Using the TPS92001EVM-645

User's Guide

Literature Number: SLUU510
August 2011

Non-Dimmable LED Lighting Driver Controller

1 Introduction

The TPS92001EVM-645 evaluation module is a constant-current, non-dimmable LED driver. It is designed to drive 9 LEDs at 330 mA and is rated for an AC input of 105 V_{RMS} to 135 V_{RMS}.

2 Description

The TPS92001/2 family of general LED lighting PWM controllers contains control and drive circuitry required for off-line isolated or non-isolated LED lighting applications. The TPS92001EVM-645 evaluation module uses the TPS92001 as a non-isolated buck controller; more specifically it is an inverting buck topology. The controller operates in fixed-frequency, current-mode switching with minimal external parts count. In LED illumination applications there is typically no need for the LED load to be referenced to ground. This utilizes the inverted buck which moves the controller and FET to the low side of the circuit, referenced to the lowest voltage, while the LED load is floated (referenced to the highest voltage). With an appropriately designed bias regulator for the controller, we can now use a much lower voltage controller which is more economical.

2.1 Typical Applications

- Commercial/Household LED lighting

2.2 Features

- Non-Dimmable, Non-Isolated LED Driver with Minimum External Part Count
- Wide Duty Cycle Range for Wide-Input Voltage
- Convenient 5-V Reference Output
- Test Points for Output Voltage/Current

3 Electrical Performance Specifications

Table 1. TPS92001EVM-645 EVM-001 Electrical Performance Specifications

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Input Characteristics					
Voltage range		105	120	135	V
Maximum input current			115		mA
Output Characteristics					
Output voltage, V_{OUT}		26	30	34	V
Output load current, I_{OUT}		290	330	370	mA
Output current ripple	V_{IN} = 120 V_{AC}		280		mApp
Output over Voltage			36		V
Systems Characteristics					
Switching frequency			133		kHz
Full load efficiency	V_{IN} = 120 V_{AC}		88%		
Power factor			0.87		

