User's Guide
SLPU003A–February 2014–Revised February 2014

High Power Density, Low Profile NexFET™ Power Block II for Notebook Power Supply

The evaluation module (EVM) CSD87381PEVM-603 uses the CSD87381P together with TI controller TPS51219 providing 1.35-V output at up to 15 A from input voltage ranging 8 to 20 V.

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1 Description

The CSD87381PEVM-603 is designed to use a regulated voltage ranging 8 to 20 V to produce 1.35-V output at up to 15 A of load current. The CSD87381PEVM-603 demonstrates Power Block II together with TI controller TPS51219 in a typical low voltage application with D-CAP2™ mode operation. The EVM also provides a number of testpoints to evaluate the performance of the CSD87381P.

1.1 Typical Applications

- Notebook computers
- I/O supplies
- System power supplies

1.2 Features

The CSD87381PEVM-603 features:

- 2% tolerance 1.35-V output voltage
- Up to 15-ADC steady state output current
- 300-kHz switching frequency
- More than 92% peak efficiency

2 Electrical Performance Specifications

Table 1. CSD87381PEVM-603 Electrical Performance Specifications

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
INPUT CHARACTERISTICS					
Voltage range	VIN voltage		12	20	V
	5V voltage	4.5	5	5.5	V
OUTPUT CHARACTERISTICS(1)					
Output voltage, VOUT	VIN = 12 V, IOUT = 10 A		1.35		V
Output load current, IOUT			10	15	A
SYSTEMS CHARACTERISTICS					
Switching frequency	VIN = 12 V, VOUT = 1.35 V, IOUT = 10 A		300		kHz
Peak efficiency	VIN = 12 V, VOUT = 1.35 V		92.0		%
Full load efficiency	VIN = 12 V, VOUT = 1.35 V, IOUT = 12 A		86.0		
Operating temperature			25		°C

(1) The output voltage can be adjusted by changing the values of R104 and R107 in Figure 1. For details, refer to the TPS51219 data sheet, SLUSAG1. The TPS51219 device supports output voltage from 0.5 to 2 V.

