

HA12002

Protector of Speakers and Power Amplifiers

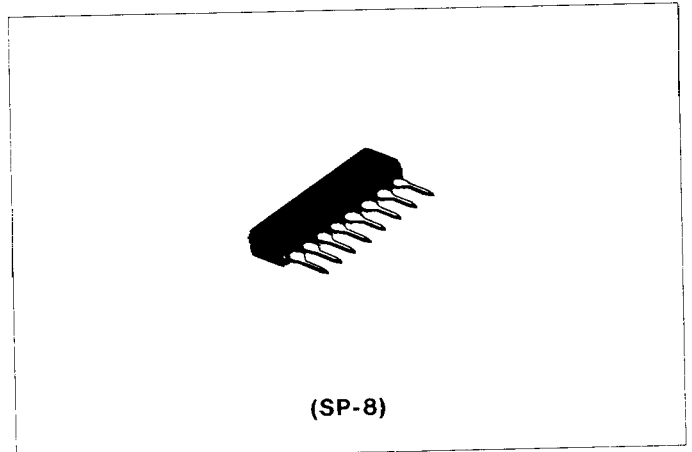
The Hitachi monolithic IC HA12002 is designed for protecting power amplifiers and speakers in various amplifiers and receivers. The HA12002 is encapsulated in 8-pin single-in-line package.

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 possess 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

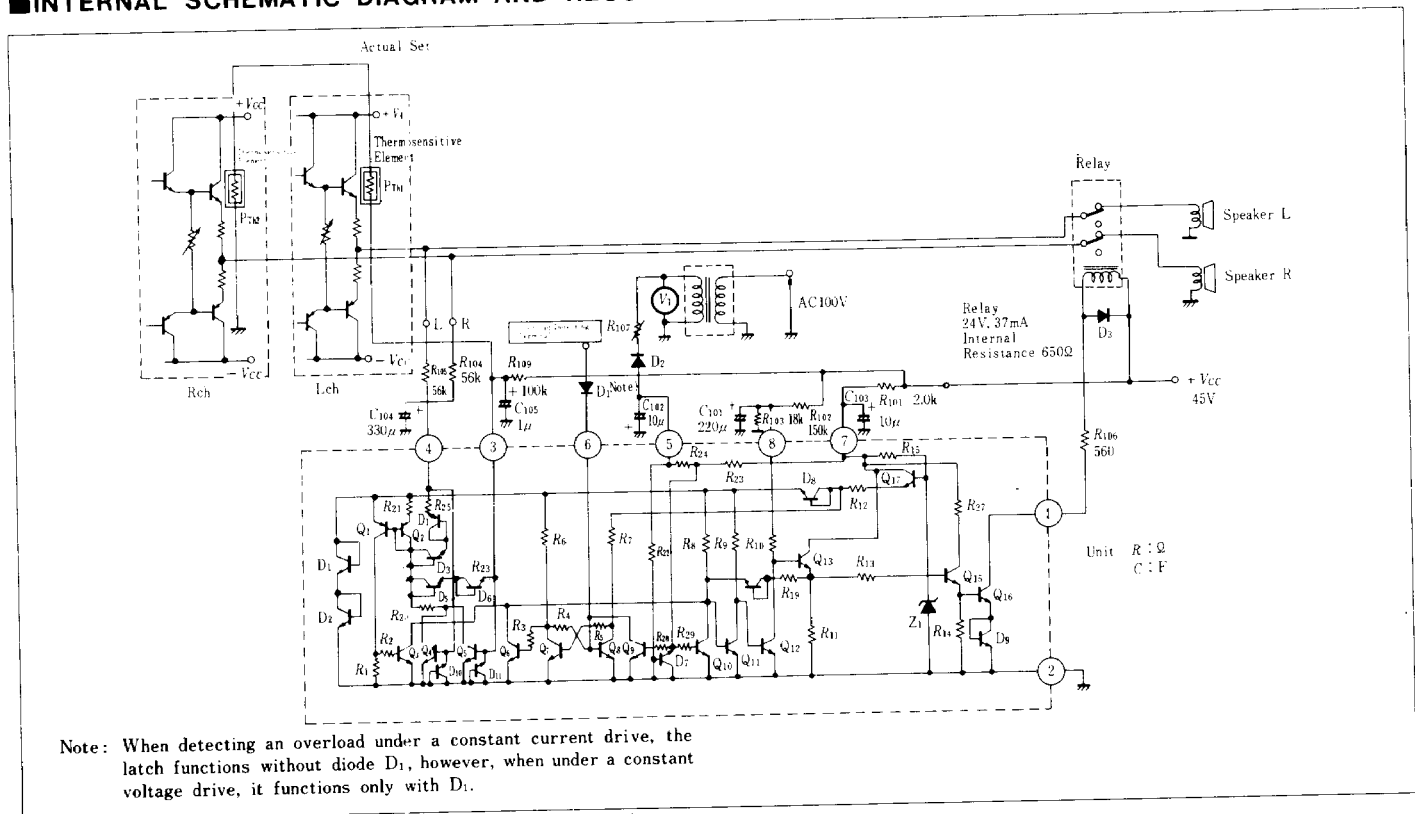
- For speakers protection, use pin-3 (or pin-4) to detect setoff of quiescent output DC voltage and to turn the relay off.
- For protection of power amplifiers, use pin-3 (or pin-4) with an external thermo-sensitive device to detect the temperature increase and to turn the relay off.
- Power amplifiers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



