TPS92515HVEVM-749 High Current Buck LED Driver Evaluation Module

This user's guide describes the characteristics, operation, and use of the TPS92515 high current buck LED driver evaluation module (EVM). A complete schematic diagram, printed-circuit board layouts, and bill of materials are included in this document.

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1 Introduction

The TPS92515HVEVM-749 evaluation module (EVM) helps designers evaluate the operation and performance of the TPS92515 buck switching regulator designed for high-current LED drive applications. The TPS92515 is designed to control the drive of high-brightness light-emitting diodes (LED) and features a wide input voltage range (5.5 V to 65 V), PWM dimming capability, analog dimming capability, and input undervoltage protection.

2 Warnings and Cautions

Observe the following precautions when using the TPS92515HVEVM-749.

CAUTION:

Caution! Do not leave EVM powered when unattended.

HOT SURFACE:

Caution Hot Surface! Contact may cause burns. Do not touch. Please take the proper precautions when operating.

HIGH VOLTAGE:

Danger High Voltage! Electric shock possible when connecting board to live wire. Board should be handled with care by a professional. For safety, use of isolated test equipment with overvoltage/overcurrent protection is highly recommended.

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 TPS92515HVEVM-749 provides a high-brightness LED driver based on the TPS92515 buck regulator. It is designed to operate with an input voltage in the range of 5.5 V to 65 V. The EVM is set up for a default output current of 1 A for an LED stack between approximately 3 V and nearly 65 V. The TPS92515 helps provide high efficiency, fast PWM dimming, and accurate wide-range analog dimming.

3.1 Typical Applications

This converter design describes an application of the TPS92515 as an LED driver with the specifications listed in Table 1. For applications with a different input voltage range or different output voltage range refer to the TPS92515 datasheet (SLUSBZ6).

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 TPS92515HVEVM-749.

3.2.1.1 J1, LED Current Setting

A three pin header, J1, is used to change the LED current default setting. The default setup is a shunt placed between pins 1 and 2 resulting in an output current of 1 A. The shunt can be moved to pins 2 and 3 which will change the output current to 1.5 A. Alternatively, the output current can be adjusted by applying a voltage to TP1 (IADJ) with the shunt removed.

3.2.1.2 J2, LED+, LED–/GND

The screw-down connector J2 is 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. Pin 1 of the connector is GND and LED– while pin 2 is LED+. This design is for approximately 1 to 18 white LEDs.

3.2.1.3 J3, VIN, GND

The screw-down connector J3 is for connecting the EVM to the DC input voltage supply. The input supply ground should be connected to pin 1 or 2 of J3 while the positive input is connected to pin 3.

3.2.1.4 TP1, IADJ

TP1 connects directly to the IADJ pin of the TPS92515. An analog voltage applied to IADJ will adjust the peak inductor current level providing an analog dimming function.

3.2.1.5 TP3, PWM

The PWM test point connects directly to the PWM pin of the TPS92515. Leave R14 connected for normal operation. If PWM dimming is used, remove R14 and apply a square wave with a low level of GND and a high level of between 2.5 V and 5 V. The dimming frequency range is 100 Hz to 10k Hz.

3.2.2 High Speed Shunt FET Dimming

The TPS92515HVEVM-749 is capable of high speed shunt FET dimming for fast PWM dimming and/or extended PWM dimming range. To implement shunt FET dimming use an externally driven FET across the LED load placed as close to the LED load as possible to minimize parasitic inductance. The EVM will need minor modifications to the OFF timer due to shorting the output. Remove R1 and populate R4, R7, and D3 as shown and calculated in the TPS92515 datasheet.

4 Electrical Performance Specifications

Table 1 lists the EVM electrical performance specifications.

Table 1. TPS92515HVEVM-749 Electrical Performance Specifications

Parameter	Test Conditions	MIN	TYP	MAX	Units
Input Characteristics					
Voltage range		5.5		65	V
Input current				2.5	A
Output Characteristics					
Output voltage, VOUT	LED+ to LED–/GND	2		65	V
Output current	Setting IADJ using VCC, J1 pins 1 and 2 shunted	0.9	1	1.1	A
	Setting IADJ using VCC, J1 pins 2 and 3 shunted	1.35	1.5	1.65	
Output current ripple	Input voltage = 14 V, 2 LEDs		250		mApp
	Input voltage = 24 V, 4 LEDs		80		
Analog dimming range	V_{IADJ} = 0.1 V to 2 V	12:1			
PWM dimming range	250 Hz PWM	200:1			
Systems Characteristics					
Efficiency	Input voltage = 42 V, 7 LEDs		94		%
Switching frequency	Input voltage = 14 V, 2 LEDs		125		k Hz

5 Schematic

Figure 1 illustrates the EVM schematic.

