Datasheet

Automotive IPD Series

1ch High Side Switch with output abnormality detection

BV1HJ180EFJ-C

General Description

BV1HJ180EFJ-C is a 1ch high side switch for automotive application. It has a built-in overcurrent limit function, thermal shutdown protection function, open load detection function, low power output-OFF function and short-to-VCC detection function. It is equipped with diagnostic output function for abnormality detection. It also operates in deep drop of supply voltage, so it can deal with cold cranking.

Features

- Cold Cranking Support
  Keeps active status of output up to 2.8 V (Max) when power supply voltage drops
- AEC-Q100 Qualified *(Note 1)*
- Built-in Overcurrent Protection Function (OCP)
- Built-in Dual TSD *(Note 2)*
- Built-in Open Load Detection Function
- Built-in Short-to-VCC Detection Function
- Built-in Under Voltage Lockout Function (UVLO)
- Built-in Diagnostic Output
- Monolithic power management IC with control unit (CMOS) and power MOSFET mounted on a single chip

(Note 1) Grade 1
(Note 2) Two type of built-in temperature protection:
Junction temperature, and Δ Tj protection that detects sudden temperature rise of the Power-MOS

Application

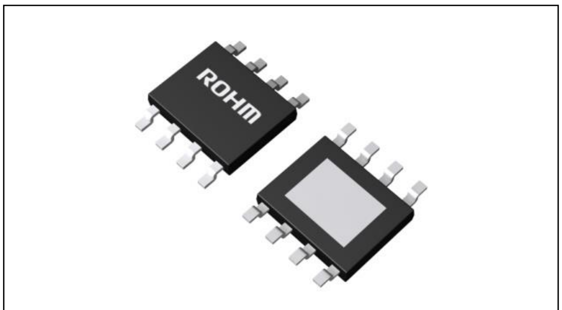
- Resistance load, inductance load and capacitance load for automotive application

Key Specifications

Power Supply Operating Range	4 V to 28 V
ON-Resistance (Tj = 25 °C)	180 mΩ (Typ)
Overcurrent Limit	2.0 A (Min)
Standby Current (Tj = 25 °C)	0.5 µA (Max)
Active Clamp Tolerance (Tj = 25 °C)	55 mJ
UVLO Detection Voltage (in supply voltage decreasing):	2.8 V (Max)

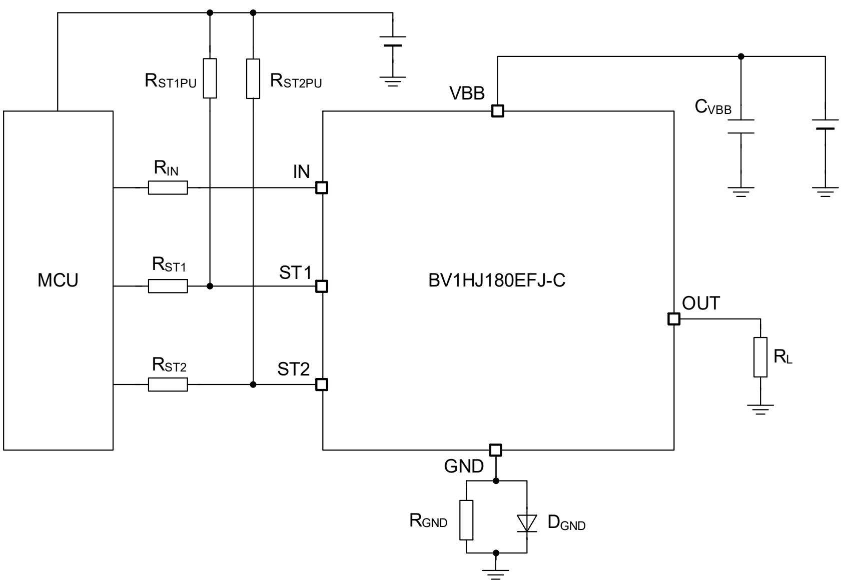
Package

Package	W (Typ) x D (Typ) x H (Max)
HTSOP-J8	4.9 mm x 6.0 mm x 1.0 mm



HTSOP-J8

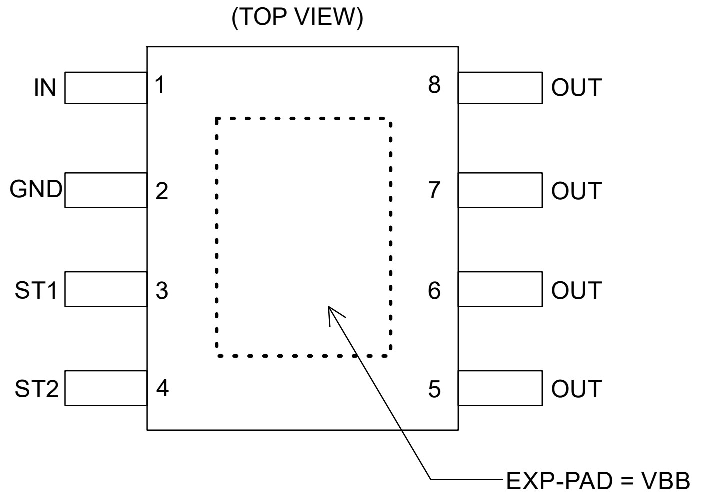
Typical Application Circuit



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

Contents

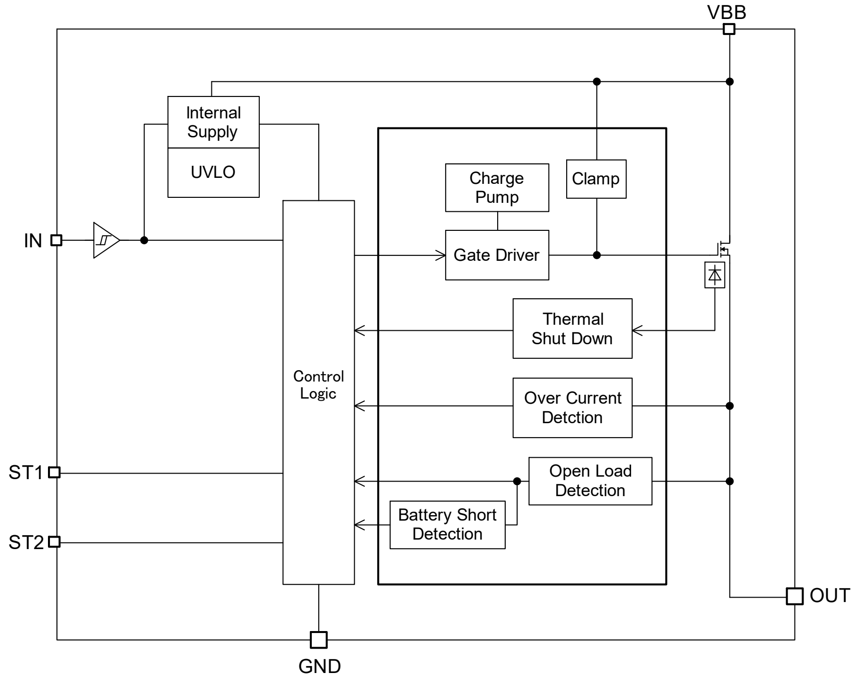
Pin Configuration



Pin Description

Pin No.	Pin Name	Function
1	IN	Input pin. Pull-down resistor is connected internally. Active High to turn on the switch.
2	GND	Ground pin
3	ST1	Self–diagnostic output pin 1
4	ST2	Self-diagnostic output pin 2
5	OUT	Switch output pin
6	OUT	Switch output pin
7	OUT	Switch output pin
8	OUT	Switch output pin
EXP-PAD	VBB	Power input pin, switch input pin

Block Diagram



Definition

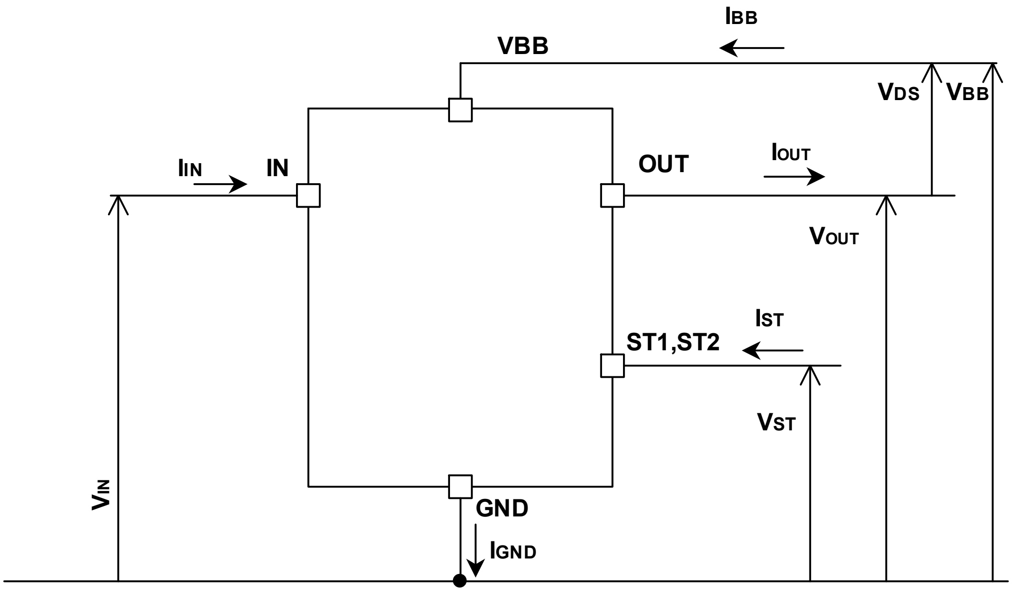


Figure 1. Voltage and Current Definition

Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
VBB - OUT Voltage	V_{DS}	-0.3 to +45	V
Power Supply Voltage	V_{BB}	-0.3 to +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}	Internal limit *(Note 1)*	A
Diagnostic Output Current	I_{ST}	10	mA
Junction Temperature Width	Tj	-40 to +150	°C
Storage Temperature Range	Tstg	-55 to +150	°C
Maximum Junction Temperature	Tjmax	+150	°C
Active Clamp Energy (Single Pulse) $Tj_{(START)}$ = 25 °C, I_{OUT} = 1 A *(Note 2)*	$E_{AS(25\ °C)}$	55	mJ
Active Clamp Energy (Single Pulse) $Tj_{(START)}$ = 150 °C, I_{OUT} = 1 A *(Note 2)*	$E_{AS(150\ °C)}$	25	mJ
Supply Voltage for Short Circuit Protection *(Note 3)*	V_{BBLIM}	28	V

(Note 1) Internally limited by over current limit.
(Note 2) Not 100 % tested.
(Note 3) Maximum power supply voltage that can detect short circuit protection.

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.*

Caution 3: *When IC turns off with an inductive load, reverse energy has to be dissipated in the BV1HJ180EFJ-C. This energy can be calculated by the following equation:*

$$E_L = \frac{1}{2} L I_{OUT(START)}{}^2 \times \left(1 - \frac{V_{BAT}}{V_{BAT} - V_{OUT(CL)}}\right)$$

Where:
L is the inductance of the inductive load.
$I_{OUT(START)}$ is the output current at the time of turning off.
$V_{OUT(CL)}$ is the output clamp voltage.

The IC integrates the active clamp function to internally absorb the reverse energy E_L which is generated when the inductive load is turned off. When the active clamp operates, the thermal shutdown function does not work. Decide a load so that the reverse energy E_L is active clamp tolerance E_{AS} (refer to Figure .2) or under when inductive load is used.

