

Using the TPSM84824, TPSM84624, and TPSM84424EVM

The TPSM84824, TPSM84624, and TPSM84424 evaluation module (EVM) is designed as an easy-to-use platform that facilitates an extensive evaluation of the features and performance of the TPSM84x24 power module. This guide provides information on the correct usage of the EVM and an explanation of the numerous test points on the board.

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1 Description

This EVM features the TPSM84824/624/424 synchronous buck power module configured for operation with a 4.5-V to 17-V input voltage range. The output voltage can be set to one of six popular values by using a configuration jumper. Similarly, the switching frequency can be set to one of six values with a jumper. Additionally, the RTT resistor value, which selects the TurboTrans feature for improved transient response, is also selectable using a jumper. The full output current rating of the device can be supplied by the EVM. Input and output capacitors are included on the board to accommodate the entire range of input and output voltages. Monitoring test points are provided to allow measurement of efficiency, power dissipation, input ripple, output ripple, line and load regulation, and transient response. Control test points and component footprints are provided for use of the ENABLE, PGOOD, and CLK features of the device. The EVM uses a recommended PCB layout that maximizes thermal performance and minimizes output ripple and noise.

2 Getting Started

Figure 1 highlights the user interface items associated with the EVM. The *VIN Power* terminal block (J1) is used for connection to the host input supply and the *VOUT Power* terminal block (J2) is used for connection to the load. These terminal blocks can accept up to 16-AWG wire.

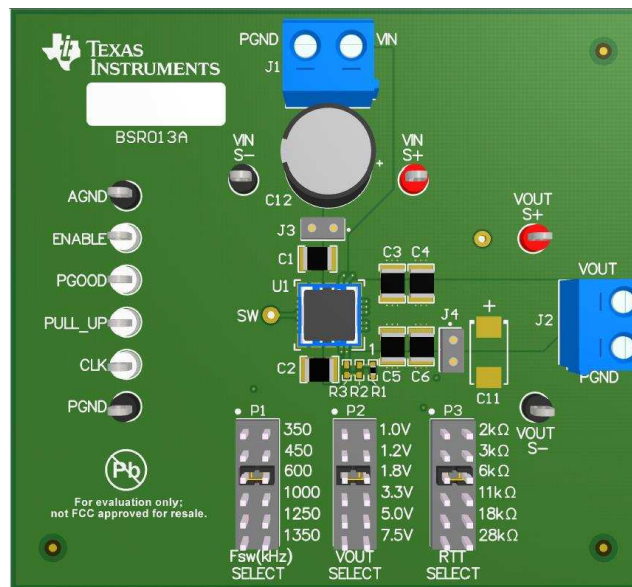


Figure 1. EVM User Interface

The S+ and S- test points for both VIN and VOUT, located near the power terminal blocks are intended to be used as voltage monitoring points where voltmeters can be connected to measure VIN and VOUT. **Do not use these S+ and S- monitoring test points as the input supply or output load connection points.** The PCB traces connecting to these test points are not designed to support high currents.

The VIN Scope (J3) and VOUT Scope (J4) test points can be used to monitor VIN and VOUT waveforms with an oscilloscope. These test points are intended for use with un-hooded scope probes outfitted with a low-inductance ground lead (ground spring) mounted to the scope probe barrel. The two sockets of each test point are on 0.1 inch centers. The scope probe tip should be inserted into the socket marked with a white dot, and the scope ground lead should be inserted into the other socket.

The control test points located to the left of the device are made available to test the features of the device. The UVLO feature can be adjusted by changing resistors R24 and R25 on the bottom of the board. An external voltage can be applied to the PULL_UP test point for the PGOOD signal. Refer to the [Test Points Descriptions](#) section of this guide for more information on the individual control test points.

The Fsw SELECT jumper (P1), the VOUT SELECT jumper (P2) and the RTT SELECT jumper (P3) are provided for selecting the desired output voltage, the appropriate switching frequency and the appropriate TurboTrans resistor value. Before applying power to the EVM, ensure that the jumpers are present and properly positioned for the intended output voltage, switching frequency, and TurboTrans resistor value. Refer to [Table 1](#) for the recommended jumper settings. Always remove input power before changing the jumper settings.