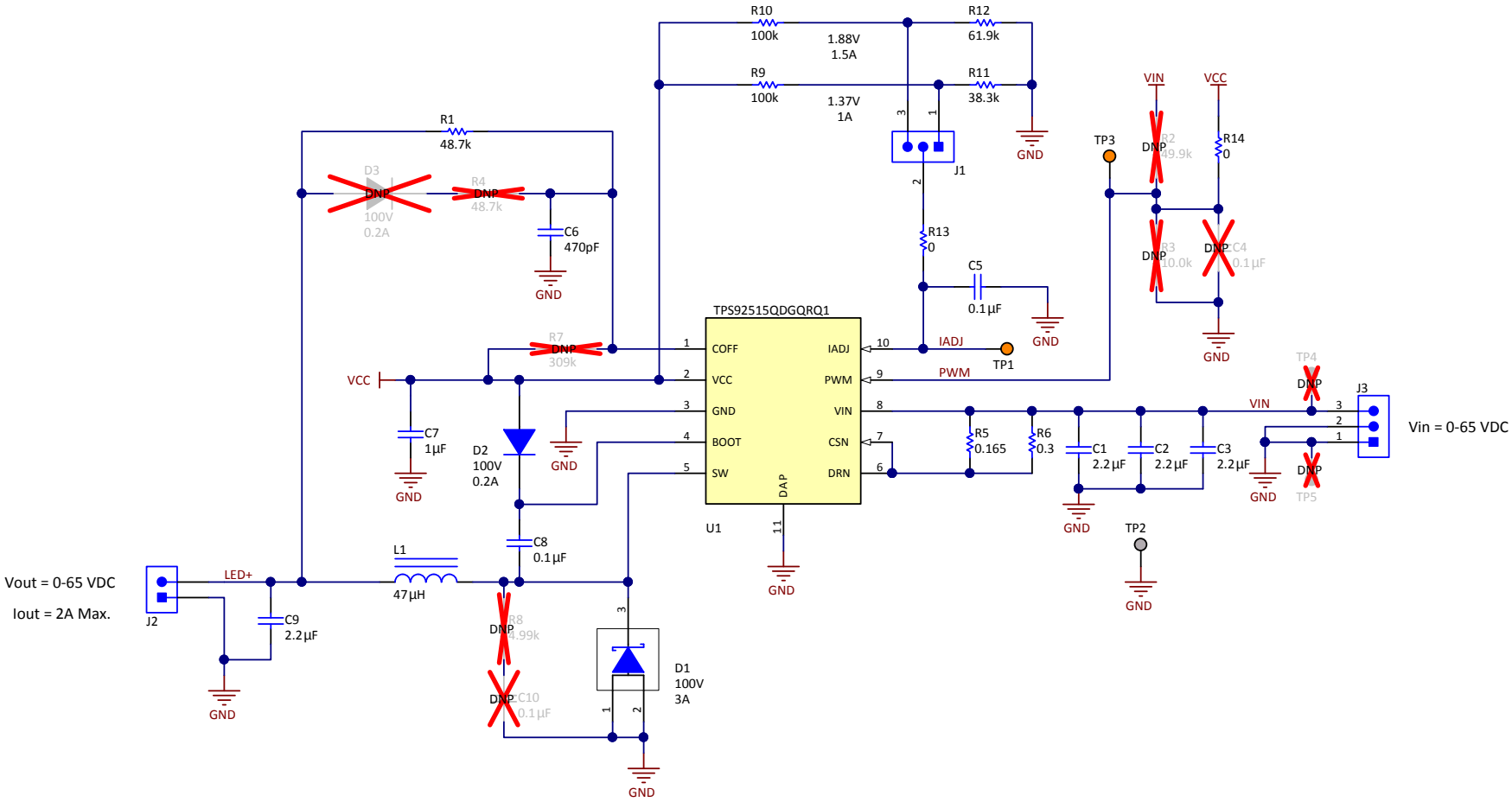

Figure 1. TPS92515HVEVM-749 Schematic

6 Performance Data and Typical Characteristic Curves

Figure 2 through Figure 10 present typical performance curves for TPS92515HVEVM-749.

