

Drivers for DC Brush Motors

Dual H-Bridge Driver High-Speed Switching Type

BD63572MUV

General Description

The BD63572MUV provides a dual H-Bridge motor driver which features wide range of motor power supply voltage from 2.0 V to 9.0 V and low power consumption to switch low ON-Resistance DMOS transistors at high speed. This small surface mounting package is most suitable for mobile system, home appliance and various applications.

Features

- Low ON-Resistance Power DMOS Output
- Charge Pump-less with PDMOS High-Side Driver
- Drive Mode Switch Function
- Under Voltage Locked Out Protection and Thermal Shutdown Function

Applications

- Mobile System
- Home Appliance
- Amusement System, etc.

Key Specifications

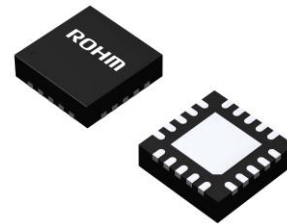
- Power Supply Voltage Range: 2.5 V to 3.6 V
- Motor Power Supply Voltage Range: 2.0 V to 9.0 V
- Circuit Current (Open Mode): 740 μ A(Typ)
- Stand-by Current: 1 μ A (Max)
- Control Input Voltage Range: 0 V to V_{CC}
- Logic Input Frequency: 1000 kHz(Max)
- Minimum Logic Input Pulse Width: 100 ns(Min)
- Turn On Time: 45 ns(Typ)
- Turn Off Time: 45 ns(Typ)
- H-Bridge Output Current (DC): -1.0 A to +1.0 A
- H-Bridge Output Current (Peak): -2.5 A to +2.5 A
- Output ON-Resistance (Total): 0.40 Ω (Typ)
- Operating Temperature Range: -30 $^{\circ}$ C to +85 $^{\circ}$ C

Package

VQFN20PV3535

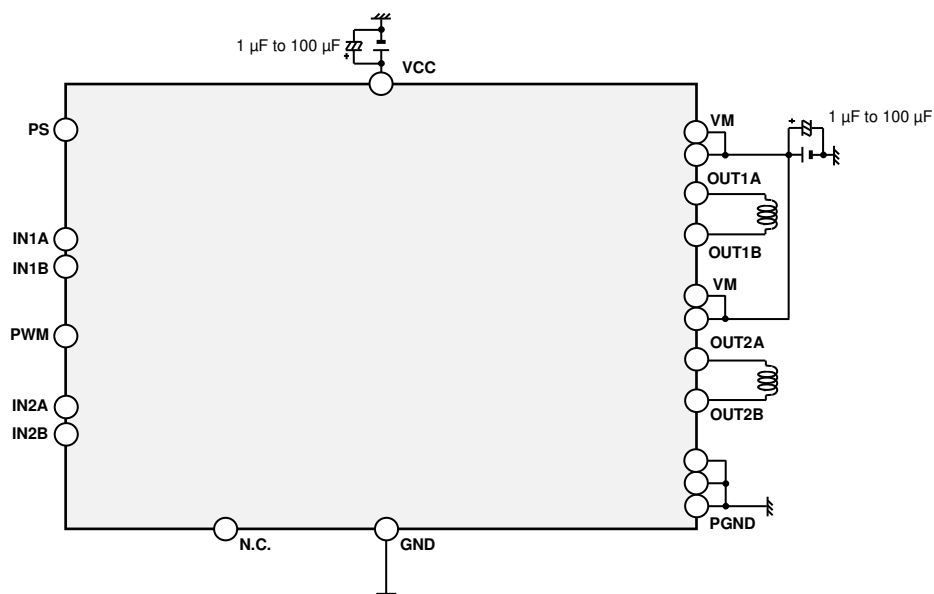
W(Typ) x D(Typ) x H(Max)

