EVM User's Guide: TPS7H4203EVM

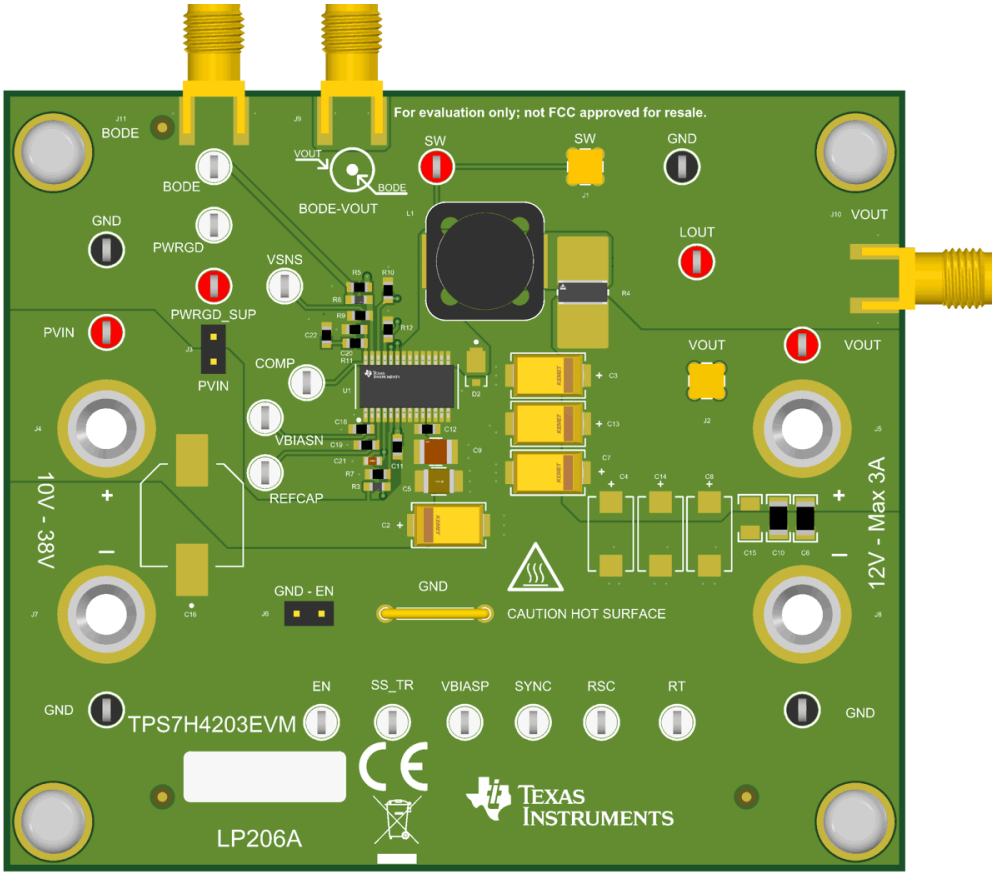
TPS7H4203-SEP Evaluation Module

Description

The TPS7H4203EVM demonstrates the operation of a single TPS7H4203-SEP synchronous buck converter. The board provides footprints that can be populated with additional components to allow for testing of customized configurations, as well as jumpers and test points for easy device configuration, and performance validation.

Features

- Input voltage range from 10V to 38V
- 3A maximum output current
- 1V ±1% voltage reference over line, temperature, and radiation
- SMA input for frequency response injection
- Supports inverting buck-boost topology



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1 Evaluation Module Overview

1.1 Introduction

The TPS7H4203EVM is the evaluation module (EVM) for the plastic package versions of the TPS7H4203-SEP and TPS7H4203-SP and provides a platform to electrically evaluate its features. This EVM user's guide provides details about the EVM, including the configuration, schematics, and bill of materials (BOM). The EVM is designed to provide flexibility in configuring the device under different conditions. Footprints for additional components and multiple connection options for monitoring device pins are provided. To configure the device in a custom configuration, please refer to the TPS7H4203-SEP and TPS7H4203-SP datasheet to calculate values of any passives that need to be changed.

