Boost Controller for LED Backlight

REV: 00

General Description

The LD5857 is a wide-input asynchronous current mode boost controller, capable to operate in the range between 9V and 28V and to generate 12V of voltage to the GATE pin of MOSFET to reduce thermal loss. The current mode control architecture enhances transient response and simplifies the loop compensation. The DIM input enables the brightness control for LED Backlight or LED lighting.

The device also features internal slope compensation, input voltage under-voltage lockout, output voltage short circuit protection, cycle-by-cycle current limit and thermal shutdown protection.

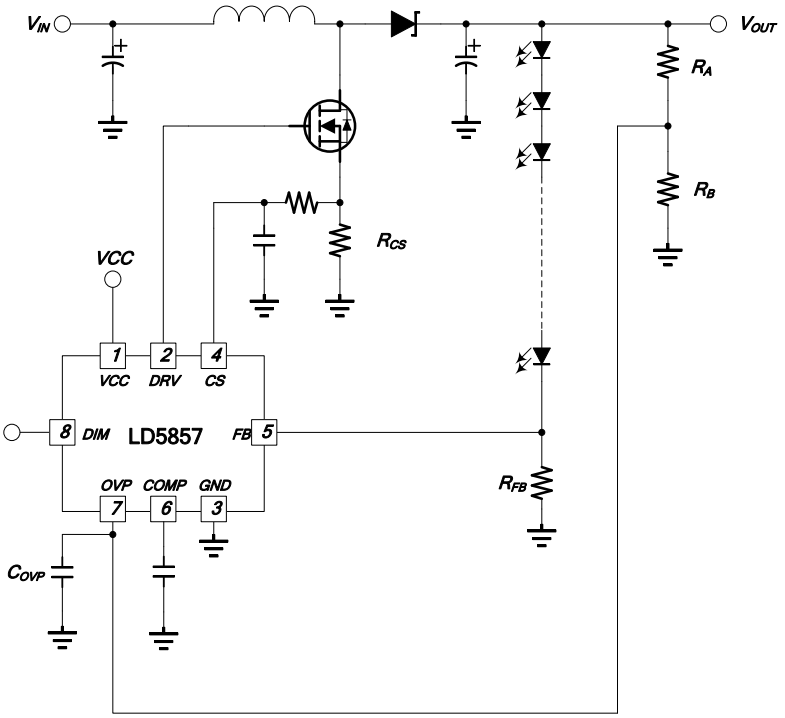
Features

- Wide Input Range: 9V to 28V
- Current Mode Control
- 0.3V LED Feedback Current Sensing Reference
- Fixed Switching Frequency
- Cycle-by-Cycle Current Limit
- Over Temperature Protection
- High performance of Dimming Linearity.
- Programmable PWM Dimming Input and Analog Dimming Output with Software Control

Applications

- LED TV Backlight
- LED Monitor Backlight
- LED lighting

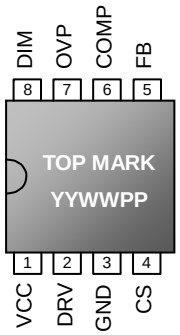
Typical Application



Application circuit

Pin Configuration

SOP-8 (TOP VIEW)



