

# HA12017

## Low Noise Preamplifier

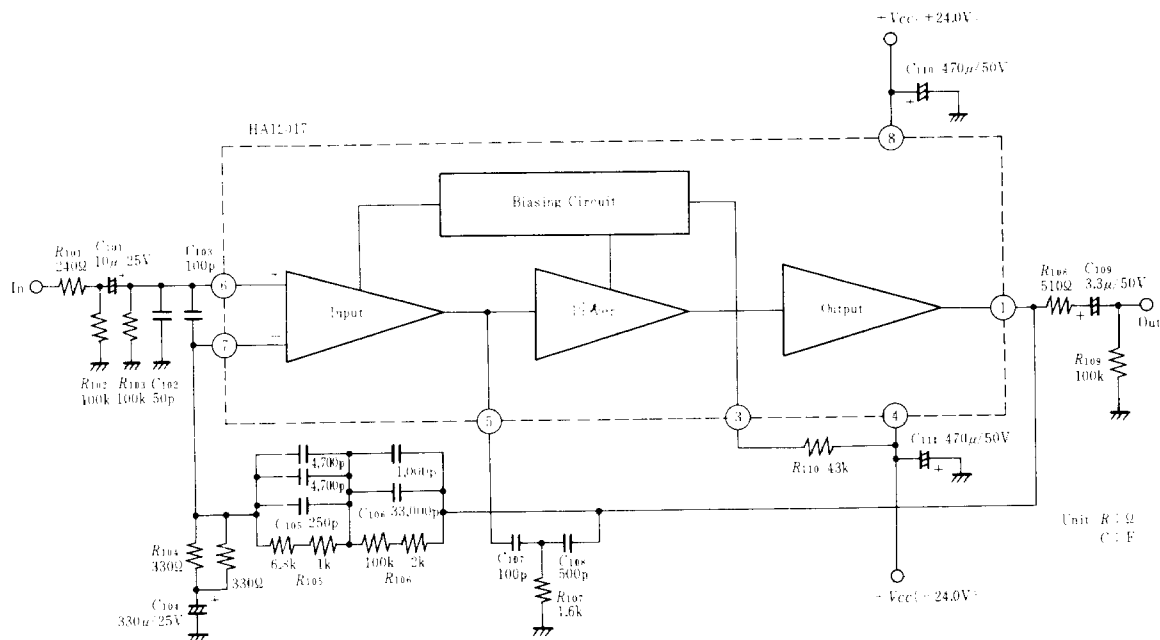
### FEATURES

- Low Noise:  $V_n(in)=0.185\mu V$  typ. (IHF-A Network,  $R_g=43\Omega$ , RIAA)
- Wide dynamic range:  $V_{in}=235mV_{rms}$  typ. ( $V_{cc}=\pm 24.0V$ ,  $f=1kHz$ , THD=0.1%,  $G_v=35.9dB$ )
- Low distortion: THD=0.002% typ. ( $f=20Hz$  to  $20kHz$ ,  $V_{out}=10V_{rms}$ , RIAA)
- Excellent supply ripple rejection:  
 $SVR(+V_{cc})=56dB$  typ. ( $f=100Hz$ ,  $R_g=43\Omega$ )  
 $SVR(-V_{cc})=45dB$  typ. ( $f=100Hz$ ,  $R_g=43\Omega$ )



(SP-7)

### BLOCK DIAGRAM & TYPICAL APPLICATION CIRCUIT



### ABSOLUTE MAXIMUM RATINGS

| Item                        | Symbol    | Rating          | Unit        |
|-----------------------------|-----------|-----------------|-------------|
| Supply Voltage              | $V_{cc}$  | $\pm 26.5$      | V           |
| Power Dissipation           | $P_T^*$   | 500             | mW          |
| Operating Temperature Range | $T_{opr}$ | $-30$ to $+75$  | $^{\circ}C$ |
| Storage Temperature Range   | $T_{stg}$ | $-55$ to $+125$ | $^{\circ}C$ |

