TPS62110EVM-346

This user's guide describes the characteristics, operation, and use of the TPS62110EVM-346 WLED Drive and Voltage Regulator evaluation module (EVM). The EVM features two independent circuits, one demonstrates the device as a typical voltage regulator and a second demonstrates the circuit as a current regulator driving a white LED (WLED). This user's guide includes setup instructions for the hardware, a schematic diagram, a bill of materials, and printed-circuit board layout drawings for the evaluation module.

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1 Introduction

The Texas Instruments TPS62110 is a synchronous, step-down converter. With a high-switching, operating frequency of 1 MHz, external components are small; the typical inductor size is 6.8 µH, and the overall solutions area is 20 mm × 15 mm. The power switch current limit of 2.4 A provides a typical output current of 1.5 A across a wide input voltage range of 5 V to 17 V.

1.1 Background

The TPS62110EVM-346 uses the TPS62110 in two independent circuits. The U1 circuit is configured as a current regulator driving a WLED at 500 mA. The U2 circuit is the traditional voltage regulator circuit set to a 3.3-V output. The EVM operates with full-rated performance at an input voltage between 4 V and 17 V.

Golden DRAGON is a trademark of OSRAM Opto Semiconductor GmbH.

1.2 Performance Specification

Table 1 provides a summary of the TPS62110EVM-346 performance specifications. All specifications are given for an ambient temperature of 25°C.

Table 1. Performance Specification Summary

Specification	Test Conditions	Min	Typ	Max	Unit
U1 Input Voltage		5		17	V
U1 WLED Current		450	500	550	mA
U1 Low Battery Output (LBO)			8.5		V
U2 Input Voltage		5		17	V
U2 Output Voltage	Iout = 10 mA to 1500 mA	3.267	3.3	3.333	V
U2 Output Current		0		1500	mA
U2 LBO	VIN		8.5		V
U2 Power Good (PG)	VOUT		3.25		V

1.3 WLED U1 Section

The upper EVM section with integrated circuit (IC) U1 is configured as a WLED driver. The TPS62110 regulates the current through the OSRAM Golden DRAGON™ WLED at 500 mA from an input voltage range of 5 V to 17 V. To reduce power dissipation on the current sense resistor, an external voltage reference is used to sum a higher voltage into the FB node reducing sense voltage, V_{sense} from 1.153 mV to 255 mV.

This summing network combined with the control topology reduces the current regulator's accuracy. This can be seen following a load transient as a change in the current regulation point. The EVM with a V_{sense} voltage of 255 mV varies approximately 10%. But as V_{sense} voltage increases, accuracy improves, 500 mV will be about 5% and 1 V about 2%.

The TPS62110 can supply a wide range of current from 100 mA to 1500 mA by adjusting the sense resistor, R10, or the reference voltage network, R1 and R2.

The equations for calculating WLED current appear in Section 3.

The U1 circuit has the option to drive an external LED through connector J2. Onboard LED D4 must be disconnected by removing 0-Ω resistor R22.

Driving multiple external series LEDs is possible providing that Vout is less than the Vin stepdown or buck converter configuration. If this is done, verify that output capacitors C4 and C5 have a high enough voltage rating. Output capacitor positions C12 and C13 are available for additional capacitors, if needed.

1.3.1 Additional WLED Section Options

Additional Heat Sinking: If it is necessary to reduce operating temperature of the LED, a heat sink can be added to the backside of the circuit board. Several types of heat sinks work in this application with the appropriate double-sided thermal adhesive. One such heat sink is the Fischer Elecktronik SK477 which is a 23-mm wide, 6-mm tall, and 50-mm long standard extruded heat sink.

Optional LED Lens: To focus the LED in a tighter beam, lens are available that mount on the board, such as the Titanum-SS from Ledil or OPGD-1-002 from Dialight.

1.3.2 Modifications to 3.3-V Regulator Section, U2

The U2 is configured for evaluation of the adjustable output version. This unit is set to 3.3 V by R18 and R4. Resistors R18 and R4 can be changed to reset the output voltage between 1.2 V and 16 V; see the TPS62110 data sheet (SLVS585) for recommended values. If the output voltage is increased, verify that the output capacitors C7 and C6 voltage rating is appropriate. Also, two extra output capacitor positions are available if needed, C14 and C15.

U2 can be replaced with the fixed output version, TPS62111 or TPS62112. For this configuration, replace R18 with a 0-Ω resistor, and remove R4 and C3.

2 Setup

This section describes how to properly use the TPS62110EVM-346.

