

TB6551FAG

Usage considerations

Summary

The TB6551FAG is a controller IC for three-phase DC brushless motor drive applications. It can generate sinusoidal current waveforms to drive a motor in either of two directions. To change the direction of the motor, first stop the motor rotation before changing the control signals. The rotational direction should not be changed while the motor is rotating. The TB6551FAG is a product intended to be used for fans.

Contents

Summary	1
1. Power Supply Voltage	3
2. Control Inputs (RES, CW/CCW, Ve, LA, OS, and Td).....	3
3. Oscillation Circuit	3
4. Application Circuit Example (Motor voltage ≤ 18 V).....	4
5. Operating Temperature Range	6
6. Others	7
Notes on Contents	8
IC Usage Considerations	8
Notes on handling of ICs.....	8
Points to remember on handling of ICs.....	8
RESTRICTIONS ON PRODUCT USE	9

1. Power Supply Voltage

Power supply voltage usage range

Characteristic	Symbol	Operating Voltage Range	Unit
Power supply for control block	V _{CC}	6 to 10	V

2. Control Inputs (RES, CW/CCW, Ve, LA, OS, and Td)

(1) Input method

The RES, CW/CCW, OS, Ve, and Td input signals should be open or low, until V_{CC} has settled.

(2) Ve and LA input

Ve and LA terminal have clamp circuits respectively at the input stage. If the input voltage exceeds V_{refout} of 5 V, this voltage is clamped to 5 V. Input voltage should be V_{CC} or less.

3. Oscillation Circuit

(1) Operating oscillation range

Characteristic	Symbol	Operating Range	Unit
Oscillation frequency	f _{osc}	2 to 8	MHz

(2) Recommended oscillator

Ceramic oscillator: 4.19 MHz

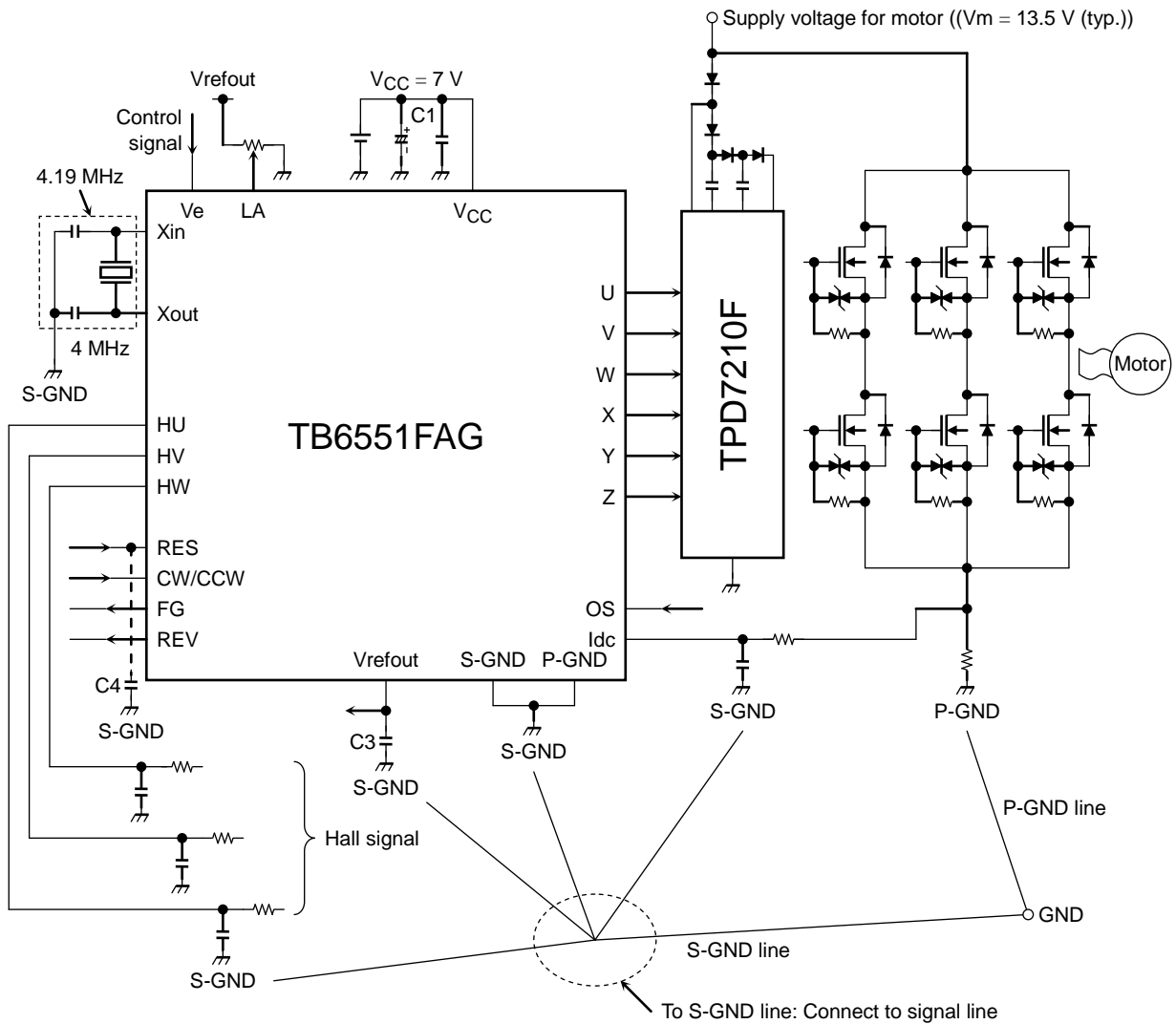
- FCR4.19MC5 (TDK Corporation)
- CSTLS4M19G56-B0 (Murata manufacturing Co. Ltd)

