

# Dual-Output (Fixed/Variable) LDO Regulators

**BA3259HFP BA30E00WHFP**

## ●General Description

The BA3259HFP and BA30E00WHFP are 2-output, low-saturation regulators. These units have both a 3.3 V fixed output as well as a variable output with a voltage accuracy of  $\pm 2\%$ , and incorporate an overcurrent protection circuit to prevent IC destruction due to output shorting along with a TSD (Thermal Shut Down) circuit to protect the IC from thermal destruction caused by overloading.

## ●Features

- Output voltage accuracy:  $\pm 2\%$ .
- Reference voltage accuracy:  $\pm 2\%$
- Ceramic capacitor can be used to prevent output oscillation (BA3259HFP)
- Low dissipation with two voltage input supported (BA30E00WHFP)
- Built-in thermal shutdown circuit
- Built-in overcurrent protection circuit

## ●Key Specifications

- Input Power Supply Voltage:
 

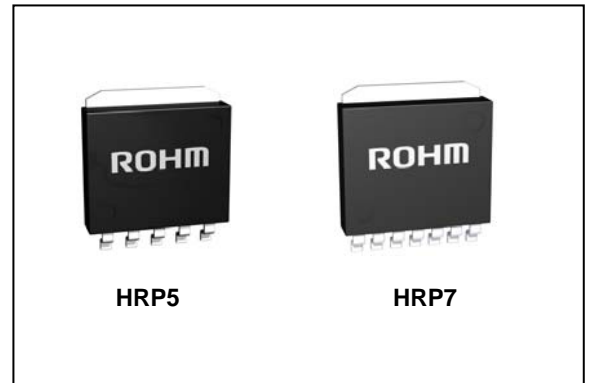
BA3259HFP	14.0V(Max.)
BA30E00WHFP	16.0V(Max.)
- Output Voltage type:  $V_{O1}$  Fixed  
 $V_{O2}$  Variable
- Output Current:
 

BA3259HFP	1A (MAX)
BA30E00WHFP	0.6A (MAX)
- Operating temperature range:
 

BA3259HFP	0 to 85°C
BA30E00WHFP	-25 to 105°C

## ●Packages

- |      |                                |
|------|--------------------------------|
|      | W (Typ.) x D (Typ.) x H (Max.) |
| HRP5 | 9.395mm x 10.54mm x 2.005mm    |
| HRP7 | 9.395mm x 10.54mm x 2.005mm    |



## ●Applications

Available to all commercial devices, such as FPD, TV, and PC sets besides DSP power supplies for DVD and CD sets.

## ●Ordering Information

<b>B A 3 x x x H F P</b>	<b>-</b>	<b>TR</b>
Part Number	Package HFP:HRP5 HRP7	Packaging and forming specification TR: Embossed tape and reel

## ●Lineup

Maximum Output Current (Max.)	Output Voltage 1 (Typ.)	Output Voltage 2 (Typ.)	Package		Orderable Part Number
1.0A	3.3V	0.8 to 3.3V	HRP5	Reel of 2000	BA3259HFP-TR
0.6A	3.3V	0.8 to 3.3V	HRP7	Reel of 2000	BA30E00WHFP-TR

○Product structure : Silicon monolithic integrated circuit ○This product is not designed protection against radioactive rays.

●Block Diagrams / Standard Example Application Circuits / Pin Configurations / Pin Descriptions

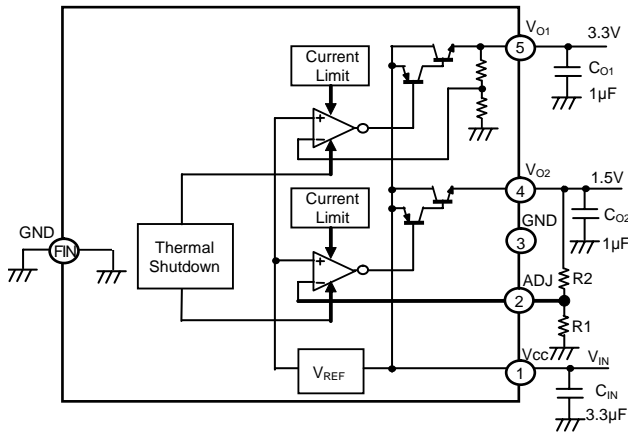


Fig.1 BA3259HFP Block Diagram

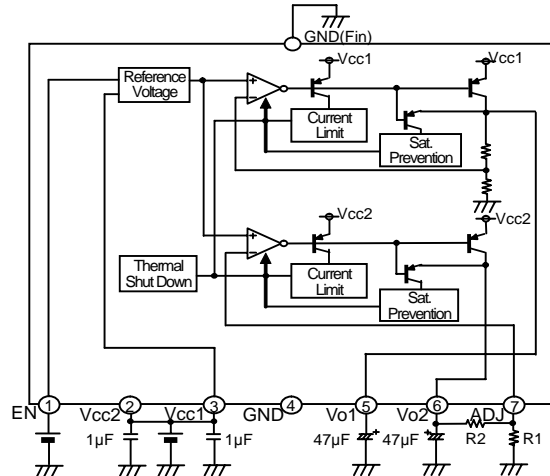


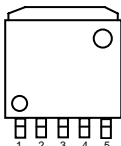
Fig.2 BA30E00WHFP Block Diagram

Pin No.	Pin name	Function
1	V <sub>CC</sub>	Power supply pin
2	ADJ	Variable output voltage detection pin
3	GND	GND pin
4	Vo <sub>2</sub>	Variable output pin
5	Vo <sub>1</sub>	3.3 V output pin
FIN	GND	GND pin

Pin No.	Pin name	Function
1	EN	Output on/off control pin: High active
2	V <sub>CC2</sub>	Power supply pin 2
3	V <sub>CC1</sub>	Power supply pin 1
4	GND	GND pin
5	Vo <sub>1</sub>	Power supply pin for 3.3 V output
6	Vo <sub>2</sub>	Variable output voltage detection pin (0.8 V to 3.3 V)
7	ADJ	Variable output voltage detection pin
FIN	GND	GND pin

PIN	External capacitor setting range
V <sub>CC</sub> (1Pin)	Approximately 3.3μF
Vo <sub>1</sub> (5Pin)	1 μF to 1000 μF
Vo <sub>2</sub> (4Pin)	1 μF to 1000 μF

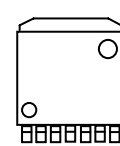
TOP VIEW



HRP5

PIN	External capacitor setting range
V <sub>CC1</sub> (3Pin)	Approximately 1 μF
V <sub>CC2</sub> (2Pin)	Approximately 1 μF
Vo <sub>1</sub> (5Pin)	47 μF to 1000 μF
Vo <sub>2</sub> (6Pin)	47 μF to 1000 μF

TOP VIEW



HRP7

●Absolute Maximum Ratings

BA3259HFP

Parameter	Symbol	Ratings	Units
Applied voltage	V <sub>CC</sub>	15 <sup>*1</sup>	V
Power dissipation	P <sub>d</sub>	2300 <sup>*2</sup>	mW
Operating temperature range	Topr	0 to 85	°C
Ambient storage temperature range	Tstg	-55 to 150	°C
Maximum junction temperature	Tjmax	150	°C

BA30E00WHFP

Parameter	Symbol	Ratings	Units
Applied voltage	V <sub>CC</sub>	18 <sup>*1</sup>	V
Power dissipation	P <sub>d</sub>	2300 <sup>*2</sup>	mW
Operating temperature range	Topr	-25 to 105	°C
Ambient storage temperature range	Tstg	-55 to 150	°C
Maximum junction temperature	Tjmax	150	°C

\*1 Must not exceed P<sub>d</sub>.

\*2 Derated at 18.4 mW/°C at T<sub>a</sub>>25°C when mounted on a glass epoxy board (70 mm × 70 mm × 1.6 mm).