2.1 Input/Output Connector Descriptions

U1--WLED Section

J1–LED VIN and LED GND	WLED input voltage source connection. Positive connects to bottom three Vin pins, and negative connects to upper three GND pins.
J2–LED VOUT and LED GND	WLED output voltage connection
JP1–SYNC PFM/PWM	WLED high forces low-noise PWM mode, low enables power save PFM/PWM mode. Also input for synchronization, if used.
JP2–EN	WLED Enable pin, low = off and high = on; also open = on
J5–LBO/PG	Low-battery output (LBO); low indicates LBI is below its threshold. Power good (PG), low indicates output voltage is less than 98.4% of the normal value.

U2--3.3-V Regulator Section

J 3–VIN and GND	3.3-V regulator input voltage source connection. Positive connects to bottom three Vin pins, and negative connects to upper three GND pins.
J4--Vout and GND	3.3-V regulator output voltage connection. Positive connects to bottom three VOUT pins, and negative connects to upper three GND pins.
JP4–SYNC PFM/PWM	3.3-V regulator high forces low-noise PWM mode, low enables power save PFM/PWM mode. Also input for synchronization, if used.
JP3–EN	3.3-V regulator Enable pin, low = off and high = on. Also open = on.
J8–LBO/PG	Low-battery output (LBO) pulled up to Vout; low indicates LBI is below its threshold. Power good (PG), low indicates output voltage is less than 98.4% of the normal value.

2.2 Configuration Selection

Both sections of the EVM are designed to operate with an input voltage from 5 V to 17 V. Connect a power supply to the appropriate section input terminals. EN jumpers must be installed in the desired ON or OFF position, JP2 for the WLED or JP3 for the voltage regulator. The WLED is very bright and appropriate precautions must be taken. The unit operates with the SYNC jumper PWM or PWM/PFM position; this impacts efficiency. See the data sheet for additional information.

3 Design Procedure Divider Network

The TPS62110 feedback voltage (FB) is set to 1.153 V. If this is used for current regulation, the power dissipation of the sense resistor is high. To reduce the power dissipation on the current sense resistor R_{10}, a reference voltage of 2.5 V is summed resulting in the reduction of the V_{sense} voltage from 1.153 V to 0.255 V.

The first step is to choose the LED operating current and V_{sense} voltage which will determine the value for R_{10}. A tradeoff occurs, however, between the power dissipation on R_{10} and the accuracy of the regulation point. As V_{sense} is increased, the current regulation accuracy improves; the maximum voltage will be 1.153 V. As V_{sense} is decreased, the power dissipation is reduced, but error due to V_{ref}, resistors R_1 and R_2 increases.

The EVM I_{LED} is set to 500 mA with a V_{sense} voltage of 0.225 V.

$V_{sense} = I_{LED} \times R_{10} = 500\ mA \times 510\ m\Omega = 0.255\ V$

$V_{R1} = V_{FB} - V_{sense} = 1.153\ V - 0.255\ V = 0.898\ V$

$V_{R2} = V_{REF} - V_{FB} = 2.5\ V - 1.153\ V = 1.347\ V$

Choose divider current of 1 mA:

$$R_1 = \frac{V_{R1}}{1\ mA} = \frac{0.898\ V}{1\ mA} = 898\ \Omega$$

Standard value 887:

$$R2 = \frac{V_{R2}}{1\ mA} = \frac{1.347\ V}{1\ mA} = 1347\ \Omega$$

Standard value 1330

Output current can be increased or decreased by changing R_{10}. For 1-A output current, decrease R_{10} to 250 mΩ. For 250-mA output current, increase R_{10} to 1 Ω.

4 Test Results

Test results using the TPS62110EVM-346 evaluation module are presented in Figure 1, Figure 2, and Figure 3.

