Multi-DC/DC Color LED Kit Hardware

This reference guide goes over kit contents and the kit hardware details and explains the functions and locations of jumpers and connectors present on the board. This document supersedes all of the documents available for the hardware of this kit.

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1 Introduction

The multi-DC/DC color LED kit provides a great way to learn and experiment with using a single MCU to accurately control a series of LED strings and efficiently control the power stages needed to make the LEDs work.

Figure 1. Picture of the Multi-DC/DC Color LED Kit Board (TMDSRGBLEDKIT)

WARNING

This evaluation module (EVM) is meant to be operated in a lab environment only and is not considered by TI to be a finished end-product fit for general consumer use.

This equipment operates at voltages and currents that can result in electrical shock, fire hazard and personal injury if not properly handled or applied. Use equipment with the necessary caution and appropriate safeguards employed to avoid personal injury or property damage.
2 Getting Familiar With the Kit

2.1 Kit Contents

The kit consists of:

- Multi-DC/DC Color LED Kit power board
- Piccolo™ F28027 controlCARD
- Color RGB LED panel with diffuser cover
- 12-V power adapter
- USB cable
- USB drive with graphical user interface (GUI) executable and Code Composer Studio™ (CCS) v4 software

The board can accept any of the C2000™ series controlCARDs. An F28027 control card is shipped with the kit. Some software changes may be necessary to have the board work with a different controlCARD.

2.2 Kit Features

The kit has the following features:

- Power board with eight independently controlled power stages (6×Boost, 2×SEPIC), each capable of providing both voltage and current feedback
- LED panel with two RGB LED strings and two white LED strings
- Onboard isolated JTAG emulation
- Isolated universal asynchronous receiver/transmitter (UART) communication through the serial communications interface (SCI) peripheral and FTDI chip
- Hardware developer’s package is available and includes schematics, bill of materials (BOM), Gerber files, and so on

2.3 Kit Specifications

The multi-DC/DC color LED kit has the following specifications: (1)

(1) Hardware component-based limitations.

### Table 1. Power Board Specifications (at Maximum (1))

<table>
<thead>
<tr>
<th>INPUT</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-V DC</td>
<td>50-V DC</td>
</tr>
<tr>
<td>350 mA per stage</td>
<td>650 mA per stage</td>
</tr>
</tbody>
</table>

(1) The DC input for the board should be chosen based on the specifications of the attached LED panel. When using the LED panel included in the kit, if the demo-mode jumper [M1]-J1 is not populated, a DC input range of 12 to 18 V is recommended. If the demo-mode jumper is populated, use a 12-V DC input to prevent damage to board components.

### Table 2. LED Panel Specifications

<table>
<thead>
<tr>
<th>RGB LED STRINGS</th>
<th>WHITE LED STRINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 LEDs</td>
<td>6 LEDs</td>
</tr>
<tr>
<td>400 mA per color (max)</td>
<td>1 A (max)</td>
</tr>
</tbody>
</table>
3 Hardware Overview

Figure 2 illustrates an LED lighting system running from DC power.

![Block Diagram for an LED Lighting Application]

There are multiple ways of controlling LEDs. On this board, use the C2000 to control a separate DC supply for each of the LED strings. Control the brightness by using the C2000 by varying the output power of each DC/DC stage independently, which allows us to control the average current passing through each LED string. Since average current is roughly proportional to lumen output, each LED string’s brightness is controlled.

3.1 Macro Blocks

The multi-DC/DC color LED board is divided into functional groups referred to as macro blocks. The following is a list of the macro blocks present on the board and a brief description of each:

- **Main board [Main]**—Contains the controlCARD socket, power connectors, jumpers, and the routing of signals between the controlCARD and the macro blocks. This section includes any area outside of other defined macro blocks.

- **DC-PwrEntry macro [M1]**—Generates the 12-V, 5-V, and 3.3-V DC power rails from a 12-V DC supply included with the kit or an external DC power supply.

- **Dual boost macro [M2],[M3], and [M4]**—Consists of two independent boost DC/DC conversion stages with voltage and output current feedback, per macro instance.

