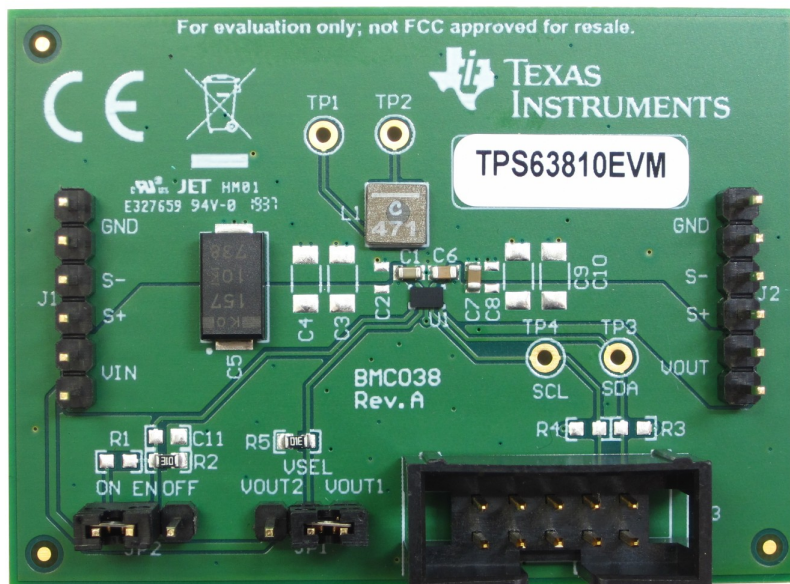


## **TPS6381xEVM**

This user's guide describes the operation and use of the TPS6381xEVM evaluation module (EVM). The EVM is designed to help users easily evaluate and test the operation and functionality of the TPS6381x buck-boost converter family. The EVM has the output voltage set to 3.3 V or 3.45 V, depending on jumper setting. The output voltage can be programmed via I<sup>2</sup>C interface between 1.8 V and 5.2 V. The EVM operates with an input voltage between 2.2 V and 5.5 V. The output current can go up to 2.5 A in buck mode and up to 2 A in boost mode. This document includes setup instructions for the hardware, together with the schematic and the PCB layout of the EVM. Throughout this document, the abbreviations EVM, TPS6381xEVM, and the term evaluation module are synonymous with the TPS6381x, unless otherwise noted.



**Figure 1. TPS6381xEVM**

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## Trademarks

All trademarks are the property of their respective owners.

## 1 Introduction

The Texas Instruments TPS6381x is a highly efficient, single-inductor, internally compensated buck-boost converter in a 15-pin, 2.3-mm × 1.4-mm WCSP package. The output voltage can be selected between two I<sup>2</sup>C-programmable values in the range from 1.8 V to 5.2 V in 25-mV steps. There are two versions of the EVM, depending on the device being used:

- TPS63810EVM uses the TPS63810, in which the power-up value of the ENABLE bit is 1.
- TPS63811EVM uses the TPS63811, in which the power-up value of the ENABLE bit is 0.

The ENABLE bit in the control register controls the output state of the power stage. See [Section 6](#) for more details.

### 1.1 Background

The TPS6381xEVM uses the TPS6381x integrated circuit (IC), and is set to 3.3 V or 3.45 V output voltage, depending on jumper setting. The EVM operates with an input voltage between 2.2 V and 5.5 V.

### 1.2 Performance Specification

[Table 1](#) provides a summary of the TPS6381xEVM performance specifications. All specifications are given for ambient temperature of 25°C.

**Table 1. Performance Specification Summary**

SPECIFICATION	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input voltage		2.2		5.5	V
Output voltage		1.8		5.2	V
Output current	$V_{IN} \geq 2.5 \text{ V}$ , $V_{OUT} = 3.3 \text{ V}$			2.5	A

### 1.3 Modifications

The printed-circuit board (PCB) for the EVM is designed to accommodate the TPS6381x. Extra positions are available for additional input and output capacitors, EN pin voltage divider, and I<sup>2</sup>C pullup resistors.

#### 1.3.1 IC U1 Operation

This EVM requires an appropriate I<sup>2</sup>C interface, such as the TI USB2ANY, to reconfigure the TPS6381x. The output voltage can be chosen between two I<sup>2</sup>C-programmable values by using an on-board jumper. See [Section 6](#) for the available output voltage values.

## 2 Setup

This section describes how to properly use the TPS6381xEVM.

### 2.1 Input and Output Connectors, Test Points, and Headers Description

#### 2.1.1 J1, Pin 1 and 2 – VIN

Positive input voltage connection from the input power supply for the EVM.

#### 2.1.2 J1, Pin 3 and 4 – S+/S-

Input voltage sense connections. Measure the input voltage at this point.