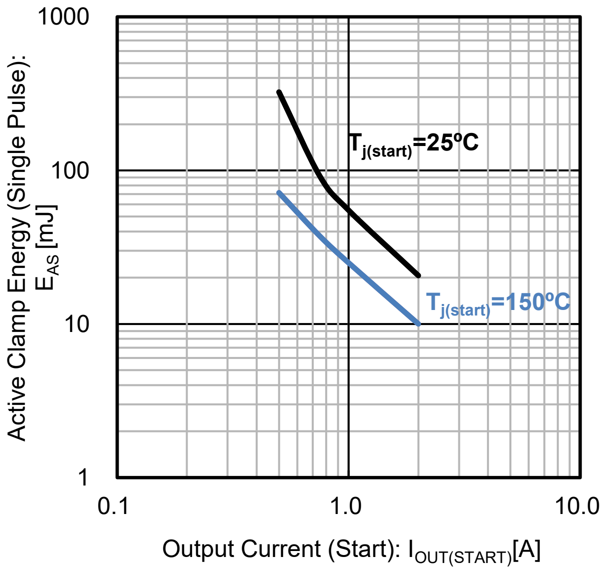


Figure 2. Active Clamp Energy (Single Pulse) vs Output Current (Start)

Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Power Supply Voltage Operating	V_{BB}	4	14	28	V
Operating Temperature	Topr	-40	-	+150	°C
Input Frequency	f_{IN}	-	-	1	kHz

Thermal Resistance*(Note 1)*

Parameter	Symbol	Typ	Unit	Condition
HTSOP-J8				
Between Junction and Surroundings Temperature Thermal Resistance	θ_{JA}	169.8	°C/W	1s *(Note 2)*
		50.7	°C/W	2s *(Note 3)*
		37.8	°C/W	2s2p *(Note 4)*

(Note 1) The thermal impedance is based on JESD51-2A (Still-Air) standard. It is used the chip of BV1HJ180EFJ-C
(Note 2) JESD51-3 standard FR4 114.3 mm x 76.2 mm x 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 x 76.2 mm x 1.60 mm 2-layers (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,
copper (top & reverse side) 2 oz.)
(Note 4) JESD51-5/- 7 standard FR4 114.3 mm x 76.2 mm x 1.60 mm 4-layers (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) 2 oz./1 oz.)

■ PCB Layout 1 layer (1s)

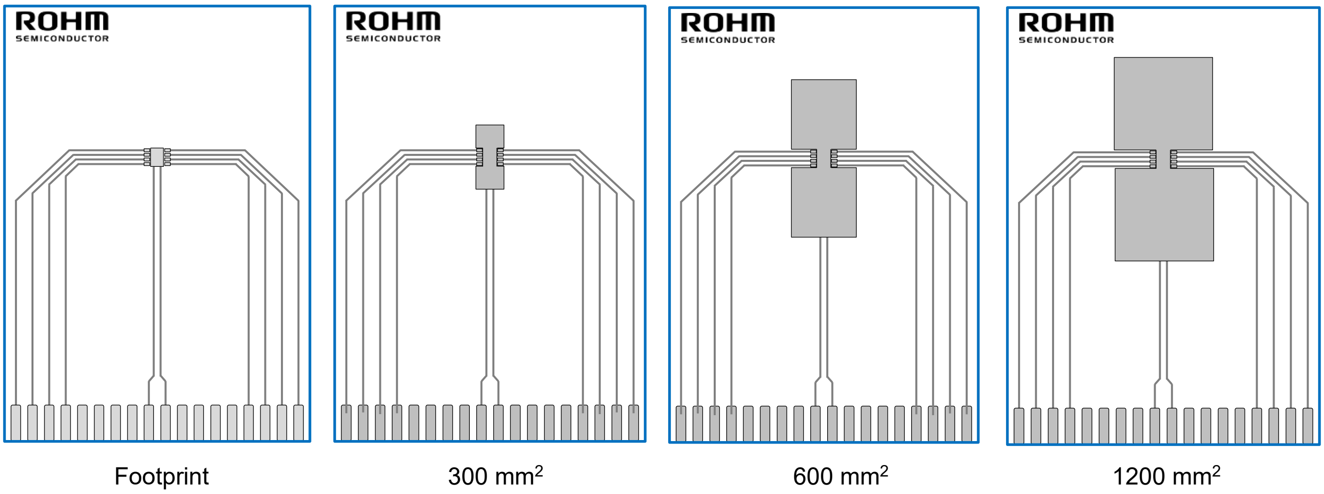


Figure 3. PCB Layout 1 Layer (1s)

Dimension	Value
Board Finish Thickness	1.57 mm ± 10 %
Board Dimension	76.2 mm x 114.3 mm
Board Material	FR4
Copper Thickness (Top Layer)	0.070 mm (Cu: 2 oz)
Copper Foil Area Dimension	Footprint/100 mm^2/600 mm^2/1200 mm^2

Thermal Resistance – continued

- PCB Layout 2 layers (2s)

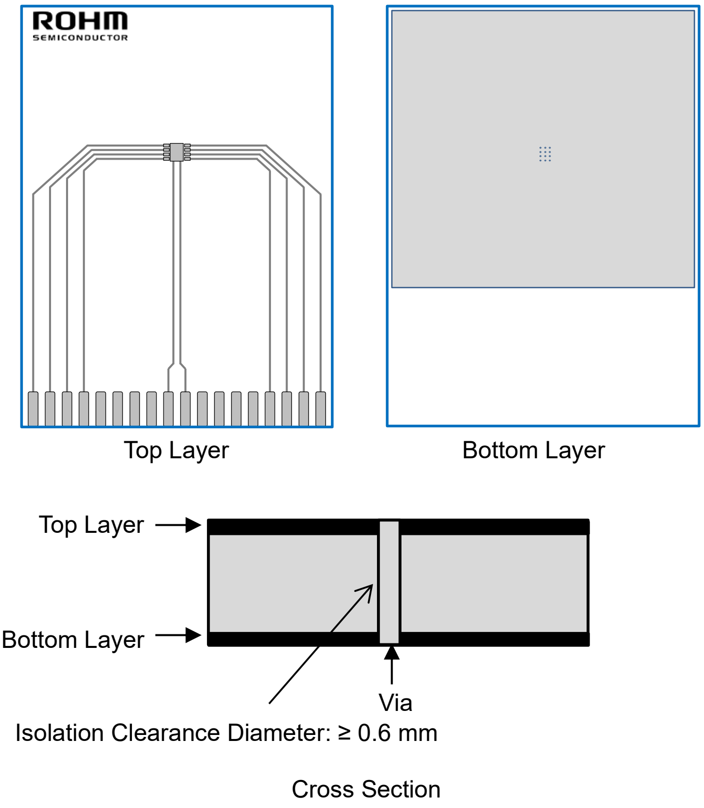
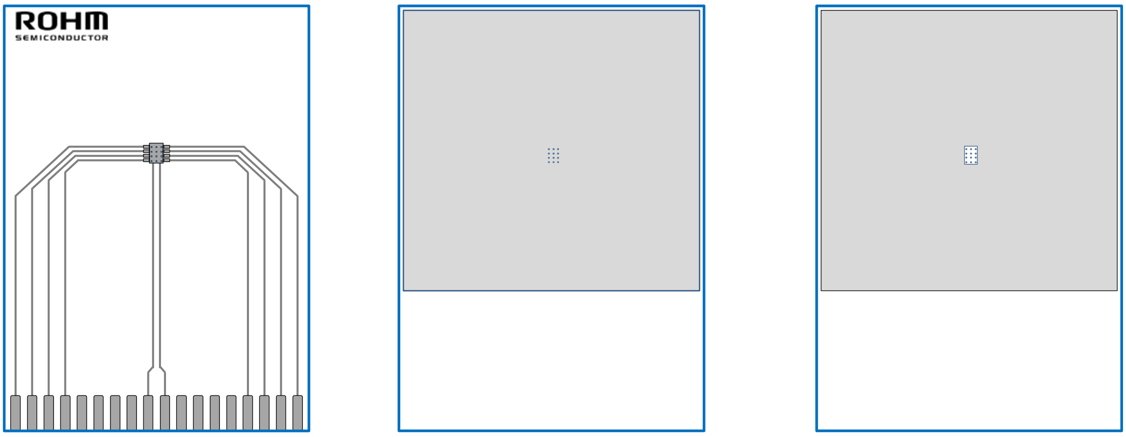


Figure 4. PCB Layout 2 Layers (2s)

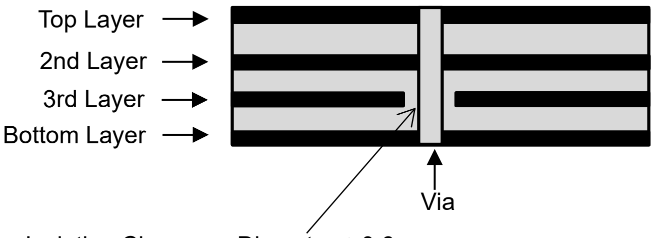
Dimension	Value
Board Finish Thickness	1.60 mm ± 10 %
Board Dimension	76.2 mm x 114.3 mm
Board Material	FR4
Copper Thickness (Top/Bottom Layers)	0.070 mm (Cu +Plating)
Thermal Vias Separation/Diameter	1.2 mm/0.3 mm

Thermal Resistance – continued

- PCB Layout 4 layers (2s2p)



TOP Layer 2nd/Bottom Layers 3rd Layer



Cross Section

Figure 5. 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)	0.070 mm (Cu +Plating)
Copper Thickness (Inner Layers)	0.035 mm
Thermal Vias Separation/Diameter	1.2 mm/0.3 mm

Thermal Resistance – continued

■ Transient Thermal Resistance (Single Pulse)

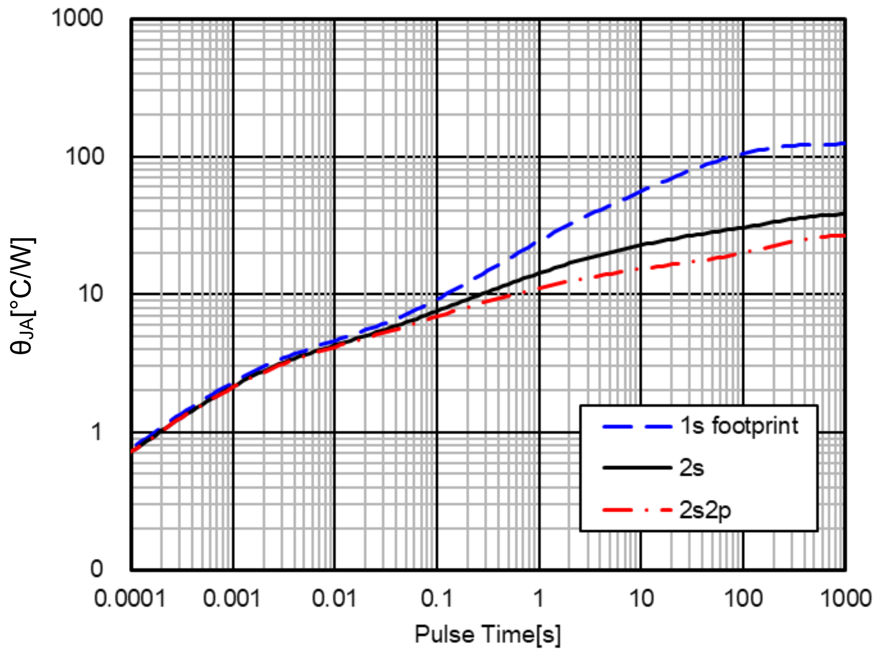


Figure 6. Transient Thermal Resistance

■ Thermal Resistance (θ_{JA} vs Copper foil area- 1s)

