Datasheet

Automotive IPD series

# 1ch High-side Switch IC

## BV1HD090FJ-C

### Features

- AEC-Q100 qualified (Note 1)
- Built-in overcurrent limiting circuit (OCP)
- Built-in thermal shutdown circuit (TSD)
- Built-in open load detection function (at output OFF)
- Direct control enabled from CMOS logic IC, etc.
- Built-in under voltage lockout function
- Built-in Output State Pin
- On-Resistance $R_{ON}$=90mΩ(Typ) ($V_{BB}$=14V, Tj=25°C, $I_{OUT}$=0.5A)
- Monolithic power management IC with the control block (CMOS) and power MOS FET mounted on a single chip
- Enables operation at low voltage down to 4.2V

(Note 1:Grade1)

### Product Summary

| | |
|---|---|
| Wide Operating Input Range | 4.5V to 36V |
| On-state Resistance (Tj=25°C, Typ) | 90mΩ |
| Overcurrent limit (Tj=25°C, Typ) | 5.5A |
| Active Clamp Energy (Tj=150°C) | 68mJ |

### Package

| | W(Typ) x D(Typ) x H(Max) |
|---|---|
| SOP-J8 | 4.90mm x 6.00mm x 1.65mm |


SOP-J8

### General Description

BV1HD090FJ-C is an automotive 1ch high side switch IC, which has built-in overcurrent limiting circuit(OCP), thermal shutdown circuit(TSD), open load detection function (OLD) and under voltage lockout function (UVLO). It is also equipped with the diagnostic output when detecting an error (ST).

### Applications

- Onboard vehicle device (engine ECU, air conditioner, body-control etc )

### Block Diagram

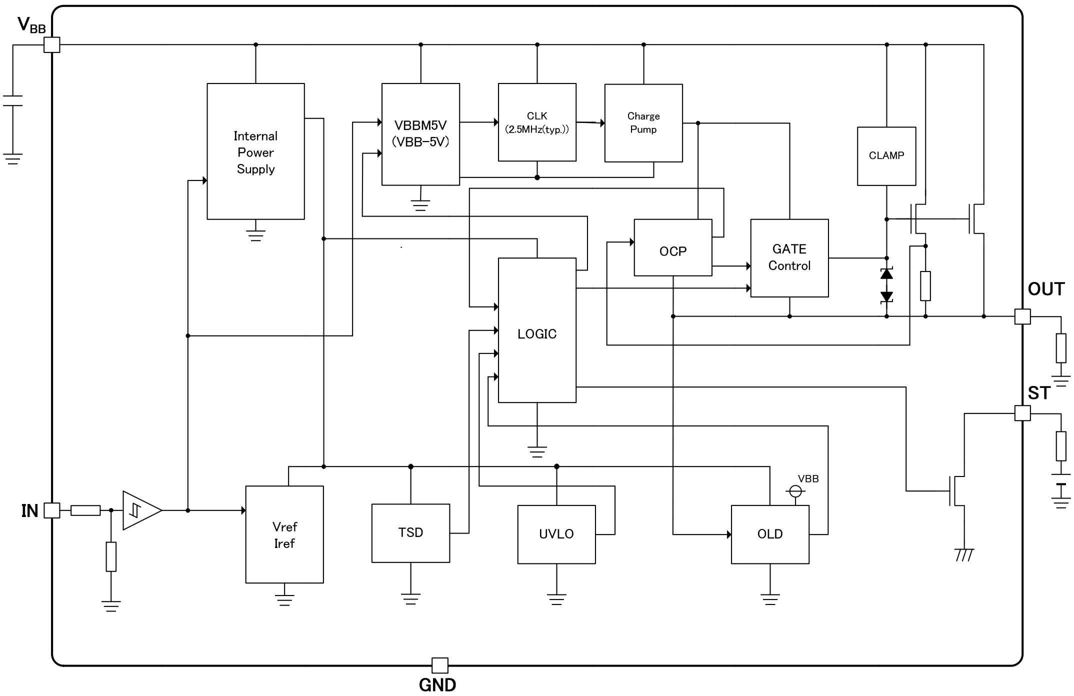



Figure 1. Block Diagram

○Product structure : Silicon monolithic integrated circuit ○This product has no designed protection against radioactive rays

## Pin Configurations

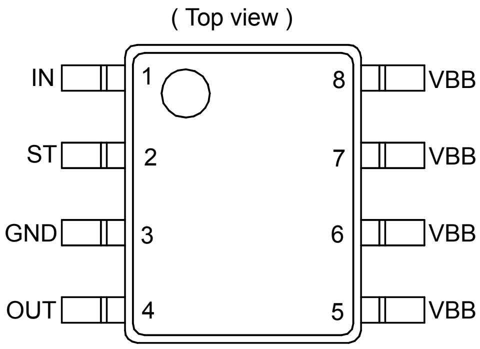



Figure 2. Pin Configurations

## Pin Descriptions

| Pin No. | Unit | Function |
|---|---|---|
| 1 | IN | Input pin. This input has a pull-down resister. |
| 2 | ST | Self-diagnostic output terminal, which outputs “Low” at overcurrent or overtemperature, and “High” at open load. It has an n-channel open drain circuit structure. |
| 3 | GND | GND pin |
| 4 | OUT | Output terminal, which limits the output current to protect the IC when the load is short-circuited and current exceeding the overcurrent detection value (2.7A min) flows to the output terminal. |
| 5, 6, 7, 8 | VBB | Power Supply Voltage |

## Definition

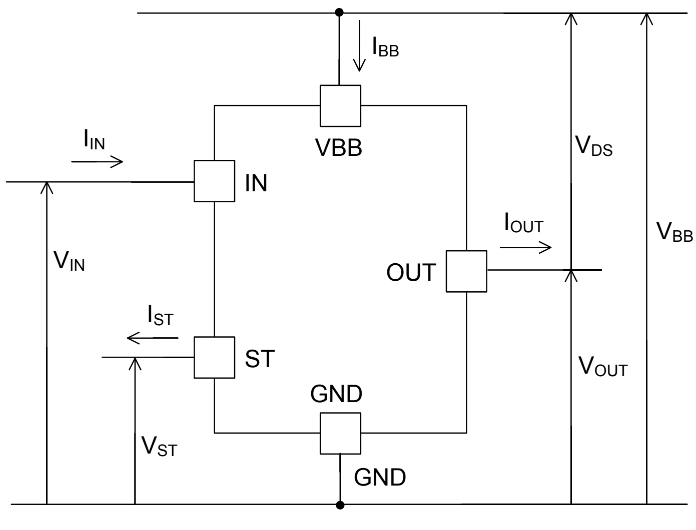



Figure 3. Voltage/Current Definition

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

| Parameter | Symbol | Rating | Unit |
|---|---|---|---|
| VBB-OUT Voltage | $V_{DS}$ | 45 (internal limit) | V |
| Power Supply Voltage | $V_{BB}$ | 40 | V |
| Input Voltage | $V_{IN}$ | -0.3 to +7.0 | V |
| Diagnostic Output Voltage | $V_{ST}$ | -0.3 to +7.0 | V |
| Output Current | $I_{OUT}$ | 9.0(Internal limit $I_{OC}$) (Note 1) | A |
| Diagnostic Output Current | $I_{ST}$ | 10 | mA |
| Junction Temperature Range | Tj | -40 to +150 | °C |
| Storage Temperature Range | Tstg | -55 to +150 | °C |
| Maximum Junction Temperature | Tjmax | +150 | °C |
| Active Clamp Energy (single pulse) $T_{j(start)}$=25°C (Note 2) | $E_{AS(25°C)}$ | 242 | mJ |
| Active Clamp Energy (single pulse) $T_{j(start)}$=150°C (Note 2) (Note 3) | $E_{AS(150°C)}$ | 68 | mJ |

(Note 1) Internally limited by the overcurrent limiting circuit. Value is a maximum.
(Note 2) Maximum Active clamp energy, using single non-repetitive pulse of $I_{AR}$ = 1.5A and $V_{BB}$ = 14V.
During demagnetization of inductive loads, energy must be dissipated in the BV1HD090FJ-C.
This energy can be calculated with following equation:

$$E_{AS} = V_{DS} \times \frac{L}{R_L} \times [\frac{V_{BB} - V_{DS}}{R_L} \times \ln\left(1 - \frac{R_L \times I_{AR}}{V_{BB} - V_{DS}}\right) + I_{AR}]$$

Following equation simplifies under the assumption of $R_L$=0Ω.

$$E_{AS} = \frac{1}{2} \times L \times I_{AR}^2 \times (1 - \frac{V_{BB}}{V_{BB} - V_{DS}})$$

(Note 3) This active clamp energy is guaranteed by design.

