Texas Instruments

TPS60230EVM-047

Evaluation Module

User's Guide

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PMP Portable Power Products

SBVU008

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Texas Instruments
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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 +25°C. The EVM is designed to operate properly with certain components above +25°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.

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265

Preface

Read This First

About This Manual

This user's guide provides the information needed to set up and operate the TPS60230EVM-047 evaluation module. For a more detailed description of the TPS60230, please refer to the product data sheet available from the Texas Instruments web site at http://www.ti.com. Additional support documents are listed in the sections of this guide entitled *Related Documentation from Texas Instruments*.

How to Use This Manual

Throughout this document, the acronym **EVM** and the phrase **evaluation module** are synonymous with the TPS60230EVM−047.

Related Documentation From Texas Instruments

The following document(s) provide information regarding Texas Instrument integrated circuits used in the assembly of the TPS60230EVM−047. These documents are available from the TI web site. The last character of the literature number corresponds to the document revision, which is current at the time of the writing of this user's guide. Newer revisions may be available from the TI web site at http://www.ti.com or by calling the Texas Instruments Literature Response Center at (800) 477−8924 or the Product Information Center at (972) 644−5580. When ordering, identify the document(s) by both title and literature number.

Data Sheets:	**Literature Number:**
TPS60230	SLVS516

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If you have questions regarding either the use of this evaluation module or the information contained in the accompanying documentation, please contact your local TI sales representative, the Texas Instruments Product Information Center at (972) 644−5580, or visit the TI Semiconductor Online Technical Support pages at http://www.ti.com.

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TPS60230EVM-047

This user's guide describes the characteristics, operation, and use of the TPS60230EVM-047 LED charge-pump current-source evaluation module (EVM). This EVM features a high-efficiency charge-pump-based white LED driver designed to operate off a single cell Li-Ion battery and drive up to five white LEDs with up to 20mA each. This user's guide includes setup instructions, test results, a schematic diagram, a bill of materials (BOM), and printed circuit board (PCB) layout drawings for the evaluation module.

Topic **Page**

1 Introduction

The Texas Instruments TPS60230EVM-047 evaluation module (EVM) helps designers evaluate the operation and performance of the TPS60230. This device is an efficient charge-pump-based current sink that can drive up to five white LEDs with 25mA each. Efficiency is improved by switching between a 1.0x and 1.5x mode, based on the input voltage.

This EVM is specifically designed and optimized to operate with a single-cell Li-Ion battery input. The default maximum current setting for this EVM is 20mA per LED. If desired, this EVM can easily be modified to supply higher or lower currents by appropriately selecting the ISET resistor, R1. Refer to the data sheet (SLVS516) for more information on adjusting the LED current.

2 Initial Configuration

This section describes the jumpers and connectors on the EVM, as well as how to properly connect, set up, and use the TPS60230EVM-047.

2.1 Input/Output Connector Descriptions

2.1.1 J1: VIN

This is the positive connection to the input power supply or battery.

2.1.2 J2: GND

This is the return connection for the input power supply or battery.

2.1.3 JP1: EN2

This jumper will ground the EN2 pin or connect it to VIN. If the both EN1 and EN2 are connected to VIN, the LED current will be the full programmed value set by R1. For this EVM, that current is 20mA. If EN2 is connected to ground and EN1 is high, the LED current will be set to 1/3 the programmed value, or 6.66mA. If both EN1 and EN2 are grounded, the LEDs will turn off.

2.1.4 JP2: EN1

This jumper will ground the EN1 pin or connect it to VIN. If the both EN1 and EN2 are connected to VIN, the LED current will be the full programmed value set by R1. For this EVM, that current is 20mA. If EN1 is connected to ground and EN2 is high, the LED current will be set to 2/3 the programmed value, or 13.33mA. If both EN1 and EN2 are grounded, the LEDs will turn off.

2.2 Setup

Connect an input supply or battery between J1 and J2. The voltage range on this supply should stay between 2.7V and 6.0V. Set the appropriate brightness by configuring JP1 and JP2.

2.3 Operation

The EVM has been optimized to operate from a single-cell Li-Ion battery with an input voltage range of 2.7V to 6.0V. The value for R1 programs the maximum LED current. For this EVM, the maximum current is set to 20mA. However, by changing the value of R1, LED currents up to 25mA can be achieved. Currents less than 20mA can be achieved by appropriately configuring JP1 and JP2, as shown in Table 1.

