18V PWM Fan Motor Driver

DESCRIPTION

EUM6861/A/B/C is a fan motor driver for the single coil brushless DC motor. With its high efficient direct PWM control mode, EUM6861/A/B/C controls the speed of brushless DC motor with a built in HALL IC interface. EUM6861/A/B/C is suitable to drive variable speed motors for personal computer's power supply radiation fans and CPU coolers.

EUM6861/A/B/C integrates PWM fan speed control, minimum speed mode, soft start, fan tachometer, lock protection, auto restart and Hall Bias functions. PWM mode controls fan speed in low noise and low vibration ways by adjusting RCTL voltage. EUM6861/A/B/C can set minimum fan speed by presetting RMIN voltage. With soft start function, EUM6861/A/B/C can drive motor from slow speed to fast speed in a settable time by setting the external capacitor between SS and GND. If a fan motor is stalled by the external force or obstacles, overdrive 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 persists, EUM6861/A/B/C shuts off power devices for a few seconds. The lock protection delay time is externally programmable by a capacitor. EUM6861/C has built in motor rotation speed feedback (FG) output, motor rotation detection (RD) output and Hall sensor bias output.

FEATURES

- Built in 18V Full-wave Motor Driver for Fan Motor
- Built in Input Surge Protection, No Zener Diode Need
- External Programmable Soft Start and Soft Restart Function
- Wide Input Range 3V~18V
- PWM Fan Speed Control
- Programmable Minimum Fan Speed
- Built in Soft Switching Function
- Built in Hall Bias
- Lock Protection and Auto Restart
- Fan Rotation Speed Feedback FG Output (EUM6861/B/C)
- Fan Rotation Detection RD Output (EUM6861/A/C)
- Thermal Shutdown Protection
- Available in TSSOP-16 and TDFN-14 Packages
- RoHS Compliant and 100% Lead (Pb)-Free Halogen-Free

APPLICATIONS

- Personal Computer's Power Supply Radiation Fans and CPU Coolers

Application Circuit

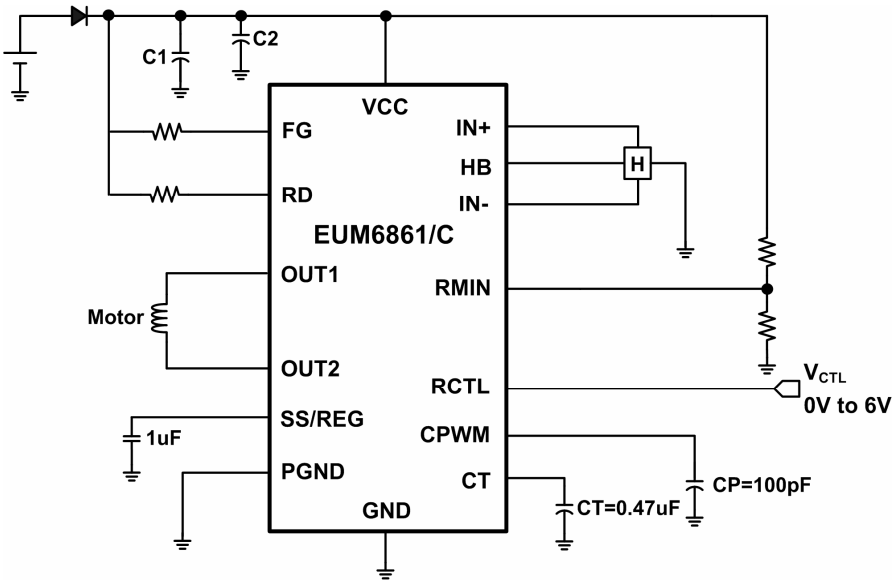


Figure 1. TSSOP -16 Typical Application Circuit

Application Circuit (continued)

