For brush motors

H-bridge driver

BD62222HFP

No.09007EAT04

● Overview

BD62222HFP is full bridge driver for brush motor applications. This IC can operate at a wide range of power-supply voltages (from 6V to 27V), supporting output currents of up to 2.5A. MOS transistors in the output stage allow for PWM signal control. The replacement is also easy because of the pin compatible with BD623XHFP series.

● Features

1) Built-in one channel driver
2) Low standby current
3) Supports PWM control signal input (20kHz to 100kHz)
4) Cross-conduction prevention circuit
5) Four protection circuits provided: OCP, OVP, TSD and UVLO

● Applications

VCR; CD/DVD players; audio-visual equipment; optical disc drives; PC peripherals;
car audios; car navigation systems; OA equipments

● Absolute maximum ratings (Ta=25°C, All voltages are with respect to ground)

Parameter	Symbol	Ratings	Unit
Supply voltage	VCC	30	V
Output current	I_{OMAX}	2.5 *1	A
All other input pins	V_{IN}	-0.3 ~ VCC	V
Operating temperature	T_{OPR}	-40 ~ +85	°C
Storage temperature	T_{STG}	-55 ~ +150	°C
Power dissipation	Pd	1.4 *2	W
Junction temperature	T_{jmax}	150	°C

*1 Do not, exceed Pd or ASO.
*2 HRP7 package. Mounted on a 70mm x 70mm x 1.6mm FR4 glass-epoxy board with less than 3% copper foil. Derated at 11.2mW/°C above 25°C.

● Operating conditions (Ta=25°C)

Parameter	Symbol	Ratings	Unit
Supply voltage	VCC	6 ~ 27	V

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● **Electrical characteristics** (Unless otherwise specified, Ta=25°C and VCC=24V)

Parameter	Symbol	Limits			Limits	Conditions
		Min.	Min.	Min.		
Supply current	I_{CC}	0.9	1.4	2.7	mA	Forward / Reverse / Brake
Stand-by current	I_{STBY}	-	0	10	µA	Stand-by
Input high voltage	V_{IH}	2.0	-	-	V	
Input low voltage	V_{IL}	-	-	0.8	V	
Input bias current	I_{IH}	30	50	100	µA	V_{IN}=5.0V
Output ON resistance	R_{ON}	0.5	1.0	1.5	Ω	I_O=1.0A, vertically total
Input frequency range	F_{MAX}	20	-	100	kHz	FIN / RIN

● **Block diagram and pin configuration**

BD62222HFP

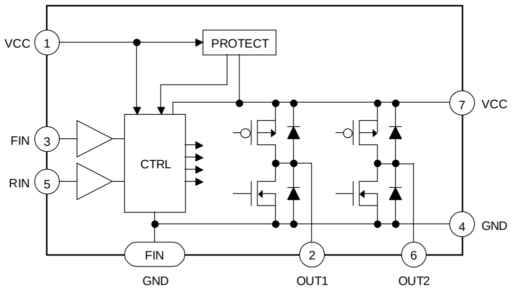

Fig.1 BD62222HFP

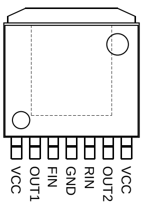

Fig.2 HRP7 package

Table 1 BD62222HFP

Pin	Name	Function
1	VCC	Power supply
2	OUT1	Driver output
3	FIN	Control input (forward)
4	GND	Ground
5	RIN	Control input (reverse)
6	OUT2	Driver output
7	VCC	Power supply
FIN	GND	Ground

Note: Use all VCC pin by the same voltage.

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● Electrical characteristic curves (Reference data)

