TB62269FTAG
Usage considerations

Summary

The TB62269 is a two-phase bipolar stepping motor driver using a PWM chopper. The clock in decoder is built in.
Fabricated with the BiCD process, rating is 40 V/1.8A.

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1. Power supply voltage

1.1. Power supply voltage and usage range

In using the TB62269, the voltage should be applied to the terminals of VM, VREF.
The absolute maximum rating of VM supply voltage is 40 V. Usage range of the power supply voltage is 10 to 35 V.
The absolute maximum rating of VREF voltage is 5 V. Usage range of the voltage is 0 to 3.6 V.
As for the voltage of VREF, the voltage of the internal regulator of the IC (VCC) can be also used. (However, if the current is pulled up exceeding the capability of the internal regulator, the regulation of VCC may not be kept. When the voltage of VREF is applied by dividing the voltage of VCC, the total of the voltage-dividing resistance should not be less than 10 kΩ.)

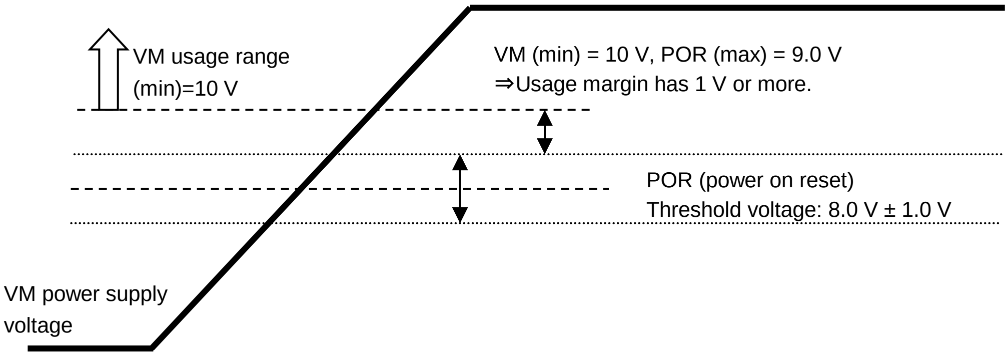


Figure 1.1 Power supply voltage and usage range

1.2. Power supply sequence

There are no special procedures of inputting a power supply and shutdown because the TB62269 incorporates the power on reset (POR). However, under the unstable state of inputting the power supply (VM) and shutdown, it is recommended to turn off the motor operation. Please operate the motor by switching the input signal after the power supply becomes in the stable state.

2. Output current

Motor usage current should be 1.8 A or less. The maximum current of the actual usage is limited depending on the usage conditions (the ambient temperature, the wiring pattern of the board, the radiation path, and the exciting design). Configure the most appropriate current value after calculating the heat and evaluating the board under the operating environment.

3. Control input

When the logic input signal is inputted under the condition that the voltage of VM is not supplied, the electromotive force by inputting signal is not generated. However, configure the input signal low level before the power supply is applied by referring to the description of the “1.2. Power supply sequence”.

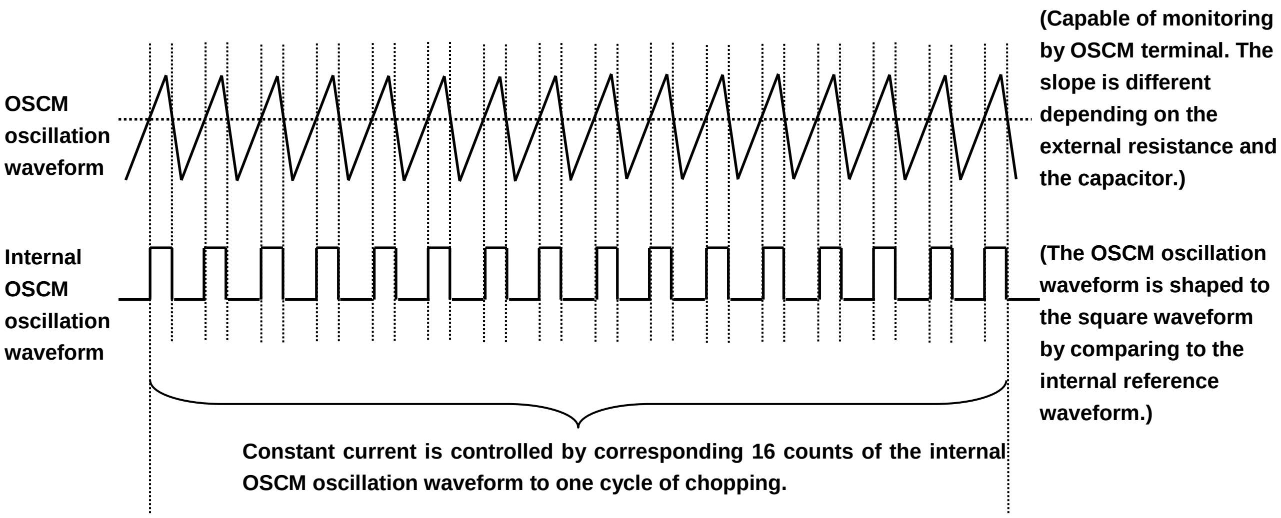
4. PWM control

The TB62269 can adjust the internal oscillation frequency (fOSCM) and the chopping frequency (fchop) with the constant number of the external parts connecting to OSCM terminal.

