

TPS60230EVM-047

Evaluation Module

User's Guide

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		Applications	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
		Telephony	www.ti.com/telephony
		Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265

Copyright © 2004, Texas Instruments Incorporated

EVM IMPORTANT NOTICE

Texas Instruments (TI) provides the enclosed product(s) under the following conditions:

This evaluation kit being sold by TI is intended for use for **ENGINEERING DEVELOPMENT OR EVALUATION PURPOSES ONLY** and is not considered by TI to be fit for commercial use. As such, the goods being provided may not be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including product safety measures typically found in the end product incorporating the goods. As a prototype, this product does not fall within the scope of the European Union directive on electromagnetic compatibility and therefore may not meet the technical requirements of the directive.

Should this evaluation kit not meet the specifications indicated in the EVM User's Guide, the kit may be returned within 30 days from the date of delivery for a full refund. **THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.**

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods. Please be aware that the products received may not be regulatory compliant or agency certified (FCC, UL, CE, etc.). Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge.

EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

TI currently deals with a variety of customers for products, and therefore our arrangement with the user **is not exclusive**.

TI assumes **no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein**.

Please read the EVM User's Guide and, specifically, the EVM Warnings and Restrictions notice in the EVM User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For further safety concerns, please contact the TI application engineer.

Persons handling the product must have electronics training and observe good laboratory practice standards.

No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which such TI products or services might be or are used.

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265

EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 0 V and 7 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 +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

Copyright © 2004, Texas Instruments Incorporated

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:

TPS60230

Literature Number:

SLVS516

If You Need Assistance

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>.

FCC Warning

This equipment is intended for use in a laboratory test environment only. It may generate, use, or radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to sub-part J of part 15 of the FCC regulations, 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.

Trademarks

All trademarks are the property of their respective owners.

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	2
2 Initial Configuration	2
3 Printed Circuit Board (PCB) Layout	4
4 Schematic	5
5 Bill of Materials	5

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

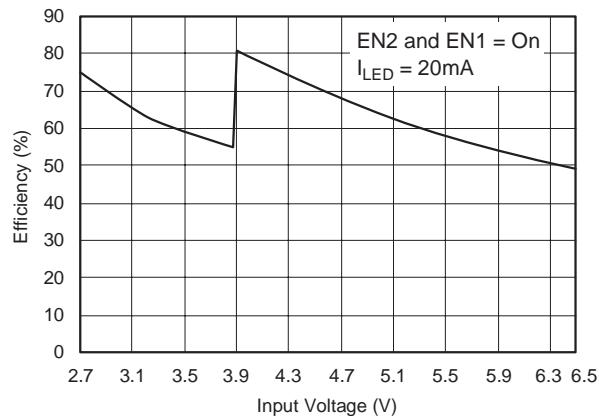
JP1 (EN2)	JP2 (EN1)	LED CURRENT
0	0	0
0	1	1/3 full
1	0	2/3 full
1	1	Full (20mA for R1 = 7.87kΩ)

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 (SLVSS16) for specific layout guidelines.