6.1 Efficiency

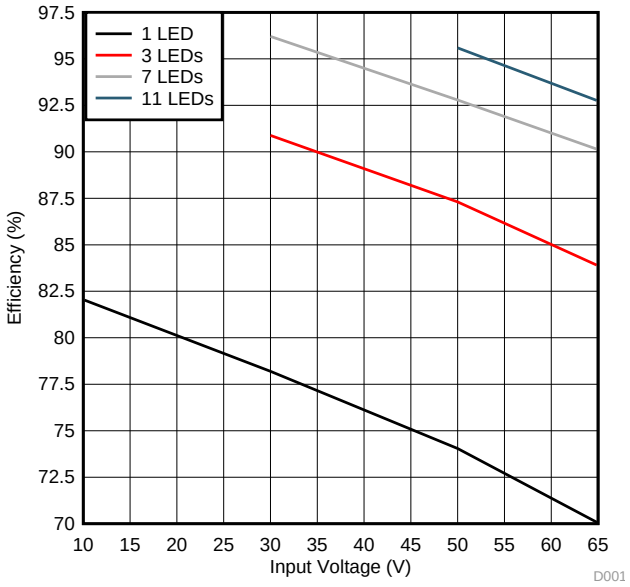

Figure 2. Efficiency vs. Input Voltage

6.2 PWM Dimming

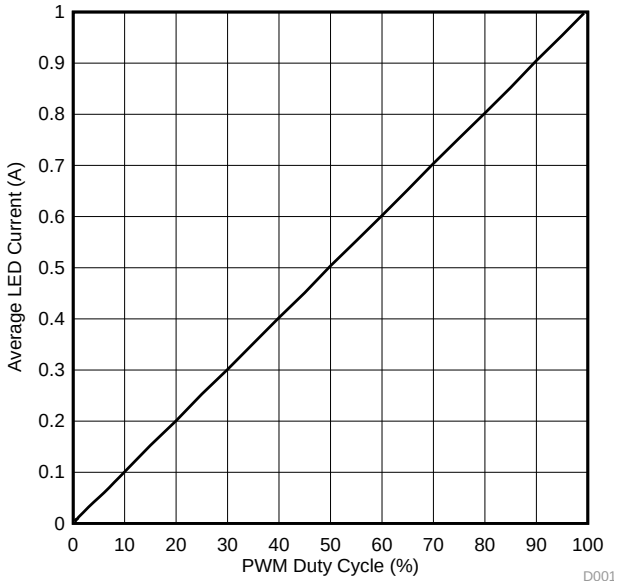

Figure 3. Output Current vs. PWM Duty Cycle (250 Hz) 14-V Input, 2 LEDs

6.3 Analog Dimming

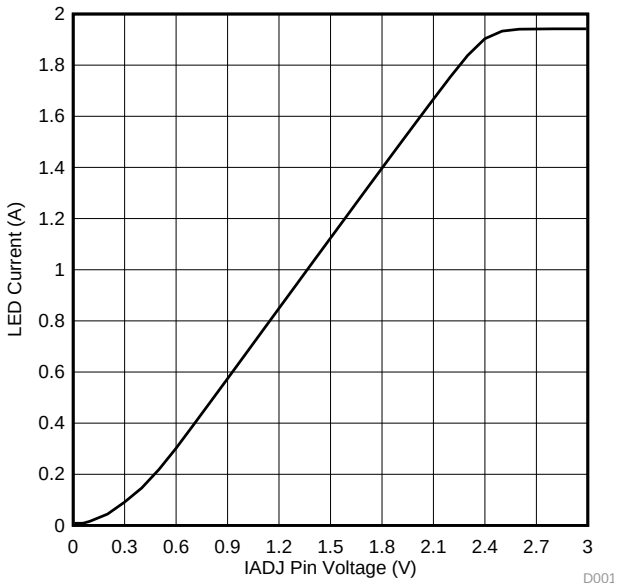

Figure 4. Output Current vs. IADJ Voltage 14-V Input, 2 LEDs

