DC Brushless Motor Drivers

Three-phase Full-wave DC Brushless Fan Motor Driver

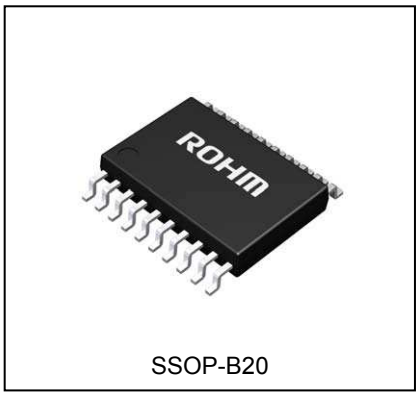
BD6345FV

●General description

BD6345FV is a three-phase sensor-less fan that suit for speed controllable fans.
Its feature is sensor-less drive which doesn't require a hall device as a location detection sensor. Furthermore, introducing a PWM soft switched driving mechanism achieves silent operations and low vibrations.

●Package

	W (Typ.) x D (Typ.) x H (Max.)
SSOP-B20	6.50mm x 6.40mm x 1.45mm



SSOP-B20

●Features

- Sensor-less drive
- Lock protection and automatic restart
- Rotating speed pulse signal (SOUT) output

●Application

- For 12V fan for general consumer equipment

●Absolute maximum ratings

Parameter	Symbol	Limit	Unit
Supply voltage	V_{CC}	20	V
Power dissipation	P_d	1200*1	mW
Storage temperature	T_{stg}	-55 to +150	℃
Operating temperature	T_{opr}	-40 to +100	℃
Output voltage	V_{omax}	20	V
Output Current	I_{omax}	1.2*2	A
SOUT signal output voltage	V_{SOUT}	20	V
SOUT signal output current	I_{SOUT}	10	mA
REF current ability	I_{REF}	8	mA
Input voltage (TOSC)	V_{IN}	6.5	V
Junction temperature	Tjmax	150	°C

*1 Reduce by 9.6mW/°C over Ta=25°C (on 70.0mm×70.0mm×1.6mm glass epoxy board)
*2 T not exceed Pd and ASO
*2 It is permissible to 1.5A, 1 or less second.

●Recommended operating conditions

Parameter	Symbol	Limit	Unit
Operating supply voltage range	V_{CC}	5.5 to 17.0	V

●**Pin configuration**

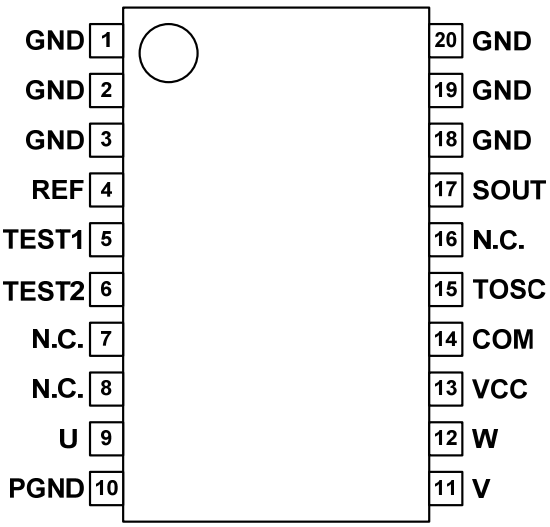


Fig.1 Pin configuration

●**Pin description**

P/No.	T/Name	Function
1	GND	GND terminal
2	GND	GND terminal
3	GND	GND terminal
4	REF	Reference voltage terminal
5	TEST1	TEST terminal
6	TEST2	TEST terminal
7	N.C.	
8	N.C	
9	U	Motor output U
10	PGND	Motor GND terminal
11	V	Motor output V
12	W	Motor output W
13	VCC	Power Supply terminal
14	COM	Motor central tap terminal
15	TOSC	Oscillating capacitor connecting terminal for synchronous driving
16	N.C	
17	SOUT	Rotating speed pulse signal output terminal
18	GND	GND terminal
19	GND	GND terminal
20	GND	GND terminal

