User's Guide

TPSM365R15EVM, TPSM365R15FEVM User's Guide

ABSTRACT

The TPSM365R15EVM and TPSM365R15FEVM enables the evaluation of the TPSM365R15 and TPSM365R15F power modules. The EVMs allow for several configurations of the power module. Additionally, electrical test points provide ease in verifying the performance of the power regulator. Lastly, these EVMs serve as a basis for the optimal TPSM365R15 and TPSM365R15F layout and component selection.

CAUTION

Read the user's guide before use.

CAUTION

Hot surface! Contact can cause burns. Do not touch!

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Trademarks

All trademarks are the property of their respective owners.

1 Introduction

The output voltage of the TPSM365R15EVM and TPSM365R15FEVM can be configured for 1.8 V, 2.5 V, 3.3 V, 5 V, and 12 V with a load current up to 150 mA. Measurement points are provided to easily measure conversion efficiency and look at other performance metrics. In addition, jumpers and test points are provided to evaluate the features of the TPSM365R15 and TPSM365R15F, such as programmable enable UVLO, adjustable switching frequency and mode select (or synchronization), and power-good flag.

The EVM layout allows the TPSM365R15 and TPSM365R15F and their orderable part numbers to be installed, and their specific features to be evaluated. The TPSM365R15EVM comes installed with the TPSM365R15RDNR, the adjustable switching frequency (RT pin) version of the TPSM365R15. The TPSM365R15FEVM comes installed with the TPSM365R15FRDNR, the fixed 1-MHz version of the TPSM365R15 with mode selection and synchronization pin.

The TPSM365R15EVM is configured by default to be enabled with an output voltage of 5 V, and a switching frequency of 2.2 MHz with frequency foldback (auto mode) at light load. The TPSM365R15FEVM is configured by default to be enabled with an output voltage of 5 V, and a switching frequency of 1 MHz with frequency foldback (auto mode) at light load. The following sections outline the step-by-step procedure to use the TPSM365R15EVM and TPSM365R15FEVM and the performance that is exhibited.

Table 1-1. EVM Overview

EVM	Buck Regulator	Buck Features
TPSM365R15EVM	TPSM365R15RDNR	Output: 3.3 V/ADJ (1-15 V) Fsw: ADJ Mode: Auto
TPSM365R15FEVM	TPSM365R15FRDNR	Output: 5 V/ADJ (1-15 V) Fsw: 1 MHz Mode: Auto/FPWM

2 Setup Procedure

The following procedure outlines the steps to be taken for using the TPSM365R15EVM and TPSM365R15FEVM. Use this section in conjunction with Section 3 to correctly setup the EVM.

1. Determine the output voltage that is to be evaluated, then reference Section 2. This table provides the recommended jumper configurations.
2. After making any required changes, confirm that the output voltage is within a couple percent of the set output voltage.
3. Verify the performance of the EVM and compare with applicable curves within this user's guide.
4. Consult on e2e if there are concerns in the evaluation of this device.

Table 2-1. Suggested Frequency and Output Voltage Settings

V_{OUT} (V)	Suggested Frequency
1.8	500 kHz
2.5	500 kHz
3.3	1 MHz
5	2.2 MHz
12	2.2 MHz

3 Test Setup

Table 3-1. Description of Jumpers, Test Points, and Terminal Blocks

Reference Designator	Description
J1	Input to series, PI filter for EMC compliance testing. Note polarity, which is annotated in the silkscreen. Connect to a terminal block with a short, thick gauge (18AWG) wire.
TP1, TP2	V_{IN} test points that bypass the EMC filter and connect directly to input capacitors. Enables more accurate efficiency measurements as well as potential parasitic minimization and signal integrity of AC measurements. Connect to test points with a short, thick gauge (18AWG) wire.
TP4	PGOOD test point for verifying PGOOD (output) flag feature
TP3, TP6	V_{OUT} test points connected directly to output capacitors. Enables more accurate efficiency measurements, as well, potential parasitic minimization and signal integrity of AC measurements. Connect to test points with a short, thick gauge (18AWG) wire.
J2	Output (V_{OUT}) terminal block. Connect to terminal block with a short, thick gauge (18AWG) wire.
TP11, TP12	EN test point for accurately measuring EN voltage. If EN voltage is to be applied (externally), resistor R2 and R4 potentially can need to be removed.
J5	Disable the regulator by shorting the pins of the jumper.
J4	TPSM365R15EVM: Jumper for configuring the switching frequency of the converter. Using the "key" annotated in the schematic and also in the silkscreen. Placing the jumper on the adjacent pins sets the annotated switching frequency. TPSM365R15FEVM: Jumper for configuring the mode or for external signal source synchronization. The EVM is configured for fixed 1-MHz operation. The mode is set by using the "key" annotated in the schematic and also in the silkscreen, and by placing the jumper on the pins next to the annotated mode. Auto mode: Diode emulation (discontinuous inductor current) and frequency foldback in light-load condition FPWM mode: Forced continuous conduction (continuous inductor current), constant frequency operation in light-load condition In addition to determining the mode of the device, this pin can be used for synchronization to the frequency and phase of an external signal source. The shunt should not be populated on the jumper if a synchronization signal is applied. Reference the data sheet for corresponding signal source requirements.
TP7, TP8	Test measurement point, or for applying an external signal source to synchronize the regulator to. The synchronization function is only to be used with the TPSM365R15FEVM (TPSM365R15FRDNR).
J3	Jumper for configuring the output voltage. Set the voltage by using the "key" annotated in the schematic and also in the silkscreen, and by placing the jumper on the pins next to the annotated output voltage.
TP9, TP10	Test points for applying an AC signal source (across an injection resistor) often used in evaluating the loop response in a current mode regulator, such as the TPSM365R15 or TPSM365R15F.

