chanhvinh.com

Datasheet

36V
2ch Stepping Motor Driver

BD68888MUV

General Description

BD68888MUV is a bipolar low-consumption driver that driven by PWM constant current. Rated power supply voltage of the device is 36 V, and rated output current is 1.65 A. PARA-IN drive mode is adopted for input interface. This motor driver can drive 2ch bipolar stepping motors.
In addition, the power supply can be driven by one single system, which simplifies the design.

Features

- Two bipolar stepping motors can be driven
- Rated Output Current 1.65 A/Phase
- Low ON Resistance DMOS Output
- PARA-IN Drive Mode correspondence
- PWM Constant Current control (the other excitation method)
- Built-in Spike Noise Blanking Function (external noise filter is unnecessary)
- Full-, Half (two kinds)-, Quarter-step correspondence
- Power Save Function
- Built-in Logic Input Pull-down Resistor
- Thermal Shutdown Circuit (TSD)
- Over-current Protection Circuit (OCP)
- Under Voltage Lockout Circuit (UVLO)
- Over Voltage Lockout Circuit (OVLO)
- Ghost Supply Prevention (protects against malfunction when power supply is disconnected)

Application

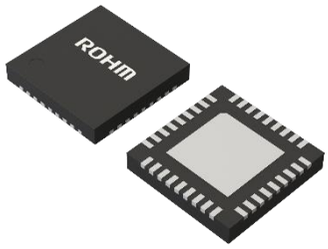
- Monitoring Camera, WEB Camera, PPC, Multi-function Printer, Laser Beam Printer, Ink-jet Printer, Sewing Machine, Photo Printer, FAX, Scanner, Mini Printer, Toy and Robot

Key Specifications

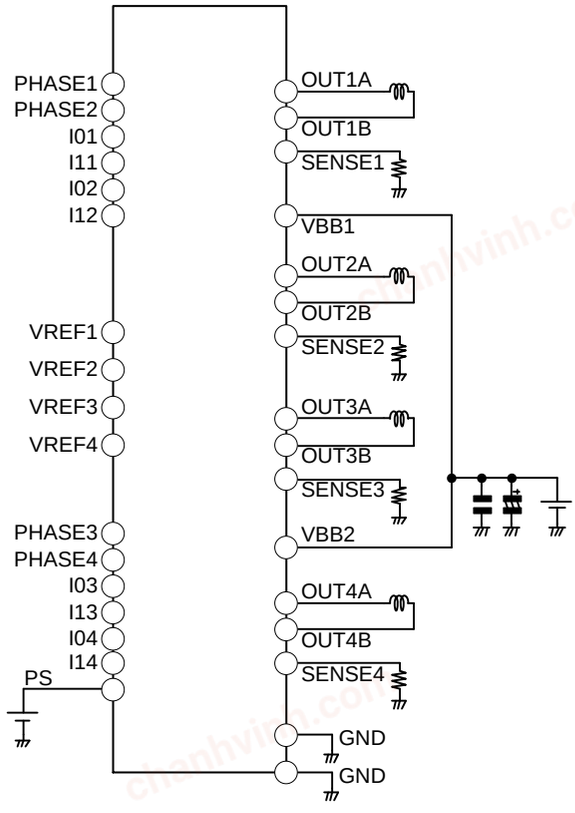
- Range of Power Supply Voltage: 8 V to 28 V
- Rated Output Current: 1.65 A/Phase
- Range of Operating Temperature: -25 °C to +85 °C
- Output ON Resistance (total of upper and lower resistors): 1.0 Ω (Typ)

Package

	W (Typ) x D (Typ)x H (Max)
VQFN036V6060	6.0 mm x 6.0 mm x 1.0 mm



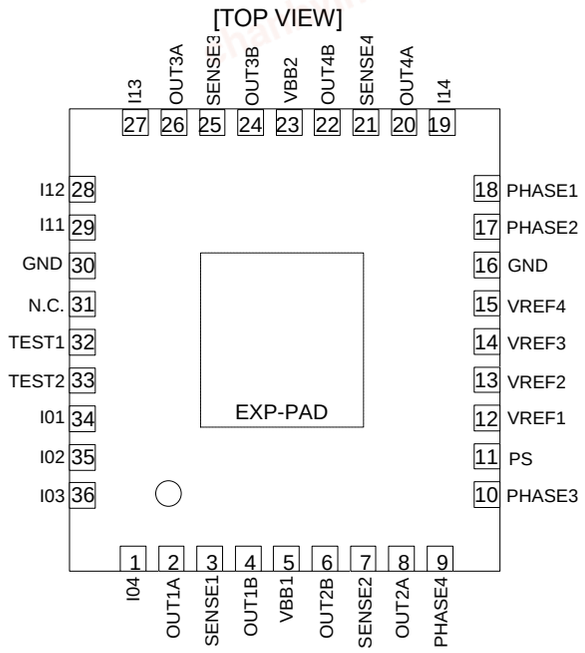
Typical Application Circuit



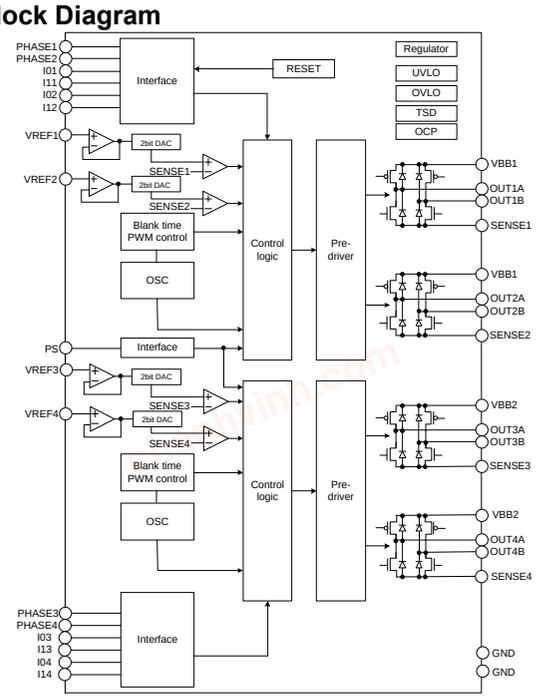
© 2020 ROHM Co., Ltd. All rights reserved.

chanhvinh.com

Pin Configuration



Block Diagram



Pin Descriptions

Pin No.	Pin Name	Function	Pin No.	Pin name	Function
1	I04	VREF division ratio setting pin	19	I14	VREF division ratio setting pin
2	OUT1A	H bridge output pin	20	OUT4A	H bridge output pin
3	SENSE1	Connection pin of resistor for output current detection	21	SENSE4	Connection pin of resistor for output current detection
4	OUT1B	H bridge output pin	22	OUT4B	H bridge output pin
5	VBB1	Power supply pin	23	VBB2	Power supply pin
6	OUT2B	H bridge output pin	24	OUT3B	H bridge output pin
7	SENSE2	Connection pin of resistor for output current detection	25	SENSE3	Connection pin of resistor for output current detection
8	OUT2A	H bridge output pin	26	OUT3A	H bridge output pin
9	PHASE4	Phase selection pin	27	I13	VREF division ratio setting pin
10	PHASE3	Phase selection pin	28	I12	VREF division ratio setting pin
11	PS	Power save pin	29	I11	VREF division ratio setting pin
12	VREF1	Output current value setting pin	30	GND	Ground pin
13	VREF2	Output current value setting pin	31	NC	Non connection
14	VREF3	Output current value setting pin	32	TEST1	Pin for testing
15	VREF4	Output current value setting pin	33	TEST2	Pin for testing
16	GND	Ground pin	34	I01	VREF division ratio setting pin
17	PHASE2	Phase selection pin	35	I02	VREF division ratio setting pin
18	PHASE1	Phase selection pin	36	I03	VREF division ratio setting pin
-	EXP-PAD	The EXP-PAD connect to GND.	-	-	-

