

TPS24742EVM-667 Evaluation Module

This user's guide describes the TPS24742 evaluation module (TPS24742EVM-667). The TPS24742EVM-667 (EVM) contains evaluation and reference circuitry for the TPS24742. The TPS24742 device is an easy-to-use, 2.5 to 18 V, hot-swap and ORing power management device that safely drives external N-channel MOSFETs.

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1 Introduction

The TPS24742EVM-667 evaluation module (EVM) is a fully assembled and tested circuit for evaluating the TPS24742 high performance hot-swap and ORing controller. The EVM contains header connectors for easy connection to external test and application circuitry.

1.1 Features

- 2.5-V to 18-V bus operation (30 V absolute maximum)
- Programmable FET SOA protection
- Dual fault timer (Over-current / Inrush)
- Interchangeable hotswap and ORing
- Analog current monitor (1% at 25 mV)
- Programmable protection settings:
 - Current limit: $\pm 5\%$ at 10 mV
 - Fast trip: $\pm 10\%$ at 20 mV
 - Reverse voltage: ± 1 mV at -1 mV
 - 4 mm \times 4 mm 24-pin QFN
 - 40 = Latch, 41 = Retry, 42 = Immediate Latch Off

1.2 Applications

- Enterprise storage
- Power muxing
- Redundant power supplies
- Battery back up

1.3 Electrical Specifications

Table 1. TPS24742EVM-667 Electrical and Performance Specifications at 25°C

Characteristics	TPS24742EVM-667
Current limit	45 A
Fast Trip Threshold	65 A
Fast Trip Filtering	0.5 μ s
Power Limit	39 W
Rising UV threshold	10 V
Rising OV threshold	14 V
Reverse Current Threshold	1.5 A
Reverse Current Filtering	0.5 μ s
inrush timer	44 ms
fault timer	300 ms
I_{load} vs V_{imon}	15 mV/A
I_{load} vs $V_{imonbuff}$	45 mV/A

2 Description

The TPS24742EVM-667 as-is, contains two separate hotswap then OR circuits.

The TPS24742EVM-667 is designed to accommodate two hotswap then OR configuration (as shown in [Figure 1](#)) mainly to evaluate systems with priority muxing as described in the priority muxing section of the TPS24742 datasheet ([SLVSCV6](#)).

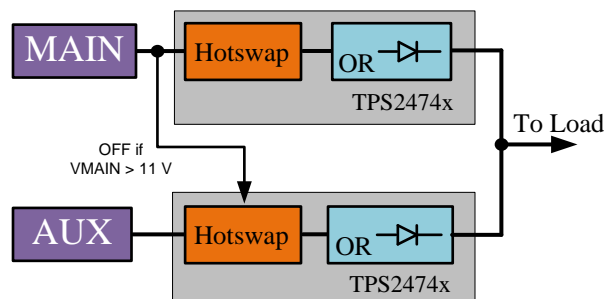


Figure 1. Block Diagram for Priority Muxing

2.1 Jumpers

Table 2. Jumpers (A and B Circuits)

JUMPER	Description
J1	Shorting J1 sets the sensing of overvoltage to be on VINA or VINB
J2	Shorting J2 sets the pull up voltage of the output flags to VIN or an external bias voltage
J3	Shorting J3 sets (+) reverse voltage on the output of the ORing or input of the hotswap
J4	Shorting J4 sets the same fault and inrush timers
J5	Shorting J5 sets (-) reverse voltage on the input of the ORing or input of the hotswap
J6	Shorting J6 disables ORing
J7	Shorting J7 disables overvoltage protection

3 Schematic

Figure 2 through Figure 4 illustrate the EVM schematics.