## Recommended Operating Conditions (Tj= -40°C to +150°C)

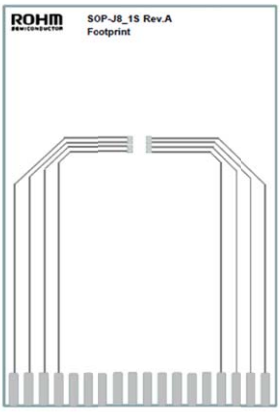
| Parameter | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Power Supply Voltage | $V_{BB}$ | 4.5 | 14 | 36 | V |

### Thermal Resistance(Note 1)

| Parameter | Symbol | Typ | Unit | Condition |
|---|---|---|---|---|
| SOP-J8 | | | | |
| Between Junction and Surroundings Temperature Thermal Resistance | $\theta_{JA}$ | 143.7 | °C / W | 1s(Note 2) |
| | | 86.9 | °C / W | 2s(Note 3) |
| | | 67.5 | °C / W | 2s2p(Note 4) |

(Note 1) The thermal impedance is based on JESD51 - 2A (Still - Air) standard. It is used the chip of BV1HD090FJ-C.
(Note 2) JESD51 - 3 standard FR4 114.3 mm × 76.2 mm × 1.57 mm 1-layer (1s)
(Top copper foil: ROHM recommended footprint + wiring to measure, 2 oz. copper.)
(Note 3) JESD51 -5 standard FR4 114.3 mm × 76.2 mm × 1.60 mm 2-layer (2s)
(Top copper foil: ROHM recommended footprint + wiring to measure /
Copper foil area on the reverse side of PCB: 74.2 mm x 74.2 mm, 2 oz. copper (top & reverse side) )
(Note 4) JESD51 -5 / -7 standard FR4 114.3 mm × 76.2 mm × 1.60 mm 4-layer (2s2p)
(Top copper foil: ROHM recommended footprint + wiring to measure /
2 inner layers and copper foil area on the reverse side of PCB: 74.2 mm x 74.2 mm,
copper (top & reverse side / inner layers) 2oz. / 1oz.)

■ PCB Layout 1 Layer (1s)




Footprint Only

Figure 4. PCB Layout 1 Layer (1s)

| Dimension | Value |
|---|---|
| Board Finish Thickness | 1.57 mm ± 10% |
| Board Dimension | 76.2 mm x 114.3 mm |
| Board Material | FR4 |
| Copper Thickness (Top/Bottom Layers) | 0.070mm (Cu:2oz) |

■ PCB Layout 2 Layers (2s)

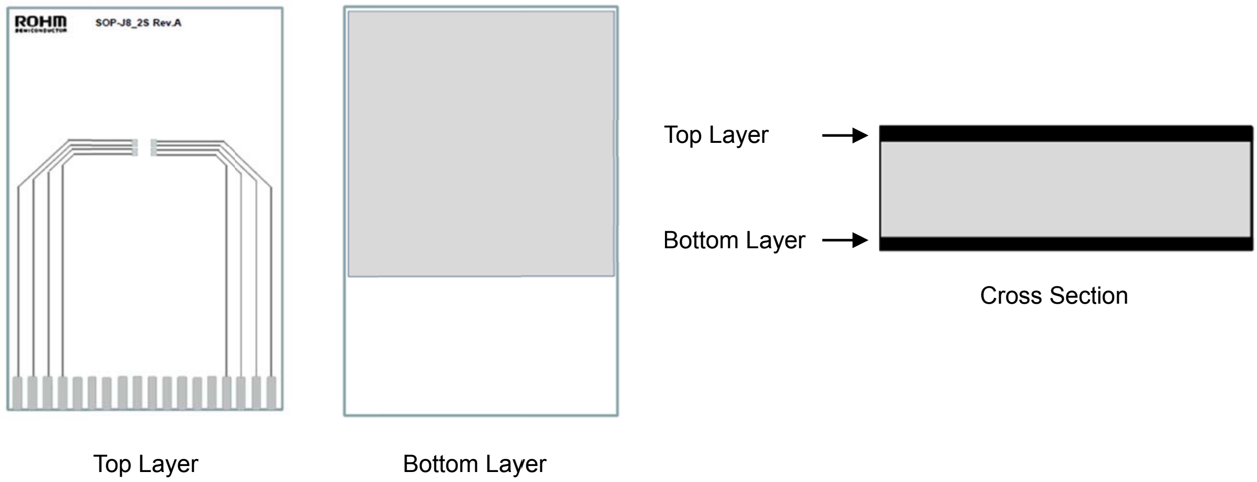



Figure 5. PCB Layout 2 Layers (2s)

| Dimension | Value |
|---|---|
| Board Finish Thickness | 1.60 mm ± 10% |
| Board Dimension | 76.2 mm x 114.3 mm |
| Board Material | FR4 |
| Copper Thickness (Top/Bottom Layers) | 0.070mm (Cu + Plating) |

■ PCB Layout 4 Layers(2s2p)

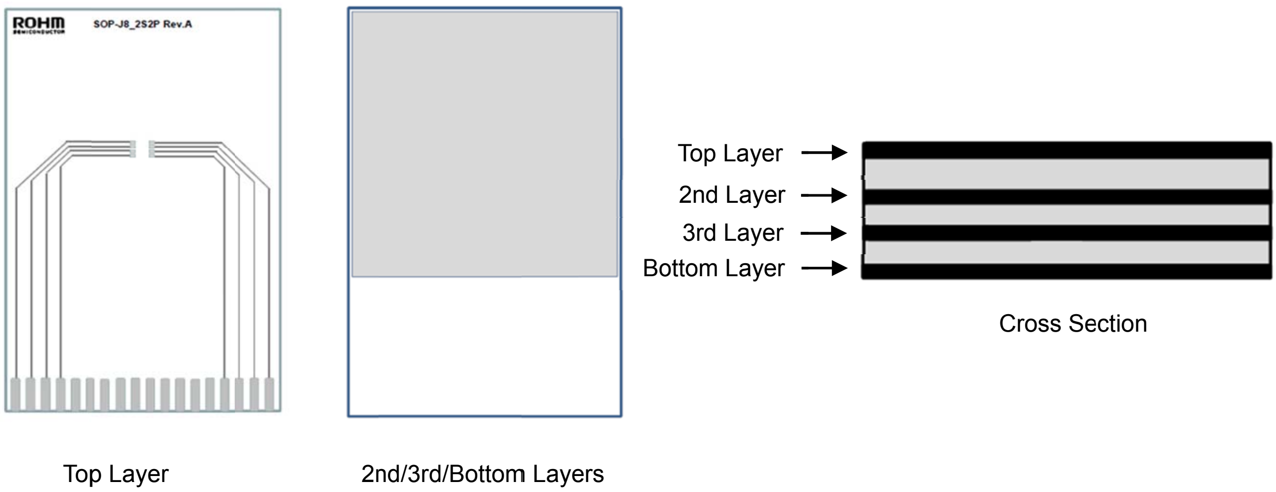



Figure 6. PCB Layout 4 Layers (2s2p)

| Dimension | Value |
|---|---|
| Board Finish Thickness | 1.60 mm ± 10% |
| Board Dimension | 76.2 mm x 114.3 mm |
| Board Material | FR4 |
| Copper Thickness (Top/Bottom Layers) | 0.070mm (Cu + Plating) |
| Copper Thickness (Inner Layers) | 0.035mm |

■ Thermal Resistance (Single Pulse)

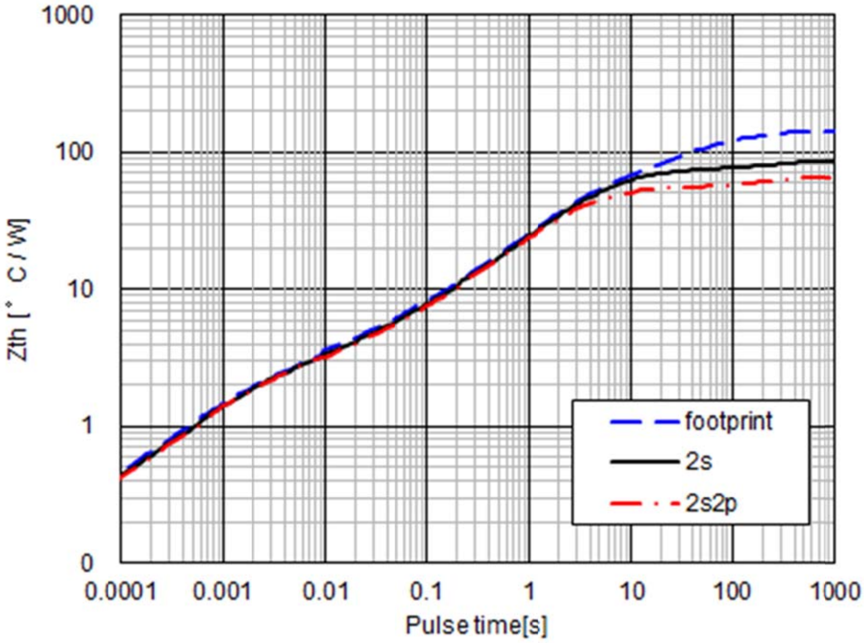



Figure 7. Thermal Resistance

### Electrical Characteristics

(Unless otherwise specified Tj = -40 °C to +150 °C, $V_{BB}$ = 4.5V to 36V)