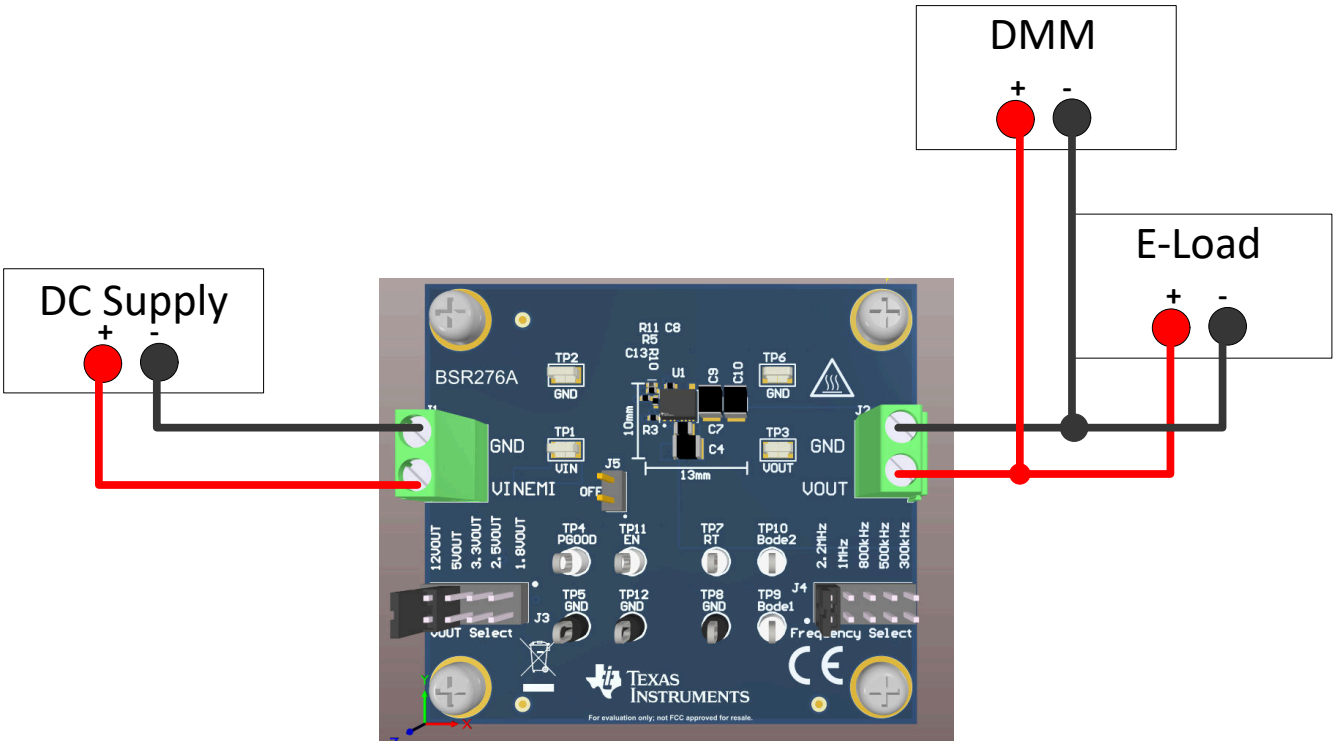

Figure 3-1. Test Setup Diagram

4 Schematic

Customers can choose to implement a PI filter in series with the input of a power regulator, which allows for the differential noise generated to be attenuated, allowing a noise emission regulation to be met. The filter crossover frequency is designed for 1-MHz switching frequency, attenuating the switching frequency and the corresponding harmonics greatly. A damping capacitor is provided (C5), to damp the high-Q, PI filter. For more information on filter damping, see Section 8.

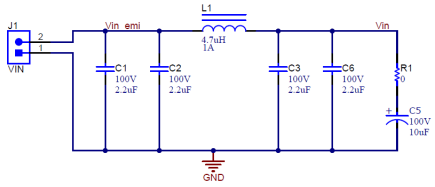

Figure 4-1. Schematic-Compliance Testing Filter

In the buck schematic, the difference between the TPSM365R15EVM and TPSM365R15FEVM is the REFDES=U1 device part number, with pin definition RT (adjustable frequency) or Mode/Sync (mode select or synchronization) differing. Additional feedback resistors are provided to program the different, possible output voltages and placeholders are supplied for additional output capacitance to achieve stability or meet a output transient specification.

