

Toshiba BiCD Process Integrated Circuit Silicon Monolithic

TB67S141HG

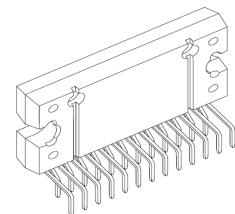
Phase controlled Unipolar stepping motor driver

The TB67S141 is a Phase controlled PWM chopping type 2 phase unipolar stepping motor driver. Using the BiCD process, the TB67S141HG can be operated with VM voltage of 45V, output voltage of 84V, and output current of 3.0A at max (absolute maximum ratings).

Features

- BiCD processed monolithic integrated circuit.
- Capable of operating one unipolar stepping motor.
- PWM controlled constant current drive.
- Full, half(a), quarter step resolution.
- Low on resistance(0.25Ω(typ.)) output MOSFET.
- High voltage and current (For specification, please refer to the absolute maximum ratings and operation ranges).
- Brake mode function
- Standby (low power) mode function
- Error detect feedback signal output function (Over current/Thermal shutdown).
- Error detect function (Thermal shutdown(TSD), Over current(IST), and Low voltage(POR)).
- Built-in VCC regulator for internal circuit use.
- Fixed off time can be adjusted by external components.

HG

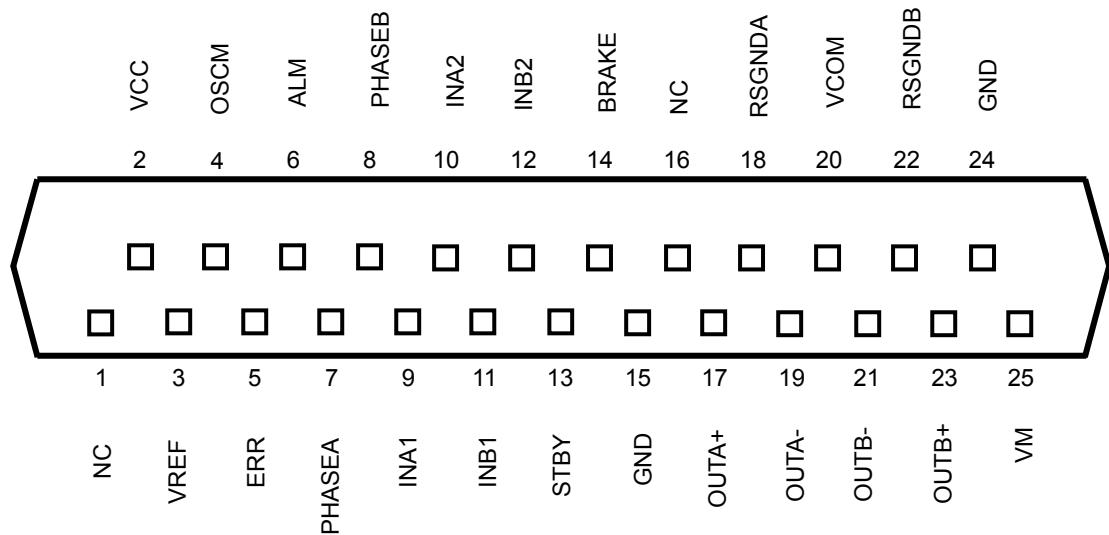


HZIP25-P-1.00F
Weight 7.6(g) (typ.)

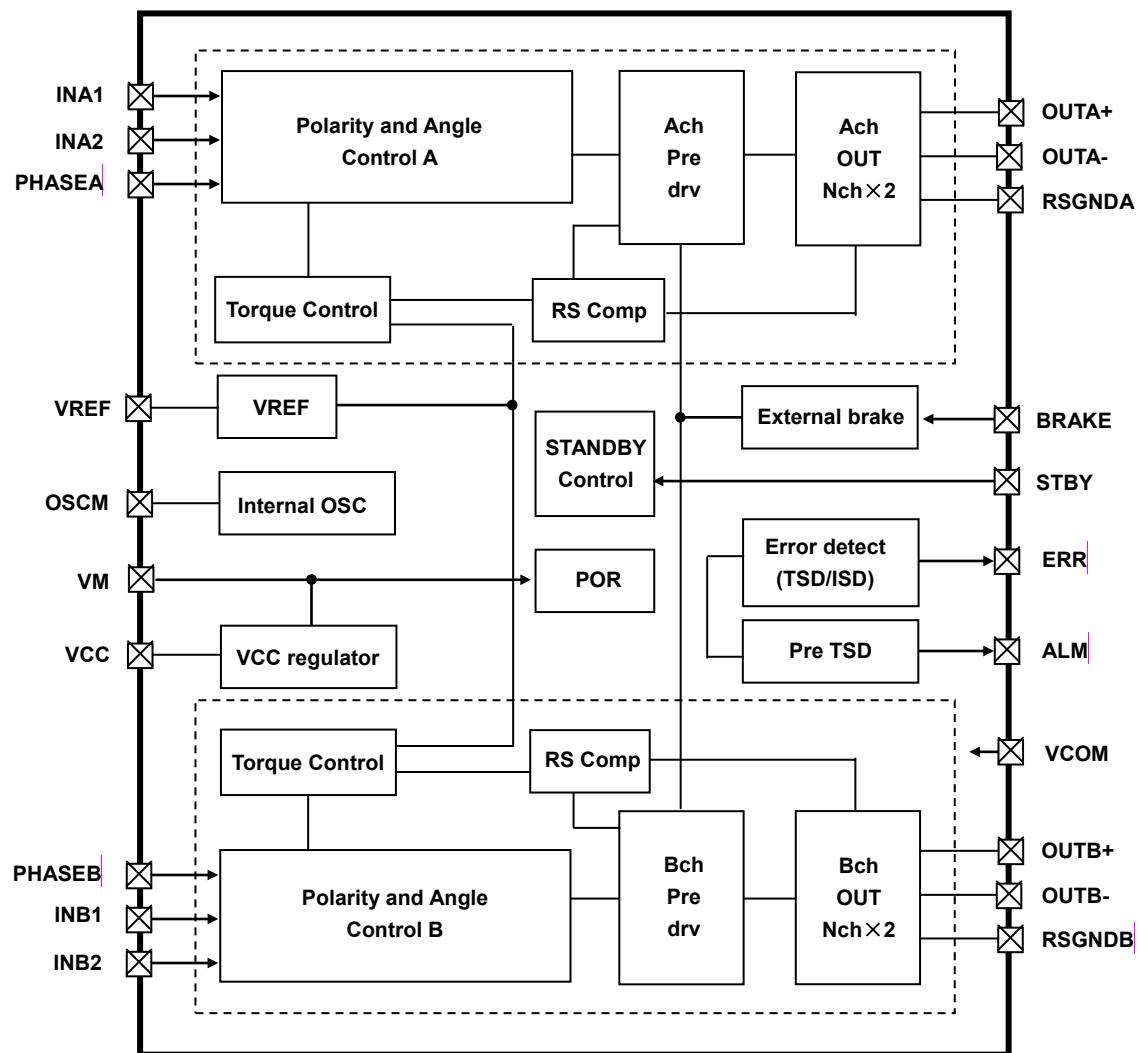
Note) Please be careful about the thermal conditions during use.

