

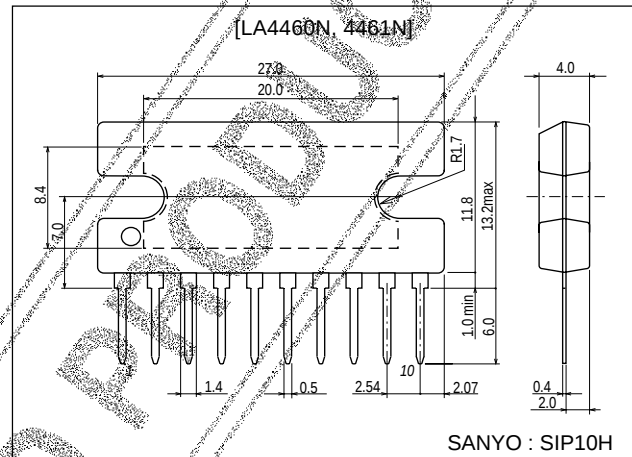
SANYO**LA4460N, 4461N****12W AF Power Amplifier
for Car Radio, Car Stereo****Features**

- 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 ($R_g=0$).
- 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 arrangement.
- Two ground terminals for pre-amplifier and power amplifier are provided for easy PC board pattern arrangement and for stabilizing distortion characteristics 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



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SANYO Electric Co.,Ltd. Semiconductor Company

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Specifications

Absolute Maximum Ratings at $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	$V_{CC\text{ max1}}$	Quiescent (30s)	25	V
	$V_{CC\text{ max2}}$	with signal	18	V
Supply current	$I_{10\text{peak}}$	Instantaneous value duty $\leq 5\%$, pulse width $\leq 1\text{ms}$ flow-in only	4.5	A
Output current	$I_L, I_g\text{ peak}$	Instantaneous value duty $\leq 5\%$, pulse width $\leq 1\text{ms}$	4.5	A
Surge supply voltage	V_{surge}	$t \leq 0.2\text{s}$	50	V
Allowable power dissipation	$P_d\text{ max}$	$T_c = 75^\circ\text{C}$, See $P_d\text{ max} - T_a$ graph.	25	W
Package thermal resistance	θ_{j-c}		3	$^\circ\text{C/W}$
Operating temperature	T_{opr}		-20 to +75	$^\circ\text{C}$
Storage temperature	T_{stg}		-40 to +150	$^\circ\text{C}$

Recommended Operating Conditions at $T_a = 25^\circ\text{C}$

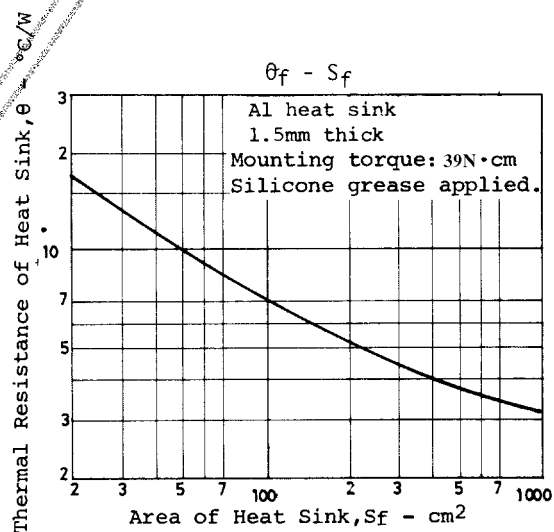
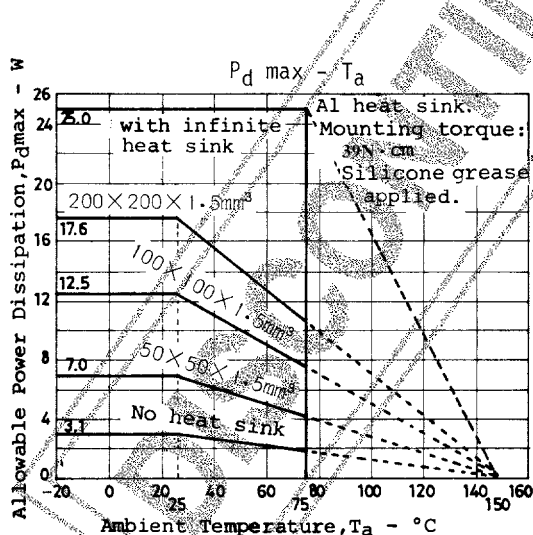
Parameter	Symbol	Conditions	Ratings	Unit
Recommended supply voltage	V_{CC}		13.2	V
Load resistance	R_L		4 to 8	Ω

Operating Characteristics at $T_a = 25^\circ\text{C}$, $V_{CC} = 13.2\text{V}$, $R_L = 4\Omega$, $f = 1\text{kHz}$, $R_g = 600\Omega$, with $100 \times 100 \times 1.5\text{mm}^3$

Al heat sink, See specified Test Circuit

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Quiescent current	I_{CCO}			65	120	mA
Voltage gain	V_G	closed loop, at specified recommended circuit.	49	51	53	dB
Output power	P_O	THD=10%	10	12		W
Total harmonic distortion	THD	$P_O = 1\text{W}$		0.1	1.0	%
Input resistance	r_i		21	30		$k\Omega$
Output noise voltage	V_{NO1}	$R_g = 0, f = 20\text{Hz to } 20\text{kHz}$, band-pass filter		0.4	1.0	mV
	V_{NO2}	$R_g = 10k\Omega, f = 20\text{Hz to } 20\text{kHz}$, band-pass filter		0.6	2.0	mV
Output offset voltage	V_{off}		-300		+300	mV
Muting attenuation (AC)	ATT	$V_O = 0\text{dBm}$, $V_M = 9\text{V}$		38		dB

