3-Phase Sensorless Fan Motor Driver

DESCRIPTION

EUM6801 is a 3-phase sensorless fan motor driver. It senses the BEMF (Back Electromotive Force) of the motor in rotation and provides corresponding commutation current to the motor. The sensorless technology doesn't need Hall sensors. The absence of the Hall sensor makes the fabrication of the motor easier, especially suitable for ultra-small motors.

EUM6801 integrates PWM speed control, soft switching, lock protection, auto restart, fan tachometer and forward/reverse functions.

As applying 3-phase driver method, PWM mode controls fan speed by adjusting duty cycle of PWM signal. Internal soft switching function drives fan motor in low noise and low vibration ways. EUM6801 can drive motor from stop mode to rotation mode by adjusting the external capacitor between OSC pin and GND pin. If a motor is stalled by external force or obstacles, over-driving current may incur coil overheat and burning. To prevent motor from overheating, the lock protection circuit shuts down the internal power devices for a few seconds after the motor lock is detected. Then the auto restart circuit resumes to power up the internal power devices. If the lock still persists, EUM6801 shuts down power devices for another few seconds. The lock protection time is built-in and need no external components. During rotation, FG outputs signal which represents motor speed. The motor rotation direction is controlled by setting FR to high or low.

FEATURES

- 3-Phase Sensorless Drive Function (No Hall Sensor Needed)
- Few External Components (3 CAP Only)
- Low Startup Voltage: <1.8V
- PWM Speed Control and Soft Switching
- 20μA Low Standby Current
- Built in FG Outputs
- Built in Thermal Protection
- UDFN Small Package with Thermal Pad (3mm×3mm×0.5mm for Small Fan)
- RoHS Compliant and 100% Lead (Pb)-Free Halogen-Free

APPLICATIONS

- NB Fan, Low Noise Fan and Low Power Consumption Fan

Application Circuit

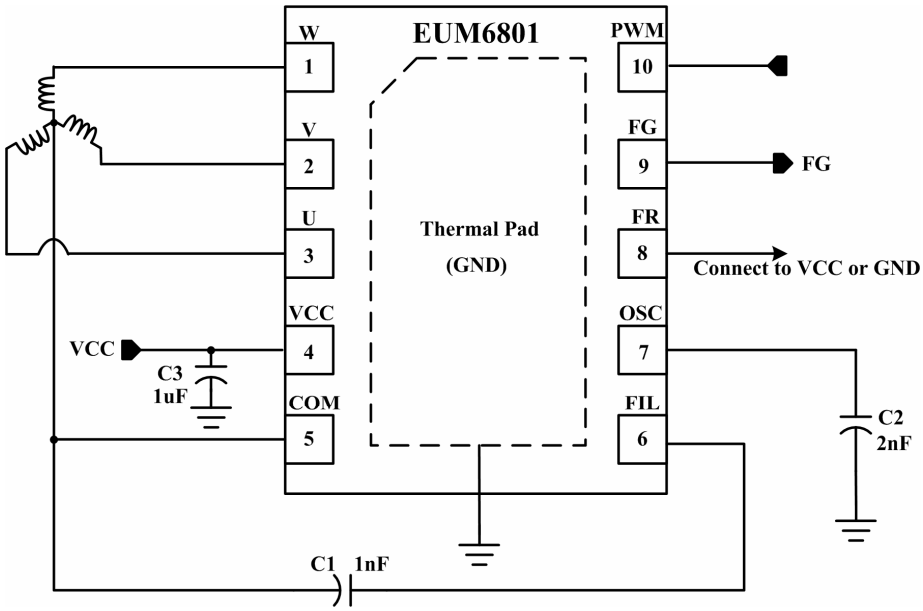
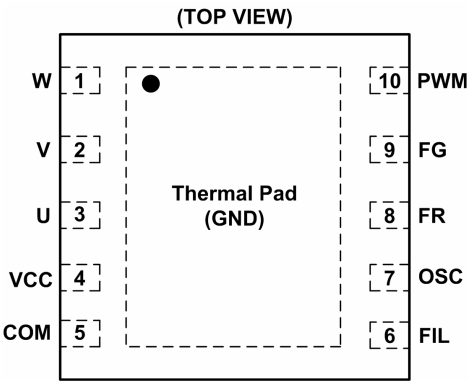


Figure 1.

