40 V Withstand Voltage 3.5 A (Peak 6 A) DC Brush Motor Driver with Current Limit

BD64950EFJ

General Description

BD64950EFJ is a built in 1 channel H-bridge motor driver for DC brush motors. This driver can facilitate low power consumption by direct PWM control or PWM constant current control.
There are built-in protection circuits in this IC, which contributes to set high reliability.

Features

- Single Power Supply Input (Rated Voltage of 40 V)
- Rated Output Current: 3.5 A
- Rated Output Current (Peak): 6.0 A
- Low ON Resistance DMOS Output
- Forward, Reverse, Brake, Open Function
- Direct PWM Control
- PWM Constant Current Control (Current Limit Function)
- Built-in Spike Noise Cancel Function (External Noise Filter is Unnecessary)
- Driver for 1 DC Brush Motor
- Built-in Logic Input Pull-Down Resistor
- Cross Conduction Prevention Circuit
- Thermal Shutdown Circuit (TSD)
- Over Current Protection Circuit (OCP)
- Under Voltage Lock Out Circuit (UVLO)
- Protects Against Malfunction when Power Supply is Disconnected (Ghost Supply Prevention Function)
- Microminiature, Ultra-thin and High Heat-radiation (Exposed Metal Type) Package

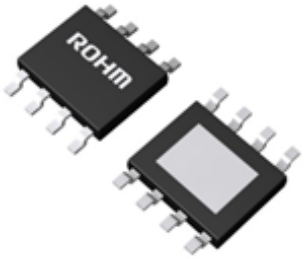
Applications

- Robot Cleaner, Vending Machine, Electric Toilet, PPC, Multi-function Printer, Laser Printer, Inkjet Printer, Photo Printer, FAX, Mini Printer and etc.

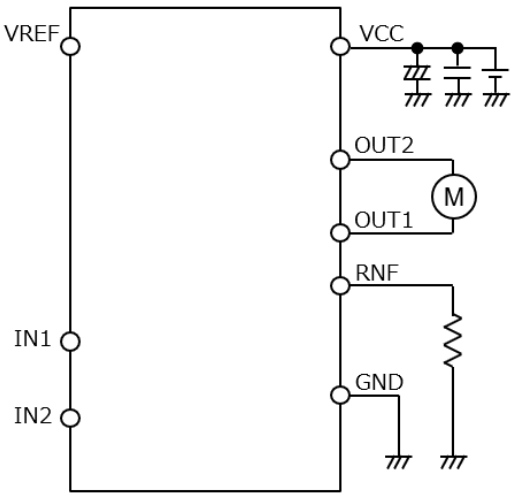
Key Specifications

- Input Voltage Range: 8 V to 40 V
- Rated Output Current (Continuous): 3.5 A
- Rated Output Current (Peak Value): 6.0 A
- Operating Temperature Range: -25 °C to +85 °C
- Output ON Resistance: 0.55 Ω (Typ)

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

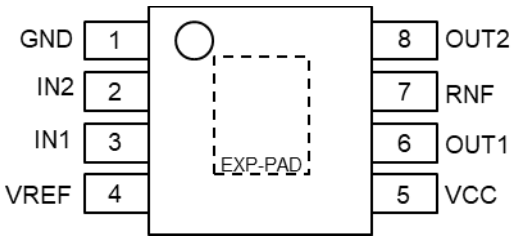


Typical Application Circuit

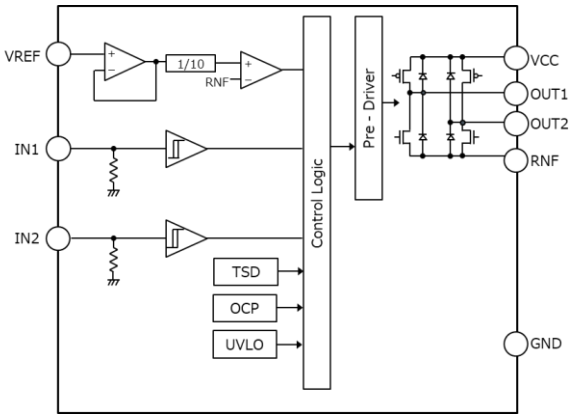


Pin Configuration

[TOP VIEW]



