Ordering number:ENN870D

Monolithic Linear IC

LA4160

Single-Chip Tape Recorder Audio System

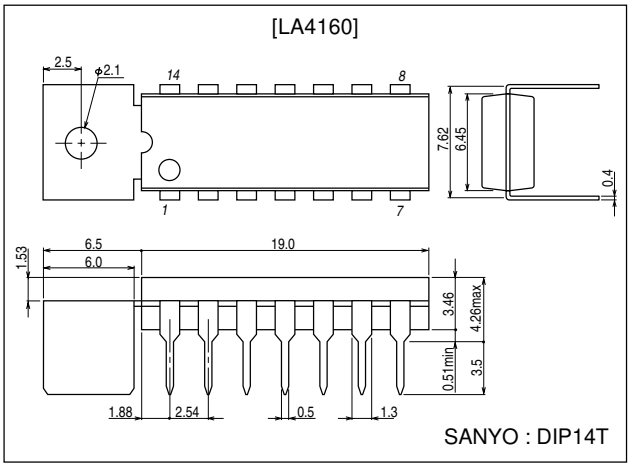
Features

- A single package contaning preamplifier, ALC circuit, power amplifier.
- Preamplifier with high gain, and power amplifier with high gain and output.
  1W typ. (V_{CC}=6V, R_L=4Ω)
  2.2W typ. (V_{CC}=9V, R_L=4Ω)
- Minimum number of external parts required.
- Soft tone quality at the time of output saturation.
- Wide range of ALC and small variation in output voltage.
- Wide range of operating supply voltage.
- Small shock noise at the time of supply voltage ON/OFF (With built-in prevention circuit).
- Variable monitor capability due to recording amplifier consisting of preamplifier alone.

Package Dimensions

unit:mm

3005A-DIP14T



Specifications

Absolute Maximum Ratings at Ta = 25˚C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum Supply Voltage	V_{CC} max		13	V
Allowable Power Dissipation	Pd max		1.2	W
		50×50×1.5mm^3 Cu-coated	2.25	W
Operating Temperature	Topr		–20 to +75	˚C
Storage Temperature	Tstg		–40 to +150	˚C

Recommended Operating Conditions at Ta = 25˚C

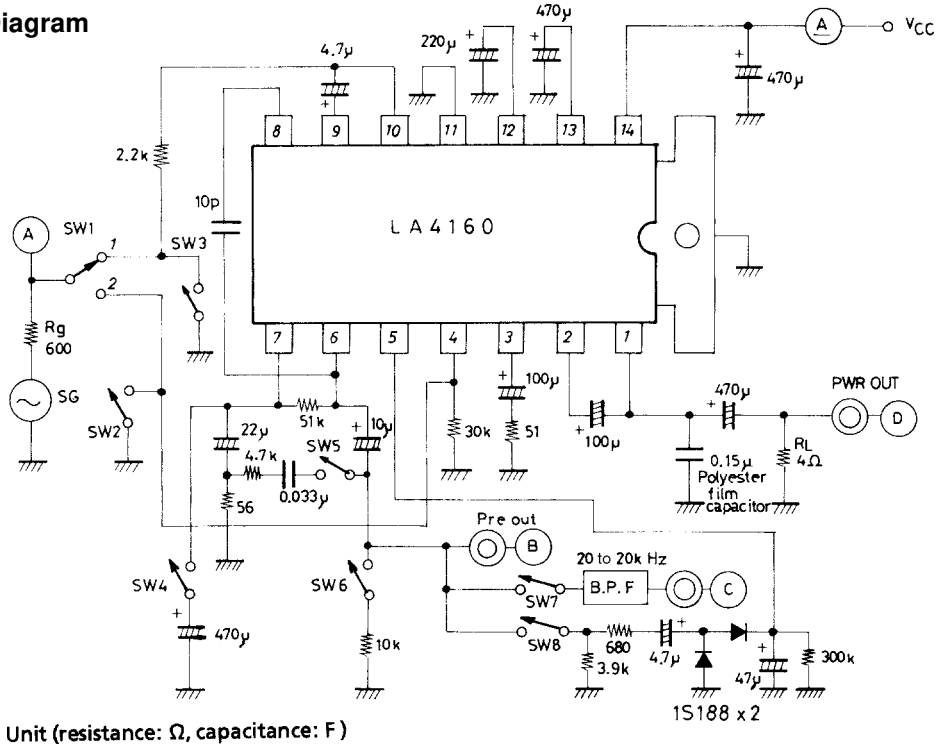
Parameter	Symbol	Conditions	Ratings	Unit
Supply Voltage	V_{CC}		6 to 9	V
Load Resistance	R_L		3.2 to 8	Ω

SANYO Electric Co.,Ltd. Semiconductor Company
TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110-8534 JAPAN

Operating Characteristics at Ta = 25°C, V_{CC}=6V, f=1kHz, See specified Test Circuit

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Quiescent Current	I_{CCO}	V_{CC}=6V		18	30	mA
		V_{CC}=9V		23	40	mA
[Preamplifier]						
Voltage Gain	VG	Open loop		85		dB
		Closed loop, Playback		40		dB
Maximum Output Voltage	V_O	THD=1%, Playback	0.9	1.2		V
Input Resistance	r_i		21	30		kΩ
Equivalent Input Noise Voltage	V_{NI}	Playback		1.0	2.0	μV
ALC Input Level	ALC	THD=1%, Playback	–20	–12		dBm
[Power amplifier]						
Voltage Gain	VG	Closed Loop, R_f=51Ω	43	45	47	dB
Output Power	P_O	V_{CC}=6V, THD=10%	0.7	1.0		W
		V_{CC}=7.5V, THD=10%	1.0	1.5		W
		V_{CC}=9V, THD=10%	1.7	2.2		W
Total Harmonic Distortion	THD	P_o=250mW		0.3	1.5	%
Input Resistnace	r_i			30		kΩ
Output Noise Voltage	V_{NO}	Rg=10kΩ		0.6	1.8	mV
Ripple Rejection	R_r	Rg=0, V_R=150mV, f=100Hz	40	45		dB

