| | |
|---|---|
| Structure | Silicon Monolithic Bipolar IC |
| Appearance | SIL-12 Pins Plastic Package<br>(FP-12S Power Type With Fin) |
| Application | Audio |
| Function | 70W (6Ω) x 1ch BTL Power Amplifier<br>Built-in Standby and Muting Features<br>Incorporating Various Protection Circuits |

| A | Absolute Maximum Ratings | | | | |
|---|---|---|---|---|---|
| No. | Item | Symbol | Ratings | Unit | Note |
| 1 | Storage Temperature | Tstg | -55 ~ +150 | ° C | |
| 2 | Operating Ambient Temperature | Topr | -25 ~ +75 | ° C | |
| 3 | Operating Ambient Pressure | Popr | $1.013 \times 10^5 \pm 0.61 \times 10^5$ | Pa | |
| 4 | Operating Constant Acceleration | Gopr | 9,810 | $m / s^2$ | |
| 5 | Operating Shock | Sopr | 4,900 | $m / s^2$ | |
| 6 | Power Supply Voltage | Vcc | 33 | V | 1 |
| 7 | Power Supply Current | Icc | 8.0 | A | |
| 8 | Power Dissipation | $P_D$ | 37.5 | W | 2 |

| | | |
|---|---|---|
| Operating Supply Voltage Range | Vcc | 10 V ~ 32V |

Note: 1) Without input signal, Vcc is up to 33V
2) Ta = 75°C with infinite heatsink

## B Electrical Characteristics

(Unless otherwise specified, the ambient temperature is 25°C±2°C, Vcc=30V, frequency=1kHz and $R_L$=6Ω.)

| No. | Item | Symbol | Test Circuit. | Condition | Limit | | | Unit | Note |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Min | Typ | Max | | |
| 1 | Quiescent Circuit Current | Icq | 1 | No input ; Vstby = 5V Vmute = 5V; | - | 100 | 300 | mA | |
| 2 | Output Noise Voltage | Vno | 1 | No Input, Rg=20kΩ Vstby = 5V;Vmute = 5V | - | 0.54 | 1 | mVrms | 1 |
| 3 | Voltage Gain | Gvc | 1 | Vin=20mV; Vstdby=5V Vmute = 5V | 38 | 40 | 42 | dB | |
| 4 | Total Harmonic Distortion | THD | 1 | Vin=20mV; Vstdby=5V Vmute = 5V; | - | 0.07 | 0.4 | % | 2 |
| 5 | Maximum Output Power | Po | 1 | THD_OUT=10% Vstdby=5V;Vmute= 5V; | 55 | 70 | - | W | |
| 6 | Output Offset Voltage | Voff | 1 | Rg=20kΩ; No input Vstdby=5V;Vmute=5V; | -350 | 0 | 350 | mV | |
| 7 | Ripple Rejection | RR | 1 | Vripple=1Vrms * freq=120Hz, Rg=20kΩ | 45 | 55 | - | dB | 1 |
| 8 | Standby Current | $I_{STB}$ | 1 | No input ; vstdby=0V; Vmute=5V; | - | 1 | 100 | µA | |
| 9 | Muting Effects | MT | 1 | Vin=20mV; Vstby=5V; Vmute = 0 to 5V** | 65 | 75 | - | dB | 2 |

* The measurement is by taking the ratio of output voltage with reference to the Vripple.
** The measurement is by taking the ratio of output (at Vmute = 0 V) to the output(at Vmute = 5V)

Note : 1) With a filter band 20Hz ~20kHz (12 dB/OCT) used.

2) With a filter band 400Hz ~30kHz used.

## B Electrical Characteristics

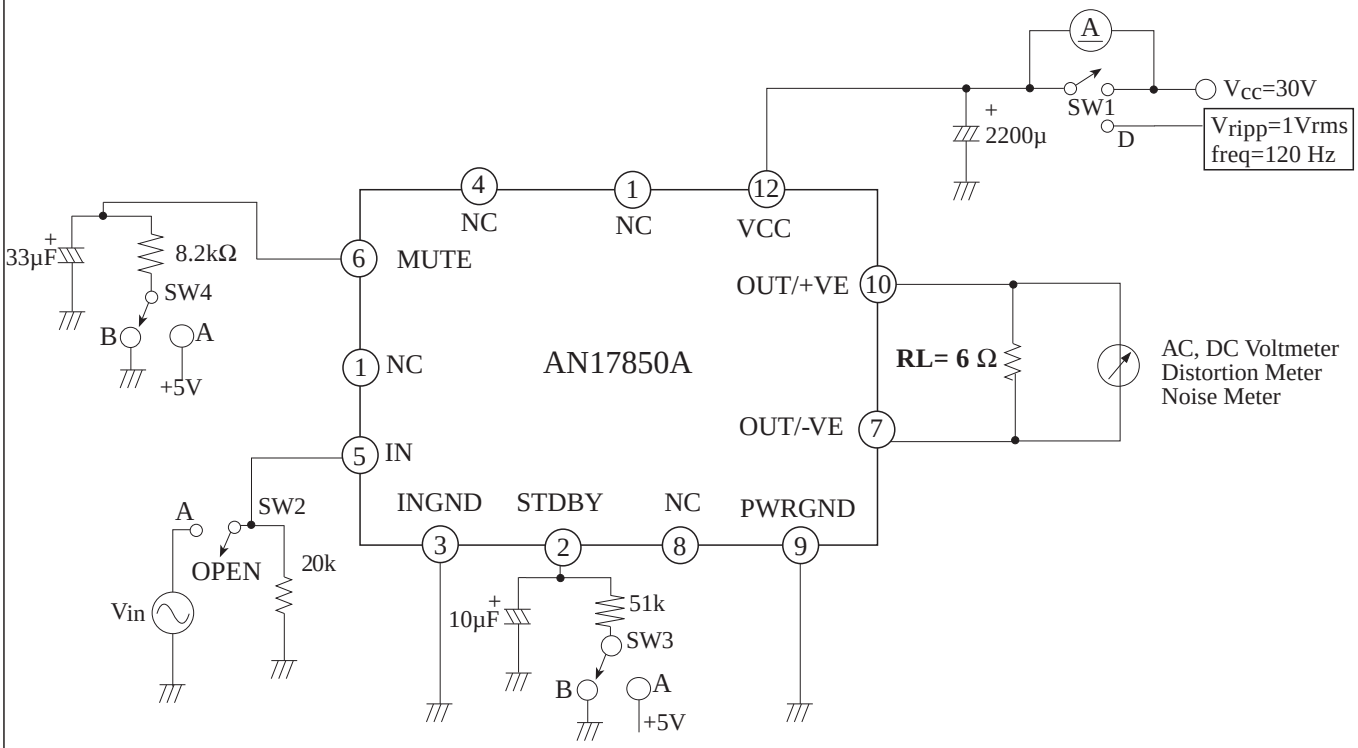
(Unless otherwise specified, the ambient temperature is 25°C±2°C, Vcc=30V, frequency=1kHz and $R_L$=6Ω.)

