CONSONANCE

Step-Up High Brightness White LED Drive IC

CN5832

General Description

The CN5832 is a boost high brightness white LED driver IC designed for applications where extremely low cost and small size are top priorities. The CN5832 adopts PFM operating mode, which provides excellent efficiency over a wide-range of input voltage and LED currents. The on-time and off-time are tuned to permit optimization of external component size. Low current consumption of 47uA(typical) makes CN5832 ideal for battery-powered applications. The LED current is set by an external sense resistor, and the feedback voltage is regulated to 130mV. The PWM signal can be applied to DIM pin to adjust the LED brightness. The CN5832 does not burst the LED current, therefore no audible noise generated during LED dimming. The CN5832 features open LED protection that prevent the LED voltage from exceeding the absolute maximum voltage ratings of the device during open LED conditions.
DIM pin can also functions as shutdown pin.
The CN5832 is available in a space-saving 6-pin SOT23 package.

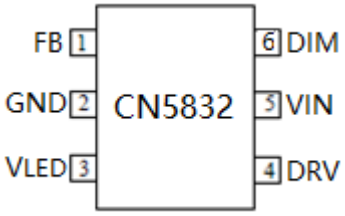
Applications

- Tablet Backlighting
- Handheld Medical Equipment
- Potable TVs
- Handheld Data Terminals

Features

- Operating voltage range：2.7V to 6.5V
- Low Operating Current: 47uA @3.7V
- Suitable for Applications Powered by Battery
- Regulated Feedback Voltage: 130mV±10%
- Output Voltage up to 17V Typical
- Open LED Protection
- PWM LED Brightness Control Without Audible Noise
- DIM Input also Functions as Shutdown Pin
- Shutdown current: 1uA Max.
- Output Power: up to 35W
- High Efficiency: up to 94%
- Operating Temperature Range
  -40°C to +85°C
- Available in SOT23-6
- Pb-free, rohs-Compliant and Halogen-free

