

PWM Pre Driver for DC Fan Motor

DESCRIPTION

EUM6867 is a pre driver for single coil brushless DC motor, specially designed for 12V power supply application. With an external PWM input signal, EUM6867 can control the speed of DC motor. It is an interface between a HALL IC and a single coil motor. The functions built in EUM6867 include soft start mode, PWM control mode, minimum speed mode, soft-switching time, fan tachometer, lock protection, auto restart, Hall Bias and current limiter.

PWM mode controls the external PMOS-NMOS FET in low noise and low vibration. With soft start function, EUM6867 can drive motor from slow speed to fast speed in a settable time by setting the external capacitor between S-S and 5VREG. Minimum speed mode makes the lowest speed of motor settable. Soft-switching time can cut the ineffective current when phase change is not set. If the motor is stalled by external force or obstacles, overdrive current may incur coil overheat/burning. To prevent this, lock protection circuit can shut down the external power devices for a few seconds after motor lockup. Then auto restart circuit will try to power up these devices. The protection and power up time are settable by an external capacitor. EUM6867 has FG output.

FEATURES

- Single-phase full-wave Pre Driver
- PWM Control Mode
- Soft Start Function
- Soft-Switching Time
- Minimum Speed Settable
- Lock Protection and Auto Restart
- FG Output
- Current Limit Protection
- Available in TSSOP-16 Package
- RoHS Compliant and 100% Lead (Pb)-Free

APPLICATIONS

- Personal Computer's Power Supply Radiation and CPU Cooler

Application Circuit

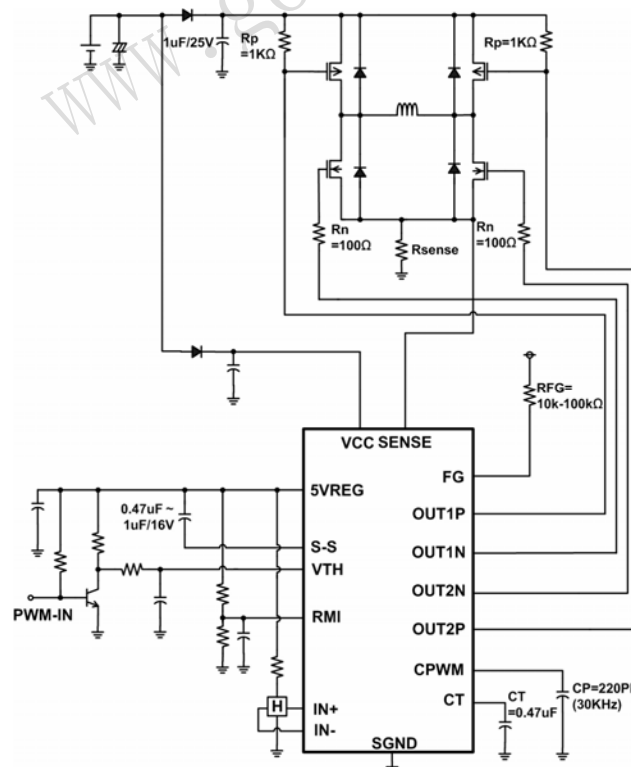


Figure 1.

Pin Configurations

Package Type	Pin Configurations
TSSOP-16	(TOP VIEW) OUT2P 1 16 OUT1P OUT2N 2 15 OUT1N VCC 3 14 SGND SENSE 4 13 5VREG RMI 5 12 S-S VTH 6 11 CT CPWM 7 10 IN+ FG 8 9 IN-

Pin Description

PIN	TSSOP-16	DESCRIPTION
OUT2P	1	Output terminal for external upper side power device
OUT2N	2	Output terminal for external lower side power device
VCC	3	Power supply terminal
SENSE	4	Motor current sense terminal
RMI	5	Motor lowest speed setup terminal
VTH	6	Motor speed control terminal
CPWM	7	External capacitor connection terminal for PWM OSC
FG	8	Rotation speed feedback terminal
IN-	9	Hall input terminal
IN+	10	Hall input terminal
CT	11	Lock protection time setup terminal
S-S	12	Soft Start setting terminal
5VREG	13	5V regulator
SGND	14	GROUND terminal
OUT1N	15	Output terminal for external lower side power device
OUT1P	16	Output terminal for external upper side power device

