

MONOLITHIC 4-CHANNEL H BRIDGE + LOW-SIDE SWITCH

DESCRIPTION

The μ PD168001 is a monolithic 4-channel H bridge driver and low-side switch IC that uses a power MOSFET at the output stage. Because of the MOSFET at the output stage, both the inputs and outputs are interfaced by PWM digital signals, and the power consumption can therefore be lowered. A 30-pin thin shrink SOP is employed as the package to help to create a small and thin set.

FEATURES

- Four H bridge circuits using power MOSFET and low-side switch
- Low on-resistance
 - 4-ch H bridge: 2 Ω MAX. (sum of upper and lower stages)
 - Low-side switch: 2 Ω MAX.
- High-speed PWM drive: Operating frequency up to 120 kHz
- Thin 30-pin shrink SOP (7.62 mm (300) with 0.65 mm pitch)

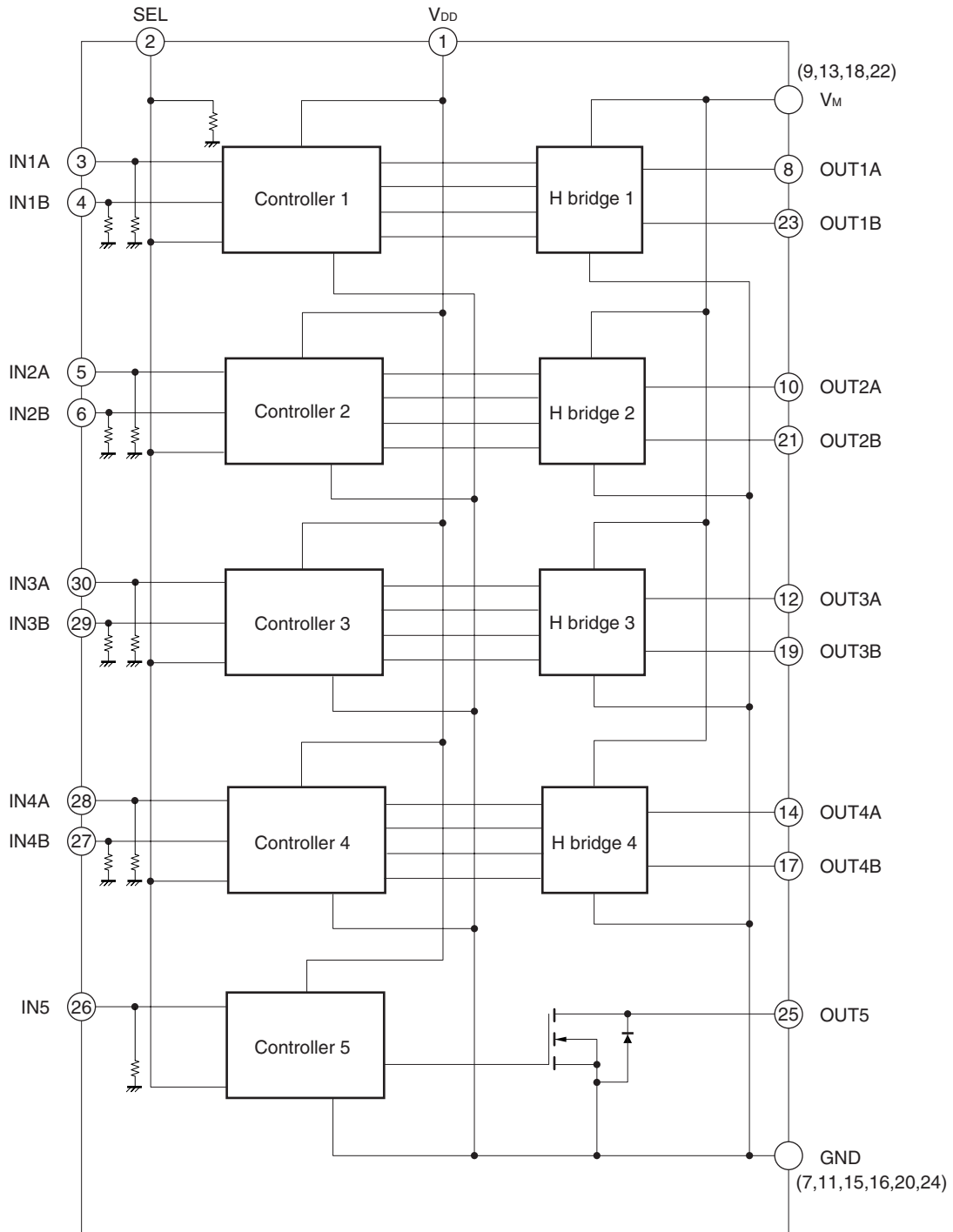
ORDERING INFORMATION

Part Number	Package
μ PD168001MC-6A4-A	30-pin plastic TSSOP (7.62 mm (300))

The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.