## ● Recommended Operating Ratings

## BA3259HFP

Parameter	Symbol	Ratings			Unit
		Min.	Typ.	Max.	
Input power supply voltage	Vcc	4.75	-	14.0	V
3.3 V output current	Io1	-	-	1	A
Variable output current	Io2	-	-	1	A

## BA30E00WHFP

Parameter	Symbol	Ratings			Unit
		Min.	Typ.	Max.	
Input power supply voltage 1	Vcc1	4.1	-	16.0	V
Input power supply voltage 2	Vcc2	2.8	-	Vcc1	V
3.3 V output current	Io1	-	-	0.6	A
Variable output current	Io2	-	-	0.6	A

## ● Electrical Characteristics

OBA3259HFP (Unless otherwise specified, Ta=25°C, Vcc=5 V, R1=R2=5 kΩ)

Parameter	Symbol	Limits			Unit	Conditions
		Min.	Typ.	Max.		
Circuit current	I <sub>B</sub>	-	3	5	mA	Io1=0mA, Io2=0mA
[3.3 V Output Block]						
Output voltage 1	Vo1	3.234	3.300	3.366	V	Io1=50mA
Minimum I/O voltage difference 1	ΔVd1	-	1.1	1.3	V	Io1=1 A, Vcc=3.8V
Current capability 1	Io1	1.0	-	-	A	
Ripple rejection 1	R.R.1	46	52	-	dB	f=120Hz, ein=0.5Vp-p, Io1=5mA
Input stability 1	ΔVLINE1	-	5	15	mV	Vcc=4.75→14V, Io1=5mA
Load stability 1	ΔVLOAD1	-	5	20	mV	Io1=5mA→1 A
Temperature coefficient of output voltage 1 <sup>*3</sup>	Tcvo1	-	±0.01	-	%/°C	Io1=5mA, Tj=0°C to 85°C
[Variable output]						
Reference voltage	VREF	0.784	0.800	0.816	V	Io2=50mA
Minimum I/O voltage difference 2	ΔVd2	-	1.1	1.3	V	Io2=1 A
Current capability 2	Io2	1.0	-	-	A	
Ripple rejection 2	R.R.2	46	52	-	dB	f=120Hz, ein=0.5Vp-p, Io2=5mA
Input stability 2	ΔVLINE2	-	5	15	mV	Vcc=4.75→14V, Io2=5mA
Load stability 2	ΔVLOAD2	-	5	20	mV	Io2=5mA→1 A
Temperature coefficient of output voltage 2 <sup>*3</sup>	Tcvo2	-	±0.01	-	%/°C	Io2=5mA, Tj=0°C to 85°C
Variable pin current	IADJ	-	0.05	1.0	μA	VADJ=0.85V

\*3 Not 100% tested

## ●Electrical Characteristics - continued

OBA30E00WHFP (Unless otherwise specified, Ta=25°C, Vcc1=Vcc2=VEN=5 V, R1=50kΩ, R2=62.5kΩ)

Parameter	Symbol	Limits			Unit	Conditions
		Min.	Typ.	Max.		
Bias current	Ib	-	0.7	1.6	mA	Io1=0mA, Io2=0mA
Standby current	IST	-	0	10	μA	VEN=GND
EN pin on voltage	VON	2.0	-	-	V	Active mode
EN pin off voltage	VOFF	-	-	0.8	V	Standby mode
EN pin current	IEN	-	50	100	μA	VEN=3.3V
[3.3 V output]						
Output voltage 1	Vo1	3.234	3.300	3.366	V	Io1=50mA
Minimum I/O voltage difference 1	ΔVd1	-	0.30	0.60	V	Io1=300mA, Vcc=3.135V
Output current capacity 1	Io1	0.6	-	-	A	
Ripple rejection 1	R.R.1	-	68	-	dB	f=120Hz, ein=1Vp-p, Io1=100mA
Input stability 1	Reg.I1	-	5	30	mV	Vcc1=4.1→16V, Io1=50mA
Load stability 1-1	Reg.L1-1	-	30	90	mV	Io1=0mA→0.6A
Load stability 1-2	Reg.L1-2	-	30	90	mV	Vcc1=3.7V, Io1=0→0.4A
Temperature coefficient of output voltage 1 *3	Tcvo1	-	±0.01	-	%/°C	Io1=5mA, Tj=0°C to 125°C
[Variable output] (at 1.8 V)						
Reference voltage	VADJ	0.784	0.800	0.816	V	Io2=50mA
Minimum I/O voltage difference 2	ΔVd2	-	0.30	0.60	V	At Io2=3.3V Io2=300mA, Vcc1=Vcc2=3.135V
Output current capacity 2	Io2	0.6	-	-	A	
Ripple rejection 2	R.R.2	-	66	-	dB	f=120Hz, ein=1Vp-p, Io2=100mA
Input stability 2	Reg.I2	-	5	30	mV	Vcc1=Vcc2=4.1V→16V, Io2=50mA
Load stability 2	Reg.L2	-	30	90	mV	Io2=0mA→0.6A
Temperature coefficient of output voltage 2 *3	Tcvo2	-	±0.01	-	%/°C	Io2=5mA, Tj=0°C to 125°C

\*3 Not 100% tested

● Typical Performance Curves

BA3259HFP (Unless otherwise specified,  $T_a=25^{\circ}\text{C}$ ,  $V_{cc}=5\text{ V}$ )

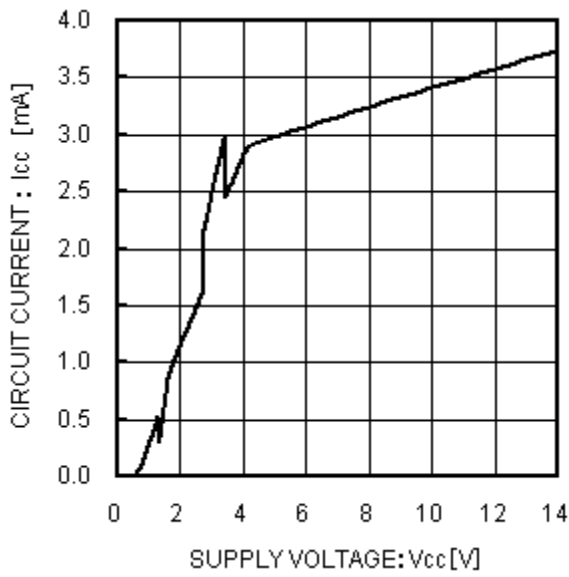


Fig.3  
Circuit Current (with no load)