- The relation equations of the OSCM oscillation frequency (fOSCM) and the chopping frequency (fchop) are as follows;

$$fOSCM = 1 / [0.56 \times \{C \times (R1 + 500)\}]$$
$$fchop = fOSCM / 16$$

* C, R1: external constant number for OSCM (C = 270 pF, R1 = 3.6 kΩ: fOSCM=about 1.6 MHz (typ.), fchop: about 100kHz (typ.))



(Capable of monitoring by OSCM terminal. The slope is different depending on the external resistance and the capacitor.)

(The OSCM oscillation waveform is shaped to the square waveform by comparing to the internal reference waveform.)

Constant current is controlled by corresponding 16 counts of the internal OSCM oscillation waveform to one cycle of chopping.

Figure 4.1 OSCM oscillation frequency

When the chopping frequency is increased, the motor can rotate faster because the following capability of the current steps increases. However, switching loss and heat increase may occur because the number of switching of output MOSFET is larger than the case of low frequency of the chopping.

(Example 1) Chopping frequency (fchop) = 100 kHz

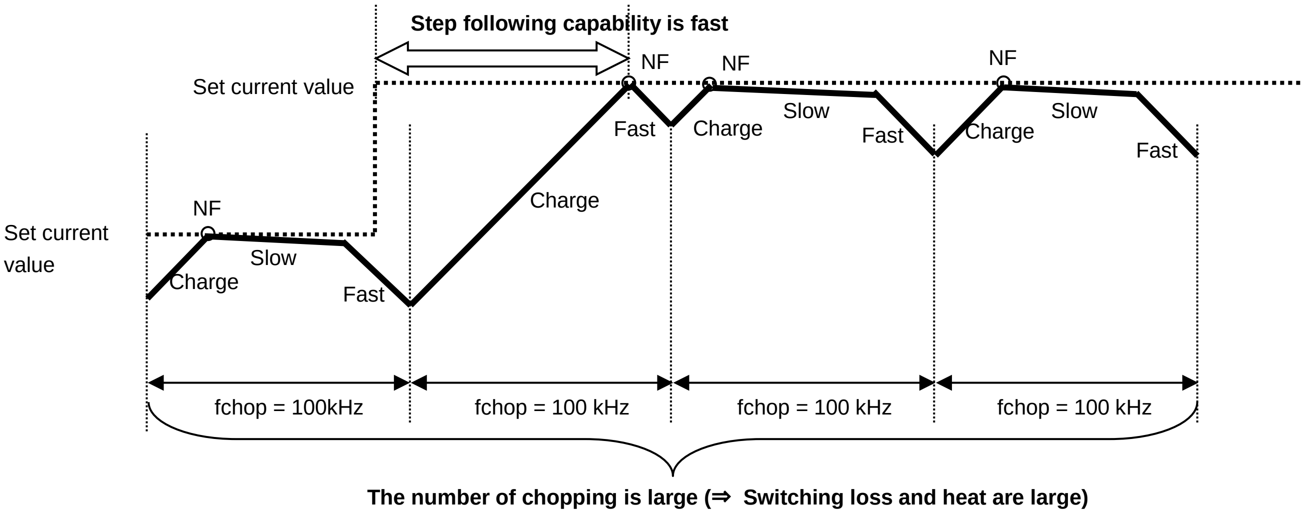


Figure 4.2 Chopping frequency (100 kHz)

(Example 2) Chopping frequency (fchop) = 50 kHz

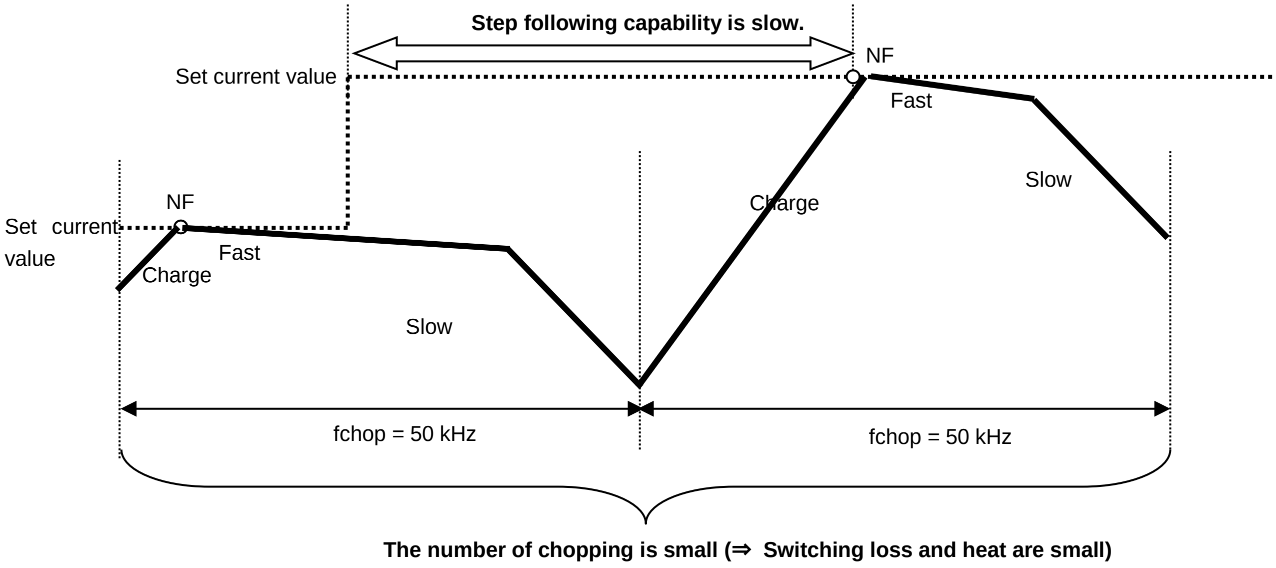


Figure 4.3 Chopping frequency (50 kHz)

Generally, it is recommended to configure the frequency in the range of 50 kHz to 100 kHz on the basis of 70 kHz.