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4 Schematic

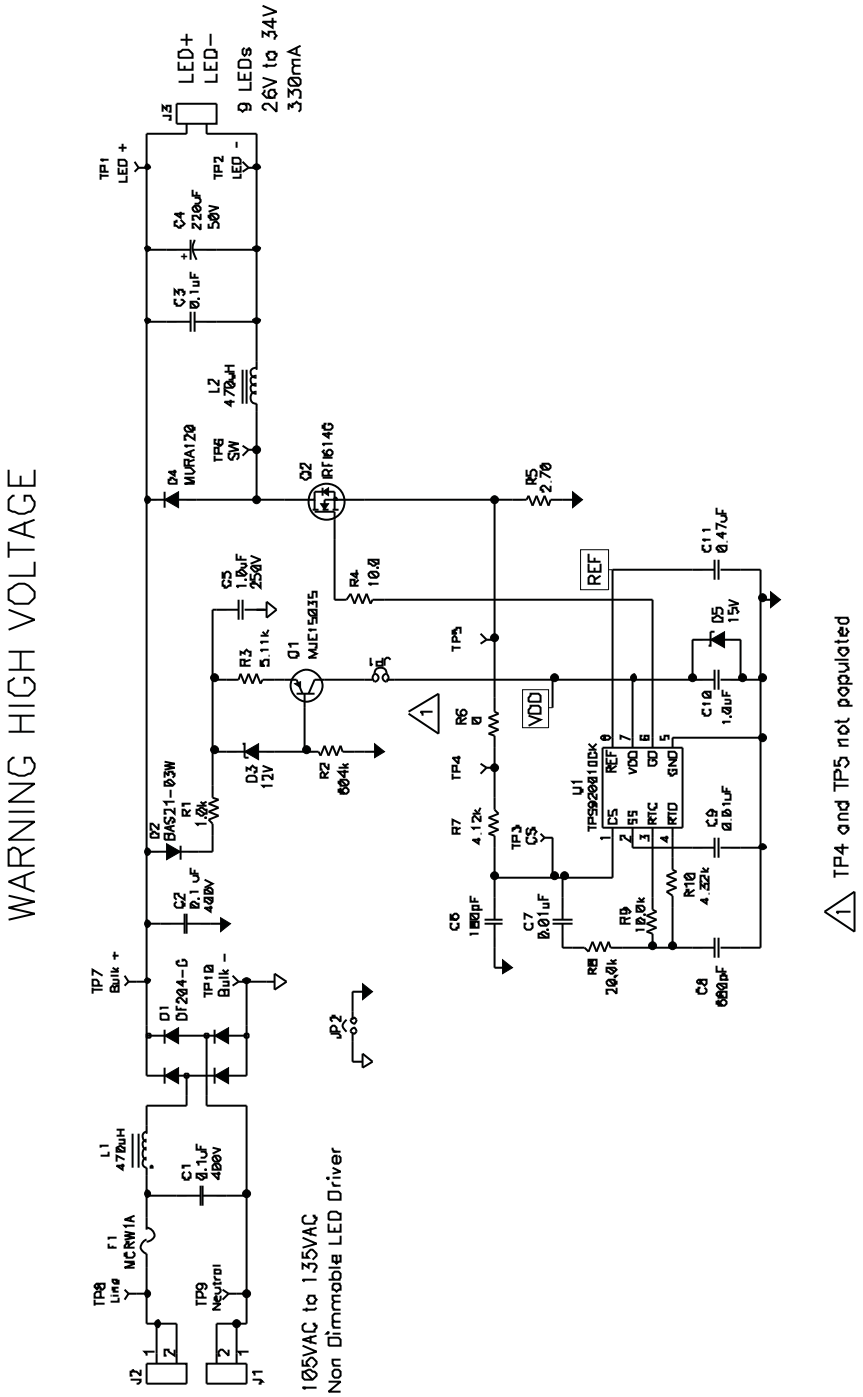

Figure 1. TPS92001EVM-645 Schematic

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5 Test Setup

WARNING

High voltages that may cause injury exist on this evaluation module (EVM). Please ensure all safety procedures are followed when working on this EVM. Never leave a powered EVM unattended. The use of isolated equipment is highly recommended.

5.1 Test Equipment

Voltage Source: 105 V_{RMS} to 135 V_{RMS} isolated AC source capable of at least 20 W.

Multimeters: Two Voltmeters for measuring up to 35 V_{DC} each and two ammeters for up to 1 A each.

Output Load: 9 LEDs in series (V_F = 3.4 V at 350 mA per LED)

Oscilloscope: 4 channel 100 MHz with high voltage probe rated for at least 600 V.

Recommended Wire Gauge: 18 AWG not more than two feet long.