#### 2.1.3 J1, Pin 5 and 6 – GND

Input voltage GND return connection from the input power supply for the EVM, common with J2 GND connection

#### 2.1.4 J2, Pin 1 and 2 – VOUT

Positive output voltage connection

#### 2.1.5 J2, Pin 3 and 4 – S+/S-

Output voltage sense connections. Measure the output voltage at this point.

#### 2.1.6 J2, Pin 5 and 6 – GND

Output voltage GND return connection, common with J1 GND connection

#### 2.1.7 TP1, TP2 – L1, L2

Test points connected to L1 and L2 switch node pins of the TPS6381x

#### 2.1.8 TP3, TP4 – GND

Test points connected to SDA and SCL pins of the TPS6381x

#### 2.1.9 J3 – I2C

10-pin header used to connect the USB2ANY adaptor to the EVM

#### 2.1.10 JP1 – VSEL

Placing a jumper across VSEL and VOUT1 pins sets the output voltage to the value in VOUT1 register. Placing a jumper across VSEL and VOUT2 pins sets the output voltage to the value in VOUT2 register.

#### 2.1.11 JP2 – ENABLE

Placing a jumper across pins EN and ON enables the device. Placing a jumper across pins EN and OFF disables the device.

## 2.2 Setup

To operate the EVM, connect a power supply with the positive lead to J1 VIN pins and the negative lead to J1 GND pins. Connect a load with the positive lead to J2 VOUT pins and the negative lead to J2 GND pins. Place a jumper across VSEL and VOUT1 or VOUT2 pins on JP1 to select the corresponding output voltage register. Place a jumper across EN and ON pins on JP2 to enable the device.

## 3 Board Layout

This section provides the TPS6381xEVM board layout and illustrations.

### 3.1 Layout

[Figure 2](#) through [Figure 6](#) show the component placement and PCB layout of the TPS6381xEVM.

