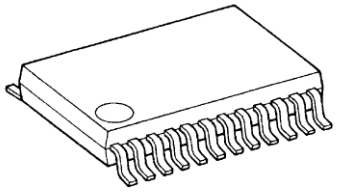
Toshiba Bi-CD Integrated Circuit Silicon Monolithic

# TB6612FNG

Driver IC for Dual DC motor

TB6612FNG is a driver IC for DC motor with output transistor in LD MOS structure with low ON-resistor. Two input signals, IN1 and IN2, can choose one of four modes such as CW, CCW, short brake, and stop mode.



SSOP24-P-300-0.65A

Weight: 0.14 g (typ.)

## Features

- Power supply voltage: VM = 15 V(Max)
- Output current: $I_{OUT}$ = 1.2 A(ave)/3.2 A (peak)
- Output low ON resistor: 0.5Ω (upper+lower Typ. @ VM ≥ 5 V)
- Standby (Power save) system
- CW/CCW/short brake/stop function modes
- Built-in thermal shutdown circuit and low voltage detecting circuit
- Small faced package(SSOP24: 0.65 mm Lead pitch)

* 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.

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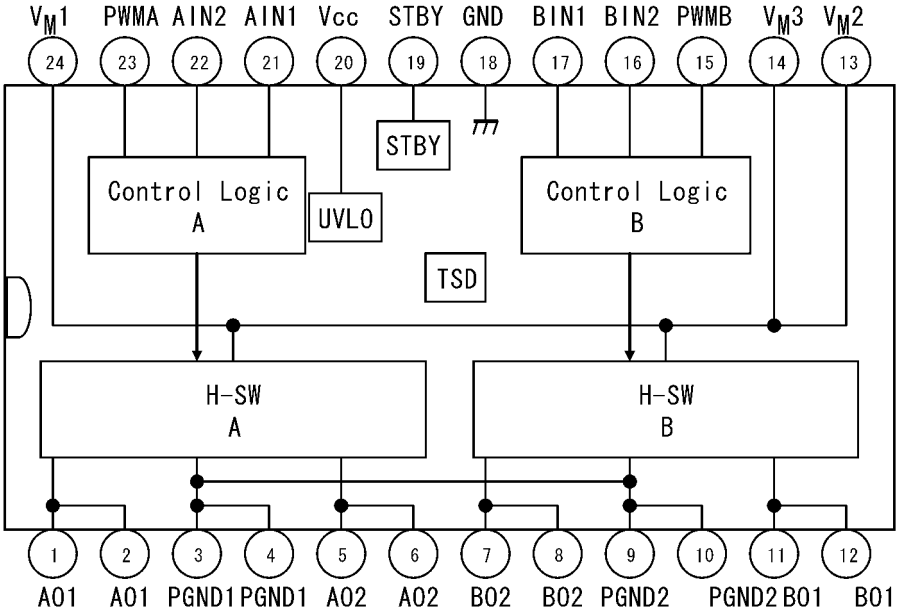
## Block Diagram




## Pin Functions

| No. | Pin Name | I/O | Function |
|---|---|---|---|
| 1 | AO1 | O | ch A output 1 |
| 2 | AO1 | | |
| 3 | PGND1 | — | Power GND 1 |
| 4 | PGND1 | | |
| 5 | AO2 | O | ch A output 2 |
| 6 | AO2 | | |
| 7 | BO2 | O | ch B output 2 |
| 8 | BO2 | | |
| 9 | PGND2 | — | Power GND 2 |
| 10 | PGND2 | | |
| 11 | BO1 | O | ch B output 1 |
| 12 | BO1 | | |
| 13 | VM2 | — | Motor supply |
| 14 | VM3 | | |
| 15 | PWMB | I | ch B PWM input/200 kΩ pull-down at internal |
| 16 | BIN2 | I | ch B input 2/200 kΩ pull-down at internal |
| 17 | BIN1 | I | ch B input 1/200 kΩ pull-down at internal |
| 18 | GND | — | Small signal GND |
| 19 | STBY | I | “L” = standby/200 kΩ pull-down at internal |
| 20 | Vcc | — | Small signal supply |
| 21 | AIN1 | I | ch A input 1/200 kΩ pull-down at internal |
| 22 | AIN2 | I | ch A input 2/200 kΩ pull-down at internal |
| 23 | PWMA | I | ch A PWM input/200 kΩ pull-down at internal |
| 24 | VM1 | — | Motor supply |