6.4 PWM Dimming Waveforms

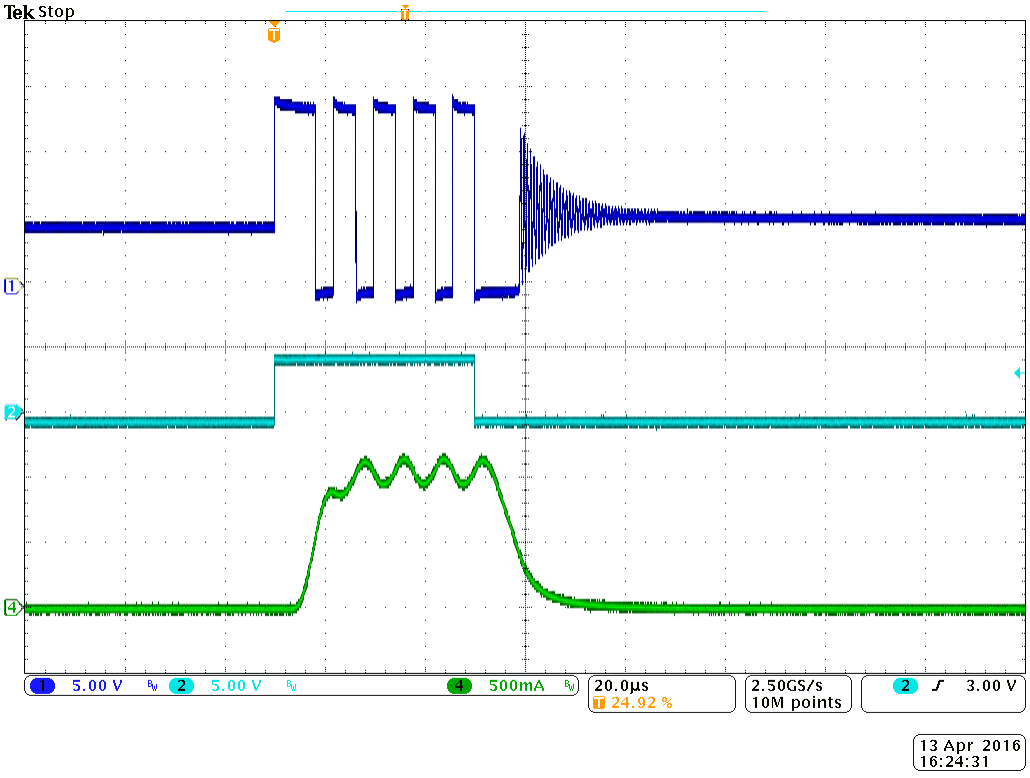

Figure 5. 1% Duty Cycle 250 Hz PWM Dimming
Top = V_{SW}, Middle = V_{PWM}, Bottom = LED Current, Input Voltage = 14 V, 2 LEDs

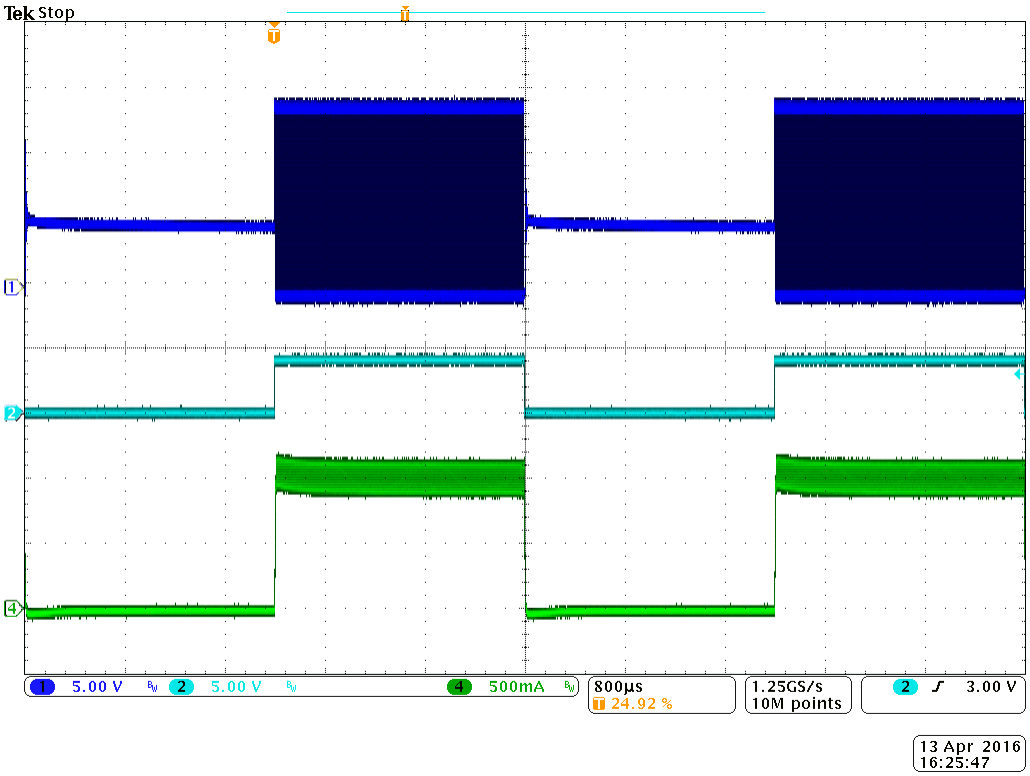

Figure 6. 50% Duty Cycle, 250 Hz PWM Dimming
Top = V_{SW}, Middle = V_{PWM}, Bottom = LED Current, Input Voltage = 14 V, 2 LEDs

