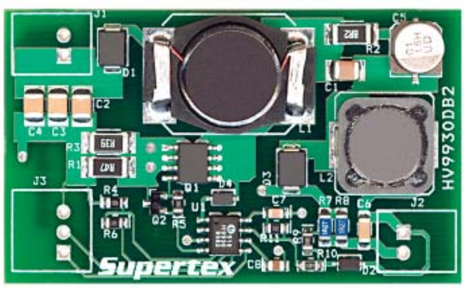
Boost-Buck High Brightness LED Driver Demoboard

General Description

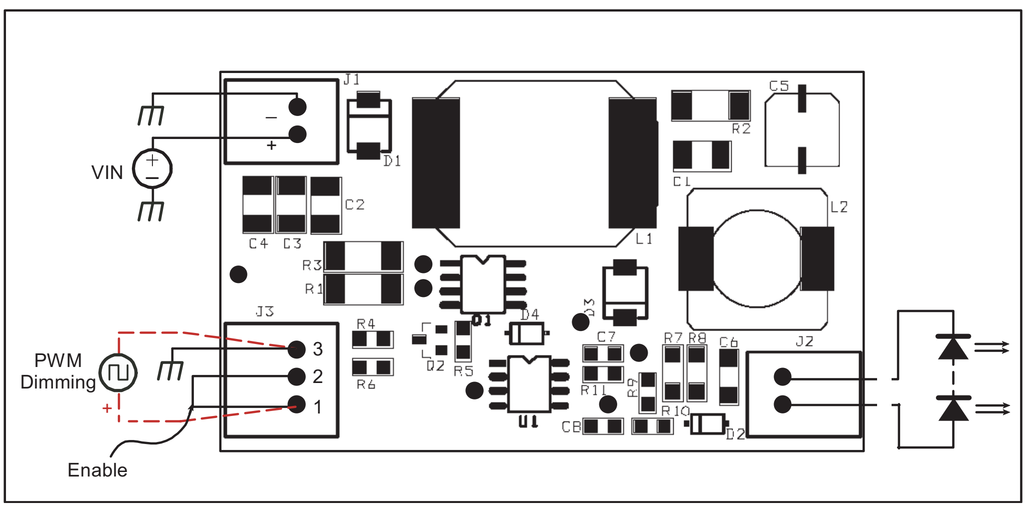
The HV9930DB2 is a LED driver capable of driving 4 3-watt LEDs in series from an input of 9 – 25V DC. The demoboard uses Supertex's HV9930 in a boost-buck topology. The converter has excellent line and load regulation over the entire input and output voltage range. The full load efficiency of the converter is typically greater than 80%. The converter is also protected against open LED and output short circuit conditions.



Specifications

Specifications	
Input Voltage (steady state):	9V – 25V DC
Output LED string voltage:	16V max
Output current:	750mA +/-5%
Output Current Ripple:	20% typical
Switching Frequency:	variable 135kHz (typical at 13V input)
Efficiency:	
Open LED protection:	Included; Clamps at 20V
Output Short circuit protection:	Included; limits current at 750mA
Input Current Limit:	2.25A
PWM Dimming frequency:	Up to 1kHz
Dimensions:	58mm X 35mm

Board Layout and Connections



Connections:

Input: The input is connected between the terminals of connector J1 as shown in the Connection Diagram.

Output: The output is connected between the terminals of connector J2 as shown.

Enable/PWM Dimming: To just enable the board, short pins 1 and 2 of connector J3 as shown. To PWM dim the board, connect the external push-pull square wave source between terminals 1 and 3 of connector J3 as shown by the dotted lines.

Note: *During PWM dimming, pin 2 of connector J3 should be left open. Also, the PWM signal must have the proper polarity with the positive connected to pin 1 of J3. Note that pin 3 of J3 is internally connected to the return path of the input voltage.*

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Testing the Demoboard

Normal Operation: Connect the input source and the output LEDs as shown in the Connection Diagram and enable the board. The LEDs will glow with a steady intensity. Connecting an Ammeter in series with the LEDs will allow measurement of the LED current. The current will be 750mA +/- 5%.

Open LED test: Connect a voltmeter across the output terminals of the HV9930DB2. Start the demoboard normally and once the LED current reaches steady state, unplug one end of the LED string from the demoboard. The output voltage will rise to about 20V and stabilize.