3.50 mm x 3.50 mm x 1.00 mm



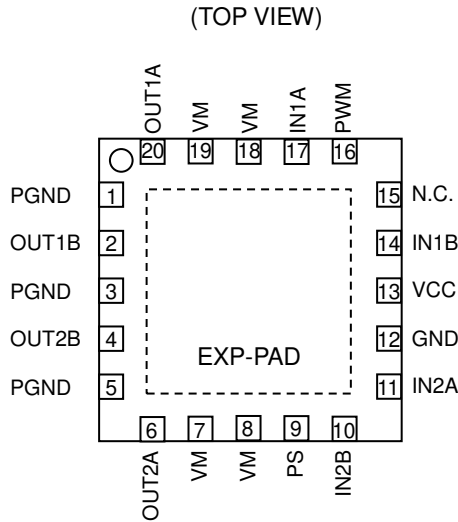
VQFN20PV3535

Typical Application Circuit



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

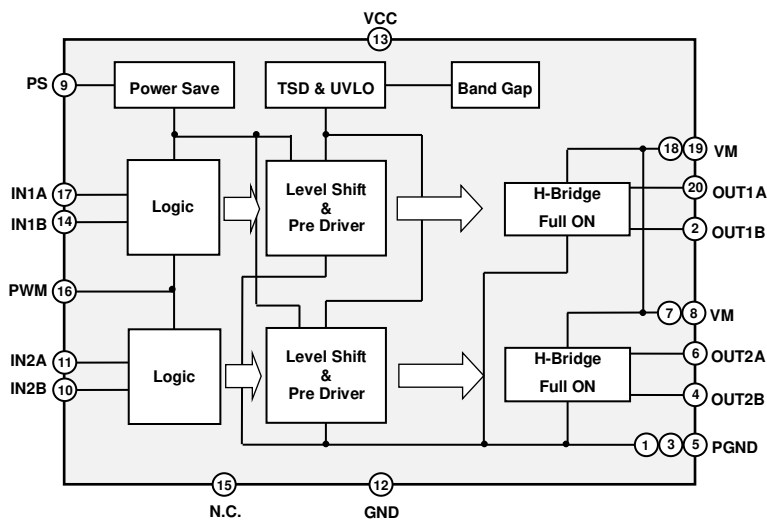
Pin Configuration



Pin Description

Pin No.	Pin Name	Function	Pin No.	Pin Name	Function
1	PGND	Motor ground	12	GND	Small signal ground
2	OUT1B	H-Bridge output 1B	13	VCC	Power supply
3	PGND	Motor ground	14	IN1B	Control logic input 1B
4	OUT2B	H-Bridge output 2B	15	N.C.	Always keep open.
5	PGND	Motor ground	16	PWM	Drive mode logic input
6	OUT2A	H-Bridge output 2A	17	IN1A	Control logic input 1A
7	VM	Motor power supply	18	VM	Motor power supply
8	VM	Motor power supply	19	VM	Motor power supply
9	PS	Power-Saving function	20	OUT1A	H-Bridge output 1A
10	IN2B	Control logic input 2B	-	EXP-PAD	The EXP-PAD of the center connect to GND Pin.
11	IN2A	Control logic input 2A			

Block Diagram



Description of Functions

1. Power-Saving Function
A Power-Saving Function is included, which allows the system to save power when not driving the motor. The voltage level on the PS Pin should be set high so as to keep the Active Mode. (See the Electrical Characteristics)
2. Motor Control Input
 - (a) IN1A, IN1B, IN2A and IN2B Pins
Logic level controls the output logic of H-Bridge.
(See the Electrical Characteristics, and I/O Truth Table)
 - (b) PWM Pin
Logic level sets the IN/IN or EN/IN drive mode.
(See the Electrical Characteristics and I/O Truth Table)
3. VM Pin
Each H-Bridge can be controlled independently. Take into consideration that each VM Pin (Pin No.7, 8, 18 and 19 pins) are short-circuited internally. (See the Block Diagram) Each VM Pins must be shorted on printed circuit board.
4. PGND Pin
Each PGND Pins must be shorted on printed circuit board.