Table 1. Output Voltage and Switching Frequency Jumper Settings

VOUT Select	Fsw Select	RTT Select
1 V	350 kHz	2 k Ω
1.2 V	450 kHz	3 k Ω
1.8 V	600 kHz	6 k Ω
3.3 V	1000 kHz	11 k Ω
5 V	1250 kHz	18 k Ω
7.5 V	1350 kHz	28 k Ω

3 Test Point Descriptions

Wire-loop test points and two scope probe test points have been provided as convenient connection points for digital voltmeters (DVM) or oscilloscope probes to aid in the evaluation of the device. A description of each test point follows:

Table 2. Test Point Descriptions⁽¹⁾

VIN S+	Input voltage monitor. Connect the positive lead of a DVM to this point for measuring efficiency.
VIN S-	Input voltage monitor. Connect the negative lead of a DVM to this point for measuring efficiency.
VOUT S+	Output voltage monitor. Connect the positive lead of a DVM to this point for measuring efficiency, line regulation, and load regulation.
VOUT S-	Output voltage monitor. Connect the negative lead of a DVM to this point for measuring efficiency, line regulation, and load regulation.
AGND	Analog ground test point.
PGND	Power ground test point.
VIN Scope (J3)	Input voltage scope monitor. Connect an oscilloscope to this set of points to measure input ripple voltage.
VOUT Scope (J4)	Output voltage scope monitor. Connect an oscilloscope to this set of points to measure output ripple voltage and transient response.
ENABLE	Enable test point. Connect this test point to AGND to disable the device. Leave this test point open to enable the device. The UVLO resistor divider (R24 and R25) is connected at this point.
PGOOD	Monitors the power good signal of the device. This is an open drain signal.
PULL_UP	Test point provided for applying a pull-up voltage for the PGOOD signal. A 100-k Ω pull-up resistor (R26) is present on the EVM between this test point and the PGOOD signal.
CLK	Synchronization clock input test point. An AC coupling capacitor (C13) is present on the EVM between this test point and the SYNC pin of the device. Pads for a termination resistor (R27) are present between this test point and PGND. An external clock signal can be applied to this point to synchronize the device to an appropriate frequency.

⁽¹⁾ Refer to the product datasheet for absolute maximum ratings associated with above features.

4 Performance Data

Figure 2 through Figure 5 demonstrate the TPSM84824EVM performance. For more data regarding the TPSM84824, TPSM84624, or the TPSM84424, please see the product data sheet.

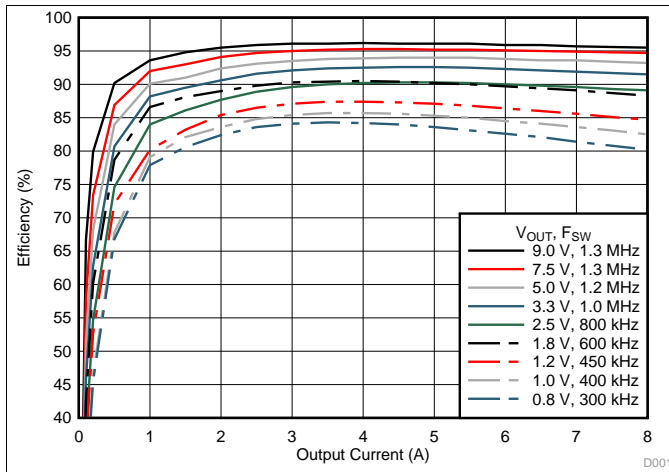


Figure 2. Efficiency (V_{IN} = 12 V)