| No | Item | Symbol | Test Circuit | Conditions | Limits min | Limits typ | Limits max | Unit | Note |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Standby on voltage | Vstdon | 1 | Vmute = 5V; Vin = 20mV; Istb < 100uA | - | - | 1 | V | |
| 2 | Standby off voltage | Vstd0ff | 1 | Vmute = 5V; Vin = 20mV; Gvc > 38 dB | 4.5 | - | - | V | |
| 3 | Mute on voltage | Vmon | 1 | VStdby = 5V; Vin = 20mV; MT > 70 dB | - | - | 1 | V | |
| 4 | Mute off voltage | Vmoff | 1 | VStdby = 5V; Vin = 20mV; Gvc > 38 dB | 4 | - | - | V | |

Note) The above characteristics are reference values determined for IC design, but not guaranteed values for shipping inspection. If problems were to occur, counter measures will be sincerely discussed.

(Description of Test Circuits and Test Methods)

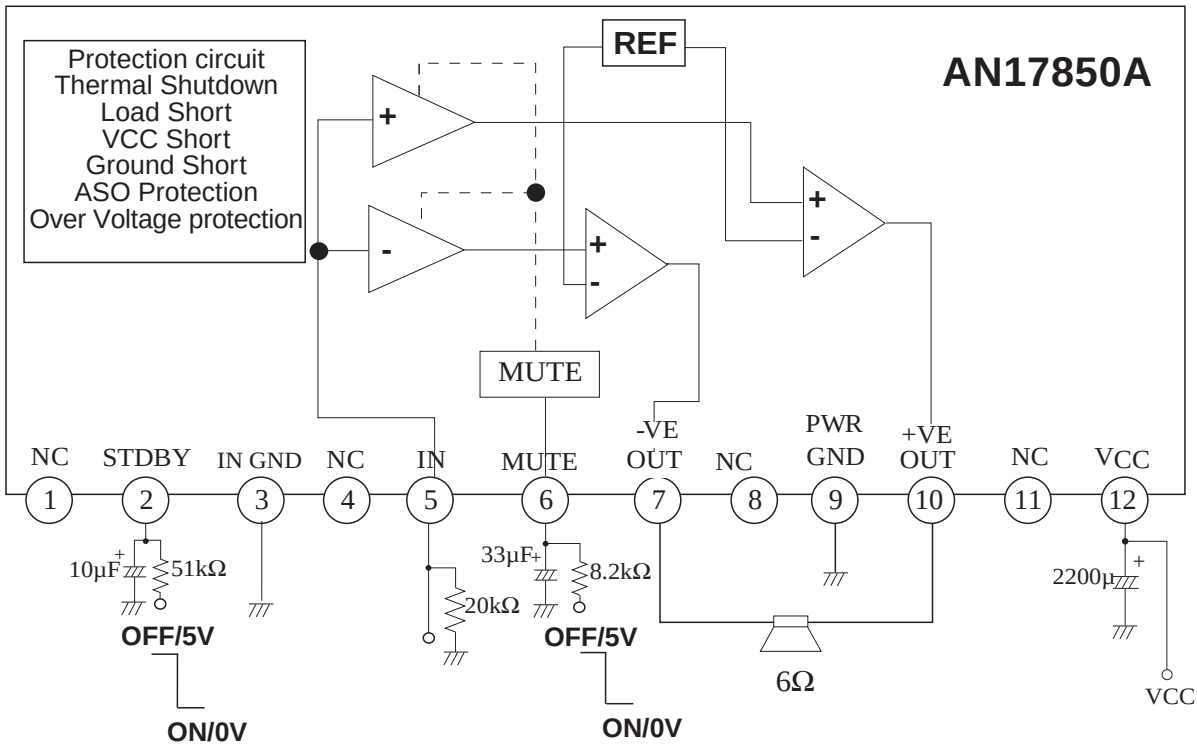
Test Circuit 1




| No. | Item | SW1 | SW2 | SW3 | SW4 |
|---|---|---|---|---|---|
| 1 | $I_{CQ}$ | OPEN | OPEN | A | A |
| 2 | Vno | Closed | OPEN | A | A |
| 3 | Gvc | Closed | A | A | A |
| 4 | THD | Closed | A | A | A |
| 5 | PO | Closed | A | A | A |
| 6 | Voff | Closed | OPEN | A | A |
| 7 | R.R | D | OPEN | A | A |
| 8 | $I_{STB}$ | OPEN | OPEN | B | A |
| 9 | MT | Closed | A | A | B/A |

Note : * STB 'OFF' means 5V.
MUTE 'OFF' means 5V.

