

# System power supply for CD radio cassette players

## BA3938

The BA3938 is a system power supply IC for use in CD radio cassette players. With one 11V output and interlocked outputs of 8.5V, 5V, 9V, and  $V_{CC}$ , the IC is best suited for CD radio cassette players.

### ●Applications

CD radio cassette players

### ●Features

- 1) One 11V output (external transistor required) and interlocked outputs of 8.5V, 5V, 9V, and  $V_{CC}$  are built in.
- 2) Output current limit circuit protects the IC against short-circuiting damage.
- 3) Compact HSIP-B12 package allows a large power dissipation.

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

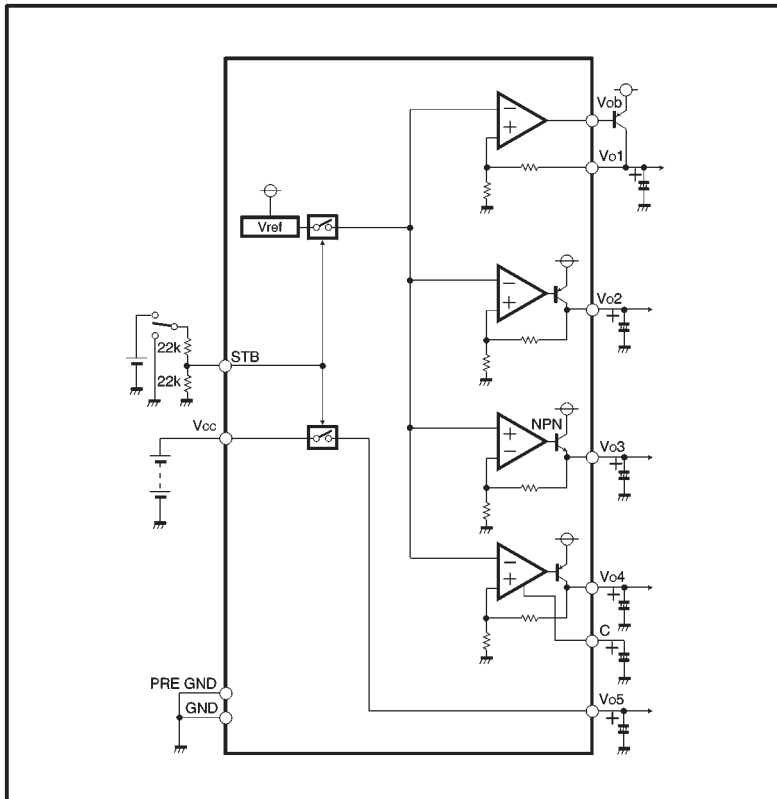
| Parameter             | Symbol    | Limits          | Unit             |
|-----------------------|-----------|-----------------|------------------|
| Power supply voltage  | $V_{CC}$  | 24              | V                |
| Power dissipation     | $P_d$     | 2200*           | mW               |
| Operating temperature | $T_{opr}$ | $-25 \sim +75$  | $^\circ\text{C}$ |
| Storage temperature   | $T_{stg}$ | $-55 \sim +150$ | $^\circ\text{C}$ |

\* Reduced by 17.6mW for each increase in  $T_a$  of  $1^\circ\text{C}$  over  $25^\circ\text{C}$ .

