Texas Instruments

TPS61042EVM-226 White Light LED Bias Supply EVM

User's Guide

September 2002 PMP EVMs

SLLU053

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EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 1.8 V to 6.0 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 60°C. The EVM is designed to operate properly with certain components above 60°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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Preface

Read This First

About This Manual

This user's guide describes the characteristics, operation, and use of the TPS61042EVM–226 white light LED bias supply evaluation module (EVM). This EVM is a Texas Instruments high-efficiency boost converter that is configured to supply 20 mA of bias current to four white light LEDs, from a 1.8 V to 6 V input voltage. The user's guide includes a schematic diagram and bill of materials (BOM).

How to Use This Manual

This document contains the following chapters:

- Chapter 1 – Introduction
- Chapter 2 – Setup
- Chapter 3 – Board Layout
- Chapter 4 – Schematic and Bill of Materials

Related Documentation From Texas Instruments

TPS61042 data sheet (SLVS439)

If You Need Assistance. . .

Contact your local TI sales representative.

FCC Warning

This equipment is intended for use in a laboratory test environment only. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to subpart J of part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

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Chapter 1

Introduction

This chapter contains background information for the TPS61042 and support documentation for the TPS61042EVM–226 evaluation module.

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1.1 Background

This TPS61042EVM uses the TPS61042 boost converter to provide 20 mA of bias current to a four-element white LED from a 1.8 V to 6 V input. This EVM may be modified to drive more or less than four LEDs. It may also be modified to deliver a higher or lower output current to the LEDs. Refer to the data sheet for more information on adjusting the rated output current. The EVM includes a CTRL pin and an ADJ pin that allows the user to dim the LEDs. The LEDs may be dimmed using either an analog or a PWM dimming scheme. Information about output voltage and current ratings of TPS61042 can be found in the data sheet SLVS439.

Chapter 2

Setup

This chapter describes how to properly connect, set up, and use the TPS61042EVM-226.

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2.1 Input/Output Connections

The TPS61042EVM–226 PWB has several connections, which are described in Table 2–1.

Table 2–1. Input/Output Connections

Reference Designator	Name	Description
J1	Vin	This is the positive connection to the input power supply. The leads to the input supply should be twisted and kept as short as possible.
J2	GND	This is the return connection for the input power supply
J3	ADJ	Input for dimming adjust of LED current
J4–1	ON	Connect J4–2 (CTRL) to J4–1 (ON) with a shorting jumper to enable the supply
J4–2	CTRL	CTRL
J4–3	OFF	Connect J4–2 (CTRL) to J4–3 (OFF) with a shorting jumper to disable the supply

2.2 EVM Operation

The EVM is configured as a constant current supply. Current regulation is accomplished by regulating the voltage across a current sense resistor. The EVM does not operate correctly unless a load is present. The EVM is shipped with four white light LEDs as a load. If these are removed, they must be replaced with another load that falls within the voltage and current limit specs of the device. The TPS61042 has built-in overvoltage protection to keep the EVM from being damaged under a no-load condition.

This EVM is designed to accommodate several LED-dimming techniques. Because of this flexibility, circuitry may be present on the EVM that is not needed for the particular dimming method that the user chooses. Depending on the PWM dimming technique used, component values may need to be changed to provide the desired LED current level. The first step to be completed before the EVM is used is to determine the method of dimming. Several dimming techniques are described below.