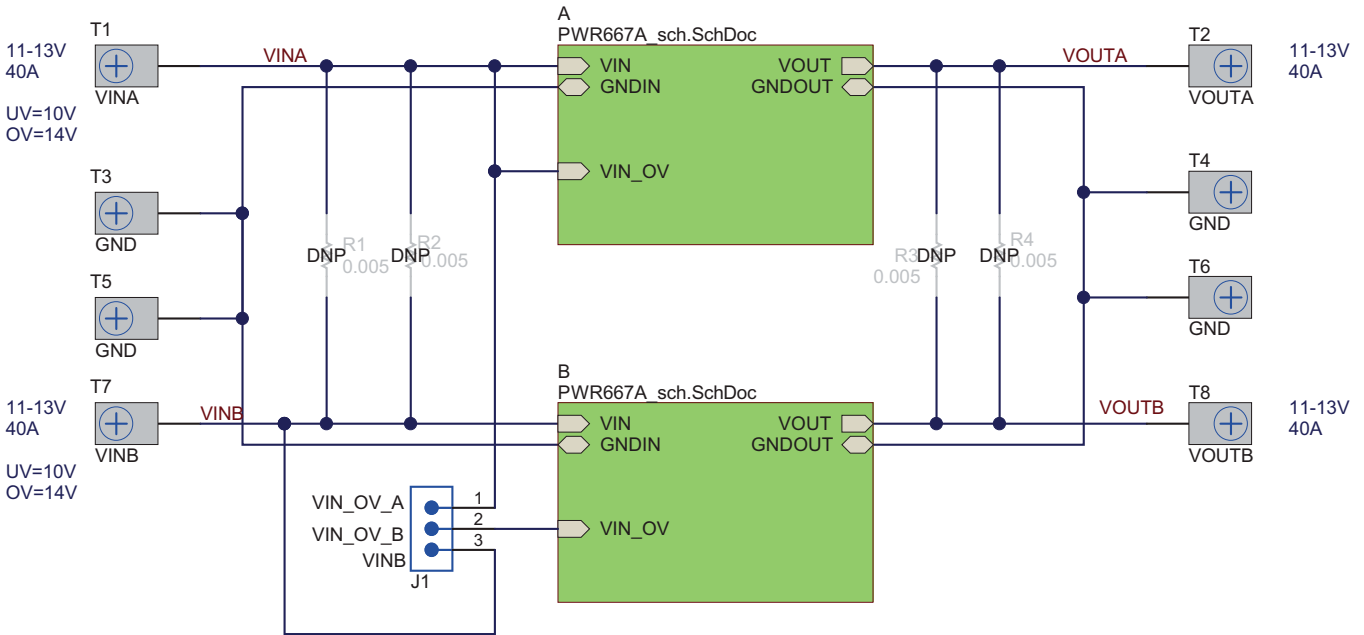


Figure 2. TPS24742EVM-667 High Level Schematic

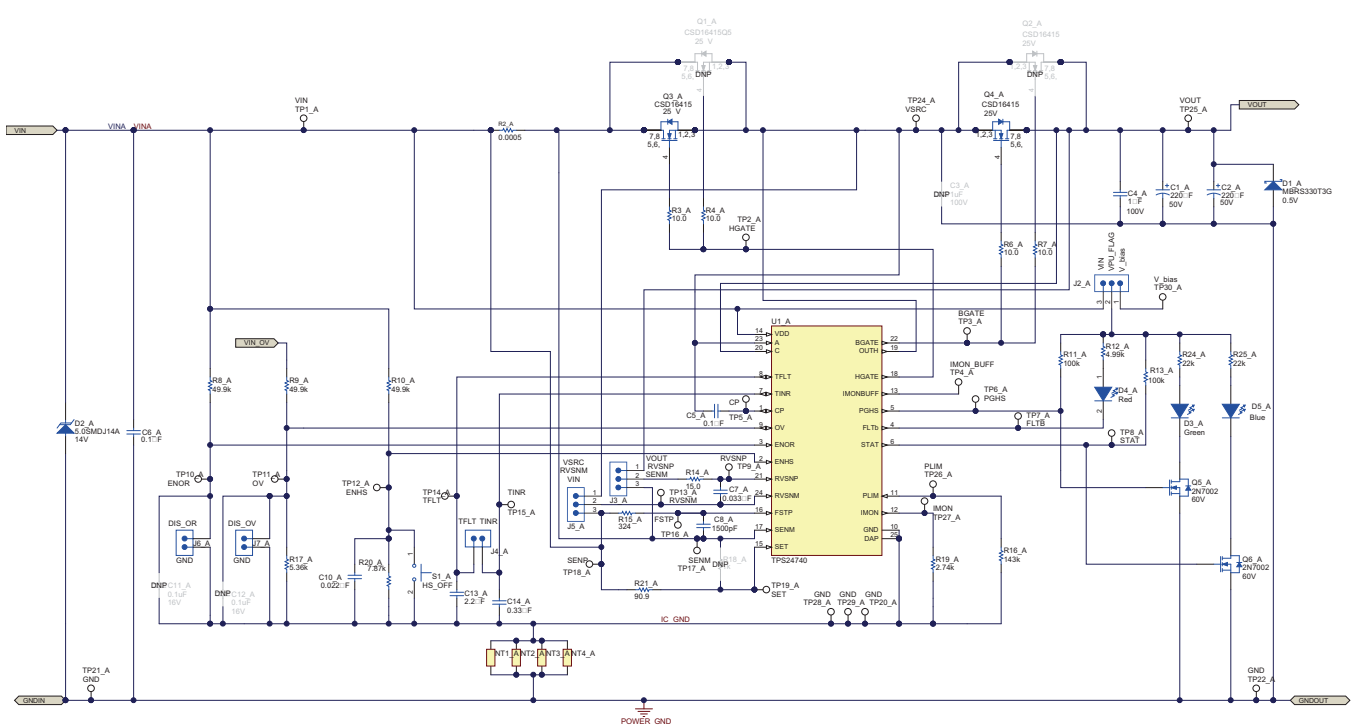


Figure 3. TPS24742EVM-667 Hotswap then OR Schematic A

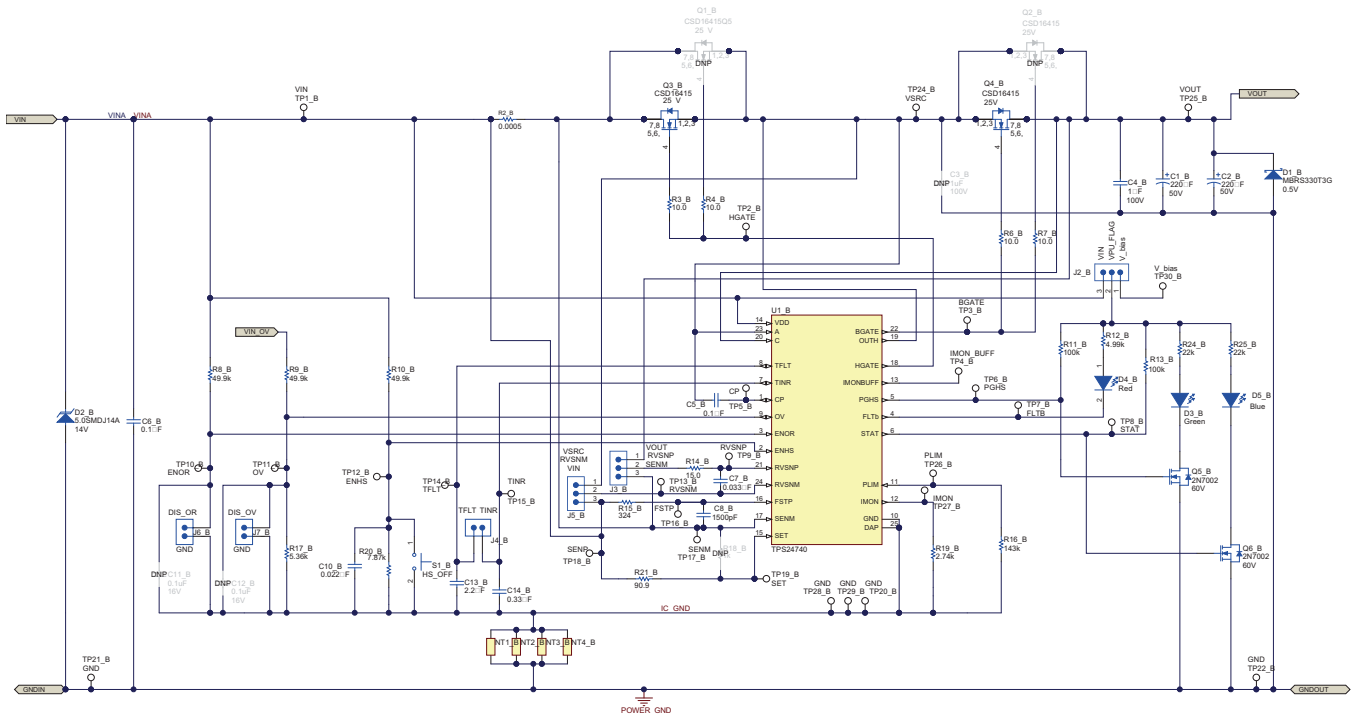


Figure 4. TPS24742EVM-667 Hotswap then OR Schematic B

4 TPS24742 Hot-Swap and OR Performance

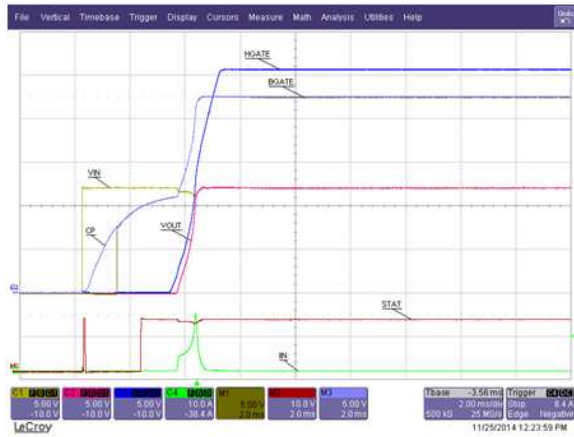


Figure 5. Start Up ($C_{OUT} = 440 \mu\text{F}$)

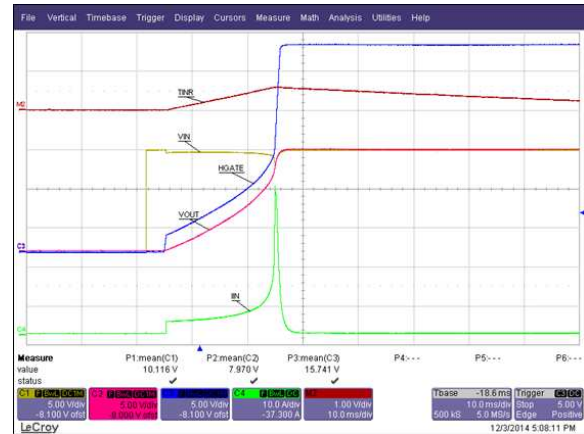


Figure 6. Start Up ($C_{OUT} = 10440 \mu\text{F}$)



Figure 7. Hot Short on V_{OUT} (Zoomed Out)

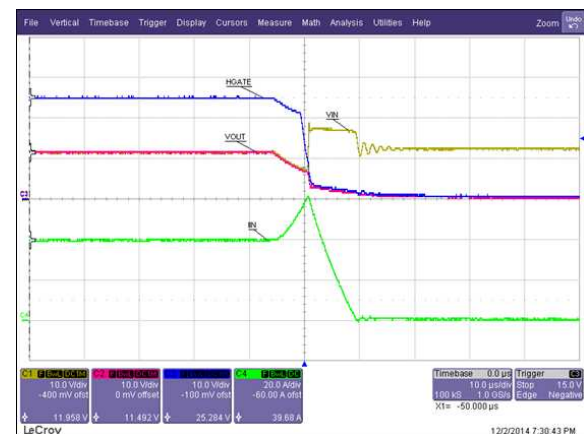


Figure 8. Hot Short on V_{OUT} (Zoomed In)



Figure 9. Under/Overvoltage With V_{IN} Rising



Figure 10. Under/Overvoltage With V_{IN} Falling



Figure 11. Start into Short on VOUT



Figure 12. Load Step – 40 A to 60 A



Figure 13. Hot – Short on VIN



Figure 14. Gradual Reverse Current

5 Priority Muxing

The TPS24742EVM-667, as is, can be evaluated to test an individual OR then hot-swap circuit (Schematic A or Schematic B). It can also be modified to accommodate priority muxing applications as shown in [Figure 1](#). The results can be found in the Priority Muxing section of the TPS24742 datasheet ([SLVSCV6](#))..

