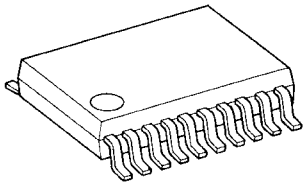
CD Integrated Circuit Silicon Monolithic

# TC78S600FNG/FTG

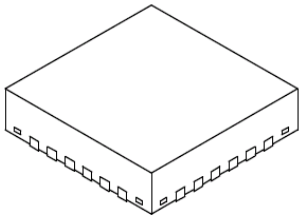
Stepping Motor Driver IC

The TC78S600FNG/FTG is a PWM constant-current type stepping motor driver IC designed for sinusoidal-input micro-step control of stepping motors.

The TC78S600FNG/FTG can be used in applications that require 1-2-phase, W1-2-phase, 2W1-2 phase, and 4W1-2 phase excitation modes. The TC78S600FNG/FTG is capable of forward and reverse driving of a 2-phase bipolar stepping motor using only a clock signal.



SSOP20-P-225-0.65A



P−WQFN24−0404−0.50−004

Weight: SSOP20-P-225-0.65A 0.09g(typ.)
P-WQFN24-0404-0.50-004 0.03g(typ.)

## Features

- Motor power supply voltage: VM = 15V (max)
- Control power supply voltage: Vcc = 2.7 to 5.5V (operation range)
- Output current: Iout ≤ 0.8A (max)
- Output ON-resistance: Ron = 1.2Ω (upper and lower sum)
- Decoder that enables micro step control with the clock signal
- Selectable phase excitation modes (1-2, W1-2, 2W1-2, and 4W1-2)
- Internal pull-down resistors on inputs: 200 kΩ (typ.)
- Output monitor pin ($\overline{\text{MO}}$)
- Over current protection (ISD), Thermal shutdown (TSD) circuit, and Undervoltage lockout (UVLO) circuit.
- Package: SSOP20 and QFN24
- Fast decay: always 12.5%
- Built-in cross conduction protection circuit

- This product has a MOS structure and is sensitive to electrostatic discharge. When handling this product, ensure that the environment is protected against electrostatic discharge by using an earth strap, a conductive mat and an ionizer. Ensure also that the ambient temperature and relative humidity are maintained at reasonable levels.
- Do not insert devices in the wrong orientation or incorrectly. Otherwise, it may cause the device breakdown, damage and/or deterioration.

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### Under voltage lockout (UVLO) circuit

The TC78S600FNG/FTG includes an undervoltage lockout circuit, which puts the output transistors in the high-impedance state when $V_{CC}$ decreases to 2.2 V (typ.) or lower.

The output transistors are automatically turned on when $V_{CC}$ increases past the lockout threshold, which is raised to 2.3 V (typ.) by a hysteresis of 0.1 V (typ.).

Even when UVLO circuit is tripped, internal circuitry continues to operate in accordance with the CK input like when ENABLE is set Low. Thus, after the TC78S600FNG/FTG exits the UVLO mode, the RESET signal should be asserted for putting the TC78S600FNG/FTG in the Initial state if necessary.

The TC78S600FNG/FTG includes an undervoltage lockout circuit, which puts the output transistors in the high-impedance state when VM decreases to 2.0 V (typ.) or lower.

The output transistors are automatically turned on when VM increases past the lockout threshold, which is raised to 2.1 V (typ.) by a hysteresis of 0.1 V (typ.).

Even when UVLO circuit is tripped, internal circuitry continues to operate in accordance with the CK input like when ENABLE is set Low. Thus, after the TC78S600FNG/FTG exits the UVLO mode, the RESET signal should be asserted for putting the TC78S600FNG/FTG in the Initial state if necessary.

State of the internal IC and output state when UVLO function operates are same as that of the enable standby mode. Start of the output waveform of automatic recovery can not be defined along with the release from the enable standby mode. It can start from the initial state by setting the reset low.

