# HA12002

Protector of Speakers and Power Amplifiers

The Hitachi monolithic IC HA12002 is designed for protecting power amplifiers and speakers in various amplifiers and receivers. The HA12002 is encapsulated in 8-pin single-in-line package.

■ FEATURES
- Built-in-relay driver
- Single power source
- Wide operating supply voltage range: (25 to 60V)
- Plus and minus voltage detections using one pin (both pins 3 and 4 posses the same functions and detect plus and minus voltages)
- AC voltage detector (pin-5)
- Circuit protection by plus voltage detection is provided by connecting D1 diode externally (pin-6). (See Note)
- Relay-on lag time adjustable by external applications.
- Short relay-off time (25ms typ under the standard external applications)

■ RECOMMENDED APPLICATIONS
- For speakers protection, use pin-3 (or pin-4) to detect setoff of quiescent output DC voltage and to turn the relay off.
- For protection of power amplifiers, use pin-3 (or pin-4) with an external thermo-sensitive device to detect the temperature increase and to turn the relay off.
- Power amplifiers can be protected by detecting overload and turning the relay off with pin-6.

(SP-8)
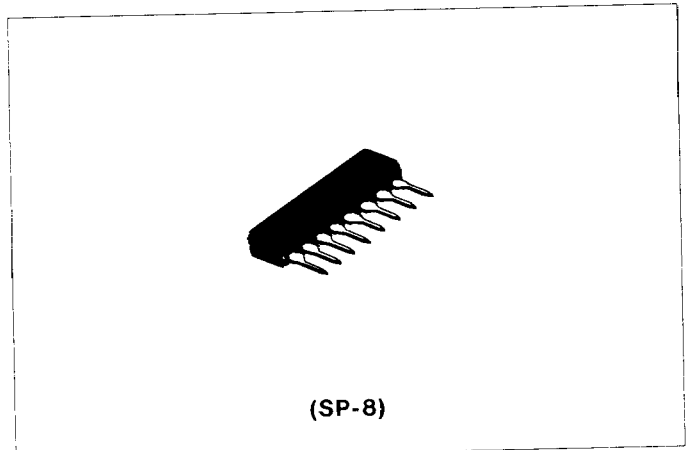
Note: Once relay is turned off, the relay off state continues until the power is switched off and then on again.
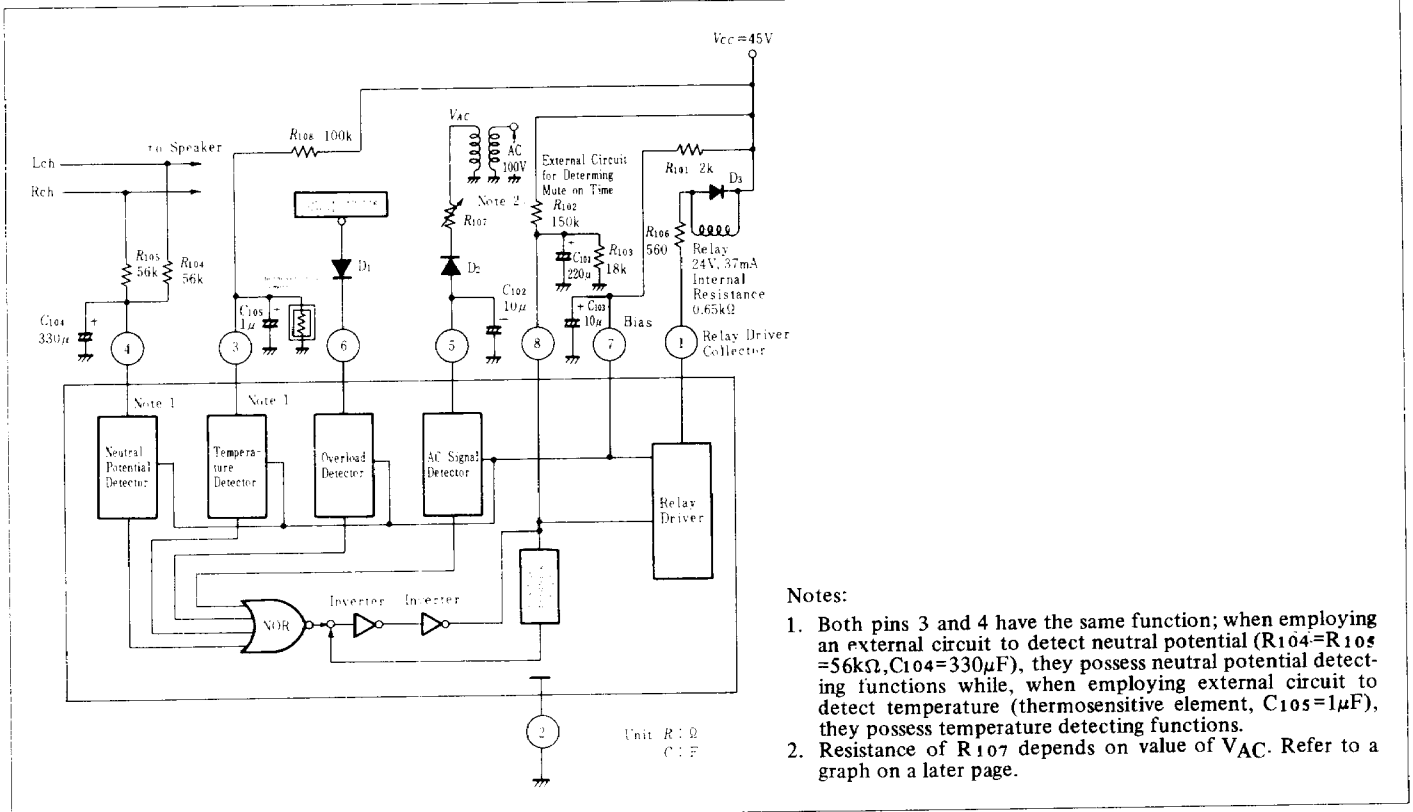
- In case of overload detection by constant-current drive or by constant-voltage drive using an external diode D1, the latch mechanism keeps the relay being on until the power is switched off.
- For prevention of pop noise at power off, use pin-5. AC voltage disappearance is immediately detected when the amp's switch has been off. This minimized the relay-off time and thus can prevent pop noise generated by mute-off time lag.