Test Circuit Diagram

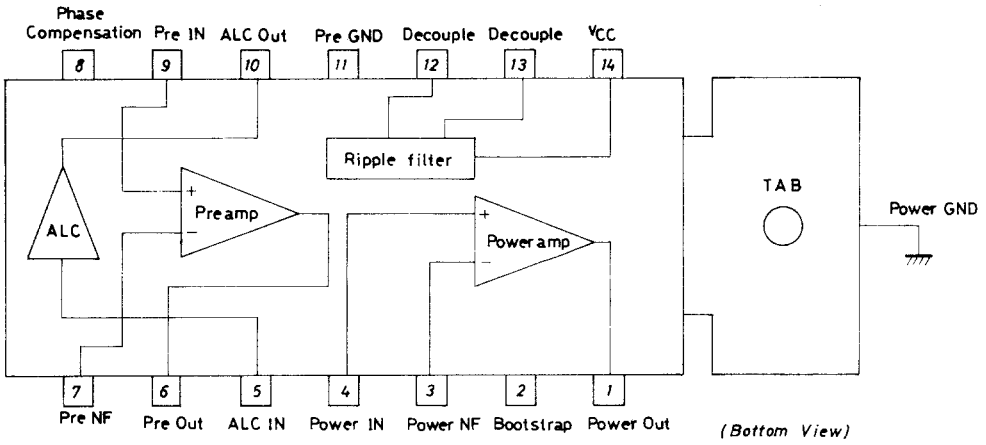


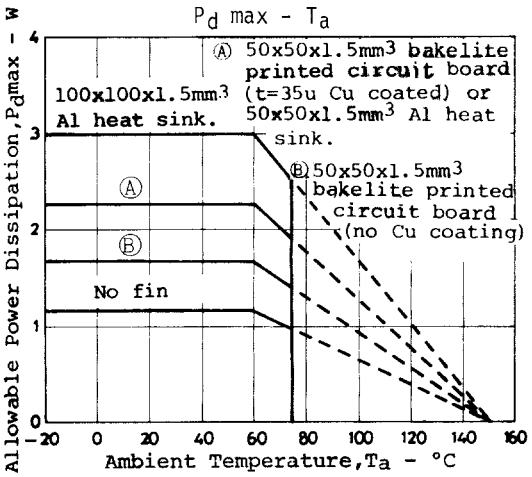
Unit (resistance: Ω, capacitance: F)

Test Method

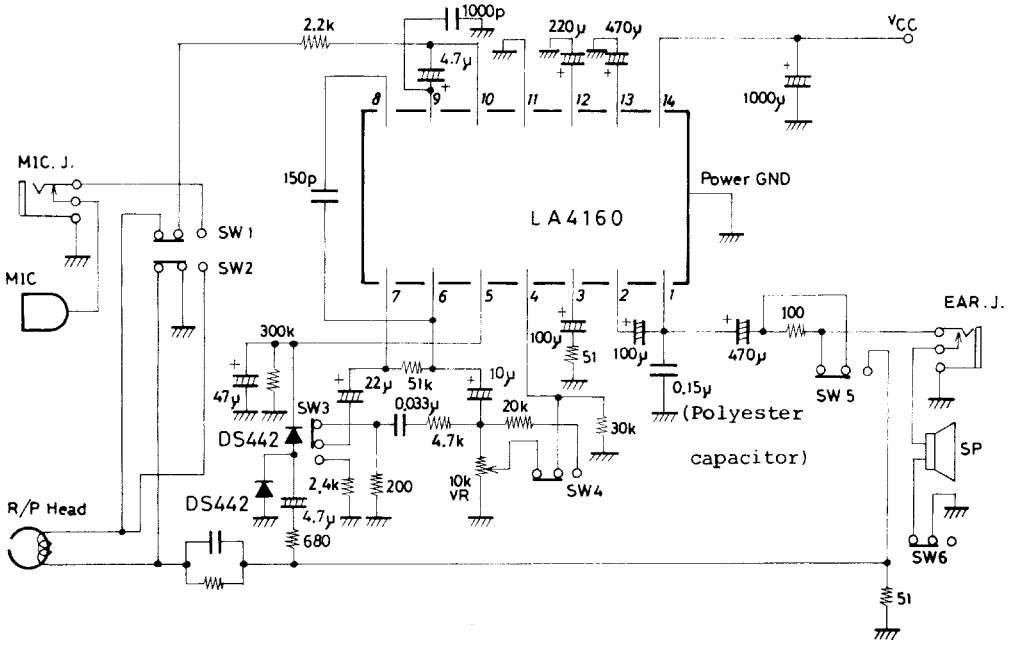
Item \ Switch		SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	Test area	Test method
Power amplifier	I_{CCO}	–	on	on	off	on	on	off	off	–	Test circuit current.
	VG	2	off	off	off	on	on	off	off	A, D	20log V_O/V_i (dB), where input voltage is V_i, output voltage V_O.
	P_o	2	off	off	off	on	on	off	off	D	Test output voltage at THD=10% and convet it into output.
	THD	2	off	off	off	on	on	off	off	D	Test THD at output voltage V_O=1V.
	V_{NO}	–	on	off	off	on	on	off	off	D	Test output noise voltage.
	V_{NR}	–	on	off	off	on	on	off	off	D	Superpose ripple (100Hz) 150mV on supply vottage and test output ripple.
preamplifier	V_{GO}	1	off	off	on	off	on	off	off	A, B	20log V_O/V_i (dB).
	V_o max	1	off	off	off	on	on	off	off	B	Test output voltage at THD=1%.
	V_{NI}	–	off	on	off	on	on	on	off	C	Convert output noise voltage at Rg=2.2k by using gain at 1kHz.
	ALC Input level	1	off	off	off	off	off	off	on	A, B	Test input voltage at THD=1%.

