

System power supply for car stereos

BA3915B

The BA3915B is an one-chip power supply IC for use in car audio systems. The IC has seven output systems : one 5V output (V_{DD}), four 8.5V outputs (COM, FM, AM, AR), and two high-side switch outputs (ANT, AMP). The 5V outputs operate all the time if only the BCAD input is provided. The other outputs operate with BACKUP and ACC inputs, and their ON / OFF is controlled by the STANDBY and MODE inputs.

● Applications

Car audio systems

● Features

- 1) ACC and BACKUP voltages are monitored, compared with the internally set values; one-shot pulses are output to MUTE, which synchronizes with the rising and falling of the STANDBY input.
- 2) ACC voltage is monitored, compared with the internally set value, and the result is output to ACCB.
- 3) All outputs use a PNP transistor with low saturation voltage.
- 4) Output current limit circuit prevents damage to the IC due to short-circuiting.
- 5) Ovovoltage protection circuit provides protection against surges from the ACC or BACKUP input.
- 6) Compact 16-pin POWER package allows large power dissipation.

● Absolute maximum ratings ($T_a = 25^\circ\text{C}$)

| Parameter | Symbol | Limits | Unit |
|-----------------------|----------------------|----------|------|
| Power supply voltage | BACKUP/ACC | 24 | V |
| Power dissipation | Pd | 3400 | mW |
| Operating temperature | Topr | -30~+85 | °C |
| Storage temperature | Tstg | -55~+150 | °C |
| Peak applied voltage | BACKUP/BCAP/ACC Peak | 50*1 | V |

*1 $t_r \geq 1$ ms, applied time is less than 200 ms.

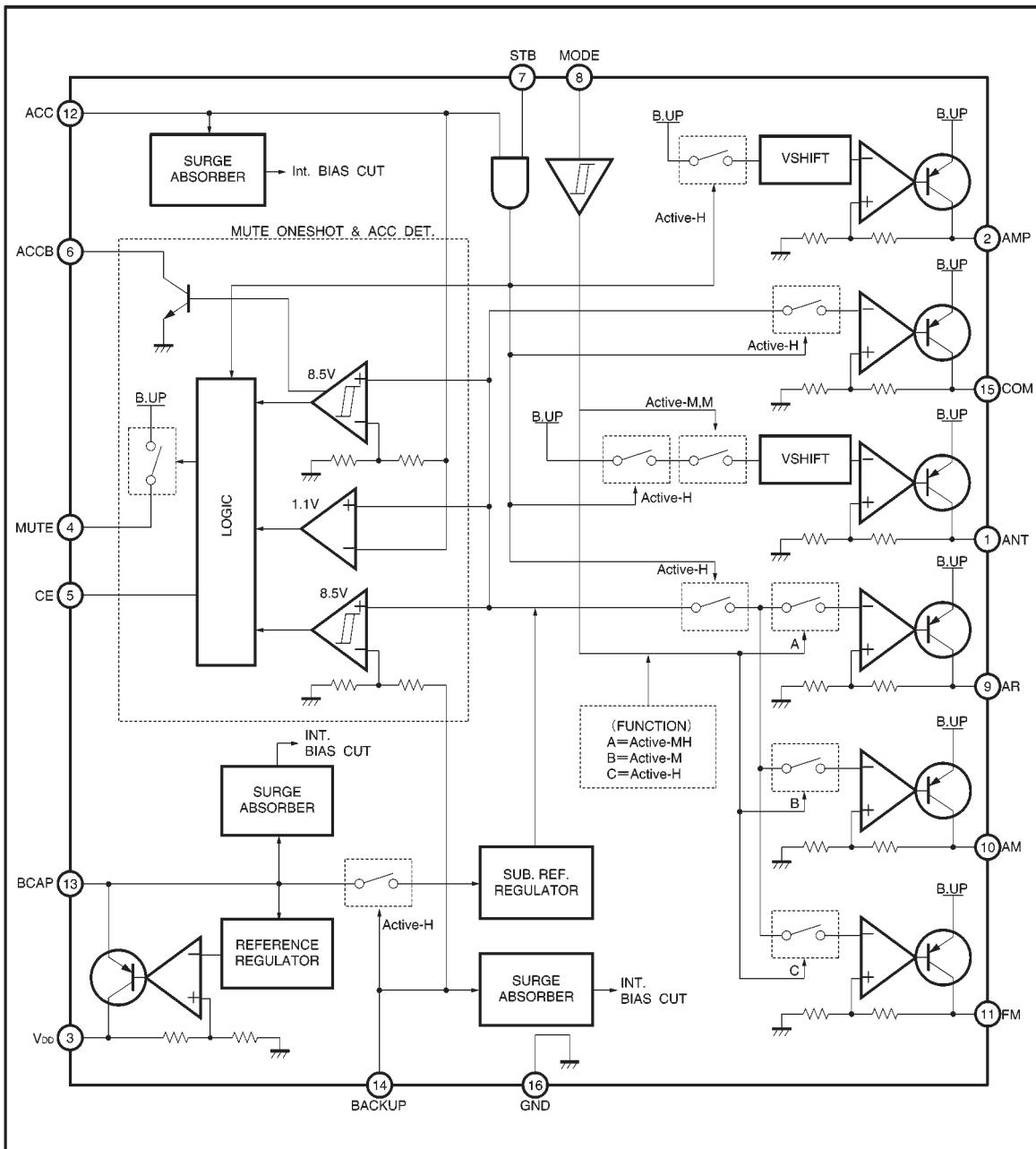
● Recommended operating conditions ($T_a = 25^\circ\text{C}$)

| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|----------------------------------|-----------------|------|------|------|------|
| Recommended power supply voltage | BACKUP/BCAP/ACC | 10 | 13.2 | 16 | V |
| Operable voltage | BACKUP/BCAP/ACC | 9.6 | 13.2 | 24 | V |
| MUTE section operating voltage | BACKUP | 4.0 | — | — | V |

Note: Not intended to ensure electrical characteristics (in particular, during a voltage drop)

Note: When the BACKUP input voltage becomes less than about 3 V, all the outputs except V_{DD} are shut down together with the logic bias voltage.

