

# Non-Isolated 240-W Offline LED Driver Using UCC28810 and UCC28811

## User's Guide



Literature Number: SLUU424

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# Non-Isolated 240-W Offline LED Driver Using UCC28810 and UCC28811

## 1 Introduction

This reference design is a non-isolated offline 240-W LED driver with Power Factor Correction (PFC), using the UCC28810 and UCC28811.

## 2 Description

This driver is comprised of two stages, PFC stage and Buck stage. Both stages are operating in critical conduction mode. A constant current is controlled to provide 3 A to LED strings, with output voltage range from 70 V to 85 V.

### 2.1 Typical Applications

- High Bay Lighting
- Street Lighting

### 2.2 Features

- 108 V<sub>RMS</sub> to 265 V<sub>RMS</sub> Offline Operation
- Power Factor Correction
- Boost Follower
- Constant Current Control
- Onboard or External PWM Dimming

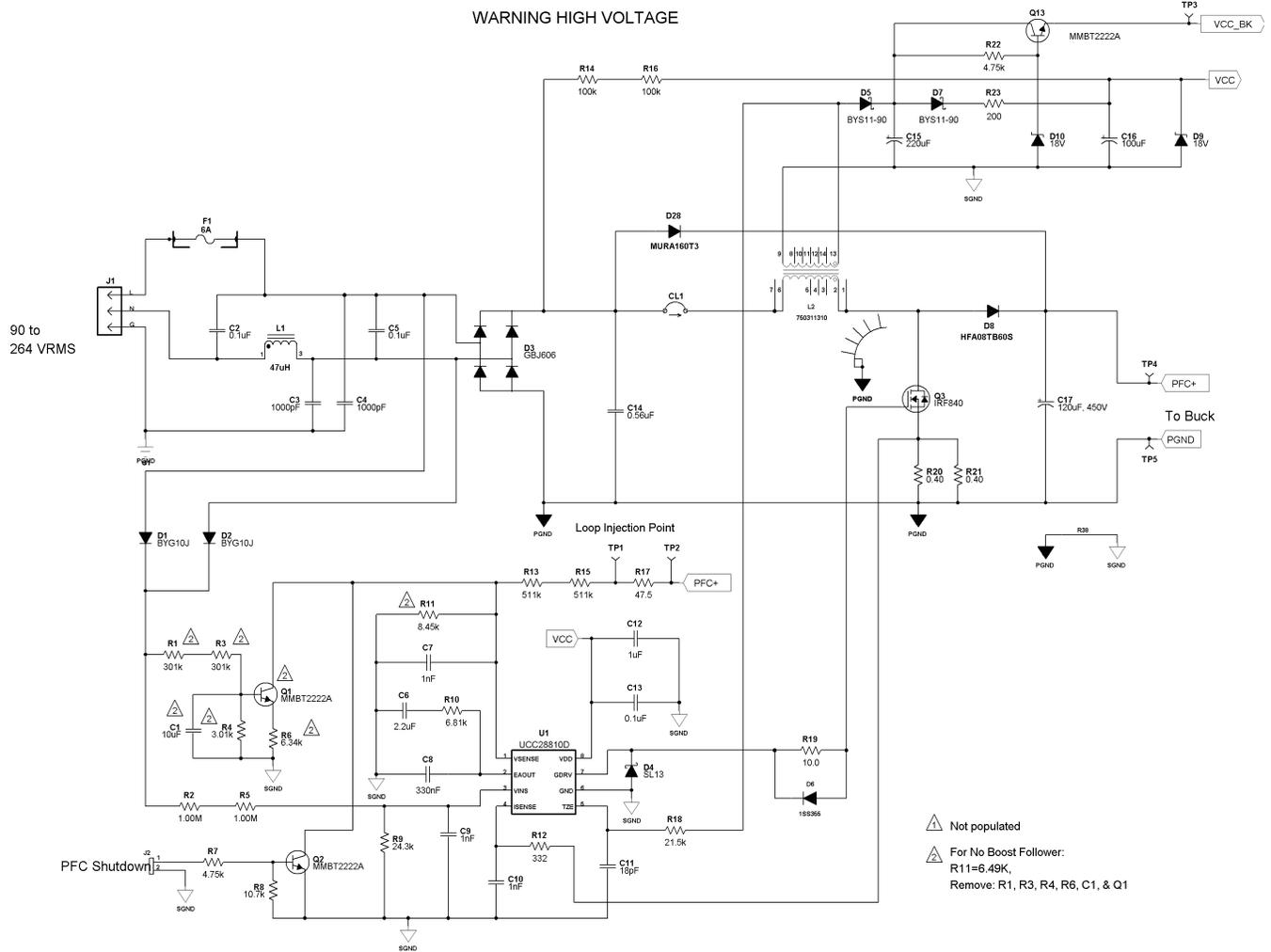
## 3 Electrical Performance Specifications

