2004-09-15

Directions of using TB6562ANG/AFG

0. Summary

TB6562ANG/AFG is a 2-phase bipolar stepping motor driver.
It drives at constant current by PWM control.

1. Power supply voltage

1) Operating power supply voltage range

Item	Symbol	Operating power supply voltage range	Unit
Power supply voltage	V_{CC}	10.0 ~ 34.0	V

The maximum rating is 40 V. Set the operating supply voltage 34 V or less.

2) Power on / Shut down

You should set the SB (Stand by) terminal low to avoid operating the IC wrong in Vcc input. You should also set the SB terminal low in shut down.

2. Output current

The maximum rating is 1.5 A (peak). Make sure not to let it be beyond this value.
The average tolerant current is limited by the total tolerant current. Take care to use the IC within this range.

3. Control input

1) Phase signal input

It switches the current direction toward the coil depending on the phase terminal of each bridge output.
In case driving 2-phase stepping, the rotation speed changes as the input frequency switches.
It is possible to control it with 3V-series input signals when the VIN(H) is 2V and the VIN(L) is 0.8V.
It has internal pull down resistor (100 kΩ(typ)).

2) Stand by input

It moves to stand by mode by setting the SB terminal low. And all the output transistors turn off.
In stand by mode, it is impossible to control the phase input, the X1 input, and the X2 input.
It is possible to control it with 3V-series input signals when the VIN(H) is 2V and the VIN(L) is 0.8V.
It has internal pull down resistor (100 kΩ(typ)) and the IC moves to stand by mode when the input is open.

3) X1, X2 inputs

The output current is switched by the X1 and the X2 input. The current can be switched digitally by these input signals. And so it is possible to operate it at not only 2-phase excitation or 1-2-phase excitation but also at W1-2-phase excitation.
It is possible to control it with 3V-series input signals when the VIN(H) is 2V and the VIN(L) is 0.8V.
It has internal pull down resistor (100 kΩ(typ)). Take care that the current setting becomes 100 % when the input is open.

4) Vref input

It is the external standard voltage input to set the output current. Set it from 0.5V to 7.0V.
It can be set by separated resistors of 5 V constant supply voltage（Vreg）.
Add the condenser (about 0.1) to reduce the noise in switching mode.

5) Vreg terminal

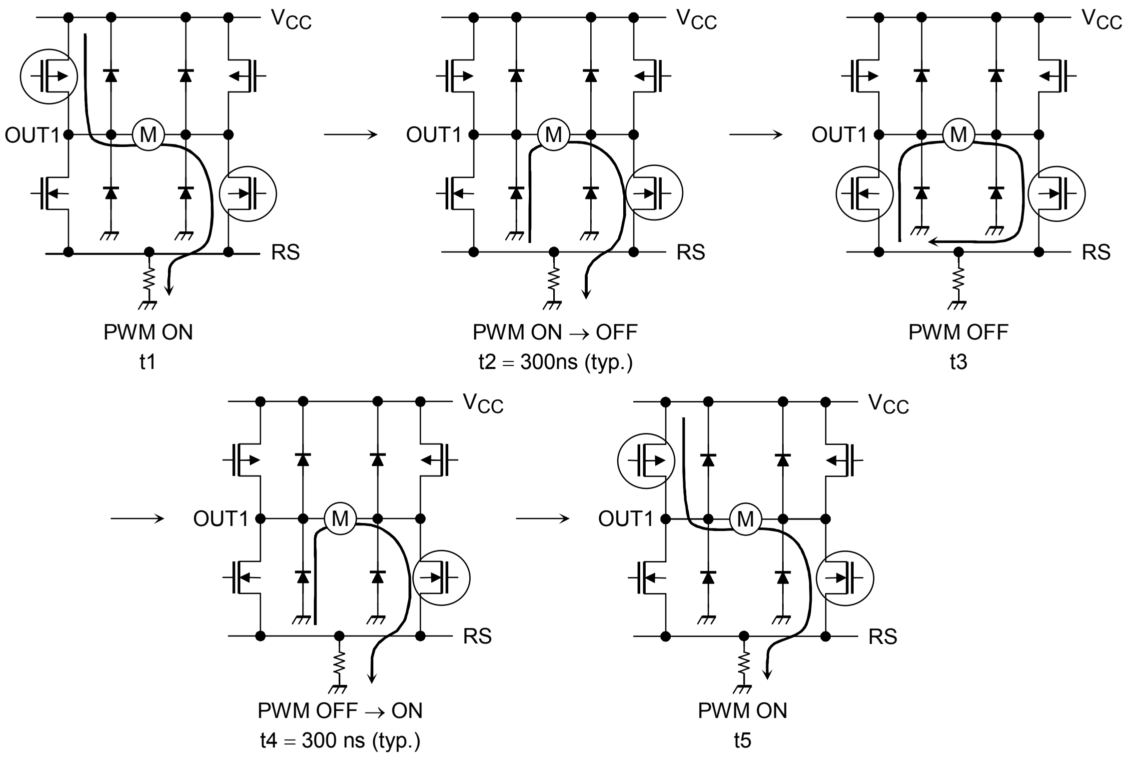
It generates 5 V power supply from the Vcc power supply and outputs this supply to Vreg terminal.
The current ability is 1mA and it is able to input it to Vref with the separated resistors.
This 5 V- power supply is applied as the internal logic power supply. So, connect it to the ceramic condenser to stabilize the IC.

