

# Automotive Hall Effect Latch Series

## BD5410xG-CZ Series

### General Description

BD5410xG-CZ series are latch type Hall IC with wide VDD voltage range and wide operation temperature range. These ICs can detect magnetic field with superior sensitivity stability by using the chopper stabilized way.

These ICs have various protection features built-in. (Reverse supply voltage protection, output over current protection, over temperature protection, under voltage lockout protection). Therefore these ICs are suitable for a wide range of automotive applications.

### Features

- AEC-Q100 Qualified (Note 1)
- Latch Type
- Nch Open Drain
- Output Over Current Protection
- Over Temperature Protection
- Reverse Supply Voltage Protection
- Under Voltage Lockout

(Note 1) Grade1

### Applications

- Rotation Detection, Position Sensing

### Key Specifications

- VDD Voltage Range: 2.7 V to 38 V
- Operate Point: 2.0 mT to 15 mT 5 type (Typ)
- Release Point: -2.0 mT to -15 mT 5 type (Typ)
- Bop Temperature Coefficient: -1200 ppm/°C (Typ)
- Magnetic Signal Input Frequency: 10 kHz (Max)
- Supply Current: 1.3 mA (Typ)
- Output Type: Nch Open Drain
- Operating Temperature Range: -40 °C to +150 °C

| Product Name | Operate Point (Typ) |
|--------------|---------------------|
| BD54102G-CZ  | 2.0 mT              |
| BD54103G-CZ  | 5.0 mT              |
| BD54104G-CZ  | 7.5 mT              |
| BD54105G-CZ  | 10.0 mT             |
| BD54107G-CZ  | 15.0 mT             |

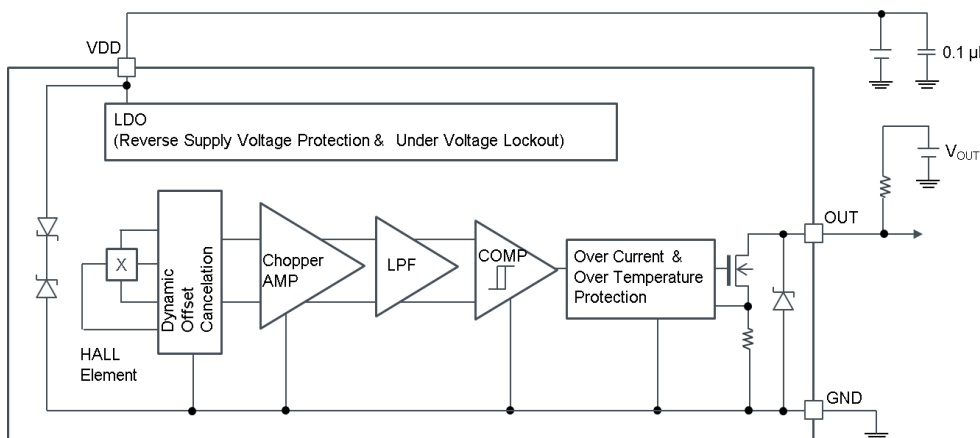
### Package

SSOP3A

W (Typ) x D (Typ) x H (Max)  
 2.92 mm x 2.4 mm x 1.12 mm



### Typical Application Circuit, Block Diagram



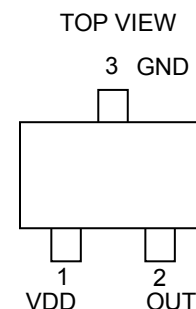
Adjust the bypass capacitor value as necessary, according to power supply noise conditions, etc.

### Pin Descriptions

| Pin No. | Pin Name | Function              |
|---------|----------|-----------------------|
| 1       | VDD      | Power supply (Note 2) |
| 2       | OUT      | Output                |
| 3       | GND      | Ground                |

(Note 2) Dispose a bypass capacitor between VDD and GND.

### Pin Configurations



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## Absolute Maximum Ratings (Ta = 25 °C)

| Parameter                    | Symbol            | Rating      | Unit |
|------------------------------|-------------------|-------------|------|
| Power Supply Voltage         | V <sub>DD</sub>   | -36 to +42  | V    |
| Output Voltage               | V <sub>OUT</sub>  | -0.3 to +42 | V    |
| Continuous Output Current    | I <sub>OUT</sub>  | 25          | mA   |
| Storage Temperature Range    | T <sub>stg</sub>  | -55 to +150 | °C   |
| Maximum Junction Temperature | T <sub>jmax</sub> | 150         | °C   |

**Caution 1:** Operating the IC over the absolute maximum ratings may damage the IC. The damage can either be a short circuit between pins or an open circuit between pins and the internal circuitry. Therefore, it is important to consider circuit protection measures, such as adding a fuse, in case the IC is operated over the absolute maximum ratings.

**Caution 2:** Should by any chance the maximum junction temperature rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. In case of exceeding this absolute maximum rating, design a PCB with thermal resistance taken into consideration by increasing board size and copper area so as not to exceed the maximum junction temperature rating.

## Thermal Resistance (Note 3)

| Parameter                                                      | Symbol          | Thermal Resistance (Typ) |                          | Unit |
|----------------------------------------------------------------|-----------------|--------------------------|--------------------------|------|
|                                                                |                 | 1s <sup>(Note 5)</sup>   | 2s2p <sup>(Note 6)</sup> |      |
| SSOP3A                                                         |                 |                          |                          |      |
| Junction to Ambient                                            | θ <sub>JA</sub> | 465.9                    | 265.1                    | °C/W |
| Junction to Top Characterization Parameter <sup>(Note 4)</sup> | Ψ <sub>JT</sub> | 48                       | 52                       | °C/W |

(Note 3) Based on JESD51-2A (Still-Air).

