

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



July, 2013

# High Power 20W 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.

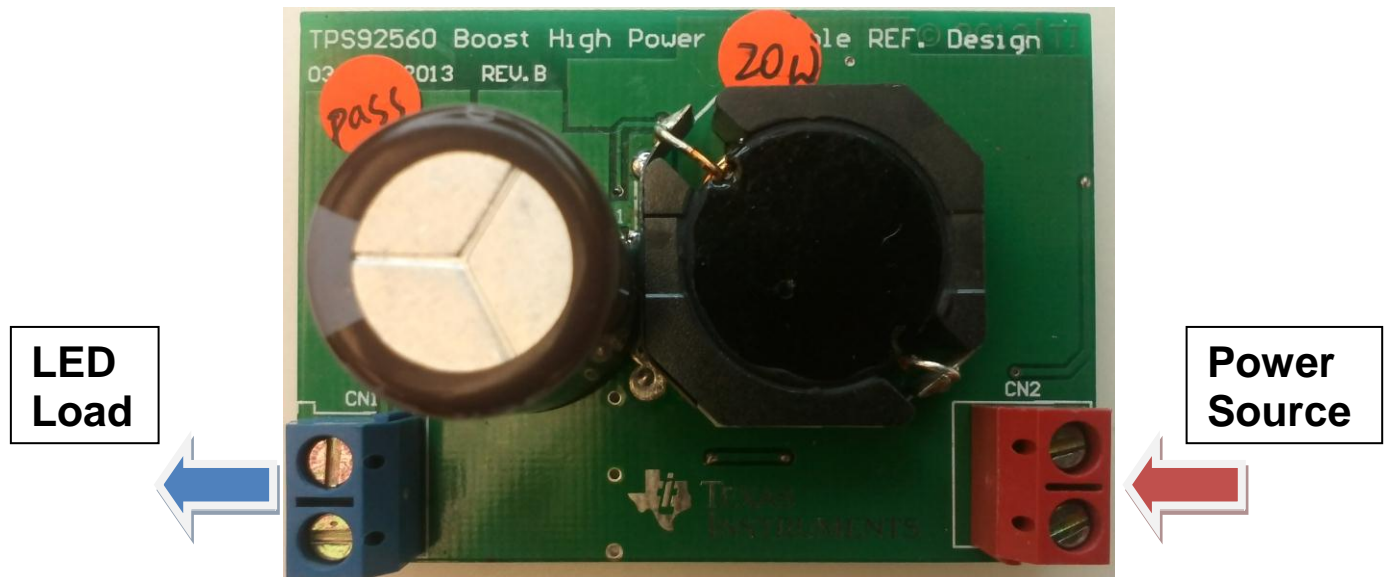


Photo 1: Connection Diagram

3 Schematic

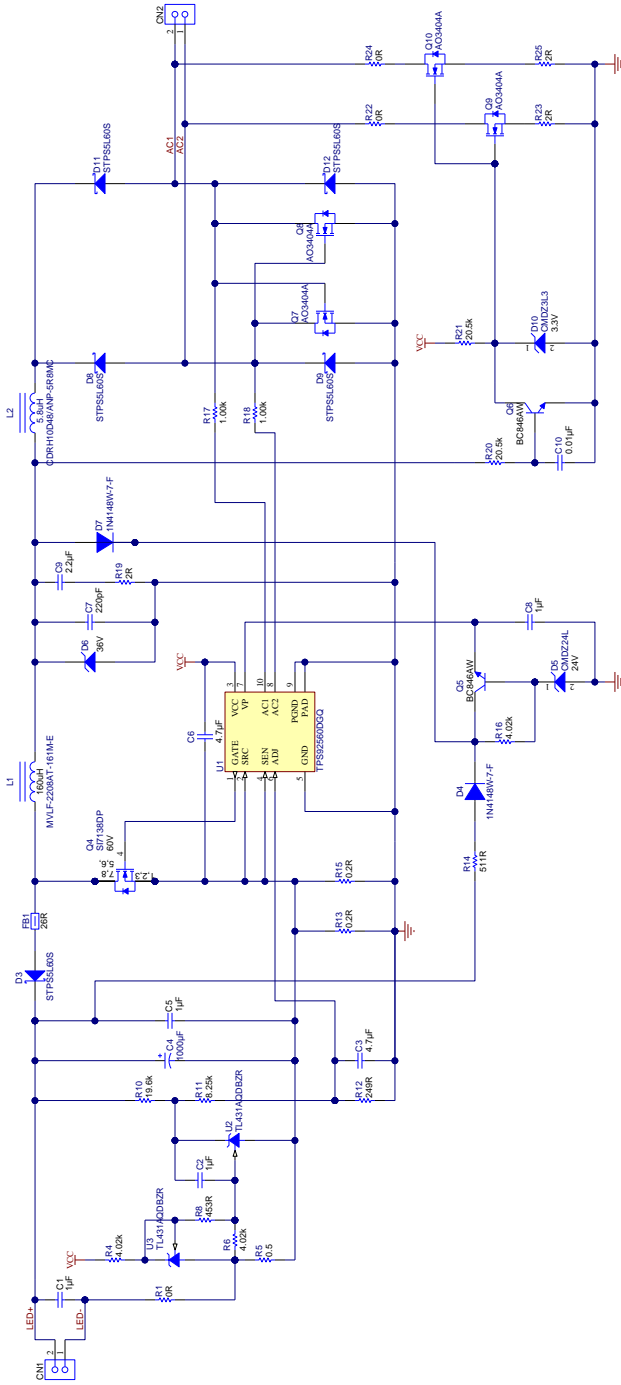


Figure 1: TPS92560 20W Boost LED Driver Schematic