| Parameter | Symbol | Min | Typ | Max | Unit | Conditions |
|---|---|---|---|---|---|---|
| Power Supply | | | | | | |
| Standby Current | $I_{BBS1}$ | - | 200 | 330 | μA | $V_{BB}$=14V, $V_{IN}$=0V, $V_{OUT}$=0V, Tj=25°C |
| | $I_{BBS2}$ | - | 250 | 500 | μA | $V_{BB}$=14V, $V_{IN}$=0V, $V_{OUT}$=0V, Tj=150°C |
| Bias Current | $I_{BB}$ | - | 3.0 | 6.0 | mA | $V_{BB}$=14V, $V_{IN}$=5V, $V_{OUT}$=open |
| Under Voltage Lockout Threshold | $V_{UVLO}$ | - | 3.6 | 4.2 | V | |
| Under Voltage Hysteresis Threshold | $V_{UVHYS}$ | - | 0.2 | - | V | |
| Input | | | | | | |
| High-Level Input Voltage | $V_{INH}$ | 2.8 | - | - | V | |
| Low-Level Input Voltage | $V_{INL}$ | - | - | 1.5 | V | |
| Input Hysteresis | $V_{INHYS}$ | - | 0.4 | - | V | |
| High-Level Input Current | $I_{INH}$ | - | 50 | 150 | μA | $V_{IN}$=5V |
| Low-Level Input Current | $I_{INL}$ | -10 | - | +10 | μA | $V_{IN}$=0V |
| Power MOS | | | | | | |
| On-State Resistance | $R_{ON1}$ | - | 90 | 120 | mΩ | $V_{BB}$=8V to 36V, Tj=25°C |
| | $R_{ON2}$ | - | 160 | 215 | mΩ | $V_{BB}$=8V to 36V, Tj=150°C |
| | $R_{ON3}$ | - | - | 500 | mΩ | $V_{BB}$=4.2V |
| Leak Current | $I_{OUTL1}$ | - | 130 | 200 | μA | $V_{BB}$=14V, $V_{IN}$=0V, $V_{OUT}$=0V, Tj=25°C |
| | $I_{OUTL2}$ | - | 160 | 250 | μA | $V_{BB}$=14V, $V_{IN}$=0V, $V_{OUT}$=0V, Tj=150°C |
| | $I_{OUTH3}$ | -160 | -90 | - | μA | $V_{BB}$=14V, $V_{IN}$=0V, $V_{OUT}$=$V_{BB}$, Tj=25°C |
| | $I_{OUTH4}$ | -400 | -110 | - | μA | $V_{BB}$=14V, $V_{IN}$=0V, $V_{OUT}$=$V_{BB}$, Tj=150°C |
| Slew Rate | $SR_{ON}$ | 0.23 | 0.70 | - | V/μs | $V_{BB}$=14V, $R_L$=10Ω, Tj=25°C |
| | $SR_{OFF}$ | 0.53 | 1.60 | - | V/μs | $V_{BB}$=14V, $R_L$=10Ω, Tj=25°C |
| Propagation Delay at ON | $t_{OUTON}$ | - | 30 | 90 | μs | $V_{BB}$=14V, $R_L$=10Ω, Tj=25°C |
| Propagation Delay at OFF | $t_{OUTOFF}$ | - | 20 | 60 | μs | $V_{BB}$=14V, $R_L$=10Ω, Tj=25°C |
| Output Clamp Voltage | $V_{DS}$ | 45 | 50 | 56.5 | V | $V_{IN}$=0V, $I_{OUT}$=-10mA |
| Output States | | | | | | |
| ST ON Voltage | $V_{STL}$ | - | - | 0.3 | V | $V_{BB}$=6V to 36V, $V_{IN}$=0V, $I_{ST}$=-0.6mA |
| ST Leak Current | $I_{STH}$ | -10 | - | - | μA | $V_{IN}$=5V, $V_{ST}$=5V |
| Diagnostic Output Delay Time at Input ON | $t_{STON}$ | - | 11 | 33 | μs | $V_{BB}$=14V, $R_L$=10Ω, Tj=25°C |
| Diagnostic Output Delay Time at Input OFF | $t_{STOFF}$ | - | 30 | 90 | μs | $V_{BB}$=14V, $R_L$=10Ω, Tj=25°C |
| Protection Circuit | | | | | | |
| Overcurrent Detection Current | $I_{OC}$ | 2.7 | 5.5 | 9.0 | A | |
| Overcurrent Detection OFF Time | $t_{OCOFF}$ | - | 550 | 1100 | μs | |
| Overcurrent Detection ON Duty | $D_{OC}$ | - | - | 30 | % | |
| Open Load Detection Resistance (Note1) | $R_{OLD}$ | 6 | - | 36 | kΩ | $V_{IN}$=0V |
| Open Load Detection Voltage (Note1) | $V_{OLD}$ | 1.5 | - | 2.5 | V | $V_{IN}$=0V |
| TSD Detection Temperature(Note2) | $T_{TSD}$ | 175 | 190 | 205 | °C | |
| TSD Hysteresis(Note2) | $T_{TSDHYS}$ | - | 15 | - | °C | |

(Note1) The detectable power voltage range for open load is $V_{BB} \geq$ 6V.
(Note2) This temperature is guaranteed by design.

