

Low-Dropout High-Power LED Driver

CN5611

General Description:

The CN5611 current regulator operates from a 2.7V to 6V input voltage range and delivers a constant current that is up to 800mA to high-brightness LEDs, including high-brightness white LED. The LED current of CN5611 can be adjusted from 30mA to 800mA by using an external resistor. An on-chip pass element minimizes external components while providing $\pm 8\%$ output current accuracy. Additional features include over temperature protection, LED short and open protection.

The CN5611 is available in a thermally enhanced 5-pin SOT89 package.

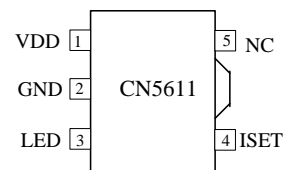
Features:

- Operating Supply Voltage Range: 2.7V to 6V
- On-chip Pass Element
- Low-Dropout Voltage
- Adjustable Output Current up to 800mA
- Output Current Accuracy: $\pm 8\%$
- Over Temperature Protection
- LED Open/Short Protection
- Operating Temperature Range:
-40°C to 85°C
- Available in 5-pin SOT89 Packages
- Pb-free

Applications:

- High-Power LED Driver
- LED Cap-Lamp
- Flash Light and Lighting
- Cell Phone, DSC and MP3 Player
- LCD and Keyboard Backlight