1.2 Kit Contents

- One TPS7H4203EVM

1.3 Specification

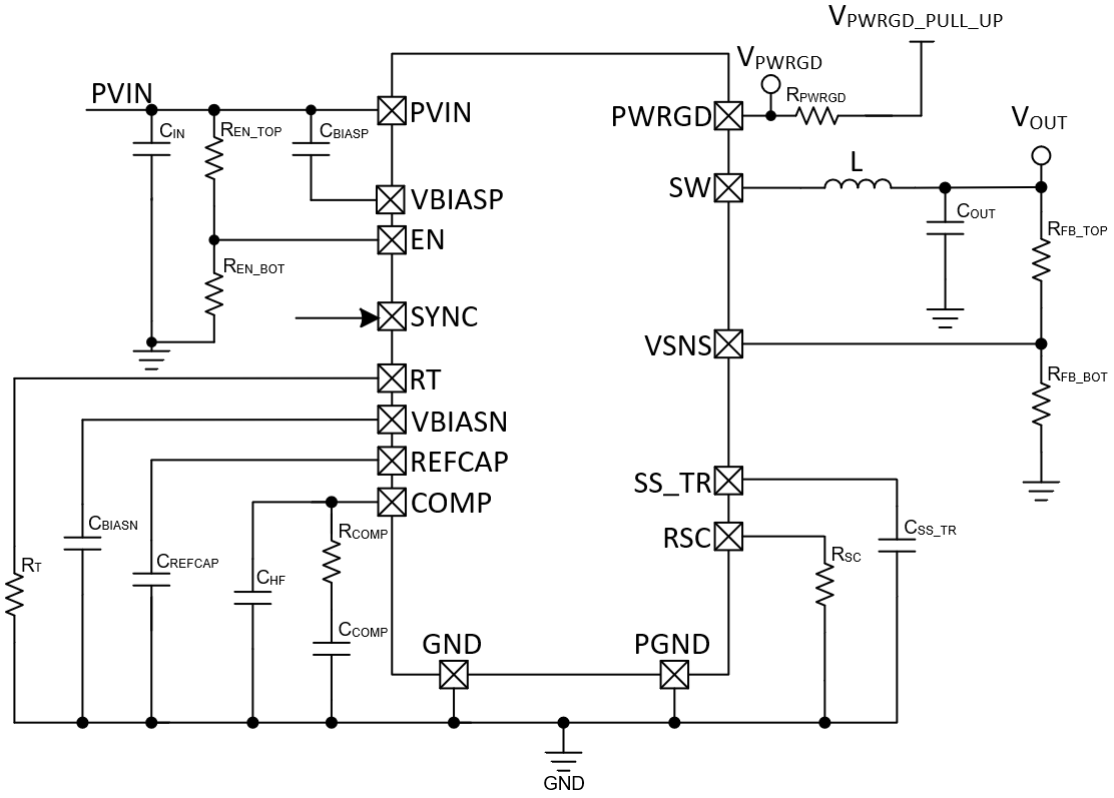


Figure 1-1. Simplified Schematic

Table 1-1. Default Configuration Options

Specification	Value	Description
Input voltage VIN	28V	Falls within the recommended device input voltage range of 10V to 38V and is greater than the configured output voltage
Output voltage VOUT	12V	Common power rail voltage within the device output capability. Configurable by changing R6 or R9
Switching frequency FSW	250kHz	Configurable by changing R10

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1.4 Device Information

The TPS7H4203-SEP is a 10V to 38V, 3A synchronous buck converter optimized for use in a space environment. The peak current mode converter offers high efficiency, excellent transient performance, and a lower component count.

The wide voltage range of the TPS7H4203-SEP allows the device to function as a point-of-load regulator, converting power directly from 28V or 12V rails. The SS_TR pin controls the output voltage start-up ramp, while the EN and PWRGD pins enable power sequencing capabilities.

Further information about the TPS7H4203-SEP can be found in the TPS7H4203-SEP and TPS7H4203-SP device datasheet.

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2 Hardware

2.1 Setup

2.1.1 Measuring Inductor Current

R4 is a wide-footprint 0Ω jumper located on the right side of the inductor (L1) that is provided to make measurements of the inductor current waveform easier. To take inductor current measurements, R4 can be removed to break the path from the inductor to the VOUT plane. Oversized solder mask cutouts on the R4 footprint provide convenient solder-points for a wire loop or other current measurement strategy. Utilizing R4 and its oversized pads removes the need to desolder the inductor to take current measurements directly from its pads.

The "LOUT" test point provides a voltage measurement point directly under the inductor pad (before R4) that can be used for efficiency measurements.

2.1.2 PWRGD Supply

The TPS7H4203-SEP PWRGD pin is open-drain and therefore requires a pullup to a voltage ≤5.5V. When jumper J3 is populated, on-board regulation provides a pullup voltage of 1V to 3.5V (depending on the input voltage used) to the PWRGD pin of the device. To bypass the on-board regulation and use an external power supply for the PWRGD pullup, jumper J3 and 0Ω-resistor R2 can be removed. This disables the on-board regulation and supply from VIN, allowing an external supply to be provided from the test point "PWRGD_SUP". Make sure the voltage provided to PWRGD_SUP is compliant with the recommended operating voltage range of the PWRGD pin as found in the device datasheet. Do not insert jumper J3 when R2 is depopulated.

2.1.3 Inverting Buck-Boost Configuration

The TPS7H4203EVM is capable of configuration in an inverting buck-boost topology configuration without any hardware modification. To configure the EVM as an inverting buck-boost, the positive (+) output from the power supply must be connected to J4, and the GND (-) output from the power supply must be connected to J5. When configured as an inverting buck-boost, all points on the EVM labeled "GND" including test points and power connectors (J7 and J6) become the negative-voltage output of the converter.

Be aware of the voltage-stress limitations inherent to the inverting buck-boost topology before attempting to configure the EVM as such. With the default 12V output voltage of the EVM, a maximum input voltage of 26V can be used. Additionally, higher current stresses in the inverting buck-boost topology limits the maximum output current of the device below what is possible in the standard configuration.

2.2 Best Practices

The following information is provided to convey best practices while operating this device.

	**WARNING**
	Hot surface! Contact can cause burns. Do not touch!
	Some components can reach high temperatures >55℃ when the board is powered on. Do not touch the board at any point during operation or immediately after operating, as high temperatures can be present.

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3 Implementation Results

3.1 Evaluation Setup

The following tests were performed using the TPS7H4203EVM in the default configuration with detailed settings shown in Table 3-1 unless otherwise noted.

