

## ABSTRACT

The TPS7H4003EVM is the evaluation module (EVM) for the TPS7H4003-SEP and provides a platform to electrically evaluate the features. This user's guide provides details about the EVM, the configuration, schematics, and bill of materials.

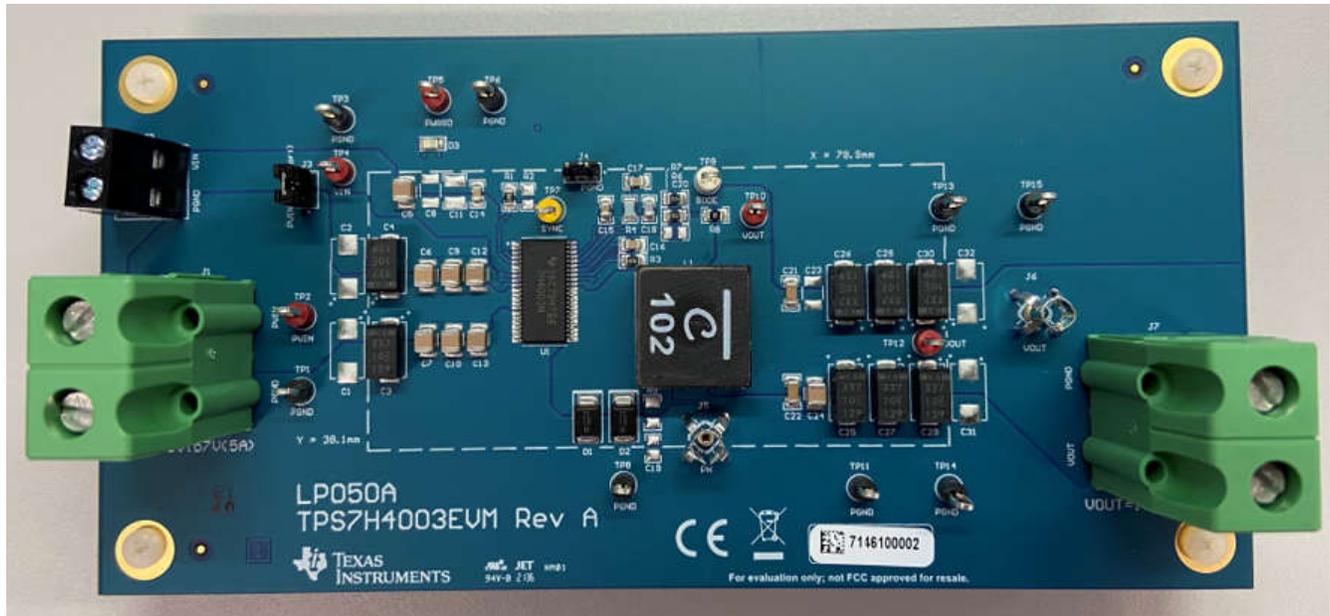


Figure 1-1. TPS7H4003EVM (Single Channel)

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## 1 TPS7H4003EVM Overview

The TPS7H4003-SEP is a radiation hardened, 7V, 18A synchronous step-down converter with integrated high-side and low-side MOSFETs. High efficiency and efficient usage of space are achieved through low resistance MOSFETs and a current mode control implementation.

The EVM is configured in a default state to accept a 5V input but can be modified to disable or change the under voltage lock out (UVLO) protection, allowing for any input voltage from 3V to 7V. The EVM is also configured for a 1V output at a maximum peak output current of 18A. Again, the regulated output voltage can be modified by changing one resistor on the board. The TSP7H4003-SEP has a dedicated soft start, enable, and adjustable slope compensation pins providing design flexibility to meet specific application requirements.

Finally, as shown in [Figure 1-1](#), this EVM supports a single POL channel. However, the device does support parallel operation. With four POLs operating in quadrature phases, a 72A load current can theoretically be provided.

### 1.1 Features

- 0.6V  $\pm$ 1.6% voltage reference over temperature, radiation, and line and load regulation
- Adjustable slope compensation
- Adjustable soft start
- Adjustable input enable and undervoltage lockout (UVLO)
- Maximum output current of 18A

### 1.2 Applications

- Point of load regulation
- Supports harsh environment applications
- Space satellite point of load supply for FPGAs, microcontrollers, data converters, and ASICs
- Space satellite payloads
- Radiation hardened applications

## 2 TPS7H4003EVM Default Configuration

Table 2-1 describes the default configuration of the TPS7H4003EVM listing the external components that define the converter design.

**Table 2-1. Default EVM Configuration**

PARAMETER	SPECIFICATIONS	DESCRIPTION
Input power supply	5V	Bound by UVLO enable circuit (R9, R10)
Regulated output voltage	1V	R6 (RTOP) = 10kΩ, R7 (RBOTTOM) = 15.4kΩ
L <sub>OUT</sub>	1.0μH	Chosen to meet inductor ripple current of 10% (Kind = 0.1)
C <sub>OUT</sub>	2mF	Chosen for (1) ESR = 1mΩ to set output voltage ripple; (2) value used during single event effects testing verify regulation maintained with single event upset to switching
Output current	0A to 18A	By design
Switching frequency	500kHz	Set by R1 (RT) = 174kΩ
Soft start time constant	≈2 ms	Set by C16 (Css) = 10nF
UVLO enable rising	≈4.432 V	Set by R10 = 10kΩ and R9 = 3.4kΩ
UVLO enable falling	≈4.284 V	Set by R10 = 10kΩ and R9 = 3.4kΩ
Loop bandwidth	≈30 kHz	Set by operational transconductance amplifier (OTA) compensation circuit: R4 (RCOMP) = 10kΩ, C17 (CCOMP) = 10nF, C18 (CHF) = 150pF
Loop phase margin	≈60°	
Gain margin	≈-25 dB	

### 3 TPS7H4003EVM Initial Setup

This section provides the test instruments required and the connections to the EVM.

1. Input DC power supply
  - a. Set for 5V DC, 8A current limit.
  - b. Connect positive output of DC supply to pin 1 of connector J1 (PVIN) and negative terminal of supply to pin 2 of connector J1 for ground using 16 AWG wire or larger.

**Note**

For more precise measurements, eliminating the IR voltage drop in the input cables is achieved by using a power supply source with sensing ports and connecting between TP2 to PVIN and TP1 to GND.

2. DC electronic load
  - a. Connect positive DC input of e-load to pin 1, VOUT, of connector J7 (VOUT) using 16 AWG wire.

**Note**

Wire from pin 1, positive terminal of connector, to the e-load must include at least some part in which the wire gauge can be strapped by the oscilloscope current probe. This eliminates the need for a setup change to cover all tests.

  - b. Connect negative DC input of e-load to pin 2, PGND, of connector J7 (VOUT) using 16 AWG wire.
  - c. Connect voltage monitoring sensing ports of e-load across test points TP12 (VOUT1) and TP13 (PGND). A voltage meter can be used to monitor this voltage also.

3. Oscilloscope
  - a. CH1 - Connect voltage scope probe to scope probe test point J5 (PH) to monitor the phase node. DC coupled, Full BW, 2V/div, Rising Edge Trigger at 0.5V.
  - b. CH2 - Connect voltage scope probe to scope probe test point J6 (VOUT) to monitor the output voltage. AC coupled, BW = 20MHz, 10mV/div.
  - c. CH4 - Connect current scope probe to monitor current through wire connecting J7 (VOUT) and e-load. 5A/div.

**Note**

Only required for transient load testing.

**Table 3-1. Summary of Connections**

REFERENCE DESIGNATOR	SILKSCREEN	FUNCTION
J1	PVIN	Input power: pin 1 = 5V, pin 2 = GND (Vsupply)
J7	VOUT	Output voltage: pin 2 = GND, pin 1 = Vout ≈ 1 V (e-load)
J5	PH	Phase switching node scope probe test point (Scope CH-1)
J6	VOUT	VOUT scope probe test point (Scope CH-2)
TP12	VOUT	VOUT test point (e-load monitor)
TP2	PVIN	PVIN test point (Vsupply_sense)
TP1, TP13	GND	GND test points (Vsupply_sense, e-load monitor)

## 4 TPS7H4003EVM Testing

The following tests is described in subsequent sections.

- Section 4.1: Output voltage regulation
- Section 4.2: Output voltage ripple
- Section 4.3: Soft startup
- Section 4.4: Transient response to positive/negative load step (9A to 18A to 9A)
- Section 4.5: Loop frequency response

### 4.1 Output Voltage Regulation

1. Turn-on input DC source (5V).
2. Turn on the e-load and sweep load current from 0A to 18A. The monitored output voltage at TP12 (VOUT) is at or near 1V across the entire current load sweep as shown in Figure 4-1.

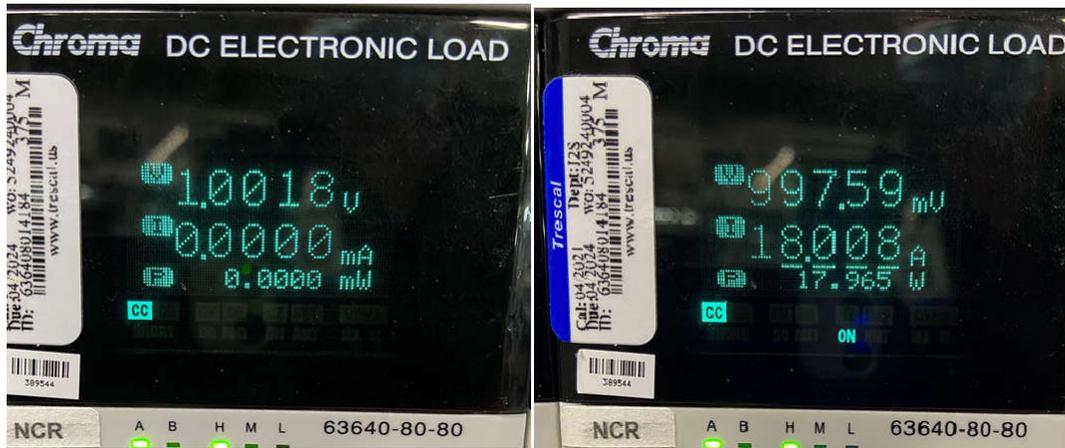


Figure 4-1. Output Voltage Regulation

### 4.2 Output Voltage Ripple

Display CH1 (PH) and CH2 (VOUT) [AC coupled, BW = 20 MHz] on oscilloscope to monitor the switching phase node and the output voltage ripple as shown in Figure 4-2.

