Power Amplifier, 6 W 2-Channel, Bridge 19 W (Typ)

LA4440

ON Semiconductor®

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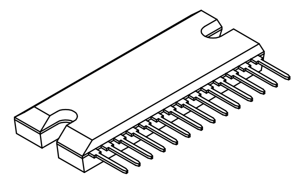
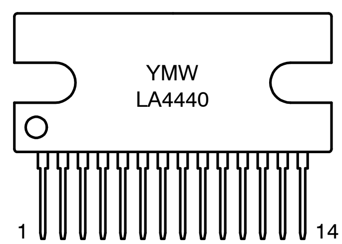
Features

- Built-in 2 Channels (Dual) Enabling Use in Stereo and Bridge Amplifier Applications.
  Dual : 6 W × 2 (typ)
  Bridge : 19 W (typ)
- Minimum Number of External Parts Required
- Small Pop Noise at the Time of Power Supply ON/OFF and Good Starting Balance
- Good Ripple Rejection: 46 dB (typ)
- Good Channel Separation
- Small Residual Noise (Rg=0)
- Low Distortion over a Wide Range from Low Frequencies to High Frequencies
- Easy to Design Radiator Fin
- Built-in Audio Muting Function
- Built-in Protectors
  - Thermal Protector
  - Overvoltage, Surge Voltage Protector
  - Pin-to-pin Short Protector
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant



SIP14
CASE 127AQ

MARKING DIAGRAM



Y	= Year of Production
M	= Assembly Operation Month
W	= Week Number
LA4440	= Specific Device Code

ORDERING INFORMATION

Device	Package	Shipping
LA4440J−E	SIP14 (Pb-Free)	600 / Tube

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C)

Parameter	Symbol	Conditions	Ratings	Unit
Maximum Supply Voltage	V_{CC} max1	Quiescent (t = 30 s)	25	V
	V_{CC} max2	Operating	18	V
Surge Supply Voltage	V_{CC} (surge)	t ≤ 0.2 s	50	V
Allowable Power Dissipation	Pd max	T_C = 75°C, See Pd max – T_A characteristic	15	W
Thermal Resistance	θj-c	Junction-to-case	3	°C/W
Operating Temperature	T_{opr}		–20 to +75	°C
Storage Temperature	T_{stg}		–40 to +150	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

RECOMMENDED OPERATING CONDITIONS (T_A = 25°C)

Parameter	Symbol	Conditions	Ratings	Unit
Supply Voltage	V_{CC}		13.2	V
Load Resistance	R_L	Stereo	2 to 8	Ω
		Bridge	4 to 8	Ω

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

OPERATING CHARACTERISTICS

(T_A = 25°C, V_{CC} = 13.2 V, R_L = 4 W, f = 1 kHz, Rg = 600 W, with 100 × 100 × 1.5 mm^3 Al fin, See specified Test Circuit.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Quiescent Current	Icco		–	100	200	mA
Voltage Gain	VG		49.5	51.5	53.5	dB
Output Power	P_O	THD = 10%, Stereo	5.0	6.0	–	W
		THD = 10%, Bridge	–	19	–	W
Total Harmonic Distortion	THD	P_O = 1 W	–	0.1	1.0	%
Input Resistance	r_i		–	30	–	kΩ
Output Noise Voltage	VNO	Rg = 0 Ω	–	0.6	1.0	mV
		Rg = 10 kΩ	–	1.0	2.0	mV
Ripple Rejection Ratio	R_r	V_R = 200 mV, f_R = 100 Hz, Rg = 0 Ω	–	46	–	dB
Channel Separation	Ch sep	V_O = 0 dBm, Rg = 10 kΩ	45	55	–	dB
Muting Attenuation	ATT	V_O = 0 dBm, V_M = 9 V	–	40	–	dB
Gain Difference between Channels	ΔVG		–	–	2	dB

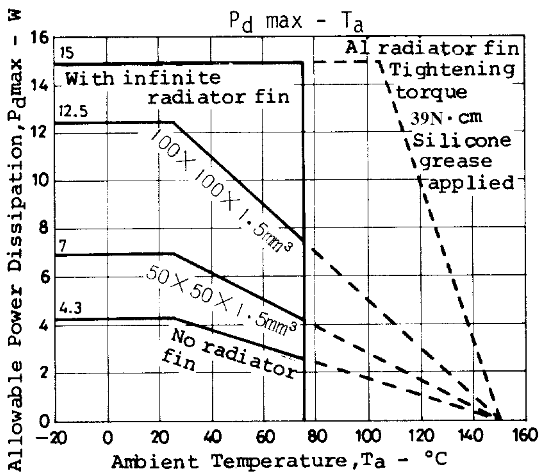


Figure 1. T_A vs. P_d max

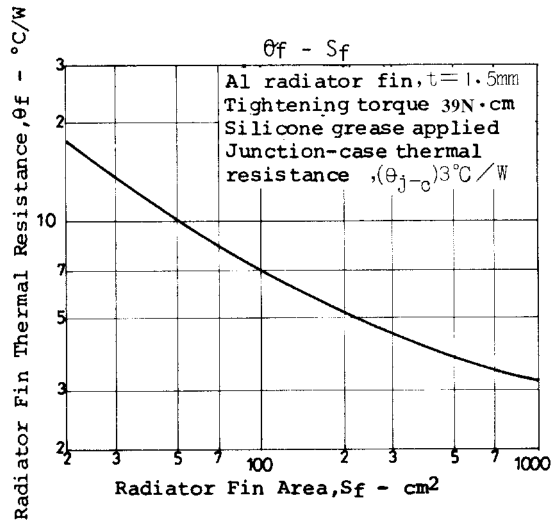


Figure 2. S_f vs. θ_f

EQUIVALENT CIRCUIT BLOCK DIAGRAM

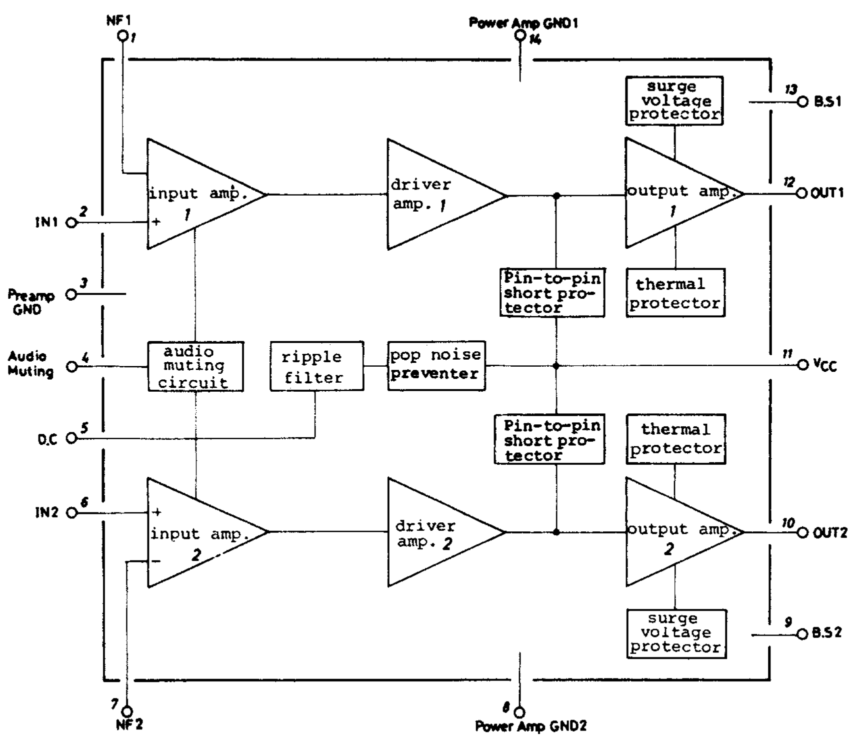
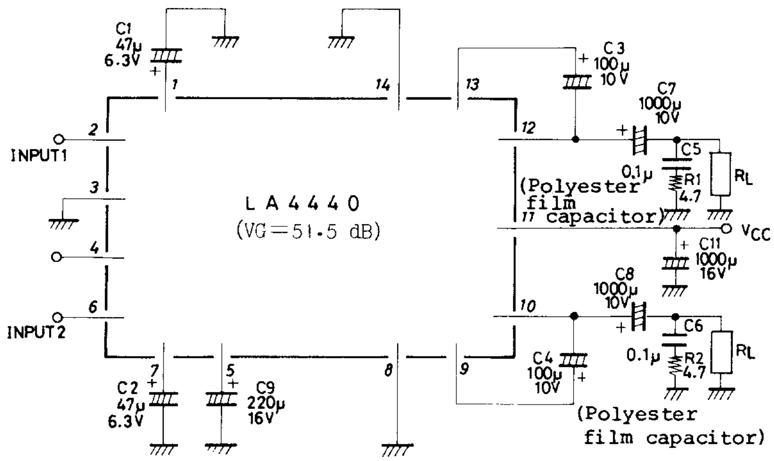
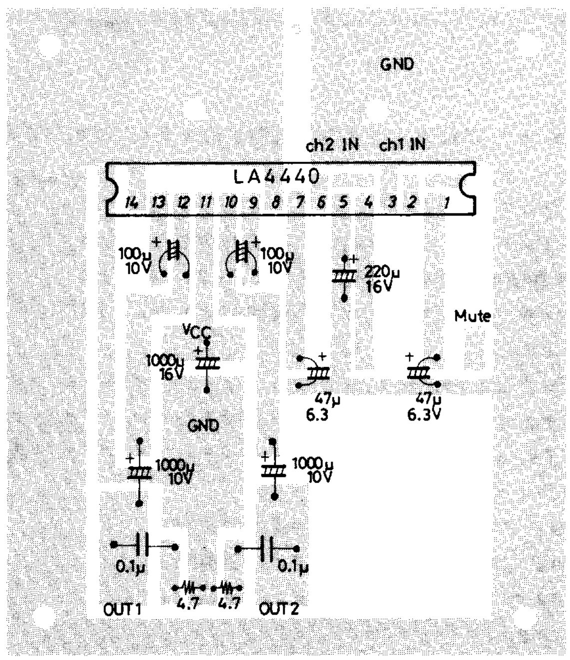