5. Mixed Decay Mode / Zero point detection

In controlling the constant current, terms of drawing current (Fast mode) is fixed to corresponding 6 clocks of OSCM.

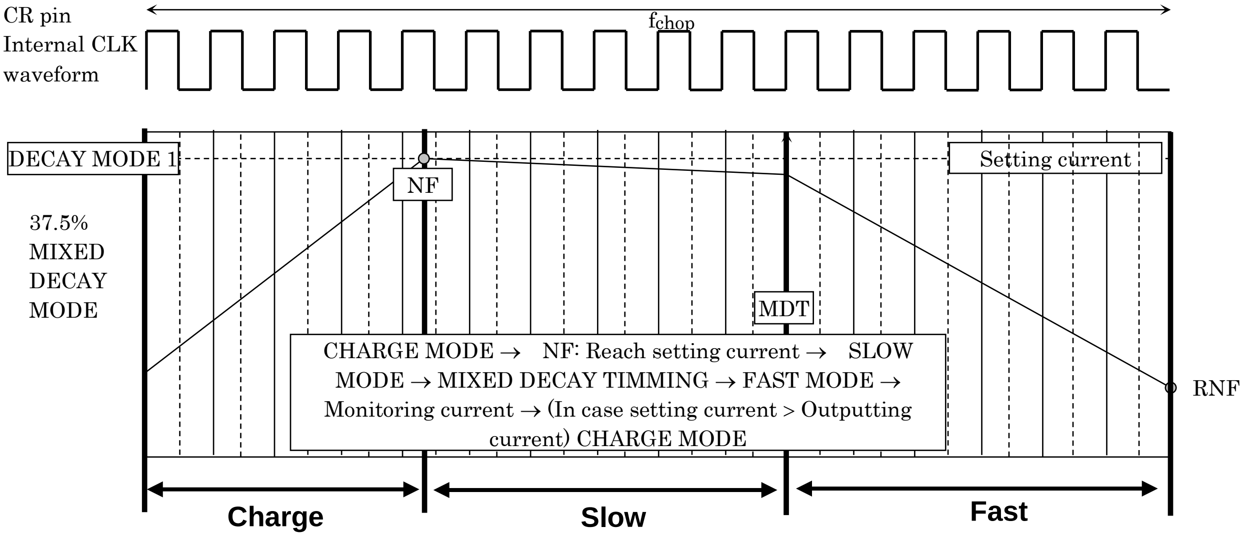


Figure 5.1 Mixed Decay waveform

6. Switching characteristics

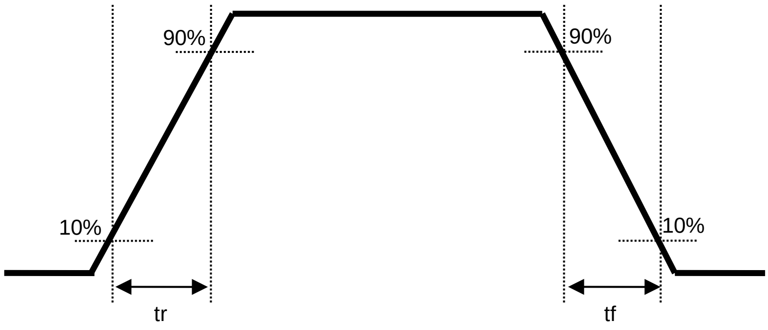


Figure 6.1 Switching characteristics

Table 6.1 Switching characteristics

T_a = 25°C, VM = 24 V, No load

Item	Typ.	Unit
tr	150	ns
tf	100	ns

7. Function explanation

(1) CLK function

Each up-edge of the CLK signal will shift the motor’s electrical angle per step.

Table 7.1 CLK function

CLK input	Function
Up-edge	Shifts the electrical angle per step.
Down-edge	— (State of the electrical angle does not change.)

(2) ENABLE function

The ENABLE terminal controls the ON and OFF of the corresponding output stage. This terminal serves to select if the motor is stopped in Off (High impedance: Z) mode or activated. Please set the ENABLE terminal to ‘L’ during VM power-on and power-off sequence.

Table 7.2 ENABLE function

ENABLE Input	Function
H	Output stage=‘ON’ (Normal operation mode)
L	Output stage=’OFF' (High impedance mode: Hi-Z)

⑶ CW/CCW function and the output terminal function (Output logic at the time of a charge start)

The CW/CCW terminal controls the rotation direction of the motor. When set to ‘Clockwise’, the current of OUT_A is output first, with a phase difference of 90°. When set to ‘Counter clockwise”, the current of OUT_B is output first with a phase difference of 90°.

