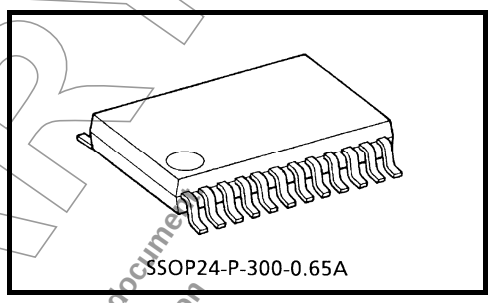
TOSHIBA Bi-CD Integrated Circuit Silicon Monolithic

TB6633FNG/AFNG

3-Phase Full-Wave PWM Driver for Sensorless DC Motors

The TB6633FNG/AFNG is a three-phase full-wave PWM driver for sensorless brushless DC (BLDC) motors. It controls motor rotation speed by changing the PWM duty cycle, based on the voltage of an analo control input.



Weight: 0.136 g (typ.)

Features

- Sensorless drive in three-phase full-wave mode
- PWM chopper control
- Controls the PWM duty cycle based on an analog input (7-bit ADC)
- Output current: I_{OUT} = 0.6 A typ. (1 A max)
- Power supply: VM = 4.5 V to 22 V (25 V max)
- Forward and reverse rotation
- Lead angle control (0°, 15° and 30°)
- Overlapping commutation (120°, 135° and 150°)
- Selectable duty cycle modulation period upon state transitions of phase signals
- Rotation speed detecting signal (FG_OUT, TB6633FNG:3ppr, TB6633AFNG:1ppr)
- Adjustable startup settings
- Forced commutation frequency control ($f_{osc}/(6 \times 2^{17})$, $f_{osc}/(6 \times 2^{18})$ and $f_{osc}/(6 \times 2^{19})$)
- Selectable PWM frequency
- Restart feature
- Overcurrent protection (ISD)
- Thermal shutdown (TSD)
- Undervoltage lockout (LVD)
- Current limiter
- Short brake control

Note1: 8 pin (IR) of this product is sensitive to electrostatic discharge. When handling this product, protect the environment to avoid electrostatic discharge.

Note2: The following conditions apply to solderability:
About solderability, following conditions were confirmed
(1) Use of Sn-37Pb solder Bath
- solder bath temperature: 230°C
- dipping time: 5 seconds
- the number of times: once
- use of R-type flux

(2) Use of Sn-3.0Ag-0.5Cu solder Bath
- solder bath temperature: 245°C
- dipping time: 5 seconds
- the number of times: once
- use of R-type flux

Absolute Maximum Ratings (Note) (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Power supply voltage	VM	25	V
Input voltage	V_{IN1} (Note 1)	−0.3 to 6.0	V
	V_{IN2} (Note 2)	−0.3 to 25	V
Output voltage	V_{OUT1} (Note 3)	25	V
	V_{OUT2} (Note 4)	6.0	V
Output current	I_{OUT1} (Note 5)	1 (Note 8)	A
	I_{OUT2} (Note 6)	5	mA
	I_{OUT3} (Note 7)	5	mA
Power dissipation	P_D	0.78 (Note 9)	W
Operating temperature	T_{opr}	−40 to 85	°C
Storage temperature	T_{stg}	−55 to 150	°C

Note: 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.
Please use the TB6633FNG/AFNG within the specified operating ranges.

Note 1: V_{IN1} is applicable to the voltage at the following pins: FPWM, VSP, CW_CCW, LA, OC, SEL_LAP, FST, BRAKE and SLOP

Note 2: V_{IN2} is applicable to the voltage at the COM pin.

Note 3: V_{OUT1} is applicable to the voltage at the following pins: U, V and W

Note 4: V_{OUT2} is applicable to the voltage at the FG_OUT pin.

Note 5: I_{OUT1} is applicable to the current at the following pins: U, V and W

Note 6: I_{OUT2} is applicable to the current at the FG_OUT pin.

Note 7: I_{OUT3} is applicable to the current at the VREF pin.

