

TB6614FNG Usage considerations

Summary

The TB6614FNG is a driver IC for DC motor. H-SW circuit is constructed by adopting the LDMOS structure with low ON-resistor in the output transistors. Modes of CW, CCW, Short brake, and Stop mode are selectable and the direct PWM drive is available.

<p>This is a reference. Please do not determine the final equipment design by this material.</p>
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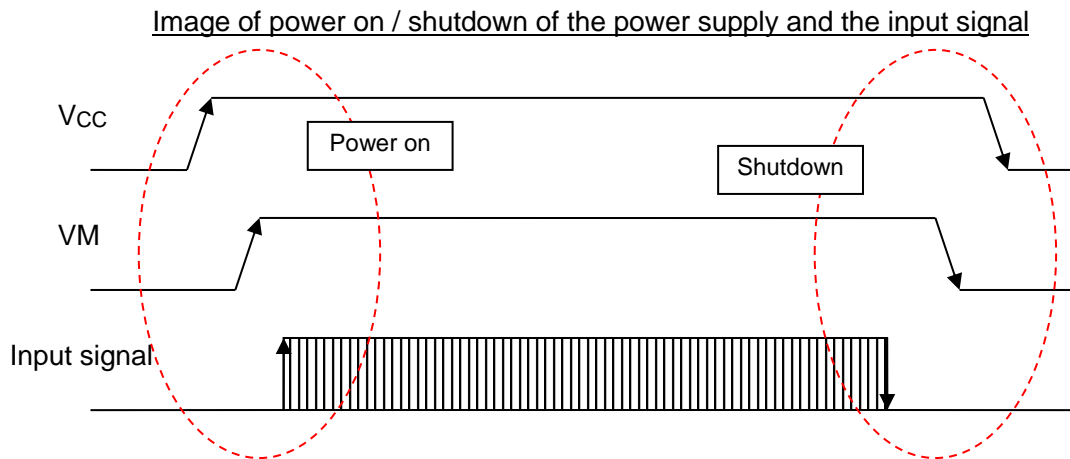
1. Power Supply Voltage

(1) Operation power supply voltage

Characteristic	Symbol	Supply voltage	Unit
Supply voltage	V _{CC}	2.7 to 5.5	V
	V _M	2.5 to 13.5	V

(2) Power on / Shut down

- ① Please apply the power supply of VM after the power of VCC is turned on.
(Input the input signal after the power of VCC is turned on and settled.)
- ② Please shut down the power supply of VCC after turning off the input signal, shutting down the VM, and confirming the voltage decreases enough.



In powering on and shutting down, STBY should be set to low level (Standby mode) to avoid the error in supplying V_{CC}.

2. Output Current

Absolute maximum rating is 4.5 A (peak). It must not be exceeded, even for a moment. Average tolerant current is limited by total dissipation. Recommended operation range is 1.0 A or less when the power supply voltage of V_M is 4.5 V or more. And when V_M range is 2.5 V to 4.5 V, the recommended operation range is 0.5 A or less. Pay attention not to exceed the dissipation in using the IC.

3. Control Input

Please input each signal after V_{CC} is tuned on.
Input voltage is TTL level (0.8 to 2.0 V) compatible.

(1) IN1 and IN2 signal input

Output mode can be chosen by IN1 or IN2 input.

Input signal of 3 V line can control the IC when V_{IN} (H) is 2.0 V and V_{IN} (L) is 0.8 V. Pull down resistance of 200 k Ω (typ.) is incorporated.

(2) Standby input

All output transistors are off by setting STBY pin to low level (Standby mode).

Input signal of 3 V line can control the IC when VIN (H) is 2.0 V and VIN (L) is 0.8 V.

Pull down resistance of 200 kΩ (typ.) is incorporated. The IC operation moves to standby mode when input pin is open.

(3) Direct PWM signal input

PWM pin is a direct PWM signal input pin

Direct PWM function (Common for channel A and B)

