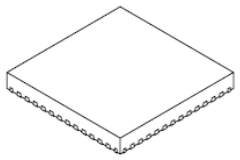
Toshiba BiCD Process Integrated Circuit Silicon Monolithic

TB67S179FTG

Clock controlled 2-phase Unipolar stepping motor driver

FTG



P-VQFN48-0707-0.50-004

Weight 0.14 (g) (typ.)

The TB67S179FTG is a Clock controlled PWM chopping type 2-phase unipolar stepping motor driver. Using the BiCD process, the TB67 S179FTG can be operated with VM voltage of 80V, output voltage of 80V, and output current of 1.5A at max (absolute maximum ratings).

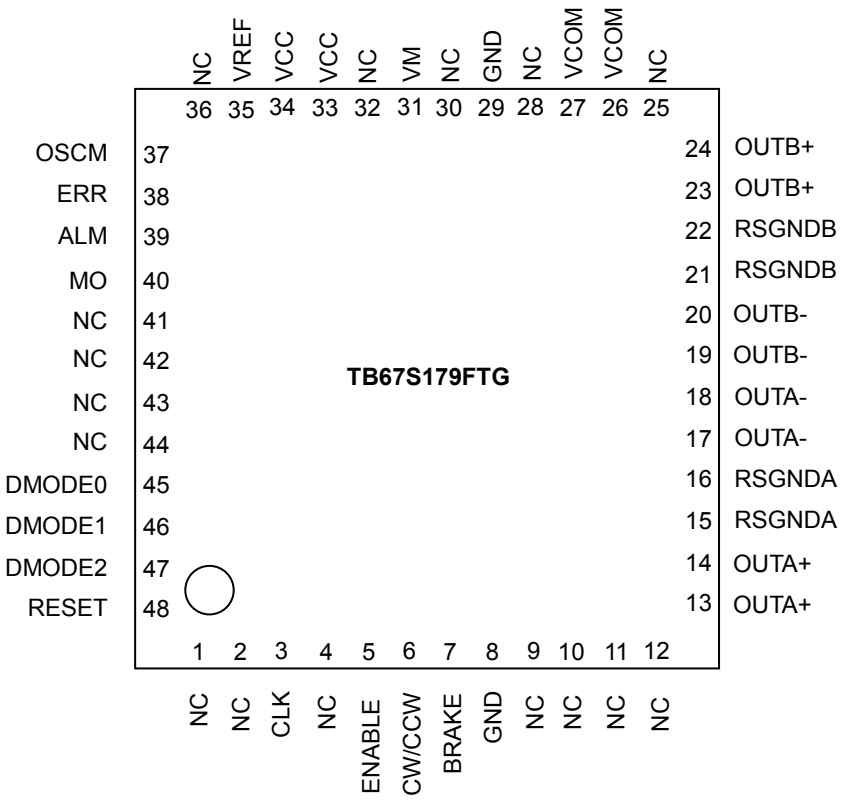
Features

- BiCD processed monolithic integrated circuit.
- Capable of operating one unipolar stepping motor.
- Full, half(a), half(b), quarter, 1/8, 1/16, 1/32 step resolution.
- PWM controlled synchronous rectification constant current drive.
- Reverse current protection function
- Error detect feedback signal output function (Over current/Thermal shutdown).
- Error detect function (Thermal shutdown(TSD), Over current(ISD), and Low voltage(POR).
- Standby mode (low power) function
- Brake function
- Low on resistance(0.5Ω (Typ.) output MOSFET.
- High voltage and current (For specification, please refer to the absolute maximum ratings and operation ranges).
- Build-in VCC regulator for internal circuit use.
- Fixed off time can be adjusted by external components.

Note: Please be careful about the thermal conditions during use.

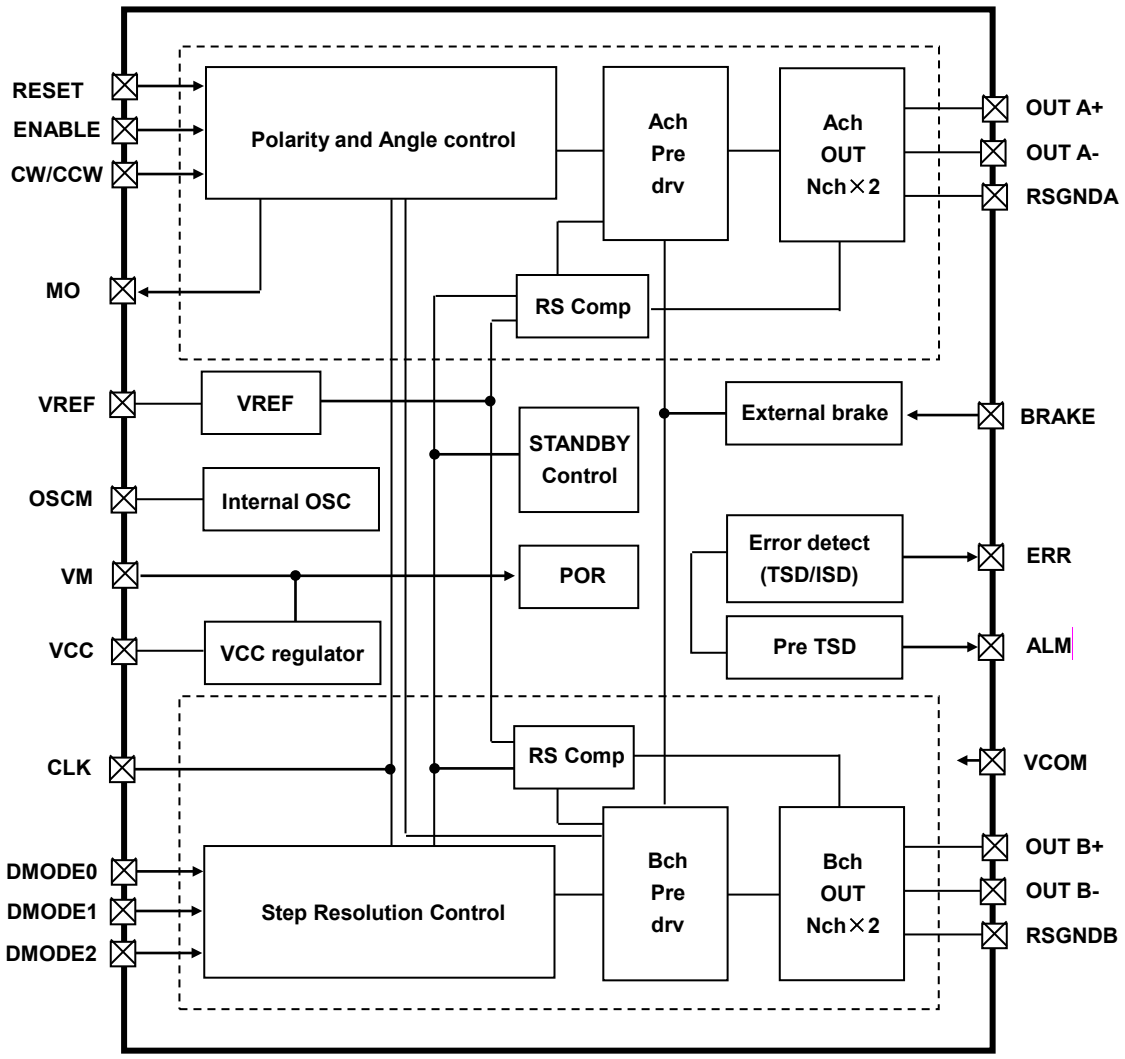
Pin assign (TB67S179FTG)

(Top View)



* Please mount the four corner pins of the VQFN package and the exposed pad to the GND area of the PCB.