Pin Assignment



Typical Application Circuit

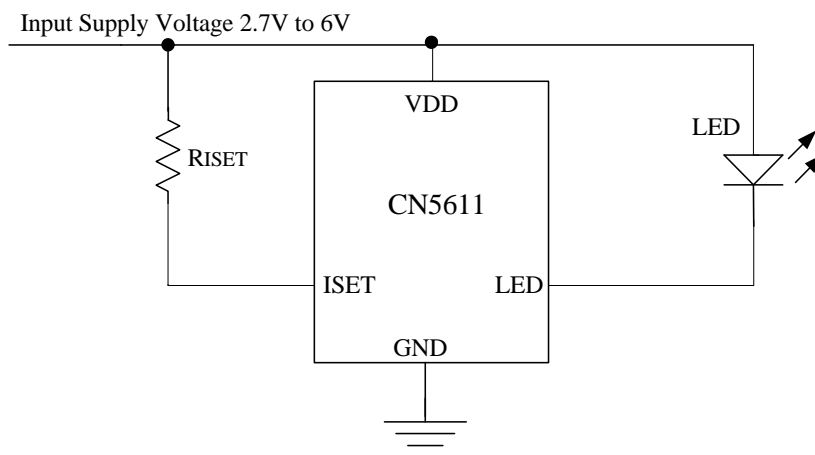


Figure 1 Typical Application Circuit

Block Diagram

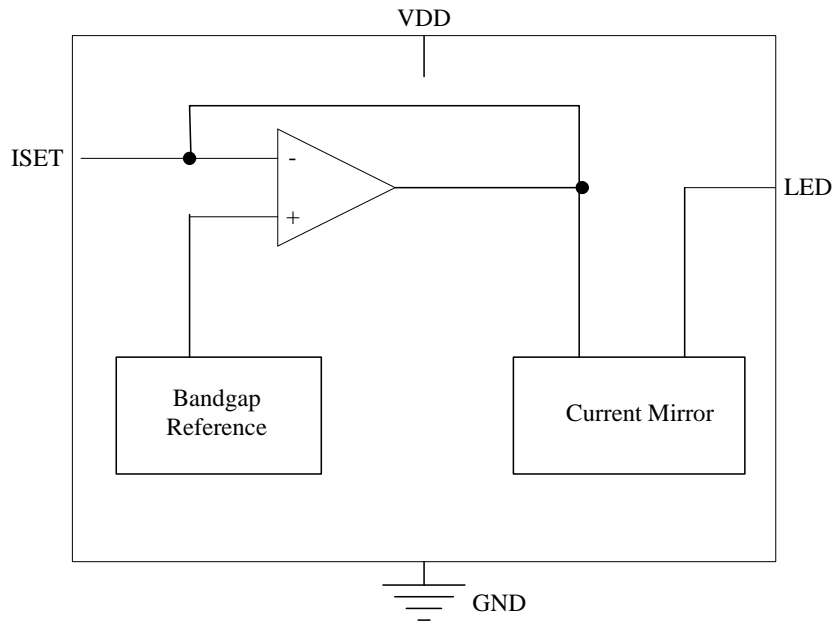


Figure 2 Block Diagram

Pin Description

Pin No.	Name	Function Description
1	VDD	Positive Supply Voltage. V _{DD} is the power supply to the internal circuit.
2	GND	Ground Terminal.
3	LED	LED Cathode Connection Pin.
4	ISET	Constant LED Current Setting Pin. The constant LED current is set by connecting a resistor R _{ISET} from this pin to VDD. The LED current is determined by the following equation: $I_{out} = 910V / R_{ISET}$ Where, I _{out} is in ampere(A) R _{ISET} is in ohm(Ω)
5	NC	No Connection.

Absolute Maximum Ratings

All Terminal Voltage..... -0.3V to 6.5V
 Operating Temperature..... -40°C to 85°C
 Thermal Resistance(Junction to Case)32°C/W

Maximum Junction Temperature.....150°C
 Storage Temperature..... -65°C to 150°C
 Lead Temperature(Soldering).....300°C

Stresses beyond those listed under 'Absolute Maximum Ratings' may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to Absolute Maximum Rating Conditions for extended periods may affect device reliability.

Electrical Characteristics

(VIN=3.7V, TA=25°C, unless otherwise noted)

Parameters	Symbol	Test Conditions	Min	Typ	Max	Unit
Input Supply Voltage	VDD		2.7		6	V
Operating Current	IVDD	R _{ISET} =10K ohm		335		uA
LED Pin Sink Current	I _{LED}	R _{ISET} =3K	279	303	327	mA
LED Current Tolerance			-8		+8	%
Over Temperature Protection Temperature	T _{OTP}			125		°C
Over Temperature Protection Hysteresis	T _H			11		°C
LED pin Leakage Current	I _{LKG}	VDD=GND, V _{LED} =5.5V			1	uA
LED Dropout Voltage	V _{DROP}	I _{LED} =100mA × 90%		95		mV
		I _{LED} =200mA × 90%		135		
		I _{LED} =300mA × 90%		175		
		I _{LED} =500mA × 90%		280		
		I _{LED} =700mA × 90%		410		
Thermal Resistance	θ _{JC}	Junction to Case		32		°C/W
Thermal Resistance	θ _{JA}	Junction to Ambient, No heat sink, No air flow		135		°C/W

Detailed Description

The CN5611 is a current regulator capable of providing LED current up to 800mA to high-power LEDs. In addition, CN5611 features over temperature protection, LED open/short protection.

The CN5611 enters a thermal-shutdown mode in the event of over temperature. This typically occurs in overload or LED short-circuit conditions. When CN5611's junction temperature exceeds T_J = +125°C (typical), the current flowing into LED pin is about 1% of that set by R_{ISET} to prevent the device from damage. CN5611 recovers from thermal-shutdown mode once the junction temperature drops by 11°C (typical). The device will therefore protect itself by thermally cycling in the event of LED short-circuit or overload condition.

Application Information

Adjusting LED Current

CN5611 uses a resistor between ISET pin and VDD pin to set the LED current. The LED current is given by the following equation:

$$I_{LED} = 910V / R_{ISET}$$

Where: I_{LED} is the LED current in ampere(A)

R_{ISET} is the resistance from the ISET pin to VDD pin in ohm(Ω)

For best stability over temperature and time, 1% and 1/10W metal film resistors are recommended.

Thermal Consideration

The CN5611's maximum allowable power dissipation is given by the following equation:

$$P_{Dmax} = (T_J - T_A) / \theta_J$$

Where, P_{Dmax} is the maximum allowable power dissipation

T_J is the maximum junction temperature of CN5611, T_J=125°C due to the

effect of over temperature protection circuit

T_A is the CN5611's ambient temperature

θ_{JA} is the thermal resistance of CN5611, when there is no heat sink and no air flow, θ_{JA} is 135°C/W, and it will be decreased to a great extent when there is heat sink, So in order to maximize LED current, careful thermal consideration must be given when designing PCB.

The actual power dissipation of CN5611 is given by the following equation:

$$P_{Dact} = V_{LED} \times I_{LED}$$

where, P_{Dact} is CN5611's actual power dissipation

V_{LED} is the maximum voltage at LED pin

I_{LED} is the designed output current

For the purpose of normal operation for CN5611, P_{Dact} must be less than P_{Dmax} .