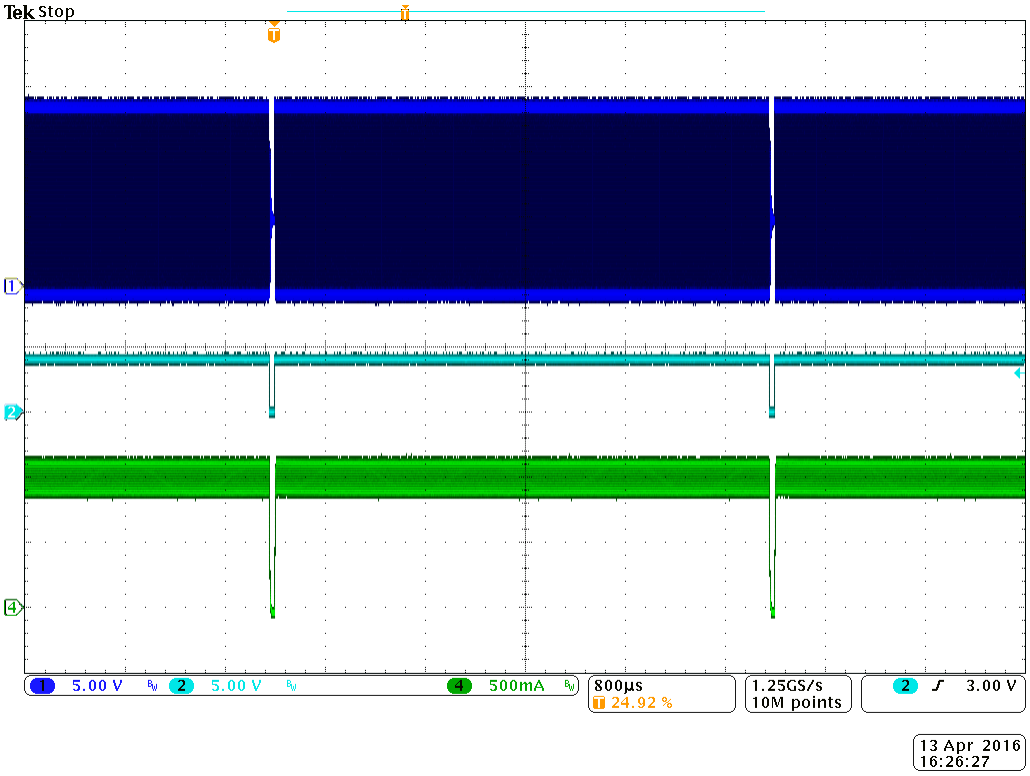

Figure 7. 99% Duty Cycle, 250 Hz PWM Dimming
Top = V_{SW}, Middle = V_{PWM}, Bottom = LED Current, Input Voltage = 14 V, 2 LEDs

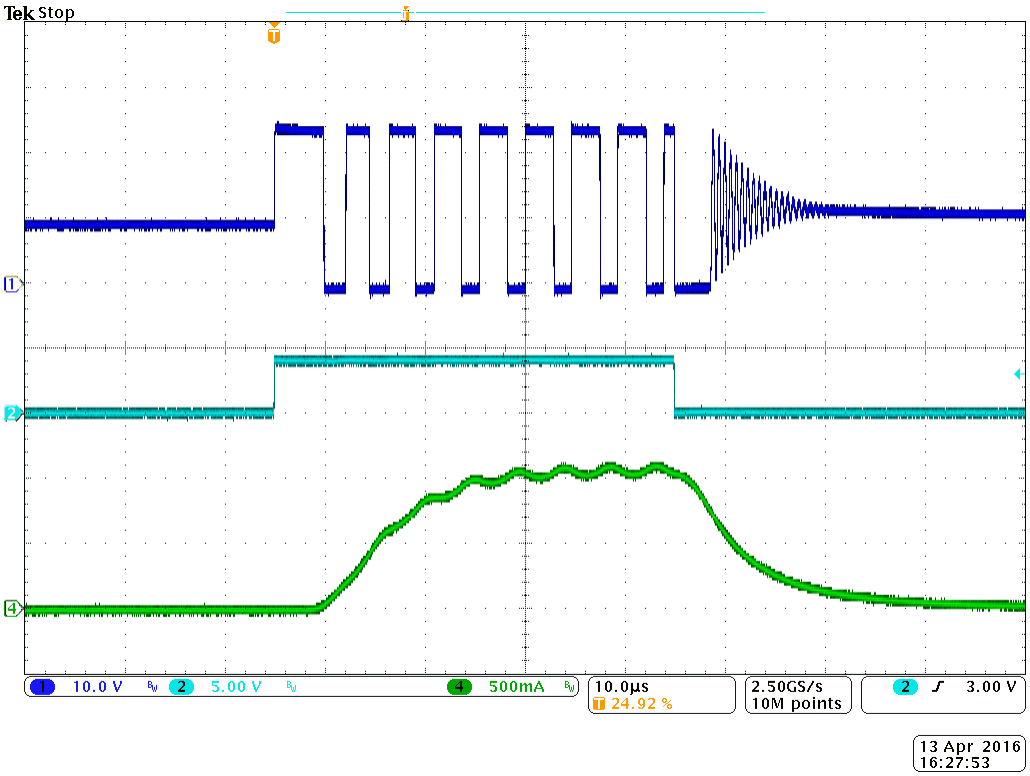

Figure 8. 1% Duty Cycle, 250 Hz PWM Dimming
Top = V_{SW}, Middle = V_{PWM}, Bottom = LED Current, Input Voltage = 24 V, 4 LEDs