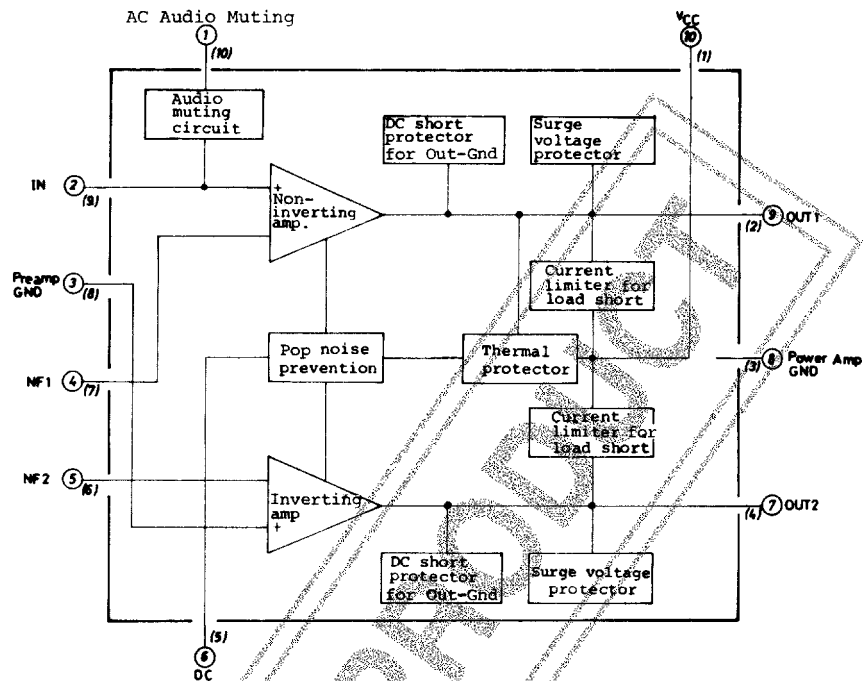
(Note) : For DC muting, $ATT = \infty$



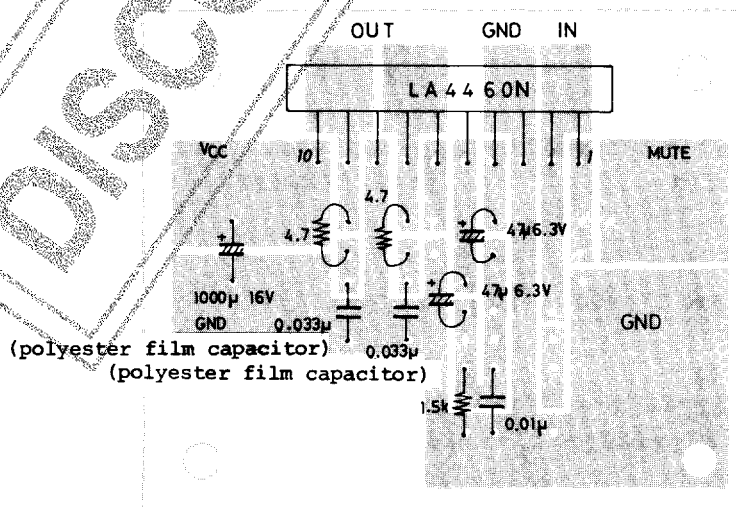
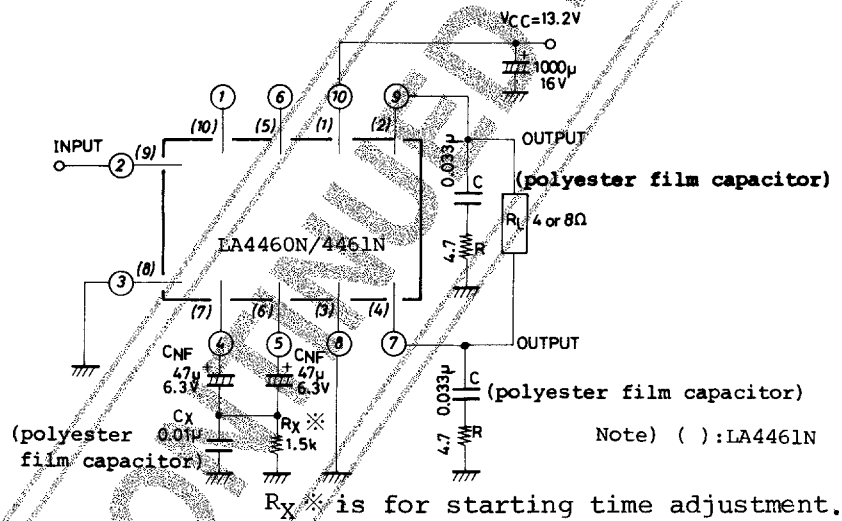
LA4460N, 4461N