2.2.1 Analog Dimming With Analog Voltage

One method for dimming the LEDs is to inject a voltage through a resistor into the FB pin of the TPS61042. The injected voltage artificially raises the voltage seen at the FB pin, which lowers the LED current. If the resistor values are chosen correctly, the analog control voltage varies the output current from 0mA to full LED current. This dimming method is accomplished by injecting an analog voltage into the ADJ pin on J3. The equations below calculate the required resistor values where:

- V_{ref} is the TPS61042 reference voltage = 0.250 V
- V_{adj_min} is the minimum adjust voltage
- V_{adj_max} is the maximum adjust voltage

- I_{o_min} is the minimum output current
- I_{o_max} is the maximum output current
- Reference designators correspond to the EVM schematic shown in Chapter 4

$$R_2 = V_{ref} \times \frac{\left(I_{o\_max} \times R_3 - I_{o\_min} \times R_3 + V_{adj\_min} - V_{adj\_max}\right)}{I_{o\_min} \times \left(V_{ref} - V_{adj\_min}\right) + I_{o\_max} \times \left(V_{adj\_max} - V_{ref}\right)}$$

$$R_1 = \frac{V_{ref} \times R_3 + V_{ref} \times R_2 - V_{adj\_max} \times R_2}{I_{o\_min} \times R_3 - V_{ref} + V_{adj\_max}}$$

If V_{ref} = 0.25 V, V_{adj_min} = 0 V, V_{adj_max} = 3.3 V, I_{o_min} = 0 A, I_{o_max} = 20 mA, and R3 = 121 kΩ, R2 is calculated to be 9.9 kΩ, and R1 is calculated to be 13.5 Ω.

2.2.2 Analog Dimming With PWM Voltage

The second method for dimming the LEDs is to inject a pulse width modulated (PWM) voltage for analog dimming. With this method, an RC filter is used to convert the PWM control voltage into an analog voltage. The component values of the RC filter depend upon the frequency of the PWM voltage and the amount of allowable ripple on the converted analog signal. The converted analog voltage is then injected into the FB pin of the TPS61042 as in the *Analog Dimming with Analog Voltage* method described above. The output current decreases as the duty cycle increases. 0% duty cycle delivers maximum LED current and 100% duty cycle delivers minimum LED current. For this dimming method the PWM signal must be filtered and converted to its analog equivalent before it is applied to the EVM. The filtered signal is then applied to J3. Assuming that the PWM control voltage amplitude varies between 0 V and 3.3 V, the resistor values calculated in the *Analog Dimming with Analog Voltage* method may still be used. The following equation converts the PWM control voltage into its equivalent analog control voltage where:

- V_{pwm_pk} is the peak to peak voltage of the injected PWM signal
- D is the duty cycle of the injected PWM signal
- V_{min} is the minimum voltage of the injected PWM signal

$$V_{analog} = V_{pwm\_pk} \times D + V_{min}$$

2.2.3 PWM Dimming Using CTRL

The third method for dimming the LEDs is to inject a PWM voltage into the CTRL pin of the TPS61042. The LED current is proportional to the CRTL pin duty cycle. Refer to the TPS61042 data sheet for more information on this dimming method. For this dimming method, R2 and R3 are not needed. R2 may be shorted and R3 may be removed if desired. R1 is calculated by the following equation where V_{ref} is the reference voltage of the TPS61042 (0.25 V) and I_{out_max} is the maximum desired output current. The reference designators correspond to the EVM schematic shown in Chapter 4.

$$R_1 = \frac{V_{ref}}{I_{o\_max}}$$

For an output current of 20 mA, R1 = 12.5 Ω.

2.3 Setup

After the EVM has been modified for the appropriate dimming method, connect an input supply between J1 and J2. The EVM operates with an input voltage between 1.8 V and 6.0 V. The user must ensure that the input voltage never exceeds the part’s absolute maximum input voltage rating of 7.0 V. To enable the supply, move the jumper on J4 so that the CTRL pin is connected to the ON pin. The EVM comes preloaded with four white light LEDs; therefore, no external load is required for the EVM to operate properly.

Chapter 3

Board Layout

This chapter provides the TPS61042EVM-226 board layout and illustrations.

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3.1 Layout

Board layout is critical for all switch mode power supplies. Figures 3–1, 3–2, and 3–3 show the board layout for the TPS61042EVM–226 PWB. The nodes with a high switching frequency are short and are isolated from the noise sensitive feedback circuitry. Careful attention has been given to the routing of high frequency current loops. Refer to the data sheet for specific layout guidelines.

