

TPS92513EVM-001 High-Current Buck Regulator With Analog and PWM Dimming for High Brightness LEDs

This user's guide describes the characteristics and use of the high-current buck light-emitting diode (LED) driver evaluation module.

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1 Introduction

The TPS92513EVM-001 evaluation module (EVM) helps designers evaluate the operation and performance of the TPS92513HV buck switching regulator designed for high-current LED drive applications. The TPS92513 is designed to control the drive of high-brightness LEDs and features a wide input voltage range (4.5 V to 60 V), PWM dimming capability, analog dimming capability, adjustable/syncable switching frequency, and input undervoltage protection.

2 Warnings and Cautions

Observe the following precautions when using the TPS92513EVM-001.

WARNING



When choosing your LED component (not included with this EVM) the end user must consult the LED data sheet supplied by the LED manufacturer to identify the EN62471 Risk Group Rating and review any potential eye hazards associated with the LED chosen. Always consider and implement the use of effective light filtering and darkening protective eyewear and be fully aware of surrounding laboratory-type set-ups when viewing intense light sources that may be required to minimize or eliminate such risks in order to avoid accidents related to temporary blindness.

3 Description

The TPS92513EVM-001 provides a high-brightness LED driver based on the TPS92513 buck regulator. It is designed to operate with an input voltage in the range of 6 V to 24 V. The EVM is set up for a default output current of 1 A for an LED stack between approximately 2.5 V and 16 V (depending on the input voltage). The TPS92513 helps provide high efficiency, good line regulation, low output ripple, and a wide dimming range.

3.1 Typical Applications

This converter design describes an application of the TPS92513 as an LED driver with the specifications listed below. For applications with a different input voltage range or different output voltage range, refer to the TPS92513 datasheet ([SLVSCX6](#)).

3.2 Features

3.2.1 Connector Description

This section describes the connectors and test points on the EVM and how to properly connect, setup, and use the TPS92513EVM-001.

3.2.1.1 LED+, LED-

The test posts marked LED+ and LED- are for connecting the LED load to the board. The leads to the LED load should be twisted and kept as short as possible to minimize voltage drop, inductance, and EMI transmission. This design is for approximately 1 to 5 white LEDs.

3.2.1.2 VIN, GND

The test posts marked VIN and GND are for connecting the EVM to the DC input voltage supply. The input supply ground should be connected to the GND test post and not to the GND test point next to the IADJ test point.

3.2.1.3 UVLO

The test point UVLO connects directly to the UVLO pin of the TPS92513. The voltage range is 0 V to 4.5 V, if driven externally. The UVLO resistor divider should be used for the UVLO function, but the UVLO voltage can be monitored via this test point. Pulling UVLO to GND will also serve to disable the part and put it into low-power shutdown mode.

3.2.1.4 PDIM

The PDIM test point connects directly to the PDIM pin of the TPS92513. Leave open for normal operation. If PWM dimming is used, apply a square wave with a low level of GND and a high level of between 2 V and 4.5 V. The dimming frequency range is 100 Hz to 1 kHz.

3.2.1.5 SYNC

The SYNC test point is AC-coupled to the RT/CLK pin of the TPS92513 through a 4.02-k Ω resistor in series with a 470-pF capacitor. Apply a square wave with a low level of GND and a high level of 3.3 V to synchronize the switching frequency to the applied frequency. The frequency range of SYNC is 200 kHz to 2 MHz.

3.2.1.6 IADJ

The IADJ test point connects to the IADJ pin of the TPS92513 through a 1-k Ω resistor. The default is pulled high through a 10-M Ω resistor to VIN, resulting in an ISENSE voltage of 300 mV. The range on the IADJ test point and pin is 0 mV to 1.8 V and the corresponding ISENSE voltage is $V_{IADJ} / 6$.

3.2.1.7 PH

A large via labeled PH is included and sized specifically to receive the probe tip of a standard 10x probe. Use this via to monitor the switching waveform at the PH pin of the device.

4 Electrical Performance Specifications

Table 1 lists the electrical performance specifications.