**Table 1. Non-Isolated 240-W LED Driver Electrical Performance Specifications**

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
<b>Input Characteristics</b>					
Voltage range		108		265	V <sub>RMS</sub>
PF		0.99			
<b>Output Characteristics</b>					
Output voltage, V <sub>OUT</sub>	Output current = 3 A	70		85	V
Output load current, I <sub>OUT</sub>			3		A
Output current ripple	C <sub>O</sub> = 4.7 μF x 3, (C31 and C32)		300		mA <sub>PP</sub>
<b>Systems Characteristics</b>					
Efficiency	V <sub>OUT</sub> = 70 V to 85 V	89			%

## 4 Schematic

### 4.1 PFC Stage



### 4.2 Buck Stage

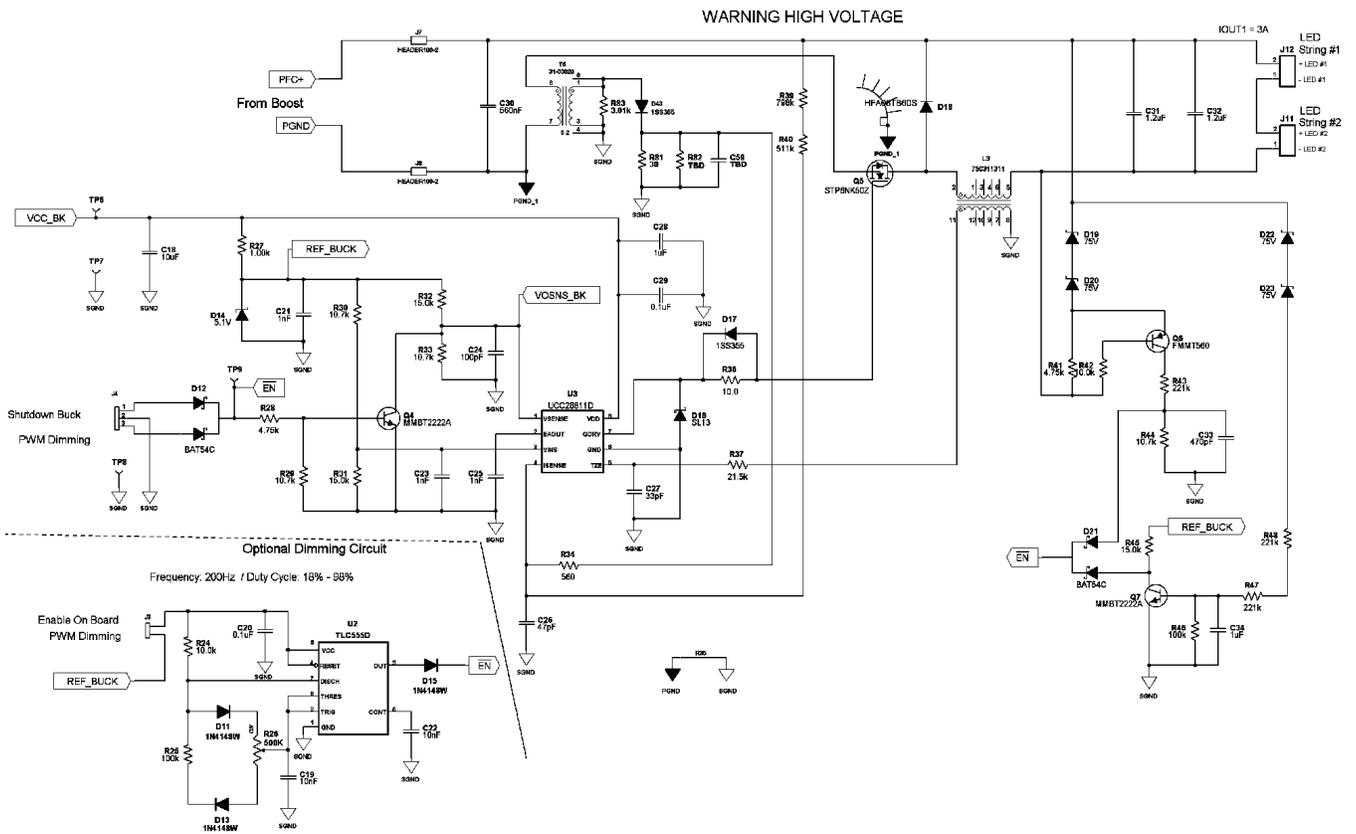


Figure 2. Non-Isolated 240-W LED Driver Schematic

## 5 Performance Data and Typical Characteristic Curves

Figure 3 through Figure 8 present typical performance curves for Non-Isolated 240-W LED Driver.

