TOSHIBA BiCD Integrated Circuit Silicon Monolithic

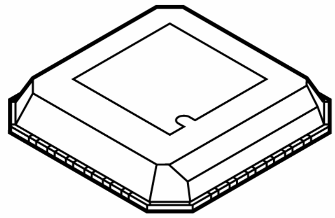
TB6594FLG

Dual DC Motor Driver with Boost DC-DC Converter

The TB6594FLG is a dual DC motor driver IC using LDMOS output transistors with low ON-resistance.

Four operation modes are selectable via IN1 and IN2: forward, reverse, short brake and stop.

The TB6594FLG incorporates boost DC-DC converter with a 5-V output, which can be used as a power supply for other ICs.



QON24-P-0505-0.50

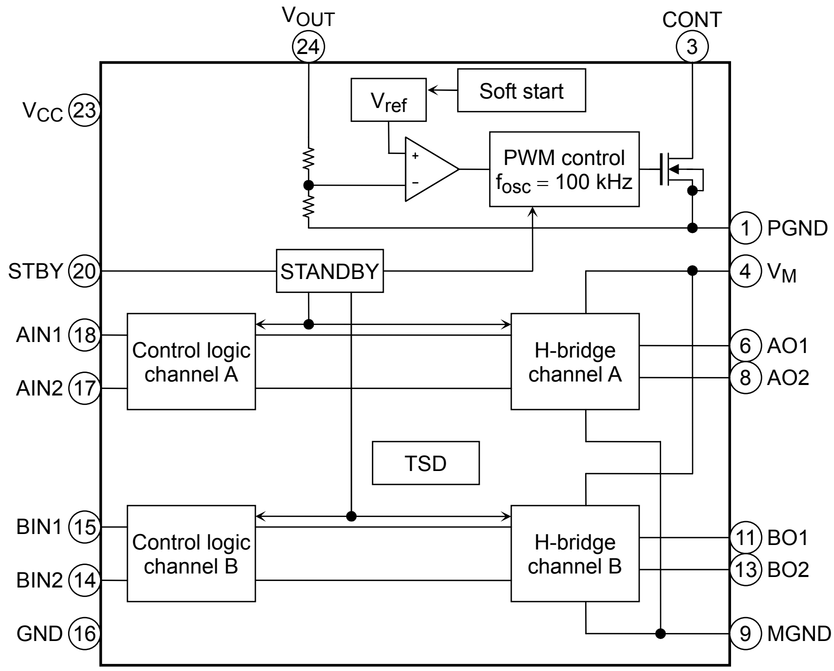
Weight: 0.05 g (typ.)

Features

- Power supply voltage: V_M = 2.2 V to 5.5 V
- Output current: I_{OUT} = 0.8 A (max) (H-bridge output)
- Output ON-resistance: 15 Ω (upper and lower sum (typ.) @V_M = 5 V)
- Dedicated standby (power-save) pin
- Forward, reverse, short brake and stop
- Boost DC-DC converter: V_{OUT} = 5.0 V (typ.)
- Boost DC-DC converter efficiency: 80% (typ.)
- Thermal shutdown (TSD)
- Small surface-mount package (QON24)

*: 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.

