

# Reference voltage power supply

## BA3932

The BA3932 is a monolithic reference voltage power supply IC for use in CD radio cassette players.

### ●Applications

CD radio cassette players, mini-component stereo audio systems

### ●Features

- 1) With 9.0V output for audio power supply, 5.0V output for microcontrollers, 5.0 and 8.0V outputs for CD players, 14.7V output for motor drivers, the IC is best suited for CD radio cassette players.
- 2) Precise power supply ( $5V \pm 0.1V$ ) can be obtained by using external reference voltage input (only AUDIO output has an internal reference voltage system).
- 3) Zero standby current. (Typ.)
- 4) Output current limit circuit protects the IC against short-circuiting damage.
- 5) Compact SIP-M12 package allows a large power dissipation (3W: no heat sink).
- 6) Thermal protection circuit prevents heat damage to the IC.

### ●Absolute maximum ratings (Ta = 25°C)

| Parameter             | Symbol           | Limits   | Unit |
|-----------------------|------------------|----------|------|
| Applied voltage       | V <sub>CC</sub>  | 23       | V    |
| Power dissipation     | P <sub>d</sub>   | 3000*    | mW   |
| Operating temperature | T <sub>opr</sub> | -25~+75  | °C   |
| Storage temperature   | T <sub>stg</sub> | -55~+150 | °C   |

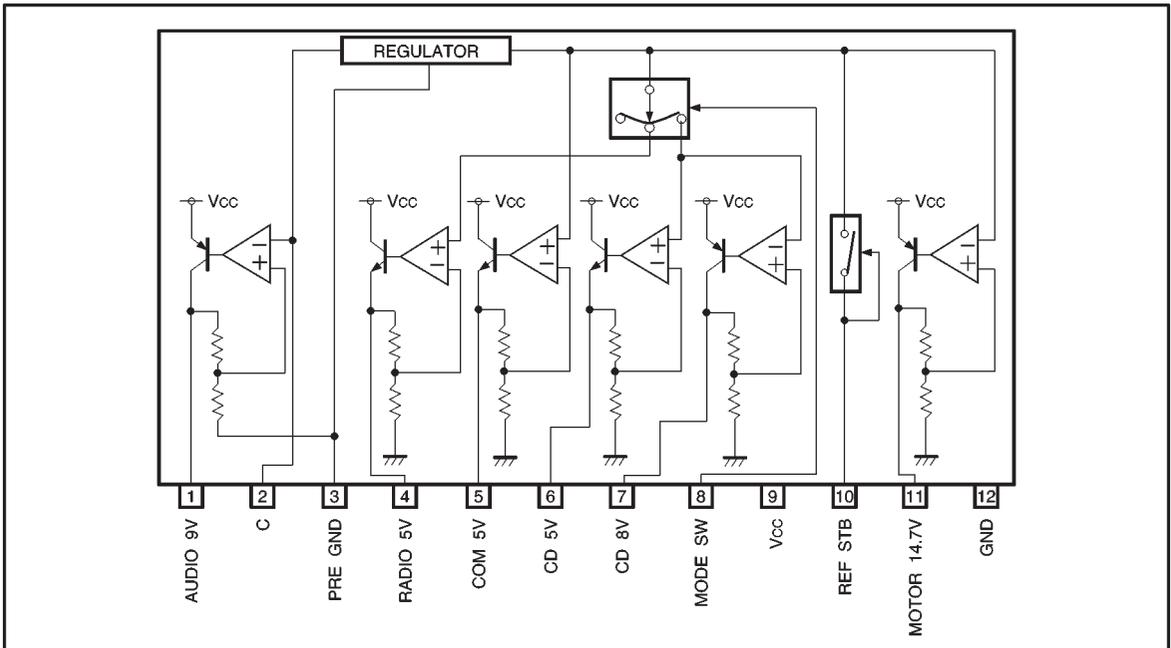
\* Reduced by 24mW for each increase in Ta of 1°C over 25°C.

### ●Recommended operating conditions

| Parameter            | Symbol          | Limits     | Unit |
|----------------------|-----------------|------------|------|
| Power supply voltage | V <sub>CC</sub> | 6.5~22.0*1 | V    |

\*1 For basic operation at Ta = 25°C.

