

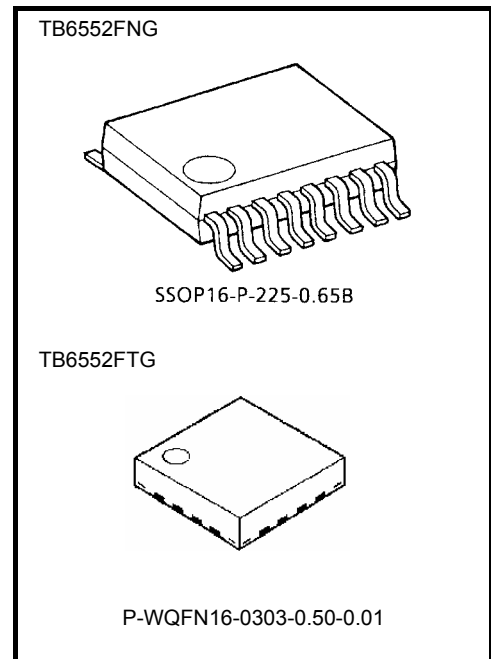
# TB6552FNG, TB6552FTG

## 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.

### Features

- Power supply voltage for motor:  $V_M \leq 15 \text{ V}$  (max)
- Power supply voltage for control:  $V_{CC} = 2.7 \text{ V}$  to  $6.0 \text{ V}$
- Output current:  $1 \text{ A}$  (max)
- Low ON resistor:  $1.5 \Omega$  (typ.)  
(Upper side + lower side combined @  $V_M = 5 \text{ V}$ )
- Direct PWM control
- Standby system (power saving)
- CW/CCW/short brake/stop function modes
- Built-in thermal shutdown circuit
- Package: FNG-SSOP16/FTG-QFN16

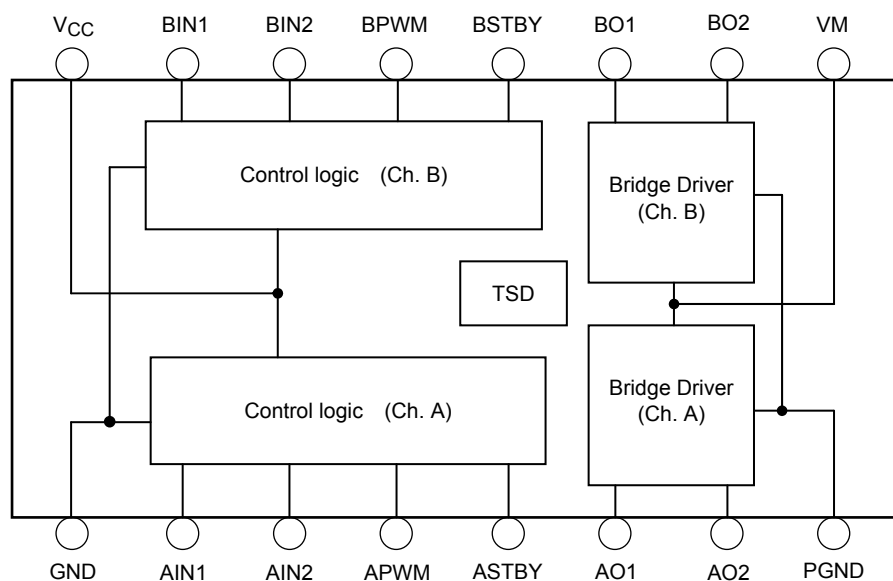


#### Weight

SSOP16-P-225-0.65B : 0.07 g (typ.)

P-WQFN16-0303-0.50-0.01 : 0.017 g (typ.)

