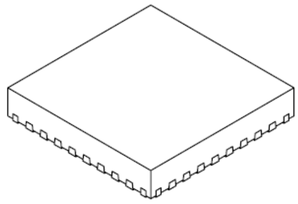
TOSHIBA BiCD Integrated Circuit Silicon Monolithic

TB67H481FTG

BiCD Constant Current Dual H-bridge Driver IC

1. Description

TB67H481FTG is a Dual H-bridge driver IC for driving 2 brushed motors / 1 stepping motor.
Fabricated with the BiCD process, output rating is 50 V/3.0 A.
The built-in regulator for IC operation allows the motor to be driven by a single VM power supply.



P-VQFN32-0505-0.50-008

Weight:0.065 g (Typ.)

2. Features

- BiCD process integrated monolithic IC
- Two Built-in H-bridge for output.
- Two Built-in H-bridge for output. (Mixed Decay / Slow Decay / Fast Decay)
- Power saving function (Sleep mode)
- PWM constant current drive
- 3.3 V regulator output
- BiCD structure: DMOSFET is used for output power transistor
- High breakdown voltage, large current: 50 V / 3.0 A (absolute maximum rating)
- Thermal shutdown detection (TSD), overcurrent detection (ISD), and low power supply voltage detection (UVLO)
- Error detection flag output function (LO).
- Reduction of external parts for charge pump
- Package : QFN32(5 mm×5 mm)