(Note 4) The thermal characterization parameter to report the difference between junction temperature and the temperature at the top center of the outside surface of the component package.

(Note 5) Using a PCB board based on JESD51-3.

(Note 6) Using a PCB board based on JESD51-7.

| Layer Number of Measurement Board | Material | Board Size                    |
|-----------------------------------|----------|-------------------------------|
| Single                            | FR-4     | 114.3 mm x 76.2 mm x 1.57 mmt |

| Top                   |           |
|-----------------------|-----------|
| Copper Pattern        | Thickness |
| Footprints and Traces | 70 μm     |

| Layer Number of Measurement Board | Material | Board Size                   |
|-----------------------------------|----------|------------------------------|
| 4 Layers                          | FR-4     | 114.3 mm x 76.2 mm x 1.6 mmt |

| Top                   |           | 2 Internal Layers |           | Bottom            |           |
|-----------------------|-----------|-------------------|-----------|-------------------|-----------|
| Copper Pattern        | Thickness | Copper Pattern    | Thickness | Copper Pattern    | Thickness |
| Footprints and Traces | 70 μm     | 74.2 mm x 74.2 mm | 35 μm     | 74.2 mm x 74.2 mm | 70 μm     |

## Recommended Operating Conditions

| Parameter             | Symbol          | Min | Typ | Max  | Unit |
|-----------------------|-----------------|-----|-----|------|------|
| Power Supply Voltage  | V <sub>DD</sub> | 2.7 | 12  | 38   | V    |
| Operating Temperature | Topr            | -40 | +25 | +150 | °C   |

Magnetic Characteristics (Unless otherwise specified V<sub>DD</sub> = 12.0 V Ta = 25 °C)

| Product Name | Parameter     | Symbol           | Min   | Typ   | Max   | Unit | Comment |
|--------------|---------------|------------------|-------|-------|-------|------|---------|
| BD54102G-CZ  | Operate Point | B <sub>OP</sub>  | 0.5   | 2.0   | 3.5   | mT   | -       |
|              | Release Point | B <sub>RP</sub>  | -3.5  | -2.0  | -0.5  | mT   | -       |
|              | Hysteresis    | B <sub>HYS</sub> | -     | 4.0   | -     | mT   | -       |
| BD54103G-CZ  | Operate Point | B <sub>OP</sub>  | 2.8   | 5.0   | 7.2   | mT   | -       |
|              | Release Point | B <sub>RP</sub>  | -7.2  | -5.0  | -2.8  | mT   | -       |
|              | Hysteresis    | B <sub>HYS</sub> | -     | 10.0  | -     | mT   | -       |
| BD54104G-CZ  | Operate Point | B <sub>OP</sub>  | 5.0   | 7.5   | 10.0  | mT   | -       |
|              | Release Point | B <sub>RP</sub>  | -10.0 | -7.5  | -5.0  | mT   | -       |
|              | Hysteresis    | B <sub>HYS</sub> | -     | 15.0  | -     | mT   | -       |
| BD54105G-CZ  | Operate Point | B <sub>OP</sub>  | 7.0   | 10.0  | 13.0  | mT   | -       |
|              | Release Point | B <sub>RP</sub>  | -13.0 | -10.0 | -7.0  | mT   | -       |
|              | Hysteresis    | B <sub>HYS</sub> | -     | 20.0  | -     | mT   | -       |
| BD54107G-CZ  | Operate Point | B <sub>OP</sub>  | 11.0  | 15.0  | 19.0  | mT   | -       |
|              | Release Point | B <sub>RP</sub>  | -19.0 | -15.0 | -11.0 | mT   | -       |
|              | Hysteresis    | B <sub>HYS</sub> | -     | 30.0  | -     | mT   | -       |

(Note) Polarity of Magnetic flux density is defined as positive when south pole side of magnet approaches top surface of the device.

**Electrical Characteristics (Unless otherwise specified  $V_{DD} = 12.0\text{ V}$   $T_a = 25\text{ }^{\circ}\text{C}$ )**

| Parameter                 | Symbol         | Min | Typ | Max | Unit          | Comment                                                                  |
|---------------------------|----------------|-----|-----|-----|---------------|--------------------------------------------------------------------------|
| Power-On Time             | $t_{PON}$      | -   | -   | 25  | $\mu\text{s}$ | -                                                                        |
| Output Leakage Current    | $I_{LEAK}$     | -   | -   | 10  | $\mu\text{A}$ | -                                                                        |
| Output Low Voltage        | $V_{OL}$       | -   | -   | 0.5 | V             | $I_{OUT} = +20\text{ mA}$                                                |
| Output Current Limitation | $I_{LIMIT}$    | 30  | 55  | 120 | mA            | -                                                                        |
| Output Rise Time          | $t_r$          | -   | -   | 2   | $\mu\text{s}$ | $V_{OUT} = 12\text{ V}$<br>$R_L = 1\text{ k}\Omega$ $C_L = 20\text{ pF}$ |
| Output Fall Time          | $t_f$          | -   | -   | 2   | $\mu\text{s}$ |                                                                          |
| Supply Current            | $I_{DD}$       | -   | 1.3 | 1.9 | mA            | -                                                                        |
| Under Voltage Lockout     | $V_{DD\_UVLO}$ | 2.1 | -   | 2.7 | V             | -                                                                        |

(Note) The on-chip over temperature protection switches off the output (High-Z).

