## 1ch Low Side Switch IC

# In-Vehicle 1ch Low Side Switch

## BD1LB500 Series (BD1LB500EFJ-C BD1LBU50EFJ-C BD1LB500FVM-C)

### Features

- Built-in overcurrent limiting circuit
- Built-in thermal shutdown circuit (TSD)
- Built-in open load detection circuit (at output OFF)
- Enables direct control from CMOS logic ICs, etc.
- Low standby current
- Built-in under voltage lock out circuit
- Built-in diagnostic output (ST) terminal
- Low ON resistance $R_{DS(ON)}$=350mΩ(Typ) ($V_{DD}$=IN=5V, Ta=25°C, $I_{OUT}$=0.25A)
- Built-in overvoltage protection(active clamp) for output circuit
- Monolithic power IC in which the control unit (CMOS) and power MOS FET are incorporated into one chip
- 1ch low side switch for driving mechanical relay coil
- AEC-Q100 Qualified(1)
  (1) Grade1

### Overview

BD1LB500 Series is an in-vehicle 1ch low side switch. This switch builds in the overcurrent limiting circuit, thermal shutdown circuit, open load detection circuit and under voltage lock out circuit. It also provides the diagnostic output circuit when an abnormality is detected.

### Application

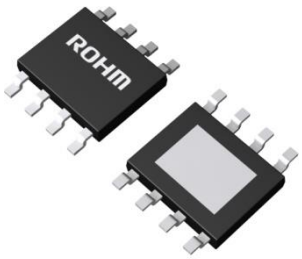
- In-vehicle application (Air conditioners, body devices, meters, etc.)

### Specifications

| | |
|---|---|
| Operating voltage range | 3.5V to 5.5V |
| ON resistance (25°C, Typ.) | 350mΩ |
| Overcurrent limitation (Typ.) | 1.50A |
| Active clamp energy (25°C) | 25mJ |

### Package

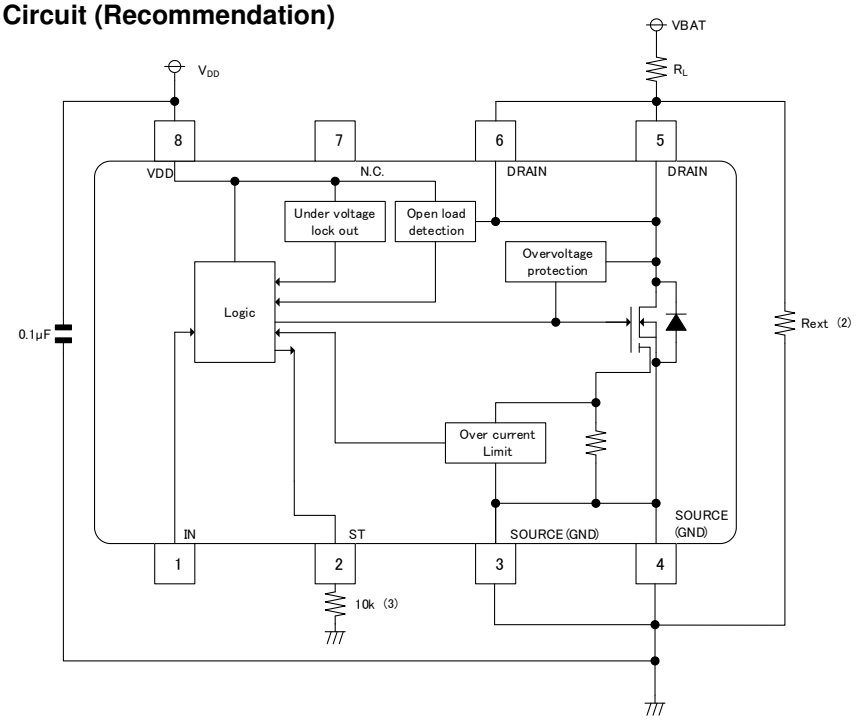
| | |
|---|---|
| HTSOP-J8 | 4.90mm x 6.00mm x 1.00mm |
| MSOP8 | 2.90mm x 4.00mm x 0.90mm |




HTSOP-J8


MSOP8

### Basic Application Circuit (Recommendation)




(2) When the open detection function is required, an external resistance must be added between DRAIN terminal and SOURCE terminal.
(3) It is necessary to detect unusual state(ST terminal is low) when VDD terminal is opened.
When ST pin is not used, it can be open.

○Product configuration: Silicon monolithic integrated circuit ○The product is not designed for radiation resistance.

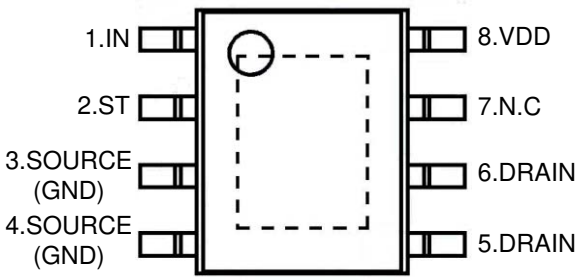
## Pin Descriptions

| Pin No. | Symbol | Function |
|---|---|---|
| 1 | IN | Input terminal; a pull down resistor is connected internally. |
| 2 | ST | Self-diagnostic output terminal; outputs “L” at detection of overcurrent, at open (IN=0V), and in the overheat state. See the truth table. It is structured as COMS inverter output circuit. |
| 3,4 | SOURCE (GND) | Ground terminal |
| 5,6 | DRAIN | Output terminal; limits output current to protect IC when load is short-circuited and current exceeding the overcurrent detection value (0.8A Min) flows to the output terminal. |
| 7 | N.C. | No Connect pin |
| 8 | VDD | Power supply terminal |
| Cooling Tab (1) | TAB | The heat radiation metal on the substrate is connected to the IC sub. Therefore, connect Cooling Tab to the external GND electrical potential (for HTSOP-J8 only). |

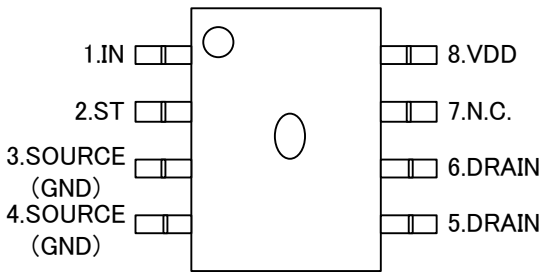
(1)MSOP8 does not have Cooling Tab.

## Pin Configurations

HTSOP-J8
(TOP VIEW)




MSOP8
(TOP VIEW)




| Product Name | PKG | Remarks | TSD function | ON resistance (25°C,Typ) |
|---|---|---|---|---|
| BD1LB500EFJ-C | HTSOP-J8 | Production Line A (2) | Self-restart | 350mΩ |
| BD1LBU50EFJ-C | HTSOP-J8 | Production Line B (2) | | |
| BD1LB500FVM-C | MSOP8 | - | | |

(2) For the purpose of improving production efficiency, Production Line A and B have a multi-line configuration.
Electrical characteristics noted in Datasheet does not differ between Production Line A and B.
Production Line B is recommended for new product.