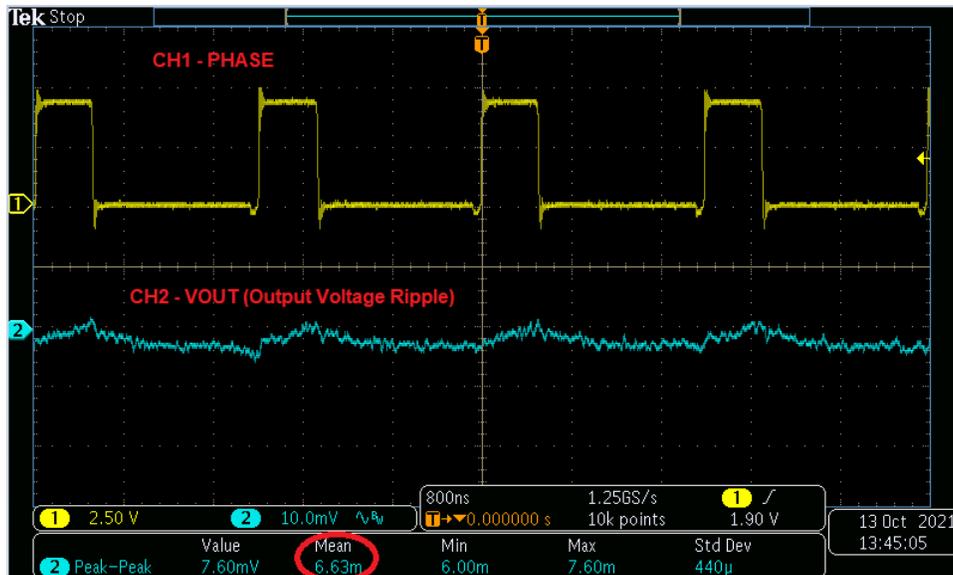


Figure 4-2. Output Voltage Ripple VIN = 5V, VOUT = 1V, IOU = 18A

### 4.3 Soft Startup

Display CH1 (PH) and CH2 (VOUT) [DC coupled, 500mV/div] on oscilloscope to monitor the switching phase and the soft start profile of the output voltage as shown in Figure 4-3.



Figure 4-3. Output Soft Start Voltage, VIN = 5V, VOUT = 1V, IOU = 18A

### 4.4 Transient Response to Positive and Negative Load Step (9A to 18A to 9A)

1. Configure e-load to switch between 9A and 18A at a rate of 1A/μs.
2. On oscilloscope, display CH2 (VOUT) [AC coupled, 20mV/div] and CH4 (Output Current Probe) [5A/div, trigger rising edge ≈12A] with 40μs/div.

Figure 4-4 shows the response to this load step to be less than 35mV or -3.5%.

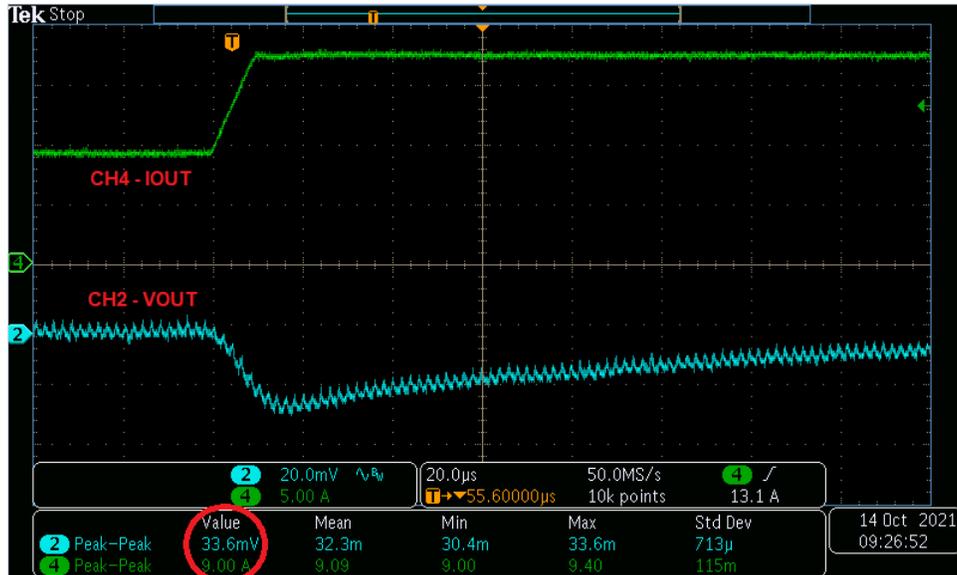


Figure 4-4. Transient Response to Load Step 9A to 18A at 1A/μs

- Change the trigger on CH4 to falling edge to capture the transient response of VOUT to negative current step from 18A to 9A as shown in Figure 4-5.

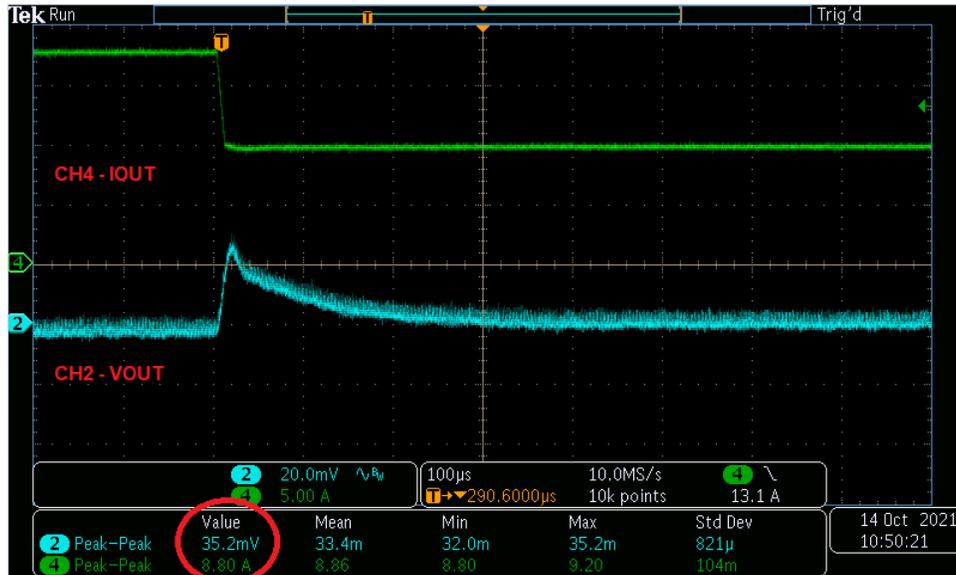


Figure 4-5. Transient Response to Load Step 18A to 9A at 1A/μs

### 4.5 Loop Frequency Response

Measuring the frequency response of the feedback loop requires a unique test setup as well as physical changes to the EVM. 0Ω resistor jumper R8, below TP9 (BODE) test point and circled in yellow in the graphic below, must be lifted to break the loop. Both test points TP9 (BODE) and TP10 (VOUT) is used for connections to the Bode100 instruments.

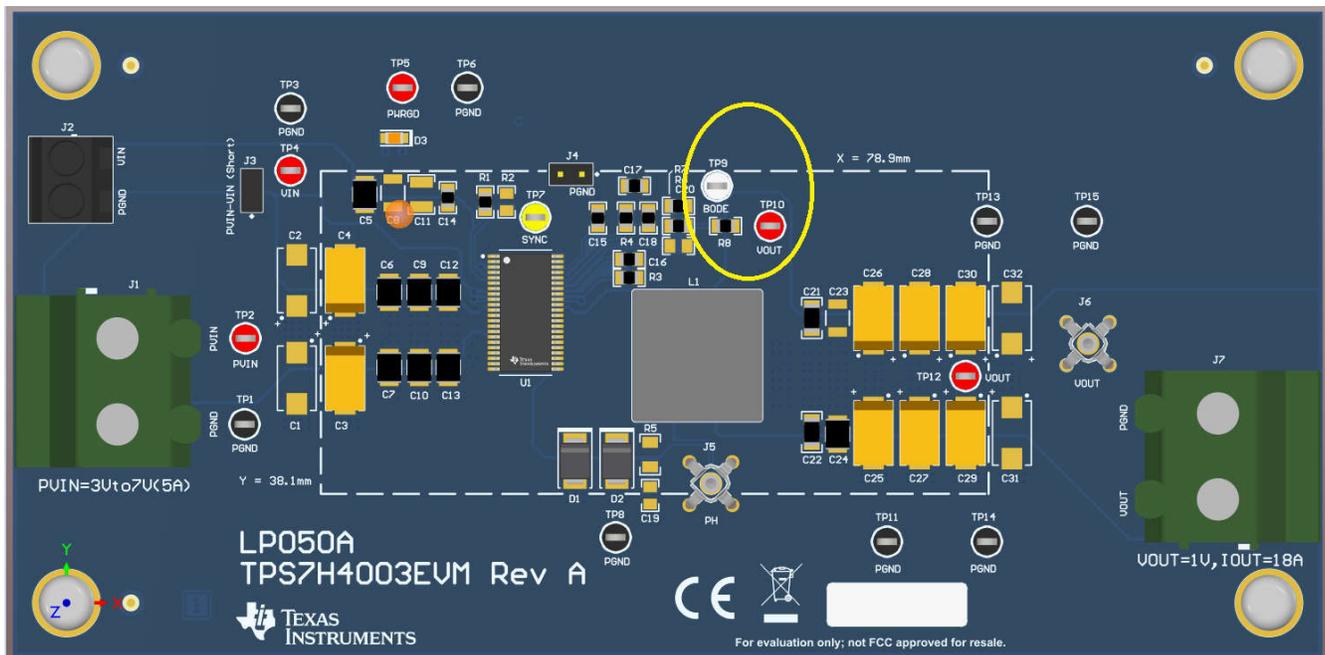


Figure 4-6. EVM Modification to Measure Frequency Response

### 4.6 Setup

The test setup, which includes several connections to Picotest Bode100 test instruments, is shown in Figure 4-7 with measurement results shown in Figure 4-8. The CHF, high frequency pole, component of the compensation circuit is optional. Omitting the CHF results in slightly increased phase margin. However, the benefit of including the CHF is that the gain curve is set in a downward trajectory as frequency increases, making a monotonic gain curve more likely to be achieved.

