Ordering number:ENN2660B

Monolithic Linear IC

LA4460N, 4461N

12W AF Power Amplifier for Car Radio, Car Stereo

Features

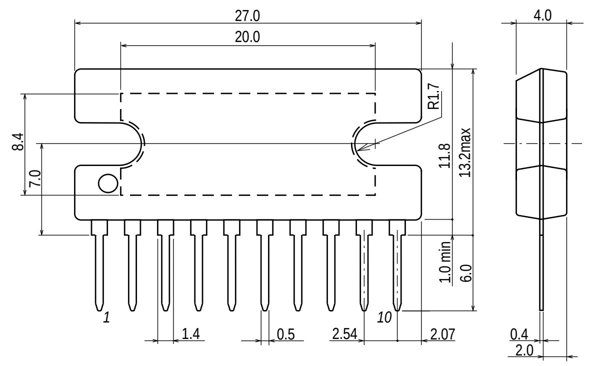
- High gain of 51dB typ. and high power output of 12W typ.
- Possible to delete output and bootstrap capacitors, this encourages cost and space reductions due to external parts reduction.
- Reduced external components (8 pieces recommended, 6 pieces minimum).
- Almost no pop noises heard during power on or off operation.
- Soft tonal quality in saturated power output.
- Low distortion over low to high ranges of the audio frequencies.
- Low residual noises (Rg=0).
- Good operation conditions because of SIP (single ended pins) package having been employed for the LA4460N.
- All pin terminal layouts of the LA4461N are reversed for easy stereo PC board pattern arrengement.
- Two ground terminals for pre-amplifier and power amplifier are provided for easy PC board pattern arrangement and for stabilizing distortion chracteristics depending on signal source impedance.
- Voltage gain is fixed at 51dB, however, lowering the gain is possible by adding a resistor.
- IC is not damaged, if it is connected reversely.
- Audio muting functions (AC mute & DC mute) are equipped.
- Several protection circuits are installed, including :
  a. Thermal protection circuit.
  b. Overvoltage & surge voltage protection circuit.
  c. Load short-circuit current limiting protection circuit.
  d. Output pins DC short-circuit protection circuit. (grounding protection between OUT & GND, and speaker protection provided.)

Package Dimensions

unit:mm

3024A-SIP10H

[LA4460N, 4461N]



SANYO : SIP10H

SANYO Electric Co.,Ltd. Semiconductor Company

TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110-8534 JAPAN

Specifications

Absolute Maximum Ratings at Ta = 25˚C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V_{CC} max1	Quiescent (30s)	25	V
	V_{CC} max2	with signal	18	V
Supply current	I_{10}peak	Instantaneous value duty≤5%, pulse width≤1ms flow-in only	4.5	A
Output current	I_7, I_9 peak	Instantaneous value duty≤5%, pulse width≤1ms	4.5	A
Surge supply voltage	Vsurge	t≤0.2s	50	V
Allowable power dissipation	Pd max	Tc=75˚C, See Pd max – Ta graph.	25	W
Package thermal resistance	θj-c		3	˚C/W
Operating temperature	Topr		–20 to +75	˚C
Storage temperature	Tstg		–40 to +150	˚C

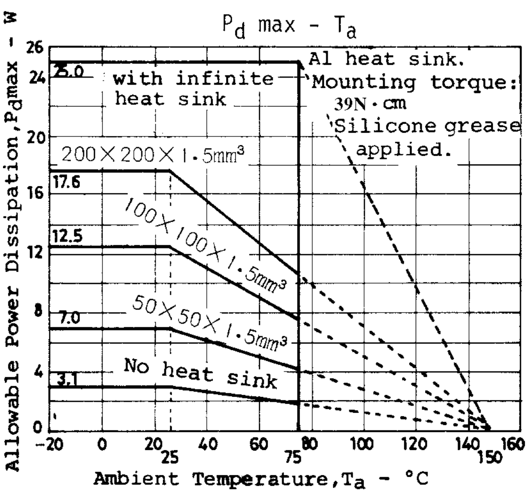
Recommended Operating Conditions at Ta = 25˚C

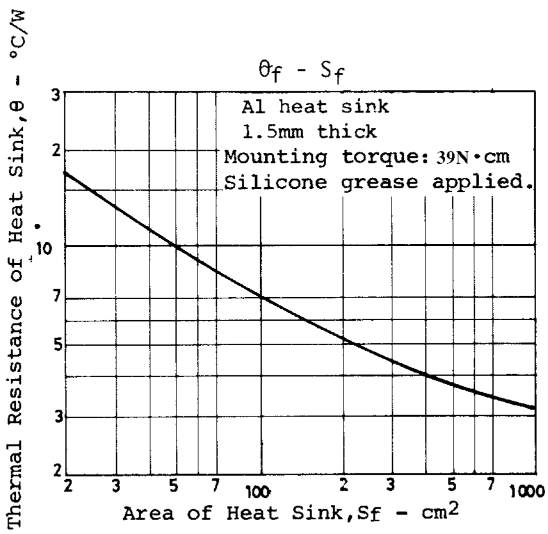
Parameter	Symbol	Conditions	Ratings	Unit
Recommended supply voltage	V_{CC}		13.2	V
Load resistance	R_L		4 to 8	Ω

Operating Characteristics at Ta = 25˚C, V_{CC}=13.2V, R_L=4Ω, f=1kHz, Rg=600Ω, with 100×100×1.5mm³ Al heat sink, See specified Test Circuit

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Quiescent current	I_{CCO}			65	120	mA
Voltage gain	VG	closed loop, at specified recommended circuit.	49	51	53	dB
Output power	P_O	THD=10%	10	12		W
Total harmonic distortion	THD	P_O=1W		0.1	1.0	%
Input resistance	r_i		21	30		kΩ
Output noise voltage	$V_{NO}1$	Rg=0, f=20Hz to 20kHz, band-pass filter		0.4	1.0	mV
	$V_{NO}2$	Rg=10kΩ, f=20Hz to 20kHz, band-pass filter		0.6	2.0	mV
Output offset voltage	Voff		–300		+300	mV
Muting attenuation (AC)	A_{TT}	V_O=0dBm, V_M=9V		38		dB

