Using the TPS548D22EVM-784

User's Guide

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TPS548D22EVM-784, 40-A Single Synchronous Step-Down Converter With Full Differential Sense

1 Introduction

The PWR784EVM evaluation module uses the TPS548D22 device. The TPS548D22 is a highly integrated synchronous buck converter that is designed for up to 40-A current output.

2 Description

The PWR784EVM is designed as a single output DC-DC converter that demonstrates the TPS548D22 in a typical low-voltage application while providing a number of test points to evaluate the performance. It uses a nominal 12-V input bus to produce a regulated 1-V output at up to 40-A load current.

2.1 Typical End-User Applications

- Enterprise Storage, SSD, NAS
- Wireless and Wired Communication Infrastructure
- Industrial PCs, Automation, ATE, PLC, Video Surveillance
- Enterprise Server, Switches, Routers
- AISIC, SoC, FPGA, DSP Core and I/O Rails

2.2 EVM Features

- Regulated 1-V output up to 40-A, steady-state output current
- Convenient Test Points for Probing Critical Waveforms

3 EVM Electrical Performance Specifications

Table 1. PWR-784EVM Electrical Performance Specifications

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNITS
Input Characteristics						
	Voltage range	V_{IN} tied to VDD	5	12	16	V
	Maximum input current	V_{IN} = 12 V, I_O = 40 A			12	A
	No load input current	V_{IN} = 12 V, I_O = 0 A		60		mA
Output Characteristics						
V_{OUT}	Output voltage	Output current = 10 A		1		V
I_{OUT}	Output load current	$I_{OUT(min)}$ to $I_{OUT(max)}$	0		40	A
	Output voltage regulation	Line regulation: input voltage = 5 V to 16 V		0.5%		
		Load regulation: output current = 0 A to $I_{OUT(max)}$		0.5%		
V_{OUT}	Output voltage ripple	V_{IN} = 12 V, I_{OUT} = 40 A		10		mV_{PP}
V_{OUT}	Output overcurrent			46		A
Systems Characteristics						
	Switching frequency	F_{SW}		650		kHz
V_{OUT}	Peak efficiency	V_{IN} = 12 V, I_O = 18 A, F_{SW} = 650 kHz		89%		
	Operating temperature	T_{oper}	0		105	ºC

4 Schematic

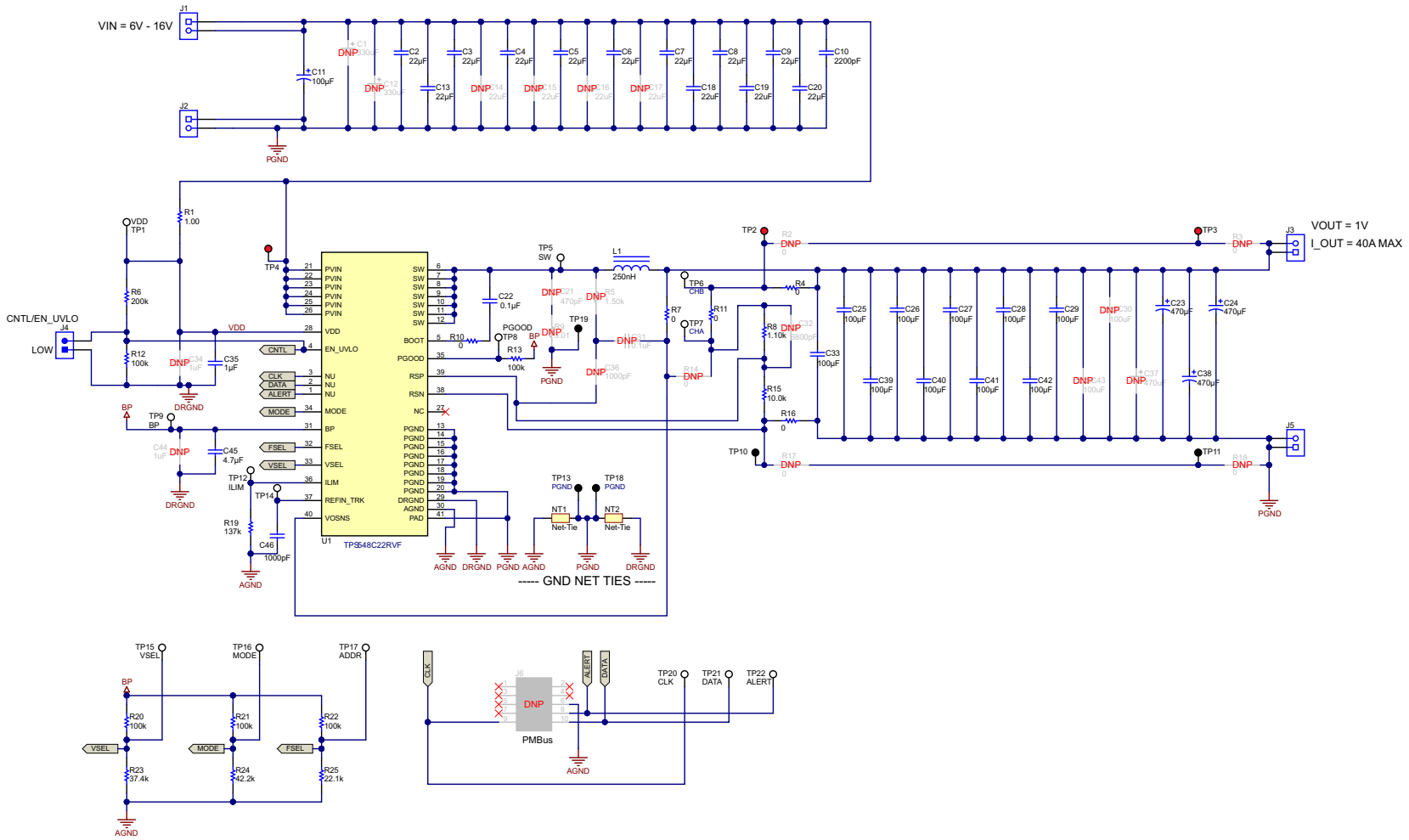


Figure 1. PWR-784EVM Schematic

5 Test Equipment

Voltage Source: The input voltage source VIN must be a 0-V to 18-V variable DC source capable of supplying at least 12 A_{DC}.

Multimeters: It is recommended to use two separate multimeters Figure 2. One meter is used to measure V_{IN} and one to measure V_{OUT}.

Output Load: A variable electronic load is recommended for testing Figure 2. It must be capable of 40 A at voltages as low as 0.6 V.

Oscilloscope: An oscilloscope is recommended for measuring output noise and ripple. Output ripple must be measured using a tip-and-barrel method or better as shown in Figure 3.The scope must be adjusted to 20-MHz bandwidth, AC coupling at 50 mV/division, and must be set to 1-µs/division.

Fan: During prolonged operation at high loads, it may be necessary to provide forced air cooling with a small fan aimed at the EVM. Temperature of the devices on the EVM must be maintained below 105°C.

Recommended Wire Gauge: The voltage drop in the load wires must be kept as low as possible in order to keep the working voltage at the load within its operating range. Use the AWG 14 wire (2 wires parallel for VOUT positive and 2 wires parallel for the VOUT negative) of no more than 1.98 feet between the EVM and the load. This recommended wire gauge and length should achieve a voltage drop of no more than 0.2 V at the maximum 40-A load.

