ROHM SEMICONDUCTOR

Datasheet

DC Brush Motor Drivers (36V Max)

BD623xxx Series

General Description

These H-bridge drivers are full bridge drivers for brush motor applications. Each IC can operate at a wide range of power supply voltages (from 6V to 32V), with output currents of up to 2A. MOS transistors in the output stage allow PWM speed control. The integrated VREF voltage control function allows direct replacement of discontinued 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: 36V(Max)
- Maximum Output Current: 0.5A / 1.0A / 2.0A
- Output ON-Resistance: 1.5Ω / 1.5Ω / 1.0Ω
- PWM Input Frequency Range: 20kHz to 100kHz
- Standby Current: 0μA (Typ)
- Operating Temperature Range: -40°C to +85°C

Packages

Packages	W(Typ) x D(Typ) x H(Max)
SOP8	5.00mm x 6.20mm x 1.71mm
HSOP25	13.60mm x 7.80mm x 2.11mm
HSOP-M28	18.50mm x 9.90mm x 2.41mm
HRP7	9.395mm x 10.540mm x 2.005mm

HRP7 (Pd=1.60W)


SOP8 (Pd=0.69W)

HSOP25((Pd=1.45W)

HSOP-M28 (Pd=2.20W)

(Note) Pd : Mounted on a 70mm x 70mm x 1.6mm glass-epoxy board.

Ordering Information

B D 6 2 3 x x x x - x x

Part Number

Package
F : SOP8
FP : HSOP25
FM : HSOP-M28
HFP : HRP7

Packaging and forming specification
E2: Embossed taping
(SOP8/HSOP25/HSOP-M28)
TR: Embossed taping
(HRP7)

Lineup

Rating Voltage (Max)	Channels	Output Current (Max)	Package		Ordering Part Number
36V	1ch	0.5A	SOP8	Reel of 2500	BD6230F-E2
		1.0A	HRP7	Reel of 2000	BD6231HFP-TR
			SOP8	Reel of 2500	BD6231F-E2
		2.0A	HRP7	Reel of 2000	BD6232HFP-TR
			HSOP25	Reel of 2000	BD6232FP-E2
	2ch	1.0A	HSOP25	Reel of 2000	BD6236FP-E2
			HSOP-M28	Reel of 1500	BD6236FM-E2
		2.0A	HSOP-M28	Reel of 1500	BD6237FM-E2

○Product structure : Silicon monolithic integrated circuit ○This product has no designed protection against radioactive rays.

Block Diagrams / Pin Configurations / Pin Descriptions

BD6230F / BD6231F

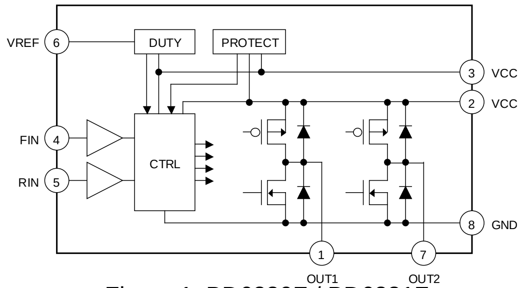


Figure 1. BD6230F / BD6231F

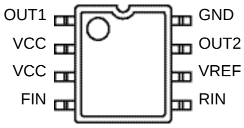


Figure 2. SOP8 (TOP VIEW)

Table 1 BD6230F/BD6231F

Pin No.	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.

BD6231HFP / BD6232HFP

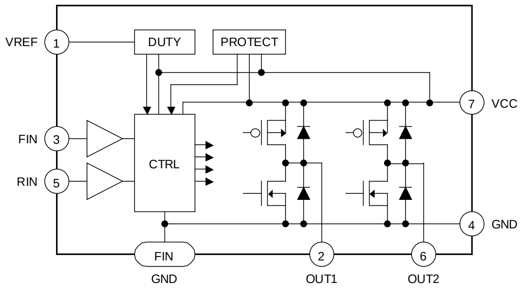


Figure 3. BD6231HFP / BD6232HFP

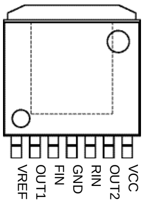


Figure 4. HRP7 (TOP VIEW)

Table 2 BD6231HFP/BD6232HFP

Pin No.	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

BD6232FP

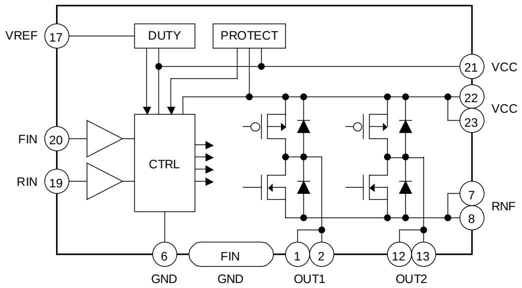


Figure 5. BD6232FP

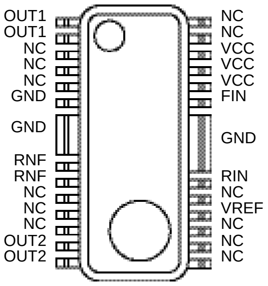


Figure 6. HSOP25 (TOP VIEW)

Table 3 BD6232FP

Pin No.	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.

Block Diagrams / Pin Configurations / Pin Descriptions - continued

BD6236FP

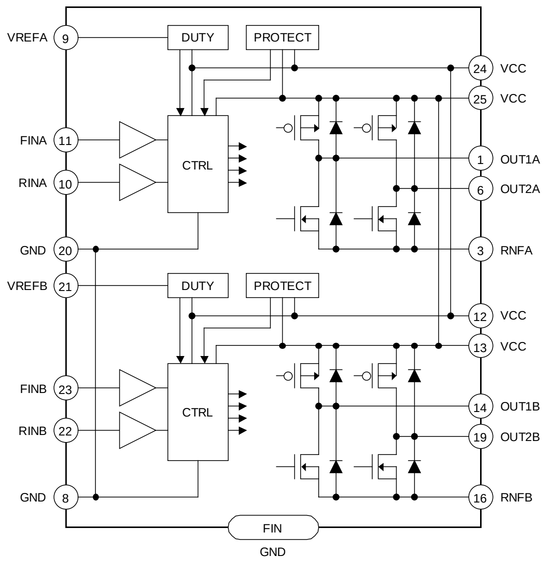


Figure 7. BD6236FP

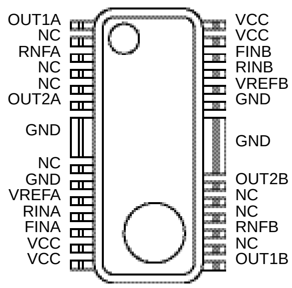


Figure 8. HSOP25 (TOP VIEW)

Table 4 BD6236FP

Pin No.	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.

Block Diagrams / Pin Configurations / Pin Descriptions - continued

BD6236FM

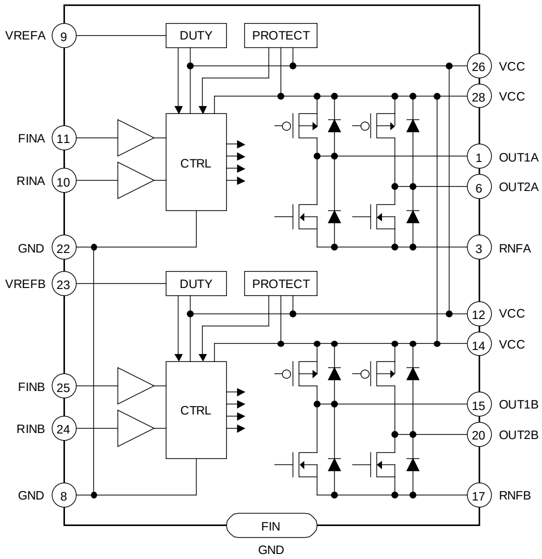


Figure 9. BD6236FM

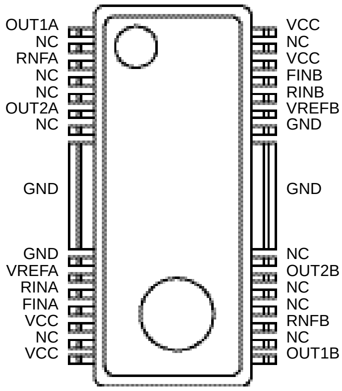


Figure 10. HSOP-M28 (TOP VIEW)

Table 5 BD6236FM

Pin No.	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
14	VCC	Power supply
15	OUT1B	Driver output
17	RNFB	Power stage ground
20	OUT2B	Driver output
22	GND	Small signal ground
23	VREFB	Duty setting pin
24	RINB	Control input (reverse)
25	FINB	Control input (forward)
26	VCC	Power supply
28	VCC	Power supply
FIN	GND	Ground

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

Block Diagrams / Pin Configurations / Pin Descriptions - Continued

BD6237FM

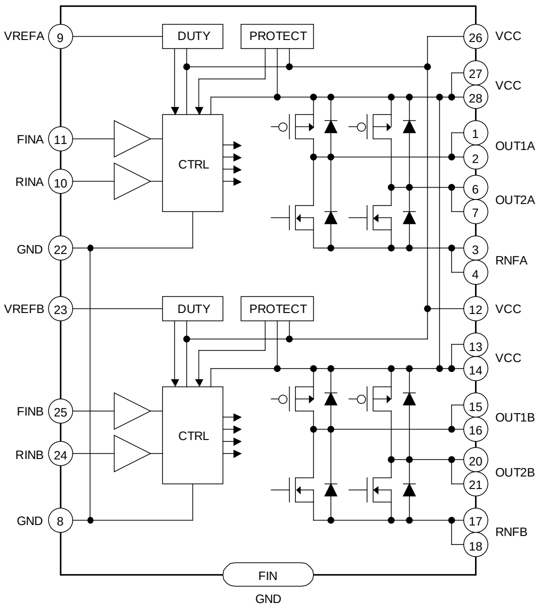


Figure 11. BD6237FM

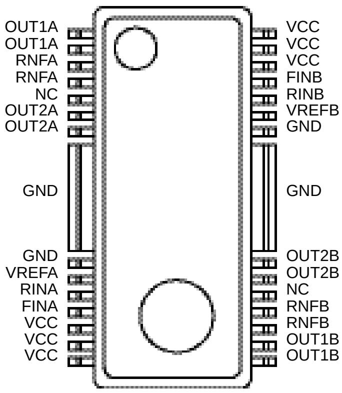


Figure 12. HSOP-M28 (TOP VIEW)

