TC78H600FTG

Usage considerations

Summary

The TC78H600FTG is a dual bridge driver.
It can control two DC brush motors by selecting the direct PWM mode and the constant current PWM mode. It can also control one stepping motor by 2-phase excitation or 1-2 phase excitation mode.

Contents

List of Figure

List of Table

1. Power supply voltage and output current

(1) Operating range of power supply voltage

Table 1 Operating range of power supply voltage and absolute maximum rating

Characteristics	Symbol	Operating voltage range	Absolute maximum rating	Unit
Power supply voltage	V_{CC}	2.7 to 5.5	6	V
Motor power supply voltage	V_M	2.5 to 15	18	V

Note: The absolute maximum ratings of a semiconductor device are a set of ratings that must not be exceeded, even for a moment.
Please use the IC within the specified operating ranges.

(2) Power on/Shutdown sequence

In applying V_{CC} or shutdown, set STBY=L or IN1A=IN2A= IN1B=IN2B=L. If STBY is configured high or any of IN1A, IN2A, IN1B, or IN2B is configured high in applying V_{CC} or shutdown, unexpected current may flow in the output terminals.

(3) Output current

The absolute maximum rating is 1.0 A (peak). The absolute maximum ratings of a semiconductor device are a set of ratings that must not be exceeded, even for a moment.
The average permissible current is restricted by total power dissipation. Please use the IC within the range of the power dissipation.

2. Power dissipation

The relation of the ambient temperature and the power dissipation in each mounting condition is shown below. (The upper limit of the ambient temperature in operation is 85℃)

