

# HA12017

## Low Noise Preamplifier

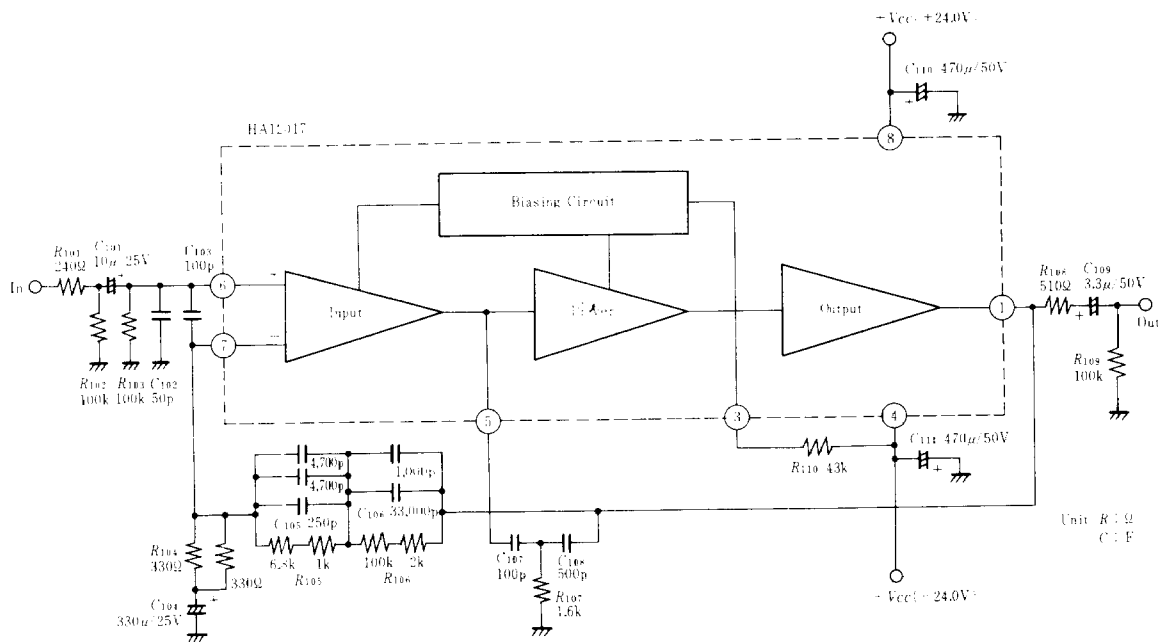
### FEATURES

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



(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  | $^{\circ}\text{C}$ |
| Storage Temperature Range   | $T_{stg}$ | -55 to +125 | $^{\circ}\text{C}$ |

