TB6562ANG/AFG Usage Considerations

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

1. Power Supply Voltage

(1) Operating Range of Power Supply Voltage

Characteristic	Symbol	Operating Power Supply Voltage	Unit
Power supply voltage	V_{CC}	10 to 34	V

Even though the absolute maximum rating of the TB6562ANG/AFG power supply voltage is 40 V, the operating voltage must be 34 V or less.

(2) Power-On and Shutdown Sequences

In order to avoid glitches upon power-on, SB must be pulled low (Standby mode); or XA1, XA2, XB1, and XB2 must be pulled high (current setting = 0%).

Likewise, upon shutdown, SB must be pulled low (Standby mode); or XA1, XA2, XB1, and XB2 must be pulled high (current setting = 0 %).

2. Output Current

The rated output current is1.5 A (max). It must not be exceeded, even for an instant.
Average power dissipation is limited depending on the total power dissipation.
Ensure that the TB6562ANG/AFG is used within the range of the rated power dissipation.

3. Control Inputs

(1) Phase Signal Input

Current directions through coils are changed by the Phase pins of each bridge output.

When the stepping motor runs in 2-phase excitation mode, motor rotation count, or motor speed, depends on frequencies switched along with the phase signal input change.

3-V input signal control is allowed where V_{IN} (H) = 2 V and V_{IN} (L) = 0.8 V.

The phase signal input has a pull-down resistor of 100 kΩ (typ.).

(2) Standby Input

By driving the SB pin low, the TB6562ANG/AFG enters Standby mode, which makes all the output transistors turned off. At the same time, all the OUT pins become high-impedance.

In Standby mode, the phase input and X1/X2 inputs are disabled.

3-V input signal control is allowed where V_{IN} (H) = 2 V and V_{IN} (L) = 0.8 V.

The SB pin has a pull-down resistor of 100 kΩ (typ.). The TB6562ANG/AFG enters Standby mode when this pin is left open upon input.

(3) X1/X2 Input

The X1/X2 input serves to switch the output current values. This input allows digital switching of current values, which enables the TB6562ANG/AFG to run in W1-2 phase excitation mode as well as in 2-phase excitation or 1-2 phase excitation mode.

3-V input signal control is allowed where V_{IN} (H) = 2 V and V_{IN} (L) = 0.8 V.

The X1/X2 input has a pull-down resistor of 100 kΩ (typ.). Care must be taken when it is left open since the current setting becomes 100% upon input.

(4) V_{ref} Input

The Vref input is external reference voltage input for setting output current. The V_{ref} voltage must be fall within the range from 0.5 V to 7.0 V.

The Vref input can be controlled by dividing resistance for the 5-V constant voltage (V_{reg}) of the TB6562ANG/AFG.

To reduce noises upon switching, a capacitor of 0.1 μF must be connected to the input.

In this regard however, a linearity of V_{ref} and output cannot be achieved when V_{CC} is about 13 V since it makes V_{ref} to be 7 V, and as a result, the output is saturated.

(5) V_{reg} Input

5-V power voltage is produced from the V_{CC} power supply, which is sent out on the V_{reg} pin.

The V_{reg} input has a power current of 1 mA which can be shared between the V_{ref} input by dividing the resistance for the V_{reg}.

The 5-V power voltage is also used for the logic power in the TB6562ANG/AFG. To stabilize the power voltage, a ceramic capacitor should be connected to the V_{reg} input.