●**Block diagram**

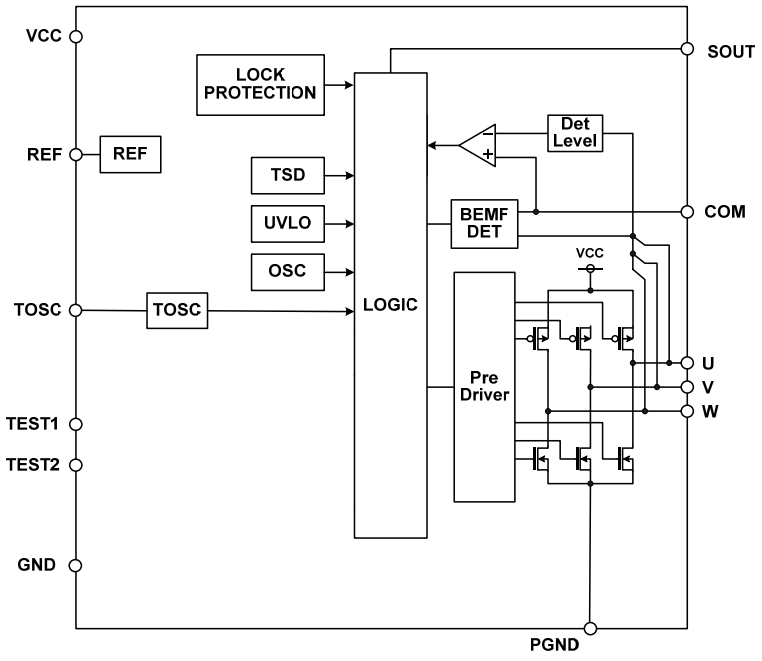


Fig.2 Block diagram

●**Electrical characteristics(Unless otherwise specified Ta=25℃, Vcc=12V)**

Parameter	Symbol	Limit			Unit	Conditions
		Min.	Typ.	Max.		
Circuit current	I_{CC}	4	7	10	mA	
<REF>						
REF voltage	V_{REF}	4.8	5	5.2	V	I_{REF}= -2mA
<TOSC>						
TOSC high voltage	V_{TOSCH}	2.3	2.5	2.7	V	
TOSC low voltage	V_{TOSCL}	0.8	1.05	1.2	V	
TOSC Charge current	I_{CTOSC}	-80	-60	-40	uA	
TOSC Discharge current	I_{DTOSC}	40	60	80	uA	
<SOUT output>						
SOUT low voltage	V_{SOUTL}	-	0.3	0.4	V	I_{SOUT}=5mA
SOUT leak current	I_{SOUTL}	-	-	10	uA	V_{SOUT}=20V
<Lock protection>						
Lock detect ON time	T_{ON}	0.3	0.5	0.8	s	TOSC=2200pF
Lock detect OFF time	T_{OFF}	3	5	8	s	
<Output>						
Output Hi voltage	V_{OH}	-	0.15	0.20	V	Io=−200mA (V_{CC} common)
Output Lo voltage	V_{OL}	-	0.09	0.16	V	Io=200mA (GND common)

About this specification, it is a provisional spec , and there is a possibility of the change.