Block Diagram



Pin Functions

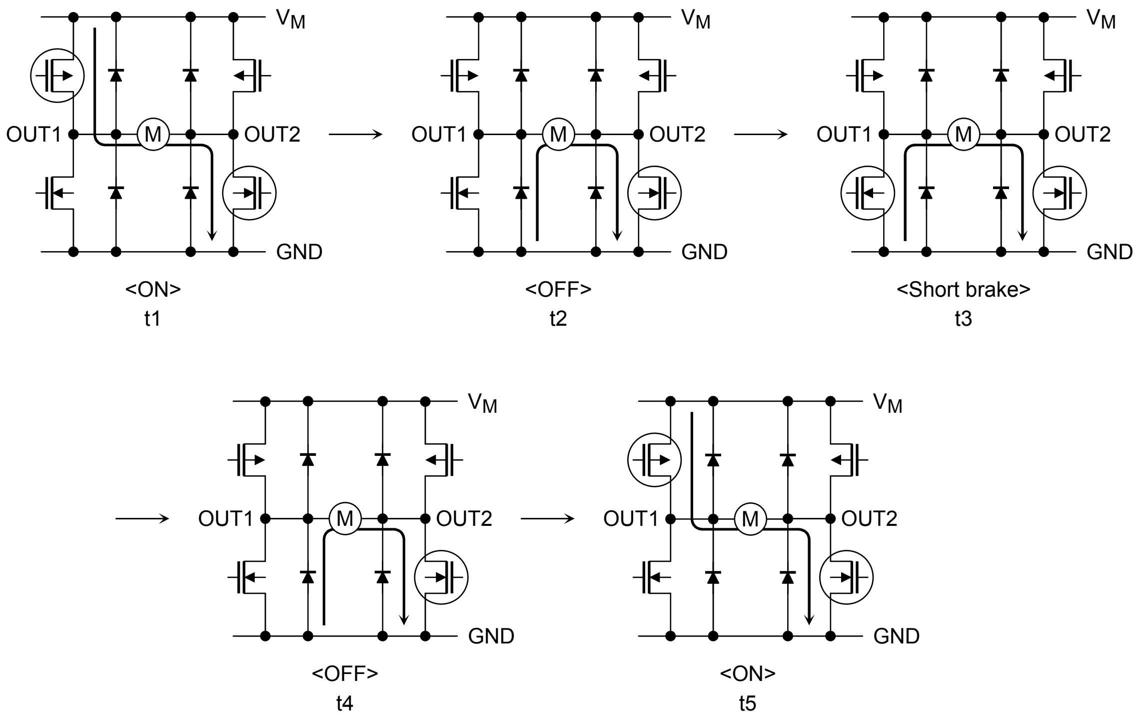
Pin No.	Symbol	Function	Remarks
1	PGND	DC-DC converter ground pin	
2	(NC)	No connect	
3	CONT	DC-DC converter switching pin	An external inductor is connected to this pin.
4	V_M	Motor power supply pin	V_M = 2.2 to 5 V
5	(NC)	No connect	
6	AO1	Channel-A motor output 1	
7	(NC)	No connect	
8	AO2	Channel-A motor output 2	
9	MGND	Motor ground	
10	(NC)	No connect	
11	BO1	Channel-B motor output 1	
12	(NC)	No connect	
13	BO2	Channel-B motor output 2	
14	BIN2	Channel-B motor control input 2	
15	BIN1	Channel-B motor control input 1	
16	GND	Small signal ground	
17	AIN2	Channel-A motor control input 2	
18	AIN1	Channel-A motor control input 1	
19	(NC)	No connect	
20	STBY	Standby control input	L = Standby (Output: Off)
21	(NC)	No connect	
22	(NC)	No connect	
23	V_{CC}	Small-signal power supply	V_{CC} = 2.7 to 5 V
24	V_{OUT}	DC-DC converter output	

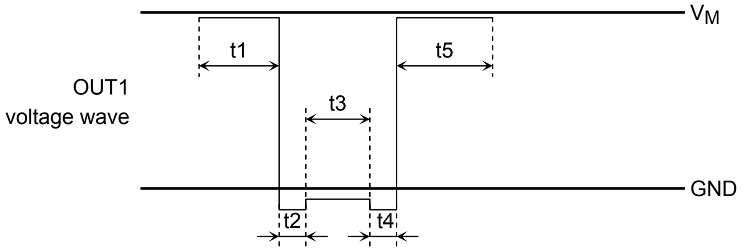
Function Table for H-Bridge Control

Input			Output		
IN1	IN2	STBY	OUT1	OUT2	Drive Mode
H	H	H	L	L	Short brake
L	H	H	L	H	Reverse/forward
H	L	H	H	L	Forward/reverse
L	L	H	OFF (high-impedance)		Stop
H/L	H/L	L	OFF (high-impedance)		Standby

Functional Description of H-Bridge Driver

To eliminate shoot-through current, a dead time (t2, t4) of 300 ns (design target only) is inserted when the PWM is turned on and off.