TB67S179 block diagram



Functional blocks/circuits/constants in the block chart etc. may be omitted or simplified for explanatory purposes.

Application Notes

All the grounding wires of the device must run on the solder mask on the PCB 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, VDD (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, RSGND, OUT, GND) 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.

Pin explanations

TB67S179FTG (VQFN48)

Pin No.1 to 28

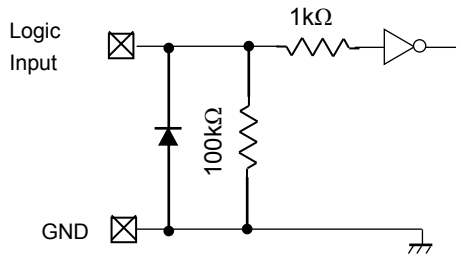
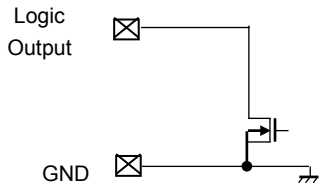
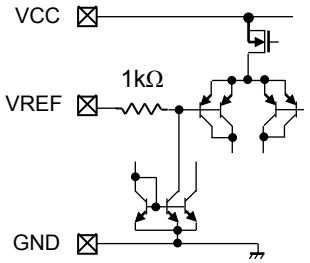
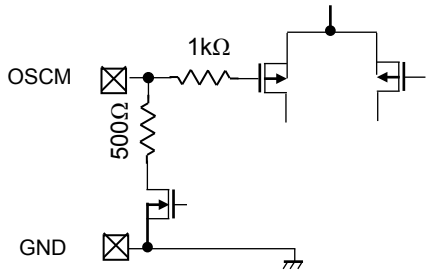
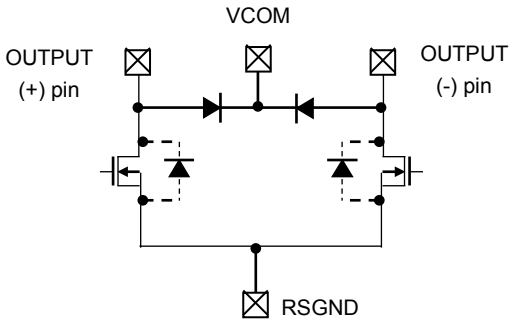
Pin No.	Pin Name	Function
1	NC	Non connection
2	NC	Non connection
3	CLK	External Clock input pin
4	NC	Non connection
5	ENABLE	Motor output ON/OFF pin
6	CW/CCW	Clock-wise/Counter Clock-wise setting pin
7	BRAKE	Brake input pin
8	GND	Ground pin
9	NC	Non connection
10	NC	Non connection
11	NC	Non connection
12	NC	Non connection
13	OUTA+	Motor output A+ pin
14	OUTA+	Motor output A+ pin
15	RSGNDA	Ach current sense ground pin
16	RSGNDA	Ach current sense ground pin
17	OUTA-	Motor output A-pin
18	OUTA-	Motor output A-pin
19	OUTB-	Motor output B-pin
20	OUTB-	Motor output B-pin
21	RSGNDB	Bch current sense ground pin
22	RSGNDB	Bch current sense ground pin
23	OUTB+	Motor output B+ pin
24	OUTB+	Motor output B+ pin
25	NC	Non connection
26	VCOM	Common pin
27	VCOM	Common pin
28	NC	Non connection

Pin No.29 to 48

Pin No.	Pin Name	Function
29	GND	Ground pin
30	NC	Non connection
31	VM	VM power supply pin
32	NC	Non connection
33	VCC	Internal VCC regulator monitor pin
34	VCC	Internal VCC regulator monitor pin
35	VREF	Constant current threshold set pin
36	NC	Non connection
37	OSCM	Fixed off time set pin
38	ERR	Error detect feedback signal output pin
39	ALM	Thermal alarm output pin
40	MO	Electrical angle monitor pin
41	NC	Non connection
42	NC	Non connection
43	NC	Non connection
44	NC	Non connection
45	DMODE0	Step setting pin 0
46	DMODE1	Step setting pin 1
47	DMODE2	Step setting pin 2
48	RESET	Electrical angle reset pin

Note:
・Please do not run patterns under NC pins.
・Please connect the pins with the same pin name, while using the device.

INPUT/OUTPUT Equivalent circuit

Pin name	Input / Output	Equivalent circuit
DMODE0 DMODE1 DMODE2 CW/CCW CLK RESET ENABLE BRAKE	Logic input (VIH/VIL) VIH: 2.0V(min) to 5.5V(max) VIL : 0V(min) to 0.8V(max)	
ERR ALM MO	Logic output (VOH/VOL) (Pullup resistance: 10kΩ to100kΩ)	
VCC VREF	VCC voltage range 4.75V(min) to 5.0V(Typ.) to 5.25V(max) VREF input voltage range 0V to 2.0V (Constant current control) VCC short (Constant current control: OFF)	
OSCM	OSCM frequency setup (reference) 0.8MHz(min) to 3.2MHz(Typ.) to 8.2MHz(max) (R_OSCM=3.9kΩ to 10kΩ to 39kΩ)	
OUT A+ OUT A- OUT B+ OUT B- RSGNDA RSGNDB VCOM	VM voltage range 10V(min) to 60V(max) OUT pin voltage range 10V(min) to 80V(max)	

The equivalent circuit diagrams may be simplified or some parts of them may be omitted for explanatory purposes.

TB67S179 function explanation

CLK function

The CLK pin controls the rotation speed of the motor. Each CLK signal will shift the motor's electrical angle per step, due to each up-edge of the CLK signal.

CLK	Function
↑ (Low to High)	Shifts the electrical angle per step.
↓ (High to Low)	− (State of the electrical angle does not change.)

ENABLE function

The ENABLE pin controls the ON and OFF of the corresponding output stage. For accurate operation, please set the ENABLE to Low during VM power-on and power-off sequence.

ENABLE	Function
High	Motor output: ON (normal operation)
Low	Motor output: OFF (high impedance)

CW/CCW function

The CW/CCW pin controls the rotation direction of the motor.