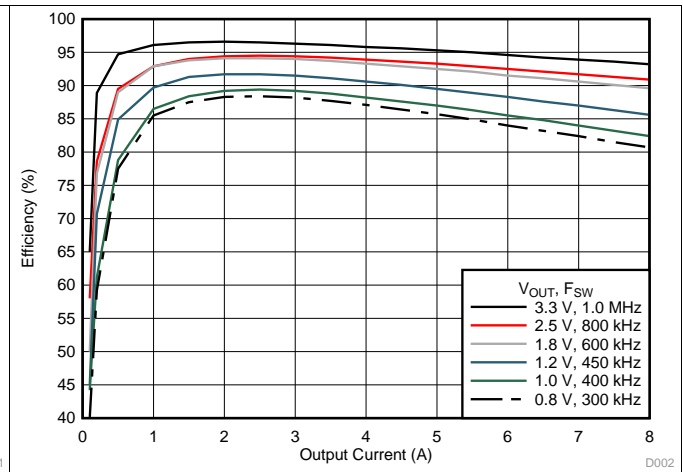


Figure 3. Efficiency (V_{IN} = 5 V)

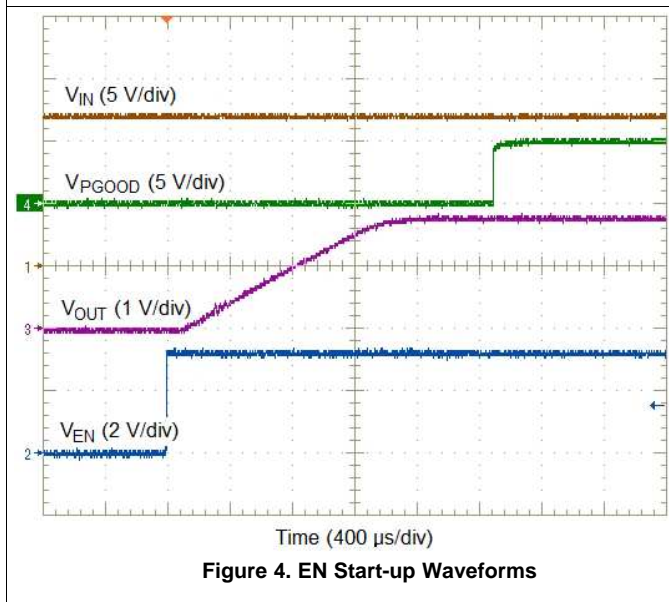


Figure 4. EN Start-up Waveforms

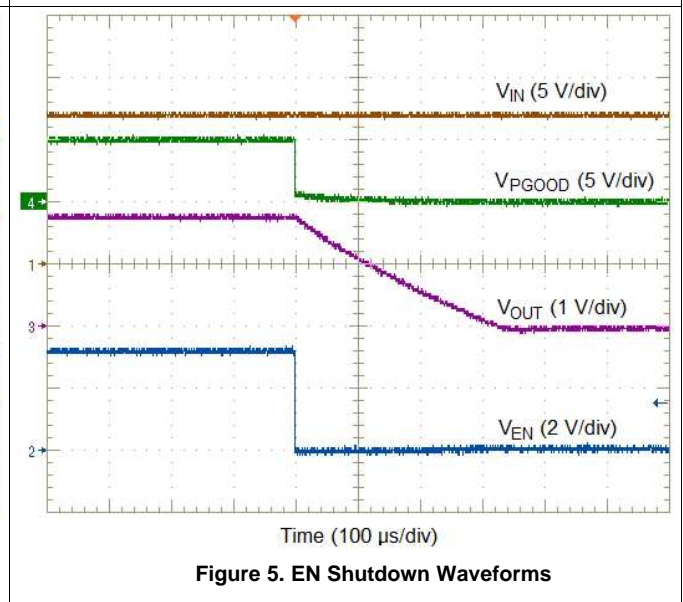


Figure 5. EN Shutdown Waveforms

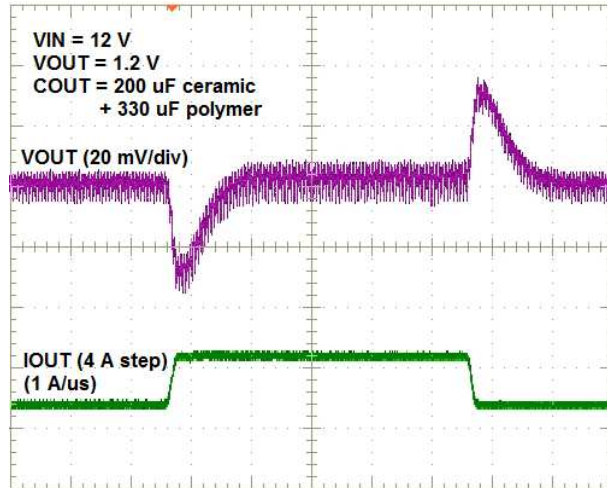


Figure 6. Transient Performance

5 Bill of Materials (BOM)

See [Table 3](#) for the TPSM84824EVM, TPSM84624EVM, or TPSM84424 bill of materials.

