

# Reference voltage power supply

## BA3935

The BA3935 is a monolithic reference voltage power supply IC for use in CD radio cassette players.

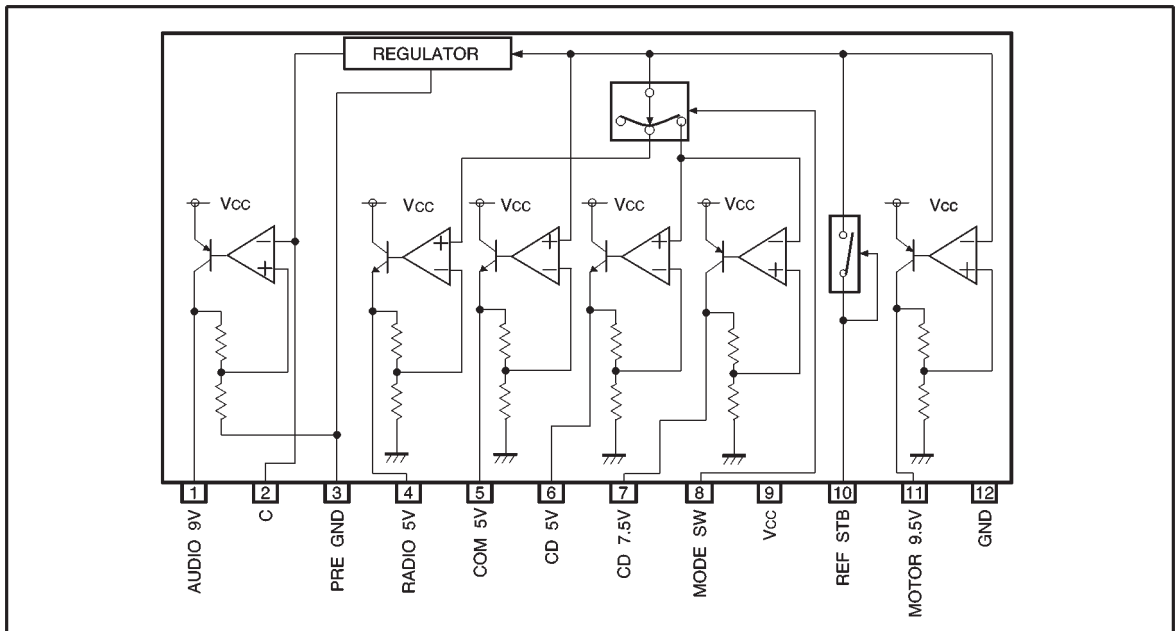
### ●Applications

CD radio cassette players, mini-component stereo audio systems

### ●Features

- 1) With 9V output for audio power supply, 5V output for microcontrollers, 5V output for radio, 5 and 7.5V outputs for CD players, 9.5V 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. (Type.)
- 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.

### ●Block diagram



## ● Pin descriptions

Pin No.	Pin name	Function
1	AUDIO 9V	AUDIO 9V output
2	C	Capacitor pin for regulating AUDIO 9V
3	PRE GND	AUDIO system GND
4	RADIO 5V	RADIO 5V output ; output when MODE SW is 1.4V (typ)
5	COM 5V	Microcontroller 5V output
6	CD 5V	CD 5V output ; output when MODE SW is 3.2V (typ)
7	CD 7.5V	CD 7.5V output ; output when MODE SW is 3.2V (typ)
8	MODE SW	Pin to select CD 5V, CD 7.5V, or RADIO 5V
9	V <sub>CC</sub>	Power supply
10	REF STB	Reference voltage 5V output ; also a standby SW
11	MOTOR 9.5V	MOTOR 9.5V output
12	GND	Large current GND, connected to the IC substrate