### Absolute Maximum Ratings

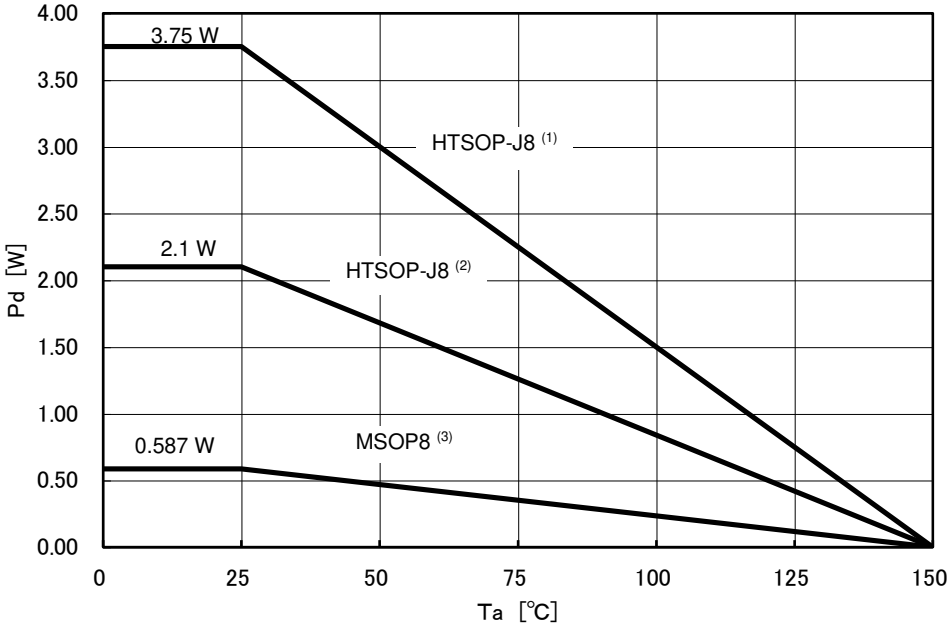
| Item | Symbol | Limit values | Unit |
|---|---|---|---|
| DRAIN-SOURCE voltage | $V_{DS}$ | 42 (internally limited) | V |
| Power supply voltage | $V_{DD}$ | 7 | V |
| Diagnostic output voltage | $V_{ST}$ | -0.3 to +7 (1) | V |
| Output current (DC) | $I_{OD}$ | 0.8 (2) | A |
| Output current (Pulse) | $I_{OP}$ | Internally limited(3) | A |
| Input voltage | $V_{IN}$ | -0.3 to +7 (1) | V |
| Power consumption | Pd | 2.1(HTSOP-J8) (4) | W |
| | | 0.587(MSOP8) (5) | |
| Operating temperature range | $T_{opr}$ | $-40 \leq T_{opr} < +150$ | °C |
| Storage temperature range | $T_{stg}$ | -55 to +150 | °C |
| Maximum junction temperature | $T_{jmax}$ | 150 | °C |
| Active clamp energy (single pulse) | $E_{AS(25°C)}$ | 25 (6) | mJ |
| | $E_{AS(150°C)}$ | 25 (7)(8) | mJ |

### Operating Voltage Ratings

| Item | Code | Limit values | Unit |
|---|---|---|---|
| Operating voltage range | $V_{DD}$ | 3.5 to 5.5 | V |

(1) The condition, $V_{DD} > V_{IN}$, $V_{ST}$ is required.
(2) The value must not exceed Pd.
(3) Internally limited by the overcurrent limiting circuit.
(4) When mounting PCB (70×70[mm], thickness 1.6[mm], copper foil area 70×70[mm], glass epoxy 2-layer substrate).
When using at Ta ≥ 25°C, power dissipation is reduced at 16.8mW/°C.
(5) When mounting PCB (70×70[mm], thickness 1.6[mm], copper foil area is Footprint only, glass epoxy single-layer substrate).
When using at Ta ≥ 25°C, power dissipation is reduced at 4.7mW/°C.
(6) Active clamp energy at $T_{j(0)}$ = 25°C, using single non-repetitive pulse of 0.4A
(7) Active clamp energy at $T_{j(0)}$ = 150°C, using single non-repetitive pulse of 0.4A
(8) Not 100% tested.

### Heat Dissipation Characteristics




(HTSOP-J8) (1) When mounting PCB (70×70[mm], thickness 1.6[mm], copper foil area 70×70[mm], glass epoxy 4-layer substrate)
When using at Ta ≥ 25°C, power dissipation is reduced at 30mW/°C.
(2) When mounting PCB (70×70[mm], thickness 1.6[mm], copper foil area 70×70[mm], glass epoxy 2-layer substrate)
When using at Ta ≥ 25°C, power dissipation is reduced at 16.8mW/°C.

(MSOP8) (3) When mounting PCB (70×70[mm], thickness 1.6[mm], copper foil area is Footprint only, glass epoxy single-layer substrate)
When using at Ta ≥ 25°C, power dissipation is reduced at 4.7mW/°C.

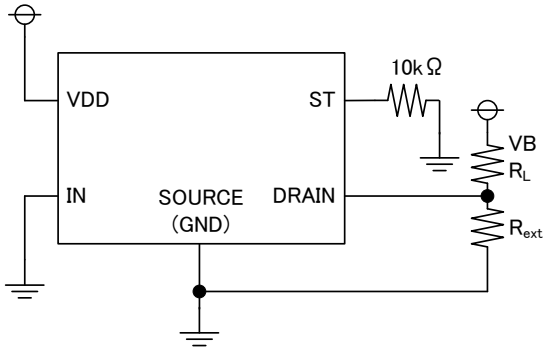
**Electrical Characteristics ($V_{DD}$=3.5V to 5.5V, -40°C≤ $T_j$≤ +150°C unless otherwise is specified)**

| Item | Symbol | Limit values | | | Unit | Condition |
|---|---|---|---|---|---|---|
| | | Min | Typ | Max | | |
| [Power Supply Block] | | | | | | |
| Standby current | $I_{DDS}$ | — | 0 | 10 | μA | $V_{DD}$=5V,$V_{IN}$=0V,$V_B$=12V,$R_L$=47Ω |
| Operating current | $I_{DD}$ | — | 0.5 | 1.0 | mA | $V_{DD}$=5V,$V_{IN}$=5V,$V_B$=12V,$R_L$=47Ω |
| Under voltage lock out threshold voltage | $V_{UVLO}$ | — | 2.5 | 3.0 | V | |
| [Input Block] | | | | | | |
| H level input voltage | $V_{TH1}$ | — | — | $V_{DD}$×0.8 | V | |
| L level input voltage | $V_{TH2}$ | $V_{DD}$×0.2 | — | — | V | |
| Input hysteresis | $V_{HYS}$ | — | 0.40 | — | V | |
| High level input current | $I_{INH1}$ | — | 50 | 100 | μA | $V_{IN}$=5V |
| Low level input current | $I_{INL}$ | -1 | 0 | 1 | μA | $V_{IN}$=0V |
| [Power MOS output] | | | | | | |
| Output ON resistance | $R_{DS(ON)}$ | — | 350 | 450 | mΩ | $V_{IN}$=5V, $V_{DD}$=5V,$I_D$=0.25A,Tj=25°C |
| | $R_{DS(ON)}$ | — | 570 | 750 | mΩ | $V_{IN}$=5V, $V_{DD}$=5V,$I_D$=0.25A,Tj=150°C |
| Output leak current | $I_{L(OFF)}$ | — | — | 10 | μA | $V_{IN}$=0V,$V_{DS}$=12V,Tj=25°C |
| | $I_{L(OFF)}$ | — | — | 100 | μA | $V_{IN}$=0V,$V_{DS}$=12V,Tj=150°C |
| Switching time | $t_{ON}$ | — | 20 | 40 | μs | $V_{DD}$=5V,$V_{IN}$=0V/5V, $R_L$=47Ω |
| | $t_{OFF}$ | — | 20 | 40 | μs | $V_{DD}$=5V,$V_{IN}$=0V/5V, $R_L$=47Ω |
| Slew rate (at ON) | $dV/dt_{ON}$ | 0.5 | 1 | 2 | V/μs | $V_{DD}$=5V,$V_{IN}$=0V/5V, $R_L$=47Ω |
| Slew rate (at OFF) | $-dV/dt_{OFF}$ | 0.5 | 1 | 2 | V/μs | $V_{DD}$=5V,$V_{IN}$=0V/5V, $R_L$=47Ω |
| Output clamp voltage | $V_{CL}$ | 42 | 47 | 52 | V | $V_{IN}$=0V,$I_{OUT}$=-1mA |
| [Diagnostic output] | | | | | | |
| Diagnostic output voltage “L level” | $V_{STL}$ | — | — | 0.4 | V | $V_{DD}$=5V,$V_{IN}$=5V,$I_{ST}$=0.1mA |
| Diagnostic output voltage “H level” | $V_{STH}$ | 4.88 | — | — | V | $V_{DD}$=5V,$V_{IN}$=0V,$I_{ST}$=-0.1mA |
| Diagnostic output current “H level” | $I_{STH}$ | — | — | 10 | μA | $V_{IN}$=0V,$V_{ST}$=5.5V |