Start of commercial production
2023-07

3. Pin Assignment

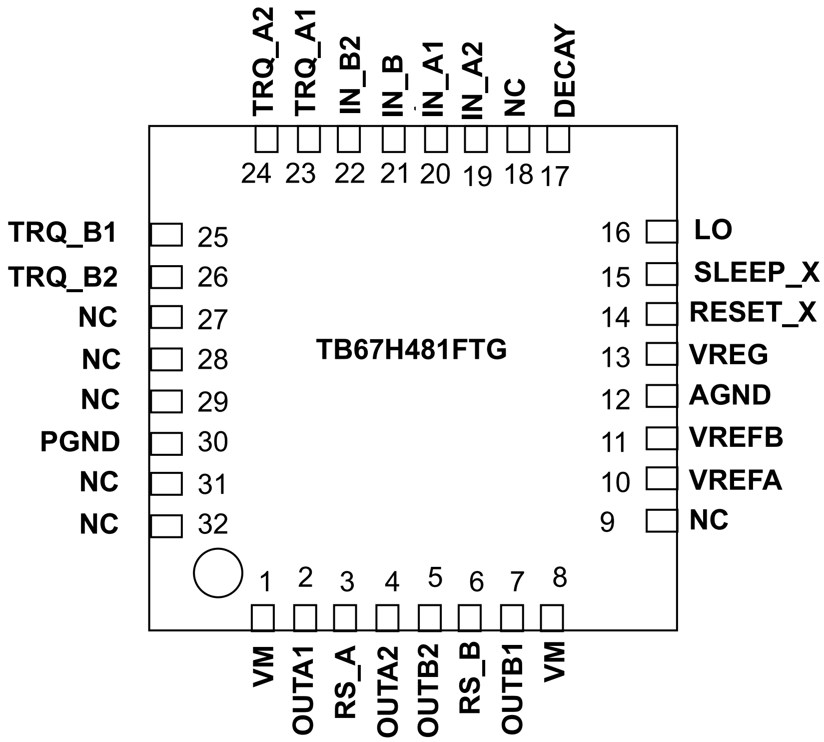


Figure3 Pin Assignment

4. Block diagram

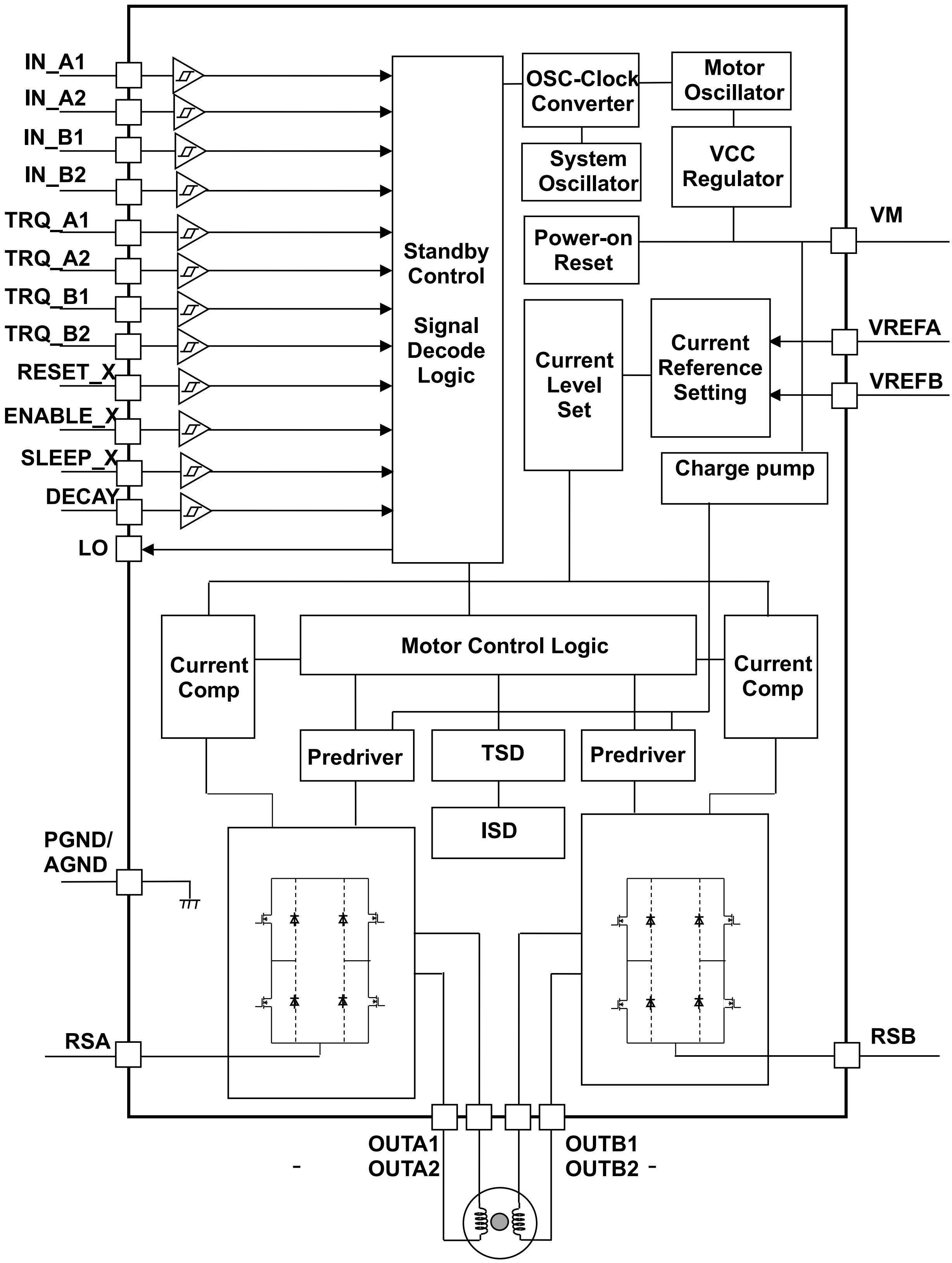


図 4 Block diagram

Note: Some of the functional blocks, circuits, or constants in the block diagram may be omitted or simplified for explanatory purpose.

Note: All the grounding wires should be solid patterns and be externally terminated at only one point. Also, a grounding method should be considered for efficient heat dissipation. Careful attention should be paid to the layout of the output, VM and GND traces, to avoid short circuits across output pins or to the power supply or ground. If such a short circuit occurs, the device may be permanently damaged. Also, the utmost care should be taken for pattern designing and implementation of the device since it has power supply pins (VM, OUTA1, OUTA2, OUTB1, OUTB2, PGND and AGND) through which a particularly large current may run. If these pins are wired incorrectly, an operation error may occur or the device may be destroyed. The logic input pins must also be wired correctly. Otherwise, the device may be damaged owing to a current running through the IC that is larger than the specified current. Careful attention should be paid to design patterns and mounting.

5. Pin Description

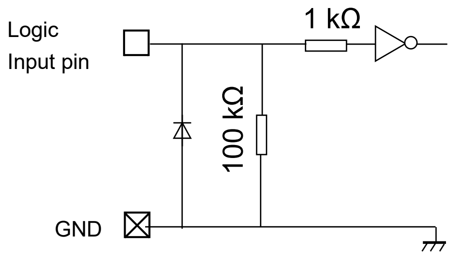
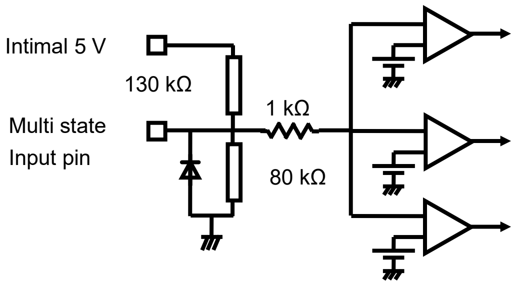
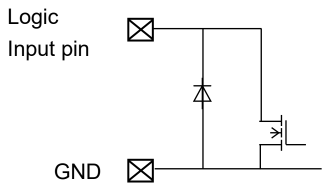
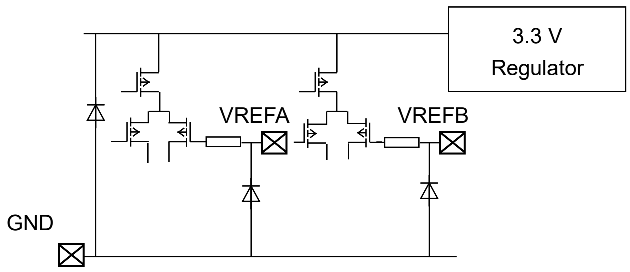
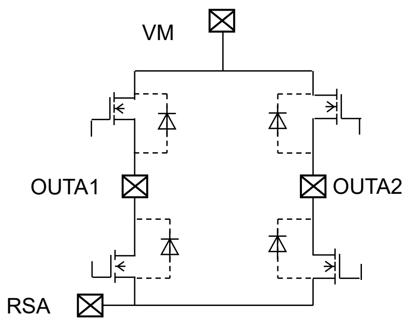
Table5 Pin Description

Pin No.	Symbol	Description
1	VM	Motor power supply input pin (HSW_Ach)
2	OUTA1	Ach motor output pin 1
3	RSA	Ach current sense resistor connected pin
4	OUTA2	Ach motor output pin 2
5	OUTB2	Bch motor output pin 2
6	RSB	Bch current sense resistor connected pin
7	OUTB1	Bch motor output pin 1
8	VM	Motor power supply input pin (HSW_Bch)
9	NC	NC pin
10	VREFA	Current threshold reference pin (Motor Ach)
11	VREFB	Current threshold reference pin (Motor Bch)
12	AGND	GND pin
13	VREG	3.3 V regulator output pin ※SLEEP_X=H Output operation
14	RESET	Reset input pin
15	SLEEP_X	Sleep mode input pin
16	LO	Error output pin
17	DECAY	Decay mode select pin
18	NC	NC pin
19	IN_A2	Motor Ach IN2 input pin
20	IN_A1	Motor Ach IN1 input pin
21	IN_B1	Motor Bch IN1 input pin
22	IN_B2	Motor Bch IN2 input pin
23	TRQ_A1	Motor Ach torque setting pin1
24	TRQ_A2	Motor Ach torque setting pin2
25	TRQ_B1	Motor Bch torque setting pin1
26	TRQ_B2	Motor Bch torque setting pin2
27	NC	NC pin
28	NC	NC pin
29	NC	NC pin
30	PGND	GND pin
31	NC	NC pin
32	NC	NC pin

Note: NC pin should be opened.

6. Input / Output Equivalent Circuit

Table6 Input / Output Equivalent Circuit

Pin name	Equivalent circuit
IN_A1 IN_A2 IN_B1 IN_B2 TRQ_A1 TRQ_A2 TRQ_B1 TRQ_B2 SLEEP_X RESET_X	
DECAY	
LO	
VREFA VREFB	
VM OUTA1 OUTA2 OUTB1 OUTB2 RSA RSB	 * The same applies to OUTB1 and OUTB2.

Note: The equivalent circuit diagrams may be simplified for explanatory purposes.