Pin assign (TB67S141HG)

(Top View)



TB67S141 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**TB67S141HG (HZIP25)**

Pin No.1 to 25

| Pin No. | Pin Name | Function |
|---------|----------|---|
| 1 | NC | Non connection |
| 2 | VCC | Internal VCC regulator monitor pin |
| 3 | VREF | Constant current threshold set pin |
| 4 | OSCM | Fixed off time set pin |
| 5 | ERR | Error detect feedback signal output pin |
| 6 | ALM | Thermal alarm output pin |
| 7 | PHASEA | Ach current phase setup pin |
| 8 | PHASEB | Bch current phase setup pin |
| 9 | INA1 | Ach current setup 1 |
| 10 | INA2 | Ach current setup 2 |
| 11 | INB1 | Bch current setup 1 |
| 12 | INB2 | Bch current setup 2 |
| 13 | STBY | Standby control pin |
| 14 | BRAKE | Brake control pin |
| 15 | GND | Ground pin |
| 16 | NC | Non connection |
| 17 | OUTA+ | Motor output A+ pin |
| 18 | RSGNDA | Ach current sense ground pin |
| 19 | OUTA- | Motor output A-pin |
| 20 | VCOM | Common pin |
| 21 | OUTB- | Motor output B-pin |
| 22 | RSGNDB | Bch current sense ground pin |
| 23 | OUTB+ | Motor output B+ pin |
| 24 | GND | Ground pin |
| 25 | VM | VM power supply pin |

Please do not run patterns under NC pins.

INPUT/OUTPUT Equivalent circuit

| Pin name | Input / Output | Equivalent circuit |
|---|---|--------------------|
| PHASEA PHASEB INA1 INA2 INB1 INB2 STBY BRAKE | Logic input (VIH/VIL) VIH: 2.0V(min) to 5.5V(max) VIL : 0V(min) to 0.8V(max) | |
| ERR ALM | Logic output (VOH/VOL) (Pullup resistance :10k to 100kΩ) | |
| VCC VREF | VCC voltage range 4.75V(min) to 5.0V(typ.) to 5.25V(max) VREF input voltage range 0V to 4.0V (Constant current control) VCC short(Constant current control : off) | |
| OSCM | OSCM frequency setup (reference) 0.82MHz(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 40V(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.

TB67S141 function explanation

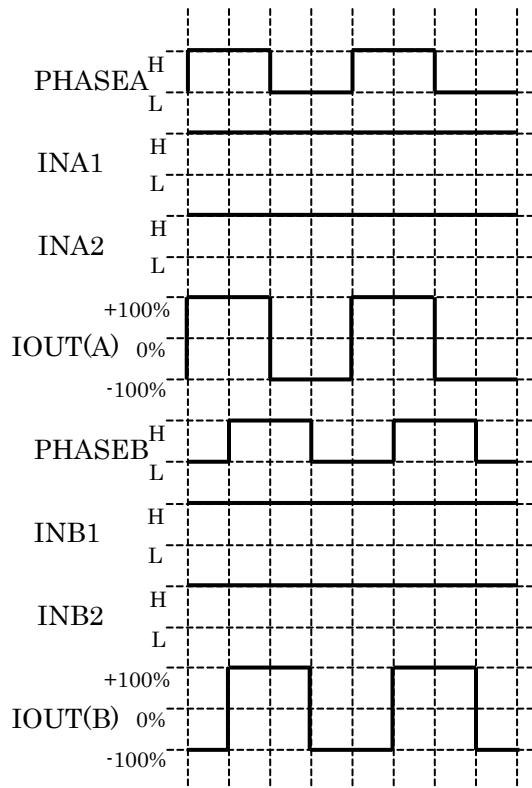
The current is defined as 'plus' when the current flows from VM to OUT+ during charge status(OUT+ side MOSFET is turned on), and is defined as 'minus' when the current flows from VM to OUT- during charge status (OUT- side MOSFET is turned on).

Step resolution and current settings

[Full step]

| Ach | | | | | | Bch | | | | | |
|--------------|------|------|--------|-------|---------|--------------|------|------|--------|-------|---------|
| Logic signal | | | MOSFET | | Current | Logic signal | | | MOSFET | | Current |
| PHASEA | INA1 | INA2 | OUTA+ | OUTA- | IOUT(A) | PHASEB | INB1 | INB2 | OUTB+ | OUTB- | IOUT(B) |
| H | H | H | ON | OFF | +100% | H | H | H | ON | OFF | +100% |
| L | H | H | OFF | ON | -100% | H | H | H | ON | OFF | +100% |
| L | H | H | OFF | ON | -100% | L | H | H | OFF | ON | -100% |
| H | H | H | ON | OFF | +100% | L | H | H | OFF | ON | -100% |

Note: About MOSFETs: motor output pin level will show 'Low' when 'ON', and pin level will show 'Hi-Z' when OFF.