**Electrical Characteristics ($V_{DD}$=3.5V to 5.5V, -40°C≤ $T_j$≤ +150°C unless otherwise is specified)**

| Item | Symbol | Rated value | | | Unit | Condition |
|---|---|---|---|---|---|---|
| | | Min | Typ | Max | | |
| [Protective circuit] | | | | | | |
| Overcurrent detection current | $I_{OCP}$ | 0.8 | 1.5 | 2.5 | A | $V_{IN}$=5V |
| Diagnostic output delay time | $t_{DHL}$ | − | 40 | 80 | μs | $V_{DD}$=5V,$R_L$=4Ω to ∞ |
| | $t_{DLH}$ | − | 320 | 640 | μs | $V_{DD}$=5V,$R_L$=∞ to 4Ω |
| Open load detection threshold voltage (1) | $V_{OPEN}$ | 1 | 2 | 3 | V | IN=0V |
| Open load detection time | $t_{OPEN}$ | 100 | 300 | 900 | μs | IN=0V |

(1) To enable detection, an external resistance must be added between DRAIN terminal and SOURCE terminal.
（Determine Rext depending on $R_L$.）




**Definition**

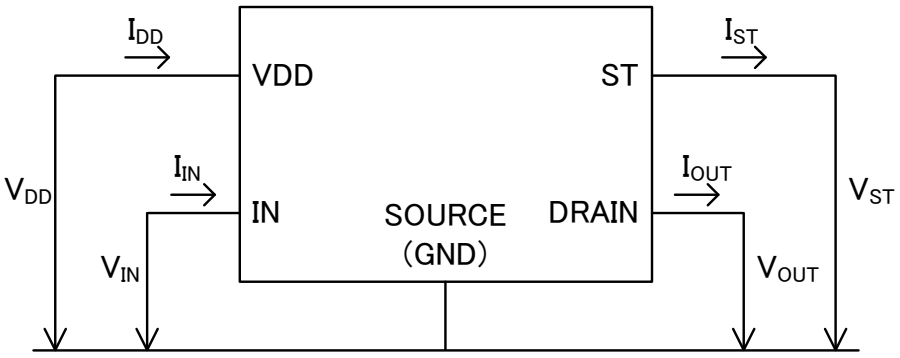



Figure 1. Definition

**Measuring Circuit Diagram**

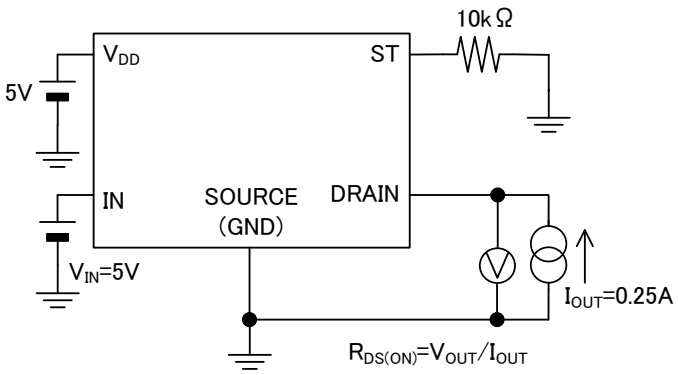



Figure 2. Output ON Resistance Measuring Circuit Diagram

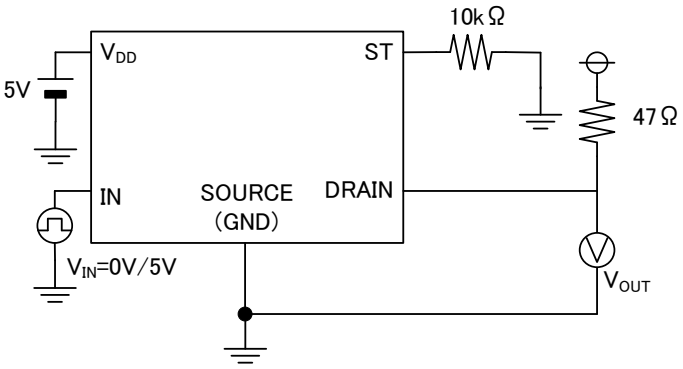



Figure 3. Switching Time Measuring Circuit Diagram

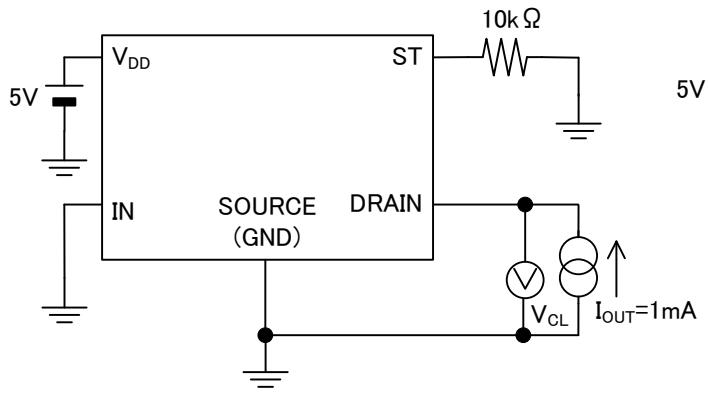



Figure 4. Output Clamp Voltage Measuring Circuit Diagram

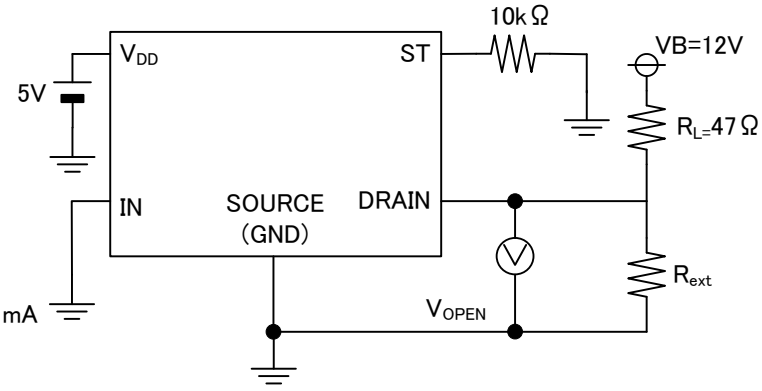



Figure 5. Open Detection Measuring Circuit Diagram

**Diagnostic Output Truth Table**

| $V_{IN}$ | Tj | OUTPUT | | Mode | $V_{ST}$ | Output state |
|---|---|---|---|---|---|---|
| | | $V_{OUT}$ | $I_{OUT}$ | | | |
| H | Tj ≤175°C(Typ) | - | $I_{OUT}$ < 1.5A(Typ) | Normal | H | ON |
| | | | $I_{OUT}$ ≥ 1.5A(Typ) | Overcurrent detection | L | OFF |
| | Tj >175°C(Typ) | - | - | Thermal shut down | L | OFF |
| L | - | H (3.0V or more) | - | Normal | H | OFF |
| | | L (2.0V(Typ) or less) | - | Open load protection | L | OFF |

**Characteristic Data (Reference Data) ($V_{DD}$=5V, IN=5V, Tj=25°C unless otherwise is specified)**

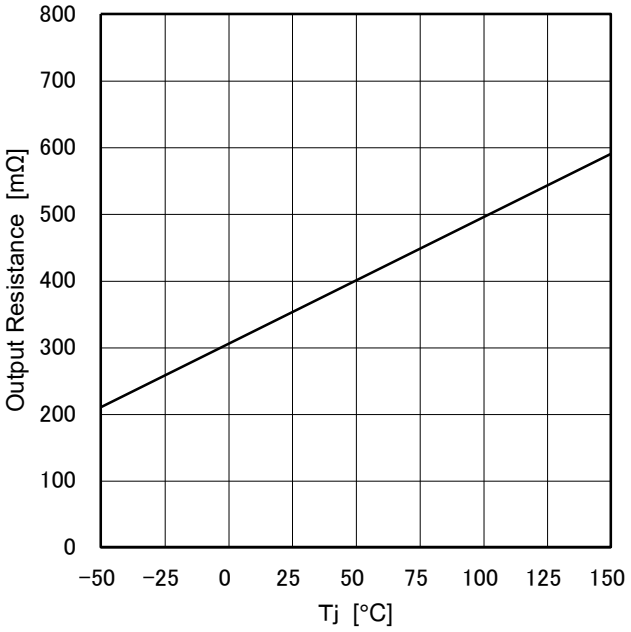



Figure 6. Output ON Resistance Characteristic
[Temperature Characteristic]

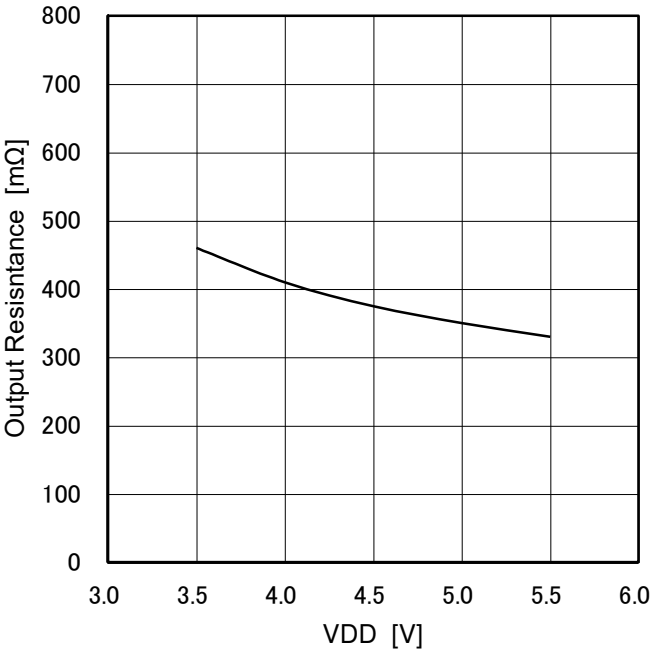



Figure 7. Output ON Resistance Characteristic
[Source Voltage Characteristic]

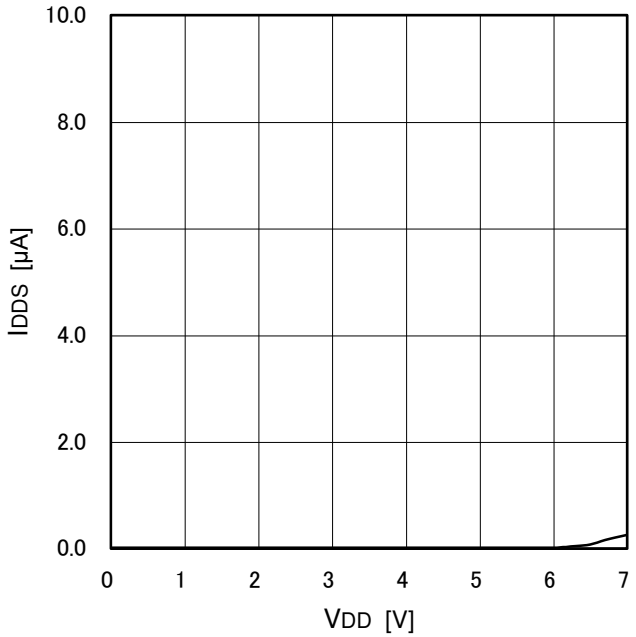



Figure 8. Standby Current Characteristic
[Source Voltage Characteristic]

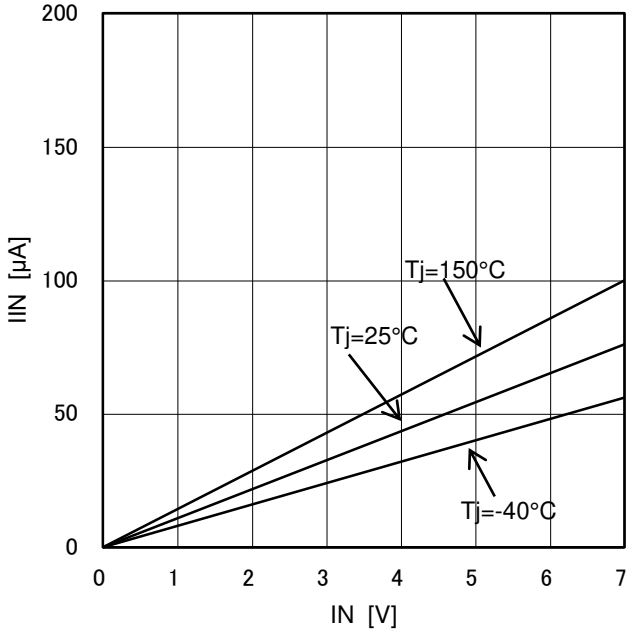



Figure 9. Input Current Characteristic
[Input Voltage Characteristic]

