TPS61160EVM-243/TPS61161EVM-243

This user's guide describes the characteristics, operation, and use of the TPS6116xEVM-243 evaluation module (EVM). This EVM contains the Texas Instruments TPS61160 or TPS61161 boost converter, configured with external components to regulate current through a string of WLEDs. This user's guide includes EVM specifications, recommended test setup, test results, bill of materials, and a schematic diagram.

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1 Introduction

The Texas Instruments TPS6116xEVM-243 evaluation module contains a TPS61160 or TPS61161 integrated circuit (IC), supporting active and passive components and either 6 or 10 white light-emitting diodes (WLEDs) in series. The goal of this EVM is to facilitate evaluation of the TPS61160 or TPS61161 in a typical WLED application.

1.1 Performance Specification Summary

Table 1 provides a summary of the TPS6116xEVM-243 performance specifications. All specifications are given for an ambient temperature of 25°C.

Table 1. Typical Performance Specification Summary

	CONDITION	MIN	TYP	MAX	UNITS
V_{IN} supply		9		18	V
TPS61161 V_{OUT}	CTRL=VIN, JP2 shorted		29.5		V
	CTRL=VIN, JP2 open	37	38	39	V
TPS61160 V_{OUT}	CTRL=VIN, JP2 shorted		17.7		
	CTRL=VIN, JP2 open	25	26	27	
I_{OUT}	JP2 shorted	19	20	21	mA

1.2 Modifications

To aid user customization of the EVM, the board was designed with devices having 0603 or larger footprints. A real-world implementation should occupy less total board space.

The inductor and compensation components (R1, C2) were designed for the V_{IN} range shown in Table 1. Using a different input voltage range may require resizing of the inductor and/or the compensation components. Also, changing components can improve or degrade EVM performance. For example, using inductors with larger dc resistances lowers efficiency of the solution.

The other members of the TPS6116x IC family have the same footprint.

> **NOTE:** When modifying the REV A version of this PCB, it is strongly recommended that you heat the PCB on a hot plate before using a soldering iron to remove/replace components, especially the input capacitor and inductor. Otherwise, the expansion when soldering and contraction when cooling of the wide traces/places connecting these components to the IC pins can damage the IC. For further explanation and guidance, see the TI application report *QFN/SON PCB Attachment* (SLUA271).

2 Setup and Test Results

2.1 Input/Output Connections

The connection points are described in the following paragraphs.

2.1.1 J1-VIN

This header is the positive connection to the input power supply. Twist the leads to the input supply, and keep them as short as possible.

2.1.2 J2-GND

This header is the return connection to the input power supply.

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VeriSign is a trademark of VeriSign, Inc..

2.1.3   J3-VOUT

This header is the positive voltage output for the device.

2.1.4   J4-GND

This header is the return connection for the load.

2.1.5   J5-USB-TO-GPIO Connector

This connector is for the 10-pin ribbon cable that connects the EVM to the USB-TO-GPIO interface box. It is only used when the software is used to perform dimming.

2.1.6   J6-FB

This header connects to the FB pin of the IC through resistor R4. Resistor R4 is unpopulated.

2.1.7   JP1-ON/CTRL

Installing this jumper ties the CTRL pin to V_{IN}, and enables the device. Removing the jumper allows the internal pulldown resistor to pull CTRL to ground, which disables the device. The jumper should be removed if using an external signal to perform dimming.

2.1.8   JP2-Open LED

Installing this jumper places the WLEDs in the boost converter feedback path and allows current to flow through the WLEDs. Removing the jumper removes the WLEDs from the boost converter feedback path. With this jumper removed and jumper JP1 installed, the overvoltage protection circuit of the IC clamps the boost converter output to 38 V (typ).

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<u>WARNING</u>

This EVM has white LEDs that shine very brightly. Protective eye wear and/or a diffuser to cover the white LED is recommended.

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2.2   Hardware Requirements

This EVM requires an external power supply capable of providing 3 V to 18 V at 1 A.