Block Diagram



Pin Descriptions

Pin No.	Pin Name	Function	Pin No.	Pin Name	Function
1	GND	Ground pin	5	VCC	Power Supply pin
2	IN2	H bridge control pin	6	OUT1	H bridge output pin
3	IN1	H bridge control pin	7	RNF	Connection pin of resistor for output current detection
4	VREF	Current limit value setting pin	8	OUT2	H bridge output pin
-	EXP-PAD	The EXP-PAD of the product connect to GND.	-	-	-

Function Explanation

1 VCC/Power supply pin

Motor's drive current is flowing in it, so please connect it in such a way that the wire is thick & short and has low impedance. VCC voltage may have great fluctuation due to motor back EMF, PWM switching noise, etc., so please connect the bypass capacitor (10 µF to 470 µF) as close as possible to the pin. Adjust in such a way that the VCC voltage is stable. Please increase the capacitance if needed, especially when large current or motors that have great back electromotive force are used.
In addition, to reduce the power supply's impedance in wide frequency bandwidth, parallel connection of multilayer ceramic capacitor (0.01 µF to 0.1 µF) is recommended. Extreme care must be observed to make sure that the VCC voltage does not exceed the rating even for a moment.
Moreover, there is a built-in clamp component in the VCC pin to prevent electrostatic destruction. If sudden pulse or surge voltage of more than the maximum absolute rating is applied, the clamp component operates which can result to destruction. Please be sure to not exceed the maximum absolute rating. It is effective to mount a Zener diode with maximum absolute rating. Also, diode is inserted between VCC pin and GND pin to prevent electrostatic destruction. If reverse voltage is applied between VCC pin and GND pin, there is a danger of IC destruction so please be careful.

2 GND/Ground pin

In order to reduce the noise caused by switching current and to stabilize the internal reference voltage of IC, please connect it in such a way that the wiring impedance from this pin is made as low as possible to achieve the lowest electrical potential no matter what operating state it may be.

3 IN1, IN2/H bridge control pin

It decides output logic for H bridge.

Input		Output		State
IN1	IN2	OUT1	OUT2	
L	L	OPEN	OPEN	STANDBY
H	L	H	L	FORWARD
L	H	L	H	REVERSE
H	H	L	L	BRAKE

When STANDBY state to normal state, be careful because there is a delay of 30 µs (Max) before the motor output state becomes FORWARD, REVERSE, and BRAKE.

4 OUT1, OUT2/H bridge output pin

Motor's drive current is flowing in it, so please connect it in such a way that the wire is thick & short and has low impedance. It is also effective to add a Schottky diode if output has great positive or negative fluctuation when large current is applied. For example, a counter electromotive voltage etc. is great.
Moreover, there is a built-in clamp component in the output pin to prevent electrostatic destruction. If sudden pulse or surge voltage of more than the maximum absolute rating is applied, the clamp component operates which can result to destruction. Please be sure to not exceed the maximum absolute rating.

5 RNF/Connection pin of resistor for output current detection

When using PWM constant current mode, to avoid exceeding the absolute maximum ratings, insert current detecting resister 0.1 Ω to 0.3 Ω between RNF and GND. Do not exceed the rating because there is the possibility of circuits' malfunction etc., if the RNF voltage has exceeded the maximum rating (0.7 V).
In addition, when a small value of resistor is used, be careful because effect of board wiring resistance becomes larger.
The power consumption of current detecting resistor (W) can be calculated by the motor output current value (I_{OUT}) and resistance for current detecting resistor (R).

$$\mathrm{W[W]} = {I_{OUT}}^2 \times R_{RNF}$$

Where:

W : is the power consumption of current detecting resistor [W]
I_{OUT} : is the motor output current value [A]
R_{RNF} : is the current-detecting resistor [Ω]

To avoid exceeding the rated power consumption of the resistor, consider its power consumption.
In addition, design it in such a way it that it has low impedance and does not have a common impedance with other GND patterns because motor's drive current flows through this pattern from the RNF pin to current-detecting resistor to GND.
If the RNF pin is open, then there is the possibility of such malfunction as output current does not flow either, so do not let it open.
In addition, if PWM constant current mode is not used, to short RNF and GND.