\* Value at  $T_a = 75^{\circ}C$

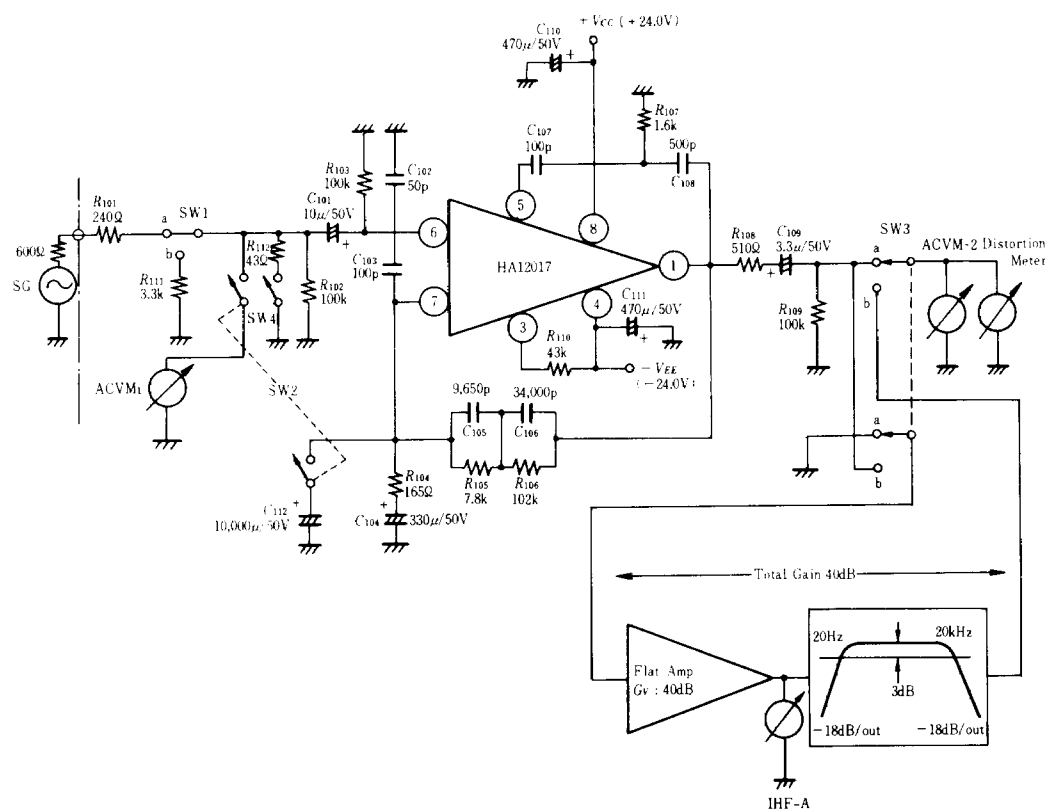
# **ELECTRICAL CHARACTERISTICS** ( $V_{CC} = \pm 24V$ , $T_a = 25^\circ C$ )

| Item*                     | Symbol      | Test Conditions                         | min. | typ.  | max. | Item |
|---------------------------|-------------|-----------------------------------------|------|-------|------|------|
| Quiescent Current         | $I_Q$       | no input signal                         | —    | 4.0   | 6.0  | mA   |
| Open Loop Voltage Gain    | $G_{V(OL)}$ | $f = 1kHz$                              | 95   | 105   | —    | dB   |
| Total Harmonic Distortion | $THD$       | $f = 1kHz$ , $V_{out} = 10V$            | —    | 0.002 | 0.01 | %    |
| Output Voltage            | $V_{out}$   | $f = 1kHz$ , $THD = 0.1\%$              | 13.5 | 14.7  | —    | V    |
| Output Noise Voltage 1**  | $V_{n1}$    | $R_g = 43\Omega$ , IHF-A Network        | —    | 1.15  | 1.56 | mV   |
| Output Noise Voltage 2**  | $V_{n2}$    | $R_g = 3.3k\Omega$ , BW = 20Hz to 20kHz | —    | 5.3   | 9.0  | mV   |

Notes : \* All the items except  $G_{V(OL)}$  is tested with RIAA curve and  $G_V = 35.9dB$ .