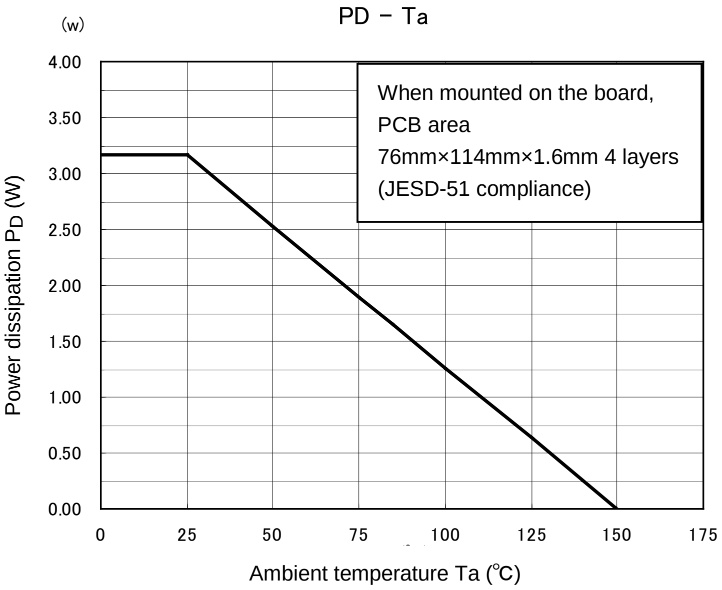


Figure 1 Power dissipation to the ambient temperature

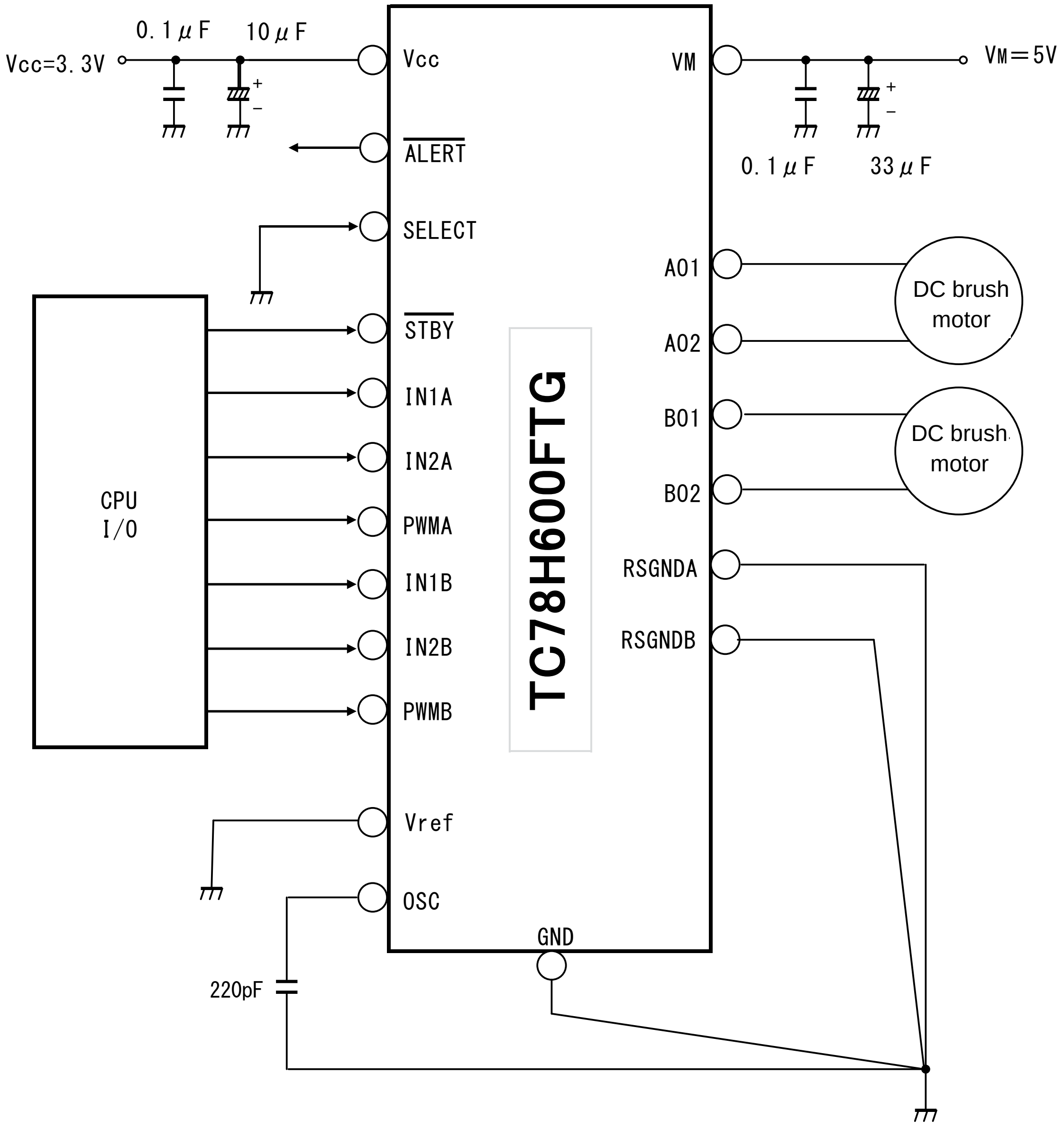
The example of calculation of power consumption is as follows;
When Iout is 0.2A, the output saturated voltage ($V_{SAT\ (U+L)}$) is 0.32V (max).
When V_{CC} is 3.3V, the consumption current (I_{CC2}) is 6mA (max). When V_M is 5V, the consumption current (I_{M2}) is 1mA (max).
Output duty is 100%. Output part is doubled because of double phases.

P_D=(Iout×(duty)×$V_{SAT(U+L)}$)×2+V_{CC}×I_{CC2}+V_M×I_{M2}
=0.2×100%×0.32×2+3.3×0.006+5×0.001
=0.15W

The heat characteristic changes largely depending on the radiation characteristics of the board and the transient property of the mounting condition. So, please check it under the condition of actual operation.

