TB6575FNG functional description

The TB6575FNG provides sensorless commutation and PWM current control for 3-phase full-wave BLDC motors.

1. Power supply voltage
      Power supply voltage usage range

Characteristic	Symbol	Operating voltage range	Unit
Power supply for control block	V_{DD}	4.5 to 5.5	V

2. Control inputs   (LA, CW/CCW, SEL_LAP, Fmax, Fst, OS, Vsp)
      1) Input method
            When V_{DD} is switched off, the LA, CW/CCW, SEL_LAP, Fmax, Fst, OS, and V_{SP} input signals should be open or low, until V_{DD} has settled.

3. Oscillation circuit
      1) Operating oscillation range

Characteristic	Symbol	Operating voltage range	Unit
Oscillation frequency	fosc	2 ～ 8	MHz

2) Recommended oscillator
      Ceramic Oscillator ; 4.19MHz
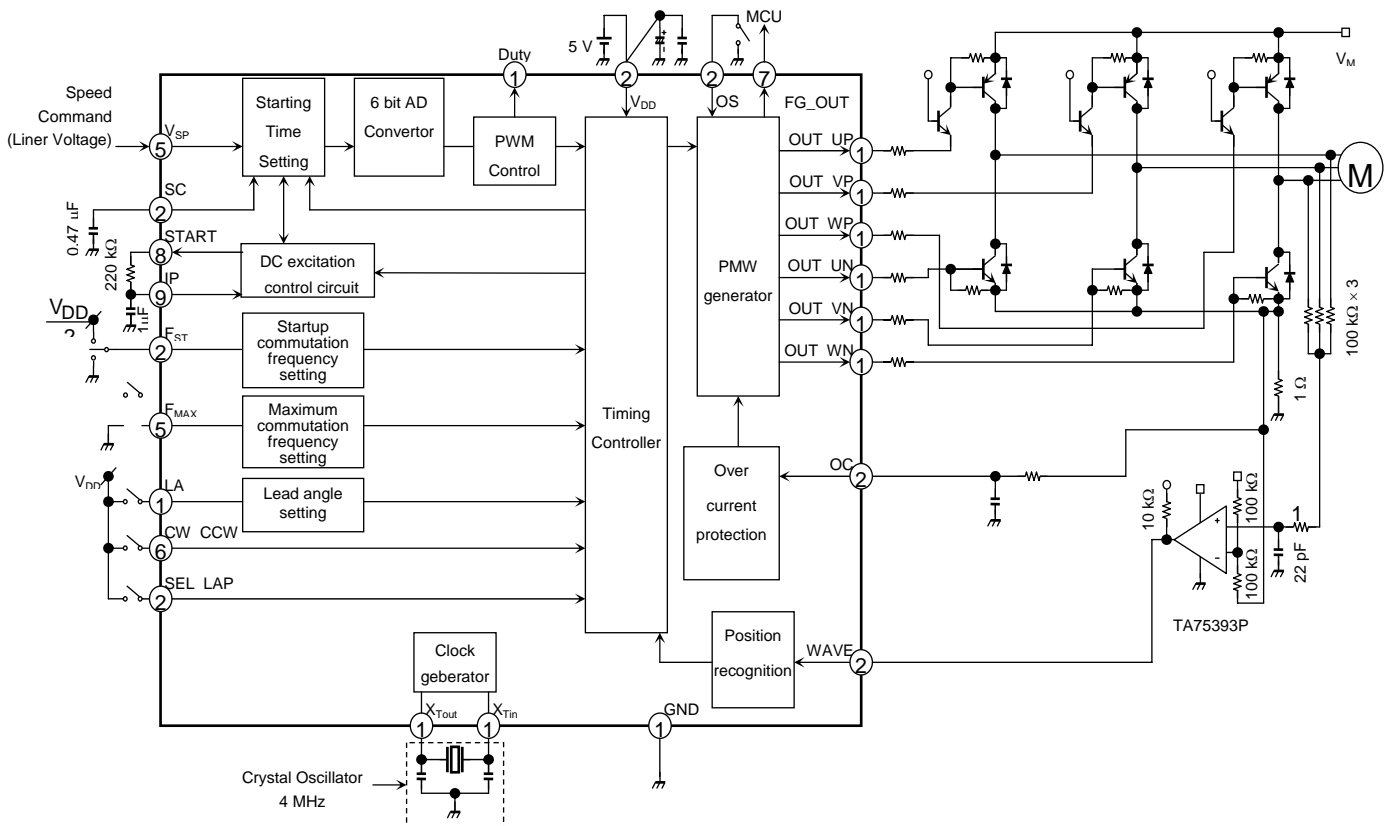   ・FCR4.19MC5   (TDK Corporation)
            ・CSTLS4M19G56-B0   (Murata manufacturing Co. Ltd)

3) Connection
      Place the oscillator's GND as close as possible to the IC's S-GND pin.

