TC78H670FTG

Usage considerations

Summary

The TC78H670FTG is a two-phase bipolar stepping motor driver using a PWM chopper. The clock-in decoder is built in.
The TC78H670FTG can be used in applications that require 2-phase, 1-2-phase, W1-2-phase, 2W1-2-phase, 4W1-2-phase 8W1-2-phase, 16W1-2-phase and 32W1-2-phase excitation modes. It is capable of forward and reverses driving of a two-phase bipolar stepping motor using only a clock signal.

* Contents in this application note are only for reference to evaluate products. Therefore, they are not guaranteed. As for details, please refer to the data sheet.

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1. Power supply voltage

1.1. Power supply voltage and operating range

In using the TC78H670FTG, the voltage should be applied to the VM and VREF pins.
The maximum rating of VM supply voltage is 18 V (active). The usage range is 2.5 to 16 V.
The slew rate in inputting a power supply should be used 0.05V/μs or less.
The usage range of VREF is 0 to 1.8V.

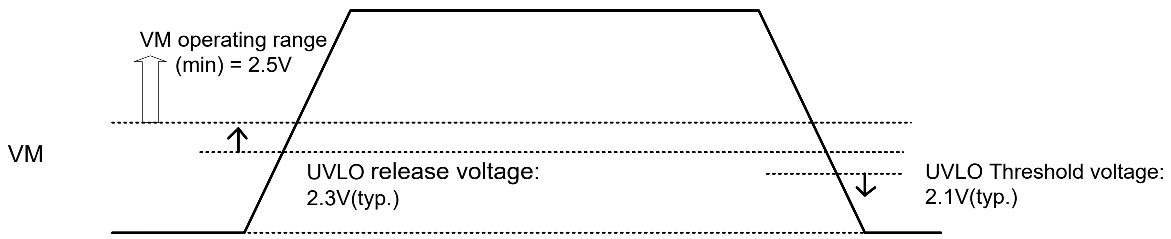


Figure 1.1 VM operation range and UVLO threshold

1.2. Power supply sequence

This IC realizes the single power supply drive by the internal regulator. Additionally, the under voltage lockout (UVLO) is embedded to prevent a malfunction at low voltage.
However, under the unstable state of inputting the power supply (VM) and shutdown (transient area), setting the motor operation to OFF state is recommended. After the power supply is in the stable state, the motor should be operated by switching the input signal.

2. Output current

Motor usage current should be 2.0A or less per phase. 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.
Input signals of the 1.8 V system can also be acceptable to control the IC because VIN (H) is 1.5 V and VIN (L) is 0.7 V. Pull down resistor of 100 kΩ (typ.) is incorporated.

3.1. Control Mode Select Function

The TC78H670FTG can be selected CLK-IN mode or Serial mode.
The control mode is set up by the input state of the MODE0-3 pins after releasing standby mode.

Table 3.1 Control mode select function

MODE3 pin input	MODE2 pin input	MODE1 pin input	MODE0 pin input	Function
L	L	L	L	Serial mode
Other than the above (see Step Resolution Select Function)				CLK-IN mode

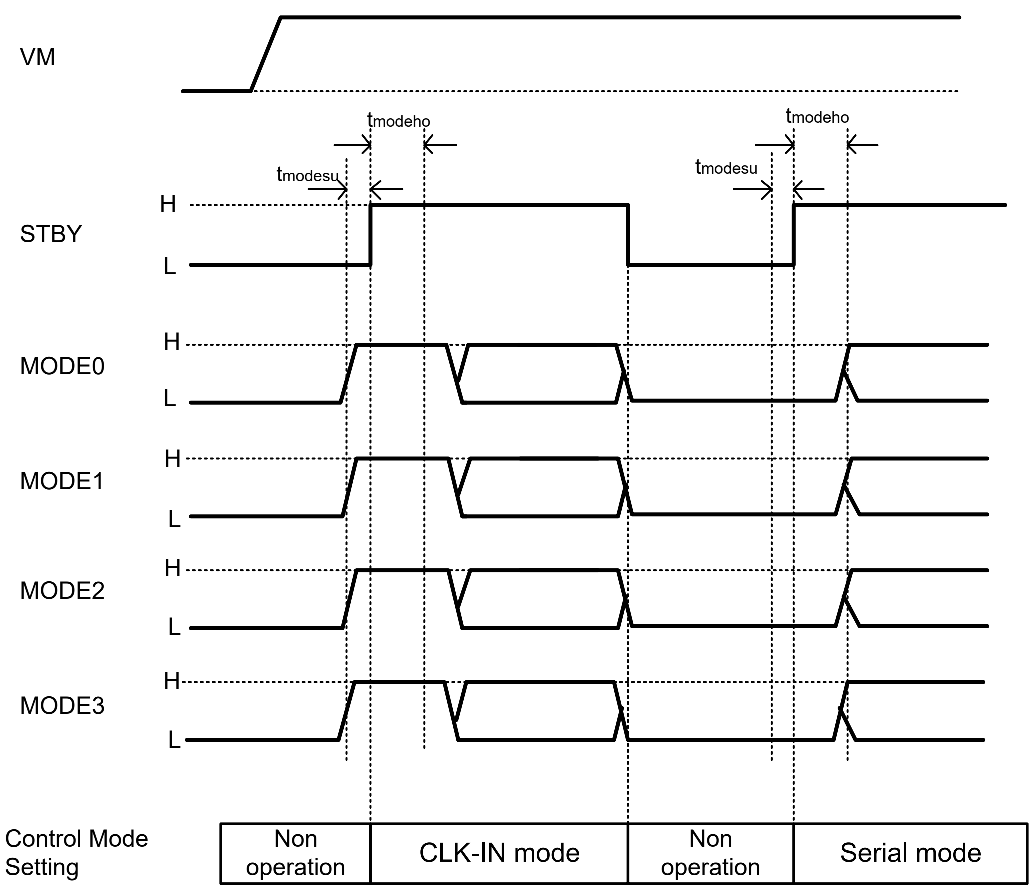


Figure 3.1 Mode selection

Table 3.2 Mode select AC characteristics

Characteristics	Symbol	Test condition	Min	Typ.	Max	Unit
Mode select Setup time	tmodesu	To STBY edge	1	—	—	µs
Mode select Data hold time	tmodeho	From STBY edge	100	—	—	µs

3.2. Functional Description 1 (for CLK-IN mode)

3.2.1. CLK Function

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

Table 3.3 CLK Function

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

3.2.2. ENABLE Function

The EN pin controls the ON and OFF of the stepping motor outputs. Motor operation starts and stops by setting H and L to the EN pin. (When EN pin is set to L (OFF), all of the MOSFETs turn off and become high impedance (hereafter, Hi-Z).)
Setting the EN pin to L, and preventing the motor from operating during VM power-on and power-off is recommended.
The EN pin should be input High level through a resistor.