3 Schematic

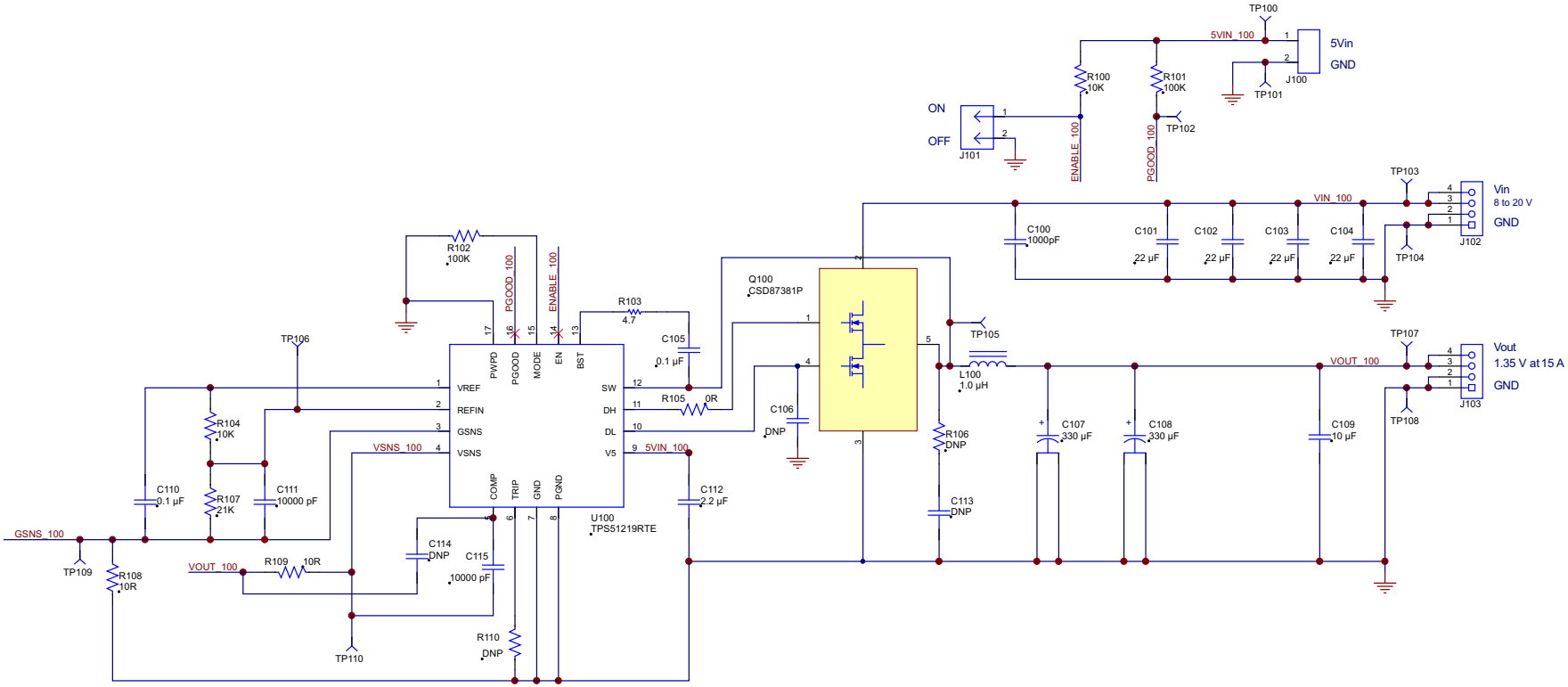


Figure 1. CSD87381PEVM-603 Schematic

4 Test Setup

4.1 Test Equipment

Voltage source VIN: The input voltage source VIN must be a 0-V to 20-V variable DC source capable of supplying 10 ADC. Connect VIN to J102 (as shown in Figure 3).

Voltage source V5VIN: The input voltage source V5VIN must be a 0-V to 5-V variable DC source capable of supplying 1 ADC. Connect V5VIN to J100 (as shown in Figure 3).

Multimeters:

- V1: VIN at TP103 (Vins) and TP104 (GNDS)
- V2: 5V at TP100 (5V) and TP101 (GND)
- V3: Vouts at TP107 (Vouts) and TP108 (GNDS)
- A1: VIN input current
- A2: 5V input current

Output load: The output load must be an electronic constant-resistance mode load capable of 0-ADC to 20-ADC at 1.35 V.

Oscilloscope: A digital or analog oscilloscope can be used to measure the switch node waveform. Differential probe must be used for the switch node waveform measurements. The oscilloscope should be set for 50-Ω impedance, 1-GHz bandwidth, DC coupling, 50-ns/division horizontal resolution, 5-V/division vertical resolution. When measuring the switch node waveform, place the negative probe tip on the GND pad of the input cap and positive tip on the CSD87381P Vsw top metal (as shown in Figure 2).

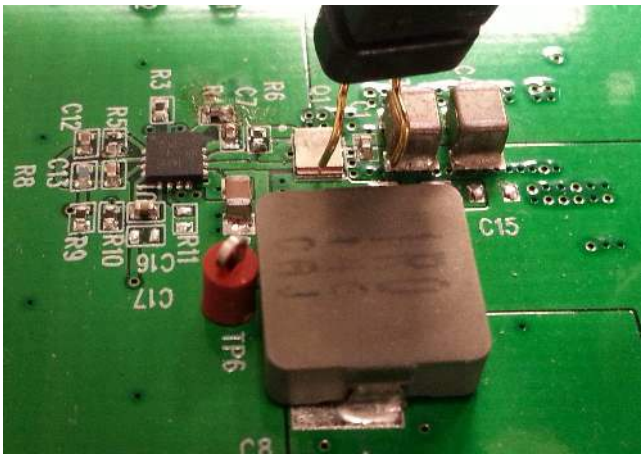


Figure 2. Tip and Barrel Measurement for Vsw Waveform

Fan: Some of the components in this EVM may approach temperatures of 60°C during operation. TI recommends a small fan capable of 200 to 400 LFM to reduce component temperatures while the EVM is operating. The fan needs to run when the load current is higher than 10 A.

Recommended Wire Gauge:

1. VIN to J102 (8-V to 20-V input):
   The recommended wire size is 1x AWG number 14 per input connection, with the total length of wire less than 4 ft (2 ft input, 2 ft return).
2. V5VIN to J100 (5-V input):
   The recommended wire size is 1x AWG number 18 per input connection, with the total length of wire less than 4 ft (2 ft input, 2 ft return).
3. J103 to LOAD:
   The minimum recommended wire size is 2x AWG number 14, with the total length of wire less than 4 ft (2 ft output, 2 ft return).