6 The PWR-784EVM

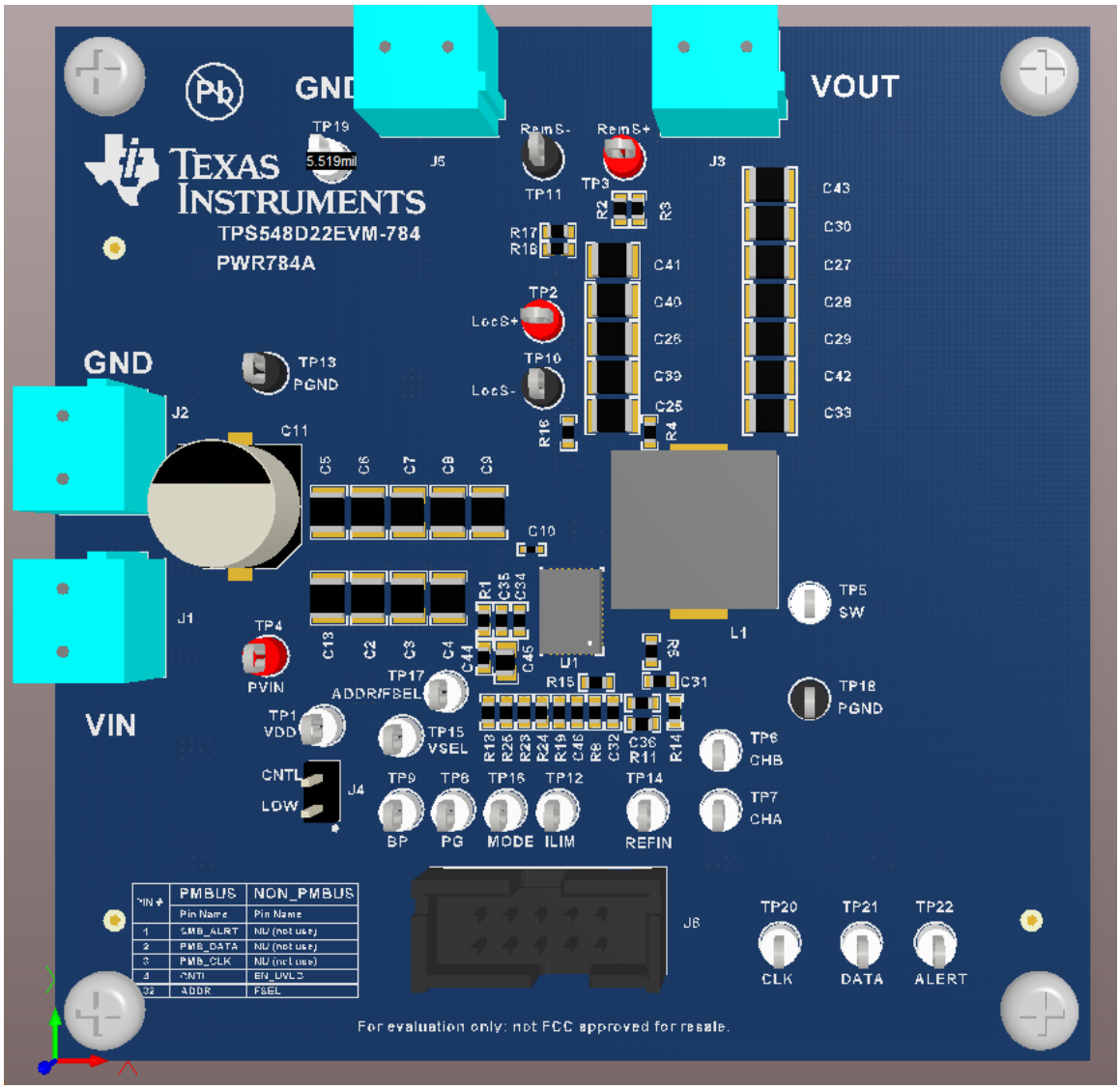
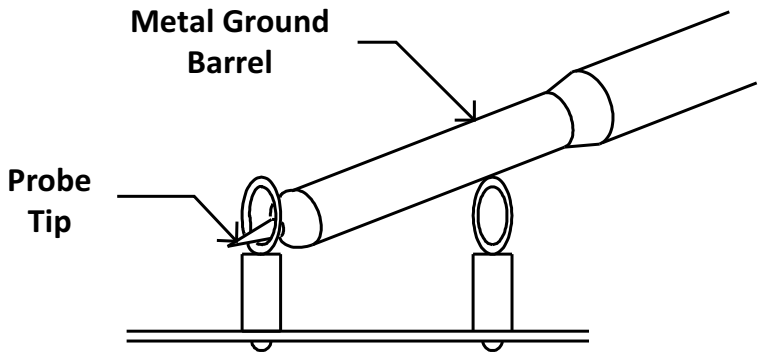


Figure 2. PWR-784EVM Overview



Tip and Barrel V_{OUT} Ripple Measurement

Figure 3. Tip and Barrel Measurement

7 List of Test Points, Jumpers, and Switch

Table 2. The Function of Each Test Point

ITEM	TYPE	NAME	DESCRIPTION
TP5	T-H loop	SW	Power supply Switch node
TP7	T-H loop	CH-A	Measure loop stability
TP6	T-H loop	CH-B	Measure loop stability
TP2	T-H loop	LocS+	Sense VOUT + locally across C5. Use for efficiency and ripple measurements
TP10	T-H loop	LocS-	Sense VOUT – locally across C5. Use for efficiency and ripple measurements
TP3	T-H loop	RemS+	Remote sense +
TP11	T-H loop	RemS-	Remote sense –
TP4	T-H loop	PVIN	Sense VIN + across C10
TP13	T-H loop	PGND	Sense VIN – across C10
TP1	T-H loop	VDD	Supplies the internal circuitry
TP17	T-H loop	FSEL	Monitor the FSEL external resistor divider ratio during initial power up.
TP15	T-H loop	VSEL	Monitor the VSEL external resistor divider ratio during initial power up.
TP9	T-H loop	BP	LDO output
TP8	T-H loop	PG	Power good
TP16	T-H loop	MODE	Monitor the MODE external resistor divider ratio during initial power up.
TP12	T-H loop	ILIM	Program over-current limit.
TP14	T-H loop	REFIN_TRK	Do not connect.(1)
TP19	T-H loop	PGND	Common GND
TP18	T-H loop	PGND	Common GND
TP20	T-H loop	CLK	Not used
TP21	T-H loop	DATA	Not used
TP22	T-H loop	ALERT	Not used
JP4	2-pin jumper	CNTL	Shunts control pin to GND

(1) Pin name changes to RESV_TRK.

8 Test Procedure

8.1 Line and Load Regulation Measurement Procedure

1. Connect VOUT to J3 and VOUT_GND to J5 Figure 2.
2. Ensure that the electronic load is set to draw 0 A_{DC}.
3. Connect VIN to J1 and VIN_GND to J2 Figure 2.
4. Increase V_{IN} from 0 V to 12 V using the digital multimeter to measure input voltage.
5. Use the other digital multimeter to measure output voltage V_{OUT} at TP2 and TP10.

Table 3. List of Test Points for Line and Load Measurements

TEST POINT	NODE NAME	DESCRIPTION
TP2	LocS+	Sense VOUT + locally across C5. Use for efficiency and ripple measurements
TP10	LocS-	Sense VOUT - locally across C5. Use for efficiency and ripple measurements
TP4	PVIN	Sense VIN + across C10
TP13	PGND	Sense VIN - across C10

6. Vary the load from 0 A_{DC} to maximum rated output 40 A_{DC}. V_{OUT} must remain in regulation as defined in Table 1.
7. Vary V_{IN} from 5 V to 16 V. V_{OUT} must remain in regulation as defined in Table 1.
8. Decrease the load to 0 A.
9. Decrease V_{IN} to 0 V or turn off the supply.

8.2 Efficiency

To measure the efficiency of the power train on the EVM, it is important to measure the voltages at the correct location. This is necessary because otherwise the measurements will include losses in efficiency that are not related to the power train itself. Losses incurred by the voltage drop in the copper traces and in the input and output connectors are not related to the efficiency of the power train, and they must not be included in efficiency measurements.