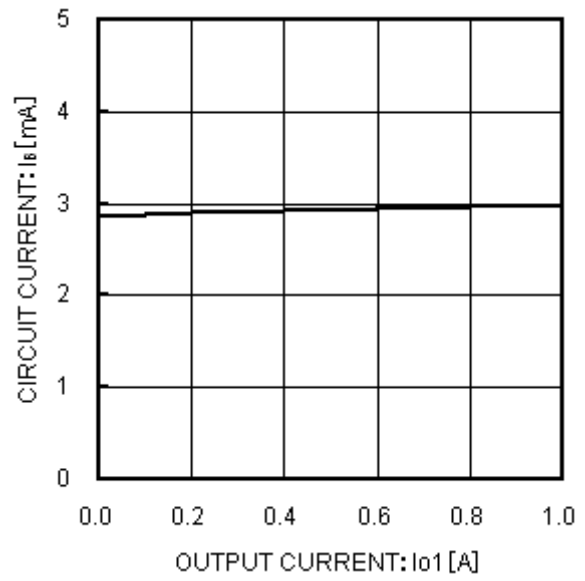


Fig.4  
Circuit Current vs Load Current  $I_o$

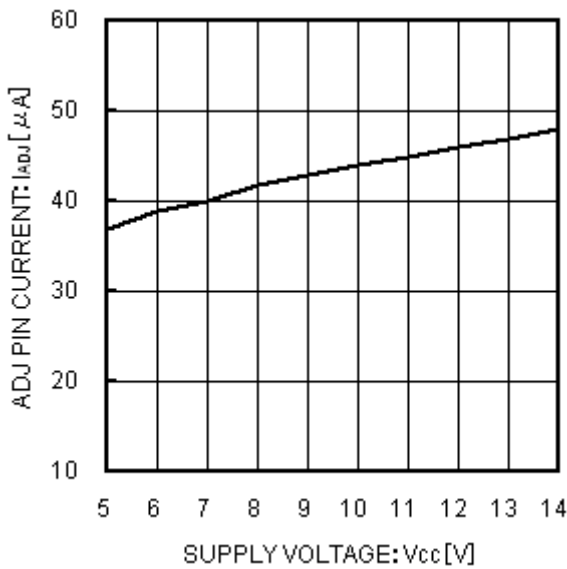


Fig.5  
ADJ Pin Outflow Current

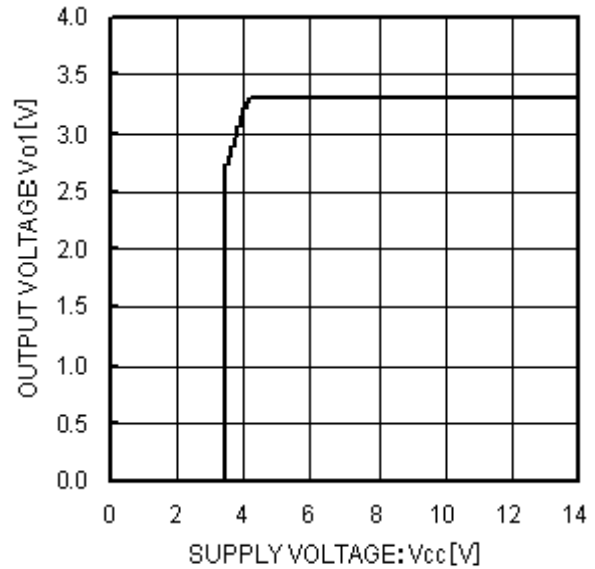


Fig.6  
Input Stability  
(3.3 V output with no load)

● Typical Performance Curves - continued

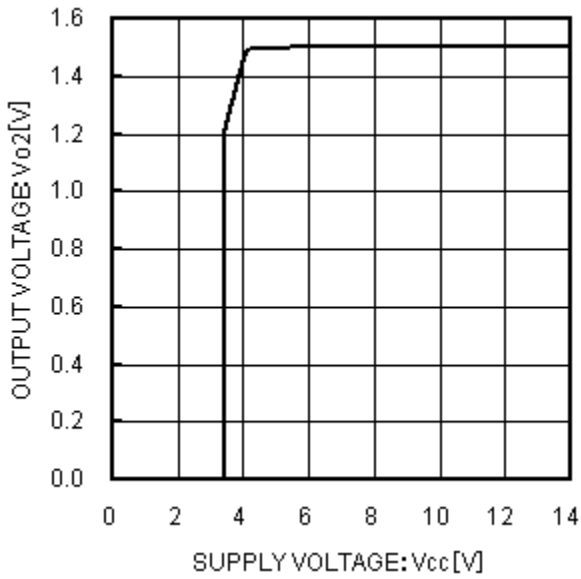


Fig.7  
Input Stability  
(Variable output with no load)

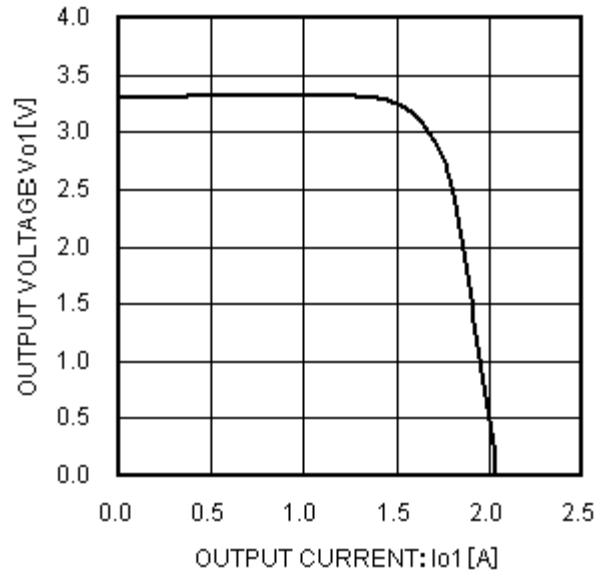


Fig.8  
Load Stability  
(3.3 V output)

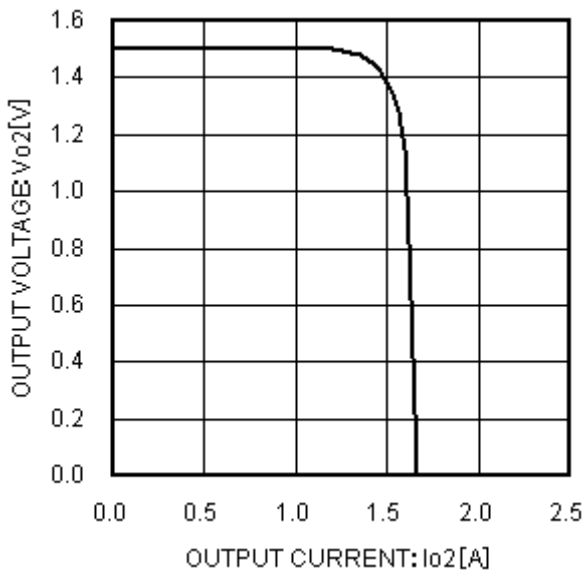


Fig.9  
Load Stability  
(Variable output: 1.5 V)

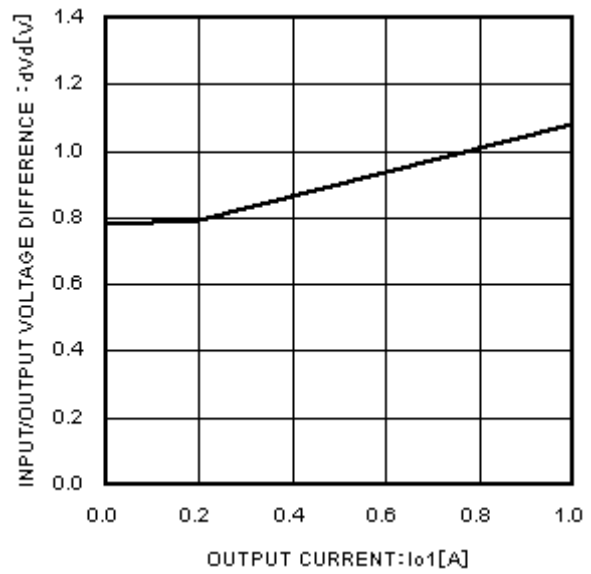


Fig.10  
I/O Voltage Difference (3.3 V output)  
(3.3 V output,  $I_{o1}=0\text{ A} \rightarrow 1\text{ A}$ )

● Typical Performance Curves - continued

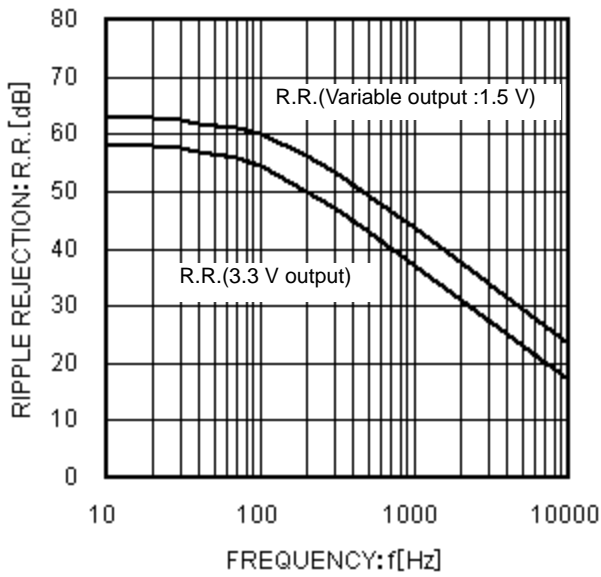


Fig.11  
R.R.