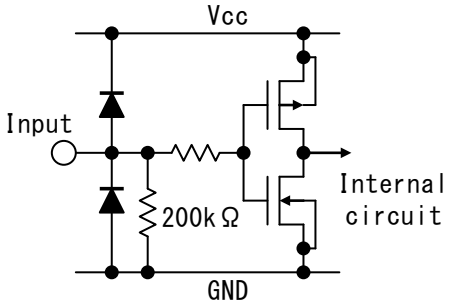
## Absolute Maximum Ratings (Ta = 25°C)

| Characteristics | Symbol | Rating | Unit | Remarks |
|---|---|---|---|---|
| Supply voltage | VM | 15 | V | |
| | $V_{CC}$ | 6 | | |
| Input voltage | $V_{IN}$ | -0.2 to 6 | V | IN1,IN2,STBY,PWM pins |
| Output voltage | $V_{OUT}$ | 15 | V | O1,O2 pins |
| Output current | $I_{OUT}$ | 1.2 | A | Per 1 ch |
| | $I_{OUT}$ (peak) | 2 | | tw = 20 ms Continuous pulse, Duty ≤ 20% |
| | | 3.2 | | tw = 10 ms Single pulse |
| Power dissipation | $P_D$ | 0.78 | W | IC only |
| | | 0.89 | | 50 mm × 50 mm t = 1.6 mm Cu ≥ 40% in PCB mounting |
| | | 1.36 | | 76.2 mm × 114.3 mm t = 1.6 mm Cu ≥ 30% in PCB mounting |
| Operating temperature | $T_{opr}$ | -20 to 85 | °C | |
| Storage temperature | $T_{stg}$ | -55 to 150 | °C | |

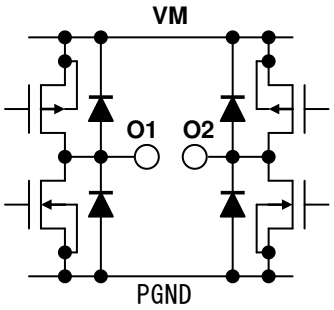
## Operating Range (Ta = -20 to 85°C)

| Characteristics | Symbol | Min | Typ. | Max | Unit | Remarks |
|---|---|---|---|---|---|---|
| Supply voltage | $V_{CC}$ | 2.7 | 3 | 5.5 | V | |
| | VM | 2.5 | 5 | 13.5 | V | |
| Output current (H-SW) | $I_{OUT}$ | — | — | 1.0 | A | VM ≥ 4.5 V |
| | | — | — | 0.4 | | 4.5 V > VM ≥ 2.5 V Without PWM Operation |
| Switching frequency | $f_{PWM}$ | — | — | 100 | kHz | |