(Note) The on-chip under voltage lockout protection switches off the output (High-Z).

Typical Performance Curves

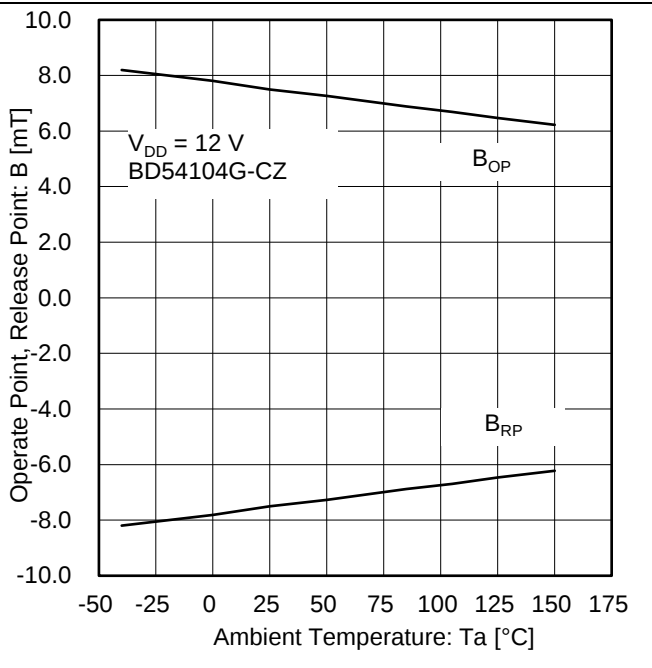


Figure 1. Operate Point, Release Point vs Ambient Temperature

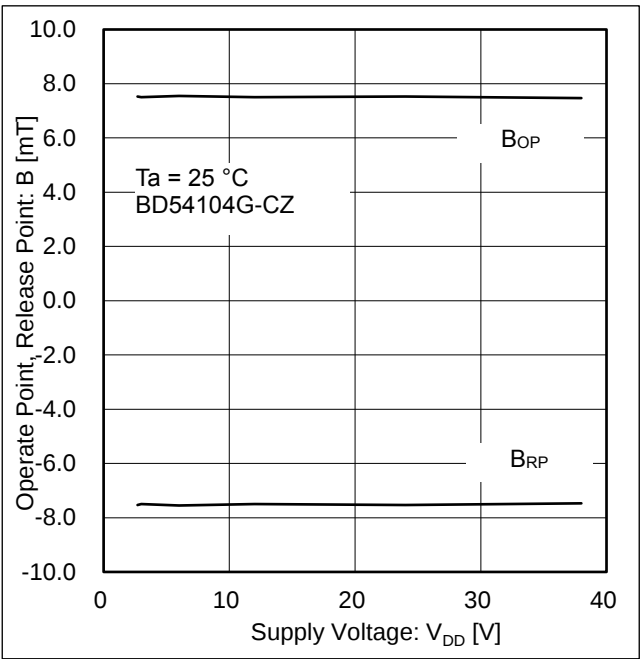


Figure 2. Operate Point, Release Point vs Supply Voltage

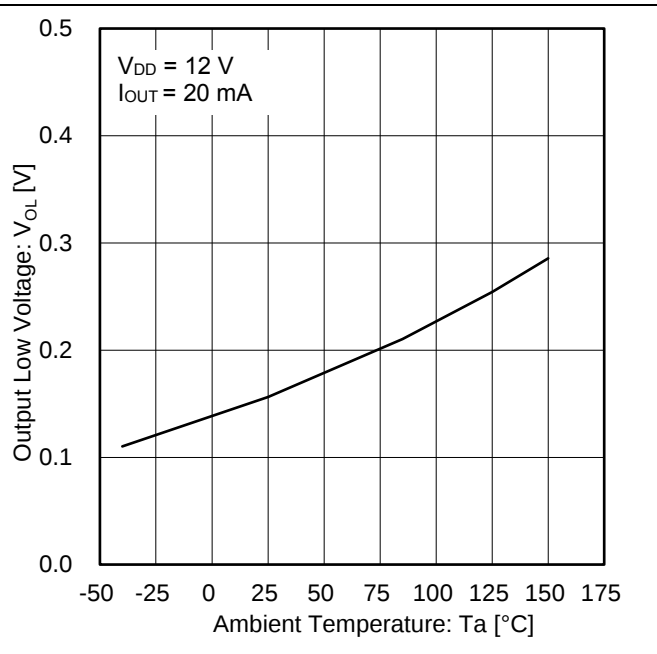


Figure 3. Output Low Voltage vs Ambient Temperature

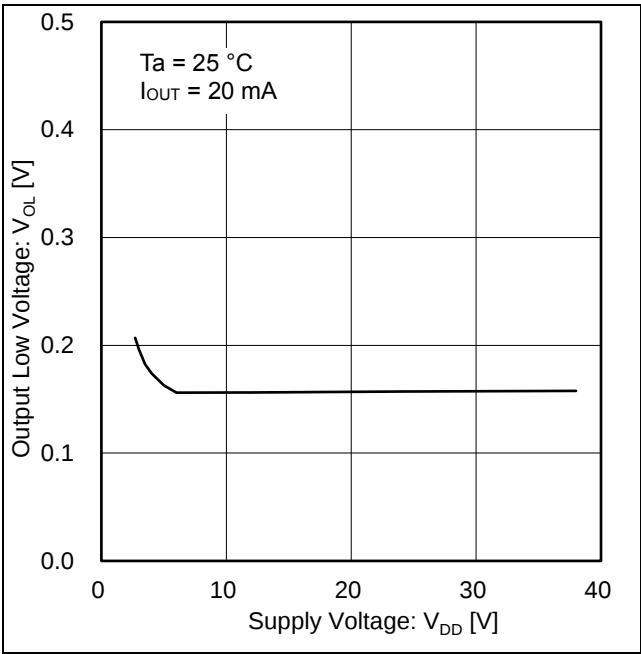


Figure 4. Output Low Voltage vs Supply Voltage

Typical Performance Curves - continued

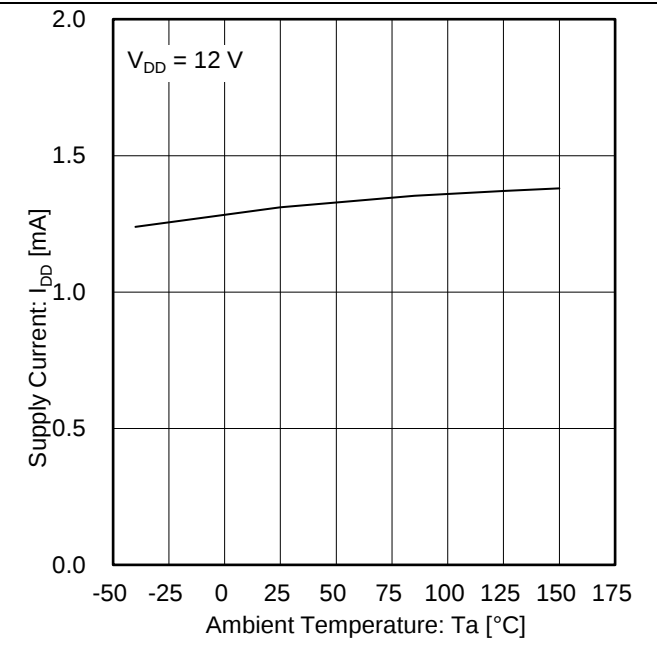


Figure 5. Supply Current vs Ambient Temperature