Table 1. TPS92513EVM-001 Electrical Performance Specifications

Parameter	Test Conditions	MIN	TYP	MAX	Units
Input Characteristics					
Voltage range		6		24	V
Maximum input current			1		A
Input UVLO setting		5.7	6	6.3	
Output Characteristics					
Output voltage, VOUT	LED+ to LED-	2.5		16	V
Output current		0.95	1	1.05	A
Output current ripple			20		mApp
Analog dimming range	$I_{ADJ} = 180 \text{ mV to } 1.8 \text{ V}$	10:1			
PWM dimming range	250-Hz PWM	100:1			
Systems Characteristics					
Efficiency	Input voltage = 16 V, 4 LEDs		94		%
Switching frequency			570		kHz

5 Schematic

Figure 1 displays the EVM schematic.

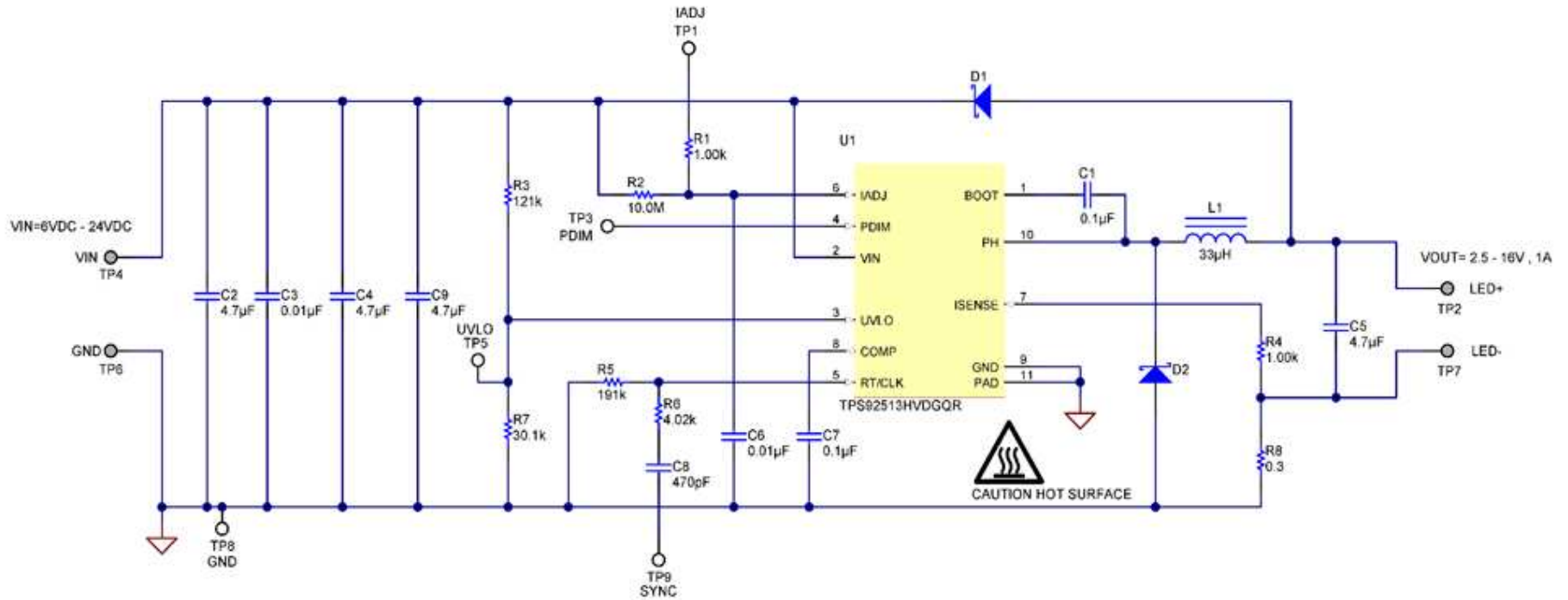


Figure 1. TPS92513EVM-001 Schematic

6 Performance Data and Typical Characteristic Curves

Figure 2 through Figure 5 present typical performance curves for TPS92513EVM-001. Unless otherwise noted, $V_{IN} = 12\text{ V}$, 2-LED output.

6.1 Efficiency

Figure 2 shows the efficiency versus input voltage graph.

