DC Brush Motor Drivers (18V max.)

Pb Free ROHM Electronic Components · RoHS Directive Compliance

BD622x Series

●General Description

These H-bridge drivers are full bridge drivers for brush motor applications. Each IC can operate at a range of power supply voltages (from 6V to 15V), supporting output currents of up to 2A. MOS transistors in the output stage allow for PWM signal control, while the integrated VREF voltage control function of previous models offers direct replacement of deprecated motor driver ICs. These highly efficient H-bridge driver ICs facilitate low-power consumption design.

●Features

- Built-in, selectable one channel or two channels configuration
- VREF voltage setting pin enables PWM duty control
- Cross-conduction prevention circuit
- Four protection circuits provided: OCP, OVP, TSD and UVLO

●Applications

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

●Key Specifications

- Supply Voltage Range: 18V(Max.)
- Maximum Output Current: 0.5A / 1.0A / 2.0A
- Output ON resistance: 1.5Ω / 1.5Ω / 1.0Ω
- PWM Input frequency range: 20 to 100kHz
- Standby current: 0μA (Typ.)
- Operating temperature range: -40 to 85℃

●Packages

	(Typ.)	(Typ.)	(Max.)
SOP8	5.00mm	x 6.20mm	x 1.71mm
HSOP25	13.60mm	x 7.80mm	x 2.11mm
HRP7	9.395mm	x 10.540mm	x 2.005mm

HRP7 (Pd=1.60W)

SOP8 (Pd=0.69W)

HSOP25 (Pd=1.45W)

*Pd : Mounted on a 70mm x 70mm x 1.6mm glass-epoxy board.

●Ordering Information

B D 6 2 2 x x x x - x x

Part Number

Package
F : SOP8
FP : HSOP25
HFP : HRP7

Packaging and forming specification
E2: Embossed tape and reel (SOP8/HSOP25)
TR: Embossed tape and reel (HRP7)

●Lineup

Rating voltage (Max.)	Channels	Maximum output current (Max.)	Package		Orderable Part Number
18V	1ch	0.5A	SOP8	Reel of 2500	BD6220F-E2
		1.0A	SOP8	Reel of 2500	BD6221F-E2
		2.0A	HSOP25	Reel of 2000	BD6222FP- E2
			HRP7	Reel of 2000	BD6222HFP-TR
	2ch	0.5A	HSOP25	Reel of 2000	BD6225FP-E2
		1.0A	HSOP25	Reel of 2000	BD6226FP-E2

○Product structure：Silicon monolithic integrated circuit ○This product is not designed protection against radioactive rays.

●Block diagrams / Pin Configurations / Pin Descriptions

BD6220F/BD6221F

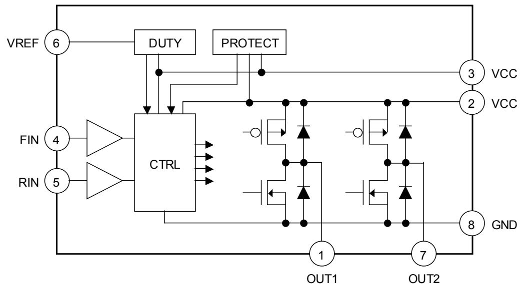


Fig.1 BD6220F / BD6221F

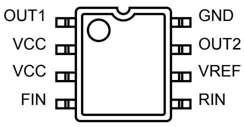


Fig.2 SOP8 (TOP VIEW)

Table1 BD6220F/BD6221F

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

Note: Use all VCC pin by the same voltage.

BD6222HFP

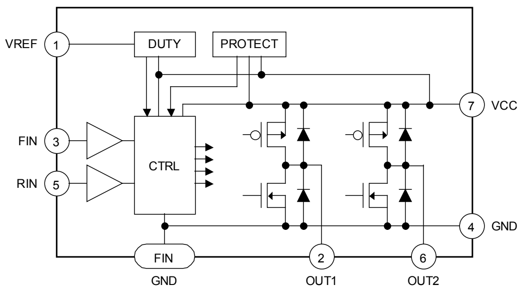


Fig.3 BD6222HFP

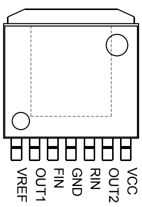


Fig.4 HRP7 (TOP VIEW)

Table 2 BD6222HFP

Pin	Name	Function
1	VREF	Duty setting pin
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

●Block diagrams / Pin Configurations / Pin Descriptions- Continued

BD6222FP

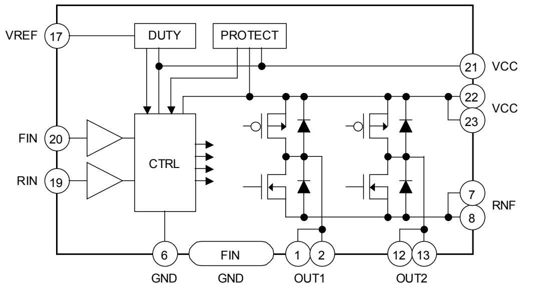


Fig.5 BD6222FP

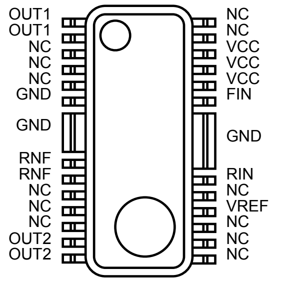


Fig.6 HSOP25 (TOP VIEW)

Table 3 BD6222FP

Pin	Name	Function
1,2	OUT1	Driver output
6	GND	Small signal ground
7,8	RNF	Power stage ground
12,13	OUT2	Driver output
17	VREF	Duty setting pin
19	RIN	Control input (reverse)
20	FIN	Control input (forward)
21	VCC	Power supply
22,23	VCC	Power supply
FIN	GND	Ground

Note: All pins not described above are NC pins.
Note: Use all VCC pin by the same voltage.

BD6225FP / BD6226FP

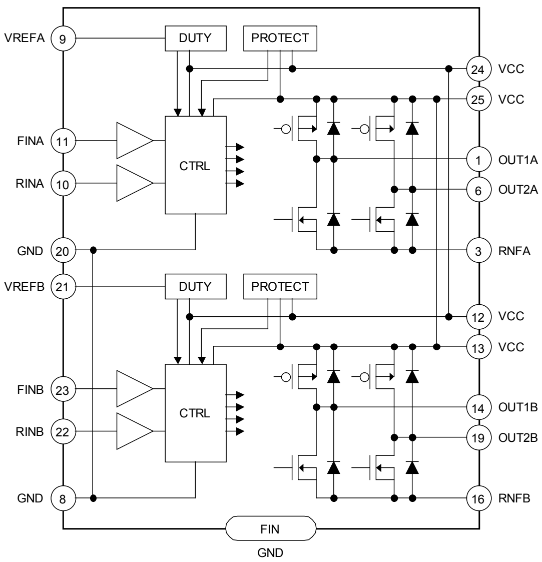


Fig.7 BD6225FP / BD6226FP

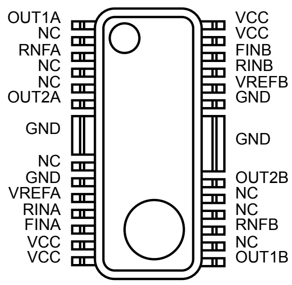


Fig.8 HSOP25 (TOP VIEW)

Table 4 BD6225FP / BD6226FP

Pin	Name	Function
1	OUT1A	Driver output
3	RNFA	Power stage ground
6	OUT2A	Driver output
8	GND	Small signal ground
9	VREFA	Duty setting pin
10	RINA	Control input (reverse)
11	FINA	Control input (forward)
12	VCC	Power supply
13	VCC	Power supply
14	OUT1B	Driver output
16	RNFB	Power stage ground
19	OUT2B	Driver output
20	GND	Small signal ground
21	VREFB	Duty setting pin
22	RINB	Control input (reverse)
23	FINB	Control input (forward)
24	VCC	Power supply
25	VCC	Power supply
FIN	GND	Ground

Note: All pins not described above are NC pins.
Note: Use all VCC pin by the same voltage.

