

# Dual circuit, variable output voltage regulator

## BA3960

The BA3960 is a dual circuit, variable output, series regulator. PNP output transistors allow minimum voltage differential between input and output. Each of the two circuits can be turned on or off independently by using the system logic control. When both circuits are off, the IC keeps a standby state with no supply current.

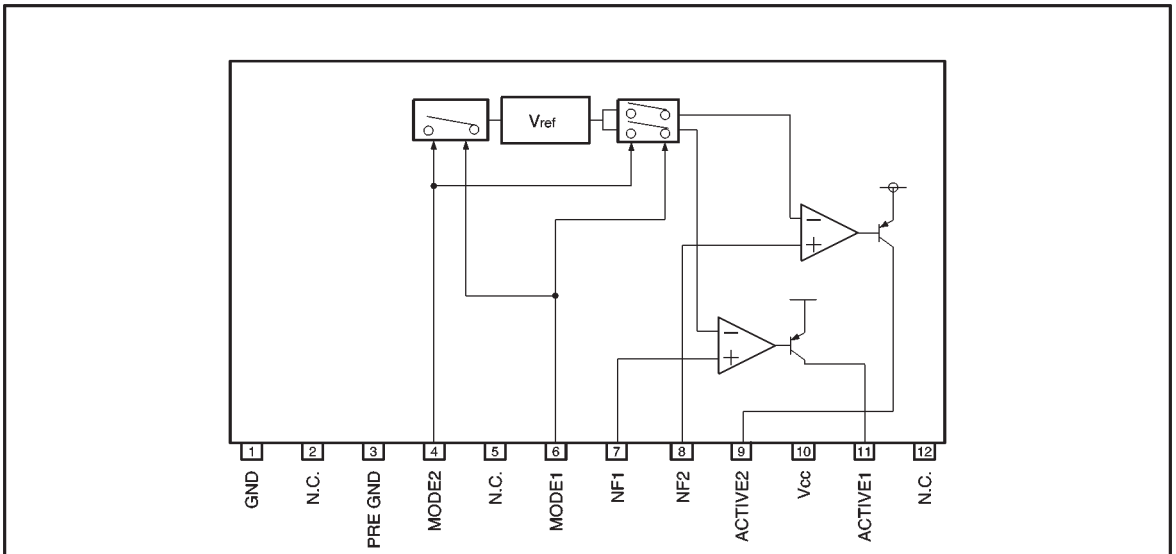
### ● Applications

Audio and video systems, CD and CD-ROM systems, computer peripheral devices, industrial equipment

### ● Features

- 1) Containing two circuits of variable-output series regulator.
- 2) PNP output transistor characterized by low saturation voltage.
- 3) Logic control allowing ON/OFF switching of output.
- 4) No supply current when both circuits are off.
- 5) Output current limit circuit protects the IC against short-circuiting damage.
- 6) Compact HSIP-B12 package allows a large power dissipation.
- 7) Thermal protection circuit prevents heat damage to the IC.

### ● Block diagram



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

Parameter	Symbol	Limits	Unit
Applied voltage	V <sub>CC</sub>	23	V
Power dissipation	P <sub>d</sub>	2200*	mW
Operating temperature	T <sub>opr</sub>	-25~+75	°C
Storage temperature	T <sub>stg</sub>	-55~+150	°C

\* Value for one unit.

Reduced by 17.5mW for each increase in Ta of 1°C over 25°C.

## ● Electrical characteristics

(unless otherwise noted, Ta = 25°C, V<sub>CC</sub> = 12.0V, ACTIVE 1 : I<sub>o</sub> = 640mA, ACTIVE 2 : I<sub>o</sub> = 400mA and R12, R22=3.9kΩ)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Standby supply current	I <sub>ST</sub>	—	0	10	μA	MODE 1, 2 pin = 0 V
NF1 reference voltage	VNF1	1.21	1.26	1.31	V	I <sub>o1</sub> =0mA
Voltage regulation	ΔV <sub>O1-1</sub>	—	20	50	mV	V <sub>CC</sub> =(V <sub>O</sub> +1V)~20V
Load regulation	ΔV <sub>O1-2</sub>	—	10	50	mV	I <sub>o1</sub> =0mA~640mA
NF2 reference voltage	VNF2	1.21	1.26	1.31	V	I <sub>o2</sub> =0mA
Voltage regulation	ΔV <sub>O2-1</sub>	—	20	50	mV	V <sub>CC</sub> =(V <sub>O</sub> +1V)~20V
Load regulation	ΔV <sub>O2-2</sub>	—	10	50	mV	I <sub>o2</sub> =0mA~400mA

