System power supply for CD radio cassette players BA3940A

With built-in 9V, 7V, and 5V outputs, the BA3940A system power supply IC is best suited for use in CD radio cassette players.

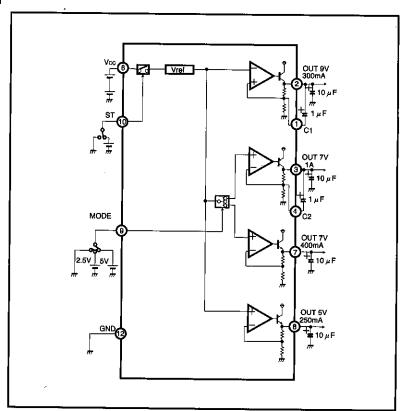
Applications

CD radio cassette players

Features

- One 9V output, two 7V outputs (switched by MODE SW, only one output is available at the same time) and one 5-V output are built in.
- 2) Output current limit circuit protects the IC against short-circuiting damage.
- 3) Thermal protection circuit prevents heat damage to the IC.
- 4) Compact SIP-M12 package allows a large power dissipation.

Block diagram



■Absolute maximum ratings (Ta=25°C)

Parameter	Symbol	Limits	Unit	
Power supply voltage	Vcc	23	V	
Power dissipation	Pd	3000*	mW	
Operating temperature	Topr	-25~75	°C	
Storage temperature	Tstg	− 55∼150	ů	

^{*} Reduce power 24mW for each above 25°C.

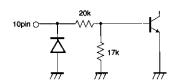
◆Recommended operating conditions (Ta=25°C)

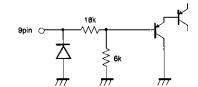
Parameter	Symbol	Min.	Тур.	Max.	Unit
Power supply voltage	Vcc	6.5	15	22	V

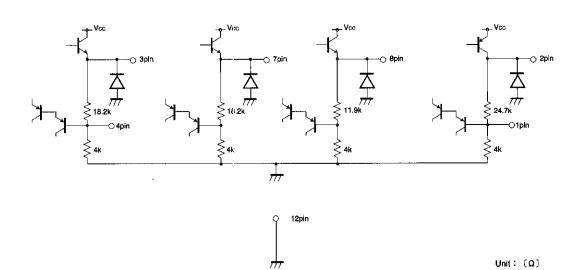
Pin descriptions

Pin No.	Pin name	Function
1	C1	Capacitor pin for improving the 9 V output ripple rejection
2	OUT9V	9 V output pin
3	OUT7V	7 V output pin (current capacity = 1 A)
4	C2	Capacitor pin for improving the 7 V (1 A) output ripple rejection
5	N. C	Not used
6	Vcc	Vcc input pin
7	OUT7V	7 V output pin (current capacity = 400 mA)
8	OUT5V	5 V output pin
9	MODE	Switch pin for 7 V outputs
10	ST	Standby switch pin
11	N. C	Not used
12	GND	GND pin

●Input/output circuits







●Electrical characteristics (unless otherwise noted, Ta=25°C and Vcc=15V)