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

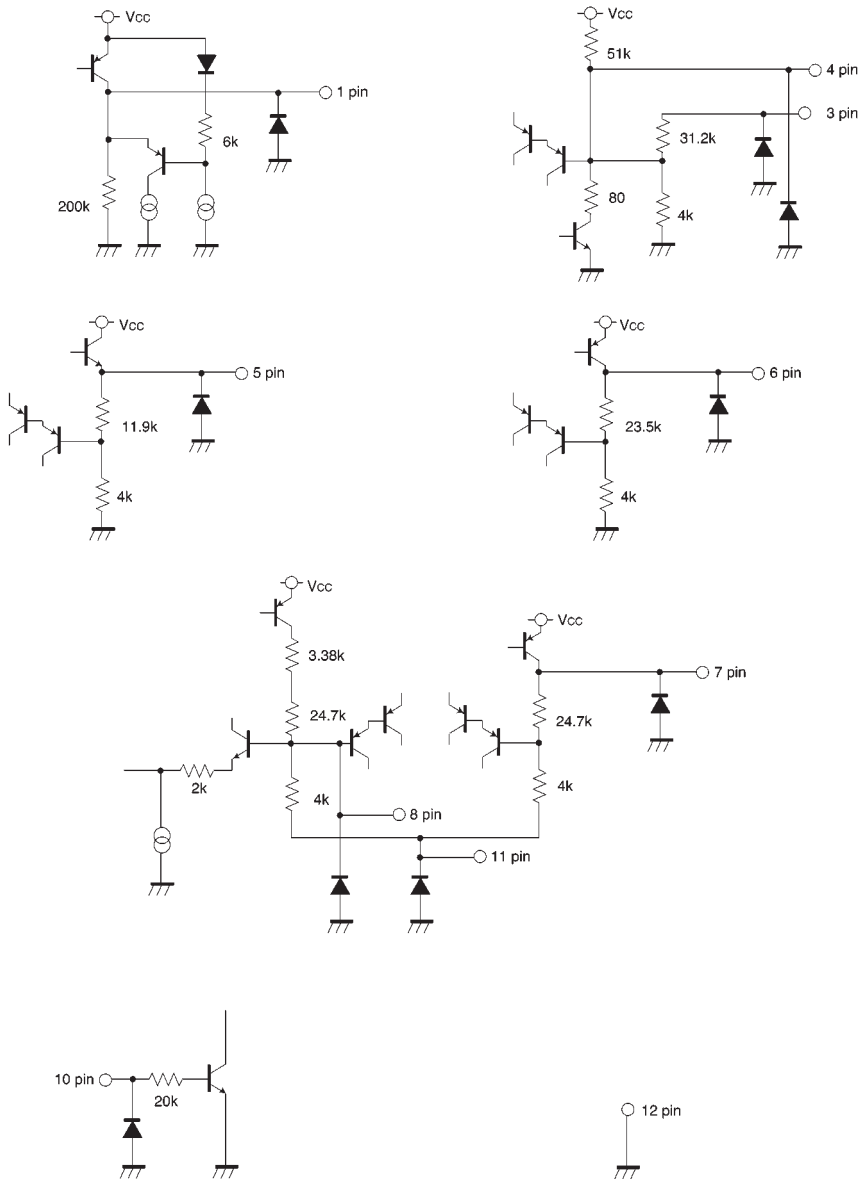
| Parameter            | Symbol   | Min. | Typ. | Max. | Unit |
|----------------------|----------|------|------|------|------|
| Power supply voltage | $V_{CC}$ | 6.5  | —    | 22   | V    |

## ● Block diagram



| Pin No. | Pin name                      | Function   |
|---------|-------------------------------|--|
| 1       | Vcc + B output                | 60 mA output current interlocked with Vcc                  |
| 2       | Vcc                           | DC supply input  |
| 3       | External transistor collector | Output pin for external transistors                        |
| 4       | External transistor base      | Base pin for external transistors                          |
| 5       | 5 V output                    | 220 mA power supply output current                         |
| 6       | 8.5 V output                  | 20 mA power supply output current                          |
| 7       | 9 V output                    | 300 mA power supply output current                         |
| 8       | C                             | Capacitor pin for improving the 9V output ripple rejection |
| 9       | N.C.                          | —  |
| 10      | STAND BY                      | Pin for ON/OFF control of each output                      |
| 11      | PRE GND                       | Small current GND  |
| 12      | GND                           | Large current GND  |

● Input / output circuits



Units : R [Ω]

