

**Preliminary**

TOSHIBA Bi-CDMOS Integrated Circuit Silicon Monolithic

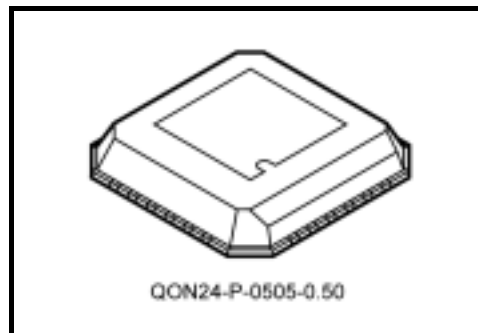
# T B 6 5 5 8 F L/FLG

## DC Motor Driver

TB6558FL/FLG is DC motor driver that uses low ON-resistance LDMOS transistors for the output block.

two inputs (IN1, IN2) are used to drive a DC motors in forward and reverse and short-break and stop directions.

The driver uses pulse width modulation (PWM) to provide constant current drive.



Weight: 0.05 g (typ.)

## Features

- Motor supply voltage:  $V_M \leq 15 \text{ V}$  (max)
- Control supply voltage:  $V_{CC} = 2.7 \text{ V}$  to  $6 \text{ V}$
- Output current:  $I_{out} \leq 0.8 \text{ A}$  (max)
- Low ON-resistance:  $1.5 \Omega$  (upper side + lower side typ. @  $V_M = 5 \text{ V}$ )
- Forward/Reverse/short beake/stop mode control
- Constant current control (PWM chopper drive)
- Standby (power-saving) mode
- On-chip thermal shutdown circuit (TSD)
- Compact package: QON24

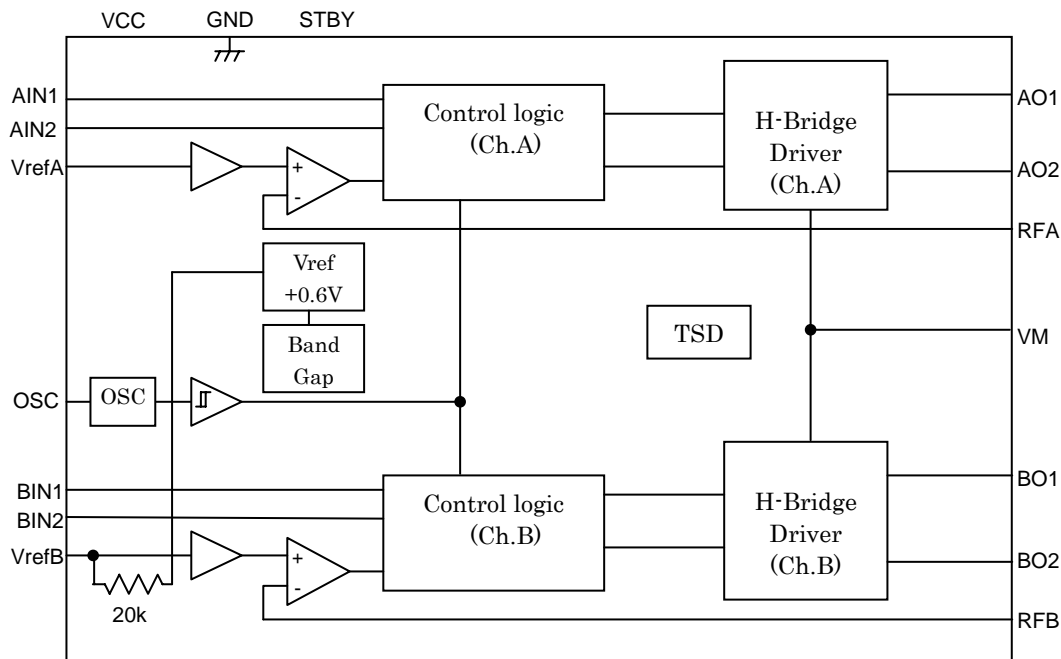
The following conditions apply to solderability:

