

# 1 Channel Compact High Side Switch ICs

## 1ch Adjustable Current Limit High Side Switch ICs

BD2222G BD2242G BD2243G

### Description

BD2222G, BD2242G and BD2243G are low on-resistance N-channel MOSFET high-side power switches, optimized for Universal Serial Bus (USB) applications. These devices are equipped with the function of over-current detection, thermal shutdown, under-voltage lockout and soft-start. Moreover, the range of Current limit threshold can be adjusted from 0.2A to 1.7A by changing the external resistance.

### Features

- Adjustable Current Limit Threshold: 200mA to 1.7A
- Low On-Resistance (Typ 89mΩ) N-channel MOSFET Built-in
- Soft-Start Circuit
- Output Discharge Function
  - BD2242G, BD2243G
- Open-Drain Fault Flag Output
- Thermal Shutdown
- Under-Voltage Lockout
- Reverse Current Protection when Power Switch Off
- Control Input Logic Active-High
  - Active-High: BD2222G, BD2242G
  - Active-Low: BD2243G

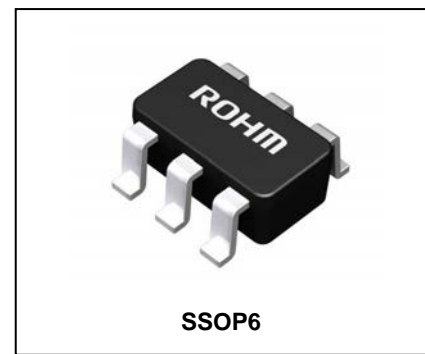
### Key Specifications

- Input Voltage Range: 2.8V to 5.5V
- On Resistance: (IN=5V) 89mΩ(Typ)
- Current Limit Threshold: 0.2A to 1.7A adjustable
- Standby Current: 0.01μA (Typ)
- Operating Temperature Range: -40°C to +85°C

### Package

SSOP6

W(Typ) D(Typ) H (Max)  
2.90mm x 2.80mm x 1.25mm



### Applications

USB hub in consumer appliances, PC, PC peripheral equipment and so forth

### Typical Application Circuit

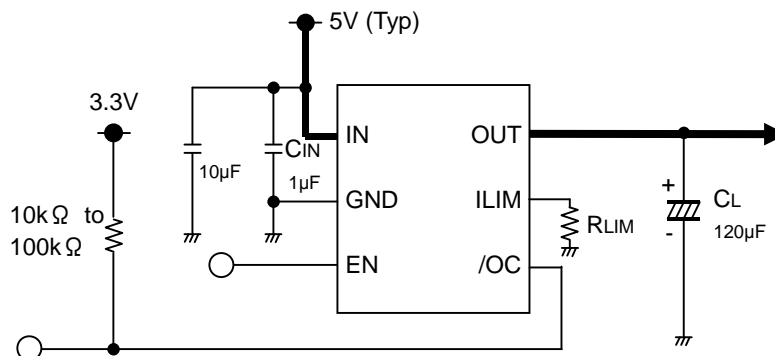


Figure 1. Typical Application Circuit

### Lineup

| Output Load Current | Adjustable Current Limit Threshold | Channel | Control input logic | Output Discharge function | Package |              | Orderable Part Number |
|---------------------|------------------------------------|---------|---------------------|---------------------------|---------|--------------|-----------------------|
|                     |                                    |         |                     |                           |         |              |                       |
| Max                 |                                    |         |                     |                           |         |              |                       |
| 1.5A                | 200mA to 1.7A                      | 1ch     | High                | No                        | SSOP6   | Reel of 3000 | BD2222G – GTR         |
| 1.5A                | 200mA to 1.7A                      | 1ch     | High                | Yes                       | SSOP6   | Reel of 3000 | BD2242G – GTR         |
| 1.5A                | 200mA to 1.7A                      | 1ch     | Low                 | Yes                       | SSOP6   | Reel of 3000 | BD2243G – GTR         |

Block Diagram

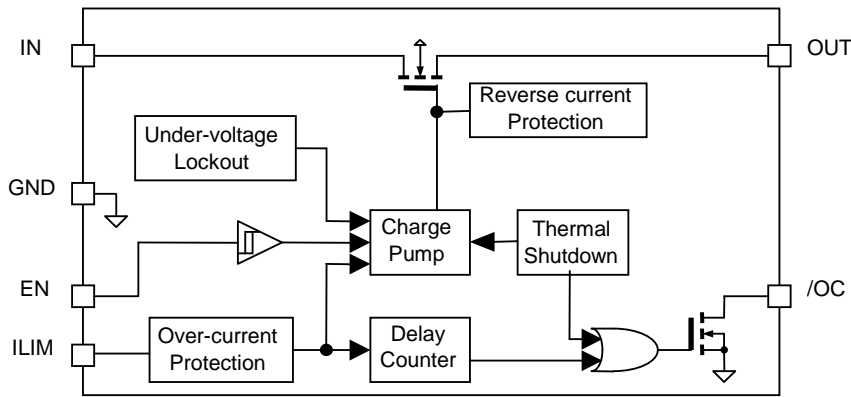


Figure 2. Block Diagram (BD2222G)

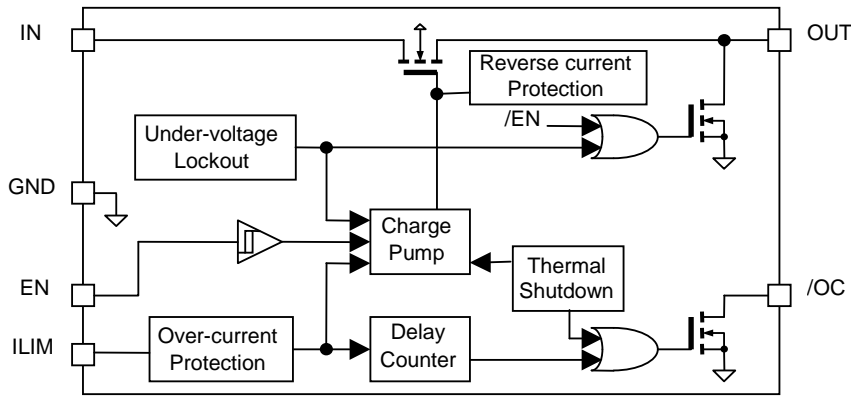


Figure 3. Block Diagram (BD2242G, BD2243G)

Pin Configuration

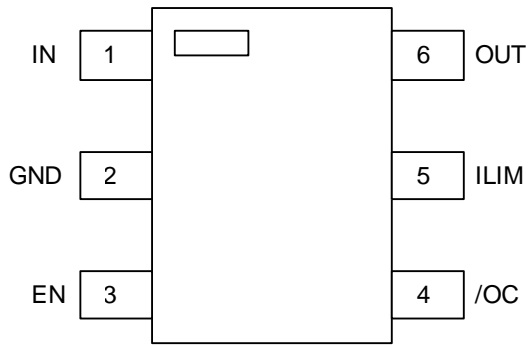


Figure 4. Pin Configuration (TOP VIEW)

Pin Descriptions

| Pin No. | Symbol | I/O | Function  |
|---------|--------|-----|---|
| 1       | IN     | I   | Switch input and the supply voltage for the IC.   |
| 2       | GND    | -   | Ground.   |
| 3       | EN     | I   | Enable input.<br>High-level input turns on the switch (BD2222G, BD2242G)<br>Low-level input turns on the switch (BD2243G)   |
| 4       | /OC    | O   | Over-current notification terminal.<br>Low level output during over-current or over-temperature condition.<br>Open-drain fault flag output.                       |
| 5       | ILIM   | O   | Current limit threshold set Pin. External resistor used to set Current limit threshold. Recommended $11.97\text{ k}\Omega \leq R_{LIM} \leq 106.3\text{ k}\Omega$ |
| 6       | OUT    | O   | Power switch output.  |

## Absolute Maximum Ratings(Ta=25°C)

| Parameter                 | Symbol            | Rating       | Unit |
|---------------------------|-------------------|--------------|------|
| IN Supply Voltage         | V <sub>IN</sub>   | -0.3 to +7.0 | V    |
| EN Input Voltage          | V <sub>EN</sub>   | -0.3 to +7.0 | V    |
| ILIM Voltage              | V <sub>ILIM</sub> | -0.3 to +7.0 | V    |
| ILIM Source Current       | I <sub>ILIM</sub> | 1            | mA   |
| /OC Voltage               | V <sub>/OC</sub>  | -0.3 to +7.0 | V    |
| /OC Sink Current          | I <sub>/OC</sub>  | 10           | mA   |
| OUT Voltage               | V <sub>OUT</sub>  | -0.3 to +7.0 | V    |
| Storage Temperature       | T <sub>stg</sub>  | -55 to +150  | °C   |
| Power Dissipation (Note1) | P <sub>d</sub>    | 0.67         | W    |

(Note 1) Mounted on 70mm x 70mm x 1.6mm glass epoxy board. Reduce 5.4mW per 1°C above 25°C

**Caution:** Operating the IC over the absolute maximum ratings may damage the IC. In addition, it is impossible to predict all destructive situations such as short-circuit modes, open circuit modes, etc. Therefore, it is important to consider circuit protection measures, like adding a fuse, in case the IC is operated in a special mode exceeding the absolute maximum ratings.

## Recommended Operating Conditions

| Parameter             | Symbol           | Rating |     |     | Unit |
|-----------------------|------------------|--------|-----|-----|------|
|                       |                  | Min    | Typ | Max |      |
| IN Operating Voltage  | V <sub>IN</sub>  | 2.8    | 5.0 | 5.5 | V    |
| Operating Temperature | T <sub>OPR</sub> | -40    | -   | +85 | °C   |

Electrical Characteristics (V<sub>IN</sub> = 5V, R<sub>LIM</sub> = 20kΩ, Ta = 25°C, unless otherwise specified.)

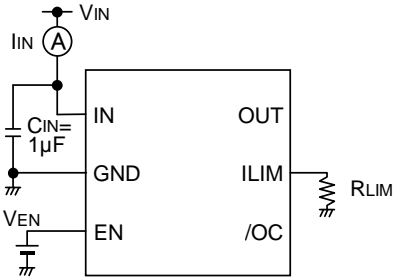
## DC Characteristics

| Parameter                   | Symbol            | Limit |      |      | Unit | Conditions  |
|-----------------------------|-------------------|-------|------|------|------|---|
|                             |                   | Min   | Typ  | Max  |      |   |
| Operating Current           | I <sub>DD</sub>   | -     | 120  | 168  | μA   | V <sub>EN</sub> = 5V, V <sub>OUT</sub> = open,<br>(BD2222G, BD2242G)<br>V <sub>EN</sub> = 0V, V <sub>OUT</sub> = open,<br>(BD2243G) |
| Standby Current             | I <sub>STB</sub>  | -     | 0.01 | 5    | μA   | V <sub>EN</sub> = 0V, V <sub>OUT</sub> = open,<br>(BD2222G, BD2242G)<br>V <sub>EN</sub> = 5V, V <sub>OUT</sub> = open,<br>(BD2243G) |
| EN Input Voltage            | V <sub>ENH</sub>  | 2.0   | -    | -    | V    | High input  |
|                             | V <sub>ENL</sub>  | -     | -    | 0.8  | V    | Low input   |
| EN Input Leakage            | I <sub>EN</sub>   | -1    | 0.01 | 1    | μA   | V <sub>EN</sub> = 0V or 5V  |
| On-Resistance               | R <sub>ON</sub>   | -     | 89   | 120  | mΩ   | I <sub>OUT</sub> = 500mA  |
| Reverse Leak Current        | I <sub>REV</sub>  | -     | -    | 1    | μA   | V <sub>OUT</sub> = 5V, V <sub>IN</sub> = 0V   |
| Current Limit Threshold     | I <sub>TH</sub>   | 112   | 212  | 313  | mA   | R <sub>LIM</sub> = 100kΩ  |
|                             |                   | 911   | 1028 | 1145 |      | R <sub>LIM</sub> = 20kΩ   |
|                             |                   | 1566  | 1696 | 1826 |      | R <sub>LIM</sub> = 12kΩ   |
| Output Discharge Resistance | R <sub>DISC</sub> | 30    | 60   | 120  | Ω    | I <sub>OUT</sub> = -1mA, V <sub>EN</sub> = 0V (BD2242G)<br>I <sub>OUT</sub> = -1mA, V <sub>EN</sub> = 5V (BD2243G)                  |
| /OC Output Low Voltage      | V <sub>/OC</sub>  | -     | -    | 0.4  | V    | I <sub>/OC</sub> = -1mA   |
| UVLO Threshold              | V <sub>TUVH</sub> | 2.35  | 2.55 | 2.75 | V    | V <sub>IN</sub> increasing  |
|                             | V <sub>TUVL</sub> | 2.30  | 2.50 | 2.70 | V    | V <sub>IN</sub> decreasing  |

