## CMOS LDO Regulator Series for Portable Equipment

# CSP(Chip Size Package) CMOS LDO Regulators Suitable for High-density Mounting

# BH□□RB1WGUT Series

### ●Description

The BH□□RB1WGUT series is a line of 150 mA output CMOS regulators that deliver a highly stable precision (± 1%) output voltage. Proprietary ROHM technology enables a small load regulation of 2 mV and a dropout voltage of 100 mV.
At just 1.0 mm × 1.04 mm, the new VCSP60N1 package is extremely compact, and the IC's enhanced protection circuits contribute to improved end products characteristics.

### ●Features

1) High accuracy output voltage: ± 1%
2) Dropout voltage: 100 mV (at 100 mA)
3) Stable with ceramic capacitors
4) Low bias current: 34 μA
5) High ripple rejection ratio: 63 dB (Typ., 1 kHz)
6) Output voltage on/off control
7) Built-in overcurrent and thermal shutdown circuits
8) VCSP60N1 WL-CSP package : (1.0 × 1.04 × 0.6mm)

### ●Applications

Battery-driven portable devices, etc.

### ●Product line

■150 mA BH□□RB1WGUT Series

| Product name | 1.5 | 1.8 | 2.5 | 2.8 | 2.9 | 3.0 | 3.1 | 3.3 | Package |
|---|---|---|---|---|---|---|---|---|---|
| BH□□RB1WGUT | √ | √ | √ | √ | √ | √ | √ | √ | VCSP60N1 |

Model name: BH□□RB1W□
a b

| Symbol | Description | | | |
|---|---|---|---|---|
| | Output voltage specification | | | |
| a | □□ | Output voltage (V) | □□ | Output voltage (V) |
| | 15 | 1.5 V (Typ.) | 29 | 2.9 V (Typ.) |
| | 18 | 1.8 V (Typ.) | 30 | 3.0 V (Typ.) |
| | 25 | 2.5 V (Typ.) | 31 | 3.1 V (Typ.) |
| | 28 | 2.8 V (Typ.) | 33 | 3.3 V (Typ.) |
| b | Package GUT: VCSP60N1 | | | |

●**Absolute maximum ratings**

| Parameter | Symbol | Limit | Unit |
|---|---|---|---|
| Applied supply voltage | VMAX | -0.3 to +6.5 | V |
| Power dissipation | Pd | 530*1 | mW |
| Operating temperature range | Topr | -40 to +85 | °C |
| Storage temperature range | Tstg | -55 to +125 | °C |

*1: Reduce by 5.3 mW/°C over 25°C, when mounted on a glass epoxy PCB (7 mm × 7 mm × 0.8 mm).

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

| Parameter | Symbol | Limit | Unit |
|---|---|---|---|
| Power supply voltage | VIN | 2.5 to 5.5 | V |
| Output current | IOUT | 0 to 150 | mA |

●**Recommended operating conditions**

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Conditions |
|---|---|---|---|---|---|---|
| Input capacitor | CIN | 0.7*2 | 1.0 | — | μF | The use of ceramic capacitors is recommended. |
| Output capacitor | CO | 0.7*2 | 1.0 | — | μF | The use of ceramic capacitors is recommended. |

*2: （Note.5） 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 cannot change as time progresses.

●**Electrical characteristics** (Unless otherwise specified, Ta = 25°C, VIN = VOUT + 1.0 V*5, STBY = 1.5 V, CIN = 1 μF, CO = 1 μF)