Figure 2. Assembly Layer

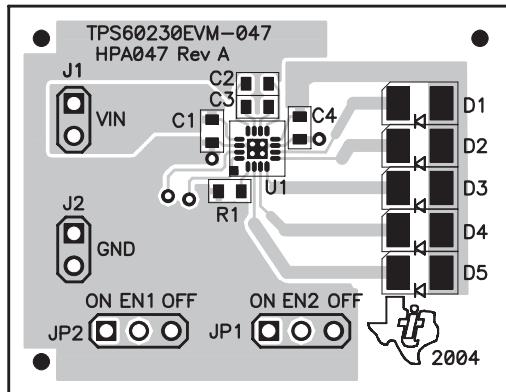


Figure 3. Top Layer Routing

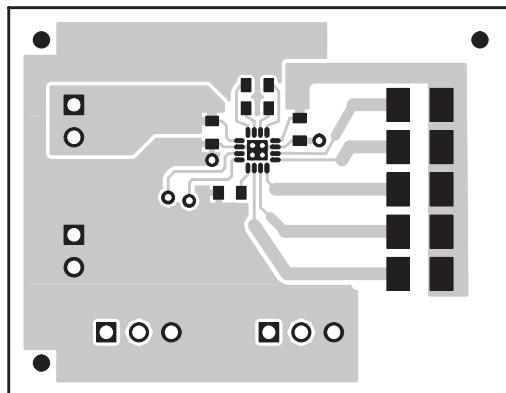
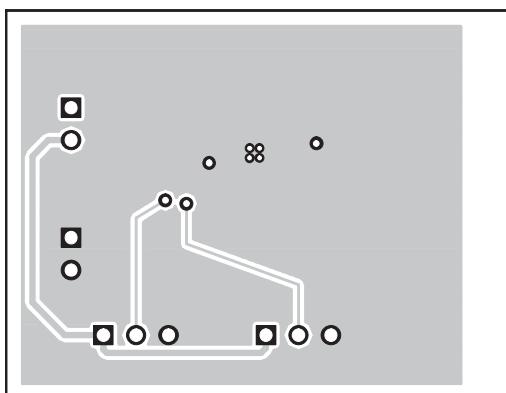
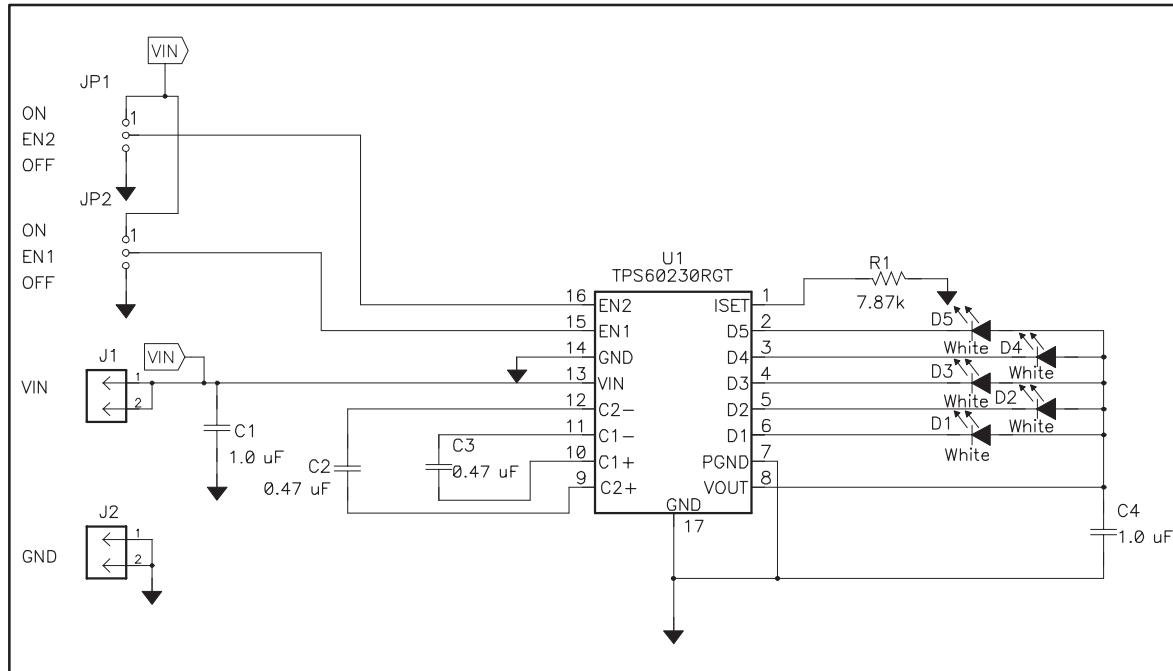


Figure 4. Bottom Layer Routing



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	TPS60230RG
1	--	PCB, 1.55 in x 1.195 in x 0.062 in		Any	HPA047
2	--	Shunt, 100mil, black	0.100	3M	929950-00