

TPS92310

Triac Dimmable AC-DC LED Driver Reference Design



Literature Number: SLVU830
January, 2013

Triac Dimmable Off-Line Primary Side-Sensing Controller with PFC

1 Introduction

This TPS92310 reference design presents the TPS92310 AC-DC controller in a configuration that is compatible with triac dimmers. The TPS92310 is designed to drive high-brightness light emitting diodes (LEDs) and features-programmable ON time, programmable delay, and zero-current detection. Additional features include cycle-by-cycle switch current limit, VCC under-voltage lockout, and output over-voltage protection.

2 Description

This reference design provides a high-brightness LED driver based on the TPS92310 configured as a power factor corrected flyback regulator that is triac dimmable. It is designed to operate with an input voltage in the range of 90 VAC to 135 VAC with a 120-VAC nominal input voltage. This design is set up for a default output current of 340 mA with an output voltage range of 21 V to 27 V or approximately 6 to 8 LEDs depending on the forward voltage of each.

2.1 Typical Applications

This converter design describes an application of the TPS92310 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 TPS92310 datasheet.

2.2 Features

2.2.1 Connector Description

This section describes the connectors and test points on the reference design board and how to properly connect, setup, and use the TPS92310.

2.2.1.1 CN1

This connector is for the AC input to the board. Use the screw down terminals to connect Line and Neutral to the circuit. Pin 1 is marked *LINE* while pin 2 is marked *NEUTRAL*. Since no earth ground is used, these two are interchangeable.

2.2.1.2 LED+, LED–, CN2

Connect the LED string between these test points with the anode of one end connected to LED+ and the cathode of the other end connected to LED–. Alternatively, the screw down connector CN2 may be used. Pin 1 of CN2 is LED+ and pin 2 is LED–.

3 Electrical Performance Specifications

Table 1. TPS92310 Triac Dimmable Electrical Performance Specifications

Parameter	Test Conditions	MIN	TYP	MAX	Units
Input Characteristics					
Voltage range		90	120	135	VAC
Maximum input current	At IO _{UT} = 340 mA		85		mA
Output Characteristics					
Output voltage, V _{OUT}	At IO _{UT} = 340 mA	21		27	V
Output load current, IO _{UT}	No Triac dimmer	323	340	357	mA
Output current regulation	At 120VAC input voltage		±5		%
Output current ripple	At IO _{UT} = 340 mA		125		mApp
Over-voltage protection level	Output rising	28	30	32	V
Systems Characteristics					
Switching frequency			48		kHz
Efficiency	Input voltage = 120VAC, Load = 7 LEDs at 24.5 V		84		%
Power Factor	Input voltage = 120VAC, Load = 7 LEDs at 24.5 V		0.943		
Triac Dim range	Dependent upon dimmer used	6:1		15:1	