### 5.1 Power Factor (PF)

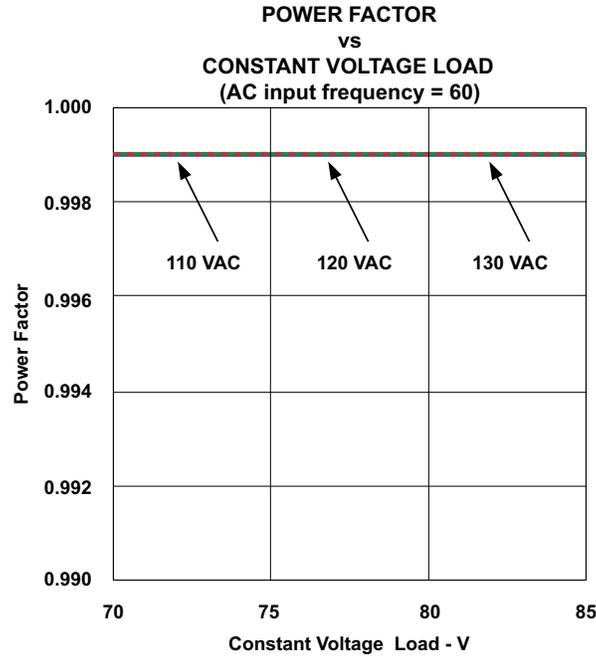


Figure 3. Non-Isolated 240-W LED Driver Power Factor

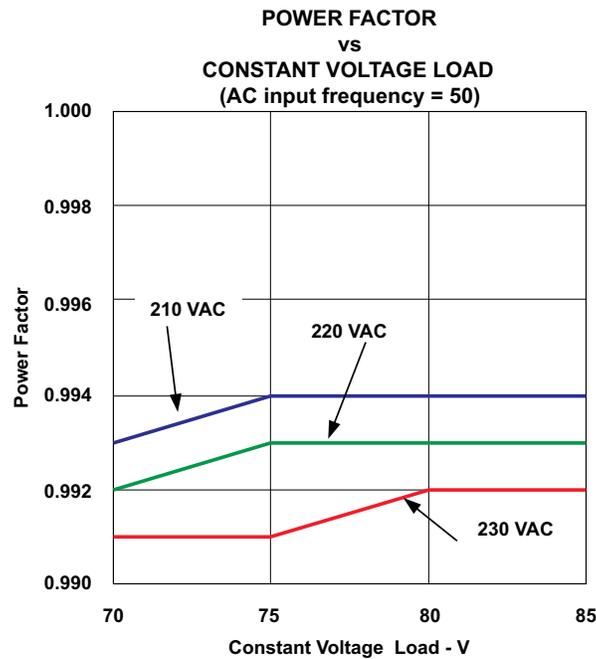


Figure 4. Non-Isolated 240-W LED Driver Power Factor

## 5.2 Efficiency

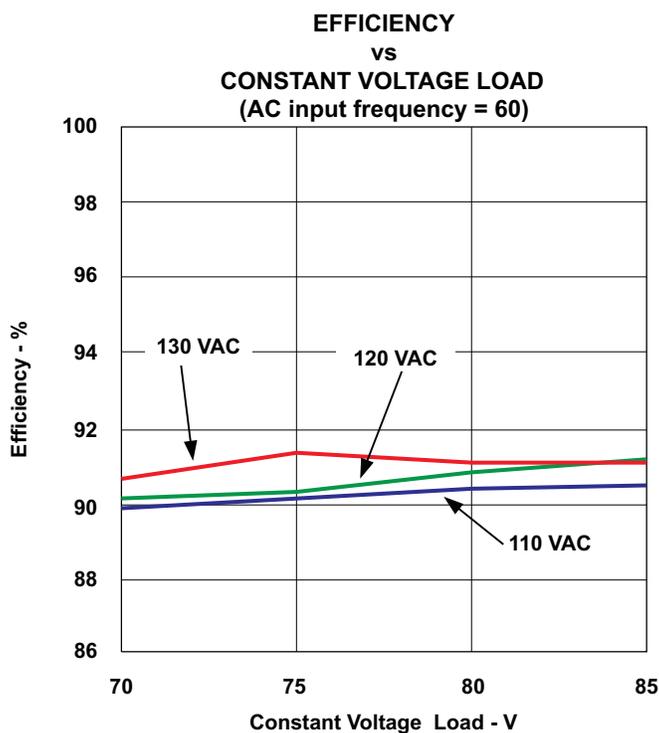


Figure 5. Non-Isolated 240-W LED Driver Efficiency

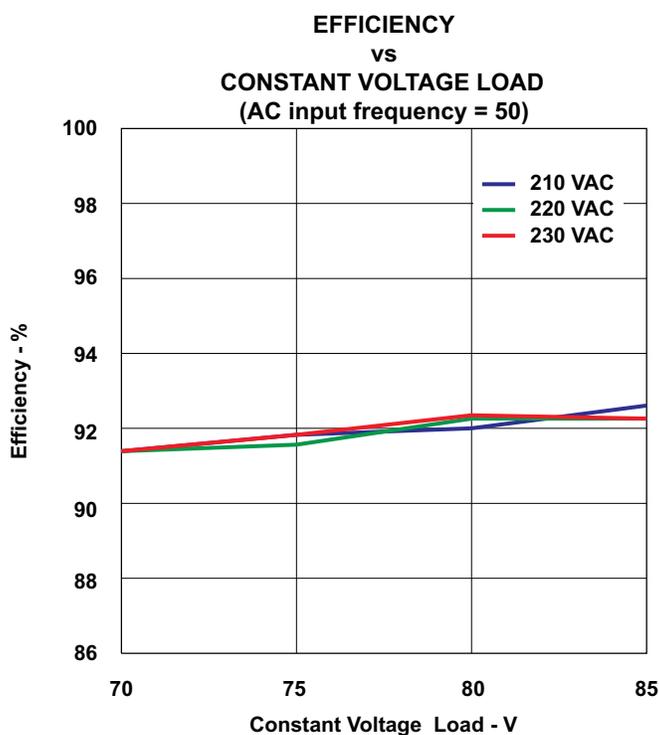


Figure 6. Non-Isolated 240-W LED Driver Efficiency