Function Explanation – continued

6 VREF/Current limit value setting pin

This is the pin to set the current limit value for PWM constant current control or peak current limit.
The current limit value can be set by VREF voltage and current-detecting resistor (RNF resistor).

$$I_{OUT}\ [A] = \frac{V_{VREF}}{10} \times \frac{1}{R_{RNF}}$$

Where:

I_{OUT}	:	is the motor output current value [A]
V_{VREF}	:	is the voltage of current limit value setting pin [V]
R_{RNF}	:	is the current-detecting resistor [Ω]

Please avoid using it with VREF pin open. If VREF pin is open, there is possibility of malfunctions as the setting current increases and a large current flow etc. This is caused by unstable input and increasing VREF voltage. Please take note of the input voltage range because if voltage of over 3 V is applied on VREF pin, there is also a danger that large current flows in the output and OCP or TSD will operate.
The minimum current, which can be controlled by VREF voltage, is determined by motor coil's L & R values and minimum ON time. There is a minimum ON time in PWM drive.

7 IC Back Metal

HTSOP-J8 package has a metal for heat dissipation on the back of the IC. Since it is assumed to be used by applying heat dissipation treatment to this metal, always GND on the substrate connect with the plane and solder, and use the GND pattern widely to ensure sufficient heat dissipation area. In addition, the backside metal is short and the back of the IC chip, so it has become a GND potential. Because there is a possibility of malfunction and destruction when it is short and the potential other than GND, never pass the wiring pattern other than GND on the back of the IC.

Protection Circuits

1 Thermal Shutdown (TSD)

This IC has a built-in thermal shutdown circuit for thermal protection. When the IC's chip temperature rises 175 °C (Typ) or more, the motor output becomes open. Also, when the temperature returns to 150 °C (Typ) or less, it automatically returns to normal operation. However, even when TSD is in operation, if heat is continued to be added externally, heat overdrive can lead to destruction.

2 Over Current Protection (OCP)

This IC has a built-in over current protection circuit as a provision against destruction when the motor outputs are shorted each other or VCC-motor output or motor output-GND is shorted. This circuit puts the motor output to OPEN condition for 400 µs (Typ) when the regulated current flows for 2 µs (Typ) and then returns. The over current protection circuit's only aim is to prevent the destruction of the IC from irregular situations such as motor output shorts, and is not meant to be used as protection or security for the set. Therefore, sets should not be designed to take into account this circuit's functions. After OCP operating, if the power is turned on again in an abnormal state, then OCP operates repeatedly and the IC may generate heat or otherwise deteriorate. When the L value of the wiring is great due to the wiring being long, the motor outputs are shorted each other or VCC-motor output or motor output-GND is shorted, if the output pin voltage jumps up and the absolute maximum values can be exceeded after the over current has flowed, there is a possibility of destruction. Also, when current which is the output current rating or more and the OCP detection current or less flows, the IC can heat up to Tjmax = 150 °C exceeds and can deteriorate, so current which or more the output rating should not be applied.

3 Under Voltage Lock Out (UVLO)

This IC has a built-in under voltage lock out function to prevent false operation such as IC output during power supply under voltage is low. When the applied voltage to the VCC pin goes 5 V (Typ) or less, the motor output is set to open. This switching voltage has a 1 V (Typ) hysteresis to prevent false operation by noise etc.

4 Protects against malfunction when power supply is disconnected (Ghost Supply Prevention Function)

If a control signal*(Note 1)* is input when there is no power supplied to this IC, there is a function which prevents a malfunction where voltage is supplied to power supply of this IC or other IC in the set via the electrostatic destruction prevention diode from these input pins to the VCC. Therefore, there is no malfunction of the circuit even when voltage is supplied to these input pins while there is no power supply.

(Note 1) control signal = IN1, IN2, VREF

5 Operation Under Strong Electromagnetic Field

The IC is not designed for using in the presence of strong electromagnetic field. Be sure to confirm that no malfunction is found when using the IC in a strong electromagnetic field.

