H-Bridge Drivers for DC Brush Motors

Single H-Bridge Driver High-Speed Switching Type

BD63576NUX

General Description

The BD63576NUX provides a single H-bridge motor driver which features wide range of motor power supply voltage from 2.0V to 10.0V 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
- Under Voltage Locked Out Protection and Thermal Shut Down Function
- Automatic Power-Saving Mode Function

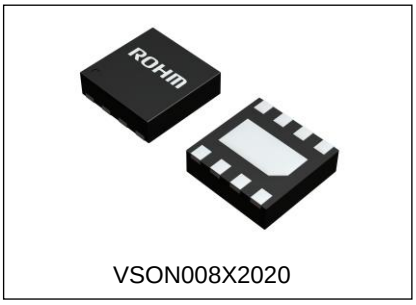
Applications

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

Key Specifications

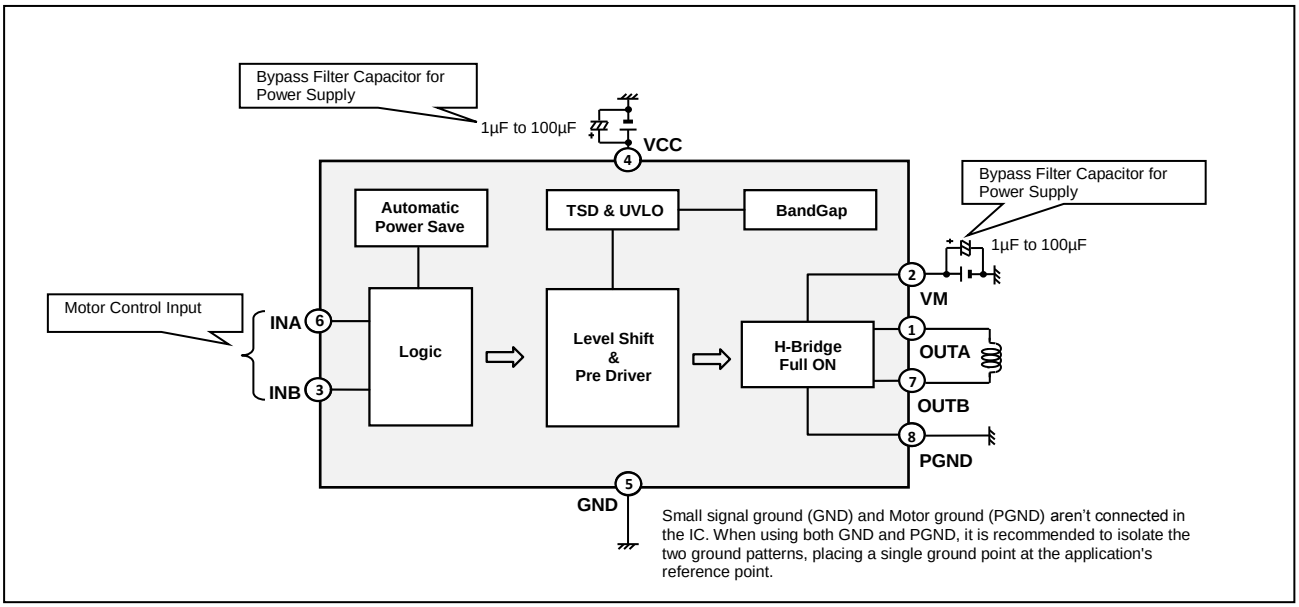
- Power Supply Voltage Range: 2.5V to 5.5V
- Motor Power Supply Voltage Range: 2.0V to 10.0V
- Circuit Current (Short Brake Mode): 150μA(Typ)
- Stand-By Current 1μA (Max)
- Control Input Voltage Range: 0V to V_{CC}V
- Operation Mode Logic Input Frequency: 20kHz to 500kHz
- Minimum Logic Input Pulse Width: 0.5μs(Min)
- Turn On Time: 240ns(Typ)
- Turn Off Time: 60ns(Typ)
- H-Bridge Output Current (DC): ±1.2A
- H-Bridge Output Current (Peak): ±3.2A
- Output ON-Resistance (Total): 0.55Ω(Typ)
- Operating Temperature Range: -30°Cto +85°C

