

# DC Brush Motor Drivers (36V max.)



## BD62321HFP

### ●General Description

BD62321HFP is a full bridge driver for brush motor applications. This IC can operate at a wide range of power-supply voltages (from 6V to 32V) with output currents of up to 3A. MOS transistors in the output stage allow PWM speed control. The BD62321HFP is pin compatible with the BD623xHFP series.

### ●Key Specifications

■ Supply Voltage Range:	36V(Max.)
■ Maximum Output Current:	3.0A
■ Output ON resistance:	1.0Ω
■ PWM Input frequency range:	20 to 100kHz
■ Standby current:	0μA (Typ.)
■ Operating temperature range:	-40 to 85°C

### ●Features

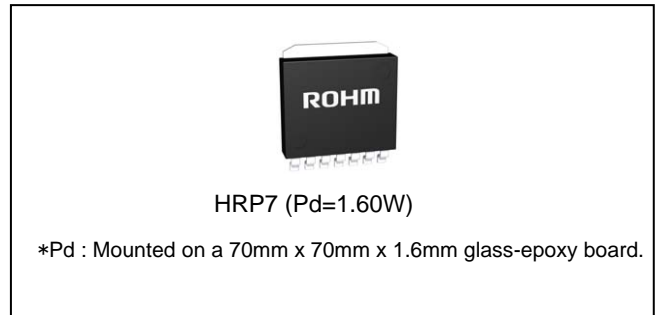
- Built-in one channel driver
- Cross-conduction prevention circuit
- Four protection circuits provided: OCP, OVP, TSD, UVLO and SAP

### ●Applications

VTR; CD/DVD players; audio-visual equipment; optical disc drives; PC peripherals; OA equipments

### ●Package

HRP7	(Typ.)	(Typ.)	(Max.)
	9.395mm	x 10.540mm	x 2.005mm



### ●Ordering Information

B D 6 2 3 2 1 H F P

-
T R

Part Number	Package HFP : HRP7	Packaging and forming specification TR: Embossed tape and reel (HRP7)
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Voltage rating (Max.)	Channels	Output current (Max.)	Package		Orderable Part Number
36V	1ch	3.0A	HRP7	Reel of 2000	BD62321HFP-TR

●Block Diagram

BD62321HFP

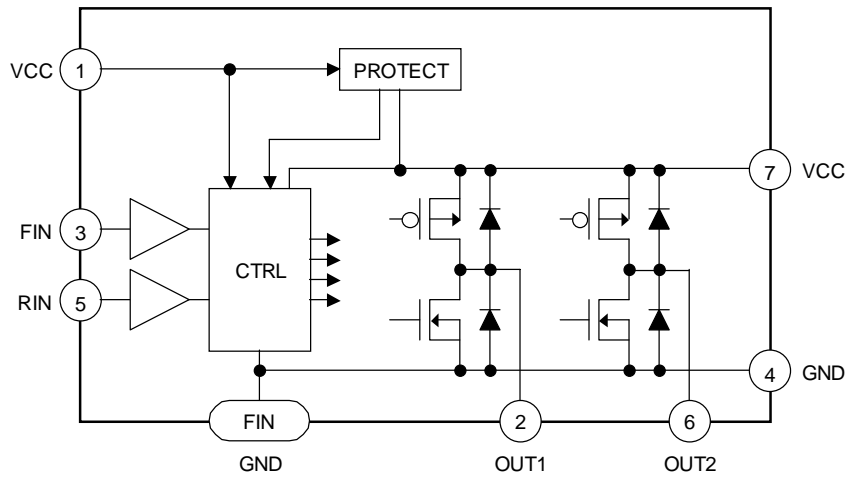


Fig.1 BD62321HFP

●Pin Configuration

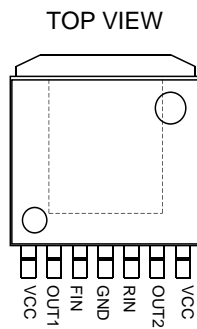


Fig.2 HRP7 package

●Pin Description

Table 1 BD62321HFP

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.