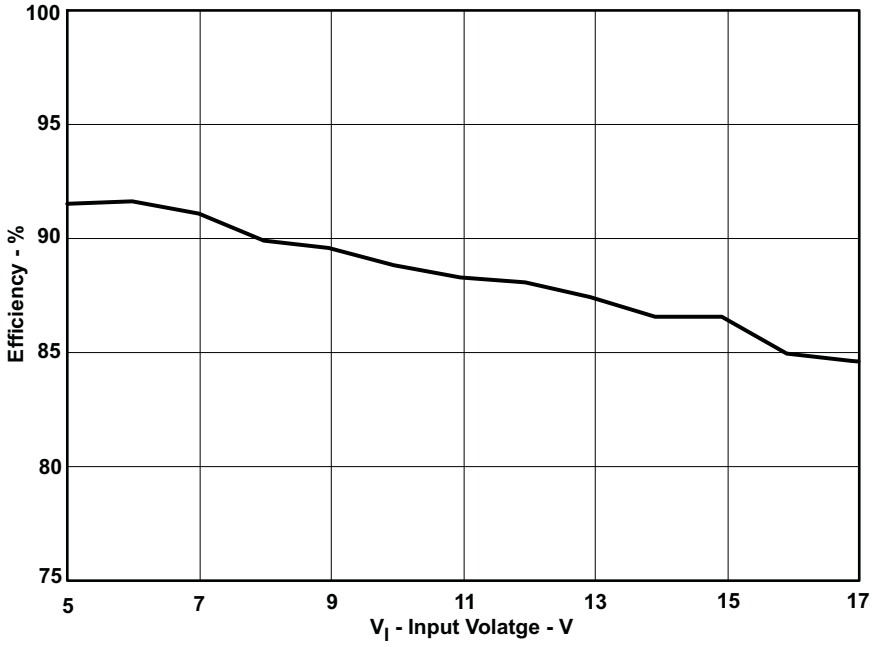

Figure 1. WLED Section Efficiency at Iout of 500 mA

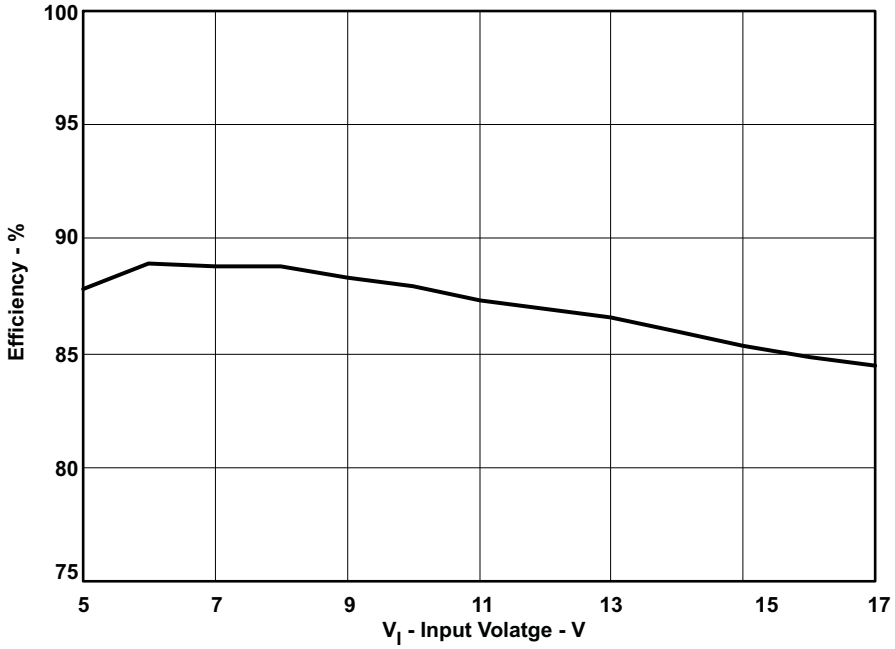

Figure 2. Voltage Regulator Section Efficiency Versus Vin at Iout of 1 A

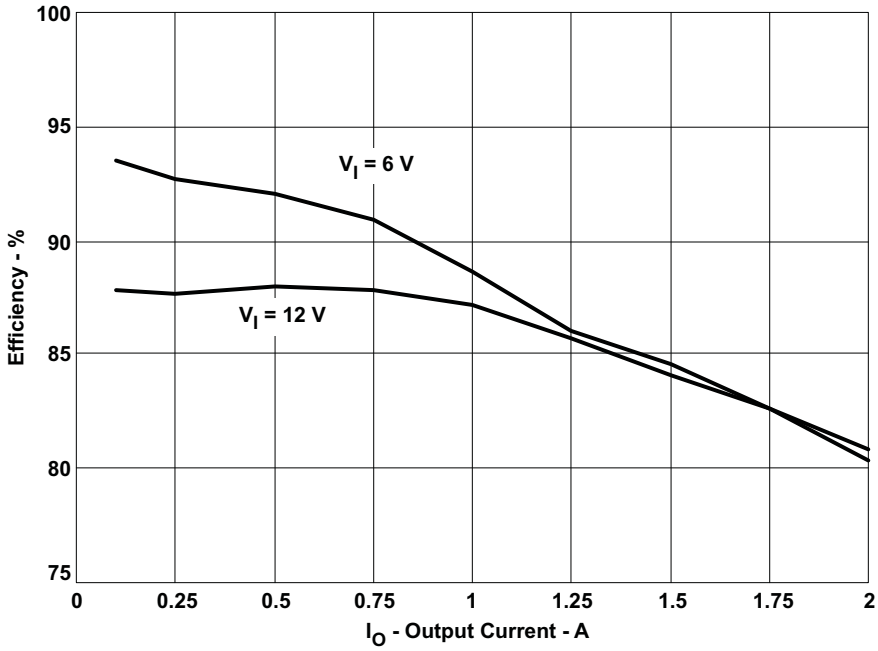

Figure 3. Voltage Regulator Section Efficiency Versus Iout for Vin 6 V and 12 V

5 Printed-Circuit Board Layout

This section provides the TPS62110EVM-346 printed-circuit board (PCB) layout and illustrations.