To change the default current value (i.e., implement dimming), the user can apply either a PWM or digital control signal to CTRL. Both signals change the feedback voltage at the FB pin of the IC so that the IC performs analog dimming. A function generator capable of driving the CTRL pin with 1.2 V to VIN amplitude and 5-kHz to 100-kHz PWM signal is required for PWM-controlled dimming. The user also can implement dimming by using a digital control signal. The EVM kit includes a PC software compact disk (CD) and USB-TO-GPIO interface box which, when installed on a personal computer (PC) and connected to the EVM, allows the user to communicate with the EVM via a GUI interface. The minimum PC requirements are:

* Windows™ 2000 or Windows™ XP operating system
* USB port
* Minimum of 30 MB of free hard disk space (100 MB recommended)
* Minimum of 256 MB of RAM

2.3 Hardware Setup

After connecting the power supply between J1 and J2, turning on the power supply, and installing JP1 and JP2, the EVM regulates the default current per Table 1 through the WLEDs. Additional input capacitance may be required in order to mitigate the inductive voltage droop that occurs at start-up and/or during a load transient event.

In order to implement analog dimming via a PWM signal, remove the jumper on JP1 and the 10-pin ribbon cable from J5, if installed, and perform the following steps in any sequence:

• Connect the power supply between J1 and J2 and turn on the power supply.
• Make sure that JP2's jumper is installed.
• Connect the appropriately configured function generator to the CTRL side of JP1.
The PWM signal's duty cycle is directly proportional to the regulated current.

To implement analog dimming by sending the digital control via a PC running the TPS6116x Controller software and USB-TO-GPIO interface box, remove the jumper or the function generator on JP1, and perform the following steps in any sequence:

• Connect one end of the USB-TO-GPIO box to the PC using the USB cable and the other end to J5 of the TPS6116xEVM using the supplied 10-pin ribbon cable as shown in the following illustration. The connectors on the ribbon cable are keyed to prevent incorrect installation.
• Connect the power supply between J1 and J2 and turn on the power supply.
• Make sure that JP2's jumper is installed.
• Run the software as explained in the next section.
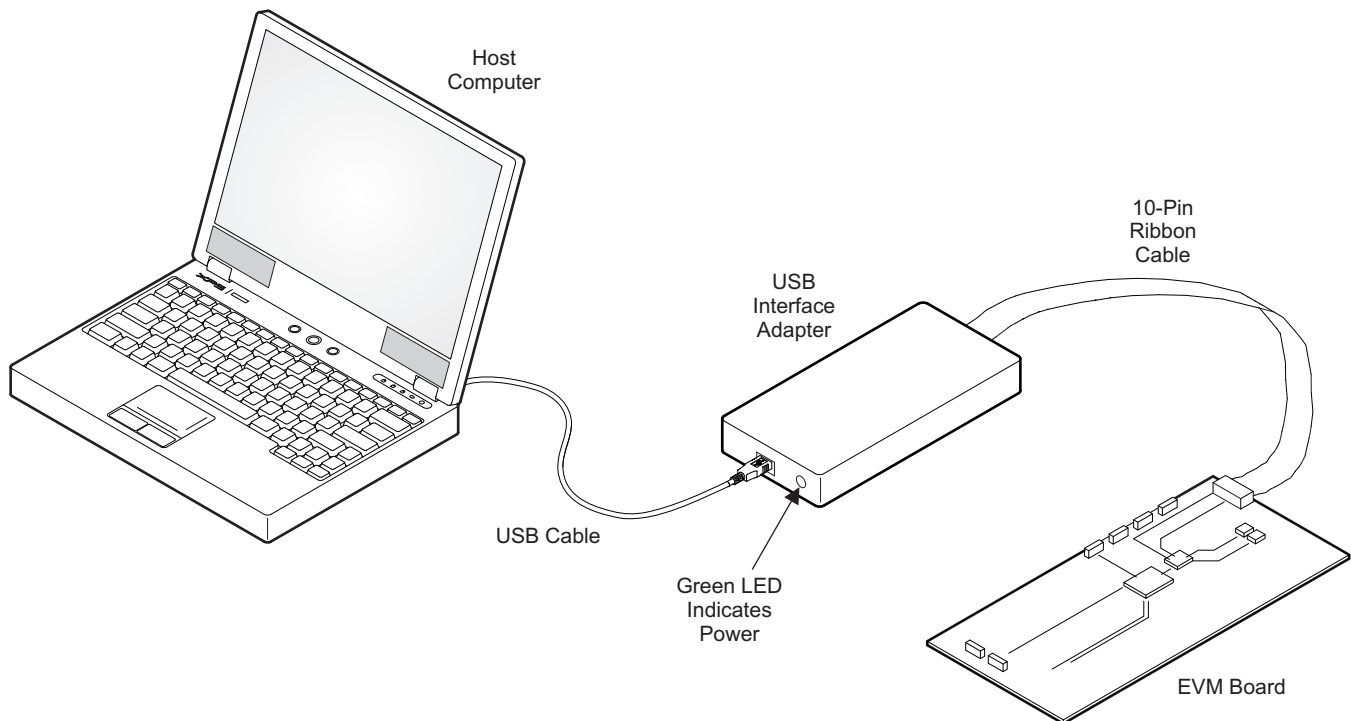
Figure 1. USB Interface Adapter

