CMOS LDO Regulator Series for Portable Equipment

CMOS LDO Regulators with Auto Power Saving Function

BH□□PB1WHFV Series

●Description

The BH□□PB1WHFV regulator series can respond to changes in output current by switching to a state in which regulator characteristics are ideal. The regulators cut power consumption by lowering their own current consumption to approximately 2 μA when the application is operating in the standby state. During normal-current operation it will automatically switch to high-speed operating mode. The IC's soft start function reduce the rush current that flows to the output capacitors during startup. The HVSOF5 package, which features excellent heat dissipation, contributes to space-saving application designs.

●Features

1) Automatic switching between low-consumption and high-speed modes
2) Built-in rush current prevention circuit
3) Low-voltage 1.7 V operation
4) High accuracy output voltage: ± 1%
5) Circuit current during low-consumption operation: 2 μA
6) Stable with a ceramic capacitor (0.47 μF)
7) Built-in temperature and overcurrent protection circuits
8) Built-in output discharge during standby operation function
9) Ultra-small HVSOF5 power package

●Applications

Battery-driven portable devices, etc.

●Product lineup

■150 mA BH□□PB1WHFV Series

Product name	1.2	1.5	1.8	2.5	2.8	2.9	3.0	3.1	3.3	Package
BH□□PB1WHFV	√	√	√	√	√	√	√	√	√	HVSOF5

Model name: BH□□PB1W□
a b

Symbol	Description			
a	Output voltage specification			
	□□	Output voltage (V)	□□	Output voltage (V)
	12	1.2 V (Typ.)	29	2.9 V (Typ.)
	15	1.5 V (Typ.)	30	3.0 V (Typ.)
	18	1.8 V (Typ.)	31	3.1 V (Typ.)
	25	2.5 V (Typ.)	33	3.3 V (Typ.)
	28	2.8 V (Typ.)		
b	Package HFV: HVSOF5			

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

Parameter	Symbol	Limits	Unit
Power supply voltage	VMAX	−0.3 to +6.5	V
Power dissipation	Pd	410 *1	mW
Operating temperature range	Topr	−40 to +85	°C
Storage temperature range	Tslg	−55 to +125	°C
Junction temperature	Tjmax	125	°C

*1: Reduced by 4.1 mW/°C over 25°C, when mounted on a glass epoxy board (70 mm × 70 mm × 1.6 mm)

●**Recommended operating ranges** (not to exceed Pd)

Parameter	Symbol	Limits	Unit
Power supply voltage	VIN	1.7 to 5.5	V
Output MAX current	IMAX	0 to 150	mA

●**Recommended operating conditions**

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Input capacitor	CIN	0.33 *2	0.47	−	μF	The use of ceramic capacitors is recommended.
Output capacitor	CO	0.33 *2	0.47	−	μF	The use of ceramic capacitors is recommended.

*2: Make sure that the output capacitor value is not kept lower than this specified level across a variety of temperature, DC bias characteristic. And also make sure that the capacitor value can not change as time progresses.

●**Electrical characteristics**

(Unless otherwise specified, Ta = 25°C, VIN = VOUT + 1.0 V, STBY = 1.5 V, SEL = 0 V, CIN = 0.47 μF, CO = 0.47 μF)

PARAMETER		Symbol	Limit			Unit	Conditions
			MIN.	TYP.	MAX.		
【Regulator】							
Output voltage (high-speed mode)		VOUT1	VOUT1×0.99	-	VOUT1×1.01	V	VOUT□2.5V, IOUT=0.1mA, SEL=1.5V
			VOUT1-0.025	-	VOUT1+0.025	V	VOUT□1.8V, IOUT=0.1mA, SEL=1.5V
Output voltage (low-consumption mode)		VOUT2	VOUT2×0.97	-	VOUT2×1.038	V	VOUT□2.5V, IOUT=0.1mA, SEL=0V
			VOUT2×0.967	-	VOUT2×1.043	V	VOUT□1.8V, IOUT=0.1mA, SEL=0V
Circuit current (high-speed mode)		ICC1	-	20	40	μA	IOUT=0mA, VIN pin monitor, SEL=1.5V
Circuit current (low-consumption mode)		ICC2	-	2	4	μA	IOUT=0mA, VIN pin monitor, SEL=0V
Circuit current (STBY)		ISTBY	-	-	1.0	μA	STBY=0V
Ripple rejection ratio (high-speed mode)		RR1	42	60	-	dB	VRR=-20dBv, fRR=1kHz, IOUT=10mA, SEL=1.5V
Dropout voltage 1 *1		VSAT1	-	100	200	mV	VIN=VOUT×0.98, IOUT=50mA
Dropout voltage 2 *1		VSAT2	-	210	400	mV	VIN=VOUT×0.98, IOUT=100mA
Dropout voltage 3 *1		VSAT3	-	315	600	mV	VIN=VOUT×0.98, IOUT=150mA
Line regulation 1 (high-speed mode)		VDL1	-	2	20	mV	VIN=VOUT+1V to 5.5V, IOUT=10mA
Line regulation 2 (low-consumption mode)		VDL2	-	2	20	mV	VIN=VOUT+1V to 5.5V, IOUT=100μA
Load regulation		VDLO	-	10	40	mV	IOUT=10mA to 100mA
【Mode switch】							
Current threshold (low-consumption mode)		ITH1	0.09	0.3	-	mA	SEL=0V IOUT=3mA□0mA sweep
Current threshold (high-speed mode)		ITH2	-	1.2	2.2	mA	SEL=0V IOUT=0mA□3mA sweep
【Over Current Protection 1】							
Limit Current		ILMAX	160	300	500	mA	Vo=VOUT×0.90
Short current		ISHORT	20	50	100	mA	Vo=0V
【Stand-by block】							
STBY pin sink current		ISTB	-	2	4	μA	STBY=1.5V
STBY control voltage	ON	VSTBH	1.5	-	VIN	V	
	OFF	VSTBL	-0.3	-	0.3	V	
Discharge resistance at standby		RDCG	1.5	2.2	3.0	kΩ	STBY=0V
【SEL PIN】							
Pull-down resistance of SEL pin		RSEL	0.5	1.0	2.0	MΩ	
SEL control voltage	ON	VSELH	1.5	-	VIN	V	Fixed high speed mode
	OFF	VSELL	-0.3	-	0.3	V	Automatic switch mode