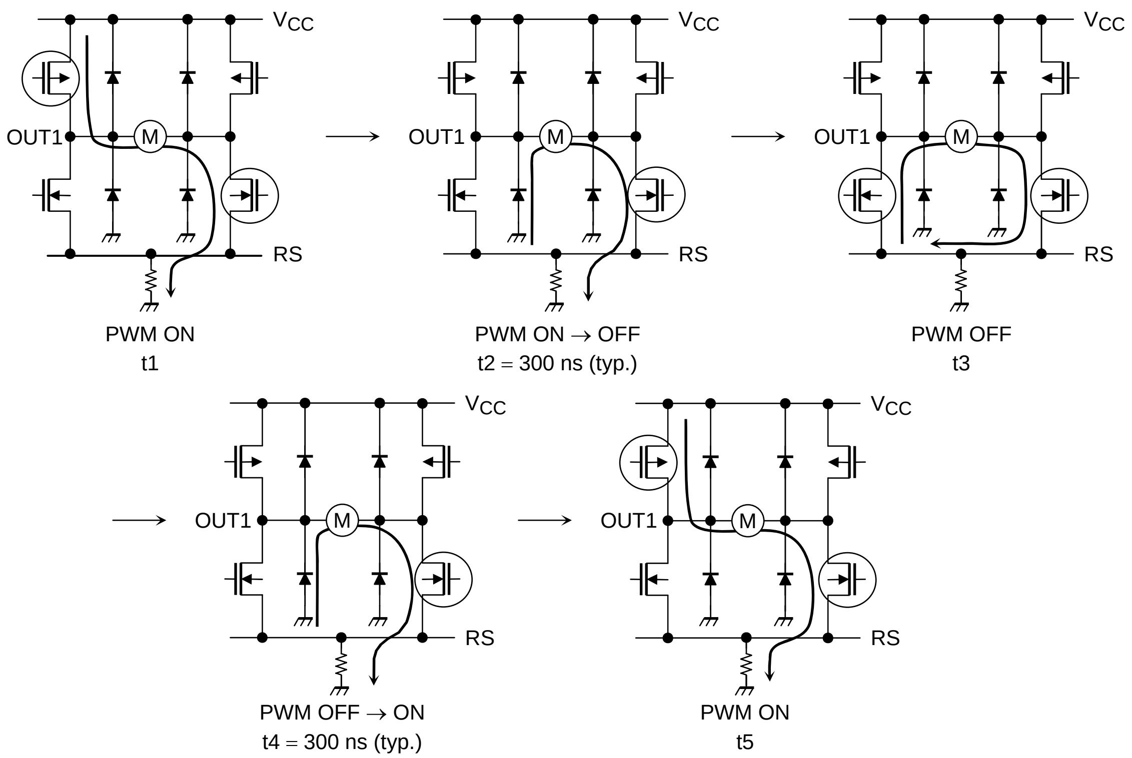
4. PWM Constant Current Control

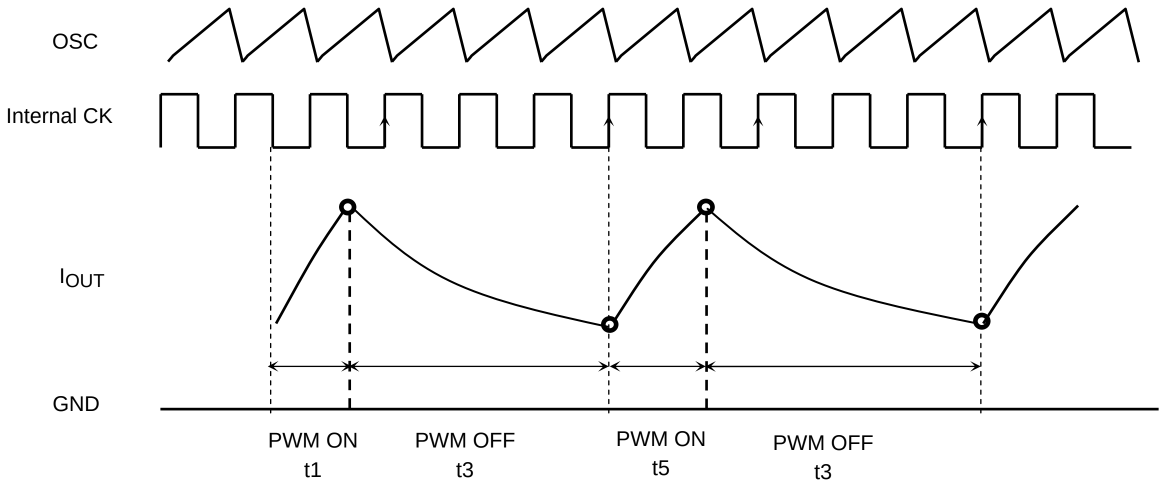
Current through the motor coils is selected by PWM control.

The TB6562ANG/AFG enters CW (CCW) mode and short brake mode alternately during 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 300 ns (design target) when the upper and lower transistors are being switched.

Therefore synchronous rectification for high efficiency in PWM current control can be achieved without an off-time generated via an external input. Even for toggling between CW and CCW modes, and CW (CCW) and short brake modes, no off-time is required due to the internally generated dead time.





The PWM OFF (t3) is determined accordingly to clock frequency generated internally by the OSC pin oscillation.

After Iout reaches a predetermined value, PWM is turned off. The PWM is turned on at the fourth rising edge of the internal clock; the off time is fixed.

The PWM ON time depends on load conditions (motor rotation L/R constant) and predetermined current values. Therefore, the off time (i.e. external capacitor value) should be selected so as to make the PWM frequency be more than 15 kHz which cannot be heard by human ears.

The internal oscillation frequency is approximated by the formula below:

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

Care must be taken for selecting the off time because if the off time is too small, a current drawing becomes not enough when the motor rotates in high speed, which results in unstable motor current.

5. Motor Current Control

Motor current is controlled by V_{ref}, current detect resistor Rs, and X1/X2 inputs.

(1) X1 = X2 = L $I_{O\ (peak)} = V_{ref} \times 1/10 \times 1/RS$[A]

(2) X1 =L, X2 = H $I_{O\ (peak)} = V_{ref} \times 1/15 \times 1/RS$[A]