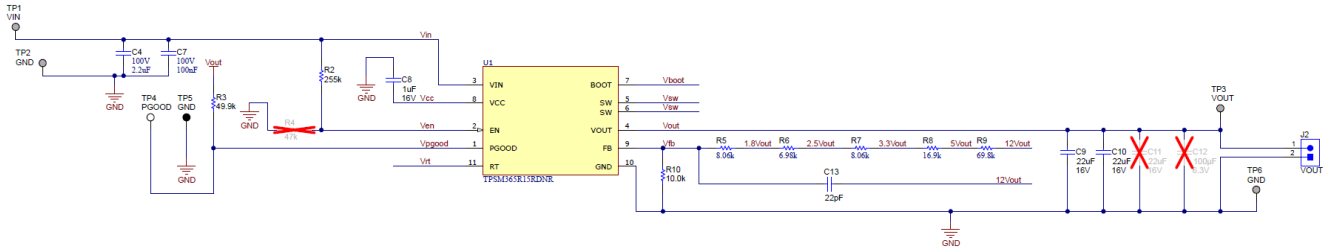

Figure 4-2. Schematic (TPSM365R15EVM) – TPSM365R15

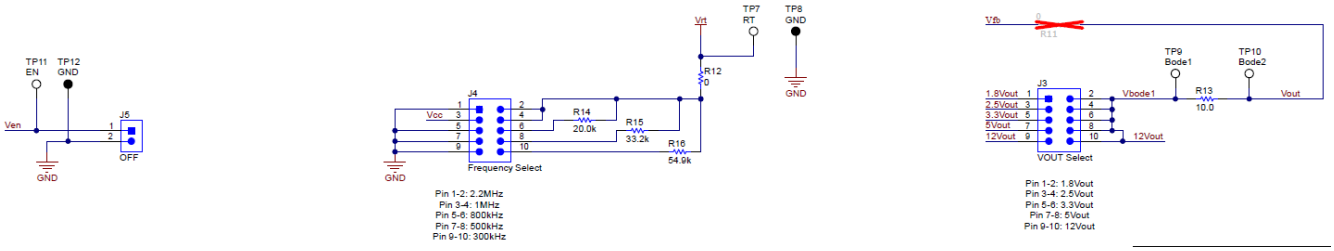

Figure 4-3. Schematic (TPSM365R15EVM) – Configuration Jumpers and Evaluation Test Points

A disable, frequency select, and output voltage select jumper are provided to aid the evaluation. Additionally, test points to evaluate product features and stability are provided.

The TPSM365R15RDNR can be configured for a fixed 3.3-V output by populating R11. Remove R10 to make sure of an accurate I_Q measurement for a fixed 3.3-V output.

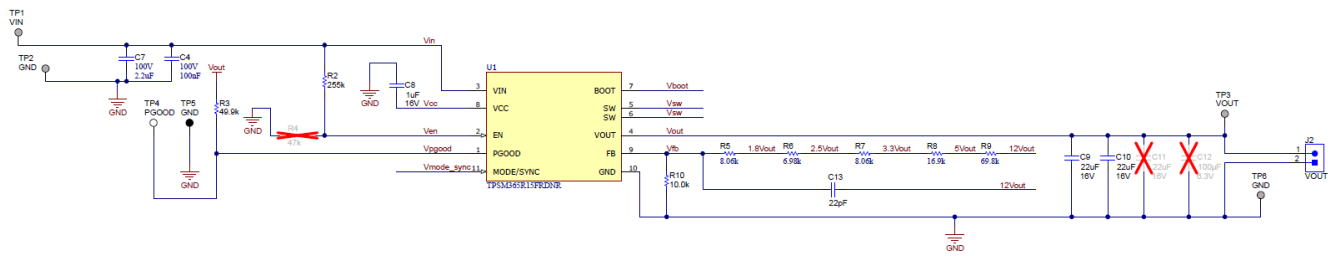

Figure 4-4. Schematic (TPSM365R15FEVM) – TPSM365R15F

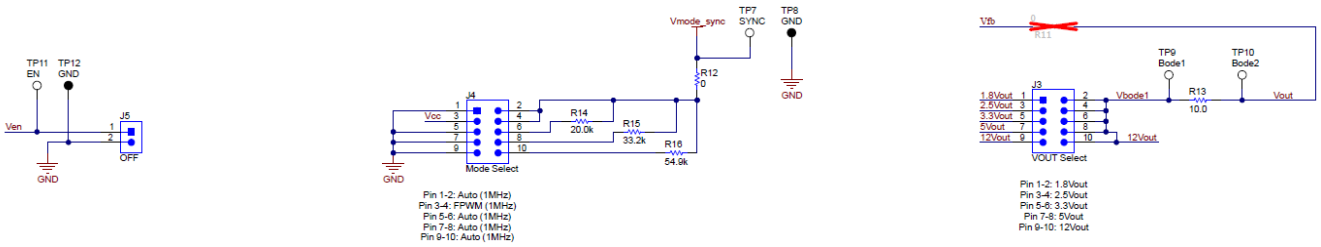

Figure 4-5. Schematic (TPSM365R15FEVM) – Configuration Jumpers and Evaluation Test Points

A disable, mode select or synchronization, and output voltage select jumper are provided to aid the evaluation. Additionally, test points to evaluate product features and stability are provided.