Equivalent Circuit Block Diagram





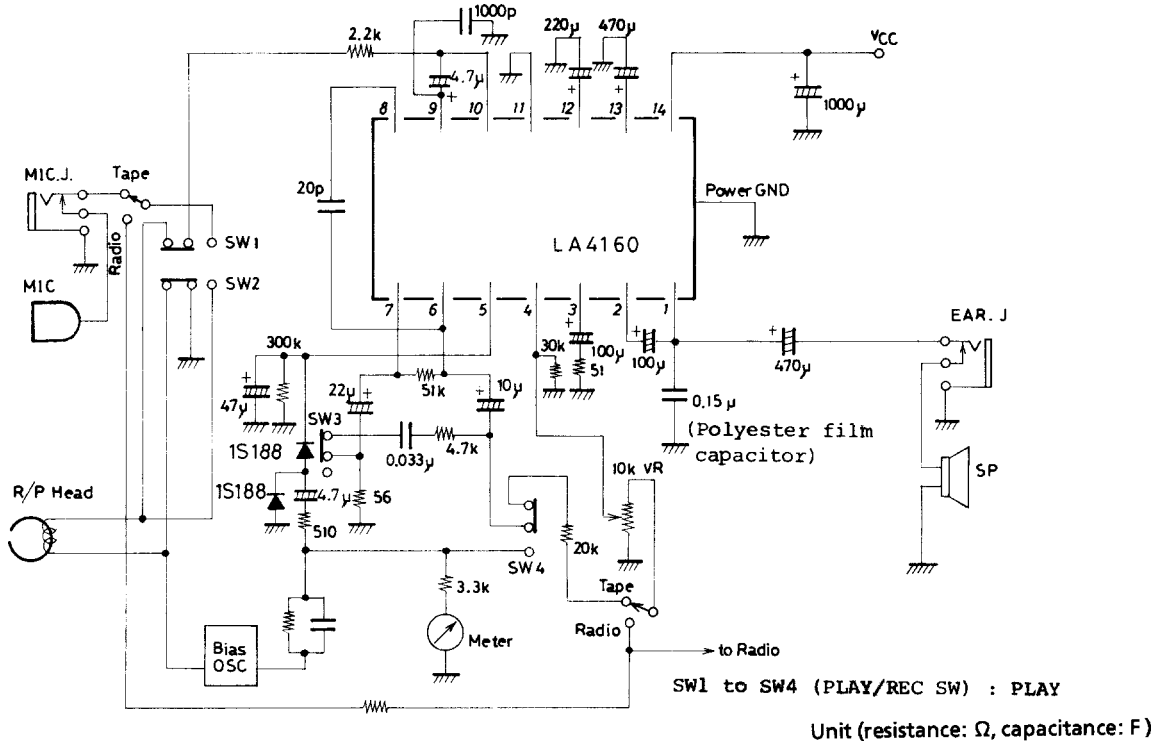
Sample Application Circuit 1 : Cassette Recorder

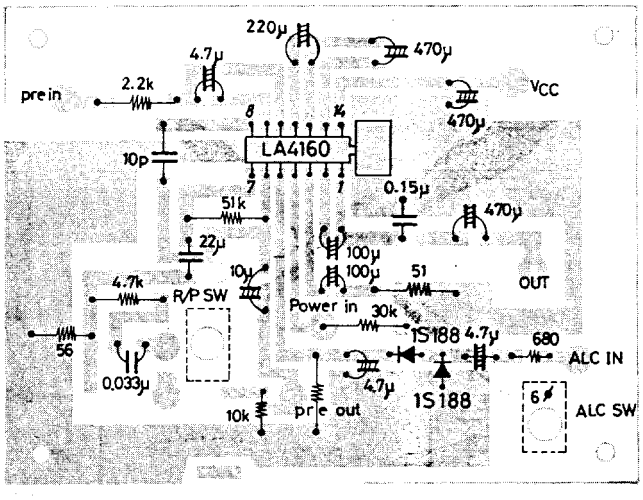


Unit (resistance: Ω, capacitance: F)

SW1 to SW6 (PLAY/REC SW) : PLAY

Sample Application Circuit 2 : Radio-Cassette Recorder





An Example of Printed Board (80 x 105 mm^2 ,Cu-foiled side)

