PMP8020
TPS92560
High Power 20W AR111 Boost LED Driver Reference Design

September, 2013

High Power 20W AR111 Boost LED Driver Reference Design

1 Introduction

This reference design is to demonstrate a very good compatibility of power source boost topology LED driver based on TPS92560. This LED driver is designed for converting a power source **DC, AC & E-transformer** to a **regulated average LED current**.

The operating conditions and performance of the reference design are as follows:

- Power source: 12VDC, 12VAC / 50Hz 60Hz or 12VAC E-transformer.
- LED Load: 30V - 40V LED voltage, 500mA regulated average LED Current
- Typical System Efficiency = **86% @ 12V DC**
- High Power Factor > **0.9 @ 12V AC**
- Output open-circuit protection

2 Connection Description

1. **CN1**
   This connector is for the LED load. Use the screw down terminal to connect the LED anode to the pin marked LED+ and connect the LED cathode to the pin marked LED-.

2. **CN2**
   This connector is for the AC/DC input supply to the board. Use the screw down terminal to connect supply to the circuit.

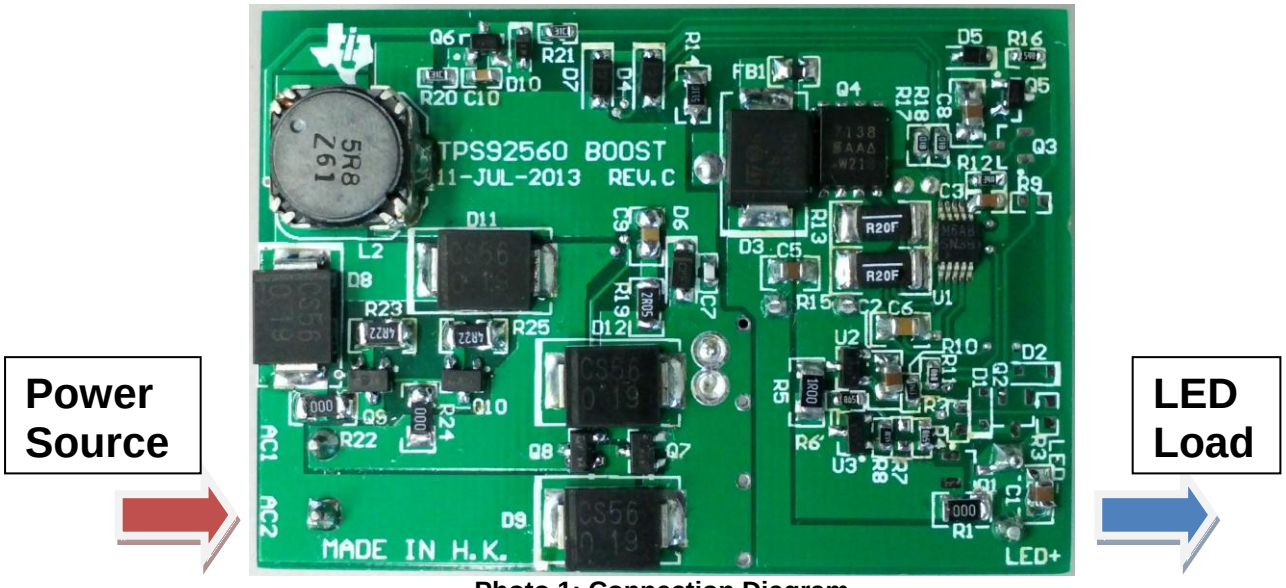

Photo 1: Connection Diagram

3 Schematic

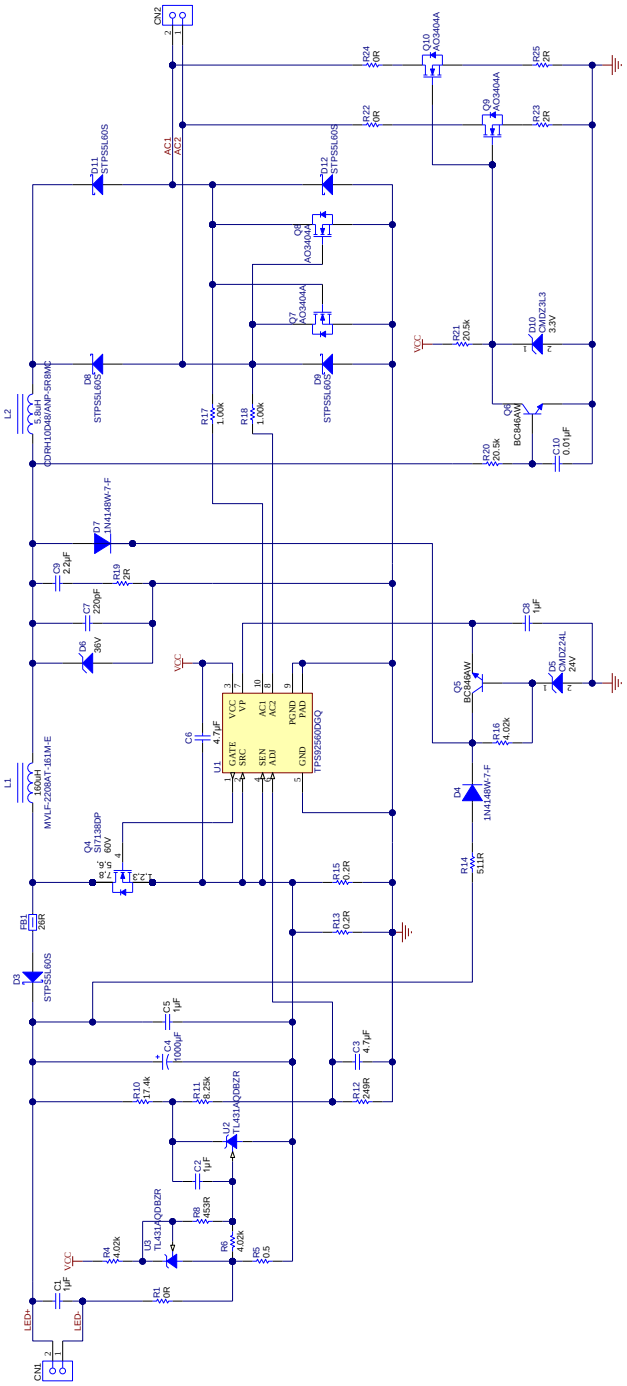

Figure 1: TPS92560 20W Boost LED Driver Schematic

4 Performance Data and Typical Characteristic Curves

Figures 2 through 7 present typical performance curves for TPS92560 20W Boost LED Driver