\*Solderability

1. Use of Sn-37Pb solder bath
  - \*solder bath temperature =  $230^\circ\text{C}$
  - \*dipping time = 5 seconds
  - \*number of times = once
  - \*use of R-type flux
2. Use of Sn-3.0Ag-0.5Cu solder bath
  - \*solder bath temperature =  $245^\circ\text{C}$
  - \*dipping time = 5 seconds
  - \*number of times = once
  - \*use of R-type flux

**Note:** 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	PinNO.	Functional Description	Remarks
GND	14	GND pin (for small signal)	GND for Vcc:small signal
OSC	5	Internal oscillation frequency setting pin	Connect an oscillator capacitor externally.
VrefA	15	Winding current setting pin (Ch.A)	setup to external circuit
AIN1	11	Control input1 ( Ch.A )	Internal pull-down resistance 200k to GND
AIN2	9	Control input2 ( Ch.A )	Internal pull-down resistance 200k to GND
RFA	19	Driving current detection pin (Ch. A)	
AO1	18	Output 1 (Ch. A-1)	Ch. A-1 motor winding connection pin
AO2	21	Output 2 (Ch. A-2)	Ch. A-2 motor winding connection pin
BO2	1	Output 2 (Ch. B-2)	Ch. B-2 motor winding connection pin
BO1	22	Output 1 (Ch. B-1)	Ch. B-1 motor winding connection pin
RFB	24	Driving current detection pin (Ch. B)	
VM	3	Motor power supply pin	VM(ope)=2.5V ~ 13.5V
BIN2	6	Control input2 ( Ch.B )	Internal pull-down resistance 200k to GND
BIN1	8	Control input1 ( Ch.B )	Internal pull-down resistance 200k to GND
VrefB	12	Driving current setting pin (Ch.A)	Typ.=0.6V internal
Vcc	13	Small-signal power supply pin	Vcc(ope)=2.7V ~ 5.5V
STBY	4	Stanby ( Power save ) pin	Internal pull-down resistance 300k to GND

2,7,10,16,17,20,23 Pin is NC ( Non connected )