### Typical Performance Curves
(Unless otherwise specified $V_{BB}$ =14V, $V_{IN}$=5V, Tj=25°C)

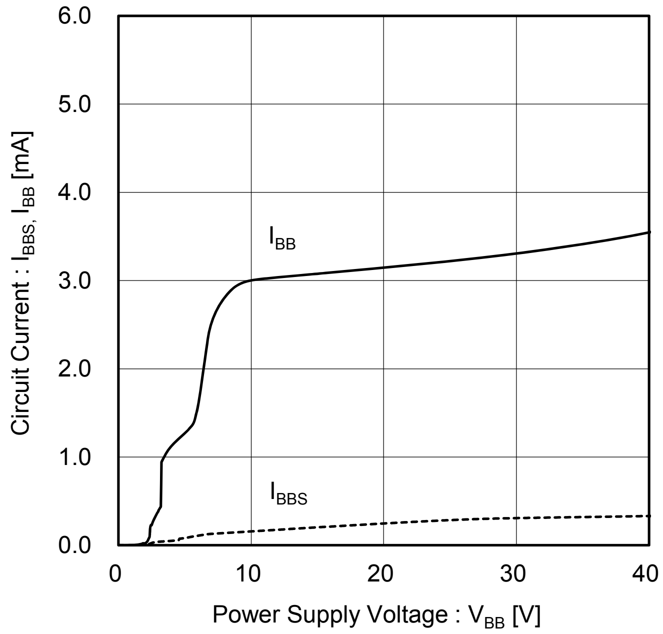



Figure 8. Circuit Current vs. Power Supply Voltage

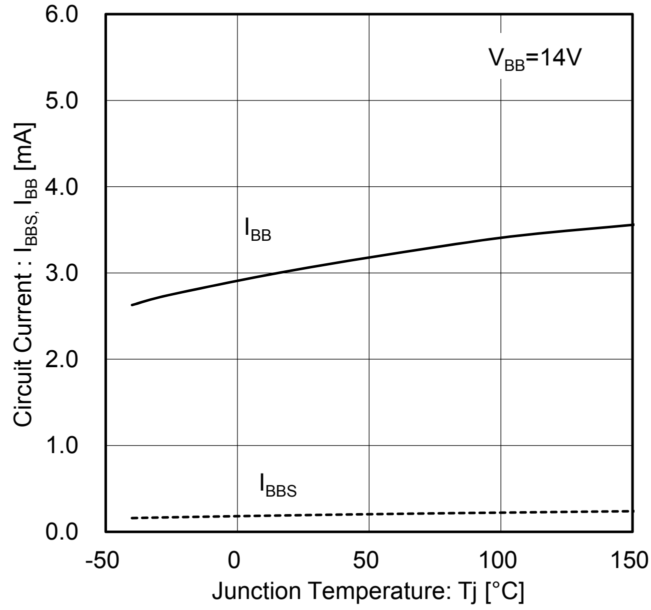



Figure 9. Circuit Current vs. Temperature

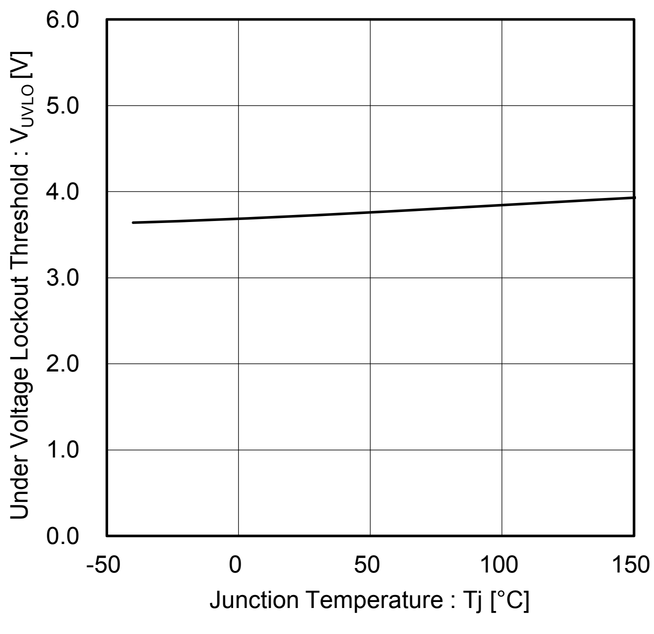



Figure 10. Under Voltage Lockout Threshold vs. Temperature

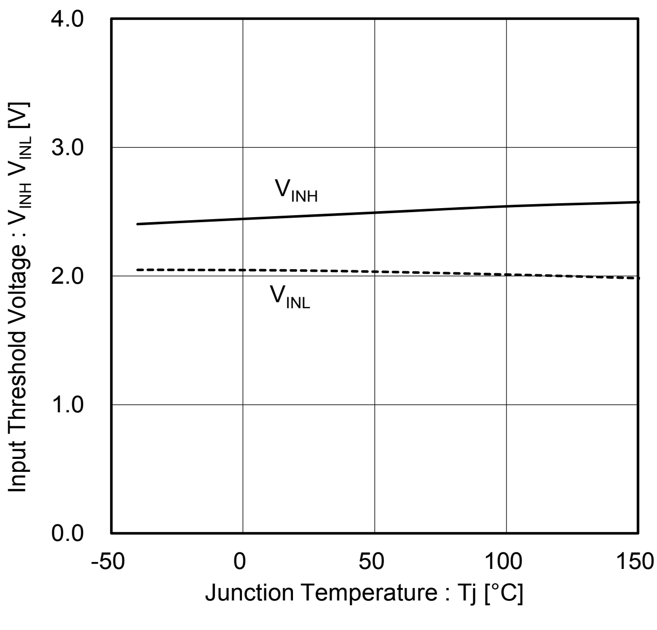



Figure 11. Input Threshold Voltage vs. Temperature

**Typical Performance Curves - continued**

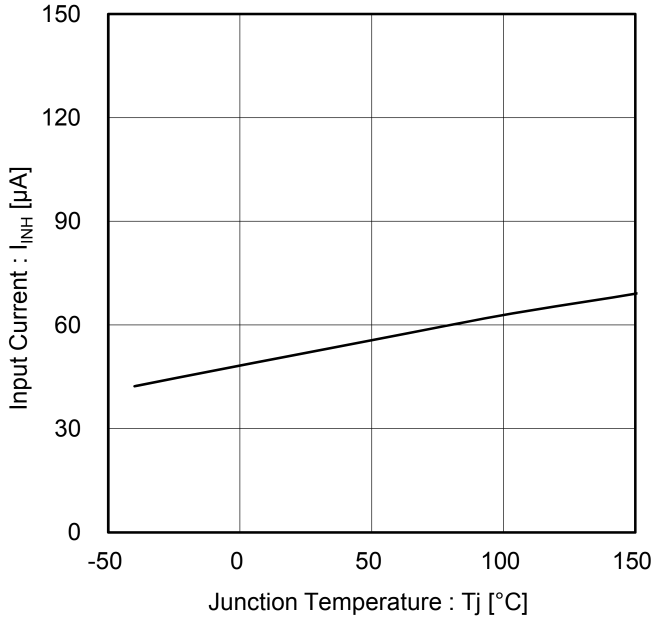



Figure 12. Input Current vs. Temperature

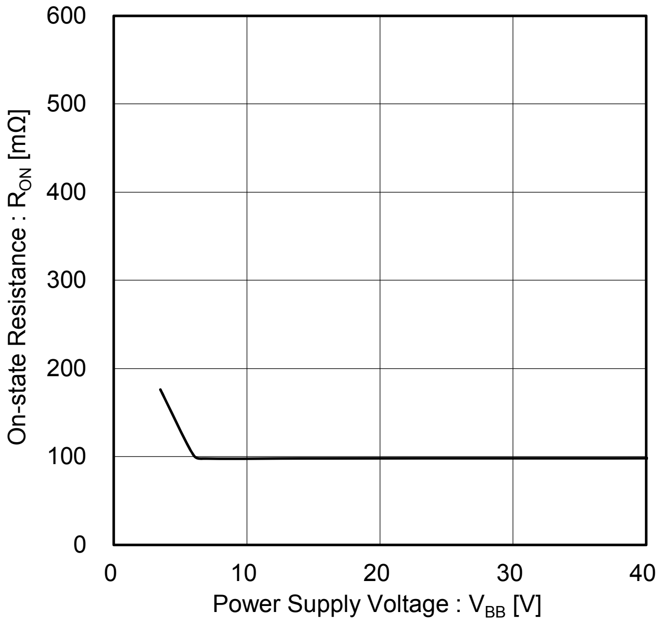



Figure 13. On-state Resistance vs. Power Supply Voltage

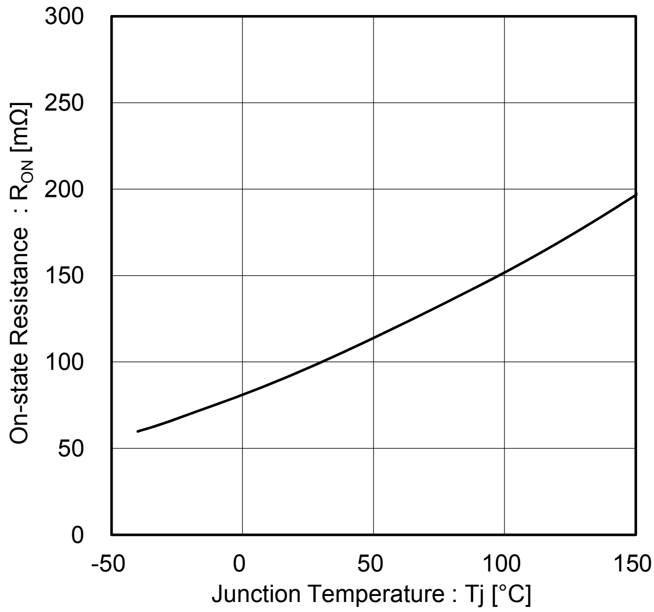



Figure 14. On-state Resistance vs. Temperature

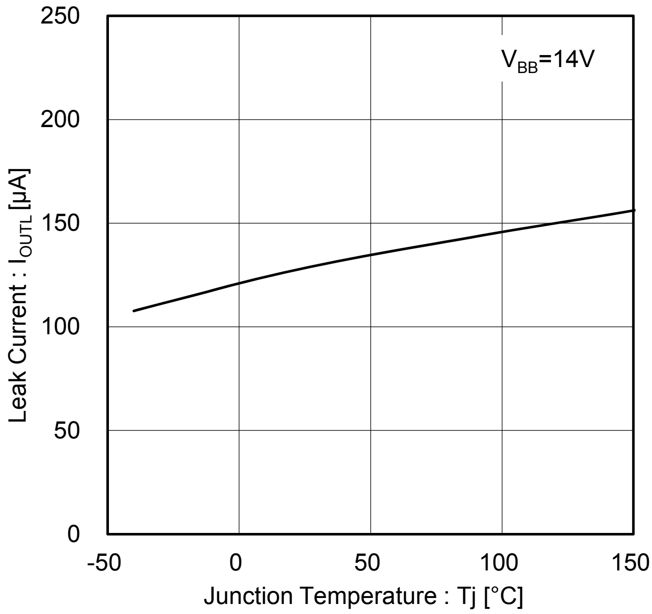



Figure 15. Leak Current vs. Temperature

**Typical Performance Curves - continued**

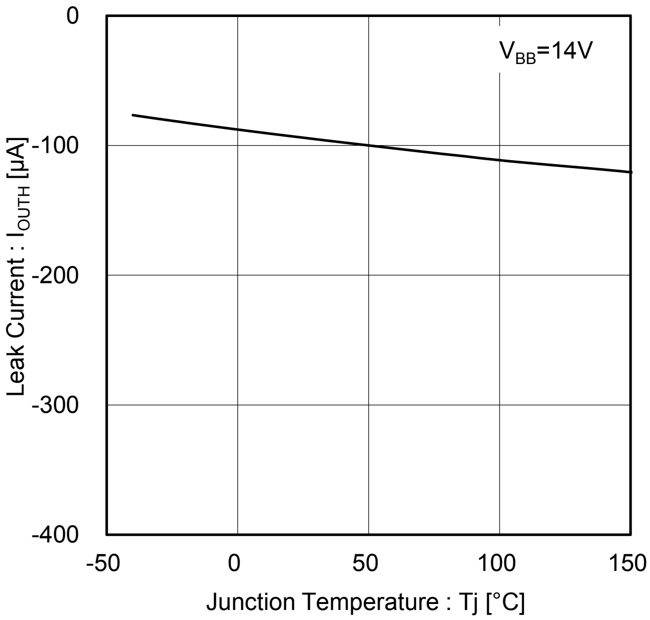



Figure 16. Leak Current vs. Temperature

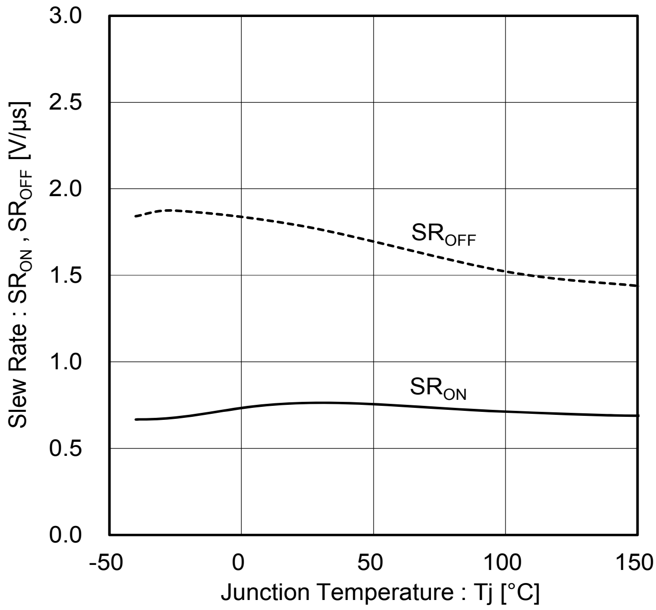