5.3 Load Regulation

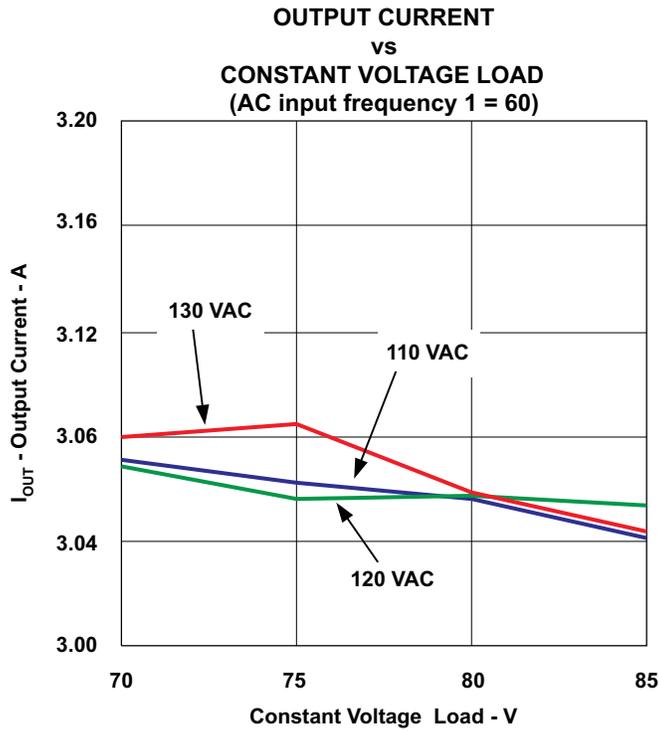


Figure 7. Non-Isolated 240-W LED Driver Load Regulation

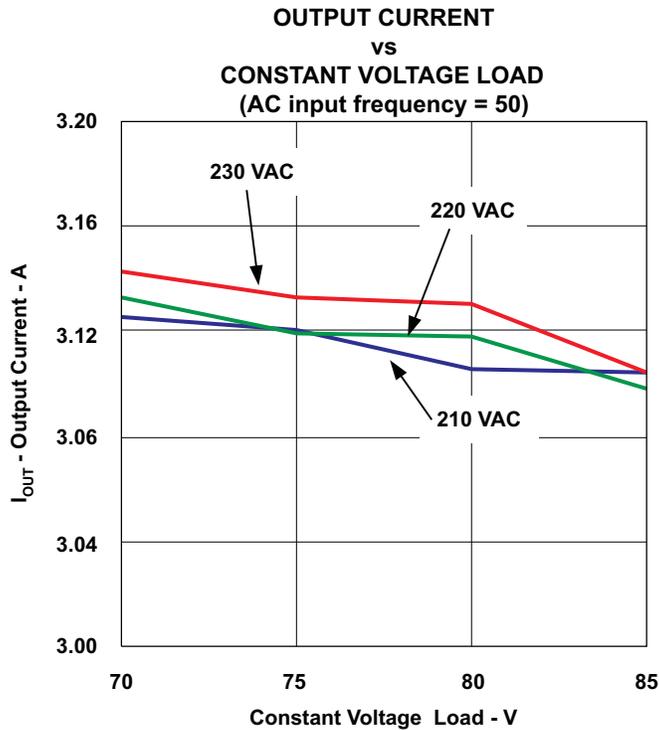


Figure 8. Non-Isolated 240-W LED Driver Load Regulation

### 5.4 PFC Stage

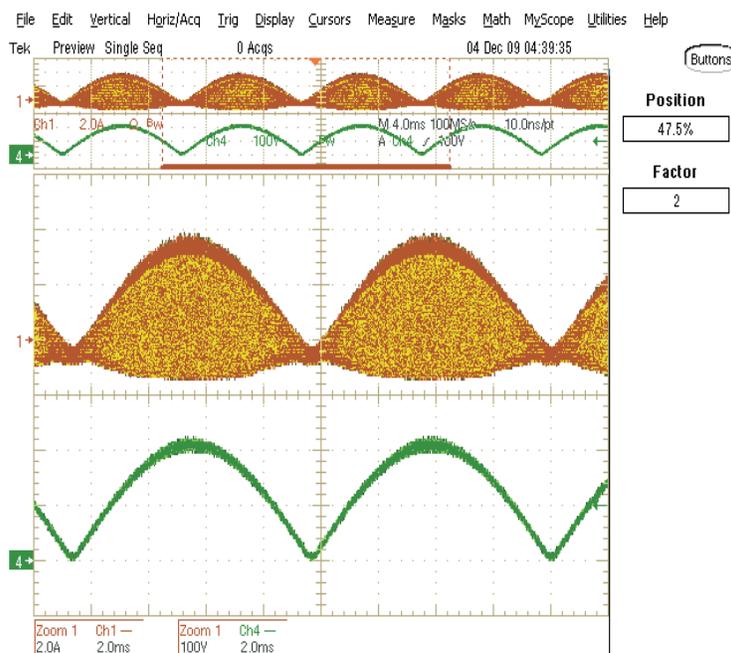


Figure 9. Non-Isolated 240-W LED Driver PFC Stage Waveforms

### 5.5 Output Ripple ( $C_o = 4.7 \mu F \times 3$ )

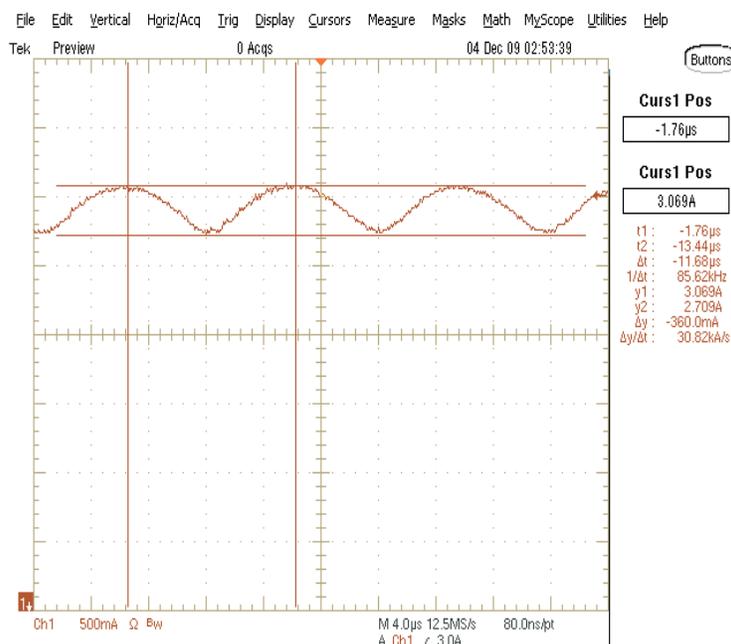