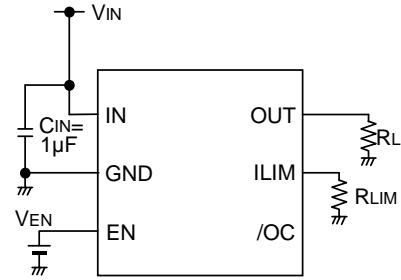
AC Characteristics

| Parameter            | Symbol     | Limits |     |     | Unit    | Conditions        |
|----------------------|------------|--------|-----|-----|---------|-------------------|
|                      |            | Min    | Typ | Max |         |                   |
| Output rise Time     | $t_{ON1}$  | -      | 0.6 | 6   | ms      | $R_L = 100\Omega$ |
| Output Turn-On Time  | $t_{ON2}$  | -      | 1   | 10  | ms      |                   |
| Output Fall Time     | $t_{OFF1}$ | -      | 1.8 | 20  | $\mu s$ |                   |
| Output Turn-Off Time | $t_{OFF2}$ | -      | 3.2 | 40  | $\mu s$ |                   |
| /OC Delay Time       | $t_{/OC}$  | 4      | 7   | 12  | ms      |                   |

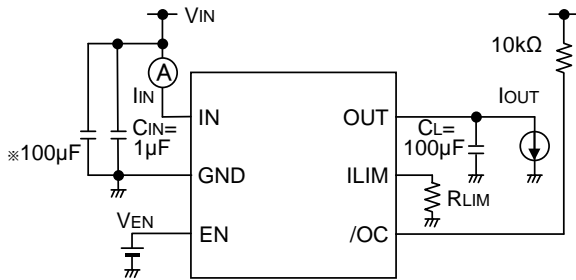
Measurement Circuit



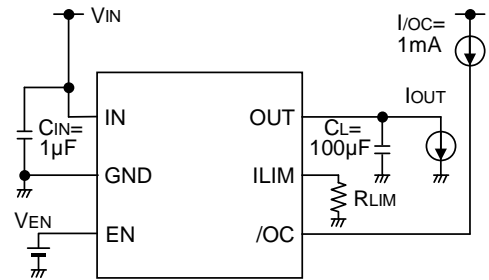
A. Operating Current, Standby Current



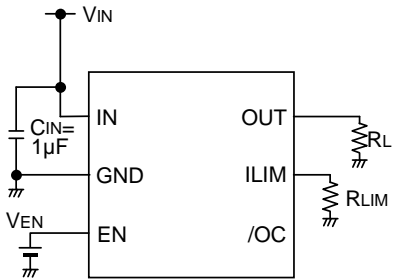
B. EN Input Voltage, Output Rise/Fall Time  
Output Turn-On/ Turn-Off Time



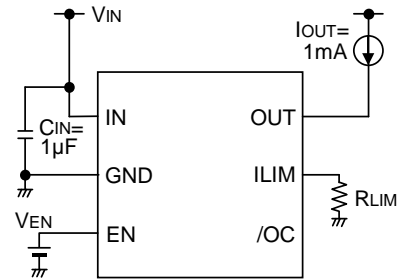
C. On-Resistance, Current Limit Threshold, /OC Delay Time  
※Use capacitance more than 100µF at output short circuit test by using external power supply.



D. /OC Output Low Voltage



E. UVLO Threshold



F. Output Discharge Resistance

Figure 5. Measurement Circuit

Timing Diagram

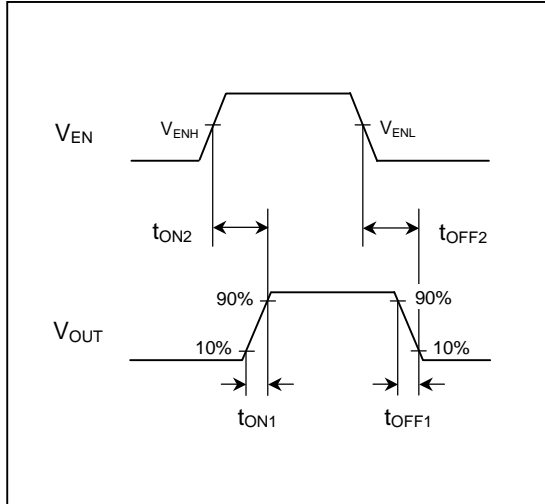


Figure 6. Output Rise/Fall Time (BD2222G, BD2242G)

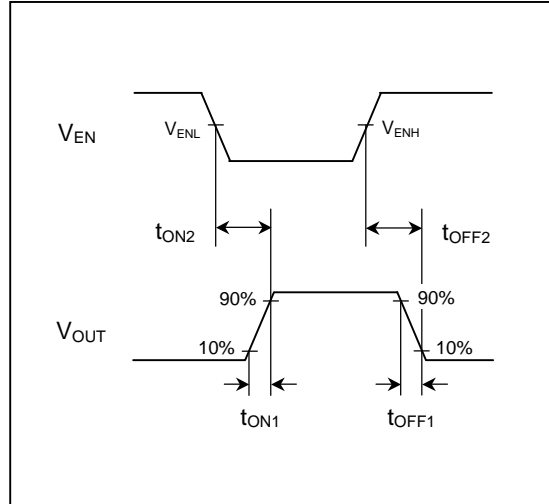


Figure 7. Output Rise/Fall Time (BD2243G)