## Circuit Function Block Diagram



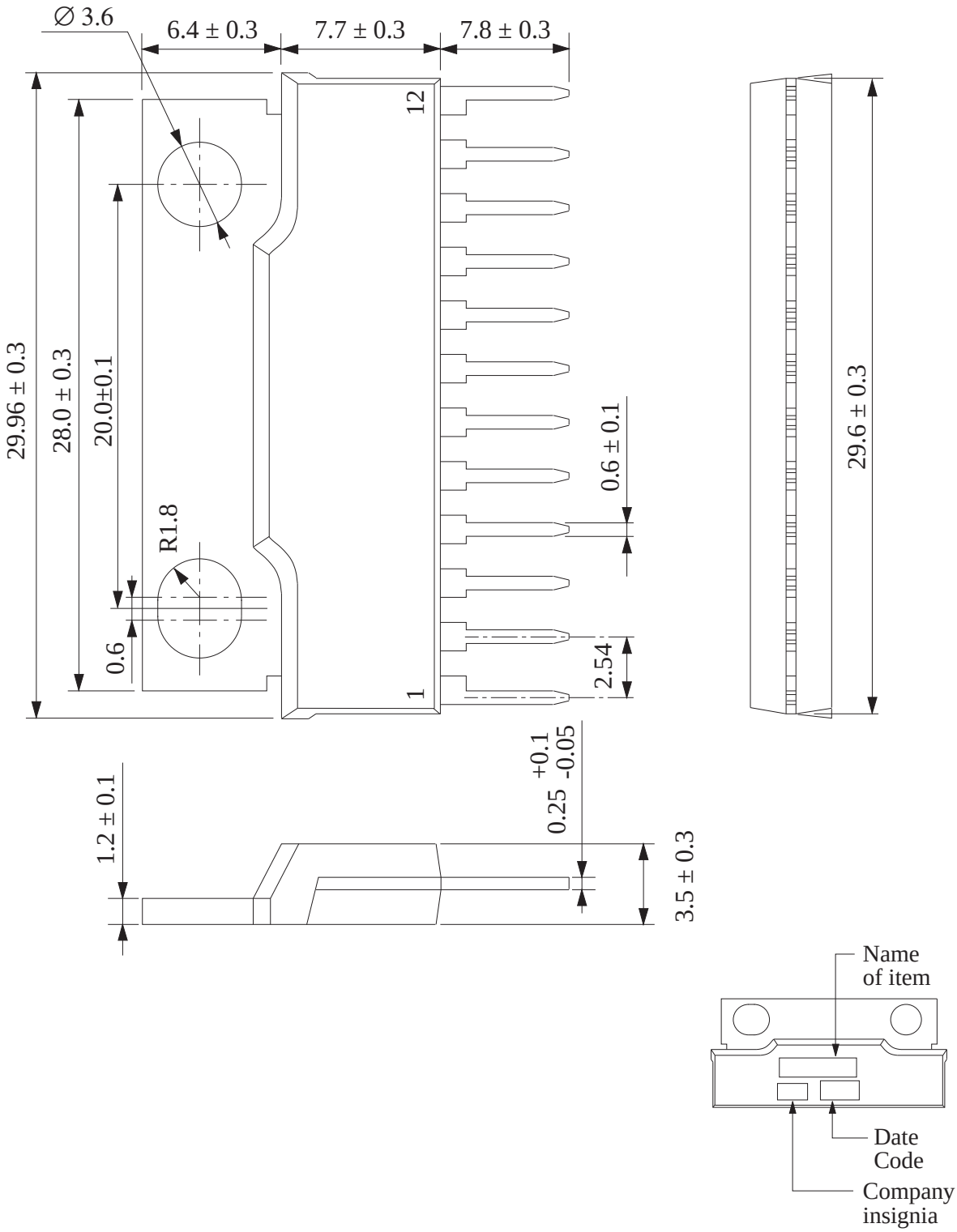

## Pin Descriptions

| Pin No. | Pin Descriptions | Pin No. | Pin Descriptions |
|---|---|---|---|
| 1 | NC | 7 | -VE PHASE OUTPUT |
| 2 | STDBY | 8 | NC |
| 3 | IN GND | 9 | PWR GND |
| 4 | NC | 10 | +VE PHASE OUTPUT |
| 5 | IN | 11 | NC |
| 6 | MUTE | 12 | VCC |

| Prepared | | Product Specifications | Ref No. | E |
|---|---|---|---|---|
| Checked | | **AN17850A** | Total Page | 17 |
| Approved | | | Page No. | 6 |

