PMP6017
TPS92074
120Vac Single Stage Non-Dimmable 50W LED Driver Reference Design

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1 Introduction

This TPS92074 reference design presents the TPS92074 controller driving a 47V string of LEDs at 1A in a buck configuration. It is a single stage and non-dimmable reference design.

2 Description

This reference design provides a high-brightness LED driver based on the TPS92074. It is designed to operate with an input voltage in the range of 108VAC to 132VAC with a 120 VAC nominal input voltage. This design is set up for a 1A output current with an output voltage of 47. This design offers a power factor and low THD solution to the high power LED lighting applications.

2.1 Typical Applications

This converter design describes an application of the TPS92074 as an LED driver with the specifications listed below. For applications with a different output voltage or current range refer to the TPS92074 datasheet. This reference design is most suitable for high power LED such as streetlight and high bay.

2.2 Features

- High power factor: >0.98
- High efficiency: >0.89
- Low THD: <20%
- Low BOM count: ~34 components
- Suitable for high power LED lighting application

3 Electrical Performance Specifications

Table 1: TPS92074 120VacSingle Stage Non-Dimmable Buck Electrical Performance Specifications

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Input Characteristics					
Voltage range	Normal operation	108	120	132	VAC
Maximum input current	At 120VAC 60Hz input voltage		0.4		A
Output Characteristics					
Output voltage, VOUT			47		V
Output load current, IOUT	Input voltage = 120V 60Hz, Load = 47V LED		1000		mA
Output current accuracy	Input voltage = 120V 60Hz, Load = 47V LED		< ±2		%
Output current ripple	Input voltage = 120V 60Hz, Load = 47V LED		<600		mApp
Output current line regulation	Input voltage 108V to 132V 60Hz, Load = 47V LED		< ±2		%
Systems Characteristics					
Power Factor	Input voltage = 120V 60Hz, Load = 47V LED		>0.98		
Efficiency	Input voltage = 120V 60Hz, Load = 47V LED		>89		%
THD	Input voltage = 120V 60Hz, Load = 47V LED		<20		%

4 Schematic*

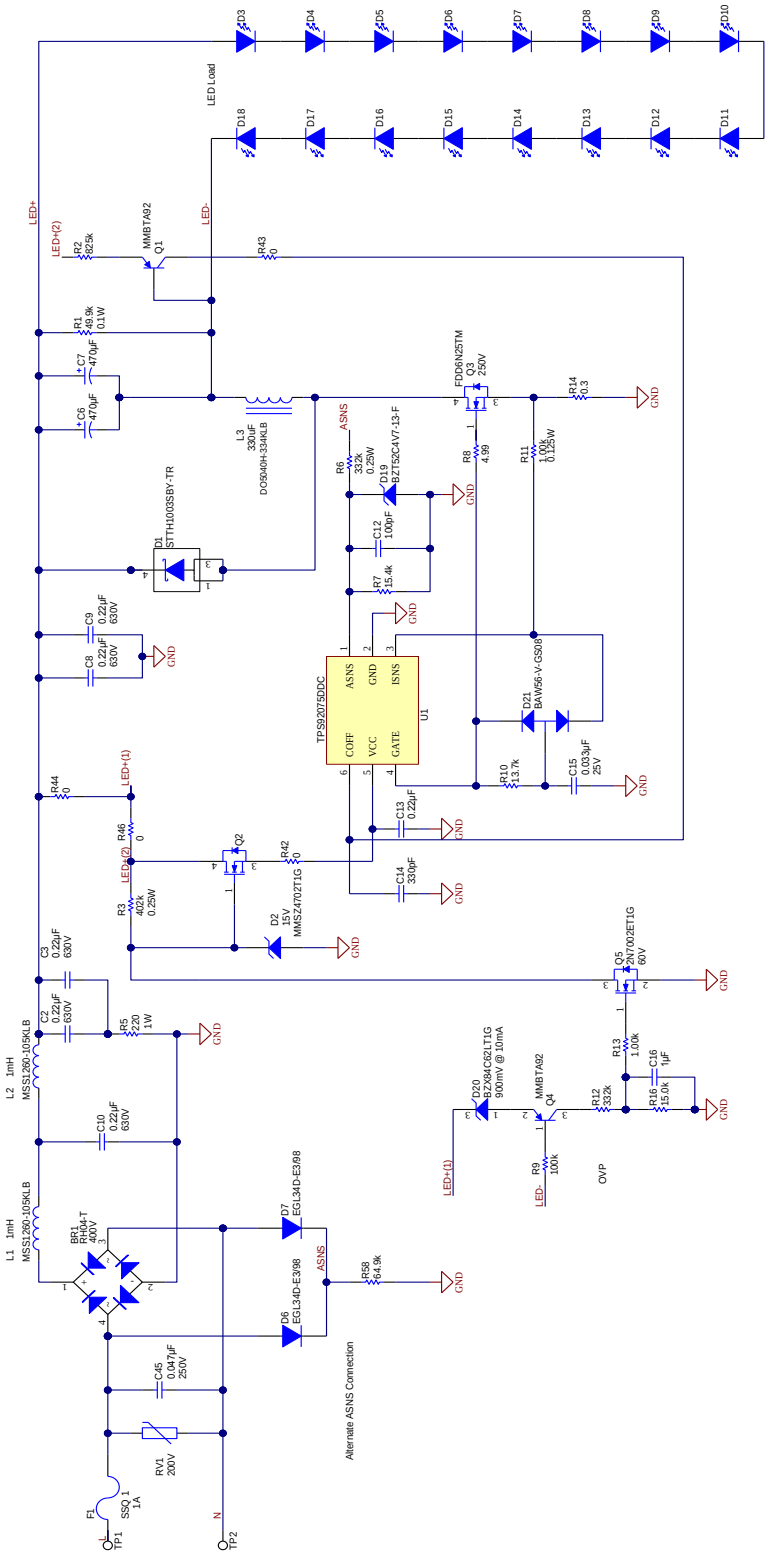

Figure 1: TPS92074 120Vac Single Stage Non-Dimmable 50W LED Driver Schematic

*The schematic may contain optional components. For detail components list and value, please refer to the BOM list on page 12.