Ordering Information

Order Number	Package Type	Marking	Operating Temperature range
EUM6867QIR1	TSSOP-16	 XXXXX EUM6867	-30°C to 90°C

EUM6867 ☐ ☐ ☐ ☐

Lead Free Code
1: Lead Free 0: Lead

Packing
R: Tape & Reel

Operating temperature range
I: Industry Standard

Package Type
Q: TSSOP

Block Diagram

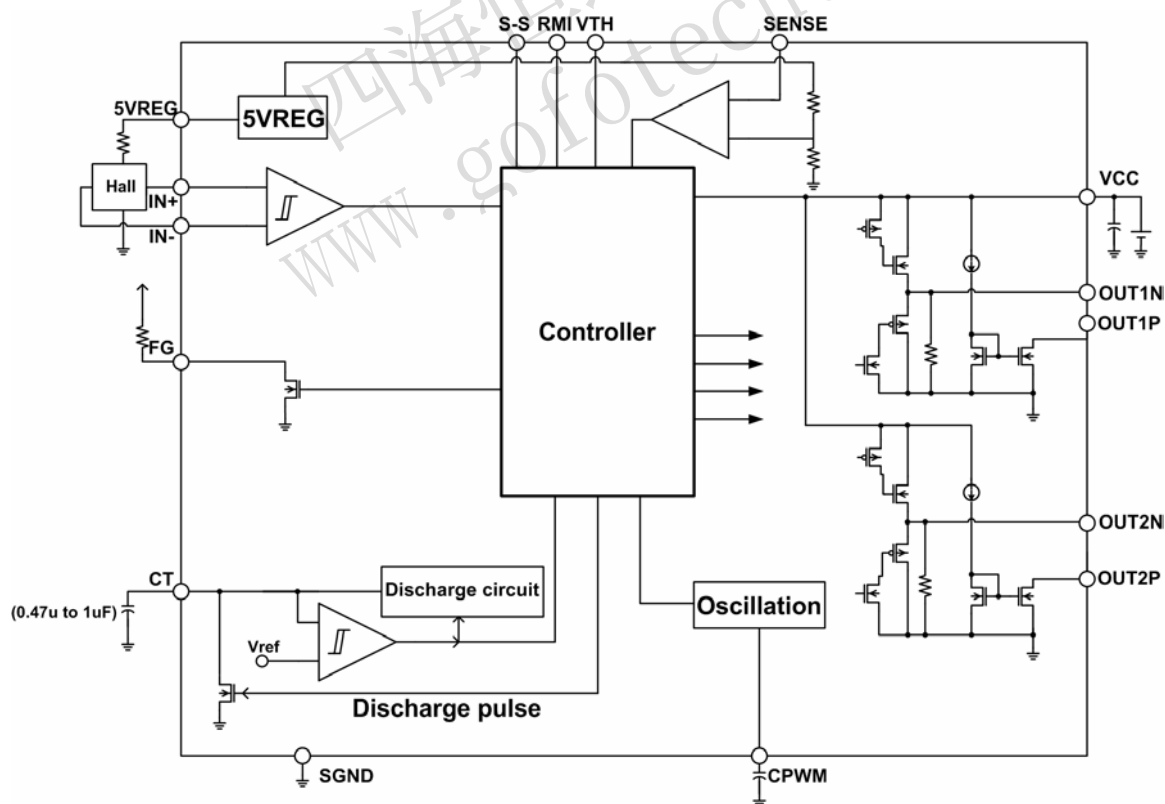


Figure 2.