●**Typical performance curves(Reference data)**

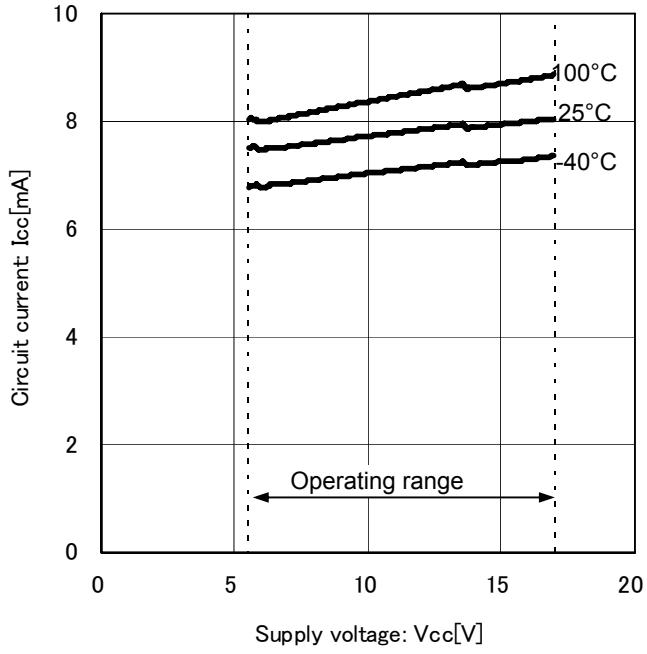


Fig.3 Circuit current

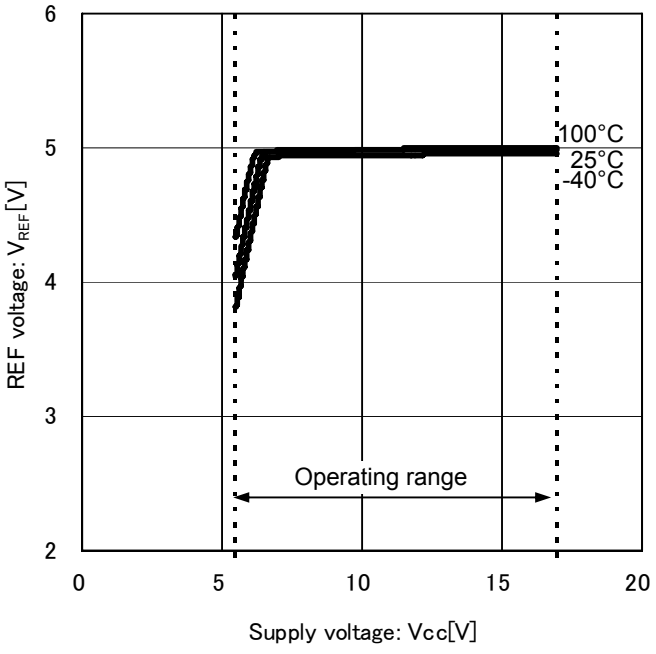


Fig.4 REF voltage

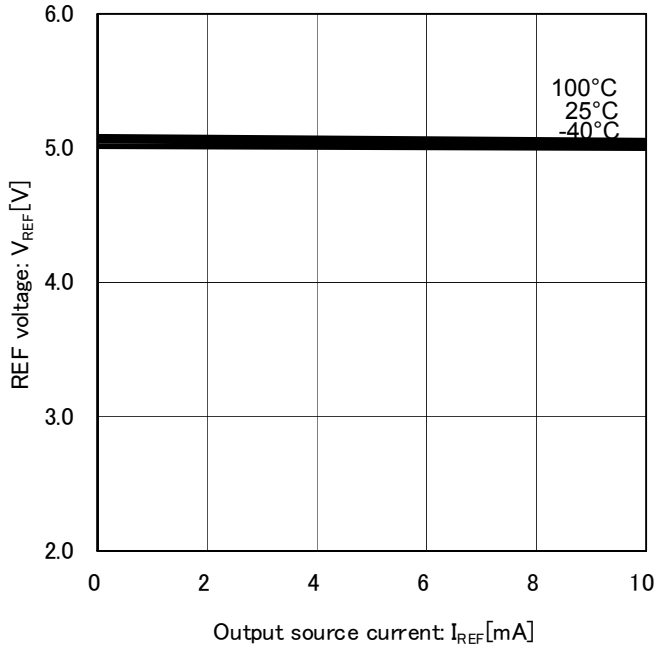


Fig.5 REF voltage current ability (Vcc=12V)

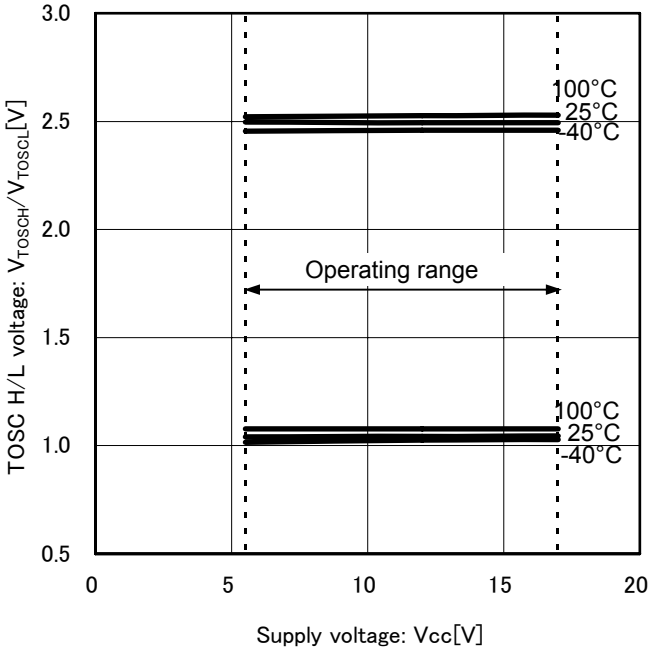


Fig.6 TOSC High/Low voltage

●**Typical performance curves(Reference data)**

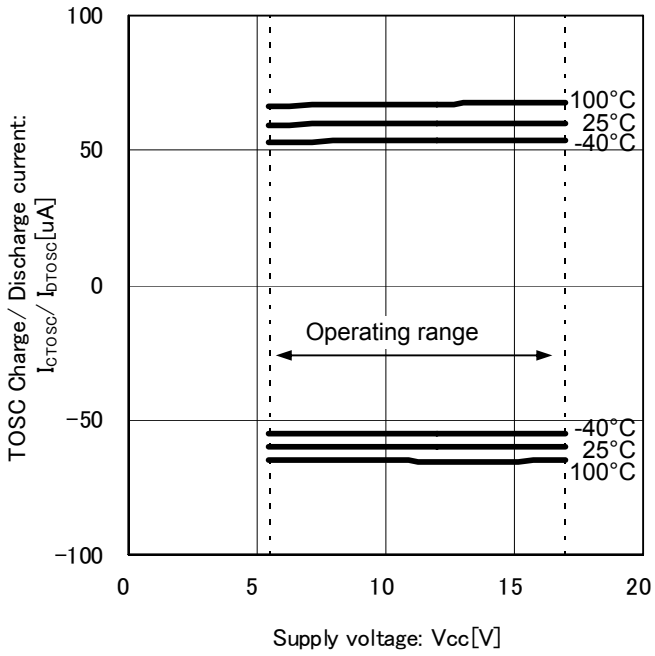


Fig.7 TOSC charge/discharge current

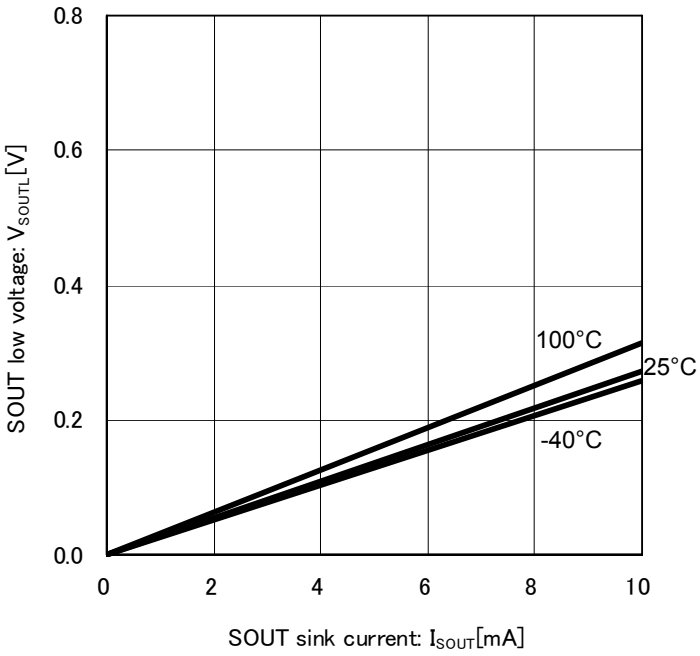


Fig.8 SOUT low voltage (Vcc=12V)