Equivalent Circuit Block Diagram

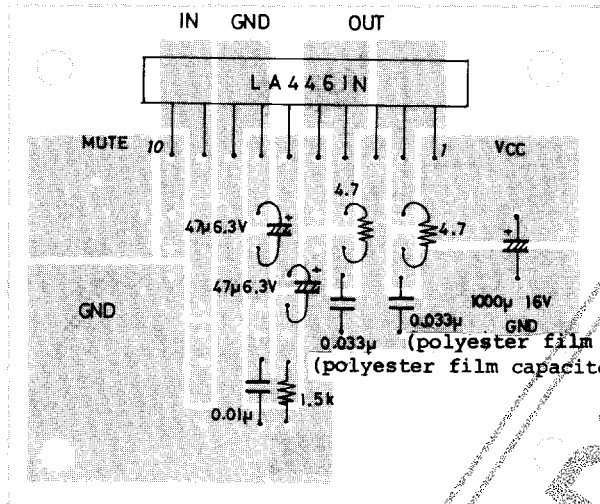
() : LA4461N



Sample Application Circuit 1 : Recommended Circuit

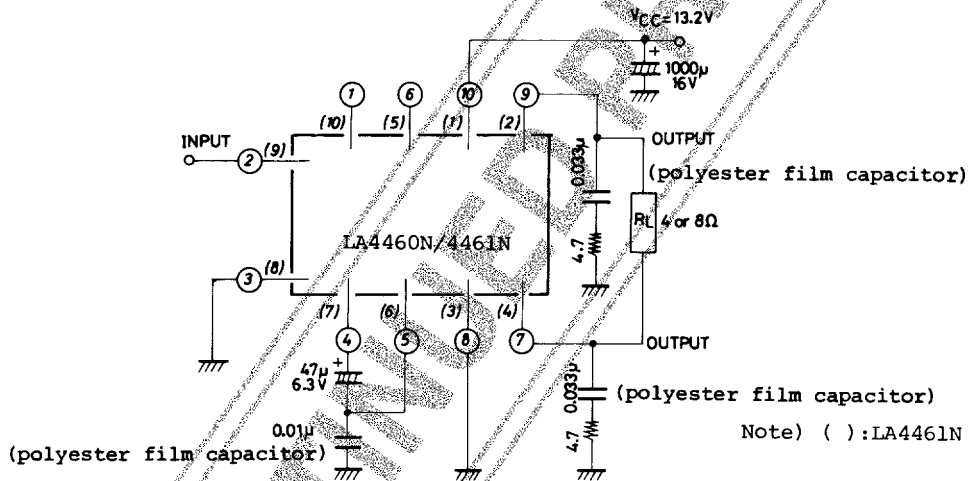


Sample Printed Circuit Pattern of LA4460N (Cu-foiled side) 40 x 50mm²



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 C_{NF}

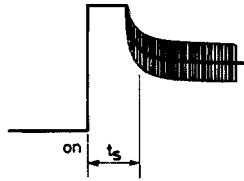
This relates to a low range cutoff frequency f_L , and f_L lowers with increasing value of the 'C_{NF} and increases with decreasing C_{NF}.

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 t_s , and a resistor of $1.5k\Omega$ is used. In this case, a rising DC locus as shown below will be obtained at the output terminals.

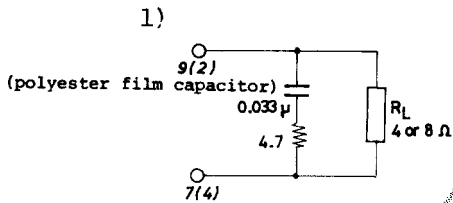


The circuit has been set to provide signals about $0.4\mu s$. after the power is turned on. Though the t_s will increase with decreasing R_X , the total output across the load will be decreased, since the signal flowing to the non-inverted side will flow into the ground through the R_X . Contrarily,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



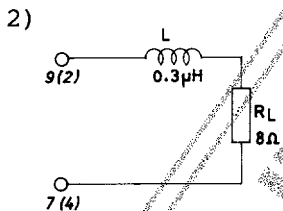
d) Oscillation compensation CR across the load

To prevent parasitic oscillation, it is recommended to connect $0.033\mu F$ 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.



Note :

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



Note :

- Check for oscillation at low temperatures.
- Use 8Ω load resistor.
- Do not use shielded wires for output cords.
- L should be higher than $0.3\mu H$.

(Removal of oscillation compensation CR)

Coil used

Air core

Inner diameter : 8 ϕ

Number of turns : 6 turns

Wire size : UEW 1.5

Winding method : Solenoid (0.3 μ H)

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.

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- 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 ($f_H \approx 30\text{kHz}$).
- To reduce variations of the voltage gain, a feedback resistor R_{NF} is also built-in, and the voltage gain is fixed to 51dB.

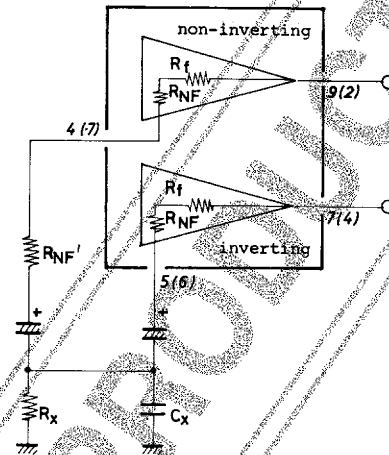
$$R_{NF}=53\Omega, R_f=20k\Omega$$

$$\text{when } R_{NF}'=0$$

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

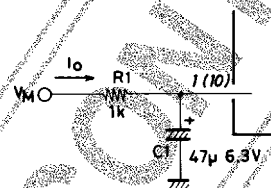
$$\text{when } R_{NF}' \text{ is used}$$

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



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 R_g 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.



$$6V \leq V_M \leq V_{CC}$$

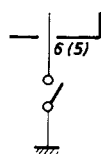
$$\text{Recommended } V_M=9V$$

$$\text{ATT}=38\text{dB} (R_g=600\Omega)$$

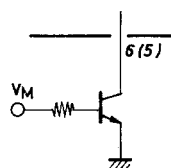
Flow-in current I_O is calculated as shown below.