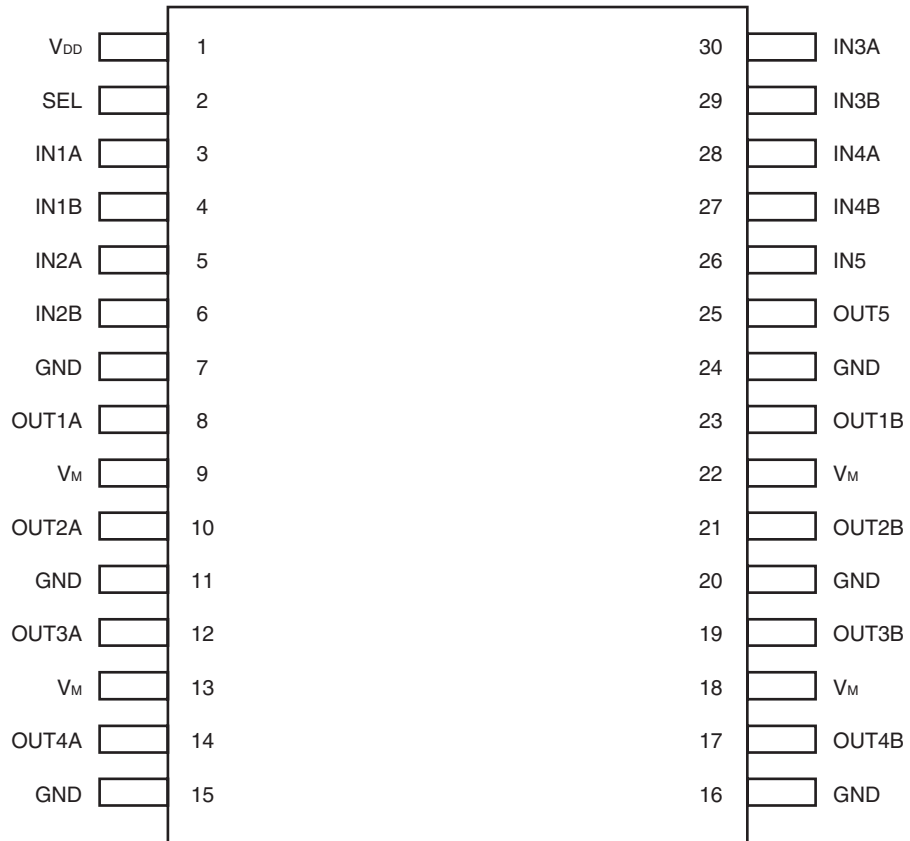
Not all products and/or types are available in every country. Please check with an NEC Electronics sales representative for availability and additional information.

BLOCK DIAGRAM



PIN CONFIGURATION

Package: 30-pin TSSOP (7.62 mm with 0.65 mm pitch)



PIN FUNCTION

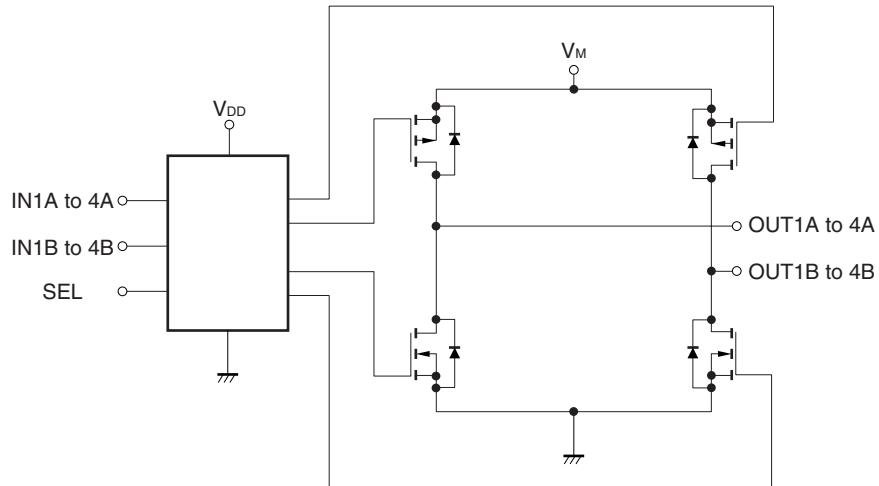
Pin No.	Pin Name	Pin Function
1	V _{DD}	Logic power supply
2	SEL	Control pin
3	IN1A	Channel 1 input pin A
4	IN1B	Channel 1 input pin B
5	IN2A	Channel 2 input pin A
6	IN2B	Channel 2 input pin B
7	GND	GND pin
8	OUT1A	Channel 1 output pin A
9	V _M	Motor power supply pin
10	OUT2A	Channel 2 output pin A
11	GND	GND pin
12	OUT3A	Channel 3 output pin A
13	V _M	Motor power supply pin
14	OUT4A	Channel 4 output pin A
15	GND	GND pin
16	GND	GND pin
17	OUT4B	Channel 4 output pin B
18	V _M	Motor power supply pin
19	OUT3B	Channel 3 output pin B
20	GND	GND pin
21	OUT2B	Channel 2 output pin B
22	V _M	Motor power supply pin
23	OUT1B	Channel 1 output pin B
24	GND	GND pin
25	OUT5	Channel 5 output pin
26	IN5	Channel 5 input pin
27	IN4B	Channel 4 input pin B
28	IN4A	Channel 4 input pin A
29	IN3B	Channel 3 input pin B
30	IN3A	Channel 3 input pin A

FUNCTION SPECIFICATIONS

(1) Revolution control

A high-level/low-level binary signal is input to the H bridge driver block incorporating 4 outputs.

The truth table of the input logic is shown below.