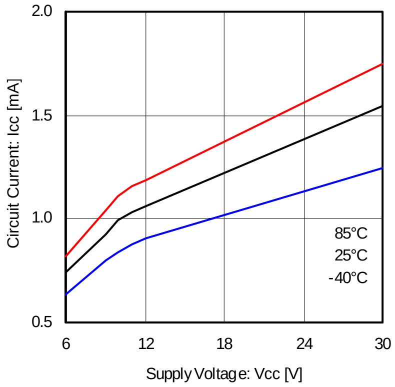

Fig.3 Supply current

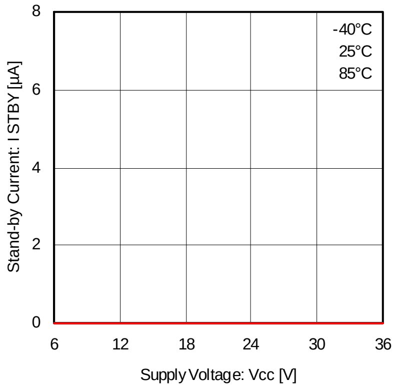

Fig.4 Stand-by current

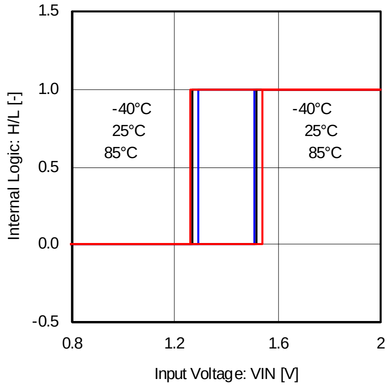

Fig.5 Input threshold voltage

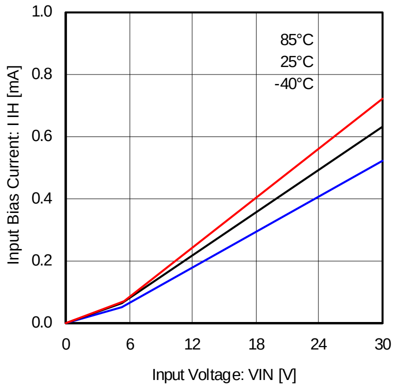

Fig.6 Input bias current

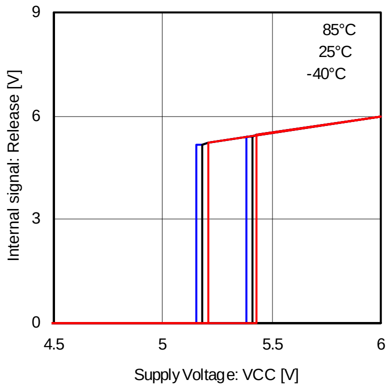

Fig.7 Under voltage lock out

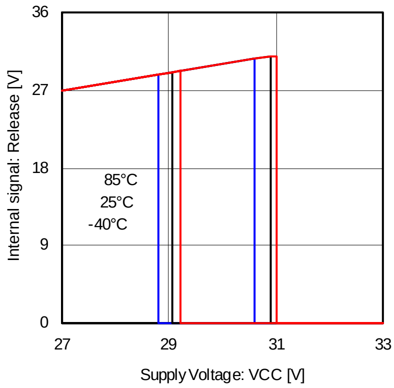

Fig.8 Over voltage protection

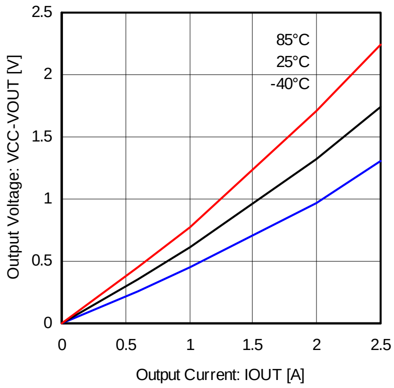

Fig.9 Output high voltage

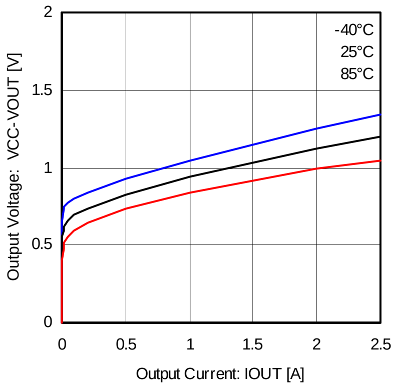

Fig.10 High side body diode

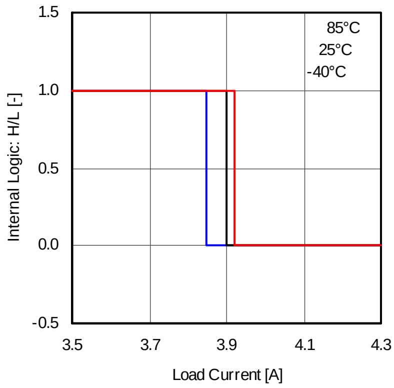

Fig.11 Over current protection (H side)