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

To increase muting attenuation, connect a resistor of 5.6k Ω 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



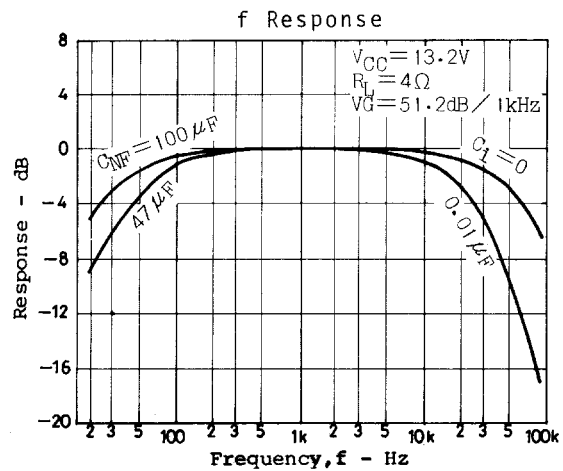
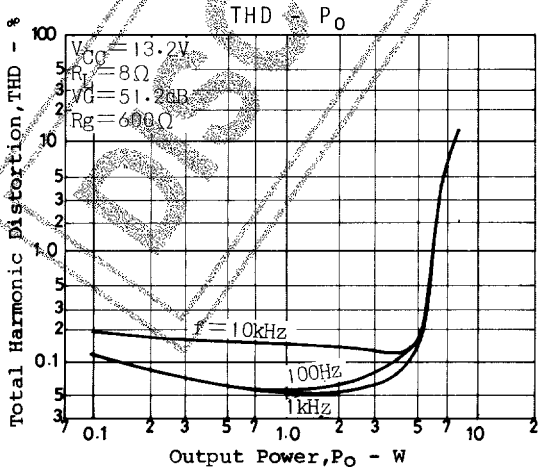
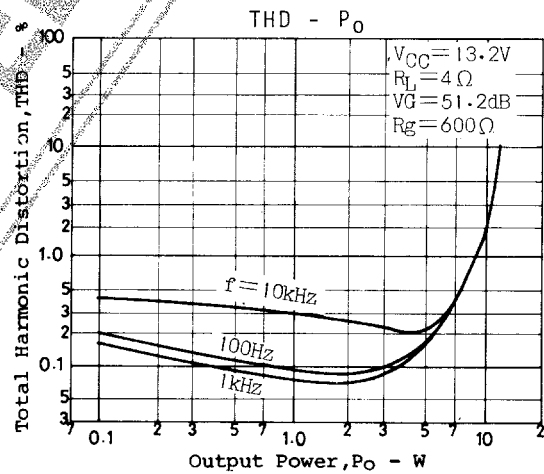
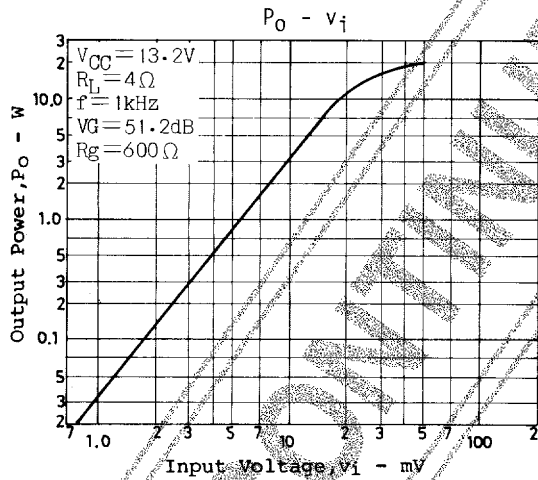
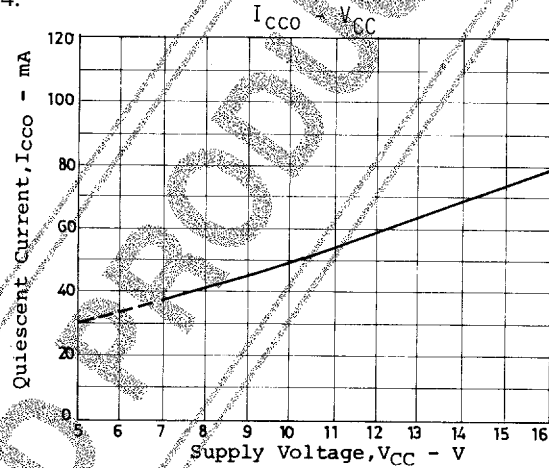
Transistorized switch