Package	W(Typ) x D(Typ) x H(Max)
VSON008X2020	2.00mm x 2.00mm x 0.60mm

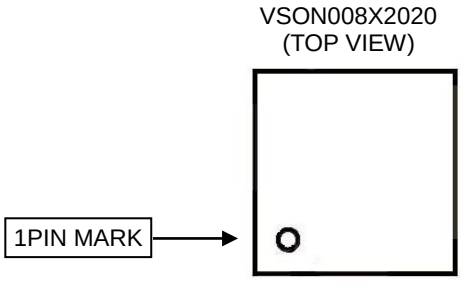


VSON008X2020

Typical Application Circuit



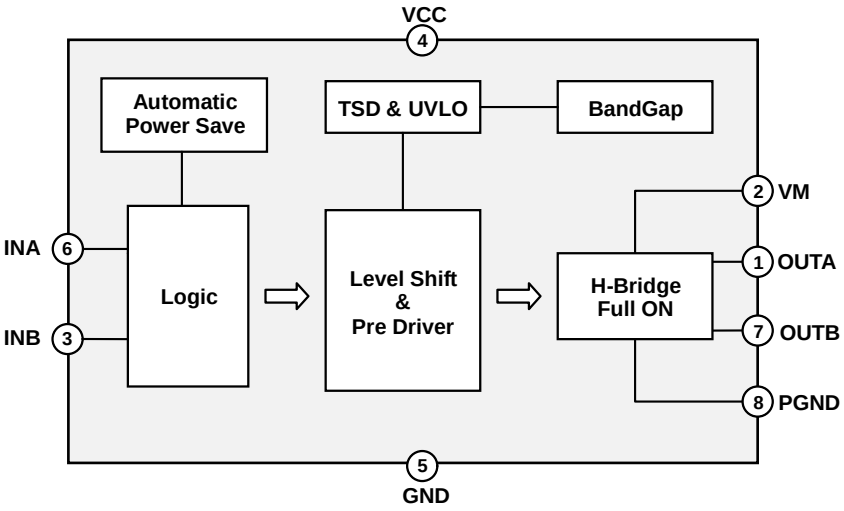
Pin Configuration



Pin Description

Pin No.	Pin Name	Function
1	OUTA	H-Bridge output terminal A
2	VM	Motor power supply terminal
3	INB	Control input terminal B
4	VCC	Power supply terminal
5	GND	Ground terminal
6	INA	Control input terminal A
7	OUTB	H-bridge output terminal B
8	PGND	Motor ground terminal

Block Diagram



Description of Blocks

1. Motor Control Input
   INA and INB Pins
   Logic level controls the output logic of H-Bridge.
   (See the Electrical Characteristics; p.4/15, and I/O Truth Table; p.7/15)

2. Automatic Power-Saving Function
   The automatic power-saving function allows the system to save power when not driving the motor. The device changes state from operating to stand-by when output logic becomes open mode between 50µs to 500µs. (See the Timing Chart; p.8/15)

Absolute Maximum Ratings (Ta=25°C)

Items	Symbol	Rating	Unit
Power Supply Voltage	V_{CC}	-0.3 to +7.0	V
Motor Power Supply Voltage	V_M	-0.3 to +10.5	V
Control Input Voltage	V_{IN}	-0.3 to VCC+0.3	V
H Bridge Output Current (DC)	I_{OUT}	±1.2(Note 1)	A
H Bridge Output Current (PEAK)	$I_{OUT(PEAK)}$	±3.2(Note 2)	A
Storing Temperature Range	T_{stg}	-55 to +150	°C
Connections Temperature	T_{jmax}	150	°C

(Note 1) ASO and Tj=150°C should not be exceeded.
(Note 2) PEAK=100 ms (Duty≤5%). ASO and Tj=150°C should not be exceeded.
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 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.

Thermal Resistance(Note 3)

Parameter	Symbol	Thermal Resistance (Typ)		Unit
		1s(Note 5)	2s2p(Note 6)	
VSON008X2020				
Junction to Ambient	θ_{JA}	309.5	77.1	°C/W
Junction to Top Characterization Parameter(Note 4)	Ψ_{JT}	53	12	°C/W

(Note 3) Based on JESD51-2A (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 JESD51-3.

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

Top	
Copper Pattern	Thickness
Footprints and Traces	70µm

(Note 6) Using a PCB board based to JESD51-5 and 7.

Layer Number of Measurement Board	Material	Board Size	Thermal Via(Note 7)	
			Pitch	Diameter
4 Layers	FR-4	114.3mm x 76.2mm x 1.6mmt	1.20mm	Φ0.30mm

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

(Note 7) This thermal via connects with the copper pattern of all layers.