| Package Name | FP-12S |
|---|---|

Unit : mm

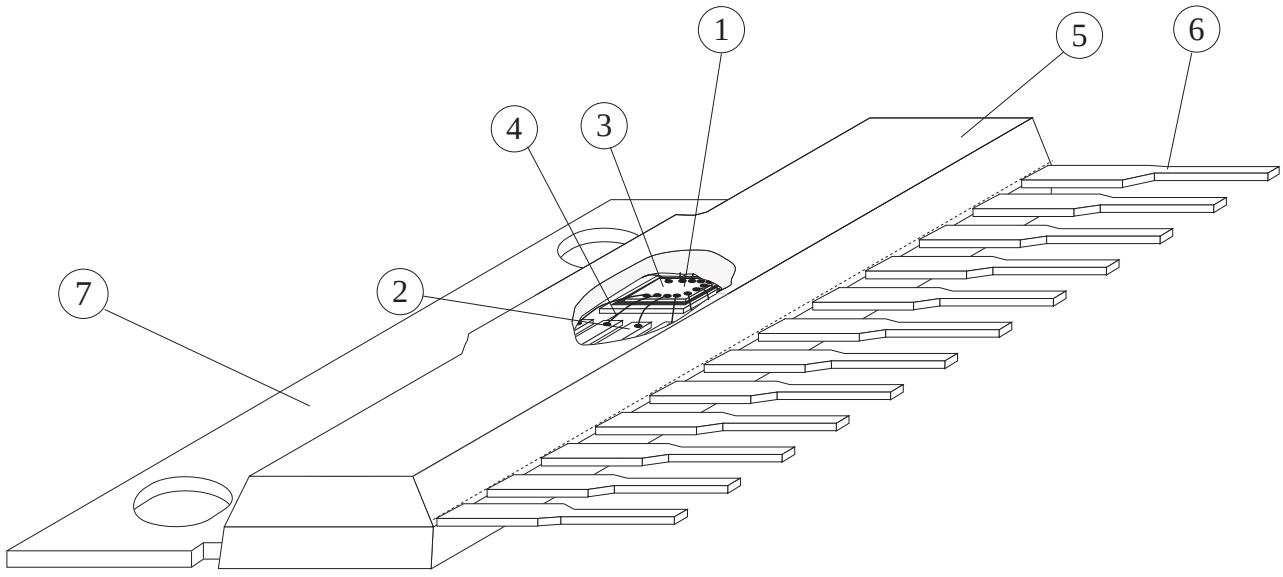



| Eff. Date | Eff. Date | Eff. Date | Eff. Date |
|---|---|---|---|
| 15-AUG-03 | | | |

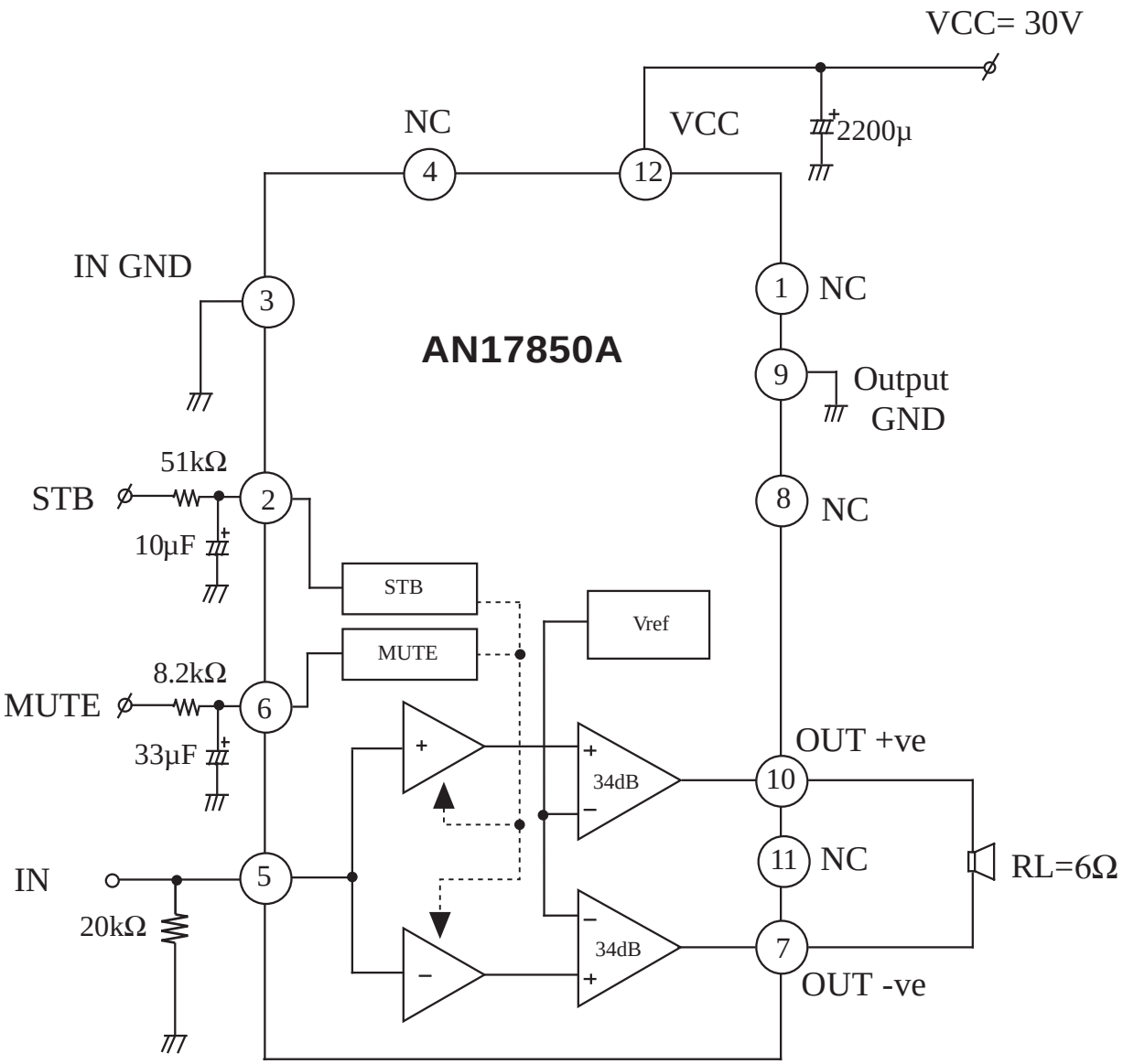
## (Structure Description)

| | | |
|---|---|---|
| Chip surface passivation | [SiN,] PSG, Others ( ) | (1) |
| Lead frame material | Fe group, [Cu group,] Others ( ) | (2), (6) |
| Inner lead surface process | [Ag plating,] Au plating, Others ( ) | (2) |
| Outer lead surface process | Solder plating, [Solder dip,] Others ( ) | (6) |
| Chip mounting method | Ag paste, Au-Si alloy, [Solder,] Others ( ) | (3) |
| Wire bonding method | [Thermalsonic bonding,] Others ( ) | (4) |
| Wire material | [Au] Others ( ) | (4) |
| Mold material | [Epoxy,] Others ( ) | (5) |
| Molding method | [Transfer mold,] Multiplunger mold, Others ( ) | (5) |
| Fin material | [Cu Group] Others ( ) | (7) |