4.2 Recommended Test Setup

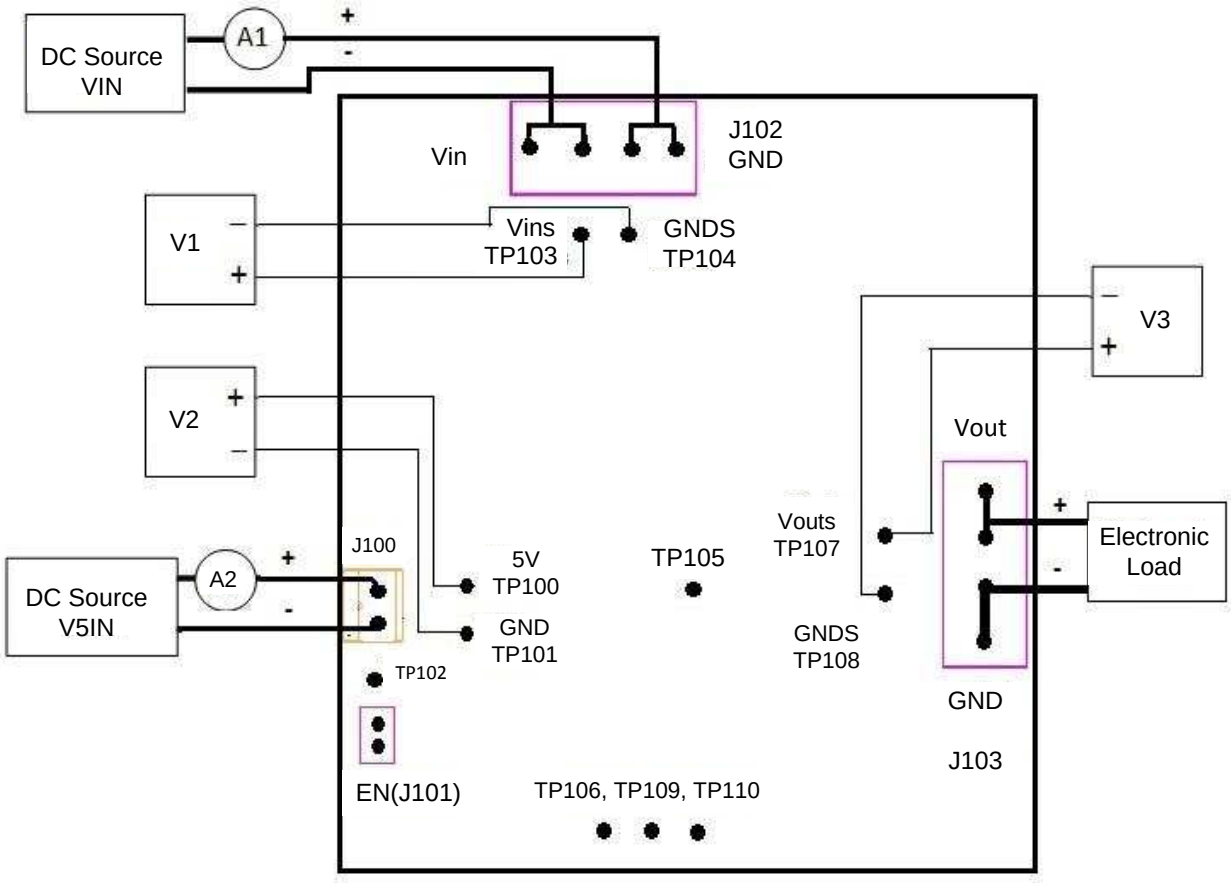


Figure 3. CSD87381PEVM-603 Recommended Test Setup

Figure 3 shows the recommended test setup to evaluate the CSD87381PEVM-603. Working at an ESD workstation, make sure that any wrist straps, bootstraps, or mats are connected. Reference the user-to-earth ground before power is applied to the EVM.

Input Connections:

1. Prior to connecting the DC source VIN, TI recommends to limit the source current from VIN to 10-A maximum. Ensure that VIN is initially set to 0 V and connected (as shown in Figure 3).
2. Prior to connecting the DC source V5VIN, TI recommends to limit the source current from V5VIN to 1-A maximum. Ensure that V5VIN is initially set to 0 V and connected (as shown in Figure 3).
3. Connect a voltmeter, V1, at TP103 (Vins) and TP104 (GNDS) to measure VIN voltage, V2 at TP100 (5V), and TP101 (GND) to measure 5V voltage (as shown in Figure 3).
4. Connect a current meter A1 between DC source VIN and J102 to measure the input current.
5. Connect a current meter V2 between DC source V5VIN and J100 to measure the 5V input current.

Output Connections:

1. Connect the load to J103 and set load to constant resistance mode to sink 0-ADC before VIN and 5V are applied.
2. Connect a voltmeter V3 at TP107 (Vouts) and TP108 (GNDS) to measure the output voltage.

5 Test Procedure

5.1 Line and Load Regulation and Efficiency Measurement Procedure

1. Ensure load is set to constant resistance mode and to sink 0 ADC.
2. Ensure a jumper is on J101 on the EVM to set the EVM at OFF position before VIN and V5VIN are applied.
3. Increase VIN from 0 to 12 V. Using V1 to measure input voltage.
4. Increase V5VIN from 0 to 5 V. Using V2 to measure input voltage.
5. Remove the jumper on J101 to enable the controller.
6. Vary load from 0 to 15 ADC, VOUT should remain in load regulation.
7. Vary VIN from 12 to 19 V, VOUT should remain in line regulation.
8. Decrease load to 0 A.
9. Put a jumper to short J101 to disable the controller.
10. Decrease V5VIN to 0 V.
11. Decrease VIN to 0 V.