Figure 10. Non-Isolated 240-W LED Driver Output Ripple Waveforms (C31 and C32 replaced with three 4.7-μF capacitors)

5.6 Output Ripple ( $C_o = 2.2 \mu F \times 2$ )

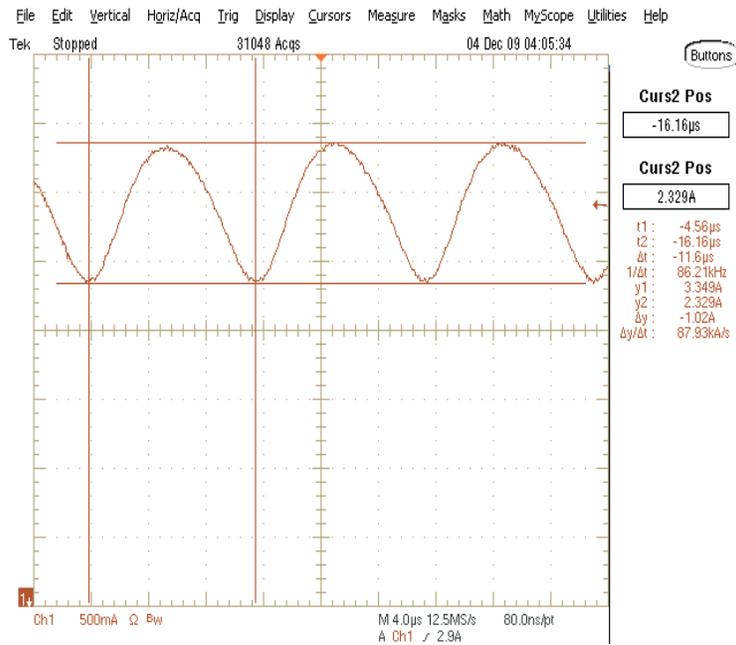


Figure 11. Non-Isolated 240-W LED Driver Output Ripple Waveforms

### 5.7 Assembly Drawing and PCB Layout

The following figures (Figure 12 through Figure 13) show the design of the Non-Isolated 240-W LED Driver printed circuit board.