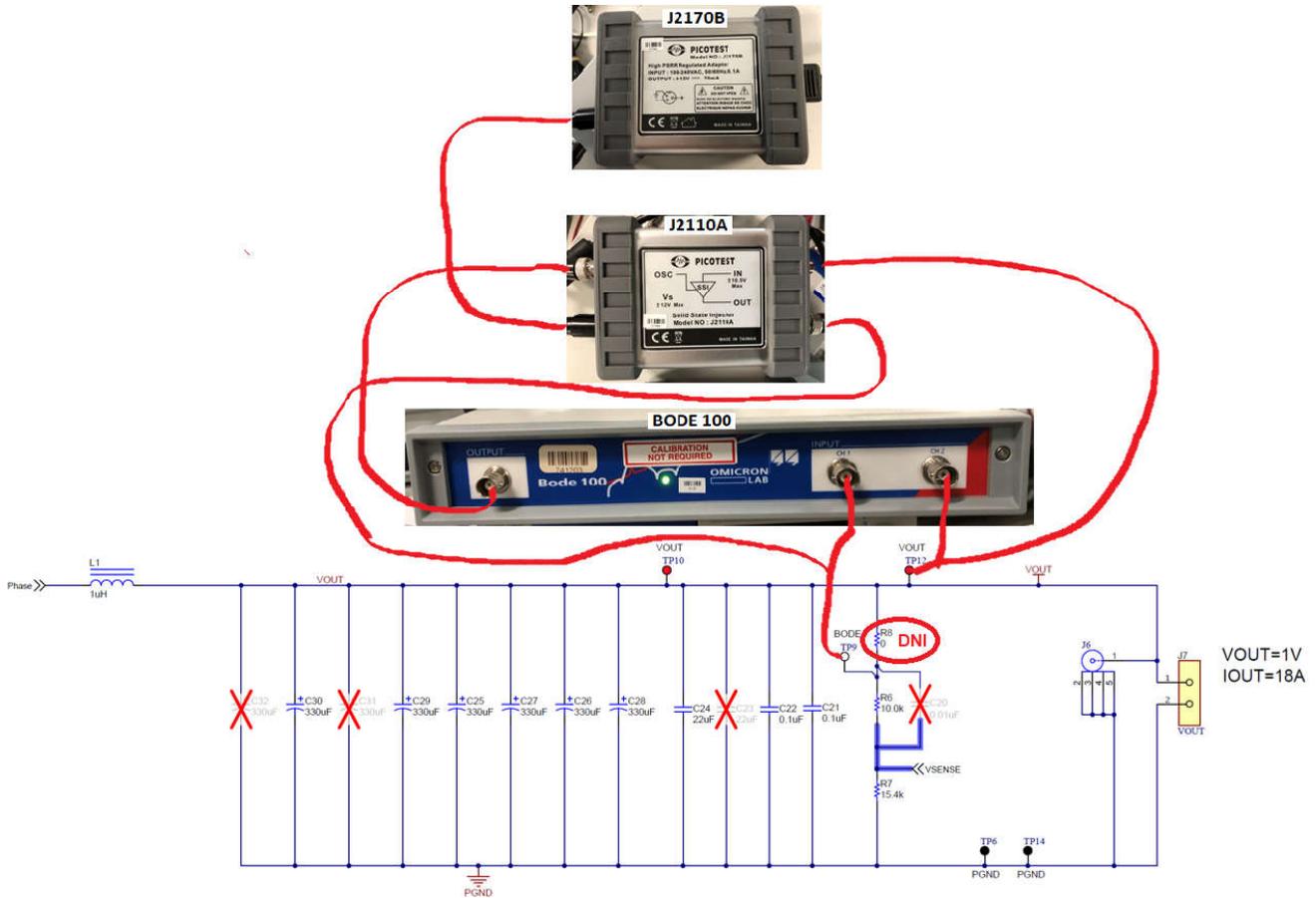
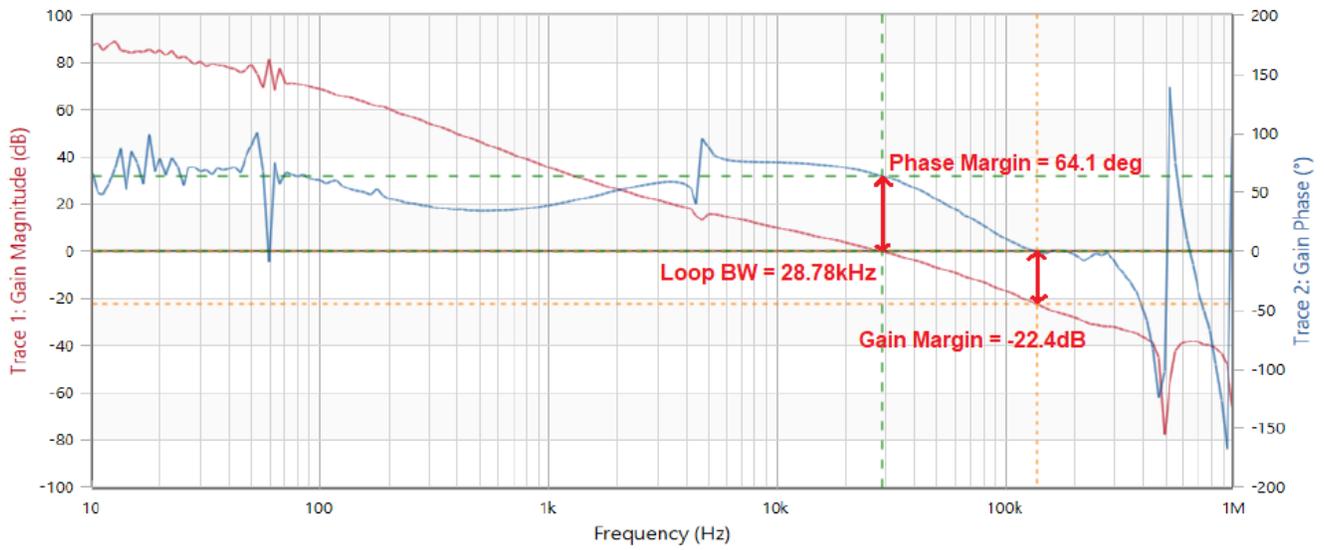
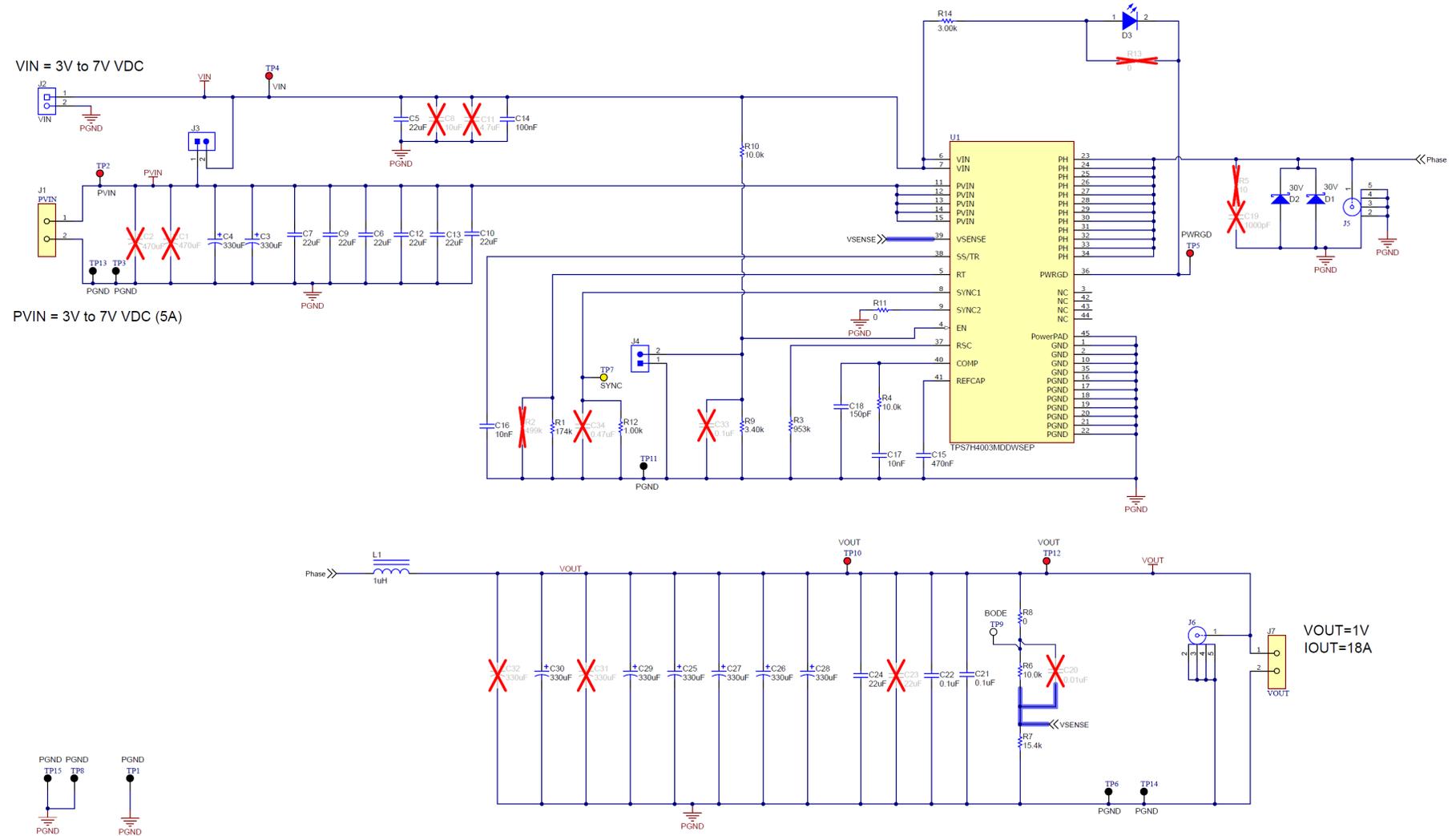