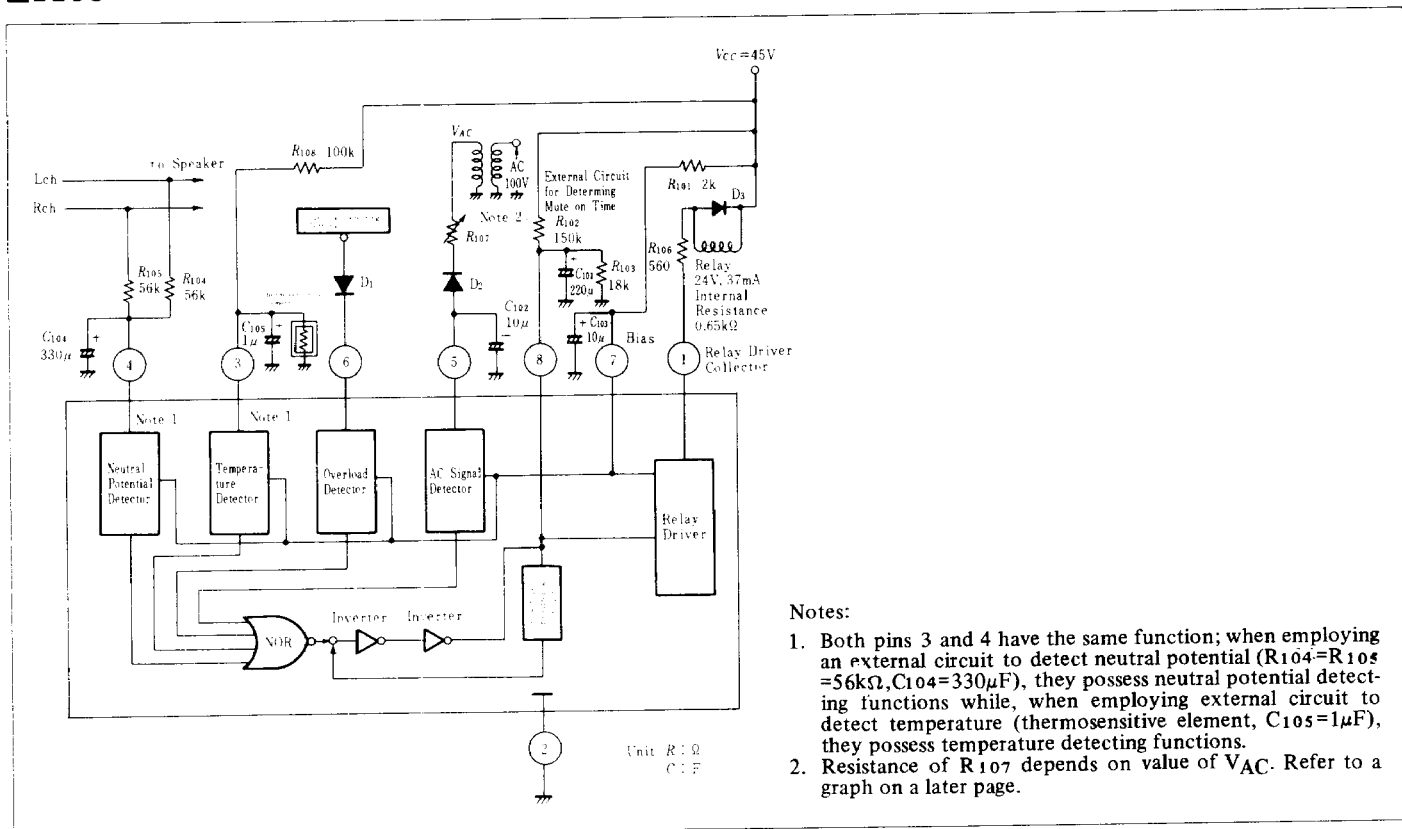
Note: Once relay is turned off, the relay off state continues until the power is switched off and then on again.