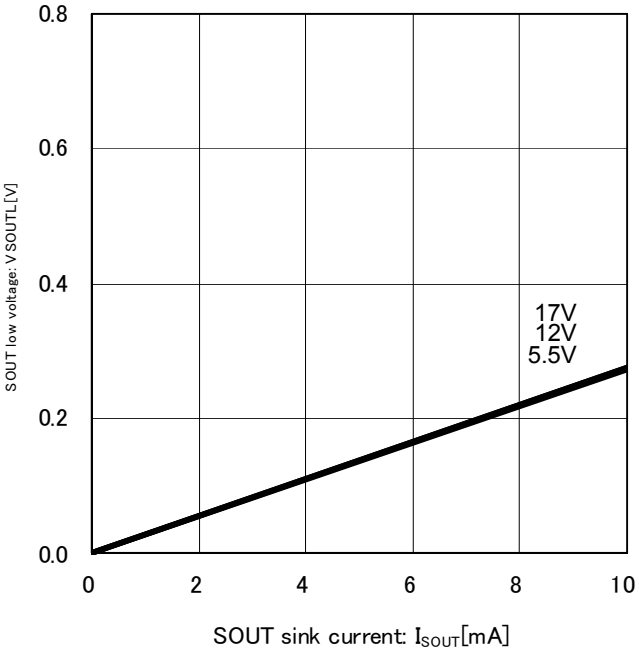


Fig.9 SOUT low voltage (Ta=25℃)

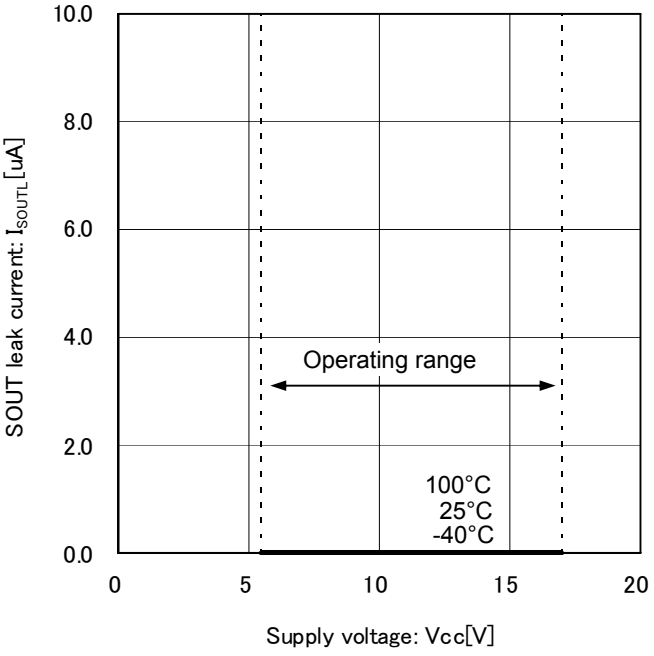


Fig.10 SOUT leak current

●**Typical performance curves(Reference data)**

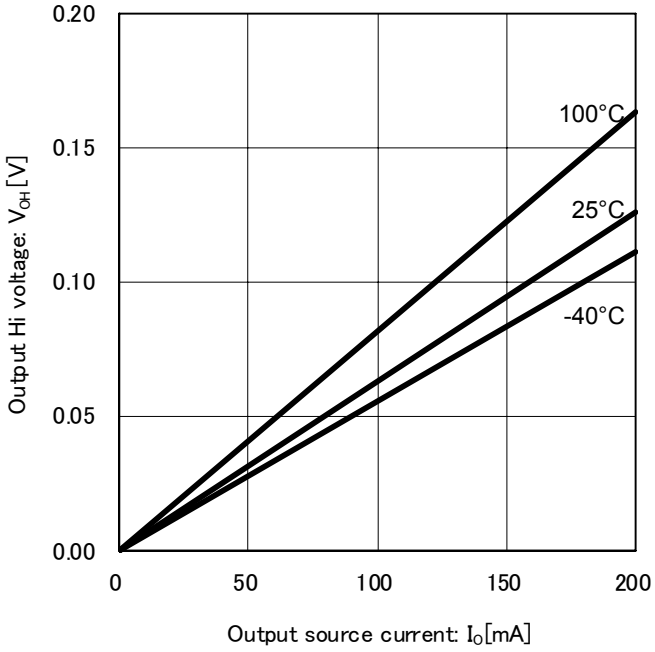


Fig.11 Output Hi voltage (Vcc=12V)