4 Schematic

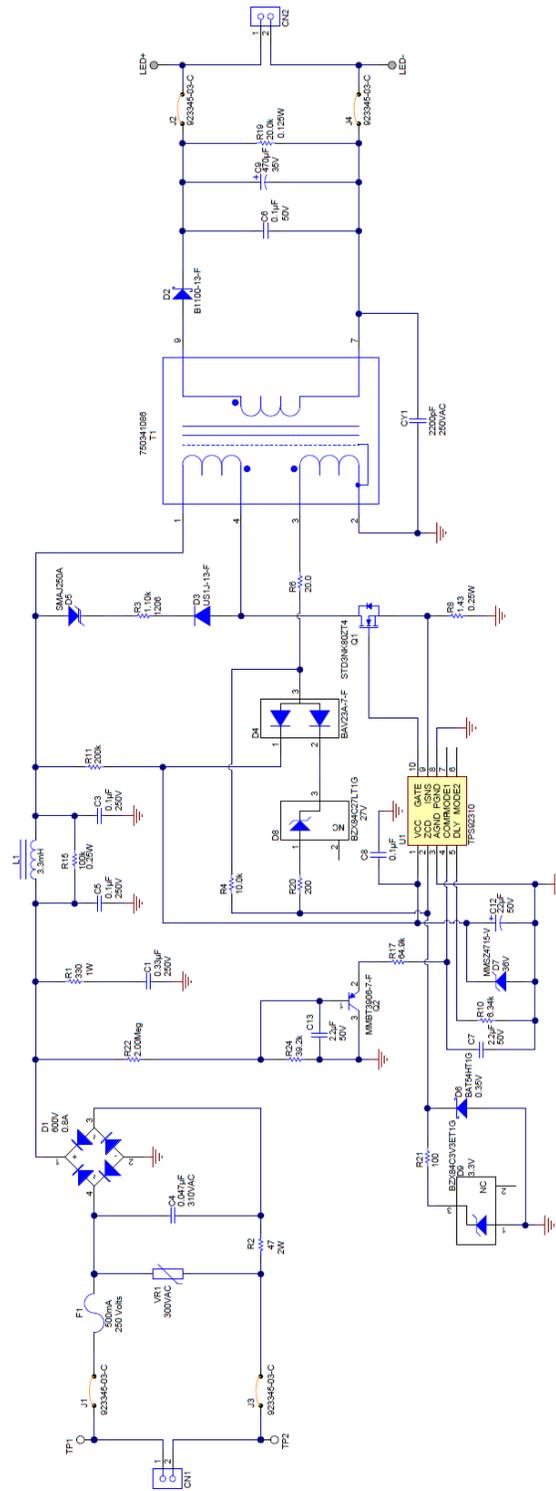


Figure 1. TPS92310 Dimmable Schematic

5 Performance Data and Typical Characteristic Curves

Figure 2 through Figure 10 present typical performance curves for the TPS92310 dimmable design.