YY: Year code
WW: Week code
PP: Production code

Ordering Information

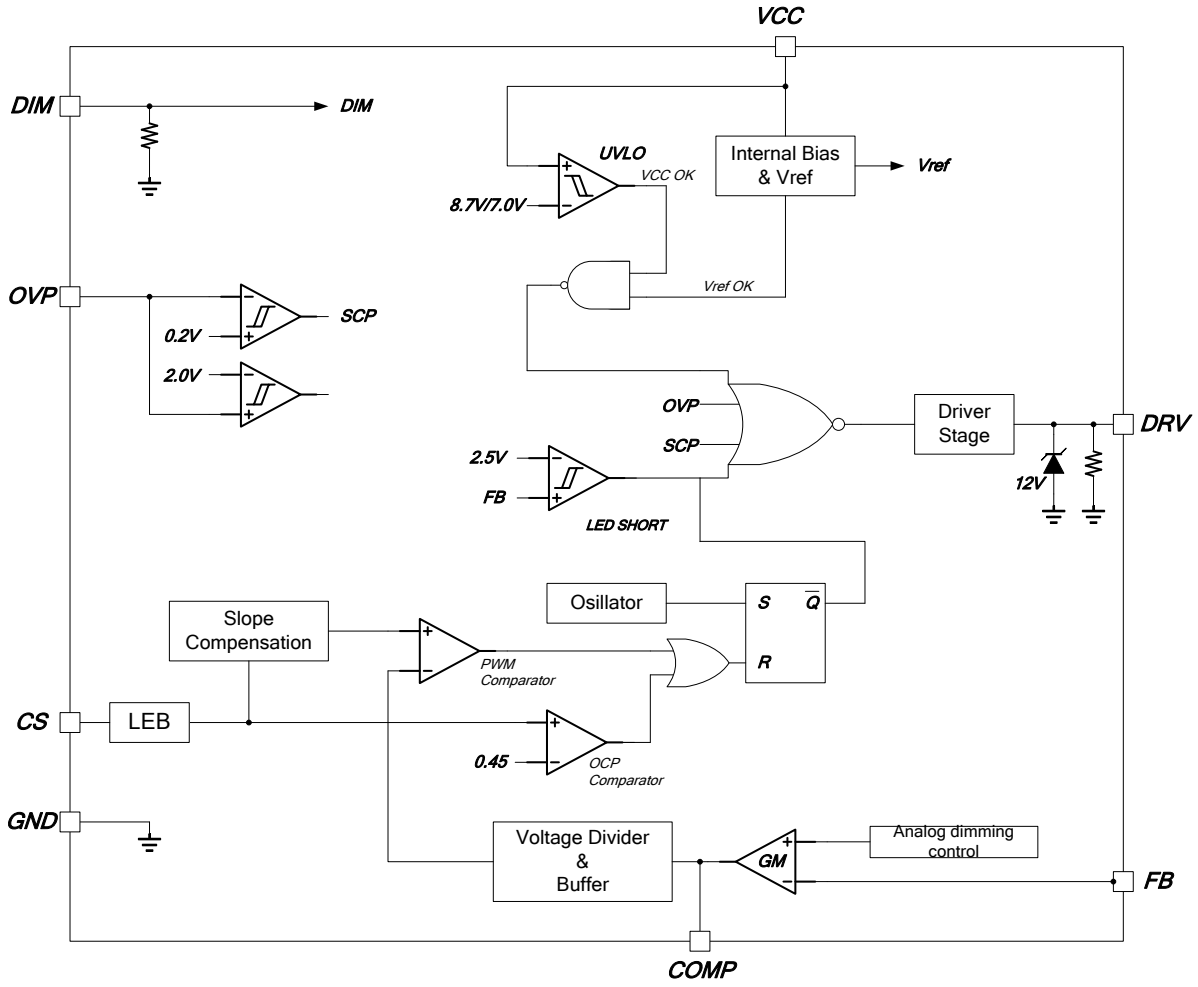
Part number	Package	TOP MARK	Shipping
LD5857 GS	SOP-8	LD5857 GS	2500 /tape & reel

Note: The LD5857 is ROHS compliant/ Green Packaged.

Pin Descriptions

PIN	NAME	FUNCTION
1	VCC	Power source VCC pin.
2	DRV	Gate drive output to drive the external MOSFET.
3	GND	Ground.
4	CS	Current Sense pin. Connect with an external current sensing resistor to GND. CS pin voltage is used to provide current feedback in the control loop and detect an overcurrent condition.
5	FB	LED output current feedback through a current sense resistor.
6	COMP	It's a compensation of the error amplifier
7	OVP	Over-voltage protection.
8	DIM	FB Dimming Input. (Input PWM signal.)

Block Diagram



Absolute Maximum Ratings

VCC, DRV, CS, FB, OVP	30V
All Other Pins	-0.3V ~ 5.5V
Power Dissipation, P_D@85°C, SOP-8	250mW
Package Thermal Resistance, SOP-8, θ_{JA}	160°C/W
Maximum Junction Temperature	150°C
Operating Junction Temperature	-40°C~ 125°C
Operating Ambient Temperature	-40°C ~ 85°C
Storage Temperature Range	-55°C~ 125°C
Lead Temperature (Soldering, 10sec)	260°C
ESD Level (Human Body Model)	2.0KV
ESD Level (Machine Model)	200V

Recommended Operating Conditions

Input Supply Voltage	10.8V ~ 26.4V
DIM Frequency	200Hz ~ 30KHz
Dimming duty cycle	5% ~ 100%
DIM PIN voltage	0V ~ 5V

Caution:

Stress exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stress above Recommended Operating Conditions may affect device reliability.

