Driver IC for single phase Brushless Motor

KA44169AB
Datasheet

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■ IMPORTANT NOTICE

Regarding the specifications of this product, it is considered that you have agreed to the quality level and disclaimer described below.

Support for industry standards and quality standards

Functional safety standards for automobiles ISO26262	**No**
AEC-Q100	**No**
Market failure rate	**50Fit**

Disclaimer

1. When the application system is designed using this IC, please design the system at your own risk. Please read, consider, and apply appropriate usage notes and description in this standard.

2. When designing your application system, please take into the consideration of break down and failure mode occurrence and possibility in semiconductor products. Measures on the systems such as, but not limited to, redundant design, mitigating the spread of fire, or preventing glitch, are recommended in order to prevent physical injury, fire, social damages, etc. in using the Nuvoton Technology Japan Corporation (hereinafter referred to as NTCJ) products.

3. When using this IC, for each actual application systems, verify the systems and the all functionality of this IC as intended in application systems and the safety including the long-term reliability at your own risk

4. Please use this IC in compliance with all applicable laws, regulations and safety-related requirements that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. NTCJ shall not be held responsible for any damage incurred as a result of this IC being used not in compliance with the applicable laws, regulations and safety-related requirements.

5. This IC does not have any security functions using cryptographic algorithms, such as authentication, encryption, tampering detection.

6. Unless this IC is indicated by NTCJ to be used in applications as meeting the requirements of a particular industry standard (e.g., ISO 9001, IATF 16949, ISO 26262, etc.), this IC is neither designed nor intended for use in such environments for that applications. NTCJ shall not be held responsible for not meeting the requirements of a particular industry standard.

7. Using IC that have been indicated as compliant with industry functional safety standards does not warrant that the application meets the requirements of industry functional safety standards. NTCJ shall not be held responsible for the application compliance with requirements of the particular industry functional safety standard.

8. Unless this IC is indicated by NTCJ to be used in applications as meeting the requirements of a particular quality standard (e.g., AECQ-100, etc.), this IC is neither designed nor intended for use in such the environments for that applications. NTCJ shall not be held responsible for not meeting the requirements of a particular quality standard.

9. In case of damages, costs, losses, and/or liabilities incurred by NTCJ arising from customer's non-compliance with above from 1 to 8, customer will indemnify NTCJ against every damages, costs, losses and responsibility.

FEATURES

- Supply voltage range: 5.6 V ~ 28 V
- Auto phase shift correction with built-in Soft Switching function
- Wide range operation (12V/24V)
- Speed Control by DC voltage input
- Motor lock protection and built-in Auto-recovery
  Adjustable by a external capacitor
- Output pin for FG pulse (open drain)
- Driving mode at Start-up can be selected
- Various protection functions:
  Under Voltage Lock Out (UVLO), Thermal protection
  GND short protection, and Over Current Protection
- Package
  TSSOP 14L (4.4x5.0x0.9mm3, Lead Pitch 0.65mm)

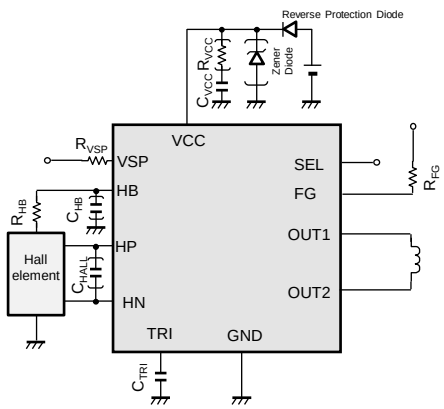
DESCRIPTION

- KA44169AB is a high efficiency single phase motor driver IC with built-in Soft Switching function for low noise operation. The soft switching period is automatically adjusted based on the motor current. This eliminates the need for individual adjustment of the soft switching period based on the Motor's specifications.
- With a wide input voltage range of 12V/24V, this IC is most suitable for usage in OA and FA equipment.

APPLICATIONS

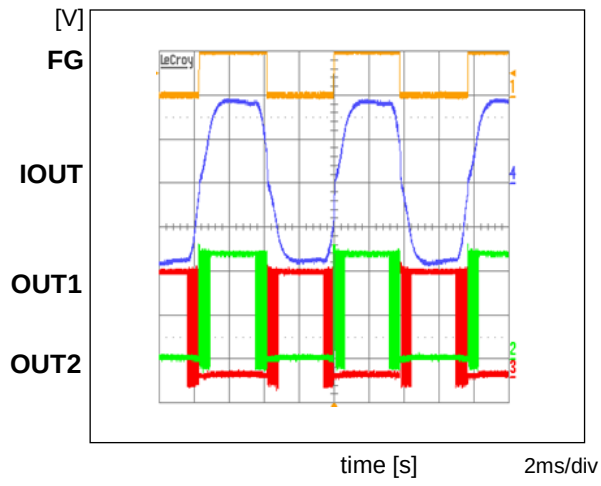
- Refrigerator, Projector, Printer, Factory automation

TYPICAL APPLICATION



Notes: The application circuit is an example. The operation of the mass production set is not guaranteed. Sufficient evaluation and verification is required in the design of the mass production set. The Customer is fully responsible for the incorporation of the above illustrated application circuit in the design of the equipment.

TYPICAL CHARACTERISTICS



Condition:
V_{CC} = 12 V, VSP = 100% duty , Cvcc = 1 μF

CONTENTS

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit	Notes
Supply voltage	V_{CC}	–0.3 ~ +36	V	*1
Operating ambient temperature	T_{opr}	–40 ~ +105	°C	*2
Junction temperature	T_j	–40 ~ +150	°C	*2
Storage temperature	T_{stg}	–55 ~ +150	°C	*2
Input Voltage Range	V_{TRI}, V_{HP}, V_{HN}, V_{SEL}	–0.3 ~ +6	V	—
	V_{VSP}	–0.3 ~ +6	V	—
Output Voltage Range	V_{OUT1}, V_{OUT2},	+36	V	*1*3
	V_{FG}	–0.3 ~ +36	V	—
	V_{HB}	–0.3 ~ +6	V	*3
Output Current Range	$I_{OUT1peak}$, $I_{OUT2peak}$	–1.4 ~ +1.4	A	*5
	I_{OUT1}, I_{OUT2}	–0.8 ~ +0.8	A	*6
	I_{FG}	–5 ~ +10	mA	—
	I_{HB}	–10 ~ 0	mA	*4
ESD	HBM	2	kV	—
	MM	200	V	—

Notes: This product may sustain permanent damage if subjected to conditions higher than the above stated absolute maximum rating. This rating is the maximum rating and device operating at this range is not guaranteed as it is higher than our stated recommended operating range. When subjected under the absolute maximum rating for a long time, the reliability of the product may be affected.

*1: The values under the condition not exceeding the above absolute maximum ratings and the power dissipation.
*2: Except for the power dissipation, operating ambient temperature, and storage temperature, all ratings are for Ta = 25℃.
*3: Applying external voltage into these pins is prohibited. Do not exceed the stated ratings even in transient state.
*4: Applying external current into these pins is prohibited. Do not exceed the stated ratings even in transient state.
*5: For VCC≧6 V, output current of ±1.4A is only allowed within 1s.
*6: Applying external current into these pins is prohibited, the maximum value in the case of satisfying the rated power consumption and other rating items. However, I except the * 1 conditions.

POWER DISSIPATION RATING

Package	θ_{j-a}	P_D (T_a=25 °C)	P_D (T_a=105°C)
TSSOP 14L (4.4x5.0x0.9mm3, Lead Pitch 0.65mm)	157.7°C/W	792.8mW	285.3mW

Notes: For the actual usage, follow the power supply voltage, load and ambient temperature conditions to ensure that there is enough margin and the thermal design does not exceed the allowable value.

*1: Glass-Epoxy Substrate (1 Layers) [70 × 70 × 1.6 t](mm)

CAUTION

Although this IC has built-in ESD protection circuit, it may still sustain permanent damage if not handled properly. Therefore, proper ESD precautions are recommended to avoid electrostatic damage to the MOS gates.

