Boost Controller for LED Backlighting

REV: 00

General Description

The LD7400 is an asynchronous current mode boost controller, can operate over a wide input range from 10.5V to 28V. The current mode architecture improve It's ideal to program the brightness of LED Backlight or LED lighting and can efficiently manage Power MOSFET thermal transient response and simplify the loop compensation.

The Device features internal slope compensation, input voltage under-voltage lockout, output voltage short circuit protection, cycle-by-cycle current limit, programmable oscillator frequency, and thermal shutdown protection.

The LD7400 is available in an SOP-8 package.

Features

- Wide Input Range: 10.5V to 28V
- Current Mode Control
- 0.5V Current Sensing Reference
- Adjustable Switching Frequency Setting
- 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

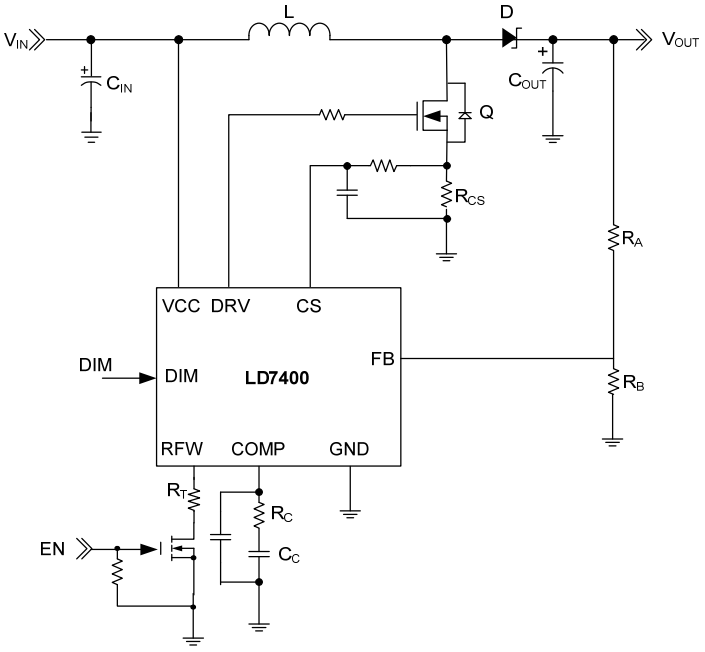
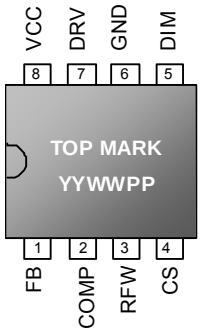


Fig. 1: Application circuit

Pin Configuration

SOP-8 (TOP VIEW)



