

# DC Brush Motor Drivers (36V max.)



## BD62321HFP

### ●General Description

BD62321HFP is full bridge driver for brush motor applications. This IC can operate at a wide range of power-supply voltages (from 6V to 32V), supporting output currents of up to 3A. 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

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

### ●Applications

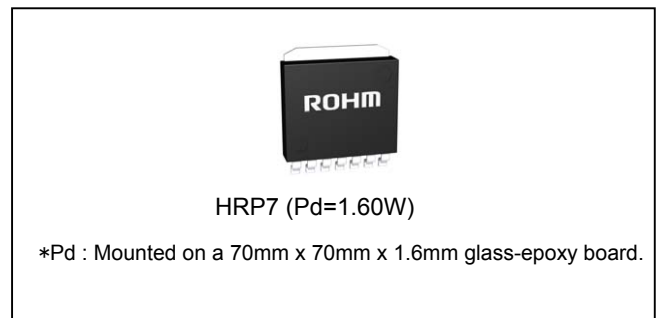
VTR; CD/DVD players; audio-visual equipment; optical disc drives; PC peripherals; OA equipments

### ●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

### ●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<br>HFP : HRP7 |   | Packaging and forming specification<br>TR: Embossed tape and reel (HRP7) |  |

| Rating voltage (Max.) | Channels | Maximum output current (Max.) | Package |              | Orderable Part Number |
|-----------------------|----------|-------------------------------|---------|--------------|-----------------------|
| 36V                   | 1ch      | 3.0A                          | HRP7    | Reel of 2000 | BD62321HFP-TR         |

●Block Diagram

BD62321HFP

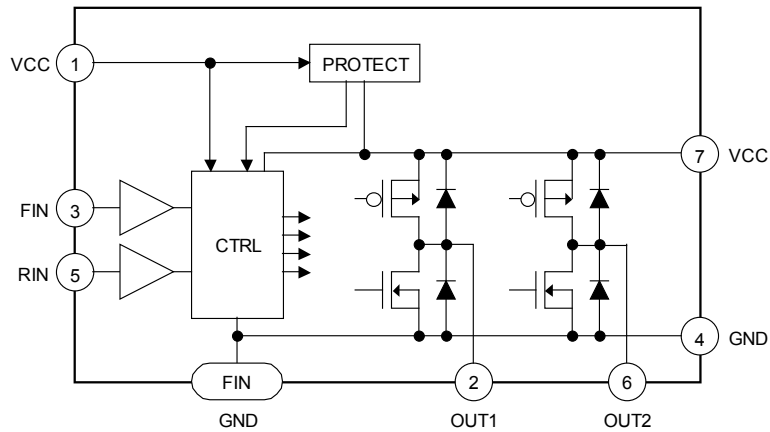


Fig.1 BD62321HFP

●Pin Configuration

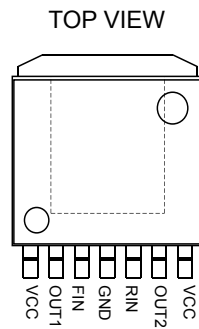


Fig.2 HRP7 package

●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. Derated at 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)