■INTERNAL SCHEMATIC DIAGRAM AND RECOMMENDED EXTERNAL APPLICATIONS
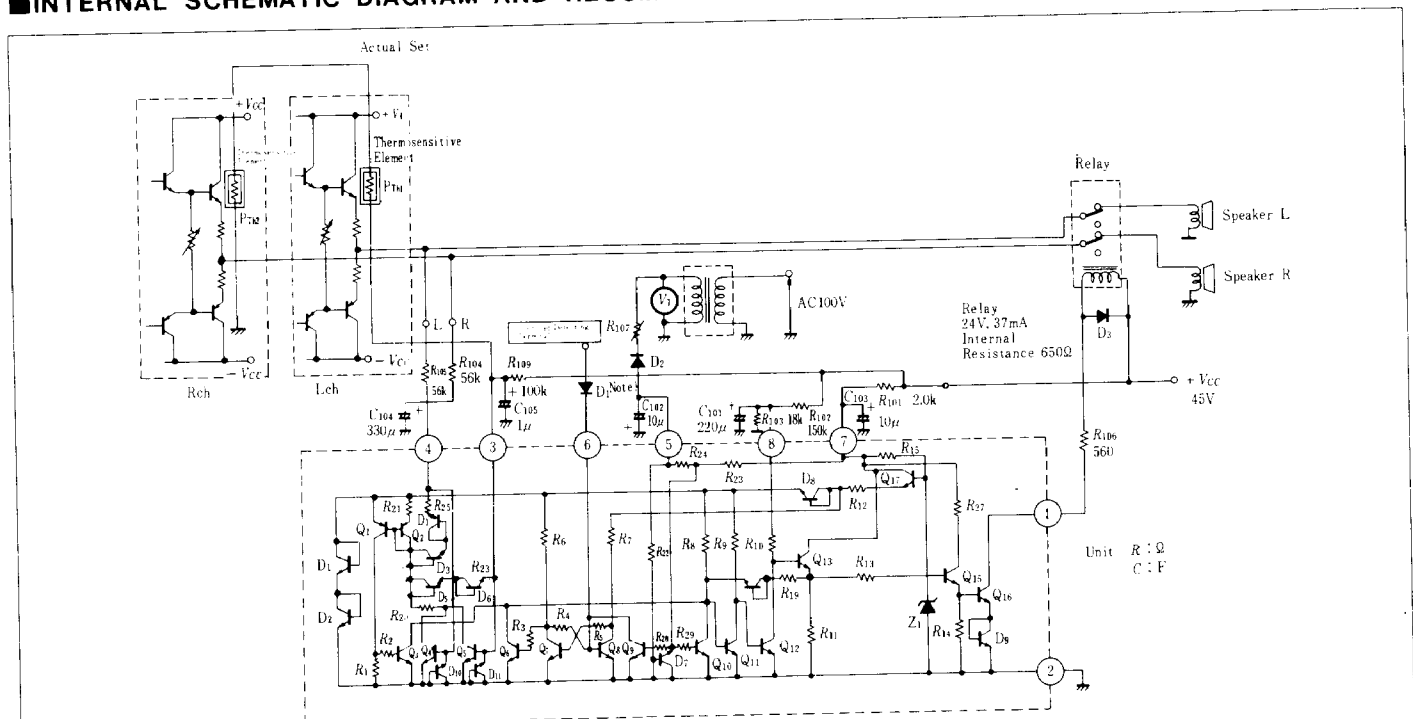
Note: When detecting an overload under a constant current drive, the latch functions without diode D1, however, when under a constant voltage drive, it functions only with D1.