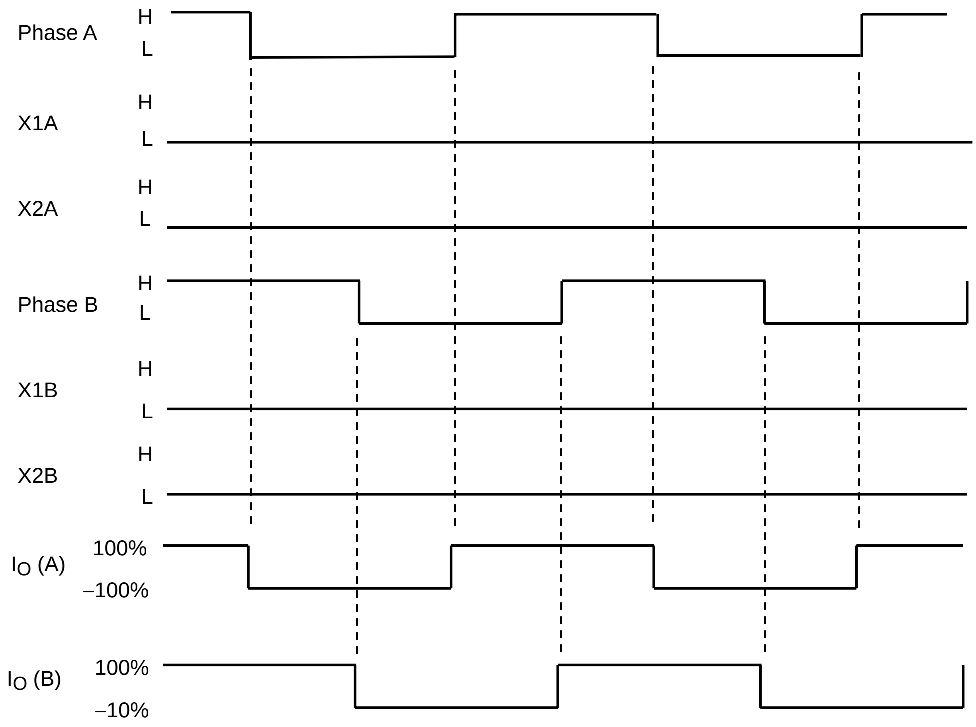
(3) X1 =H, X2 = L $I_{O\ (peak)} = V_{ref} \times 1/30 \times 1/RS$[A]

(4) X1 = X2 = H $I_{O\ (peak)}$ = 0[A]: Output off (out pins become high impedance.)

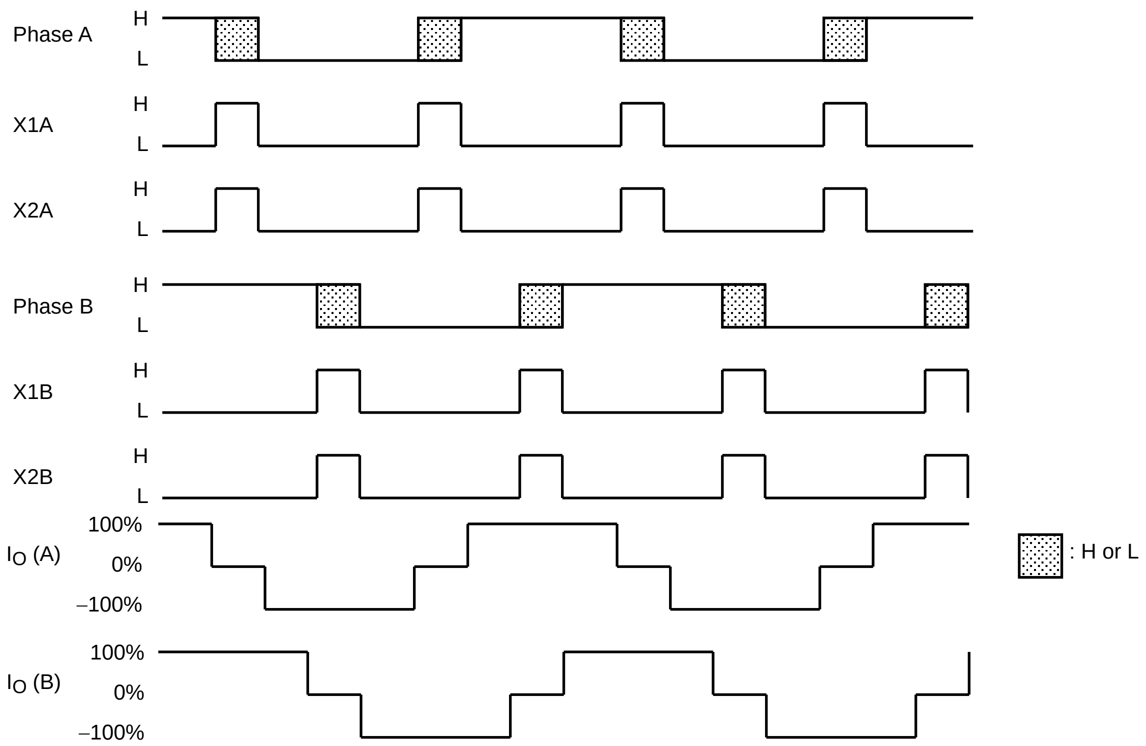
6. Excitation Modes

Input timing chart examples for each excitation mode are shown below.

