TB6552FNG/FTG
Usage considerations

Description

TB6552FNG/FTG is a dual H- bridge driver for DC brush motor.
Modes of CW, CCW, Short brake, and Stop mode are selectable and the direct PWM drive is available.

Toshiba Electronic Devices & Storage Corporation

The contents described in the application note are reference for evaluating the product. Therefore, the contents described cannot be guaranteed. As for the detailed materials, please check the data sheet.

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1. Power Supply Voltage

1.1. Operation power supply voltage

Table 1.1 Operation power supply voltage

Characteristic	Symbol	Supply voltage	Unit
Supply voltage	V_{CC}	2.7 to 5.5	V
	VM	2.5 to 13.5	V

1.2. Power on / Shut down

① Please apply the power supply of VM after the power of V_{CC} is turned on.
(Input the input signal after the power of V_{CC} is turned on and settled.)

② Please shut down the power supply of V_{CC} after turning off the input signal, shutting down the VM, and confirming the voltage decreases enough.

Image of power on / shutdown of the power supply and the input signal

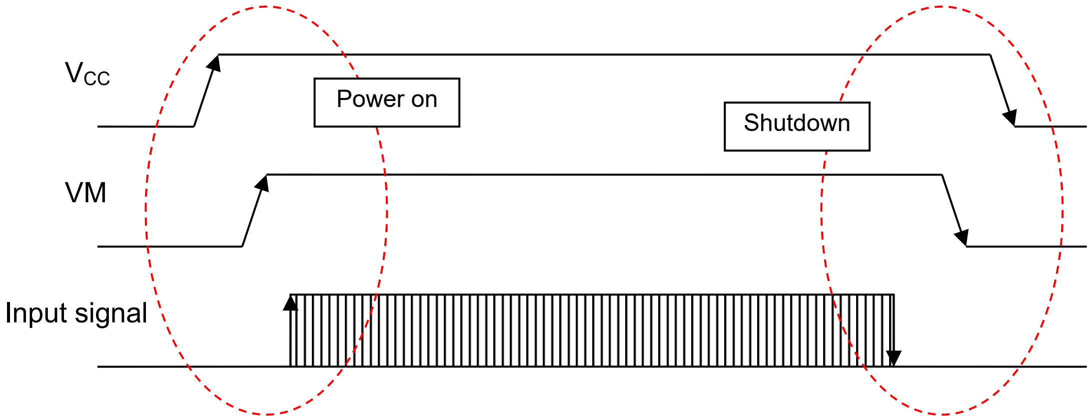

Figure 1.1 Power-on sequence with control input signals

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

2. Output Current

Absolute maximum rating is 1 A (peak). It must not be exceeded, even for a moment. Average tolerant current is limited by total dissipation. Recommended operation range is 0.8 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 V) compatible.

3.1. IN1 (AIN1 for Ach, BIN1 for Bch), IN2 (AIN2 for Ach, BIN2 for Bch), signal input

Output mode can be chosen by IN1 or IN2 input.
Since VIN(H) = 2 V and VIN(L) = 0.8 V, both 5 V and 3 V logic-level input signals are supported.

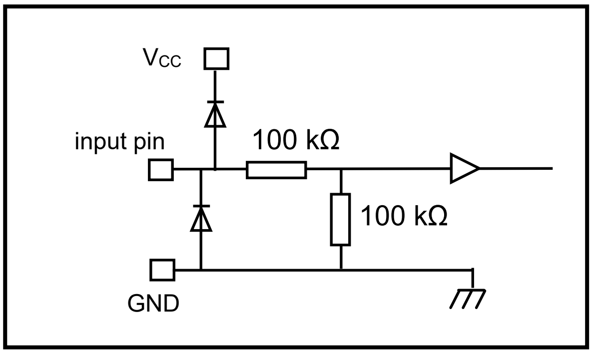

Figure 3.1 Equivalent Circuit of input pin

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

3.2. Standby input

All output transistors are off by setting STBY (ASTBY for Ach, BSTBY for Bch) pin to low level (Standby mode).
Since VIN(H) = 2 V and VIN(L) = 0.8 V, both 5 V and 3 V logic-level input signals are supported.
IC moves to standby mode when input pin is open.

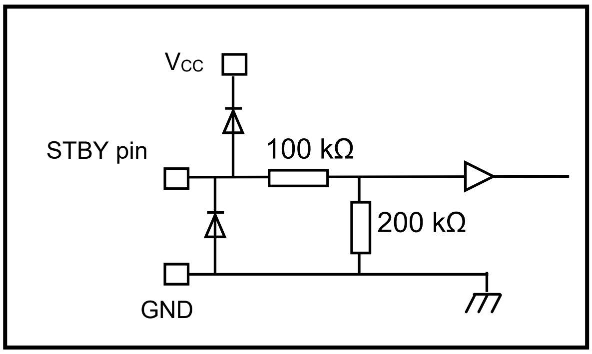

Figure 3.2 Equivalent Circuit of STBY pin

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

3.3. Direct PWM signal input

PWM (APWM for Ach, BPWM for Bch) pin is a direct PWM signal input pin.