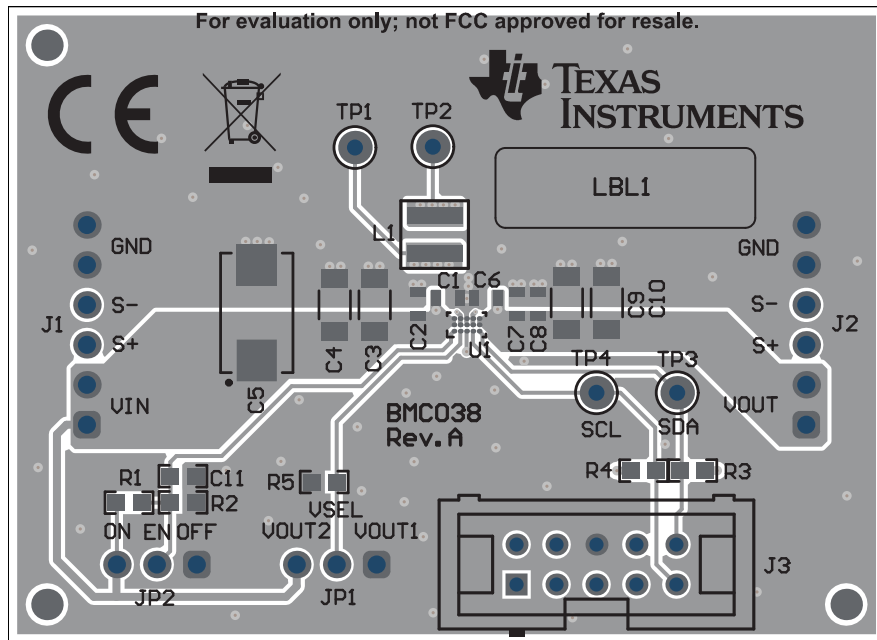


Figure 2. TPS6381xEVM PCB - Assembly Layer

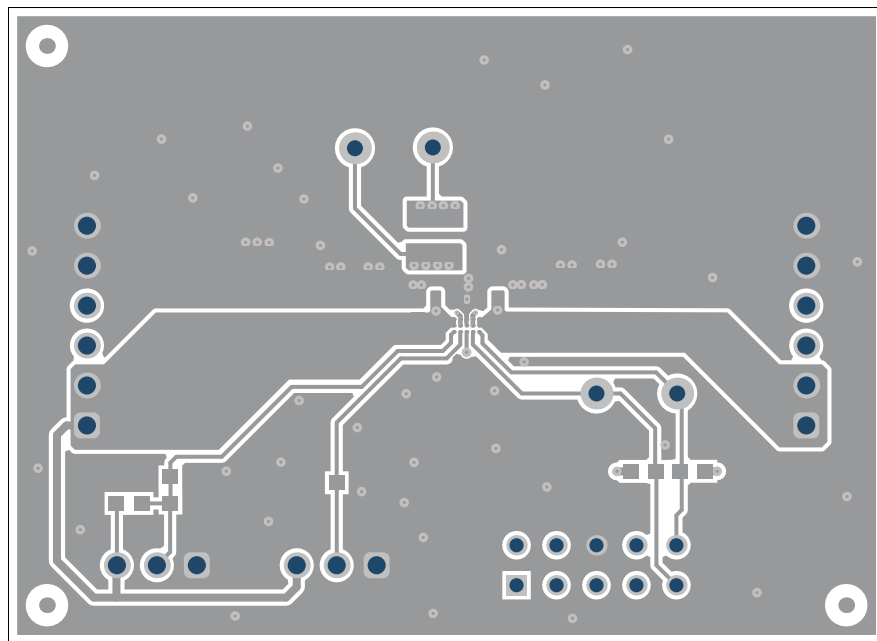


Figure 3. TPS6381xEVM PCB - Top Layer

