

### General Description

The EC4188B is a highly-integrated, low startup current, average current mode, one cycle control PFC and fixed switching frequency PWM controller.

These functions enable the LED driver to easily meet the accuracy average LED current and high power factor requirements. The integrated functions also include the LED short protection, open protection, and internal over temperature protection. The COMP pin controls the duty by connected an RC compensation network to ground and forming the closed loop feedback control. To protect the external power MOSFET from being damaged by supply over voltage, the EC4188B OUT pin voltage is clamped to about 15V.

The EC4188B improves the performance and reduces the cost of the LED driver. It is a 6-pin SOT23-6L package.

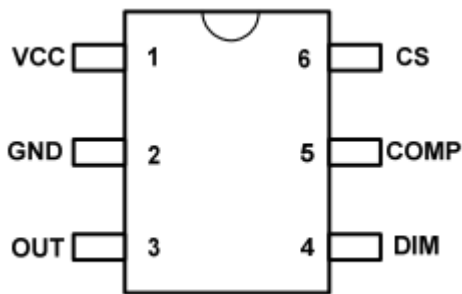
### Features

- High Power Factor by One Cycle Control
- Accuracy Constant Current
- Low BOM Cost
- Linear Dimming on DIM Pin
- Average Current / Fixed Frequency Control
- Gate Output Voltage Clamp
- LED Open Protection (OVP)
- LED Short Protection (SCP)
- Over Current Protection (OCP)
- Internal OTP Protection
- 300mA Driving Capability for OUT Pin
- Fast Start Current
- Incompatible Electronic Ballast and Inductance Ballast