5.2 TPS92001EVM-645 Recommended Test Setup

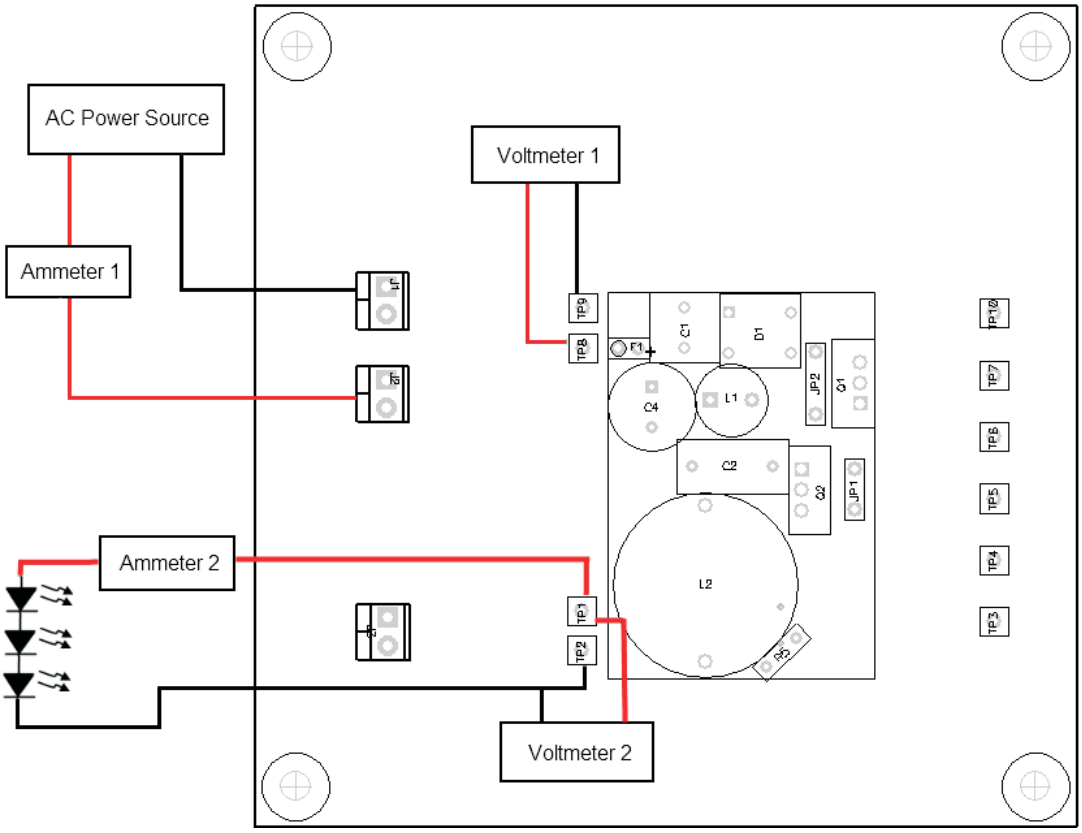

Figure 2. Recommended Test Set Up

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5.3 List of Test Points

Table 2. Test Point Functions

TEST POINTS	NAME	DESCRIPTION
TP1	LED +	LED output
TP2	LED -	LED return point
TP3	CS	Feedback pin of TPS92001
TP6	SW	Buck switch node
TP7	Bulk +	Rectified AC positive input
TP8	Line	AC line input
TP9	Neutral	AC neutral input
TP10	Bulk -	Rectified AC negative input

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6 Test Procedure

All tests should use the set up described in Section 5 of this user guide.

WARNING

High voltage levels are present on this evaluation module whenever it is energized. Proper precautions must be observed whenever working with this module. Serious injury can occur if proper safety procedures are not followed.