4. Application circuit

<**Example for ~30Vmax**>

1) Capacitors for power supply

Connect capacitors between V_{DD} and GND, and between VM and GND as near the IC as possible.

< Recommended values>

Characteristic	Recommended value	Remarks
$V_{DD}-$GND	10μF ～ 33μF	Electrolytic capacitor
VM$-$GND	0.001μ ～ 0.22μF	Ceramic capacitor

2) Startup setting

Please decide the value from the results of your evaluation because it depends on the motors.

<Conditions of Toshiba's Evaluation>

Characteristic	Value	Remarks
SC：C1	0.47uF	Ceramic capacitor
START$-$IP：R1	220kΩ	Resistor
IP：C2	1uF	Ceramic capacitor

Our fan motor for evaluation operates under these conditions.

3) Protection filter for input

The input pins of over current protection and of position recognition have high impedance and are easily influenced by noise, so it has a possibility to cause a wrong operation. Please provide CR filter not to let it operate wrongly. Please decide the value of the filter from the noise frequency.

We recommend to set the capacity of 0.001μF to 0.1μF.

4) Comparator

The standard voltage is based on the middle voltage of VM and the voltage in front of the over current detective resistor that exists between output Tr and GND. A minute adjusting is needed depending on the conditions of noise and the motor because it detects the introducing voltage of OFF phase.

VM is limited by withstand voltage of this comparator, so when you use it at more than 30V, please refer '8. Level shift' written later.
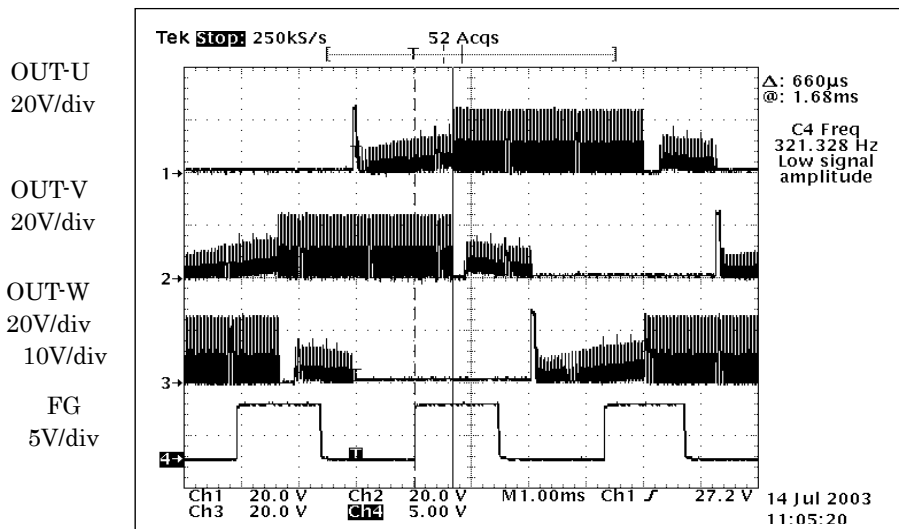
5. Lead angle controller

It can operate the driving signal electrically in the range of 7.5 to 15 degrees against introducing voltage. However, when it is in the DC excitation mode or in the forced commutation mode just after startup, it operates with zero degree.

After it detects the introducing voltage and moves to the sensor less mode, it drives at the lead angle according to the LA pin.