Recommended Operation Conditions

Items	Symbol	Min	Typ	Max	Unit
Power Supply Voltage	V_{CC}	2.5	-	5.5	V
Motor Power Supply Voltage	V_M	2.0	-	10.0	V
Control Input Voltage	V_{IN}	0	-	V_{CC}	V
Operation Mode Logic Input Frequency	F_{IN}	20	-	500	kHz
Minimum Logic Input Pulse Width	T_{IN}	0.5	-	-	µs
Operation Temperature Range	T_{OPR}	-30	-	+85	°C

Electrical Characteristics (Unless otherwise specified, VCC=3.3V, VM=5.0V, T_a=25°C)

Parameters	Symbol	Min	Typ	Max	Unit	Conditions
All Circuits						
Stand-by Current	I_{CCST}	-	0	1	μA	V_{IN}=0V
Circuit Current 1(NOTE 8)	I_{CC1}	50	135	225	μA	INA=0V↔3.3V (F_{IN}=20kHz, Duty=10%) INB=0V
Circuit Current 2	I_{CC2}	50	145	225	μA	CW & CCW Mode
Circuit Current 3	I_{CC3}	50	150	225	μA	Short Brake Mode
Control Input (IN=INA, INB)						
High-Level Input Voltage	V_{INH}	0.7×V_{CC}	-	V_{CC}	V	
Low-Level Input Voltage	V_{INL}	0	-	0.3×V_{CC}	V	
High-Level Input Current	I_{INH}	16	33	66	μA	V_{IN}=3.3V
Low-Level Input Current	I_{INL}	-1	0	+1	μA	V_{IN}=0V
Under Voltage Locked Out (UVLO)						
UVLO Voltage	V_{UVLO}	1.9	-	2.5	V	
Full ON Driver						
Output On-Resistance	R_{ON}	-	0.55	0.75	Ω	I_{OUT}=±500mA, High & Low-side total
Turn On Time	T_{ON}	-	240	400	ns	20Ω Load
Turn Off Time	T_{OFF}	-	60	400	ns	20Ω Load

(Note 8) This is same with condition INB=0V↔3.3V (F_{IN}=20KHz, Duty=10%), INA=0V.

Typical Performance Curves (Reference Data)

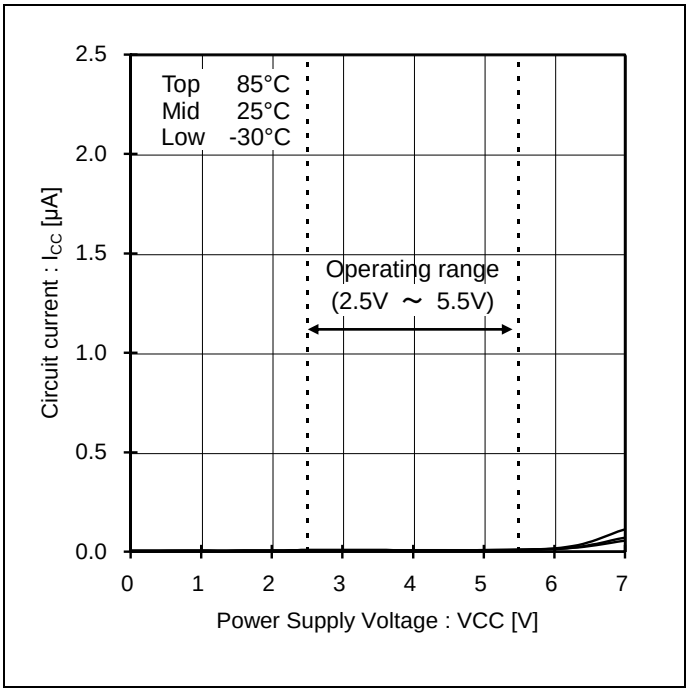


Figure 1.
Circuit Current vs Power Supply Voltage
(“Circuit Current”, Stand-by Mode)

