TPS62113EVM-465

This user's guide describes the characteristics, operation, and use of the TPS62113EVM-465 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. The TPS62113 device features an adjustable undervoltage shutdown feature using the LBI input. See the data sheet for additional information.

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1 Introduction

The Texas Instruments TPS62113 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 TPS62113EVM-465 uses the TPS62113 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. To demonstrate the Enhanced LBI (low-battery input) feature of the TPS62113, the shutdown point for WLED (U1) has been set to 6 V; for 3.3 V (U2), the shutdown point has been set to 10.5 V. But the converters can operate at input voltages down to 5 V with the LBI correctly configured for a lower input voltage. As part of the Enhanced LBI function, an additional resistor has been added between the LBI input and the LBO output, R20 for U1 and R19 for U2. This resistor provides additional hysteresis for the LBI comparator; see the data sheet (SLVS585) for additional information.

1.2 Performance Specification

Table 1 provides a summary of the TPS62113EVM-465 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 LBI/Low-Battery Shutdown			6		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 LBI/Low-Battery Shutdown			10.5		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 TPS62113 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.

The LBI circuit is configured to shut the WLED section down at a 6-V input voltage. This is adjustable using resistors R5 and R6; see the data sheet for additional information.

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%. As V_{sense} voltage increases, the accuracy improves, and 500 mV is approximately 5% and 1 V is approximately 2%.

The TPS62113 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.

1.3.1 Additional WLED Section Options

External control of the WLED section is possible using the EZ430-RF2500 EVM. This module plugs into connector J6. See the TPS62113 product folder on the TI Web site for additional information on this option.

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 R17 and R4. Resistors R17 and R4 can be changed to reset the output voltage between 1.2 V and 16 V; see the TPS62113 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, C12 and C13.

U2 can be replaced with the fixed output version, TPS62111 or TPS62112. For this configuration, replace R17 with a 0-Ω resistor, and remove R4 and C9.

The LBI circuit is configured to shut the 3.3-V section down at a 10.5-V input voltage. This is adjustable using resistors R14 and R13; see the data sheet for additional information.

2 Setup

This section describes how to properly use the TPS62113EVM-465.

2.1 Input/Output Connector Descriptions

U1 – WLED Section:

J1 – LED VIN and LED GND	WLED input voltage source connection.
J2 – LED+ and LED–	WLED output voltage connection
JP1 – LED – RTN	WLED header for monitoring LED current or disconnecting onboard LED

U2 – 3.3-V Regulator Section:

J3 – 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.
JP3 – 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.
JP2 – EN	3.3-V regulator Enable pin, low = off and high = on. Also open = on.
J5 – 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

The WLED (U1) section of the EVM is configured to operate with an input voltage from 6 V to 17 V. EN is hard wired to the ON position; it begins operating when power is applied. SYNC input is hard wired to the nonpower save mode. Because the WLED is very bright, appropriate precautions must be taken.

The 3.3-V (U2) section of the EVM is configured to operate with an input voltage from 10.5 V to 17 V. EN jumper JP2 must be installed in the desired ON or OFF position. 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 TPS62113 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 3.3 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 is 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.

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

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

$V_{R2} = V_{REF} - V_{FB} = 3.3\ V - 1.153\ V = 2.147\ V$

Choose divider current of 0.1 mA:

$$R_1 = \frac{V_{R1}}{0.1\ mA} = \frac{0.898\ V}{0.1\ mA} = 898\ \Omega$$

Standard value 8.87 kΩ:

$$R_2 = \frac{V_{R2}}{0.1\ mA} = \frac{2.147\ V}{0.1\ mA} = 21.47\ \Omega$$

Standard value 21.5 kΩ.

4 Test Results

Test results using the TPS62113EVM-465 evaluation module are presented in Figure 1, Figure 2, and Figure 3.