Table 3-1. Test Settings

Specification	Value
VIN	28V
VOUT	12V
FSW	250kHz
IOUT	3A

3.2 Performance Data and Results

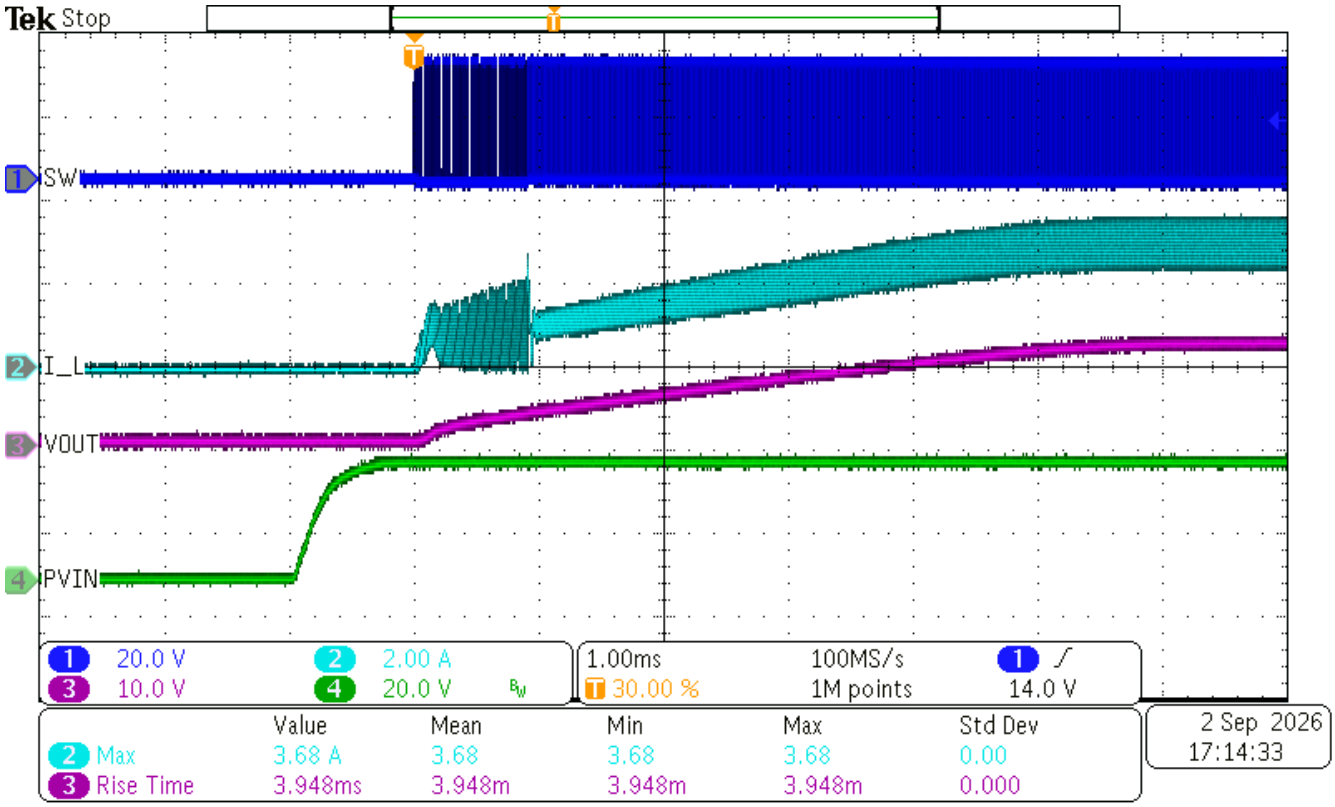


Figure 3-1. Start-up Into 4Ω Load

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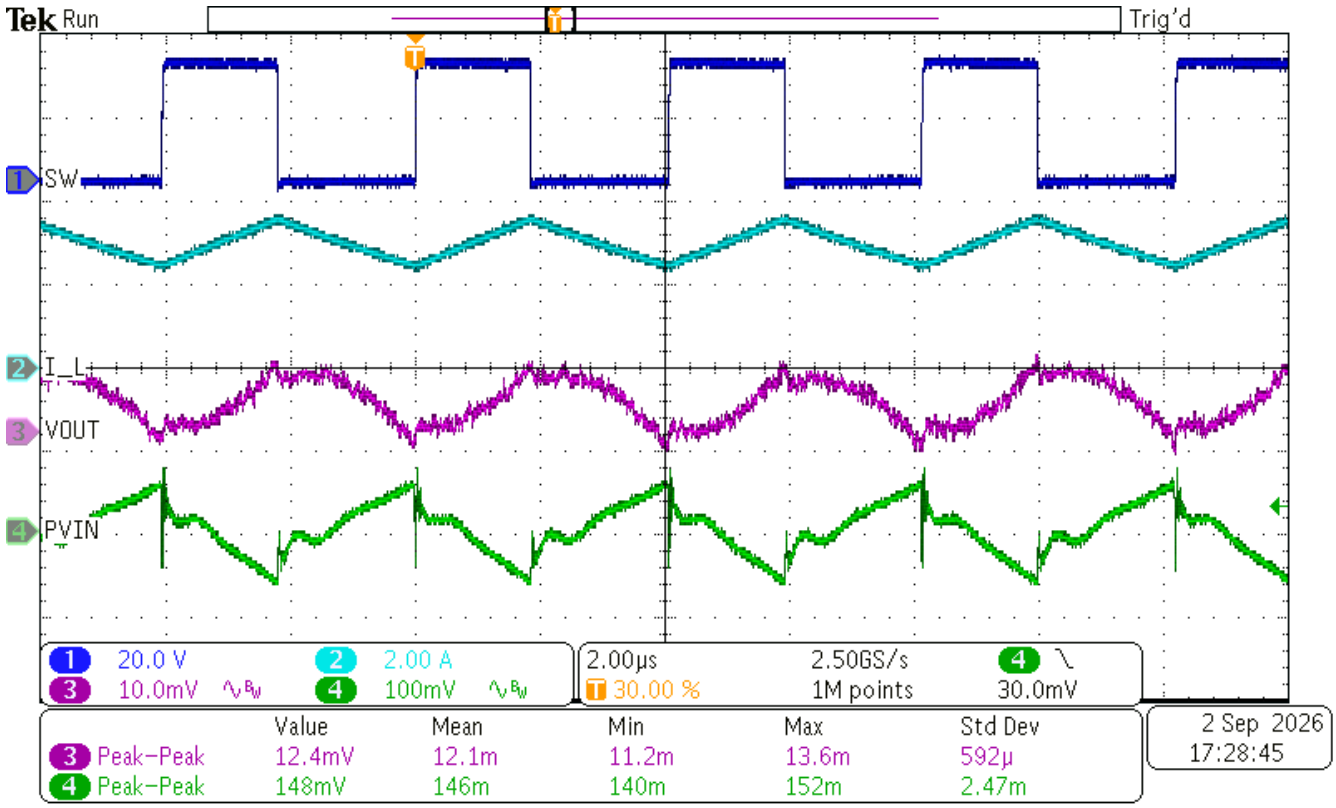