\* 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**

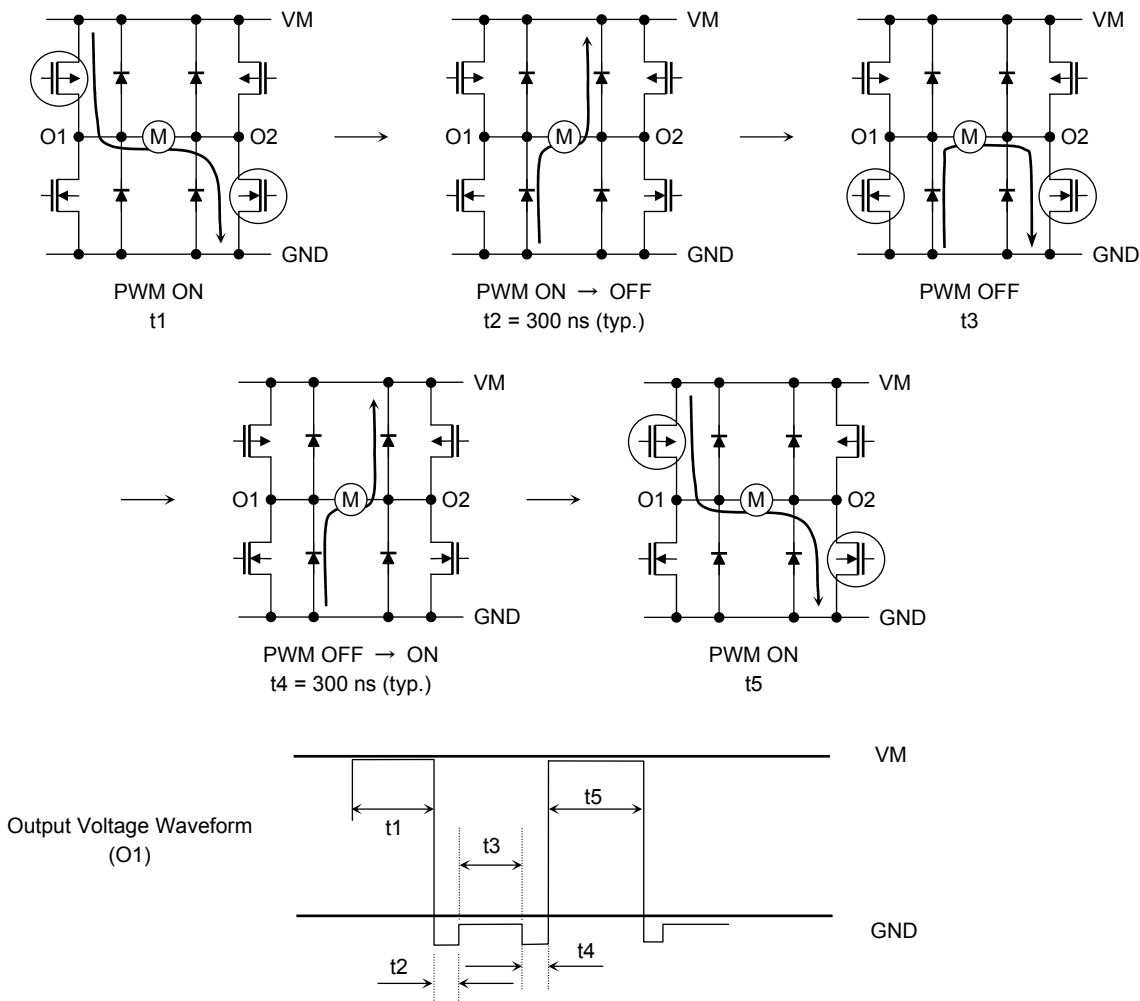
| Pin.Name        | Pin No |     | Functional Description               | Remarks  |
|-----------------|--------|-----|--------------------------------------|--|
|                 | FNG    | FTG |                                      |  |
| GND             | 1      | 11  | Small-signal GND pin                 | GND for small-signal power supply (V <sub>CC</sub> )                     |
| 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 <sub>(ope)</sub> = 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 <sub>CC</sub> | 16     | 10  | Small-signal power supply pin        | V <sub>CC</sub> (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<br>(high impedance) |    | Stop        |
|       |     |      | L   |                         |    |             |
| H/L   | H/L | L    | H   | OFF<br>(high impedance) |    | Standby     |
|       |     |      | L   |                         |    |             |