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

Parameter	Symbol	Ratings	Unit
Supply voltage	VCC	18	V
Output current	I_{OMAX}	0.5 *1 / 1.0 *2 / 2.0 *3	A
All other input pins	V_{IN}	-0.3 to VCC	V
Operating temperature	T_{OPR}	-40 to +85	℃
Storage temperature	T_{STG}	-55 to +150	℃
Power dissipation	Pd	0.687 *4 / 1.6 *5 / 1.45 *6	W
Junction temperature	T_{jmax}	150	℃

*1 BD6220 / BD6225. Do not, exceed Pd or ASO.
*2 BD6221 / BD6226. Do not, exceed Pd or ASO.
*3 BD6222. Do not, exceed Pd or ASO.
*4 SOP8 package. Mounted on a 70mm x 70mm x 1.6mm glass-epoxy board. Derated at 5.5mW/℃ above 25℃.
*5 HRP7 package. Mounted on a 70mm x 70mm x 1.6mm glass-epoxy board. Derated at 12.8mW/℃ above 25℃.
*6 HSOP25 package. Mounted on a 70mm x 70mm x 1.6mm glass-epoxy board. Derated at 11.6mW/℃ above 25℃.

●Recommended Operating Ratings (Ta=25℃)

Parameter	Symbol	Ratings	Unit
Supply voltage	VCC	6 to 15	V
VREF voltage	VREF	3 to 15	V

●Electrical Characteristics (Unless otherwise specified, Ta=25℃ and VCC=VREF=12V)

Parameter	Symbol	Limits			Unit	Conditions
		Min.	Min.	Min.		
Supply current (1ch)	I_{CC}	0.8	1.3	2.5	mA	Forward / Reverse / Brake
Supply current (2ch)	I_{CC}	1.3	2.0	3.5	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 *1	R_{ON}	1.0	1.5	2.5	Ω	I_O=0.25A, vertically total
Output ON resistance *2	R_{ON}	1.0	1.5	2.5	Ω	I_O=0.5A, vertically total
Output ON resistance *3	R_{ON}	0.5	1.0	1.5	Ω	I_O=1.0A, vertically total
VREF bias current	I_{VREF}	-10	0	10	μA	VREF=VCC
Carrier frequency	F_{PWM}	20	25	35	kHz	VREF=9V
Input frequency range	F_{MAX}	20	-	100	kHz	FIN / RIN

*1 BD6220 / BD6225
*2 BD6221 / BD6226
*3 BD6222

●**Typical Performance Curves (Reference data)**

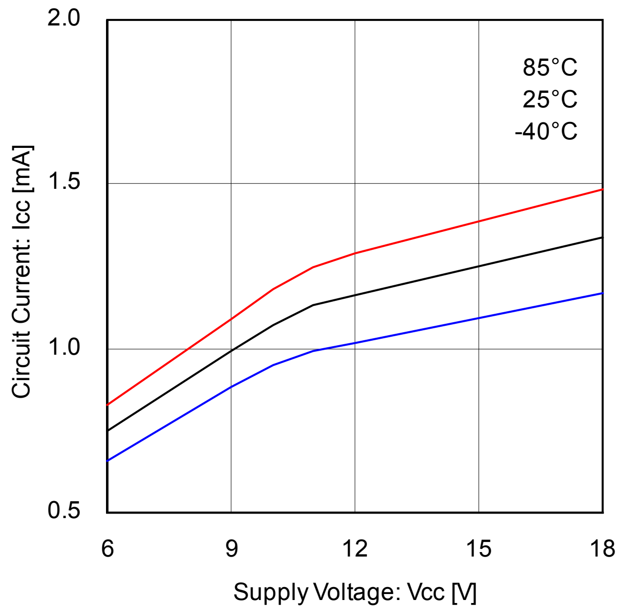


Fig.9 Supply current (1ch)

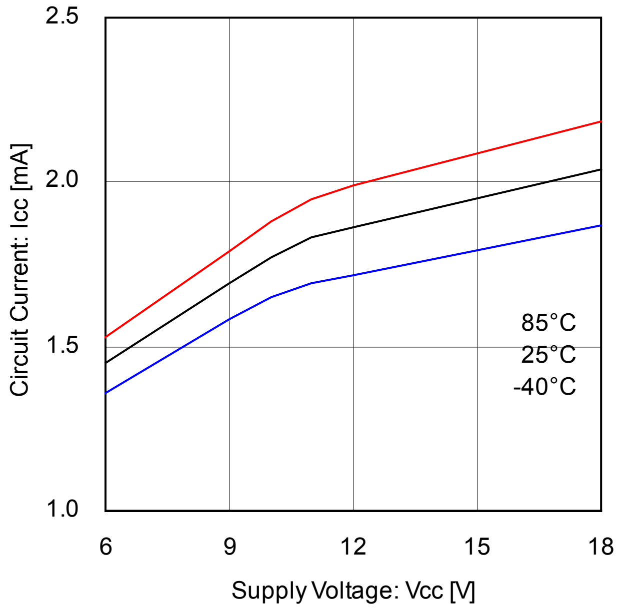


Fig.10 Supply current (2ch)