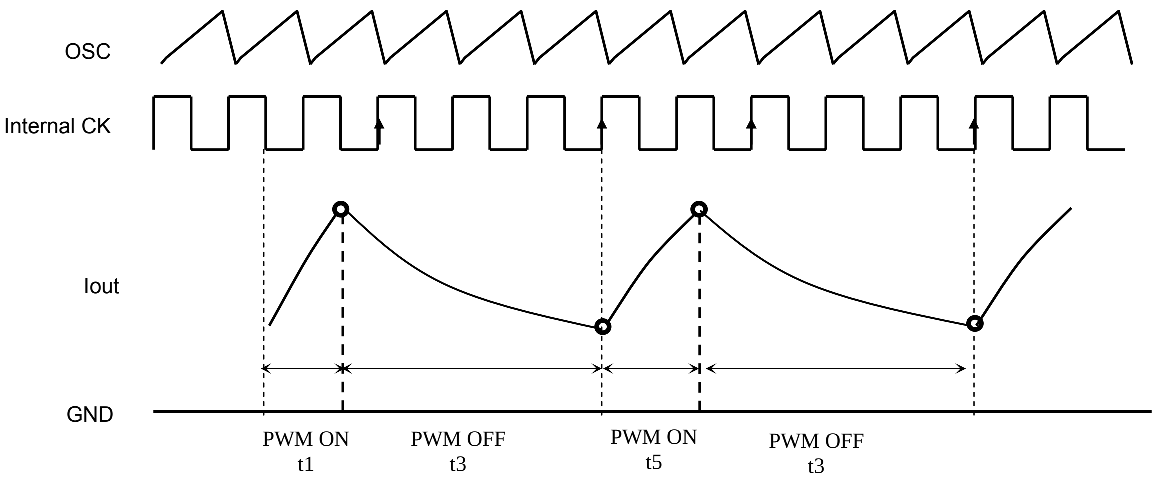
4. PWM operation at the constant current

It sets the current toward the motor coil with PWM control.
The IC enters CW (CCW) mode and short brake mode alternately in PWM current control.
To prevent shoot-through current caused by simultaneous conduction of upper and lower transistors in the output stage, a dead time is internally generated for 500 ns (target spec) when switching the upper and lower transistors.

Therefore, synchronous rectification for high efficiency in PWM current control can be achieved without an off-time that is generated via an external input.

Even when toggling between CW and CCW modes, and CW (CCW) and short brake modes, the off-time is not required due to the internally generated dead time.





PWM OFF (t3) is determined by the clock frequency generated from the OSC terminal inside the IC. PWM turns off after the Iout reaches the set value. PWM turns on when the 4^{th} internal clock rises. It is the fixed off time type.
Set the external condenser (off time) to make the PWM frequency to maintain above the hearing frequency (15 kHz or more). Because ON time is changeable depending on the load condition (L, R constant) and setting current.
Internal oscillation frequency is determined by charging and discharging an external capacitor (Cosc).

$$f_{osc} = 1 / (0.523 \times (Cosc \times 3700 + Cosc \times 600)$$

Take care there is a possibility that the motor current becomes unstable when the off time is too short to decrease the current ineffectively in motor’s fast rotation.

5. How to set motor current

The motor current is set by Vref voltage, current detective resistor (Rs), X1 input, and X2 input.

(1) X1 = X2 = L I_O (peak) = Vref × 1/10 × 1/RS[A]

(2) X1 =L, X2 = H I_O (peak) = Vref × 1/15 × 1/RS[A]

