TPS61166EVM-446 User's Guide

The TPS61166EVM-446 is an evaluation board to assist in evaluating the TPS61166 IC as a WLED driver.

Contents

List of Figures

List of Tables

1 Introduction

1.1 Description

The TPS61166 is a boost converter with a 20-V rated integrated switch FET and power diode that drives up to 5 LEDs in series. This device integrates a high side switch FET that can turn on/off the LED current within 1-µs of the applied external PWM signal. The high side switch also provides input-to-output isolation during IC shutdown.

The default white LED current is set with the external sensor resistor R1, and the feedback voltage is regulated to 200-mV, as shown in the typical application circuit. The LED current can be adjusted using a pulse width modulation (PWM) signal through the PWM pin. The LED current is synchronized to the PWM signal. The device does not discharge the output ceramic capacitor during dimming, thus reducing audible noise when dimming.

Separating the IC input (VIN pin) and power stage input (VBAT pin) makes the device flexible enough to support single- or two-cell Li-ion battery applications. Other protection features include 1.1-A peak-to-peak over current protection (OCP), over voltage protection (OVP), over load protection (OLP), and thermal shutdown. The TPS61166 is available in a 2.5 mm × 2.5 mm SON package with thermal pad.

1.2 Applications

- Small Form Factor LCD Backlight
- Mobile Phone
- Digital Camera
- Personal Camcorder
- Single Lens Reflex

1.3 Features

- IC Supply Range: 2.5-V to 6-V
- Power Stage Input Range: 4.5-V to 10-V
- Integrated 1.1-A / 20-V Internal Switch FET and Power Diode
- Drive up to 5 LEDs in Series
- Fast on/off LED Current Within 1-µs in Brightness Dimming
- Burst PWM Dimming Method With Frequency Range From 60-Hz to 40-kHz
- Built-in Soft Start-up
- Over Load Protection
- Over Voltage Protection
- 2.5 × 2.5 × 0.8 mm SON Package

2 TPS61166evm Electrical Performance Specifications

The specifications below are for TA = 25°C unless otherwise specified.

Table 1. TPS61166evm Electrical and Performance Specifications

Parameter		Notes & Conditions	Min	Nom	Max	Units
INPUT CHARACTERISTICS						
V_{IN} at J1	Input Voltage	JP4 installed tying $V_{BAT} = V_{IN}$	2.5		6	V
V_{IN} at J1	Input Voltage	JP4 removed	4.5		10	V
V_{IN_UVLO}	Input UVLO	V_{IN} falling		1.5	1.55	V
f_{DIM}	PWM dimming frequency	V_{PWML} < 0.3V, 1.2V < V_{PWMH} < 6V	0.06		40	kHz
OUTPUT CHARACTERISTICS						
I_{OUT} through JP3	LED current	V_{BAT} = 2.5V - 10V, EN=PWM=Logic High, JP4 installed	29	30	31	mA
OUT	Voltage at J4	V_{BAT} = 2.5V - 10V, EN=PWM=Logic High, JP4 installed	12		17	V
OUT	Voltage at J4	V_{BAT} = 2.5V - 10V, EN=PWM=Logic High, JP4 removed, OVP active		18	19	V
F_{SW}	Switching Frequency		1.0	1.2	1.4	MHz

3 Modifications

3.1 General

To aid user customization of the EVM, the board was designed with devices having 0603 or larger footprints. A real implementation likely occupies less total board space. Changing components can improve or degrade EVM performance. For example, adding a larger output capacitor reduces output voltage undershoot but lengthens response time after a load transient event. Due to the internal compensation, the inductor and output capacitor should remain within the datasheet limits in order for the boost converter to remain control loop stability.

3.2 Output Voltage

The TPS61166's LED current is adjustable and is set by resistor R1. To change the LED current, the user should consult the datasheet on how to properly size R1.