5 Performance Data and Typical Characteristic Curves

Figures 2 through 12 and table 2 present typical performance of the TPS92074 120Vac Single Stage Non-Dimmable 50W LED Driver.

5.1 Efficiency

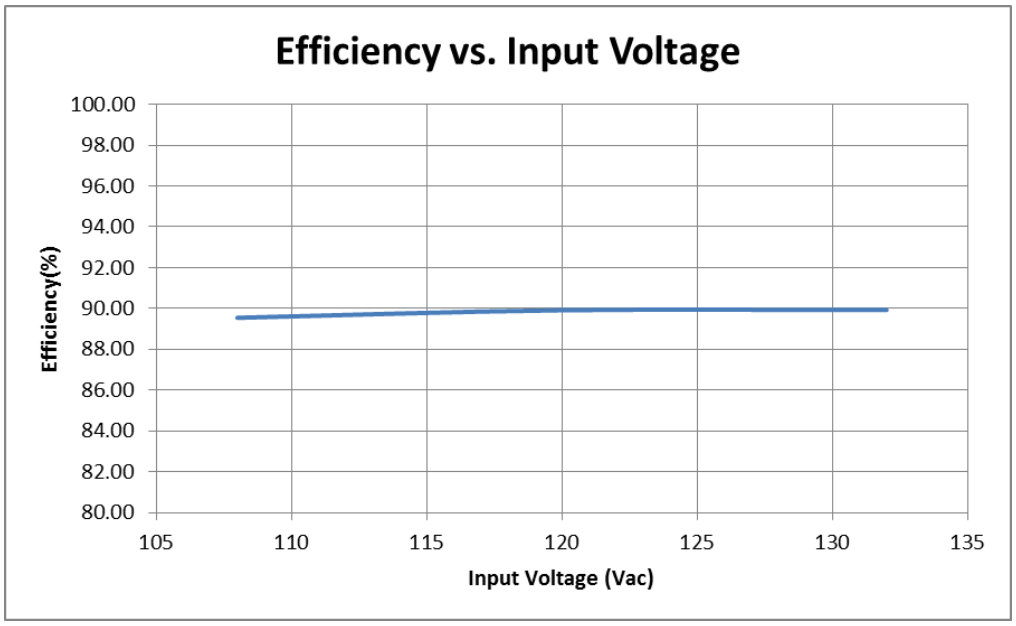

Figure 2: Efficiency with 47V LED stack

5.2 Current Regulation

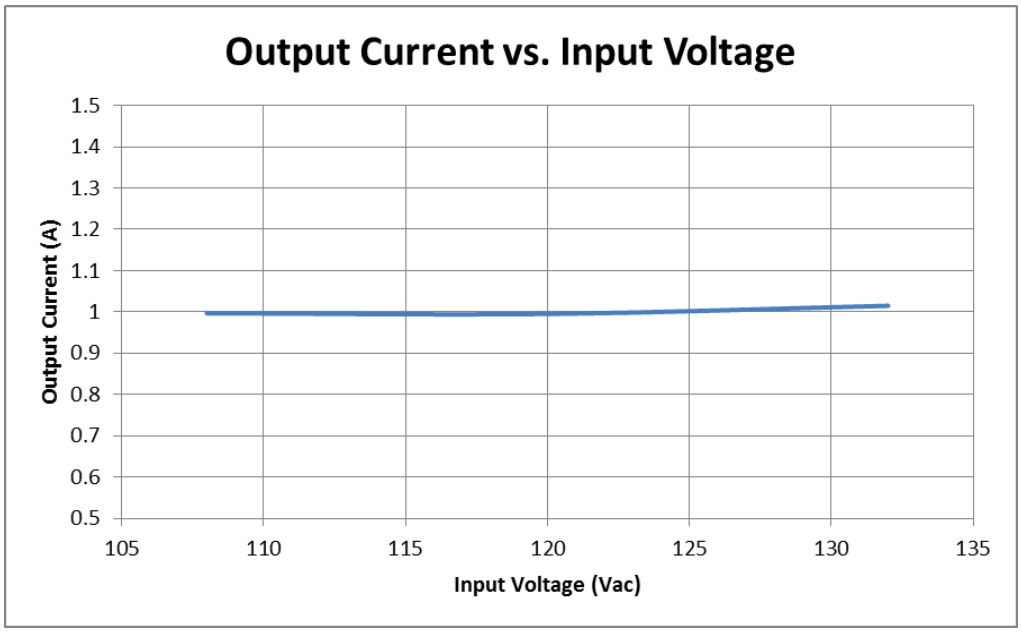

Figure 3: Output Current with 47V LED stack

