

HA12002

Protector of Speakers and Power Amplifiers

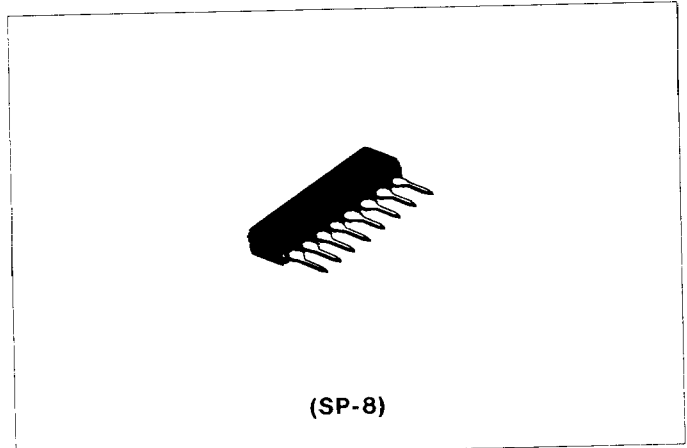
The Hitachi monolithic IC HA12002 is designed for protecting power amplifiers and speakers in various amplifiers and receivers. The HA12002 is encapsulated in 8-pin single-in-line package.

■ 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

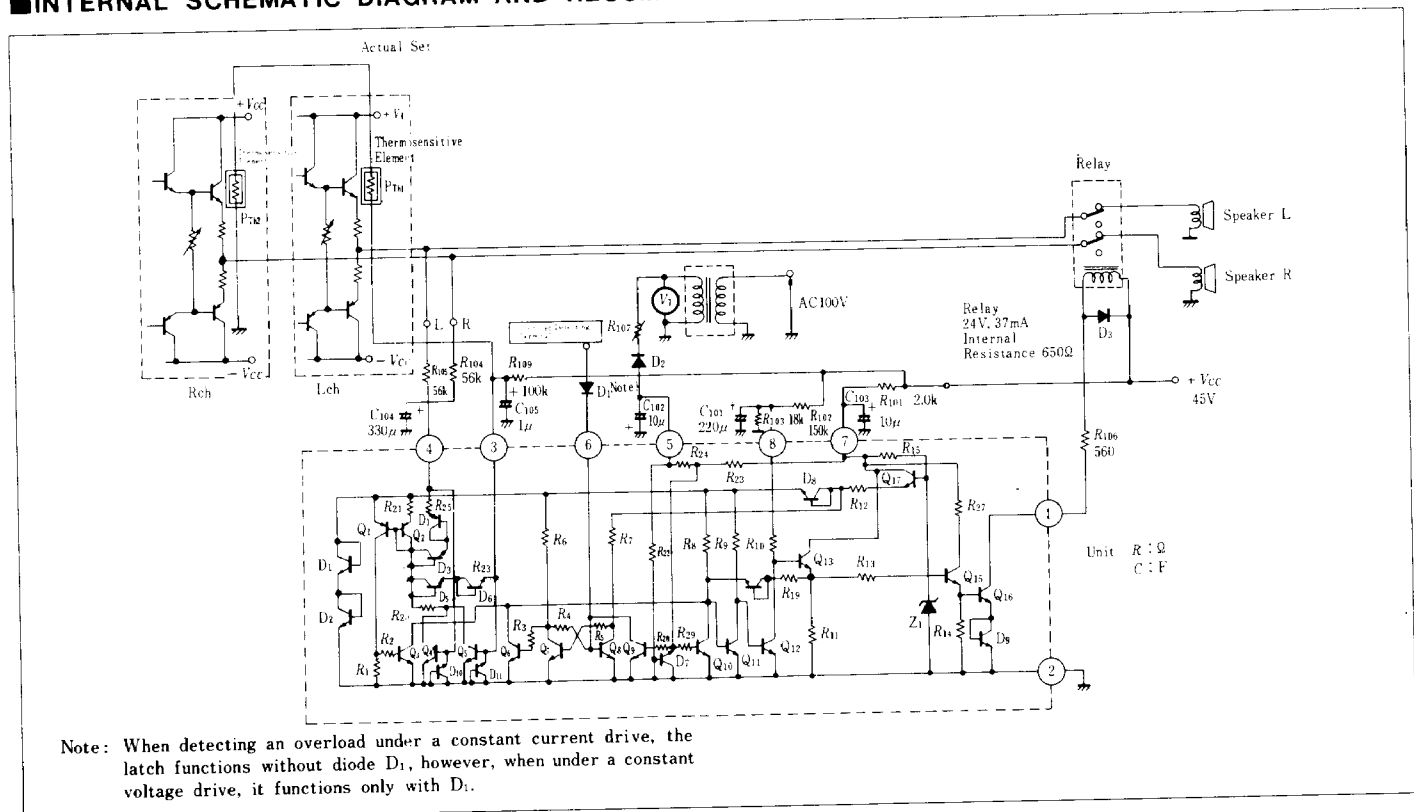
- For speakers protection, use pin-3 (or pin-4) to detect setoff of quiescent output DC voltage and to turn the relay off.
- For protection of power amplifiers, use pin-3 (or pin-4) with an external thermo-sensitive device to detect the temperature increase and to turn the relay off.
- Power amplifiers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