#### 4 Performance Data and Typical Characteristic Curves

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

##### Specifications

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

##### Test Conditions

- LED Forward Voltage  $\approx$  40V
- LED Current  $\approx$  500mA
- Ambient Temperature  $\approx$  25°C

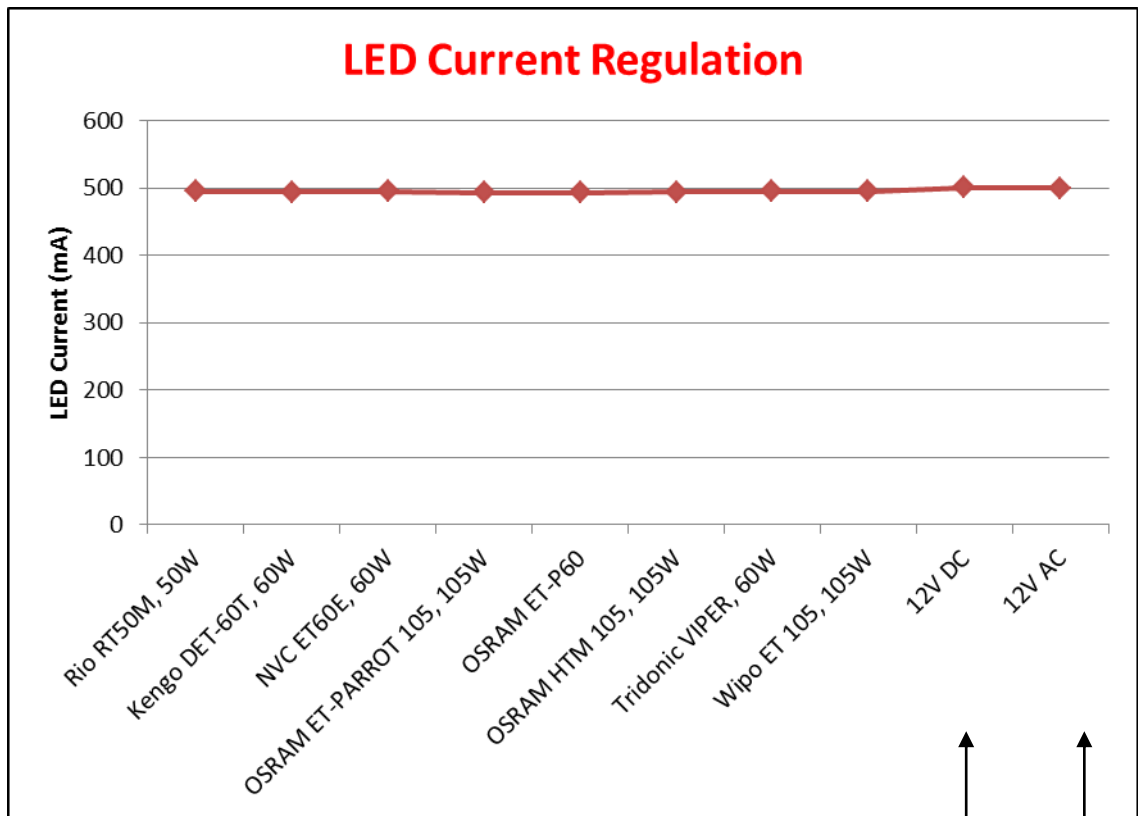
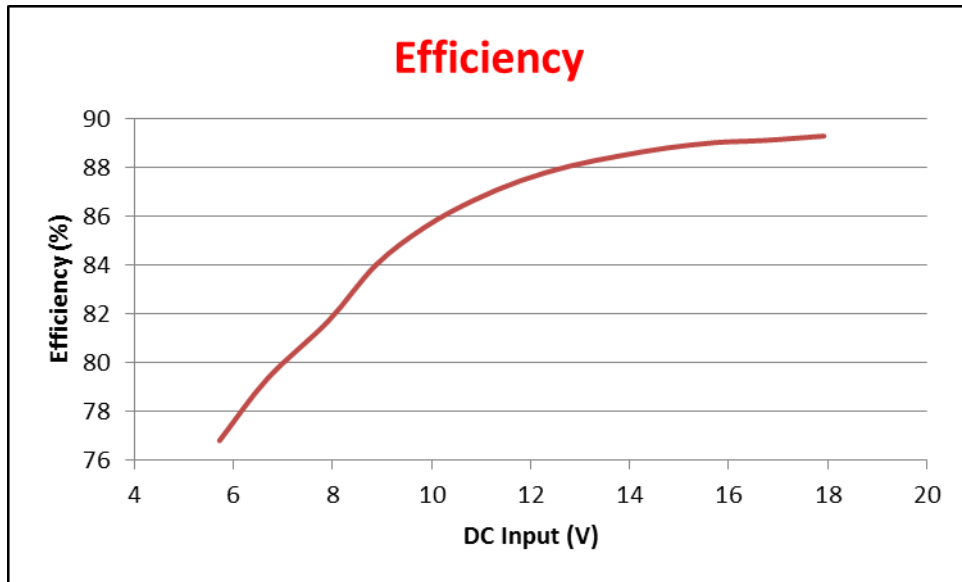