Table 3.4 ENABLE Function

EN pin input	Function
L	OFF (Hi-Z)
H	ON (Normal operation mode)

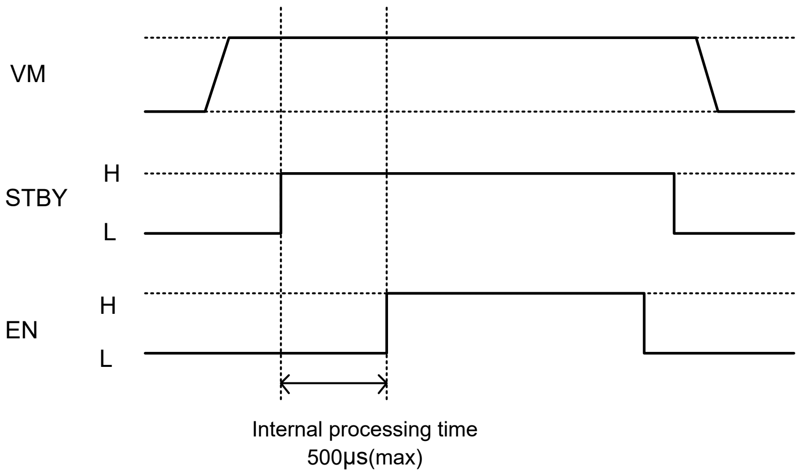


Figure 3.2 Enable timing

Note: After setting the Standby mode: OFF, the internal circuit will restart from low power mode. During the startup period (500µs after setting the Standby mode: OFF), please do not send any control signals.

3.2.3. CW-CCW Function

CW-CCW pin controls the rotation direction of the motor.

Table 3.5 CW-CCW Function

CW-CCW pin input	Function
L	Counter clockwise operation (CCW)
H	Clockwise operation (CW)

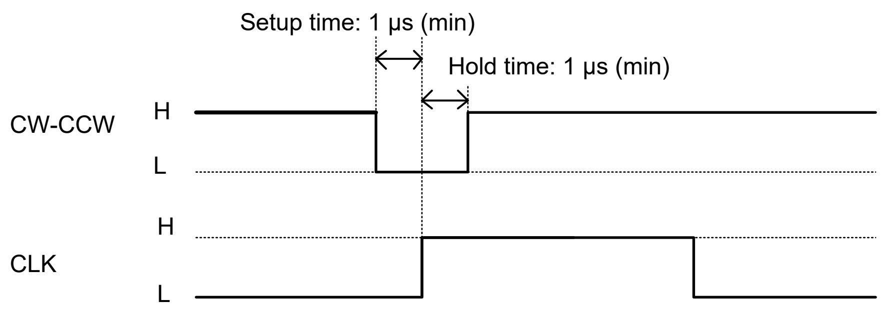


Figure 3.3 CW-CCW AC specification

Note: Above times are reference values, and are not guaranteed.

3.2.4. Step Resolution Select Function

In the case of CLK-IN mode, step resolution is set up by the input state of MODE0-3 pins after releasing standby mode.
TC78H670FTG has the two modes, Variable Mode and Fixed Mode.

Variable Mode: Variable mode can be started in Full step resolution and changed step resolution during motor operating
Fixed Mode: Fixed mode can be started in the mode user selected and continued it during motor operating

Table 3.6 Step Resolution Select Function

MODE3 pin input	MODE2 pin input	MODE1 pin input	MODE0 pin input	Mode	Function
L	L	L	H	Variable Mode	Full step resolution <-> 1/2 step resolution (2-phase excitation) (1-2-phase excitation)
L	L	H	L		Full step resolution <-> 1/4 step resolution (2-phase excitation) (W1-2-phase excitation)
L	L	H	H		Full step resolution <-> 1/8 step resolution (2-phase excitation) (2W1-2-phase excitation)
L	H	L	L		Full step resolution <-> 1/16 step resolution (2-phase excitation) (4W1-2-phase excitation)
L	H	L	H		Full step resolution <-> 1/32 step resolution (2-phase excitation) (8W1-2-phase excitation)
L	H	H	L		Full step resolution <-> 1/64 step resolution (2-phase excitation) (16W1-2-phase excitation)
L	H	H	H		Full step resolution <-> 1/128 step resolution (2-phase excitation) (32W1-2-phase excitation)
H	L	L	L	Fixed Mode	Full step resolution (2-phase excitation)
H	L	L	H		1/2 step resolution (1-2-phase excitation)
H	L	H	L		1/4 step resolution (W1-2-phase excitation)
H	L	H	H		1/8 step resolution (2W1-2-phase excitation)
H	H	L	L		1/16 step resolution (4W1-2-phase excitation)
H	H	L	H		1/32 step resolution (8W1-2-phase excitation)
H	H	H	L		1/64 step resolution (16W1-2-phase excitation)
H	H	H	H		1/128 step resolution (32W1-2-phase excitation)

When Step mode is changed during operating, step resolution can be set by SET_EN pin and UP-DW pin.
Step mode is changed synchronously with Step Clock.

