

Reference voltage power supply

BA3935

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

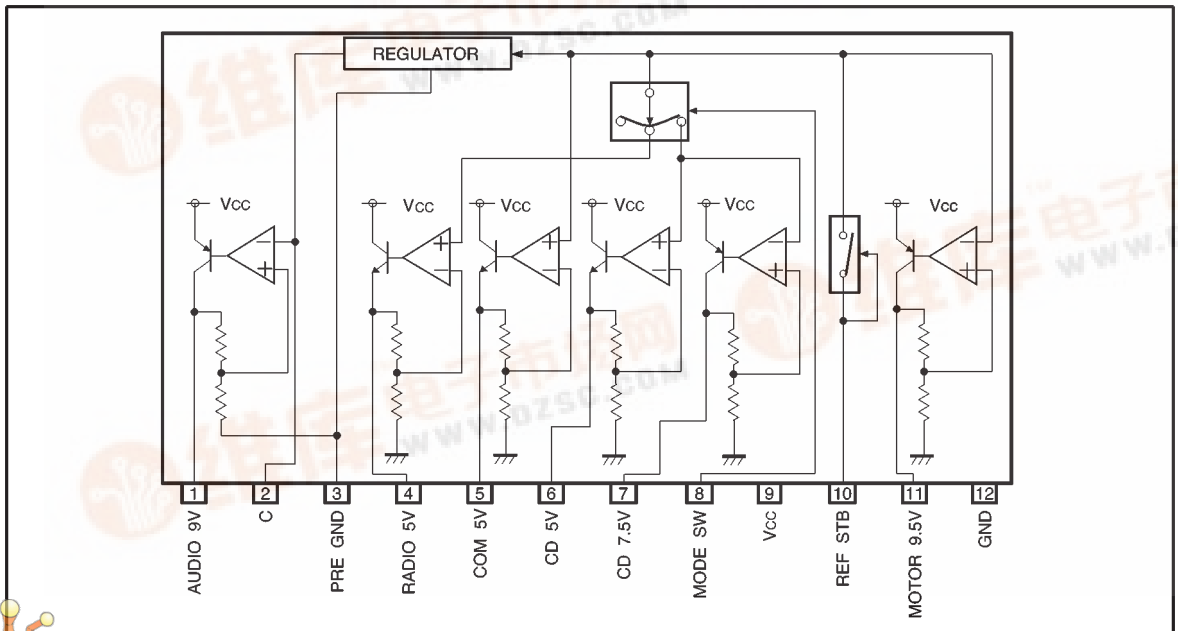
● Applications

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 input 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 _{cc}	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 _{cc}	23	V
Power dissipation	P _d	3000*	mW
Operating temperature	T _{opr}	-25~+75	°C
Storage temperature	T _{stg}	-55~+150	°C

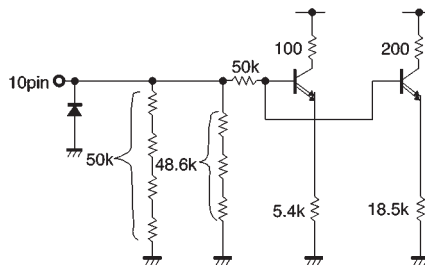
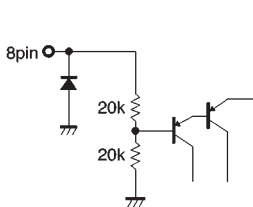
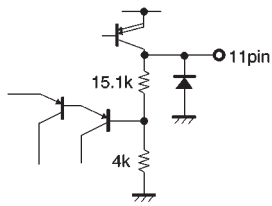
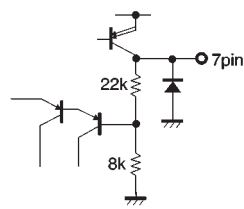
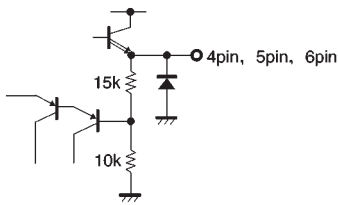
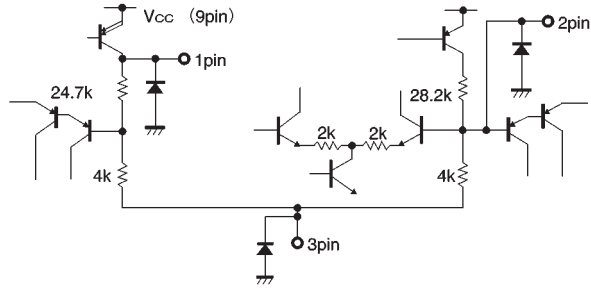
* Reduced by 24mW for each increase in Ta of 1°C over 25°C.

