3-Phase Sensorless Fan Motor Driver

DESCRIPTION

EUM6812A is a 3-phase sensorless fan motor driver. It is controlled by a variable speed provided through the PWM input signal. Its feature is sensorless drive which doesn't require a hall device as a location detection sensor. Furthermore, it does not need external BEMF filter capacitor and motor downsizing can be achieved by limiting the number of external components as much as possible.

EUM6812A integrates PWM speed control, soft switching, lock protection, auto restart, fan tachometer, current limit, under voltage lock out circuit and forward/reverse functions.

As the application of three-phase driving 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. EUM6812A 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 drive current may incur coil overheat and burning. In order 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 is still continuing, EUM6812A shuts down power devices for another few seconds. The lock protection time is built-in and does not need external components. During rotation, FG outputs motor speed feedback signal. The motor rotation direction can be changed by setting FR to high or low.

FEATURES

- 3-Phase Sensorless Drive (No Hall Sensor Needed)
- Input Voltage Range:1.8V~6.0V
- Total Driver H+L R_{ON} less than 950mΩ
- No Need BEMF External Filter Cap
- UVLO Protection
- PWM Speed Control and Soft Switching
- Few External Components
- 20μA Low Standby Current
- Built in TSD
- Available in UDFN-10 Package
- RoHS Compliant and 100% Lead (Pb)-Free Halogen-Free

APPLICATIONS

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

Application Circuit

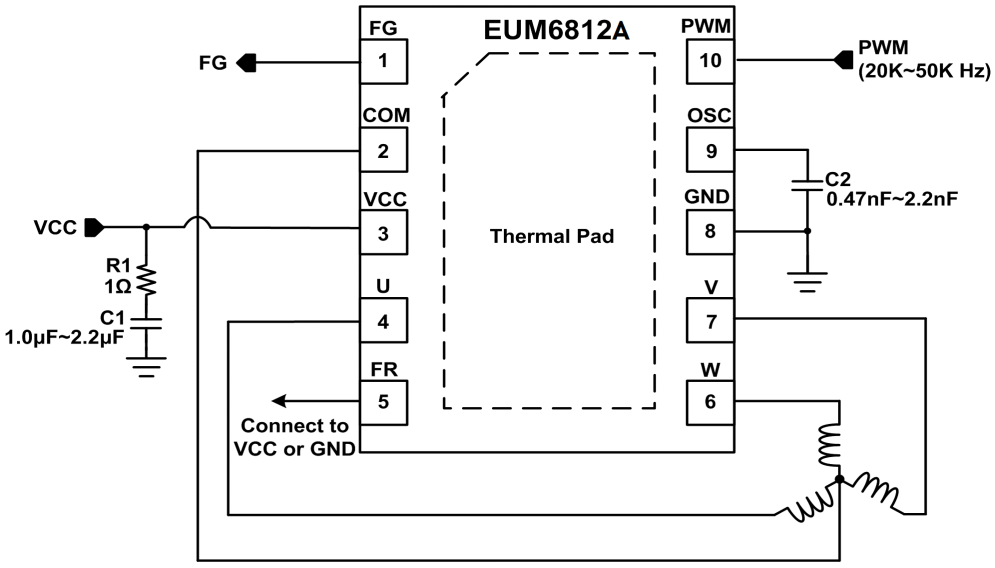
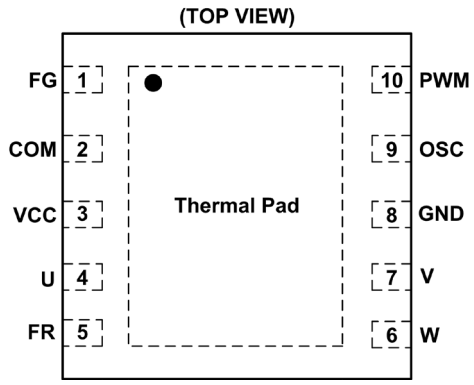


Figure 1.