## Power-on Sequence with Control Input Signals

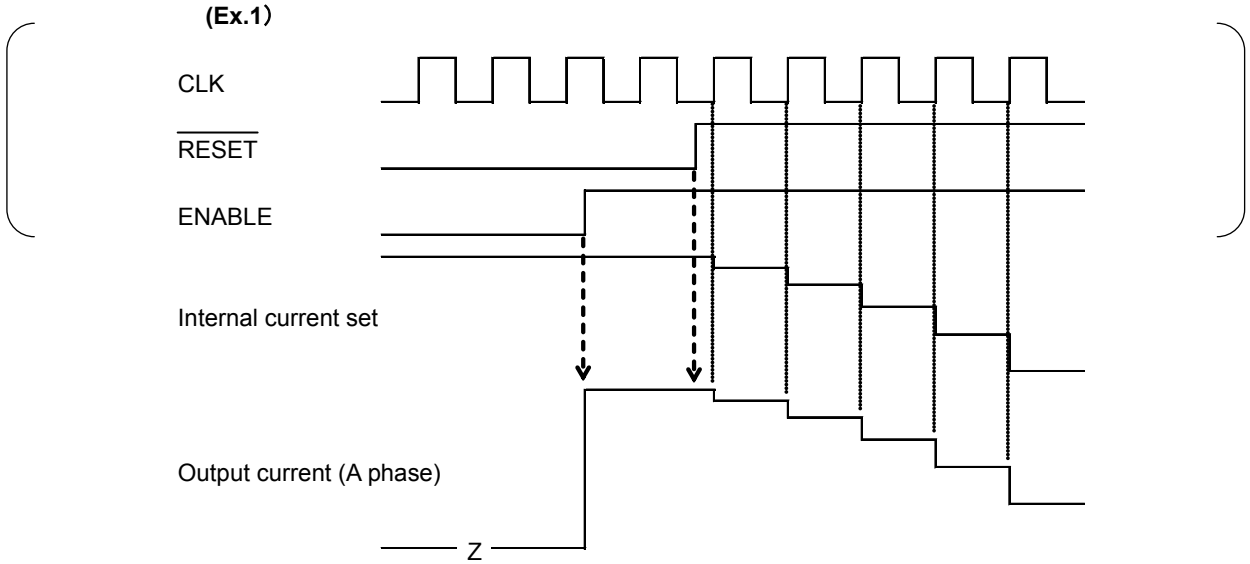
The order of turning on Vcc and VM is not settled for the user. So, please design the IC not to be damaged even in case of the start-up (or, even in case of shutdown) from either power supply.
In supplying and shutting down the power, there should be no abnormal operations in outputting. Power supply monitoring circuit should be provided in necessary. The IC should not be damaged if the power-on sequence is wrong. The IC should not be damaged in power-on if each input terminal (M1, M2, M3,CLK, CW/CCW, ENABLE, $\overline{\text{RESET}}$,DCY, and TQ) is high or low, and Vref outputs any value within the operating range.

Two examples are shown below figures.
(Example 1): ENABLE = High → $\overline{\text{RESET}}$ = High
(Example 2): $\overline{\text{RESET}}$ = High → ENABLE = High
Motor can start rotating from the initial state in the Example 1.

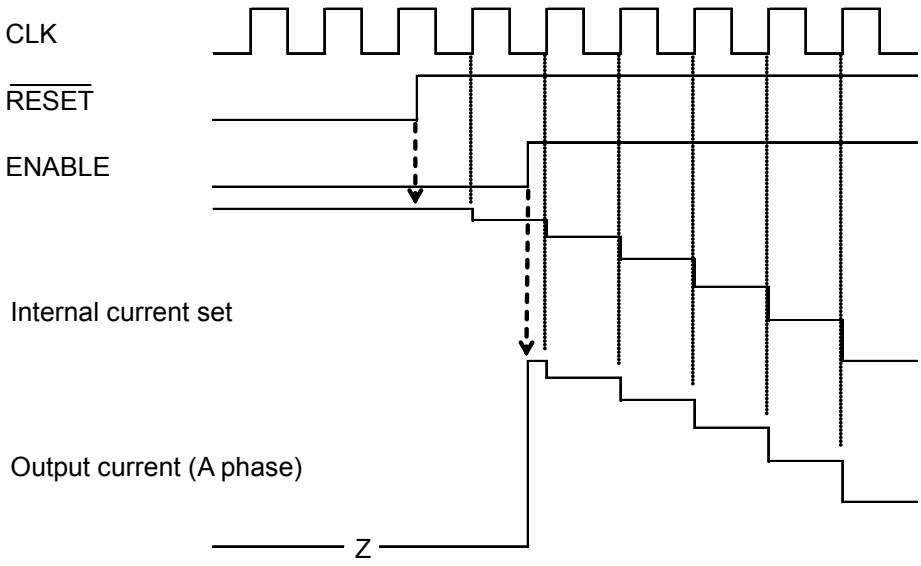
(1)CLK: Current steps proceed in every rising edge of CLK.
(2)ENABLE: Low: Output is Hi-Z. High: Outputting.
$\overline{\text{RESET}}$: Low: Initial state (A phase 100%, B phase 0%).
①ENABLE = Low and $\overline{\text{RESET}}$ = Low: Setting of internal current is initial state though output is Hi-Z.
②ENABLE = Low and $\overline{\text{RESET}}$ = High: Setting of internal current is proceeded by the internal counter though output is Hi-Z.
③ENABLE = High and $\overline{\text{RESET}}$ = Low: Outputting in the initial state (A phase 100%, B phase 0%).
④ENABLE = High and $\overline{\text{RESET}}$ = High: Outputting at the value proceeded by the internal counter.