\*\*These items are measured after the flat amplifier ( $G_V = 40dB$ ).

## **TEST CIRCUIT**



## **NOTES "ON" TESTING**

### **1. Measuring Apparatus**

SG: Matsushita VP7220B  
Distortion Meter: NF DM155  
IHF-A ACVM 3: B & K 2112  
ACVM 1 & 2: HP 400EL

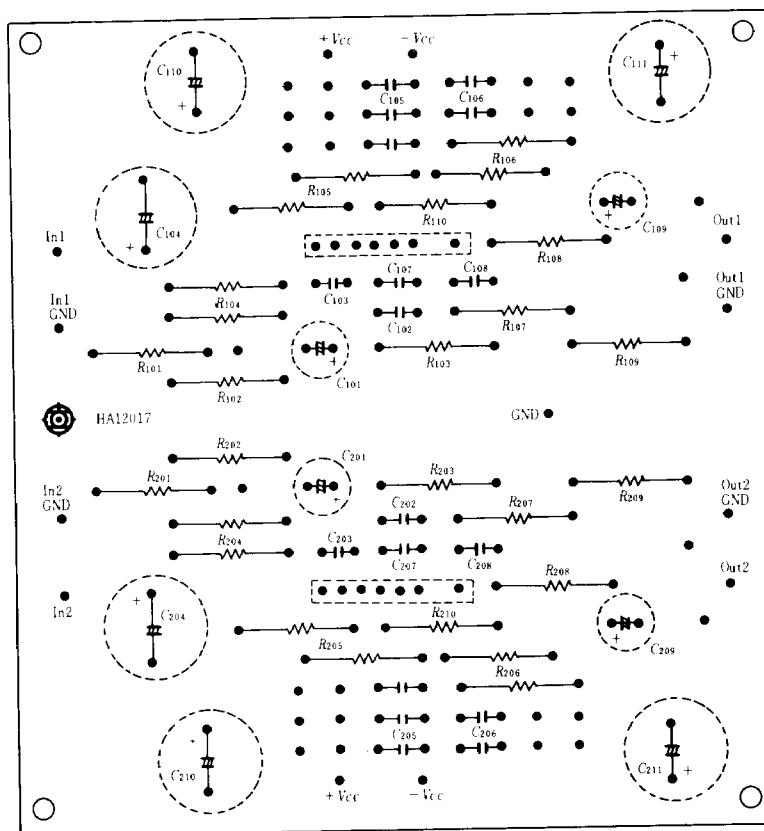
### **2. Tolerance of External Parts**

Resistors:  $\pm 1\%$   
Mira Capacitor ( $C_{105}$ ,  $C_{106}$ ):  $\pm 2\%$   
Chemical Capacitor:  $\pm 10\%$   
Ceramic Capacitor ( $C_{102}$ ,  $C_{105}$ ,  $C_{107}$ ,  $C_{108}$ ):  $\pm 5\%$   
Temp. Coefficient  $-80ppm/^\circ C$