Table 7.3 CW/CCW function

CW/CCW Input	OUT (+)	OUT (-)
H: Clockwise operation(CW)	H	L
L: Counter clockwise operation(CCW)	L	H

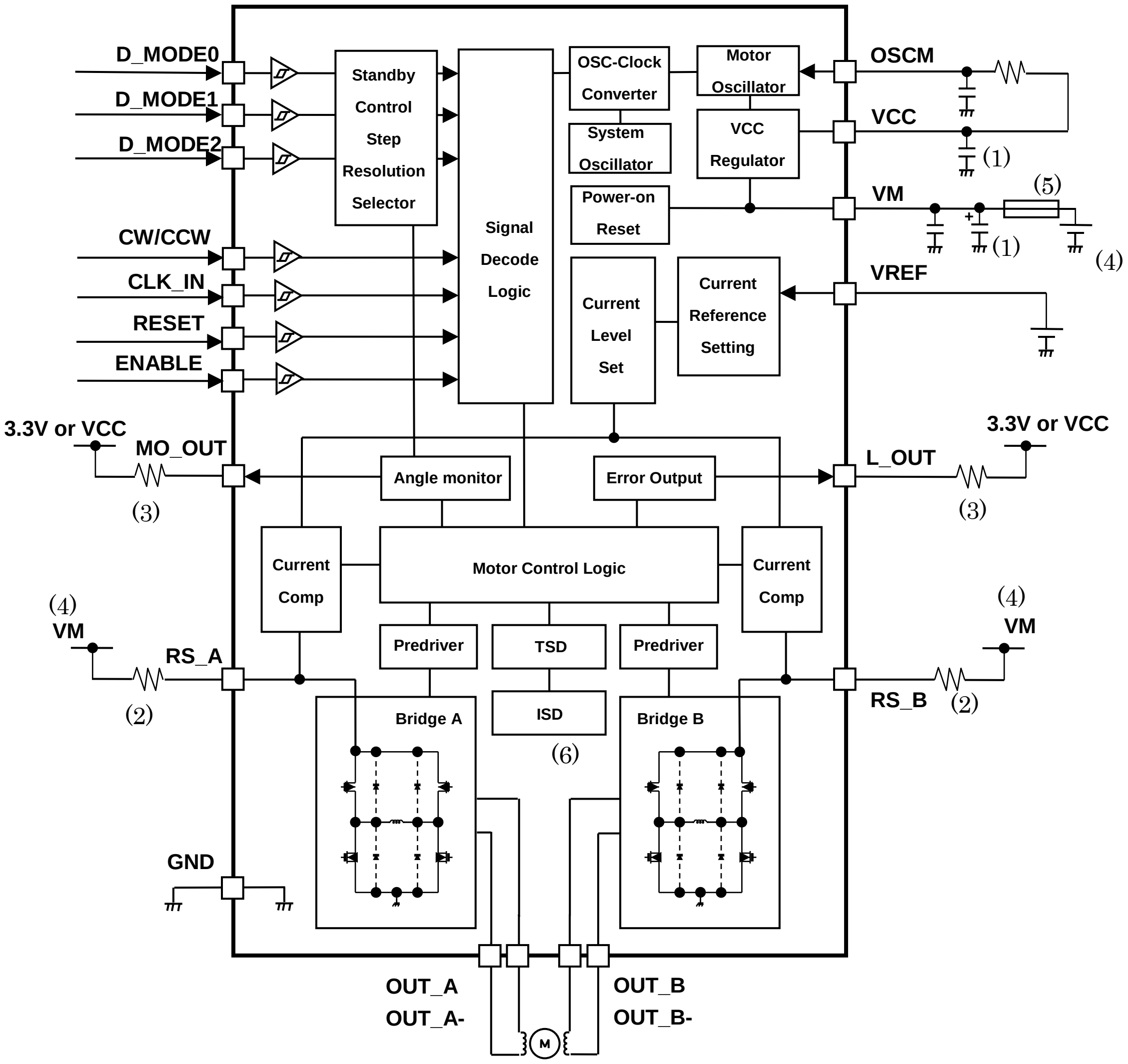
⑷ DMODE (step resolution select) function

Table 7.4 DMODE function

D_MODE0	D_MODE1	D_MODE2	Function
L	L	L	Standby mode (the OSCM is disabled and the output stage is set to ‘OFF’ status)
L	L	H	Full step resolution
L	H	L	Half step resolution(Type (A))
L	H	H	Quarter step resolution
H	L	L	Half step resolution(Type (B))
H	L	H	1/8 step resolution
H	H	L	1/16 step resolution
H	H	H	1/32 step resolution

*After STANDBY MODE is released, do not input a signal until the internal circuit becomes stable. (1 ms passes after the release of STANDBY MODE is the indication)
It is recommended to switch the D_MODE 0, 1, and 2 after setting the RESET signal to Low in the initial state (MO_OUT = Low).

8. Application circuit example



The application circuits shown in this document are provided for reference purposes only. Thorough evaluation is required, especially at the mass-production design stage.

Figure 8.1 Application circuit example

(1) Capacitor for power supply terminal

To stabilize the power supply voltage of the IC and reduce the noise, connect the appropriate capacitor to each terminal. It is recommended to connect the capacitor as close to the IC as possible. Especially, by connecting the ceramic capacitor near the IC, the change of the power supply at the high frequency range and the noise can be reduced.

Table 8.1 Recommended capacitor values for power supply terminal

Item	Parts	Typ.	Recommended range
VM-GND	Electrolytic capacitor	100 μF	47 to 100 μF
	Ceramic capacitor	0.1 μF	0.01 to 1 μF
VCC-GND	Ceramic / Electrolytic capacitor	0.1 μF	0.01 to 1 μF
(VREF-GND)	Ceramic capacitor	0.1 μF	0.01 to 1 μF

＊VREF-GND: Connect the capacitor in necessary depending on the usage environment.
＊It is possible to use the capacitor, which is not the recommended capacitor, depending on the motor load condition and the design pattern of the board.

