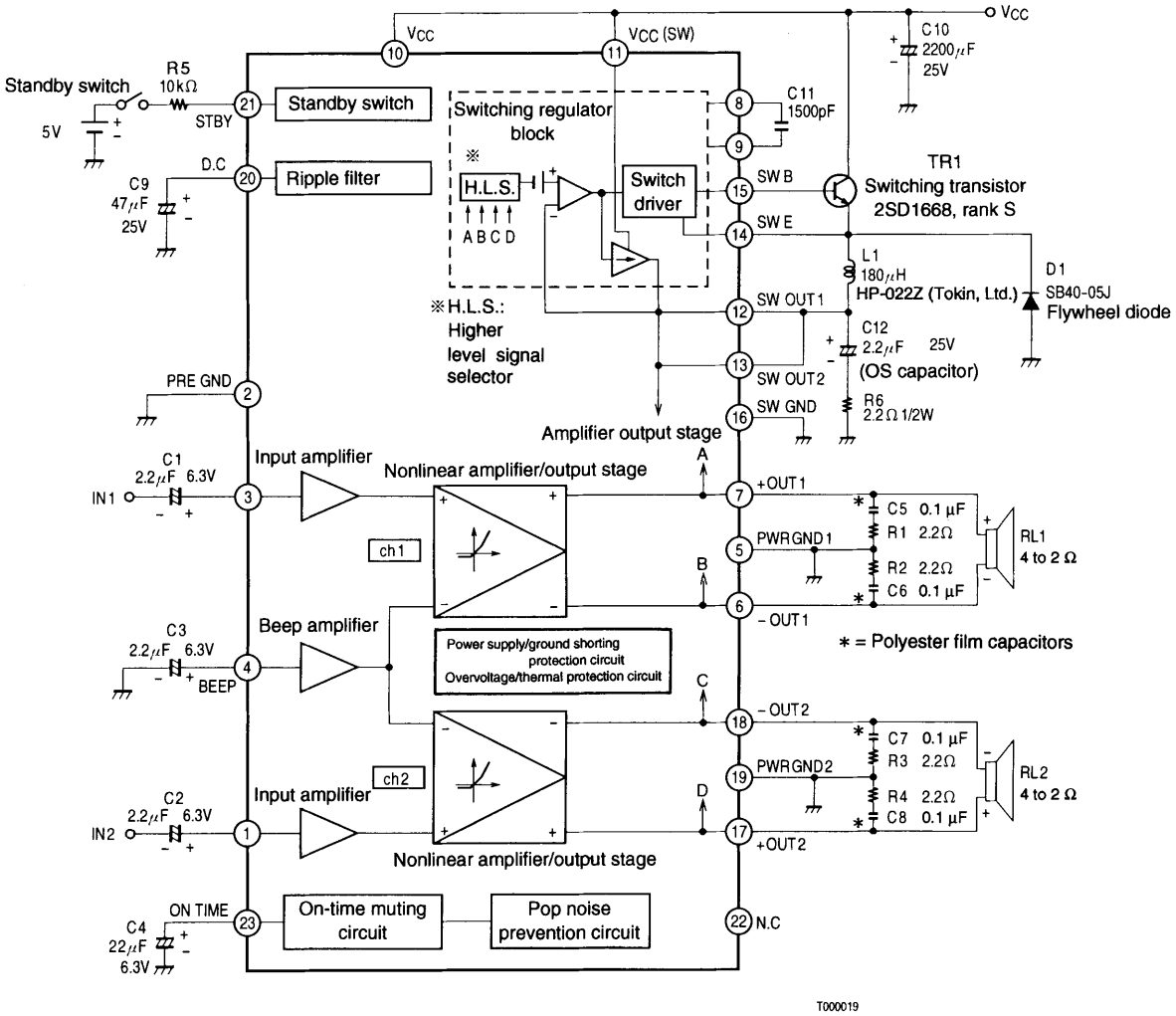


Figure 4 Power Dissipation Comparison with Earlier Products

Equivalent Circuit Block Diagram



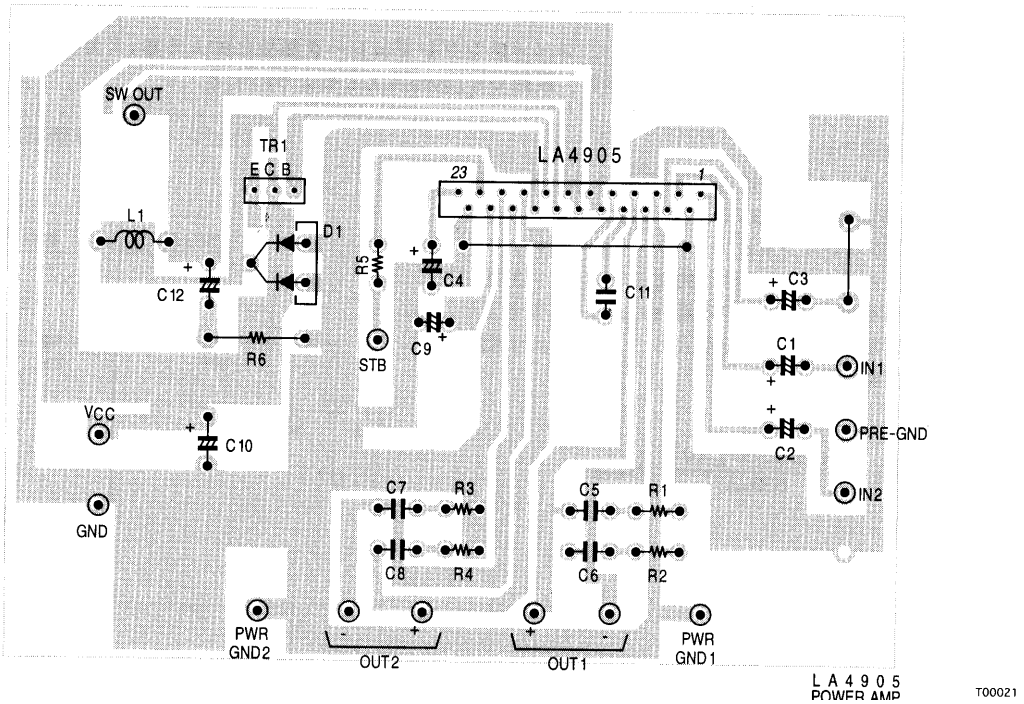
Pin Voltages V_{CC} = 13.2 V, 5 V applied to STBY through a 10-kΩ resistor, using a digital voltmeter

Pin No.	1	2	3	4	5	6	7	8
Pin	IN2	Pre-GND	IN1	BEEP	PWR-GND 1	–OUT1	+OUT1	C
Pin voltage (V)	1.36	0	1.36	1.36	0	2.03	2.03	13.0

Pin No.	9	10	11	12	13	14	15	16
Pin	C	V_{CC}	V_{CC} (SW)	SW OUT 1	SW OUT 2	SW E	SW B	SW-GND
Pin voltage (V)	3.92	13.2	13.2	3.70	3.70	3.73	4.0	0

Pin No.	17	18	19	20	21	22	23	
Pin	+OUT 2	–OUT 2	PWR-GND 2	D. C	STAND-BY	N. C	ON-TIME	
Pin voltage (V)	2.03	2.03	0	12.1	3.21	0	2.81	

Sample Printed Circuit Board Pattern



1. External Component Functions

C1, C2 • Input capacitors; recommended value: 2.2 µF. Note that the low-frequency band can be adjusted by changing the values of C1 and C2, since fL depends on their value, although the value must not exceed 3.3 µF (when C4 is 22 µF) due to pop noise considerations.

C3 • Beep amplifier input capacitor. Use the same value as that used for C1 and C2. Connect the beep amplifier to PRE-GND through C3 if the beep function is not used.

C4 • Amplifier power-on delay time setting capacitor; recommended value: 22 µF. At the recommended value, the amplifier will turn on in about 0.7 second after power is applied. The delay time is proportional to the capacitance and can be set to an arbitrary value. However, a value of 22 µF or larger should be used due to pop noise considerations.