5.3 Power Factor

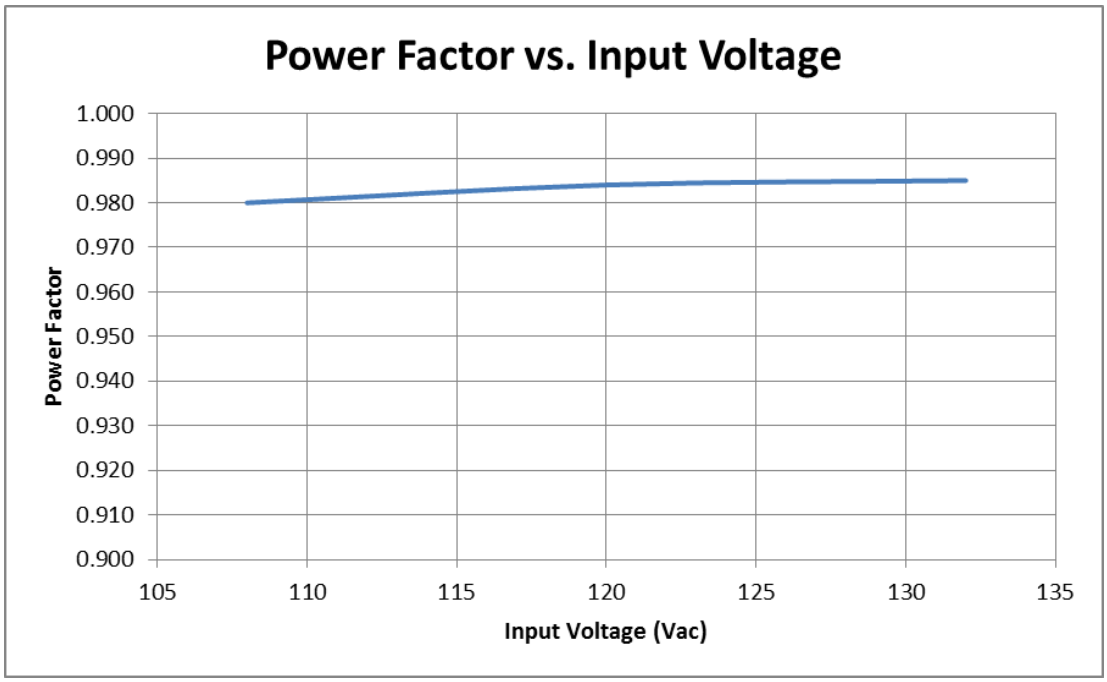

Figure 4: Power Factor 120Vac 60Hz input with 47V LED stack

5.4 THD

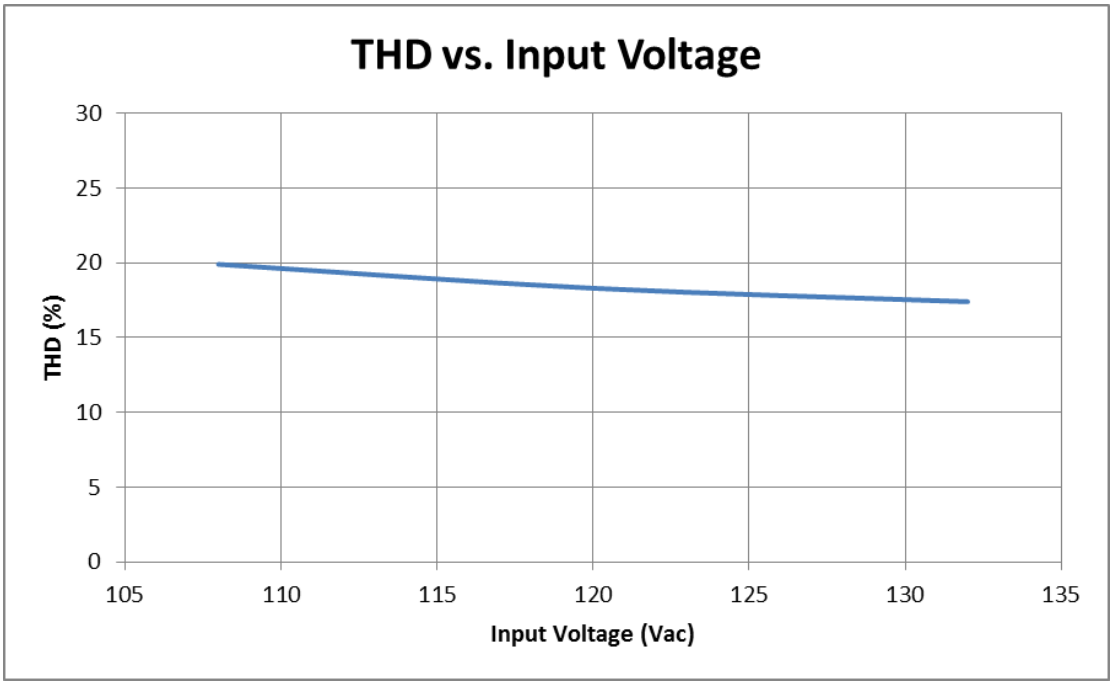

Figure 5: Total Harmonic Distortion 120Vac 60Hz input with 47V LED stack

5.5 Waveforms

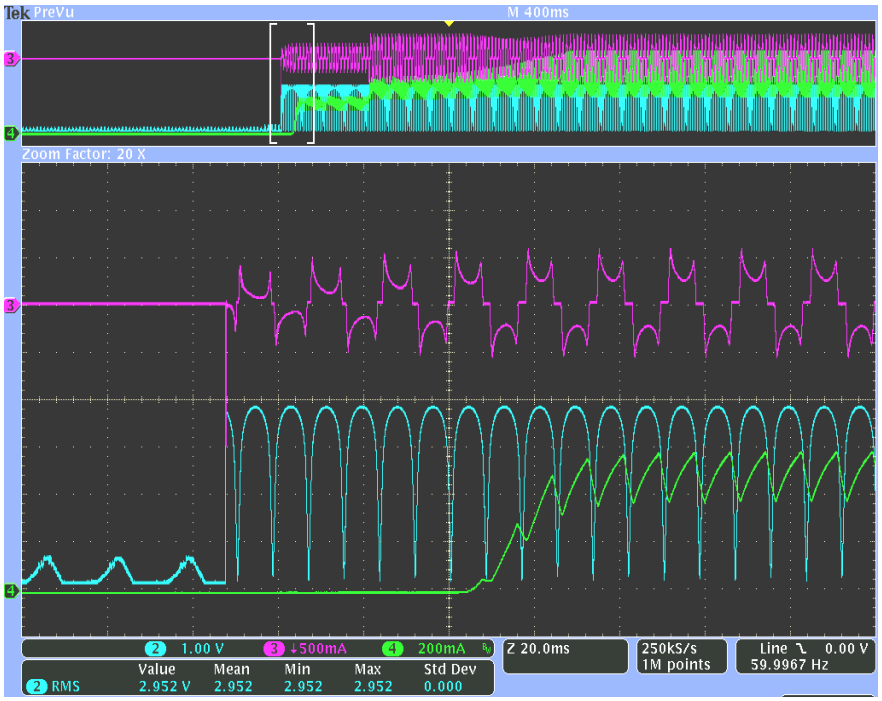

Figure 6: CH2: ASNS, CH3: Input Current, CH4: Output LED Current (Start-Up Ph1 – Line Sampling for PFC lock)