Figure 4-7. Frequency Response Test Setup



**Figure 4-8. Frequency Response**

## 5 TPS7H4003EVM Schematic



## 6 TPS7H4003EVM Bill of Materials (BOM)

**Table 6-1. TPS7H4003EVM BOM**

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
!PCB1	1		Printed Circuit Board		LP050	Any
C3, C4, C25, C26, C27, C28, C29, C30	8	330uF	CAP, Tantalum Polymer, 330uF, 10V, +/- 20%, 0.006 ohm, 7343-43 SMD	7343-43	T530X337M010ATE006	Kemet
C5, C6, C7, C9, C10, C12, C13, C24	8	22uF	CAP, CERM, 22uF, 16V, +/- 10%, X7R, 1210	1210	C3225X7R1C226K250AC	TDK
C14	1	0.1uF	CAP, CERM, 0.1uF, 50V, +/- 5%, X7R, 0805	0805	08055C104JAT2A	AVX
C15	1	0.47uF	CAP, CERM, 0.47uF, 50V, +/- 10%, X7R, 0805	0805	C2012X7R1H474K125AB	TDK
C16	1	0.01uF	CAP, CERM, 0.01uF, 50V, +/- 10%, X7R, 0805	0805	C0805C103K5RACTU	Kemet
C17	1	0.01uF	CAP, CERM, 0.01uF, 50V, +/- 20%, X7R, 0805	0805	C0805C103M5RACTU	Kemet
C18	1	150pF	CAP, CERM, 150pF, 50V, +/- 5%, C0G/NP0, 0805	0805	08055A151JAT2A	AVX
C21, C22	2	0.1uF	CAP, CERM, 0.1uF, 50V, +/- 5%, X7R, 1206	1206	C1206C104J5RACTU	Kemet
D1, D2	2	30V	Diode, Schottky, 30V, 2A, SMB	SMB	B230-13-F	Diodes Inc.
D3	1	Orange	LED, Orange, SMD	LED_0805	LTST-C170KFKT	Lite-On
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1, J7	2		Fixed Terminal Blocks MKDSP 10 HV/ 2-10	HDR2	1929517	Phoenix Contact
J2	1		Terminal Block, 5.08mm, 2x1, TH	Terminal Block, 5.08mm, 2x1, TH	0395443002	Molex
J3, J4	2		Header, 100mil, 2x1, Gold, TH	2x1 Header	TSW-102-07-G-S	Samtec
J5, J6	2		Compact Probe Tip Circuit Board Test Points, TH, 25 per	TH Scope Probe	131-5031-00	Tektronix
L1	1	1uH	Inductor, Shielded, Composite, 1uH, 57.5A, 0.000929 ohm, SMD	15.2x8x16.2mm	XAL1580-102MEB	Coilcraft
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
R1	1	174k	RES, 174 k, 1%, 0.125 W, 0805	0805	ERJ-6ENF1743V	Panasonic

**Table 6-1. TPS7H4003EVM BOM (continued)**

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
R3	1	953k	RES, 953 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW0805953KFKEA	Vishay-Dale
R4	1	10.0k	RES, 10.0 k, 1%, 0.2 W, 0805	0805	MCU08050C1002FP500	Vishay/Beyschlag
R6	1	10.0k	RES, 10.0 k, 0.01%, 0.125 W, 0805	0805	RNCF0805TKY10K0	Stackpole Electronics Inc
R7	1	15.4k	RES, 15.4 k, 0.1%, 0.125 W, 0805	0805	RG2012P-1542-B-T5	Susumu Co Ltd
R8, R11	2	0	RES, 0, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW08050000Z0EA	Vishay-Dale
R9	1	3.40k	RES, 3.40 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW08053K40FKEA	Vishay-Dale
R10	1	10.0k	RES, 10.0 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW080510K0FKEA	Vishay-Dale
R12	1	1.00k	RES, 1.00 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW08051K00FKEA	Vishay-Dale
R14	1	3.00k	RES, 3.00 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	ERJ-6ENF3001V	Panasonic
SH-J1	1	1x2	Shunt, 100mil, Flash Gold, Black	Closed Top 100mil Shunt	SPC02SYAN	Sullins Connector Solutions
TP1, TP3, TP6, TP8, TP11, TP13, TP14, TP15	8		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone
TP2, TP4, TP5, TP10, TP12	5		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone
TP7	1		Test Point, Multipurpose, Yellow, TH	Yellow Multipurpose Testpoint	5014	Keystone
TP9	1		Test Point, Multipurpose, White, TH	White Multipurpose Testpoint	5012	Keystone
U1	1		Radiation-Hardened 3V to 7V Input 18A Synchronous Buck Converter in Space Enhanced Plastic	TSSOP44	TPS7H4003MDDWSEP	Texas Instruments
C1, C2	0	470uF	CAP, TA, 470uF, 10V, +/- 10%, 0.023 ohm, SMD	7343-43	TPME477K010R0023	AVX
C8	0	10uF	CAP, CERM, 10uF, 25V, +/- 10%, X7R, 1210	1210	12103C106KAT2A	AVX
C11	0	4.7uF	CAP, CERM, 4.7uF, 10V, +/- 10%, X7R, 1210	1210	C1210C475K8RACTU	Kemet
C19	0	1000pF	CAP, CERM, 1000pF, 50V, +/- 5%, X7R, 0805	0805	C0805C102J5RACTU	Kemet

**Table 6-1. TPS7H4003EVM BOM (continued)**

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
C20	0	0.01uF	CAP, CERM, 0.01uF, 100V, +/- 5%, X7R, 0805	0805	08051C103JAT2A	AVX
C23	0	22uF	CAP, CERM, 22uF, 16V, +/- 10%, X7R, 1210	1210	C3225X7R1C226K250AC	TDK
C31, C32	0	330uF	CAP, Tantalum Polymer, 330uF, 10V, +/- 20%, 0.006 ohm, 7343-43 SMD	7343-43	T530X337M010ATE006	Kemet
C33	0	0.1uF	CAP, CERM, 0.1uF, 50V, +/- 5%, X7R, 0805	0805	08055C104JAT2A	AVX
C34	0	0.47uF	CAP, CERM, 0.47uF, 50V, +/- 10%, X7R, 0805	0805	C2012X7R1H474K125AB	TDK
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
R2	0	499k	RES, 499 k, 0.1%, 0.125 W, 0805	0805	RG2012P-4993-B-T5	Susumu Co Ltd
R5	0	10	RES, 10, 5%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	CRCW120610R0JNEA	Vishay-Dale
R13	0	0	RES, 0, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW08050000Z0EA	Vishay-Dale

## 7 Board Layout

The following is the layer stack of the TPS7H4003EVM board.