C5, C6, C7, C8 • Oscillation prevention capacitors. Use capacitors with excellent temperature characteristics such as polyester film or Mylar capacitors. These capacitors function in conjunction with R1, R2, R3, and R4. We recommend using capacitors of 0.1 µF or larger, since the stability varies somewhat depending on the printed circuit board layout.

C9 • Decoupling capacitor (ripple filter)

C10 • Power-supply capacitor

C11 • Switching regulator oscillation prevention capacitor; recommended value: 1500 pF.

C12 • Switching regulator output smoothing capacitor. The LA4905 adopts a self-excitation switching regulator scheme. Since this capacitor influences the stability of the self-excitation and the regulator efficiency, there is an optimal value. We recommend the use of a 2.2-µF, 25-V OS capacitor with good temperature characteristics. Note that a 2.2-Ω, 1/2-W resistor should be used for R5 for the same reason.

R5 • Standby switch current limiting resistor; recommended value: 10 kΩ.
(When the voltage applied to the standby switch is between 3 and 13.2 V.) Note that this resistor cannot be removed. See the section "Standby Function" elsewhere in this document.

TR1 • External switching transistor. We recommend using a 2SD1668 of rank S. A 2SD1667 of rank S may be used if the application is designed to handle 4-Ω loads (R_L). A heat sink must be provided along with that for the IC.

D1 • Flywheel diode that takes up the coil energy. We recommend using an SB40-05J, which is a Schottky barrier diode with a low V_F.
An SB10-05A2 may be used if the application is designed to handle 4-Ω loads (R_L). A joint heat sink is not required.

L1 • We recommend the use of the HP-022Z 180-µH coil manufactured by Tokin, Ltd. The 200-µH HP-011Z may be used if the application is designed to handle 4-Ω loads (R_L).

