

## Multi-function High Brightness LED Driver IC

### CN5728

#### General Description

The CN5728 is a current regulation integrated circuit operating from an input voltage of 2.85V to 6V, the constant output current can be set up to 1.5A with an external resistor. The CN5728 is ideal to be used to drive LED. The on-chip power transistor and current sense block greatly reduce the external component count.

The chip also integrates the mode selection circuit, oscillator and state registers, which can control the LED to operate in one of the following four modes: Off, High Brightness(HB), Low Brightness(LB), Flashing and off.

The CN5728 adopts the temperature regulation instead of temperature protection function, the temperature regulation can make the LED being turned on continuously in case of high ambient temperature or high voltage drop.

The other features include the chip enable and button de-bounce functions.

CN5728 is available in thermally-enhanced 8-pin small outline package (SOP8).

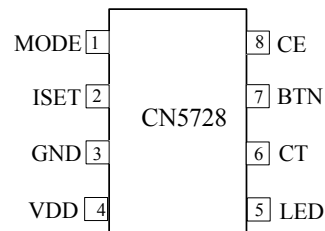
#### Applications

- Flashlight
- High-brightness LED driver
- LED headlights
- Emergency lights and lighting

#### Features

- Operating Voltage Range: 2.85V to 6V
- Four Operating Modes: HB, LB, Flash and Off
- On-chip Power Transistor
- Low dropout voltage: 0.4V @ 1.5A
- LED pin output current up to 1.5A
- Output Current Accuracy:  $\pm 5\%$
- Chip Temperature Regulation
- Operating Temperature Range:  $-40\text{ }^{\circ}\text{C}$  to  $85\text{ }^{\circ}\text{C}$
- Thermally-enhanced 8-pin SOP package
- Pb-free, rohs compliant and halogen free

#### Pin Assignment



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## Typical Application Circuit

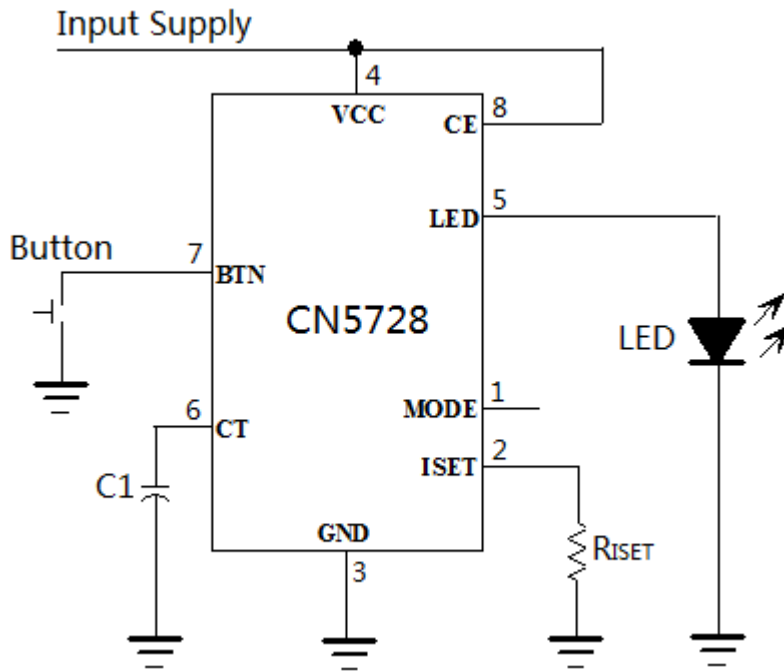


Figure 1 Typical Application Circuit

(MODE pin is floating, LED works in sequence of HB, LB and Off)