YY: Year code (D:2004, E:2005…)
WW: Week code
PP: Production code

Ordering Information

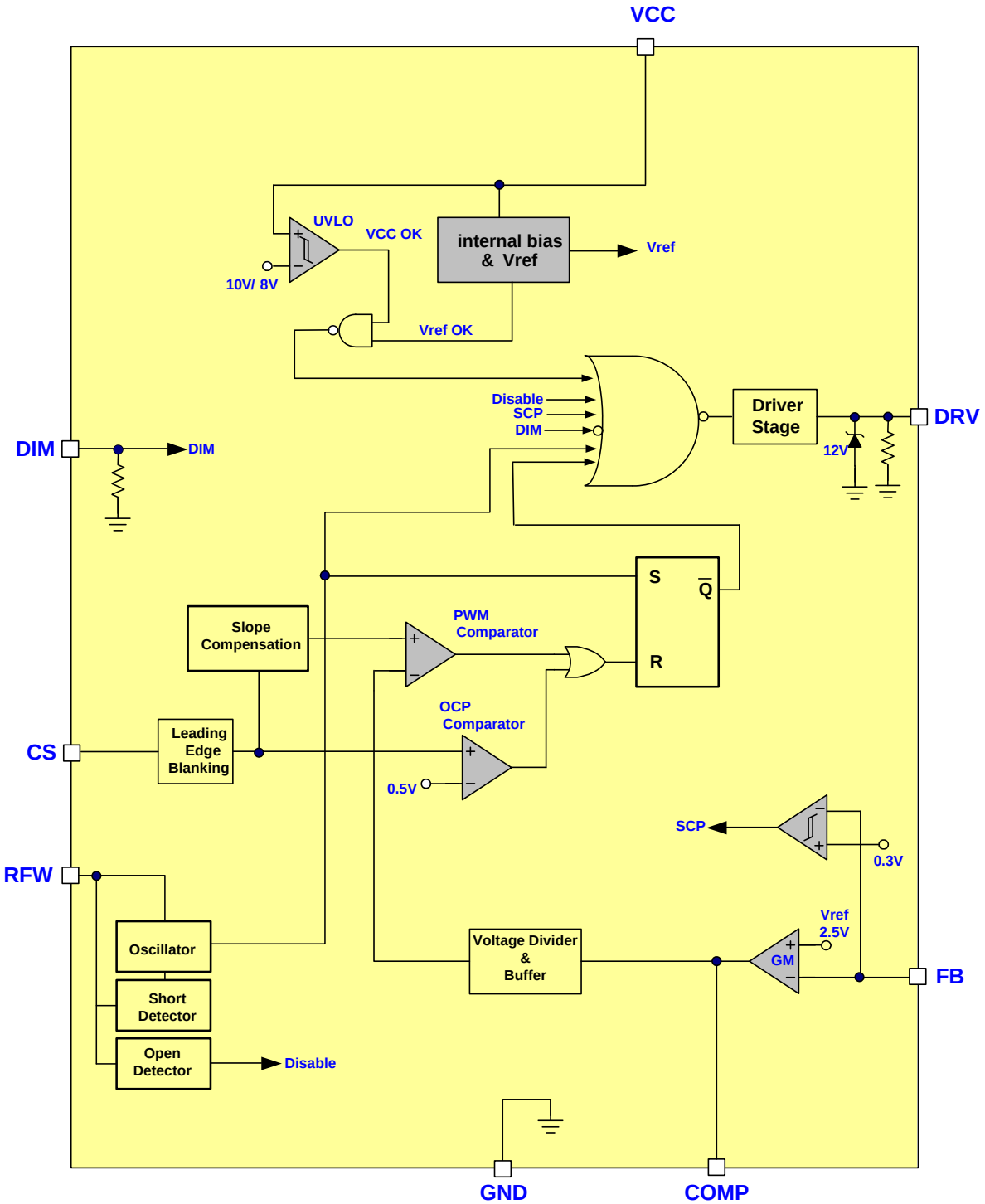
Part number	Package	Top Mark	Shipping
LD7400GS	SOP-8	LD7400GS	2500 /tape & reel

The LD7400 is green packaged.

Pin Descriptions

PIN	NAME	FUNCTION
1	FB	Feedback input. Connect a divider resistor from output to this pin to set the output voltage.
2	COMP	Compensation of the error amplifier for voltage loop compensation.
3	RFW	Operating Frequency setting. Connect a resistor from this pin to ground to set the boost switching frequency. The controller will be shutdown soon as it detects this pin floating.
4	CS	Current Sense pin, Connect an current sensing resistor to GND. The voltage on this pin is used to provide current feedback in the control loop and detect a condition of overcurrent.
5	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.
6	GND	Ground.
7	DRV	Gate drive output to drive the external MOSFET.
8	VCC	Power source VCC pin.