Figure 3–1. Assembly Layer

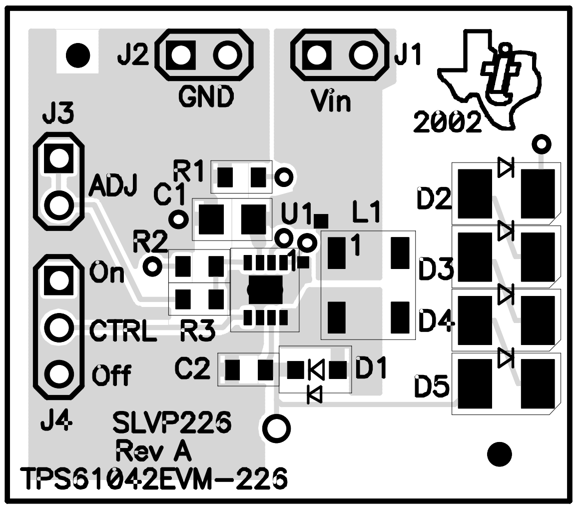


Figure 3–2. Top Layer Routing

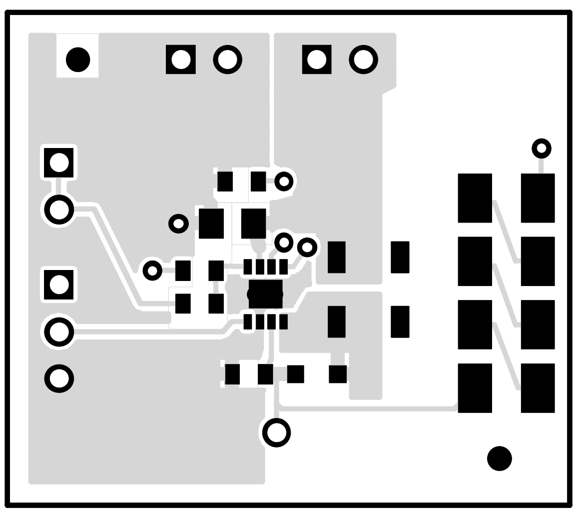
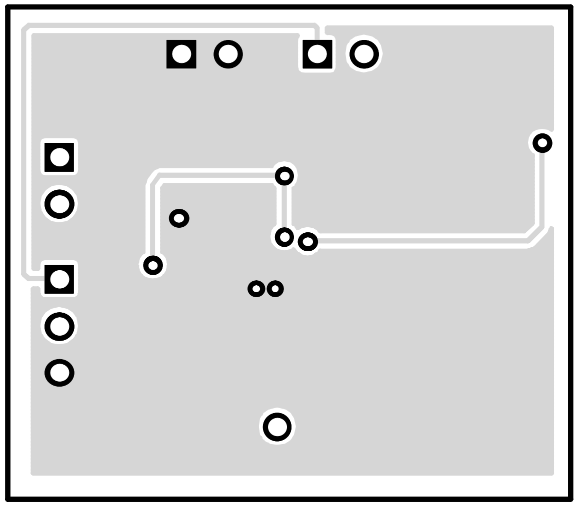


Figure 3–3. Bottom Layer Routing



Chapter 4

Schematic and Bill of Materials

This chapter provides the TPS61042EVM–226 schematic and bill of materials.