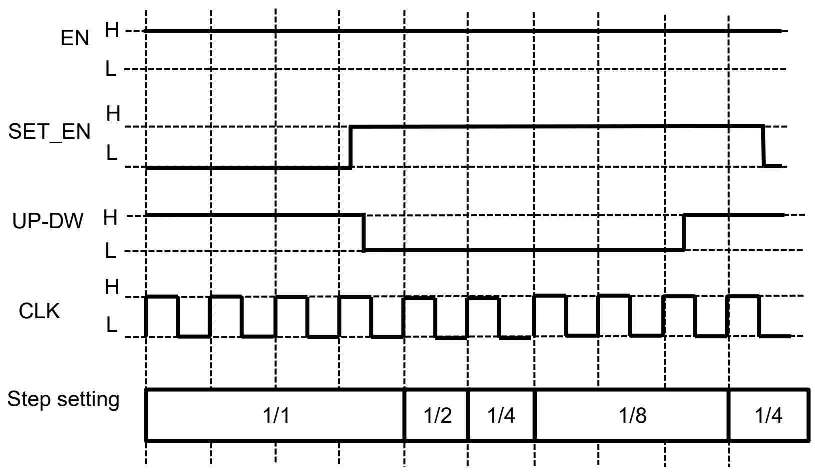
Table 3.7 SET_EN Function

SET_EN pin input	Function
L	Setting step mode is invalid
H	Setting step mode is available

Table 3.8 UP-DW Function

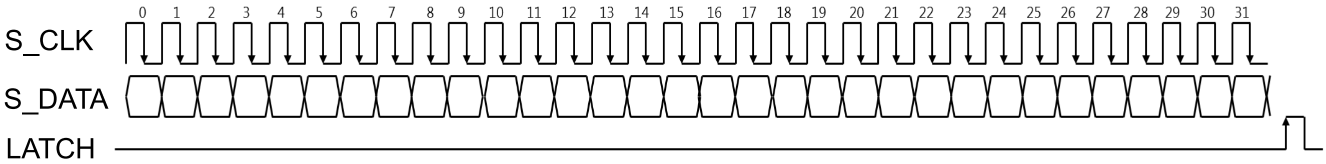
UP-DW pin input	Function
L	Change step mode to high resolution
H	Change step mode to Low resolution

[Example: Full Step to 1/8 Step (MODE3=L, MODE2=L, MODE1=H, MODE0=H)]



3.3. Functional Description 2 (for Serial mode)

In the serial mode, it performs setting and motor controlling the following 32-bit format. For the motor control, each current value is set in the serial setting, and the output is updated to the set current value at the timing of the LATCH signal.



D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15
MDT _A0	MDT _A1	PHA	CA0	CA1	CA2	CA3	CA4	CA5	CA6	CA7	CA8	CA9	—	—	—

D16	D17	D18	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	D31
MDT _B0	MDT _B1	PHB	CB0	CB1	CB2	CB3	CB4	CB5	CB6	CB7	CB8	CB9	TRQ 0	TRQ 1	OPD

Figure 3.4 Serial Format

Note: Every issuing a command, the current setting transfers by one step.

3.3.1. Register

The registers to use the serial control are shown below.

3.3.2. PHx (x = A or B)

The polarity of the output current can be selected by PHx registers for each channel.

Table 3.9 PHx register

PHx	Function
L	Setting the polarity of the output current to minus * Default
H	Setting the polarity of the output current to plus

3.3.3. Cx0 to Cx9 (x = A or B)

The output of each channel's DAC for current limitation can be set by Cx0 to Cx9 registers.
The relation between Setting DAC and the output current (Iout) are shown below.

$$\mathrm{Iout\ \ (Max)} = \mathrm{Vref\ \ (V)} \times \frac{\mathrm{Cx[9:0]}}{1023} \times \mathrm{Setting\ \ torque\ \ by\ \ the\ \ torque\ \ function\ \ (\%)}$$

3.3.4. TRQ0 and TRQ1

The value of the motor torque can be set by TRQ0 and TRQ1 registers.

Table 3.10 TRQ0 and TRQ1 registers

TRQ1	TORQ0	Function
L	L	Torque setting: 100% * Default
L	H	Torque setting: 75%
H	L	Torque setting: 50%
H	H	Torque setting: 25%

3.3.5. OPD

An ON/OFF of the open detection function of motor output pins can be switched by OPD register.

Table 3.11 OPD register

OPD	Function
L	Open detection OFF * Default
H	Open detection ON

3.3.6. Selectable Mixed Decay Function MDT_x0 and MDT_x1 (x = A or B)

The Selectable Mixed Decay can adjust the amount of regeneration current during the period of current regeneration. Though the Mixed Decay is determined by controlling 2 different types of Decay (Fast Decay and Slow Decay), this function enables the user to select the ratio of the Mixed Decay using MDT_x0 and MDT_x1 registers.

Table 3.12 MDT_x0 and MDT_x1 registers

MDT_x1	MDT_x0	Function
L	L	Fast Decay: 37.5% (Fast Decay = OSCM × 6) * Default
L	H	Fast Decay: 75%
H	L	Fast Decay: 50%
H	H	Fast Decay only