Pin Assignment



Typical Application Circuit

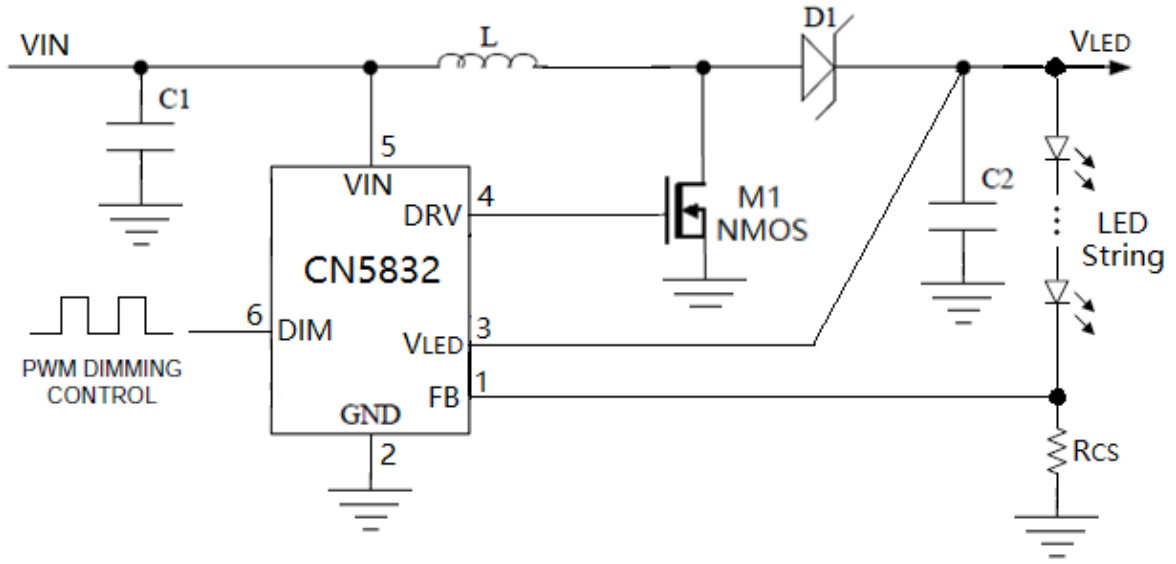


Figure 1 Typical Application Circuit

Block Diagram

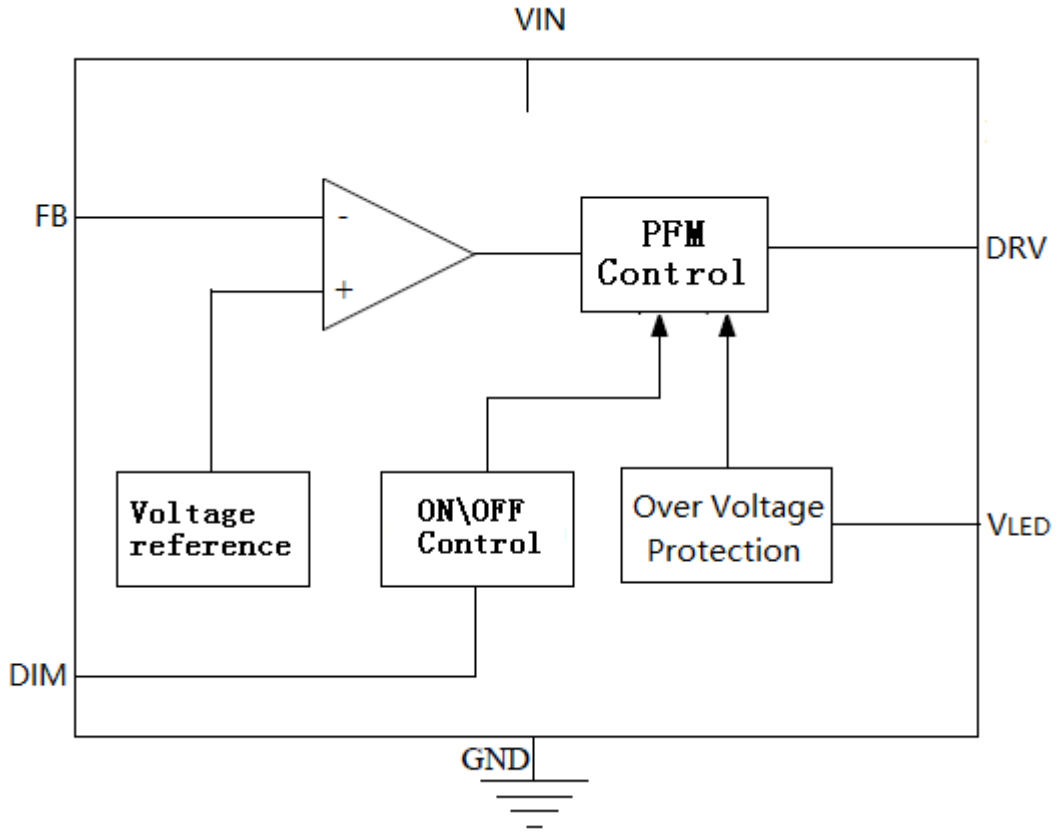


Figure 2 Block Diagram

Ordering Information

Part No.	Marking	Shipping	Operating Ambient Temperature
CN5832	5832	Tape and Reel, 3000/reel	－40℃ to 85℃

Pin Description

Pin No.	Symbol	Description
1	FB	**LED Current Feedback Input.** LED current is sensed via an external current sense resistor, and feedback to this pin. During normal operation, the FB pin voltage is regulated at 130mV with 10% accuracy. The relationship between FB pin voltage and LED current is expressed by the following equation: $I_{LED} = V_{FB} / R_{CS}$
2	GND	**GND.** Ground, namely the negative terminal of input supply.
3	V_{LED}	**Positive Terminal of LED String.** The LED voltage is sensed through this pin for open LED protection, the maximum voltage of V_{LED} pin is 19V(Typical).
4	DRV	**Gate Drive for external N-Channel MOSFET.** Connect DRV pin to the gate of external N-Channel MOSFET.
5	VIN	**Positive Terminal of Power Supply.** The internal circuits of CN5832 are powered from this pin.
6	DIM	**LED Brightness Dimming Input.** A PWM signal between 10KHZ and 80KHz can be applied to DIM pin to control the LED brightness. If DIM pin is held at low for more than 9ms, the CN5832 will be shutdown. In shutdown mode the current consumption is less than 1uA. The DIM pin can be driven by TTL or CMOS logic level.