7. Operation Description

7.1. Input / Output Function

Table 7.1 Input / Output Function

IN_x1	IN_x2	OUTx1	OUTx2	mode
L	L	L	L	short brake
L	H	L	H	CCW (Counter clock-wise)
H	L	H	L	CW (Clock-wise)
H	H	H	H	short brake

Note: For the current path, OUTx1 -> OUTx2 is forward rotation and OUTx2 -> OUTx1 is reverse rotation.
(x = A or B)

7.2. LO(Error output) Function

LO pin is an Nch MOS output open drain terminal. When using this function, pull up the LO pin to the VIN(H) level. Normally, it is Hi-Z (internal MOS is OFF), and when the error detection function (overheat (TSD), overcurrent (ISD)) is activated, the pin level is L (internal MOSFET is ON).
If the error detection is released by turning the VM power supply on again or resetting, the LO pin will return to normal (the internal MOS is off) again. If the LO pin is not used, leave it open.

Table 7.2 LO (Error output) Function

LO	Function
H	Normal state (normal operation)
L	Error condition detected (ISD, TSD)

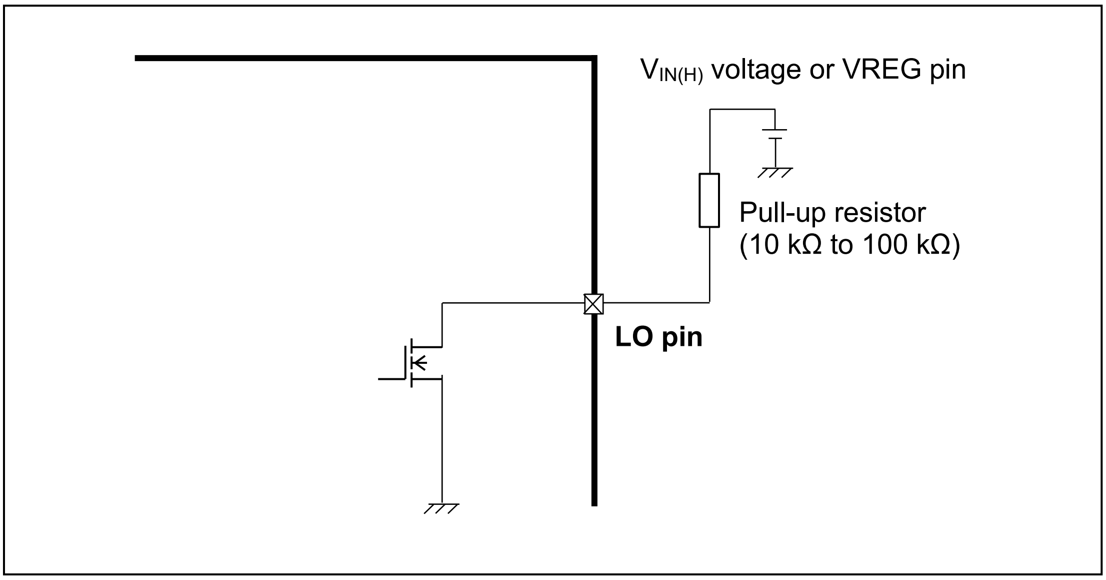


Figure 7.2 LO pin equivalent circuit diagram

Note: This figure may be simplified for explanatory purpose.

7.3. Constant current control

TB67H481FTG has a current limit function that monitors the current flowing in the motor and performs constant current PWM control.
When the motor current reaches the set current value (Iout(maximum)), it shifts to Decay mode for a fixed OFF time (toff) and attenuates the current.

The setting current value is determined by the VREF pin voltage and the current detection resistance value.
Also, the setting current value can be adjusted with the torque function. When high torque is not needed, the motor current can be suppressed by lowering the torque setting.

To disable the constant current control function, connect the RSA and RSB terminals to GND and the VREFA and VREFB, terminals to VREG.

7.4. Torque Function (TRQ_x1,0)

TRQ_x2, TRQ_x1 pins set the torque of the motor. (x = A or B)

Table7.4 Torque Function

TRQ_x2	TRQ_x1	Function
L	L	Torque: 100 %
L	H	Torque: 71 %
H	L	Torque: 38 %
H	H	Torque: 0 % (Bridge disabled)

7.5. About the constant current value

The constant current PWM threshold (I_{OUT} (Max)) can be set via the current-sensing resistor (RRSx) and the reference voltage (V_{REF}).(X=A or B)

$$\text{Iout (Max)} = \frac{V_{REF}\ (V)}{V_{REF(GAIN)} \times RSx\ (\Omega)} \times \text{torque (\%)} \qquad \text{(x=A or B)}$$

$V_{REF(GAIN)}$: V_{REF} decay ratio is 5 (Typ.).

Example: When V_{REF} =2.0 V and RSA = RSB = 0.22 Ω, Torque: 100 %, then Iout (Max) = 1.82 A.

7.6. DECAY Function (DECAY)

Decay control can be selected during constant current control; Mixed Decay mode switches to Slow after a certain period of time (75 % of the PWM cycle). Fixed PWM cycle (25 % of PWM cycle) is Slow mode.

Table7.6 DECAY Function

DECAY	Function
L	Slow decay
H	Fast decay
OPEN	Mixed Decay

7.7. Constant current PWM blanking time

TB67H481FTG is provided with the following blanking time as a measure against spike current generated during motor operation and noise jump from the outside.

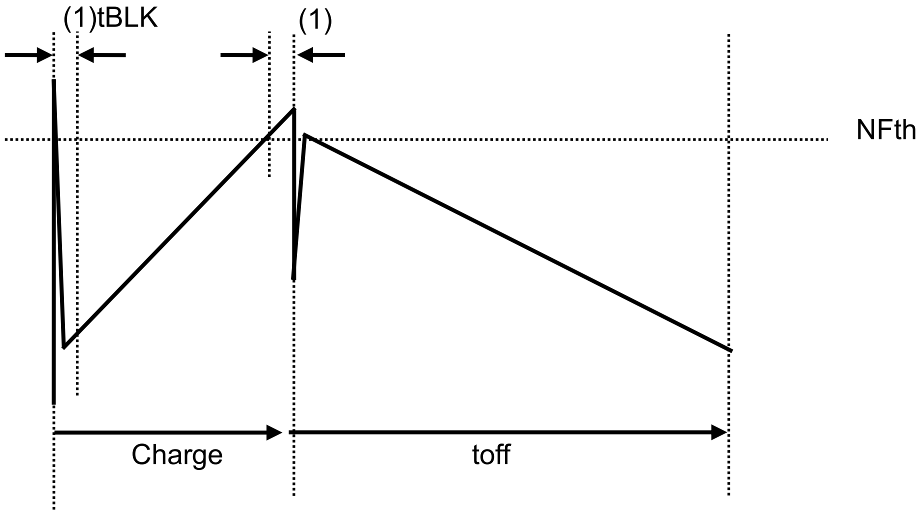


Figure7.7 Constant current PWM timing charts

Note: (1)tBLK (For preventing false detection of spike current generated during Decay -> Charge): 3.75 μs (Typ.)
Note: Timing charts may be simplified for explanatory purposes.