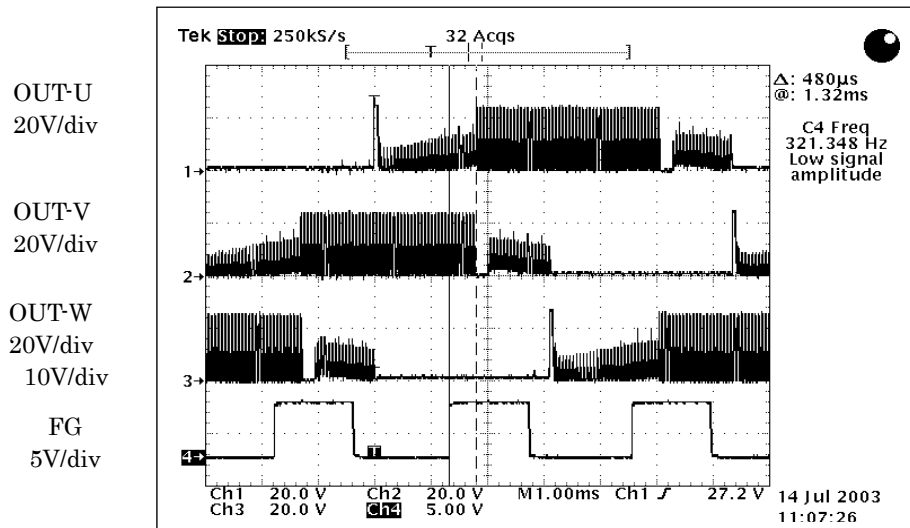| LA	Lead angle(°)
LOW or OPEN	7.5
HIGH	15

The setting of lead angle depends on the motor and the numbers of spin, so please decide it by doing experiments.

＜**TB6575FNG＋MP6404 Driving Wave（for Reference）** ＞

6. Lap conduction

   During the lap conduction, it overlaps to other phases by starting the conduction from zero-cross to reduce the noise. This noise is produced in the changing of excitation that arises in the 120 degree conduction.

   The term of overlap changes depends on the lead angle setting. When the lead angle is 7.5 degrees, it overlaps 22.5 degrees and when the lead angle is 15 degrees, it overlaps 15 degrees.

SEL_LAP	Conduction method
HIGH or OPEN	120°
LOW	LAP

＜TB6575FNG＋MP6404 Driving Wave（for Reference）＞

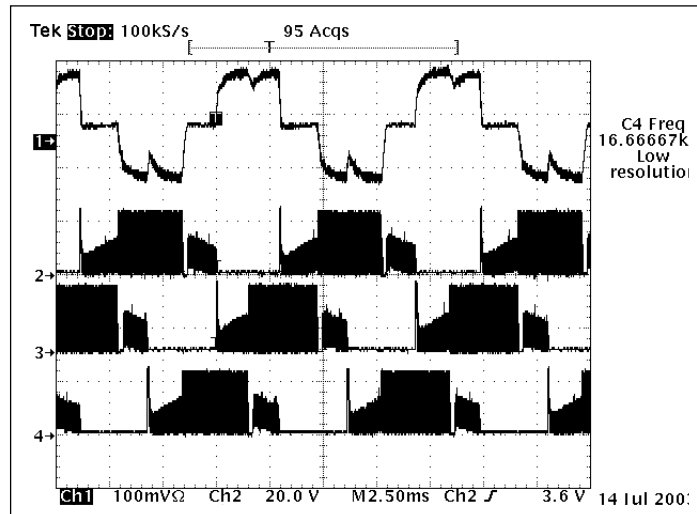U phase motor current
0.1A/div

OUT-U
20V/div

OUT-V
20V/div

OUT-W
20V/div
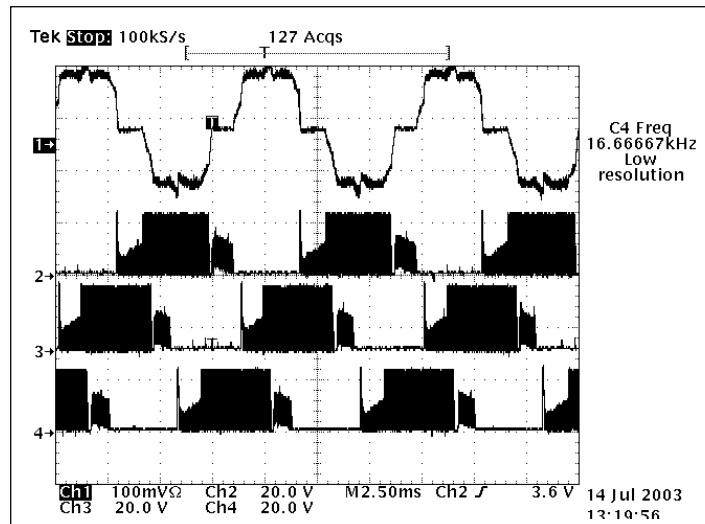10V/div

Lead angle：7.5 degrees
120° Conduction

VM＝24V
VSP=2V

U phase motor current
0.1A/div

OUT-U
20V/div

OUT-V
20V/div

OUT-W
20V/div
10V/div

LAP Conduction

VM＝24V
VSP=2V

> Using the motor at higher than withstand voltage of comparator.

