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

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 Vrefout 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	fosc	2 to 8	MHz

(2) Recommended oscillator

Ceramic oscillator: 4.19 MHz

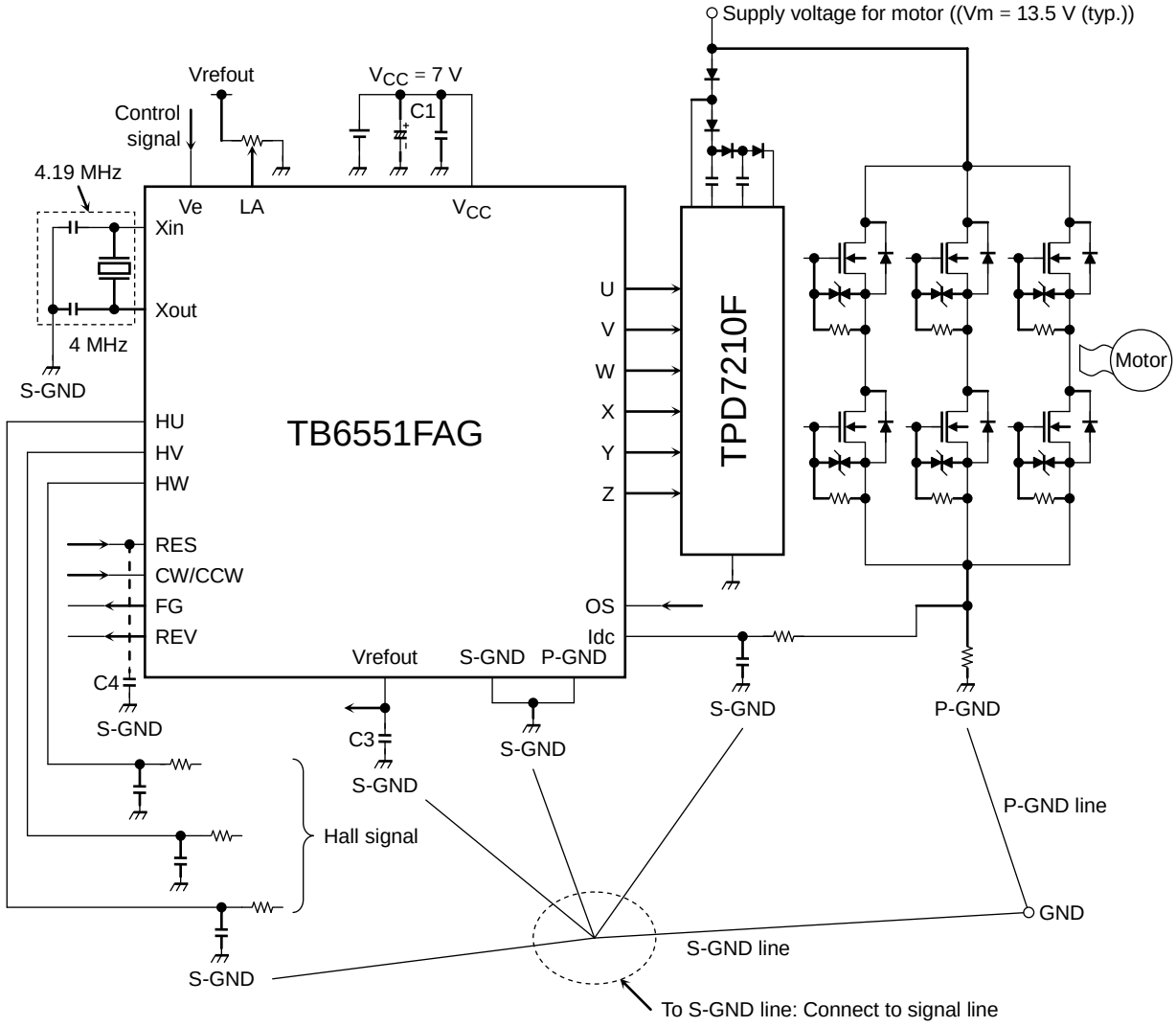
- FCR4.19MC5 (TDK Corporation)
- CSTLS4M19G56-B0 (Murata manufacturing Co. Ltd)

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 μF to 33 μF	Electrolytic capacitor
	0.001 μF to 0.22 μF	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 μF to 1.0 μF	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 kΩ, and the capacitance should be 0.001 μF to 0.1 μF. 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.