| Parameter | | Symbol | Min. | Typ. | Max. | Unit | Conditions |
|---|---|---|---|---|---|---|---|
| Output voltage 1 | | VOUT1 | VOUT × 0.99 | VOUT | VOUT × 1.01 | V | IOUT = 1 mA, Ta = 25°C, BH25RB1WGUT or higher |
| | | | VOUT - 25 mV | | VOUT + 25 mV | | IOUT = 1mA, Ta = 25°C, BH15, 18RB1WGUT |
| Output voltage 2 | | VOUT2 | VOUT × 0.97 | VOUT | VOUT × 1.03 | V | IOUT = 1 mA Ta = -40°C to 85°C*3 |
| Circuit current | | IGND | — | 34 | 72 | μA | IOUT = 0 mA Ta = -40°C to 85°C*3 |
| Circuit current (STBY) | | ICCST | — | — | 1.0 | μA | STBY = 0 V |
| Ripple rejection ratio | | RR | — | 63 | — | dB | VRR = -20 dBv, fRR = 1 kz, IOUT = 10 mA |
| Dropout voltage | | VSAT | — | 100 | 150 | mV | VIN = 0.98 × VOUT, IOUT = 100 mA (Excluding BH15, 18RB1WGUT) |
| Line regulation | | VDLI | — | 2 | 20 | mV | IOUT = 10 mA VIN = VOUT + 0.5 V to 5.5 V*4 |
| Load regulation | | VDLO | — | 2 | 30 | mV | IOUT = 1 mA to 100 mA |
| Overcurrent protection limit current | | ILMAX | — | 300 | — | mA | VO = VOUT × 0.98 |
| Short current | | ISHORT | — | 40 | — | mA | VO = 0 V |
| STBY pin current | | ISTBY | 0.5 | 1.3 | 3.6 | μA | Ta = -40°C to 85°C*3 |
| STBY control voltage | ON | VSTBH | 1.2 | — | VIN | V | Ta = -40°C to 85°C*3 |
| | OFF | VSTBL | -0.2 | — | 0.2 | V | Ta = -40°C to 85°C*3 |

* This IC is not designed to be radiation-resistant.

*3: These specifications are guaranteed by design.

*4: For BH15, 18RB1WGUT, VIN = 3.0 V to 5.5 V.

*5: For BH15, 18RB1WGUT, VIN = 3.5 V.

## ●Typical characteristics

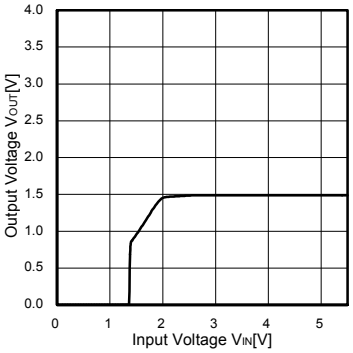



Fig. 1 Output Voltage vs Input Voltage (BH15RB1WGUT)

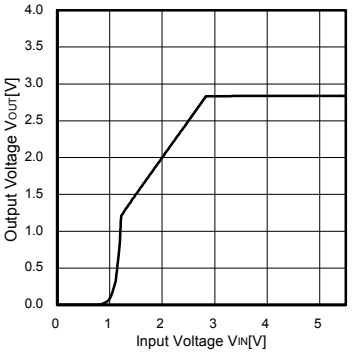



Fig. 2 Output Voltage vs Input Voltage (BH28RB1WGUT)

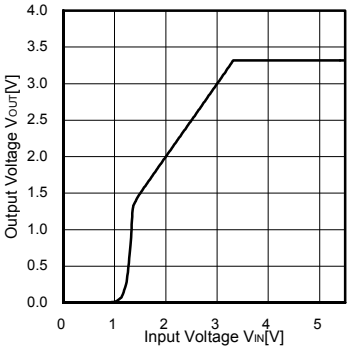



Fig. 3 Output Voltage vs Input Voltage (BH33RB1WGUT)

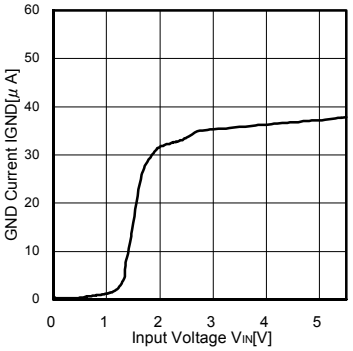



Fig. 4 GND Current vs Input Voltage (BH15RB1WGUT)

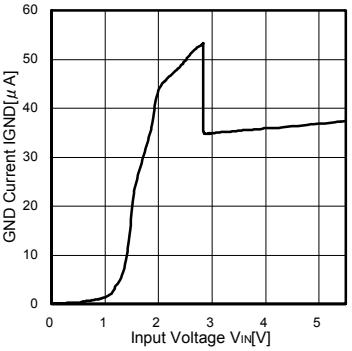



Fig. 5 GND Current vs Input Voltage (BH28RB1WGUT)

