Ordering number : EN4376A

Thick Film Hybrid IC

STK4067

High-Output Power Amplifier for Car Stereos (Po = 60 W typ.)

Overview

Higher output amplification of the car stereo has been generally dependent on boosting voltage of the power supply. The STK4067 supports low-load impedance and is designed for up to 60 W of high output without the need for a power supply voltage booster circuit.

Applications

- Power amplifier for car stereos
- Home karaoke systems
- Radio-cassette players

Features

- Superior heat sink capacity using IMST (insulated metal substrate technology)
- Designed for high output while supporting low-load impedance

① R_L = 1Ω	60 W typ. (EIAJ)	100 W (max.)
② R_L = 2Ω	40 W typ. (EIAJ)	70 W (max.)
③ R_L = 4Ω	23 W typ. (EIAJ)	40 W (max.)

- Supports sufficient amplifier configurations for high power output
- Low-load impedance driver

  Supports independent or parallel speaker connections for low-load impedance driving.
- Low distortion

  THD = 0.025% typ. (V_{CC} = 13.2 V, R_L = 2Ω, Po = 10 W, f = 1 kHz)

  Compared with a monolithic IC, with a base frequency of 100 Hz, the following is established: secondary high frequency harmonics switches to –58 dB, with third-order switching to –20 dB, fourth-order to –45 dB, and fifth-order to –18 dB.
- High temperature operation

  Provides guaranteed high output to the passenger compartments protected interior even when operating in excessive heat
- Compact heat sink mounting

  Supports compact total-set packaging, occupying 1/3 the heat sink area compared of monolithic ICs, and equipped with an 85°C temperature range and 110°C guaranteed case temperature rating
- Low operating power supply voltage range (9 V to 16 V)
- Built-in muting circuit

  Short attack time with muting quickly enabled
- Built-in protection circuits

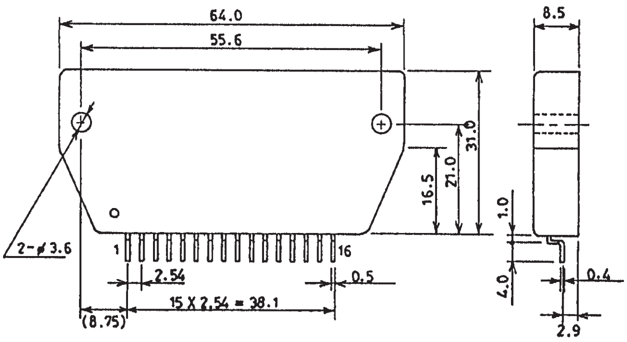
  Built-in thermal shutdown and overvoltage protector

Package Dimensions

unit : mm

4131

[STK4067]



Specifications

Maximum Ratings at Ta=25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V_{CC} max (1)	No signal (with circuit cut off) 30s	30	V
	V_{CC} max (2)	With signal (f = 100 kHZ, Vin = 1 Vrms, t = 100 ms)	18	V
Output current	I_O max		15	A
Junction temperature	Tj		150	°C
Thermal resistance	θj-c	Per power transistor	1.6	°C/W
Operating substrate temperature	Tc		110	°C
Storage temperature	Tstg		–40 to +125	°C
Available time for load shorted	ts	V_{CC} = 13.2 V, R_L = 2 Ω, f = 50 Hz, P_O = 25 W	2	s

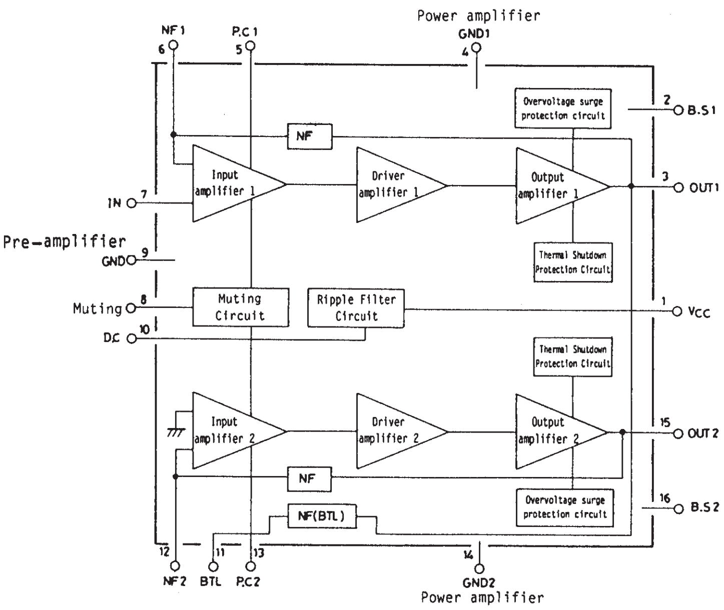
Recommended Operating Conditions at Ta=25°C