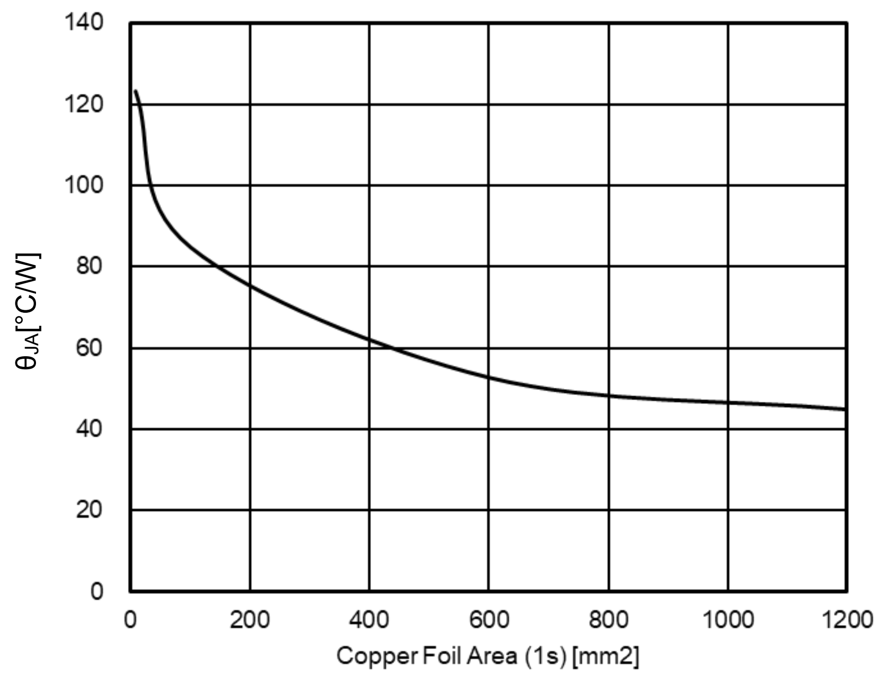


Figure 7. Thermal Resistance

Electrical Characteristics (unless otherwise specified V_{BB} = 4 V to 28 V, T_j = -40 °C to 150 °C)

Parameter	Symbol	Limit			Unit	Condition
		Min	Typ	Max		
Power Supply						
Standby current 1	I_{BBL1}	-	-	0.5	µA	V_{BB} = 14 V, V_{IN} = 0 V, V_{OUT} = 0 V, Tj = 25 °C
Standby current 2	I_{BBL2}	-	-	20	µA	V_{BB} = 14 V, V_{IN} = 0 V, V_{OUT} = 0 V, Tj = 150 °C
Operating Current	I_{BBH}	-	3.0	4.5	mA	V_{BB} = 14 V, V_{IN} = 5 V, V_{OUT} = open
UVLO Detection Voltage	V_{UVLO}	-	-	2.8	V	
UVLO Hysteresis	V_{UVHYS}	-	-	0.45	V	
Input						
High Level Input Voltage	V_{INH}	2.1	-	-	V	
Low Level Input Voltage	V_{INL}	-	-	0.9	V	
Input Hysteresis	V_{HYS}	-	0.15	-	V	
High Level Input Current	I_{INH}	-	50	150	µA	V_{IN} = 5 V
Low Level Input Current	I_{INL}	-10	-	+10	µA	V_{IN} = 0 V
Power MOS Output						
Output ON Resistance 1	R_{ON1}	-	180	240	mΩ	V_{BB} = 8 V to 28 V, Tj = 25 °C, I_{OUT} = 1 A
Output ON Resistance 2	R_{ON2}	-	-	400	mΩ	V_{BB} = 8 V to 28 V, Tj = 150 °C, I_{OUT} = 1 A
Output ON Resistance 3	R_{ON3}	-	-	300	mΩ	V_{BB} = 4 V, Tj = 25 °C, I_{OUT} = 1 A
Output ON Resistance 4	R_{ON4}	-	-	1800	mΩ	V_{BB} = 2.8 V, Tj = 150 °C, I_{OUT} = 200 mA
Output Leak Current 1	I_{OUTL1}	-	-	0.5	µA	V_{IN} = 0 V, V_{OUT} = 0 V, Tj = 25 °C
Output Leak Current 2	I_{OUTL2}	-	-	10	µA	V_{IN} = 0 V, V_{OUT} = 0 V, Tj = 150 °C
Output Slew Rate when ON	SR_{ON}	-	0.3	1.0	V/µs	V_{BB} = 14 V, R_L = 15 Ω V_{OUT} = 20 % -> 80 % of V_{BB}
Output Slew Rate when OFF	SR_{OFF}	-	0.3	1.0	V/µs	V_{BB} = 14 V, R_L = 15 Ω V_{OUT} = 80 % -> 20 % of V_{BB}
Propagation Delay when ON	t_{OUTON}	-	60	120	µs	V_{BB} = 14 V, R_L = 15 Ω
Propagation Delay when OFF	t_{OUTOFF}	-	60	120	µs	V_{BB} = 14 V, R_L = 15 Ω
Output Clamp Voltage	V_{DS}	45	50	55	V	V_{IN} = 0 V, I_{OUT} = 10 mA
Diagnostics						
Diagnostic Output L Voltage	V_{STL}	-	-	0.5	V	I_{ST} = 1 mA
Diagnostic Output Leak Current	I_{STL}	-	-	10	µA	V_{ST} = 5 V
Propagation Delay Time when Diagnostic Output is ON	t_{STON}	-	100	200	µs	V_{BB} = 14 V, R_L = 15 Ω
Propagation Delay Time when Diagnostic Output is OFF	t_{STOFF}	-	50	125	µs	V_{BB} = 14 V, R_L = 15 Ω
Protection Circuit						
Overcurrent Limit Value	I_{LIM}	2.0	3.2	4.4	A	V_{DS} > 5 V
Short-to-VBB Detection Voltage	V_{SHV}	V_{BB}-1.8	V_{BB}-1.2	V_{BB}-0.5	V	V_{BB} = 6 V to 28 V, V_{IN} = 0 V
Open Load Detection Voltage	V_{OLD}	2.0	3.0	4.0	V	V_{BB} = 6 V to 28 V, V_{IN} = 0 V
Open Load Detection Sink Current	I_{OLD}	-	8	24	µA	V_{BB} = 6 V to 28 V, V_{IN} = 0 V, V_{OUT} = 4 V
Open Load Detection Time	t_{OLD}	-	200	350	µs	V_{BB} = 6 V to 28 V, V_{IN} = 5 V to 0 V
Thermal Shutdown *(Note 1)*	T_{TSD}	150	175	200	°C	
Thermal Shutdown Hysteresis *(Note 1)*	T_{TSDHYS}	8	15	24	°C	
Operating Temperature Detection Value *(Note 1)*	T_{DTJ}	-	90	-	°C	

(Note 1) Not 100 % tested.