The TPSM365R15FRDNR can be configured for a fixed 5-V output by populating R11. Remove R10 to make sure of an accurate I_Q measurement for a fixed 5-V output.

5 TPSM365R15EVM and TPSM365R15FEVM Evaluation

The data was tested on unmodified EVM, configured for 1-MHz operation and 5 V_{OUT}, and was measured at 24 V_{IN} with a 150-mA load.

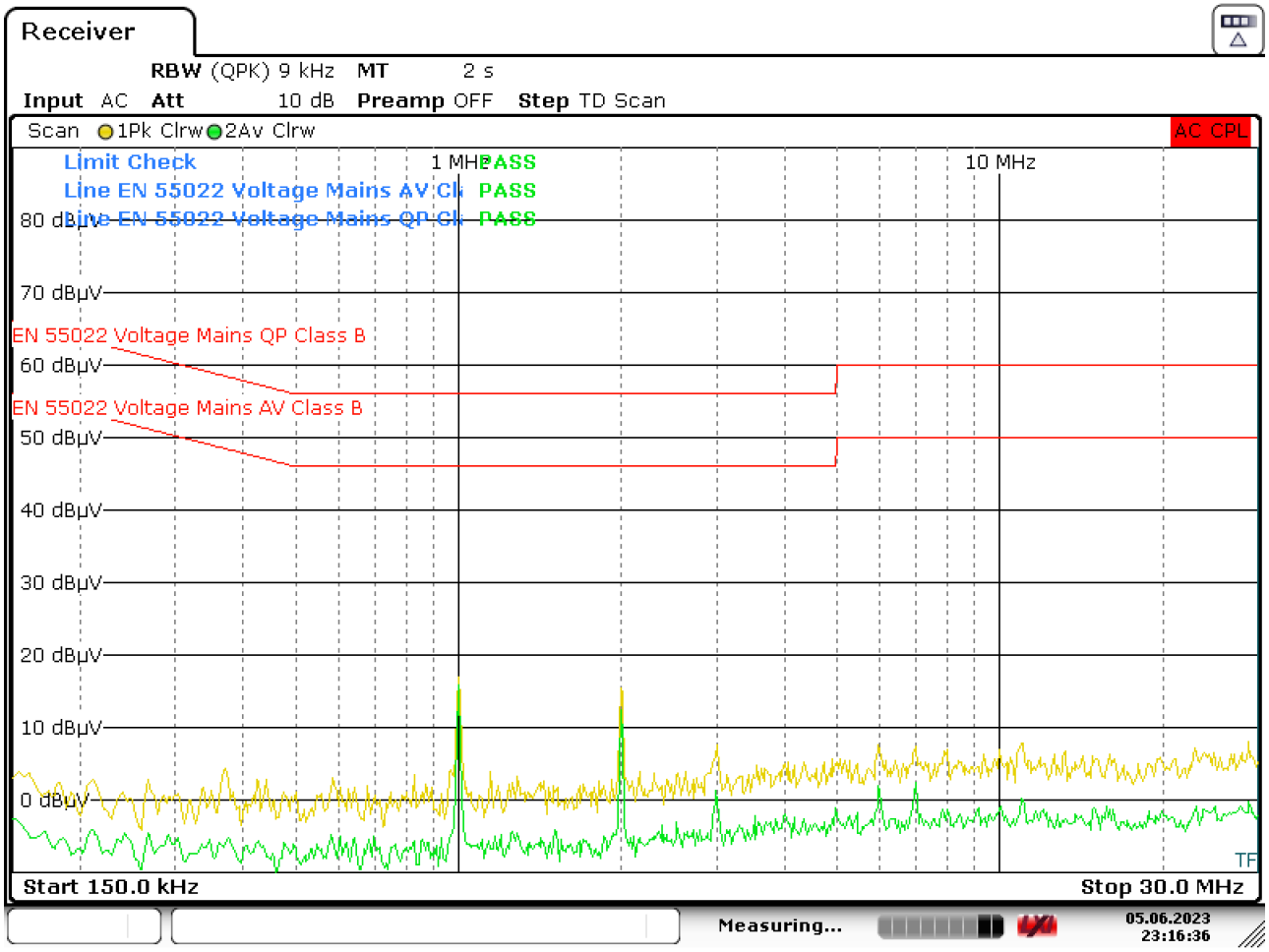

Figure 5-1. CISPR32 Conducted Scan