Pin Configurations

Package Type	Pin Configurations
UDFN-10	

Pin Description

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

Ordering Information

Order Number	Package Type	Marking	Quantity per Reel	Operating Temperature Range
EUM6812ASIR1	UDFN-10	xxxxx 6812A	2500	-30°C to 90°C

EUM6812A □ □ □ □

- Lead Free Code
  1: Lead Free, Halogen Free
- Packing
  R: Tape & Reel
- Operating temperature range
  I: Industry Standard
- Package Type
  S: UDFN

Block Diagram

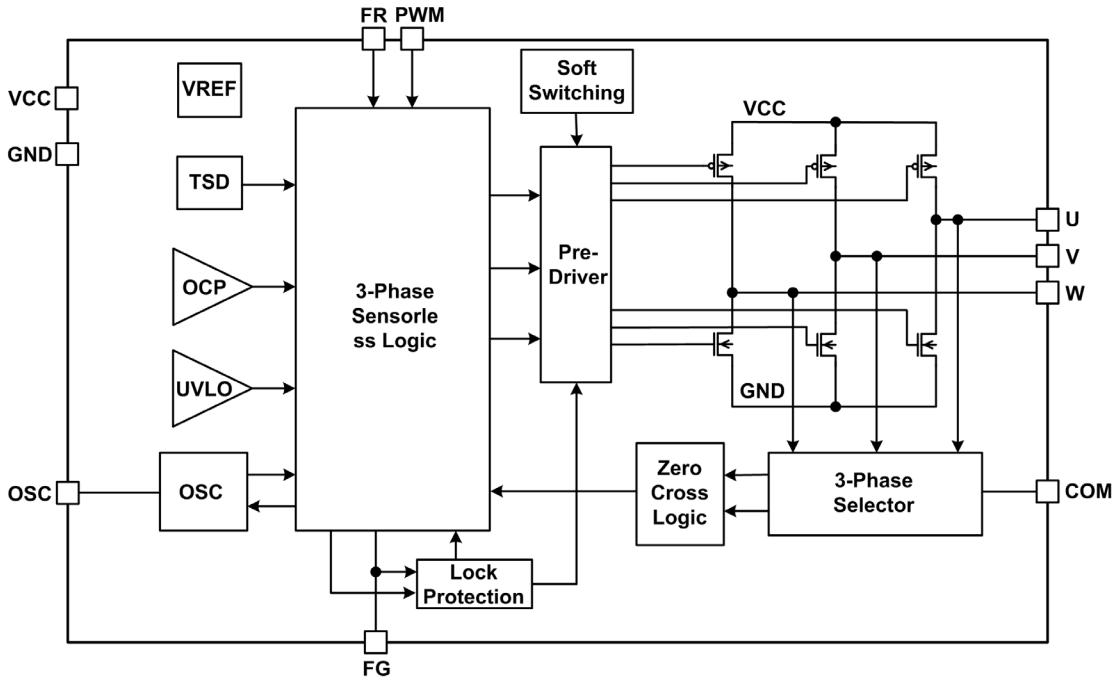


Figure 2.