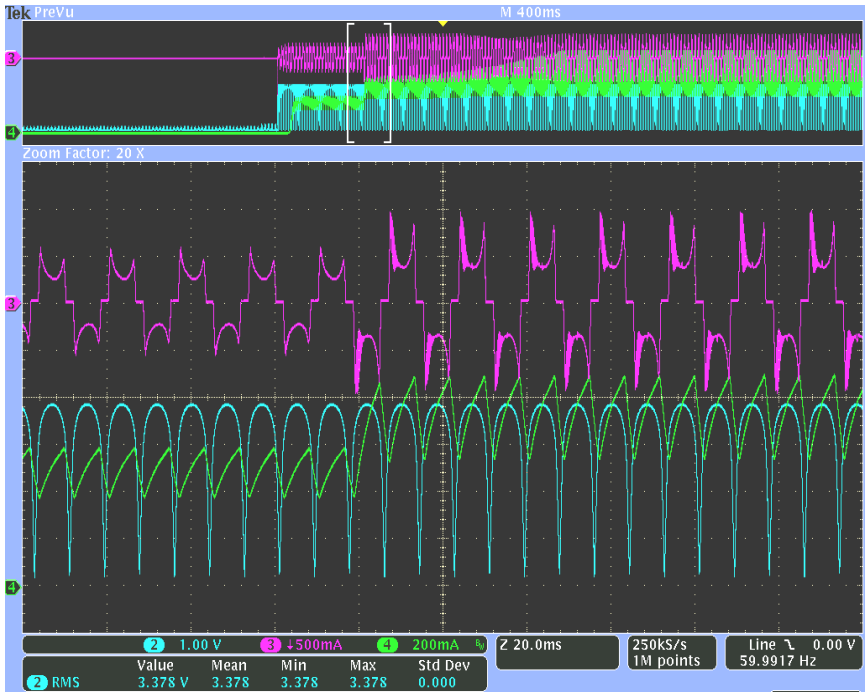

Figure 7: CH2: ASNS, CH3: Input Current, CH4: Output LED Current (Start-Up Ph2 – Line Frequency recognized, begin triangular ramp creation)

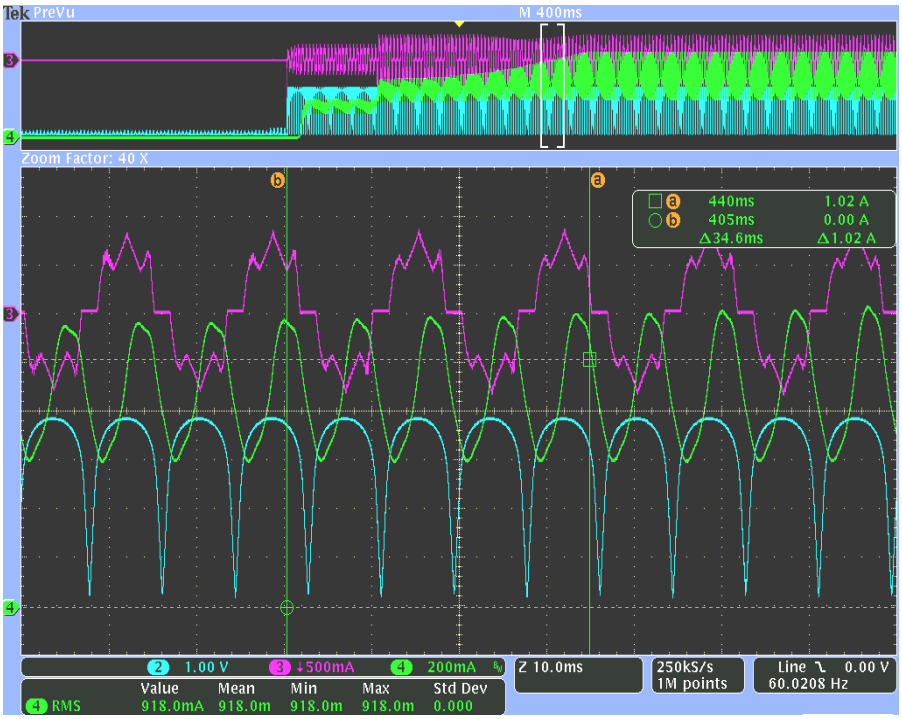

Figure 8: CH2: ASNS, CH3: Input Current, CH4: Output LED Current (Start-Up Ph3 – Ramp creation mode nearing completion)

