Boost Controller for LED Backlight

REV: 00

General Description

The LD5850 is a wide-input asynchronous current mode boost controller, capable to operate in the range between 9V and 28V and to generate 14V 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 allows 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
- PWM Dimming Input
- Internal Slope Compensation
- Cycle-by-Cycle Current Limit
- Over Temperature Protection

Applications

- LED TV Backlight
- LED Monitor Backlight
- LED lighting

Typical Application

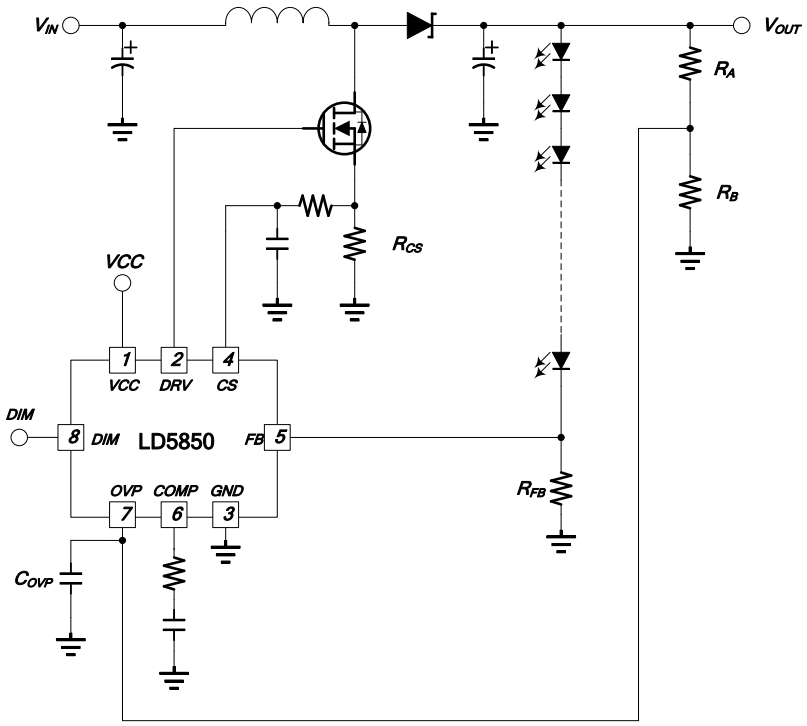
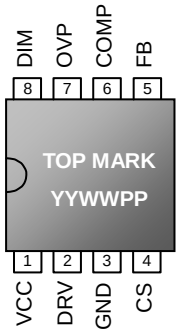


Fig. 1 Application circuit

Pin Configuration

SOP-8 (TOP VIEW)