**● Absolute Maximum Ratings (Ta=25°C, All voltages are with respect to ground)**

Parameter	Symbol	Ratings	Unit
Supply voltage	VCC	36	V
Output current	I <sub>OMAX</sub>	3.0 * <sup>1</sup>	A
All other input pins	V <sub>IN</sub>	-0.3 to VCC	V
Operating temperature	T <sub>OPR</sub>	-40 to +85	°C
Storage temperature	T <sub>STG</sub>	-55 to +150	°C
Power dissipation	Pd	1.6 * <sup>2</sup>	W
Junction temperature	T <sub>jmax</sub>	150	°C

\*1 Do not exceed Pd or ASO.

\*2 HRP7 package. Mounted on a 70mm x 70mm x 1.6mm glass-epoxy board. Derate by 12.8mW/°C above 25°C.

**● Recommended Operating Rating (Ta=25°C)**

Parameter	Symbol	Ratings	Unit
Supply voltage	VCC	6 to 32	V

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

Parameter	Symbol	Limits			Unit	Conditions
		Min.	Min.	Min.		
Supply current	I <sub>CC</sub>	0.7	1.4	2.2	mA	Forward / Reverse / Brake
Stand-by current	I <sub>STBY</sub>	-	0	10	μA	Stand-by
Input high voltage	V <sub>IH</sub>	2.0	-	-	V	
Input low voltage	V <sub>IL</sub>	-	-	0.8	V	
Input bias current	I <sub>IH</sub>	30	50	100	μA	V <sub>IN</sub> =5.0V
Output ON resistance	R <sub>ON</sub>	0.5	1.0	1.5	Ω	I <sub>O</sub> =1.0A, vertically total
Input frequency range	F <sub>MAX</sub>	20	-	100	kHz	FIN / RIN

● Typical Performance Curves (Reference data)