Table 6 BD6237FM

Pin No.	Pin Name	Function
1,2	OUT1A	Driver output
3,4	RNF A	Power stage ground
6,7	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
13,14	VCC	Power supply
15,16	OUT1B	Driver output
17,18	RNFB	Power stage ground
20,21	OUT2B	Driver output
22	GND	Small signal ground
23	VREFB	Duty setting pin
24	RINB	Control input (reverse)
25	FINB	Control input (forward)
26	VCC	Power supply
27,28	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°C, All voltages are with respect to ground)

Parameter	Symbol	Rating	Unit
Supply Voltage	V_{CC}	36	V
Output Current	I_{OMAX}	0.5 (Note 1) / 1.0 (Note 2) / 2.0 (Note 3)	A
All Other Input Pins	V_{IN}	-0.3 to V_{CC}	V
Operating Temperature	Topr	-40 to +85	°C
Storage Temperature	Tstg	-55 to +150	°C
Power Dissipation	Pd	0.68 (Note 4) / 1.6 (Note 5) / 1.45 (Note 6) / 2.2 (Note 7)	W
Junction Temperature	Tjmax	150	°C

(Note 1) BD6230. Do not exceed Pd or ASO.
(Note 2) BD6231 / BD6236. Do not exceed Pd or ASO.
(Note 3) BD6232 / BD6237. Do not exceed Pd or ASO.
(Note 4) SOP8 package. Mounted on a 70mm x 70mm x 1.6mm glass-epoxy board. Derate by 5.5mW/°C for Ta above 25°C.
(Note 5) HRP7 package. Mounted on a 70mm x 70mm x 1.6mm glass-epoxy board. Derate by 12.8mW/°C for Ta above 25°C.
(Note 6) HSOP25 package. Mounted on a 70mm x 70mm x 1.6mm glass-epoxy board. Derate by 11.6mW/°C for Ta above 25°C.
(Note 7) HSOP-M28 package. Mounted on a 70mm x 70mm x 1.6mm glass-epoxy board. Derate by 17.6mW/°C for Ta above 25°C.
Caution: 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.

Recommended Operating Conditions (Ta=25°C)

Parameter	Symbol	Rating	Unit
Supply Voltage	V_{CC}	6 to 32	V
VREF Voltage	V_{REF}	3 to 32	V

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

Parameter	Symbol	Limit			Unit	Conditions
		Min	Typ	Max		
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 (Note 8)	R_{ON}	1.0	1.5	2.5	Ω	I_{OUT}=0.25A, vertically total
Output ON-Resistance (Note 9)	R_{ON}	1.0	1.5	2.5	Ω	I_{OUT}=0.5A, vertically total
Output ON-Resistance (Note 10)	R_{ON}	0.5	1.0	1.5	Ω	I_{OUT}=1.0A, vertically total
VREF Bias Current	I_{VREF}	-10	0	+10	µA	V_{REF}=V_{CC}
Carrier Frequency	f_{PWM}	20	25	35	kHz	V_{REF}=18V
Input Frequency Range	f_{MAX}	20	-	100	kHz	FIN / RIN

(Note 8) BD6230
(Note 9) BD6231 / BD6236
(Note 10) BD6232 / BD6237

Typical Performance Curves (Reference Data)

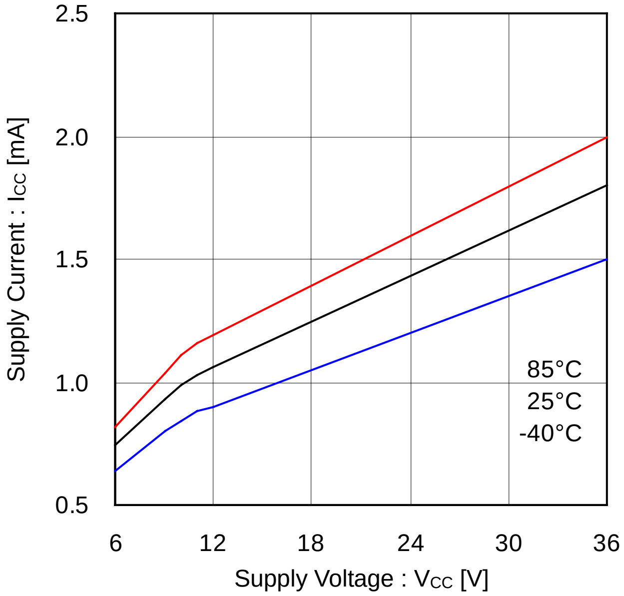


Figure 13. Supply Current vs Supply Voltage (1ch)

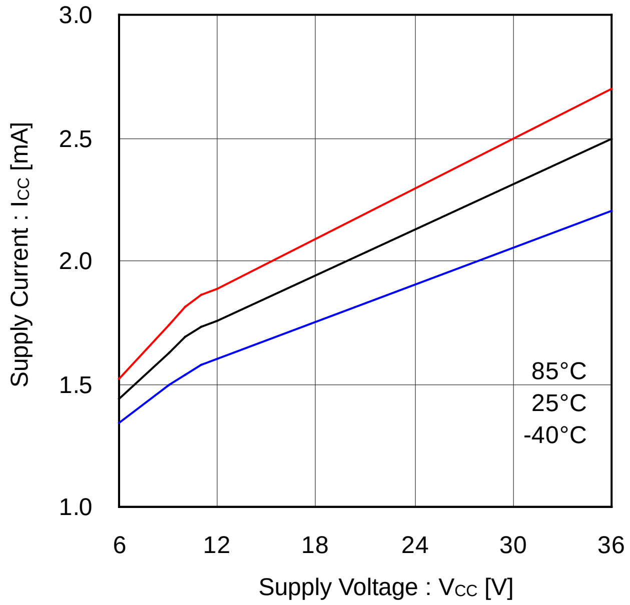


Figure 14. Supply Current vs Supply Voltage (2ch)

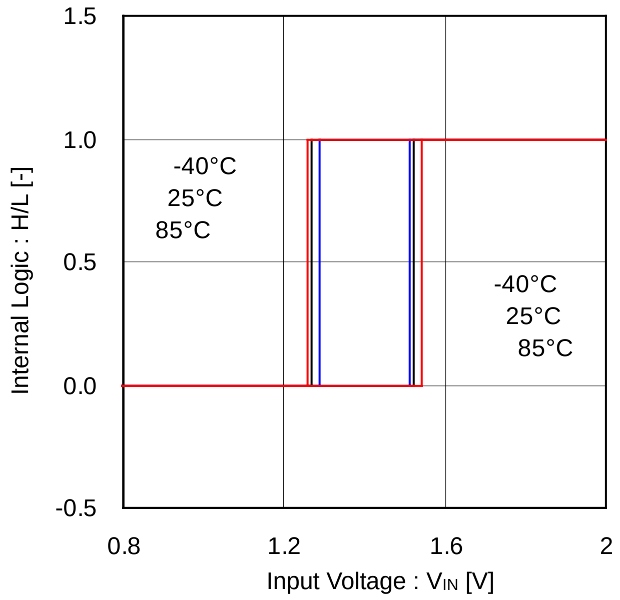


Figure 15. Internal Logic vs Input Voltage (Input Threshold Voltage)

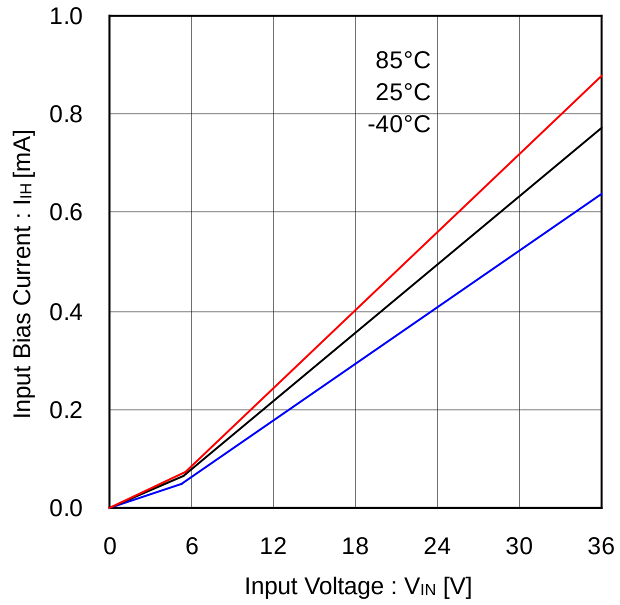


Figure 16. Input Bias Current vs Input Voltage

Typical Performance Curves (Reference Data) - continued

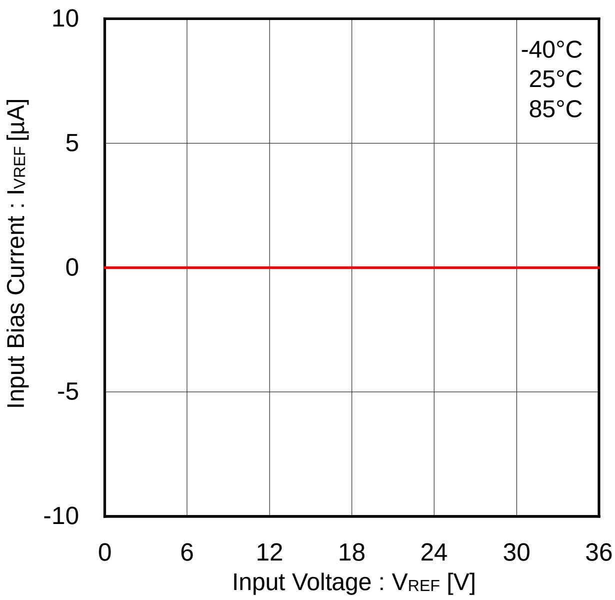


Figure 17. VREF Input Bias Current vs Input Voltage

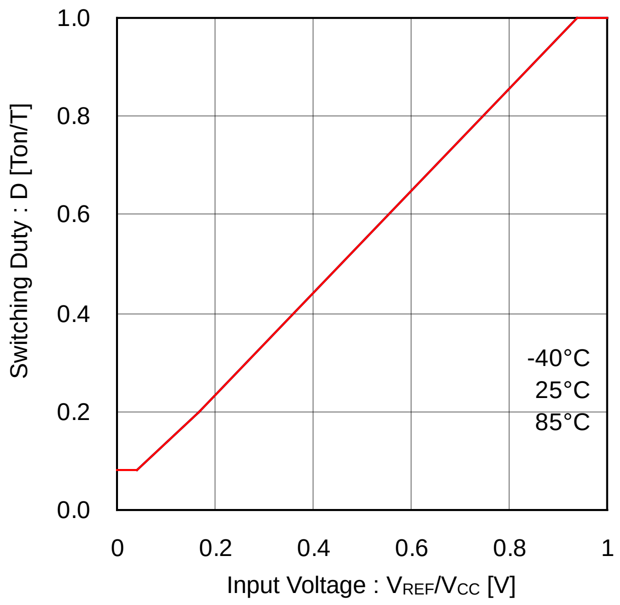


Figure 18. Switching Duty vs Input Voltage
(VREF – DUTY, V_{CC}=24V)