Figure 3. Equivalent Circuit Block Diagram

SAMPLE APPLICATION CIRCUIT 1 – STEREO USE





Sample printed circuit pattern for dual mode
(Cu-foiled area) 60 x 70 mm2

Figure 4. Application Circuit – Stereo Use

SAMPLE APPLICATION CIRCUIT 2 – BRIDGE AMPLIFIER 1

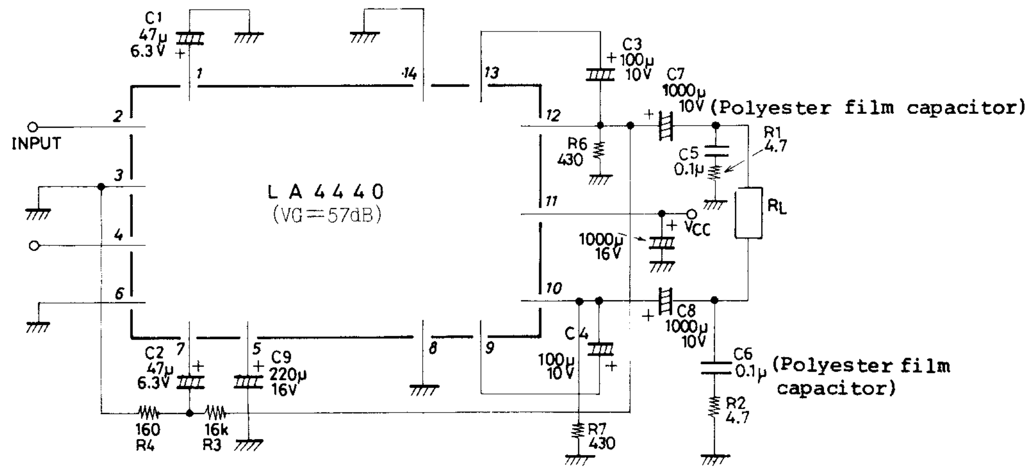


Figure 5. Application Circuit – Bridge Amplifier 1

SAMPLE APPLICATION CIRCUIT 3 – BRIDGE AMPLIFIER 2

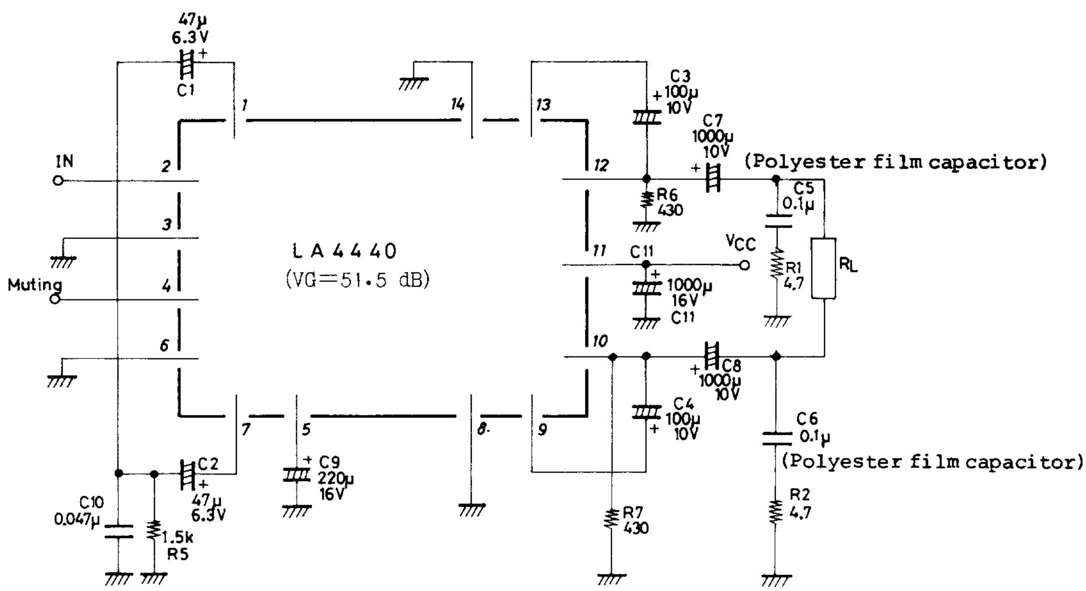


Figure 6. Application Circuit – Bridge Amplifier 2

Description of External Parts

- C1 (C2) – Feedback Capacitor:
  The low cutoff frequency depends on this capacitor. If the capacitance value is increased, the starting time is delayed.
- C3 (C4) – Bootstrap Capacitor:
  If the capacitance value is decreased, the output at low frequencies goes lower.
- C5 (C6) – Oscillation Preventing Capacitor:
  Polyester film capacitor, being good in temperature characteristic, frequency characteristic, is used.
  The capacitance value can be reduced to 0.047 μF depending on the stability of the board.
- C7 (C8) – Output Capacitor:
  The low cutoff frequency depends on this capacitor.
  At the bridge amplifier mode, the output capacitor is generally connected.
- C9 – Decoupling Capacitor:
  Used for the ripple filter. Since the rejection effect is saturated at a certain capacitance value, it is meaningless to increase the capacitance value more than required. This capacitor, being also used for the time constant of the muting circuit, affects the starting time.
- R1 (R2) – Filter resistor for preventing oscillation.
- R3 (R4) – Resistor for making input signal of inverting amplifier in Voltage Gain Adjust at Bridge Amplifier Mode (No. 1).
- R5 – Resistor for adjusting starting time in Voltage Gain Adjust at Bridge Amplifier Mode (No. 2)
- C10 – Capacitor for preventing oscillation in Voltage Gain Adjust at Bridge Amplifier Mode (No. 2)
- C11 – Power Source Capacitor
- R6 (R7) – Used at bridge amplifier mode in order to increase discharge speed and to secure transient stability.

Feaures of IC System and Functions of Remaining Pins

a. Since the input circuit uses PNP transistors and the input potential is designed to be 0 bias, no input coupling capacitor is required and direct coupling is available. However, when slider contact noise caused by the variable resistor presents a problem, connect an capacitor in series with the input.

b. The open-loop voltage gain is lowered and the negative feedback amount is reduced for stabilization. An increase in distortion resulted from the reduced negative feedback amount is avoided by use of the built–in unique distortion reduction circuit, and thus distortion is kept at 0.1% (typ.).