2.4 Software Installation and Operation

If installing from a CD, insert the CD and run Setup.exe; follow all the prompts to install the software.

If installing from the TI Web site, go to the URL, http://focus.ti.com/docs/toolsw/folders/print/tps6116xevm-sw.html .

NOTE: This installation page is best viewed with the Microsoft™ Internet Explorer browser (It may not work correctly with other browsers)

Click on the install button; your PC gives you a security warning and asks if you want to install this application. Select Install to proceed. If a pre-release or Beta version is currently installed on your PC, you must uninstall this version of the software before installing the final version from either the CD or the TI Web site.

With both types of installation, the software attempts to install the Microsoft Dot Net Framework 2.0 (if it is not already installed) This framework is required for the software to run.

Immediately following installation, the software automatically runs.

To run the software after installation, go to

Start → all programs → Texas Instruments, Inc. → TPS6116x Controller EVM Software.

At start-up, the software first checks the firmware version of the USB-TO-GPIO adapter box. If an incorrect firmware version is installed, the software automatically searches on the Internet (if connected) for updates. If a new update is available, the software notifies the user of the update, and downloads and installs the software. Note that after the firmware is updated, the user must disconnect and then reconnect the USB cable between the adapter and PC, as instructed during the installation process. The host PC software also automatically searches on the Internet (if connected) for updates. If a new update is available, the software notifies the user of the update, downloads and installs it.

NOTE: VeriSign™ Code Signing is used to prevent any malicious code from changing this application. If at any time in the future the binaries are modified, the code will no longer attempt to run.