Specifications

- Output Power ≈ 20W
- Input Voltage = 12VDC, or 12Vac / 50Hz 60Hz, or 12VAC E-transformer
- LED Forward Voltage ≈ 40V
- LED Current ≈ 500mA
- Efficiency > 86% @ 12VDC
- Power Factor ≥ 0.9 @ 12VAC
- Topology: Boost

Test Conditions

- LED Forward Voltage ≈ 40V
- LED Current ≈ 500mA
- Ambient Temperature ≈ 25^{0}C

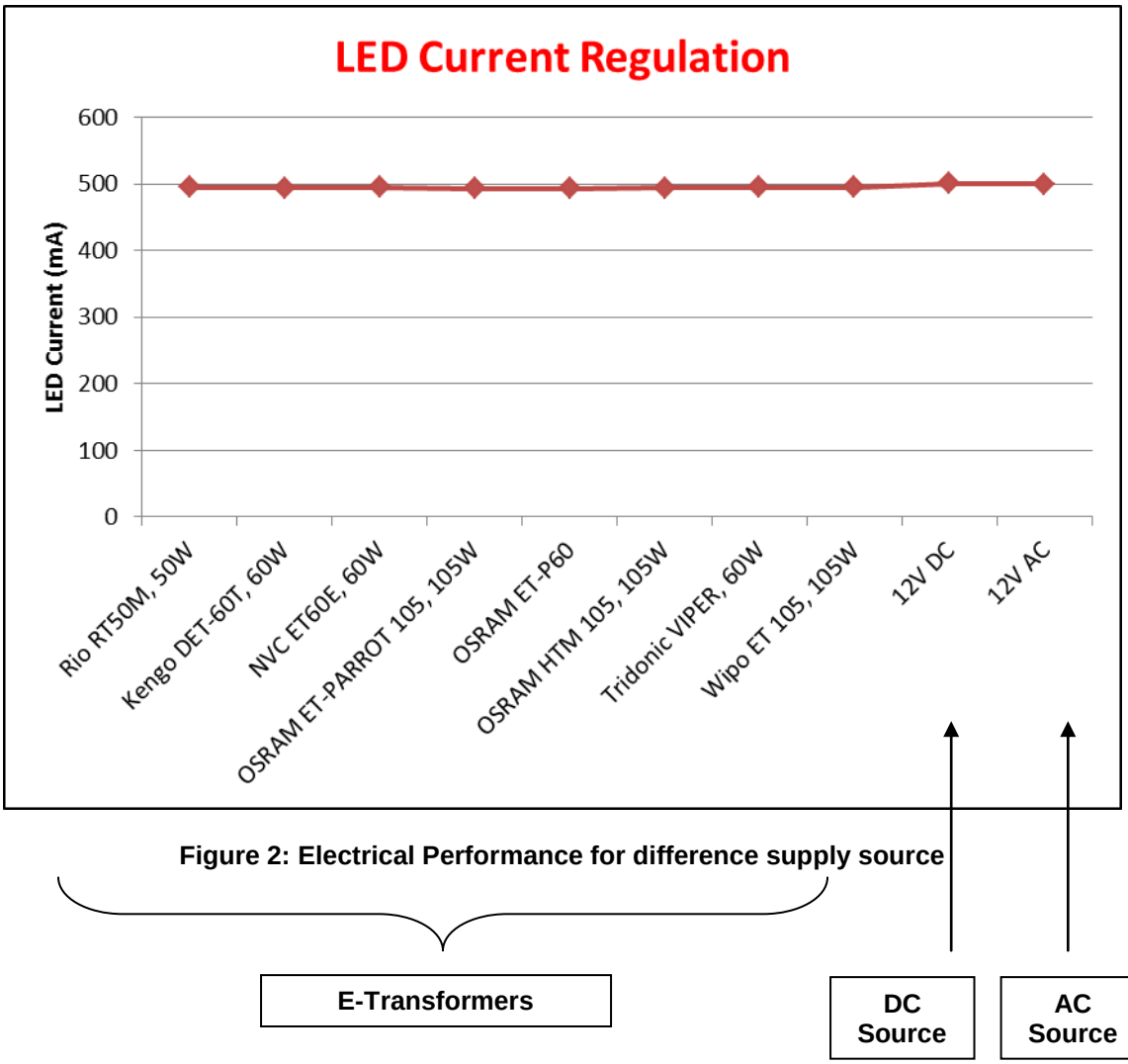

Figure 2: Electrical Performance for difference supply source

Electrical Performance for DC Source

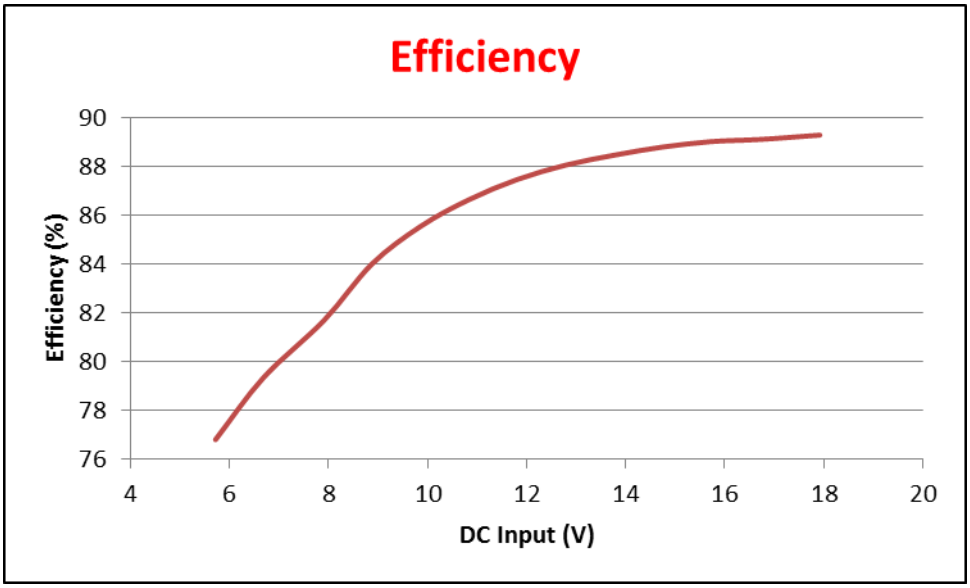