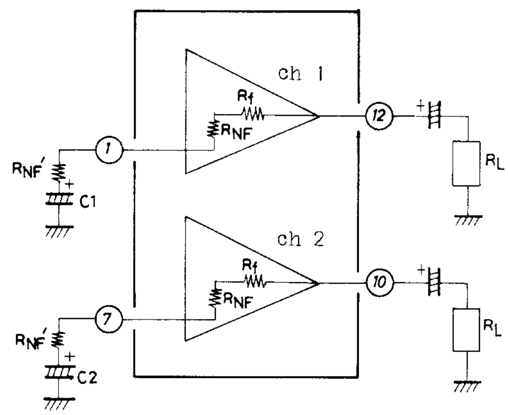
c. A capacitor for oscillation compensation is contained as a means of reducing the number of external parts. The capacitance value is 35 pF which determines high cutoff frequency f_H (–3 dB point) of the amplifier ($f_H \approx 20$ kHz).

d. For preventing the IC from being damaged by a surge applied on the power line, an overvoltage protector is contained. Overvoltage setting is 25 V. It is capable of withstanding up to 50 V at giant pulse surge 200 ms.

e. No damege occurs even when power is applied at a state where pins 10, 11, and 12 are short-circuited with solder bridge, etc.

f. To minimize the variations in voltage gain, feedback resistor R_{NF} is contained and voltage gain (51.5 dB) is fixed.

Voltage Gain Adjust at Stereo Mode:



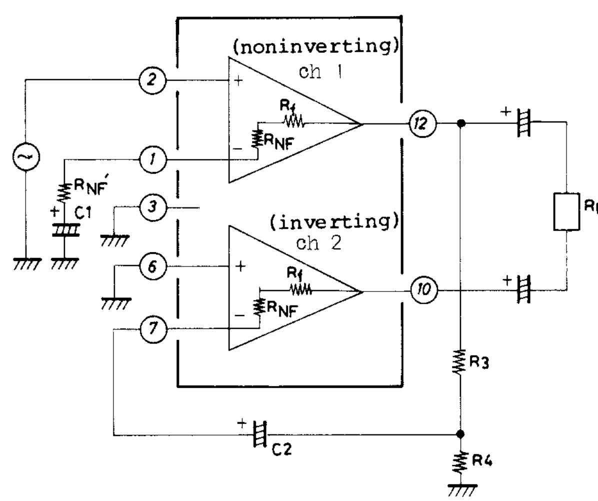
$R_{NF} = 50\ \Omega$ (typ), $R_f = 20\ k\Omega$ (typ) At $R_{NF}' = 0$ (recommended VG)

$$VG = 20\log\frac{VG}{R_{NF}}\ (dB) \qquad (eq.\ 1)$$

In case of using RNF'

$$VG = 20\log\frac{R_f}{R_{NF} + R_{NF}'}\ (dB) \qquad (eq.\ 2)$$

Voltage Gain Adjust at Bridge Amplifier Mode (No. 1)



The bridge amplifier configuration is as shown left, in which ch1 and ch2 operate as noninverting amplifier and inverting amplifier respectively.

The output of the noninverting amplifier divided by resistors R3, R4 is applied, as input, to the inverting amplifier.

Since attenuation (R4/R3) of the non−inverting amplifier output and amplification factor ($R_f/R4+R_{NF}$) of the inverting amplifier are fixed to be the same, signals of the same level and 1805 out of phase with each other can be obtained at output pins (12) and (10).

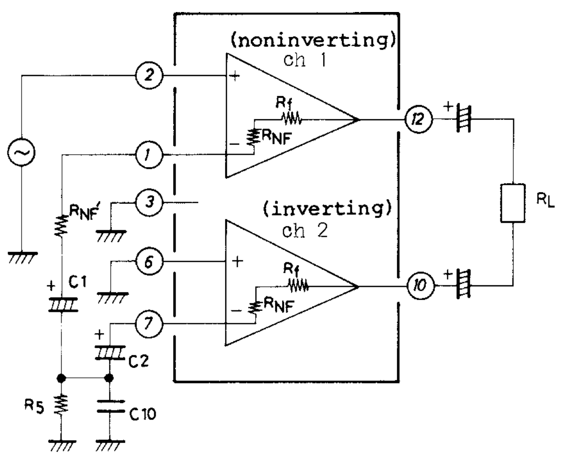
The total voltage gain is apparently higher than that of the noninverting amplifier by 6 dB and is approximately calculated by the following formula.

$$VG = 20\log\frac{R_f}{R_{NF}} + 6\ dB \qquad (eq.\ 3)$$

In case of reducing the voltage gain, RNF' is connected to the noninverting amplifier side only and the following formula is used.

$$VG = 20\log\frac{R_f}{R_{NF} + R_{NF}'} + 6\ dB \qquad (eq.\ 4)$$

Voltage Gain Adjust at Bridge Amplifier Mode (No. 2)

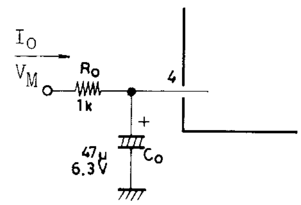


$$VG = 20\log\frac{R_f}{R_{NF} + \frac{R_{NF}'}{2}}\ (dB) \qquad (eq.\ 5)$$

where $(R_{NF} + R_{NF}') << R5$

From this formula, it is seen that connecting R_{NF}' causes the voltage gain to be reduced at the modes of both stereo amplifier and bridge amplifier.

g. In case of applying audio muting in each application circuit, the following circuit is used.

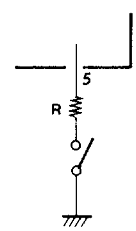


$6\ V \le V_M \le V_{CC}$
Recommended $V_M = 9\ V$
$A_{TT} = 40\ dB\ (Rg = 600\ \Omega)$

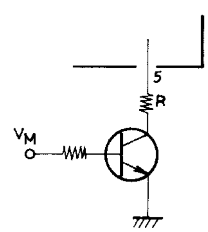
Flow-in current IO is calculated by the following formula.

$$I_O = \frac{V_M - V_{BE}}{R_O} \qquad (eq.\ 6)$$

In case of increasing the muting attenuation, resistor 5.6 kΩ is connected in series with the input, and then the attenuation is made to be 55 dB. Be careful that connecting an input capacitor causes pop noise to be increased at the time of application of AC muting. Increased R_O, C_O make it possible to reduce the noise. In case of completely cutting off power IC, pin (5) is grounded, and then DC control is available and the attenuation is made to be ∝.



General-purpose switch



Transistor switch

Stereo:	$20\ \Omega \le R \le 100\ \Omega$
Bridge No.1:	$20\ \Omega \le R \le 100\ \Omega$
Bridge No. 2:	$0\ \Omega \le R \le 50\ \Omega$

Table 1. PIN VOLTAGE (UNIT: V)

Pin No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Function Pin	CH1 NF	CH1 NF	Pre GND	AC Audio Muting	DC	CH2 IN	CH2 NF	CH2 Power GND	CH2 BS	CH2 OUT	VCC	CH1 OUT	CH1 BS	CH1 Power GND
Pin Voltage at Quiescent Mode	1.4	0.03	0	0	13.0	0.03	1.4	0	11.9	6.8	13.2	6.8	11.9	0

Proper Cares in Using IC

- Maximum Ratings:
  If the IC is used in the vicinity of the maximum ratings, even a slight variation in conditions may cause the maximum ratings to be exceeded, thereby leading to breakdown. Allow an ample margin of variation for supply voltage, etc. and use the IC in the range where the maximum ratings are not exceeded.
- Printed Circuit Board:
  When making the board, refer to the sample printed circuit pattern and be careful that no feedback loop is formed between input and output.
- Oscillation Preventing Capacitor:
  Normally, a polyester film capacitor is used for 0.1 μF + 4.7 Ω. The capacitance value can be reduced to 0.047 F depending on the stability of the board.
- Others:
  Connect the radiator fin of the package to GND.