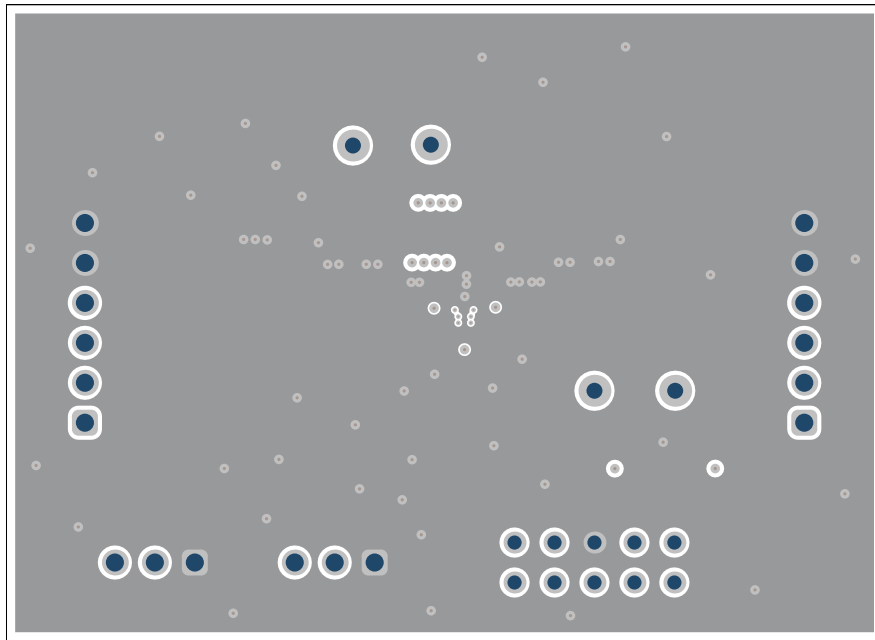


Figure 4. TPS6381xEVM PCB - Signal Layer 1 (Top View)

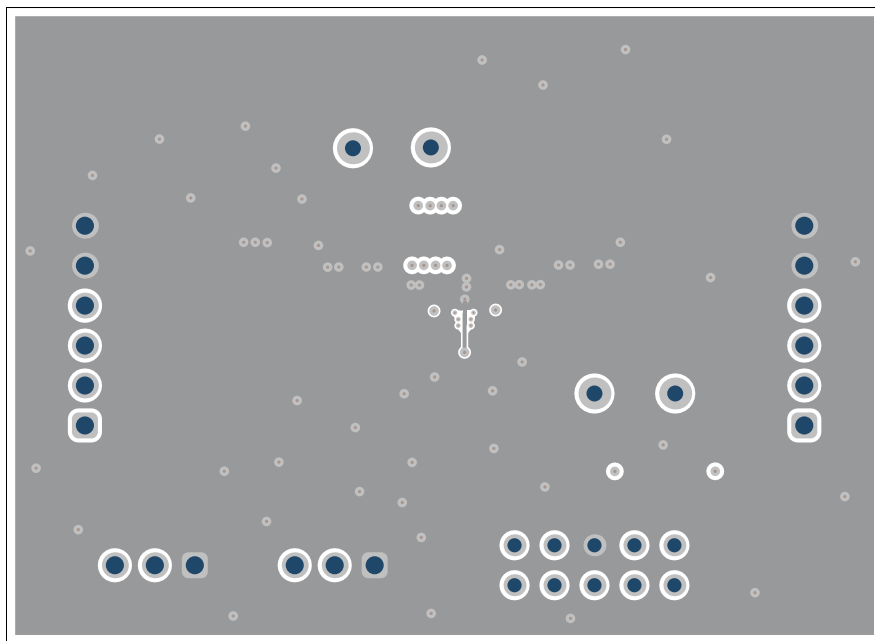
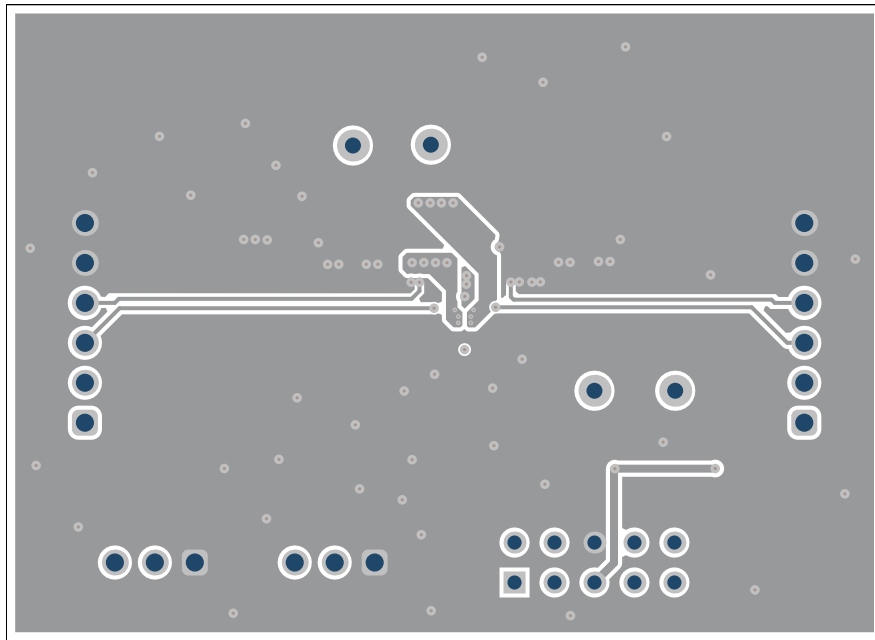