Note 8: Output current may be limited by the ambient temperature or the device implementation.
The maximum junction temperature should not exceed T_{jmax} = 150°C

Note 9: Measured for the IC only. (Ta = 25°C)

Operating Ranges

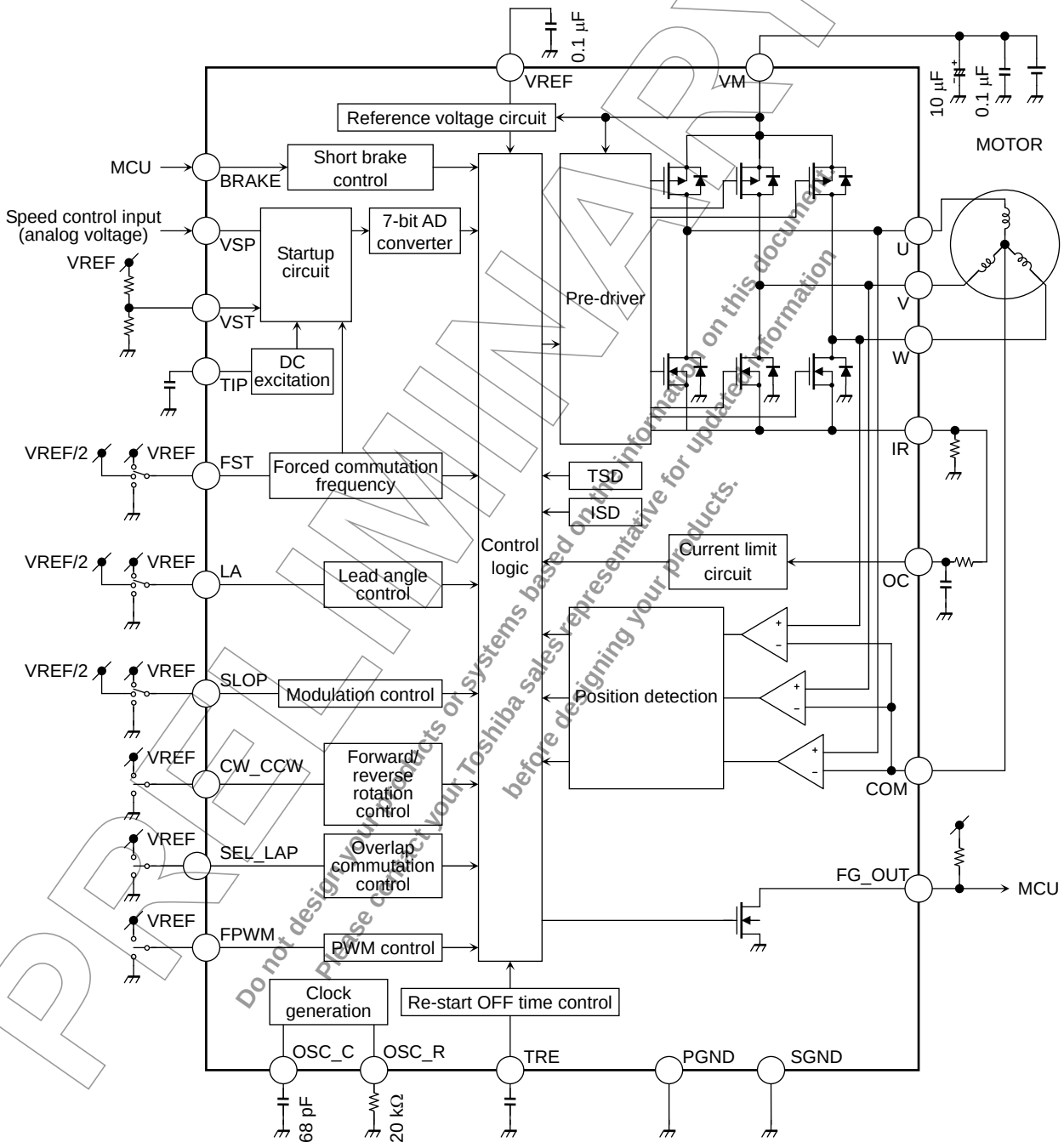
Characteristics	Symbol	Min	Typ.	Max	Unit
Power supply voltage 1	VM_{opr1}	5.5	12	22	V
Power supply voltage 2	VM_{opr2}	4.5	5	5.5	V

Application Circuit Example

Some of the functional blocks, circuits, or constants in the block diagram may be omitted or simplified for explanatory purposes.