LA4460N, 4461N

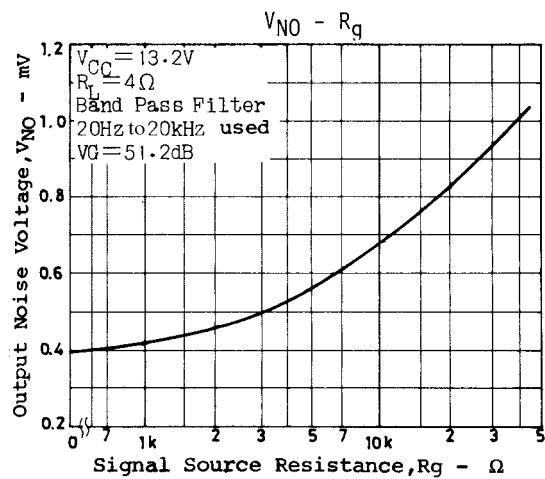
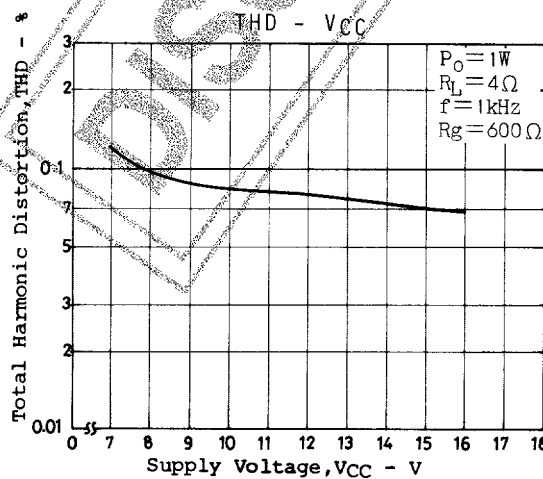
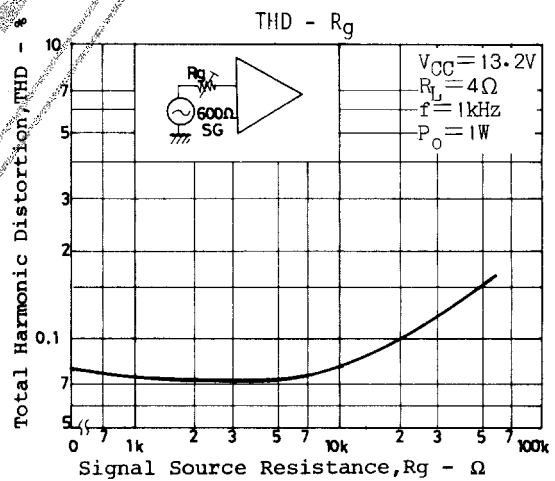
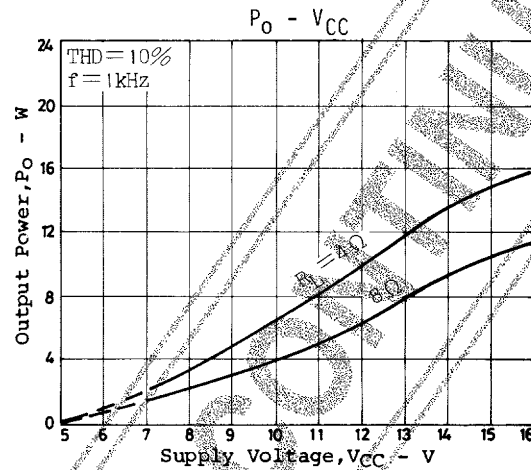
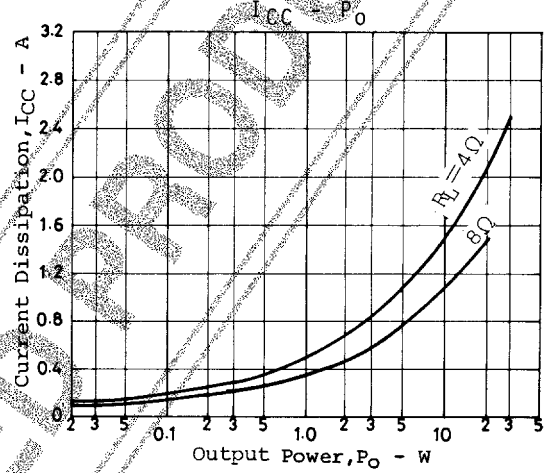
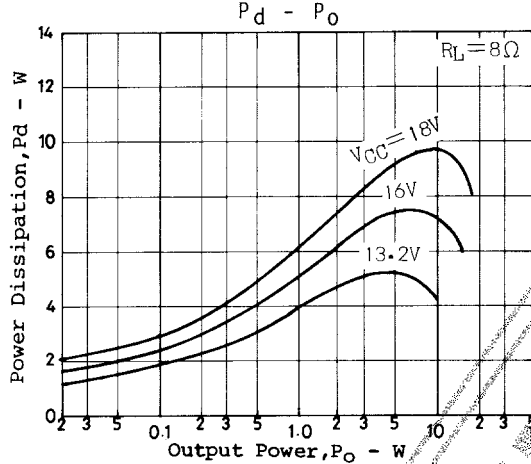
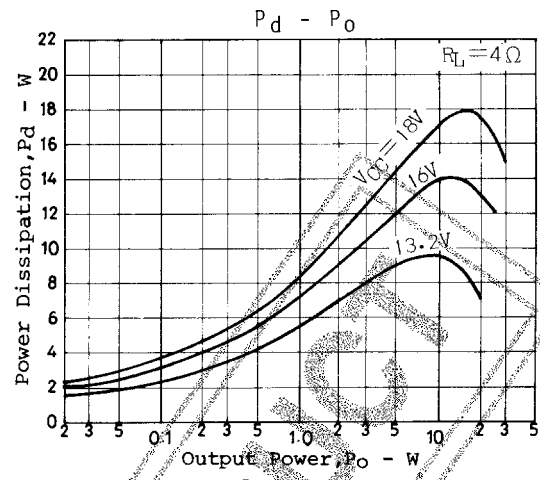
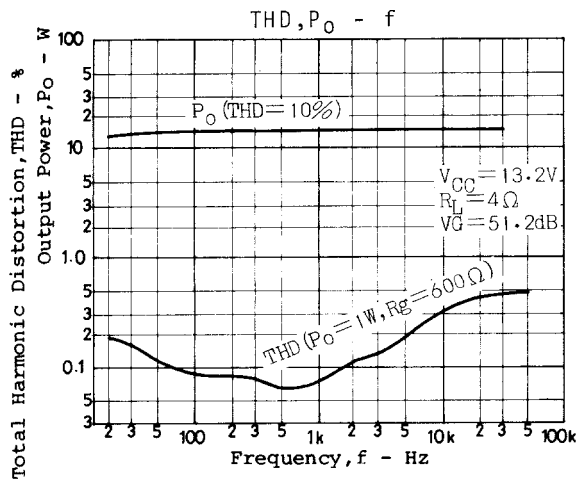
Pin Voltage (unit : V)