5.1 Efficiency

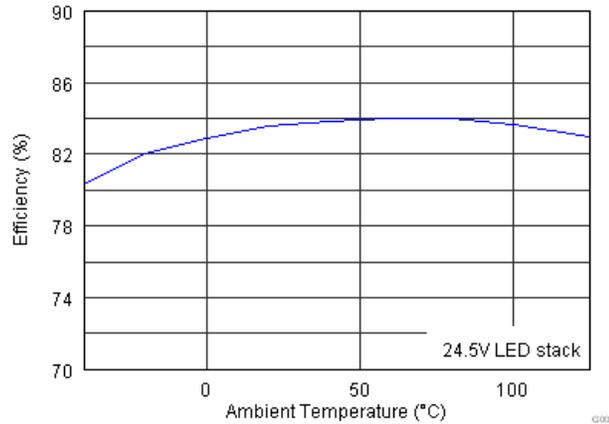


Figure 2. Efficiency

5.2 Line Regulation

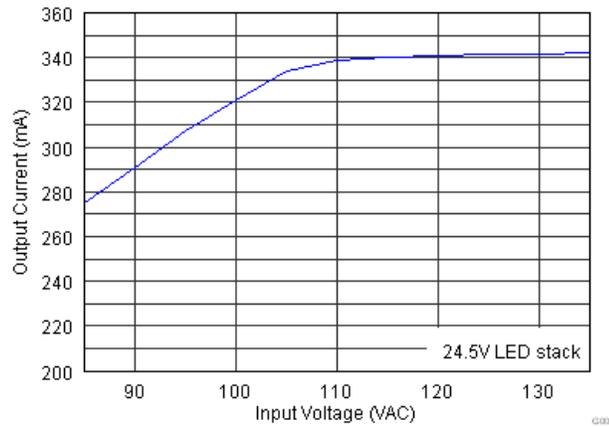


Figure 3. Line Regulation

5.3 Power Factor

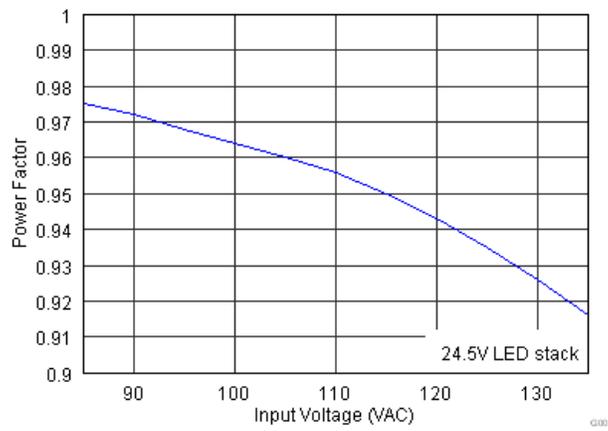