6.1 Line/Load Regulation and Efficiency Measurement Procedure

1. Connect EVM per Figure 2 above. An external LED load must be used to start up the EVM.
2. Prior to turning on the AC source, set the voltage to 105 V_{RMS}.
3. Turn on the AC source.
4. Record the output voltage and current readings from Voltmeter 2 and output current reading from Ammeter 2 and input voltage reading from Voltmeter 1 and Ammeter 1.
5. Increase output voltage by 5 V_{RMS}
6. Repeat steps 4 and 5 until you reach 135 V_{RMS}
7. Refer to Section 6.2 for shutdown procedure.

6.2 Equipment Shutdown

1. Turn off the AC source.
2. Make sure that output capacitors are fully discharged.

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7 Performance Data and Typical Characteristic Curves

Figure 3 through 12 present typical performance curves for TPS92001EVM-645.

7.1 Efficiency

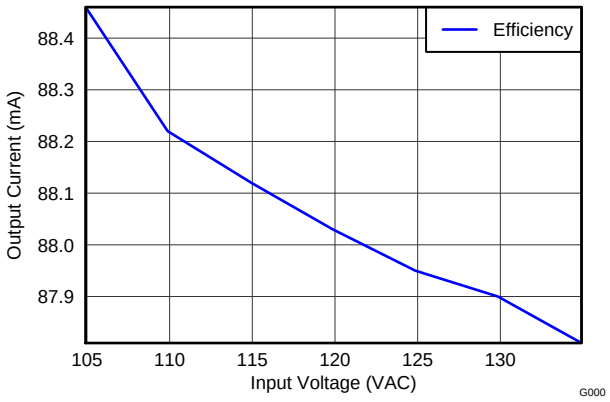

Figure 3. Efficiency

7.2 Input Voltage vs. Power Factor

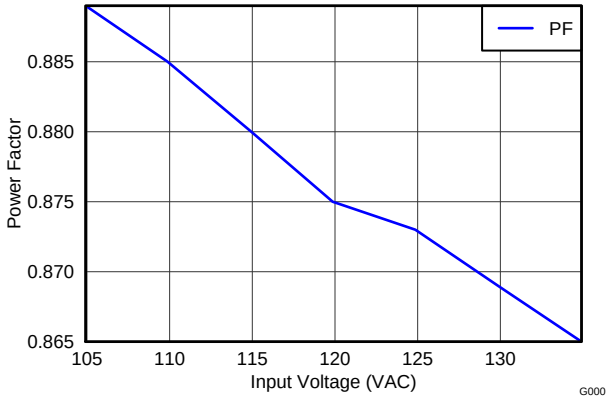

Figure 4. PF Variation

7.3 Input Voltage vs. Output Current

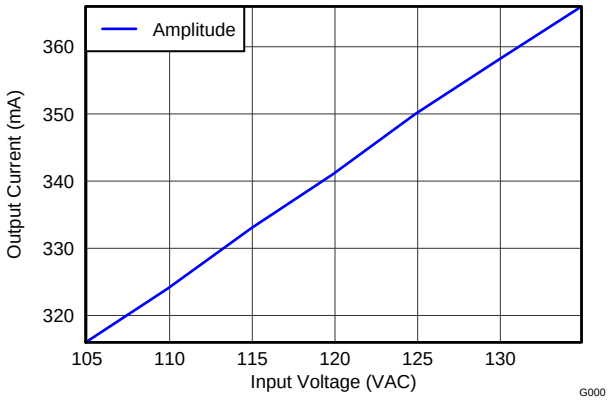

Figure 5. Output Current variation with Respect to Input Voltage

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7.4 Output Ripple

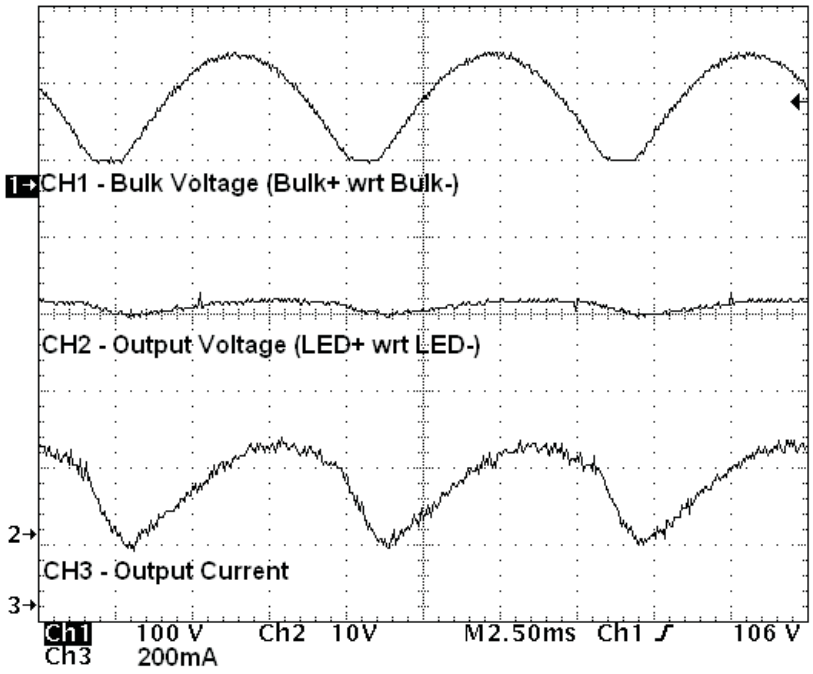

Figure 6. Output Ripple

7.5 Input Waveforms

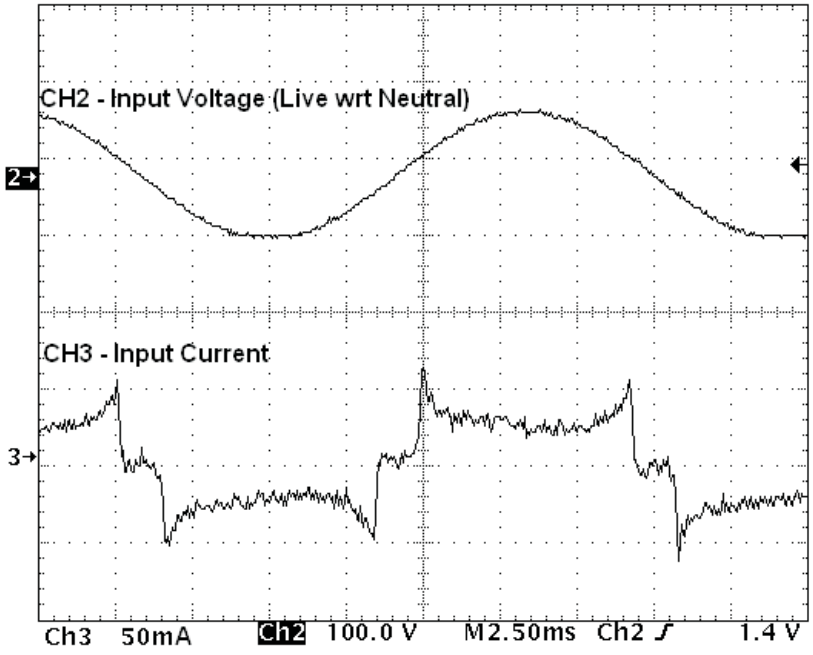

Figure 7. Input Waveform

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7.6 Clock Signal and Switch Node Voltage