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

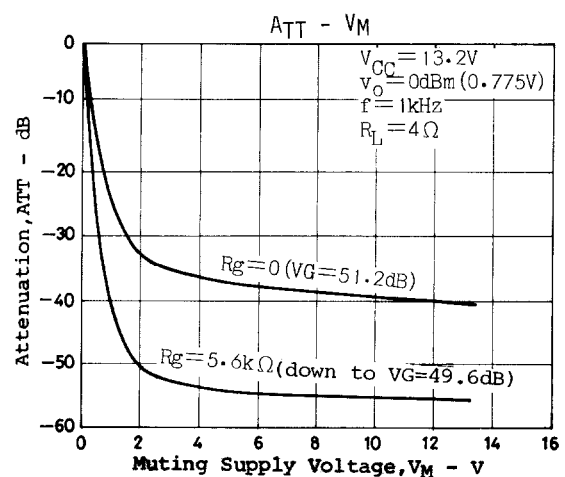
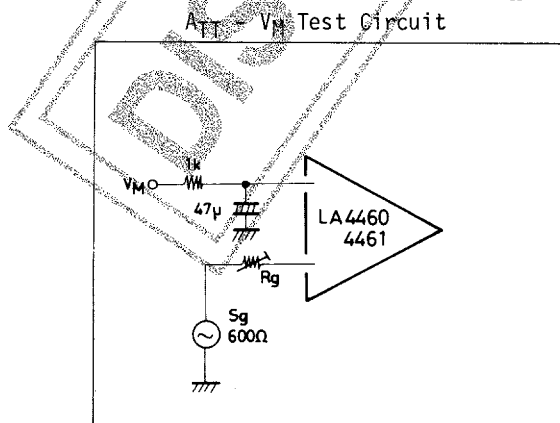
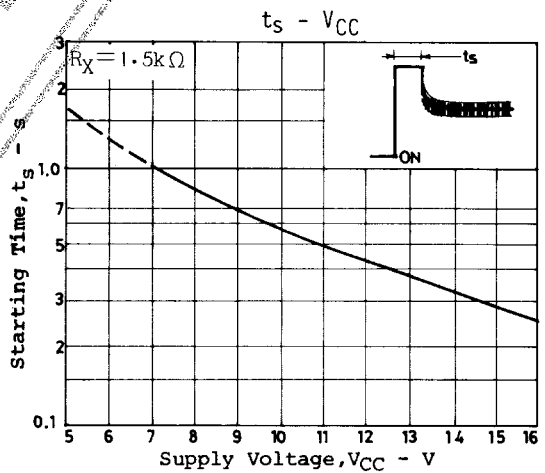
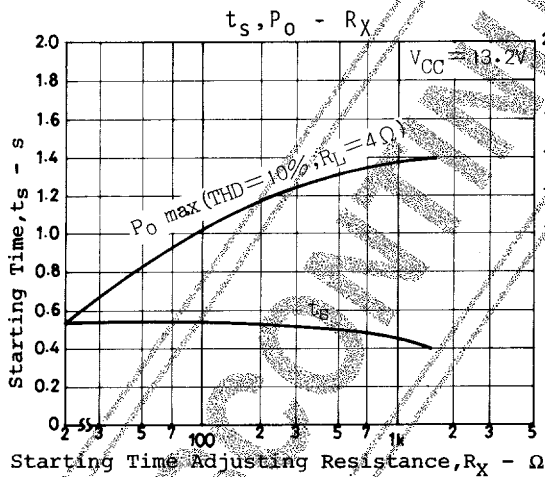
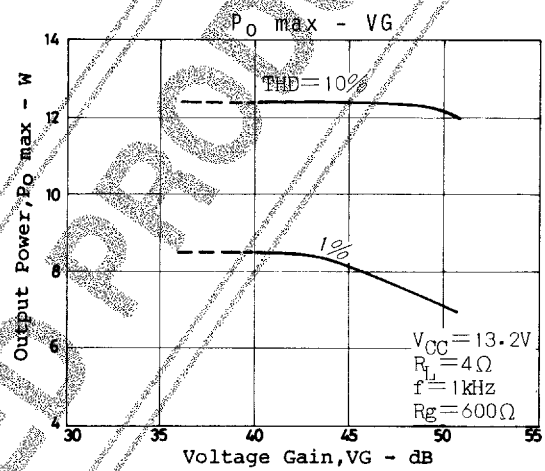
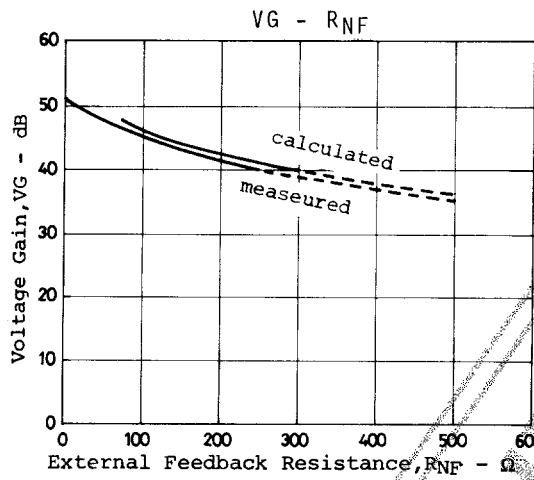
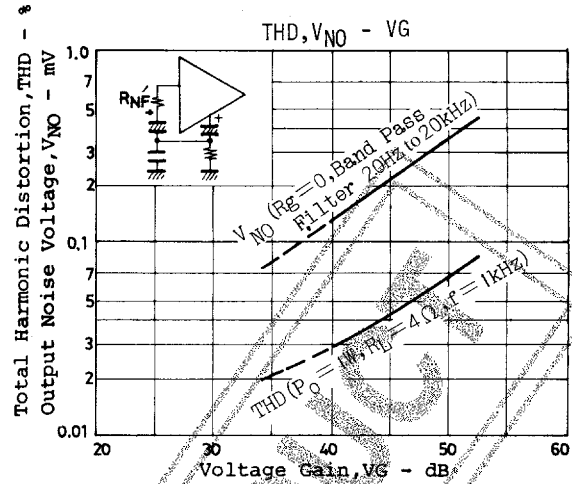
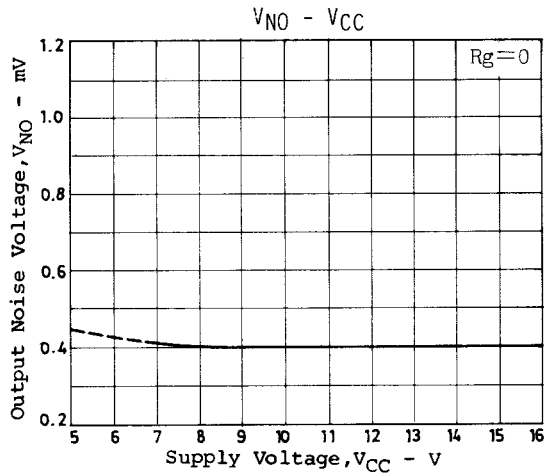
Much data on general characteristics are given for the Sample Application 1, but these data can be also applied to the Sample Application 2 because of no characteristic changed. However, the data on "Pop noise at power turned on", "Starting time t_s " and "DC muting" are shown for only the Sample Application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