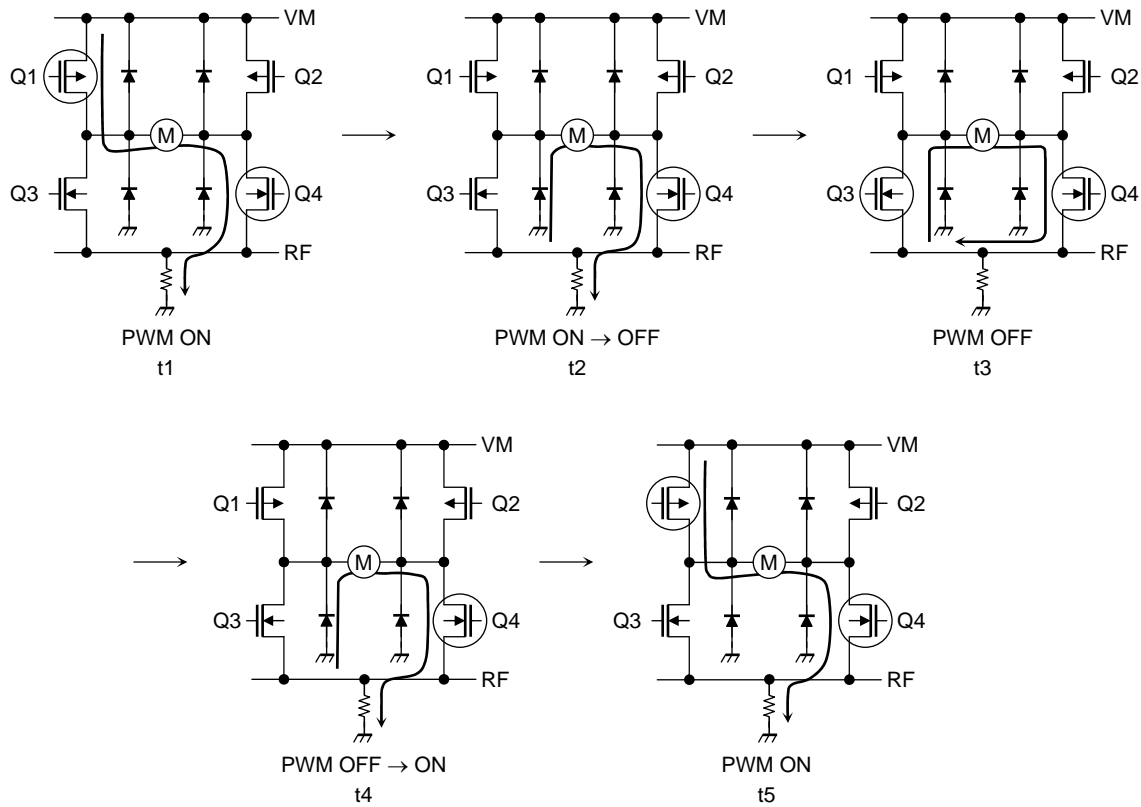
Truth Table

input			output		
IN1	IN2	STBY	OUT1	OUT2	mode
H	H	H	L	L	Short brake
L	H	H	L	H	Reverse
H	L	H	H	L	Forward
L	L	H	ALL OFF		Stop
H or L	H or L	L	ALL OFF		standby (Power save)

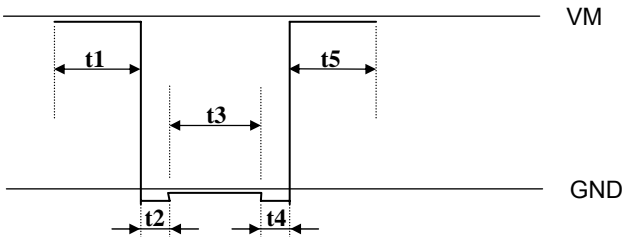
Operating Description

PWM control function

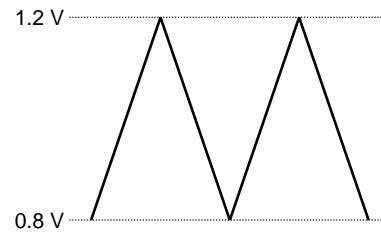
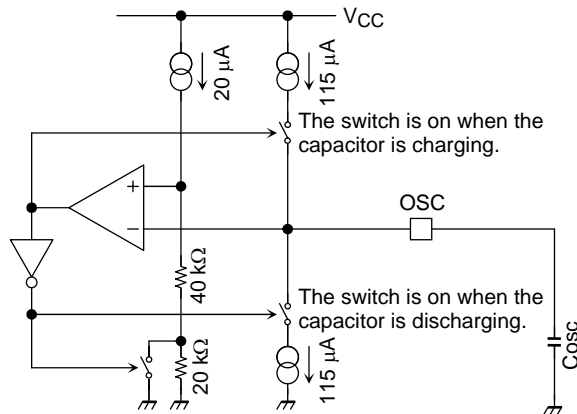
When PWM control is activated, normal operation and short brake operation are repeated.  
To prevent shoot-through current, dead time  $t_2$  and  $t_4$  is provided in the IC.



Example)  
OUT1 Voltage wave



## Oscillator circuit



### Oscillator block

### Vosc waveform

A voltage ( $V_{OSC}$ ) that is charged to or discharged from the capacitor is calculated as follows:

$$V_{OSC} = \frac{1}{C_{OSC}} \int i \, dt$$

Where a time when  $V_{OSC} = 0.8 \, \text{V}$  is  $t_1$ , and a time when  $V_{OSC} = 1.2 \, \text{V}$  is  $t_2$ :

$$\Delta V_{OSC} = I (t_1 - t_2) / C_{OSC}$$

$$\frac{1}{t_1 - t_2} = \frac{1}{\Delta V_{OSC} \cdot C_{OSC}}$$

Triangular wave oscillation waveform ( $f_{OSC}$ ) is calculated:

$$f_{OSC} = \frac{1}{2(t_1 - t_2)} = \frac{I}{2 \cdot \Delta V_{OSC} \cdot C_{OSC}}$$