© 2020 ROHM Co., Ltd. All rights reserved.

chanhvinh.com

Absolute Maximum Ratings (Ta = 25 °C)

Item	Symbol	Rated Value	Unit
Supply Voltage	VBB1,VBB2	-0.2 to +36.0	V
Input Voltage for Control Pin(Note 1)	V_{IN}	-0.2 to +5.5	V
SENSEx(Note 2) Maximum Input Voltage	V_{SENSE}	0.7	V
Output Current	I_{OUT}	1.65(Note 3)	A/Phase
Storage Temperature Range	Tstg	-55 to +150	°C
Maximum Junction Temperature	Tjmax	+150	°C

(Note 1) Control pin = PHASE1, PHASE2, PHASE3, PHASE4, VREF1, VREF2, VREF3, VREF4, I01, I02, I03, I04, I11, I12, I13, I14.
(Note 2) x = 1, 2, 3 or 4
(Note 3) Do not exceed Tjmax = 150 °C.
Caution 1: *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 and the internal circuitry. 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.*
Caution 2: *Should by any chance the maximum junction temperature 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, design a PCB boards with thermal resistance taken into consideration by increasing board size and copper area so as not to exceed the maximum junction temperature rating.*

Recommended Operating Conditions

Item	Symbol	Min	Typ	Max	Unit
Operating Temperature	Topr	-25	+25	+85	°C
Supply Voltage	VBB1,VBB2	+8	+24	+28	V
Maximum Output Current (DC)	I_{OUT}	-	-	+1.2(Note 4)	A/ Phase

(Note 4) Do not exceed Tjmax = 150 °C.

Thermal Resistance(Note 5)

Parameter	Symbol	Thermal Resistance (Typ)		Unit
		1s(Note 7)	2s2p(Note 8)	
VQFN036V6060				
Junction to Ambient	θ_{JA}	103.9	24.5	°C/W
Junction to Top Characterization Parameter(Note 6)	Ψ_{JT}	4	2	°C/W

(Note 5) Based on JESD51-2A (Still-Air).
(Note 6) The thermal characterization parameter to report the difference between junction temperature and the temperature at the top center of the outside surface of the component package.
(Note 7) Using a PCB board based on JESD51-3.
(Note 8) Using a PCB board based on JESD51-5, 7.

Layer Number of Measurement Board	Material	Board Size
Single	FR-4	114.3 mm x 76.2 mm x 1.57 mmt

Top	
Copper Pattern	Thickness
Footprints and Traces	70 µm

Layer Number of Measurement Board	Material	Board Size	Thermal Via(Note 9)	
			Pitch	Diameter
4 Layers	FR-4	114.3 mm x 76.2 mm x 1.6 mmt	1.20 mm	Φ0.30 mm

Top		2 Internal Layers		Bottom	
Copper Pattern	Thickness	Copper Pattern	Thickness	Copper Pattern	Thickness
Footprints and Traces	70 µm	74.2 mm x 74.2 mm	35 µm	74.2 mm x 74.2 mm	70 µm

(Note 9) This thermal via connects with the copper pattern of all layers.

© 2020 ROHM Co., Ltd. All rights reserved.

chanhvinh.com

Electrical Characteristics (Unless otherwise specified Ta = 25 °C, VBB1, VBB2 = 24 V)

Item	Symbol	Limit			Unit	Condition
		Min	Typ	Max		
[Whole]						
Circuit Current at Standby	I_{CCST}	-	0	10	μA	PS = L
Circuit Current	I_{CC}	-	5.0	8.0	mA	PS = H, VREFx = 1.5 V
[Control Logic Input*(Note 1)*]						
H-level Input Voltage	V_{INH}	2.0	-	-	V	
L-level Input Voltage	V_{INL}	-	-	0.8	V	
H-level Input Current	I_{INH}	35	50	100	μA	V_{IN} = 5 V
L-level Input Current	I_{INL}	-10	0	-	μA	V_{IN} = 0 V
[Output*(Note 2)*]						
Output ON Resistance	R_{ON}	-	1.0	1.4	Ω	I_{OUT} = ±1.0 A (total of upper and lower)
Output Leak Current	I_{LEAK}	-	-	10	μA	
[Current Control]						
SENSEx*(Note 3)* Input Current	I_{SENSE}	-80	-40	-	μA	SENSEx = 0 V
VREFx*(Note 3)* Input Current	I_{VREF}	-2.0	-0.1	-	μA	VREFx = 0 V
VREFx*(Note 3)* Input Voltage Range	V_{VREF}	0	-	1.5	V	
Minimum ON Time (Blank Time)	t_{ONMIN}	0.3	1.0	1.5	μs	
Comparator Threshold	V_{CTH}	0.48	0.50	0.52	V	VREFx = 1.5 V

(Note 1) Control Logic input = PHASE1, PHASE2, PHASE3, PHASE4, I01, I02, I03, I04, I11, I12, I13, I14
(Note 2) Output = OUT1A, OUT1B, OUT2A, OUT2B, OUT3A, OUT3B, OUT4A, OUT4B
(Note 3) x = 1, 2, 3 or 4

© 2020 ROHM Co., Ltd. All rights reserved.

chanhvinh.com

Function Explanation

1 PS/Power Save Pin

The PS pin can make the circuit standby state and make the motor output OPEN. When PS = L→H, be careful because there is a delay of 40 µs (Max) before it is returned from standby state to normal state and the motor output becomes ACTIVE.

PS	Status
L	Standby state
H	ACTIVE

2 PHASEx *(Note 1)*/Phase Selection Pin

These pins determine output state.

PHASEx	OUTxA*(Note 1)*	OUTxB*(Note 1)*
L	L	H
H	H	L

(Note 1) x = 1, 2, 3 or 4

3 I0x *(Note 2)*, I1x*(Note 2)*/VREF Division Ratio Setting Pin

Although VREF pins voltage is input to 2bit-DAC, these pins set the split ratio of 2bit-DAC output voltage.

I0x	I1x	Output Current Level (%)
L	L	100
H	L	67
L	H	33
H	H	0

(I0x, I1x) = (H, H): motor outputs are open.

(Note 2) x = 1, 2, 3 or 4

4 VBB1, VBB2/Power Supply Pin

The wire should be thick, short and has low impedance, because Motor's drive current is flowing in it. The VBB1 pin and the VBB2 pin voltage may have great fluctuation, so arrange the bypass capacitor of about 100 µF to 470 µF as close to the pin as possible and adjust the VBB1 pin and the VBB2 pin voltage is stable. Increase the capacity as needed especially, when a large current is used or those motors that have great back electromotive force are used.

In addition, for the purpose of reducing of power supply's impedance in wideband, it is recommended to set parallel connection of multi-layered ceramic capacitor of 0.01 µF to 0.1 µF etc. Extreme care must be used to make sure that the VBB1 pin and the VBB2 pin voltage do not exceed the rating even for a moment. The VBB1 pin and the VBB2 pin are shorted inside the IC, but be sure to short externally the VBB1 pin and the VBB2 pin when using. If used without shorting, malfunction or destruction may occur because of concentration of current routes etc. Still more, in the power supply pin, there is built-in clamp component for preventing of electrostatic destruction. When a steep pulse signal or voltage such as a surge exceeding the absolute maximum rating is applied, this clamp component operates, and the IC might be destroyed as a result. Be sure that the maximum absolute rating must not be exceeded. It is effective to mount a Zener diode of about the maximum absolute rating. Moreover, the diode for preventing electrostatic destruction is inserted between the VBB1 pin, the VBB2 pin and the GND pin. Be careful about the reverse voltage because the IC might be destroyed as a result if reverse voltage is applied to the VBB1 pin, the VBB2 pin and the GND pin.