5.1 Layout

Figure 4 shows the board layout for the TPS62110EVM-346 PCB.

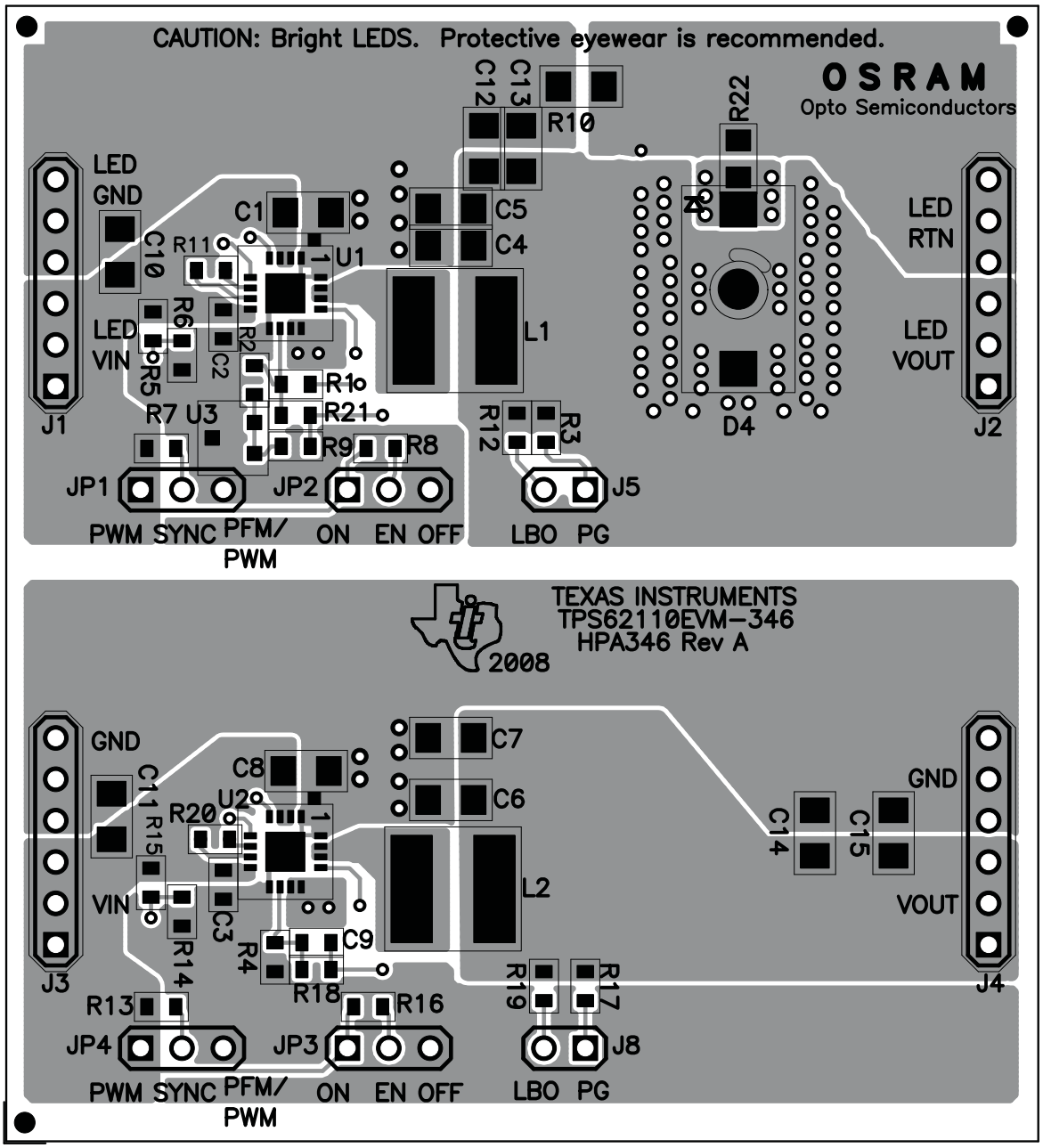

Figure 4. Assembly Layer