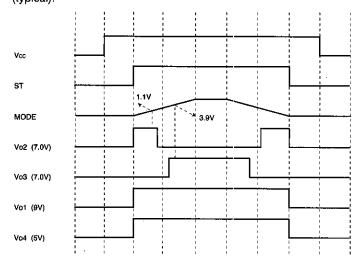
Standby circuit current Ist 0 10 μA VIh-st=0V MODE=0V	Parameter	Symbol	Min.	Тур.	Max.	Unit	Conditions
Output voltage Vo1 8.55 9.0 9.45 V Io1=240mA Voltage variation Δ Vo11 — 40 200 mV Io1=240mA Load variation Δ Vo12 — 75 200 mV Io1=240mA Minimum I/O voltage differential Δ Vo13 — 0.5 1.0 V Io1=240mA Output current capacity Io1 300 — — mA I Ripple rejection ratio R.R11 45 56 — dB I=100Hz Io1=240mA R RIpple rejection ratio R.R12 60 70 — dB I=100Hz Io1=240mA *C1=1 μF I 7 V output section] — 30 200 mV Io2=800mA *C1=1 μF Voltage variation Δ Vo21 — 30 200 mV Io2=800mA Minimum I/O voltage differential Δ Vo23 — 0.5 1.0 V Io2=800mA Voltage variation R.R21 45 55 <td< td=""><td>Standby circuit current</td><td>lst</td><td></td><td>0</td><td>10</td><td>μΑ</td><td>Vth-st=0V MODE=0V</td></td<>	Standby circuit current	lst		0	10	μΑ	Vth-st=0V MODE=0V
Voltage variation	[9 V output section]						
Loed variation	Output voltage	Vo1	8.55	9.0	9.45	٧	Io1=240mA
Minimum I/O voltage differential	Voltage variation	Δ Vo11	_	40	200	m۷	Io1=240mA
Output current capacity Io1 300 — — mA Ripple rejection ratio R.R11 45 56 — dB f=100Hz lo1=240mA **Ripple rejection ratio R.R12 60 70 — dB f=100Hz lo1=240mA *C1=1 μF [7 V output section] Vol 6.5 7.0 7.5 V lo2=800mA Output voltage Vo2 6.5 7.0 7.5 V lo2=800mA Load variation ΔVo22 — 140 550 mV lo2=00mA Minimum I/O voltage differential ΔVo23 — 0.5 1.0 V lo2=800mA Minimum I/O voltage differential R.R21 45 55 — dB f=100Hz lo2=800mA *C2=1 μF [7 V output section] Vo3 6.5 7.0 7.5 V lo3=320mA *C2=1 μF [7 V output section] Vo3 6.5 7.0 7.5 V lo3=320mA Load variation ΔVo33 —	Load variation	Δ Vo12	_	75	200	mV	Io1=0~240mA
Ripple rejection ratio R.R11	Minimum I/O voltage differential	ΔVo13	_	0.5	1.0	٧	Io1=240mA
#Ripple rejection ratio [7 V output section] Vo2	Output current capacity	lo1	300	_	_	mA	
[7 V output section]	Ripple rejection ratio	R.R11,	45	56	_	dB	f=100Hz lo1=240mA
Output voltage Vo2 6.5 7.0 7.5 V Io2=800mA Voltage variation Δ Vo21 — 30 200 mV Io2=800mA Load variation Δ Vo22 — 140 550 mV Io2=800mA Minimum I/O voltage differential Δ Vo23 — 0.5 1.0 V Io2=800mA Minimum I/O voltage differential Δ Vo23 — 0.5 1.0 V Io2=800mA Ripple rejection ratio R.R21 45 55 — dB f=100Hz Io2=800mA *Ripple rejection ratio R.R22 60 70 — dB f=100Hz Io2=800mA Voltage variation Δ Vo31 — 7.0 7.5 V Io3=320mA Voltage variation Δ Vo32 — 130 200 mV Io3=0320mA Ijs V utput section] Vo3 400 — — mA Ripple rejection ratio R.R3 50 60 — dB f=100Hz Io	* Ripple rejection ratio	R.R12	60	70	_	dB	f=100Hz lo1=240mA *C1=1 μF