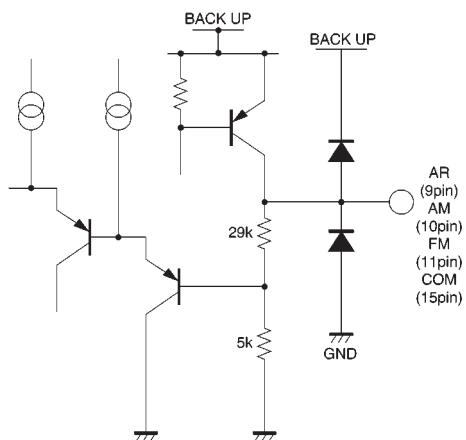
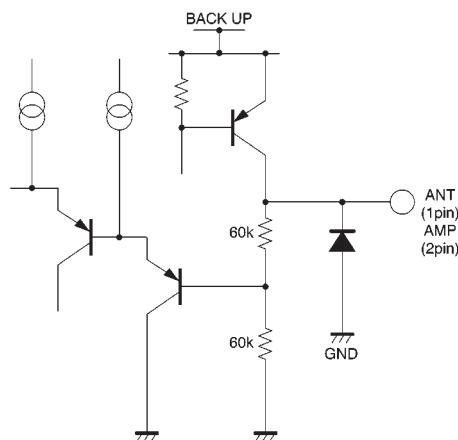
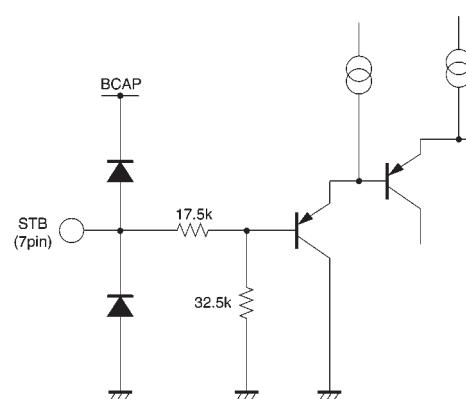
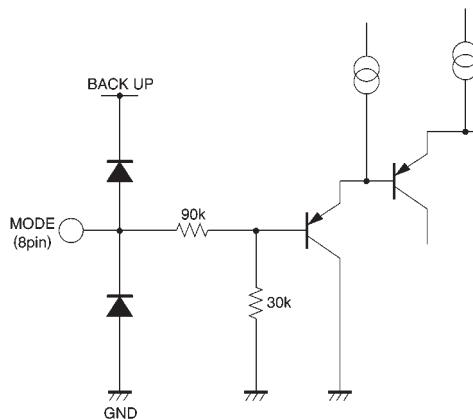
● Block diagram

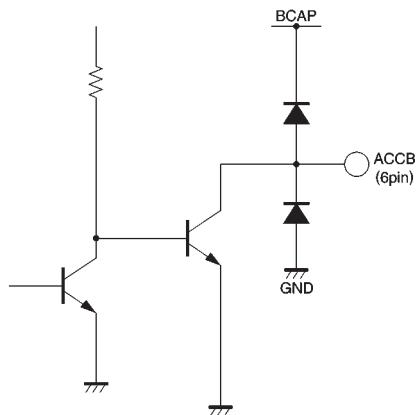
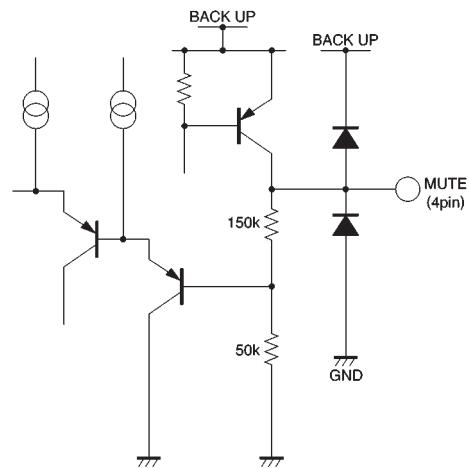
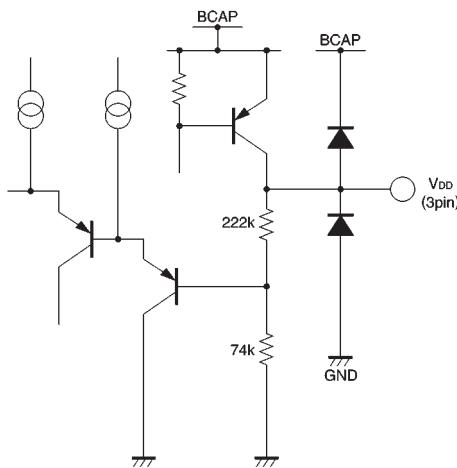


●Pin descriptions (Ta = 25°C, BACKUP / ACC = 13.2V)

| Pin No. | Pin name | Function |
|---------|-----------------|--|
| 1 | ANT | 12.6V power supply output pin for antenna drive |
| 2 | AMP | 12.6V power supply output pin for amplifiers |
| 3 | V _{DD} | 5.0V power supply output pin for microcontroller; always output when BACKUP input is provided |
| 4 | MUTE | One-shot pulse output |
| 5 | CE | Capacitor connection pin for one-shot pulse time constant (TM) setting |
| 6 | ACCB | NPN transistor open collector output; ON when ACC is 8.5 V (typical) or more |
| 7 | STANDBY | Only V _{DD} is output when LOW; COM, FM, AM, AR, ANT, and AMP can be output when HIGH |
| 8 | MODE | 3-mode input controls ON/OFF of FM, AM, AR, ANT, and AMP outputs |
| 9 | AR | 8.5V power supply output pin for AR |
| 10 | AM | 8.5V power supply output pin for AM tuner |
| 11 | FM | 8.5V power supply output pin for FM tuner |
| 12 | ACC | Accessory power supply connection |
| 13 | BCAP | Capacitor connection pin for V _{DD} backup |
| 14 | BACKUP | Backup power supply connection |
| 15 | COM | 8.5V power supply output pin for COMMON |
| 16 | GND | Ground |

● Input / output circuits





● Electrical characteristics (unless otherwise noted, Ta = 25°C, BACKUP / ACC = 13.2V)