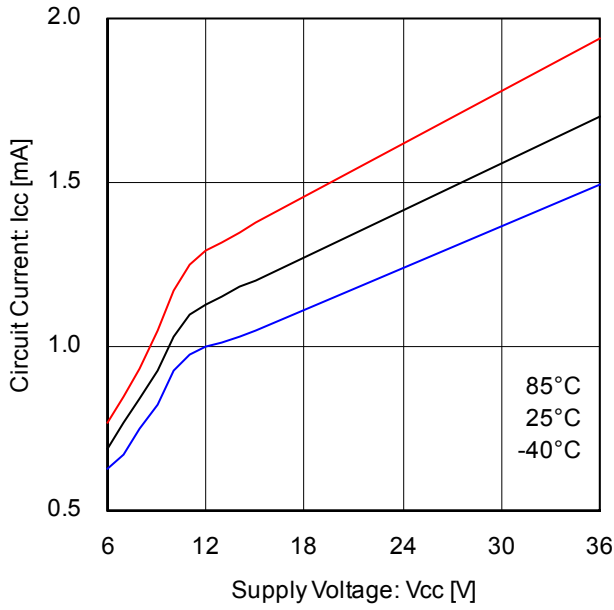


Fig.3 Supply current

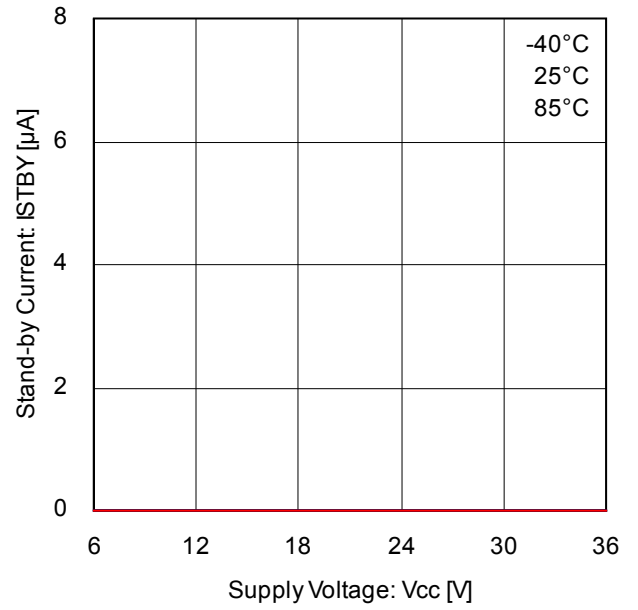


Fig.4 Stand-by current

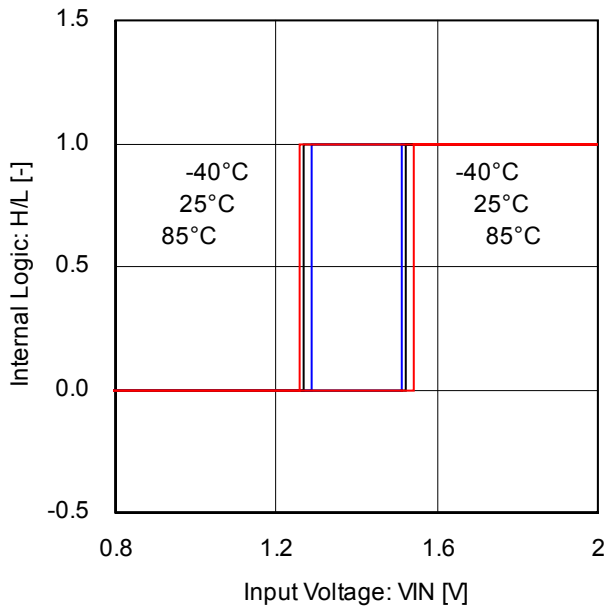


Fig.5 Input threshold voltage

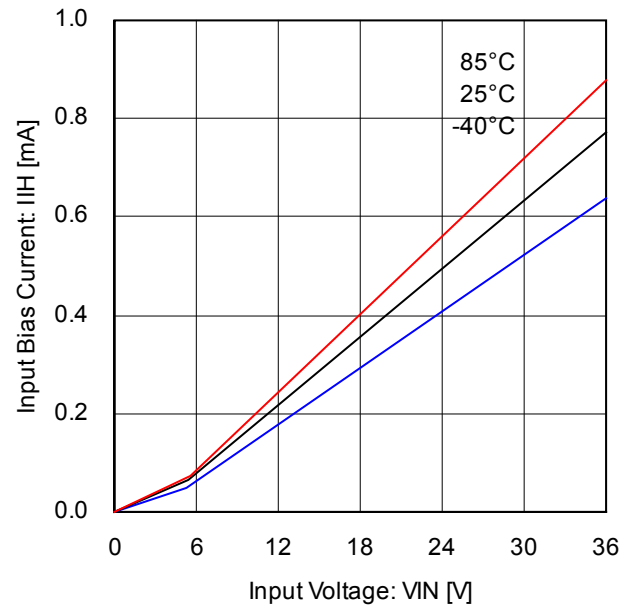