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

Ordering Information

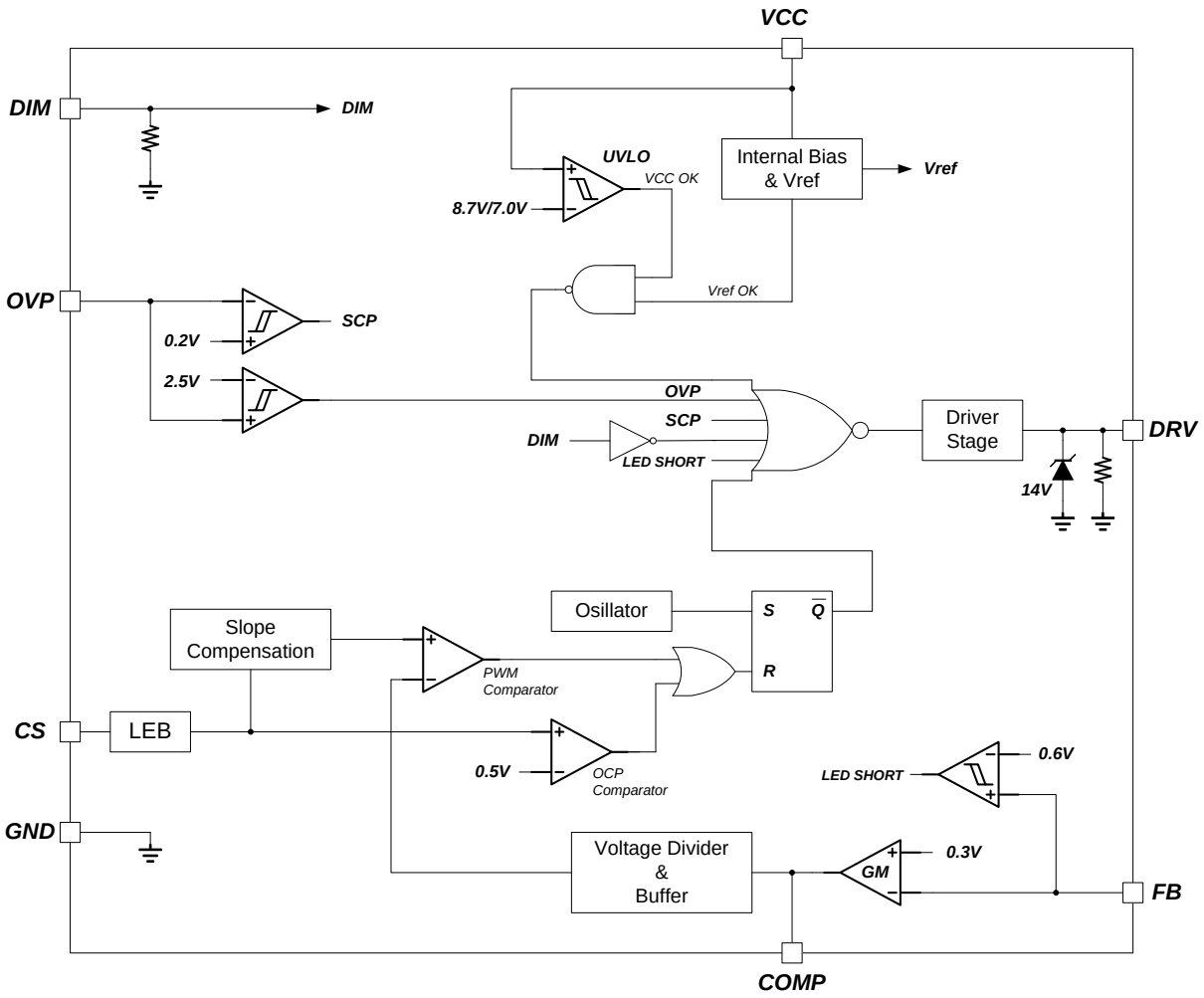
Part number	Package	TOP MARK	Shipping
LD5850 GS	SOP-8	LD5850 GS	2500 /tape & reel

The LD5850 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	Compensation of the error amplifier for voltage loop compensation.
7	OVP	Over-voltage protection.
8	DIM	PWM Dimming Input. If the DIM pin voltage is below logic Voltage threshold, the DRV control would be stopped immediately until DIM pin voltage rises to high again.

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 to 125°C
Operating Ambient Temperature	-40°C to 85°C
Storage Temperature Range	-55°C to 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	9V to 28V
DIM Frequency	100Hz to 800Hz
Dimming duty cycle	1% ~ 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.