Typical Performance Curves

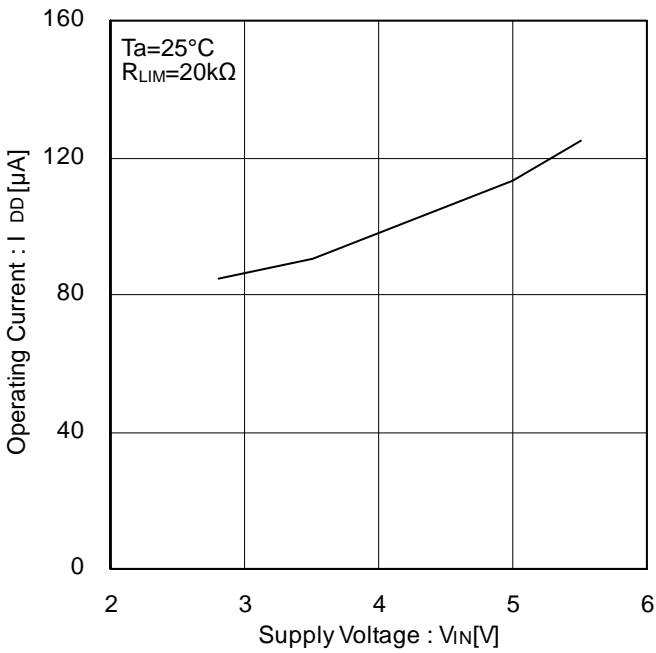


Figure 8. Operating Current vs Supply Voltage EN Enable

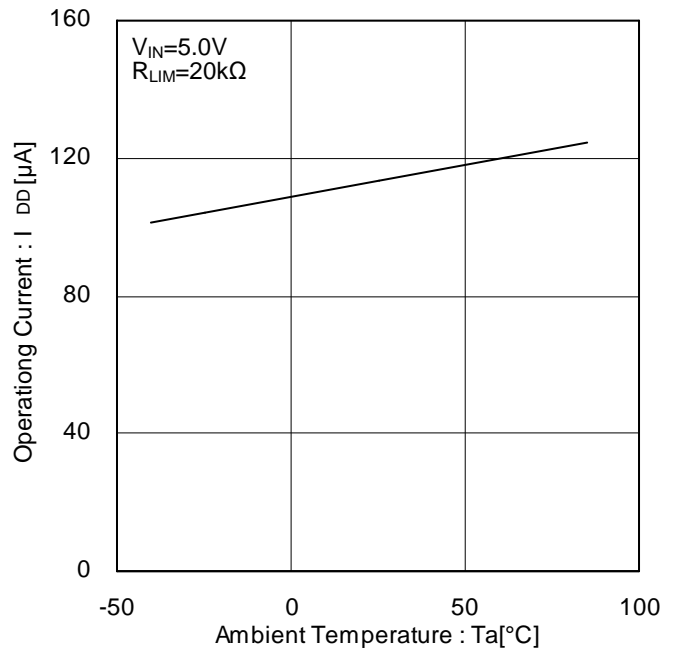


Figure 9. Operating Current vs Ambient Temperature EN Enable

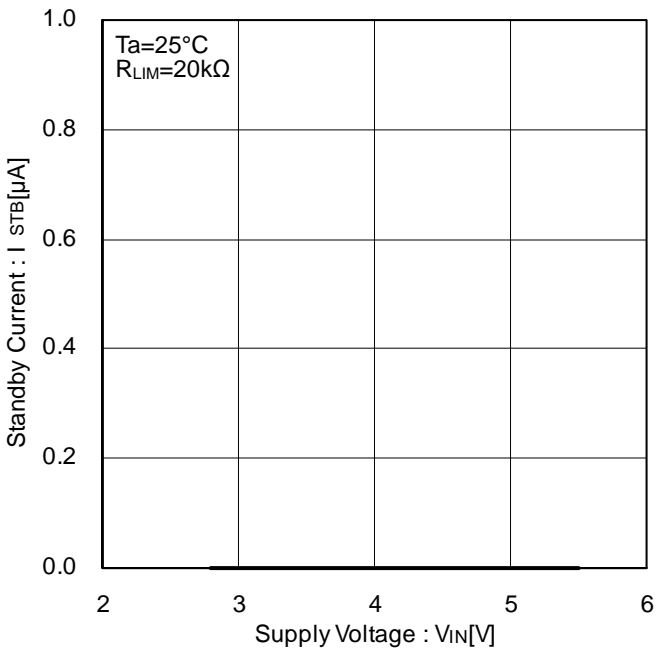


Figure 10. Standby Current vs Supply Voltage EN Disable

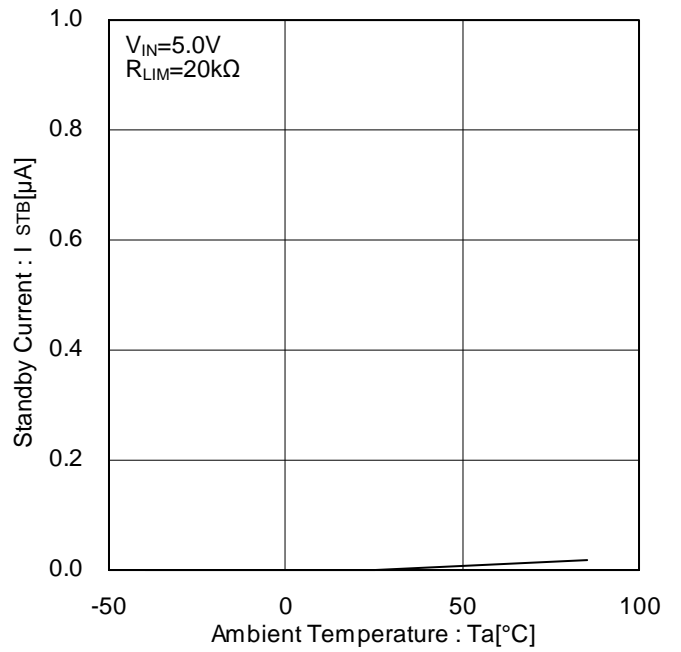


Figure 11. Standby Current vs Ambient Temperature EN Disable

Typical Performance Curves - continued

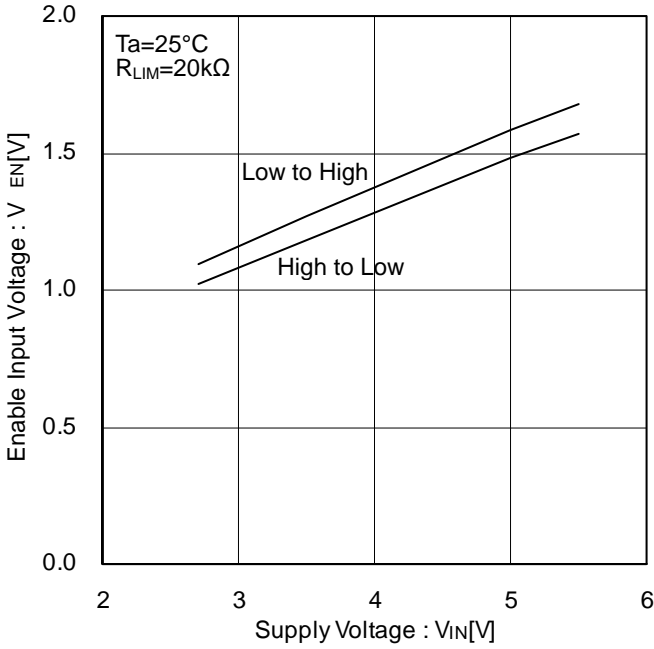


Figure 12. EN Input Voltage vs Supply Voltage

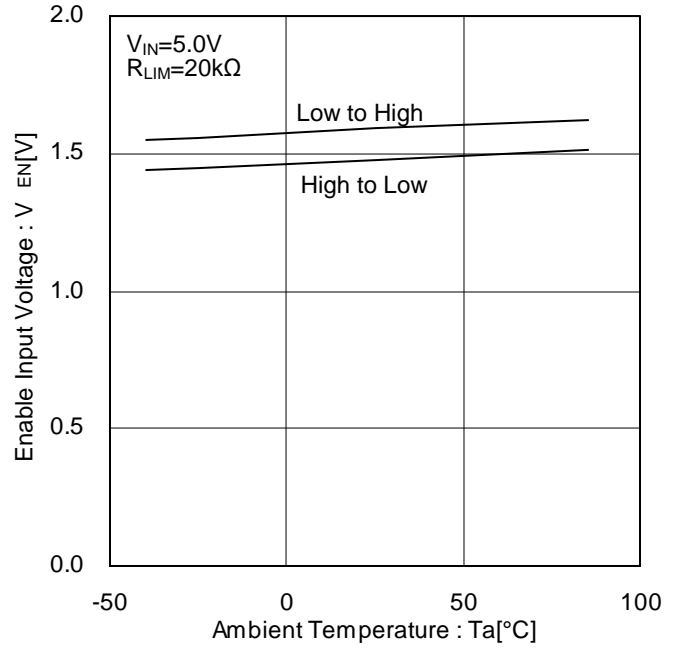


Figure 13. EN Input Voltage vs Ambient Temperature

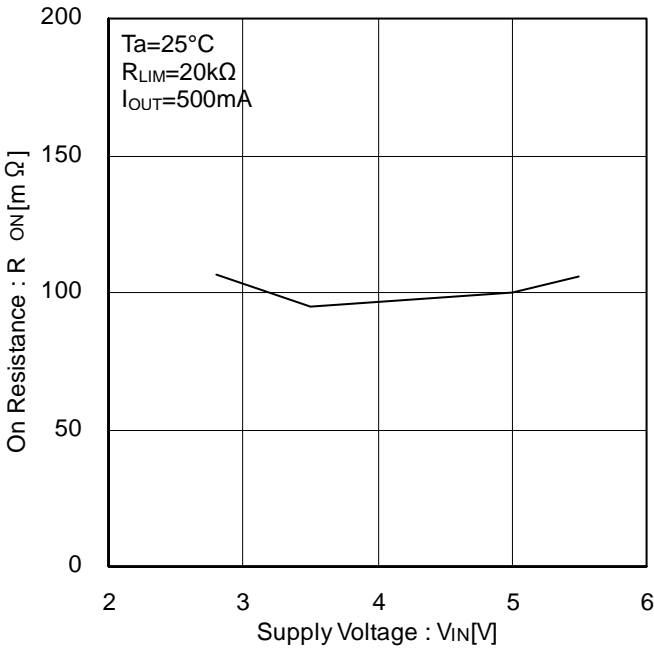


Figure 14. On-Resistance vs Supply Voltage

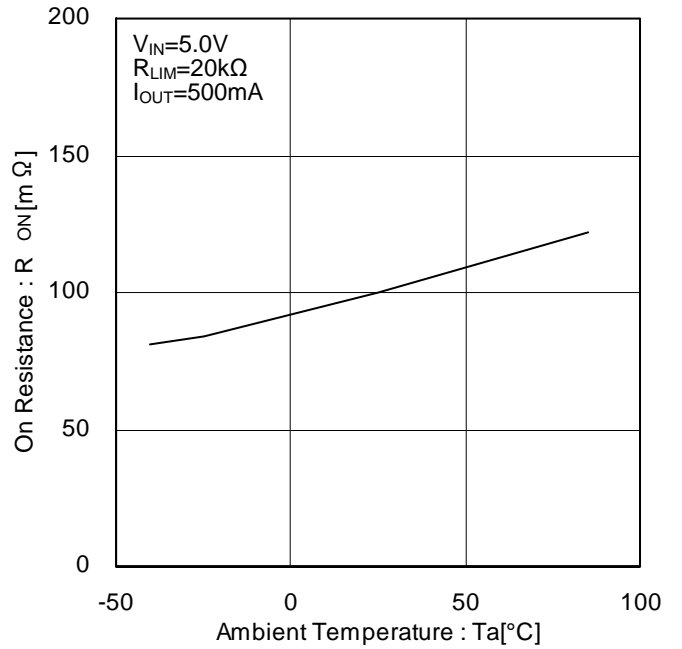


Figure 15. On-Resistance vs Ambient Temperature

Typical Performance Curves - continued

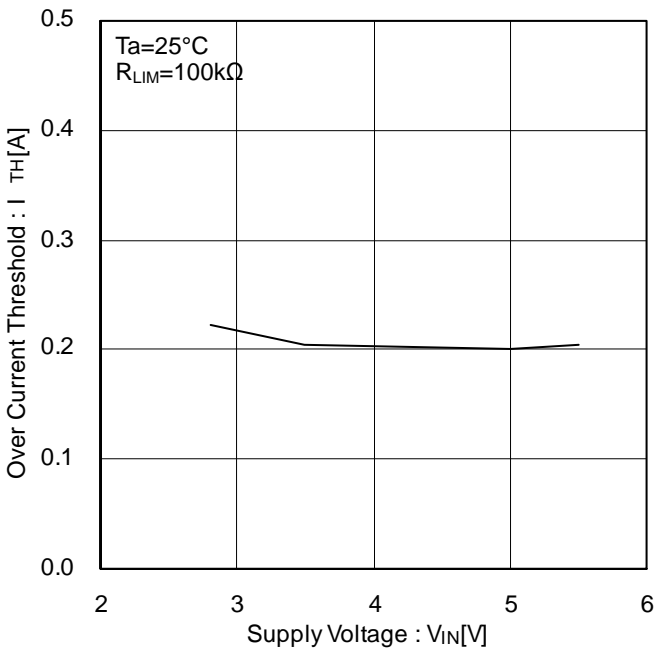


Figure 16. Over-Current Threshold 1 vs Supply Voltage

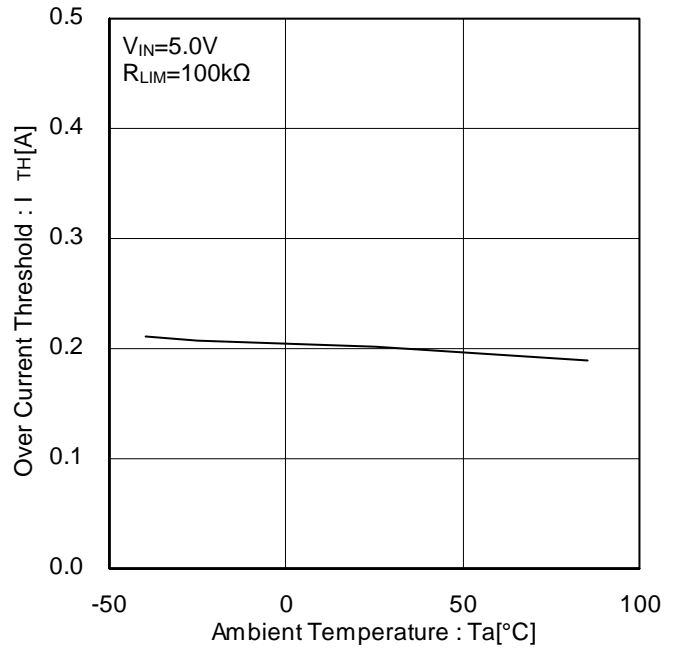


Figure 17. Over-Current Threshold 1 vs Ambient Temperature