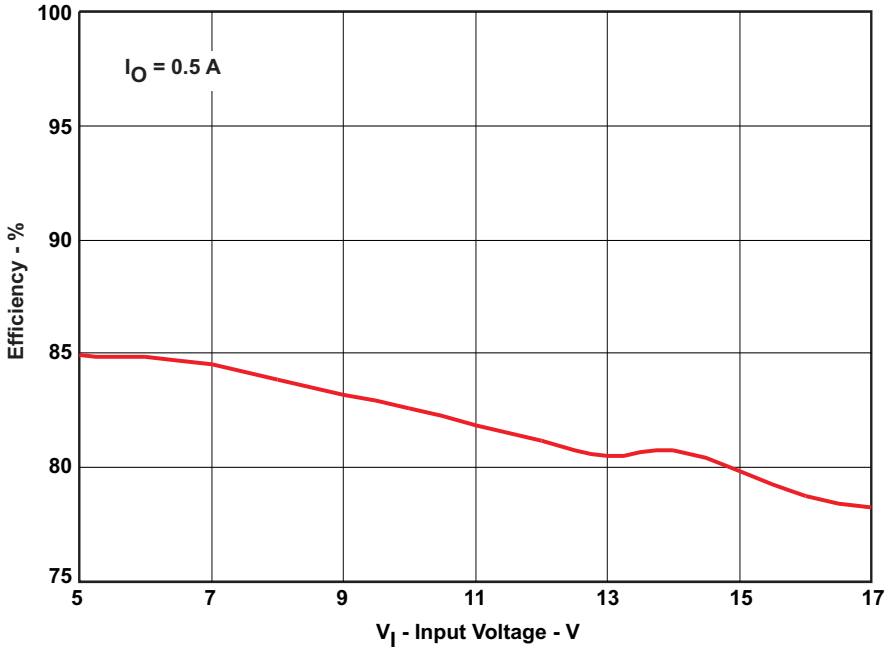

Figure 1. WLED Section Efficiency at Iout of 500 mA

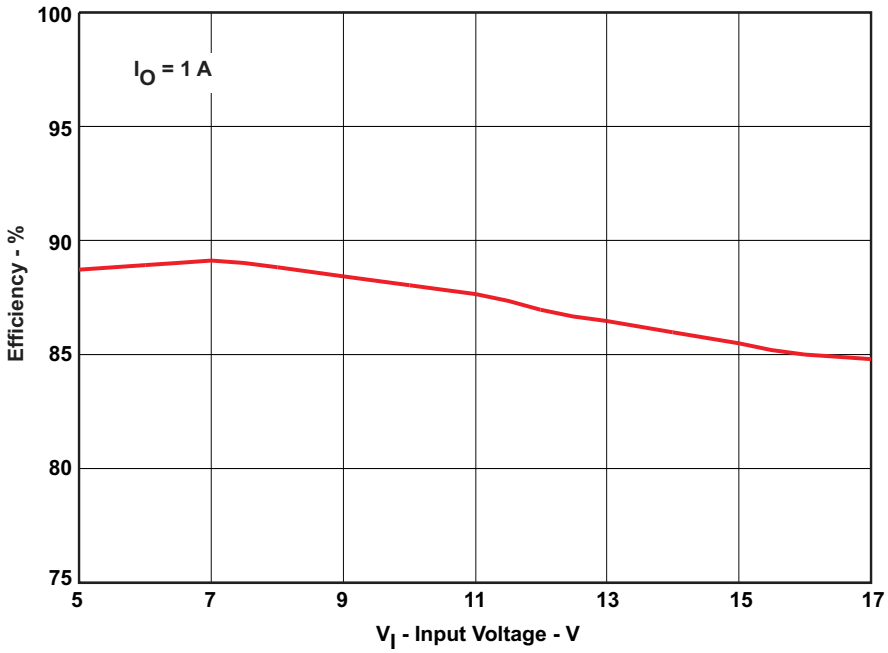

Figure 2. Voltage Regulator Section Efficiency Versus Vin at Iout of 1 A

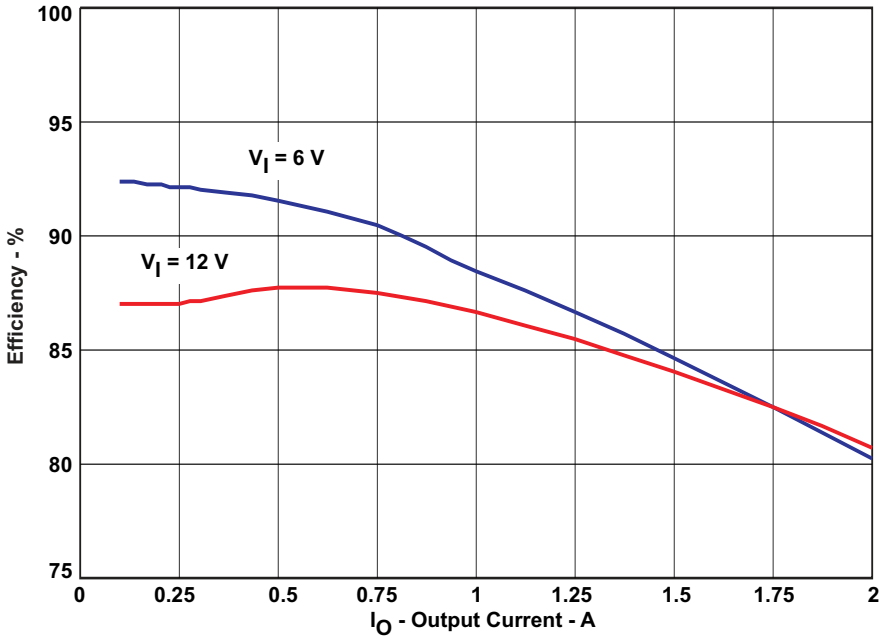

Figure 3. Voltage Regulator Section Efficiency Versus Iout for Vin 6 V and 12 V

5 Printed-Circuit Board Layout

This section provides the TPS62113EVM-465 printed-circuit board layout and illustrations (Figure 4, Figure 5, and Figure 6).