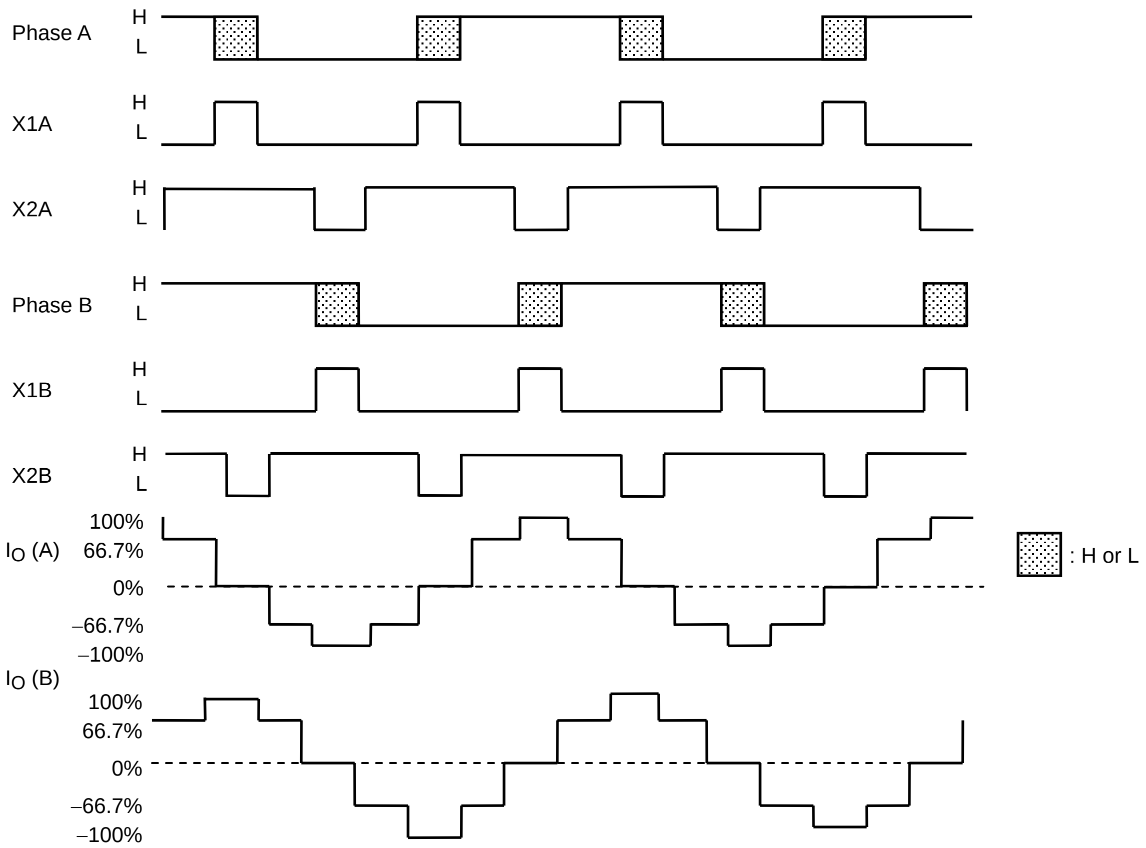
(1) 2-Phase Excitation



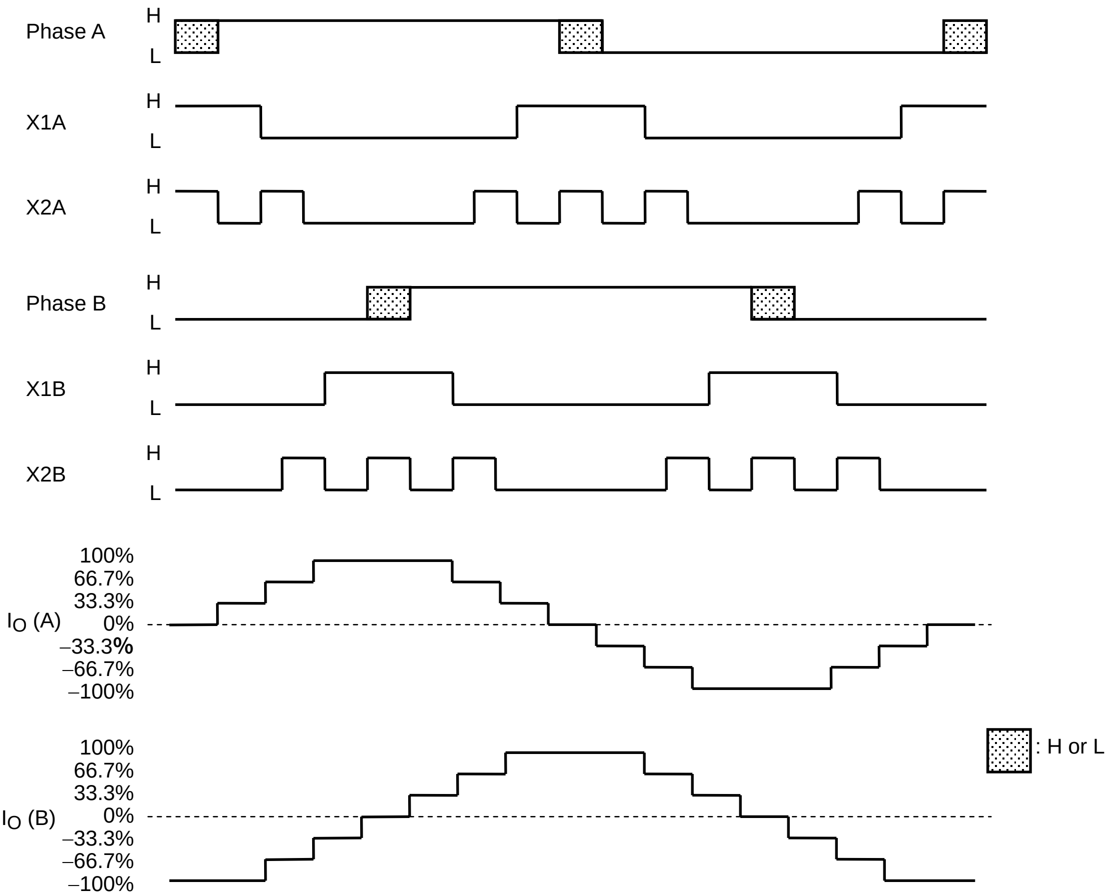
(2) 1-2 Phase Excitation



(3) 1-2 Phase Excitation (Torque ripples are reduced)