Figure 5. TPS6381xEVM PCB - Signal Layer 2 (Top View)



**Figure 6. TPS6381xEVM PCB - Bottom Layer (Top View)**

## 4 Schematic and Bill of Materials

This section provides the TPS6381xEVM schematic and bill of materials.

### 4.1 Schematic

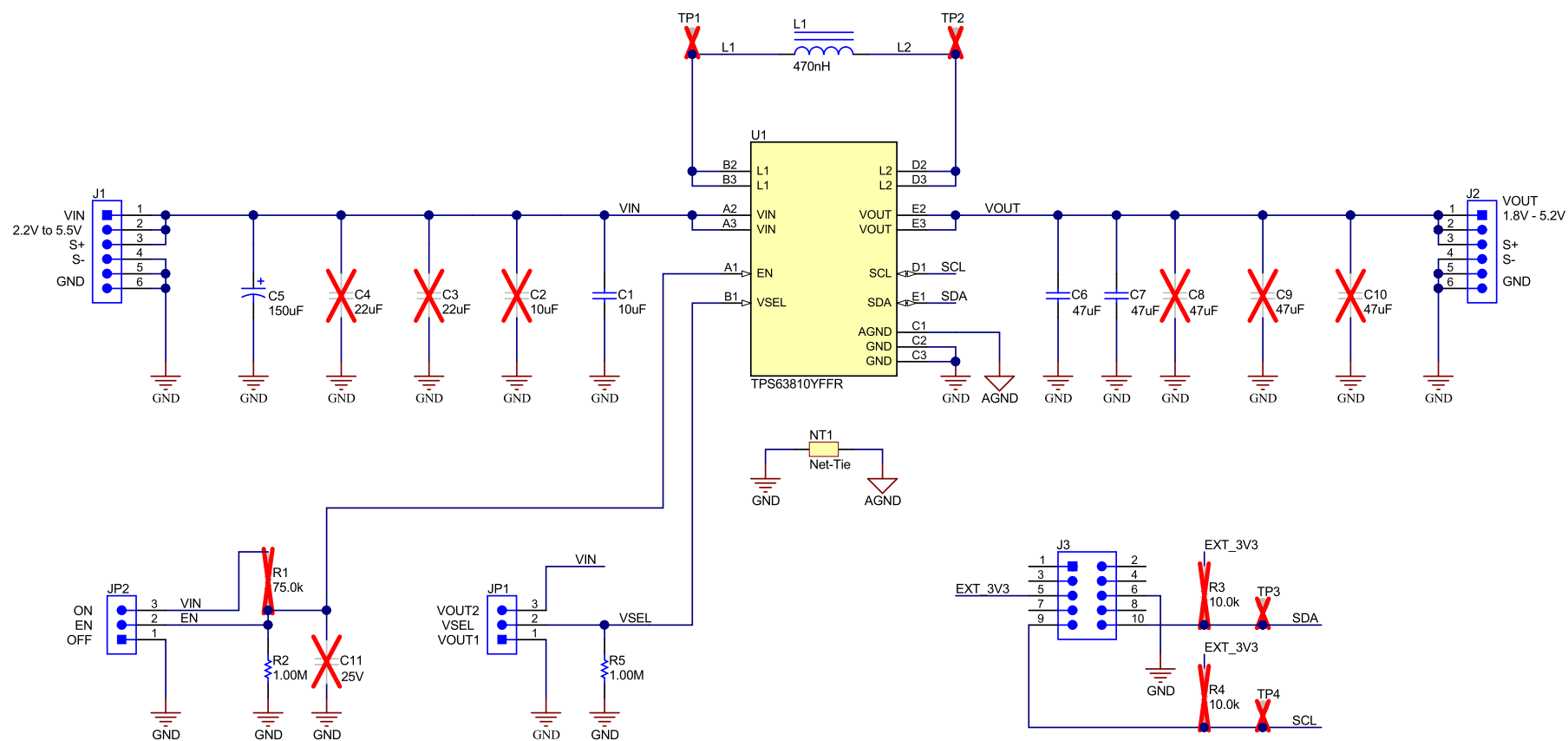


Figure 7. TPS6381xEVM Schematic



## 4.2 Bill of Materials

**Table 2. TPS63810EVM Bill of Materials**

QTY	DESIGNATOR	VALUE	DESCRIPTION	SIZE	PART NUMBER	MANUFACTURER
1	C1	10 $\mu$ F	CAP, CERM, 10 $\mu$ F, 6.3 V, $\pm$ 20%, X5R, 0603	0603	GRM188R60J106ME84	Murata
1	C5	150 $\mu$ F	CAP, TA, 150 $\mu$ F, 10 V, $\pm$ 20%, 0.005 $\Omega$	7343-31	T530D157M010ATE005	Kemet
2	C6, C7	47 $\mu$ F	CAP, CERM, 47 $\mu$ F, 6.3 V, $\pm$ 20%, X5R, 0603	0603	GRM188R60J476ME15D	Murata
1	L1	470 nH	Inductor, Shielded, Composite, 470 nH, 3.5A, 7.6 m $\Omega$	4x4x1.5 mm	XFL4015-471MEC	Coilcraft
1	R2, R5	1.00 M $\Omega$	RES, 1.00 M, 1%, 0.1 W, 0603	0603	CRCW06031M00FKEA	Vishay-Dale
1	U1	N/A	IC, Single Inductor Buck-Boost Converter	2.3x1.4x1 mm	TPS63810YFFR	TI

**Table 3. TPS63811EVM Bill of Materials**

QTY	DESIGNATOR	VALUE	DESCRIPTION	SIZE	PART NUMBER	MANUFACTURER
1	C1	10 $\mu$ F	CAP, CERM, 10 $\mu$ F, 6.3 V, $\pm$ 20%, X5R, 0603	0603	GRM188R60J106ME84	Murata
1	C5	150 $\mu$ F	CAP, TA, 150 $\mu$ F, 10 V, 20%, 0.005 $\Omega$	7343-31	T530D157M010ATE005	Kemet
2	C6, C7	47 $\mu$ F	CAP, CERM, 47 $\mu$ F, 6.3 V, $\pm$ 20%, X5R, 0603	0603	GRM188R60J476ME15D	Murata
1	L1	470 nH	Inductor, Shielded, Composite, 470 nH, 3.5 A, 7.6 m $\Omega$	4x4x1.5 mm	XFL4015-471MEC	Coilcraft
1	R2, R5	1.00 M $\Omega$	RES, 1.00 M, 1%, 0.1 W, 0603	0603	CRCW06031M00FKEA	Vishay-Dale
1	U1	N/A	IC, Single Inductor Buck-Boost Converter	2.3x1.4x1 mm	TPS63811YFFR	TI

## 5 Software User Interface

### 5.1 Software Setup

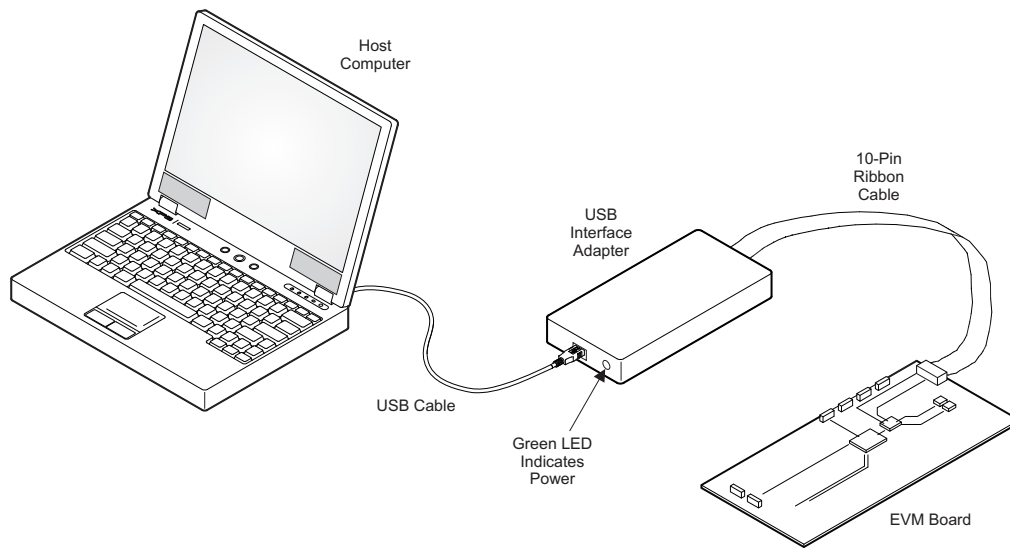
A graphical user interface (GUI) is available from ti.com website (<http://www.ti.com/product/TPS63810/toolsoftware>) which allows simple and convenient programming of the device through the TI USB2ANY (<http://www.ti.com/tool/USB2ANY>) device. Alternatively, the user can use any I<sup>2</sup>C-standardized programming tool or I<sup>2</sup>C host to configure the device. Mind the I<sup>2</sup>C pins specification, such as timing parameters and proper pullup resistors, provided with the [High Current, High Efficiency Single Inductor Buck-Boost Converter Data Sheet](#).