3. Application circuit

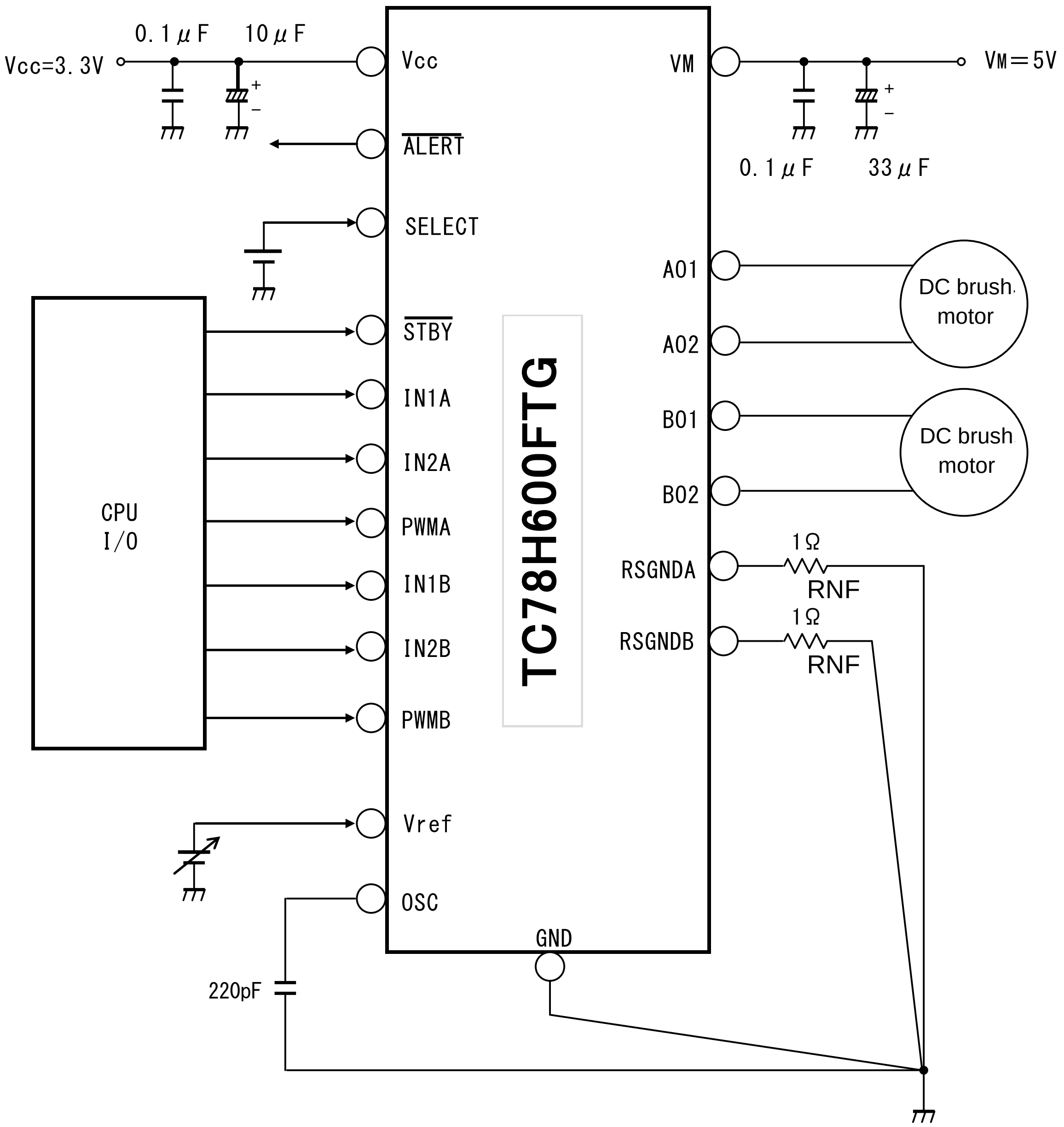
[1] Direct PWM mode: SELECT=L



- Connect RSGNDA, RSGNDB, and Vref to GND.

Figure 2 Application circuit (direct PWM mode)

[2] Constant PWM: ELECT=H



- Connect the current detection resistance (RNF) to RSGNDA and RSGNDB.

Figure 3 Application circuit (constant current PWM mode)

Setting of output current is as follows;

Iout (A) = (1/5×Vref (V))÷RNF (Ω)

Vref should be configured in the range of 0.4V to 3.4V and Vcc − 1.8V or less. If it is configured less than 0.4V, the accuracy of the operation is decreased.
Use the IC by connecting the resistance (RNF) of 0.3Ω or more.

The following (1) to (3) describe [1] Direct PWM mode and [2] Constant current PWM mode in common.

(1) **Capacitor for power supply voltage terminal**
Capacitors between V_{CC} and GND should be connected as close to the IC as possible.

Table 2 Recommended value of the capacitor for Vcc pin

Item	Recommended value	Remarks
Between V_{CC} and GND	10 μF to 100 μF	Electrolytic capacitor
	0.1 μF to 1 μF	Ceramic capacitor

(2) **Capacitor for V_M terminal**
Capacitors between V_M and GND should be connected as close to the IC as possible.

