Maximizing IC Performance

MT7285

Boost/Buck-Boost/Buck White LED Driver With High Frequency PWM Dimming

DESCRIPTION

The MT7285 is a constant current white LED driver designed for wide input voltage range from 4.2V to 40V system rail. The MT7285 can be configured as Buck, Boost and Buck-Boost topology. The MT7285 drives up to 20W with AC12V/DC12V input voltage. Current mode and fixed frequency operation provides fast transient response and eases loop stabilization. With a current sense amplifier threshold of 205mV, the LED current is programmable with one external current sense resistor and the power loss is minimized. The 450kHz operating frequency minimizes external inductor, input and output capacitor.

The MT7285 supports both PWM and analog dimming by a single control pin. Fault condition protection includes over voltage protection (OVP), cycle-by-cycle peak current limiting and thermal shutdown.

The MT7285 is available in ESOP8 packages.

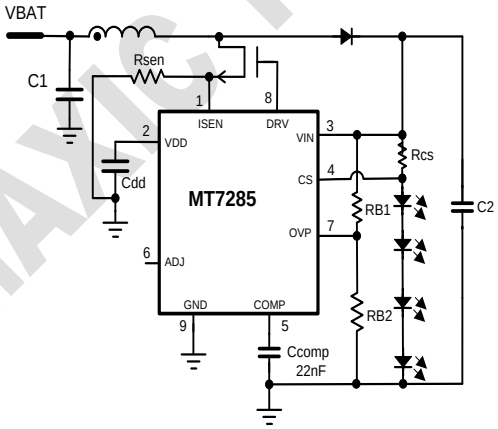
FEATURES

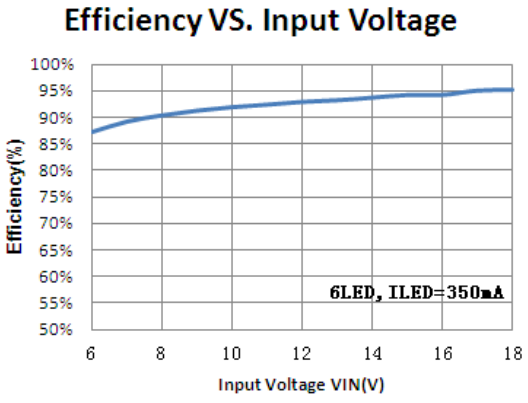
- 4.2V to 40V input/output voltage range
- High efficiency up to 95%
- Cycle by Cycle Over Current Protection
- External MOSFET driver
- Support Boost ,Buck-Boost ,Buck topology
- LED temperature protection
- Stable with Low ESR Ceramic Capacitor
- OTP and OVP protection
- External setting over voltage protection
- Fixed switching frequency: 450kHz
- Frequency jittering for reduced EMI
- Low feedback voltage: 205mV
- Adjustable soft-start
- Support one pin analog dimming and up to 10kHz PWM dimming
- Available in ESOP8 package

APPLICATION

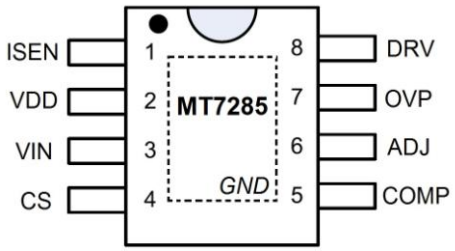
- Automotive and Marine Lighting
- High Power LED Driver
- Torch Driver
- Low Voltage LED Lighting (Landscape, Desk, Room, MR16 lighting)
- LED backlighting

TYPICAL APPLICATION (STEP-UP/BOOST APPLICATION)