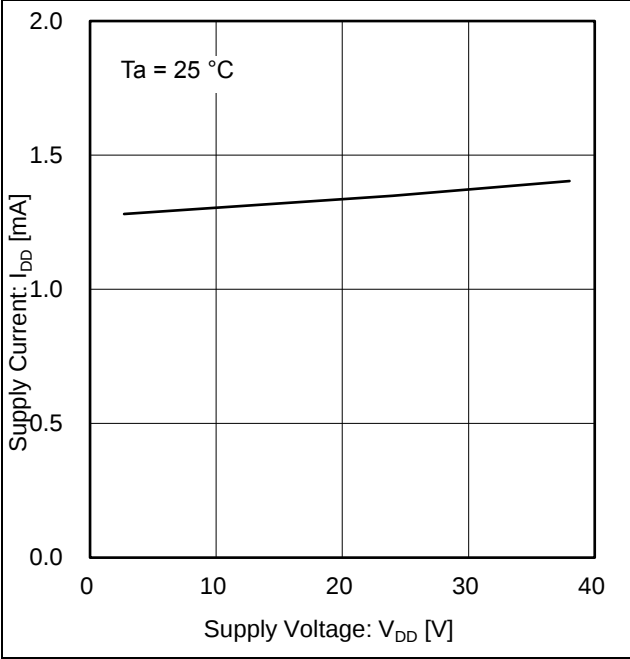


Figure 6. Supply Current vs Supply Voltage

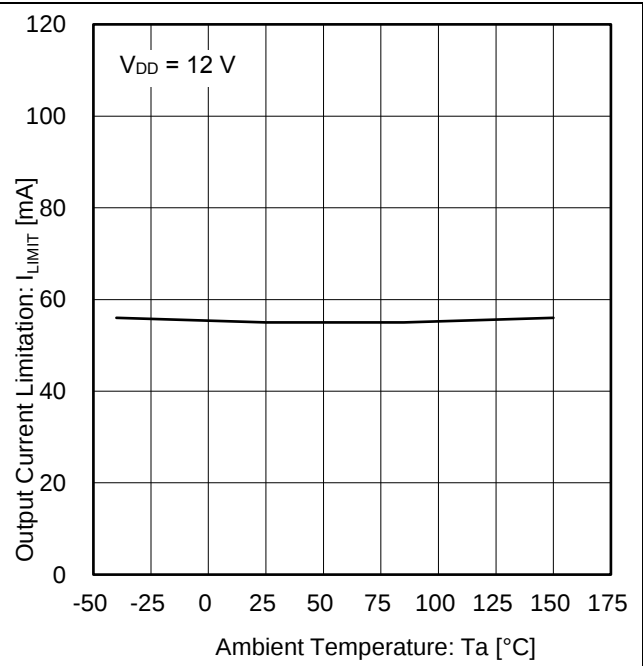


Figure 7. Output Current Limitation vs Ambient Temperature

## Description of Operations

(Offset Cancellation)

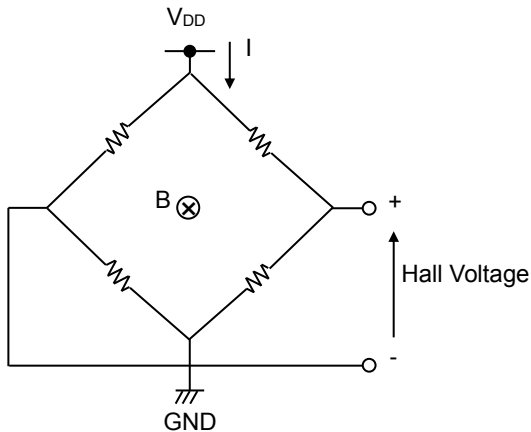


Figure 8. Equivalent Circuit of Hall Elements

The Hall elements are shown with an equivalent Wheatstone (resistor) bridge circuit. Offset voltage may be generated by a differential in this bridge resistance, or can arise from changes of resistance due to package or bonding stress. A dynamic offset cancellation circuit is employed to cancel this offset voltage.

