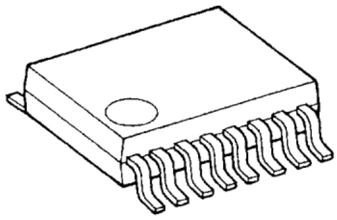
Toshiba Bi-CD Integrated Circuit Silicon Monolithic

TB6552FNG, TB6552FTG

DUAL-BRIDGE DRIVER IC FOR DC MOTORS

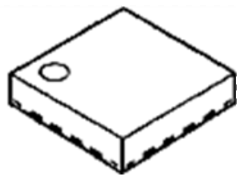
The TB6552FNG/FTG is a dual-bridge driver IC for DC motors with output transistors in an LD MOS structure with low ON-resistance. Two input signals, IN1 and IN2, can choose one of four modes such as CW, CCW, short brake, and stop mode. A PWM drive system supports high heat efficiency driving.

TB6552FNG



SSOP16-P-225-0.65B

TB6552FTG



P-WQFN16-0303-0.50-0.01

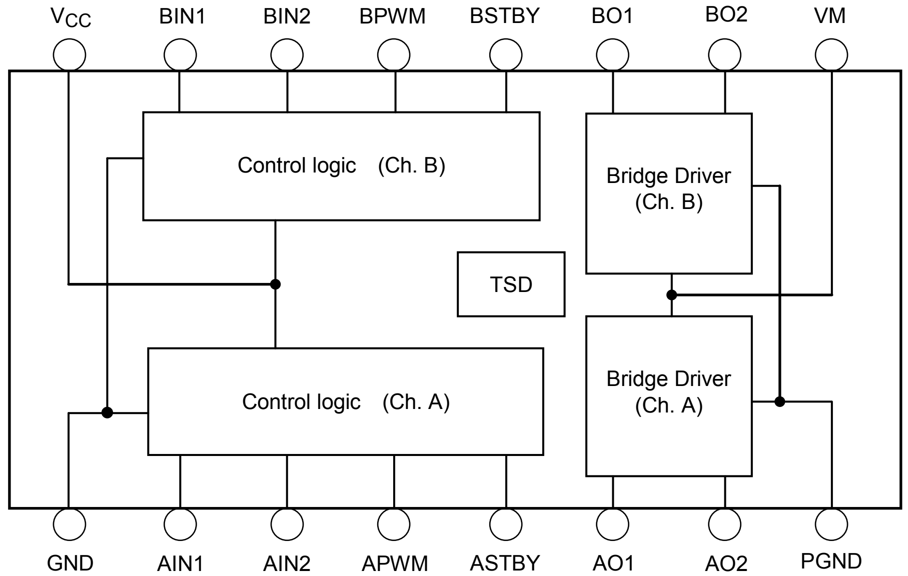
Weight
SSOP16-P-225-0.65B : 0.07 g (typ.)
P-WQFN16-0303-0.50-0.01 : 0.017 g (typ.)

Features

- Power supply voltage for motor: VM ≤ 15 V (max)
- Power supply voltage for control: V_{CC} = 2.7 V to 6.0 V
- Output current: 1 A (max)
- Low ON resistor: 1.5 Ω (typ.)
  (Upper side + lower side combined @ VM = 5 V)
- Direct PWM control
- Standby system (power saving)
- CW/CCW/short brake/stop function modes
- Built-in thermal shutdown circuit
- Package: FNG-SSOP16/FTG-WQFN16

