Datasheet

FS6989

Single-phase Full-wave Motor Driver

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1. General Description

The FS6989 is a single-phase full wave brushless DC motor driver IC with the functions for thermal shutdown, lock protection, power polarity reverse protection, hall bias circuit and external PWM speed control. The driver is optimal for single coil fan applications with less external components.

The FS6989 is available in an 8-lead MSOP-8 package.

2. Features

- Support Single-Phase Full-Wave Brushless DC Motor Driver
- Soft switched drive
- Built-in hall sensor input amplifier
- Low voltage startup (VDD = 2.8V)
- High output sinking and driving capability
- Lock detection and automatic self-restart
- Thermal shutdown circuit
- External PWM control signal input
- FG open drain output, suitable for 4-poles fan motor
- 8-pin MSOP-8 package

3. Applications

- Single Phase Full Wave Brushless DC Motor

4. Ordering Information

FS6989A-P

Package Type
P: Pb Free Standard

5. Pin Configurations

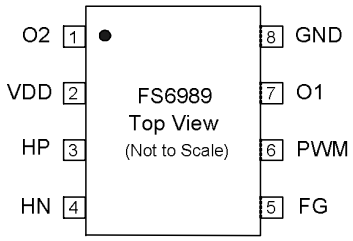

Fig1 Pin Configuration

6. Pin Description

Pin	Name	Function
1	O2	Motor output terminal
2	VDD	Power supply terminal
3	HP	Hall input terminal
4	HN	Hall input terminal
5	FG	FG signal output terminal
6	PWM	PWM signal input terminal
7	O1	Motor output terminal
8	GND	GROUND terminal

7. Functional Block Diagram

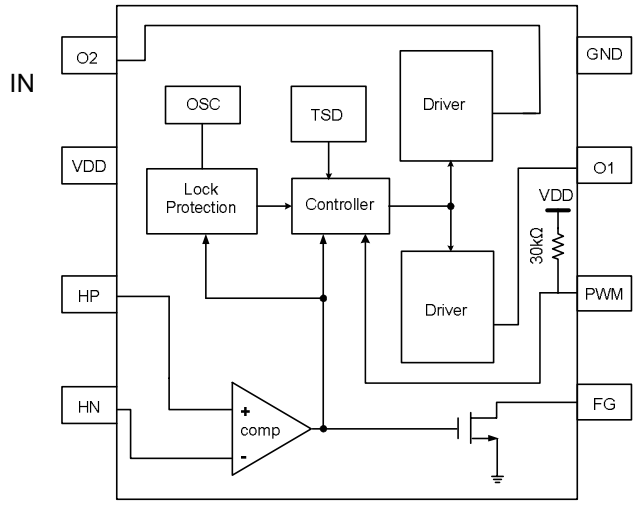

Fig2 Functional Block Diagram

8. Typical Application Circuit

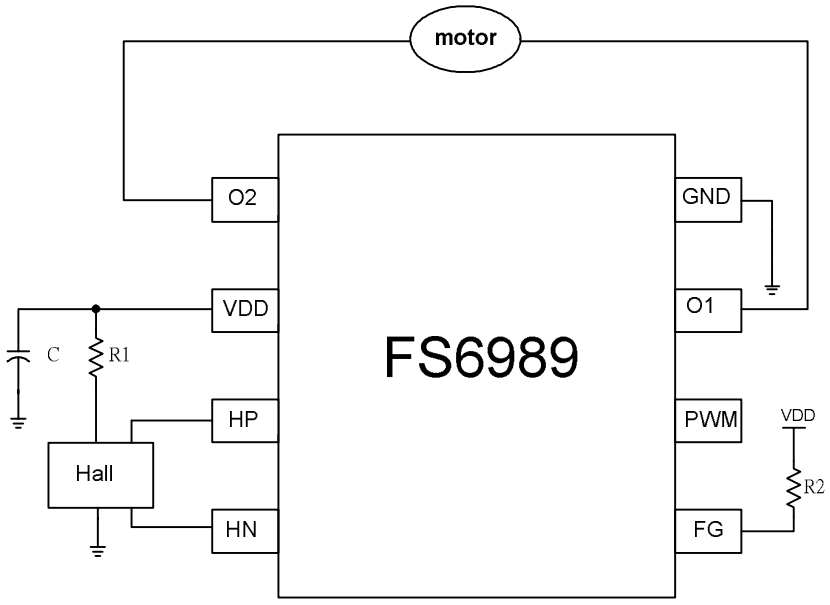

Fig3 Application Circuit

9. Absolute Maximum Ratings*

(T_A = 25℃ unless otherwise noted.)