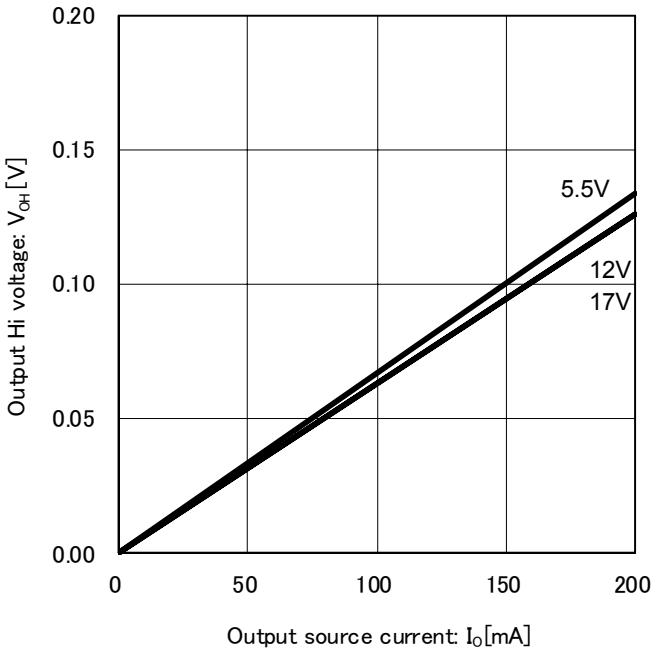


Fig.12 Output Hi voltage (Ta=25℃)

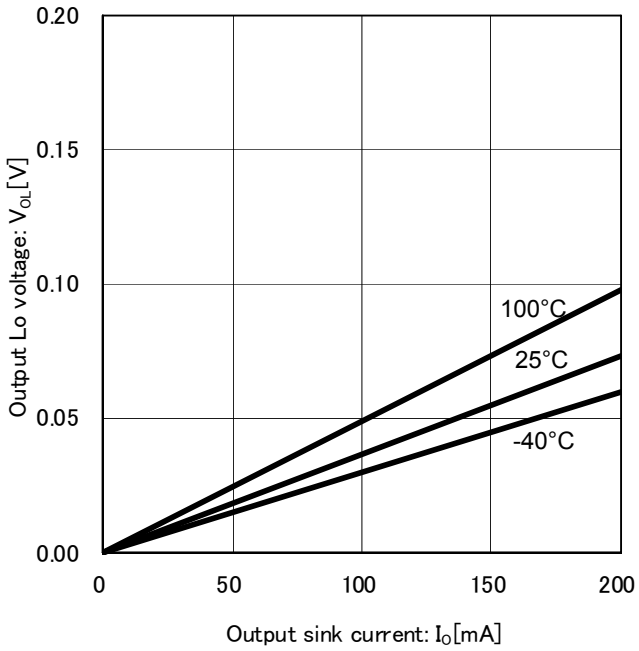


Fig.13 Output Lo voltage (Vcc=12V)

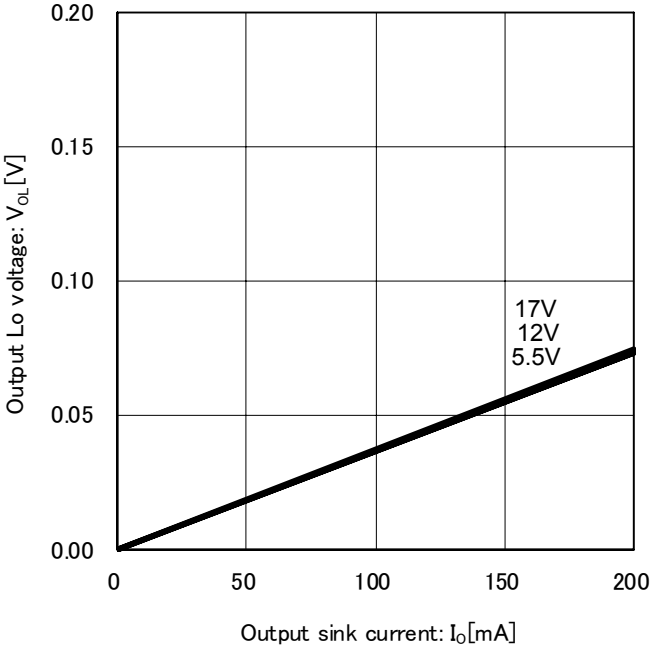


Fig.14 Output Lo voltage (Ta=25℃)