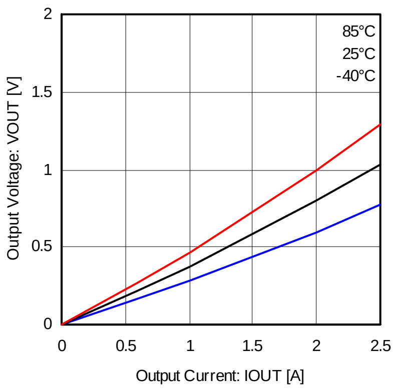

Fig.12 Output low voltage

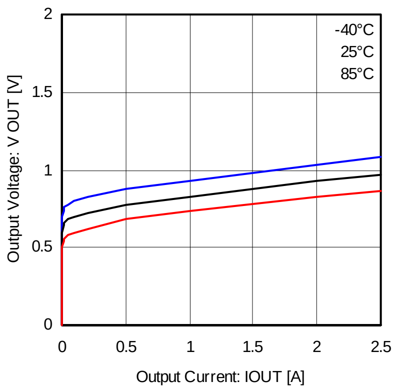

Fig.13 Low side body diode

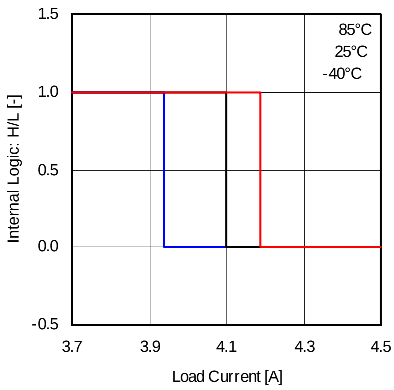

Fig.14 Over current protection (L side)

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● Functional descriptions

1) Operation modes

Table 2 Logic table

	FIN	RIN	OUT1	OUT2	Operation
a	L	L	Hi-Z*	Hi-Z*	Stand-by (idling)
b	H	L	H	L	Forward (OUT1 > OUT2)
c	L	H	L	H	Reverse (OUT1 < OUT2)
d	H	H	L	L	Brake (stop)
e	PWM	L	H	$\overline{\text{PWM}}$	Forward (PWM control)
f	L	PWM	$\overline{\text{PWM}}$	H	Reverse (PWM control)

* Hi-Z is the off state of all output transistors. Please note that this is the state of the connected diodes, which differs from that of the mechanical relay.

a) Stand-by mode

In stand-by mode, all internal circuits are turned off, including the output power transistors. Motor output goes to high impedance. If the motor is running at the switch to stand-by mode, the system enters an idling state because of the body diodes. However, when the system switches to stand-by from any other mode (except the brake mode), the control logic remains in the high state for at least 50µs before shutting down all circuits.

b) Forward mode

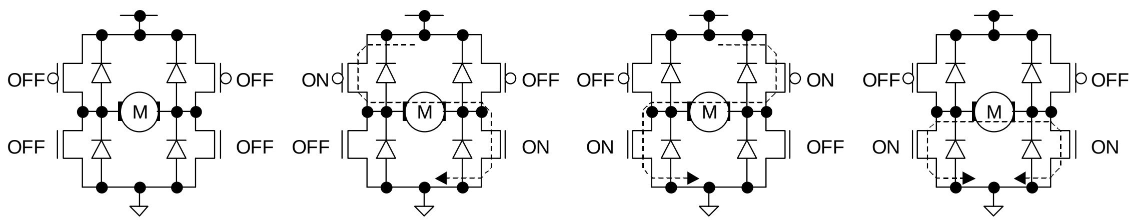
This operating mode is defined as the forward rotation of the motor when the OUT1 pin is high and OUT2 pin is low. When the motor is connected between the OUT1 and OUT2 pins, the current flows from OUT1 to OUT2.

c) Reverse mode

This operating mode is defined as the reverse rotation of the motor when the OUT1 pin is low and OUT2 pin is high. When the motor is connected between the OUT1 and OUT2 pins, the current flows from OUT2 to OUT1.