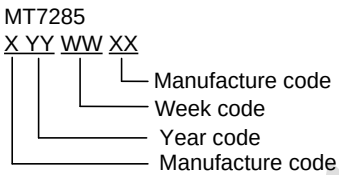




PIN CONFIGURATIONS



Chip Mark



Pin description

Name	Pin No.	Description
ISEN	1	OCP detect pin.
VDD	2	5V Reference Output. Bypass VDD to GND with a 1μF or greater ceramic capacitor.
VIN	3	Supply voltage. Bypass VIN to GND with 10u ceramic capacitor. MT7285 operates from a 4.2V to 40V unregulated input.
CS	4	LED current sense pin, the voltage between VIN and CS is 205mV.
COMP	5	Compensation Pin. Connect a 22nF ceramic capacitor (C_{COMP}) from COMP to GND. This capacitor stabilizes the loop, controls soft-start time.
ADJ	6	Brightness and On/Off Control Pin. A voltage greater than 0.4V will turn on the chip. When ADJ pin voltage varying from 0.8V to 1.6V, the LED current will change from 0% to 100% of the maximum current. Any voltage above 1.6V will clamp to 100% maximum current. To use PWM dimming, apply a 200Hz to 10kHz square wave signal with amplitude greater than 1.6 V to this pin. Hold ADJ below 200mV for 3.5ms to shut down the IC ..
OVP	7	Over voltage protection Pin. OVP happening in Boost or Buck-Boost converter turns off the chip after OVP pin voltage higher than 1.2V, OVP comparator have internal 100mV hysteresis.
DRV	8	The gate Driver for external MOS
GND	9	Ground

ABSOLUTE MAXIMUM RATINGS

VIN/CS/OVP pin	-0.3V to +40V
All other pins	+0.3V to 6V
Storage Temperature	-55°C to 150°C
Junction to ambient ($R_{\theta JA}$)	120°C/W

RECOMMENDED OPERATING CONDITIONS

Supply voltage	4.2V to 40V
Output Voltage	Vin to 40V
Operating Temperature	-40°C to 105°C
Maximum Driving LEDs in series	15 LEDs in series

ELECTRICAL CHARACTERISTICS

(Test conditions: V_{BAT}=5V, T_A=25°C unless otherwise stated.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{BAT}	Input (Battery) Voltage		4.2		40	V
Ishutdown	Supply current (Shutdown)	V_{ADJ}=0V		30		μA
I_Q	Supply current (No Switching)	Vcomp=0V		280		μA
f_{SW}	Switching frequency			450		kHz
Dmax	Maximum duty cycle	V_{IN}-V_{CS}=0.1V	85	95		%
Over Voltage lockout (OVP Pin)						
OV	Over voltage protection reference			1.2		V
	OV reference hysteresis			100		mV
Enable/Dimming (ADJ Pin)						
V_{EN}	Enable Threshold	ADJ rising		0.8		V
	ADJ Pin pull up current	ADJ=0V		1		uA
	Analog dimming voltage range		0.8		1.6	V
	PWM dimming frequency	***Note 1***	0.2		10	kHz
	ADJ shutdown delay	ADJ pin keep low		3.5		ms
Current Sense (CS Pin)						
V_{IN}-V_{CS}	Current sense voltage			205		mV
Output Switch (ISEN Pin)						
OTP	Thermal protection threshold			160		°C
	OTP hysteresis			30		°C