5 GND/Ground Pin

In order to reduce the electric noise by switching current and to stabilize the internal reference voltage of the IC, make the wiring impedance from this pin as low as possible to achieve the lowest electrical potential no matter what operating state it can be. Moreover, design the patterns not to have any common impedance with other GND patterns.

6 OUTxA*(Note 3)*, OUTxB*(Note 3)*/H Bridge Output Pin

Motor's drive current is flowing in it, so the wire should be thick, short and has low impedance. It is also effective to add a schottky diode if output has positive or negative great fluctuation when large current is used. For example, counter electromotive voltage etc. Moreover, in the output pin, there is built-in clamp component for preventing of electrostatic destruction. When a steep pulse signal or voltage such as a surge exceeding the absolute maximum rating is applied, this clamp component operates, and the IC might be destroyed in the end. Be sure that the maximum absolute rating must not exceeded.

(Note 3) x = 1, 2, 3 or 4

© 2020 ROHM Co., Ltd. All rights reserved.

chanhvinh.com

Function Explanation – continued

7 SENSEx(Note 1)/Connection Pin of Resistor for Detecting of Output Current

Connect the resistor of 0.1 Ω to 0.3 Ω for current detection between this pin and GND. Determine the resistor so that power consumption W = I_{OUT}^2•R [W] of the current-detecting resistor does not exceed the maximum absolute rating of the resistor. In addition, it has a low impedance and does not have a common impedance with other GND patterns because motor's drive current flows in the pattern through the SENSEx pin to current-detecting resistor to GND. Do not exceed the rating because there is the possibility of circuits' malfunction etc., if the SENSE pin voltage exceeds the maximum rating (0.7V). Moreover, be careful because if the SENSEx pin is shorted to GND, large current flows without normal PWM constant current control, and OCP or TSD might operate. If there is a possibility of malfunction, such as output does not flow even when the SENSEx pin is open, please do not put to such a state.

(Note 1) x = 1, 2, 3 or 4

8 VREFx(Note 2)/Output Current Value Setting Pin

This is the pin to set the output current value. It can be set by the VREF pin voltage and current-detecting resistor (SENSE resistor).

$$I_{OUT} = \frac{VREFx}{3} / \ SENSEx \qquad [A]$$

Where

I_{OUT}: The output current.

$VREFx$: The voltage of output current value-setting pin.

$SENSEx$: The current-detecting resistor.

Avoid using the IC with the VREFx pin is open because if it is open, it may have malfunctions such as flowing a large current by unstable input, the increased the VREFx pin voltage and increased setting current. The input voltage range must be kept because a large current might flow to output and OCP or TSD might operate if the voltage of over 1.5 V is applied on the VREFx pin. Besides, select the resistance value in consideration of the outflow current (Max 2 μA) if it is inputted by resistance division. The minimum current, which can be controlled by the VREFx pin voltage, is determined by motor coil's L, R values and minimum ON time because there is a minimum ON time in PWM drive.

(Note 2) x = 1, 2, 3 or 4

9 TESTx(Note 3)/Pin for Inspection

This pin is used for delivery inspection of the IC, and shall be grounded before use.
In addition, malfunctions can be caused by application without grounding.

(Note 3) x = 1 or 2

10 NC Pin

This pin is unconnected electrically with the IC internal circuit.

11 EXP-PAD

For VQFN036V6060 package, the heat-radiating metal is mounted on the IC's backside. It is the precondition that making the heat-radiating treatment when in use. Therefore, it must be connected by solder with the GND plane on the board and ensure the sufficient heat-radiation area by taking the GND pattern as wide as possible. Moreover, the back side metal is shorted with IC chip's back side and becomes the GND potential, so there is the danger of malfunction and destruction if shorted with potentials other than GND. Never design any wiring patterns other than GND through the IC's backside.

© 2020 ROHM Co., Ltd. All rights reserved.

chanhvinh.com

Protection Circuits

1 Thermal Shutdown (TSD)

This IC has a built-in thermal shutdown circuit for thermal protection. When the IC's chip temperature rises to 175 °C (Typ) or more, the motor output becomes OPEN. Also, when the temperature returns to 150 °C (Typ) or less, it automatically returns to normal operation. However, if heat is continued to be added externally even while TSD is in operation, heat overdrive can lead to destruction.

2 Over Current Protection (OCP)

This IC has a built in over current protection circuit as a provision against destruction when the motor outputs are shorted each other or VBB1, VBB2-motor output or motor output-GND is shorted. This circuit latches the motor output to OPEN condition when the regulated current flows for 4 µs (Typ). It returns with power reactivation or a reset of the PS pin. The over current protection circuit's only aim is to prevent the destruction of the IC from irregular situations such as motor output shorts, and is not meant to be used as protection or security for the set. Therefore, sets should not be designed to take into account this circuit's functions. After OCP operating, if irregular situations continue and the return by power reactivation or a reset of the PS pin is carried out repeatedly, then OCP operates repeatedly and the IC may generate heat or otherwise deteriorate. When the L value of the wiring is great due to the wiring being long of faults, ground faults and shorting, there is a possibility of destruction after the over current has flowed and the output pin voltage jumps up and the absolute maximum values can be exceeded. Also, when current which is the output current rating or more and the OCP detection current or less flows, the IC can heat up to over Tjmax = 150 °C and can deteriorate, so current which exceeds the output rating should not be applied.

3 Under Voltage Lock Out (UVLO)

This IC has a built-in under voltage lock out function to prevent false operation such as IC output during power supply under voltage. When the applied voltage to the VBB1 pin and the VBB2 pin goes 5 V (Typ) or less, the motor output is set to OPEN. This switching voltage has a 1 V (Typ) hysteresis to prevent malfunction due to noise etc. Be aware that this circuit does not operate during power save mode. Also, the electrical angle is reset when the UVLO circuit operates.

4 Over Voltage Lock Out (OVLO)

This IC has a built-in over voltage lock out function to protect the IC output and the motor during power supply over voltage. When the applied voltage to the VBB1 pin and the VBB2 pin goes 32 V (Typ) or more, the motor output is set to OPEN. This switching voltage has a 1 V (Typ) hysteresis and a 4 µs (Typ) mask time to prevent malfunction due to noise etc.

Although this over voltage locked out circuit is built-in, there is a possibility of destruction if the absolute maximum value for power supply voltage is exceeded, therefore the absolute maximum value should not be exceeded. Be aware that this circuit does not operate during power save mode.

5 Ghost Supply Prevention (protects against malfunction when power supply is disconnected)

If a control signal (logic input, VREFx(Note 1)) is input when there is no power supplied to this IC, there is a function which prevents a malfunction where voltage is supplied to power supply of this IC or other IC in the set via the electrostatic destruction prevention diode from these input pins to the VBB1 pin and the VBB2 pin. Therefore, there is no malfunction of the circuit even when voltage is supplied to these input pins while there is no power supply.

(Note 1) x = 1, 2, 3 or 4

6 Operation Under Strong Electromagnetic Field

The IC is not designed for using in the presence of strong electromagnetic field. Be sure to confirm that no malfunction is found when using the IC in a strong electromagnetic field.

© 2020 ROHM Co., Ltd. All rights reserved.

chanhvinh.com

PWM Constant Current Control

1 Current control operation

The output current increases due to the output transistor turned on. When the voltage on the SENSEx(Note 1) pin, the output current is converted voltage due to connect the external resistance to the SENSEx pin, reaches the voltage value set by the internal 2-bit DAC and the VREFx(Note 1) input voltage, the current limit comparator engages and enters current decay mode. Thereafter the output turned on again after a period of time determined the internal timer. The process repeats itself constantly.

(Note 1) x = 1, 2, 3 or 4

2 Noise-masking function

In order to avoid misdetection of current detection comparator due to SENSEx spike noise that may occur when the output turns on, the IC employs the minimum ON-time (t_{ONMIN}). It invalids the current detection for the minimum ON-time of 1 µs (Typ) from the output transistor turned on. This allows constant-current drive without the need for an external filter.