d) Brake mode

This operating mode is used to quickly stop the motor (short circuit brake). It differs from the stand-by mode because the internal control circuit is operating in the brake mode. Please switch to the stand-by mode (rather than the brake mode) to save power and reduce consumption.



a) Stand-by mode b) Forward mode c) Reverse mode d) Brake mode

Fig.15 Four basic operations (output stage)

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e) f) PWM control mode

The rotational speed of the motor can be controlled by the switching duty when the PWM signal is input to the FIN pin or the RIN pin. In this mode, the high side output is fixed and the low side output does the switching, corresponding to the input signal. The switching operates by the output state toggling between "L" and "Hi-Z".

The PWM frequency can be input in the range between 20kHz and 100kHz. Note that control may not be attained by switching on duty at frequencies lower than 20kHz, since the operation functions via the stand-by mode. Also, circuit operation may not respond correctly when the input signal is higher than 100kHz. In addition, establish a current path for the recovery current from the motor, by connecting a bypass capacitor (10μF or more is recommended) between VCC and ground.

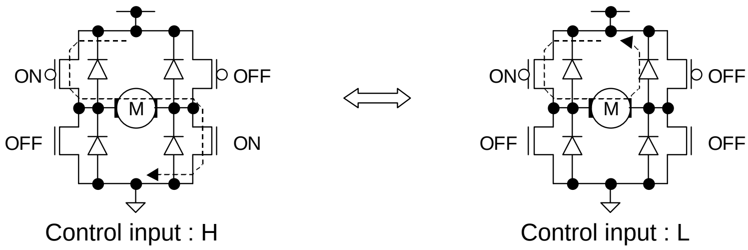

Fig.16 PWM control operation (output stage)

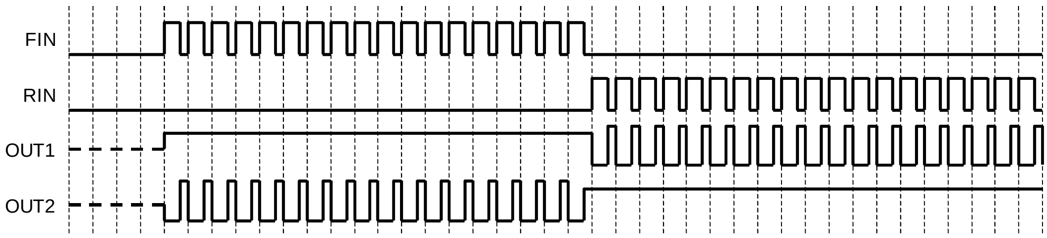

Fig.17 PWM control operation (timing chart)

2) Cross-conduction protection circuit

In the full bridge output stage, when the upper and lower transistors are turned on at the same time, and this condition exists during the period of transition from high to low, or low to high, a rush current flows from the power supply to ground, resulting in a loss. This circuit protects against the rush current by providing a dead time (about 400ns, nominal) at the transition.

3) Output protection circuits

a) Under voltage lock out (UVLO) circuit

To secure the lowest power supply voltage necessary to operate the controller, and to prevent under voltage malfunctions, a UVLO circuit has been built into this driver. When the power supply voltage falls to 5.3V (nominal) or below, the controller forces all driver outputs to high impedance. When the voltage rises to 5.5V (nominal) or above, the UVLO circuit ends the lockout operation and returns the chip to normal operation.

b) Over voltage protection (OVP) circuit

When the power supply voltage exceeds 31V (nominal), the controller forces all driver outputs to high impedance. The OVP circuit is released and its operation ends when the voltage drops back to 29V (nominal) or below. This protection circuit does not work in the stand-by mode. Also, note that this circuit is supplementary, and thus if it is asserted, the absolute maximum rating will have been exceeded. Therefore, do not continue to use the IC after this circuit is activated, and do not operate the IC in an environment where activation of the circuit is assumed.

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c) Thermal shutdown (TSD) circuit

The TSD circuit operates when the junction temperature of the driver exceeds the preset temperature (175°C nominal). At this time, the controller forces all driver outputs to high impedance. Since thermal hysteresis is provided in the TSD circuit, the chip returns to normal operation when the junction temperature falls below the preset temperature (150°C nominal). Thus, it is a self-returning type circuit.