Table 3. EVM Bill of Materials

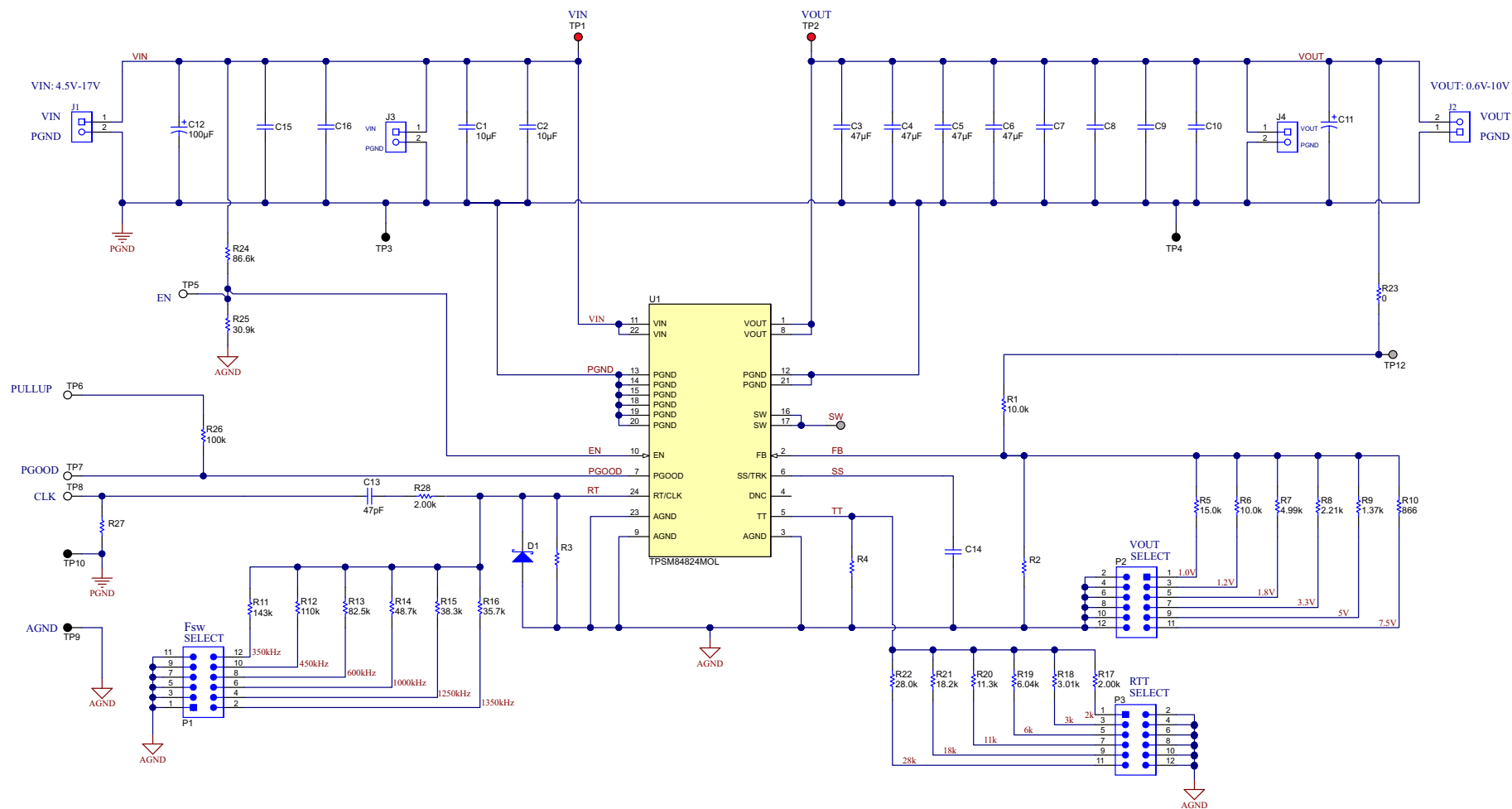
Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
C1, C2	2	10 μ F	CAP, CERM, 10 μ F, 25 V,+/- 10%, X7R, 1210	1210	GRM32DR71E106KA12L	MuRata
C3, C4, C5, C6	4	47 μ F	CAP, CERM, 47 μ F, 10 V,+/- 10%, X7R, 1210	1210	GRM32ER71A476KE15L	MuRata
C12	1	100 μ F	CAP, AL, 100 μ F, 50 V, +/- 20%, 0.162 ohm, TH		EEUFC1H101B	Panasonic
C13	1	47pF	CAP, CERM, 47 pF, 50 V,+/- 1%, C0G/NPO, 0603	0603	GRM1885C1H470FA01J	MuRata
J1, J2	2		Terminal Block, 5.08 mm, 2x1, Brass, TH	2x1 5.08 mm Terminal Block	ED120/2DS	On-Shore Technology
J3, J4	2		Socket Strip, 2x1, 100mil, Black, Tin, TH	Socket Strip, 100mil, 2pin	310-43-102-41-001000	Mill-Max
P1, P2, P3	3		Header, 100mil, 6x2, Tin, TH	Header, 6x2, 100mil, Tin	PEC06DAAN	Sullins Connector Solutions
R1	1	10.0k	RES, 10.0 k, 1%, 0.063 W, 0402	0402	CRCW040210K0FKED	Vishay-Dale
R5	1	15.0k	RES, 15.0 k, 1%, 0.1 W, 0603	0603	CRCW060315K0FKEA	Vishay-Dale
R6	1	10.0k	RES, 10.0 k, 1%, 0.1 W, 0603	0603	CRCW060310K0FKEA	Vishay-Dale
R7	1	4.99k	RES, 4.99 k, 1%, 0.1 W, 0603	0603	CRCW06034K99FKEA	Vishay-Dale
R8	1	2.21k	RES, 2.21 k, 1%, 0.1 W, 0603	0603	CRCW06032K21FKEA	Vishay-Dale