●Electrical characteristics (unless otherwise noted, Ta = 25°C and V<sub>CC</sub> = 15.0V)

| Parameter  | Symbol             | Min.  | Typ. | Max.  | Unit | Conditions  |
|--|--------------------|-------|------|-------|------|---|
| Standby supply current                                 | I <sub>ST</sub>    | —     | 0    | 10    | μA   | STB pin=0 V   |
| Output voltage 1 (11 V)                                | V <sub>O1</sub>    | 10.45 | 11.0 | 11.55 | V    | Load current=550 mA,<br>external transistor (2SB1185, F-rank) |
| Base current drive capacity                            | I <sub>O1</sub>    | 22    | 32   | 40    | mA   |   |
| Output voltage 2 (8.5 V)                               | V <sub>O2</sub>    | 8.0   | 8.5  | 9.0   | V    | I <sub>O2</sub> =10mA   |
| Voltage regulation                                     | ΔV <sub>O21</sub>  | —     | 40   | 200   | mV   | V <sub>CC</sub> =10~24V, I <sub>O2</sub> =10mA                |
| Current variation                                      | ΔV <sub>O22</sub>  | —     | 20   | 200   | mV   | I <sub>O2</sub> =0~10mA                                       |
| Minimum I/O voltage differential                       | ΔV <sub>O23</sub>  | —     | 0.3  | 0.5   | V    | I <sub>O2</sub> =10mA   |
| Output current capacity                                | I <sub>O2</sub>    | 20    | —    | —     | mA   |   |
| Ripple rejection ratio                                 | R.R2               | 50    | 60   | —     | dB   | f=100Hz, V <sub>RR</sub> =-10dBV                              |
| Output voltage 3 (5 V)                                 | V <sub>O3</sub>    | 4.75  | 5.0  | 5.25  | V    | I <sub>O3</sub> =200mA  |
| Voltage regulation                                     | ΔV <sub>O31</sub>  | —     | 20   | 200   | mV   | V <sub>CC</sub> =7.25~24V, I <sub>O3</sub> =200mA             |
| Current variation                                      | ΔV <sub>O32</sub>  | —     | 100  | 250   | mV   | I <sub>O3</sub> =0~200mA                                      |
| Minimum I/O voltage differential                       | ΔV <sub>O33</sub>  | —     | 1.0  | 1.5   | V    | I <sub>O3</sub> =200mA  |
| Output current capacity                                | I <sub>O31</sub>   | 220   | —    | —     | mA   |   |
| Instantaneous output current capacity                  | I <sub>O32</sub>   | 500   | —    | —     | mA   | t=10ms  |
| Ripple rejection ratio                                 | R.R3               | 50    | 60   | —     | dB   | f=100Hz, V <sub>RR</sub> =-10dBV                              |
| Output voltage 4 (9 V)                                 | V <sub>O4</sub>    | 8.5   | 9.0  | 9.5   | V    | I <sub>O4</sub> =240mA  |
| Voltage regulation                                     | ΔV <sub>O41</sub>  | —     | 20   | 200   | mV   | V <sub>CC</sub> =12~24V, I <sub>O4</sub> =240mA               |
| Current variation                                      | ΔV <sub>O42</sub>  | —     | 40   | 200   | mV   | I <sub>O4</sub> =0~240mA                                      |
| Minimum I/O voltage differential                       | ΔV <sub>O43</sub>  | —     | 1.1  | 2.1   | V    | I <sub>O4</sub> =240mA  |
| Output current capacity                                | I <sub>O41</sub>   | 300   | —    | —     | mA   |   |
| Instantaneous output current capacity                  | I <sub>O42</sub>   | 500   | —    | —     | mA   | t= 10ms   |
| Ripple rejection ratio                                 | R.R4               | 50    | 62   | —     | dB   | f=100Hz, V <sub>RR</sub> =-10dBV                              |
| Minimum I/O voltage differential (V <sub>CC</sub> + B) | ΔV <sub>O51</sub>  | —     | 0.3  | 0.5   | V    | I <sub>O5</sub> =35mA   |
| Current variation                                      | ΔV <sub>O52</sub>  | —     | 20   | 200   | mV   | I <sub>O5</sub> =0~35mA                                       |
| Output current capacity                                | I <sub>O5</sub>    | 60    | —    | —     | mA   |   |
| 〈Input (STB)〉  |                    |       |      |       |      |   |
| Voltage when standby OFF                               | V <sub>STOFF</sub> | —     | —    | 0.9   | V    | STANDBY state   |
| Voltage when standby ON                                | V <sub>STON</sub>  | 1.7   | —    | —     | V    | All output ON   |
| Input high level current *                             | I <sub>H1</sub>    | —     | 195  | 300   | μA   | STANDBY pin=5 V   |