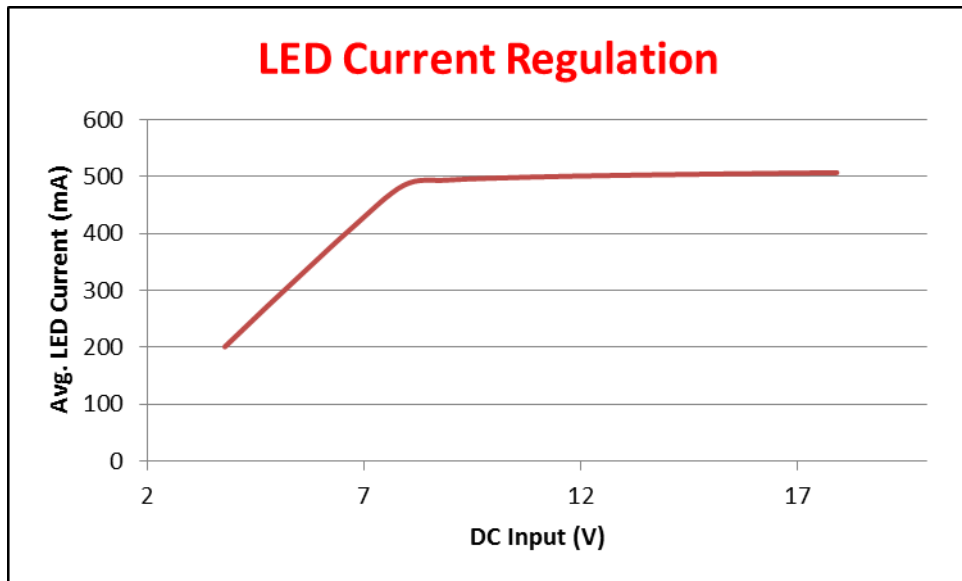
Figure 2: Electrical Performance for difference supply source