3.3 VBAT > 6V

The EVM is shipped with JP4's shunt installed which ties V_{BAT} to V_{IN}. If the EVM's input power supply is higher than 6 V, JP4 must be removed to prevent the V_{IN} pin from being damaged. With JP4 removed, pin 1 of JP1 is no longer pulled up. So, the user must apply an external voltage between 1.2v and 6V to EN (the middle pin of JP1) in order to enable the device. Alternatively, the user can install a 590kΩ resistor on the R3 footprint. This resistor and the internal pull down resistor on EN form a resistor divider from V_{BAT} which provides a pull up voltage between 1.2V and 6V for 4.5V < V_{BAT} < 10V.

4 Schematic

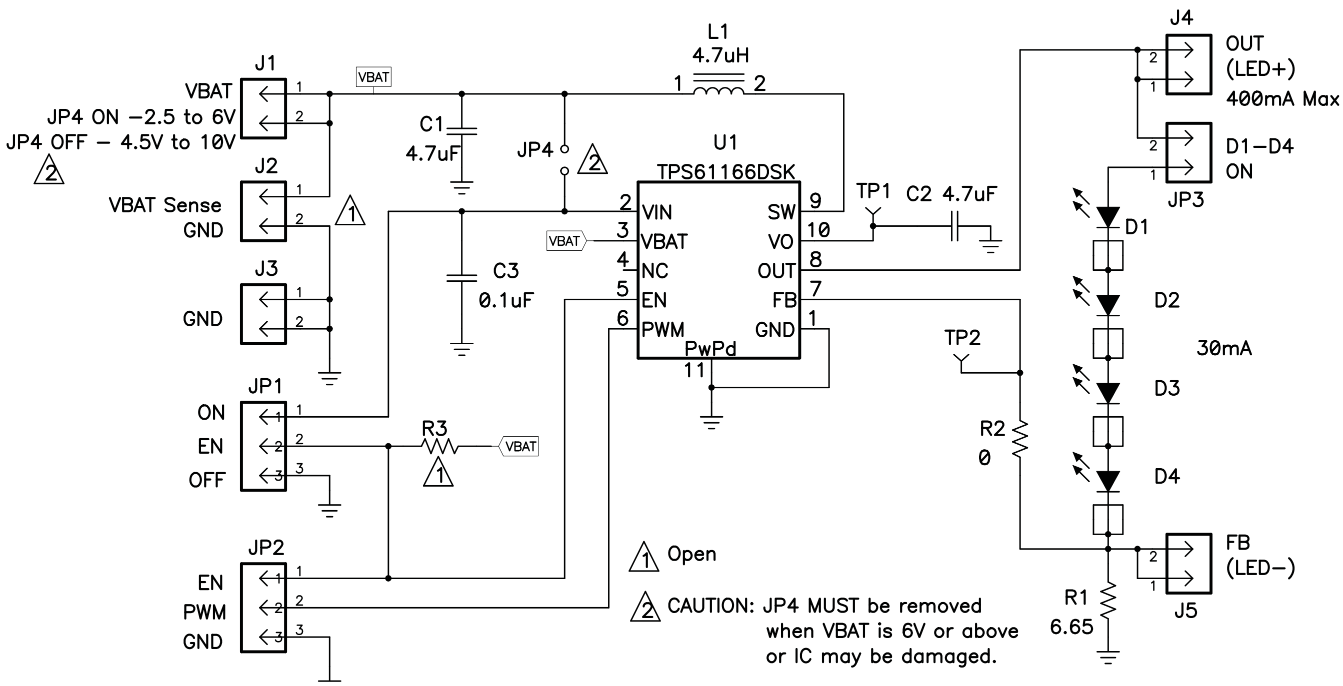

Figure 1. TPS61166 EVM Schematic

5 Connector and Test Point Descriptions

5.1 J1 –VBAT

This header is the positive connection to the input power supply and is tied to the ICs VBAT pin. The user must connect the power supply between J1 and J3 (GND). The leads to the input supply should be twisted and kept as short as possible. The input voltage must be between 1.6-V and 6-V.