Operating Description

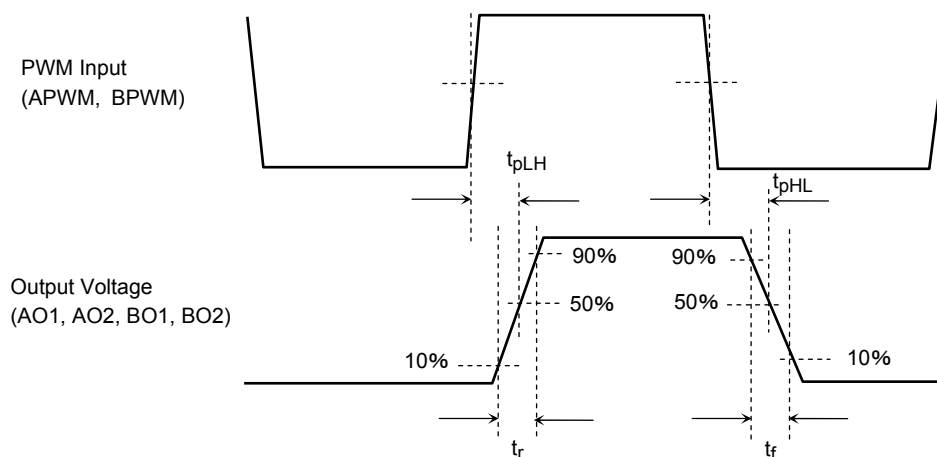
- PWM control function  
Speed can be controlled by inputting the high-level or low-level PWM signal to the pin PWM.  
When PWM control is provided, normal operation and short brake operation are repeated.  
To prevent penetrating current, dead time ( $t_2$  and  $t_4$ ) is provided in the IC.



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 ( $T_a = 25^\circ\text{C}$ )**

| Characteristics       | Symbol           | Rating           | Unit | Remarks                   |
|-----------------------|------------------|------------------|------|---------------------------|
| Supply voltage        | VM               | 15               | V    |                           |
|                       | V <sub>CC</sub>  | 6                |      |                           |
| Input voltage         | V <sub>IN</sub>  | -0.2 to 6        | V    | IN1, 2, STBY and PWM pins |
| Output current        | I <sub>OUT</sub> | 1                | A    |                           |
| Power dissipation     | P <sub>D</sub>   | 0.78<br>(Note 1) | W    |                           |
| Operating temperature | T <sub>opr</sub> | -20 to 85        | °C   |                           |
| Storage temperature   | T <sub>stg</sub> | -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  $85^\circ\text{C}$ )**