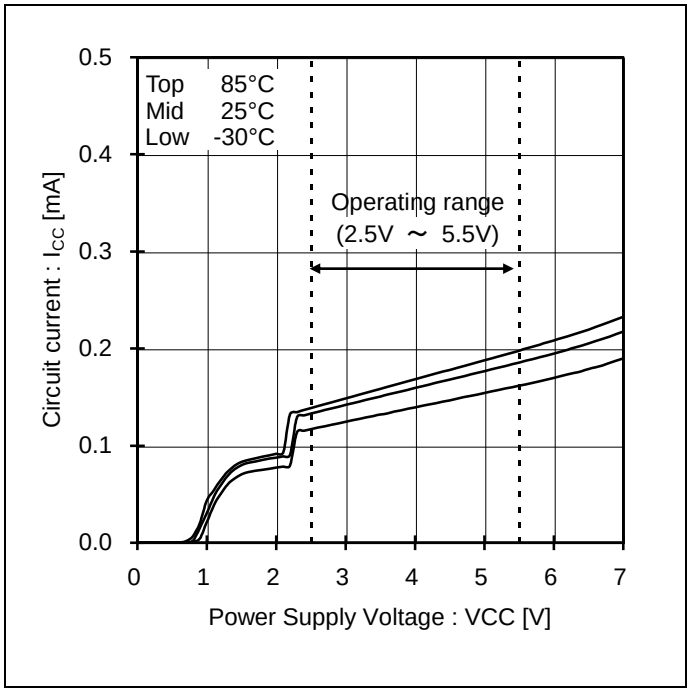


Figure 2.
Circuit Current vs Power Supply Voltage
(“Circuit Current”, Short Brake Mode)

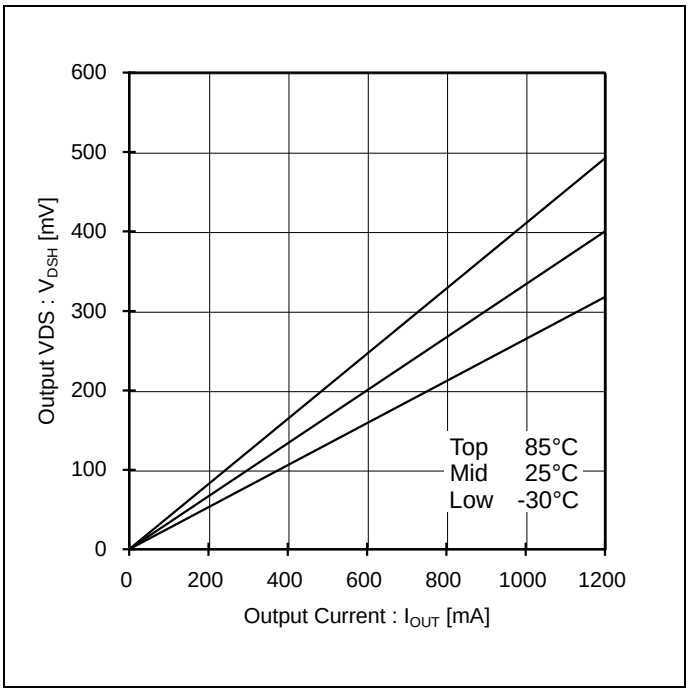


Figure 3.
Output VDS vs Output Current
(“Output High-Side On-Resistance”, VM=5V and VCC=3.3V)

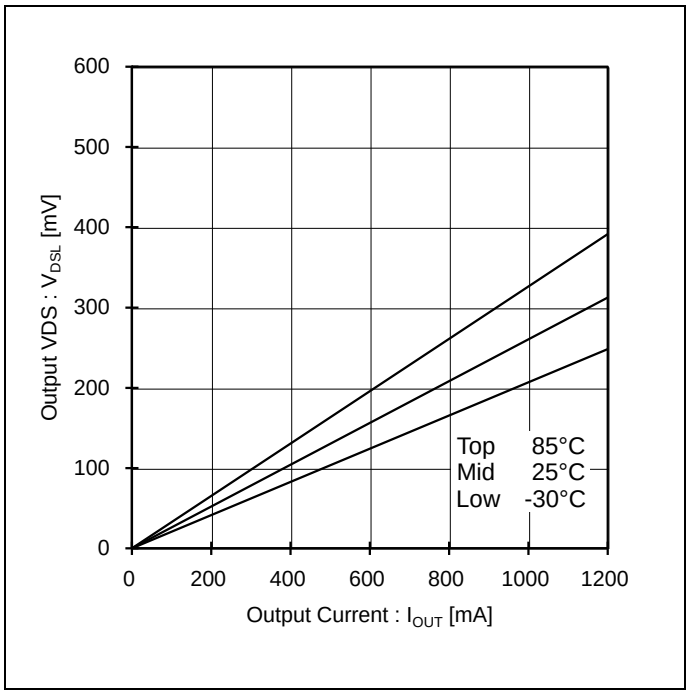


Figure 4.
Output VDS vs Output Current
(“Output Low-Side On-Resistance”, VM=5V and VCC=3.3V）