**Input pin:** IN1, IN2, PWM, STBY




**Output pin:** O1, O2

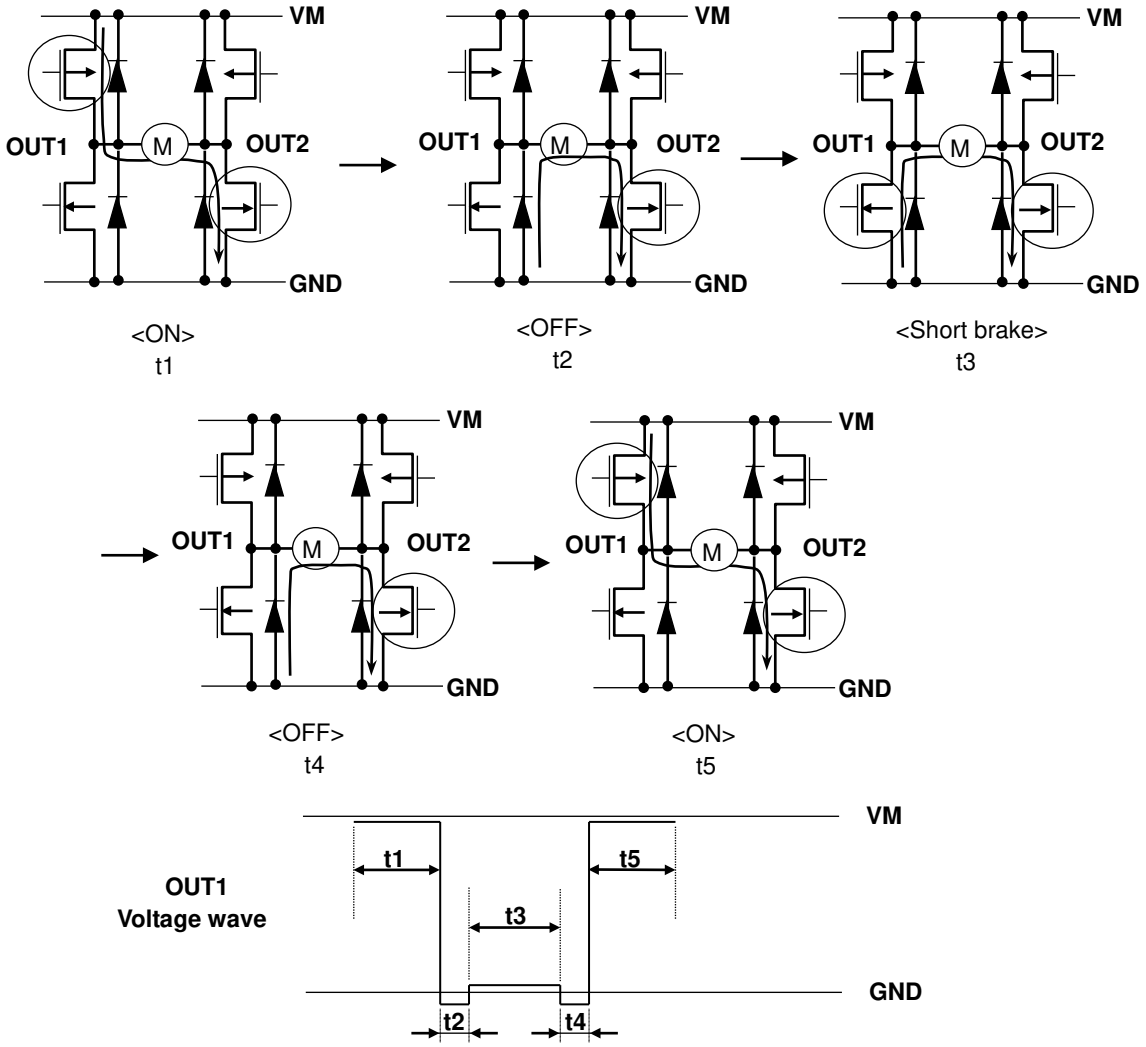


## H-SW Control Function

| Input | | | | Output | | |
|---|---|---|---|---|---|---|
| IN1 | IN2 | PWM | STBY | OUT1 | OUT2 | Mode |
| H | H | H/L | H | L | L | Short brake |
| L | H | H | H | L | H | CCW |
| | | L | H | L | L | Short brake |
| H | L | H | H | H | L | CW |
| | | L | H | L | L | Short brake |
| L | L | H | H | OFF (High impedance) | | Stop |
| H/L | H/L | H/L | L | OFF (High impedance) | | Standby |