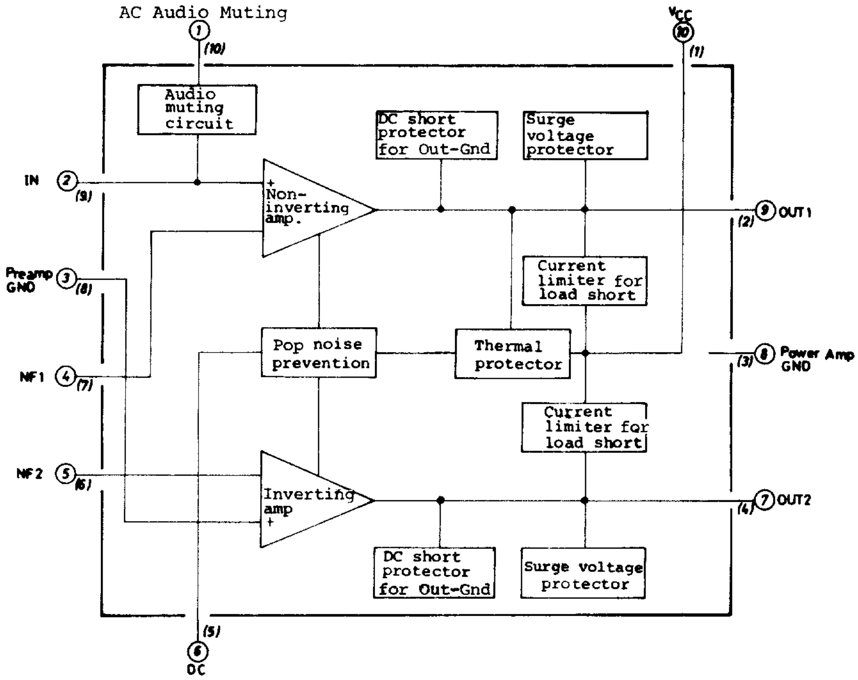
(Note) : For DC muting, ATT=∞



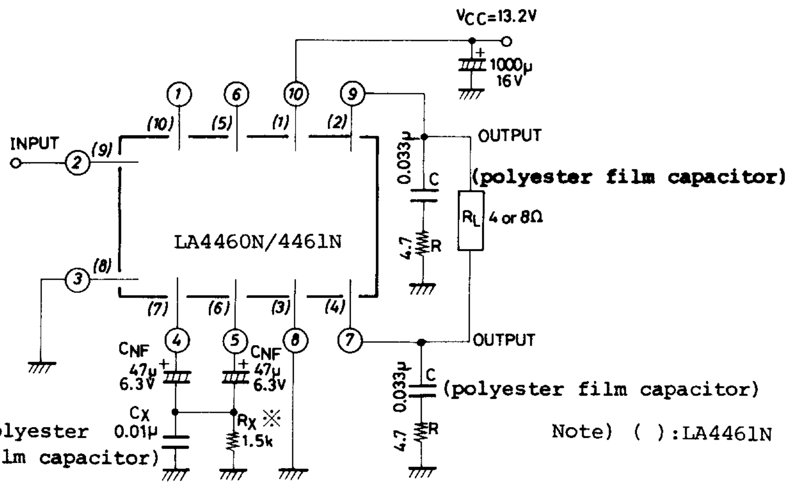


Equivalent Circuit Block Diagram

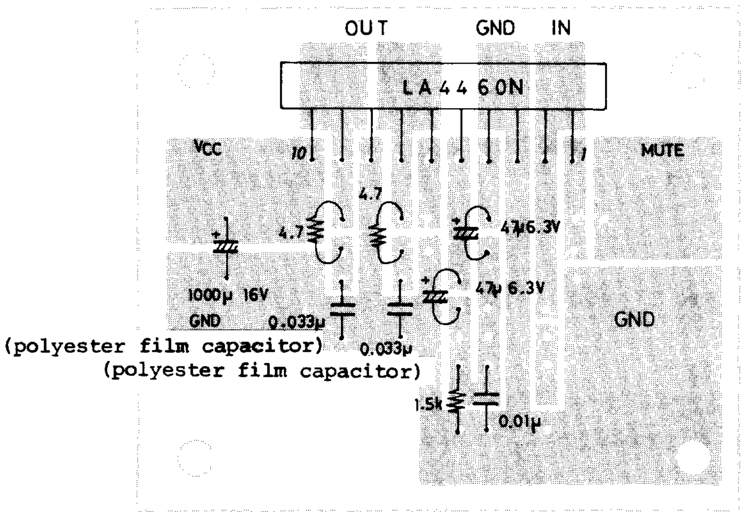
( ): LA4461N



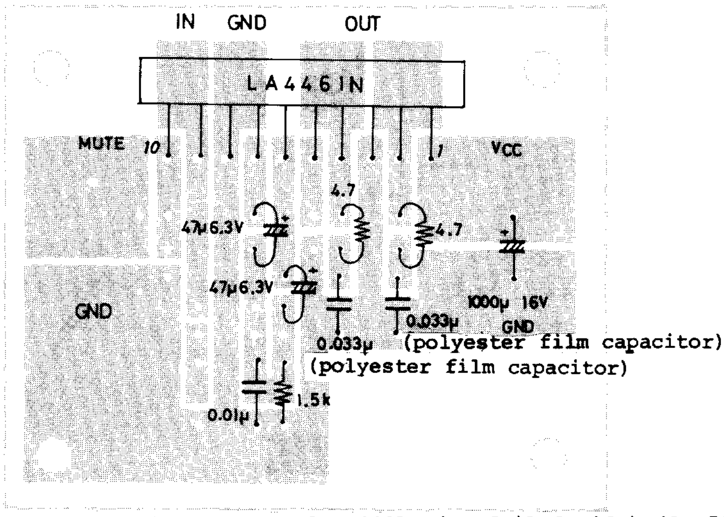
Sample Application Circuit 1 : Recommended Circuit



Rx ※ is for starting time adjustment.

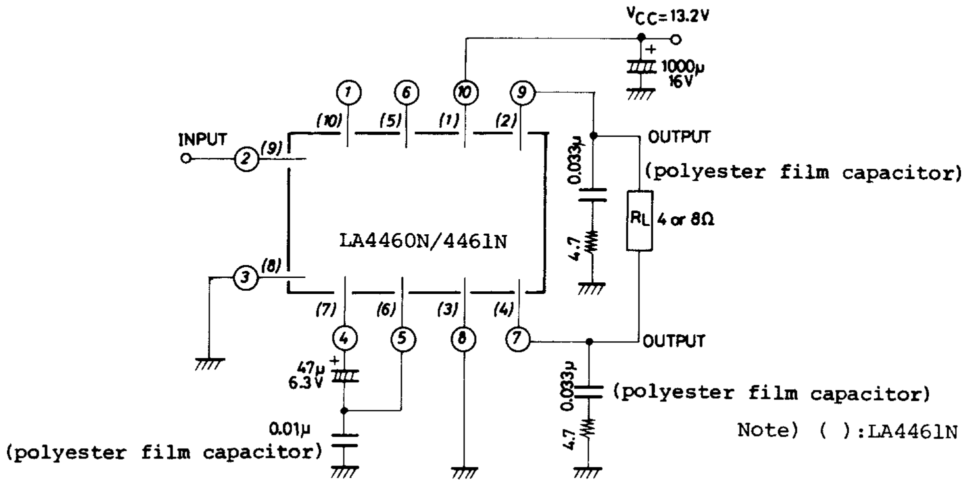


Sample Printed Circuit Pattern of LA4460N (Cu-foiled side) 40 x 50mm²



Sample Printed Circuit Pattern of LA4461N (Cu-foiled side) 40 x 50mm2

Sample Application Circuit 2 : An Example with Minimum Parts



Functional Description on the External Parts

Recommended number of the external parts for the LA4460N/4461N is 8 as shown in the Sample Application Circuit 1. Namely they are :