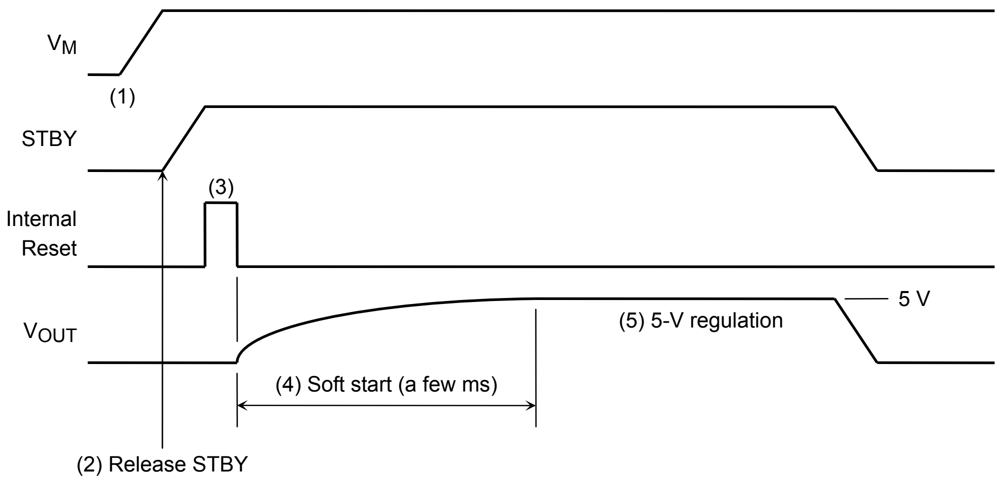




Functional Description of DC-DC Converter

STBY	V_{OUT} (DC-DC converter output)	Remarks
L	Standby (Off)	H-bridge transistors: Off
H	On (Constant voltage)	V_{OUT} reaches 5 V after the soft-start time.

Control Input Sequence



(1) Turn on V_M.
(2) Release STBY (from Low to High).
(3) The internal logic is reset.
(4) A soft-start operation is started.
(5) V_{OUT} reaches 5 V.

Note: If the V_{OUT} output voltage falls below the undervoltage lockout (UVLO) trip threshold due to an overload condition or a short-circuit, UVLO circuitry is activated to prevent large inrush currents. As a result, the TB6594FLG operates in the following sequence:

1. Resets the internal logic.
2. Soft-start operation.
3. V_{OUT} reaches 5 V.

Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit	Remarks
Supply voltage	V_M	5.5	V	
	V_{CC}	5.5		
Input voltage	V_{IN}	−0.2 to 5.5	V	AIN1, AIN2, BIN1, BIN2 and STBY pins
Output voltage	V_{OUT}	5.5	V	AO1, AO2, BO1 and BO2 pins
	V_{CONT}	5.5		CONT pin
Output current	I_{OUT}	0.8	A	AO1, AO2, BO1 and BO2 pins
	I_{CONT}	0.5		CONT pin
Power dissipation	P_D	0.78	W	
Operating temperature	T_{opr}	−20 to 85	°C	
Storage temperature	T_{stg}	−55 to 150	°C	