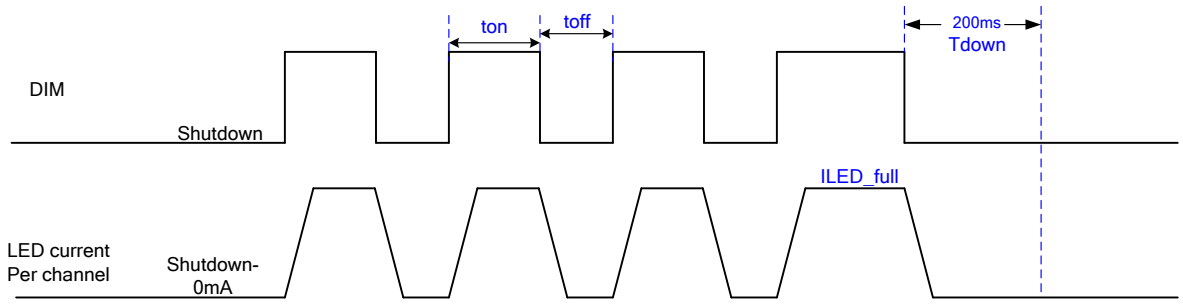
Electrical Characteristics

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

PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Power (VCC)					
Turn On Level	UVLO(on)			8.7	V
Turn Off Level	UVLO(off)	7			V
Shutdown Current	DIM=Low, over 200ms		40		μA
Standby Current	DIM=Low		1		mA
Operating Current	DIM=High, Switching at no load		5		mA
Boost Converter					
Switching frequency		162	180	198	KHz
Boost Maximum duty cycle	Switching frequency=180KHz	85	90	95	%
DRV gate drive	Source current, VIN=12V		1.2		A
	Sink current, VIN=12V		1.3		A
Output High Clamp Level	V_{CC}=24V		14		V
DRV pin Rising Time	DRV pin load=1nF		75		ns
DRV pin Falling Time	DRV pin load=1nF		75		ns
COMP clamp voltage		3.6	3.8	4.0	V
Feedback (FB)					
Reference Voltage			0.3		V
Tolerance of Reference Voltage		-3		3	%
PWM Dimming (DIM)					
DIM Voltage threshold	Enable	2			V
	Disable			0.8	V
Resistance from DIM pin to GND			600		KΩ
PWM dimming frequency		0.1		1	KHz
Dimming Duty-Cycle		0		100	%
Shutdown Recover Delay Time (T_{DOWN})	(Note 1)		200		ms
Current Sensing (CS)					
Current Sense Input Threshold Voltage		0.45	0.5	0.55	V
LEB time			275		nS

PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Over Voltage Protection					
Over Voltage Threshold	OVP	2.375	2.5	2.625	V
LED Over Voltage Hysteresis	OVP Hysteresis		1		V
Output Short Circuit Protection					
Output short Voltage Threshold	OSP		0.17		V
Over Temperature Protection					
OTP Trip Point			150		°C
De-bounce Point			30		°C

Note 1:



Typical Performance Characteristics

17 LEDs in series, 500mA/string, unless otherwise noted.

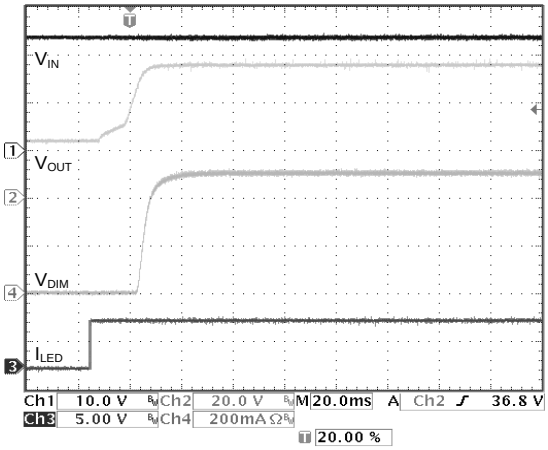


Fig. 2 V_{IN}=24V, "DIM Turn On, Duty=100%"

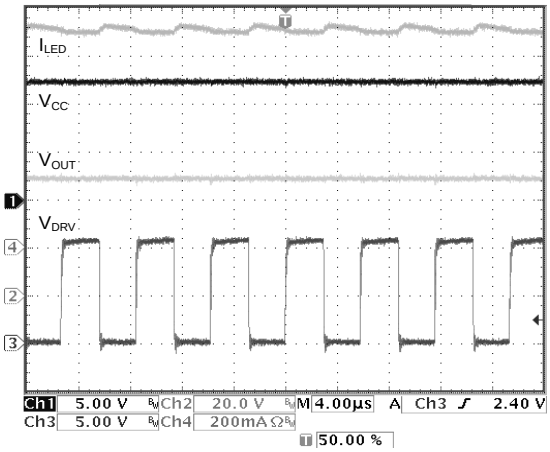


Fig. 3 V_{IN}=24V, "Steady State, Duty=100%"

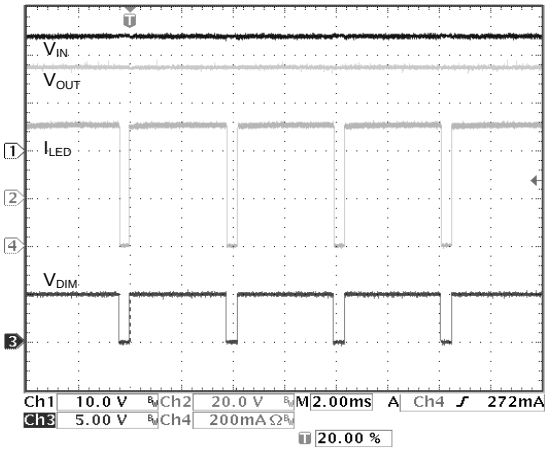


Fig. 4 V_{IN}=24V, "f_{DIM}=240Hz ,Dim Duty=100%"