· Feedback capacitors	2 pieces	4.7μF/6.3V×2
· Starting time adjustmant resistor	1 pieace	1.5kΩ
· Oscillation compensation capacitor	1 piece	0.01μF
· Oscillation compensation C · R	4 pieces	0.033μF×2, 4.7Ω×2

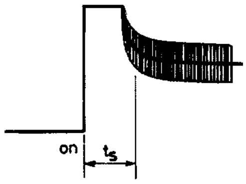
a) Feedback capacitor CNF

This relates to a low range cutoff frequency f_L, and f_L lowers with increasing value of the ‘C_{NF} and increases with decreasing C_{NF}.

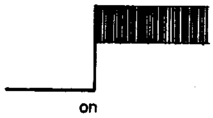
b) Oscillation compensation capacitor C_X

Signals are applied from the non-inverted NF terminal to the inverted NF terminal through the two C_{NF} capacitors. It is recommended to connect the oscillation compensation capacitor C_X=0.01μF between the floating junction of the capacitors (minus side of C_{NF}) and GND. As a rule a polyester film capacitor is recommended, but a ceramic type may be used if a PC board shows good circuit stability.

c) Starting time adjustment resistor R_X
The purpose of the R_X is to adjust the starting time ts, and a resistor of 1.5kΩ is used. In this case, a rising DC locus as shown below will be obtained at the output terminals.

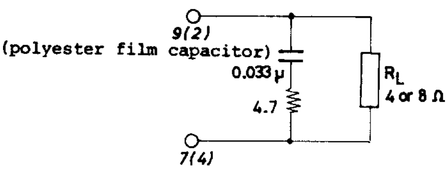


The circuit has been set to provide signals about 0.4µs. after the power is turned on. Though the ts will increase with decreasing R_X, the total output across the load will be decreased, since the signal flowing to the non-inverted side will flow into the ground through the R_X. Contrarily, increasing the R_X to $R_X=\infty$ as shown in the Sample Application Circuit 2, the ts reduces to zero s., and the rising locus as shown below will be obtained.



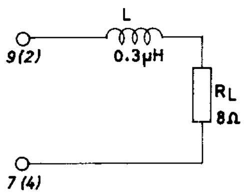
d) Oscillation compensation CR across the load
To prevent parasitic oscillation, it is recommended to connect 0.033µF plus 4.7Ω between each channel output terminal and GND. (As a rule the capacitor should be a polyester film capacitor.) This measure against the oscillation may be replaced with the methods as shown below, depending upon the stability of PC boards used.

1)



Note :
· Check for oscillation at low temperatures.
· Check for oscillation on stereo PC boards.
· Do not use shielded wires for output cords.

2)



Note :
· Check for oscillation at low temperatures.
· Use 8Ω load resistor.
· Do not use shielded wires for output cords.
· L should be higher than 0.3µH.

(Removal of oscillation compensation CR)

Coil used

Air core	Inner diameter : 8ø	Number of turns : 6 turns
Wire size : UEW 1.5	Winding method : Solenoid (0.3µH)	

Above examples can be applied to the Sample Application Circuits 1, 2.

Features of IC System and Roles of the Remaining Pin Terminals

· Since a zero-bias design is introduced into the input circuit to keep the input potential at about zero by employing PNP in the input circuit, an input coupling capacitor can be removed for direct connection. However, when noises caused by a DC current flowing to a volume control circuit or the input circuit causes problems, connect a capacitor in series with the input circuit.
· To prevent damage or deterioration of the IC due to the load short-circuited, a load short-circuit current limiting type protection circuit has been provided.
However, when making the load short-circuit test, always mount the IC on the specified heat sink.
· A circuit which prevents pop noise caused by the power on-off operation is also provided, thereby reducing the offset voltage and protecting speaker systems against damage.

Continued on next page.

Continued from preceding page.

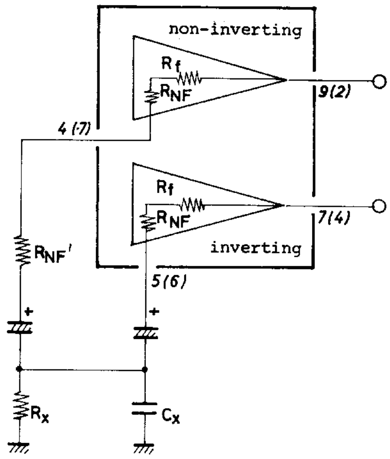
- · Soft clipping characteristics are accomplished by lowering the open loop voltage gain and reducing the amount of feedback to reduce undesired radiation to radio frequency circuits and to increase the circuit stability. The distortion deterioration resulted from the decreased amount of feedback will be avoided by using a unique distortion reduction circuit, thus 0.1% typ. will be assured.
- · A capacitor for oscillation compensation is included inside the IC as a method of reducing external parts. The capacitance is 30pF and this determines the cutoff frequency f_H (–3dB point) of the high range (f_H≈30kHz).
- · To reduce variations of the voltage gain, a feedback resistor R_{NF} is also built-in, and the voltage gain is fixed to 51dB.

R_{NF}=53Ω, R_f=20kΩ
when R_{NF}'=0

$$VG=20\log \frac{R_f}{R_{NF}} \text{ (dB)}$$

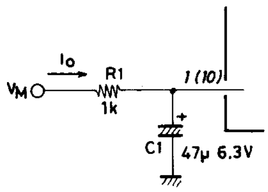
when R_{NF}' is used

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



However the voltage gain will be decreased by adding a resistor R_{NF}', where the R_{NF}' is the resistor to be connected to the pin 4. (In the Sample Application Circuit 2, the gain adjustment will be made with the resistor connected to either pin 4 or 5.)

- · Two ground pin terminals are provided, one for the preamplifier and the other for the power amplifier. Accordingly, stability of the IC is increased, especially, distortion deterioration phenomenon caused by increased signal source impedance Rg is improved and a flat response will be obtained.
- · An overvoltage protector circuit is included to protect the IC from damage when a surge voltage is applied to the power line. The overvoltage is set at 25V, however, the circuit can resist 50V for giant pulse surge of 200ms.
- · For OCL connections, a DC short-circuit protection circuit is required. Therefore a grounding protection circuit which endures against the OUTPUT-GND short-circuit is provided. Since consideration is given to the offset caused by short-circuit or releasing the short-circuit both the speaker and the IC can be protected.
- · When adding an audio muting circuit in each application circuit, refer to the illustration below.