Absolute Maximum Ratings (Ta = 25 °C)

Parameter	Symbol	Rating	Unit
Supply Voltage	V_{CC}	40	V
Input Voltage for Control Pin *(Note 1)*	V_{IN}	-0.3 to +6.0	V
RNF Maximum Voltage	V_{RNF}	0.7	V
Output Current (Continuous)	I_{OUT}	3.5 *(Note 2)*	A
Output Current (Peak Value)	$I_{OUTPEAK}$	6.0 *(Note 3)*	A
Storage Temperature Range	Tstg	-55 to +150	°C
Maximum Junction Temperature	Tjmax	150	°C

(Note 1) Control Logic Input = IN1, IN2, VREF
(Note 2) Duty cycle = 100 %
(Note 3) T_W < 500 ns

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: *To avoid exceeding the maximum voltage of 0.7 V on the RNF pin at the maximum load in the case of selecting a resistor for current detection. If an overcurrent occurs, this rating may be exceeded in a short time.*

Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	V_{CC}	8	24	40	V
Operating Temperature	Topr	-25	+25	+85	°C
Maximum Output Current (Continuous)	I_{OUT}	-	-	3.5 *(Note 4)*	A

(Note 4) Do not exceed Tjmax = 150 °C

Thermal Resistance *(Note 5)*

Parameter	Symbol	Thermal Resistance (Typ)		Unit
		1s *(Note 7)*	2s2p *(Note 8)*	
HTSOP-J8				
Junction to Ambient	θ_{JA}	130.50	26.40	°C/W
Junction to Top Characterization Parameter *(Note 6)*	Ψ_{JT}	9.00	3.00	°C/W

(Note 5) Based on JESD51-2A (Still-Air), using a BD64950EFJ Chip.
(Note 6) The thermal characterization parameter to report the difference between junction temperature and the temperature at the top center of the outside surface of the component package.
(Note 7) Using a PCB board based on JESD51-3.
(Note 8) Using a PCB board based on JESD51-5, 7.

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

Top	
Copper Pattern	Thickness
Footprints and Traces	70 µm

Layer Number of Measurement Board	Material	Board Size	Thermal Via *(Note 9)*	
			Pitch	Diameter
4 Layers	FR-4	114.3 mm x 76.2 mm x 1.6 mmt	1.20 mm	Φ0.30 mm

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

(Note 9) This thermal via connect with the copper pattern of layers 1,2, and 4. The placement and dimensions obey a land pattern.

Electrical Characteristics (Unless otherwise specified V_{CC} = 24 V, Ta = 25 °C)

Item	Symbol	Min	Typ	Max	Unit	Condition
[Whole]						
Circuit Current at Standby	I_{CCST}	-	0	1	μA	IN1 = IN2 = 0 V
Circuit Current	I_{CC}	-	2.4	5.0	mA	IN1 = 5 V, IN2 = 0 V
[Control Logic Input*(Note 1)*]						
H-level Input Voltage	V_{INH}	2.0	-	-	V	
L-level Input Voltage	V_{INL}	-	-	0.8	V	
H-level Input Current	I_{INH}	-	40	100	μA	V_{IN} = 2.0 V
Control Logic Input Pulldown Resistance	$R_{LOGIC(PD)}$	-	50	-	kΩ	
Standby Timer	t_{ST}	-	1.0	1.5	ms	IN1 = IN2 < $V_{INL(max)}$
[Output*(Note 2)*]						
Output ON Resistance	R_{ON}	-	0.55	0.70	Ω	I_{OUT} = ±2.5 A (Sum of upper and lower)
Output Leak Current	I_{LEAK}	-	-	1	μA	
[Current Control]						
VREF Input Voltage Range	V_{VREF}	0	-	3.0	V	
Minimum ON Time (Cancel Time)	t_{ONMIN}	2	3	4	μs	
Fixed OFF Time	t_{OFF}	16	25	34	μs	
Comparator Threshold	V_{CTH}	0.289	0.300	0.311	V	V_{VREF} = 3 V

(Note 1) Control Logic Input = IN1, IN2
(Note 2) Output = OUT1, OUT2

Direct PWM Control

This series can drive motors by IN1 and IN2 input directly from the microcomputer (up to 5 μs pulse width).
SLOW DECAY can be used for DECAY mode.
The control sequence example and the current decay route are shown below:

SLOW DECAY (Forward Rotation)

Input		Output		State
IN1	IN2	OUT1	OUT2	
H	L	H	L	ON
H	H	L	L	SLOW DECAY
H	L	H	L	ON
H	H	L	L	SLOW DECAY
H	L	H	L	ON

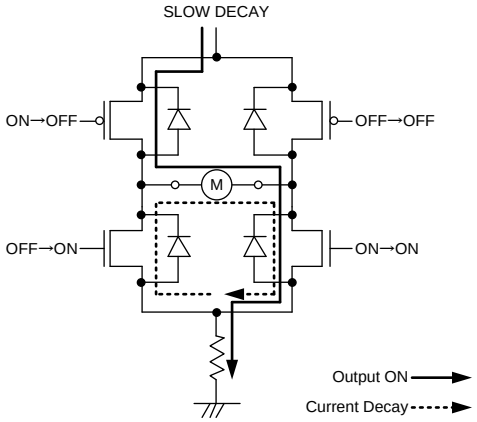


Figure 1. Route of Regenerative Current during Current Decay

PWM Constant Current Control

This function can limit the peak current or switching current in driving DC brush motor.