Fig.6 Input bias current

● Typical Performance Curves (Reference data)-Continued

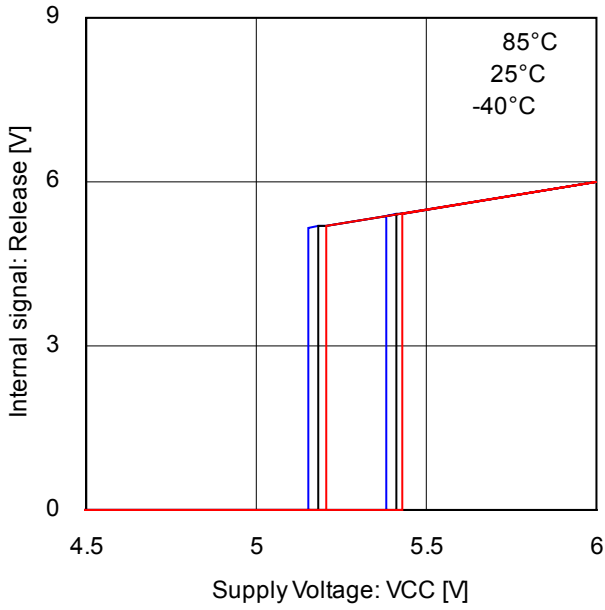


Fig.7 Under voltage lock out

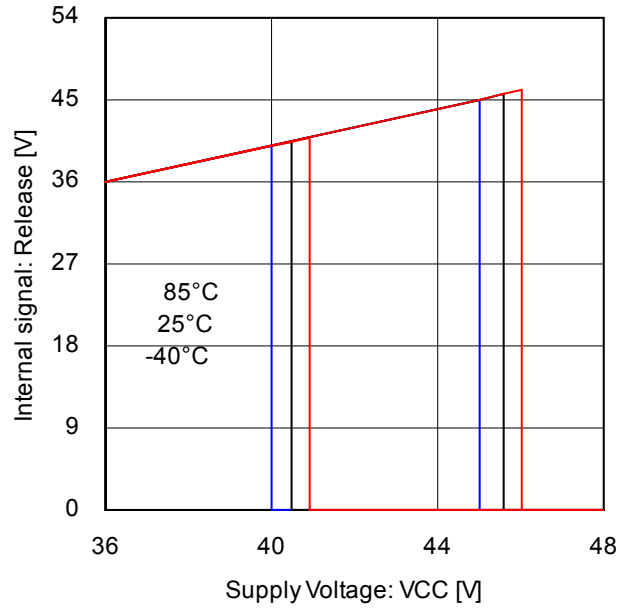


Fig.8 Over voltage protection

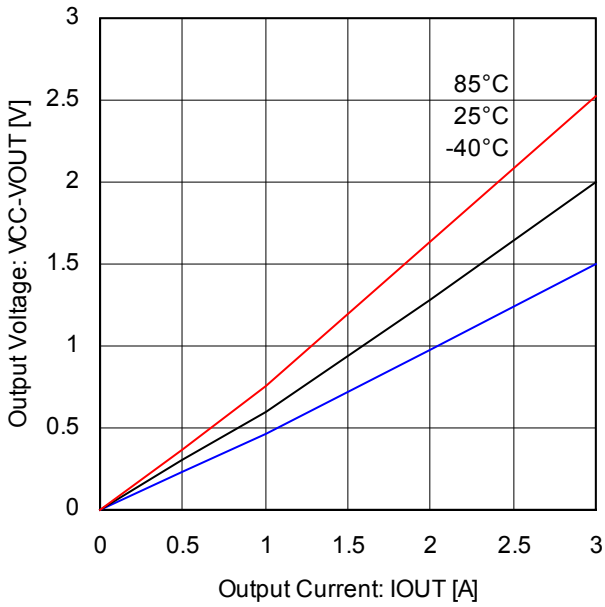