R9	1	1.37k	RES, 1.37 k, 1%, 0.1 W, 0603	0603	CRCW06031K37FKEA	Vishay-Dale
R10	1	866	RES, 866, 1%, 0.063 W, 0603	0603	CRCW0603866RFKEA	Vishay-Dale
R11	1	143k	RES, 143 k, 1%, 0.1 W, 0603	0603	CRCW0603143KFKEA	Vishay-Dale
R12	1	110k	RES, 110 k, 1%, 0.1 W, 0603	0603	CRCW0603110KFKEA	Vishay-Dale
R13	1	82.5k	RES, 82.5 k, 1%, 0.1 W, 0603	0603	CRCW060382K5FKEA	Vishay-Dale
R14	1	48.7k	RES, 48.7 k, 1%, 0.1 W, 0603	0603	CRCW060348K7FKEA	Vishay-Dale
R15	1	38.3k	RES, 38.3 k, 1%, 0.1 W, 0603	0603	CRCW060338K3FKEA	Vishay-Dale
R16	1	35.7k	RES, 35.7 k, 1%, 0.1 W, 0603	0603	CRCW060335K7FKEA	Vishay-Dale
R17, R28	2	2.00k	RES, 2.00 k, 1%, 0.1 W, 0603	0603	CRCW06032K00FKEA	Vishay-Dale
R18	1	3.01k	RES, 3.01 k, 1%, 0.1 W, 0603	0603	CRCW06033K01FKEA	Vishay-Dale
R19	1	6.04k	RES, 6.04 k, 1%, 0.1 W, 0603	0603	CRCW06036K04FKEA	Vishay-Dale
R20	1	11.3k	RES, 11.3 k, 1%, 0.1 W, 0603	0603	CRCW060311K3FKEA	Vishay-Dale
R21	1	18.2k	RES, 18.2 k, 1%, 0.1 W, 0603	0603	CRCW060318K2FKEA	Vishay-Dale
R22	1	28.0k	RES, 28.0 k, 1%, 0.1 W, 0603	0603	CRCW060328K0FKEA	Vishay-Dale
R23	1	0	RES, 0, 5%, 0.1 W, 0603	0603	ERJ-3GEY0R00V	Vishay-Dale
R24	1	86.6k	RES, 86.6 k, 1%, 0.1 W, 0603	0603	CRCW060386K6FKEA	Vishay-Dale