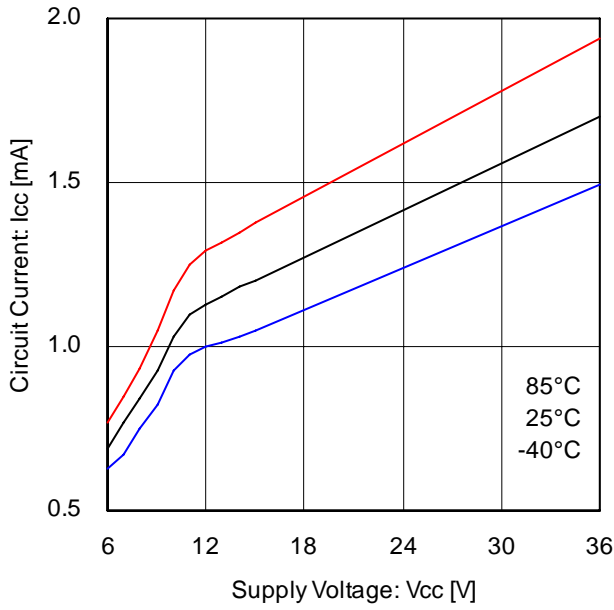


Fig.3 Supply current

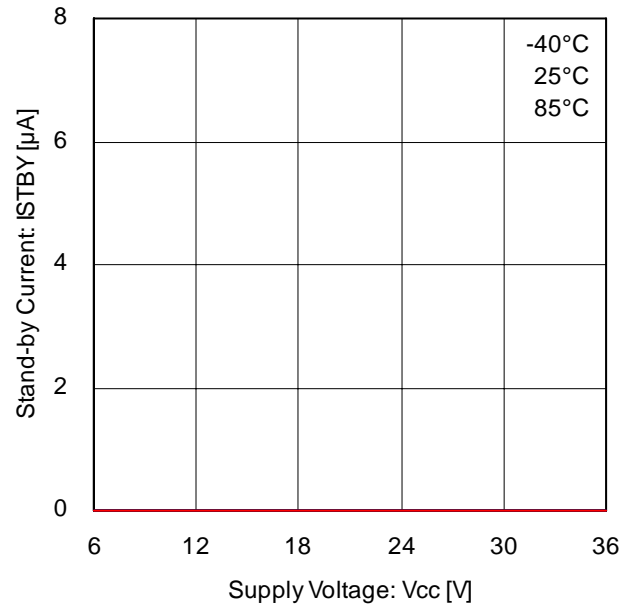


Fig.4 Stand-by current

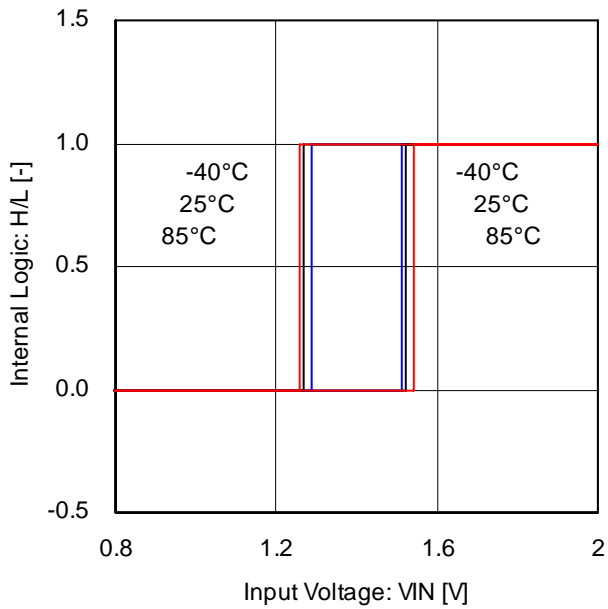


Fig.5 Input threshold voltage

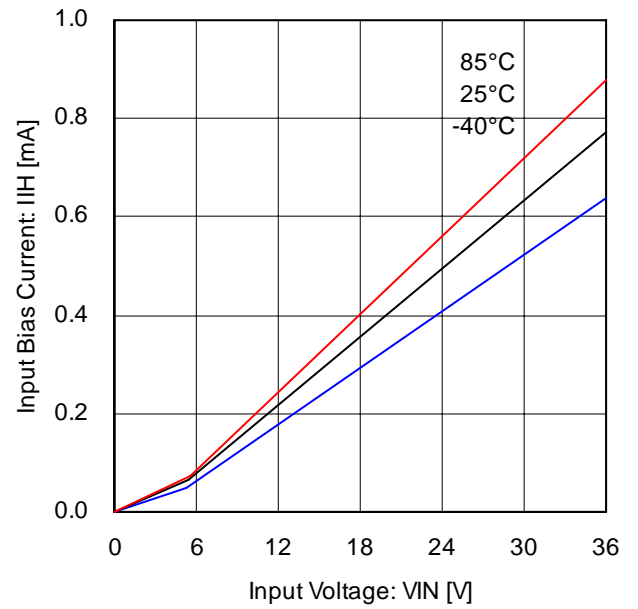


Fig.6 Input bias current

● Typical Performance Curves (Reference data) - Continued

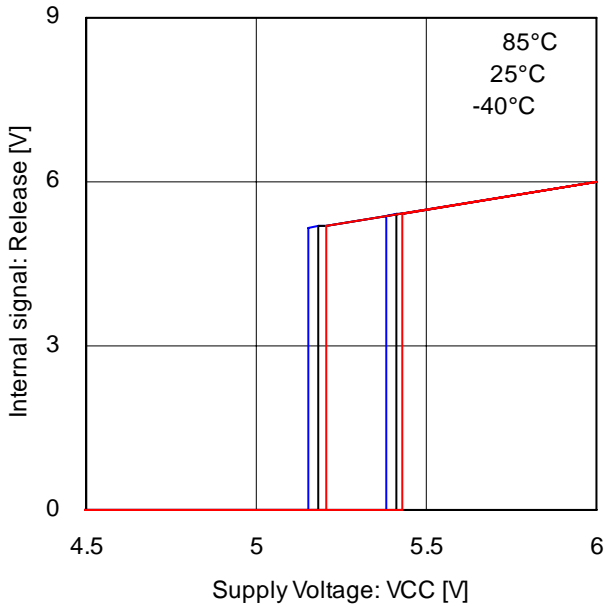