(2) Resistance of current detection

This IC configures the threshold of the constant current detection by connecting the resistance of current detection between VM and RS terminals. The detection resistance is recommended to connect near the IC. (The motor can be controlled with the accurate current because the influence of the wire resistance of the board can be reduced.)

Table 8.2 Recommended resistance values for current detection

Item	Parts	Typ.	Recommended range
VM-RS	Chip / Lead resistance	0.51 Ω (0 to 1.8 A)	0.51 to 1.0 Ω

The relation equation of the threshold of the constant current detection, Vref voltage, and the resistance of RS detection is as follows;

$$\mathrm{Iout(max)} = \mathrm{Vref(gain)} \times \frac{\mathrm{Vref(V)}}{\mathrm{RRS(\Omega)}}$$

Vref (gain): Vref decay ratio is 1 / 5.0(typ.).

As for the resistance of current detection, the constant number which is out of recommended range can be adopted. In this case, please pay attentions to the followings when the used resistance is high and low.

- When the detection resistance is low, the difference voltage between VM and RS comparing to the internal reference voltage becomes small. So, the current may be largely different from the configured current value.
- When the detection resistance is high, the power applied to the detection resistance increases during motor operation (P=I^2×R). So, in case the same current flows as the case of adopting a low resistance, the power dissipation should be larger.

(3) Resistance for monitor terminal

This IC has two open-drain terminals of MO_OUT and L_OUT. When internal MOSFET is turned off, it is high impedance as a terminal level. In order to operate the IC with accurate high and low levels, connect the pull-up resistance to the power supply of 3.3 V or 5 V in using.

Table 8.3 Recommended resistance for monitor terminal

Item	Parts	Typ.	Recommended range
MO_OUT,L_OUT- (3.3V or VCC)	Chip / Lead resistance	10 kΩ	10 to 100 kΩ

(4) Wiring pattern for power supply and GND

Since large current may flow in VM, RS, and GND pattern especially, design the appropriate wiring pattern to avoid the influence of wiring impedance. It is very important for surface mounting package to radiate the heat from the heat sink of the back side of the IC to the GND. So, design the pattern by considering the heat design.

(5) Fuse

Use an appropriate power supply fuse for the power supply line to ensure that a large current does not continuously flow in the 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 to smoke or ignition. To minimize the effects of the flow of a large current in the case of breakdown, appropriate settings, such as fuse capacity, fusing time and insertion circuit location, are required.

This IC incorporates over current detection circuit (ISD) that turns off the output of the IC when over current is detected in the IC. However, it does not necessarily protect ICs under all circumstances. If the Over current detection 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 detection 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.

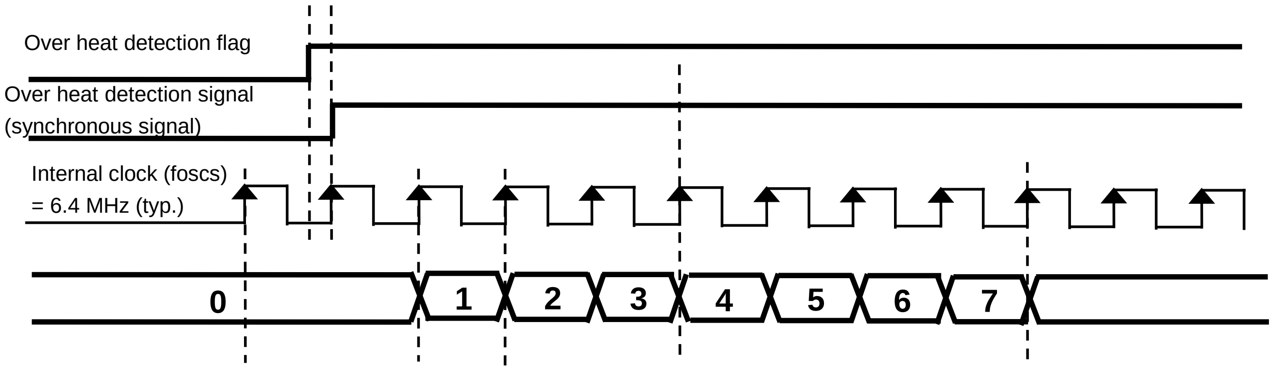
To avoid above IC destruction and malfunctions caused by noise, the over current detection circuit has a dead band time. So, it is concerned that the over current detection circuit may not operate depending on the output load conditions because of the dead band time. Therefore, in order to avoid continuing this abnormal state, use the fuse for the power supply line.

(6) Abnormality detection function

- Thermal shutdown circuit (TSD)
  When the IC detects an over temperature, the internal circuit turns off the output MOSFETs. It has a dead band time to avoid TSD misdetection, which may be triggered by external noise. Reassert the VM power supply or use the standby mode by D_MODE terminal to release this function. The TSD is triggered when the device is over heated irregularly. Make sure not to use the TSD function aggressively.

- Over current detection (ISD)
  When the IC detects an over current, the internal circuits turns off the output MOSFETs. It has a dead band time to avoid ISD misdetection, which may be triggered by external noise. Reassert the VM power supply or use the standby mode by D_MODE terminal to release this function.

Dead band time of ISD



Timing charts may be simplified for explanatory purposes.

Figure 8.2 Dead band time of ISD

ISD has a dead band time to avoid false detection caused by spike current in switching. This dead band time is configured by counting up the internal counter by the fixed frequency (6.4 MHz (typ.)) in the IC.

* foscs = 6.4 MHz(typ.) internal clock
1 / foscs × 7 to 8 clk (1.09 to 1.25 μs)

9. Power consumption of the IC

Power of the IC is consumed by the transistor of the output block and that of the logic block mainly.