3 Internal Timer

IC internal voltage repeat charging and discharging between VL to VH.

The detection of the internal comparator is masked while charging from VL to VH. This period defines the minimum ON-time (t_{ONMIN}). The internal voltage begins discharging once the voltage reaches VH. When the output current reaches the current limit during this period, then the IC enters decay mode. It reaches VL, at which point the IC internal voltage is switched back ON. The current output and internal terminal begin charging simultaneously.

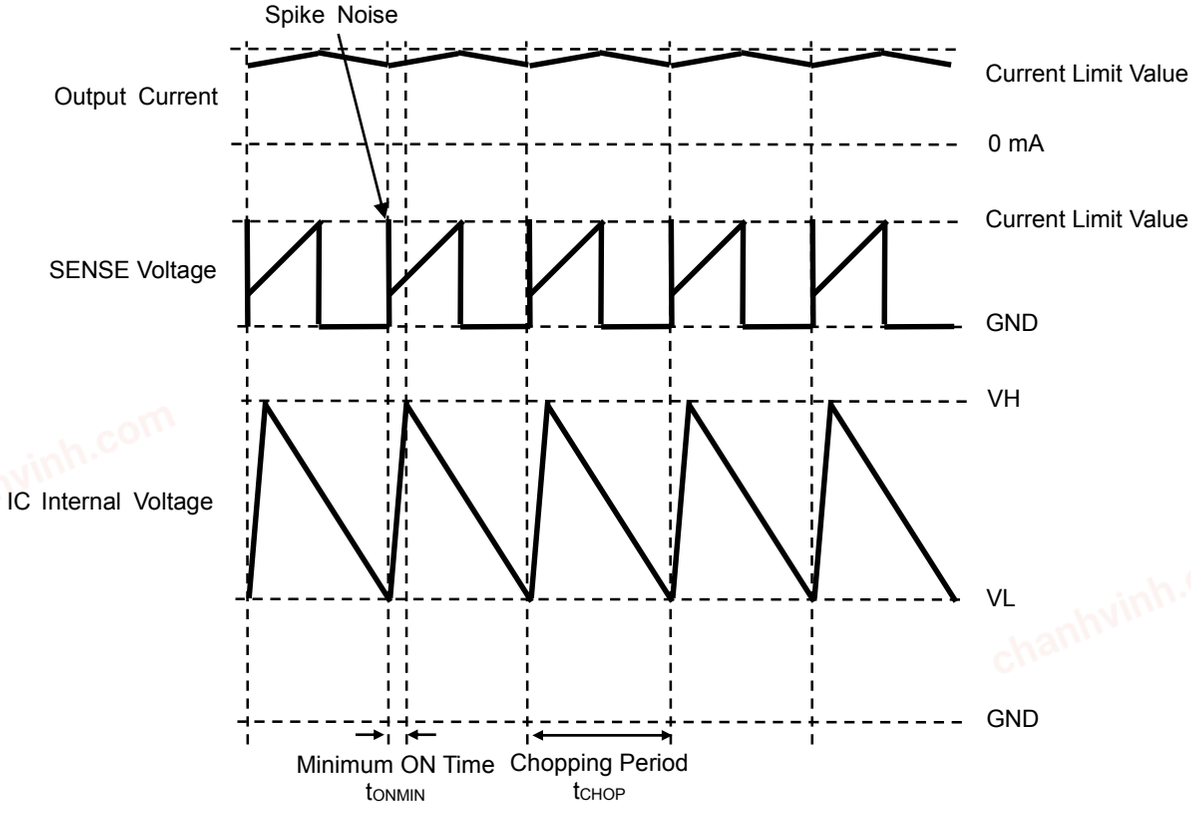


Figure 1. Timing Chart of IC Internal Voltage, the SENSEx pin voltage and Output Current

© 2020 ROHM Co., Ltd. All rights reserved.

chanhvinh.com

PWM Constant Current Control – continued

4 Current Decay Mode

The current decay method is SLOW DECAY for PWM Constant Current Control.
The following diagrams show the state of each transistor and the regenerative current path during the current decay for SLOW DECAY mode:

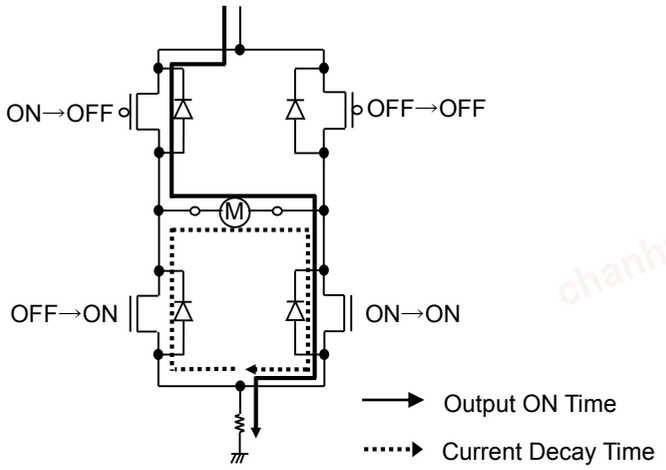


Figure 2. Route of Regenerated Current during Current Decay

© 2020 ROHM Co., Ltd. All rights reserved.

chanhvinh.com

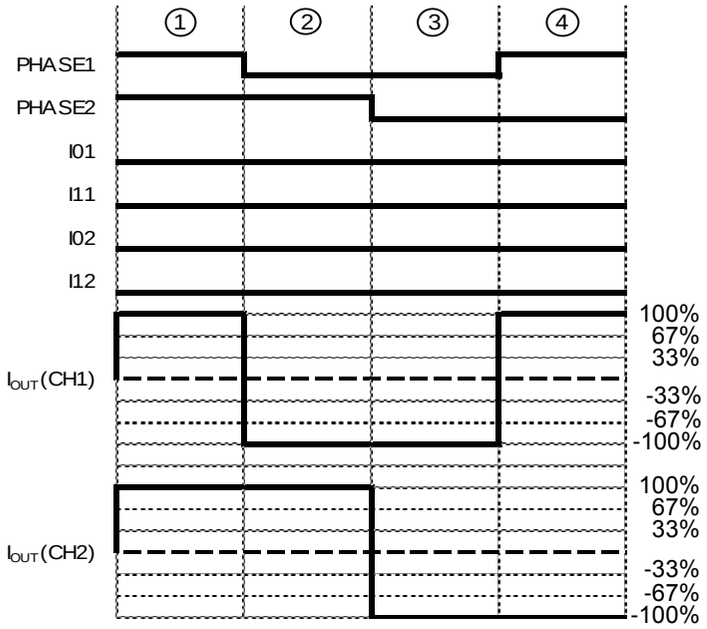
PARALLEL-IN Drive Mode - Description for CH1 (CH2: same as CH1)-

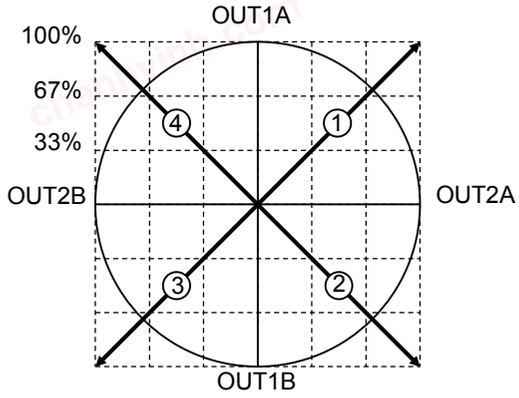
It is possible to drive stepping motor with FULL STEP, HALF STEP, and QUARTER STEP by inputting the following motor control signals using PARALLEL-IN drive mode.