7.8. Input signal and blanking time of t_{BLK}

The blanking time t_{BLK} is set in consideration of the influence of the inrush current that originally occurs at the timing of switching from Decay to Charge. With the TB67H481FTG, not only constant current PWM control but also motor drive by direct PWM control, which controls the PHASE input signal by switching at arbitrary timing, is assumed, so at each PHASE input signal switching timing (gray in the timing chart below). T_{BLK} is generated in the hatched area).

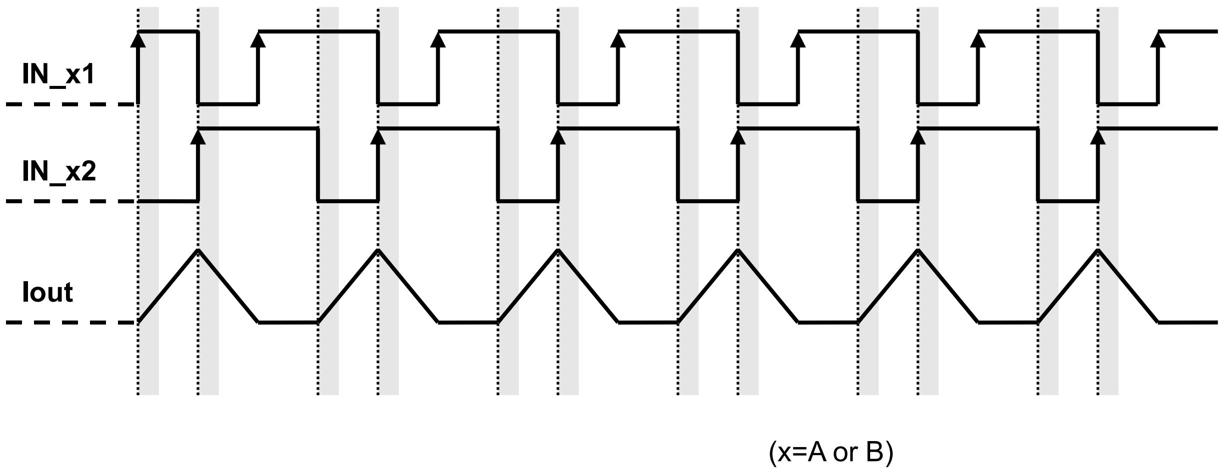


Figure7.8 input signal and blanking time of tBLK timing charts

Timing charts may be simplified for explanatory purposes.

7.9. SLEEP Function

SLEEP_X pin switches between normal mode and sleep mode. In addition, VREG output is stopped in Sleep mode. Therefore, SLEEP_X = L also clears the error condition.

Table7.9 SLEEP Function

SLEEP_X	Function
L	Sleep mode
H	Normal operation mode

Note: When the SLEEP_X pin is L, the internal oscillation circuit and motor output block stop, and the state is low consumption.

7.10. RESET Function

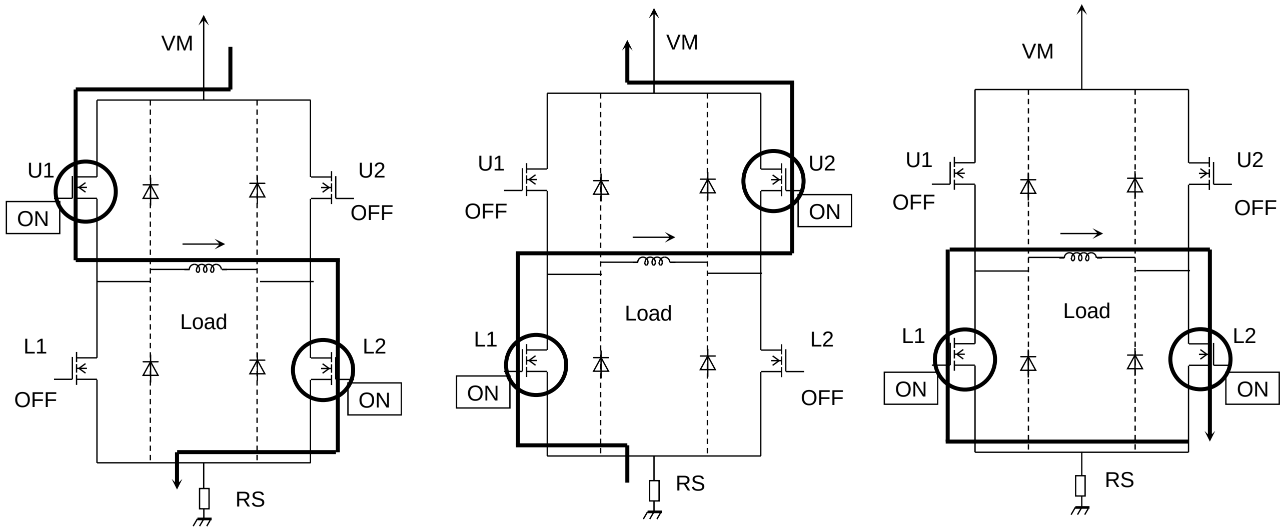
The RESET_X pin switches between normal mode and reset state.

Table 7.10 RESET Function

RESET_X	Function
L	Reset mode (internal Logic clear)
H	Normal operation mode

Note: When the RESET_X pin is low, the internal logic is cleared.

8. Motor output MOSFET operation mode (Mixed Decay)



Charge operation
A current flows into the motor coil.

Fast operation
The energy of the motor coil is fed back to the power.

Slow operation
A current circulates around the motor coil and the device.