## ● 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

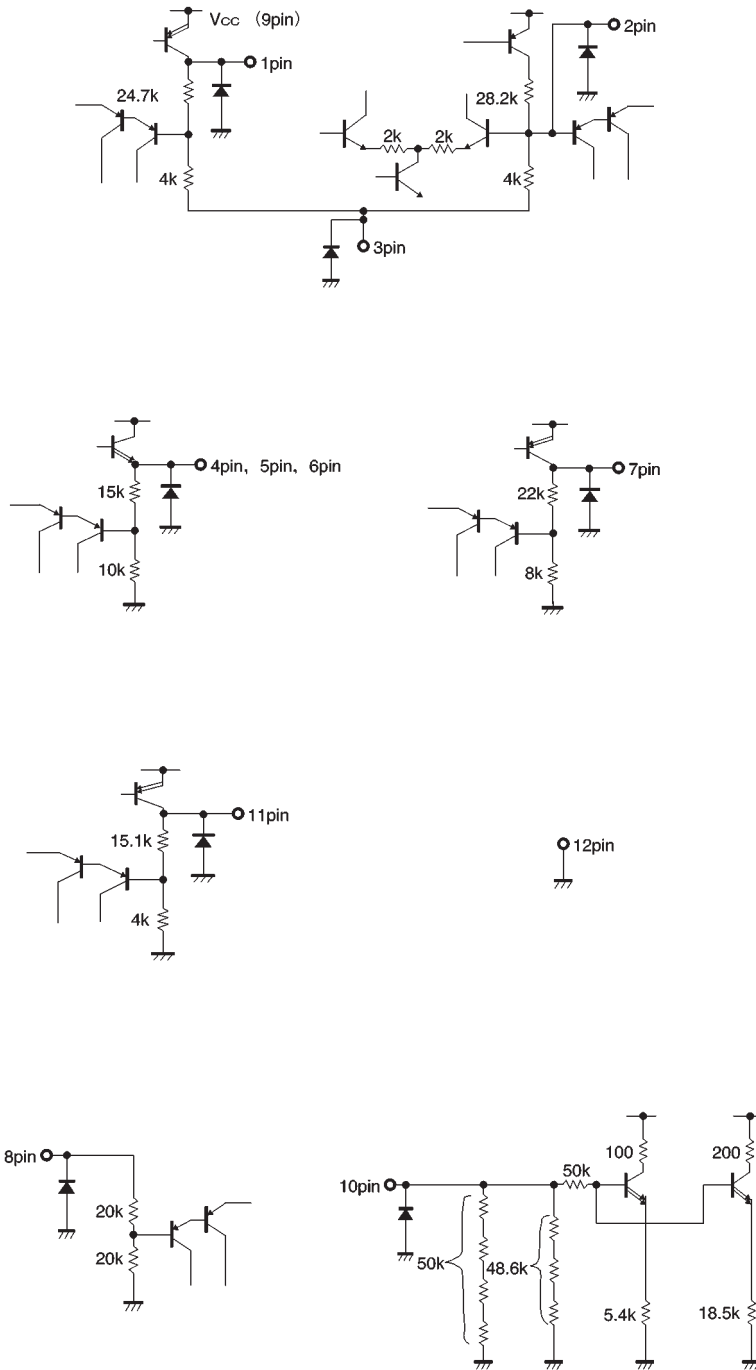
\* Reduced by 24mW for each increase in Ta of 1°C over 25°C.

## ● 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.

● 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 9.0)	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 9.5V)	V <sub>O2</sub>	8.9	9.5	10.1	V	I <sub>O2</sub> =600mA
Voltage regulation	ΔV <sub>O21</sub>	—	50	200	mV	V <sub>CC</sub> =11.5~22V 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> ≥8.9V
Output voltage (CD 7.5V)	V <sub>O3</sub>	7.0	7.5	8.0	V	I <sub>O3</sub> =400mA
Voltage regulation	ΔV <sub>O31</sub>	—	20	200	mV	V <sub>CC</sub> =9.5~22V 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> ≥7.0V
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, CD7.5V output voltage when switched to HIGH
Input high level current	$I_{IH1}$	50	110	200	$\mu\text{A}$	MODE SW pin=5 V

〈Input (REF STB)〉

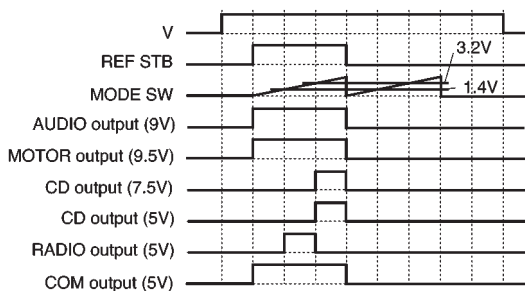
Input high level current	$I_{ref}$	—	210	500	$\mu\text{A}$	REF STB=5V
Output voltage differential for each 5V system	$\Delta V_{DEF}$	—	0	0.25	V	

©Not designed for radiation resistance.