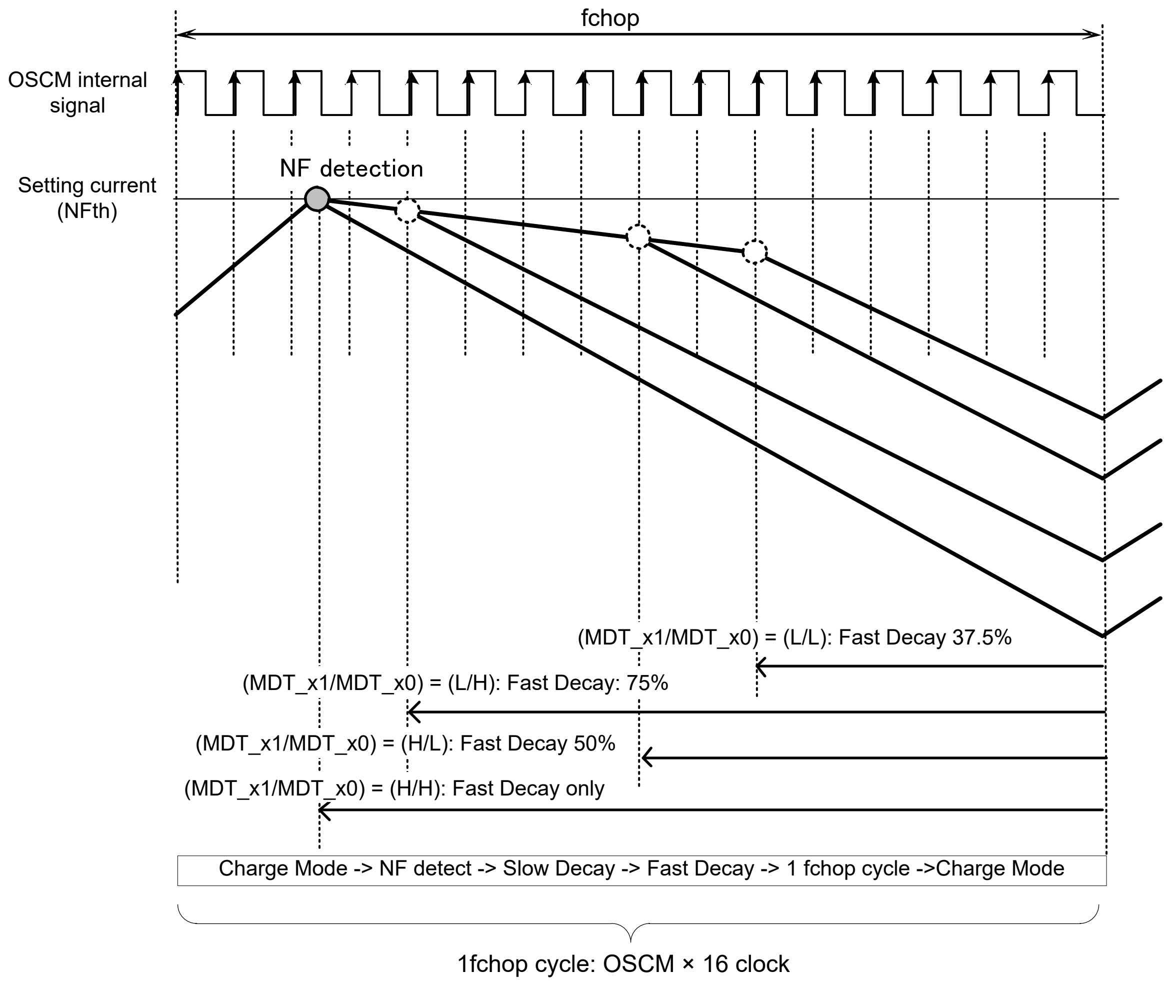


Figure 3.5 Waveform in Mixed Decay Mode (Serial mode)

Note: x = A or B

Note: Decay control is controlled in order of Charge, Slow Decay and Fast Decay.

Note: The blanking time (AtBLK) is also set to prevent an incorrect operation in the NF detection (the motor current reaches the set current value (NFth)).

Note: Timing charts may be simplified for explanatory purpose.

3.4. Common Function (CLK-IN Mode and Serial Mode)

3.4.1. Error Function (Error detect flag output)

When TC78H670FTG detects some errors, ERR pin outputs low level to peripheral block.
Since ERR pin and EN pin share the function, the below peripheral circuit between TC78H670FTG and HOST MCU should be inserted. EN pin should input High level through a resistor.
In normal status, since the internal MOSFET is OFF, the level of ERR pin is equal to the EN control voltage from outside. When the error function (Thermal shutdown (TSD), Over current (ISD), or motor load open (OPD)) occurs, ERR pin will become Low (the internal MOSFET is ON). When the error detection is released by reasserting the VM power supply or setting the device to STANDBY mode, ERR pins show “normal status”.

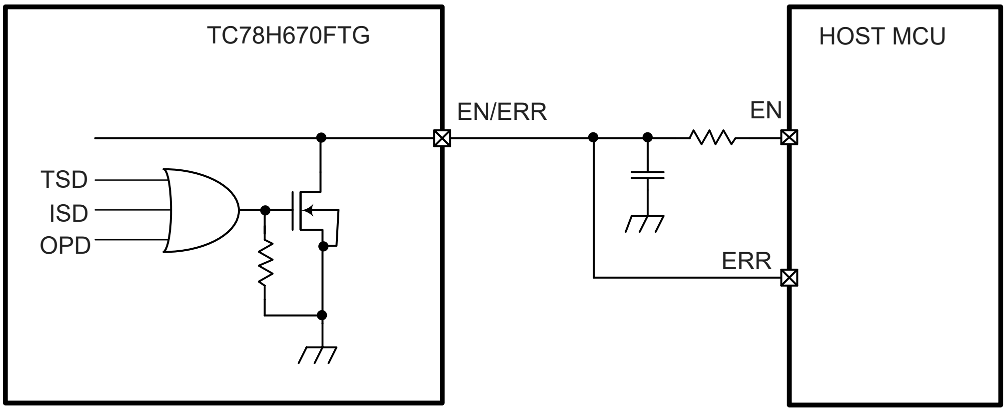


Figure 3.6 Example of EN/ERR connection

Note: This figure may be simplified for explanatory purpose.

Note: It is possible to detect OPD only when Serial mode is selected.

Table 3.13 Error function

ERR pin output	Function
H (Pull-up)	Normal status (Normal operation)
L	Detect error status (ISD, TSD, OPD)

After detecting TSD detection: TC78H670FTG draws out currents of motor by Fast mode. If the output current is zero-detected or after 1ms elapses at maximum, the outputs become Hi-Z.

After detecting ISD detection: In H Bridge high-side (Pch DMOS) detection, TC78H670FTG draws out currents of motor by Slow mode on low-side. The outputs become Hi-Z after 80 ms (typ.). In H Bridge low-side (Nch DMOS) detection, it draws out by Slow mode on high-side.

Note:Above times are reference values, and are not guaranteed.

3.4.2. STANDBY Function

It is possible to switch to Standby mode by STBY pin.

Table 3.14 Standby function

STBY pin input	Function
L	Standby mode
H	Normal operation

Note: When STBY pin is Low, TC78H670FTG stops supplying the power to logic circuit.
Therefore, Logic circuit is reset and electrical angle and step mode are initialized.

When the electrical angle is initialized by setting STBY pin to low level, the relation of the current setting for each H-bridge (Ach and Bch) and the electrical angle is shown below.