Table 1. Relative LED Current Levels

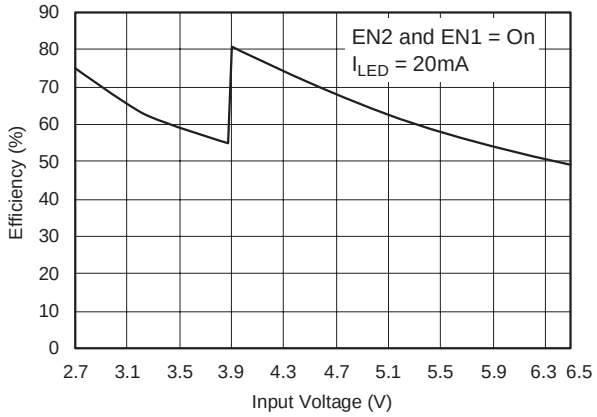
JP1 (EN2)	JP2 (EN1)	LED CURRENT
0	0	0
0	1	1/3 full
1	0	2/3 full
1	1	Full (20mA for R1 = 7.87kΩ)

EN1 and EN2 can also be used for pulse width modulator (PWM) dimming. The PWM signal can be applied to EN1, EN2, or both. In this case, the LED current is proportional to duty factor and can have a maximum current dictated by how EN1 and EN2 are configured. The maximum recommended PWM frequency is 50kHz, and the minimum recommended ON time is 2.5us. Refer to the datasheet (SLVS516) for more information in regards to PWM dimming.

2.4 Test Results

The efficiency curve in Figure 1 reflects the power delivered to the LED. The output power used for the efficiency calculation is the sum of all the LED currents multiplied by the LED forward voltage.

Figure 1. Efficiency vs VIN



3 Printed Circuit Board (PCB) Layout

PCB layout is critical for all switch-mode power supplies. Figure 2, Figure 3, and Figure 4 show the board layout for the TPS60230EVM-047 PWB. The nodes with high switching frequencies and currents 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 product datasheet (SLVS516) for specific layout guidelines.