Typical Performance Curves (Reference Data) - continued

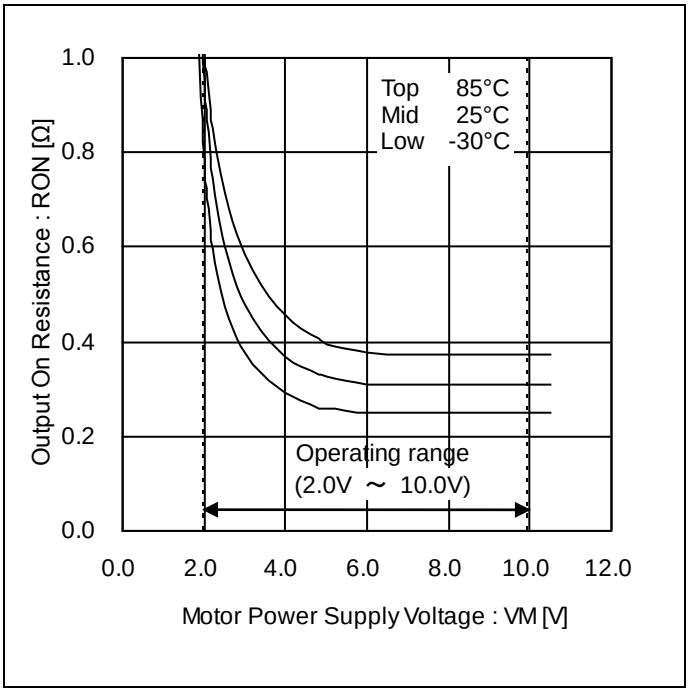


Figure 5.
Output On-Resistance vs Motor Power Supply Voltage
("Output High-Side ON-Resistance VM Dependence",
VCC=3.3V)

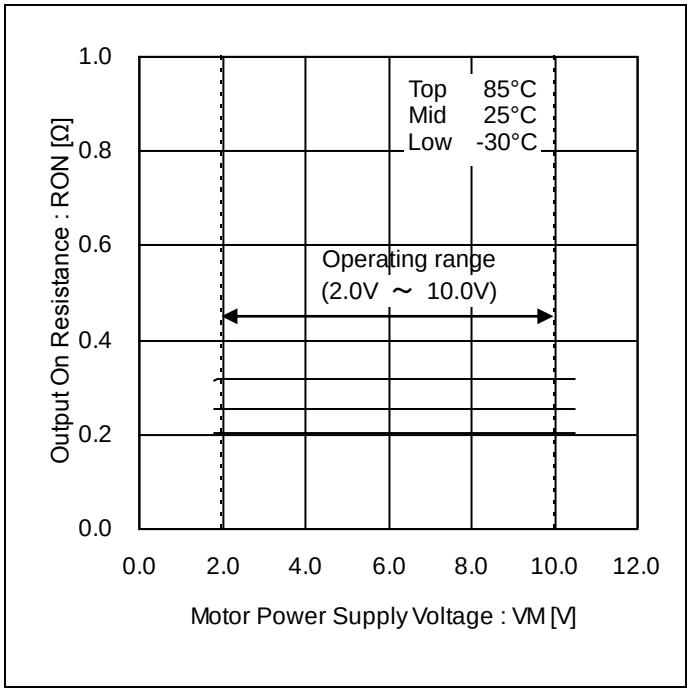


Figure 6.
Output On-Resistance vs Motor Power Supply Voltage
("Output Low-Side On-Resistance VM Dependence",
VCC=3.3V)

Timing Chart

Table1. I/O Truth Table

Input System	INPUT		OUTPUT		
	INA	INB	OUTA	OUTB	Output Mode (Note 9)
IN/IN	L	L	Z	Z	Open
	H	L	H	L	Clockwise
	L	H	L	H	Counter clockwise
	H	H	L	L	Short Brake

L: Low, H: High, X: Don't care, Z: High-Impedance
(Note 9) CW: Current flows from OUTA to OUTB, CCW: Current flows from OUTB to OUTA