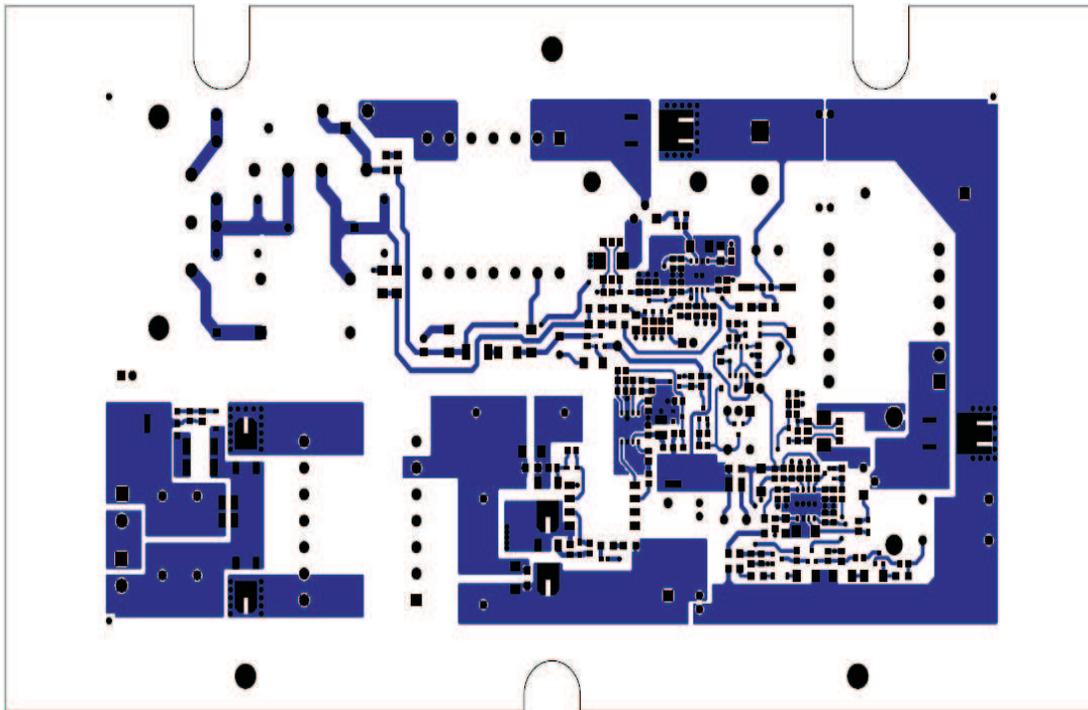


Figure 12. Non-Isolated 240-W LED Driver PCB (top view)

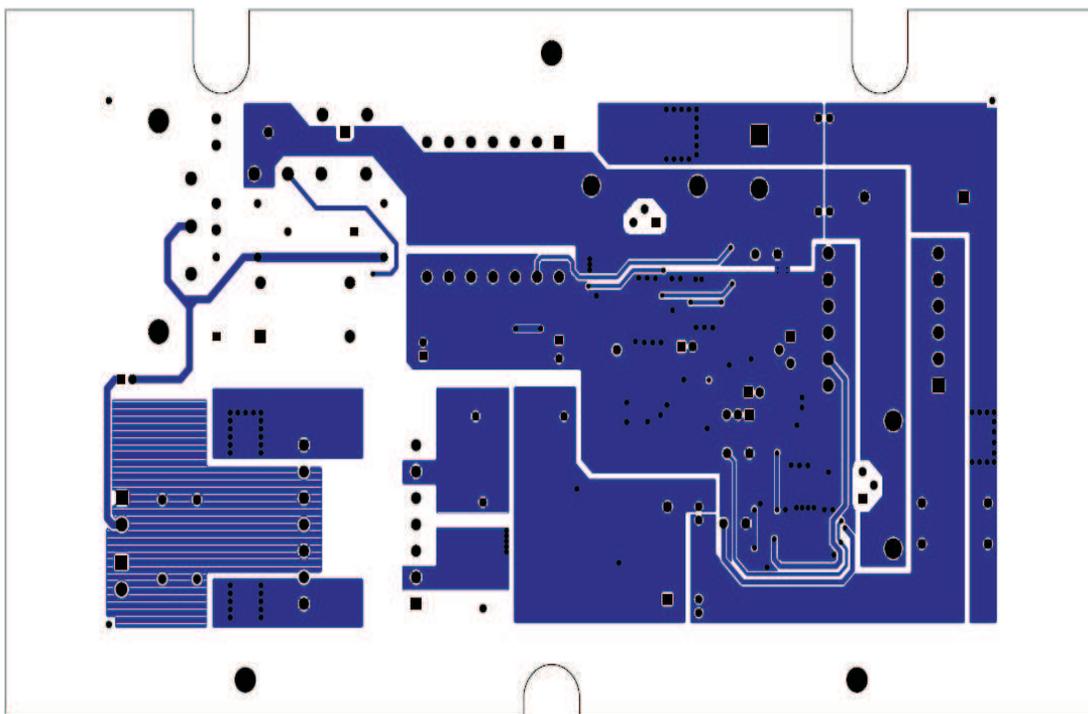


Figure 13. Non-Isolated 240-W LED Driver PCB (bottom view)

## 6 List of Materials

Components list according to the schematic shown in [Figure 1](#) and [Figure 2](#).