Pin Configurations

Package Type	Pin Configurations
UDFN-10	

Pin Description

PIN	UDFN-10	DESCRIPTION
W	1	3-phase output pin
V	2	3-phase output pin
U	3	3-phase output pin
VCC	4	Power supply
COM	5	Motor coil middle point connection
FIL	6	Filter CAP connection pin
OSC	7	Startup OSC setting pin
FR	8	Rotation direction control
FG	9	Rotation speed feedback output
PWM	10	PWM control pin
GND	Thermal Pad	Ground

Ordering Information

Order Number	Package Type	Marking	Operating Temperature Range
EUM6801SIR1	UDFN-10	xxxxx M6801	-30°C to 90°C

EUM6801 □ □ □ □

Lead Free Code
1: Lead Free, Halogen Free

Packing
R: Tape & Reel

Operating temperature range
I: Industry Standard

Package Type
S: UDFN

Block Diagram

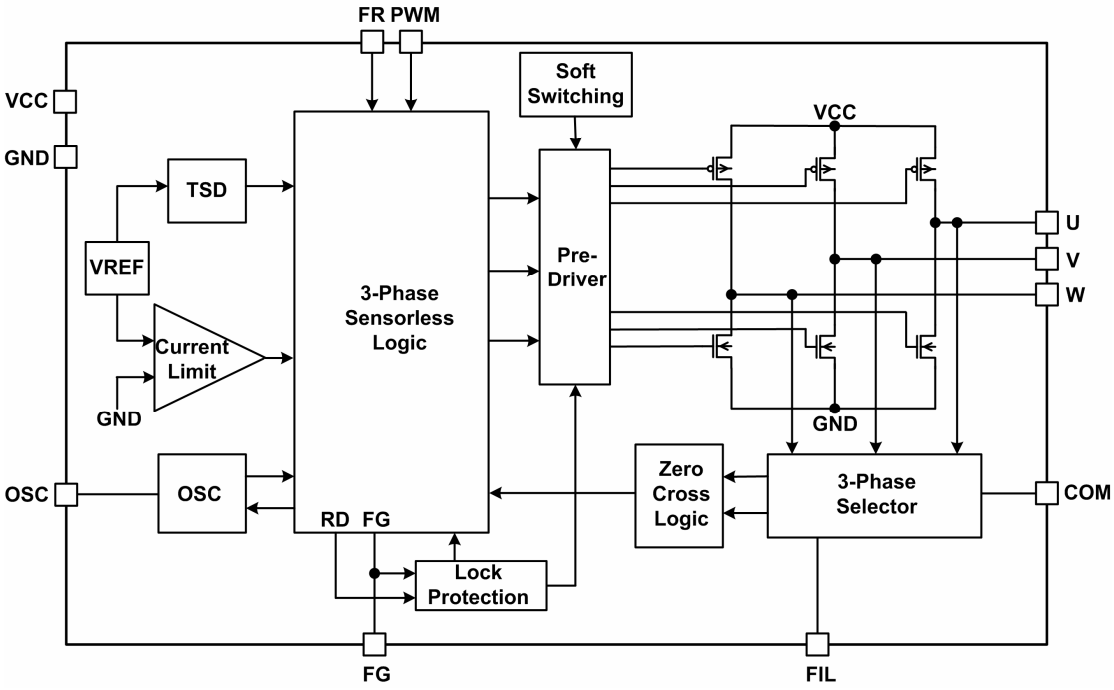


Figure 2.