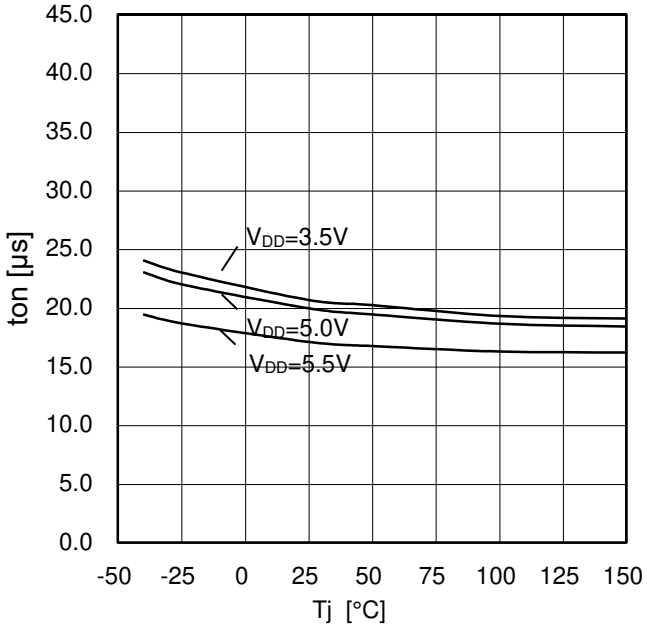



Figure 10. Switching Time (ton) [Temperature Characteristic]

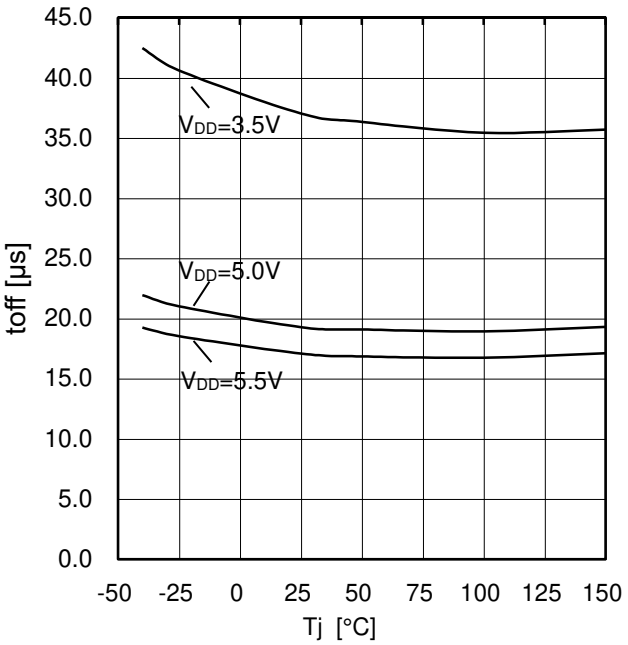



Figure 11. Switching Time (toff) [Temperature Characteristic]

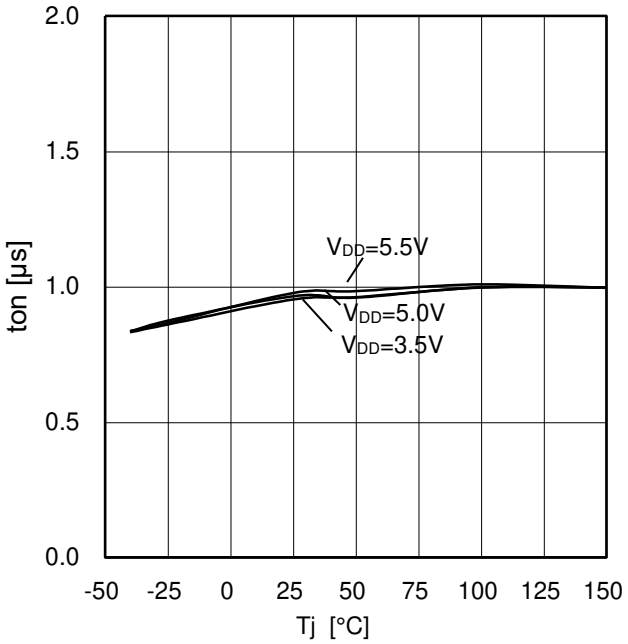



Figure 12. Slew Rate (at ON) [Temperature Characteristic]

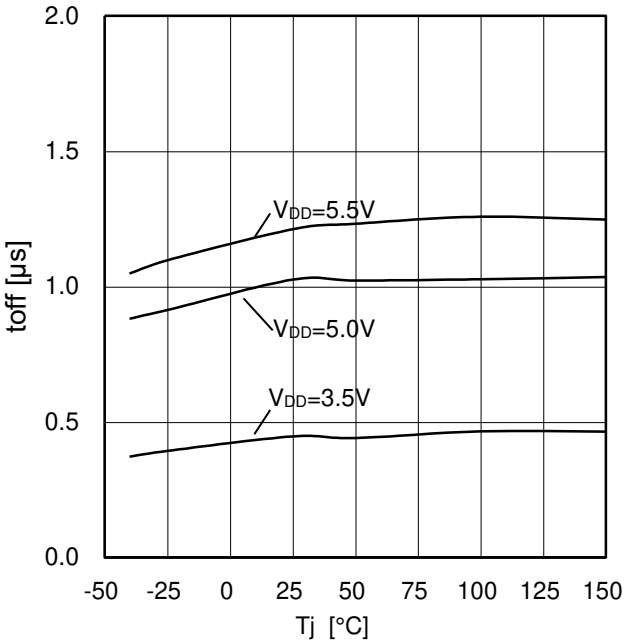



Figure 13. Slew Rate (at OFF) [Temperature Characteristic]

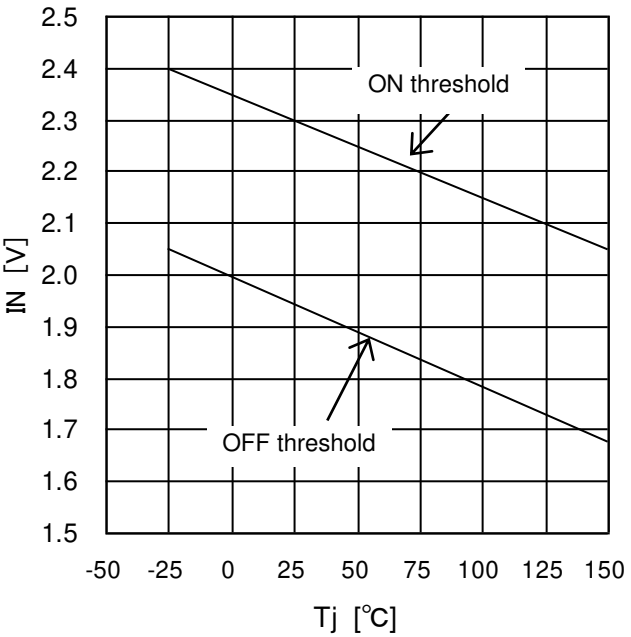



Figure 14. Input Voltage Threshold Characteristic [Temperature Characteristic]