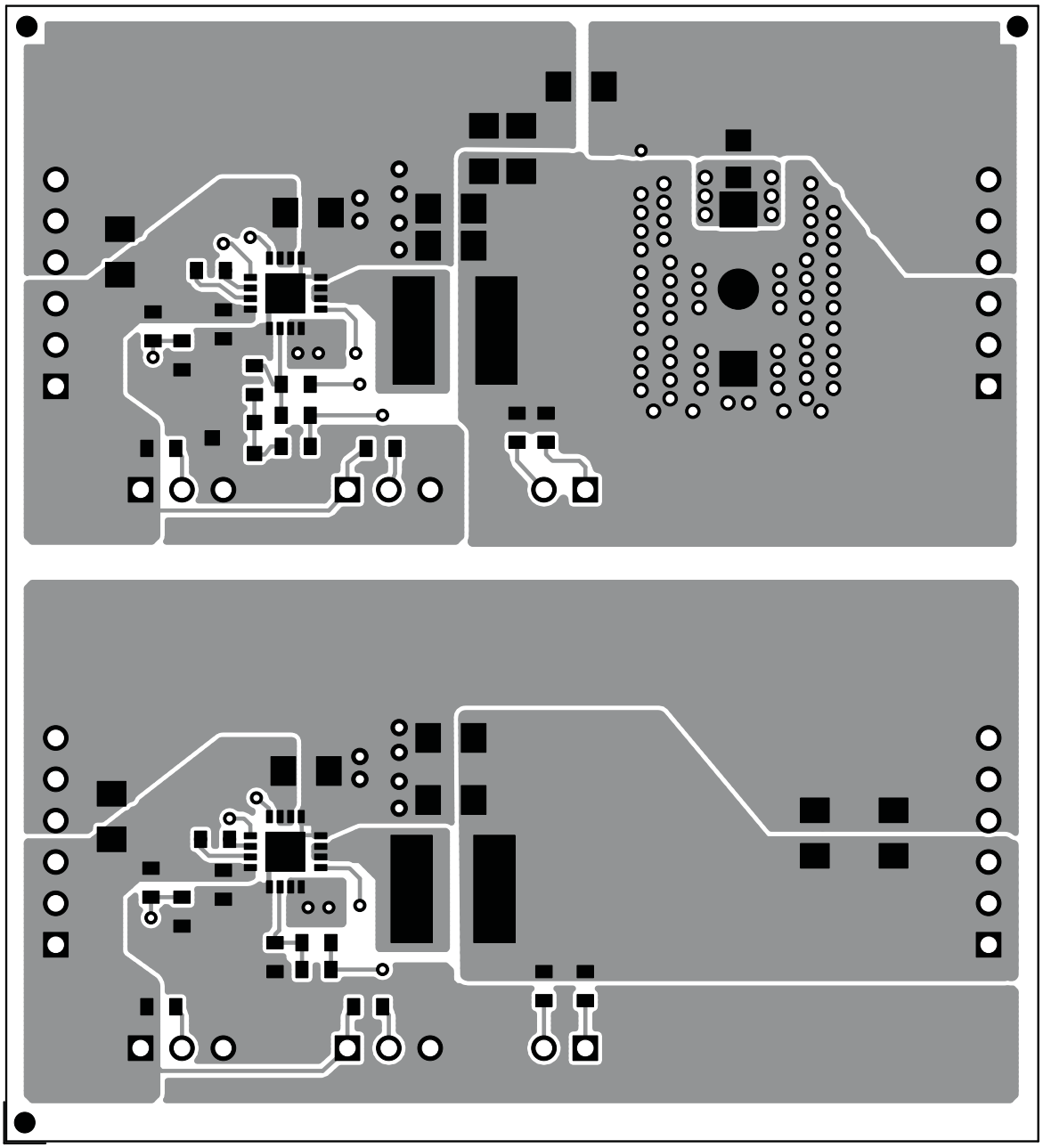

Figure 5. Top Layer Routing

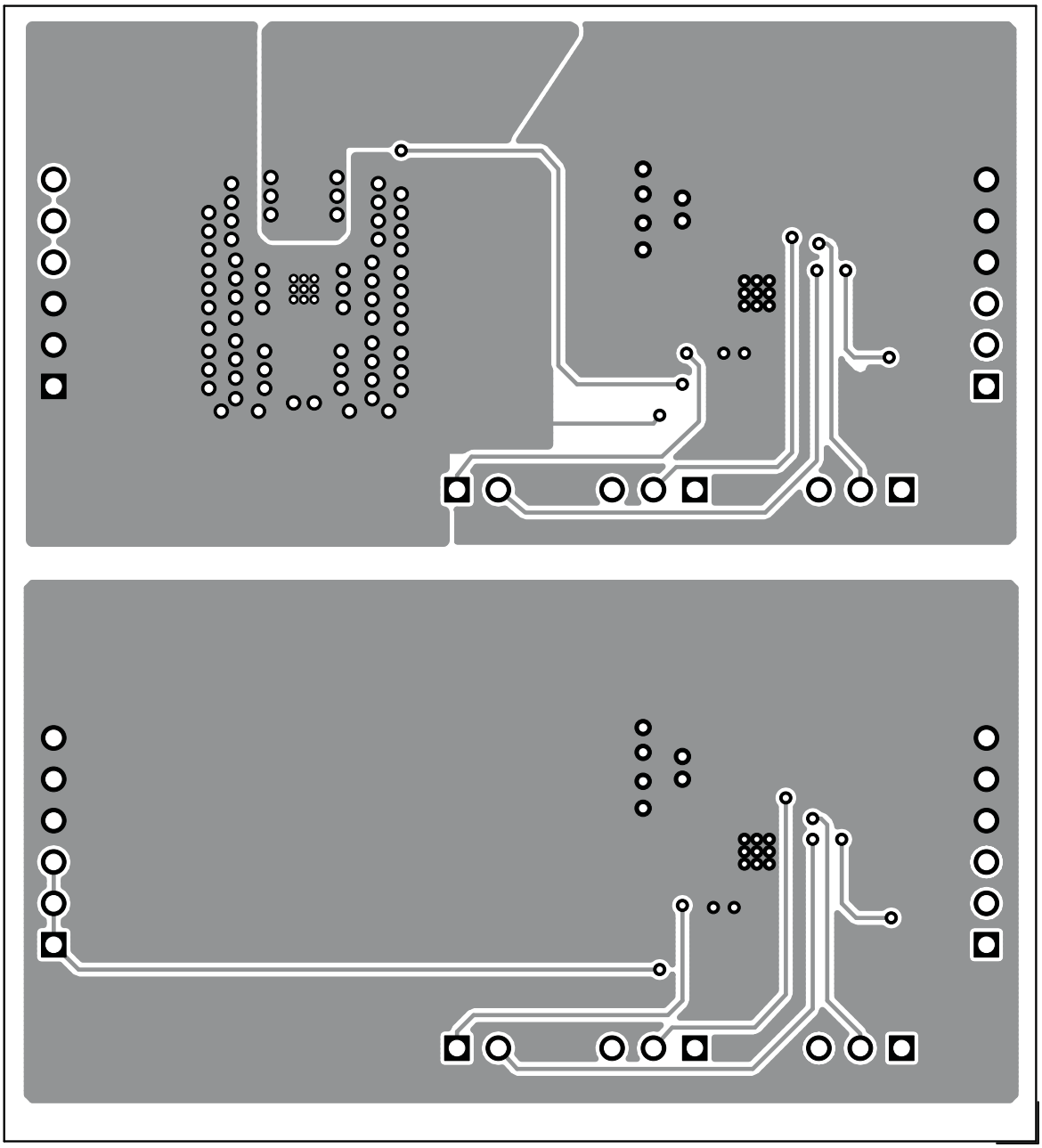

Figure 6. Bottom Layer Routing

6 Schematic and Bill of Materials

This section provides the TPS62110EVM-346 schematic and bill of materials.