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Conditions | Measurement circuit |
|----------------------------------|------------------|------|------|------|------|--|---------------------|
| BCAP supply current 1 | I_{CAP1} | — | 0.40 | 0.55 | mA | BCAP=12.5V, BUP=0V | Fig.1 |
| BACKUP standby supply current | I_{BUP} | — | 0.18 | 0.20 | mA | BUP=13.2V, BCAP=12.5V | Fig.1 |
| BCAP supply current 2 | I_{CAP2} | — | 1.30 | 1.75 | mA | BUP=13.2V, BCAP=12.5V | Fig.1 |
| ⟨V_{DD} | | | | | | | |
| Output voltage | V_{O1} | 4.75 | 5.00 | 5.25 | V | $I_{O1}=80\text{mA}$ | Fig.1 |
| Voltage regulation | ΔV_{O11} | — | 100 | 300 | mV | $I_{O1}=80\text{mA}$ | Fig.1 |
| Load regulation | V_{O11} | — | 50 | 170 | mV | $I_{O1}=0\rightarrow80\text{mA}$ | Fig.1 |
| Minimum I/O voltage differential | ΔV_{O12} | — | 0.4 | 0.7 | V | $I_{O1}=80\text{mA}$ | Fig.1 |
| Output current capacity | I_{O1} | 80 | — | — | mA | | Fig.1 |
| Ripple rejection ratio | RR1 | 41 | 45 | — | dB | $f=100\text{Hz}, V_{RR}=-10\text{dBV}$ | Fig.2 |
| ⟨COM⟩ | | | | | | | |
| Output voltage | V_{O2} | 8.05 | 8.50 | 8.95 | V | $I_{O2}=300\text{mA}$ | Fig.1 |
| Voltage regulation | ΔV_{O21} | — | 100 | 300 | mV | $I_{O2}=300\text{mA}$ | Fig.1 |
| Load regulation | V_{O21} | — | 50 | 170 | mV | $I_{O2}=0\rightarrow300\text{mA}$ | Fig.1 |
| Minimum I/O voltage differential | ΔV_{O22} | — | 0.4 | 0.7 | V | $I_{O2}=300\text{mA}$ | Fig.1 |
| Output current capacity | I_{O2} | 300 | — | — | mA | | Fig.1 |
| Ripple rejection ratio | RR2 | 41 | 45 | — | dB | $f=100\text{Hz}, V_{RR}=-10\text{dBV}$ | Fig.2 |
| ⟨FM⟩ | | | | | | | |
| Output voltage | V_{O3} | 8.05 | 8.50 | 8.95 | V | $I_{O3}=300\text{mA}$ | Fig.1 |
| Voltage regulation | ΔV_{O31} | — | 100 | 300 | mV | $I_{O3}=300\text{mA}$ | Fig.1 |
| Load regulation | V_{O31} | — | 50 | 170 | mV | $I_{O3}=0\rightarrow300\text{mA}$ | Fig.1 |
| Minimum I/O voltage differential | ΔV_{O32} | — | 0.4 | 0.7 | mV | $I_{O3}=300\text{mA}$ | Fig.1 |
| Output current capacity | I_{O3} | 300 | — | — | mA | | Fig.1 |
| Ripple rejection ratio | RR3 | 41 | 45 | — | dB | $f=100\text{Hz}, V_{RR}=-10\text{dBV}$ | Fig.2 |
| ⟨AM⟩ | | | | | | | |
| Output voltage | V_{O4} | 8.05 | 8.50 | 8.95 | V | $I_{O4}=200\text{mA}$ | Fig.1 |
| Voltage regulation | ΔV_{O41} | — | 100 | 300 | mV | $I_{O4}=200\text{mA}$ | Fig.1 |
| Load regulation | V_{O41} | — | 50 | 170 | mV | $I_{O4}=0\rightarrow200\text{mA}$ | Fig.1 |
| Minimum I/O voltage differential | ΔV_{O42} | — | 0.4 | 0.7 | V | $I_{O4}=200\text{mA}$ | Fig.1 |
| Output current capacity | I_{O4} | 200 | — | — | mA | | Fig.1 |
| Ripple rejection ratio | RR4 | 36 | 40 | — | dB | $f=100\text{Hz}, V_{RR}=-10\text{dBV}$ | Fig.2 |
| ⟨ANT⟩ | | | | | | | |
| Minimum I/O voltage differential | ΔV_{O52} | — | 0.6 | 1.1 | V | $I_{O5}=250\text{mA}$ | Fig.1 |
| Load regulation | V_{O51} | — | 180 | 540 | mV | $I_{O5}=0\rightarrow250\text{mA}$ | Fig.1 |
| Output current capacity | I_{O5} | 250 | — | — | mA | | Fig.1 |
| ⟨AMP⟩ | | | | | | | |
| Minimum I/O voltage differential | ΔV_{O62} | — | 0.6 | 1.1 | V | $I_{O6}=100\text{mA}$ | Fig.1 |
| Load regulation | V_{O61} | — | 100 | 300 | mV | $I_{O6}=0\rightarrow100\text{mA}$ | Fig.1 |
| Output current capacity | I_{O6} | 100 | — | — | mA | | Fig.1 |