Parameter	Symbol	Conditions	Ratings	Unit
Recommended supply voltage	V_{CC}		13.2	V
Load resistance	R_L		2	Ω

Operating Characteristics at Ta = 25°C, V_{CC} = 13.2 V, R_L = 2 Ω, Rg = 600 Ω, VG = 46 dB

Parameter	Symbol	Conditions	min	typ	max	Unit
Quiescent current	I_{CCO}	Rg = 10 kΩ		70	140	mA
Output power	P_O (1)	THD = 10%, f = 1 kHz, R_L = 1 Ω	50	60		W
	P_O (2)	THD = 10%, f = 1 kHz, R_L = 2 Ω		40		W
Total harmonic distortion	THD (1)	P_O = 10 W, f =1kHz		0.025	0.1	%
	THD (2)	P_O = 1 W, f = 20 to 20 kHz			0.4	%
Voltage gain	VG	P_O = 1 W, f = 1 kHz	43.8	46.0	48.2	dB
Frequency response	f_L, f_L	P_O =1 W, $^{+0}_{-3}$ dB		20 to 30k		Hz
Input resistance	r_i	P_O = 1 W, f = 1 kHz	20	30		kΩ
Output noise voltage	V_{NO}	Rg = 10 kΩ, BPF		0.6	1.2	mVrms
Output offset voltage	ΔVN	Rg = 10 kΩ	–200	0	+200	mV
Muting suppression level	ATT	V_M = +5 V		∞		dB
Ripple rejection	SVRR	f_R = 100 Hz, Rg = 0 Ω, V_R = 0 dBm		–47		dB

Equivalent Circuit



STK4067 Design Data

(1) The Protection Circuits

a) Overvoltage Protector

Since the STK4067 is designed for car stereo applications, V_{CC} max for operating mode is set to 18 V. Exceeding the V_{CC} maximum level activates the overvoltage protector and the circuit switches to an off-state and delivers no output. The overvoltage protection circuit is set for a functional range from 18 to 28 V; 100% operation at 28 V. For this reason, you should be careful not to exceed the 18 V limit in quiescent mode and keep in mind AC line regulations when setting using a transformer power supply for designs such as home stereo systems. Exceeding 18 V activates the overvoltage protector and results in the generation of abnormal sounds.

b) Thermal Shutdown

The thermal shutdown protection circuit is designed to first detect abnormal temperature rises which occur during abnormal operation (such as load shorts) and then prevent damage to the IC by limiting the input signal; thereby preventing a further rise in the temperature. The thermal shutdown protector is set to activate at substrate temperature of 135°C with a complete shutdown by switching to an off-state if temperatures rise to 175°C. Under normal application, the IC is equipped with a heat sink and the temperature never reaches a level resulting in a complete off-state switch and saturation occurs at a specific temperature. For example, when a short occurs with an IC mounted 4.5°C/W heat sink, saturation is achieved at approximately 160°C. At this point, Tj exceeds its maximum rating of 170°C. As previously mentioned, this circuit is designed to protect the IC from damage sustained in a short period of time and you should note that the protection circuit will not protect the IC if abnormal temperature rises occur over a long period of time.

(2) Precautions

a) Excessive Input

If a 1 V or greater (f = 1 kHz.rms) overinput is applied to the input pin, the DC balance of the input channel for the input monolithic amplifier is disrupted and output is cut off. In addition, DC voltage is generated on the output pins and causes damage to the speakers. Proper caution should be displayed in preventing input above this voltage.

b) Parasitic Oscillation

The STK4067 performs phase compensation using 2.2Ω and 0.47µF between V_{CC} and the bootstrap pins. Under such conditions, the power supply line must be in a close proximity to the bootstrap pins for the inverting and non-inverting amplifiers. If the power line is too long, parasitic oscillation is likely to occur at low temperatures. If such a problem arises, add a 0.1µF rated condenser between the ground and the head of the power supply line in order to lower the impedance.

c) Power Supply Voltage Inverse Application

The STK4067 is not equipped with a built-in power supply voltage inversion protection circuit. If the possibility exists, one should be externally connected.