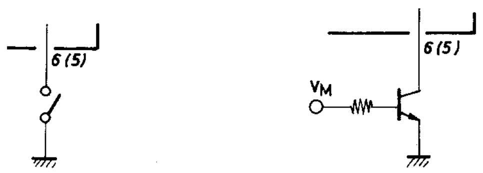


6V≤V_M≤V_{CC}
Recommended V_M=9V
ATT=38dB (Rg=600Ω)

Flow-in current I_O is calculated as shown below.

$$I_O=\frac{V_M-V_{BE}}{R_1}$$

To increase muting attenuation, connect a resistor of 5.6kΩ in series with the input circuit, then the attenuation will be increased to 55dB. It should be noted that adding an input capacitor will increase pop noise when the AC muting is operated. Pop noise can be reduced by increasing the value of R_1 and C_1.

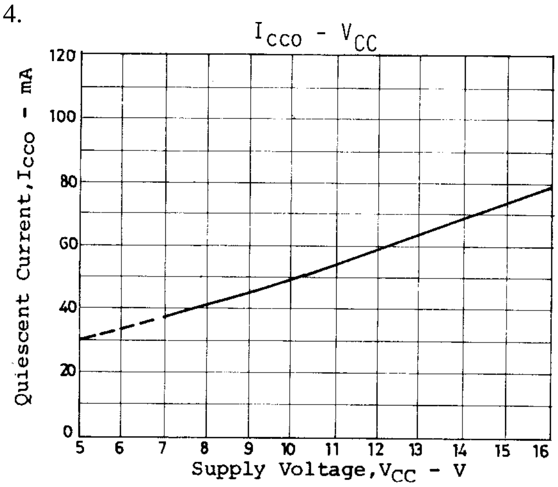


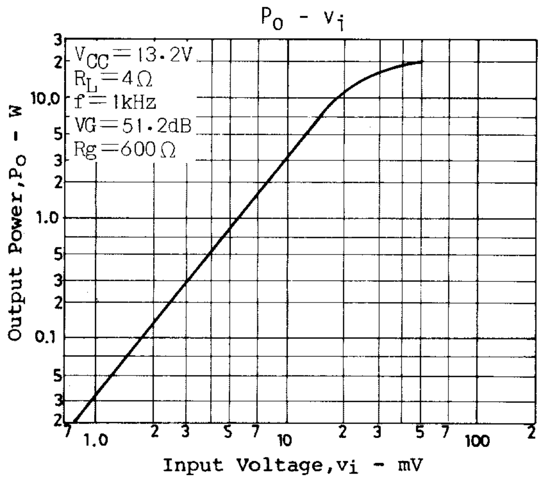
Common switch　　Transistorized switch

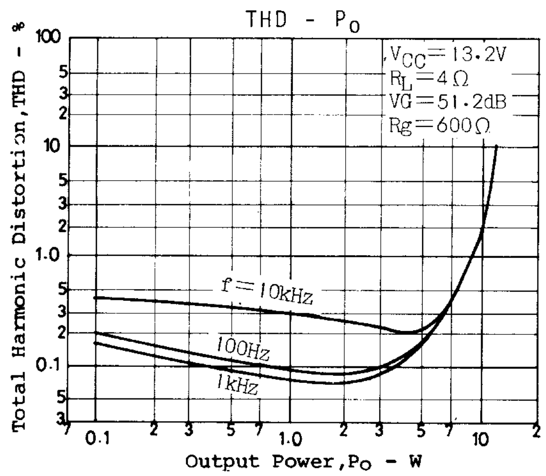
Pin Voltage (unit : V)

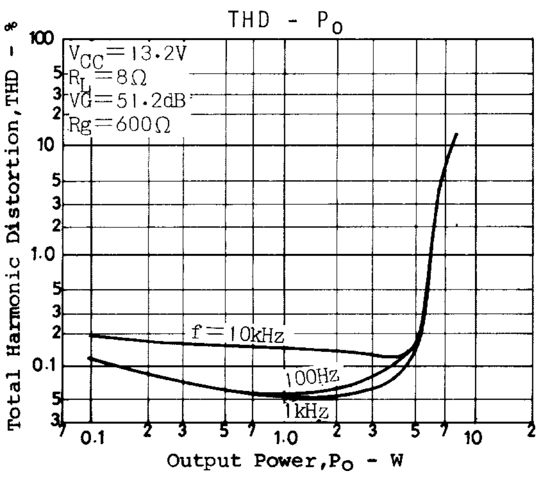
LA4460N	1	2	3	4	5	6	7	8	9	10
LA4461N	10	9	8	7	6	5	4	3	2	1
Function	AC Audio Muting	INPUT	Pre GND	NON INV NF	INV OUT	DC Audio Muting	INV OUT	Power GND	NON INV OUT	V_{CC}
Quiescent pin voltage	0	0.06	0	2.8	2.8	5.6	6.6	0	6.6	13.2

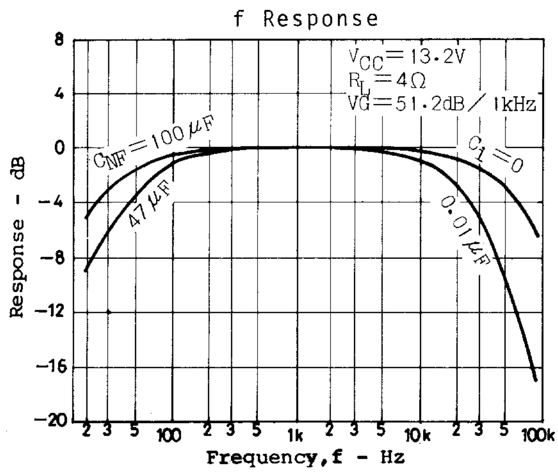
Much data on general characteristics are given for the Sample Application 1, but these data can be also applied to the Sample Application 2 because of no characteristic changed. However, the data on “Pop noise at power turned on”, “Starting time t_s” and “DC muting” are shown for only the Sample Application 1. For the same characteristics to be applied to the Sample Application 2, refer to 1-C on page 4.