6 EVM Assembly Drawing and PCB Layout

6.1 PCB Drawings

Figure 15 to Figure 19 show component placement and layout of the TPS24742EVM-667.

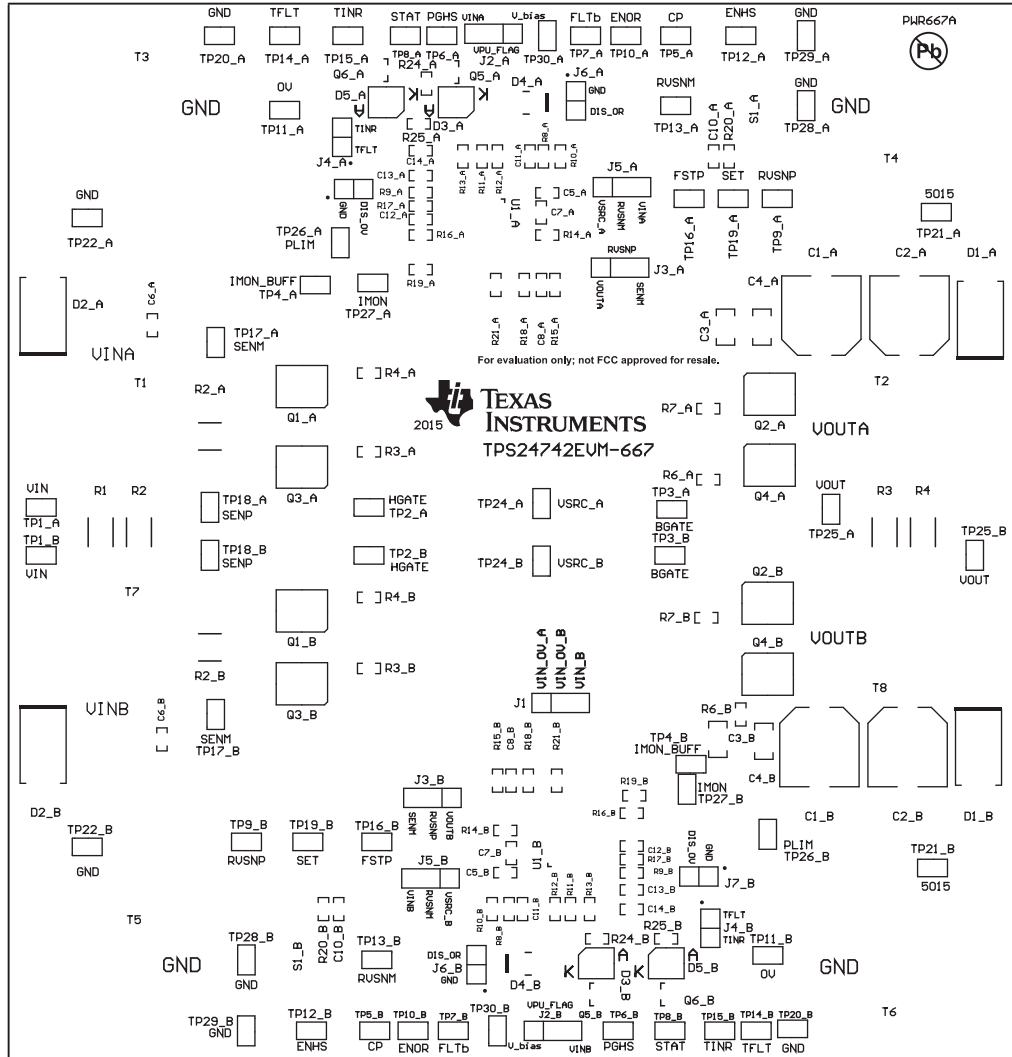


Figure 15. Top Side Component Placement

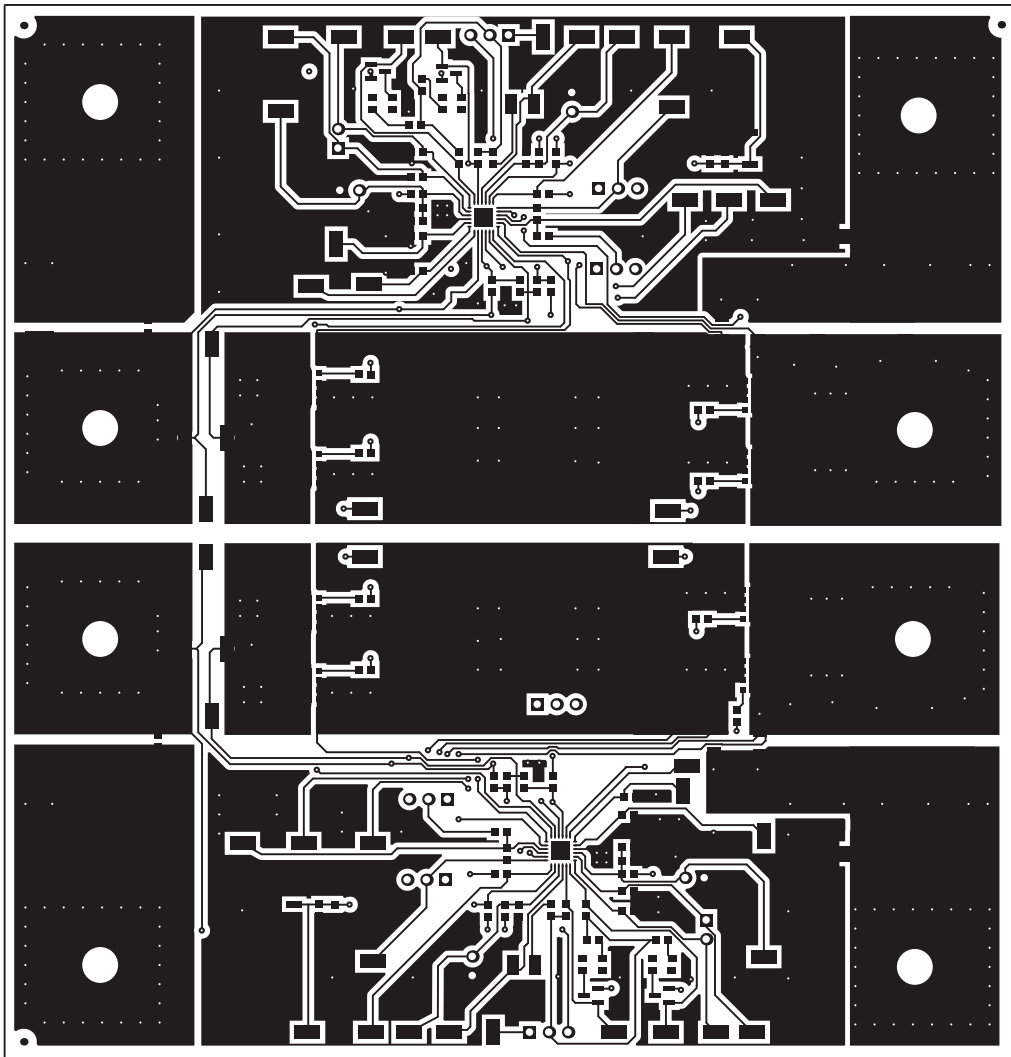


Figure 16. Top Side Routing

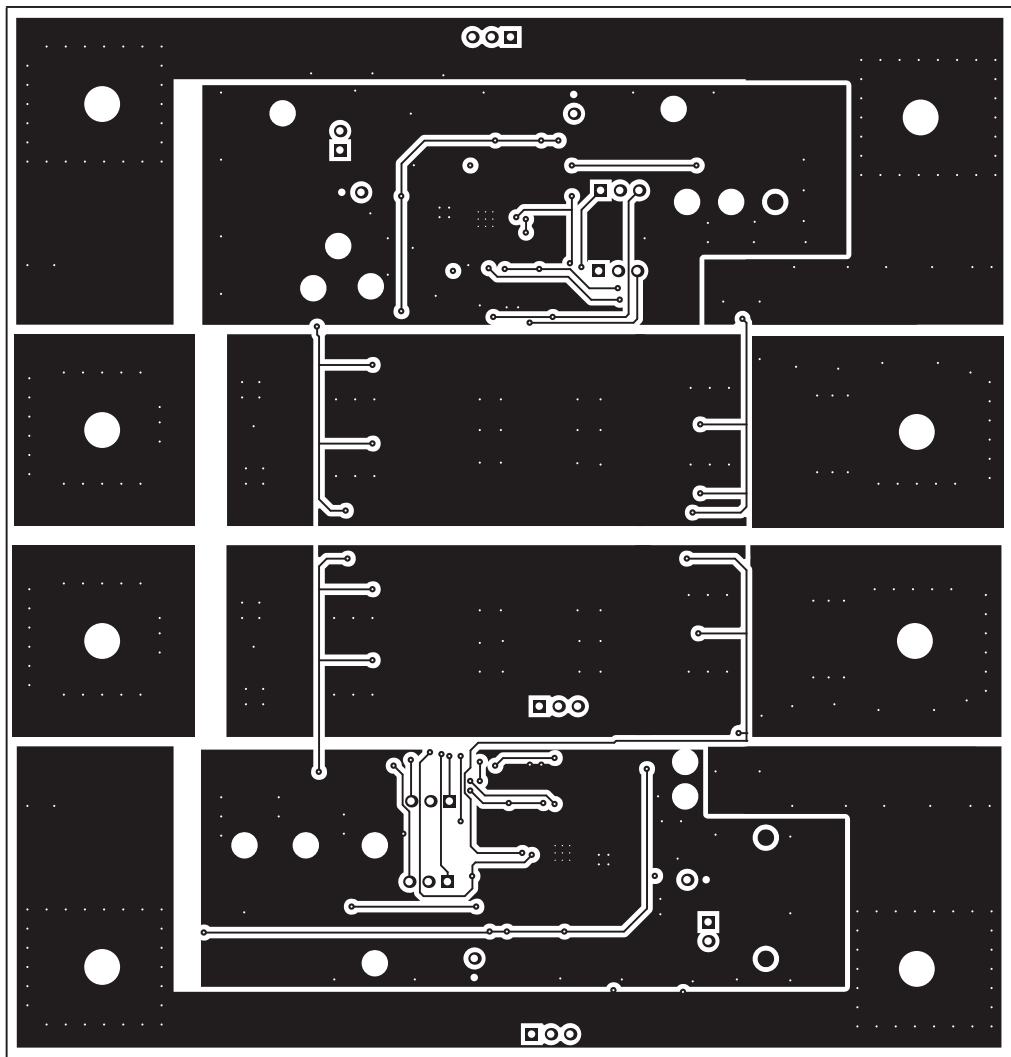


Figure 17. Midlayer 1 Routing

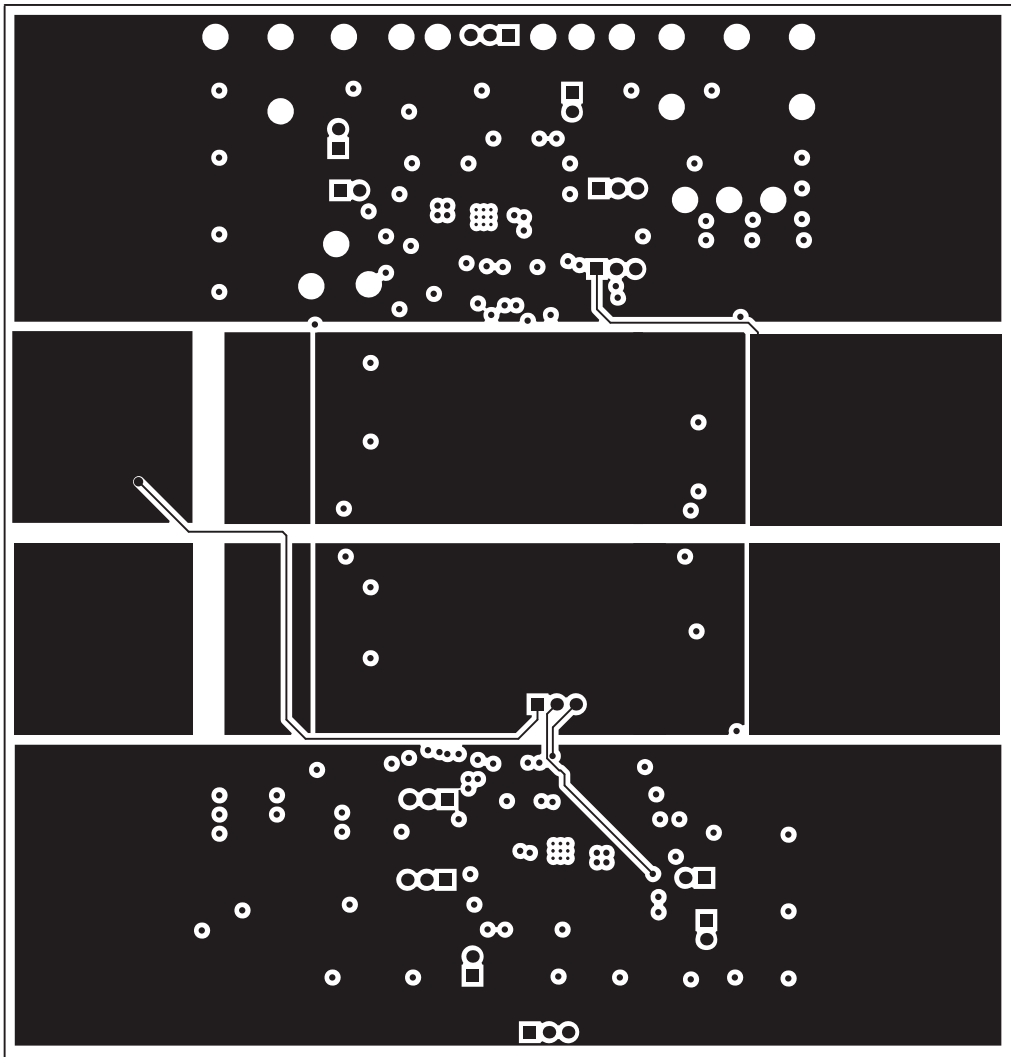


Figure 18. Midlayer 2 Routing

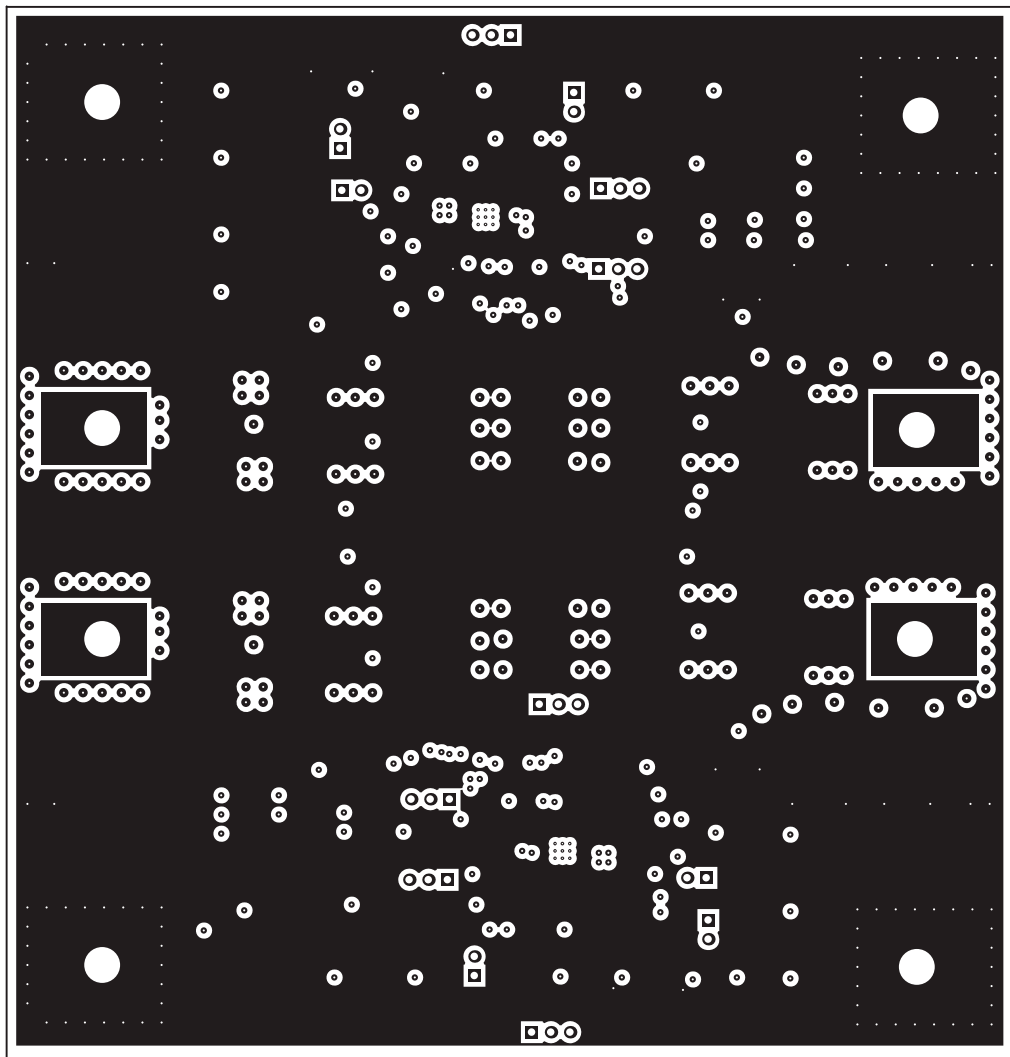


Figure 19. Bottom Layer Routing

7 Bill of Material

Table 3. TPS24742EVM-667 BOM

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
!PCB1	1		PWR667	N/A	Used in BOM report	Any
C1_A, C1_B, C2_A, C2_B	4	220uF	CAP, AL, 220uF, 50V, +/-20%, 0.3 ohm, SMD	SMT Radial G	EEE-FC1H221P	Panasonic
C4_A, C4_B	2	1uF	CAP, CERM, 1uF, 100V, +/-10%, X7R, 1206	1206	GRM31CR72A105KA01L	MuRata
C5_A, C5_B, C6_A, C6_B	4	0.1uF	CAP, CERM, 0.1uF, 16V, +/-5%, X7R, 0603	0603	0603YC104JAT2A	AVX