**Electrical Performance for DC Source**

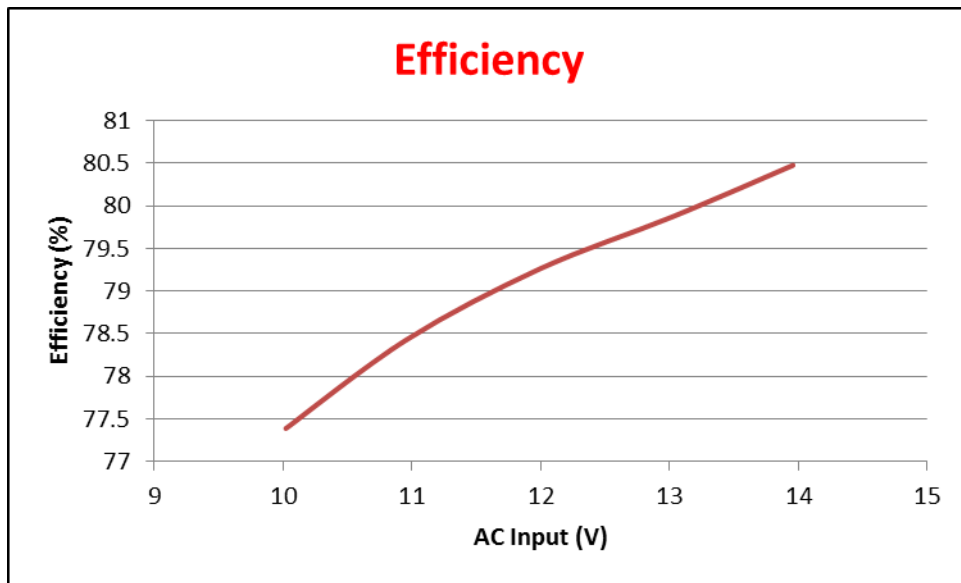


**Figure 3: Efficiency at DC Supply Source**

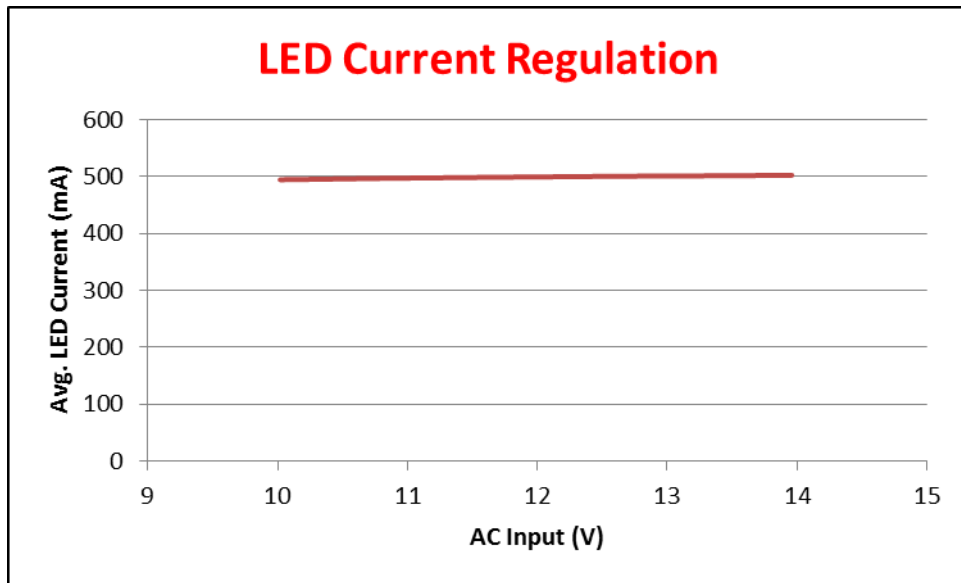