The TPS6116x IC has a 5-bit register that stores the feedback voltage to which the error amplifier will regulate the FB pin. Using the EasyScale™ protocol, the user can program a separate digital IC to generate a signal that changes this register to one of 32 discrete settings, thereby changing the FB voltage and subsequent regulated WLED current. The software provides a GUI interface which allows the user to change the bits directly or by a drop-down box. After changing the bits, the WRITE button must be pressed. See a screen shot of the software in Figure 2.
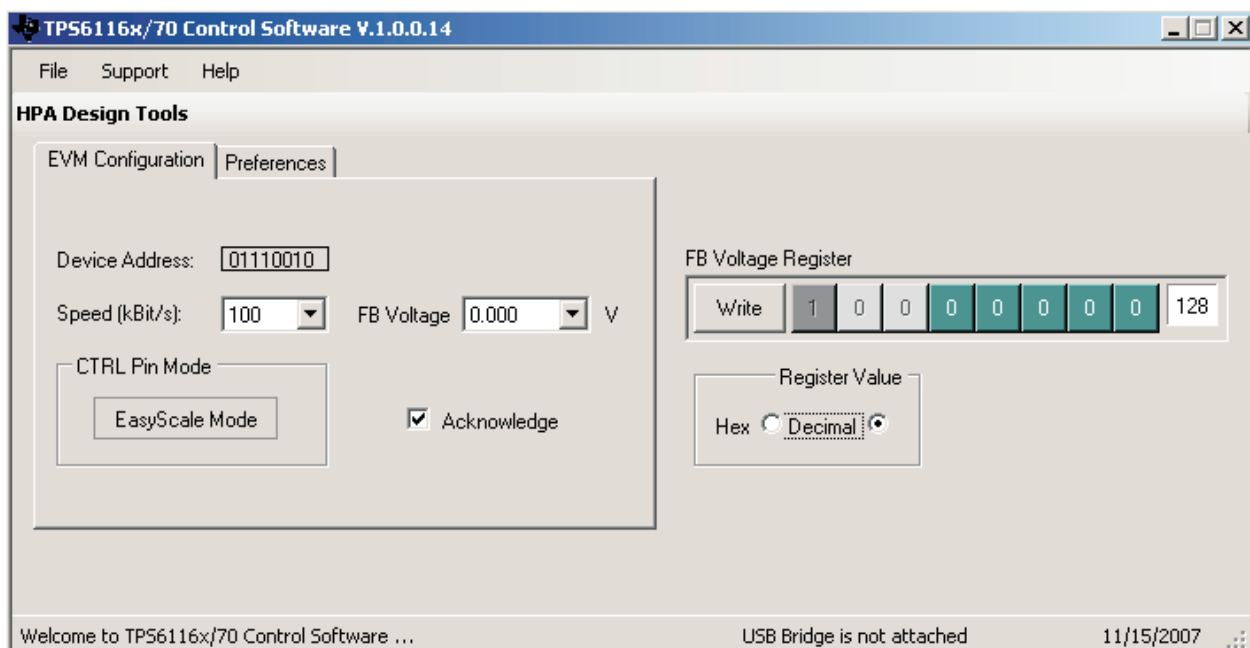
Figure 2. Screen Capture of TPS6116x Controller Software GUI Interface

2.5 Test Results

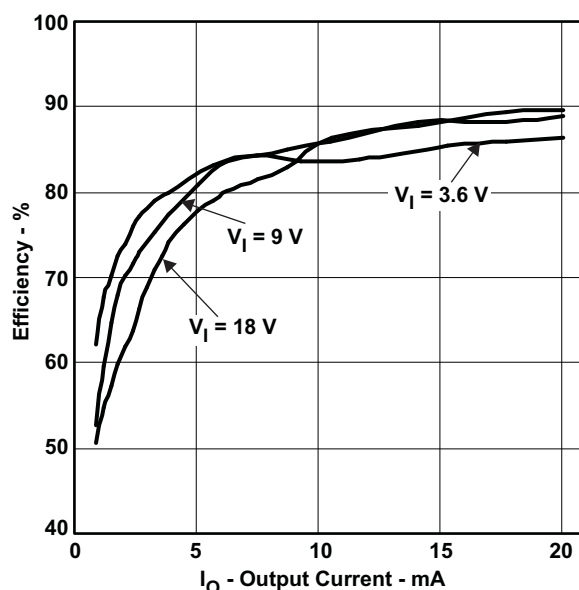This section provides typical efficiency for the TPS6116xEVM-243 board.

Figure 3. TPS61161 Efficiency vs Output Current

3 Board Layout

This section provides the TPS6116xEVM-243 board layout and illustrations.