- 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



■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS ($T_a = 25^\circ C$)

Item	Symbol	Rating	Unit
Power Dissipation	P_T	400*	mW
Operating Temperature	T_{opr}	-20 to +70	$^\circ C$
Storage Temperature	T_{stg}	-55 to +125	$^\circ C$
Supply Voltage (pin 1)	$V_{CC(max)}$	60	V
Max. Current for Pin 1	$I_{T(max)}$	80	mA
Max. Current for Pin 3	$I_{(3)(max)}$	$\pm 3^{**}$	mA
Max. Current for Pin 4	$I_{(4)(max)}$	$\pm 3^{**}$	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 $T_a = 70^\circ C$

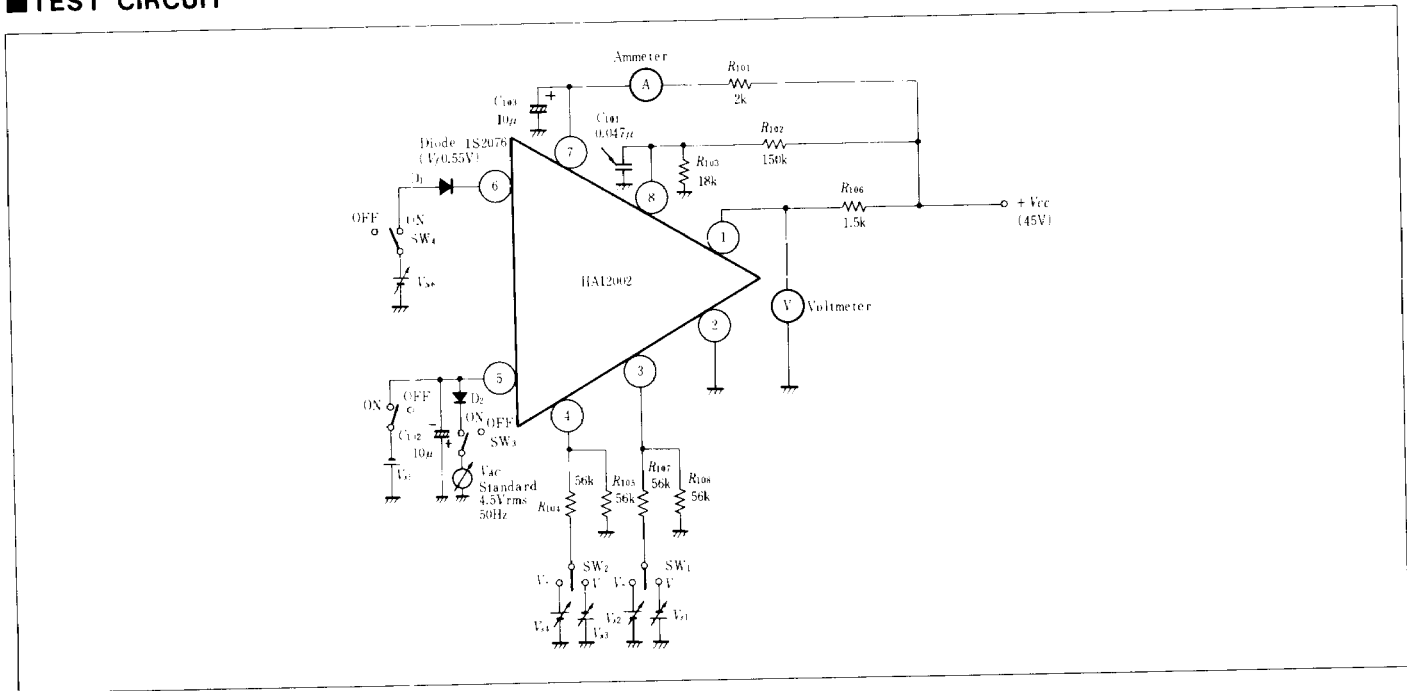
** : Positive current denotes input current at pins 3 and 4, negative current denotes output current.