< Recommended Control Input Sequence >

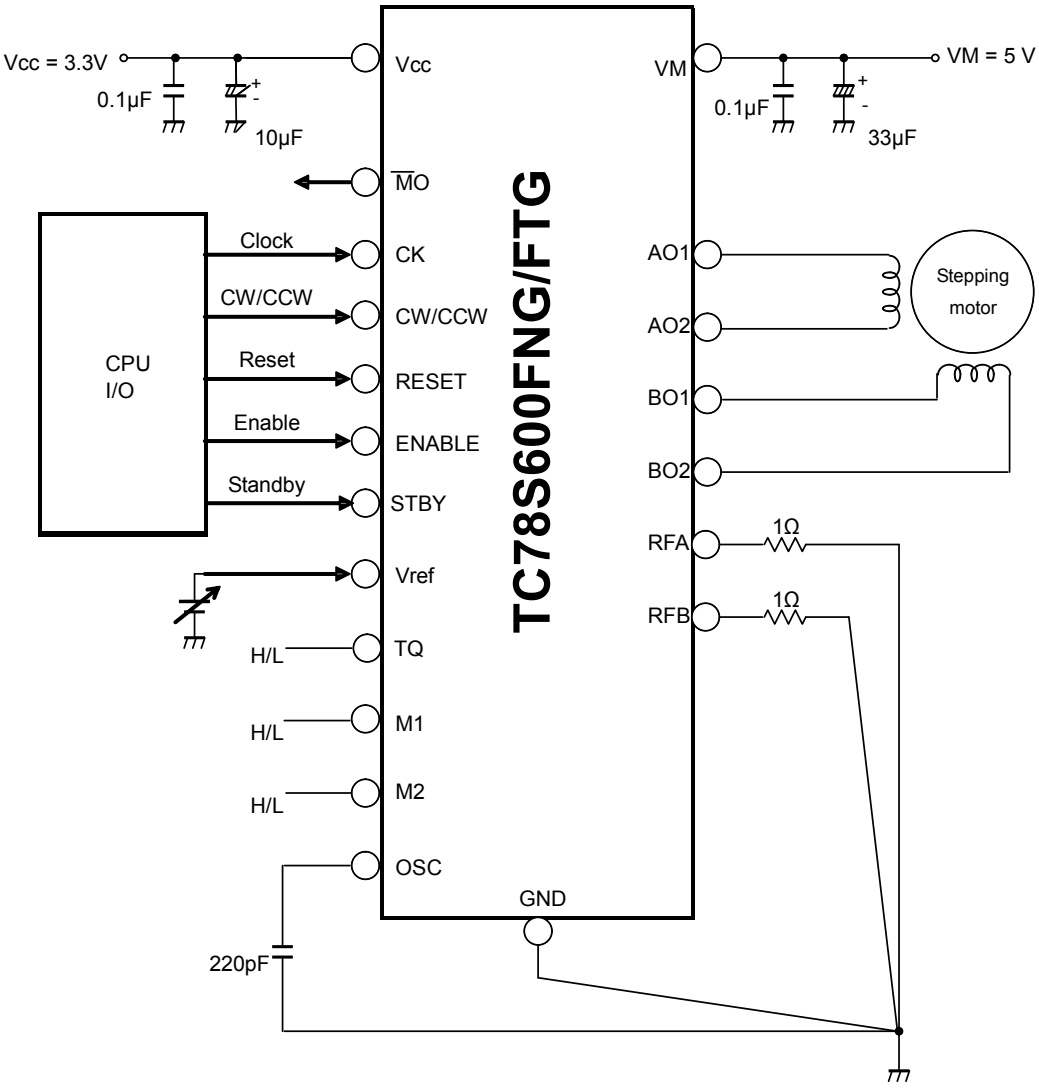
**(Ex.1)**




**(Ex.2)**



## Application Circuit Example




Note 1: Capacitors for the power supply lines should be connected as close to the IC as possible.

Note 2: The ENABLE pin must be set Low upon powering on and off the device. Otherwise, a large current might abruptly flow through the output pins.

## Usage Considerations

A large current might abruptly flow through the IC in case of a short-circuit