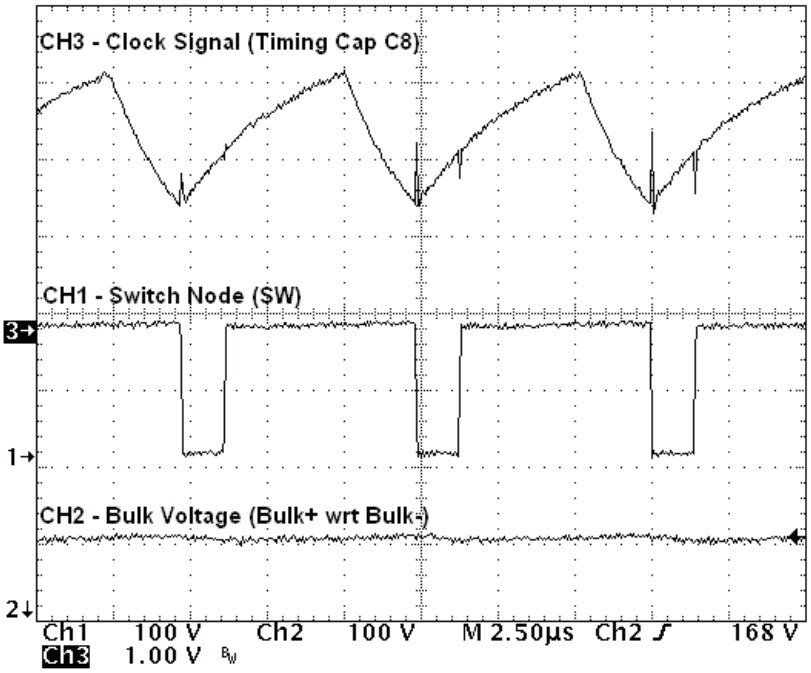

Figure 8. Clock Signal and Switching Node Waveform

7.7 Current Sense

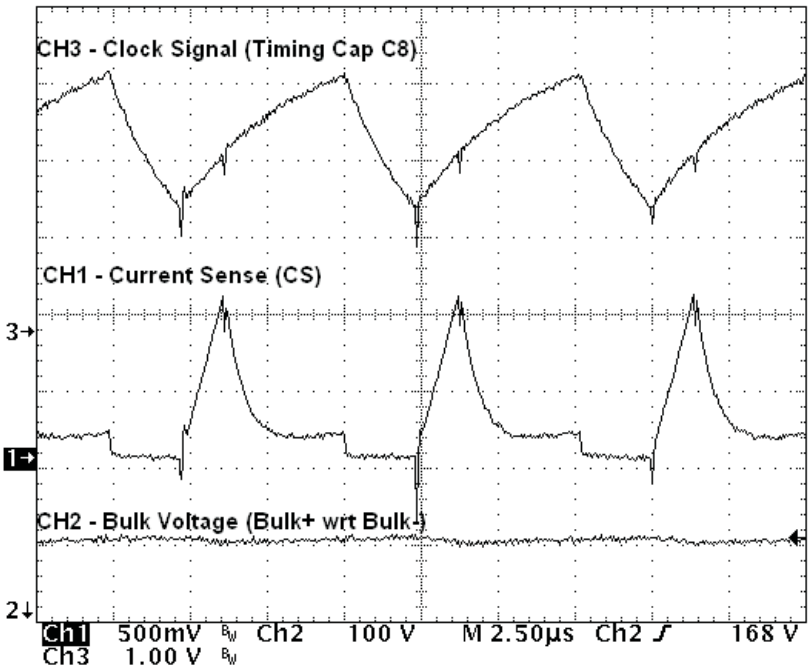

Figure 9. Clock Signal and Current Sense Waveform

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7.8 Turn-On Waveform

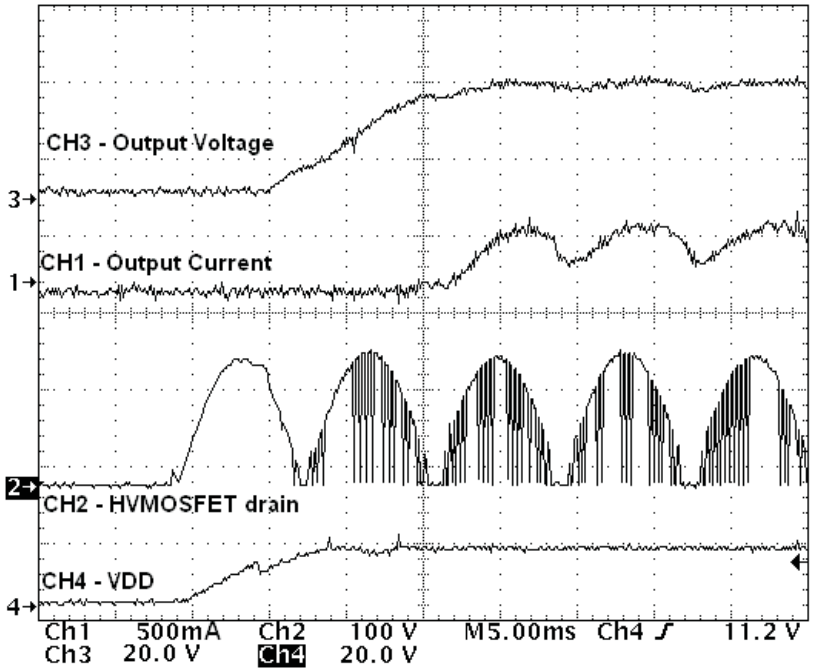

Figure 10. Enable Turn On Waveforms

7.9 Turn-Off Waveform

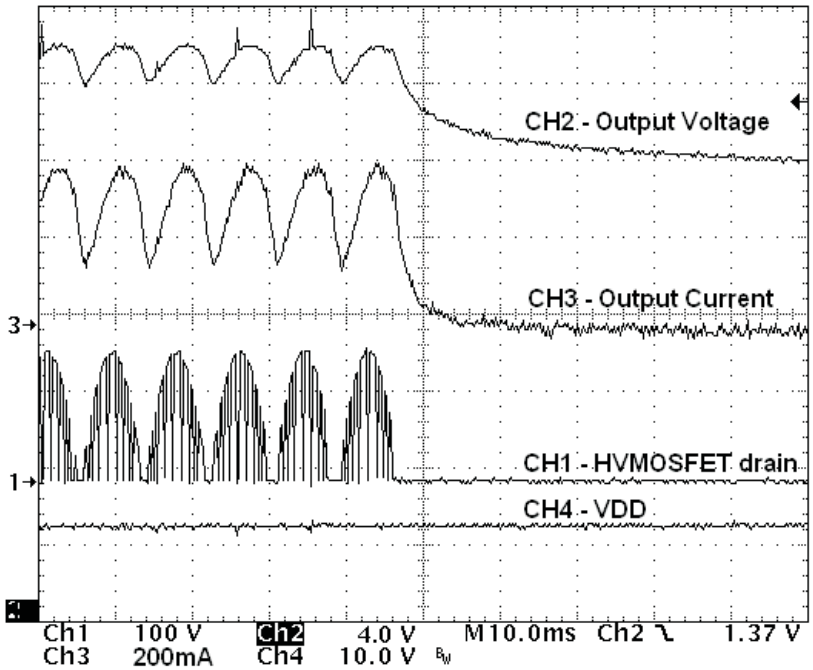

Figure 11. Enable Turn Off Waveforms

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8 TPS92001EVM-645 EVM Assembly Drawing and PCB layout

The following figures (Figure 12 through Figure 14) show the design of the TPS92001EVM-645 printed circuit board.