Fig.9 Output high voltage

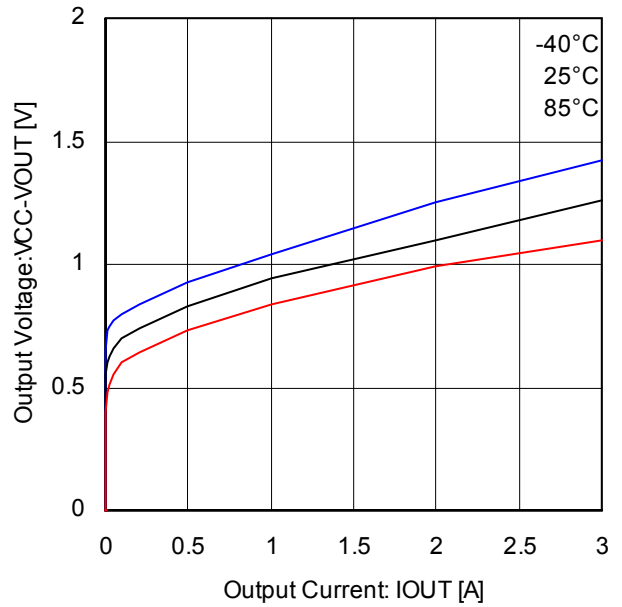


Fig.10 High side body diode

● Typical Performance Curves (Reference data)-Continued

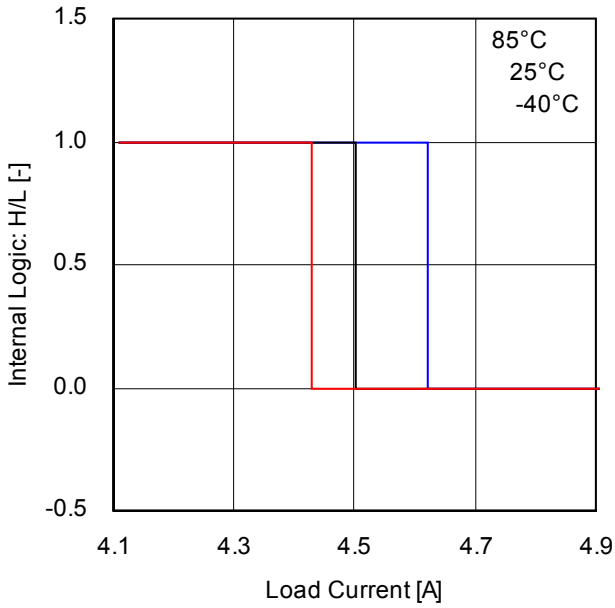


Fig.11 Over current protection (H side)