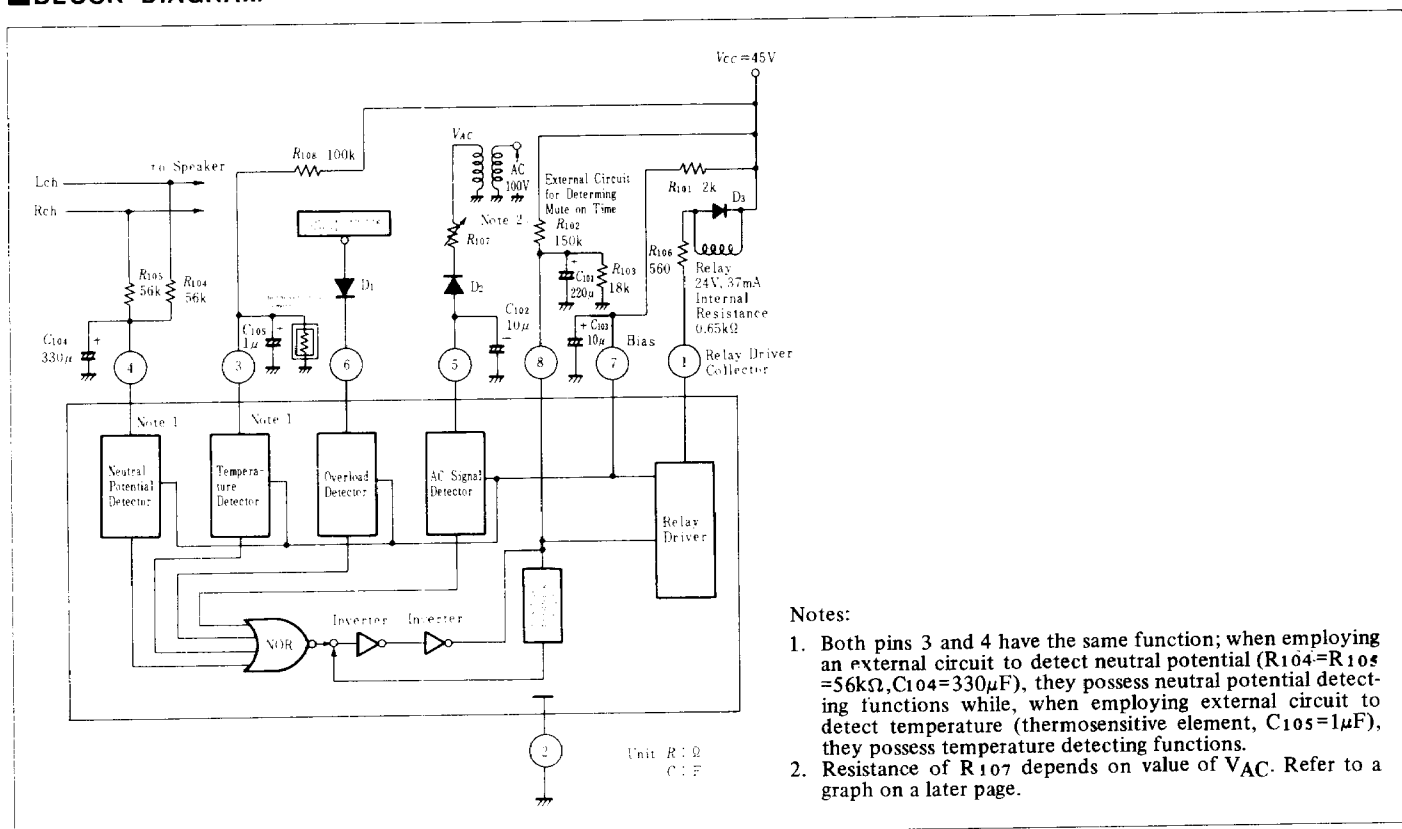
Note: Once relay is turned off, the relay off state continues until the power is switched off and then on again.