5.2 J2 – VBAT and GND Kelvin Sense

Although not installed, this header provides Kelvin sense connections across input capacitor C1.

5.3 J3 – GND

This header is the return connection to the input power supply and is tied to the ICs GND pin. The user must connect the power supply between J3 and J1 (VIN). The leads to the input supply should be twisted and kept as short as possible. The input voltage must be between 1.6-V and 6-V.

5.4 J4– OUT (LED+)

This header connects to the IC's OUT pin. After removing the shunt on JP4, the user can attach the anode of an off-board LED string between this pin and J5.

5.5 J5– FB (LED-)

This header connects to the IC's FB pin. After removing the shunt on JP4, the user can attach the cathode of an off-board LED string between this pin and J4.

5.6 JP1– EN

The middle pin of this jumper ties to the IC's EN pin. When JP4's shunt is installed, placing JP1's shunt at ON ties the middle EN pin to VBAT=VIN thereby turning on the boost converter. Removing the shunt from this jumper allows the IC's internal pull down resistor to pull it to ground (or moving the shunt to the OFF position) thereby disabling the converter. When JP4's shunt is not installed, pin 1 of JP1 is no longer pulled up. So, the user must apply an external voltage between 1.2v and 6V to EN (the middle pin of JP1) in order to enable the device. Alternatively, the user can install a 590kΩ resistor on the R3 footprint. This resistor and the internal pull down resistor on EN form a resistor divider from V_{BAT} which provides a pull up voltage between 1.2V and 6V for 4.5V < V_{BAT} < 10V. With R3 installed, the user must move JP1's shunt to the OFF position in order to disable the converter.

5.7 JP2 – PWM

The middle pin of this jumper ties to the IC's PWM pin. The user can apply an external PWM signal within the voltage and frequency ranges specified in Table 1 to this pin to implement PWM dimming of the LEDs. For 100% full brightness, the user can place JP2's shunt to the EN position thereby tying the PWM pin to the EN pin voltage. The user can also completely disconnect the LEDs from the boost converter output, thereby turning them off, by moving JP2's shunt to GND.

5.8 JP3 – D1-D4 ON

This jumper is in series with the on board LEDs. The user can remove this jumpers shunt and replace it with an ammeter in order to measure the LED current. The user must remove this jumper if off-board LEDs are being connected between J4 and J5.

5.9 TP1 – Test Point 1

This test point connects to the IC's VO pin. Since the VO pin is the output of the boost converter before the internal PWM dimming switching, the user can monitor the boost converter output and, for example, confirm that the over voltage protection circuit properly clamps the output voltage if the LEDs are removed from the output.

5.10 TP2 – Test Point 2

This test point can be used to measure the small signal control loop gain and phase with Venable® or similar gain phase analyzer. For example, the user would replace the 0-Ω resistor in R2 with a 49.9-100 Ω resistor before attaching a Venable® gain/phase analyzer between header J5 and TP2.