Figure 3-2. Switching and Voltage Ripple

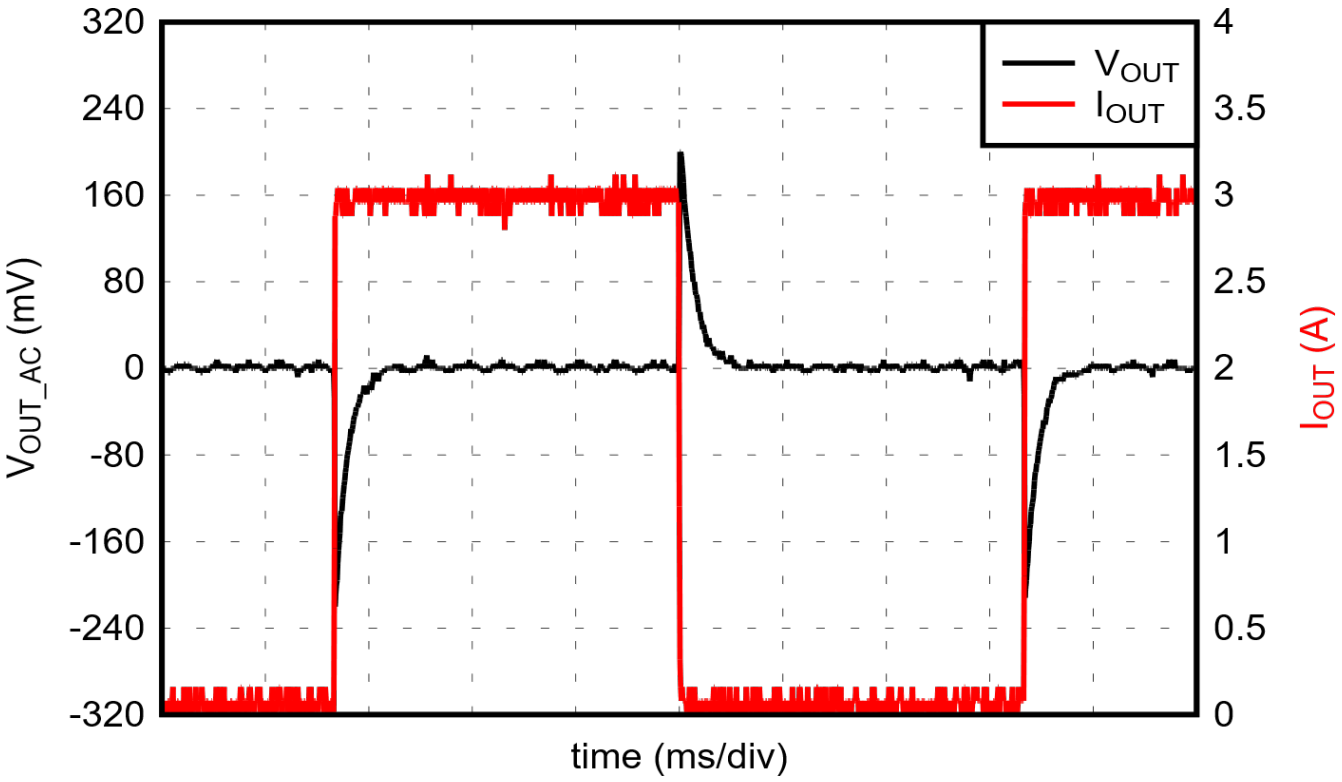


Figure 3-3. Load Step 100mA to 3A

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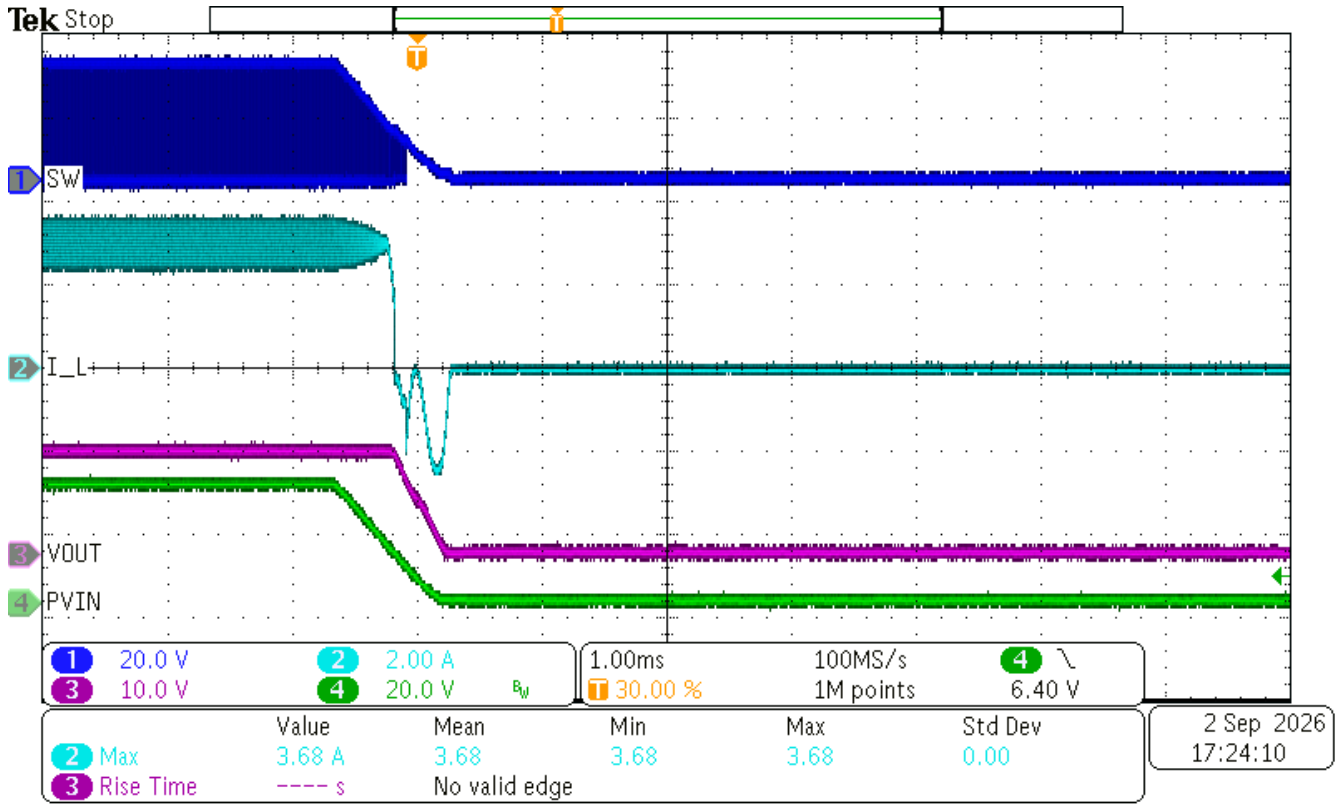