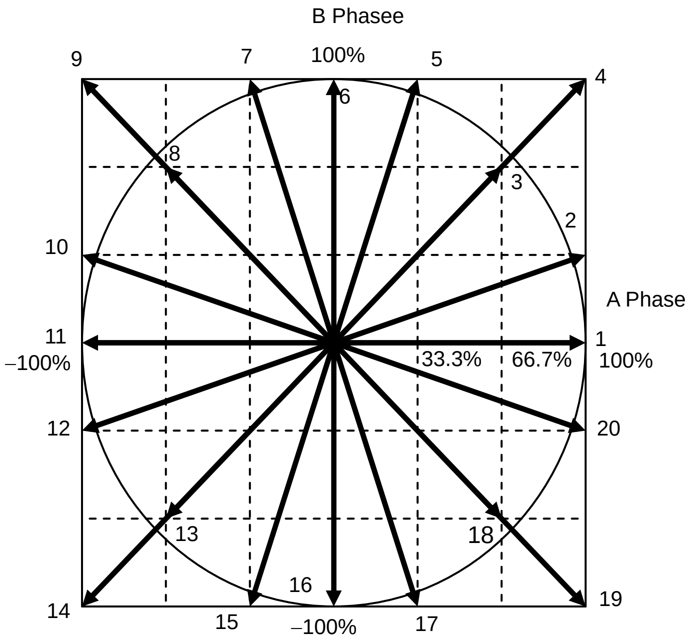
(4) W1-2 Phase Excitation



7. Composite Vector Chart

The figure to the right shows vectors of A phase and B phase current changes in stepping mode.

Slant of arrows indicates a step angle (with normalization of 1 step = 90°C), and the length of the arrows indicate torques.



(1) 2-Phase Excitation

4 → 9 → 14 → 19

(2) 1-2 Phase Excitation

1 → 4 → 6 → 9 → 11 → 14 → 16 → 19

Torque is reduced ($1/\sqrt{2}$), compared to 2-phase excitation, but the step angle becomes half the step angles of 2-phase excitation.

(3) 1-2 Phase Excitation (torque is reduced)

1 → 3 → 6 → 8 → 11 → 13 → 16 → 18

Compared to (2), torque is suppressed at each time of simultaneous commutation of two phases, which reduces the torque ripples.

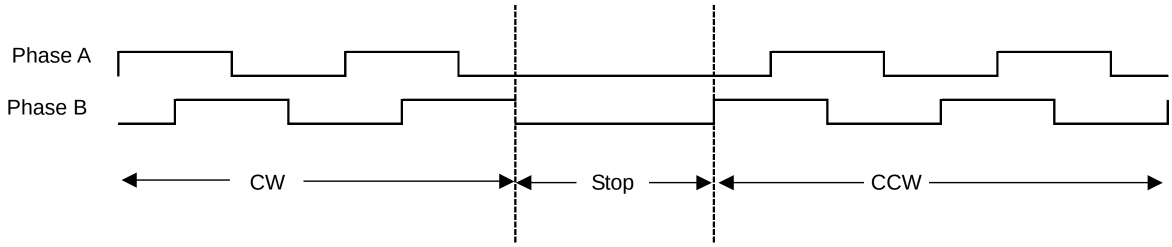
(4) W1-2 Phase Excitation

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

Step angles of half the step angles of the 1-2 phase excitation are achieved, which allows the further suppression of motor vibration.

8. CCW Drive Method

An example of motor drive in 2-phase excitation mode is shown below.



X1A = X2A = X1B = X2B = L

- Stop period may be inserted anywhere.

  The motor will not rotate unless the input state is changed.

  It may be easy-to-understand if you think that input signals for CCW rotation are sent symmetrically reversed relative to the CW input.

9. Detection Circuitry

The TB6562ANG/AFG incorporates the following protection circuits. However, they do not provide the TB6562ANG/AFG with complete protection. The TB6562ANG/AFG must be used within the rated conditions.

(1) Overcurrent Protection Circuit

Currents flowing through the eight output transistors are monitored individually. If overcurrent (more than 2.5 A typical) is detected in at least one of the transistors, all transistors are turned off. After the 50 μs (typ.), the transistors are turned on automatically.

Overcurrent detection values vary in a range from approximately 1.5 A to 3.5 A.