Note: If there are any questions about a ceramic oscillator, please ask to a manufacture maker.

(3) Connection

Please connect the oscillator as close to the IC as possible. And place the oscillator's GND as close as possible to the IC's S-GND terminal.

4. Application Circuit Example (Motor voltage ≤ 18 V)



(1) Capacitors for power supply

Please connect capacitors between V_{CC} and GND, and between VM and GND as close to the IC as possible.

Recommended values

Characteristic	Recommended Value	Remarks
Between V_{CC} and GND: C1	10 μ F to 33 μ F	Electrolytic capacitor
	0.001 μ F to 0.22 μ F	Ceramic capacitor

(2) Capacitor for Vrefout

Please connect a capacitor between Vrefout and GND as close to the IC as possible.

Recommended values

Characteristic	Recommended Value	Remarks
Between Vrefout and GND: C3	0.1 μ F to 1.0 μ F	Ceramic capacitor

Vrefout line is used for the reference power supply of the internal IC. Make sure to connect the capacitor whether the power supply of Vrefout is applied or not. Recommended values above are actual values for fan motors of air conditioner. So, when the board and the usage environment are different from above conditions, the appropriate capacitor value changes. Therefore, please confirm the state of Vrefout terminal with an oscilloscope whether the voltage is stabilized under the usage environment. Then, determine the capacitor value.

(3) Filter for hall signal

The hall input terminal is susceptible to noise because it has high impedance. To prevent malfunction, connect a C, R filter to each hall input terminal.

The appropriate values of the C, R filter can vary according to the noise frequency: the resistor should be 1 k Ω , and the capacitance should be 0.001 μ F to 0.1 μ F. Connect C, R filter as near the IC as possible. And connect GND line of the capacitor to the S-GND.

(4) Capacitor for RES

The RES terminal is susceptible to noise because it has high impedance. To prevent malfunction, connect a capacitor to the RES terminal when necessary. Place the load side of the capacitor as close as possible to the IC's S-GND terminal.