5.2 List of Testpoints

Table 2. Function of Each Testpoint

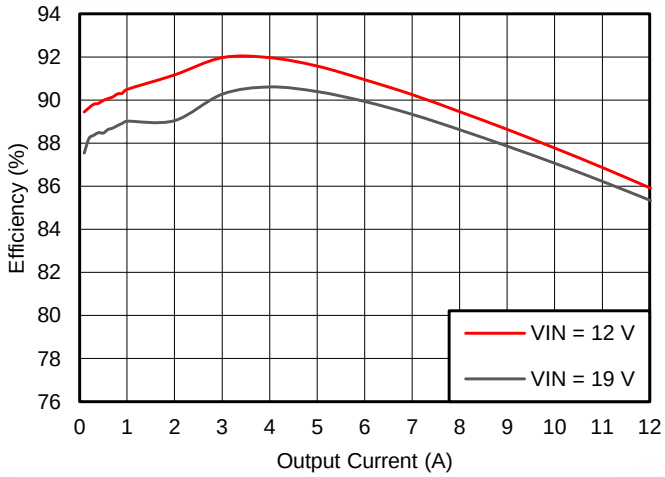
Testpoints	Name	Description
TP100	5V	5V supply
TP101	GND	GND for 5V supply
TP102	PGOOD	Power good
TP103	Vins	VIN supply
TP104	GND	GND for VIN supply
TP105	SW	Switch node
TP107	Vouts	VOUT sense
TP108	GNDS	GND sense
TP106	REFIN	REFIN (Vout Setting)
TP109	GSNS	Differential sensing (low)
TP110	VSNS	Differential sensing (high)

5.3 Equipment Shutdown

1. Shut down the load.
2. Put the jumper on J101.
3. Shut down V5VIN and VIN.

6 Performance Data and Typical Characteristic Curves

Figure 4 through Figure 6 show typical performance curves for CSD87381PEVM-603.



(1) Efficiency at V_{GS} = 5.0 V, V_O = 1.35 V, f_{SW} = 300 kHz, L_O = 1 µH, T_A = 25°C

Figure 4. Efficiency versus Output Current for CSD87381P With TPS51219

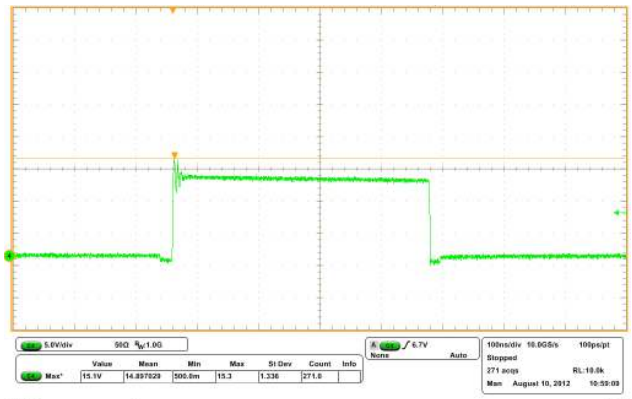


Figure 5. Switching Node Waveform, VIN = 12 V, Iout = 10 A

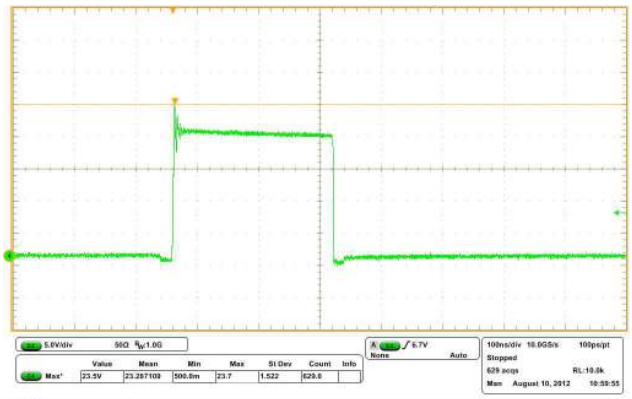


Figure 6. Switching Node Waveform, VIN = 19 V, Iout = 10 A

7 EVM Assembly Drawing and PCB Layout

Figure 7 through Figure 14 show the design of the CSD87381PEVM-603 printed circuit board. The EVM was designed using a six-layer, 1-oz. copper circuit board.