Voltage variation Δ Vo21 — 30 200 mV lo2=800mA Load variation Δ Vo22 — 140 550 mV lo2=0~800mA Minimum I/O voltage differential Δ Vo23 — 0.5 1.0 V lo2=800mA Minimum I/O voltage differential A Vo23 — 0.5 1.0 V lo2=800mA Ripple rejection ratio R.R21 45 55 — dB f=100Hz lo2=800mA *Ripple rejection ratio R.R22 60 70 — dB f=100Hz lo2=800mA *C2=1 μF — dB f=100Hz lo2=800mA *C2=1 μF *Uptu voltage Vo3 6.5 7.0 7.5 V lo3=320mA Voltage variation Δ Vo31 — 30 200 mV lo3=320mA Uptu toursent capacity lo3 400 — — mA Ripple rejection ratio R.R3 50 60 — dB f=100Hz lo3=320mA	[7 V output section]						
Load variation Δ Vo22 — 140 550 mV Io2=0~800mA Minimum I/O voltage differential function in the pipe rejection ratio R.R21 45 55 — A Ripple rejection ratio R.R21 45 55 — dB f=100Hz Io2=800mA **Ripple rejection ratio R.R22 60 70 — dB f=100Hz Io2=800mA **Ripple rejection ratio R.R22 60 70 — dB f=100Hz Io2=800mA **C2=1 μF — - dB f=100Hz Io2=800mA *C2=1 μF Io voltput section] Vol - - dB f=100Hz Io2=800mA Voltage variation Δ Vo31 — 30 200 mV Io3=320mA Uotput current capacity Io3 400 — — mA Ripple rejection ratio R.R3 50 60 — dB f=100Hz Io3=320mA Voltage variation Δ Vo41 — 20 200 mV Io4=200mA <td>Output voltage</td> <td>Vo2</td> <td>6.5</td> <td>7.0</td> <td>7.5</td> <td>٧</td> <td>lo2=800mA</td>	Output voltage	Vo2	6.5	7.0	7.5	٧	lo2=800mA
Minimum I/O voltage differential ΔVo23	Voltage variation	∆Vo21	_	30	200	mV	Io2=800mA
Dutput current capacity Io2 1.0 -	Load variation	Δ Vo22	_	140	550	mV	lo2=0~800mA
Ripple rejection ratio R.R21 45 55 - dB f=100Hz lo2=800mA * Ripple rejection ratio R.R22 60 70 - dB f=100Hz lo2=800mA * C2=1 μF [7 V output section]	Minimum I/O voltage differential	Δ Vo23	_	0.5	1.0	٧	lo2=800mA
*Ripple rejection ratio	Output current capacity	102	1.0	_	_	Α	
T V output section	Ripple rejection ratio	R.R21	45	55	_	dB	f=100Hz lo2=800mA
Output voltage Vo3 6.5 7.0 7.5 V io3=320mA Voltage variation Δ Vo31 — 30 200 mV io3=320mA Load variation Δ Vo32 — 130 260 mV io3=0~320mA Minimum I/O voltage differential Δ Vo33 — 1.0 1.5 V io3=320mA Output current capacity Io3 400 — — mA — Ripple rejection ratio R.R3 50 60 — dB f=100Hz Io3=320mA Output section] — — mA — mA — Voltage variation Δ Vo41 — 20 200 mV Io4=200mA Voltage variation Δ Vo42 — 30 200 mV Io4=200mA Minimum I/O voltage differential Δ Vo43 — 1.0 1.5 V Io4=200mA Minimum I/O voltage differential Δ Vo43 — 1.0 1.5 V Io4=2	*Ripple rejection ratio	R.R22	60	70	_	dB	f=100Hz lo2=800mA *C2=1 μF
Voltage variation Δ Vo31 — 30 200 mV Io3=320mA Load variation Δ Vo32 — 130 260 mV Io3=0~320mA Minimum I/O voltage differential Δ Vo33 — 1.0 1.5 V Io3=320mA Output current capacity Io3 400 — — mA Ripple rejection ratio R.R3 50 60 — dB f=100Hz Io3=320mA Is Voutput section Io3 400 — — mA Io4=200mA Voltage variation Δ Vo41 — 20 200 mV Io4=200mA Voltage variation Δ Vo42 — 30 200 mV Io4=200mA Load variation Δ Vo43 — 1.0 1.5 V Io4=200mA Minimum I/O voltage differential Δ Vo43 — 1.0 1.5 V Io4=200mA Ripple rejection ratio R.R4 50 60 — dB f=100Hz Io4=200mA	[7 V output section]						
Load variation	Output voltage	Vo3	6.5	7.0	7.5	V	lo3=320mA
Minimum I/O voltage differential	Voltage variation	∆ Vo31	_	30	200	mV	lo3=320mA