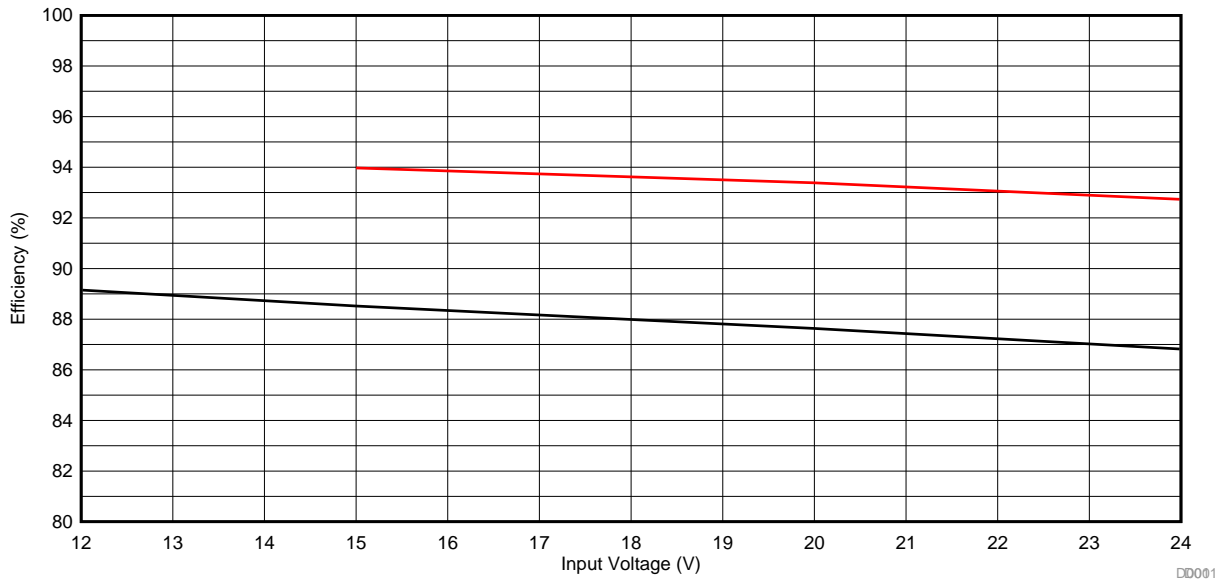


Figure 2. Efficiency vs. Input Voltage, Top = 4 LEDs, Bottom = 2 LEDs

6.2 Line Regulation

Figure 3 shows the output current vs. input voltage.

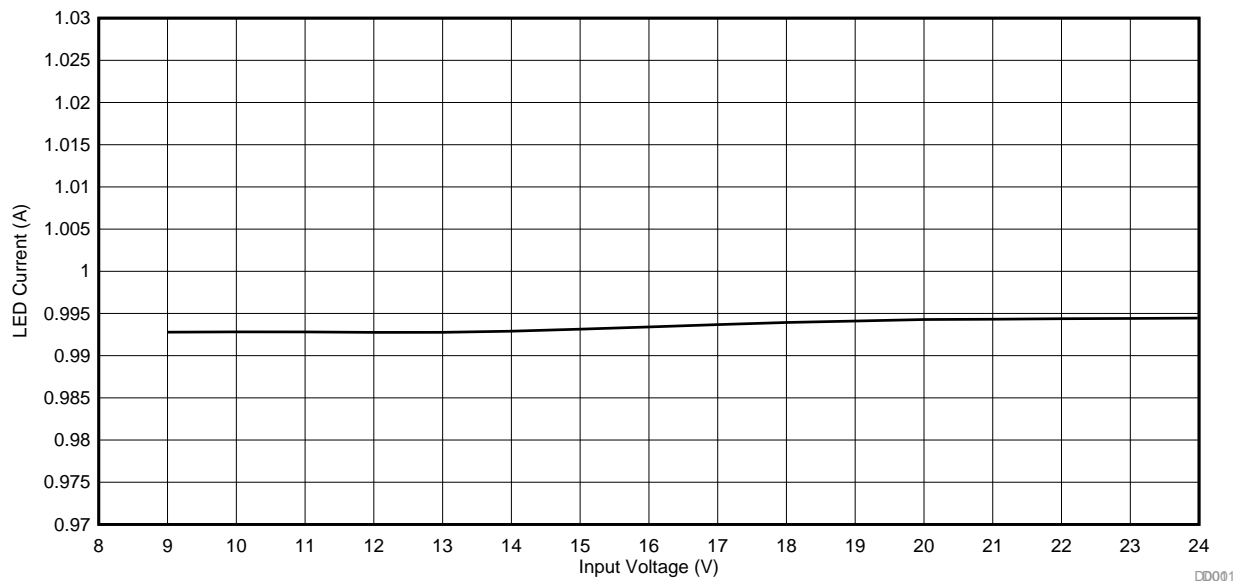


Figure 3. Output Current vs. Input Voltage

6.3 PWM Dimming

Figure 4 shows the output current versus PWM duty cycle at 250 Hz.