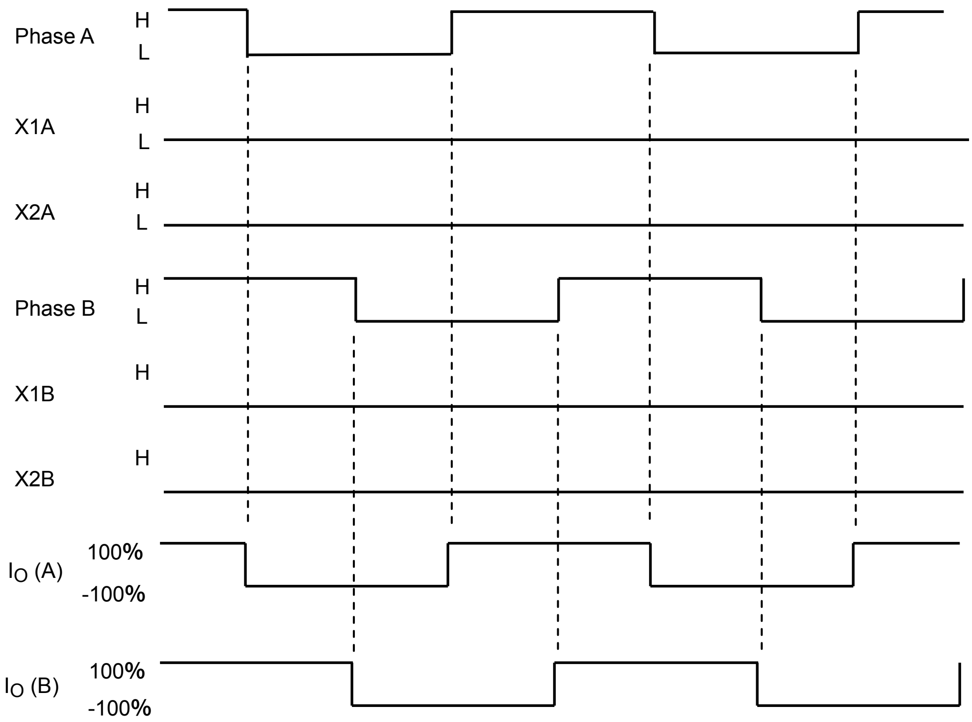
(3) X1 =H, X2 = L I_O (peak) = Vref × 1/30 × 1/RS[A]

(4) X1 = X2 = H I_O (peak) = 0[A] ：Output OFF

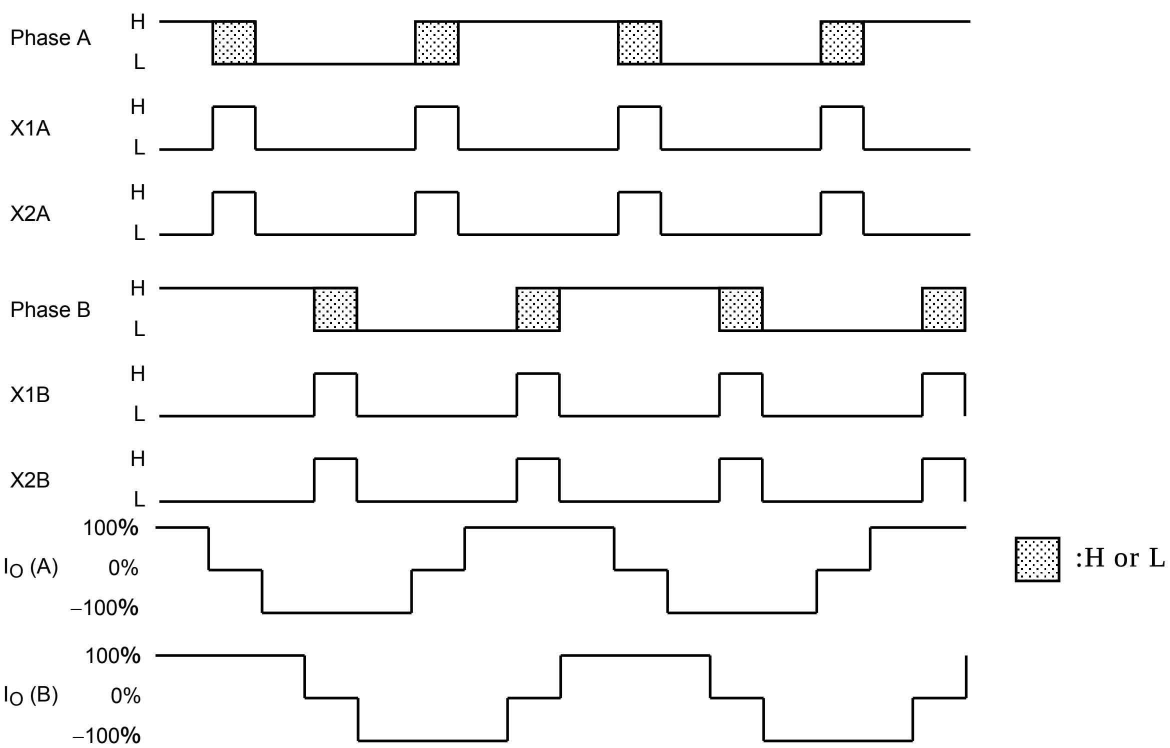
6. Excitation mode

The example of input timing chart of each excitation mode is shown below.