●**Application circuit example(Constant values are for reference)**

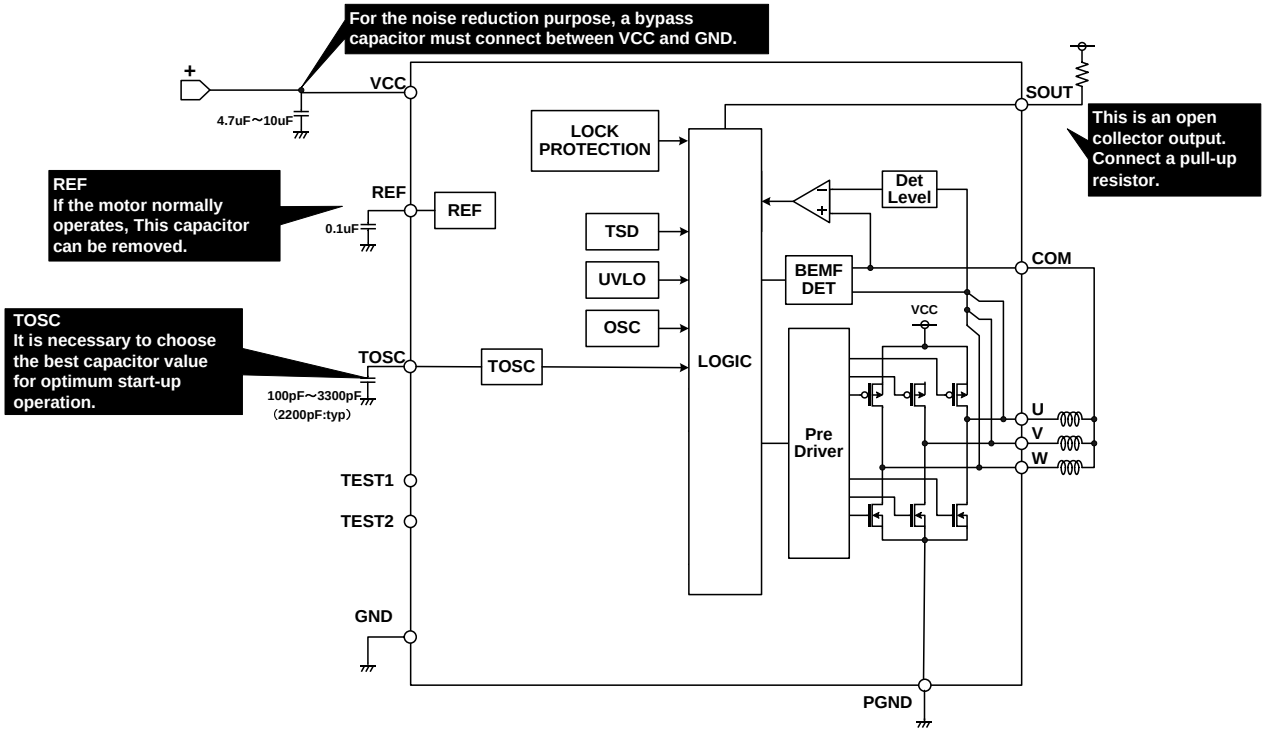


Fig.15 Application circuit

Substrate design note

a) IC power, motor outputs, and motor ground lines are made as fat as possible.
b) IC ground (signal ground) line is common with the application ground except motor ground, and arranged near to (–) land.
c) The bypass capacitor and/or Zenner diode are arrangement near to Vcc terminal.

●Description of operations

1) Sensorless Drive

BD6345FV is a motor driver IC for driving a three-phase brushless DC motor without a hall sensor. Detecting a rotor location firstly at startup, an appropriate logic for the rotation direction is obtained using this information and given to each phase to rotate the motor. Then, the rotation of the motor induces electromotive voltage in each phase wiring and the logic based on the induced electromotive voltage is applied to the each phase to continue rotating.

2) Motor output U,V,W and FG output signals

In Fig.16, the timing charts of the output signals from the U, V and W phases as well as the SOUT terminal is shown. Assuming that a three-slot tetrode motor is used, two pulse outputs of SOUT are produced for one motor cycle. The three phases are excited in the order of U, V and W phases.

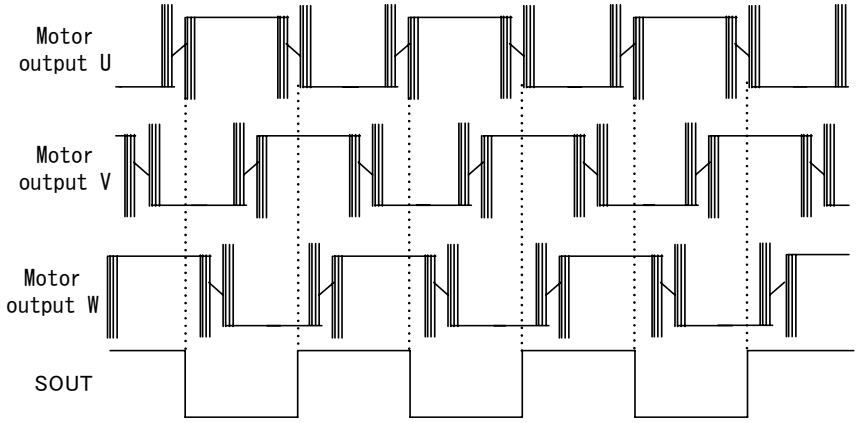


Fig.16 sensor-less drive

Output pattern	Motor output		
	Motor output U	Motor output V	Motor output W
1	H	L	Hi-Z
2	H	Hi-Z	L
3	Hi-Z	H	L
4	L	H	Hi-Z
5	L	Hi-Z	H
3	Hi-Z	L	H

* About the output pattern, It changes in the flow of “1→2→3 ～ 6→1”.

3) Lock Protection Feature, Automatic Recovery Circuit

To prevent passing a coil current on any phase when a motor is locked, it is provided with a function, which can turn OFF the output for a certain period of time and then automatically restore itself to the normal operation. During the motor rotation, an appropriate logic based on the induced electromotive voltage can be continuously given to each phase ; on the other hand, when the motor is locked, no induced electromotive voltage is obtained. Utilizing this phenomenon to take a protective against locking, when the induced electromotive voltage is not detected for a predetermined period of time (TON), it is judged that the motor is locked and the output is turned OFF for a predetermined period of time (TOFF). In Fig.17, the timing chart is shown.