Board layout is critical for all high-frequency, switch-mode power supplies. Figure 4 through Figure 4 show the board layout for the TPS6116xEVM-243 printed circuit board (PCB). The nodes with high-switching frequencies and currents are kept as short as possible to minimize trace inductance. Careful attention Was given to the routing of high-frequency current loops: a single-point grounding scheme is used. See the data sheet for specific layout guidelines.
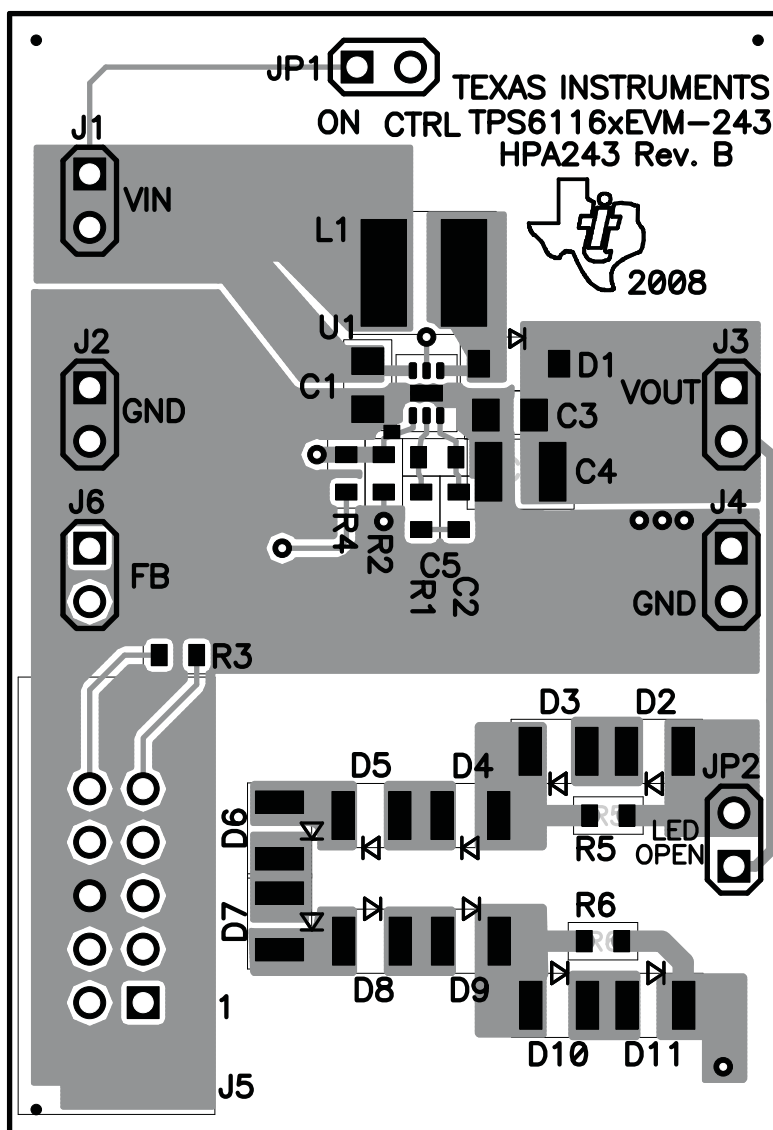
Figure 4. Assembly Layer

Figure 5. Bottom Layer
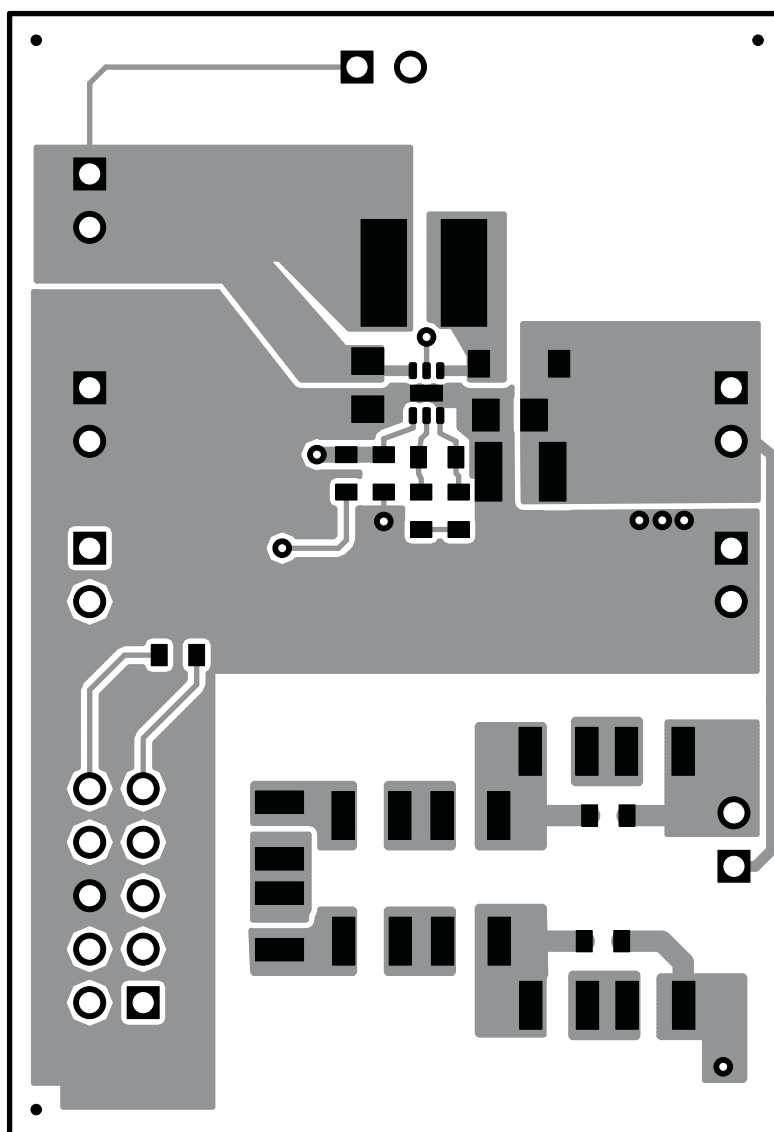
4   Schematics and Bill of Materials