When the Hall elements are connected as shown in Figure 8 and a magnetic field is applied perpendicular to the Hall elements, a voltage is generated at the mid-points of the bridge. This is known as Hall voltage.

Dynamic offset cancellation switches the wiring to redirect the current flow to a 90° angle from its original path, and thereby cancels the offset voltage of Hall elements.

Only the magnetic signal is maintained in the sample/hold circuit process and then released.

(Magnetic Field Direction Definition)

Polarity of Magnetic flux density is defined as positive when south pole side of magnet approaches top surface of the device.

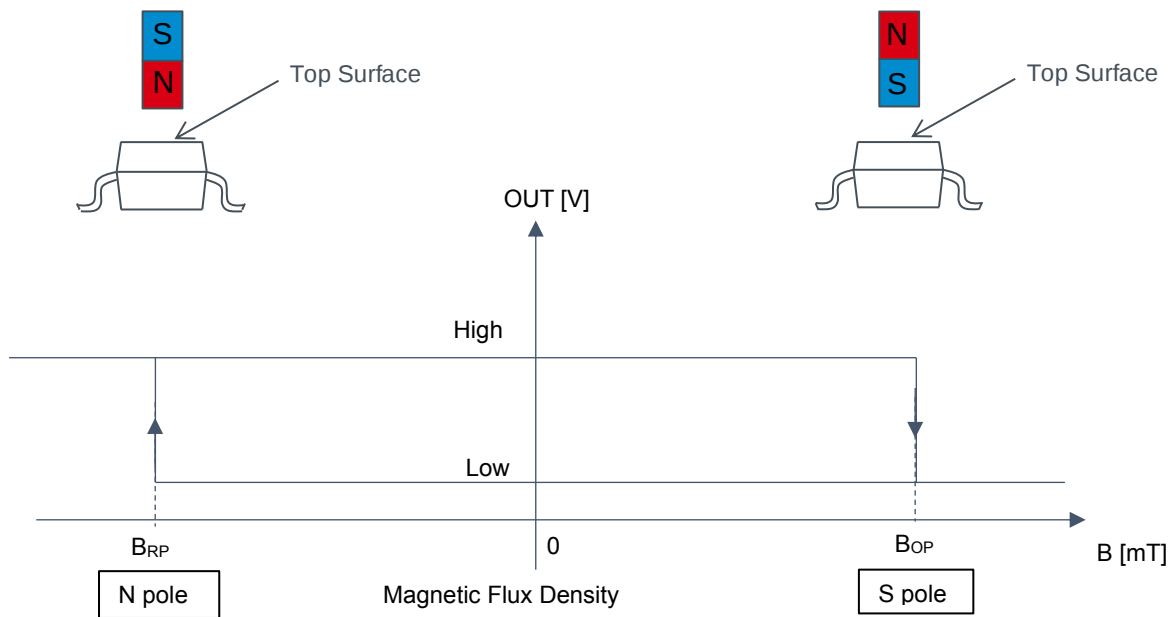


Figure 9. Magnetic Field Detection

OUT changes to low at S pole magnetic field. OUT changes to high at N pole magnetic field.

## Operation at Power ON and Under Voltage Lockout

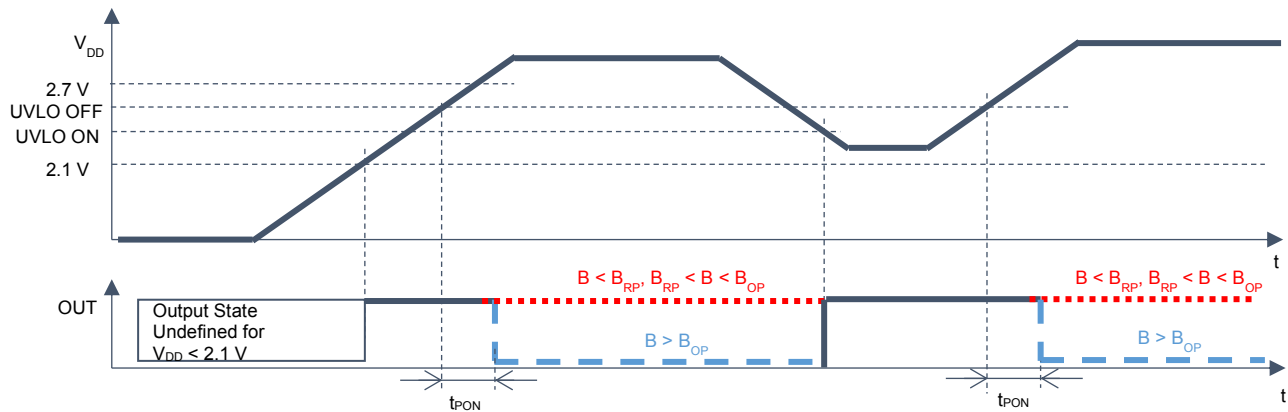


Figure 10. Operation at Power ON and UVLO

After  $V_{DD}$  power on, the initial state of OUT is High (Hi-Z).