2. IC Internal Characteristics and Usage Notes

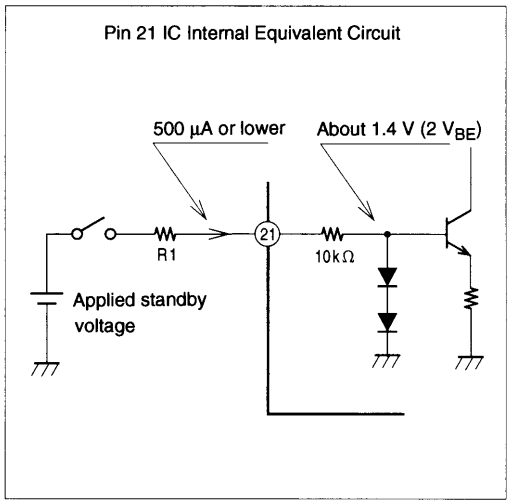
Switching Regulator

- To reduce power dissipation, the LA4905 includes a signal-following type switching regulator. When there is no input signal, the self-excited oscillator operates at about 100 kHz.
- It is desirable for the amplifier block to be separated as far as possible from the tuner block to prevent interference from extraneous radiation within the set. Also, when designing the printed circuit board layout, the pattern lines for the switching regulator components should be made as short and as broad as possible.
- To prevent degradation of the characteristics of the LA4905 itself, the separation between the switching regulator components and the IC input block (the input block pattern, the input capacitors, and the beep capacitor) should be at least 1.5 cm.

Standby Function

- Pin 21 is the standby switch pin. The amplifier is turned on by applying a voltage of about 3 V or higher through an external resistor (R1).
- The value of R1 must be determined, using the following formula, so that the pin 5 influx current remains under 500 μA if a voltage in excess of 13.2 volts is applied as the standby switch voltage.

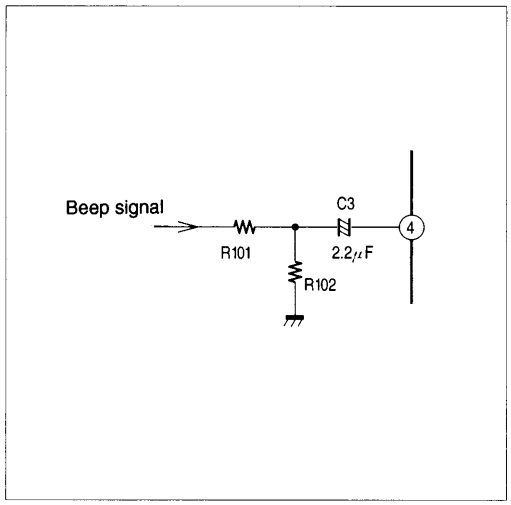
$$R1 = \frac{\text{applied voltage} - 1.4\ \text{V}}{500\ \mu\text{A}} - 10\ \text{k}\Omega$$



T00022

BEEP Pin (pin 4)

- If the BEEP pin is used, use a value for R102 shown in the figure that is under 100 Ω and is as small as possible to prevent degradation of the IC output noise voltage (VNO).