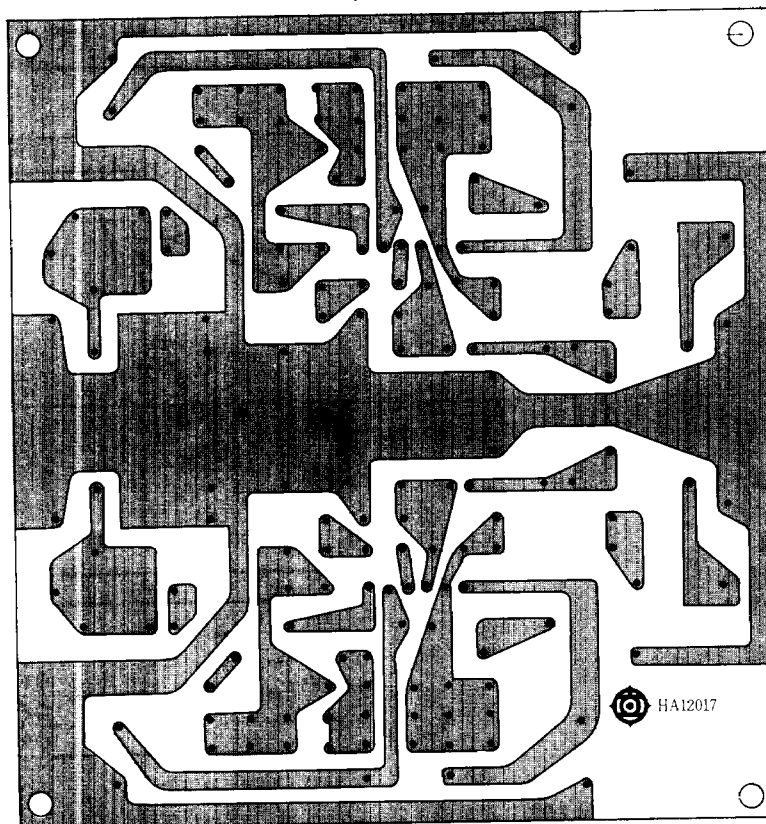
### **3. Positions of Switches**

| Item        | SW1 | SW2 | SW3 | SW4 |
|-------------|-----|-----|-----|-----|
| $G_{V(OL)}$ | a   | ON  | a   | OFF |
| $V_{out}$   | a   | OFF | a   | OFF |
| $THD$       | a   | OFF | a   | OFF |
| $V_{n1}$    | b   | OFF | b   | ON  |
| $V_{n2}$    | b   | OFF | b   | OFF |

## ■ PC-BOARD LAYOUT PATTERN



(Top View)



(Bottom View)