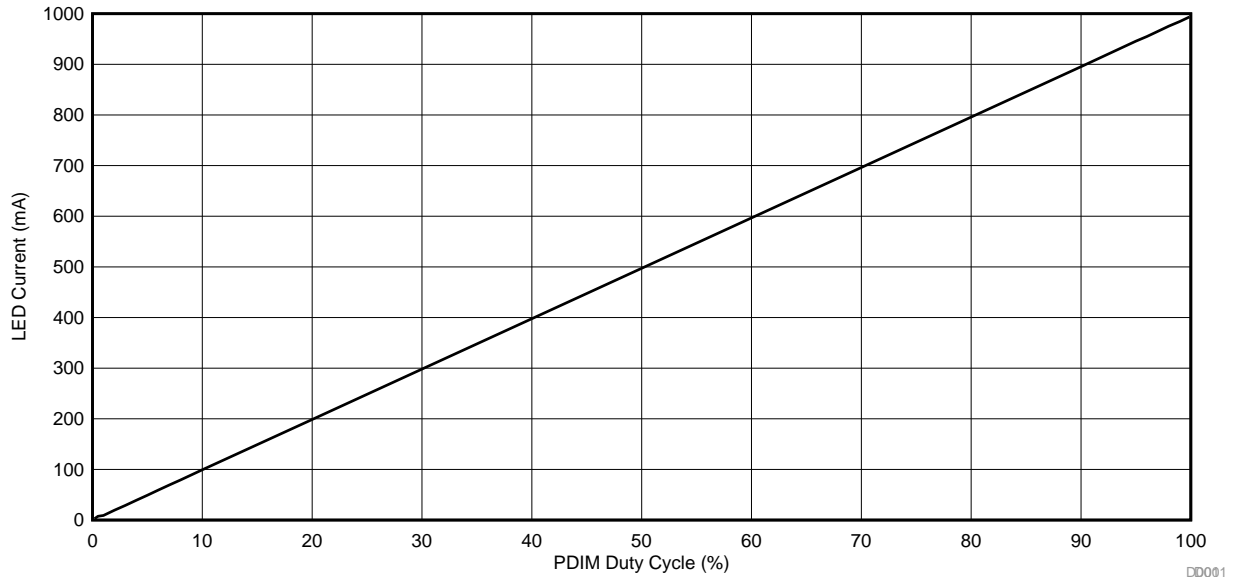


Figure 4. Output Current vs. PWM Duty Cycle (250 Hz)

6.4 Analog Dimming

Figure 5 shows the output current versus I_{ADJ} test point voltage.