- **Isolated-USB-to-JTAG macro [M6]**—Provides an onboard isolated JTAG connection through USB to the host as well as isolated SCI (UART) communication.

- **Dual SEPIC macro [M5]**—Consists of two independent SEPIC DC/DC conversion stages with voltage and output current feedback.
Figure 3 illustrates the position of these macro blocks on the board. The use of a macro block approach for different power stages enables easy debug and testing of one stage at a time. All of the pulse width modulator (PWM) and analog-to-digital converter (ADC) signals have designated test points on the board, which makes it easy for an application developer to not only debug but try out new algorithms and strategies.

Nomenclature: A component on the board is referred to with a macro number in the brackets followed by a dash and the reference number. For example, [M2]-J1 refers to the jumper J1 located in the macro M2, and [Main]-J1 refers to the jumper J1 located on the board outside of the defined macro blocks.

Table 3. Macro Block Locations Legend

<table>
<thead>
<tr>
<th>Macro</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Main]</td>
<td>controlCARD socket, power connectors, and jumpers</td>
</tr>
<tr>
<td>[M1]</td>
<td>12-V, 5-V, and 3.3-V DC power rails</td>
</tr>
<tr>
<td>[M6]</td>
<td>Isolated JTAG and SCI (UART) communication via USB</td>
</tr>
<tr>
<td>[M2],[M3], and [M4]</td>
<td>Two independent Boost stages, per macro instance</td>
</tr>
<tr>
<td>[M5]</td>
<td>Two independent SEPIC stages</td>
</tr>
</tbody>
</table>
3.2 Powering the Board

The DC/DC LED Lighting board has two separate power domains and two major modes of operation. The two power domains are the primary power rail, which feeds the eight DC/DC power stages, and the auxiliary power rail, which powers all of the support chips along with the MCU. The question of which mode of operation to use depends on if the board is being used to evaluate or experiment.

**WARNING**
Always use caution when using the board’s electronics.

- Demo Mode – used to quickly show how the boards functions. All power used by the board is provided from a single 12-V DC power supply. The CE marked, 12-V, 2-A power supply that is included with the Multi-DC/DC Color LED Kit is ideal for this mode.
  - Demo-mode enable jumper [M1]-J1 should be populated
  - A 12-V DC supply should be connected to either [M1]-JP1 or [Main]-BS1, but not both
- Experimentation Mode – uses two different power supplies to minimize the risk of damage caused while experimenting. The primary and auxiliary power rails will each use a separate power supply. This mode allows the user to verify PWM output and ADC feedback signals before energizing the DC/DC power stages and helps protect the MCU if a fault occurs on the primary power rail. This mode also allows for more experimentation with how the eight DC/DC power stages work under different input voltages.
  - Demo-mode enable jumper [M1]-J1 should not be populated
  - A 12-V DC supply should be connected to [M1]-JP1
  - A separate 12-18V DC supply (or some other voltage chosen based on desired input/output power), should be connected to [Main]-TB1
  - [M1]-SW1 controls power to the MCU and support chips

3.3 Boot Modes

Table 4 describes the jumper and switch settings that are needed for booting from Flash and SCI for the board.

<table>
<thead>
<tr>
<th>DEVICE</th>
<th>BOOT FROM FLASH</th>
<th>BOOT FROM SCI (USING ISO JTAG MACRO)</th>
</tr>
</thead>
</table>
| F2802x | SW1 on controlCARD  
  • Position 1 = 1  
  • Position 2 = 1  
  Remove the jumper [Main]-J2 | SW1 on controlCARD  
  • Position 1 = 1  
  • Position 2 = 0  
  Depopulate R10 on controlCARD  
  Remove the jumper [Main]-J2  
  Populate the jumper [M6]-J4 |
| F2803x | SW2 on controlCARD  
  • Position 1 = 1  
  • Position 2 = 1  
  Remove the jumper [Main]-J2 | SW2 on controlCARD  
  • Position 1 = 1  
  • Position 2 = 0  
  SW3 on controlCARD should be off  
  Remove the jumper [Main]-J2  
  Populate the jumper [M6]-J4 |
3.4 **GUI Connection**

The FTDI chip present on the board can be used as an isolated SCI for communicating with a host (for example, a PC). The following jumper settings must be done to enable this connection:

2. Remove jumper [Main]-J2.
3. For F28035, put SW3 on the F28035 controlCARD to the OFF position. For F28027, verify that R10 on the controlCARD is removed.
4. Connect a USB cable from [M6]-JP1 to the host.