Description of Application Circuit

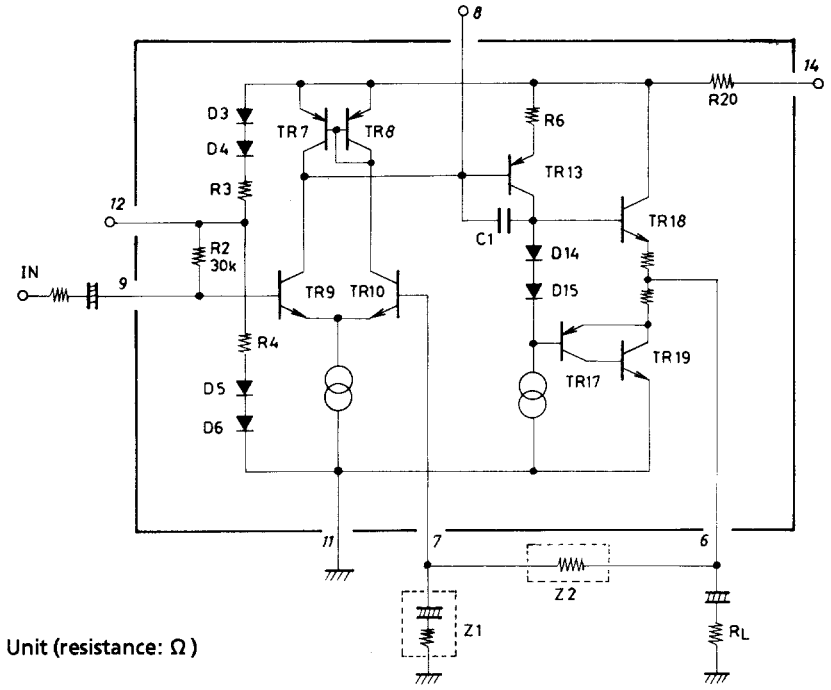
1. Preamplifier

   The preamplifier circuit consists of the input differential stage (TR9, 10), level shift stage (TR13), and output stage (TR17, 18, 19). Since the output stage is of push-pull type, no remarkable drop in the output voltage occurs even at low load impedances and the output can be connected direct to the ALC circuit and meter circuit. The external DC/AC feedback resistor (Z2) can be set arbitrarily and the closed loop gain is obtained by the following equation.

   $$\text{VG (pre)} \quad 20 \log \left(\frac{Z2}{Z1} \right) \quad \text{(dB)}$$

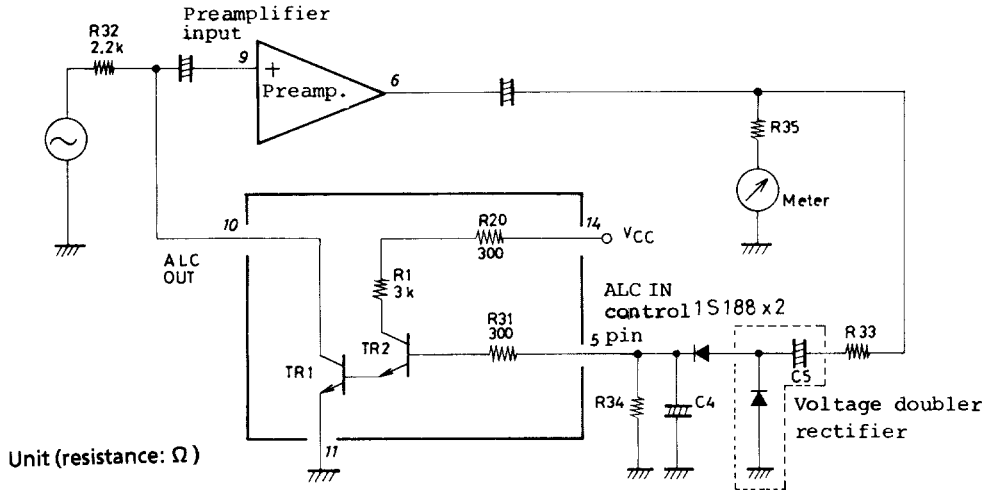
   The input impedance depends on internal resistance R2 which is 30kΩ.

Preamplifier Circuit



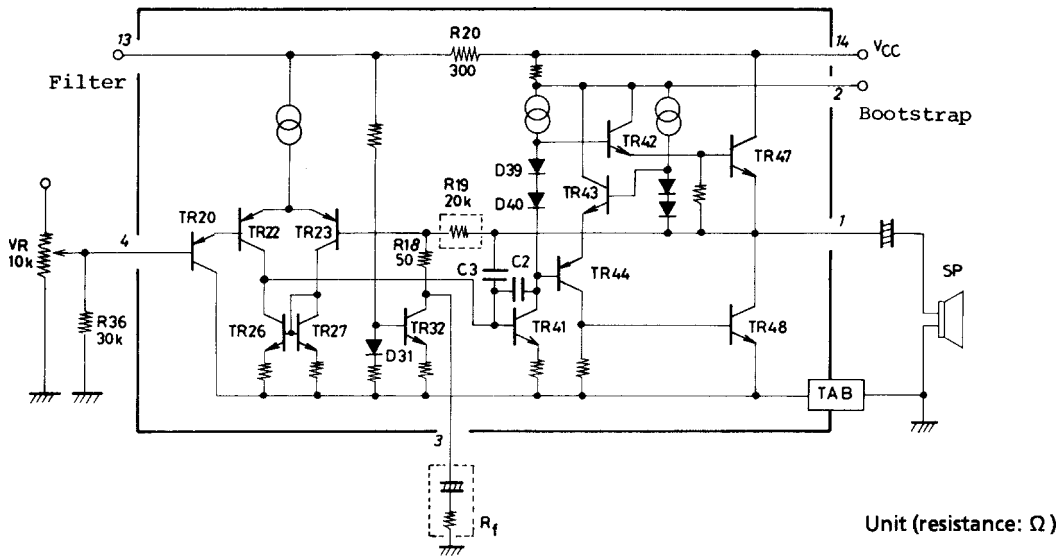
Since the maximum output voltage for THD=1% drops at less than 600Ω of the composite load impedance viewed from output pin (6), it is desirable to make the composite load impedance more than 600Ω when using this IC. (Refer to V_O max, THD – R_L characteristics.)