## Package FP-12S



Application Circuit




| | |
|---|---|
| STB 'OFF' | 5V |
| STB 'ON' | 0V |
| Mute 'OFF' | 5V |
| Mute 'ON' | 0V |

| Eff. Date | Eff. Date | Eff. Date | Eff. Date | |
|---|---|---|---|---|
| 15-AUG-03 | | | | |

PD - Ta Curves

(1) Tc = Ta, 62.5W ( θj-c = 2 °C/W )

(2) 20.83W ( θf = 4.0 °C/W )

With a 100cm$^2$ X 3mm Al heat sink (black colour coated)

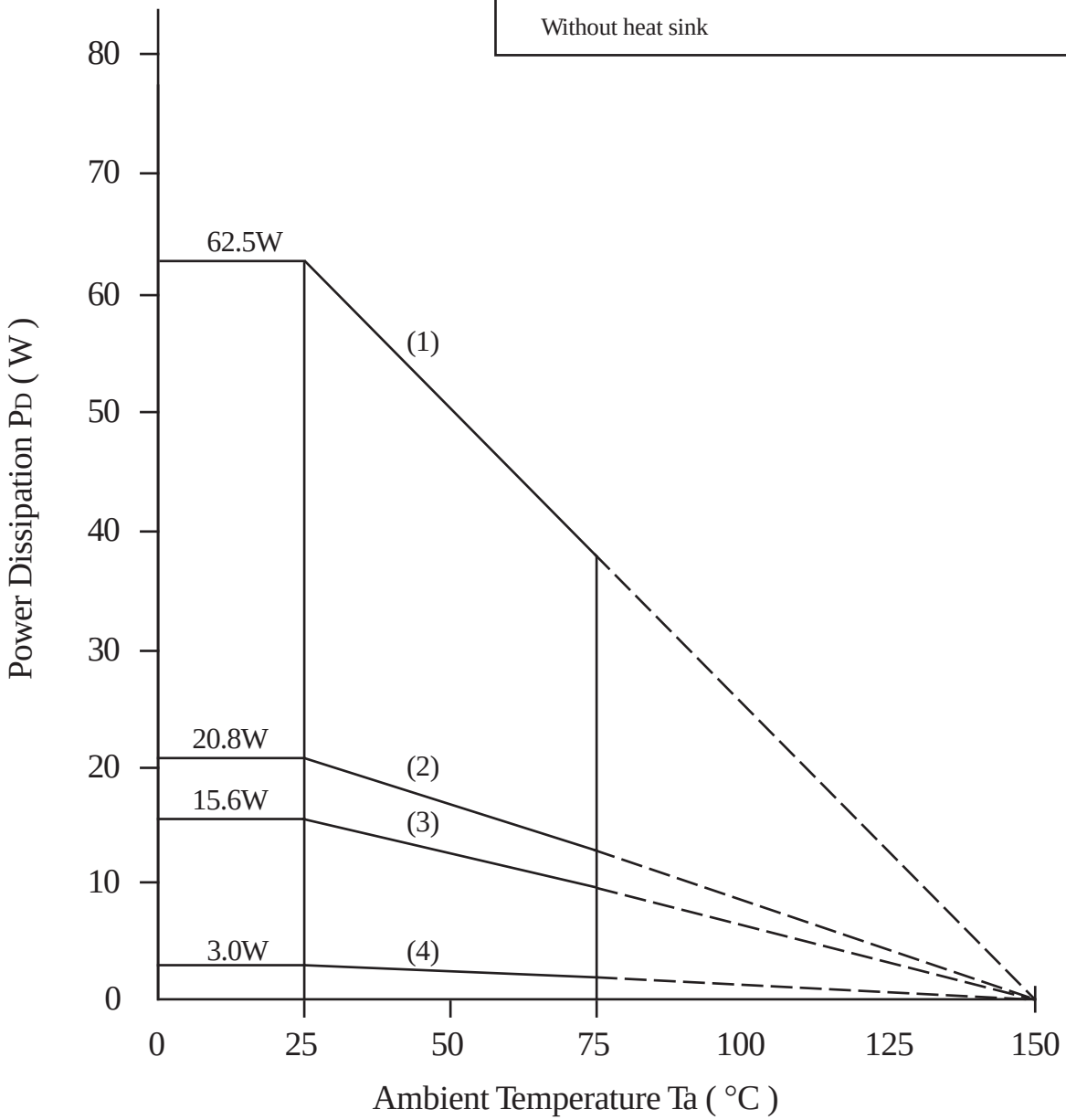
or a 200cm$^2$ X 2mm Al heat sink (not lacquered)

(3) 15.63W ( θf = 6.0 °C/W )