Figure8 Motor output MOSFET operation mode

Note: In the timing of an output switching, the time to prevent a through current is predefined.

8.1. Operation Function of Output Transistor

Table 8.1.1 At positive current

Mode	U1	U2	L1	L2
CHARGE	ON	OFF	OFF	ON
FAST	OFF	ON	ON	OFF
SLOW	OFF	OFF	ON	ON

Note: The parameters shown in the table above are examples when the current flows in the directions shown in the figures above. For the current flowing in the reverse direction, the parameters is shown below.

Table 8.1.2 At negative current

Mode	U1	U2	L1	L2
CHARGE	OFF	ON	ON	OFF
FAST	ON	OFF	OFF	ON
SLOW	OFF	OFF	ON	ON

This IC controls the motor current to be constant by 3 modes listed above.
The equivalent circuit diagrams may be simplified or some parts of them may be omitted for explanatory purposes.

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.

9.1. Power consumption of the power transistor

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

Power consumption of the upper or lower transistor of the H-Bridge is calculated from below formula.

$P\ (out) = I_{OUT}\ (A) \times V_{DS}\ (V) = I_{OUT}\ (A)^2 \times R_{ON}\ (\Omega)$ .... (1)

When the current waveform of the motor output corresponds to the ideal square waveform in the full-step resolution, average power of output block can be provided as follows

When $R_{ON} = 0.4\ \Omega$, I_{OUT} (peak: Max) = 1.0 A, and $V_M = 24$ V,
$P\ (out) = 2\ (Tr) \times 1.0\ (A)^2 \times 0.4\ (\Omega)$ .... (2)
$= 0.8\ (W)$

9.2. Power consumption of logic and I_M systems

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

$I\ (I_{M2}) = 5$ mA (Typ.) : Operating/axis
$I\ (I_{M1}) = 10\ \mu A$ (Typ.) : Standby/axis

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

Power consumption is calculated as follows;

$P\ (I_{M2}) = 24\ (V) \times 0.005\ (A)$ .... (3)
$= 0.12\ (W)$

9.3. Power consumption

Total power consumption P (total) is calculated from the results of ‘1’ and ’2’ above.

$P\ (total) = P\ (out) + P\ (I_{M2}) = 0.92\ (W)$

Power consumption of 1 axle in standby mode is as follows;

$P\ (Standby\ mode) = 24\ (V) \times 0.00001\ (A) = 0.00024\ (W)$

About the heat design of the board etc., please evaluate it by the actual board enough, and configure the appropriate margin.

10. Thermal shutdown detection (Auto return type)

This function turns off the IC operation temporarily when the over heat of the device is detected. It has a dead band time to avoid error detection occurred by the external noise. When over heat is detected, all channels are turned off. Since the temperature has a hysteresis range, when the junction temperature falls to the return temperature, the operation returns automatically to the normal operation.

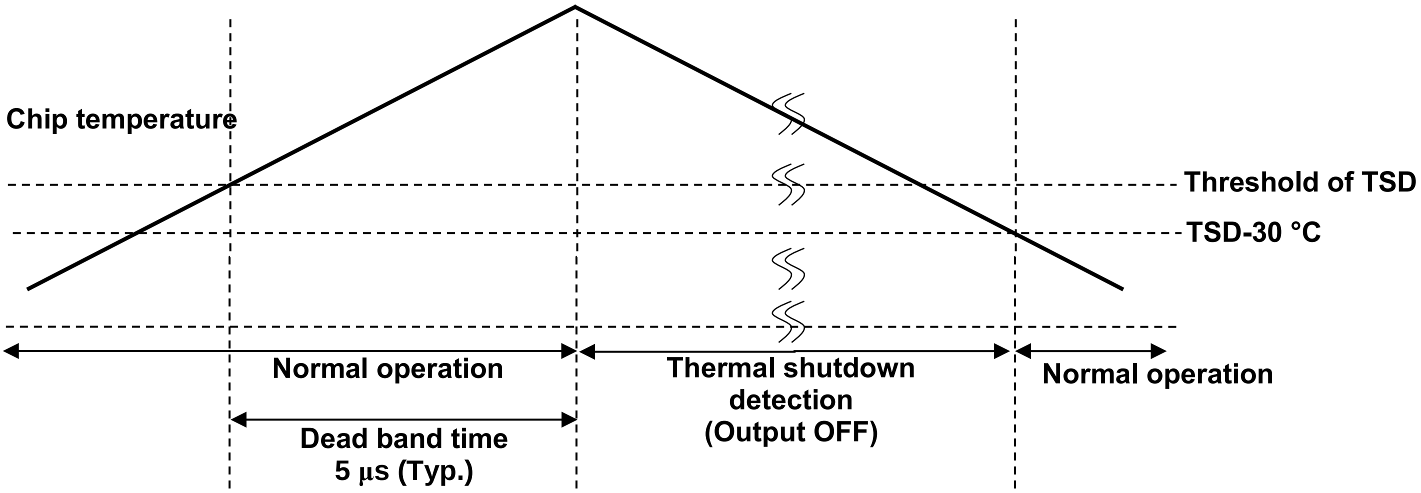


Figure10 Thermal shutdown detection timing chart

Timing charts may be simplified for explanatory purposes. The value in the timing chart is the reference value.

11. Over current detection(Latch type: Operation state before detection is maintained.)

This function turns off the IC operation temporarily when the short-circuiting between outputs and the short-circuiting to the power supply or ground occur. It has a dead band time to avoid error detection occurred by the spike current which generates in switching and the external noise. When over current is detected, not only the corresponding channels but both channels are turned off.