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■BLOCK DIAGRAM

Notes:
1. Both pins 3 and 4 have the same function; when employing an external circuit to detect neutral potential ($R_{104}=R_{105}=56k\Omega$, $C_{104}=330\mu F$), they possess neutral potential detecting functions while, when employing external circuit to detect temperature (thermosensitive element, $C_{105}=1\mu F$), they possess temperature detecting functions.
2. Resistance of R_{107} depends on value of V_{AC}. Refer to a graph on a later page.

■ABSOLUTE MAXIMUM RATINGS ($Ta=25°C$)

| Item	Symbol	Rating	Unit
Power Dissipation	P_T	400*	mW
Operating Temperature	T_{opr}	-20 to $+70$	°C
Storage Temperature	T_{stg}	-55 to $+125$	°C
Supply Voltage (pin 1)	$V_{CC\,(max)}$	60	V
Max. Current for Pin 1	$I_{1\,(max)}$	80	mA
Max. Current for Pin 3	$I_{3\,(max)}$	± 3**	mA
Max. Current for Pin 4	$I_{4\,(max)}$	± 3**	mA
Max. Voltage for Pin 5	$V_{5\,(max)}$	-10	V
Max. Current for Pin 6	$I_{6\,(max)}$	3	mA
Max. Voltage for Pin 7	$V_{7\,(max)}$	8***	V
Max. Current for Pin 7	$I_{7\,(max)}$	25***	mA
Max. Voltage for Pin 8	$V_{8\,(max)}$	less than voltage of pin 7	V
Max. Current for Pin 8	$I_{8\,(max)}$	50	mA(peak)

Notes:
* : Value at $Ta=70°C$
** : Positive current denotes input current at pins 3 and 4, negative current denotes output current.

*** : $V_{7\,(max)}=8V$ is derived when driven by a constant voltage source, without any resistance. When applying current to V_7 through a resistance V_{CC}, the max. value of the input current to pin 7 should be used instead of the above values.

■ELECTRICAL CHARACTERISTICS ($V_{CC} = 45V$)