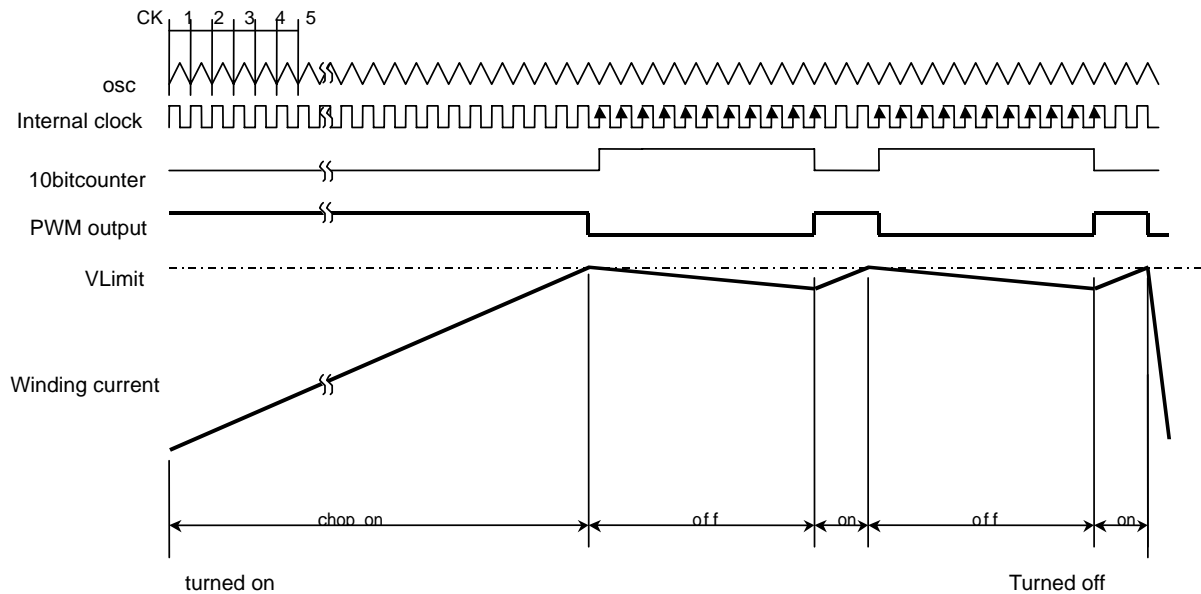
$$f_{OSC} = \frac{1}{2(t_1 - t_2)} = \frac{1}{2 \cdot \Delta V_{OSC} \cdot C_{OSC} / I}$$

$$= \frac{1}{2 \times 0.4 / 115 \, \mu\text{A} \times C_{OSC}} = \frac{1}{6.957 \times 10^3 \times C_{OSC}}$$

## • Chopper control

The winding current flows while an output drive transistor is turned On. When the V<sub>RF</sub> reaches the limit voltage level (V<sub>limit</sub>), the comparator detects it and turns off the output drive transistor.

The oscillator output is squared to generate an internal clock. The off timer starts on the rising edge of the internal clock and is active for eleven internal clocks. When the off timer stops, the PWM goes high.



The PWM control limits the winding current to a level determined by the current value ( $I_0$ ) as expressed in the equation below.

$$I_0 = V_{\text{limit}} / R_{\text{NF}}$$

**Absolute Maximum Ratings (Ta = 25°C)**

Characteristics	Symbol	Rating	Unit	Remarks
Power supply voltage	V <sub>M</sub>	15	V	
	V <sub>CC</sub>	6		
Input voltage	V <sub>IN</sub>	−0.2 to 6	V	IN1, IN2, STANBY, VrefA,B pins
Output current	I <sub>OUT</sub>	0.8	A	
Power dissipation	P <sub>D</sub>	0.78 (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: When mounted on a glass-epoxy PCB (50 mm × 30 mm × 1.6 mm, Cu area: 40%)