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Supply voltage range	V_{CC}	5.6	—	28	V	*1
Input voltage range	V_{HP}	0	—	1.5	V	*2
	V_{HN}	0	—	1.5	V	*2
	V_{VSP}	0	—	3	V	*2
External constants	C_{VCC}	—	1	—	µF	*3
	C_{TRI}	—	220	—	pF	*3

Notes *1: It is a value under the conditions which do not exceed the absolute maximum rating and the power dissipation.
*2: For setting range of input control voltage, refer to Electrical Characteristics and Operation.
*3: Operation of mass production set is not guaranteed. Perform enough evaluation and verification on the design of mass production set. If the VCC pin voltage is raised by the regenerative current, at the time of start-up or stop operating Please connect a zener diode between VCC – GND pin.

ELECTRICAL CHARACTERISTICS

V_{CC} = 12.0 V, 24.0 V

Note: T_a = 25°C ± 2°C unless otherwise noted.

Parameter	Symbol	Condition	Limits			Unit	Note
			Min	Typ	Max		
Circuit Current							
V_{CC} current 1	I_{CC1}	Output OPEN, Lock State	—	1.5	3	mA	—
V_{CC} current 2	I_{CC2}	Output OPEN, 50% duty	—	2.0	4	mA	—
FG Block							
Low-level output voltage	V_{OLFG}	I_O = 5 mA	—	0.1	0.3	V	—
Output leak current	I_{LFG}	Vo=28V	—	—	30	µA	—
Power Block							
On resistance (High Side + Low Side)	R_{ONHL}	I = 200 mA	—	1.6	2.25	Ω	—
Diode forward voltage	V_{DI}	I = 200 mA	0.6	0.8	1	V	—
Hall Block							
Input dynamic range	V_{HA}	—	0	—	1.5	V	—
Pin input current	I_{HA}	—	–2	0	2	µA	—
Minimum input voltage amplitude	V_{HA}	—	25	—	—	mV	—
Hysteresis width	V_{HHYS}	—	—	10	20	mV	—
Hall Bias							
Output Voltage	V_{HB}	Io = -2mA	2.7	3.0	3.3	V	—

ELECTRICAL CHARACTERISTICS (continued)

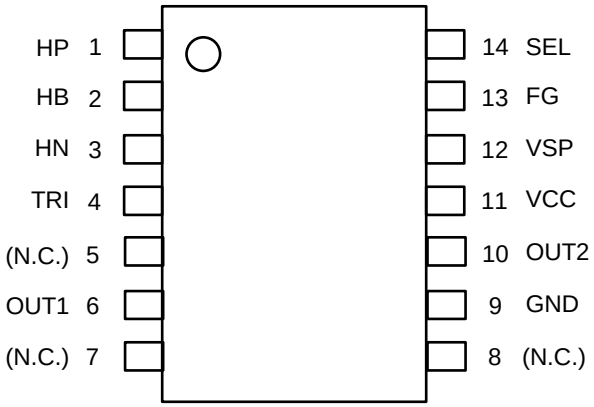
V_{CC} = 12.0 V, 24.0 V

Note: T_a = 25°C ± 2°C unless otherwise noted.

Parameter	Symbol	Condition	Limits			Unit	Note
			Min	Typ	Max		
VSP							
Stop control VSP input	V_{VSPMIN}		0.27	0.31	0.35	V	—
Maximum acceleration VSP input	V_{VSPMAX}		1.70	1.95	2.2	V	—
SEL							
SEL input “L" level voltage	V_{SELL}		—	—	0.4	V	—
SEL input "H" level voltage	V_{SELH}		1.1	—	—	V	—
TRI							
Oscillating frequency	F_{PWM}	C_{TRI} = 220pF	21.0	27.7	35.5	kHz	—
Oscillating frequency range	F_{PWM2}		15	—	50	kHz	*1
Motor Lock Protection							
Lock detection time	t_{LOCK1}	Built-in oscillator	0.41	0.6	0.79	s	*1
Lock release time	t_{LOCK2}	Built-in oscillator	3.3	4.8	6.3	s	*1
Thermal Protection							
Protection operating temperature	TSD_{ON}	—	—	160	—	°C	*1*2
Hysteresis width	TSD_{HYS}	—	—	25	—	°C	*1*2
Under Voltage Lock Out							
Protection operating voltage	V_{LVON}	—	—	3.5	—	V	*1*2
Hysteresis width	V_{LVOHYS}	—	—	0.2	—	V	*1*2
Overcurrent Protection							
Output limit Current	I_{OCL}	Normal operation with Motor	1.0	1.2	1.4	A	—

Notes : *1 : These are values checked by design but not production tested.
*2 : Typical Design Value.

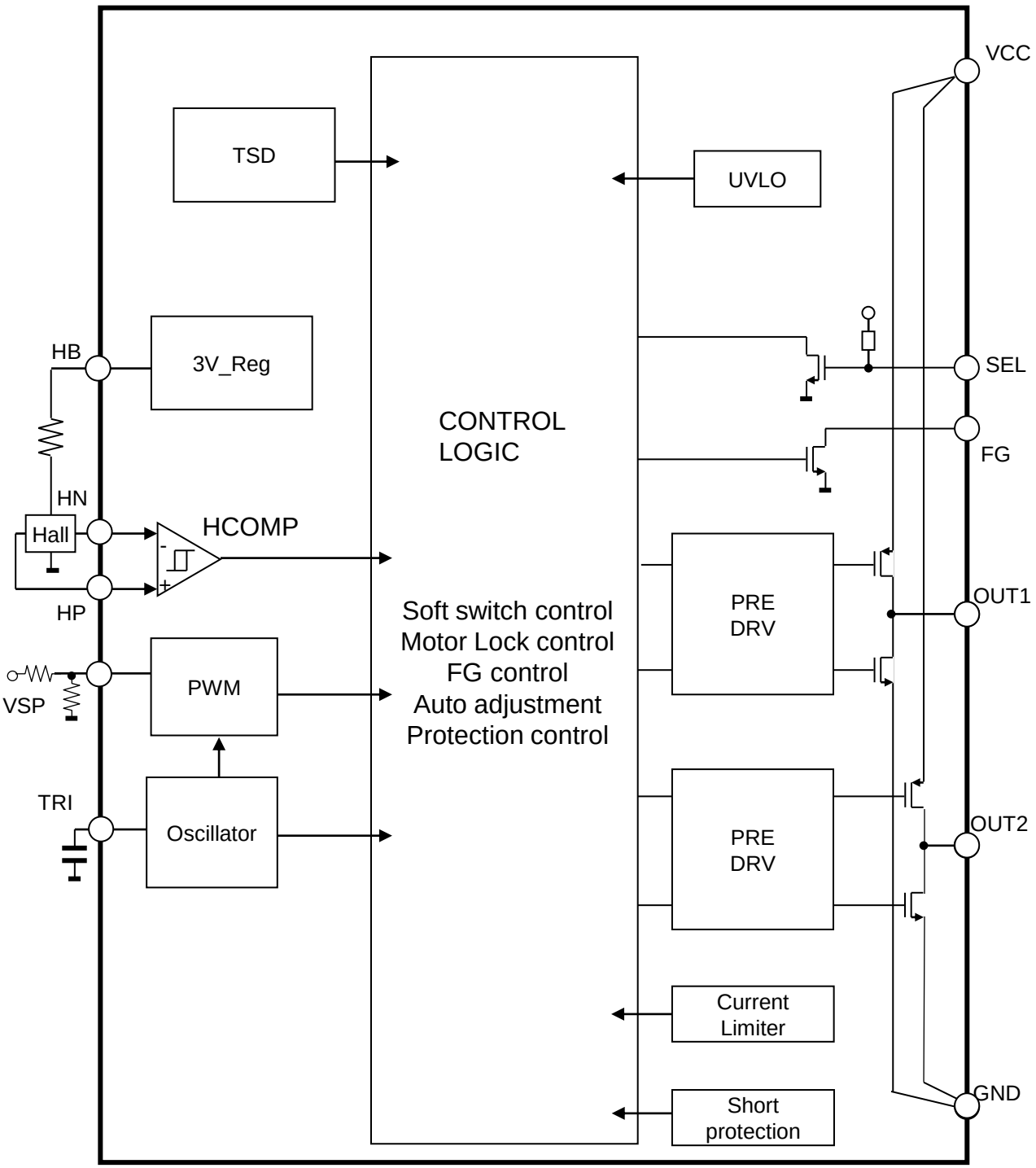
PIN CONFIGURATION



PIN FUNCTIONS

Pin No.	Pin name	Type	Description
1	HP	In	Hall amplifier input (+) pin
2	HB	Out	Hall bias output pin
3	HN	In	Hall amplifier input (-) pin
4	TRI	In/Out	Triangle wave capacitor connection pin for PWM duty & frequency
5	(N.C.)	—	Non connection
6	OUT1	Out	OUT1 : Motor drive output 1 pin
7	(N.C.)	—	Non connection
8	(N.C.)	—	Non connection
9	GND	Ground	Ground pin
10	OUT2	Out	OUT2 : Motor drive output 2 pin
11	VCC	Vcc	Supply voltage pin for the internal circuit
12	VSP	In	Voltage input pin for setting the rotational speed
13	FG	Out	FG external output pin
14	SEL	In	Driving mode selection input pin at Start-up Open(> 1.1V) : startup assist mode (driving at 50% duty) < 0.4V : Without the startup assist mode(driving at the duty which is set by VSP pin voltage.)