Electrical Characteristics

(V_{CC}=12V, T_A=25°C, unless otherwise noted.)

PARAMETER	CONDITIONS	Symbol	MIN.	TYP.	MAX.	UNITS
Input Power (VCC)						
Turn On Level	UVLO(on)	UVLO_ON			8.7	V
Turn Off Level	UVLO(off)	UVLO_OFF	7			V
Shutdown Current	DIM=Low, over 30ms	IOFFVIN		40		μA
Operating Current	DIM=High, Switching at no load	IQVIN		5		mA
Boost Converter						
Switching Frequency		FSW	180	200	220	KHz
Boost Maximum Duty Cycle	Switching frequency=200KHz	DMAX	85	90	95	%
DRV Gate Drive	Source current, V_{IN}=12V	CR_DRV		1.2		A
	Sink current, V_{IN}=12V	CF_DRV		1.3		A
DRV Output High Clamp Level	V_{CC}=24V	DRV_H		12		V
DRV pin Rising Time	DRV pin load=1nF	TR_DRV		75		ns
DRV pin Falling Time	DRV pin load=1nF	TF_DRV		75		ns
COMP clamp voltage		VCOMP		3.8		V
Feedback (FB)						
Reference Voltage		VFB	0.291	0.3	0.309	V
Tolerance of Reference Voltage			-3.0		3.0	%
PWM Dimming (DIM)						
DIM Voltage threshold	Enable	VDIM_H	2.5			V
	Disable	VDIM_L			1	V
Resistance from DIM pin to GND		R_DIM		150		KΩ
PWM dimming Frequency			200		30K	Hz
Dimming Duty-Cycle			5		100	%
Shutdown Recover Delay Time (T_{DOWN})		TRSD		21		ms
Current Sensing (CS)						
Current Sense Input Threshold Voltage		VCS	0.4	0.45	0.5	V
LEB time		T_LEB		275		nS

PARAMETER	CONDITIONS	SYM	MIN.	TYP.	MAX.	UNITS
Over Voltage Protection						
Over Voltage Threshold	OVP	VOVP	1.86	2	2.14	V
Output Short Circuit Protection						
Output Short Voltage Threshold	OSP	VOSP		0.17		V
Over Temperature Protection						
OTP Trip Point				150		°C
De-Bounce Point				30		°C

Typical Performance Characteristics

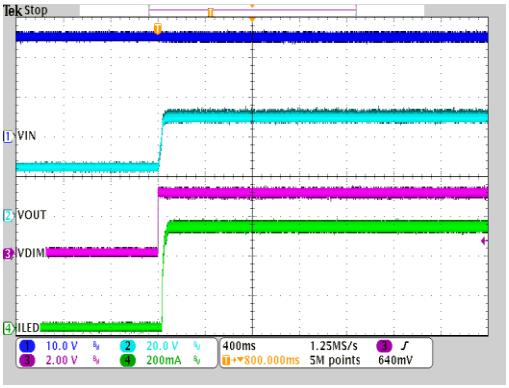


Fig. 1 V_{IN}=24V, "DIM Turn On, Duty=100%"

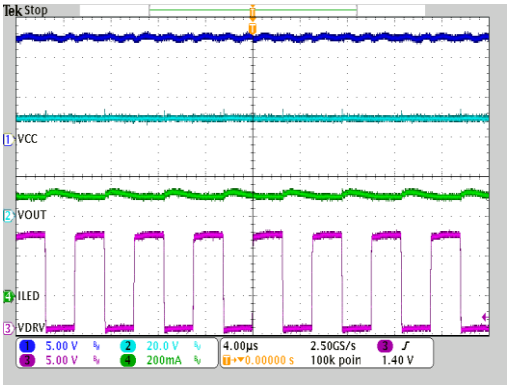


Fig. 2 V_{CC}=24V, "Steady State, Duty=100%"