Table 3. EVM Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
R25	1	30.9k	RES, 30.9 k, 1%, 0.1 W, 0603	0603	CRCW060330K9FKEA	Vishay-Dale
R26	1	100k	RES, 100 k, 5%, 0.063 W, 0402	0402	CRCW0402100KJNED	Vishay-Dale
SH-P1, SH-P2 SH-P3	3	1x2	Shunt, 2mm, Gold plated, Black	2mm Shunt, Closed Top	2SN-BK-G	Samtec
TP1, TP2	2		Test Point, Multipurpose, Red, TH	Multipurpose Testpoint Red	5010	Keystone
TP3, TP4, TP9, TP10	4		Test Point, Multipurpose, Black, TH	Multipurpose Testpoint Black	5011	Keystone
TP5, TP16, TP7, TP8	4		Test Point, Multipurpose, White, TH	Multipurpose Testpoint White	5012	Keystone
U1	1		TPSM84824 MOL0024A (QFN-24)	MOL0024A	TPSM84824MOL	Texas Instruments
			TPSM84624 MOL0024A (QFN-24)		TPSM84624MOL	
			TPSM84424 MOL0024A (QFN-24)		TPSM8424MOL	
C7, C8, C9, C10	0		CAP, CERM, 1210	1210		
C11	0		CAP, Tantalum Polymer, 7343-40 SMD	7343-40		
C14	0		CAP, CERM, 0402	0402		
C15, C16	0		CAP, CERM, 1210	1210		
D1	0		Diode, Schottky, 30 V, 0.2 A, SOD-323	SOD-323	BAT54WS-7-F	Diodes Inc.
R2, R3	0		RES, 0.1 W, 0603	0603		
R4	0		RES, 0.063 W, 0402	0402		
R27	0		RES, 1W, 2512	2512		
TP11	0		Test Point. No entry in BOM.	N/A		

6 Schematic

Figure 7 is the schematic for the TPSM84824EVM. The schematic for the TPSM84624EVM and TPSM84424EVM is identical with the only difference is the U1 IC.



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Figure 7. TPSM84824EVM Schematic

7 PCB Layout

Figure 8 through Figure 13 show the PCB layers of the TPSM84824EVM, TPSM84624EVM and TPSM84424EVM.

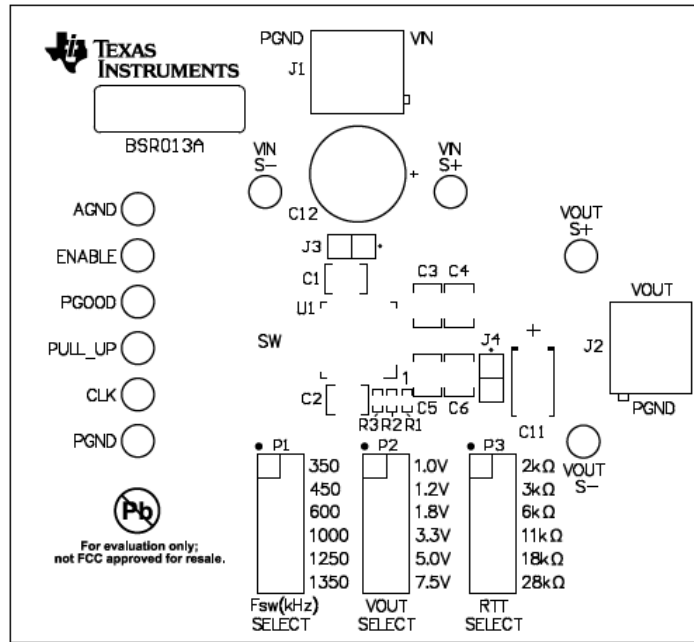


Figure 8. Topside Component Layout (Top View)