across its outputs, a short-circuit to power supply or a short-circuit to ground, leading to a damage of the IC. Also, the IC or peripheral parts may be permanently damaged or emit smoke or fire resulting in injury especially if a power supply pin ($V_{CC}$, VM) or an output pin (AO1, AO2, BO1, BO2) is short-circuited to adjacent or any other pins.

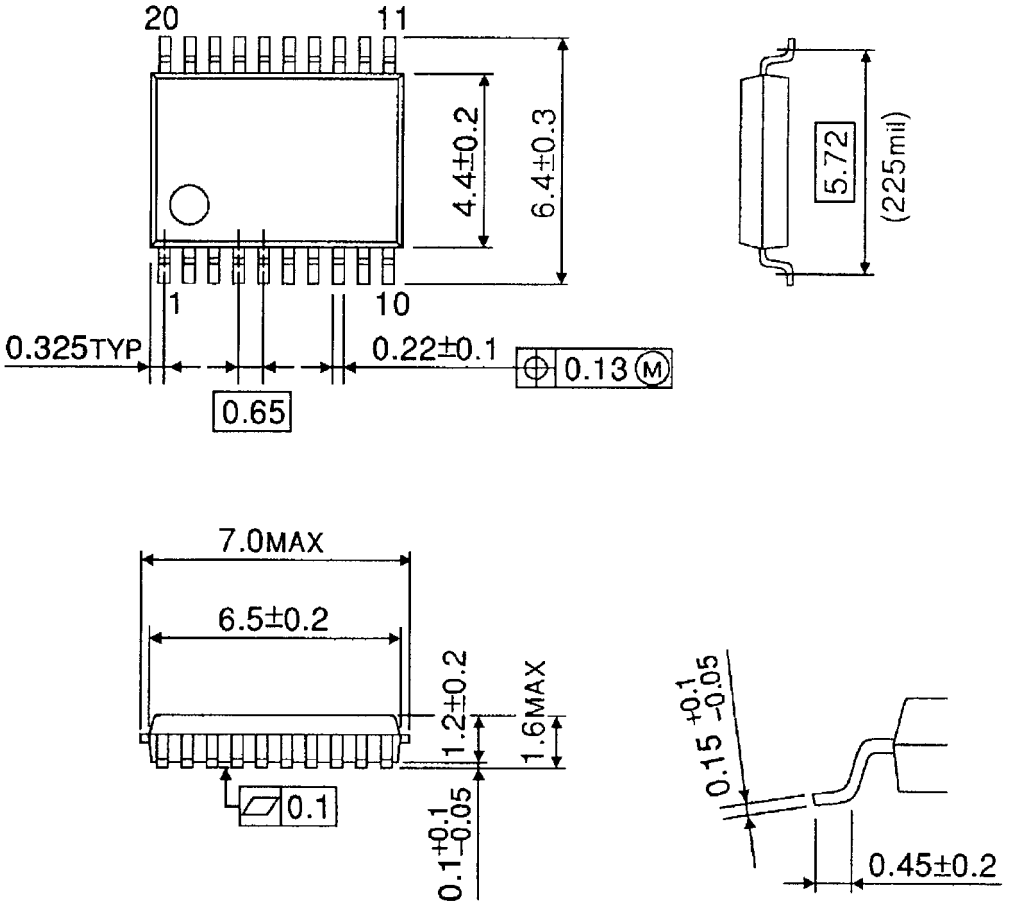
These possibilities should be fully considered in the design of the output, $V_{CC}$, VM and ground lines.