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

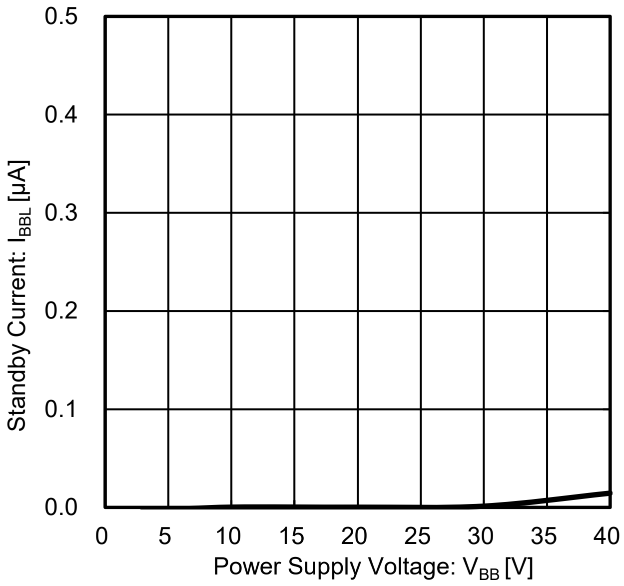


Figure 8. Standby Current vs Power Supply Voltage

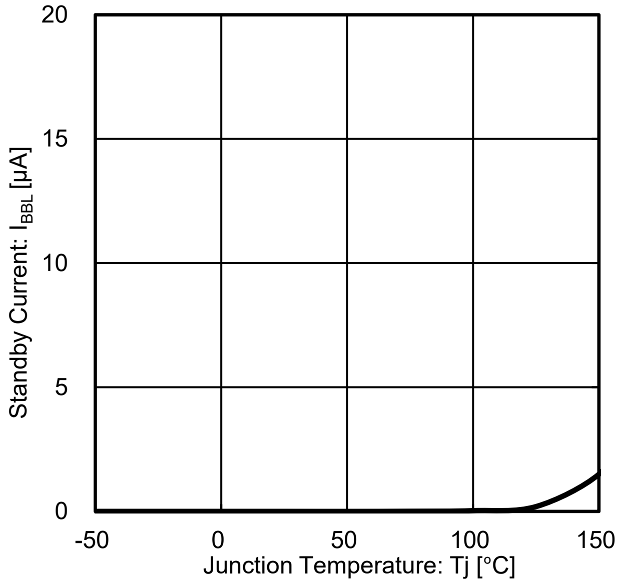


Figure 9. Standby Current vs Junction Temperature

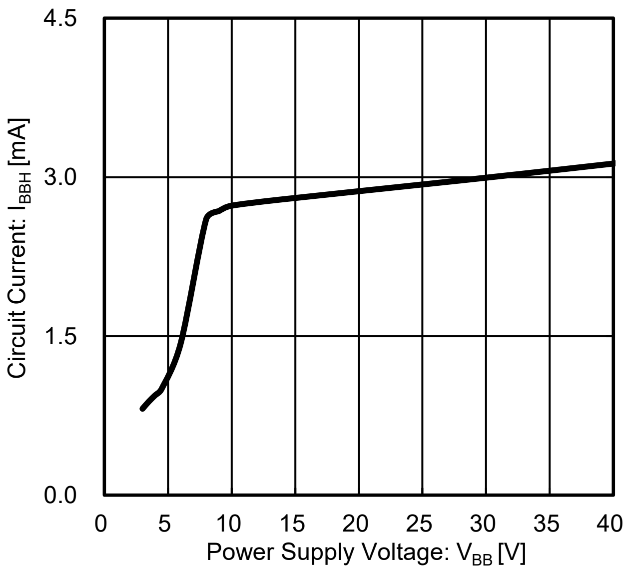


Figure 10. Circuit Current vs Power Supply Voltage

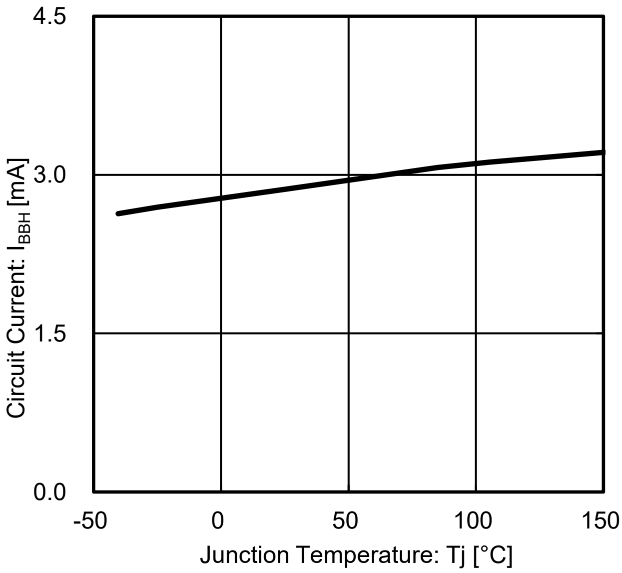


Figure 11. Circuit Current vs Junction Temperature

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

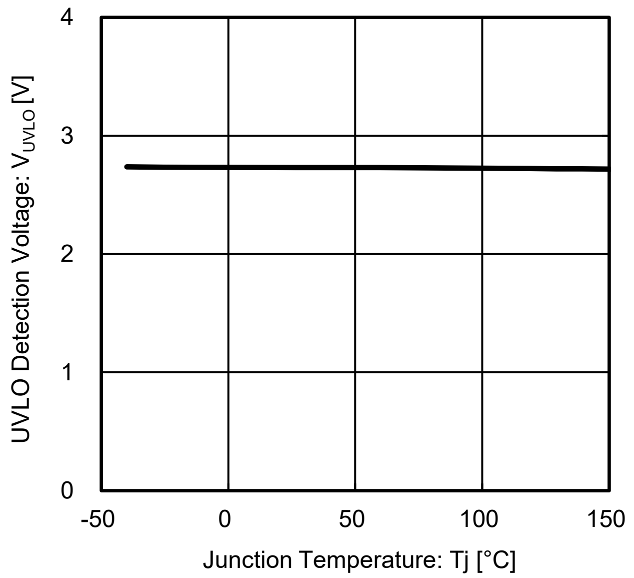


Figure 12. UVLO Detection Voltage vs Junction Temperature

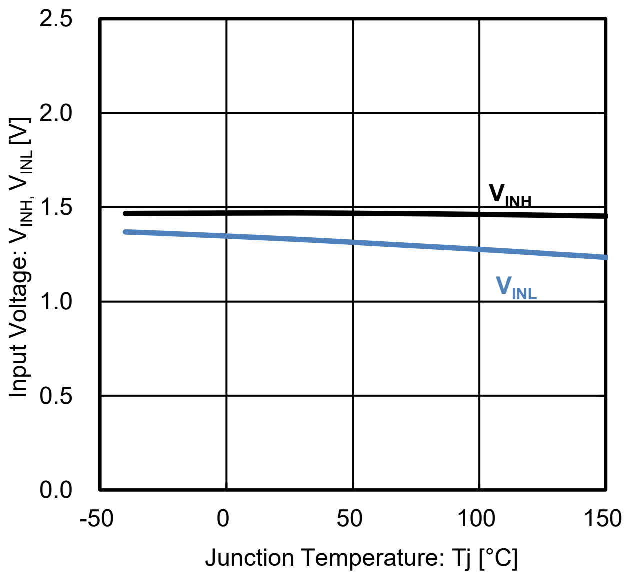


Figure 13. Input Voltage vs Junction Temperature

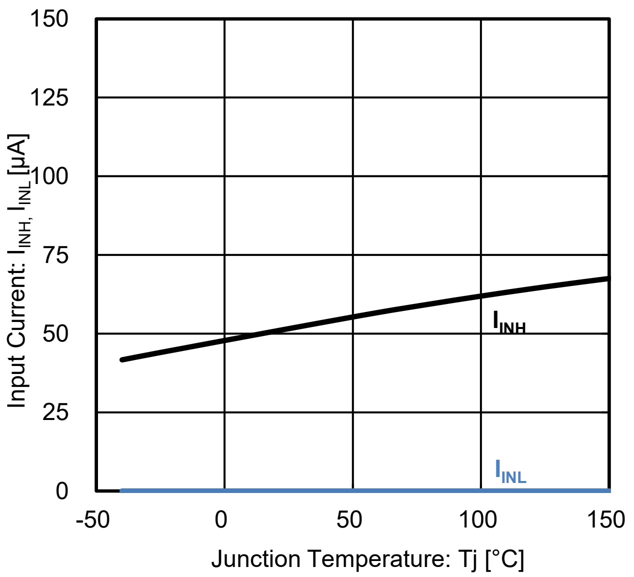


Figure 14. Input Current vs Junction Temperature

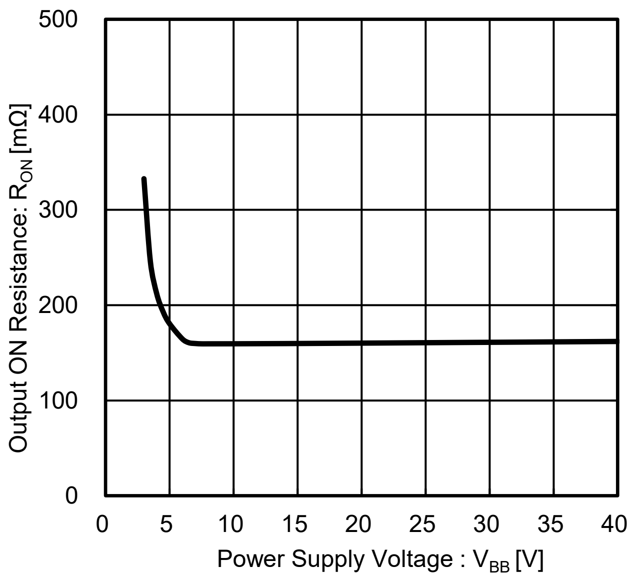


Figure 15. Output ON Resistance vs Supply Voltage

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

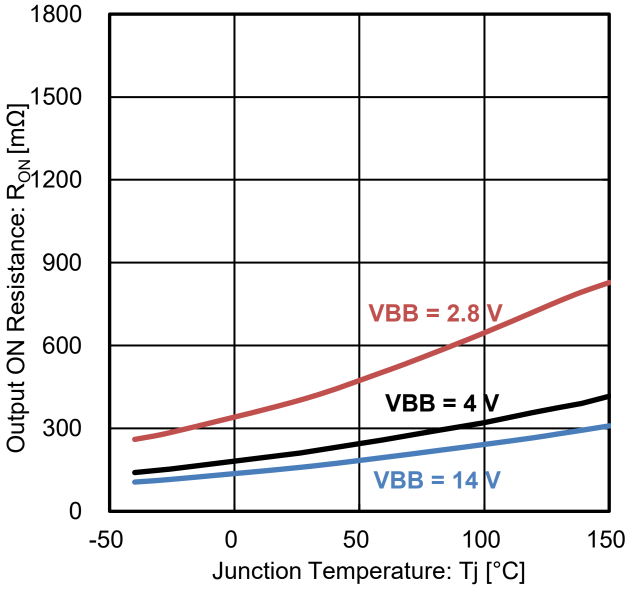


Figure 16. Output ON Resistance vs Junction Temperature

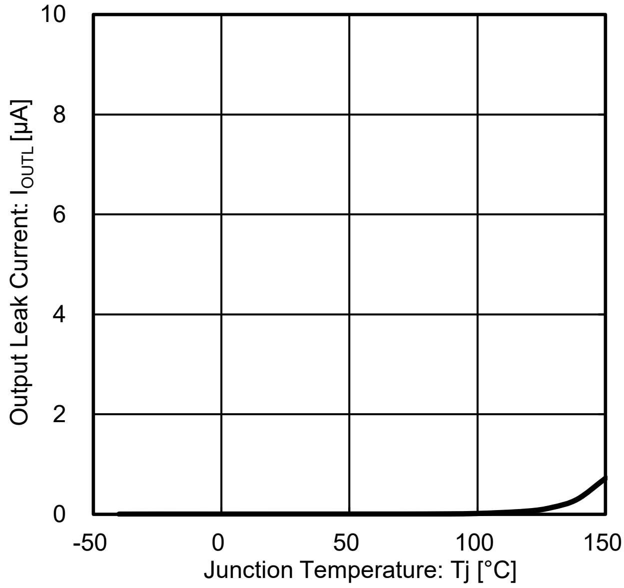


Figure 17. Output leak Current vs Junction Temperature

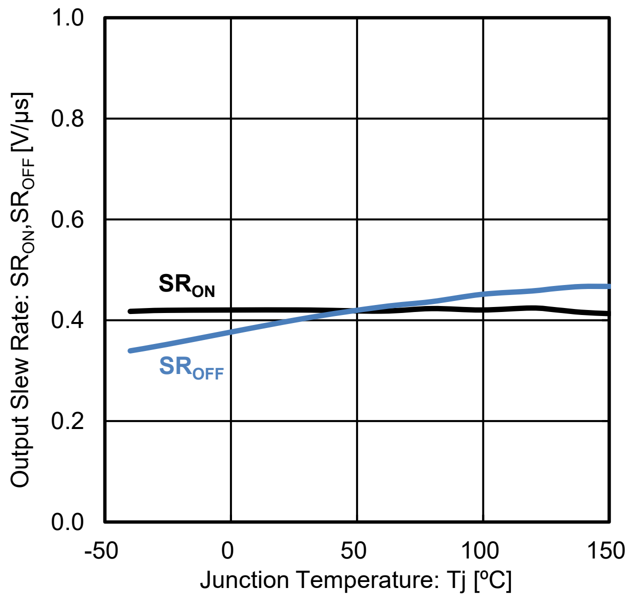


Figure 18. Output Slew Rate vs Junction Temperature

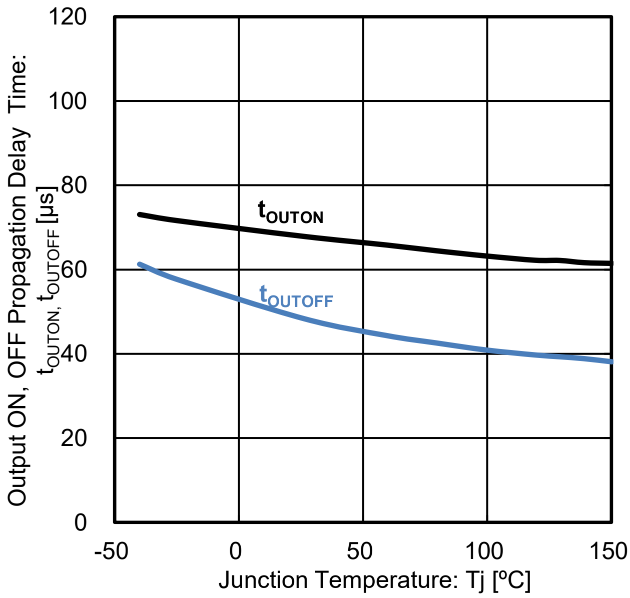


Figure 19. Output ON, OFF Propagation Delay Time vs Junction Temperature

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

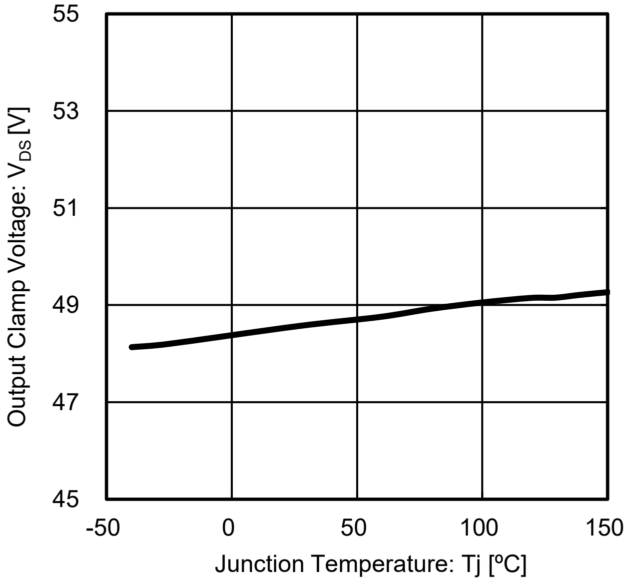


Figure 20. Output Clamp Voltage vs Junction Temperature

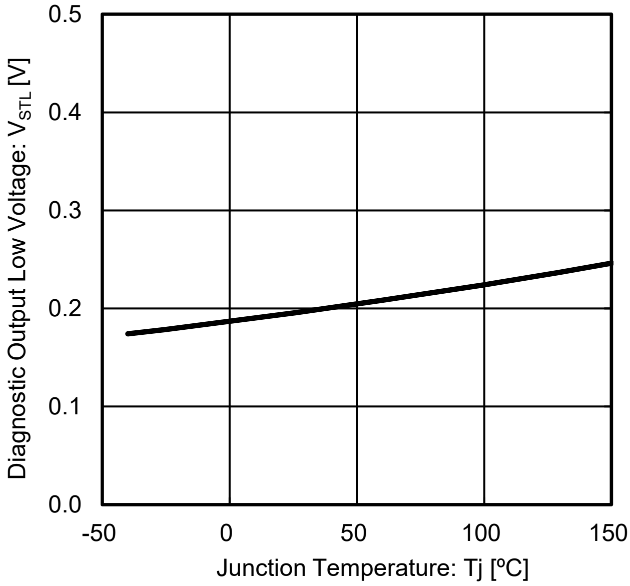