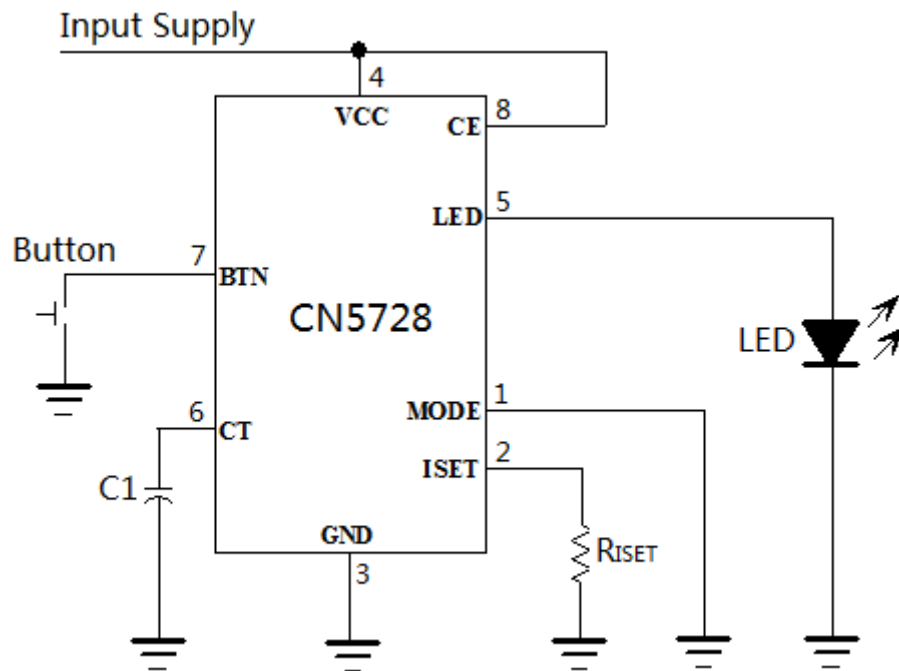


Figure 2 Typical Application Circuit

(MODE pin grounded, LED works in sequence of HB, Flashing and Off)

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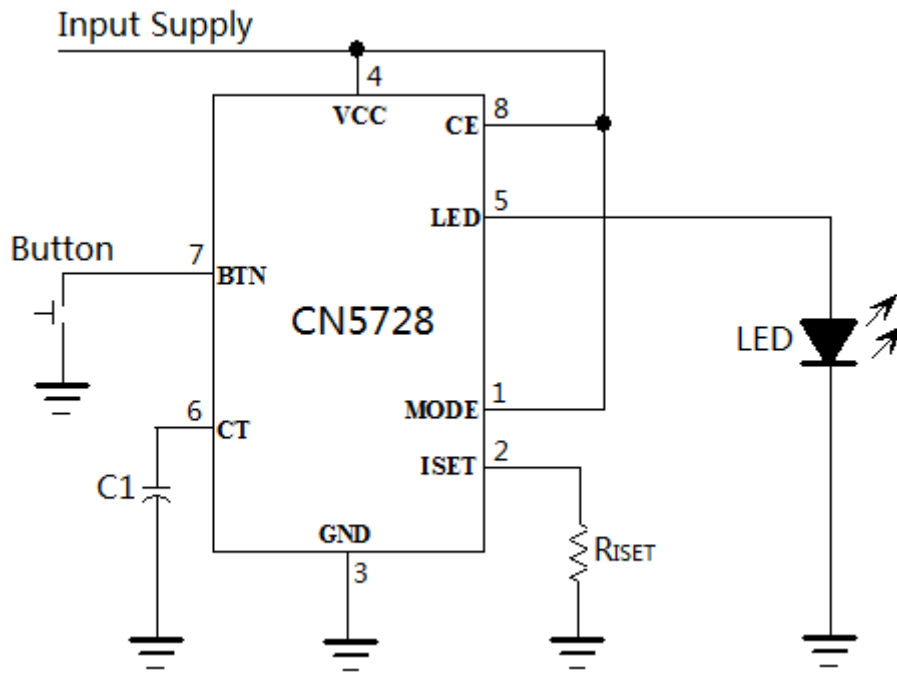


Figure 3 Typical Application Circuit

(MODE pin is connected to VCC, LED works in sequence of HB, LB, Flashing and Off)