Fig.7 Under voltage lock out

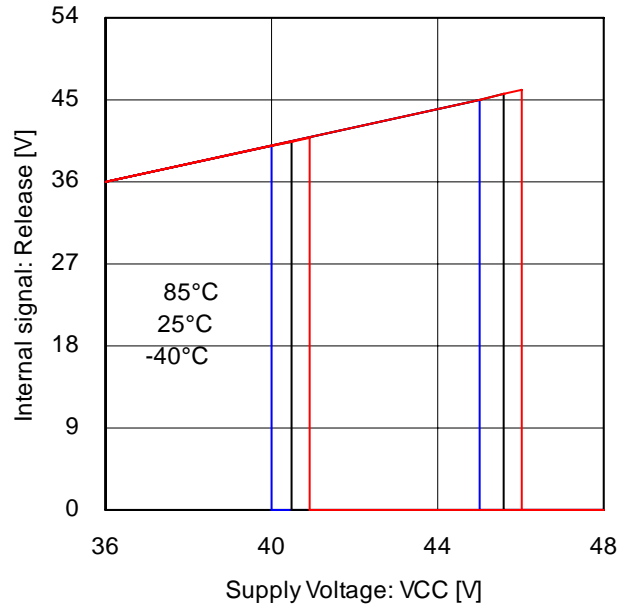


Fig.8 Over voltage protection

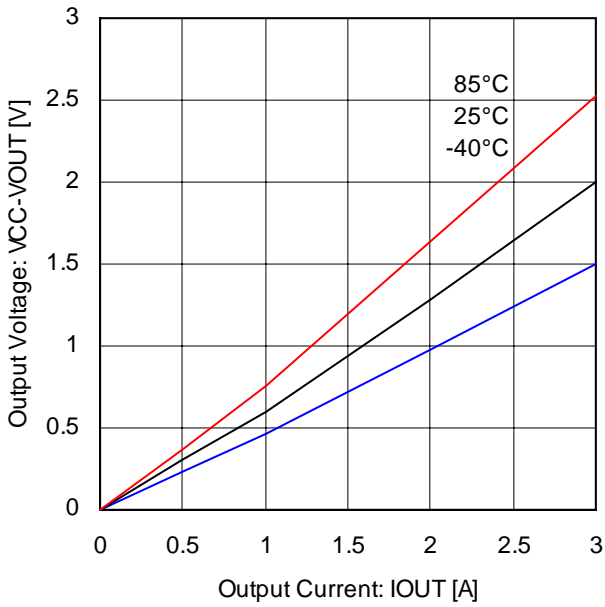


Fig.9 Output high voltage

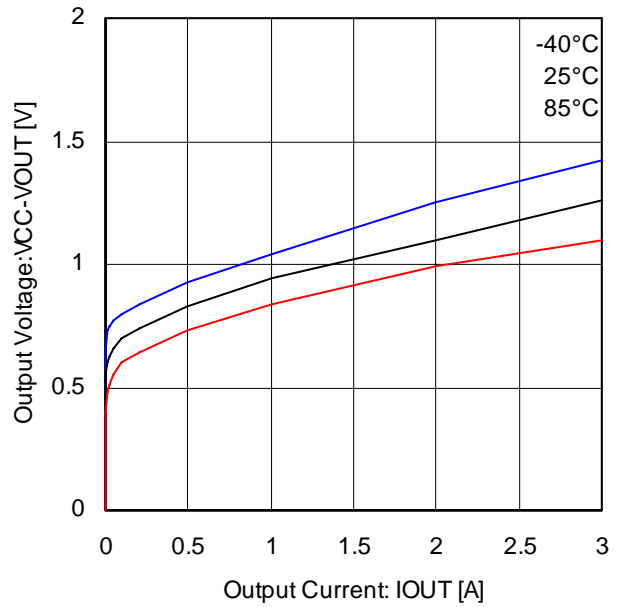


Fig.10 High side body diode

● Typical Performance Curves (Reference data) - Continued

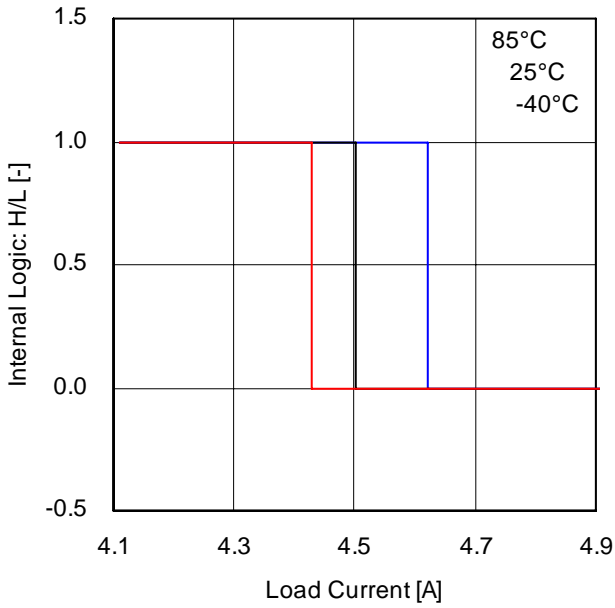