Figure 3-4. Shutdown With 4Ω Load

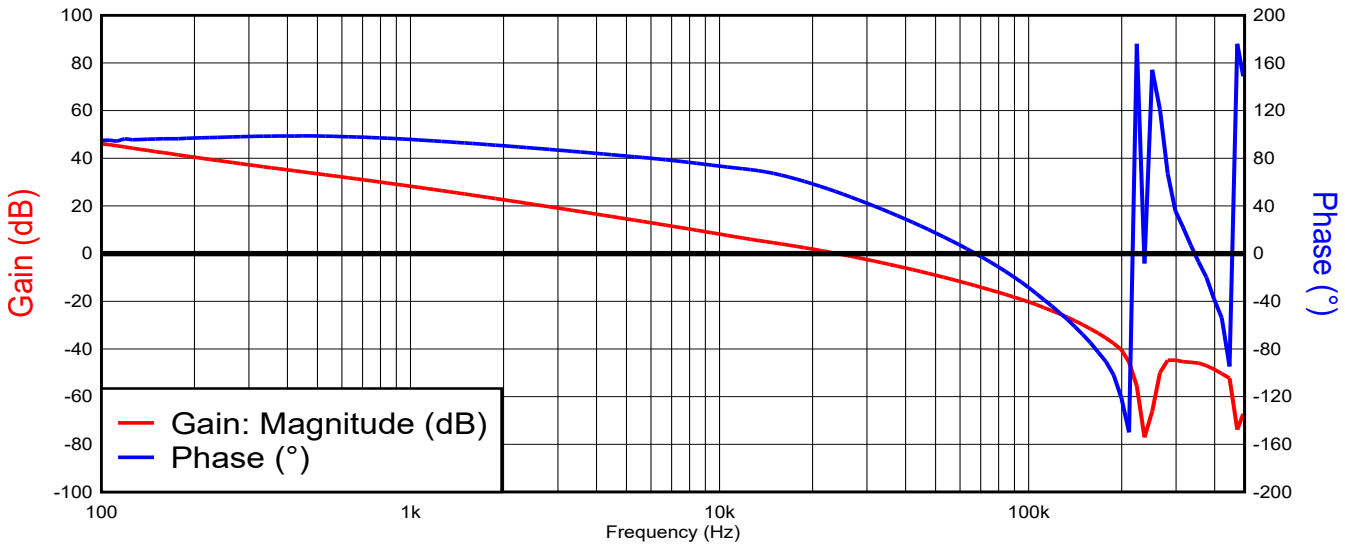


Figure 3-5. AC Response With 3A Load

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4 Hardware Design Files

4.1 Schematics

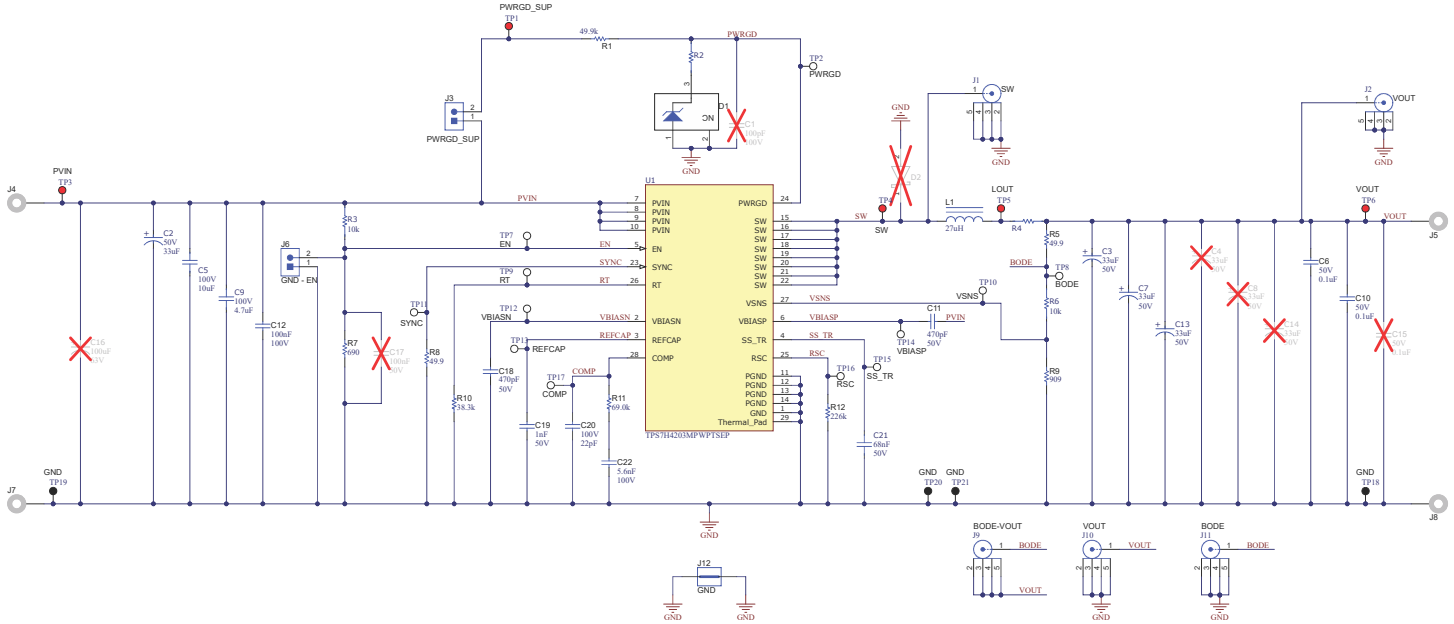


Figure 4-1. TPS7H4203EVM Schematic

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4.2 PCB Layouts

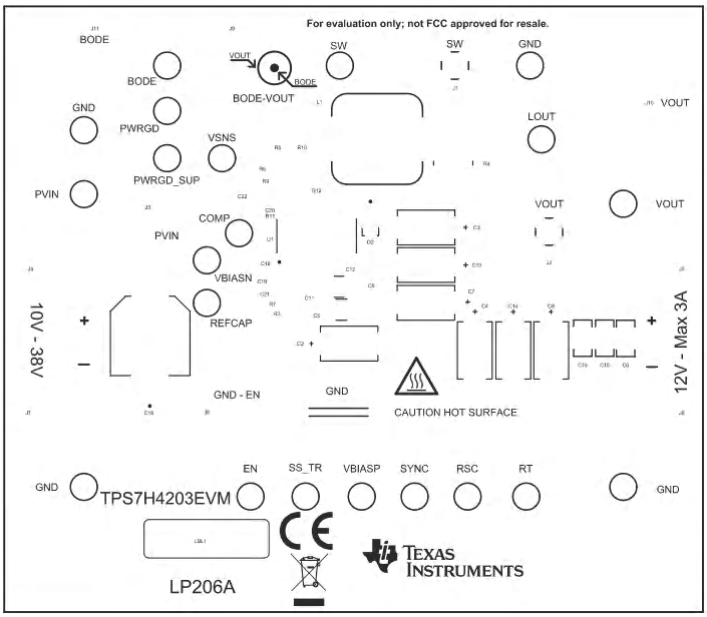