## EXTERNAL COMPONENTS

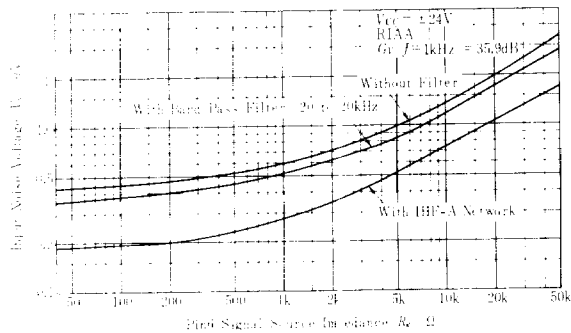
### 1. Resistor

| Part No.                             | Recommended Value | Functions                                                                                                                                                                                                               | Deteriorations by using a value less than recommended                                                                                                                                                         | Deteriorations by using a value more than recommended                                                                                               | Cautions                                                                                                                  |
|--------------------------------------|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| R <sub>101</sub>                     | 240Ω              | <ul style="list-style-type: none"> <li>Protects the IC from abnormal input voltage.</li> <li>Prevents parastic oscillation caused by signal-source impedance.</li> <li>Decreases high-frequency disturbance.</li> </ul> | <ul style="list-style-type: none"> <li>High-frequency often disturbed.</li> <li>Using less than 43Ω deteriorates stability to a high degree.</li> </ul>                                                       | <ul style="list-style-type: none"> <li>Thermal noise generates, resulting in signal-to-noise ratio deterioration.</li> </ul>                        |                                                                                                                           |
| R <sub>102</sub>                     | 100kΩ             | <ul style="list-style-type: none"> <li>Passes the electric charge of C<sub>101</sub>.</li> <li>Decides R<sub>in</sub> (input resistance)<br/><math>R_{in} = R_{101} + (R_{102}/R_{103})</math></li> </ul>               | <ul style="list-style-type: none"> <li>Input resistance decreases.</li> </ul>                                                                                                                                 | <ul style="list-style-type: none"> <li>Electric-charge passing lowered.</li> </ul>                                                                  |                                                                                                                           |
| R <sub>103</sub>                     | 100kΩ             | <ul style="list-style-type: none"> <li>Supplies DC bias to pin-6 (input pin)</li> <li>Decides input resistance.</li> </ul>                                                                                              | <ul style="list-style-type: none"> <li>Input resistance decreases.</li> </ul>                                                                                                                                 | <ul style="list-style-type: none"> <li>Output offset voltage increases.</li> </ul>                                                                  | <ul style="list-style-type: none"> <li><math>R_{103} \div R_{105} + R_{106}</math></li> </ul>                             |
| R <sub>104</sub>                     | 165Ω              | <ul style="list-style-type: none"> <li>Decides voltage gain as feedback resistance.</li> </ul>                                                                                                                          | <ul style="list-style-type: none"> <li>Load of pin-1 (output pin) increases in high-frequency range, reducing output voltage.</li> </ul>                                                                      | <ul style="list-style-type: none"> <li>Thermal noise generates, resulting in signal-to-noise ratio deterioration.</li> </ul>                        |                                                                                                                           |
| R <sub>105</sub><br>R <sub>106</sub> | 7.8kΩ<br>102kΩ    | <ul style="list-style-type: none"> <li>Decides RIAA characteristics, in pairs with C<sub>105</sub> and C<sub>106</sub>.</li> </ul>                                                                                      | <ul style="list-style-type: none"> <li>Unbalance with R<sub>103</sub> increases output offset voltage.</li> </ul>                                                                                             | <ul style="list-style-type: none"> <li>Unbalance with C<sub>103</sub> increases output offset voltage.</li> </ul>                                   | <ul style="list-style-type: none"> <li>The errors of R<sub>105</sub> and R<sub>106</sub> must be small enough.</li> </ul> |
| R <sub>107</sub>                     | 1.6kΩ             | <ul style="list-style-type: none"> <li>In a pair with C<sub>108</sub>, decides the frequency at which <math>G_{V(OL)}</math> characteristic changes from -12dB/oct to -6dB/oct.</li> </ul>                              | <ul style="list-style-type: none"> <li>Incomplete phase-compensation deteriorates stability.</li> </ul>                                                                                                       | <ul style="list-style-type: none"> <li>Total harmonic distortion increases.</li> </ul>                                                              |                                                                                                                           |
| R <sub>108</sub>                     | 510Ω              | <ul style="list-style-type: none"> <li>Prevents parastic oscillation caused by capacitive load.</li> </ul>                                                                                                              | <ul style="list-style-type: none"> <li>Prevention of parastic oscillation lowered.</li> </ul>                                                                                                                 |                                                                                                                                                     |                                                                                                                           |
| R <sub>109</sub>                     | 100kΩ             | <ul style="list-style-type: none"> <li>Keeps the voltage of output terminals at DC standard level.</li> <li>Prevents shock noise caused by function-switching.</li> </ul>                                               | <ul style="list-style-type: none"> <li>Load increasing, max. output voltage decreases.</li> </ul>                                                                                                             | <ul style="list-style-type: none"> <li>Prevention of shock noise lowered.</li> </ul>                                                                |                                                                                                                           |
| R <sub>110</sub>                     | 43kΩ              | <ul style="list-style-type: none"> <li>Decides basic bias current<br/><math>R_{110} = (+V_{CC} - (-V_{CC}) - 5) \text{ k}\Omega</math></li> </ul>                                                                       | <ul style="list-style-type: none"> <li>Excessive <math>P_T</math> causes breakdown</li> <li><math>G_{V(OL)}</math> increasing, stability deteriorates.</li> <li>Noise caused by current increases.</li> </ul> | <ul style="list-style-type: none"> <li><math>G_{V(OL)}</math> decreasing, total harmonic distortion increases.</li> <li>Noise increases.</li> </ul> | <ul style="list-style-type: none"> <li>Capacitance must not connected between R<sub>110</sub> and pin-4 /GND.</li> </ul>  |