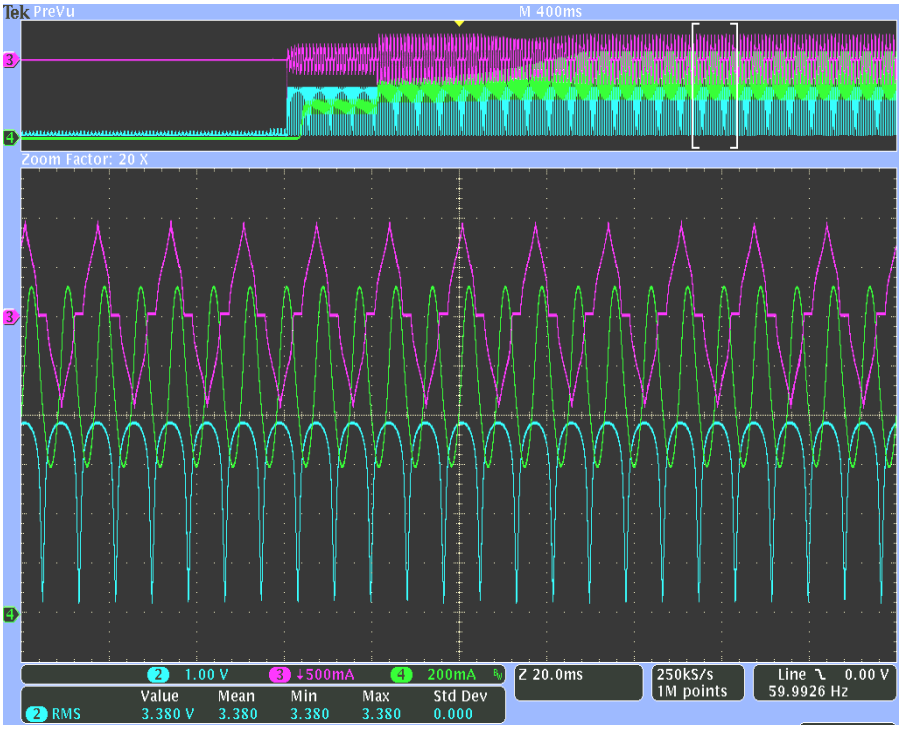

Figure 9: CH2: ASNS, CH3: Input Current, CH4: Output LED Current (Start-Up, Ph4 – Ramp synchronization is complete, digital control is locked to the line frequency)