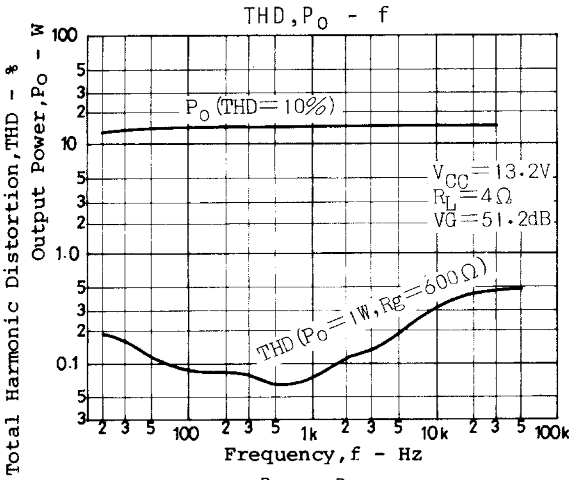


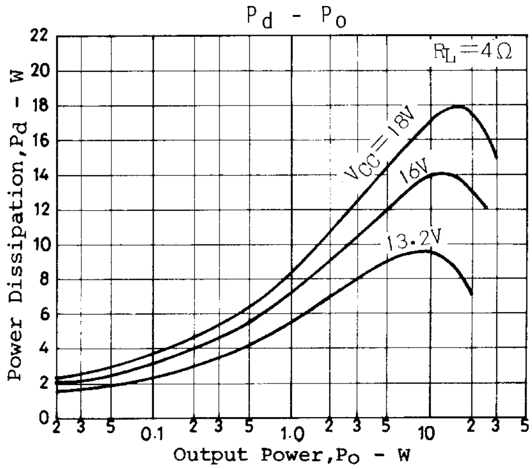


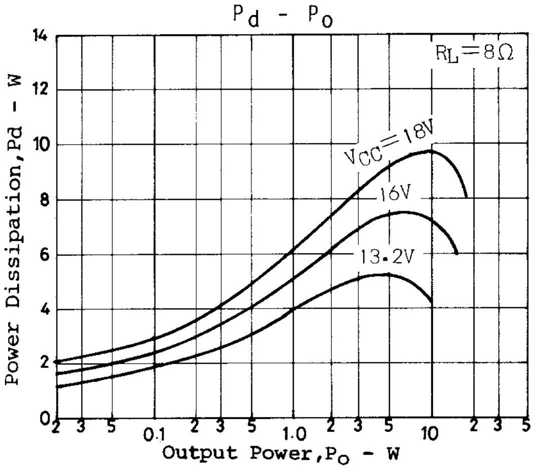


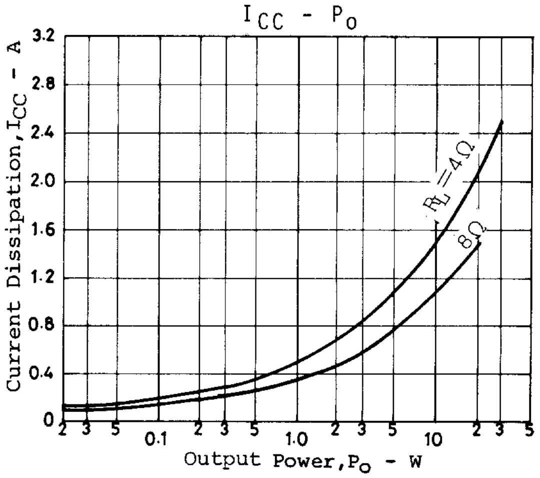


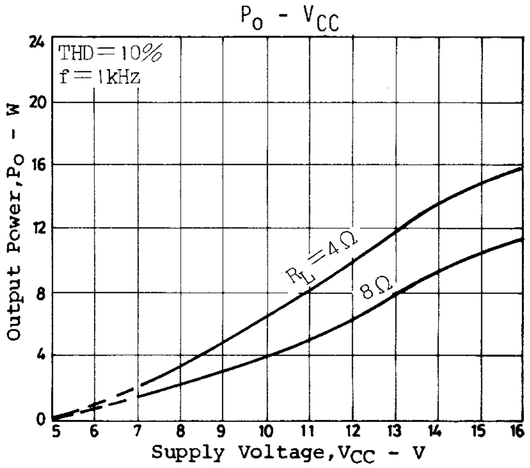


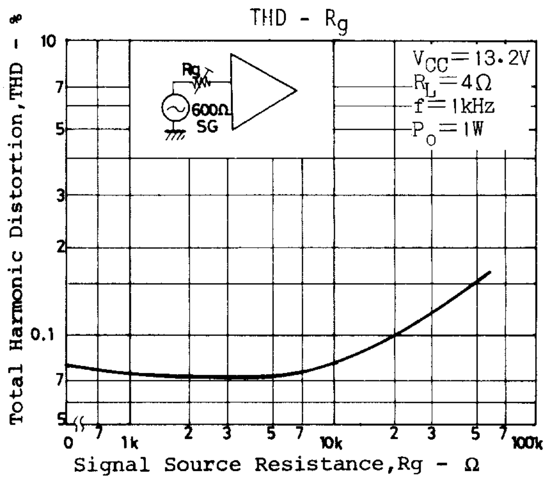

THD, Po – f
Total Harmonic Distortion, THD – %
Output Power, Po – W
Po (THD=10%)
VCC=13.2V
RL=4Ω
VG=51.2dB
THD (Po=1W, Rg=600Ω)
Frequency, f – Hz