Block Diagram



Absolute Maximum Ratings

VCC, DRV	30V
All Other Pins	-0.3V ~ 5.5V
Power Dissipation, P_D@85°C (SOP-8)	250mW
Package Thermal Resistance, θJA (SOP-8)	160°C/W
Operating Temperature Range	-40°C to 85°C
Storage Temperature Range	-55°C to 125°C
Junction Temperature	125°C
Lead Temperature (Soldering, 10sec)	260°C
ESD Level (Human Body Model)	2KV
ESD Level (Machine Model)	200V

Recommended Operating Conditions

Input Supply Voltage	10.5V to 28V
DIM Frequency	100Hz to 800Hz

Caution:

Stresses beyond the ratings specified in “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

Electrical Characteristics1

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

PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Power					
Turn On Level	UVLO(on)	9.5		10.4	V
Turn Off Level	UVLO(off)	8		8.5	V
Shutdown Current	R_{FW}=Floating		40		μA
Standby Current	DIM=Low		1		mA
Operating Current	DIM=High Switching at no load		5		mA
Boost Converter					
Adjustable Switching frequency		100		1000	KHz
Switching frequency	RFW=350kΩ	145	174	200	KHz
Boost Maximum duty cycle	Switching frequency=300KHz	85	90	95	%
DRV gate drive	Source current, V_{IN}=12V		1.2		A
	Sink current, V_{IN}=12V		1.3		A
Output High Clamp Level	V_{CC}=24V		12		V
DRV pin Rising Time	DRV pin load=1nF		50	150	ns
DRV pin Falling Time	DRV pin load=1nF		50	150	ns
Feedback (FB)					
Reference Voltage		2.45	2.5	2.55	V
PWM Dimming (DIM)					
DIM Voltage threshold	Enabled	2			V
	Disabled			1	V
Resistance from DIM pin to GND			600		kΩ
PWM dimming frequency		100		1000	Hz
Dimming Duty-Cycle		0		100	%
Current Sensing (CS)					
Current Sense Input Threshold Voltage			0.5		V
LEB time			250		ns
Over Temperature Protection					
OTP Trip Point			150		°C
De-bounce Point			30		°C