6 Test Setup and Results

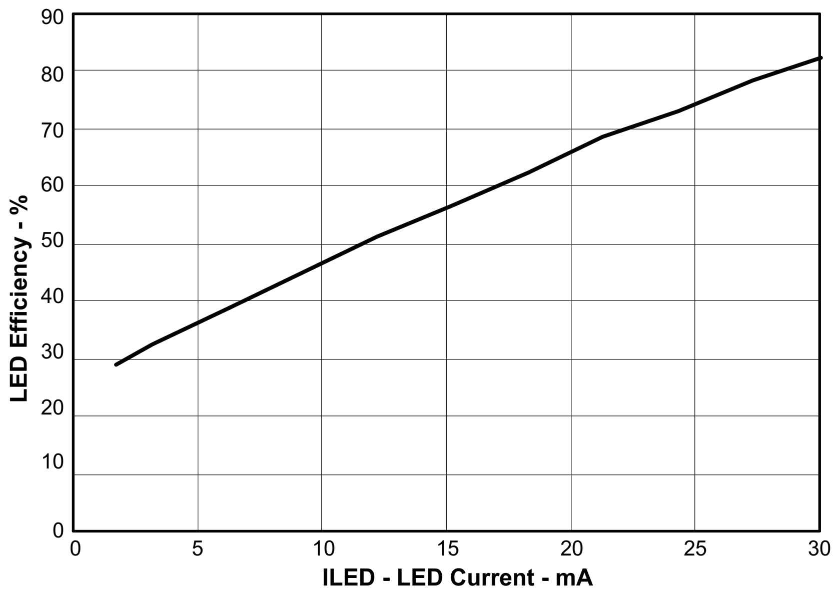

Figure 2. LED Efficiency

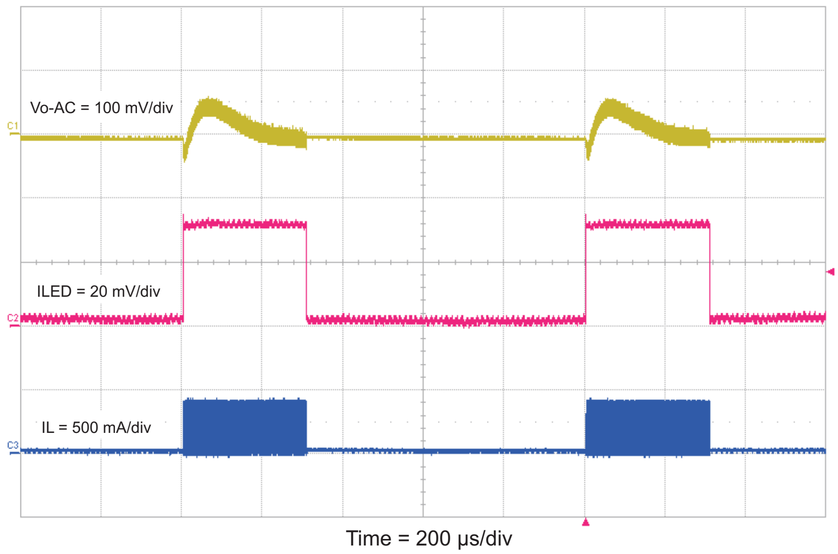

Figure 3. 1kHz PWM Dimming with D = 30%

7 EVM Assembly Drawings and Layout

Figure 4 through Figure 6 show the design of HPA446, the TPS61166EVM's printed circuit board. The EVM has been designed using a 2-Layer, 1oz copper-clad, 2 inch x 2 inch circuit board.