## H-SW Operating Description

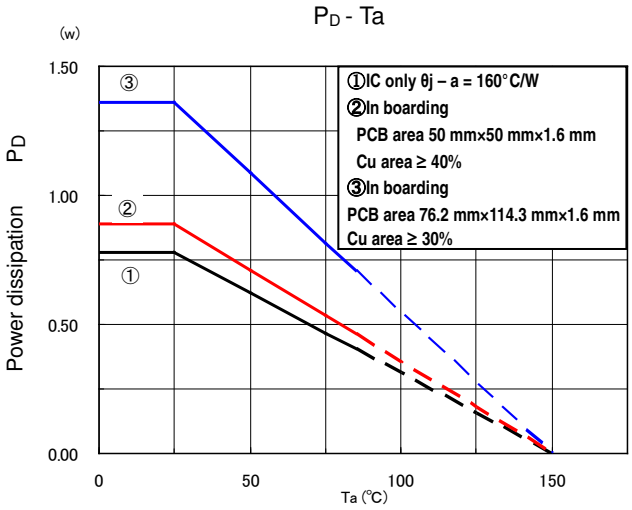
・To prevent penetrating current, dead time t2 and t4 is provided in switching to each mode in the IC.

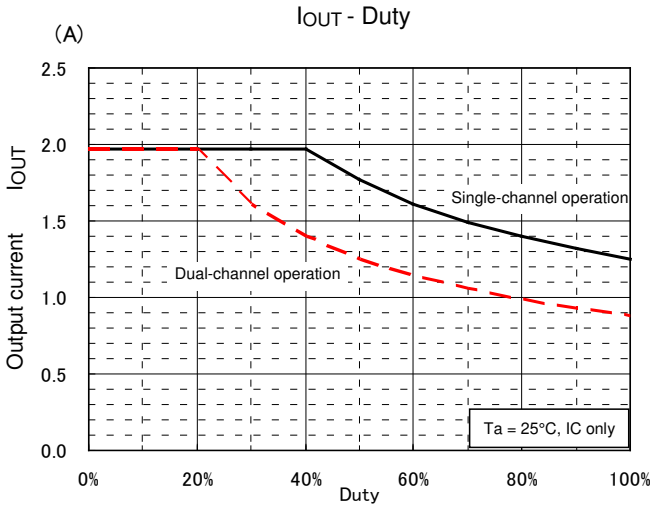


## Electrical Characteristics (unless otherwise specified, Ta = 25°C, Vcc = 3 V, VM = 5 V)

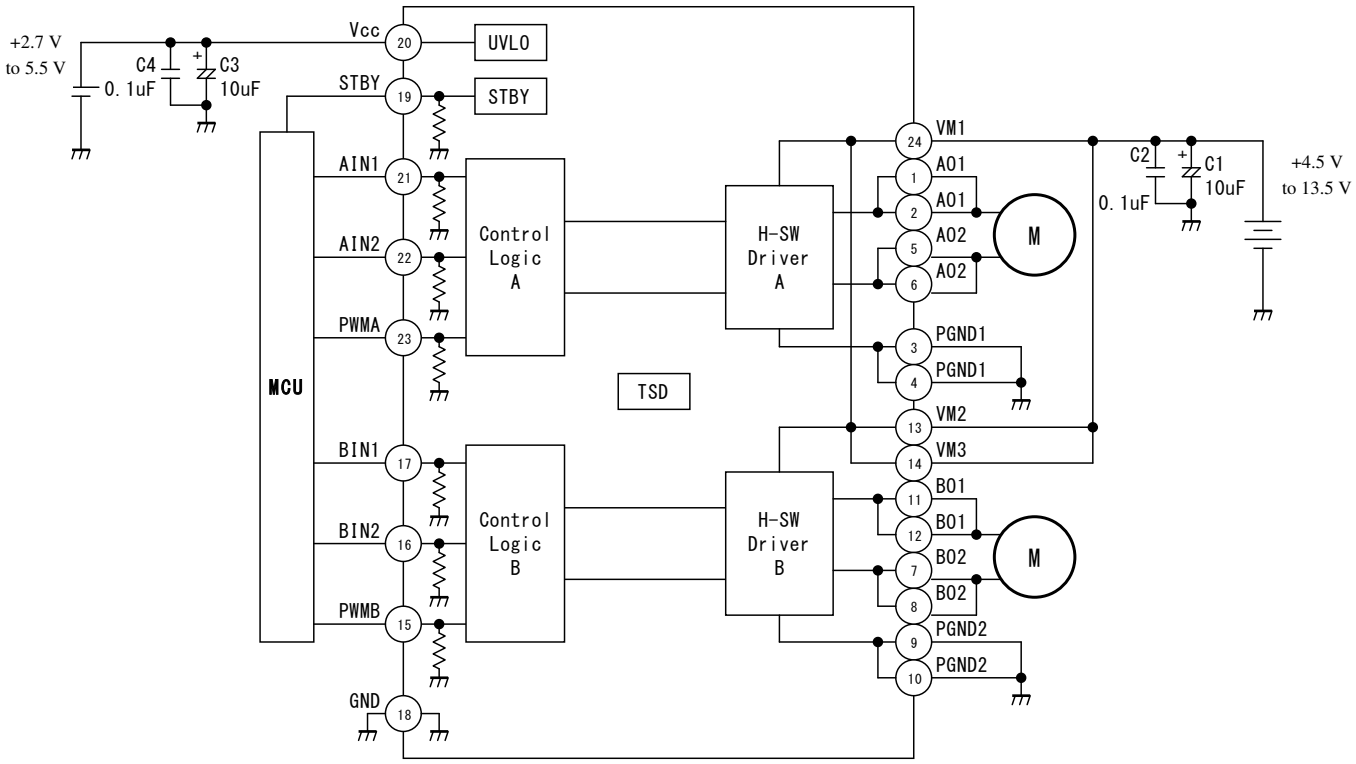
| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Supply current | $I_{CC}$(3 V) | STBY = Vcc = 3 V, VM = 5 V | — | 1.1 | 1.8 | mA |
| | $I_{CC}$(5.5 V) | STBY = Vcc = 5.5 V, VM = 5 V | — | 1.5 | 2.2 | |
| | $I_{CC(STB)}$ | STBY = 0 V | — | — | 1 | μA |
| | $I_{M(STB)}$ | | — | — | 1 | |
| Control input voltage | $V_{IH}$ | — | Vcc×0.7 | — | Vcc+0.2 | V |
| | $V_{IL}$ | | -0.2 | — | Vcc×0.3 | |
| Control input current | $I_{IH}$ | $V_{IN}$ = 3 V | 5 | 15 | 25 | μA |
| | $I_{IL}$ | $V_{IN}$ = 0 V | — | — | 1 | |
| Standby input voltage | $V_{IH(STB)}$ | — | Vcc×0.7 | — | Vcc+0.2 | V |
| | $V_{IL(STB)}$ | | -0.2 | — | Vcc×0.3 | |