Typical Performance Characteristics

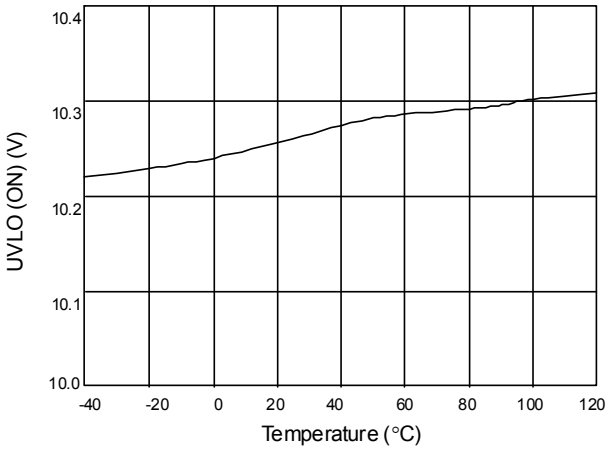


Fig. 2 UVLO (ON) vs. Temperature

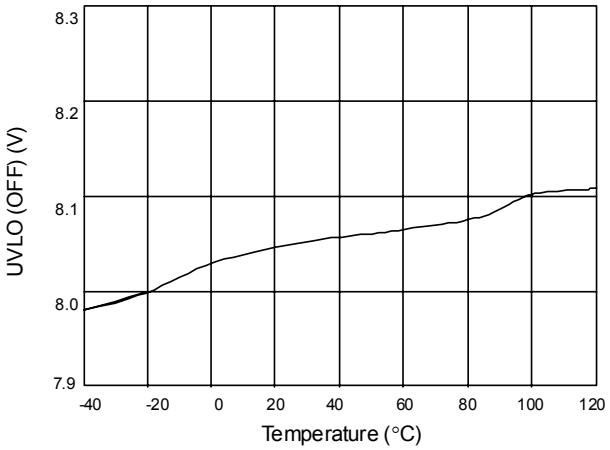


Fig. 3 UVLO (OFF) vs. Temperature

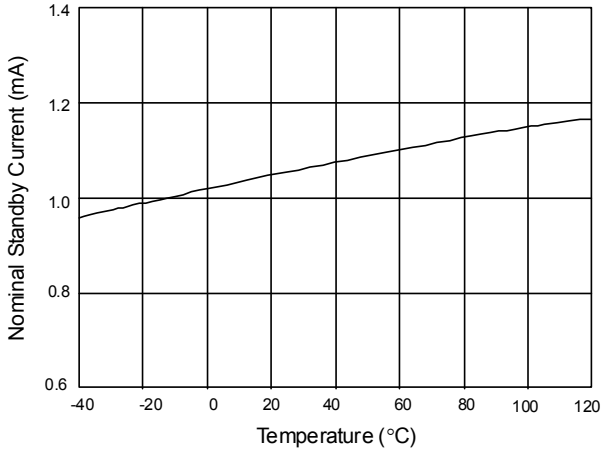


Fig. 4 Quiescent current vs. Temperature

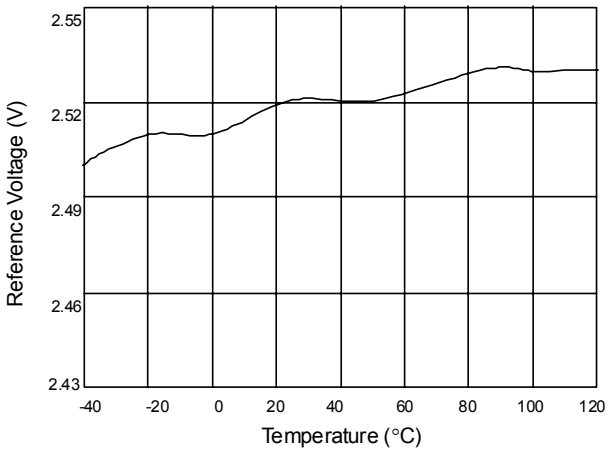


Fig. 5 Reference Voltage vs. Temperature

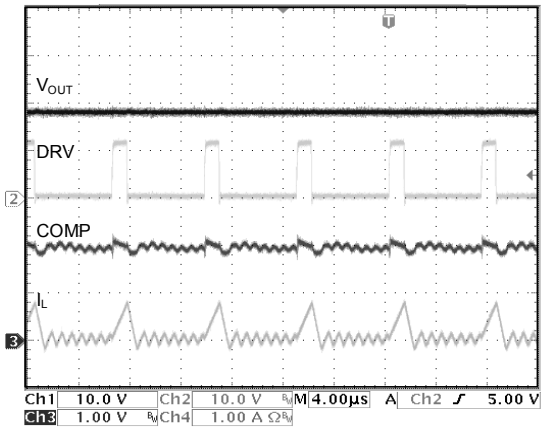


Fig. 6 I_{OUT}=30mA ; "Stability Operation"

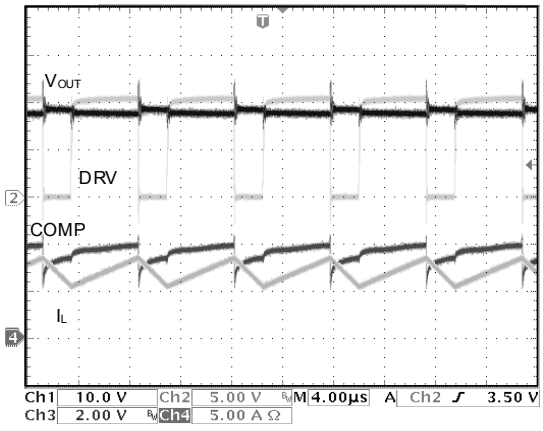


Fig. 7 I_{OUT}=2.0A ; "Stability Operation"

Note (Fig. 6, 7):
V_{IN}=16V, V_{OUT}=50V, C_{IN}=220µF, C_{OUT}=33µFx2, L=47µH, F_{REQ}=140KHz, COMP=60kΩ+100nF, unless otherwise noted