Absolute Maximum Ratings (Ta=25 °C)

Parameter	Symbol	Rating	Unit
Power Supply Voltage	V _{CC}	-0.3 to +4.5	V
Motor Power Supply Voltage	V _M	-0.3 to +10.0	V
Control Input Voltage	V _{IN}	-0.3 to V _{CC} +0.3	V
H-Bridge Output Current (DC)	I _{OUT}	-1.0 to +1.0 ^(Note 1)	A
H-Bridge Output Current (PEAK)	I _{OUT(PEAK)}	-2.5 to +2.5 ^(Note 2)	A
Maximum Junction Temperature	T _{jmax}	150	°C
Storage Temperature Range	T _{stg}	-55 to +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 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.

(Note 1) ASO and T_j=150 °C should not be exceeded.

(Note 2) PEAK=100 ms (Duty≤10 %). ASO and T_j=150 °C should not be exceeded.

Thermal Resistance ^(Note 3)

Parameter	Symbol	Thermal Resistance (Typ)		Unit
		1s ^(Note 5)	2s2p ^(Note 6)	
VQFN20PV3535				
Junction to Ambient	θ _{JA}	181.9	50.5	°C/W
Junction to Top Characterization Parameter ^(Note 4)	Ψ _{JT}	19	7	°C/W

(Note 3) Based on JE51-2A (Still-Air)

(Note 4) 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 5) Using a PCB board based on JE51-3.

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

(Note 6) Using a PCB board based to JE51-5, 7.

Layer Number of Measurement Board	Material	Board Size	Thermal Via ^(Note 7)		
			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 7) This thermal via connects with the copper pattern of all layers.

Recommended Operation Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Power Supply Voltage	V _{CC}	2.5	-	3.6	V
Motor Power Supply Voltage	V _M	2.0	-	9.0	V
Control Input Voltage	V _{IN}	0	-	V _{CC}	V
Logic Input Frequency	f _{IN}	0	-	1000	kHz
Minimum Logic Input Pulse Width	t _{IN}	100	-	-	ns
Operation Temperature	T _{opr}	-30	-	+85	°C

Electrical Characteristics (Unless otherwise specified, $V_{CC}=3.0\text{ V}$, $V_M=5.0\text{ V}$, $T_a=25\text{ }^\circ\text{C}$)

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
All Circuits						
Stand-by Current	I_{CCST}	-	0	1	μA	$V_{PS}=0\text{ V}$
Circuit Current 1	I_{CC1}	200	740	1150	μA	$V_{PS}=3\text{ V}$, Open Mode ^(Note 8)
Circuit Current 2	I_{CC2}	200	750	1150	μA	$V_{PS}=3\text{ V}$, CW & CCW Mode ^(Note 8)
Circuit Current 3	I_{CC3}	300	770	1200	μA	$V_{PS}=3\text{ V}$, Short Brake Mode ^(Note 8)
PS Input (PS)						
High-Level Input Voltage	V_{PSH}	1.85	-	V_{CC}	V	
Low-Level Input Voltage	V_{PSL}	0	-	0.9	V	
High-Level Input Current	I_{PSH}	15	30	60	μA	$V_{PS}=3\text{ V}$
Low-Level Input Current	I_{PSL}	-1	0	+1	μA	$V_{PS}=0\text{ V}$
Control Input (IN=IN1A, IN1B, IN2A, IN2B, PWM)						
High-Level Input Voltage	V_{INH}	1.85	-	V_{CC}	V	
Low-Level Input Voltage	V_{INL}	0	-	0.9	V	
High-Level Input Current	I_{INH}	15	30	60	μA	$V_{IN}=3\text{ V}$
Low-Level Input Current	I_{INL}	-1	0	+1	μA	$V_{IN}=0\text{ V}$
Under Voltage Locked Out (UVLO)						
UVLO Voltage	V_{UVLO}	2.0	-	2.4	V	
FULL ON Type H-Bridge Driver						
Output ON-Resistance	R_{ON}	-	0.40	0.60	Ω	$I_{OUT}=\pm 500\text{ mA}$, High & Low-side total Resistance
Turn On Time	t_{ON}	-	45	200	ns	20 Ω Loading
Turn Off Time	t_{OFF}	-	45	200	ns	20 Ω Loading

(Note 8) Refer to Table 1.