Figure 4-2. Top Overlay

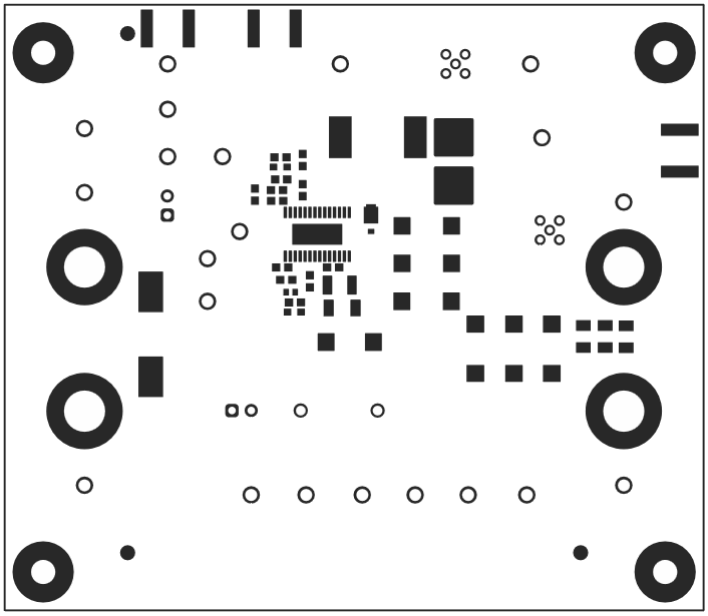


Figure 4-3. Top Solder Mask

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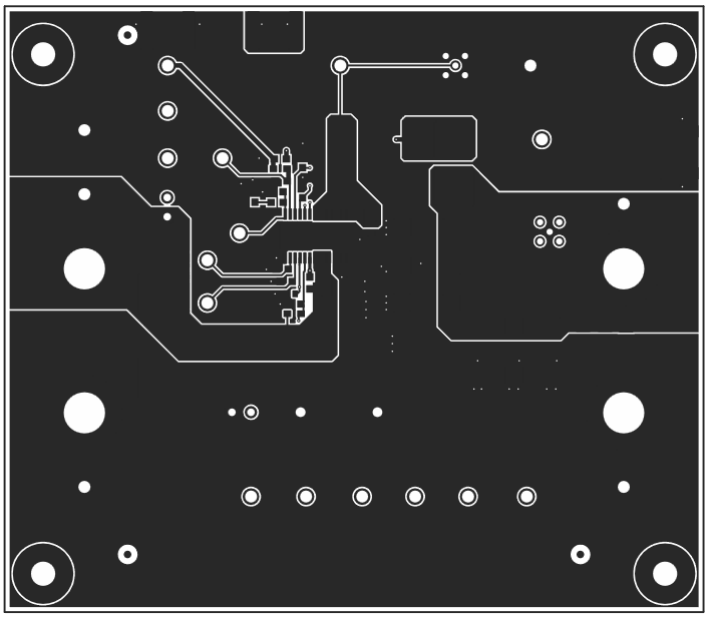


Figure 4-4. Layer 1 (Top)

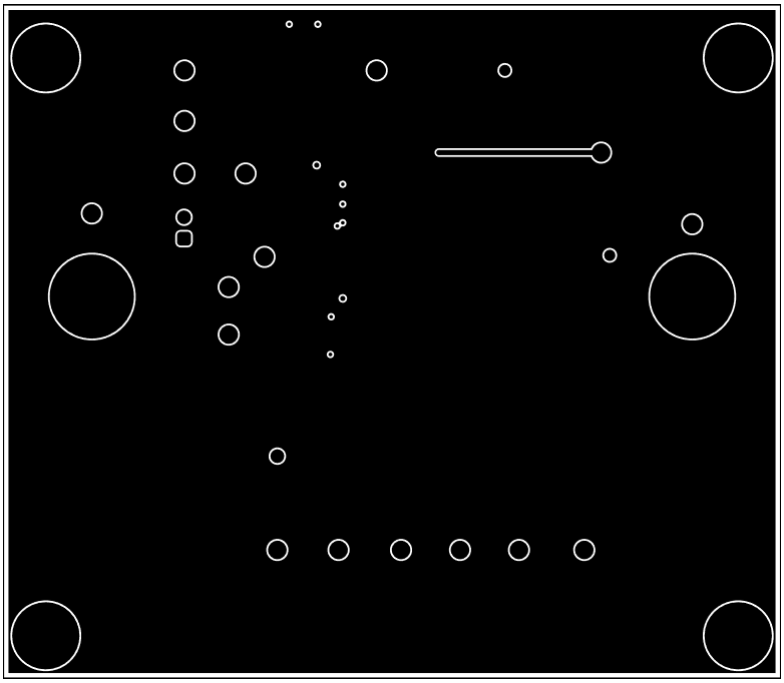


Figure 4-5. Layer 2

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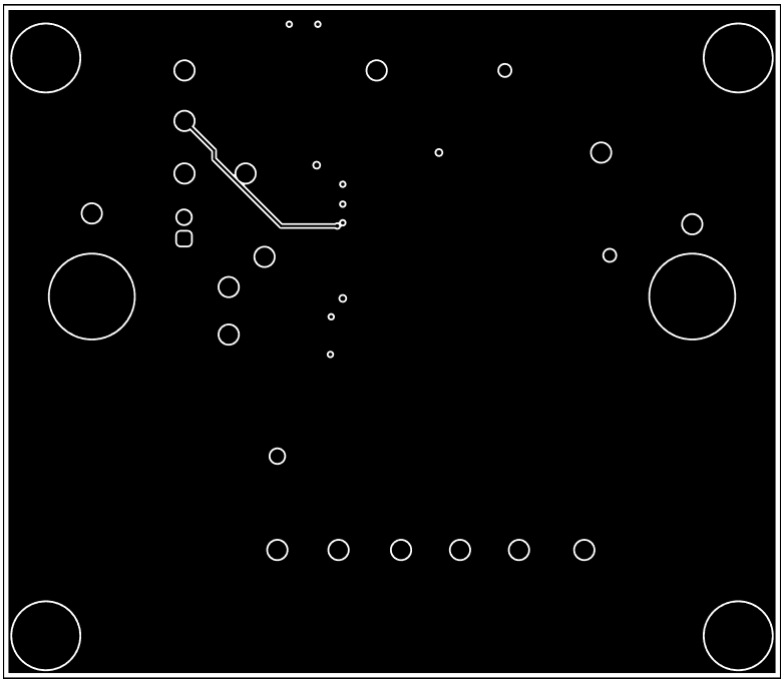