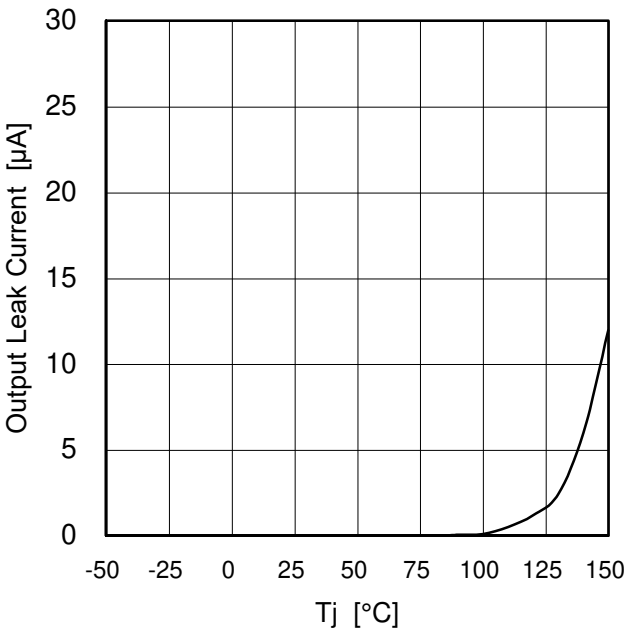



Figure 15. Output Leak Current [Temperature Characteristic] ($V_{IN}$=0V)