Typical Performance Curves (Reference Data)

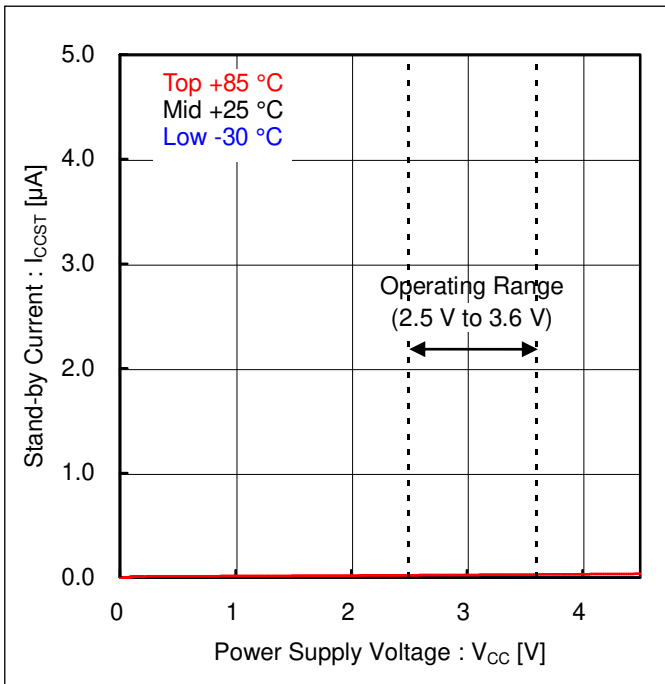


Figure 1. Stand-by Current vs Power Supply Voltage (Stand-by Mode)

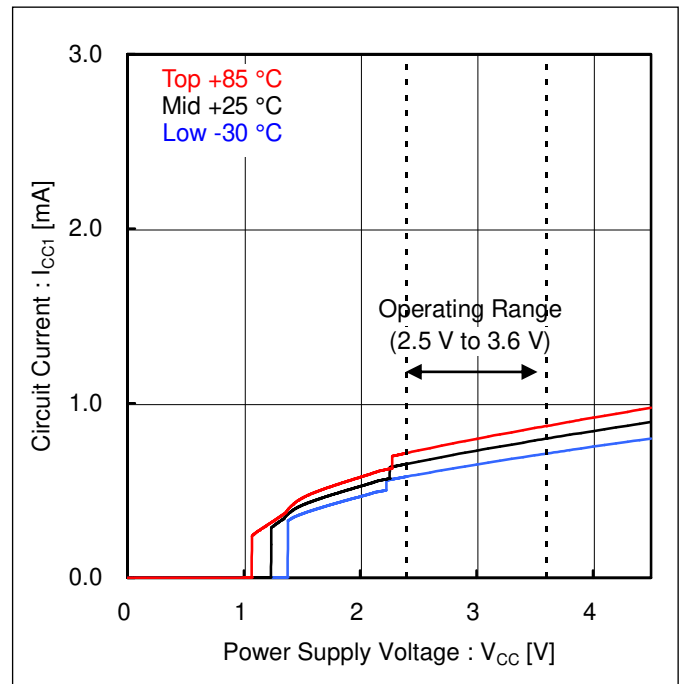


Figure 2. Circuit Current vs Power Supply Voltage (Open Mode)

