

# EUM6167

## Single-Phase Full-Wave Pre Driver for Fan Motor

### DESCRIPTION

EUM6167 is a pre driver for single coil brushless DC motor. With an external PWM input signal, EUM6167 can control the speed of DC motor. It is an interface between a HALL IC and a single coil motor. The functions built in EUM6167 include 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. 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 external capacitor. EUM6167 has FG output and RD output.

### FEATURES

- Single-phase Pre Driver
- PWM control mode
- Soft-switched time
- Built in Hall Bias
- Minimum speed settable
- Current Limiter
- Lock protection and auto restart
- FG and RD Output
- 12V/24V/48V Power Supplies Applicable
- Available in TSSOP-20 Package
- RoHS Compliant and 100% Lead (Pb)-Free

### APPLICATIONS

- PC/Server FAN Motor

### Application Circuit

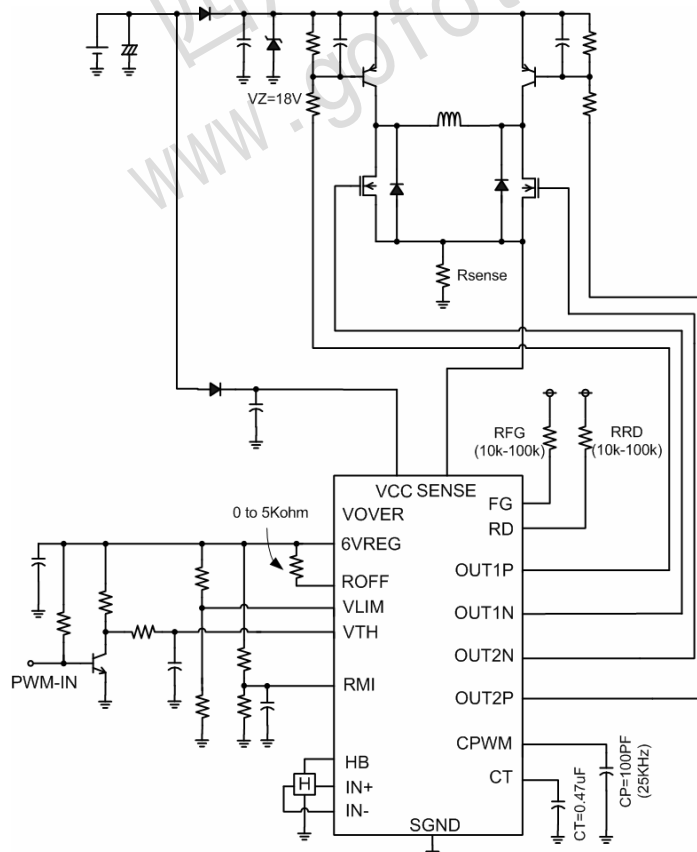


Figure 1. 12V Application Circuit

## Application Circuit (continued)

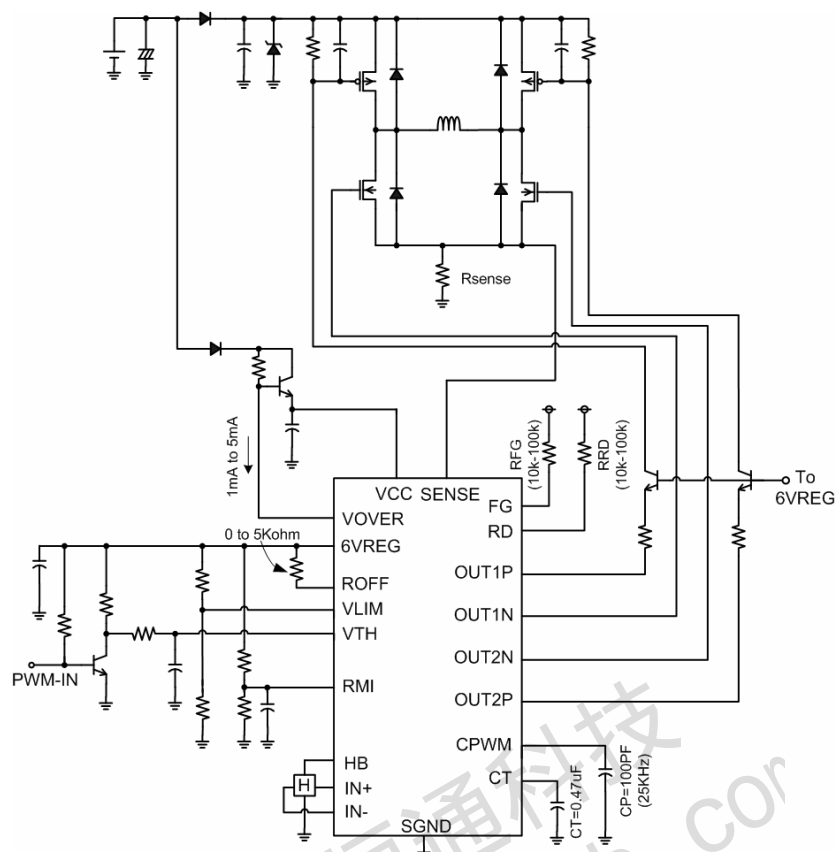


Figure 2. 24V, 48V Application Circuit

## Block Diagram

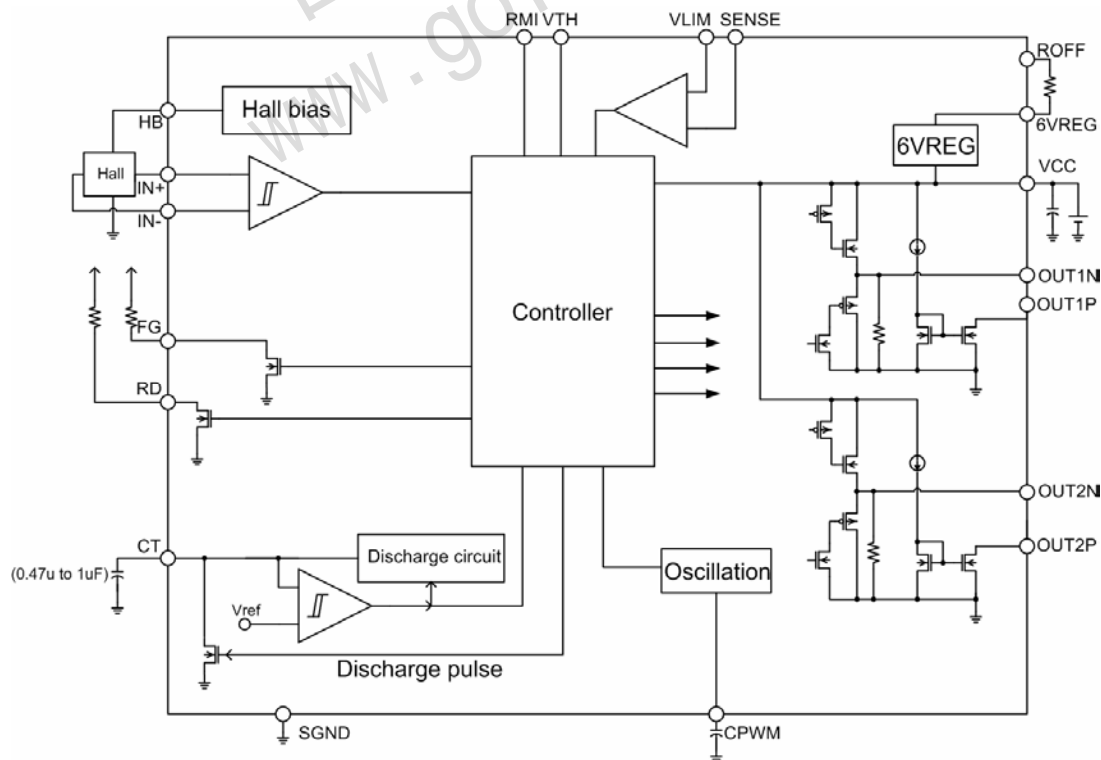


Figure 3

**Pin Configurations**

Package Type	Pin Configurations
TSSOP-20	

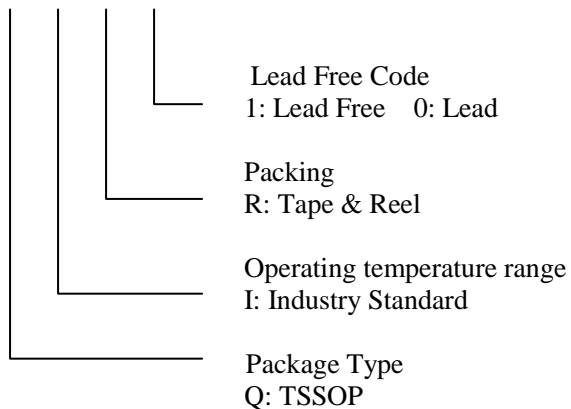
**Pin Description**

PIN	Pin	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