CW/CCW	Function
High	Clock-wise (CW)
Low	Counter Clock-wise (CCW)

When set to 'CW', the Ach current phase leads the Bch current phase by 90°.
When set to 'CCW', the Bch current phase leads the Ach current phase by 90°.

RESET function

The RESET pin controls the reset of the internal electrical angle. For accurate operation, please set the RESET pin to 'High' during VM power-on. Switch the RESET to 'Low', once the
VM voltage has reached the operation range.

RESET	Function
High	Sets the electrical angle to the initial position
Low	Normal operation

The current setting for each channel while RESET is applied is shown in the table below.
MO pin level will show 'Low' level at this time.

Step resolution setting	Ach current	Bch current	Electrical angle to the initial position
Full step	100%	100%	45°
Half step (a)	100%	100%	45°
Quarter step	71%	71%	45°
Half step (b)	71%	71%	45°
1/8 step	71%	71%	45°
1/16 step	71%	71%	45°
1/32 step	71%	71%	45°

DMODE (Step resolution setting) function

The DMODE pin controls the Standby mode and the step resolution setting.

DMODE0	DMODE1	DMODE2	Function
Low	Low	Low	Standby mode (The internal oscillator is disabled and the motor output is set to 'OFF' status. The internal status is Full step, Torque100% (*))
Low	Low	High	Full step
Low	High	Low	Half step(a)
Low	High	High	Quarter step
High	Low	Low	Half step(b)
High	Low	High	1/8 step
High	High	Low	1/16 step
High	High	High	1/32 step

(*) [Full step, Torque 100%] written above shows the initial status of the logic. (During Standby mode, the internal oscillator and motor output is set to OFF, therefore does not mean that the device will operate at [Full step, Torque 100%])

Standby mode function

Setting all of the DMODE pins(DMODE0,DMODE1,and DMODE2) to Low will set the device to Standby mode. During Standby mode, the internal bias current is cut so that the device be set to low power mode. Also, setting the device to Standby mode will release the error detection such as TSD and ISD. Moreover, the electrical angle is initialized by setting the Standby mode.

Standby mode	Function
ON (DMODE0,1,2=L,L,L)	Standby mode: ON (Low power mode)
OFF (other than DMODE0,1,2=L,L,L)	Standby mode: OFF (Normal operation)

After the device detects an error such as TSD or ISD, setting the device to Standby mode to OFF and then ON again will release the error detect latch signal. (Reasserting the VM power will also release the error detect latch signal.)

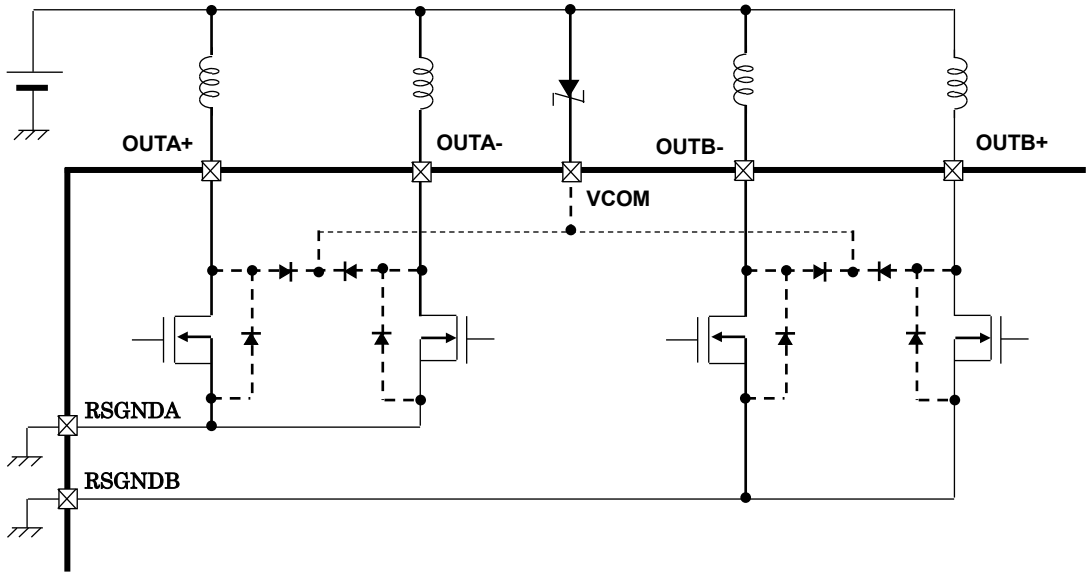
In the Standby mode, the internal functions are suspended. Therefore, during the startup period (10μs after setting the Standby mode: OFF), please do not send any control signals. (If the signal is sent to the device during the startup period, the device may not be able to accept the signal correctly.)

Step resolution and current ratio

Characteristics	Step resolution							Step	Typ.	Unit
	Full	Half (a)	Half (b)	Quarter	1/8	1/16	1/32			
Current Ratio	○	○	○	○	○	○	○	θ32	100	%
	-	-	-	-	-	-	○	θ31	100	
					-	○	○	θ30	100	
						-	○	θ29	99	
				-	○	○	○	θ28	98	
					-	-	○	θ27	97	
						○	○	θ26	96	
						-	○	θ25	94	
				(*2)	○	○	○	θ24	92	
				-	-	-	○	θ23	90	
						○	○	θ22	88	
						-	○	θ21	86	
				-	○	○	○	θ20	83	
					-	-	○	θ19	80	
						○	○	θ18	77	
						-	○	θ17	74	
		(*1)	○	○	○	○	○	θ16	71	
		-	-	-	-	-	○	θ15	67	
						○	○	θ14	63	
						-	○	θ13	60	
				-	○	○	○	θ12	56	
					-	-	○	θ11	52	
						○	○	θ10	47	
						-	○	θ9	43	
				○	○	○	○	θ8	38	
				-	-	-	○	θ7	34	
						○	○	θ6	29	
						-	○	θ5	25	
				-	○	○	○	θ4	20	
					--	-	○	θ3	15	
						○	○	θ2	10	
						-	○	θ1	5	
		○	○	○	○	○	○	θ0	0	

(*1) At Half (a) setting, the current ratio will be 100%.
(*2) At Quarter setting, the current ratio will be 100%.

BRAKE mode function



Equivalent circuit(s) may be omitted for explanatory purpose.

BRAKE	Function
H	Brake mode: ON
L	Brake mode: OFF (Normal operation)

The brake function is changed according to the control setting (of the constant current or the constant voltage).

・During Constant current control: VREF≤2.0V

When BRAKE is set to H, the constant current operation is performed with the current of 100% setting value, regardless of the current setting value then.

Internal current setting when BRAKE is set to H from L.	Setting value of constant current when BRAKE is set to H.
IOUT= 0% to +100%	+100%
IOUT= 0% to -100%	-100%

* The IOUT in the above table is indicated as plus current when OUT+ turns on, and as minus current when OUT- turns on, at the time of Charge.
* When the CLK signal is input during BRAKE=H, the internal current setting status is advanced ordinarily.