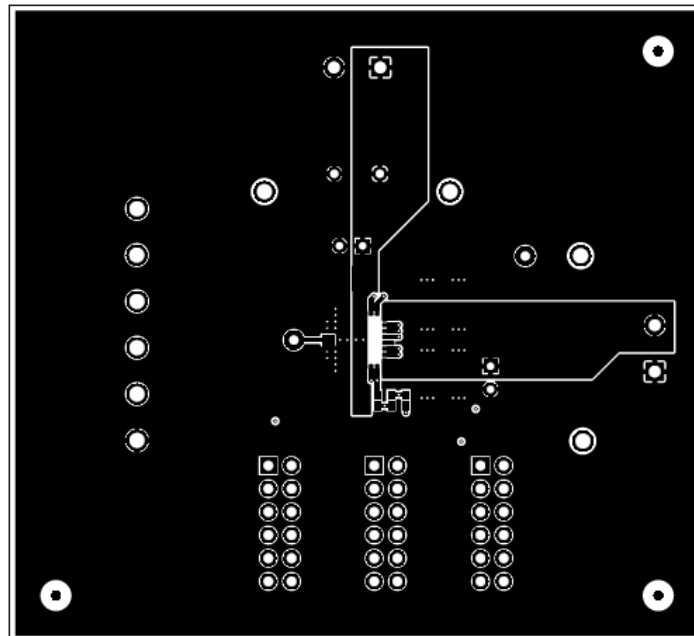


Figure 9. Topside Copper (Top View)

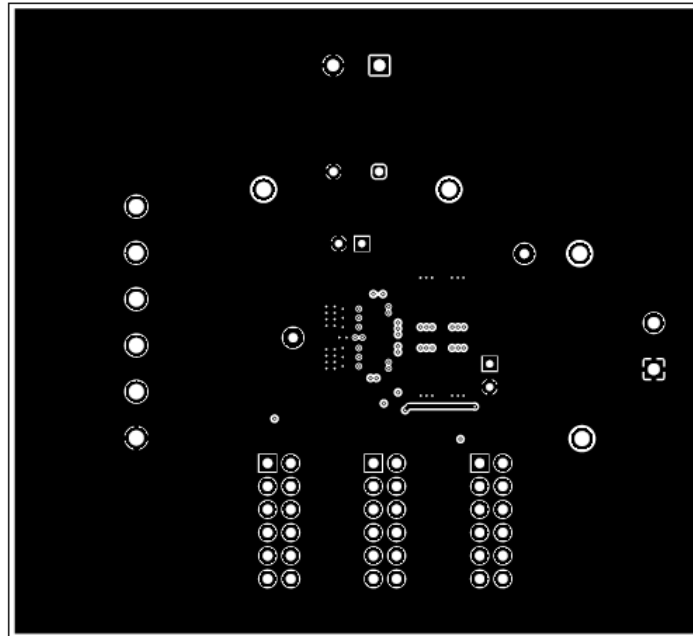


Figure 10. Layer 2 Copper (Top View)