Figure 3: Efficiency at DC Supply Source

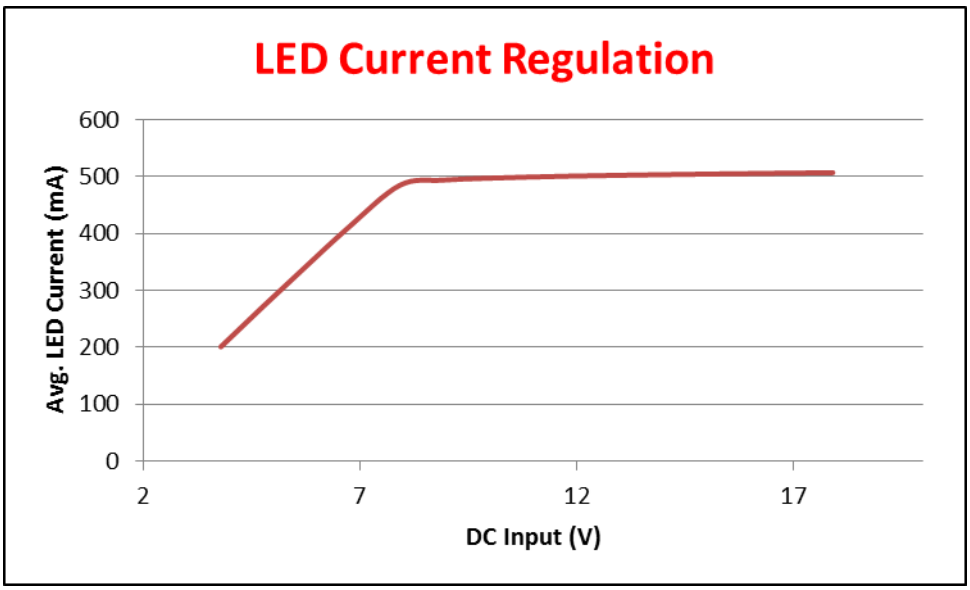

Figure 4: LED Current Regulation at DC Supply Source

Electrical Performance for AC / 50Hz source

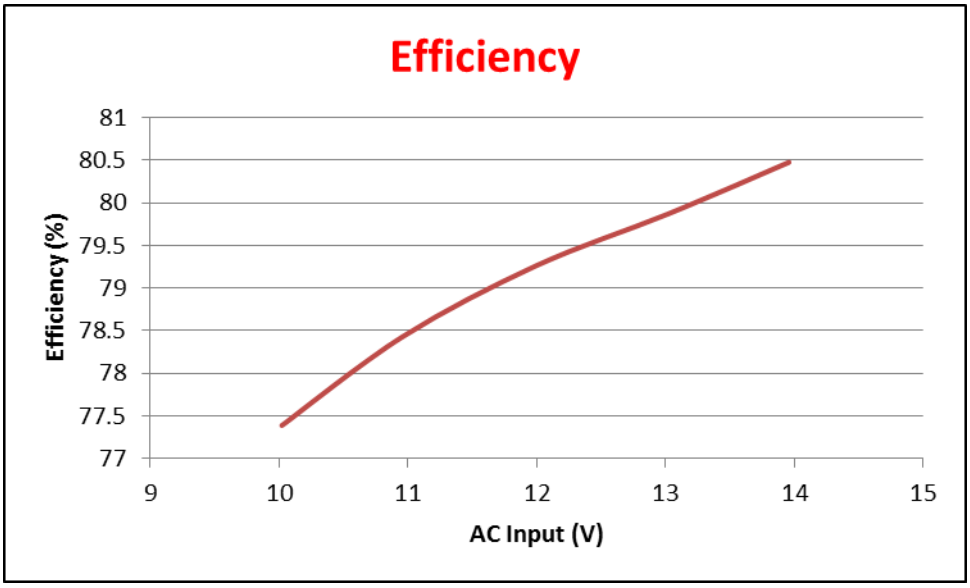

Figure 5: Efficiency at AC Supply Source

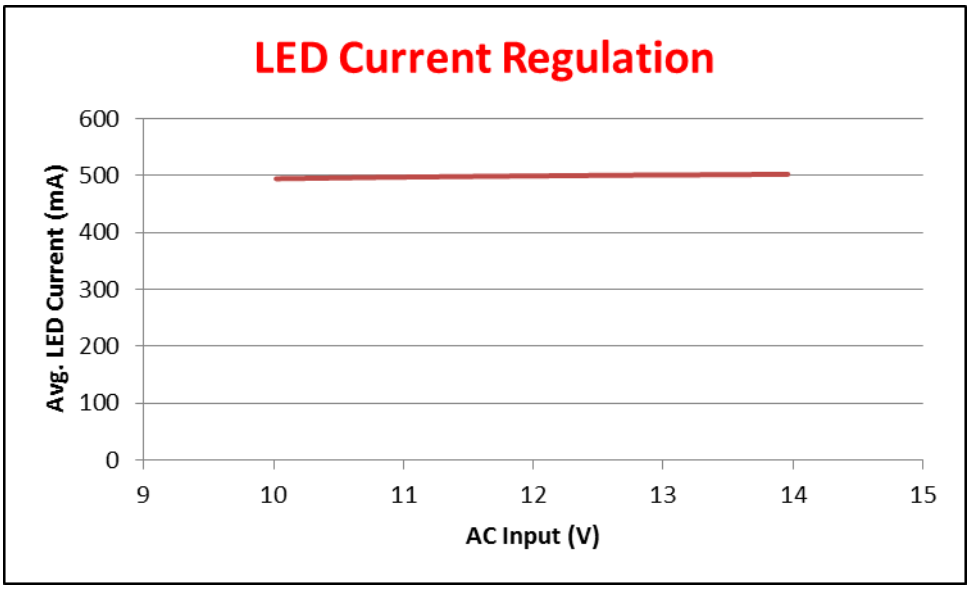

Figure 6: LED Current Regulation at AC Supply Source

Waveform for E-Transformer Source operation

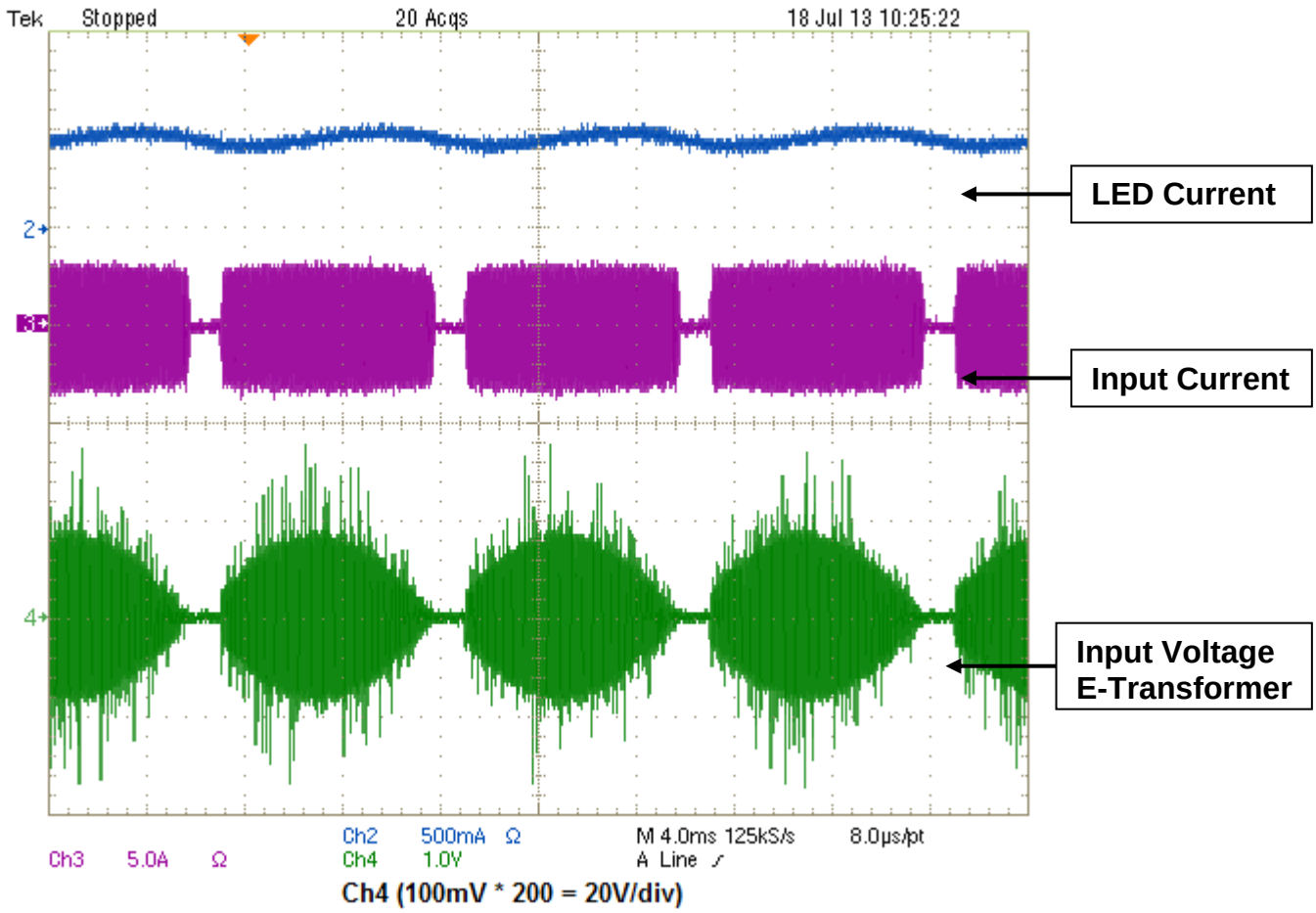

Figure 7: Waveform for E-Transformer (Osram ET-A60)