### Applications

- E26/27, T8 LED Tube
- Others LED Lighting Applications

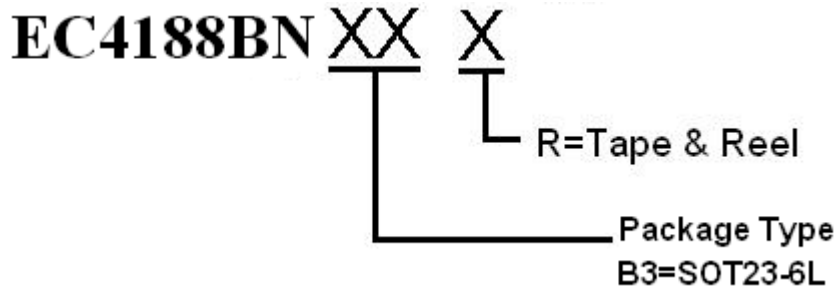
### Pin Assignments



### Pin Description

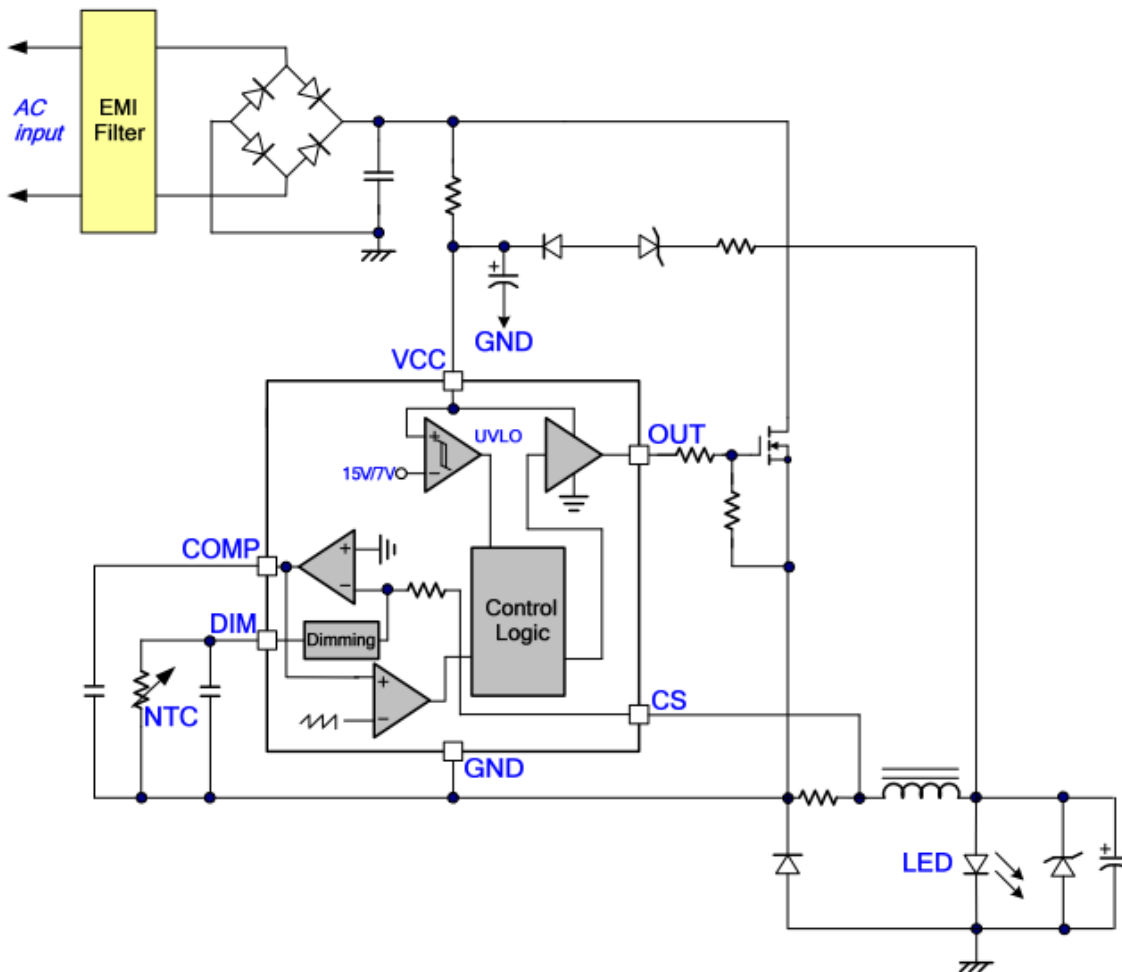
Pin No.	Name	Function
1	VCC	Power Supply Pin
2	GND	Ground Pin
3	OUT	The Output Driver for Driving The External MOSFET
4	DIM	Dimming Control Pin by Input a DC Voltage
5	COMP	Feedback Compensation Network
6	CS	Current Sense Pin, Connect to Sense The MOSFET Current

### Ordering Information



Part Number	Package	Marking	Marking Information
EC4188BNB3R	SOT23-6L	4188B LLLLL	<ol style="list-style-type: none"> <li>"4188B" part no, fixed.</li> <li>LLLLL : Lot No</li> </ol>

### Typical Application Circuit





### Absolute Maximum Ratings

Parameter	Value
Supply Voltage VCC	30V
DIM,COMP, CS	-0.3 to 7V
OUT	15V
Junction Temperature	150°C
Operating Ambient Temperature	-20°C~85°C
Storage Temperature Range	-65°C~150 °C
SOT23-6L Package Thermal Resistance (junction to ambient)	250°C/W
Power Dissipation (SOT23-6L, at ambient temperature = 85°C)	250mW
Lead Temperature (All Pb free packages, soldering, 10 sec)	260°C
ESD voltage protection, machine model	200V
ESD voltage protection, human body model	2KV

### Electrical Characteristics(VCC = 15.0V & T<sub>A</sub> = +25°C, unless otherwise specified.)

Parameters	Pin	Min.	Typ.	Max.	Unit
<b>SUPPLY VOLTAGE</b>					
Startup Current (VCC=UVLO on -1V)	1		8	15	uA
Operating Current (with 1nF load on OUT pin),V <sub>COMP</sub> =2.5V	1		2	3	mA
Operating Current (with 1nF load on OUT pin) Protection triggered(OCP,OVP,SCP,OTP)	1		0.7	1.1	mA
UVLO(off)	1	6	7	8	V
UVLO(on)	1	14	15	16	V
OVP Level on VCC Pin	1	29.5	31.5	33.5	V
OVP De-bounce Time	1		40		us
<b>VOLTAGE FEEDBACK</b>					
Feedback Reference Voltage	5	0.195	0.200	0.205	V
Tran-conductance	5		120		us
Output Sink Current	5		12		uA
Output Source Current	5		12		uA
<b>CURRENT SENSING</b>					
Input over Voltage Protection	6		0.8		V
Open Loop Voltage, CS pin Open	6		5		V
Leading-Edge Blanking Time	6		410		nS
Delay to Output	6		100	220	nS
<b>SWITCHING FREQUENCY</b>					
Switching Frequency	-	42	45	48	KHz
Maximum Duty	-	90			%
Frequency Jitter Range			+/-4		%
Temp. Stability(-40°C ~ 125°C)			-	6	%
Voltage Stability (VCC = 11V~25V)	-			1	%