Table 3.15 Electrical angle

Step resolution	Ach current	Bch current	Electrical angle
Full step resolution (2-phase excitation)	100%	100%	45°
1/2 step resolution (1-2-phase excitation)	71%	71%	45°
1/4 step resolution (W1-2-phase excitation)	71%	71%	45°
1/8 step resolution (2W1-2-phase excitation)	71%	71%	45°
1/16 step resolution (4W1-2-phase excitation)	71%	71%	45°
1/32 step resolution (8W1-2-phase excitation)	71%	71%	45°
1/64 step resolution (16W1-2-phase excitation)	71%	71%	45°
1/128 step resolution (32W1-2-phase excitation)	71%	71%	45°

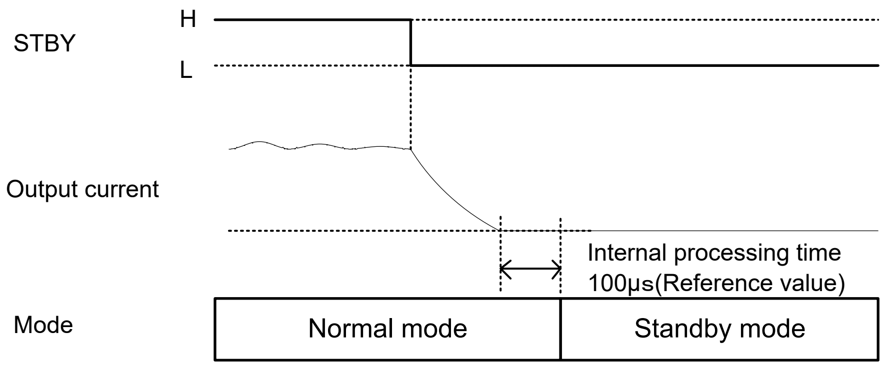


Figure 3.7 Standby timing

If the output current is zero-detected, the operation mode enters into the standby mode after 100μs. The mode enters into the standby mode forcedly after 1 ms(max) from STBY=L.

Note: Above times are reference values, and are not guaranteed.

4. Constant Current Control

In the case of constant current control in CLK-IN mode, the rate of Mixed Decay Mode which determines the current ripple is fixed to 37.5%. Peak current is set by the voltage value of VREF pin.

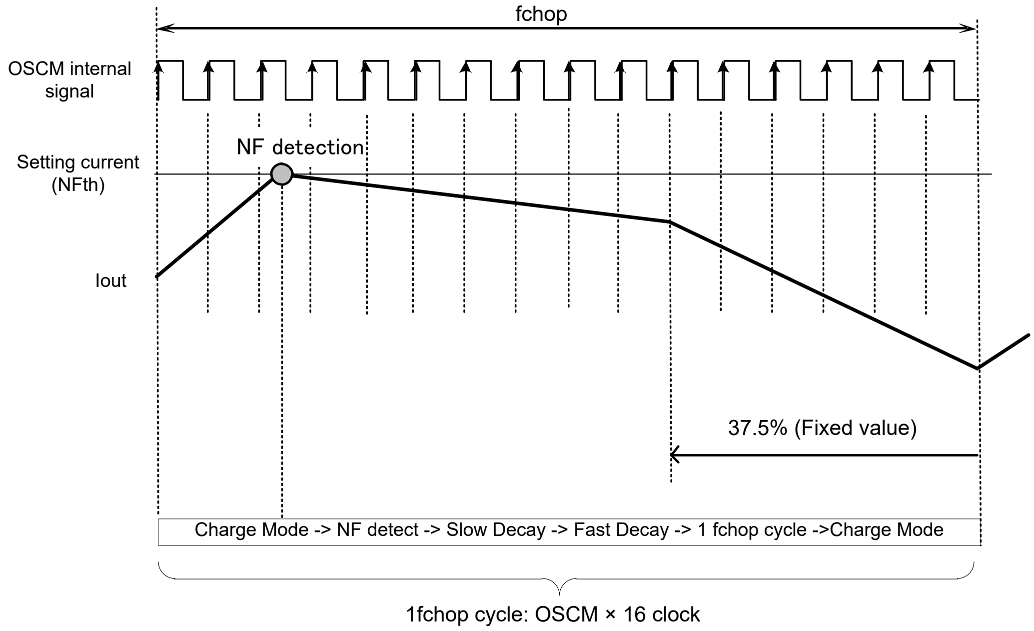


Figure 4.1 Waveform in Mixed Decay Mode

Note:The blanking time (AtBLK) is also set to prevent an incorrect operation in the NF detection (the motor current reaches the set current value (NFth))

Note:Timing charts may be simplified for explanatory purpose.

4.1. Calculation of the Predefined Output Current

TC78H670FTG can configure the constant current value only by the input voltage to the VREF pin. External current detection resistor is not required. The setting current value: Iout(max) can be set, as follows:

Iout (max) = 1.1 × Vref (V)

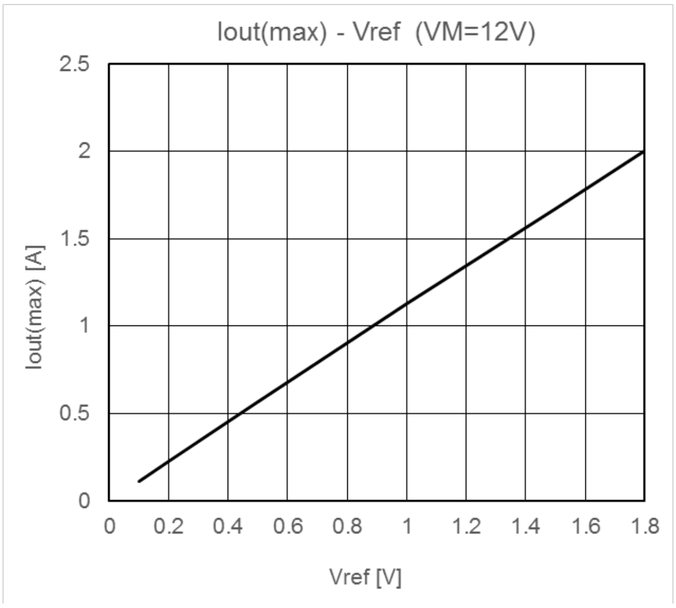


Figure 4.2 Setting current value vs VREF input voltage

Note: Characteristics shown above are reference values and not guaranteed.

4.2. OSCM Oscillation Frequency and Chopping Frequency

The OSCM oscillation frequency (fOSCM) and chopping frequency (fchop) can be adjusted by the external resistor (ROSC) connecting to OSCM pin.