Figure 21. Diagnostic Output Low Voltage vs Junction Temperature

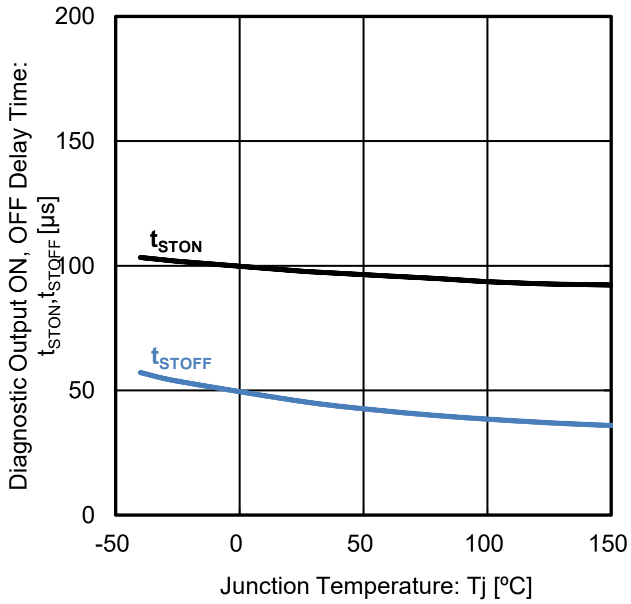


Figure 22. Diagnostic Output ON, OFF Propagation Delay Time vs Junction Temperature

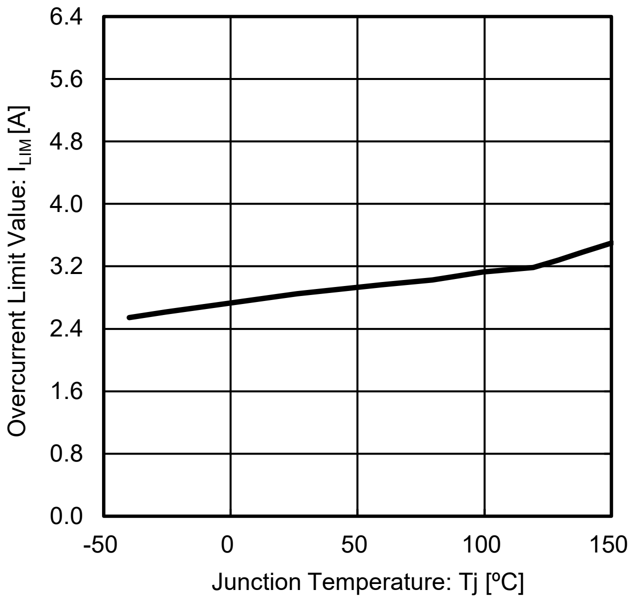


Figure 23. Overcurrent Limit Value vs Junction Temperature

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

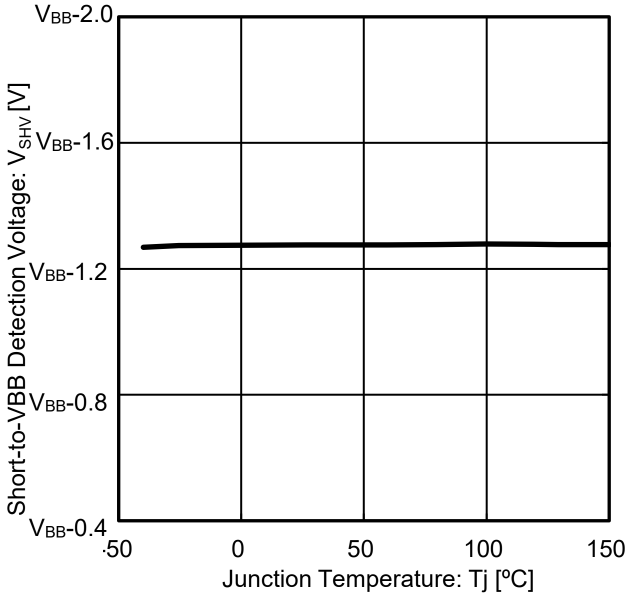


Figure 24. Short-to-VBB Detection Voltage vs Junction Temperature

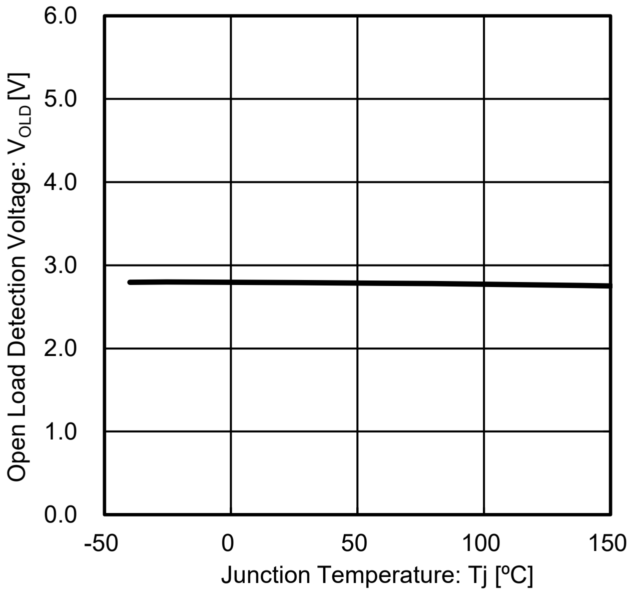


Figure 25. Open Load Detection Voltage vs Output Current

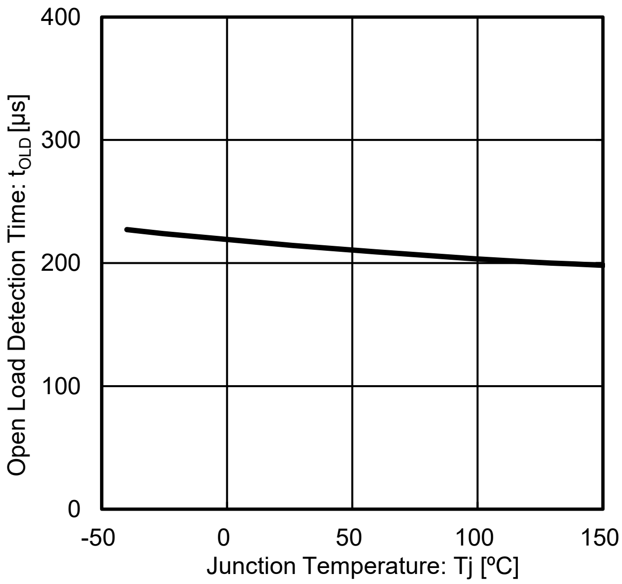


Figure 26. Open Load Detection Time vs Junction Temperature

Measurement Circuit

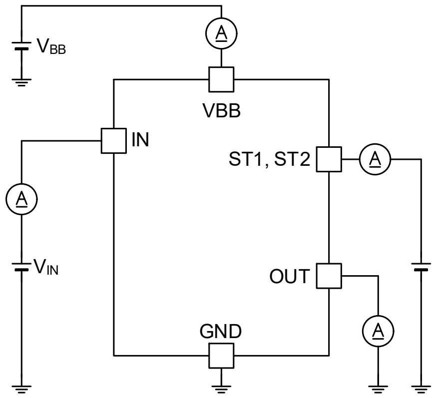


Figure 27. Standby Current 1/2
Low Level Input Current
Output Leak Current 1/2
Diagnostic Output Leak Current

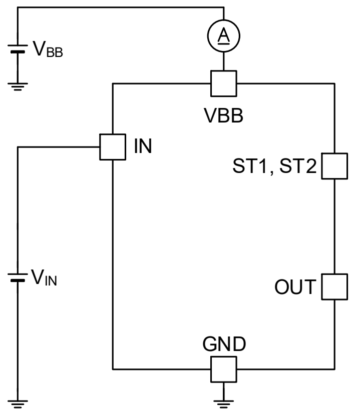


Figure 28.Operating Current

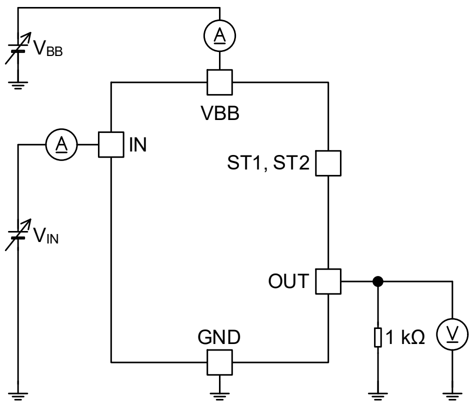


Figure 29. UVLO Detection Voltage
UVLO Hysteresis
High Level Input Voltage
Low Level Input Voltage
Input Voltage Hysteresis
High Level Input Current
Thermal Shutdown
Thermal Shutdown Hysteresis

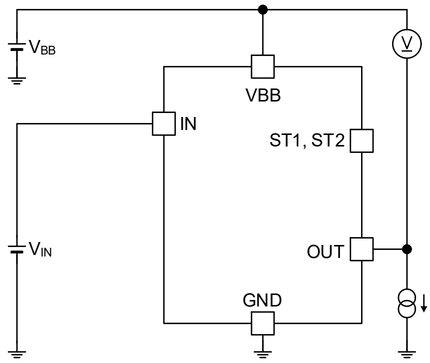


Figure 30. Output ON Resistance 1/2/3/4
Output Clamp Voltage

Measurement Circuit - continued

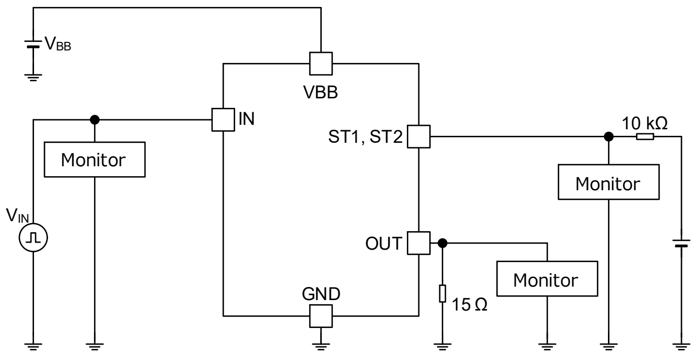


Figure 31. Output ON Slew Rate
Output OFF Slew Rate
Output ON Propagation Delay Time
Output OFF Propagation Delay Time
Diagnostic Output ON Propagation Delay Time
Diagnostic Output OFF Propagation Delay Time