・During Constant voltage control: VREF-VCC direct connected

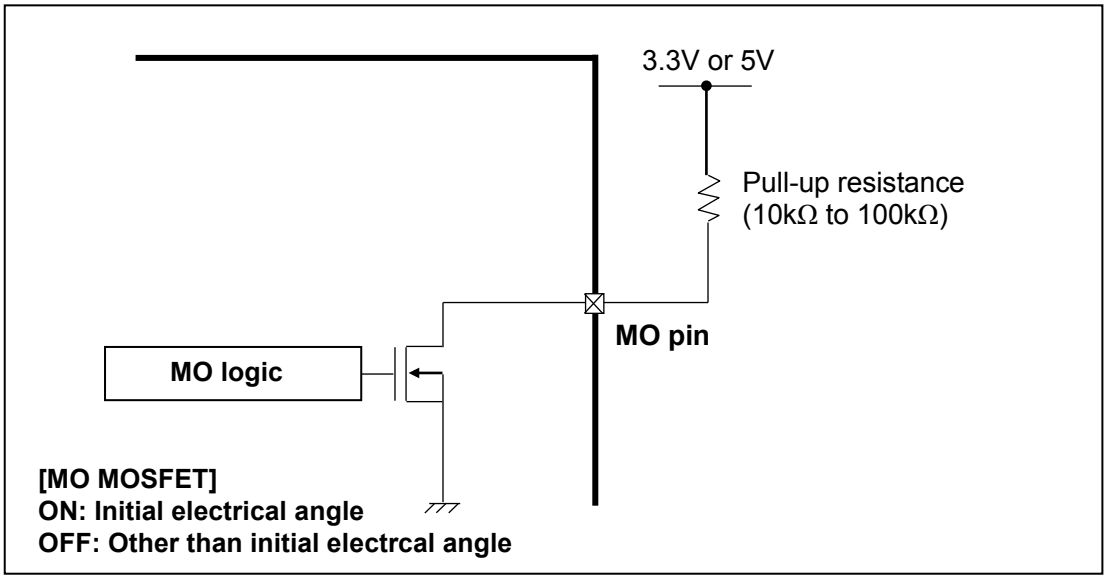
When BRAKE is set to H, the motor output becomes the full step resolution (OUTA+, OUTA-, OUTB+, and OUTB-: ON).

* Make sure to connect the VREF pin and VCC pin directly without using the external power supply in the constant voltage mode.

MO pin functions (MO feedback)

MO pin	Function
Hi-Z (*)	− (Other than initial electrical angle)
Low	Initial electrical angle

(*) MO pin is an open drain logic output. To use the function correctly, please make sure the MO pin is connected to 3.3V or 5.0V with a pull-up resistance. If the internal electrical angle is at the initial angle, the pin level will be Low (internal MOSFET: ON). If the internal electrical angle is not at the initial angle, the pin level will be Hi-Z (internal MOSFET: OFF) (it will show High level when pulled up correctly). Please refer to the 'RESET function' for the initial angle. MO pin should be left open; when not using the MO feedback function.

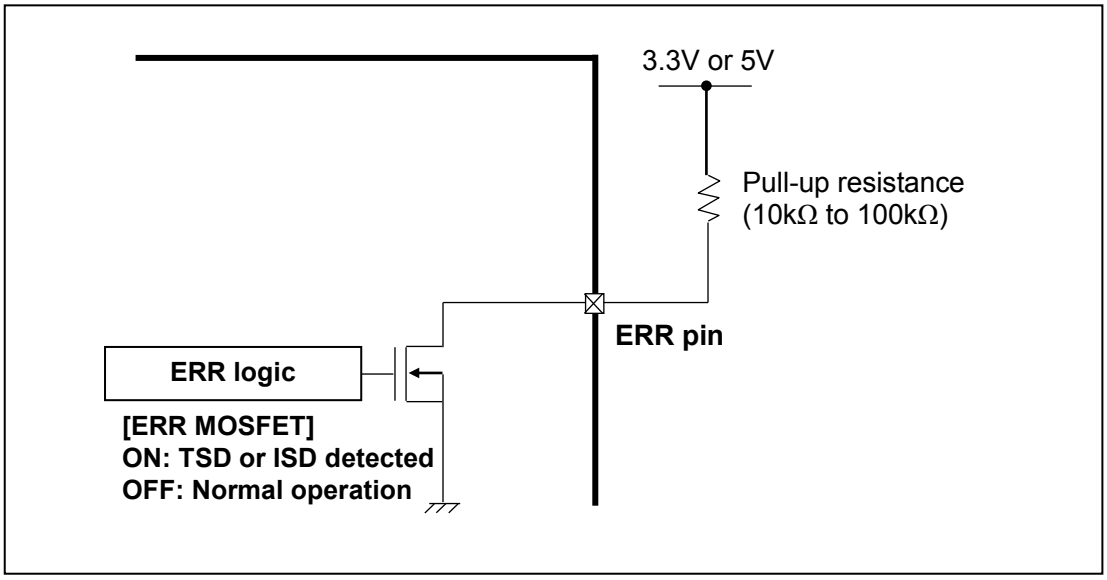


Equivalent circuit(s) may be omitted for explanatory purpose.

ERR pin functions (ERR feedback)

ERR pin	Function
Hi-Z (*)	Normal operation
Low	Error detected (TSD or ISD)

(*) The ERR pin an open drain logic output. To use this function correctly, please make sure the ERR pin is connected to 3.3V or 5.0V with a pull-up resistance. During normal operation, the pin level will be Hi-Z (internal MOSSET: OFF) (it will show High level when pulled up), and once an error (TSD or ISD) has been detected, the pin level will be Low (internal MOSFET: ON). Reasserting the VM power supply or using the STBY function, the ERR pin will return to the initial status (internal MOSFET: OFF). ERR pin should be left open; when not using the ERR feedback function.