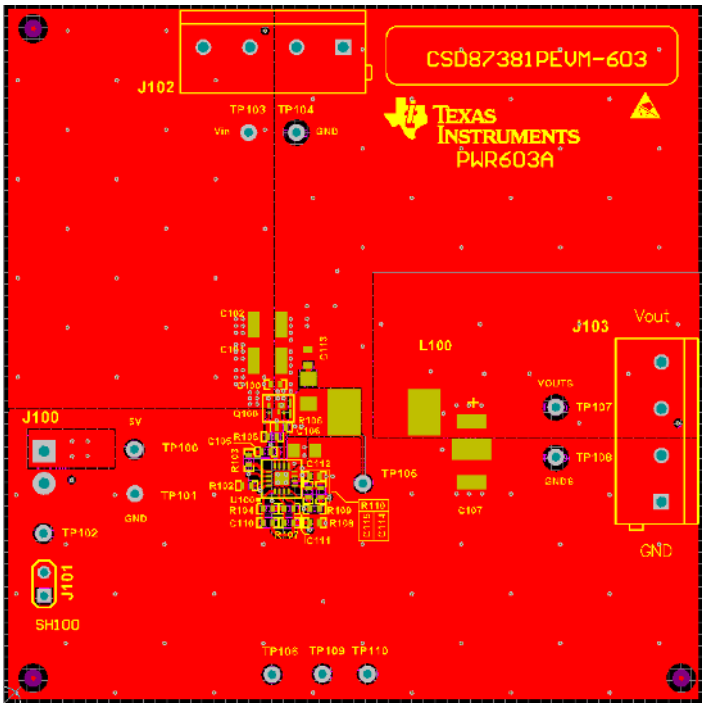


Figure 7. CSD87381PEVM-603 Top Layer Assembly Drawing (Top View)

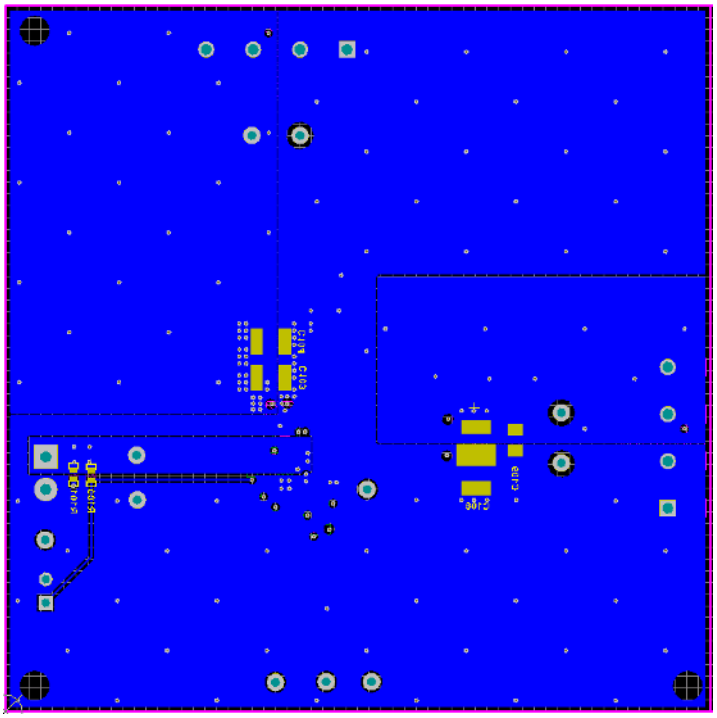


Figure 8. CSD87381PEVM-603 Bottom Assembly Drawing (Bottom View)

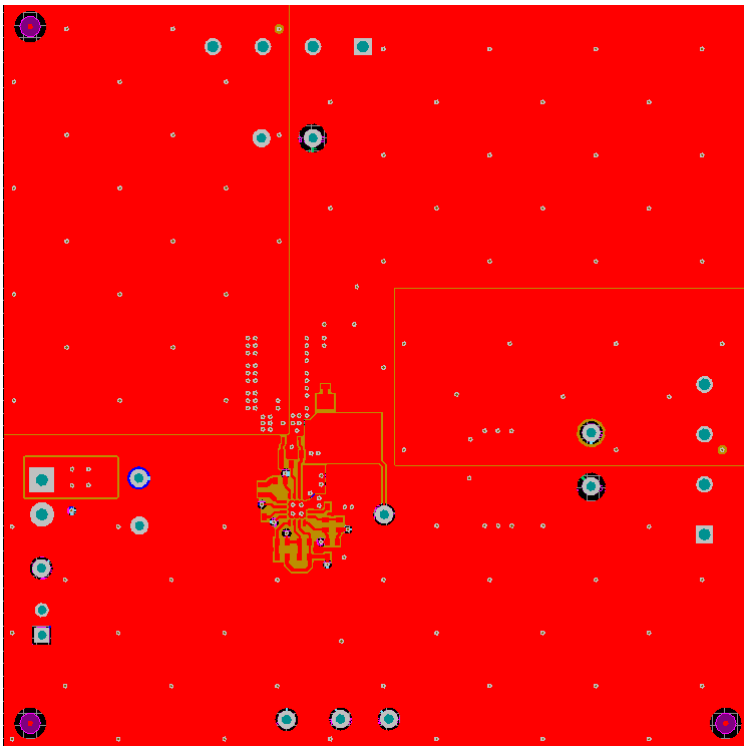


Figure 9. CSD87381PEVM-603 Top Copper (Top View)