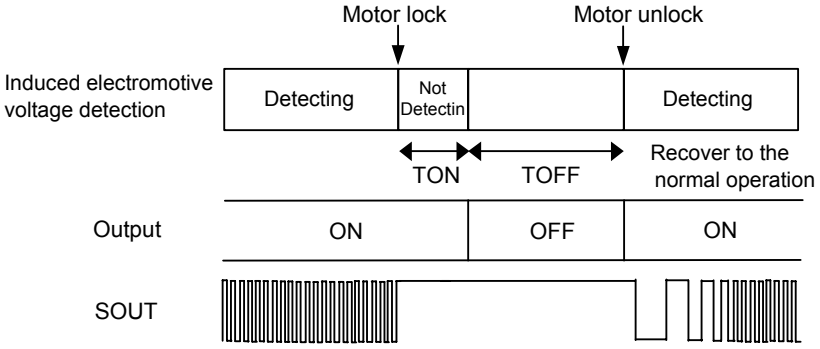


Fig.17 Lock protection

4) SOUT signal mask time when power supply is turned on
SOUT signal is masked at start operation.
When supply is turned on, SOUT signal is fixed Hi between 0.6sec. SOUT signal operates usually after 0.6 sec.

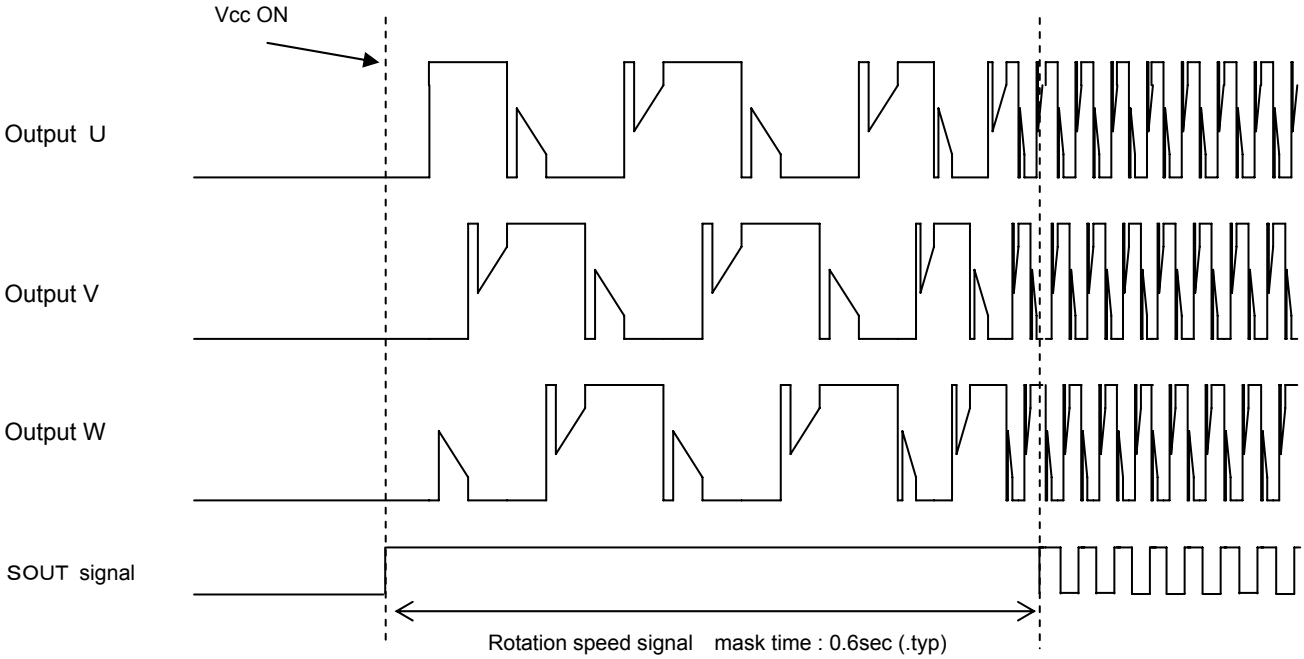


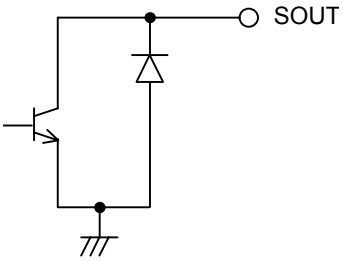
Fig.18 SOUT operation at start

5) UVLO（Under voltage lock out circuit）
In the operation area under the guaranteed operating power supply voltage of 5.5V (typ.), the transistor on the output can be turned OFF at a power supply voltage of 3.9V (typ.). A hysteresis width of 250mV is provided and a normal operation can be performed at 4.15V(typ.). This function is installed to prevent unpredictable operations, such as a large amount of current passing through the output, by means of intentionally turning OFF the output during an operation at a very low power supply voltage which may cause an abnormal function in the internal circuit.
About turning off a output voltage at UVLO, It becomes a OFF mode.
(Upper MOS FET and Under MOS FET are turned OFF.)