Note 1: *Guaranteed by design*

BLOCK DIAGRAM

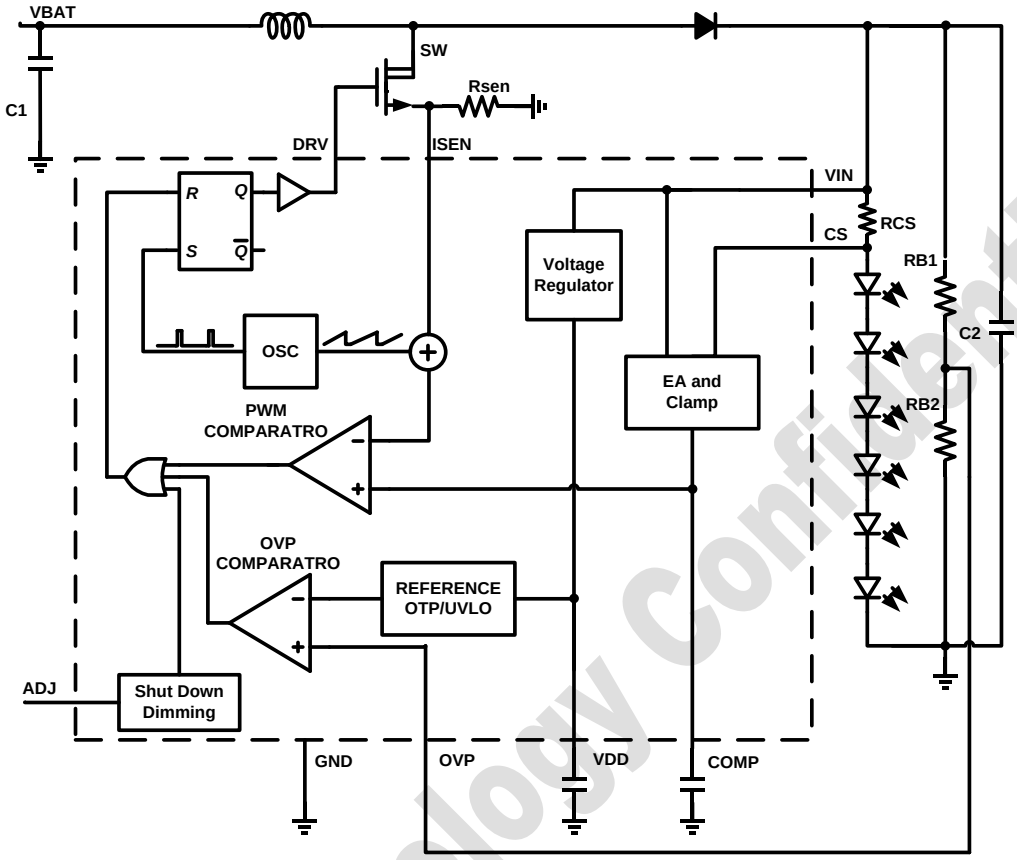
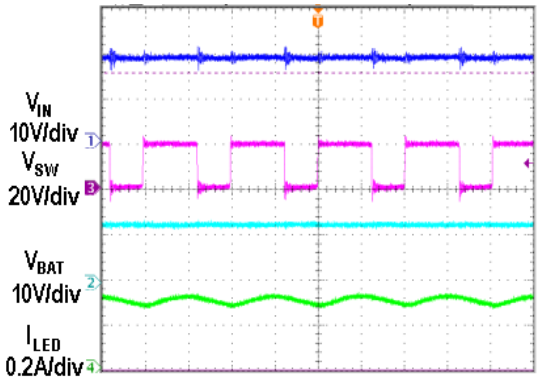


Figure 1—Function Block Diagram

TYPICAL OPERATING CHARACTERISTICS

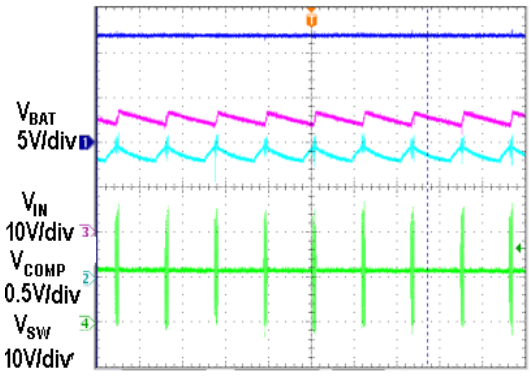
(V_{BAT} =12V, 6 LEDs, Boost Topology, Iout set as 350mA, unless otherwise noted.)