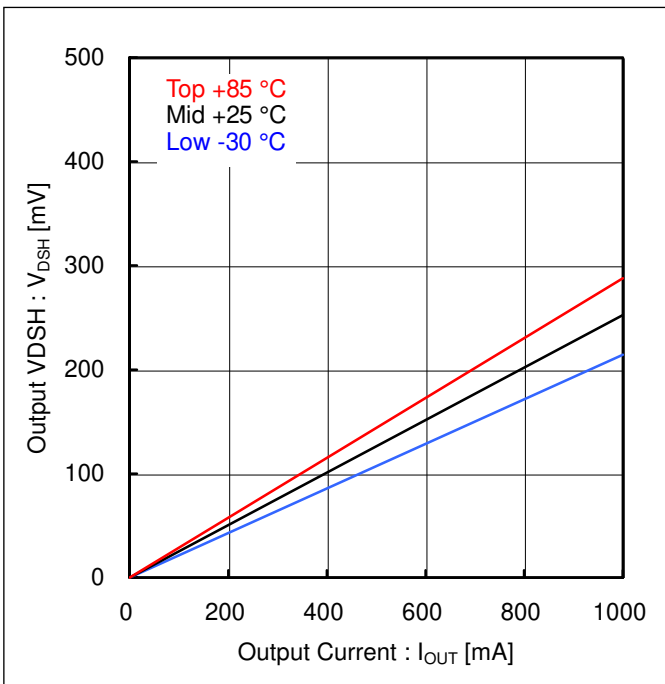


Figure 3. Output VDSH vs Output Current (Output ON-Resistance on high-side, $V_M=5\text{ V}$, $V_{CC}=3\text{ V}$)

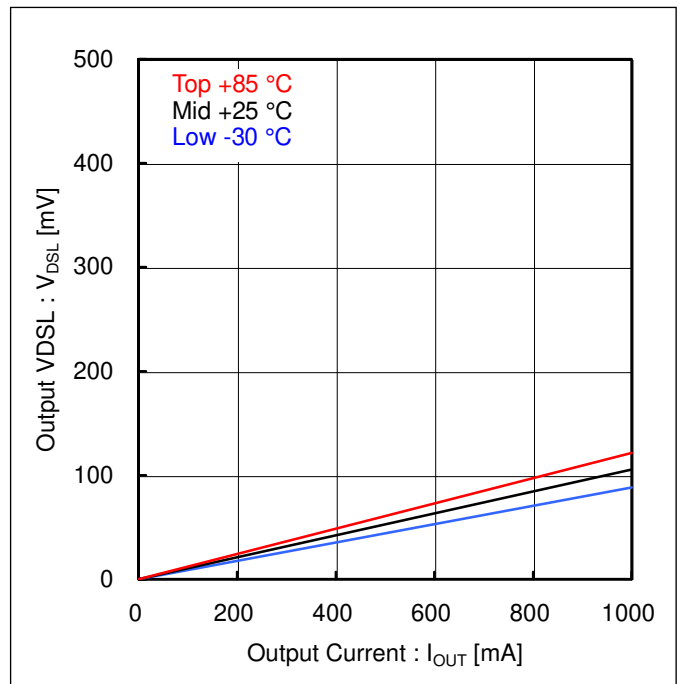


Figure 4. Output VDSL vs Output Current (Output ON-Resistance on low-side, $V_M=5\text{ V}$, $V_{CC}=3\text{ V}$)

Typical Performance Curves (Reference Data) - continued

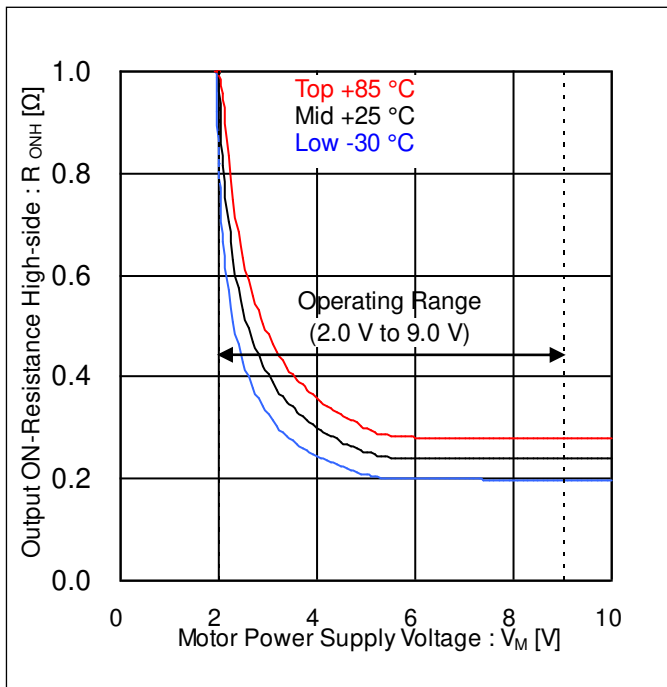


Figure 5. Output ON-Resistance High-side vs Motor Power Supply Voltage
 (Output ON-Resistance on High-side V_M Dependency, $V_{CC}=3$ V)