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

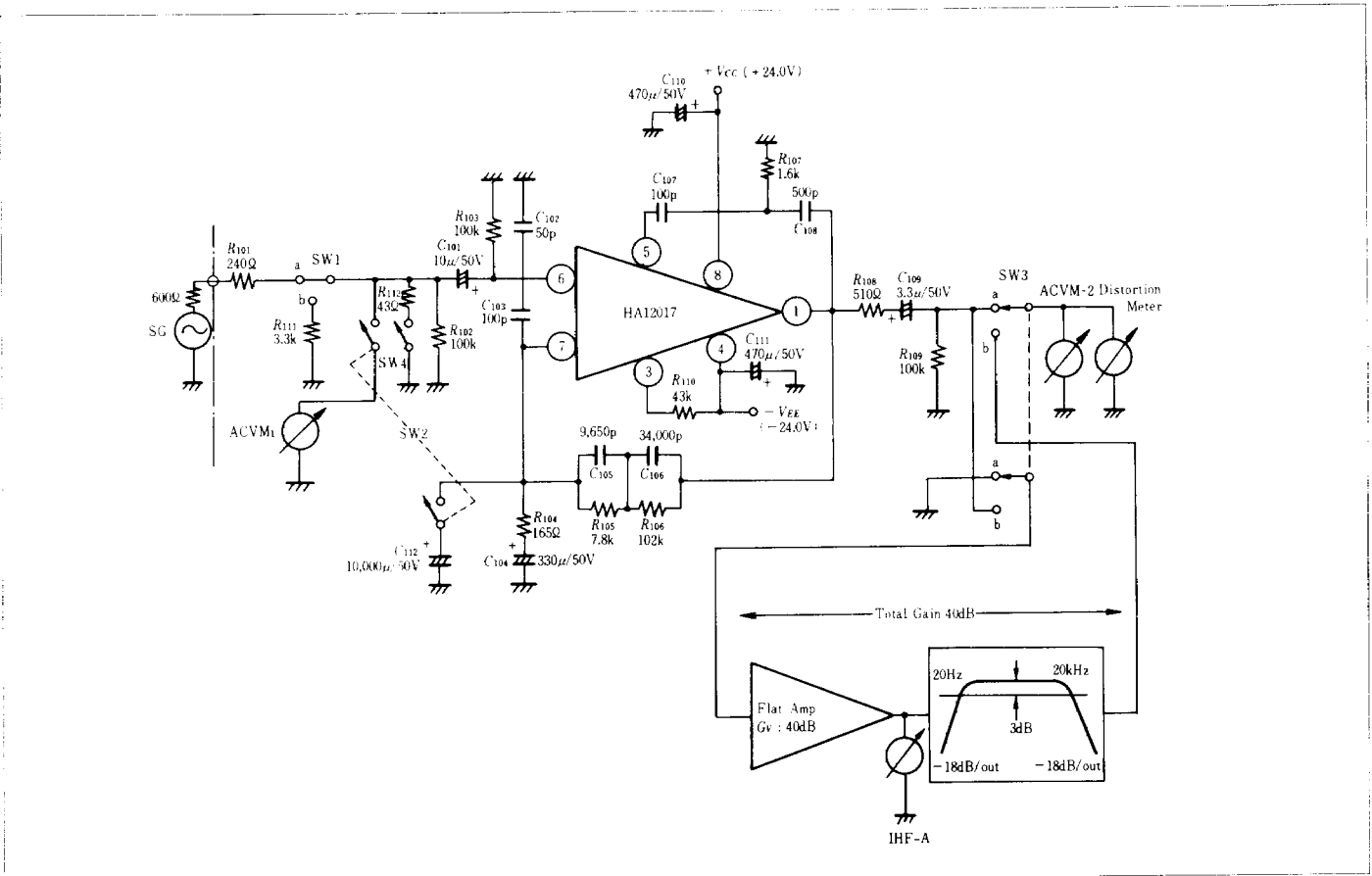
■ ELECTRICAL CHARACTERISTICS ( $V_{CC} = \pm 24V$ ,  $T_a = 25^\circ C$ )