P (total) = P (out) + P (bias)

- Power consumption of the motor output block

  Power of the output block (P (out)) is consumed by MOSFET of upper and lower H-Bridge.

P (out) =Number of H-Bridge × Iout (A) × VDS (V) = 2 (ch) × Iout (A) × Iout (A) × Ron (Ω)………. (1)

When the current waveform of the motor output corresponds to the ideal waveform (full step resolution / square wave), average power of output block can be provided as follows;

When Ron = 0.8Ω, Iout (peak: Max) = 1.5 A, VM = 24 V
P (out) = 2 (ch) × 1.5 (A) × 1.5 (A) × 0.8(Ω)……………………………………..………………. (2)
= 3.6 (W)

When the maximum resolution capability of the TB62269 (1/32 step resolution) is configured by using μ-stepping function, the average power is about 71% (= 1/√2) and P (out) is 2.55 (W).

- Power consumption of logic and IM systems.

  Power consumptions of logic and IM systems are calculated by separating the states (operating and stopping).

I (IM3) = 5.0 mA (typ.) : Operating
I (IM2) = 4.0 mA (typ.) : Stopping

Output system is connected to VM (24V). (Output system: Current consumed by the circuit connected to VM + Current consumed by switching output steps)

Power consumption is calculated as follows;

P (bias) = 24 (V) × 0.005 (A)……………………………………………………………………… (3)
= 0.120 (W)

- Power consumption

  Total power consumption P (total) is calculated from the values of formula (2) and (3).

P (total) = P (out) + P (bias) = 3.6 + 0.120 = 3.720 (W)

Standby mode is released. The power consumption in non-operation mode of the motor (waiting mode) is calculated as follows;

P = 24 (V) × 0.0025 (A) = 0.0600 (W)

In actual motor operation, the average current becomes lower than the calculated value because of transition time of the current steps and the ripple of the constant current PWM. Refer to the above equations, evaluate the heat design of the board by the actual board enough, and configure the appropriate margin.

10. Power dissipation

Relation equation of the ambient temperature (T_a), junction temperature (T_j), and the heat resistance ($R_{th\ (j\text{-}a)}$) between junction temperature to ambient temperature is as follows;

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

(Example) When 4-layer mounting board ($R_{th\ (j\text{-}a)} = 25°C/W$), $T_a = 25°C$, P (total) = 3.72 W ($I_{out} = 1.5$ A, full step resolution)

$$T_j = 25\ (°C) + 25\ (°C/W) \times 3.72\ (W) = 118.00°C$$

(Reference) Relation between the power dissipation and the ambient temperature

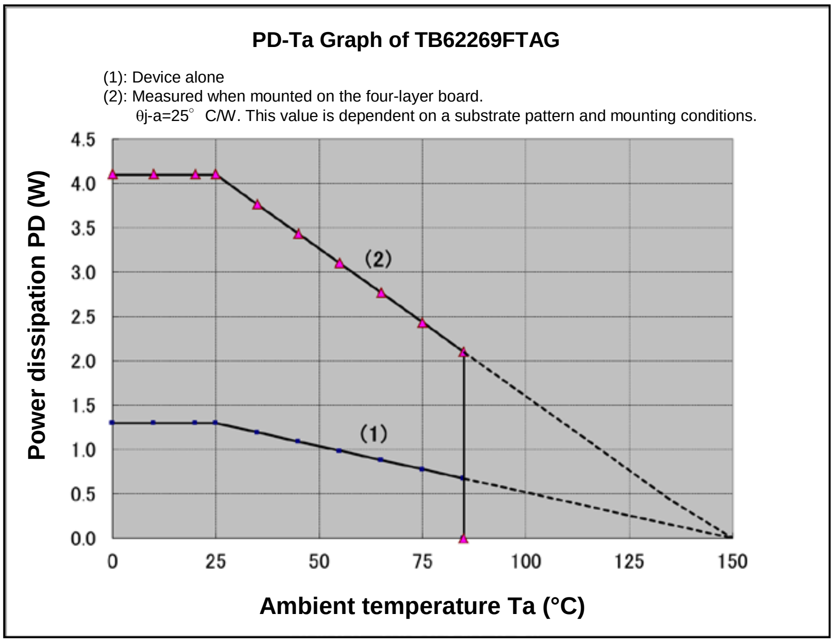


Figure 10.1 Power dissipation

* Pay attention that T_a, $R_{th\ (j\text{-}a)}$, and P (total) depend on the usage environment. When ambient temperature is high, the allowable power consumption decreases.