Table 3 Recommended value of the capacitor for VM pin

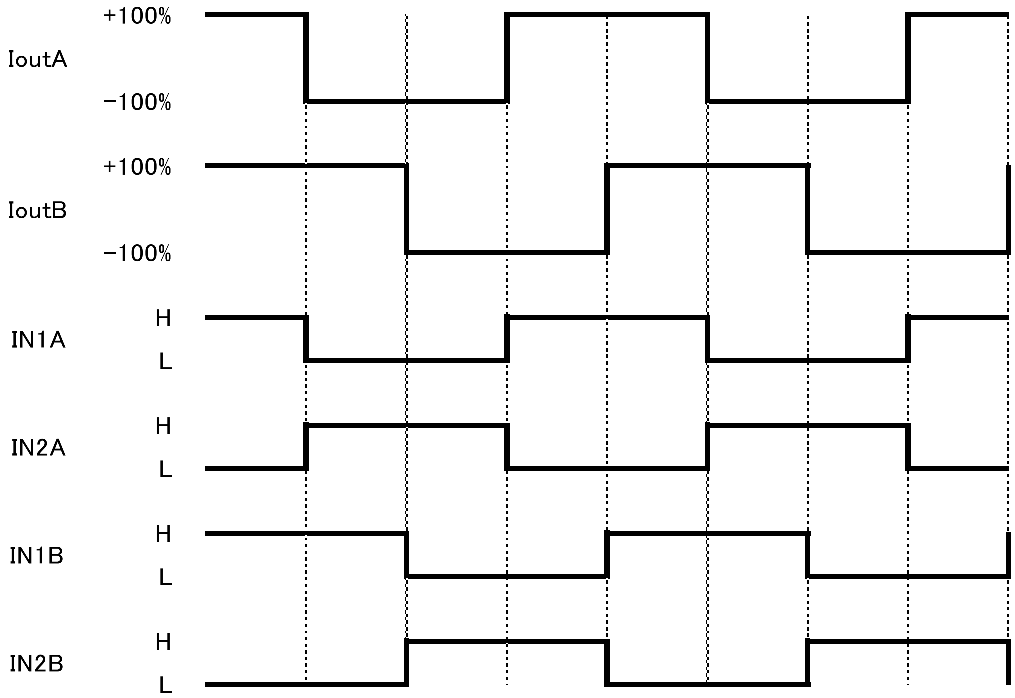
Item	Recommended value	Remarks
Between V_M and GND	10 μF to 100 μF	Electrolytic capacitor
	0.1 μF to 1 μF	Ceramic capacitor

(3) **Capacitor for OSC terminal**
The internal oscillation frequency is determined by the capacitor of OSC terminal.
When C_{OSC} is 220 pF, the oscillation frequency is 320 kHz (typ.).

4. Method of driving 2-phase stepping motor by using the TC78H600FTG

Two-phase stepping motor can be driven as shown in the below input signal waveform.
Iout: The current direction is defined as follows;
AO1→AO2 (or BO1→BO2): Plus current
AO2→AO1 (or BO2→BO1): Minus current *STBY=H, PWMA=PWMB=H