BLOCK DIAGRAM



OPERATION

■Protection Function

Note) The characteristics listed below are reference values derived from design of the IC and are not guaranteed.

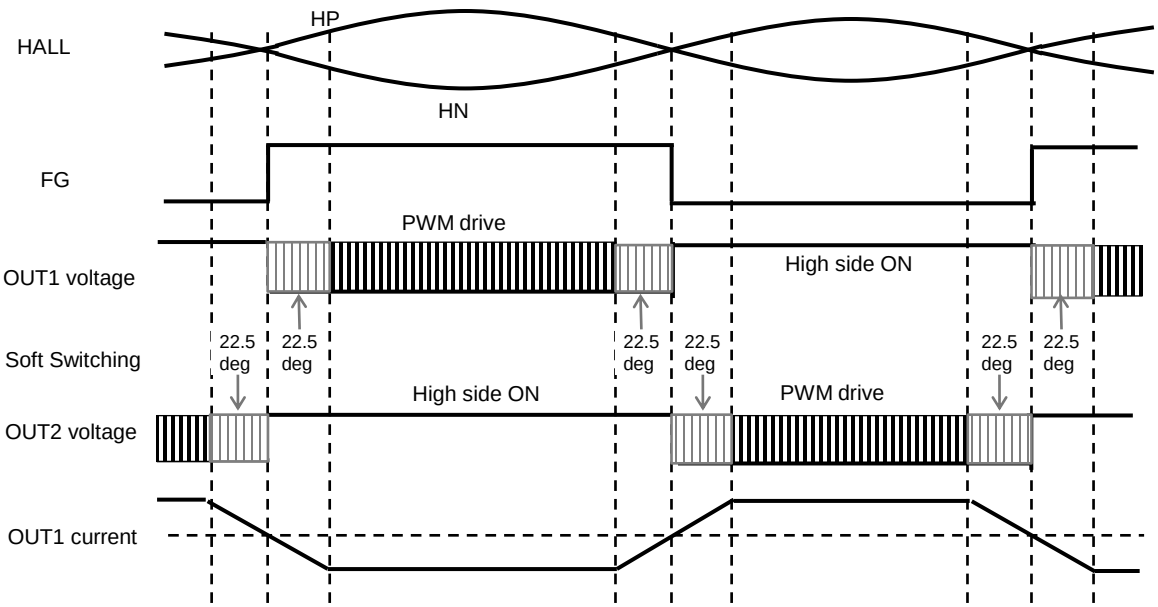
Function name	Operate	Release	Note
TSD	160℃	135℃	Motor energization off while protection function works.
Current limit	1.2A	After fixed time progress	If motor current reaches 1.2A, output current will be restricted in turning off an output for a fixed time. ON time , and OFF time are such as below. ON : 2µsec, OFF : 10.0µsec (in start up period ON:1.5µsec, OFF:40µsec)
UVLO (VCC)	3.5V	3.7V	It is protection of the low-voltage condition of the power supply voltage. Motor energization off while protection function works.
Motor locked protection	When FG pulse does not change within a set time. (latch protection)	・at UVLO ・After fixed time progress ・ at VSP stop control	UVLO and VSP stop control release protection and a count are reset.
Short protection of Motor output - VCC	Current limiting	After fixed time progress	Protection by output current limiting
Short protection of Motor output - GND	latch protection by constant time detection.	・at UVLO	Latch protection is carried out. Release is performed by UVLO.

Note : These are values checked by design but not production tested.

OPERATION (continued)

■ Drive State Diagram

Note) The characteristics listed below are reference values derived from design of the IC and are not guaranteed.



OPERATION (continued)

■ Functional explanation

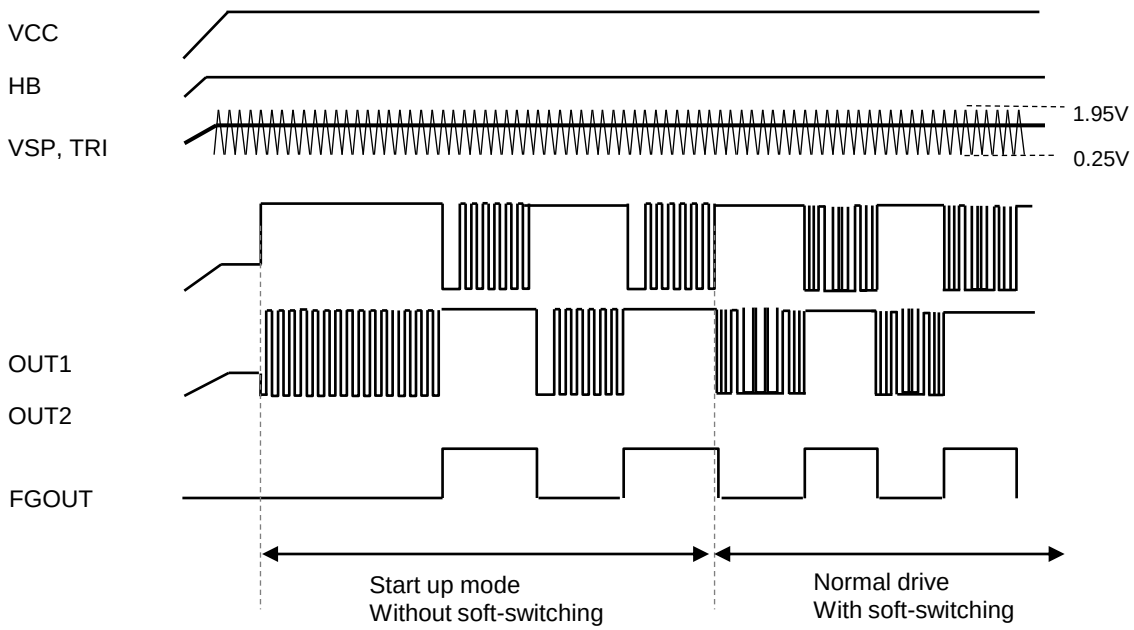
Note) The characteristics listed below are reference values derived from design of the IC and are not guaranteed.

1. Start up, Normal drive

After applying the VCC of power supply within the operation limits, IC becomes startup mode.
By the input voltage level of SEL pin, you can select the driving mode at startup.

SEL = High : Fixed 50% duty
SEL = Low : Driving at the duty which is set by VSP pin voltage

During normal driving, it is driven by PWM output with the duty set by VSP and the frequency set by TRI.



OPERATION (continued)

■ Functional explanation (continued)

Note) The characteristics listed below are reference values derived from design of the IC and are not guaranteed.