11. Board dimensions

11.1. Input

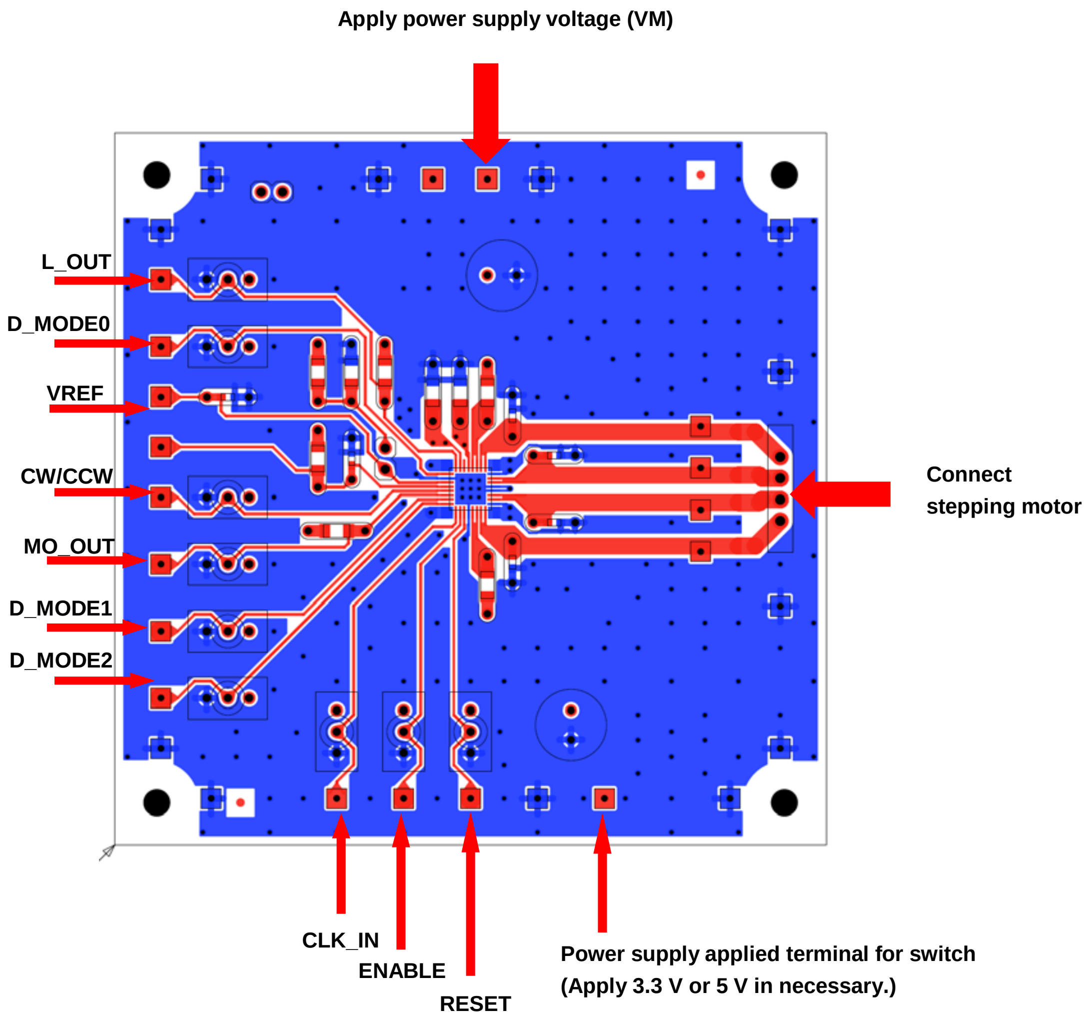


Figure 11.1 Input

Input each power supply and control signal according to above figure.

11.2. Main part

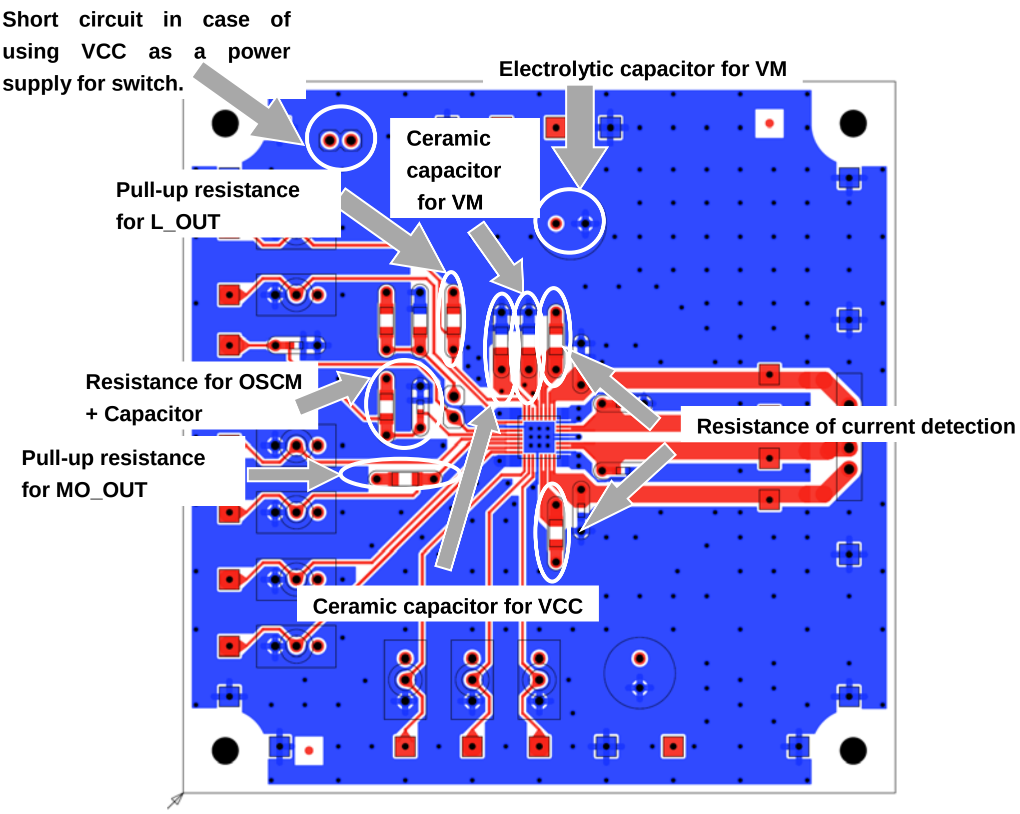
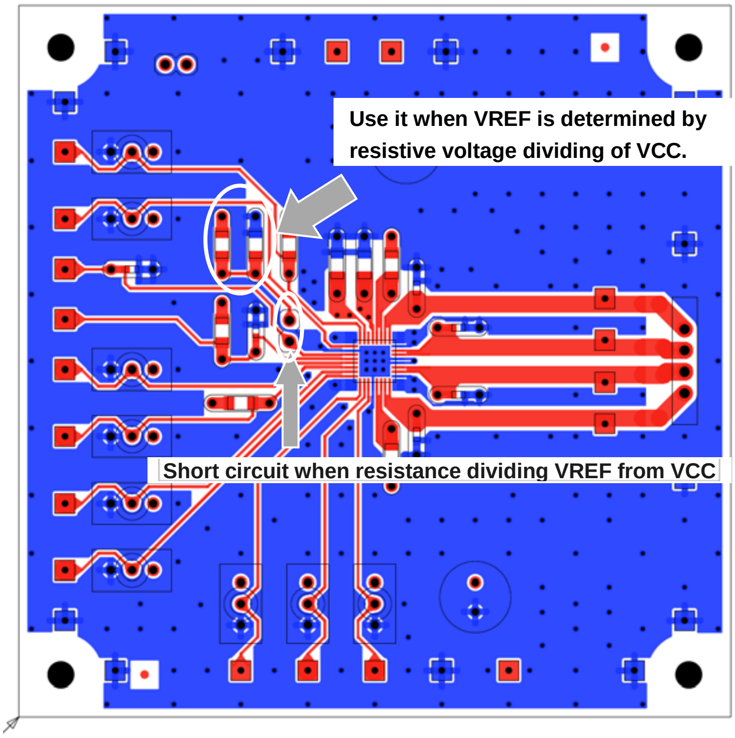