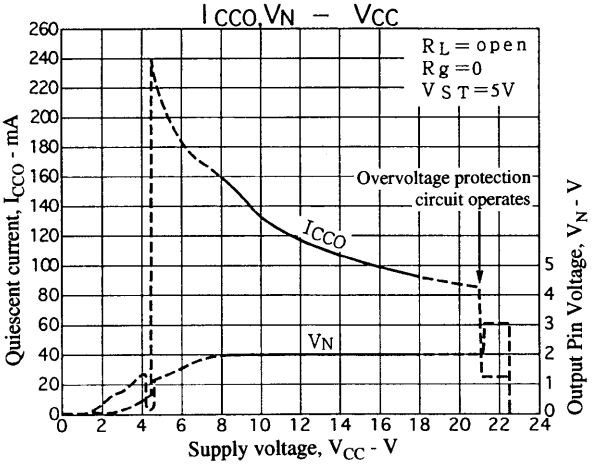
T00023

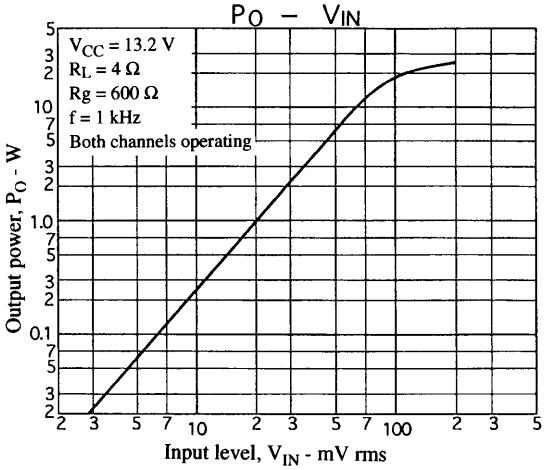
Protection Circuits

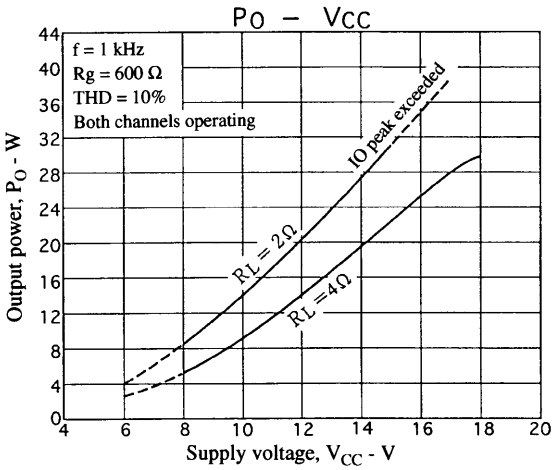
- The LA4905 includes a built-in thermal protection circuit to prevent destruction or degradation if the IC generates abnormal amounts of heat. The thermal protection circuit controls the IC so that the output is gradually lowered if the IC junction temperature (Tj) increases to about 160°C due to an insufficient heat sink or other reason.
- The overvoltage protection circuit operates if the V_{CC} voltage exceeds a value of about 20 volts.
- Although the LA4905 includes an on-chip protection circuit for shorts to V_{CC} and shorts to ground, it does not include a load shorted protection circuit. The idea behind this design is that the thermal protection circuit will protect the IC against load shorting. However, since load shorting can also cause heating in external transistors and coils, designs should take load shorting into consideration.

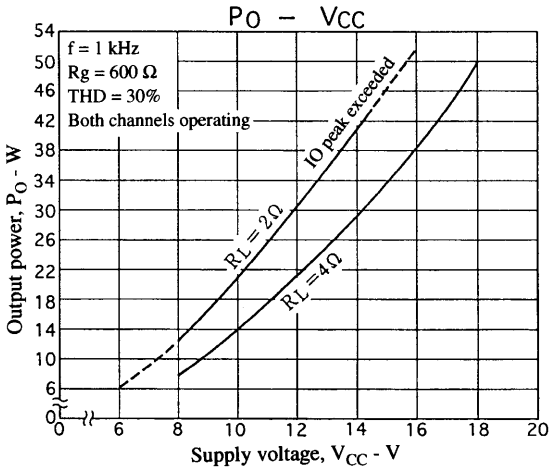
Other Notes

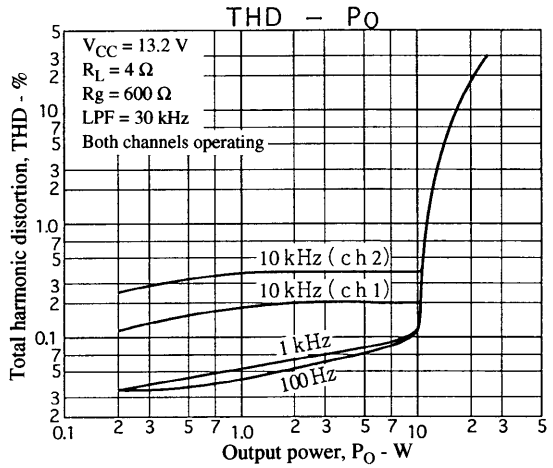
- Pin 22 is an NC pin, and is not connected within the package.

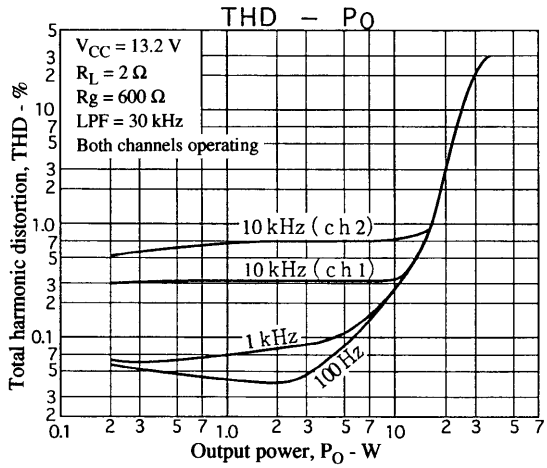

ICCO, VN – VCC
RL = open
Rg = 0
VST = 5V
Overvoltage protection circuit operates
ICCO
VN
Quiescent current, ICCO - mA
Output Pin Voltage, VN - V
Supply voltage, VCC - V

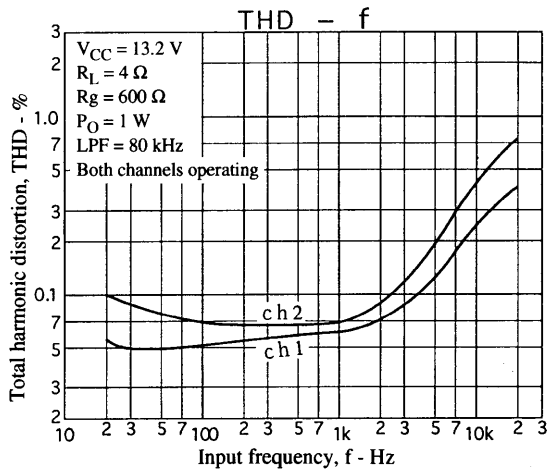

PO – VIN
VCC = 13.2 V
RL = 4 Ω
Rg = 600 Ω
f = 1 kHz
Both channels operating
Output power, PO - W
Input level, VIN - mV rms