Steady State Operation



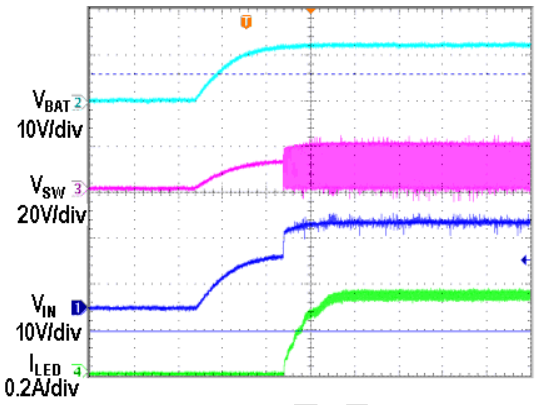
1us/div

Open LED Protection



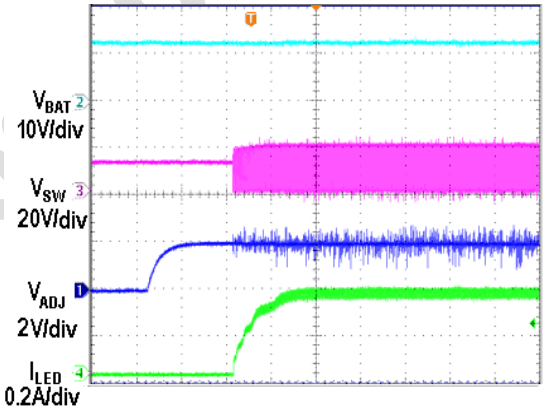
4ms/div

Start up with VBAT



4ms/div

Start up with ADJ

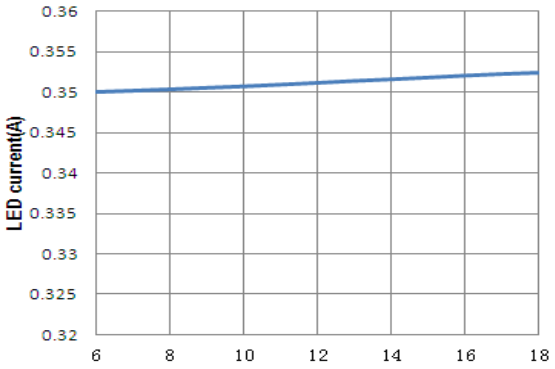


4ms/div

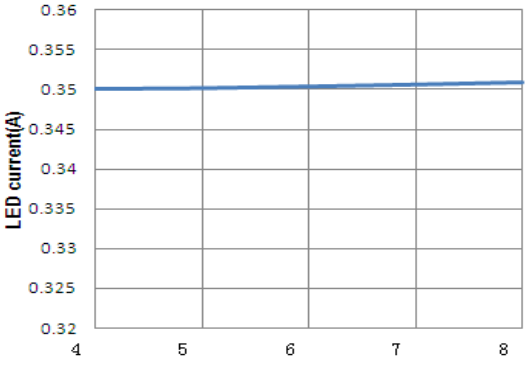
TYPICAL OPERATING CHARACTERISTICS (CONTINUED)

(V_{BAT} =12V, 6 LEDs, Boost Topology, Iout set as 350mA, unless otherwise noted.)

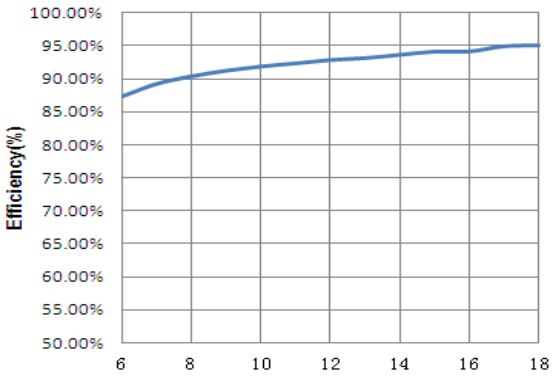
LED Current VS. Input Voltage (6LEDs)