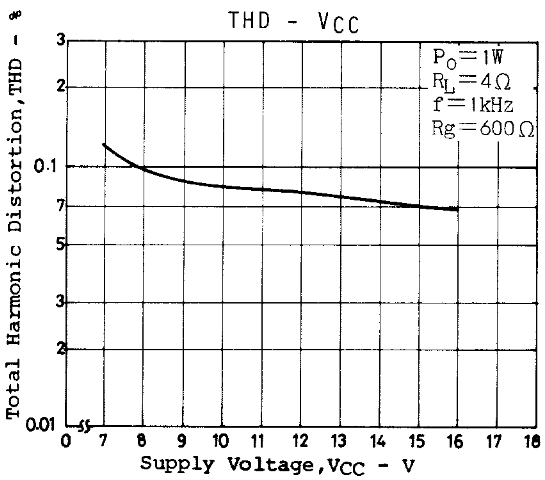

Pd – Po
RL=4Ω
VCC=18V
16V
13.2V
Power Dissipation, Pd – W
Output Power, Po – W

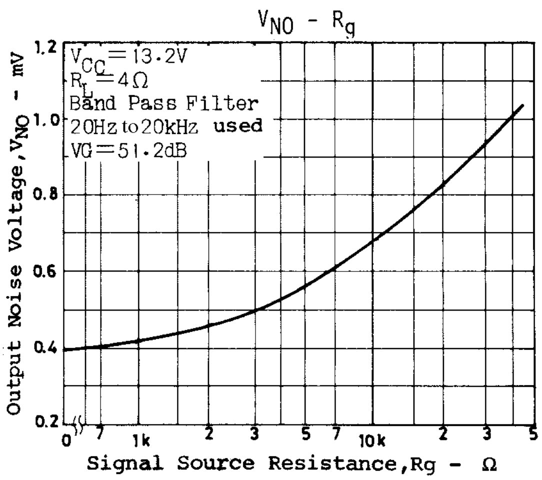

Pd – Po
RL=8Ω
VCC=18V
16V
13.2V
Power Dissipation, Pd – W
Output Power, Po – W

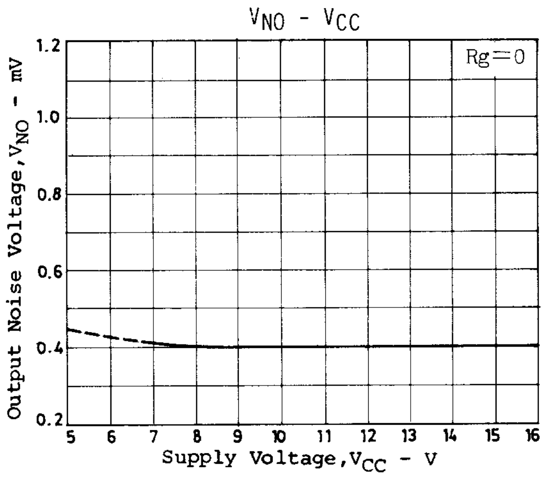

ICC – Po
RL=4Ω
8Ω
Current Dissipation, ICC – A
Output Power, Po – W

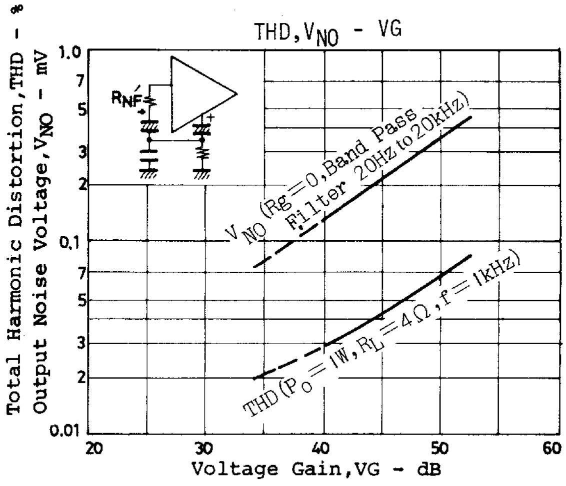

Po – VCC
THD=10%
f=1kHz
RL=4Ω
8Ω
Output Power, Po – W
Supply Voltage, VCC – V

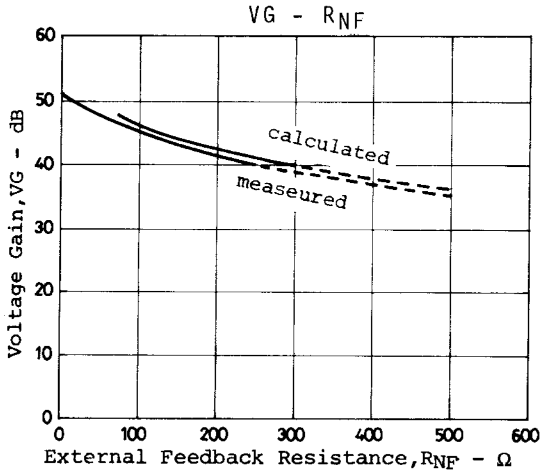

THD – Rg
Rg
600Ω
SG
VCC=13.2V
RL=4Ω
f=1kHz
Po=1W
Total Harmonic Distortion, THD – %
Signal Source Resistance, Rg – Ω

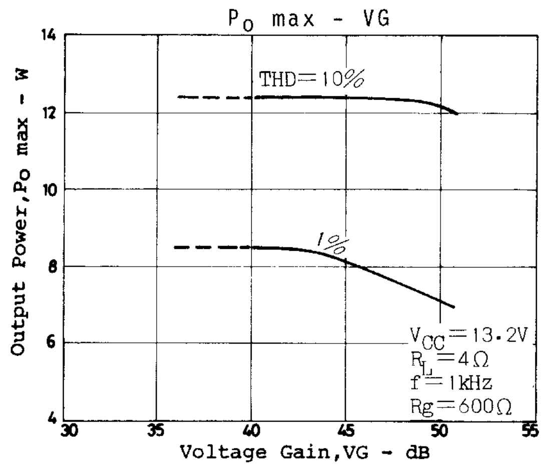

THD – VCC
Po=1W
RL=4Ω
f=1kHz
Rg=600Ω
Total Harmonic Distortion, THD – %
Supply Voltage, VCC – V

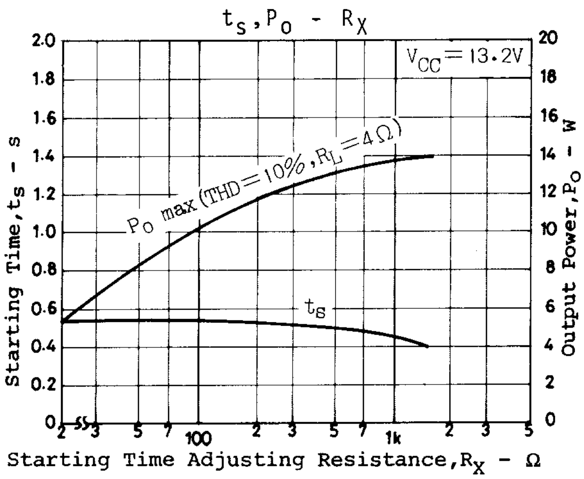

VNO – Rg
VCC=13.2V
RL=4Ω
Band Pass Filter
20Hz to 20kHz used
VG=51.2dB
Output Noise Voltage, VNO – mV
Signal Source Resistance, Rg – Ω

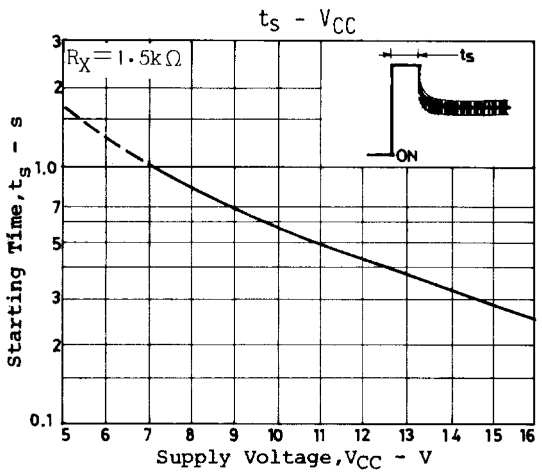

VNO - VCC
Rg=0
Output Noise Voltage,VNO - mV
Supply Voltage,VCC - V

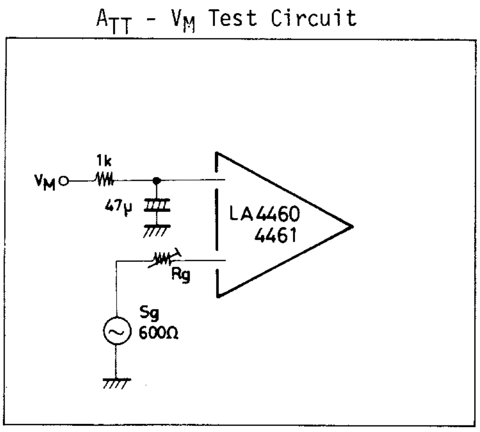

THD,VNO - VG
VNO (Rg=0,Band Pass Filter 20Hz to 20kHz)
THD(Po=1W,RL=4Ω,f=1kHz)
Total Harmonic Distortion,THD - %
Output Noise Voltage,VNO - mV
Voltage Gain,VG - dB