Drive Multi-LEDs

When multi-LEDs are needed to be driven, the circuit in Figure 3 or in Figure 4 can be used. V_{IN} is the high input supply voltage that is used to drive multi-LEDs, CN5611's operating voltage can be from an independent source as shown in figure 3, or generated from V_{IN} as shown in figure 4.

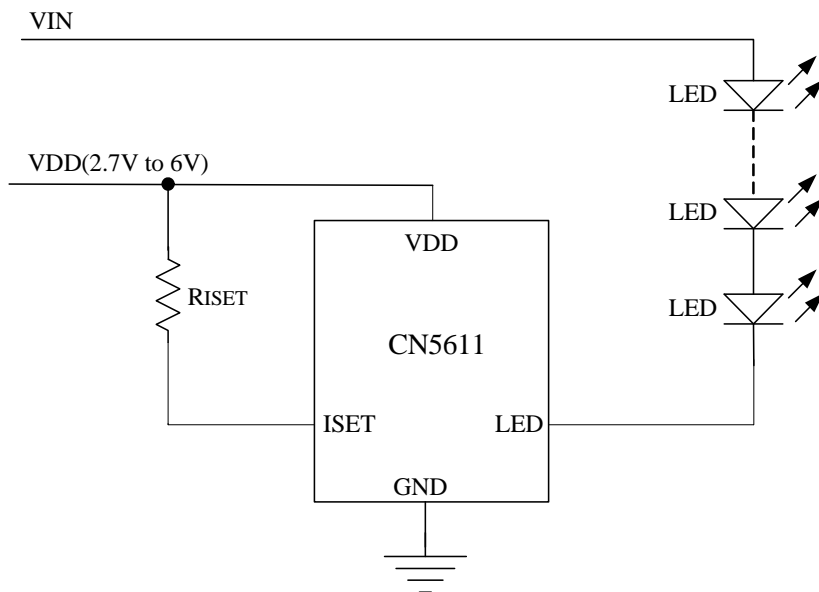


Figure 3 Drive Multi-LEDs from 2 Voltage Sources

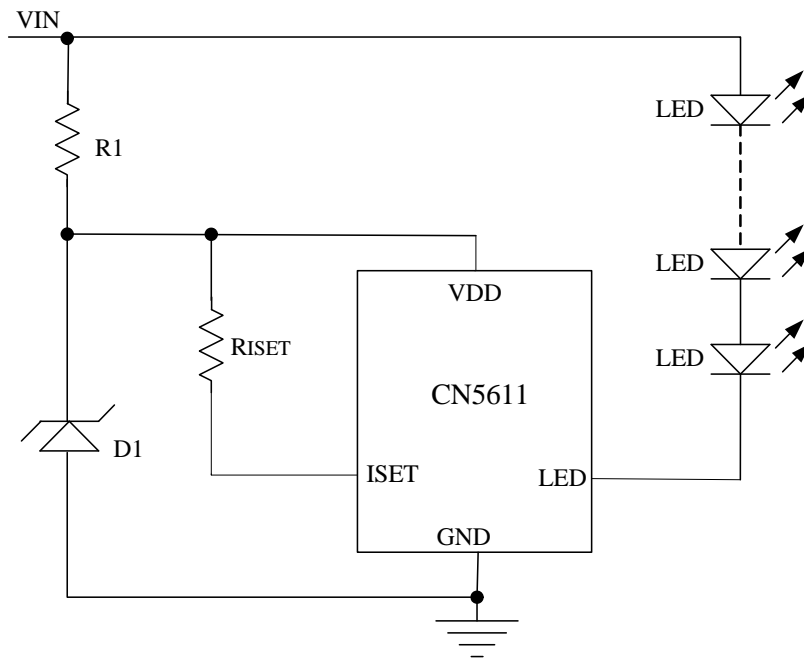


Figure 4 Drive Multi-LEDs from a High Voltage Sources

In the circuit of Figure 3 and Figure 4, care must be taken to make sure that the voltage at CN5611’s LED pin should be kept less than 6V under any conditions.

In the circuit of Figure 4, D1 is the zener diode whose breakdown voltage is between 2.7V to 6V. R1’s resistance should be small enough so that the current flowing through R1 is greater than 3mA under worst case.