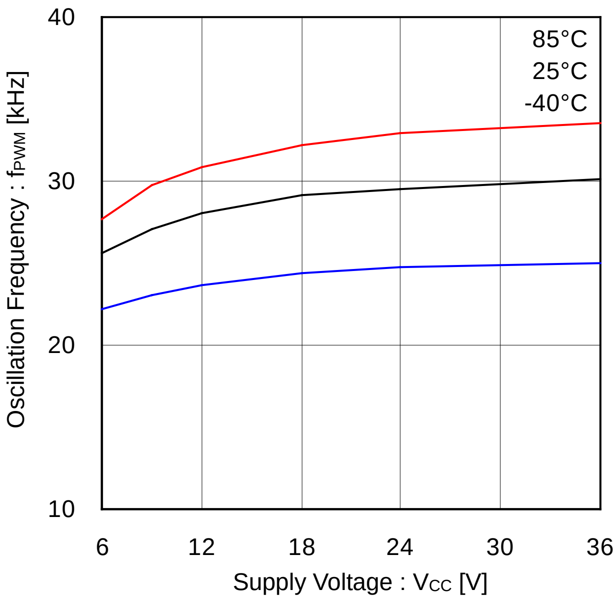


Figure 19. Oscillation Frequency vs Supply Voltage
(VCC – Carrier Frequency)

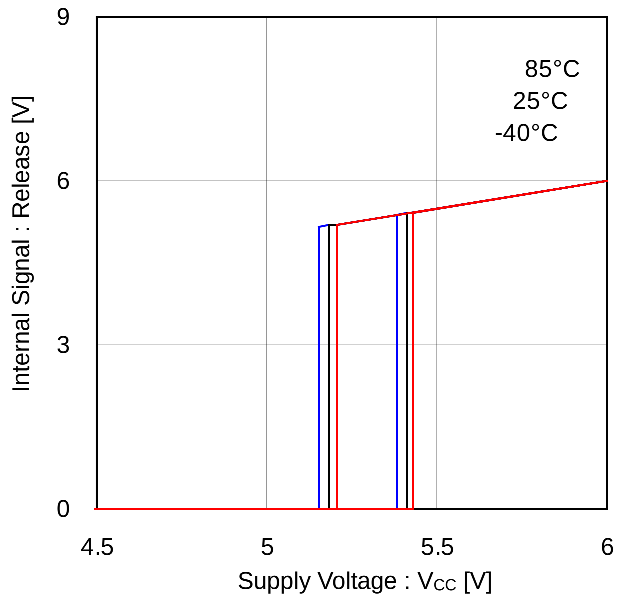


Figure 20. Internal Signal vs Supply Voltage
(Under Voltage Lock Out)

Typical Performance Curves (Reference Data) - continued

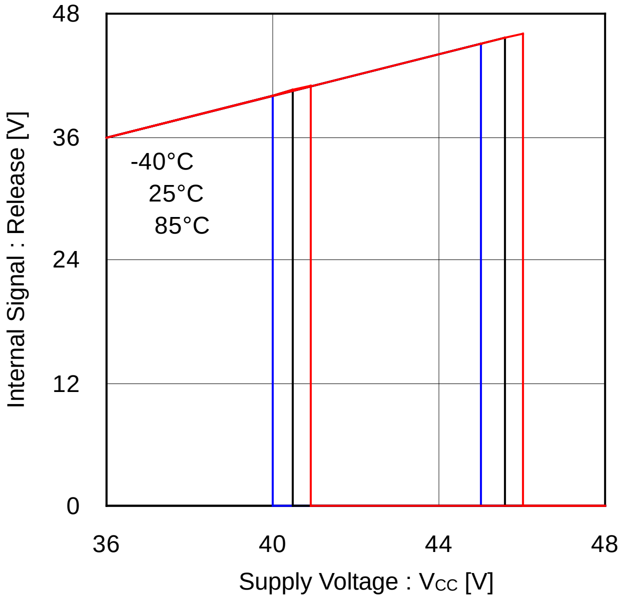


Figure 21. Internal Signal vs Supply Voltage
(Over Voltage Protection)

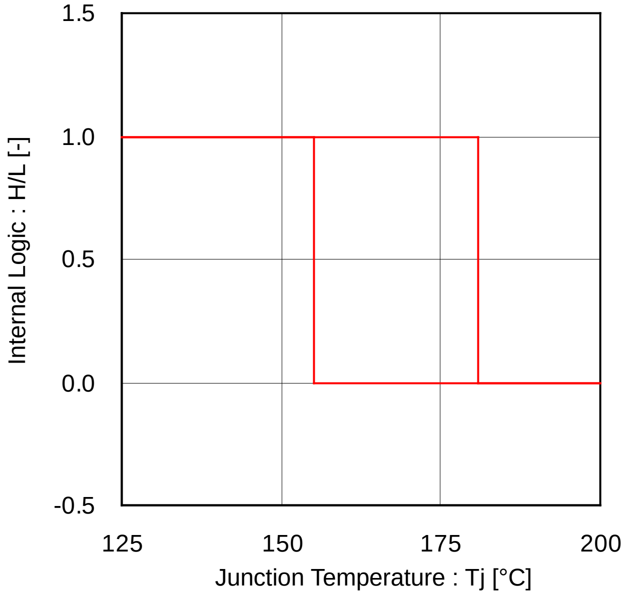


Figure 22. Internal Logic vs Junction Temperature
(Thermal Shutdown)

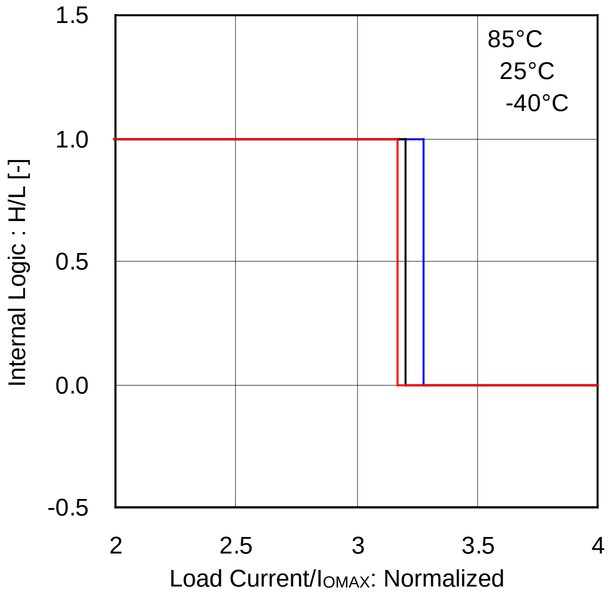


Figure 23. Internal Logic vs Load Current
(Over-Current Protection, H side)

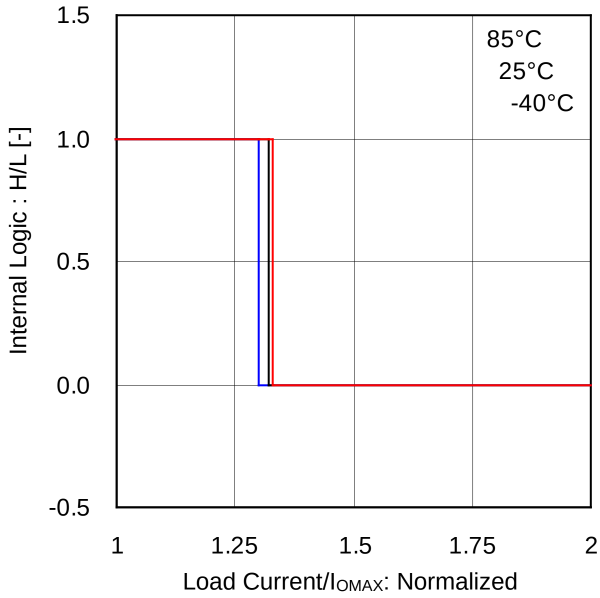


Figure 24. Internal Logic vs Load Current
(Over-Current Protection, L side)

Typical Performance Curves (Reference Data) – continued

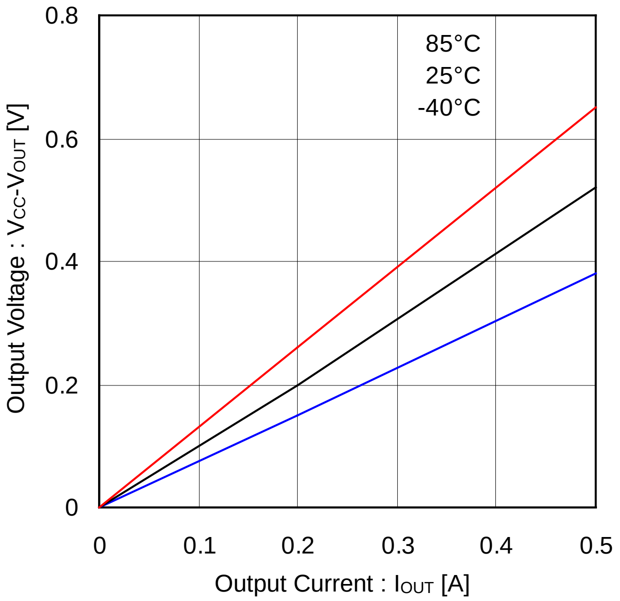


Figure 25. Output Voltage vs Output Current
(Output High Voltage, BD6230)