After  $t_{PON}$  time pass after  $V_{DD}$  exceeds the OFF voltage of Under Voltage Lockout (UVLO), OUT becomes L when the magnetic field is beyond  $B_{OP}$ .

When  $V_{DD}$  is less than ON voltage of UVLO, OUT becomes High (Hi-Z).

## Magnet Selection

Neodymium and ferrite are major permanent magnets. Neodymium generally offers greater magnetic power per volume than ferrite, thereby enabling miniaturization of magnet. The larger neodymium magnet is, the stronger magnetic flux density is. And the farther detection distance is, the weaker it is. Therefore, the proper size and detection distance of the magnet should be determined according to the operate point of Hall IC. To increase the magnet's detection distance, the magnet which is thicker or larger sectional area is used.

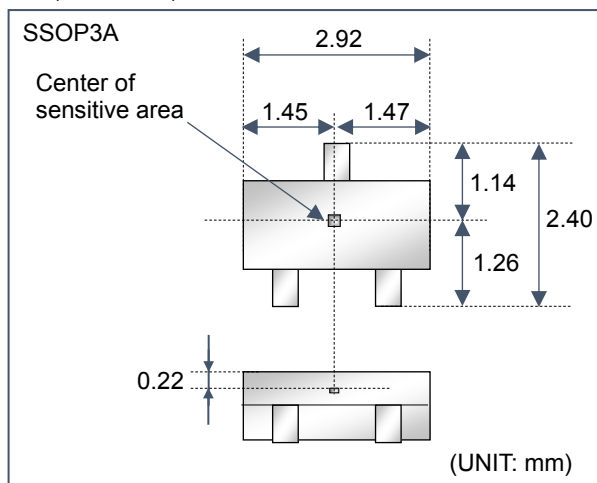
Position of the Hall Element  
(Reference)

Figure 11. Position of the Hall Element

## Output Equivalence Circuit

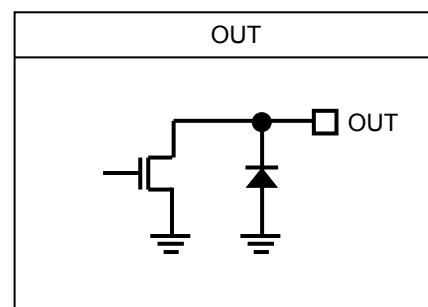


Figure 12. Output Equivalence Circuit

## Operational Notes

### 1. Reverse Connection of Power Supply

This IC has a built-in reverse supply voltage protection circuit that prevents damage to the IC. Do not use in a situation that exceeds the absolute maximum ratings of built-in reverse supply voltage protection circuit.

### 2. Power Supply Lines

Design the PCB layout pattern to provide low impedance supply lines. Furthermore, connect a capacitor to ground at all power supply pins. Consider the effect of temperature and aging on the capacitance value when using electrolytic capacitors.

### 3. Ground Voltage

Except for pins built-in reverse protection, ensure that no pins are at a voltage below that of the ground pin at any time, even during transient condition.

### 4. Ground Wiring Pattern

When using both small-signal and large-current ground traces, the two ground traces should be routed separately but connected to a single ground at the reference point of the application board to avoid fluctuations in the small-signal ground caused by large currents. Also ensure that the ground traces of external components do not cause variations on the ground voltage. The ground lines must be as short and thick as possible to reduce line impedance.

### 5. Recommended Operating Conditions

The function and operation of the IC are guaranteed within the range specified by the recommended operating conditions. The characteristic values are guaranteed only under the conditions of each item specified by the electrical characteristics.

### 6. Inrush Current

When power is first supplied to the IC, it is possible that the internal logic may be unstable and inrush current may flow instantaneously due to the internal powering sequence and delays, especially if the IC has more than one power supply. Therefore, give special consideration to power coupling capacitance, power wiring, width of ground wiring, and routing of connections.

### 7. Testing on Application Boards

When testing the IC on an application board, connecting a capacitor directly to a low-impedance output pin may subject the IC to stress. Always discharge capacitors completely after each process or step. The IC's power supply should always be turned off completely before connecting or removing it from the test setup during the inspection process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

## Operational Notes – continued

**8. Inter-pin Short and Mounting Errors**

Ensure that the direction and position are correct when mounting the IC on the PCB. Incorrect mounting may result in damaging the IC. Avoid nearby pins being shorted to each other especially to ground, power supply and output pin. Inter-pin shorts could be due to many reasons such as metal particles, water droplets (in very humid environment) and unintentional solder bridge deposited in between pins during assembly to name a few.

**9. Unused Input Pins**

Input pins of an IC are often connected to the gate of a MOS transistor. The gate has extremely high impedance and extremely low capacitance. If left unconnected, the electric field from the outside can easily charge it. The small charge acquired in this way is enough to produce a significant effect on the conduction through the transistor and cause unexpected operation of the IC. So unless otherwise specified, unused input pins should be connected to the power supply or ground line.

**10. Regarding the Input Pin of the IC**

This monolithic IC contains P<sup>+</sup> isolation and P substrate layers between adjacent elements in order to keep them isolated. P-N junctions are formed at the intersection of the P layers with the N layers of other elements, creating a parasitic diode or transistor. For example (refer to figure below):

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 inevitably occur in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions that cause these diodes to operate, such as applying a voltage lower than the GND voltage to an input pin (and thus to the P substrate) should be avoided.