- 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	$I_{(1) (max)}$	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 $T_a = 70^\circ C$

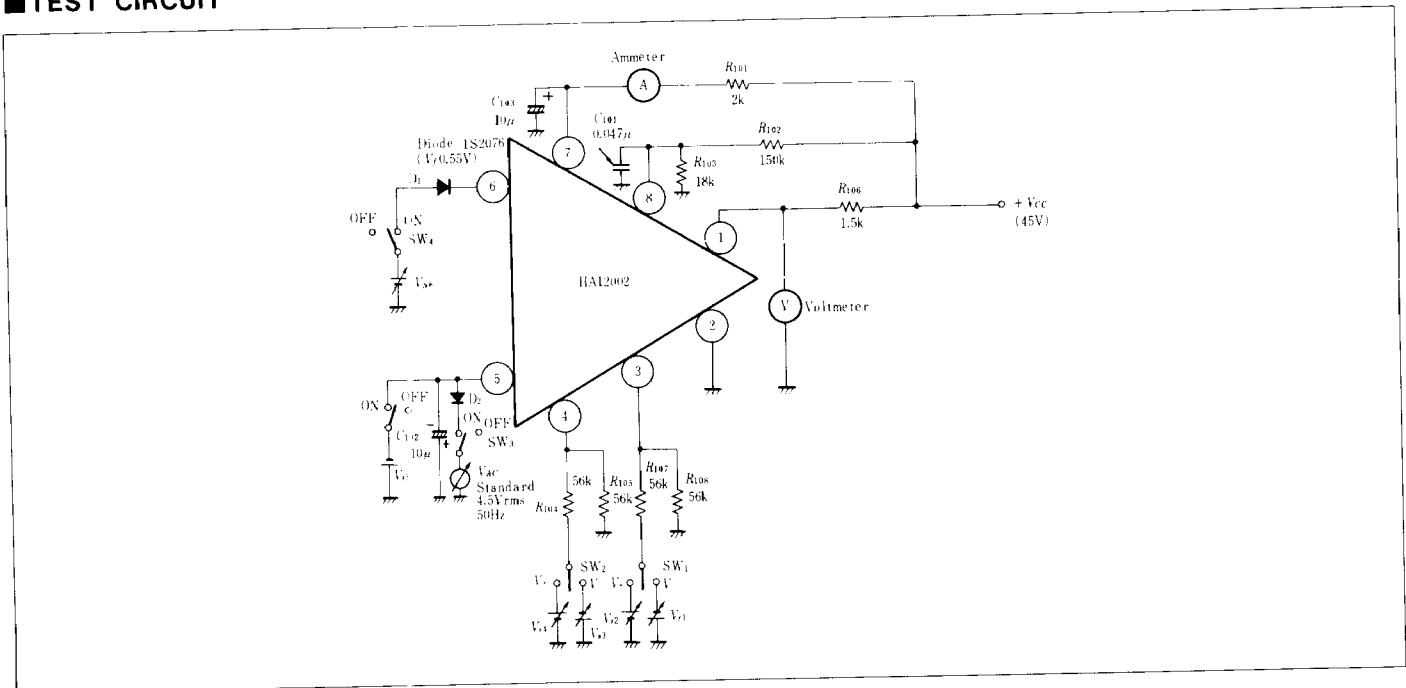
** : Positive current denotes input current at pins 3 and 4, negative current denotes output current.

*** : $V_{(7) (max)} = 8V$ 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 ($56k\Omega$). 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 ($56k\Omega$). 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 ($56k\Omega$). 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 ($56k\Omega$). 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	$V_{AC(5)}$	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

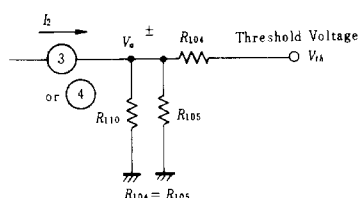
Both plus and minus sides DC voltage setoff can be detected with one power supply. This detection protects speakers by turning the relay off.

- 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

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

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

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

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

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

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.