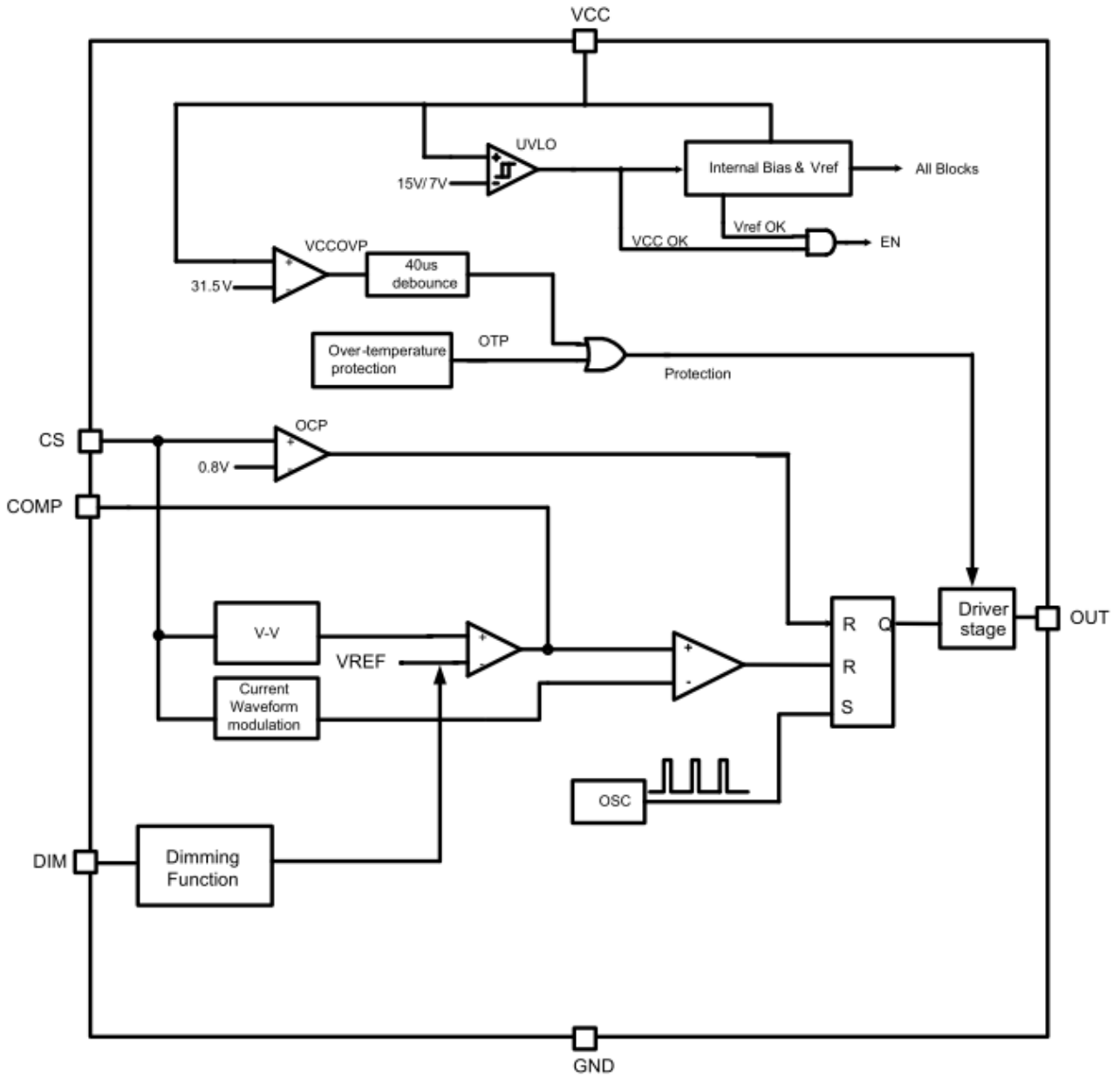
**Electrical Characteristics(VCC = 15.0V & T<sub>A</sub> = +25°C, unless otherwise specified.)**