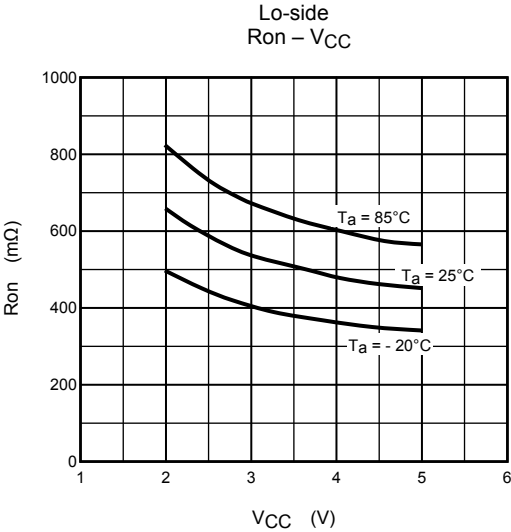
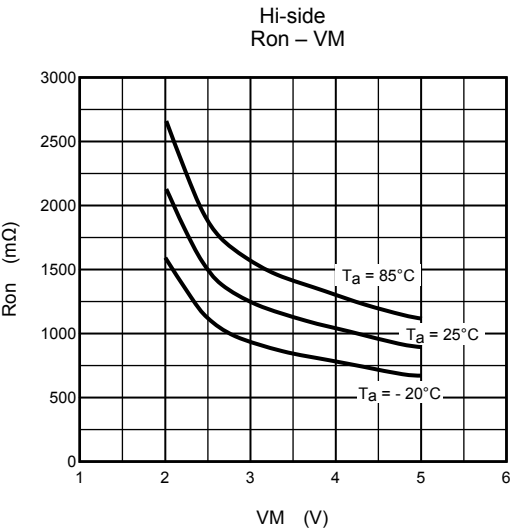
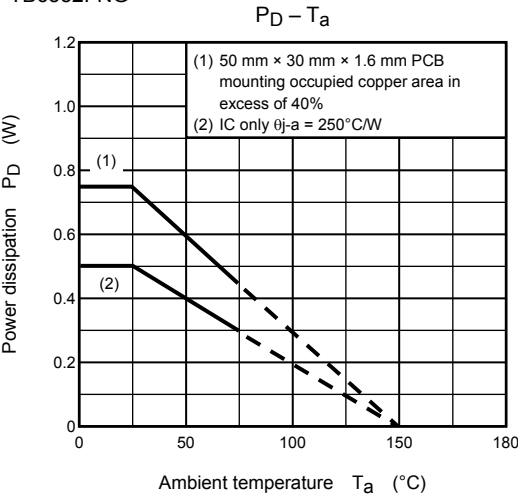
| Characteristics                   | Symbol           | Min | Typ. | Max  | Unit |
|-----------------------------------|------------------|-----|------|------|------|
| Supply voltage (V <sub>CC</sub> ) | V <sub>CC</sub>  | 2.7 | 3.0  | 5.5  | V    |
| Supply voltage (VM)               | VM               | 2.5 | 5.0  | 13.5 | V    |
| Output current                    | I <sub>OUT</sub> | —   | —    | 0.8  | A    |
| PWM frequency                     | f <sub>PWM</sub> | —   | —    | 100  | kHz  |

**Electrical Characteristics (unless otherwise specified,  $V_{CC} = 3\text{ V}$ ,  $V_M = 12\text{ V}$ ,  $T_a = 25^\circ\text{C}$ )**