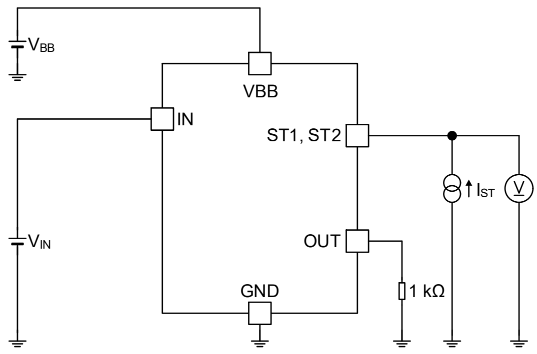


Figure 32. Diagnostic Output Low Voltage

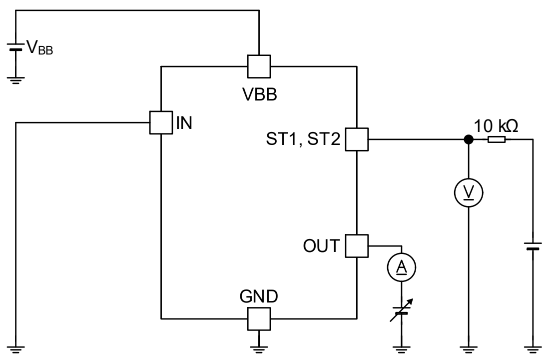


Figure 33. Overcurrent Limit
Short to VBB Detection Voltage
Open Load Detection Voltage
Open Load Detection Sink Current

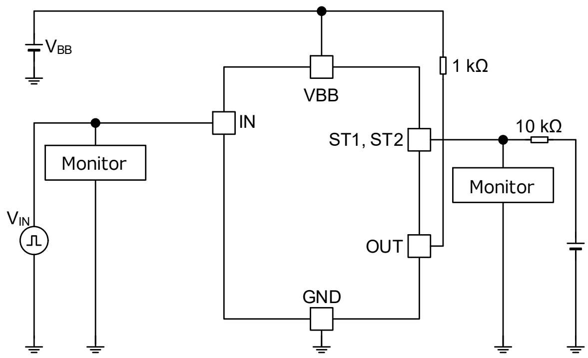


Figure 34.Diagnostic Output Low Voltage

Timing Chart

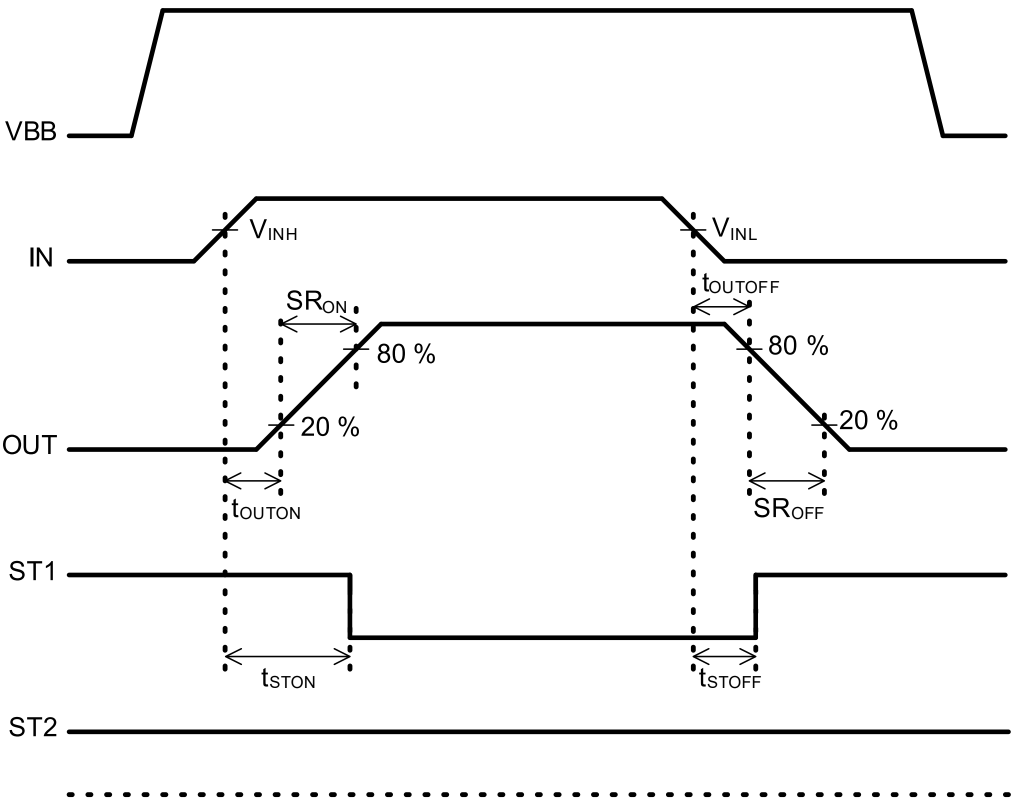


Figure 35. ON/OFF Operation Timing Chart

Function Description

1. Protection Function

Table 1. Detection and Release Conditions of Each Protection Function and Diagnostic Output

Mode		Conditions	IN	ST1	ST2
Normal Condition	Standby	-	Low	High	High
	Operating	-	High	Low	High
Open Load Detect (OLD)		Detect V_{OUT} ≥ 3.0 V (Typ)	Low	Low	High
		Release V_{OUT} ≤ 2.4 V (Typ)	Low	High	High
Short-to-VBB Detection		Detect V_{OUT} ≥ VBB - 1.2 V (Typ)	Low	Low	Low
		Release V_{OUT} ≤ VBB - 1.6 V (Typ)	Low	Low	High
Thermal Shutdown (TSD)		Detect Tj ≥ 175 °C (Typ)	High	High	High
		Release Tj ≤ 160 °C (Typ)	High	Low	High
ΔTj Protection (Note 1)		Detect ΔTj ≥ 90 °C (Typ)	High	High	High
		Release ΔTj ≤ 30 °C (Typ)	High	Low	High
Over Current Protection (OCP)		Detect I_{OUT} ≥ 3.2 A (Typ)	High	High	High
		Release I_{OUT} ≤ 3.2 A (Typ)	High	Low	High

(Note 1) Protect function by detecting Power-MOS sharp increase of temperature difference with control circuit.

This IC has a built-in abnormal detection function as mentioned above and outputs the abnormal condition with ST1 and ST2 pins.
It will automatically recover when the abnormality is resolved.

ST1 outputs the diagnostic result that detects the output voltage.
ST1 change from High to Low when OUT rise more than VBB – 1.2 V (typ) during normal operation.
And change from Low to High when detect each protection or OUT is less than VBB - 1.6 V (Typ).

ST2 is output to identify the difference between Open Load Detection and Short-to-VBB Detection during IN = Low.

Function Description - continued

2. Overcurrent Protection

This IC has a built-in overcurrent protection function. When overcurrent flows in the output, the output current is limited to 3.2 A (Typ) and self-diagnostic output (ST1) becomes High.
Figure 36 shows the timing chart during output short to GND fault.

3. Thermal Shutdown and ΔTj Protection

3.1 Thermal Shutdown Protection

This IC has a built-in thermal shutdown protection function. When the IC chip temperature exceeds175 °C (Typ), the output is turned OFF and self-diagnostic output (ST1) becomes High. When the temperature goes below 160 °C (Typ), output will self-reset and operation becomes normal.

3.2 ΔTj Protection

This IC has a built-in ΔTj protection function. When the difference (T_{DTJ}) between the temperature ($T_{POWER\text{-}MOS}$) of Power-MOS part in the IC and the temperature (T_{AMB}) of the control part is 90 °C (Typ) or more, the output is turned off.
The delta Tj protector has a built-in hysteresis that returns to normal when the temperature difference reaches 30 °C (Typ) or less (T_{DTJREL}).
Figure 36 shows the timing chart during output short to GND fault.