| 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

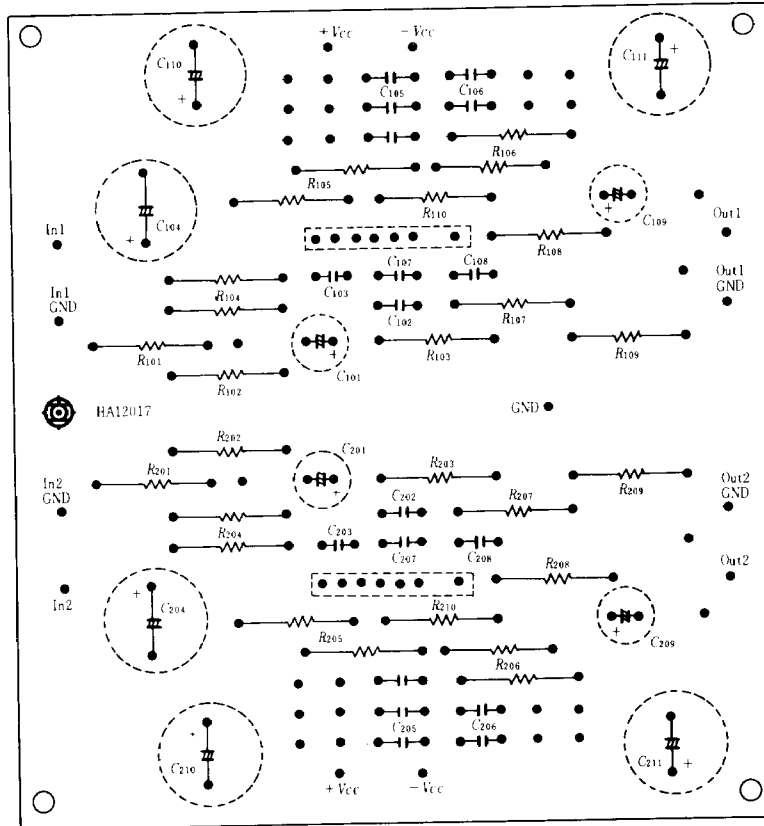
2. Tolerance of External Parts

- 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  $-80ppm/^\circ C$

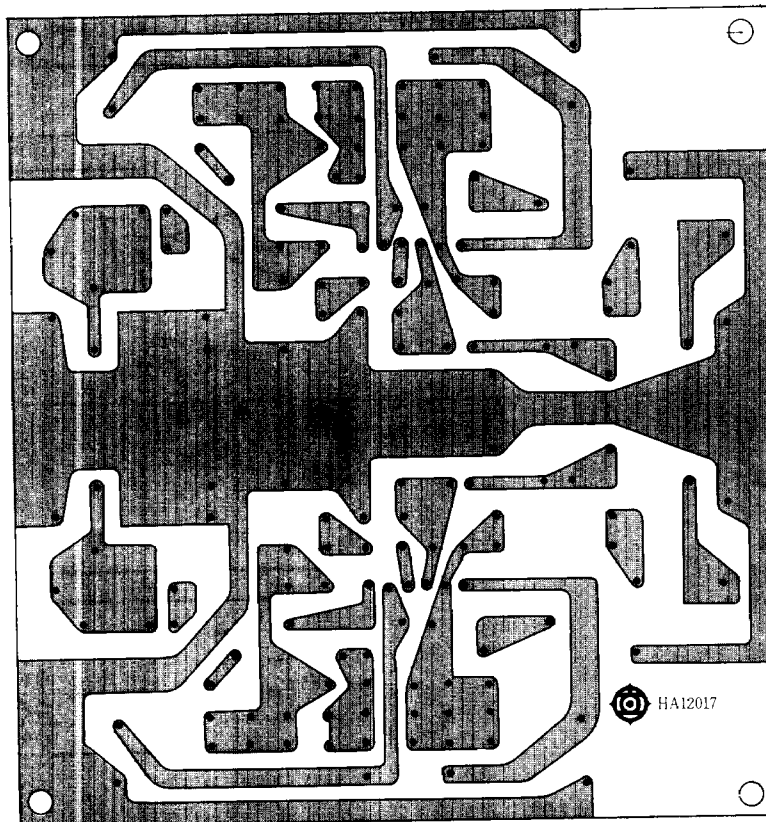
3. Positions of Switches

| Item        | SW 1 | SW 2 | SW 3 | SW 4 |
|-------------|------|------|------|------|
| $G_{V(OL)}$ | 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

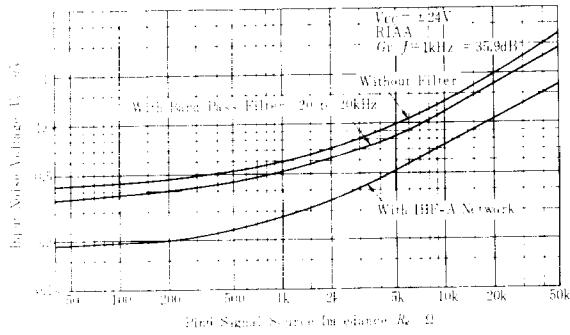
### 1. Resistor

| 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 parasitic 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} \cong 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 G<sub>V(OL)</sub> 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 parasitic oscillation caused by capacitive load.</li> </ul>  | <ul style="list-style-type: none"> <li>Prevention of parasitic 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 P<sub>7</sub> causes breakdown</li> <li>G<sub>V(OL)</sub> increasing, stability deteriorates.</li> <li>Noise caused by current increases.</li> </ul> | <ul style="list-style-type: none"> <li>G<sub>V(OL)</sub> decreasing, total harmonic distortion increases.</li> <li>Noise increases.</li> </ul> | <ul style="list-style-type: none"> <li>Capacitance must not connect-ed between R<sub>110</sub> and pin-4 /GND.</li> </ul> |