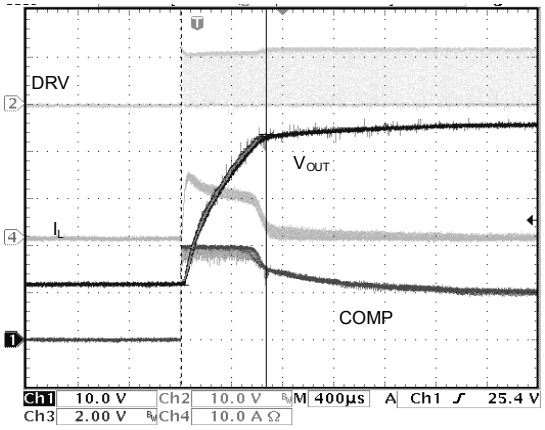


Fig. 8 I_{out}=0mA; "Power ON Sequence"

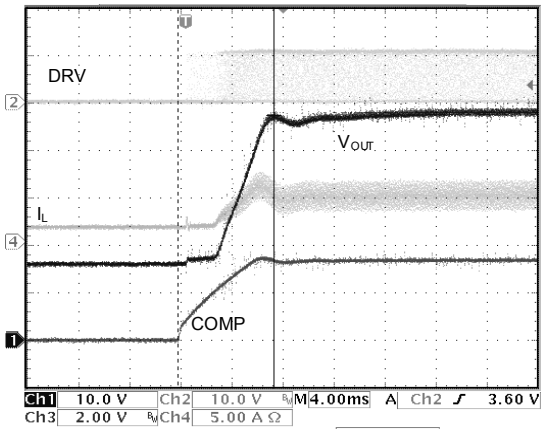


Fig. 9 I_{OUT}=2A,COMP=60k+100nF//100nF "Power ON"

Note (Fig. 8, 9):
V_{IN}=16V, V_{OUT}=50V, C_{IN}=220µF, C_{OUT}=33µFx2, L=47µH, FREQ=140KHz, COMP=60kΩ+100nF, unless otherwise noted

Application Information

Operation Overview

The LD7400 is a current-mode control power converter, featuring current-mode control, cycle-by-cycle current limit and simplified loop compensation.

Output Drive Stage

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

Under Voltage Lockout (UVLO)

An UVLO comparator is implemented in it to detect the voltage over VCC pin. It would assure the supply voltage enough to turn on the LD7400 and further to drive the power MOSFET. As shown in Fig. 10, 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.

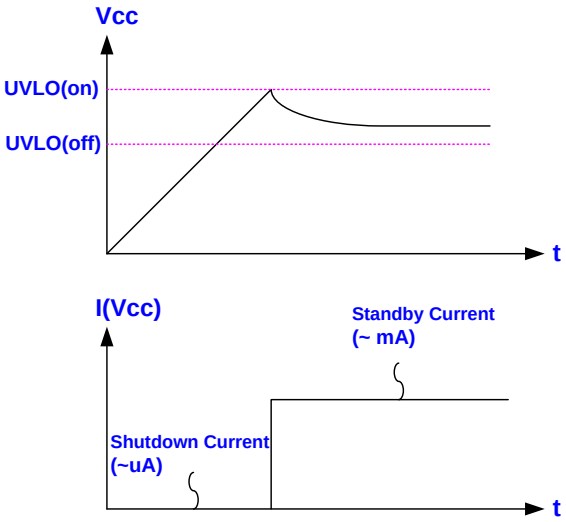


Fig. 10

Output Voltage Setting

The LD7400 monitors the output voltage signal over FB pin through a pair of resistor divider, RA and RB. The output voltage is determined by the following relationship.

$$V_{OUT} = 2.5V(1+\frac{R_A}{R_B})$$

RA and RB are values for top and bottom feedback

resistors, respectively. See below.