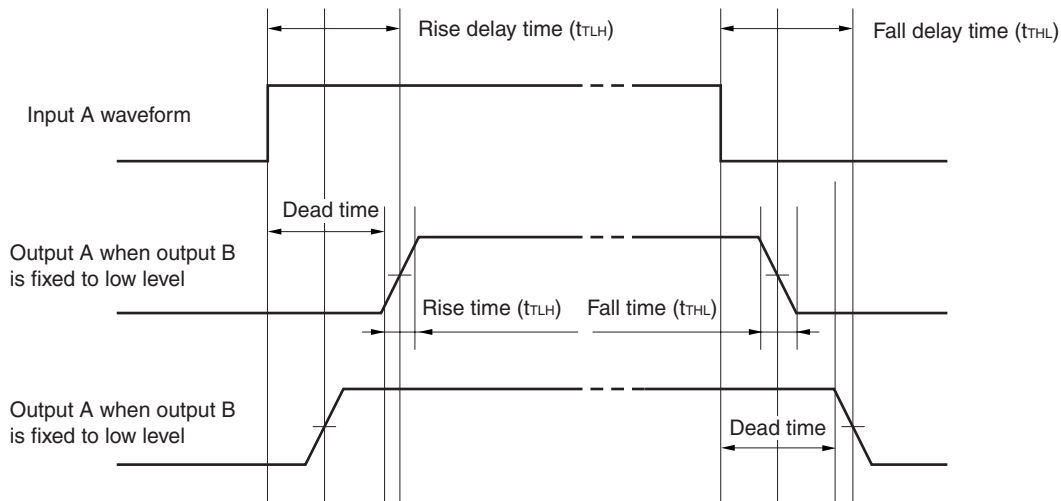
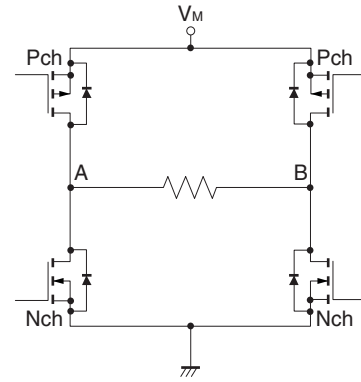


Function Table (Common to All Channels)				
Input			Output	
IN1A to IN4A	IN1B to IN4B	SEL	1A to 4A	1B to 4B
L	L	H	L	L
H	L	H	H	L
L	H	H	L	H
H	H	H	H	H
-	-	L	Hi-Z	Hi-Z

(2) Switching of H bridges

When output A is switched in the figure shown on the right, a dead time (time for which both Pch and Nch are OFF) elapses to prevent through current. Consequently, the waveform of output A (rise time, fall time, and delay time) changes depending on whether output B is fixed to the high or low level.

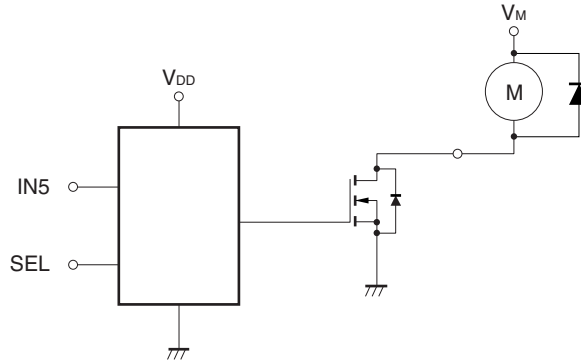
The figure below shows the voltage waveform of output B in response to an input waveform when output B is fixed to the low level and the high level.



- When output B is fixed to low level
Output A goes into a high-impedance state and is undefined during the dead time period, but a low level is output to output A because output B is pulled down by the load
- When output B is fixed to high level
Output A goes into a high-impedance state and is undefined during the dead time period, but a high level is output to output A because output B is pulled up by the load.

(3) Low-side switch

The low-side switch of ch 5 has an output stage configured of an N-ch MOSFET. Its input is a high-level/low-level binary signal. The truth table of the input logic is shown below.



Function Table (Channel 5)		
Input		Output
IN5	SEL	OUT5
L	H	Hi-Z (output off)
H	H	L (output on)
-	L	Hi-Z (output off)

(4) Power sequence

This IC has logic power supply (V_{DD}) and output power supply (V_M) pins. The power sequence of these pins must be as follows.

Turn on V_M with V_{DD} turned on to turn on power.

To turn off power, turn off V_M with V_{DD} turned on, and then turn off V_{DD} .

(However, V_{DD} and V_M can be turned off at the same time.)

Cautions 1. Because this IC switches a high current at high speeds, surge may be generated by V_M , GND wiring, and inductance, degrading the IC.

On the PWB, widen and shorten the pattern width of the GND lines as much as possible, and locate bypass capacitors between V_M and GND as close to the IC as possible. Connect two capacitors in parallel: a magnetic capacitor with a low inductance (4700 pF or more) and an electrolytic capacitor of 10 μF or more, depending on the load current.

2. When a load such as a DC motor is connected to ch 5 and the switch is turned OFF, a counter electromotive force is generated. If the absolute maximum rating of the output pin voltage may be exceeded by the voltage applied to the load, be sure to connect a Schottky barrier diode to both the ends of the load to prevent the rating of the output pin voltage from being exceeded.

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C)

Parameter	Symbol	Conditions	Rating	Unit
Power supply voltage	V _{DD}	Control block	-0.5 to +6.0	V
	V _M	Motor block	-0.5 to +6.0	V
Input voltage	V _{IN}		-0.5 to V _{DD} +0.5	V
Output pin voltage	V _{OUT}		6.0	V
DC output current	I _{DD}	DC	±0.3	A/ch
Instantaneous output current ^{Note 1}	I _{DP}	When two or more channels are turned ON at the same time PW ≤ 50 ms, Duty ≤ 5%	±1.0	A/ch
Power consumption ^{Note 2}	P _T		1.0	W
Peak junction temperature	T _{CH(MAX)}		150	°C
Storage temperature	T _{stg}		-55 to 150	°C

- Notes**
1. DUTY indicates the period during which a current flows, exceeding I_{DD} for the entire sequence
 2. When mounted on a glass epoxy board (100 mm × 100 mm × 1 mm, with a copper foil area of 15%)