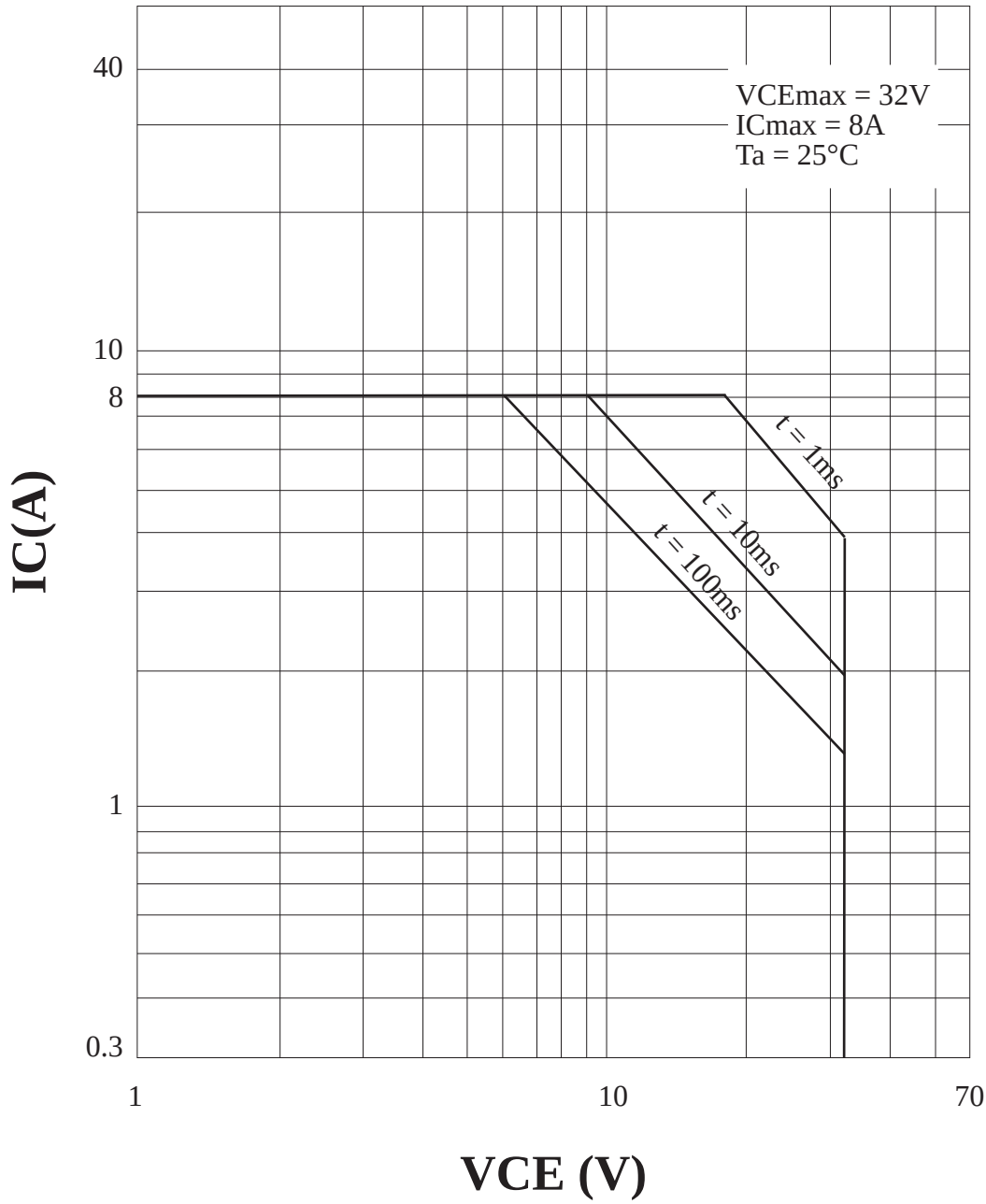
With a 100cm$^2$ X 2mm Al heat sink (not lacquered)

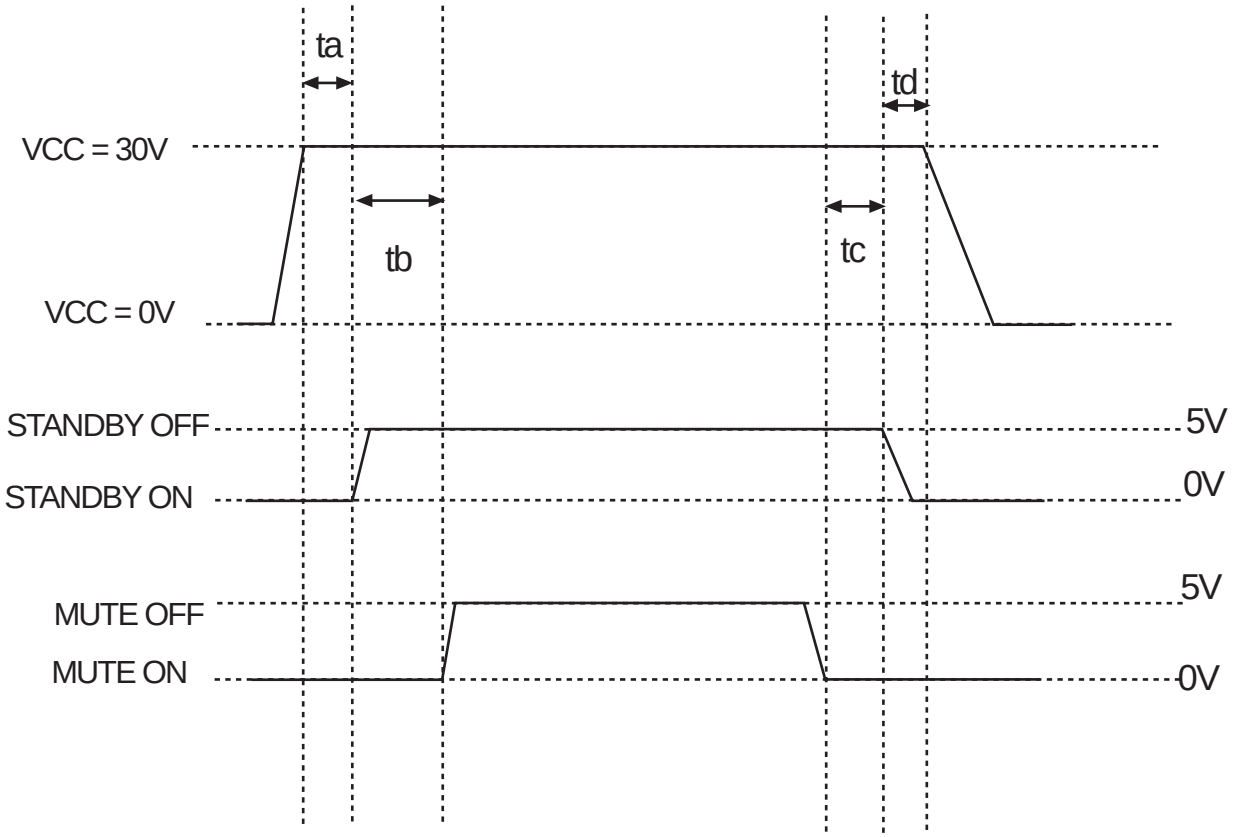
(4) 3.0W at Ta = 25°C ( θj-a = 42°C/W )