Figure 4. Power Factor

5.4 Output Current over Ambient Temperature

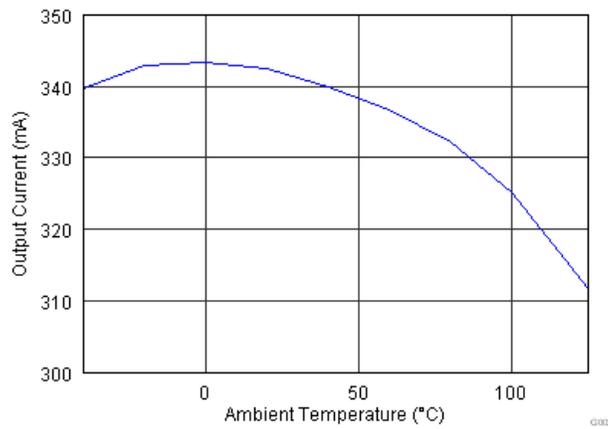


Figure 5. Output Current versus Temperature

5.5 Triac Dimmer Response

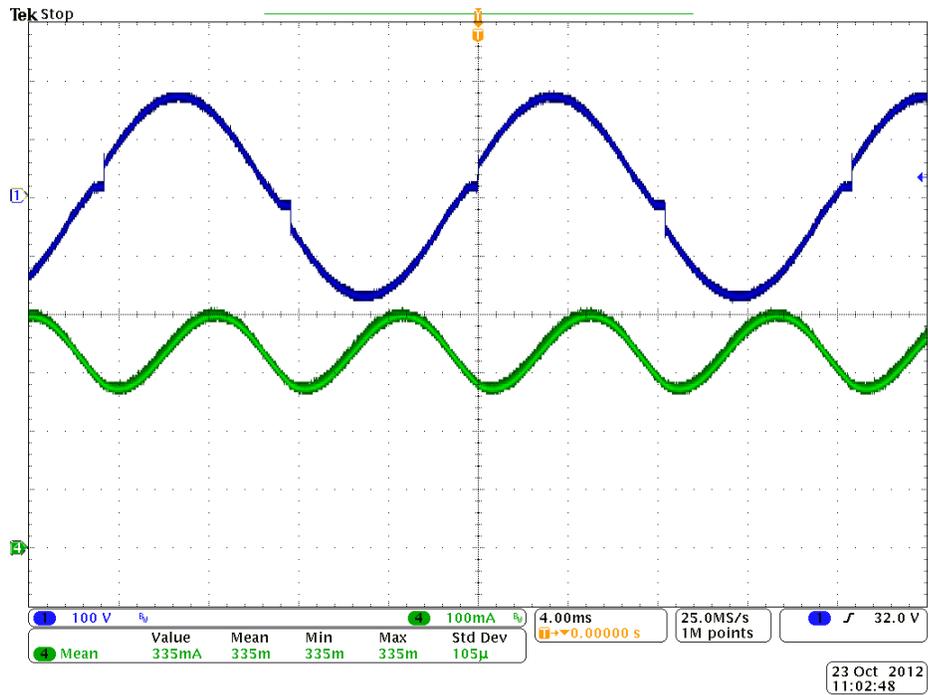