Absolute Maximum Ratings

■ VCC -----	18V
■ IOUTN-----	20mA
■ IOUTP-----	20mA
■ VOUT -----	18V
■ VTH,RMI -----	7V
■ VS-S -----	7V
■ VFG -----	18V
■ IFG -----	10mA
■ I5VREG-----	20mA
■ Power Dissipation -----	0.8W
■ Operating Temperature -----	-30°C to 90°C
■ Storage Temperature -----	-55°C to 150°C

Recommended Operating Conditions at Ta = 25°C

■ Supply Voltage, VCC -----	4.5V to 16V
■ VTH and RMI Input Voltage Range -----	0V to 5V
■ Hall Input Voltage Range -----	0.2V to 3V
■ OSC Voltage Range -----	0.2V to 3V

Electrical Characteristics

(Unless otherwise specified Ta = 25°C, VCC = 12V)

(Unless otherwise specified $T_a = 25^{\circ}\text{C}$, $V_{CC} = 12\text{V}$)						
	Parameter	Conditions	EUM6867			Unit
			Min.	Typ.	Max.	
ICC1	Supply current drain	Rotation mode		10		mA
ICC2		Lock protection mode		10		
Hall Input						
VHN	Input hysteresis voltage	Zero to peak (Offset & Hysteresis included)		± 10		mV
Output						
VONH	OUTN output high voltage	Output current of OUT-N= 10mA		$V_{CC}-0.9$		V
VONL	OUT-N output low voltage	Output current of OUT-N= 10mA		0.9		V
VOPL	OUT-P output low voltage	Output current of OUT-P = 10mA		0.5		V
Voltage Reference						
5VREG	5V Regulator	I5VREG = 5mA		5		V
PWM Block						
FPWM	CPWM oscillation frequency	$C = 220\text{pF}$		30		KHz
VLIM	Current limit voltage			200		mV
VCRL	CPWM Low voltage			1		V
VCRH	CPWM High voltage			3		V
Lock Protection Block						
ICT1	CT charge current	$V_{CT} = 0.5\text{V}$		2		μA
ICT2	CT discharge current	$V_{CT} = 3.5\text{V}$		0.2		μA
RCT	Ratio of charge current to discharge current	$RCT = ICT1 / ICT2$		10		-
VCTH	CT high level voltage			3		V
VCTL	CT low level voltage			1		V

Electrical Characteristics (continued)

(Unless otherwise specified $T_a = 25^{\circ}\text{C}$, $V_{CC} = 12\text{V}$)

(Unless otherwise specified T _a = 25 °C, V _{CC} = 12 V)						
	Parameter	Conditions	EUM6867			Unit
			Min.	Typ.	Max.	
Lock Protection Block						
IS-S	S-S pin charge current	VS-S=1V		0.5		μ A
FG Signal Output						
VFGL	FG low voltage	IFG = 5mA		0.15		V
IFGL	FG leakage current	VFG = 19V			30	μ A
IVTH/ IRMI	VTH/RMI pin bias current	CPWM=VTH/RMI=2V		0.1		μ A

* This product is not designed for protection against radioactive rays.

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Notes

Absolute maximum ratings

This product is produced with strict quality control, but destroyed in using exceed the absolute maximum ratings. Once IC destroyed, failure mode cannot be defined (like short-mode or open-mode). Therefore, physical security countermeasure, like fuse, is to be given when a specific Mode to exceed the absolute maximum ratings is considered.

SGND potential

The SGND terminal should be the location of the lowest voltage on the chip.

Mounting failures

Mounting failures, such as misdirection or mismount, may destroy the device. The electrical short caused by falling particle, between outputs; power supply and output; or output and ground, may damage the device.

Electromagnetic field

A strong electromagnetic field may cause malfunction.

ASO

Please consider output transistors not to exceed absolute maximum ratings.