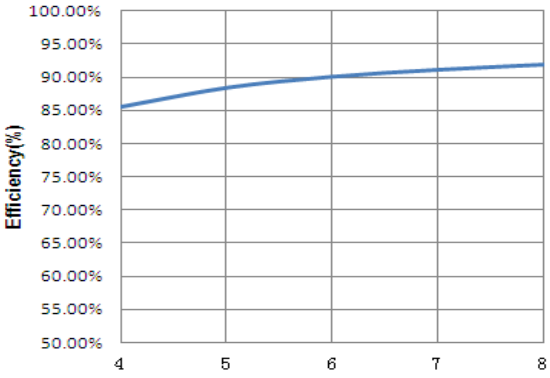
LED Current VS. Input Voltage (3LEDs)



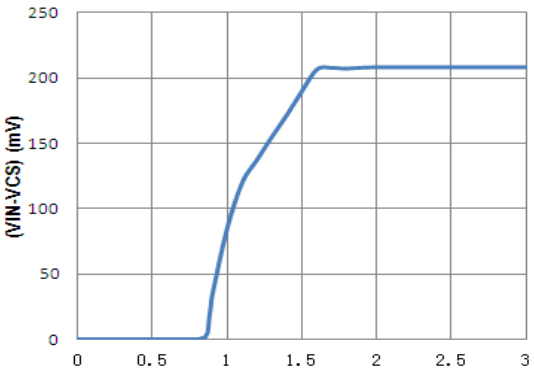
Efficiency VS. Input Voltage (6LEDs)



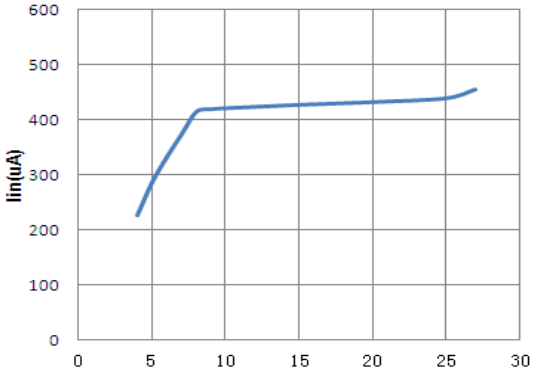
Efficiency VS. Input Voltage (3LEDs)