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Conditions | Measurement circuit |
|-----------------------------------|------------------|------|------|------|---------------|--|---------------------|
| ⟨AR⟩ | | | | | | | |
| Output voltage | V_{O7} | 8.05 | 8.50 | 8.95 | V | $I_{O7}=200\text{mA}$ | Fig.1 |
| Voltage regulation | ΔV_{O71} | — | 100 | 300 | mV | $I_{O7}=200\text{mA}$ | Fig.1 |
| Load regulation | V_{O71} | — | 50 | 170 | mV | $I_{O7}=0\rightarrow200\text{mA}$ | Fig.1 |
| Minimum I/O voltage differential | ΔV_{O72} | — | 0.4 | 0.7 | V | $I_{O7}=200\text{mA}$ | Fig.1 |
| Output current capacity | I_{O7} | 200 | — | — | mA | | Fig.1 |
| Ripple rejection ratio | $RR7$ | 41 | 45 | — | dB | $f=100\text{Hz}, V_{RR}=-10\text{dBV}$ | Fig.2 |
| ⟨MUTE⟩ | | | | | | | |
| Output voltage | V_{O8} | 4.3 | 4.9 | 5.5 | V | $I_{O8}=10\text{mA}$ | Fig.3 |
| Pulse CE output current | I_{TM} | 0.6 | 1.0 | 1.4 | μA | $I_{O8}=10\text{mA}$ | Fig.3 |
| Pulse threshold voltage | V_{TM} | 0.9 | 1.0 | 1.1 | V | $I_{O8}=10\text{mA}$ | Fig.3 |
| Pulse width | TM | — | 0.1 | — | SEC | $CE=0.1\ \mu\text{F}$ | Fig.3 |
| ⟨ACC⟩ | | | | | | | |
| Output A rising threshold | V_{TAR1} | 1.0 | 1.1 | 1.2 | V | TM is counted from ACC = V_{TAR2} | Fig.3 |
| Pulse A rising threshold | V_{TAR2} | 8.0 | 8.5 | 9.0 | V | | Fig.3 |
| Output A falling threshold | V_{TAF1} | 8.0 | 8.5 | 9.0 | V | | Fig.3 |
| Pulse A falling threshold | V_{TAF2} | 1.0 | 1.1 | 1.2 | V | | Fig.3 |
| ⟨BACKUP⟩ | | | | | | | |
| Output B rising threshold | V_{TBR1} | 4.7 | 5.0 | 5.3 | V | | Fig.3 |
| Pulse B rising threshold | V_{TBR2} | 8.0 | 8.5 | 9.0 | V | | Fig.3 |
| Output B falling threshold | V_{TBF1} | 8.0 | 8.5 | 9.0 | V | | Fig.3 |
| Pulse B falling threshold | V_{TBF2} | 4.7 | 5.0 | 5.3 | V | | Fig.3 |
| ⟨STANDBY⟩ | | | | | | | |
| Output S rising threshold | V_{TSR1} | 1.6 | 1.9 | 2.2 | V | | Fig.3 |
| Pulse S rising threshold | V_{TSR2} | 2.6 | 2.9 | 3.2 | V | | Fig.3 |
| Output S falling threshold | V_{TSF1} | 2.6 | 2.9 | 3.2 | V | | Fig.3 |
| Pulse S falling threshold | V_{TSF2} | 1.6 | 1.9 | 2.2 | V | | Fig.3 |
| ⟨MODE⟩ | | | | | | | |
| OFF MODE threshold | V_{TR1} | — | — | 1.1 | V | OFF MODE | Fig.1 |
| AM ON threshold | V_{TR2} | 1.25 | 1.5 | 1.75 | V | AM MODE WITH ANT, AMP & AR | Fig.1 |
| FM ON threshold | V_{TR3} | 2.5 | 3.0 | 3.5 | V | FM MODE WITH ANT, AMP & AR | Fig.1 |
| AM hysteresis width | V_{AHY} | 0.1 | 0.2 | 0.3 | V | AM MODE WITH ANT, AMP & AR | Fig.1 |
| FM hysteresis width | V_{FHY} | 0.1 | 0.2 | 0.3 | V | FM MODE WITH ANT, AMP & AR | Fig.1 |
| Input current | I_{MO} | 15 | 40 | 65 | μA | MODE=5V | Fig.1 |
| ⟨STANDBY⟩ | | | | | | | |
| Standby level | V_{SB1} | — | — | 2.4 | V | | Fig.1 |
| Active level | V_{SB2} | 3.2 | — | — | V | | Fig.1 |
| Input current | V_{STB} | 75 | 100 | 125 | μA | STANDBY=5V | Fig.1 |
| ⟨ACCB⟩ | | | | | | | |
| Detected voltage | V_{DET} | 8.0 | 8.5 | 9.0 | V | Same as V_{TAF} | Fig.1 |
| Output saturation voltage when ON | V_{SAT1} | — | 0.5 | 0.9 | V | $ACC=13.2\text{V}$ $I_{O9}=2\text{mA}$ | Fig.1 |