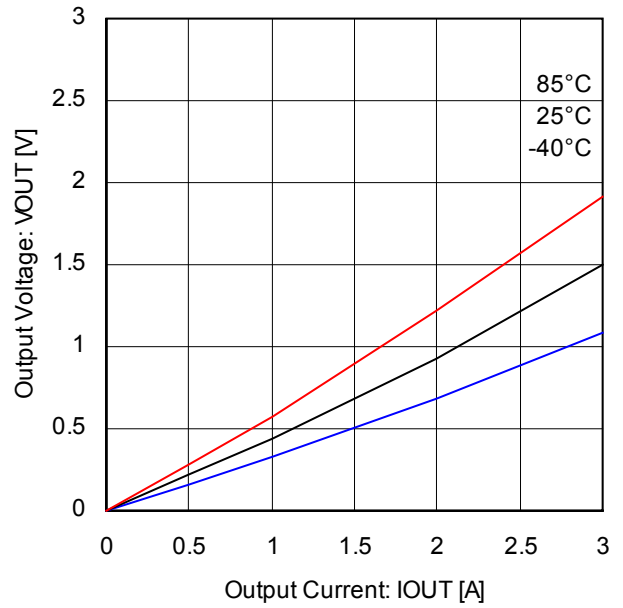


Fig.12 Output low voltage

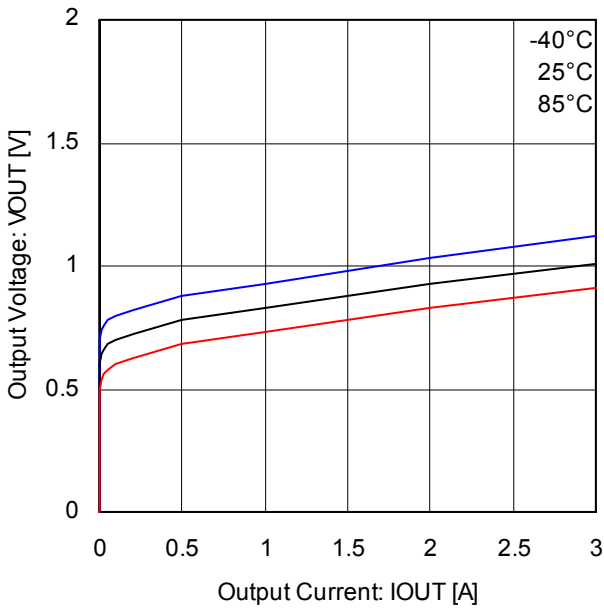


Fig.13 Low side body diode

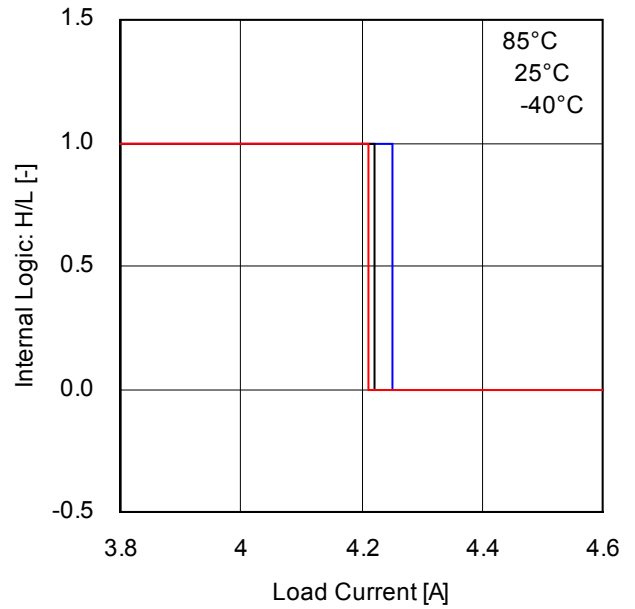


Fig.14 Over current protection (L side)

●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 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

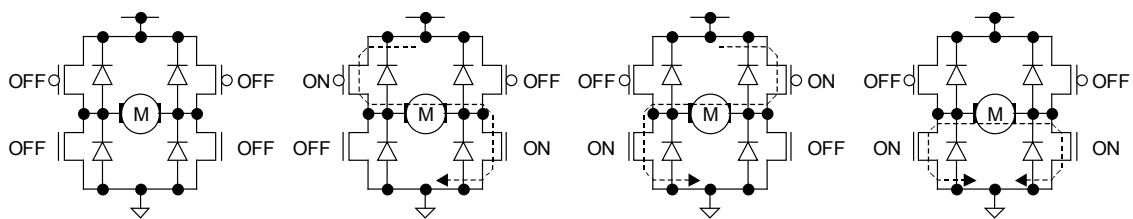
This operating mode is defined as the forward rotation of the motor when the OUT1 pin is high and OUT2 pin is low. When the motor is connected between the OUT1 and OUT2 pins, the current flows from OUT1 to OUT2.

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)

## 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 (10 $\mu$ F or more is recommended) between VCC and ground.

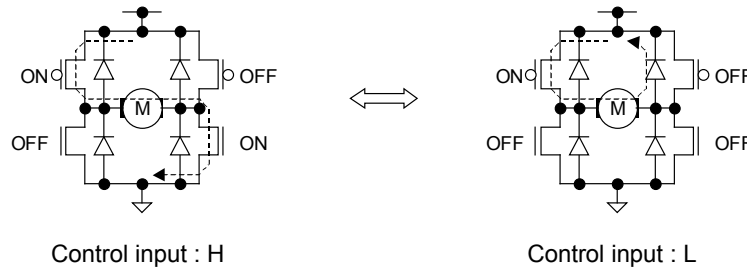


Fig.16 PWM control operation (output stage)

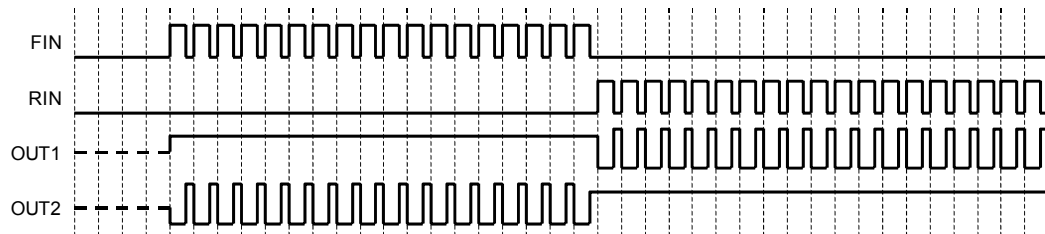


Fig.17 PWM control operation (timing chart)

## 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 800ns, 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 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-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.