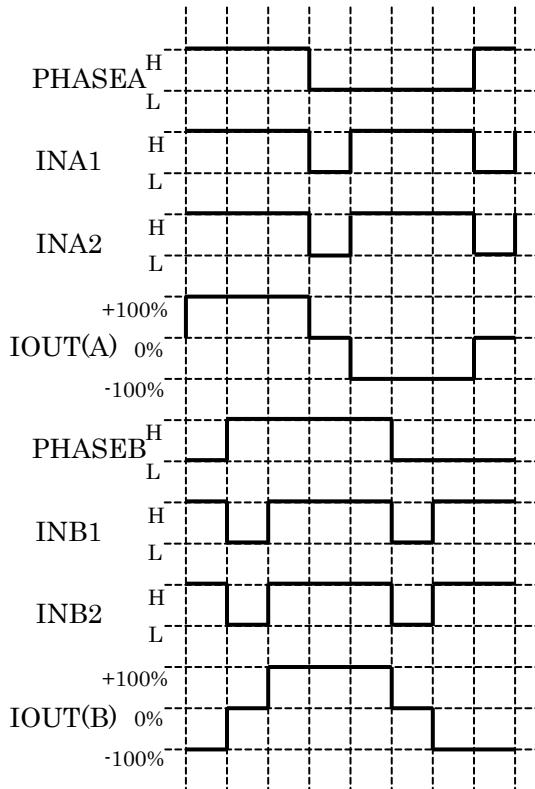


Timing charts may be simplified for explanatory purpose.

[Half(a) step]

| Ach | | | | | | Bch | | | | | |
|--------------|------|------|--------|-------|---------|--------------|------|------|--------|-------|---------|
| Logic signal | | | MOSFET | | Current | Logic signal | | | MOSFET | | Current |
| PHASEA | INA1 | INA2 | OUTA+ | OUTA- | IOUT(A) | PHASEB | INB1 | INB2 | OUTB+ | OUTB- | IOUT(B) |
| H | H | H | ON | OFF | +100% | H | H | H | ON | OFF | +100% |
| L or H | L | L | OFF | OFF | 0 | H | H | H | ON | OFF | +100% |
| L | H | H | OFF | ON | -100% | H | H | H | ON | OFF | +100% |
| L | H | H | OFF | ON | -100% | L or H | L | L | OFF | OFF | 0 |
| L | H | H | OFF | ON | -100% | L | H | H | OFF | ON | -100% |
| L or H | L | L | OFF | OFF | 0 | L | H | H | OFF | ON | -100% |
| H | H | H | ON | OFF | +100% | L | H | H | OFF | ON | -100% |
| H | H | H | ON | OFF | +100% | L or H | L | L | OFF | OFF | 0 |

Note: About MOSFETs: motor output pin level will show 'ON' when 'ON', and pin level will show 'Hi-Z' when OFF.

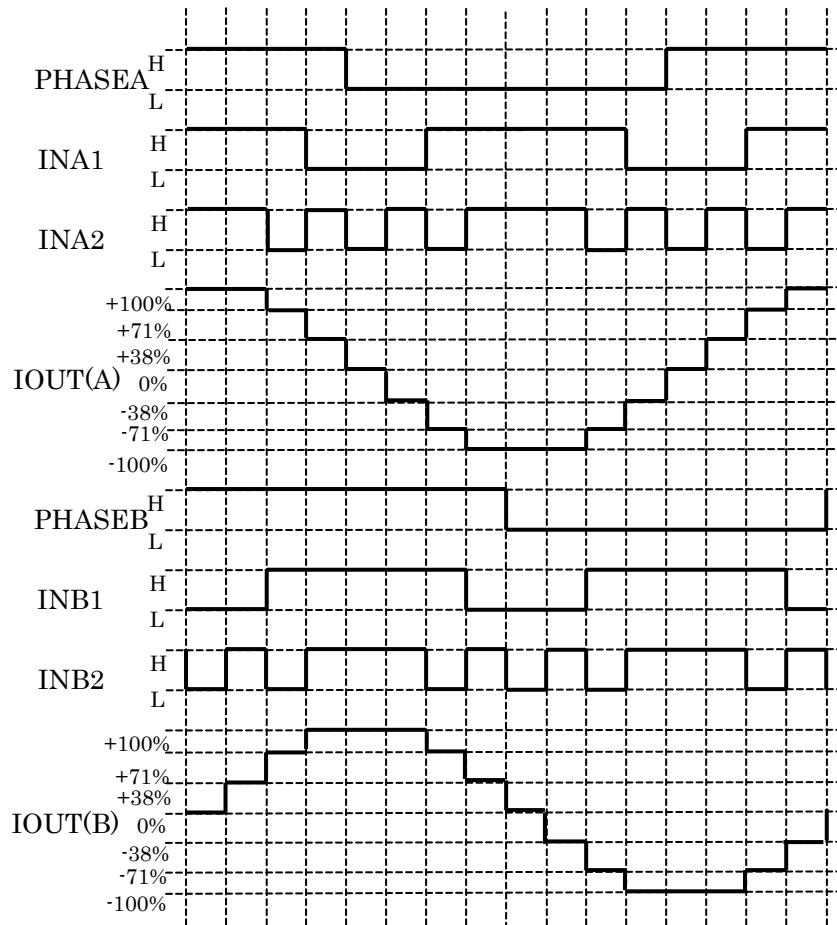


Timing charts may be simplified for explanatory purpose.

[Quarter step]