* Note: This IC is not designed to be radiation-resistant. *3: Except at VOUT ≤ 1.5 V.

●**Electrical characteristics of each output voltage**

Output Voltage	Parameter	Min.	Typ.	Max.	Unit	Conditions
1.2 V	Max. output current	70	120	−	mA	VCC = 1.7 V
		150	−	−		VCC = 2.0 V
1.5 V		50	100	−		VCC = 1.8 V
		150	−	−		VCC = 2.2 V
1.8 V ≤ VOUT		75	143	−		VCC = VOUT + 0.3 V
		150	−	−		VCC = VOUT + 0.6 V

●Typical characteristics

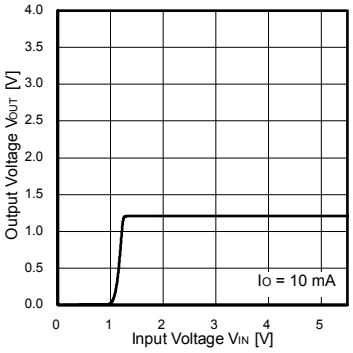


Fig. 1 Output Voltage vs Input Voltage (BH12PB1WHFV)

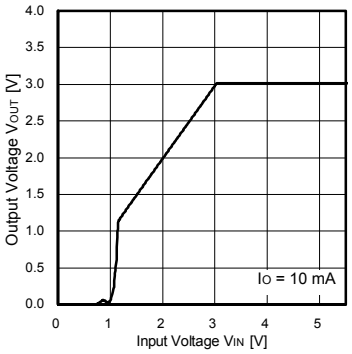


Fig. 2 Output Voltage vs Input Voltage (BH30PB1WHFV)

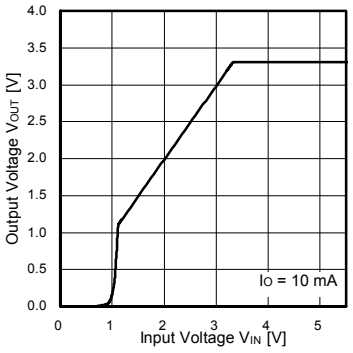


Fig. 3 Output Voltage vs Input Voltage (BH33PB1WHFV)

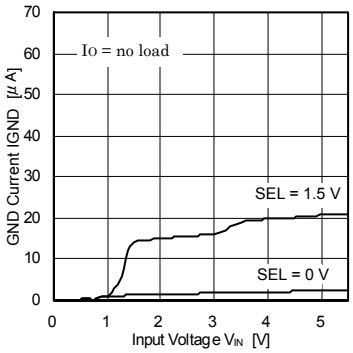
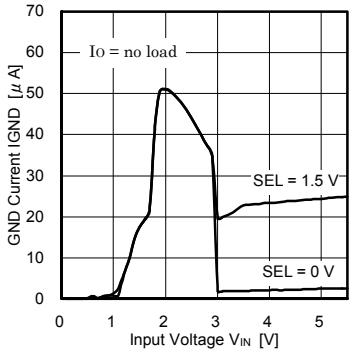
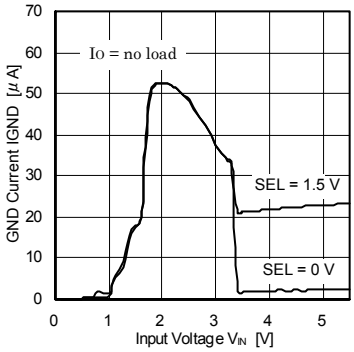


Fig.4 GND Current vs Input Voltage (BH12PB1WHFV)



(BH33PB1WHFV)