Figure 17. Slew Rate vs. Tempareture

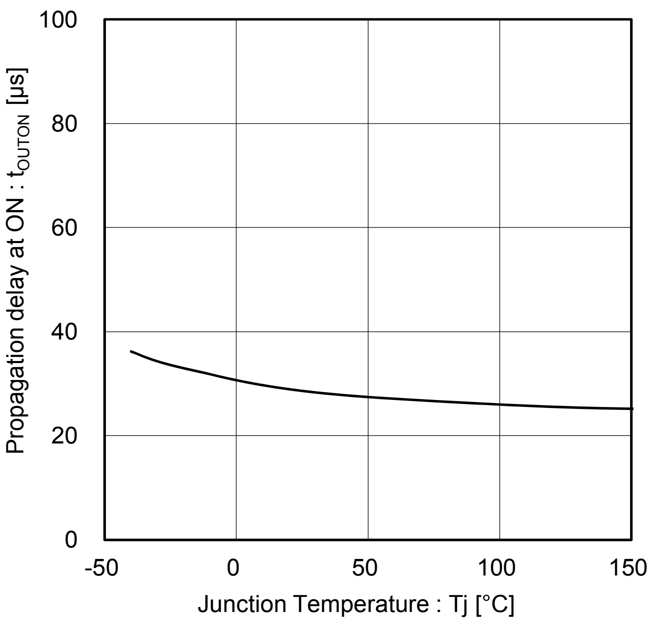



Figure 18. Propagation Delay at ON vs. Temperature

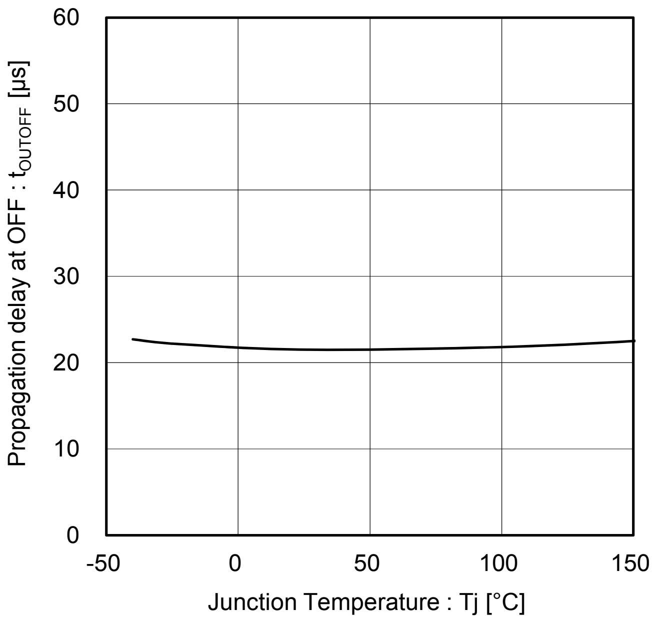



Figure 19. Propagation Delay at OFF vs. Temperature

### Typical Performance Curves - continued

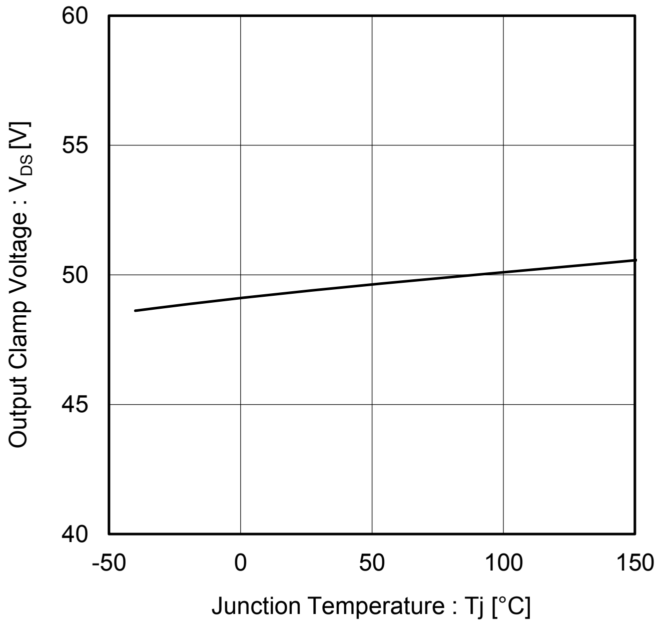



Figure 20. Output Clamp Voltage vs. Temperature

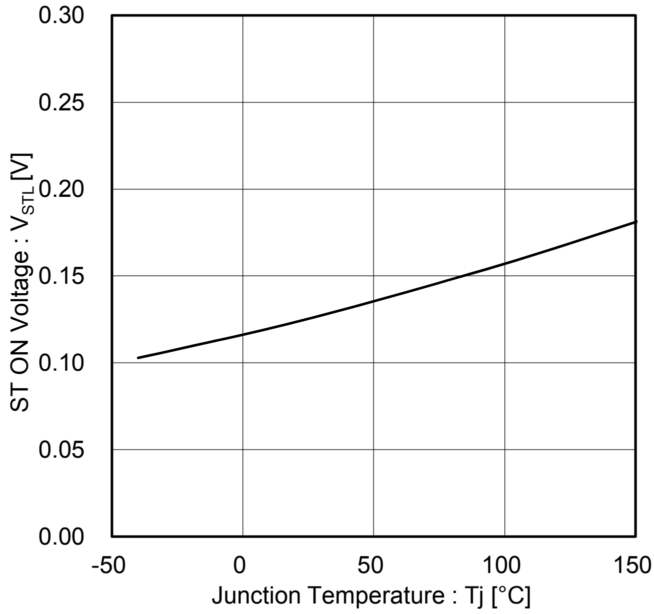



Figure 21. ST ON Voltage vs. Temperature

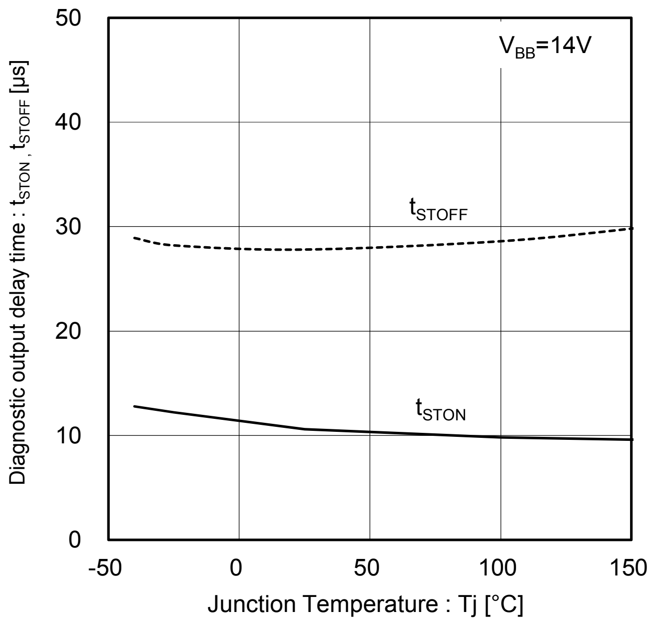



Figure 22. Diagnostic Output Delay Time vs. Temperature

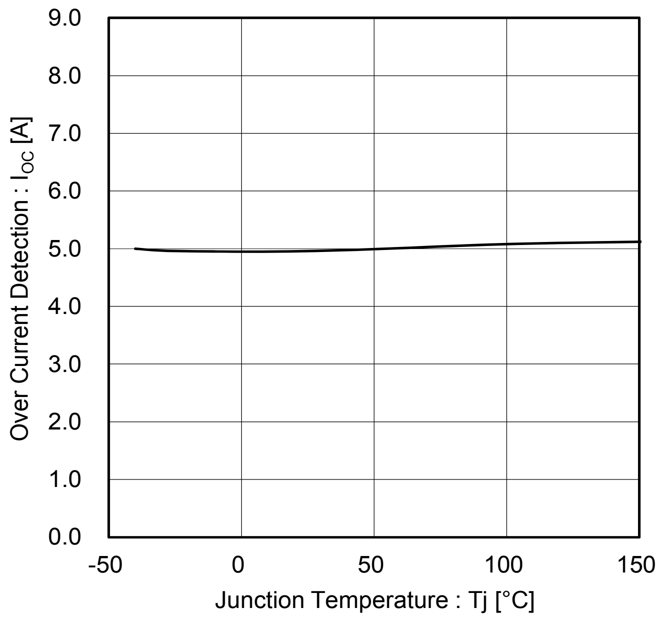



Figure 23. Overcurrent Detection vs. Temperature

**Typical Performance Curves - continued**

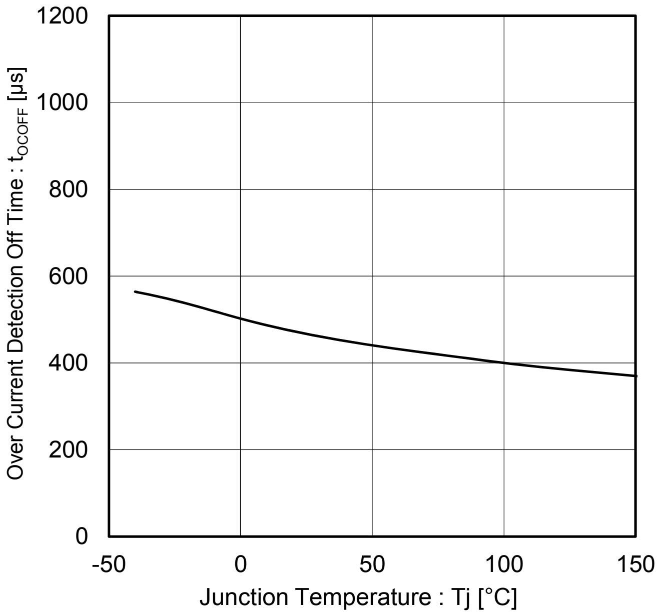



Figure 24. Overcurrent Detection Off Time vs. Temperature

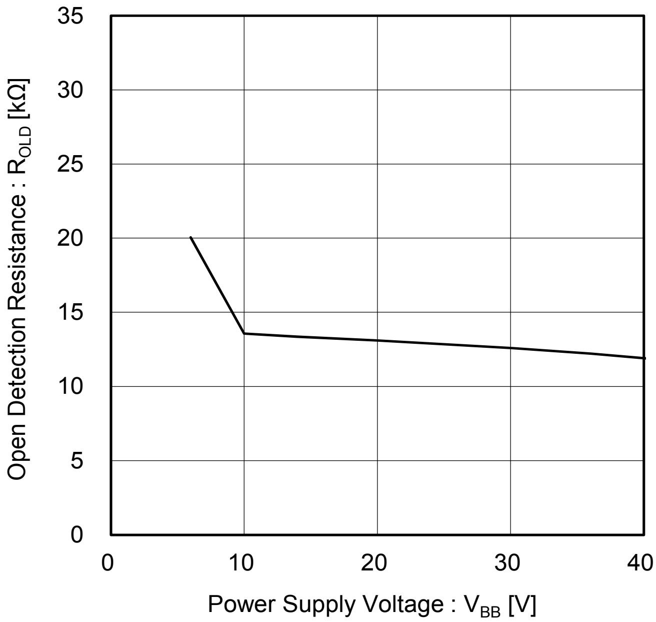



Figure 25. Open Detection Resistance vs. Power Supply Voltage

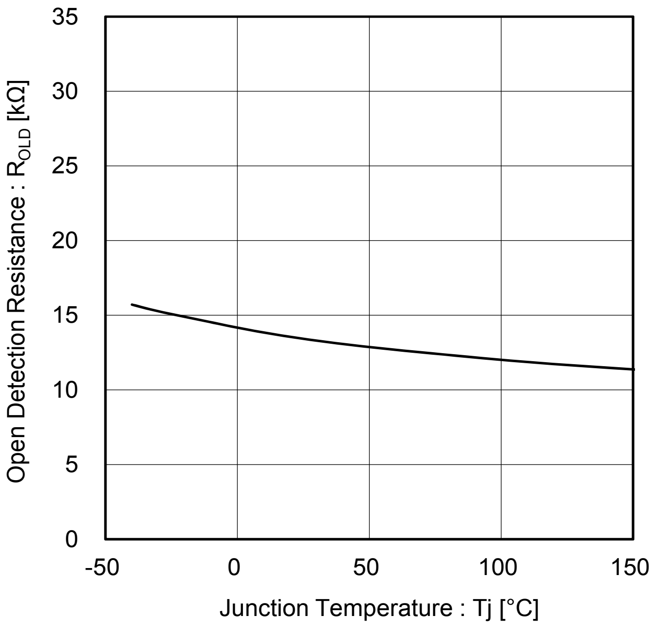



Figure 26. Open Detection Resistance vs. Temperature