Item	Symbol	Test Conditions	min.	typ.	max.	Unit
Threshold voltage at pin 3, positive side	$+V_{th(3)}$	Apply positive voltage to pin 3 through an external resistance (56kΩ). Measure pin 3 voltage while pin 1 voltage changes from low (1.0V) to high (45V) during the above process.	0.89	1.20	1.61	V
Threshold voltage at pin 3, positive side	$-V_{th(3)}$	Apply negative voltage to pin 3 through an external resistance (56kΩ) Measure pin 3 voltage while pin 1 voltage changes from low (1.0V) to high (45V) during the above process.	−1.86	−1.20	−0.84	V
Threshold voltage at pin 4, positive side	$+V_{th(4)}$	Apply positive voltage to pin 4 through an external resistance (56kΩ). Measure pin 4 voltage while pin 1 voltage changes from low (1.0V) to high (45V) during the above process.	0.89	1.20	1.61	V
Threshold voltage at pin 4, negative side	$-V_{th(4)}$	Apply negative voltage to pin 4 through an external resistance (56kΩ). Measure pin 4 voltage while pin 1 voltage changes from low (1.0V) to high (45V) during the above process.	−1.86	−1.20	−0.84	V
Threshold voltage at pin 6	$V_{th(6)}$	Apply voltage to pin 6 through D_1. Measure pin 6 voltage while pin 1 voltage change from low (1.0V) to high (45V) during the above process.	0.90	1.15	1.40	V
Threshold AC voltage at pin 5	$V_{AC(on)}$	Apply AC voltage to pin 5 through D_2. Measure AC voltage while pin 1 voltage change from low (1.0V) to high (45V) during the above process.	−	2.5	−	Vrms
Threshold voltage at pin 5	$V_{th(5)}$	Apply voltage to pin 5 directly. Measure voltage of pin 5 while pin 1 voltage changes from low (1.0V) to high (45V) during the above process.	−1.8	−1.2	0	V
Current drain at pin 7	$I_{(7)}$	Measure pin 7 input current when turning relay on.	16.5	18.5	20.5	mA

■TEST CIRCUIT
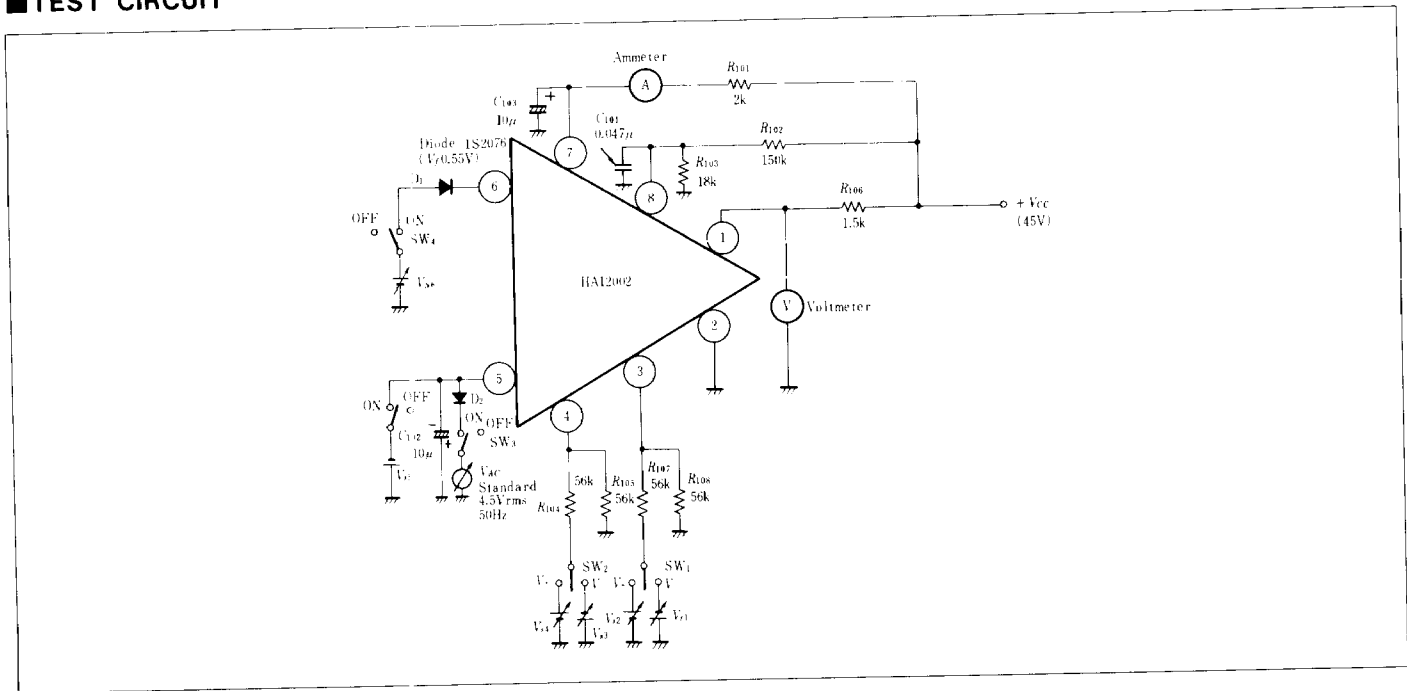
■ CHARACTERISTICS

This unit has been developed specifically for protection of speakers and power amplifiers. Following characteristics are delivered by giving careful consideration to the designing.