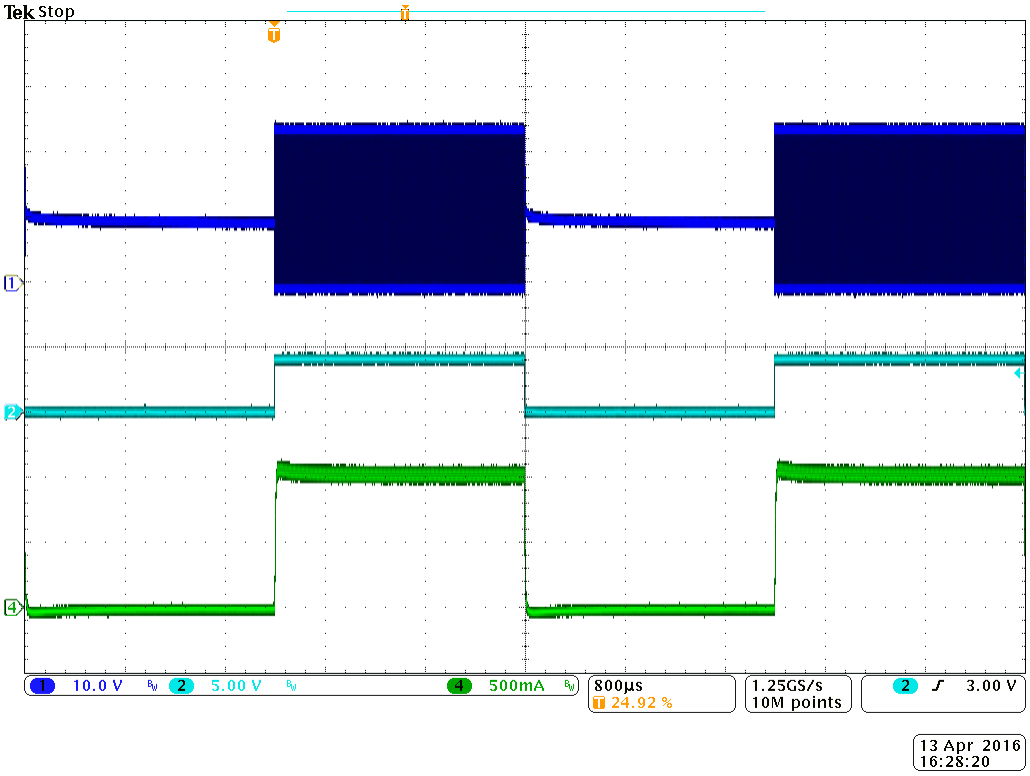

Figure 9. 50% Duty Cycle, 250 Hz PWM Dimming
Top = V_{SW}, Middle = V_{PWM}, Bottom = LED Current, Input Voltage = 24 V, 4 LEDs