Install this IC correctly. If not, (e.g., installing it in the wrong position,) the IC may be damaged permanently.

Fuses should be connected to the power supply lines.

**Package Dimensions**

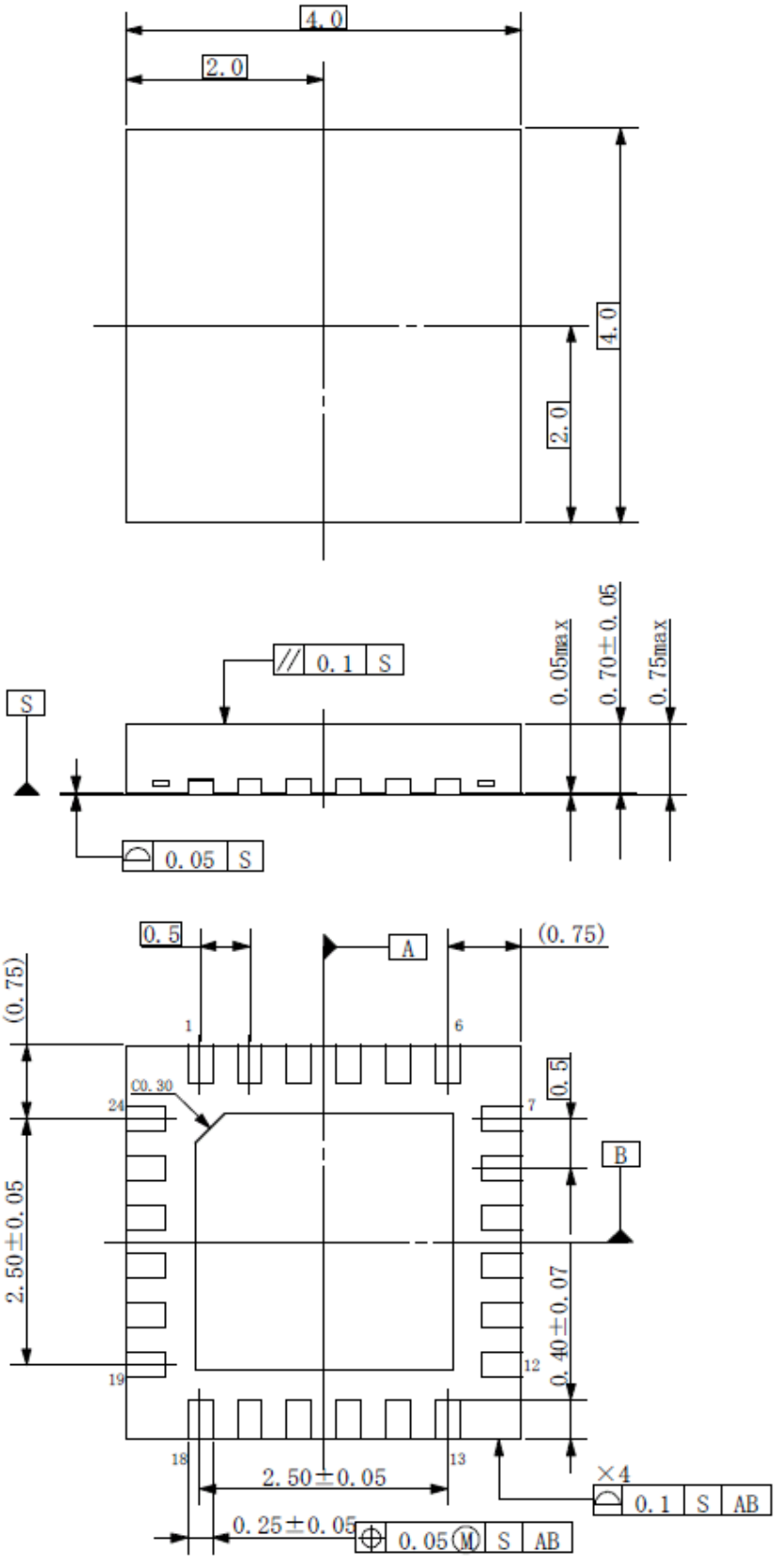
SSOP20-P-225-0.65A Unit : mm




Weight: 0.09g(typ.)