Parameters	Pin	Min.	Typ.	Max.	Unit
<b>GATE DRIVER OUTPUT</b>					
Rising Time, Load Capacitance = 1000pF	3		160	320	nS
Falling Time, Load Capacitance = 1000pF	3		80	160	nS
VGATE-Clamp (VCC = 25V )	3		13.5	15	V
<b>DIM INPUT SECTION</b>					
Saturation Threshold Voltage	4	3.0			V
Linear Dimming Range	4	0.3		3	V
LED Current off Threshold Voltage	4			0.5	V
Current Source	4	270	300	330	uA
<b>OTP SECTION</b>					
OTP Trip Point	-		150		°C
OTP Release Point			130		°C
OTP Threshold Level			20		°C
OTP De-bounce Time	-		80		uS

Note :

1. OVP, OCP,SCP,OTP : Auto Recovery Type.

### Function Block



### Typical Performance Characteristics

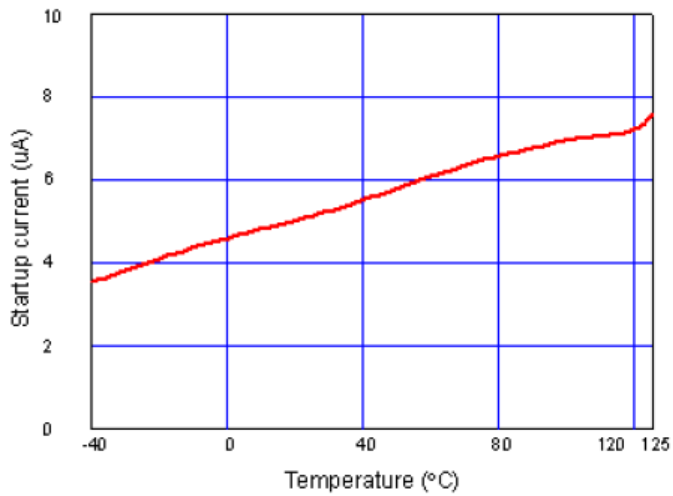


Fig. 1 Startup current vs. Temperature

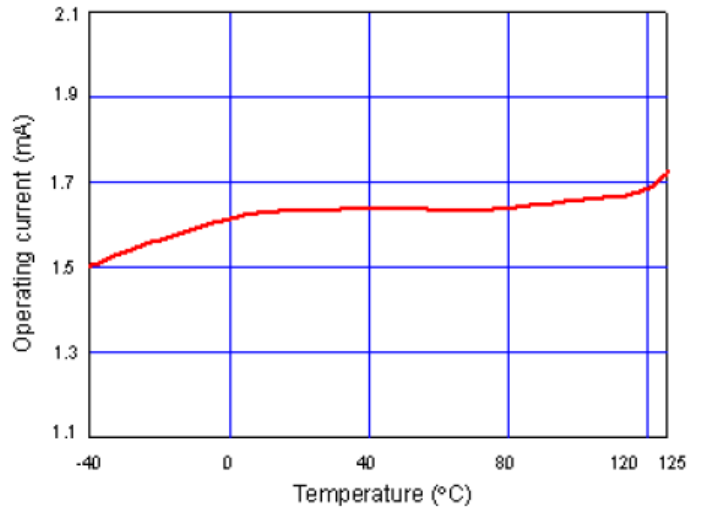


Fig. 2 Operating current vs. Temperature

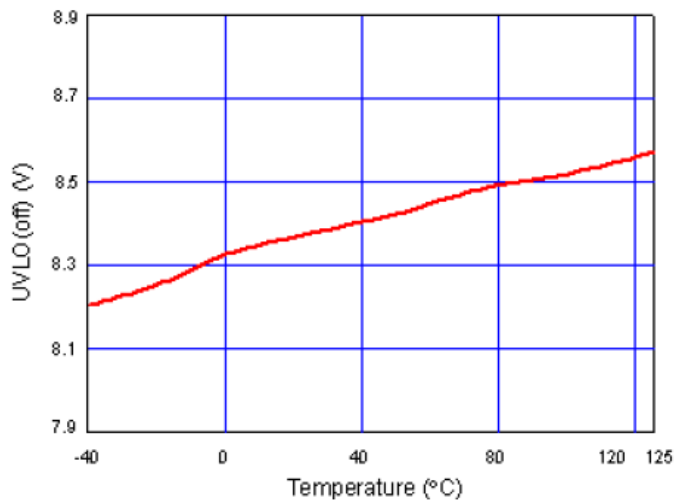


Fig. 3 UVLO(off) vs. Temperature

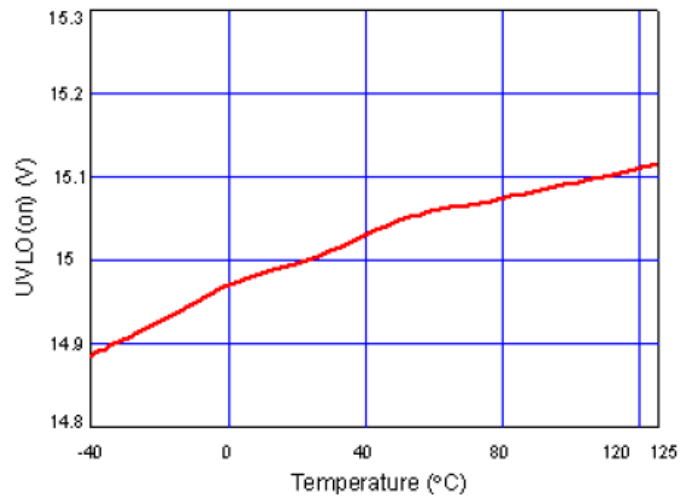


Fig. 4 UVLO(on) vs. Temperature

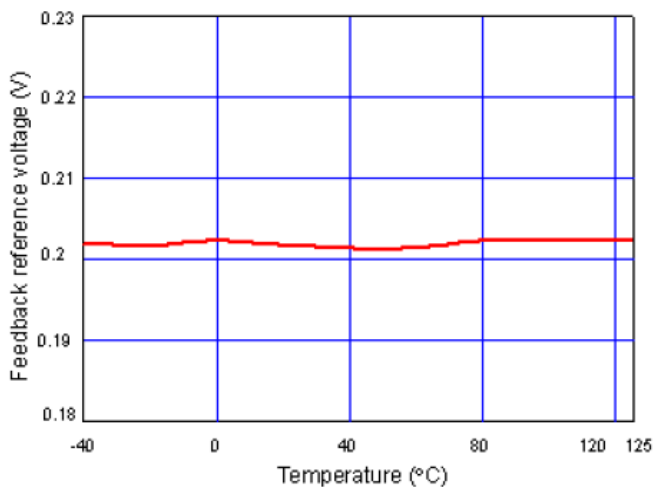


Fig. 5 Feedback reference voltage vs. Temperature

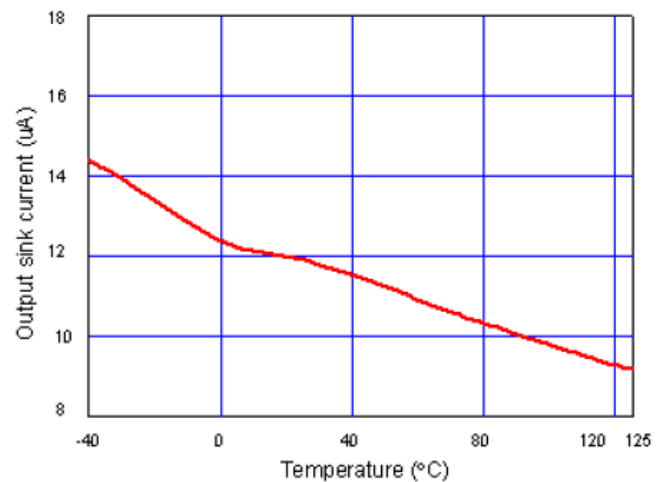


Fig. 6 Output sink current vs. Temperature

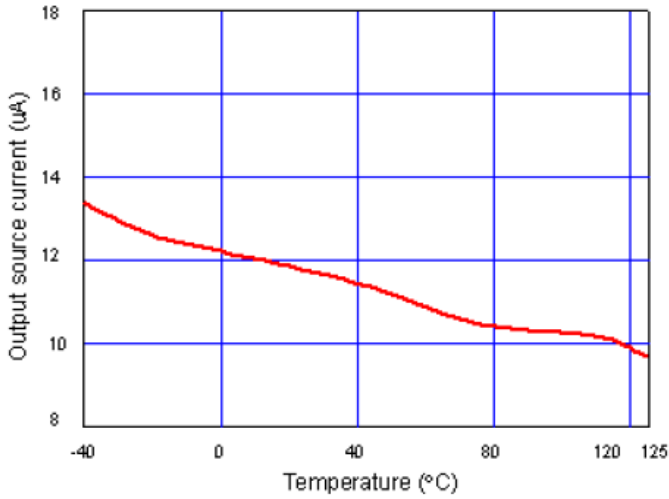