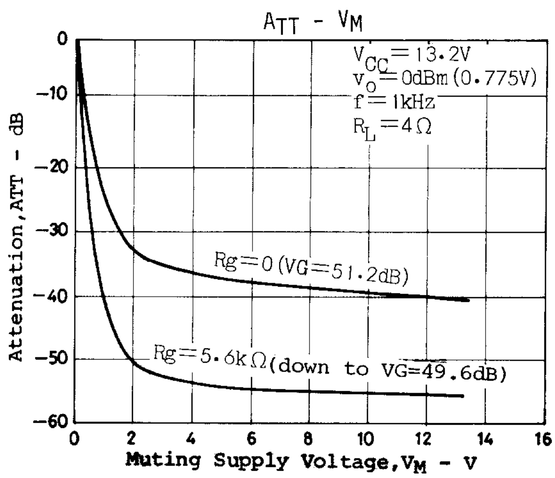

VG - RNF
calculated
measeured
Voltage Gain,VG - dB
External Feedback Resistance,RNF - Ω

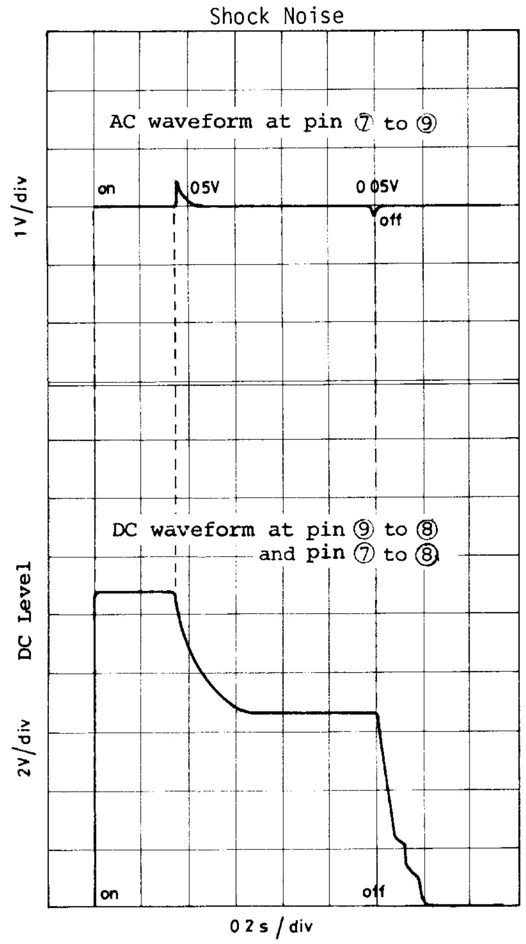

Po max - VG
THD=10%
1%
VCC=13.2V
RL=4Ω
f=1kHz
Rg=600Ω
Output Power,Po max - W
Voltage Gain,VG - dB


ts,Po - RX
VCC=13.2V
Po max (THD=10%,RL=4Ω)
ts
Starting Time,ts - s
Output Power,Po - W
Starting Time Adjusting Resistance,RX - Ω

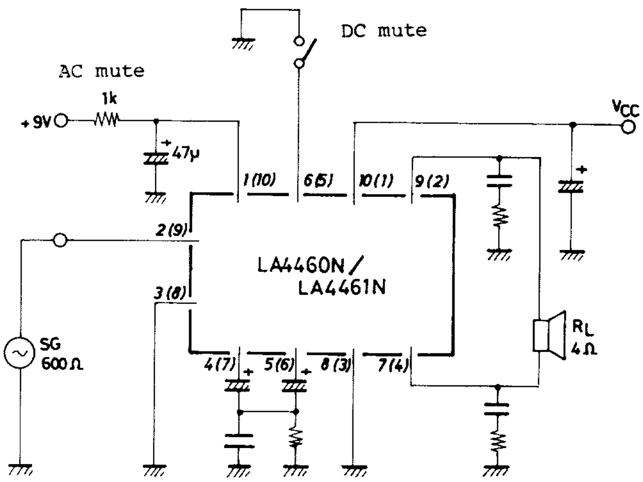

ts - VCC
RX=1.5kΩ
ts
ON
Starting Time,ts - s
Supply Voltage,VCC - V

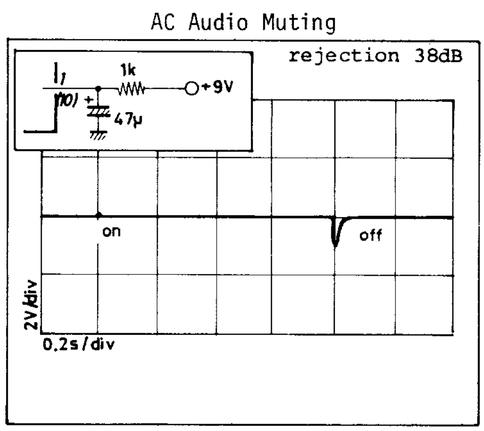

ATT - VM Test Circuit
VM
1k
47μ
LA4460
4461
Rg
Sg
600Ω

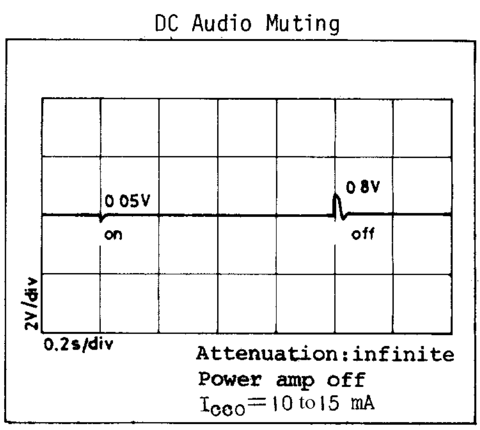

ATT - VM
VCC=13.2V
vo=0dBm(0.775V)
f=1kHz
RL=4Ω
Rg=0 (VG=51.2dB)
Rg=5.6kΩ(down to VG=49.6dB)
Attenuation,ATT - dB
Muting Supply Voltage,VM - V