Table 3.1 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, a dead time of 300 ns (design target value) is provided 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.

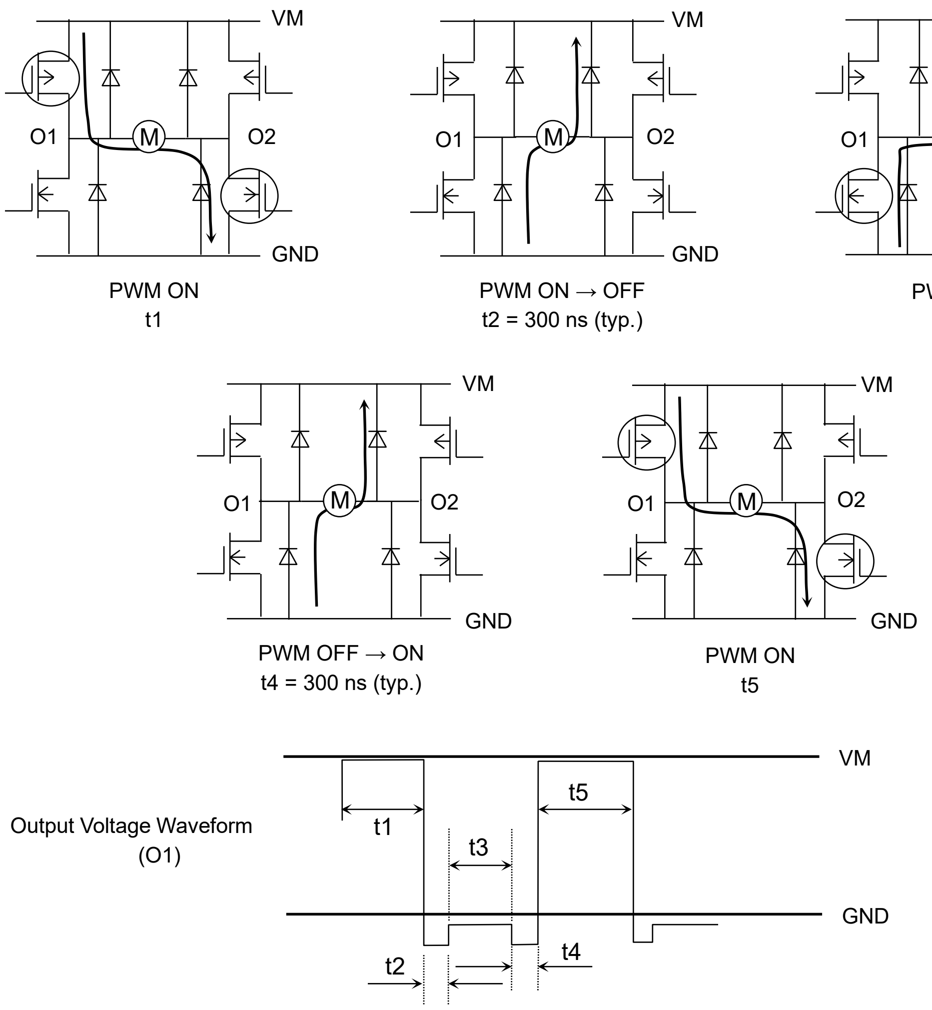

Figure 4.1 PWM operation

5. Protect circuit

This IC includes the functions below but it is not intended to 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>
All outputs turn off when junction temperature exceeds 170 °C (typ.).
It has also temperature hysteresis of 20 °C (typ.). They recover when junction temperature decreases to 150 °C.