2. ACL Circuit



The ALC circuit is of Darlington configuration which consists of TR1, 2. The collector-to-emitter impedance of TR1 made variable by the DC voltage to be applied to control pin (5) and the input voltage of the preamplifier is controlled. Whe the DC voltage to be applied to pin (5) is set at approximately 1.1V, TR1, 2 are turned ON and ALC is turned ON. For the rectifier circuit, it is recommended to use the voltage doubler rectifirer which is excellent in compression ratio. For the sets of 6V V_{CC}, it is recommended to use a germanium diode so that the ALC width can be made wider even at the time of decreased voltages.

3. Power Amplifier



The power amplifier circuit consists of the differential stage (TR22, 23), predriver stage (TR41), driver stage (TR42, 44), and output stage (TR47,48). Bias resistor R36 of TR20 at the first stage is attached externally and the input impedance depends on this R36. Input pin (4) whose potential is nearly equal to the ground potential can be connected direct to the variable resistor without using an input coupling capacitor. The closed loop voltage gain is obtained by the following equation.

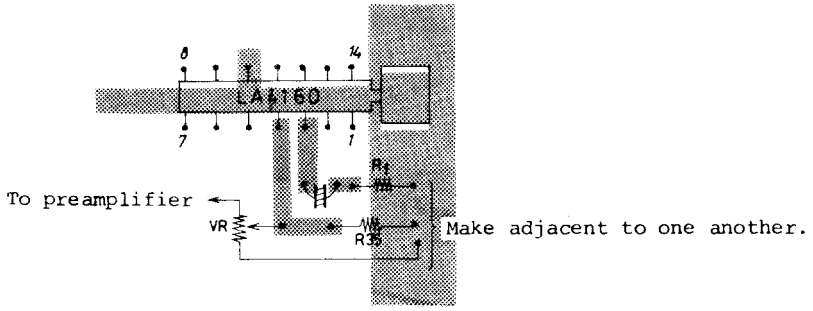
$$VG\ (pwr)=20\log\left\{\frac{R19}{(R18+Rf)}\right\}$$

Since R19=20kΩ, R18=50Ω are set, approximately 52dB max. is available if R_f=0 is taken.

Proper Cares in Using IC

1. Printed Circuit Board

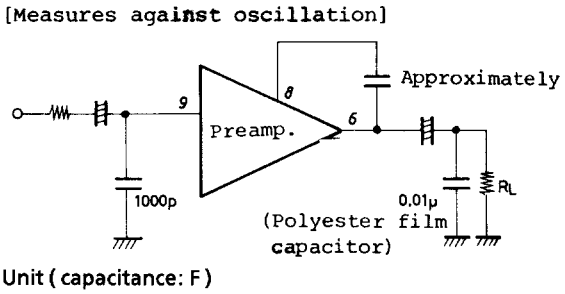
For the printed circuit board layout, refer to the printed circuit pattern example in principle. It is necessary that the grounding points of the power amplifier input (variable resistor), pin (3) feedback resistor (R_f), and bias resistor (R35) should be adjacent to one another. Especially, it should be noted that if a common impedance exists in the variable resistor grounding, the distortion, residual ripple, and cross interference (leak of signal between preamplifier and power amplifier) may worsen.



2. Oscillation

a) Preamplifier

Since oscillation may osccur when used at a low voltage gain, a capacitor of approximately 10pF must be connected across pins (8) and (6) for phase compensation. If the capacitor connected across pins (8) and (6) has a large capacitance at a low load impedance, further oscillation may occur, and in this case the load pin must be grounded through a capacitor of approximately 0.01μF (Polyester film capacitor). The input pin must be grounded through a capacitor of approximately 1000pF for the purpose of prevention of radio disturbance and oscillation.

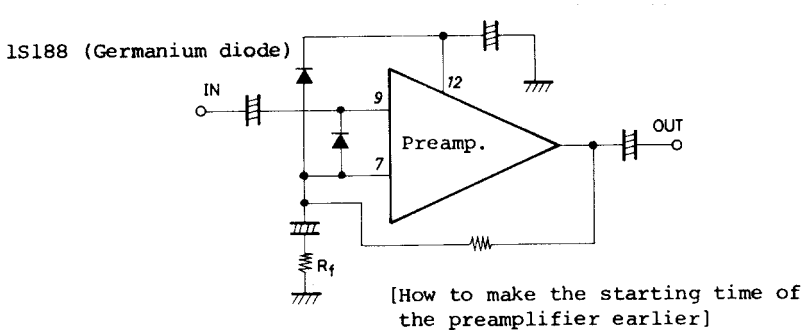


b) Power Amplifier

For the oscillation preventing capacitor connected across output pin (1) and ground, it is recommended to use a polyester film capacitor which is excellent in temperature characteristic and frequency characteristic. It should be noted, however, that if such a polyester film capacitor as to have a resonance point at a high frequency is used oscillation may not be prevented.

3. Shock Noise

The shock noise which occurs from the power amplifier at the time of power supply ON/OFF is reduced by means of the prevention circuit. However, when the starting time of the power amplifier is set earlier than that of the preamplifier or the power supply is turned ON immediately after turning OFF, it may happen that the shock noise of the preamplifier cannot be masked. In this case, a germanium diode is connected across pins (7) and (9), and pins (7) and (12) respectively to make the starting time as early as possible. Even if no germanium diode is connected across pins (7) and (12), the starting time can be made earlier, but the starting time can be made much earlier by using 2pcs. of germanium diode.

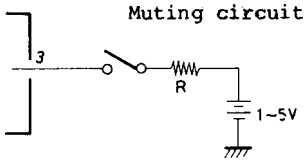


4. Power Supply for Radio's Built-in Capacitor Microphone

Pin (13) is for the low ripple power supply. This pin cannot be used as the power supply for a block, such as radio, which requires a large amount of current. The reason for this is that if this pin is used for this purpose, the middle point of the power amplifier shifts, thereby causing the drop in output. However, this pin can be safely used as the power supply for a built-in capacitor microphne.