**Switching Time Measurement**

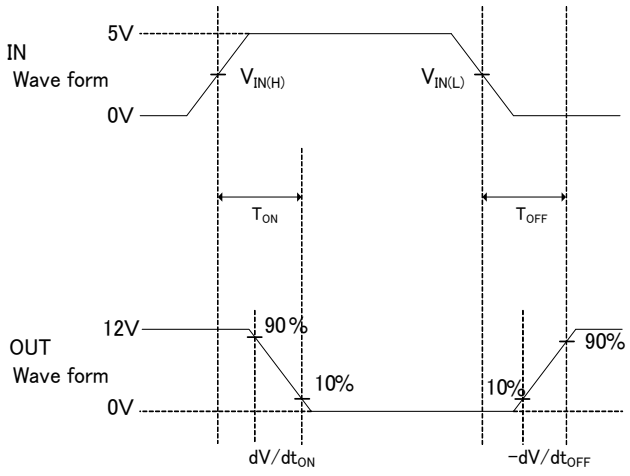



Figure 16. Switching Time

**Timing Chart with Inductive Load**

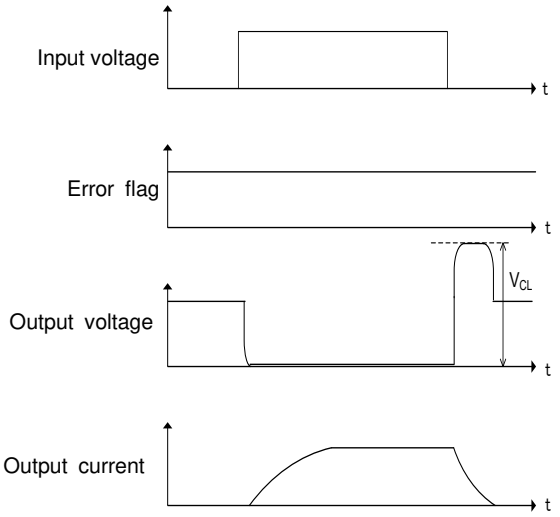



Figure 17.Timing Chart with Inductive Load

### Protective Function Timing Charts

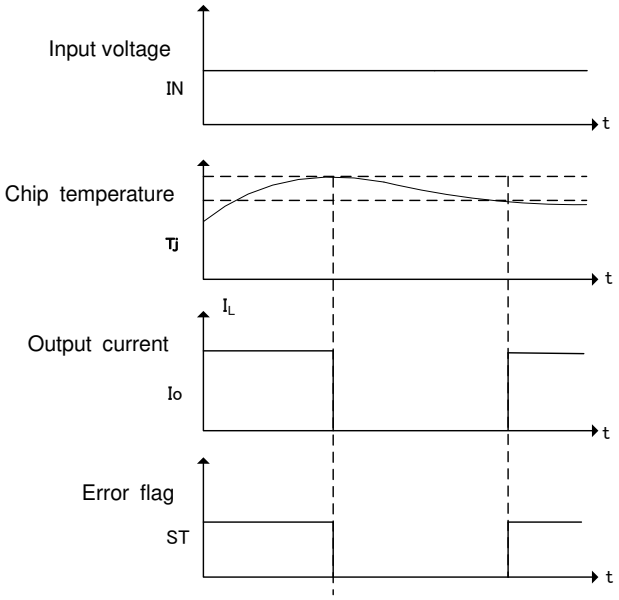



Figure 18. Overheat Protection Timing Chart

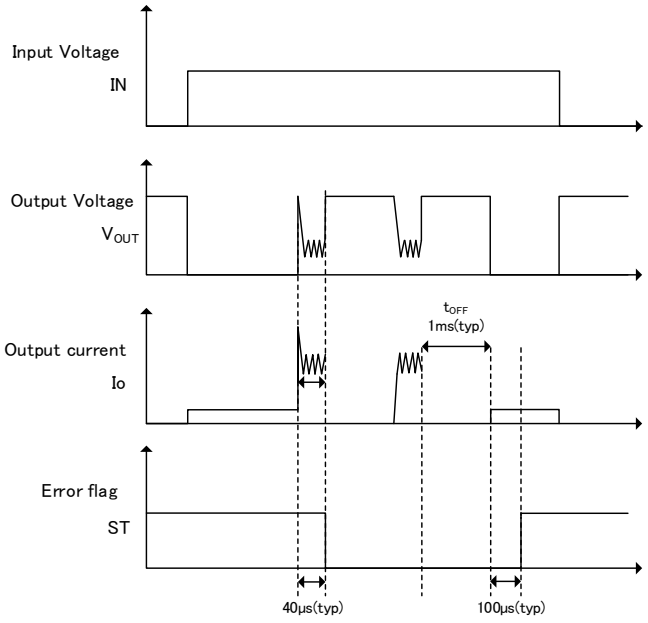



Figure 19. Overcurrent Protection Timing Chart

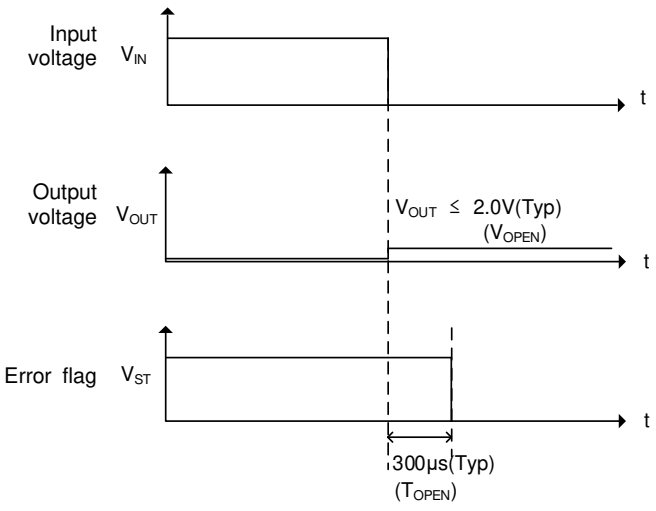
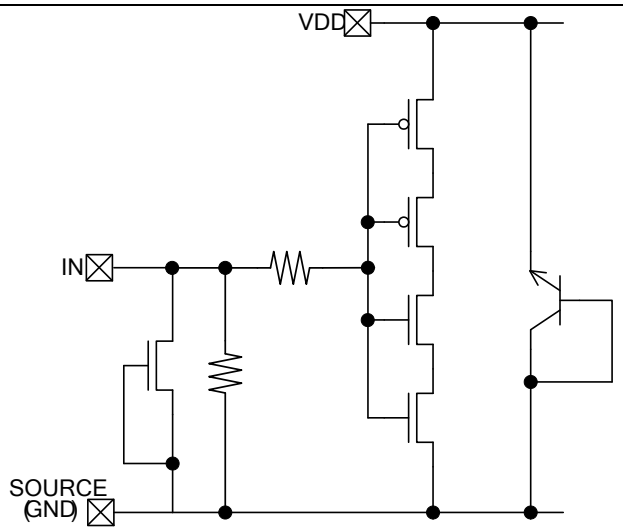
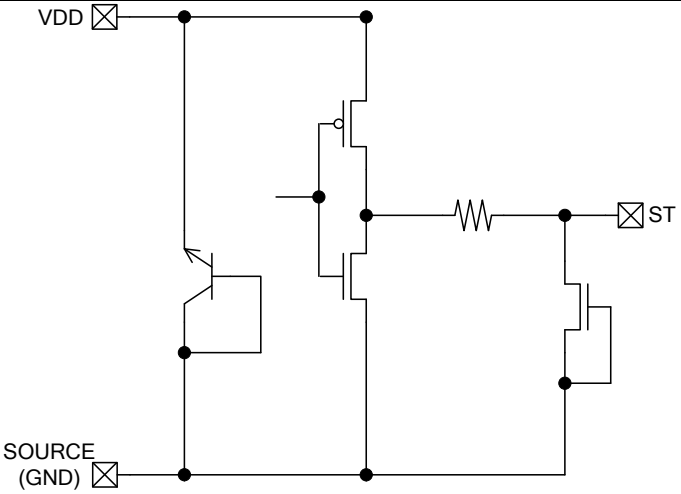
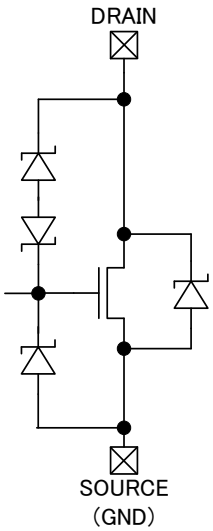



Figure 20. Open Detection Protection Timing Chart

**I/O Equivalent Circuits**

| Pin | Symbol | I/O Equivalent Circuits |
|---|---|---|
| 1 | IN |  |
| 2 | ST |  |
| 3.4 | SOURCE<br>（GND） | |
| 5,6 | DRAIN |  |
| 8 | VDD | |
| Cooling Tab | TAB | |

### Ordering Information

| B | D | 1 | L | B | 5 | 0 | 0 | E | F | J | - | CE2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

PKG
EFJ: HTSOP-J8
Production Line A

C: High reliability
Packaging and forming specification
E2: Embossed tape and reel

| B | D | 1 | L | B | U | 5 | 0 | E | F | J | - | CE2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

PKG
EFJ: HTSOP-J8
Production Line B

C: High reliability
Packaging and forming specification
E2: Embossed tape and reel

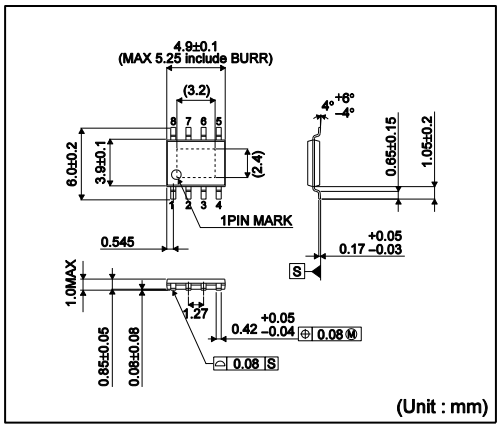
| B | D | 1 | L | B | 5 | 0 | 0 | F | V | M | - | CGTR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