## Ordering Information

Part Number	Package	Shipping	Operating temperature
CN5728	SOP8	Tape and Reel, 4000/Reel	-40°C to 85°C

## Block Diagram

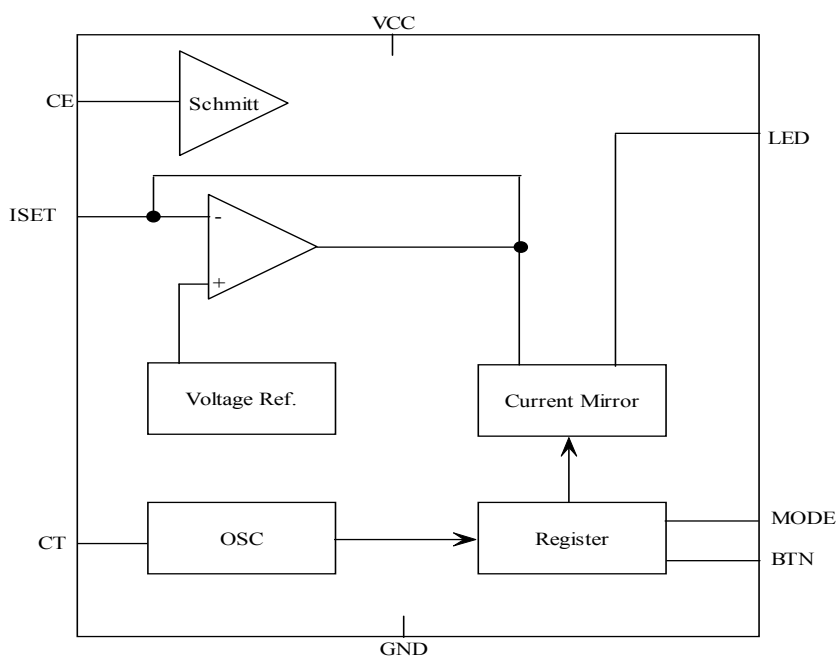


Figure 4 Functional Block Diagram

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## Pin Function Description

Pin No.	Symbol	Description
1	MODE	<b>The Operating Mode Selection Pin.</b> This pin defines the sequence LED works in. When MODE pin is grounded, the sequence is HB, Flashing and Off. When MODE pin is floating, the sequence is HB, LB and Off. When MODE pin is tied to VCC, the sequence is HB, LB, Flashing and Off.
2	ISET	<b>LED Current Setting Pin.</b> The current from LED pin is set by a resistor $R_{ISET}$ from ISET pin to ground. The equation to calculate the current is as below: $I_{LED} = 1800V / R_{ISET}$ Where, $I_{LED}$ is the current out of LED pin, and is in amperes (A) ; $R_{ISET}$ 's unit is ohm.
3	GND	<b>The Negative Terminal of Power Supply(Ground).</b>
4	VCC	<b>The Positive Terminal of Power Supply.</b> The internal circuit is powered by this pin.
5	LED	<b>The Anode of LED.</b> LED's anode is connected to this pin, and LED current flows out of this pin.
6	CT	<b>The Timing Capacitor Pin.</b> The timing capacitor for flashing period is connected between CT pin to GND. The flashing period is determined by the following formula: $\text{Period} = 3.96 \times 10^7 \times CT \quad (\text{s})$ Where, CT is the capacitance at CT pin and is in farads (F) If flash mode is not needed, then CT pin can be connected to VCC pin.
7	BTN	<b>Button Input Pin.</b> Button is connected between this pin and GND. There are on-chip pull up resistors and button de-bounce circuit. The CN5728 will go to the next mode in the sequence selected by MODE pin on each valid input at BTN pin.
8	CE	<b>Chip Enable Input.</b> A high input will put the device in the normal operating mode. Pulling the CE pin to low voltage level will put the CN5728 into disable mode.
9	Exposed Pad	<b>Soldered to GND.</b>