VLIM	4	Motor maximum current setup terminal
SENSE	5	Motor current sense terminal
RMI	6	Motor lowest speed setup terminal
VTH	7	Motor speed control terminal
CPWM	8	External capacitor connection terminal for PWM OSC
FG	9	Rotation speed feedback terminal
RD	10	Rotation detection terminal
IN-	11	Hall input terminal
HB	12	Hall bias terminal
IN+	13	Hall input terminal
CT	14	Lock protection time setup terminal
ROFF	15	Soft-switching time setup terminal
6VREG	16	6V regulator
SGND	17	GROUND terminal
VOVER	18	Voltage reference bias terminal
OUT1N	19	Output terminal for external lower side power device
OUT1P	20	Output terminal for external upper side power device

## Ordering Information

Order Number	Package Type	Marking	Operating Temperature range
EUM6167QIR1	TSSOP-20	 XXXXX EUM6167	-30°C to 95°C

EUM6167



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**Absolute Maximum Ratings**

■	VCC -----	18V
■	IOUT -----	50mA
■	VOUT -----	18V
■	IHB -----	10mA
■	VTH -----	8V
■	VFG & VRD -----	18V
■	IFD & IRD -----	10mA
■	Power Dissipation -----	0.8W
■	Operating Temperature -----	-30°C to 95°C
■	Storage Temperature -----	-55°C to 150°C
■	Lead Temperature (Soldering, 10sec.) -----	260°C

**Recommended Operating Conditions at Ta = 25°C**

■	Supply Voltage, VCC -----	6V to 16V
■	V threshold input voltage, VTH -----	0V to 7V