**Figure 4: LED Current Regulation at DC Supply Source**

**Electrical Performance for AC / 50Hz source**

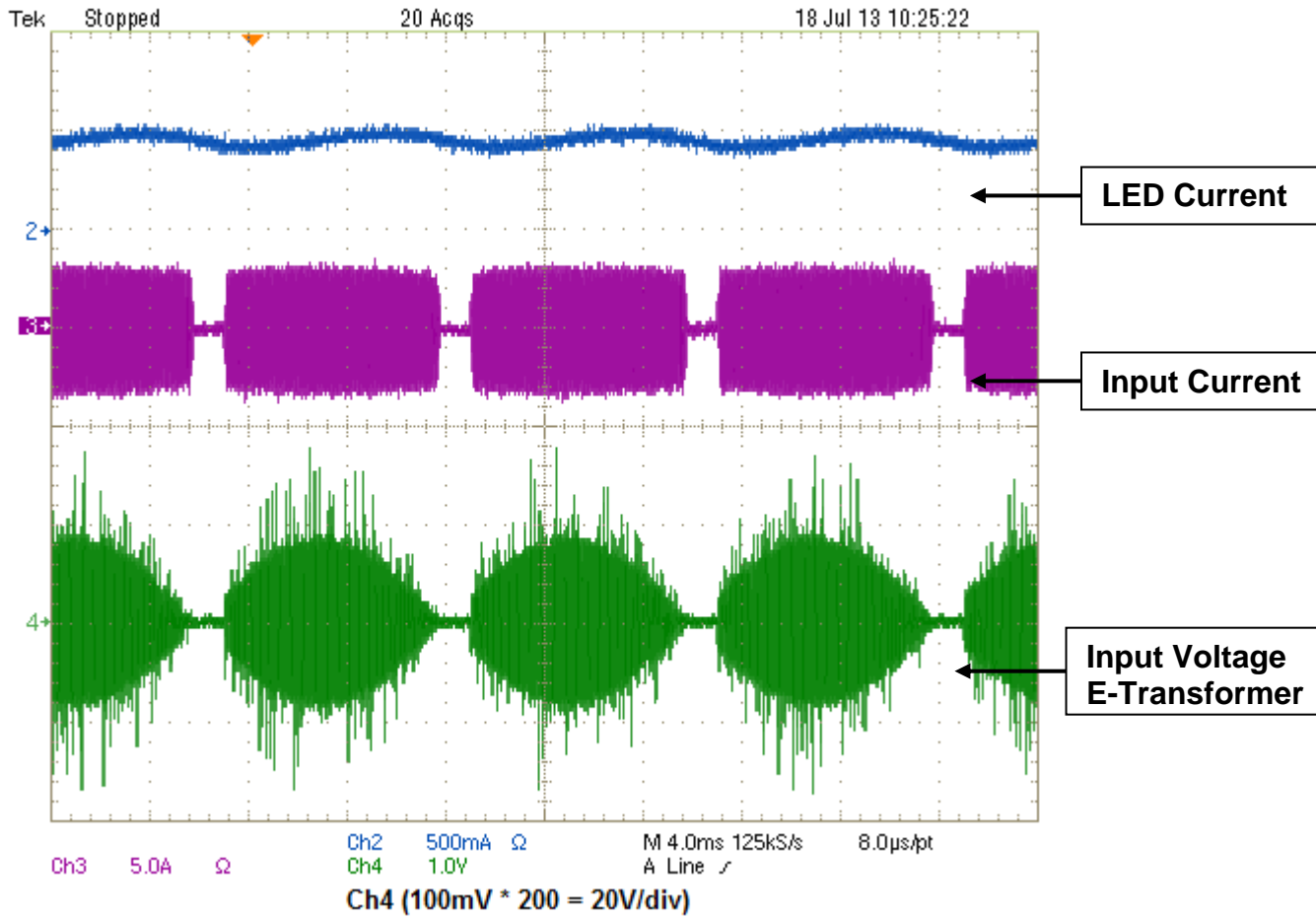


**Figure 5: Efficiency at AC Supply Source**