6.1 Schematic

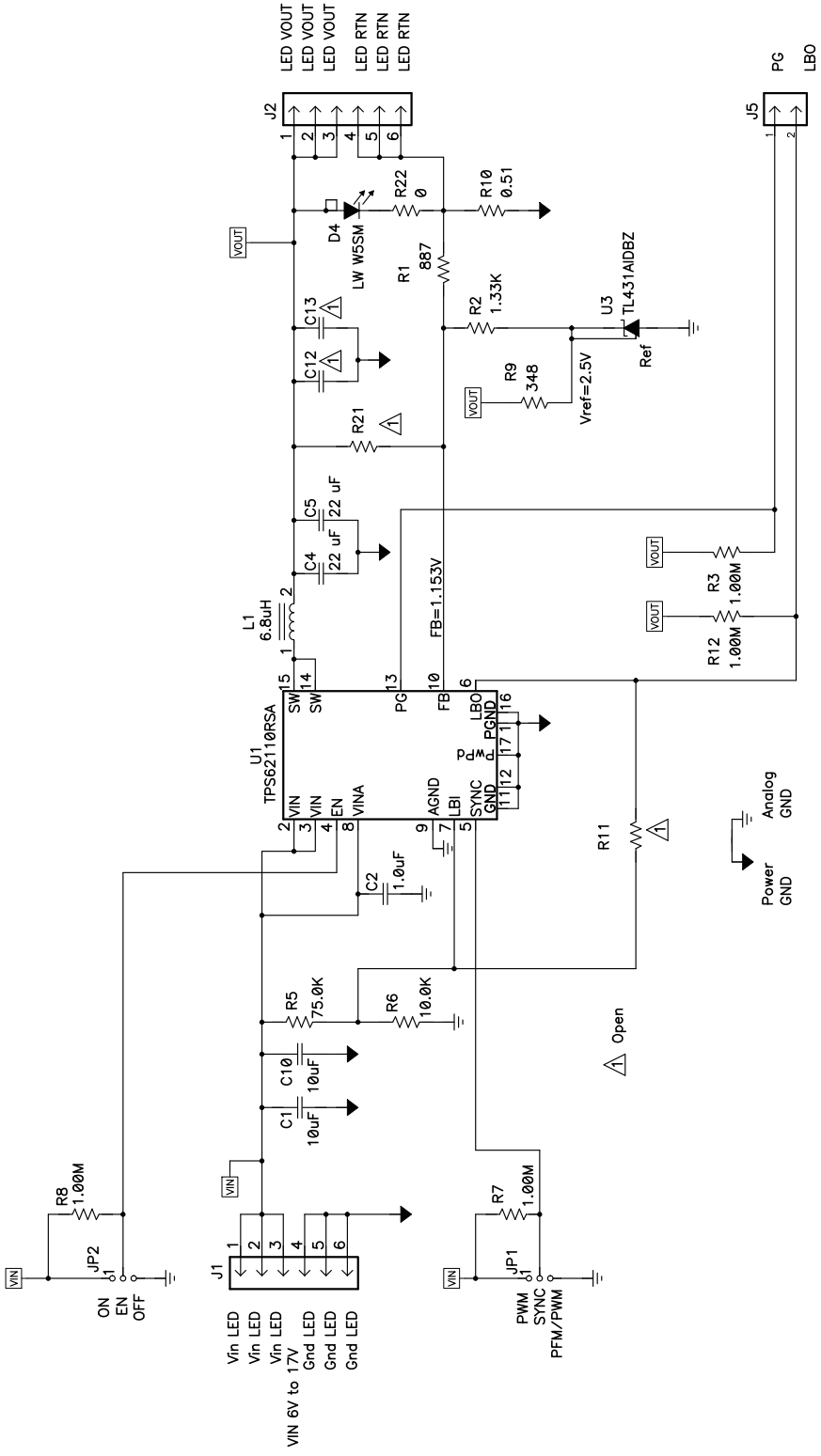

Figure 7. TPS62110EVM-346 Schematic, WLED Section

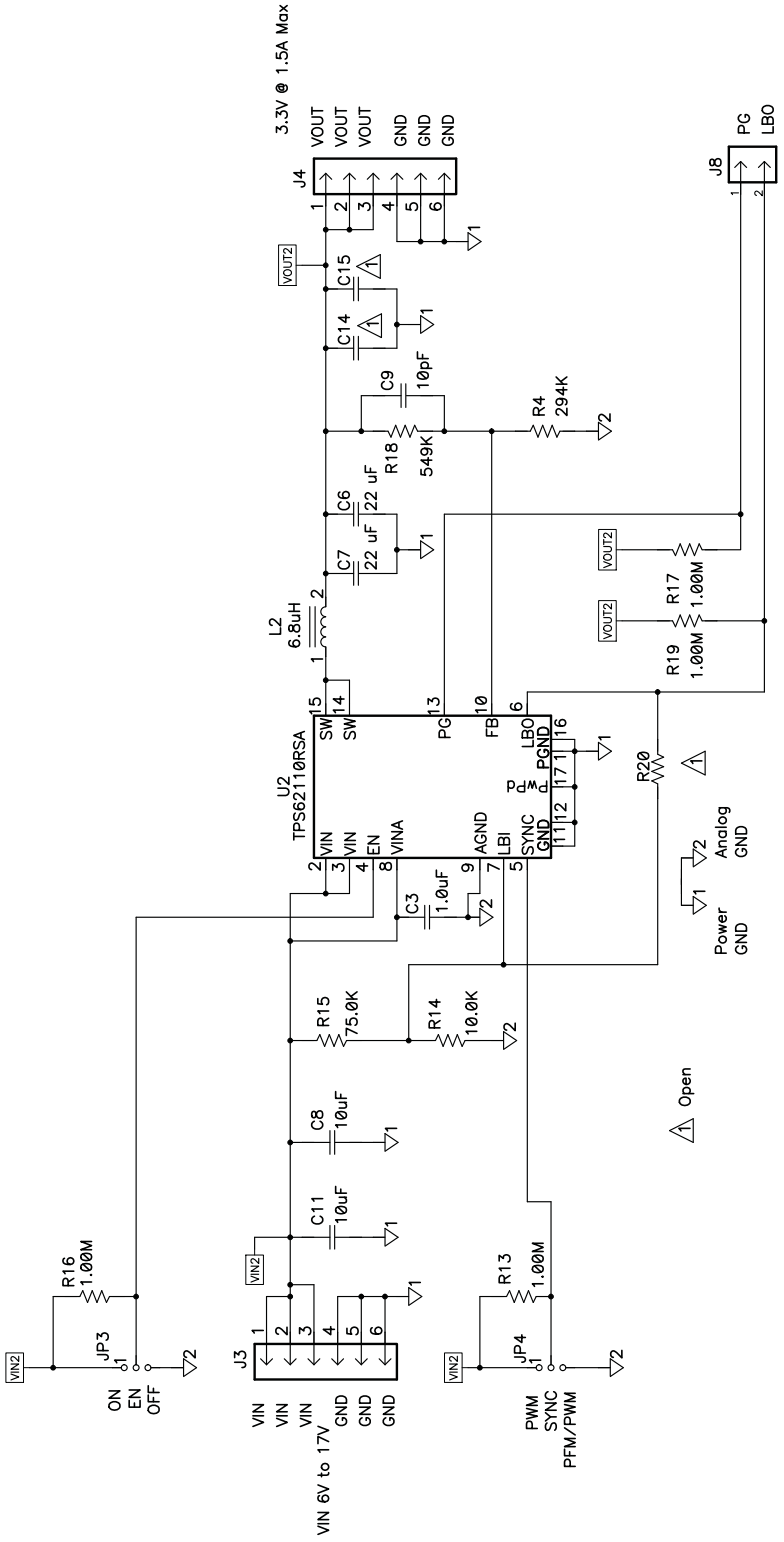

Figure 8. TPS62110EVM-346 Schematic, Voltage Regulator Section

6.2 Bill of Materials

Table 2. TPS62110EVM-346 Bill of Materials

Count	Ref Desig	Value	Description	Size	Part Number	MFR
4	C1, C8, C10, C11	10uF	Capacitor, Ceramic, 25V, X5R, 20%	1206	C3216X5R1E106	TDK
0	C12–C15	Open	Capacitor, Ceramic,	1206	Std	Std
2	C2, C3	1.0 µF	Capacitor, Ceramic, 25V, X7R, 10%	0603	C1608X7R1E105K	TDK
4	C4–C7	22 µF	Capacitor, Ceramic, 10V, X5R, 20%	1206	C3216X5R1A226	TDK
1	C9	10 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	C1608C0G1H100DB	TDK
1	D4	LW W5SM-HYJZ-5K8L-Z LW W5SM-JXJY-5K8L-Z LW W5SM-JXJZ-5K8L-Z (see Note 5 and 6)	Diode, LED White, 500-mA, 17000-mcd	0.244 × 0.441 inch	LW W5SM-HYJZ-5K8L-Z LW W5SM-JXJY-5K8L-Z LW W5SM-JXJZ-5K8L-Z (see Note 5 and 6)	Osram
4	J1–J4	PTC36SAAN	Header, Male 6-pin, 100 mil spacing, (36-pin strip)	0.100 inch × 6	PTC36SAAN	Sullins
2	J5, J8	PTC36SAAN	Header, 2-pin, 100 mil spacing, (36-pin strip)	0.100 × 2	PTC36SAAN	Sullins
4	JP1–JP4	PTC36SAAN	Header, 3-pin, 100 mil spacing, (36-pin strip)	0.100 × 3	PTC36SAAN	Sullins
2	L1, L2	6.8 µH	Inductor, SMT, 3.0A, 97 mΩ	0.276 × 0.276 inch	HA3808-AL	Coilcraft
1	R1	887	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
1	R10	0.51	Resistor, Chip, 1/2W, 1%	1206	CRCW1206R510FKEA	Vishay
0	R11, R20, R21	Open	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
1	R18	549K	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
1	R2	1.33K	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
1	R22	0	Resistor, Chip, 1/10W, 1%	0805	Std	Std