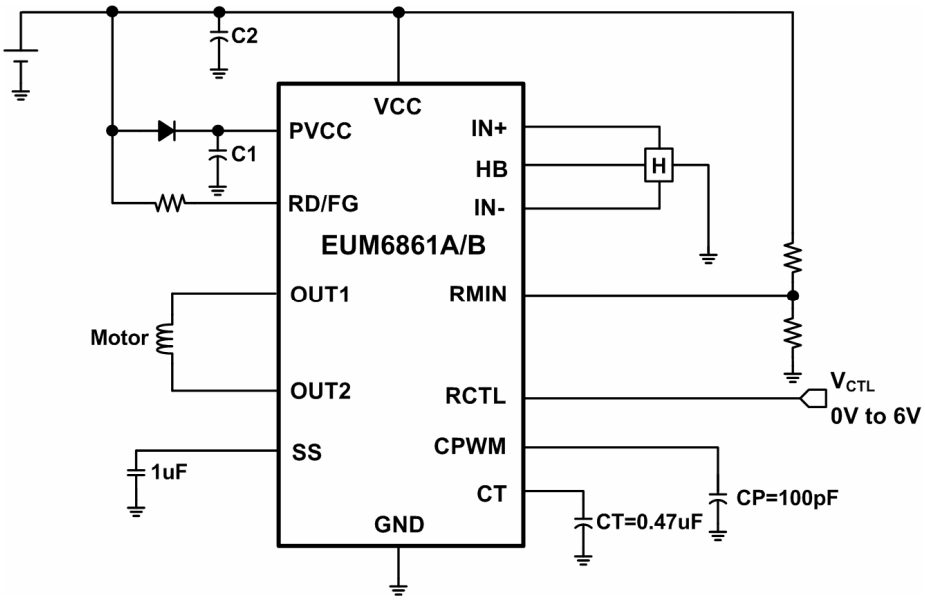


Figure 2. TDFN-14 Typical Application Circuit

Functional Block Diagram

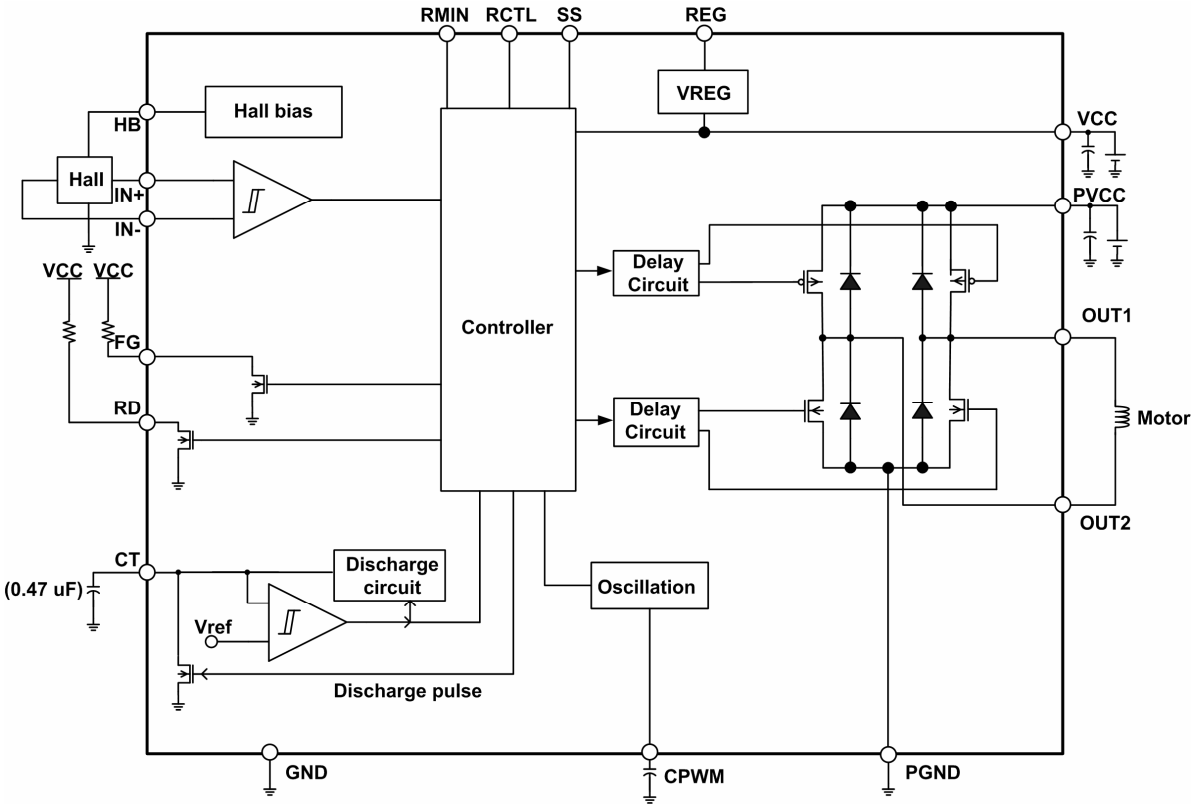
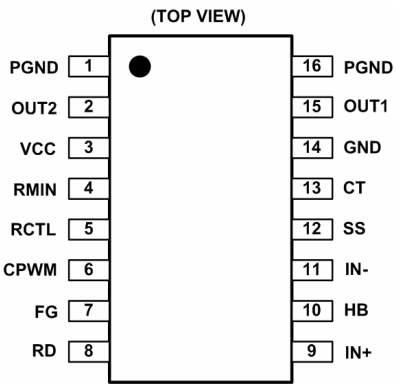
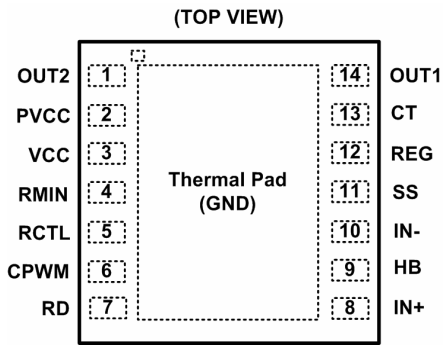
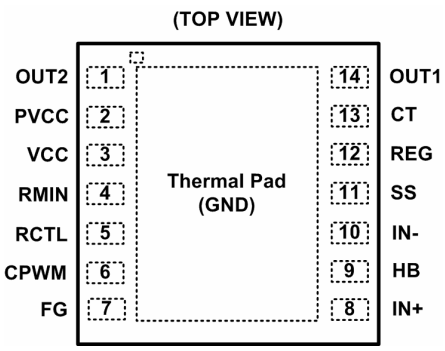
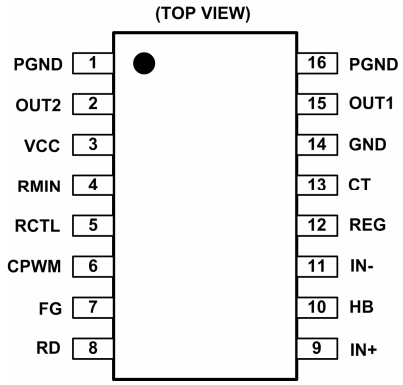