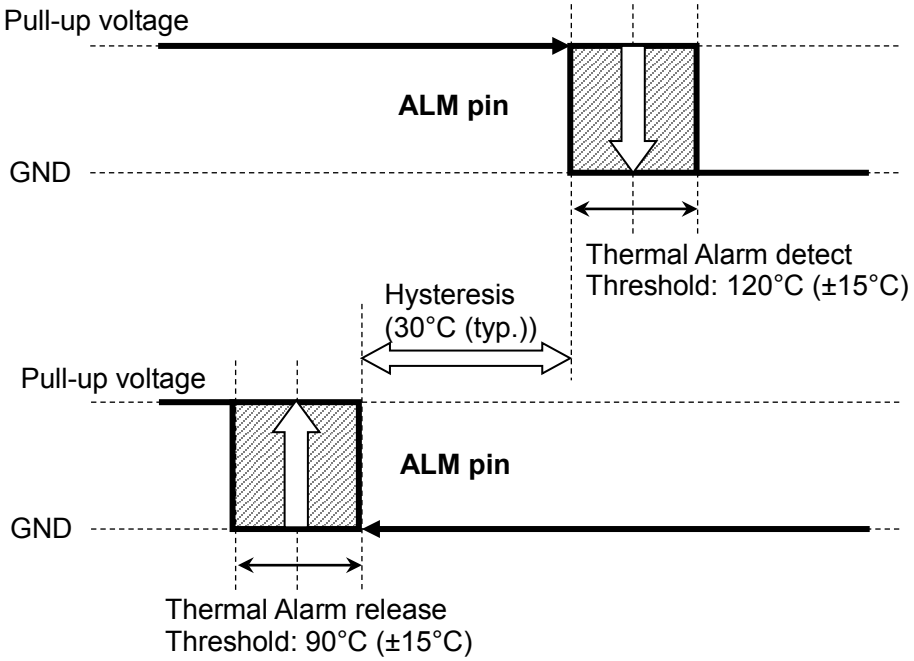


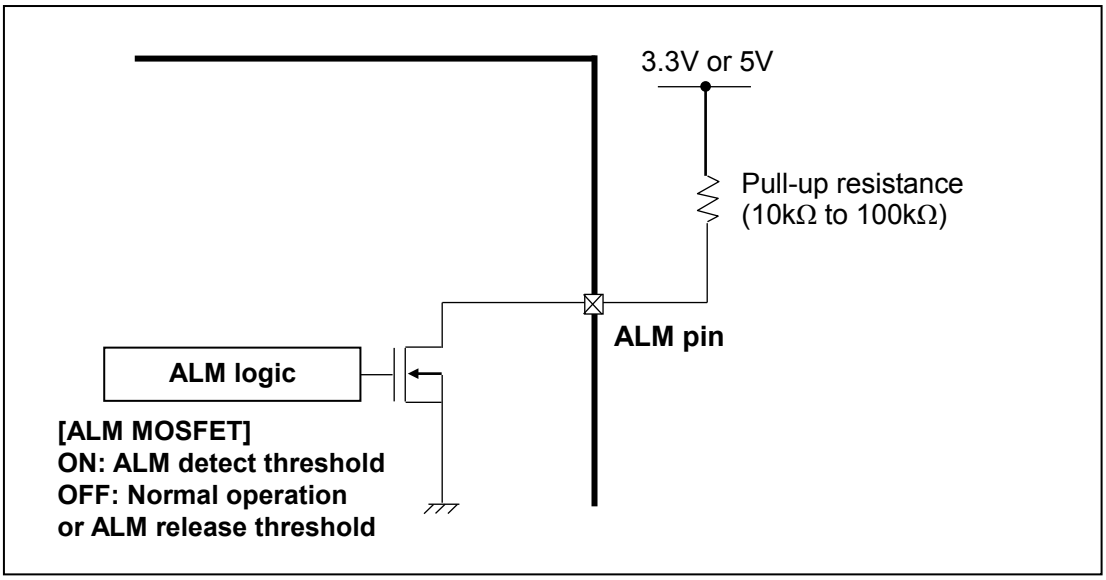
Equivalent circuit(s) may be omitted for explanatory purpose.

ALM pin functions (Thermal ALM feedback)

ALM pin	Function
Hi-Z (*)	Normal operation
Low	Thermal Alarm detected

(*)The ALM pin is an open drain logic output. To use the function correctly, please make sure the ALM pin is connected to 3.3V or 5.0V with a pull-up resistance. During normal operation, the pin level will be Hi-Z (internal MOSFET: OFF) (it will show High level when pulled up), and once the device detects a temperature rise, the pin level will be Low (internal MOSFET: ON). The ALM is an auto recovery type output. Once the device reaches the ALM detect threshold (120°C±15°C), the pin level will show Low (internal MOSFET: ON), and after the device reaches the ALM release threshold ('detect threshold'-30°C), the pin level will show Hi-Z (internal MOSFET: OFF) (it will show High level when pulled up). ALM pin should be left open; when not using the thermal ALM feedback function.





Equivalent circuit(s) may be omitted for explanatory purpose.

TB67S179 setup

Constant-current threshold setting

The constant-current threshold can be set by asserting the VREF voltage.

IOUT = VREF × 3/4 × IOUT(RATIO)

Example: Current setting 100%, VREF=2.0V: The constant current threshold (peak current) will be as shown below.

IOUT = 2.0×3/4×1.0=1.5A

To set the constant-current function ‘off’, connect the VCC and VREF pin directly (do not use any external power supply).

Fixed off time setting

To set the fixed off time for constant-current PWM control, please connect a pull-down resistance to the OSCM pin.
The relation between the pull-down resistance (ROSCM) and fixed off time is as shown below.

Operation mode	Pull-down resistance (ROSCM)	Fixed off time (toff (Typ.))	Note
Constant-current mode	3.9kΩ	4.1μs	Electric characteristics [fOSCM1] prescribes.
	4.7kΩ	4.9μs	
	5.6kΩ	5.8μs	
	6.8kΩ	7.0μs	
	8.2kΩ	8.3μs	
	10kΩ	10μs	
	15kΩ	15μs	
	18kΩ	18μs	
	22kΩ	21μs	
	27kΩ	26μs	
	39kΩ	37μs	
	Open	10μs	Electric characteristics [fOSCM2] prescribes.
Constant-voltage mode	(GND short: GND) open	-	Stops the internal oscillator.

The value shown in the table above does not include any dispersion of the device / external components.

Absolute maximum ratings (Ta=25°C)

Characteristics	Symbol	Rating	Unit
Motor power supply	VM	80	V
VM-VCOM voltage differential	VDIFF	70	V
Motor output voltage	VOUT	80	V
Motor output current (per channel)	IOUT	1.5	A
Internal logic power supply	VCC	6.0	V
Logic input voltage	VIN(H)(max)	6.0	V
	VIN(L)(min)	-0.4	V
VREF input voltage	VREF	6.0	V
Open drain output pin (ERR,ALM,MO) voltage	VOD	6.0	V
Open drain output pin (ERR,ALM,MO) inflow current	IOD	20	mA
Power dissipation (VQFN48; device alone)	PD	1.3	W
Operating temperature	Topr	-20 to 85	°C
Storage temperature	Tstg	-55 to 150	°C
Junction temperature	Tj	150	°C

Caution) 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 device 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.

Note: Allowable power dissipation
When Ta exceeds 25°C, the derating at 10.4 mw/°C is required.