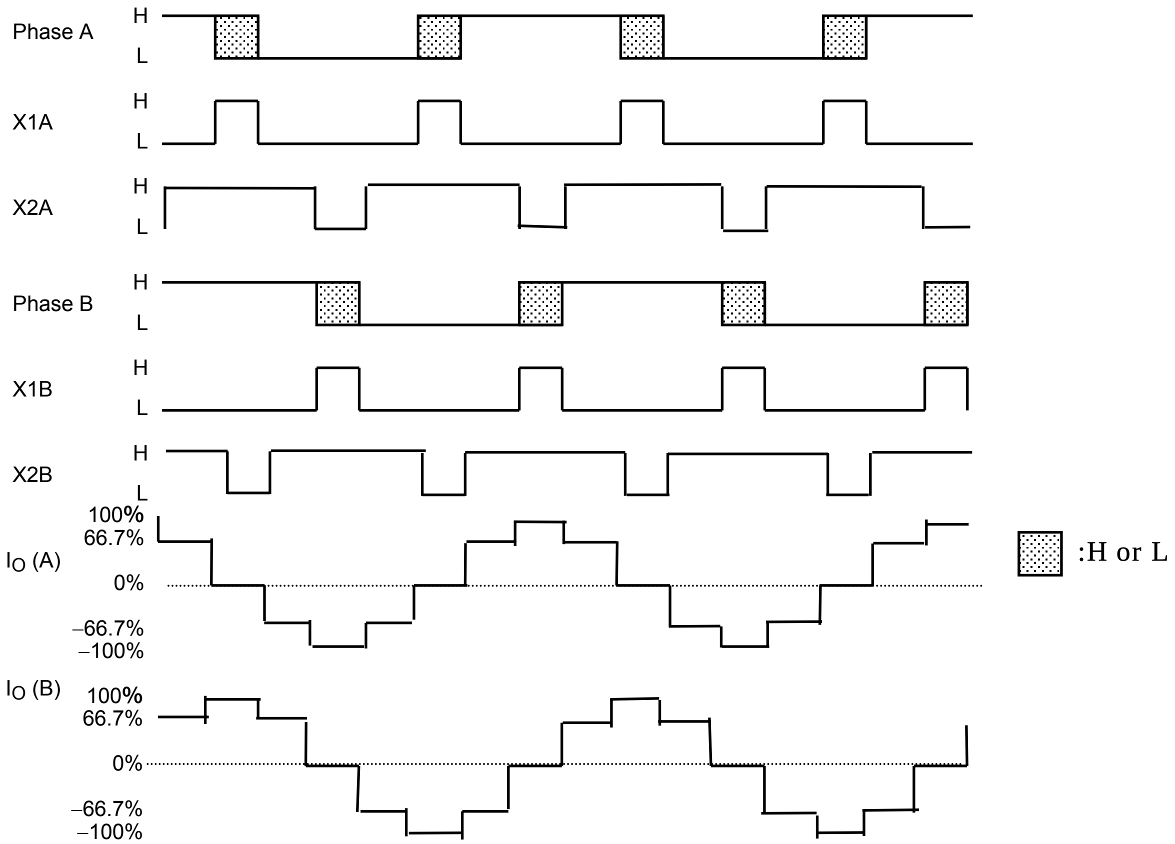
(1) 2-phase excitation



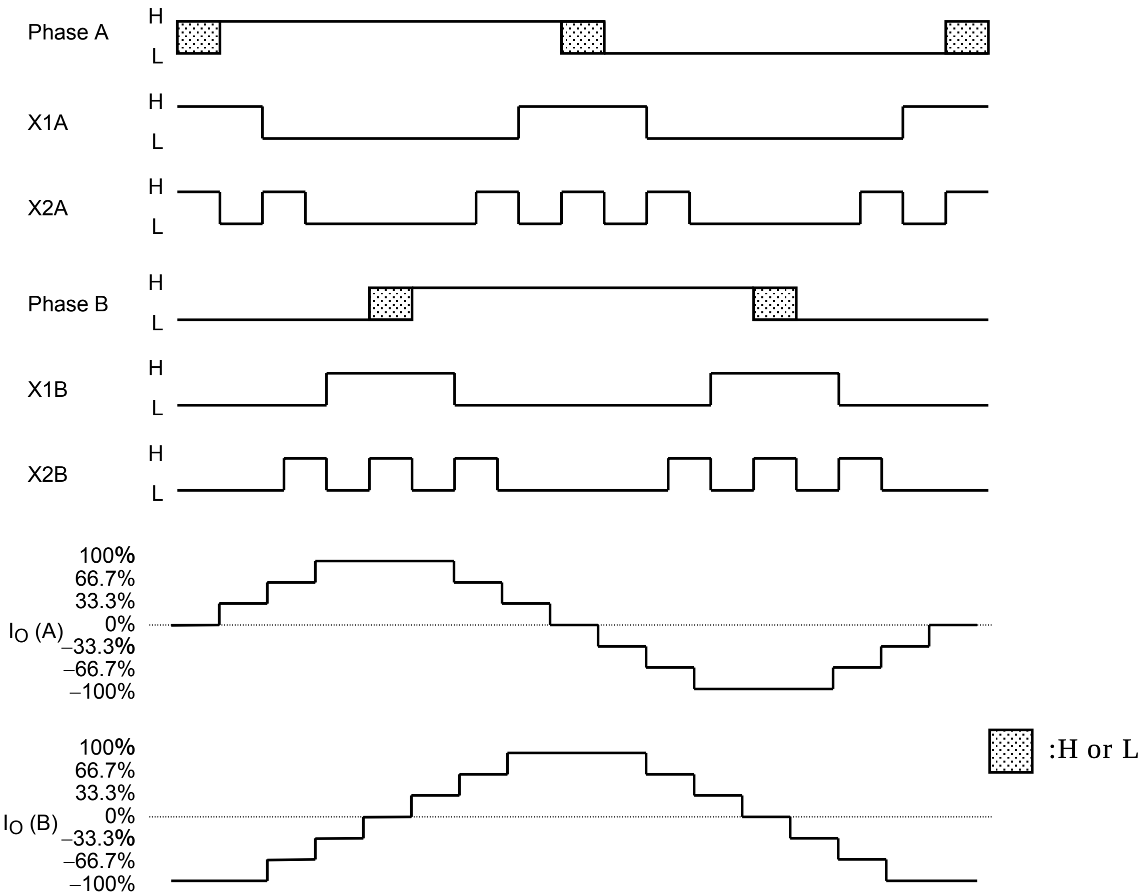
(2) 1-2-phase excitation



(3) 1-2-phase excitation（Torque ripple improvement）

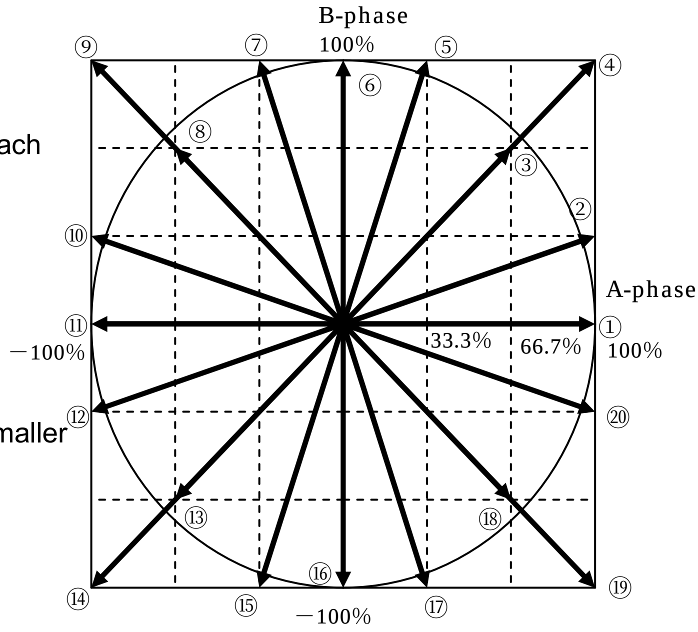


(4) W1-2phase excitation



6. Combined vector

Combined vectors of A-phase and B-phase current in stepping transition are shown in the figure on the right. The inclination of each arrow corresponds to stepping angle (One step equals to 90 degrees.). The length of each arrow corresponds to torque.



(1)2-phase excitation

④→ ⑨→ ⑭→ ⑲