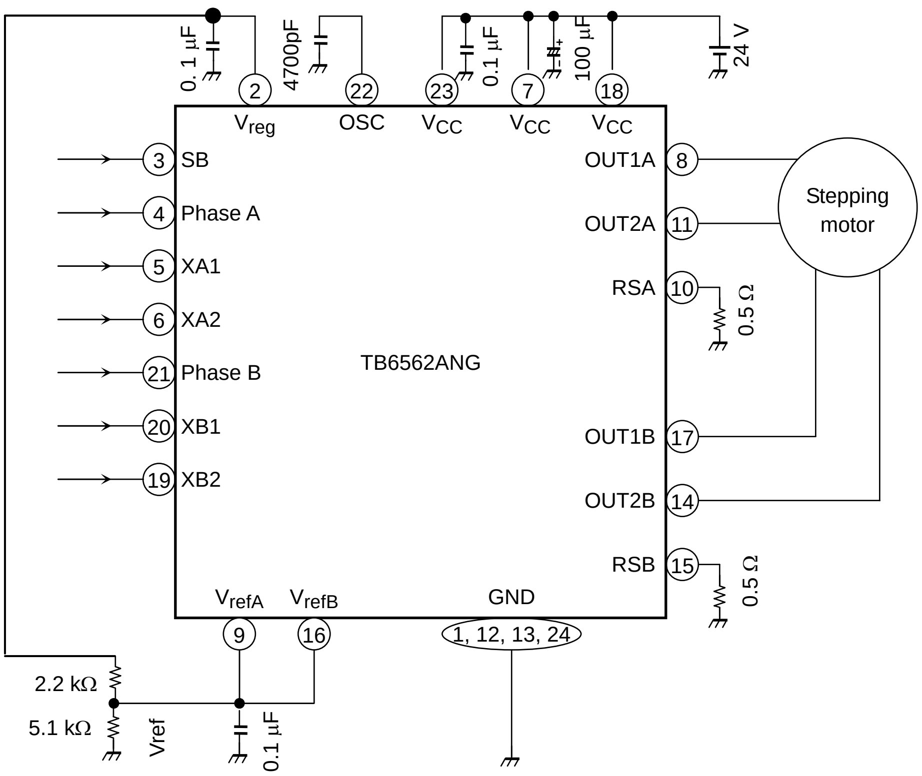
(2) Thermal Shutdown Circuit

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

The TB6562ANG/AFG has 40°C temperature hysteresis. If the junction temperature falls under 120°C, the TB6562ANG/AFG is automatically turned on.

10. Application Circuit Example

0.7 A Configuration Example



(1) Capacitors for Power Supply Pins

Capacitors between the V_{CC} and GND must be connected as close to the IC as possible.

Recommended Values

Characteristic	Recommended Values	Remarks
V_{CC} − GND	10 μF to 100 μF	Electrolytic capacitor
	0.1 μF to 1 μF	Ceramic capacitor

V_{CC} pins (7 Pin, 18 Pin, 23 Pin) must be shorted externally.

(2) Capacitor for V_{reg} Pin

A capacitor between V_{reg} and GND should be connected as close to the IC as possible.

Recommended Values

Characteristic	Recommended Values	Remarks
V_{reg} − GND	0.1 μF to 1 μF	Ceramic capacitor

(3) Capacitors for V_{ref} Pins

Ceramic capacitors must be used for Vref pins since the Vref is a reference voltage to determine constant current values and it is important to reduce switching noises.

Recommended Values

Characteristic	Recommended Values	Remarks
V_{ref} − GND	0.022 μF to 0.1 μF	Ceramic capacitor

(4) GND

GND pins (1 Pin, 12 Pin, 13 Pin, 24 Pin) are connected to the chip frame (leads of the TB6562ANG/AFG).

The chip is mounted on the leads. GND pattern, therefore, should be wide to achieve heatsink effect. If the current is large, GND pattern must be improved; it must be as wide as possible.

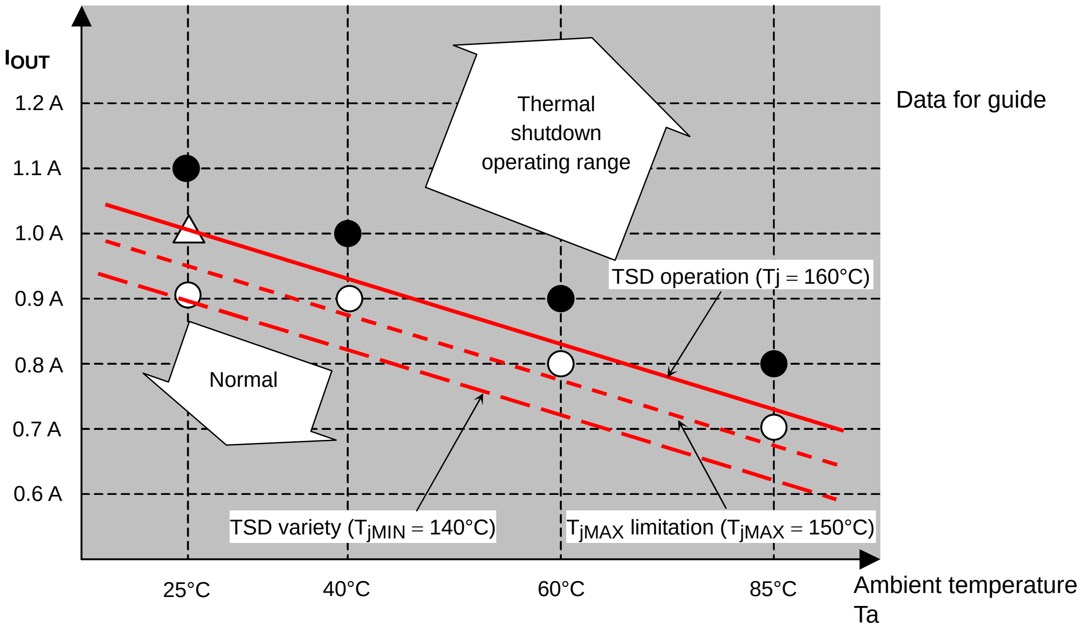
11. Maximum Output Current

When ambient temperature becomes high due to the continuous commutation in 2-phase excitation mode, the thermal shutdown tends to occur, and as a result, current cannot go through the motors.