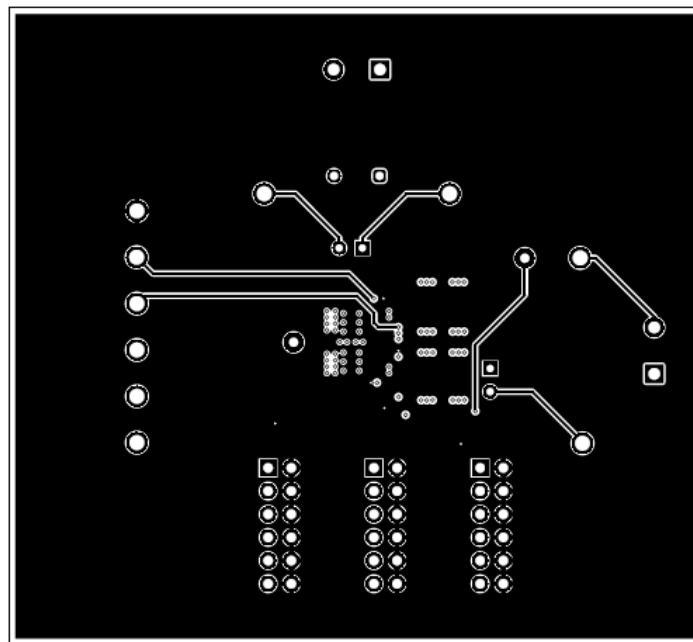


Figure 11. Layer 3 Copper (Top View)

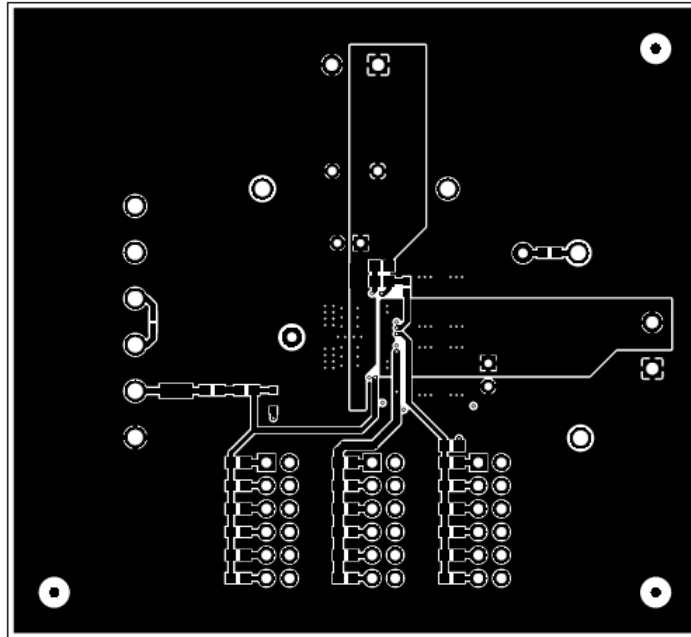


Figure 12. Bottom-Side Copper (Top View)

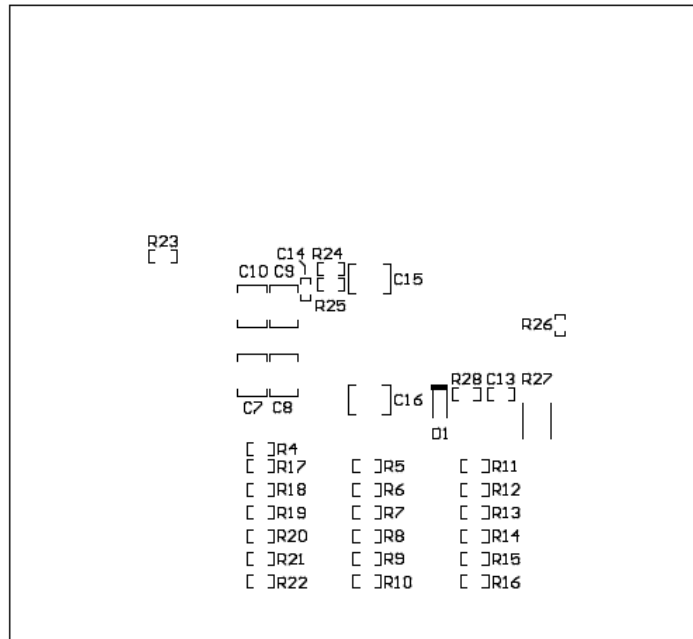


Figure 13. Bottom-Side Component Layout (Bottom View)

Revision History

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

Changes from Original (November 2017) to A Revision	Page
• Added TPSM84624EVM option to user guide.....	1

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 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.
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 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page

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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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
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3.4 *European Union*

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

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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:*

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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.

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