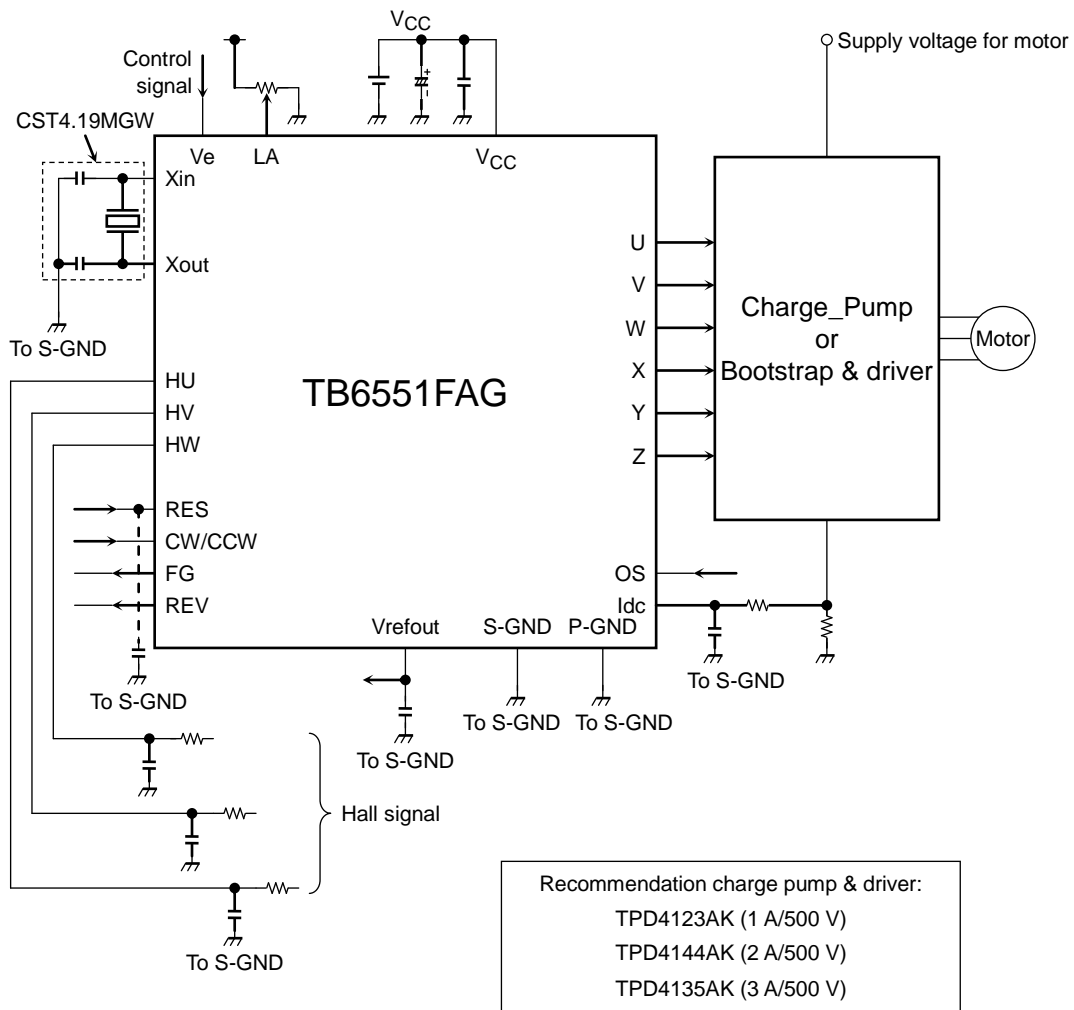
(5) Filter for Idc

The Idc terminal is affected by noise from the power supply block when resistor of over current detection is connected. It occurs though the Idc terminal incorporates a filter (200 k Ω / 5 pF) at the input stage. So, please connect a C, R filter externally to avoid the noise affection. Determine the C, R filter value according to the noise conditions. Please connect the ceramic capacitor as close to the IC as possible. In this time, connect GND line of the capacitor to IC's S-GND.