Hall signal input terminals (IN+, IN-)

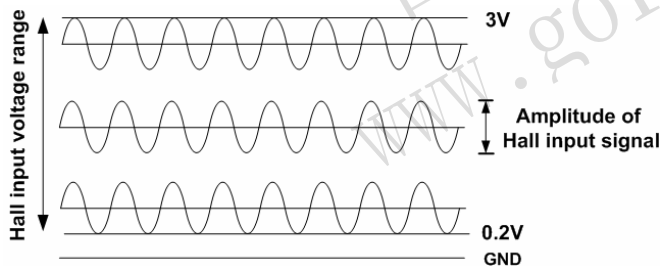


Figure 3. Hall input voltage range

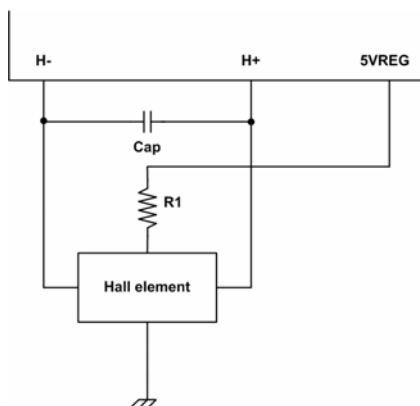


Figure 4. Hall element

Hall input signal should contain voltage within range 0.2V to 3V. So, please adjust Hall input level by R1. In the case of long board wiring pattern from hall element to hall signal input terminal, please connect capacitor between IN+ and IN- to avoid noise. The amplitude of Hall input signal is recommended to be 100mVp-p or bigger, because the Hall input amplifier has 20mVp-p hysteresis and has the soft switching range of 35mV (the input difference voltage).

VCC line

The capacitor about 0.1 μ F or bigger between VCC and Ground is recommended to absorb kick back voltage. Because of upper side PWM control, the re-circulation current is in the external lower side power device.

SGND line

Divides each line and external parts of control stage are connect to SGND.

Zener diode of re-circulation stability

Because kickback can increase the power supply voltage, a Zener diode is recommended to avoid IC destroy.

PWM OSC frequency

The PWM OSC frequency is settable by value of CP witch is connected between CPWM and GND. Using 220pF CP can get frequency of 30 KHz.

Lowest speed settable

Lowest speed of motor is set by input voltage of RMI. Connect RMI to VTH (or to 5VREG with a resistor of 10k) when this function is not used. When IC power supply may turn off first, please put a resistor for current limitation between external power supply and RMI to prevent large current from flowing.

Soft start time

A capacitor is connected between S-S and 5VREG. Soft start time can be set by the capacitance of capacitor. Please connect this pin to Ground when this pin is not used. Soft start time function will drive motor from slow speed to fast speed in a settable time by external Cap between S-S and 5VREG.

Current limiter

When SENSE pin voltage is over 0.2V, output current for motor will be shut down. Connect SENSE to Ground when this function is not used.

Truth Table

PWM Control Mode (CT, S-S=Low)

VTH RMI	CPWM	IN+	IN-	OUT1P	OUT1N	OUT2P	OUT2N	Motor Current Mode
L	H	L	H	L	L	OFF	H	OUT1→OUT2
		H	L	OFF	H	L	L	OUT2→OUT1
H	L	L	H	OFF	L	OFF	H	Rotation Re-circulation
		H	L	OFF	H	OFF	L	

Drive-Lockup (CPWM=High VTH,RMI,S-S=Low)

IN+	IN-	CT	OUT1P	OUT1N	OUT2P	OUT2N	FG	Motor Current Mode
L	H	L	L	L	OFF-	H	L	OUT1→OUT2
H	L		OFF	H	L	L	OFF	OUT2→OUT1
L	H	H	OFF	L	OFF	H	L	Lock Protection
H	L		OFF	H	OFF	L	OFF	

Control Timing Chart (Speed Control)