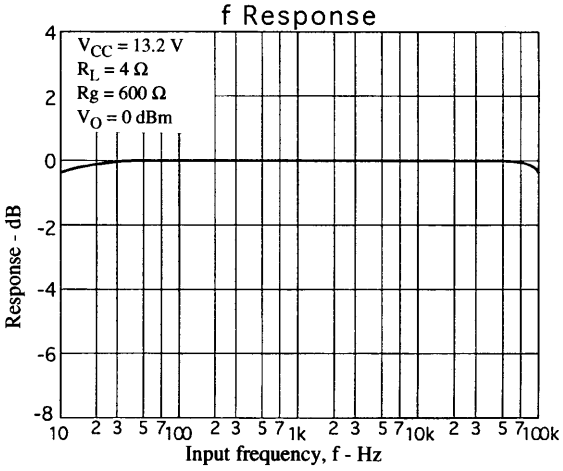

PO – VCC
f = 1 kHz
Rg = 600 Ω
THD = 10%
Both channels operating
IO peak exceeded
RL = 2Ω
RL = 4Ω
Output power, PO - W
Supply voltage, VCC - V

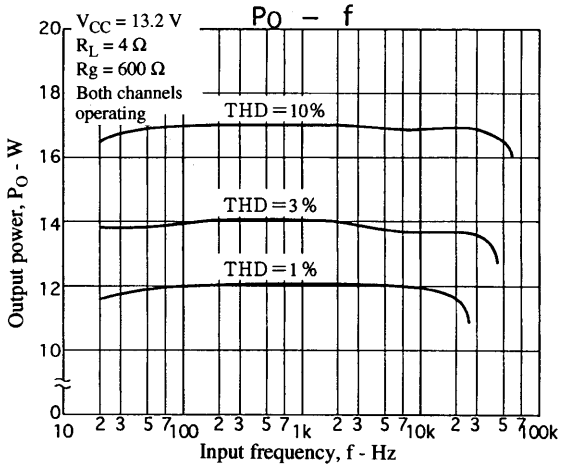

PO – VCC
f = 1 kHz
Rg = 600 Ω
THD = 30%
Both channels operating
IO peak exceeded
RL = 2Ω
RL = 4Ω
Output power, PO - W
Supply voltage, VCC - V

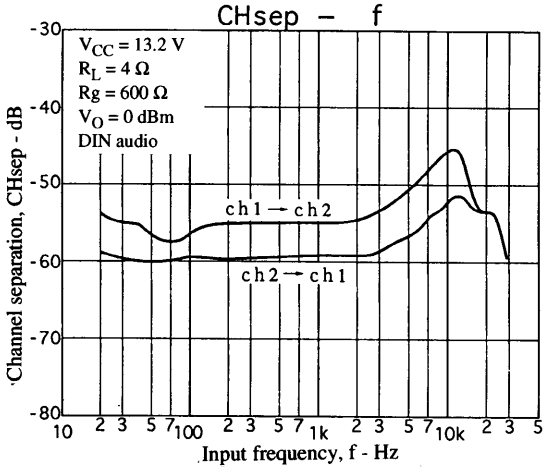

THD – PO
VCC = 13.2 V
RL = 4 Ω
Rg = 600 Ω
LPF = 30 kHz
Both channels operating
10 kHz (c h 2)
10 kHz (c h 1)
1 kHz
100 Hz
Total harmonic distortion, THD - %
Output power, PO - W

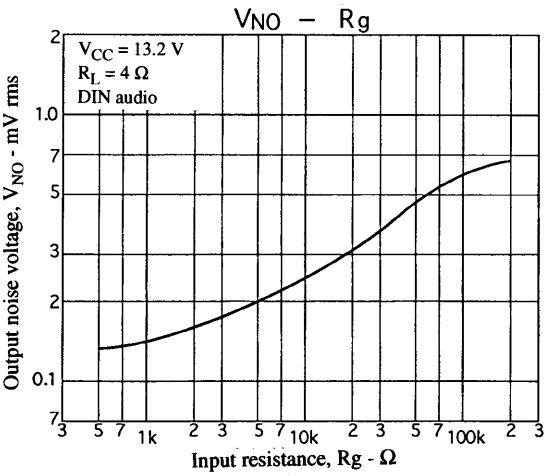

THD – PO
VCC = 13.2 V
RL = 2 Ω
Rg = 600 Ω
LPF = 30 kHz
Both channels operating
10 kHz (c h 2)
10 kHz (c h 1)
1 kHz
100 Hz
Total harmonic distortion, THD - %
Output power, PO - W