Short Circuit Test: When the HV9930DB2 is operating in steady state, connect a jumper across the terminals of the LED string. Notice that the output current will remain steady.

PWM Dimming: With the input voltage to the board disconnected, apply a TTL compatible, push-pull square wave signal between PWMD and GND terminals of connector J3 as shown in the Connection Diagram. Turn the input voltage back on and adjust the duty cycle and / or frequency of the PWM dimming signal. The output current will track the PWM dimming signal. Note that although the converter operates perfectly well at 1kHz PWM dimming frequency, the best PWM dimming ratio can be obtained at lower frequencies like 100 or 200Hz.

Typical Results

Fig.1 shows the efficiency plot for the HV9930DB2 over the input voltage range. The converter has efficiencies greater than 80% over 13V input.

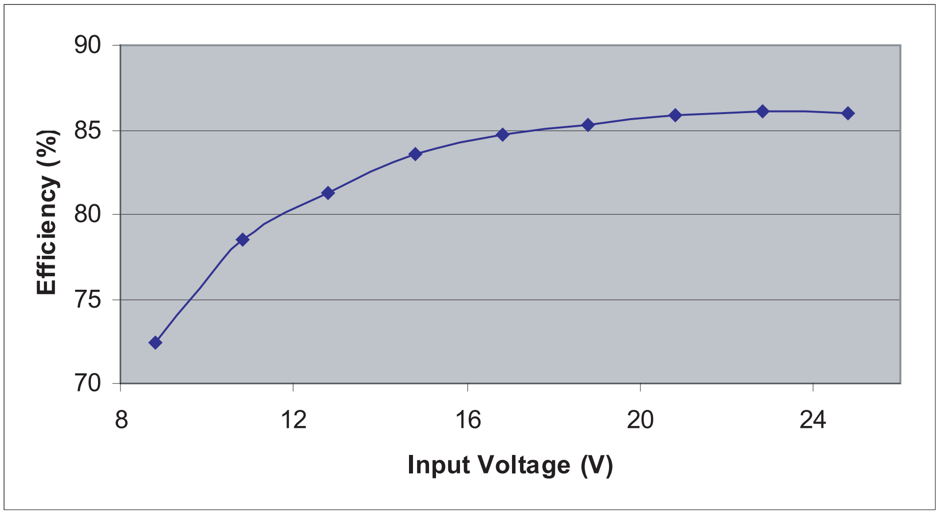

Fig. 1. Efficiency vs Input Voltage

Fig.2 shows the output current variation over the input voltage range at full load. The LED current has a variation of about 5mA over the entire voltage range.

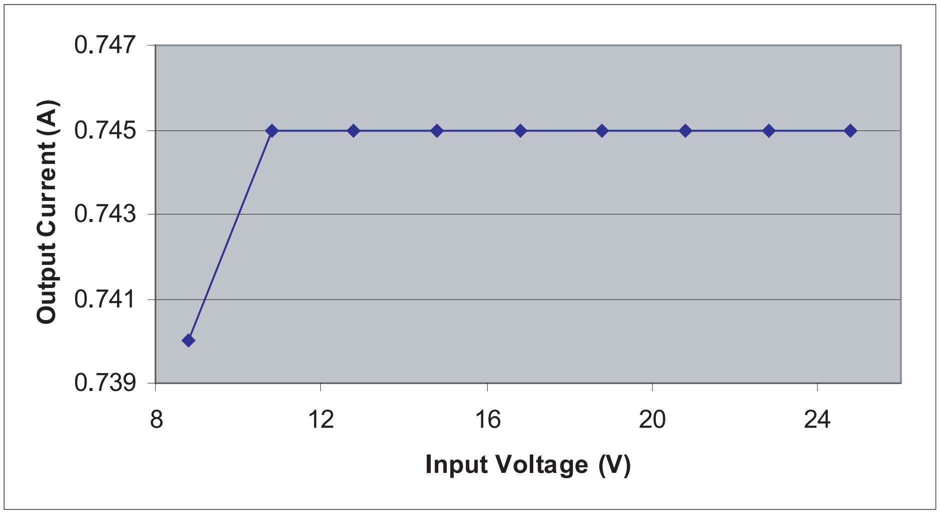

Fig. 2. Line Regulation of the Output Current

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Fig.3 shows the variation of the output current with varying output voltage (different number or LEDs) at 13V input.