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Power supply voltage	V _{DD}	Control block	3.0	3.3	3.6	V
	V _{MACT}	Motor block	4.5	5.0	5.5	V
Input voltage	V _{IN}		0		V _{DD}	V
DC output current	I _{DD}	DC			±0.2	A/ch
Instantaneous output current	I _{DP}	When two or more channels are turned ON at the same time PW ≤ 50 ms, Duty ≤ 5%			±0.85	A/ch
Operating frequency	f _{IN}				120	kHz
Operating temperature range	T _A		0		75	°C

ELECTRICAL CHARACTERISTICS

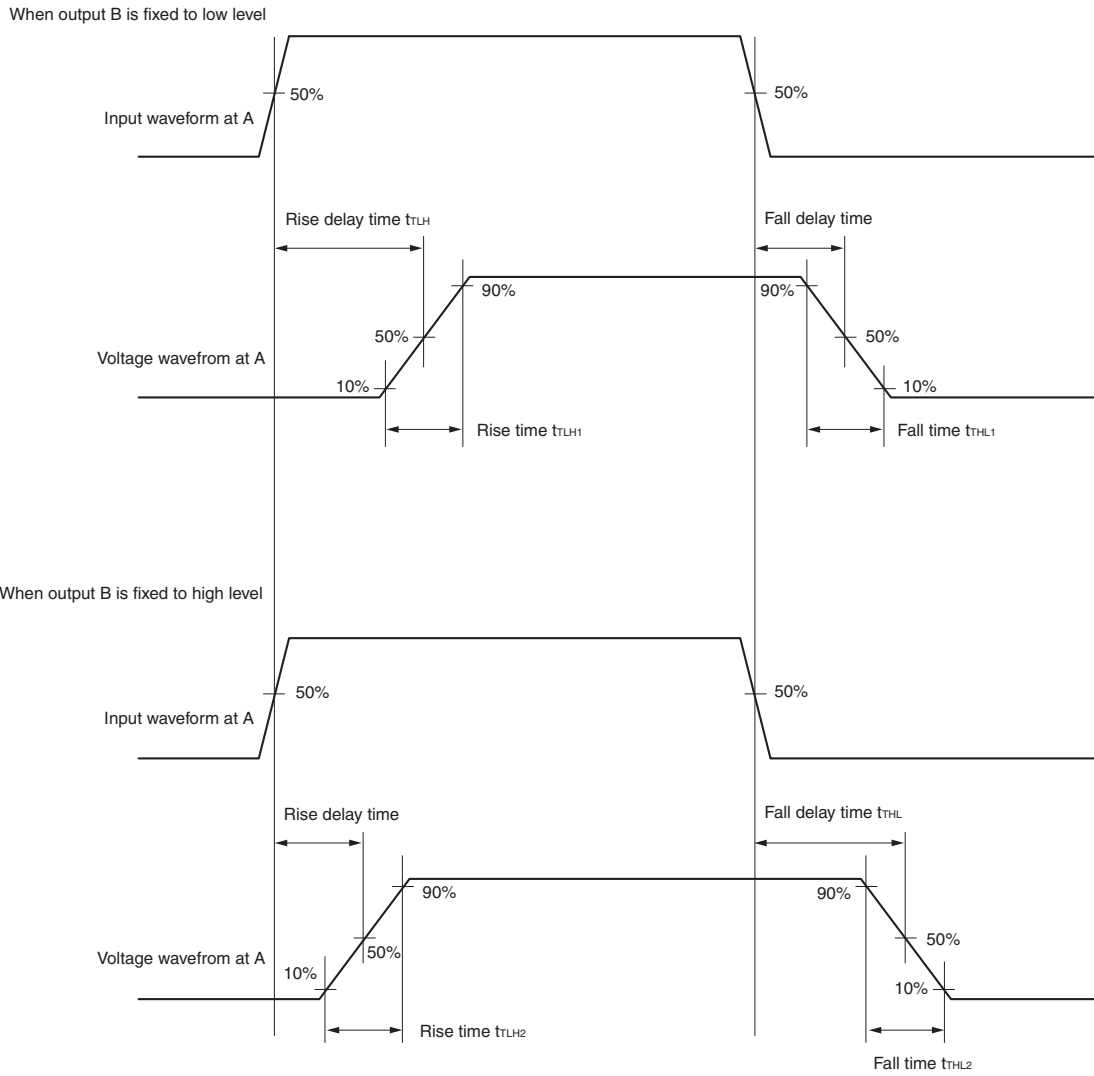
(UNLESS OTHERWISE SPECIFIED, $V_{DD} = 3.3\text{ V}$, $V_M = 5\text{ V}$, $T_A = 25^\circ\text{C}$)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit		
1. DC characteristics								
V_M pin current	I_M	SEL = L			10	μA		
V_{DD} pin current	$I_{DZ(OFF)}$	SEL = L			10	μA		
Input pull-down resistance	R_{IN}	IN and SEL pins	50		200	kΩ		
High-level input voltage	V_{IH}	IN and SEL pins	$0.7 \times V_{DD}$		V_{DD}	V		
Low-level input voltage	V_{IL}	IN and SEL pins	-0.3		$0.3 \times V_{DD}$	V		
High-level input current	I_{IH}	$V_{IN} = V_{DD}$			80	μA		
Low-level input current	I_{IL}	$V_{IN} = 0\text{ V}$	-2.0			μA		
On-resistance (ch1 to 4, sum of upper and lower stages)	R_{ON}	$I_D = 0.2\text{ A}$			2.0	Ω		
On-resistance (ch 5)	R_{ON}	$I_D = 0.2\text{ A}$			2.0	Ω		
Switching current with no load on H bridge ^{Note}	$I_{S(AVE)}$	Input frequency: 100 kHz			4.5	mA		
2. AC characteristics								
1 to 4ch	With output of one side fixed to low	Rise delay time	t_{TLH}	Load: 20 Ω Input frequency: 1 kHz	150	400	800	ns
		Rise time	t_{TLH1}		35	250	500	
		Fall time	t_{THL1}		35	75	150	
	With output of one side fixed to high	Fall delay time	t_{THL}		150	500	800	
		Rise time	t_{THL2}		35	75	150	
		Fall time	t_{THL2}		35	300	600	
5ch	Rise time		t_{TLH3}		100	200		
	Fall time		t_{THL3}		50	100		