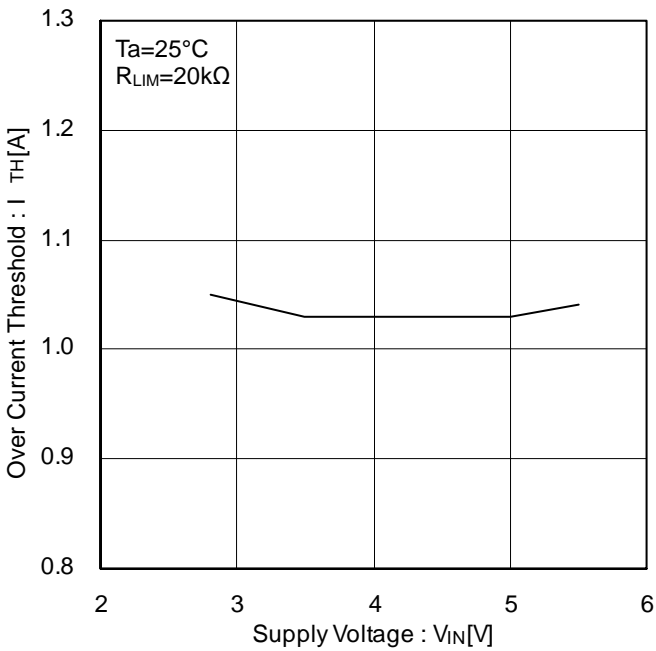


Figure 18. Over-Current Threshold 2 vs Supply Voltage

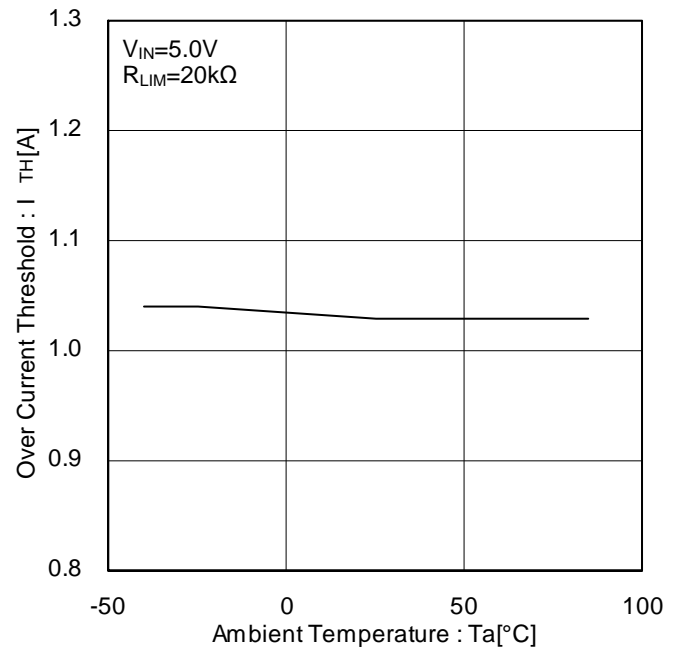


Figure 19. Over-Current Threshold 2 vs Ambient Temperature



Typical Performance Curves - continued

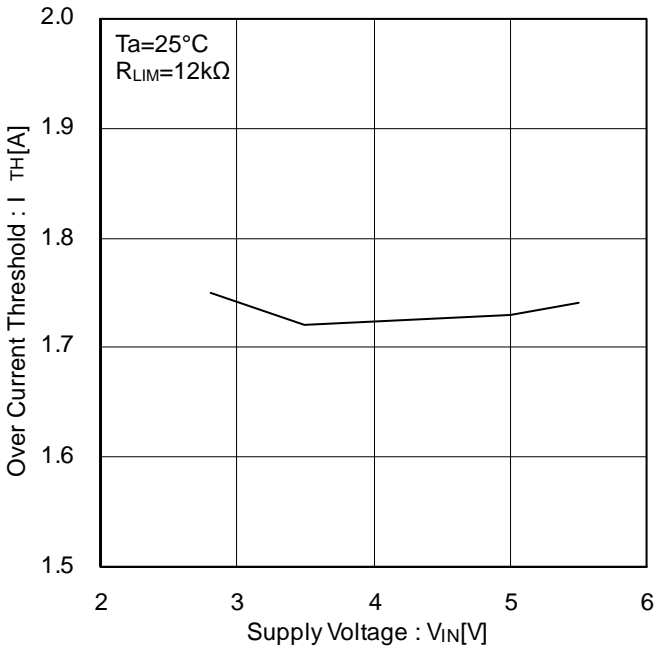


Figure 20. Over-Current Threshold 3 vs Supply Voltage

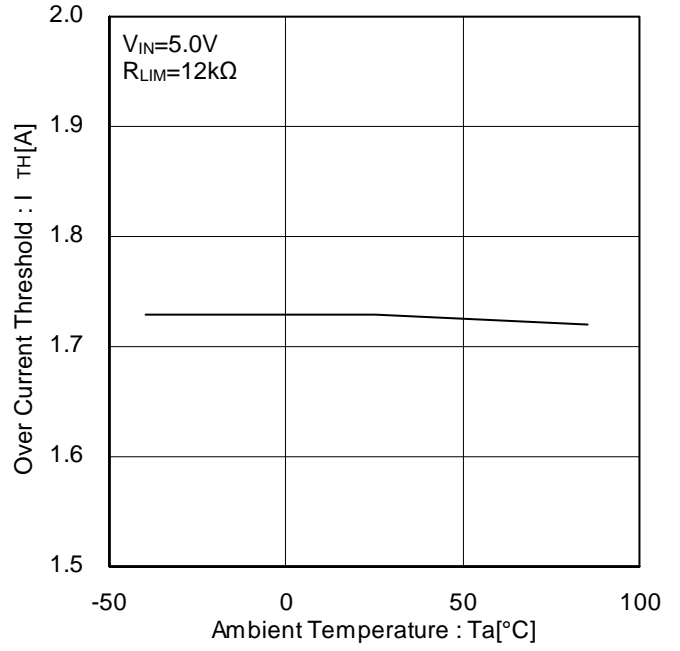


Figure 21. Over-Current Threshold 3 vs Ambient Temperature

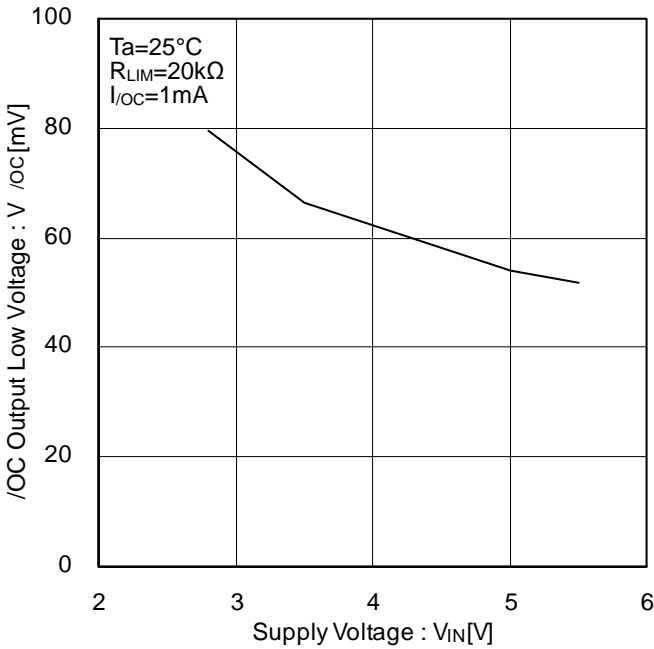


Figure 22. /OC Output Low Voltage vs Supply Voltage

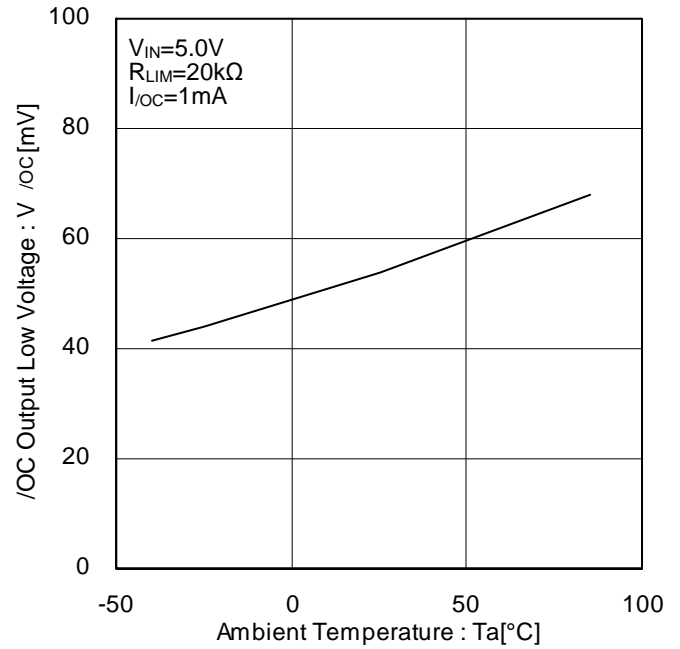


Figure 23. /OC Output Low Voltage vs Ambient Temperature

Typical Performance Curves - continued

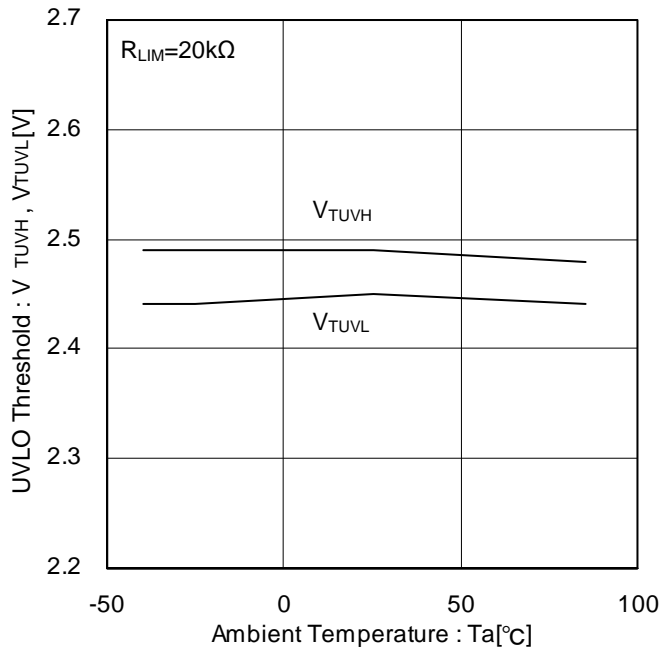


Figure 24. UVLO Threshold vs Ambient Temperature

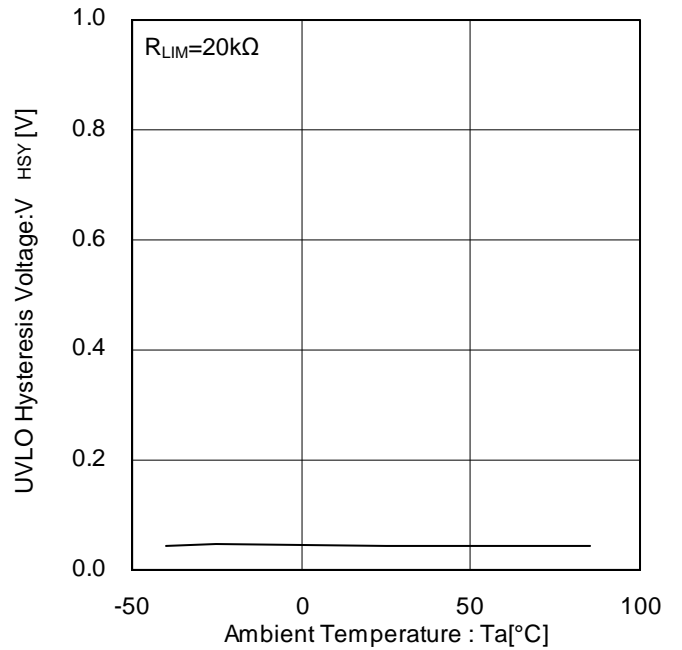


Figure 25. UVLO Hysteresis Voltage vs Ambient Temperature

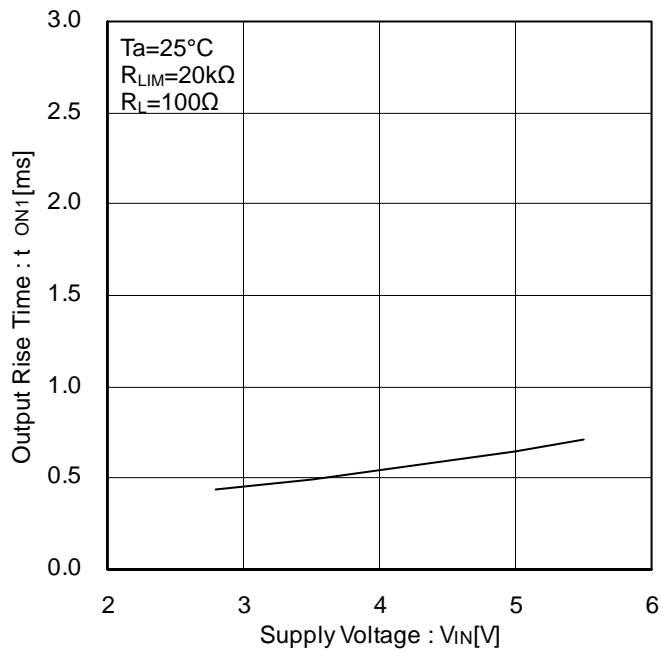


Figure 26. Output Rise Time vs Supply Voltage

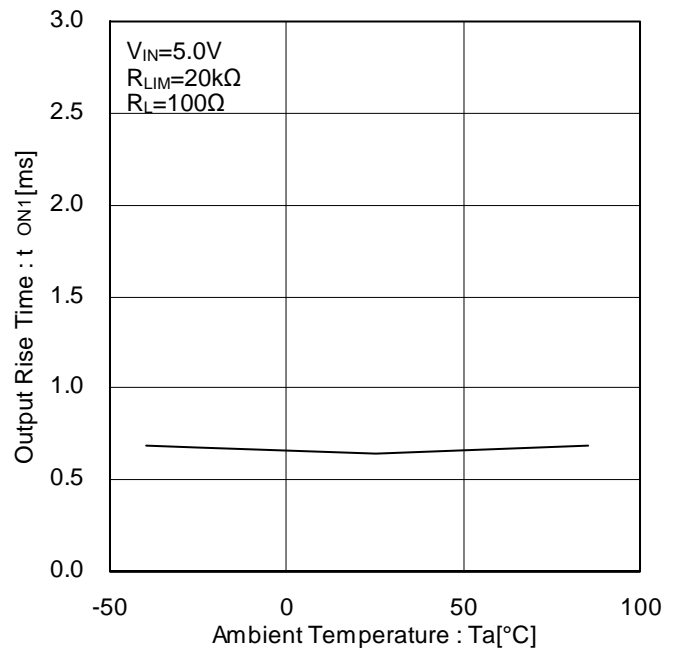


Figure 27. Output Rise Time vs Ambient Temperature