d) Power Off

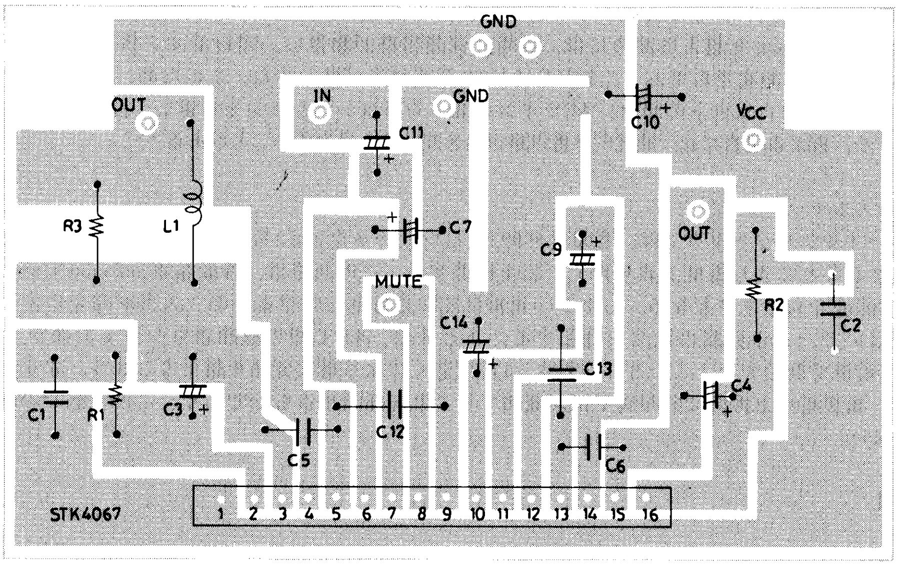
Do not connect pin 1 of the V_{CC} pin directly to the ground or else the IC will be damaged. When connecting pin 1, install a resistor rated for 100Ω or greater in series with pin 1, or you may place a diode between pin 10 and pin 1.

(3) Application Circuits

a) The under frequency band may be magnified, for applications using a booster amplifier or woofer driver amplifier, the bootstrap condensers (C3 and C4) can be changed from 220µF to 470µF. Refer to P_O-f graphs.

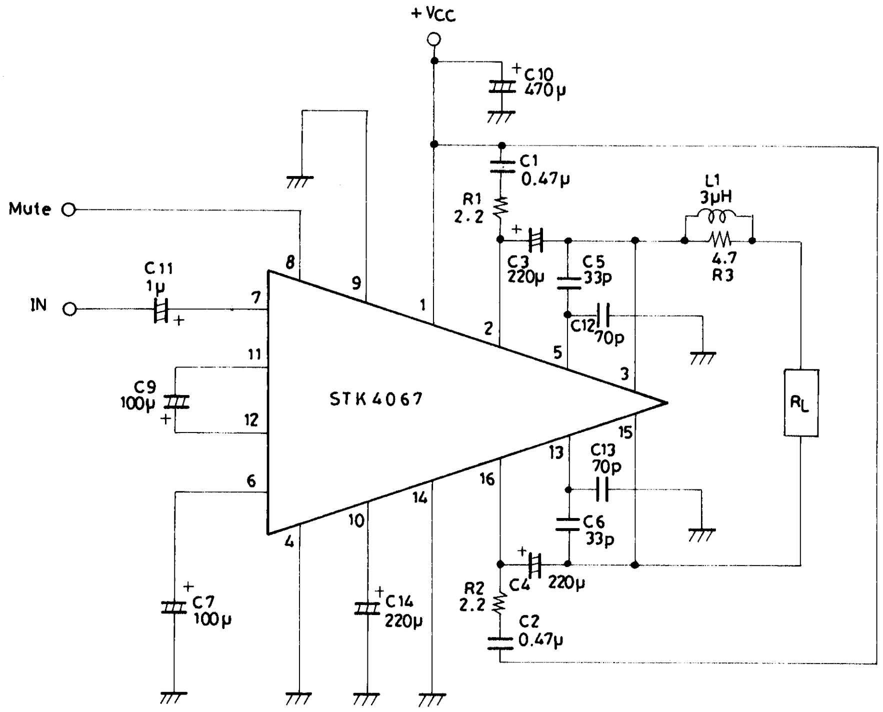
b) L1 = 3 µH and R3 = 4.7Ω are for anti-oscillation applications against capacity loads. We recommend the use of this coil and resistor with the most compatible amplifier sets connected to general use speakers. This coil is not necessary when the load capacity is low using a chosen speaker connected to a radio-cassette player or active speaker.

Example PCB



Bottom view

Sample Application Circuit



Unit (resistance: Ω, capacitance: F)

Sample STK4067 Heat Sink Design

The radiator thermal resistance θc-a required for total substrate power dissipation Pd in the STK4067 is determined as:

Condition 1: IC substrate temperature Tc not to exceed 110°C.

$Pd \times \theta c\text{-}a + Ta < 110°C$ ··························· (1)

where Ta is set assured ambient temperature.