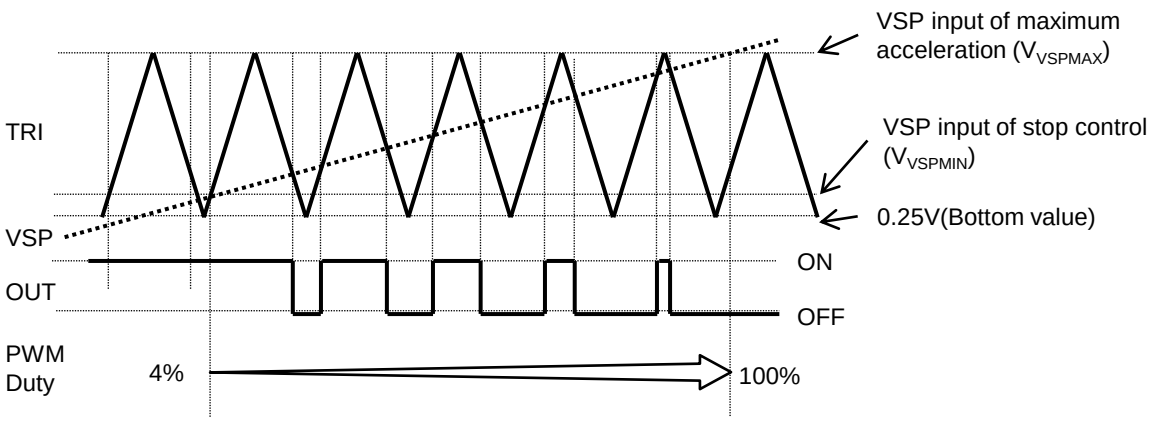
2. VSP Pin and TRI Pin (Speed control)

The motor speed can be controlled by the PWM duty in response to the input voltage of VSP pin.
PWM driving frequency is equal to the frequency of triangle waveform which is set by TRI pin, and PWM duty is set by comparing TRI triangular waveform and VSP terminal voltage.
Each formula can be calculated by the following formula.

$$\text{Duty} = \frac{\text{“VSP pin voltage”} - \text{“TRI bottom value(0.25V)”}}{\text{[“VSP input of maximum acceleration } (V_{VSPMAX})\text{” } - \text{ “TRI bottom value(0.25V)”]}} \times 100\ (\%)$$

$$\text{Frequency} = \frac{I_{TRI}\ (=20.7uA)}{\text{[VSP input of maximum acceleration } (V_{VSPMAX})\text{”” } - \text{ “TRI bottom value(0.25V)”]} \times C_{TR} \times 2}\ (\text{Hz})$$

IC doesn’t drive if VSP pin voltage is lower than ,VSP input of stop control voltage, 0.31V(less than 4%)



OPERATION (continued)

■ Functional explanation (continued)

Note) The characteristics listed below are reference values derived from design of the IC and are not guaranteed.

3. Motor locked protection circuit

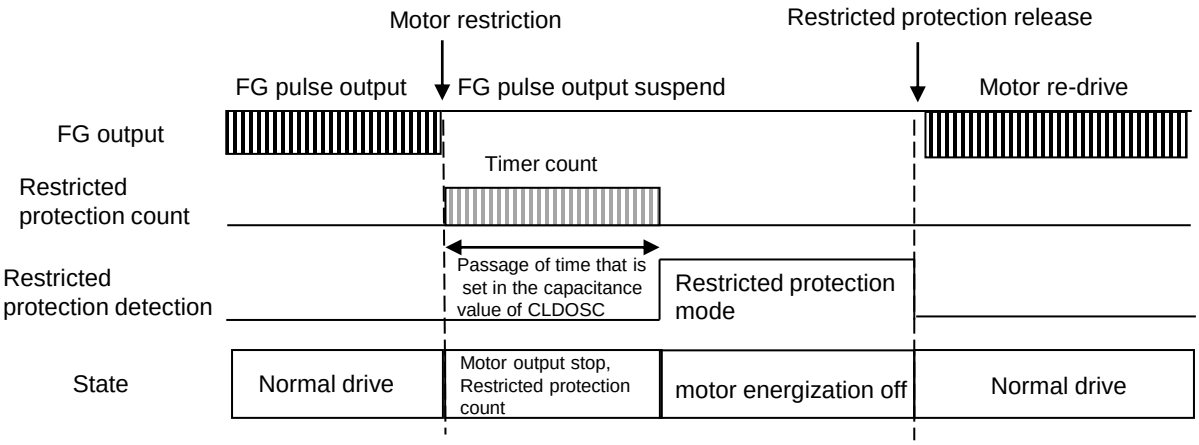
When FG non-signal state continues for a certain period of time in the motor normal operation mode, locked protection circuit operates.
In the locked protection mode, motor energization off.
The value of the locked protection time can be calculated by the following equation approximately.

Restricted protection setting time (sec) ≒ 0.6 sec

Make setting with a margin for motor start-up time.

Conditions to release the motor restricted protection, and to reset the counter are as follows.
- ・In detecting UVLO mode
- ・After fixed time progress (about 4.8 sec)
- ・In inputting VSP stop control voltage

・Restricted protection explanation



OPERATION (continued)

■ Functional explanation (continued)

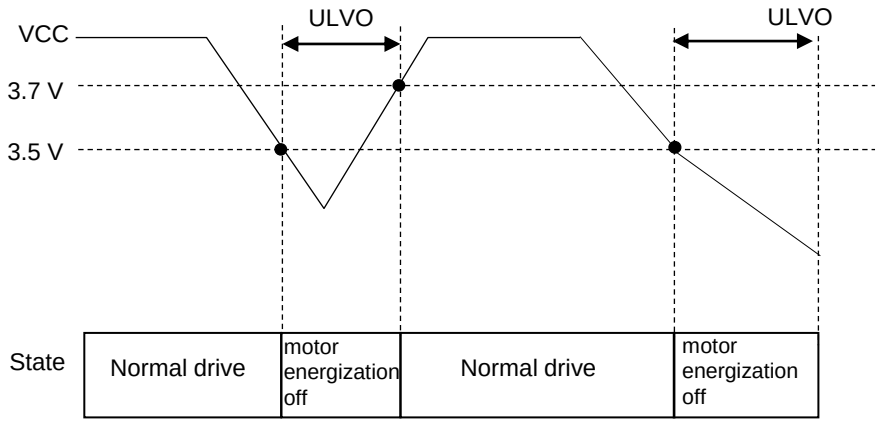
Note) The characteristics listed below are reference values derived from design of the IC and are not guaranteed.

4. Low voltage protection

This IC monitors the voltage VCC. If VCC voltage becomes 3.5V or less, low-voltage protection is activated.
In the low voltage protection operation, motor energization off.

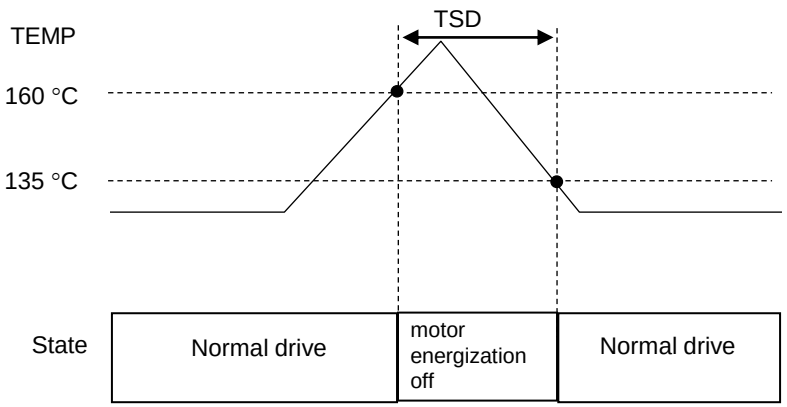
In addition, if the VCC voltage drops further, the internal circuit is no longer working properly, the outputs, all phases are HiZ (all phases OFF).

Hysteresis of 0.2V is set in the VCC low voltage protection function. If the VCC is restored to 3.7V from protection mode, the low voltage protection is released.



5. Thermal protection (TSD)

If an IC junction temperature is 160℃ (design target value) or more, the thermal protection is activated, and the motor energization off .
If the IC junction temperature is 135℃ (design target value) or less, the protection is released.