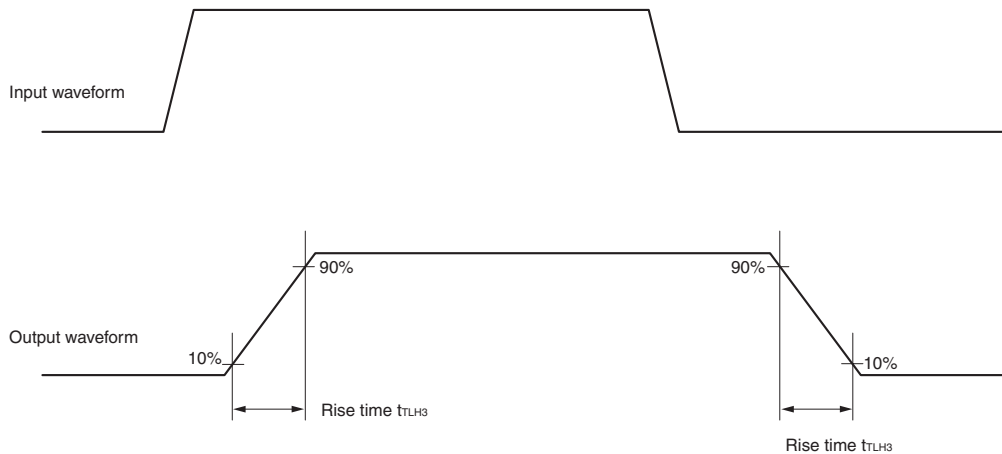
Note Average value of current consumed inside the H bridge when the switching operation is performed without a load.