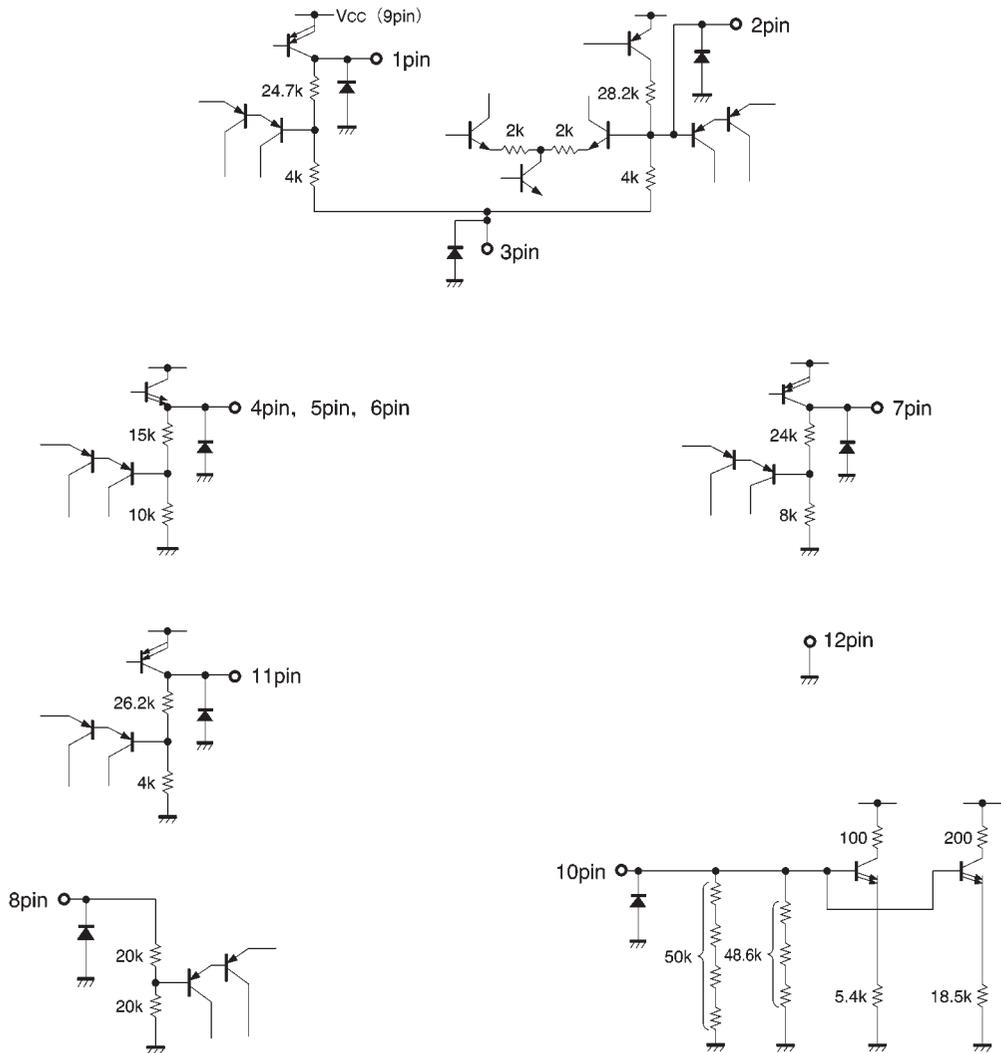
## ● Block diagram



## ● Pin descriptions

| Pin No. | Pin name    | Function   |
|---------|-------------|--|
| 1       | AUDIO 9V    | AUDIO 9V output  |
| 2       | C           | Capacitor for regulating AUDIO 9V                          |
| 3       | PRE GND     | AUDIO system GND   |
| 4       | RADIO 5V    | RADIO 5V output pin; output when MODE SW is 1.4V (typical) |
| 5       | COM 5V      | Microcontroller 5V output                                  |
| 6       | CD 5V       | CD 5V output pin; output when MODE SW is 3.2V (typical)    |
| 7       | CD 8V       | CD 8V output pin; output when MODE SW is 3.2V (typical)    |
| 8       | MODE SW     | Pin to select CD 5V, CD 8V, or RADIO 5V output             |
| 9       | Vcc         | Power supply   |
| 10      | REF STB     | Reference voltage 5V output pin; also a standby SW         |
| 11      | MOTOR 14.7V | MOTOR 14.7V output   |
| 12      | GND         | Large current GND, connected to the IC substrate           |

● Input / output circuits



Units : R [Ω]

