

Motor Driver IC for single phase Brushless Motor

KA44169AB Product Brief

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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 |
| AECQ-100 | No |
| Market failure rate | 50 Fit |

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.
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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.

Motor Driver IC for single phase Brushless Motor

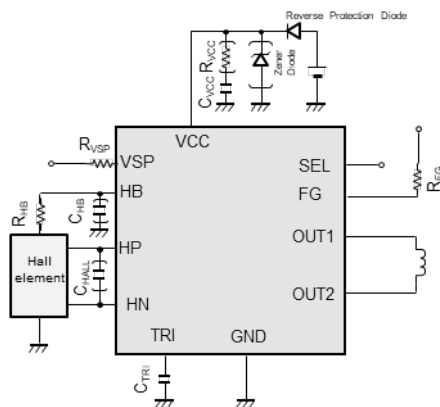
FEATURES

- 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.
 - Supply voltage range : 5.6 V to 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)

APPLICATION

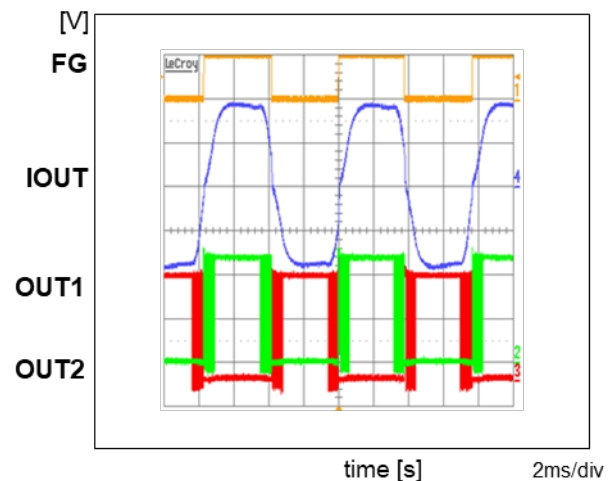
Refrigerator, Projector, Printer, Factory automation

TYPICAL APPLICATION



Note: 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.

MOTOR DRIVE WAVEFORM



Condition:
VCC = 12 V, VSP = 100% duty , C_{vcc} = 1 μF

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1. ELECTRICAL CHARACTERISTICS

1.1 ABSOLUTE MAXIMUM RATINGS

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

Note: 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 $T_a = 25^\circ\text{C}$.

*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 $V_{CC} \geq 6\text{ V}$, output current of $\pm 1.4\text{ A}$ 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.

1.2 POWER DISSIPATION RATING

| Package | θ_{j-a} | $P_D (T_a=25^\circ\text{C})$ | $P_D (T_a=105^\circ\text{C})$ |
|---|----------------|------------------------------|-------------------------------|
| TSSOP 14L (4.4x5.0x0.9mm ³ , Lead Pitch 0.65mm) | 157.7°C/W | 792.8mW | 285.3mW |

Note: 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.

* Glass-Epoxy Substrate (1 Layers) [70 x 70 x 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.

1.3 RECOMMENDED OPERATING CONDITIONS

| Parameter | Pin Name | 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 |

Note:

*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.

1.4 ELECTRICAL CHARACTERISTICS

at VCC = 12.0 V, 24.0 V

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

| Parameter | Symbol | Condition | Limits | | | Unit | Notes |
|---|---------------------|--------------------------|--------|------|------|------|-------|
| | | | 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} | V _O =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} | I _O = -2mA | 2.7 | 3.0 | 3.3 | V | — |
| 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 | — |
| MOTORLOCK 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 |

at VCC = 12.0 V, 24.0 V

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

| Parameter | Symbol | Condition | Limits | | | Unit | Notes |
|-------------------------------|---------------------|-----------------------------|--------|------|------|------|-------|
| | | | Min. | Typ. | Max. | | |
| 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 | — |