### 5.2 Interface Hardware Setup

Connect the USB2ANY adapter to your PC using the supplied USB cable. Connect the EVM connector J3 to the USB2ANY adapter using the supplied 10-pin ribbon cable. The connectors on the ribbon cable are keyed to prevent incorrect installation.

[Figure 8](#) shows a quick adapter connection overview.

**USB Interface Adaptor Quick Connection Diagram**



**Figure 8. Quick Connection Overview**

### 5.3 User Interface Operation

Upon startup, the GUI automatically connects to the EVM. If not, click on the Connect button in the lower left corner of the GUI window. The following sections give short overview of the three main GUI screens.

#### 5.3.1 Home Screen

The Home screen gives a short overview of the TPS6381x devices. To start evaluating the device, click on the Start button or on the Settings or Register Map icons on the left side of the GUI window.

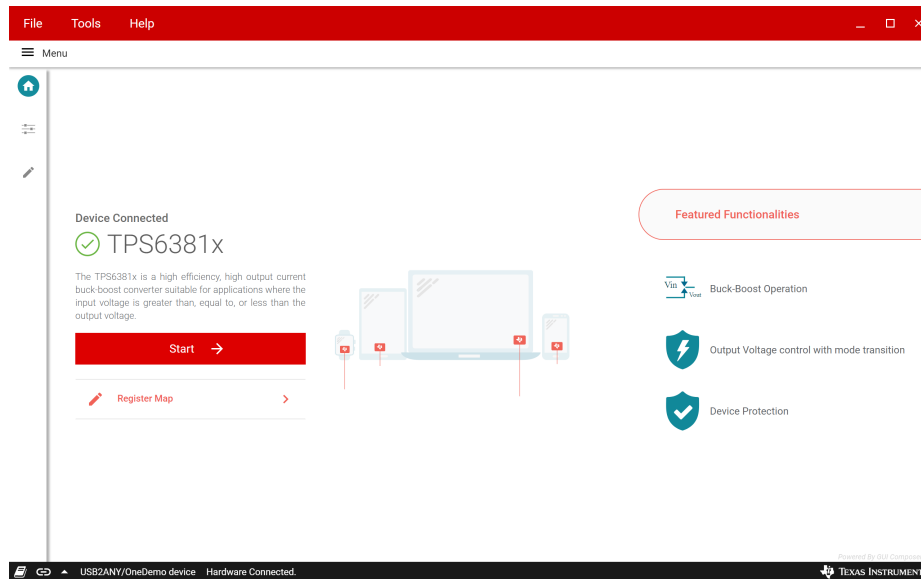


Figure 9. GUI Home Screen

#### 5.3.2 Settings Screen

The Settings screen provides control over the output voltage and operating modes of the TPS6381x.