Condition 2: Power transistor junction temperature Tj not to exceed 150°C.

$Pd \times \theta c\text{-}a + Pd/N \times \theta j\text{-}c + Ta < 150°C$ ·········· (2)

where N is the number of power transistors and θj-c is the thermal resistance per power transistor chip. However, power transistor power consumption is Pd equally divided by N units.

Expressions (1) and (2) can be rewritten based on θc-a to yield:

$\theta c\text{-}a < (110 - Ta)/Pd$ ································ (1)'

$\theta c\text{-}a < (150 - Ta)/Pd - \theta j\text{-}c/N$ ······················ (2)'

The required radiator thermal resistance will satisfy both of these expressions.

From expressions (1)' and (2)', the required radiator thermal resistance can be determined once the following specifications are known:

- Supply voltage V_{CC}
- Load resistance R_L
- Assured ambient temperature Ta

The total substrate power consumption when STK4067 V_{CC} is ±13.2 V and R_L is 2 Ω, for a continuous sine wave signal, is a maximum of 19.3W (Fig. 2).

The STK4067 has four power transistors, so the thermal resistance per transistor θj-c is 1.6°C / W. With an assured ambient temperature Ta of 50°C, the required radiator thermal resistance θc-a would be:

From expression (1)' θc-a <(110–50)/19.3
<3.1
From expression (2)' θc-a <(150–50)/19.3–1.6/4
<4.78

To satisfy both, 3.1°C/W is the required radiator thermal resistance.

Figure 1 illustrates Pd - P_O when the V_{CC} of STK4067 is 13.2V and R_L is functioning at 1Ω.

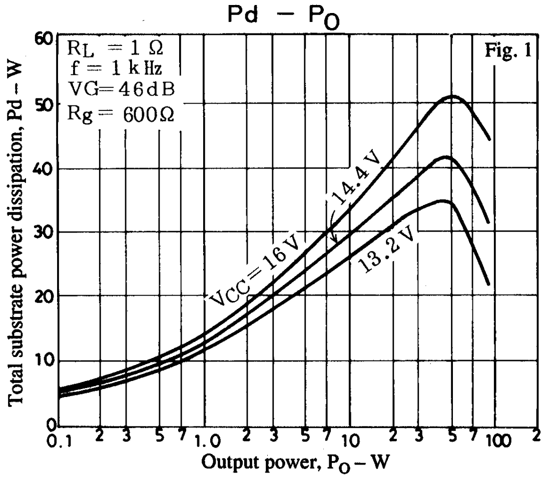
Pd max= 34.8W
From expression (1)' θc-a <(110–50)/34.8
<1.72
From expression (2)' θc-a <(150-50)/34.8–1.6/4
<2.47

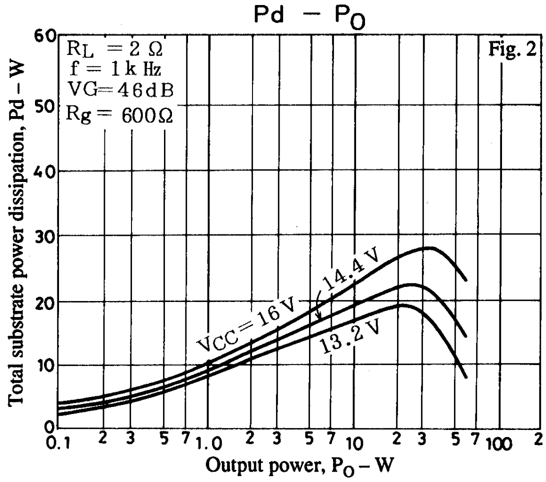
To satisfy both, 1.72°C/W is the required radiator thermal resistance.

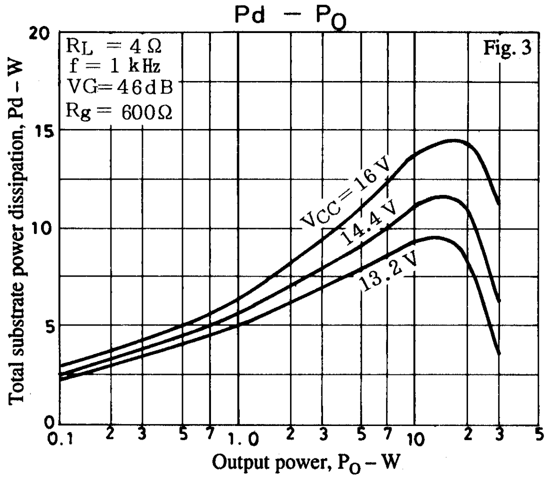
Similar to figure 3 when the STK4067's V_{CC} is 13.2 V and R_L is 4Ω.