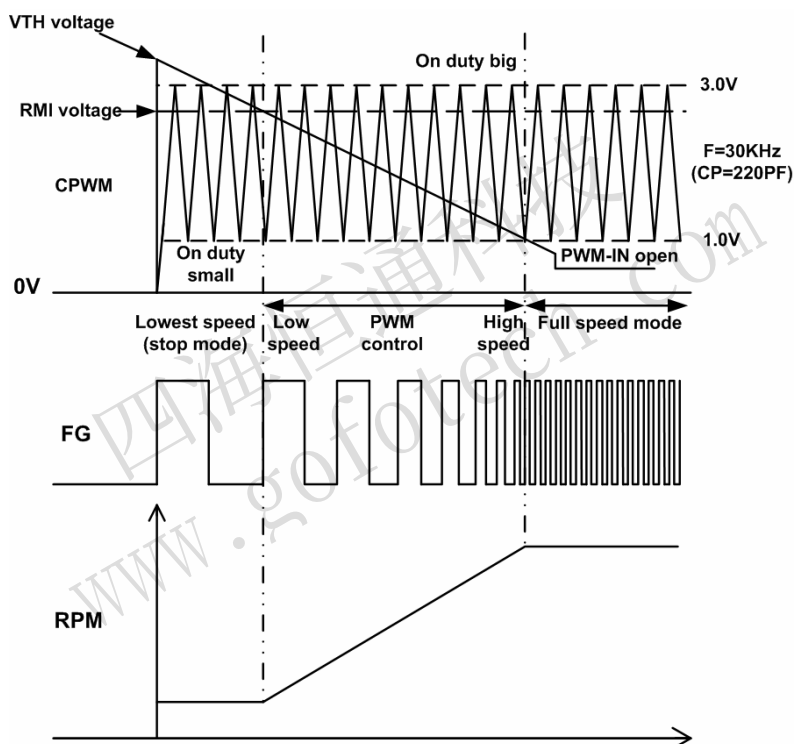


Figure 5.

1. Lowest speed setting mode (stop mode)

Lowest speed of motor is settable by RMI pin. When VTH voltage is bigger than RMI, the lowest drive duty is settable by comparing RMI and CPWM oscillating voltage. Fan motor will stop when minimum speed is not set by the RMI pin.

2. PWM control speed mode

Through comparing the voltage of VTH and CPWM, which is 1.0V to 3.0V, PWM control mode works. Upper and lower sides power devices will be turned on to charge the motor coil when VTH is low.

And upper side power devices will be turned off and the current in motor coil will re-circulate in lower side power devices when VTH is high. The lower VTH is, the bigger the output on duty becomes. Big coil current makes motor run fast. FG output feedbacks motor rotational speed.

3. Full speed mode

The motor coil is charged all the time and motor speed becomes full speed when VTH voltage is lower than 1.0 V. If PWM-IN opens, VTH will become lower than 1.0V, output becomes full speed mode.

Control Timing Chart (Soft Start)