●Electrical characteristics (unless otherwise noted, Ta = 25°C and V<sub>CC</sub> = 16.0V)

| Parameter                          | Symbol            | Min. | Typ. | Max. | Unit | Conditions  |
|------------------------------------|-------------------|------|------|------|------|---|
| Standby supply current             | I <sub>ST</sub>   | —    | 0    | 10   | μA   | REF STB=0V  |
| Output voltage (AUDIO 9V)          | V <sub>O1</sub>   | 8.5  | 9.0  | 9.5  | V    | I <sub>O1</sub> =250mA                            |
| Voltage regulation                 | ΔV <sub>O11</sub> | —    | 40   | 200  | mV   | V <sub>CC</sub> =11 ~ 22V I <sub>O1</sub> =250mA  |
| Load regulation                    | ΔV <sub>O12</sub> | —    | 30   | 200  | mV   | I <sub>O1</sub> =0 ~ 250mA                        |
| Minimum I/O voltage differential * | ΔV <sub>O13</sub> | —    | 1.1  | 2.1  | V    | I <sub>O1</sub> =250mA                            |
| Output current capacity *          | I <sub>O1</sub>   | 300  | 710  | —    | mA   | V <sub>O1</sub> ≥8.5V                             |
| Ripple rejection ratio             | R.R1              | 50   | 62   | —    | dB   | f=100Hz V <sub>RR</sub> =-10dBV                   |
| Output voltage (MOTOR 14.7V)       | V <sub>O2</sub>   | 14.1 | 14.7 | 15.3 | V    | I <sub>O2</sub> =600mA                            |
| Voltage regulation                 | ΔV <sub>O21</sub> | —    | 50   | 200  | mV   | V <sub>CC</sub> =16 ~ 22V I <sub>O2</sub> =600mA  |
| Load regulation                    | ΔV <sub>O22</sub> | —    | 150  | 600  | mV   | I <sub>O2</sub> =0 ~ 600mA                        |
| Minimum I/O voltage differential * | ΔV <sub>O23</sub> | —    | 0.5  | 0.9  | V    | I <sub>O2</sub> =600mA                            |
| Output current capacity            | I <sub>O2</sub>   | 1.2  | 1.4  | —    | A    | V <sub>O2</sub> ≥14.1V                            |
| Output voltage (CD 8.0V)           | V <sub>O3</sub>   | 7.5  | 8.0  | 8.5  | V    | I <sub>O3</sub> =400mA                            |
| Voltage regulation                 | ΔV <sub>O31</sub> | —    | 20   | 200  | mV   | V <sub>CC</sub> =9 ~ 22V I <sub>O3</sub> =400mA   |
| Load regulation                    | ΔV <sub>O32</sub> | —    | 70   | 250  | mV   | I <sub>O3</sub> =0 ~ 400mA                        |
| Minimum I/O voltage differential * | ΔV <sub>O33</sub> | —    | 0.3  | 1.0  | V    | I <sub>O3</sub> =400mA                            |
| Output current capacity            | I <sub>O3</sub>   | 0.8  | 1.2  | —    | A    | V <sub>O3</sub> ≥7.5V                             |
| Ripple rejection ratio             | R.R3              | 40   | 60   | —    | dB   | f=100Hz V <sub>RR</sub> =-10dBV                   |
| Output voltage (CD 5V)             | V <sub>O4</sub>   | 4.90 | 5.0  | 5.10 | V    | I <sub>O4</sub> =180mA                            |
| Voltage regulation                 | ΔV <sub>O41</sub> | —    | 20   | 200  | mV   | V <sub>CC</sub> =6.5 ~ 22V I <sub>O4</sub> =180mA |
| Load regulation                    | ΔV <sub>O42</sub> | —    | 20   | 200  | mV   | I <sub>O4</sub> =0 ~ 180mA                        |
| Minimum I/O voltage differential * | ΔV <sub>O43</sub> | —    | 1.0  | 1.5  | V    | I <sub>O4</sub> =180mA                            |
| Output current capacity            | I <sub>O4</sub>   | 220  | 400  | —    | mA   | V <sub>O4</sub> ≥4.90V                            |
| Ripple rejection ratio             | R.R4              | 50   | 60   | —    | dB   | f=100Hz V <sub>RR</sub> =-10dBV                   |
| Output voltage (RADIO 5V)          | V <sub>O5</sub>   | 4.90 | 5.0  | 5.10 | V    | I <sub>O5</sub> =80mA                             |
| Voltage regulation                 | ΔV <sub>O51</sub> | —    | 20   | 200  | mV   | V <sub>CC</sub> =6.5 ~ 22V I <sub>O5</sub> =80mA  |
| Load regulation                    | ΔV <sub>O52</sub> | —    | 20   | 200  | mV   | I <sub>O5</sub> =0 ~ 80mA                         |
| Minimum I/O voltage differential * | ΔV <sub>O53</sub> | —    | 0.8  | 1.5  | V    | I <sub>O5</sub> =80mA                             |
| Output current capacity            | I <sub>O5</sub>   | 100  | 220  | —    | mA   | V <sub>O5</sub> ≥4.90V                            |
| Ripple rejection ratio             | R.R5              | 50   | 68   | —    | dB   | f=100Hz V <sub>RR</sub> =-10dBV                   |