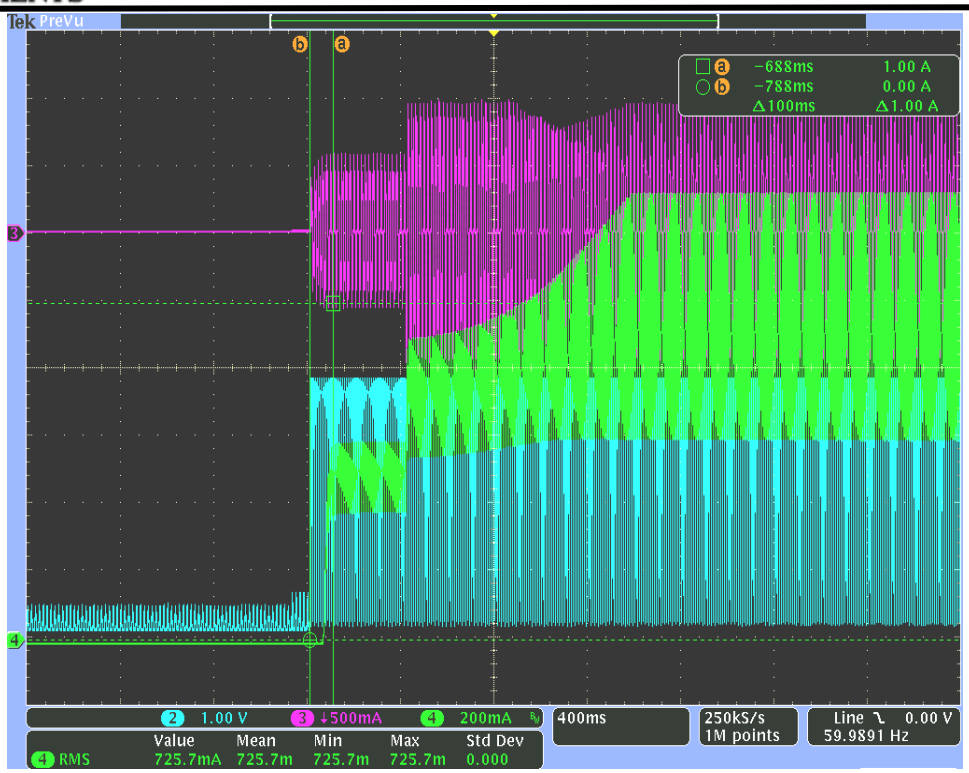

Figure 10: CH2: ASNS, CH3: Input Current, CH4: Output LED Current

Time to reach 500mA: 100ms (Start-up Delay), 750mA: 425ms, 1A: 1380ms

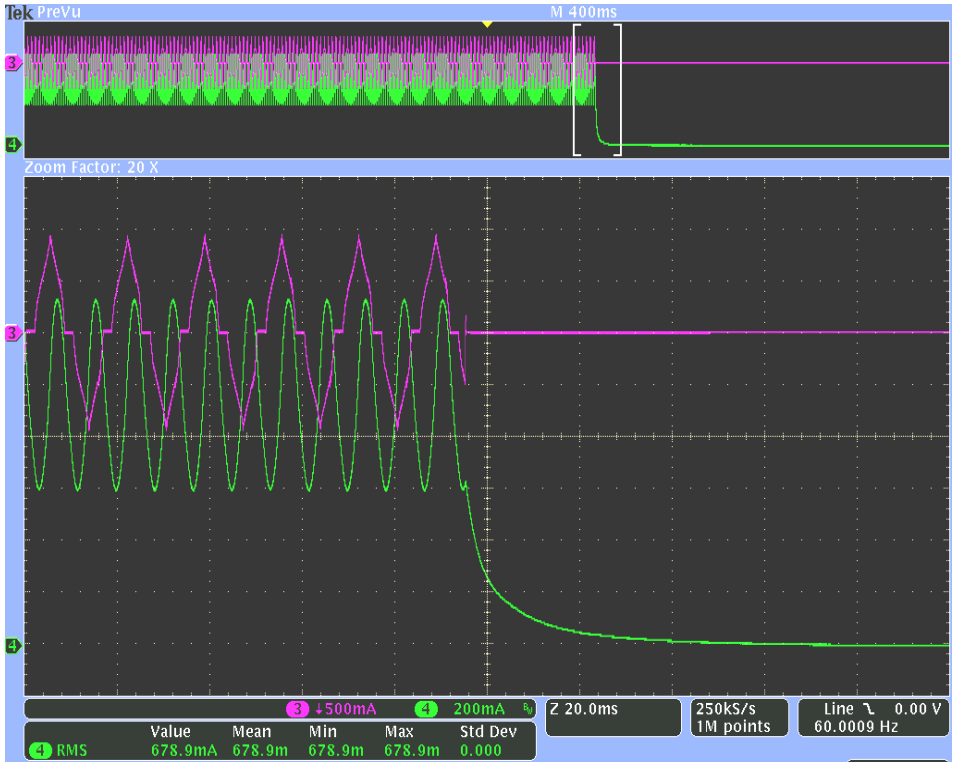

Figure 11: CH3: Input Current, CH4: Output LED Current (Turn Off)