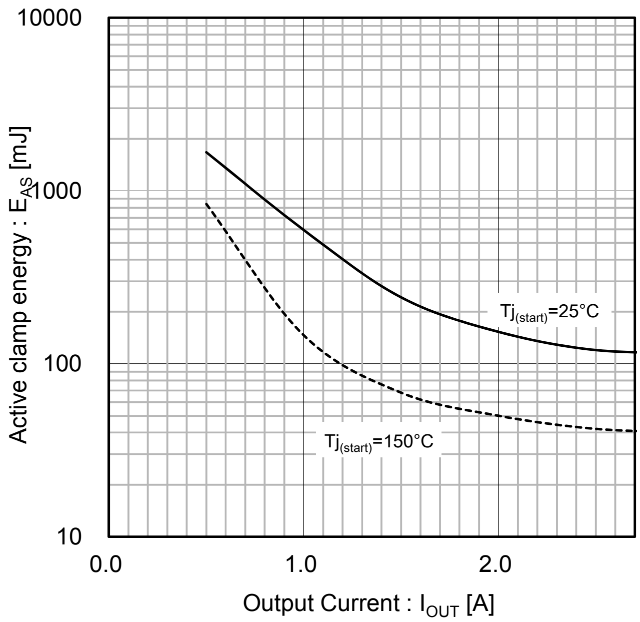



Figure 27. Active Clamp Energy vs. Output Current

## Measurement Circuit

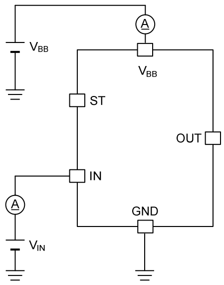



Figure 28. Standby Current
Bias Current
High-level Input Current
Low-level Input Current

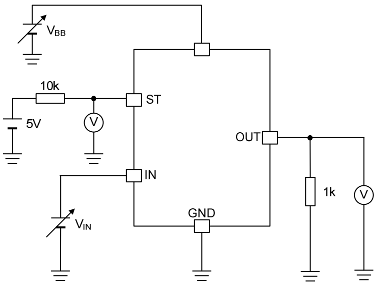



Figure 29. Under Voltage Lockout Threshold
Under Voltage Hysteresis Threshold
High-Level Input Voltage
Low-Level Input Voltage
Input Hysteresis
TSD Detection Temperature
TSD Hysteresis

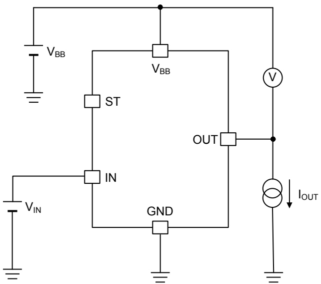



Figure 30. On-state Resistance
Output Clamp Voltage

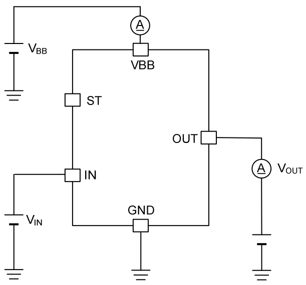



Figure 31. Leak Current

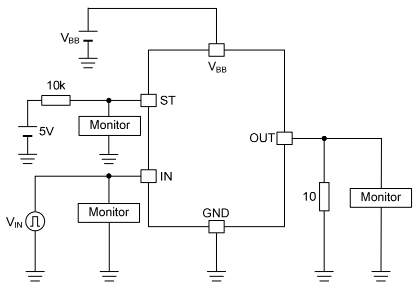



Figure 32. Slew Rate
Propagation Delay at ON
Propagation Delay at OFF
Diagnostic Output Delay Time
at Input ON
Diagnostic Output Delay Time
at Input OF

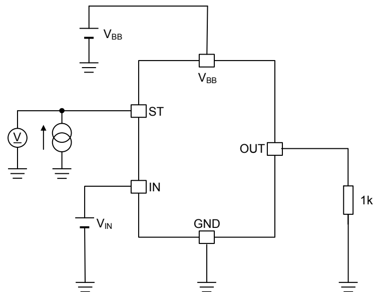



Figure 33. ST ON Voltage

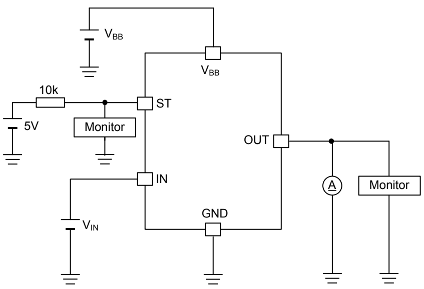



Figure 34. Overcurrent Detection Current
Overcurrent Detection OFF Time
Overcurrent Detection ON Duty