● Detection of Quiescent Output DC Voltage Setoff — pin-3 or 4

Both plus and minus sides DC voltage setoff can be detected with one power supply. This detection protects speakers by turning the relay off.

● Determination of Plus and Minus Threshold Voltages — pin-3 or 4

Threshold voltage for turning the relay on or off can be defined by external applications as follows.

Plus side threshold voltage +Vth is defined as

$$+Vth = \left(2 + \frac{R_{104}}{R_{110}}\right)Va+ \qquad \ldots \ldots eq.\ 1$$

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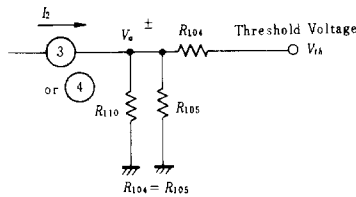
where Va+ is 0.57V typ, the threshold voltage with a plus voltage applied directly to pin-3 or 4.

Minus side threshold voltage −Vth is defined as

$$-Vth = -\left\{ Va - \left(2 + \frac{R_{104}}{R_{110}}\right) + I_2 \cdot R_{104} \right. \quad \ldots\ldots \text{eq. 2}$$

where Va⁻ is −0.28V typ, the threshold voltage with a minus voltage applied directly to pin-3 or 4 and where I_2 is 12.5μA typ, the pull-out current.

Plus and minus unbalanced thresholds can be corrected by adjusting R_{104} and R_{110} so as to satisfy

$$\left\{ Va^- \left(2 + \frac{R_{104}}{R_{110}}\right) + I_2 \cdot R_{104} \right. = \left(2 + \frac{R_{104}}{R_{110}}\right) Va+$$

$$\ldots\ldots \text{eq. 3}$$

The plus-side threshold voltage has approximately 40mV hysteresis and the minus-side threshold voltage has approximately 300mV hysteresis.

((Example Applications))

R_{104}, R_{105} and R_{110} external resistor values can be defined to meet ±Vth=1.8V,

(a) From eq. 1 and ±Vth=1.8V,

$$1.8 = \left(2 + \frac{R_{104}}{R_{110}}\right) \times 0.57 \quad\quad\quad \text{(V)}$$

Therefore R_{104}/R_{110} is defined as

$$\frac{R_{104}}{R_{110}} = 1.158$$

(b) From eq. 2 and −Vth=−1.8V,

$$-1.8 = -0.28\,(2 + 1.158) - 12.5\,(\mu A) \times R_{104}\,(k\Omega) \quad \text{(V)}$$

$$R_{104} = \frac{1.8 - 0.884}{12.5} = 73.3 \quad\quad (k\Omega)$$

$$R_{110} = 63.3 \quad\quad\quad\quad (k\Omega)$$

Therefore, for Vth=1.8V,

$$R_{104} = R_{105} = 75 \quad\quad\quad (k\Omega)$$

$$R_{110} = 62 \quad\quad\quad\quad\quad (k\Omega)$$

Minimum values of R_{104} and R_{105} can be defined by the maximum ratings of pin-3 and 4 (±3mA).

$$\frac{\pm Vcc}{R_{104}\,(105)} < \pm 3 \quad\quad\quad (mA)$$

Employing the recommended application values, $R_{104} = R_{105} = 56k\Omega$ $R_{110} = \infty$, threshold voltage can be defined as follows.

(a) $$+Vth = \left(2 + \frac{56k\Omega}{\infty}\right) 0.57 = 1.14 \quad\quad (V)$$

(b) $$-Vth = -0.28\left(2 + \frac{56k\Omega}{\infty}\right) - 12.5\mu A \cdot 56k\Omega = -1.26(V)$$

● Temperature Increase Detection — pin-3 or 4

Pin-3 or 4 with an external thermo-sensitive device protects power amplifiers by detecting temperature increase and turning the relay off. Please see the recommended external applications.