5 Conducted EMI Performance

Test Specification/Standard: EN55015
Operation Condition: with E-Transformer (Osram ECO-ET60) at 230VAC 50Hz

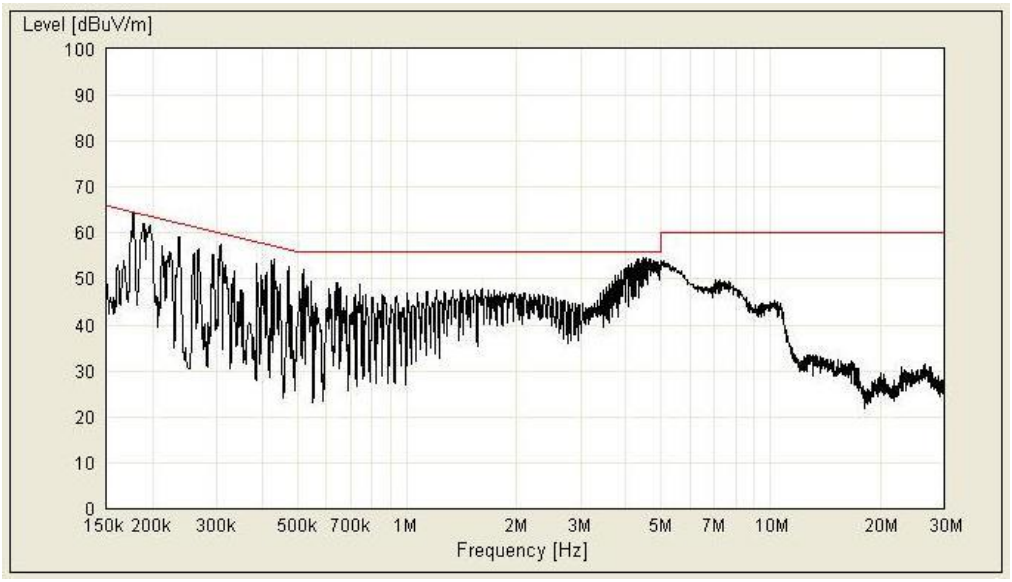

Figure 8: Conducted EMI (Line) Scan

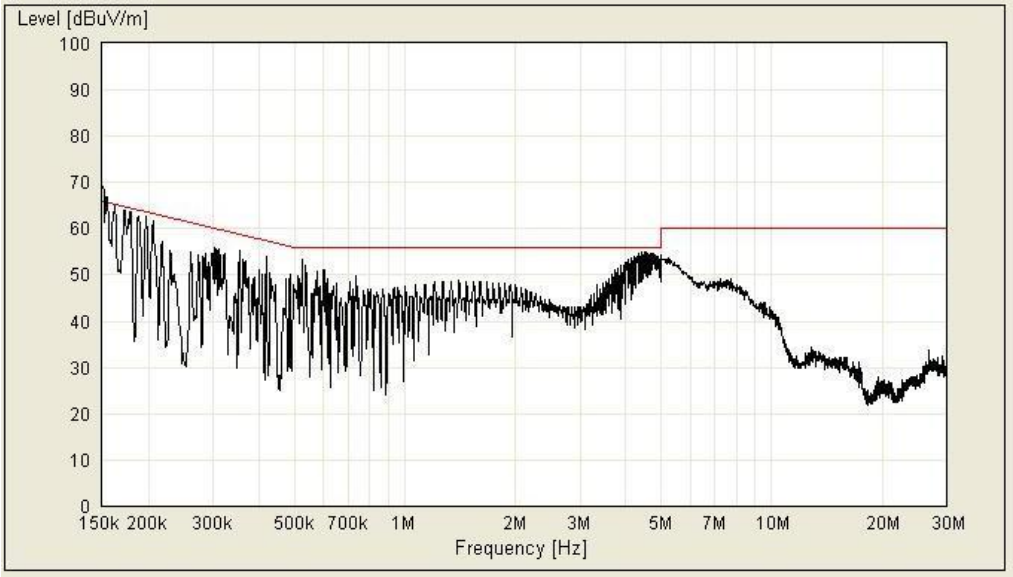

Figure 9: Conducted EMI (Neutral) Scan

6 Radiated EMI Performance

Test Specification/Standard: EN55015
Antenna: Height=3m / Range = 10m
Operation Condition: with E-Transformer (Osram ECO-ET60) at 230VAC 50Hz