TIMING CHARTS

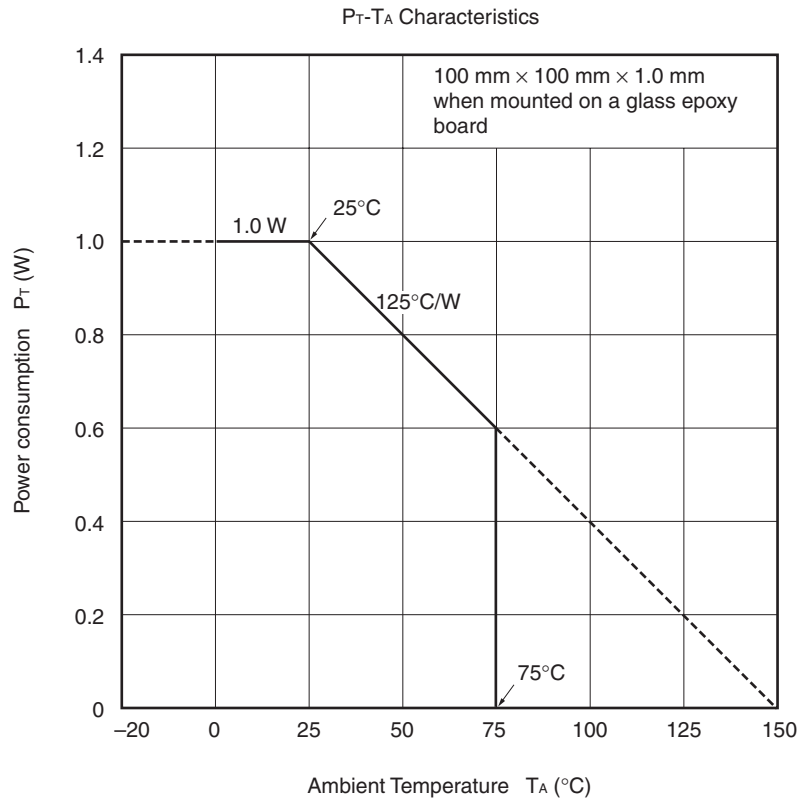
• Channel 1 to Channel 4



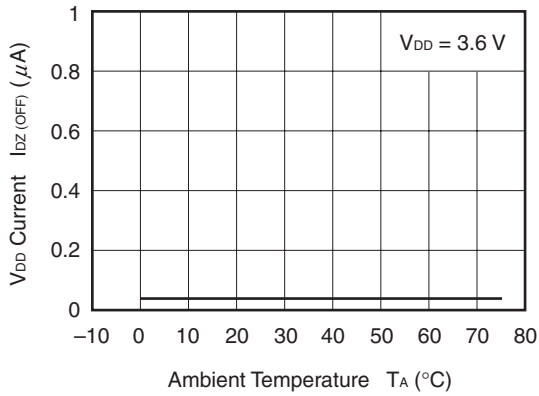
• Channel 5



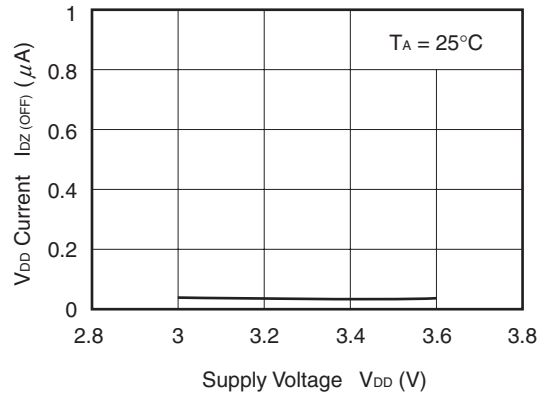
POWER CONSUMPTION CHARACTERISTICS



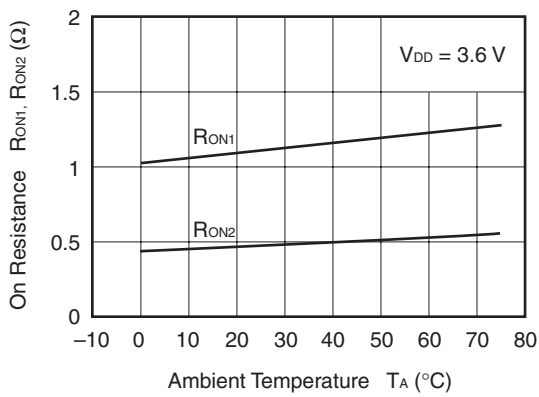
Idz (OFF) -TA Characteristics



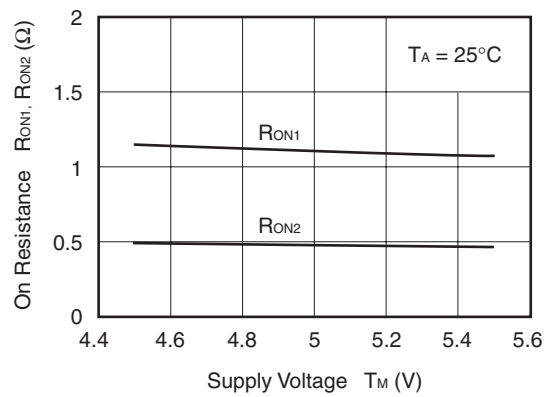
Idz (OFF) -VDD Characteristics



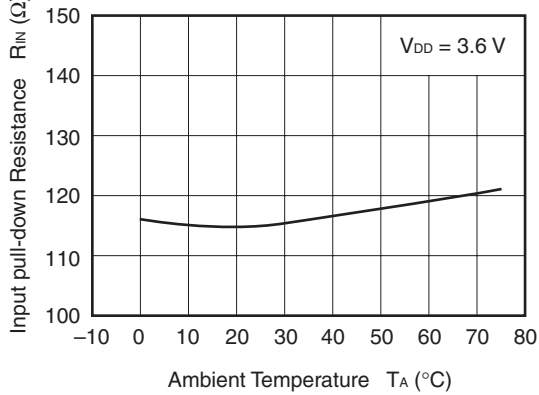
RON1, RON2 Characteristics