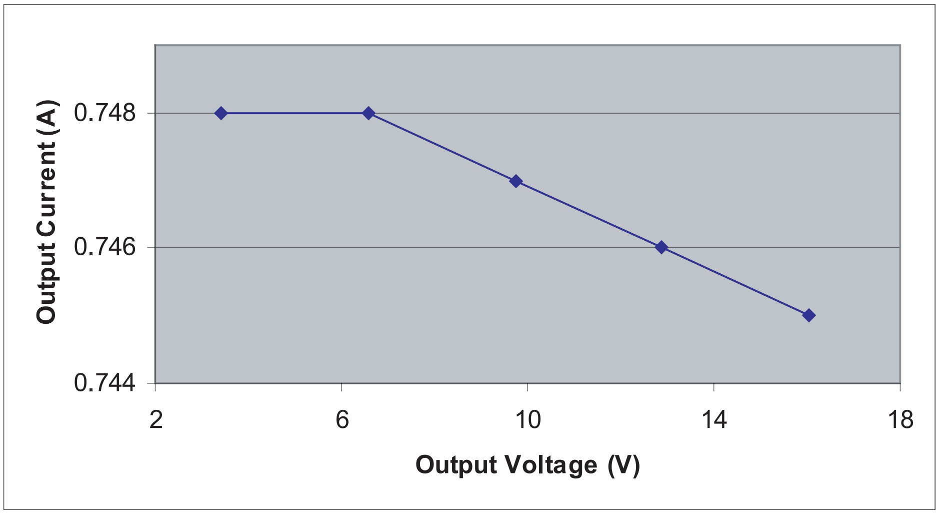


Fig. 3. Load Regulation of the Output Current

Fig. 4 shows the variation of the switching frequency over the input voltage range at full load. The frequency varies from 90kHz to 180kHz over the entire input voltage range.

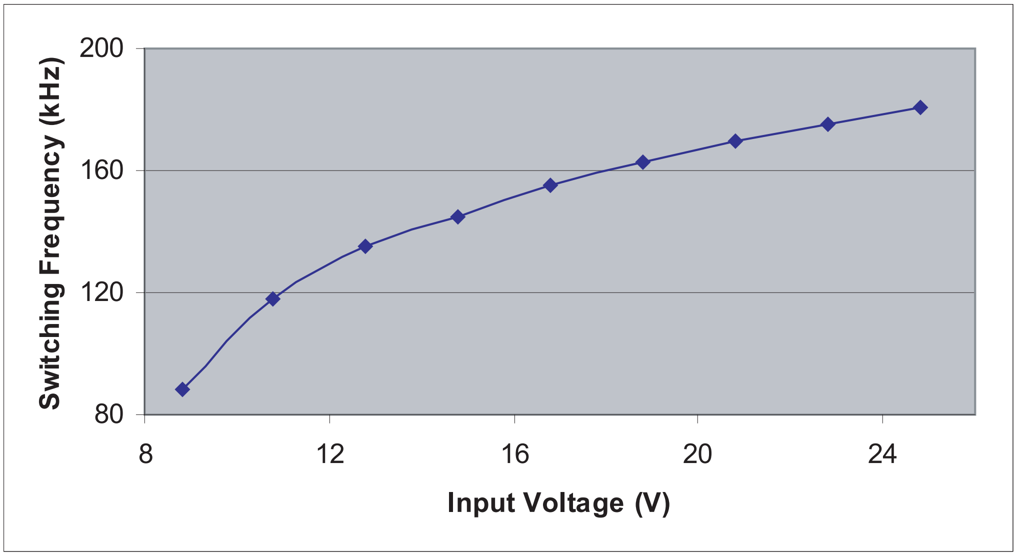
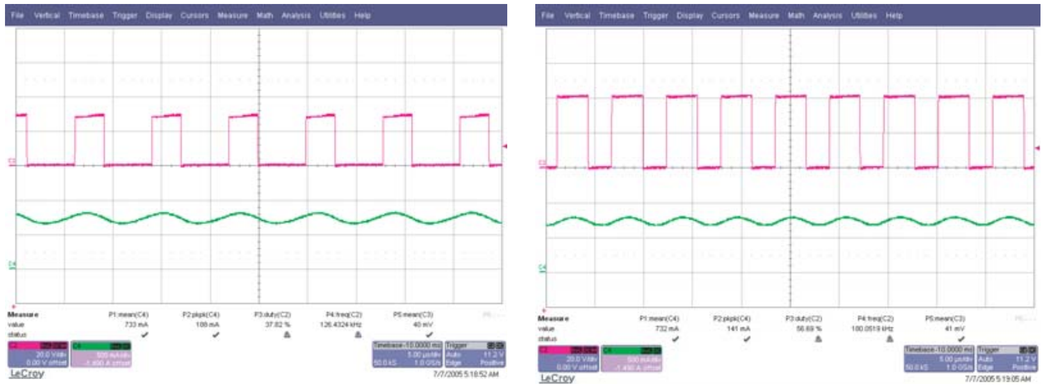