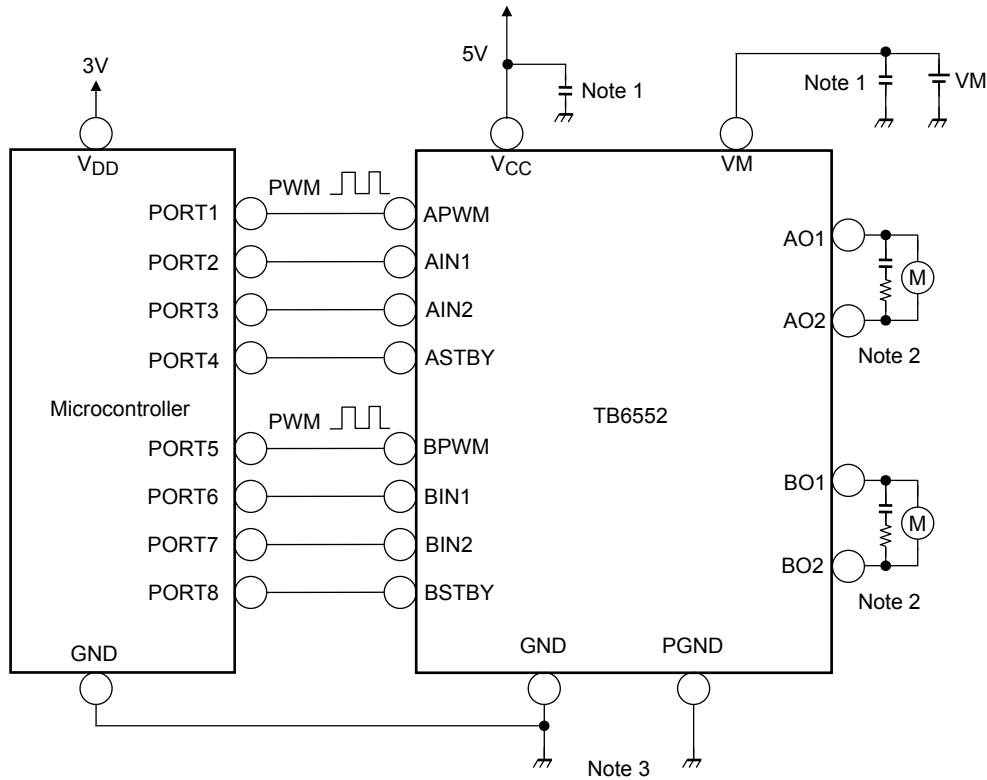
| Characteristics                                |                           | Symbol                  | Test Circuit | Test Condition         | Min  | Typ. | Max                   | Unit |
|--|---------------------------|-------------------------|--------------|------------------------|------|------|-----------------------|------|
| Supply current                                 |                           | I <sub>CC</sub> (STP)   | —            | Stop mode              | —    | 0.9  | 1.2                   | mA   |
|  |                           | I <sub>CC</sub> (W)     | —            | CW/CCW mode            | —    | 0.9  | 1.2                   |      |
|  |                           | I <sub>CC</sub> (SB)    | —            | Short brake mode       | —    | 0.9  | 1.2                   |      |
|  |                           | I <sub>CC</sub> (STB)   | —            | (Standby mode)         | —    | —    | 10                    | μA   |
|  |                           | I <sub>M</sub> (STB)    | —            |                        | —    | —    | 1                     |      |
| Control circuit                                | Input voltage             | V <sub>INH</sub>        | —            | —                      | 2    | —    | V <sub>CC</sub> + 0.2 | V    |
|  |                           | V <sub>INL</sub>        | —            | —                      | −0.2 | —    | 0.8                   |      |
|  | Hysteresis voltage        | V <sub>IN</sub> (HIS)   | —            | (Not tested)           | —    | 0.2  | —                     |      |
|  | Input current             | I <sub>INH</sub>        | —            | —                      | 5    | 15   | 25                    | μA   |
|  |                           | I <sub>INL</sub>        | —            | —                      | —    | —    | 1                     |      |
| Standby circuit                                | Input voltage             | V <sub>INSH</sub>       | —            | —                      | 2    | —    | V <sub>CC</sub> + 0.2 | V    |
|  |                           | V <sub>INSL</sub>       | —            | —                      | −0.2 | —    | 0.8                   |      |
|  | Input current             | I <sub>INSH</sub>       | —            | —                      | 5    | 10   | 20                    | μA   |
|  |                           | I <sub>INSL</sub>       | —            | —                      | —    | —    | 1                     |      |
| Output saturating voltage                      |                           | V <sub>sat</sub> (U, L) | —            | I <sub>O</sub> = 0.2 A | —    | 0.3  | 0.4                   | V    |
|  |                           |                         | —            | I <sub>O</sub> = 0.8 A | —    | 1.2  | 1.5                   |      |
| Output leakage current                         |                           | I <sub>L</sub> (U)      | —            | V <sub>M</sub> = 15 V  | —    | —    | 1                     | μA   |
|  |                           | I <sub>L</sub> (L)      |              |                        | —    | —    | 1                     |      |
| Diode forward voltage                          |                           | V <sub>F</sub> (U)      | —            | I <sub>O</sub> = 0.8 A | —    | 1    | 1.2                   | V    |
|  |                           | V <sub>F</sub> (L)      |              | I <sub>O</sub> = 0.8 A | —    | 1    | 1.2                   |      |
| PWM control circuit                            | PWM frequency             | f <sub>PWM</sub>        | —            | —                      | —    | —    | 100                   | kHz  |
|  | Minimum clock pulse width | t <sub>w</sub> (PWM)    | —            | —                      | —    | —    | 10                    | μs   |
| Output transistor switching                    |                           | T <sub>r</sub>          | —            | (Not tested)           | —    | 100  | —                     | ns   |
|  |                           | T <sub>f</sub>          |              |                        | —    | 100  | —                     |      |
|  |                           | t <sub>pLH</sub> (PWM)  |              |                        | —    | 1000 | —                     |      |
|  |                           | t <sub>pHL</sub> (PWM)  |              |                        | —    | 1000 | —                     |      |
| Thermal shutdown circuit operating temperature |                           | T <sub>SD</sub>         | —            | (Not tested)           | —    | 170  | —                     | °C   |
| Thermal shutdown hysteresis                    |                           | ΔT <sub>SD</sub>        | —            | (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.