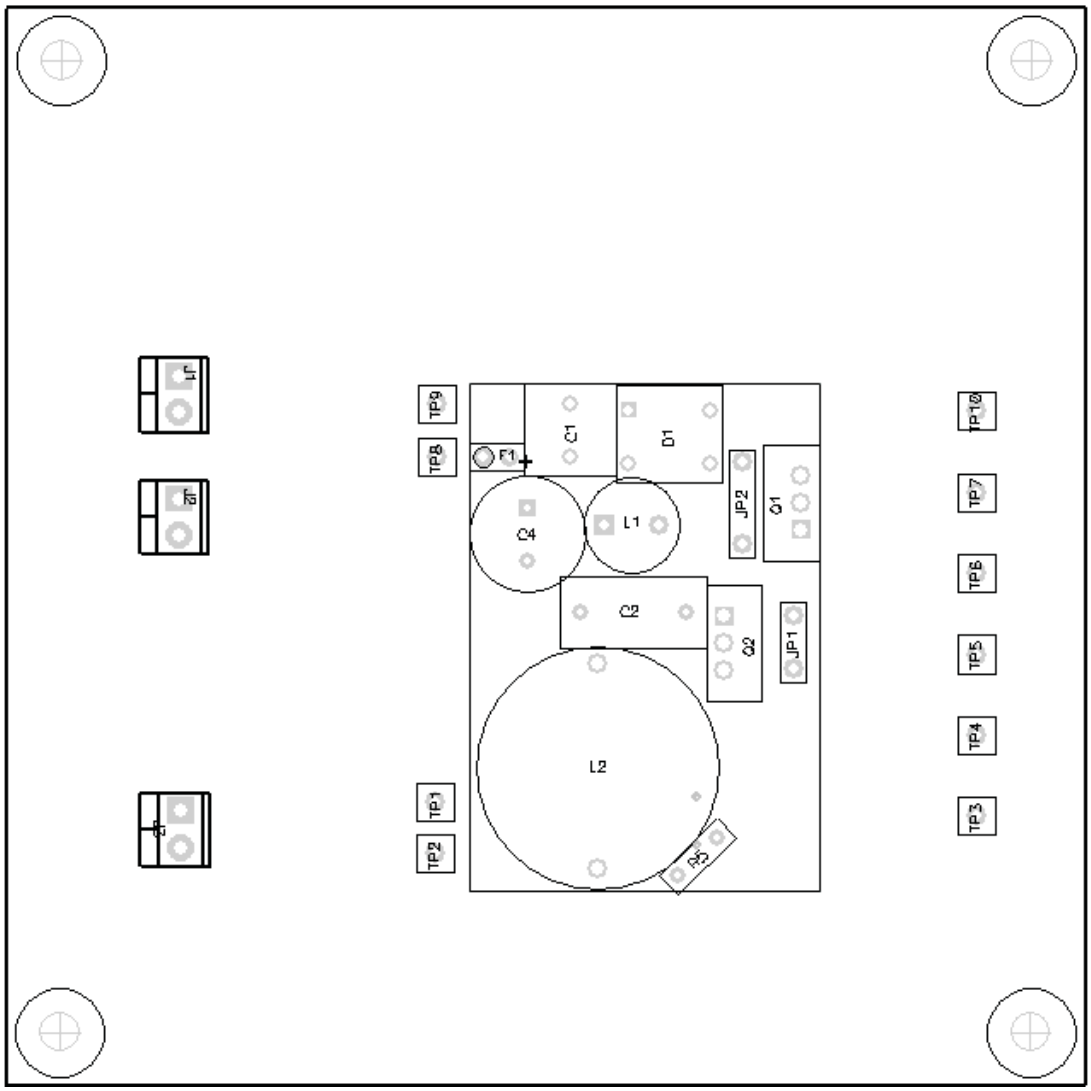

Figure 12. Top Layer Assembly Drawing (top view)

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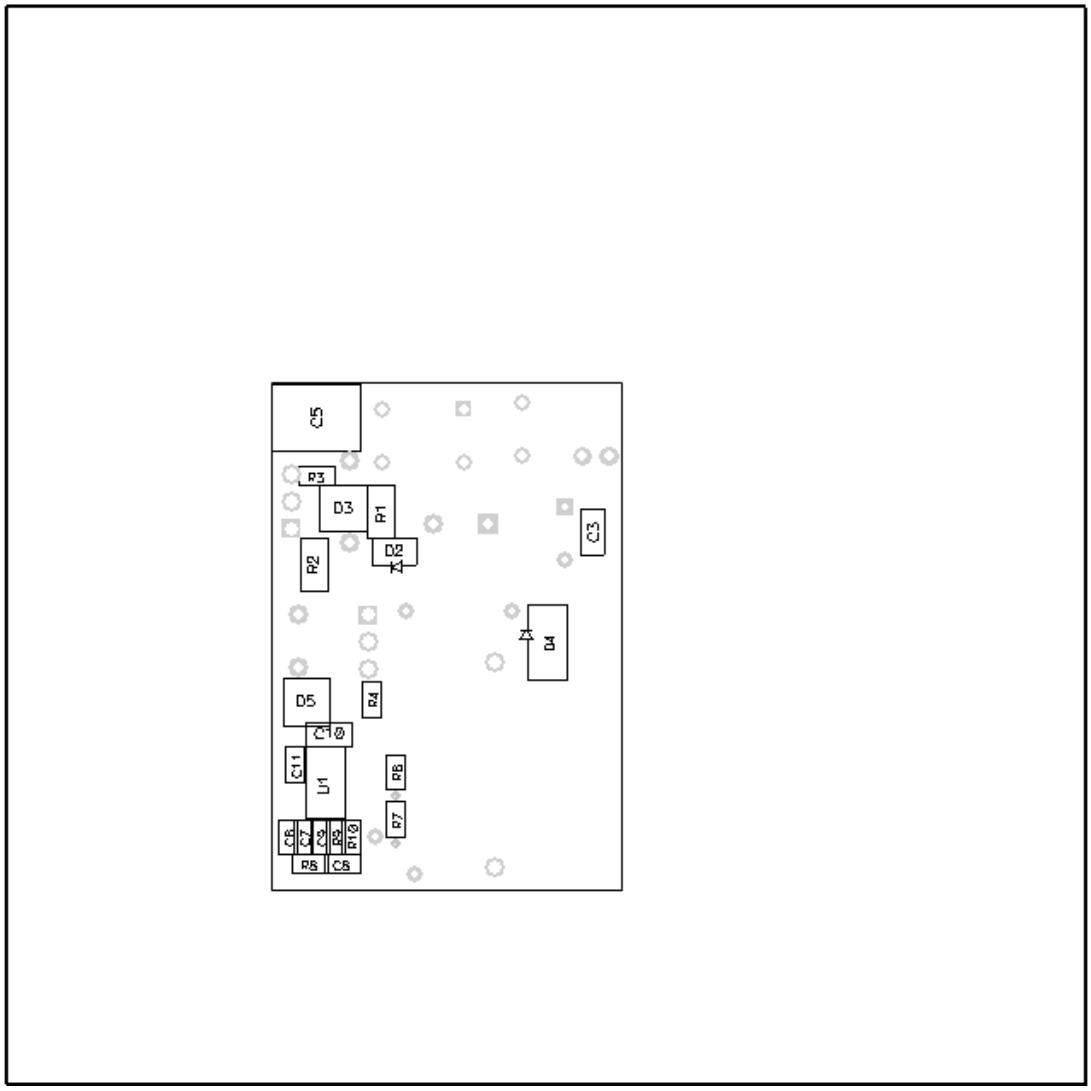