(BH33PB1WHFV)
－Input Voltage
(BH33PB1WHFV)

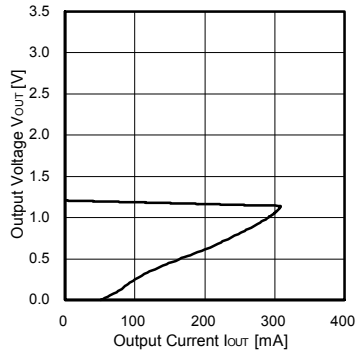
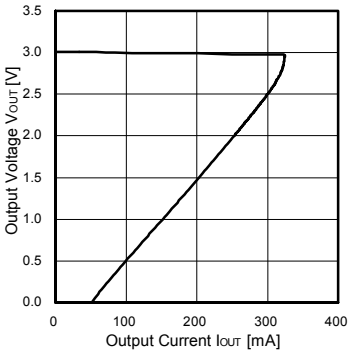


Fig. 7 Output Voltage vs Outout Current (BH12PB1WHFV)



(BH30PB1WHFV)
(BH30PB1WHFV)

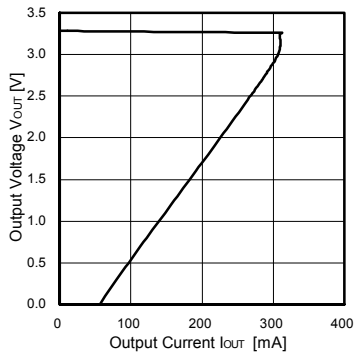


Fig.9 Output Voltage vs Output Current (BH33PB1WHFV)

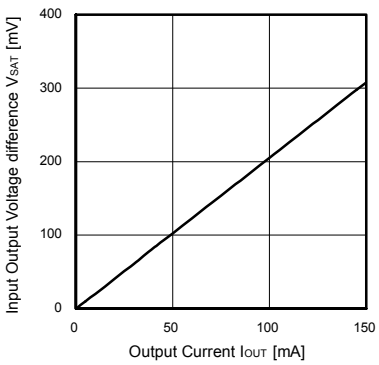


Fig. 10 Dropout voltage vs Output Current (BH18PB1WHFV)

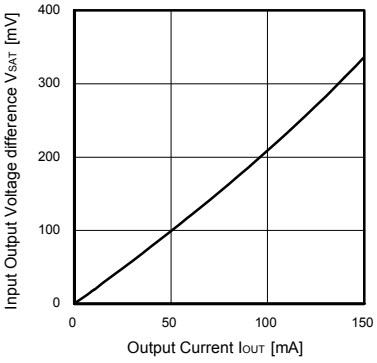


Fig. 11 Dropout voltage vs Output Current (BH30PB1WHFV)

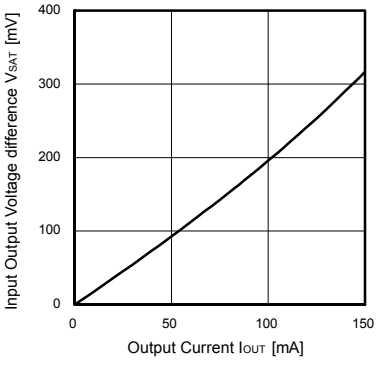


Fig. 12 Dropout voltage vs Output Current (BH33PB1WHFV)

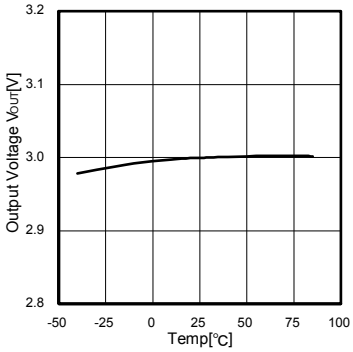


Fig. 13 Output Voltage vs Temperature (BH30PB1WHFV)

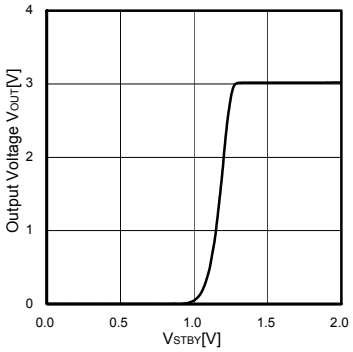


Fig. 14 Standby Pin Threshold (BH30PB1WHFV)

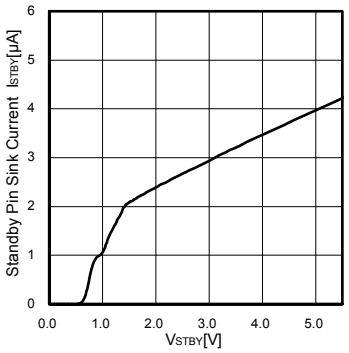


Fig. 15 Standby Pin Sink Current (BH30PB1WHFV)