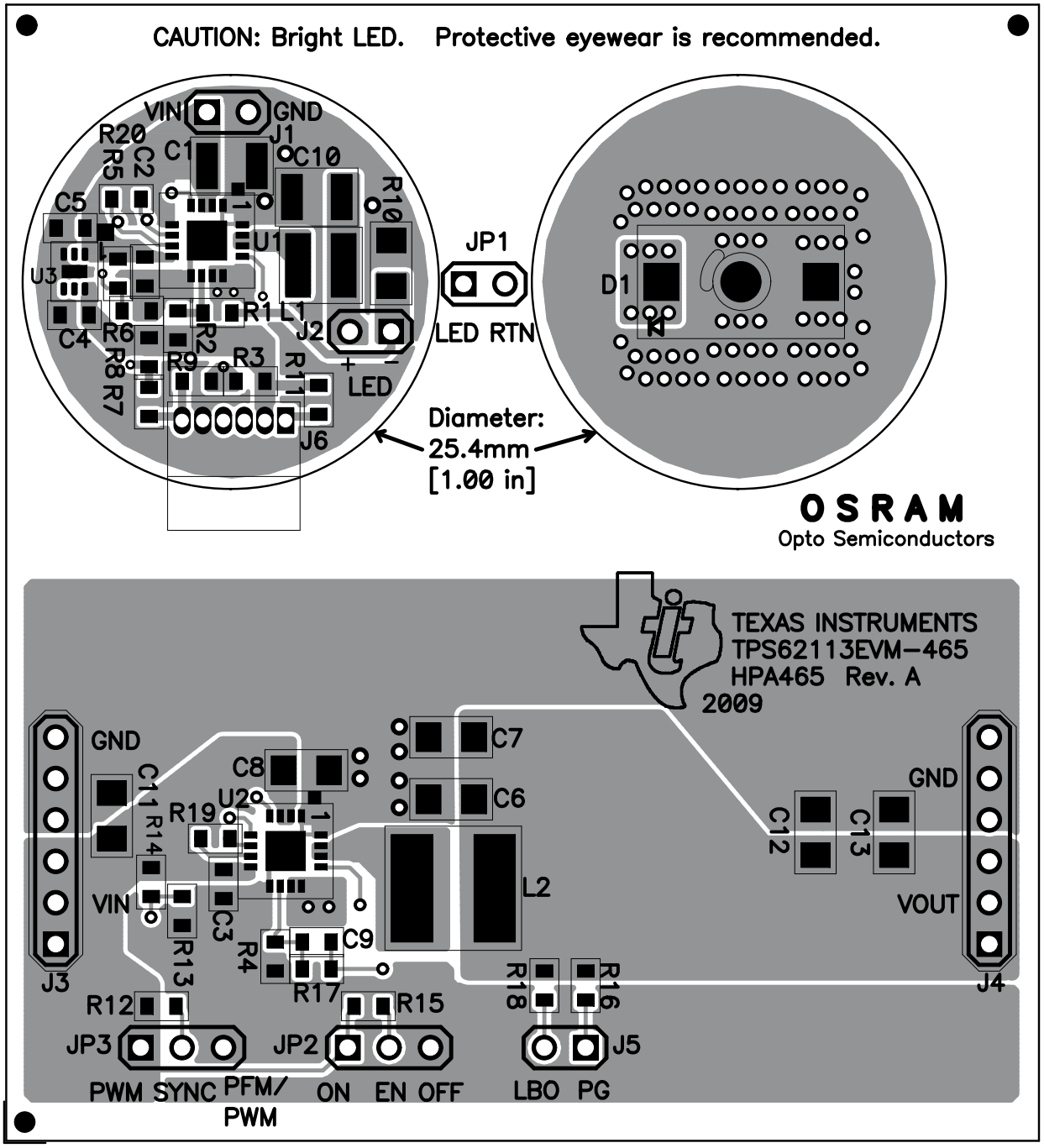

Figure 4. Assembly Layer

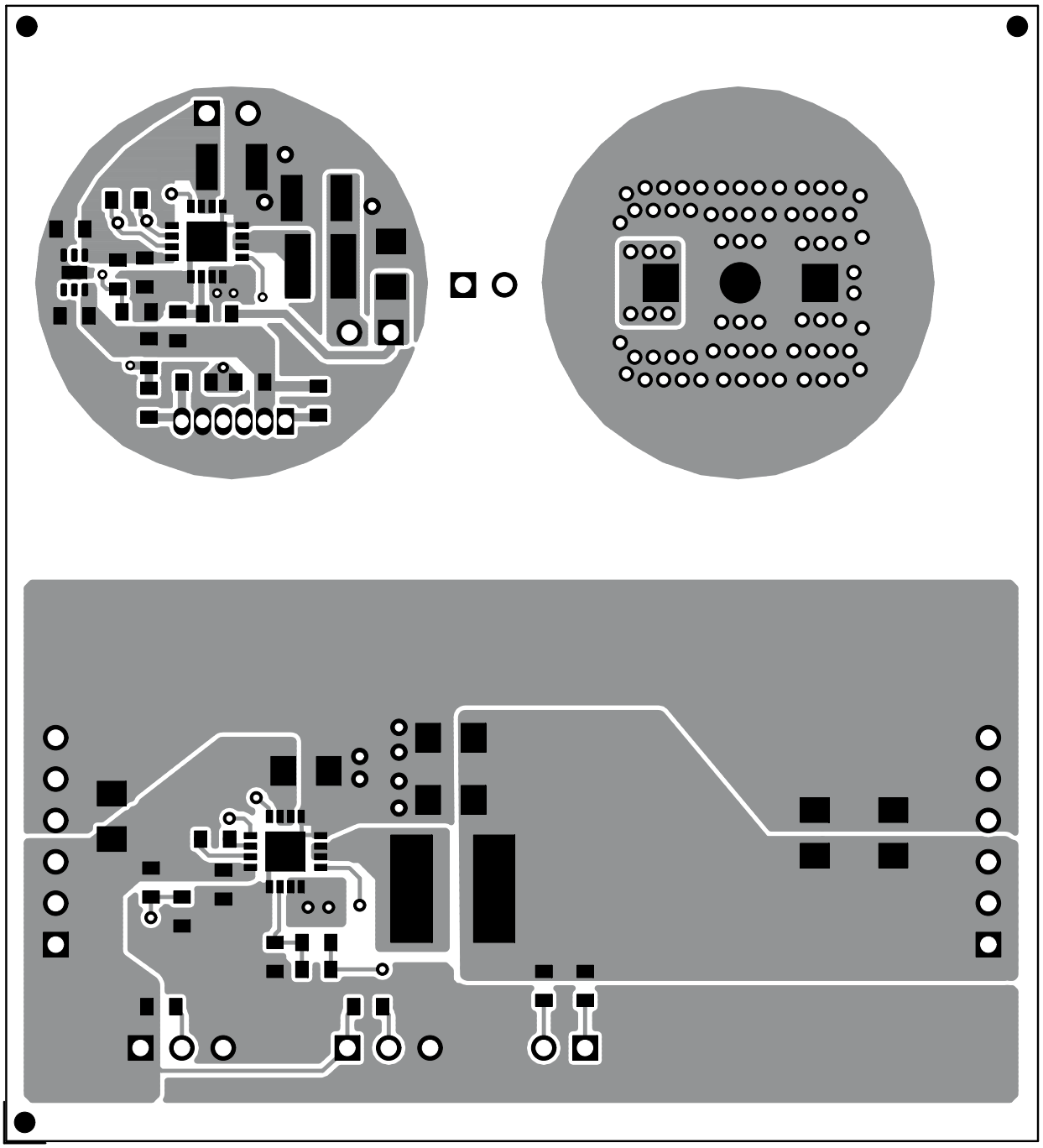

