White LED Step-Up Regulator

The EL7513 is a constant current boost regulator specially designed for white LEDs. It can drive up to 5 LEDs in series or 12 LEDs in parallel/series configuration. Up to 91% of efficiency can be achieved.

The brightness of the LEDs is adjusted through a voltage level on the CNTL pin. When the level falls below 0.1V, the chip goes into shut-down mode and consumes less than 1µA of current.

EL7513 is available in a thin SOT-23 package with maximum height of 1mm vs 1.45mm for a regular SOT-23 package.

The complete demo board schematic diagram is shown in Figure 1. Only D_2-D_5 is stuffed.

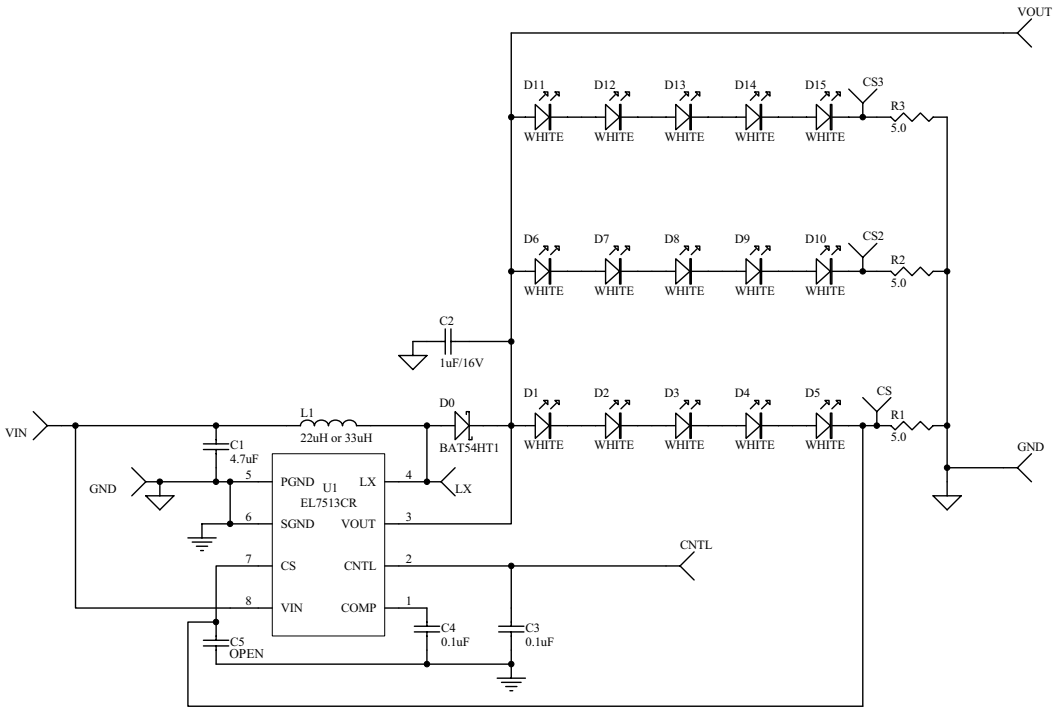

FIGURE 1. DEMO BOARD SCHEMATIC

Demo Board Bill of Materials

REFERENCE DESIGNATOR	VALUE	PACKAGE	MAX HEIGHT (mm)	MANUFACTURER	MANUFACTURER'S PN	MANUFACTURER'S PHONE NUMBER
C1	4.7µF/6.3V	0805	1.25	TDK	C2012X5R0J475K	847-803-6100
C2	1µF/16V	0805	1.25	TDK	C2012X5R1C105K	847-803-6100
C3	0.1µF	0603		Any		
C4	OPEN	0603		Any		
C5	0.1µF	0603		Any		
D0	BAT54HT1	SOD323	1	Any		
R1, R2, R3	4.99Ω	0603				
L1	33µH		1	Coilcraft	LPO1704-333M	847-639-6400
U1	EL7513	SOT23-8	1	Intersil	EL7513	888-ELANTEC

Input Voltage

This demo board is intended for V_{IN} = 2.7 to 5.5V. However, with higher voltage rating input and output capacitors (C_1 and C_2), it can be used for higher input voltage up to 13.5V.

Brightness Control

The relationship between the LED current and CNTL voltage level is as follows:

$$I_{LED} = \frac{V_{CNTL}}{13.33 \times R_1}$$

When R_1 is 5Ω, 1V of V_{CNTL} conveniently sets I_{LED} to 15mA. The range of V_{CNTL} is 250mV to 5.5V.

Component Selection

The input and output capacitors are not very important for the converter to operate normally. The input capacitance is normally 2.22µF - 4.7µF, output capacitance 0.22µF -1µF, depending on number of LEDs with 3 LEDs, 0.22µF is sufficient. Higher capacitances are allowed to reduce the voltage/ current ripple, but at added cost. Use X5R or X7R ceramic type (for its good temperature characteristics) capacitors with correct voltage rating and maximum allowed height.

When choosing an inductor, make sure the inductor can handle the average and peak currents giving by following formulas:

$$I_{LAVG} = \frac{I_O \times V_O}{0.8 \times V_{IN}}$$

$$I_{LPK} = I_{LAVG} + \frac{1}{2} \times \Delta I_L$$

$$\Delta I_L = \frac{V_{IN} \times (V_O - V_{IN})}{L \times V_O}$$

Where ΔI_L is the peak-to-peak inductor current ripple, L inductance in µH.