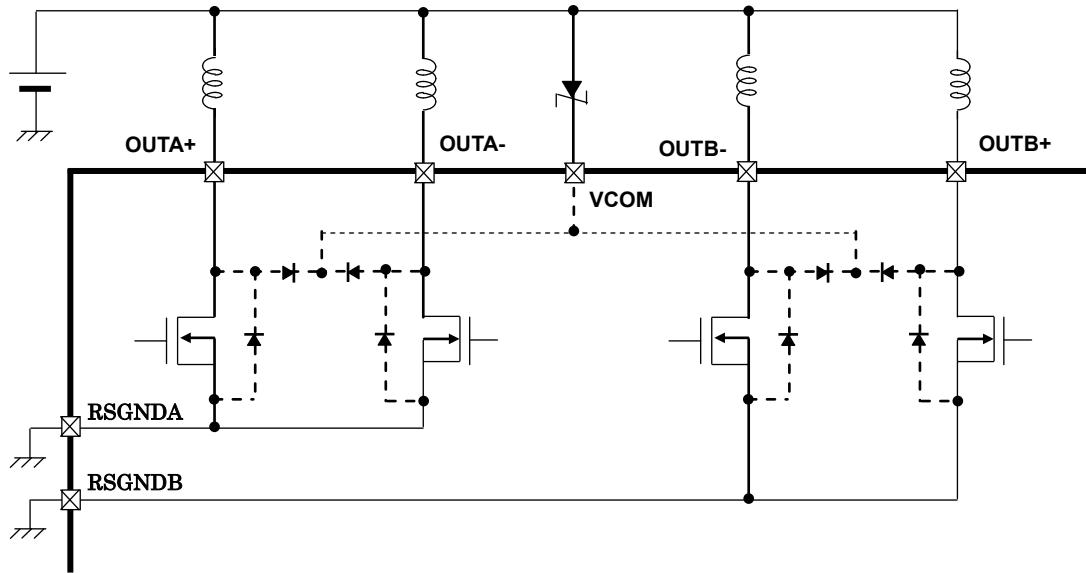
| Ach | | | | | | Bch | | | | | |
|--------------|------|------|--------|-------|---------|--------------|------|------|--------|-------|---------|
| Logic signal | | | MOSFET | | Current | Logic signal | | | MOSFET | | Current |
| PHASEA | INA1 | INA2 | OUTA+ | OUTA- | IOUT(A) | PHASEB | INB1 | INB2 | OUTB+ | OUTB- | IOUT(B) |
| H | H | L | ON | OFF | +71% | H | H | L | ON | OFF | +71% |
| H | L | H | ON | OFF | +38% | H | H | H | ON | OFF | +100% |
| L or H | L | L | OFF | OFF | 0% | H | H | H | ON | OFF | +100% |
| L | L | H | OFF | ON | -38% | H | H | H | ON | OFF | +100% |
| L | H | L | OFF | ON | -71% | H | H | L | ON | OFF | +71% |
| L | H | H | OFF | ON | -100% | H | L | H | ON | OFF | +38% |
| L | H | H | OFF | ON | -100% | L or H | L | L | OFF | OFF | 0% |
| L | H | H | OFF | ON | -100% | L | L | H | OFF | ON | -38% |
| L | H | L | OFF | ON | -71% | L | H | L | OFF | ON | -71% |
| L | L | H | OFF | ON | -38% | L | H | H | OFF | ON | -100% |
| L or H | L | L | OFF | OFF | 0% | L | H | H | OFF | ON | -100% |
| H | L | H | ON | OFF | +38% | L | H | H | OFF | ON | -100% |
| H | H | L | ON | OFF | +71% | L | H | L | OFF | ON | -71% |
| H | H | H | ON | OFF | +100% | L | L | H | OFF | ON | -38% |
| H | H | H | ON | OFF | +100% | L or H | L | L | OFF | OFF | 0% |
| H | H | H | ON | OFF | +100% | H | L | H | ON | OFF | +38% |

Note: About MOSFETs: motor output pin level will show 'Low' when 'ON', and pin level will show 'Hi-Z' when OFF.



Timing charts may be simplified for explanatory purpose.

BRAKE mode function



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

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

(During Constant current control; $V_{REF} \leq 4.0V$)

| | |
|--|-------|
| Phase status when BRAKE is set to 'High' | IOUT |
| PHASE=L | -100% |
| PHASE=H | +100% |

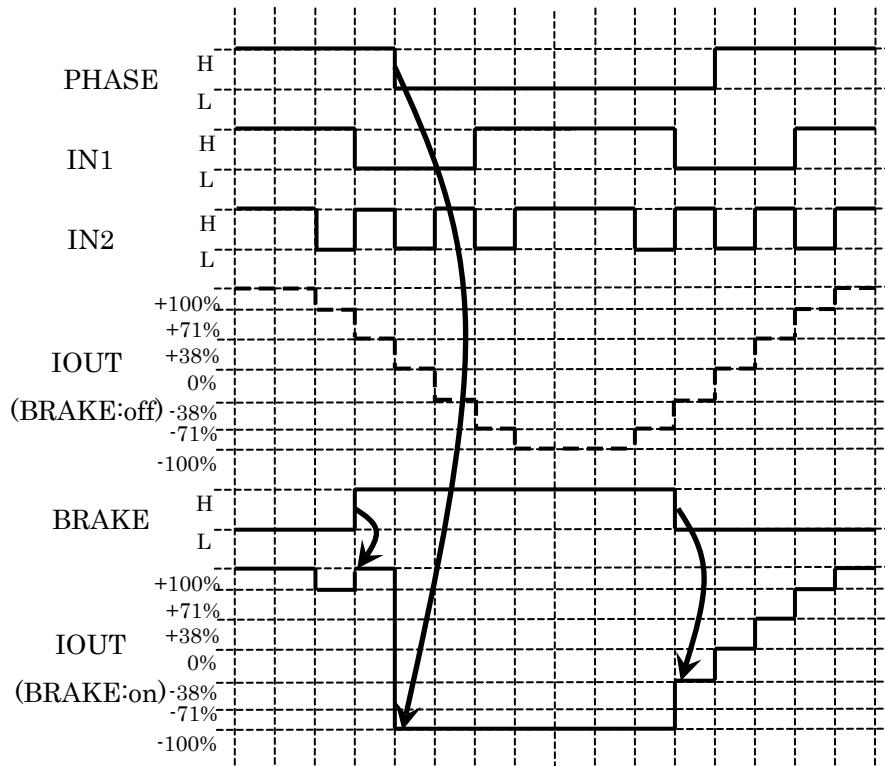
Note) When the PHASE signal is switched during BRAKE=H, the current flow will also be switched, as shown in the graph above. (For example, when PHASE is switched from 'Low' to 'High', the current control will be switched from OUT(-) side to OUT(+) side.)

Note) When BRAKE is set to High, the current setting will be set to 100%; regardless of IN1 and IN2 input.

(During Constant current control “off”; VREF-VCC direct connected)

When BRAKE is set to 'High'; All four output MOSFETs(OUTA+,A-,B+,B-) will turn on.

Example: Relation between BRAKE mode and current setting
(BRAKE mode during Quarter step operation.)