OPERATION (continued)

■ Functional explanation (continued)

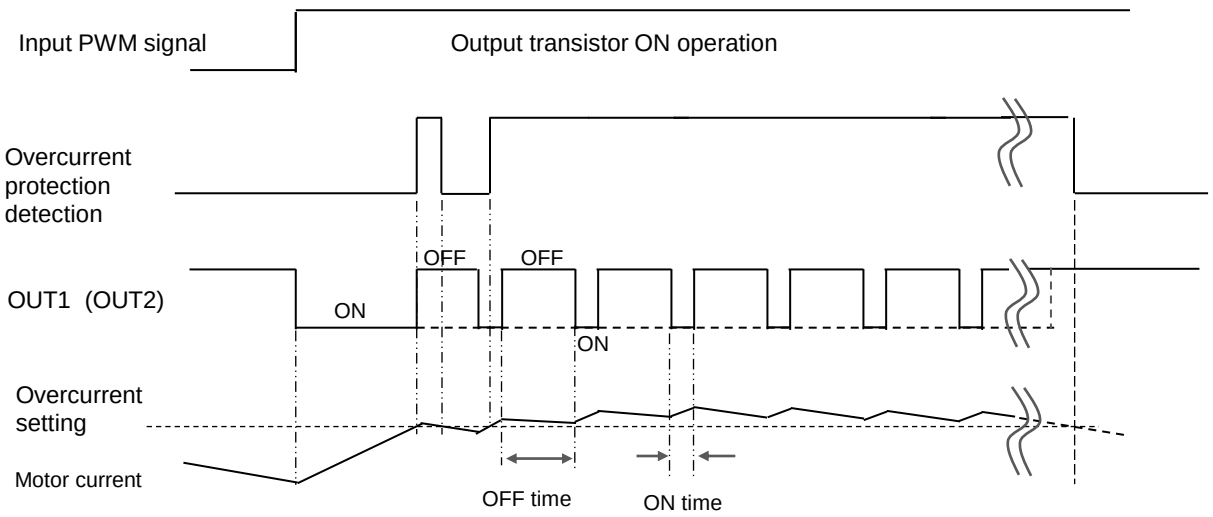
Note) The characteristics listed below are reference values derived from design of the IC and are not guaranteed.

6. Overcurrent protection

Here, describes the overcurrent protection.
It detects an overcurrent at 1.2A, as overcurrent does not flow at OUT1, OUT2

After detecting a current greater than the setting value, by shutting off the output transistor during the predetermined time, it protects an over-current.

On time 2 µsec (in start up period 1.5µsec)
Off time 10 µsec (in start up period 40µsec)



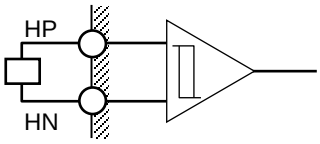
OPERATION (continued)

■ Functional explanation (continued)

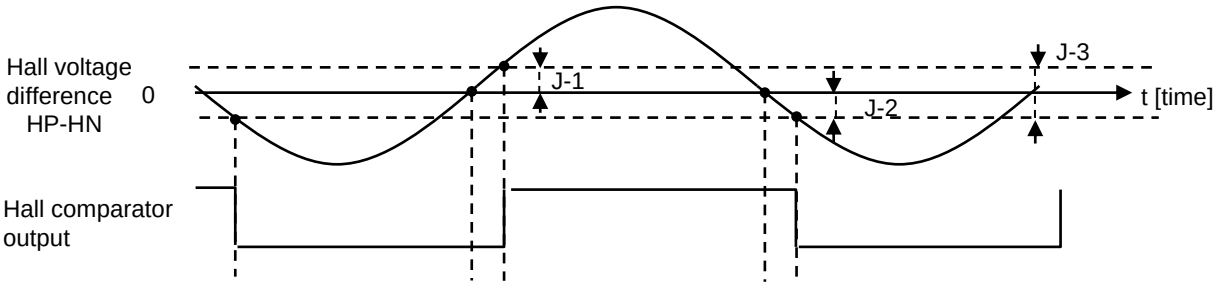
Note) The characteristics listed below are reference values derived from design of the IC and are not guaranteed.

7. Hall input

Hall hysteresis comparator carries out position detection. If the amplitude of the sine wave is small, the phase delay of the comparator output becomes significant, therefore, increase the amplitude. Recommendation is 100 mV or more. Also, if the hole chattering occurs, put capacitor between HP (1 pin) and HN (3 pin).

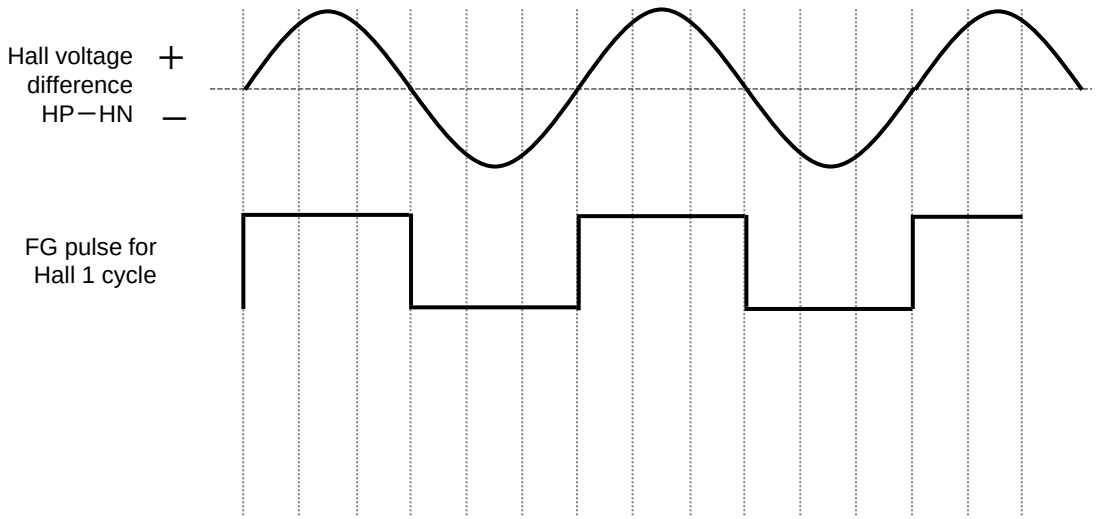


The following is a schematic diagram of the characteristics.
J-1 hysteresis level: 5 mV L → H
J-2 hysteresis level: 5 mV H → L
J-3 hysteresis width: 10 mV (typ)



・Relationship between Hall voltage and FG

For the one cycle sine wave of Hall, it outputs FG pulse one cycle.



OPERATION (continued)

■ Functional explanation (continued)

Note) The characteristics listed below are reference values derived from design of the IC and are not guaranteed.

8. FG pin

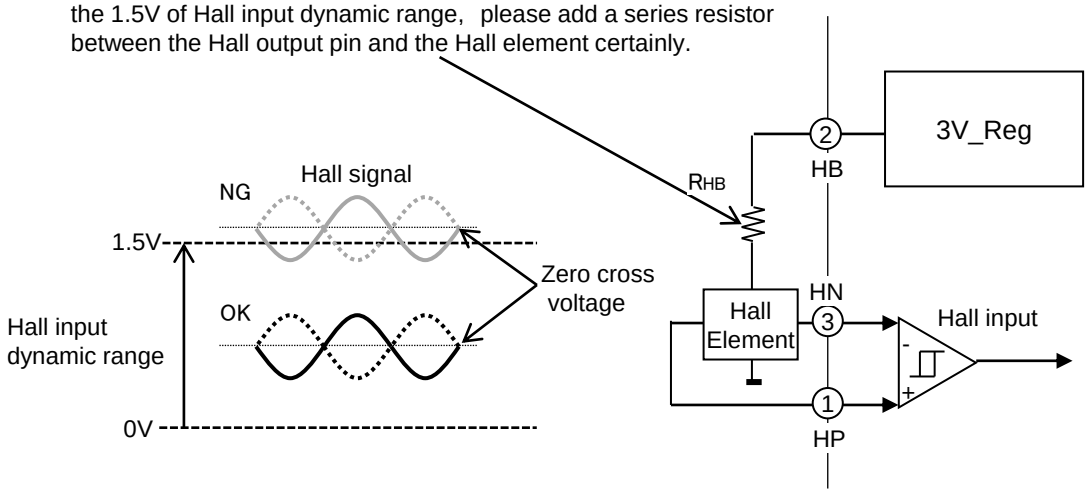
FG pin outputs a switching of HALL signal.
Since it is an open-drain output, please connect a pull-up resistor to the power supply, when you use this function.
FG outputs high, when HP voltage > HN voltage.

9. HB pin

HB pin is a pin for supplying the bias voltage to the hall element .
3.0V is outputted from HB pin.
If it is necessary to take countermeasures to prevent the noise, please add the hall capacitance between HB pin and GND pin.
The maximum value of the hall capacitance is 0.1µF.