| Standby input current | $I_{IH(STB)}$ | $V_{IN}$ = 3 V | 5 | 15 | 25 | μA |
| | $I_{IL(STB)}$ | $V_{IN}$ = 0 V | — | — | 1 | |
| Output saturating voltage | $V_{sat(U+L)1}$ | $I_O$ = 1 A, Vcc = VM = 5 V | — | 0.5 | 0.7 | V |
| | $V_{sat(U+L)2}$ | $I_O$ = 0.3 A, Vcc = VM = 5 V | — | 0.15 | 0.21 | |
| Output leakage current | $I_{L(U)}$ | VM = $V_{OUT}$ = 15 V | — | — | 1 | μA |
| | $I_{L(L)}$ | VM = 15 V, $V_{OUT}$ = 0 V | -1 | — | — | |
| Regenerative diode VF | $V_{F(U)}$ | $I_F$ = 1A | — | 1 | 1.1 | V |
| | $V_{F(L)}$ | | — | 1 | 1.1 | |
| Low voltage detecting voltage | UVLD | (Design target only) | — | 1.9 | — | V |
| Recovering voltage | UVLC | | — | 2.2 | — | |
| Response speed | $t_r$ | (Design target only) | — | 24 | — | ns |
| | $t_f$ | | — | 41 | — | |
| | Dead time H to L | Penetration protect time (Design target only) | — | 50 | — | |
| | Dead time L to H | | — | 230 | — | |
| Thermal shutdown circuit operating temperature | TSD | (Design target only) | — | 175 | — | °C |
| Thermal shutdown hysteresis | ΔTSD | | — | 20 | — | |