Timing charts may be simplified for explanatory purpose.

Note) When BRAKE is set to 'High, the current will be determined by PHASE input. Also, the current setting will be set to 100%; regardless of IN1 and IN2.

Standby mode function

Setting the STBY pin will enable the device to be set to Standby mode (=Low power mode) which will cut all unnecessary internal bias current to reduce power consumption. The ISD(over current)/TSD(Thermal shutdown) status can also be reseted by STBY.

| STBY | Function |
|------|-------------------------------------|
| H | Standby mode: OFF(normal operation) |
| L | Standby mode: ON(Low power mode) |

The ISD(over current)/TSD(Thermal shutdown) status will be reseted when STBY is set to Low.

Note) After STBY is set to High, the internal circuit will restart from low power mode. Therefore it is preferable not to input any logic signal for 10μs, after the STBY is set to High. (If the logic signal is input to the device during wake-up period, the device may not be able to receive the signal correctly.)

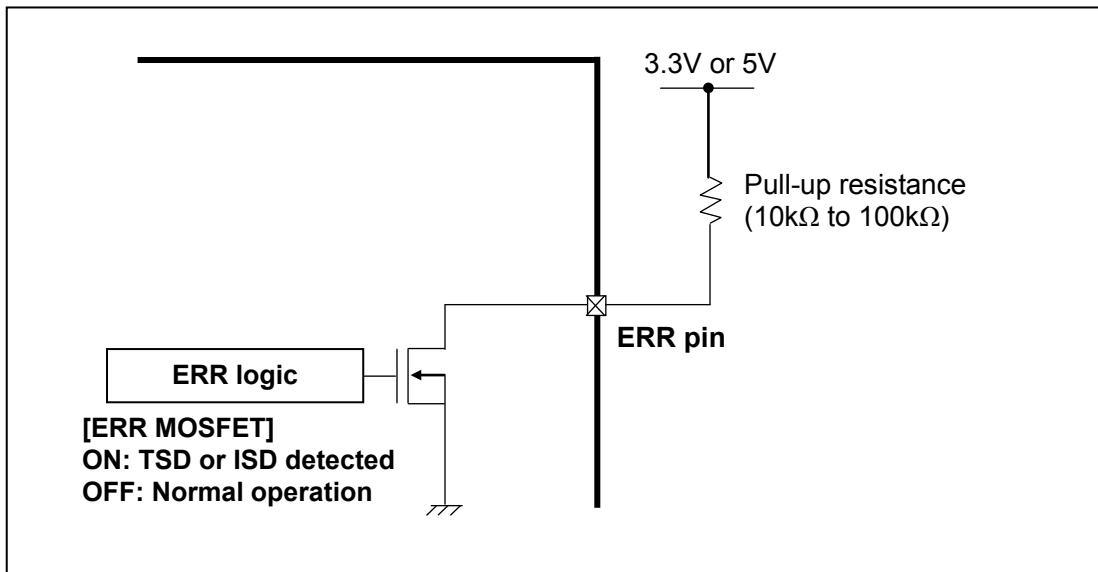
Monitor pin functions (ERR feedback)

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

Note) The ERR pin is an open drain logic output. To use the 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 MOSFET: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.

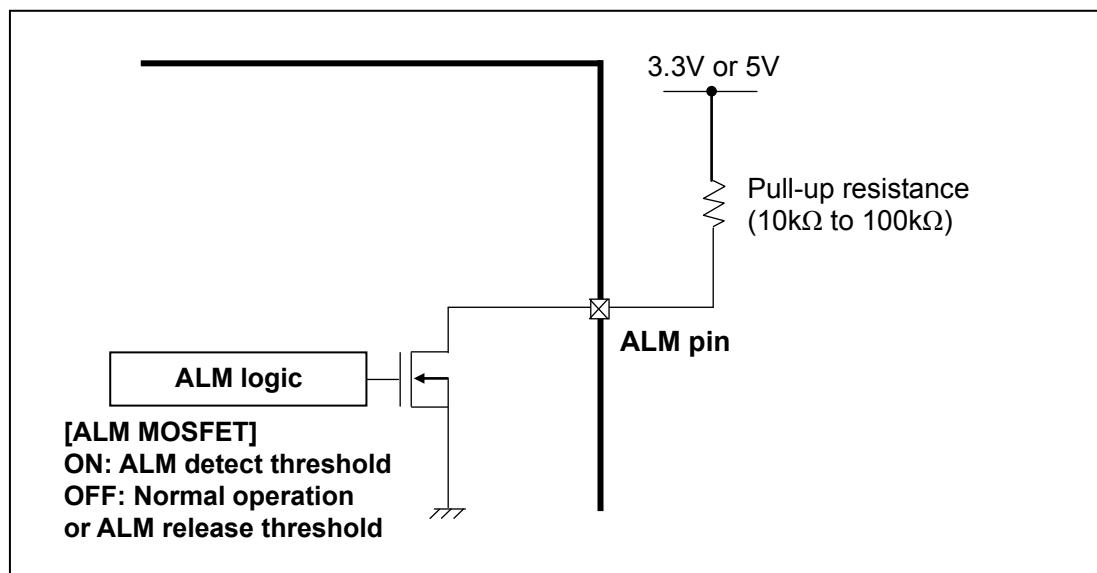
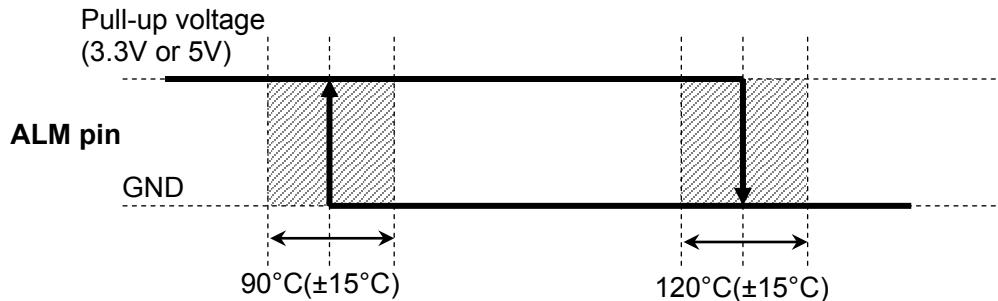
Monitor pin functions (Thermal ALM feedback)

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

Note) 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($120^{\circ}\text{C} \pm 15^{\circ}\text{C}$), 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.