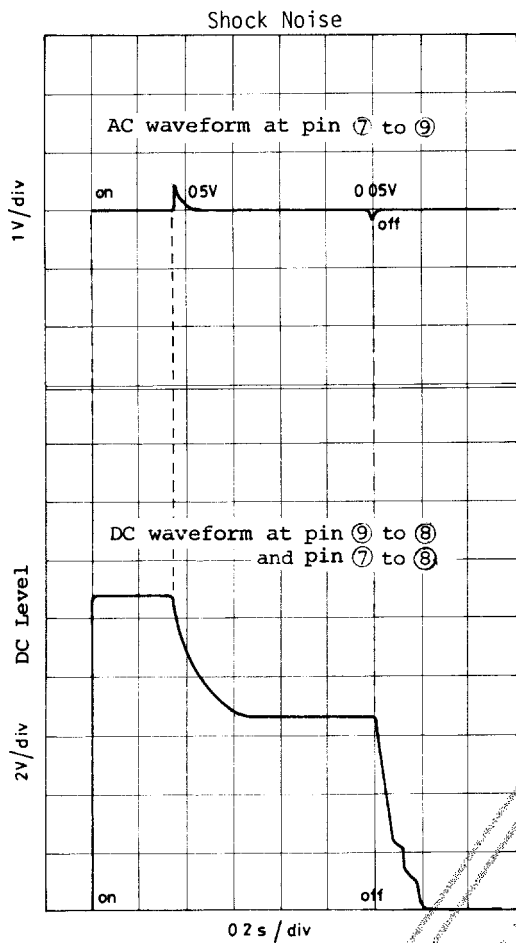


LA4460N, 4461N

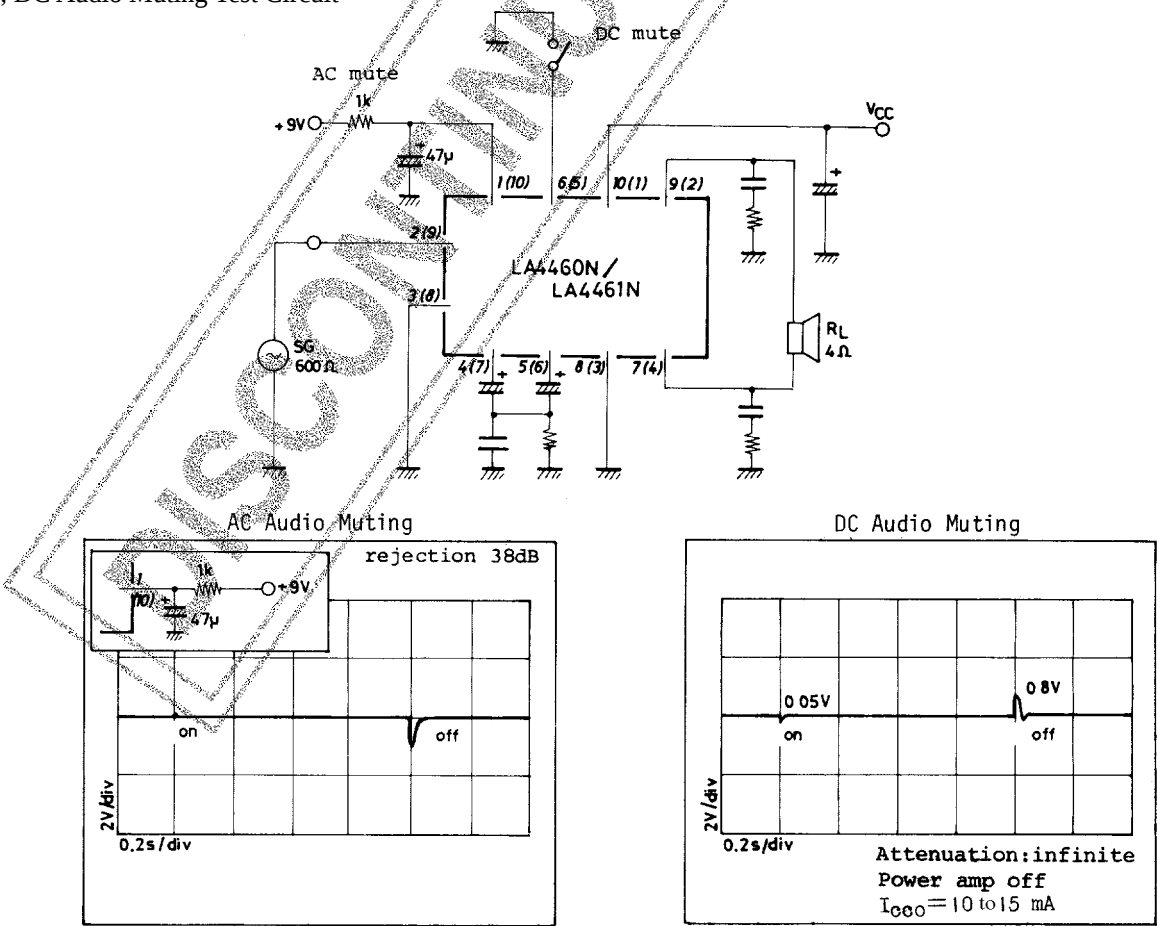


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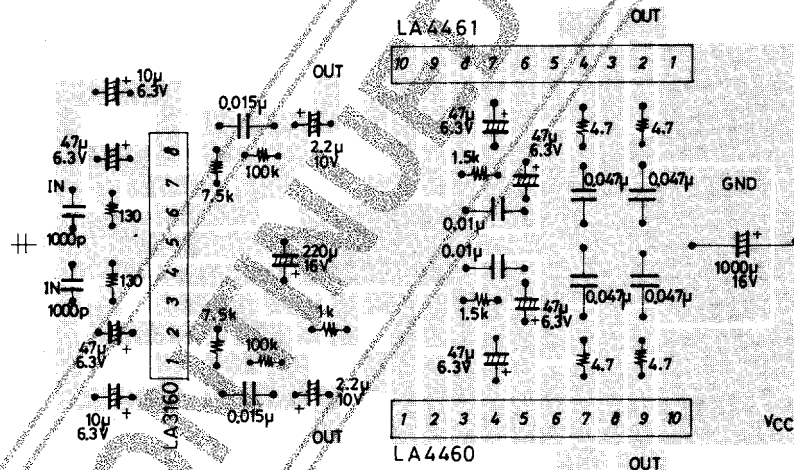
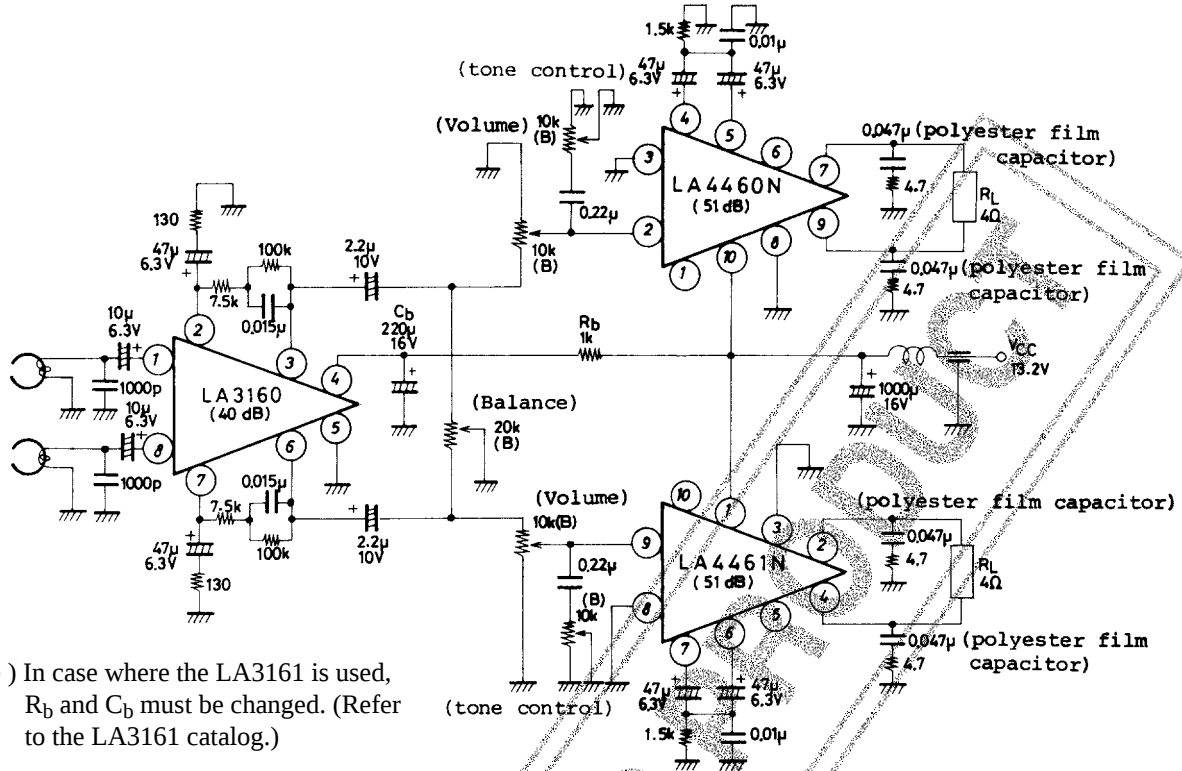


AC, DC Audio Muting Test Circuit



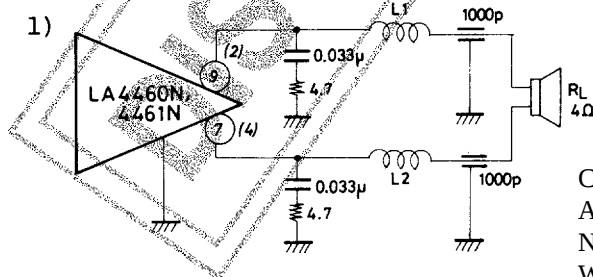
LA4460N, 4461N

Sample Application Circuit 3 :



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

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



Coil used :

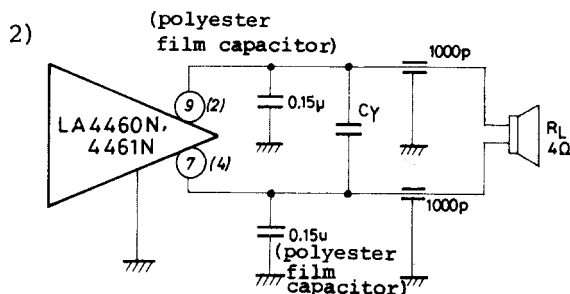
Air core Inner diameter : 8ø

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 0.5 μ F.

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 damage. 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.

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