Power Dissipation

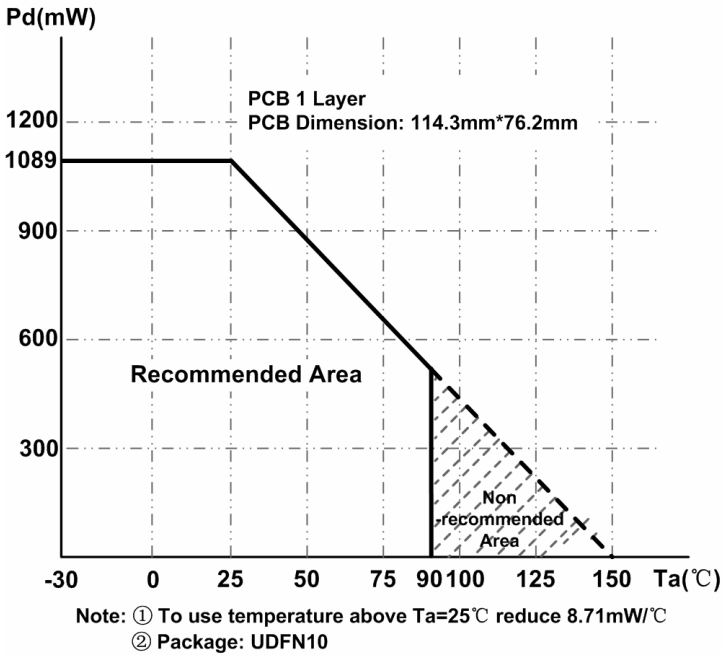
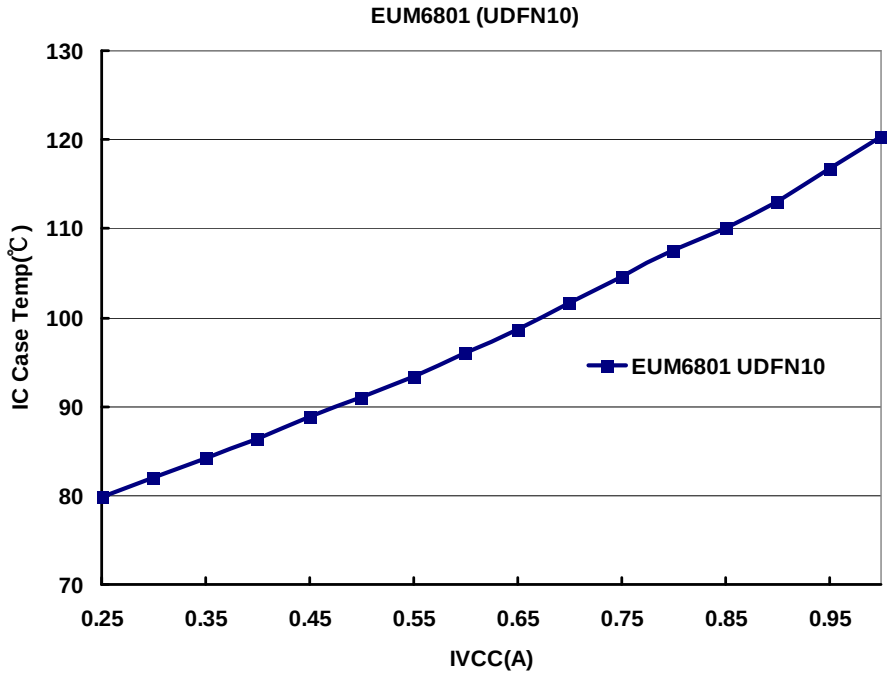


Figure 3. Power Dissipation Curve

IC Case Temperature VS Current



Note(1): VCC=5V, T_A=70°C.

Note(2): Single Layer Annular PCB, inner diameter = 5mm, outer diameter = 20mm.

Figure 4.

Absolute Maximum Ratings (1)

- VCC, FG, U, V, W to GND ---------- -0.3V to 7V
- Iout ---------- 0.9A
- IFG ---------- 10mA
- Maximum Junction Temperature ---------- +150°C
- Lead Temperature (Soldering, 10sec.) ---------- +300°C
- Package Thermal Resistance θ_{JA} (UDFN-10) ---------- 114.81°C/W (2)
- Power Dissipation PD @ T_A=+25°C (UDFN-10) ----------1089 mW (2)
- Storage Temperature ---------- -55°C to +150°C
- ESD Ratings Human Body Mode ---------- 2kV
- Thermal Shut Down----------180°C

Recommended Operating Conditions (3)

- Supply Voltage VCC ---------- 1.8V to 6.0V
- Operating Temperature Range ---------- -30°C to +90°C

Note (1): Stress beyond those listed under "Absolute Maximum Ratings" may damage the device.

*Note (2): PCB: 1 layer, dimension 114.3mm*76.2mm.*

Note (3): The device is not guaranteed to function outside the recommended operating conditions.

Electrical Characteristics

Specifications in standard type face are for T_A=+25°C, and those with **boldface type** apply over the full operating temperature range T_A=-30°C ~+90°C. VCC＝5.0V unless otherwise specified.