Typical Performance Curves - continued

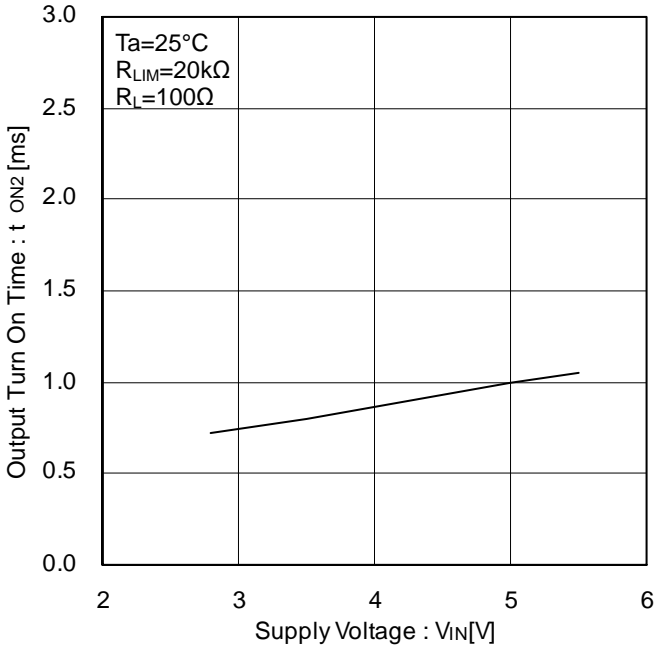


Figure 28. Output Turn-On Time vs Supply Voltage

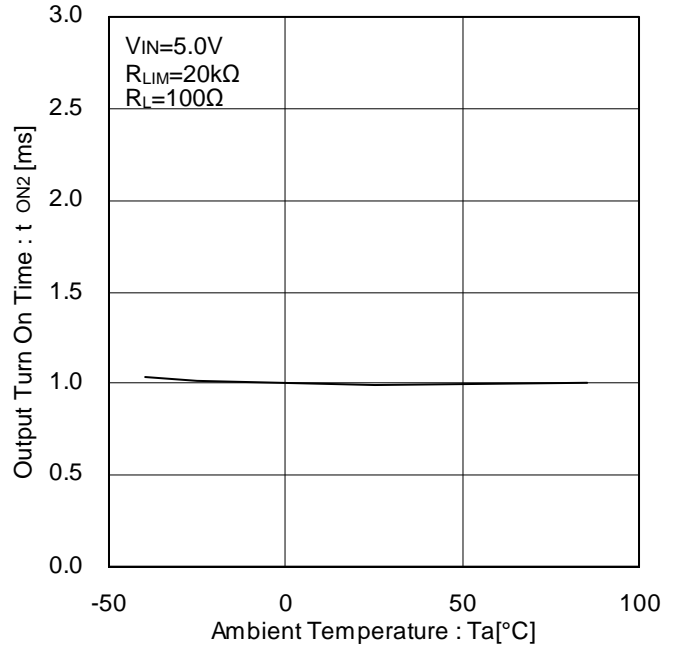


Figure 29. Output Turn-On Time vs Ambient Temperature

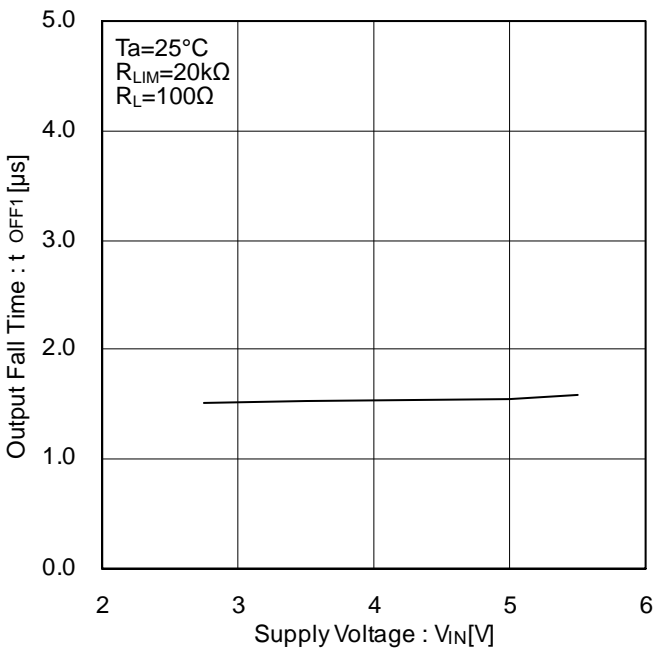


Figure 30. Output Fall Time vs Supply Voltage

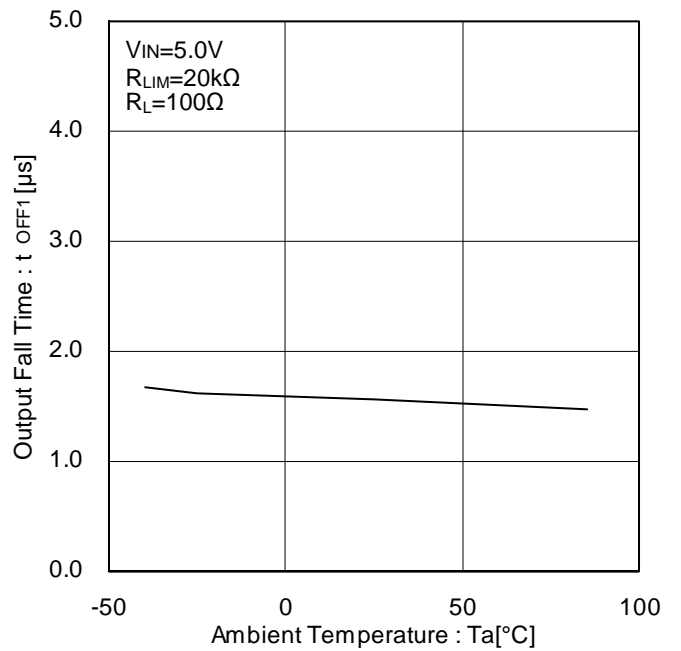


Figure 31. Output Fall Time vs Ambient Temperature

Typical Performance Curves - continued

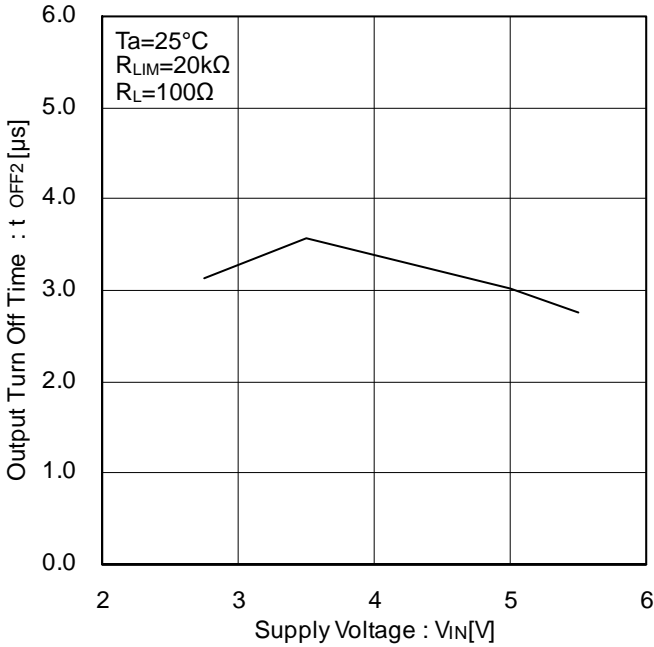


Figure 32. Output Turn-Off Time vs Supply Voltage

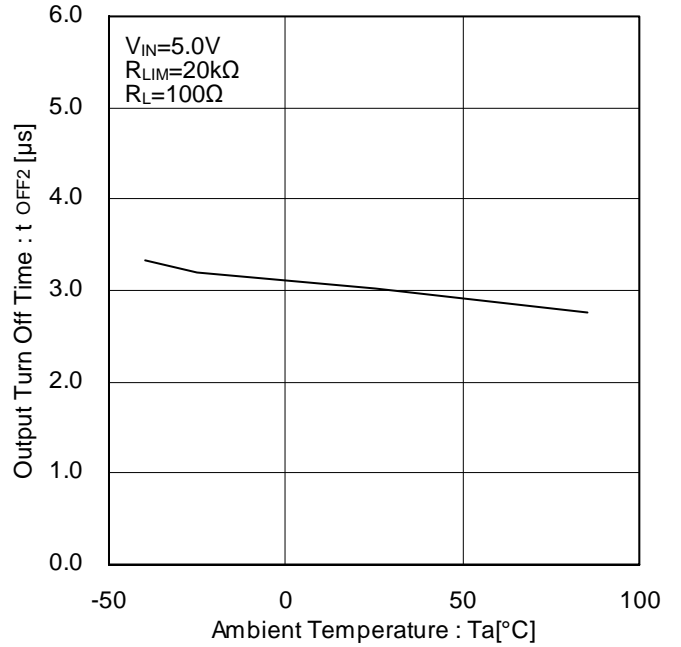


Figure 33. Output Turn-Off Time vs Ambient Temperature

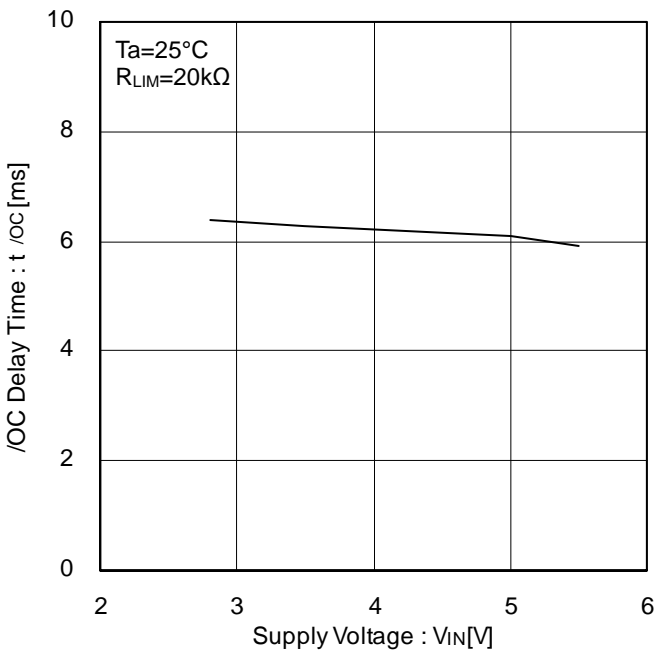


Figure 34. /OC Delay Time vs Supply Voltage

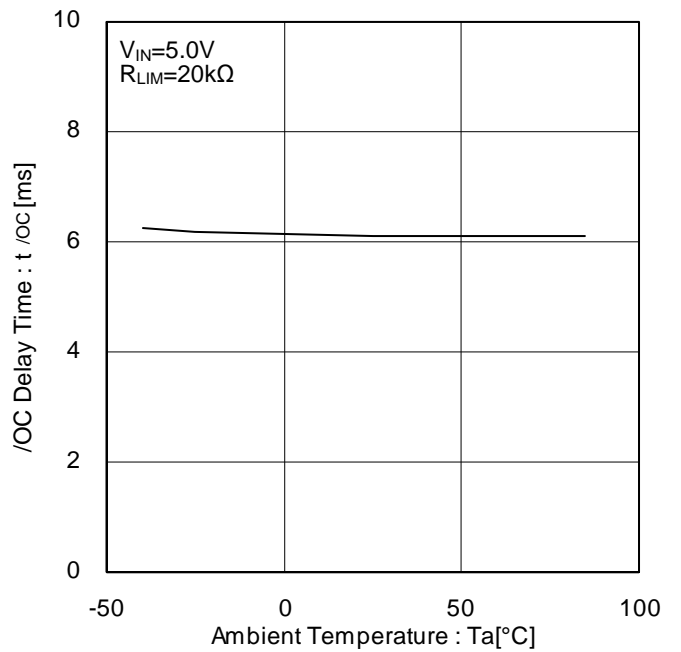


Figure 35. /OC Delay Time vs Ambient Temperature

Typical Performance Curves - continued

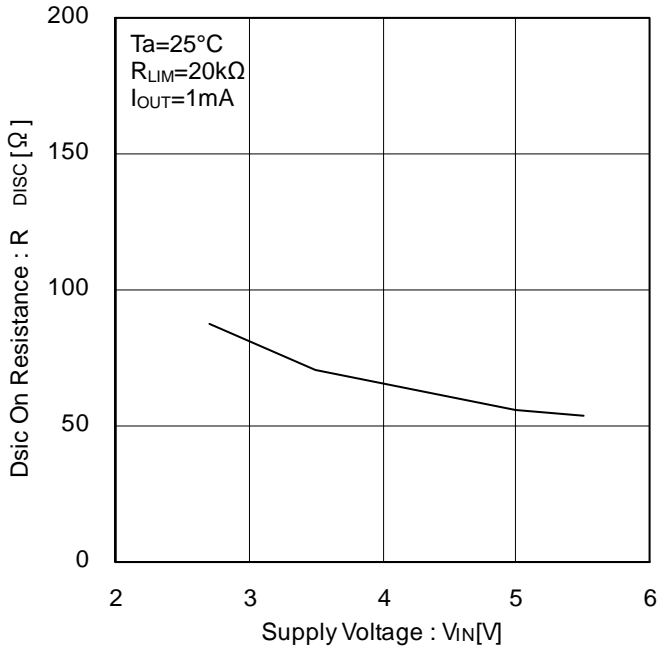


Figure 36. Discharge On Resistance vs Supply Voltage

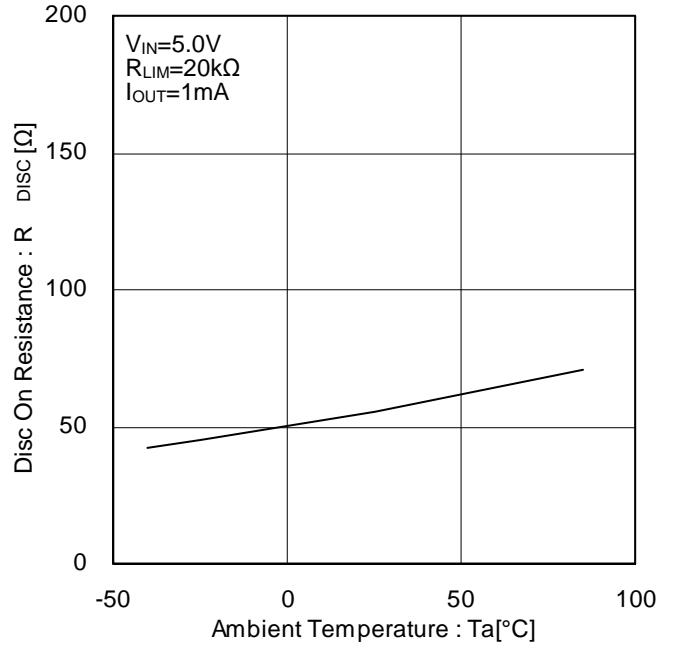
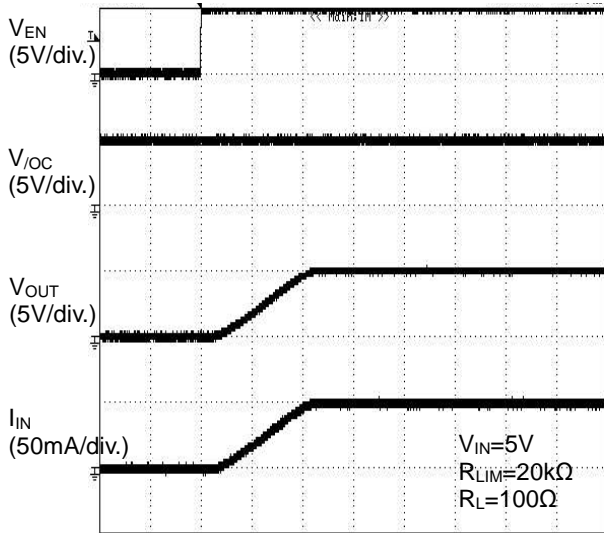
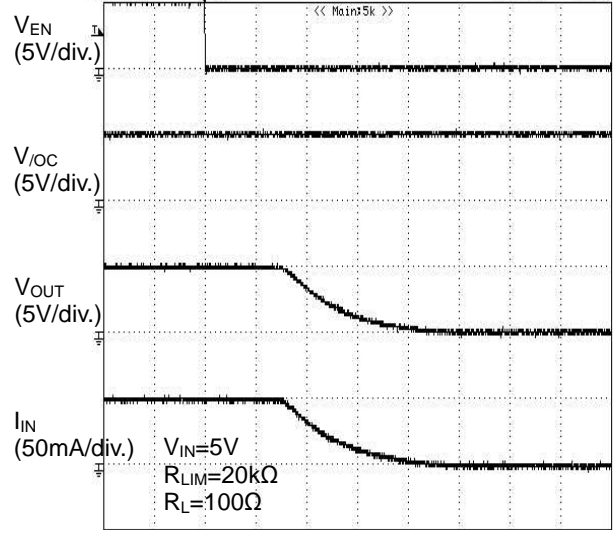