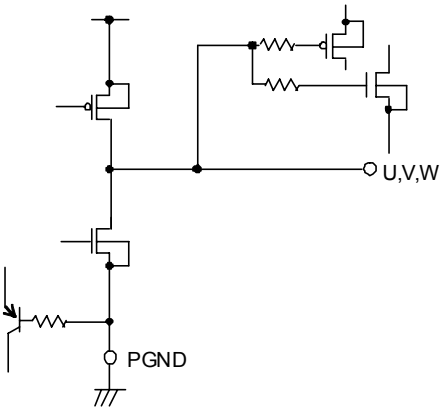
6) Motor start up frequency setting
The TOSC terminal starts a self-oscillation by connecting a capacitor between the TOSC terminal and GND terminal. It becomes a start-up frequency, and synchronized time can be adjusted by changing external capacitor. When the capacitor value is small, synchronized time becomes short. It is necessary to choose the best capacitor value for optimum start-up operation.

●**Equivalent circuit**

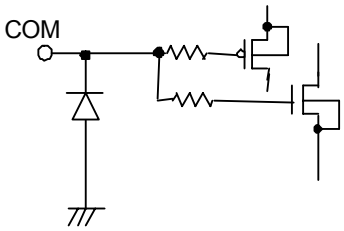
1) SOUT output terminal



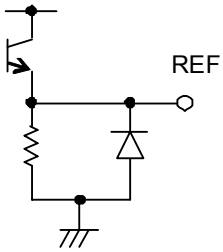
2) Motor output terminal



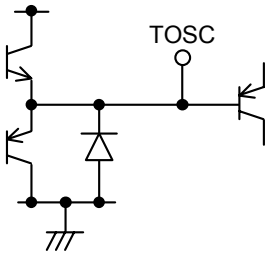
3) Coil midpoint terminal



4) Reference voltage terminal



5) Oscillating capacitor connecting terminal



●Safety measure

1) Reverse connection protection diode

Reverse connection of power results in IC destruction as shown in Fig.19. When reverse connection is possible, reverse connection protection diode must be added between power supply and V_{CC}.

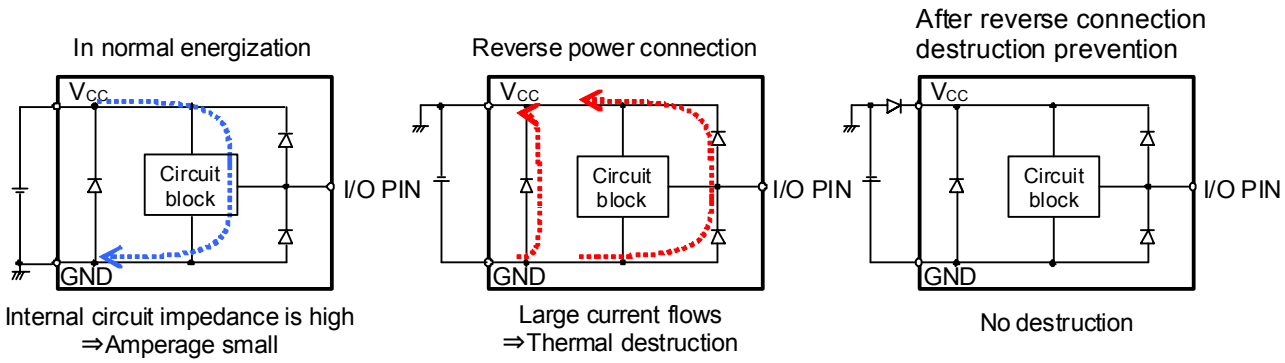


Fig.19 Flow of current when power is connected reversely

2) Measure against V_{CC} voltage rise by back electromotive force

Back electromotive force (Back EMF) generates regenerative current to power supply. However, when reverse connection protection diode is connected, V_{CC} voltage rises because the diode prevents current flow to power supply.

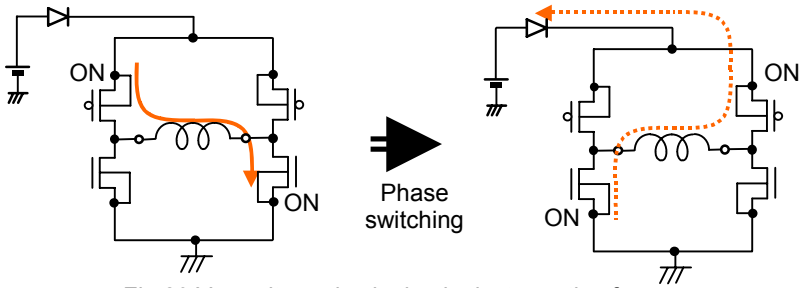


Fig.20 Vcc voltage rise by back electromotive force

When you use reverse connection protection diode, Please connect Zenner diode.
Do not exceed absolute maximum ratings Vcc=20V.

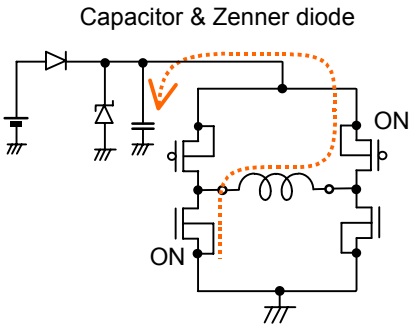


Fig.21 Measure against VCC voltage rise