5. Recording Muting

The recording muting at the time of recording by use of the built-in microphone is enabled by applying 1 to 5V DC voltage to feedback pin (3) of the power amplifier. (Power amplifier : Cutoff)

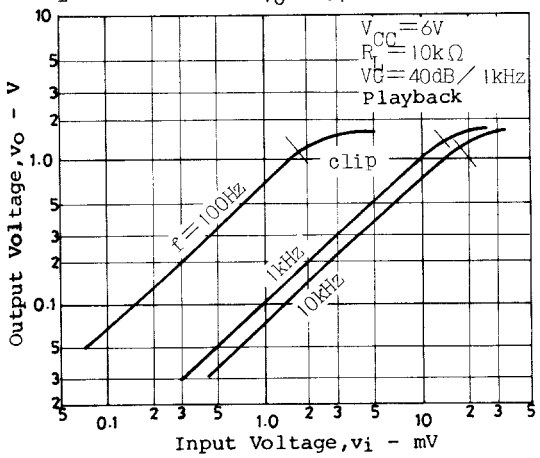


6. In case of using in a radio-cassette recorder, the IC and the bar antenna must be arranged sufficiently distant from each other to avoid the radiation of higher harmonic component at the time of output saturation of the power amplifier.

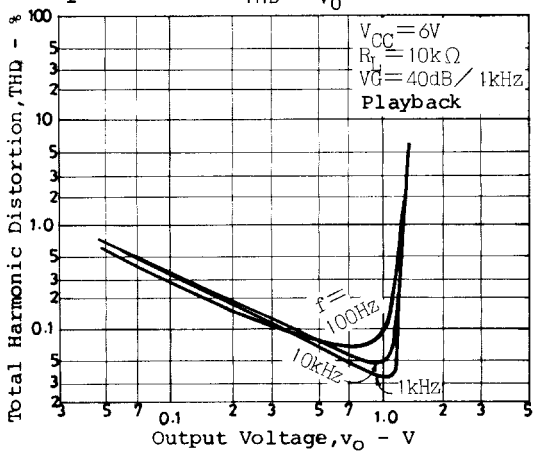
7. Pin-to-pin short causes breakdown and deterioration.