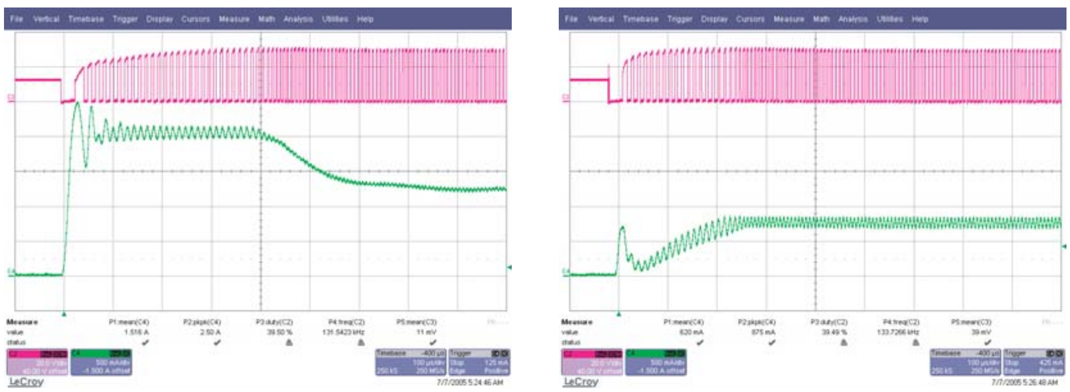
Fig. 4. Switching Frequency Regulation

The waveforms in Fig. 5 show the drain voltage of the FET (channel 2 (pink); 20V/div) and the LED current (channel 4 (green); 500mA/div) at two different operating conditions – 12V input and 24V input.



(a) (b)

Fig. 5. Drain Voltage and LED Current Waveforms in Steady State

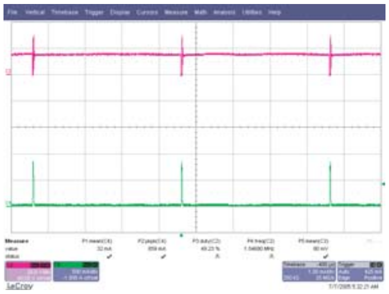


(a) (b)

Fig. 6. Startup Waveforms

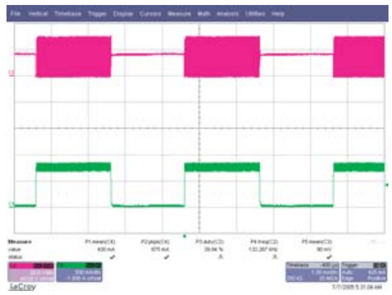
Fig. 6a shows the drain (channel 2 (pink); 20V/div) and input current (channel 4 (green); 500mA/div) waveforms during startup and Fig. 6b shows the drain waveform (channel 2 (pink); 20V/div) and the output current (channel 4 (green); 500mA/div) during startup.

Fig. 7 shows the PWM dimming performance of the HV9930DB1 with a 250Hz, 5V square wave signal. The converter can easily operate at PWM dimming duty cycles from 1% - 99%.