Table 4. List of Test Points for Efficiency Measurements

TEST POINT	NODE NAME	DESCRIPTION
TP2	LocS+	Sense VOUT + locally across C5. Use for efficiency and ripple measurements
TP10	LocS-	Sense VOUT - locally across C5. Use for efficiency and ripple measurements
TP4	PVIN	Sense VIN + across C10
TP13	PGND	Sense VIN - across C10

Input current can be measured at any point in the input wires, and output current can be measured anywhere in the output wires of the output being measured. Using these measurement points result in efficiency measurements that do not include losses due to the connectors and PCB traces.

8.3 Equipment Shutdown

1. Reduce the load current to 0 A.
2. Reduce input voltage to 0 V.
3. Shut down the external fan if in use.
4. Shut down equipment.

9 Performance Data and Typical Characteristic Curves

Figure 4 through Figure 13 present typical performance curves for the PWR-784EVM.

9.1 Efficiency

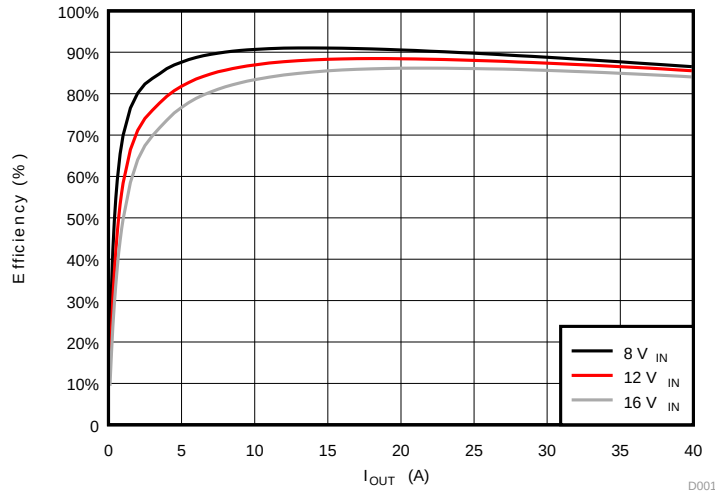


Figure 4. Efficiency of 1-V Output vs Load

9.2 Load Regulation

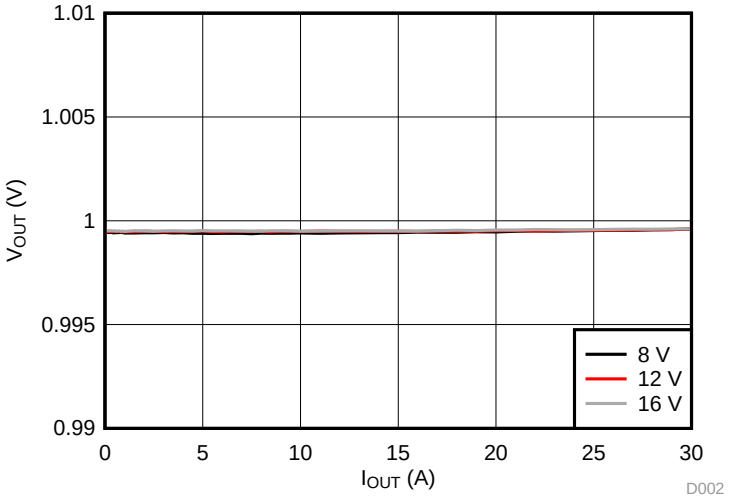


Figure 5. Load Regulation of 1-V Output

9.3 Line Regulation

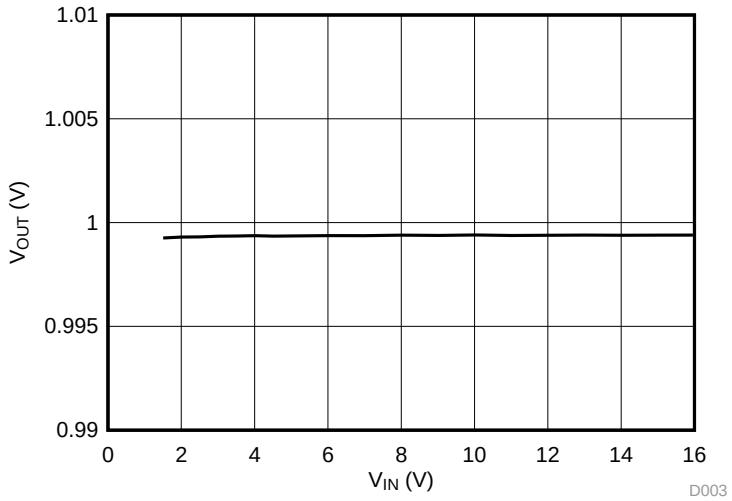


Figure 6. Line Regulation of 1-V Output

9.4 Transient Response

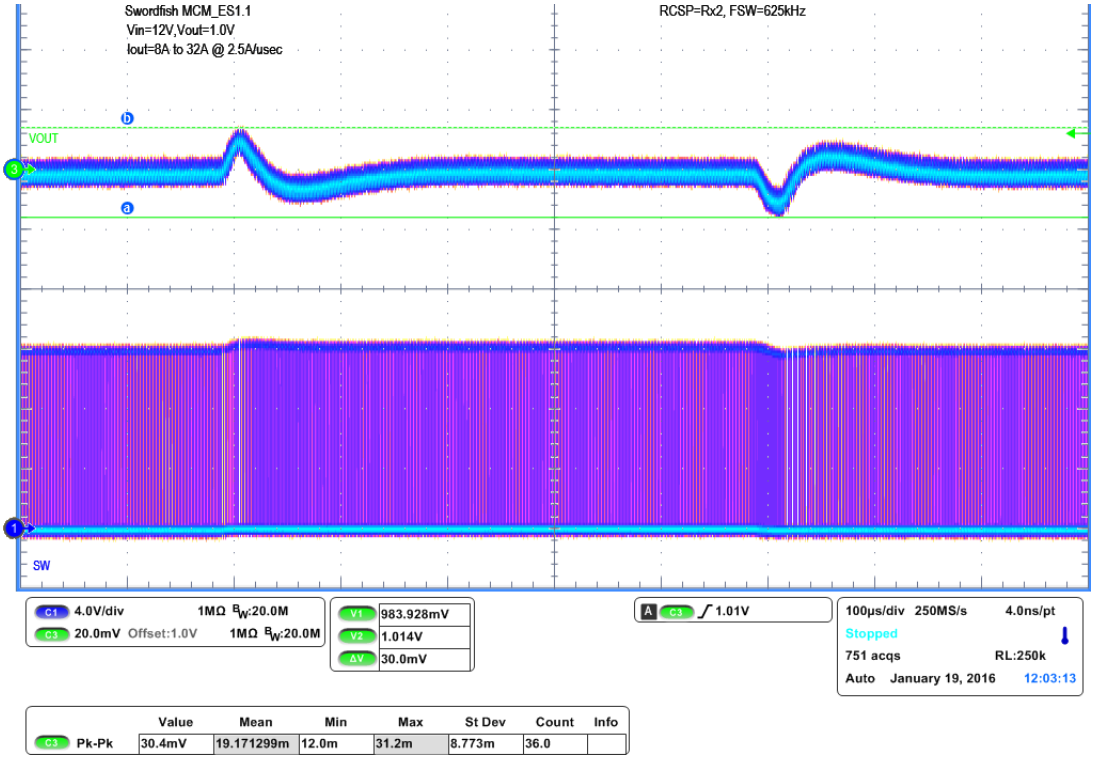


Figure 7. Transient Response of 1-V Output at 12 V_{IN}, Transient is 8 A to 32 A, 2.5 A/µs