VDD (Supply Voltage)……–0.3V to +7V

I_{OUT} (Maximum Output Current)……800mA

I_{FG} (FG Output Current)……10mA

Pd (Power Dissipation)……600mW

T_{OPR} (Operating Temperature Range)…… -40℃ to +125℃

T_{STG} (Storage Temperature Range)…… -55℃ to +150℃

TJMAX (Junction Temperature)……150℃

8-Lead MSOP-8:

θ_{JA} Thermal Impedance……112℃/W

Lead Temperature, Soldering

Vapor Phase (60sec)……215℃

Infrared (15sec)……220℃

*Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those listed in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

10. Operating Conditions (Ta = 25℃)

Parameter	Symbol	Limit	Unit
Operating Supply Voltage Range	V_{DD}	2.8 ~ 6.5	V
Hall Input Voltage Range	V_H	0 ~ V_{DD}-1.1	V

11. Electrical Characteristic (V_{DD} = 5V, Ta = 25℃)

Parameter	Unit			Unit	Test Condition/Comments
	Min	Typ	Max		
HP/HN Input Terminal					
V_{HYS} (Input Hysteresis Voltage)	±5	±10	±20	mV	
PWM Input Terminal					
PWM Input High Level	0.8*V_{DD}		V_{DD}+0.4	V	
PWM Input Low Level	-0.4		0.2* V_{DD}	V	
Input Frequency	0.02		50	KHz	
O1/O2 Output Terminal					
V_{OH} Output Voltage High	4.4			V	I_{OUT} = 400mA
V_{OL} Output Voltage Low			0.6	V	I_{OUT} = 400mA
I_{OUT} Output Current		400		mA	R_L = 10Ω
FG Open Drain Terminal					
I_{LEAK} Output Leakage Current			5	μA	V_{FG} = 5V
V_{FGOL} FG Output Voltage Low			0.3	V	I_{FG} = 7.5 mA
Automatic Self-Restart Circuit					
T_{ON}		256		ms	
R_{DR}		7			T_{OFF} / T_{ON}

12. Truth Table

HP	HN	PWM	O1	O2	FG
H	L	H	H	L	L(Output Tr: ON)
L	H	H	L	H	Z(Output Tr: OFF)
H	L	L	L	L	L(Output Tr: ON)
L	H	L	L	L	Z(Output Tr: OFF)

13. Detail Description

1. Wide supply voltage range
   The FS6989 drives fan motor with wide supply voltage range from 2.8 ~ 6.5V. With low voltage start-up feature, the design, specifications and performance have been optimized for 3V and 5V single-phase full-wave brushless DC motor applications.

2. FG pin open-drained output
   The FG pin is an open-drained output and the output frequency is the same with that sensed by HALL sensor. With suitable output pull up, the fan tachometer output can be used directly with bipolar or MOS logic for motor speed monitoring/control. This output is suitable for standard 4 poles fan applications.

3. Thermal shutdown (TSD)

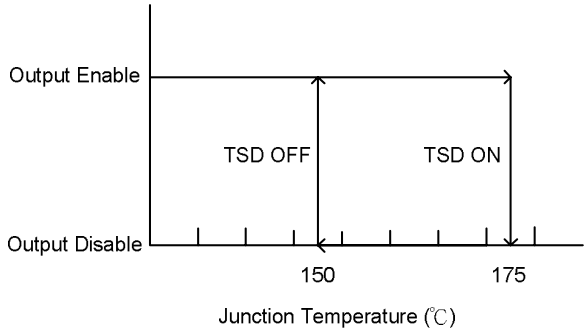

Fig4 Thermal shutdown

A thermal shutdown circuit is built in FS6989 with 25℃(Typ) hysteresis.

- TSD ON (Typ: 175℃): Force all output to low and shutdown all blocks.
- TSD OFF (Typ: 150℃): Recover to ordinary operation.

4. Reverse connection of power supply
   There is no requirement of protection diode for power reverse fault in normal applications. The power polarity protection circuit is built-in.

5. Power supply line
   The connection of the capacitor or Zener Diode between VDD and GND, and a capacitor between two Hall sensor outputs will increase stability of operation, if required.