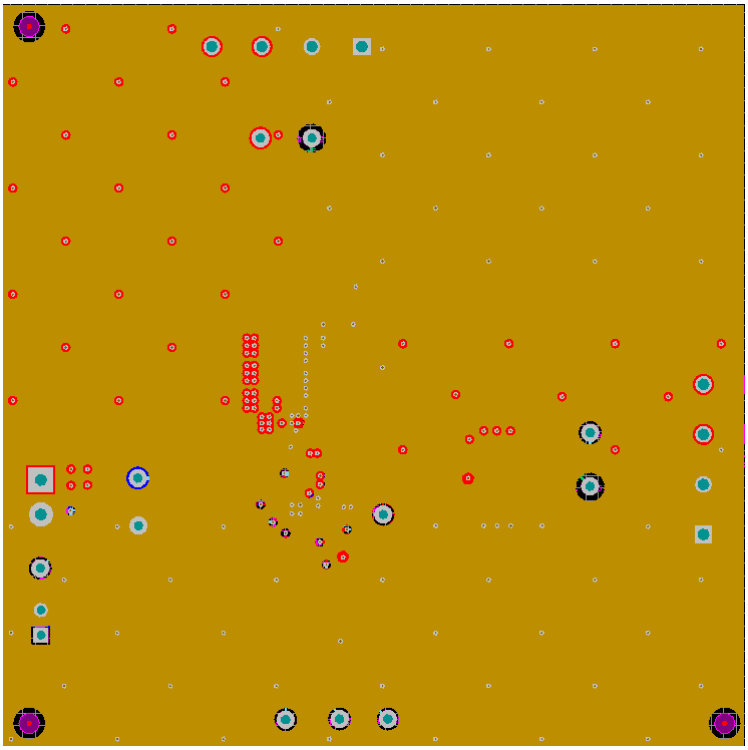


Figure 10. CSD87381PEVM-603 Internal Layer 1 (Top View)

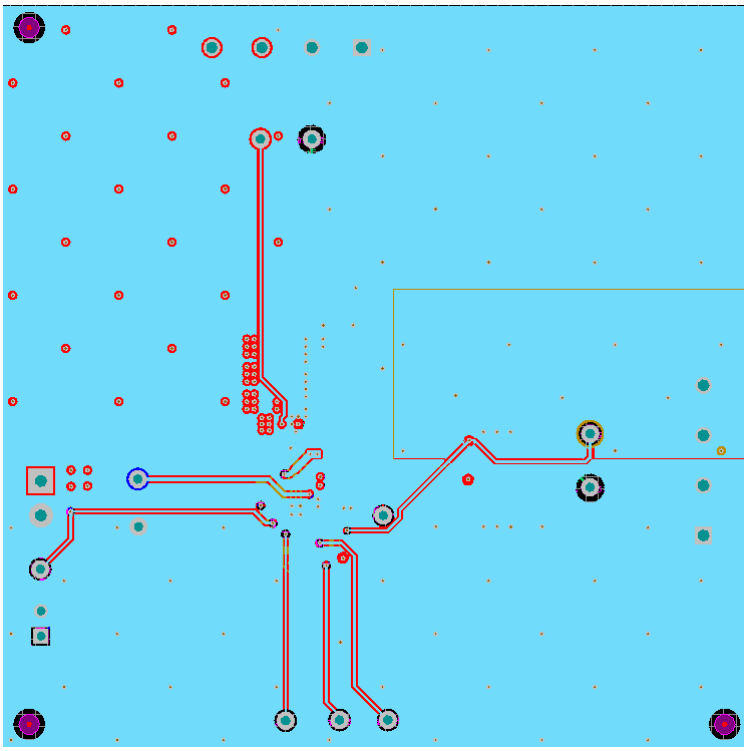


Figure 11. CSD87381PEVM-603 Internal Layer 2 (Top View)

