Reference voltage power supply
BA3933

The BA3933 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 7.5V output for audio power supply, 5V output for microcontrollers, 5V output for radio 5 and 7.5V outputs for CD players, 9V output for motor drivers, the IC is best suited for CD radio cassette players.
2) Precise power supply (5V ± 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_{CC}	23	V
Power dissipation	Pd	3000[*1]	mW
Operating temperature	Topr	$-25 \sim +75$	℃
Storage temperature	Tstg	$-55 \sim +150$	℃

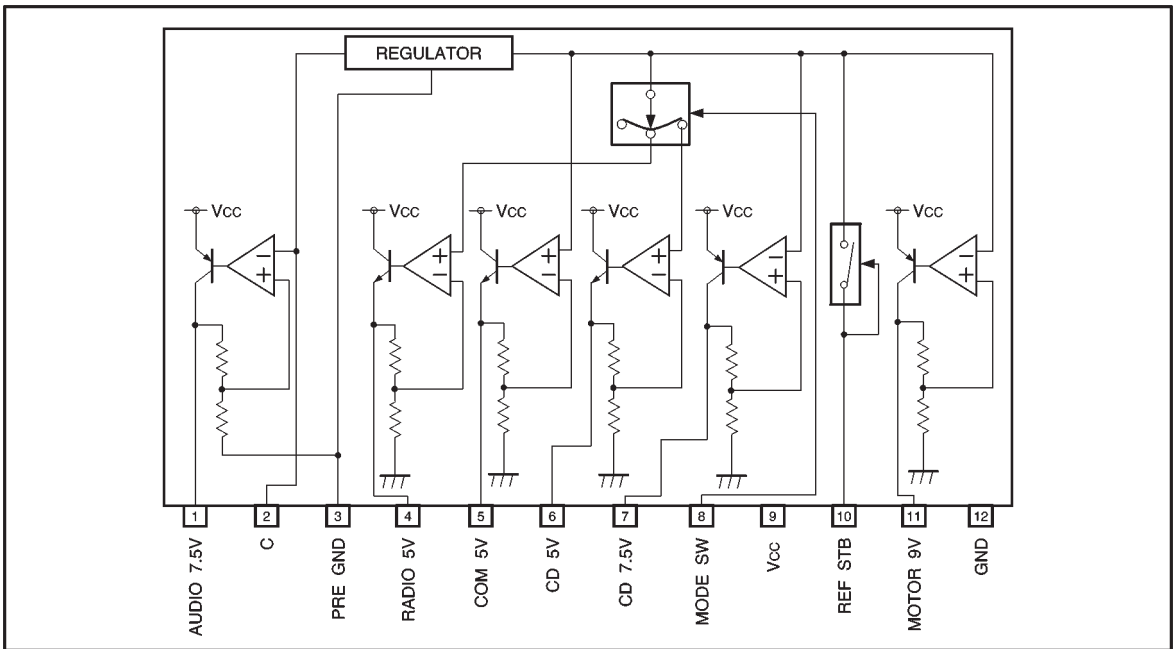＊1 Reduced by 24mW for each increase inTa of 1℃ over 25℃.

●Recommended operating conditions (Topr = 25°C)

Parameter	Symbol	Limits	Unit
Power supply voltage	V_{CC}	$6.5 \sim 22.0$[*2]	V

＊2 For basic operation at Ta = 25 ℃.