(1) Excitation mode: 2-phase excitation



(2) Excitation mode: 1-2-phase excitation

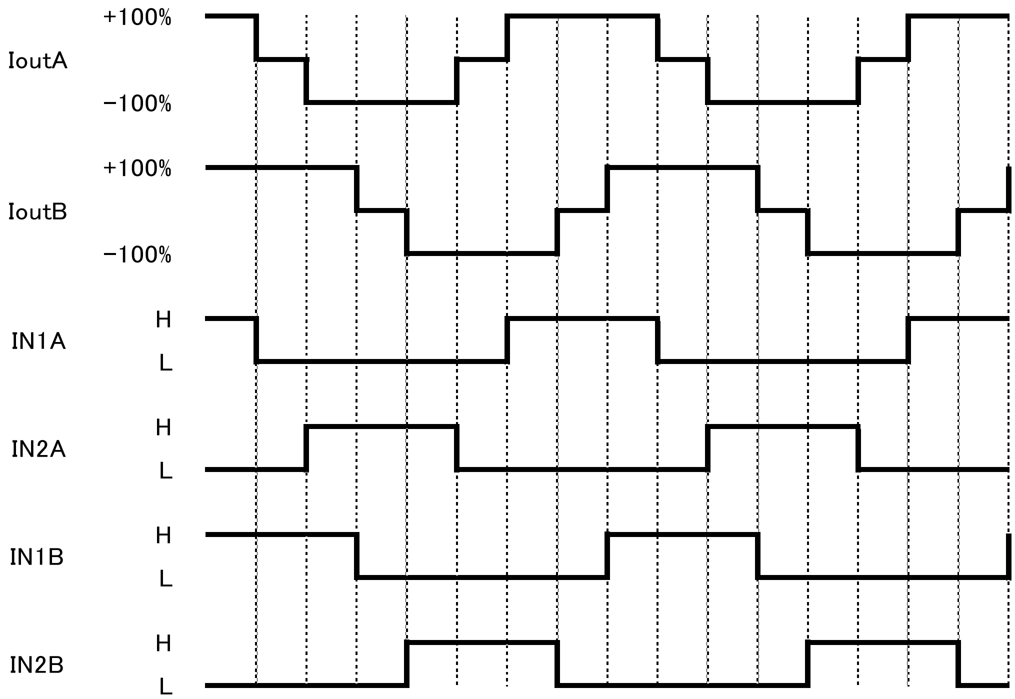


Figure 4 Waveform when the stepping motor is driving

5. Test of short-circuit

Test of short-circuit between outputs, air contamination faults, or faults due to improper grounding

Test conditions: Vcc=5V, VM=12V, Vref=1V, RSGNDA=RSGNDB =1.5Ω, OSC=220pF, STBY=SELECT=IN1A=IN2A=PWMA=IN1B=IN2B=PWMB=H, Motor load (The resistance of 1kΩ is adopted between IN1B terminal and Vcc. between PWMB terminal and Vcc, and between SELECT terminal and Vcc to reduce the IC destruction.)