Figure 6. Triac Maximum Level Waveform

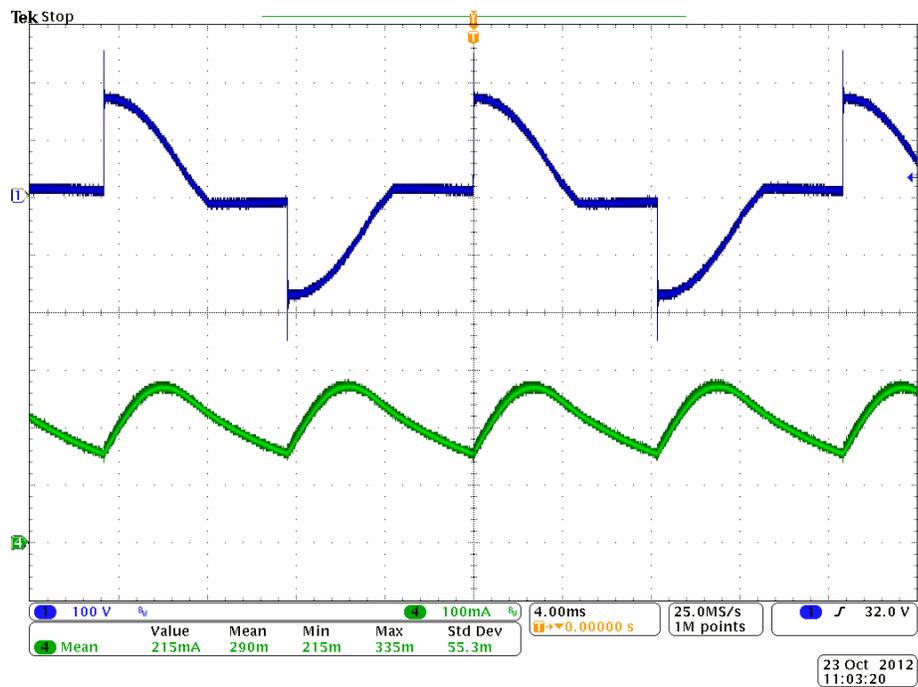


Figure 7. 90 Degree Conduction Angle Waveform

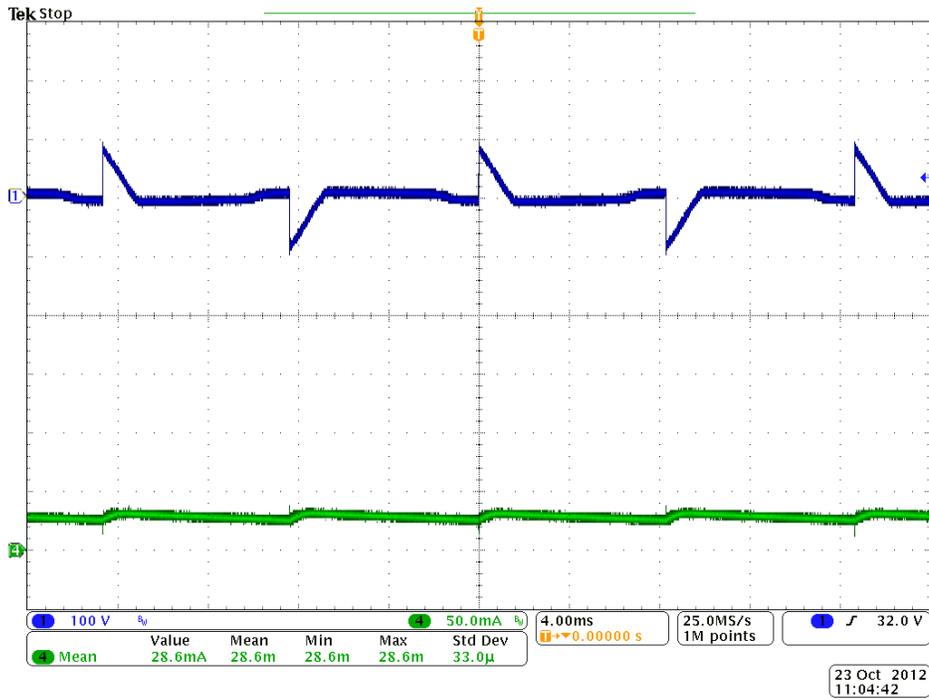
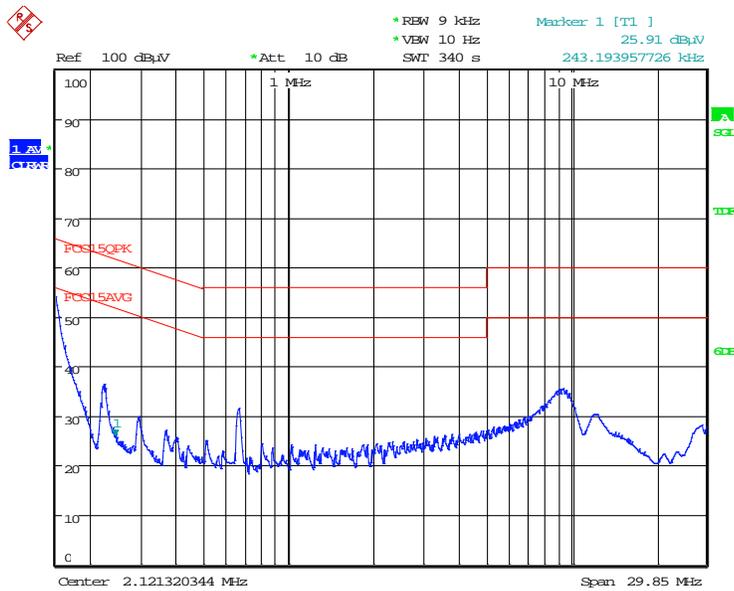
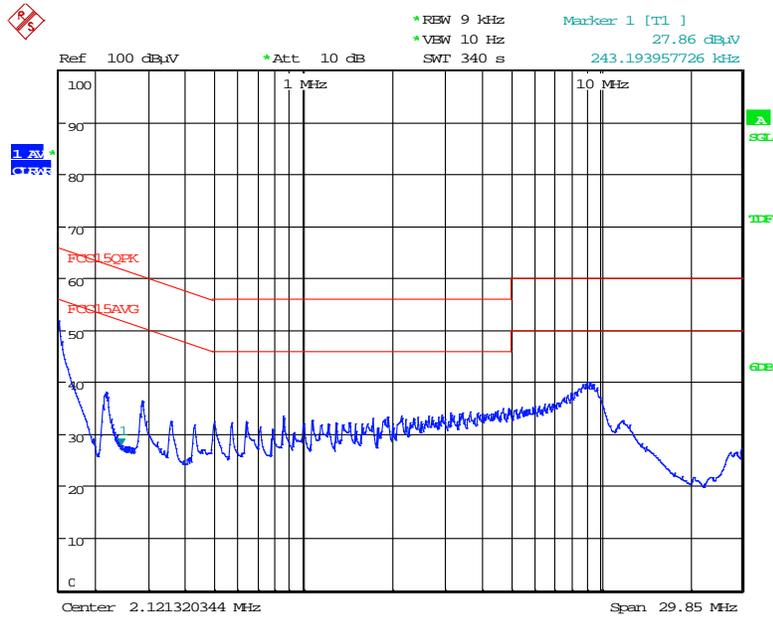