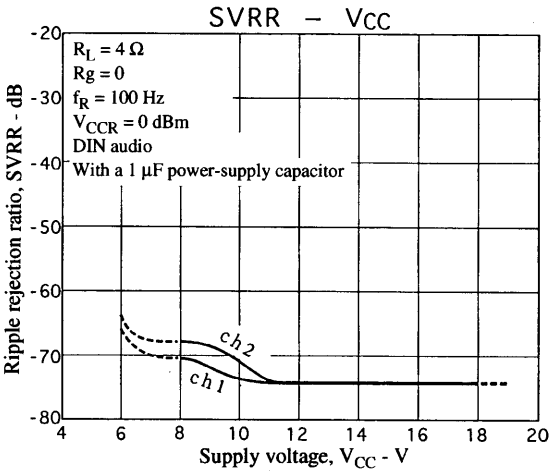

THD – f
VCC = 13.2 V
RL = 4 Ω
Rg = 600 Ω
PO = 1 W
LPF = 80 kHz
Both channels operating
ch 2
ch 1
Total harmonic distortion, THD - %
Input frequency, f - Hz

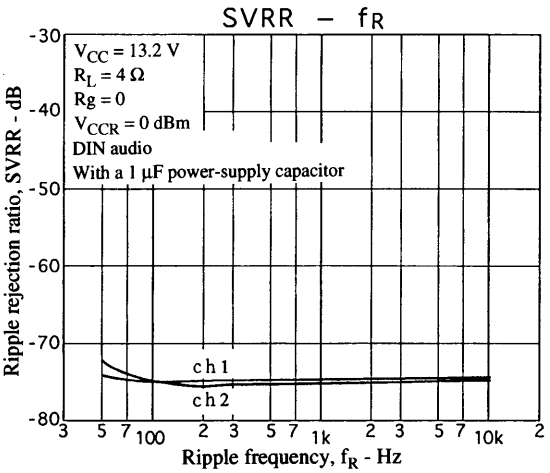

f Response
VCC = 13.2 V
RL = 4 Ω
Rg = 600 Ω
VO = 0 dBm
Response - dB
Input frequency, f - Hz

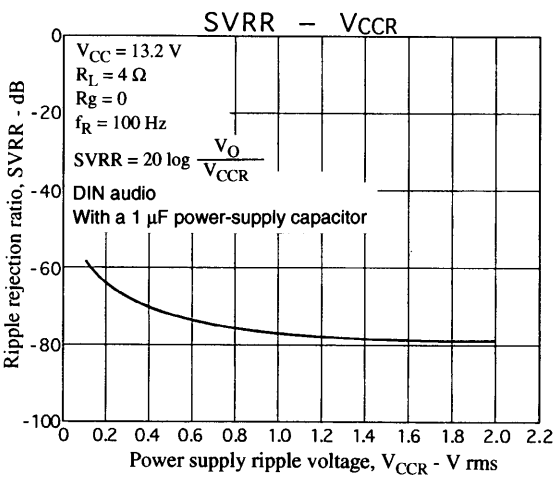

PO – f
VCC = 13.2 V
RL = 4 Ω
Rg = 600 Ω
Both channels operating
THD = 10%
THD = 3%
THD = 1%
Output power, PO - W
Input frequency, f - Hz

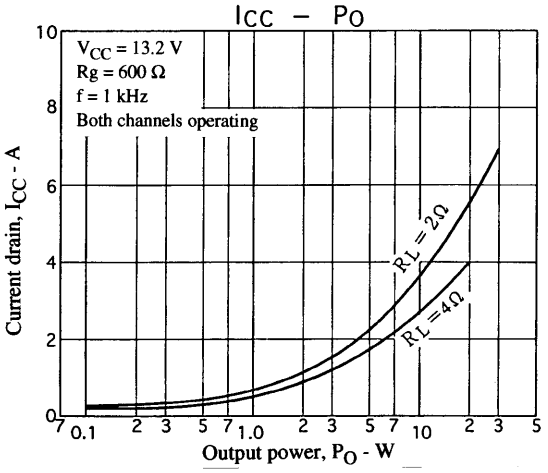

CHsep – f
VCC = 13.2 V
RL = 4 Ω
Rg = 600 Ω
VO = 0 dBm
DIN audio
ch1 → ch2
ch2 → ch1
Channel separation, CHsep - dB
Input frequency, f - Hz

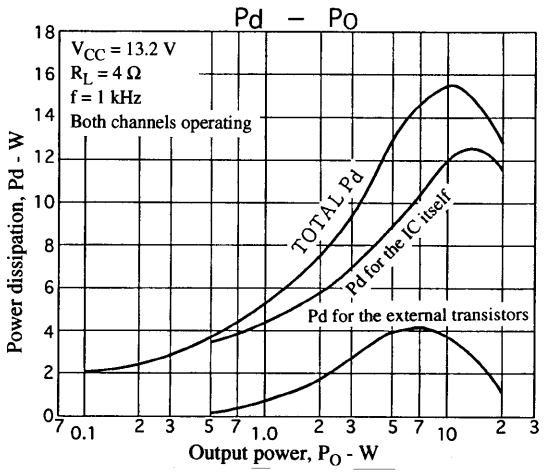

VNO – Rg
VCC = 13.2 V
RL = 4 Ω
DIN audio
Output noise voltage, VNO - mV rms
Input resistance, Rg - Ω