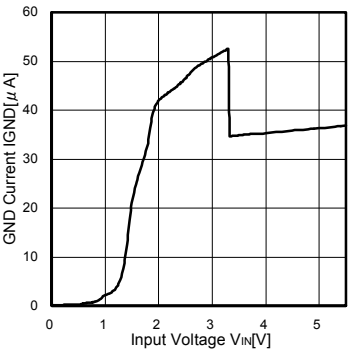



Fig. 6 GND Current vs Input Voltage (BH33RB1WGUT)

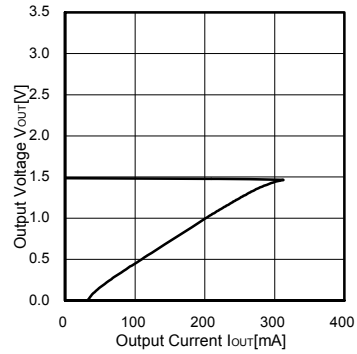



Fig. 7 Output Voltage vs Output Current (BH15RB1WGUT)

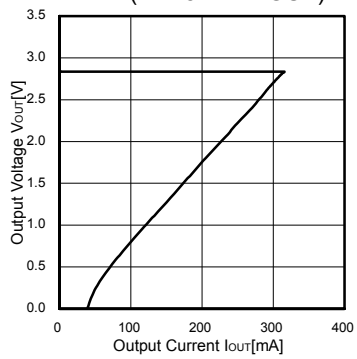



Fig. 8 Output Voltage vs Output Current (BH28RB1WGUT)

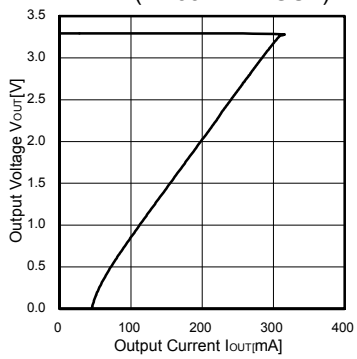



Fig. 9 Output Voltage vs Output Current (BH33RB1WGUT)

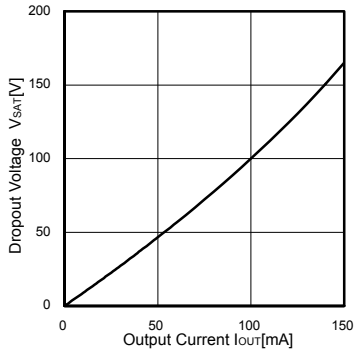



Fig. 10 Dropout Voltage vs Output Current (BH28RB1WGUT)

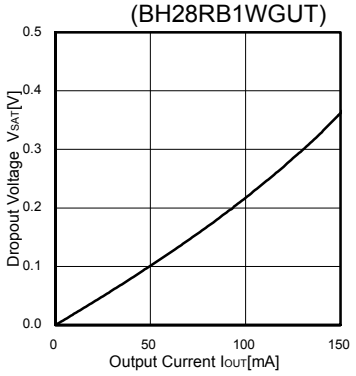



Fig. 11 Dropout Voltage vs Output Current (BH33RB1WGUT)

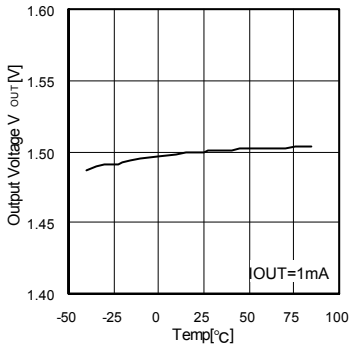



Fig. 12 Output Voltage vs Temperature (BH15RB1WGUT)

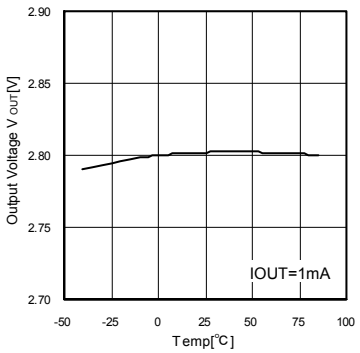



Fig. 13 Output Voltage vs Temperature (BH28RB1WGUT)

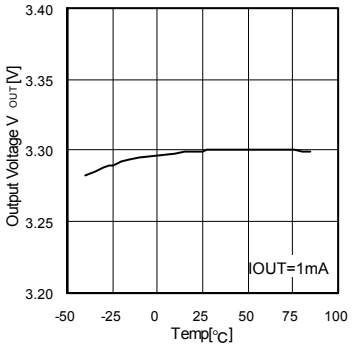



Fig. 14 Output Voltage vs Temperature (BH33RB1WGUT)