9.5 Output Ripple

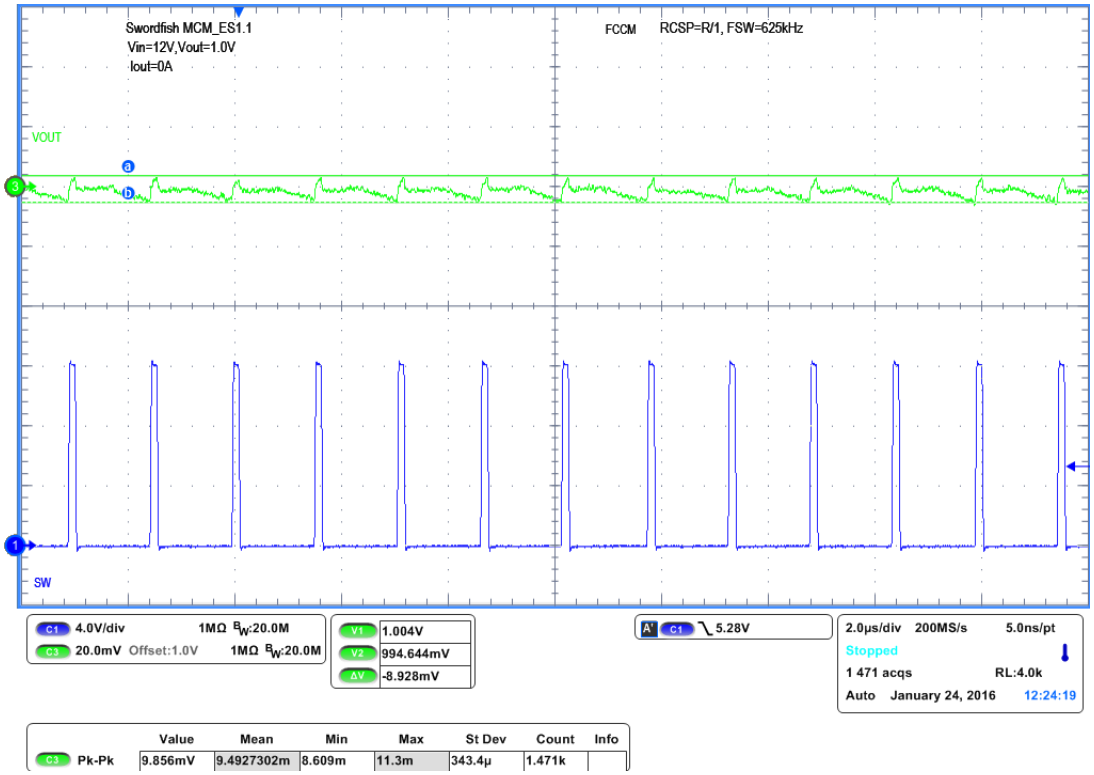


Figure 8. Output Ripple and SW Node of 1-V Output at 12 V_{IN}, 0-A Output

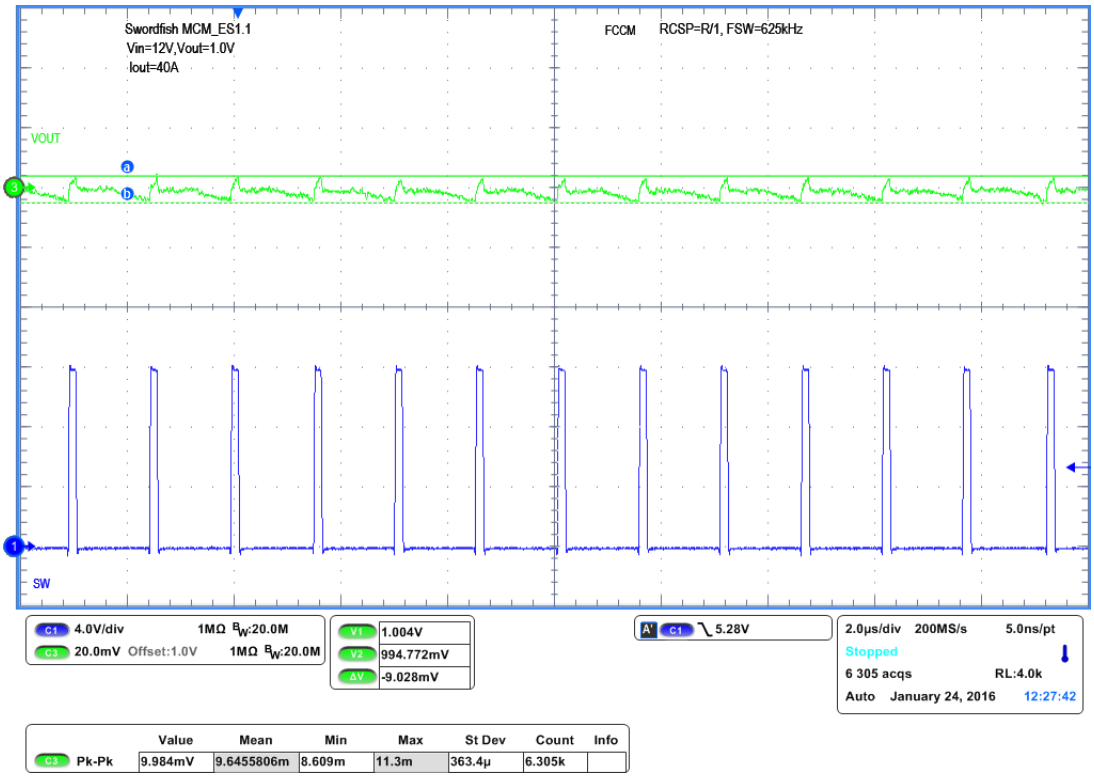


Figure 9. Output Ripple and SW Node of 1-V Output at 12 V_{IN}, 40-A Output