Figure 3. Functional Block Diagram

Pin Configurations

Package Type	Pin Configurations	Package Type	Pin Configurations
EUM6861 TSSOP-16		EUM6861A TDFN-14	
EUM6861B TDFN-14		EUM6861C TSSOP-16	

Pin Description

PIN	EUM6861	EUM6861A	EUM6861B	EUM6861C	DESCRIPTION
PGND	1,16	-	-	1,16	Power device ground
OUT2	2	1	1	2	Power device output terminal 2. Connect OUT2 to one side of the motor
VCC	3	-	-	3	Power supply of internal control circuitry and power devices
	-	3	3	-	Power supply of internal control circuitry
RMIN	4	4	4	4	Motor minimum rotation speed control
RCTL	5	5	5	5	Motor rotation speed control
CPWM	6	6	6	6	External capacitor connection input for PWM OSC
FG	7	-	7	7	Rotation speed feedback output
RD	8	7	-	8	Rotation detection output
IN+	9	8	8	9	Hall sensor positive input
HB	10	9	9	10	Hall sensor bias output
IN-	11	10	10	11	Hall sensor negative input
SS	12	11	11	-	Soft start time setting terminal
CT	13	13	13	13	Lock protection time setup input
GND	14	-	-	14	Analog control circuit ground
	-	Thermal Pad	Thermal Pad	-	IC ground
OUT1	15	14	14	15	Power device output terminal 1. Connect OUT1 to the other side of the motor.
PVCC	-	2	2	-	Power supply of power devices
REG	-	12	12	12	6V regulator

Ordering Information

Order Number	Package Type	Marking	Operating Temperature Range
EUM6861QIR1	TSSOP-16	xxxxx EUM6861	-30°C to +90°C
EUM6861AJIR1	TDFN-14	xxxxx M6861	-30°C to +90°C
EUM6861BJIR1	TDFN-14	xxxxx 6861B	-30°C to +90°C
EUM6861CQIR1	TSSOP-16	xxxxx EUM6861C	-30°C to +90°C