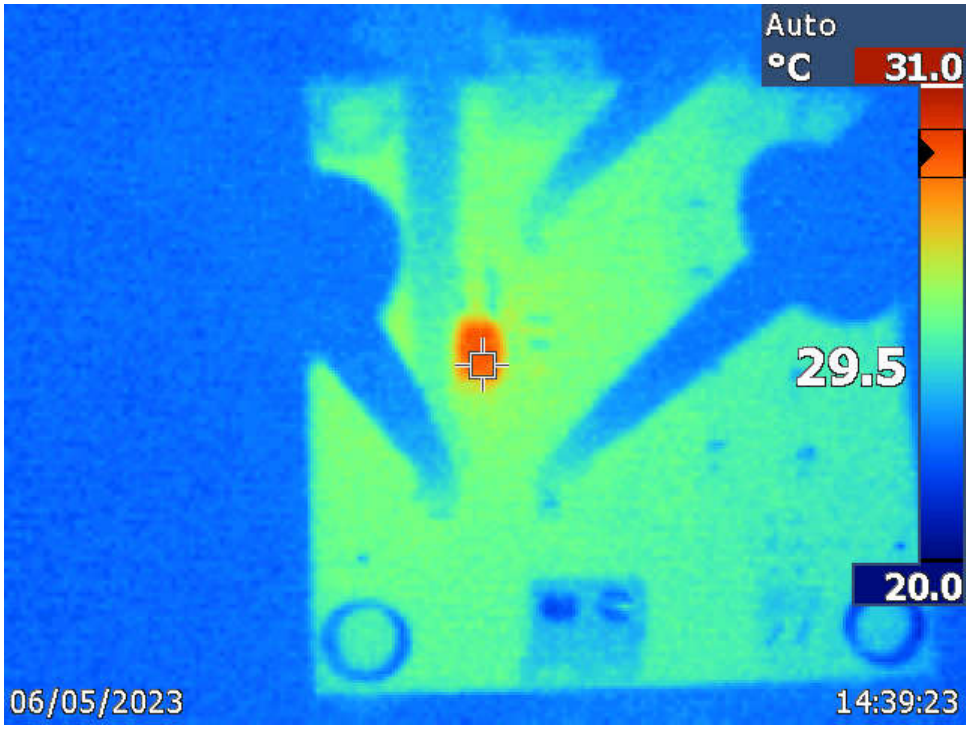

Figure 5-2. IR Top Case Measurement

6 Layout

The top silkscreen (that is, J4) differs between the TPSM365R15EVM and TPSM365R15FEVM, which is the only difference between the layer plots (no routing).

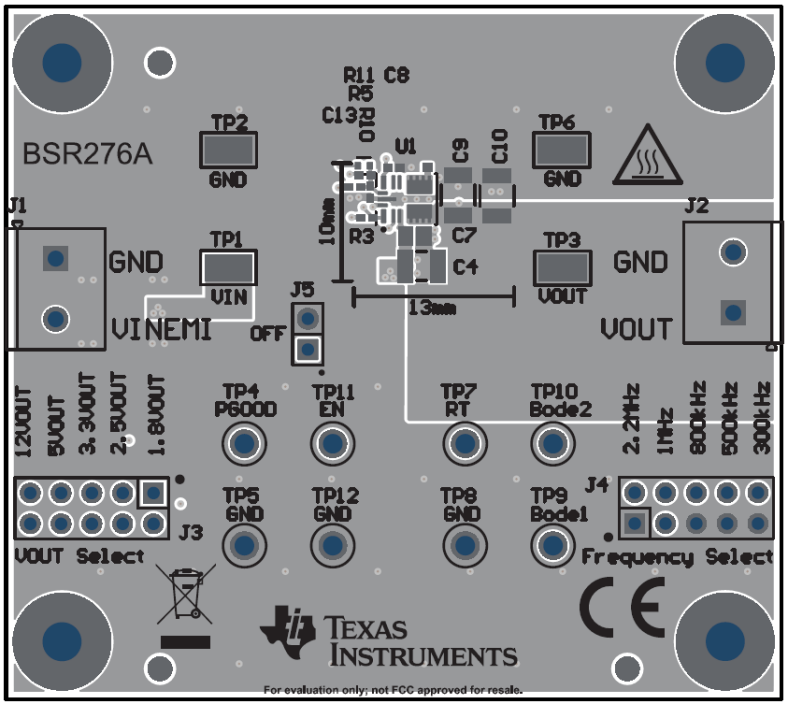

Figure 6-1. PCB Top 2-D (TPSM365R15EVM)

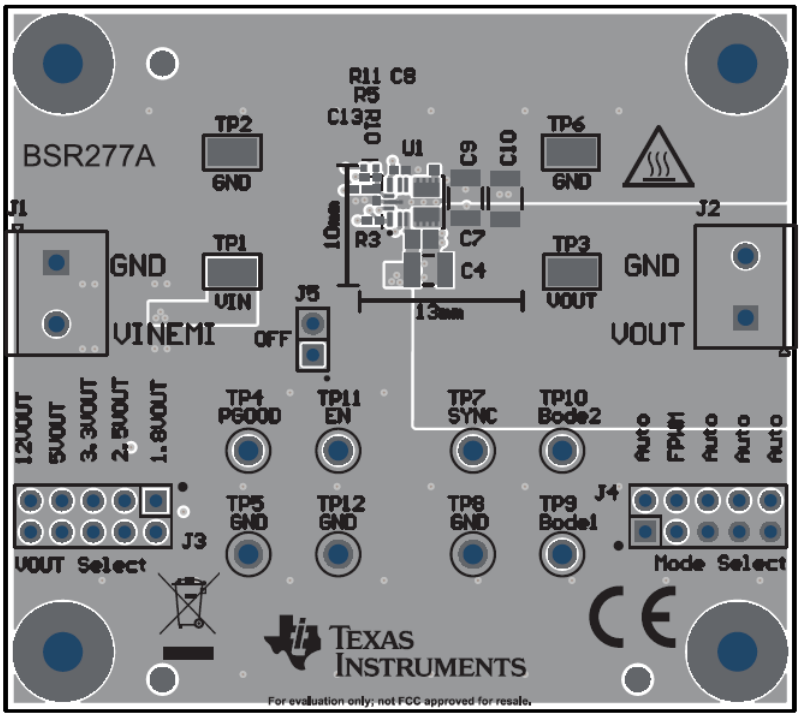

Figure 6-2. PCB Top 2-D (TPSM365R15FEVM)