©Not designed for radiation resistance.

\* Input current (HIGH) on the STANDBY pin depends on the external resistors, whose recommended resistance is 22kΩ.

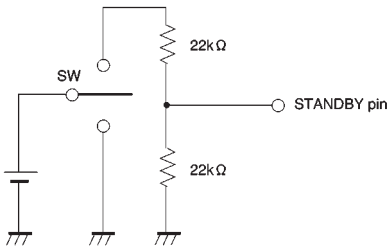


Fig.1 Standby pin external resistance

● Circuit operation

All outputs rise when voltage is applied on the STANDBY pin.

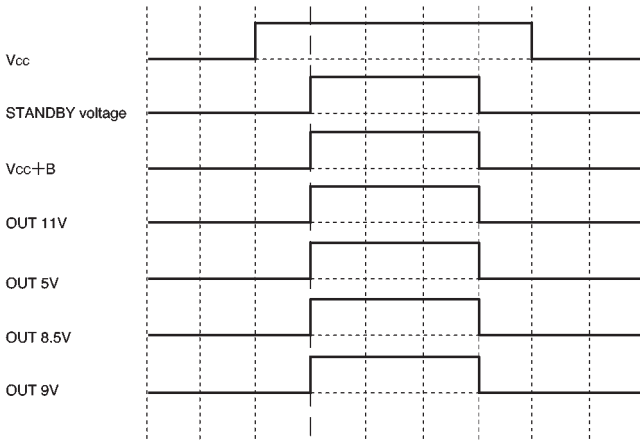


Fig.2 Timing chart

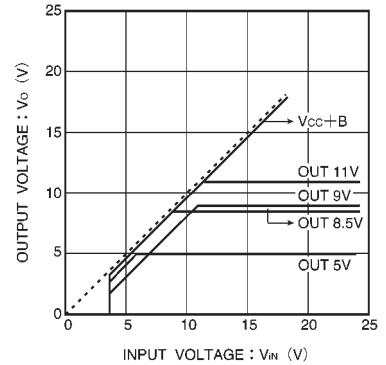


Fig.3 Input voltage vs. output voltage

## ●Application example

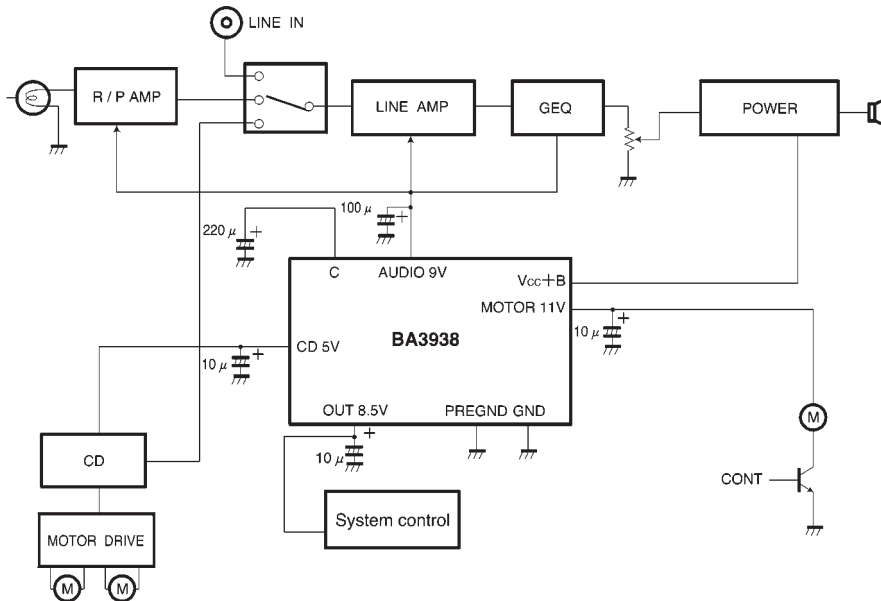


Fig.4

## ●Operation notes

## (1) Operating power supply voltage

When operating within 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.

## (2) Power dissipation (Pd)

Refer to the heat reduction characteristics (Fig. 5) and the rough estimation of IC power dissipation given on a separate page. If power dissipation exceeds the allowable limit, the functionality of IC will be degraded (such as reduction of current capacity by increased chip temperature). Make sure to use the IC within the allowable range of power dissipation with a sufficient margin.

## (3) Preventing oscillation at each output

To stop oscillation of output, make sure to connect a capacitor having a capacitance of 10µF or greater between GND and each output pin. Oscillation can occur if capacitance is susceptible to temperature. We recommend using a tantalum electrolytic capacitor with minimal changes in capacitance. Also, output can be further sta-

bilized by connecting a bypass capacitor between  $V_{cc}$  and GND.

## (4) Overcurrent protection circuit

An overcurrent protection circuit is installed in each output system, based on the respective output current. This prevents IC destruction by overcurrent, by limiting the current with a curve shape of "7" in the voltage-current graph (a curve shape of "inverted -L" for  $V_{cc} + B$ ). 