The TSD circuit is designed only to shut the IC off to prevent thermal runaway. It is not designed to protect the IC or guarantee its operation in the presence of extreme heat. Do not continue to use the IC after the TSD circuit is activated, and do not operate the IC in an environment where activation of the circuit is assumed.

d) Over current protection (OCP) circuit

To protect this driver IC from ground faults, power supply line faults and load short circuits, the OCP circuit monitors the output current for the circuit's monitoring time (10µs, nominal). When the protection circuit detects an over current, the controller forces all driver outputs to high impedance during the off time (290µs, nominal). The IC returns to normal operation after the off time period has elapsed (self-returning type). At the two channels type, this circuit works independently for each channel.

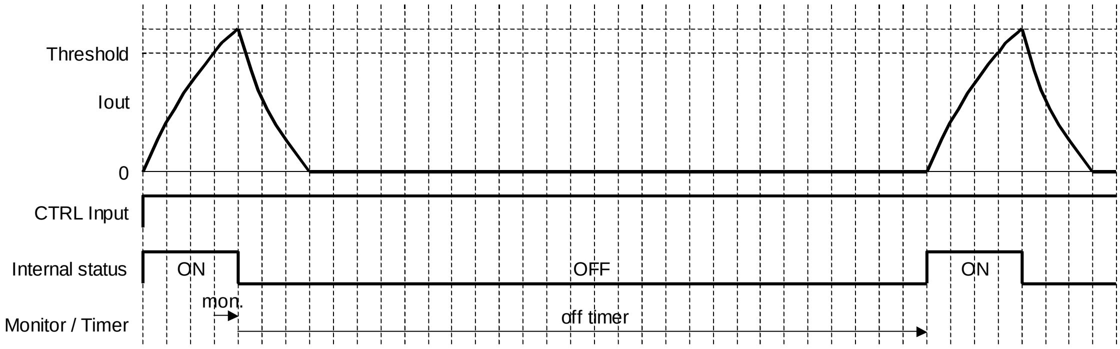

Fig.18 Over current protection (timing chart)

●ASO (Area of Safety Operation)

~Reference data~

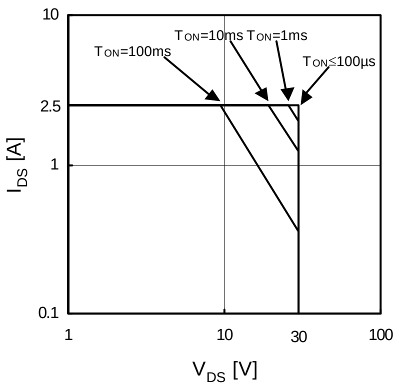

Fig.19 ASO curve (Ta=25°C)

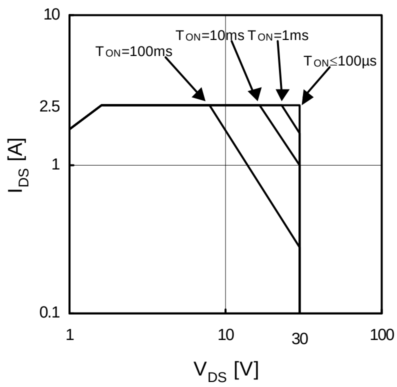

Fig.20 ASO curve (Tj=150°C)

When the current of extent where OCP circuit does not operate keeps flowing, i.e.) ground faults, power supply line faults and load short circuits, it might not be able to protect it with the over current protection circuit.

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● Thermal design

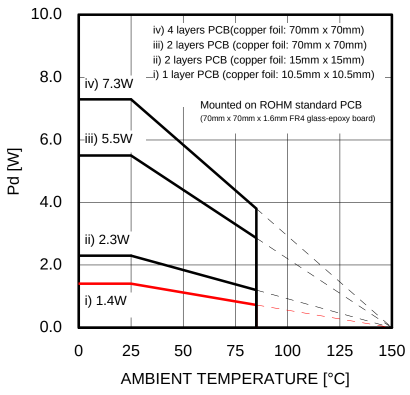

Fig.21 Thermal derating curve (HRP7 package)

Table 3 Thermal resistance

Board	$\theta_{j\text{-}a}$ [°C/W]
Board (4)	17.1
Board (3)	22.7
Board (2)	54.4
Board (1)	89.3

* Transient thermal resistance is measured data only; values are not guaranteed.