For more application circuits, please refer to “CN5611-CN5612 Application Circuit Collection”.

Dimming Control

There are 3 different ways of dimming control:

1. Using a PWM signal for dimming control as shown in Figure 5

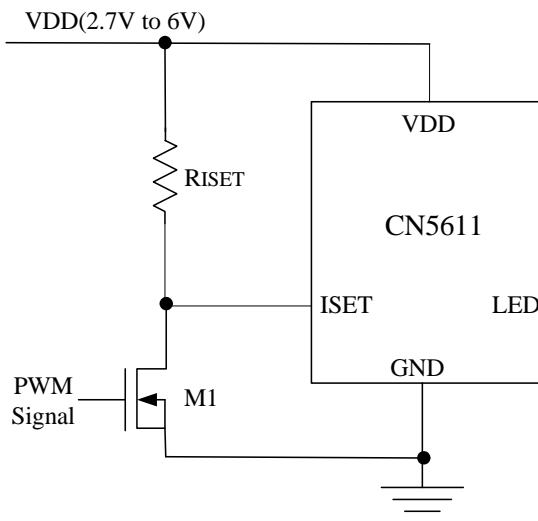


Figure 5 Dimming Control by Using PWM Signal

With PWM signal applied to the gate of N channel MOSFET M1, the LEDs operate at either zero or full current. The average LED current decreases with the increasing duty cycle of PWM signal. A 100% duty cycle will turn off LEDs completely, a 0% duty cycle corresponds to full LED current. The frequency of PWM signal should be under 10KHz.

2. Using a logic signal for dimming control as shown in Figure 6

For applications that need to adjust the LED current in discrete steps, a logic signal can be used as shown in Figure 6. R_{ISET1} sets the minimum LED current (when the PMOS is off, namely logic signal is high). R_{ISET2} sets how much the LED current increases when the PMOS is turned on (logic signal is logic low).