Figure 2. Assembly Layer

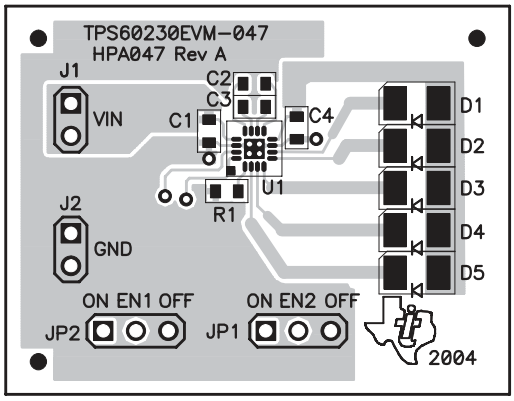


Figure 3. Top Layer Routing

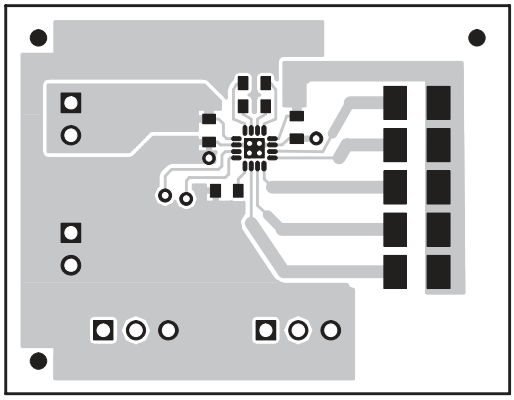
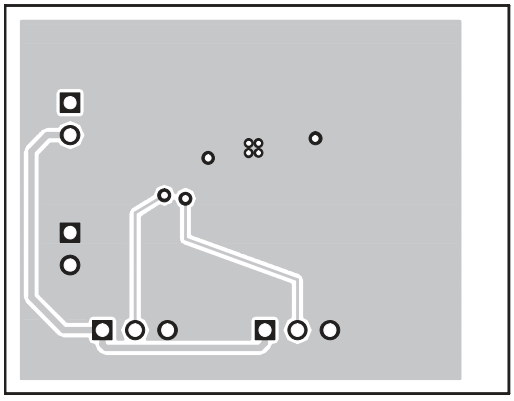
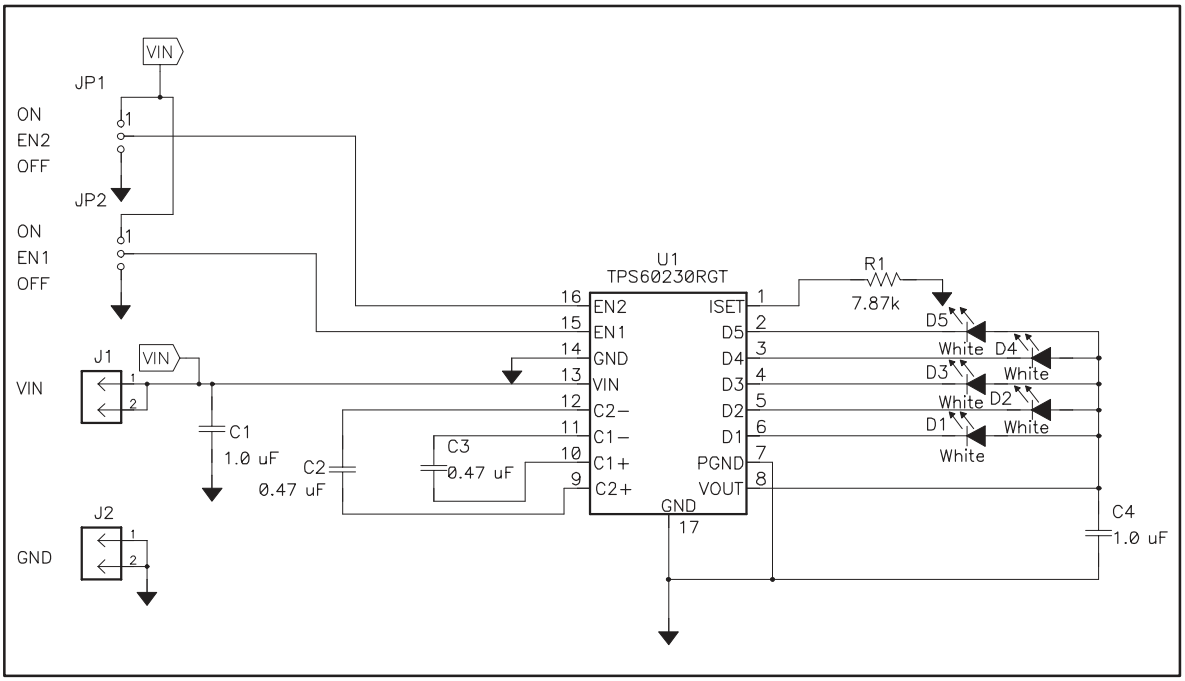


Figure 4. Bottom Layer Routing



4 Schematic

Figure 5. TPS60230EVM−047 Schematic



5 Bill of Materials

Table 2. Bill of Materials

Qty	Ref Des	Description	Size	Mfr	Part Number
2	C1, C4	Capacitor, ceramic, 1.0µF, 6.3V, X5R, 10%	603	TDK	C1608X5R0J105KT
2	C2, C3	Capacitor, ceramic, 0.47µF, 10V, X5R, 10%	603	TDK	C1608X5R1A474KT
5	D1 − D5	Diode, LED, White, 30mA	1210	Lumex	SML−LX2832UWC−TR
2	J1, J2	Header, 2-pin, 100mil spacing, (36-pin strip)	0.100 x 2	Sullins	PTC36SAAN
2	JP1, JP2	Header, 3-pin, 100mil spacing, (36-pin strip)	0.100 x 3	Sullins	PTC36SAAN
1	R1	Resistor, chip, 7.87kΩ, 1/16W, 1%	603	Std	Std
1	U1	IC, white LED charge pump current source	0.80 x 0.80	TI	TPS60230RGT
1	−−	PCB, 1.55 in x 1.195 in x 0.062 in		Any	HPA047
2	−−	Shunt, 100mil, black	0.100	3M	929950−00