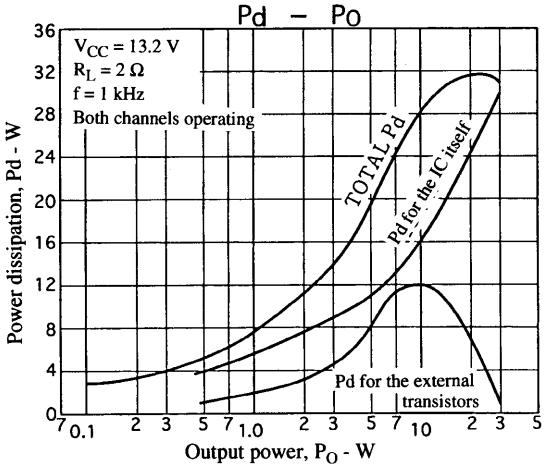

SVRR – VCC
RL = 4 Ω
Rg = 0
fR = 100 Hz
VCCR = 0 dBm
DIN audio
With a 1 µF power-supply capacitor
ch2
ch1
Ripple rejection ratio, SVRR - dB
Supply voltage, VCC - V

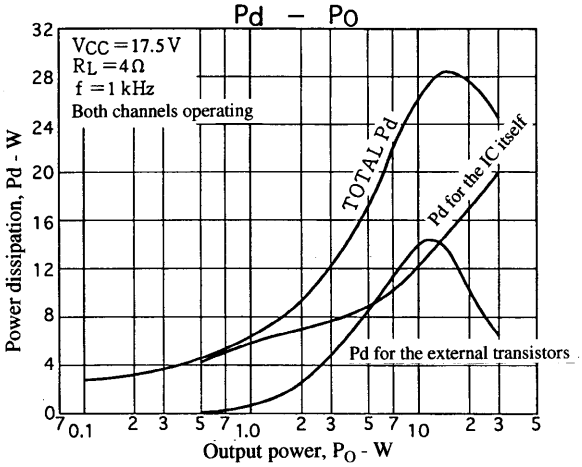

SVRR – fR
VCC = 13.2 V
RL = 4 Ω
Rg = 0
VCCR = 0 dBm
DIN audio
With a 1 µF power-supply capacitor
ch1
ch2
Ripple rejection ratio, SVRR - dB
Ripple frequency, fR - Hz

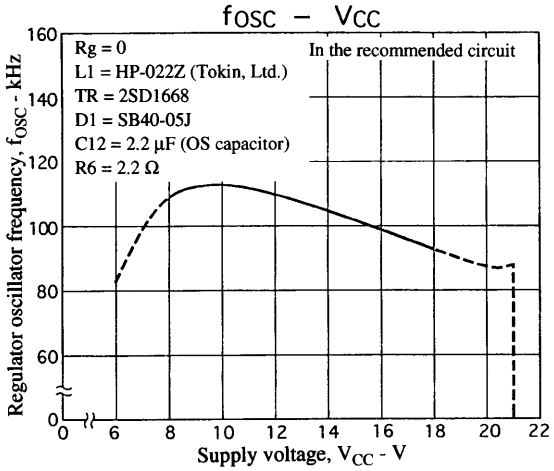

SVRR – VCCR
VCC = 13.2 V
RL = 4 Ω
Rg = 0
fR = 100 Hz
SVRR = 20 log VO / VCCR
DIN audio
With a 1 µF power-supply capacitor
Ripple rejection ratio, SVRR - dB
Power supply ripple voltage, VCCR - V rms

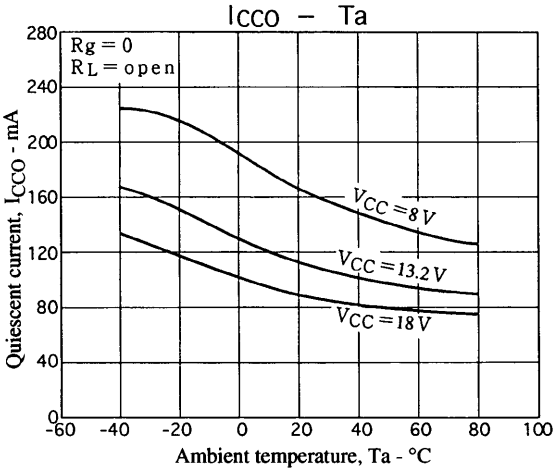

ICC – PO
VCC = 13.2 V
Rg = 600 Ω
f = 1 kHz
Both channels operating
RL = 2Ω
RL = 4Ω
Current drain, ICC - A
Output power, PO - W

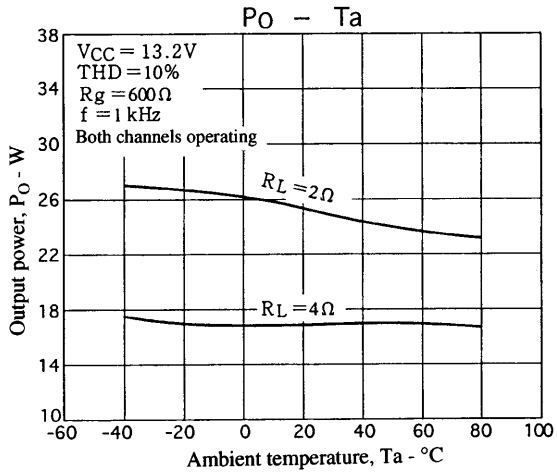

Pd – PO
VCC = 13.2 V
RL = 4 Ω
f = 1 kHz
Both channels operating
TOTAL Pd
Pd for the IC itself
Pd for the external transistors
Power dissipation, Pd - W
Output power, PO - W