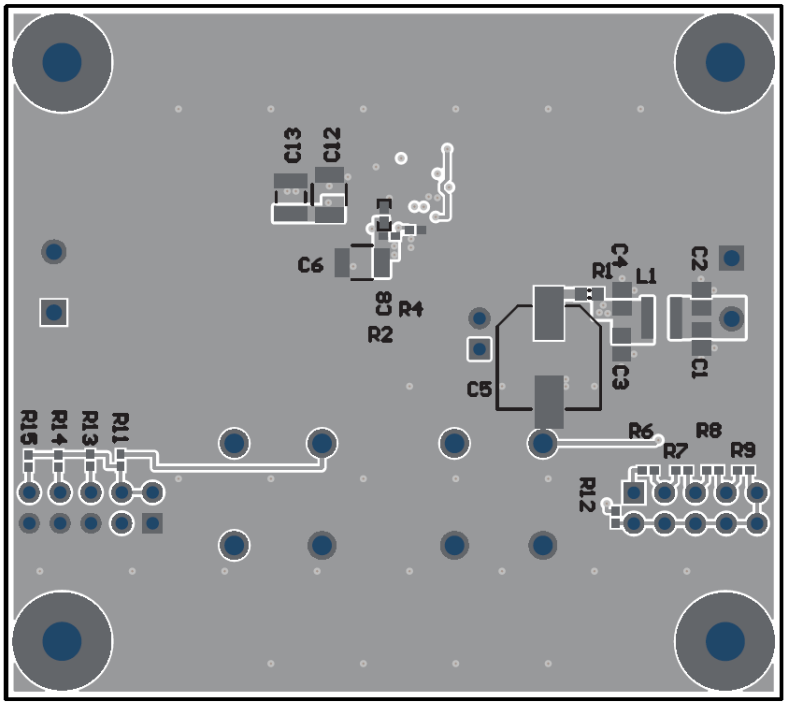

Figure 6-3. PCB Bottom 2-D

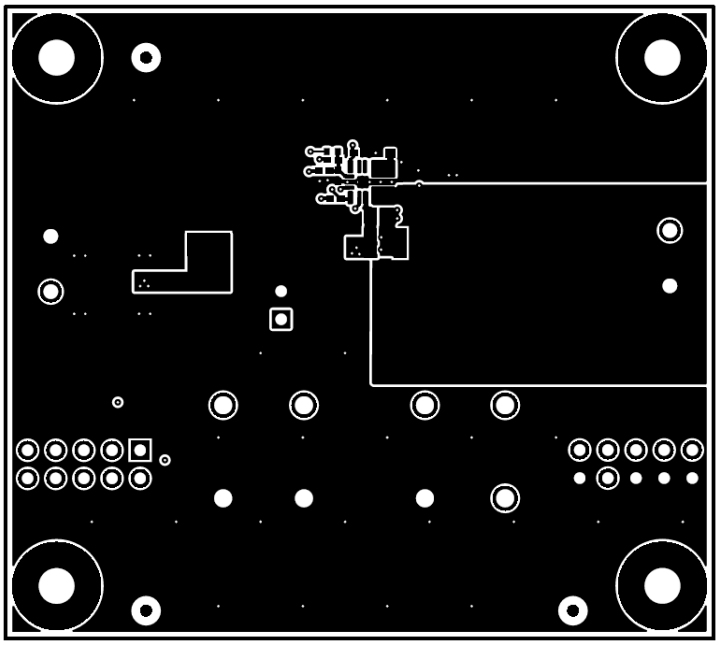

Figure 6-4. Top Layer

Reserved for solid ground plane for low-noise and optimized thermal design.