PKG
FVM: MSOP8

C: High reliability
G: Manufacturing code
Packaging and forming specification
TR: Embossed tape and reel

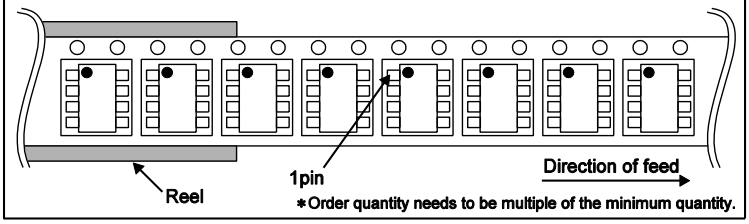
### Physical Dimension Tape and Reel Information

#### HTSOP-J8



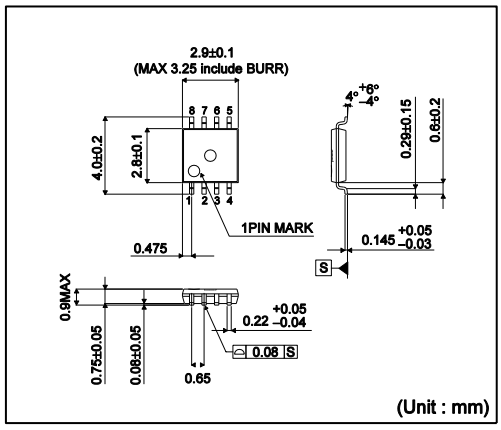

<Tape and Reel information>

| Tape | Embossed carrier tape |
|---|---|
| Quantity | 2500pcs |
| Direction of feed | E2 ( 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 ) |



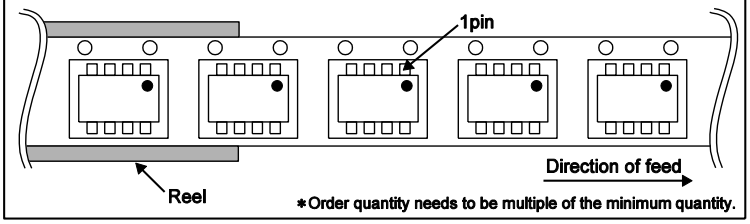

∗Order quantity needs to be multiple of the minimum quantity.

#### MSOP8




<Tape and Reel information>

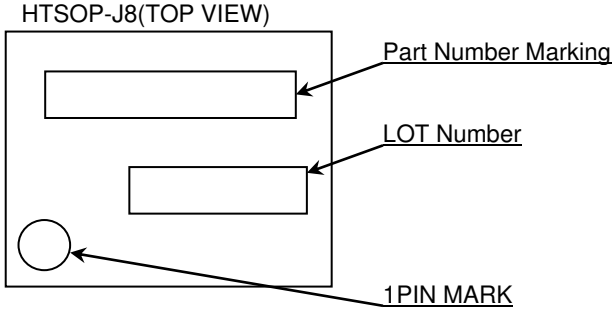
| Tape | Embossed carrier tape |
|---|---|
| Quantity | 3000pcs |
| Direction of feed | TR ( The direction is the 1pin of product is at the upper right when you hold reel on the left hand and you pull out the tape on the right hand ) |




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

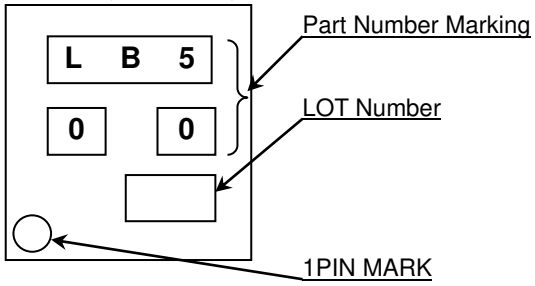
**Marking Diagram**

HTSOP-J8(TOP VIEW)




| Part Number Marking | Part Number |
|---|---|
| LB500E | BD1LB500EFJ-CE2 |
| LBU50E | BD1LBU50EFJ-CE2 |

MSOP8(TOP VIEW)



**Operational Notes**

1) Absolute Maximum Ratings
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 or open circuit modes. Therefore, it is important to consider circuit protection measures, like adding a fuse, in case the IC is expected to be operated in a special mode exceeding the absolute maximum ratings.