* 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

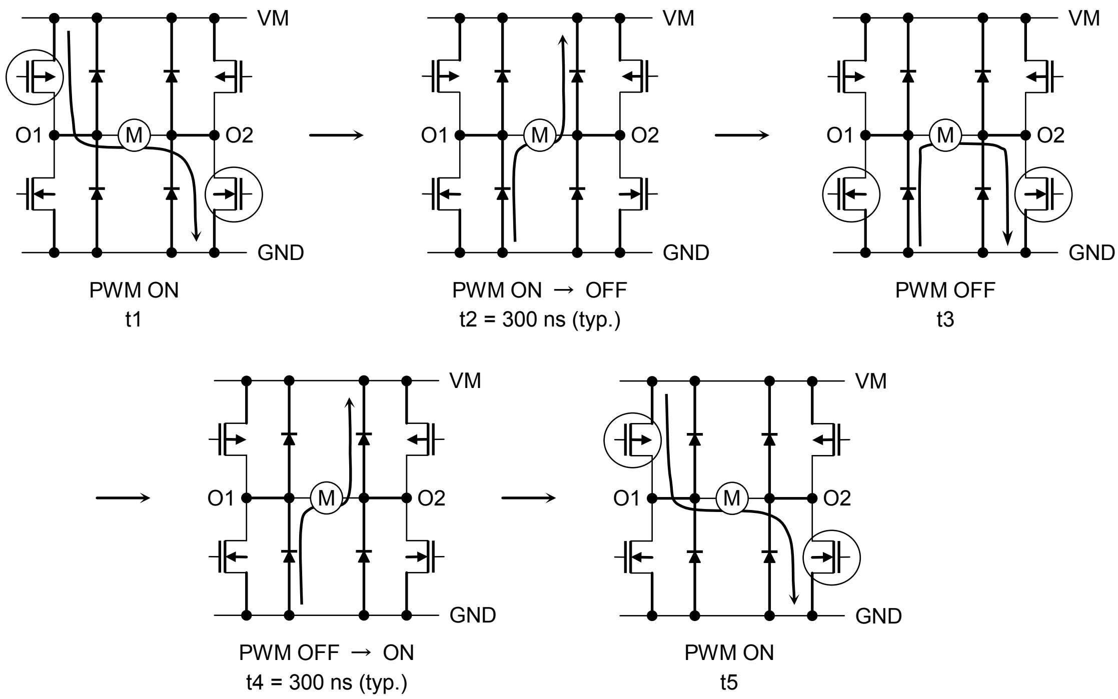
Pin.Name	Pin No		Functional Description	Remarks
	FNG	FTG		
GND	1	11	Small-signal GND pin	GND for small-signal power supply (V_{CC})
AIN1	2	12	Control signal input 1 (Ch. A)	
AIN2	3	13	Control signal input 2 (Ch. A)	
APWM	4	14	PWM control signal input pin (Ch. A)	Input PWM signal
ASTBY	5	15	Standby control input pin (Ch. A)	Ch. A circuit is in standby (power save) state while this signal is Low.
AO1	7	1	Output pin 1 (Ch. A)	Ch. A connect to motor coil pin
AO2	8	2	Output pin 2 (Ch. A)	Ch. A connect to motor coil pin
PGND	9	3	GND pin for motor	GND for motor power supply (VM)
VM	6	16	Motor power supply pin	$VM_{(ope)}$ = 2.5 V to 13.5 V
BO2	10	4	Output pin 2 (Ch. B)	Ch. B connect to motor coil pin
BO1	11	5	Output pin 1 (Ch. B)	Ch. B connect to motor coil pin
BSTBY	12	6	Standby control input pin (Ch. B)	Ch. B circuit is in standby (power save) state while this signal is Low.
BPWM	13	7	PWM control signal input pin (Ch. B)	Input PWM signal
BIN2	14	8	Control signal input 2 (Ch. B)	
BIN1	15	9	Control signal input 1 (Ch. B)	
V_{CC}	16	10	Small-signal power supply pin	$V_{CC\ (ope)}$ = 2.7 V to 5.5 V

Input/Output Function (common for channel A and B)