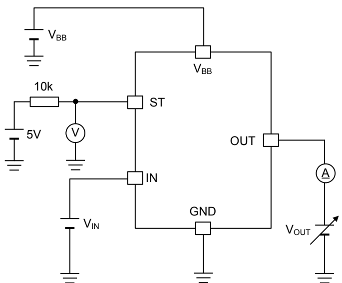



Figure 35. Open Load Detection Resistance
Open Load Detection Voltage

### Measurement conditions

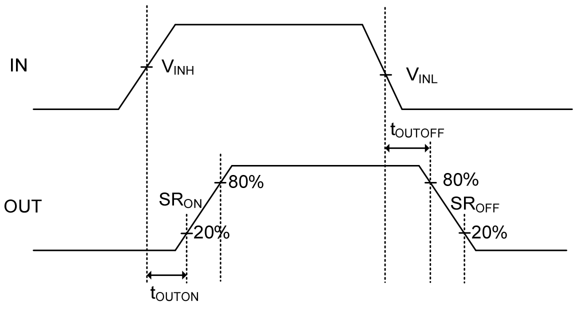



Figure 36. Slew Rate

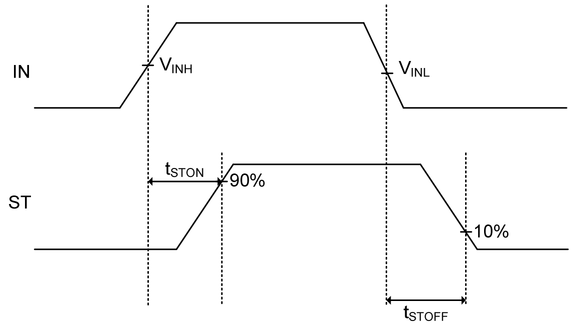



Figure 37. Diagnostic Output Delay Time

### I/O Pin Truth Table

| Operating Status | Input Signal | Output Level | Diagnostic Output (ST) | Error Detection Reset Condition |
|---|---|---|---|---|
| Normal | Low | Low | Low | - |
| | High | High | High | |
| Overtemperature | Low | Low | Low | Self-Reset |
| | High | Low | Low | |
| Overcurrent | Low | Low | Low | Self-Reset |
| | High | Switching | Low | |
| Open Load Detected | Low | High | High | Self-Reset |
| | High | High | High | |

### Timing Chart

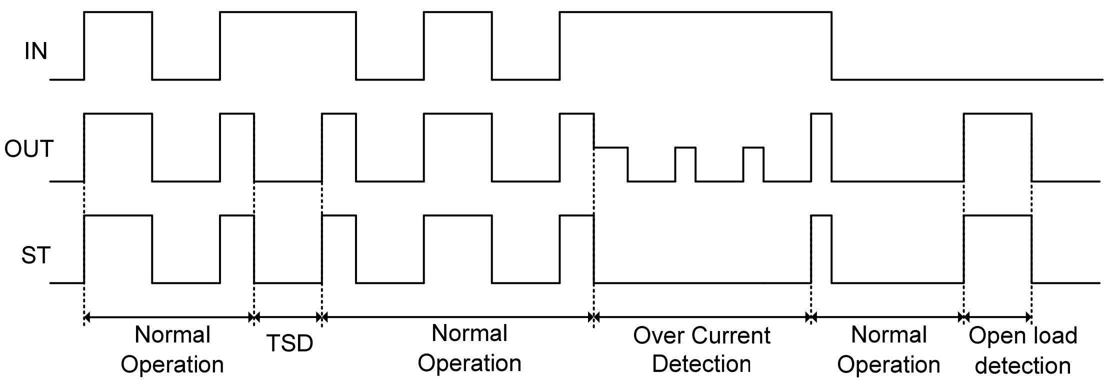
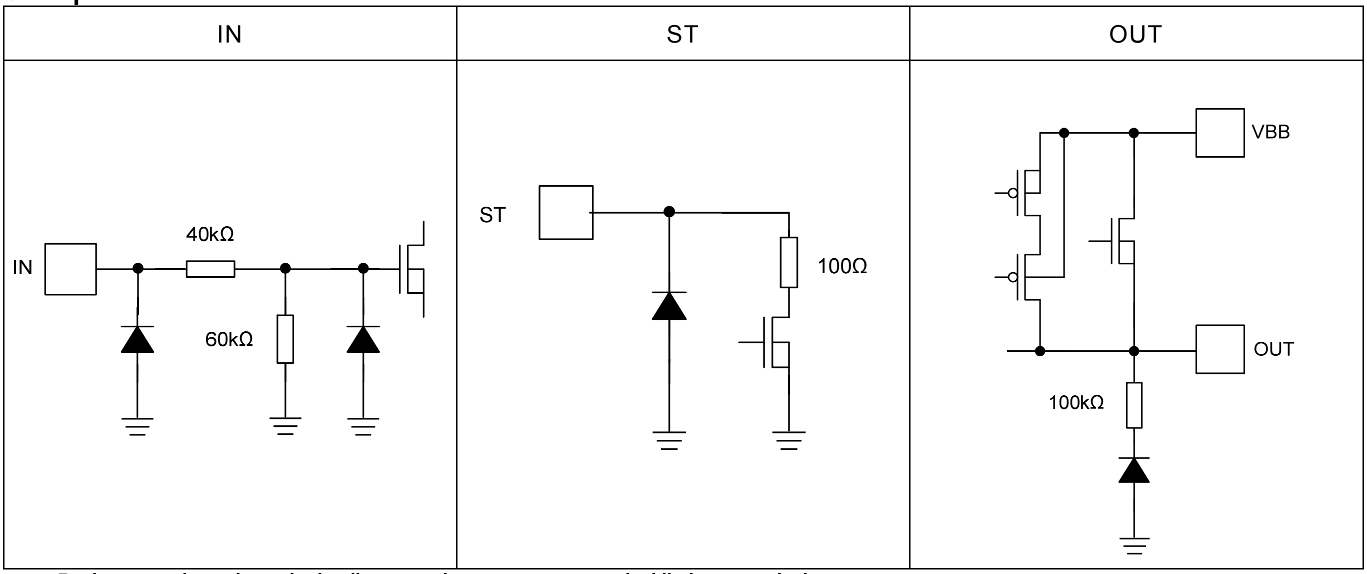



Figure 38. Timing Chart

## I/O Equivalent Circuits




**Resistance values shown in the diagrams above represent a typical limit, respectively**

Figure 39. I/O Equivalent Circuits

## Application Circuits

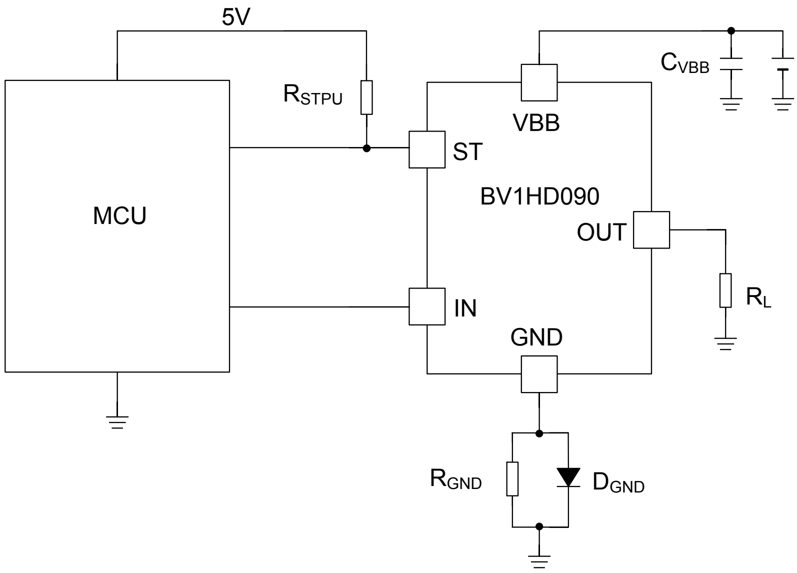



Figure 40. Application Circuits

| Symbol | Value | Purpose |
|---|---|---|
| $R_{STPU}$ | 10kΩ | ST terminal is open drain output. ST terminal is pulled up by MCU power supply. |
| $R_{GND}$ | 1kΩ | Current limitation during reverse battery. |
| $C_{VBB}$ | 100nF | Filter of the voltage spikes on the VBB line. |
| $D_{GND}$ | - | Protection of the BV1HD090FJ-C during reverse battery. |

## Precautions for use

1. **Ground Wiring Pattern**
   When both small signal ground and large current ground are provided, it is recommended to isolate the large current ground pattern from the small signal ground pattern and ground at one point at the reference point of the set PCB so as to prevent change of the small signal ground voltage caused by the pattern wiring resistance and large current. Also, pay attention not to change the voltage of ground wiring pattern of the external parts. When wiring the ground line, be sure to set it to low impedance.

2. **Thermal Design**
   The generated calorific value Pc is determined by Pc ≒ $V_{DS}\times I_{OUT}+V_{BB}\times I_{BB}$, using VBB - OUT potential difference ($V_{DS}$), amperage flowing through load ($I_{OUT}$) and operating current ($I_{BB}$).
   In consideration of the thermal resistance value in the actual service condition, complete the thermal design having sufficient margins.
   Should the project be used in the condition exceeding Tjmax = 150 °C, the essential IC properties may be deteriorated.
   Since the thermal resistance value described in this specification is measured in the PCB conditions and environments recommended by JEDEC, you should remember that the value in the actual service environments may differ from that.

3. **Absolute Maximum Rating**
   If the temperature value exceeds the absolute maximum rating due to overvoltage applied or rise in temperature, the IC may be broken. If a special mode is assumed where a short circuit between terminals or an excess of the absolute maximum rating may occur, it is recommended to take physical safety measures such as fuses.

4. **Inspection Using a Set PCB**
   In the assembly process, apply grounding as a measure against IC damage caused by static electricity and pay special attention during transportation and storage.
   When connecting the IC to or removing the IC from the mount board in the inspection process, be sure to turn OFF the power supply. If a terminal to which a capacitor is connected is included, residual charge may apply stress to the IC. To avoid this, be sure to discharge electricity before performing the following inspection.

5. **Mis-mounting and Short Circuit Between Terminals**
   When mounting the IC on the PCB, pay special attention to the IC direction, displacement and short circuit between terminals. Mis-mounting or short circuit between terminals may cause IC damage.