Fig.11 Over current protection (H side)

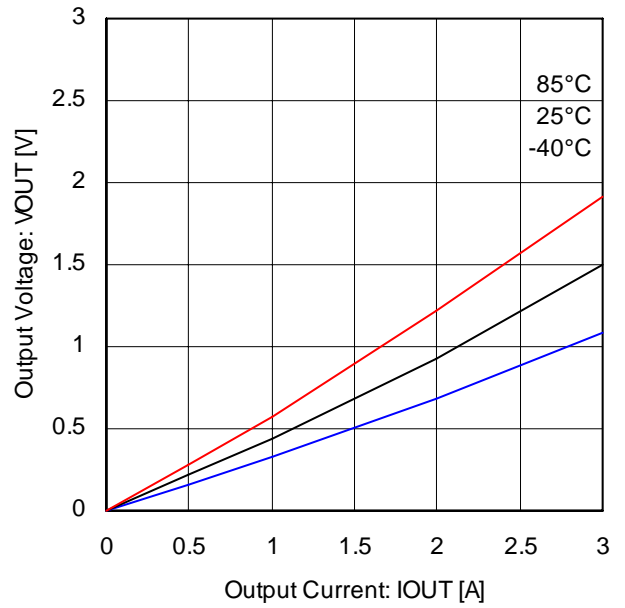


Fig.12 Output low voltage

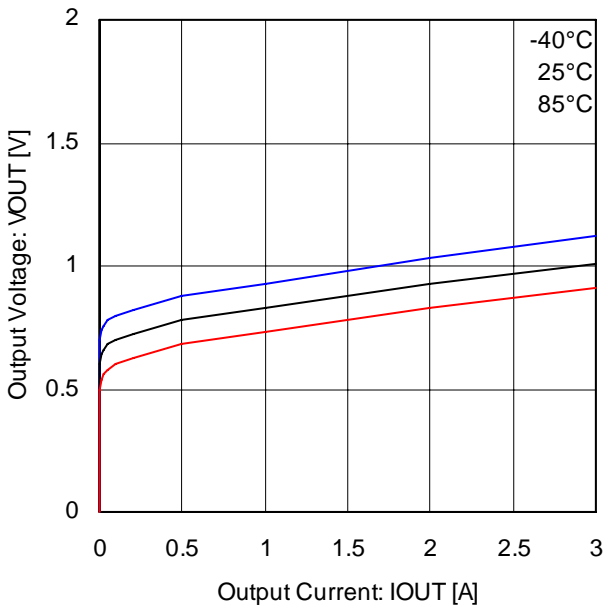


Fig.13 Low side body diode

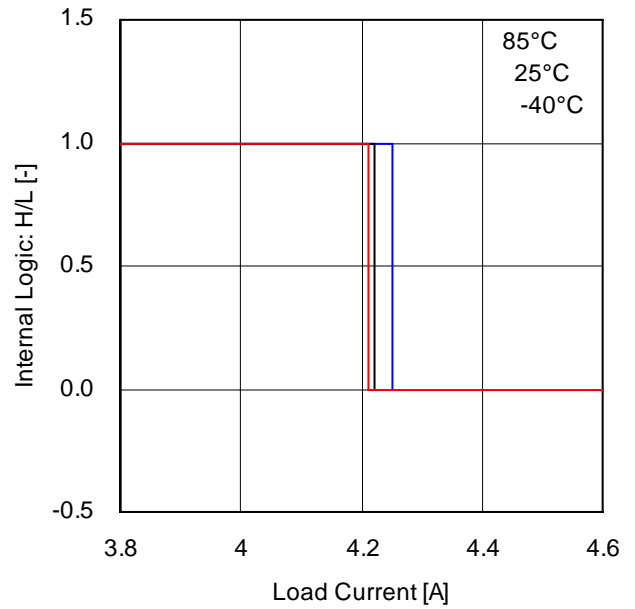


Fig.14 Over current protection (L side)

●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 : all output transistors are off.