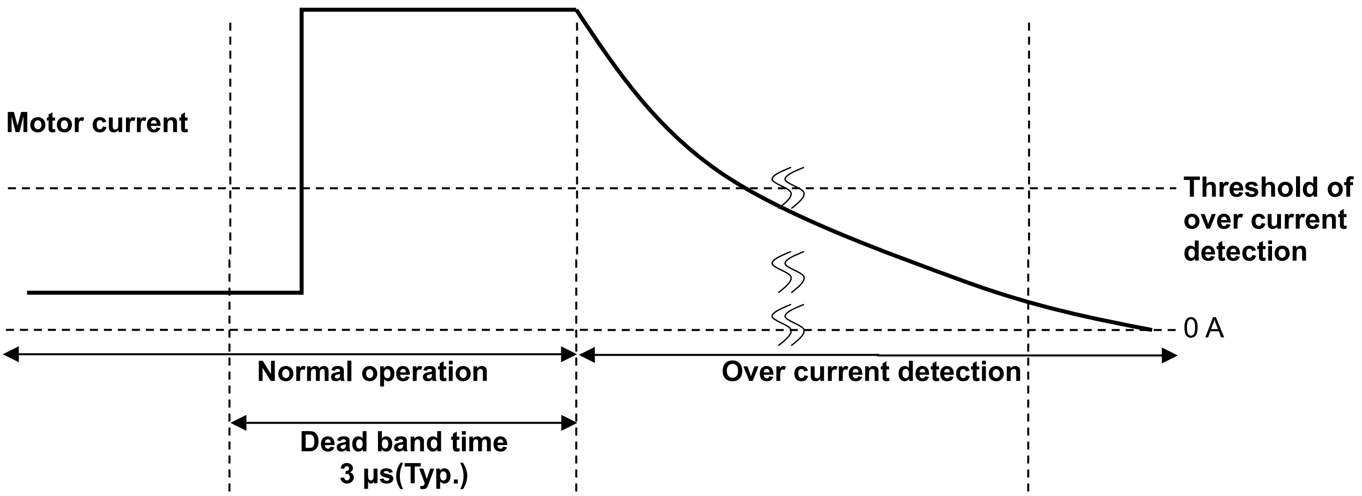


Figure11 Over current detection timing chart

Timing charts may be simplified for explanatory purposes. The value in the timing chart is the reference value.

12. Absolute Maximum Ratings (T_a = 25 °C)

Table 12 Absolute Maximum Ratings

Characteristics	Symbol	Rating	Unit
Motor output voltage	V_{OUT}	50	V
Motor power supply	V_M	45	V
Motor output current (Note1)	I_{OUT}	3.0	A
Logic input voltage	V_{IN}	6.0	V
VREF reference voltage	V_{REF}	6.0	V
LO output voltage	V_{LO}	6.0	V
Power dissipation (Note2)	P_D	1.3	W
Operating temperature	T_{opr}	-40 to 85	°C
Storage temperature	T_{stg}	-55 to 150	°C
Junction temperature	$T_{j\,(MAX)}$	150	°C

Note1: The maximum current value in normal operation should be kept 2.7 A or less per phase after calculating heat generation. The maximum output current may be further limited in view of the thermal considerations, depending on the ambient temperature and board conditions.

Note2: IC stand alone(T_a = 25 °C)
When T_a exceeds 25 °C, derating with 10.4 mW / °C is necessary.
T_a : Ambient temperature of the IC
T_{opr} : Ambient temperature while the IC is active.
T_j : Junction temperature while the IC is active. The maximum junction temperature is limited by thethermal shutdown circuit (TSD).

It is advisable to keep the maximum current below a certain level so that the maximum junction temperature, $T_{j(MAX)}$, will not exceed 120 °C.

Absolute maximum ratings

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. The value of even one parameter of the absolute maximum ratings should not be exceeded under any circumstances. The TB67H481FTG does not have overvoltage detection circuit. Therefore, the device is damaged if a voltage exceeding its rated maximum is applied.
All voltage ratings, including supply voltages, must always be followed. The other notes and considerations described later should also be referred to.

13. Operating Range (Ta = -40 to 85 °C)

Table 13 Operating Range

Entry	Symbol	Minimum	Typ.	Maximum	Unit	Note
Motor power supply	V_M	8.2	24.0	44	V	—
Motor output current	I_{OUT}	—	—	2.7	A	Per phase (Note1)
Logic input voltage	$V_{IN(H)}$	2.2	—	5.25	V	Logic input High Level
	$V_{IN(L)}$	0	—	0.7	V	Logic input Low Level
Chopping frequency	f_{CHOP}	—	50	—	kHz	—
Clock frequency	f_{logic}	—	—	100	kHz	—
VREF reference voltage	V_{REF}	1	—	3.6	V	—

Note1: The actual maximum current may be limited by the operating environment (operating conditions such as exciting mode and operating time, or by the surrounding temperature or board heat dissipation). Determine a realistic maximum current by calculating the heat generated under the operating environment.

14. Electrical Specifications

14.1. Electrical Specifications 1 (T_a = 25 °C, V_M = 24 V unless otherwise specified)

Table 14.1 Electrical Specifications 1

Characteristics		Symbol	Test condition	Min	Typ.	Max	Unit
Logic input voltage	**High**	$V_{IN(H)}$	Logic input pin (Note)	2.2	—	5.25	V
	Low	$V_{IN(L)}$	Logic input pin (Note)	0	—	0.7	V
Logic input hysteresis voltage		$V_{IN(HIS)}$	Logic input pin (Note)	—	150	—	mV
Logic input current	**High**	$I_{IN(H)}$	Logic input voltage:3.3 V	—	—	100	µA
	Low	$I_{IN(L)}$	Logic input voltage:0 V	-20	—	20	µA
LO output voltage		$V_{OL(MO)}$	IOL=5 mA, Output: Low	—	0.2	0.5	V
Power consumption		I_{M1}	Output pin: Open, Sleep mode	—	10	20	µA
		I_{M2}	Output pin: Open, Operating mode (f_{logic} < 50 kHz)	—	5	8	mA
Output leakage current	**High-side**	I_{OH}	V_M = 44 V, V_{OUT} = 0 V	—	—	1	µA
	Low-side	I_{OL}	V_M = V_{OUT} = 44 V	1	—	—	µA
Motor current channel differential		ΔI_{OUT1}	Current differential between Ch I_{OUT} = 1.0 A	-5	0	5	%
Motor current setting accuracy		ΔI_{OUT2}	I_{OUT} = 1.0 A	-5	0	5	%
Motor output ON-resistance (High-side + Low-side)		$R_{ON(D-S)}$	T_j = 25 °C I_{OUT} = 2.0 A	—	0.4	0.52	Ω

Note: $V_{IN(H)}$ is defined as the V_{IN} voltage that changes the output voltage by being applied to the test pin and raising this voltage from 0 V gradually. $V_{IN(L)}$ is defined as the V_{IN} voltage that changes the output voltage by being applied to the test pin and lowering this voltage gradually. The difference between $V_{IN(H)}$ and $V_{IN(L)}$ is defined as $V_{IN(HYS)}$.