Figure 8. Triac Minimum Level Waveform



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Figure 9. 120VAC Line-Conducted Average EMI Scan



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Figure 10. 120VAC Neutral-Conducted Average EMI Scan

6 TPS92310 Dimmable Reference Design Printed-Circuit Board Layout

Figure 11 and Figure 12 show the design of the TPS92310 dimmable printed-circuit board.

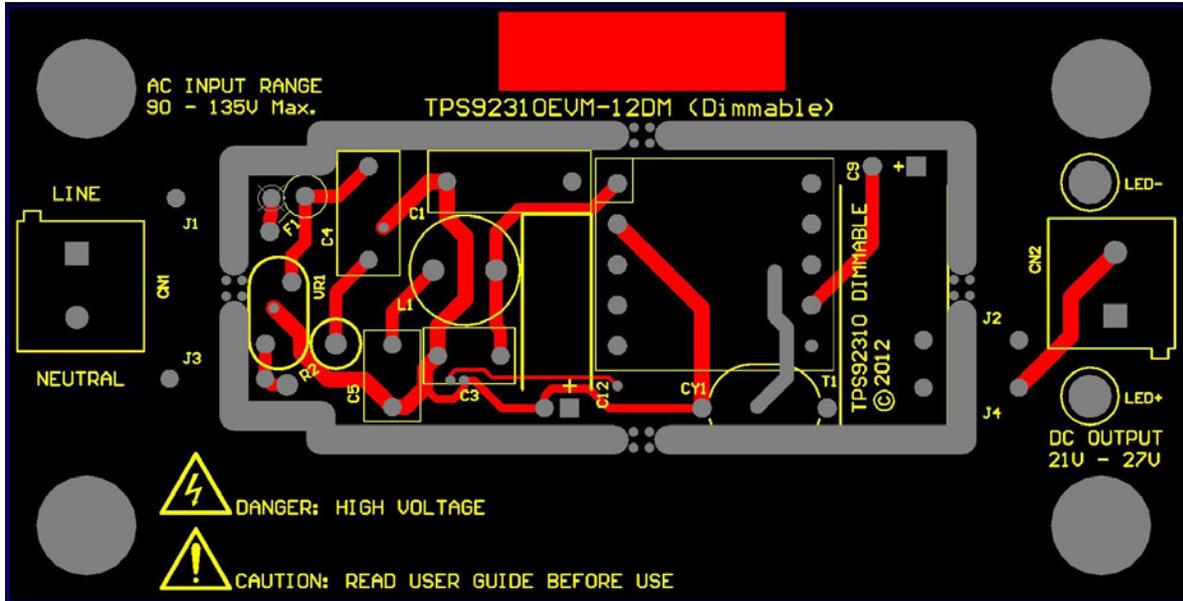


Figure 11. Top Layer and Top Overlay (Top view)

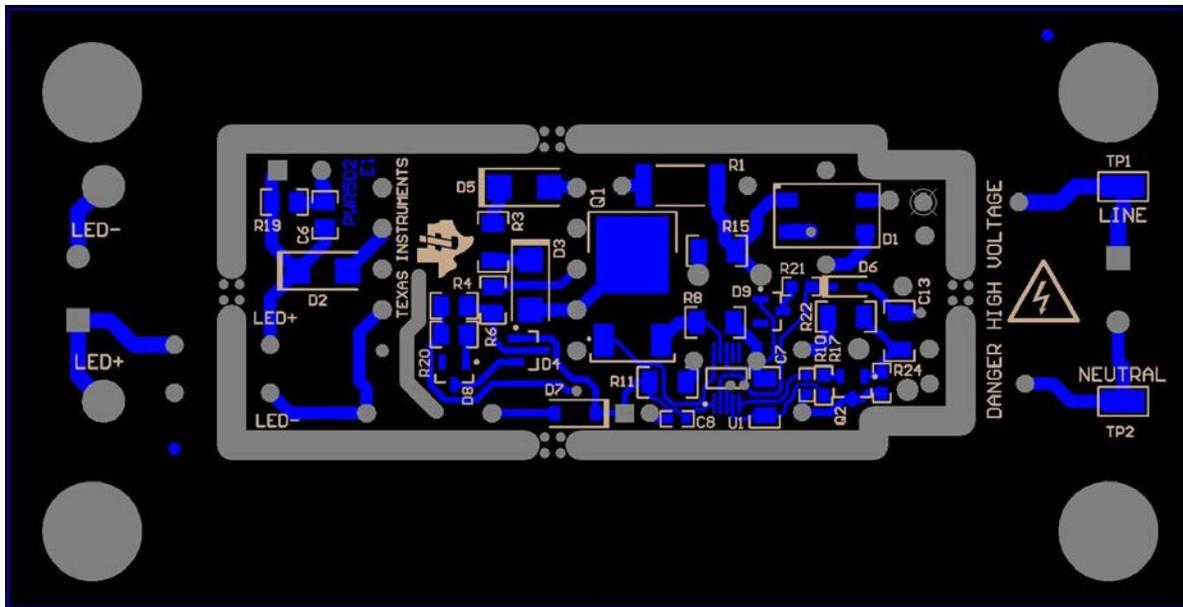


Figure 12. Bottom Layer and Bottom Overlay (Bottom view)

7 Bill of Materials

Table 2. TPS92310 Dimmable Components List According to the Schematic (Figure 1)