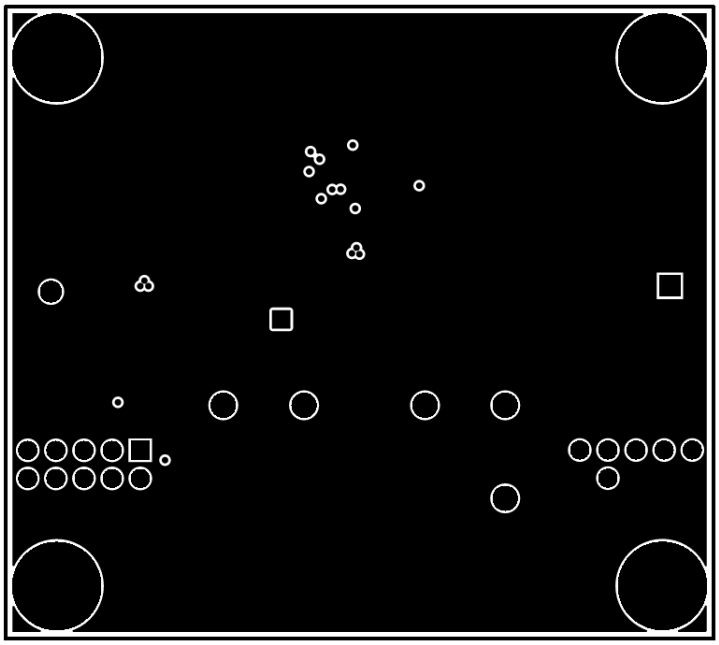

Figure 6-5. Mid Layer 1

Primary routing layer

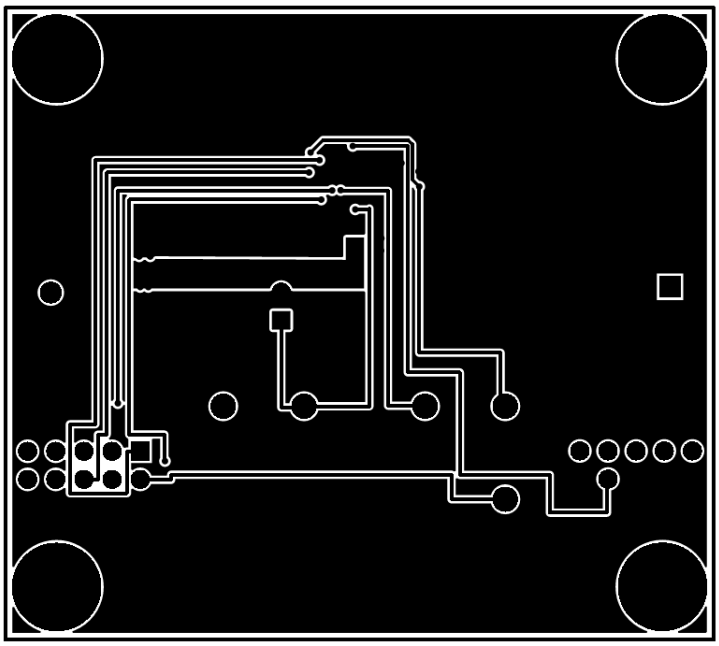

Figure 6-6. Mid Layer 2

Reserved for PI filter and non-critical passive component placement (minus input capacitor). An input capacitor is placed on the bottom side of the PCB as this placement provides a slightly lower input loop inductance. A single layer implementation is satisfactory as well.