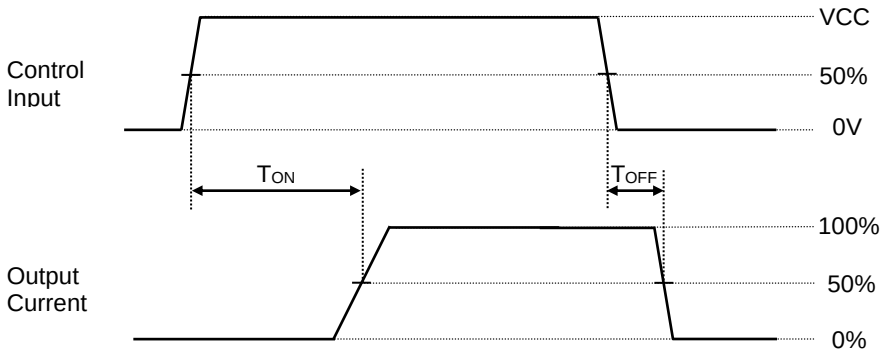
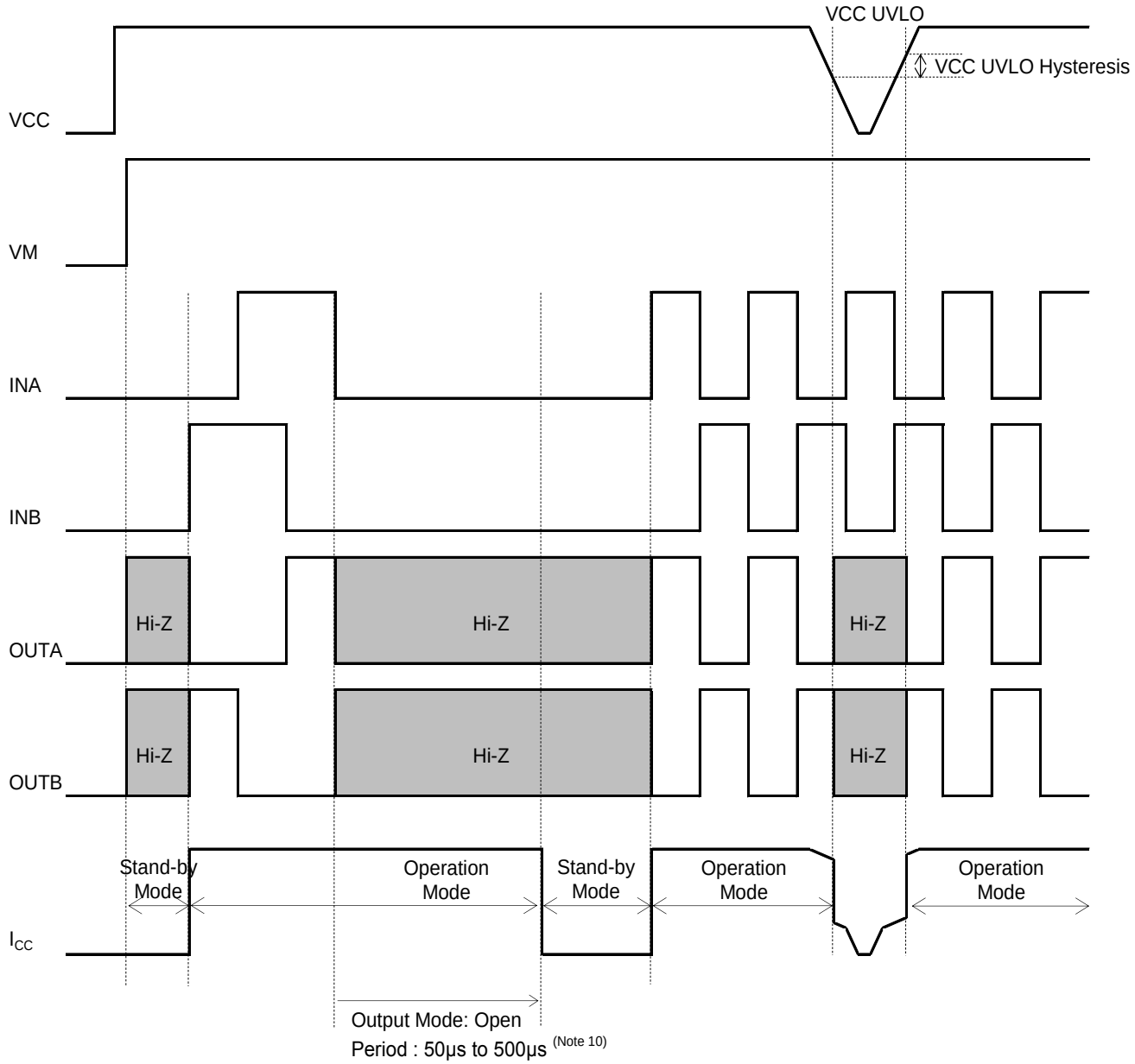