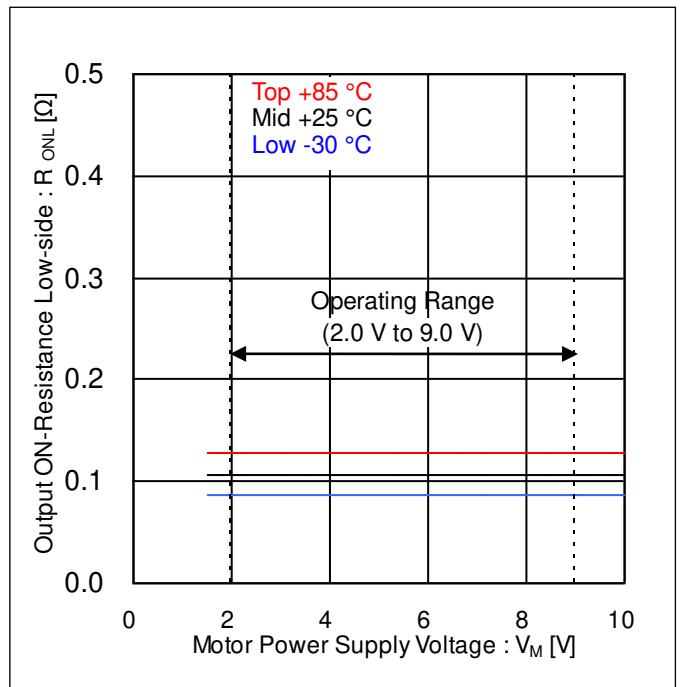


Figure 6. Output ON-Resistance Low-side vs Motor Power Supply Voltage
 (Output ON-Resistance on Low-side V_M Dependency, $V_{CC}=3$ V)

Timing Chart

Table 1. I/O Truth Table

Input Mode	INPUT				OUTPUT			
	PS ^(Note 9)	PWM	IN1A / IN2A	IN1B / IN2B	OUT1A / OUT2A	OUT1B / OUT2B	Output Mode ^(Note 10)	
EN/IN	H	H	L	X	L	L	Short Brake	
			H	L	H	L	CW	
			H	H	L	H	CCW	
IN/IN		L	L	L	L	Z	Z	Open
				H	L	H	L	CW
				L	H	L	H	CCW
				H	H	L	L	Short Brake
-	L	X	X	X	Z	Z	Open	

L: Low, H: High, X: Don't care, Z: Hi impedance

(Note 9) PS=High: Active Mode, PS=Low: Stand-by Mode

(Note 10) CW: Current flows from OUTxA to OUTxB, CCW: Current flows from OUTxB to OUTxA (x=1,2)