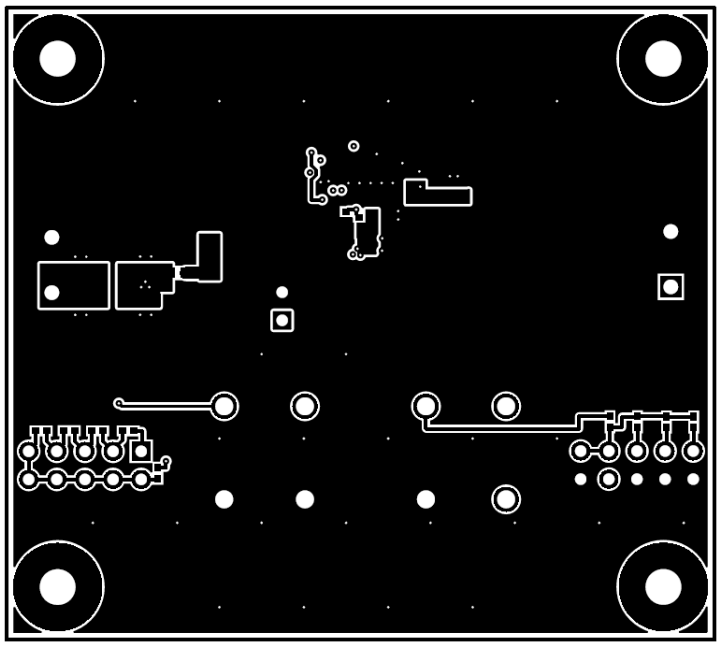

Figure 6-7. Bottom Layer

7 Bill of Materials

Fitted	Description	Designator	Part Number	Quantity	Manufacturer	Package Reference	Value
Fitted	CAP, CERM, 2.2 uF, 100 V, +/- 10%, X7R, AEC-Q200 Grade 1,	C1, C2, C3, C4, C6	CGA6N3X7R2A225K230AB	5	TDK		2.2 uF
Fitted	10 µF 100 V Aluminum - Polymer Capacitors Radial, Can - SMD 45mOhm 2000 Hrs @ 105°C	C5	875075955001	1	Wurth Electronics	SMT_CAP_8MM3_8MM3	10 µF
Fitted	CAP, CERM, 0.1 µF, 100 V,+/- 10%, X7R, 0805	C7	885012207128	1	Wurth Elektronik	0805	0.1 uF
Fitted	CAP, CERM, 1 uF, 16 V, +/- 10%, X5R, 0402	C8	EMK105BJ105KVHF	1	Taiyo Yuden	0402	1 uF
Fitted	CAP, CERM, 22 uF, 16 V, +/- 20%, X7R, AEC-Q200 Grade 1, 1210	C9, C10	CGA6P1X7R1C226M250AC	2	TDK	1210	22 uF
Fitted	CAP, CERM, 22 pF, 50 V, +/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0402	C13	CGA2B2NP01H220J050BA	1	TDK	0402	22 pF
Fitted	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	H1, H2, H3, H4	NY PMS 440 0025 PH	4	B&F Fastener Supply	Screw	
Fitted	TERM BLOCK 2POS 5mm, TH	J1, J2	1729018	2	Phoenix Contact	10x10x8.1 mm	
Fitted	Header, 100mil, 5x2, Tin, TH	J3, J4	PEC05DAAN	2	Sullins Connector Solutions	Header, 5x2, 100mil, Tin	
Fitted	Header, 100mil, 2x1, Gold, TH	J5	HTSW-102-07-G-S	1	Samtec	Header, 100mil, 2x1, TH	
Fitted	Inductor, Shielded, Powdered Iron, 4.7 uH, 1 A, 0.345 ohm, SMD	L1	74438324047	1	Wurth Elektronik	SMD, 2.5x2mm	4.7 uH
Fitted		MP1, MP2, MP3, MP4	1902D_Ndrill	4	Keystone Electronics	HEX_STANDOFF	
Fitted	RES, 0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	R1	RMCF0603ZT0R00	1	Stackpole Electronics Inc	0603	0
Fitted	RES, 255 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	R2	CRCW0402255KFKED	1	Vishay-Dale	0402	255k
Fitted	RES, 49.9 k, 1%, 0.063 W, 0402	R3	CRCW040249K9FKED	1	Vishay-Dale	0402	49.9k
Fitted	RES, 8.06 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	R5, R7	CRCW04028K06FKED	2	Vishay-Dale	0402	8.06k
Fitted	RES, 6.98 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	R6	CRCW04026K98FKED	1	Vishay-Dale	0402	6.98k
Fitted	RES, 16.9 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	R8	CRCW040216K9FKED	1	Vishay-Dale	0402	16.9k
Fitted	RES, 69.8 k, 1%, 0.063 W, 0402	R9	CRCW040269K8FKED	1	Vishay-Dale	0402	69.8k
Fitted	RES, 10.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	R10	CRCW040210K0FKED	1	Vishay-Dale	0402	10.0k
Fitted	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	R12	CRCW04020000Z0ED	1	Vishay-Dale	0402	0

Fitted	Description	Designator	Part Number	Quantity	Manufacturer	Package Reference	Value
Fitted	RES, 10.0, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	R13	CRCW040210R0FKED	1	Vishay-Dale	0402	10.0
Fitted	RES, 20.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	R14	CRCW040220K0FKED	1	Vishay-Dale	0402	20.0k
Fitted	RES, 33.2 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	R15	CRCW040233K2FKED	1	Vishay-Dale	0402	33.2k
Fitted	RES, 54.9 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	R16	CRCW040254K9FKED	1	Vishay-Dale	0402	54.9k
Fitted	Shunt, 100mil, Gold plated, Black	SH-J1, SH-J2	881545-2	2	TE Connectivity	Shunt 2 pos. 100 mil	
Fitted	Test Point, Miniature, SMT	TP1, TP2, TP3, TP6	5019	4	Keystone	Test Point, Miniature, SMT	
Fitted	Test Point, Multipurpose, White, TH	TP4, TP7, TP9, TP10, TP11	5012	5	Keystone Electronics	White Multipurpose Testpoint	
Fitted	Test Point, Multipurpose, Black, TH	TP5, TP8, TP12	5011	3	Keystone Electronics	Black Multipurpose Testpoint	
Fitted	Synchronous Buck Converter Power Module, QFN-FCMOD11	U1	TPSM365R15RDNR/TPSM365R15FRDNR	1	Texas Instruments	QFN-FCMOD11	
Not Fitted	CAP, CERM, 22 uF, 16 V, +/- 20%, X7R, AEC-Q200 Grade 1, 1210	C11	CGA6P1X7R1C226M250AC	0	TDK	1210	22 uF
Not Fitted	CAP, CERM, 100 µF, 6.3 V,+/- 20%, X7S, 1210	C12	GRM32EC70J107ME15L	0	MuRata	1210	100 uF
Not Fitted	Fiducial mark. There is nothing to buy or mount.	FID1, FID2, FID3	N/A	0	N/A	N/A	
Not Fitted	RES, 47 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	R4	CRCW040247K0JNED	0	Vishay-Dale	0402	47k
Not Fitted	Res Thick Film 0402 0 Ohm Jumper Molded SMD Paper T/R	R11	RMCF0402ZT0R00	0	Stackpole	0402	0

8 Reference

Texas Instruments, *Input Filter Design for Switching Power Supplies* application report

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。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

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東京都新宿区西新宿 6 丁目 2 4 番 1 号

西新宿三井ビル

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

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

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.

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, INDEMITY 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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