● Measurement circuits

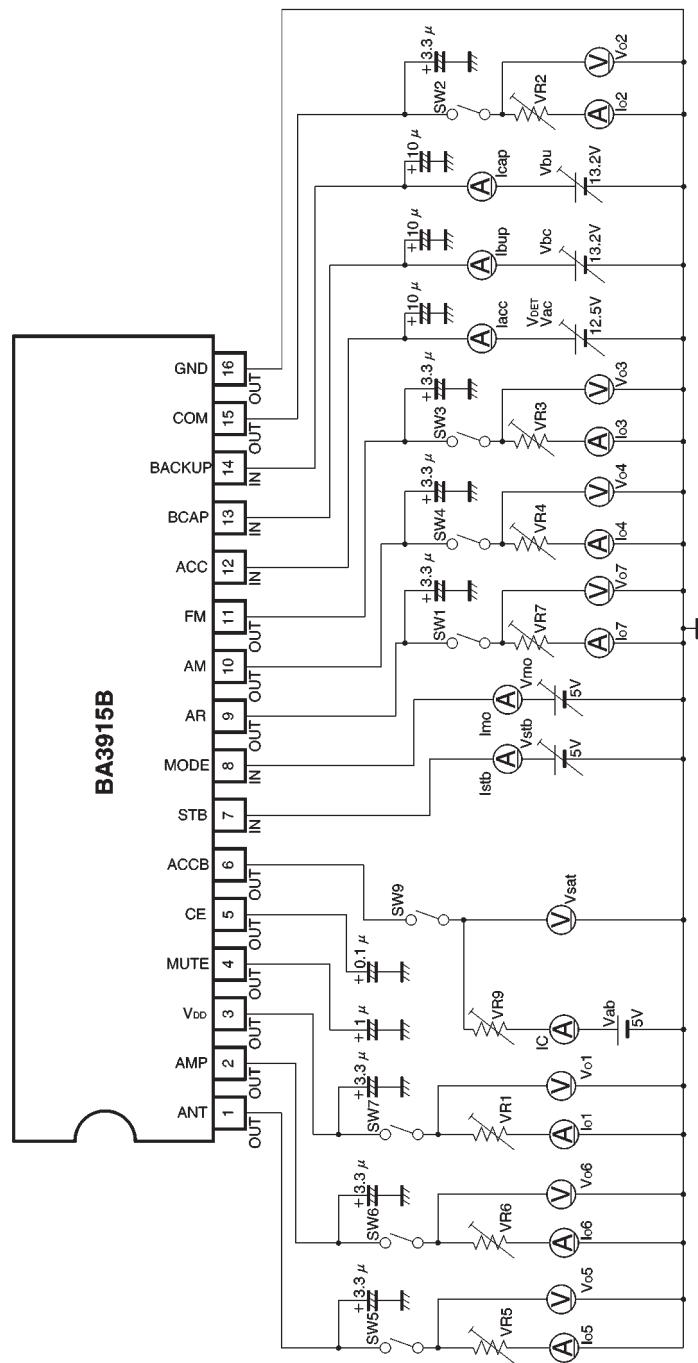


Fig. 7

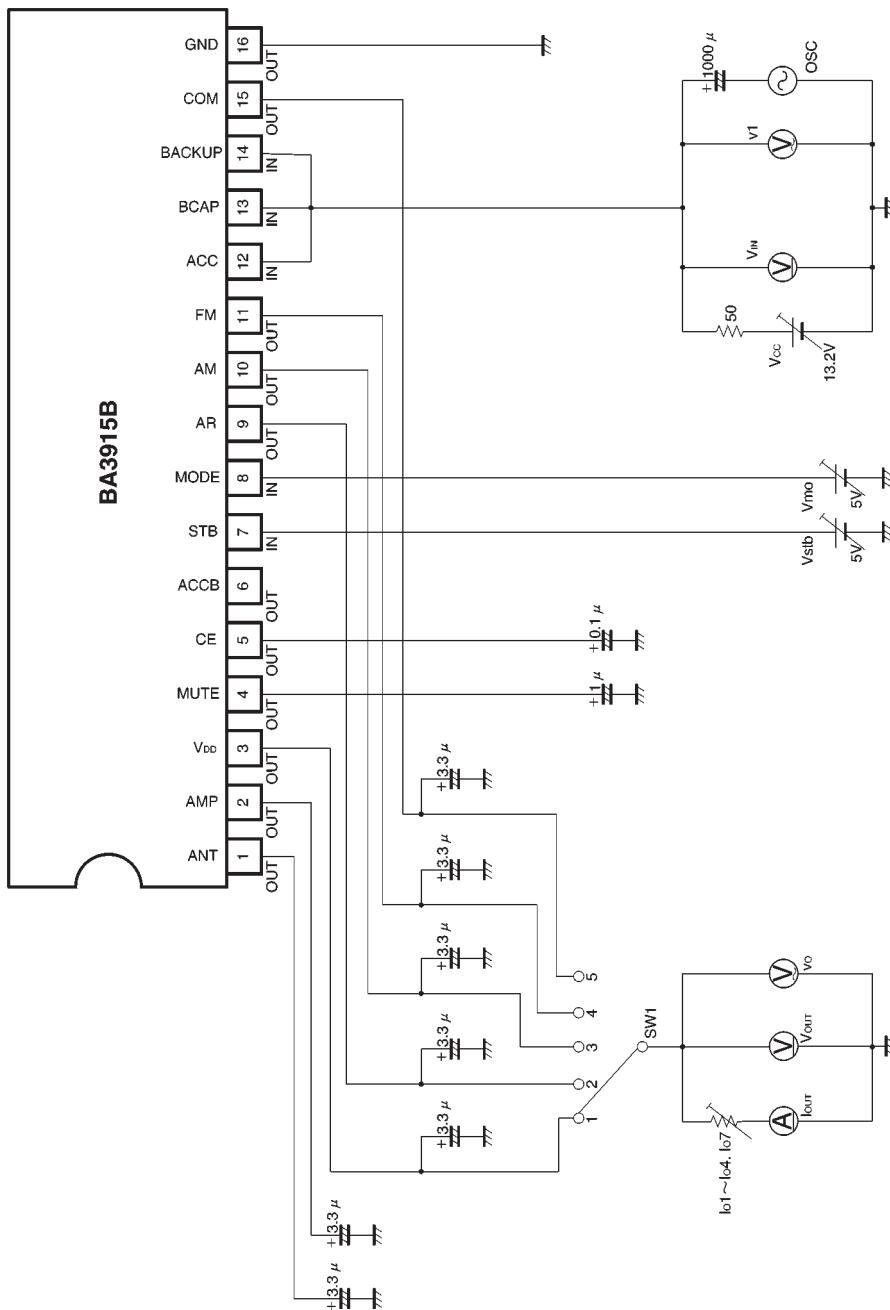


Fig.2

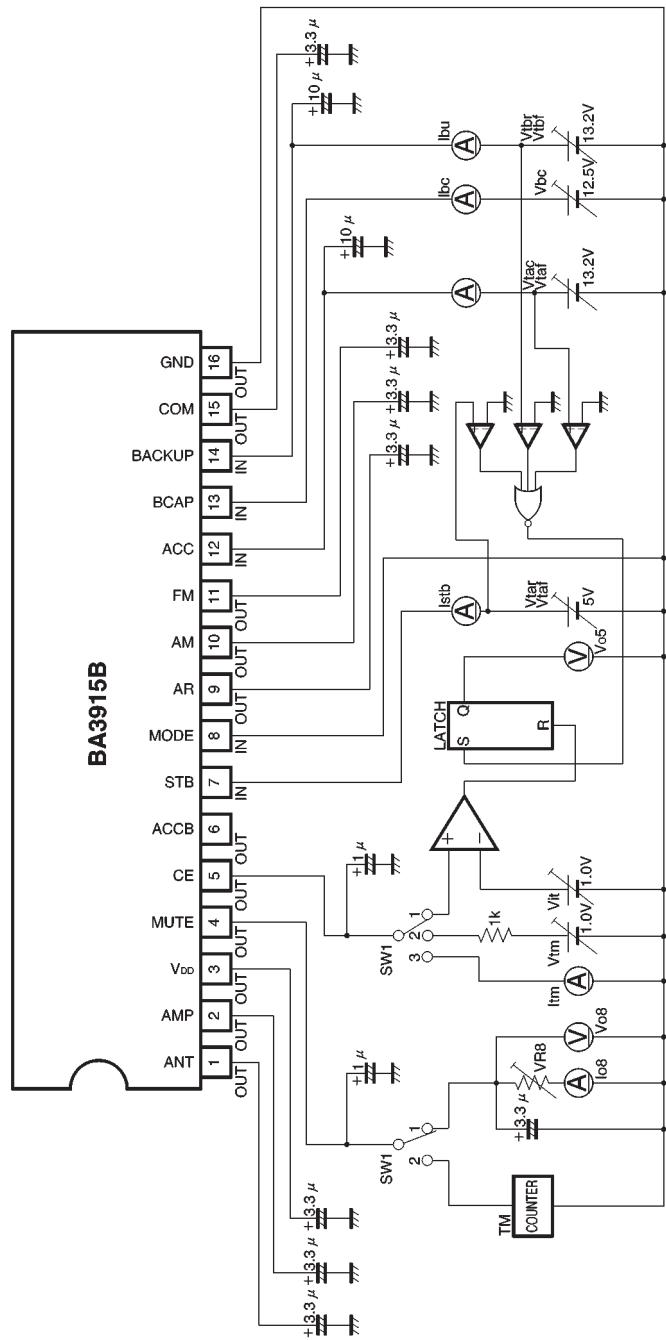
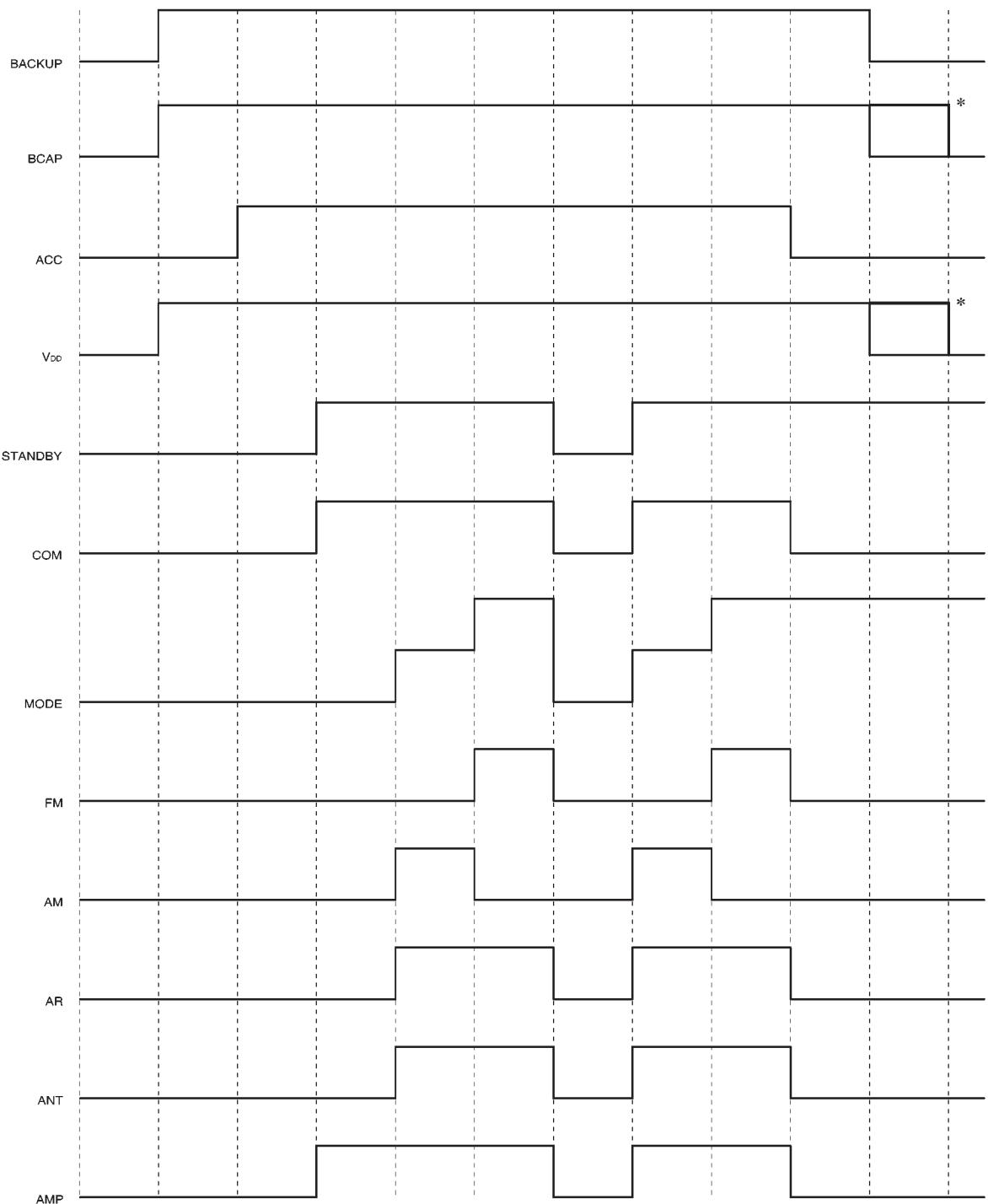