8. Load short causes breakdown and deterioration of both preamplifier and power amplifier.

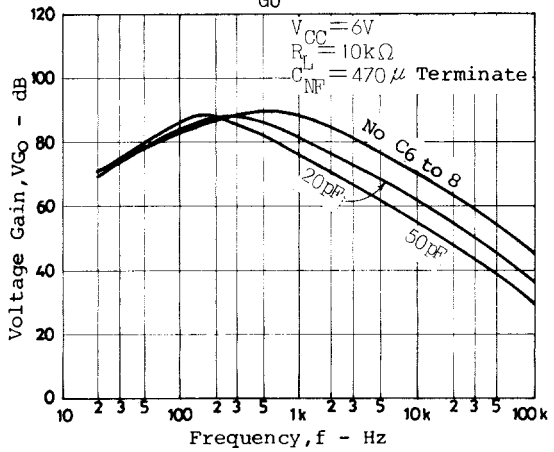
Preamplifier V_O - V_i



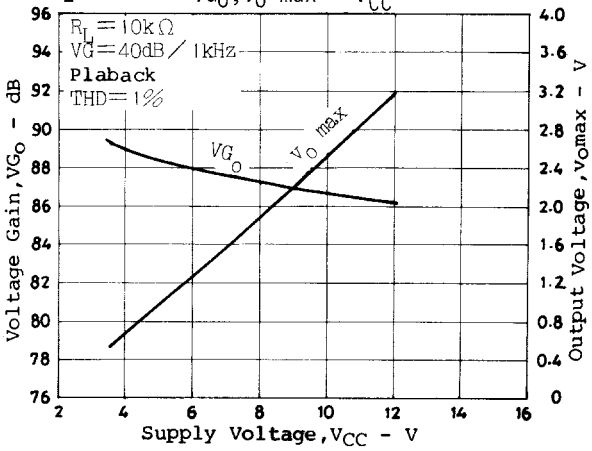
Preamplifier THD - V_O



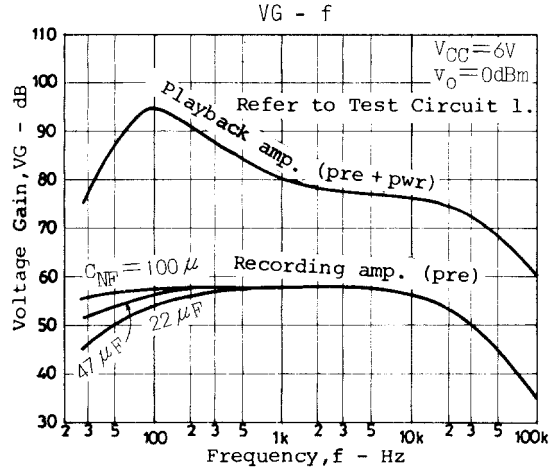
Preamplifier V_{GO} - f



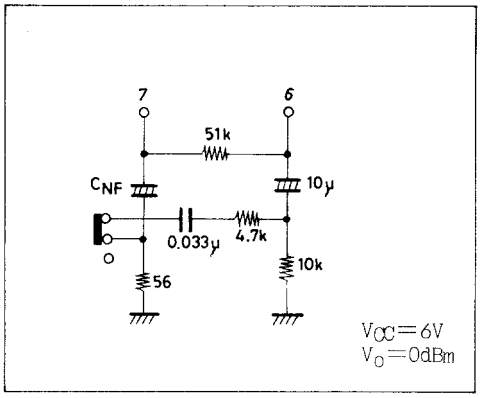
Preamplifier VG_O,v_O max - V_{CC}



VG - f

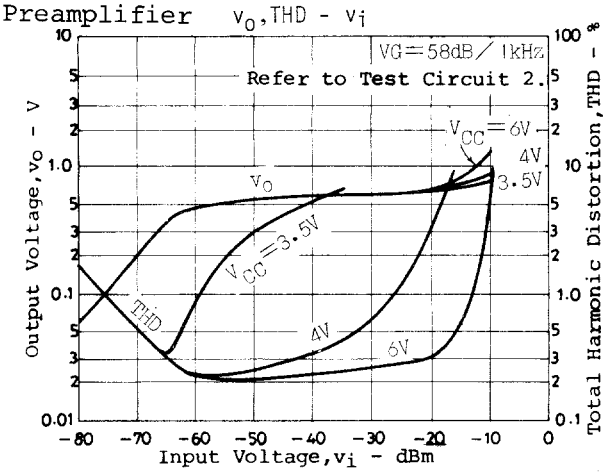


Test Circuit 1

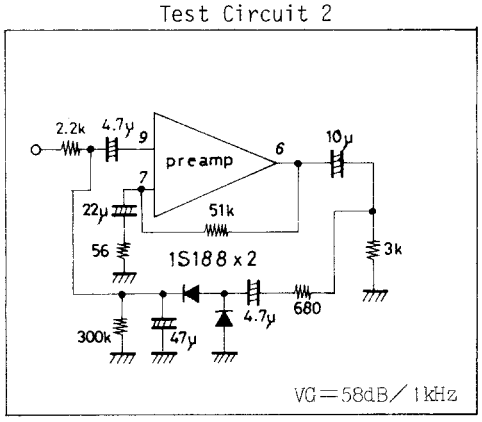


Unit (resistance: Ω, capacitance: F)