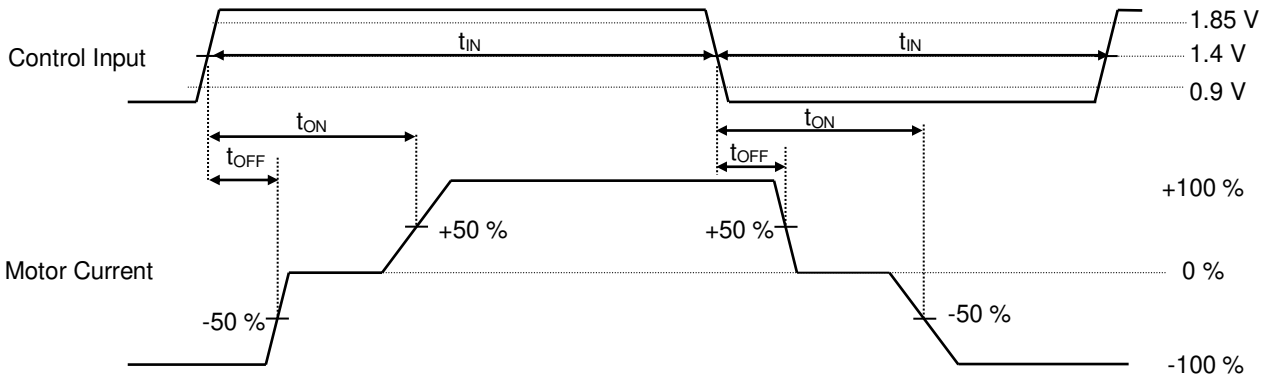


Figure 7. Input-Output AC Characteristic 1

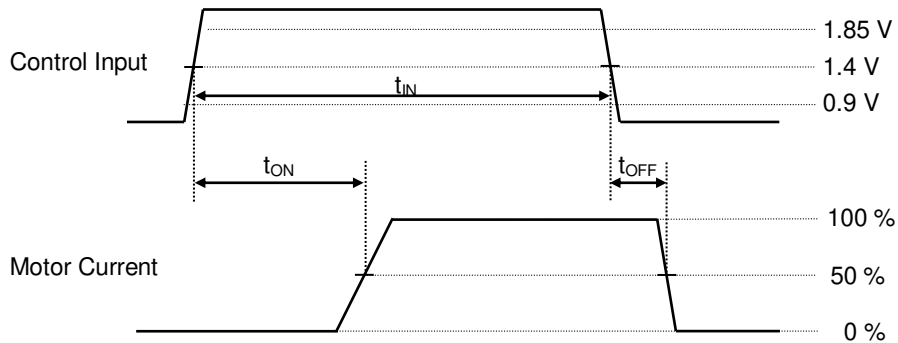
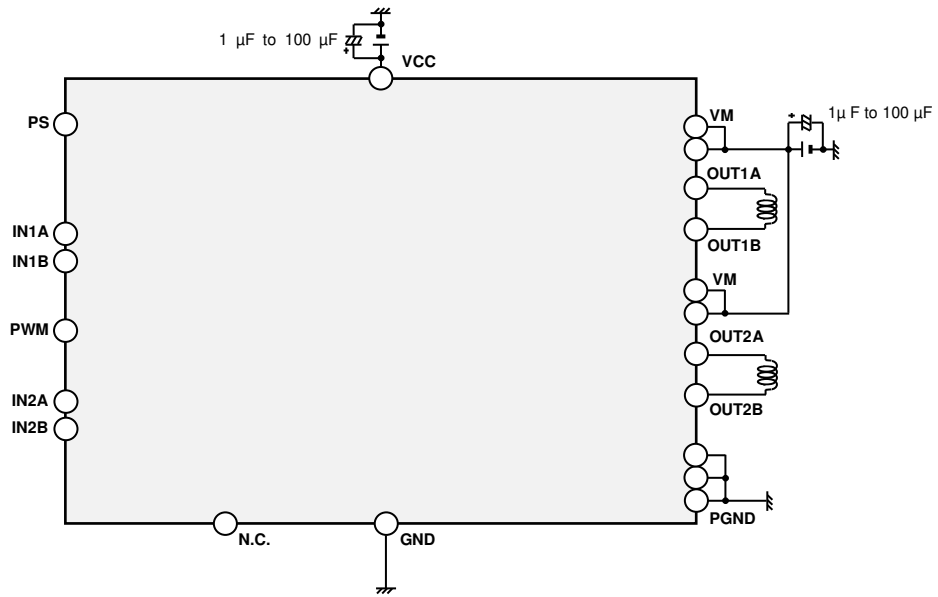


Figure 8. Input-Output AC Characteristic 2

Application Example



Selection of Components Externally Connected

When using the circuit with changes to the external circuit constants, make sure to leave an adequate margin for external components including static and transitional characteristics as well as dispersion of the IC.