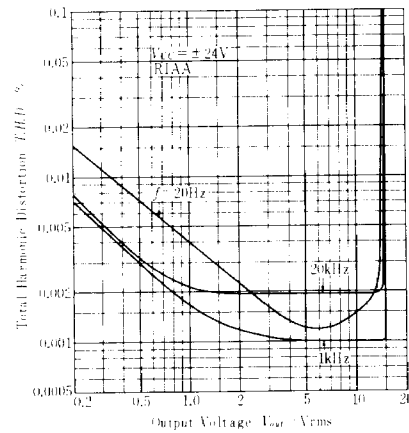
### 2. Capacitor

| Part No.                             | Recommended Value | Functions                                                                                                                                                                                                                                                                       | Deteriorations by using a value less than recommended                                                                                                    | Deteriorations by using a value more than recommended                                                                                                     | Cautions                                                                                                                                                                      |
|--------------------------------------|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| C <sub>101</sub>                     | 10μF              | <ul style="list-style-type: none"> <li>Makes input-coupling.</li> </ul>                                                                                                                                                                                                         | <ul style="list-style-type: none"> <li>Impedance of signal source increasing, 1/f noise increases.</li> </ul>                                            |                                                                                                                                                           | <ul style="list-style-type: none"> <li>The leakage-current of C<sub>101</sub> must be small enough.</li> </ul>                                                                |
| C <sub>102</sub>                     | 50pF              | <ul style="list-style-type: none"> <li>In combination with C<sub>103</sub>, increases stability of large-amplitude operation in high frequency range.</li> </ul>                                                                                                                | <ul style="list-style-type: none"> <li>Prevention of parastic oscillation lowered.</li> </ul>                                                            | <ul style="list-style-type: none"> <li>Input impedance decreases at high frequency range.</li> <li>Prevention of parastic oscillation lowered.</li> </ul> | <ul style="list-style-type: none"> <li>High-frequency characteristic of C<sub>102</sub> must be sufficient.</li> </ul>                                                        |
| C <sub>103</sub>                     | 100pF             | <ul style="list-style-type: none"> <li>In strong field, prevents detection of TV, FM and AM signals.</li> </ul>                                                                                                                                                                 | <ul style="list-style-type: none"> <li>High-frequency often disturbed in a strong field.</li> <li>Prevention of parastic oscillation lowered.</li> </ul> | <ul style="list-style-type: none"> <li>Prevention of parastic oscillation lowered.</li> </ul>                                                             | <ul style="list-style-type: none"> <li>High-frequency characteristic of C<sub>103</sub> must be sufficient.</li> </ul>                                                        |
| C <sub>104</sub>                     | 330μF             | <ul style="list-style-type: none"> <li>Supplies full DC-feedback.</li> <li>Decides roll-off frequency (<math>f_L</math>) in low frequency range.<br/><math>f_L = 3\text{Hz}</math> (Typical application)<br/><math>f_L = \frac{1}{2\pi C_{104} \cdot R_{104}}</math></li> </ul> | <ul style="list-style-type: none"> <li>Roll-off frequency in low-frequency range goes higher.</li> </ul>                                                 | <ul style="list-style-type: none"> <li>More time is required to stabilize the potential of pin-1.</li> </ul>                                              |                                                                                                                                                                               |
| C <sub>105</sub><br>C <sub>106</sub> | 9650pF<br>34000pF | <ul style="list-style-type: none"> <li>Decides RIAA characteristics in pairs with R<sub>105</sub> and R<sub>106</sub>.</li> </ul>                                                                                                                                               | <ul style="list-style-type: none"> <li>RIAA characteristics deteriorates.</li> </ul>                                                                     | <ul style="list-style-type: none"> <li>RIAA characteristics deteriorates.</li> </ul>                                                                      | <ul style="list-style-type: none"> <li>The errors of C<sub>105</sub> and C<sub>106</sub> must be small enough.</li> </ul>                                                     |
| C <sub>107</sub>                     | 100pF             | <ul style="list-style-type: none"> <li>Supplies phase-compensation.</li> </ul>                                                                                                                                                                                                  | <ul style="list-style-type: none"> <li>Incomplete phase-compensation deteriorates stability.</li> </ul>                                                  | <ul style="list-style-type: none"> <li>Total harmonic distortion increases.</li> </ul>                                                                    | <ul style="list-style-type: none"> <li>For C<sub>107</sub>, temperature and high-frequency characteristics must be sufficient, and the error must be small enough.</li> </ul> |
| C <sub>108</sub>                     | 500pF             | <ul style="list-style-type: none"> <li>In a pair with R<sub>107</sub>, decides the frequency at which <math>G_{V(OL)}</math> characteristic changes from -12dB/oct to -6dB/oct.</li> </ul>                                                                                      | <ul style="list-style-type: none"> <li>Incomplete phase-compensation deteriorates stability.</li> </ul>                                                  | <ul style="list-style-type: none"> <li>Total harmonic distortion increases.</li> </ul>                                                                    | <ul style="list-style-type: none"> <li>For C<sub>108</sub>, temperature and high-frequency characteristics must be sufficient, and the error must be small enough.</li> </ul> |
| C <sub>109</sub>                     | 3.3μF             | <ul style="list-style-type: none"> <li>Makes output-coupling.</li> </ul>                                                                                                                                                                                                        | <ul style="list-style-type: none"> <li>Too low capacitance increases output-impedance and reduces output voltage in low frequency range.</li> </ul>      |                                                                                                                                                           |                                                                                                                                                                               |
| C <sub>110</sub><br>C <sub>111</sub> | 470μF<br>470μF    | <ul style="list-style-type: none"> <li>Removes ripple on <math>V_{CC}</math> line.</li> </ul>                                                                                                                                                                                   | <ul style="list-style-type: none"> <li>Increases cross-talk between left and right channels.</li> </ul>                                                  |                                                                                                                                                           |                                                                                                                                                                               |