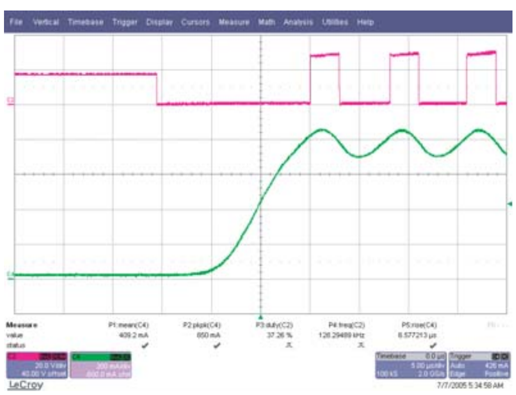
(a) – 1%

(c) – 99%

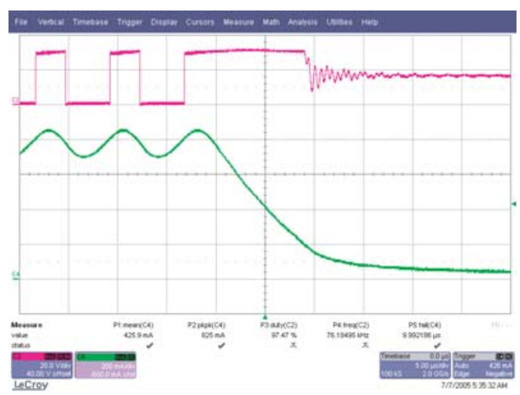


(b) – 50%

Fig. 7. PWM Dimming Performance



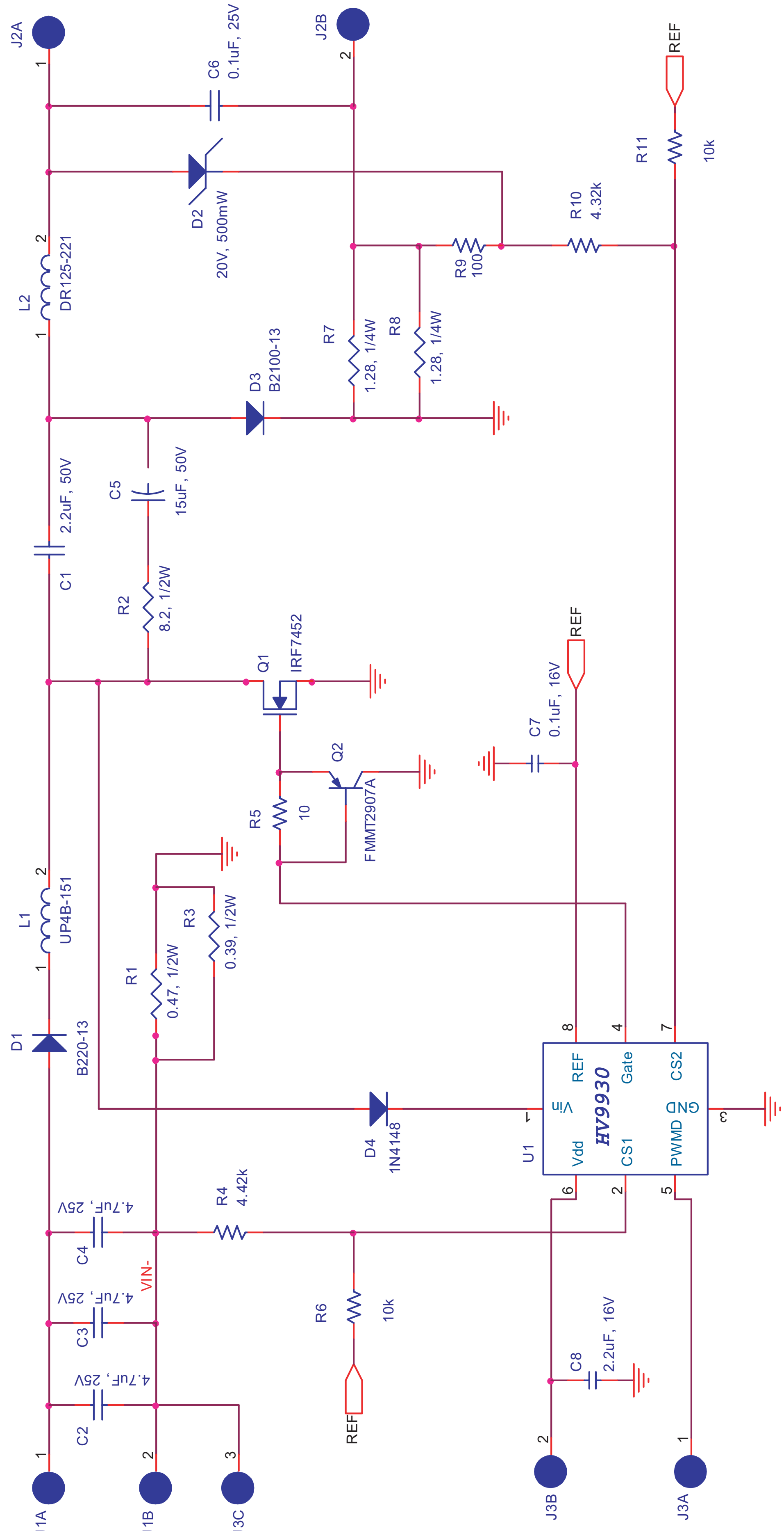
(a) – Rise Time



(b) – Fall Time

Fig. 8. Dynamic Performance during PWM Dimming

Fig. 8 shows the rise and fall times of the output current during PWM dimming. The converter has nearly symmetric rise and fall times of about 8μs. These rise and fall times can be reduced (if desired) by reducing the output capacitance C6. However, this will lead to increased ripple in the output current.


J2A