Operation ranges

Characteristics	Symbol	Test condition	Min	Typ.	Max	Unit
Motor power supply	VM	-	10	-	60	V
Motor output voltage	VOUT	-	10	-	80	V
Motor output current (per channel)	IOUT	Ta=25°C	-	1.0	1.5	A
Internal logic power supply	VCC	-	4.75	5.0	5.25	V
Logic input voltage	VIN(H)	Logic input High level	2.0	-	5.5	V
	VIN(L)	Logic input Low level	0	-	0.8	V
Voltage range of VREF input pin	VREF(range)1	Constant-current mode	GND	-	2.0	V
	VREF(Vrange)2	Constant-voltage mode Connected between VREF and VCC directly	-	VCC	-	V
Pull-up voltage range of open drain pin	VOD(range)	ERR,ALM,MO pin	3.0	-	5.5	V
Inflow current range of open drain output pin	IOD(range)	ERR,ALM,MO pin	-	-	10	mA
Motor setting frequency range	fOSCM1(range)	-	820	3200	8200	kHz
Fixed off time range	tOFF(range)	-	5	10	40	μs

Note: Maximum current for actual usage may be limited by the operating circumstances such as operating conditions (exciting mode, operating time, and so on), ambient temperature, and heat conditions (board condition and so on).

DC Electrical Specifications 1 (Ta = 25°C, VM = 24 V, unless specified otherwise)

Characteristics		Symbol	Test condition	Min	Typ.	Max	Unit
Logic input voltage		VIH	Logic input pin High level (*)	2.0	-	5.5	V
		VIL	Logic input pin Low level (*)	GND	-	0.8	V
Logic input hysteresis voltage		VIN(HYS)	Login input pin (*)	100	-	300	mV
Login input current	High	IIN(H)	Logic input voltage High level (VIN=VIH)	-	33	55	μs
	Low	IIN(L)	Logic input voltage Low level (VIN=VIL)	-	-	1	μA
Power consumption		IM1	Output pins: open, Standby mode	-	-	1.0	mA
		IM2	Output pins: open, Normal operation, Full step resolution	-	3.0	5.0	mA
Open drain output pin voltage		VOD(L)	IOD=10mA	0	-	0.5	V
Motor current setting differential		⊿IOUT1	Current differential between channels (IOUT=1.0A)	-5	0	+5	%
Motor current setting accuracy		⊿IOUT2	IOUT=1.0A	-6	0	+6	%
Source-drain diode forward voltage		VFN	IOUT=1.5A	1.0	-	1.6	V
Motor output off leak current		Ileak	VOUT=80V, Output MOSFET:OFF	-	-	1	μA
Motor output ON-resistance (Low side)		RON (D-S)	IOUT=1.5A	-	0.5	0.65	Ω

(*)VIN (H) is defined as the VIN voltage that causes the outputs (OUTA, OUTB) to change when a pin under test is gradually raised from 0 V. VIN (L) is defined as the VIN voltage that causes the outputs (OUTA and OUTB) to change when the pin is then gradually lowered. The difference between VIN (L) and VIN (H) is defined as VIN (HYS).

DC Electrical Specifications 2 (Ta =25°C, VM = 24 V, unless specified otherwise)

Characteristics	Symbol	Test condition	Min	Typ.	Max	Unit
VCC regulator voltage	VCC	ICC=5.0mA	4.75	5.0	5.25	V
VCC regulator current	ICC	4.75V≤VCC≤5.25V	-	2.5	5.0	mA
VREF input current	IREF	VREF=2.0V	-	0	1.0	μA
Thermal shutdown (TSD) threshold (*)	TjTSD	-	140	155	170	°C
VCC recovery voltage	VCCR	-	3.5	4.0	4.5	V
VM recovery voltage	VMR	-	7.0	8.0	9.0	V
Over-current detection (ISD) threshold (*)	ISD	-	2.1	3.0	4.0	A

(*) About Thermal shutdown (TSD)
When the junction temperature of the device reached the TSD threshold, the TSD circuit is triggered; the internal reset circuit then turns off the output stage. Noise rejection blanking time is built-in to avoid misdetection by the switching and so on.
Once the TSD circuit is triggered; the detect latch signal can be cleared by reasserting the VM power source, or setting the device to standby mode. The TSD circuit is a backup function to detect a thermal error, therefore is not recommended to be used aggressively.

(*) About 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 stage. The masking time is built in the IC to avoid misdetection by the switching and so on. Once the ISD circuit is triggered, the detect latch signal can be cleared by reasserting the VM power source, or setting the device to standby mode. The ISD function is a function to detect that the over-current flows into the motor output, therefore, is not recommended to be used aggressively.

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 device or other components will be damaged or fail due to the motor back-EMF.

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-circuits; 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 condition persists for a long time, the device may be damaged due to overstress. Overcurrent conditions must be removed immediately by external hardware.

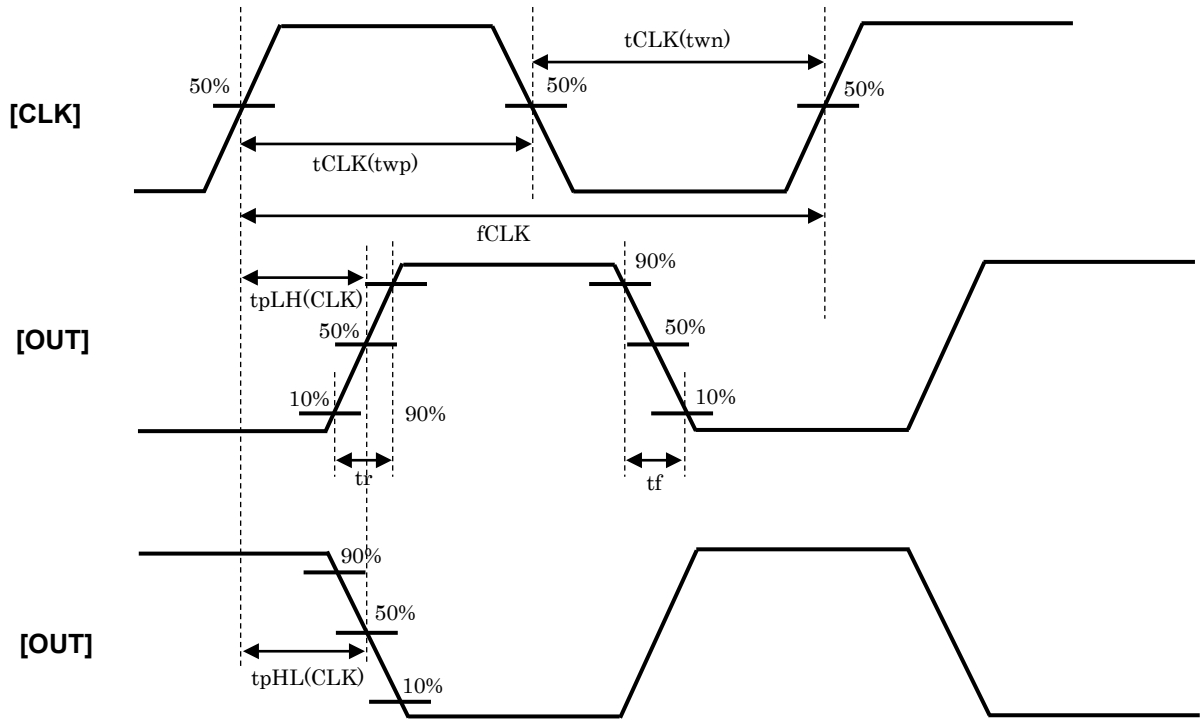
IC Mounting

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

AC Electrical Specifications (Ta=25°C, VM=24V, unless specified otherwise)