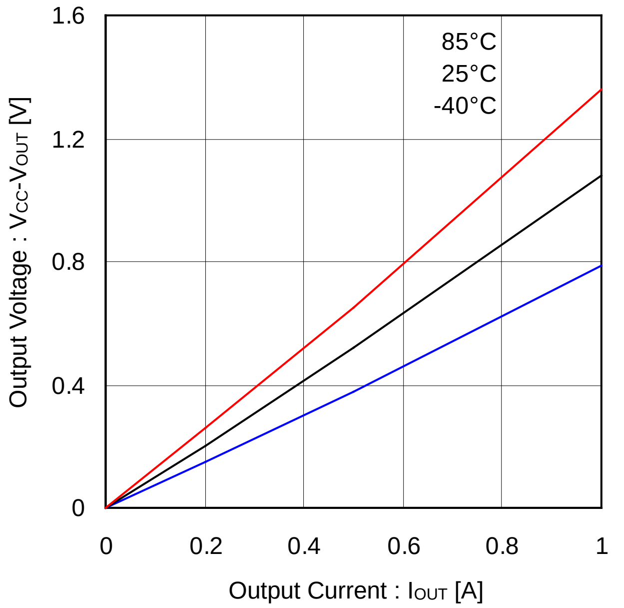


Figure 26. Output Voltage vs Output Current
(Output High Voltage, BD6231/36)

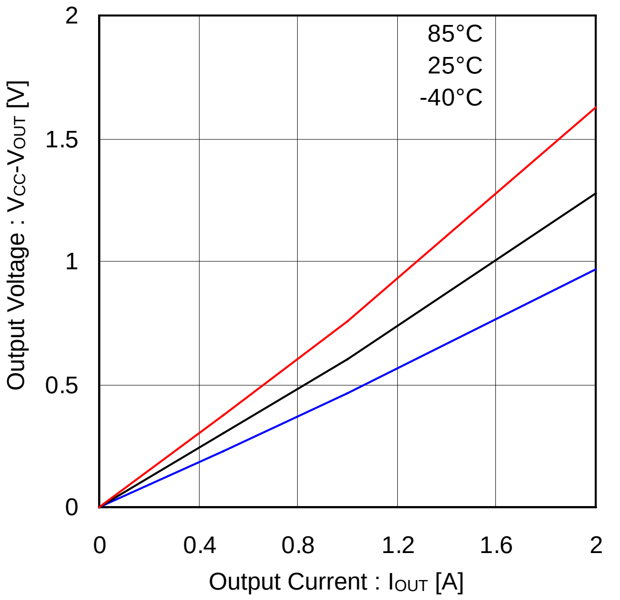


Figure 27. Output Voltage vs Output Current
(Output High Voltage, BD6232/37)

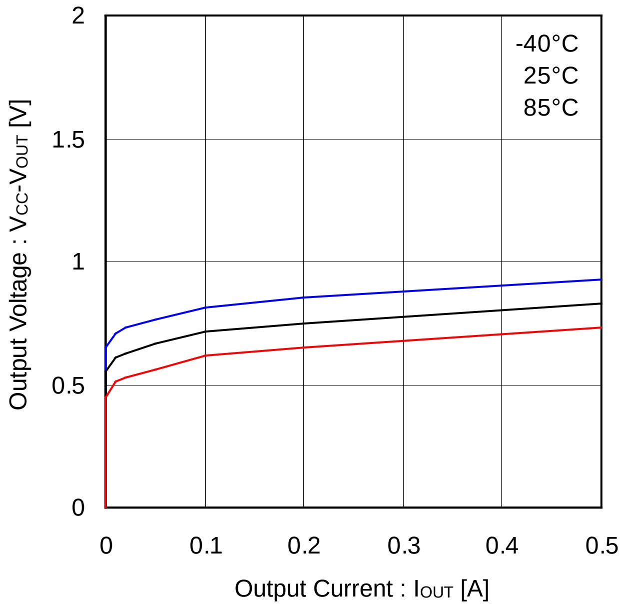


Figure 28. Output Voltage vs Output Current
(High Side Body Diode, BD6230)

Typical Performance Curves (Reference Data) – continued

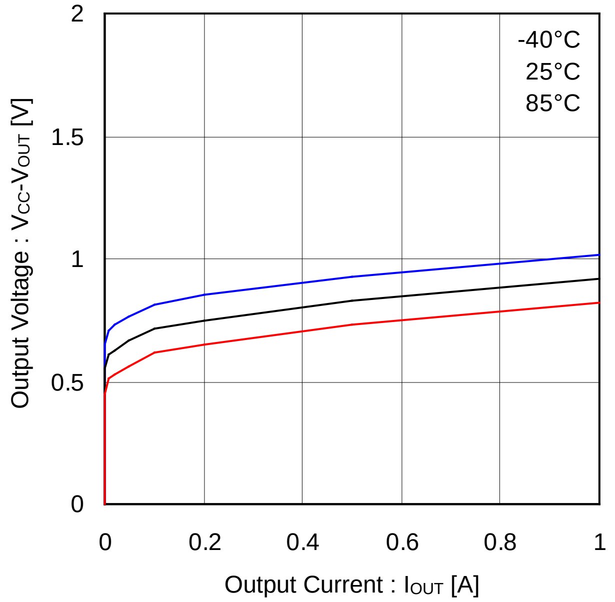


Figure 29. Output Voltage vs Output Current
(High Side Body Diode, BD6231/36)

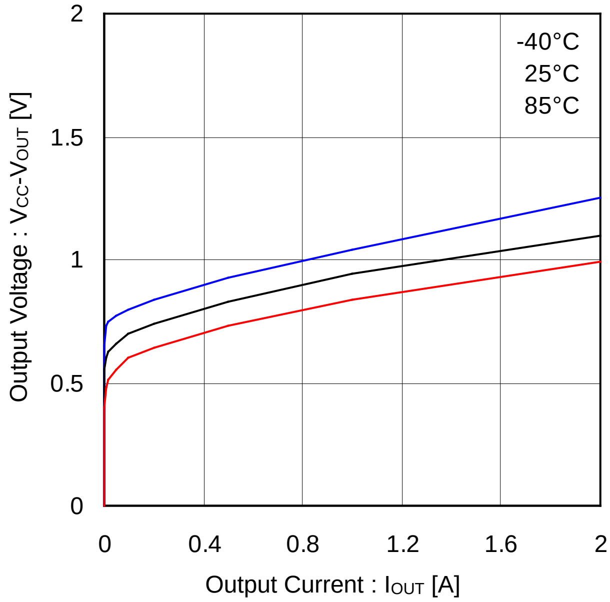


Figure 30. Output Voltage vs Output Current
(High Side Body Diode, BD6232/37)

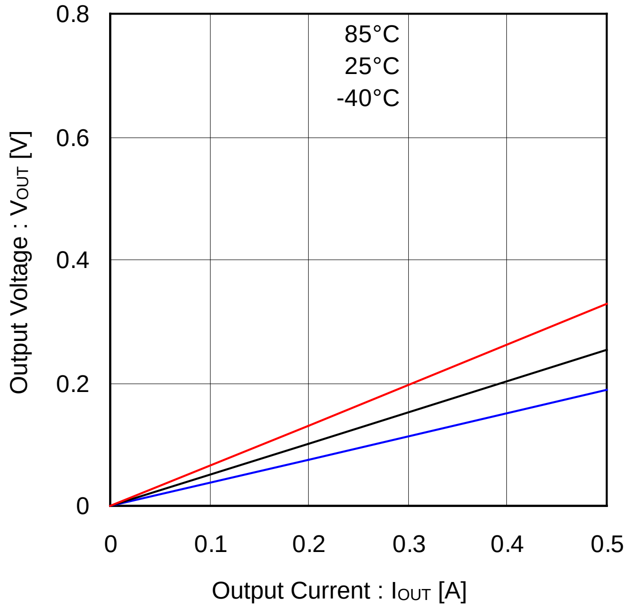


Figure 31. Output Voltage vs Output Current
(Output Low Voltage, BD6230)

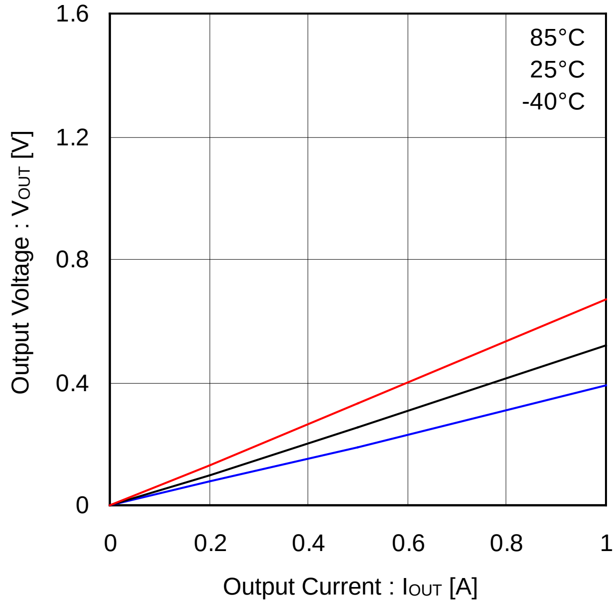


Figure 32. Output Voltage vs Output Current
(Output Low Voltage, BD6231/36)