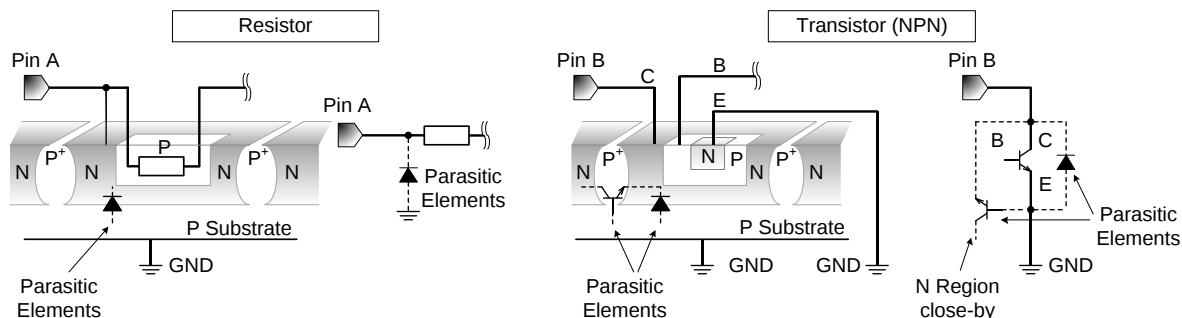


Figure 13. Example of Monolithic IC Structure

**11. Ceramic Capacitor**

When using a ceramic capacitor, determine a capacitance value considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

**12. Thermal Shutdown Circuit (TSD)**

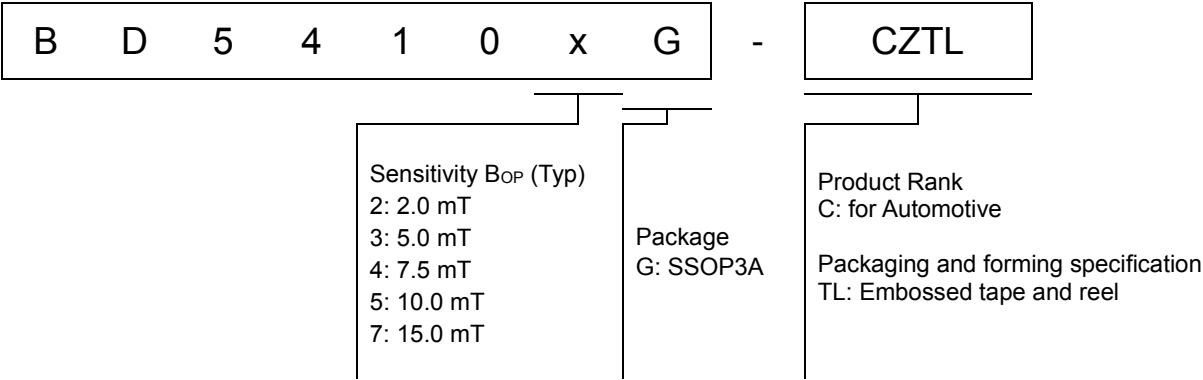
This IC has a built-in thermal shutdown circuit that prevents heat damage to the IC. Normal operation should always be within the IC's maximum junction temperature rating. If however the rating is exceeded for a continued period, the junction temperature ( $T_j$ ) will rise which will activate the TSD circuit that will turn OFF power output pins. When the  $T_j$  falls below the TSD threshold, the circuits are automatically restored to normal operation.

Note that the TSD circuit operates in a situation that exceeds the absolute maximum ratings and therefore, under no circumstances, should the TSD circuit be used in a set design or for any purpose other than protecting the IC from heat damage.

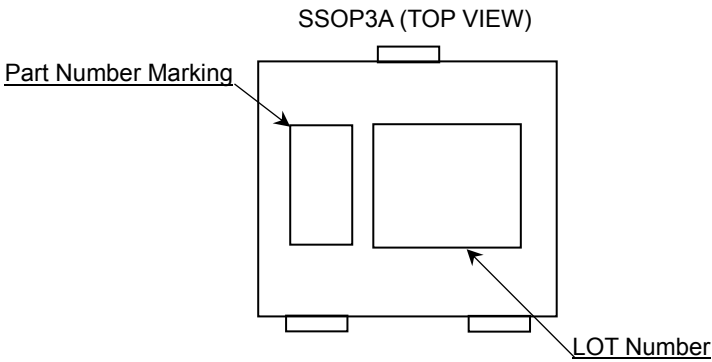
**13. Over Current Protection Circuit (OCP)**

This IC incorporates an integrated overcurrent protection circuit that is activated when the load is shorted. This protection circuit is effective in preventing damage due to sudden and unexpected incidents. However, the IC should not be used in applications characterized by continuous operation or transitioning of the protection circuit.