(2) 1-2-phase excitation

①→ ④→ ⑥→ ⑨→ ⑪→ ⑭→ ⑯→ ⑲

In comparing to 2-phase excitation, the torque is smaller (1/√2). But the stepping angle is half.

(3)1-2-phase excitation (torque improvement)

①→ ③→ ⑥→ ⑧→ ⑪→ ⑬→ ⑯→ ⑱

In comparing to the case (2), it can improve the torque ripple by decreasing the torque with conducting 2-phase at the same timing.

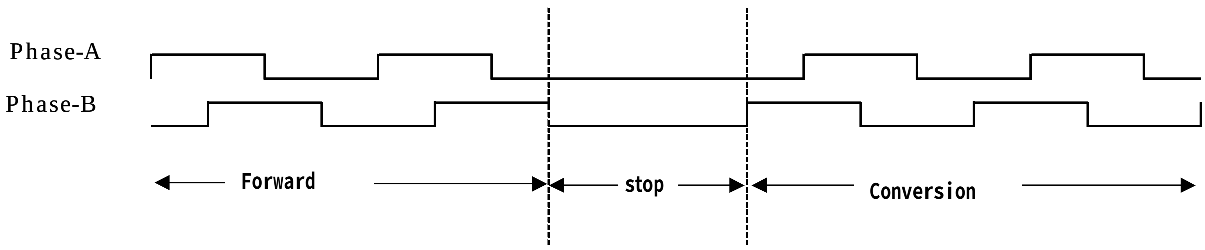
(4)W1-2-phase excitation

①→ ②→ ③→ ⑤→ ⑥→ ⑦→ ⑧→ ⑩→ ⑪→ ⑫ → ⑬→ ⑮→ ⑯→ ⑰→ ⑱→ ⑳

It can reduce the motor vibration by making the stepping angle half of 1-2-phase excitation.