● Recommended operating conditions

Parameter	Symbol	Limits	Unit
Power supply voltage	V _{cc}	6.5~22.0 *1	V

*1 For basic operation at Ta = 25°C.

● Input / output circuits



● Electrical characteristics (unless otherwise noted, $T_a = 25^\circ\text{C}$ and $V_{CC} = 16.0\text{V}$)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Standby supply current	I_{ST}	—	0	10	μA	REF STB=0V
Output voltage (AUDIO 9.0)	V_{O1}	8.5	9.0	9.5	V	$I_{O1}=250\text{mA}$
Voltage regulation	ΔV_{O11}	—	40	200	mV	$V_{CC}=11\sim 22\text{V}$ $I_{O1}=250\text{mA}$
Load regulation	ΔV_{O12}	—	30	200	mV	$I_{O1}=0\sim 250\text{mA}$
Minimum I/O voltage differential *	ΔV_{O13}	—	1.1	2.1	V	$I_{O1}=250\text{mA}$
Output current capacity	I_{O1}	300	710	—	mA	$V_{O1}\geq 8.5\text{V}$
Ripple rejection ratio	R.R1	50	62	—	dB	$f=100\text{Hz}$ $V_{RR}=-10\text{dBV}$
Output voltage (MOTOR 9.5V)	V_{O2}	8.9	9.5	10.1	V	$I_{O2}=600\text{mA}$
Voltage regulation	ΔV_{O21}	—	50	200	mV	$V_{CC}=11.5\sim 22\text{V}$ $I_{O2}=600\text{mA}$
Load regulation	ΔV_{O22}	—	150	600	mV	$I_{O2}=0\sim 600\text{mA}$
Minimum I/O voltage differential *	ΔV_{O23}	—	0.5	0.9	V	$I_{O2}=600\text{mA}$
Output current capacity	I_{O2}	1.2	1.4	—	A	$V_{O2}\geq 8.9\text{V}$
Output voltage (CD 7.5V)	V_{O3}	7.0	7.5	8.0	V	$I_{O3}=400\text{mA}$
Voltage regulation	ΔV_{O31}	—	20	200	mV	$V_{CC}=9.5\sim 22\text{V}$ $I_{O3}=400\text{mA}$
Load regulation	ΔV_{O32}	—	70	250	mV	$I_{O3}=0\sim 400\text{mA}$
Minimum I/O voltage differential *	ΔV_{O33}	—	0.3	1.0	V	$I_{O3}=400\text{mA}$
Output current capacity	I_{O3}	0.8	1.2	—	A	$V_{O3}\geq 7.0\text{V}$
Ripple rejection ratio	R.R3	40	60	—	dB	$f=100\text{Hz}$ $V_{RR}=-10\text{dBV}$
Output voltage (CD 5V)	V_{O4}	4.90	5.0	5.10	V	$I_{O4}=180\text{mA}$
Voltage regulation	ΔV_{O41}	—	20	200	mV	$V_{CC}=6.5\sim 22\text{V}$ $I_{O4}=180\text{mA}$
Load regulation	ΔV_{O42}	—	20	200	mV	$I_{O4}=0\sim 180\text{mA}$
Minimum I/O voltage differential *	ΔV_{O43}	—	1.0	1.5	V	$I_{O4}=180\text{mA}$
Output current capacity	I_{O4}	220	400	—	mA	$V_{O4}\geq 4.90\text{V}$
Ripple rejection ratio	R.R4	50	60	—	dB	$f=100\text{Hz}$ $V_{RR}=-10\text{dBV}$
Output voltage (RADIO 5V)	V_{O5}	4.90	5.0	5.10	V	$I_{O5}=80\text{mA}$
Voltage regulation	ΔV_{O51}	—	20	200	mV	$V_{CC}=6.5\sim 22\text{V}$ $I_{O5}=80\text{mA}$
Load regulation	ΔV_{O52}	—	20	200	mV	$I_{O5}=0\sim 80\text{mA}$
Minimum I/O voltage differential *	ΔV_{O53}	—	0.8	1.5	V	$I_{O5}=80\text{mA}$
Output current capacity	I_{O5}	100	220	—	mA	$V_{O5}\geq 4.90\text{V}$
Ripple rejection ratio	R.R5	50	68	—	dB	$f=100\text{Hz}$ $V_{RR}=-10\text{dBV}$