**Table 2. Non-Isolated 240-W LED Driver Components List**

QTY	REF DES	DESCRIPTION	MFR	PART NUMBER
1	C1	Capacitor, ceramic, 10 $\mu$ F, 25 V, X5R, $\pm$ 20%	Std	Std
2	C2, C5	Capacitor, metallized polyester film, 0.1 $\mu$ F, 275 VAC, $\pm$ 10%	Panasonic	ECQ-U2A104ML
2	C3, C4	Capacitor, ceramic disc, 1 nF, 250 V, Y1/X1	Panasonic	ECK-ANA102MB
1	C6	Capacitor, ceramic, 2.2 $\mu$ F, 25 V, X7R, $\pm$ 10%	Std	Std
6	C7, C9, C10, C21, C23, C25	Capacitor, ceramic, 1 nF, 50 V, NPO, $\pm$ 5%	Std	Std
1	C8	Capacitor, ceramic, 330 nF, 16 V, X7R, $\pm$ 10%	Std	Std
1	C11	Capacitor, ceramic, 18 pF, 50 V, NPO, $\pm$ 5%	Std	Std
3	C12, C28, C34	Capacitor, ceramic, 1 $\mu$ F, 25 V, X5R, $\pm$ 10%	Std	Std
3	C13, C20, C29	Capacitor, ceramic, 0.1 $\mu$ F, 25 V, X7R, $\pm$ 10%	Std	Std
1	C14	Capacitor, polypropylene film, 0.56 $\mu$ F, 400 V, $\pm$ 55%	Panasonic	ECW-F4564JL
1	C15	Capacitor, aluminum electrolytic, 220 $\mu$ F, 35 V, $\pm$ 20%	Std	Std
1	C16	Capacitor, aluminum electrolytic, 100 $\mu$ F, 35 V, $\pm$ 20%	Std	Std
1	C17	Capacitor, aluminum electrolytic, 120 $\mu$ F, 450 V, TS-HB	Panasonic	ECO-S2WB121BA
1	C18	Capacitor, Ceramic, 10 $\mu$ F, 25 V, X7R, $\pm$ 10%	Std	Std
2	C19, C22	Capacitor, ceramic, 10-nF, 50 V, X7R, $\pm$ 10%	Std	Std
1	C24	Capacitor, ceramic, 100-pF, 50 V, NPO, $\pm$ 5%	Std	Std
1	C26	Capacitor, ceramic, 47-pF, 50 V, NPO, $\pm$ 5%	Std	Std
1	C27	Capacitor, ceramic, 33-pF, 50 V, NPO, $\pm$ 5%	Std	Std
1	C30	Capacitor, polypropylene film, 0.56 $\mu$ F, 630 V, $\pm$ 5%	Panasonic	ECW-F6564JL
2	C31, C32	Capacitor, metallized polyester film, 2.2 $\mu$ F, 250 V, 10%	Panasonic	ECQ-E2225KF
1	C33	Capacitor, ceramic, 470 pF, 50 V, NPO, $\pm$ 5%	Std	Std
2	CL1, CL2	Current loop, wire, 20 ga., stranded, 3.0 in.	Std	NA
2	D1, D2	Diode, 1.5 A, 600 V	Vishay	BYG10J
1	D3	Diode, bridge rectifier, 6 A, 600 V	Diodes	GBJ606
2	D4, D16	Diode, Schottky, 1.5 A, 30 V	Vishay	SL13-E3/61T
2	D5, D7	Diode, Schottky, 1 A, 90 V	Vishay	BYS11-90-E3/TR
2	D6, D17	Diode, switching, 90 V, 225 mA Ifm, high speed	Rohm	1SS355
2	D8, D18	Diode, ultra fast, 8 A, 600 V	IR	HFA08TB60S
2	D9, D10	Diode, Zener, 18 V, 1 W	Diodes	SMAZ18-13
3	D11, D13, D15	Diode, signal, 300 mA, 75 V, 350 mW	Vishay	1N4148W
2	D12, D21	Diode, dual Schottky, 200 mA, 30 V	Vishay	BAT54C
1	D14	Diode, Zener, 5.1 V, 1 W	Vishay	SMAZ5V1-13-F
4	D19, D20, D22, D23	Diode, Zener, 500 mW, 75 V	Onsemi	MMSZ5267BT1

