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.

(SP-8)

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

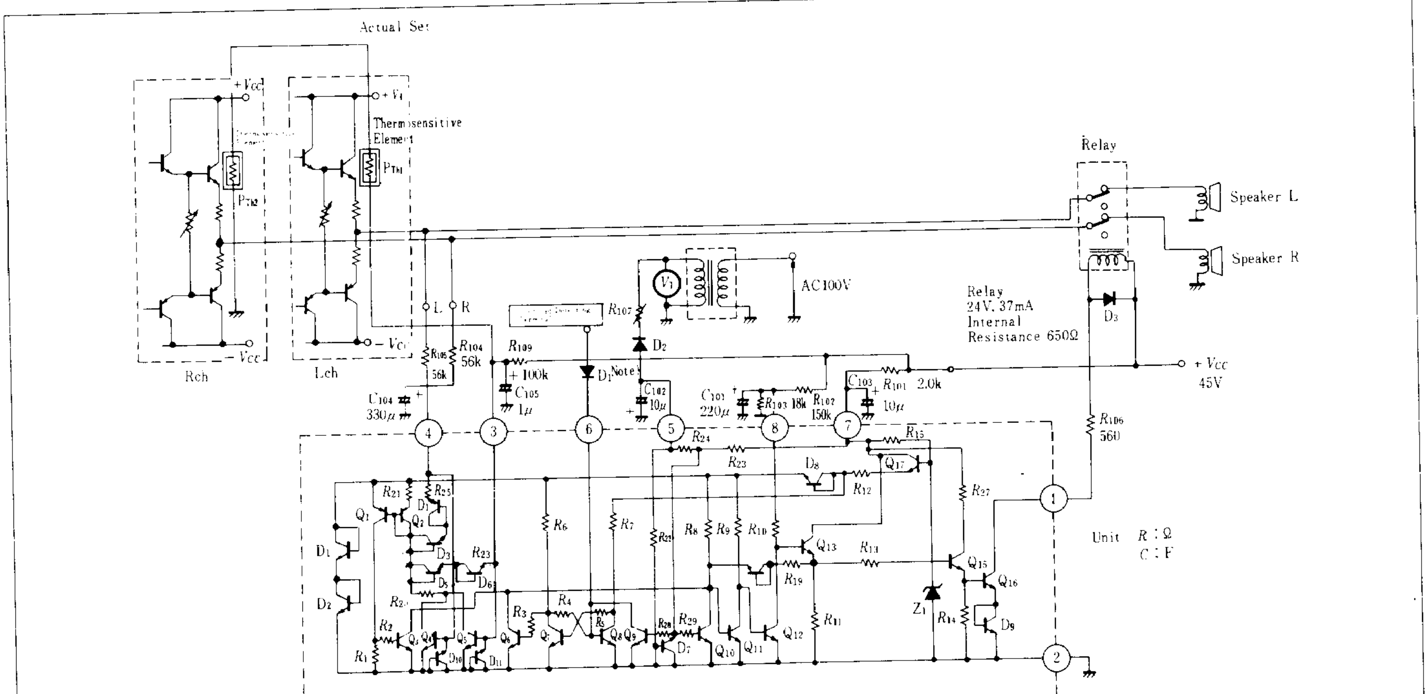
■ FEATURES

- 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.
- 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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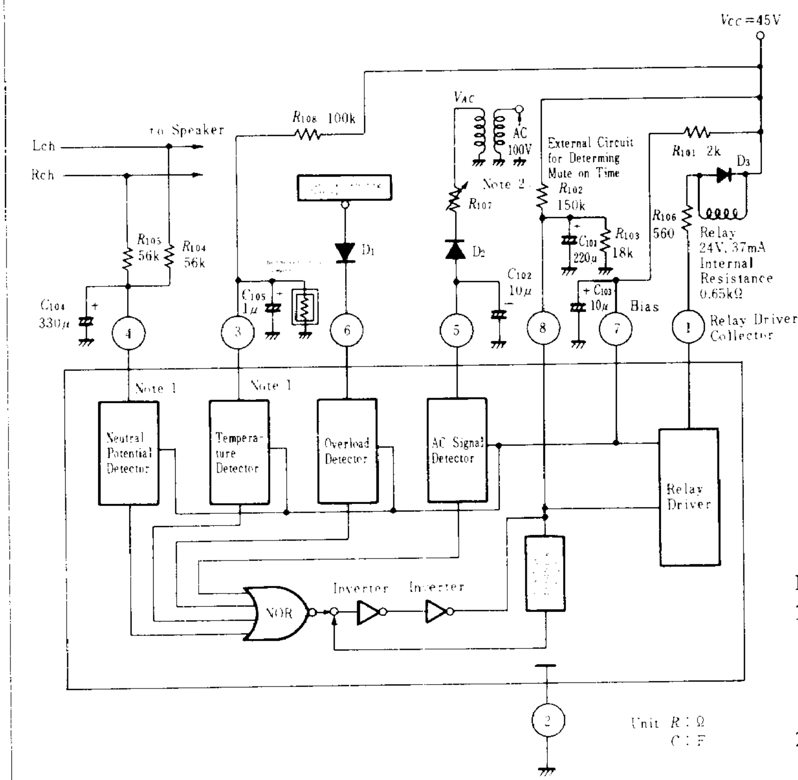
■BLOCK DIAGRAM