Typical Performance Curves (Reference Data) - continued

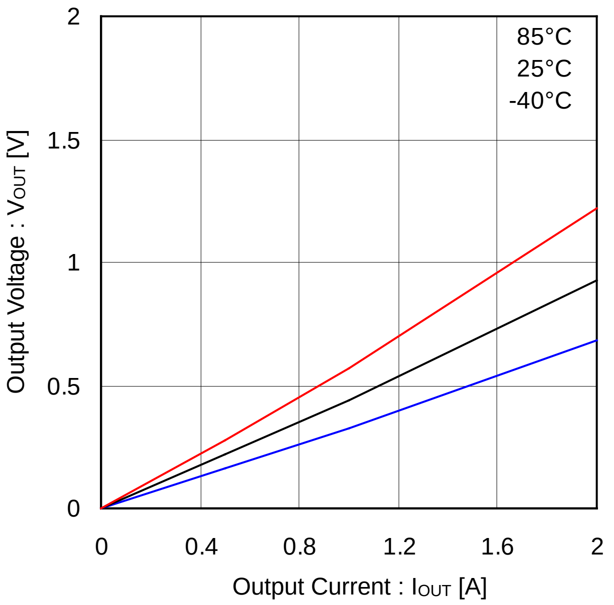


Figure 33. Output Voltage vs Output Current
(Output Low Voltage, BD6232/37)

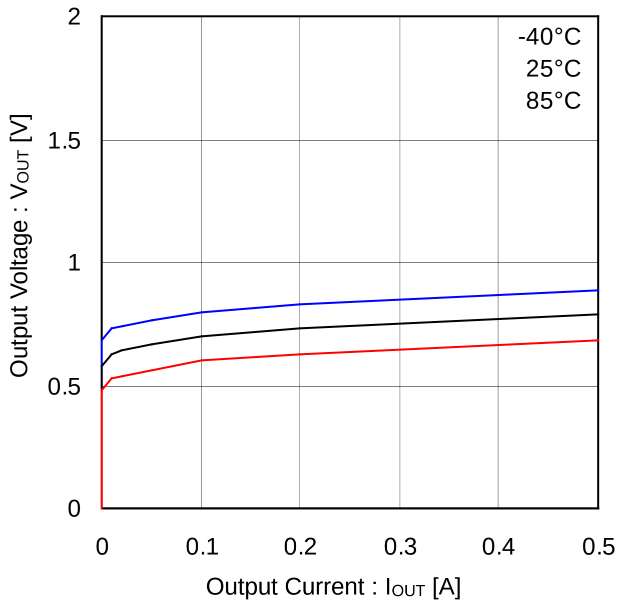


Figure 34. Output Voltage vs Output Current
(Low Side Body Diode, BD6230)

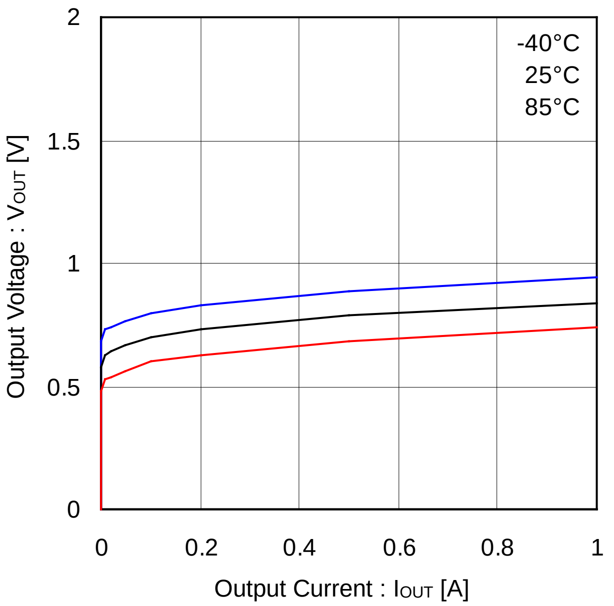


Figure 35. Output Voltage vs Output Current
(Low Side Body Diode, BD6231/36)

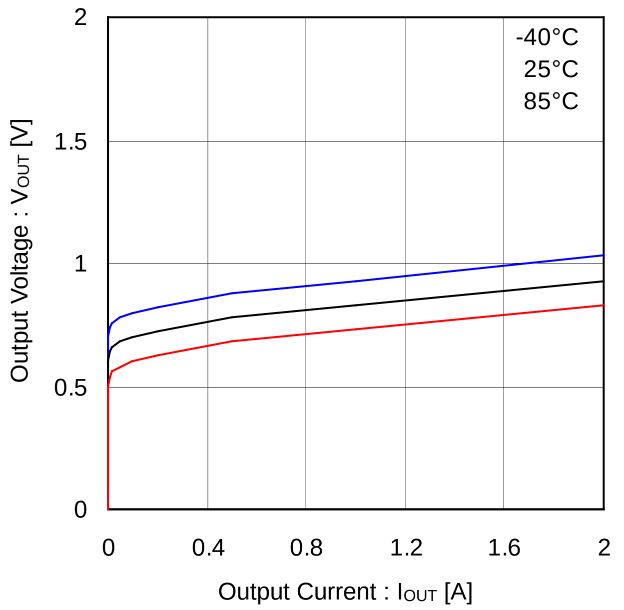


Figure 36. Output Voltage vs Output Current
(Low Side Body Diode, BD6232/37)

Application Information

1. Description of Functions

(1) Operation Modes

Table 7 Logic table

Mode	FIN	RIN	VREF	OUT1	OUT2	Operation
a	L	L	X	Hi-Z (Note)	Hi-Z (Note)	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)

(Note) Hi-Z : all output transistors are OFF. Note that this is the state of the connected diodes, which differs from that of the mechanical relay.
X : Don't care

Mode (a) Stand-by Mode

Stand-by operates independently with 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. 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.

Mode (b) Forward Mode

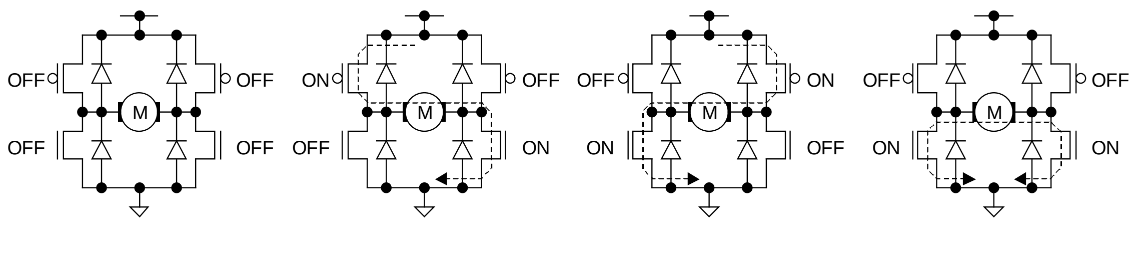
This operating mode is defined as the forward rotation of the motor when the OUT1 pin is high and OUT2 pin is low. When the motor is connected between the OUT1 and OUT2 pins, the current flows from OUT1 to OUT2. To operate in this mode, connect the VREF pin to the VCC pin.

Mode (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. To operate in this mode, connect the VREF pin to the VCC pin.

Mode (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

Figure 37. Four Basic Operations (Output Stage)

Mode (e),(f) PWM Control Mode A

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 (10µF or higher is recommended) between VCC and ground.

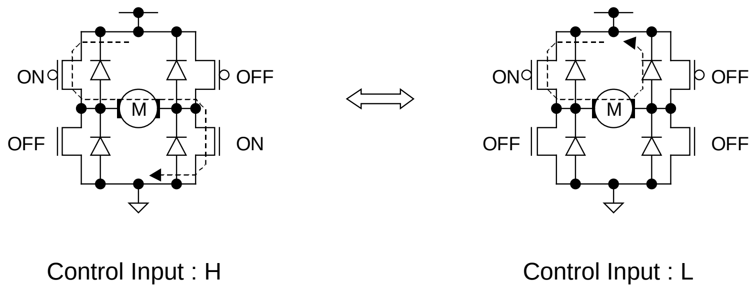


Figure 38. PWM Control Mode A Operation (Output Stage)

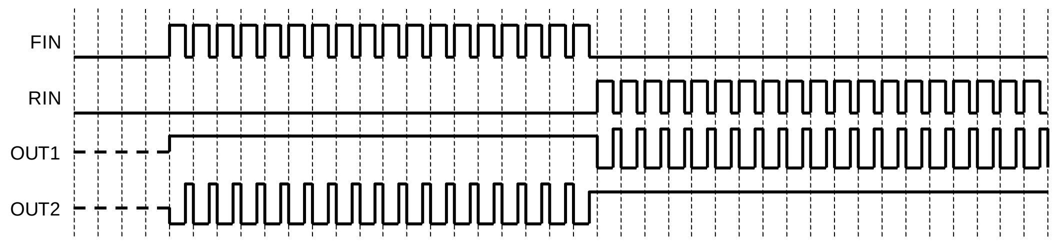


Figure 39. PWM Control Mode A Operation (Timing Chart)

Mode (g),(h) PWM Control Mode B

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 low side output is fixed and the high side output is switching, corresponding to the input signal. The state of the output toggles between "L" and "H".

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. 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 (10µF or higher is recommended) between VCC and ground.