Without heat sink

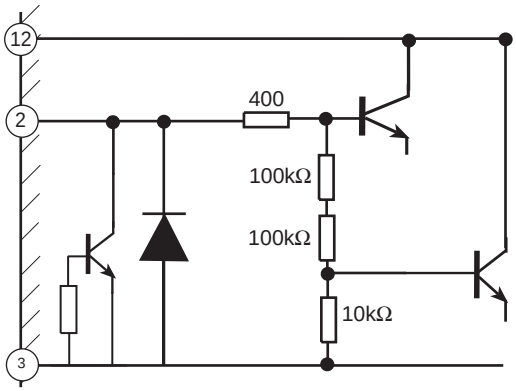
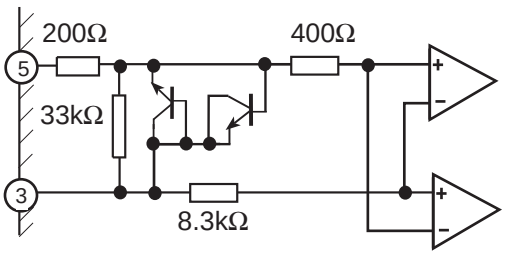
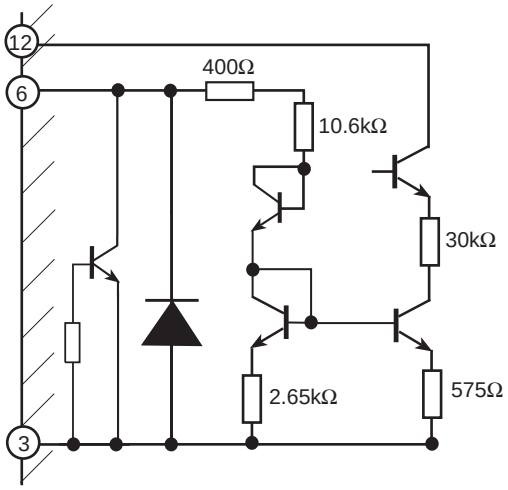


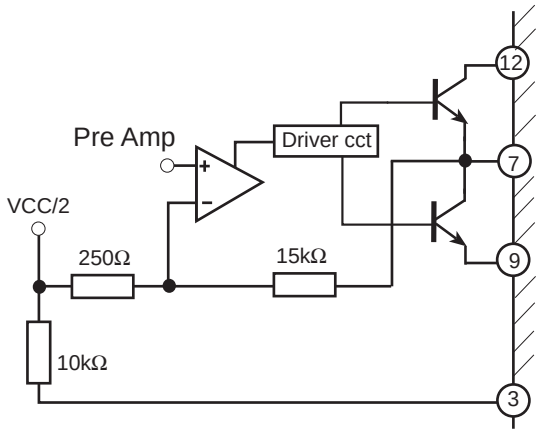
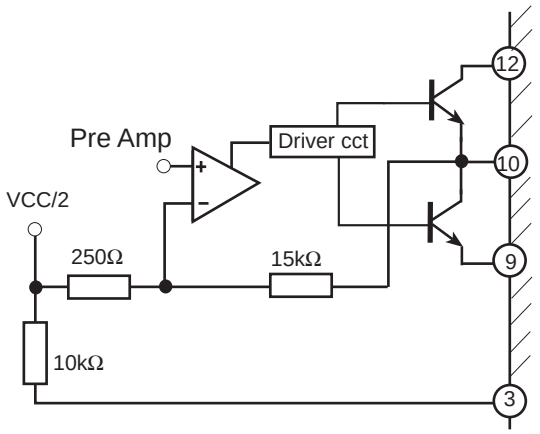
## Area of Safe Operation






| | Description | Minimum | Unit |
|---|---|---|---|
| ta | Wating time required for Standby to turn off after VCC is on. | 0 | ms |
| tb | Wating time required for Mute turn off after Standby is off. | 500 | ms |
| tc | Wating time required for Standby to turn on after Mute is on | 300 | ms |
| td | Waiting time required for VCC to turn off after Standby is on | 0 | ms |

| Pin No. | Function | Internal circuitry | Description | DC BIAS (V) |
|---|---|---|---|---|
| 1 | NC | ——— | ——— | ——— |
| 2 | Standby |  | Standby control pin<br>Standby “ON” = 0V<br>Standby “OFF” = 5V | Determined by external |
| 3 | IN GND | | Input ground | 0V |
| 4 | NC | ——— | ——— | ——— |
| 5 | INPUT |  | AC input Terminal | 0V |
| 6 | MUTE |  | MUTE Control<br>MUTE “OFF” = 5V<br>MUTE ON = 0V | Determined by external |

| Pin No. | Function | Internal circuitry | Description | DC BIAS (V) |
|---|---|---|---|---|
| 7 | Output (-) |  | Negative output terminal | VCC/2 |
| 8 | NC | ——— | ——— | ——— |
| 9 | PWR GND | | Output Power Ground | 0V |
| 10 | Output (+) |  | Positive output terminal | VCC/2 |
| 11 | NC | ——— | ——— | ——— |
| 12 | VCC | | Power Supply Pin | Typ 30V |

Power dissipation and Heat Sink

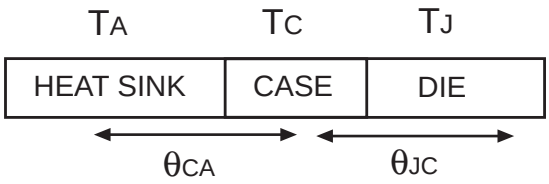



**FIG1. Simplified Illustration of IC and Heat Sink attached**

## Definition of terms

PD: Power Dissipation
Tj: Junction Temperature
TC: Case Temperature
TA: Ambient Temperature
θJC: Thermal Resistance of junction to case
θCA: Thermal Resistance of case to ambient, normally through heat sink

The following two equations represent the relations of these terms.

$$( Tj - TC ) / \theta JC = PD \qquad (1)$$
$$( TC - TA ) / \theta CA = PD' \qquad (2)$$

For reliable and long-term, continuous operation, junction temperature should not exceed 125°C and θJC for FP-12S package is 2°C/W. Substitute these values in Equation 1. After specify the PD, TC can be determined.