Power Dissipation

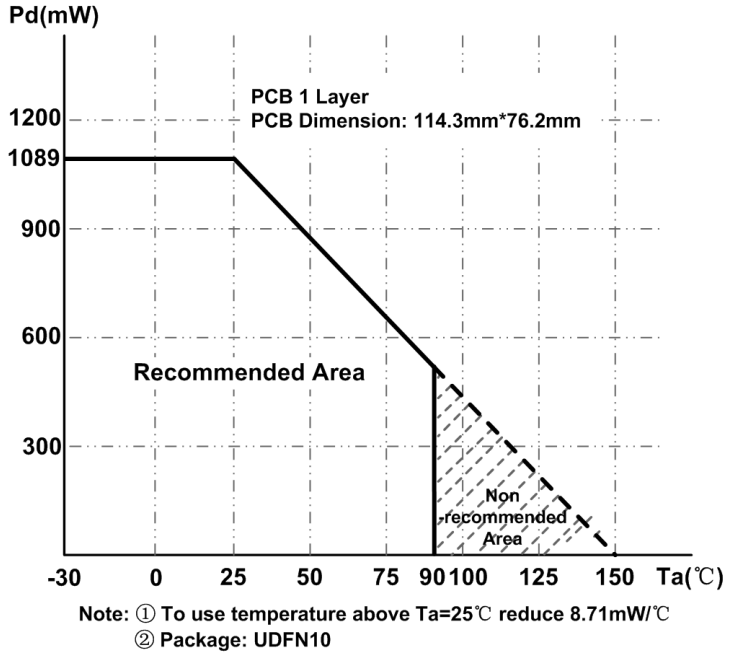
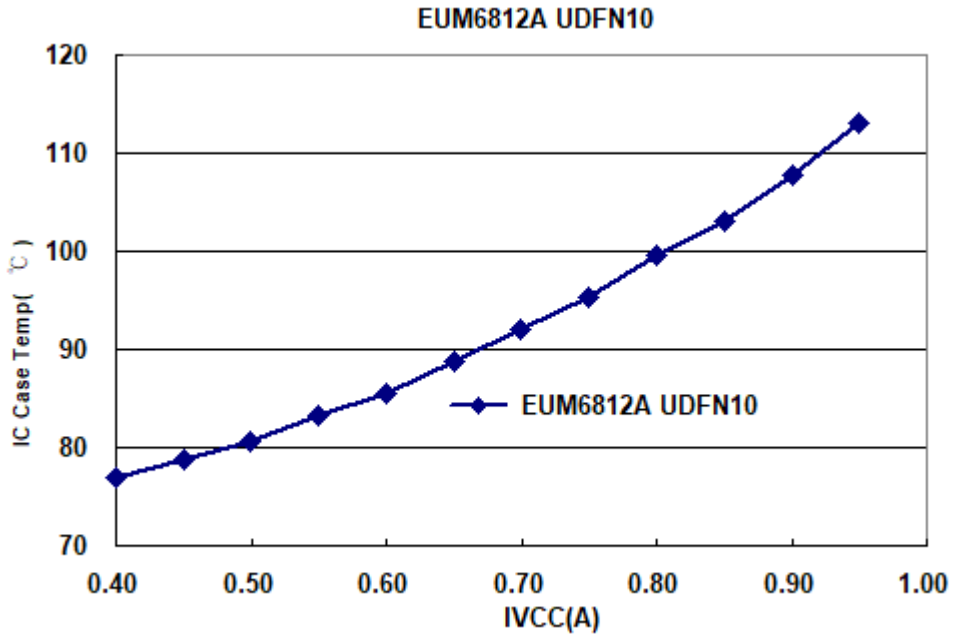


Figure 3. Power Dissipation Curve

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.) ---------- +260°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.

Symbols	Parameters	Conditions	EUM6812A			Unit
			Min.	Typ.	Max.	
ICC1	Power supply current 1	PWM pin = VCC	-	0.9	1.5	mA
ICC2	Power supply current 2	PWM pin = 0V	-	20	30	μA
Output						
Ron(H)	Output upper side saturation	Io=500mA		0.50	0.75	Ω
Ron(L)	Output lower side saturation	Io=500mA		0.40	0.60	Ω
Ron(Total)	Ron(H)+ Ron(L)	Io=500mA		0.90	1.35	Ω
Startup Oscillation						
IOSC1	CPWM charge current		7.5	10.4	13.3	μA
IOSC2	CPWM discharge current		7.5	10.4	13.3	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		0.8	V
FPWM	Input frequency		20	25	50	kHz
IPWM	Input current	PWM pin=0V	-30	-20	-	μA
FR Input Signal						
VFRH	High-level input voltage		3.0		VCC	V
VFRL	Low-level input voltage		0		1.0	V
FG & RD Signal Output						
VFG	FG pin low voltage	IFG = 5mA		0.05	0.15	V
IFGL	FG pin leak current	VFG = 7V			1.0	μA
Lock Protection and Auto-Restart						
Ton	Lock detection on time		0.65	1	1.35	s
Toff	Lock detection off time		3.3	5	6.8	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 synchronous commutation PWM drive method is used to reduce the power loss in EUM6812A. To further minimize the power loss in the driver IC, low on-resistance power devices are used in EUM6812A.

EUM6812A 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 pull high resistor causes the PWM pin 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, EUM6812A adopts variable duty soft switching technology during the phase changing.

UVLO (Under Voltage Lock Out)

In the operation area under the guaranteed operating power supply voltage of 1.8V (typ.), the transistor on the output can be turned OFF at a power supply voltage of 1.55V (typ.). A hysteresis width of 100mV is provided and a normal operation can be performed at 1.65V. 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.

Over Current Protection（Internal OCP Function）

A current passing through the motor coil can be detected on the internal current detection devices to prohibit a current flow large than a current limit value. The current limit value is determined by setting of the IC internal limit voltage and the internal current detection devices. The internal current limit value is 1.38A (typ.).