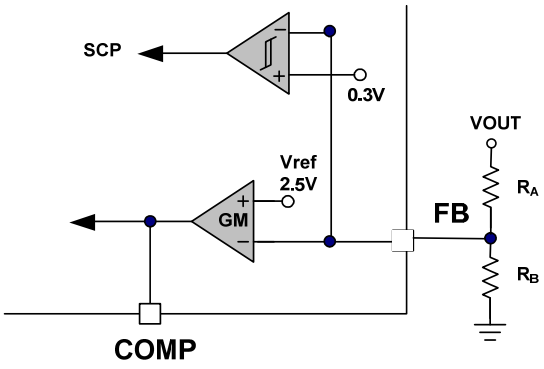


Fig. 11

Switching Frequency Selection

LD7400 can operate in fixed frequency mode. The constant operation frequency is set by the external resistor connected between RFW pin and ground. The resistor sets the charging current for internal oscillator.

$$F_{SW}\,(\text{kHz}) = \frac{70750}{[RT\,(\text{k}\Omega)]} - 28.3$$

For example, a 350kΩ RT sets switching frequency to 173kHz.

Dimming Control

The DIM pin delivers an external PWM signal to control the switching status. When DIM pin is at high, the Switching work normally, otherwise it will cease the switching.

Current Sensing and Leading-edge Blanking

The LD7400 detects the primary MOSFET current over CS pin for cycle-by-cycle current limiting. The maximum voltage threshold of the current sensing pin is set at 0.5V. From above, the MOSFET peak current can be obtained from below.

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

A 250ns leading-edge blanking (LEB) time is included in the input of CS pin to prevent false-triggering from current spike. The R-C filter is eliminatable in some low power applications, or in cases that the pulse width of the turn-on spikes is below 250ns and the negative spike on the CS pin is 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 adopt a smaller R-C filter for higher power application to avoid the CS pin being damaged by the negative turn-on spike.

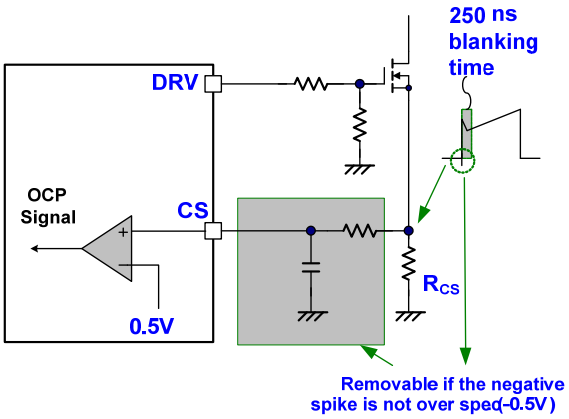


Fig. 12

Thermal Protection

Thermal protection limits total power dissipation in this device. When the junction temperature reaches 150°C approximately, the thermal sensor signals the shutdown logic turning off this device. The thermal sensor will turn this device on again after the IC's junction temperature is decreased 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 issues, a few guidelines are recommended for the PCB layout, as below.

1. The VIN bypass capacitor connected with signal ground must be placed close around the IC as possible. The traces between capacitor and VIN pin should be routed as 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, such as power MOSFET and decoupling capacitors, carry high input/output current. To minimize power loss in these traces, the resistance of traces should be as low as possible.
3. Use broader traces between power MOSFET drain, inductor and diode. These traces deliver high current. To minimize power loss in these traces, the resistance of traces should be as low as possible.
4. Keep the gate drive traces short and wide between 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 wide and short as possible to minimize resistance and parasitic inductance.