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 ($Ta=25$℃)

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

Notes: * : Value at $Ta=70$℃

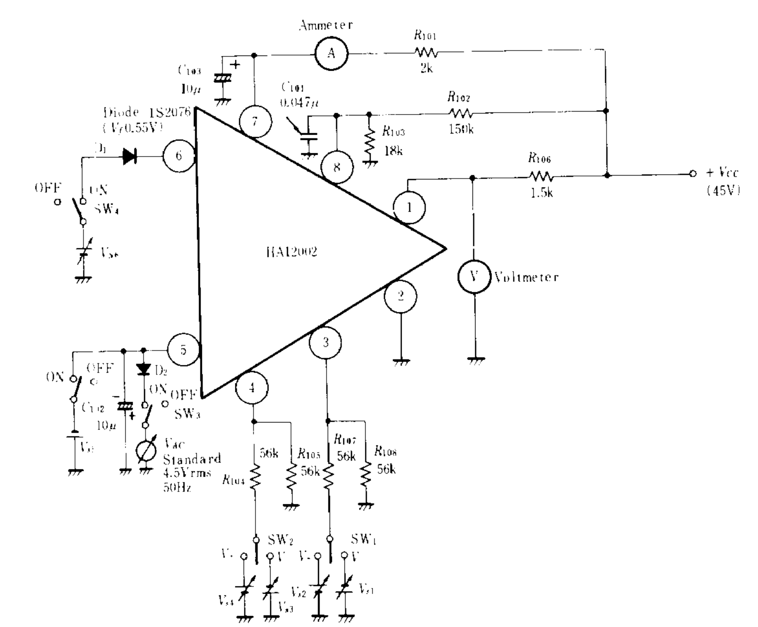
** : Positive current denotes input current at pins 3 and 4, negative current denotes output current.

*** : $V_{\text{⑦}\,(max)}=8V$ is derived when driven by a constant voltage source, without any resistance. When applying current to $V_{\text{⑦}}$ 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

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

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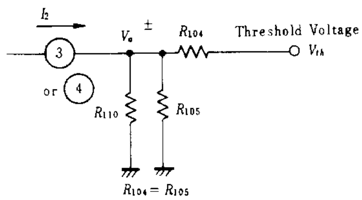


where Va+ is 0.57V typ, the threshold voltage with a plus voltage applied directly to pin-3 or 4.

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

$$\left\{ Va^{-}\left(2+\frac{R_{104}}{R_{110}}\right) + I_2 \cdot R_{104} \right. = \left(2+\frac{R_{104}}{R_{110}}\right)Va+ \quad \ldots\ldots \text{eq. 3}$$

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,

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

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

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

(b) From eq. 2 and −Vth=−1.8V,

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

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

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

Therefore, for Vth=1.8V,

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

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

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

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

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

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

(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.