Examples of control sequence and torque vector

FULL STEP

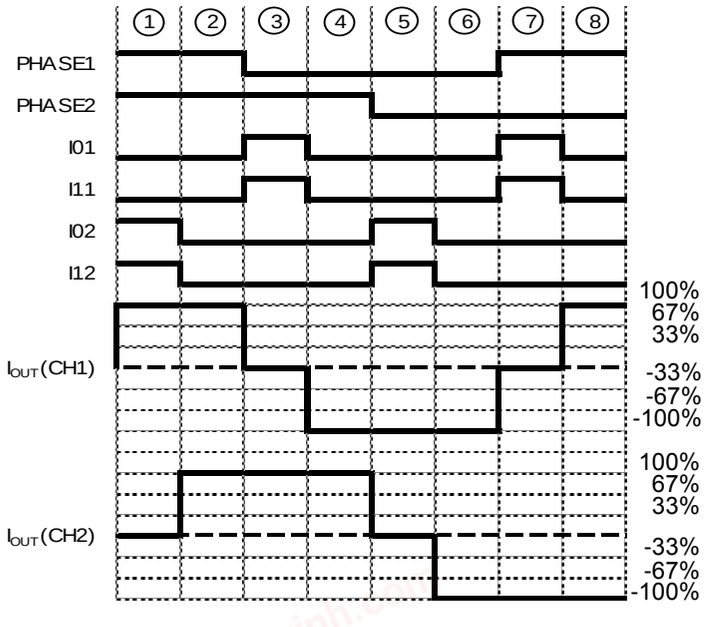
Controlled by 2 logic signals of PHASE1 and PHASE2

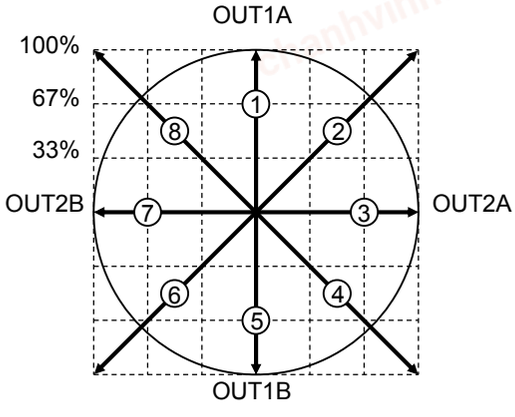




HALF STEP A

Controlled by 4 logic signals of PHASE1, PHASE2, I01 (I11), and I02 (I12)





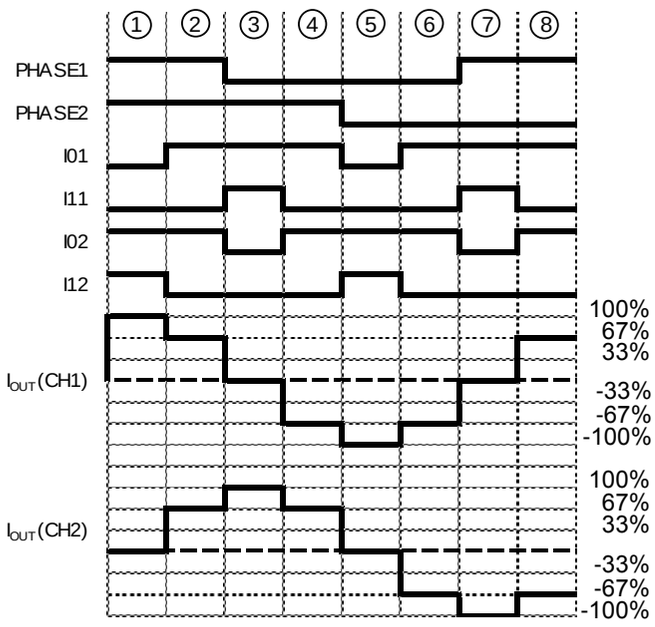
© 2020 ROHM Co., Ltd. All rights reserved.

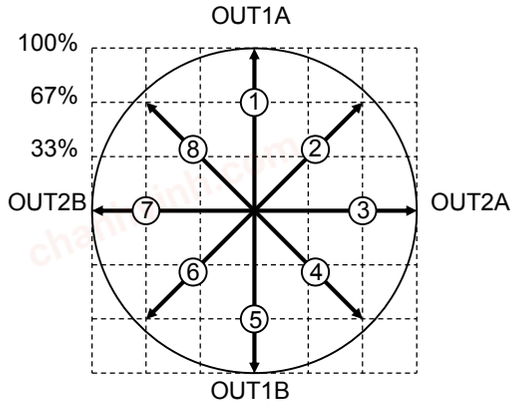
chanhvinh.com

PARALLEL-IN Drive Mode – continued

HALF STEP B

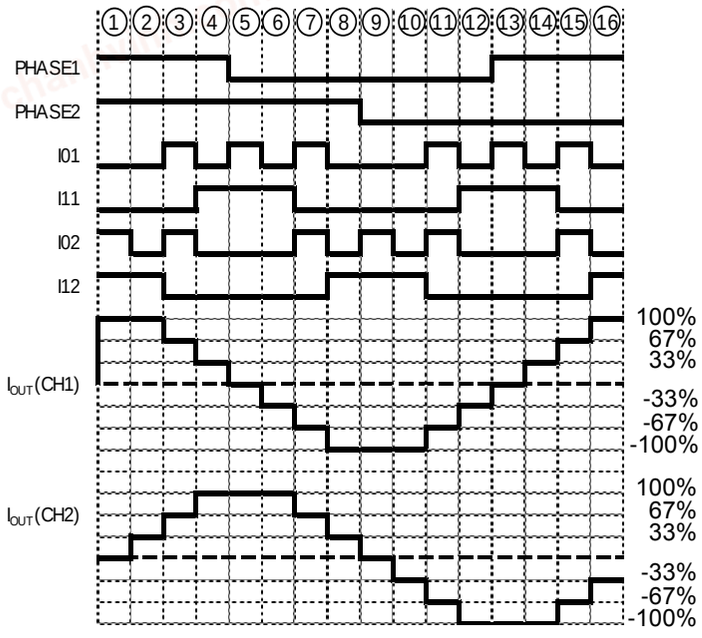
Controlled by 6 logic signals of PHASE1, PHASE2, I01, I11, I02 and I12

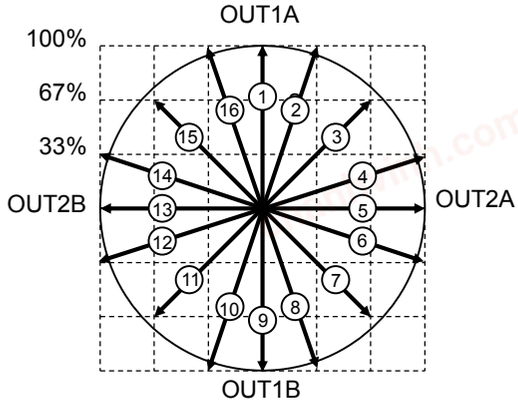




QUARTER STEP

Controlled by 6 logic signals of PHASE1, PHASE2, I01, I11, I02 and I12





© 2020 ROHM Co., Ltd. All rights reserved.

chanhvinh.com

Power Dissipation

Confirm that the IC's chip temperature Tj is not over 150 °C in consideration of the IC's power consumption (W), thermal resistance (°C/W) and ambient temperature (Ta). When Tj = 150 °C is exceeded, the functions as a semiconductor do not operate and problems such as parasitism and leaks occur. Constant use under these circumstances leads to deterioration and eventually destruction of the IC. Tjmax = 150 °C must be strictly obeyed under all circumstances.