Figure 5. Top Layer Routing

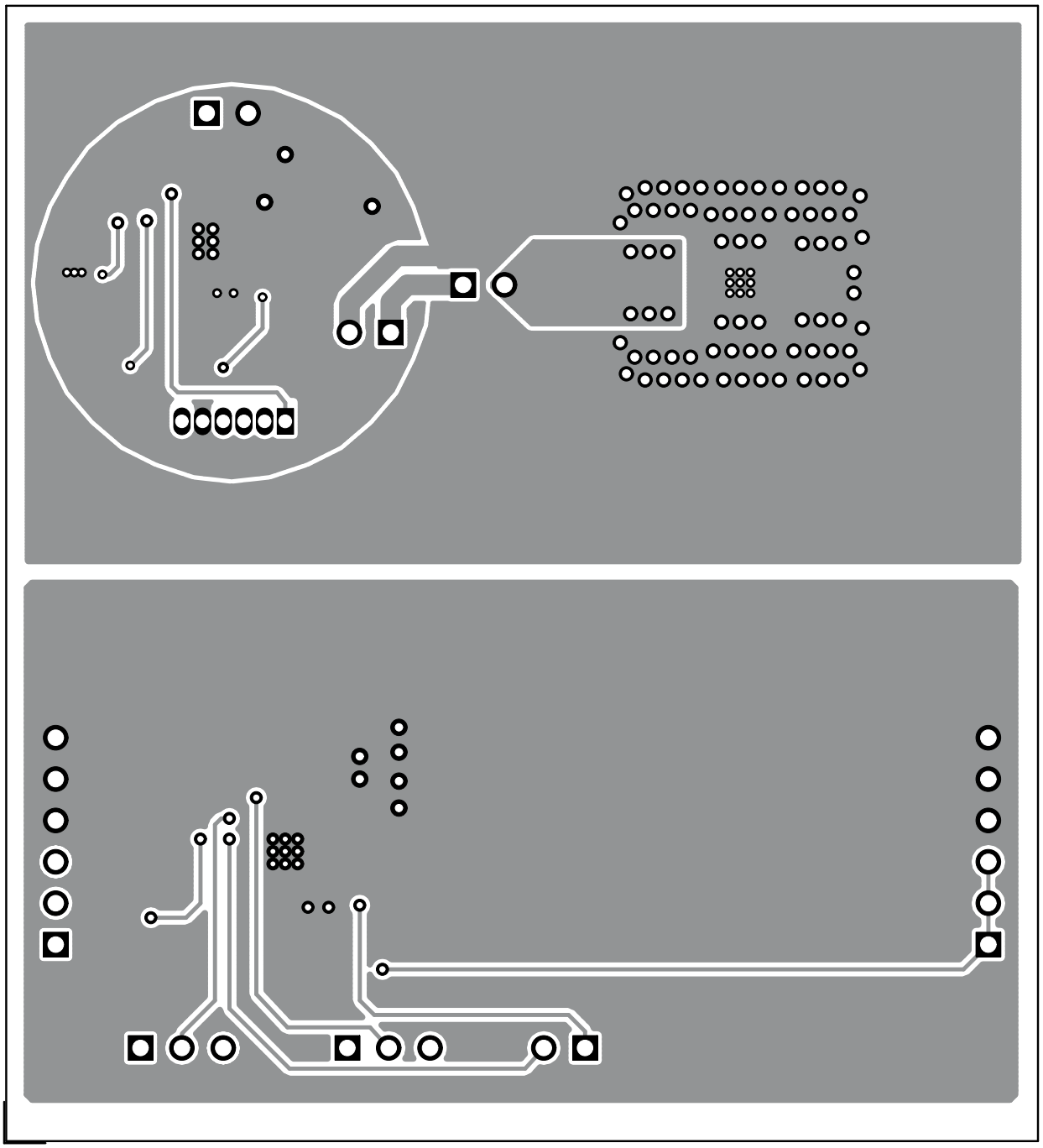

Figure 6. Bottom Layer Routing

6 Schematic and Bill of Materials

This section provides the TPS62113EVM-465 schematic and bill of materials.