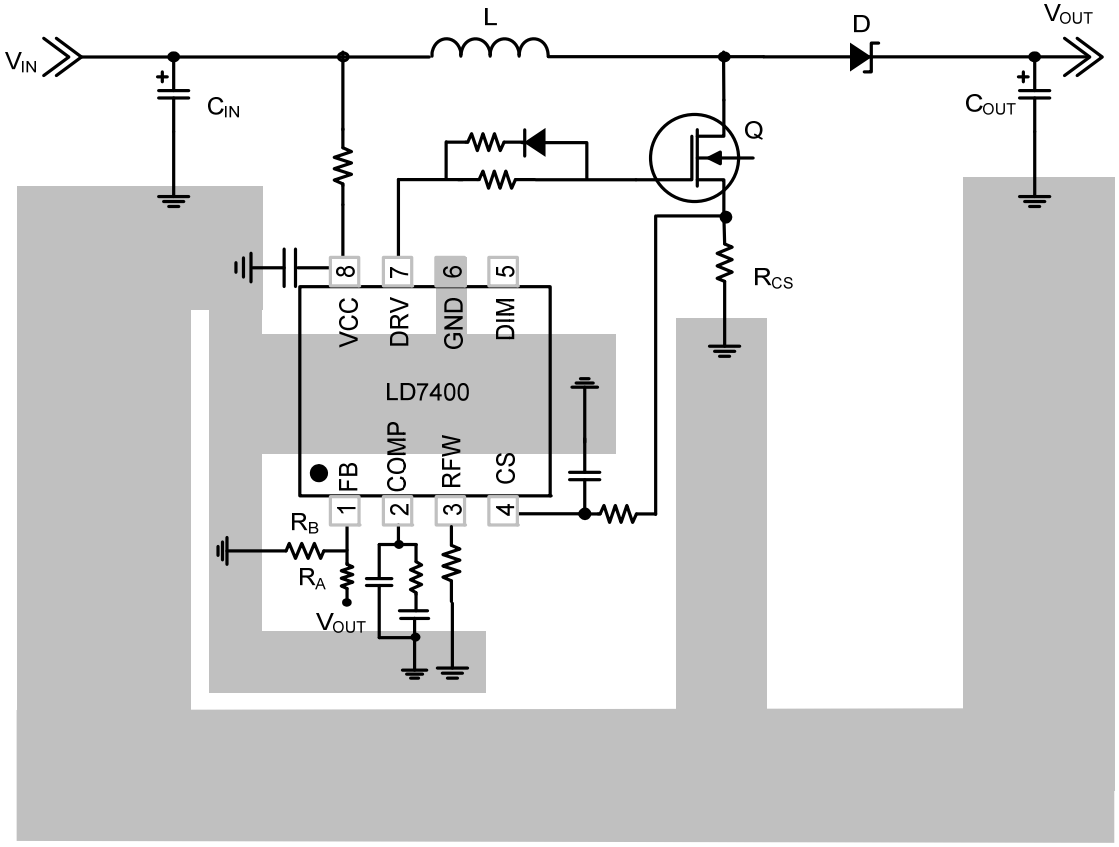
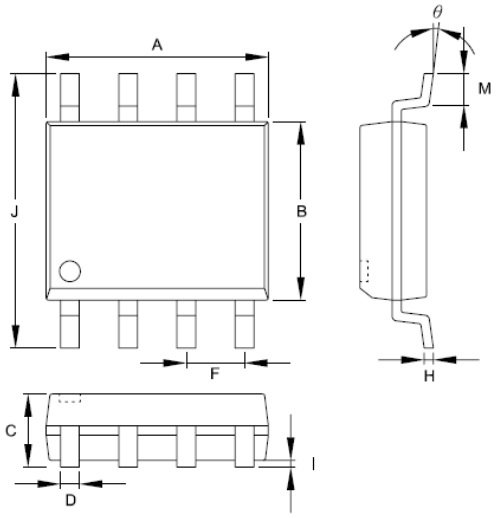