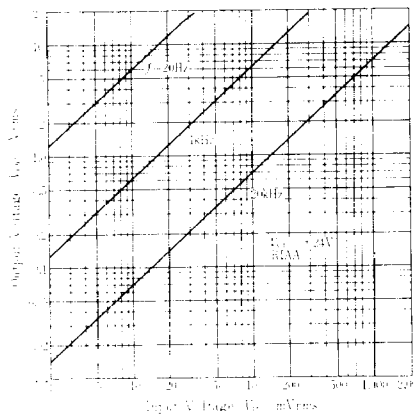
### INPUT NOISE VOLTAGE vs. SOURCE IMPEDANCE



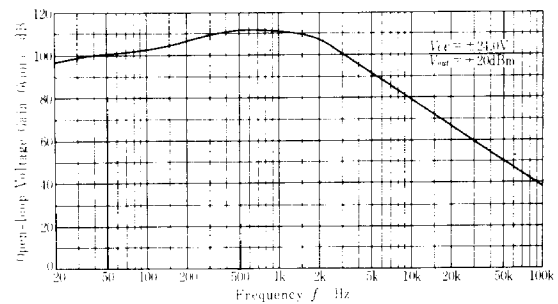
### TOTAL HARMONIC DISTORTION vs. OUTPUT VOLTAGE



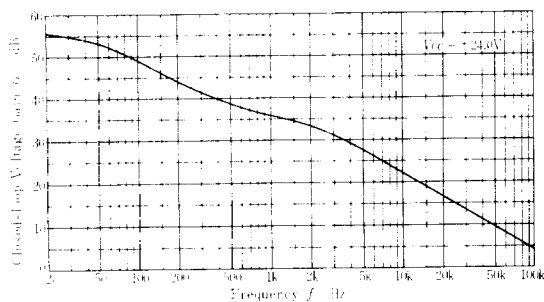
### OUTPUT VOLTAGE vs. INPUT VOLTAGE



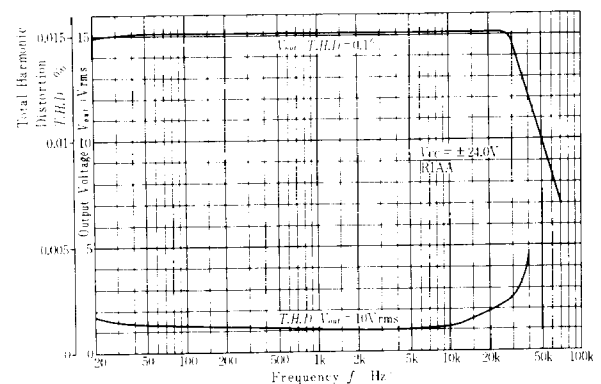
### OPEN-LOOP VOLTAGE GAIN vs. FREQUENCY