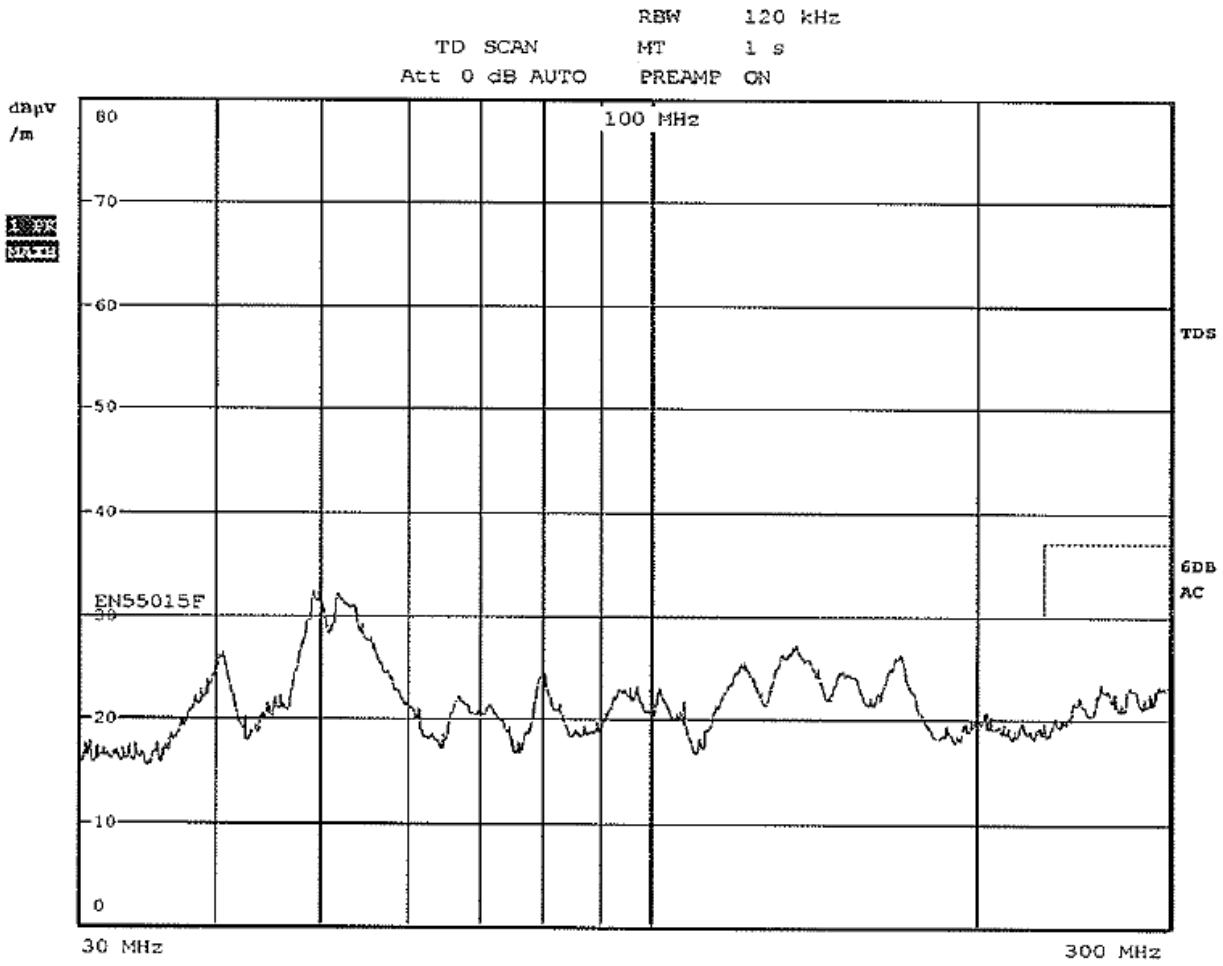

Figure 10: Radiated EMI (Vertical) Scan

	Frequency (MHz)	Detector Type (pk/av/qp)	Ant. Pol. (H/V)	Ant. Height (m)	Turntable Azimuth (°)	Result (dBµV/m)	Limit (dBµV/m)	Margins & Comments
14	49.700	QP	V	1.0	300	27.7	30.0	Pass
14	52.640	QP	V	1.0	0	27.7	30.0	Pass

Figure 11: QPK Measurement (Vertical)