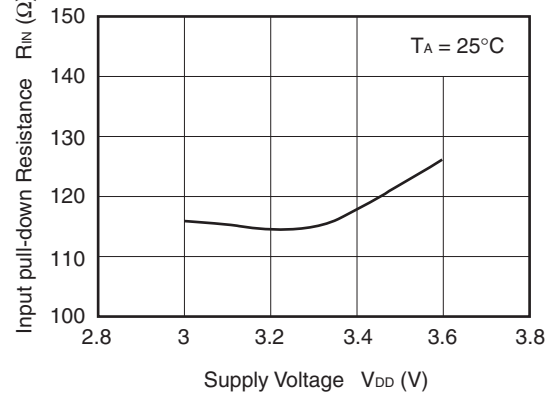
RON1, RON2-VM Characteristics

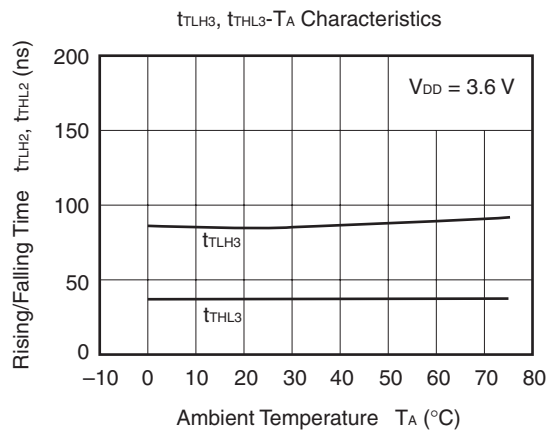
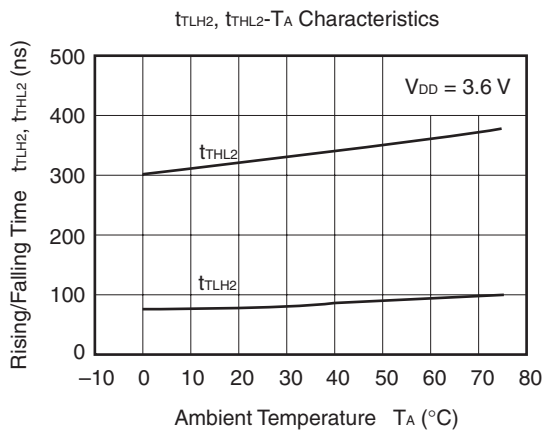
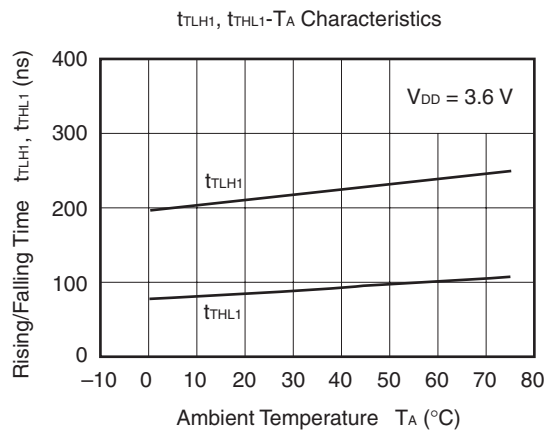
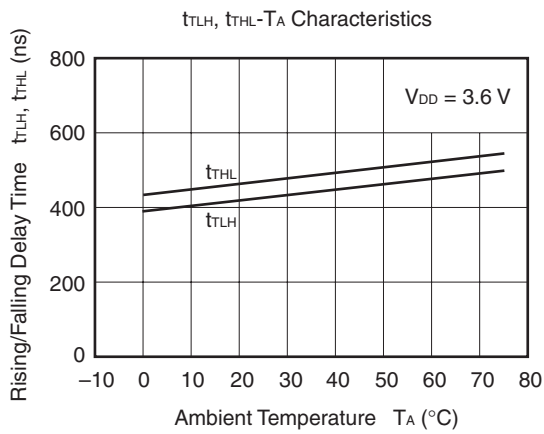
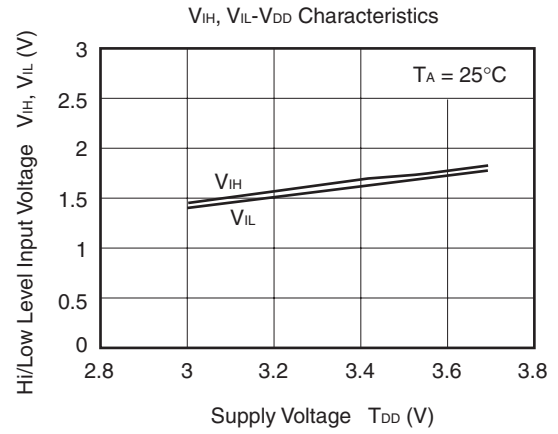
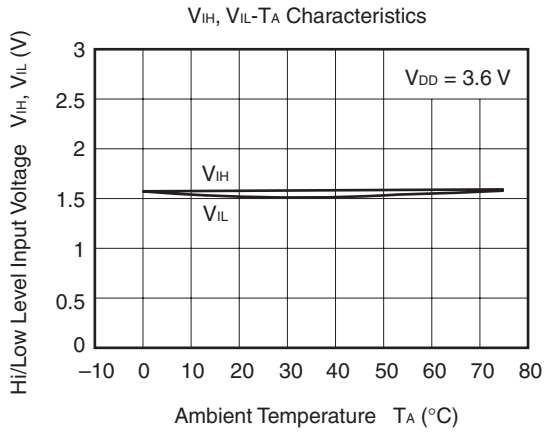


RIN-TA Characteristics



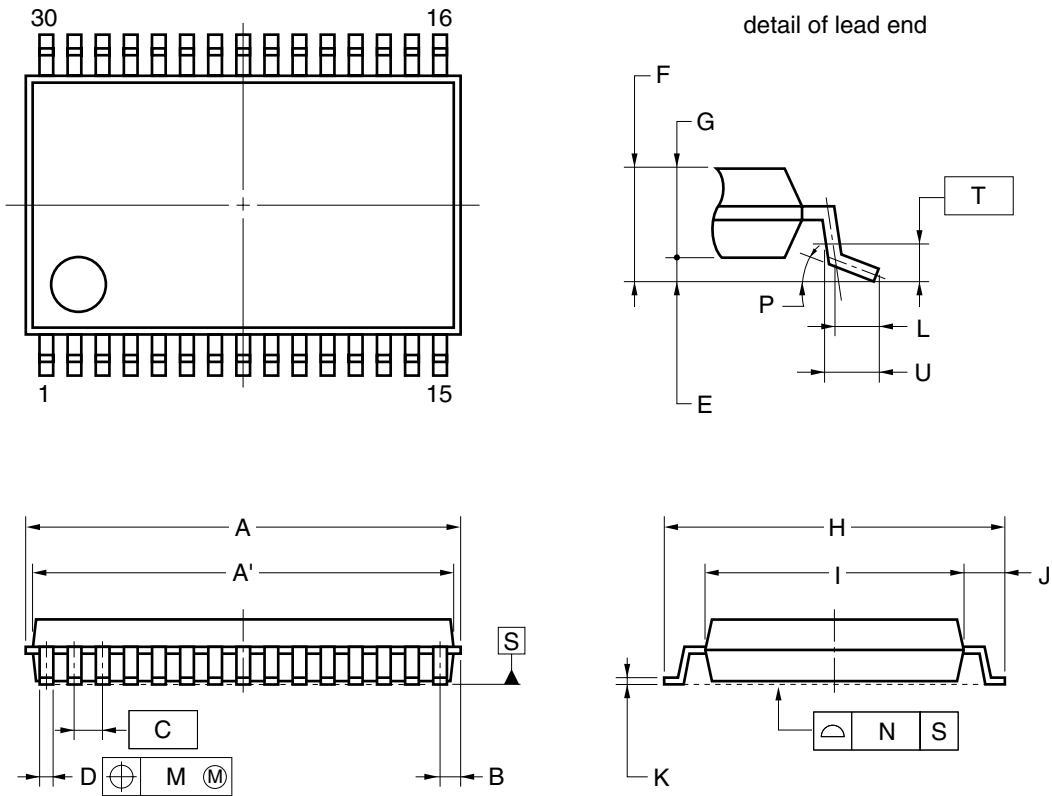
RIN-VDD Characteristics





PACKAGE DRAWING

30-PIN PLASTIC TSSOP (7.62mm(300))