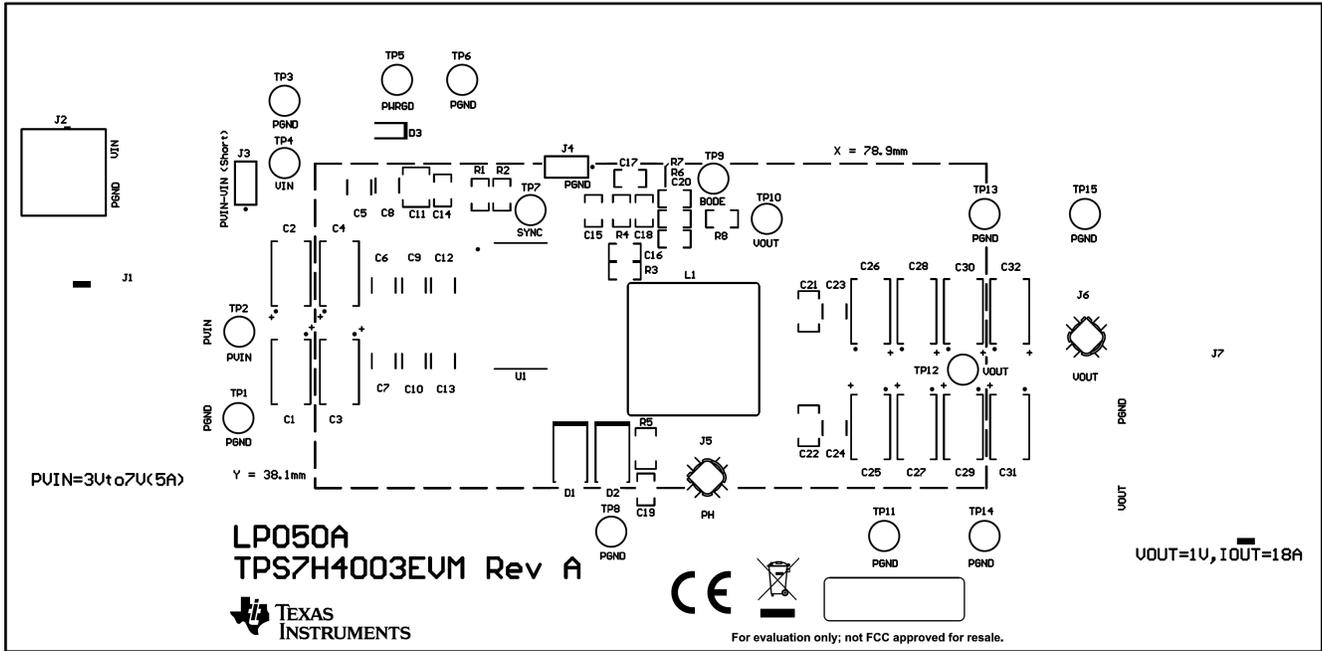


Figure 7-1. Top Overlay

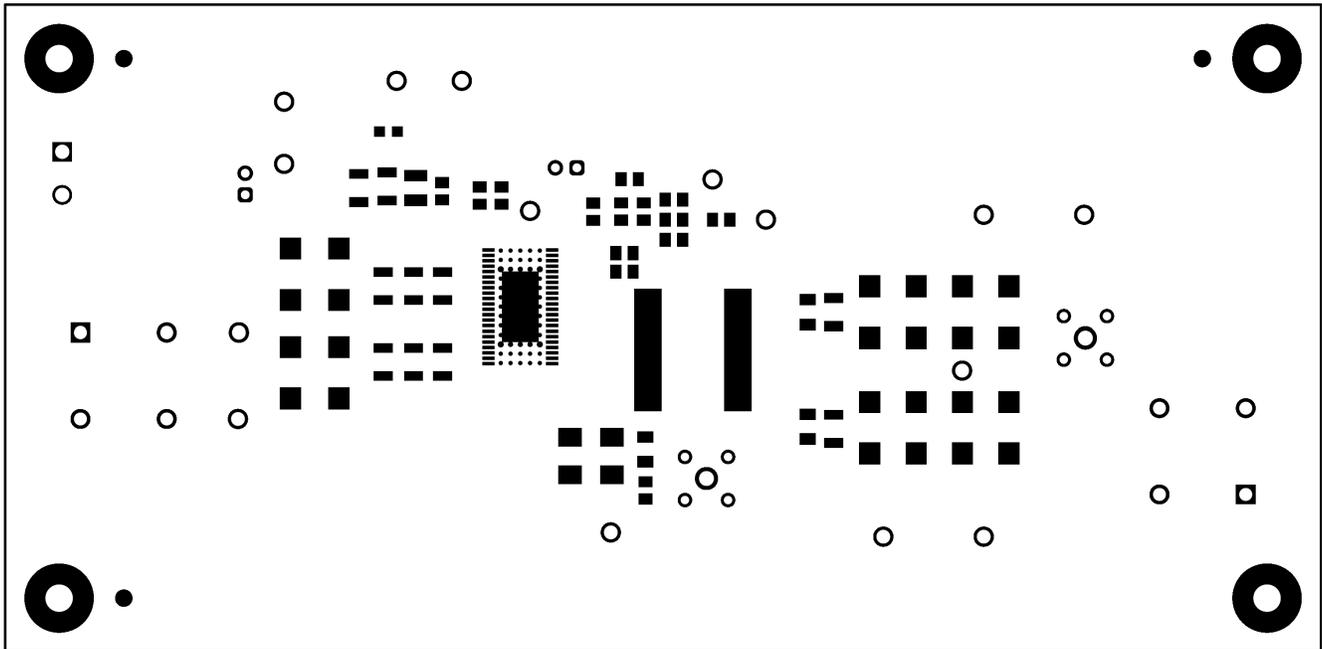


Figure 7-2. Top Solder

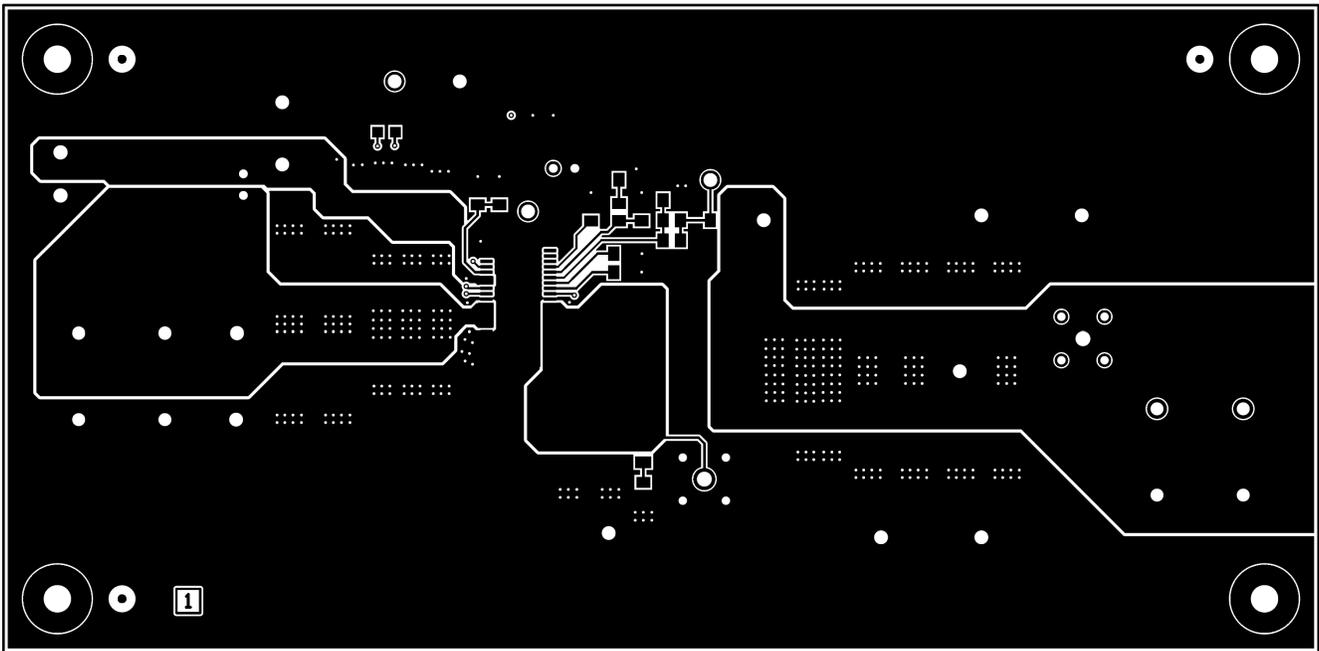


Figure 7-3. Top Layer

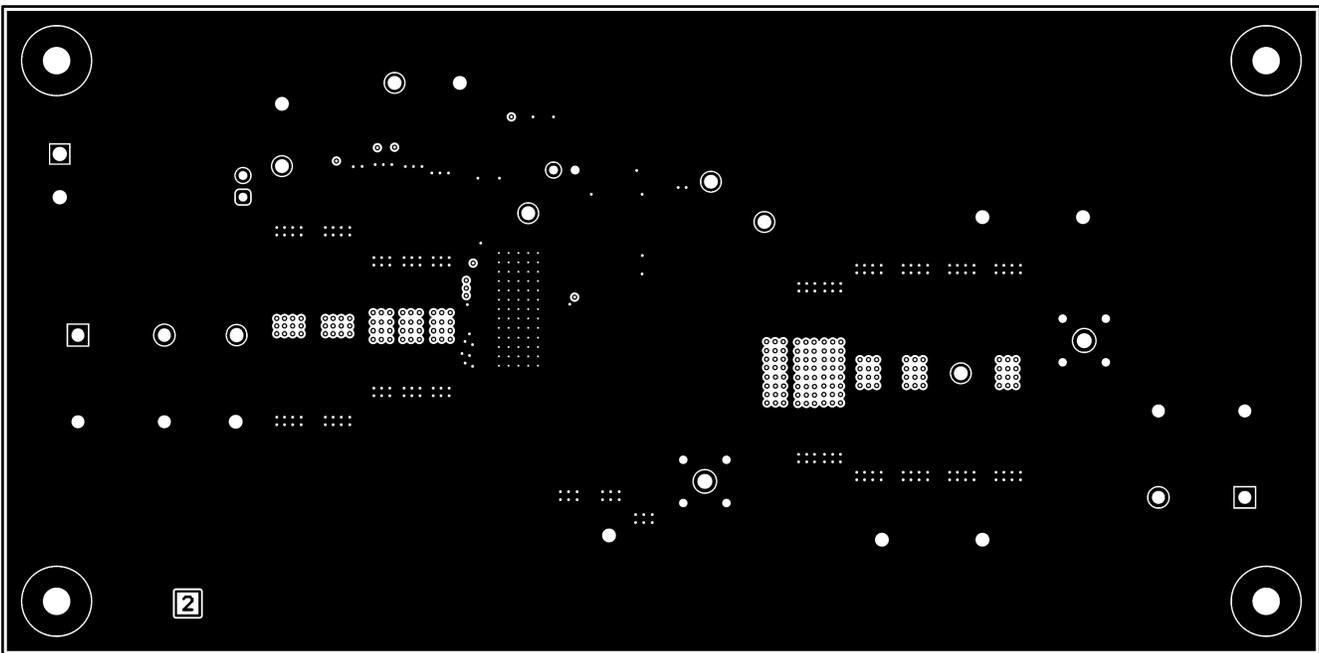