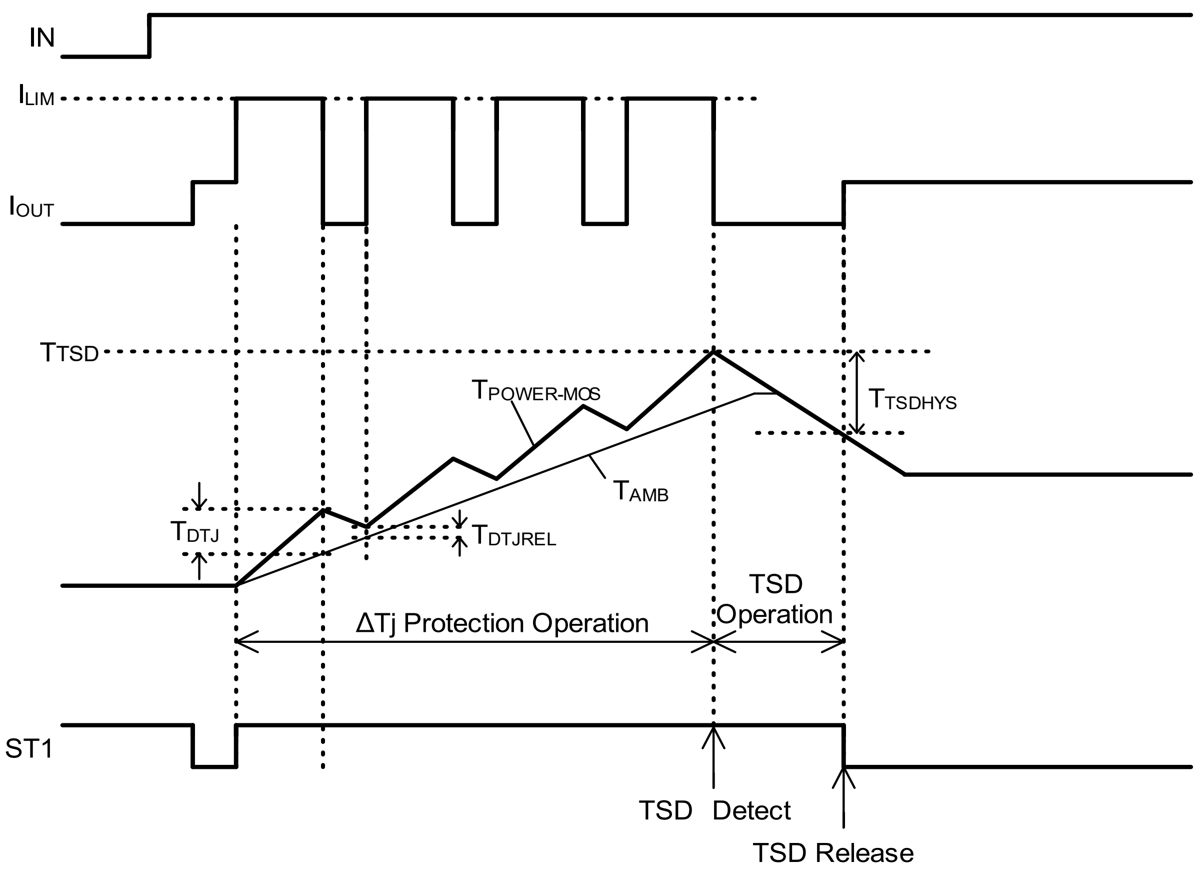


Figure 36. Timing Chart during output short to GND fault

Function Description - continued

4. Open Load Detection

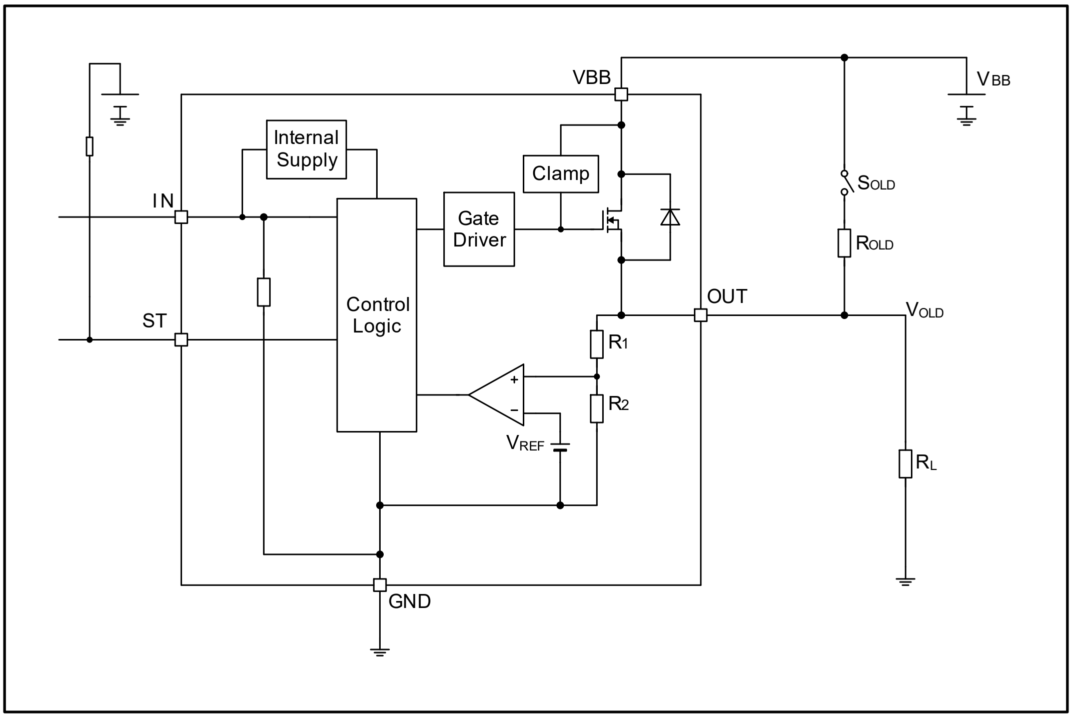


Figure 37. Open Load Detection Block Diagram

By inserting an external resistor R_{OLD} between the power supply V_{BB} and the output OUT, this IC detects a disconnection of the load when the input IN is low and self-diagnostic output (ST1) becomes Low.
When the OUT voltage is higher than the Short-to-VBB Detection Voltage V_{BB}-1.2 V (Typ), the auto-diagnostic output (ST2) becomes Low, so that the open-load and short-to-VBB can be distinguished.
An undetected period is provided to prevent false detection immediately after the output is turned off. Therefore, it is possible to judge the abnormality after the Open Load Detection Time 350 µs (Max) after switching the input IN to Low.
Similarly, immediately after the power supply (VBB) is turned on, the open-load and short-to-VBB are not detected for 350 µs (Max).
Also, note that if R_L is large enough, the open-load may be detected without lowering the output OUT even if the input IN is low.

The external resistance R_{OLD} value for detecting the open-load can be calculated from the maximum value of the Open Load Detection Voltage V_{OLD} and the minimum value of the power supply voltage V_{BB} used by the following equation.

$$R_{OLD} < \frac{V_{BB(Min)} \times (R_{1(Min)} + R_{2(Min)})}{V_{OLD(\mathrm{Max})}} - (R_{1(Min)} + R_{2(Min)}) \quad [\mathrm{k\Omega}]$$

$$R_{OLD} < V_{BB(Min)} \times 75 - 300 \quad [\mathrm{k\Omega}]$$

To distinguish between the open-load state and the short-to-VBB state, set R_{OLD} value to be greater than R_{OLD} value of the following equation and less than R_{OLD} value of the above equation, which is obtained from the maximum value of the Short-to-VBB Detection Voltage V_{SHV}.

$$R_{OLD} > \frac{V_{BB(Min)} \times (R_{1(Min)} + R_{2(Min)})}{V_{SHV(\mathrm{Max})}} - (R_{1(MIn)} + R_{2(Min)}) \quad [\mathrm{k\Omega}]$$

$$R_{OLD} > \frac{V_{BB(Min)}}{V_{SHV(\mathrm{Max})}} \times 300 - 300 \quad [\mathrm{k\Omega}]$$

Function Description - continued

5. Other Detection

5.1 GND open protection

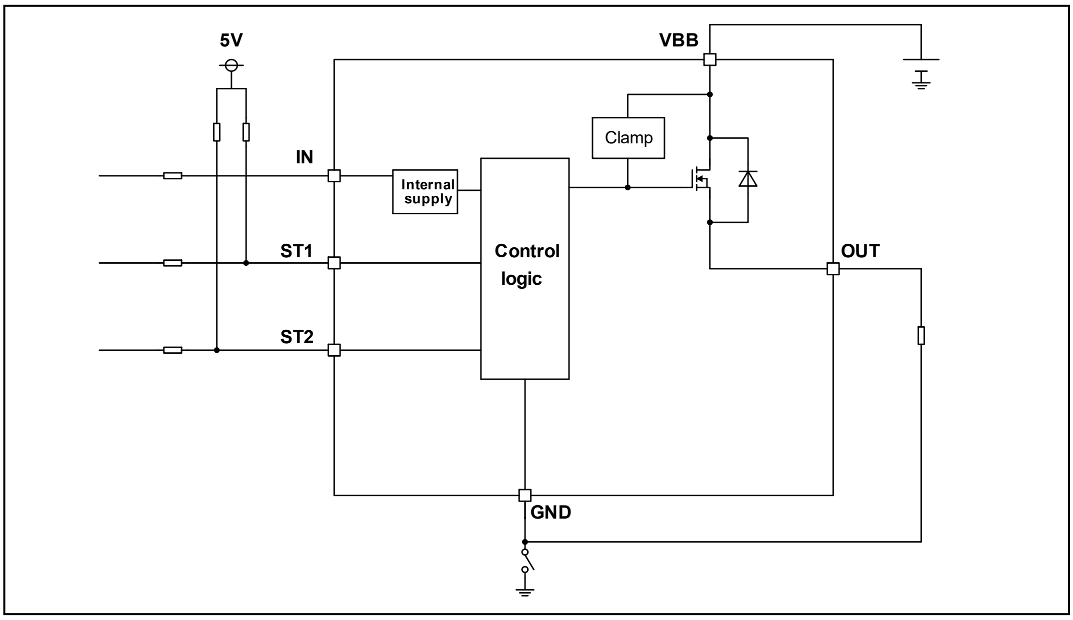


Figure 38. GND Open Detection Block Diagram

When GND of the IC is open, the output is switched OFF regardless of the input voltage. However, self-diagnostic output is not flagged. When an inductive load is connected, the active clamp operates when the GND pin is open

5.2 MCU I/O Protection

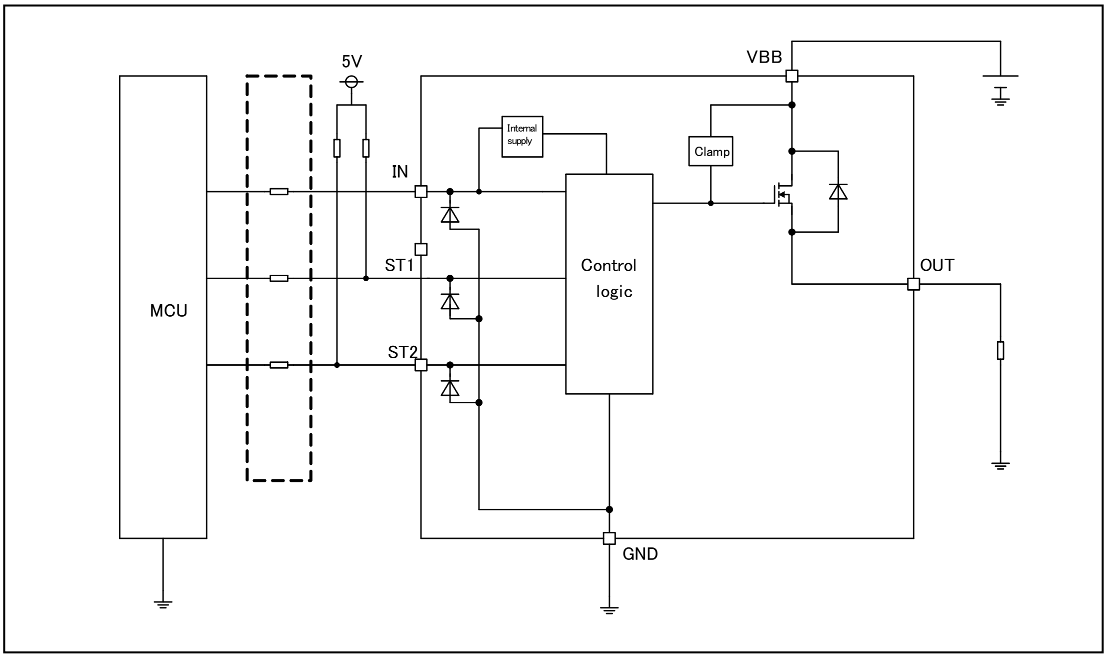


Figure 39. MCU I/O Protection

As a countermeasure to prevent damage from the surge voltage, limiting resistance is inserted in between input terminal and MCU.
Recommended input resistance range values are 4.7 kΩ to 10 kΩ.