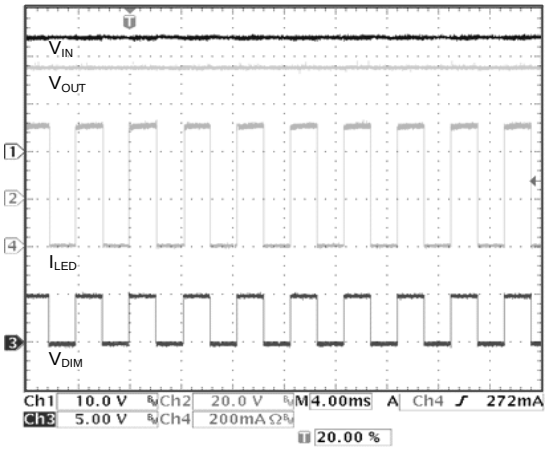


Fig. 5 V_{IN}=24V, " f_{DIM}=240Hz, Duty=10%

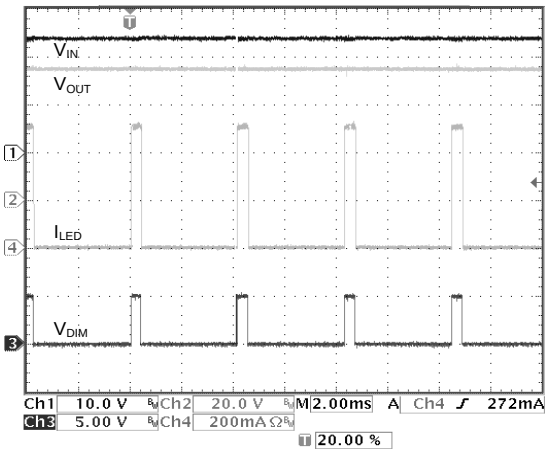


Fig. 6 V_{IN}=24V, "f_{DIM}=240Hz, Dim Duty=100%"

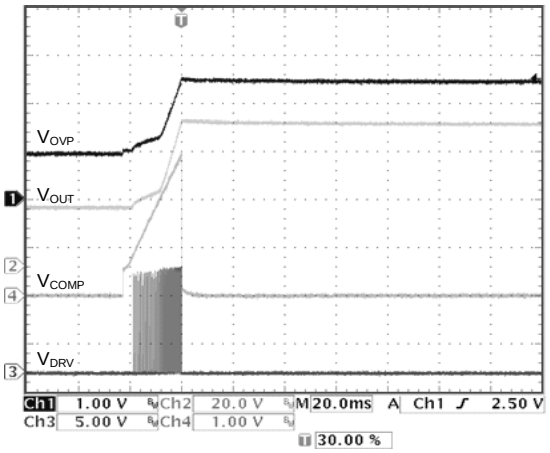


Fig. 7 V_{IN}=24V, "LED Open Protection , Duty=100%

Application Information

Operation Overview

The LD5850 is designed for current-mode control power converters. It provides all the advantages of 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 a power MOSFET directly. The output voltage is clamped at 14V to protect the MOSFET gate even when the VCC voltage is higher than 14V.

Under Voltage Lockout (UVLO)

An UVLO comparator is implemented in it to detect the voltage across the VCC pin. It would detect if the supply voltage is enough to turn on the LD5850 and further to drive the power MOSFET. As shown in Fig. 1, a hysteresis is built in to prevent the shutdown from the voltage dip during start up. The turn-on and turn-off threshold level are set at 10.0V and 8V, respectively.

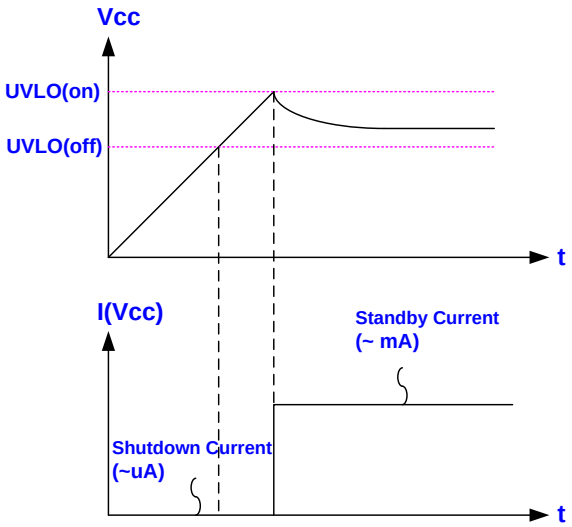


Fig. 1

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 up to the threshold of around 2.5V, the MOSFET drive output (DRV) will turn off and the IC restart it only after OVP voltage drops below 1.5V.

$$V_{OVP} = 2.5 \times \frac{R_B + R_A}{R_B}$$

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 an external current sense resistor (R_{FB}) to set the LED current.