EUM6861/A/B/C □ □ □ □

Lead Free Code
1: Lead Free, Halogen Free

Packing
R: Tape & Reel

Operating temperature range
I: Industry Standard

Package Type
Q: TSSOP
J: TDFN

Power Dissipation

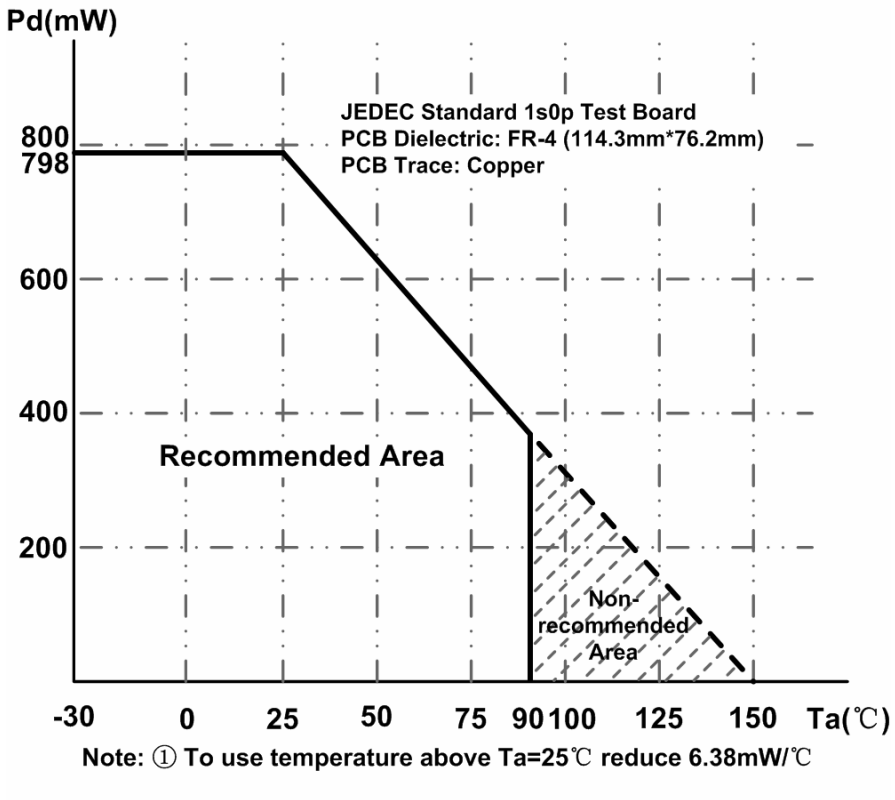


Figure 4. TSSOP-16 Package

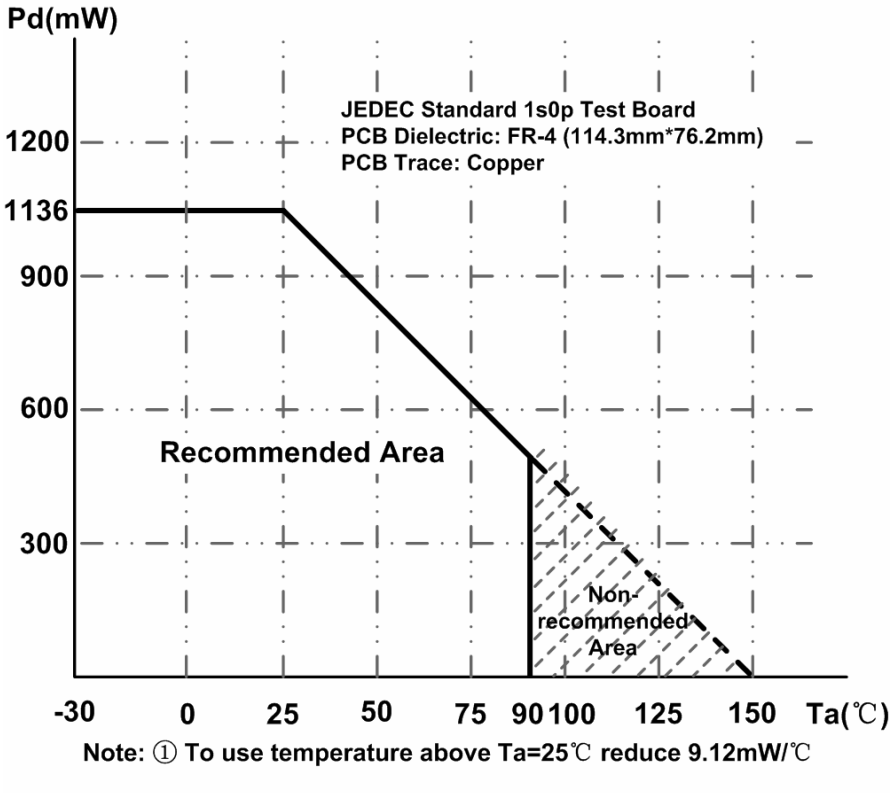


Figure 5. TDFN-14 Package

Absolute Maximum Ratings (1)