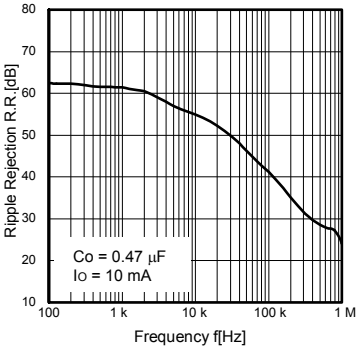


Fig. 16 Ripple Rejection (BH12PB1WHFV)

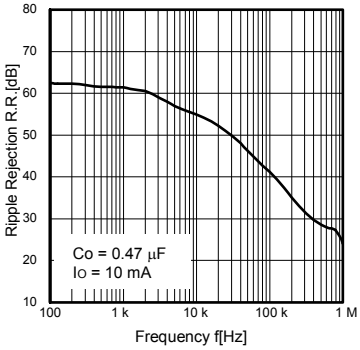


Fig. 17 Ripple Rejection (BH30PB1WHFV)

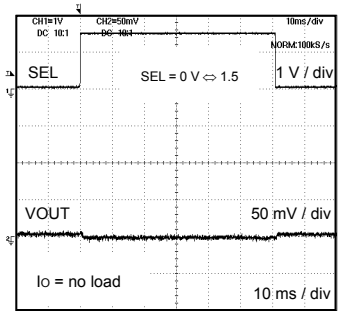


Fig. 18 Output Voltage Waveform During SEL Switching (BH30PB1WHFV)

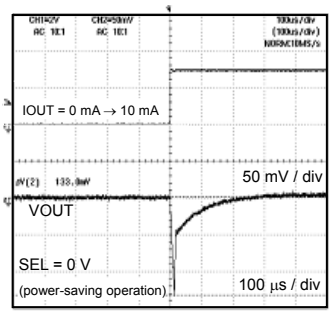


Fig. 19 Load Response (Co = 1.0 μF) (BH30PB1WHFV)

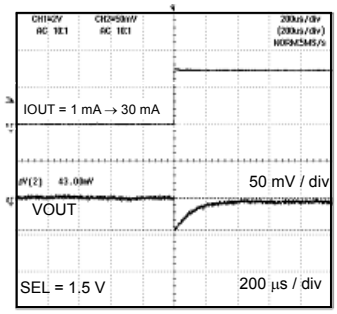


Fig. 20 Load Response (Co = 1.0 μF) (BH30PB1WHFV)

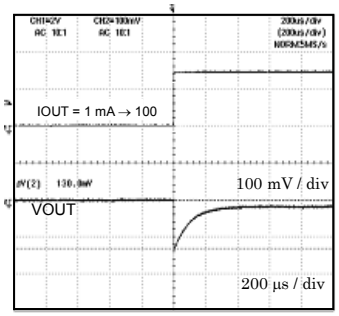


Fig. 21 Load Response (Co = 1.0 μF) (BH30PB1WHFV)

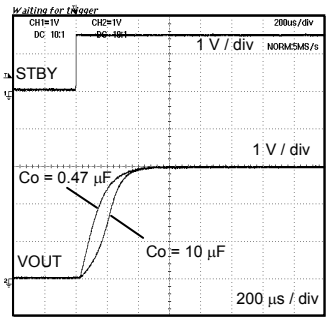


Fig. 22 Output Voltage Rise Time (BH30PB1WHFV)

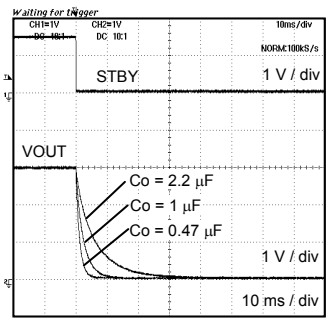


Fig. 23 Output Voltage Fall Time (BH30PB1WHFV)

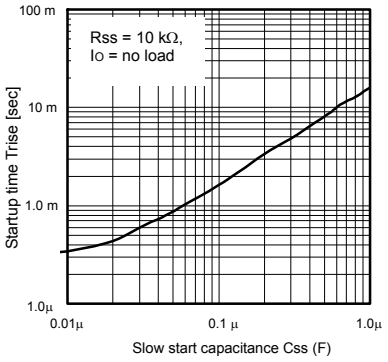
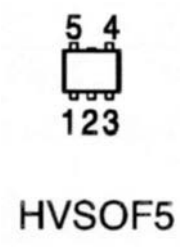


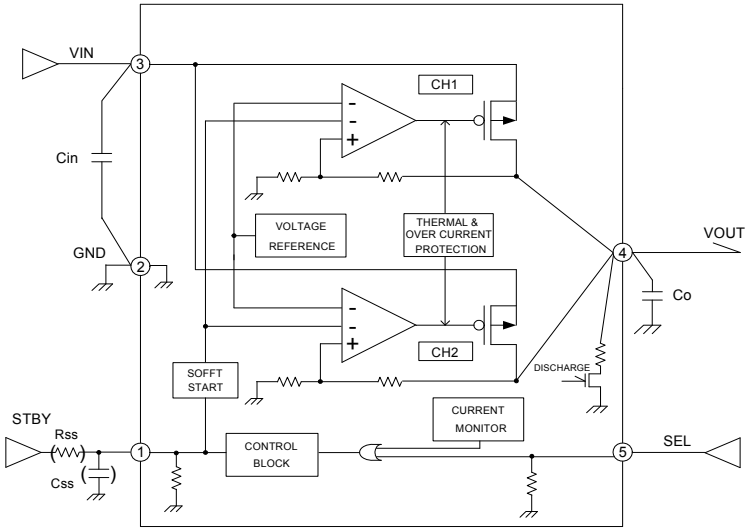
Fig. 24 Soft Start Rise Time (BH30PB1WHFV)