7. Converting method

The example at the 2-phase excitation operation is shown below.



X1A=X2A=X1B=X2B=L

(1) You can select any stopping timing

Motor does not move unless the input condition does not change.

The input signals at conversion are easily understood by regarding the forward input patterns as converting timing.

8. Protect circuit

This IC has features written below. However, it does not mean they protect the IC under any circumstances. Make sure to use it within the rating.

(1)Over current detecting circuit

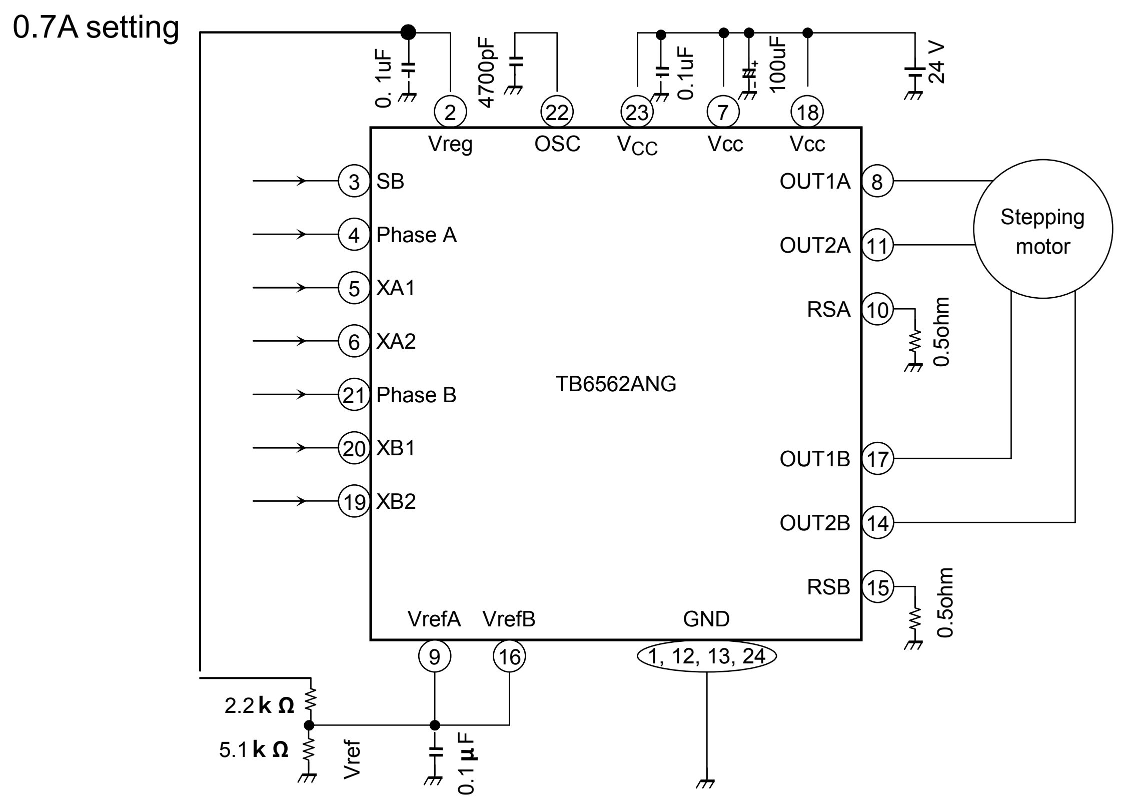
It detects the current towards 8 output transistors. It turns off all the outputs when one of the current flows beyond the setting value (2.5Atyp). After it turns off, the current flows again at 50us (typ).
The range of over current detecting value is from 1.5 A to 3.5 A.

(2)Thermal shut down circuit

When the junction temperature (T_j) reaches 160°C (typ.), the output transistors are turned off.

It also has thermal hiss (40 degrees (typ)) and operates again when the junction temperature (T_j) decreases and reaches 160°C (typ.).

9. Application circuit



1) Condenser for power supply terminal

・Connect the condenser between Vcc and GND as near the IC as possible.

＜Recommendation＞

Item	Recommendation	Remarks
Vcc－GND	10μF to 100μF	Electric field condenser
	0.1μF to 1μF	Ceramic condenser

・Connect 7, 18, and 23 pins of Vcc terminal each other outside the IC.