Figure 37. Discharge On Resistance vs Ambient Temperature

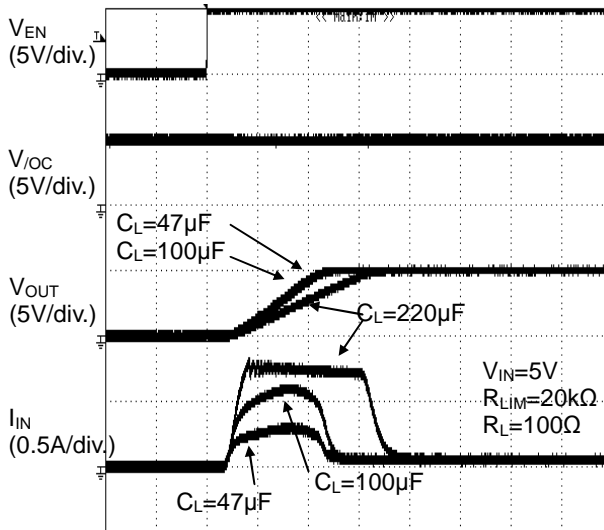
Typical Wave Forms



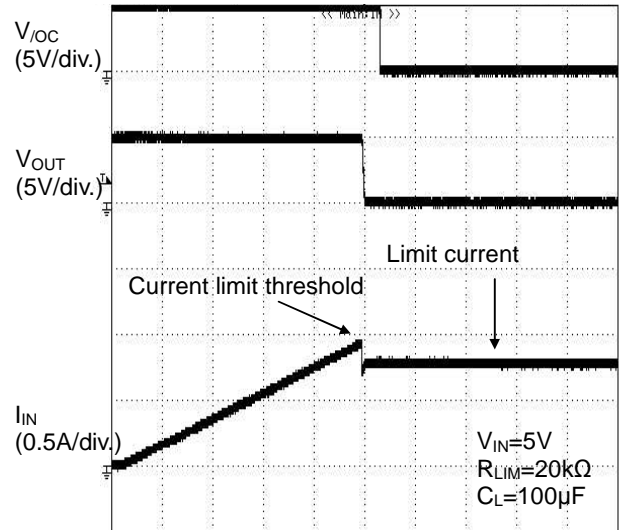
TIME (0.5ms/div.)  
Figure 38. Output Rise Characteristic (BD2242G)



TIME (1μs/div.)  
Figure 39. Output Fall Characteristic (BD2242G)



TIME (1ms/div.)  
Figure 40. Inrush Current Response (BD2242G)



TIME (20ms/div.)  
Figure 41. Over Current Response Ramped Load

Typical Wave Forms - continued

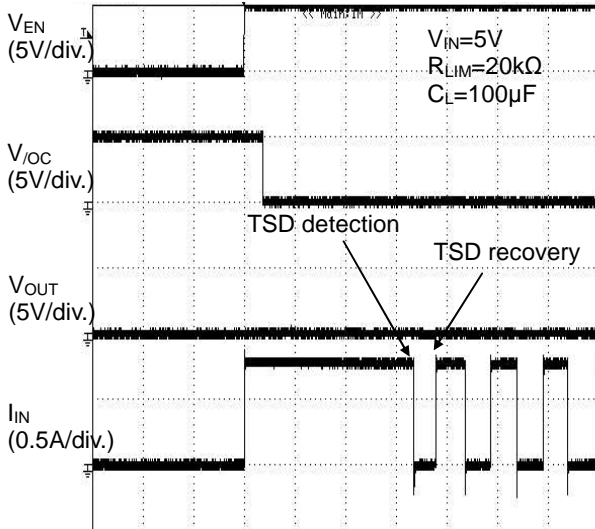


Figure 42. Over Current Response Enable Into Short Circuit (BD2242G)

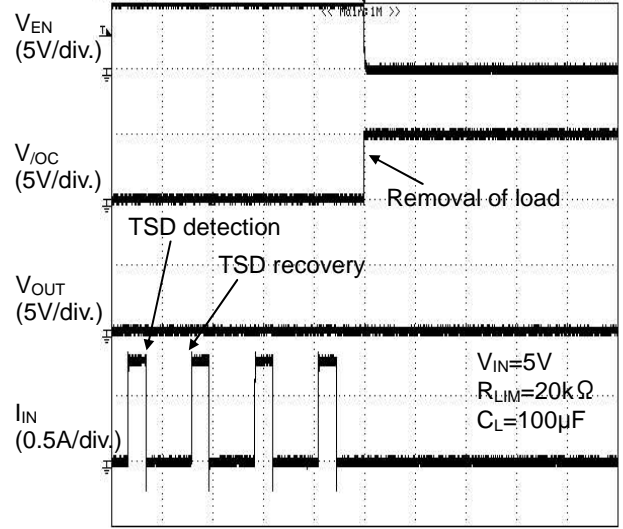


Figure 43. Over Current Response Disable From Short Circuit (BD2242G)

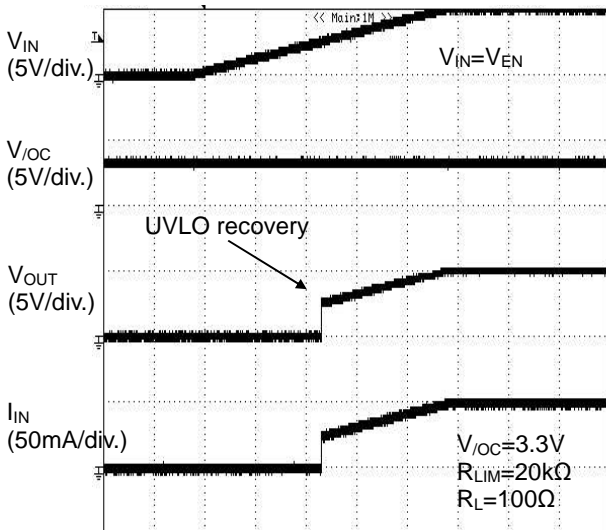


Figure 44. UVLO Response Increasing V<sub>IN</sub> (BD2242G)

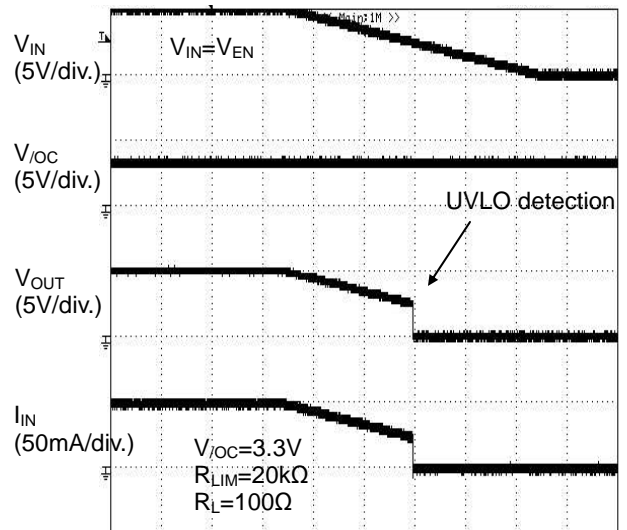
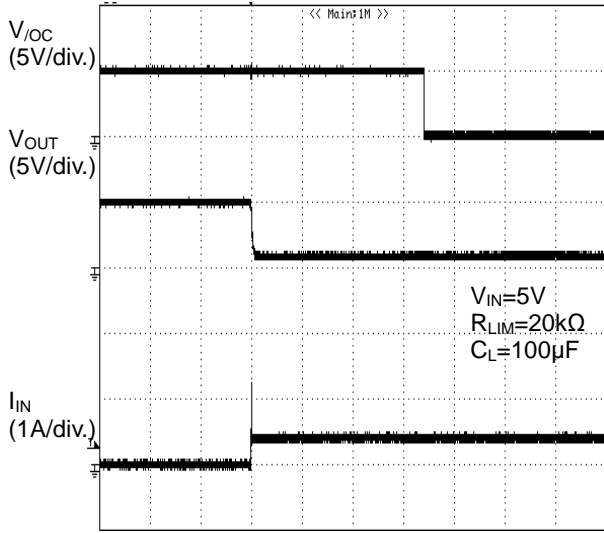
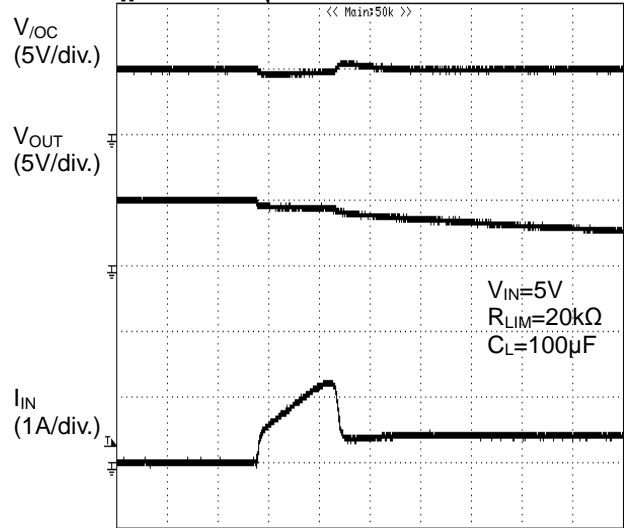


Figure 45. UVLO Response Decreasing V<sub>IN</sub> (BD2242G)

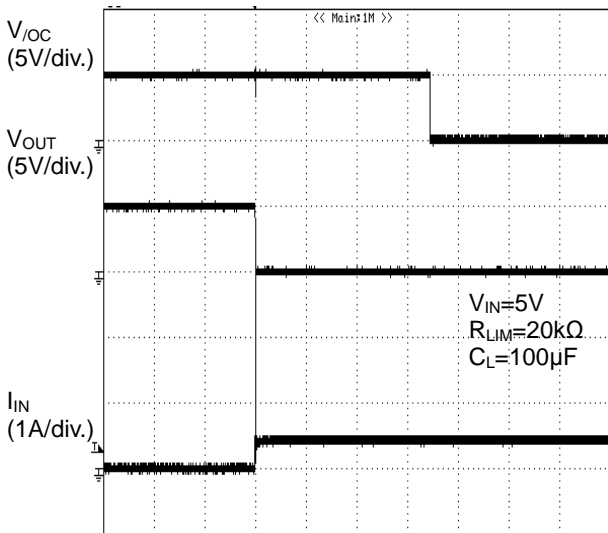
Typical Wave Forms - continued



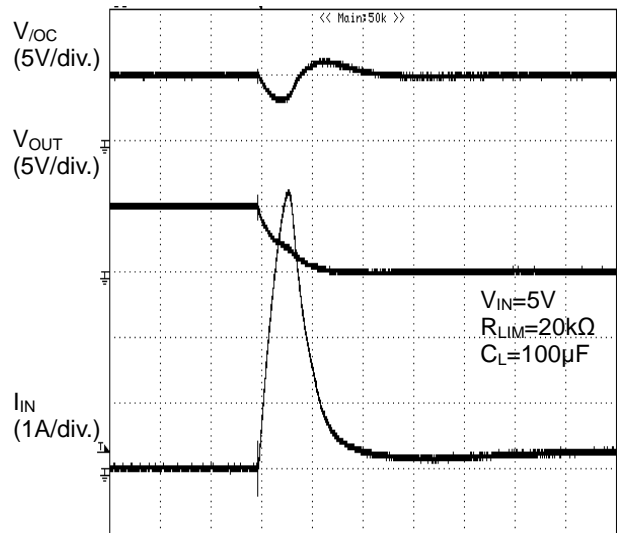
TIME (2ms/div.)  
Figure 46. Over Current Response  
1Ω Load Connected At Enable



TIME (5μs/div.)  
Figure 47. Over Current Response  
1Ω Load Connected At Enable



TIME (2ms/div.)  
Figure 48. Over Current Response  
0Ω Load Connected At Enable



TIME (5μs/div.)  
Figure 49. Over Current Response  
0Ω Load Connected At Enable



## Application Circuit Example

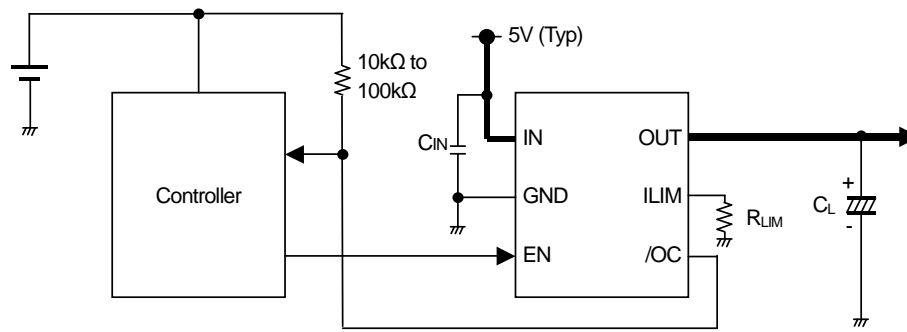


Figure 50. Application Circuit Example

## Application Information

Ringing may cause bad influences on IC operations. In order to avoid this case, connect a bypass capacitor across IN terminal and GND terminal of IC. 1 $\mu$ F or higher is recommended. When excessive current flows due to output short-circuit or so, ringing occurs because of inductance between power source line to IC may exert a bad influence upon IC. In order to decrease voltage fluctuations from power source line to IC, connect a low ESR capacitor in parallel with C<sub>IN</sub>. 10 $\mu$ F to 100 $\mu$ F or higher is effective.