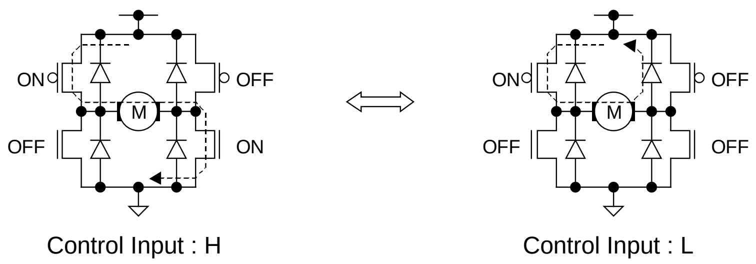


Figure 40. PWM Control Mode B Operation (Output Stage)

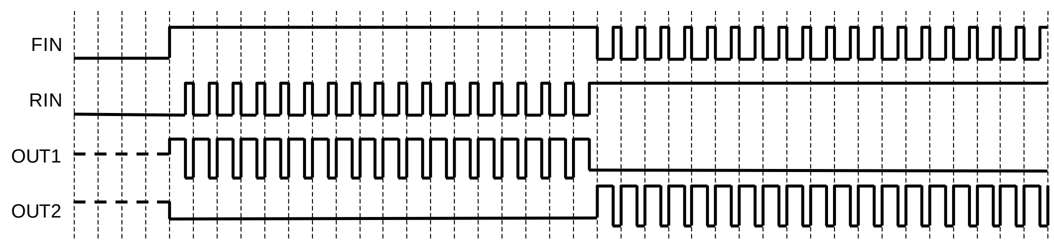


Figure 41. PWM Control Mode B Operation (Timing Chart)

Mode (i),(j) VREF Control Mode

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

$$DUTY \approx V_{REF}[V]/V_{CC}[V]$$

For example, if VCC voltage is 24V and VREF pin voltage is 18V, the duty cycle is about 75 percent. However, please note that the duty cycle might be limited by the range of the VREF pin voltage (Refer to the recommended operating conditions, shown on page 6). The PWM carrier frequency in this mode is 25kHz (nominal), and the switching operation is the same as the PWM control modes. When operating in this mode, do not input a 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.

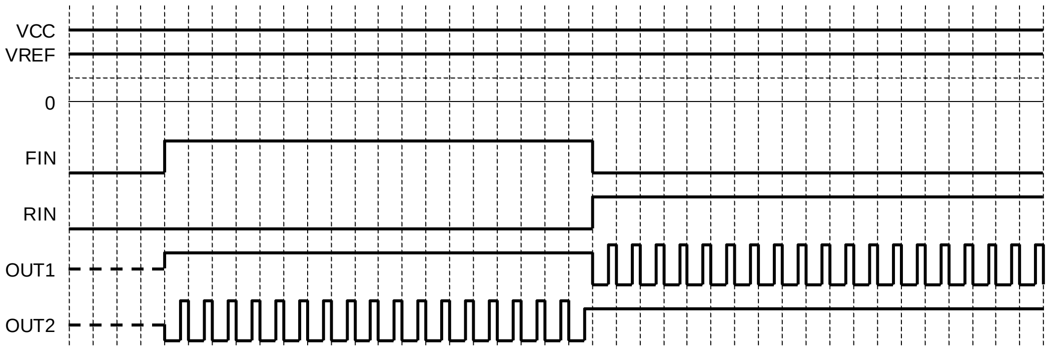


Figure 42. VREF Control Operation (Timing Chart)

(2) Cross-conduction Protection Circuit

In the full bridge output stage, when the upper and lower transistors are turned ON at the same time 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 400ns, 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 5.0V (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 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.

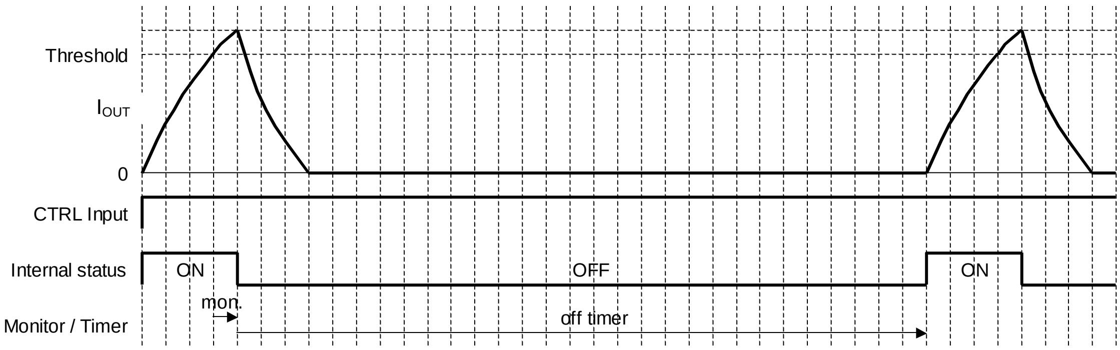


Figure 43. Over-Current Protection (Timing Chart)

I/O Equivalent Circuits

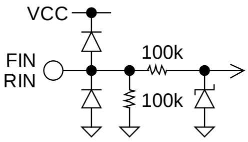


Figure 44. FIN / RIN

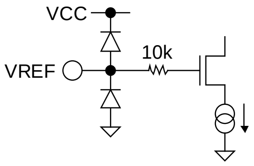


Figure 45. VREF

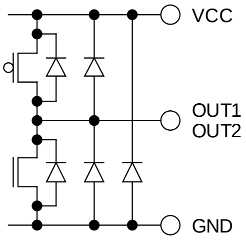


Figure 46. OUT1 / OUT2
(SOP8/HRP7)

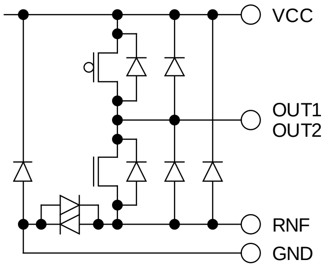


Figure 47. OUT1 / OUT2
(HSOP25/HSOPM28)

Operational Notes

1. **Reverse Connection of Power Supply**
   Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply, such as mounting an external diode between the power supply and the IC's power supply pins.

2. **Power Supply Lines**
   Design the PCB layout pattern to provide low impedance supply lines. 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.

3. **Ground Voltage**
   Ensure that no pins are at a voltage below that of the ground pin at any time, even during transient condition.

4. **Ground Wiring Pattern**
   When using both small-signal and large-current ground traces, the two ground traces should be routed separately but connected to a single ground at the reference point of the application board to avoid fluctuations in the small-signal ground caused by large currents. Also ensure that the ground traces of external components do not cause variations on the ground voltage. The ground lines must be as short and thick as possible to reduce line impedance.

5. **Thermal Consideration**
   Should by any chance the power dissipation rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. In case of exceeding this absolute maximum rating, increase the board size and copper area to prevent exceeding the Pd rating.

6. **Recommended Operating Conditions**
   These conditions represent a range within which the expected characteristics of the IC can be approximately obtained. The electrical characteristics are guaranteed under the conditions of each parameter.

7. **Inrush Current**
   When power is first supplied to the IC, it is possible that the internal logic may be unstable and inrush current may flow instantaneously due to the internal powering sequence and delays, especially if the IC has more than one power supply. Therefore, give special consideration to power coupling capacitance, power wiring, width of ground wiring, and routing of connections.

8. **Operation Under Strong Electromagnetic Field**
   Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

9. **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.

10. **Inter-pin Short and Mounting Errors**
    Ensure that the direction and position are correct when mounting the IC on the PCB. Incorrect mounting may result in damaging the IC. Avoid nearby pins being shorted to each other especially to ground, power supply and output pin. Inter-pin shorts could be due to many reasons such as metal particles, water droplets (in very humid environment) and unintentional solder bridge deposited in between pins during assembly to name a few.

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

Operational Notes – continued

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.

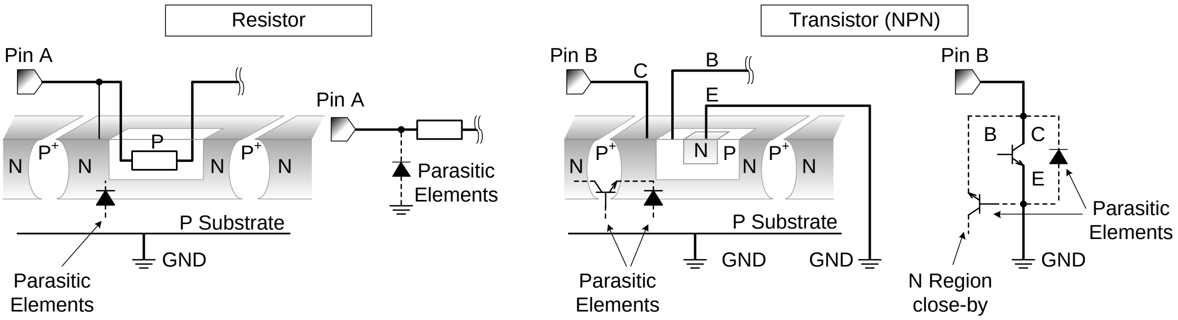


Figure 48. Example of monolithic IC structure

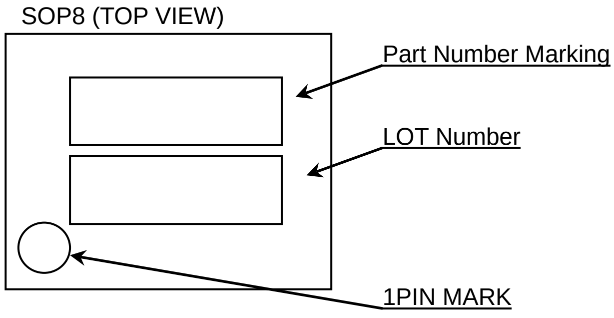
13. **Area of Safe Operation (ASO)**
    Operate the IC such that the output voltage, output current, and power dissipation are all within the Area of Safe Operation (ASO).

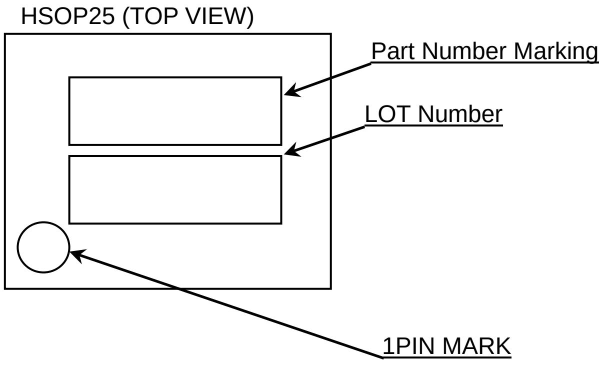
14. **Power supply lines2**
    Return current generated by the motor's Back-EMF requires countermeasures, such as providing a return current path by inserting capacitors across the power supply and GND (10µF, ceramic capacitor is recommended). In this case, it is important to conclusively confirm that 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.