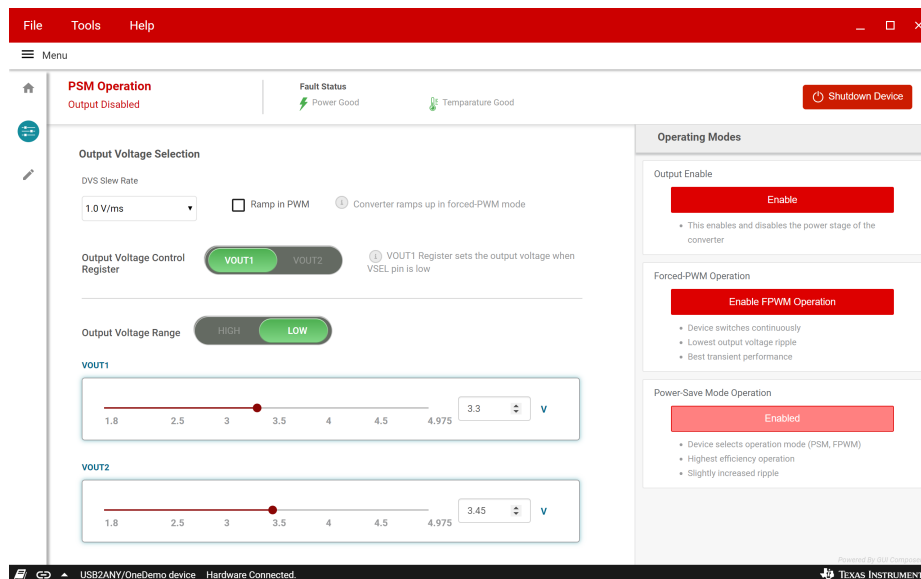


Figure 10. GUI Settings Screen

### 5.3.3 Register Map Screen

The Register Map screen shows a register-wise view of all parameters. Here, single registers can be read or written to the device (if applicable). Refer to [Section 6](#) for a detailed description of the TPS6381x registers.

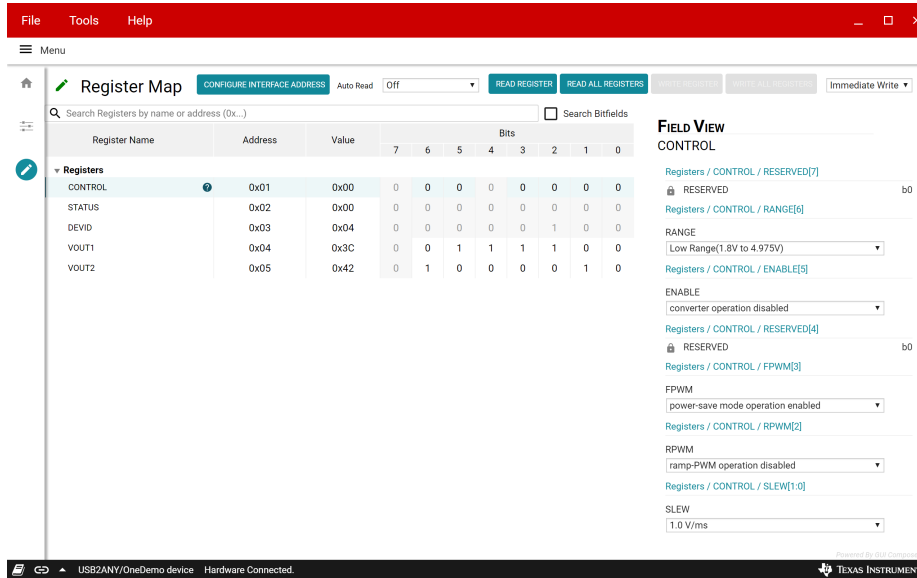


Figure 11. GUI Register Map Screen

## 6 Register Map

[Table 4](#) lists the memory-mapped registers for the Device registers. All register offset addresses not listed in [Table 4](#) must be considered as reserved locations and the register contents must not be modified.

Table 4. Device Registers

Address	Acronym	Register Name	Section
1h	CONTROL	Control	<a href="#">Go</a>
2h	STATUS	Status	<a href="#">Go</a>
3h	DEVID	Device Identity	<a href="#">Go</a>
4h	VOUT1	Output Voltage 1	<a href="#">Go</a>
5h	VOUT2	Output Voltage 2	<a href="#">Go</a>

## 6.1 CONTROL Register (Address = 1h) [reset = X]

Table 5 shows the CONTROL register.

Return to [Summary Table](#).

This register configures the device. This register is volatile, so it loses its contents if the voltage on the VIN pin becomes less than the UVLO threshold or a low logic level is applied to the EN pin.

**Table 5. CONTROL Register Field Descriptions**

Bit	Field	Type	Reset	Description
7	RESERVED	R/W	0b	This bit is reserved for future use and must be programmed to 0.
6	RANGE	R/W	0b	This bit selects the output voltage range. 0b = low range (1.8 V to 4.975 V) 1b = high range (2.025 V to 5.2 V)
5	ENABLE	R/W	X	This bit enables and disables the converter. In the TPS63810 the reset value of this bit is 1. In the TPS63811 the reset value of this bit is 0. 0b = converter is disabled 1b = converter is enabled
4	RESERVED	R/W	0b	This bit is reserved for future use and must be programmed to 0.
3	FPWM	R/W	0b	This bit controls forced-PWM operation. 0b = forced-PWM operation disabled 1b = forced-PWM operation enabled
2	RPWM	R/W	0b	This bit controls ramp-PWM operation. 0b = ramp-PWM disabled 1b = ramp-PWM enabled
1-0	SLEW	R/W	00b	These bits control the slew rate of the converter when the output voltage setting is changed to a new value. 00b = 1 V/ms 01b = 2.5 V/ms 10b = 5 V/ms 11b = 10 V/ms

## 6.2 STATUS Register (Address = 2h) [reset = 0h]

Table 6 shows the STATUS register.