Pull up /OC output via resistance value of 10k $\Omega$  to 100k $\Omega$ .

Set up a value for C<sub>L</sub> which satisfies the application.

This system connection diagram does not guarantee operation as the intended application.

When using the circuit with changes to the external circuit values, make sure to leave an adequate margin for external components including static and transitional characteristics as well as the design tolerance of the IC.

## Functional Description

### 1. Switch Operation

IN terminal and OUT terminal are connected to the drain and the source of switch MOSFET respectively. The IN terminal is also used as power source input to internal control circuit.

When the switch is turned on from EN control input, the IN terminal and OUT terminal are connected by a 89m $\Omega$ (Typ) switch. In ON status, the switch is bidirectional. Therefore, when the potential of OUT terminal is higher than that of the IN terminal, current flows from OUT terminal to IN terminal.

Since a parasitic diode between the drain and the source of switch MOSFET is canceled, current flow from OUT to IN is prevented during off state.

### 2. Thermal Shutdown Circuit (TSD)

If over-current would continue, the temperature of the IC would increase drastically. If the junction temperature were beyond 120 $^{\circ}$ C(Typ) in the condition of over-current detection, thermal shutdown circuit operates and makes power switch turn off and outputs fault flag (/OC). Then, when the junction temperature decreases lower than 110 $^{\circ}$ C(Typ), power switch is turned on and fault flag (/OC) is cancelled. Also, regardless of over-current condition, if the junction temperature were beyond 160 $^{\circ}$ C(Typ), thermal shutdown circuit makes power switch turn off and outputs fault flag (/OC).When junction temperature decreases lower than 140 $^{\circ}$ C(Typ), power switch is turned on and fault flag (/OC) is cancelled. Unless the fact of the increasing chips temperature is removed or the output of power switch is turned off, this operation repeats. Fault flag (/OC) is output without delay time at thermal shutdown.

The thermal shutdown circuit operates when the switch is on (EN signal is active).

### 3. Over-Current Detection (OCD)

The over current detection circuit (OCD) limits current and outputs error flag (/OC) when current flowing in each switch MOSFET exceeds a specified value. There are three cases when the OCD is activated. The OCD operates when the switch is on (EN signal is active).

(1). When the switch is turned on while the output is in short-circuit status, the switch gets in current limit status immediately. (See figure 42)

(2). When the output short-circuits or when high current load is connected while the switch is on, very large current flows until the over current limit circuit reacts. When this happens, the over-current limit circuit is activated and the current limitation is carried out. (See figure 48)

(3). When the output current increases gradually, current limitation does not work until the output current exceeds the over current detection value. When it exceeds the detection value, current limitation is carried out.  
(See Figure 41)

4. Under-Voltage Lockout (UVLO)

UVLO circuit prevents the switch from turning on until the  $V_{IN}$  exceeds 2.55V(Typ). If the  $V_{IN}$  drops below 2.5V(Typ) while the switch turns on, then UVLO shuts off the power switch. UVLO has hysteresis of a 50mV(Typ). Under-voltage lockout circuit works when the switch is on (EN signal is active). (see Figure 44,45)

5. Fault Flag (/OC) Output

Fault flag output is an N-MOS open drain output. At detection of over-current or thermal shutdown, output is low-level. Over-current detection has delay filter. This delay filter prevents instantaneous current detection such as inrush current at switch on, hot plug from being informed to outside, but if charge up time for output capacitance is longer than delay time, fault flag output asserts low level. When output current is close to Current Limit Threshold value, fault flag output (/OC) might be low level before turning to over-current condition because it is affected by current swinging or noise. If fault flag output is unused, /OC pin should be connected to open or ground line.

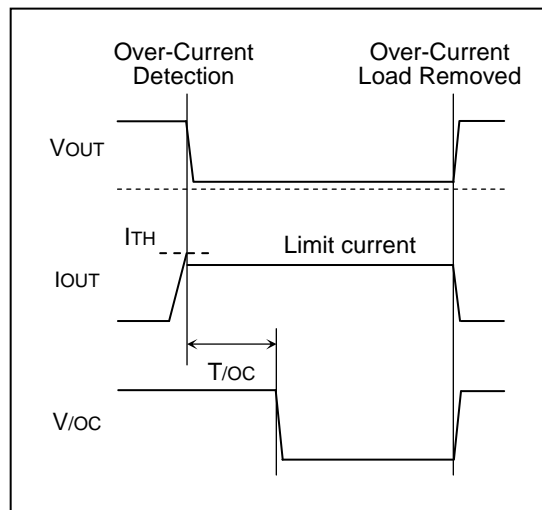


Figure 51. Over-Current Detection

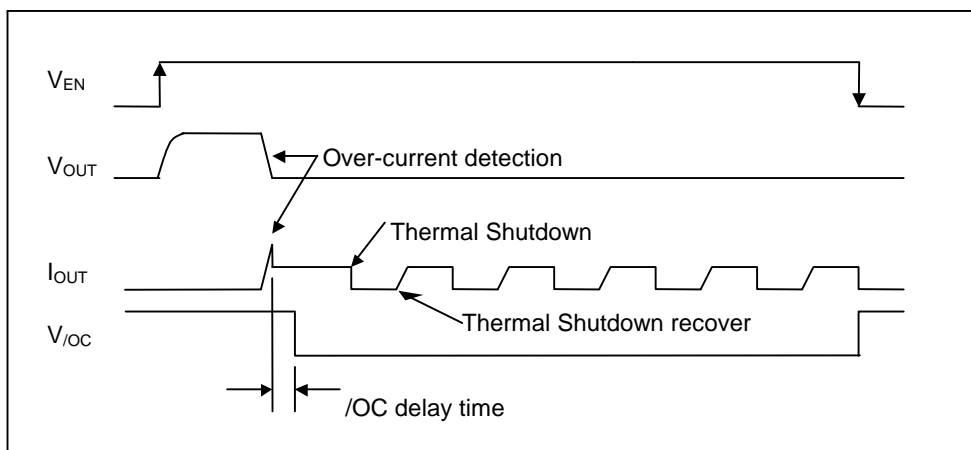


Figure 52. Over-Current Detection, Thermal Shutdown Timing (BD2222G, BD2242G)

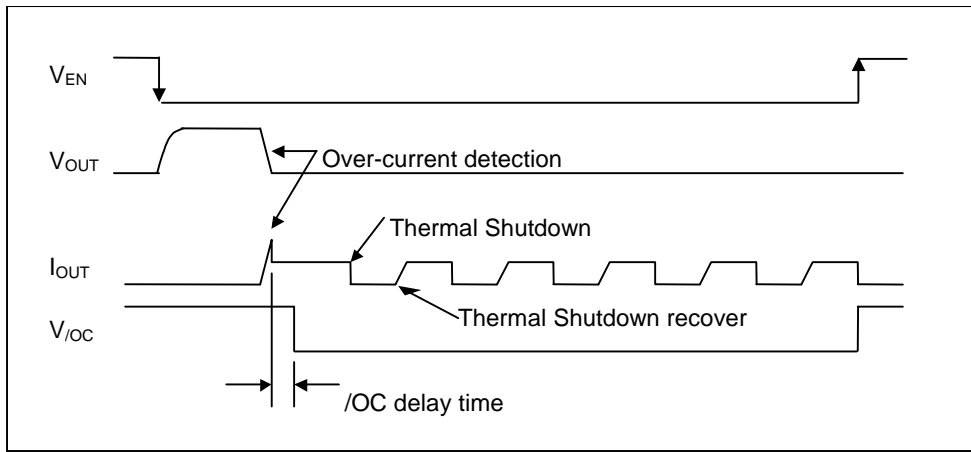


Figure 53. Over-Current Detection, Thermal Shutdown Timing (BD2243G)

6. Adjustable Current Limit Threshold

BD2222/42/43G is able to change over-current detection value from 200mA to 1.7A by connecting resistance ( $R_{LIM}$ ) between ILIM pin and GND pin. The resistance value from 11.97k $\Omega$  to 106.3k $\Omega$  is recommended for  $R_{LIM}$ . The relational expression and the table for resistance value and over-current detection value are described below. Allocate  $R_{LIM}$  close to IC as possible. Be careful not to be affected by parasitic resistance of board pattern because over-current detection value is depended on the resistance value between ILIM pin and GND pin. ILIM pin cannot be used as open and short to GND pin. The  $R_{LIM}$  resistance tolerance directly affects the current limit threshold accuracy. Recommended to use low tolerance resistance.

Over Current Threshold Equation,

$$I_{th}(Typ)[mA] = 19364 \times R_{LIM}[k\Omega]^{-0.98}$$

$$I_{th}(Min)[mA] = I_{th}(Typ)[mA] \times 0.98 - 96$$

$$I_{th}(Max)[mA] = I_{th}(Typ)[mA] \times 1.02 + 96$$

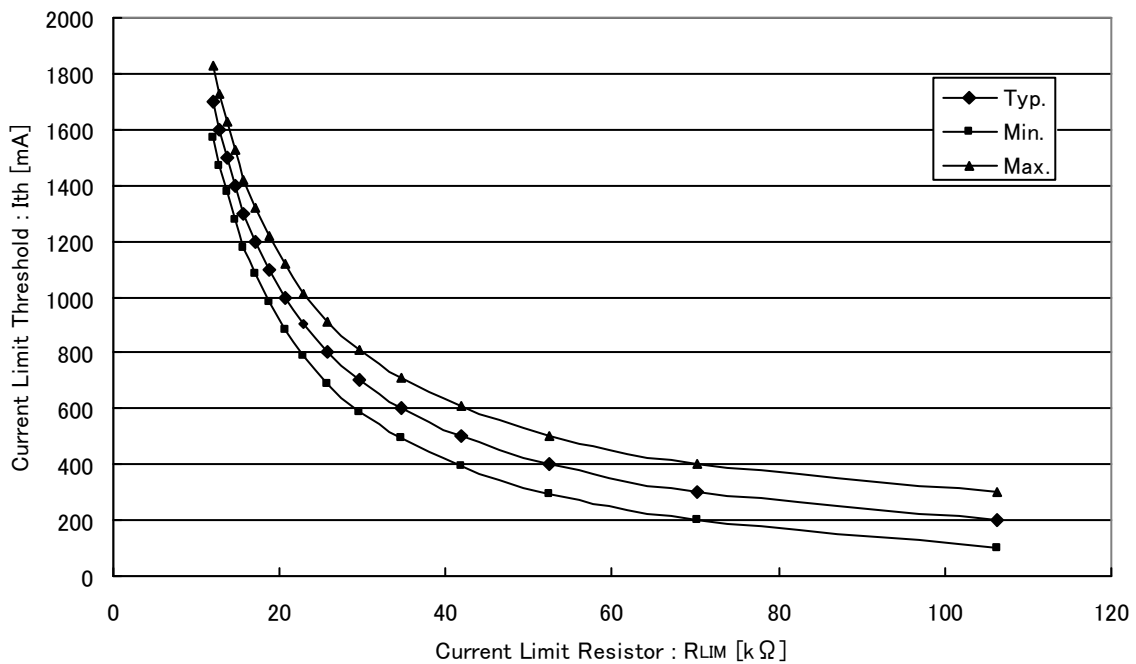


Figure 54.  $I_{th}$  vs.  $R_{LIM}$  graph

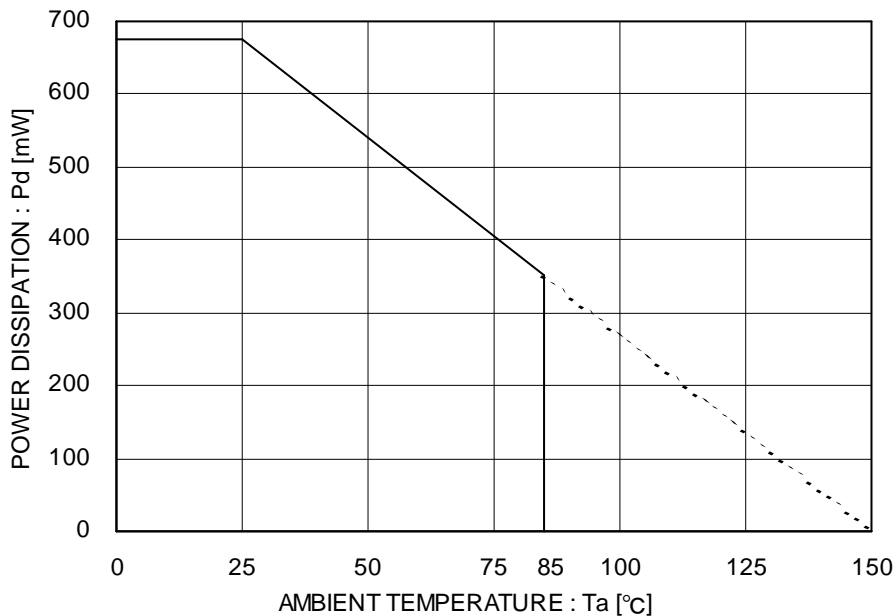
| R <sub>LIM</sub> (kΩ) | Current Limit Threshold (mA) |      |      |
|-----------------------|------------------------------|------|------|
|                       | MIN                          | TYP  | MAX  |
| 106.30                | 100                          | 200  | 300  |
| 70.28                 | 198                          | 300  | 402  |
| 52.40                 | 296                          | 400  | 504  |
| 41.73                 | 394                          | 500  | 606  |
| 34.65                 | 492                          | 600  | 708  |
| 29.60                 | 590                          | 700  | 810  |
| 25.83                 | 688                          | 800  | 912  |
| 22.91                 | 786                          | 900  | 1014 |
| 20.57                 | 884                          | 1000 | 1116 |
| 18.67                 | 982                          | 1100 | 1218 |
| 17.08                 | 1080                         | 1200 | 1320 |
| 15.74                 | 1178                         | 1300 | 1422 |
| 14.59                 | 1276                         | 1400 | 1524 |
| 13.60                 | 1374                         | 1500 | 1626 |
| 12.73                 | 1472                         | 1600 | 1728 |
| 11.97                 | 1570                         | 1700 | 1830 |