**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 EMI Performance

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

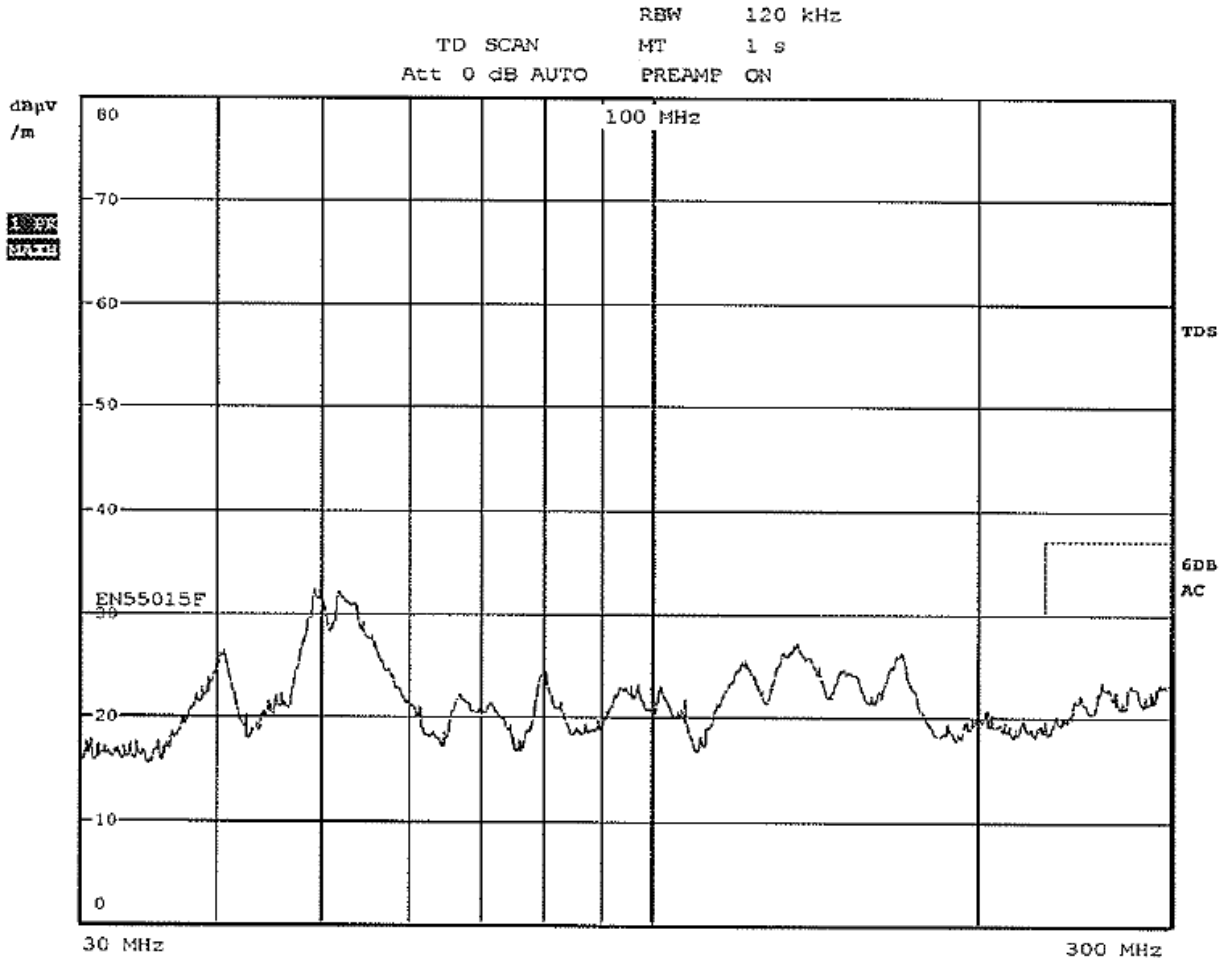
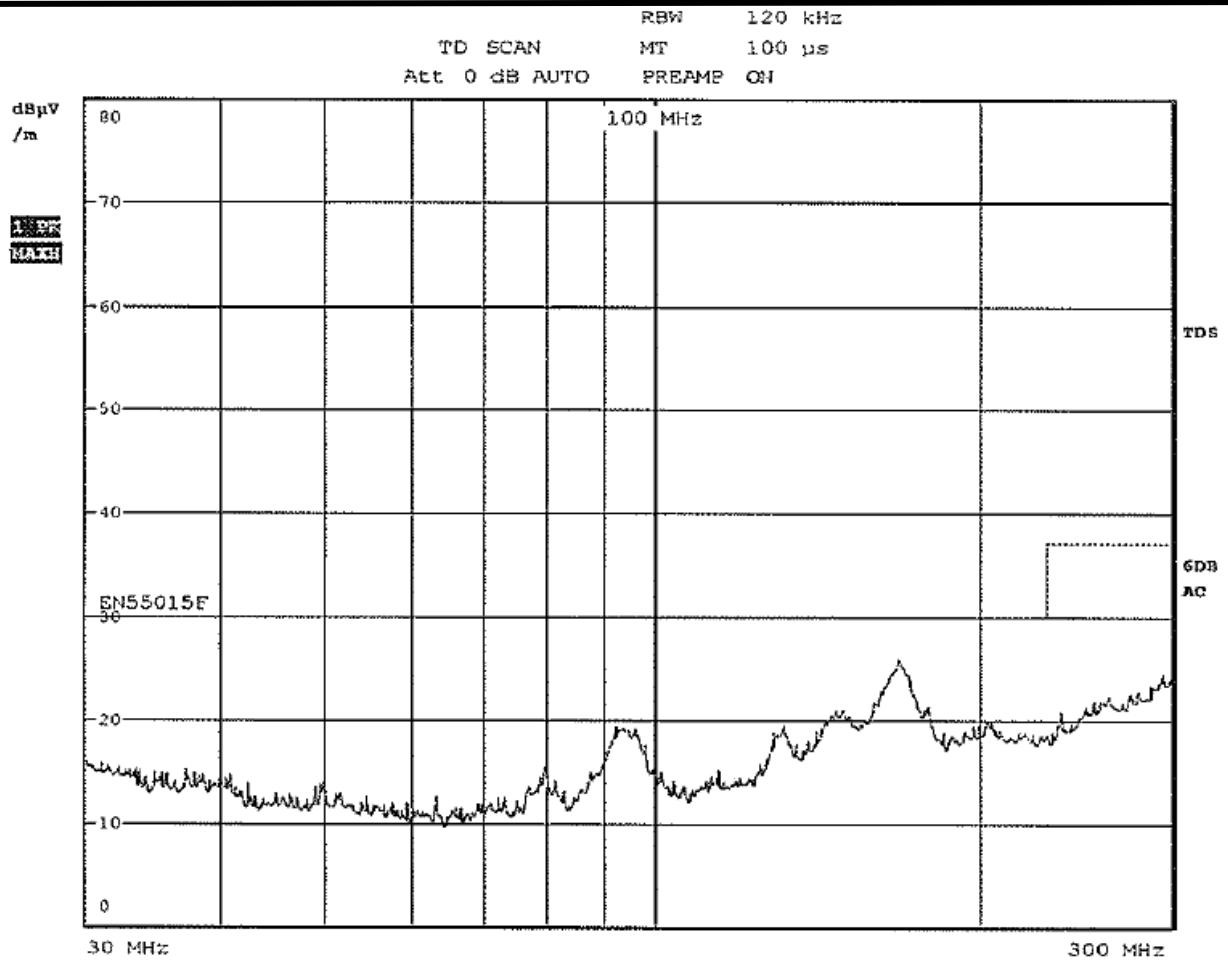