2) 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.

3) Power supply lines
Design the PCB layout pattern to provide low impedance ground and 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.

4) Source (GND) Voltage
The voltage of the Source (GND) pin must be the lowest voltage of all pins of the IC at all operating conditions. Ensure that no pins are at a voltage below the ground pin at any time, even during transient condition.

5) Thermal consideration
Use a thermal design that allows for a sufficient margin by taking into account the permissible power dissipation (Pd) in actual operating conditions. Consider Pc that does not exceed Pd in actual operating conditions (Pc≥Pd).

Package Power dissipation : Pd (W)=(Tjmax－Ta)/ $\theta$ ja
Power dissipation : Pc (W)=(Vcc－Vo)×Io+Vcc×Ib

Tjmax : Maximum junction temperature=150℃, Ta : Peripheral temperature[℃] ,
$\theta$ ja : Thermal resistance of package-ambience[℃/W], Pd : Package Power dissipation [W],
Pc : Power dissipation [W], Vcc : Input Voltage, Vo : Output Voltage, Io : Load, Ib : Bias Current

6) Short between pins and mounting errors
Be careful when mounting the IC on printed circuit boards. The IC may be damaged if it is mounted in a wrong orientation or if pins are shorted together. Short circuit may be caused by conductive particles caught between the pins.

7) Thermal shutdown circuit (TSD)
The IC incorporates a built-in thermal shutdown circuit, which is designed to turn off the IC when the internal temperature of the IC reaches 175°C (25°C hysteresis). It is not designed to protect the IC from damage or guarantee its operation. Do not continue to operate the IC after this function is activated. Do not use the IC in conditions where this function will always be activated.

8) Over voltage protection (active clamp)
There is a built-in over voltage protection circuit (active clamp) to absorb the induced current when inductive load is off (Power MOS = off). During active clamp and when IN=0V, TSD will not function so keep IC temperature below 150°C.

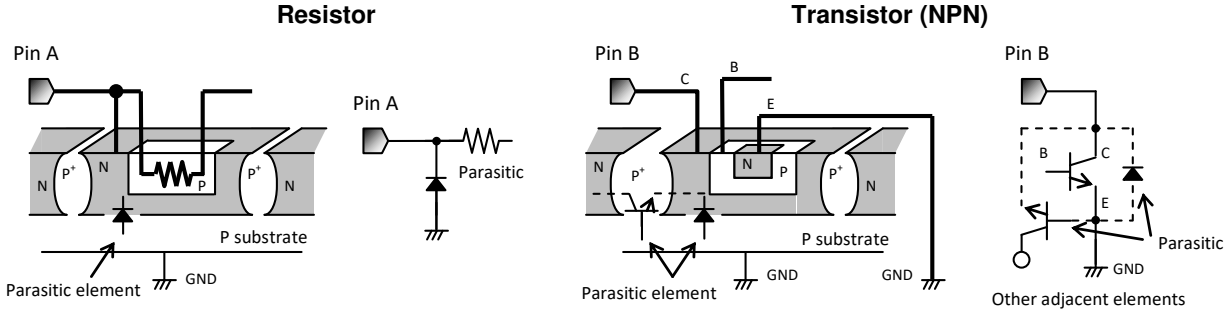
9) Over current protection circuit (OCP)
The IC incorporates an over-current protection circuit that operates in accordance with the rated output capacity. This circuit protects the IC from damage when the load becomes shorted. It is also designed to limit the output current (without latching) in the event of more than 1.5A (typ) flow, such as from a large capacitor or other component connected to the output pin. This protection circuit is effective in preventing damage to the IC in cases of sudden and unexpected current surges. The IC should not be used in applications where the over current protection circuit will be activated continuously.

10) 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.

11) Regarding input pins 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.




Example of monolithic IC structure

12) GND wiring pattern

When using both small-signal and large-current GND 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 GND traces of external components do not cause variations on the GND voltage. The power supply and ground lines must be as short and thick as possible to reduce line impedance.

13) Back electromotive force (BEMF)

There is a possibility that the BEMF is changed by using the operating condition, environment and the individual characteristics of motor. Please make sure there is no problem when operating the IC even though the BEMF is changed.

14) Rush Current

When power is supplied to the IC, inrush current may flow instantaneously. It is possible that the charge current from the parasitic capacitance of the internal logic may be unstable. Therefore, give a special consideration with the power coupling capacitance, power wiring, width of GND wiring, and routing of connections.

15) TAB

IC' sub is already connected to TAB, please short TAB to External GND.

**Revision History**

| Date | Revision | Changes |
|---|---|---|
| 01.Aug.2013 | 003 | New release |
| 06.Aug.2013 | 004 | ・P.11 Figure20 $V_{OUT}$ timing chart is modified. |
| 10.Jan.2014 | 005 | ・P4. Condition of Diagnostic output voltage “L level” is added.<br>・P4. Item of Diagnostic output voltage “H level” is added. |
| 1.Apr.2015 | 006 | ・P1. “AEC-Q100 qualified” is added in Features<br>・P1. Note (1),(2) and (3) are added<br>・P2. Pin No 7 N.C. is added in Pin Description<br>・P2. “Cooling Tab”(Symbol; TAB) is added in Pin Description<br>・P3. Note (6) is added<br>・P4. Min of “ Diagnostic output voltage “H level” “ is changed to 4.88V<br>・P9. ”ton” is changed to “toff” in Figure 11. 13.<br>・P10. Figure 17 is changed<br>・P15. FIN is changed to TAB in 15) |
| 10.Nov.2015 | 007 | ・P3. “Absolute Maximum Ratings” Note (5) is changed<br>・P3. “Heat Dissipation Characteristics” Note(3) is changed |
| 26.May.2017 | 008 | ・P1. “Basic Application Circuit(Recommendation)” Comment of note (3) is added<br>・P3. Active clamp energy (single pulse) limit value of Tj(0)=150°C is added in “Absolute Maximum Ratings”.<br>・P13. Revised expression on the information of Ordering Information. |
| 10.May.2022 | 009 | ・P1.2.13.14 Added BD1LBU50EFJ-C |

# 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 (Exclude cases where no-clean type fluxes is used. However, recommend sufficiently about the residue.); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   [h] Use of the Products in places subject to dew condensation

4. The Products are not subject to radiation-proof design.

5. Please verify and confirm characteristics of the final or mounted products in using the Products.

6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse, is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7. De-rate Power Dissipation depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction temperature.

8. Confirm that operation temperature is within the specified range described in the product specification.

9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

## Precaution for Mounting / Circuit board design

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2. In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

## Precautions Regarding Application Examples and External Circuits

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

## Precaution for Electrostatic

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

## Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
   [a] the Products are exposed to sea winds or corrosive gases, including $Cl_2$, $H_2S$, $NH_3$, $SO_2$, 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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