C7_A, C7_B	2	0.033uF	CAP, CERM, 0.033 uF, 16 V, +/-10%, X7R, 0603	0603	GRM188R71C333KA01D	MuRata
C8_A, C8_B	2	1500pF	CAP, CERM, 1500 pF, 100 V, +/-5%, X7R, 0603	0603	06031C152JAT2A	AVX
C10_A, C10_B	2	0.022uF	CAP, CERM, 0.022 uF, 16 V, +/-10%, X7R, 0603	0603	C0603C223K4RACTU	Kemet
C13_A, C13_B	2	2.2uF	CAP, CERM, 2.2 uF, 35 V, +/- 10%, X5R, 0603	0603	GRM188R6YA225KA12D	MuRata
C14_A, C14_B	2	0.33uF	CAP, CERM, 0.33 uF, 16 V, +/-10%, X7R, 0603	0603	C0603C334K4RACTU	Kemet
D1_A, D1_B	2	0.5V	Diode, Schottky, 30V, 3A, SMC	SMC	MBRS330T3G	ON Semiconductor
D2_A, D2_B	2	14V	Diode, TVS, Uni, 14V, 5000W, SMC	SMC	5.0SMDJ14A	Littelfuse
D3_A, D3_B	2	Green	LED, Green, SMD	Power TOPLED w/lens	LT E63C-CADB-35-L-Z	OSRAM
D4_A, D4_B	2	Red	LED, Red, SMD	SMD, 2-Leads, Body 3.2x3mm	SML-LX2832IC-TR	Lumex
D5_A, D5_B	2	Blue	LED, Blue, SMD	Power TOPLED w/lens	LB E63C-U2V2-35-L-Z	OSRAM
J1, J2_A, J2_B, J3_A, J3_B, J5_A, J5_B	7	1x3	Header, TH, 100mil, 1x3, Gold plated, 230 mil above insulator	PBC03SAAN	PBC03SAAN	Sullins Connector Solutions