1. VTH voltage < RMI voltage

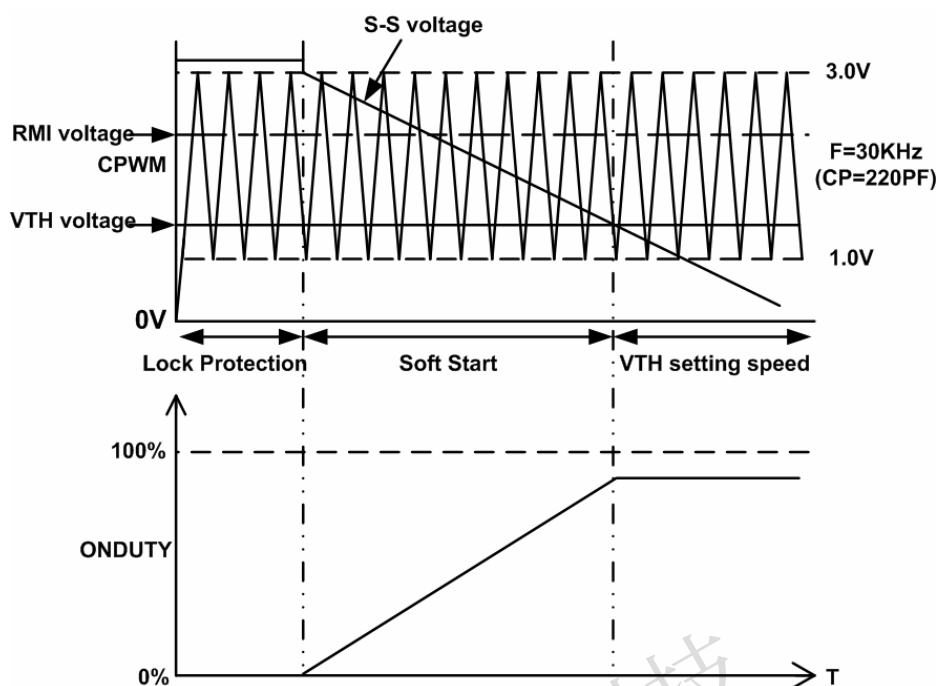


Figure 6.

2. VTH voltage > RMI voltage

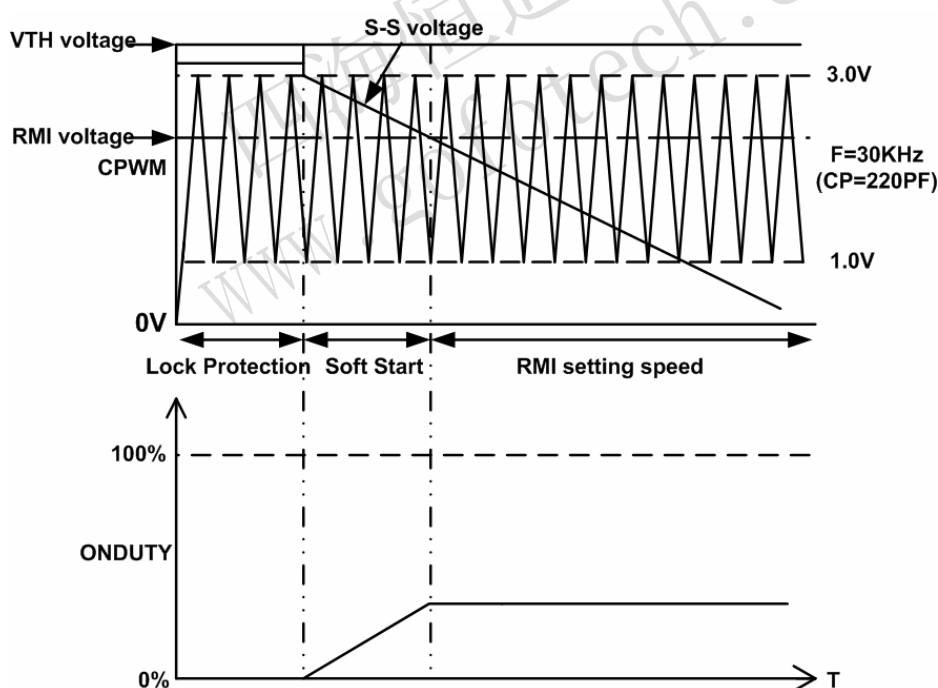


Figure 7.

The inclination of S-S voltage is adjusted according to the capacitor between S-S and 5VREG. Recommended capacitor: 0.1μ 1.0μ.

Lock Protection and Auto Restart

When motor lock is detected, the output will be turned off by lock protection function. After a few seconds, auto restart circuit will try to start motor. If motor start fail (still lockup), another lock protection will be turned off output for a few seconds until next restart time comes.