\* Minimum I/O voltage differential refers to the difference between input and output voltage when  $V_{CC}$  is set to the minimum output voltage (see the relationship between  $V_{CC}$  and each output on a separate page Fig. 4).

●Circuit operation

(1) Timing chart



AUDIO 9V, MOTOR 9.5V, and COM 5V are output regardless of MODE SW.

RADIO 5V rises when MODE SW is 1.4V (typical), and CD 5V and CD 7.5V 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. 1 for thermal derating characteristics, including some cases where heat sinks are used.

●Thermal derating curve

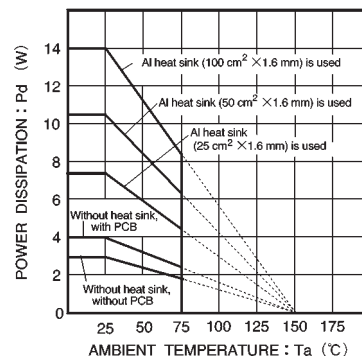


Fig.1

## ● Circuit operation

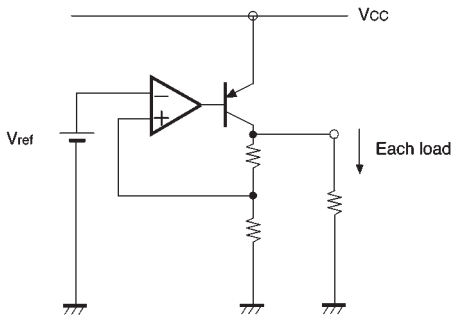


Fig.2

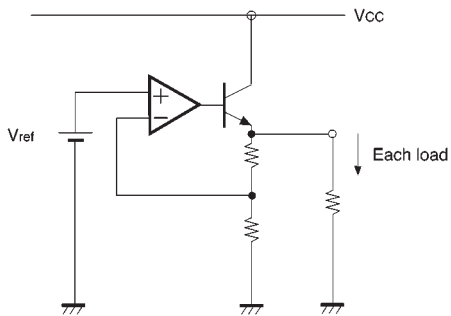


Fig.3

Calculation of  $P_{MAX}$ .

- Power consumed by AUDIO 9V  
 $P_1 = (V_{CC} - 9.0V) \times I_1$
- Power consumed by MOTOR 9.5V  
 $P_2 = (V_{CC} - 9.5V) \times I_2$
- Power consumed by CD 7.5V  
 $P_3 = (V_{CC} - 7.5V) \times I_3$
- 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 9.0V
- $I_2$  = maximum output for MOTOR 9.5V
- $I_3$  = maximum output for CD 7.5V
- $I_4$  = 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 (Pd)**

Refer to the heat reduction characteristics (Fig. 1) 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 7.5V (pin 7), and MOTOR 9.5V (pin 11) output pins. We recommend using a tantalum electrolytic capacitor having a capacitance of 10 $\mu$ F or greater (100 $\mu$ 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 $\mu$ 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 7.5V (pin 7), and MOTOR 9.5V (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<sub>F</sub> or higher, short mode circuit operates at 1V<sub>F</sub> 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 except V<sub>DD</sub> 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.

●Electrical characteristic curve

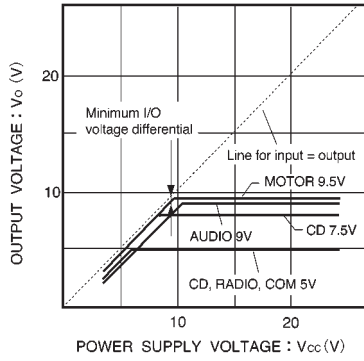


Fig.4 Output voltage vs. power supply voltage

●External dimensions (Units: mm)