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. Note that these protection circuits are only good for preventing damage from sudden accidents. Make sure your design does not cause the protection circuit to operate continuously under transitional conditions (for instance, if output is clamped at  $1V_F$  or higher, short mode circuit operates at  $1V_F$  or lower). Note that the circuit ability is negatively correlated with temperature.

## (5) Thermal protection circuit

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

## (6) Grounding

To minimize the variation of output voltage due to variations in load current, the GND (pin 12, for large current) and the PRE GND (pin 11, for small current) pins are separately provided. Make sure to connect circuits to correct pins.

## (7) STANDBY voltage

Note that ON-state voltage and HIGH-state input current of each output change when the external resistors of the STANDBY pin are changed. These values are roughly estimated as :

$$\text{STB voltage when ON} = 0.7 (R1 + R2) / R2$$

$$\text{STB current when HIGH} = (5 - 0.7) / R1$$

## ● Thermal derating curve

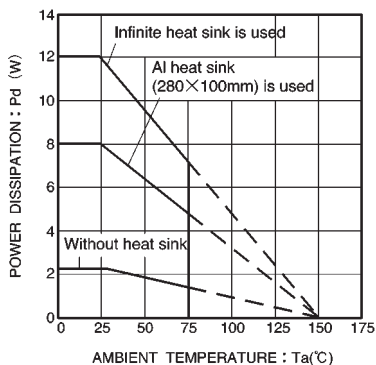


Fig.5

Estimate of allowable power dissipation ( $P_{MAX}$ .)

- Power consumed by  $V_{CC} + B$
- Power consumed by OUT 5V
- Power consumed by CD 8.5V
- Power consumed by OUT 9V
- Power consumed internally by each circuit

$$P_1 = (V_{CC} - V_{CC} + B) \times \text{maximum output current of } V_{CC} + B$$

$$P_2 = (V_{CC} - 5V) \times \text{maximum output current of OUT 5V}$$

$$P_3 = (V_{CC} - 8.5V) \times \text{maximum output current of OUT 8.5V}$$

$$P_4 = (V_{CC} - 9V) \times \text{maximum output current of OUT 9V}$$

$$P_5 = V_{CC} \times \text{supply current}$$

$$P_{MAX.} = P_1 + P_2 + P_3 + P_4 + P_5$$

## ● External dimensions (Units: mm)