CHARACTERISTICS AT STEREO AMPLIFIER MODE

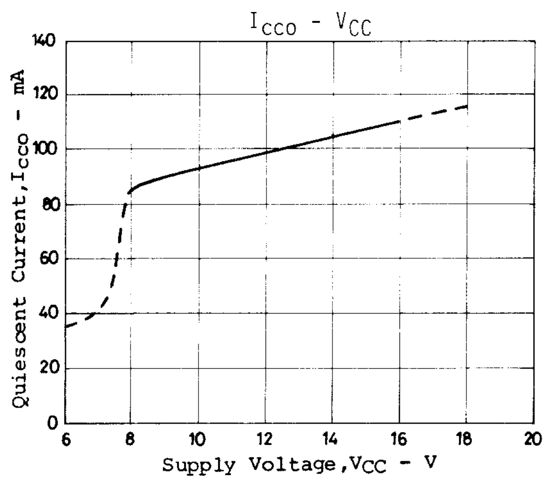


Figure 7. I_{CC} – V_{CC}

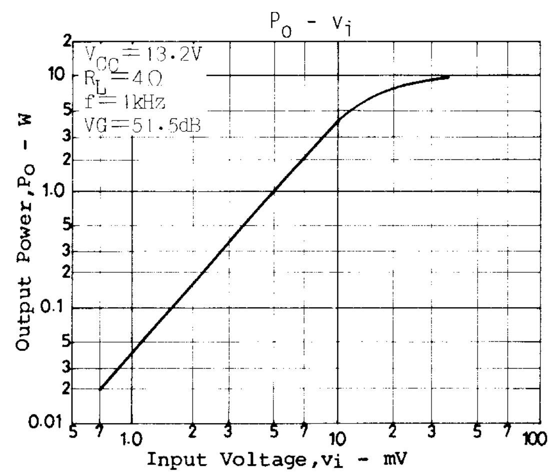


Figure 8. P_O – V_i

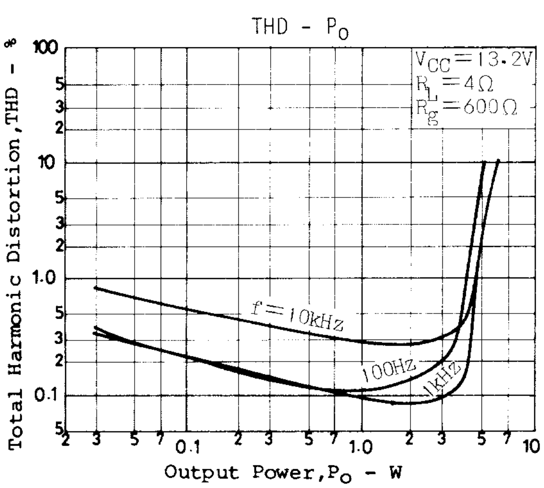


Figure 9. THD – P_O

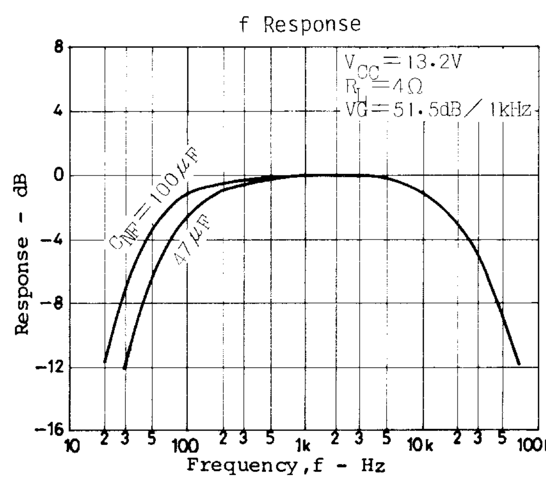


Figure 10. f Response

CHARACTERISTICS AT STEREO AMPLIFIER MODE (Continued)

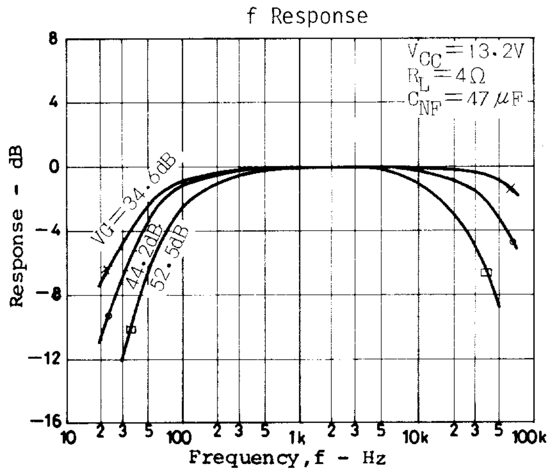


Figure 11. f Response

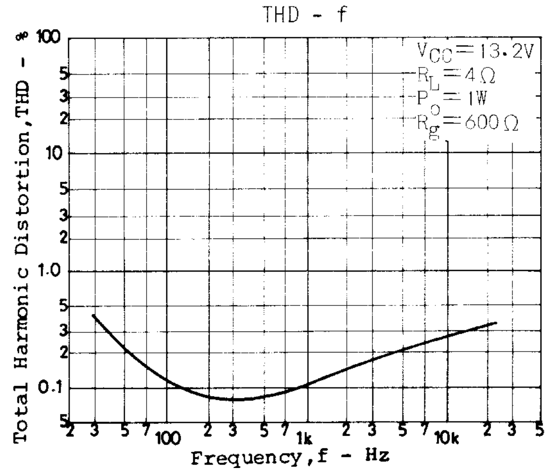


Figure 12. THD – f

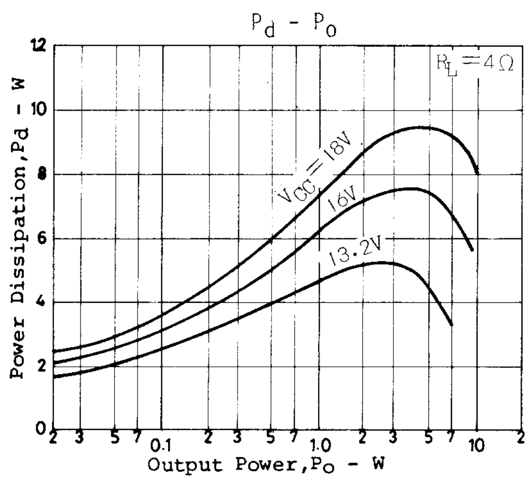


Figure 13. P_d – P_O

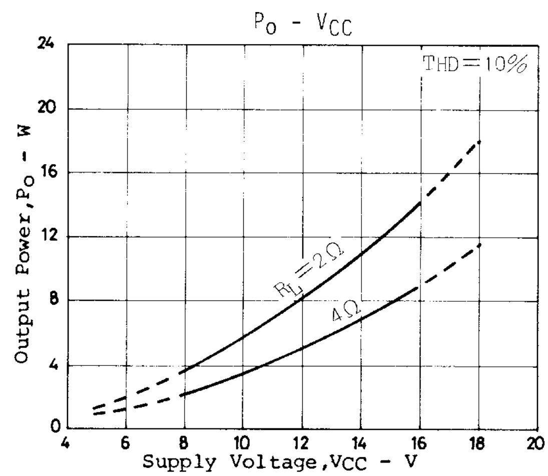


Figure 14. P_O – V_{CC}

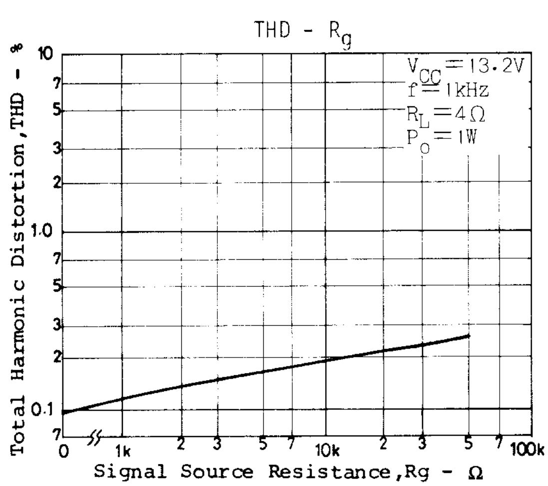


Figure 15. THD – R_g

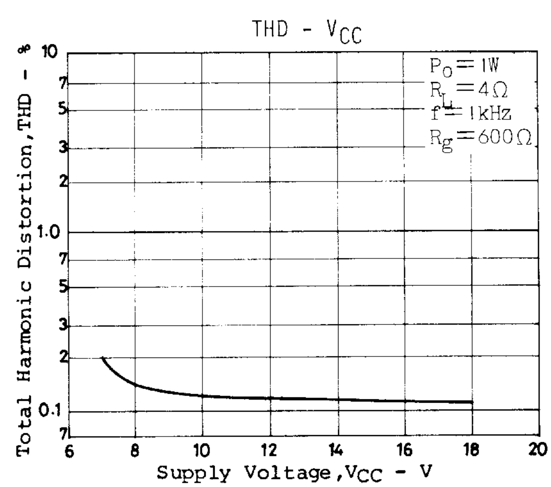


Figure 16. THD – V_{CC}

CHARACTERISTICS AT STEREO AMPLIFIER MODE (Continued)