●**Block diagram, recommended circuit diagram, and pin assignment table**

BH□□PB1WHFV



PIN No.	Symbol	Function
1	STBY	Output voltage on/off control (High: ON, Low: OFF)
2	GND	Ground
3	VIN	Power supply input
4	VOUT	Voltage output
5	SEL	Mode switching (High: Fix in high-speed mode Low: Automatic low-consumption mode switching)



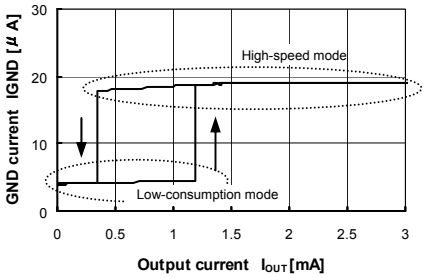
Cin … 0.47 μF
Co … 0.47 μF

Fig. 25

●**Auto Power-saving Function**

The IC incorporates a built-in auto power-saving function that continuously monitors the output current and switches automatically between a low current consumption regulator and a high-speed operation regulator. This function reduces the regulator's own current consumption to approximately 1/10 or lower of normal levels when the output current falls below approximately 300 μA.

To operate only the high-speed operation regulator without using the auto power-saving function, fix the SEL pin to high.



Measurement conditions
BH12PB1WHFV
VCC = 2.2 V
VSEL = open,
VSTBY = 1.5 V

Fig. 26 Auto Power-Saving Function (Example)

●**Power Dissipation (Pd)**

1. Power Dissipation (Pd)

Power dissipation calculations include estimates of power dissipation characteristics and internal IC power consumption, and should be treated as guidelines. In the event that the IC is used in an environment where this power dissipation is exceeded, the attendant rise in the junction temperature will trigger the thermal shutdown circuit, reducing the current capacity and otherwise degrading the IC's design performance. Allow for sufficient margins so that this power dissipation is not exceeded during IC operation.

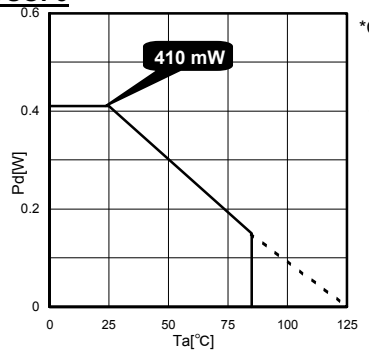
Calculating the maximum internal IC power consumption (PMAX)

$P_{MAX} = (V_{IN} - V_{OUT}) \times I_{OUT}$ (MAX.)

V_{IN} : Input voltage
V_{OUT} : Output voltage
I_{OUT} (MAX) : Max. output current

2. Power Dissipation/Heat Reduction (Pd)

HVSOF5



*Circuit design should allow a sufficient margin for the temperature range so that P_{MAX} < Pd.

Fig. 27 HVSOF5 Power Dissipation vs Heat Reduction (Example)

●Input Output capacitors

It is recommended to insert bypass capacitors between input and GND pins, positioning them as close to the pins as possible. These capacitors will be used when the power supply impedance increases or when long wiring paths are used, so they should be checked once the IC has been mounted.

Ceramic capacitors generally have temperature and DC bias characteristics. When selecting ceramic capacitors, use X5R or X7R, or better models that offer good temperature and DC bias characteristics and high tolerant voltages.

Typical ceramic capacitor characteristics

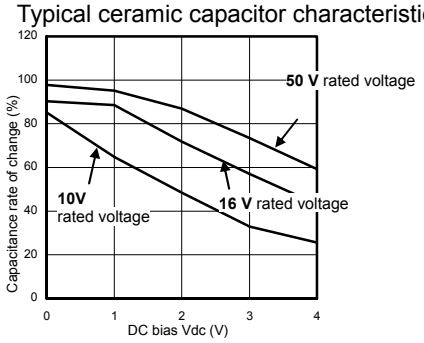


Fig. 28 Capacitance vs Bias (Y5V)

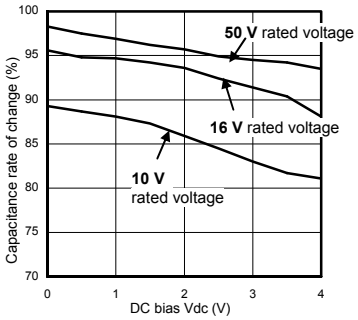


Fig. 29 Capacitance vs Bias (X5R, X7R)

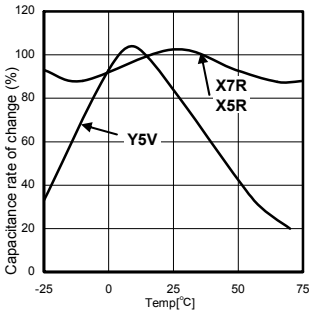


Fig. 30 Capacitance vs Temperature (X5R, X7R, Y5V)

●Output capacitors

Mounting input capacitor between input pin and GND(as close to pin as possible), and also output capacitor between output pin and GND(as close to pin as possible) is recommended.