ABSOLUTE MAXIMUM RATINGS

Terminal Voltage (With respect to GND)
VIN.....-0.3V to +6.5V
V_{LED} Voltage……－0.3V to 19V
FB, DRV and DIM voltage….....-0.3V to VIN
Lead Temperature (soldering, 10s) …....+260°C
Thermal Resistance……..300°C/W
Operating Temperature…..……...-40 to +85°C
Maximum Junction Temperature..... 150°C
Storage Temperature.....….....-65 to +150°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.

Electrical Characteristics

(VIN = 3.7V, T_A = −40°C to +85°C, Typical values are at T_A = +25°C, unless otherwise noted)

Parameters	Symbol	Test Conditions	Min	Typ	Max	Unit
Operating Voltage Range	VIN		2.7		6.5	V
UVLO Threshold	V_{UVLO}		1.8	2.25	2.65	V
Operating current	I_{VIN}		36	47	58	uA
Shutdown Current	I_{SD}	Shutdown mode		0	1	uA
FB Pin						
Feedback Voltage	V_{FB}	DIM is high	117	130	143	mV
FB Bias Current	I_{FB}	V_{FB}=6V			100	nA
V_{LED} Pin						
V_{LED} pin input current	I_{VLED}	V_{LED}=9V	3.6	4.4	5.2	uA
		V_{LED}=18V	7.6	9.2	10.8	
Over Voltage Threshold	V_{OVP}	V_{LED} voltage rises	17.1	19	21	V
Over Voltage Release Threshold	V_{RLS}	V_{LED} voltage falls		18.25		V
DRV Pin						
DRV Source Current				0.65		A
DRV Sink Current		V_{DRV}＝0.5×VIN		0.65		A
DRV Output High	V_{OH}	I_{DRV}＝5mA	VIN－0.3			V
DRV Output Low	V_{OL}	I_{DRV}＝－5mA			0.3	V
DIM Pin						
Input Low Voltage	V_{DIML}	DIM voltage falls			0.7	V
Input High Voltage	V_{DIMH}	DIM voltage rises	2.2			V
PWM signal Frequency	F_{DIM}		10		80	KHz
Low Time to Shutdown	t_{SD}	DIM pin is held low	7.6	9.85	12	ms
Input Current	I_{DIML}	DIM=GND，VIN=6V	－1			uA
	I_{DIMH}	DIM=VIN=6V			1	

Detailed Description

The CN5832 is a simple, compact PFM boost controller designed for LED driving applications. The device is designed specifically to provide a simple application circuit with a minimum of external components

The CN5832 operates from the input voltage rang of 2.7V to 6.5V with only 47uA current consumption, which is suitable for the applications powered by single-cell lithium battery.

The CN5832 uses a unique variable on-time and off-time architecture, which provides excellent efficiency over a wide range of input voltage and LED currents. By adopting external N-channel MOSFET, the CN5832output power can be up to 35W, which can drive single or parallel LED strings.

The FB pin voltage is regulated at 130mV (Typical) during normal operation, which reduces the power dissipation of the current sense resistor.

The PWM signal can be applied to DIM pin to adjust LED brightness. Although a PWM signal is used for

brightness dimming, only the WLED DC current is modulated, which is often referred as analog dimming. This eliminates the audible noise which often occurs when the LED current is pulsed in replica of the frequency and duty cycle of PWM control. What is more is that if the DIM input is held low for 12ms at least, the CN5832 will enter shutdown mode, in which the current consumption is only 1uA maximum. The CN5832 also features open LED protection that prevent the LED voltage from exceeding the absolute maximum voltage ratings of the device during open LED conditions.