## ABSOLUTE MAXIMUM RATINGS

Terminal Voltage (With respect to GND)	Thermal Resistance( $\theta_{JC}$ ).....30°C/W
VCC.....-0.3V to +6.5V	Operating Temperature.....-40 to +85°C
Other terminal voltage.....-0.3V to VCC	Storage Temperature.....-65 to +150°C
Maximum Junction Temperature..... 150°C	Lead Temperature (soldering, 10s) .....+260°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 beyond 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.*

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## Electrical Characteristics

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

Parameters	Symbol	Test Conditions	Min	Typ	Max	Unit
Operating Voltage Range	VCC		2.85		6	V
Operating Current	I <sub>VCC1</sub>	R <sub>ISET</sub> =1.8kΩ, I <sub>LED</sub> =0A	250	310	370	uA
Operating Current in Off Mode	I <sub>VCC2</sub>	Off mode, MODE pin floating		26		uA
		Off mode, MODE pin tied to VCC or GND		15		
Disabled Current	I <sub>VCC3</sub>	V <sub>CE</sub> =0V, MODE is floating or tied to VCC			1	uA
		V <sub>CE</sub> =0V, MODE tied to GND		8	12	
LED Pin Current	I <sub>LED1</sub>	R <sub>ISET</sub> =1.8kΩ, HB mode	0.95	1	1.05	A
	I <sub>LED2</sub>	R <sub>ISET</sub> =1.8kΩ, LB mode	346	365	383	mA
LED Current Accuracy			-5		+5	%
LED pin voltage drop	V <sub>DROP</sub>	I <sub>LED</sub> =100mA×95%		40		mV
		I <sub>LED</sub> =350mA×95%		85		
		I <sub>LED</sub> =500mA×95%		130		
		I <sub>LED</sub> =900mA×95%		300		
		I <sub>LED</sub> =1.2A×95%		360		
		I <sub>LED</sub> =1.5A×95%		400		
LED Flashing Period	Period	Flashing mode		3.96×10 <sup>7</sup> C		s
LED Flashing Period Temperature Coefficient		Flashing mode		-0.24%		/°C
Soft Start Time				150		uS
<b>MODE Pin</b>						
MODE Pin Current	I <sub>MODE1</sub>	V <sub>MODE</sub> =3.7V	5	7.5	10.3	uA
	I <sub>MODE2</sub>	V <sub>MODE</sub> =0V	5.2	7.9	10.6	
<b>BTN Pin</b>						
BTN Pull Up Resistor	R <sub>BTN</sub>			52		kΩ
De-bounce Time	t <sub>debounce</sub>		20	36	52	mS
<b>CE Pin</b>						
CE input low	V <sub>CEL</sub>	CE voltage falls			0.6	V
CE input high	V <sub>CEH</sub>	CE voltage rises	2.3			V
CE input current	I <sub>CEL</sub>	CE=GND, VCC=6V	-1			uA
	I <sub>CEH</sub>	CE=VCC=6V			1	

## Detailed Description

The CN5728 is a current regulation integrated circuit operating from an input voltage of 2.85V to 6V, the constant output current can be set up to 1.5A with an external resistor. The CN5728 consists of high precision reference voltage, amplifier, current mirror, etc. The on-chip power transistor and current sense block greatly reduce the external component count, which makes the CN5728 ideal for LED driver.

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The chip also integrates the mode selection circuit, button de-bounce circuit, oscillator and state registers, which can control the LED operating in one of the following four modes: High Brightness (HB), Low Brightness (LB), Flashing and Off.

The CN5728 adopts the temperature regulation instead of temperature protection function, the temperature regulation can make the LED being turned on continuously in case of high ambient temperature or high voltage drop.

The CN5728 also has the chip enable function, which can shutdown the whole chip to limit the current consumption within 1uA.

## Application Information

### Soft Start

CN5728 has built-in soft start circuit, the soft start is activated on power up, CE pin's rising edge or entering of HB mode. The soft start time is 150uS.

### Four Operating Mode of CN5728

CN5728 integrates mode selection circuit, state registers and button de-bounce circuit, which can control the CN5728 to operate in one of the 4 modes: High Brightness (HB), Low Brightness (LB), Flashing and Off.