(6) GND pattern

Connect the IC's S-GND and P-GND terminals directly near the IC and connect them to the S-GND line of the motor. In this time, make sure to avoid having the common impedance between motor's P-GND and S-GND.

(7) Other Applications Example (Motor voltage > 30 V)



5. Operating Temperature Range

Operating temperature range of -30 to 115°C is guaranteed. The high-temperature operation is limited by usage condition. The operating temperature range changes because the power dissipation differs depending on the adopted package.

Calculate the Pd value (W) from the equation below.

$$Pd = V_{CC} \times I_{CC} + (V_{CC} - V_{refout}) \times I_{refout} + I_{out} \times (V_{out} (H) + V_{out} (L)) \times 2$$

$$R_{th} (j-a) = 139^{\circ}C/W \text{ (} 50 \times 50 \times 1.6 \text{ mm: Cu30\%)}$$

$$\text{The acceptable ambient temperature (max): } T_a = 150^{\circ}C - (Pd \times 139^{\circ}C/W)$$

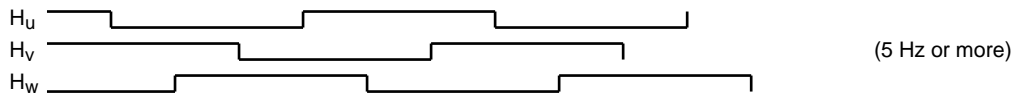
Please configure enough margins in designing.

6. Others

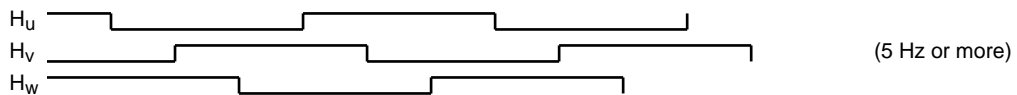
- **FG & REV function**
FG and REV terminals output detection signal continually for hall signal input. Vcc power supply and Reset should be released.
- **Switching of sine-wave drive and square-wave drive**
The switching is controlled by the hall signal and CW/CCW terminal.

The condition of sine-wave drive

In case of forward rotation (CW = Low), a motor operates with a sine-wave drive when a hall signal was inputted by the following timings.

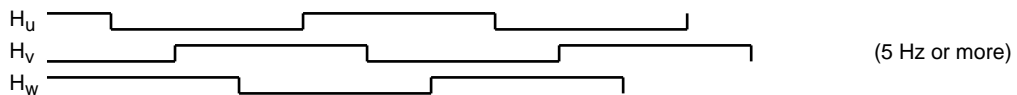


In case of reverse rotation (CW = High), a motor operates with a sine-wave drive when a hall signal was inputted by the following timings.

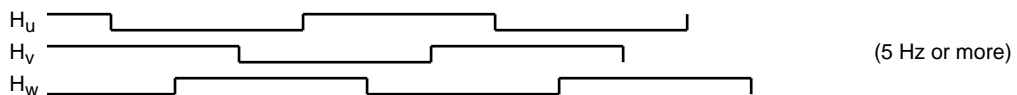


The condition of square-wave drive

In case of forward rotation (CW = Low), a motor operates with a square-wave drive when a hall signal was inputted by the following timings.



In case of reverse rotation (CW = High), a motor operates with a square-wave drive when a hall signal was inputted by the following timings.



Note: Motor rotation direction should be reversed to change the operation from the square-wave drive to the sine-wave drive. In this time, voltage level of CW and CCW terminals should be fixed. Therefore, high and low level (plus and minus) of the hall signal should be reversed.

Notes on Contents

1. Block Diagrams

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.

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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 the device breakdown, damage or deterioration, and may result injury by explosion or combustion.
- (2) 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) 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 terminals 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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