1 Current Control Operation

When the output transistor is turned on, the output current increases. The output current is converted to voltage due to the connected external resistance to the RNF pin. When the voltage on the RNF pin reaches the voltage value set by the VREF input voltage, the current limit comparator operates and enters current decay mode. Output turns on again after fixed off time. The process repeats itself with chopping period (t_{CHOP}).

2 Cancel Time (Fixed in Internal Circuit)

In order to avoid misdetection of current detection comparator due to RNF spike noise that may occur when the output turns on, the IC has the minimum on time t_{ONMIN} (Cancel Time). The current detection is invalid from the output transistor turned on to 3.0 μs (Typ). This allows for constant-current drive without the need for an external filter.

3 Current Limit

Maximum value of current limit can be set by VREF voltage and current-detecting resistor (RNF resistor).
The transconductance function is approximated by the maximum value of current limit ($I_{TripMAX}$).

$$I_{TripMAX}\ [A] \fallingdotseq \frac{V_{VREF}}{10 \times R_{RNF}}$$

V_{VREF} : is the voltage of current limit value setting pin [V]
R_{RNF} : is the current-detecting resistor [Ω]

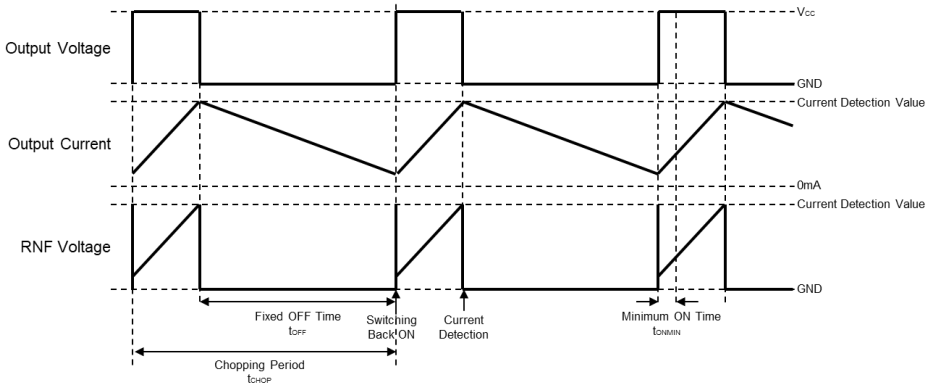
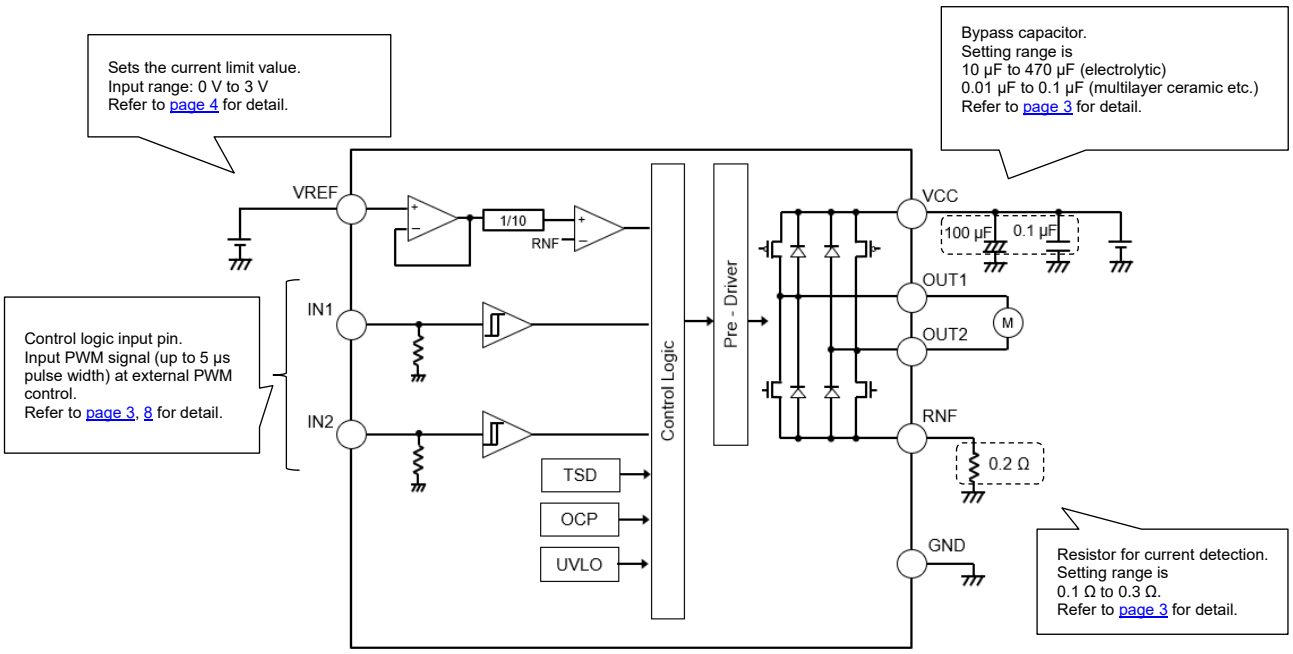