5.6 EMI Performance

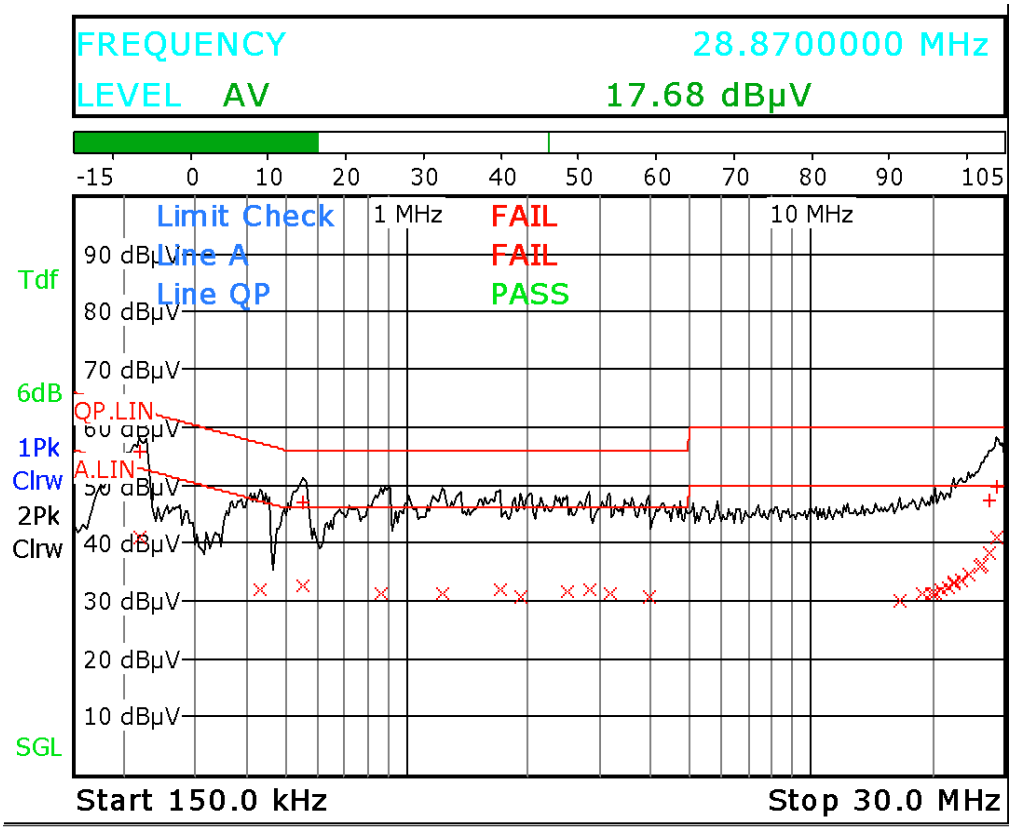

Figure 12: 120VAC Conducted EMI Scan - PEAK with Average and QP Measurements

1 = AV	Hz	dB	dB	1 = AV	Hz	dB	dB
2 = QP	FREQ	Level	**Margin**	2 = QP	FREQ	Level	**Margin**
1	2.2E+05	55.9	-6.99478	2	2E+07	31.18	-18.82
2	2.2E+05	40.98	-11.9148	2	2E+07	31.38	-18.62
2	4.3E+05	31.99	-15.1858	2	2.1E+07	31.87	-18.13
1	5.5E+05	47.06	-8.94	2	2.2E+07	32.25	-17.75
2	5.5E+05	32.54	-13.46	2	2.3E+07	33.11	-16.89
2	8.6E+05	31.37	-14.63	2	2.3E+07	33.49	-16.51
2	1.2E+06	31.2	-14.8	2	2.4E+07	33.61	-16.39
2	1.7E+06	32.04	-13.96	2	2.5E+07	34.69	-15.31
2	1.9E+06	30.65	-15.35	2	2.6E+07	36.14	-13.86
2	2.5E+06	31.59	-14.41	2	2.6E+07	36.23	-13.77
2	2.8E+06	31.87	-14.13	1	2.7E+07	47.55	-12.45
2	3.2E+06	31.34	-14.66	2	2.7E+07	38.31	-11.69
2	4.0E+06	30.53	-15.47	1	2.9E+07	49.92	-10.08
2	1.6E+07	30.08	-19.92	2	2.9E+07	40.92	-9.08
2	1.9E+07	31.28	-18.72				

Table 2: Average and QP with listed Margins

6 TPS92074 120Vac Single Stage Non-Dimmable 50W LED Driver Reference Design PCB layout*

The following figures show the design of the printed circuit board. The PCB design is single sided and is suitable for using on metal-core single sided PCB.

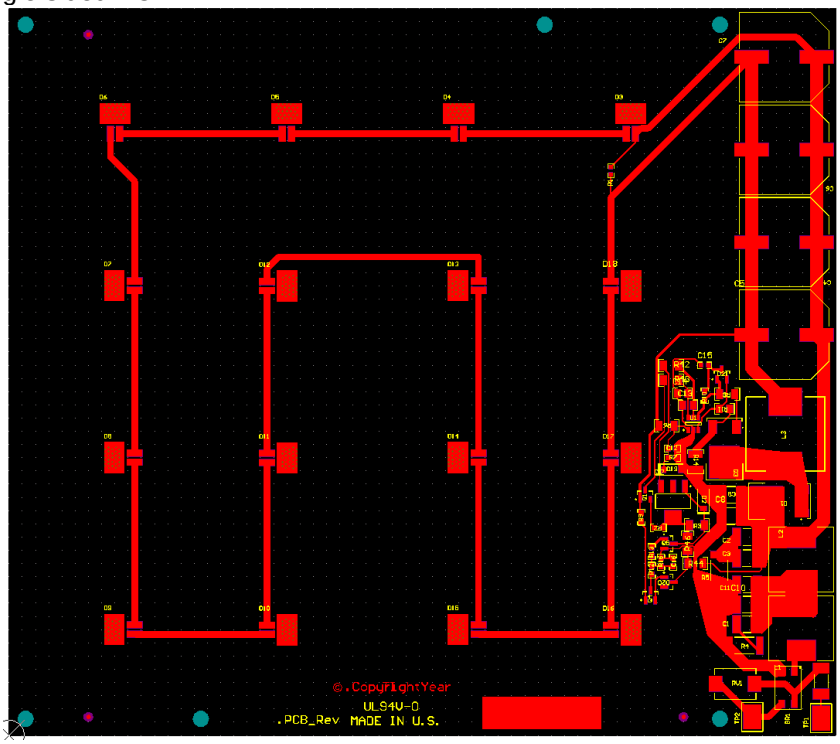

Figure 13: Top Layer and Top Overlay (Top view)

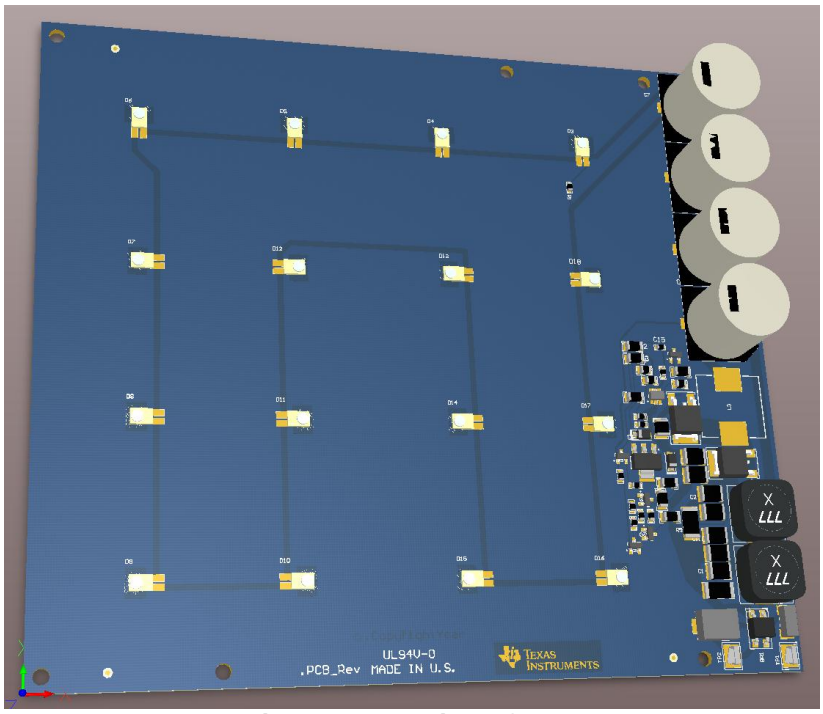

Figure 14: 3D View of PCB

*The layout may contain optional components. For detail components list, please refer to the BOM list on page 12.