Figure 11.2　Main part

Connect each part referring to “8. Application circuit example”.

11.3. Options



Use it when VREF is determined by resistive voltage dividing of VCC.

Short circuit when resistance dividing VREF from VCC

Figure 11.3 Options

12. Foot pattern example (for reference only)

(1) QFN32 foot pattern (unit: mm)

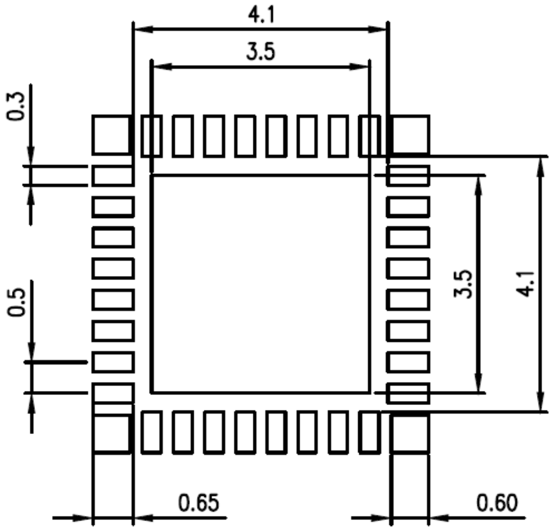


Figure 12.1 QFN32 foot pattern

Toshiba does not guarantee the data for mass production. Please use the data as reference data for customer’s application.
Note: In determining the size of mounting board, design the most appropriate pattern by considering the solder bridge, the solder connecting strength, the pattern accuracy in making board, and the mounting accuracy of the IC board. It is recommended to install a thermal via in the E-PAD section.

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 device breakdown, damage or deterioration, and may result in injury by explosion or combustion.

(2) Use an appropriate power supply fuse to ensure that a large current does not continuously flow in the case of overcurrent 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 to smoke or ignition. To minimize the effects of the flow of a large current in the 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 device breakdown, damage or deterioration, and may result in injury by explosion or combustion.
In addition, do not use any device inserted in the wrong orientation or incorrectly to which current is applied even just once.

(5) Carefully select external components (such as inputs and negative feedback capacitors) and load components (such as speakers), for example, power amp and regulator.
If there is a large amount of leakage current such as from input or negative feedback condenser, the IC output DC voltage will increase. If this output voltage is connected to a speaker with low input withstand voltage, overcurrent or IC failure may cause smoke or ignition. (The overcurrent may cause smoke or ignition from the IC itself.) In particular, please pay attention when using a Bridge Tied Load (BTL) connection-type IC that inputs output DC voltage to a speaker directly.

Points to remember on handling of ICs

(1) Overcurrent detection Circuit

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

Depending on the method of use and usage conditions, exceeding absolute maximum ratings may cause the overcurrent detection circuit to operate improperly or IC breakdown may occur before operation. In addition, depending on the method of use and usage conditions, if overcurrent continues to flow for a long time after operation, the IC may generate heat resulting in breakdown.

(2) 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, exceeding absolute maximum ratings may cause the thermal shutdown circuit to operate improperly or IC breakdown to occur before operation.

(3) Heat Radiation Design

When using an IC with large current flow such as power amp, regulator or driver, design the device so that heat is appropriately radiated, in order not to exceed the specified junction temperature (TJ) at any time or under any 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, when designing the device, take into consideration the effect of IC heat radiation with peripheral components.

(4) Back-EMF

When a motor rotates in the reverse direction, stops or slows abruptly, current flows back to the motor's power supply owing 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 terminals might be exposed to conditions beyond the absolute maximum ratings. To avoid this problem, take the effect of back-EMF into consideration in system design.

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