14.2. Electrical Specifications 2 (T_a = 25 °C, V_M = 24 V unless otherwise specified)

Table 14.2 Electrical Specifications 2

Characteristics	Symbol	Test condition	Min	Typ.	Max	Unit
VREF input current	I_{REF}	V_{REF}= 3.3 V	-3	—	3	µA
VREF decay ratio	$V_{REF(GAIN)}$	V_{REF} = 2.0 V	—	5	—	—
VREG voltage	V_{REG}	Iout=1 mA	3.2	3.3	3.4	V
TSD threshold	T_{jTSD}	—	150	160	180	°C
TSD hysteresis	T_{TSDHYS}	—	—	30	—	°C
VM power ON reset voltage	V_{MPOR}	—	3.8	4.0	4.2	V
VM power ON reset hysteresis voltage	$V_{MPOR(HYS)}$	—	—	200	—	mV
Over current detection circuit operating current	I_{SD}	—	3.0	—	—	A

14.2.1. Back-EMF

While a motor is rotating, there is a timing at which power is fed back to the power supply. At that timing, the motor current recirculates back to the power supply due to the effect of the motor back-EMF.
If the power supply does not have enough sink capability, the power supply and output pins of the device might rise above the rated voltages. The magnitude of the motor back-EMF varies with usage conditions and motor characteristics. It must be fully verified that there is no risk that the TB67H481FTG or other components will be damaged or fail due to the motor back-EMF.

14.2.2. Cautions on Overcurrent Shutdown (ISD) and Thermal Shutdown (TSD)

The ISD and TSD circuits are only intended to provide temporary protection against irregular conditions such as an output short-circuit; they do not necessarily guarantee the complete IC safety.
If the device is used beyond the specified operating ranges, these circuits may not operate properly: then the device may be damaged due to an output short-circuit.
The ISD circuit is only intended to provide a temporary protection against an output short-circuit. If such a condition persists
for a long time, the device may be damaged due to overstress. Overcurrent conditions must be removed immediately by external hardware.

14.2.3. IC Mounting

Do not insert devices incorrectly or in the wrong orientation. Otherwise, it may cause breakdown, damage and/or deterioration of the device.

15. AC Electrical Specifications (T_a = 25 °C, V_M = 24 V)

Characteristics	Symbol	Test condition	Min	Typ.	Max	Unit
Logic input pulse width	tw(H)	—	1.9	—	—	μs
	tw(L)	—	1.9	—	—	μs
Output transistor switching characteristics	tr	—	30	—	200	ns
	tf	—	30	—	200	ns
	tpLH	—	—	440	—	ns
	tpHL	—	—	400	—	ns
Wakeup time	t_{WAKE}	—	—	—	10	ms
Chopping frequency	f_{CHOP}	—	—	50	—	kHz
tBLANK time	tBLANK	—	—	3.75	—	μs
Blanking time of noise rejection	tDEG	—	—	3	—	μs

15.1. AC Electrical Specification Timing charts

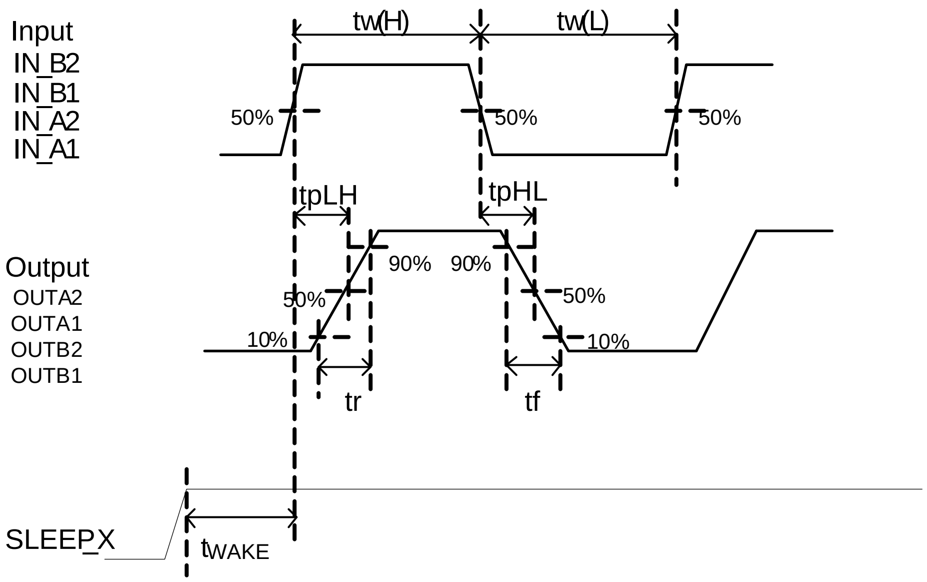


Figure15.1 AC Electrical Specification Timing charts

Note:Timing charts may be simplified for explanatory purposes.