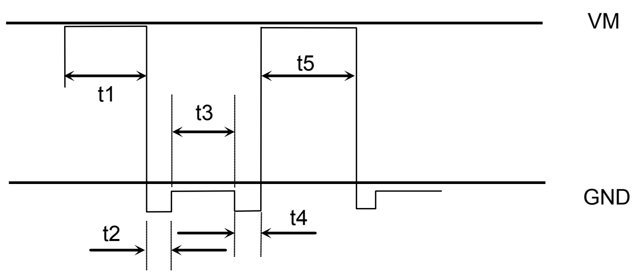
Input				Output		
IN1	IN2	STBY	PWM	O1	O2	Mode
H	H	H	H	L	L	Short brake
			L			
L	H	H	H	L	H	CW/CCW
			L	L	L	Short brake
H	L	H	H	H	L	CCW/CW
			L	L	L	Short brake
L	L	H	H	OFF (high impedance)		Stop
			L			
H/L	H/L	L	H	OFF (high impedance)		Standby
			L			

Operating Description

- PWM control function
  Speed can be controlled by inputting the high-level or low-level PWM signal to the pin PWM.
  When PWM control is provided, normal operation and short brake operation are repeated.
  To prevent penetrating current, dead time (t2 and t4) is provided in the IC.

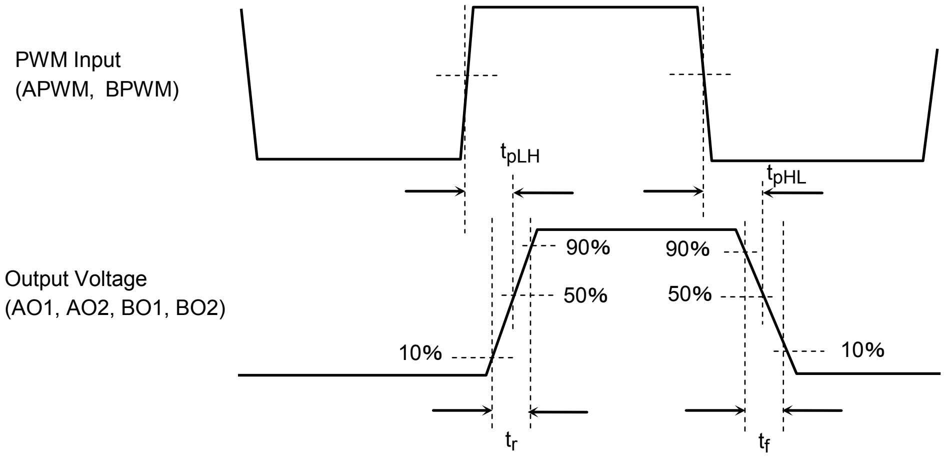


Output Voltage Waveform
(O1)



Note: Be sure to set the PWM pin to high level if the PWM control function is not used.

- Switching characteristics of output transistors
  The switching characteristics between the PWM input and the output transistors are shown below.



<Typical Value>

Item	Typical Value	Unit
t_{pLH}	1000	ns
t_{pHL}	1000	
t_r	100	
t_f	100	

- Input pins
  Input pins AIN1, AIN2, APWM, ASTBY, BIN1, BIN2, BPWM and BSTBY have internal pull-down resistors that are connected to ground.

Absolute Maximum Ratings (T_a = 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, 2, STBY and PWM pins
Output current	I_{OUT}	1	A	
Power dissipation	P_D	0.78 (Note 1)	W	
Operating temperature	T_{opr}	−20 to 85	°C	
Storage temperature	T_{stg}	−55 to 150	°C	

Note 1: This rating is obtained when the product is mounted on a 50 mm × 30 mm × 1.6 mm glass-epoxy PCB of which 40% or more is occupied by copper.