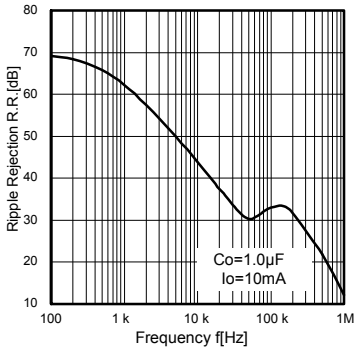



Fig. 15 Ripple Rejection (BH15RB1WGUT)

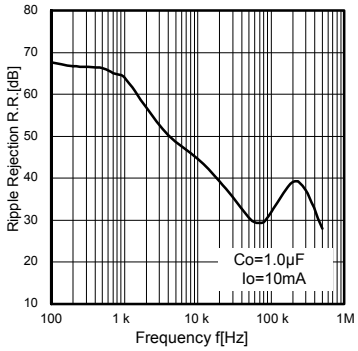



Fig. 16 Ripple Rejection (BH28RB1WGUT)

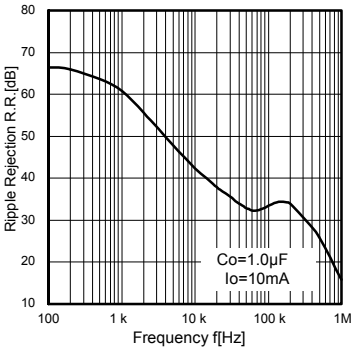



Fig. 17 Ripple Rejection (BH33RB1WGUT)

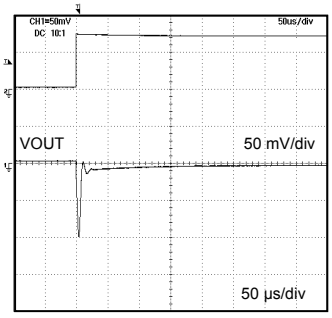



Fig. 18 Load Response (Co = 1.0 µF) (BH15RB1WGUT)

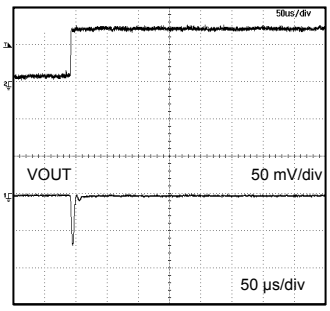
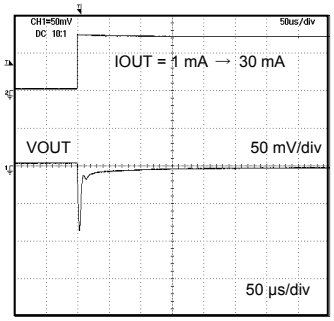



Fig. 19 Load Response (Co = 1.0 µF) (BH28RB1WGUT)




Fig, 20 Load Response (Co = 1.0 µF) (BH33RB1WGUT)

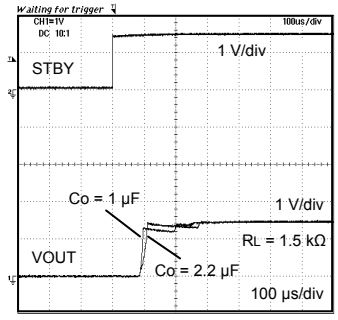



Fig. 21 Output Voltage Rise Time (BH15RB1WGUT)

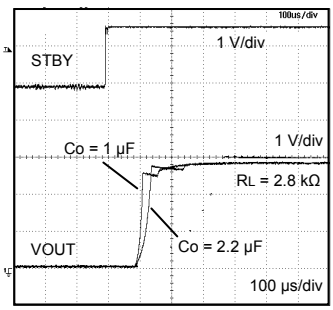



Fig. 22 Output Voltage Rise Time (BH28RB1WGUT)