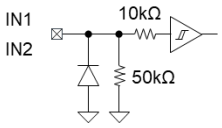
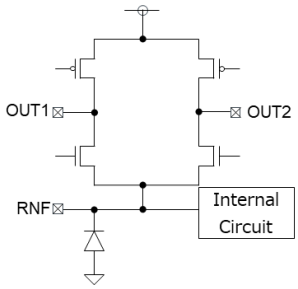
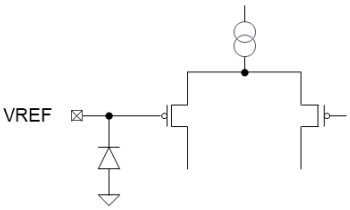
Figure 2. Decay Mode Timing Chart

Application Example

PWM Constant Current Control



I/O Equivalence Circuits

Pin No.	Pin Name	Equivalence Circuits	Pin No.	Pin Name	Equivalence Circuits
2	IN2		6	OUT1	
3	IN1		7	RNF	
			8	OUT2	
4	VREF		-	-	

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
Ensure that no pins are at a voltage below that of the ground pin at any time, even during transient condition. However, pins that drive inductive loads (e.g. motor driver outputs, DC-DC converter outputs) may inevitably go below ground due to back EMF or electromotive force. In such cases, the user should make sure that such voltages going below ground will not cause the IC and the system to malfunction by examining carefully all relevant factors and conditions such as motor characteristics, supply voltage, operating frequency and PCB wiring to name a few.

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 especially to ground, power supply and output pin. Inter-pin shorts could be due to many reasons such as metal particles, water droplets (in very humid environment) and unintentional solder bridge deposited in between pins during assembly to name a few.

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

Operational Notes – continued

10 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.