Thermal design needs to meet the following operating conditions.
In creating the thermal design, sufficient margin must be provided to guarantee the temperature conditions below.

1. The ambient temperature Ta must be 85°C or below
2. The junction temperature Tj must be 150°C or below

The junction temperature Tj can be determined using the following equation.

$$Tj \approx Ta + \theta_{j\text{-}a} \times Pc \text{ [°C]}$$

The power consumption Pc can be determined using the following equation. Refer to page 3 about $V_{ON(H)}$ and $V_{F(H)}$.

$$Pc \approx (I_{OUT}^2 \times R_{ON}) \times D + I_{OUT} \times (V_{ON(H)} + V_{F(H)}) \times (1 - D) + V_{CC} \times I_{CC} \text{ [W]}$$

Example)

Conditions: Ta=50°C, VCC=24V, Iout=0.5A, D (on duty)=100%.

The power consumption of the IC and the junction temperature are as follows:

$$Pc \approx 0.5^2 \times 1.0 + 24 \times 1.4m = 283.6mW$$
$$Tj \approx 50 + 89.3 \times 283.6m = 75.3 \text{ [°C]}$$

Where the Tjmax parameter is 150°C and the derating is set to 80 percents, the maximum ambient temperature Tamax is determined as follows.

$$Ta \leq Tjmax \times 0.8 - \theta_{j\text{-}a} \times Pc \approx 94.7 \text{ [°C]}$$

In this example, thermal design can be considered satisfactory (meaning that there are no problems in thermal design), since the system meets the operating temperature conditions.

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●Interfaces

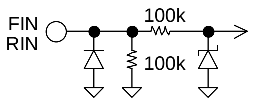

Fig.22 FIN / RIN

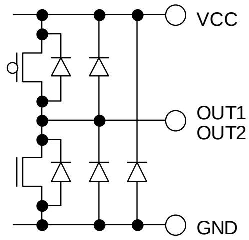

Fig.23 OUT1 / OUT2

● Notes for use

1) Absolute maximum ratings

Devices may be destroyed when supply voltage or operating temperature exceeds the absolute maximum rating. Because the cause of this damage cannot be identified as, for example, a short circuit or an open circuit, it is important to consider circuit protection measures – such as adding fuses – if any value in excess of absolute maximum ratings is to be implemented.

2) Connecting the power supply connector backward

Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply lines, such as adding an external direction diode.

3) Power supply lines

Return current generated by the motor's Back-EMF requires countermeasures, such as providing a return current path by inserting capacitors across the power supply and GND (10µF, ceramic capacitor is recommended). In this case, it is important to conclusively confirm that none of the negative effects sometimes seen with electrolytic capacitors – including a capacitance drop at low temperatures - occurs. Also, the connected power supply must have sufficient current absorbing capability. Otherwise, the regenerated current will increase voltage on the power supply line, which may in turn cause problems with the product, including peripheral circuits exceeding the absolute maximum rating. To help protect against damage or degradation, physical safety measures should be taken, such as providing a voltage clamping diode across the power supply and GND.

4) Electrical potential at GND

Keep the GND terminal potential to the minimum potential under any operating condition. In addition, check to determine whether there is any terminal that provides voltage below GND, including the voltage during transient phenomena. When both a small signal GND and high current GND are present, single-point grounding (at the set's reference point) is recommended, in order to separate the small signal and high current GND, and to ensure that voltage changes due to the wiring resistance and high current do not affect the voltage at the small signal GND. In the same way, care must be taken to avoid changes in the GND wire pattern in any external connected component.

5) Thermal design

Use a thermal design that allows for a sufficient margin in light of the power dissipation (Pd) under actual operating conditions.

6) Inter-pin shorts and mounting errors

Use caution when positioning the IC for mounting on printed circuit boards. The IC may be damaged if there is any connection error, or if pins are shorted together.