**Table 2. Non-Isolated 240-W LED Driver Components List (continued)**

QTY	REF DES	DESCRIPTION	MFR	PART NUMBER
1	F1	Fuse, slow, 5 mm x 20 mm, 3.15 A, 250 V	Std	Std
1	FH1	Fuse clip, 5 mm x 20 mm, PC mount	Wickmann	01000056H
2	HS1, HS2	Heatsink, TO-220, vertical mount, 15°C/W	Aavid	593002B03400G
1	J1	Connector, AC receptacle, board mount, R/A, 9 mm	Qualtek	703W-00/54
2	J2, J3	Header, male 2-pin, 100mil spacing, (36-pin strip)	Sullins	PTC36SAAN
1	J4	Header, male 3 pin, 100-mil spacing, (36-pin strip)	Sullins	PTC36SAAN
4	J7, J8, J9, J10	Terminal block, 2 pin, 15 A, 5.1 mm	OST	D120/2DS
1	L1	Inductor, thru hole, 47 $\mu$ H, 3.50 A, 48 m $\Omega$	muRata	33470C
1	L2	Transformer, 1 primary, 1 secondary, 100 $\mu$ H, 6A	WE	750311310
1	L3	Transformer, 1 primary, 1 secondary, 100 $\mu$ H, 3A	WE	750311311
5	Q1, Q2, Q4, Q7, Q13	Transistor, NPN, 75 V, 500 mA	Fairchild	MMBT2222A
2	Q3, Q5	MOSFET, N-channel, 650 V, 21 A, 165 m $\Omega$	Infineon	IPP60R165CP
1	Q6	Bipolar, PNP, 500 V, 500 mA	Zetex	FMMT560
2	R1, R3	Resistor, chip, 301 k $\Omega$ , 1/4 W, 1%	Std	Std
2	R2, R5	Resistor, chip, 1.00 M $\Omega$ , 1/4 W, 1%	Std	Std
1	R4	Resistor, chip, 3.01 k $\Omega$ , 1/8 W, 1%	Std	Std
1	R6	Resistor, chip, 6.49 k $\Omega$ , 1/8 W, 1%	Std	Std
3	R7, R22, R28	Resistor, chip, 4.75 k $\Omega$ , 1/8 W, 1%	Std	Std
5	R8, R29, R30, R33, R44	Resistor, chip, 10.7 k $\Omega$ , 1/8 W, 1%	Std	Std
1	R9	Resistor, chip, 24.3 k $\Omega$ , 1/8 W, 1%	Std	Std
1	R10	Resistor, chip, 6.81 k $\Omega$ , 1/8 W, 1%	Std	Std
1	R11	Resistor, chip, 8.45 k $\Omega$ , 1/8 W, 1%	Std	Std
1	R12	Resistor, chip, 332 $\Omega$ , 1/8 W, 1%	Std	Std
3	R13, R15, R40	Resistor, chip, 511 k $\Omega$ , 1/4 W, 1%	Std	Std
2	R14, R16	Resistor, chip, 100 k $\Omega$ , 1/4 W, 1%	Std	Std
1	R17	Resistor, Chip, 47.5 $\Omega$ , 1/8 W, 1%	Std	Std
2	R18, R37	Resistor, chip, 21.5 k $\Omega$ , 1/8 W, 1%	Std	Std
2	R19, R36	Resistor, chip, 10.0 $\Omega$ , 1/8 W, 1%	Std	Std
2	R20, R21	Resistor, chip, 0.40 $\Omega$ , 1 W, 1%	Std	Std
1	R23	Resistor, chip, 200 $\Omega$ , 1/2 W, 5%	Std	Std
2	R24, R42	Resistor, chip, 10.0 k $\Omega$ , 1/8 W, 1%	Std	Std
2	R25, R46	Resistor, chip, 100 k $\Omega$ , 1/8 W, 1%	Std	Std
1	R26	Potentiometer, 3/8 cermet, singleturn, flat	Bourns	3362P-504
1	R27	Resistor, chip, 1.00 k $\Omega$ , 1/4 W, 1%	Std	Std
3	R31, R32, R45	Resistor, chip, 15.0 k $\Omega$ , 1/8 W, 1%	Std	Std

**Table 2. Non-Isolated 240-W LED Driver Components List (continued)**

QTY	REF DES	DESCRIPTION	MFR	PART NUMBER
1	R34	Resistor, chip, 560 $\Omega$ , 1/8 W, 1%	Std	Std
1	R39	Resistor, chip, 798 k $\Omega$ , 1/4 W, 1%	Std	Std
1	R41	Resistor, chip, 4.75 k $\Omega$ , 1/4 W, 1%	Std	Std
1	R43	Resistor, chip, 221 k $\Omega$ , 1/8 W, 1%	Std	Std
2	R47, R48	Resistor, chip, 221 k $\Omega$ , 1/4 W, 1%	Std	Std
1	R81	Resistor, 30 $\Omega$ , 0603	Std	Std
1	R83	Resistor, 3.01 k $\Omega$ , 0603	Std	Std
1	T5	XFMR: current sense 1:100	Xfmrs	031-00020
2	TP1, TP2	Test point, SMT	Keystone	5015
4	TP3, TP4, TP6, TP9	Test point, white, thru hole color keyed	Keystone	5002
3	TP5, TP7, TP8	Test point, black, thru hole color keyed	Keystone	5001
1	U1	LED Lighting Power Controller	TI	UCC28810D
1	U2	Timer, Low-Power CMOS	TI	TLC555D
1	U3	LED Lighting Power Controller	TI	UCC28811D

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Logic	<a href="http://logic.ti.com">logic.ti.com</a>	Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>	Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>	Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>	Space, Avionics & Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
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