Output current capacity Io3 400 — mA Ripple rejection ratio R.R3 50 60 — dB f=100Hz lo3=320mA [5 V output section] — 60 — dB f=100Hz lo3=320mA Output voltage Vo4 4.75 5.0 5.25 V Io4=200mA Voltage variation Δ Vo41 — 20 200 mV Io4=200mA Load variation Δ Vo42 — 30 200 mV Io4=200mA Minimum I/O voltage differential Δ Vo43 — 1.0 1.5 V Io4=200mA Output current capacity Io4 250 — — mA F=100Hz Io4=200mA Ripple rejection ratio R.R4 50 60 — dB f=100Hz Io4=200mA Input section] — — — 1.0 V Vo1=Vo4=OFF (MODE=0V) Standby voltage when ON Vth - st — — V Vo1=Vo4=OF (MODE=0V) Input c	Load variation	∆ Vo32	_	130	260	mV	lo3=0~320mA
Ripple rejection ratio R.R3 S0 60 dB f=100Hz lo3=320mA	Minimum I/O voltage differential	∆ Vo33	_	1.0	1.5	V	lo3=320mA
S V output section Cutput voltage Vo4 4.75 5.0 5.25 V Io4=200mA	Output current capacity	103	400	_	_	mA	
Output voltage Vo4 4.75 5.0 5.25 V Io4=200mA Voltage variation Δ Vo41 — 20 200 mV Io4=200mA Load variation Δ Vo42 — 30 200 mV Io4=0~200mA Minimum I/O voltage differential Δ Vo43 — 1.0 1.5 V Io4=200mA Output current capacity Io4 250 — — mA Ripple rejection ratio R.R4 50 60 — dB f=100Hz Io4=200mA [Input section] — — — dB f=100Hz Io4=200mA Standby voltage when OFF Vth - st — — 1.0 V Vo1=Vo4=200mA Input current when HIGH Ist 1.8 — — V Vo1=Vo4=OFF (MODE=0V) Input current when HIGH Ist 140 220 300 μA Vth-st=5V [MODE voltage 1 Vth - m1 — — 1.1 V When Vth - st = 5V, Vo2 = ON	Ripple rejection ratio	R.R3	50	60	_	dB	f=100Hz lo3=320mA
Voltage variation Δ Vo41 — 20 200 mV Io4=200mA Load variation Δ Vo42 — 30 200 mV Io4=0~200mA Minimum I/O voltage differential Δ Vo43 — 1.0 1.5 V Io4=200mA Output current capacity Io4 250 — — mA Ripple rejection ratio R.R4 50 60 — dB f=100Hz Io4=200mA [Input section] — — — 1.0 V Vo1=Vo4=OPF (MODE=0V) Standby voltage when OFF Vth - st — — V Vo1=Vo4=OFF (MODE=0V) Input current when HIGH Ist 140 220 300 μA Vth-st=5V [MODE sW section] — — — 1.1 V When Vth - st = 5V, Vo2 = ON and Vo3 = OFF MODE voltage 2 Vth - m2 3.9 — — V When Vth - st = 5V, Vo2 = OFF and Vo3 = ON	[5 V output section]						
Load variation Δ Vo42 — 30 200 mV lo4=0~200mA Minimum I/O voltage differential Δ Vo43 — 1.0 1.5 V lo4=200mA Output current capacity Io4 250 — — mA Ripple rejection ratio R.R4 50 60 — dB f=100Hz lo4=200mA [Input section] — — 1.0 V Vo1=Vo4=OFF (MODE=0V) Standby voltage when OFF Vth - st 1.8 — — V Vo1=Vo4=OFF (MODE=0V) Input current when HIGH Ist 140 220 300 μA Vth-st=5V [MODE SW section] — — 1.1 V When Vth - st = 5V, Vo2 = ON and Vo3 = OFF MODE voltage 2 Vth - m2 3.9 — — V When Vth - st = 5V, Vo2 = OFF and Vo3 = ON	Output voltage	Vo4	4.75	5.0	5.25	V	lo4=200mA
Minimum I/O voltage differential Δ Vo43 — 1.0 1.5 V Io4=200mA Output current capacity Io4 250 — — mA Ripple rejection ratio R.R4 50 60 — dB f=100Hz Io4=200mA [Input section]	Voltage variation	∆V041	_	20	200	mV	Io4=200mA