7. Level Shift

When you use the motor at higher than 30 V, please shift the input voltage of comparator by the mithod written below.

1) Please put the standard voltage of GND side on the lower resistor (R12).
   Please input the comparator for position recognition on R12, which is a resistor for a overcurrent detector, as a standard. Because the motor is influenced by R12's voltage reducing at startup and this reducing voltage should be canceled each other out.
   When you put it on the GND, there is a possibility that it can not move to sesorless mode because of its errors.

2) In caluculation, please use the voltage in each phase that connects to the motor. Please do not use VM.
   VM and the voltage to the motor is different.

Resistor for Level shift
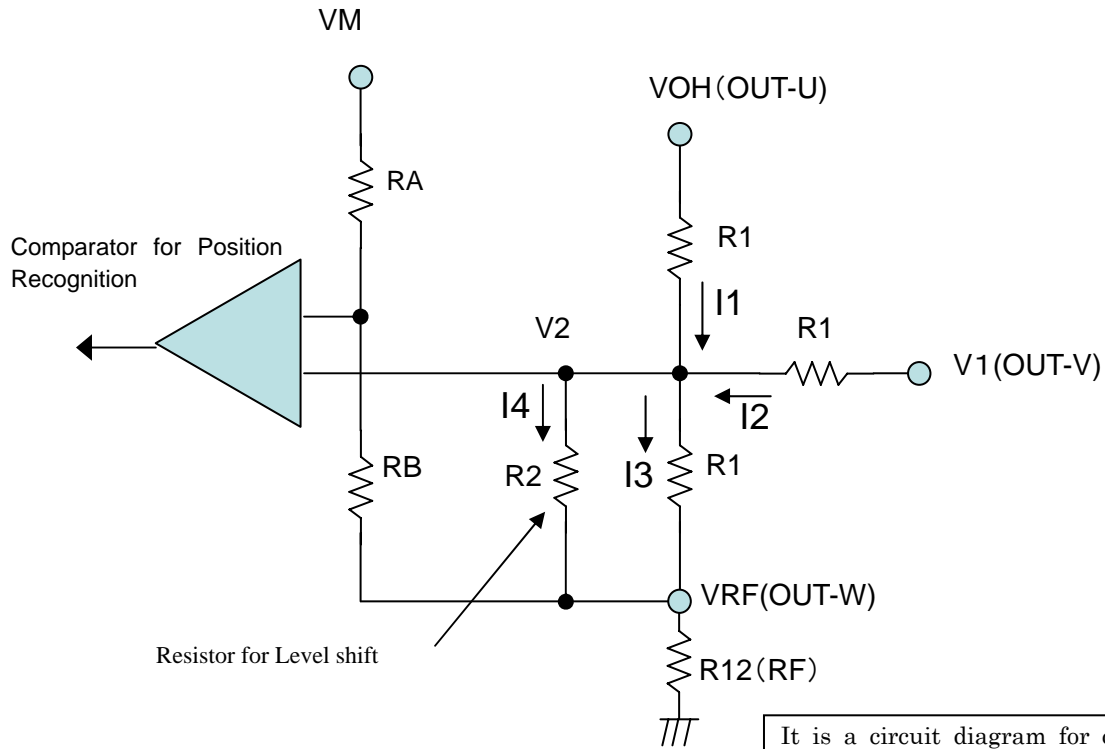
> It is a circuit diagram for calculation. Keep in mind that it differs that it is actual.