In HB mode, LED pin current is 100% of the current set by the resistor at ISET pin.

In LB mode, LED pin current is 36.5% of the current set by the resistor at ISET pin.

In flashing mode, LED pin current switches between 0A and the current in HB mode. The flashing period is calculated by the following formula:

$$\text{Period} = 3.96 \times 10^7 \times C_T \quad (\text{s})$$

Where,  $C_T$  is the capacitance at CT pin, and is in farads (F).

If flash mode is not needed, then  $C_T$  pin can be connected to VCC pin.

In Off mode, LED pin current is 0A, and CN5728 only consumes 15uA current typical(MODE pin is tied to GND or VCC).

MODE pin is used to select the operating sequence as the follows:

- When MODE pin is grounded, the sequence is HB, Flashing and Off.
- When MODE pin is floating, the sequence is HB, LB and Off.
- When MODE pin is tied to VCC, the sequence is HB, LB, Flashing and Off.

On power up, the CN5728 works in HB mode by default, and will go to the next mode in the sequence selected by MODE pin on each valid input at BTN pin.

### Set the LED Current (HB mode)

The CN5728 use a resistor  $R_{ISET}$  between the ISET pin and GND to set the LED current, the current is calculated as follows:

$$I_{LED} = 1800V / R_{ISET}$$

Where,  $I_{LED}$  is the LED pin current, and is in amperes (A);

$R_{ISET}$  is in ohms ( $\Omega$ )

For example, if 1A LED current in HB mode is required:

$$R_{ISET} = 1800V/1A = 1.8K\Omega$$

In LB mode, the LED pin current is 36.5% of the current in HB mode.

In order to ensure good stability and temperature characteristics, it is recommended to use a 1%, metal film resistor for  $R_{ISET}$ .

### Considerations on Power consumption

CN5728's maximum allowable power dissipation is:

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

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Where,  $P_{Dmax}$  is the CN5728's maximum allowable power dissipation

$T_j$  is the CN5728's maximum junction temperature, which is 135 °C

$T_A$  is the CN5728's operating environment temperature

$\theta_{JA}$  is the thermal resistance of the package

CN5728's actual power consumption is calculated with the following formula:

$$P_{Dact} = (V_{CC} - V_{LED}) \times I_{LED}$$

Where,  $P_{Dact}$  is CN5728's actual power consumption

$V_{LED}$  is the voltage at LED pin

$I_{LED}$  is the current flowing out of LED pin

For normal operation,  $P_{Dact}$  should be less than  $P_{Dmax}$ .

## LEDs in parallel

The CN5728 can drive more than one LEDs in parallel, as shown in Figure 5.

In order to make sure the current is evenly distributed among the LEDs, a robust resistor in series with each LED is recommended.