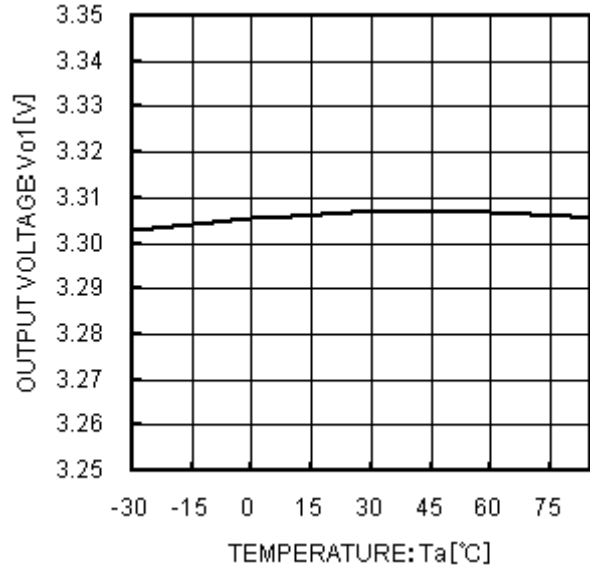


Fig.12  
Output Voltage vs Temperature  
(3.3 V output)

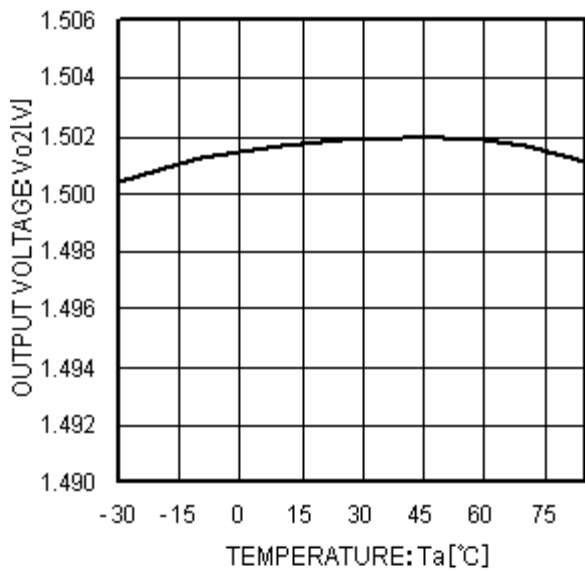


Fig.13  
Output Voltage vs Temperature  
(Variable output: 1.5 V)

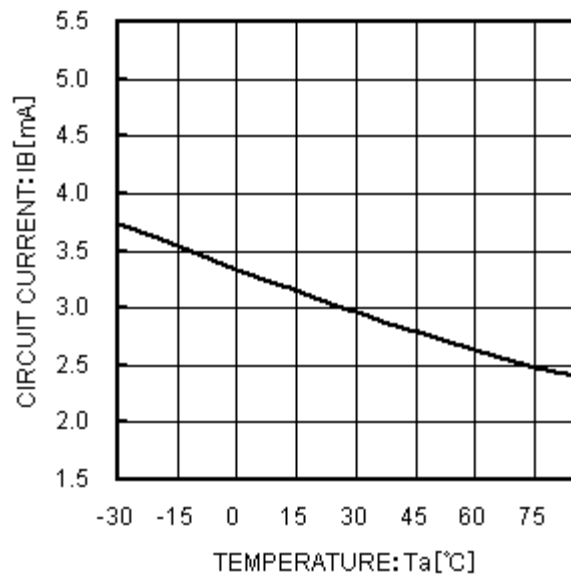


Fig.14  
Circuit Current vs Temperature

● Typical Performance Curves - continued

BA30E00WHFP (Unless otherwise specified,  $T_a=25^\circ\text{C}$ ,  $V_{cc1}=V_{cc2}=5\text{V}$ )

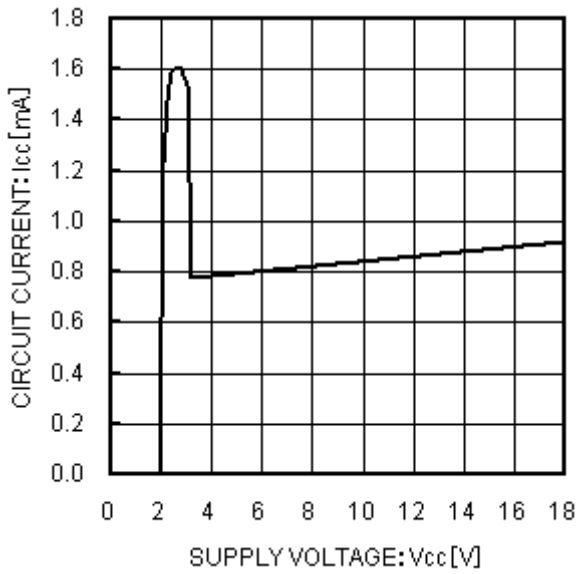


Fig.15  
Circuit Current  
(with no load)

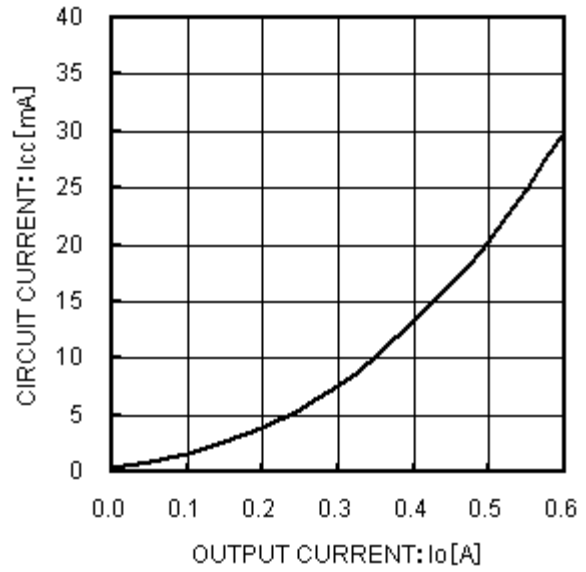


Fig.16  
Circuit Current vs Load Current  $I_o$   
( $I_o=0 \rightarrow 600\text{ mA}$ )

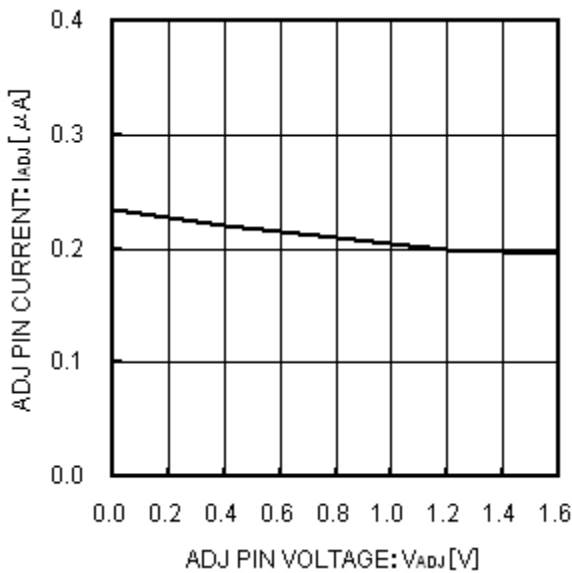


Fig.17  
ADJ Pin Source Current

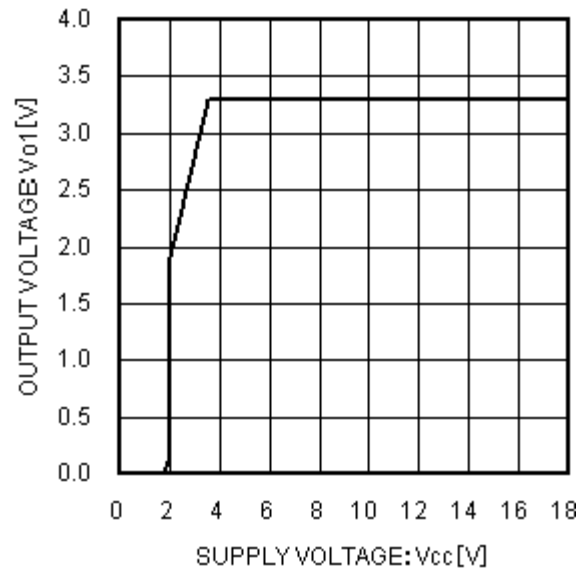


Fig.18  
Input Stability  
(3.3 V output  $I_o=600\text{ mA}$ )