Applications Information

Input Voltage Range

The CN5832 functions well when the input voltage is between 2.7V to 6.5V. On-chip UVLO circuit will shut down the CN5832 if input voltage falls below UVLO threshold (2.65V Max.).

LED Brightness Dimming

The PWM signal can be applied to DIM pin to adjust LED brightness. Although a PWM signal is used for brightness dimming, only the WLED current is modulated, which is often referred as analog dimming. This eliminates the audible noise which often occurs when the LED current is pulsed in replica of the frequency and duty cycle of PWM signal. When the DIM pin is constantly high, the FB voltage is regulated to 130mV typically. When the duty cycle of the input PWM signal is low, the regulation voltage at FB pin is reduced correspondingly, and the total LED current is reduced, too; therefore, it achieves LED brightness dimming. What is more is that if the DIM input is held low for 12ms at least, the CN5832 will enter shutdown mode, in which the current consumption is only 1uA maximum.

For optimum performance, the PWM signal frequency should be between 10KHz and 80KHz. If the PWM frequency is lower than 10KHz, the audible noise may be generated.

Do not apply a voltage between 0.7V and 2.2V on DIM pin, otherwise CN5832 may be in uncertain state and draw more current.

Set The LED Current

The FB pin voltage is regulated at 130mV typically during normal operation, the LED current is set by an external resistor:

$$I_{LED} = V_{FB} / R_{CS} \quad (A)$$

Where,

I_{LED} is the LED current in ampere

V_{FB} is the regulation voltage at FB pin, typical value is 0.13V

R_{CS} is the resistance of current sense resistor in ohm

So the LED current tolerance depends on FB pin voltage accuracy and the current sensor resistor accuracy.

Shutdown Mode

The CN5832 enters shutdown mode when the DIM pin voltage is logic low for more than 12ms at least. During shutdown, the input supply current for the device is less than 1uA (max). Although the external N-channel MOSFET does not switch in shutdown, there is still a DC current path between the input and the LEDs through the inductor and Schottky diode. The minimum forward voltage of the LED string must exceed the maximum input voltage to ensure that the LEDs remain off in shutdown.

Open LED Protection

Open LED protection circuitry prevents IC damage as the result of white LED disconnection. The CN5832 monitors the voltage at the V_{LED} pin. The circuitry turns off the external N-channel MOSFET when the V_{LED} voltage rises above the over voltage threshold(19V typical). The over voltage protection status will not be released until the V_{LED} voltage falls below 18.25V(Typical)

The Selection of Input Bypass Capacitor

In most applications, a bypass capacitor at VIN is needed. A ceramic capacitor, placed in close proximity to VIN and GND pins, works well. The capacitance is chosen based on the input current, the power supply characteristics and cable length. The capacitor's breakdown voltage should be higher than the maximum input voltage.

Generally a capacitor between 4.7uF and 47uF works well, ceramic capacitor of X5R or X7R is highly recommended.

The Selection of Output Capacitor

In a boost DC-DC LED drivers, the output capacitor requirements are demanding due to the fact that the current waveform is pulsed. The choice of component is driven by the acceptable ripple voltage which is affected by the ESR, ESL and bulk capacitance.

The capacitance of the output capacitor should meet the requirement of the following 2 formulas and be rounded up to the nearest standard value.

$$C_{OUT} \geqslant 30 \text{ X } 10^{-6} \text{ X } I_{LED}$$

and

$$C_{OUT} \geqslant 10uF$$

For many designs it is possible to choose a single capacitor type that satisfies both the ESR and bulk C requirements. In certain demanding applications, however, the ripple voltage can be improved significantly by connecting two or more types of capacitors in parallel. For example, using a low ESR ceramic capacitor can minimize the ESR step, while an electrolytic capacitor can be used to supply the required bulk C.

When selecting the output capacitor, caution should also be given to ensure that the LED voltage is less than 20V when the heavy LED current is suddenly dumped.