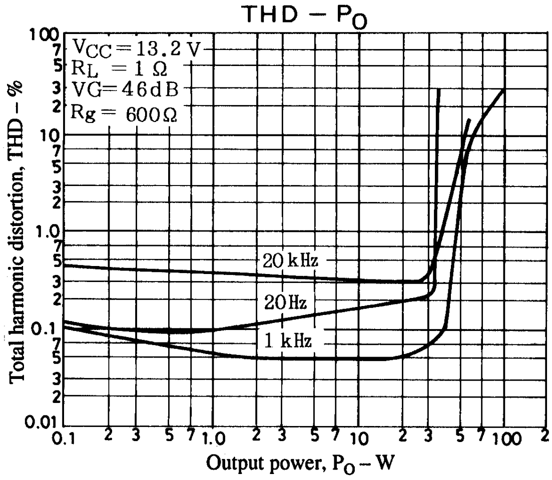
Pd max= 12W
From expression (1)' θc-a <(110–50)/12
<5
From expression (2)' θc-a <(150-50)/12–1.6/4
<7.93

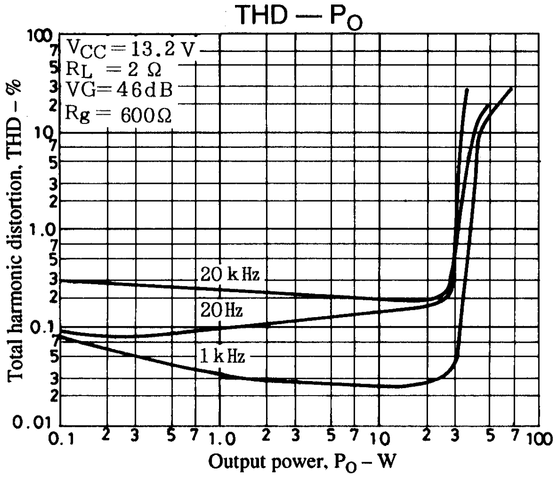
To satisfy both, 5°C / W is the required radiator thermal resistance. This design example is based on a fixed voltage supply, and will require verification within your specific set environment.

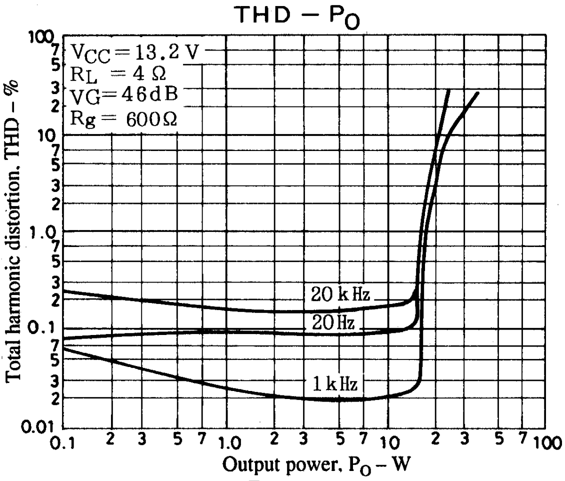

Pd − PO
Fig. 1
RL = 1 Ω
f = 1 kHz
VG=46dB
Rg = 600Ω
VCC=16V
14.4V
13.2V
Total substrate power dissipation, Pd – W
Output power, PO – W

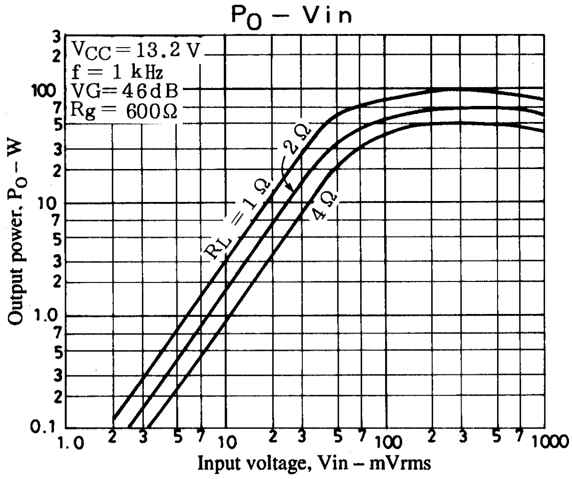

Pd − PO
Fig. 2
RL = 2 Ω
f = 1 kHz
VG=46dB
Rg = 600Ω
VCC=16V
14.4V
13.2V
Total substrate power dissipation, Pd – W
Output power, PO – W