● Typical Performance Curves - continued

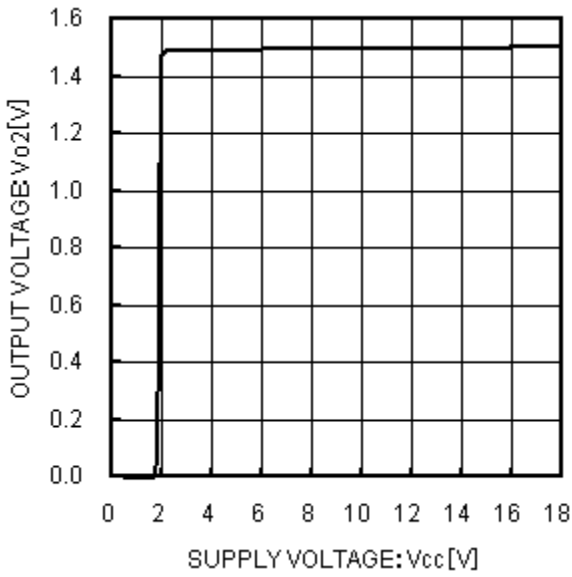


Fig.19  
Input Stability  
(Variable output: 1.8 V)

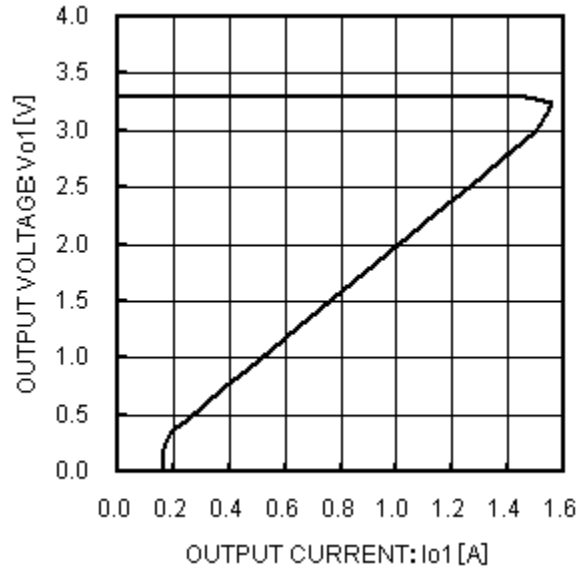


Fig.20  
Load Stability  
(3.3 V output)

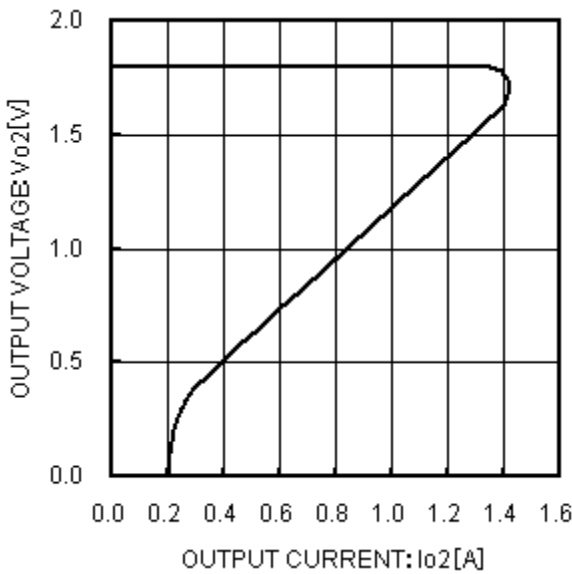


Fig.21  
Load Stability  
(Variable output: 1.8 V)

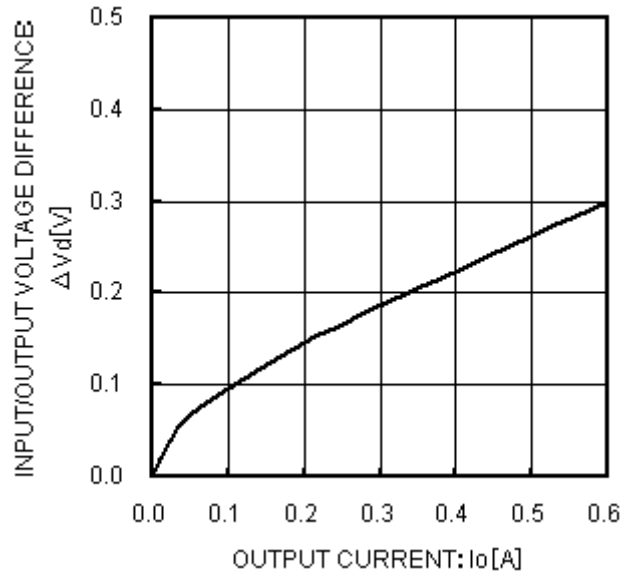


Fig.22  
I/O Voltage Difference  
( $V_{cc}=3.135$  V, 3.3 V output)

● Typical Performance Curves - continued

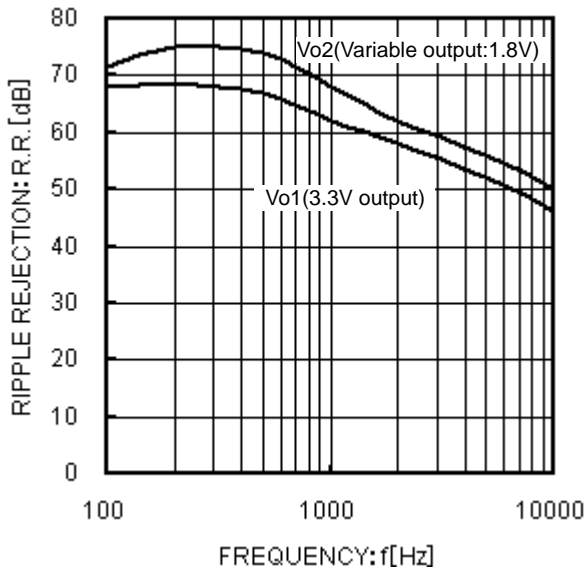


Fig.23  
R.R.  
( $e_{in}=1$  Vp-p,  $I_o=100$  mA)

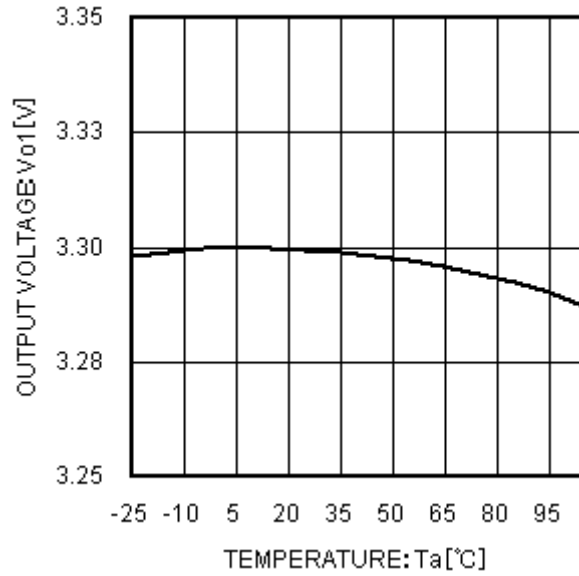


Fig.24  
Output Voltage vs Temperature  
(3.3 V output)