Figure 8: Radiated EMI (Vertical) Scan

	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 9: QPK Measurement (Vertical)

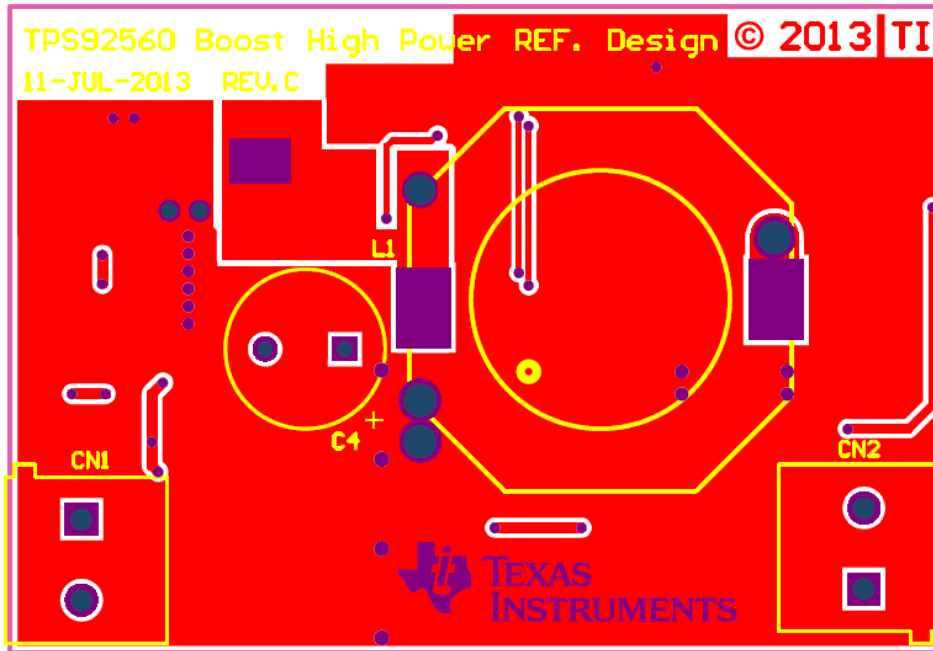




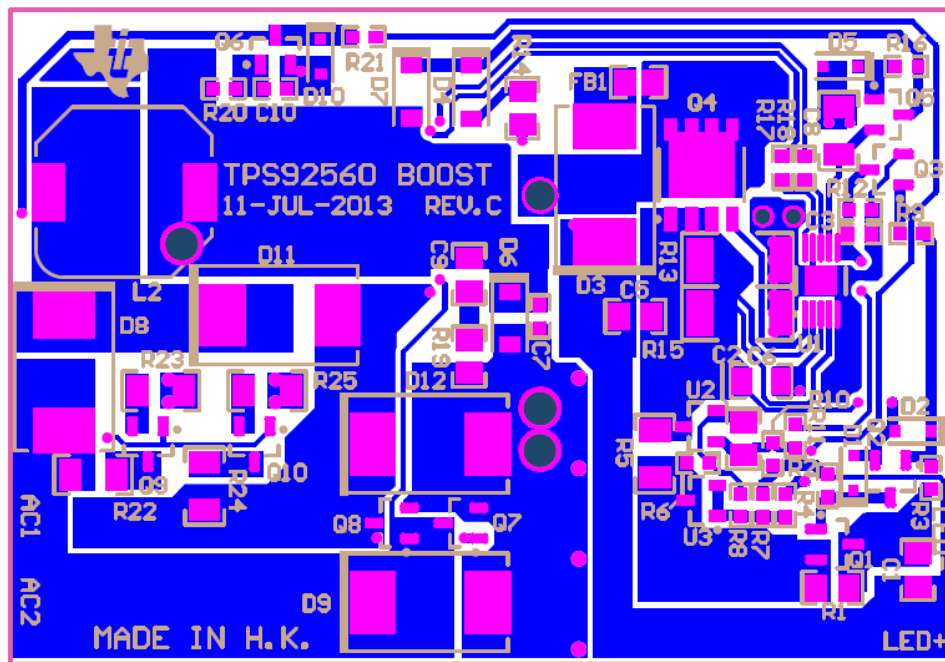
**Figure 10: Radiated EMI (Horizontal) Scan**