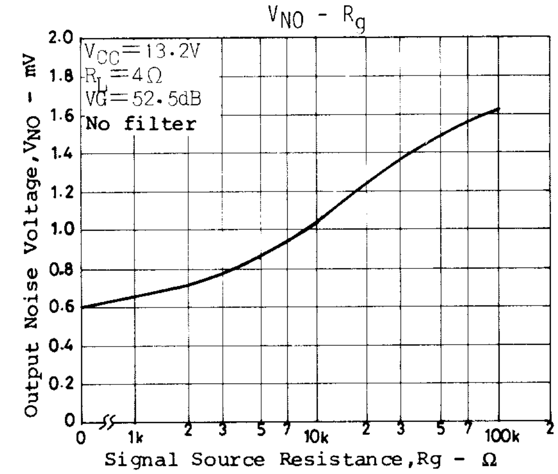


Figure 17. $V_{NO} - R_g$

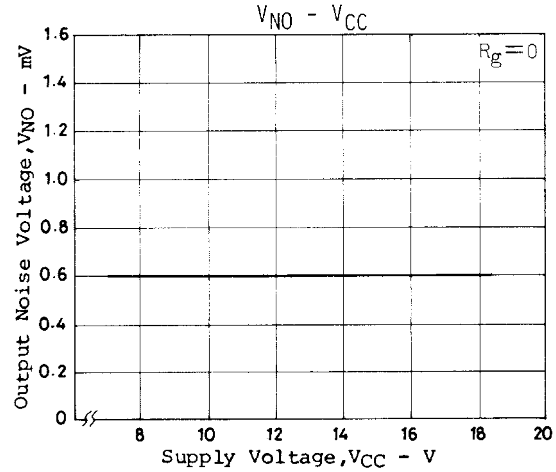


Figure 18. $V_{NO} - V_{CC}$

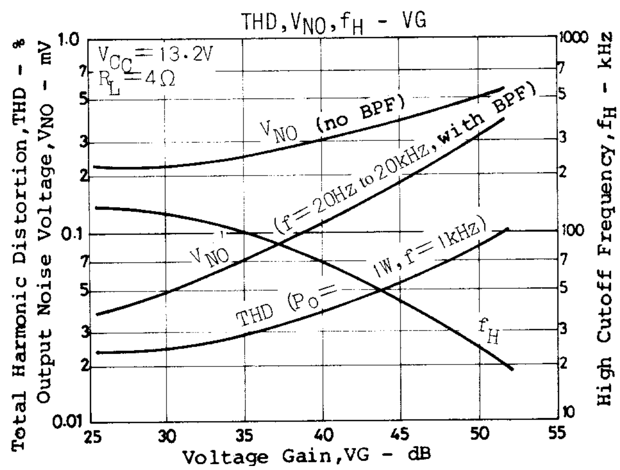


Figure 19. THD, V_{NO}, $f_H - V_G$

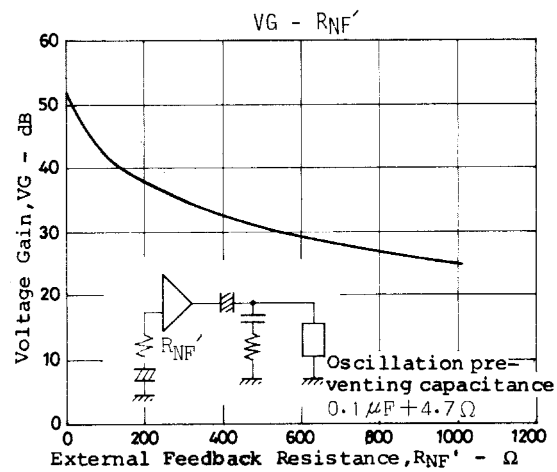


Figure 20. $V_G - R_{NF}$'

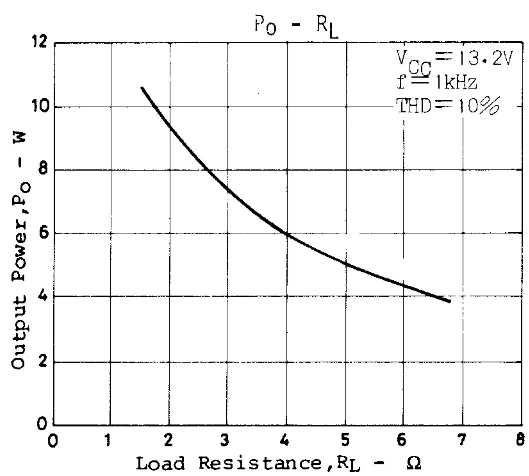


Figure 21. $P_O - R_L$

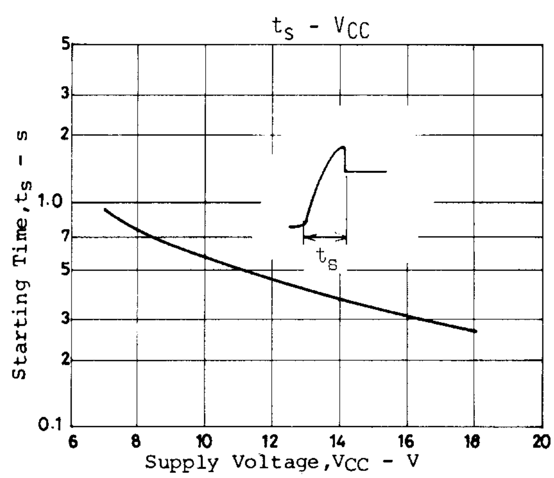


Figure 22. $t_S - V_{CC}$

CHARACTERISTICS AT STEREO AMPLIFIER MODE (Continued)