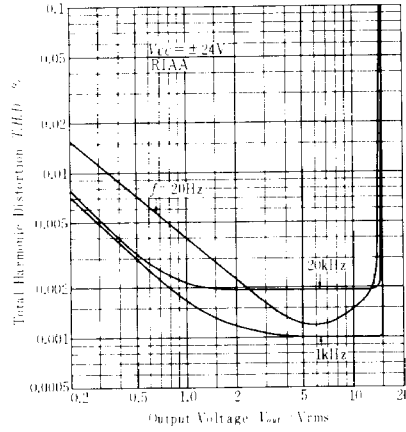
### 2. Capacitor

| 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 parasitic oscillation lowered.</li> </ul>  | <ul style="list-style-type: none"> <li>Input impedance decreases at high frequency range.</li> <li>Prevention of parasitic 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 parasitic oscillation lowered.</li> </ul> | <ul style="list-style-type: none"> <li>Prevention of parasitic 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 (f<sub>L</sub>) 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 G<sub>V(OL)</sub> 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 V<sub>CC</sub> line.</li> </ul>   | <ul style="list-style-type: none"> <li>Increases cross-talk between left and right channels.</li> </ul>   |  |   |

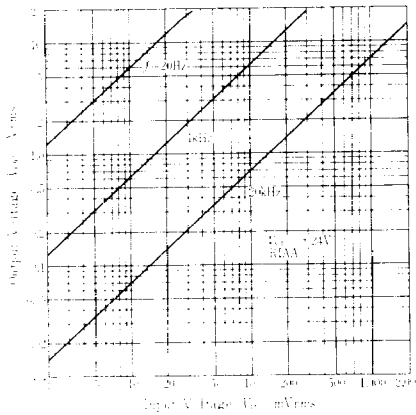
**INPUT NOISE VOLTAGE vs. SOURCE IMPEDANCE**



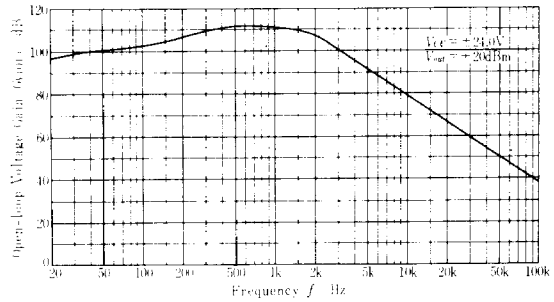
**TOTAL HARMONIC DISTORTION vs. OUTPUT VOLTAGE**



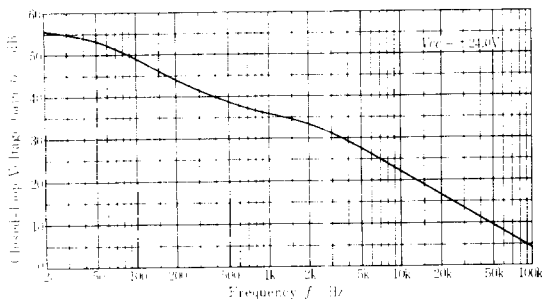
**OUTPUT VOLTAGE vs. INPUT VOLTAGE**



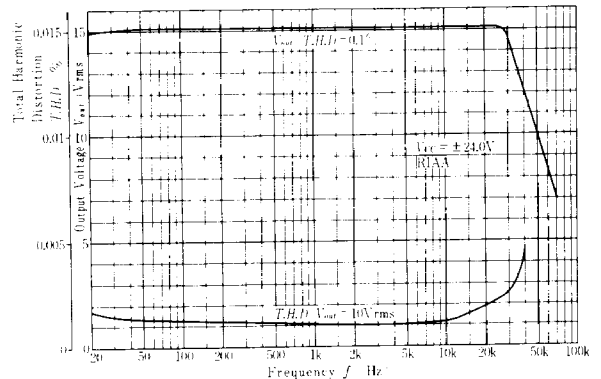
**OPEN-LOOP VOLTAGE GAIN vs. FREQUENCY**