J4_A, J4_B, J6_A, J6_B, J7_A, J7_B	6		Header, TH, 100mil, 2x1, Gold plated, 230 mil above insulator	TSW-102-07-G-S	TSW-102-07-G-S	Samtec, Inc.
Q3_A, Q3_B, Q4_A, Q4_B	4	CSD16415	MOSFET, N-CH, 25V, 100A, SON 5x6mm	SON 5x6mm	CSD16415Q5	Texas Instruments
Q5_A, Q5_B, Q6_A, Q6_B	4	60V	MOSFET, N-CH, 60V, 0.17A, SOT-23	SOT-23	2N7002-7-F	Diodes Inc.
R2_A, R2_B	2	0.0005	RES, 0.0005, 1%, 3 W, 2512	2512	HCS2512FTL500	Stackpole Electronics Inc
R3_A, R3_B, R4_A, R4_B, R6_A, R6_B, R7_A, R7_B	8	10.0	RES, 10.0 ohm, 1%, 0.1W, 0603	0603	CRCW060310R0FKEA	Vishay-Dale
R8_A, R8_B, R9_A, R9_B, R10_A, R10_B	6	49.9k	RES, 49.9k ohm, 1%, 0.1W, 0603	0603	CRCW060349K9FKEA	Vishay-Dale
R11_A, R11_B, R13_A, R13_B	4	100k	RES, 100k ohm, 1%, 0.1W, 0603	0603	CRCW0603100KFKEA	Vishay-Dale
R12_A, R12_B	2	4.99k	RES, 4.99 k, 1%, 0.1 W, 0603	0603	CRCW06034K99FKEA	Vishay-Dale