Table 4.1 Relation of ROSC and Internal oscillation frequency, chopping frequency

ROSC[kΩ]	fOSCM [kHz](typ.)	fchop[kHz](typ.)
18	3290	206
22	2691	168
30	1982	124
39	1526	95
47	1266	79
56	1064	66
75	795	50
91	656	41

If chopping frequency is raised, ripple of current will become small and wave-like reproducibility will improve.
However, the gate loss inside IC goes up and generation of heat becomes large.
By lowering chopping frequency, reduction in generation of heat is expectable. However, ripple of current may become large.
It is a standard about 70 kHz. A setup in the range of 50 kHz to 100 kHz is recommended.

4.3. Constant current waveform when chopping frequency changes

Chopping frequency (fchop) is recommended to set about 70 kHz in using the IC. When the chopping frequency is increased, ripple current of the motor is decreased and the waveform quality is improved. However, the heat is generated because the increased chopping frequency enhances the switching loss. To improve the waveform quality, increase the chopping frequency. To reduce the heat generation, decrease the frequency.

Example 1: When chopping frequency (fchop) = 100 kHz,

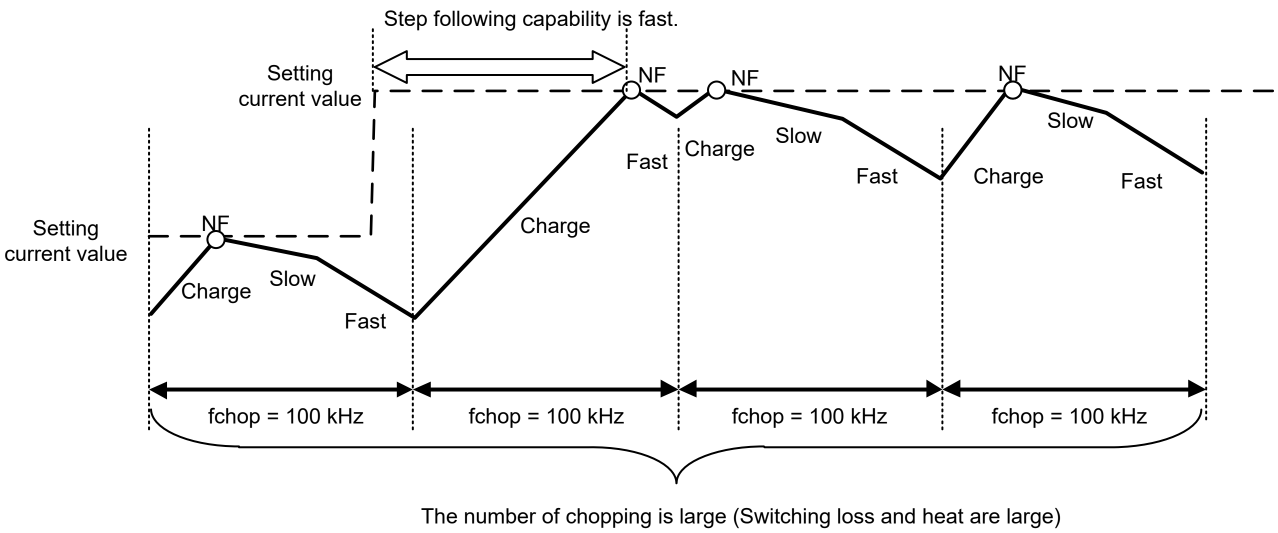


Figure 4.3 Constant current waveform (fchop = 100 kHz)

Example 2: When chopping frequency (fchop) = 50 kHz,

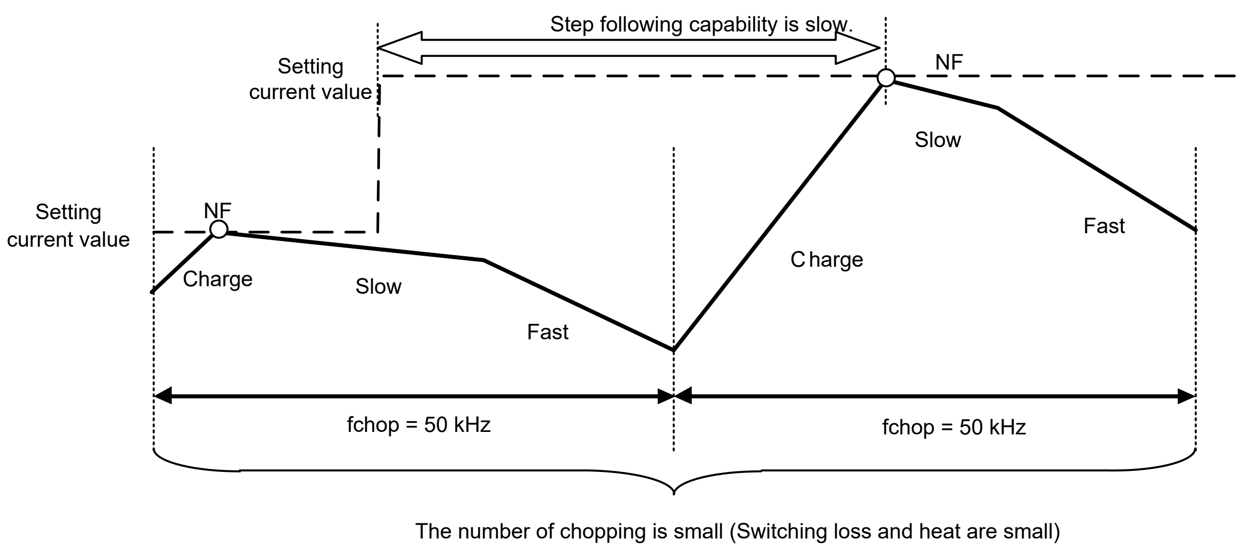


Figure 4.4 Constant current waveform (fchop = 50 kHz)

5. Error detection circuit

- **Thermal shutdown (TSD)**

When the junction temperature of the device reaches 165°C (typ.), the TSD circuit is triggered; the internal reset circuit then turns off the output transistors. Once the TSD circuit is triggered, the device will set output pin to Hi-Z, and can be cleared by reasserting the VM power source, or setting the STBY pin to standby mode. The TSD circuit is a backup function to detect a thermal error, therefore is not recommended to be used aggressively.

- **Under voltage lockout (UVLO)**

When the supply voltage to VM pin is 2.1 V or less (typ.), the internal circuit is triggered; the internal reset circuit then turns off the output transistors. Once the UVLO is triggered, it can be cleared by reasserting the VM supply voltage to 2.3 V or more (typ.)