6. Application Circuit

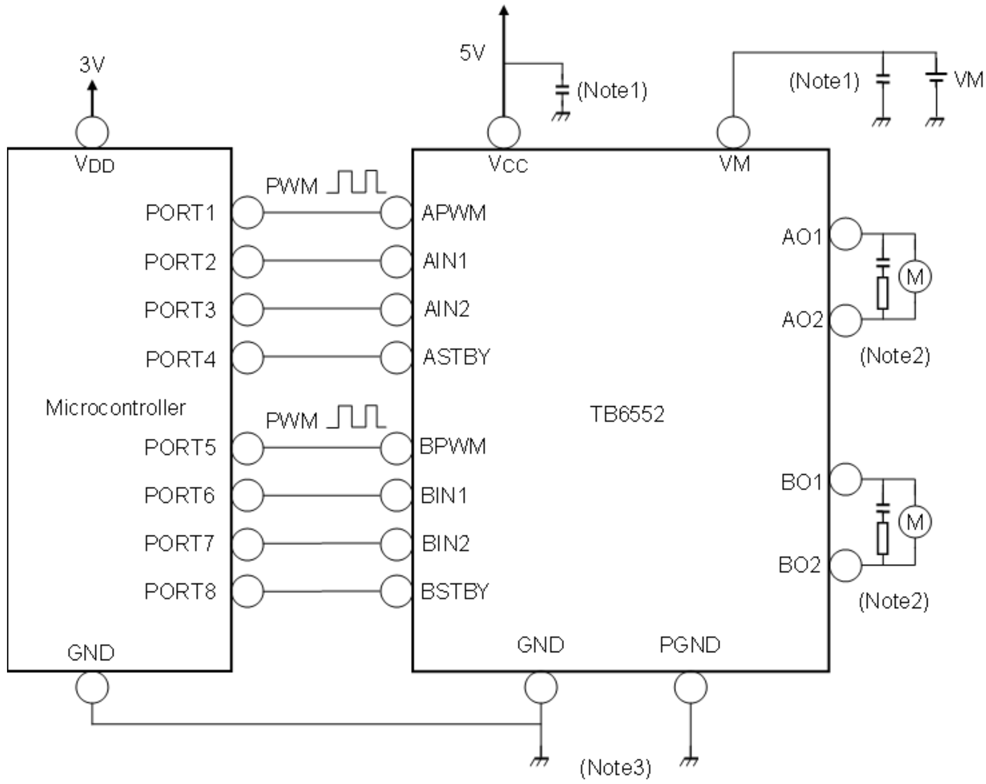

Figure 6.1 Application Circuit

Note1: Connect the capacitor between V_{CC} (VM) and GND as near the IC as possible.
Note2: When connecting the motor pins through the capacitor for reducing noise, connect a resistor to the capacitor to limit the charge current.
Note3: Avoid using common impedance for GND and PGND.

6.1. Capacitor for supply pin <Recommended value>

Table 6.1 Capacitor for supply pin

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.
<PWM Duty = 100%>

$P = V_{CC} \times I_{CC} + Io^2 \times Ron$ (upper + lower)

When the ambient temperature is high, the dissipation becomes low. Design the radiation taking enough margins by applying Pd - Ta 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.

Tj = P × Rth (j-a) + Ta
Rth (j-a): Heat resistance between junction and ambient temperature
Ta: Ambient temperature

Pay attention that Rth (j-a) depends on the usage circumstances (ex. mounted board).
(The reference data for thermal resistance, measured with the IC alone or mounted on a board under the following conditions, are shown below.)

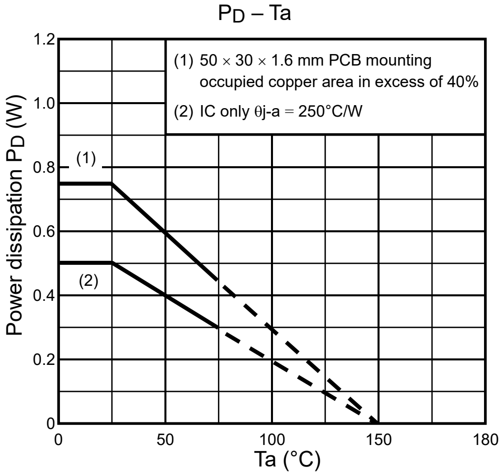

Figure 7.1 PD - Ta

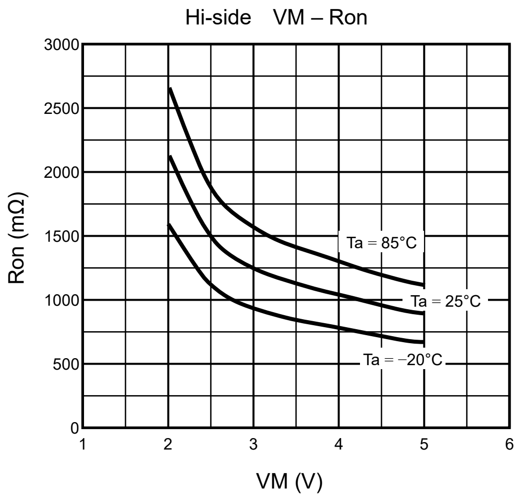

Figure 7.2 Hi-side VM – Ron

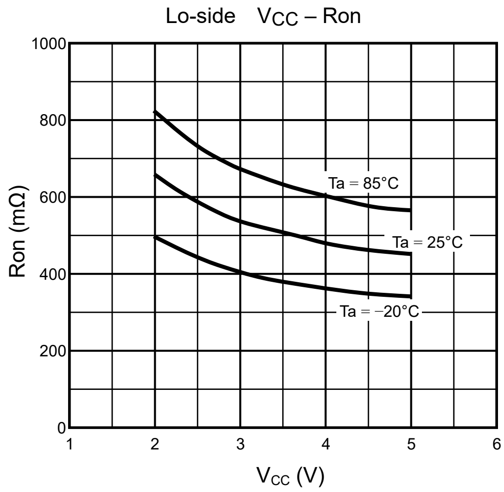

Figure 7.3 Lo-side V_{CC} - Ron

8. Others

TB6552FNG/FTG has a CMOS device in the control circuit and has a LDMOS (Pch/Nch) device in output circuit.
Generally, MOS devices are highly sensitive to electrostatic discharge. When handling them, ensure that the environment is protected against electrostatic discharge.

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 (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.

(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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