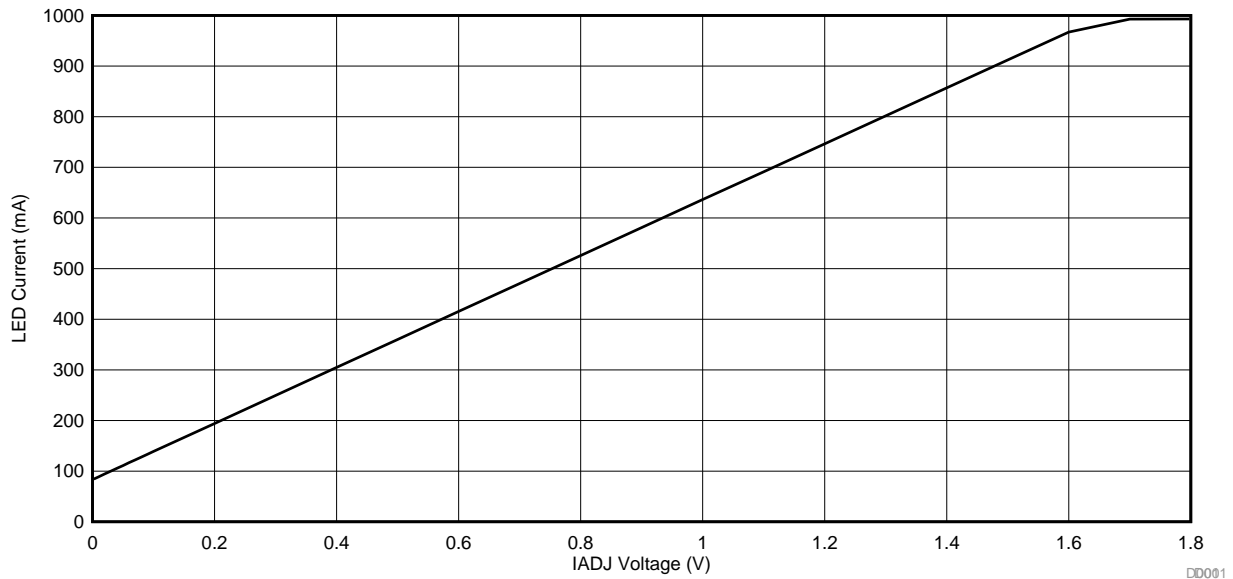


Figure 5. Output Current vs. I_{ADJ} Voltage

6.5 PWM Dimming Waveforms

Figure 6, Figure 7, and Figure 8 illustrate the PWM dimming waveforms at 1%, 50%, and 99% duty cycles, respectively.