Operating Range (T_a = −20 to 85°C)

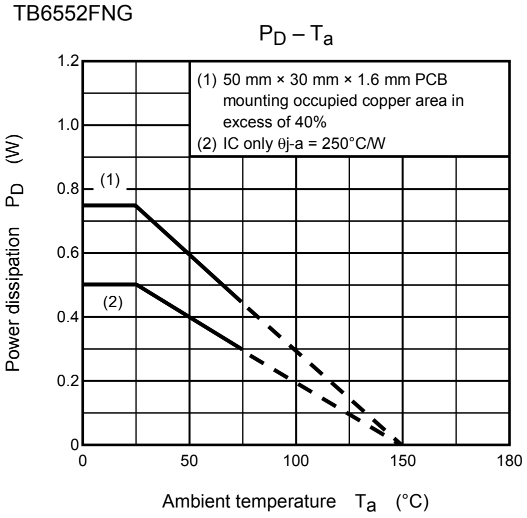
Characteristics	Symbol	Min	Typ.	Max	Unit
Supply voltage (V_{CC})	V_{CC}	2.7	3.0	5.5	V
Supply voltage (VM)	VM	2.5	5.0	13.5	V
Output current	I_{OUT}	—	—	0.8	A
PWM frequency	f_{PWM}	—	—	100	kHz

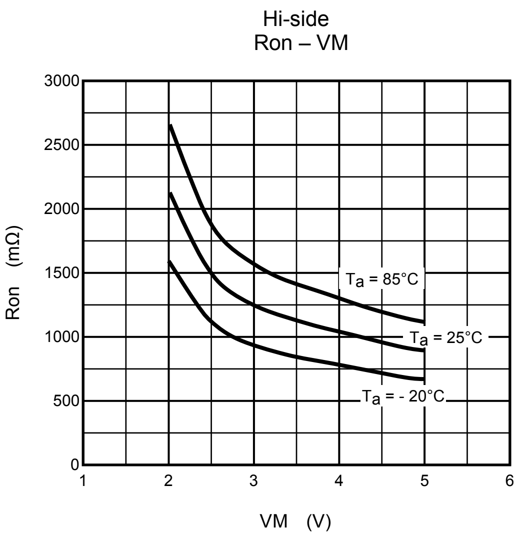
Electrical Characteristics (unless otherwise specified, V_{CC} = 3 V, VM = 12 V, T_a = 25°C)

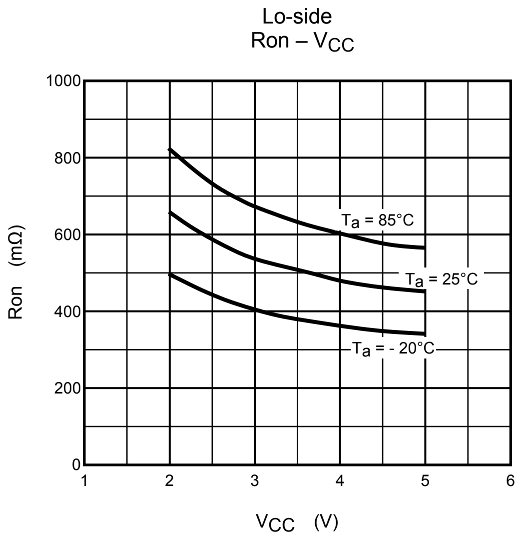
Characteristics		Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Supply current		$I_{CC\ (STP)}$	—	Stop mode	—	0.9	1.2	mA
		$I_{CC\ (W)}$	—	CW/CCW mode	—	0.9	1.2	
		$I_{CC\ (SB)}$	—	Short brake mode	—	0.9	1.2	
		$I_{CC\ (STB)}$	—	(Standby mode)	—	—	10	μA
		$I_{M\ (STB)}$	—		—	—	1	
Control circuit	Input voltage	V_{INH}	—	—	2	—	V_{CC} + 0.2	V
		V_{INL}	—	—	−0.2	—	0.8	
	Hysteresis voltage	$V_{IN\ (HIS)}$	—	(Not tested)	—	0.2	—	
	Input current	I_{INH}	—	—	5	15	25	μA
		I_{INL}	—	—	—	—	1	
Standby circuit	Input voltage	V_{INSH}	—	—	2	—	V_{CC} + 0.2	V
		V_{INSL}	—	—	−0.2	—	0.8	
	Input current	I_{INSH}	—	—	5	10	20	μA
		I_{INSL}	—	—	—	—	1	
Output saturating voltage		$V_{sat\ (U,\ L)}$	—	I_O = 0.2 A	—	0.3	0.4	V
			—	I_O = 0.8 A	—	1.2	1.5	
Output leakage current		$I_{L\ (U)}$	—	VM = 15 V	—	—	1	μA
		$I_{L\ (L)}$			—	—	1	
Diode forward voltage		$V_{F\ (U)}$	—	I_O = 0.8 A	—	1	1.2	V
		$V_{F\ (L)}$		I_O = 0.8 A	—	1	1.2	
PWM control circuit	PWM frequency	f_{PWM}	—	—	—	—	100	kHz
	Minimum clock pulse width	$t_{w\ (PWM)}$	—	—	—	—	10	μs
Output transistor switching		T_r	—	(Not tested)	—	100	—	ns
		T_f			—	100	—	
		$t_{pLH\ (PWM)}$			—	1000	—	
		$t_{pHL\ (PWM)}$			—	1000	—	
Thermal shutdown circuit operating temperature		T_{SD}	—	(Not tested)	—	170	—	°C
Thermal shutdown hysteresis		ΔT_{SD}	—	(Not tested)	—	20	—	°C