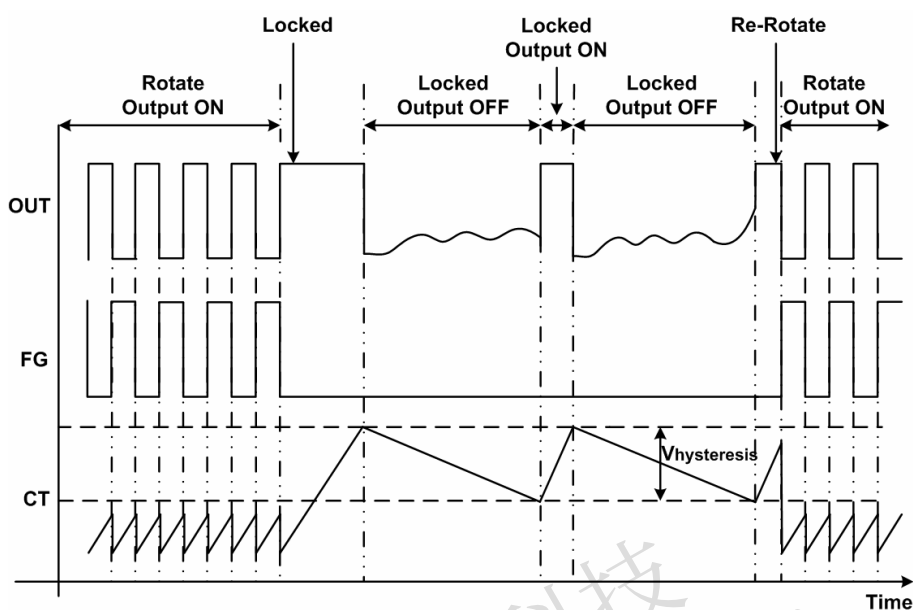
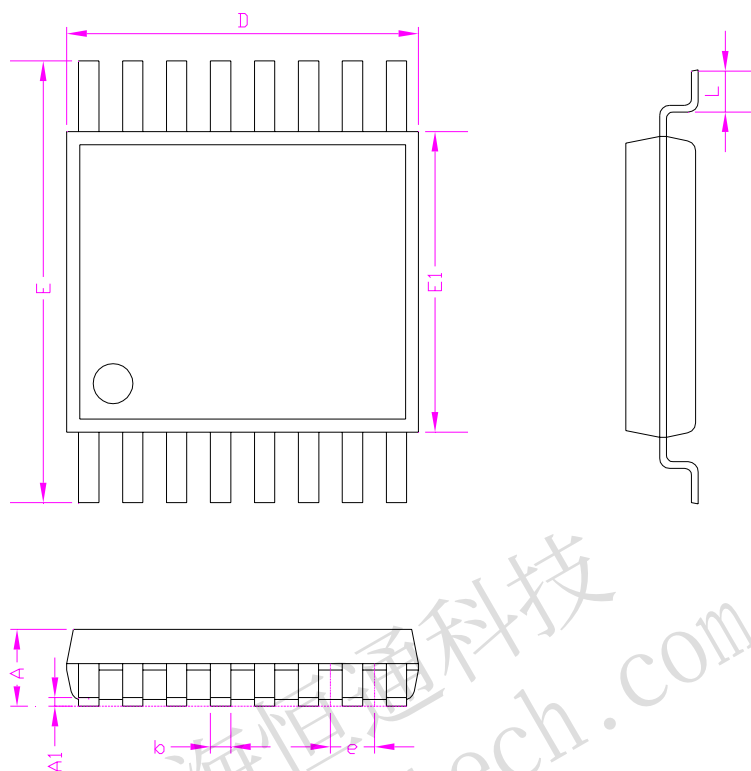


Figure 8.

Packaging Information

TSSOP-16



SYMBOLS	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	-	1.20	-	0.047
A1	0.00	0.15	0.000	0.006
b	0.19	0.30	0.007	0.012
E1	4.40		0.173	
D	5.00		0.197	
E	6.20	6.60	0.244	0.260
e	0.65		0.026	
L	0.45	0.75	0.018	0.030