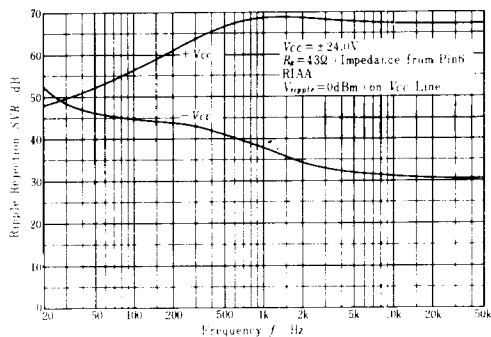
### CLOSED-LOOP VOLTAGE GAIN vs. FREQUENCY



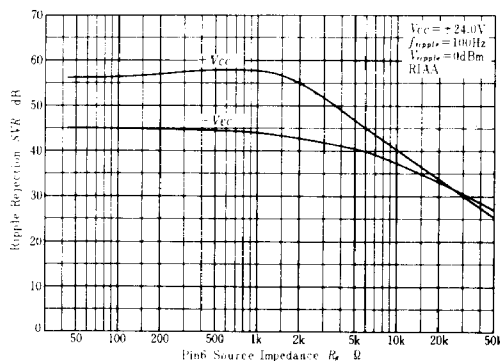
### OUTPUT VOLTAGE AND TOTAL HARMONIC DISTORTION vs. FREQUENCY



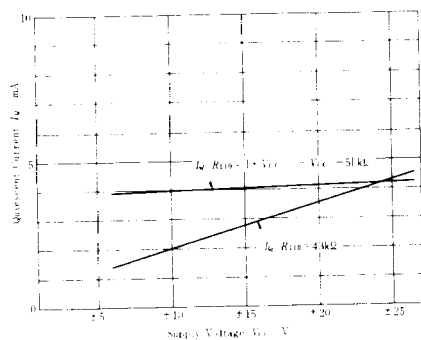
### RIPPLE REJECTION VS. FREQUENCY



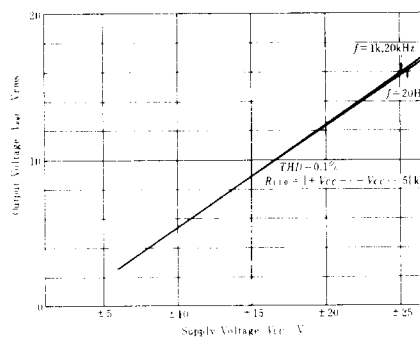
### RIPPLE REJECTION VS. SOURCE IMPEDANCE



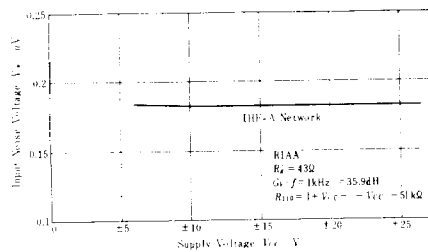
### QUIESCENT CURRENT VS. SUPPLY VOLTAGE



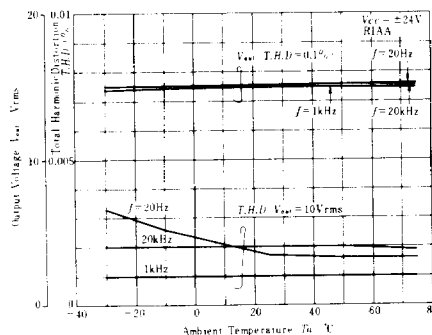
### OUTPUT VOLTAGE VS. SUPPLY VOLTAGE



### INPUT NOISE VOLTAGE VS. SUPPLY VOLTAGE



### OUTPUT VOLTAGE AND TOTAL HARMONIC DISTORTION VS. AMBIENT TEMPERATURE



### QUIESCENT CURRENT VS. AMBIENT TEMPERATURE