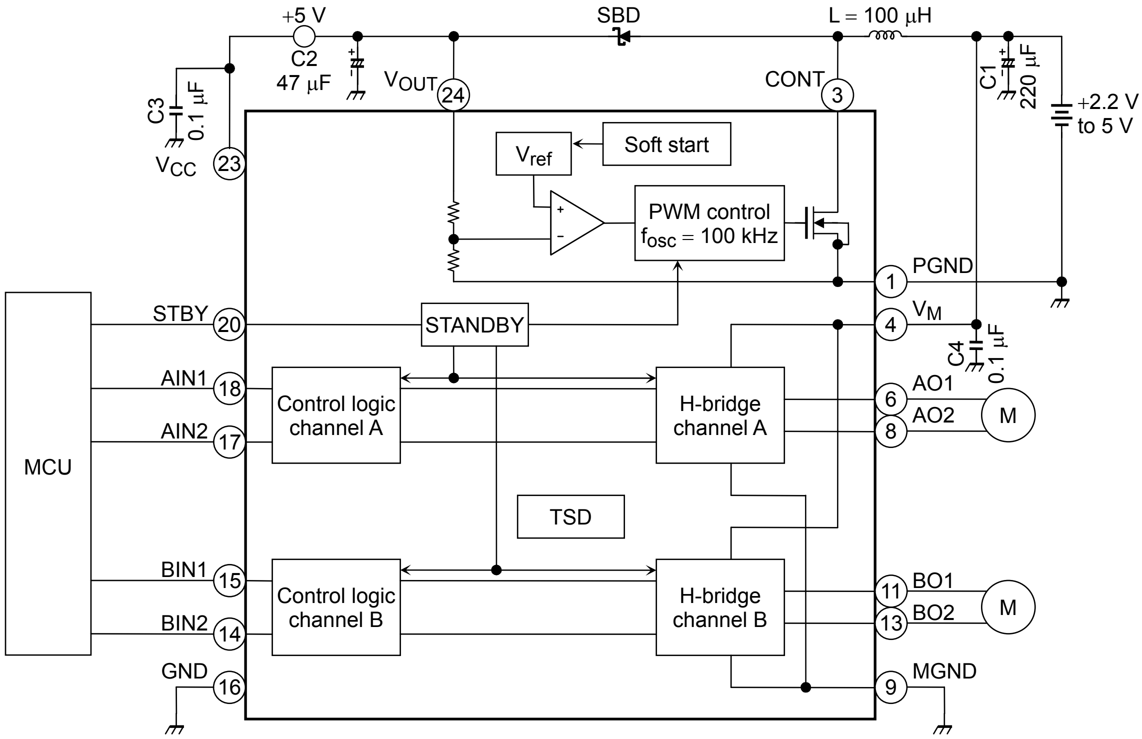
Operating Ranges (Ta = −20 to 85°C)

Characteristics	Symbol	Min	Typ.	Max	Unit
Supply voltage	V_{CC}	2.7	3	5	V
	V_M	2.2	3	5	V
Output current (H-bridge)	I_{OUT}	—	—	0.6	A

Electrical Characteristics (unless otherwise specified, V_{CC} = 3 V, V_M = 5 V, Ta = 25°C)