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:

$$f = \frac{1}{\frac{0.5V \times C_{OSC}}{I_{OSC1}} + \frac{0.5V \times C_{OSC}}{I_{OSC2}}} = \frac{10.4\mu A}{1V \times C_{OSC}}$$

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

Motor Position Detection Comparator Filter

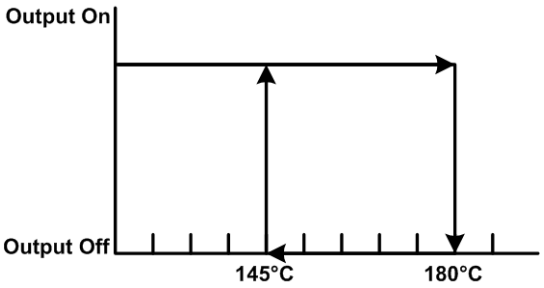
EUM6812A detects the position of motor by sensing the BEMF (Back Electromotive Force) of the motor in rotation and provides corresponding commutation current to the motor. Furthermore, the position information is got by the motor position detection comparator.

FG Output Circuit

FG pin have 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

EUM6812A is 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

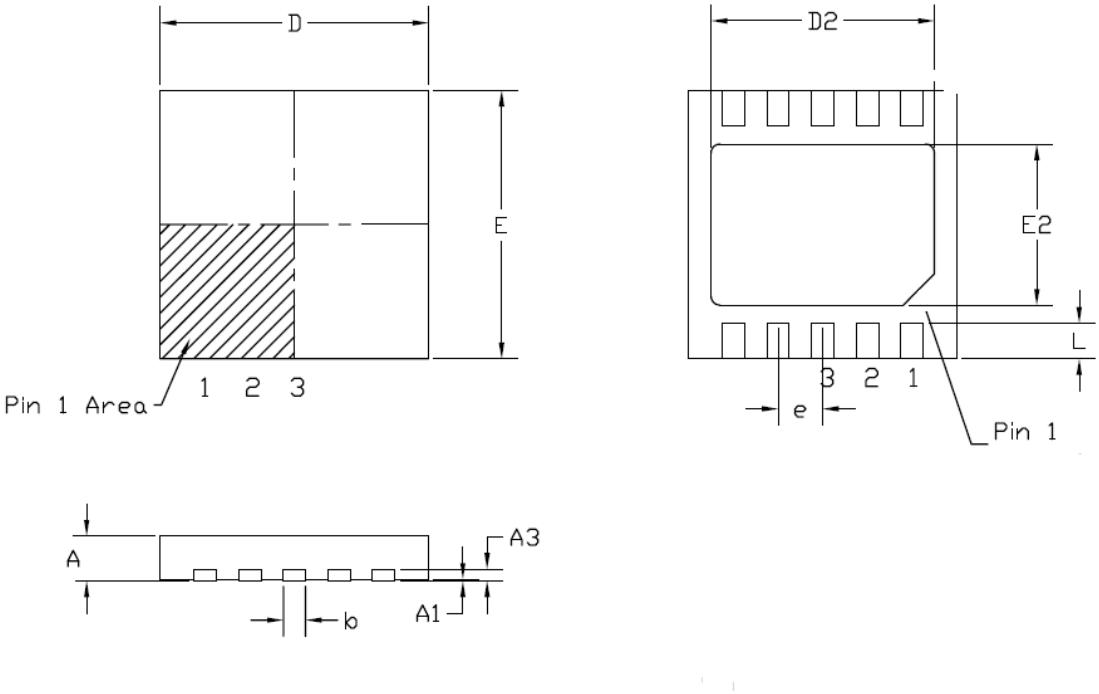
Reverse connection of power supply may break the devices. A countermeasure is needed such as using reverse current protection diode between power supply and VCC pin.

Notes 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	0.50	0.55	0.60	0.020	0.022	0.024
A1	0.00	-	0.05	0.000	-	0.002
A3	0.13 REF			0.005 REF		
b	0.15	0.23	0.35	0.006	0.009	0.014
D	2.90	3.00	3.10	0.114	0.118	0.122
D2	2.20	2.30	2.60	0.087	0.091	0.102
E	2.90	3.00	3.10	0.114	0.118	0.122
E2	1.50	1.60	1.85	0.059	0.063	0.073
e	0.50 REF			0.020 REF		
L	0.32	0.40	0.48	0.013	0.016	0.019