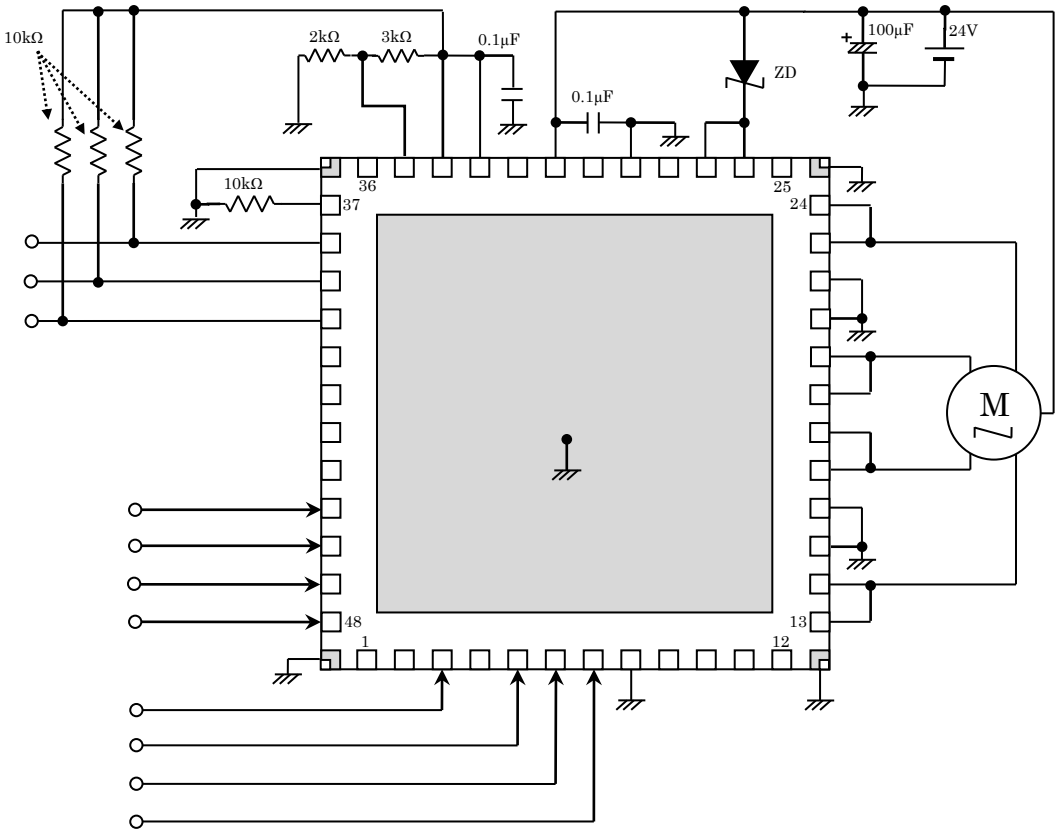
Characteristics	Symbol	Test condition	Min	Typ.	Max	Unit
CLK input frequency	fCLK	fOSCM=3200kHz	-	-	100	kHz
Minimum CLK pulse width	tCLK(twp)	-	50	-	-	ns
	tCLK(twn)	-	50	-	-	ns
Output MOSFET switching specification	tr	-	50	100	150	ns
	tf	-	50	100	150	ns
Output MOSFET response specification	tpLH(CLK)	CLK→OUT	200	700	1200	ns
	tpHL(CLK)	CLK→OUT	200	700	1200	ns
Analog noise blanking time	AtBLK	Analog tblank time	250	400	550	ns
OSCM frequency tolerance	fOSCM1	ROSC=10kΩ	-15	0	+15	%
	fOSCM2	ROSC=Open	-20	-	+20	%
OSCS frequency tolerance	fOSCS	-	-20	0	+20	%
Fixed OFF time	tOFF	fOSCM=3.2MHz	8.5	10	11.5	μs
Over current (ISD) detect masking time	tISD(mask)	fOSCS(=6.4MHz)*8clk	1.0	1.25	1.5	μs
Thermal shutdown (TSD) detect masking time	tTSD(mask)	fOSCS(=6.4MHz)*32clk	4.0	5.0	6.0	μs
Thermal Alarm (ALM) detect masking time	tALM(mask)	fOSCS(=6.4MHz)*16clk	2.0	2.5	3.0	μs

AC specification timing chart



Timing charts may be simplified for explanatory purpose.

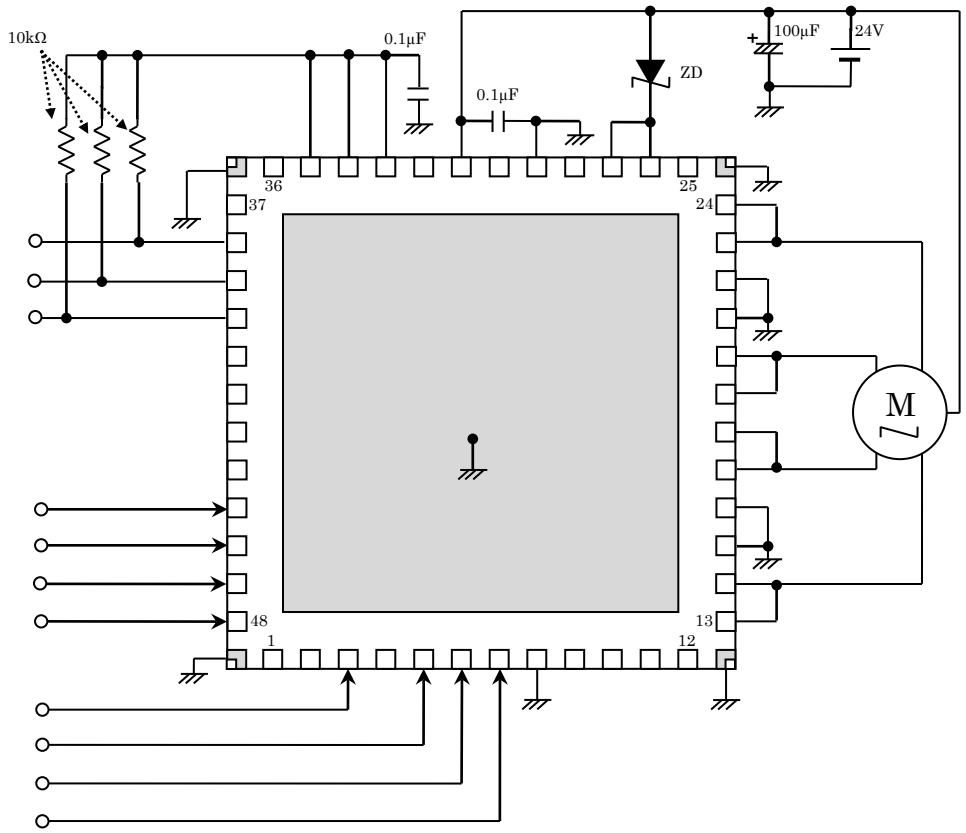
Application circuit example (Constant current control)



* Please mount the four corner pins of the VQFN package and the exposed pad to the GND area of the PCB.