For a reference, we mounted the IC on a Toshiba evaluation board, checked the maximum output current upon the continuous excitation in 2-phase excitation mode and illustrated the result in the following figure. As for 1-2 phase excitation and W1-2 phase excitation, average current is lowered and therefore the temperature is lowered; the maximum output current becomes larger than that in 2-phase excitation.

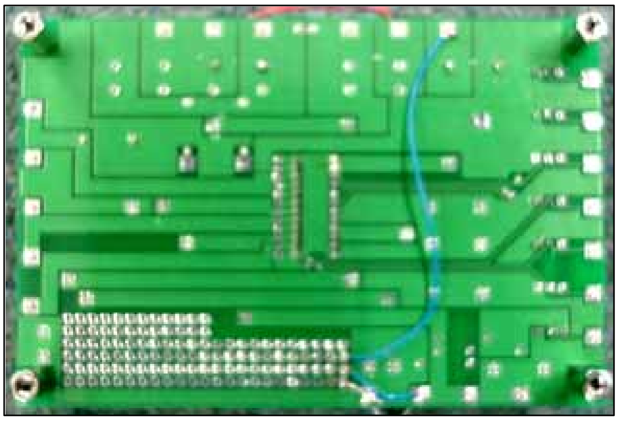
Higher current values can be applied if the heatsink effect is enhanced due to the GND pattern improvement.

TB6562ANG Output Current Range (2-phase excitation)

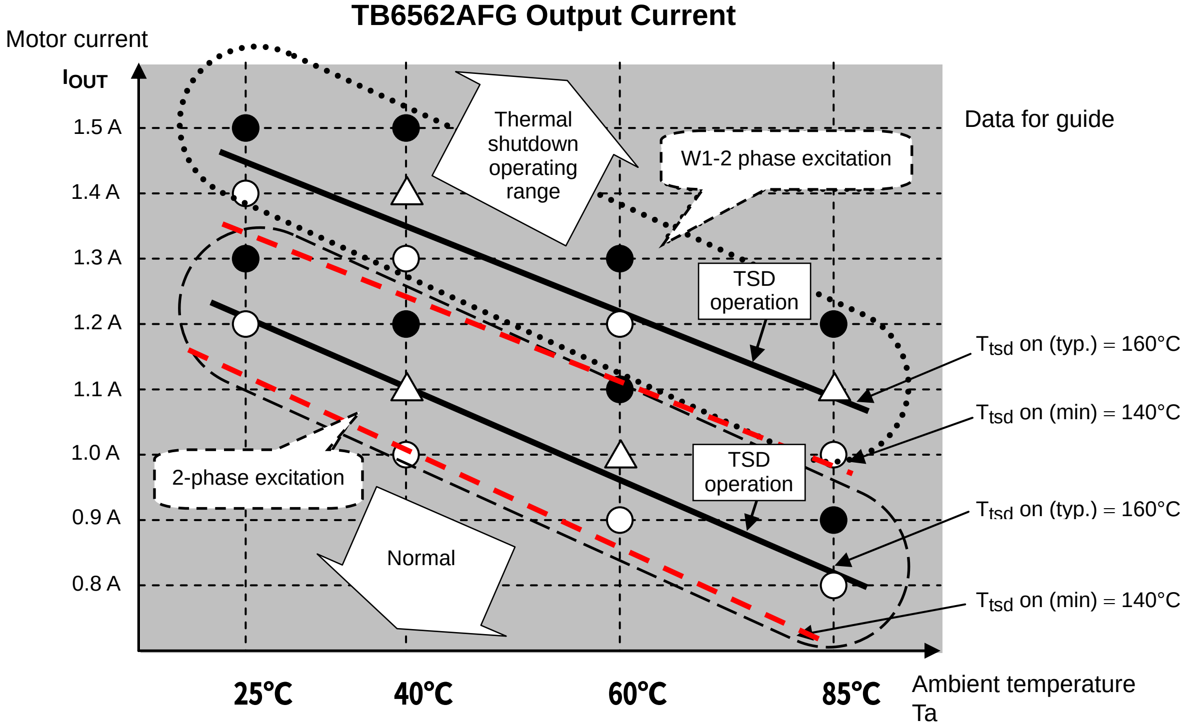


Test conditions: V_{CC} = 24 V, X1 = X2 = Low (2-phase excitation), RS = 0.25 Ω, phase input frequency = 100 Hz, When mounted on a Toshiba two-sided evaluation board (80 mm × 120 mm) and connected to motors.