## Target characteristics



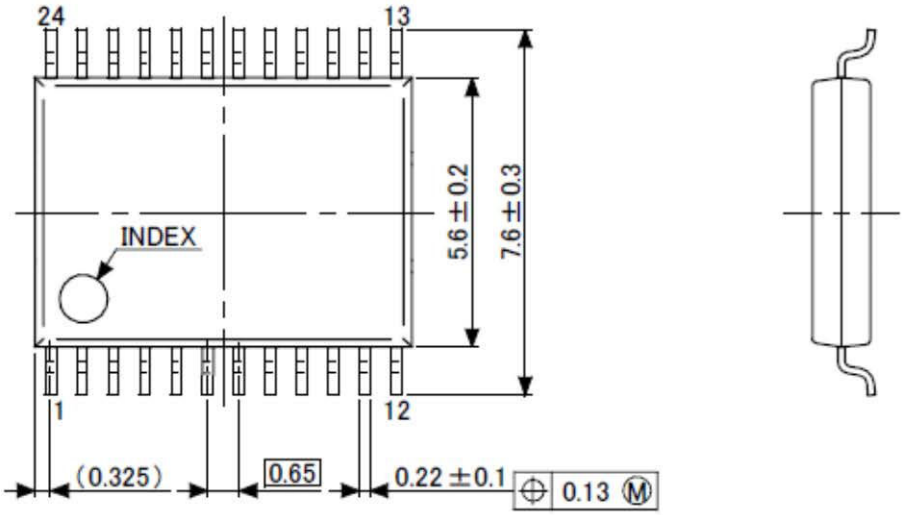
## Typical Application Diagram

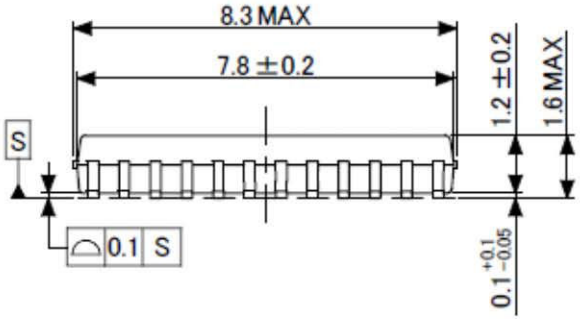



Note: Condensers for noise absorption (C1, C2, C3, and C4) should be connected as close as possible to the IC.

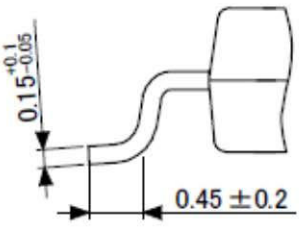
## Package Dimennsions

SSOP24-P-300-0.65A "Unit : mm"




**Detail of a terminal**




Weght: 0.14 g (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.
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### 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) 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.

(2) 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 (Tj) 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.

(3) 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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