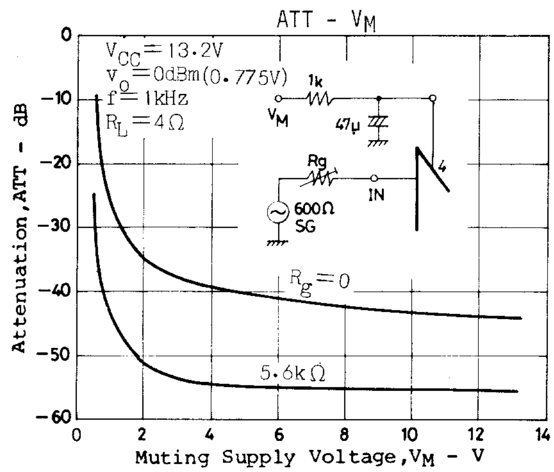


Figure 23. $ATT_O - V_M$

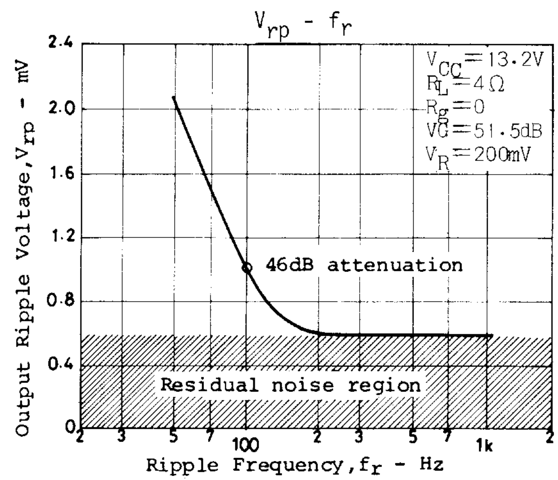


Figure 24. $V_{rp} - f_r$

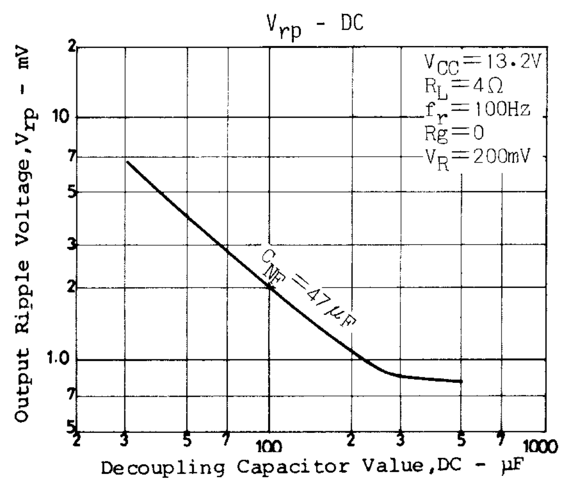


Figure 25. V_{rp} – DC

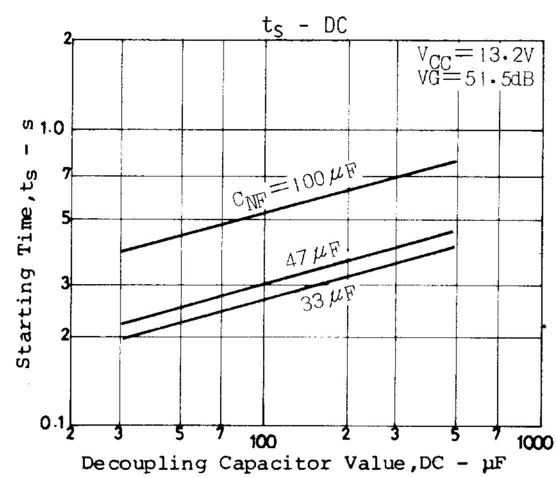


Figure 26. t_S – DC

CHARACTERISTICS AT BRIDGE AMPLIFIER MODE NO. 1

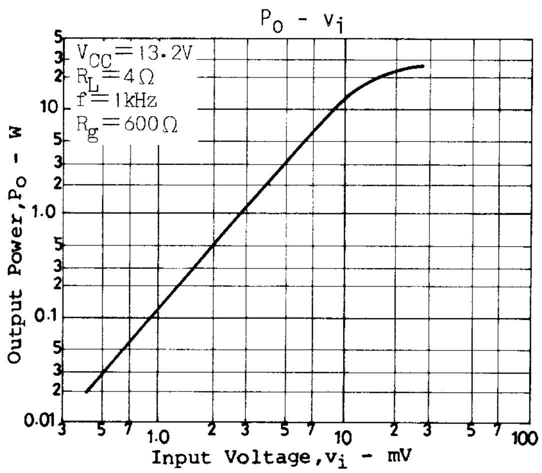


Figure 27. $P_O - V_i$

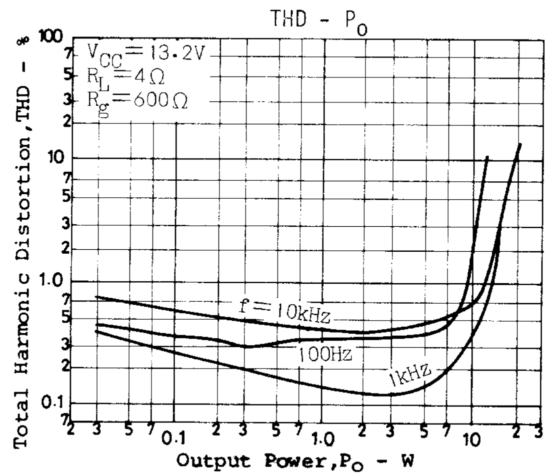


Figure 28. THD – P_O

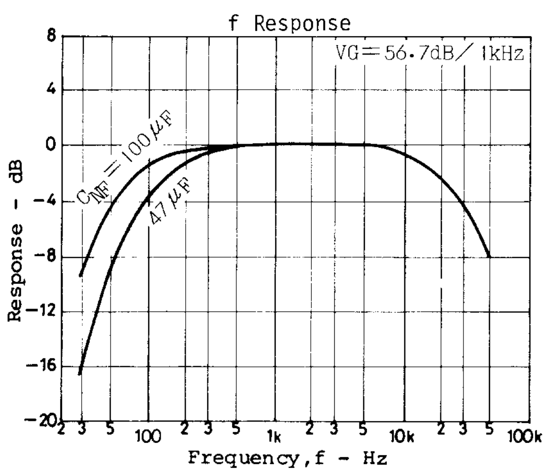


Figure 29. f Response

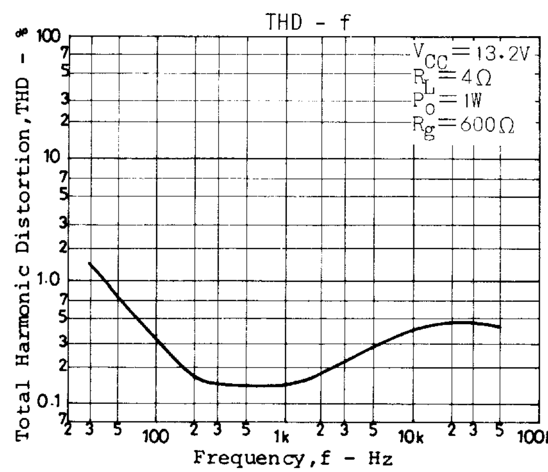


Figure 30. THD – f

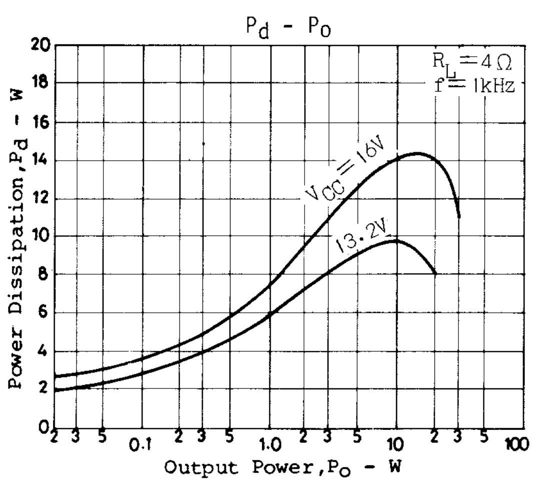


Figure 31. $P_d - P_O$

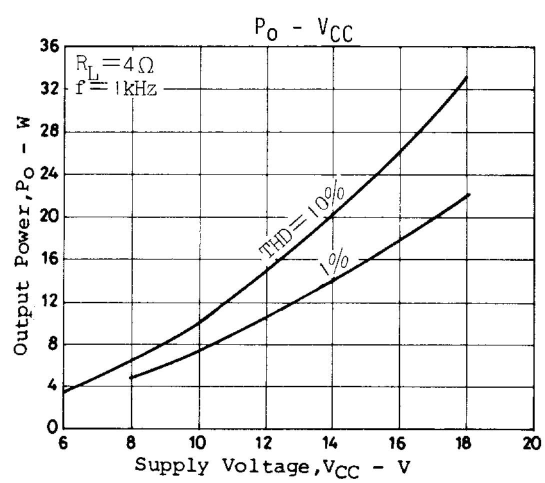


Figure 32. $P_O - V_{CC}$

CHARACTERISTICS AT BRIDGE AMPLIFIER MODE NO. 1 (Continued)