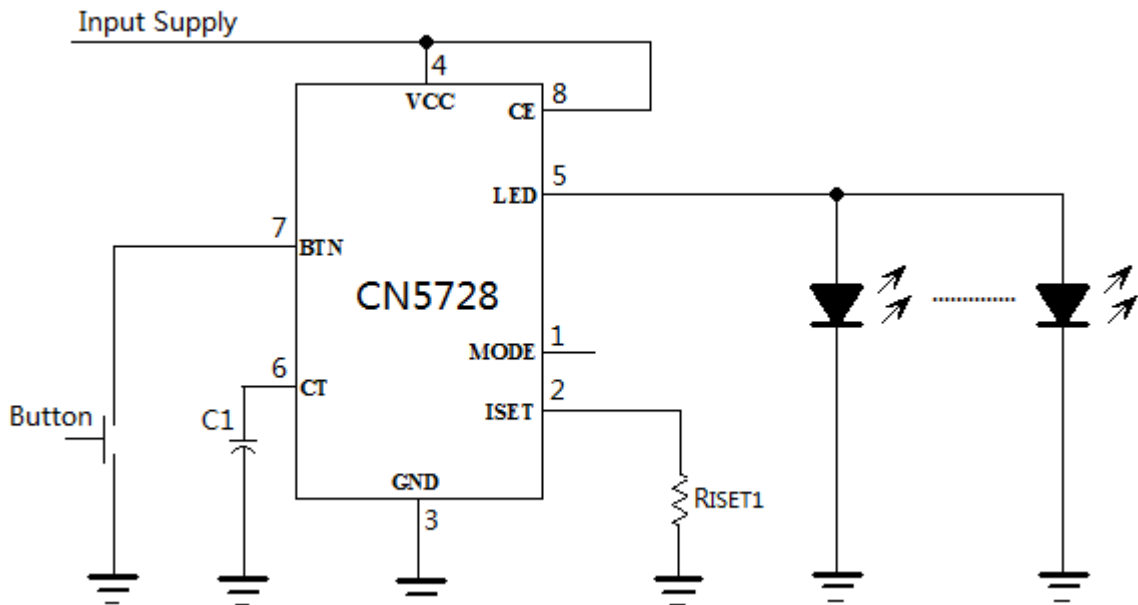


Figure 5 CN5728 Drive LEDs in Parallel

## LED Dimming

**Method 1:** The PWM signal is applied to the chip enable pin (CE). Since soft start is activated by the rising edge of CE pin, the soft start time should be taken into consideration when choosing PWM signal's frequency and pulse width. Generally speaking, the frequency of the PWM signal should be less than 2KHz.