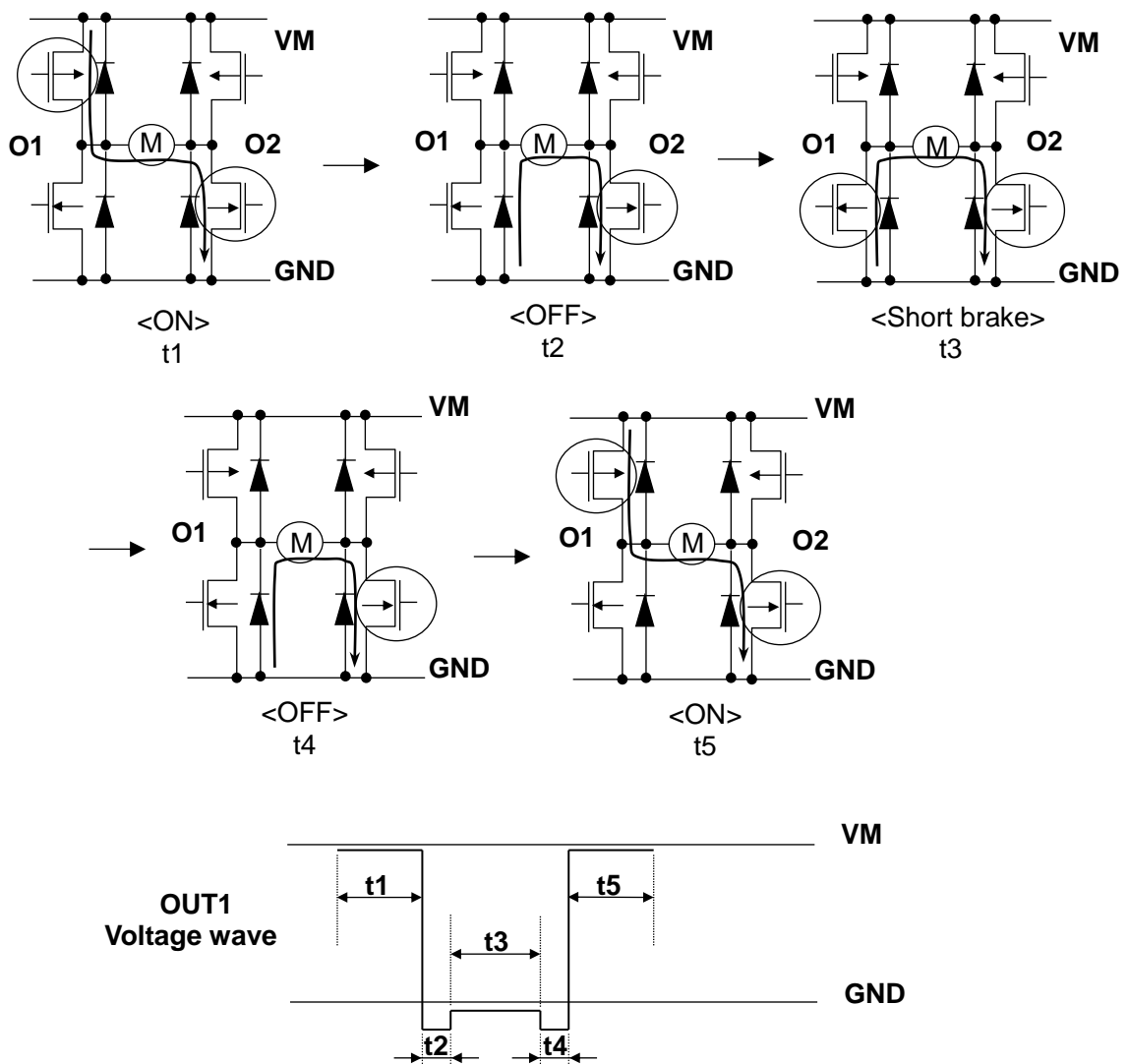
Input				Output		
IN1	IN2	STBY	PWM	O1	O2	Mode
H	H	H	H	L	L	Short brake
			L			
L	H	H	H	L	H	CW/CCW
			L	L	L	Short brake
H	L	H	H	H	L	CCW/CW
			L	L	L	Short brake
L	L	H	H	OFF (High impedance)		Stop
			L			
H/L	H/L	L	H	OFF (High impedance)		Standby
			L			

4. PWM Operation

During PWM operation, normal operation and short brake operation are repeated.

If the upper and lower power transistors in the output circuit were ON at the same time, a shoot-through current would be produced. To prevent this current from being produced, dead time of t_2 and t_4 (typ. = 80 ns) are provided in switching to each mode in the IC when either of the transistors changes from ON to OFF, or vice versa.

Therefore, synchronous rectification PWM control is realized without an OFF time being inserted by external input. Note that a dead time is also provided in the IC at the time of transition between CW and CCW or between CW (CCW) and short brake mode, thereby eliminating the need for an OFF time.