R14_A, R14_B	2	15.0	RES, 15.0, 1%, 0.1 W, 0603	0603	CRCW060315R0FKEA	Vishay-Dale
R15_A, R15_B	2	324	RES, 324, 1%, 0.1 W, 0603	0603	RC0603FR-07324RL	Yageo America
R16_A, R16_B	2	143k	RES, 143 k, 1%, 0.1 W, 0603	0603	CRCW0603143KFKEA	Vishay-Dale
R17_A, R17_B	2	5.36k	RES, 5.36 k, 1%, 0.1 W, 0603	0603	CRCW06035K36FKEA	Vishay-Dale
R19_A, R19_B	2	2.74k	RES, 2.74 k, 1%, 0.1 W, 0603	0603	CRCW06032K74FKEA	Vishay-Dale
R20_A, R20_B	2	7.87k	RES, 7.87 k, 1%, 0.1 W, 0603	0603	CRCW06037K87FKEA	Vishay-Dale
R21_A, R21_B	2	90.9	RES, 90.9, 1%, 0.1 W, 0603	0603	CRCW060390R9FKEA	Vishay-Dale
R24_A, R24_B, R25_A, R25_B	4	22k	RES, 22k ohm, 5%, 0.1W, 0603	0603	CRCW060322K0JNEA	Vishay-Dale
S1_A, S1_B	2		Switch, Push Button, SMD	2.9x2x3.9mm SMD	SKRKAEE010	Alps
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10, SH-J11, SH-J12, SH-J13	13	1x2	Shunt, 2mm, Gold plated, Black	2mm Shunt, Closed Top	2SN-BK-G	Samtec
T1, T2, T3, T4, T5, T6, T7, T8	8	50A	Terminal 50A Lug	CB35-36-CY	CB35-36-CY	Panduit