The selection of Inductor

An inductor should be chosen that can carry the maximum input DC current which occurs at the minimum input voltage. The peak-to-peak ripple current is set by the inductance and a good starting point is to choose a ripple current of 30% of its maximum value:

$$\triangle I_L = 30\% \times \frac{V_{LED} \text{ X } I_{LED}}{0.9 \text{ X VIN}}$$

Where,

V_{LED} is the LED voltage, I_{LED} is the LED current, and VIN is the input voltage.

The inductor value should meet the requirement of the following equation and be rounded down to the nearest standard value.

$$L \leqslant \frac{VIN \times 1.5 \text{ X } 10^{-6}}{\triangle I_L}$$

The Selection of N-channel MOSFET

The CN5832's gate driver is capable of sourcing 0.65A and sinking 0.65A of current. The N-channel MOSFET selection is based on the LED voltage, inductor current. Choose an N-channel MOSFET that has a higher breakdown voltage than the LED voltage, low Rds(ON), and low total gate charge(Qg) for better efficiency. MOSFET threshold voltage must be adequate if operated at the low end (2.7V) of the input-voltage operating range.

The Selection of Free-Wheeling Diode

The forward voltage of the freewheeling diode (D1 in Fig.1) should be as low as possible for better efficiency. A Schottky diode is a good choice as long as the breakdown voltage is high enough to withstand the LED voltage. The forward current rating of the diode must be at least equal to the maximum LED current.

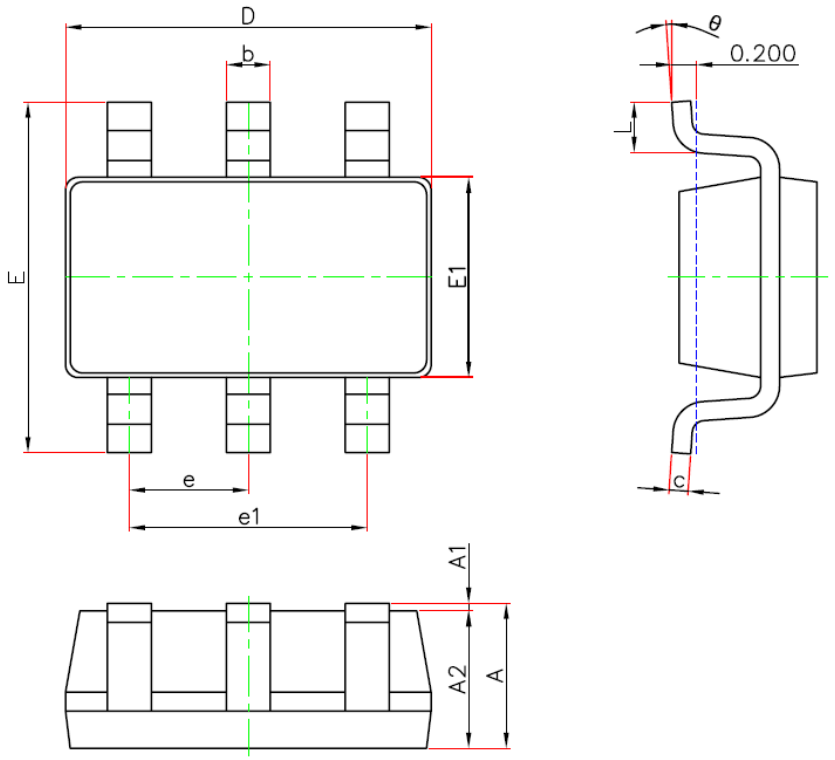
PCB Considerations

A good PCB design is very important to efficiency and performance. When laying out the printed circuit board, the following considerations should be taken to ensure proper operation of the IC.

- Use double-layer PCB for better performance.
- The ground connections of output capacitor and the source of N-channel MOSFET need to feed into same copper that connects to the input capacitor ground before tying back into system ground. This copper should be as wide as possible, and back to system ground separately.
- To minimize radiation, the diode, inductor, N-channel MOSFET, the input bypass capacitor and the output bypass capacitor traces should be kept as short as possible and wide enough.

Package Information

SOT-23-6L(12R) PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E1	1.500	1.700	0.059	0.067
E	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°