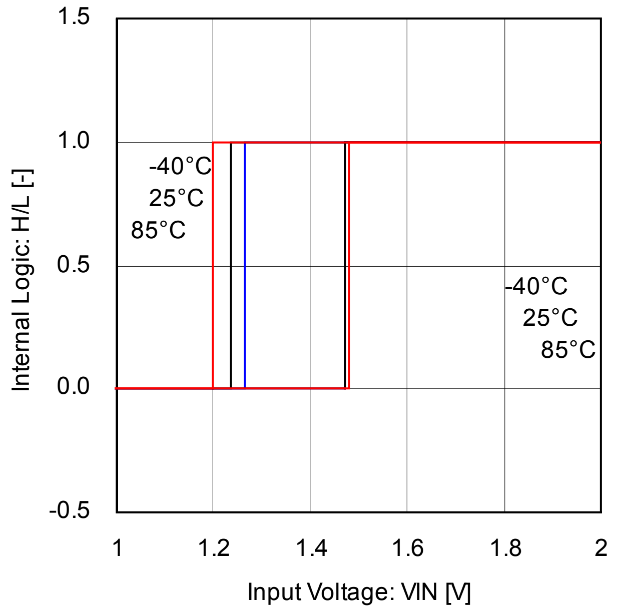


Fig.11 Input threshold voltage

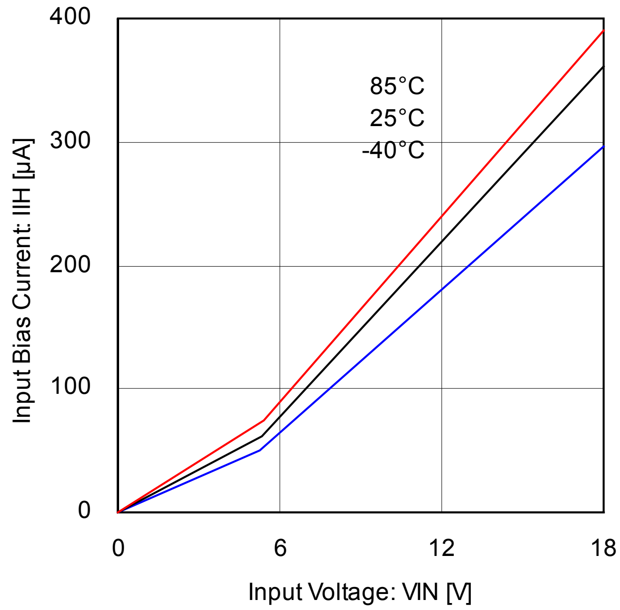


Fig.12 Input bias current

●Typical Performance Curves (Reference data) - Continued

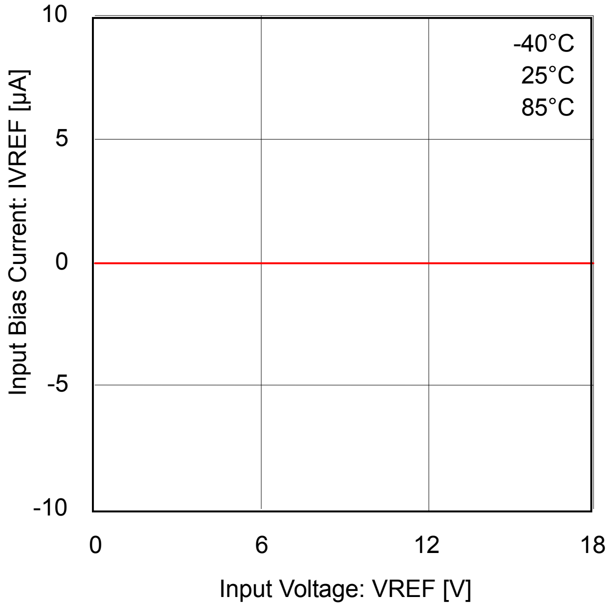


Fig.13 VREF input bias current

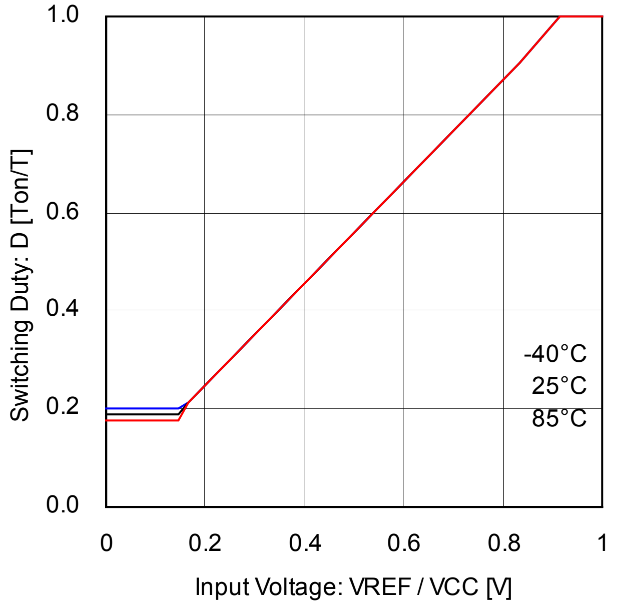


Fig.14 VREF - DUTY(VCC=12V)