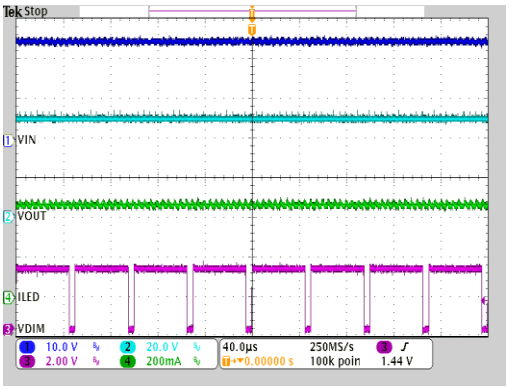


Fig. 3 V_{IN}=24V, "f_{DIM}=20kHz ,Dim Duty=90%"

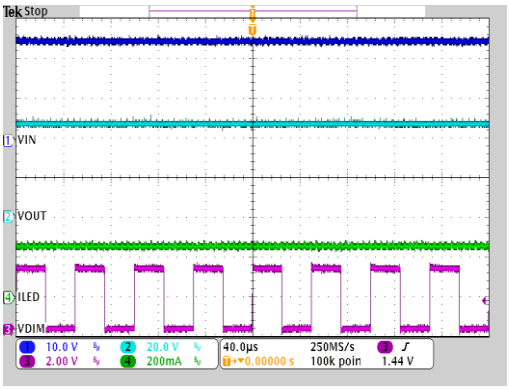


Fig. 4 V_{IN}=24V, " f_{DIM}=20kHz, Duty=50%

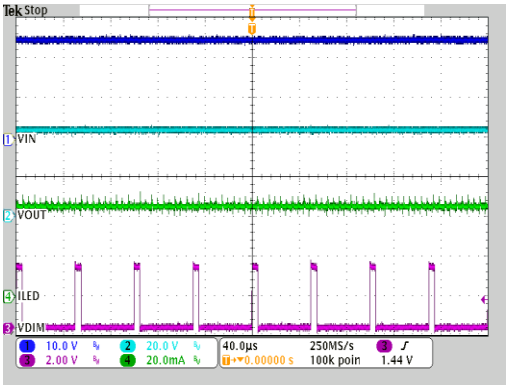


Fig. 5 V_{IN}=24V, "f_{DIM}=20kHz, Dim Duty=10%"

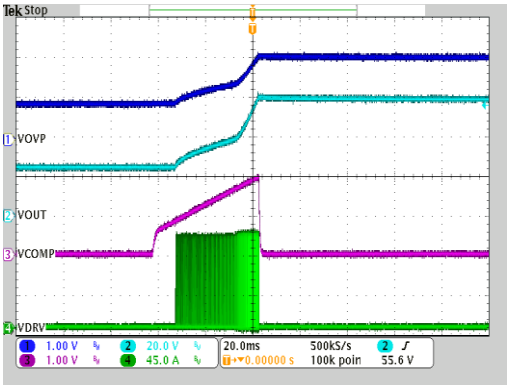


Fig. 6 V_{IN}=24V, "LED Open Protection , Duty=100%

Application Information

Operation Overview

The LD5857 is designed for current-mode control power converters. It features current-mode control, including cycle-by cycle current limit and the simplified loop compensation.

Output Drive Stage

An output stage of a CMOS buffer, with typical driving capability of 1.2A/-1.3A, is incorporated to drive the power MOSFET directly. The output voltage is clamped at 12V to protect the MOSFET gate even when the VCC voltage rises over 12V.

Under Voltage Lockout (UVLO)

An UVLO comparator is implemented in it to detect the voltage across the VCC pin. It would turn on the LD5857 as it detects there's enough supply voltage to drive the power MOSFET. As shown in Fig. 7, a hysteresis is built in to prevent shutdown from the voltage dip during start up. The turn-on and turn-off threshold level are set at 10.0V and 8V, respectively.