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. When the system is switched to stand-by mode while the motor is running, 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

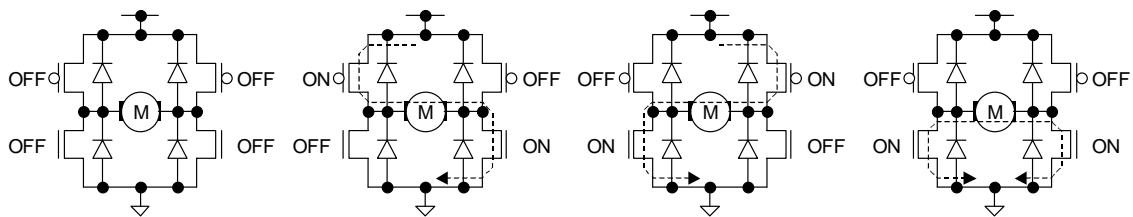
This operating mode is defined as the forward rotation of the motor when OUT1 pin is high and OUT2 pin is low. When the motor is connected between OUT1 and OUT2 pins, the current flows from OUT1 to OUT2.

c) Reverse mode

This operating mode is defined as the reverse rotation of the motor when 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 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)

## e) f) PWM control mode

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

The frequency of the input PWM signal can be between 20kHz and 100kHz. The circuit may not operate properly for PWM frequencies below 20kHz and above 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. To operate in this mode, connect the VREF pin to the VCC pin. In addition, establish a current path for the recovery current from the motor, by connecting a bypass capacitor (10 $\mu$ F or higher is recommended) between VCC and ground.

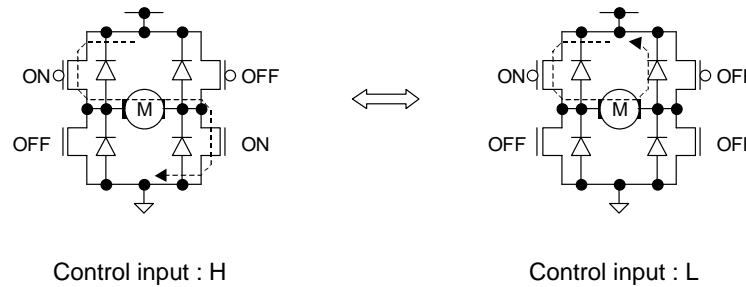


Fig.16 PWM control operation (output stage)

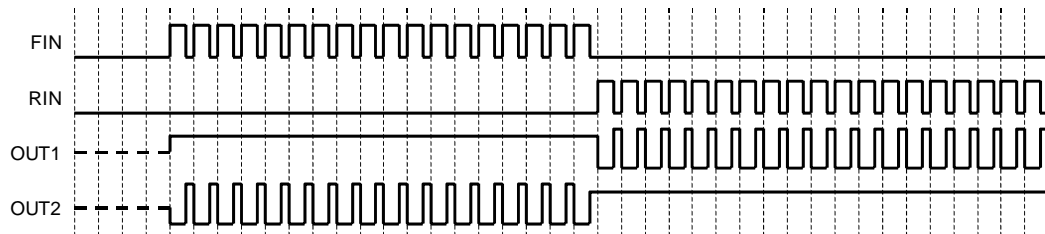


Fig.17 PWM control operation (timing chart)

## 2) Cross-conduction protection circuit

In the full bridge output stage, when the upper and lower transistors are turned on at the same time during high to low or low to high transition, an inrush current flows from the power supply to ground, resulting to a loss. This circuit eliminates the inrush current by providing a dead time (about 800ns, nominal) during the transition.

## 3) Output protection circuits

## a) Under voltage lock out (UVLO) circuit

To ensure 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 45V (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 40V (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.



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-resetting 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.