The input capacitor reduces the output impedance of the voltage supply source connected to the VCC. The higher value the output capacitor goes, the more stable the whole operation becomes. This leads to high load transient response. Please confirm the whole operation on actual application board.

Generally, ceramic capacitor has wide range of tolerance, temperature coefficient, and DC bias characteristic. And also its value goes lower as time progresses. Please choose ceramic capacitors after obtaining more detailed data by asking capacitor makers.

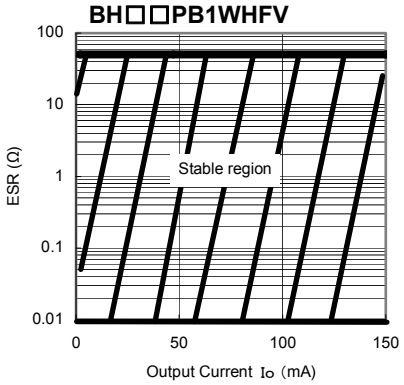


Fig. 31 Stable Operation Region (Example)

●Operation 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. Thermal design

   Use a thermal design that allows for a sufficient margin in light of the power dissipation (Pd) in actual operating conditions.

3. 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.

4. Thermal shutdown circuit (TSD)

   The IC incorporates a built-in thermal shutdown circuit (TSD circuit). The thermal shutdown circuit is designed only to shut the IC off to prevent runaway thermal operation. It is not designed to protect the IC or guarantee its operation. Do not continue to use the IC after operating this circuit or use the IC in an environment where the operation of this circuit is assumed.

5. Ground wiring patterns

   The power supply and ground lines must be as short and thick as possible to reduce line impedance. Fluctuating voltage on the power ground line may damage the device.

6. Overcurrent protection circuit

   The IC incorporates a built-in overcurrent protection circuit that operates according to the output current capacity. This circuit serves to protect the IC from damage when the load is shorted. The protection circuit is designed to limit current flow by not latching in the event of a large and instantaneous current flow originating from a large capacitor or other component. These protection circuits are effective in preventing damage due to sudden and unexpected accidents.

However, the IC should not be used in applications characterized by the continuous operation or transitioning of the protection circuits. At the time of thermal designing, keep in mind that the current capability has negative characteristics to temperatures.

7. 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.

8. Back Current

In applications where the IC may be exposed to back current flow, it is recommended to create a path to dissipate this current by inserting a bypass diode between the VIN and VOUT pins.

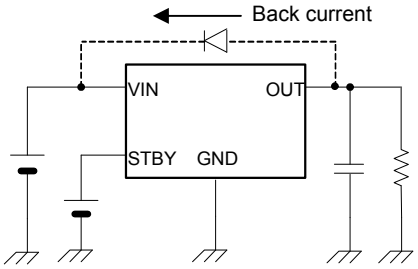


Fig. 32 Example
Bypass Diode Connection

9. I/O voltage difference

Using the IC in automatic switching mode when the I/O voltage differential becomes saturated (VIN - VOUT < 150 mV) may result in a large output noise level. If the noise level becomes problematic, use the IC with the SEL pin in the high state when the voltage differential is saturated.

10. GND Voltage

The potential of GND pin must be minimum potential in all operating conditions.

11. Preventing Rush Current

By attaching the Rss and Css time constants to the STBY pin, sudden rises in the regulator output voltage can be prevented, dampening the flow of rush current to the output capacitors. The larger the time constant used, the greater the resulting reduction. However, large time constants also result in longer startup times, so the constant should be selected after considering the conditions in which the IC is to be used.

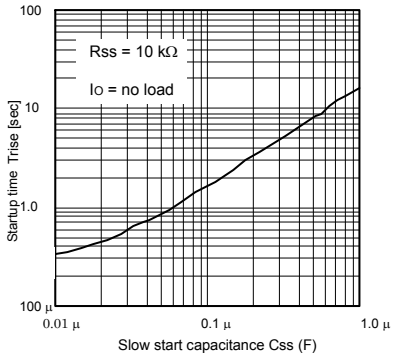


Fig. 33 VOUT Startup Time vs CSS Capacitance (Reference)

12. Regarding input Pin of the IC (Fig.34)

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.