J2B
C6
0.1uF, 25V
D2
20V, 500mW
L2
DR125-221
R9
100
R10
4.32k
R11
10k
REF
D3
B2100-13
R7
1.28, 1/4W
R8
1.28, 1/4W
C1
2.2uF, 50V
C5
15uF, 50V
R2
8.2, 1/2W
Q1
IRF7452
Q2
FMMT2907A
R5
10
C7
0.1uF, 16V
L1
UP4B-151
R1
0.47, 1/2W
R3
0.39, 1/2W
D1
B220-13
D4
1N4148
U1
HV9930
Vdd
Vin
REF
CS1
Gate
PWMD
GND
CS2
C2
4.7uF, 25V
C3
4.7uF, 25V
C4
4.7uF, 25V
VIN-
R4
4.42k
R6
10k
C8
2.2uF, 16V
J1A
J1B
J3C
J3B
J3A

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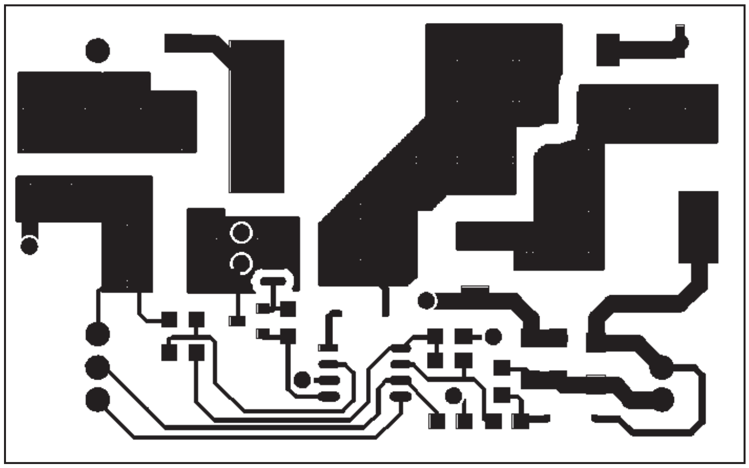
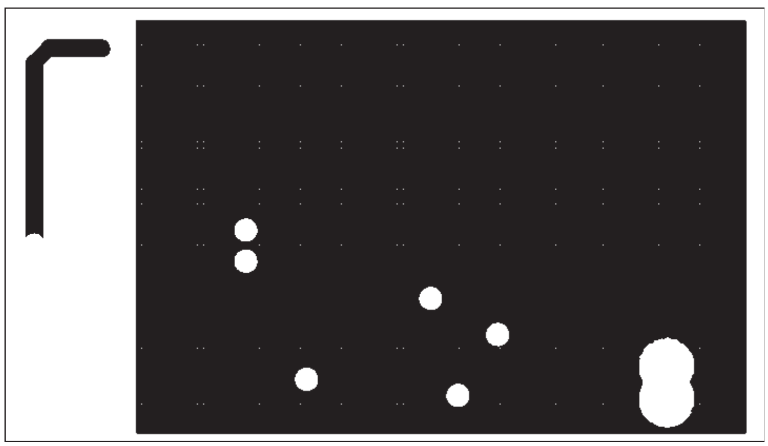
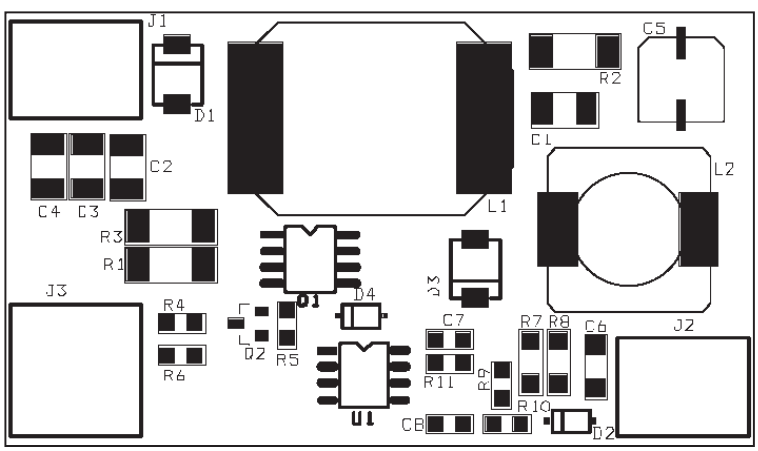
Top Layer