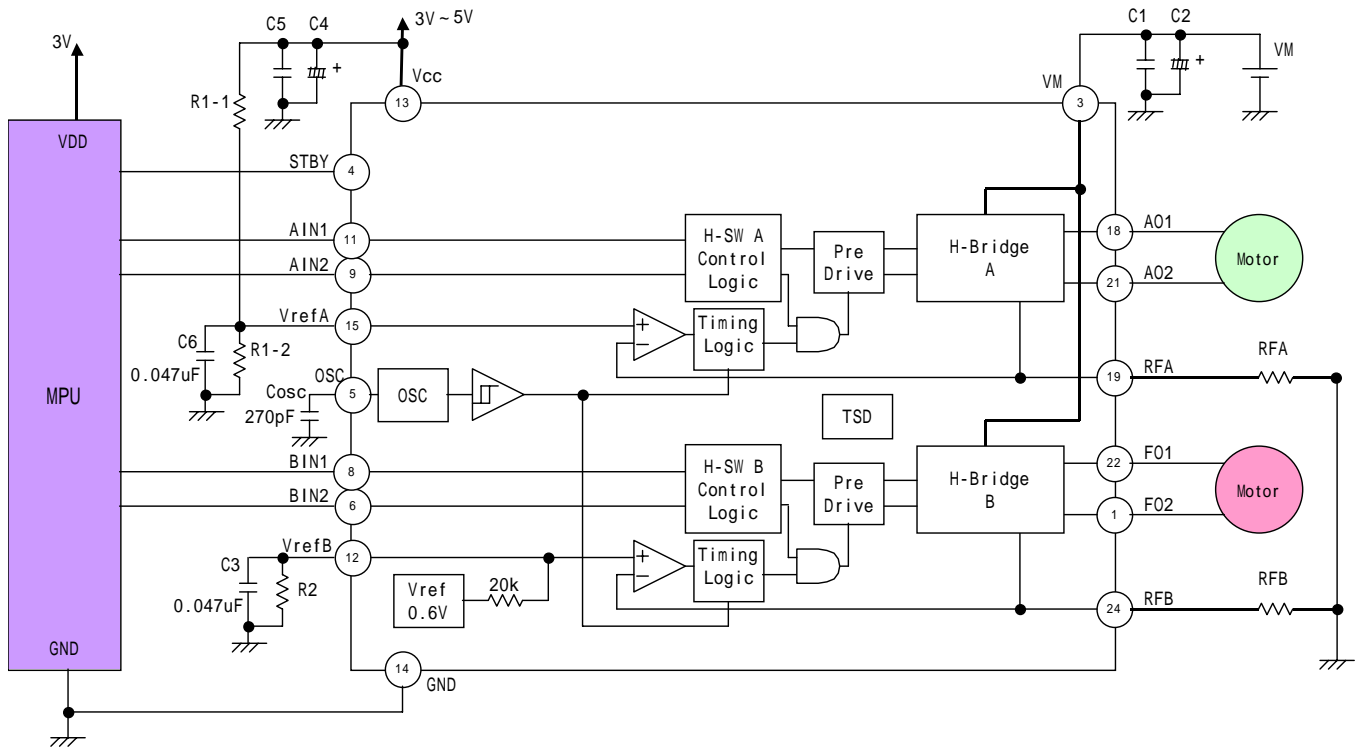
**Operating Range (Ta = −20 to 85°C)**

Characteristics	Symbol	Min	Typ.	Max	Unit
Power supply voltage (V <sub>CC</sub> )	V <sub>CC</sub>	2.7	3	5.5	V
Power supply voltage (V <sub>M</sub> )	V <sub>M</sub>	2.5	5	13.5	V
Output current	I <sub>OUT</sub>	—	—	0.6	A
OSC frequency	f <sub>osc</sub>	—	—	1	MHz
Chopping frequency	f <sub>chop</sub>	20	—	250	kHz

**Electrical Characteristics (Unless otherwise specified,  $V_{CC} = 3\text{ V}$ ,  $V_M = 5\text{ V}$ ,  $T_a = 25^\circ\text{C}$ )**

Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Supply current		I <sub>CC(STP)</sub>	Stop mode	—	1.4	3	m A
		I <sub>CC(W)</sub>	Forward/reverse mode	—	1.4	3	
		I <sub>CC(SB)</sub>	Short-breake mode	—	1.4	3	
		I <sub>cc(STB)</sub>	Standby mode	—	—	15	μ A
		I <sub>M(STB)</sub>	STBY=L	—	—	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(HIS)</sub>	(Design guarantee)	—	0.2	—	μ A
	Input current	I <sub>INH</sub>		10	15	20	
		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	15	μ A
		I <sub>INSL</sub>		—	—	1	
Output saturating voltage		V <sub>sat(U+L)</sub>	I <sub>o</sub> =0.2A	—	0.3	0.4	V
			I <sub>o</sub> =0.6A	—	0.8	1.2	
Output constant current detection level		V <sub>RF</sub>	V <sub>lim</sub> t=0.6V,R <sub>F</sub> =1	0.575	0.6	0.635	V
Reference voltage		V <sub>ref</sub>	V <sub>ref</sub> B=open	0.57	0.6	0.63	V
Output leakage current		I <sub>L(U)</sub>	V <sub>M</sub> =15V	—	—	1	μ A
		I <sub>L(L)</sub>		—	—	1	
Diode forward voltage		V <sub>F(U)</sub>	I <sub>o</sub> =0.6A	—	1	—	V
		V <sub>F(L)</sub>	(Design guarantee)	—	1	—	
Oscillation frequency		f <sub>osc</sub>	C <sub>osc</sub> =270pF	430	530	660	kHz
Thermal shutdown circuit operating temperature		TSD	(Design guarantee)	—	170	—	
Thermal shutdown hysteresis		TSD		—	20	—	

## Application Circuit Example

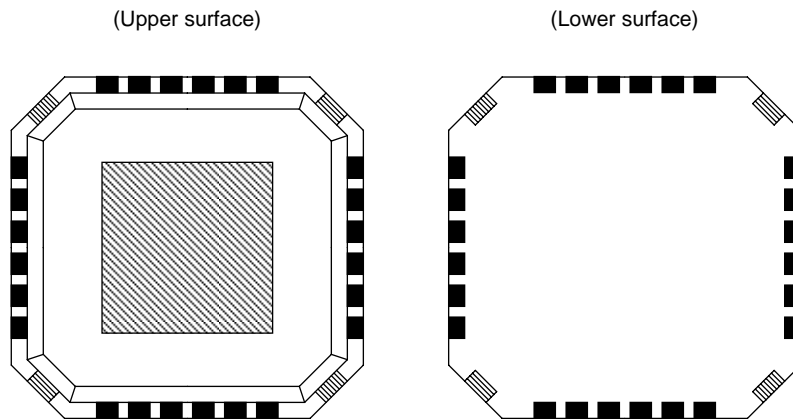


Note1: Noise suppression capacitors and oscillator capacitors should be connected as close as possible to the IC.

### Technical example)

- Iout setup :  $I_{out} (A) = V_{ref} (V) \div R_F ( \Omega )$   
 ch.A :  $I_{o-A} = V_{refA} \div R_{FA}$   
 ch.B :  $I_{o-B} = V_{refB} \div R_{FB}$
- VrefA,Bsetup :  $V_{refA} = V_{cc} \times R_{1-2} / (R_{1-1} + R_{1-2})$   
 $V_{refB} = V_{ref}(0.6V) \times R_2 / (20k + R_2)$



**Requests Concerning Use of QON****Outline Drawing of Package**

When using QON, please take into account the following items.