Table 1. Ith Tolerance vs. R<sub>LIM</sub>

7. Output Discharge Function (BD2242G and BD2243G)

When the switch is turned off from disable control input or UVLO function, the 60Ω(Typ.) discharge circuit between OUT and GND turns on. By turning on this switch, electric charge at capacitive load is discharged. But when the voltage of IN declines extremely, then the OUT pin becomes Hi-Z without UVLO function.

**Power Dissipation**  
(SSOP6 package)



\* 70mm x 70mm x 1.6mm Glass Epoxy Board  
Figure 55. Power Dissipation Curve (Pd-Ta Curve)

I/O Equivalence Circuit

| Symbol                    | Pin No. | Equivalent Circuit |
|---------------------------|---------|--------------------|
| EN                        | 3       |                    |
| /OC                       | 4       |                    |
| ILIM                      | 5       |                    |
| OUT<br>BD2222G            | 6       |                    |
| OUT<br>BD2242G<br>BD2243G | 6       |                    |

## 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 terminals.

### 2. Power Supply Lines

Design the PCB layout pattern to provide low impedance supply lines. Separate the ground and supply lines of the digital and analog blocks to prevent noise in the ground and supply lines of the digital block from affecting the analog block. 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

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. Thermal Consideration

Should by any chance the power dissipation rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. The absolute maximum rating of the Pd stated in this specification is when the IC is mounted on a 70mm x 70mm x 1.6mm glass epoxy board. In case of exceeding this absolute maximum rating, increase the board size and copper area to prevent exceeding the Pd rating.

### 6. Recommended Operating Conditions

These conditions represent a range within which the expected characteristics of the IC can be approximately obtained. The electrical characteristics are guaranteed under the conditions of each parameter.

### 7. Rush 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.

### 8. Operation Under Strong Electromagnetic Field

Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

### 9. 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.

### 10. 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.

### 11. Unused Input Terminals

Input terminals 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 terminals should be connected to the power supply or ground line.

## Operational Notes – continued

## 12. Regarding the Input Pin of the IC

This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated. P-N junctions are formed at the intersection of 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.

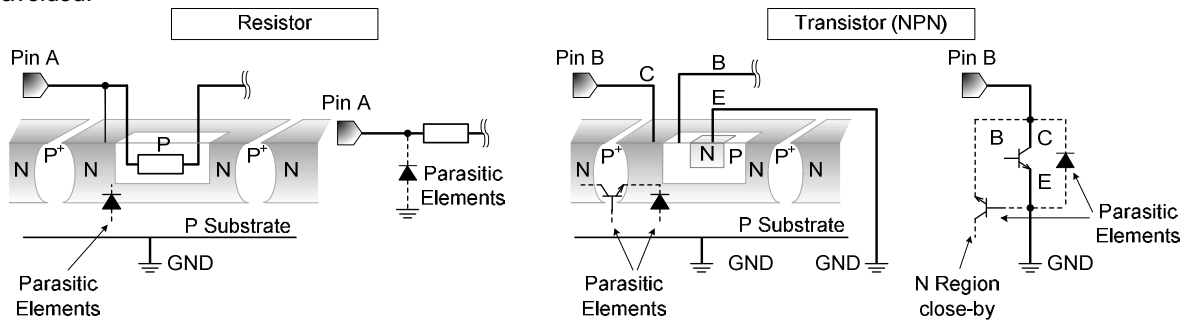


Figure 56. Example of monolithic IC structure

## 13. Ceramic Capacitor

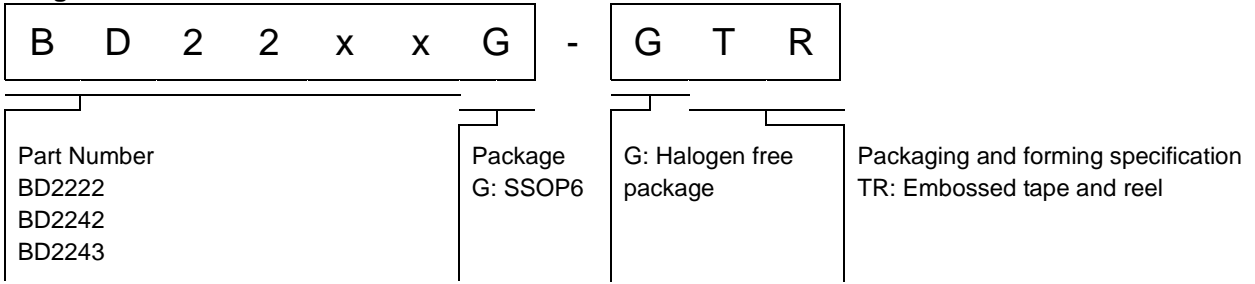
When using a ceramic capacitor, determine the dielectric constant considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

## 14. Thermal Shutdown Circuit(TSD)

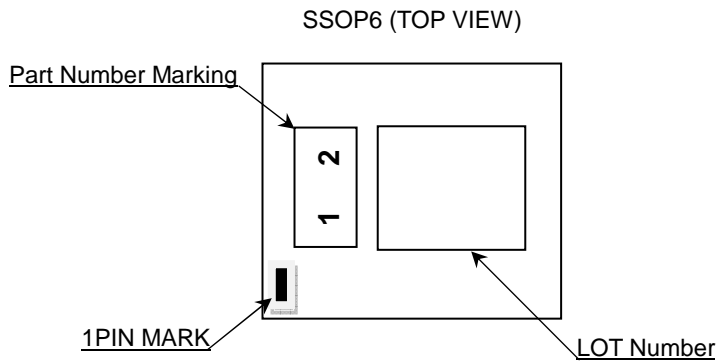
This IC has a built-in thermal shutdown circuit that prevents heat damage to the IC. Normal operation should always be within the IC's power dissipation rating. If however the rating is exceeded for a continued period, the junction temperature ( $T_j$ ) will rise which will activate the TSD circuit that will turn OFF all 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.

Ordering Information



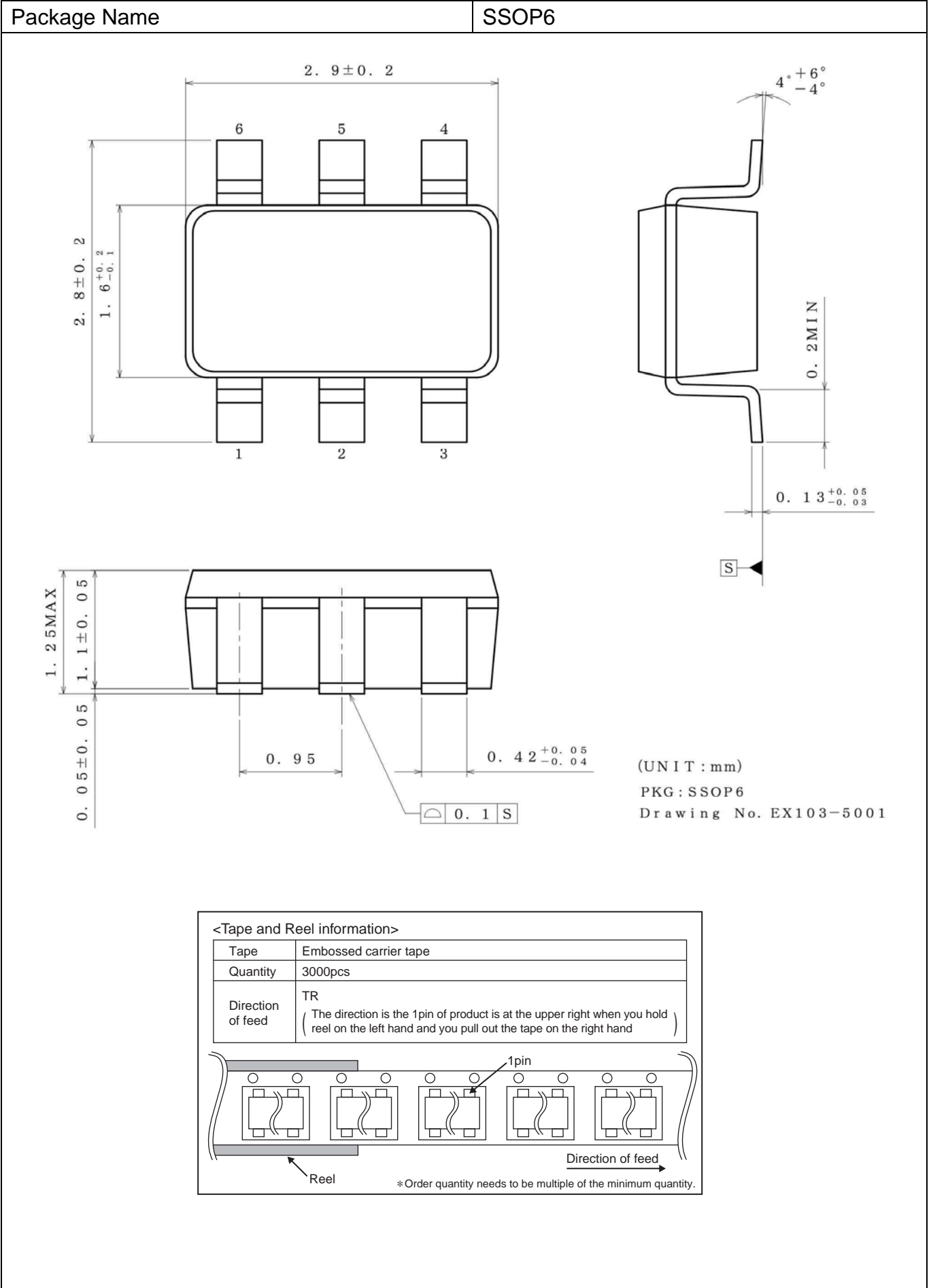
Marking Diagram



| Part Number | Part Number Marking |
|-------------|---------------------|
| BD2222G     | BN                  |
| BD2242G     | AY                  |
| BD2243G     | AZ                  |



Physical Dimension, Tape and Reel Information



## Revision History

| Date        | Revision | Changes   |
|-------------|----------|---|
| 12.OCT.2012 | 0000     | Draft   |
| 27.FEB.2013 | 0001     | Over Current Threshold Limits   |
| 7.MAR.2013  | 001      | Authentic Release   |
| 23.APR.2013 | 002      | Add Typical Wave Forms for over current response<br>Change I/O Equivalence Circuit (EN)   |
| 12.FEB.2014 | 003      | Applied new style and improved understandability.<br>Improved Symbol name.<br>Improved in Operational Notes.<br>Add Output Discharge Function in Functional Description |
| 9.JUN.2014  | 004      | Add BD2222G   |

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(Note1) Medical Equipment Classification of the Specific Applications

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|-----------|-----------|------------|-----------|
| CLASS III | CLASS III | CLASS II b | CLASS III |
| CLASS IV  |           | CLASS III  |           |

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  - Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
  - Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
  - Sealing or coating our Products with resin or other coating materials
  - 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
  - Use of the Products in places subject to dew condensation
- The Products are not subject to radiation-proof design.
- Please verify and confirm characteristics of the final or mounted products in using the Products.
- 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.
- De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.
- Confirm that operation temperature is within the specified range described in the product specification.
- ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

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For details, please refer to ROHM Mounting specification

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1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
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  - [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
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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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