■	Hall input voltage range -----	0.2V to 3V

**Electrical Characteristics**

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

	Parameter	Conditions	Limit			Unit
			Min	Typ	Max.	
ICC1	Supply Current	Rotation mode	--	4.61	8	mA
ICC2		Lock protection mode	--	4.65	8	
Hall input						
VHN	Hall input sensitivity	Zero to peak (Offset & Hysteresis included)	--	8.88	15	mV
Output						
IOP	OUT-P sink current		25	34	--	mA
VON	OUT-N output voltage	Output current of OUT-N = 20mA	8	9.89	--	V
Voltage Reference						
6VREG	6V Regulator	IHB = 5mA	5.74	5.89	6.15	V
VOVER	VOVER voltage		12.2	12.7	13.4	
PWM Block						
FPWM	CPWM OSC frequency	C = 100pF	20	23	30	KHz
VCRL	CPWM Low level voltage		1.46	1.54	1.75	V
VCRH	CPWM High level voltage		4.46	4.55	4.65	V
Lock Protection Block						
ICT1	CT charge current	VCT = 0V	1.80	2.12	2.40	μA
ICT2	CT discharge current	VCT = 4.2V	0.14	0.22	0.30	μA
RCT	Ratio of charge current to discharge current	RCT = ICT1 / ICT2	6.37	9.71	13.06	--
VCTH	CT high level voltage		3.5	3.6	3.7	V
VCTL	CT low level voltage		1.5	1.6	1.7	V

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

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

	Parameter	Conditions	Limit			Unit
			Min	Typ	Max.	
FG & RD signal output						
VFG	FG & RD low voltage	IFG = 5mA		0.09	0.15	V
IFGL	FG & RD leak current	VFG = 16V			10	μA