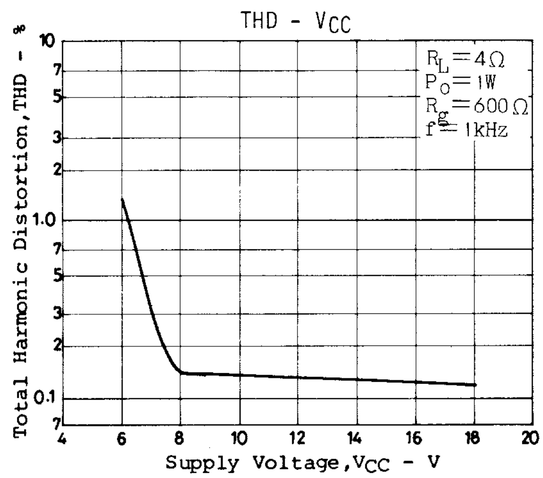


Figure 33. THD – V_{CC}

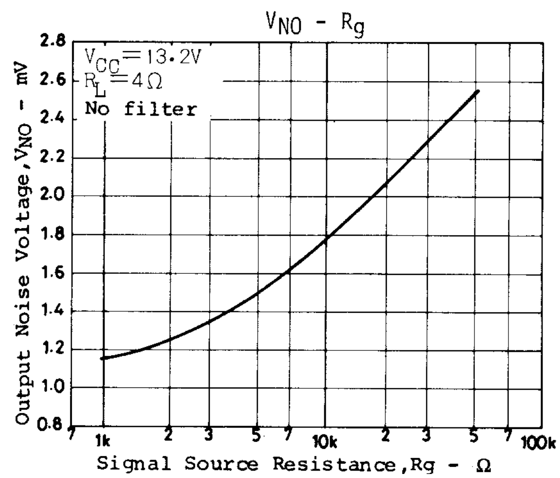


Figure 34. V_{NO} – R_g

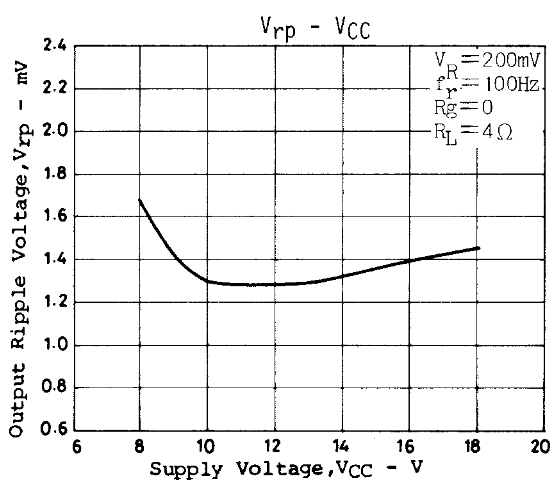


Figure 35. Vrp – V_{CC}

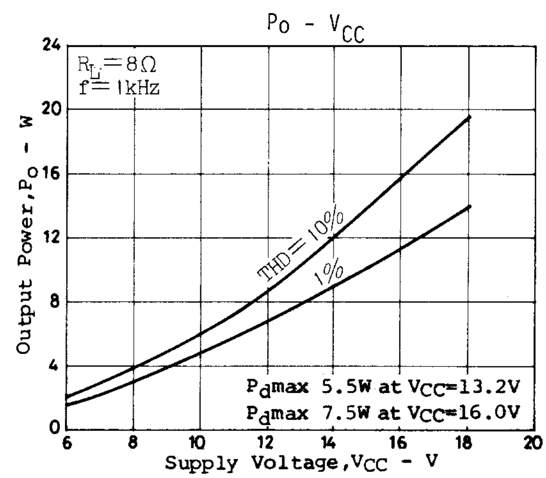


Figure 36. P_O – V_{CC}

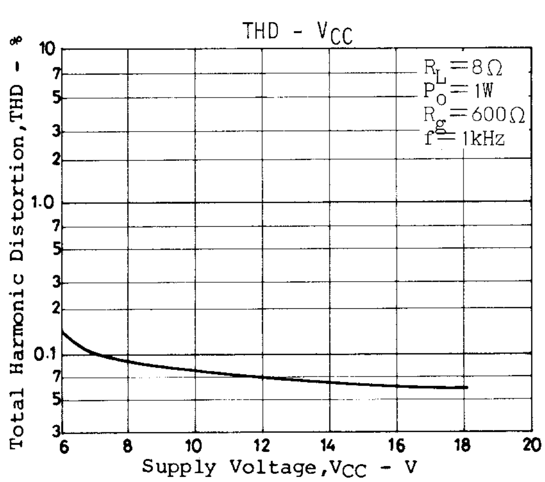


Figure 37. THD – V_{CC}

CHARACTERISTICS AT BRIDGE AMPLIFIER MODE NO. 2

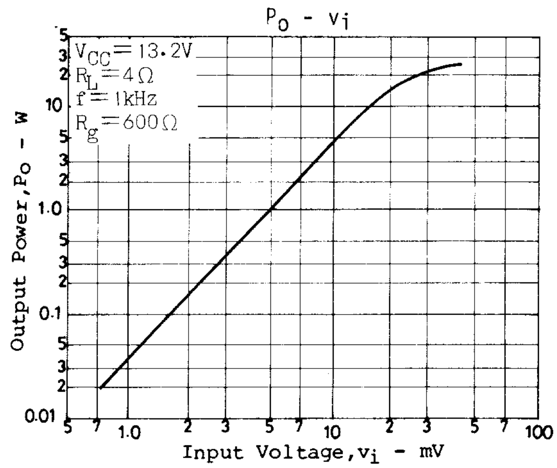


Figure 38. P_O – V_i

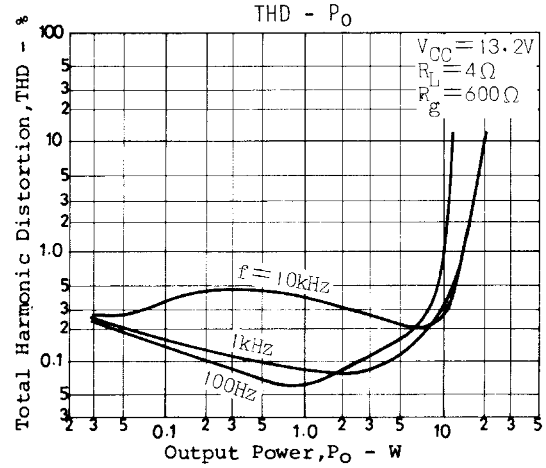


Figure 39. THD – P_O

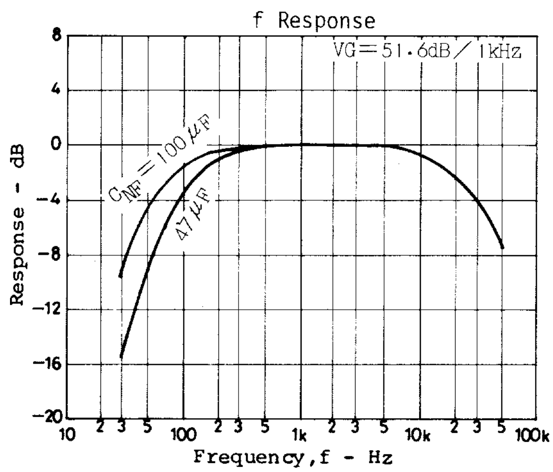


Figure 40. f Response

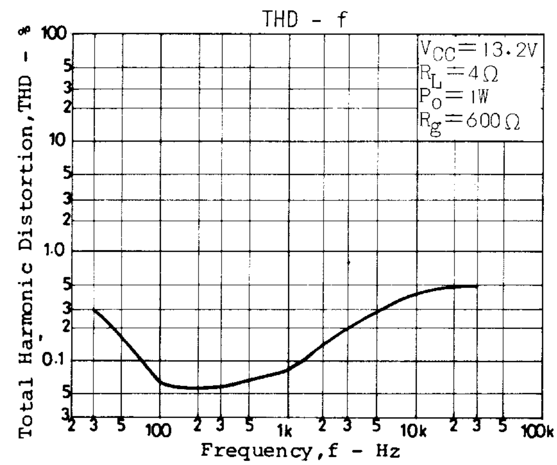


Figure 41. THD – f

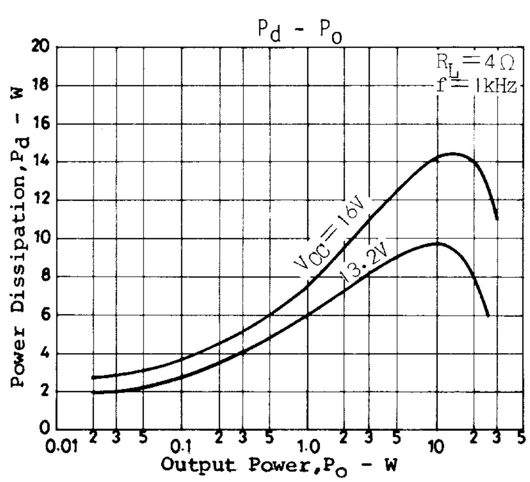


Figure 42. P_d – P_O

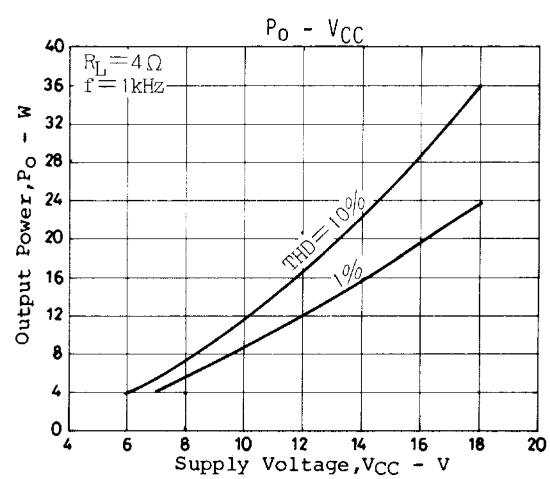


Figure 43. P_O – V_{CC}

CHARACTERISTICS AT BRIDGE AMPLIFIER MODE NO. 2 (Continued)