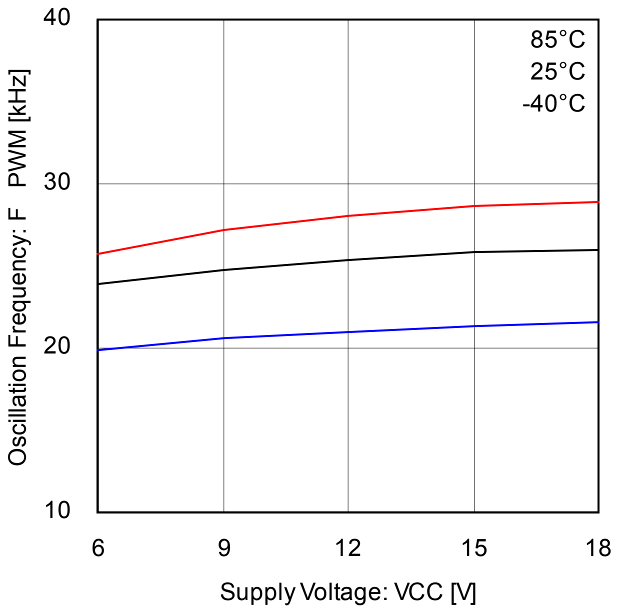


Fig.15 VCC - Carrier frequency

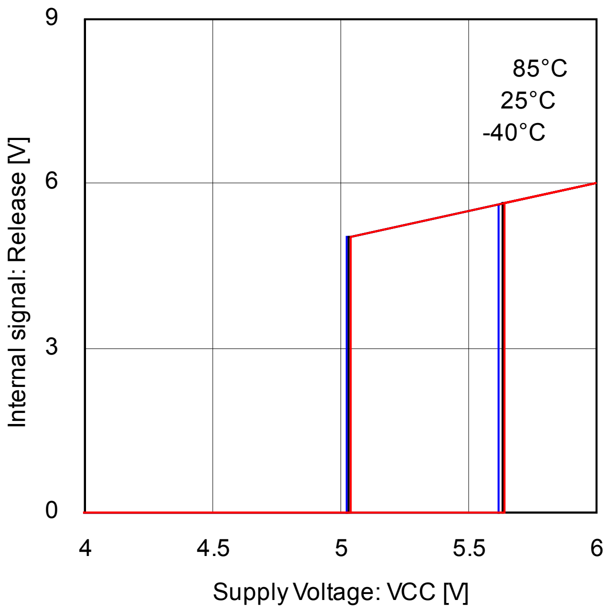


Fig.16 Under voltage lock out

●**Typical Performance Curves(Reference data)-Continued**

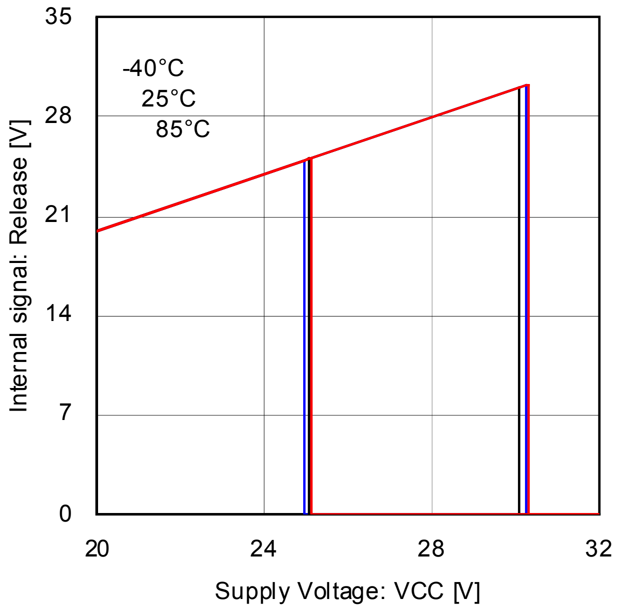


Fig.17 Over voltage protection

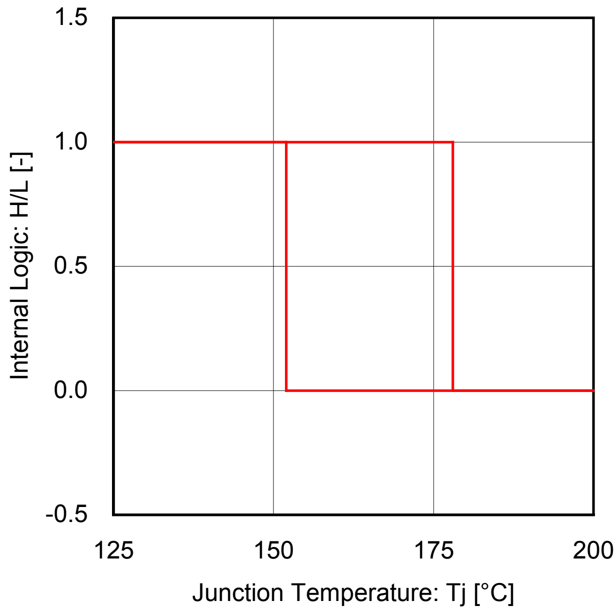


Fig.18 Thermal shutdown

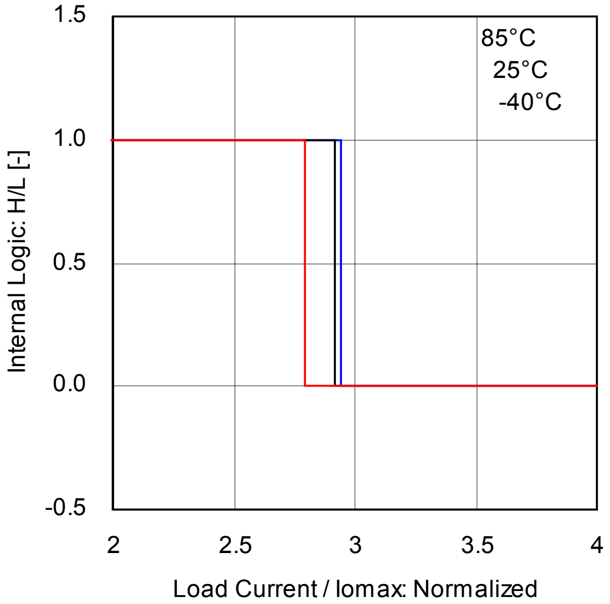


Fig.19 Over current protection (H side)

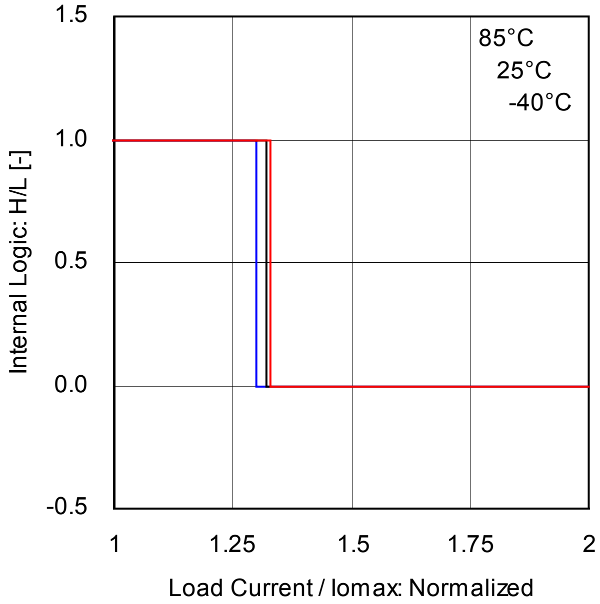


Fig.20 Over current protection (L side)

●**Typical Performance Curves (Reference data) - Continued**

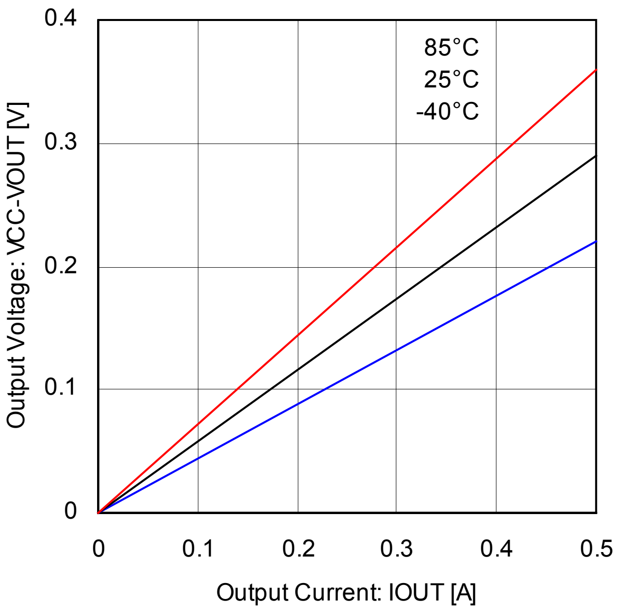


Fig.21 Output high voltage (BD6220/25)

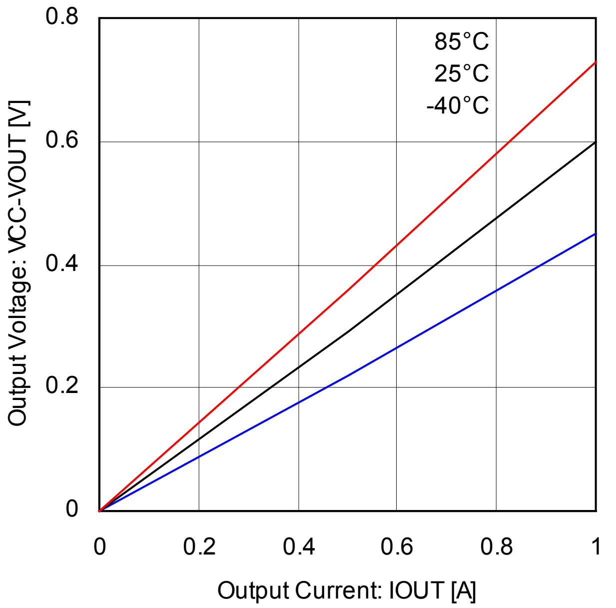


Fig.22 Output high voltage (BD6221/26)

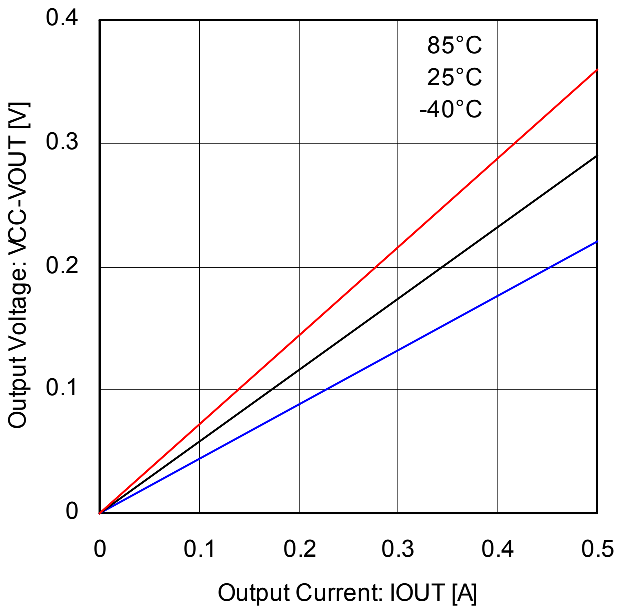


Fig.23 Output high voltage (BD6222)