Bill of Materials

Ref Designator	QTY	Value	Description	Part Number	Manufacturer
BR1	1	400V	RECT BRIDGE GP 400V 0.5A MINIDIP	RH04-T	DIODES INC (VA)
C1, C2, C3, C8, C9, C10, C11	7	0.22uF	CAP CER 0.22UF 630V 20% X7T 1812	CGA8M1X7T2J224M200KC	TDK CORPORATION
C6, C7	2	470uF	CAP ALUM 470UF 63V 20% SMD	EEV-FK1J471M	PANASONIC
C12	1	0.1uF	CAP CER 10000PF 16V 10% X7R 0603	GRM188R71C103KA01D	MURATA ELECTRONICS (VA)
C13	1	0.22uF	CAP CER 0.22UF 25V 10% X7R 0603	GRM188R71E224KA88D	MURATA ELECTRONICS (VA)
C14	1	330pF	CAP CER 330PF 50V 10% X7R 0603	GRM188R71H331KA01D	MURATA ELECTRONICS (VA)
C15	1	33nF	CAP CER 0.033UF 25V 20% X7R 0603	C1608X7R1E333M	TDK CORPORATION (VA)
C16	1	1uF	CAP CER 1UF 25V X7R 10% 0603	GRM188R71E105KA12D	MURATA ELECTRONICS (VA)
D1	1	400V	DIODE ULT FAST 400V 3A SMC	STTH3R04S	STMICROELECTRONICS
D2	1	15V	DIODE ZENER 15V 500MW SOD123	MMSZ4702T1G	ON SEMICONDUCTOR (VA)
D19	1	4.7V	DIODE ZENER 4.7V 500MW SOD123	BZT52C4V7-13-F	DIODES INC
D20	1	62V	DIODE ZENER 62V 225MW SOT23-3	BZX84C62LT1G	ON SEMICONDUCTOR (VA)
D21	1	70V	DIODE ARRAY 70V 250MA SOT23	BAW56-V-GS08	VISHAY
F1	1	1A	FUSE 1A 125V 6125 FAST SSQ	SSQ 1	BEL FUSE INC
L1, L2	2	1mH	INDUCTOR 1MH 500MA SMD	SRR1208-102KL	BOURNS INC
L3	1	270uH	INDUCTOR POWER 270UH 1.6A SMD	7447709271	WURTH ELECTRONICS INC
Q1, Q4	2	300V	TRANSISTOR, PNP, 300V, 0.2A, SOT-23	MMBTA92	FAIRCHILD
Q2	1	250V	MOSFET N-CH 250V 790MA SOT223	IRFL214TRPBF	VISHAY SILICONIX
Q3	1	250V	MOSFET N-CH 250V 4.4A DPAK	FDD6N25TM	FAIRCHILD
Q5	1	60V	MOSFET N-CH 60V 260MA SOT-23	2N7002ET1G	ON SEMICONDUCTOR (VA)
R1	1	49.9k	RES 49.9K OHM 1/10W 1% 0603 SMD	CRCW060349K9FKEA	VISHAY DALE
R2	1	825	RES 825 OHM 1/10W 1% 0603 SMD	CRCW0603825RFKEA	VISHAY DALE
R3	1	402k	RES 402K OHM 1/4W 1% 1206 SMD	CRCW1206402KFKEA	VISHAY DALE
R4, R5	2	220	RES 220 OHM 1W 5% 2512 SMD	CRCW2512220RJNEG	VISHAY DALE
R6	1	332k	RES 332K OHM 1/4W 1% 1206 SMD	CRCW1206332KFKEA	VISHAY DALE
R7	1	33.2k	RES 33.2K OHM 1/10W 1% 0603 SMD	CRCW060333K2FKEA	VISHAY DALE
R8	1	4.99	RES 4.99 OHM 1/10W 1% 0603 SMD	CRCW06034R99FKEA	VISHAY DALE
R9, R10	2	100k	RES 100K OHM 1/10W 1% 0603 SMD	CRCW0603100KFKEA	VISHAY DALE
R11	1	1k	RES 1.00K OHM 1/8W 1% 0805 SMD	CRCW08051K00FKEA	VISHAY DALE
R12	1	332k	RES 332K OHM 1/10W 1% 0603 SMD	CRCW0603332KFKEA	VISHAY DALE
R13	1	1k	RES 1.00K OHM 1/10W 1% 0603 SMD	CRCW06031K00FKEA	VISHAY DALE
R14, R15	2	0.24	RES 0.24 OHM 1/2W 1% 1210 SMD	MCR25JZHFLR240	ROHM
R16	1	15k	RES 15.0K OHM 1/10W 1% 0603 SMD	CRCW060315K0FKEA	VISHAY DALE
U1	1		Non-Isolated, Buck PFC LED Driver with Digital Ref Controller	TPS92074DDCR/NOPB	TEXAS INSTRUMENTS

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