16. Application Circuit Example

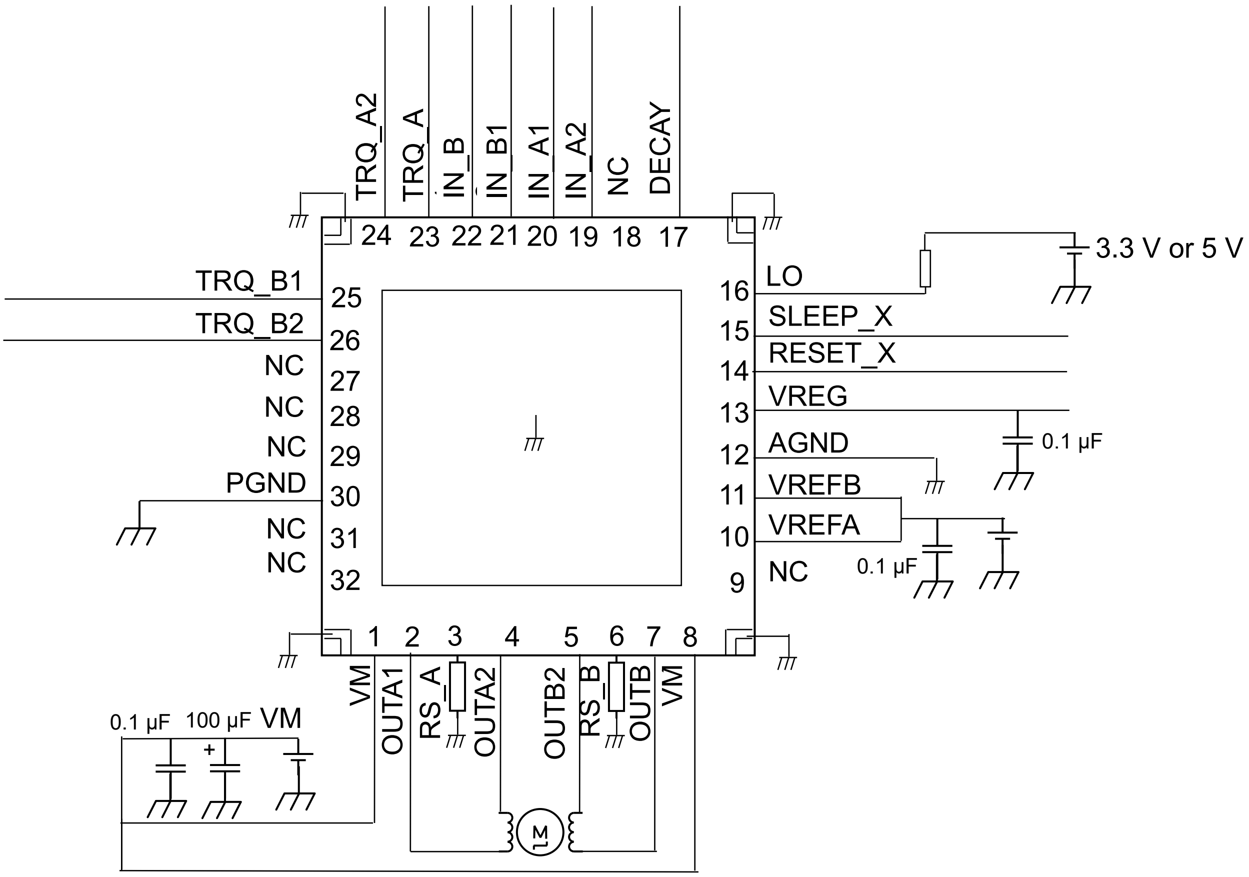


Figure 16 Application Circuit Example

17. Package Information

P-VQFN32-0505-0.50-008

Unit: mm

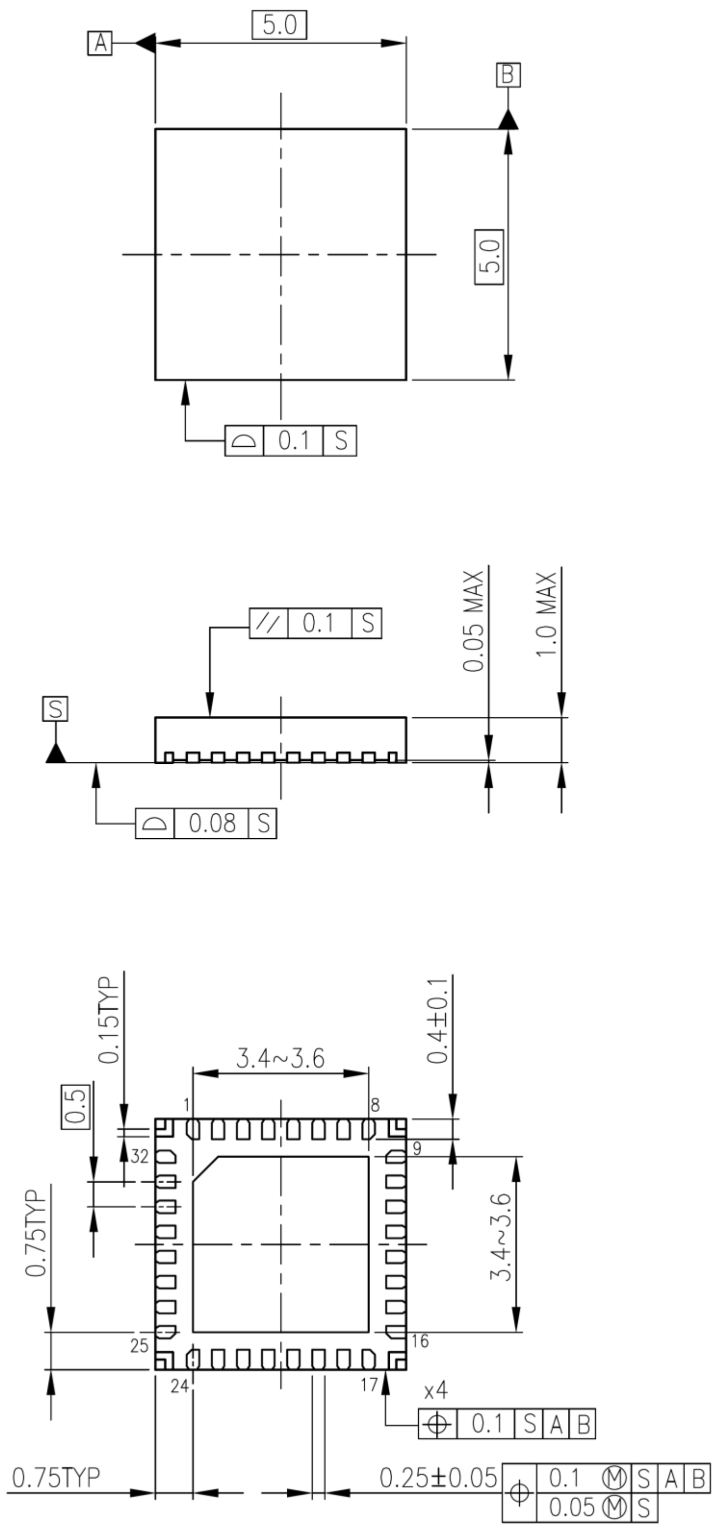


Figure17 Package Dimensions

Weight: 0.065 g (Typ.)

18. Notes on Contents

Block Diagrams

Some of the functional blocks, circuits, or constants in the block diagram may be omitted or simplified for explanatory purposes.

Timing Charts

Timing charts may be simplified for explanatory purposes.

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. Providing these application circuit examples does not grant a license for industrial property rights.

19. IC Usage Considerations

19.1. 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.

(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.

19.2. 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 reverses the rotation 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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