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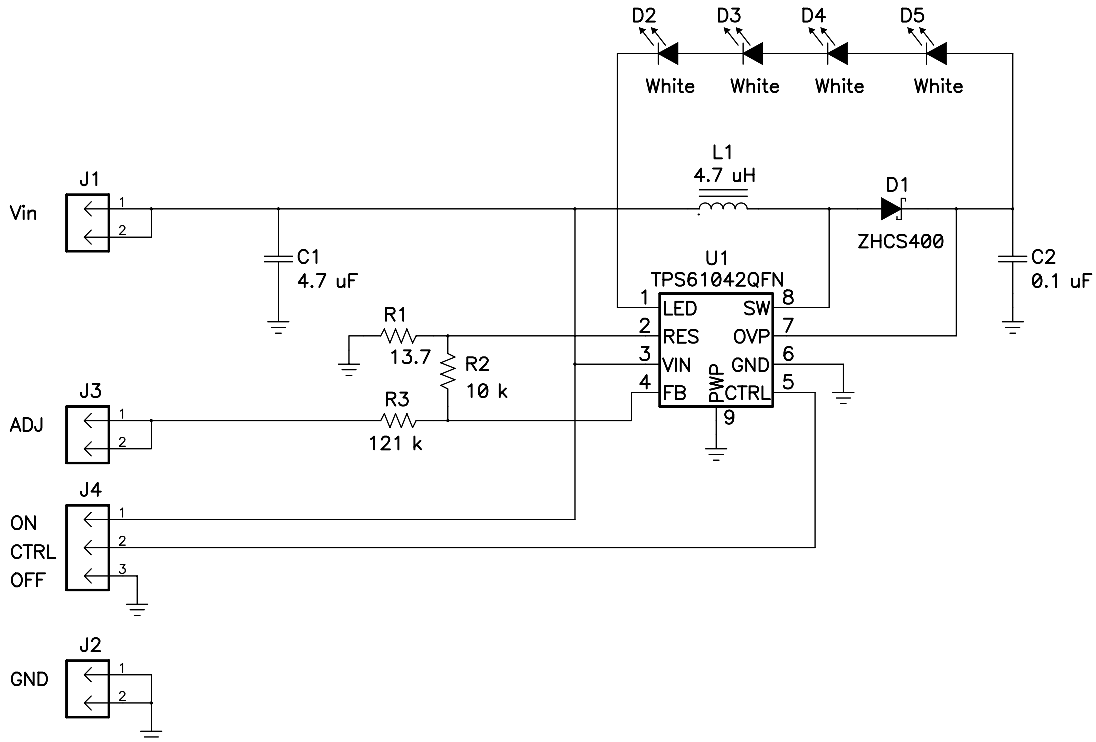
4.1 Schematic



4.2 Bill of Materials

Table 4–1. TPS61042EVM-226 Bill of Materials

Count	Ref Des	Description	Size	MFR	Part Number
1	C1	Capacitor, ceramic, 4.7 µF, 6.3 V, X5R, 10%	805	Murata	GRM21BR60J475KA11
1	C2	Capacitor, ceramic, 0.1 µF, 25 V, X7R, 10%	603	Murata	GRM188R71E104KA01
1	D1	Diode, Schottky, 400 mA, 40 V	SOD323	Zetex	ZHCS400
4	D2, D3, D4, D5	Diode, LED, white, 30 mA	1210	Lumex	SML–LX2832UWC–TR
3	J1, J2, J3	Header, 2-pin, 100 mil spacing, (36-pin strip)	0.100 x 2	Sullins	PTC36SAAN
1	J4	Header, 3-pin, 100 mil spacing, (36-pin strip)	0.100 x 3	Sullins	PTC36SAAN
1	L1	Inductor, 4.7 µH, 750 mA, 216 mΩ	0.500 x 0.500	Sumida	CMD4D11–4R7
1	R1	Resistor, chip, 13.7 Ω, 1/16-W, 1%	603	Std	Std
1	R2	Resistor, chip, 10 kΩ, 1/16-W, 1%	603	Std	Std
1	R3	Resistor, chip, 121 kΩ, 1/16-W, 1%	603	Std	Std
1	U1	IC, LED driver	QFN–8P	TI	TPS61042QFN
1	—	PCB, 1.2 In x 1.05 In x .062 In		Any	SLVP226
1	—	Shunt, 100 mil, black	0.100	3M	929950–00