- VCC, RD, FG (3), OUT1, OUT2 to GND ---------- -0.3V to 30V
- RMIN, RCTL to GND ---------- -0.3V to 7V
- CPWM, SS, CT, IN+, IN-, HB to GND ---------- -0.3V to 6V
- PGND to GND ---------- -0.3V to +0.3V
- IOUT1, IOUT2---------- 1.0A
- IHB, IFG, IRD ---------- 10mA
- Maximum Junction Temperature ---------- +150°C
- Lead Temperature (Soldering, 10sec.) ---------- +300°C
- Package Thermal Resistance θ_{JA} (TSSOP-16) ---------- 157°C/W
- Package Thermal Resistance θ_{JA} (TDFN-14) ---------- 110°C/W
- Power Dissipation P_D @ T_A=+25°C (TSSOP-16) ---------- 0. 8W
- Power Dissipation P_D @ T_A=+25°C (TDFN-14) ---------- 1.14W
- Storage Temperature ---------- -55°C to +150°C
- ESD Ratings
  Human Body Mode ---------- 2kV
- Thermal Shut Down---------- 180°C

Recommended Operating Conditions (2)

- Supply Voltage VCC ---------- 3V to 16V
- Threshold Input Voltage RCTL, RMIN ---------- 0V to 6V
- Hall Input Voltage Range IN+, IN- ---------- 0.2V to 3V
- Operating Temperature Range ---------- -30°C to +90°C

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

Note (2): The device is not guaranteed to function outside the recommended operating conditions.

Note (3): FG is open drain output, it can bear 30V voltage when FG is off (IN+=H, IN-=L).

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＝12V unless otherwise specified.

Symbols	Parameters	Conditions	EUM6861/A/B/C			Unit
			Min.	Typ.	Max.	
ICC1	Operating current	Rotation mode	-	3.2	**5**	mA
ICC2		Lock protection mode	-	1.6	**3**	
Hall Input and Hall Bias						
VHN	Hall input sensitivity	Zero to peak (Offset & Hysteresis included)		10	15	mV
VHB	HB Output Voltage	IHB=5mA	1.1	1.2	1.3	V
Output						
VOL	Output lower side saturation	Io=200mA		**0.10**	**0.13**	V
VOH	Output upper side saturation	Io=200mA		**0.20**	**0.26**	
Soft Start Block						
ISS	SS pin discharge current	VSS = 3.6V	0.37	0.5	0.64	μA
PWM Blocks						
FPWM	CPWM OSC frequency	CP = 100pF	19	25	28	KHz
VCRL	CPWM low level voltage		1.9	2	2.1	V
VCRH	CPWM high level voltage		3.4	3.55	3.7	V

Electrical Characteristics (continued)

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＝12V unless otherwise specified.

Symbols	Parameters	Conditions	EUM6861/A/B/C			Unit
			Min.	Typ.	Max.	
Lock Protection Block						
ICT1	CT charge current	VCT = 0V	1.6	2	2.3	μA
ICT2	CT discharge current	VCT = 4.2V	0.16	0.2	0.25	μA
RCT	Ratio of charge current to discharge current	RCT = ICT1 / ICT2	8.5	10	11	-
VCTH	CT high level voltage		3.54	3.9	4.2	V
VCTL	CT low level voltage		1.78	1.8	1.82	V
FG & RD Signal Output						
VFG	FG & RD pin low voltage	IFG = 5mA		0.1	-	V
IFGL	FG & RD pin leak current	VFG = 7V			5	μA
Regulator Output						
VREG	Regulator Output Voltage	IREG=3mA	5.8	6.0	6.2	V

Application Notes

Hall Sensor Connection

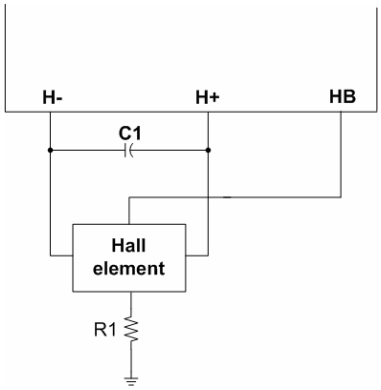


Figure 6. Hall Sensor Inputs

Hall signal input terminals (H+、H-)

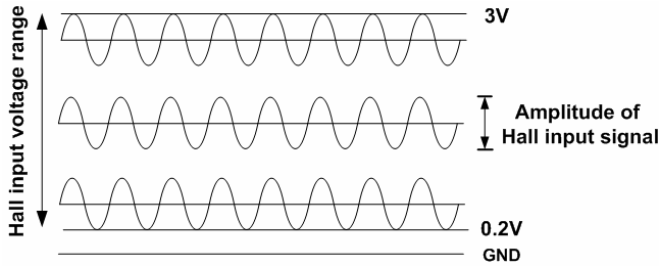


Figure 7. Hall Sensor Input Voltage Range

Set Hall sensor input signal range 0.2V to 3V by adjusting the Hall input level setting resistor R1. In the case of long board wiring pattern from hall element to hall signal input terminal, connect a capacitor between IN+ and IN- to avoid noise. The amplitude of Hall input signal is recommended to be 60mV or higher due to the Hall input amplifier 20mV hysteresis. The Hall bias is 1.2V.