REFERENCE DESIGNATOR	QTY	VALUE	DESCRIPTION	SIZE	MFR	PART NUMBER
U1	1		AC-DC Flyback LED Driver	MSOP-10	TI	TPS92310DGS
C1	1	0.33 μ F	Capacitor, Film, 250 V	13 mm x 5 mm	EPCOS	B32521C3334J
C3, C5	2	0.1 μ F	Capacitor, Film, 250 V	7.3 mm x 4.5 mm	EPCOS	B32529C3104K
C4	1	0.047 μ F	Capacitor, Film, 630 V	10 mm x 5 mm	Vishay/BC	BFC233920473
C6	1	0.1 μ F	Capacitor, Ceramic, 50 V, X7R	0805	AVX	08055C104JAT2A
C7, C13	2	2.2 μ F	Capacitor, Ceramic, 50 V, X7R	1206	MuRata	GRM31CR71H225KA88L
C8	1	0.1 μ F	Capacitor, Ceramic, 50 V, X7R	0603	MuRata	GRM188R71H104KA93D
C9	1	470 μ F	Capacitor, Aluminum, 35 V	20 mm x 8 mm	Panasonic	EEU-FR1V471L
C12	1	22 μ F	Capacitor, Aluminum, 50 V	12.5 mm x 5 mm	Panasonic	EEU-FR1H220
CN1, CN2	2		Connector Terminal Block	5.08 mm	Phoenix Contact	1715721
CY1	1	2200 pF	Capacitor, Ceramic, 250 V, X1Y1	9 mm x 12 mm	MuRata	DE1E3KX222MA4BL01
D1	1		Diode, Switching Bridge, 600 V, 0.8 A	4-MiniDIP	Diodes Inc.	HD06-T
D2	1		Diode, Schottky, 100 V, 1 A	SMA	Diodes Inc.	B1100-13-F
D3	1		Diode, Ultrafast, 600 V, 1 A	SMA	Diodes Inc.	US1J-13-F
D4	1		Diode, Switch, 200 V, 0.4 A	SOT-23	Diodes Inc.	BAV23A-7-F
D5	1		Diode, TVS, 250 V, 400 W	SMA	Littlefuse	SMAJ250A
D6	1		Diode, Schottky, 30 V, 0.2 A	SOD-323	ON Semi	BAT54HT1G
D7	1		Diode, Zener, 36 V, 500 mW	SOD-123	Vishay	MMSZ4715-V
D8	1		Diode, Zener, 27 V, 225 mW	SOT-23	ON Semi	BZX84C27LT1G
D9	1		Diode, Zener, 3.3 V, 225 mW	SOT-23	ON Semi	BZX84C3V3ET1G
F1	1		Fuse, 0.5 A, 250 V	3.9 mm x 11 mm	Littlefuse	0677.500MXEP
J1, J2, J3, J4	4		Jumper Wire, 300 mil spacing	300 mil	3M	923345-03-C
L1	1	3300 μ H	Inductor, 0.14 A	8 mm x 8 mm	TDK Corp.	TSL0808RA-332KR14-PF
LED+, LED-	2		Test Turret, Double		Keystone	1502-2
Q1	1		MOSFET, N-channel, 800 V, 2.5 A	DPAK	ST Micro	STD3NK80ZT4
Q2	1		Transistor, PNP, 40 V, 0.2 A	SOT-23	Diodes Inc.	MMBT3906-7-F
R1	1	330 Ω	Resistor, Chip, 1W, 5%	2512	Dale	CRCW2512330RJNEG
R2	1	47 Ω	Resistor, Axial, 2W, 10%	4 mm x 10 mm	Welwyn	EMC2-47RKI
R3	1	1.1 k Ω	Resistor, Chip, 1/4W, 1%	1206	Std	
R4	1	10 k Ω	Resistor, Chip, 1/8W, 1%	0805	Std	
R6	1	20 Ω	Resistor, Chip, 1/8W, 1%	0805	Std	

R8	1	1.43 Ω	Resistor, Chip, 1/4W, 1%	1206	Yageo	RC1206FR-071R43L
R10	1	6.34 k Ω	Resistor, Chip, 1/10W, 1%	0603	Std	
R11	1	200 k Ω	Resistor, Chip, 1/4W, 1%	1206	Std	
R15	1	100 k Ω	Resistor, Chip, 1/4W, 1%	1206	Std	
R17	1	64.9 k Ω	Resistor, Chip, 1/10W, 1%	0603	Std	
R19	1	20 k Ω	Resistor, Chip, 1/8W, 1%	0805	Std	
R20	1	200 Ω	Resistor, Chip, 1/8W, 1%	0805	Std	
R21	1	100 Ω	Resistor, Chip, 1/10W, 1%	0603	Std	
R22	1	2 M Ω	Resistor, Chip, 1/4W, 1%	1206	Std	
R24	1	39.2 k Ω	Resistor, Chip, 1/10W, 1%	0603	Std	
T1	1		Transformer	EE-16	Würth	750341086
TP1, TP2	0	DNP	Test Point, SMT		Keystone	5015
VR1	1		Varistor, 300 VAC, 385 VDC, 30J	7 mm Radial	EPCOS	S07K300E2

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