9.6 Control On

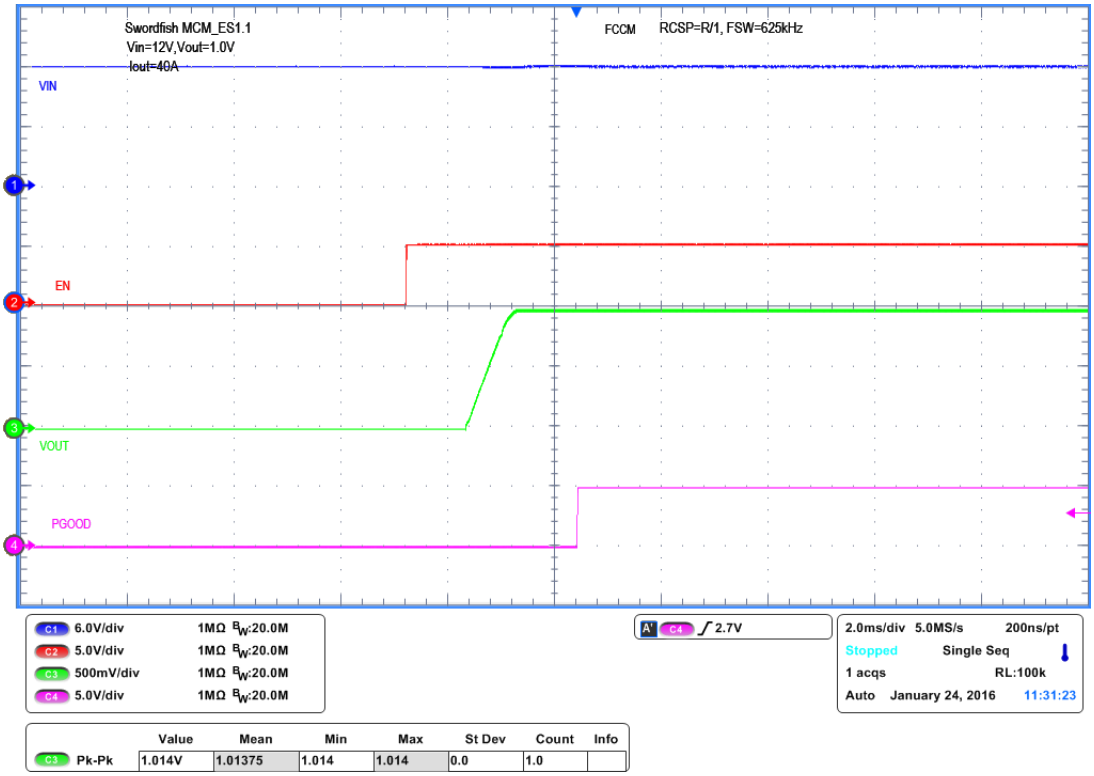


Figure 10. Start up from Control, 1-V Output at 12 V_{IN}, 40-A Output

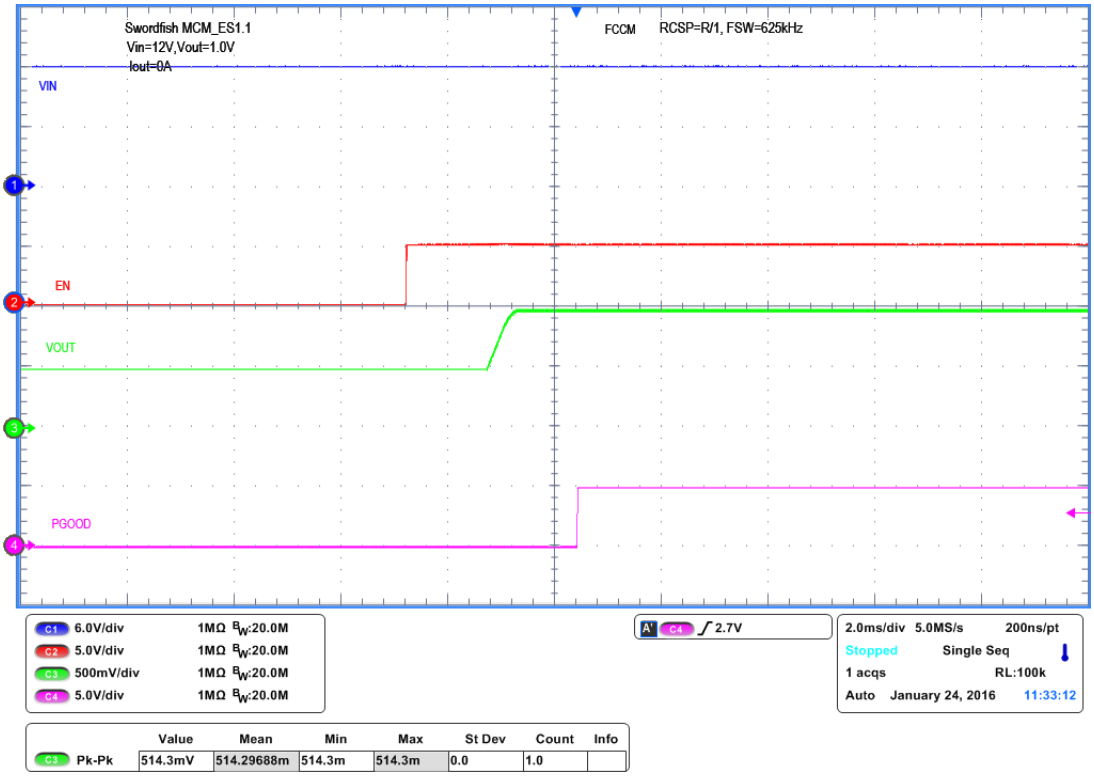


Figure 11. 0.5-V Pre-bias start up from Control, 1-V Output at 12 V_{IN}, 40-A Output