Figure 7.
Input-Output AC Characteristics

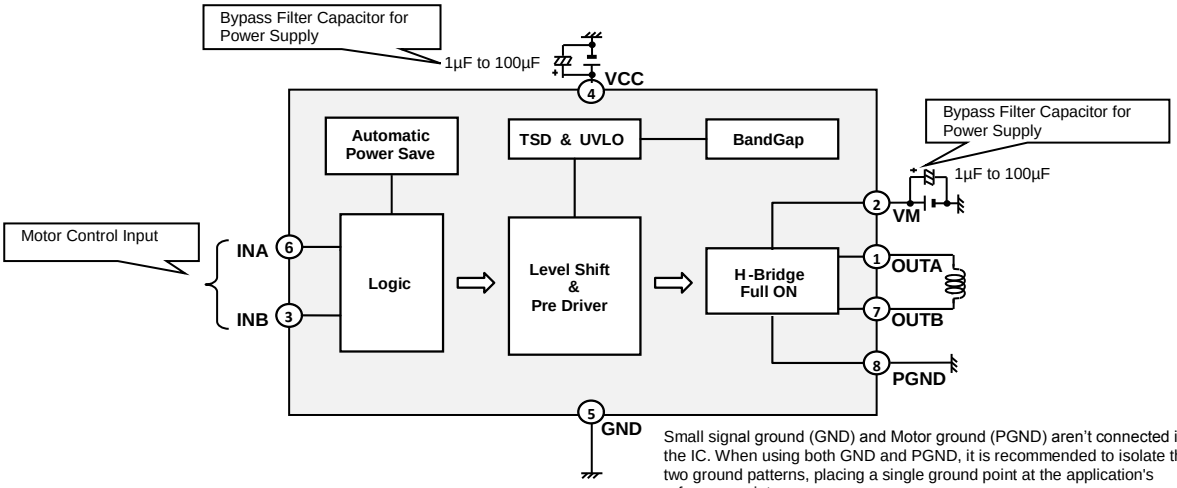
Timing Chart - continued



(Note 10) In PWM drive operation, condition INA=Low and INB=Low must be kept less than 50µs. If condition INA=Low and INB=Low exceeds 500µs period, device will switch to stand-by mode.

Figure 8.
Timing Diagram

Application Example

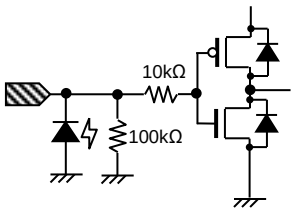
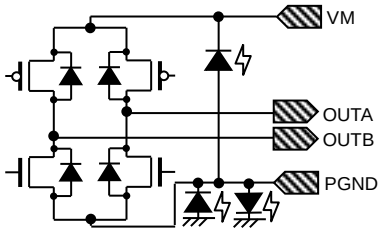


Small signal ground (GND) and Motor ground (PGND) aren't connected in the IC. When using both GND and PGND, it is recommended to isolate the two ground patterns, placing a single ground point at the application's reference point.

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

INA, INB	VM, PGND, OUTA, OUTB
	

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. **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.

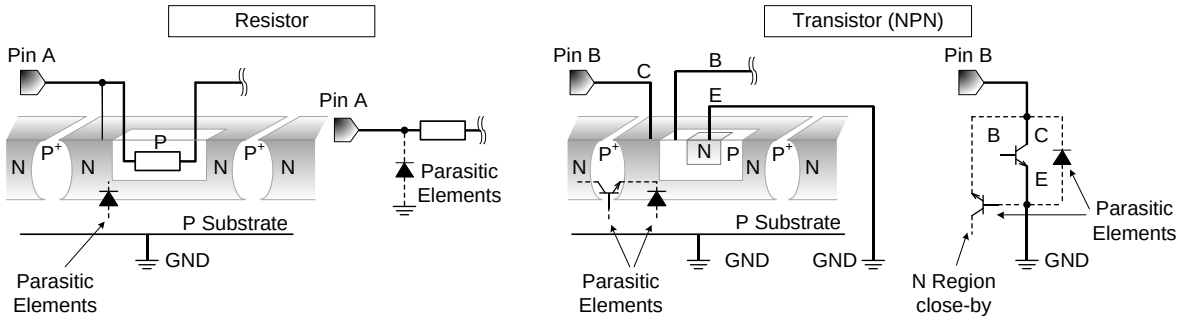


Figure 9.
Example of monolithic IC structure

13. Ceramic Capacitor

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

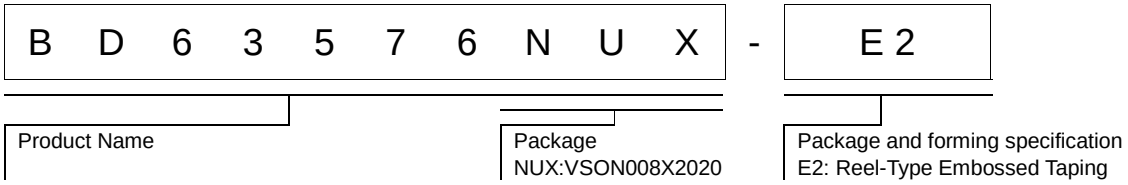
14. Area of Safe Operation (ASO)