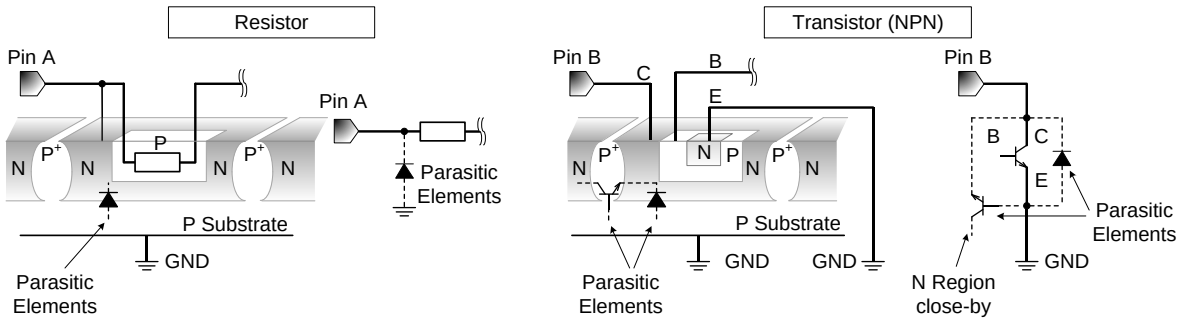


Figure 3. Example of Monolithic IC Structure

11 Ceramic Capacitor

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

12 Thermal Shutdown Circuit (TSD)

This IC has a built-in thermal shutdown circuit that prevents heat damage to the IC. Normal operation should always be within the IC's maximum junction temperature rating. If however the rating is exceeded for a continued period, the junction temperature (Tj) will rise which will activate the TSD circuit 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 circuit operates in a situation that exceeds the absolute maximum ratings and therefore, under no circumstances, should the TSD circuit be used in a set design or for any purpose other than protecting the IC from heat damage.

13 Over Current Protection Circuit (OCP)

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

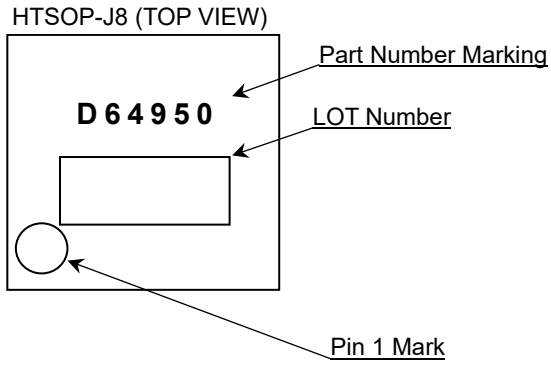
Ordering Information

B	D	6	4	9	5	0	E	F	J	-	E 2

Package
EFJ: HTSOP-J8

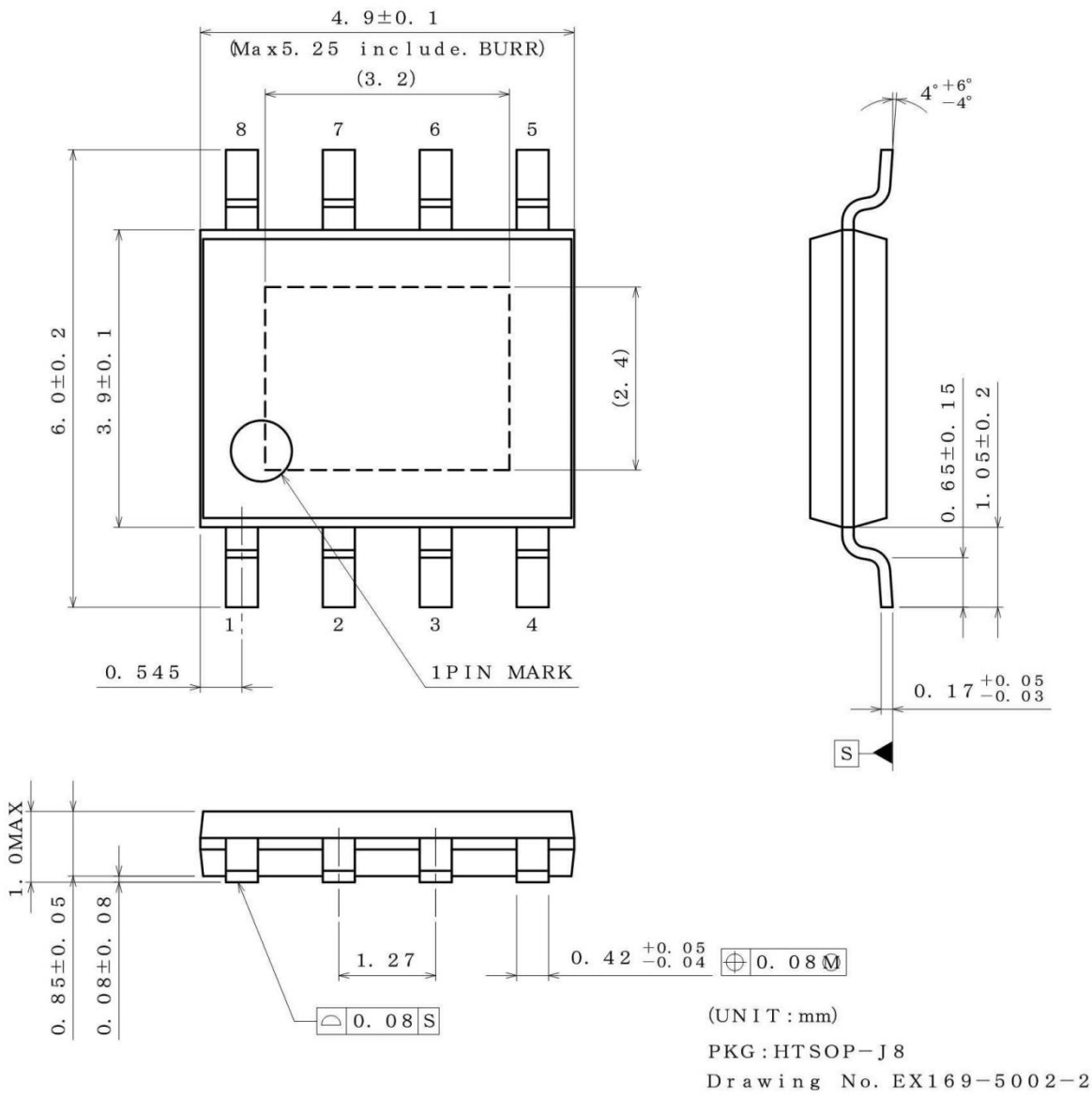
Packaging and forming specification
E2: Embossed tape and reel