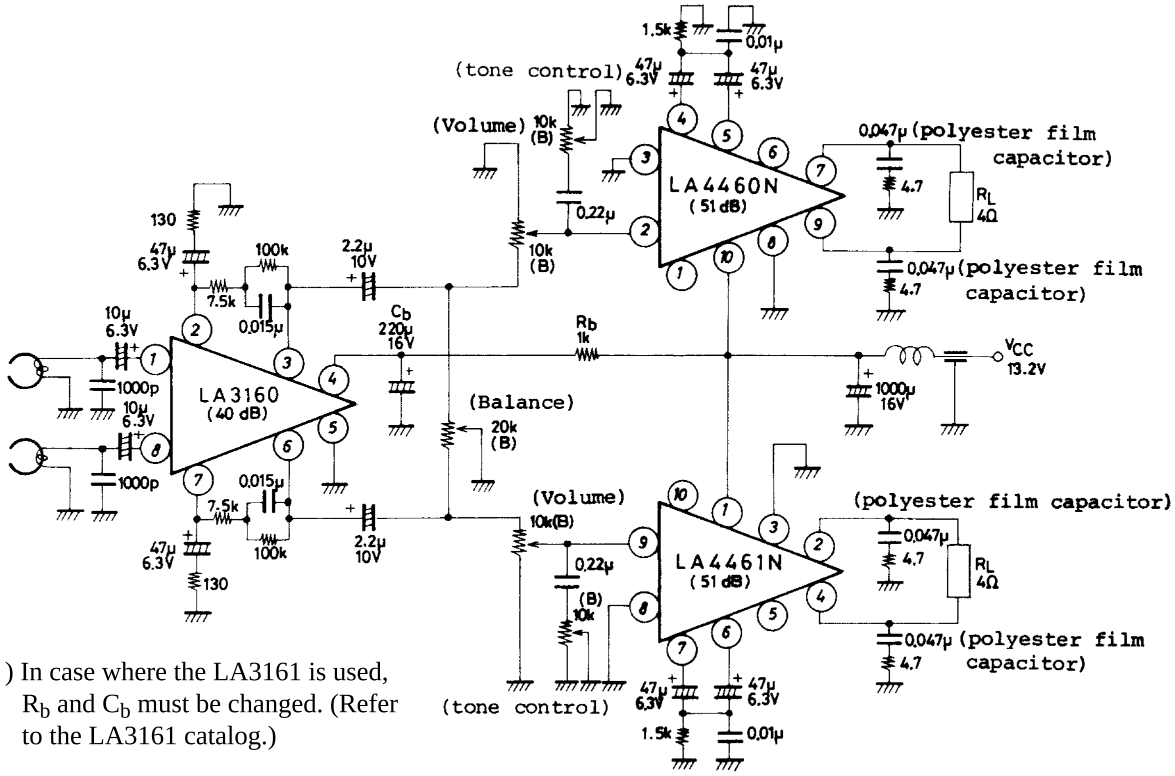
AC, DC Audio Muting Test Circuit



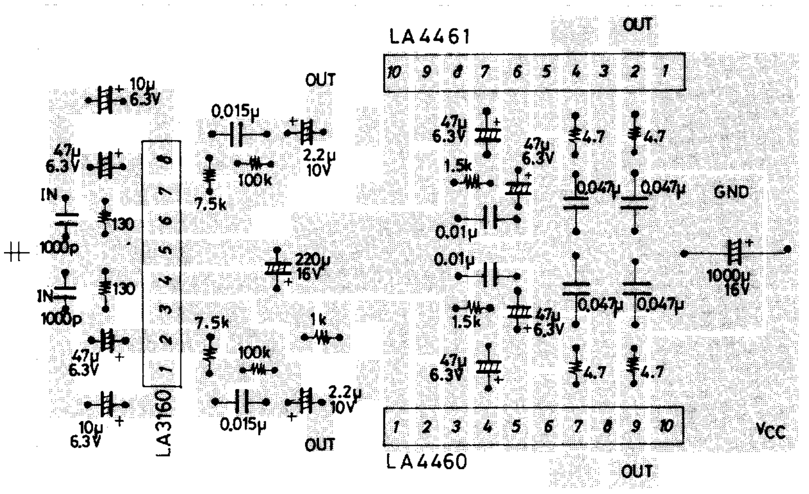




Sample Application Circuit 3 :



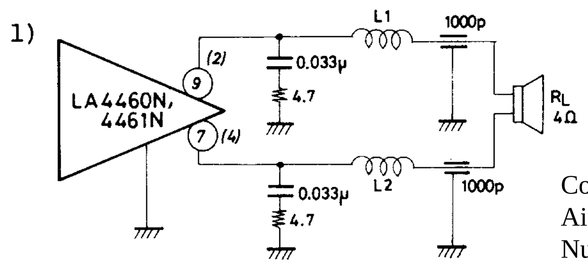
Note) In case where the LA3161 is used, R_b and C_b must be changed. (Refer to the LA3161 catalog.)



Sample Printed Circuit Pattern (42 x 65mm², Cu-foiled side)

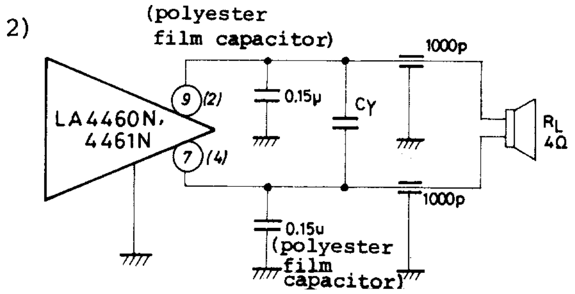
Example of oscillation compensation where feedthrough capacitors and used at the output terminals.

1)



Coil used :
Air core Inner diameter : 8ø
Number of turns : 6 turns
Wire size : UEW 1.5
Winding method : solenoid (0.3μH)

Connect each coil, L1 and L2, in series with each output terminal, where L_1=L_2.



Cy is a semiconductor ceramic capacitor (B.C.) of 0.5µF.

Note on LA4460N/4461N Usage

- Maximum ratings
  When the IC is used in the vicinity of the maximum ratings, a minor change in the conditions could result in exceeding the maximum ratings, and this may lead the IC to damege. Therefore sufficient precautions should be taken in this case.
- Short-circuiting among pin terminals
  Damage or deterioration could result if the power is turned on with pins short-circuited. Therefore always make sure the pins are not bridged by solder, etc. when mounting the IC on the PC board and turn the power on.
- Printed circuit board
  In designing a printed circuit board, refer to the foil pattern example attached. Also make sure no feedback loop exists between the input and output circuits.
- Others
  The IC is an OCL type power IC in which a bridge connection is made. Care should be given to the ground connections of the test equipment so that the ground of the test equipment (VTVM, distortion analyzer, oscilloscope, etc.) connected to the output terminals are not commonly connected to those of the test equipment connected to the input terminals.

This catalog provides information as of February, 2000. Specifications and information herein are subject to change without notice.