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	ΔV_{O61}	—	20	200	mV	$V_{CC}=6.5\sim 22\text{V}$ $I_{O6}=180\text{mA}$
Load regulation	ΔV_{O62}	—	20	200	mV	$I_{O6}=0\sim 180\text{mA}$
Minimum I/O voltage differential *	ΔV_{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.R.6	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	μA	MODE SW pin=5 V

⟨Input (REF STB)⟩

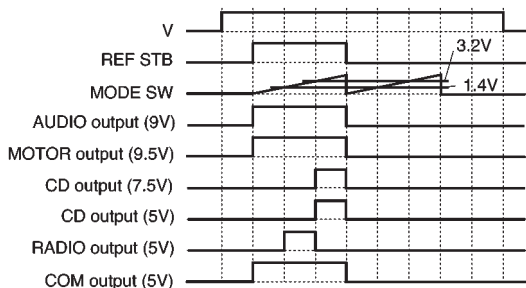
Input high level current	I_{ref}	—	210	500	μA	REF STB=5V
Output voltage differential for each 5V system	ΔV_{DEF}	—	0	0.25	V	

Ⓞ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

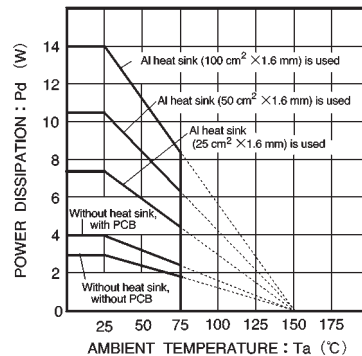


Fig.1

● Circuit operation

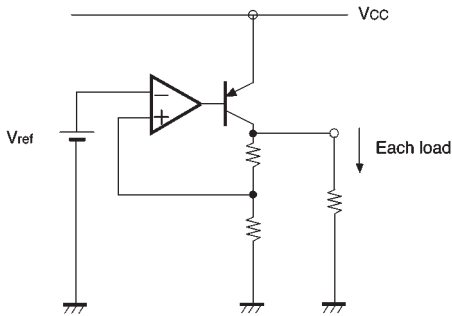


Fig.2

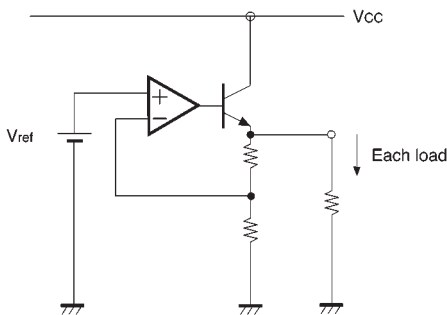


Fig.3

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 μ F or greater (100 μ 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 μ 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_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 except V_{DD} 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

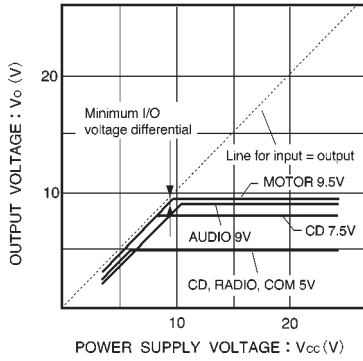


Fig.4 Output voltage vs. power supply voltage

● External dimensions (Units: mm)