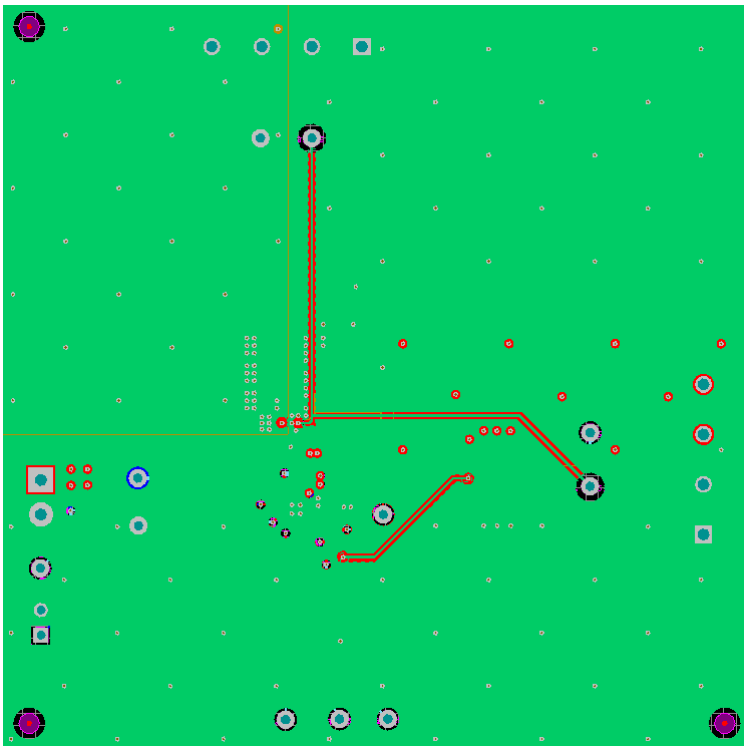


Figure 12. CSD87381PEVM-603 Internal Layer 3 (Top View)

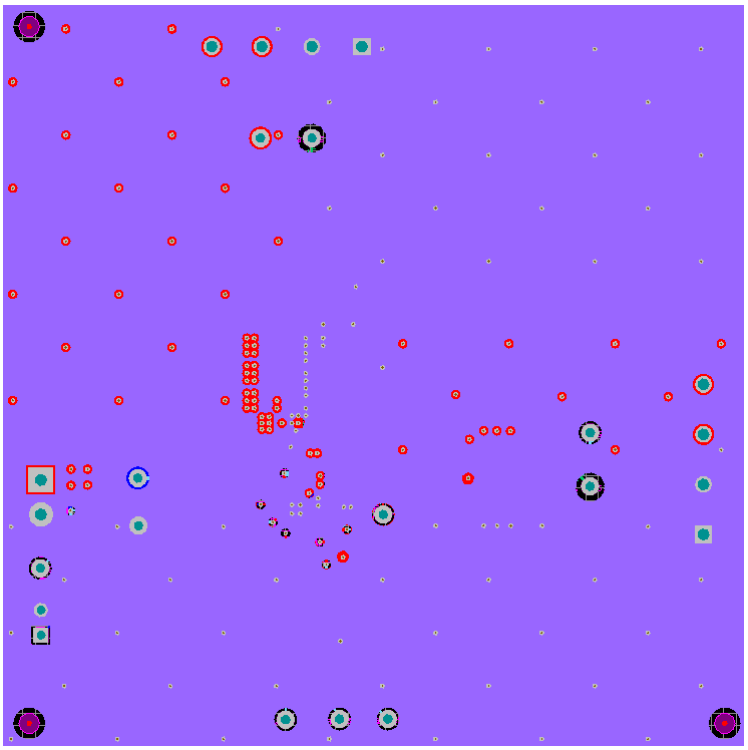


Figure 13. CSD87381PEVM-603 Internal Layer 4 (Top View)

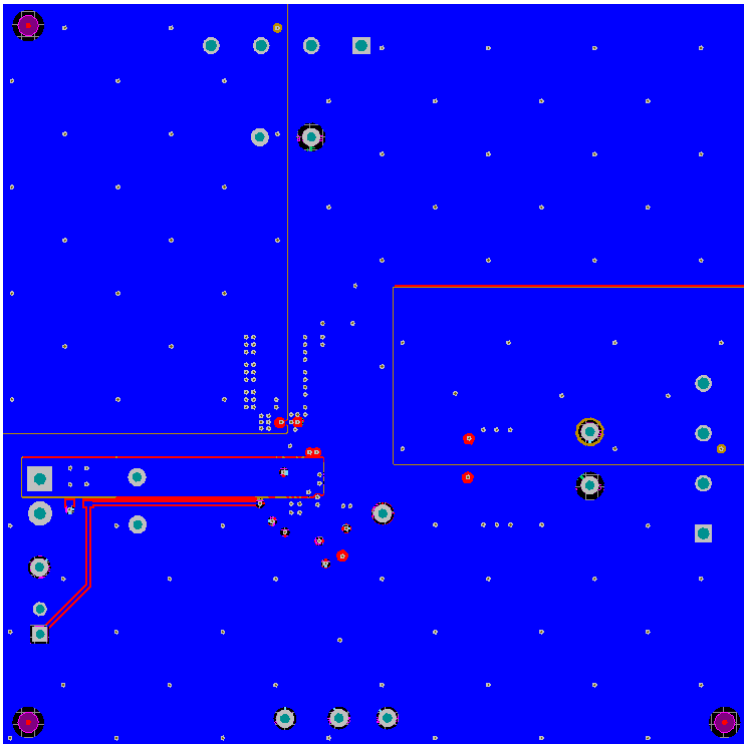


Figure 14. CSD87381PEVM-603 Bottom Copper (Top View)