A wide range of inductance (6.8µH - 68µH) can be used for the converter to function correctly. However, try different values of inductor in the same series to see which generates best efficiency.

The diode should be Schottky type with minimum reverse voltage of 20V. The diode's peak current is the same as inductor's peak current, the average current is I_O, and RMS current is:

$$I_{DRMS} = \sqrt{I_{LAVG} \times I_O}$$

Ensure the diode's ratings exceed these current requirements.

The compensation capacitor C_4 can be any value from 4700pF to 1µF. C_3 and C_5 are for noise filtering; they may not be needed if there is no noise interference.

White LED Connections

One leg of LEDs connected in series will ensure all the uniformity of the brightness. 18V maximum voltage enables 4-5 LEDs can be placed in series. When placing 5 LEDs in series, make sure the worst total forward voltage does not exceed 18V.

PCB Layout Considerations

The layout is very important for the converter to function properly. Power Ground (⏚) and Signal Ground (⏚) should be separated to ensure the high pulse current in the power ground does not interference with the sensitive signals connected to Signal Ground. Both grounds should only be connected at one point right at the chip. The heavy current paths (V_{IN}-L-LX pin-PGND, and V_{IN}-L-D-Co-PGND) should be as short as possible.

The trace connected to pin 7 (CS) is most important. The current sense resister R_1 should be very close to the pin and when the trace is long, use a small filter cap (C_5) close to pin 7.

The heat of the IC is mainly dissipated through the PGND pin. Maximizing the copper area around the plane is preferable. In addition, a solid ground plane is always helpful for the EMI performance.

Demo Board Layout

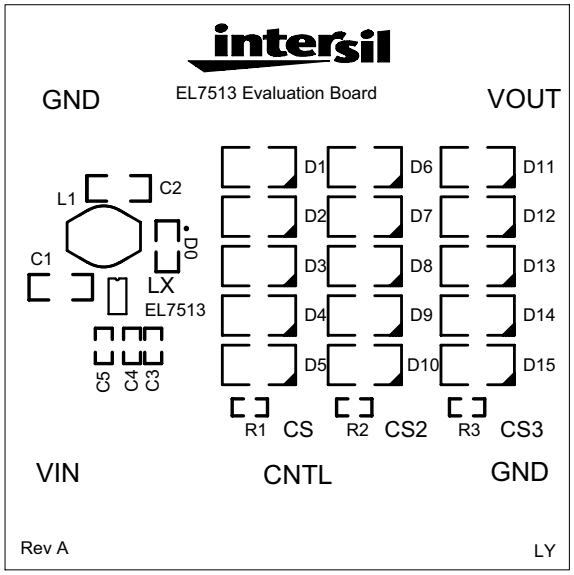

FIGURE 2. SILKSCREEN

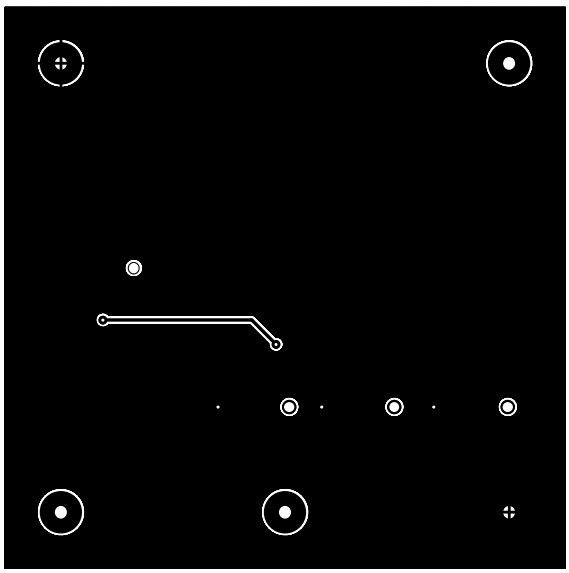

FIGURE 4. BOTTOM LAYER

Demo Board Layout (continued)

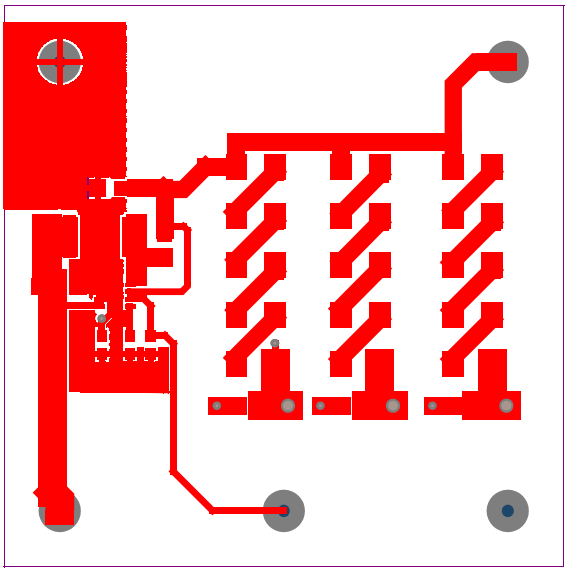

FIGURE 3. TOP LAYER