● Relay-off by AC Voltage Disappearance Detection

The time from power amp's switch off to the relay off depends on the charging time determined by pin-5 voltage level, an external capacitor C_{102} and internal resistors R_{22}, R_{23}, R_{24} When pin-5 voltage is −3.5V with the typical applications, relay-off time is defined as 25ms typ.

● Overload Detection — Pin-6

When using pin-6 as overload-detecting constant-current drive pin, the threshold current is 110μA typ. Thus over 110μA current causes the relay to go off. In this case, latch function operates without an external diode D_1. (When using constant-voltage drive, D_1 is needed for latching.)

● Relay-on Time Lag — pin-8

To prevent pop noise at power on, time constant circuit at pin-8 lags relay-on after power amp's switch is turned on.
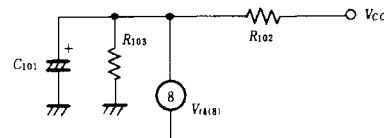
The relay-on time lag is defined as

$$t = \frac{R_{102} \cdot R_{103} \cdot C_{101}}{R_{102} + R_{103}} \cdot \ln\left\{\frac{1}{1 - \frac{Vth(8) \cdot (R_{103} + R_{102})}{Vcc \cdot R_{103}}}\right\}$$

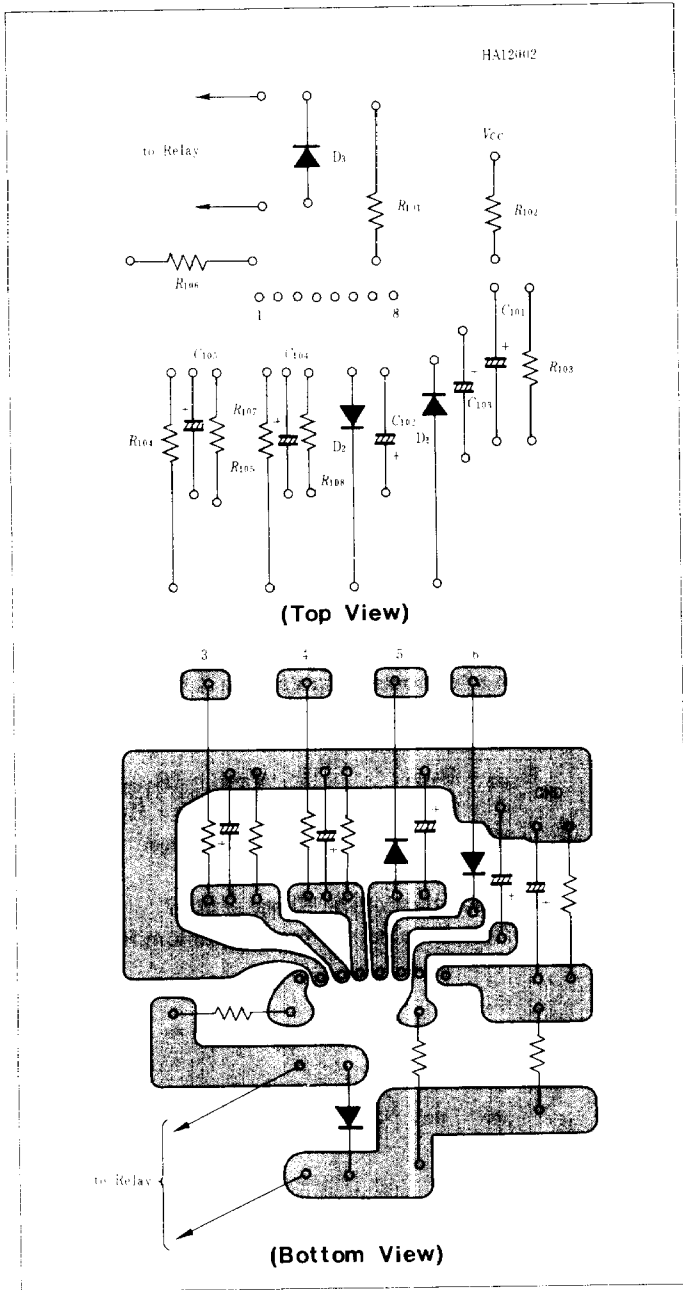where $Vth(8)$ is 2.65V typ, pin-8 threshold voltage.
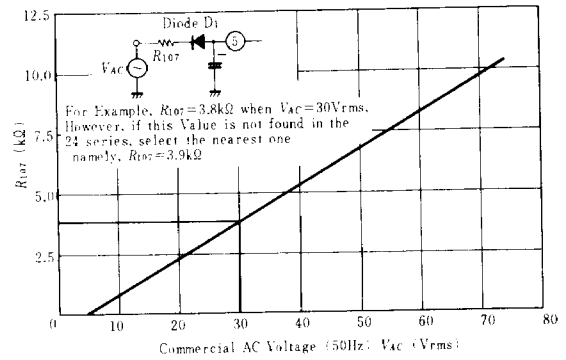
● Wide Operating Supply Voltage Range — pin-7