1 Thermal Calculation

The IC's consumed power can be estimated roughly with the power supply voltage (VBB1 and VBB2), circuit current (I_{CC}), output ON resistance (R_{ONH}, R_{ONL}) and motor output current value (I_{OUT}).
The calculation method during FULL STEP drive, SLOW DECAY mode is shown here:

$$W_{VBB} = VBB \times I_{CC} \quad [W]$$

where:
W_{VBB} is the consumed power of the VBB.
VBB is the power supply voltage.
I_{CC} is the circuit current.

$$W_{DMOS} = W_{ON} + W_{DECAY} \ [W]$$

$$W_{ON} = (R_{ONH} + R_{ONL}) \times {I_{OUT}}^2 \times 2 \times on_duty \ [W]$$

$$W_{DECAY} = (2 \times R_{ONL}) \times {I_{OUT}}^2 \times 2 \times (1 - on_duty) \ [W]$$

where:
W_{DMOS} is the consumed power of the output DMOS.
W_{ON} is the consumed power during output ON.
W_{DECAY} is the consumed power during current decay.
R_{ONH} is the upper P-channel DMOS ON-resistance.
R_{ONL} is the lower N-channel DMOS ON-resistance.
I_{OUT} is the motor output current value.
on_duty PWM on duty=t_ON / t_CHOP
"2" is the H bridge A and B.

t_{ON} varies depending on the L and R values of the motor coil and the current set value. Confirm by actual measurement, or make an approximate calculation.
t_{CHOP} is the chopping period, which is determined by the internal timer. Refer to P.8, 9 for details.

IC number	Upper Pch DMOS ON Resistance R_{ONH}[Ω] (Typ)	Lower Nch DMOS ON Resistance R_{ONL}[Ω] (Typ)
BD68888MUV	0.70	0.30

$$W_total = W_{VBB} + W_{DMOS} \ [W]$$

$$Tj = Ta + \theta ja \times W_total \ [°C]$$

where:
W_total is the consumed total power of IC.
Tj is the junction temperature.
Ta is the air temperature.
θja is the thermal resistance value.

However, the thermal resistance value θja [°C/W] differs greatly depending on circuit board conditions. The calculated values above are only theoretical. For actual thermal design, perform sufficient thermal evaluation for the application board used, and create the thermal design with enough margin not to exceed Tjmax = 150 °C. Although unnecessary with normal use, if the IC is to be used under especially strict heat conditions, consider externally attaching a Schottky diode between the motor output pin and GND to abate heat from the IC.

© 2020 ROHM Co., Ltd. All rights reserved.

chanhvinh.com

Power Dissipation – continued

2 Temperature Monitoring

In respect of BD68888MUV, there is a way to directly measure the approximate chip temperature by using the LOGIC pin (I0x(Note 1) or I1x(Note 1)) with a protection diode for prevention from electrostatic discharge. However, temperature monitor using this LOGIC pin is only for evaluation and experimenting, and must not be used in actual usage conditions.

(Note 1) x = 1, 2, 3 or 4

Process 1 Measure the pin voltage when a current of I_{DIODE} = 50 μA flows from the LOGIC pin to the GND, without supplying VBB1 and VBB2 to the IC. This measurement is of the V_F voltage inside the diode.

Process 2 Measure the temperature characteristics of this pin voltage. (V_F has a linear negative temperature factor against the temperature.) With the results of these temperature characteristics, chip temperature may be calibrated from the LOGIC pin voltage.

Process 3 Supply VBB1 and VBB2, confirm the LOGIC pin voltage while running the motor, and calculate approximately the chip temperature from the results of Process 2.

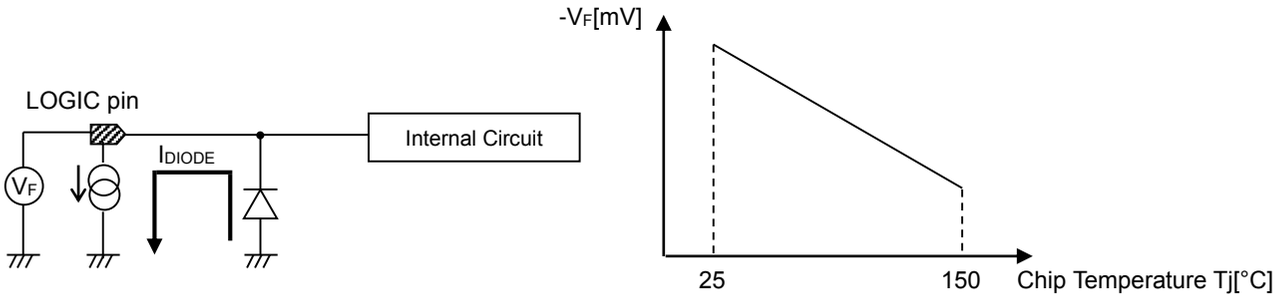
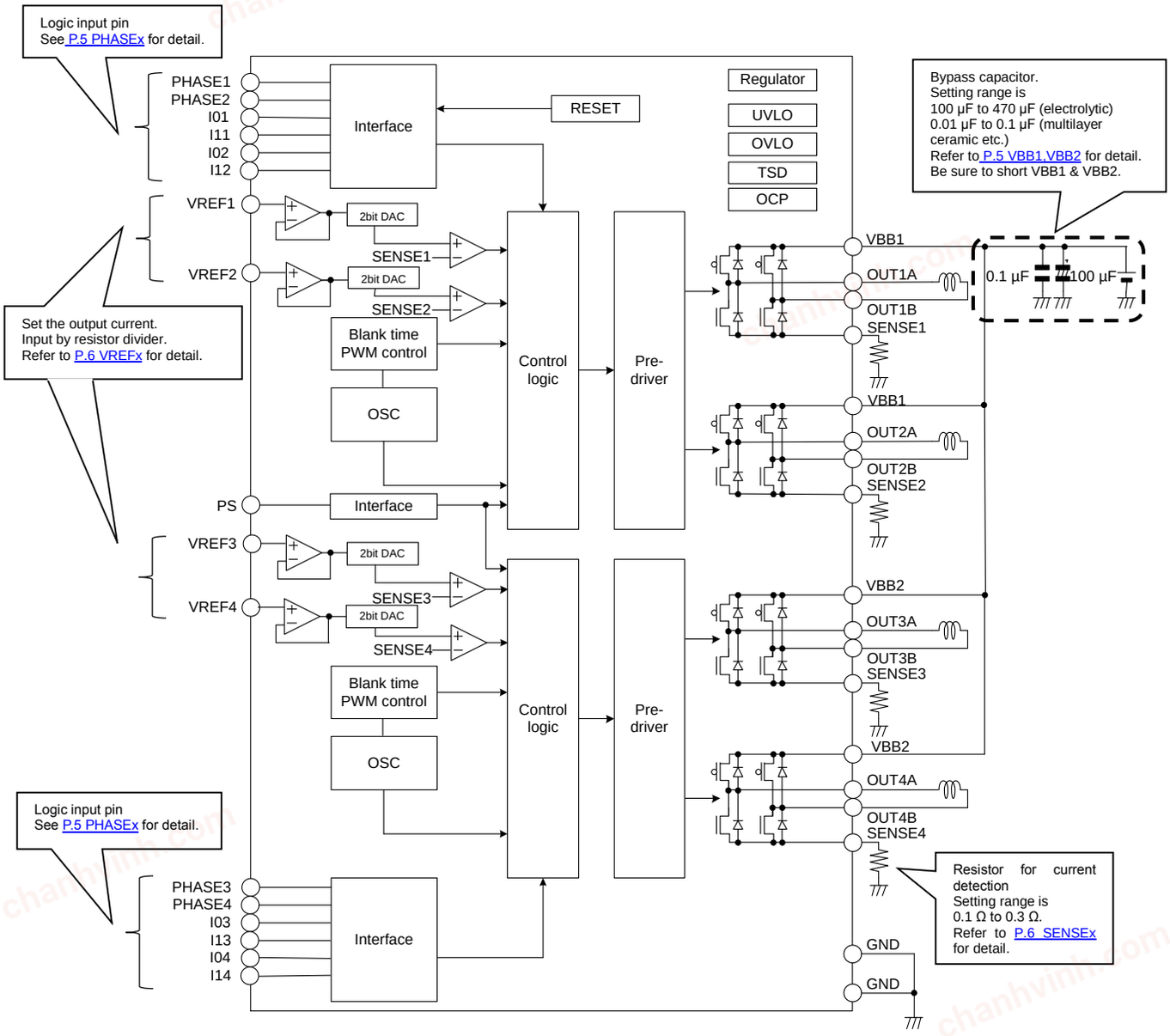