- **Over current detection (ISD)**

When the output current reaches the threshold, the ISD circuit is triggered; the internal reset circuit then turns off the output transistors. It has a dead band time of 1.2 µs (typ.) to avoid ISD false triggering by switching noise. Once the ISD circuit is triggered, the device will set output pins to Hi-Z, and can be cleared by reasserting the VM power source, or setting the STBY pin to standby mode.

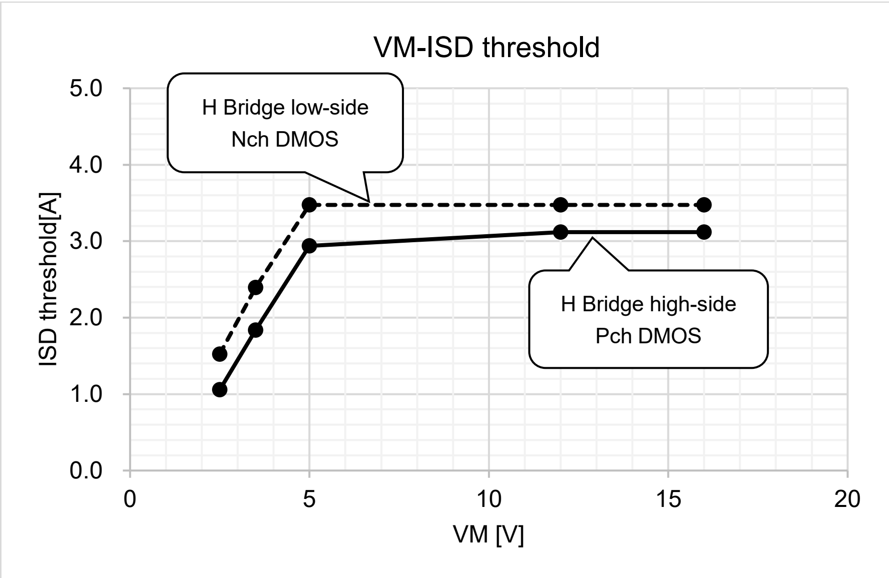


Figure 5.1 VM – ISD threshold

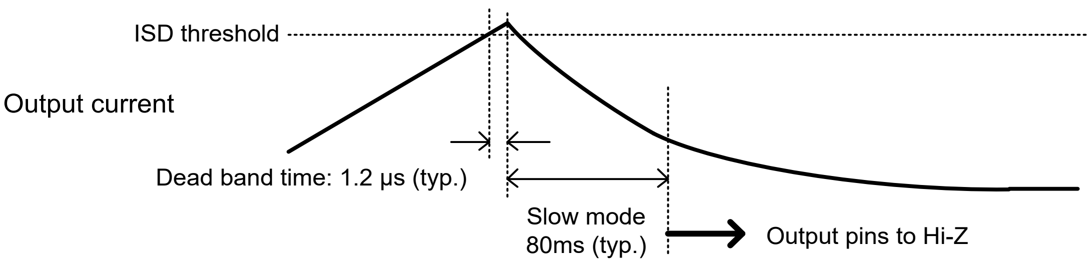


Figure 5.2 ISD operation

Note: Above ISD operation threshold value and band times are reference values, and are not guaranteed.

6. 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.

$P_D = P_D(out) + P_D(bias)$

- **Power consumption of the motor output block**

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

$P_D(out)$ = Number of H-Bridge × Iout (A) × VDS (V) = 2(ch) ×Iout (A) ^{2} × Ron (Ω)........ (1)

When the current waveform of the motor output corresponds to the ideal waveform (2-phase excitation / square wave), average power of output block can be provided as follows;

When Ron = 0.48 Ω, Iout (peak: max) = 1.0 A, VM = 12 V

$P_D(out)$ = 2 (ch) × 1.0 (A) ^{2} × 0.48 (Ω) = 0.96 (W)... (2)

* Ron: On-resistance (Upper + lower) of MOSFET to configure the H-Bridge circuit
Please keep in mind that this value has the characteristic depending on power supply voltage and temperature although it is defined as 0.48 Ω in the above-mentioned formula.
Please refer to the following graph about the characteristics of Ron at VM=5V or less.

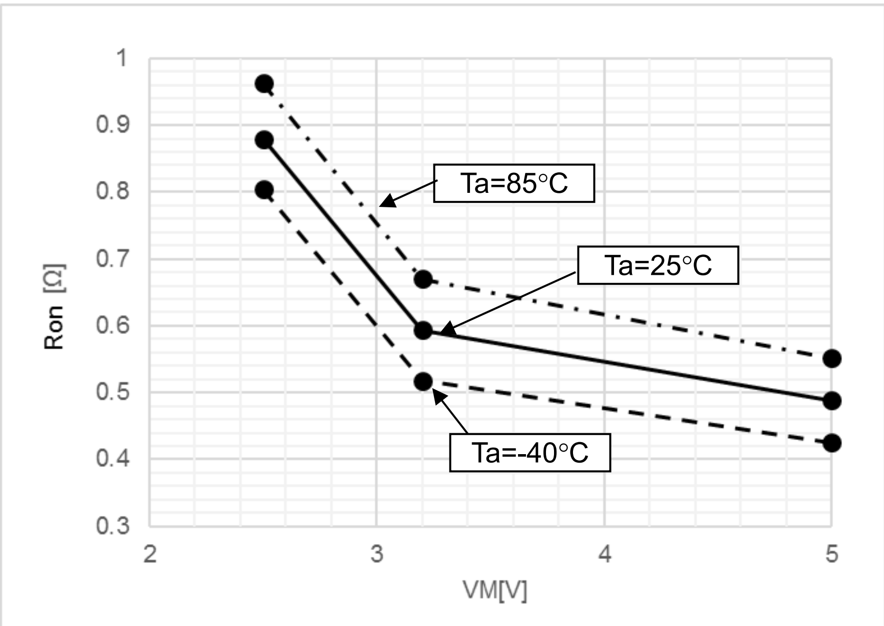


Figure 6.1 Ron characteristics (Iout=0.5A)

Note: The values shown in the above graphs are reference, not design values.