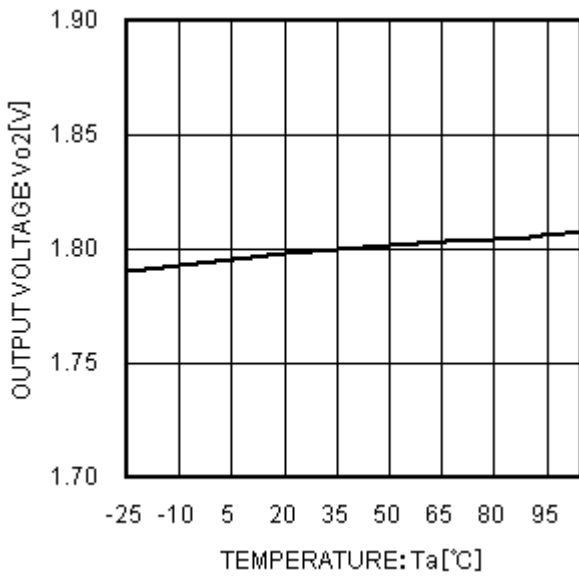


Fig.25  
Output Voltage vs Temperature  
(Variable output: 1.8 V)

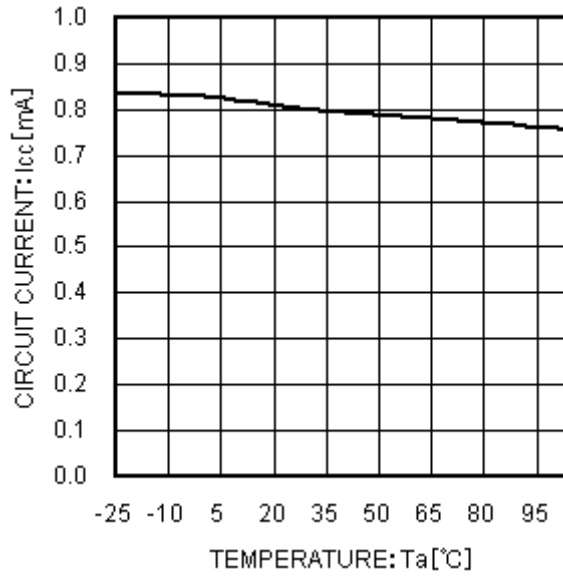


Fig.26  
Circuit Current vs Temperature  
( $I_o=0$  mA)

**Application Information**

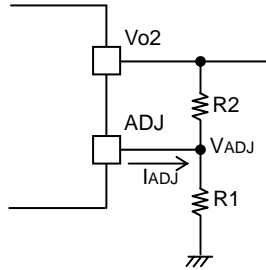
**●Setting the Output Voltage Vo2**

The following output voltage setting method applies to the variable output pin.

$$Vo2 = V_{ADJ} \times \left( 1 + \frac{R2}{R1} \right) - R2 \times I_{ADJ}$$

V<sub>ADJ</sub>: Output feedback reference voltage (0.8 V typ.)

I<sub>ADJ</sub>: ADJ pin source current (0.05μA typ.: BA3259HFP)  
(0.2μA typ.: BA30E00WHFP)



R1  
BA3259HFP: 1 kΩ to 10 kΩ  
BA30E00HFP: 1 kΩ to 5 kΩ  
The above is recommended.

Note: Connect R1 and R2 to make output voltage settings as shown in Fig.1 and Fig.2. Keep in mind that the offset voltage caused by the current (I<sub>ADJ</sub>) flowing out of the ADJ pin will become high if higher resistance is used.

**●Function Explanation**

1) Two-input power supply (BA30E00WHFP)

The input voltages (V<sub>cc1</sub> and V<sub>cc2</sub>) supply power to two outputs (Vo<sub>1</sub> and Vo<sub>2</sub>, respectively). The power dissipation between the input and output pins can be suppressed for each output according to usage.

Efficiency comparison:

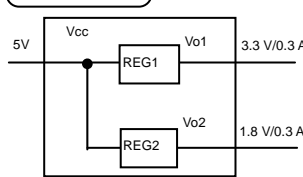
5V single input vs. 5V/3V two inputs

•Regulator with single input and two outputs

•Regulator with two inputs and two outputs

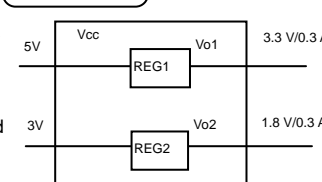
(Vo<sub>2</sub>=1.8V, Io<sub>1</sub>=Io<sub>2</sub>=0.3A)

**Conventional**



Power loss between input and output  
(V<sub>cc</sub> - Vo<sub>1</sub>) × Io<sub>1</sub> + (V<sub>cc</sub> - Vo<sub>2</sub>) × Io<sub>2</sub>  
= (5 - 3.3) × 0.3 + (5 - 1.8) × 0.3  
= 0.51W + 0.96W  
= 1.47W  
→ Single 5V input results in decreased efficiency

**Current**



Power loss between input and output  
(V<sub>cc1</sub> - Vo<sub>1</sub>) × Io<sub>1</sub> + (V<sub>cc2</sub> - Vo<sub>2</sub>) × Io<sub>2</sub>  
= (5 - 3.3) × 0.3 + (5 - 1.8) × 0.3  
= 0.51W + 0.36W  
= 0.87W  
→ Additional 3V input improves efficiency  
Reduced power loss by 0.6W.

2) Standby function (BA30E00WHFP)

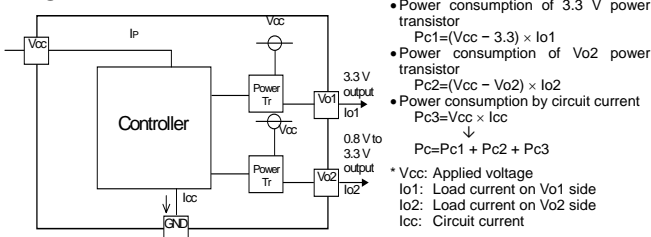
The standby function is operated through the EN pin. Output is turned on at 2.0 V or higher and turned off at 0.8 V or lower.

**●Power Dissipation**

If the IC is used under the conditions of excess of the power dissipation, the chip temperature will rise, which will have an adverse effect on the electrical characteristics of the IC, such as a reduction in current capability. Furthermore, if the temperature exceeds T<sub>jmax</sub>, element deterioration or damage may occur. Implement proper thermal designs to ensure that the power dissipation is within the permissible range in order to prevent instantaneous IC damage resulting from heat and maintain the reliability of the IC for long-term operation. Refer to the power derating characteristics curves in Fig.27.

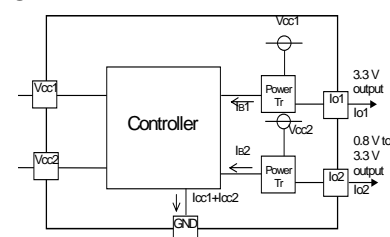
• Power Consumption Pc (W) Calculation Method:

**OBA3259HFP**



• Power consumption of 3.3 V power transistor  
Pc1=(V<sub>cc</sub> - 3.3) × Io1  
• Power consumption of Vo2 power transistor  
Pc2=(V<sub>cc</sub> - Vo2) × Io2  
• Power consumption by circuit current  
Pc3=V<sub>cc</sub> × I<sub>cc</sub>  
Pc=Pc1 + Pc2 + Pc3  
\* V<sub>cc</sub>: Applied voltage  
Io1: Load current on Vo1 side  
Io2: Load current on Vo2 side  
I<sub>cc</sub>: Circuit current

**OBA30E00WHFP**



• Power consumption of power transistor on Vo1 (3.3 V output)  
Pc1=(V<sub>cc1</sub> - Vo1) × Io1  
• Power consumption of power transistor on Vo2 (variable output)  
Pc2=(V<sub>cc2</sub> - Vo2) × Io2  
• Power consumption by circuit current  
Pc3=V<sub>cc1</sub> × I<sub>cc1</sub> + V<sub>cc2</sub> × I<sub>cc2</sub>  
Pc=Pc1 + Pc2 + Pc3  
\* V<sub>cc1</sub>, V<sub>cc2</sub>: Applied voltage  
Io1: Load current on 3.3 V output side  
Io2: Load current on variable output side  
I<sub>cc1</sub>, I<sub>cc2</sub>: Circuit currents

The  $I_{cc}$  (circuit current) varies with the load.