## 〈 ACTIVE1〉

Minimum I/O voltage differential *1	ΔV <sub>O3-1</sub>	—	0.5	1.0	V	V <sub>CC</sub> = ACTIVE 1 output voltage
Output current capacity	I <sub>o1</sub>	800	—	—	mA	
Ripple rejection ratio	R. R1	50	60	—	dB	f=100Hz V <sub>RR</sub> =-10dBV

## 〈 ACTIVE2〉

Minimum I/O voltage differential *1	ΔV <sub>O3-2</sub>	—	0.5	1.0	V	V <sub>CC</sub> = ACTIVE 2 output voltage
Output current capacity A	I <sub>o2-A</sub>	700	—	—	mA	V <sub>CC</sub> >8V
Output current capacity B	I <sub>o2-B</sub>	500	—	—	mA	V <sub>CC</sub> ≤8V
Ripple rejection ratio	R. R2	50	60	—	dB	f=100Hz V <sub>RR</sub> =-10dBV

## 〈MODE SW〉

Voltage when MODE 1 is ON	V <sub>m1 ON</sub>	2.5	—	—	V	ACTIVE 1 HIGH switching voltage
Voltage when MODE 1 is OFF	V <sub>m1 OFF</sub>	—	—	0.5	V	ACTIVE 1 LOW switching voltage
Voltage when MODE 2 is ON	V <sub>m2 ON</sub>	2.5	—	—	V	ACTIVE 2 HIGH switching voltage
Voltage when MODE 2 is OFF	V <sub>m2 OFF</sub>	—	—	0.5	V	ACTIVE 2 LOW switching voltage
Input high level current (MODE 1, 2)	I <sub>HI1, 2</sub>	—	150	200	μA	MODE1, 2=5V

◎Not designed for radiation resistance.

\*1 Minimum I/O voltage differential refers to the difference between input and output voltage when V<sub>CC</sub> is set to the minimum output voltage.

## ● Recommended operating conditions

Parameter	Symbol	Voltage range	Unit
Input voltage	V <sub>CC</sub>	4.5~22.0*1	V
Output voltage	V <sub>OUT</sub>	1.5~21.0	V

\*1 For basic operation at Ta = 25°C.

● Input pin descriptions and equivalent circuits

Pin No.	Pin name	Function
1	GND	GND for large current, connected to IC substrate
2	N.C.	
3	PRE GND	GND for small current
4	MODE2	Pin to control ON/OFF of ACTIVE 2 output
5	N.C.	—
6	MODE1	Pin to control ON/OFF of ACTIVE 1 output
7	NF1	Return pin for setting ACTIVE 1 output voltage; reference voltage is 1.26 V (typical).
8	NF2	Return pin for setting ACTIVE 2 output voltage; reference voltage is 1.26 V (typical).
9	ACTIVE2	Power supply output for 500 mA output current
10	Vcc	DC power supply input
11	ACTIVE1	Power supply output for 800 mA output current
12	N.C.	—

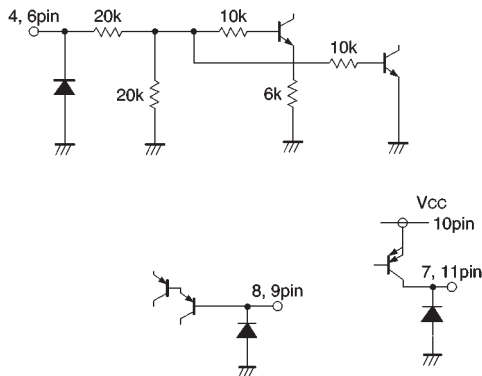


Fig.1 Input/output equivalent circuits

● Output voltage setting

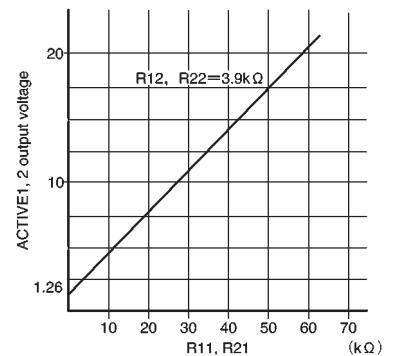


Fig.2 Feedback resistance vs. output voltage

Output voltage setting

$$V_{ref} = \frac{R_{11} (21) + R_{12} (22)}{R_{12} (22)}$$

(1.26V)

Example of output voltage setting resistance  
(V<sub>o1</sub> = 6V, V<sub>o2</sub> = 8V)