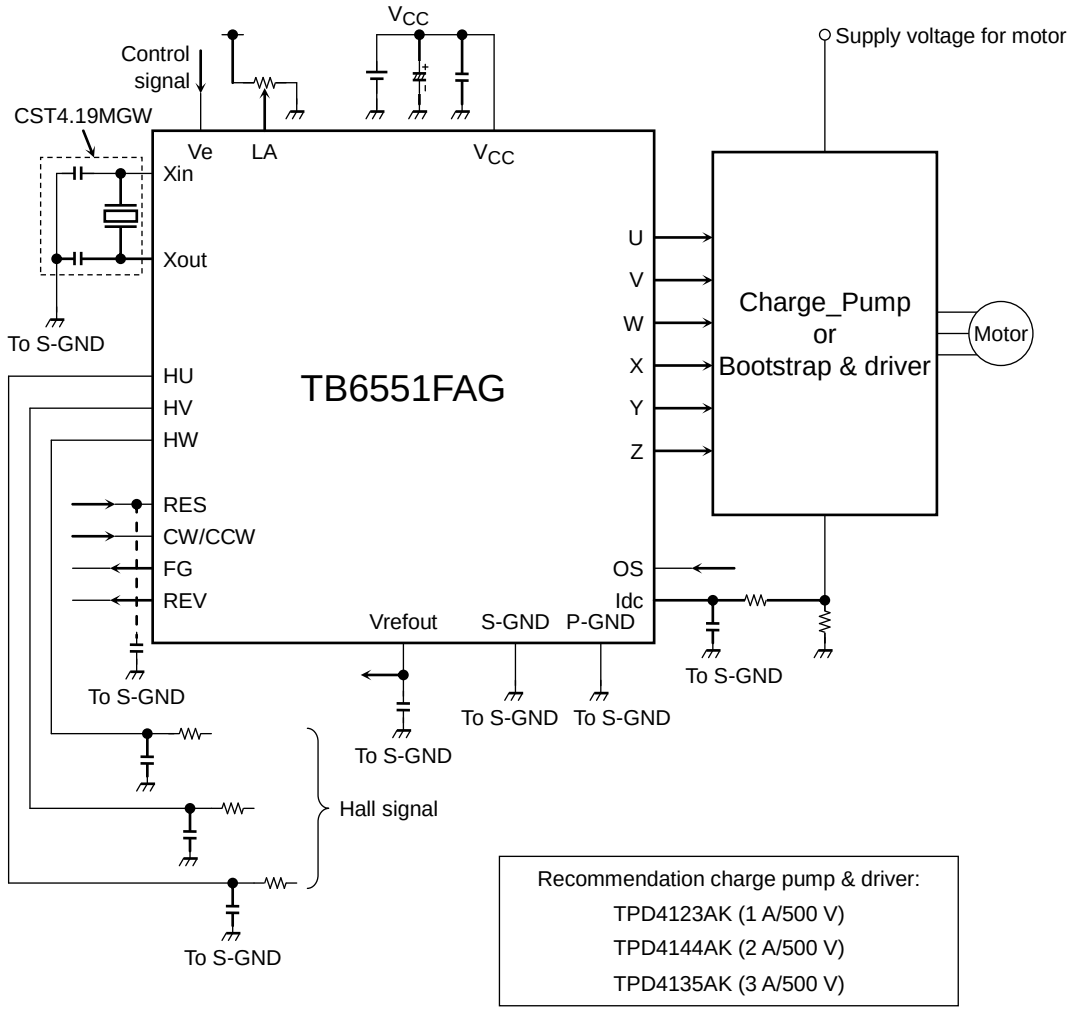
(5) Filter for Idc

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 kΩ/ 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.

$Pd = V_{CC} \times I_{CC} + (V_{CC} - Vrefout) \times Irefout + Iout \times (Vout\ (H) + Vout\ (L)) \times 2$

Rth (j-a) = 139°C/W (50 × 50 × 1.6 mm: Cu30%)
The acceptable ambient temperature (max): Ta = 150°C − (Pd × 139°C/W)

Please configure enough margins in designing.

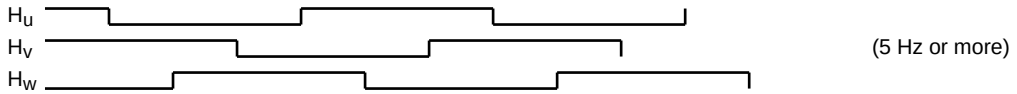
6. Others

- FG & REV function
  FG and REV terminals output detection signal continually for hall signal input. V_{CC} power supply and Reset should be released.

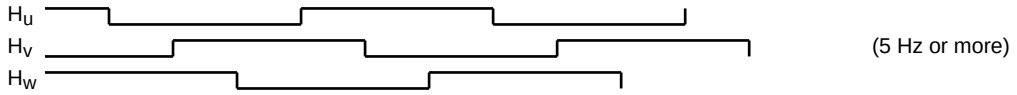
- Switching of sine-wave drive and square-wave drive
  The switching is controlled by the hall signal and CW/CCW terminal.

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.

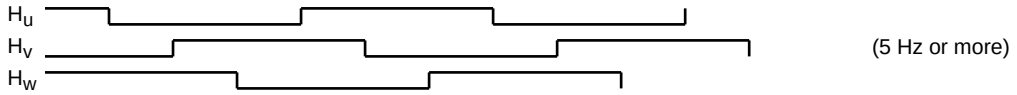


In case of reverse rotation (CW = High), a motor operates with a sine-wave drive when a hall signal was inputted by the following timings.