Output current capacity Io4 250 — mA Ripple rejection ratio R.R4 50 60 — dB f=100Hz Io4=200mA [Input section] Standby voltage when OFF Vth - st — — 1.0 V Vo1=Vo4=OFF (MODE=0V) Standby voltage when ON Vth - st 1.8 — — V Vo1=Vo4=ON (MODE=0V) Input current when HIGH Ist 140 220 300 μA Vth-st=5V [MODE SW section] MODE voltage 1 Vth - m1 — — 1.1 V When Vth - st = 5V, Vo2 = ON and Vo3 = OFF MODE voltage 2 Vth - m2 3.9 — — V When Vth - st = 5V, Vo2 = OFF and Vo3 = ON	Load variation	∆V042	_	30	200	mV	1o4=0~200mA
Ripple rejection ratio R.R4 50 60 — dB f=100Hz lo4=200mA [Input section] Standby voltage when OFF Vth - st — — 1.0 V Vo1=Vo4=OFF (MODE=0V) Standby voltage when ON Vth - st 1.8 — — V Vo1=Vo4=ON (MODE=0V) Input current when HIGH Ist 140 220 300 μA Vth-st=5V [MODE SW section] MODE voltage 1 Vth - m1 — — 1.1 V When Vth - st = 5V, Vo2 = ON and Vo3 = OFF MODE voltage 2 Vth - m2 3.9 — V When Vth - st = 5V, Vo2 = OFF and Vo3 = ON	Minimum I/O voltage differential	∆ Vo43		1.0	1.5	V	lo4=200mA
[Input section] Standby voltage when OFF	Output current capacity	lo4	250	_	_	mA	
Standby voltage when OFF Vth - st — — 1.0 V Vo1=Vo4=OFF (MODE=0V) Standby voltage when ON Vth - st 1.8 — — V Vo1=Vo4=ON (MODE=0V) Input current when HIGH Ist 140 220 300 μA Vth-st=5V [MODE SW section] When Vth - st = 5V, Vo2 = ON and Vo3 = OFF MODE voltage 1 Vth - m1 — — V When Vth - st = 5V, Vo2 = OFF and Vo3 = ON	Ripple rejection ratio	R.R4	50	60	_	dB	f=100Hz lo4=200mA
Standby voltage when ON Vth - st 1.8 — V Vo1=Vo4=ON (MODE=0V) Input current when HIGH ist 140 220 300 μA Vth-st=5V [MODE SW section] When Vth - st = 5V, Vo2 = ON and Vo3 = OFF MODE voltage 1 Vth - m1 — 1.1 V When Vth - st = 5V, Vo2 = ON and Vo3 = OFF MODE voltage 2 Vth - m2 3.9 — V When Vth - st = 5V, Vo2 = OFF and Vo3 = ON	[Input section]						
Input current when HIGH Ist 140 220 300 μA Vth—st=5V MODE SW section	Standby voltage when OFF	Vth - st	_	_	1.0	V	Vo1=Vo4=OFF (MODE=0V)
[MODE SW section] When Vth - st = 5V, Vo2 = ON and Vo3 = OFF MODE voltage 1 Vth - m1 - - 1.1 V When Vth - st = 5V, Vo2 = ON and Vo3 = OFF MODE voltage 2 Vth - m2 3.9 - - V When Vth - st = 5V, Vo2 = OFF and Vo3 = ON	Standby voltage when ON	Vth - st	1.8	-	_	V	Vo1=Vo4=ON (MODE=0V)
MODE voltage 1 Vth - m1 — 1.1 V When Vth - st = 5V, Vo2 = ON and Vo3 = OFF MODE voltage 2 Vth - m2 3.9 — V When Vth - st = 5V, Vo2 = OFF and Vo3 = ON	Input current when HIGH	lst	140	220	300	μА	Vth-st=5V
MODE voltage 2 Vth - m2 3.9 - V When Vth - st = 5V, Vo2 = OFF and Vo3 = ON	[MODE SW section]				1		
MODE voltage 2 Vth - m2 3.9 - V When Vth - st = 5V, Vo2 = OFF and Vo3 = ON	MODE voltage 1	Vth - m1	_	-	1.1	٧	When Vth - st = 5V, Vo2 = ON and Vo3 = OFF
Input current when HIGH Im 140 220 300 μA MODE=5V		Vth - m2	3.9	_	_	٧	When Vth - st = 5V, Vo2 = OFF and Vo3 = ON
	Input current when HIGH	lm	140	220	300	μА	MODE=5V