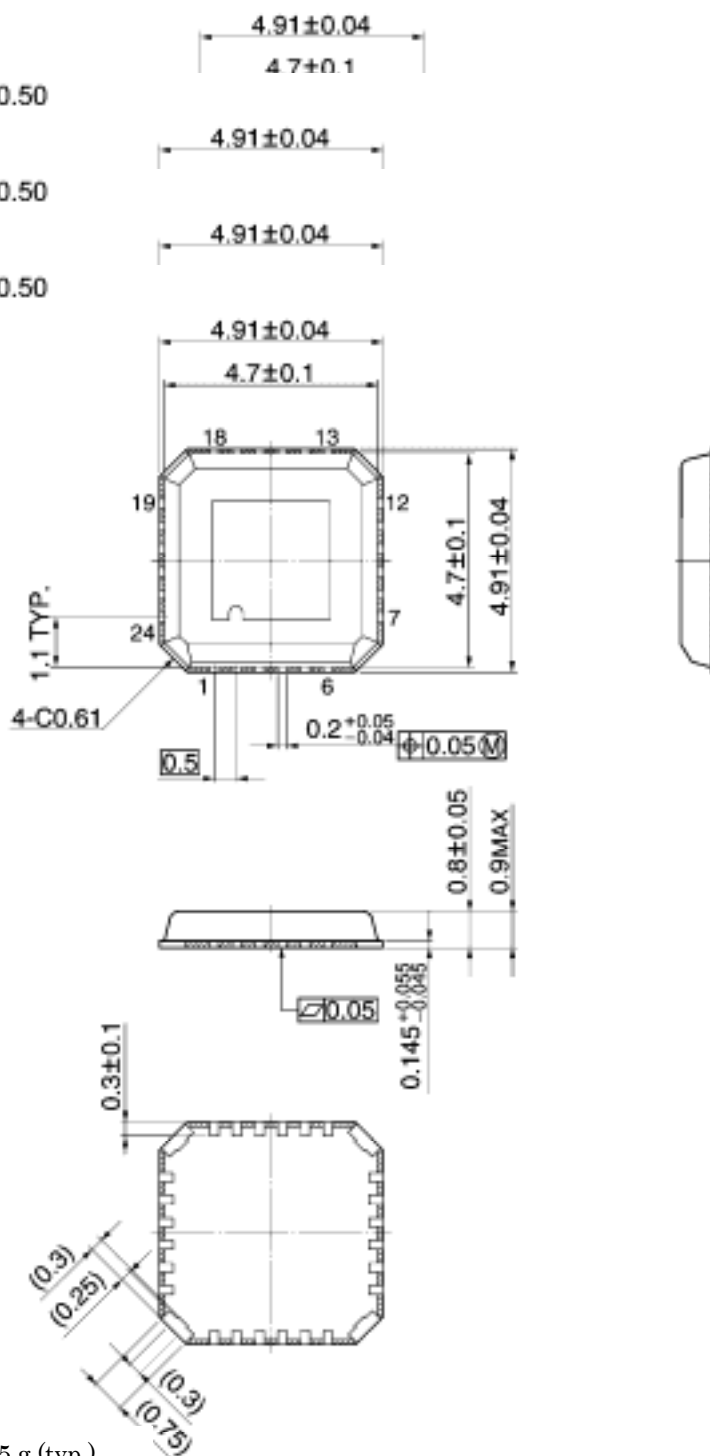
**Caution**

- (1) Do not carry out soldering on the island section in the four corners of the package (the section shown on the lower surface drawing with diagonal lines) with the aim of increasing mechanical strength.
- (2) The island section exposed on the package surface (the section shown on the upper surface drawing with diagonal lines) must be used as (Note 6) below while electrically insulated from outside.


Note 6: Ensure that the island section (the section shown on the lower surface drawing with diagonal lines) does not come into contact with solder from through-holes on the board layout.

- When mounting or soldering, take care to ensure that neither static electricity nor electrical overstress is applied to the IC (measures to prevent anti-static, leaks, etc.).
- When incorporating into a set, adopt a set design that does not apply voltage directly to the island section.

QON24-P-0505-0.50		Unit: mm
QON24-P-0505-0.50		Unit: mm
QON24-P-0505-0.50		Unit: mm
QON24-P-0505-0.50		Unit: mm



Weight: 0.05 g (typ.)

- Note 1) The solder plating portion in four corners of the package shall not be treated as an external terminal.
- Note 2) Don't carry out soldering to four corners of the package.
- Note 3)  area : Resin surface

## **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) Over current Protection Circuit**

Over current protection circuits (referred to as current limiter circuits) do not necessarily protect ICs under all circumstances. If the Over current protection circuits operate against the over current, clear the over current status immediately.

Depending on the method of use and usage conditions, such as exceeding absolute maximum ratings can cause the over current protection circuit to not operate properly or IC breakdown before operation. In addition, depending on the method of use and usage conditions, if over current continues to flow for a long time after operation, the IC may generate heat resulting in breakdown.

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

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