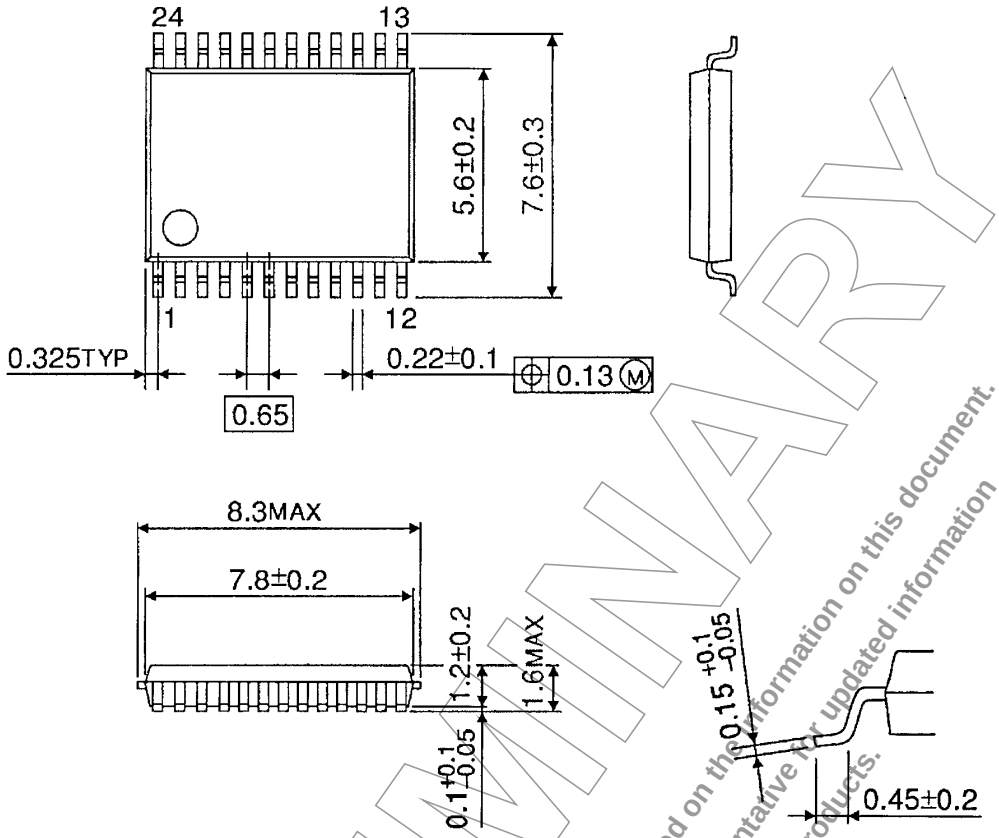
The application circuits shown in this document are provided for reference purposes only. Thorough evaluation is required, especially at the mass production design stage.

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



Package Dimensions

SSOP24-P-300-0.65A Unit : mm



Weight: 0.136 g (typ.)

Pin No.	Symbol
1	VM
2	FPWM
3	CW_CCW
4	SEL_LAP
5	U
6	V
7	W
8	IR
9	PGND
10	OC
11	COM
12	SGND
13	FG_OUT
14	BRAKE
15	OSC_C
16	OSC_R
17	VSP
18	VST
19	TIP
20	TRE
21	FST
22	LA
23	SLOP
24	VREF

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

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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) 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.

(5) Carefully select external components (such as inputs and negative feedback capacitors) and load components (such as speakers), for example, power amp and regulator.
If there is a large amount of leakage current such as input or negative feedback condenser, the IC output DC voltage will increase. If this output voltage is connected to a speaker with low input withstand voltage, overcurrent or IC failure can cause smoke or ignition. (The over current can cause smoke or ignition from the IC itself.) In particular, please pay attention when using a Bridge Tied Load (BTL) connection type IC that inputs output DC voltage to a speaker directly.

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 (T_j) 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 maximum ratings. To avoid this problem, take the effect of back-EMF into consideration in system design.

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