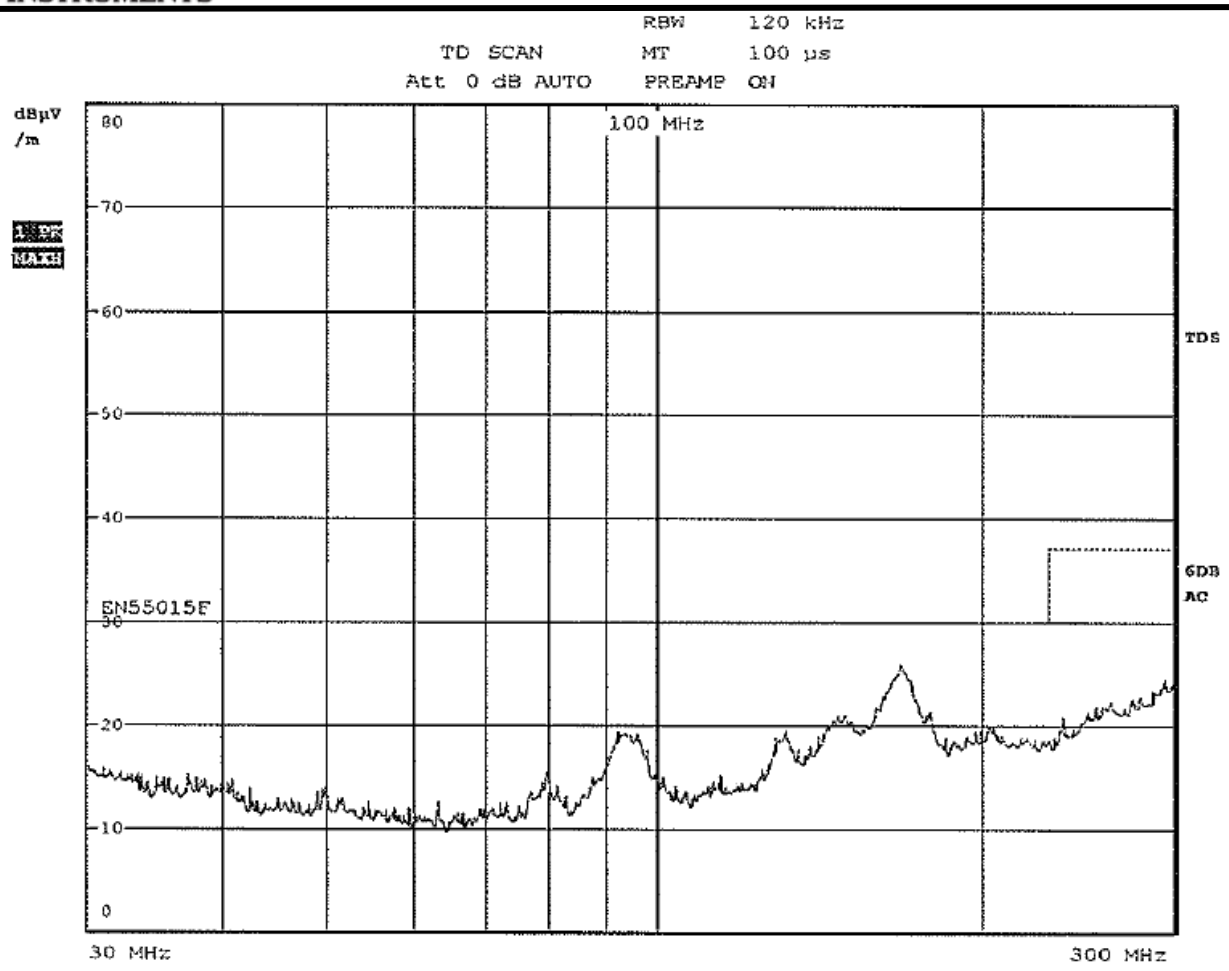

Figure 12: Radiated EMI (Horizontal) Scan

7 TPS92560 High Power 20W Boost LED Driver Reference Design PCB layout

The following figures (Figure 13 through Figure 14) show the design of the printed circuit board.

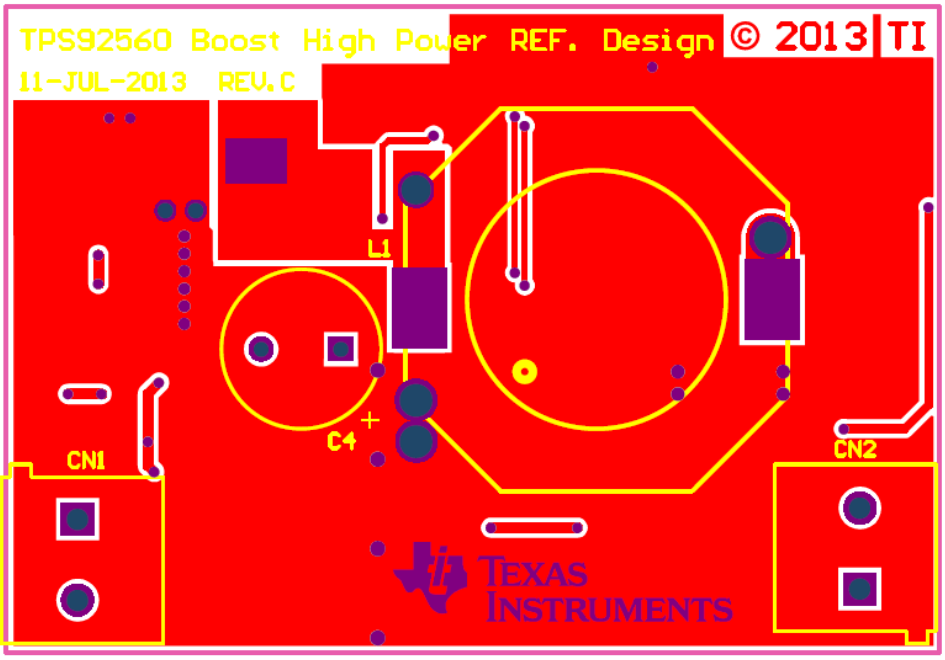

Figure 13: Top Layer and Top Overlay (Top view)

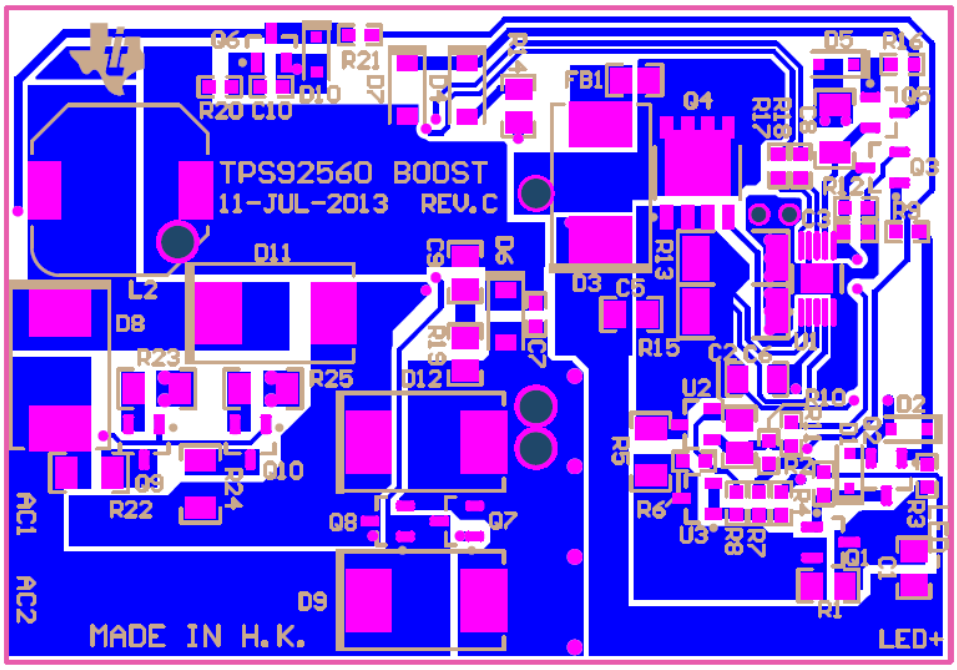

Figure 14: Bottom Layer and Bottom Overlay (Bottom view)