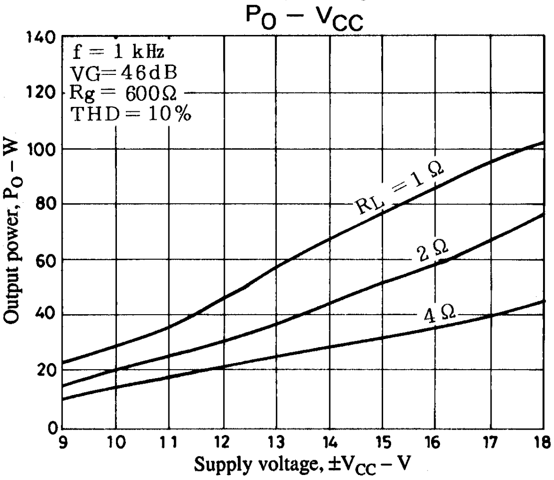

Pd − PO
Fig. 3
RL = 4 Ω
f = 1 kHz
VG=46dB
Rg = 600Ω
VCC=16V
14.4V
13.2V
Total substrate power dissipation, Pd – W
Output power, PO – W

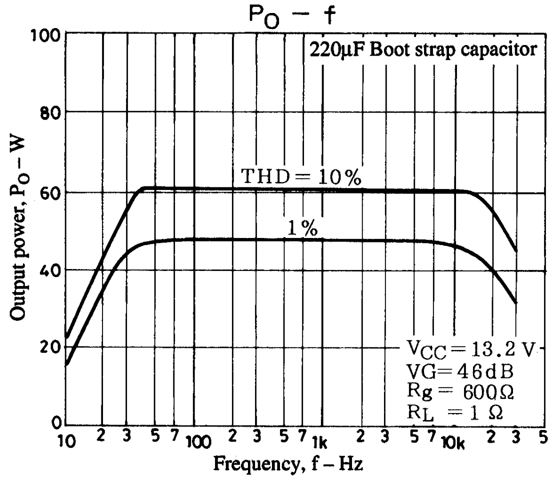

THD − PO
VCC=13.2V
RL = 1 Ω
VG=46dB
Rg = 600Ω
20kHz
20Hz
1kHz
Total harmonic distortion, THD – %
Output power, PO – W

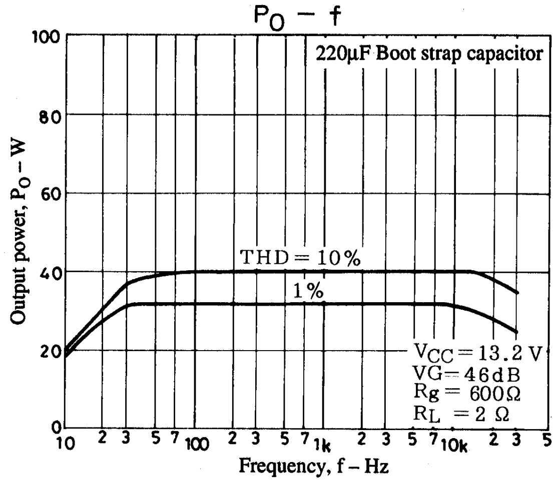

THD — PO
VCC=13.2V
RL = 2 Ω
VG=46dB
Rg = 600Ω
20kHz
20Hz
1kHz
Total harmonic distortion, THD – %
Output power, PO – W

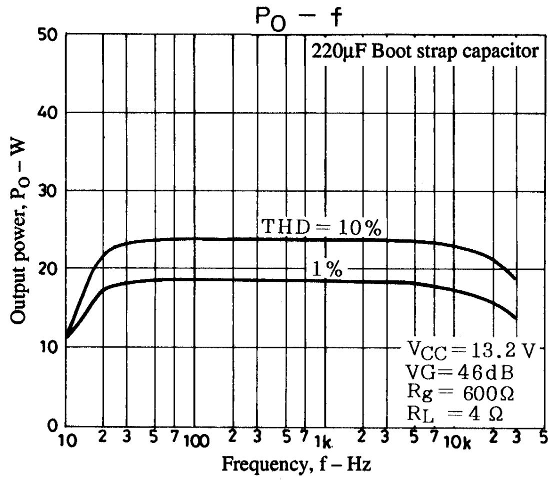

THD − PO
VCC=13.2V
RL = 4 Ω
VG=46dB
Rg = 600Ω
20kHz
20Hz
1kHz
Total harmonic distortion, THD – %
Output power, PO – W