- **Power consumption of logic and IM systems**

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

I (IM3) = 3.3 mA (typ.) : Operating
I (IM2) = 2.8 mA (typ.) : Stopping

Output system is connected to VM (12V). (Output system: Current consumed by the circuit connected to VM + Current consumed by switching output steps)
Power consumption is calculated as follows;

P_D(bias) = 12 (V) × 0.0033 (A) = 0.04 (W).. (3)

- **Power consumption**

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

P_D = P_D(out) + P_D(bias) = 0.96 + 0.04 = 1.00 (W)

The power consumption in non-operation mode (stopping) of the motor is calculated as follows;

P_D = 12 (V) × 0.0028 (A) = 0.034 (W)

Additionally, the power consumption can be reduced by stopping the operation with the standby mode.

IM1=0.1μA (max))

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.

7. Example of application circuit

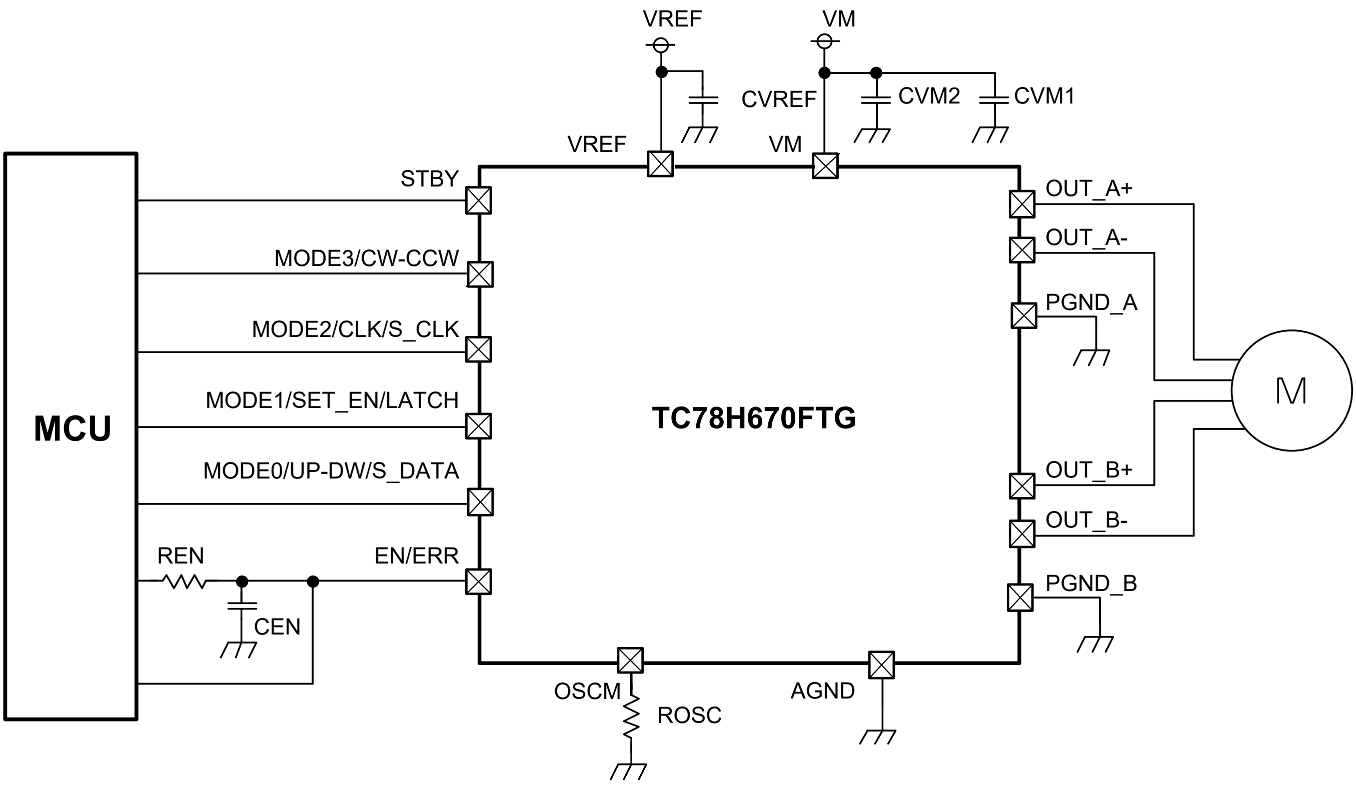


Figure 7.1 Example of application circuit

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

7.1. 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 fluctuation of the power supply at the high frequency range and the noise can be reduced.

Table 7.1 Recommended capacitor values for power supply terminal

Item	Parts	Typ.	Recommended range
VM-GND	Electrolytic capacitor	47 µF	47 to 100 µF
	Ceramic 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 by necessity, 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.

7.2. Wiring pattern for power supply and GND

Since large current may flow in the pattern to VM pin, AGND pin, PGND_x pin, OUT_x+ pin, and OUT_x- pin (x = A or B) especially, design the appropriate board in order to avoid the influence of wiring impedance. It is very important for surface mounting package to radiate the heat from the heat sink back side to the GND. So, design the pattern by considering the heat design.

7.3. 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 may 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.

8. Reference Land Pattern

P-VQFN16-0303-0.50-001

Unit: mm

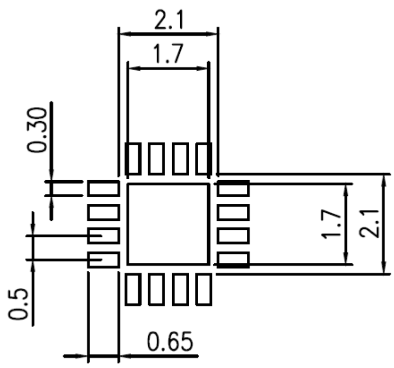


Figure 8.1 Reference Land Pattern

Notes

- All linear dimensions are given in millimeters unless otherwise specified.
- This drawing is based on JEITA ET-7501 Level3 and should be treated as a reference only.
  We are not responsible for any incorrect or incomplete drawings and information.
- You are solely responsible for all aspects of your own land pattern, including but not limited to soldering processes.
- The drawing shown may not accurately represent the actual shape or dimensions.
- Before creating and producing designs and using, customers must also refer to and comply with the latest versions of all relevant our information and the instructions for the application that Product will be used with or for.

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.

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) 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.

(3) 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.

(4) 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.

(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 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 can cause smoke or ignition. (The over current can 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) 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) 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.

(3) 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 (Tj) 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.

(4) 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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