| Parameter                                      | Symbol           | Min. | Typ. | Max. | Unit          | Conditions  |
|--|------------------|------|------|------|---------------|---|
| Output voltage (COM 5V)                        | $V_{O6}$         | 4.90 | 5.0  | 5.10 | V             | $I_{O6}=180\text{mA}$                             |
| Voltage regulation                             | $\Delta V_{O61}$ | —    | 20   | 200  | mV            | $V_{CC}=6.5\sim 22\text{V}$ $I_{O6}=180\text{mA}$ |
| Load regulation                                | $\Delta V_{O62}$ | —    | 20   | 200  | mV            | $I_{O6}=0\sim 180\text{mA}$                       |
| Minimum I/O voltage differential *             | $\Delta V_{O63}$ | —    | 1.0  | 1.5  | V             | $I_{O6}=180\text{mA}$                             |
| Output current capacity                        | $I_{O6}$         | 220  | 400  | —    | mA            | $V_{O6}\geq 4.90\text{V}$                         |
| Ripple rejection ratio                         | R.R6             | 50   | 60   | —    | dB            | $f=100\text{Hz}$ $V_{RR}=-10\text{dBV}$           |
| 〈Input (MODE SW)〉                              |                  |      |      |      |               |   |
| Voltage when RADIO MODE ON                     | $V_{MTHH}$       | 1.1  | 1.4  | 1.7  | V             | RADIO output voltage when switched to HIGH        |
| Voltage when RADIO MODE OFF                    | $V_{MTHL}$       | 2.9  | 3.2  | 3.5  | V             | RADIO output voltage when switched to LOW         |
| Voltage when CD MODE ON                        | $V_{RTHH}$       | 2.9  | 3.2  | 3.5  | V             | CD5V, CD8.0V output voltage when switched to HIGH |
| Input high level current                       | $I_{IH1}$        | 80   | 110  | 140  | $\mu\text{A}$ | MODE SW pin=5 V                                   |
| 〈Input (REF STB)〉                              |                  |      |      |      |               |   |
| Input high level current                       | $I_{ref}$        | —    | 210  | 500  | $\mu\text{A}$ | REF=5V, STAND BY pin=5V                           |
| Output voltage differential for each 5V system | $\Delta V_{DEF}$ | —    | 0    | 0.25 | V             |   |

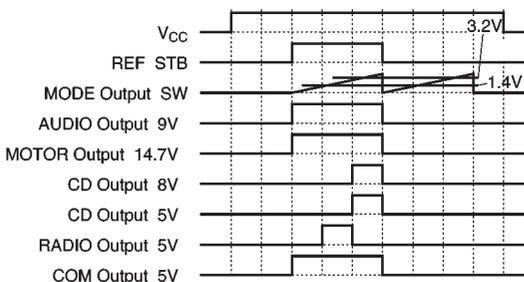
©Not designed for radiation resistance.

※ Output current of AUDIO (9V) is theoretically 300 to 970 mA.

\* Minimum I/O voltage differential refers to the difference between input and output voltage when VCC is set to the minimum output voltage (see the relationship between VCC is and each output on a separate page).

## ● Circuit operation

### (1) Timing chart



AUDIO 9V, MOTOR 14.7V, and COM 5V are output regardless of MODE SW.

RADIO 5V rises when MODE SW is 1.4V (typical), and CD 8V and CD 5V rise when MODE SW is 3.2V (typical).

### (2) Estimate of allowable power dissipation

Except under transitional conditions, the power dissipation of this IC is 3W per unit at 25°C. See Fig. 3 for heat reduction characteristics, including some cases where heat sinks are used.