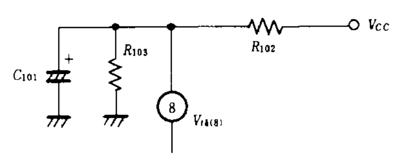
The relay-on time lag is defined as

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

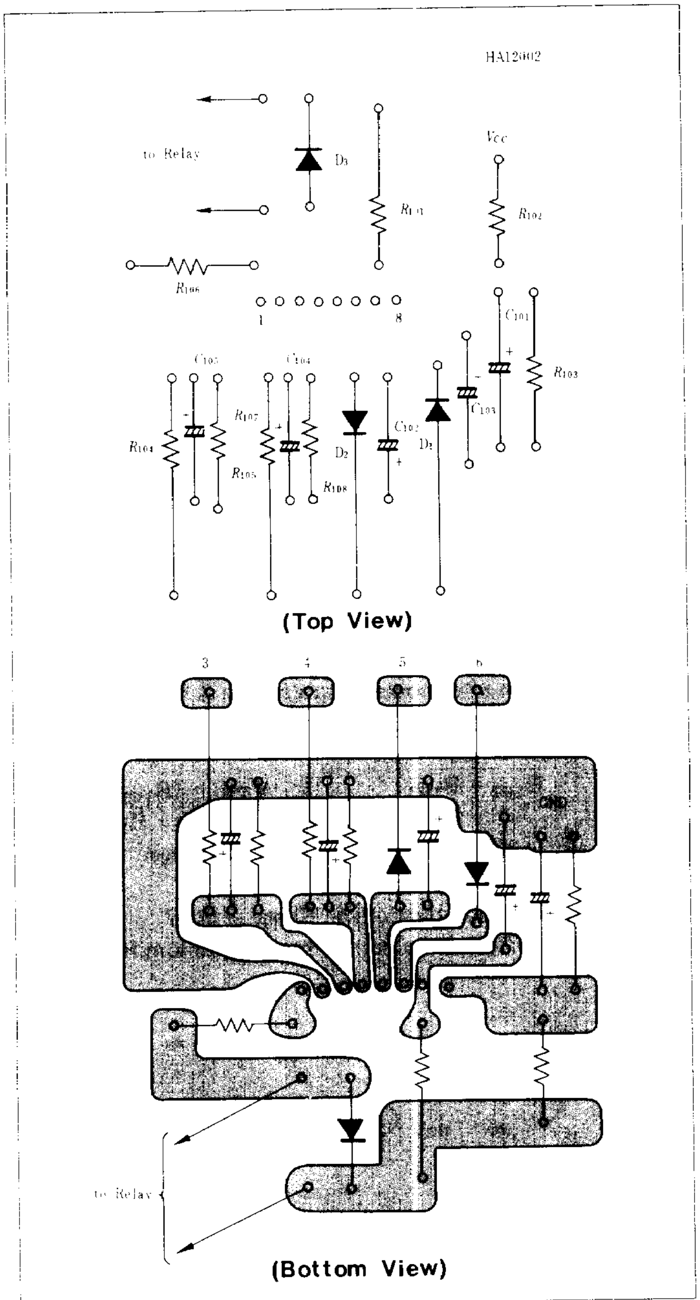
where $V_{th(8)}$ is 2.65V typ, pin-8 threshold voltage.

- Wide Operating Supply Voltage Range — pin-7

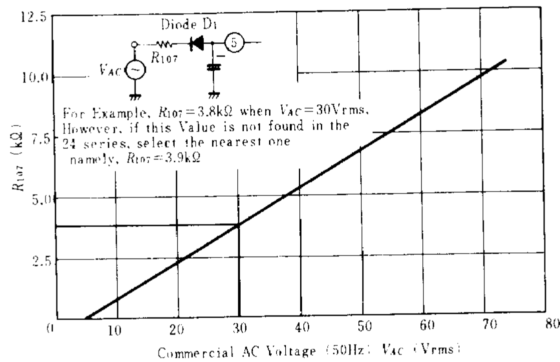
Vcc=25 to 60V can be obtained by an optimum R_{101} value.



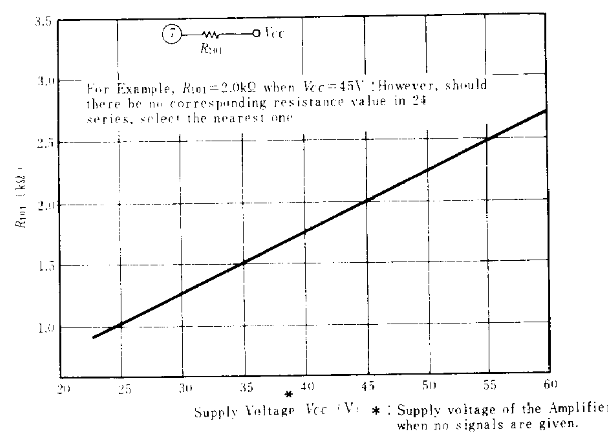
■PC-BOARD LAYOUT PATTERN



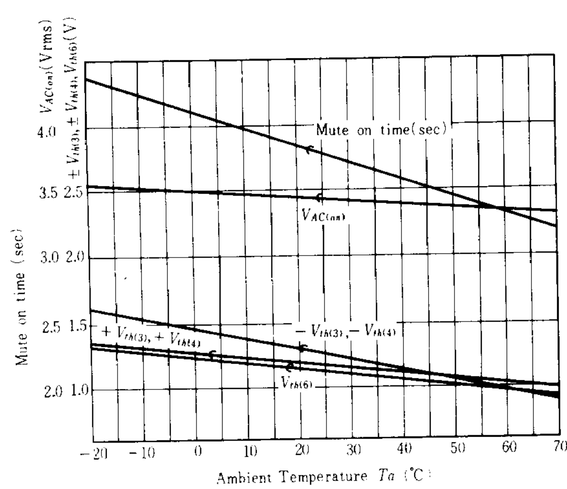
《SELECTING AN OPTIMAL R_{107} VALUE》
R_{107} VS. COMMERCIAL AC VOLTAGE



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



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



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