Figure 3. Model Diagram for Measuring Chip Temperature

© 2020 ROHM Co., Ltd. All rights reserved.

chanhvinh.com

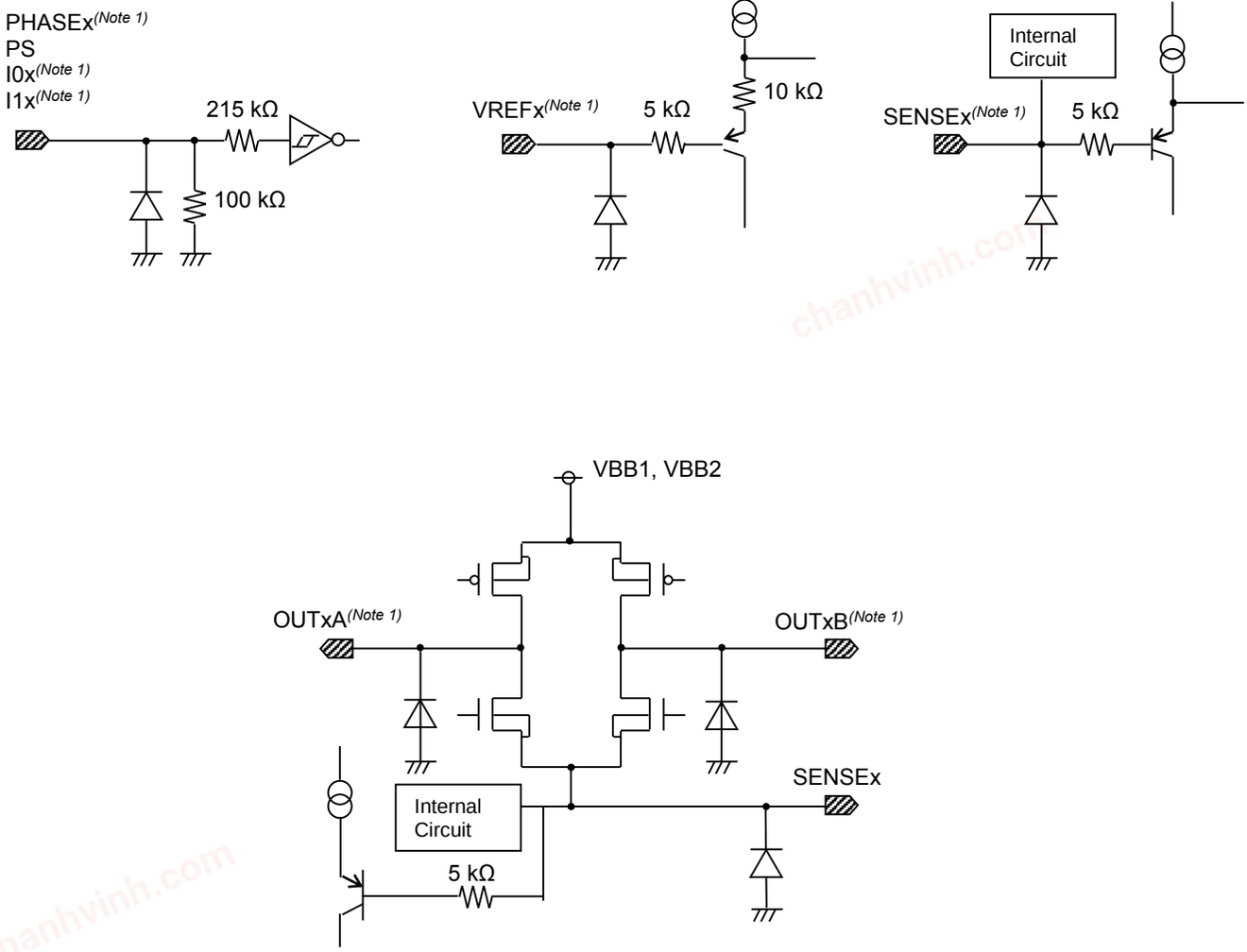
Application Example



© 2020 ROHM Co., Ltd. All rights reserved.

chanhvinh.com

I/O Equivalence Circuit



(Note 1) x = 1, 2, 3 or 4

© 2020 ROHM Co., Ltd. All rights reserved.

chanhvinh.com

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. 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. **Recommended Operating Conditions**
   The function and operation of the IC are guaranteed within the range specified by the recommended operating conditions. The characteristic values are guaranteed only under the conditions of each item specified by the electrical characteristics.

6. **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.

7. **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.

8. **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.

9. **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.

© 2020 ROHM Co., Ltd. All rights reserved.

chanhvinh.com

Operational Notes – continued

10. 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.

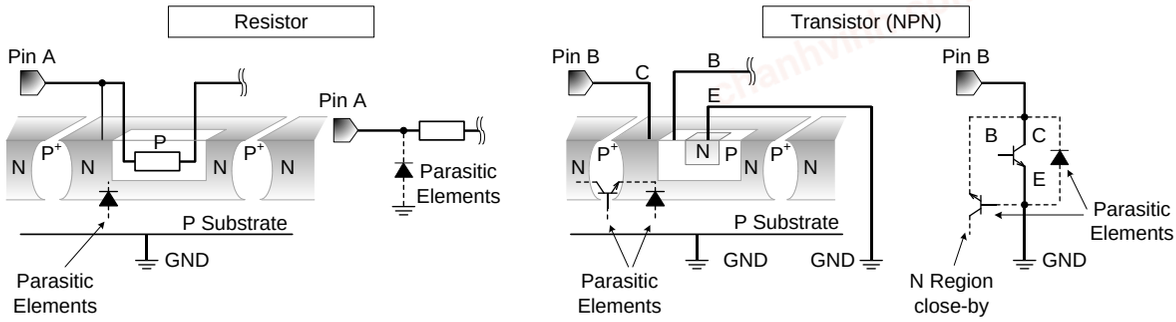


Figure 4. Example of monolithic IC structure

11. Ceramic Capacitor

When using a ceramic capacitor, determine a capacitance value considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

12. Thermal Shutdown Circuit (TSD)

This IC has a built-in thermal shutdown circuit that prevents heat damage to the IC. Normal operation should always be within the IC's maximum junction temperature rating. If however the rating is exceeded for a continued period, the junction temperature (Tj) will rise which will activate the TSD circuit that will turn OFF power output pins. When the Tj falls below the TSD threshold, the circuits are automatically restored to normal operation.
Note that the TSD circuit operates in a situation that exceeds the absolute maximum ratings and therefore, under no circumstances, should the TSD circuit be used in a set design or for any purpose other than protecting the IC from heat damage.

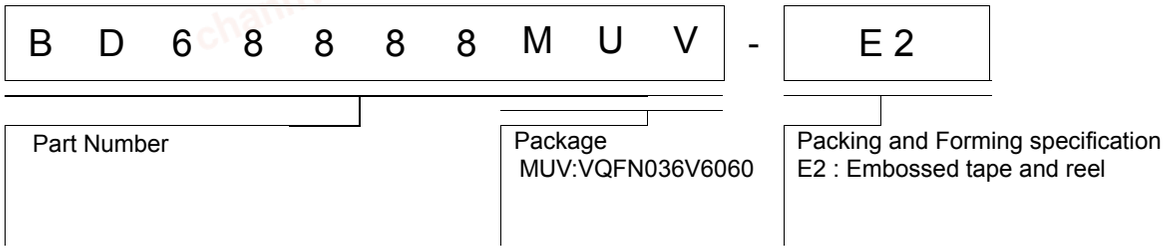
13. Over Current Protection Circuit (OCP)

This IC incorporates an integrated overcurrent protection circuit that is activated when the load is shorted. This protection circuit is effective in preventing damage due to sudden and unexpected incidents. However, the IC should not be used in applications characterized by continuous operation or transitioning of the protection circuit.