Hall output voltage is 3.0V, and Hall input dynamic range is 1.5V.
As the zero-cross voltage of the Hall signal does not higher than the 1.5V of Hall input dynamic range.
Please mount a series resistor RHB between the Hall output pin and the Hall element.
Please note the rated current of HB pin and Hall signal amplitude in the case of using RHB.

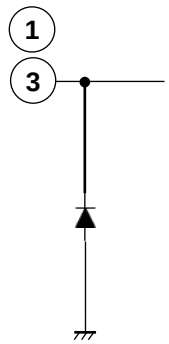
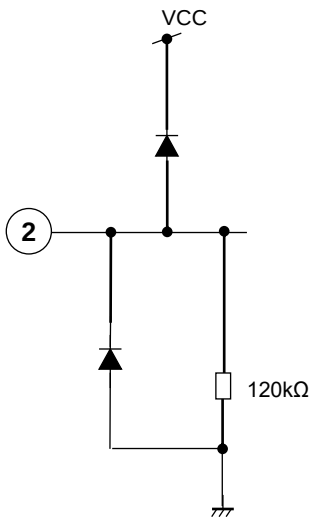
So that the zero-crossing voltage of the Hall signal is not higher than the 1.5V of Hall input dynamic range, please add a series resistor between the Hall output pin and the Hall element certainly.



Ex: In case of Hall element ASAHIKASEI “HW-101A-4T, (B=50mT)”, RHB=330Ω is set.

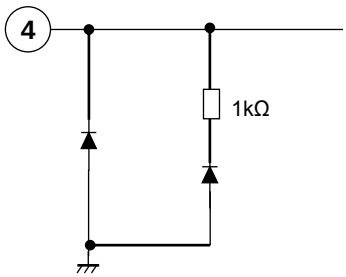
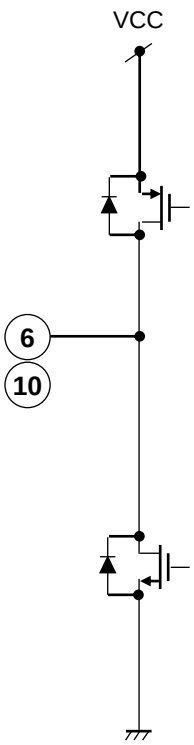
PIN EQUIVALENT CIRCUIT

Note: The characteristics listed below are reference values derived from the design of the IC and are not guaranteed.

Pin No.	Internal circuit	Impedance	Description
1, 3		—	Pin1(HP) :Hall amplifier + input pin Pin3(HN) :Hall amplifier – input pin
2		120kΩ	Pin2(HB) :Hall bias 3.0V output pin

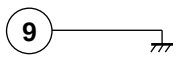
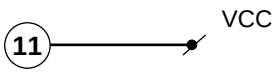
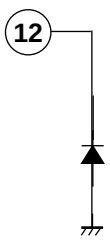
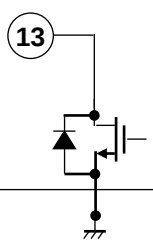
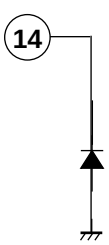
PIN EQUIVALENT CIRCUIT (continued)

Note: The characteristics listed below are reference values derived from the design of the IC and are not guaranteed.

Pin No.	Internal circuit	Impedance	Description
4		—	Pin4(TRI) Triangle wave capacitor connection pin for PWM duty & frequency
6, 10		—	Pin6(OUT1), Pin10(OUT2) Motor drive output pin

PIN EQUIVALENT CIRCUIT (continued)

Note: The characteristics listed below are reference values derived from the design of the IC and are not guaranteed.

Pin No.	Internal circuit	Impedance	Description
9		—	Pin9（GND） GND pin
11		—	Pin11（VCC） Power supply pin
12		—	Pin12(VSP) Voltage input pin for controlling the rotational speed
13		—	Pin13(FG) FG signal output pin
14		—	Pin14(SEL) Motor lock protection signal output pin

APPLICATION INFORMATION

1.Precaution at restarting under decelerating.

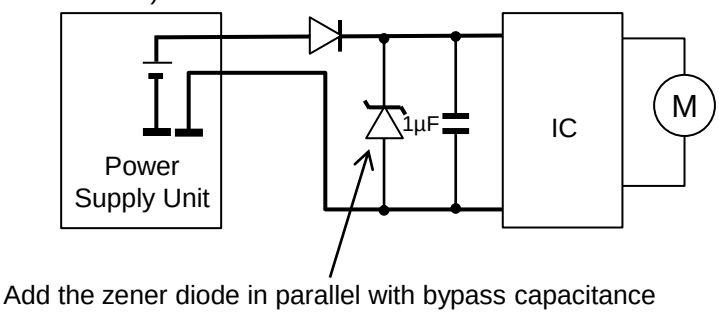
When IC turns on, The duty of PWM pulse is forced 50%(SEL = High). When restarting during motor deceleration, because the possibility which the motor current is switched before the motor current becomes to zero is high, the motor current flows into VCC. So VCC rises higher than setting voltage, there is possibility that VCC voltage is over IC's absolute maximum voltage.

2.Precaution at turn off VCC

When the power supply voltage is turned off under high speed rotation. Because the motor's BEMF voltage is high, VCC is supplied by BEMF voltage, and IC repeats start and stop.
The possibility which the motor current flows into VCC is high, VCC rises higher than setting voltage, there is possibility that VCC voltage is over IC's absolute maximum voltage.

If the reverse current to VCC, including of above 1 or 2, occurs and the countermeasure is needed, please countermeasure to cramp VCC voltage by adding the zener diode in parallel with bypass capacitance and ensure sufficient evaluation is performed to verify that there is no problem.

(Countermeasure Circuit)



APPLICATION INFORMATION (continued)

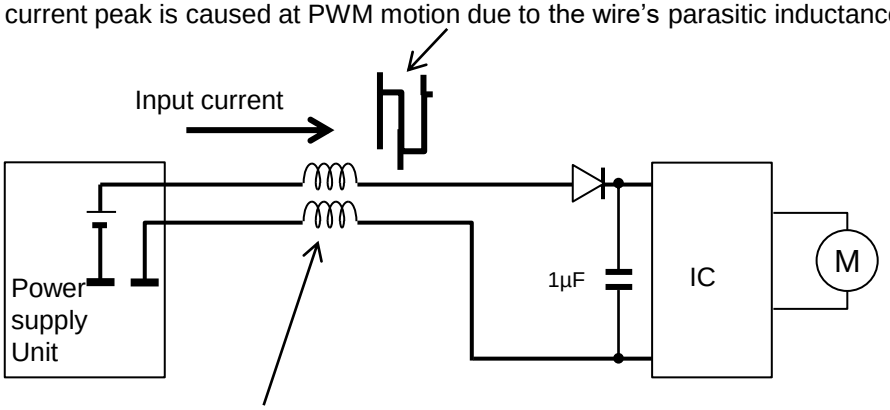
3.Precaution at PWM Motion

When VCC and GND wire is long, There is possibility which current peak of motor input current is caused at PWM motion due to wire's parasitic inductance.

Please countermeasure to reduce current peak of motor input current by adding a resistance in series with bypass capacitance and ensure sufficient evaluation is performed to verify that there is no problem.

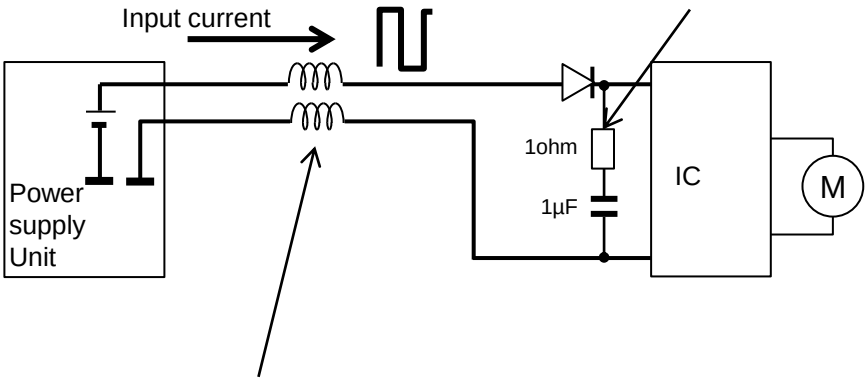
(Circuit)

The current peak is caused at PWM motion due to the wire's parasitic inductance.