**NOTE:** To boot from Flash and connect using the GUI, use the proper Boot from Flash settings described in Table 4.

3.5 **Ground Levels and Safety**

Do not touch any part of the board or components connected to the board while energized.

The power stages on the board are individually rated. Make sure that these ratings (such as the voltage, current and power levels) are well understood and complied with prior to connecting these power blocks together and energizing the board or simulation.

4 **Hardware Resource Mapping**

4.1 **Resource Allocation**

Figure 4 shows the various stages of the board in a circuit diagram format and illustrates the major connections and feedback values being mapped to the C2000 MCU. Table 5 lists these resources. It is important to note that not all resources are available on every C2000 MCU. For example, Piccolo F28027 devices only have 13 ADC channels, so not all feedback signals are available for use even if they are routed to the DIM100 controlCARD socket. For more detailed information, see the schematics and device-specific data sheets.

<table>
<thead>
<tr>
<th>MACRO NAME</th>
<th>SIGNAL NAME</th>
<th>PWM/ADC CHAN</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Board</td>
<td>[Main]</td>
<td>VDCin- meas</td>
<td>ADC-B4</td>
</tr>
<tr>
<td>Dual Boost</td>
<td>[M2]</td>
<td>PWM-1</td>
<td>PWM-1A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PWM-2</td>
<td>PWM-1B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vfb-1</td>
<td>V-Led-1A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vfb-2</td>
<td>V-Led-1B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ifb-1</td>
<td>I-Led-1A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ifb-2</td>
<td>I-Led-1B</td>
</tr>
<tr>
<td>Dual Boost</td>
<td>[M3]</td>
<td>PWM-1</td>
<td>PWM-2A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PWM-2</td>
<td>PWM-2B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vfb-1</td>
<td>V-Led-2A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vfb-2</td>
<td>V-Led-2B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ifb-1</td>
<td>I-Led-2A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ifb-2</td>
<td>I-Led-2B</td>
</tr>
</tbody>
</table>
### Table 5. PWM and ADC Resource Allocation (continued)

<table>
<thead>
<tr>
<th>MACRO NAME</th>
<th>SIGNAL NAME</th>
<th>PWM/ADC CHANNEL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dual Boost (M4)</td>
<td>PWM-1</td>
<td>PWM-3A</td>
<td>PWM-3A</td>
</tr>
<tr>
<td></td>
<td>PWM-2</td>
<td>PWM-3B</td>
<td>PWM-3B</td>
</tr>
<tr>
<td></td>
<td>Vfb-1</td>
<td>V-Led-3A</td>
<td>ADC-B5</td>
</tr>
<tr>
<td></td>
<td>Vfb-2</td>
<td>V-Led-3B</td>
<td>ADC-B6</td>
</tr>
<tr>
<td></td>
<td>Ifb-1</td>
<td>I-Led-3A</td>
<td>ADC-A6</td>
</tr>
<tr>
<td></td>
<td>Ifb-2</td>
<td>I-Led-3B</td>
<td>ADC-A3</td>
</tr>
<tr>
<td>Dual SEPIC (M5)</td>
<td>PWM-1</td>
<td>PWM-4A</td>
<td>PWM-4A</td>
</tr>
<tr>
<td></td>
<td>PWM-2</td>
<td>PWM-4B</td>
<td>PWM-4B</td>
</tr>
<tr>
<td></td>
<td>Vfb-1</td>
<td>V-Led-4A</td>
<td>ADC-B7</td>
</tr>
<tr>
<td></td>
<td>Vfb-2</td>
<td>V-Led-4B</td>
<td>ADC-B8</td>
</tr>
<tr>
<td></td>
<td>Ifb-1</td>
<td>I-Led-4A</td>
<td>ADC-A4</td>
</tr>
<tr>
<td></td>
<td>Ifb-2</td>
<td>I-Led-4B</td>
<td>ADC-A7</td>
</tr>
</tbody>
</table>

![Multi-DC/DC Color LED Kit Circuit Diagram](image_url)

**Figure 4. Multi-DC/DC Color LED Kit Circuit Diagram**
### 4.2 Jumpers, Connectors, and Switches

Table 6 lists the jumpers, connectors, and switches available on the board. Figure 5 shows the location of these items with help of a board image.