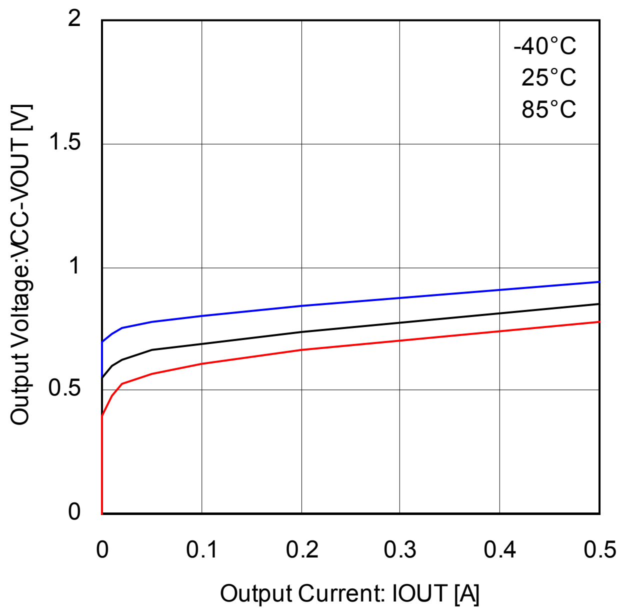


Fig.24 High side body diode (BD6220/25)

●**Typical Performance Curves (Reference data) - Continued**

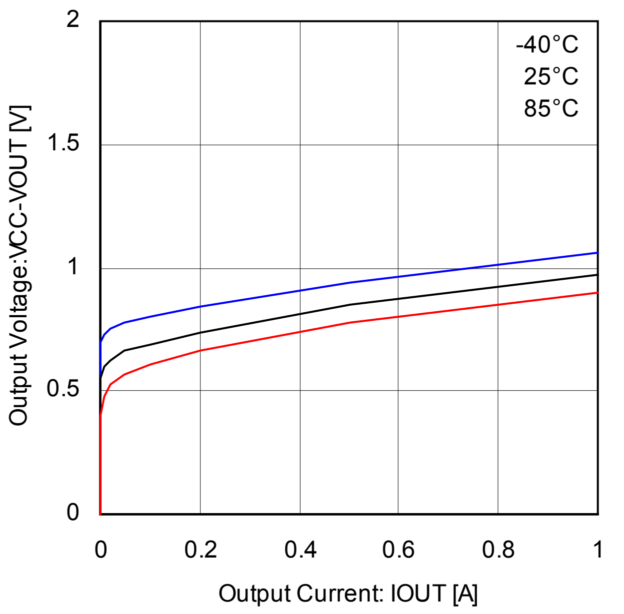


Fig.25 High side body diode (BD6221/26)

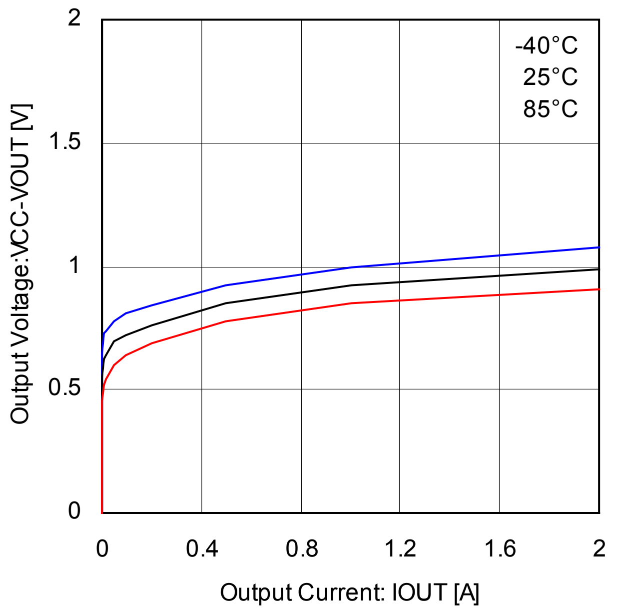


Fig.26 High side body diode (BD6222)

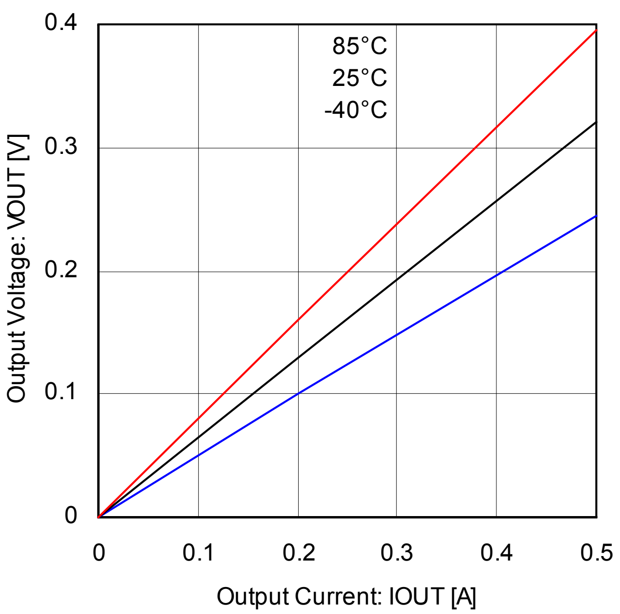


Fig.27 Output low voltage (BD6220/25)

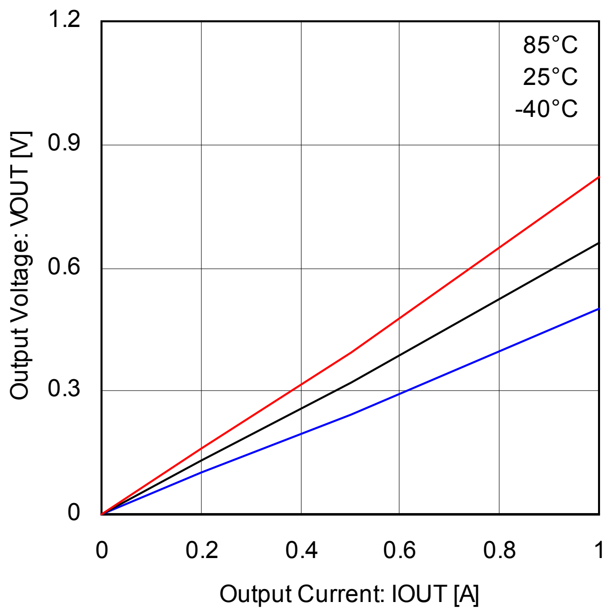


Fig.28 Output low voltage (BD6221/26)

●Typical Performance Curves (Reference data) - Continued

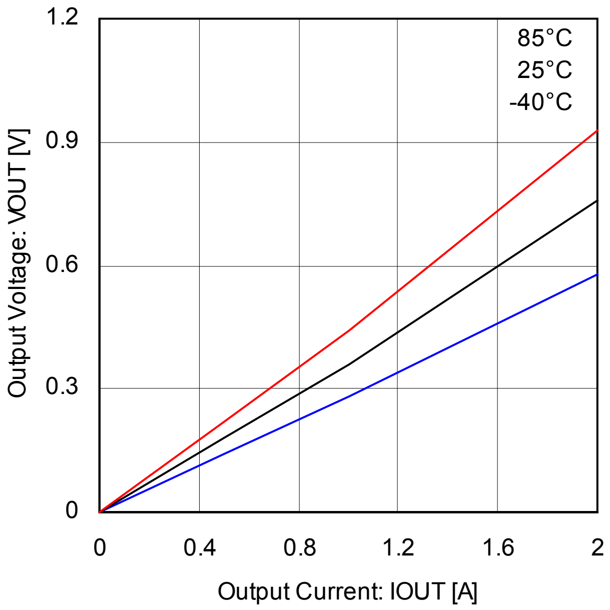


Fig.29 Output low voltage (BD6222)