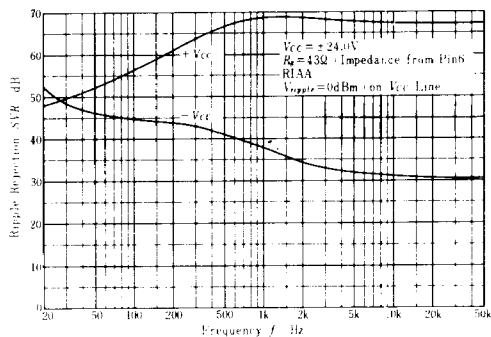
**CLOSED-LOOP VOLTAGE GAIN vs. FREQUENCY**



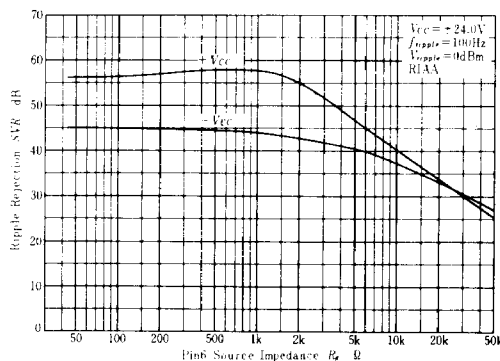
**OUTPUT VOLTAGE AND TOTAL HARMONIC DISTORTION vs. FREQUENCY**



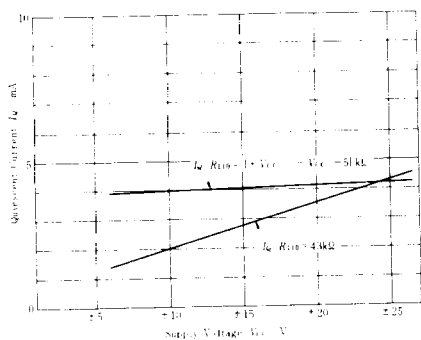
**RIPPLE REJECTION VS. FREQUENCY**



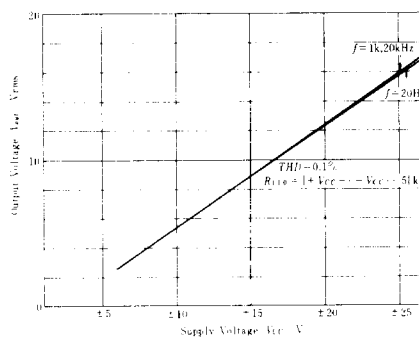
**RIPPLE REJECTION VS. SOURCE IMPEDANCE**



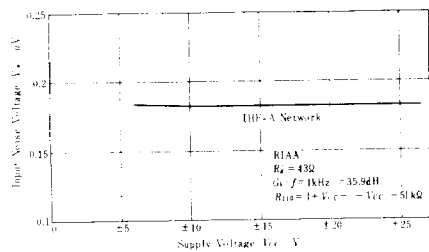
**QUIESCENT CURRENT VS. SUPPLY VOLTAGE**



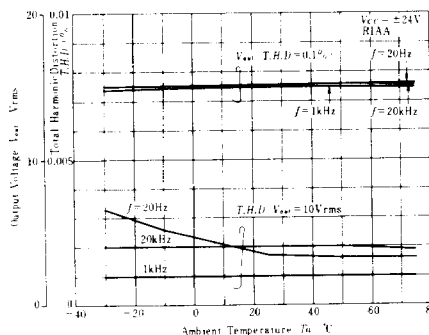
**OUTPUT VOLTAGE VS. SUPPLY VOLTAGE**



**INPUT NOISE VOLTAGE VS. SUPPLY VOLTAGE**



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



**QUIESCENT CURRENT VS. AMBIENT TEMPERATURE**