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

The following figures (Figure 11 through Figure 12) show the design of the 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**

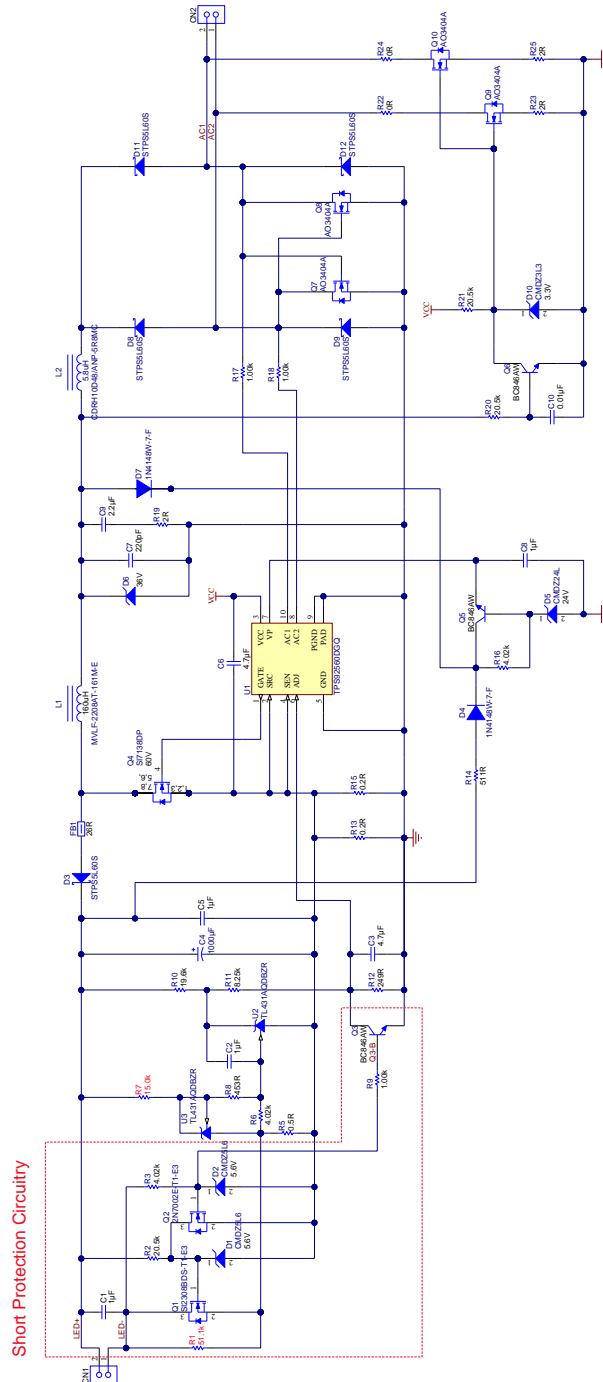
Designator	Description	Manufacturer	PartNumber	Quantity
C1, C2, C5	CAP, CERM, 1uF, 50V, +/-10%, X7R, 0805	MuRata	GRM21BR71H105KA12L	3
C3	CAP, CERM, 4.7uF, 16V, +/-10%, X5R, 0603	MuRata	GRM188R61C475KAAJ	1
C4	CAP ALUM 1000UF 50V 20% RADIAL	United Chemi-Con	EKZE500ELL102ML25S	1
C6	CAP, CERM, 4.7uF, 10V, +/-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, 19.6k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW060319K6FKEA	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	TPS92560DGG	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**

**8 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 13: 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, 19.6k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW060319K6FKEA	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 13**

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Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
RF/IF and ZigBee® Solutions	<a href="http://www.ti.com/lprf">www.ti.com/lprf</a>

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Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
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Telephony	<a href="http://www.ti.com/telephony">www.ti.com/telephony</a>
Video & Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
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