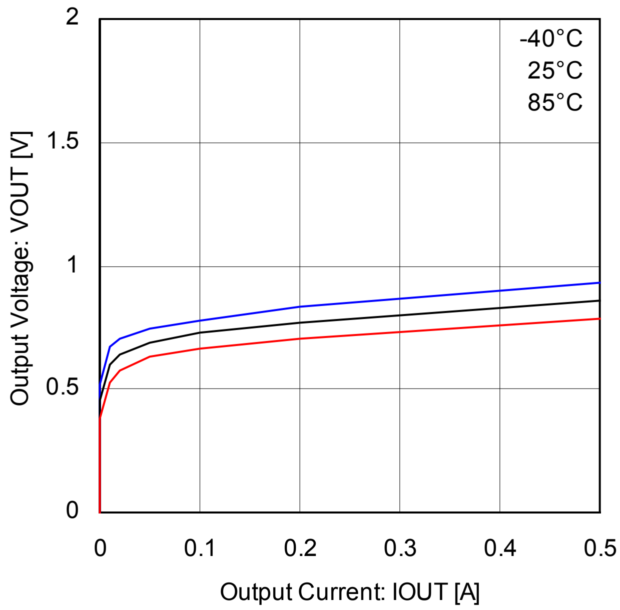


Fig.30 Low side body diode (BD6220/25)

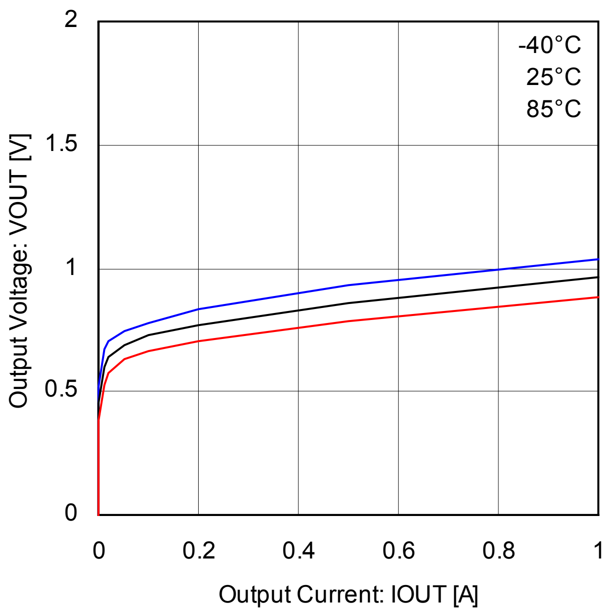


Fig.31 Low side body diode (BD6221/26)

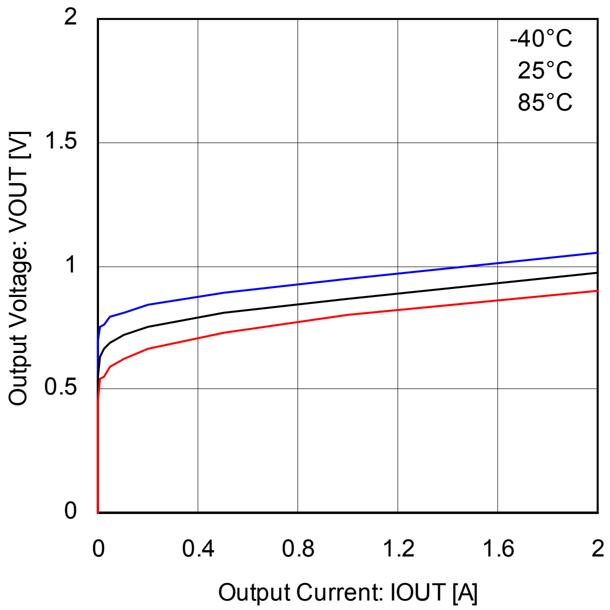


Fig.32 Low side body diode (BD6222)

●Functional Descriptions

1) Operation modes

Table 5 Logic table

	FIN	RIN	VREF	OUT1	OUT2	Operation
a	L	L	X	Hi-z*	Hi-z*	Stand-by (idling)
b	H	L	VCC	H	L	Forward (OUT1 > OUT2)
c	L	H	VCC	L	H	Reverse (OUT1 < OUT2)
d	H	H	X	L	L	Brake (stop)
e	PWM	L	VCC	H	$\overline{\text{PWM}}$	Forward (PWM control mode A)
f	L	PWM	VCC	$\overline{\text{PWM}}$	H	Reverse (PWM control mode A)
g	H	PWM	VCC	$\overline{\text{PWM}}$	L	Forward (PWM control mode B)
h	PWM	H	VCC	L	$\overline{\text{PWM}}$	Reverse (PWM control mode B)
i	H	L	Option	H	$\overline{\text{PWM}}$	Forward (VREF control)
j	L	H	Option	$\overline{\text{PWM}}$	H	Reverse (VREF control)

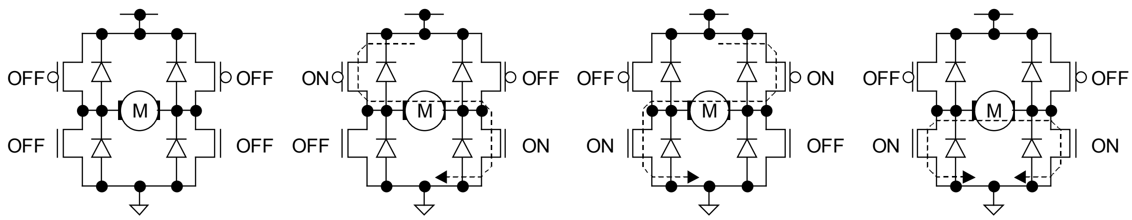
* Hi-z is the off state of all output transistors. Please note that this is the state of the connected diodes, which differs from that of the mechanical relay.
X : Don't care

a) Stand-by mode
Stand-by operates independently of the VREF pin voltage. 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. For operation in this mode, connect the VREF pin with VCC pin.

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. For operation in this mode, connect the VREF pin with VCC pin.

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.33 Four basic operations (output stage)

e) f) PWM control mode A

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. To operate in this mode, connect the VREF pin with VCC pin. 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.

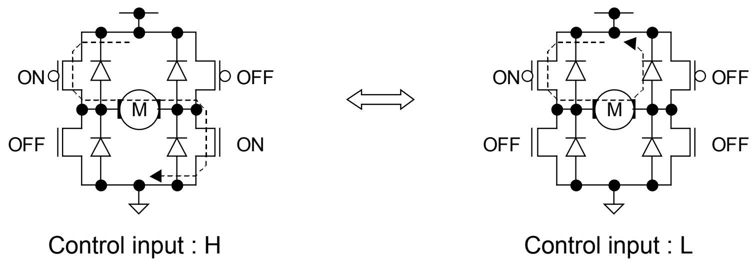


Fig.34 PWM control mode A operation (output stage)

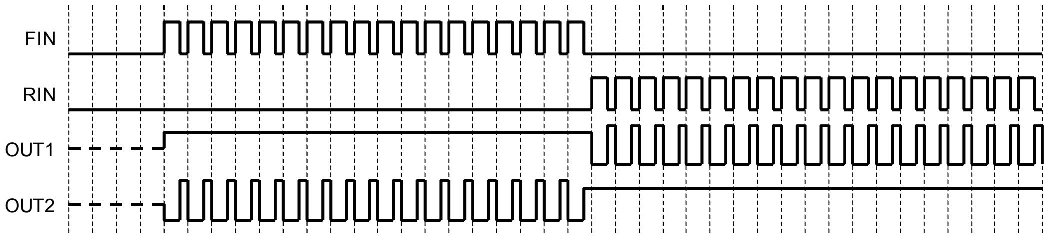


Fig.35 PWM control mode A operation (timing chart)

g) h) PWM control mode B

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 low side output is fixed and the high side output does the switching, corresponding to the input signal. The switching operates by the output state toggling between "L" and "H".