© 2020 ROHM Co., Ltd. All rights reserved.

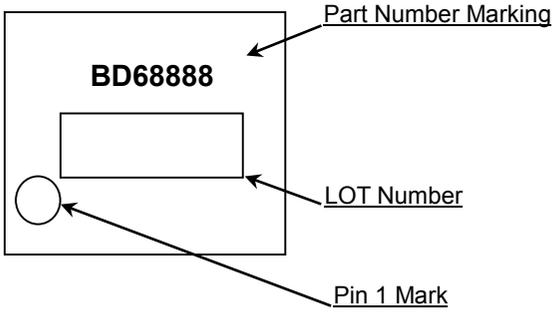
chanhvinh.com

Ordering Information



Marking Diagram

VQFN036V6060 (TOP VIEW)

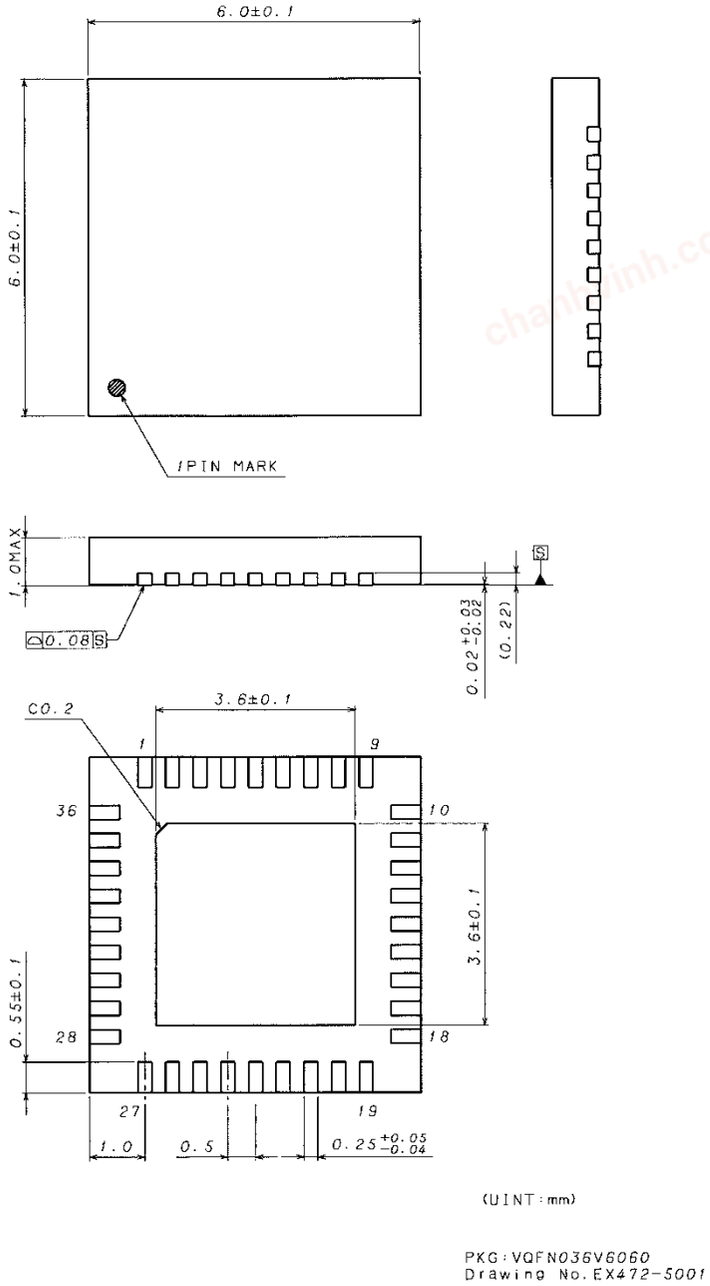


© 2020 ROHM Co., Ltd. All rights reserved.

chanhvinh.com

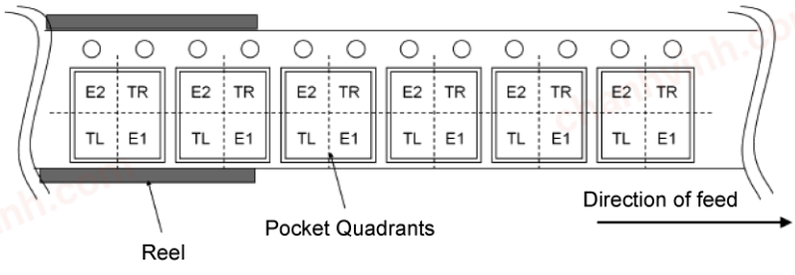
Physical Dimension and Packing Information

Package Name	VQFN036V6060



< Tape and Reel Information >

Tape	Embossed carrier tape (with dry pack)
Quantity	2000pcs
Direction of feed	E2 The direction is the pin 1 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



© 2020 ROHM Co., Ltd. All rights reserved.

chanhvinh.com

Revision History

Date	Revision	Changes
14.Sep.2020	001	New Release

chanhvinh.com

© 2020 ROHM Co., Ltd. All rights reserved.

chanhvinh.com

Notice

Precaution on using ROHM Products

1. Our Products are designed and manufactured for application in ordinary electronic equipment (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

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 (Exclude cases where no-clean type fluxes is used. However, recommend sufficiently about the residue.) ; 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 depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction 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 on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

© 2015 ROHM Co., Ltd. All rights reserved.

chanhvinh.com

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 Cl_2, H_2S, NH_3, SO_2, and NO_2
   - [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

A two-dimensional barcode 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 concerned goods might be fallen under listed items of export control prescribed by Foreign exchange and Foreign trade act, please consult with ROHM in case of export.

Precaution Regarding Intellectual Property Rights

1. All information and data including but not limited to application example contained in this document is for reference only. ROHM does not warrant that foregoing information or data will not infringe any intellectual property rights or any other rights of any third party regarding such information or data.

2. ROHM shall not have any obligations where the claims, actions or demands arising from the combination of the Products with other articles such as components, circuits, systems or external equipment (including software).

3. No license, expressly or implied, is granted hereby under any intellectual property rights or other rights of ROHM or any third parties with respect to the Products or the information contained in this document. Provided, however, that ROHM will not assert its intellectual property rights or other rights against you or your customers to the extent necessary to manufacture or sell products containing the Products, subject to the terms and conditions herein.

Other Precaution

1. This document may not be reprinted or reproduced, in whole or in part, without prior written consent of ROHM.

2. The Products may not be disassembled, converted, modified, reproduced or otherwise changed without prior written consent of ROHM.

3. In no event shall you use in any way whatsoever the Products and the related technical information contained in the Products or this document for any military purposes, including but not limited to, the development of mass-destruction weapons.

4. The proper names of companies or products described in this document are trademarks or registered trademarks of ROHM, its affiliated companies or third parties.

© 2015 ROHM Co., Ltd. All rights reserved.

chanhvinh.com

General Precaution

1. Before you use our Products, you are requested to carefully read this document and fully understand its contents. ROHM shall not be in any way responsible or liable for failure, malfunction or accident arising from the use of any ROHM's Products against warning, caution or note contained in this document.

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.

3. The information contained in this document is provided on an "as is" basis and ROHM does not warrant that all information contained in this document is accurate and/or error-free. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties resulting from inaccuracy or errors of or concerning such information.

© 2015 ROHM Co., Ltd. All rights reserved.