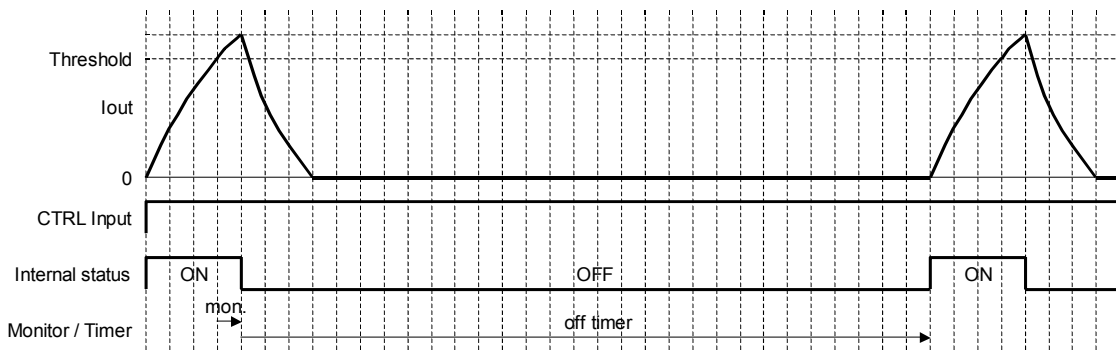


Fig.18 Over current protection (timing chart)

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 equivalence circuit

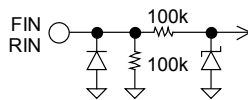


Fig.19 FIN / RIN

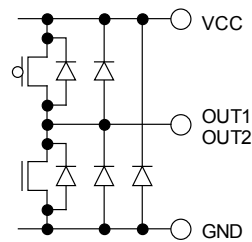


Fig.20 OUT1 / OUT2

**●Operational Notes**

- 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 (10 $\mu$ F, 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.
- 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) 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 1 $\mu$ F between output and GND.
- 10) 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.
- 11) 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 (10k $\Omega$  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 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. Do not force the voltage of the input pins in excess of 5.5V when the power does not supply to the IC.

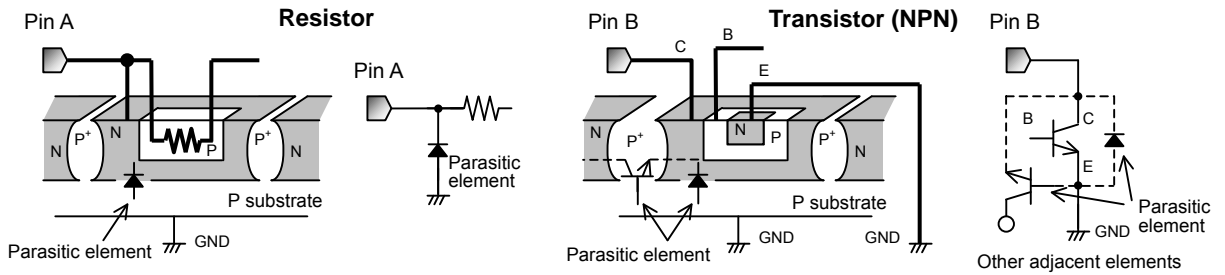


Fig.21 Example of monolithic IC structure

Status of this document

The Japanese version of this document is formal specification. A customer may use this translation version only for a reference to help reading the formal version.

If there are any differences in translation version of this document formal version takes priority.



## ●Revision History

| Date        | Revision | Changes     |
|-------------|----------|-------------|
| 12.Apr.2012 | 001      | New Release |

# Notice

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  - [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure
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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

● **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.
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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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● **Precaution for Disposition**

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