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

**TRUTH TABLE****PWM Control Mode**

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

**Full Speed Mode**

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

## 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.

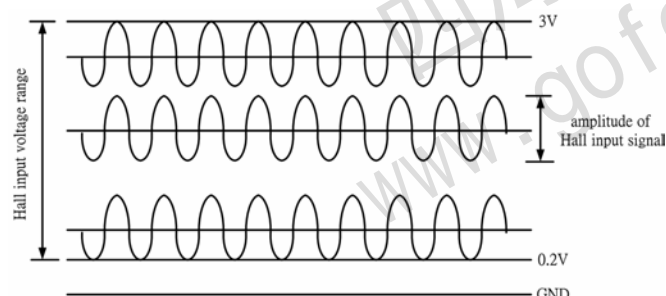
### Electromagnetic field

A strong electromagnetic field may cause malfunction.

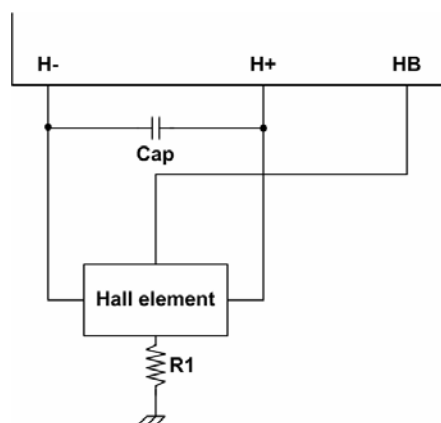
### ASO

Please consider output transistors not to exceed absolute maximum ratings.

### Hall signal input terminals (H+, H-)



**Figure 4. Hall input voltage range**



**Figure 5. 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 60mV or bigger, because the Hall input amplifier has 20mV hysteresis.

### Hall bias

The Hall bias is 1.2V.

### VCC line

The capacitor about 0.1 to 1  $\mu$ F 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 need to avoid IC destroy.

### PWM OSC frequency

The PWM OSC frequency is settable by value of CP. Using 100pF CP can get frequency of 23 KHz (Typ.).

### Lowest speed settable

Lowest speed of motor is set by input voltage of RMI. Connect RMI to VTH 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-switching time

A resistor between ROFF and 6VREG can cut the ineffective current when phase change is not set. Connect ROFF to 6VREG when this function is not used.

### Current limiter

When SENSE voltage is bigger than VLIM voltage, output current for motor will be shut. Connect SENSE to Ground and VLIM to 6VREG when this function is not used.

### VOVER

VOVER is voltage reference for VCC when external power supply is bigger than the Maximum Ratings of VCC. Please refer to application circuit and use current limitation resistor to avoid large current flowing into VOVER pin.