Assume no heat loss at the casing,i.e. all power is dissipated to the ambient through heat sink, which is quite true. So PD = PD'. Since TC is also known, one can determine the following using equation2:

a) The rating of heat sink for specific maximum operating ambient temperature, or
b) The maximum operating ambient temperature for specific heat sink rating.

A more general equation can be used for rough calculation.

$$( TJ - TA ) / \theta JA = PD \qquad (3)$$
$$\theta JA = \theta CA + \theta JC \qquad (4)$$

In this case, θJA is total thermal resistance of the heat sink and IC package. Therefore, for specified power dissipation, either heat sink rating or maximum operating ambient temperature can be decided if the other is known.

Take note that it's essential to know PD value before hand in order to work out other quantities. PD calculation is as shown.

$$PD = Vcc \times Icc - Po\_total \qquad (5)$$

Vcc: DC supply voltage
Icc: RMS value of IC current
Po_total: Total output power

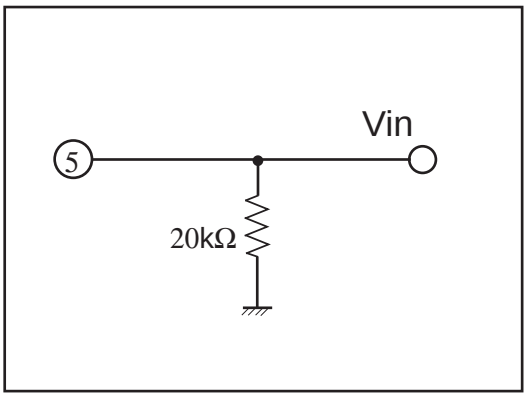



**FIG2. Input DC Biasing**

## Input DC biasing

Input DC bias is maintained at ground level. If the input signal contains DC bias voltage, AC coupling should be included on the application circuit.

The value of 20kΩ resistor is set in order to achieve the minimum output DC offset.

## Output Zobel Network

It should be noted that this device is designed such that the Zobel network (RC pair) at the output pins is not necessary for stable operation.

In practical application, the Zobel network may be applied optionally for two reasons:

a) Ensuring stability for different PCB layout and speaker types.

b) Ability to withstand to high ESD levels.

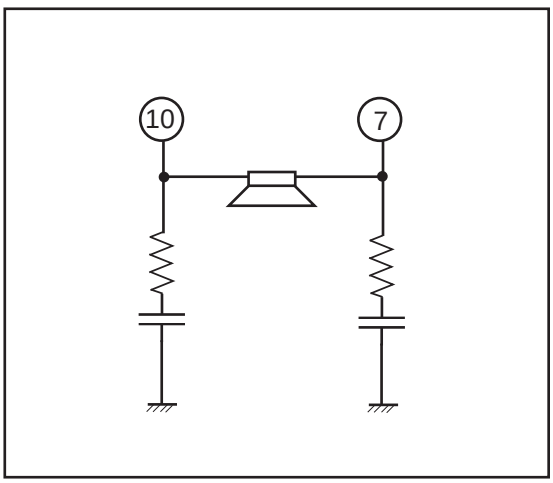



**FIG3. Output Zobel Network**

## Standby operation

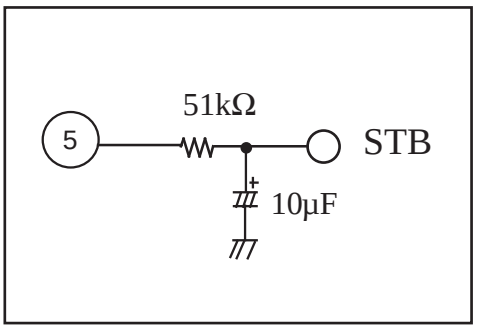



**FIG4. Standby Application circuit**

Standby pin should be connected with carefully selected components in order to avoid "Pop Noise" during Standby ON/OFF transient.

The 51k resistor and 10uF capacitor pair can delay the rising of voltage at pin 5 to reach the Standby threshold. When Standby is switching on together with supply, this delay would be very useful to ensure no "Pop Noise".

If the Standby voltage is provided by a microcontroller, the suppression of "Pop" could even be better.

For further details of timing and delay for standby circuit, please refer to page 11.

## Mute operation

Mute pin should be connected with carefully selected components in order to avoid "Pop Noise" during MUTE ON/OFF transient.

The 8.2k resistor and 33uF capacitor pair can delay the rising of voltage at pin 6 to reach the Mute threshold. When Mute is switching on together with supply, this delay would be very useful to ensure no "Pop Noise".

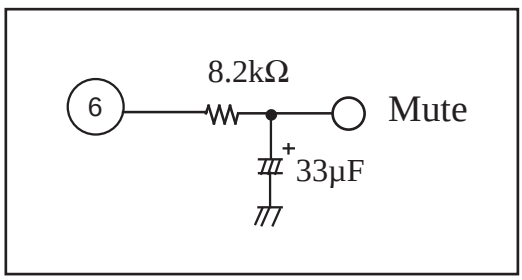



**FIG5. Mute application circuit**

For further details of timing and delay for Mute application circuit, please refer to page 11.

# (Precaution for use)

1) Ground the radiation fin so that there will be no difference in electric potential between the radiation fin and ground.

2) The thermal protection circuit operates at Tj at approximately 150°C. Thermal protection circuit is reset automatically when the temperature drops.

3) Be sure to attach heatsink to the IC before use. Make sure that the heatsink is secured to the chassis.

4) In order to prevent IC from being damaged during the fault test, prior to standby switching from on to off or vice versa, it is important to assert the mute on. Please refer to the timing diagram on page 11.