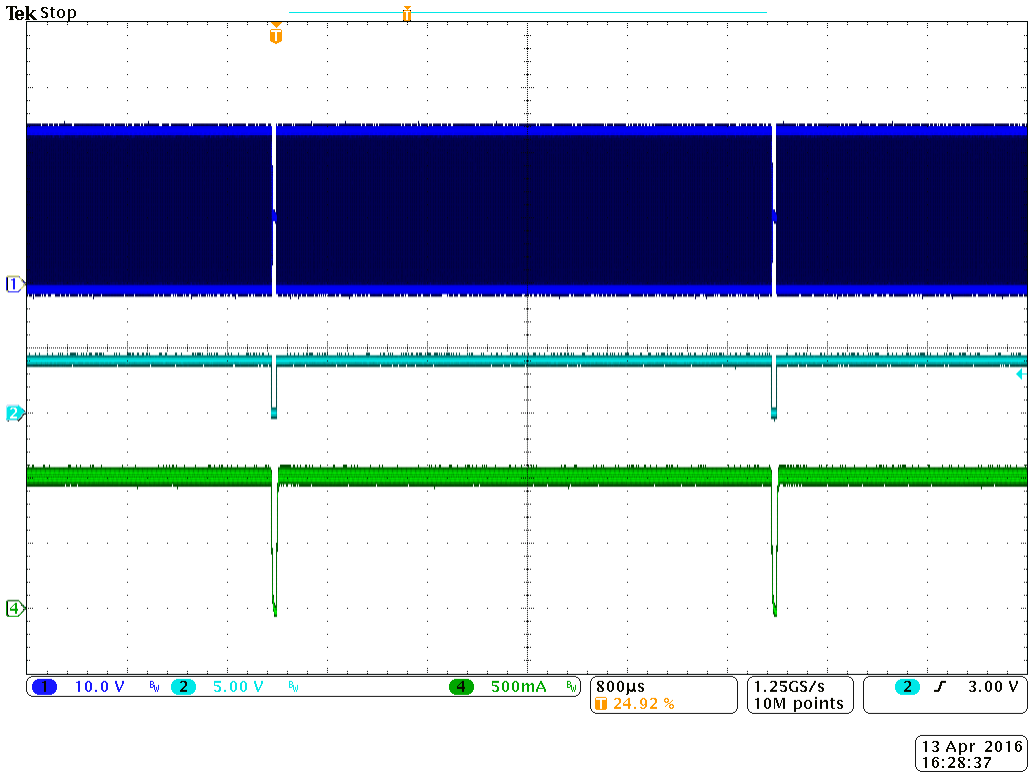

Figure 10. 99% Duty Cycle, 250 Hz PWM Dimming
Top = V_{SW}, Middle = V_{PWM}, Bottom = LED Current, Input Voltage = 24 V, 4 LEDs

7 TPS92515HVEVM-749 PCB Layout

Figure 11 and Figure 12 show the design of the TPS92515HVEVM-749 printed circuit board.

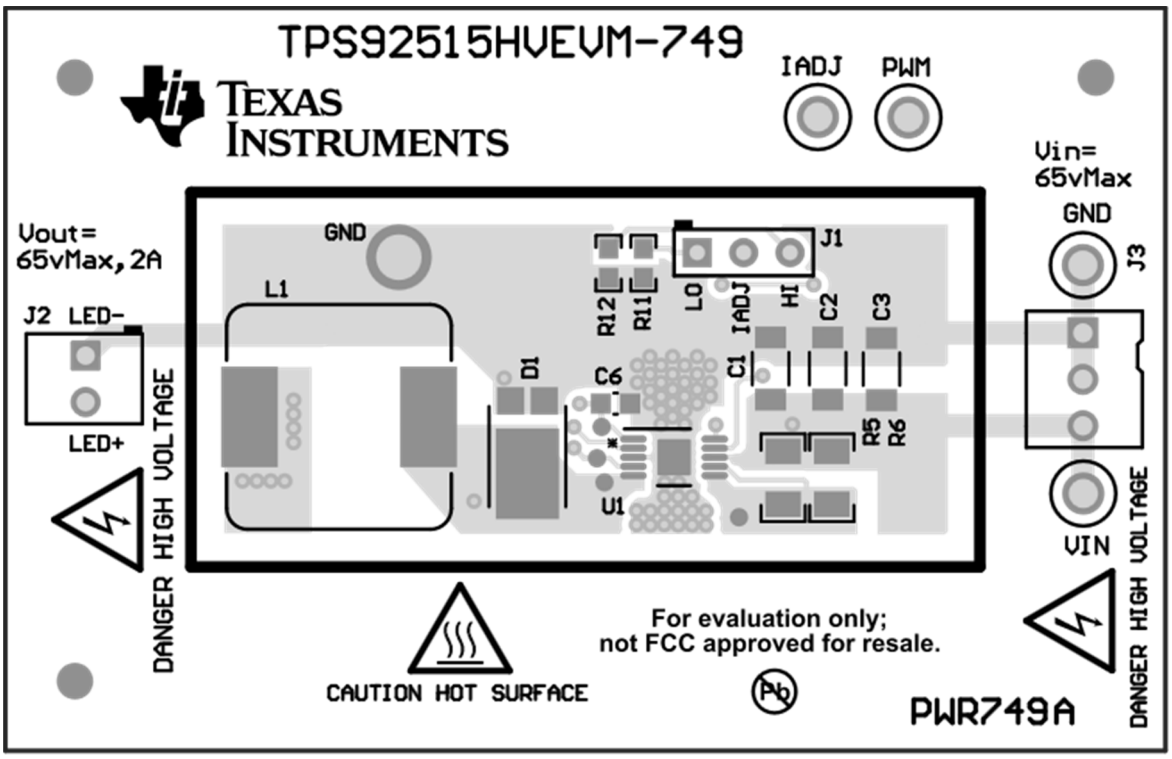

Figure 11. Top Layer and Top Overlay (Top View)