R<sub>11</sub> = 15kΩ     R<sub>21</sub> = 22kΩ

R<sub>12</sub> = 3.9kΩ     R<sub>22</sub> = 3.9kΩ

● Output voltage setting

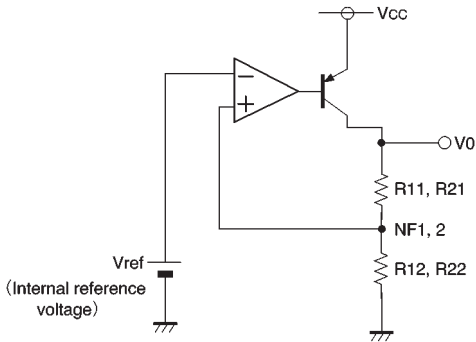


Fig.3 Output equivalent circuit

● Application example

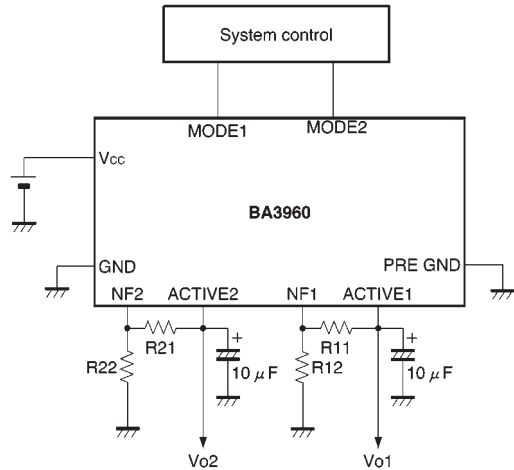


Fig.4

● Estimate of allowable power dissipation

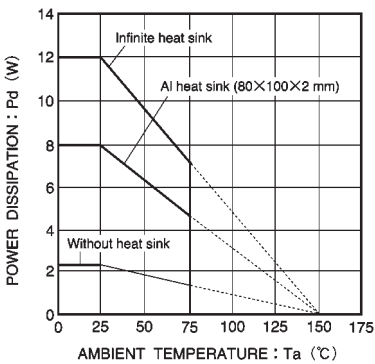


Fig.5 Thermal derating curves

Except under transitional conditions, the power dissipation of this IC is 2.2W per unit at 25°C.

See Fig. 5 for thermal derating characteristics, including some cases where heat sinks are used.

P<sub>MAX.</sub> calculation

- Power consumed by ACTIVE 1  $P_1 = (V_{CC} - \text{set output voltage}) \times \text{maximum output current}$
- Power consumed by ACTIVE 2  $P_2 = (V_{CC} - \text{set output voltage}) \times \text{maximum output current}$
- Power consumed internally by each circuit  $P_3 = V_{CC} \times \text{circuit current}$

$$P_{MAX.} = P_1 + P_2 + P_3$$

### ● 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. 5) and the rough estimation of IC power dissipation presented 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 10  $\mu$ F or greater between GND and each of the Active 1 and 2 output pins. Oscillation can occur if capacitance is susceptible to temperature. We recommend using a tantalum electrolytic capacitor with minimal changes in capacitance. Also, output can be further stabilized by connecting a bypass capacitor between  $V_{CC}$  and GND.

#### (4) Overcurrent protection circuit

An overcurrent protection circuit is installed on the Active 1 and 2 outputs, based on the respective current capacity. This prevents IC destruction when the load is short-circuited, 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). 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) Grounding

To minimize the variation of output voltage due to variations in load current, the GND (pin 1, for large current) and the PRE GND (pin 3, for small current) pins are separately provided. Make sure to connect circuits to correct pins.

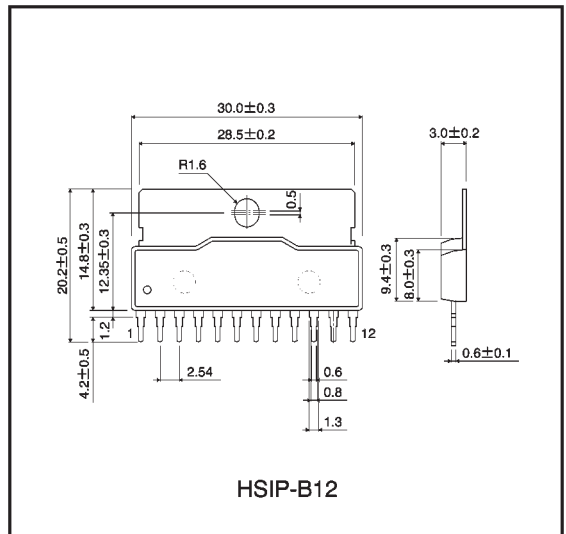
#### (7) Output voltage setting

ROHM recommends using a 3.9k $\Omega$  resistor for R12 and R22. Refer to a separate page for the output voltage setting. Note that making a large change to the R12 and R22 values will affect the current capacity.

#### (8) MODE voltage

Due to the IC's internal structure, a reverse current flow will occur if the MODE voltage exceeds the  $V_{CC}$  voltage. Make sure to avoid this.

### ● External dimensions (Units: mm)





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