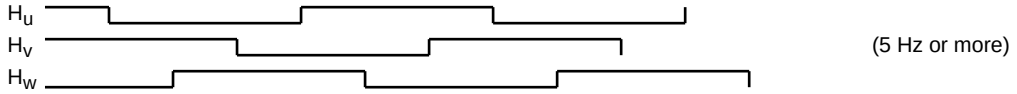


The condition of square-wave drive

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

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

RESTRICTIONS ON PRODUCT USE

- Toshiba Corporation, and its subsidiaries and affiliates (collectively "TOSHIBA"), reserve the right to make changes to the information in this document, and related hardware, software and systems (collectively "Product") without notice.
- This document and any information herein may not be reproduced without prior written permission from TOSHIBA. Even with TOSHIBA's written permission, reproduction is permissible only if reproduction is without alteration/omission.
- Though TOSHIBA works continually to improve Product's quality and reliability, Product can malfunction or fail. Customers are responsible for complying with safety standards and for providing adequate designs and safeguards for their hardware, software and systems which minimize risk and avoid situations in which a malfunction or failure of Product could cause loss of human life, bodily injury or damage to property, including data loss or corruption. Before customers use the Product, create designs including the Product, or incorporate the Product into their own applications, customers must also refer to and comply with (a) the latest versions of all relevant TOSHIBA information, including without limitation, this document, the specifications, the data sheets and application notes for Product and the precautions and conditions set forth in the "TOSHIBA Semiconductor Reliability Handbook" and (b) the instructions for the application with which the Product will be used with or for. Customers are solely responsible for all aspects of their own product design or applications, including but not limited to (a) determining the appropriateness of the use of this Product in such design or applications; (b) evaluating and determining the applicability of any information contained in this document, or in charts, diagrams, programs, algorithms, sample application circuits, or any other referenced documents; and (c) validating all operating parameters for such designs and applications. **TOSHIBA ASSUMES NO LIABILITY FOR CUSTOMERS' PRODUCT DESIGN OR APPLICATIONS.**
- **PRODUCT IS NEITHER INTENDED NOR WARRANTED FOR USE IN EQUIPMENTS OR SYSTEMS THAT REQUIRE EXTRAORDINARILY HIGH LEVELS OF QUALITY AND/OR RELIABILITY, AND/OR A MALFUNCTION OR FAILURE OF WHICH MAY CAUSE LOSS OF HUMAN LIFE, BODILY INJURY, SERIOUS PROPERTY DAMAGE AND/OR SERIOUS PUBLIC IMPACT ("UNINTENDED USE").** Except for specific applications as expressly stated in this document, Unintended Use includes, without limitation, equipment used in nuclear facilities, equipment used in the aerospace industry, medical equipment, equipment used for automobiles, trains, ships and other transportation, traffic signaling equipment, equipment used to control combustions or explosions, safety devices, elevators and escalators, devices related to electric power, and equipment used in finance-related fields. **IF YOU USE PRODUCT FOR UNINTENDED USE, TOSHIBA ASSUMES NO LIABILITY FOR PRODUCT.** For details, please contact your TOSHIBA sales representative.
- Do not disassemble, analyze, reverse-engineer, alter, modify, translate or copy Product, whether in whole or in part.
- Product shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable laws or regulations.
- The information contained herein is presented only as guidance for Product use. No responsibility is assumed by TOSHIBA for any infringement of patents or any other intellectual property rights of third parties that may result from the use of Product. No license to any intellectual property right is granted by this document, whether express or implied, by estoppel or otherwise.
- **ABSENT A WRITTEN SIGNED AGREEMENT, EXCEPT AS PROVIDED IN THE RELEVANT TERMS AND CONDITIONS OF SALE FOR PRODUCT, AND TO THE MAXIMUM EXTENT ALLOWABLE BY LAW, TOSHIBA (1) ASSUMES NO LIABILITY WHATSOEVER, INCLUDING WITHOUT LIMITATION, INDIRECT, CONSEQUENTIAL, SPECIAL, OR INCIDENTAL DAMAGES OR LOSS, INCLUDING WITHOUT LIMITATION, LOSS OF PROFITS, LOSS OF OPPORTUNITIES, BUSINESS INTERRUPTION AND LOSS OF DATA, AND (2) DISCLAIMS ANY AND ALL EXPRESS OR IMPLIED WARRANTIES AND CONDITIONS RELATED TO SALE, USE OF PRODUCT, OR INFORMATION, INCLUDING WARRANTIES OR CONDITIONS OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, ACCURACY OF INFORMATION, OR NONINFRINGEMENT.**
- Do not use or otherwise make available Product or related software or technology for any military purposes, including without limitation, for the design, development, use, stockpiling or manufacturing of nuclear, chemical, or biological weapons or missile technology products (mass destruction weapons). Product and related software and technology may be controlled under the applicable export laws and regulations including, without limitation, the Japanese Foreign Exchange and Foreign Trade Law and the U.S. Export Administration Regulations. Export and re-export of Product or related software or technology are strictly prohibited except in compliance with all applicable export laws and regulations.
- Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product. Please use Product in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. **TOSHIBA ASSUMES NO LIABILITY FOR DAMAGES OR LOSSES OCCURRING AS A RESULT OF NONCOMPLIANCE WITH APPLICABLE LAWS AND REGULATIONS.**