$I1 = (VOH - V2) / R1$ Equation (1)
$I2 = (V1 - V2) / R1$ Equation (2)
$I3 = (V2 - VRF) / R1$ Equation (3)
$I4 = (V2 - VRF) / R2$ Equation (4)
$I1 + I2 = I3 + I4$ Equation (5)
When you substitute the equations (1), (2), (3), and (4) for (5),
$(VOH - V2) / R1 + (V1 - V2) / R1 = (V2 - VRF) / R1 + (V2 - VRF) / R2$

From this equation,
$V2 = (VOH + VRF + V1) / (3 + R1 / R2)$ Equation (6)

In recognizing V1 as a middle point that is $((VOH - VRF) / 2 + VRF)$, equation (6) becomes as follows;

$$V2\,(\text{Middle point}) = \frac{3 \times R2 \times (VOH + VRF)}{2 \times (3 \times R2 + R1)}$$

The standard voltage of the comparator is as follows;

$$VA = (VM - VRF) \times \frac{RB}{RA + RB} + VRF$$

If recognizing the middle point V2 as VA,

$$(VM - VRF) \times \frac{RB}{RA+RB} + VRF = \frac{3\times R2\times(VOH + VRF)}{2 \times (3 \times R2 + R1)}$$

$$\frac{RB}{RA + RB} = \frac{1}{VM \cdot VRF} \times \left\{ \frac{3 \times R2 \times (VOH + VRF)}{2 \times (3 \times R2 + R1)} - VRF \right\}$$

Ex） If you substitute 40 V for VM, 0.5 V for VRF, 37 V for VOH, 100 kΩ for R1 and, 30 kΩ for R2, it is concluded that

RB / (RA + RB) = 0.2248

That is RA : RB = 7752 : 2248

For example, when RB equals to 10kΩ, RA becomes 34.5kΩ.

7. Others

<Position recognition>

It recognizes the position by comparing the changes of introducing voltage of OFF phase and that of standard value which means postulating middle point.

When it recognizes the position recognizing signal in the IC, it masks opposite startup voltage. This opposite startup voltage equivalents to the Diode-ON time. This masking term changes according to the lead angle as follows;

In recognizing the term of masking after changing, the term written below is masked.

Lead angle（°）	Masking term（°）
7.5	22.5
15	30

When Diode-ON time is beyond the masking time written above, it may cause wrong operation and the motor may not work correctly.

In this case, you should change the setting of lead angle, improve the speed of output diode, change the applying conditions, or change the motor it self.

<Maximum commutation frequency>

If the commutation frequency set up with the FMAX terminal is exceeded, it is judged as the unusual state of a motor and an output is turned off. However, Maximum commutation frequency changes with setup of Forced commutation frequency (Fst terminal), cautions are required.

Commutation frequency means motor current frequency (1 electricity angle).

・Fst=Low>

F_{MAX} =High or Open , Maximum commutation frequency $f_{MX} = f_{XT}/ (6\times2^{11})$
F_{MAX} =Low , Maximum commutation frequency $f_{MX} = f_{XT}/(6 \times 2^{12})$

・Fst=High or Middle>

F_{MAX} =High or Open , Maximum commutation frequency $f_{MX} = f_{XT}/ (6\times2^{8})$
F_{MAX} =Low , Maximum commutation frequency $f_{MX} = f_{XT}/(6 \times 2^{9})$
The pin has a pull-up resistor.

Note） In FST=Low and FMAX=Low, since the number of rotations which becomes protection mode becomes low, cautions are required.

Ex. ; fxt=4.19MHz、In 4pole Motor
$f_{MX} = f_{XT}/ (6\times2^{12})$ = 4.19MHz/ (6×2^{12}) = 170.5Hz
Number of rotations of a motor = (170.5Hz/2)*60sec = 5115rpm
Therefore, if the number of rotations of a motor is set to 5115rpm, it will become protection mode.

＜Control method of Vsp terminal in startup＞

Though DC excitation time and forced commutation are adjusted by experiment, it is difficult to 100% startup because of other conditions including the load.

When the motor does not start, please re-start by checking the motor conditions with microcomputer. Find the best value of Vsp to start the motor by experiment and apply this Vsp. To judge whether the motor starts or not, use the microcomputer with FG pulse. When the rotation number corresponding to the Vsp is gained, change the Vsp to adjust to the target rotation number.

Step1) Apply Vsp which is easy to startup.
Step2) When the motor operates at the appropriate rotation number which corresponds to the Vsp of Step1, change the Vsp to gain the target rotation number.

※If you cannot have the rotation number which corresponds to the Vsp of Step1, lower the Vsp to 1V and start again.

TB6575FNG Startup method

A — Control signal from MCU

B — Vsp input signal

Determine the voltage to startup easily (Ex. 2V) by experiment.

To target speed

FG — RPM information

Check the rotation number by microcomputer.