Return to [Summary Table](#).

This register contains the device status. A read operation to this register clears the status bits. This register is volatile, so it loses its contents if the voltage on the VIN pin becomes less than the UVLO threshold or a low logic level is applied to the EN pin.

**Table 6. STATUS Register Field Descriptions**

Bit	Field	Type	Reset	Description
7-2	RESERVED	R	000000b	Reserved
1	TSD	R	0b	This bit shows the status of the thermal shutdown function. This bit is cleared if the STATUS register is read when the overtemperature condition no longer exists. 0b = temperature good 1b = an overtemperature event was detected
0	$\overline{\text{PG}}$	R	0b	This bit shows the status of the output power good comparator. This bit is cleared if the STATUS register is read when the power-not-good condition no longer exists. 0b = power good 1b = a power-not-good event was detected

### 6.3 DEVID Register (Address = 3h) [reset = 4h]

Table 7 shows the DEVID register.

Return to [Summary Table](#).

This register identifies the die revision of the device.

**Table 7. DEVID Register Field Descriptions**

Bit	Field	Type	Reset	Description
7-4	MANUFACTURER	R	0000b	These bits identify the manufacturer (0000b = Texas Instruments).
3-2	MAJOR	R	01b	These bits identify the major die revision. 00b = A (initial silicon) 01b = B (first major revision) 10b = C (second major revision) 11b = D (third major revision)
1-0	MINOR	R	00b	These bits identify the minor die revision. 00b = 0 (initial silicon) 01b = 1 (first minor revision) 10b = 2 (second minor revision) 11b = 3 (third minor revision)

#### 6.4 VOUT1 Register (Address = 4h) [reset = 3Ch]

Table 8 shows the VOUT1 register.

Return to [Summary Table](#).

This register sets the device output voltage when the VSEL pin is low. This register is volatile, so it loses its contents if the voltage on the VIN pin becomes less than the UVLO threshold or a low logic level is applied to the EN pin.

**Table 8. VOUT1 Register Field Descriptions**

Bit	Field	Type	Reset	Description
7	RESERVED	R	0b	Reserved
6-0	VOUT1	R/W	0111100b	These bits set the output voltage of the converter when the VSEL pin is low. When the RANGE bit = 0, the output voltage in volts is $1.8 + (\text{VOUT1} \times 0.025)$ . When the RANGE bit = 1, the output voltage in volts is $2.025 + (\text{VOUT1} \times 0.025)$ .



## 6.5 VOUT2 Register (Address = 5h) [reset = 42h]

Table 9 shows the VOUT2 register.

Return to [Summary Table](#).

This register sets the device output voltage when the VSEL pin is high. This register is volatile, so it loses its contents if the voltage on the VIN pin becomes less than the UVLO threshold or a low logic level is applied to the EN pin.

**Table 9. VOUT2 Register Field Descriptions**

Bit	Field	Type	Reset	Description
7	RESERVED	R	0b	Reserved
6-0	VOUT2	R/W	1000010b	These bits set the output voltage of the converter when the VSEL pin is low. When the RANGE bit = 0, the output voltage in volts is $1.8 + (\text{VOUT2} \times 0.025)$ . When the RANGE bit = 1, the output voltage in volts is $2.025 + (\text{VOUT2} \times 0.025)$ .

## Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

<b>Changes from Original (July 2019) to A Revision</b>	<b>Page</b>
• Replaced TPS63810 with TPS6381x.....	1
• Added TPS63811 to the user's guide .....	1
• Updated images through user's guide.....	1
• Removed pre-production note .....	1
• Edited <a href="#">Section 1</a> .....	3
• Added "and EN pin voltage divider" to <a href="#">Section 1.3</a> .....	3
• Added TPS63811EVM bill of materials.....	9
• Changed the link to the register map .....	12
• Removed the pre-production note and errata list.....	12

## STANDARD TERMS FOR EVALUATION MODULES

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  - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, 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.

### **WARNING**

**Evaluation Kits 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 shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.**

**NOTE:**

**EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.**

### 3 Regulatory Notices:

#### 3.1 United States

##### 3.1.1 Notice applicable to EVMs not FCC-Approved:

**FCC NOTICE:** 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 or RSS-247

#### **Concerning EVMs Including Radio Transmitters:**

This device complies with Industry Canada license-exempt RSSs. 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/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/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/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page)

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

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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2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see [http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page)  
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#### 3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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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.
    - 4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.
  5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.
  6. *Disclaimers:*
    - 6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.
    - 6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.
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8. *Limitations on Damages and Liability:*

8.1 *General Limitations.* IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

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9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

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