Refer to the above and implement proper thermal designs so that the IC will not be used under conditions of excess power dissipation  $P_d$  under all operating temperatures.

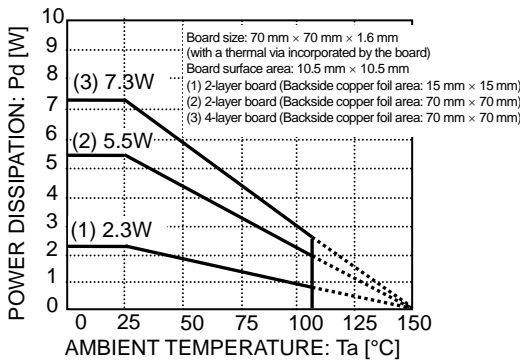


Fig.27 Ambient Temperature vs. Power Dissipation

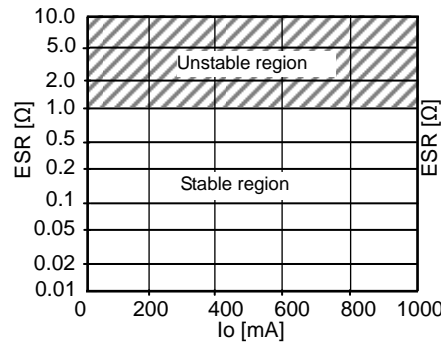


Fig.28 BA3259HFP ESR Characteristics

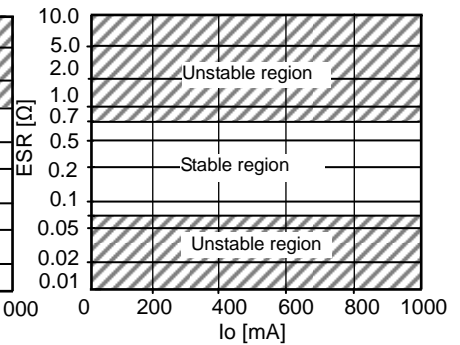


Fig.29 BA30E00WHFP ESR Characteristics

● I/O equivalence circuit

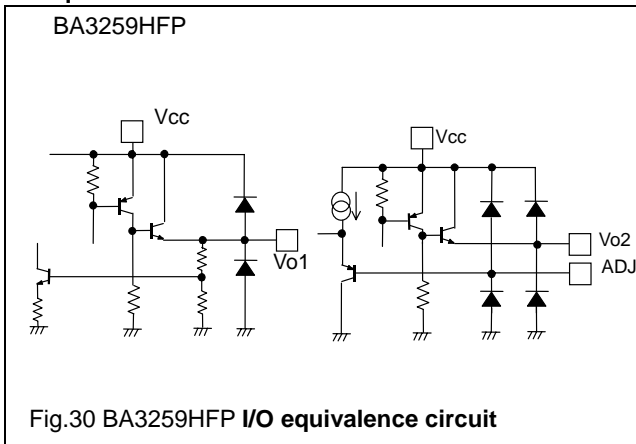


Fig.30 BA3259HFP I/O equivalence circuit

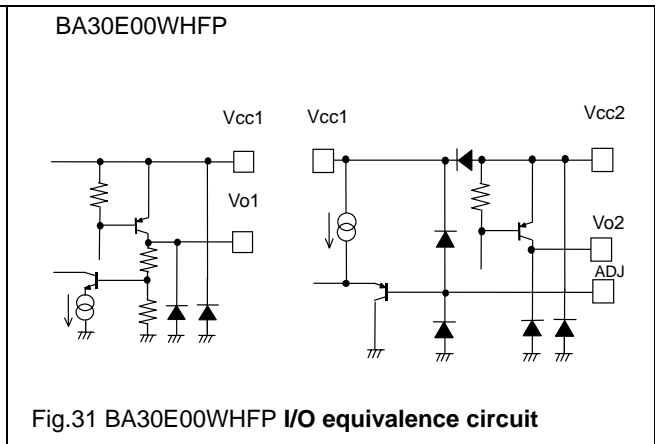


Fig.31 BA30E00WHFP I/O equivalence circuit

● Explanation of External Components

OBA3259HFP

1) Vcc (Pin 1)

It is recommended that a ceramic capacitor with a capacitance of approximately 3.3μF is placed between Vcc and GND at a position closest to the pins as possible.

2) Vo (Pins 4 and 5)

Insert a capacitor between Vo and GND in order to prevent output oscillation. The capacitor may oscillate if the capacitance changes as a result of temperature fluctuations. Therefore, it is recommended that a ceramic capacitor with a temperature coefficient of X5R or above and a maximum capacitance change (resulting from temperature fluctuations) of ±10% be used. The capacitance should be between 1μF and 1,000μF. (Refer to Fig.28.)

OBA33E00HFP

1) Vcc1 (Pin 3) and Vcc2 (Pin 2)

Insert capacitors with a capacitance of 1μF between Vcc1 and GND and Vcc2 and GND. The capacitance value will vary depending on the application. Be sure to implement designs with sufficient margins.

2) Vo1 (Pin 5) and Vo2 (Pin 6)

Insert a capacitor between Vo and GND in order to prevent oscillation. The capacitance of the capacitor may greatly vary with temperature changes, making it impossible to completely prevent oscillation. Therefore, use a tantalum aluminum electrolytic capacitor with a low ESR (Equivalent Serial Resistance) that ensures good performance characteristics at low temperatures. The output oscillates if the ESR is too high or too low. Refer to the ESR characteristics in Fig.29 and operate the IC within the stable operating region. If there is a sudden load change, use a capacitor with a higher capacitance. A capacitance between 47μF and 1,000μF is recommended.

**●Operational Notes**

- 1) Absolute maximum ratings  
An excess in the absolute maximum ratings, such as supply voltage, temperature range of operating conditions, etc., can break down the devices, thus making impossible to identify breaking mode, such as a short circuit or an open circuit. If any over rated values will expect to exceed the absolute maximum ratings, consider adding circuit protection devices, such as fuses.
- 2) GND voltage  
The potential of GND pin must be minimum potential in all operating conditions.
- 3) Thermal design  
Use a thermal design that allows for a sufficient margin in light of the power dissipation (Pd) in actual operating conditions.
- 4) Inter-pin shorts and mounting errors  
Use caution when positioning the IC for mounting on printed circuit boards. The IC may be damaged if there is any connection error or if pins are shorted together.
- 5) Actions in strong electromagnetic field  
Use caution when using the IC in the presence of a strong electromagnetic field as doing so may cause the IC to malfunction.
- 6) Testing on application boards  
When testing the IC on an application board, connecting a capacitor to a pin with low impedance subjects the IC to stress. Always discharge capacitors after each process or step. Always turn the IC's power supply off before connecting it to or removing it from a jig or fixture during the inspection process. Ground the IC during assembly steps as an antistatic measure. Use similar precaution when transporting or storing the IC.
- 7) Regarding input pin of the IC  
This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated. P-N junctions are formed at the intersection of these P layers with the N layers of other elements, creating a parasitic diode or transistor. For example, the relation between each potential is as follows:  
When  $GND > PIN A$  and  $GND > PIN B$ , the P-N junction operates as a parasitic diode.  
When  $GND > PIN B$ , the P-N junction operates as a parasitic transistor.  
Parasitic diodes can occur inevitable in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Accordingly, methods by which parasitic diodes operate, such as applying a voltage that is lower than the GND (P substrate) voltage to an input pin, should not be used.
- 8) Ground wiring patterns  
When using both small signal and large current GND patterns, it is recommended to isolate the two ground patterns, placing a single ground point at the ground potential of application so that the pattern wiring resistance and voltage variations caused by large currents do not cause variations in the small signal ground voltage. Be careful not to change the GND wiring pattern of any external components, either.
- 9) Thermal Shutdown Circuit (TSD)  
This IC incorporates a built-in thermal shutdown circuit for protection against thermal destruction. Should the junction temperature (Tj) reach the thermal shutdown ON temperature threshold, the TSD will be activated, turning off all output power elements. The circuit will automatically reset once the chip's temperature Tj drops below the threshold temperature. Operation of the thermal shutdown circuit presumes that the IC's absolute maximum ratings have been exceeded. Application designs should never make use of the thermal shutdown circuit.
- 10) Overcurrent protection circuit  
An overcurrent protection circuit is incorporated in order to prevention destruction due to short-time overload currents. Continued use of the protection circuits should be avoided. Please note that current increases negatively impact the temperature.
- 11) Damage to the internal circuit or element may occur when the polarity of the Vcc pin is opposite to that of the other pins in applications. (I.e. Vcc is shorted with the GND pin while an external capacitor is charged.)  
Use a maximum capacitance of 1000 mF for the output pins. Inserting a diode to prevent back-current flow in series with Vcc or bypass diodes between Vcc and each pin is recommended.