The application circuit above is an example; therefore, mass-production design is not guaranteed.

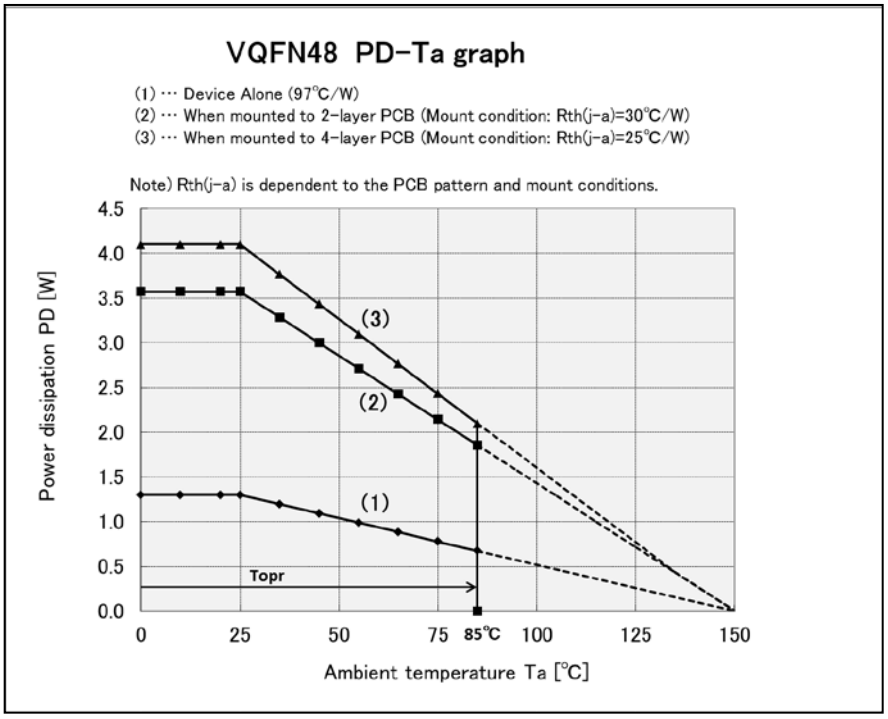
Application circuit example (Constant voltage control)



* Please mount the four corner pins of the VQFN package and the exposed pad to the GND area of the PCB.

The application circuit above is an example; therefore, mass-production design is not guaranteed.

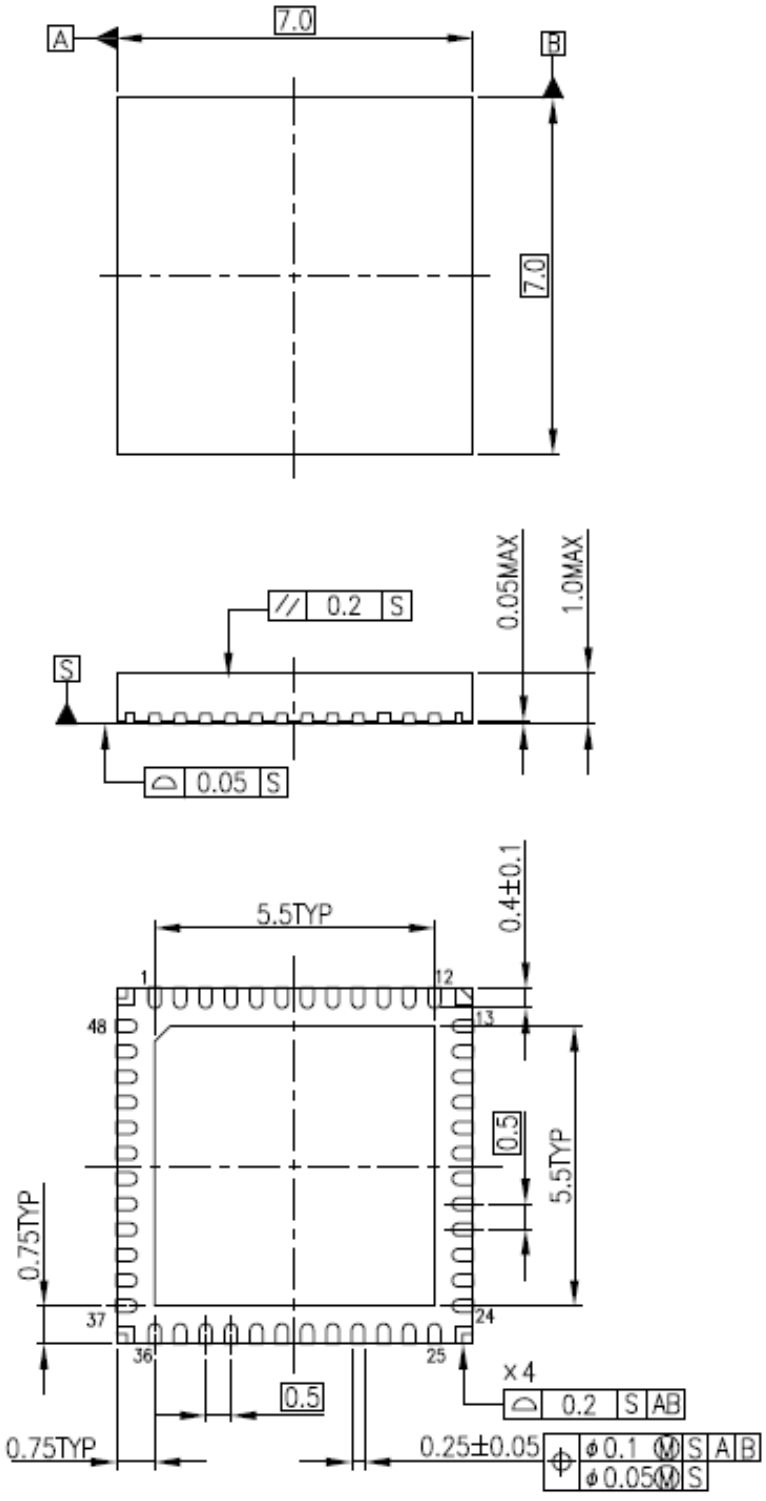
(For reference) PD-Ta graph



Note that Ta, Rth(j-a), and Ptotal are dependent on the usage environment.
Moreover, when ambient environment temperature is high, permissible power consumption is reduced accordingly.

Other reference value: T(j-c)=3.5°C/W of the VQFN48 package

Package dimensions (Unit: mm): P-VQFN48-0707-0.50-004



Weight 0.14 g (Typ.)

Notes on Contents

1. Block Diagram

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 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

・Over current 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.

・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.

・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.

・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 pins 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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