Characteristic Wave Form

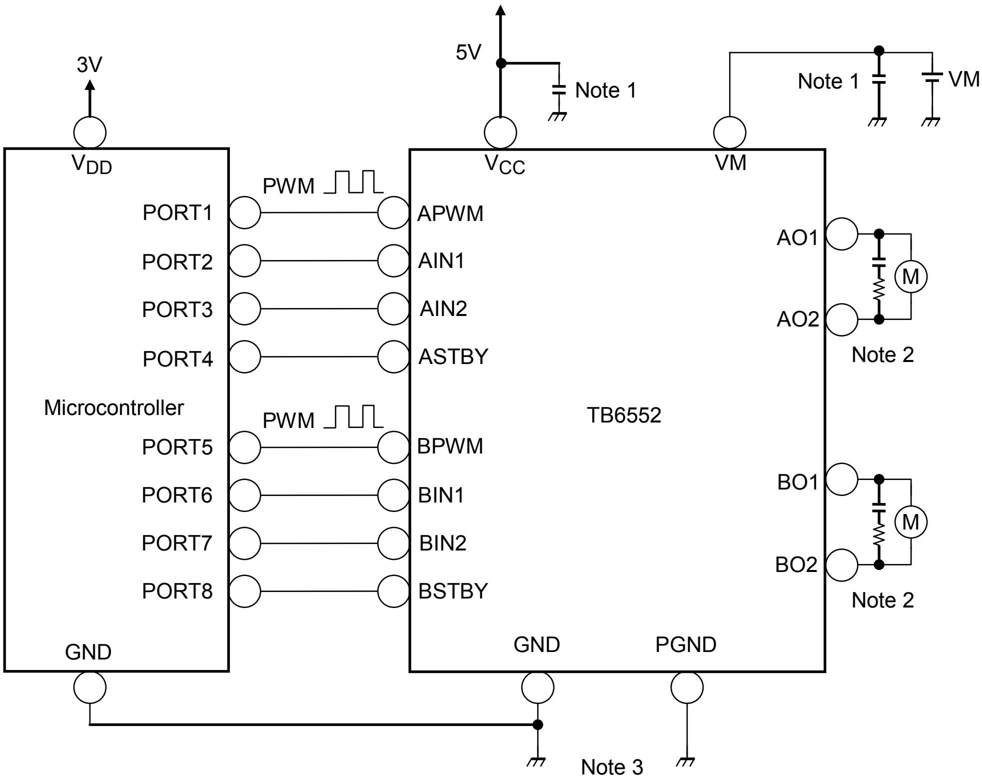
TB6552FNG







Typical Application Diagram



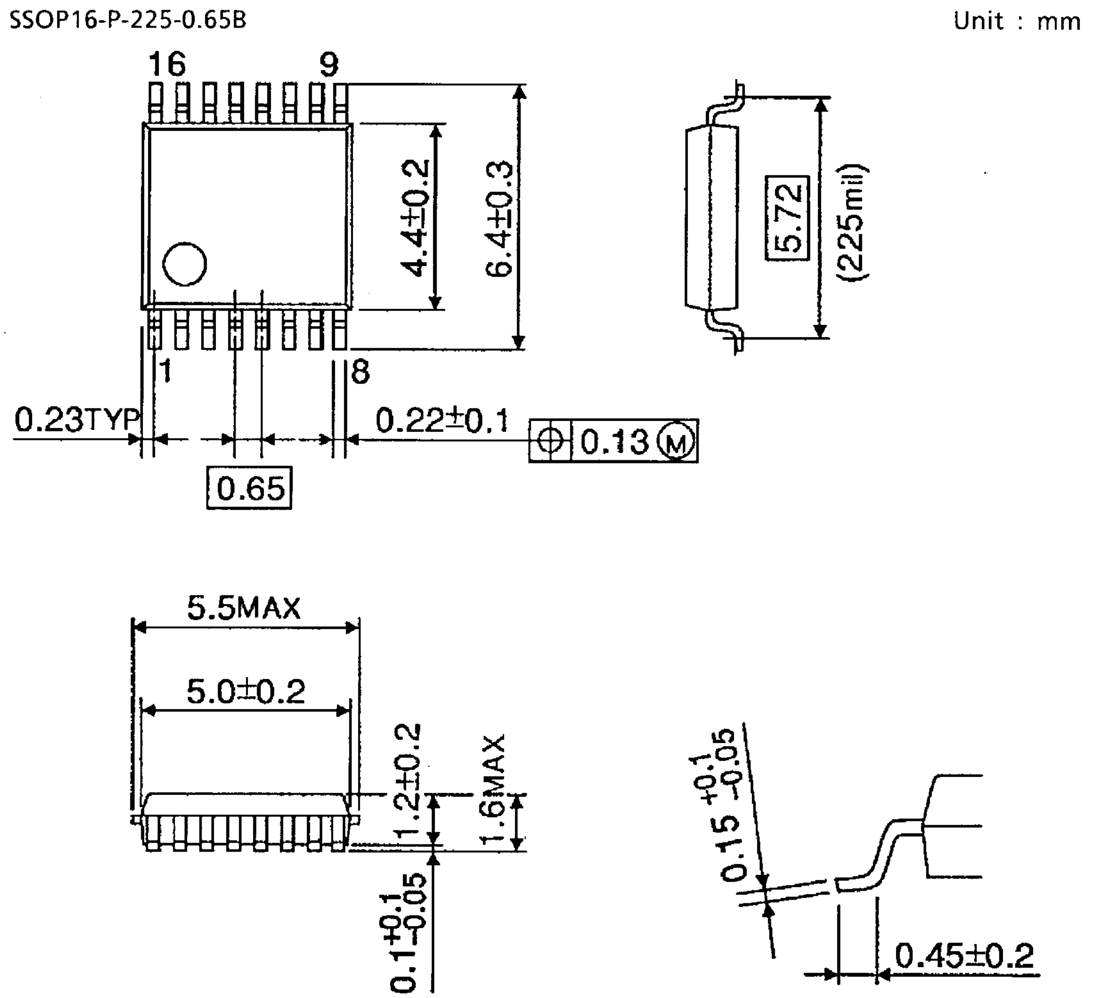
Note 1: The power supply capacitor should be connected as close as possible to the IC.

Note 2: When connecting the motor pins through the capacitor for reducing noise, connect a resistor to the capacitor to limit the charge current.

Note 3: Avoid using common impedance for GND and PGND.

Note : Utmost care is necessary in the design of the output, V_{CC}, VM, and GND lines since the IC may be destroyed by short-circuiting between outputs, air contamination faults, or faults due to improper grounding, or by short-circuiting between contiguous pins.