Asterisked ripple rejection ratio corresponds to a case where capacitors (1 μF) are used between pins 1 and 2 and between pins 3 and 4 to improve ripple rejection
 Not designed to be radiation tolerant.



Circuit operation

Vo2 and Vo4 rise when ST pin is 1.8V. With voltage applied on ST, the Vo2 output turns OFF when MODE is 1.6V (typical), and Vo3 turns ON when MODE is 3.2V (typical).



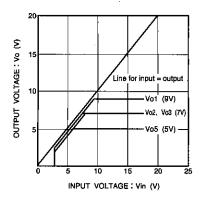
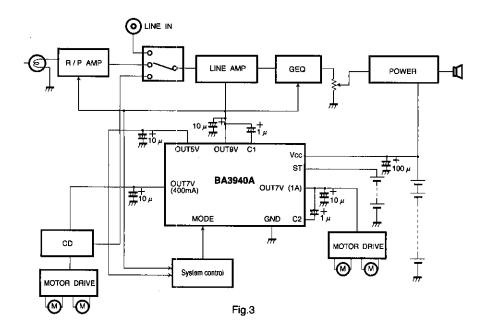


Fig.2 Input voltage vs. output voltage

Fig.1 Timing chart



Regulator ICs

Operation notes

(1) Operating power supply

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. 4) 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 1 μ F or greater between GND and each output pin. (To avoid the noise effect, lay out the grounding close to the IC) Oscillation can occur if capacitance is susceptible to temperature. We recommend using a tantalum electrolytic capacitor with minimal changes in capacitance.

(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. 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, when output is clamped at 1VF or higher). 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 are switched OFF when the circuit operates, and revert to the original state when temperature drops to a certain level.

- (6) Improving ripple rejection by capacitors
 Ripple rejection of the 9V and 7V (current capacity = 1A) outputs can be improved by installing a capacitor that reduces the AC gain.
- (7) Malfunction in intense electric fields Note that bringing the IC into an intense electric field (such as a radio relay station) may result in malfunction.

Regulator ICs

BA3940A

Thermal derating curves

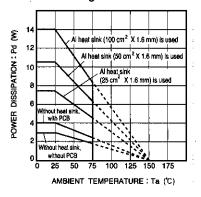


Fig.4 Thermal derating characteristics

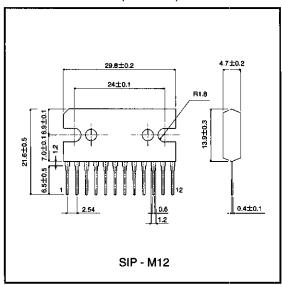
Rough estimation of IC power dissipation (PMAX.)

• Power consumed by OUT 7V $P_1 = (V_{CC} - 7V) \times \text{maximum load current of OUT 7V}$ • Power consumed by OUT 5V $P_2 = (V_{CC} - 5V) \times \text{maximum load current of OUT 5V}$ • Power consumed by OUT 9V $P_3 = (V_{CC} - 9V) \times \text{maximum load current of OUT 9V}$

• Power consumed internally by each circuit $P_4 = V_{CC} \times circuit current$

$$P_{MAX} = P1 + P2 + P3 + P4$$

External dimensions (Units: mm)



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