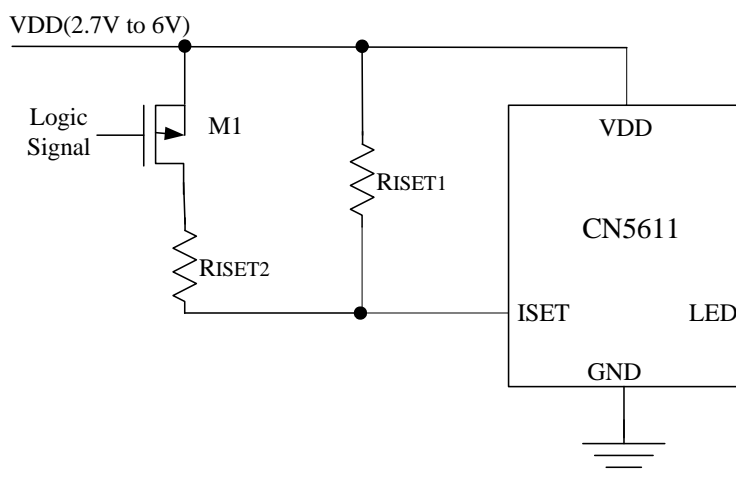


Figure 6 Dimming Control by Using Logic Signal

3. Using a variable resistor for dimming control as shown in Figure 7

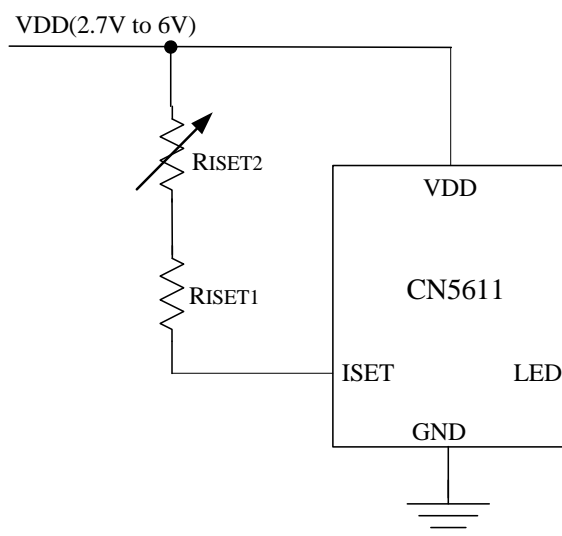


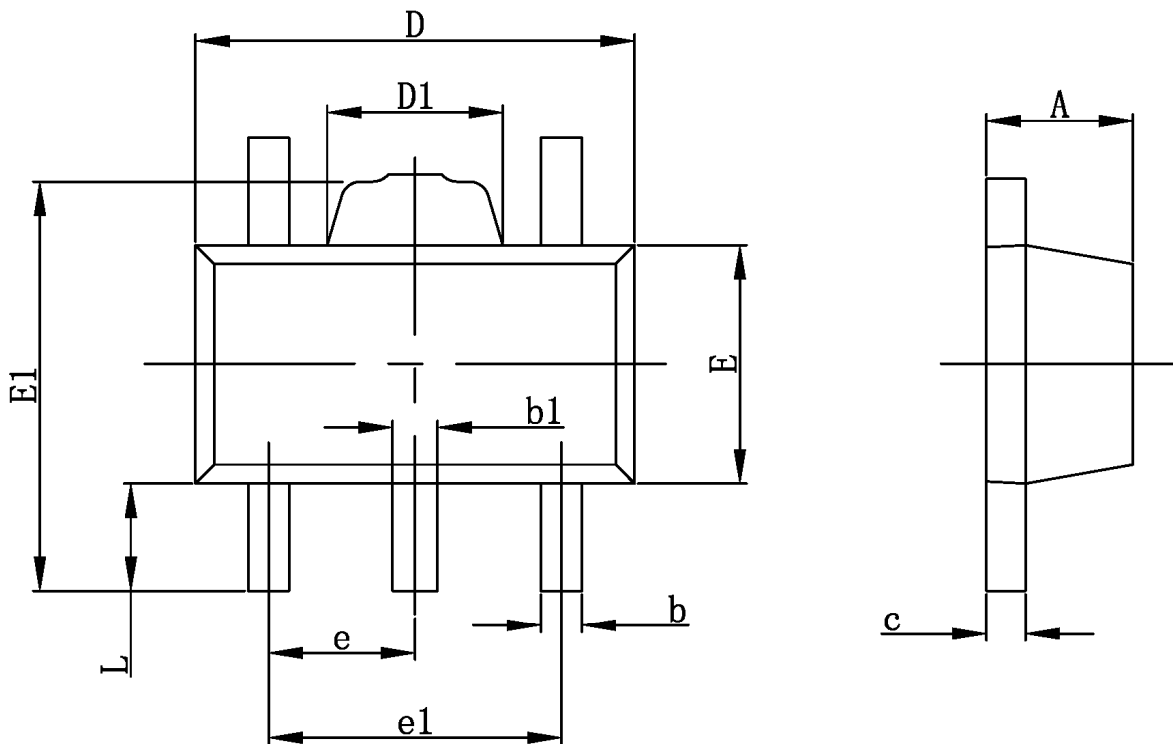
Figure 7 Dimming Control by Using Variable Resistor

Board Layout Considerations

It is very important to use a good thermal PC board layout to maximize LED current. The thermal path for the heat generated by the IC is from the die to the copper lead frame through the package lead (especially the LED and ground lead) to the PC board copper, the PC board copper is the heat sink. The footprint copper pads should be as wide as possible and expand out to larger copper areas to spread and dissipate the heat to the surrounding ambient. Feedthrough vias to inner or backside copper layers are also useful in improving the overall thermal performance of CN5611. Other heat sources on the board, not related to CN5611, must also be considered when designing a PC board layout because they will affect overall temperature rise and the maximum LED current.

The ability to deliver maximum LED current under all conditions require that the exposed metal pad on the back side of the CN5611 package be soldered to the PC board ground. Failure to make the thermal contact between the exposed pad on the backside of the package and the copper board will result in larger thermal resistance.

Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.400	1.600	0.055	0.063
b	0.320	0.520	0.013	0.020
b1	0.360	0.560	0.014	0.022
c	0.350	0.440	0.014	0.017
D	4.400	4.600	0.173	0.181
D1	1.400	1.800	0.055	0.071
E	2.300	2.600	0.091	0.102
E1	3.940	4.250	0.155	0.167
e	1.500TYP		0.060TYP	
e1	2.900	3.100	0.114	0.122
L	0.900	1.100	0.035	0.043

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