Timing charts may be simplified for explanatory purpose.

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

TB67S141 setup

Constant-current threshold setting

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

$$I_{OUT(max)} = V_{REF} \times 3/4$$

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

$$I_{OUT} = 2.0 \times 3/4 = 1.5A$$

To set the constant-current function 'off', connect the VCC and VREF pin directly (do not use any external power supply). Also, please be careful about the thermal conditions during use.

Fixed off time setting

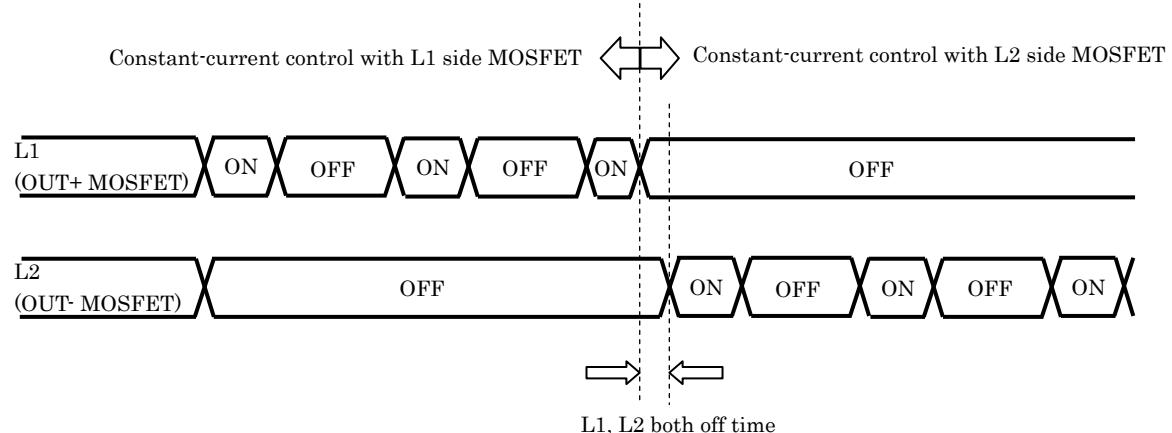
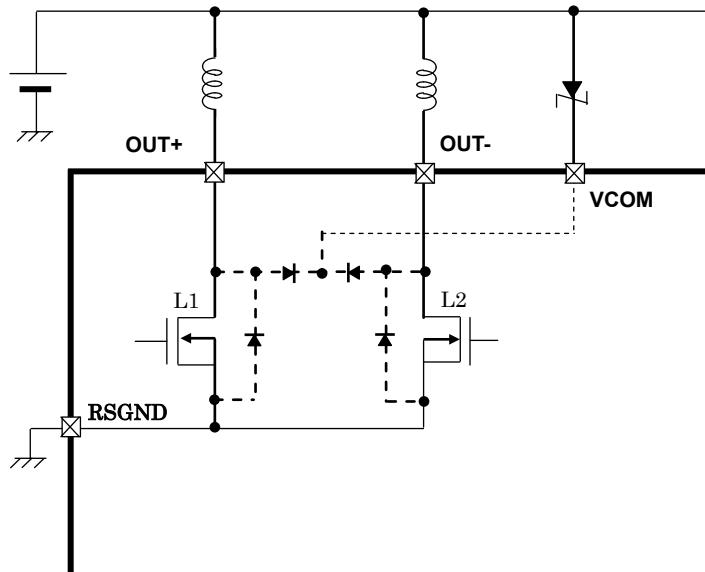
To set the fixed off time for constant-current PWM control, please connect a pull-down resistance to the OSCM pin. The relation between the pull-down resistance(ROSCM) and fixed off time is as shown below.

(For reference)

| Pull-down resistance (ROSCM) | Fixed off time (toff) |
|------------------------------|-----------------------|
| 3.9kΩ | 4.1μs |
| 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 |

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

OFF TIME for PHASE switching



Timing charts may be simplified for explanatory purpose.

When the PHASE signal is switched from Low to High or High to Low (the above timing chart is one example), there is an off time, to avoid both OUT+ and OUT- MOSFET to turn ON at the same time.

Using the internal system oscillator ($f_{OSCS}=6.4\text{MHz}$), the switching time is about 3CLK (including the synchronous time difference; $1+3\text{CLK}=4\text{CLK}$ at the most): the off time is about 470 to 625ns.

Absolute maximum ratings (Ta=25°C)

| Characteristics | Symbol | Rating | Unit |
|--|-------------|------------|------|
| Motor power supply | VM(max) | 45 | V |
| VM-VCOM voltage differential | VDIFF(max) | 45 | V |
| Motor output voltage | VOUT(max) | 84 | V |
| Motor output current (per channel) | IOUT(max) | 3.0 | A |
| Internal logic power supply | VCC(max) | 6.0 | V |
| Logic input voltage | VIN(H)(max) | 6.0 | V |
| | VIN(L)(min) | -0.4 | V |
| VREF input voltage | VREF(max) | 6.0 | V |
| Open drain output pin (ERR,ALM) voltage | VOD(max) | 6.0 | V |
| Open drain output pin (ERR,ALM) inflow current | IOD(max) | 20 | mA |
| Power dissipation (HZIP25; device alone) | PD | 3.2 | W |
| Operating temperature | Topr | -20 to 85 | °C |
| Storage temperature | Tstr | -55 to 150 | °C |
| Junction temperature | Tj(max) | 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.

Operation ranges

| Characteristics | Symbol | Test condition | Min | Typ. | Max | Unit |
|-------------------------------------|--------------|------------------------|------|------|------|------|
| Motor power supply | VM | - | 10 | - | 40 | V |
| Motor output voltage | VOUT | - | 10 | - | 80 | V |
| Motor output current (per channel) | IOUT | Ta=25°C | - | 1.5 | 3.0 | 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 |
| VREF input voltage range | VREF(range) | - | GND | - | 5.5 | V |
| Open drain pin voltage range | VOD(range) | ERR,ALM pin | 3.0 | - | 5.5 | V |
| Open drain pin inflow current range | IOD(range) | ERR,ALM pin | - | - | 10 | mA |
| Internal oscillator frequency range | fOSCM(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).