Toshiba Evaluation Board

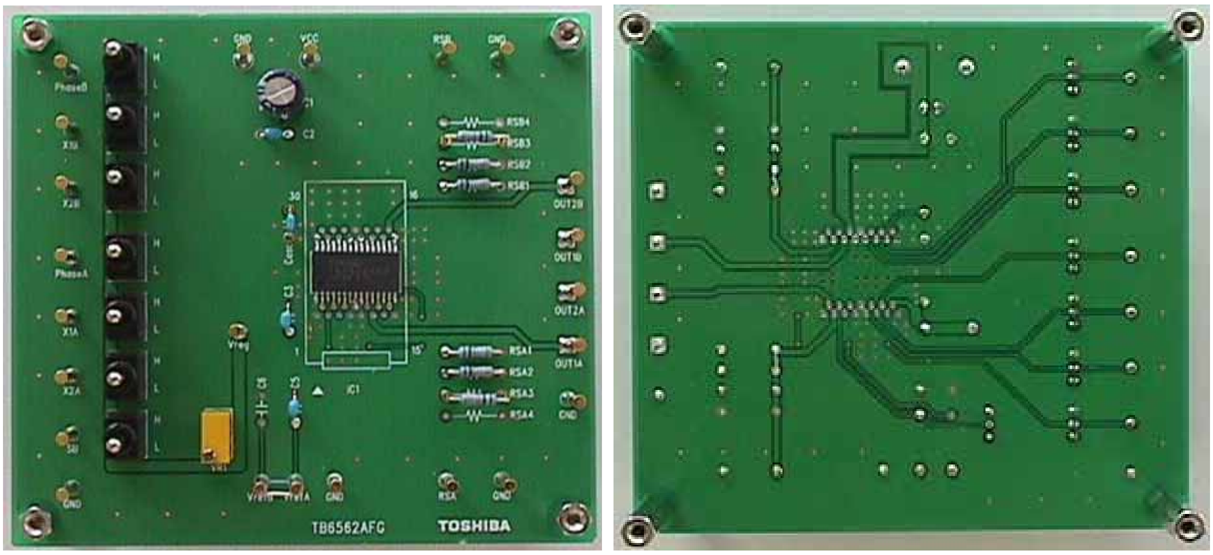


TB6562AFG Output Current



Test conditions: V_{CC} = 24 V, RS = 0.33 Ω, phase input frequency = 100 Hz,
When mounted on a Toshiba evaluation board (105 × 100 mm) and connected to motors.

Toshiba Evaluation Board



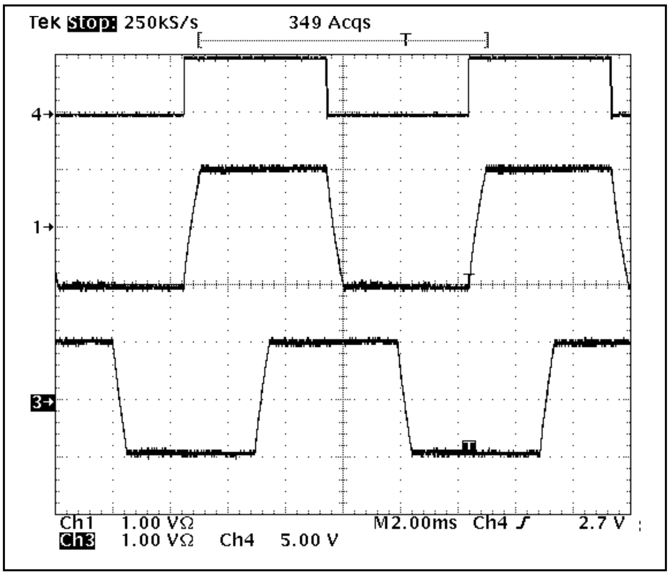
12. Driving Waveform Example (2-Phase Excitation, 1A/phase)

Driving Waveforms

V phase-A
5 V/div

I_{OUT}-A
1A/div

I_{OUT}-B
1A/div

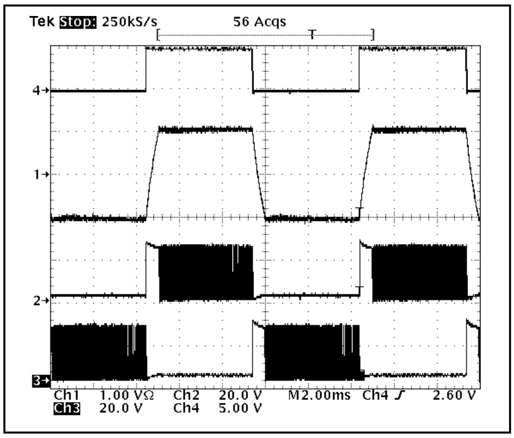


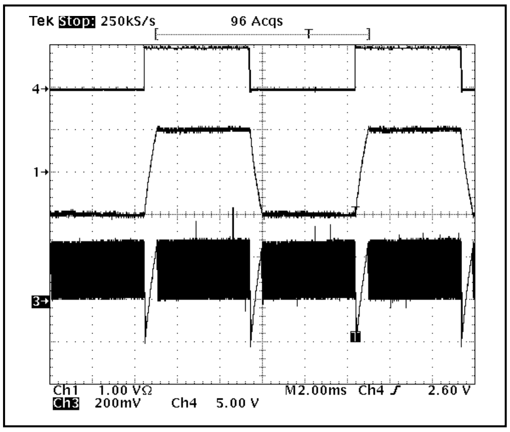
V phase-A

I_{OUT} A

V_{OUT}-A1

V_{OUT}-A2





V RSA

Test Conditions

V_{CC} = 24 V, V_{ref} = 3.14 V (for adjustment of Iout = 1.0 A), RS = 0.25 Ω, Cosc = 4700 pF, L = 10 mH + 5 Ω, fphase = 100 Hz, X1 = X2 = Low (2-phase excitation), Ta = 27°C

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