Fig.3

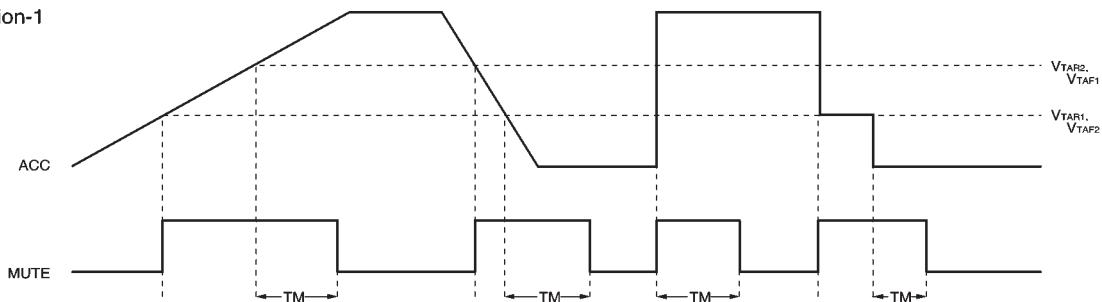
● Input / output timing chart



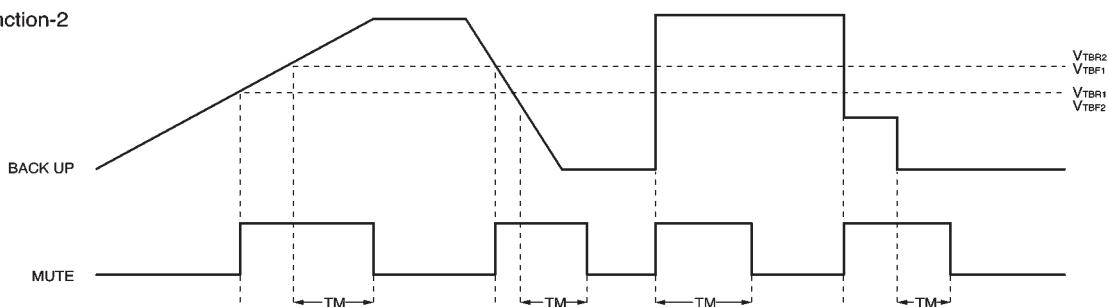
* ... When an external capacitor is connected