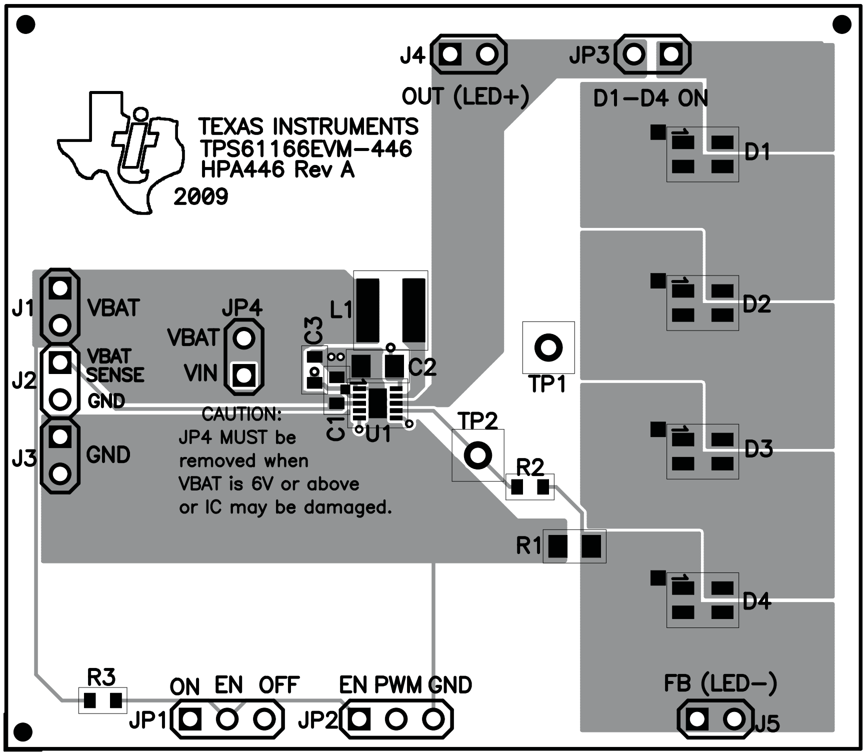

Figure 4. TPS61166EVM-446 Top and Silkscreen (Viewed from Top)