6.1 Schematic

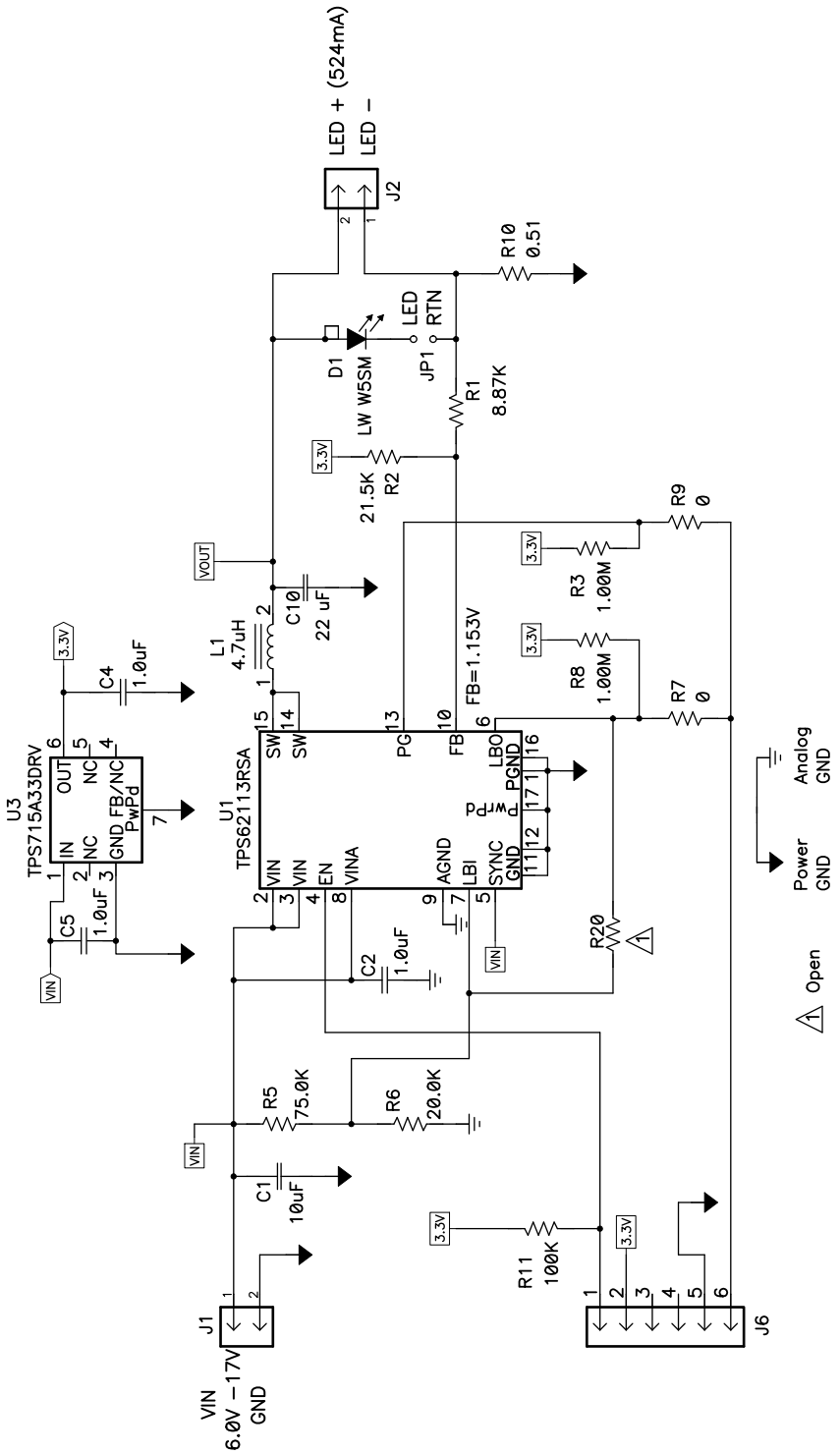

Figure 7. TPS62113EVM-465 Schematic, WLED Section

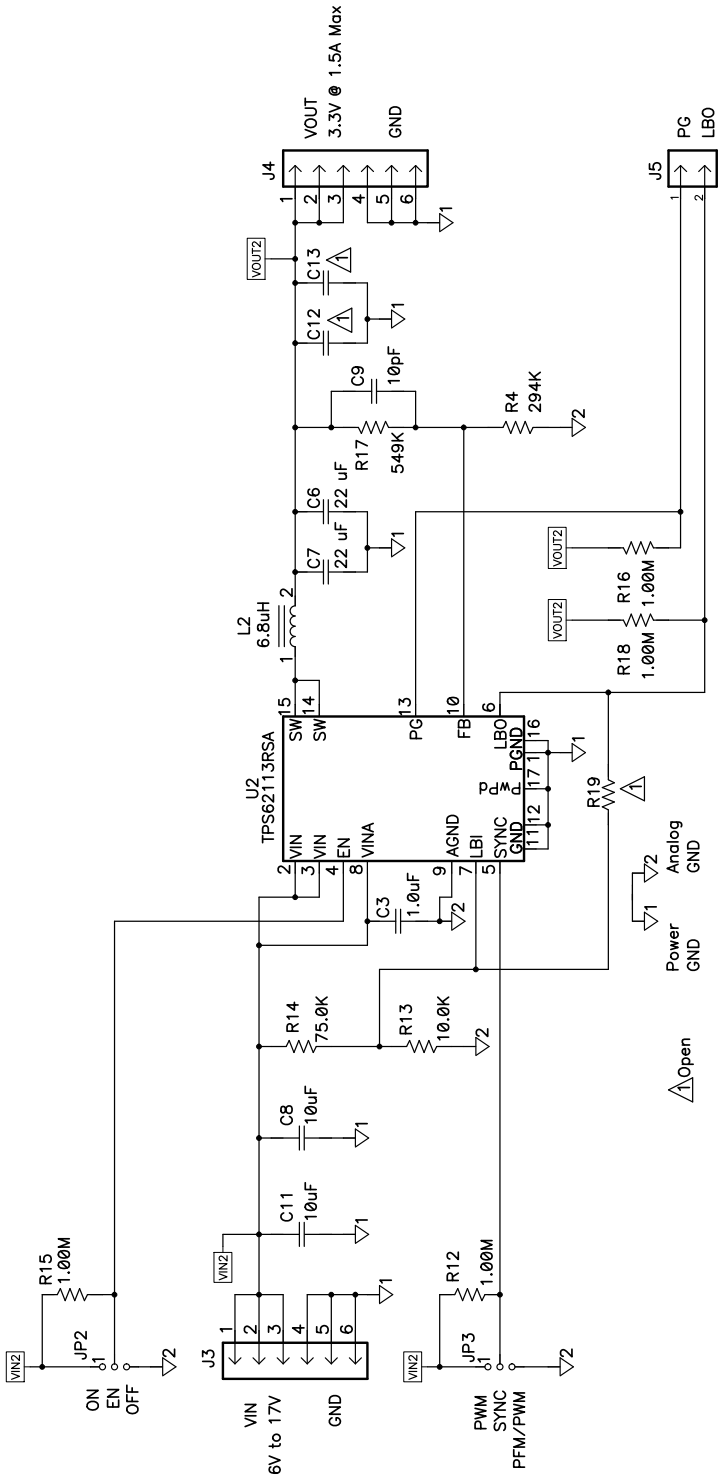

Figure 8. TPS62113EVM-465 Schematic, Voltage Regulator Section

6.2 Bill of Materials

Table 2. TPS62113EVM-465 Bill of Materials

Count	Ref Des	Value	Description	Size	Part Number	Manufacturer
1	C1	10 F	Capacitor, Ceramic, 25V, X5R, 20%	1210	Std	Std
1	C10	22 µF	Capacitor, Ceramic, 10V, X5R, 20%	1210	Std	Std
0	C12, C13	Open	Capacitor, Ceramic, 10V, X5R, 20%	1206	Std	Std
4	C2–C5	1 F	Capacitor, Ceramic, 25V, X7R, 10%	0603	Std	Std
2	C6, C7	22 µF	Capacitor, Ceramic, 10V, X5R, 20%	1206	Std	Std
2	C8, C11	10 F	Capacitor, Ceramic, 25V, X5R, 20%	1206	Std	Std
1	C9	10 pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
1	D1	LUW W5AM-KXKZ-Z LUW W5AM-KXKZ-5FG-Z	Diode, LED White, 500-mA, 17000-mcd	0.244 × 0.441 inch	LUW W5AM-KXKZ-4C8E-Z LUW W5AM-KXKZ-5FG-Z	Osram
1	L1	4.7 H	Inductor, SMT, 1.9A, 135 mΩ	0.157 × 0.157 inch	XPL4020-472ML	Coilcraft
1	L2	6.8 µH	Inductor, SMT, 4.4A, 99 mΩ	0.276 × 0.276 inch	HA3808-AL	Coilcraft
1	R1	8.87K	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
1	R10	0.51	Resistor, Chip, 1/2W, 1%	1206	CRCW1206R510FKEA	Vishay
1	R11	100K	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
1	R13	10.0K	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
1	R17	549K	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
2	R17, R20	Open	Resistor, Chip, 1/10W, 1%	0805	Std	Std
1	R2	21.5K	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
6	R3, R8, R12, R15, R16, R18	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, R14	75.0K	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
1	R6	20.0K	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
2	R7, R9	0	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
2	U1, U2	TPS62113RSA	IC, Synchronous Step-Down Converter, 17V, 1.5A	QFN-16	TPS62113RSA	TI
1	U3	TPS715A33DRV	IC, High Input Voltage, Micropower, 3.2 A @ 80 mA LDO, 3.3V	QFN-6	TPS715A33DRV	TI

7 Related Documentation From Texas Instruments

1. *TPS62113, 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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