Fig. 7 Output source current vs. Temperature

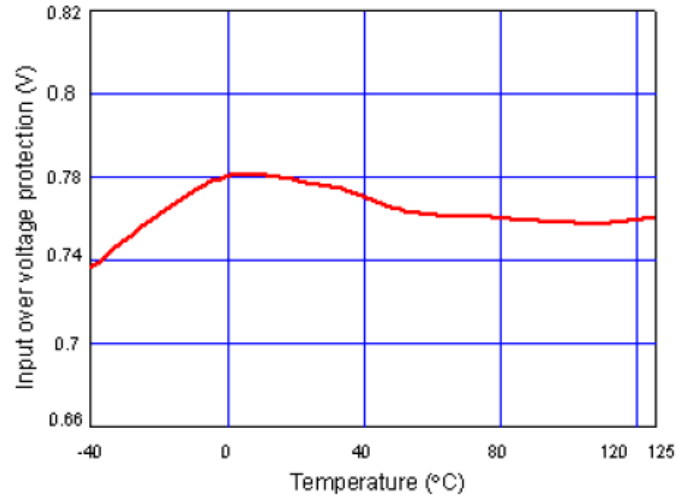


Fig. 8 Input over voltage protection vs. Temperature

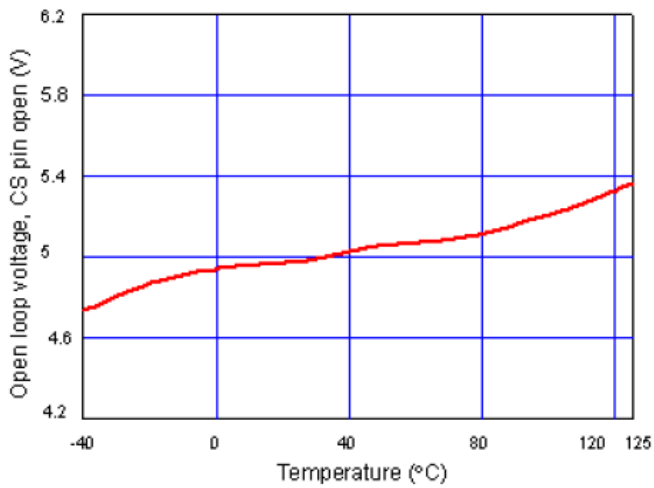


Fig. 9 Open loop voltage, CS pin open vs. Temperature

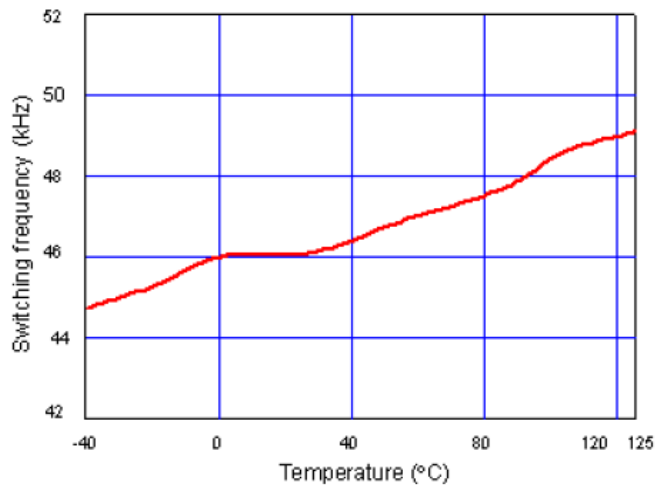


Fig. 10 Switching frequency vs. Temperature

### Application Information

#### Start-up Current

The typical start-up current is around 8uA. Very low start-up current allows the PWM controller to increase the value of start-up resistor and then reduce the power dissipation on it.