(VIN-VCS) Voltage VS. ADJ Voltage



No Switching Current VS. VIN



TYPICAL APPLICATION CIRCUITS

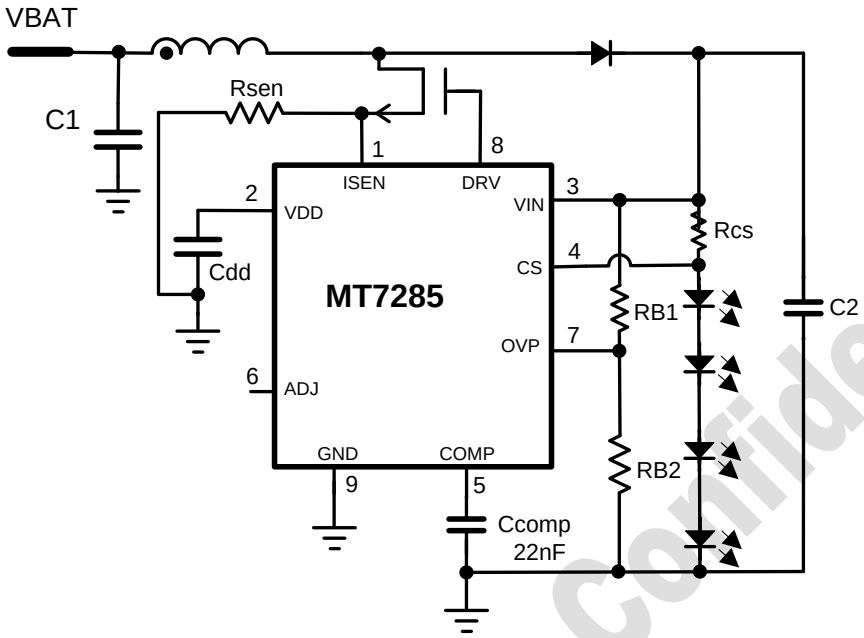


Figure 2— BOOST application for VBAT<VLED

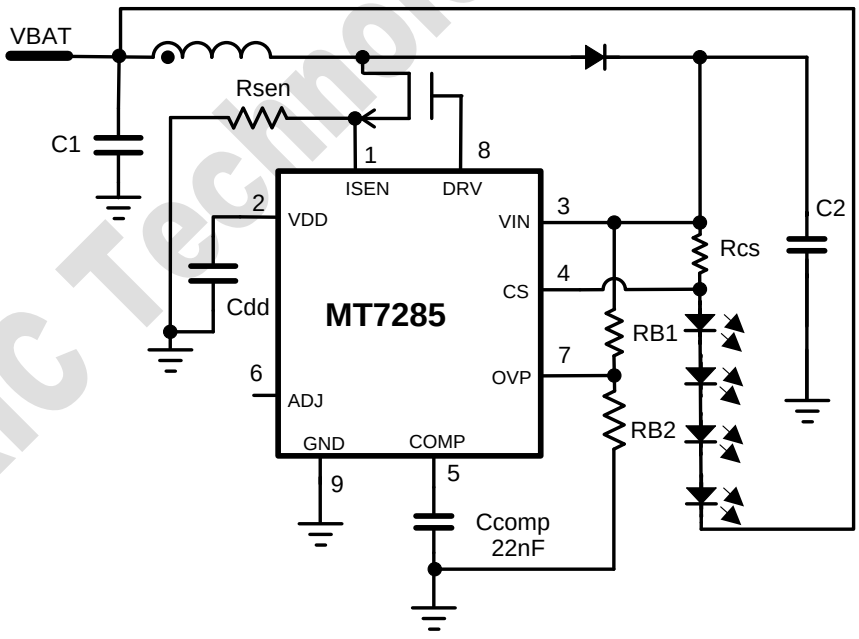


Figure 3— BUCK-BOOST application for VBAT>VLED and/or VBAT<VLED

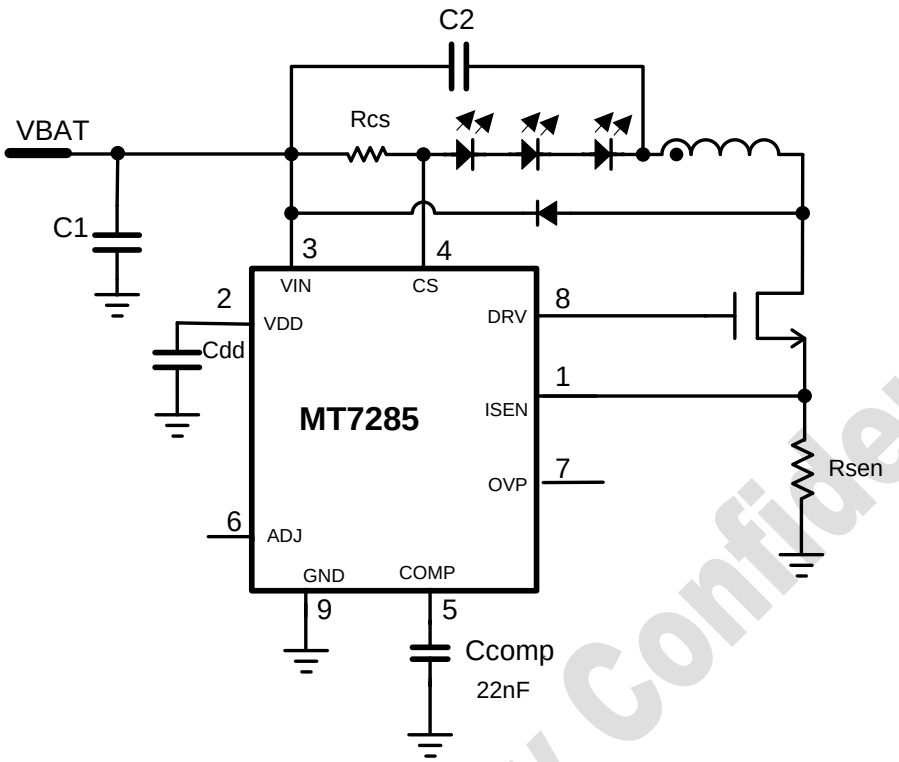


Figure 4— BUCK application for VBAT>VLED

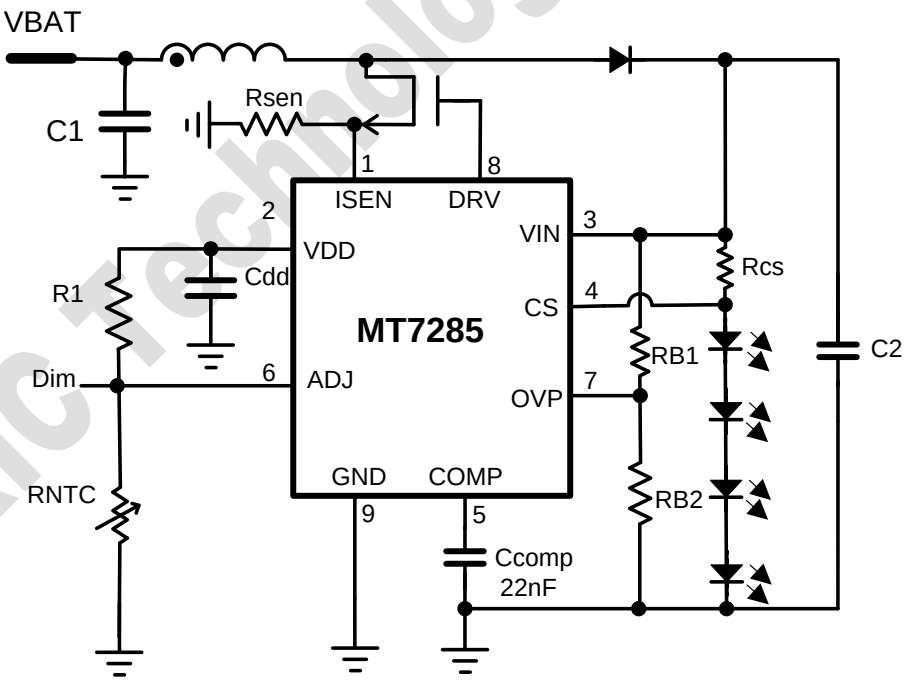


Figure 5— BOOST application with NTC resistor to protect LED

APPLICATION INFORMATION

Soft-Start

The MT7285 attains soft-start by charging C_{COMP} gradually with a current source (8uA). When V_{COMP} rises above 1.3V, the internal MOSFET begins switching with an incremental duty cycle. Use 22nF ceramic capacitor is enough for stabilizing the loop and the soft start function.

Shutdown

The MT7285 enters shutdown mode when V_{ADJ} is less than 200mV for more than 3.5ms. In shutdown mode, supply current is reduced to 40μA by powering down the entire IC except the ADJ voltage-detection circuitry. C_{COMP} is discharged to zero during shutdown period, allowing the device to re-initiate a soft-start procedure when the chip is enabled.

Over-Voltage Protection

Over Voltage Protection (OVP) occurs when the LED is open in Boost and Buck-Boost application. The LED open will breakdown the chip if there is no OVP protection circuitry. *(Refer to waveform of Open LED protection in TYPICAL OPERATING CHARACTERISTICS Section)*. The over voltage protection threshold can be set according to actual number of LEDs by the external resistor ratio. The OVP comparator reference is 1.2V with 100mV hysteresis.