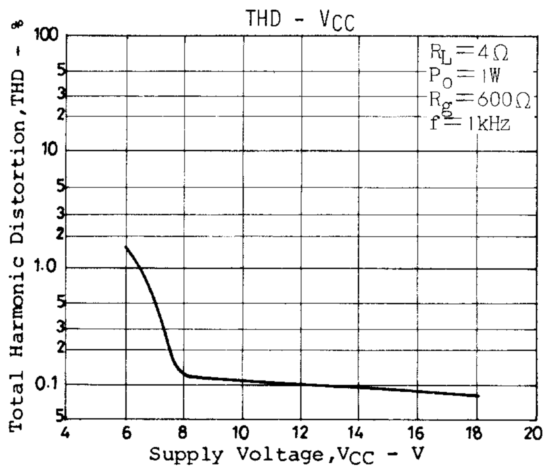


Figure 44. THD – V_{CC}

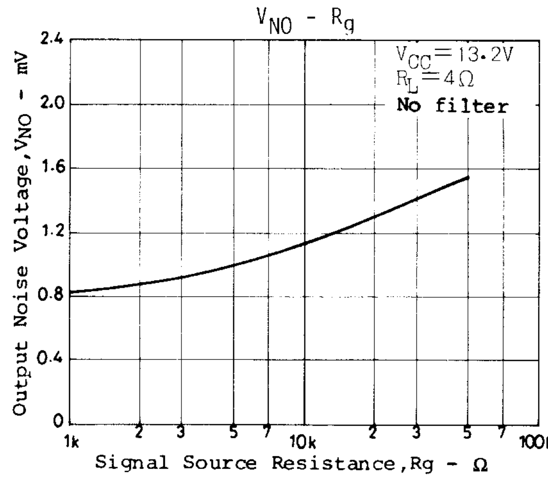


Figure 45. V_{NO} – R_g

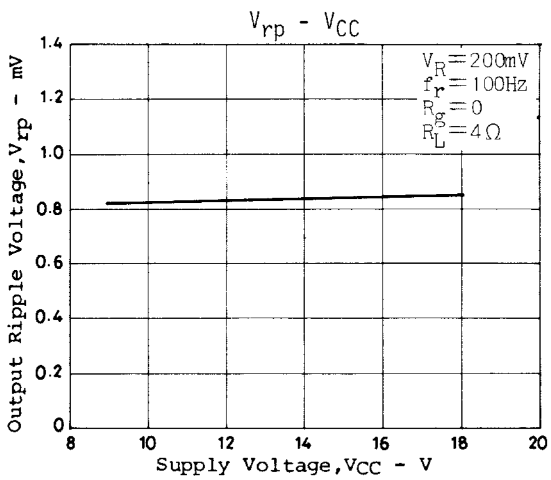


Figure 46. Vrp – V_{CC}

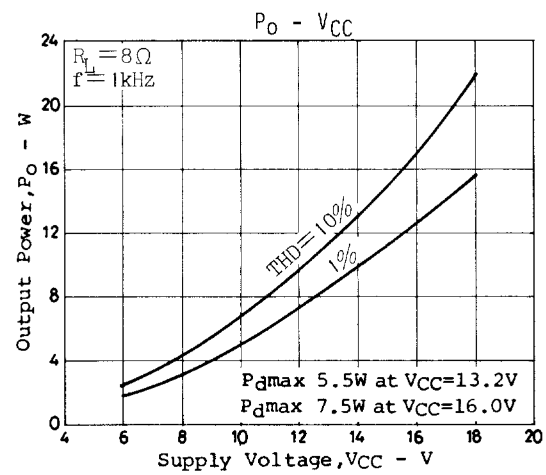


Figure 47. P_O – V_{CC}

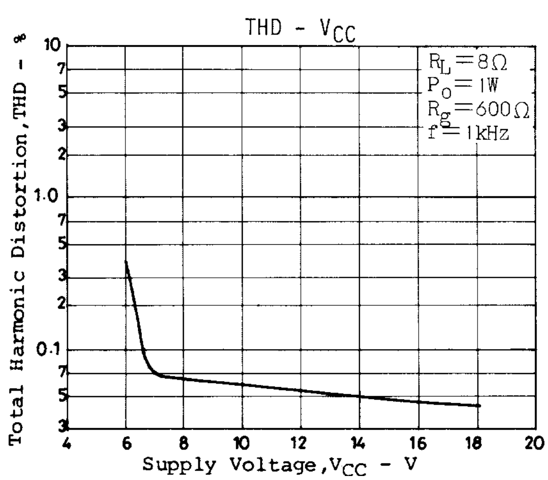
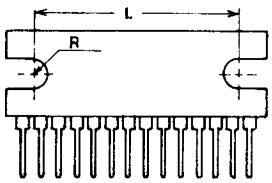


Figure 48. THD – V_{CC}

Proper Cares in Mounging Radiator Fin

1. The mounting torque is in the range of 39 to 59N · cm.
2. The distance between screw holes of the radiator fin must coincide with the distance between screw holes of the IC.
   With case outline dimensions L and R referred to, the screws must be tightened with the distance between them as close to each other as possible.



3. The screw to be used must have a head equivalent to the one of truss machine screw or binder machine screw defined by JIS. Washers must be also used to protect the IC case.
4. No foreign matter such as cutting particles shall exist between heat sink and radiator fin. When applying grease on the junction surface, it must be applied uniformly on the whole surface.
5. IC lead pins are soldered to the printed circuit board after the radiator fin is mounted on the IC.

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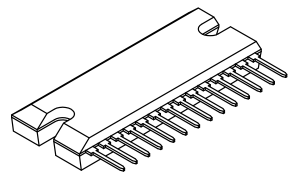
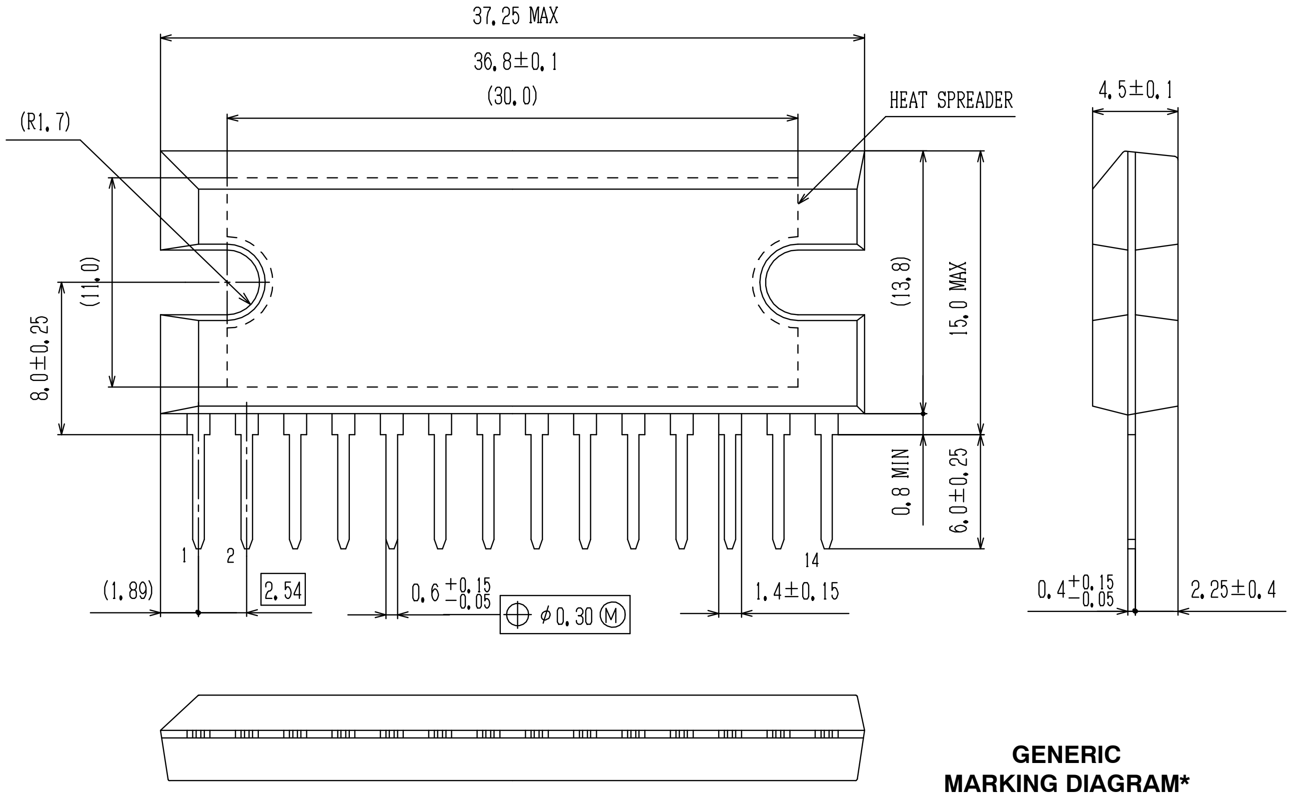
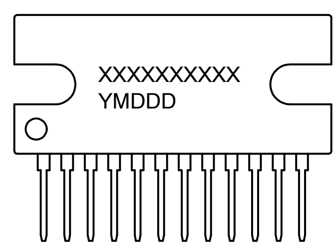


SIP14 36.8x13.8 / SIP14H
CASE 127AQ
ISSUE A

DATE 23 OCT 2013



GENERIC
MARKING DIAGRAM*



XXXXX = Specific Device Code
Y = Year
M = Month
DDD = Additional Traceability Data

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “ ▪”, may or may not be present.

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