● MUTE timing chart

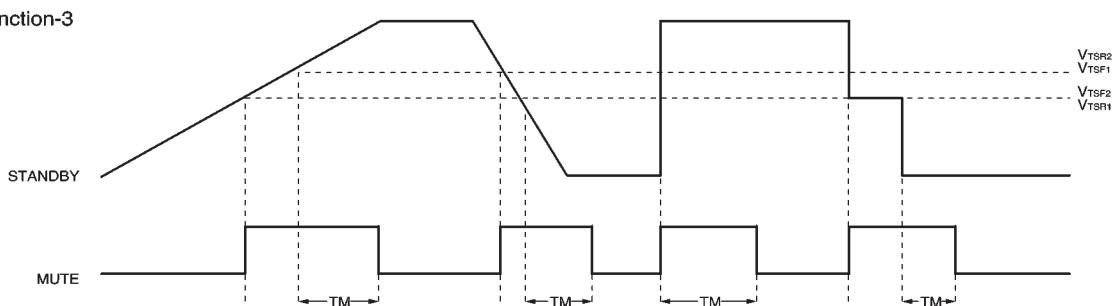
Function-1



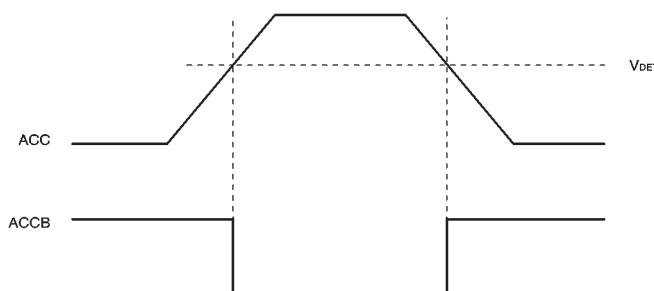
Function-2



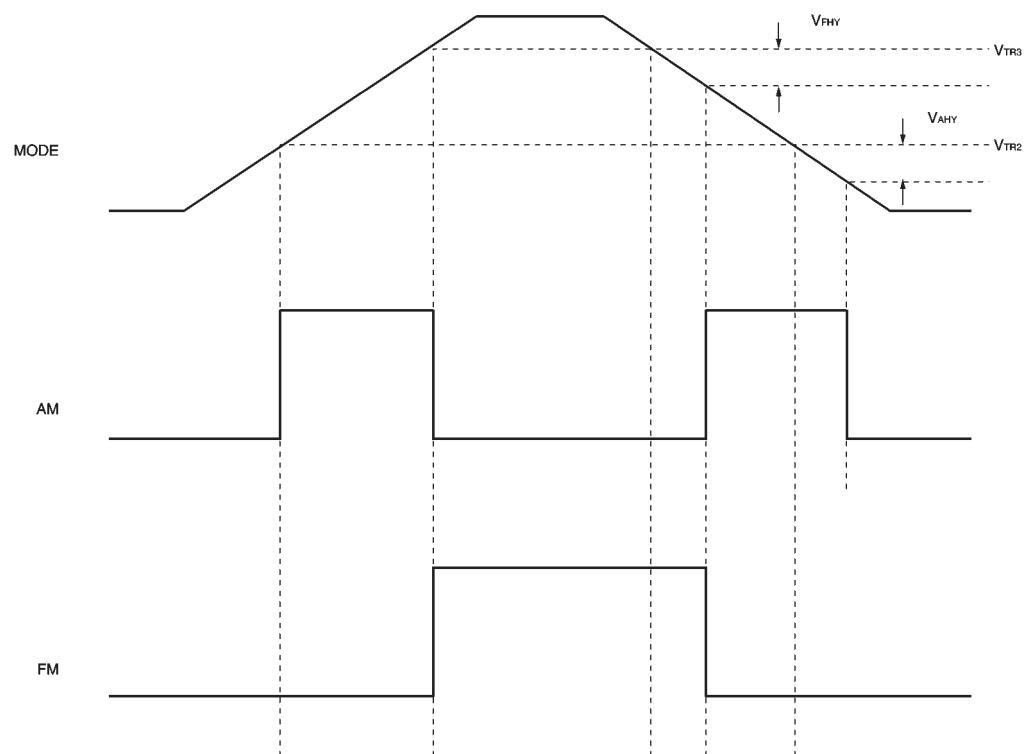
Function-3



ACCB timing chart

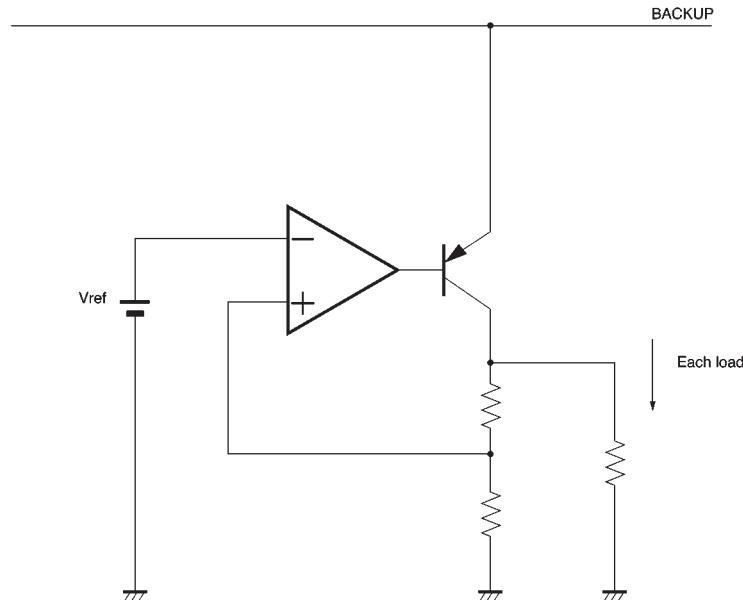


●AM / FM output timing chart



● Estimate of allowable power dissipation

Except under transitional conditions, the power dissipation of this IC is 3.4W per unit at 25°C. See Fig. 4 for heat reduction characteristics, including some cases where heat sinks are used.



A = maximum BACKUP voltage

B = maximum BCAP voltage

I_1 = maximum output current for V_{DD} (80mA)

I_2 = maximum output current for COM (300mA)

I_3 = maximum output current for FM (300mA)

I_4 = maximum output current for AM (200mA)

I_5 = maximum output current for AR (200mA)

I_6 = maximum output current for ANT (250mA)

I_7 = maximum output current for AMP (100mA)