9.7 Control Off

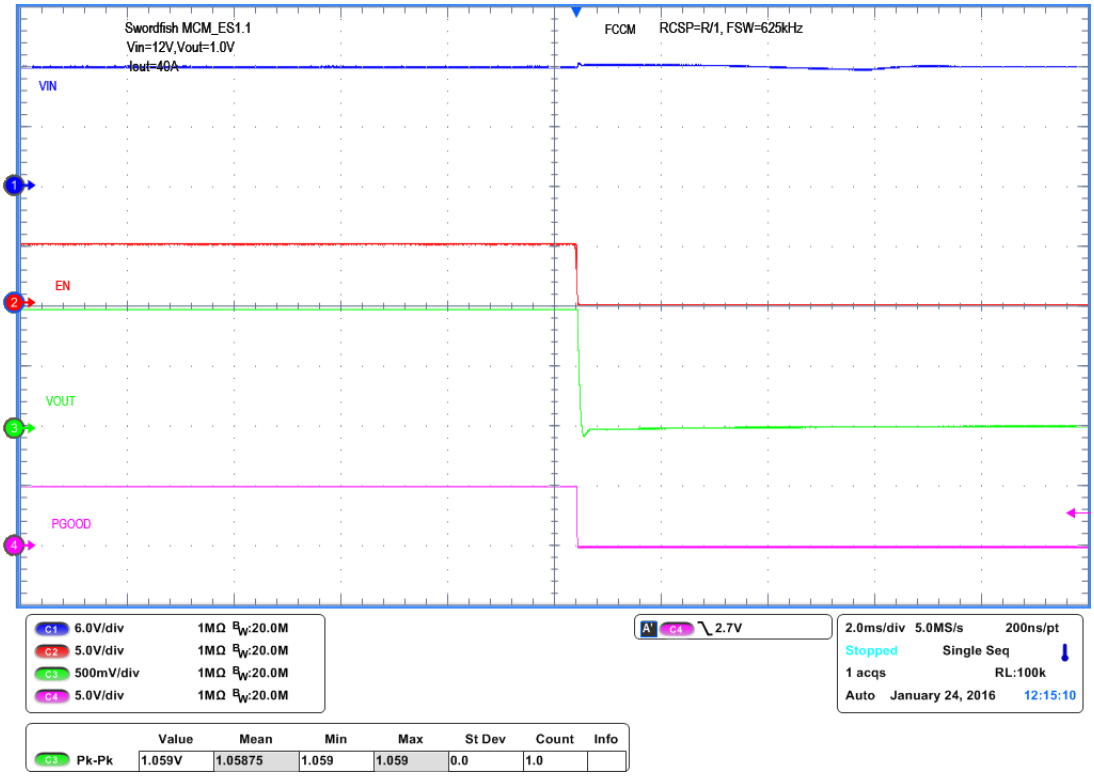


Figure 12. Soft Stop from Control, 1-V Output at 12 V_{IN}, 40-A Output

9.8 Thermal Image

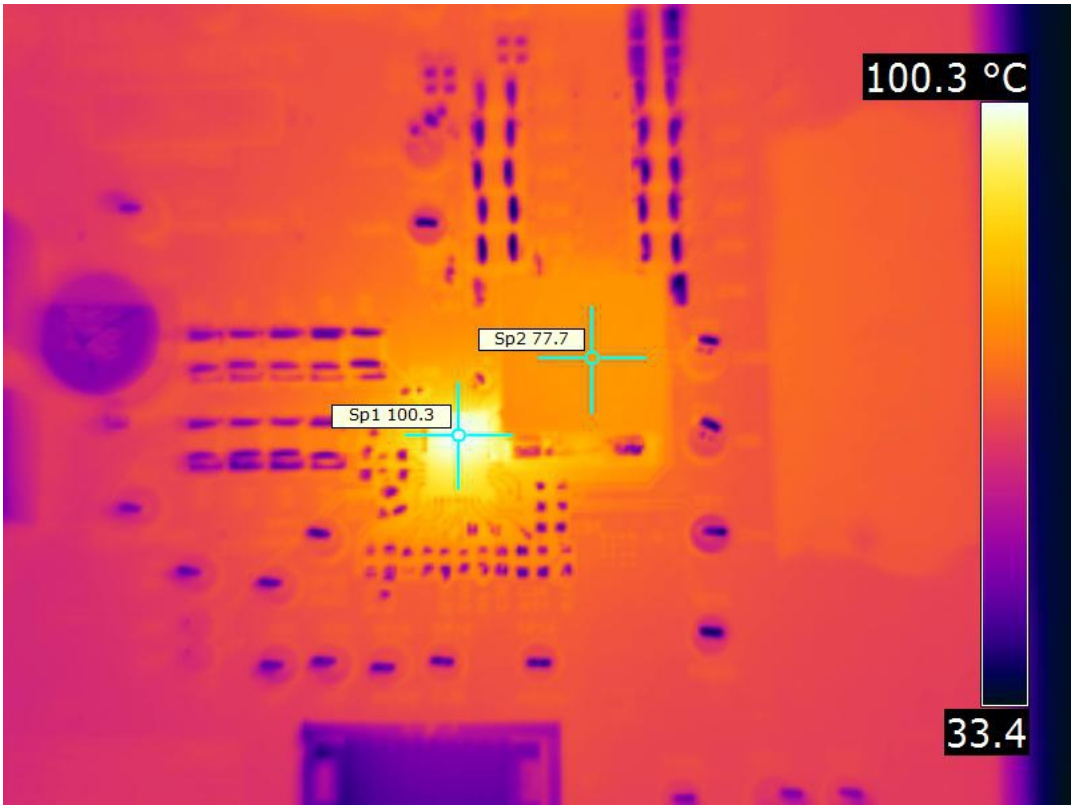


Figure 13. Thermal Image at 1-V Output at 12 V_{IN}, 40-A Output

10 EVM Assembly Drawing and PCB Layout

Figure 14 through Figure 21 show the design of the PWR-784EVM printed-circuit board (PCB). The PWR-784EVM has a 2-oz. copper finish for all layers.

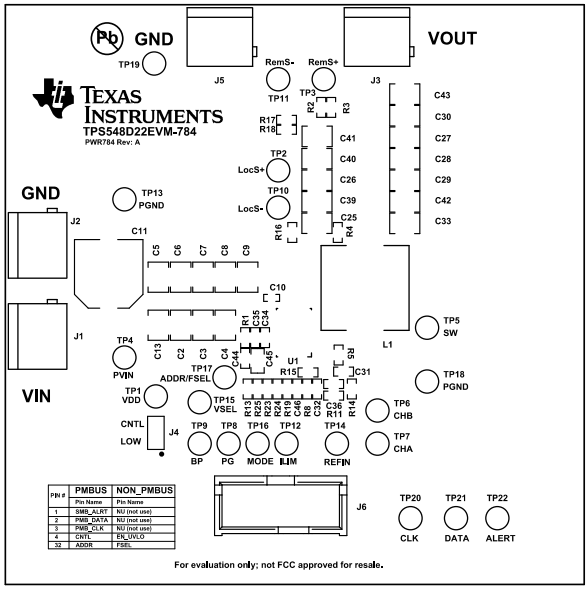


Figure 14. PWR-681EVM Top Layer Assembly Drawing (top view)

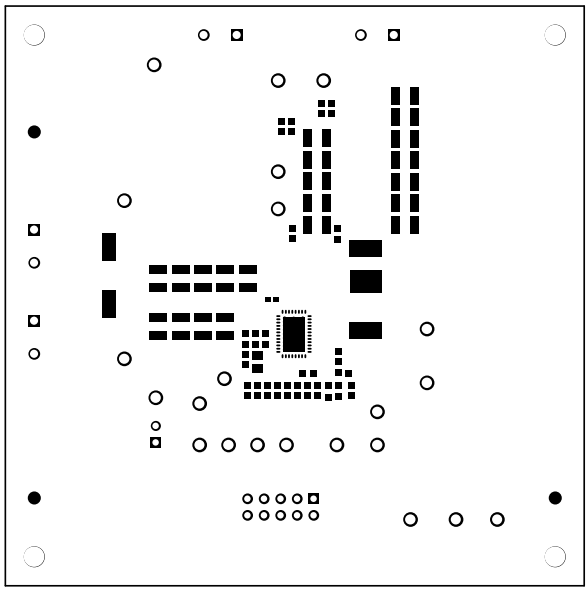


Figure 15. PWR-784EVM Top Solder Mask (top view)

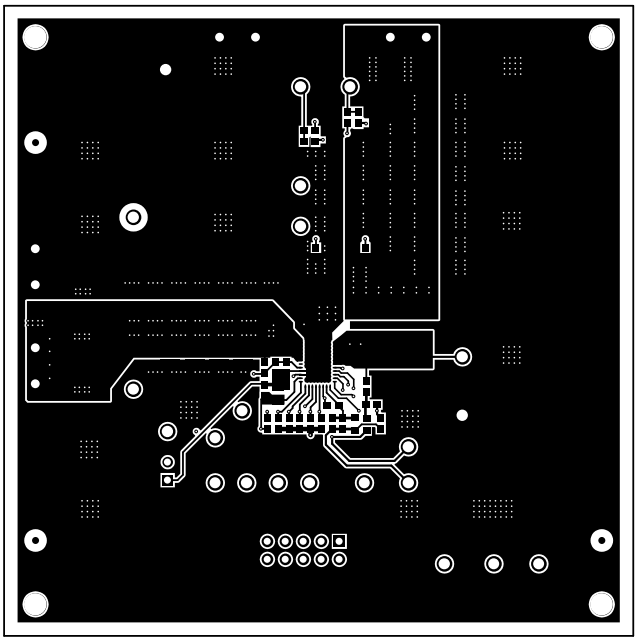


Figure 16. PWR-784EVM Top Layer (top view)

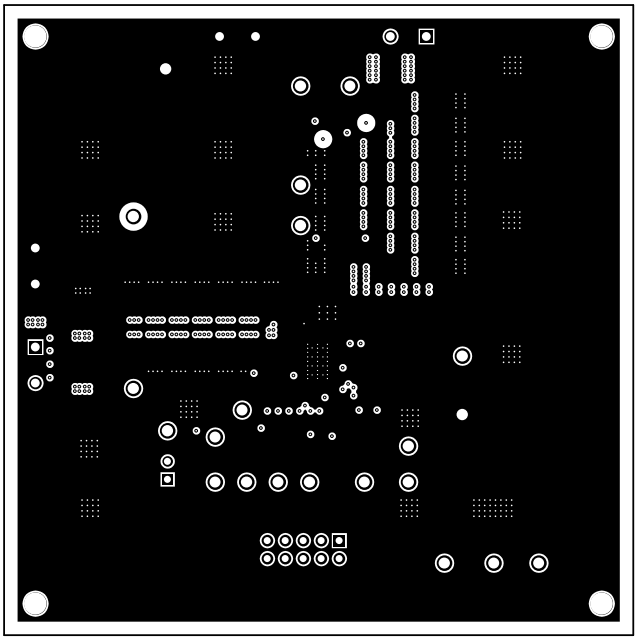


Figure 17. PWR-784EVM Inner Layer 1 (top view)