In normal operation, MT7285 over voltage protection threshold voltage calculates as:

VIN = 205mV + VBAT + VLED×K < V_{OVP}= 1.2 ×(1+RB1/RB2)

Where

K -- Number of LEDs in each string

VBAT -- Input battery voltage, if used in Boost mode, VBAT=0,

VLED -- one LED forward voltage

The recommended OVP point is about 1.3~1.5 times higher than the normal output voltage.

Setting the LED Current

The LED current is programmed by the external current sense resistor Rcs through the following equation

$$ILED = \frac{205}{Rcs(ohm)}(mA)$$

Analog and PWM Dimming

The MP7285 allows both DC and PWM dimming. When V_{ADJ} is less than 0.2V, the chip is turned off. For analog dimming, when V_{ADJ} rises from 0.8V to 1.6V, the LED current will change from 0% to 100% of the maximum LED current. If V_{ADJ} is higher than 1.6V, maximum LED current is generated. If a PWM signal is used, its amplitude V_{ADJ} must exceed 1.6V. Apply a 200Hz to 10kHz PWM signal to ADJ pin, the LED current will change from 5% to 100% according to the duty cycle.

Capacitor Selection

The typical value for the input capacitor is 10μF and the typical value for the output capacitor is 1μF. Larger value capacitors can be used to further reduce input and output ripple. Keep the capacitor impedance low at switching frequency is important, ceramic capacitors with X5R or X7R dielectrics are highly recommended. C_{COMP} stabilizes the loop and controls soft-start time. Connect a 22nF capacitor from COMP pin to GND.

Inductor Selection

Inductor value ranges from 10μH to 47μH. A 22μH inductor optimizes the efficiency for most applications To prevent core saturation, ensure that the inductor-saturation current rating exceeds about 30%-40% of the peak inductor current for the application.

Schottky Diode Selection

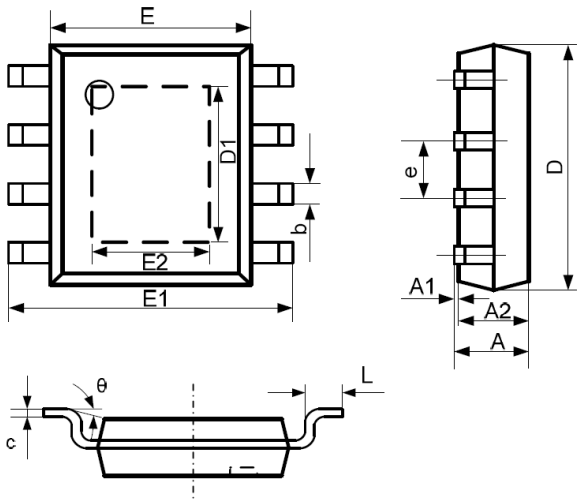
The MT7285's high switching frequency demands a high-speed rectification diode for optimum efficiency. A Schottky diode is recommended due to its fast recovery time and low forward-voltage drop. Ensure that the diode's average and peak current rating exceed the average output current and peak inductor current. In addition, the diode's reverse breakdown voltage must exceed the maximum output voltage.

PC Board Layout

Due to fast switching waveform and high-current paths (VIN, SW), careful PC board layout is required. An evaluation kit is available to speed design. When laying out a board, minimize trace lengths between the chip and Rcs, the inductor, the diode, the input capacitor, and the output capacitor. Keep traces short, direct, and wide. Keep noisy traces, such as the SW node trace, away from Rcs. The ground connections of input capacitor C1 and output capacitor C2 should be as close as possible.

PACKAGE INFORMATION

SOP-8/EP PACKAGE OUTLINE AND DIMENSIONS



SYMBOL	DIMENSION IN MILLIMETERS		DIMENSION IN INCHES	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.150	0.002	0.006
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	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 TYP		0.050 TYP	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

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