(Countermeasure Circuit)

The current peak is reduces according to adding in series with bypass capacitance.



APPLICATION INFORMATION (continued)

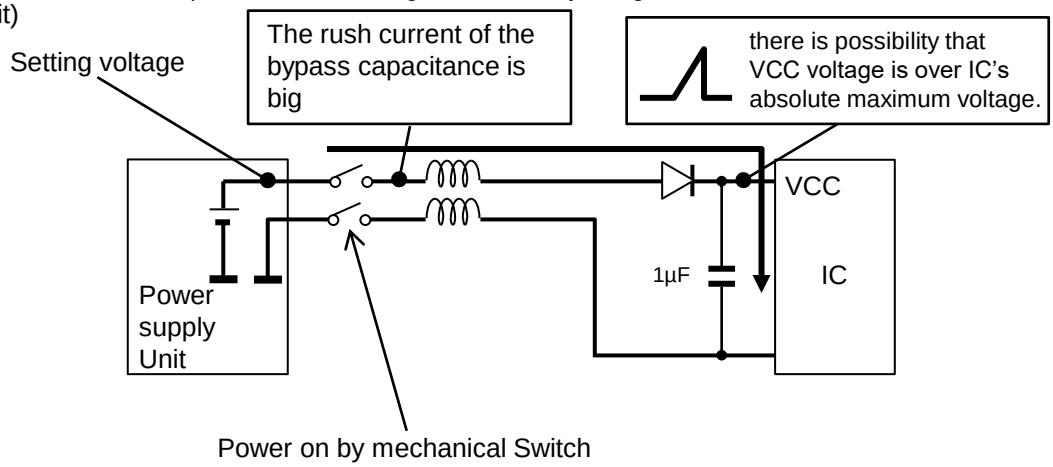
4.Precaution at inputting power to VCC

When the IC is powered on, it is recommended that VCC voltage rises slower than 0.24V/us, also when IC is shut down, it is recommended that VCC voltage falls higher than -0.24V/us, When power up is performed at high-speed, rush current must flow into bypass capacitance between VCC and GND. So VCC rises higher than setting voltage due to wire's parasitic inductance, there is possibility that VCC voltage is over IC's absolute maximum voltage.

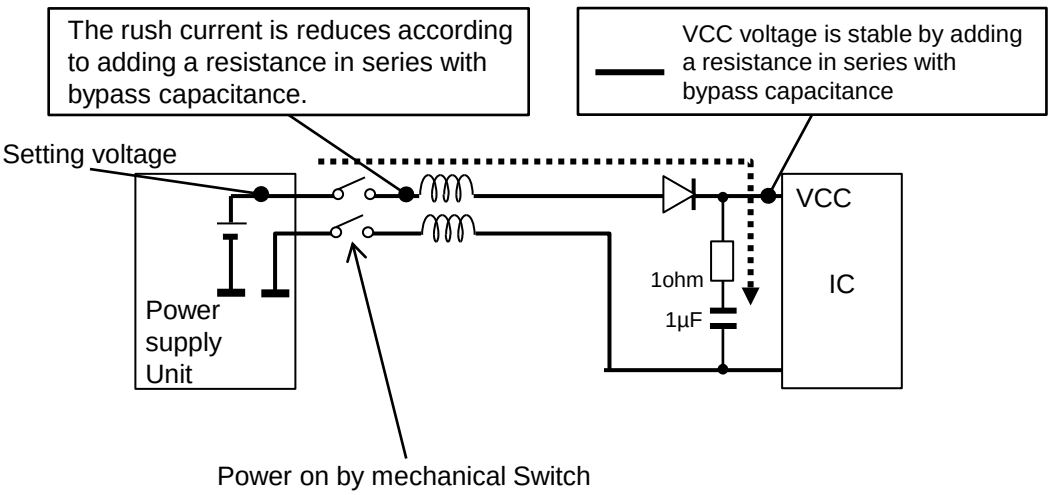
please countermeasure to reduce rush current by adding a resistance in series with bypass capacitance and ensure sufficient evaluation is performed to verify that there is no problem.

For example, in case of turning on the VCC by using the mechanical switch.

(Circuit)



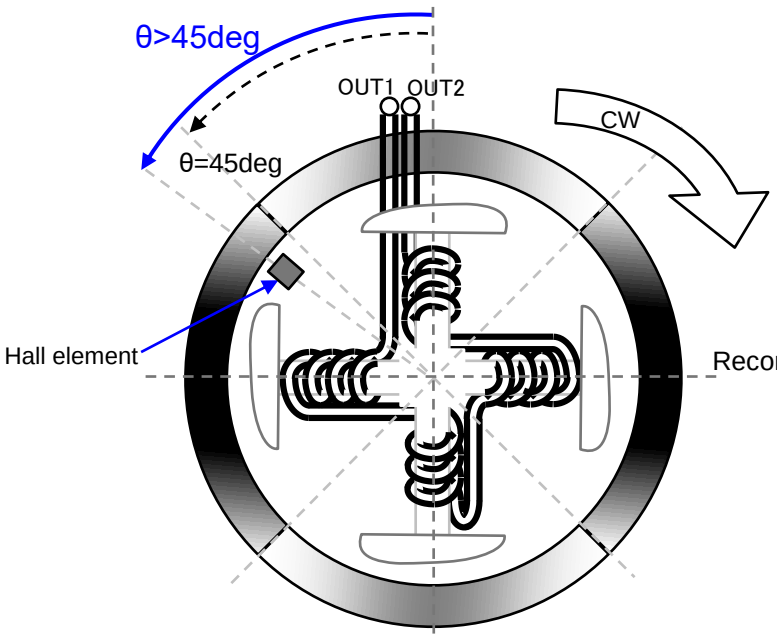
(Countermeasure Circuit)



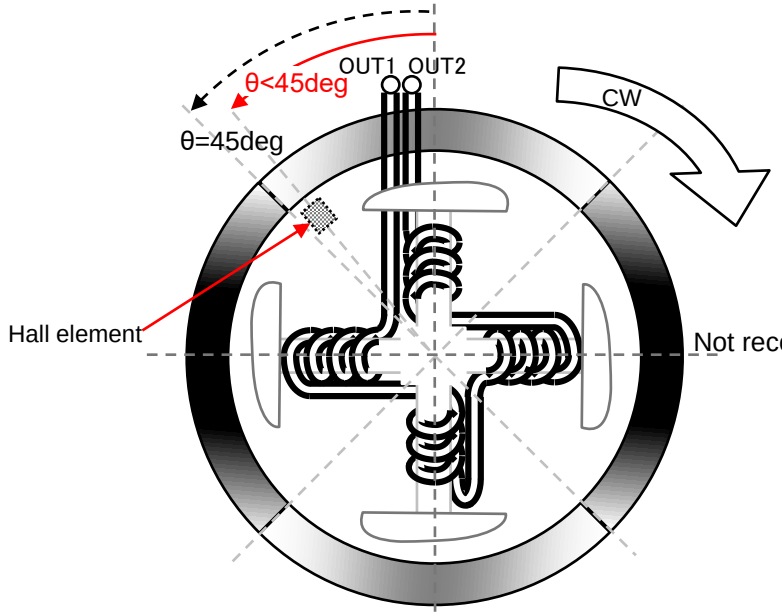
APPLICATION INFORMATION (continued)

5. Recommended position for hall element

This driver has automatic phase adjustment for optimized motor current.
We recommend that you set the hall element in the position shown in the following figure1.
If you set the hall element in the position shown in the following figure2, it may not be started the motor and it may be that automatic phase adjustment is low performance.



Recommended position for hall element
(Figure1)



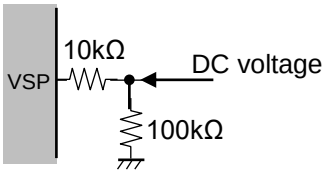
Not recommended position for hall element
(Figure2)

APPLICATION INFORMATION (continued)

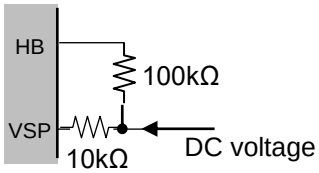
6. VSP terminal input

Because the pull-up and pull-down resistor to the VSP terminal does not have a built, do not use under open condition.
If the default setting is required, please use by adding a pull-up or down resistor to the external.
And, if you take out to the outside VSP terminal as an interface terminal, ESD, as well as the negative voltage (rated voltage -0.3V or less) should be used by inserting a series resistor for protection as input measures.
An example of this is shown below.