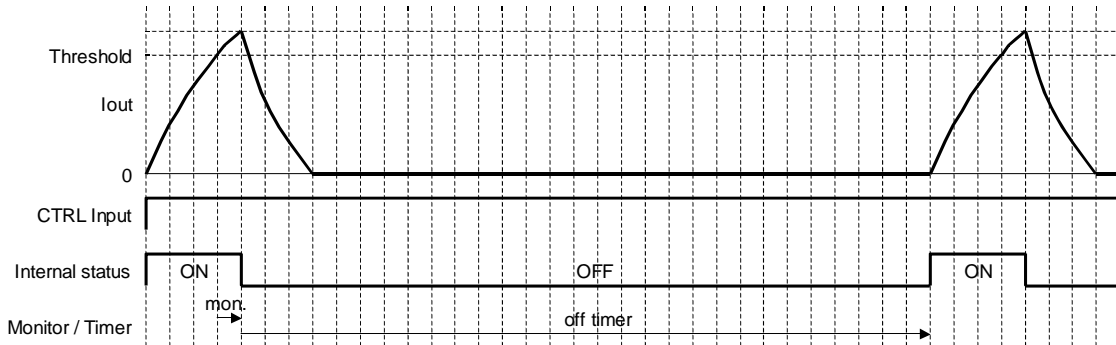


Fig.18 Over current protection (timing chart)

e) Safe area protection (SAP) circuit

To protect the output MOS transistors from ASO, ground faults, power supply line faults and load short circuits, the SAP circuit monitors the conditions for the circuit's monitoring time (10µs, nominal). When the protection circuit detects to exceed ASO, the controller forces all driver outputs to high impedance and latch in the state. It is released that via standby mode during 150µs or more by the control inputs FIN and RIN.

● I/O equivalent circuit

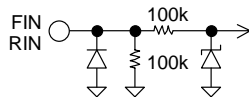


Fig.19 FIN / RIN

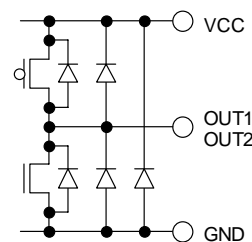


Fig.20 OUT1 / OUT2

## ●Operational Notes

### 1) Absolute maximum ratings

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. 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.

### 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) Ground Voltage

The voltage of the ground 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 ( $P_c \geq P_d$ ).

Package Power dissipation :  $P_d (W) = (T_{jmax} - T_a) / \theta_{ja}$   
 Power dissipation :  $P_c (W) = (V_{cc} - V_o) \times I_o + V_{cc} \times I_b$

(  $T_{jmax}$  : Maximum junction temperature=150°C,  $T_a$  : Peripheral temperature[°C] ,  
 $\theta_{ja}$  : Thermal resistance of package-ambience[°C/W],  $P_d$  : Package Power dissipation [W],  
 $P_c$  : Power dissipation [W],  $V_{cc}$  : Input Voltage,  $V_o$  : Output Voltage,  $I_o$  : Load,  $I_b$  : 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) Operation under strong electromagnetic field

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

### 8) Area of Safe Operation (ASO)

Operate the IC such that the output voltage, output current, and power dissipation are all within the Area of Safe Operation (ASO).

### 9) Capacitor between output and GND

If a large capacitor is connected between the output pin and GND pin, current from the charged capacitor can flow into the output pin and may destroy the IC when the VCC or VIN pin is shorted to ground or pulled down to 0V. Use a capacitor smaller than 10uF between output and GND.

### 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) Switching noise

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

**12) Regarding the input pin of the IC**

This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated. P-N junctions are formed at the intersection of the P layers with the N layers of other elements, creating a parasitic diode or transistor. For example (refer to figure below):

When  $GND > Pin A$  and  $GND > Pin B$ , the P-N junction operates as a parasitic diode.  
 When  $GND > Pin B$ , the P-N junction operates as a parasitic transistor.

Parasitic diodes inevitably occur in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions that cause these diodes to operate, such as applying a voltage lower than the GND voltage to an input pin (and thus to the P substrate) should be avoided.