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

Dimming Control

The LED brightness control is accomplished by the PWM signal from DIM pin in proportion to the various duty cycles. LD5850 can apply the external PWM signal to DIM pin in the range from 100Hz to 1 KHz with a swing voltage of 0V to a level greater than 2.0V.

Current Sensing and Leading-edge Blanking

The LD5850 detects the primary MOSFET current across the CS pin for the protection of cycle-by-cycle current limit. The voltage threshold of the current sensing pin is set at 0.5V maximum. The MOSFET peak current can be obtained as below.

$$I_{PEAK\,(MAX)} = \frac{0.5V}{R_{CS}}$$

A 275ns leading-edge blanking (LEB) time is programed in the input of CS pin to prevent the false-triggering from the current spike. The R-C filter is eliminable in those low power applications, 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.

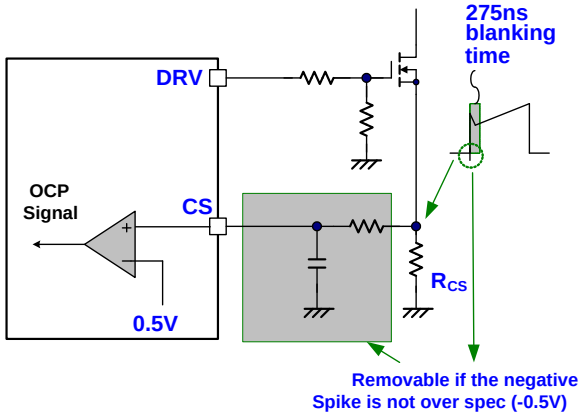
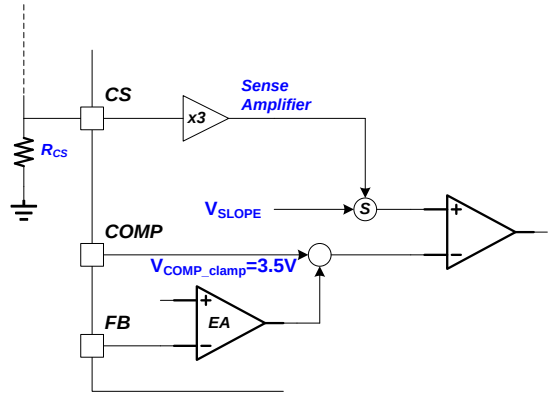


Fig. 2

The V_{RCS} need be checked again by below equation to avoid the output power be limited by V_{COMP_CLAMP}.

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



Thermal Protection

Thermal protection limits the whole power dissipation in this device. When the junction temperature reaches 150°C approximately, the thermal sensor will send the signal of shutdown logic to turn off this device and resume the operation after the IC's junction temperature cools by 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 other 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.

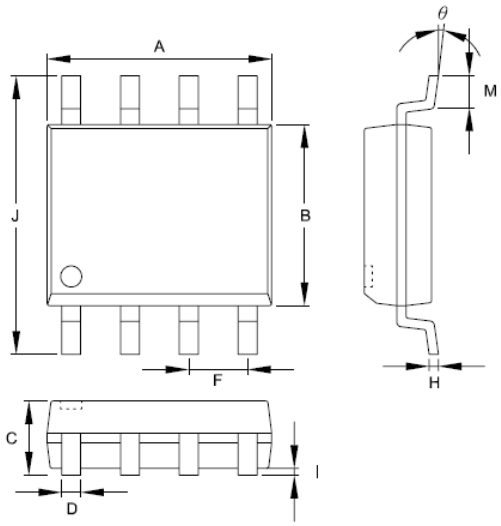
2. Use broader traces for VIN, VOUT and power ground. Those components connected to VIN, VOUT and power ground carry high input/output current, such as power MOSFET and decoupling capacitors. To minimize power loss in these traces, the resistance of traces should be kept as low as possible.

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	11/30/2012	Original Specification