Package Dimensions (TB6552FNG)

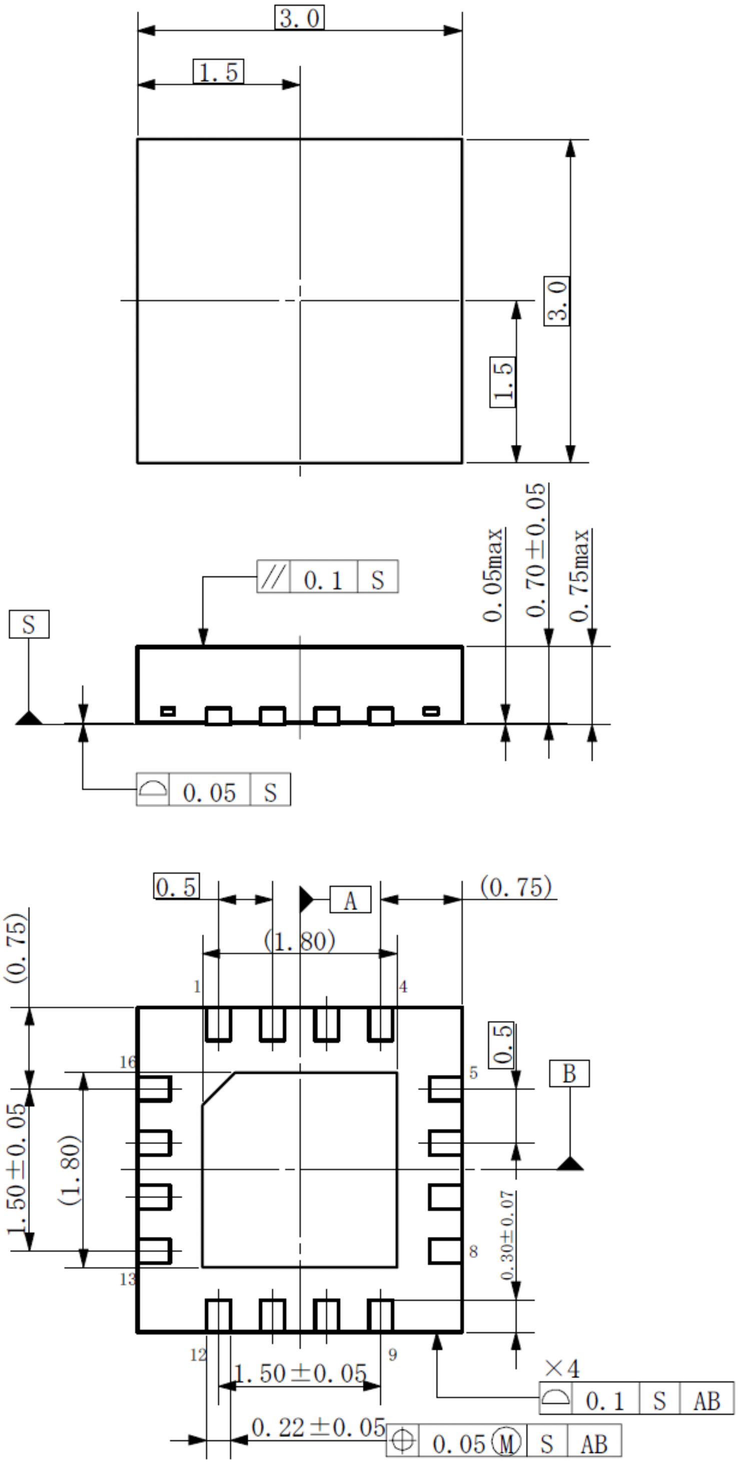


Weight: 0.07 g (typ.)

Package Dimensions (TB6552FTG)

P-WQFN16-0303-0.50-0.01

Unit: mm



Weight: 0.017g (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) 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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