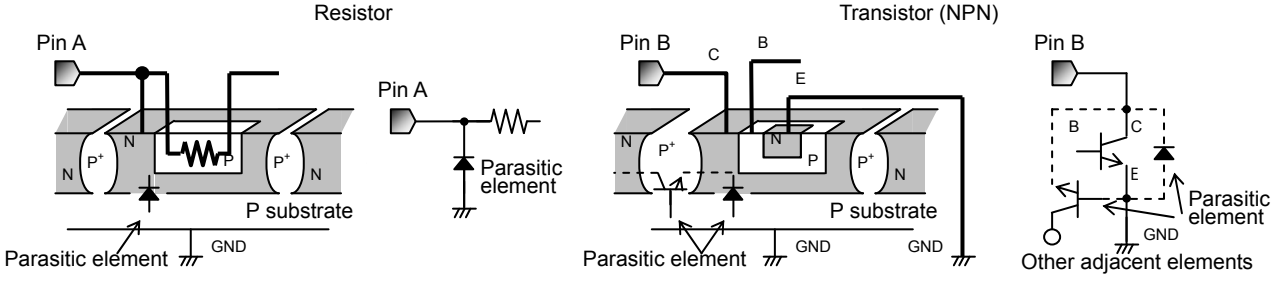


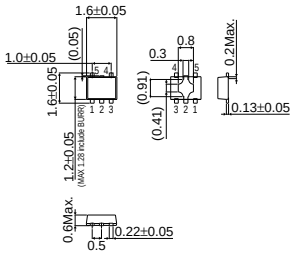
Fig.34 Example of IC structure

●Selecting a Model Name When Ordering

B H	3 0	P B 1	W	H F V	–	T R
ROHM model name	Output voltage	Series PB1: Auto power-saving type	Shutdown switch W: Includes switch	Package HFV : HVSOF5		Packaging specifications TR: Embossed taping

HVSOF5

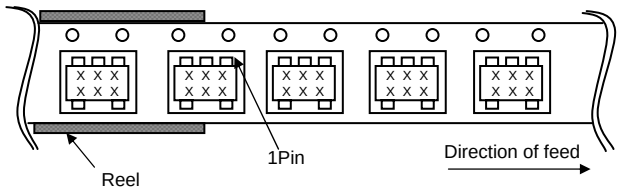
<Dimension>



(Unit:mm)

<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	3000pcs
Direction of feed	TR (The direction is the 1pin of product is at the upper light when you hold reel on the left hand and you pull out the tape on the right hand)



※When you order , please order in times the amount of package quantity.

Excellence in Electronics

ROHM

ROHM CO., LTD.

21 Saiin Mizosaki-cho, Ukyo-ku, Kyoto
615-8585, Japan
TEL: +81-75-311-2121 FAX: +81-75-315-0172
URL http: // www. rohm. com

Published by
KTC LSI Development Headquarters
LSI Business Pomotion Group

Contact us for further information about the products.