This section provides the TPS6116xEVM-243 schematic and bill of materials.

4.1   *TPS6116xEVM-243 Schematic*

4.2   Bill of Materials

Table 2. HPA243 Bill of Materials

Version		RefDes	Value	Description	Size	Part Number	MFR
61	**60**						
1	1	C1	1μF	Capacitor, Ceramic, 25V, X5R, 10%	0805	Std	Std
1	1	C2	0.22μF	Capacitor, Ceramic, 10V, X5R, 10%	0603	C1608X5R1A224K	TDK
1	1	C3	1μF	Capacitor, Ceramic, 50V, X7R, 10%	0805	GRM21BR71H474KA88L	Murata
0	0	C4	Open	Capacitor, Ceramic	1812	Std	Std
0	0	C5	Open	Capacitor, Ceramic	0603	Std	Std
1	1	D1	MBR0540T1G	Diode, Schottky, 0.5A, 40V	SOD-123	MBR0540T1G	On Semi
4	0	D2, D3, D10, D11	NSSW100CT	Diode. LED, White	0.079 x 0.118 inch	NSSW100CT	Nichia
6	6	D4–D9	NSSW100CT	Diode. LED, White	0.079 x 0.118 inch	NSSW100CT	Nichia
5	5	J1–J4, J6	PTC36SAAN	Header, 2 pin, 100mil spacing, (36-pin strip)	0.100 inch x 2	PTC36SAAN	Sullins
1	1	J5	2510-6002UB	Connector, Male Straight 2x5 pin, 100mil spacing, 4 Wall	0.338 x 0.788 inch	2510-6002UB	3M
2	2	JP1, JP2	PTC36SAAN	Header, 2 pin, 100mil spacing, (36-pin strip)	0.100 inch x 2	PTC36SAAN	Sullins
1	1	L1	22μH	Inductor, SMT, 0.58A, 311mΩ	0.157 x 0.157 inch	VLCF5020T-220MR75-1	TDK
1	1	R1	0	Resistor, Chip, 1/16W, 5%	0603	Std	Std
1	1	R2	10	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R3	1.82k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0	R4	Open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	2	R5, R6	0	Resistor, Chip, 1/16W, 5%	0603	Std	Std
0	1	U1	TPS61160DRV	IC, 1200 kHz/0.7A PWM/38V OVP	SON-6	TPS61160DRV	TI
1	0	U1	TPS61161DRV	IC, 1200 kHz/0.7A PWM/26V OVP	SON-6	TPS61161DRV	TI
1	1	–		PCB, 2.1 In x 1.43 In x 0.062 In		HPA243	Any
2	2	–		Shunt, 100 mil, Black	0.1	929950-00	

4.3   Related Documentation From Texas Instruments

TPS61160, TPS61161, White LED Driver With Digital and PWM Brightness Control in 2mm x 2mm QFN Package for up to 10 LEDs in Series data sheet (SLVS791)

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EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 3 V to 18 V and the output voltage range of up to 39 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.

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