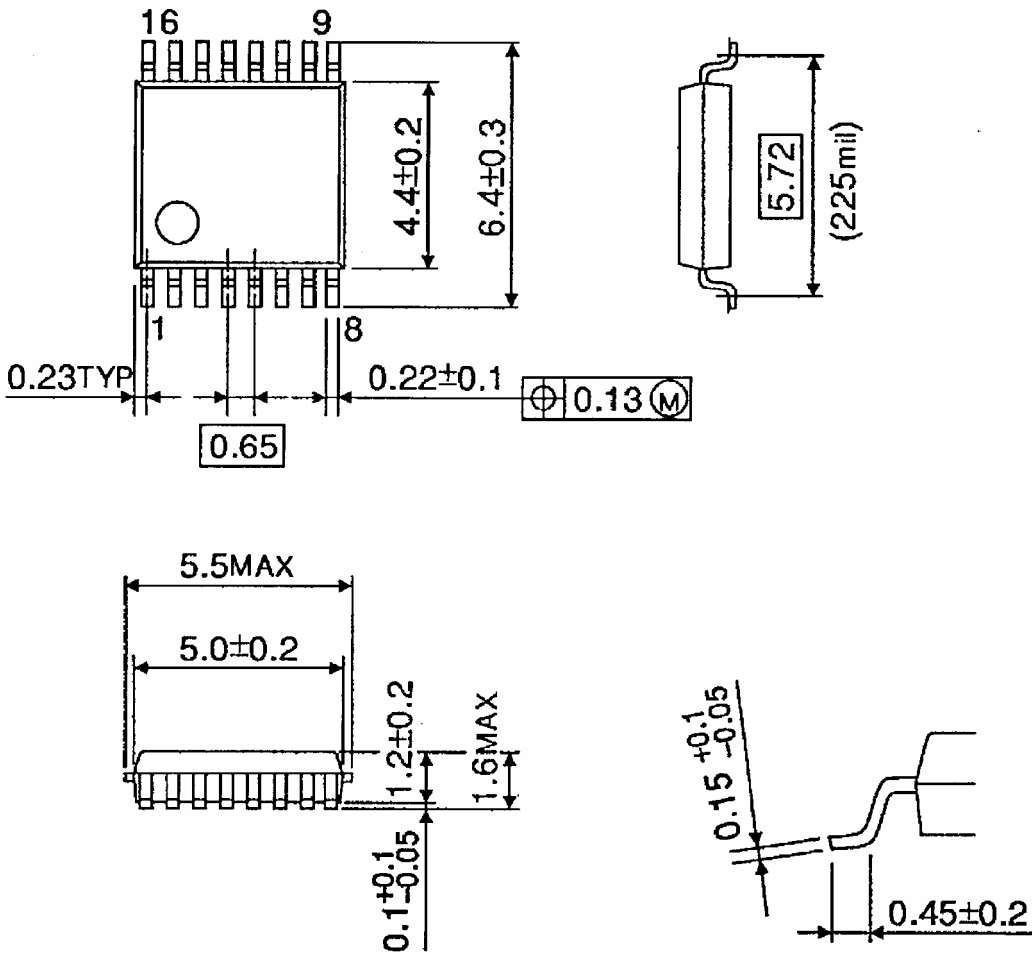
Note : Utmost care is necessary in the design of the output, VCC, VM, and GND lines since the IC may be destroyed by short-circuiting between outputs, air contamination faults, or faults due to improper grounding, or by short-circuiting between contiguous pins.