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

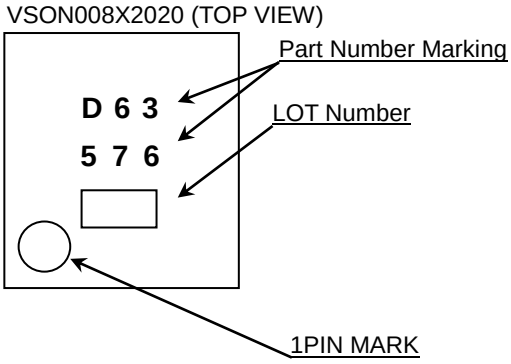
15. Thermal Shutdown Circuit(TSD)

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 power dissipation 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 all 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.

Ordering Information



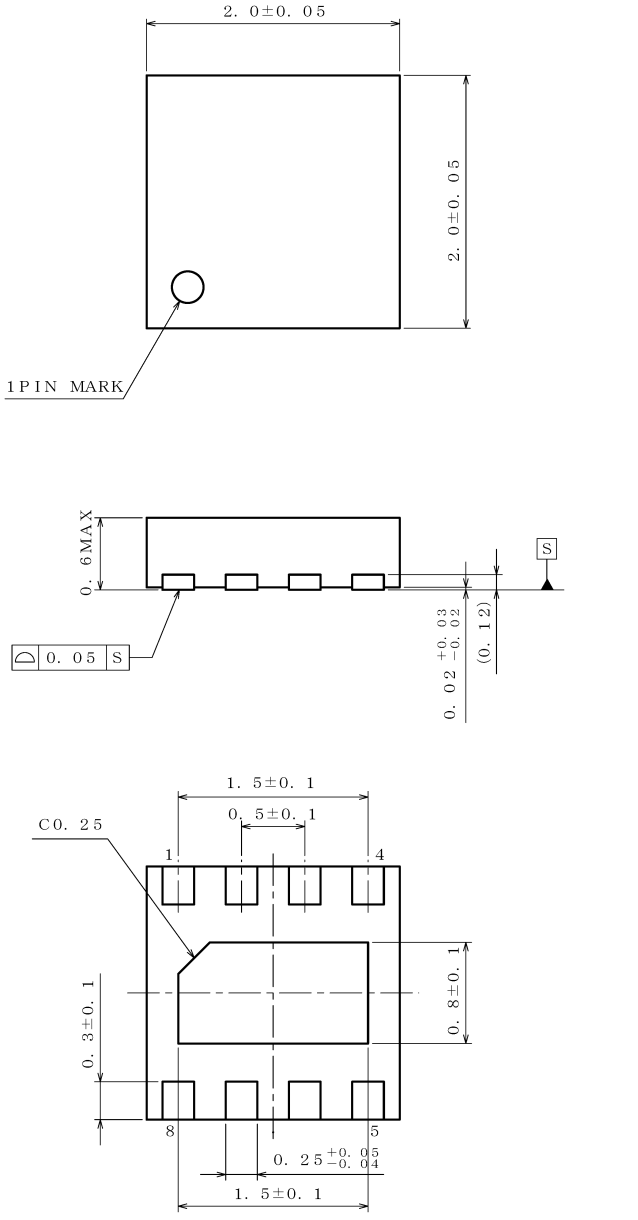
Marking Diagram



Part Number Marking	Package	Orderable Part Number
D63576	VSON008X2020	BD63576NUX-E2

Physical Dimension and Packing Information

Package Name	VSON008X2020

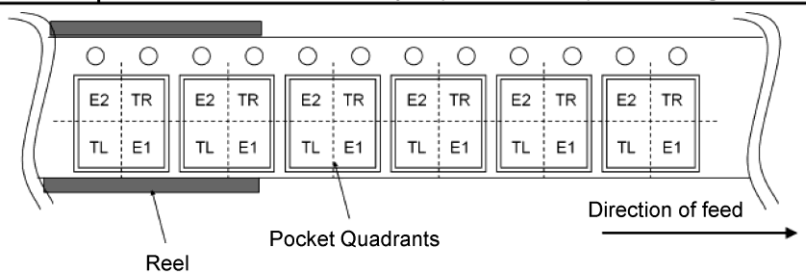


(UNIT : mm)

PKG : VSON008X2020
Drawing No. EX178−5001

< Tape and Reel Information >

Tape	Embossed carrier tape
Quantity	4000pcs
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



Revision History

Date	Revision	Changes
14.Mar.2017	001	New Release
22.Jan.2018	002	P.14 Update Physical Dimension, Tape and Reel Information.

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

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

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