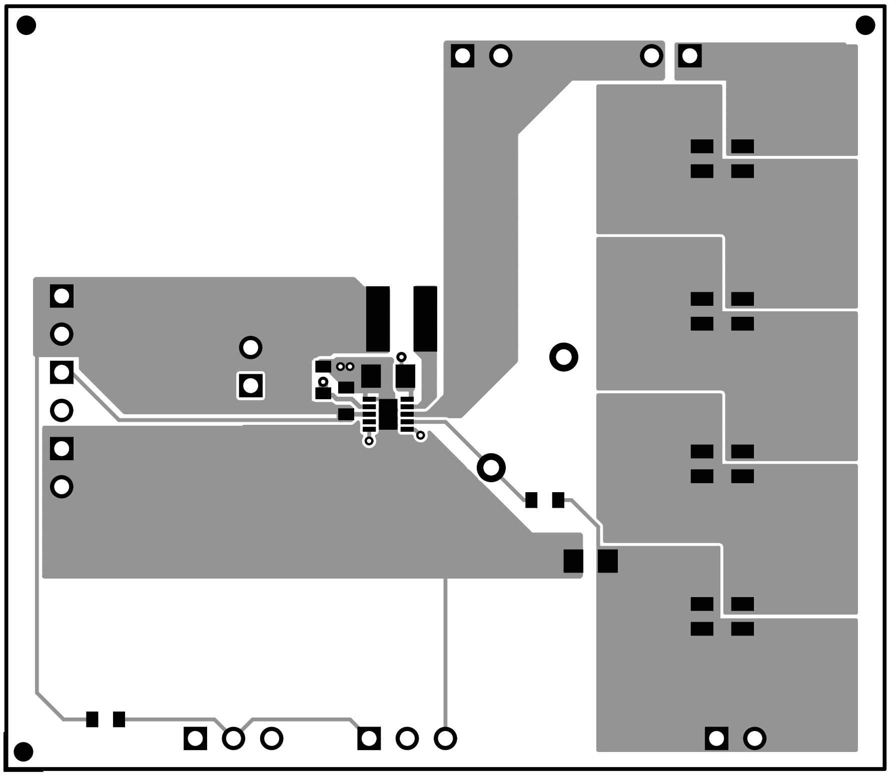

Figure 5. TPS61166EVM-446 Top Copper

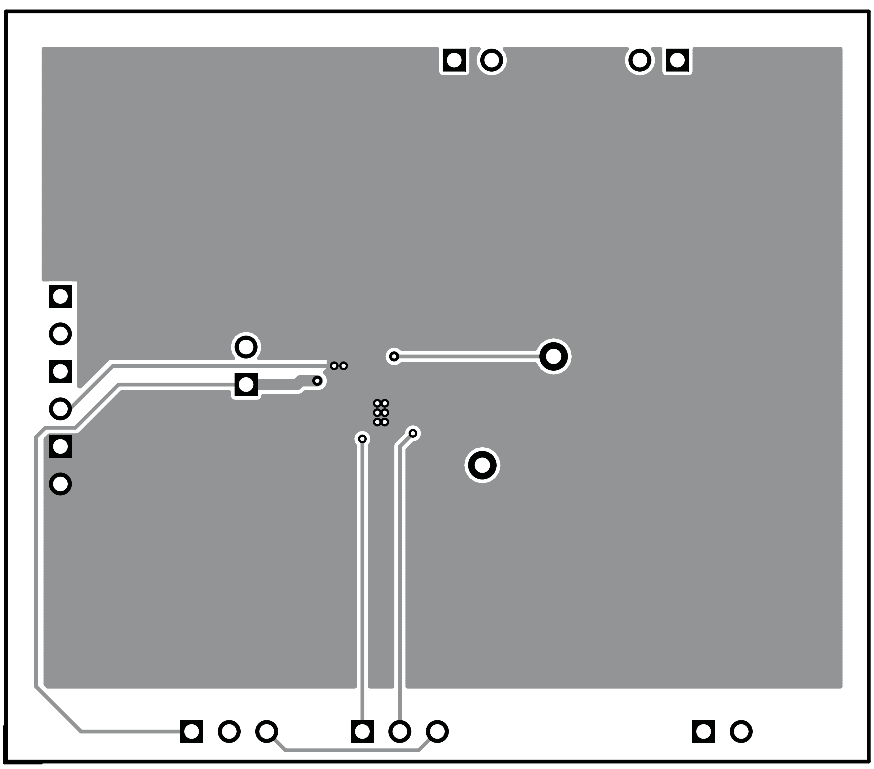

Figure 6. TPS61166EVM-446 Bottom Layer

7.1 Bill of Materials

Table 2 lists the EVM components as configured according to the schematic shown in Figure 1.

Table 2. Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
1	C1	4.7μF	Capacitor, Ceramic, 6.3V, X5R, 20%	0603	Std	Std
1	C2	0.1μF	Capacitor, Ceramic, 25V, X5R, 20%	0603	Std	Std
1	C3	0.1μF	Capacitor, Ceramic, 6.3V, X5R, 20%	0603	Std	Std
1	C4	1μF	Capacitor, Ceramic, 25V, X5R, 20%	0603	Std	Std
1	C5	1μF	Capacitor, Ceramic, 6.3V, X5R, 20%	0603	Std	Std
0	C6	Open	Capacitor, Ceramic, 6.3V, X5R, 20%	0603	Std	Std
0	J2, J5, J8	Open	Header, Male 2-pin, 100mil spacing	0.100 inch x 2	PEC02SAAN	Sullins
6	J1, J3, J4, J6, J7, J9	PEC02SAAN	Header, Male 2-pin, 100mil spacing,	0.100 inch x 2	PEC02SAAN	Sullins
1	JP1	PEC02SAAN	Header, 2-pin, 100mil spacing Inductor,	0.100 inch x 2	PEC02SAAN	Sullins
1	L1	10uH	SMT, 1.4A, 127 milliohm	0.189 x 0.189 inch	LPS5030-103ML	Coilcraft
1	R1	294k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R2	10.2k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	R3	Open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R4	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R5	200k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	TP1	Open	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
1	U1	TPS61166DSK	IC, Low Input Boost Converter with Integrated Power Diode and Isolation	QFN	TPS61166DSK	TI

EVALUATION BOARD/KIT IMPORTANT NOTICE

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

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. Persons handling the product(s) must have electronics training and observe good engineering practice standards. As such, the goods being provided are not intended to be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including product safety and environmental measures typically found in end products that incorporate such semiconductor components or circuit boards. This evaluation board/kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and therefore may not meet the technical requirements of these directives or other related directives.

Should this evaluation board/kit not meet the specifications indicated in the User’s Guide, the board/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. 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 User’s Guide and, specifically, the Warnings and Restrictions notice in the User’s Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI’s environmental and/or safety programs, please contact the TI application engineer or visit www.ti.com/esh.

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.

FCC Warning

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to 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.

EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the charge regulation input voltage range of 2.5 V to 10 V and the adapter output voltage range of Vin to 20 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 85°C. The EVM is designed to operate properly with certain components above 85°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

IMPORTANT NOTICE