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) | Logic input pin (*) | 100 | - | 300 | mV |
| Logic input current | High | IIN(H) | Logic input voltage High level (VIN=VIH) | - | 33 | 55 | µA |
| | 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 channel differential | | ΔIOUT1 | Current differential between channels (IOUT=1.0A) | -5 | 0 | +5 | % |
| Motor current setting accuracy | | ΔIOUT2 | IOUT=1.0A | -6 | 0 | +6 | % |
| Source-drain diode forward voltage | | VFN | IOUT=2.0A | 0.85 | - | 1.45 | V |
| Motor output off leak current | | Ileak | VOUT=80V, Output MOSFET:OFF | - | - | 1 | µA |
| Motor output ON-resistance (Low side) | | RON (D-S) | IOUT=2.0A | - | 0.25 | 0.35 | 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, OUTB) to change when the pin is then gradually lowered. The difference between VIN (L) and VIN (H) is defined as the VIN(HYS).

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 | 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 | - | 3.1 | 4.0 | 5.0 | 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 transistors. Noise rejection blanking time is built-in to avoid misdetection. 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 transistors. 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. For fail-safe, please insert a fuse to avoid secondary trouble.

Electrical Specifications 3 (Ta =25°C, VM = 24 V, unless specified otherwise)

| Characteristics | Symbol | Test condition | Min | Typ. | Max | Unit |
|-----------------|--------|----------------|-----|------|-----|------|
| Current ratio | - | IN1=H, IN2=H | - | 100 | - | % |
| | | IN1=H, IN2=L | 66 | 71 | 76 | % |
| | | IN1=L, IN2=H | 33 | 38 | 43 | % |
| | | IN1=L, IN2=L | - | 0 | - | % |