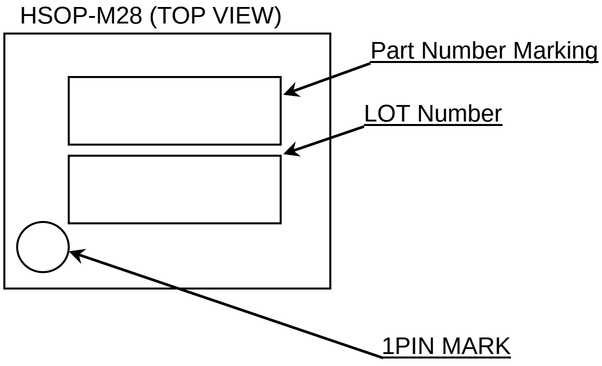
15. **Capacitor Between Output and Ground**
    If a large capacitor is connected between the output pin and ground pin, current from the charged capacitor can flow into the output pin and may destroy the IC when the VCC or VIN pin is shorted to ground or pulled down to 0V. Use a capacitor smaller than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

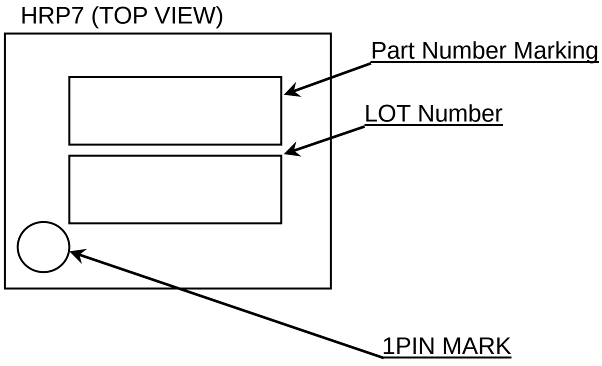
16. **Switching Noise**
    When the operation mode is in PWM control or VREF control, PWM switching noise may affect the control input pins and cause IC malfunctions. In this case, insert a pull down resistor (10kΩ is recommended) between each control input pin and ground.

Marking Diagrams





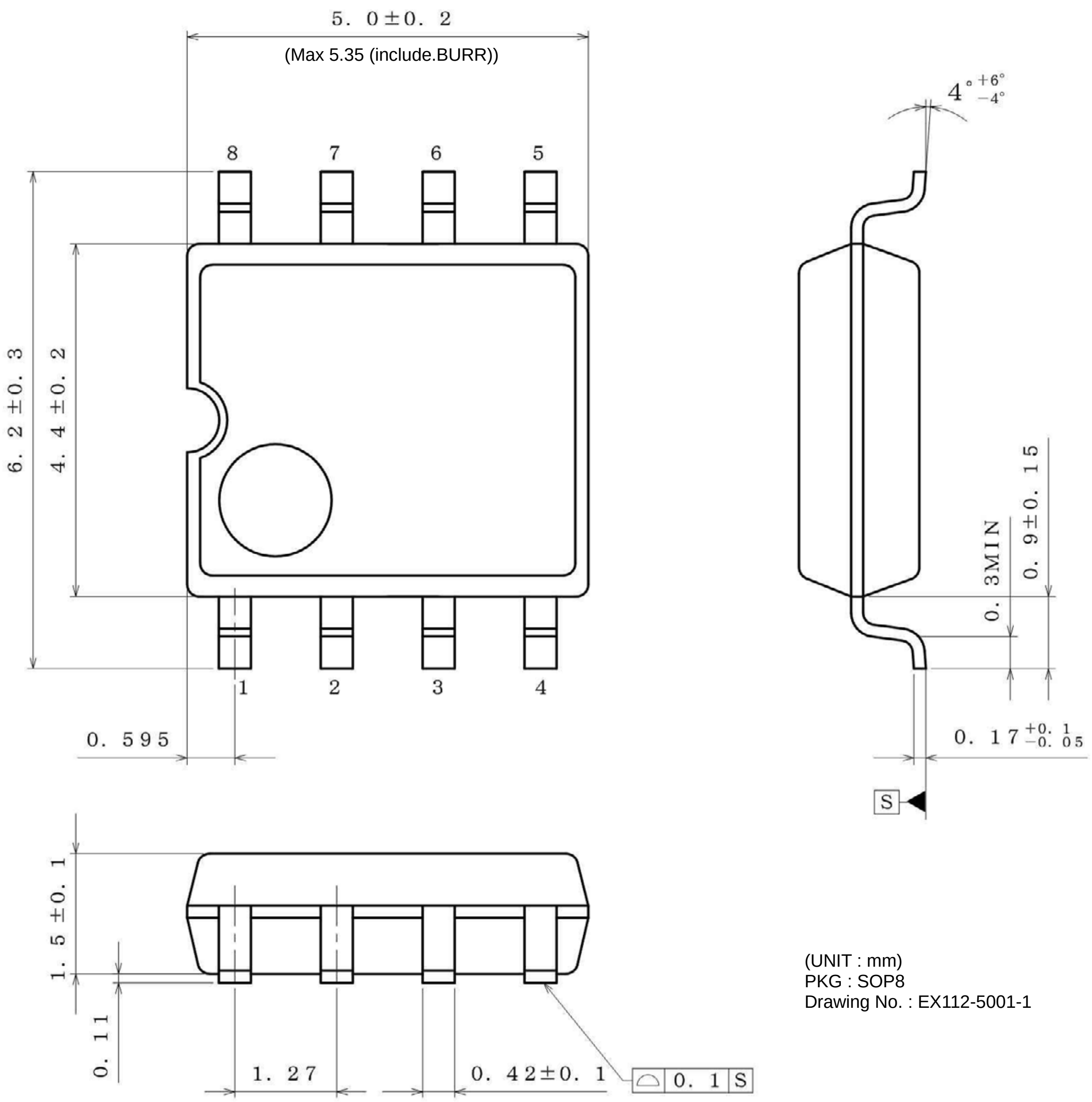




Part Number	Package	Part Number Marking
BD6230F	SOP8	6230
BD6231HFP	HRP7	BD6231HFP
BD6231F	SOP8	6231
BD6232HFP	HRP7	BD6232HFP
BD6232FP	HSOP25	BD6232FP
BD6236FP	HSOP25	BD6236FP
BD6236FM	HSOP-M28	BD6236FM
BD6237FM	HSOP/M28	BD6237FM

Physical Dimension, Tape and Reel Information

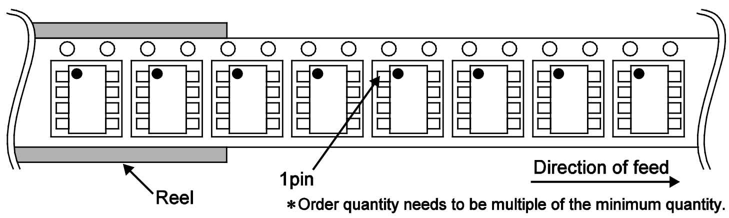
Package Name	SOP8



(UNIT : mm)
PKG : SOP8
Drawing No. : EX112-5001-1

<Tape and Reel information>

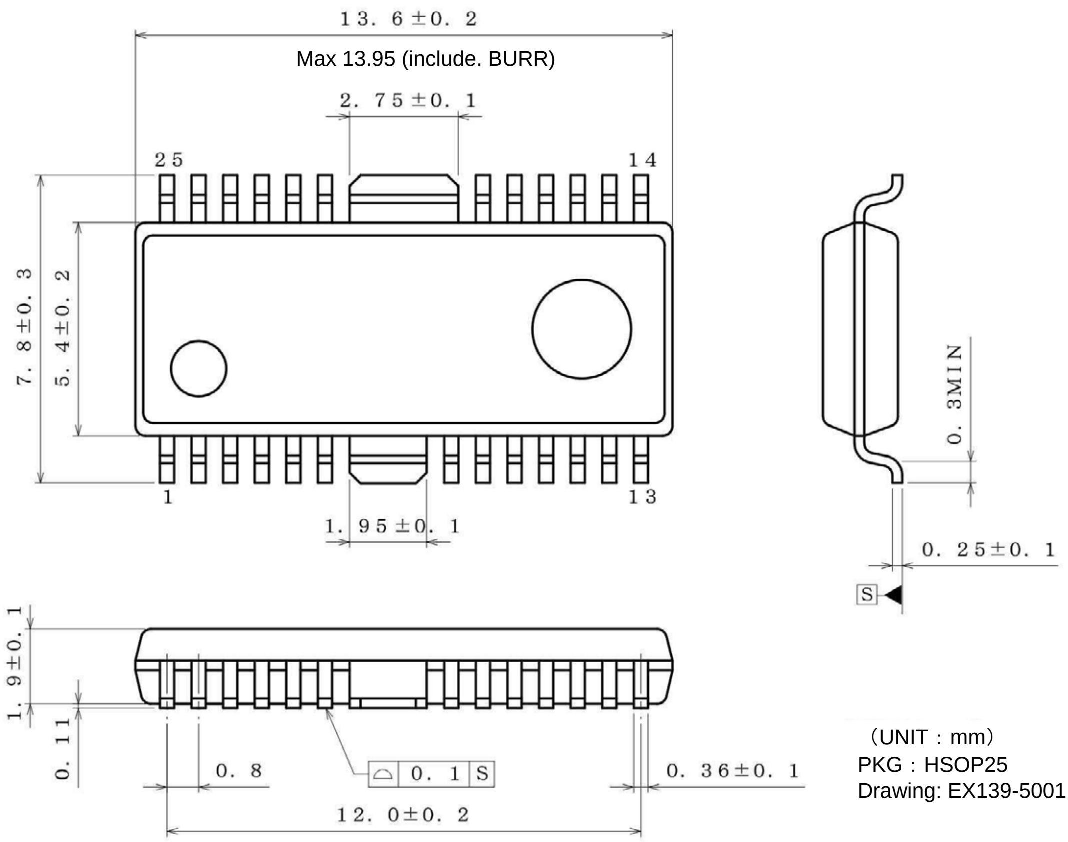
Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