Fig. 13 Recommended PCB layout

Package Information

SOP-8

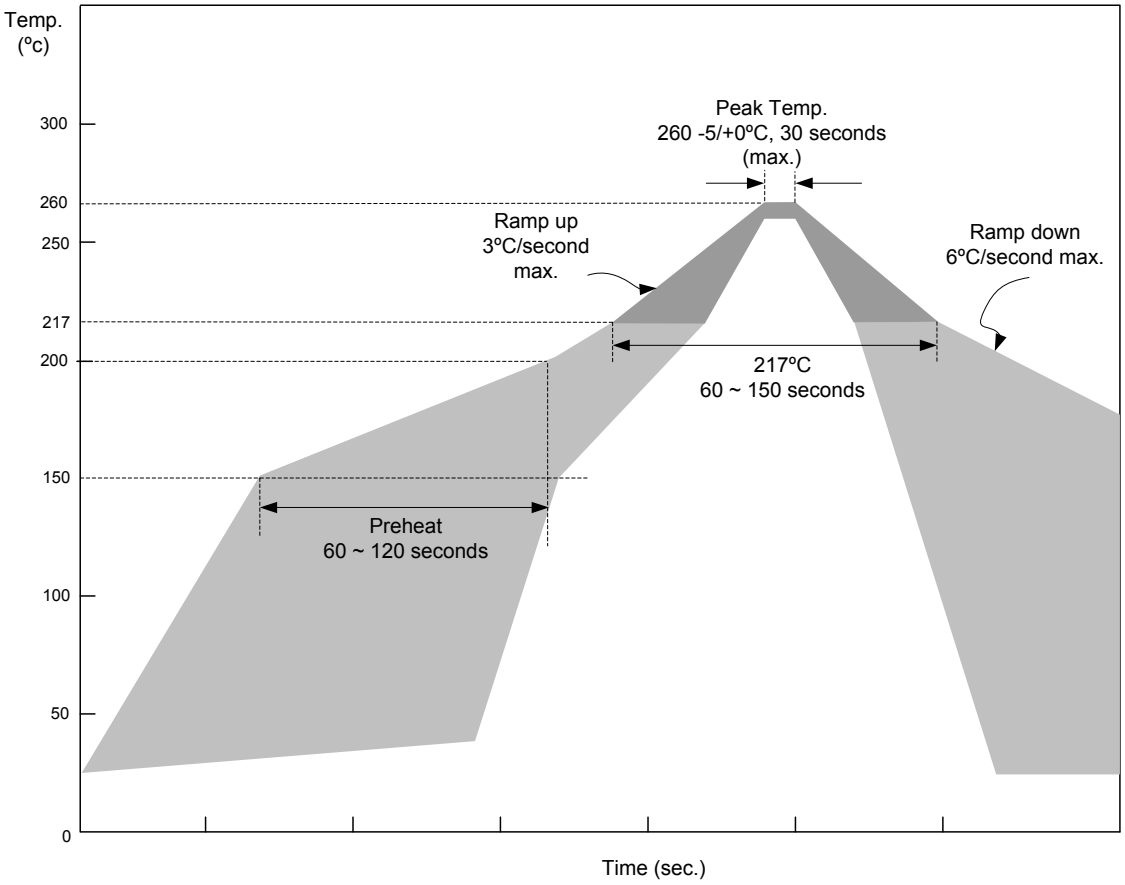


Symbols	Dimensions in Millimeters		Dimensions in Inch	
	MIN	MAX	MIN	MAX
A	4.801	5.004	0.189	0.197
B	3.810	3.988	0.150	0.157
C	1.346	1.753	0.053	0.069
D	0.330	0.508	0.013	0.020
F	1.194	1.346	0.047	0.053
H	0.178	0.254	0.007	0.009
I	0.102	0.254	0.004	0.010
J	5.791	6.198	0.228	0.244
M	0.406	1.270	0.016	0.050
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.

IR Profile for SMD Devices



Item	Average Ramp-up Rate	Pre-heat (150 ~ 200°C)	Time Maintained Above 217°C	Peak Temp.	Ramp-down Rate
Required	3°C(max) /sec	60~120 sec	60~150 seconds	260 +0/-5°C 30 seconds	6°C (max) /sec

Revision History

Rev.	Date	Change Notice
00	02/23/2012	Original Specification