Figure 7-4. Signal Layer One

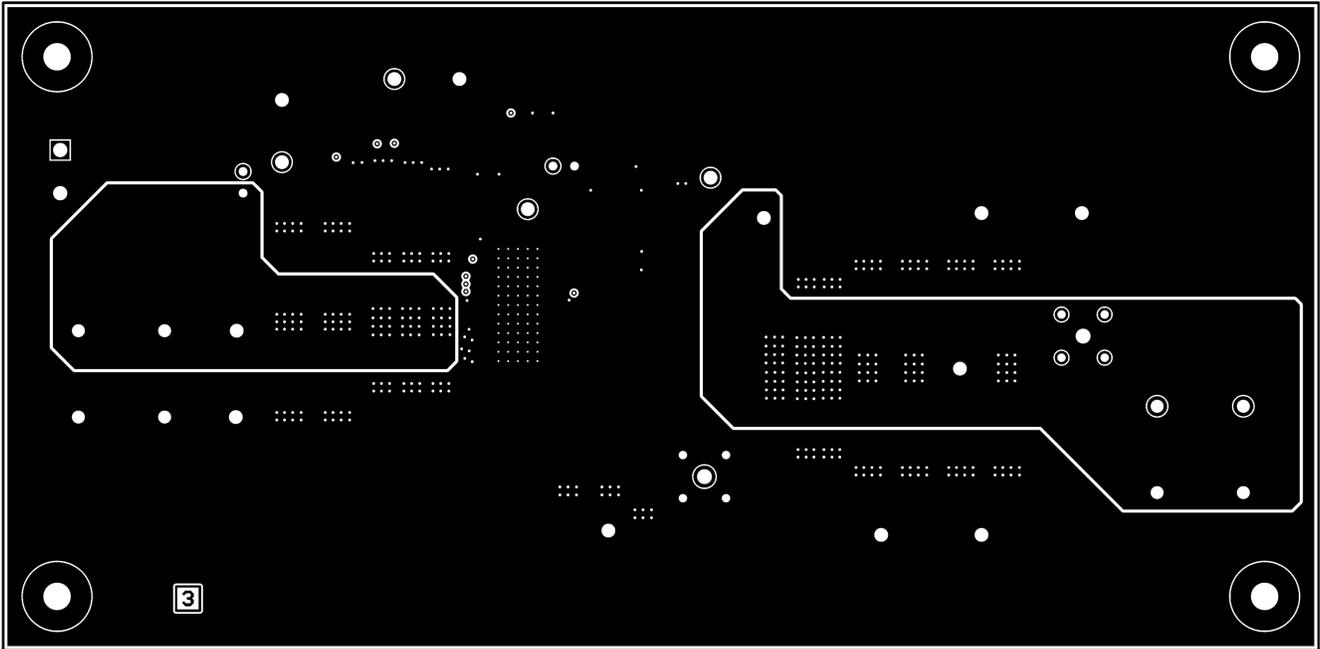


Figure 7-5. Signal Layer Two

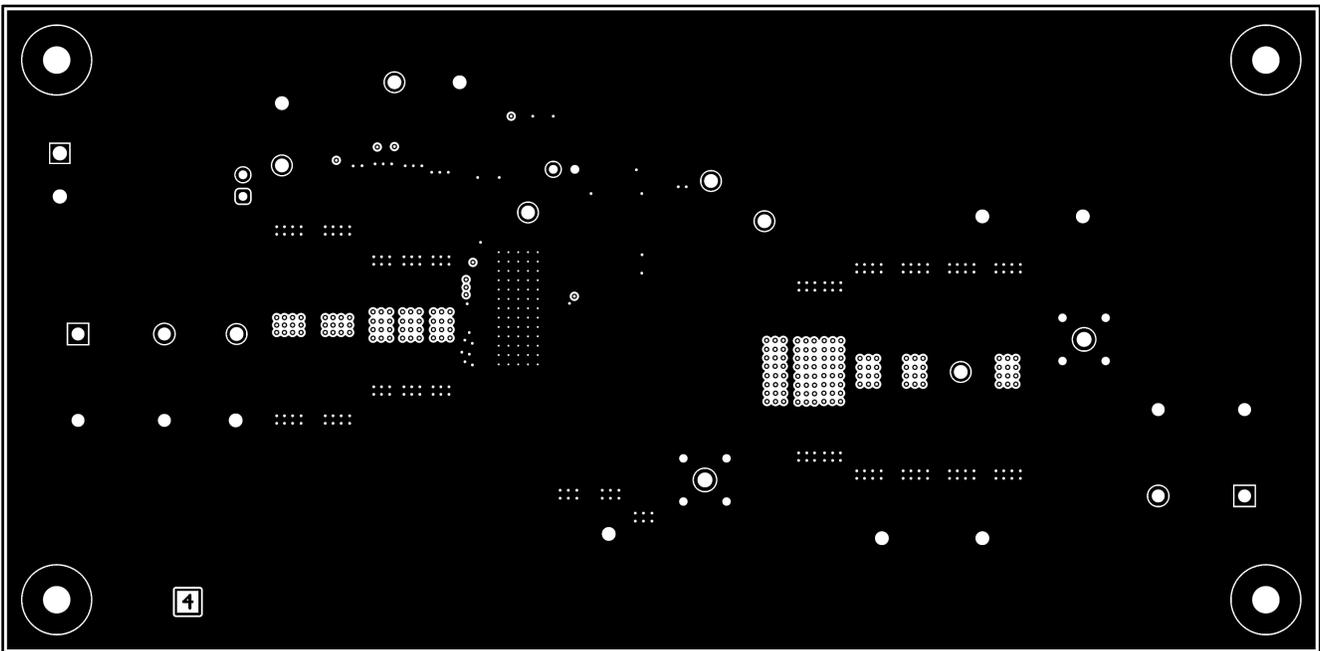


Figure 7-6. Signal Layer Three

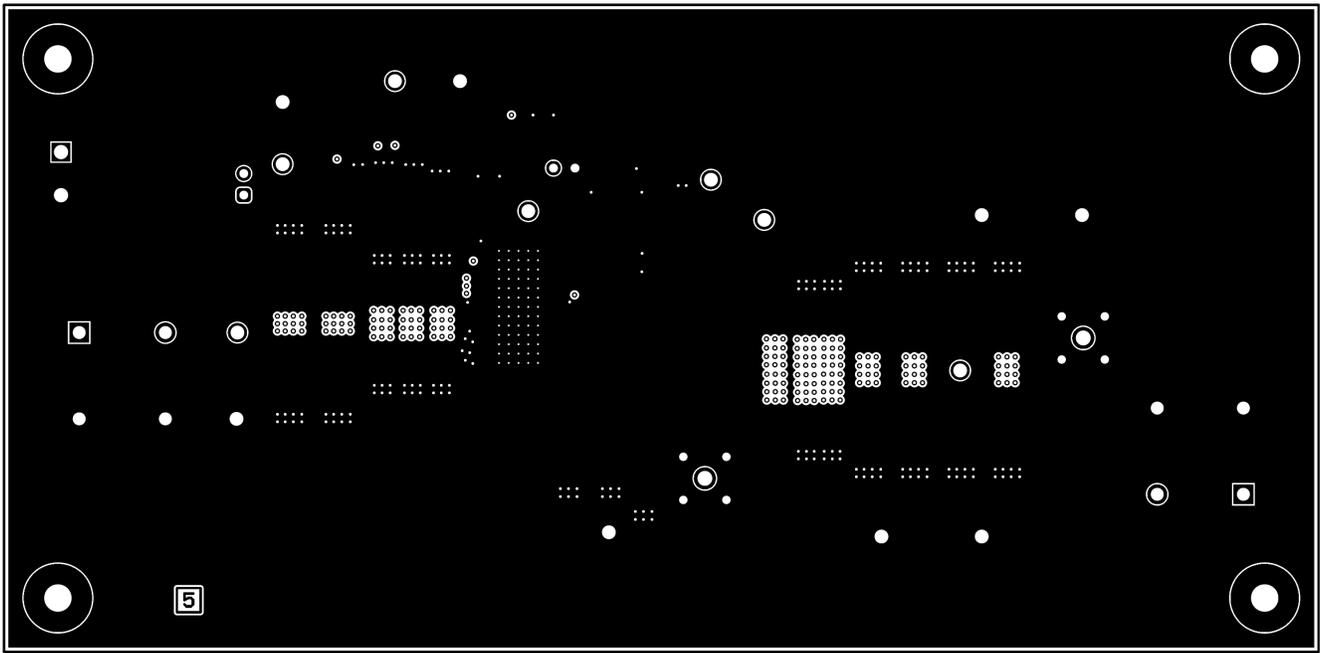


Figure 7-7. Signal Layer Four