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

Physical Dimension, Tape and Reel Information - continued

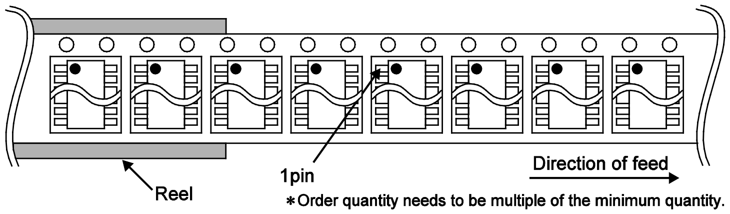
Package Name	HSOP25



（UNIT : mm）
PKG : HSOP25
Drawing: EX139-5001

<Tape and Reel information>

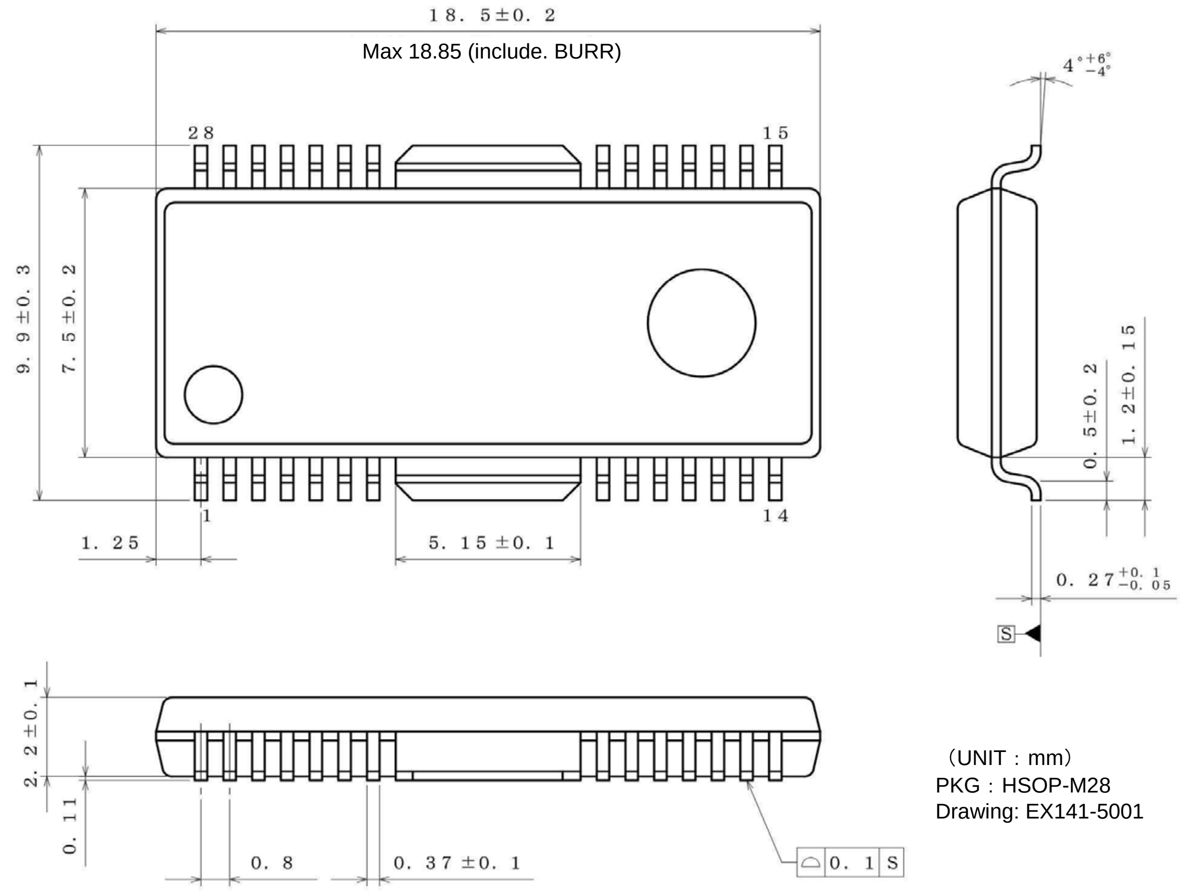
Tape	Embossed carrier tape
Quantity	2000pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



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

Physical Dimension, Tape and Reel Information - continued

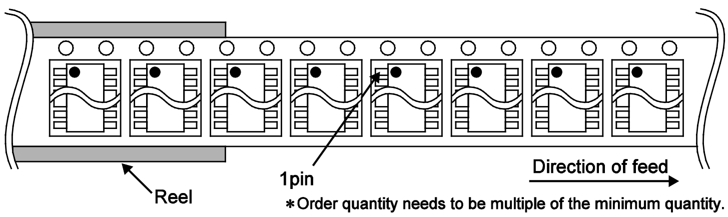
Package Name	HSOP-M28



（UNIT：mm）
PKG：HSOP-M28
Drawing: EX141-5001

<Tape and Reel information>

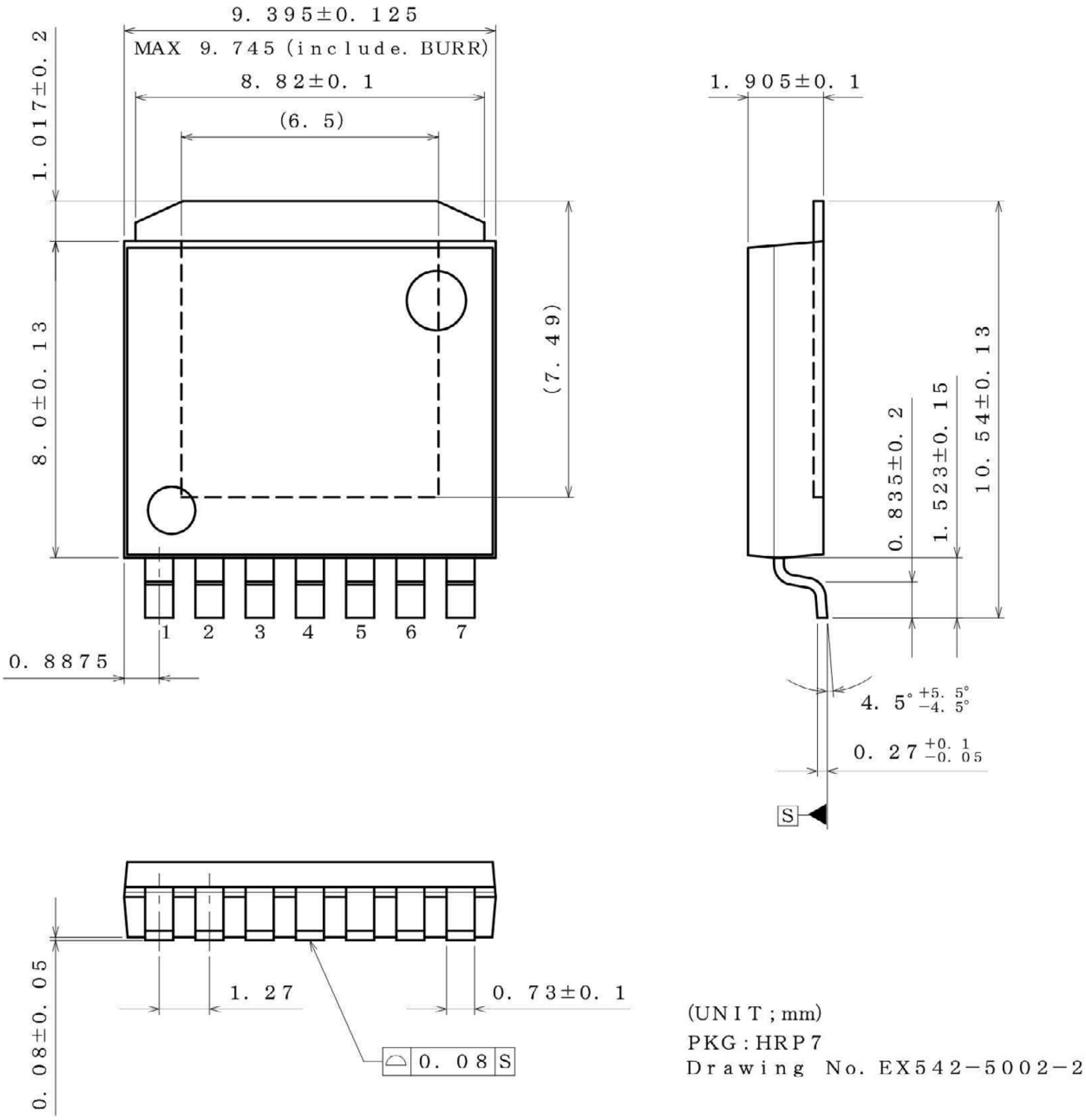
Tape	Embossed carrier tape
Quantity	1500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



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

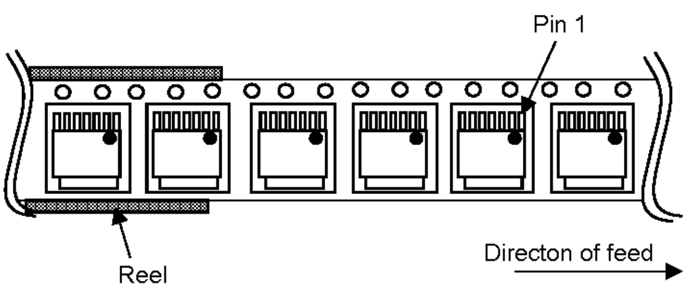
Physical Dimension, Tape and Reel Information - continued

Package Name	HRP7



< Tape and Reel Information >

Tape	Embossed carrier tape
Quantity	2000pcs
Direction of feed	TR The direction is the pin 1 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



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 18.
09.Sep.2014	003	Applied the ROHM Standard Style. Improved Operational Notes.

Notice

Precaution on using ROHM Products

1. Our Products are designed and manufactured for application in ordinary electronic equipments (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
   [a] Installation of protection circuits or other protective devices to improve system safety
   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

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   [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

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Distribution Inventory

Part Number	BD6232HFP
Package	HRP7
Unit Quantity	2000
Minimum Package Quantity	2000
Packing Type	Taping
Constitution Materials List	inquiry
RoHS	Yes