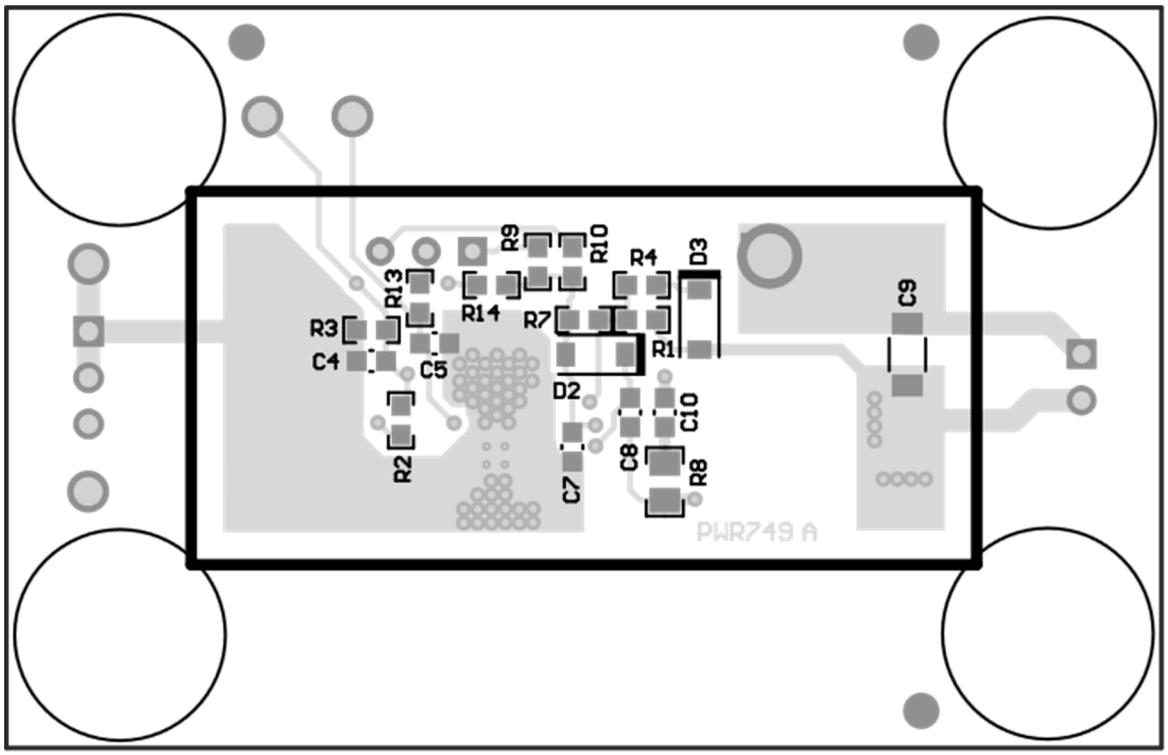

Figure 12. Bottom Layer and Bottom Overlay (Bottom View)

8 Bill of Materials

Table 2 contains the TPS92515HVEVM-749 components list according to the schematic shown in Figure 1.

Table 2. TPS92515HVEVM-749 Bill of Materials

Reference Designator	QTY	Value	Description	Size	Part Number	MFR
C1, C2, C3, C9	4	2.2uF	CAP, CERM, 2.2 µF, 100 V, +/- 20%, X7S	1206	CGA5L3X7S2A225M160AB	TDK
C5, C8	2	0.1uF	CAP, CERM, 0.1 µF, 16 V, +/- 10%, X7R	0603	GCM188R71C104KA37J	Murata
C6	1	470pF	CAP, CERM, 470 pF, 50 V, +/- 5%, C0G/NP0	0603	GCM1885C1H471JA16D	Murata
C7	1	1uF	CAP, CERM, 1 µF, 16 V, +/- 10%, X7R	0603	GCM188R71C105KA64D	Murata
D1	1	100V	Diode, Schottky, 100 V, 3 A, AEC-Q101, PowerDI5	PowerDI5	PDS3100Q-13	Diodes Inc.
D2	1	100V	Diode, Switching, 100 V, 0.2 A, SOD-123	SOD-123	MMSD4148T1G	ON Semiconductor
L1	1	47uH	Inductor, Wirewound, Ferrite, 47 µH, 2.3 A, 0.064 ohm, AEC-Q200 Grade 1	SMD, 2-Leads, Body 12x12mm	784771470	Wurth Elektronik
L1	Alt	47uH	AECQ MBH12575C	SMD, 2-Leads, Body 12x12mm	MBH12575C-470MA	Toko
R1	1	48.7k	RES, 48.7 k, 1%, 0.1 W	0603	CRCW060348K7FKEA	Vishay-Dale
R5	1	0.165	RES, 0.165, 1%, 0.25 W	1206	PT1206FR-070R165L	Yageo America
R6	1	0.3	RES, 0.3, 1%, 0.5 W	1206	CSR1206FKR300	Stackpole Electronics Inc
R9, R10	2	100k	RES, 100 k, 1%, 0.1 W	0603	CRCW0603100KFKEA	Vishay-Dale
R11	1	38.3k	RES, 38.3 k, 1%, 0.1 W	0603	CRCW060338K3FKEA	Vishay-Dale
R12	1	61.9k	RES, 61.9 k, 1%, 0.1 W	0603	CRCW060361K9FKEA	Vishay-Dale
R13, R14	2	0	RES, 0, 5%, 0.1 W	0603	CRCW06030000Z0EA	Vishay-Dale
U1	1		2A, 65V, Automotive Buck LED Driver with Integrated N-FET	DGQ0010A	TPS92515HV-Q1	Texas Instruments

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      This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

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      This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

      Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *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.*

3.2 *Canada*

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

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

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Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

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Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

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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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4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

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4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

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