Figure 13. Bottom Assembly Drawing (bottom view)

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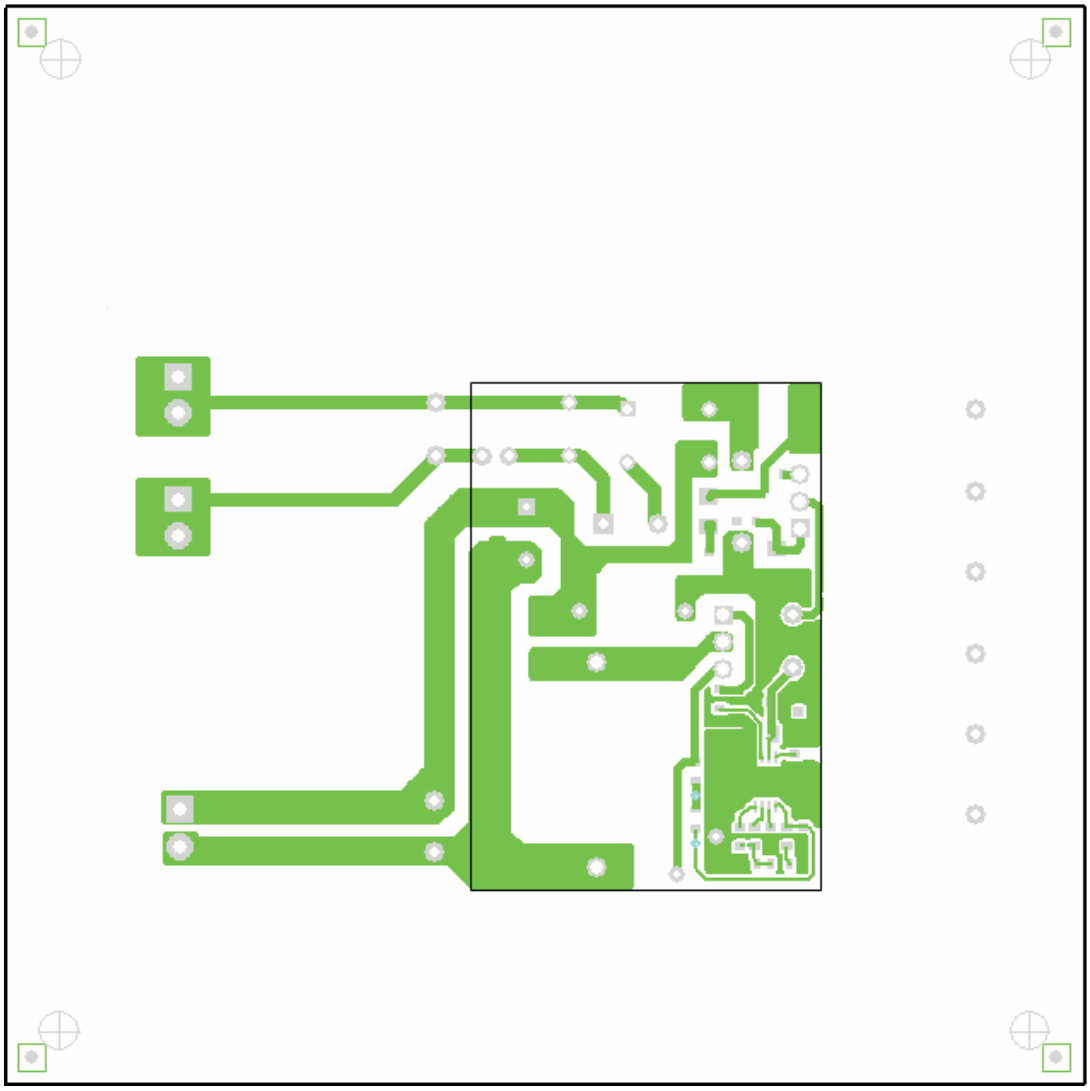

Figure 14. Bottom Copper (top view)

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9 List of Materials

The EVM components list according to the schematic shown in Figure 1.