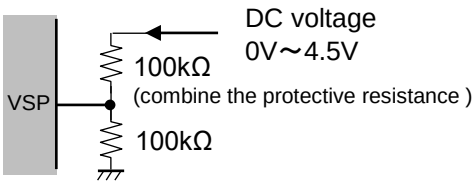
Ex)default low setting
(Stop：Duty=0%)



Ex)default High setting
(max acceleration：Duty=100%)



Ex) Level shift setting(Att=1/2)

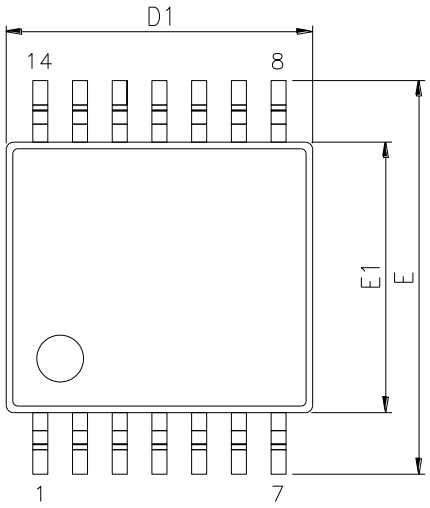


Since the resistance value is a reference value, please change according to the operating conditions.
In addition, the input voltage of the VSP terminal ask attention to the absolute maximum rating.
It should be noted that, If you connect a resistor to the HB terminal, please set the resistance value with attention to the rated current of the HB terminal.

PACKAGE INFORMATION

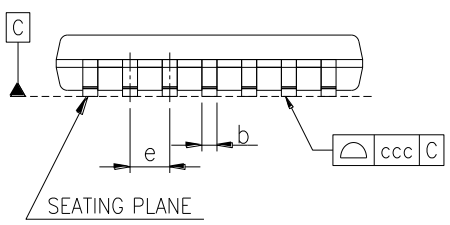
Outline Drawing

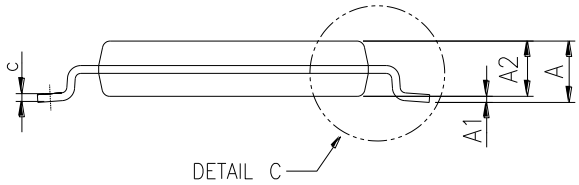
TSSOP 14L 4.4x5.0mm², Thickness 0.9mm, Lead Pitch 0.65mm, Lead Length 1mm

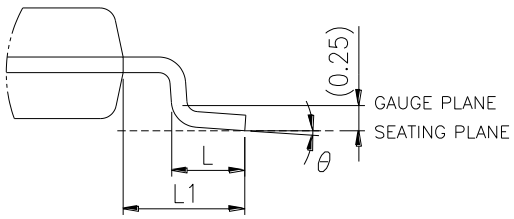


VARIATIONS (ALL DIMENSIONS SHOWN IN MM)

SYMBOLS	MIN.	NOM.	MAX.
A	–	–	1.10
A1	0.05	–	0.15
A2	0.85	0.90	0.95
D1	4.90	5.00	5.10
E	6.30	6.40	6.50
E1	4.30	4.40	4.50
b	0.19	–	0.30
c	0.13	–	0.20
ccc	0.10		
L	0.45	0.60	0.75
L1	1.00REF		
e	0.65BSC		
θ	0.0°	–	8.0°







DETAIL C

USAGE NOTES

1. Pay attention to the direction of the IC. When mounting it in the wrong direction onto the PCB (printed-circuit-board), it might be damaged.
2. Pay attention in the PCB (printed-circuit-board) pattern layout in order to prevent damage due to short circuit between pins. In addition, refer to the Pin Description for the pin configuration.
3. Perform visual inspection on the PCB before applying power, otherwise damage might happen due to problems such as solder-bridge between the pins of the IC. Also, perform full technical verification on the assembly quality, because the same damage possibly can happen due to conductive substances, such as solder ball, that adhere to the IC during transportation.
4. Take notice in the use of this IC that it might be damaged and be emitted a little smoke when an abnormal state occurs such as output pin-VCC short (Power supply fault), output pin-GND short (Ground fault), or output-to-output-pin short (load short). Safety measures such as installation of fuses are recommended because the extent of the above-mentioned damage will depend on the current capability of the power supply.

   Although the following pins comes with short circuit protection function, the IC may be damaged and emit smoke depending on the VCC voltage. Pins with short circuit protection function: Pin6(OUT1) and Pin10(OUT2).
5. The protection circuit is for maintaining safety against abnormal operation.

   When sudden voltage or current change is applied to the pin, it may exceed the designated voltage and current level and therefore, customer shall perform sufficient evaluation and verification to ensure these are not exceeded in the usage.

   Especially for the thermal protection circuit, if the area of safe operation or the absolute maximum rating is momentarily exceeded due to output pin to VCC short (Power supply fault), or output pin to GND short (Ground fault), the IC might be damaged and emit smoke before the thermal protection circuit could operate.
6. Unless specified in the product specifications, make sure that negative voltage or excessive voltage are not applied to the pins because the IC might be damaged, which could happen due to negative voltage or excessive voltage generated during the ON and OFF timing when the inductive load of a motor coil or actuator coils of optical pick-up is being driven.
7. Product which has specified ASO (Area of Safe Operation) should be operated in ASO
8. Verify the risks which might be caused by the malfunctions of external components.
9. Comply with the instructions for use in order to prevent breakdown and characteristics change due to external factors (ESD, EOS, thermal stress and mechanical stress) at the time of handling, mounting or at customer's process.
10. Dip soldering is not recommended.
11. Follow the power supply voltage, load and ambient temperature conditions to ensure that there is enough margin and the thermal design does not exceed the allowable value.
12. When designing your equipment, comply with the range of absolute maximum rating and the guaranteed operating conditions (operating power supply voltage and operating environment, etc.). Especially, please be careful not to exceed the range of absolute maximum rating on the transient state, such as power-on, power-off and mode switching. Otherwise, we will not be liable for any defect which may arise later in your equipment.

    Even when the products are used within the guaranteed values, take into the consideration of incidence of break down and failure mode, possible to occur to semiconductor products. Measures on the systems such as redundant design, arresting the spread of fire or preventing glitch are recommended in order to prevent physical injury, fire, social damage, for example, by using the products.
13. Pin 12(VSP) pins are MCU interface. In the case that the current setting of the motor is large and lead line of GND is long, the potential of GND pin of the IC may be increased.
    If 0V is input from the microcomputer, there is a case to be negative potential in the potential difference between the GND pin of this IC and the interface pin. If these pins detect under -0.3V, note that there is a possibility to break or malfunction.

Revision History

Date	Revision		Description	
2020.10.31	1.00	1	Initially issued.	
2022.01.28	1.05	1	Changed important notice	Page2
		2	Remove important notice page from previous version page32,33	-
		3	Added usage notes	Page33
2023.8.31	1.06	1	Changed power dissipation rating notice	Page5
		2	Added parameter of the TRI Oscillating Range parameter in electrical characteristics	Page8
		3	Changed block diagram composition	Page10
		4	Changed pin equivalent circuit composition	Page22-24

Important Notice

Nuvoton Products are neither intended nor warranted for usage in systems or equipment, any malfunction or failure of which may cause loss of human life, bodily injury or severe property damage. Such applications are deemed, "Insecure Usage".

Insecure usage includes, but is not limited to: equipment for surgical implementation, atomic energy control instruments, airplane or spaceship instruments, the control or operation of dynamic, brake or safety systems designed for vehicular use, traffic signal instruments, all types of safety devices, and other applications intended to support or sustain life.

All Insecure Usage shall be made at customer's risk, and in the event that third parties lay claims to Nuvoton as a result of customer's Insecure Usage, customer shall indemnify the damages and liabilities thus incurred by Nuvoton.