Ordering Information

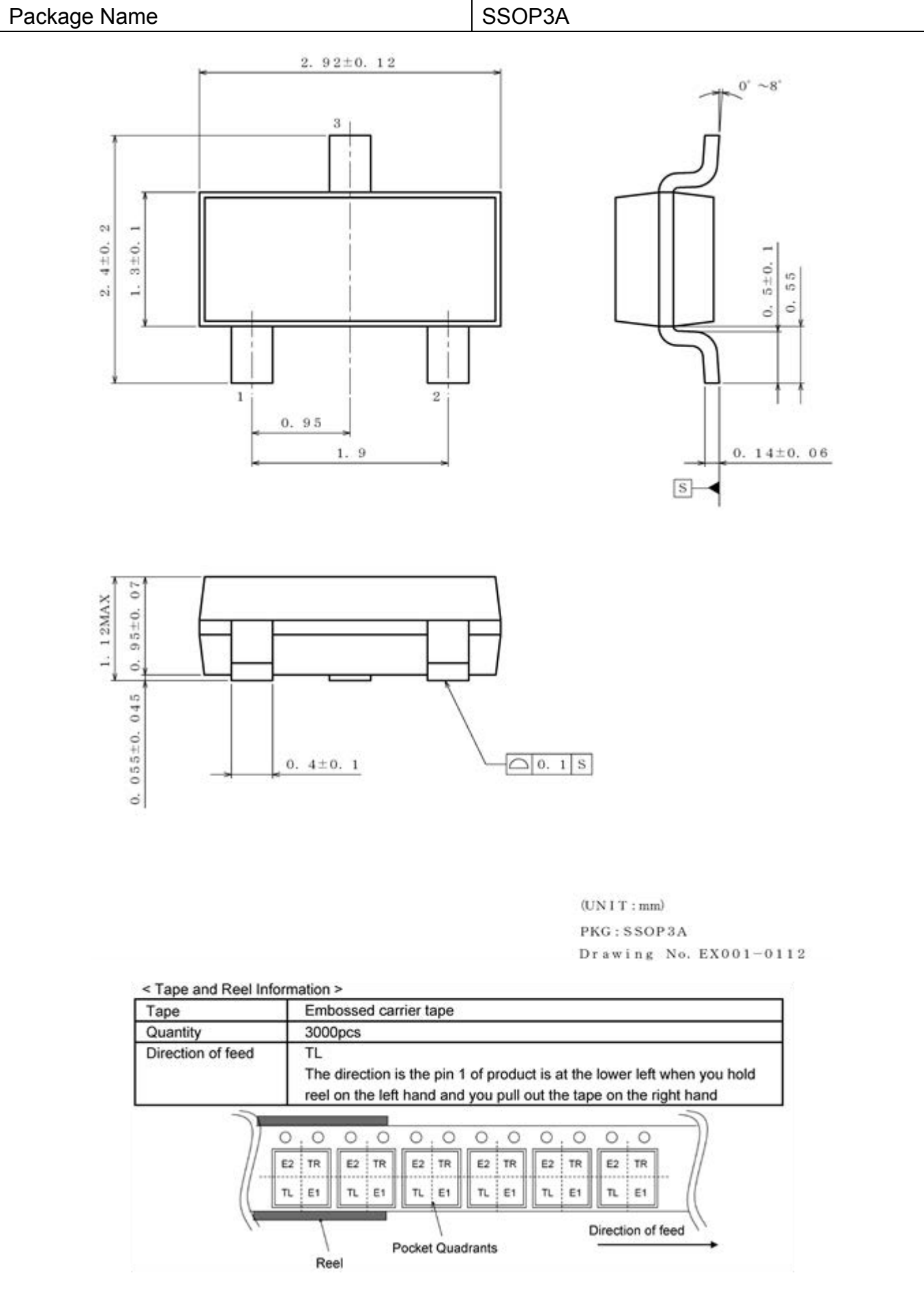


Marking Diagram



| Part Number Marking | Package | Orderable Part Number |
|---------------------|---------|-----------------------|
| AL                  | SSOP3A  | BD54102G-CZTL         |
| AM                  |         | BD54103G-CZTL         |
| AN                  |         | BD54104G-CZTL         |
| AP                  |         | BD54105G-CZTL         |
| AQ                  |         | BD54107G-CZTL         |

Physical Dimension and Packing Information



Revision History

| Date        | Revision | Changes     |
|-------------|----------|-------------|
| 23.May.2022 | 001      | New Release |

# Notice

## Precaution on using ROHM Products

1. If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment <sup>(Note 1)</sup>, aircraft/spacecraft, nuclear power controllers, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

| JAPAN     | USA       | EU         | CHINA     |
|-----------|-----------|------------|-----------|
| CLASS III | CLASS III | CLASS II b | CLASS III |
| CLASS IV  |           | CLASS III  |           |

2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
  - [a] Installation of protection circuits or other protective devices to improve system safety
  - [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure
3. Our Products are not designed under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
  - [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
  - [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
  - [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, SO<sub>2</sub>, and NO<sub>2</sub>
  - [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
  - [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
  - [f] Sealing or coating our Products with resin or other coating materials
  - [g] Use of our Products without cleaning residue of flux (Exclude cases where no-clean type fluxes is used. However, recommend sufficiently about the residue.); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
  - [h] Use of the Products in places subject to dew condensation
4. The Products are not subject to radiation-proof design.
5. Please verify and confirm characteristics of the final or mounted products in using the Products.
6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse, is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.
7. De-rate Power Dissipation depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction temperature.
8. Confirm that operation temperature is within the specified range described in the product specification.
9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

## Precaution for Mounting / Circuit board design

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.
2. In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

## Precautions Regarding Application Examples and External Circuits

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.
2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

## Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of ionizer, friction prevention and temperature / humidity control).

## Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
  - [a] the Products are exposed to sea winds or corrosive gases, including Cl<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, SO<sub>2</sub>, and NO<sub>2</sub>
  - [b] the temperature or humidity exceeds those recommended by ROHM
  - [c] the Products are exposed to direct sunshine or condensation
  - [d] the Products are exposed to high Electrostatic
2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.
3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.
4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

## Precaution for Product Label

A two-dimensional barcode printed on ROHM Products label is for ROHM's internal use only.

## Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

## Precaution for Foreign Exchange and Foreign Trade act

Since concerned goods might be fallen under listed items of export control prescribed by Foreign exchange and Foreign trade act, please consult with ROHM in case of export.

## Precaution Regarding Intellectual Property Rights

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### General Precaution

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