8 Bill of Materials

Designator	Description	Manufacturer	PartNumber	Quantity
C1, C2, C5	CAP, CERM, 1uF, 50V, +/-10%, X7R, 0805	MuRata	GRM21BR71H105KA12L	3
C3	CAP, CERM, 4.7uF, 16V, +/-10%, X5R, 0603	MuRata	GRM188R61C475KAAJ	1
C4	CAP ALUM 1000UF 50V 20% RADIAL	United Chemi-Con	EKZE500ELL102ML25S	1
C6	CAP, CERM, 4.7uF, 10V, +/-10%, X5R, 0805	MuRata	GRM219R61A475KE34	1
C7	CAP, CERM, 220pF, 100V, +/-5%, C0G/NP0, 0603	MuRata	GRM1885C2A221JA01D	1
C8	CAP, CERM, 1uF, 50V, +/-10%, X7R, 1206	MuRata	GRM31MR71H105KA88L	1
C9	CAP, CERM, 2.2uF, 25V, +/-10%, X7R, 0805	MuRata	GRM21BR71E225KA73L	1
C10	CAP, CERM, 0.01uF, 50V, +/-10%, X7R, 0603	MuRata	GRM188R71H103KA01D	1
CN1, CN2	Conn Term Block, 2POS, 5.08mm PCB	Phoenix Contact	1715721	2
D3, D8, D9, D11, D12	Diode, Schottky, 60V, 5A, SMC	ST	STPS5L60S	5
D4, D7	Diode, Ultrafast, 100V, 0.15A, SOD-123	Diodes Inc.	1N4148W-7-F	2
D5	Diode, Zener, 24V, 250mW, SOD-323	Central Semiconductor	CMDZ24L	1
D6	Diode, Zener, 36V, 500mW, SOD-123	Central Semiconductor	CMHZ4715	1
D10	Diode, Zener, 3.3V, 250mW, SOD-323	Central Semiconductor	CMDZ3L3	1
FB1	6A Ferrite Bead, 26 ohm @ 100MHz, SMD	MuRata	BLM18SG260TN1D	1
L1	Inductor, 160uH, 3A, 0.07 ohm, Shield Core, Ferrite, SMT	MAG. LAYERS	MVLF-2208AT-161M-E	1
L2	Inductor, 5.8uH, SMD	SUMIDA AMERICA COMPONENTS INC	CDRH10D48/ANP-5R8MC	1
Q4	MOSFET, N-CH, 60V, 30A, PowerPAK SO-8	Vishay-Siliconix	SI7138DP	1
Q5, Q6	Transistor, NPN, 65V, 0.1A, SOT-23	ON Semiconductor	BC846AW	2
Q7, Q8, Q9, Q10	MOSFET, N-CH, 30V, 5.8A, SOT-23		AO3404A	4
R1	RES, 0 ohm, 5%, 0.125W, 0805	Vishay-Dale	CRCW08050000Z0EA	1
R4, R6, R16	RES, 4.02k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW06034K02FKEA	3
R5	RES, 0.5 ohm, 1%, 0.5W, 1206	Stackpole Electronics Inc	CSR1206FKR500	1
R8	RES, 453 ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603453RFKEA	1
R10	RES, 17.4k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW060317K4FKEA	1
R11	RES, 8.25k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW06038K25FKEA	1
R12	RES, 249 ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603249RFKEA	1
R13, R15	RES, 0.2 ohm, 1%, 0.5W, 1210	Rohm	MCR25JZHFLR200	2
R14	RES, 511 ohm, 1%, 0.125W, 0805	Vishay-Dale	CRCW0805511RFKEA	1
R17, R18	RES, 1.00k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW06031K00FKEA	2
R19	RES, 2.00 ohm, 1%, 0.125W, 0805	Vishay-Dale	CRCW08052R00FKEA	1
R20, R21	RES, 20.5k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW060320K5FKEA	2
R22, R24	RES, 0 ohm, 5%, 0.25W, 1206	Vishay-Dale	CRCW12060000Z0EA	2
R23, R25	RES, 2.00 ohm, 1%, 0.25W, 1206	Vishay-Dale	CRCW12062R00FKEA	2
U1	SIMPLE LED DRIVER FOR MR16 AND AR111 APPLICATIONS, DGQ0010A	Texas Instruments	TPS92560DGQ	1
U2, U3	Adjustable Precision Zener Shunt Regulator, 3-pin SOT-23	Texas Instruments	TL431AQDBZR	2

Table 1: The TPS92560 20W Boost components list according to the schematic shown in Figure 1

9 Appendix – Short Circuit Protection

For an accidental short across the LED+ and LED– terminals of the board, external short protection circuitry should be given sufficient protection to prevent the damage of components. For reconnecting terminals with a LED load, the LED could instantly light on.