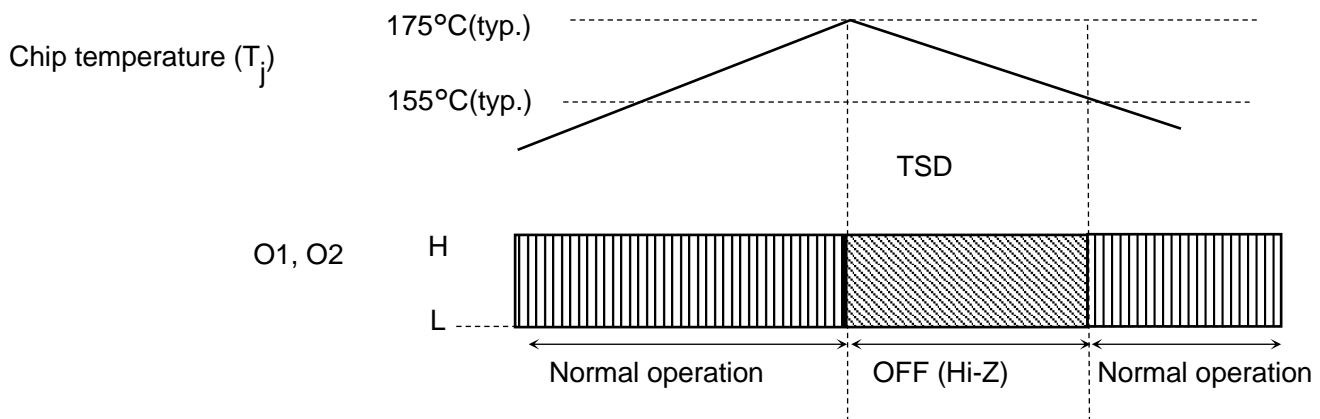
5. Protect Circuit

This IC includes the functions below but it does not necessary protect ICs under all circumstances. Be sure to use the IC within the rating. If a short circuit takes place between output pins or if an output pin is connected to the voltage source or ground directory, a heavy current temporarily flows though the IC. It might destroy the IC.

<Thermal shutdown circuit (TSD)>

- The TB6614FNG incorporates a thermal shutdown circuit. If the junction temperature (T_j) exceeds 175°C (typ.), all outputs are turned off (Hi-Z).
- The TB6614FNG has a hysteresis of 20°C (typ.). The IC operation resumes automatically when the IC temperature becomes 155°C (typ.) or less.