Figure 4-6. Layer 3

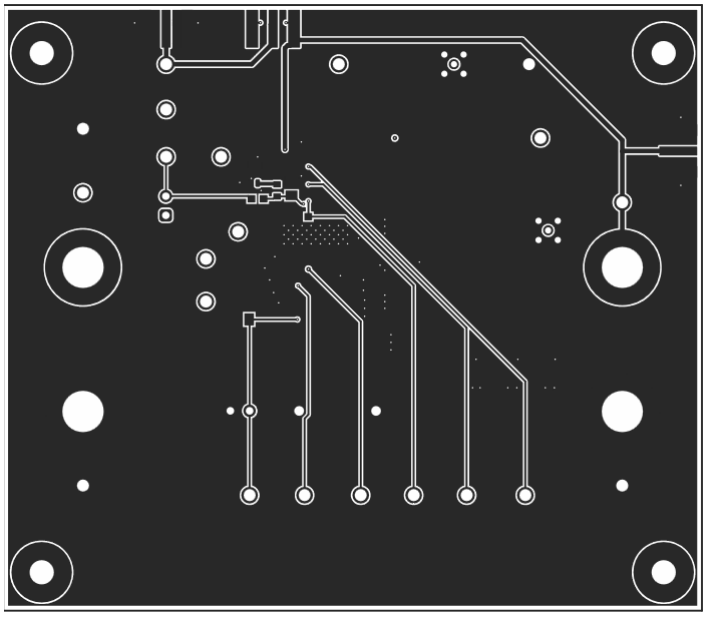


Figure 4-7. Layer 4 (Bottom)

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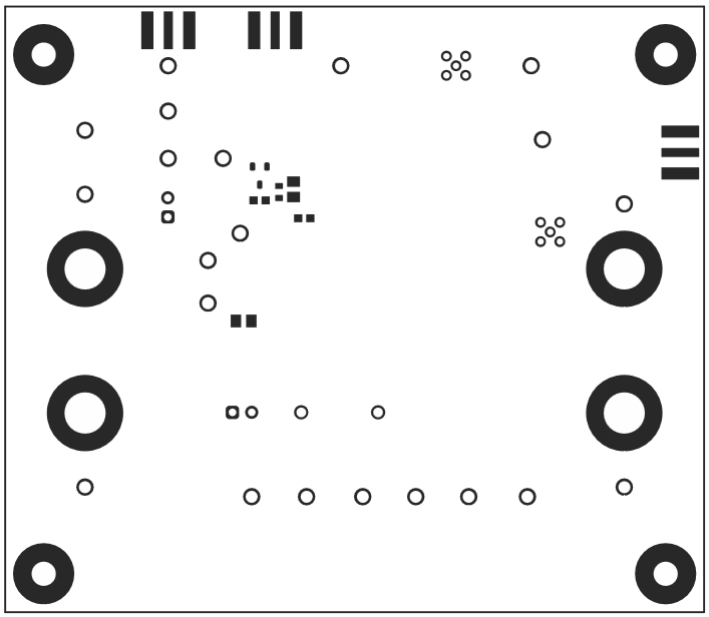


Figure 4-8. Bottom Solder Mask

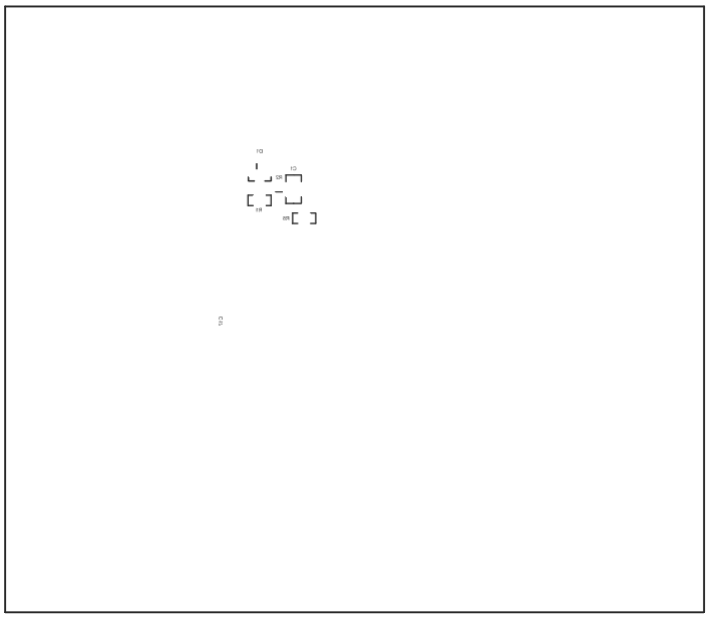
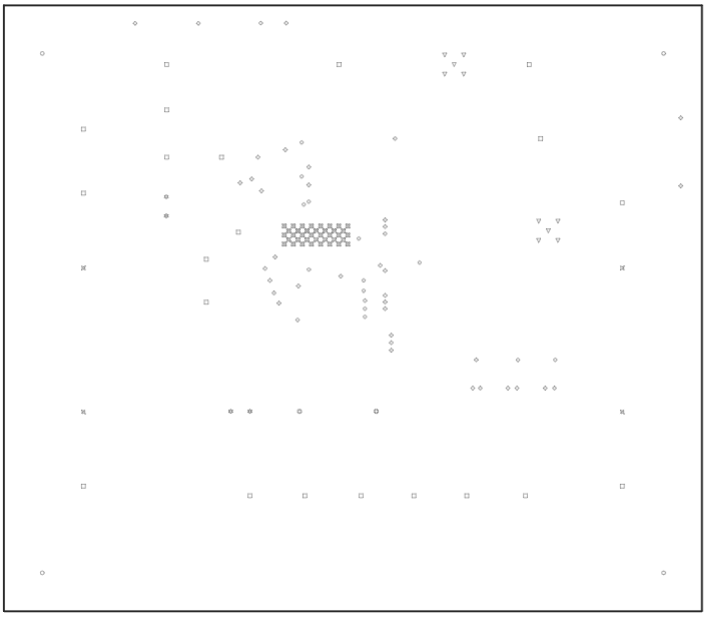