Section	Characteristics	Symbol	Test Condition		Min	Typ.	Max	Unit
DC-DC Converters	Output voltage	V_{OUT}		V_M = 2.4 V	4.75	5	5.25	V
	Input voltage	V_{IN}			—	—	5	V
	Turn-on voltage	V_{ST1}	I_{OUT} = 1 mA		—	—	2.2	V
	Oscillation start voltage	V_{ST2}	No load, V_{OUT} = variable		—	—	2	V
	Undervoltage lockout (UVLO) threshold	V_{LD}	I_{OUT} = 1 mA, V_{IN} = variable		—	—	1.9	V
	Output current	I_{OUT1}	No load, V_{OUT} = 4.75 V		—	420	600	μA
		$I_{OUT (STB)}$	STBY = 0 V		—	0	0.5	μA
	H-bridge transistor ON-resistance	Rsw (on)	V_{CONT} = 0.4 V		—	1	2	Ω
	H-bridge transistor leakage current	ILCONT	V_{OUT} = V_{CONT} = 5.5 V		—	0	1	μA
	Line regulation	ΔV_{OUT}	V_M = 2.2 V to 3 V		—	10	60	mV
	Load regulation	Vo load	I_{OUT} = 10 μA to 50 mA		—	150	250	mV
	Oscillation frequency	f_{osc}	Obtained by monitoring the V_{CONT} waveform.		70	100	130	kHz
	Maximum duty cycle	Maxduty			78	87	92	%
	Efficiency	EFFI			—	80	—	%
	Soft-start time	T_{ss}	RL = 5 kΩ		2.5	5	7.5	ms
H-Bridge Drivers	Supply current	I_{CC}	STBY = V_{CC}		—	0.23	0.5	mA
		$I_{CC (STB)}$	STBY = 0 V		—	0	1	μA
		$I_{M (STB)}$			—	0	1	μA
	Control input voltage	V_{IH}			2	—	V_{CC} + 0.2	V
		V_{IL}			−0.2	—	0.8	V
		$V_{IN (his)}$	(Design target only)		—	0.2	—	V
	Control input voltage	I_{IH}	V_{IN} = 3 V		5	15	25	μA
		I_{IL}	V_{IN} = 0 V		—	0	1	μA
	Standby input voltage	$V_{IH (STB)}$			2	—	V_{CC} + 0.2	V
		$V_{IL (STB)}$			−0.2	—	0.8	V
	Standby input current	$I_{IH (STB)}$	V_{IN} = 3 V		15	40	80	μA
		$I_{IL (STB)}$	V_{IN} = 0 V		—	0	1	μA
	Output saturation voltage	$V_{sat (U + L)}$	I_O = 0.2 A		—	0.2	0.4	V
			I_O = 0.6 A		—	0.6	1.2	V
	Output leakage current	$I_{L (U)}$	V_M = AO1, AO2, BO1, BO2 = 5.5 V		—	0	1	μA
		$I_{L (L)}$	V_M = 5.5 V, AO1, AO2, BO1, BO2 = 0 V		−1	0	—	μA
	Diode forward voltage	$V_{F (U)}$	I_F = 0.6 A		—	0.9	1.2	V
		$V_{F (L)}$			—	0.9	1.2	V
TSD	Thermal shutdown threshold	TSD	(Design target only)		—	170	—	°C
	Thermal shutdown hysteresis	ΔTSD			—	20	—	°C

Application Circuit Example



L: CD54 inductor with an inductance of 100 μH from Sumida Corporation (or its equivalent)
SBD: MA720 from Matsushita Electric Industrial Co., Ltd. (or its equivalent)
C2: Tantalum electrolytic capacitor with a capacitance of 47 μF from Nichicon Corporation (or its equivalent)

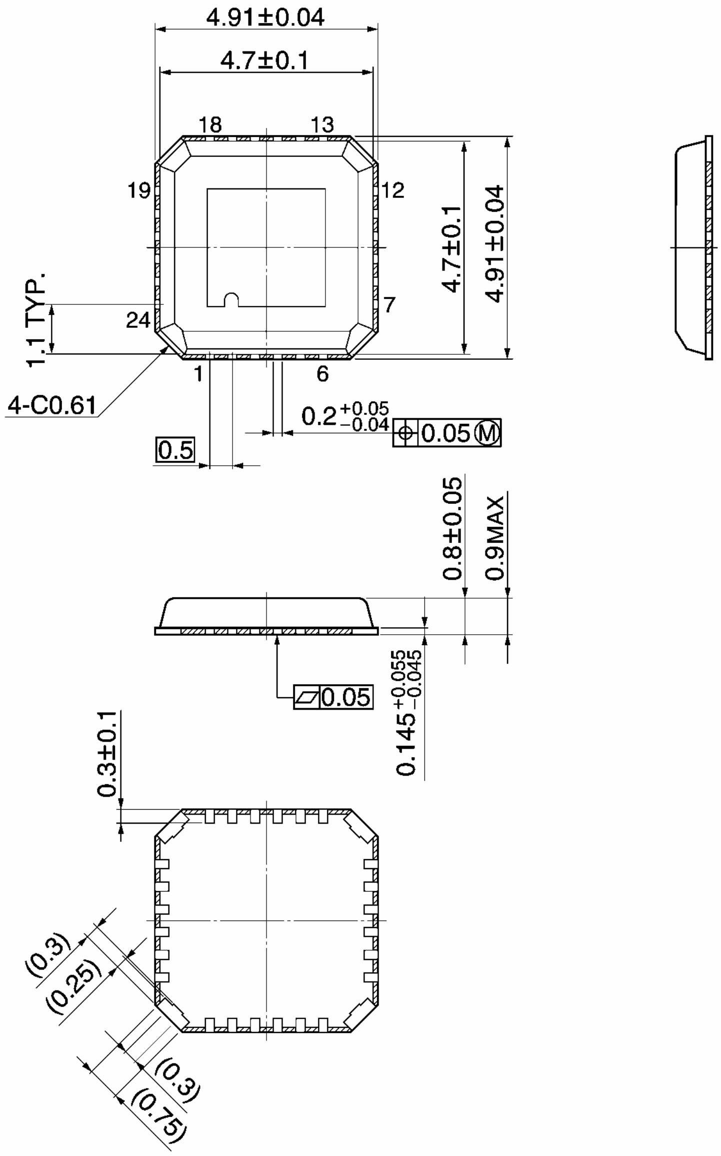
Note: Bypass capacitors should be places as close to the IC as possible.