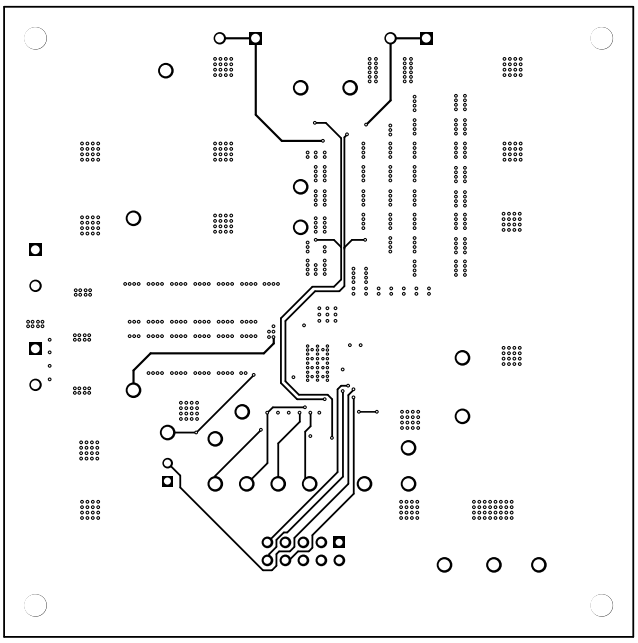


Figure 18. PWR-784EVM Inner Layer 2 (top view)

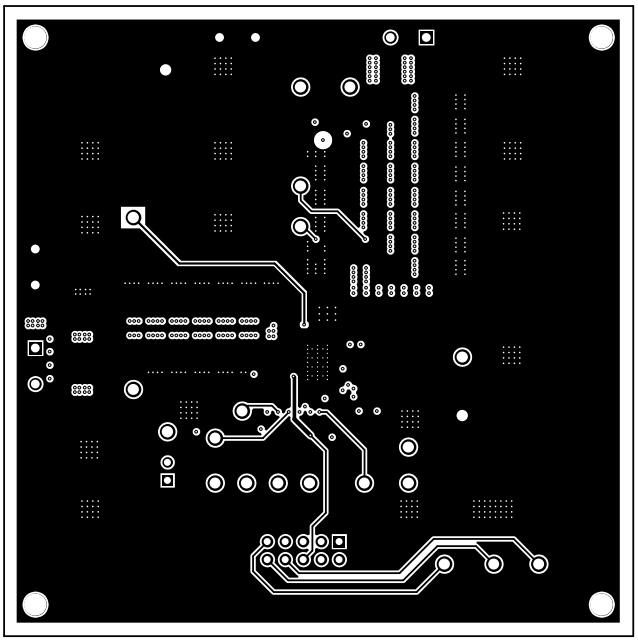


Figure 19. PWR-784EVM Inner Layer 3 (top view)

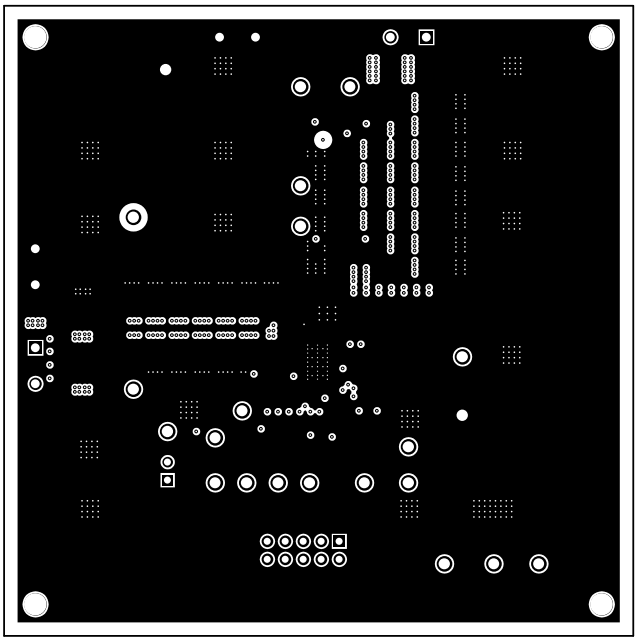


Figure 20. PWR-784EVM Inner Layer 4 (top view)

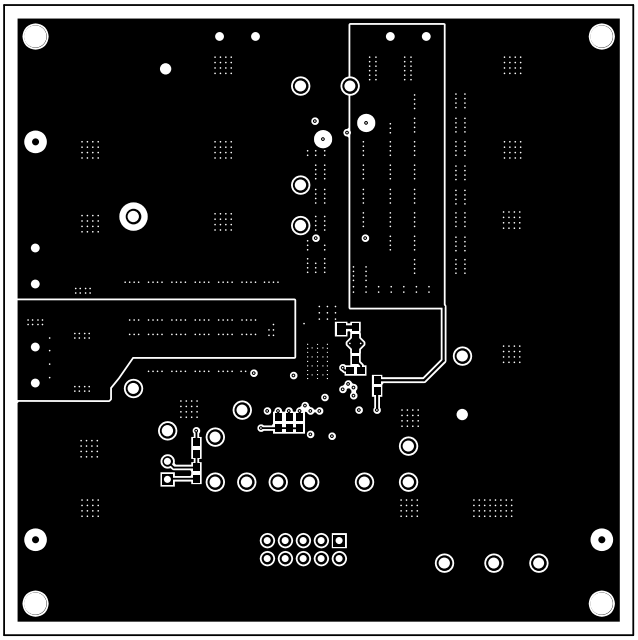


Figure 21. PWR-784EVM Bottom Layer (top view)

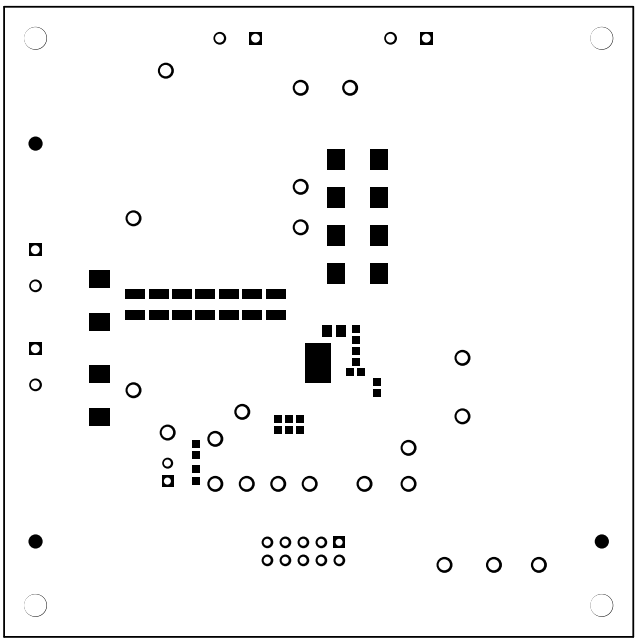


Figure 22. PWR-784EVM Bottom Solder Mask (top view)

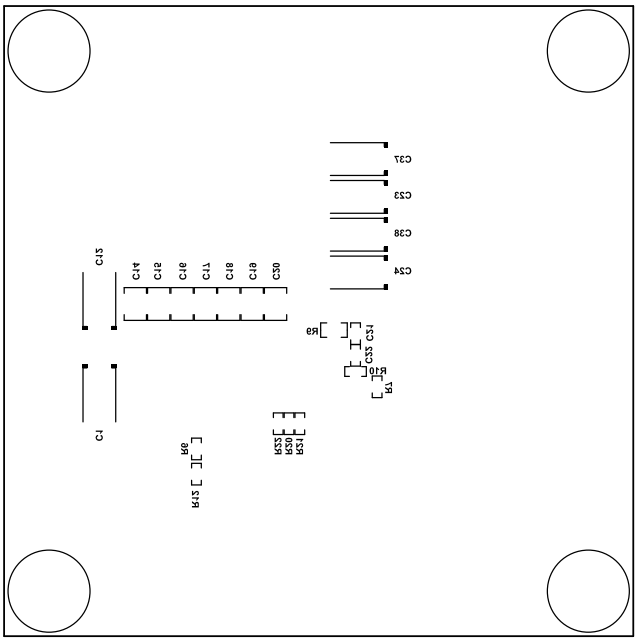


Figure 23. PWR-784EVM Bottom Overlay Layer (top view)

11 List of Materials

The EVM components list according to the schematic shown in Table 5.