#### Table 6. Description of Jumpers, Connectors, and Switches

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Main]-BS1</td>
<td>Banana jack for primary power rail DC input</td>
</tr>
<tr>
<td>[Main]-BS2, BS3</td>
<td>Banana jack for ground connection</td>
</tr>
<tr>
<td>[Main]-H1</td>
<td>100-pin DIM100 controlCARD socket</td>
</tr>
<tr>
<td>[Main]-J1</td>
<td>ADC-B4 Mux, used to select the input signal for ADC-B4. Place a jumper across pins 1-2 to select V-Led-4B. Place a jumper across pins 2-3 to select VDCin-meas.</td>
</tr>
<tr>
<td>[Main]-J2</td>
<td>JTAG enable jumper, populating the jumper enables JTAG connection to the microcontroller. The jumper needs to be unpopulated when booting from Flash, SCI, or another medium.</td>
</tr>
<tr>
<td>[Main]-TB1-TB8</td>
<td>Terminal blocks used to connect the output of the DC/DC power stages to a load, such as an LED panel.</td>
</tr>
<tr>
<td>[M1]-J1</td>
<td>Demo-mode enable jumper. This jumper connects the primary and auxiliary power rails together to allow board operation from a single 12-V DC supply. For more information, see Section 3.2.</td>
</tr>
<tr>
<td>[M1]-JP1</td>
<td>Auxiliary 12-V DC input. This connector is designed to connect up with the 12-V power supply included with this kit and supplies power to the auxiliary power rail powering the C2000 MCU and support chips.</td>
</tr>
<tr>
<td>[M1]-SW1</td>
<td>Power switch for the auxiliary 12-V DC input. This switch determines whether power is passed to the auxiliary power stage from the auxiliary 12-V DC input. The auxiliary power rail can still be powered from the primary power rail if the demo mode enable jumper, [M1]-J1, is populated.</td>
</tr>
<tr>
<td>[M6]-J2</td>
<td>External JTAG connector. This connector gives access to the JTAG emulation pins. If external emulation is desired, place a jumper across [M6]-J5 and connect the emulator to the board. However, a USB connector still needs to be connected to [M2]-JP1 to power the emulation logic.</td>
</tr>
<tr>
<td>[M6]-J4</td>
<td>FTDI UART enable jumper. Populate this jumper when using the FTDI chip as a UART (for example, when using a GUI to interact with the MCU).</td>
</tr>
<tr>
<td>[M6]-J5</td>
<td>Onboard emulation disable jumper: Place a jumper here to disable the onboard emulator and give access to the external interface.</td>
</tr>
<tr>
<td>[M6]-JP1</td>
<td>USB connector for on-board JTAG emulation and SCI (UART) communication.</td>
</tr>
</tbody>
</table>
Figure 5. Multi-DC/DC Color LED Board Jumpers, Connectors, and Switches Locations
STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. Delivery: TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

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2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:
This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:

CAUTION
This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices
NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.
FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210

Concerning EVMs Including Radio Transmitters:
This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:
(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:
Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:
Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables
Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

3.3 Japan

3.3.1 Notice for EVMs delivered in Japan: Please see http://www.tij.co.jp/lsds/ti JA/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti JA/general/eStore/notice_01.page

3.3.2 Notice for Users of EVMs Considered “Radio Frequency Products” in Japan: EVMs entering Japan are NOT certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, User is required by Radio Law of Japan to follow the instructions below with respect to EVMs:
1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry’s Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.
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3.3.3 Notice for EVMs for Power Line Communication: Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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4 EVM Use Restrictions and Warnings:

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 Safety-Related Warnings and Restrictions:

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user 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, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

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