	Parameter	Conditions	EUM6801			Unit
			Min.	Typ.	Max.	
ICC1	Power supply current 1	PWM pin = VCC	-	1.35	2	mA
ICC2	Power supply current 2	PWM pin = 0V	-	20	30	μA
Output						
Ron(H)	Output upper side saturation	I_O=500mA	-	0.5	0.6	Ω
Ron(L)	Output lower side saturation	I_O=500mA	-	0.5	0.75	Ω
Ron(Total)	Ron(H)+ Ron(L)	I_O=500mA	-	1	1.35	Ω
Startup Oscillation						
IOSC1	CPWM charge current		2.5	3	3.5	μA
IOSC2	CPWM discharge current		2.4	3	3.5	μA
Vpp	CPWM peak to peak voltage			0.5		V
PWM Input Signal						
VPWMH	High-level input voltage		2.5		VCC	V
VPWML	Low-level input voltage		0		1.0	V
FPWM	Input frequency		20	25	50	kHz
IPWM	Input current	PWM pin=0V	-	-20	-30	μA
FG & RD Signal Output						
VFG	FG pin low voltage	IFG = 5mA	-	0.1	0.15	V
IFGL	FG pin leak current	VFG = 7V			0.1	μA
Lock Protection and Auto-Restart						
Ton	Lock detection on time		1.4	2	2.3	s
Toff	Lock detection off time		3.1	4	4.5	s
Thermal Shutdown						
TSD	TSD operating temperature	Design Target		180		°C
ΔTSD	Temperature hysteresis width	Design Target		35		°C

APPLICATION NOTES

PWM Input Terminal

The EUM6801 adopts the synchronous commutation PWM drive method to minimize power loss in the output circuits. To further minimize the power loss in the driver IC, low on-resistance power devices are used in EUM6801.

EUM6801 is able to control motor rotation speed by switching power device through an externally input PWM signal. To charge the motor coil current or to re-circulate the motor coil current depends on the input signal of PWM terminal. When the PWM input signal is high, the power device is ON, and the current in motor coil is charged; when the PWM input signal is low, the power device is OFF, and the current in motor coil is re-circulated.

When the PWM terminal is open, the built-in resistor causes the PWM pin to change to high-level voltage and the motor speed rises to full speed. And when PWM pin is fixed at low-level voltage, the motor decelerates, and after the motor stops it enters into “Power Saving Mode”.

Soft Switching Circuit

To reduce the vibration and minimize acoustic noise during motor rotation, EUM6801 adopts variable duty soft switching technology during the phase changing.

Oscillation Startup Circuit

The OSC Pin is used for controlling motor startup. And the external capacitor should be connected between the OSC pin and GND pin. Through changing the capacitor value of OSC pin, we could adjust the external startup frequency, and the frequency can be given by:

$$f = \frac{1}{\frac{0.5V \times C_{OSC}}{I_{OSC1}} + \frac{0.5V \times C_{OSC}}{I_{OSC2}}} = \frac{3\mu A}{1V \times C_{OSC}}$$

Therefore, to optimize the startup characteristics, it is necessary to select a right value of the capacitor.

Motor Position Detection Comparator Filter

EUM6801 detects the position of motor by sensing the BEMF (Back Electromotive Force) of the motor in rotation and provides corresponding commutation current to the motor. Furthermore, the position information is got by the motor position detection comparator.

Therefore, it is necessary to add a capacitor between COM pin and FIL pin to prevent input noise. And the inserted filter capacitor can be 1nF to 10nF.

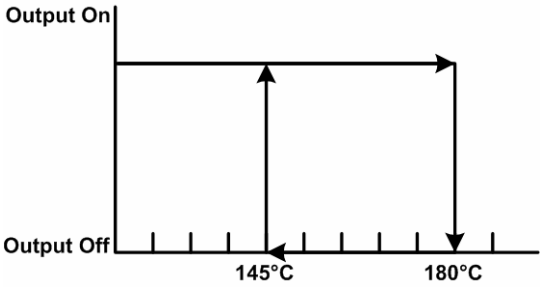
FG Output Circuit

FG pin has an open drain output structure. It must be used with a pull-up resistor. 10kΩ pull-up resistor is recommended.

FG provides a pulse signal, which is used for feedback motor rotation speed.

Thermal Shut Down

EUM6801 has built-in thermal shutdown protection function. And TSD has the temperature hysteresis.



TSD ON (TYP. 180°C): output transistor is OFF; TSD OFF (TYP. 145°C): reset ordinary motion. (It has the temperature hysteresis of 35°C <TYP.>).