8.1 Schematic

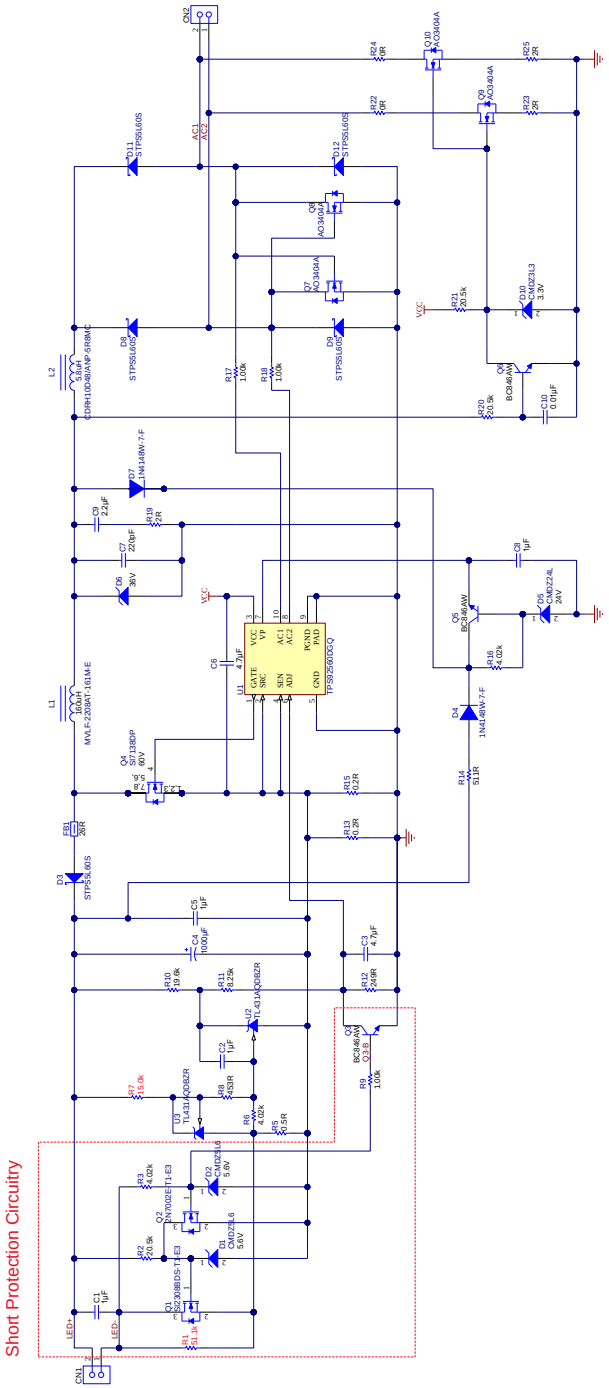

Figure 15: TPS92560 20W Boost LED Driver with Short Protection Schematic

8.2 Bill of Materials

Designator	Description	Manufacturer	PartNumber	Quantity
C1, C2, C5	CAP, CERM, 1uF, 50V, +/-10%, X7R, 0805	MuRata	GRM21BR71H105KA12L	3
C3	CAP, CERM, 4.7uF, 16V, +/-10%, X5R, 0603	MuRata	GRM188R61C475KAAJ	1
C4	CAP ALUM 1000UF 50V 20% RADIAL	United Chemi-Con	EKZE500ELL102ML25S	1
C6	CAP, CERM, 4.7uF, 10V, +/-10%, X5R, 0805	MuRata	GRM219R61A475KE34	1
C7	CAP, CERM, 220pF, 100V, +/-5%, C0G/NP0, 0603	MuRata	GRM1885C2A221JA01D	1
C8	CAP, CERM, 1uF, 50V, +/-10%, X7R, 1206	MuRata	GRM31MR71H105KA88L	1
C9	CAP, CERM, 2.2uF, 25V, +/-10%, X7R, 0805	MuRata	GRM21BR71E225KA73L	1
C10	CAP, CERM, 0.01uF, 50V, +/-10%, X7R, 0603	MuRata	GRM188R71H103KA01D	1
CN1, CN2	Conn Term Block, 2POS, 5.08mm PCB	Phoenix Contact	1715721	2
D1, D2	Diode, Zener, 5.6V, 250mW, SOD-323	Central Semiconductor	CMDZ5L6	2
D3, D8, D9, D11, D12	Diode, Schottky, 60V, 5A, SMC	ST	STPS5L60S	5
D4, D7	Diode, Ultrafast, 100V, 0.15A, SOD-123	Diodes Inc.	1N4148W-7-F	2
D5	Diode, Zener, 24V, 250mW, SOD-323	Central Semiconductor	CMDZ24L	1
D6	Diode, Zener, 36V, 500mW, SOD-123	Central Semiconductor	CMHZ4715	1
D10	Diode, Zener, 3.3V, 250mW, SOD-323	Central Semiconductor	CMDZ3L3	1
FB1	6A Ferrite Bead, 26 ohm @ 100MHz, SMD	MuRata	BLM18SG260TN1D	1
L1	Inductor, 160uH, 3A, 0.07 ohm, Shield Core, Ferrite, SMT	MAG. LAYERS	MVLF-2208AT-161M-E	1
L2	Inductor, 5.8uH, SMD	SUMIDA AMERICA COMPONENTS INC	CDRH10D48/ANP-5R8MC	1
Q1	MOSFET N-CH 60V 2.3A SOT23-3	Vishay Siliconix	SI2308BDS-T1-E3	1
Q2	MOSFET, N-CH, 60V, 0.24A, SOT-23	Vishay-Siliconix	2N7002E-T1-E3	1
Q3, Q5, Q6	Transistor, NPN, 65V, 0.1A, SOT-23	ON Semiconductor	BC846AW	3
Q4	MOSFET, N-CH, 60V, 30A, PowerPAK SO-8	Vishay-Siliconix	SI7138DP	1
Q7, Q8, Q9, Q10	MOSFET, N-CH, 30V, 5.8A, SOT-23		AO3404A	4
R1	RES, 51.1k ohm, 1%, 0.125W, 0805	Vishay-Dale	CRCW080551K1FKEA	1
R2, R20, R21	RES, 20.5k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW060320K5FKEA	3
R3, R6, R16	RES, 4.02k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW06034K02FKEA	3
R5	RES, 0.5 ohm, 1%, 0.5W, 1206	Stackpole Electronics Inc	CSR1206FKR500	1
R7	RES, 15.0k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW060315K0FKEA	1
R8	RES, 453 ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603453RFKEA	1
R9, R17, R18	RES, 1.00k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW06031K00FKEA	3
R10	RES, 17.4k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW060317K4FKEA	1
R11	RES, 8.25k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW06038K25FKEA	1
R12	RES, 249 ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603249RFKEA	1
R13, R15	RES, 0.2 ohm, 1%, 0.5W, 1210	Rohm	MCR25JZHFLR200	2
R14	RES, 511 ohm, 1%, 0.125W, 0805	Vishay-Dale	CRCW0805511RFKEA	1
R19	RES, 2.00 ohm, 1%, 0.125W, 0805	Vishay-Dale	CRCW08052R00FKEA	1
R22, R24	RES, 0 ohm, 5%, 0.25W, 1206	Vishay-Dale	CRCW12060000Z0EA	2
R23, R25	RES, 2.00 ohm, 1%, 0.25W, 1206	Vishay-Dale	CRCW12062R00FKEA	2
U1	SIMPLE LED DRIVER FOR MR16 AND AR111 APPLICATIONS, DGQ0010A	Texas Instruments	TPS92560DGQ	1
U2, U3	Adjustable Precision Zener Shunt Regulator, 3-pin SOT-23	Texas Instruments	TL431AQDBZR	2

Table 2: The TPS92560 20W Boost components list according to the schematic shown in Figure 15

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No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed an agreement specifically governing such use.

Only those TI components that TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components that have ***not*** been so designated is solely at Buyer's risk, and Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

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