VCC Bypass Capacitor

Connect a ceramic capacitor 0.47μF or more between VCC and GND to absorb kick back voltage resulting from the high side re-circulation current.

GND and PGND Line

GND is connected to internal analog control circuits, and PGND is connected to power devices. Connect GND to PGND at only one place on the PCB board.

PWM Oscillator Frequency

The PWM OSC frequency is programmed by the CP capacitor. A 100pF CP sets frequency 25 KHz. The PWM OSC ramp CPWM swings between 2V to 3.55V.

PWM Control Speed Mode

PWM control mode works by comparing the voltage of RCTL and CPWM. When RCTL is low, one side upper power device and the other side lower side power device are turned on to charge the motor coil. When RCTL is high, the upper side power device is turned off. The motor coil current is re-circulated between lower side power devices. The lower RCTL is, the bigger the output duty is. Big coil current makes motor run fast. FG output feedbacks motor rotational speed. The motor coil is charged all the time and motor speed becomes full speed when RCTL voltage is lower than 2V.

Soft Start Time

Connect a capacitor between SS and GND to set soft start time. EUM6861/A/B/C drives a motor from slow speed to fast speed during soft start time which is set by the external capacitor between SS and GND. Floating SS pin if soft start function is not used. If motor start current is too big, please increase capacitor between SS and GND to make start time longer and start current smaller. If motor start current is too small to run, please decrease capacitor between SS and GND to make start time shorter and start current bigger.

Minimum Speed Mode

Minimum speed of motor is set by the RMIN voltage. When RCTL voltage is higher than RMIN voltage, the lowest duty is set by comparing RMIN and PWM oscillator ramp CPWM voltage. When minimum speed mode function is not used, connect RMIN to RCTL. If RMIN pin is connected to RCTL and the RCTL/RMIN voltage is above 3.6V, EUM6861/A/B/C PWM duty cycle is 0% and motor stops.

Lock Protection and Auto Restart

When the motor is locked, the EUM6861/A/B/C outputs will be disabled by the lock protection function. After a few seconds, the auto restart circuit will restart the motor. If the motor lockup persists, the lock protection will keep EUM6861/A/B/C outputs off until the lock removes. Rotation detection output RD pin is open-drain output, and RD is internally pulled down during rotation mode. When motor lock is detected, RD pin becomes high impedance. See Figure 8.