2) Condenser for Vreg terminal

Connect the condenser between Vreg and GND as near the IC as possible.

＜Recommendation＞

Item	Recommendation	Remarks
Vreg－GND	0.1μF to 1μF	Ceramic condenser

3) Condenser for Vref terminal

Connect the ceramic condenser for the standard voltage which determines the constant current and for removing the switching noise.

＜Recommendation＞

Item	Recommendation	Remarks
Vref－GND	0.022μF to 0.1μF	Ceramic condenser

4) GND

GND terminal (1pin,12pin,13pin, and 24pin) is connected to the IC leads.

The chip is mounted to these leads and so the effect of depressing the heat becomes larger by taking the GND pattern bigger. When the current level is high, strengthen the GND pattern.

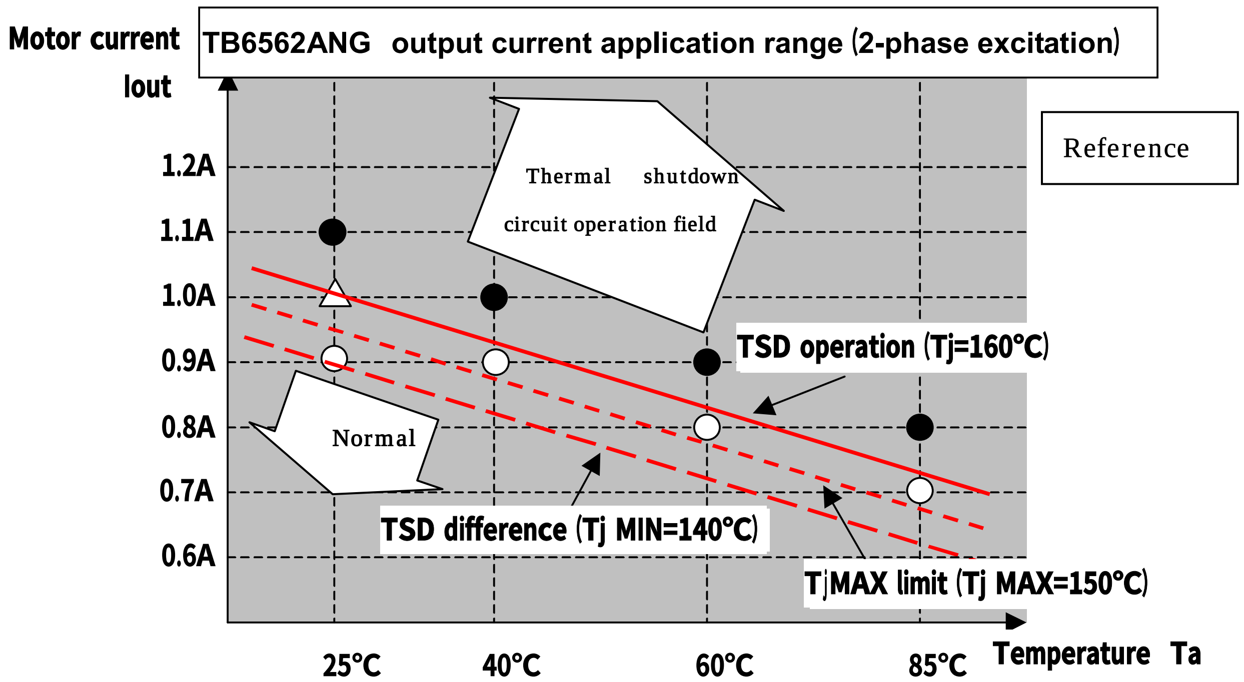
10. Maximum output current

The thermal shutdown circuit operates easily and the motor current does not flow when the excitation mode conducts continually at 2-phase excitation and the circumstance temperature increases.

We applied it to your test board and confirmed the maximum output current. This confirmation is done with 2-phase excitation continuous conducting. See the graph shown below as your reference. （TB6562ANG data）

The maximum output current of the 1-2-phase and W-1-2-phase excitations are higher than that of the 2-phase excitation because the average current and heat decrease.

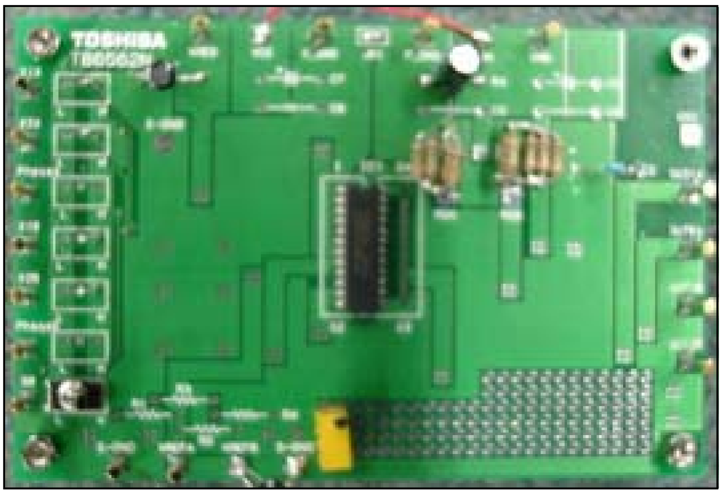
It is possible to increase the current by strengthening GND pattern and improving the effect of depressing heat.