Reverse Connection of Power Supply

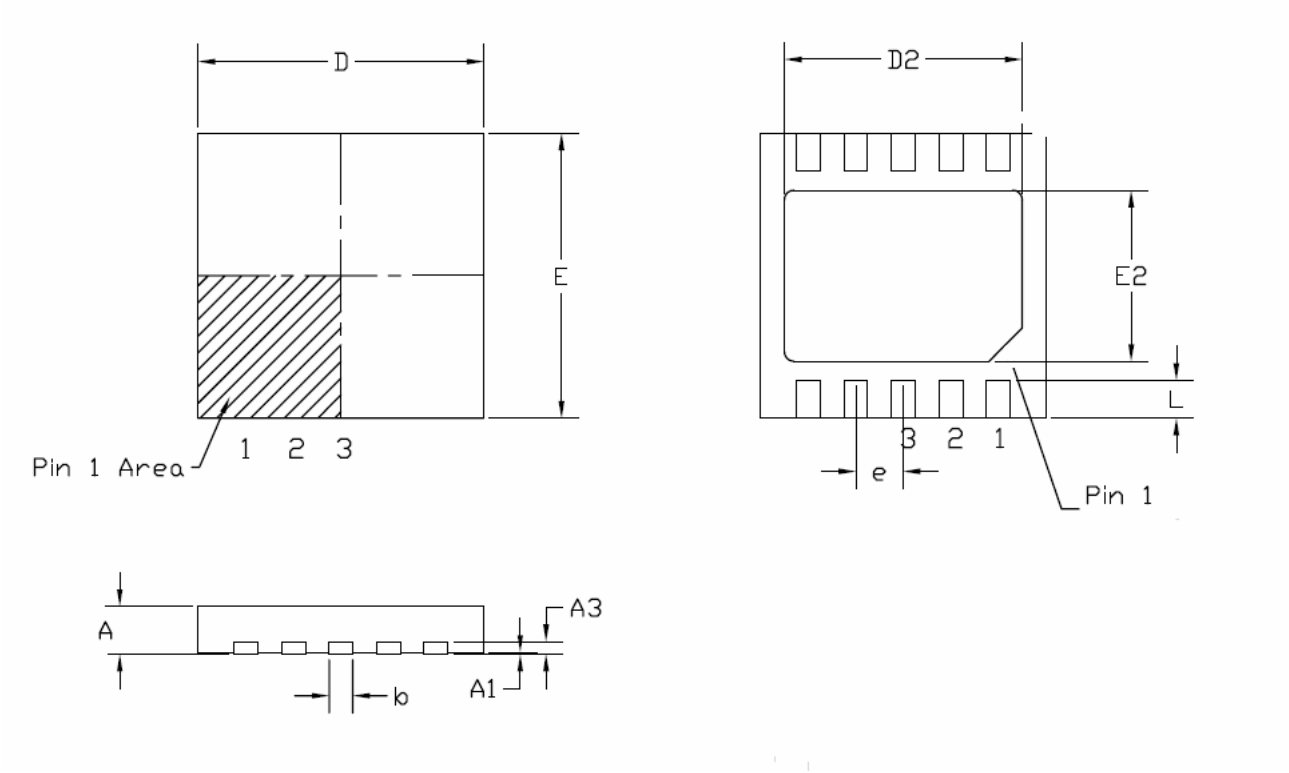
Reverse connection of power supply may break the devices. A countermeasure is needed such as using reverse current protection diode between power supply and VCC pin.

Note on PCB Pattern Design

Connect a ceramic capacitor 1.0μF or more between VCC pin and GND pin. And the capacitor should be as near as possible to the VCC pin and GND pin.

Packaging Information

UDFN-10



Note: Exposed pad outline drawing is for reference only.

SYMBOLS	MILLIMETERS			INCHES		
	MIN.	Normal	MAX.	MIN.	Normal	MAX.
A	0.45	0.50	0.55	0.018	0.020	0.022
A1	0.00	-	0.05	0.000	-	0.002
A3	0.13 REF			0.006 REF		
b	0.15	0.25	0.35	0.006	0.010	0.014
D	2.90	3.00	3.10	0.114	0.118	0.122
D2	2.40	2.50	2.60	0.094	0.098	0.102
E	2.90	3.00	3.10	0.114	0.118	0.122
E2	1.70	1.80	1.85	0.067	0.071	0.073
e	0.50 BSC			0.020 BSC		
L	0.35	0.40	0.45	0.014	0.016	0.018