6. **Ceramic Capacitor Characteristic Variation**
   When using a ceramic capacitor as the external component, determine the constant in consideration of lowering of nominal capacity due to direct current bias and change of capacity caused by thermal conditions.

7. **Thermal Shut Down Function**
   The IC integrates the thermal shut down function. When the IC chip temperature exceeds 190°C (Typ), the function turns OFF the output and sets the diagnostic output (ST) to Low. When the temperature becomes lower than 175°C (Typ), the IC returns to the normal operation.
   The thermal shut down function is provided only in order to shut down a thermal runaway, not in order to protect or secure the IC. Since the thermal shut down function turns ON in the state exceeding the absolute maximum rating, be sure to avoid designing a set PCB pre-requiring use of this function.

8. **Overcurrent Protection Function**
   The IC integrates the overcurrent protection function. When overcurrent flows, the function limits the output current to 5.5A (Typ), turns OFF the output if the limited state continues for 3μs (Typ) or longer and sets the diagnostic output (ST) to Low. If the output OFF state continues for 550μs (Typ), the IC resets itself. During the erroneous state where overcurrent flows, the function turns ON/OFF the output repeatedly.
   The overcurrent protection function is to protect the IC from damage caused only by a sudden abnormality such as a load short circuit and short circuit between terminals. Be sure to avoid designing a set PCB pre-requiring use of this function.

9. **Active Clamp Operation**
   The IC integrates the active clamp circuit to internally absorb the counter electromotive force generated when the inductive load is turned OFF. When the active clamp operates, VBB - OUT voltage becomes 50V (Typ) and the IC chip temperature rises. However, since this is the operation at IN=0V, the thermal shut down function does not turn ON. To drive the inductive load, refer to Figure. 27 to determine the load which will be below the active clamp tolerance dose.

10. **Power Supply Line**
    Since the power supply line where large current flows may influence the normal operation, design the power supply line so that the power supply pattern wiring resistance will become smaller.

**11. Reverse Connection of Power Connector (**VBB - GND**)**
A reverse connection of the power connector (between VBB and GND) incurs a risk to break the IC.
In order to prevent the IC from damage at reverse connection, take an appropriate measure, for example, to insert a diode and resistor between the GND terminal of the PCB ground and that of the IC, or to insert a diode between VBB of the power supply and that of the IC. (Refer to Figure No.40)

**12. Power Terminal in The Open State**
When the power terminal (VBB) becomes open at ON (IN=High), the output is switched to OFF irrespective of input voltage.
If an inductive load is connected, the active clamp operates when VBB is open, and then becomes the same potential as that on the ground and the output voltage drops down to - 50V (Typ).

**13. GND Terminal in The Open State**
When the GND terminal becomes open at ON (IN=High), the output is switched to OFF irrespective of input voltage. If an inductive load is connected, the active clamp operates when the GND terminal is open.

## Ordering Information

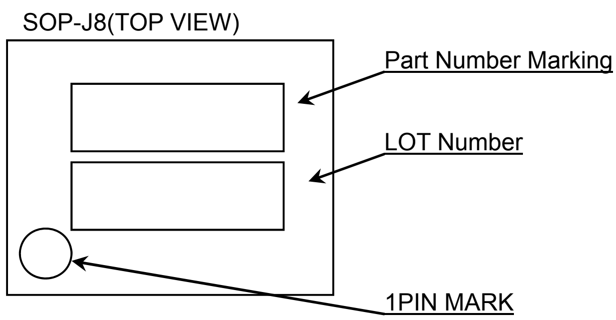
| B | V | 1 | H | D | 0 | 9 | 0 | F | J | - | CE2 |
|---|---|---|---|---|---|---|---|---|---|---|---|

Part Number

Package
FJ:SOP-J8

Packaging and forming specification
C : Automotive product
E2 : Embossed tape and reel

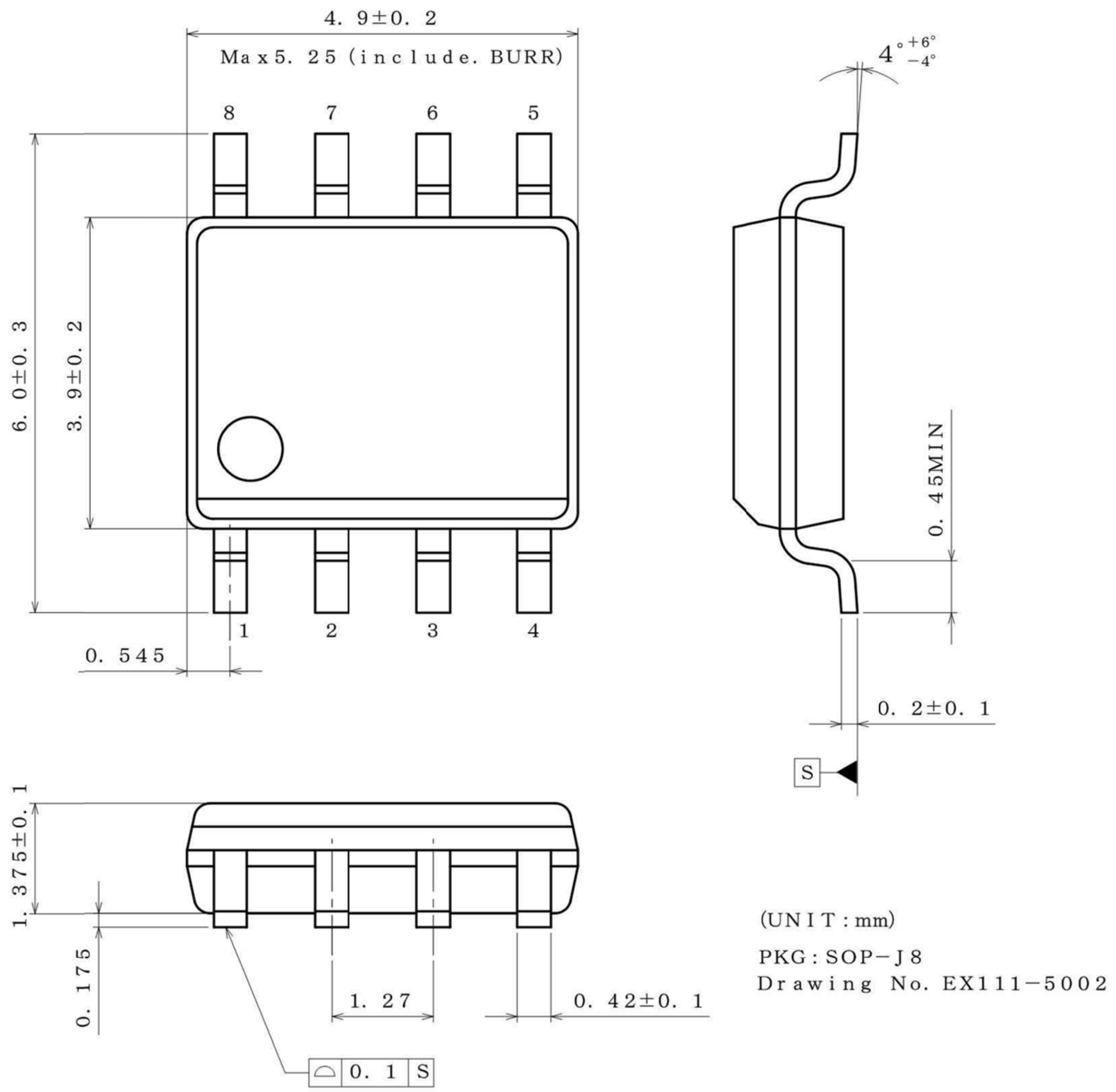
## Marking Diagrams




| Part Number Marking | Package | Orderable Part Number |
|---|---|---|
| 1HD90 | SOP-J8 | BV1HD090FJ-CE2 |

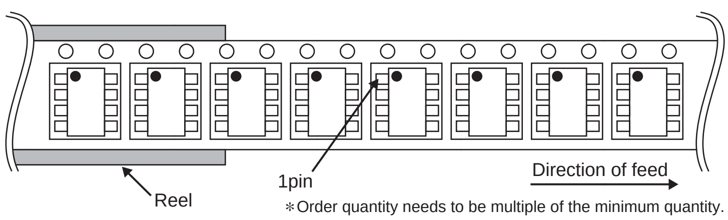
**Physical Dimension, Tape and Reel Information**

| Package Name | SOP-J8 |
|---|---|




<Tape and Reel information>

| | |
|---|---|
| Tape | Embossed carrier tape |
| Quantity | 2500pcs |
| 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 ) |




∗Order quantity needs to be multiple of the minimum quantity.

Revision History

| Date | Revision | Changes |
| --- | --- | --- |
| 27.Dec.2016 | 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 (Note 1), 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 |
|---|---|---|---|
| CLASSⅢ | CLASSⅢ | CLASSⅡb | CLASSⅢ |
| CLASSⅣ | | CLASSⅢ | |

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:
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   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

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   [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 $Cl_2$, $H_2S$, $NH_3$, $SO_2$, and $NO_2$
   [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 (even if you use no-clean type fluxes, cleaning residue of flux is recommended); 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 Cl2, H2S, NH3, SO2, and NO2
   [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.

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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.

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