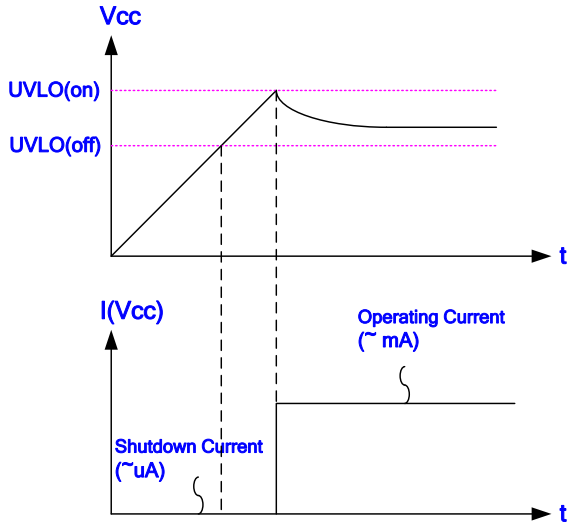


Fig. 7

LED Open Protection and OVP Trip Point

If there's open in LED string, V_{OUT} will start to boost up OVP voltage. Once it rises over the threshold of around 2.0V, the MOSFET will disable drive output (DRV).

$$V_{OVP} = 2.0 \times \frac{R_B + R_A}{R_B}$$

Place the bypass capacitor (C_{OVP}) between OVP and signal ground as close as possible. It's superior to suppress the noise and protect OVP from abnormal condition.

Programming the LED Current

Select a proper external current sense resistor ($R_{FB,}$ see below parameter) to set the LED current.

$$R_{FB} = \frac{0.3V}{I_{LED}}$$

Dimming Output of LED Current

The output current can be achieved by applying a PWM signal to DIM pin, the brightness is adjusted in direct proportion to the width of duty cycles. This frequency of input signal varies in the range from 200Hz to 30KHz . Also the LD5857 can program analog diming with software control. The dimming linearity offset is approaching to 1%(typ.).

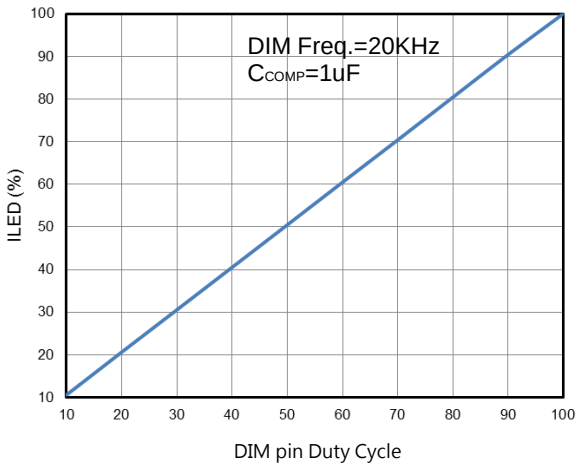


Fig8. The Curve between LED Current and DIM duty

Current Sensing and Leading-edge Blanking

The LD5857 detects the primary MOSFET current across CS pin for the protection of cycle-by-cycle current limit. The voltage threshold of the current sensing pin is set at 0.45V maximum. The MOSFET peak current can be obtained as below.

$$I_{PEAK(MAX)} = \frac{0.45V}{R_{CS}}$$

A 275ns leading-edge blanking (LEB) time is set in CS pin to prevent the false-triggering from the current spike. The R-C filter is eliminable in those low power applications, for LD5857 features pulse width of the turn-on spikes below 275ns and the negative spike of the CS pin below -0.5V.

However, the pulse width of the turn-on spike is determined according to the output power, circuit design and PCB layout. It is strongly recommended to add a smaller R-C filter for large power application to avoid CS pin from being damaged by the negative turn-on spike.

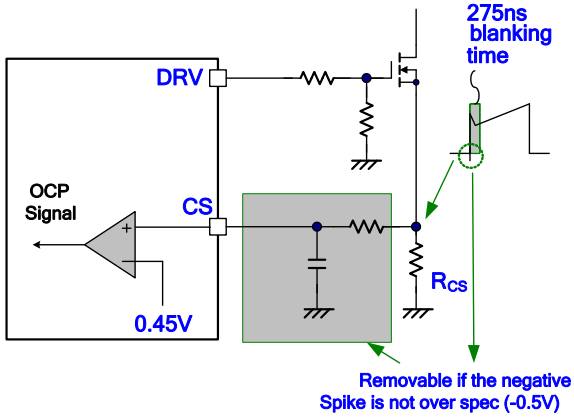


Fig. 9

Select a proper value of V_{RCS} according to the below equation to avoid the output power from being clamped due to the limit of V_{COMP_CLAMP}.