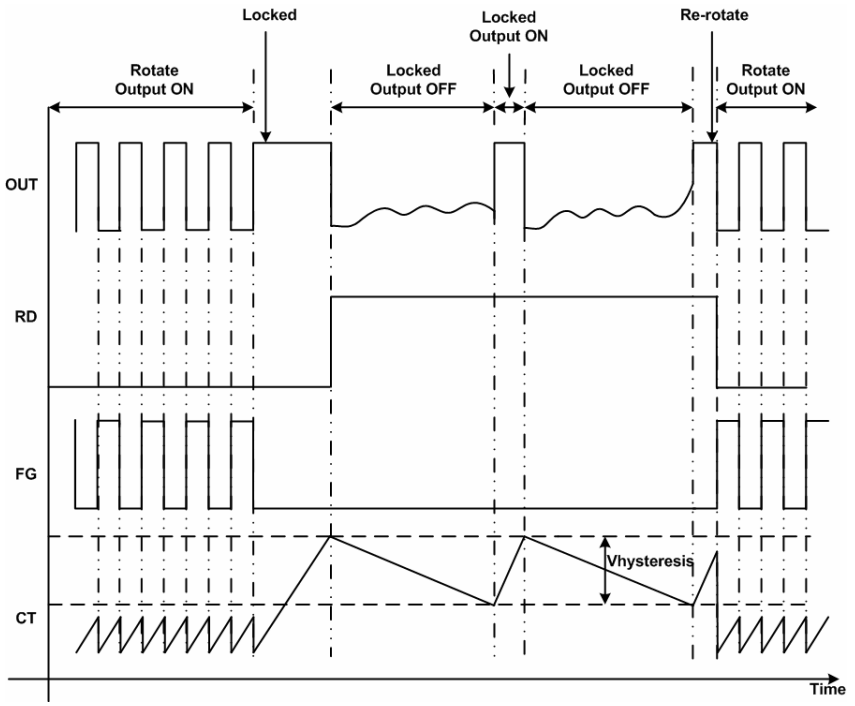


Figure 8. Lock Protection and Auto Restart

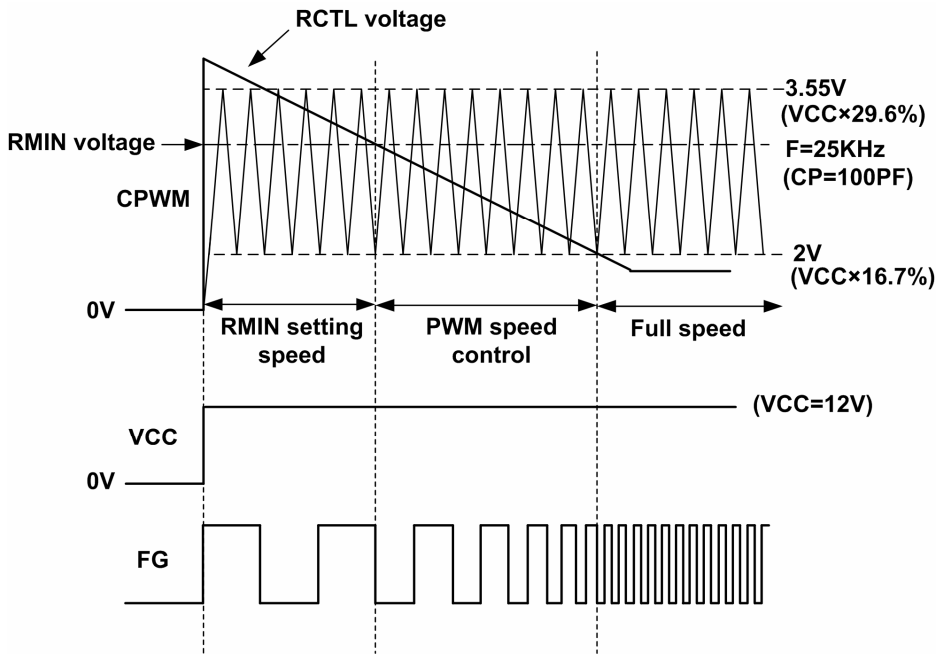


Figure 9. Control Time Chart

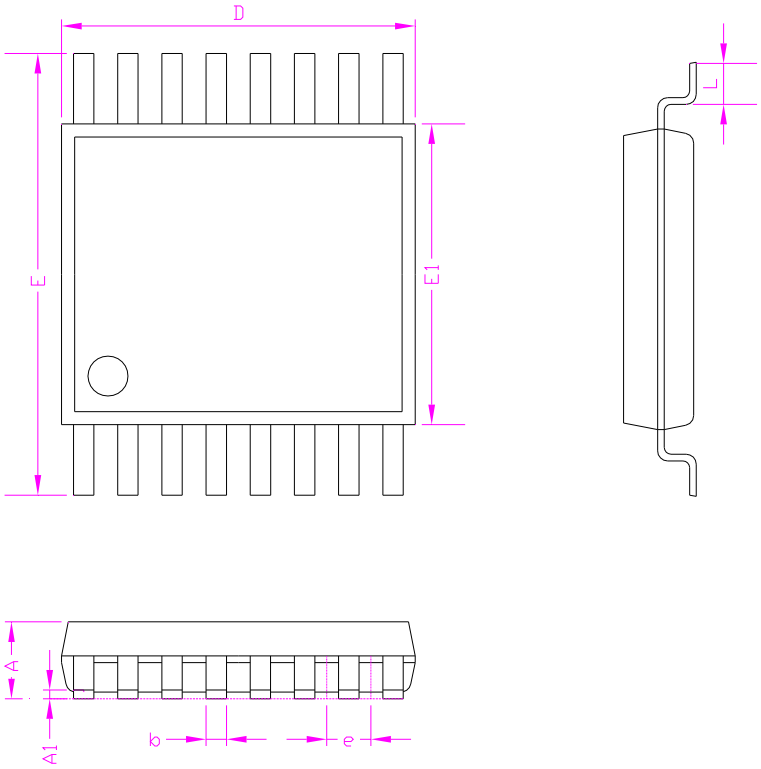
EUM6861/A/B/C Operation Truth Table

(CPWM-H=CPWM > RCTL, CPWM-L=CPWM < RCTL)