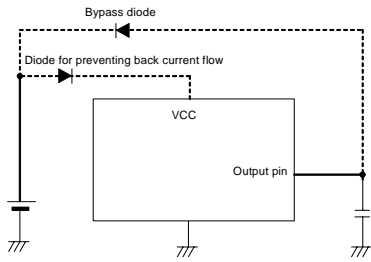


Fig.32 Bypass diode

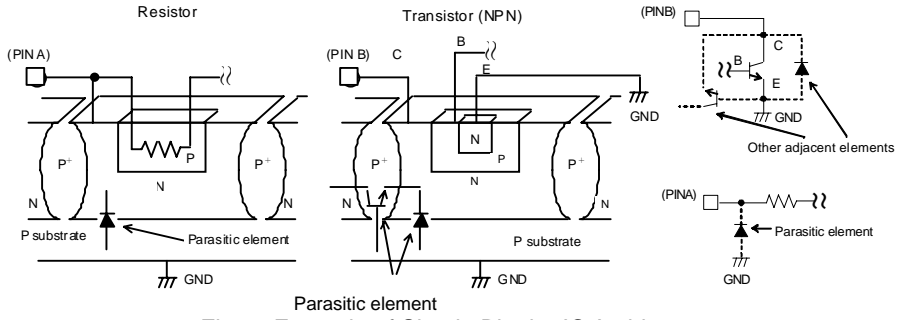


Fig.33 Example of Simple Bipolar IC Architecture

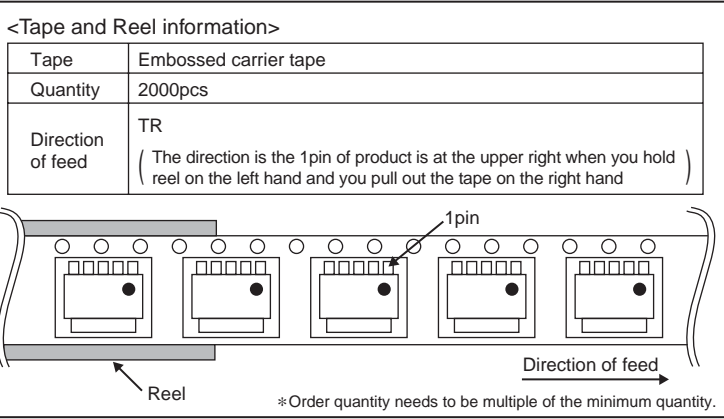
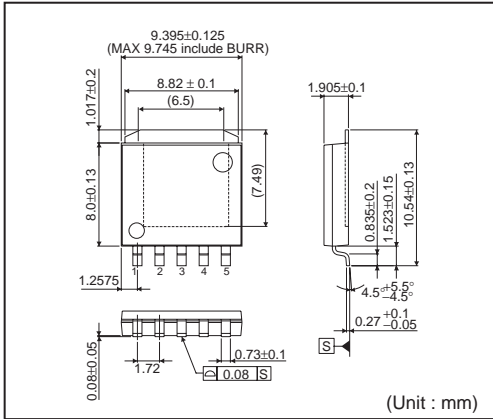
Status of this document

The Japanese version of this document is formal specification. A customer may use this translation version only for a reference to help reading the formal version.

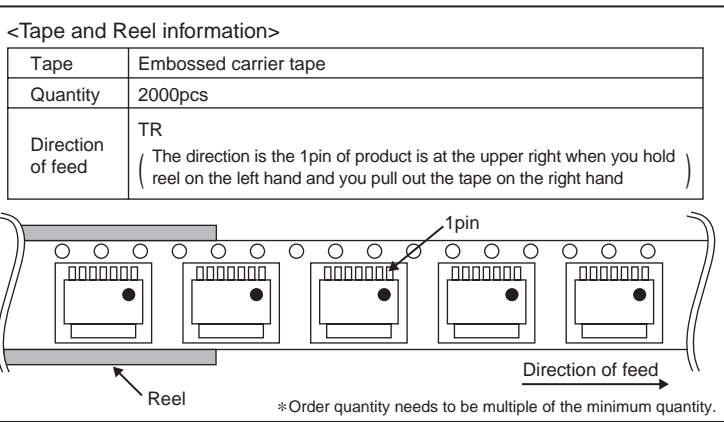
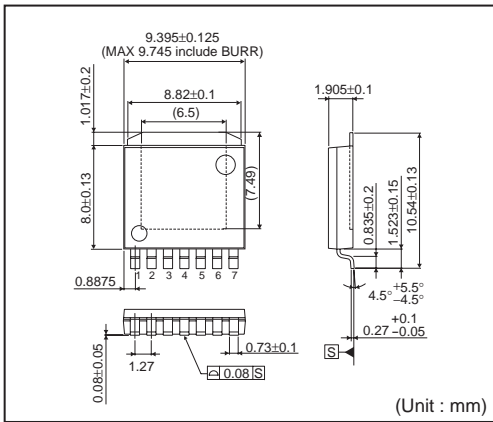
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●Physical Dimension Tape and Reel Information

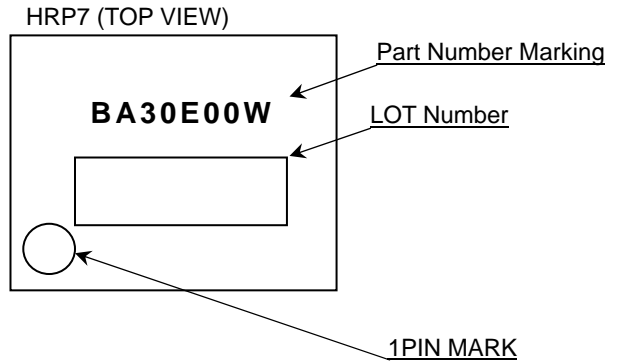
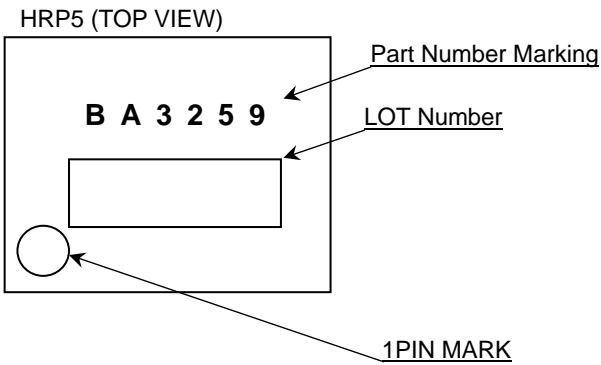
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HRP7



●Marking Diagrams



●Revision History

Date	Revision	Changes
26.Jun.2012	001	New Release



# Notice

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