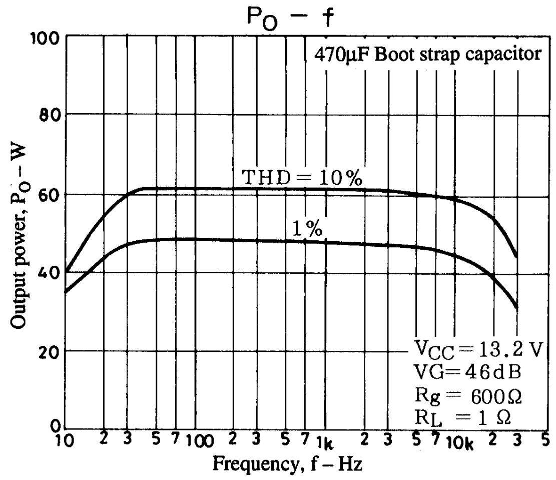

PO − Vin
VCC=13.2V
f = 1 kHz
VG=46dB
Rg = 600Ω
RL=1Ω
2Ω
4Ω
Output power, PO – W
Input voltage, Vin – mVrms

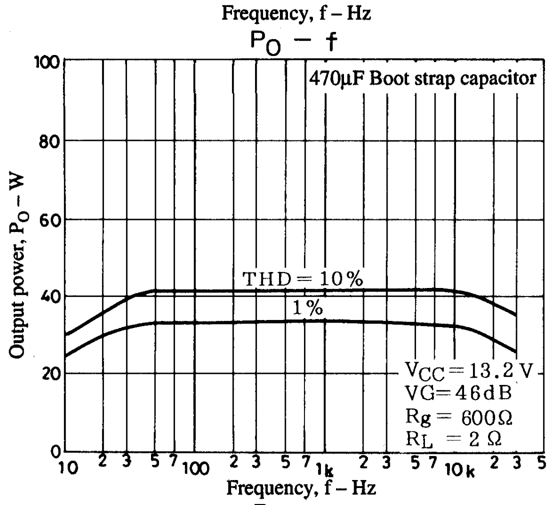

PO − VCC
f = 1 kHz
VG=46dB
Rg = 600Ω
THD = 10%
RL=1Ω
2Ω
4Ω
Output power, PO – W
Supply voltage, ±VCC – V

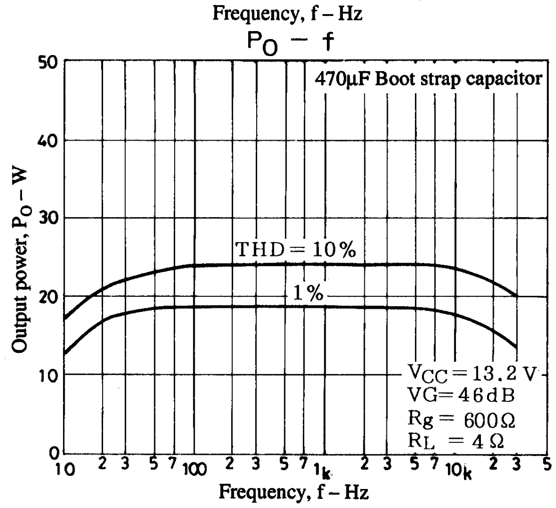

PO − f
220µF Boot strap capacitor
THD = 10%
1%
VCC = 13.2 V
VG = 46dB
Rg = 600Ω
RL = 1 Ω
Output power, PO – W
Frequency, f – Hz

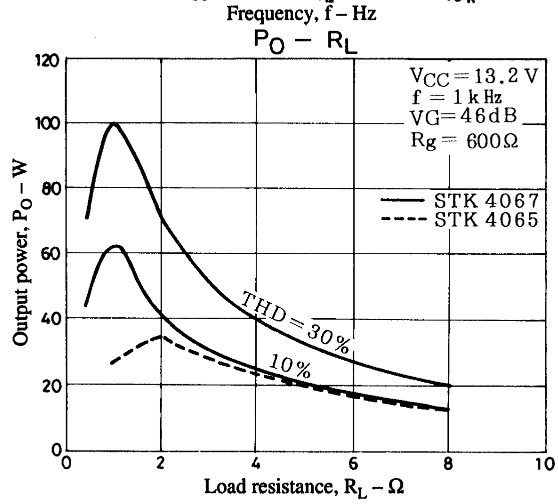

PO − f
220µF Boot strap capacitor
THD = 10%
1%
VCC = 13.2 V
VG = 46dB
Rg = 600Ω
RL = 2 Ω
Output power, PO – W
Frequency, f – Hz