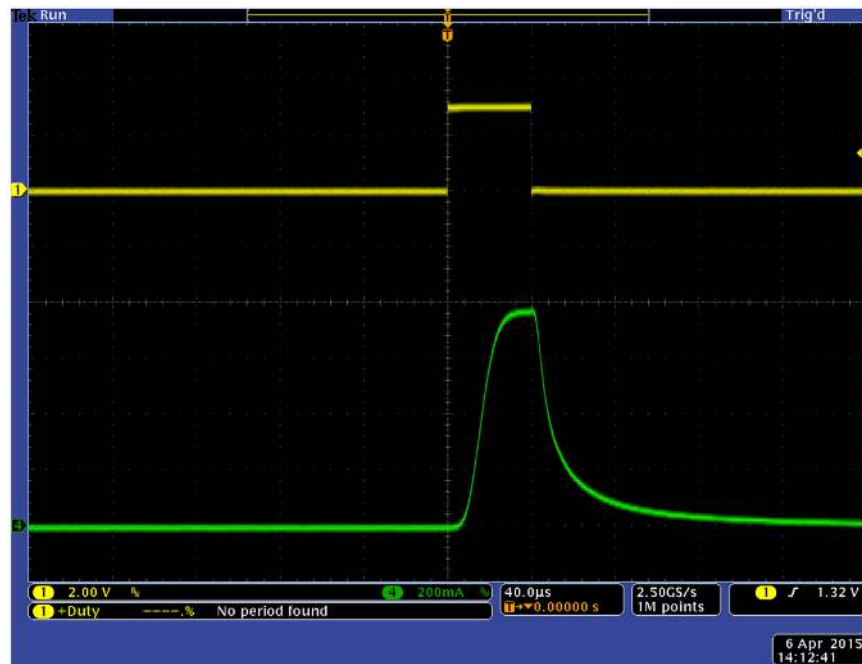


Figure 6. 1% Duty Cycle 250 Hz PWM Dimming, Top = PDIM, Bottom = LED Current

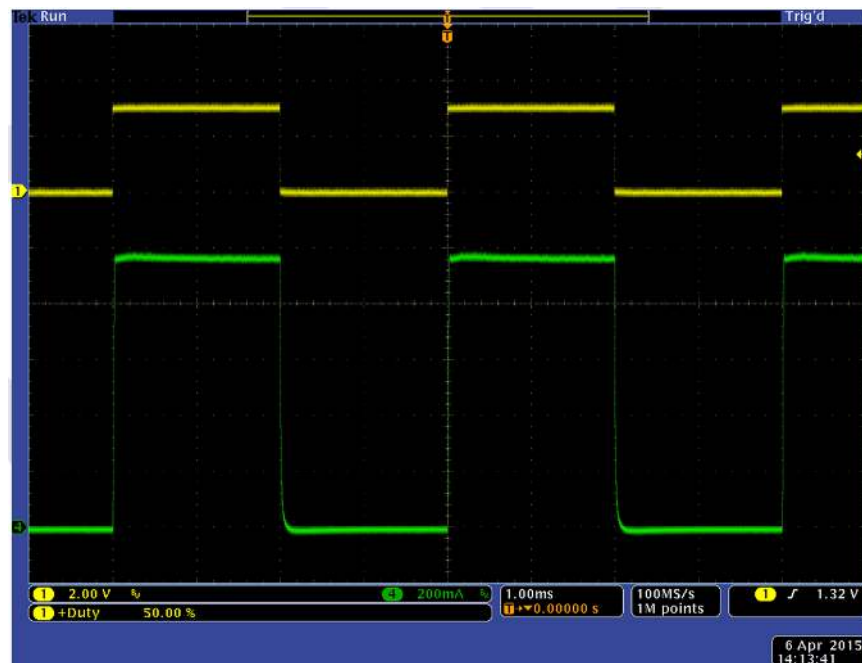


Figure 7. 50% Duty Cycle 250 Hz PWM Dimming, Top = PDIM, Bottom = LED Current



Figure 8. 99% Duty Cycle 250 Hz PWM Dimming, Top = PDIM, Bottom = LED Current

7 TPS92513EVM-001 PCB Layout

Figure 9 and Figure 10 show the design of the TPS92513EVM-001 printed-circuit board.

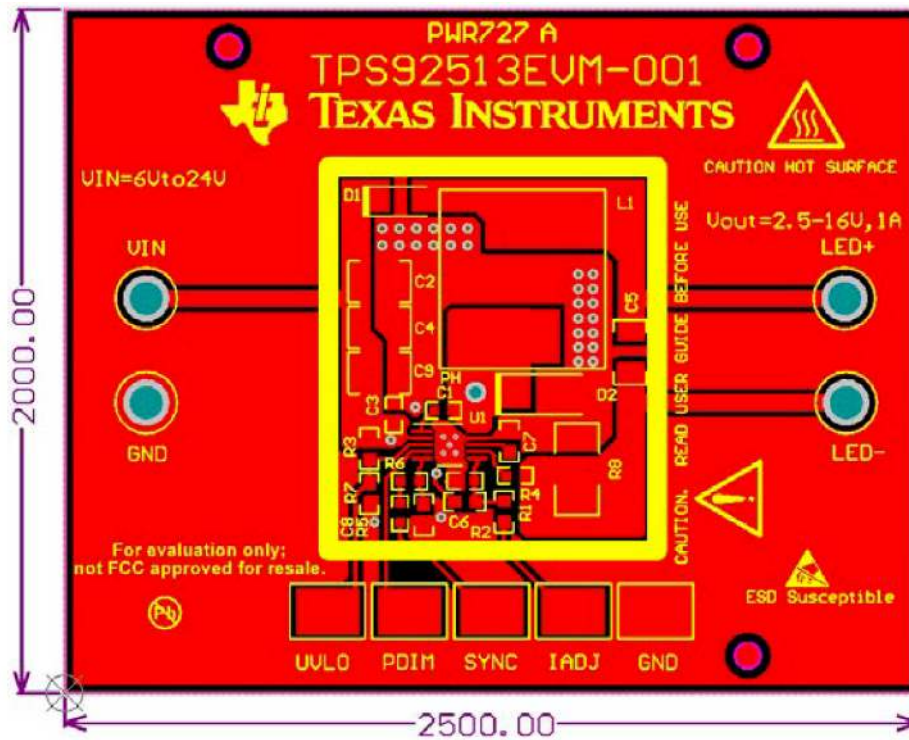


Figure 9. Top Layer and Top Overlay (Top View)