*** : $V_{(7)(max)} = 8V$ 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, negative 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

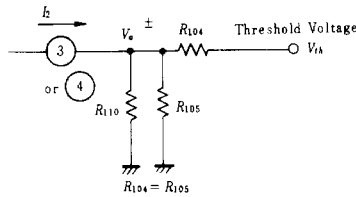
Both plus and minus sides DC voltage setoff can be detected with one power supply. This detection protects speakers by turning the relay off.

- 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 +V_{th} is defined as

$$+V_{th} = \left(2 + \frac{R_{104}}{R_{110}} \right) V_a + \dots \text{eq. 1}$$



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

Minus side threshold voltage $-V_{th}$ is defined as

$$-V_{th} = - \left\{ V_{a-} \left(2 + \frac{R_{104}}{R_{110}} \right) + I_2 \cdot R_{104} \right\} \dots \dots \text{eq. 2}$$

where V_{a-} is $-0.28V$ typ, the threshold voltage with a minus voltage applied directly to pin-3 or 4 and where I_2 is $12.5\mu A$ typ, the pull-out current.

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

$$\left\{ V_{a-} \left(2 + \frac{R_{104}}{R_{110}} \right) + I_2 \cdot R_{104} \right\} = \left(2 + \frac{R_{104}}{R_{110}} \right) V_{a+} \dots \dots \text{eq. 3}$$

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 $\pm V_{th} = 1.8V$,

(a) From eq. 1 and $\pm V_{th} = 1.8V$,

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

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

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

(b) From eq. 2 and $-V_{th} = -1.8V$,

$$-1.8 = -0.28 \left(2 + \frac{R_{104}}{R_{110}} \right) - 12.5 (\mu A) \times R_{104} (k\Omega) \quad (V)$$

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

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

Therefore, for $V_{th} = 1.8V$,

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

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

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

$$\frac{\pm V_{CC}}{R_{104} (105)} < \pm 3 \quad (mA)$$

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

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

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

• 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 $110\mu A$ typ. Thus over $110\mu A$ 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.

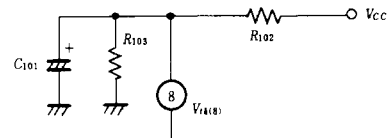
The relay-on time lag is defined as

$$t = \frac{R_{102} \cdot R_{103} \cdot C_{101}}{R_{102} + R_{103}} \cdot 1n \left\{ \frac{1}{1 - \frac{V_{th(8)} \cdot (R_{103} + R_{102})}{V_{CC} \cdot R_{103}}} \right\}$$