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

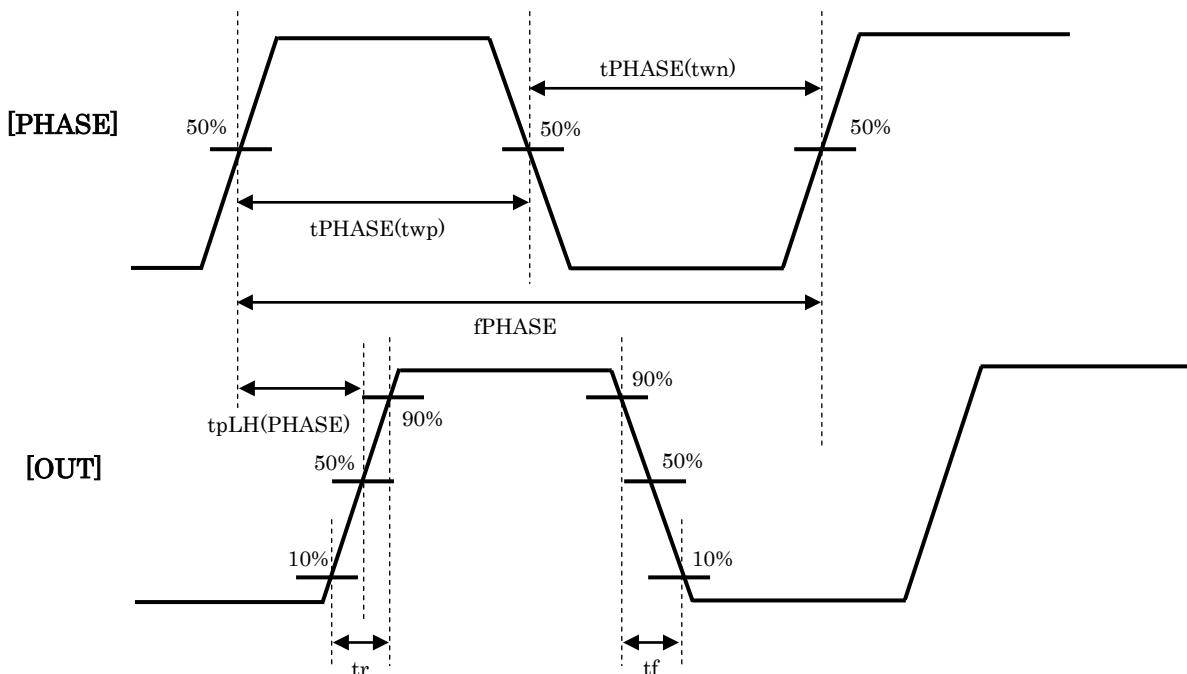
IC Mounting

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

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

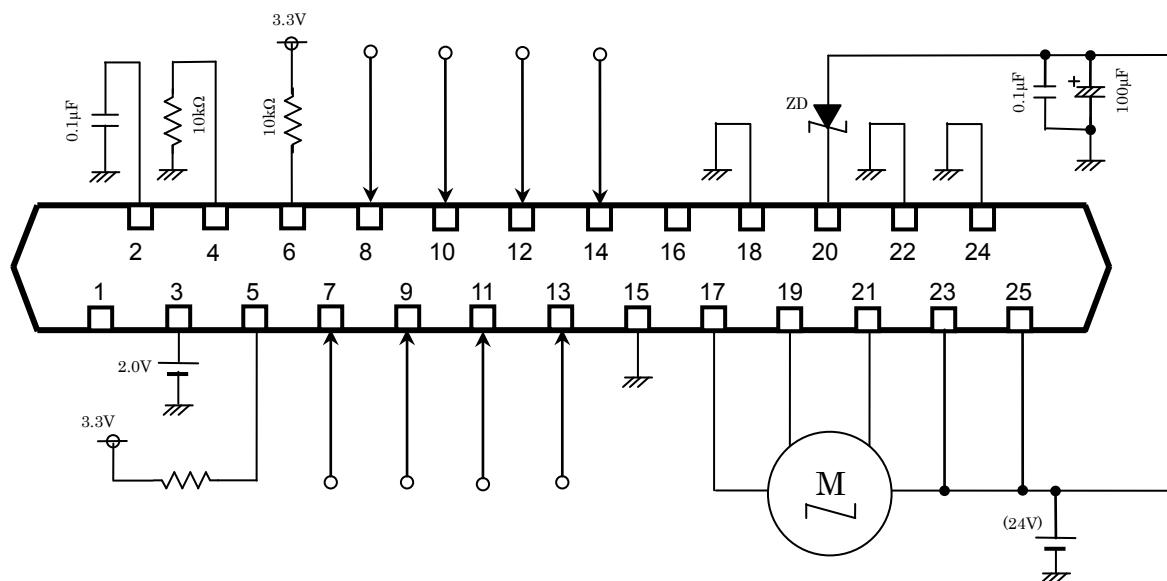
| Characteristics | Symbol | Test condition | Min | Typ. | Max | Unit |
|--|-------------|----------------------|------|------|------|------|
| PHASE input frequency | fPHASE | fOSCM=3200kHz | - | - | 400 | kHz |
| Minimum PHASE pulse width | tPHASE(twp) | - | 50 | - | - | ns |
| | tPHASE(twn) | - | 50 | - | - | ns |
| Output MOSFET switching specific (rise time, fall time) | tr | - | 50 | 100 | 150 | ns |
| | tf | - | 50 | 100 | 150 | ns |
| Output MOSFET switching specific (PHASE-OUT response time) | tpLH(PHASE) | PHASE→OUT | 200 | 700 | 1200 | ns |
| | tpHL(PHASE) | PHASE→OUT | 200 | 700 | 1200 | ns |
| Analog noise blanking time | AtBLK | Analog tblank | 250 | 400 | 550 | ns |
| OSCM frequency | fOSCM | ROSC=10kΩ | 2720 | 3200 | 3680 | kHz |
| OSCS frequency | fOSCS | - | 5120 | 6400 | 7680 | kHz |
| 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



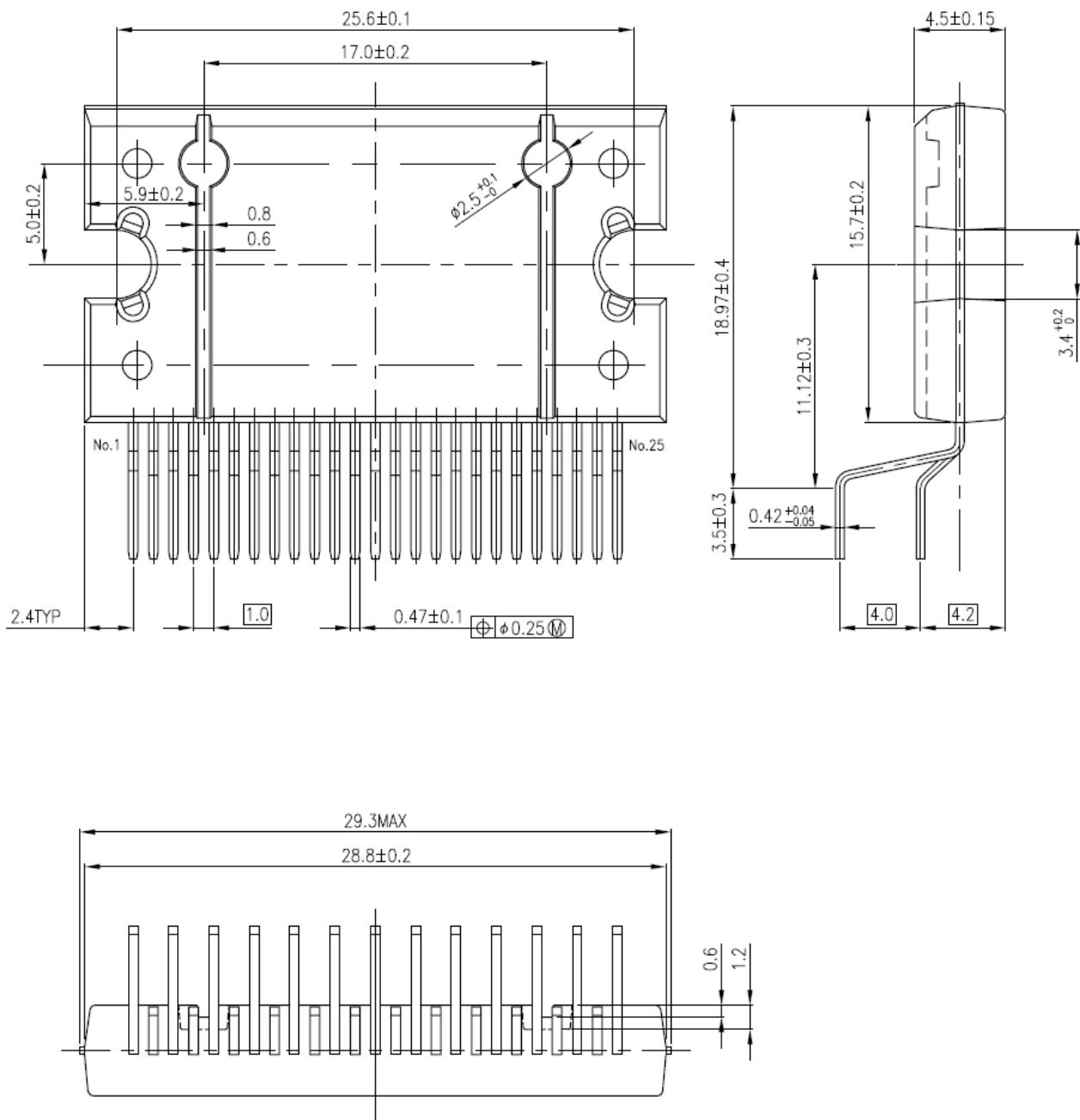
Timing charts may be simplified for explanatory purpose.

Application circuit example



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

Package dimensions (Unit:mm) : HZIP25-P-1.00F



Weight: 7.6(g)(typ.)

The tightening torque for the mounting bracket should be controlled between 0.4N · m to 0.6N · m.

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.

Equivalent Circuits

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

Toshiba does not grant any license to any industrial property rights by providing these examples of application circuits.

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

Overcurrent detection Circuit

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

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

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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