I/O Equivalence Circuits

PS	IN1A, IN1B, IN2A, IN2B, PWM	VM, PGND, OUTxA, OUTxB (x=1,2)

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(GND) and large-current ground(PGND) 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. Operation Under Strong Electromagnetic Field

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

8. 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.

9. 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.

10. 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

11. 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.

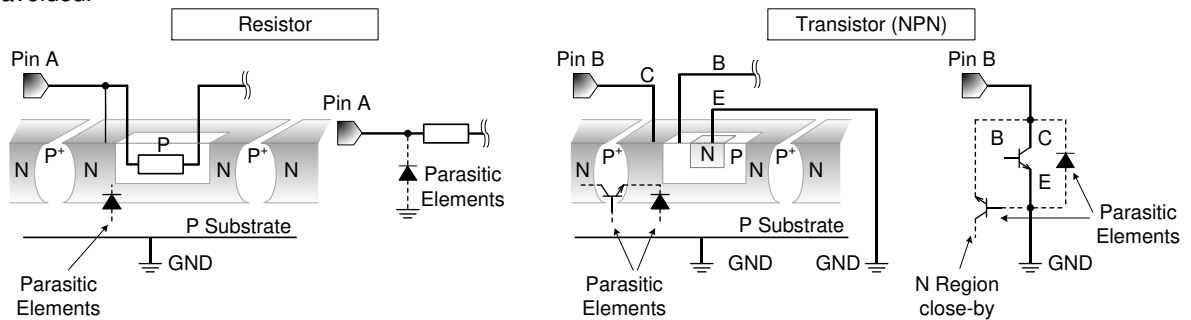


Figure 9. Example of monolithic IC structure

12. 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.

13. Area of Safe Operation (ASO)

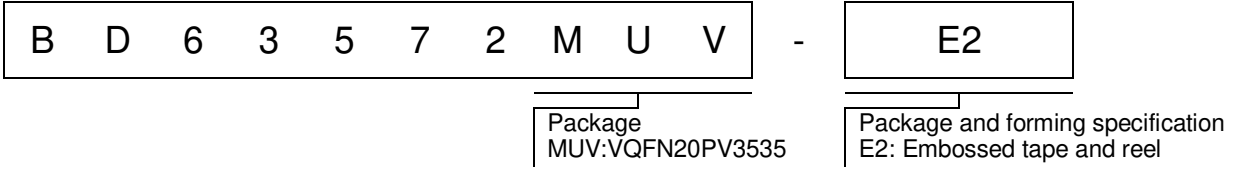
Operate the IC such that the output voltage, output current, and the maximum junction temperature rating are all within the Area of Safe Operation (ASO).

14. Thermal Shutdown Circuit(TSD)

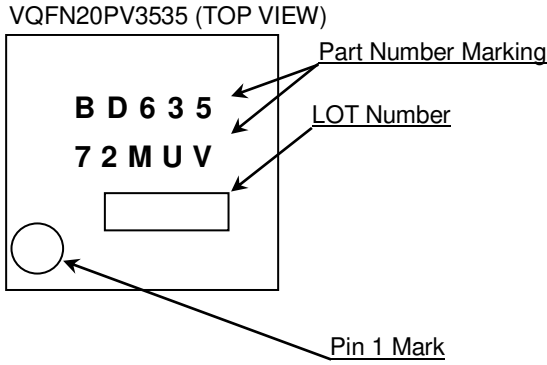
This IC has a built-in thermal shutdown circuit that prevents heat damage to the IC. Normal operation should always be within the IC's maximum junction temperature rating. If however the rating is exceeded for a continued period, the junction temperature (T_j) will rise which will activate the TSD circuit that will turn OFF power output pins. When the T_j 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.

Ordering Information



Marking Diagram



Revision History

Date	Revision	Changes
07.Dec.2017	001	New Release
25.Jan.2019	002	Change Physical Dimension and Packing Information

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(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASS III	CLASS III	CLASS II b	CLASS III
CLASS IV		CLASS III	

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 - Use of the Products in places subject to dew condensation
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- Confirm that operation temperature is within the specified range described in the product specification.
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