CT	CPWM	IN+	IN-	OUT1	OUT2	FG	RD	Mode
L	H	L	H	H	L	L	ON	Rotation (Drive)
		H	L	L	H	OFF		
	L	L	H	L	L	L		Rotation (Recirculation)
		H	L	L	L	OFF		
H	-	L	H	L	L	L	OFF	Lock Protection
		H	L	L	L	OFF		

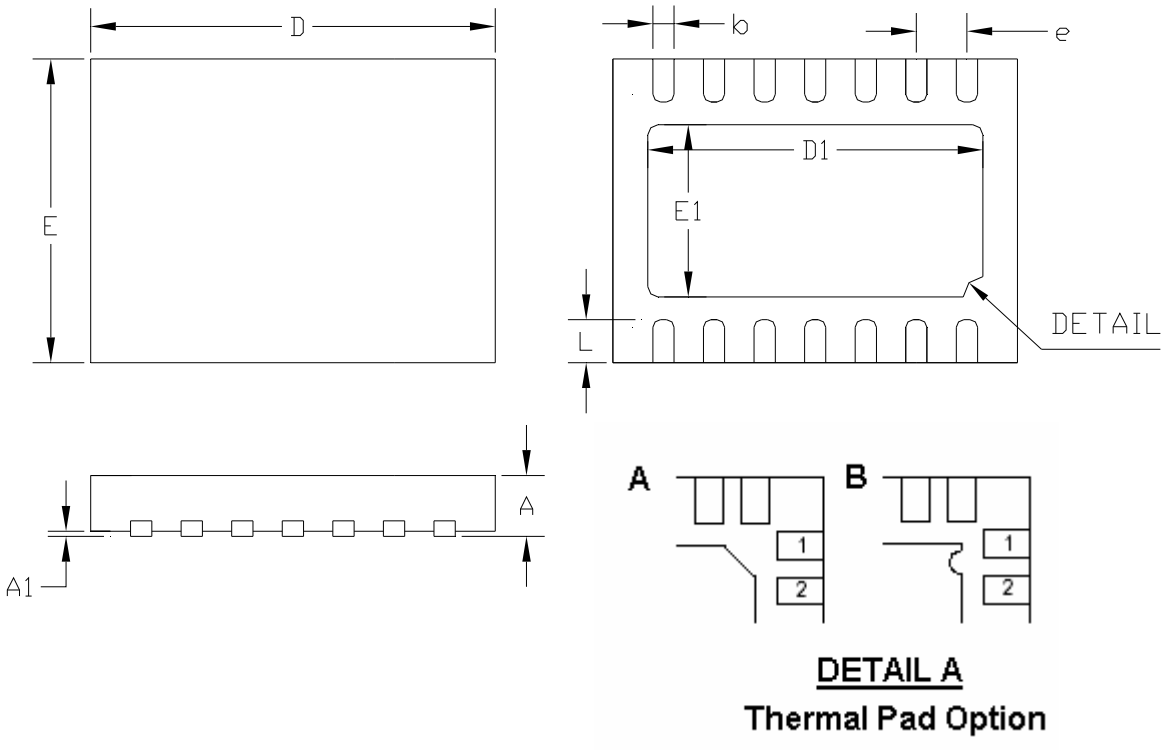
Packaging Information

TSSOP-16



SYMBOLS	MILLIMETERS			INCHES		
	MIN.	Normal	MAX.	MIN.	Normal	MAX.
A	-	-	1.20	-	-	0.047
A1	0.00	-	0.15	0.000	-	0.006
b	0.15	-	0.30	0.006	-	0.012
E1	4.25	4.40	4.55	0.167	0.173	0.179
D	4.85	5.00	5.15	0.191	0.197	0.202
E	6.20	6.40	6.60	0.244	0.252	0.260
e	0.65			0.026		
L	0.45	0.60	0.75	0.018	0.024	0.030

TDFN-14



SYMBOLS	MILLIMETERS			INCHES		
	MIN.	Normal	MAX.	MIN.	Normal	MAX.
A	0.70	0.75	0.80	0.028	0.030	0.032
A1	0.00	0.02	0.05	0.000	0.001	0.002
b	0.15	0.25	0.35	0.006	0.010	0.014
D	3.90	4.00	4.10	0.154	0.157	0.161
D1	2.70	3.00	3.30	0.106	0.118	0.129
E	2.90	3.00	3.10	0.114	0.118	0.122
E1	1.50	1.60	1.70	0.059	0.063	0.067
e		0.50			0.020	
L	0.30	0.40	0.50	0.012	0.016	0.020