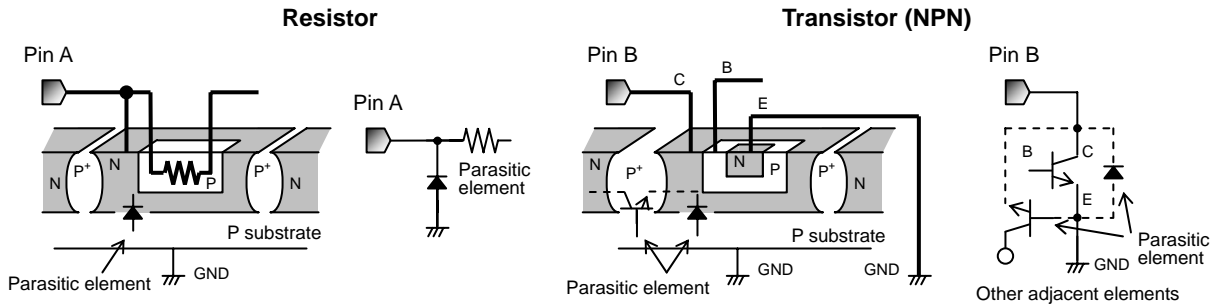
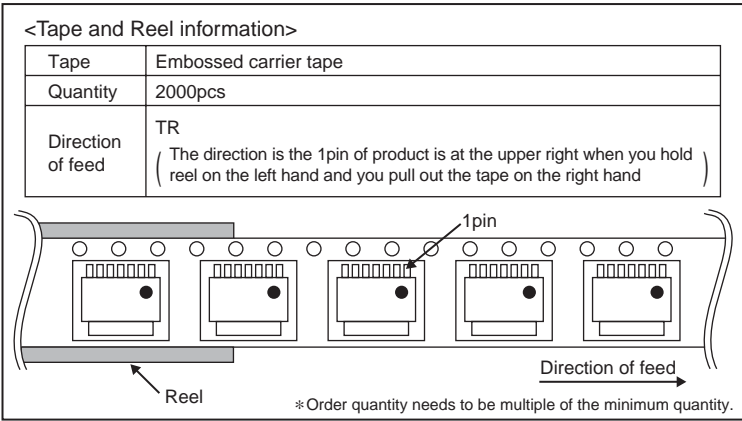
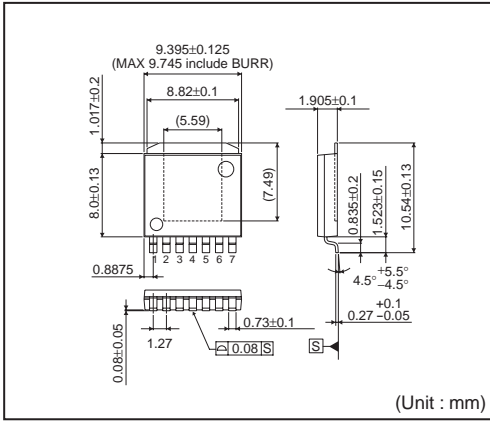


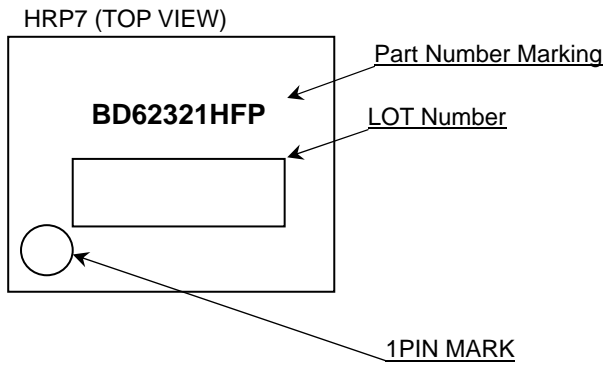
Fig21. Example of monolithic IC structure

●Physical Dimension Tape and Reel Information

HRP7



●Marking Diagram



## ●Revision History

Date	Revision	Changes
10.Apr.2012	001	New Release
25.Dec.2012	002	Improved the statement in all pages. Deleted "Status of this document" in page 11.

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  - [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<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, SO<sub>2</sub>, and NO<sub>2</sub>
  - [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 (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
  - [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 (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient 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; if flow soldering method is preferred, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

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- 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.
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**●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<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, SO<sub>2</sub>, and NO<sub>2</sub>
  - [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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