$$1.5 + (1.3 \times Duty_{(\%)}) + (3 \times I_{L(Peak)} \times R_{CS}) < 3.5V$$

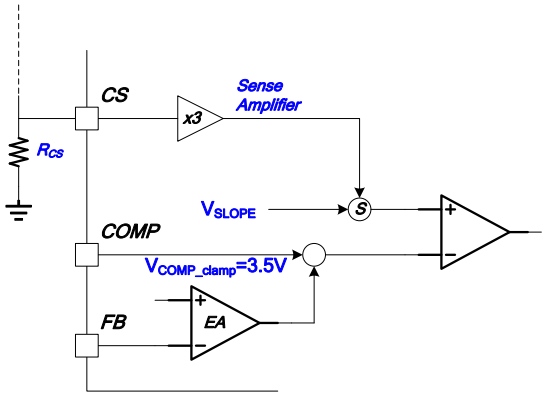


Fig. 10

Thermal Protection

Thermal protection limits the whole power dissipation in this device. When the junction temperature reaches 150°C, the thermal sensor will send a signal of shutdown logic to disable the device and would not resume operation unless the IC's junction temperature cools down for 30°C

PCB Layout Guideline

It's recommended to separate the high frequency switching current from the low-level control signals in layout. The high switching current (MOSFET, inductor, gate driver and FB return ends) may disturb the low-level signals in the feedback loop and protection circuitry. As a result, it may cause the control function to behave abnormally. To avoid these side effects, a few guidelines are recommended for the PCB layout as below.

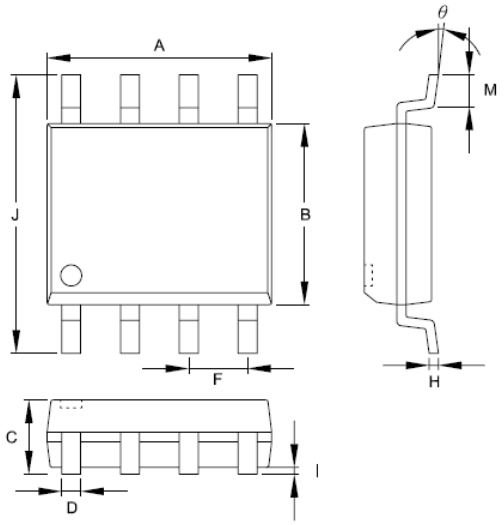
1. Route the VIN bypass capacitor and the signal ground close to the IC as possible. The traces between capacitor and VIN pin should be short as possible to avoid noise interference.

2. Use broader traces for VIN, VOUT and power ground. Those components connected to VIN, VOUT and power ground carry high input/output current, such as power MOSFET and decoupling capacitors. To minimize power loss in these traces, the resistance of traces should be kept as low as possible.

3. Use broader traces between power MOSFET drain, inductor and diode since they often carry high current in these traces. To minimize power loss in these traces, the resistance of traces should be minimized as possible.
4. Keep the gate drive traces short and broad around the IC driver output, DRV pin, and the power MOSFET. The driving traces have a high current spike during inverter operation. To minimize power MOSFET switching loss or oscillation voltage in the gate driver signal, the drive traces should be as broad and short as possible to minimize resistance and parasitic inductance.

Package Information

SOP-8



Symbols	Dimensions in Millimeters		Dimensions in Inch	
	MIN	MAX	MIN	MAX
A	4.801	5.004	0.189	0.197
B	3.810	3.988	0.150	0.157
C	1.346	1.753	0.053	0.069
D	0.330	0.508	0.013	0.020
F	1.194	1.346	0.047	0.053
H	0.178	0.254	0.007	0.010
I	0.102	0.254	0.004	0.010
J	5.791	6.198	0.228	0.244
M	0.406	1.270	0.016	0.050
θ	0°	8°	0°	8°

Important Notice

Leadtrend Technology Corp. reserves the right to make changes or corrections to its products at any time without notice. Customers should verify the datasheets are current and complete before placing order.

Revision History

Rev.	Date	Change Notice
00	4/15/2014	Original Specification