## Control Timing Chart

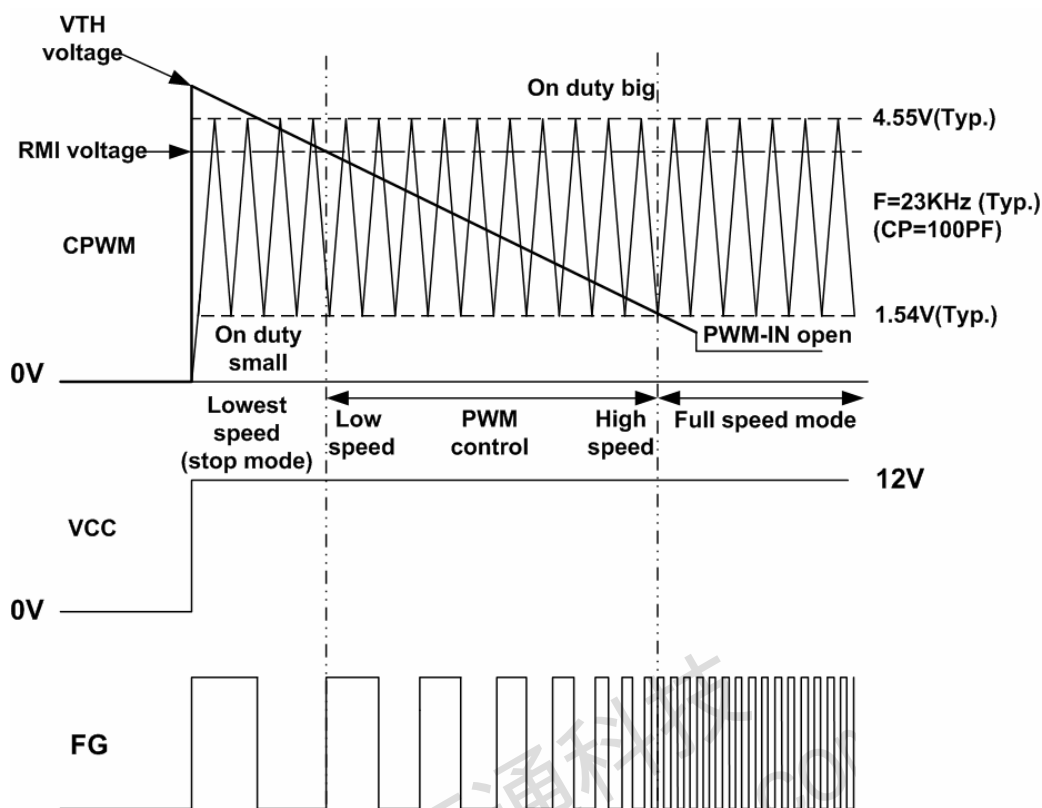


Figure 6.

### 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. If RMI pin is open or connected to VTH, motor will stop when VTH is bigger than 4.55V (but lower than 6.7V).

### 2. PWM control speed mode

PWM control mode works by comparing the voltage of VTH and CPWM (1.54V to 4.55V). When VTH is low, upper and lower sides power devices turn on to charge the motor coil. When VTH is high, upper side power device turn off and motor coil current re-circulates by lower side power device. 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 1.54V. If PWM-IN opens, VTH will become lower than 1.54V, output becomes full speed mode. Also, output will be full speed mode, when VTH is bigger than 6.7V.



### Lock Protection and Auto Restart

RD pin is Open-drain output and it is Low during rotation mode. When motor lock is detected, the output will turn off even if the auto restart circuit has restored the drive mode. The RD pin will come back to low voltage unless the motor rotation actually resumes.