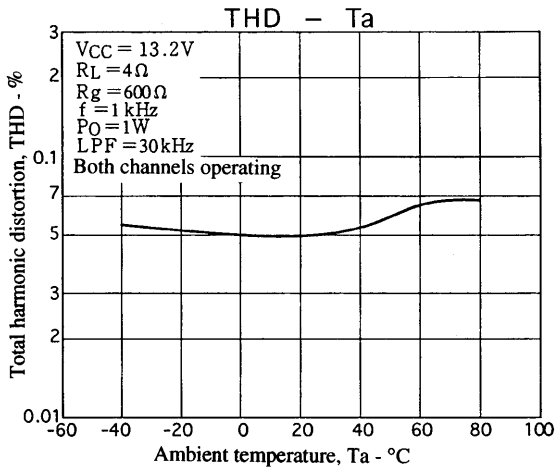

Pd – Po
VCC = 13.2 V
RL = 2 Ω
f = 1 kHz
Both channels operating
TOTAL Pd
Pd for the IC itself
Pd for the external transistors
Power dissipation, Pd - W
Output power, PO - W

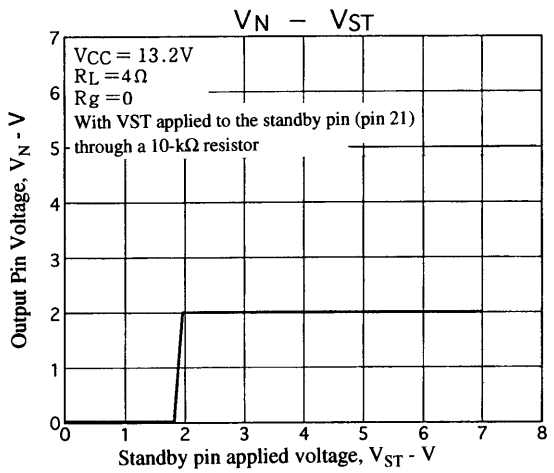

Pd – Po
VCC = 17.5 V
RL = 4 Ω
f = 1 kHz
Both channels operating
TOTAL Pd
Pd for the IC itself
Pd for the external transistors
Power dissipation, Pd - W
Output power, PO - W

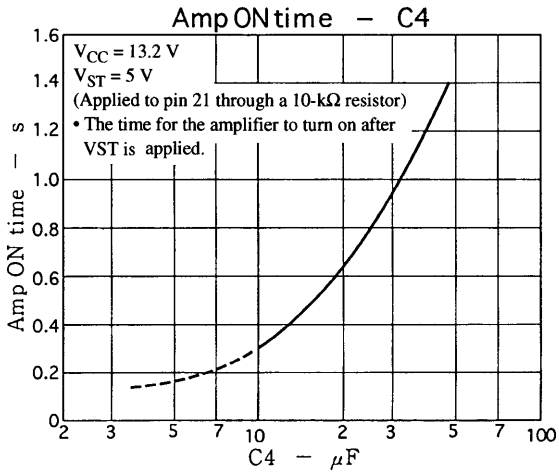

fosc – Vcc
Rg = 0
In the recommended circuit
L1 = HP-022Z (Tokin, Ltd.)
TR = 2SD1668
D1 = SB40-05J
C12 = 2.2 µF (OS capacitor)
R6 = 2.2 Ω
Regulator oscillator frequency, fOSC - kHz
Supply voltage, VCC - V


Icco – Ta
Rg = 0
RL = open
VCC = 8 V
VCC = 13.2 V
VCC = 18 V
Quiescent current, ICCO - mA
Ambient temperature, Ta - °C


PO – Ta
VCC = 13.2V
THD = 10%
Rg = 600 Ω
f = 1 kHz
Both channels operating
RL = 2Ω
RL = 4Ω
Output power, PO - W
Ambient temperature, Ta - °C


THD – Ta
VCC = 13.2V
RL = 4 Ω
Rg = 600 Ω
f = 1 kHz
PO = 1W
LPF = 30 kHz
Both channels operating
Total harmonic distortion, THD - %
Ambient temperature, Ta - °C


VN – VST
VCC = 13.2V
RL = 4 Ω
Rg = 0
With VST applied to the standby pin (pin 21)
through a 10-kΩ resistor
Output Pin Voltage, VN - V
Standby pin applied voltage, VST - V


Amp ON time – C4
VCC = 13.2 V
VST = 5 V
(Applied to pin 21 through a 10-kΩ resistor)
• The time for the amplifier to turn on after VST is applied.
Amp ON time – s
C4 – µF