Table 3. TPS24742EVM-667 BOM (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
TP1_A, TP1_B, TP2_A, TP2_B, TP3_A, TP3_B, TP4_A, TP4_B, TP5_A, TP5_B, TP6_A, TP6_B, TP7_A, TP7_B, TP8_A, TP8_B, TP9_A, TP9_B, TP10_A, TP10_B, TP11_A, TP11_B, TP12_A, TP12_B, TP13_A, TP13_B, TP14_A, TP14_B, TP15_A, TP15_B, TP16_A, TP16_B, TP17_A, TP17_B, TP18_A, TP18_B, TP19_A, TP19_B, TP20_A, TP20_B, TP21_A, TP21_B, TP22_A, TP22_B, TP24_A, TP24_B, TP25_A, TP25_B, TP26_A, TP26_B, TP27_A, TP27_B, TP28_A, TP28_B, TP29_A, TP29_B, TP30_A, TP30_B	58	SMT	Test Point, Miniature, SMT	Testpoint_Keystone_Minature	5015	Keystone
U1_A, U1_B	2		2.5-V to 18-V Positive Voltage Hot-Swap and Oring Controller, RGE0024B	RGE0024B	TPS24740RGE	Texas Instruments
C3_A, C3_B	0	1uF	CAP, CERM, 1uF, 100V, +/-10%, X7R, 1206	1206	GRM31CR72A105KA01L	MuRata
C11_A, C11_B, C12_A, C12_B	0	0.1uF	CAP, CERM, 0.1uF, 16V, +/-5%, X7R, 0603	0603	0603YC104JAT2A	AVX
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A
Q1_A, Q1_B, Q2_A, Q2_B	0	DNP	MOSFET, N-CH, 25V, 100A, SON 5x6mm	SON 5x6mm	CSD16415Q5	Texas Instruments
R1, R2, R3, R4	0	DNP	RES, 0.005 ohm, 1%, 2W, 2512	2512	73M2R005F	CTS Resistor
R18_A, R18_B	0	DNP	RES, 1.00k ohm, 1%, 0.1W, 0603	0603	CRCW06031K00FKEA	Vishay-Dale

STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.
 - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI 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 and conditions that accompany such Software
 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
 - 2.1 These terms and conditions do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
 - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for any defects that are caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.
 - 2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.
3. *Regulatory Notices:*
 - 3.1 *United States*
 - 3.1.1 *Notice applicable to EVMs not FCC-Approved:*

This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.
 - 3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/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 by Radio Law of Japan to follow the instructions below with respect to EVMs:

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/llds/ti_ja/general/eStore/notice_02.page
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4 *EVM Use Restrictions and Warnings:*

- 4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
- 4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
- 4.3 *Safety-Related Warnings and Restrictions:*
 - 4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.
 - 4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.
- 4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

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