Application Circuit Diagram

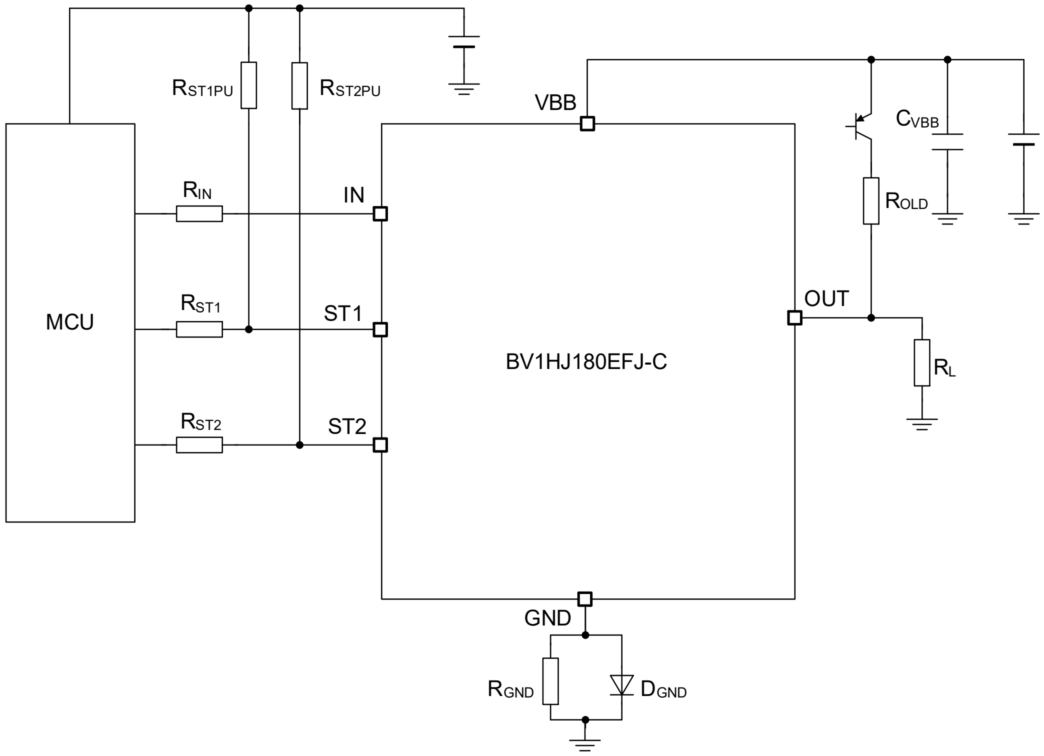
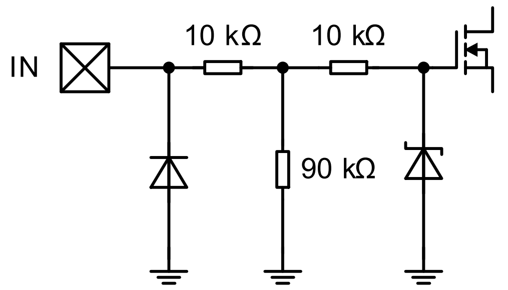
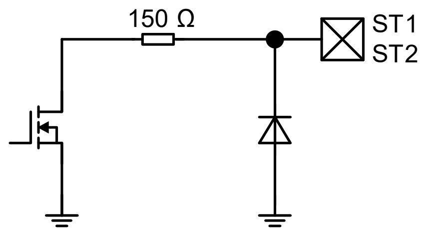
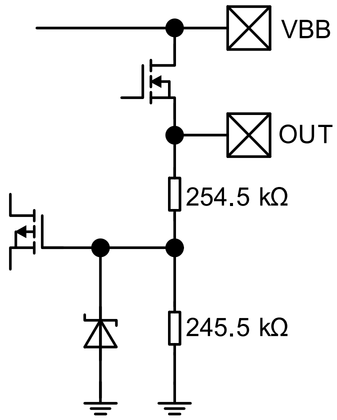


Figure 40. Application Circuit Diagram

Symbol	Value	Purpose
R_{IN}	4.7 kΩ	Limit resistance for negative surge
R_{ST1}, R_{ST2}	4.7 kΩ	Limit resistance for negative surge
R_{ST1PU}, R_{ST2PU}	10 kΩ	Pull up ST1/ST2 pin to MCU power supply, these pins are open drain output
C_{VBB}	1 µF	For battery line voltage spike filter
R_{GND}	1 kΩ	For current limit for reverse battery connection
D_{GND}	-	BV1HJ180EFJ-C protection for reverse battery connection
R_{OLD}	51 kΩ	For open load detection

I/O Equivalence Circuits

IN	ST1, ST2
	
OUT	
	

Resistance values shown in the diagrams above are typical values

Operational Notes

1. **Reverse Connection of Power Supply**
   Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply, such as mounting an external diode between the power supply and the IC's power supply pins.

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 the output and the input of which were designed to go below ground, 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.

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 specially 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. **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.

11. **Thermal Shutdown Circuit (TSD)**
    This IC has a built-in thermal shutdown function that prevents heat damage to the IC. Normal operation should always be within the IC's maximum junction temperature rating. If by any chance the rating is exceeded for a continued period, the junction temperature (Tj) will rise which will activate the TSD function that will turn OFF power output pins. When the Tj falls below the TSD threshold, the circuits are automatically restored to normal operation. Note that the TSD function operates in a situation that exceeds the absolute maximum ratings and therefore, under no circumstances, should the TSD function be used in a set design or for any purpose other than protecting the IC from heat damage.

Operational Notes – continued

12. **Over Current Protection Function (OCP)**
This IC incorporates an integrated overcurrent protection function that is activated when the load is shorted. This protection function 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 function.

13. **Active Clamp Operation**
The IC integrates the active clamp function to internally absorb the reverse energy E_L which is generated when the inductive load is turned off. When the active clamp operates, the thermal shutdown function does not work. Decide a load so that the reverse energy E_L is active clamp tolerance E_{AS} (refer to Figure 2. Active Clamp Energy (Single Pulse) vs Output Current (Start)) or under when inductive load is used.

14. **OPEN Power Supply Pin**
When power supply pin (VBB) becomes open at ON (IN = High), the output is switched to OFF regardless of input voltage. If an inductive load is connected, the active clamp operates when VBB is OPEN and becomes the same potential as that on the ground. At this time, the output voltage drops down to -50 V (Typ).

15. **OPEN GND Pin**
When GND pin becomes open at ON (IN = High), the output is switched to OFF regardless of the input voltage. If an inductive load is connected, the active clamp operates when GND pin is open.

16. **OUT Pin Voltage**
Ensure that keep OUT pin voltage less than (VBB + 0.3 V) at any time, even during transient condition.
Otherwise malfunction or other problems can occur.

Ordering Information

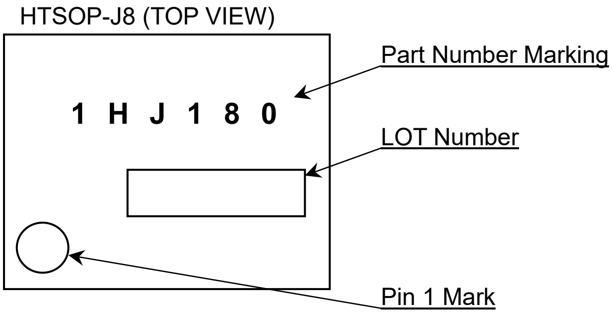
B V 1 H J 1 8 0 E F J - CE 2

- V1: 1ch
- H: High side switch

Package
EFJ: HTSOP-J8

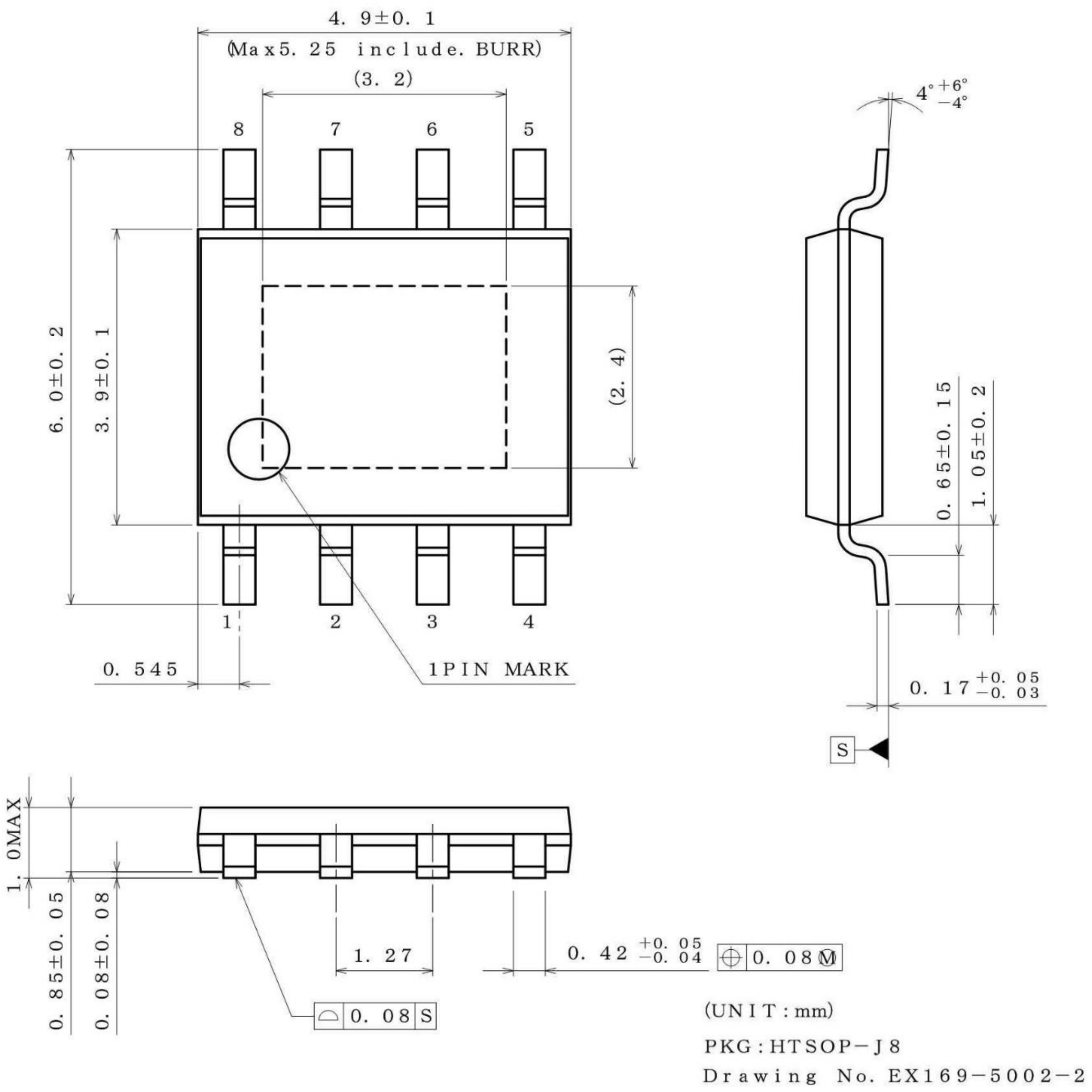
Product Rank
C: Automotive product Packaging and Forming Specification
E2: Embossed tape and reel

Marking Diagram



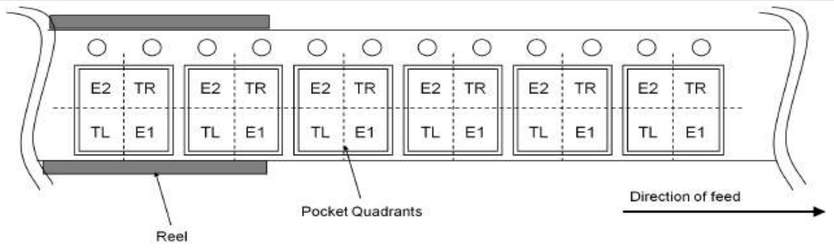
Physical Dimension and Packing Information

Package Name	HTSOP-J8



< Tape and Reel Information >

Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 The direction is the pin 1 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



Revision History

Date	Revision	Changes
14.Jul.2021	001	New Release
08.Oct.2021	002	P.10 Electrical Characteristics Limit of Open Load Detection Time is changed. Limit of Thermal Shutdown Hysteresis is changed. P.21 Function Description Value of Open Load Detection Time is changed.

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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 (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

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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.

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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_2, H_2S, NH_3, SO_2, and NO_2
   [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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