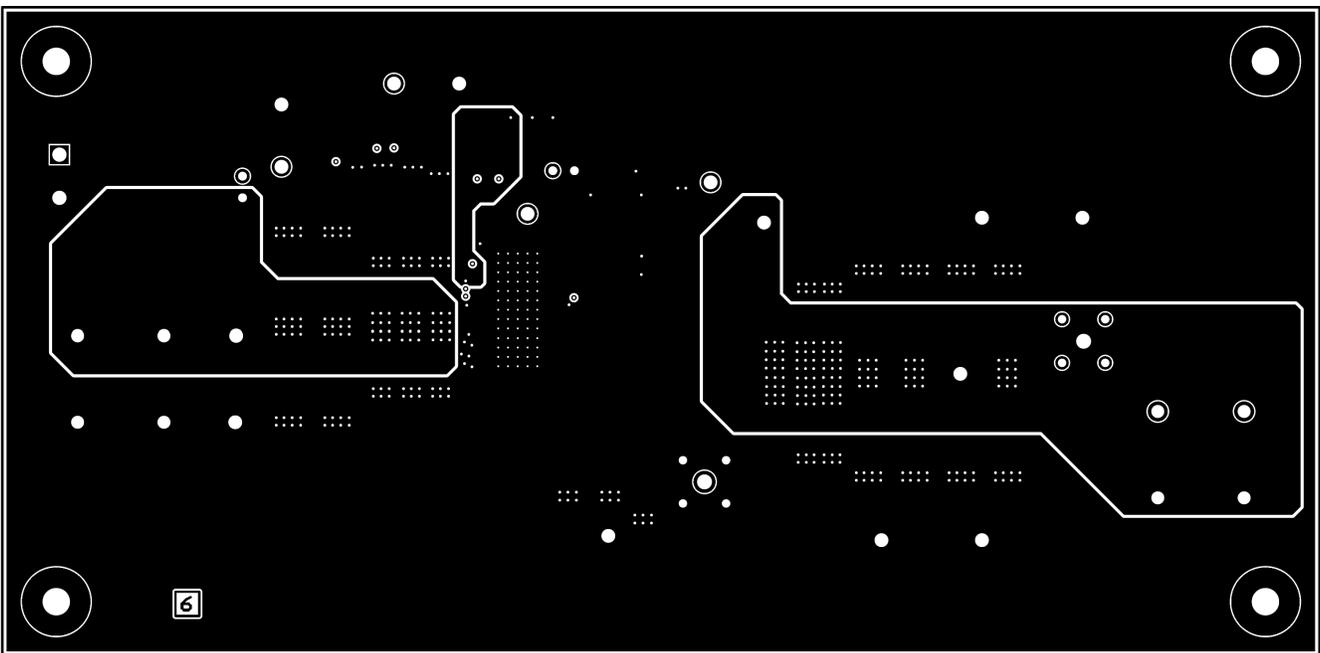


Figure 7-8. Signal Layer Five

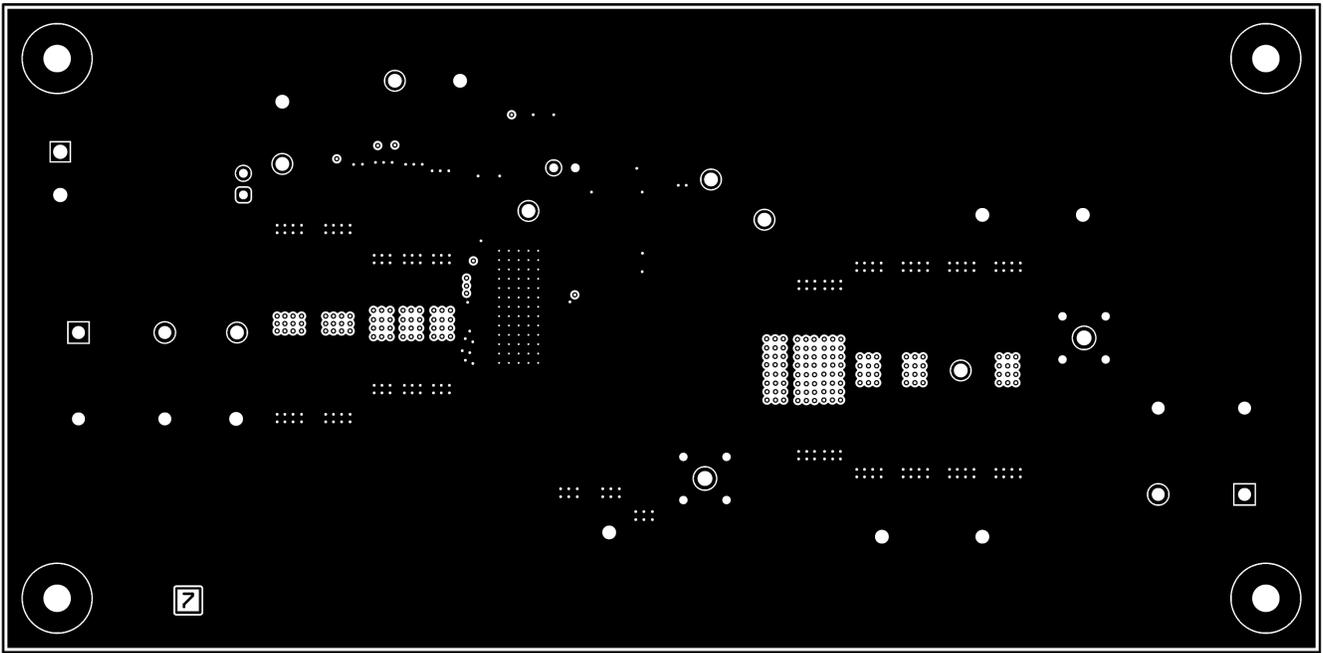


Figure 7-9. Signal Layer Six

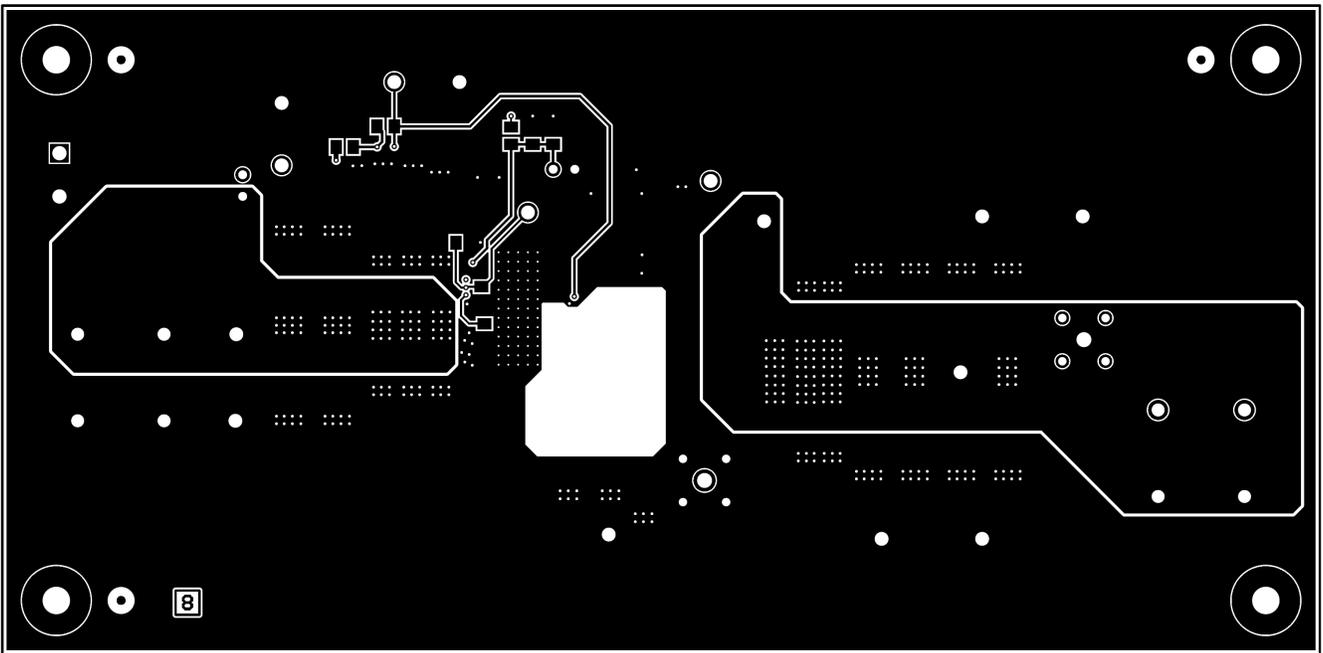
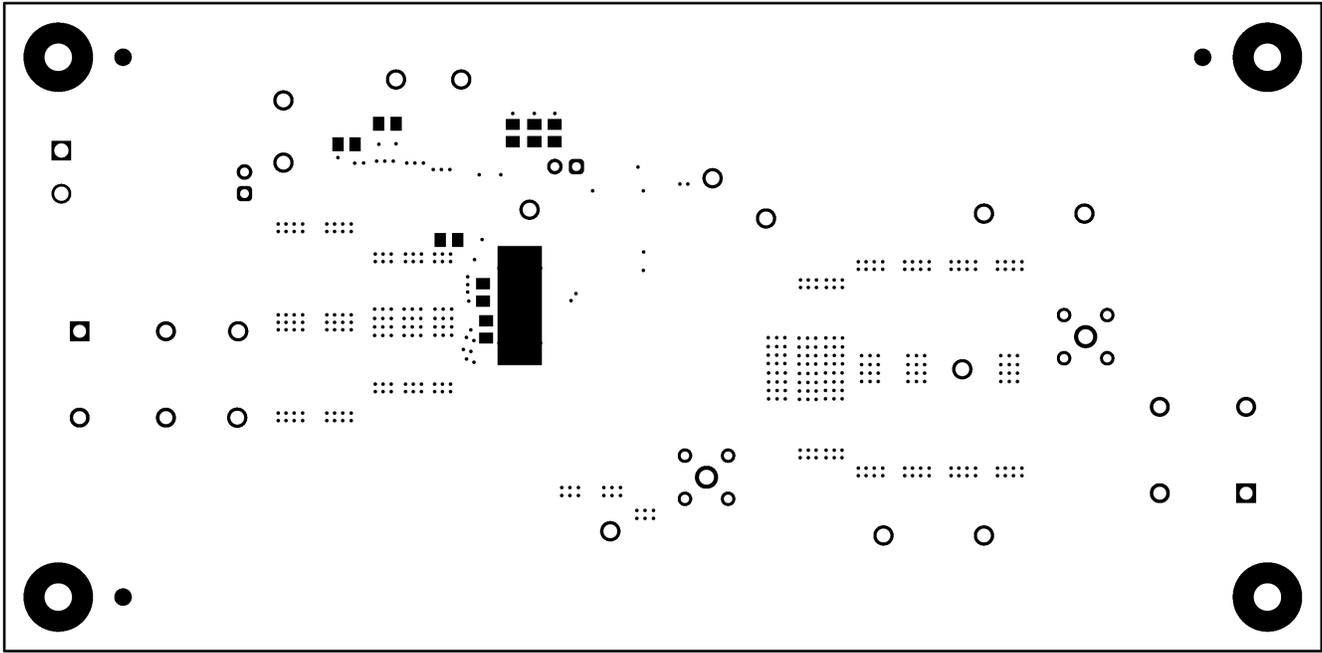
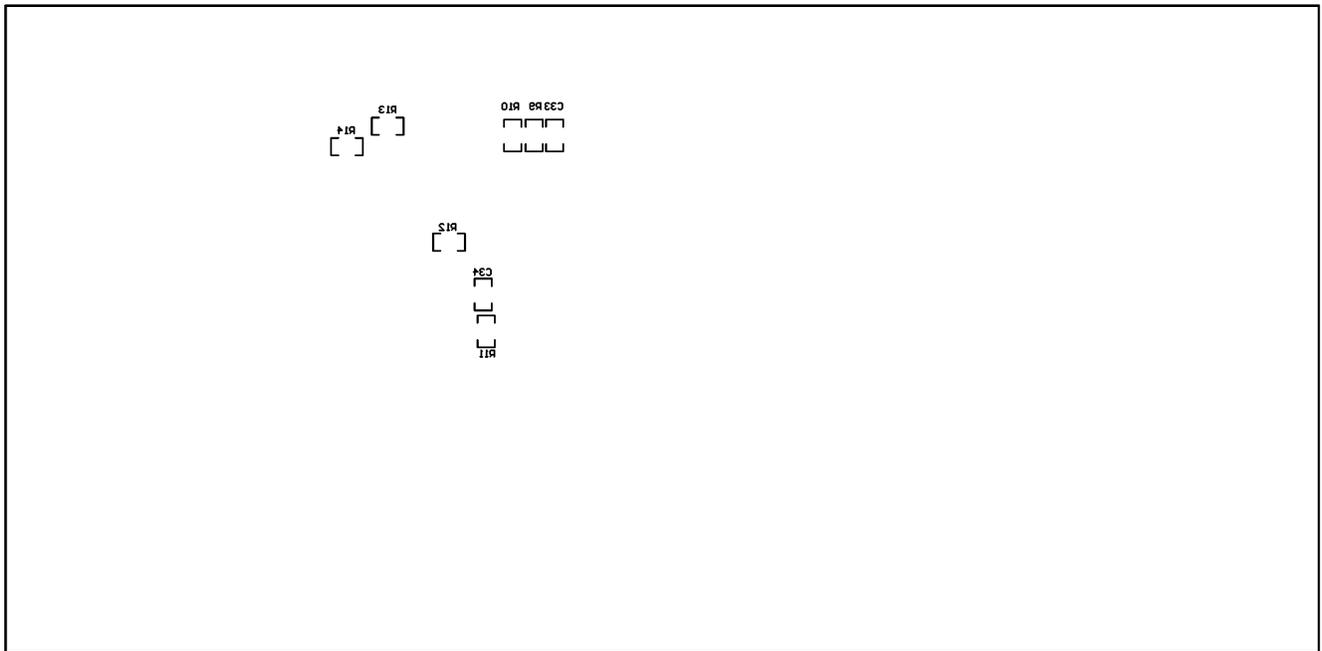