**Method 2:** A logic signal is applied to the gate of an NMOS as shown in Figure 6.

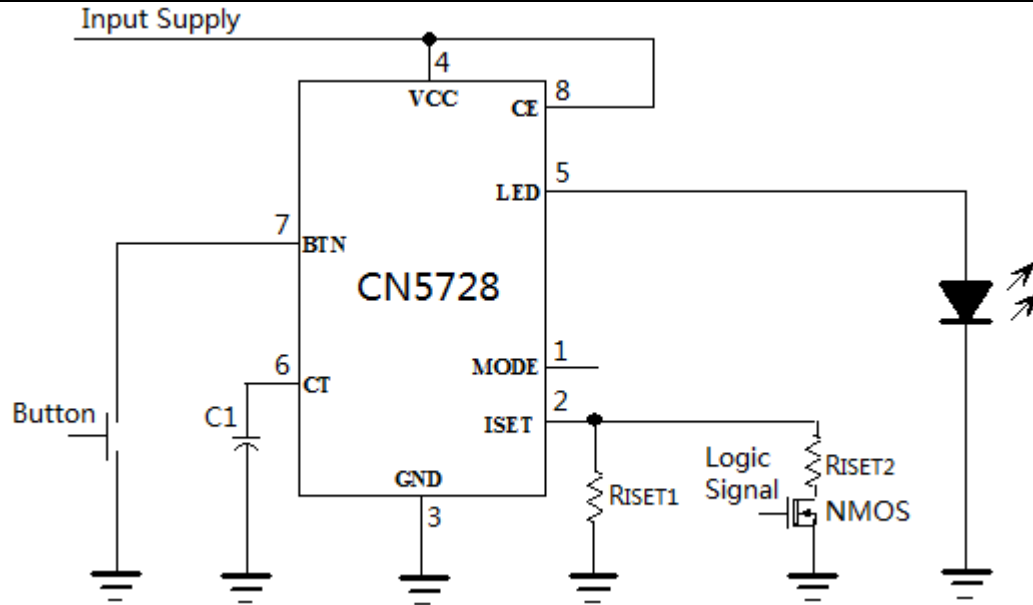


Figure 6 A logic signal to Dim the LED

**Method 3:** A potentiometer is used to dim the LED as shown in Figure 7.

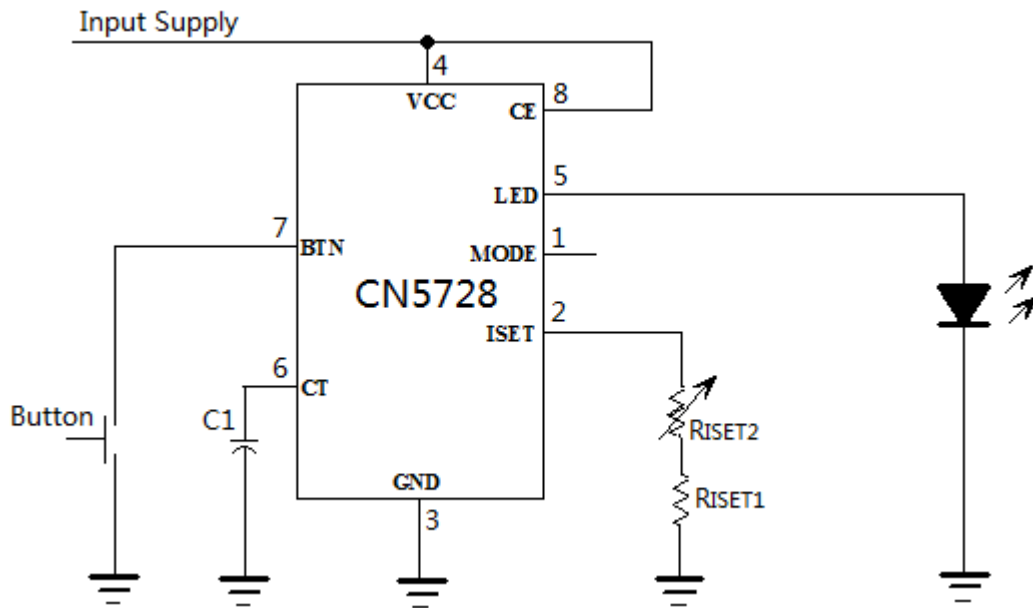


Figure 7 A Potentiometer to Dim the LED

## PCB Design Considerations

1. R<sub>ISET</sub> at ISET pin should be as close to the CN5728 as possible, also the parasitic capacitance at ISET pin should be kept as small as possible.
2. 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 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. Other heat sources on the board, not related to the CN5728, must also be



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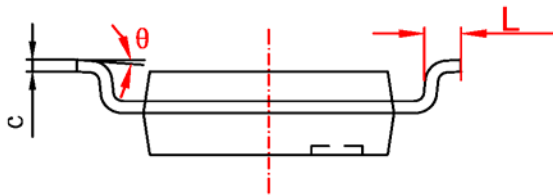
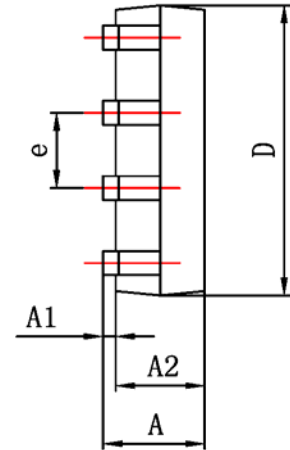
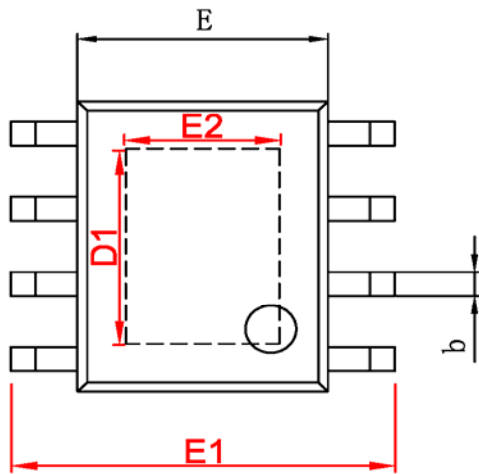
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considered when designing a PC board layout because they will affect overall temperature rise and the maximum LED current.

3. The ability to deliver maximum LED current under all conditions require that the exposed metal pad on the back side of the CN5728 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.

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## Package Information



字符	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.050	0.150	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
D1	3.202	3.402	0.126	0.134
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
E2	2.313	2.513	0.091	0.099
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

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