Package Dimensions (TB6552FNG)

SSOP16-P-225-0.65B

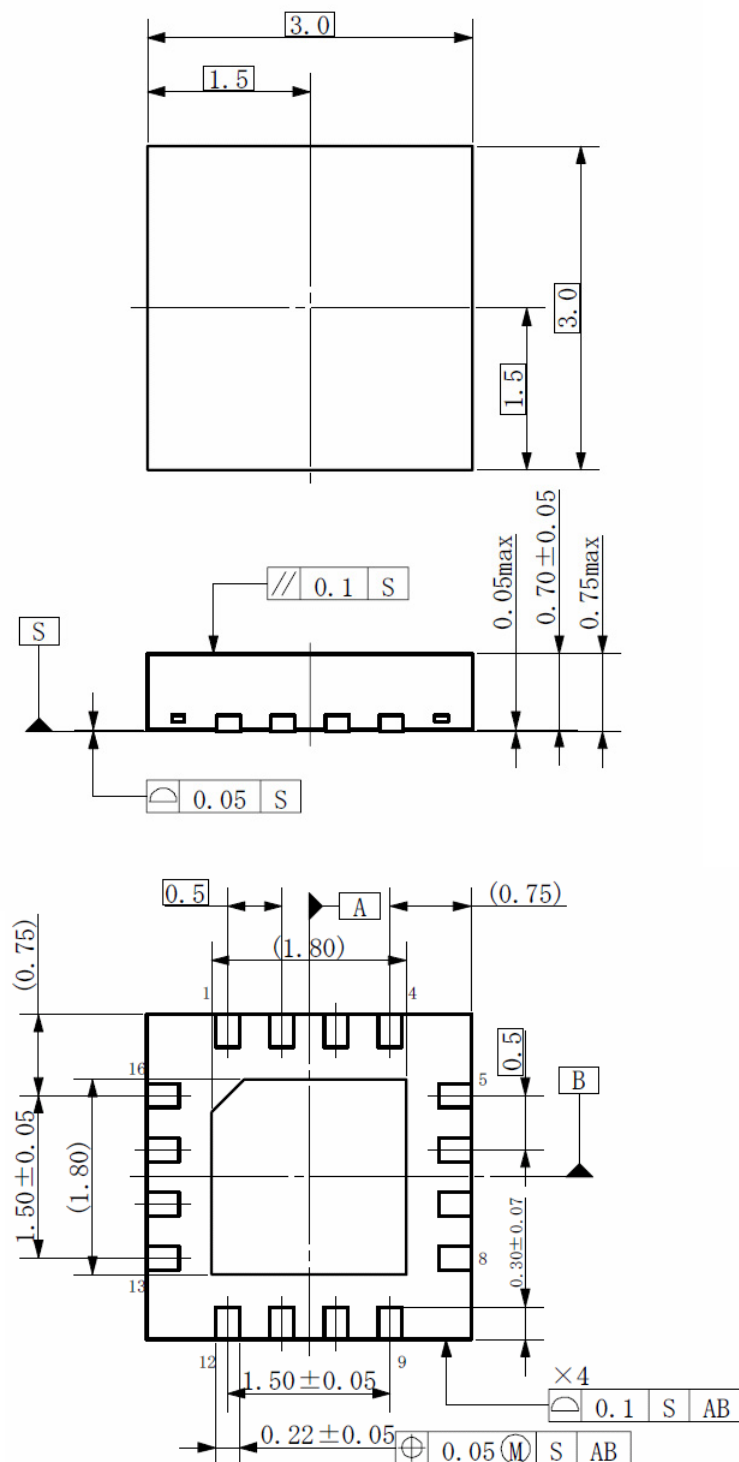
Unit : mm



Weight: 0.07 g (typ.)

**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 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 flows 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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