NOTE

Each lead centerline is located within 0.10 mm of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS
A	9.85±0.10
A'	9.7±0.1
B	0.375
C	0.65 (T.P.)
D	0.24±0.05
E	0.1±0.05
F	1.2 MAX.
G	1.0±0.05
H	8.1±0.1
I	6.1±0.1
J	1.0±0.1
K	0.145±0.025
L	0.5
M	0.10
N	0.10
P	3° ^{+5°} _{-3°}
T	0.25
U	0.6±0.15

S30MC-65-6A4

RECOMMENDED SOLDERING CONDITIONS

The μPD168001 should be soldered and mounted under the following recommended conditions.

For soldering methods and conditions other than those recommended below, contact an NEC Electronics sales representative.

For technical information, see the following website.

Semiconductor Device Mount Manual (<http://www.necel.com/pkg/en/mount/index.html>)

μPD168001MC-6A4-A 30pin plastic TSSOP (7.62mm (300))

Soldering Method	Soldering Conditions	Recommended Condition Symbol
Infrared reflow	Package peak temperature: 260°C, Time: 60 seconds max. (at 220°C or higher), Count: Three times or less, Exposure limit: None, Flux: Rosin flux with low chlorine (0.2 Wt% or below) recommended	IR60-00-3

Caution Do not use different soldering methods together (except for partial heating).

[MEMO]

[MEMO]

[MEMO]

NOTES FOR CMOS DEVICES

① PRECAUTION AGAINST ESD FOR SEMICONDUCTORS

Note:

Strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it once, when it has occurred. Environmental control must be adequate. When it is dry, humidifier should be used. It is recommended to avoid using insulators that easily build static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work bench and floor should be grounded. The operator should be grounded using wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with semiconductor devices on it.

② HANDLING OF UNUSED INPUT PINS FOR CMOS

Note:

No connection for CMOS device inputs can be cause of malfunction. If no connection is provided to the input pins, it is possible that an internal input level may be generated due to noise, etc., hence causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using a pull-up or pull-down circuitry. Each unused pin should be connected to V_{DD} or GND with a resistor, if it is considered to have a possibility of being an output pin. All handling related to the unused pins must be judged device by device and related specifications governing the devices.

③ STATUS BEFORE INITIALIZATION OF MOS DEVICES

Note:

Power-on does not necessarily define initial status of MOS device. Production process of MOS does not define the initial operation status of the device. Immediately after the power source is turned ON, the devices with reset function have not yet been initialized. Hence, power-on does not guarantee out-pin levels, I/O settings or contents of registers. Device is not initialized until the reset signal is received. Reset operation must be executed immediately after power-on for devices having reset function.

- **The information in this document is current as of March, 2003. The information is subject to change without notice. For actual design-in, refer to the latest publications of NEC Electronics data sheets or data books, etc., for the most up-to-date specifications of NEC Electronics products. Not all products and/or types are available in every country. Please check with an NEC Electronics sales representative for availability and additional information.**
- No part of this document may be copied or reproduced in any form or by any means without the prior written consent of NEC Electronics. NEC Electronics assumes no responsibility for any errors that may appear in this document.
- NEC Electronics does not assume any liability for infringement of patents, copyrights or other intellectual property rights of third parties by or arising from the use of NEC Electronics products listed in this document or any other liability arising from the use of such products. No license, express, implied or otherwise, is granted under any patents, copyrights or other intellectual property rights of NEC Electronics or others.
- Descriptions of circuits, software and other related information in this document are provided for illustrative purposes in semiconductor product operation and application examples. The incorporation of these circuits, software and information in the design of a customer's equipment shall be done under the full responsibility of the customer. NEC Electronics assumes no responsibility for any losses incurred by customers or third parties arising from the use of these circuits, software and information.
- While NEC Electronics endeavors to enhance the quality, reliability and safety of NEC Electronics products, customers agree and acknowledge that the possibility of defects thereof cannot be eliminated entirely. To minimize risks of damage to property or injury (including death) to persons arising from defects in NEC Electronics products, customers must incorporate sufficient safety measures in their design, such as redundancy, fire-containment and anti-failure features.
- NEC Electronics products are classified into the following three quality grades: "Standard", "Special" and "Specific".

The "Specific" quality grade applies only to NEC Electronics products developed based on a customer-designated "quality assurance program" for a specific application. The recommended applications of an NEC Electronics product depend on its quality grade, as indicated below. Customers must check the quality grade of each NEC Electronics product before using it in a particular application.

"Standard": Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots.

"Special": Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support).

"Specific": Aircraft, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems and medical equipment for life support, etc.

The quality grade of NEC Electronics products is "Standard" unless otherwise expressly specified in NEC Electronics data sheets or data books, etc. If customers wish to use NEC Electronics products in applications not intended by NEC Electronics, they must contact an NEC Electronics sales representative in advance to determine NEC Electronics' willingness to support a given application.

(Note)

- (1) "NEC Electronics" as used in this statement means NEC Electronics Corporation and also includes its majority-owned subsidiaries.
- (2) "NEC Electronics products" means any product developed or manufactured by or for NEC Electronics (as defined above).