7) Operation in strong electromagnetic fields

Using this product in strong electromagnetic fields may cause IC malfunctions. Use extreme caution with electromagnetic fields.

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8) ASO - Area of Safety Operation

When using the IC, set the output transistor so that it does not exceed absolute maximum ratings or ASO.

9) Built-in thermal shutdown (TSD) circuit

The TSD circuit is designed only to shut the IC off to prevent thermal runaway. It is not designed to protect the IC or guarantee its operation in the presence of extreme heat. Do not continue to use the IC after the TSD circuit is activated, and do not operate the IC in an environment where activation of the circuit is assumed.

10) Capacitor between output and GND

In the event a large capacitor is connected between the output and GND, if VCC and VIN are short-circuited with 0V or GND for any reason, the current charged in the capacitor flows into the output and may destroy the IC. Use a capacitor smaller than 1μF between output and GND.

11) Testing on application boards

When testing the IC on an application board, connecting a capacitor to a low impedance pin subjects the IC to stress. Therefore, always discharge capacitors after each process or step. Always turn the IC's power supply off before connecting it to or removing it from the test setup during the inspection process. Ground the IC during assembly steps as an antistatic measure. Use similar precaution when transporting or storing the IC.

12) Switching noise

When the operation mode is in PWM control, PWM switching noise may effects to the control input pins and cause IC malfunctions. In this case, insert a pulled down resistor (10kΩ is recommended) between each control input pin and ground.

13) Regarding the input pin of the IC

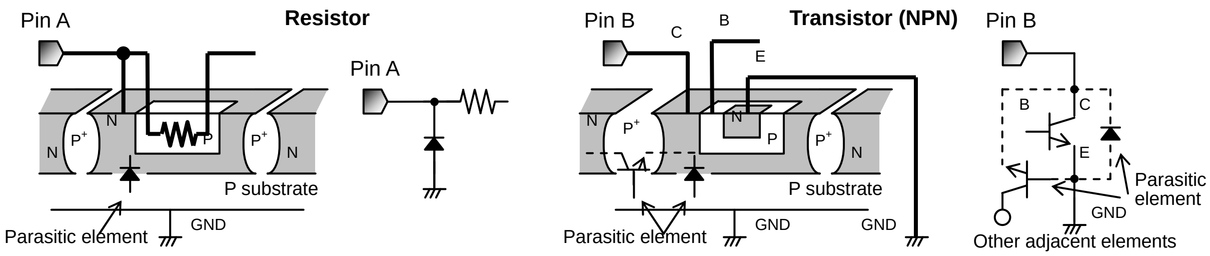
This monolithic IC contains P+ isolation and P substrate layers between adjacent elements, in order to keep them isolated.

P-N junctions are formed at the intersection of these P layers with the N layers of other elements, creating a parasitic diode or transistor. For example, the relation between each potential is as follows:

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, as well as operating malfunctions and physical damage. Therefore, do not use methods by which parasitic diodes operate, such as applying a voltage lower than the GND (P substrate) voltage to an input pin.



Appendix: Example of monolithic IC structure

●**Ordering part number**

B	D	6	2	2	2	2	H	F	P	-	T	R

ROHM part number

Type

Package
HFP: HRP7

Packaging spec.
TR: Embossed taping

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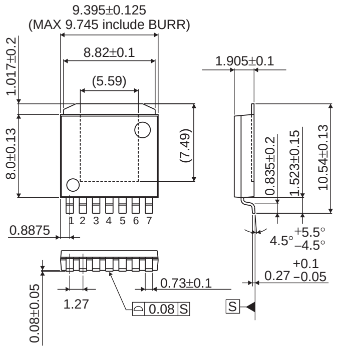
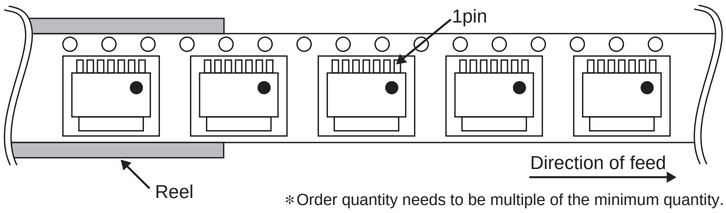
HRP7



(Unit : mm)

<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	2000pcs
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.

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