●Block diagram

●Pin descriptions

Pin No.	Pin name	Function
1	AUDIO 7.5V	AUDIO 7.5V output
2	C	Pin to connect a capacitor that regulates AUDIO 7.5V
3	PRE GND	AUDIO system GND
4	RADIO 5V	RADIO 5V output ; output when MODE SW is 1.4V (typical)
5	COM 5V	Microcontroller 5V output
6	CD 5V	CD 5V output ; output when MODE SW is 3.2V (typical)
7	CD 7.5V	CD 7.5V output
8	MODE SW	Pin to select CD 5V, CD 7.5V, or RADIO 5V
9	Vcc	Power supply voltage.
10	REF STB	Reference voltage 5V output ; also a standby SW
11	MOTOR 9V	MOTOR 9V 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_{CC} = 16.0V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Standby supply current	I_{ST}	—	0	10	μA	STAND BY pin = 0 V
Output voltage (AUDIO 7.5V)	V_{O1}	7.0	7.5	8.0	V	$I_{O1}=250mA$
Voltage regulation	ΔV_{O11}	—	40	200	mV	$V_{CC}=11V\sim22V$ $I_{O1}=250mA$
Load regulation	ΔV_{O12}	—	30	200	mV	$I_{O1}=0\sim250mA$
Minimum I/O voltage differential ∗	ΔV_{O13}	—	1.1	2.1	V	$I_{O1}=250mA$
Output current capacity ∗	I_{O1}	350	710	—	mA	$V_{O1}\geqq7.0V$
Ripple rejection ratio	R.R1	50	60	—	dB	$f=100Hz$ $V_{RR}=-10dBV$
Output voltage (MOTOR 9V)	V_{O2}	8.4	9.0	9.6	V	$I_{O2}=600mA$
Voltage regulation	ΔV_{O21}	—	50	200	mV	$V_{CC}=11\sim22V$ $I_{O2}=600mA$
Load regulation	ΔV_{O22}	—	150	600	mV	$I_{O2}=0\sim600mA$
Minimum I/O voltage differential ∗	ΔV_{O23}	—	0.5	0.9	V	$I_{O2}=600mA$
Output current capacity	I_{O2}	1.2	1.4	—	A	$V_{O2}\geqq8.4V$
Output voltage (CD 7.5V)	V_{O3}	7.0	7.5	8.0	V	$I_{O3}=400mA$
Voltage regulation	ΔV_{O31}	—	20	200	mV	$V_{CC}=8.5\sim22V$ $I_{O3}=400mA$
Load regulation	ΔV_{O32}	—	70	250	mV	$I_{O3}=0\sim400mA$
Minimum I/O voltage differential ∗	ΔV_{O33}	—	0.3	1.0	V	$I_{O3}=400mA$
Output current capacity	I_{O3}	1.0	1.2	—	A	$V_{O3}\geqq7.0V$
Ripple rejection ratio	R.R3	40	60	—	dB	$f=100Hz$ $V_{RR}=-10dBV$
Output voltage (CD 5V)	V_{O4}	4.90	5.0	5.10	V	$I_{O4}=180mA$
Voltage regulation	ΔV_{O41}	—	20	200	mV	$V_{CC}=6.5\sim22V$ $I_{O4}=180mA$
Load regulation	ΔV_{O42}	—	20	200	mV	$I_{O4}=0\sim180mA$
Minimum I/O voltage differential ∗	ΔV_{O43}	—	1.0	1.5	V	$I_{O4}=180mA$
Output current capacity	I_{O4}	220	400	—	mA	$V_{O4}\geqq4.90V$
Ripple rejection ratio	R.R4	50	60	—	dB	$f=100Hz$ $V_{RR}=-10dBV$
Output voltage (RADIO 5V)	V_{O5}	4.90	5.0	5.10	V	$I_{O5}=80mA$
Voltage regulation	ΔV_{O51}	—	20	200	mV	$V_{CC}=6.5\sim22V$ $I_{O5}=80mA$
Load regulation	ΔV_{O52}	—	20	200	mV	$I_{O5}=0\sim80mA$
Minimum I/O voltage differential ∗	ΔV_{O53}	—	0.8	1.5	V	$I_{O5}=80mA$
Output current capacity	I_{O5}	100	220	—	mA	$V_{O5}\geqq4.90V$
Ripple rejection ratio	R.R5	50	68	—	dB	$f=100Hz$ $V_{RR}=-10dB$