#### UVLO (Under Voltage Lockout)

A hysteresis UVLO comparator is implemented in EC4188B, then the turn-on and turn-off thresholds level are fixed at 15V and 7V respectively. This hysteresis shown in Fig.11 ensures that the start-up capacitor will be adequate to supply the chip during start-up. For quickly startup the LED driver, the start-up resistor should be matched with the startup capacitor. Due to the low UVLO on level, so the turn-on delay time will also never greater than the general PWM IC.

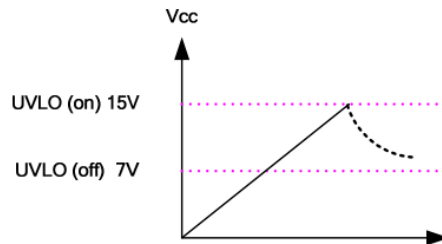


Fig.11

#### Oscillator

The maximum duty-cycle of internal oscillator is up to 90% for driving high LED voltage string. The frequency of the oscillator is fixed to 45KHz by internal setting.

#### LEB (Leading-Edge Blanking)

Each time the power MOSFET is switched on, a turn-on spike will inevitably occur at the sense resistor. To avoid fault trigger, a 410ns leading-edge blanking time is built in. Conventional RC filtering can therefore be omitted. During this blanking period, the current-limit comparator is disabled and can not switch off the gate driver.

#### OCP (Over Current Protection)

The EC4188B has an over current protection function on CS pin. An internal circuit detects the current level, when the current is larger than a threshold level, the gate output will keep on low level. Then VCC decreases below UVLO off level, the controller resets again.

#### OVP (Over Voltage Protection) on VCC

To prevent the LED driver from being damaged, the EC4188B is implemented an OVP function on VCC. When the VCC voltage is higher than the OVP threshold voltage 31.5V, the output gate driver circuit will be shut down immediately to stop the switching of power MOSFET. The VCC pin OVP function is an auto recovery type protection (latch off type optional). If the OVP condition happens, the pulses will be stopped and never recovery unless the VCC pin voltage is down to the UVLO off level. The EC4188B is working in an auto-recovery mode as shown in Fig. 12.

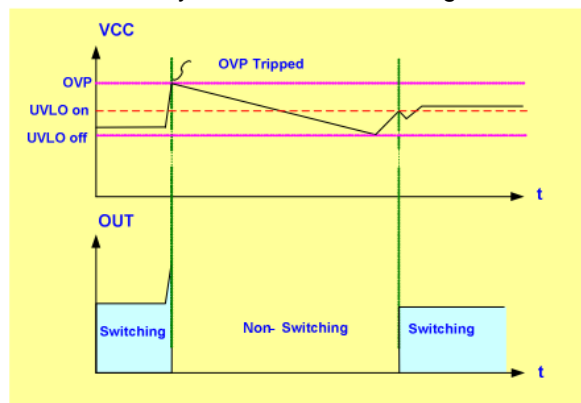


Fig. 12



### Gate Clamp/Soft Driving

Driver is clamped to 15V by an internal clamping circuit. Those damages usually come from undesired over-voltage gate signals. Under the conditions listed below, the gate output will turn off immediately to protect the power circuit. The EC4188B also has soft driving function to minimize EMI.