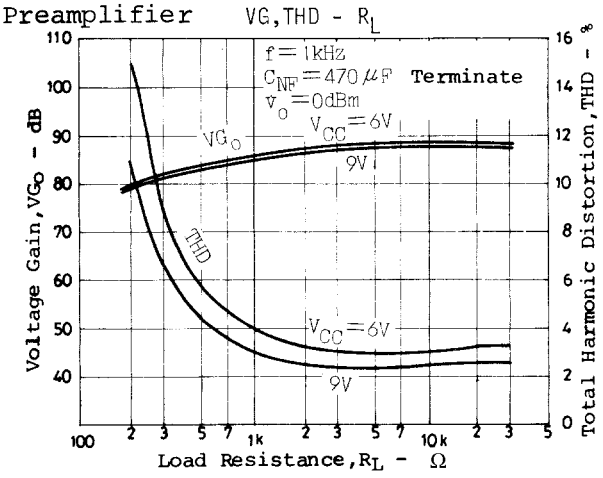
Preamplifier V_O,THD - V_i



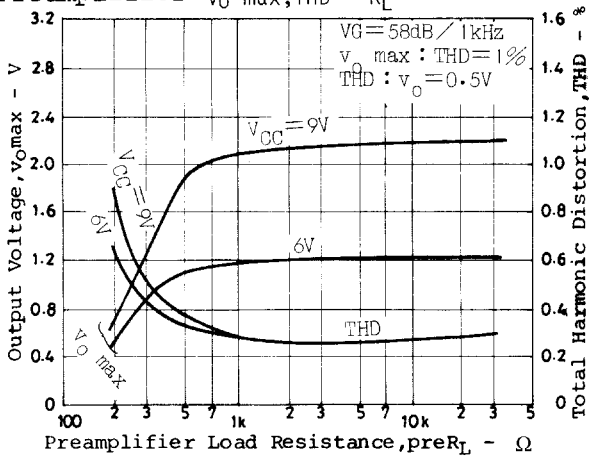
Test Circuit 2



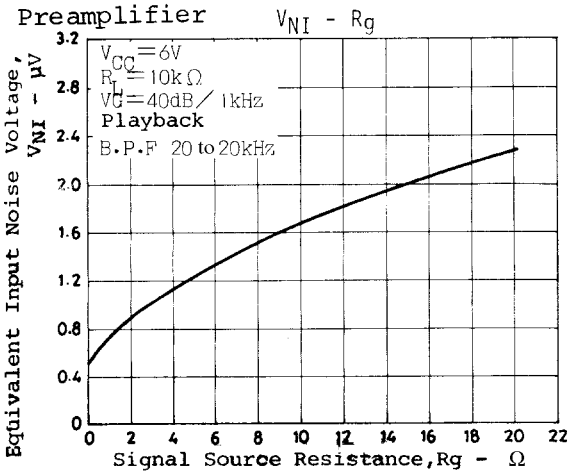
Preamplifier VG,THD - R_L



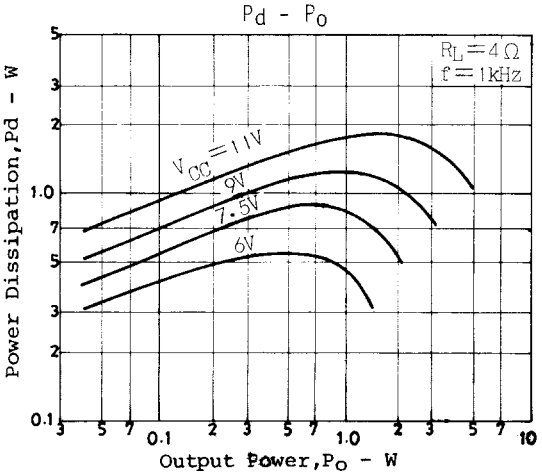
Preamplifier v_o max,THD - R_L



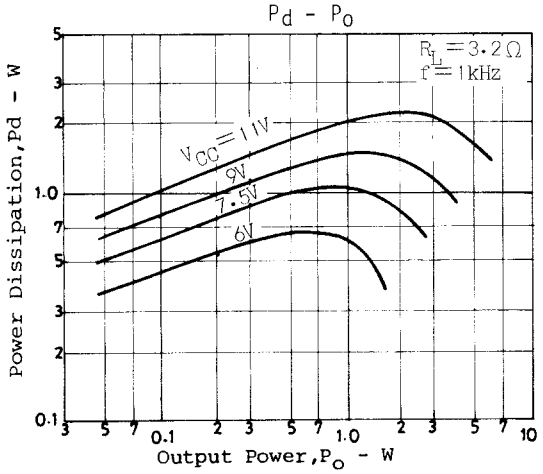
Preamplifier V_{NI} - Rg



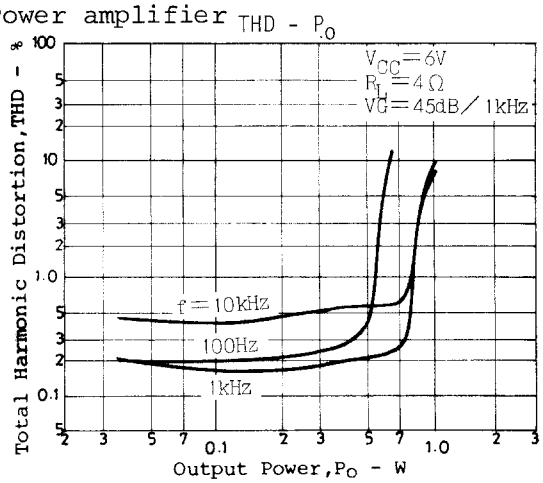
Pd - P_O



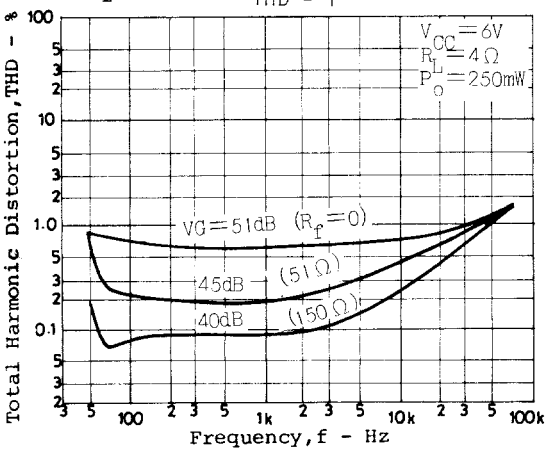
Pd - P_O



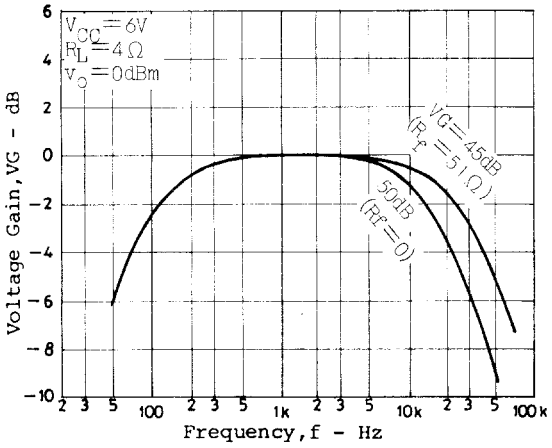
Power amplifier THD - P_O



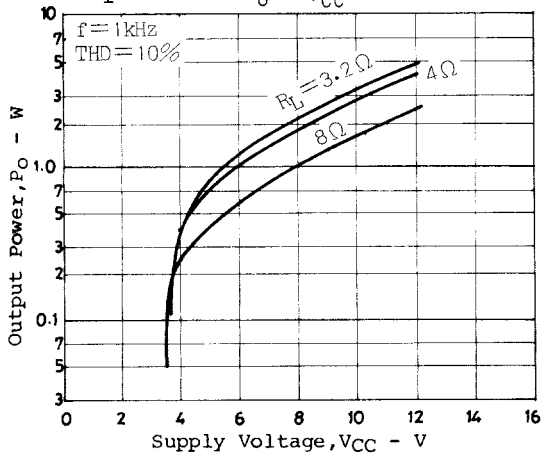
Power amplifier THD - f



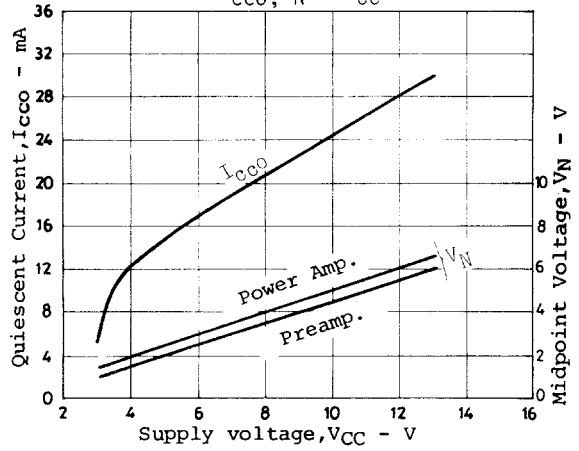
Power amplifier VG - f



Power amplifier P_O - V_{CC}



I_{CCO}, V_N - V_{CC}



I_{CCO} - T_a