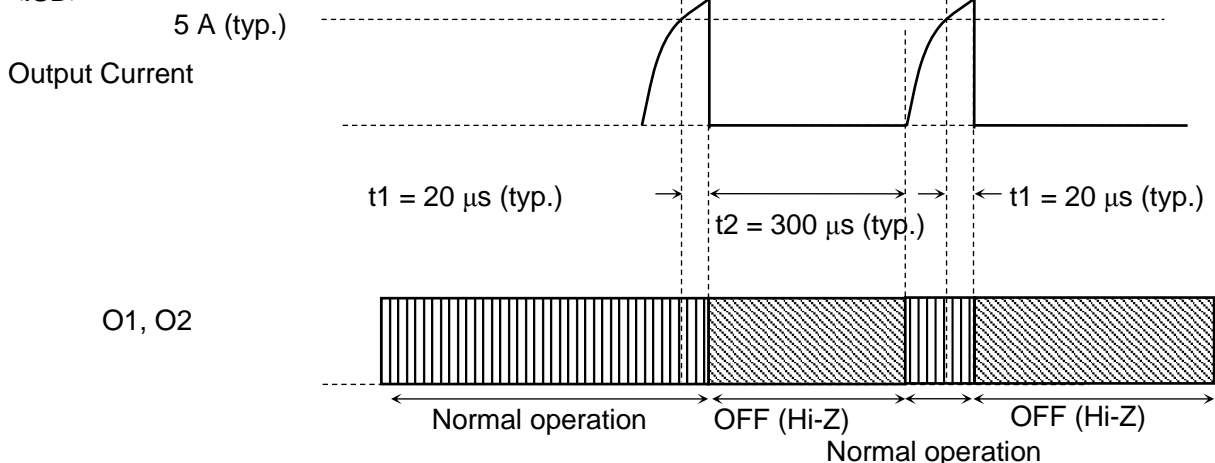
<Thermal Shutdown>



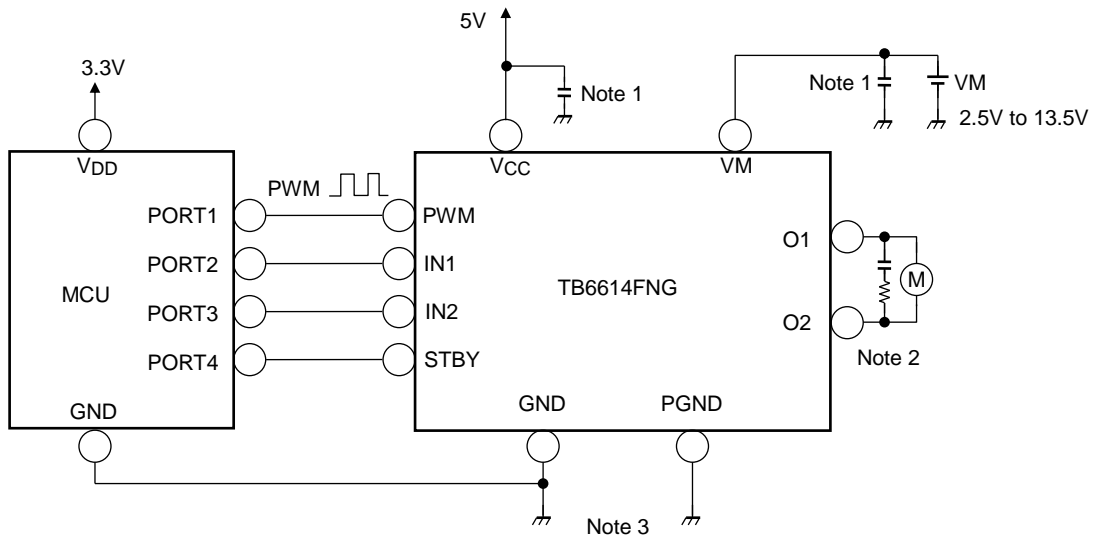
<Overcurrent Protection Circuit (ISD)>

- The TB6614FNG monitors a current flowing through each of the four output power transistors. If the current of any output power transistor exceeds the configured limit, this circuit turns off all outputs.
- This circuit has a timer that turns off the outputs for t_2 after detection of an overcurrent, and then turns them on again automatically. If the overcurrent continues to flowing, this ON-OFF operation is repeated. Note that to prevent a malfunction due to an abnormality, an insensitive period of t_1 is provided.
- The design target value for current limit is 5.0 A (typ.)

<ISD>



6. Application Circuit Example



- Note 1: Capacitors for noise absorption of Vcc and VM power supplies should be connected as close as possible to the IC.
- Note 2: Please add a resistor to charge the current limitation, if the capacitor is adopted between the motor pins to avoid noise.
- Note 3: Please avoid common impedance between GND and PGND as possible.
- Others: Design with extra care for Vcc, VM, GND, and PGND lines as there is a possibility of IC destruction occurred by short circuit between output pins, power supply to output pin, ground to output pin, or adjacent pins.
Please use fuse or current confine device for the application safety, when the current beyond the absolute maximum rating would generate through the IC.

*) Capacitor for supply pin
<Recommended value>

Capacitor	Recommended values	Remarks
C1 (Between V _{CC} and GND)	10 μF to 33 μF	Electrolytic capacitor
	0.001 μF to 0.1 μF	Ceramic capacitor
C2 (Between VM and GND)	10 μF to 100 μF	Electrolytic capacitor
	0.001 μF to 0.1 μF	Ceramic capacitor

7. Calculation of Power Dissipation

Power dissipation is calculated by the formula below.

$$P = V_{cc} \times I_{cc} + I_o^2 \times R_{on} \text{ (upper + lower)}$$

When the ambient temperature is high, the dissipation becomes low. Design the radiation taking enough margins by applying $P_d - T_a$ property data.

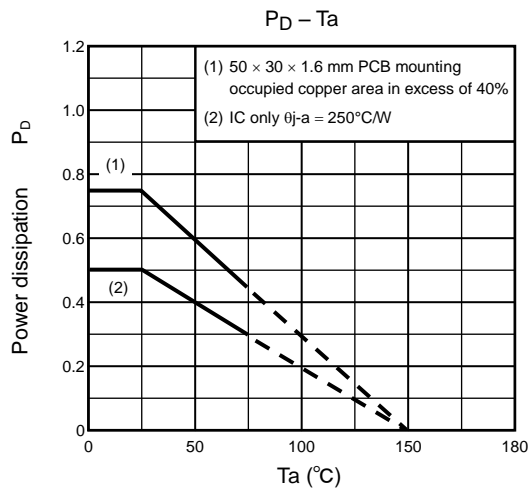
The relation between ambient temperature and junction temperature is calculated by the formula below. Be sure to set the junction temperature 150 °C or less.

$$T_j = P \times R_{th} (j-a) + T_a$$

* $R_{th} (j-a)$: Heat resistance between junction and ambient temperature

* T_a : Ambient temperature

Pay attention that $R_{th} (j-a)$ depends on the usage circumstances (ex. mounted board). (Reference data of transient heat resistance in boarding only IC or constant conditioned IC is shown below.



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 (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 consideration 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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