- Power consumed by V_{DD} 5.0V
- Power consumed by COM 8.5V
- Power consumed by FM 8.5V
- Power consumed by AM 8.5V
- Power consumed by AR 8.5V
- Power consumed by ANT
- Power consumed by AMP
- Power consumed internally by each circuit

$$\begin{aligned}
 P_1 &= (B - 5.0V) \times I_1 + (I_1 / 16 + I_1 / 10) \times B \\
 P_2 &= (A - 8.5V) \times I_2 + (I_2 / 60 + I_2 / 10) \times A \\
 P_3 &= (A - 8.5V) \times I_3 + (I_3 / 60 + I_3 / 10) \times A \\
 P_4 &= (A - 8.5V) \times I_4 + (I_4 / 40 + I_4 / 10) \times A \\
 P_5 &= (A - 8.5V) \times I_5 + (I_5 / 40 + I_5 / 10) \times A \\
 P_6 &= (0.6V) \times I_6 + (I_6 / 50 + I_6 / 10) \times A \\
 P_7 &= (0.6V) \times I_7 + (I_7 / 50 + I_7 / 10) \times A \\
 P_8 &= A \times \text{circuit current (about 10mA)}
 \end{aligned}$$

$$P_{MAX} = P_1 + P_2 + (P_3 \text{ or } P_4, \text{ whichever is larger}) + P_5 + P_6 + P_7 + P_8$$

● Operation notes

(1) Although the quality of this IC is rigorously controlled, the IC may be destroyed when the supply voltage or the operating temperature exceeds their absolute maximum ratings. Because short mode or open mode cannot be specified when the IC is destroyed, be sure to take physical safety measures, such as fusing, if any of the absolute maximum ratings might be exceeded.

(2) Operating power supply voltage

When operating within the proper ranges of power supply voltage and ambient temperature, most circuit functions are guaranteed. Although the rated values of electrical characteristics cannot be absolutely guaranteed, characteristic values do not change drastically within the proper ranges.

(3) Power dissipation (Pd)

Refer to the power dissipation characteristics (Fig. 4) and the rough estimation of IC power dissipation given on a separate page. Make sure your design allows the maximum required power within the operating temperature range.

(4) Overvoltage protection circuit

The overvoltage protection circuit turns OFF all outputs when the potential difference between BACKUP (pin 14), BCAP (pin 13), or ACC (pin 12) and GND (pin 16) is more than about 26V at normal temperature. Make sure to use the IC within this voltage limit.

(5) Preventing oscillation at each output

To stop output oscillation, make sure to connect a capacitor having a capacitance of $10\mu\text{F}$ or greater between GND and each of the ANT (pin 1), AMP (pin 2), V_{DD} (pin 3), AM (pin 10), FM (pin 11), and COM (pin 15) output pins. We recommend using a tantalum electrolytic capacitor whose capacitance is unsusceptible to temperature.

(6) Overcurrent protection circuit

An overcurrent protection circuit is installed on the ANT (pin 1), AMP (pin 2), V_{DD} (pin 3), AM (pin 10), FM (pin 11), and COM (pin 15) outputs, based on the respective output current. This prevents IC destruction due to overcurrent, by limiting the current with a curve shape of "7" in the voltage-current graph. The IC is designed with margins so that current flow will be restricted and latching will be prevented even if a large current suddenly flows through

a large capacitor. The circuit should be carefully set because output current is further restricted when output voltage is less than 1V_F (considered as short mode).

(7) Thermal protection circuit

A built-in thermal protection circuit prevents thermal damage to the IC. All outputs except V_{DD} are switched OFF when the circuit operates, and revert to the original state when the temperature drops to a certain level.

(8) BACKUP-ACC potential difference

If the BACKUP voltage exceeds the ACC voltage, a current flows through a protection diode connected internally between BACKUP and ACC. If the potential difference is more than 1V_F , this diode is fully turned on.

(9) BCAP pin external diode

Voltage is supplied to BCAP from BACKUP through an external diode. The maximum current consumption is about 100mA. A reverse bias will be applied to the diode if the BCAP pin becomes 0V. Select a diode that has sufficient electrical characteristics to cope with the above conditions.

(10) Grounding

Each ground trace must be adequately short from GND (pin 16). Make sure to arrange the ground traces in a pattern that prevents mutual interference.

(11) We recommend installing a bypass line in your application if there is a mode where potential difference between each output and input (V_{cc}) or GND is reversed from the normal state.

● Electrical characteristic curves

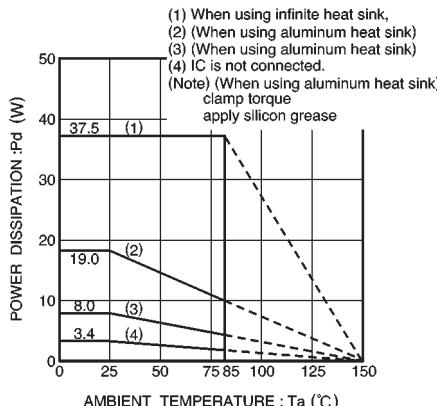


Fig.4 Thermal derating curve

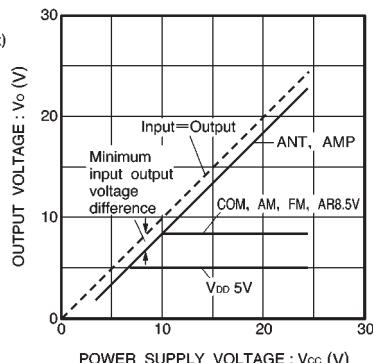


Fig.5 Output voltage vs. power supply voltage

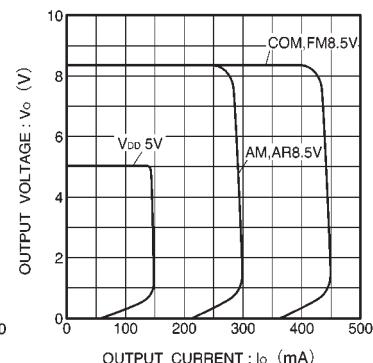


Fig.6 Output voltage vs. output current

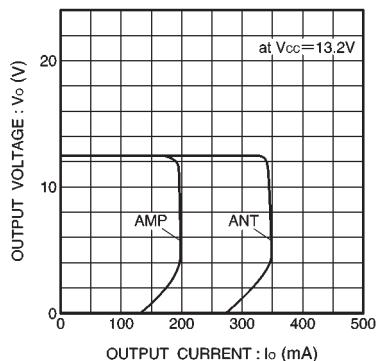


Fig.7 Output voltage vs. output current

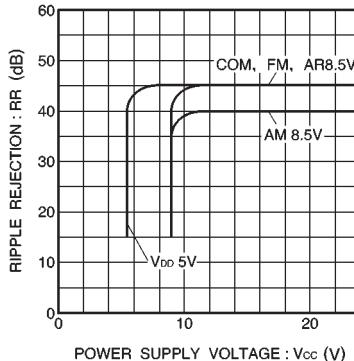


Fig.8 Ripple rejection ratio vs. power supply voltage

● External dimensions (Units: mm)