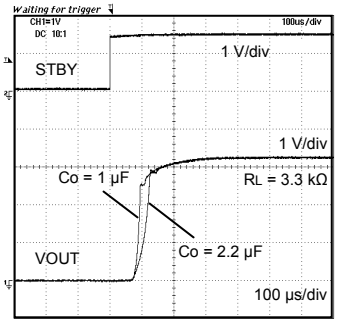
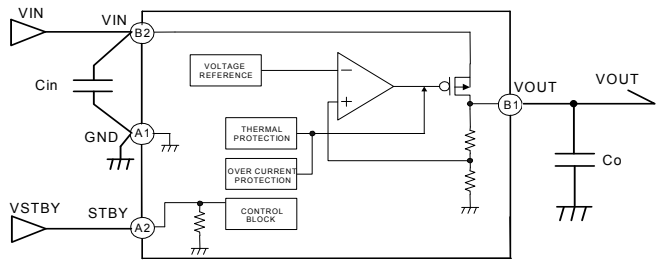



Fig. 23 Output Voltage Rise Time (BH33RB1WGUT)

●**Block Diagram, Recommended Circuit Diagram, and Pin Assignment Diagram**

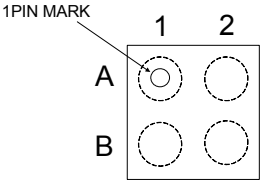
**BH□□RB1WGUT**




Cin: 1.0 μF
Co: 1.0 μF

Fig. 24

| Pin No. | Symbol | Function |
|---|---|---|
| B2 | VIN | Power supply input |
| B1 | VOUT | Voltage output |
| A1 | GND | Ground |
| A2 | STBY | Output voltage on/off control (High: ON, Low: OFF) |




TOP VIEW (Mark side)

●Power Dissipation (Pd)

1. Power dissipation (Pd)

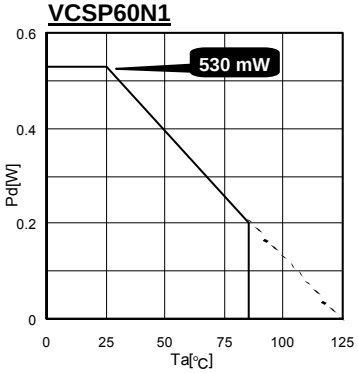
Power dissipation calculations include output power dissipation characteristics and internal IC power consumption. In the event that the IC is used in an environment where this power dissipation is exceeded, the attendant rise in the junction temperature will trigger the thermal shutdown circuit, reducing 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)

**PMAX = (VIN - VOUT) × IOUT (MAX.)**

VIN: Input voltage
VOUT: Output voltage
IOUT (MAX): Output current

2. Power dissipation/power dissipation reduction (Pd)




Board: 7 mm × 7 mm × 0.8 mm
Material: Glass epoxy PCB

Fig. 25 VCSP60N1 Power Dissipation/Power Dissipation Reduction (Example)

*Circuit design should allow a sufficient margin for the temperature range for PMAX < Pd.

●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 are 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. Use X5R or X7R ceramic capacitors, which offer good temperature and DC bias characteristics as well as stable high voltages.

Typical ceramic capacitor characteristics

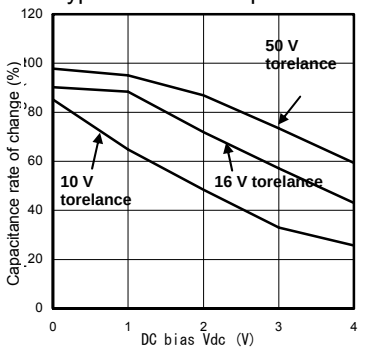



Fig. 26 Capacitance vs Bias (Y5V)

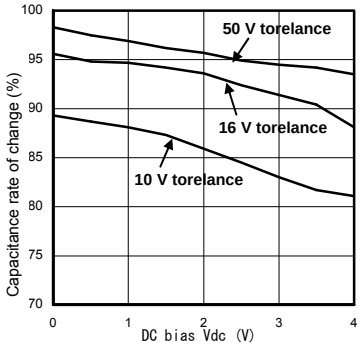



Fig.27 Capacitance vs Bias (X5R, X7R)

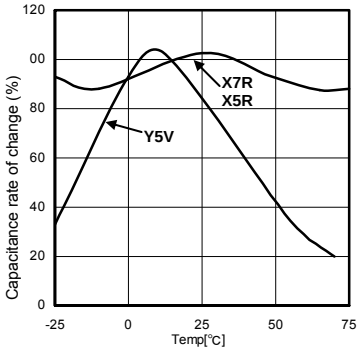



Fig. 28 Capacitance vs Temperature (X5R, X7R, Y5V)

●**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.