Usage Considerations

- Though the TB6594FLG has thermal shutdown (TSD) circuitry, 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 permanent damage of the IC.
  These possibilities should be fully considered in the design of the output, V_{CC} and ground lines.
- The IC should be installed correctly. Otherwise, the IC or peripheral parts and devices may be degraded or permanently damaged.

Package Dimensions

QON24-P-0505-0.50 Unit: mm



Note 1) The solder plating portion in four corners of tne package shall not be treated as an external terminal.

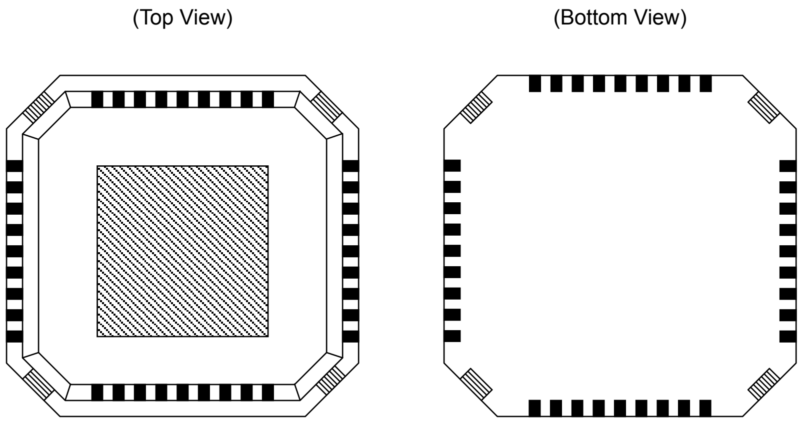
Note 2) Don`t carry out soldering to four corners of the package.

Note 3) [hatched area] area : Resin surface

Weight: 0.05 g (typ.)

QON Package Considerations

Package Appearances



Please follow the following guidelines for the QON package.

Guidelines:

(1) The solder plated pads at the four corners of the package (shaded areas in the bottom view) should not be soldered for the purpose of improving the mechanical strength of solder joints.

(2) When using the TB6594FLG, it should be ensured that the thermal pad and solder plated pads (shaded areas in the top and bottom views) are electrically insulated (Note).

Note: Care should be taken in the board design to prevent solder for through-hole joints from flowing to the solder plated pads on the bottom of the package (shaded areas in the bottom view).

- When mounting or soldering this package, care must be taken to avoid electrostatic discharge or electrical overstress to the IC. (This is to avoid electrical leakage and a buildup of electrostatic charge in the end product.)
- It should be ensured that no voltage is directly applied to the solder plated pads when designing the PC board.

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) 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 maximum ratings. To avoid this problem, take the effect of back-EMF into consideration in system design.

About solderability, following conditions were confirmed

- Solderability

(1) Use of Sn-37Pb solder Bath
- solder bath temperature = 230°C
- dipping time = 5 seconds
- the number of times = once
- use of R-type flux

(2) Use of Sn-3.0Ag-0.5Cu solder Bath
- solder bath temperature = 245°C
- dipping time = 5 seconds
- the number of times = once
- use of R-type flux