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Output voltage (COM 5V)	V_{O6}	4.90	5.0	5.10	V	I_{O6}=180mA
Voltage regulation	V_{O61}	—	20	200	mV	V_{CC}=6.5~22V I_{O6}=180mA
Load regulation	V_{O62}	—	20	200	mV	I_{O6}=0~180mA
Minimum I/O voltage differential ∗	V_{O63}	—	1.0	1.5	V	I_{O6}=180mA
Output current capacity	I_{O6}	220	400	—	mA	$V_{O6} \geqq$ 4.90V
Ripple rejection ratio	R.R6	50	60	—	dB	f=100Hz V_{RR}=−10dBV
⟨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	CD 5 V 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=5V STAND BY pin=5 V
Output voltage differential for each 5V system	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 Vcc is set to the minimum output voltage.

●Circuit operation

(1)   Timing chart

AUDIO 7.5V, MOTOR 9V, and COM 5V are output regardless of MODE SW.
RADIO 5V rises when MODE SW is 1.4V (typical), and CD 5V rises 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.
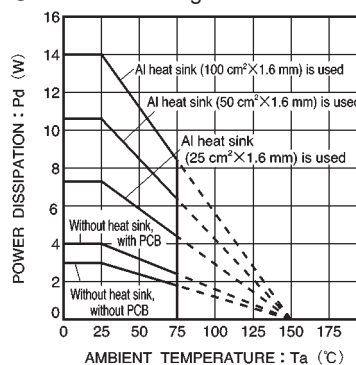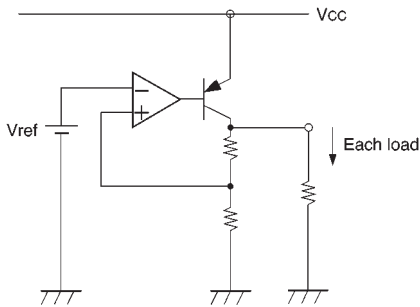
●Thermal derating characteristics
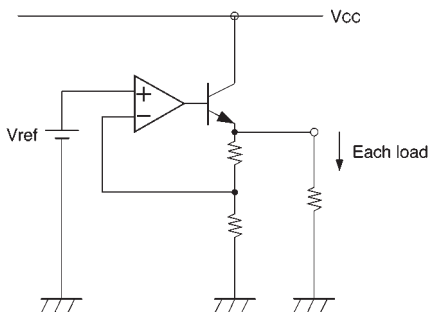