Conditions：Vcc=24V, X1=X2=LOW (2-phase excitation) , RS=0.25Ω, PHASE input frequency=100Hz

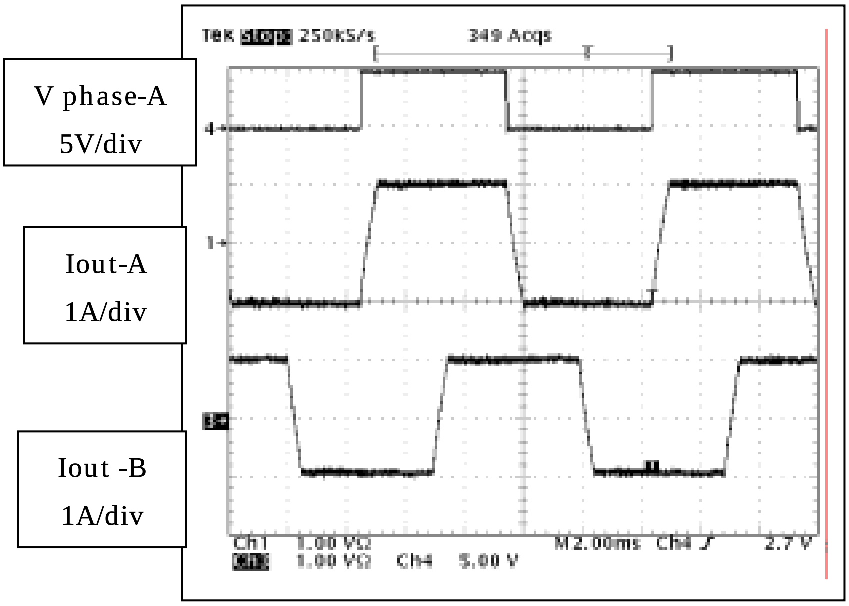
Applying to Toshiba test board (80mm×120mm in both side)

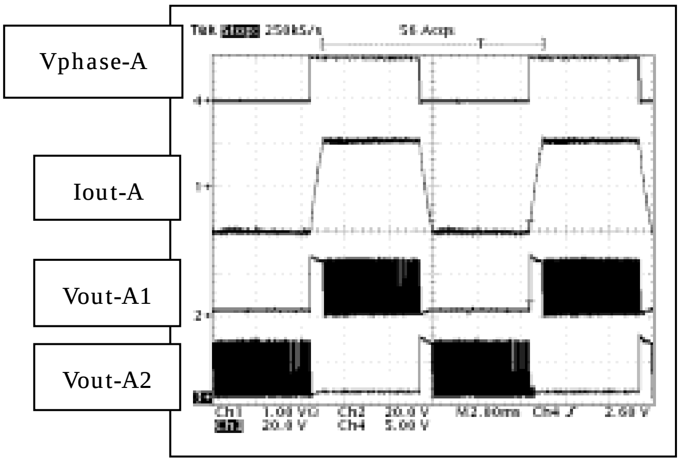
<Toshiba test board>

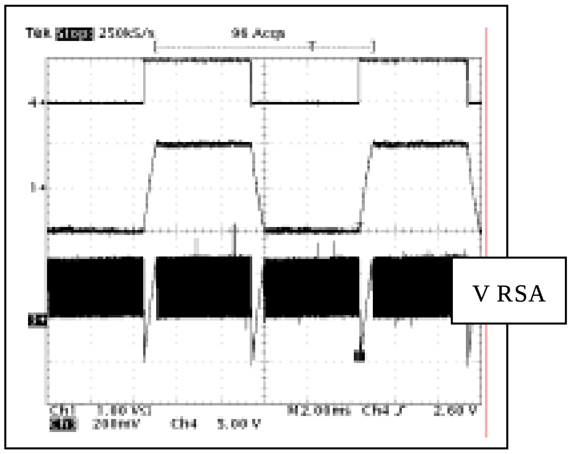


11. Example of driving wave（2-phase excitation, 1A/phase）

（Driving wave）







（Conditions）

Vcc＝24V、Vref=3.14V（Adjusting Iout=1.0A）, RS＝0.25Ω, Cosc＝4700ｐF, L=10mH+5Ω

ｆphase＝100Hz, X1=X2=Low（2-phase excitation）, Ta＝27℃