Figure 4-9. Bottom Overlay

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Symbol	Quantity	Finished Hole Size	Plated	Hole Type	Drill Layer Pair	Hole Tolerance
⊠	38	7.87mil (0.200mm)	PTH	Round	Top Layer - Bottom Layer	
◇	54	8.00mil (0.203mm)	PTH	Round	Top Layer - Bottom Layer	
▽	10	33.07mil (0.840mm)	PTH	Round	Top Layer - Bottom Layer	
✡	4	40.00mil (1.016mm)	PTH	Round	Top Layer - Bottom Layer	
⯃	2	51.18mil (1.300mm)	PTH	Round	Top Layer - Bottom Layer	
□	21	63.00mil (1.600mm)	PTH	Round	Top Layer - Bottom Layer	
○	4	125.98mil (3.200mm)	PTH	Round	Top Layer - Bottom Layer	
⌑	4	214.57mil (5.450mm)	PTH	Round	Top Layer - Bottom Layer	
	137 Total					

Figure 4-10. Drill Drawing

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4.3 Bill of Materials (BOM)

Table 4-1. TPS7H4203 Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C2, C3, C7, C13	4	33µF	Cap Tant Solid 33uF 50V X CASE 20% (7.3 X 4.3 X 4mm) SMD 7343-43 0.04 Ohm 105°C T/R	2917	T543X336M050ATE040	KEMET
C5	1	10µF	10 µF ±10% 100V Ceramic Capacitor X7R 1210 (3225 Metric)	1210	CGA6P1X7R2A106K250AC	TDK
C6, C10	2	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 5%, X7R, 1206	1206	C1206C104J5RACTU	Kemet
C9	1	4.7µF	4.7 µF ±10% 100V Ceramic Capacitor X7R 1210 (3225 Metric)	1210	12101C475K4T2A	KYOCERA AVX
C11, C18	2	470pF	CAP, CERM, 470 pF, 50 V, +/- 10%, X7R, 0603	0603	C0603C471K5RACTU	Kemet
C12	1	0.1uF	CAP, CERM, 0.1 µF, VAC/100 VDC,+/- 20%, X7R, AEC-Q200 Grade 1, 0603	0603	HMK107B7104MAHT	Taiyo Yuden
C19	1	1000pF	CAP, CERM, 1000 pF, 50 V, +/- 5%, X7R, AEC-Q200 Grade 1, 0603	0603	C0603C102J5RACAUTO	Kemet
C20	1	22pF	CAP, CERM, 22 pF, 100 V, +/- 5%, C0G/NP0, 0603	0603	GRM1885C2A220JA01D	MuRata
C21	1	68nF	Cap Ceramic 0.068uF 50V X7R 10% SMD 0603 125°C Paper T/R	0603	C0603C683K5RAC7867	KEMET
C22	1	5600pF	CAP, CERM, 5600 pF, 100 V, +/- 5%, X7R, 0603	0603	06031C562JAT2A	AVX
D1	1	3.3V	Diode, Zener, 3.3 V, 225 mW, SOT-23	SOT-23	MMBZ5226BLT1G	ON Semiconductor
FID1, FID2, FID3	3		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
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

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Table 4-1. TPS7H4203 Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1, J2	2		MMCX JACK, 50 Ohm, Gold, TH	MMCX JACK, Gold, TH	0734151471	Molex
J3, J6	2		Header, 100mil, 2x1, Gold, TH	2x1 Header	TSW-102-07-G-S	Samtec
J4, J5, J7, J8	4		Standard Banana Jack, Uninsulated, 5.5mm	Keystone_575-4	575-4	Keystone
J9, J10, J11	3		CONN SMA JACK STR EDGE MNT	CONN_JACK	CON-SMA-EDGE-S	RF Solutions Ltd.
J12	1		1mm Uninsulated Shorting Plug, 10.16mm spacing, TH	Shorting Plug, 10.16mm spacing, TH	D3082-05	Harwin
L1	1	27uH	Inductor, Shielded Drum Core, Metal Composite, 27 uH, 4.6 A, 0.03 ohm, SMD	SMD	7447709270	Wurth Elektronik
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	49.9k	RES, 49.9 k, 1%, 0.1 W, 0603	0603	RC0603FR-0749K9L	Yageo
R2	1	0	0 Ohms ±1% 0.1W, 1/10W Chip Resistor 0603 (1608 Metric) Anti-Sulfur Thick Film	0603	D1TFAS0603WJUMPF-T5	Thin Film Technology
R3, R6	2	10k	10 kOhms ±0.1% 0.1W, 1/10W Chip Resistor 0603 (1608 Metric) Current Sense Thin Film	0603	CRT0603-BY-1002ELF	Bourns Inc.
R4	1	0	0 Ohms Jumper Chip Resistor Wide 2010 (5025 Metric), 1020 Automotive AEC-Q200 Thick Film	1020	RCL10200000Z0EF	Vishay
R5, R8	2	49.9	RES, 49.9, 1%, 0.1 W, 0603	0603	RC0603FR-0749R9L	Yageo
R7	1	690	RES, 690, 0.1%, 0.1 W, 0603	0603	RT0603BRD07690RL	Yageo America

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Table 4-1. TPS7H4203 Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
R9	1	909	RES, 909, 0.1%, 0.1 W, 0603	0603	RT0603BRD07909RL	Yageo America
R10	1	38.3k	RES, 38.3 k, 0.1%, 0.1 W, 0603	0603	RT0603BRD0738K3L	Yageo America
R11	1	69.0k	RES, 69.0 k, 0.1%, 0.1 W, 0603	0603	RT0603BRD0769KL	Yageo America
R12	1	226k	RES, 226 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603226KFKEA	Vishay-Dale
TP1, TP3, TP4, TP5, TP6	5		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone
TP2, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17	12		Test Point, Multipurpose, White, TH	White Multipurpose Testpoint	5012	Keystone Electronics
TP18, TP19, TP20, TP21	4		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone
U1	1		10V to 38V Input 3A Radiation Hardened Synchronous Buck Converter	HTSSOP28	TPS7H4203MPWPTSEP	Texas Instruments

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5 Compliance Information

5.1 Compliance and Certifications

Texas Instruments, TPS7H4203EVM EU Declaration of Conformity (DoC)

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6 Additional Information

Trademarks

All trademarks are the property of their respective owners.

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7 References

- Texas Instruments, TPS7H4203-SP and TPS7H4203-SEP 10V to 38V Input 3A Radiation Hardened Synchronous Buck Converter, datasheet

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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 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 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 DEGREDATION 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/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。

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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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。
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/lsds/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.

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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