**BH□□RB1WGUT**

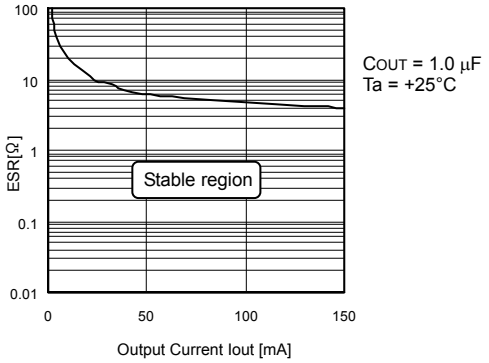



Fig. 29 Stable Operating Region Characteristics (Example)

●**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. 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.

6. 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.

7. 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.

8. Influence of strong light

Exposure of the IC to strong light sources such as infrared light from a halogen lamp may cause the IC to malfunction. When it is necessary to use the IC in such environments, implement measures to block exposure to light from the light source. During testing, exposure to neither fluorescent lighting nor white LEDs had a significant effect on the IC.

9. GND voltage

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

10. 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.

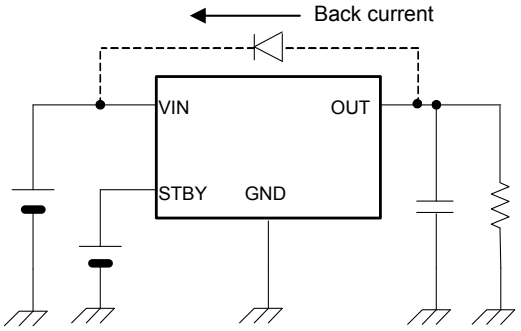



Fig. 30 Example Bypass Diode Connection

11. 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.

12. Regarding Input Pin of the IC (Fig.31)

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.

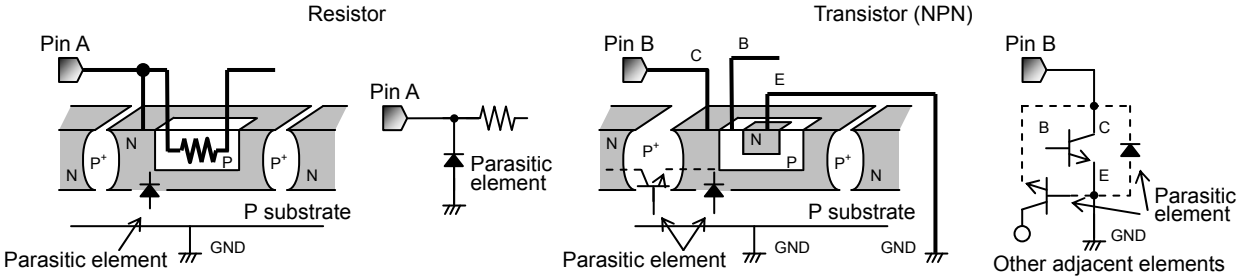


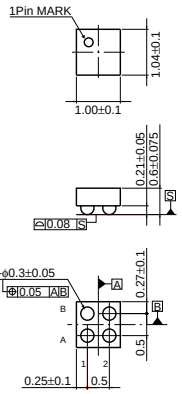

Fig. 31 Example of IC structure

## ●Selecting a model name when ordering

| B H | 3 0 | R B 1 | W | G U T | – | E 2 |
|---|---|---|---|---|---|---|
| ROHM model name | Output voltage | Series RB1: Chip size package | Shutdown switch W: Includes switch | Package GUT: VCSP60N1 | | Packaging specifications E2: Embossed taping |

## VCSP60N1

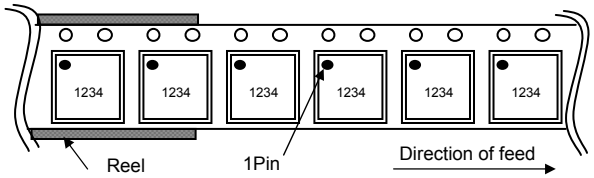
<Dimension>




(Unit:mm)

<Tape and Reel information>

| | |
|---|---|
| Tape | Embossed carrier tape |
| Quantity | 3000pcs |
| Direction of feed | E2<br>(The direction is the 1pin of product is at the upper left 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.



Contact us for further information about the products.

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