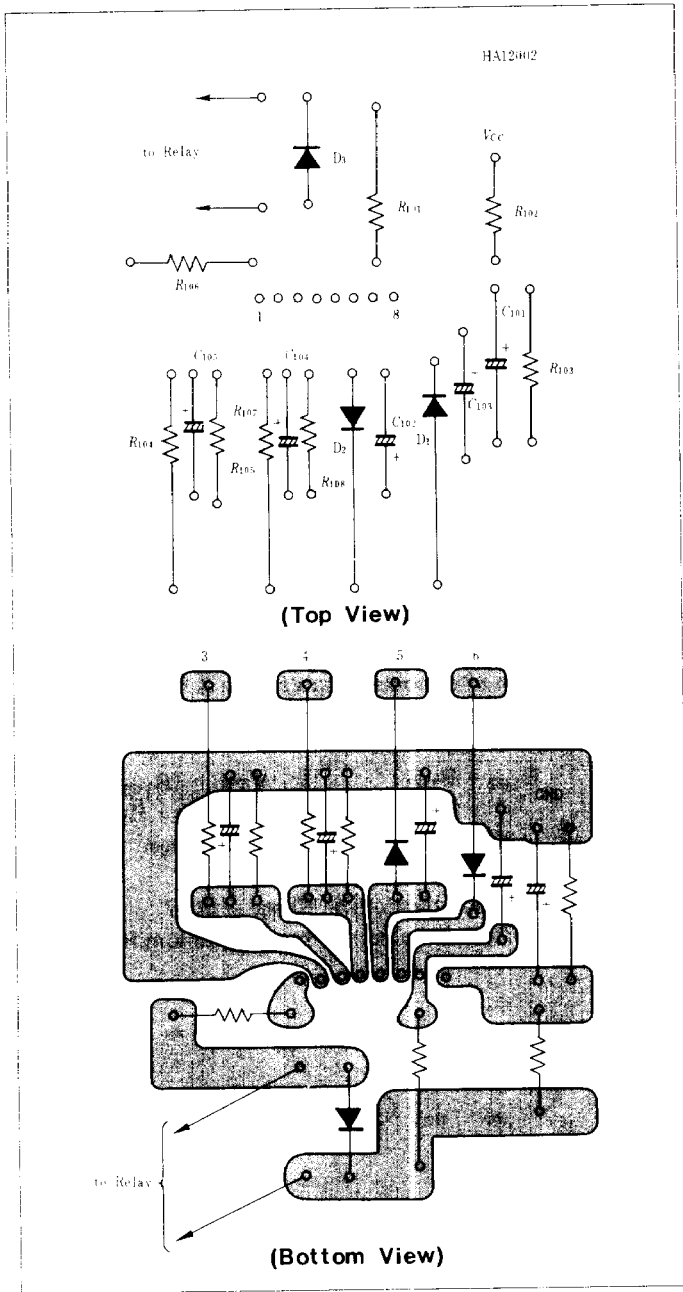
where $V_{th(8)}$ is 2.65V typ, pin-8 threshold voltage.

• Wide Operating Supply Voltage Range – pin-7

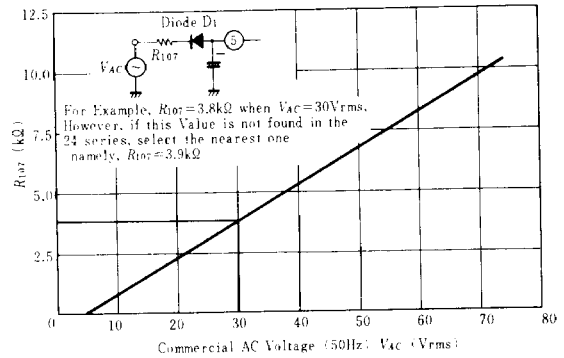
$V_{CC} = 25$ to $60V$ can be obtained by an optimum R_{101} value.



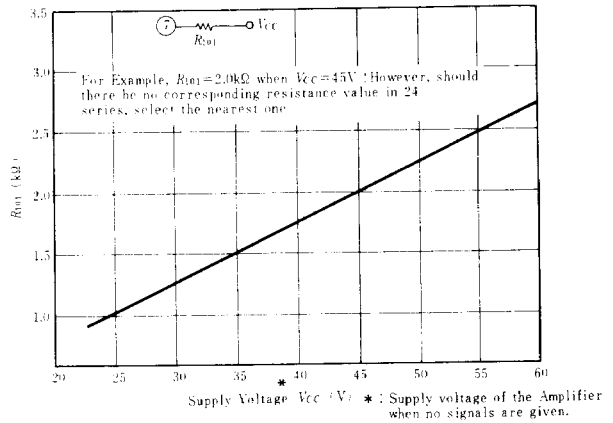
■ PC-BOARD LAYOUT PATTERN



《SELECTING AN OPTIMAL R_{107} VALUE》
 R_{107} VS. COMMERCIAL AC VOLTAGE



《SELECTING AN OPTIMAL R_{101} VALUE》
 R_{101} VS. SUPPLY VOLTAGE



$\pm V_{th(3)}, \pm V_{th(4)}, V_{AC}$ (on), MUTE ON TIME VS. AMBIENT TEMPERATURE