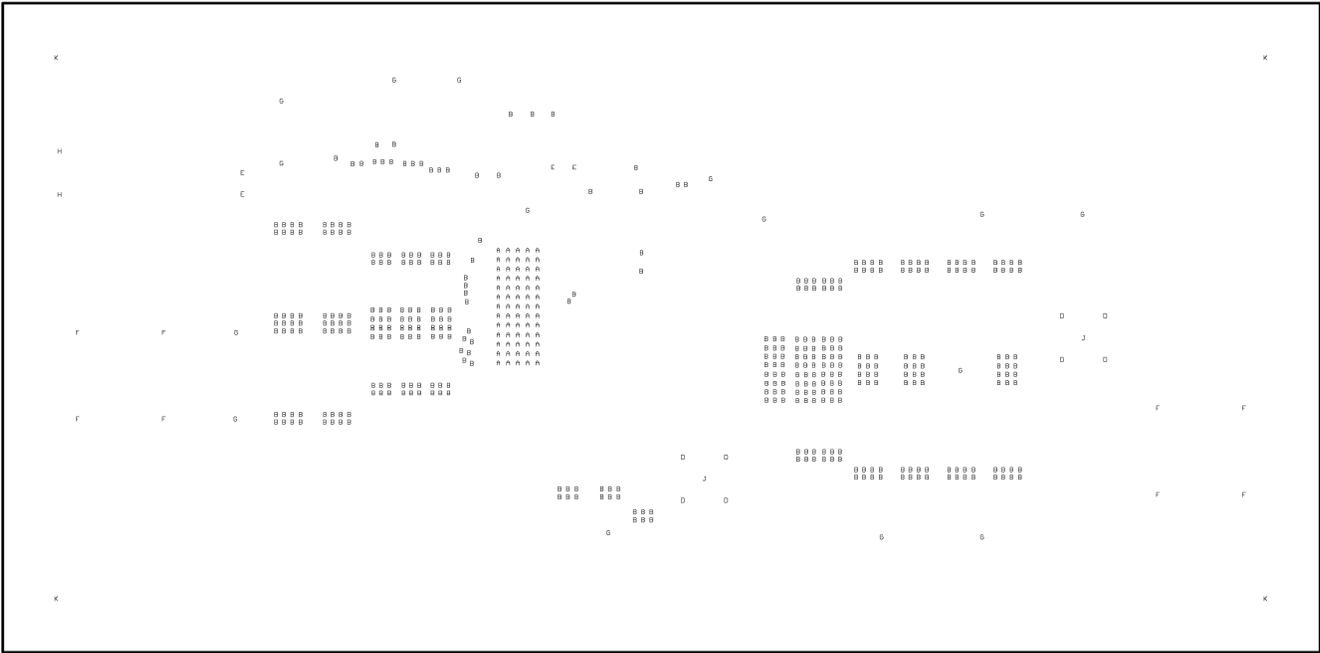
Figure 7-10. Bottom Layer



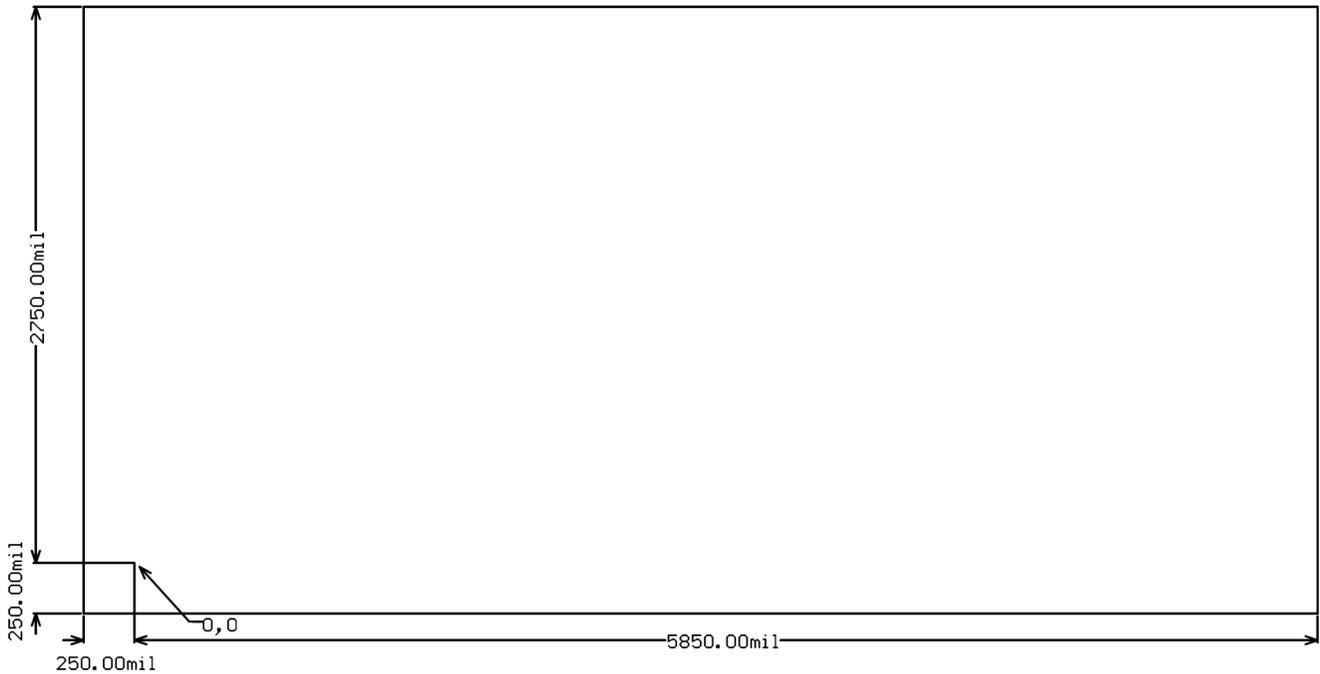
**Figure 7-11. Bottom Solder**



**Figure 7-12. Bottom Overlay**



**Figure 7-13. Drill Drawing**



**Figure 7-14. PCB Dimensions**

## 8 Support Resources

[TI E2E™ support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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## 9 Revision History

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

### Changes from Revision A (August 2023) to Revision B (February 2024) Page

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- Updated values in *Bill of Materials* table..... 12
- 

### Changes from Revision \* (January 2022) to Revision A (August 2023) Page

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- Deleted last sentence in *TPS7H4003EVM Overview* section..... 3
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## STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
  - 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 semiconductor 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 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 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 a nonconforming EVM if (a) the nonconformity was 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, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
  - 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。

<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html>

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.
  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. 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 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.

8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM 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.

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