Table 5. PWR784 List of Materials

Quantity	Designator	Value	Description	Package Reference	Manufacturer	Part Number
12	C2, C3, C4, C5, C6, C7, C8, C9, C13, C18, C19, C20	22 µF	CAP, CERM, 22 µF, 25 V, +/- 10%, X7R, 1210	1210	MuRata	GRM32ER71E226KE15L
1	C10	2200 pF	CAP, CERM, 2200 pF, 25 V, +/- 10%, X5R, 0402	0402	MuRata	GRM155R61E222KA01D
1	C11	100 µF	CAP, AL, 100uF, 35V, +/-20%, 0.15 ohm, SMD	SMT Radial G	Panasonic	EEE-FC1V101P
1	C22	0.1 µF	CAP, CERM, 0.1 µF, 50 V, +/- 10%, X7R, 0603	0603	MuRata	GRM188R71H104KA93D
3	C23, C24, C38	470 µF	CAP, Tantalum Polymer, 470 µF, 2.5 V, +/- 20%, 0.006 ohm, 7.3x2.8x4.3mm SMD	7.3x2.8x4.3mm	Panasonic	2R5TPF470M6L
10	C25, C26, C27, C28, C29, C33, C39, C40, C41, C42	100 µF	CAP, CERM, 100 µF, 6.3 V, +/- 20%, X5R, 1210	1210	MuRata	GRM32ER60J107ME20L
1	C35	1 µF	CAP, CERM, 1 µF, 16 V, +/- 10%, X5R, 0603	0603	Kemet	C0603C105K4PACTU
1	C45	4.7 µF	CAP, CERM, 4.7 µF, 16 V, +/- 10%, X7R, 0805	0805	MuRata	GRM21BR71C475KA73L
1	C46	1000 pF	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603	Kemet	C0603C102J5GACTU
4	J1, J2, J3, J5		TERMINAL BLOCK 5.08MM VERT 2POS, TH	TERM_BLK, 2pos, 5.08mm	On-Shore Technology	ED120/2DS
1	J4		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	Sullins Connector Solutions	PEC02SAAN
1	L1	250 nH	Inductor, Shielded Drum Core, Ferrite, 250 nH, 50 A, 0.000165 ohm, SMD	12.5x13mm	Wurth Elektronik	744309025
1	R1	1.00	RES, 1.00, 1%, 0.1 W, 0603	0603	Yageo America	RC0603FR-071RL
5	R4, R7, R10, R11, R16	0	RES, 0, 5%, 0.1 W, 0603	0603	Vishay-Dale	CRCW06030000Z0EA
1	R6	200 k	RES, 200 k, 1%, 0.1 W, 0603	0603	Vishay-Dale	CRCW0603200KFKEA
1	R8	1.10 k	RES, 1.10 k, 1%, 0.1 W, 0603	0603	Vishay-Dale	CRCW06031K10FKEA
5	R12, R13, R20, R21, R22	100 k	RES, 100 k, 1%, 0.1 W, 0603	0603	Vishay-Dale	CRCW0603100KFKEA
1	R15	10.0 k	RES, 10.0k ohm, 1%, 0.1W, 0603	0603	Vishay-Dale	CRCW060310K0FKEA
1	R19	137 k	RES, 137 k, 1%, 0.1 W, 0603	0603	Vishay-Dale	CRCW0603137KFKEA
1	R23	37.4 k	RES, 37.4 k, 1%, 0.1 W, 0603	0603	Vishay-Dale	CRCW060337K4FKEA
1	R24	42.2 k	RES, 42.2 k, 1%, 0.1 W, 0603	0603	Vishay-Dale	CRCW060342K2FKEA
1	R25	22.1 k	RES, 22.1 k, 1%, 0.1 W, 0603	0603	Vishay-Dale	CRCW060322K1FKEA
14	TP1, TP5, TP6, TP7, TP8, TP9, TP12, TP14, TP15, TP16, TP17, TP20, TP21, TP22	White	Test Point, Multipurpose, White, TH	White Multipurpose Testpoint	Keystone	5012
3	TP2, TP3, TP4	Red	Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	Keystone	5010
5	TP10, TP11, TP13, TP18, TP19	Black	Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	Keystone	5011
1	U1		High Performance, 40-A Single Synchronous Step-Down Converter with Analog REFIN, RVF0040A	RVF0040A	Texas Instruments	TPS548C22RVF
0	C1, C12	330 µF	CAP, TA, 330 µF, 6.3 V, +/- 20%, 0.025 ohm, SMD	7.3x2.8x4.3mm	Sanyo	6TPE330ML
0	C14, C15, C16, C17	22 µF	CAP, CERM, 22 µF, 25 V, +/- 10%, X7R, 1210	1210	MuRata	GRM32ER71E226KE15L

Table 5. PWR784 List of Materials (continued)

Quantity	Designator	Value	Description	Package Reference	Manufacturer	Part Number
0	C21	470 pF	CAP, CERM, 470 pF, 50 V, +/- 10%, X7R, 0603	0603	MuRata	GRM188R71H471KA01D
0	C30, C43	100 µF	CAP, CERM, 100 µF, 6.3 V, +/- 20%, X5R, 1210	1210	MuRata	GRM32ER60J107ME20L
0	C31	0.1 µF	CAP, CERM, 0.1 µF, 50 V, +/- 10%, X7R, 0603	0603	MuRata	GRM188R71H104KA93D
0	C32	6800 pF	CAP, CERM, 6800 pF, 50 V, +/- 10%, X7R, 0603	0603	MuRata	GRM188R71H682KA01D
0	C34, C44	1 µF	CAP, CERM, 1 µF, 16 V, +/- 10%, X5R, 0603	0603	Kemet	C0603C105K4PACTU
0	C36	1000 pF	CAP, CERM, 1000 pF, 25 V, +/- 10%, X7R, 0603	0603	MuRata	GRM188R71E102KA01D
0	C37	470 µF	CAP, Tantalum Polymer, 470 µF, 2.5 V, +/- 20%, 0.006 ohm, 7.3x2.8x4.3mm SMD	7.3x2.8x4.3mm	Panasonic	2R5TPF470M6L
0	J6		Header (shrouded), 100mil, 5x2, Gold, TH	5x2 Shrouded header	TE Connectivity	5103308-1
0	R2, R3, R14, R17, R18	0	RES, 0, 5%, 0.1 W, 0603	0603	Vishay-Dale	CRCW06030000Z0EA
0	R5	1.50 k	RES, 1.50 k, 1%, 0.1 W, 0603	0603	Yageo America	RC0603FR-071K5L
0	R9	3.0 1	RES, 3.01 ohm, 1%, 0.125W, 0805	0805	Vishay-Dale	CRCW08053R01FKEA

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.

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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。
2. 実験局の免許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/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.

6. *Disclaimers:*

   6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY WRITTEN DESIGN MATERIALS PROVIDED WITH THE EVM (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 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 AND CONDITIONS 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 MADE, CONCEIVED OR ACQUIRED PRIOR TO OR AFTER DELIVERY OF THE EVM.

7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS AND CONDITIONS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

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 ANDCONDITIONS OR THE USE OF THE EVMS PROVIDED HEREUNDER, 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 ONE YEAR AFTER THE RELATED CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY WARRANTY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS AND CONDITIONS, OR ANY USE OF ANY TI EVM PROVIDED HEREUNDER, EXCEED THE TOTAL AMOUNT PAID TO TI FOR THE PARTICULAR UNITS SOLD UNDER THESE TERMS AND CONDITIONS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM AGAINST THE PARTICULAR UNITS SOLD TO USER UNDER THESE TERMS AND CONDITIONS SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

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.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

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In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

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