6. Hall signal input (HP HN)

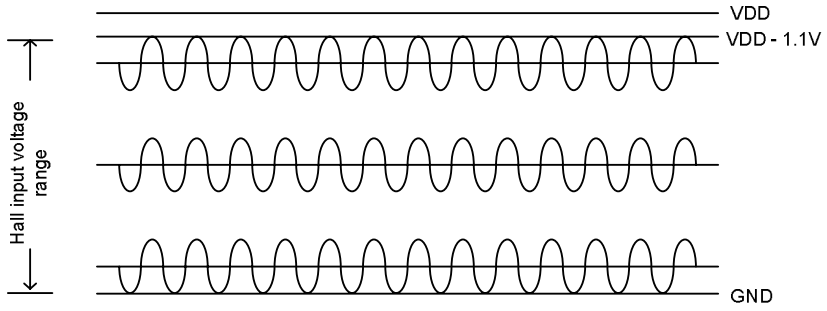

Fig5 Hall Input Voltage Range

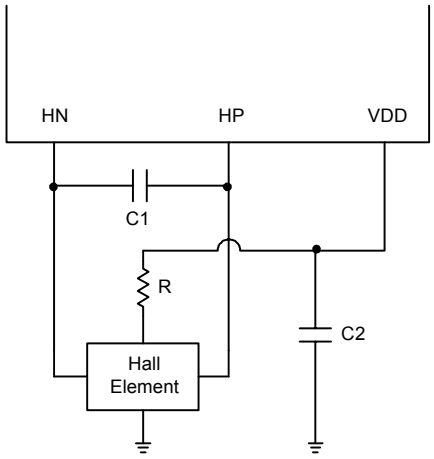

Fig6 Hall Element Application Circuit

- Please adjust hall input voltage amplitude within range 0.4V ~ V_{DD}-1.1V
- The hall amp of this IC has ± 10mV (Typ.) input hysteresis to against environmental noise. If the V_{DD} noise still influences the hall signal by board wiring pattern, please connect capacitor C2 in fig6. If there is long board wiring pattern from hall element to hall signal input terminal, please connect C1 like fig6.

7. PWM Speed Control

It is easy to change rotation speed of the motor by switching output transistor. The on-duty of switching depends on the input signal to PWM terminal. The rotation speed of the motor is proportional to the duty ratio of the input signal to PWM terminal.

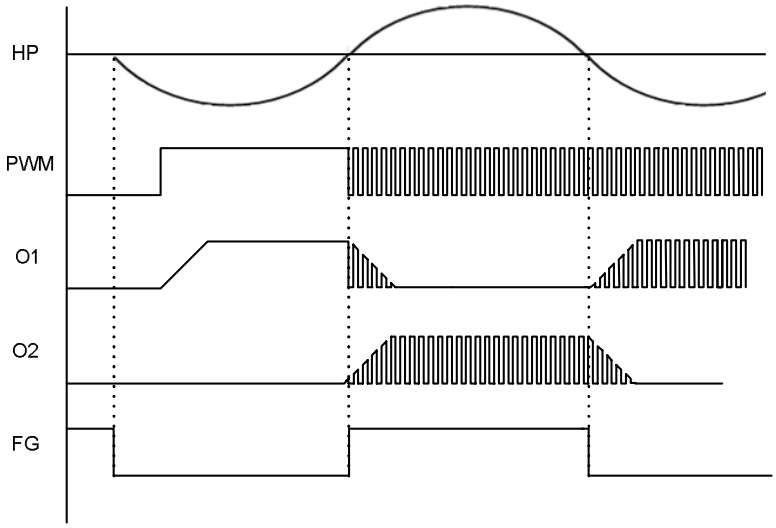

Fig7 PWM speed control timing chart

The PWM terminal is internally pulled high. When PWM terminal is open, it is equal to high.

PWM terminal has input hysteresis. It is ±600mV (Typ.)

8. There is no need of external timing capacitor for lock protection and auto-restart function. This driver IC detects the rotation of the motor by hall signal, and control output on time and off time by internal counters. The driver will be shut down roughly 1 ~ 3 seconds after the motor is locked. When the drivers have been shut down, the automatic self-restart circuit will try to power up the drivers every 1 ~ 3 seconds until lock is released.