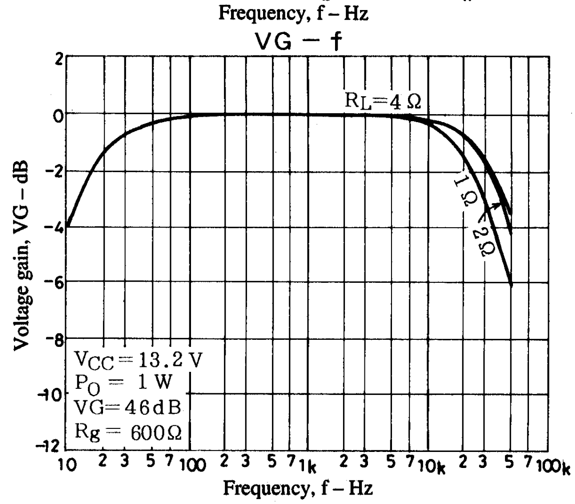

PO − f
220µF Boot strap capacitor
THD = 10%
1%
VCC = 13.2 V
VG = 46dB
Rg = 600Ω
RL = 4 Ω
Output power, PO – W
Frequency, f – Hz

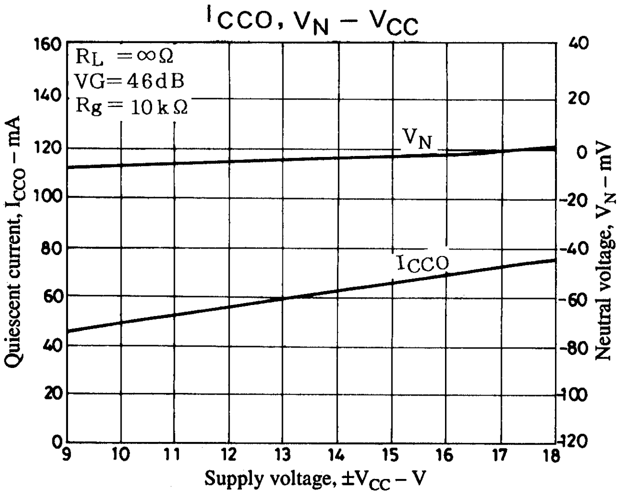

PO − f
470µF Boot strap capacitor
THD = 10%
1%
VCC = 13.2 V
VG = 46dB
Rg = 600Ω
RL = 1 Ω
Output power, PO – W
Frequency, f – Hz

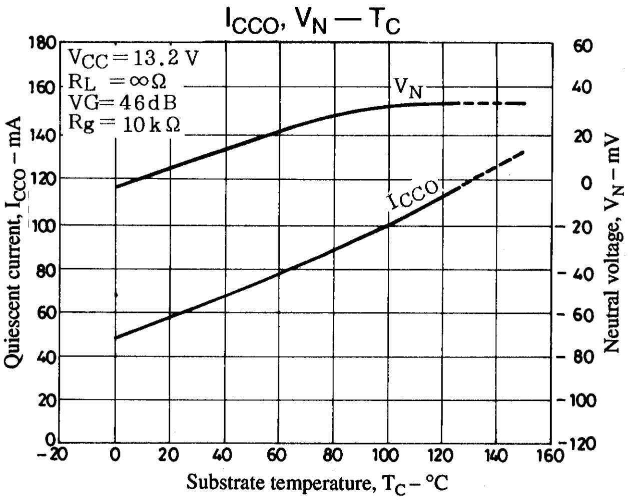

PO − f
470µF Boot strap capacitor
THD = 10%
1%
VCC = 13.2 V
VG = 46dB
Rg = 600Ω
RL = 2 Ω
Output power, PO – W
Frequency, f – Hz


PO − f
470µF Boot strap capacitor
THD = 10%
1%
VCC = 13.2 V
VG = 46dB
Rg = 600Ω
RL = 4 Ω
Output power, PO – W
Frequency, f – Hz


PO − RL
VCC = 13.2 V
f = 1 kHz
VG = 46dB
Rg = 600Ω
STK 4067
STK 4065
THD = 30%
10%
Output power, PO – W
Load resistance, RL – Ω


VG − f
RL = 4 Ω
1 Ω
2 Ω
VCC = 13.2 V
PO = 1 W
VG = 46dB
Rg = 600Ω
Voltage gain, VG – dB
Frequency, f – Hz


ICCO, VN — VCC
RL = ∞Ω
VG= 46dB
Rg= 10kΩ
VN
ICCO
Quiescent current, ICCO – mA
Neutral voltage, VN – mV
Supply voltage, ±VCC – V


ICCO, VN — TC
VCC= 13.2 V
RL = ∞Ω
VG= 46dB
Rg= 10kΩ
VN
ICCO
Quiescent current, ICCO – mA
Neutral voltage, VN – mV
Substrate temperature, TC – °C