### Over Temperature Protection/Dimming Function

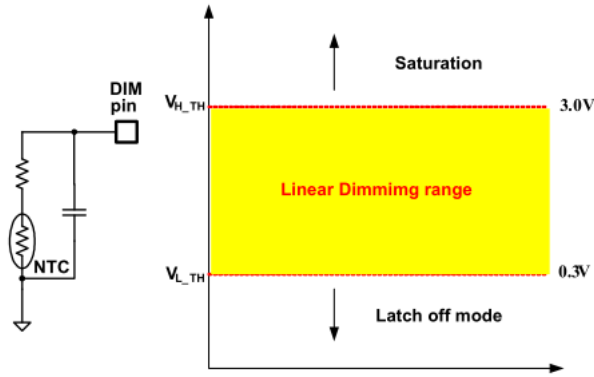
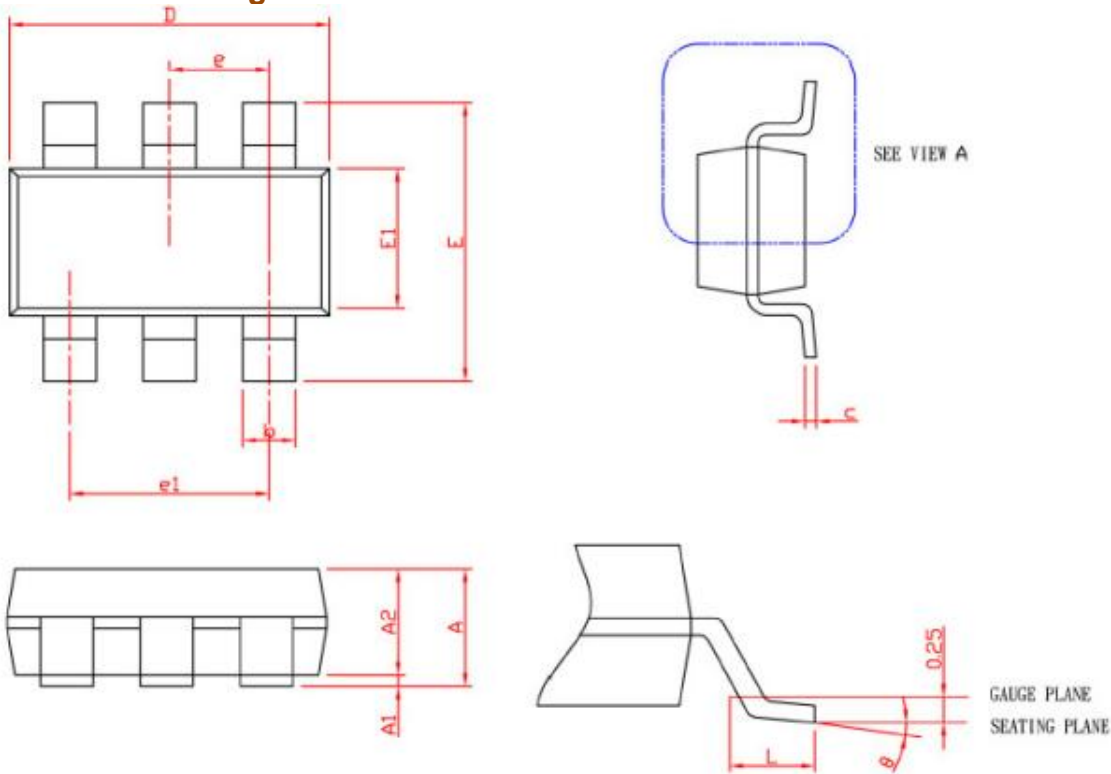


Fig. 13

The typical application for DIM pin is shown in Fig.13. The NTC thermistor is setting as an external OTP protection. In the DIM pin, there is one comparator for latch-off mode protection. While the voltage on this pin is lower than 0.3V, the EC4188B will shut down. When the voltage is in the range of 0.3 to 3.0V, the EC4188B is operating on the linear dimming range. While the voltage is higher than 3.0V, the EC4188B is operating on the normal status. It also could let this Pin open when the function is not required for the user.

### Package Information

#### SOT23-6L Package Outline Dimensions



SYMBOL	SOT23-6L			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A		1.45		0.057
A1	0.00	0.15	0.000	0.006
A2	0.90	1.30	0.035	0.051
b	0.30	0.50	0.012	0.020
c	0.08	0.22	0.003	0.009
D	2.70	3.10	0.106	0.122
E	2.60	3.00	0.102	0.118
E1	1.40	1.80	0.055	0.071
e	0.95 BSC		0.037 BSC	
e1	1.90 BSC		0.075 BSC	
L	0.30	0.60	0.012	0.024
$\theta$	0°	8°	0°	8°

**Note:**

1. Followed from JEDEC TO-178 AB.
2. Dimension D and E1 do not include mold flash, protrusions or gate burrs. Mold flash, protrusions or gate burrs shall not exceed 10 mil per side