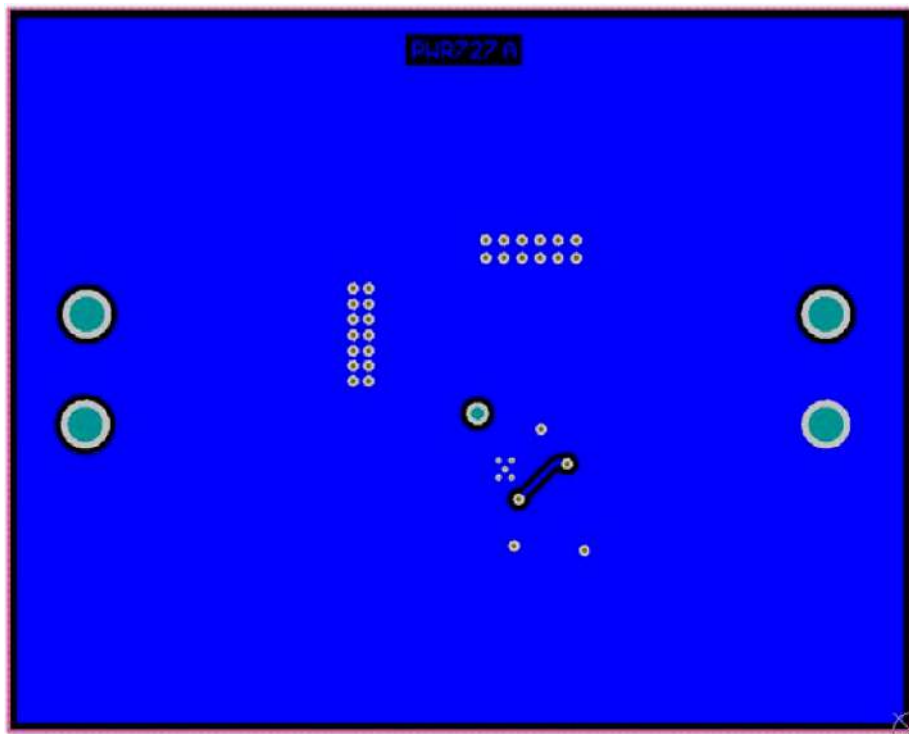


Figure 10. Bottom Layer and Bottom Overlay (Bottom View)

8 Bill of Materials

Table 2 displays the TPS92513EVM-001 components list according to the schematic shown in Figure 1.

Table 2. TPS92513EVM-001 Components List

Ref. Designator	QTY	Value	Description	Size	Part Number	MFR
C1	1	0.1 μ F	CAP, CERM, 0.1 μ F, 25V, +/-10%, X5R	0603	06033D104KAT2A	AVX
C2, C4, C9	3	4.7 μ F	CAP, CERM, 4.7 μ F, 100 V, +/- 10%, X7S	1210	C3225X7S2A475K200AB	TDK
C3, C6	2	0.01 μ F	CAP, CERM, 0.01 μ F, 100V, +/-10%, X7R	0603	06031C103KAT2A	AVX
C5	1	4.7 μ F	CAP, CERM, 4.7 μ F, 25 V, +/- 10%, X7R	1206	GRM31CR71E475KA88L	Murata
C7	1	0.1 μ F	CAP, CERM, 0.1 μ F, 50 V, +/- 10%, X7R	0603	GCM188R71H104KA57D	Murata
C8	1	470pF	CAP, CERM, 470pF, 50V, +/-10%, X7R	0603	GRM188R71H471KA01D	Murata
D1	1	800mV @ 500mA	DIODE SCHOTTKY 80V 0.5A	SOD-123	MBR0580-TP	Micro Commercial Co
D2	1	850mV @ 2A	DIODE SCHOTTKY 80V 2A	DO-214AC, SMA	CDBA280-G	Comchip Technology
L1	1	33 μ H	Inductor, Shielded Drum Core, Ferrite, 33 μ H, 2.6 A, 0.08 ohm	MSS1246	MSS1246-333MLB	Coilcraft
R1	1	0	RES, 0, 5%, 0.1 W	0603	CRCW06030000Z0EA	Vishay-Dale
R2	1	10.0Meg	RES, 10.0 M, 1%, 0.1 W	0603	CRCW060310M0FKEA	Vishay-Dale
R3	1	121k	RES, 121 k, 1%, 0.1 W	0603	CRCW0603121KFKEA	Vishay-Dale
R4	1	1.00k	RES, 1.00k ohm, 1%, 0.1W	0603	CRCW06031K00FKEA	Vishay-Dale
R5	1	191k	RES, 191 k, 1%, 0.1 W	0603	CRCW0603191KFKEA	Vishay-Dale
R6	1	4.02k	RES, 4.02k ohm, 1%, 0.1W	0603	CRCW06034K02FKEA	Vishay-Dale
R7	1	30.1k	RES, 30.1 k, 1%, 0.1 W	0603	CRCW060330K1FKEA	Vishay-Dale
R8	1	0.3	RES, 0.3, 1%, 1 W	2010	CSRN2010FKR300	Stackpole Electronics Inc
U1	1		TPS92513 1.5A Buck Current Regulator for High-Brightness LEDs with Integrated Analog Current Adjust	DGQ0010D	TPS92513HV	Texas Instruments

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NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

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3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210

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2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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