8 Bill of Materials

The EVM components list according to the schematic shown in Figure 1.

Qty	Designator	Value	Description	Package Ref	Part Number	Manufacturer
1	C100	1000pF	CAP CER 1000PF 50V 5% X7R 0402	0402	CC0402JRX7R9BB102	Yageo
4	C101, C102, C103, C104	22uF	CAP CER 22UF 25V 20% X7R 1210	1210	TMK325B7226MM-TR	TAIYO
2	C105, C110	0.1uF	CAP CER 0.1UF 25V 20% X7R 0402	0402	C1005X7R1E104M050BB	TDK
1	C106	DNP	CAP CER 1000PF 25V 5% X7R 0402	0402	C0402C102J3RACTU	KEMET
2	C107, C108	330uF	Capacitor, POSCAP, 330uF, 2.0V, 0.006 Ohms, 20%, D2T Size	D2T	EEF-SX0D331XE	Panasonic
1	C109	10uF	CAP CER 10UF 25V 10% X5R 0805	0805	C2012X5R1E106K	TDK
2	C111, C115	10000pF	CAP CER 10000PF 25V 5% X7R 0402	0402	C0402C103J3RACTU	KEMET
1	C112	2.2uF	CAP CER 2.2UF 25V 20% X7R 0805	0805	C2012X7R1E225M085AB	TDK
1	C113	DNP	CAP CER 330PF 50V 1% NP0 0603	0603	C1608C0G1H331F080AA	TDK
1	J100	ED1514	Terminal Block, 2-pin, 6-A, 3.5mm	0.27 x 0.25 inch	ED1514	ON SHORE TECH
1	J101	2 position	CONN HDR BRKWAY .100 2POS VERT	0.100 inch x 2	5-146274-2	TE connecttivity
2	J102, J103	ED120/4DS	Terminal Block, 4x1, 5.08mm, TH	TERM_BLK, 4pos, 5.08mm	ED120/4DS	On-Shore Technology
1	L100	1.0uH	Inductor, 1.0uH, 20A, 0.003 Ohms, 20%	0.400 x 0.453 inch	PIMB103E-1R0MS	cyntec
1	Q100	CSD87381P	Pico	LGA2.5X5 mm	CSD87381P	TI
2	R100, R104	10K	RES 10.0K OHM 1/16W 1% 0402 SMD	0402	RC0402FR-0710KL	Yageo
2	R101, R102	100K	RES 100K OHM 1/16W 1% 0402 SMD	0402	RC0402FR-07100KL	Yageo
1	R103	4.7	RES, 4.7 ohm, 5%, 0.063W, 0402	0402	CRCW04024R70JNED	Vishay-Dale
1	R105	0R	RES 0.0 OHM 1/10W JUMP SMD 0402	0402	MCS04020Z0000ZE000	VISHAY
1	R107	21K	Resistor, Chip, 1/16W, 1%	0402	RC0402FR-0721KL	Yageo
2	R108, R109	10R	RES 10 OHM 1/10W 1% 0402 SMD	0402	ERJ-2RKF10R0X	PANASONIC
1	SH100	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M
7	TP100, TP102, TP103, TP105, TP106, TP107, TP110	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
4	TP101, TP104, TP108, TP109	5001	Test Point, Black, Thru Hole Color Keyed	0.100 x 0.100 inch	5001	Keystone
1	U100	TPS51219RTE	IC, High Performance, Single Synchronous Step-Down Controller	QFN-16	TPS51219RTE	Texas Instruments
0	C114	DNP	Capacitor, Ceramic, 16V, X7R, 10%	0402	STD	TDK
0	R106	DNP	RES 2.2 OHM 1/4W 1% 1206 SMD	1206	Std	Panasonic
0	R110	DNP	Resistor, Chip, 1/16W, 1%	0402	Std	Std

Revision History

Changes from Original (February 2014) to A Revision	Page
• Updated Figure 2	4
• Updated Figure 7	8
• Updated Figure 8	8

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

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.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms and conditions that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms and conditions do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for any defects that are caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.

   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 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 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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。 技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/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.

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.

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