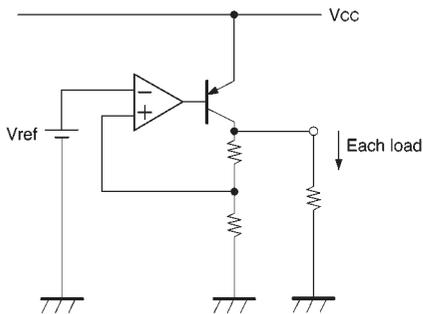


Fig.1

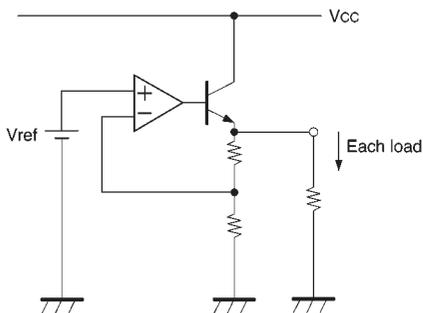


Fig.2

Calculation of  $P_{MAX}$ 

- Power consumed by AUDIO 9V

$$P_1 = (V_{CC} - 9.0V) \times I_1$$

- Power consumed by MOTOR 14.7V

$$P_2 = (V_{CC} - 14.7V) \times I_2$$

- Power consumed by CD 8.0V

$$P_3 = (V_{CC} - 8.0V) \times I_3$$

- Power consumed by CD 5.0V

$$P_4 = (V_{CC} - 5.0V) \times I_4$$

- Power consumed by RADIO 5.0V

$$P_5 = (V_{CC} - 5.0V) \times I_5$$

- Power consumed by COM 5.0V

$$P_6 = (V_{CC} - 5.0V) \times I_6$$

- Power consumed internally by each circuit

$$P_7 = V_{CC} \times \text{circuit current}$$

\*  $I_1$  = maximum output for AUDIO 9V

$I_2$  = maximum output for MOTOR 14.7V

$I_3$  = maximum output for CD 8.0V

$I_4$  = maximum output for CD 5.0V

$I_5$  = maximum output for RADIO 5.0V

$I_6$  = maximum output for COM 5.0V

## ● 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 ( $P_d$ )

Refer to the heat reduction characteristics (Fig. 3) and the rough estimation of IC power dissipation given on a separate page. Make sure to use the IC within the allowable power dissipation with a sufficient margin.

## (3) Preventing oscillation at each output and installing a ripple filter capacitor.

To stop oscillation of output, make sure to connect a capacitor between GND and each of the AUDIO 9V (pin 1), RADIO (pin 4), COM (pin 5), CD 5V (pin 6), CD 8V (pin 7), and MOTOR 14.7V (pin 11) output pins. We recommend using a tantalum electrolytic capacitor having a capacitance of  $10\mu\text{F}$  or greater ( $100\mu\text{F}$  or greater for AUDIO 9V) with minimal temperature susceptibility. Also,

sudden deterioration of the AUDIO 9V ripple rejection during a power drop can be prevented by connecting a capacitor ( $220\mu\text{F}$  or greater recommended) to the C pin (pin 2).

## (4) Overcurrent protection circuit

An overcurrent protection circuit is installed on the AUDIO 9V (pin 1), RADIO (pin 4), COM (pin 5), CD 5V (pin 6), CD 8V (pin 7), and MOTOR 14.7V (pin 11) outputs, 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. 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).

(5) Reference voltage

Because output voltage is dependent on the input reference voltage, unstable input results in output wavering and degradation of ripple rejection. Take care when setting the reference voltage power supply. Note that the AUDIO output, which has a built-in reference voltage system, is not affected by the external reference voltage.

(6) Thermal protection circuit

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

(7) Grounding

Each ground line in the application circuit must be adequately short regarding the PREGND (pin 3) and GND (pin 12) pins. Make sure to arrange the ground lines, the AUDIO system, and other outputs in a pattern that prevents electric interference.

● Thermal derating curve

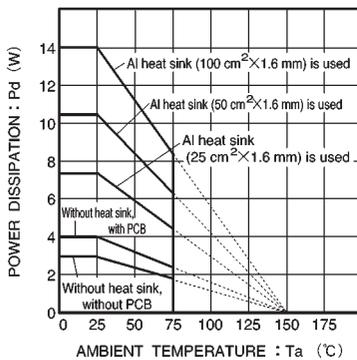


Fig.3

● External dimensions (Units: mm)