Test circuit

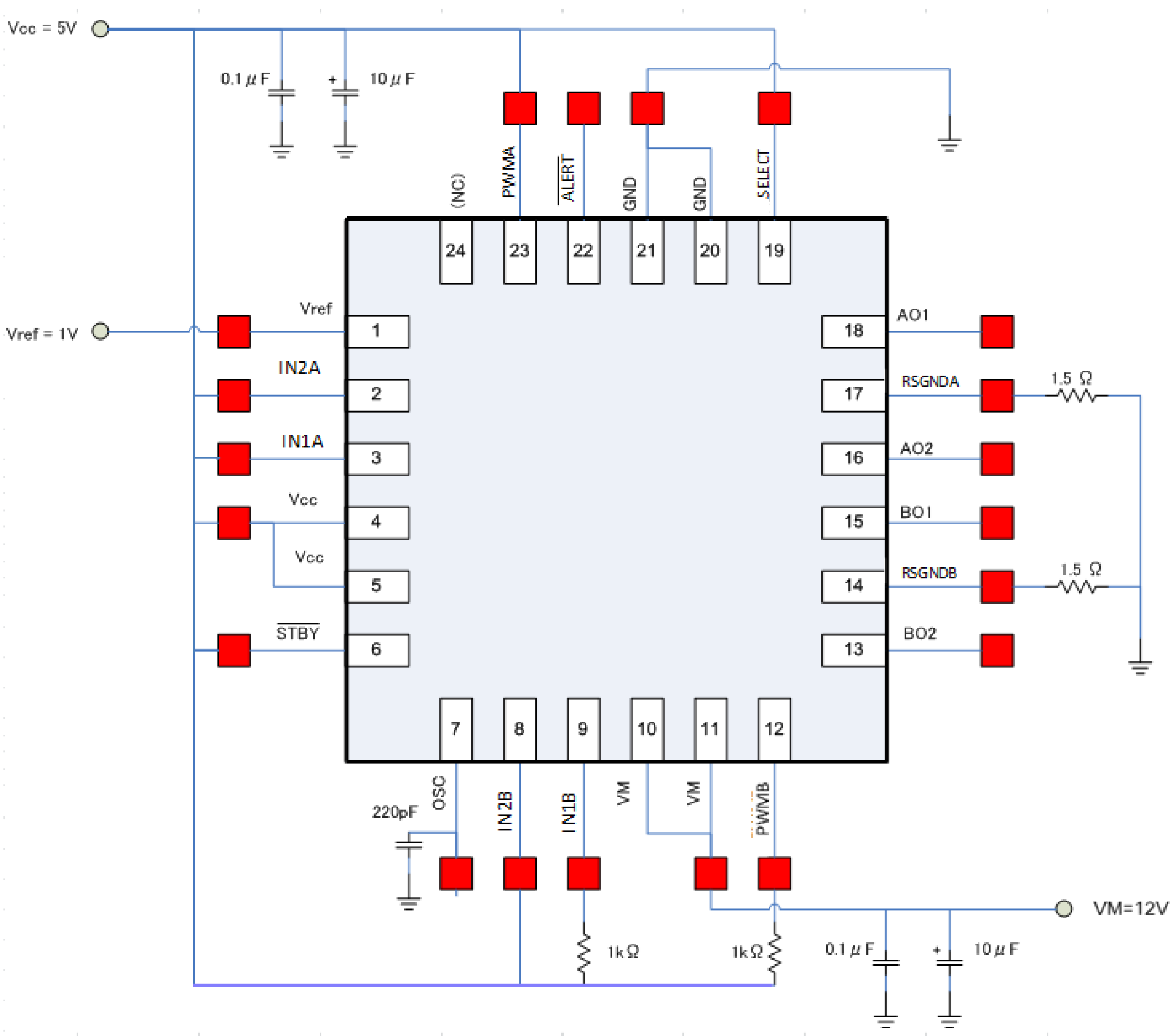


Figure 5 Test circuit of the short-circuit test

(1) Test of short-circuit between adjacent terminals

Table 4 Result of the test of short-circuit between adjacent terminals

(2)

Pin No.	Pin name	Result	Judgment
1	Vref	Normal appearance, no smoke, normal operation after test	Pass
2	IN2A	Normal appearance, no smoke, normal operation after test	Pass
3	IN1A	Normal appearance, no smoke, normal operation after test	Pass
4	VCC		
5	VCC	Normal appearance, no smoke, normal operation after test	Pass
6	STBY_B		
7	OSC	Normal appearance, no smoke, normal operation after test	Pass
8	IN2B	Normal appearance, no smoke, normal operation after test	Pass
9	IN1B	Normal appearance, no smoke. Changing excitation mode by IN1B pin after test is impossible. Pin is destroyed by round over voltage (12V) from the VM pin.	Pass
10	VM		
11	VM	Normal appearance, no smoke. Changing forward and reverse rotation by PWMB pin after test is impossible. Pin is destroyed by round over voltage (12V) from the VM pin.	Pass
12	PWMB		
13	BO2	Normal appearance, no smoke, normal operation after test	Pass
14	RSGNDB	Normal appearance, no smoke, normal operation after test	Pass
15	BO1	Normal appearance, no smoke, normal operation after test	Pass
16	AO2	Normal appearance, no smoke, normal operation after test	Pass
17	RSGNDA	Normal appearance, no smoke, normal operation after test	Pass
18	AO1		
19	SELECT	Normal appearance, no smoke, normal operation after test	Pass
20	GND		
21	GND	Normal appearance, no smoke, normal operation after test	Pass
22	ALERT	Normal appearance, no smoke, normal operation after test	Pass
23	PWMA	---	-
24	(NC)		

(2) Test of short-circuiting between outputs, air contamination faults, or faults due to improper grounding
Test of short-circuiting between outputs, air contamination faults, or faults due to improper grounding. The results of the test are shown below. There is no problem.

Test conditions: VCC=5V, VM=12V, Vref=1V, RSGNDA=RSGNDB=1.5Ω, Cosc=220pF, STBY= SELECT= IN1A=IN2A=PWMA=IN1B=IN2B=PWMB= High (VCC), Motor load

Table 5 Result of the test of short-circuiting between outputs, air contamination faults, or faults due to improper grounding

Terminal	Result	Judgment
AO1 ⇔ AO2	Normal appearance, no smoke, normal operation after test	Pass
AO1 ⇔ VM	Normal appearance, no smoke, normal operation after test	Pass
AO1 ⇔ GND	Normal appearance, no smoke, normal operation after test	Pass
AO2 ⇔ VM	Normal appearance, no smoke, normal operation after test	Pass
AO2 ⇔ GND	Normal appearance, no smoke, normal operation after test	Pass
BO1 ⇔ BO2	Normal appearance, no smoke, normal operation after test	Pass
BO1 ⇔ VM	Normal appearance, no smoke, normal operation after test	Pass
BO1 ⇔ GND	Normal appearance, no smoke, normal operation after test	Pass
BO2 ⇔ VM	Normal appearance, no smoke, normal operation after test	Pass
BO2 ⇔ GND	Normal appearance, no smoke, normal operation after test	Pass

ISD (over current detection) enables.

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 Circuit
   The application circuits shown in this document are provided for reference purposes only.
   Thorough evaluation is required, especially at the mass production design stage.
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5. Test Circuit
   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 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.

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 rotates in the reverse 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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