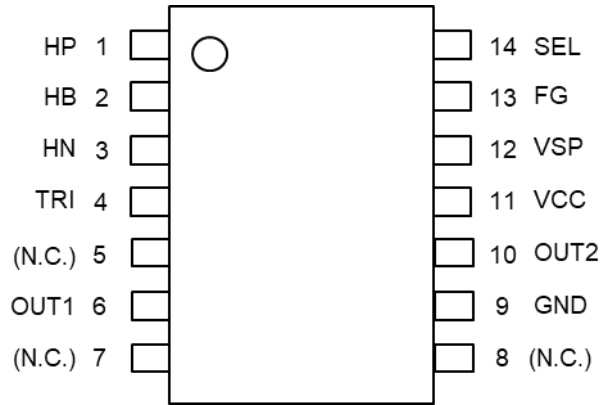
Notes :

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

*2 : Typical Design Value.

2. PIN CONFIGURATION

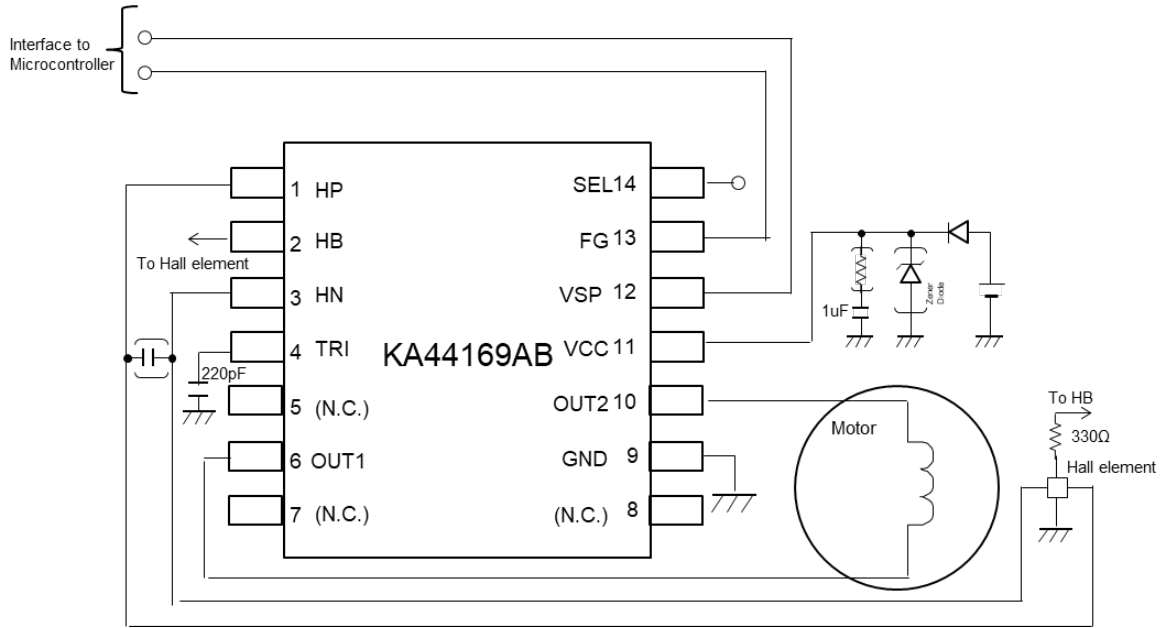
2.1 PIN ASSIGNMENT



2.2 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.) |

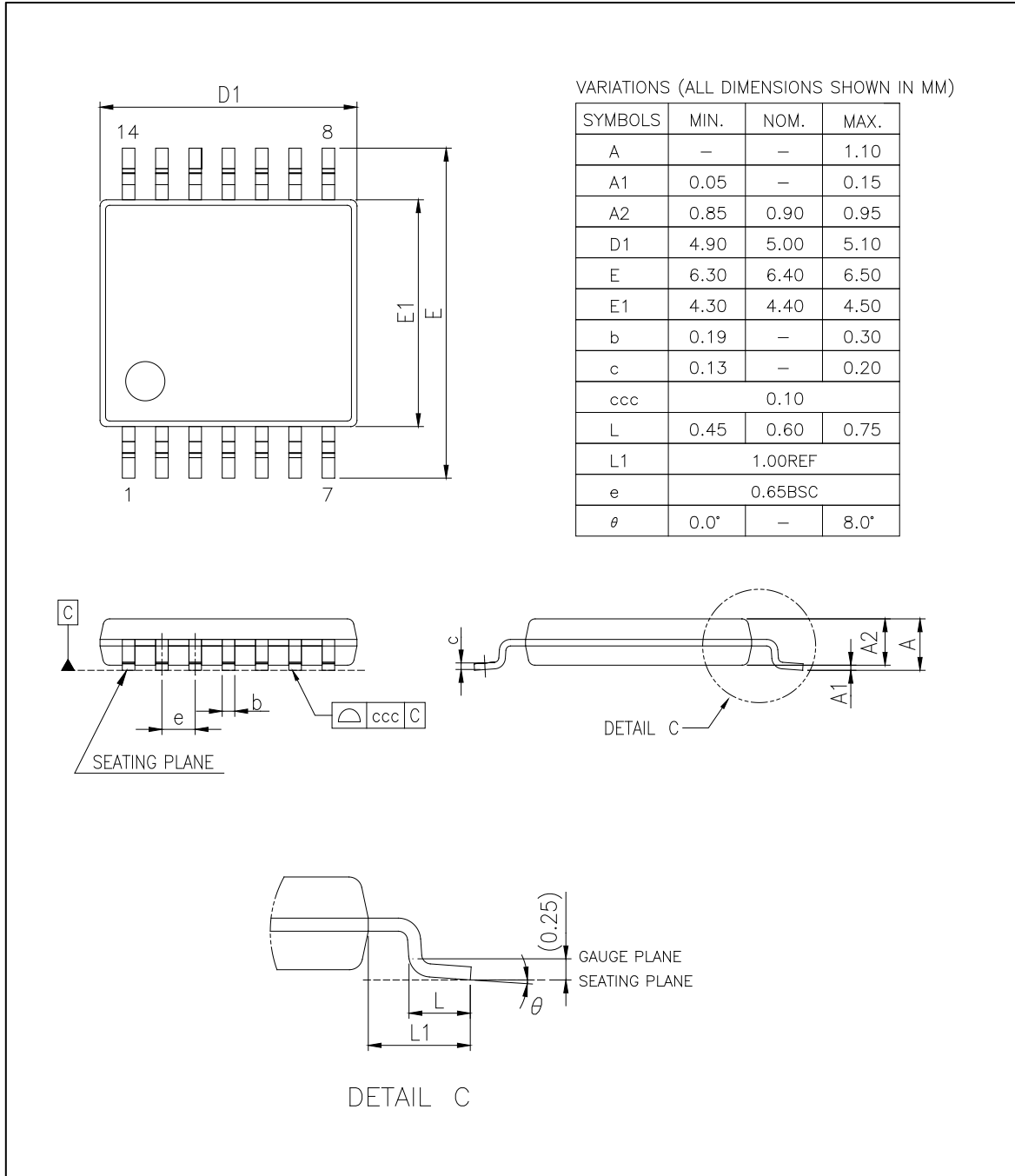
3. RECOMMENDED CIRCUIT



Note: The recommended 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. Customer is fully responsible for the incorporation of the above illustrated application circuit in the production.

4. PACKAGE INFORMATION

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



5. 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.

6. REVISION HISTORY

| Date | Revision | Description |
|-------------|-----------------|---|
| 2021.2.8 | 1.00 | 1. initially issued. |
| 2021.2.24 | 1.03 | 1. initially issued as Datasheet |
| 2022.1.28 | 1.05 | 1. Added important notice on page2 2. Remove important notice page from previous version page 13 |

Important Notice

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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.

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