San Diego	TEL: +1-858-625-3630	FAX: +1-858-625-3670
Atlanta	TEL: +1-770-754-5972	FAX: +1-770-754-0691
Boston	TEL: +1-978-371-0382	FAX: +1-928-438-7164
Chicago	TEL: +1-847-368-1006	FAX: +1-847-368-1008
Dallas	TEL: +1-469-287-5366	FAX: +1-469-362-7973
Denver	TEL: +1-303-708-0908	FAX: +1-303-708-0858
Detroit	TEL: +1-248-348-9920	FAX: +1-248-348-9942
Nashville	TEL: +1-615-620-6700	FAX: +1-615-620-6702
Mexico	TEL: +52-33-3123-2001	FAX: +52-33-3123-2002
Düsseldorf	TEL: +49-2154-9210	FAX: +49-2154-921400
Munich	TEL: +49-8999-216168	FAX: +49-8999-216176
Stuttgart	TEL: +49-711-7272-370	FAX: +49-711-7272-3720
France	TEL: +33-1-5697-3060	FAX: +33-1-5697-3080
United Kingdom	TEL: +44-1-908-306700	FAX: +44-1-908-235788
Denmark	TEL: +45-3694-4739	FAX: +45-3694-4789
Espoo	TEL: +358-9725-54491	FAX: +358-9-7255-4499
Salo	TEL: +358-2-7332234	FAX: +358-2-7332237
Oulu	TEL: +358-8-5372930	FAX: +358-8-5372931
Barcelona	TEL: +34-9375-24320	FAX: +34-9375-24410
Hungary	TEL: +36-1-4719338	FAX: +36-1-4719339
Poland	TEL: +48-22-5757213	FAX: +48-22-5757001
Russia	TEL: +7-495-739-41-74	FAX: +7-495-739-41-74
Seoul	TEL: +82-2-8182-700	FAX: +82-2-8182-715
Masan	TEL: +82-55-240-6234	FAX: +82-55-240-6236
Dalian	TEL: +86-411-8230-8549	FAX: +86-411-8230-8537
Beijing	TEL: +86-10-8525-2483	FAX: +86-10-8525-2489
Tianjin	TEL: +86-22-23029181	FAX: +86-22-23029183
Shanghai	TEL: +86-21-6279-2727	FAX: +86-21-6247-2066
Hangzhou	TEL: +86-571-87658072	FAX: +86-571-87658071
Nanjing	TEL: +86-25-8689-0015	FAX: +86-25-8689-0393
Ningbo	TEL: +86-574-87654201	FAX: +86-574-87654208
Qingdao	TEL: +86-532-5779-312	FAX:+86-532-5779-653
Suzhou	TEL: +86-512-6807-1300	FAX: +86-512-6807-2300
Wuxi	TEL: +86-510-82702693	FAX: +86-510-82702992
Shenzhen	TEL: +86-755-8307-3008	FAX: +86-755-8307-3003
Dongguan	TEL: +86-769-8393-3320	FAX: +86-769-8398-4140
Fuzhou	TEL: +86-591-8801-8698	FAX: +86-591-8801-8690
Guangzhou	TEL: +86-20-3878-8100	FAX: +86-20-3825-5965
Huizhou	TEL:+86-752-205-1054	FAX: +86-752-205-1059
Xiamen	TEL: +86-592-238-5705	FAX: +86-592-239-8380
Zhuhai	TEL: +86-756-3232-480	FAX: +86-756-3232-460
Hong Kong	TEL: +852-2-740-6262	FAX: +852-2-375-8971
Taipei	TEL: +886-2-2500-6956	FAX: +886-2-2503-2869
Kaohsiung	TEL: +886-7-237-0881	FAX: +886-7-238-7332
Singapore	TEL: +65-6332-2322	FAX: +65-6332-5662
Philippines	TEL: +63-2-807-6872	FAX: +63-2-809-1422
Thailand	TEL: +66-2-254-4890	FAX: +66-2-256-6334
Kuala Lumpur	TEL: +60-3-7958-8355	FAX: +60-3-7958-8377
Penang	TEL: +60-4-2286453	FAX: +60-4-2286452
Kyoto	TEL: +81-75-365-1218	FAX: +81-75-365-1228
Yokohama	TEL: +81-45-476-2290	FAX: +81-45-476-2295

Catalog No.08T518A '08.9 ROHM ©

Notes

No copying or reproduction of this document, in part or in whole, is permitted without the consent of ROHM CO.,LTD.

The content specified herein is subject to change for improvement without notice.

The content specified herein is for the purpose of introducing ROHM's products (hereinafter "Products"). If you wish to use any such Product, please be sure to refer to the specifications, which can be obtained from ROHM upon request.

Examples of application circuits, circuit constants and any other information contained herein illustrate the standard usage and operations of the Products. The peripheral conditions must be taken into account when designing circuits for mass production.

Great care was taken in ensuring the accuracy of the information specified in this document. However, should you incur any damage arising from any inaccuracy or misprint of such information, ROHM shall bear no responsibility for such damage.

The technical information specified herein is intended only to show the typical functions of and examples of application circuits for the Products. ROHM does not grant you, explicitly or implicitly, any license to use or exercise intellectual property or other rights held by ROHM and other parties. ROHM shall bear no responsibility whatsoever for any dispute arising from the use of such technical information.

The Products specified in this document are intended to be used with general-use electronic equipment or devices (such as audio visual equipment, office-automation equipment, communication devices, electronic appliances and amusement devices).

The Products are not designed to be radiation tolerant.

While ROHM always makes efforts to enhance the quality and reliability of its Products, a Product may fail or malfunction for a variety of reasons.

Please be sure to implement in your equipment using the Products safety measures to guard against the possibility of physical injury, fire or any other damage caused in the event of the failure of any Product, such as derating, redundancy, fire control and fail-safe designs. ROHM shall bear no responsibility whatsoever for your use of any Product outside of the prescribed scope or not in accordance with the instruction manual.

The Products are not designed or manufactured to be used with any equipment, device or system which requires an extremely high level of reliability the failure or malfunction of which may result in a direct threat to human life or create a risk of human injury (such as a medical instrument, transportation equipment, aerospace machinery, nuclear-reactor controller, fuel-controller or other safety device). ROHM shall bear no responsibility in any way for use of any of the Products for the above special purposes. If a Product is intended to be used for any such special purpose, please contact a ROHM sales representative before purchasing.

If you intend to export or ship overseas any Product or technology specified herein that may be controlled under the Foreign Exchange and the Foreign Trade Law, you will be required to obtain a license or permit under the Law.

Thank you for your accessing to ROHM product informations.
More detail product informations and catalogs are available, please contact your nearest sales office.

ROHM Customer Support System

THE AMERICAS / EUROPE / ASIA / JAPAN

www.rohm.com

Contact us : webmaster@rohm.co.jp

ROHM Co.,Ltd. 21 Saiin Mizosaki-cho, Ukyo-ku, Kyoto 615-8585, Japan
TEL : +81-75-311-2121
FAX : +81-75-315-0172

ROHM SEMICONDUCTOR