**P-WQFN24-0404-0.50-004**

Unit: mm




Weight: 0.03g(typ.)

## Notes on Contents

### 1. Block Diagrams

Some of the functional blocks, circuits, or constants in the block diagram may be omitted or simplified for explanatory purposes.

### 2. Equivalent Circuits

The equivalent circuit diagrams may be simplified or some parts of them may be omitted for explanatory purposes.

### 3. Timing Charts

Timing charts may be simplified for explanatory purposes.

### 4. Application Circuits

The application circuits shown in this document are provided for reference purposes only. Thorough evaluation is required, especially at the mass production design stage.

Toshiba does not grant any license to any industrial property rights by providing these examples of application circuits.

### 5. Test Circuits

Components in the test circuits are used only to obtain and confirm the device characteristics. These components and circuits are not guaranteed to prevent malfunction or failure from occurring in the application equipment.

## IC Usage Considerations

### Notes on handling of ICs

[1] The absolute maximum ratings of a semiconductor device are a set of ratings that must not be exceeded, even for a moment. Do not exceed any of these ratings.

Exceeding the rating(s) may cause the device breakdown, damage or deterioration, and may result injury by explosion or combustion.

[2] Use an appropriate power supply fuse to ensure that a large current does not continuously flow in case of over current and/or IC failure. The IC will fully break down when used under conditions that exceed its absolute maximum ratings, when the wiring is routed improperly or when an abnormal pulse noise occurs from the wiring or load, causing a large current to continuously flow and the breakdown can lead smoke or ignition. To minimize the effects of the flow of a large current in case of breakdown, appropriate settings, such as fuse capacity, fusing time and insertion circuit location, are required.

[3] If your design includes an inductive load such as a motor coil, incorporate a protection circuit into the design to prevent device malfunction or breakdown caused by the current resulting from the inrush current at power ON or the negative current resulting from the back electromotive force at power OFF. IC breakdown may cause injury, smoke or ignition.

Use a stable power supply with ICs with built-in protection functions. If the power supply is unstable, the protection function may not operate, causing IC breakdown. IC breakdown may cause injury, smoke or ignition.

[4] Do not insert devices in the wrong orientation or incorrectly.

Make sure that the positive and negative terminals of power supplies are connected properly.

Otherwise, the current or power consumption may exceed the absolute maximum rating, and exceeding the rating(s) may cause the device breakdown, damage or deterioration, and may result injury by explosion or combustion.

In addition, do not use any device that is applied the current with inserting in the wrong orientation or incorrectly even just one time.

## Points to remember on handling of ICs

(1) Over current Protection Circuit

Over current protection circuits (referred to as current limiter circuits) do not necessarily protect ICs under all circumstances. If the over current protection circuits operate against the over current, clear the over current status immediately.

Depending on the method of use and usage conditions, such as exceeding absolute maximum ratings can cause the over current protection circuit to not operate properly or IC breakdown before operation. In addition, depending on the method of use and usage conditions, if over current continues to flow for a long time after operation, the IC may generate heat resulting in breakdown.

(2) Thermal Shutdown Circuit

Thermal shutdown circuits do not necessarily protect ICs under all circumstances. If the thermal shutdown circuits operate against the over temperature, clear the heat generation status immediately.

Depending on the method of use and usage conditions, such as exceeding absolute maximum ratings can cause the thermal shutdown circuit to not operate properly or IC breakdown before operation.

(3) Heat Radiation Design

In using an IC with large current flow such as power amp, regulator or driver, please design the device so that heat is appropriately radiated, not to exceed the specified junction temperature ($T_j$) at any time and condition. These ICs generate heat even during normal use. An inadequate IC heat radiation design can lead to decrease in IC life, deterioration of IC characteristics or IC breakdown. In addition, please design the device taking into considerate the effect of IC heat radiation with peripheral components.

(4) Back-EMF

When a motor rotates in the reverse direction, stops or slows down abruptly, a current flow back to the motor's power supply due to the effect of back-EMF. If the current sink capability of the power supply is small, the device's motor power supply and output pins might be exposed to conditions beyond absolute maximum ratings. To avoid this problem, take the effect of back-EMF into consideration in system design.

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