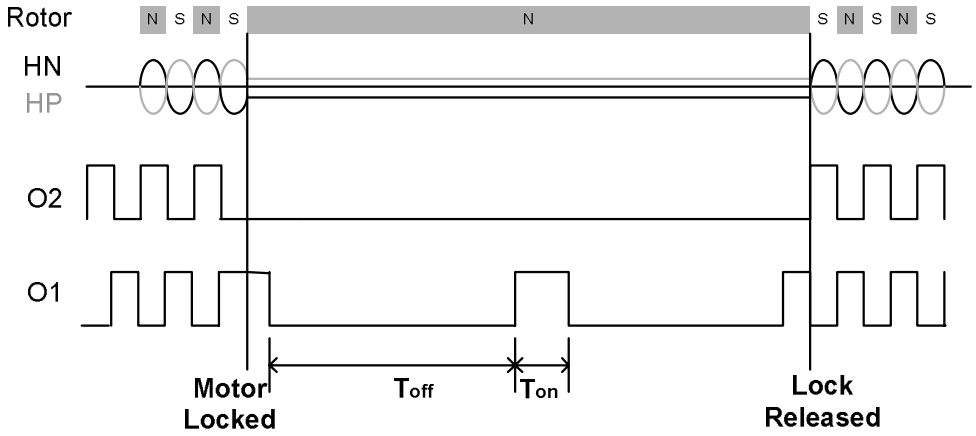

Fig8 Lock protection and auto-restart waveform

9. The power dissipated by the IC varies widely with the supply voltage, the output current, and loading. It is important to ensure the application does not exceed the allowable power dissipation of the IC package. The recommended motor driver power dissipation versus temperature is depicted as follows.

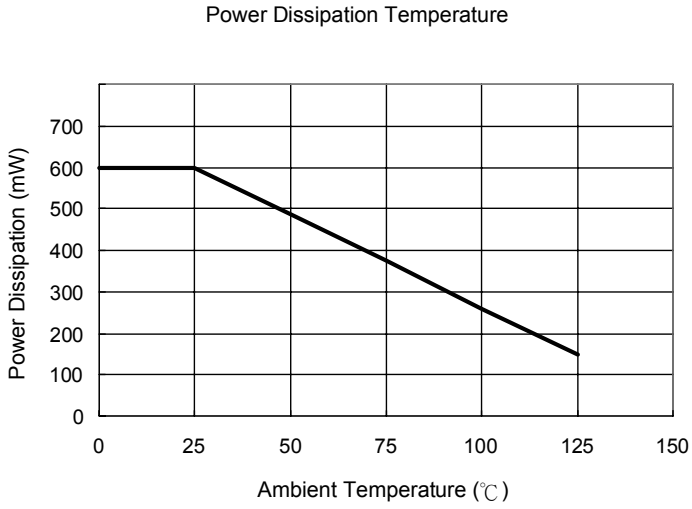

Fig9 Power dissipation versus temperature

To use at temperature above Ta=25℃ reduce 4.6mW/℃

14. Package Outline

14.1 MSOP－8

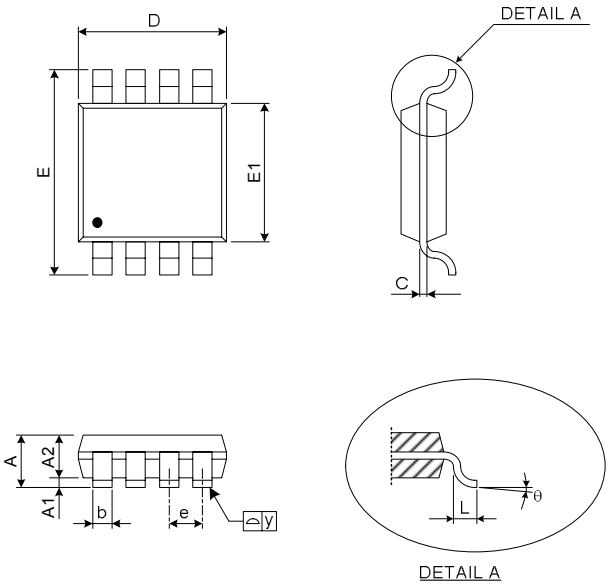

Fig10 Package Outline

Symbols	Dimensions in Millimeter			Dimensions in Inch		
	Min	Nom	Max	Min	Nom	Max
A	0.81	0.95	1.10	0.032	0.0375	0.043
A1	0.05	0.09	0.15	0.002	0.004	0.006
A2	0.76	0.86	0.97	0.030	0.034	0.038
b	0.28	0.30	0.38	0.011	0.012	0.015
C	0.13	0.15	0.23	0.005	0.006	0.009
D	2.90	3.00	3.10	0.114	0.118	0.122
E	4.70	4.90	5.10	0.185	0.193	0.201
E1	2.90	3.00	3.10	0.114	0.118	0.122
e	----	0.65	----	----	0.026	----
L	0.40	0.53	0.66	0.016	0.021	0.026
θ	0^0	----	6^0	0^0	----	6^0
L1	0.85	0.95	1.05	0.033	0.037	0.041

REVISION HISTORY

Ver.	Date	Page	Description	Revised By
0.1	2006/1/20	-	New Release.	J.S.Hu
0.2	2006/11/1	-	Format Revised	J.S.Hu
		3	Ordering information Revised	J.S.Hu
		6	Electrical Characteristic VHYS Max changed to ± 20 mV	
		9	Fig 7 PWM speed control timing chart revised	