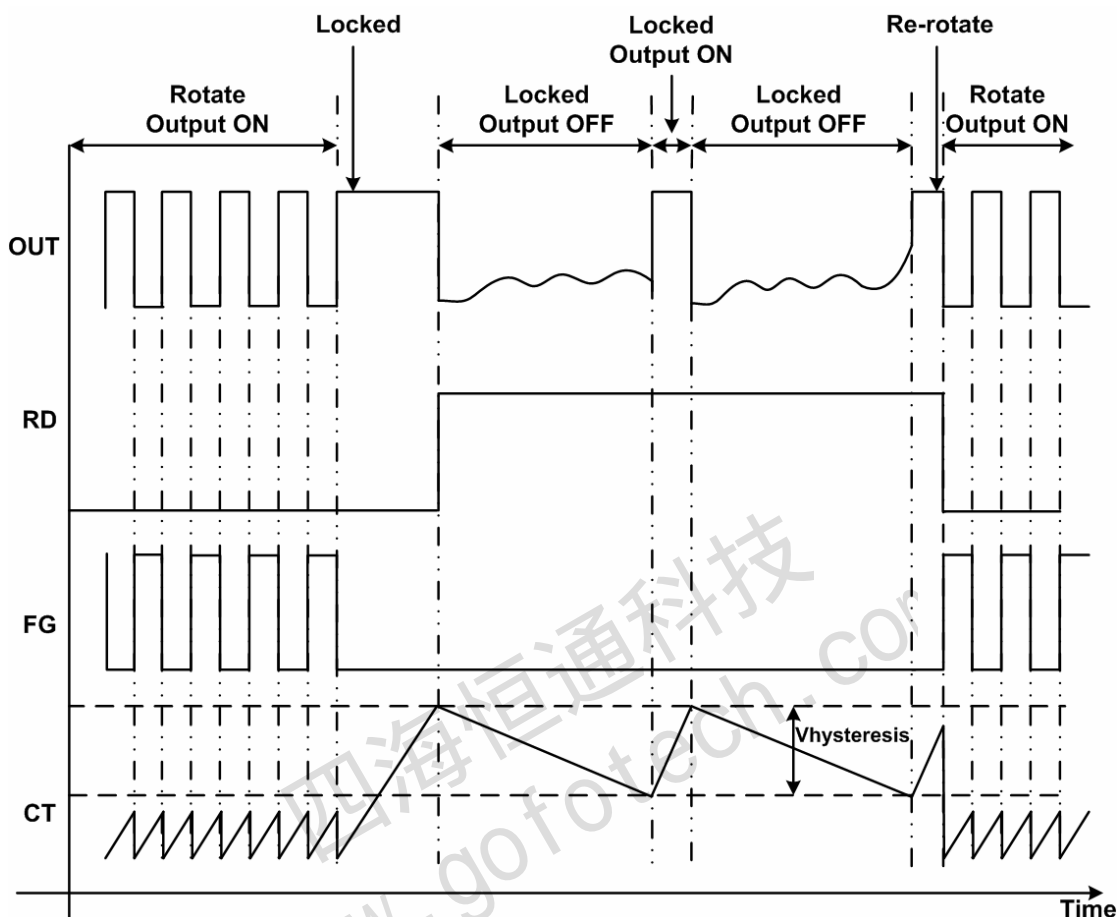
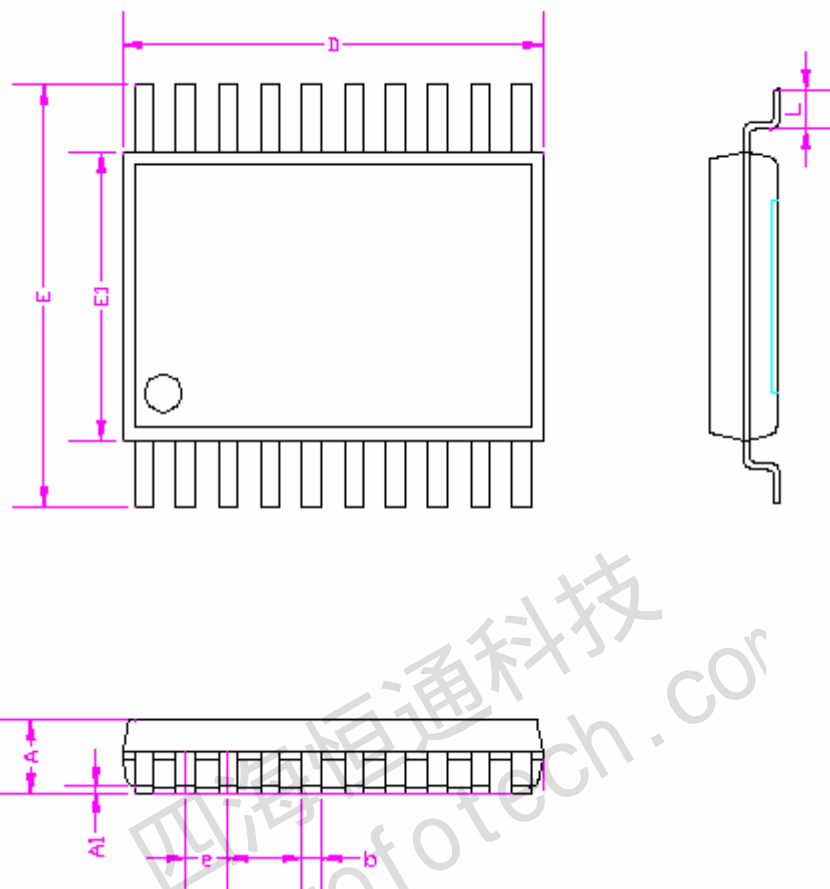


Figure 7.

## Packaging Information

### TSSOP-20



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	6.50		0.256	
E	6.20	6.60	0.244	0.260
e	0.65		0.026	
L	0.45	0.75	0.018	0.030