The PWM frequency can be input in the range between 20kHz and 100kHz. Also, circuit operation may not respond correctly when the input signal is higher than 100kHz. To operate in this mode, connect the VREF pin with VCC pin. 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.

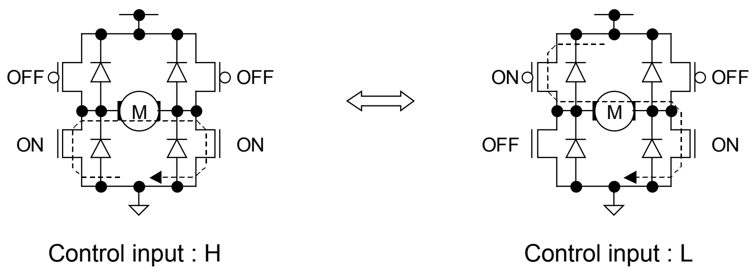


Fig.36 PWM control mode B operation (output stage)

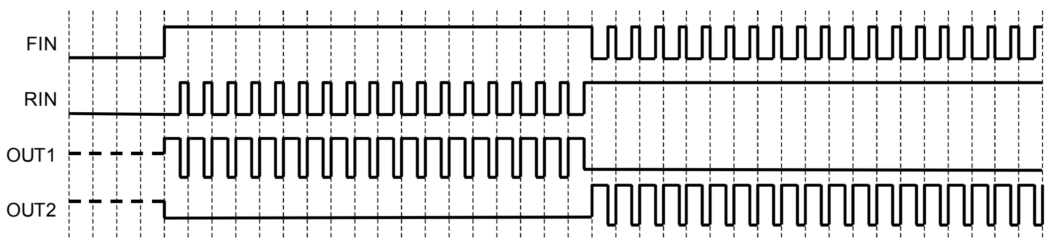


Fig.37 PWM control mode B operation (timing chart)

i) j) VREF control mode

The built-in VREF-switching on duty conversion circuit provides switching duty corresponding to the voltage of the VREF pin and the VCC voltage. The function offers the same level of control as the high voltage output setting function in previous models. The on duty is shown by the following equation.

DUTY ≈ VREF [V] / VCC [V]

For example, if VCC voltage is 12V and VREF pin voltage is 9V, the switching on duty is about 75 percent. However, please note that the switching on duty might be limited by the range of VREF pin voltage (Refer to the operating conditions, shown on page 4). The PWM carrier frequency in this mode is 25kHz (nominal), and the switching operation is the same as it is the PWM control modes. When operating in this mode, do not input the PWM signal to the FIN and RIN pins. 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.

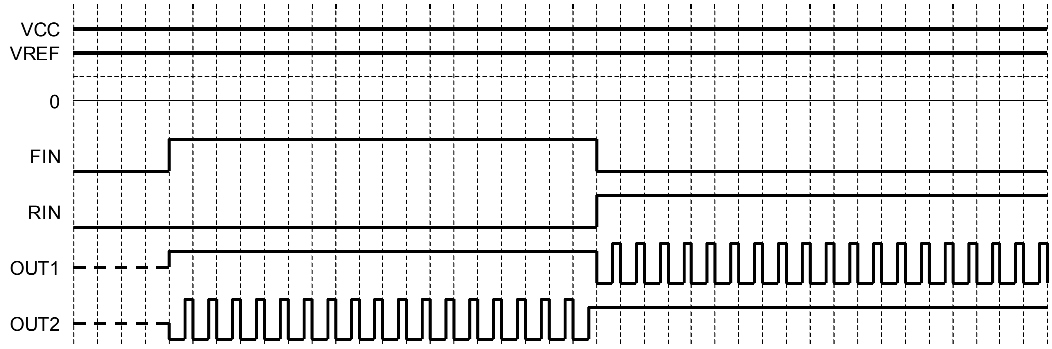


Fig.38 VREF control operation (timing chart)

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 5.0V (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 30V (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 25V (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℃ 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℃ 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.

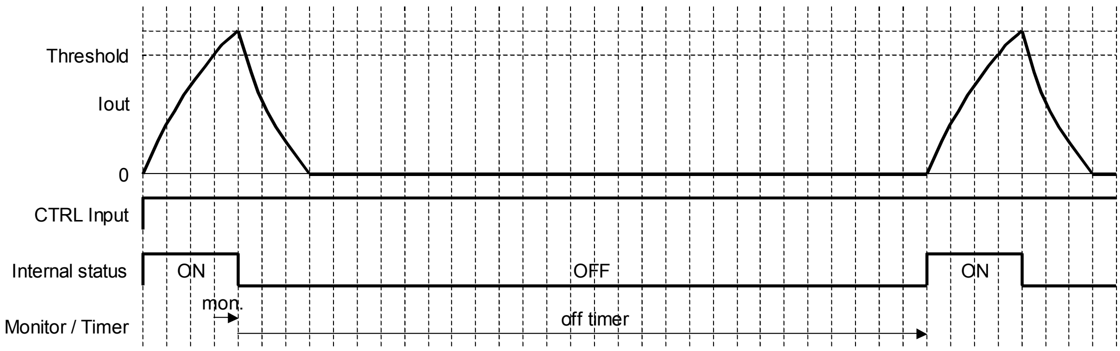


Fig.39 Over current protection (timing chart)

●I/O equivalence circuit

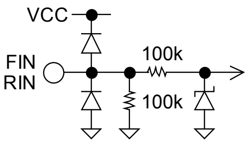


Fig.40 FIN / RIN

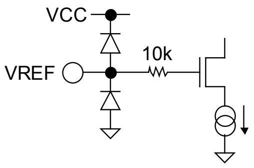


Fig.41 VREF

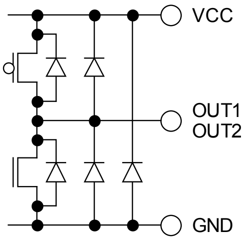


Fig.42 OUT1 / OUT2
(SOP8/HRP7)

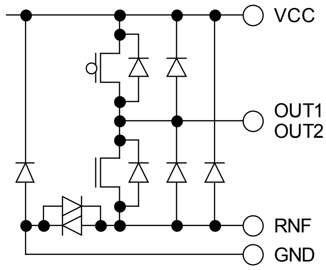


Fig.43 OUT1 / OUT2
(HSOP25)

●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 (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.

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 1μF 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 or VREF 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.

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.