Fig.1

ROHM

Fig.2

Fig.3

Calculation of P_{MAX}

- Power consumed by AUDIO 7.5V

  $P_1 = (V_{CC} - 7.5V) \times I_1$

- Power consumed by MOTOR 9V

  $P_2 = (V_{CC} - 9V) \times I_2$

- Power consumed by CD 7.5V

  $P_3 = (V_{CC} - 7.5V) \times I_3$

- Power consumed by CD 5.0V

  $P_4 = (V_{CC} - 5V) \times I_4$

- Power consumed by RADIO 5.0V

  $P_5 = (V_{CC} - 5V) \times I_5$

- Power consumed by COM 5.0V

  $P_6 = (V_{CC} - 5V) \times I_6$

- Power consumed internally by each circuit

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

I_1 = maximum output for AUDIO 7.5V
I_2 = maximum output for MOTOR 9V
I_3 = maximum output for CD 7.5V
I_4 = maximum output for CD 5V
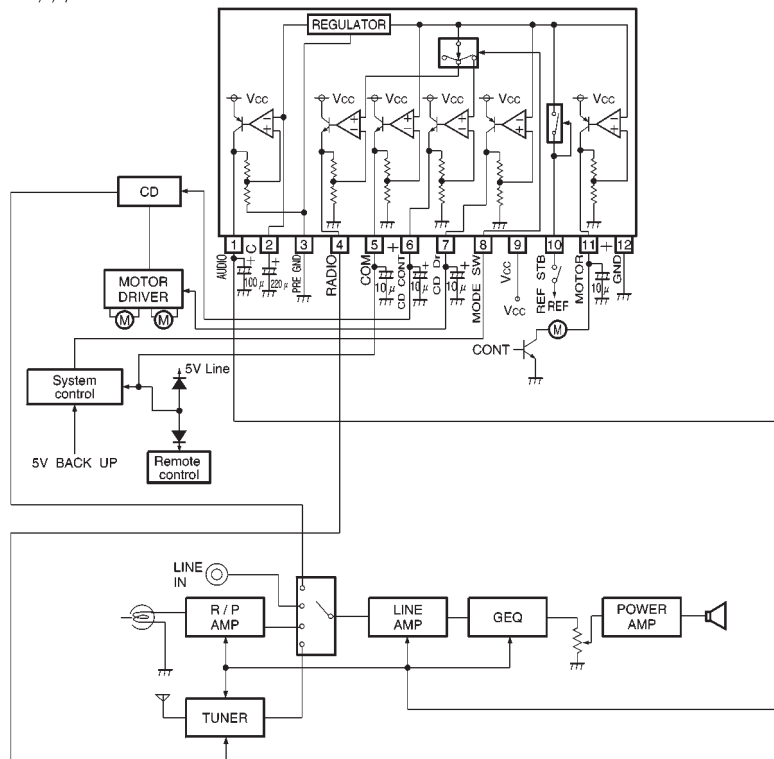I_5 = maximum output for RADIO 5V
I_6 = maximum output for COM 5V

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 and the rough estimation of IC power dissipation given on a separate pages. 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 7.5V (pin 1), RADIO (pin 4), COM (pin 5), CD 5V (pin 6), CD 7.5V (pin 7), and MOTOR 9V (pin 11) output pins. We recommend using a tantalum electrolytic capacitor having a capacitance of 10μF or greater (100μF or greater for AUDIO 7.5V) with minimal temperature susceptibility. Also, sudden deterioration of the AUDIO 7.5V ripple rejection during a power drop can be prevented by connecting a capacitor (220μF or greater recommended) to the C pin (pin 2).

(4)　Overcurrent protection circuit

An overcurrent protection circuit is installed on the AUDIO 7.5V (pin 1), RADIO (pin 4), COM (pin 5), CD 5V (pin 6), CD 7.5V (pin 7), and MOTOR 9V (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 alarge 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.
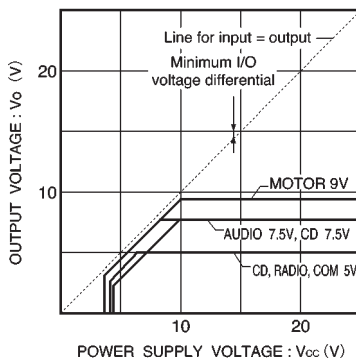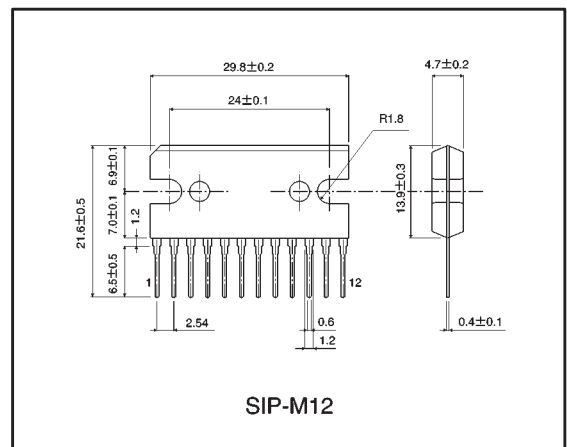
●Electrical characteristic curve

Fig.5　Output voltage vs.
　　　　power supply voltage

●External dimensions (Units: mm)

SIP-M12