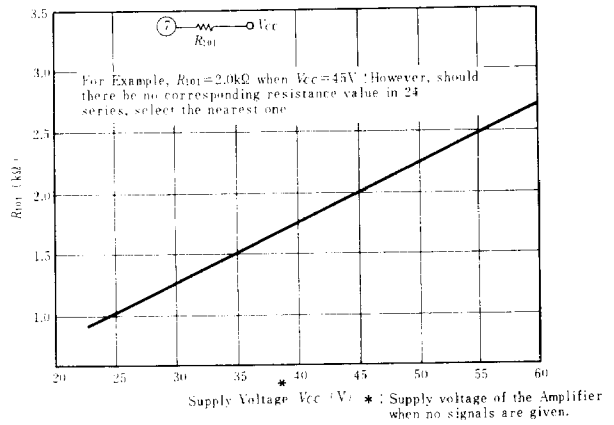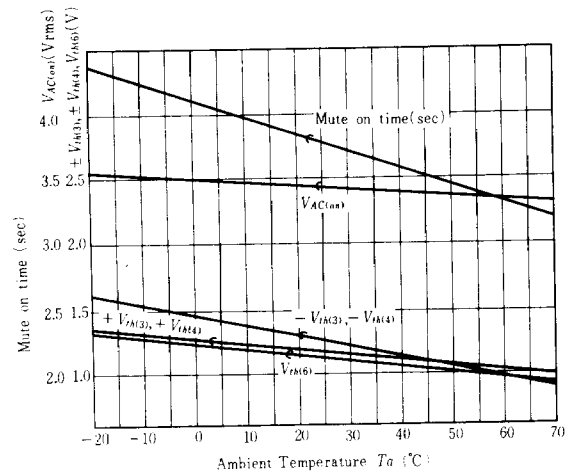Vcc=25 to 60V can be obtained by an optimum R_{101} value.

■PC-BOARD LAYOUT PATTERN

HA12002

(Top View)

(Bottom View)

《SELECTING AN OPTIMAL R₁₀₇ VALUE》
R₁₀₇ VS. COMMERCIAL AC VOLTAGE

For Example, $R_{107}=3.8k\Omega$ when $V_{AC}=30$Vrms. However, if this Value is not found in the 24 series, select the nearest one namely, $R_{107}=3.9k\Omega$

Commercial AC Voltage (50Hz) V_{AC} (Vrms)

《SELECTING AN OPTIMAL R₁₀₁ VALUE》
R₁₀₁ VS. SUPPLY VOLTAGE

For Example, $R_{101}=2.0k\Omega$ when $V_{CC}=45$V. However, should there be no corresponding resistance value in 24 series, select the nearest one

Supply Voltage V_{CC} (V) ＊ : Supply voltage of the Amplifier when no signals are given.

±V th(3),(4), V_AC(on), MUTE ON TIME VS.
AMBIENT TEMPERATURE

Mute on time(sec)

$V_{AC(on)}$

$+V_{th(3)}, +V_{th(4)}$ $-V_{th(3)}, -V_{th(4)}$

$V_{th(6)}$

Ambient Temperature Ta (°C)

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