Bottom Layer



Silk Screen



Bill of Materials

Item #	Quantity	RefDes	Description	Package	Manufacturer	Manufacturer's Part Number
1	1	C1	2.2uF, 50V, X7R ceramic chip capacitor	SMD1210	TDK Corp.	C3225X7R1H225K
2	3	C2,C3, C4	4.7uF, 25V X5R ceramic capacitor	SMD1210	Panasonic	ECJ-4YB1E475K
3	1	C5	15uF, 50V electrolytic capacitor	SMT	Nichion	UUD1H150MCL1GS
4	1	C6	0.1uF, 25V, X7R ceramic chip capacitor	SMD1206	Panasonic	ECJ-3VB1E104K
5	1	C7	0.1uF, 16V, X7R ceramic chip capacitor	SMD0805	Panasonic	ECJ-2VB1C104K
6	1	C8	2.2uF, 16V X7R ceramic capacitor	SMD0805	TDK Corp.	C2012X7R1C225K
7	1	D1	20V, 2A schottky diode	SMB	Diodes Inc.	B220-13
8	1	D2	20V, 500mW zener diode	SOD123	ON Semi	MMSZ5250BT1
9	1	D3	100V, 2A schottky diode	SMB	Diodes Inc.	B2100-13
10	1	D4	75V, 400mW switching diode	SOD123	Diodes Inc.	1N4148W-7
11	2	J1,J2	2 pin, 2.5mm pitch right angle connector	Thru-Hole	JST Sales Amer.	S2B-EH
12	1	J3	3 pin, 2.5mm pitch right angle connector	Thru-Hole	JST Sales Amer.	S3B-EH
13	1	L1	150uH, 1.7A rms, 3A sat inductor	SMT	Coiltronics	UP4B-151
14	1	L2	220uH, 1.19A rms, 1.51A sat inductor	SMT	Coiltronics	DR125-221
15	1	Q1	100V, 4.5A N channel MOSFET	SO-8	IR	IRF7452
16	1	Q2	-60V, 600mA PNP transistor	SOT-23	Zetex Inc.	FMMT2907ATA
17	1	R1	0.47, 1/2W, 5% chip resistor	SMD2010	Panasonic	ERJ-12ZQJR47U
18	1	R2	8.2, 1/2W, 5% chip resistor	SMD2010	Panasonic	ERJ-12ZYJ8R2U
19	1	R3	0.39, 1/2W, 5% chip resistor	SMD2010	Panasonic	ERJ-12ZQJR39U
20	1	R4	4.42k, 1/8W, 1% chip resistor	SMD0805	Yageo	9C08052A4421FKHFT
21	1	R5	10, 1/8W, 1% chip resistor	SMD0805	Yageo	9C08052A10R0FKHFT
22	2	R6,R11	10k, 1/8W, 1% chip resistor	SMD0805	Yageo	9C08052A1002FKHFT
23	2	R7,R8	1.28, 1/4W, 1% chip resistor	SMD1206	Yageo	9C12063A1R28FGHFT
24	1	R9	100, 1/8W, 1% chip resistor	SMD0805	Yageo	9C08052A1000FKHFT
25	1	R10	4.32k, 1/8W, 1% chip resistor	SMD0805	Yageo	9C08052A4321FKHFT
26	1	U1	Boost-Buck LED Driver	SO-8	Supertex	HV9930

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