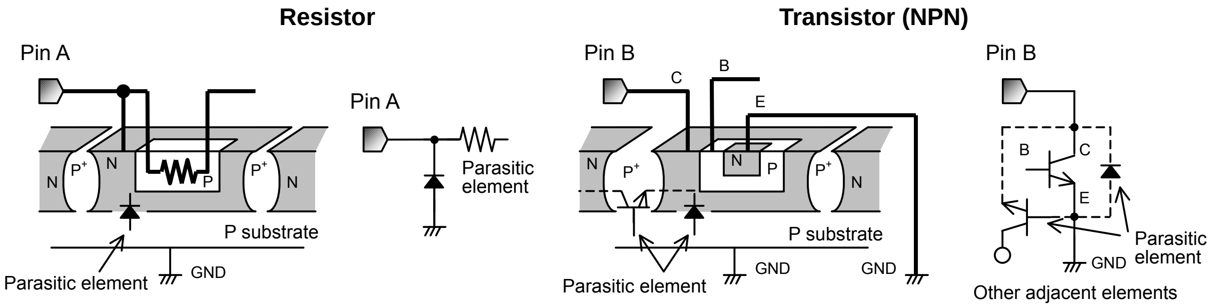


Fig.44 Example of monolithic IC structure

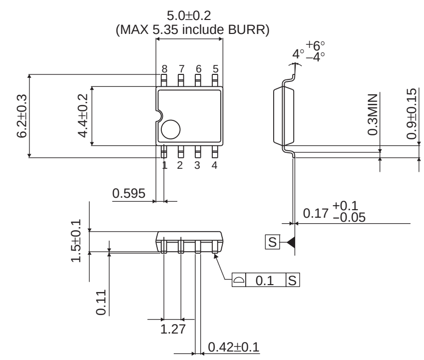
Status of this document

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.

●Physical Dimensions Tape and Reel Information

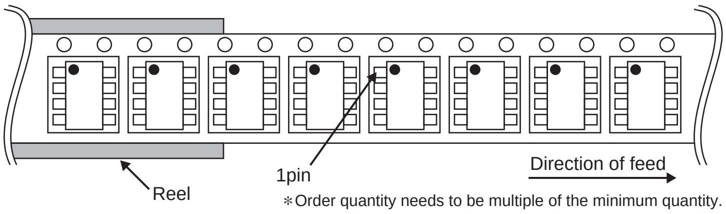
SOP8



(Unit : mm)

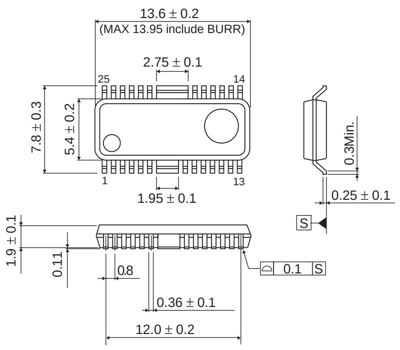
<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



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

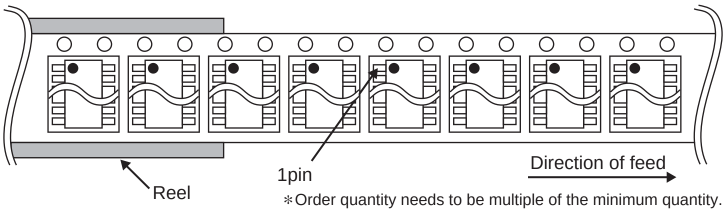
HSOP25



(Unit : mm)

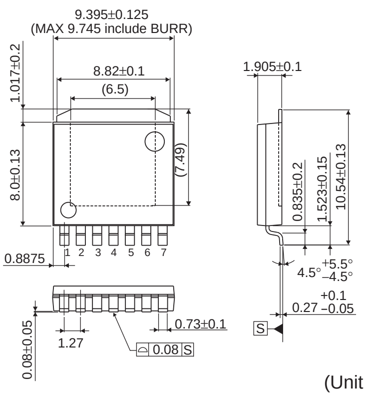
<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	2000pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



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

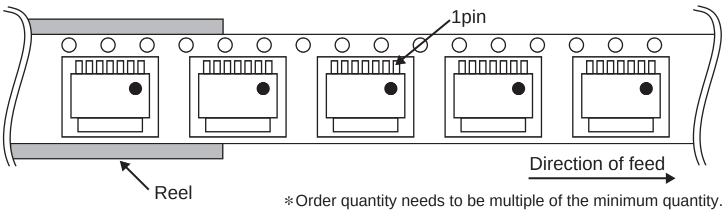
HRP7



(Unit : mm)

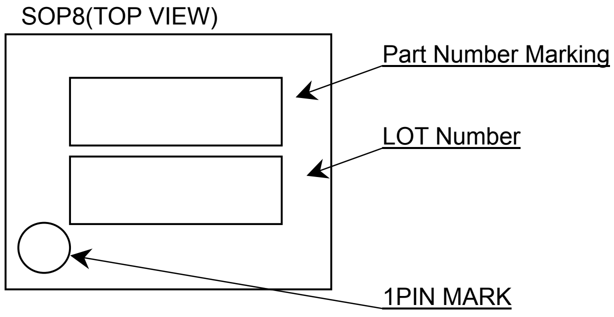
<Tape and Reel information>

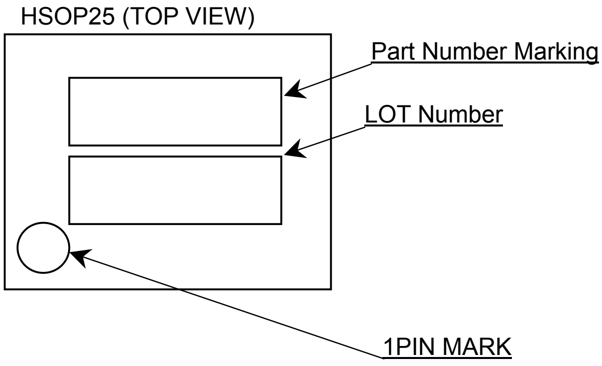
Tape	Embossed carrier tape
Quantity	2000pcs
Direction of feed	TR (The direction is the 1pin of product is at the upper right when you hold reel on the left hand and you pull out the tape on the right hand)

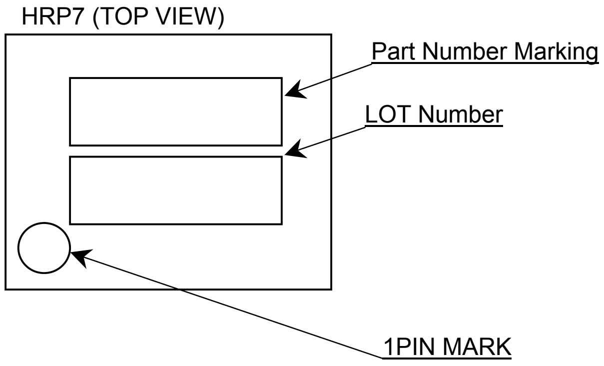


∗Order quantity needs to be multiple of the minimum quantity.

● **Marking Diagrams**







Part Number	Package	Part Number Marking
BD6220F	SOP8	6220
BD6221F	SOP8	6221
BD6222HFP	HRP7	BD6222HFP
BD6222FP	HSOP25	BD6222FP
BD6225FP	HSOP25	BD6222FP
BD6226FP	HSOP25	BD6222FP

●Revision History

Date	Revision	Changes
12.Apr.2012	001	New Release

Notice

●General Precaution

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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.

●Precaution on using ROHM Products

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   [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 (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.

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 Cl2, H2S, NH3, SO2, and NO2
   [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**

QR code 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 our Products might fall under controlled goods prescribed by the applicable foreign exchange and foreign trade act, please consult with ROHM representative in case of export.

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