Table 3. TPS92001EVM-645 List of Materials

QTY	REF DES	DESCRIPTION	PART NUMBER	MFR
1	C1	Capacitor, leaded, metalized film, 400 VDC, 125°C, 20 ±%, 0.1 µF, 0.310 inch x 0.310 inch	B32529D6104M	Epcos
1	C10	Capacitor, ceramic, 25 V, X7R, 10%, 1.0 µF, 0805	Std	Std
1	C11	Capacitor, ceramic, 10 V, X7R, 10%, 0.47 µF, 0603	Std	Std
1	C2	Capacitor, poly film, 200 VAC, ±20%, 0.1 µF, 6.00 mm x 13.00 mm	B32521C6104J	Epcos
1	C3	Capacitor, ceramic, 100 V, X7R, 10%, 0.1 µF, 0805	std	Std
1	C4	CAP, aluminum elec, 220 µF, 50 V, radial, 5000 hrs at 105°C, 850-mA ripple, 10 mm x 16 mm	UPW1H221MPD	Rubycon/Nichicon
1	C5	Capacitor, ceramic, 250 V, X7R, 20%, 1.0 µF, 2220	"C5750X7R2E105M orGRM55DR72E105K W01L"	"TDK or Murata"
1	C6	Capacitor, ceramic, 50 V, X7R, 10%, 180 pF, 0603	Std	Std
2	C7, C9	Capacitor, ceramic, 25 V, X7R, 10%, 0.01 µF, 0603	Std	Std
1	C8	Capacitor, ceramic, 50 V, X7R, 10%, 680 pF, 0603	Std	Std
1	D1	Diode, bridge, 2.0 A, 400 V, 4 EDIP	DF204-G	Comchip
1	D2	Diode, high-speed switching, 250 mA, 200 V, SOD-323	BAS21-03W	Infineon
1	D3	Diode, Zener, 12 V, 20 mA, 225 mW, 5%, 12 V, SOT23	MMBZ5242BLT1	Motorola
1	D4	Rectifier, ultrafast power, 200 V, 1 A, 403D	MURA120T3G	On Semi
1	D5	Diode, Zener, 15 V, 20 mA, 225 mW, 5%, 15 V, SOT23	MMBZ5245BLT1	Motorola
1	F1	1-A fuse, subminiature fast acting, 0.125 diameter	MCRW1A	Bussmann
1	JP1	Jumper, 0.200 inch length, PVC insulation, AWG 22, 0.035 inch diameter	923345-02-C	3M
1	JP2	Jumper, 0.300 inch length, PVC insulation, AWG 22	923345-03-C	3M
1	L1	Inductor, radial, 470 µH, 310 mA, 10%, 70°C, 470 µH, 0.315 inch diameter	22R474C	Murata
1	L2	Inductor toroid 470 µH, 15%, horizontal, 470 µH, 0.860 inch x 0.450 inch	2100LL-471-H-RC	Bourns
1	Q1	Transistor, power bipolar PNP, 350 V, 4 A, TO-220	MJE15035G	On Semi
1	Q2	Transistor, NFET, 250 V, 2.1 A, 2 Ω, TO-220	IRFI614GPBF	Vishay
1	R1	Resistor, 1/4 W, ± 5%, 1.0 kΩ, 1206	Std	Std
1	R10	Resistor, chip, 1/16 W, 1%, 4.32 kΩ, 0603	Std	Std
1	R2	Resistor, 1/4 W, ± 5%, 604 kΩ, 1206	Std	Std
1	R3	Resistor, chip, 1/16 W, 1%, 5.11 kΩ, 0603	Std	Std
1	R4	Resistor, chip, 1/16 W, 1%, 10 Ω, 0603	Std	Std
1	R5	Resistor, SM, 3/4 W, 1%, 2.7 Ω, 2010	Std	Std
1	R6	Resistor, chip, 1/16 W, 5%, 0 Ω, 0603	Std	Std
1	R7	Resistor, chip, 1/16 W, 1%, 4.12 kΩ, 0603	Std	Std
1	R8	Resistor, chip, 1/16 W, 1%, 20.0 kΩ, 0603	Std	Std
1	R9	Resistor, chip, 1/16 W, 1%, 10.0 kΩ, 0603	Std	Std
1	U1	G.P LED Lighting PWM Controller, MSOP-8	TPS92001DGK	TI
1	--	PCB, 4 inch x 4 inch x 0.062 inch	HPA645	Any

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EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 105 V to 135 V and the output voltage range of 26 V to 34 V .

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than 50° C. The EVM is designed to operate properly with certain components above 50° C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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