8	R3, R7, R8, R12, R13, R16, R17, R19	1.00M	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
1	R4	294K	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
2	R5, R15	75.0K	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
2	R6, R14	10.0K	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
1	R9	348	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
2	U1, U2	TPS62110RSA	IC, Synchronous Step-Down Converter, 17V, 1.2A	QFN-16	TPS62110RSA	TI
1	U3	TL431AIDBZ	IC, Precision Adjustable Shunt Regulator	SOT23-3	TL431AIDBZ	TI
4	–		Shunt, 100-mil, Black	0.100	929950-00	3M
1			PCB, 2.505" × 2.755" × 0.062"		HPA346	Any

Notes: 1. These assemblies are ESD sensitive, ESD precautions shall be observed.
2. These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.
3. These assemblies must comply with workmanship standards IPC-A-610 Class 2.
4. Ref designators marked with an asterisk ('**') cannot be substituted. All other components can be substituted with equivalent MFG's components.
5. D4 can be any LW W5SM. The last eight characters of the orderable number are don't cares.
6. D4 cannot be washed in solvent, reference data sheet for cleaning options

7 Related Documentation From Texas Instruments

1. *TPS62110, 17-V, 1.5-A, Synchronous Step-Down Converter* data sheet (SLVS585)

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EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 3.6 V to 17 V and the output voltage range of 3 V to 16 V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than 50°C. The EVM is designed to operate properly with certain components above 50°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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