Marking Diagram



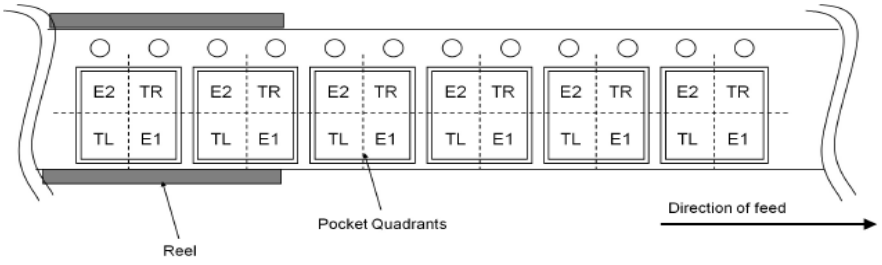
Physical Dimension and Packing Information

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
31.Oct.2023	001	New Release

Notice

Precaution on using ROHM Products

1. Our Products are designed and manufactured for application in ordinary electronic equipment (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, 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:
   [a] Installation of protection circuits or other protective devices to improve system safety
   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3. Our Products are designed and manufactured for use under standard conditions and not under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
   [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl_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.

Precaution for Product Label

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

Precaution for Disposition

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

Precaution for Foreign Exchange and Foreign Trade act

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

Precaution Regarding Intellectual Property Rights

1. All information and data including but not limited to application example contained in this document is for reference only. ROHM does not warrant that foregoing information or data will not infringe any intellectual property rights or any other rights of any third party regarding such information or data.

2. ROHM shall not have any obligations where the claims, actions or demands arising from the combination of the Products with other articles such as components, circuits, systems or external equipment (including software).

3. No license, expressly or implied, is granted hereby under any intellectual property rights or other rights of ROHM or any third parties with respect to the Products or the information contained in this document. Provided, however, that ROHM will not assert its intellectual property rights or other rights against you or your customers to the extent necessary to manufacture or sell products containing the Products, subject to the terms and conditions herein.

Other Precaution

1. This document may not be reprinted or reproduced, in whole or in part, without prior written consent of ROHM.

2. The Products may not be disassembled, converted, modified, reproduced or otherwise changed without prior written consent of ROHM.

3. In no event shall you use in any way whatsoever the Products and the related technical information contained in the Products or this document for any military purposes, including but not limited to, the development of mass-destruction weapons.

4. The proper names of companies or products described in this document are trademarks or registered trademarks of ROHM, its affiliated companies or third parties.

General Precaution

1. Before you use our Products, you are requested to carefully read this document and fully understand its contents. ROHM shall not be in any way responsible or liable for failure, malfunction or accident arising from the use of any ROHM's Products against warning, caution or note contained in this document.

2. All information contained in this document is current as of the issuing date and subject to change without any prior notice. Before purchasing or using ROHM's Products, please confirm the latest information with a ROHM sales representative.

3. The information contained in this document is provided on an "as is" basis and ROHM does not warrant that all information contained in this document is accurate and/or error-free. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties resulting from inaccuracy or errors of or concerning such information.