TPSM84A21 and TPSM84A22, 10-A, SWIFT™ Power Module Evaluation Module

This user's guide contains information for the TPSM84A21EVM-808 and TPSM84A22EVM-809 evaluation modules (PWR808 and PWR809). Also included are the performance specifications, schematic, bill of materials, and layout of the EVMs.

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1 Description

The TPSM84A21 and TPSM84A22 are synchronous buck power modules designed to provide up to 10 A of output current. The TPSM84A21 and TPSM84A22 power modules combine the TPS54A20, a 10-A DC/DC synchronous series capacitor buck converter with power MOSFETs, shielded inductors, input and output capacitors, and passive components into a low-profile package. The input voltage range of both devices is 8 V to 14 V. See Figure 11 of the TPSM84A22 datasheet for the minimum required input voltage for VOUT > 1.5 V. The output voltage ranges of both devices are given in Table 1. The output voltage of the EVM can be set to one of five popular values by using a configuration jumper.

This evaluation module is designed to demonstrate the ease-of-use and small printed-circuit board (PCB) area possible when designing with the TPSM84A21 and TPSM84A22 power modules. Monitoring test points are provided to allow measurement of efficiency, power dissipation, input ripple, output ripple, line and load regulation, and transient response. Additionally, control test points are provided for use of the power good, inhibit control, and undervoltage lockout features of the device. The EVM uses a recommended PCB layout that maximizes thermal performance and minimizes output ripple and noise.

Table 1. Output Voltage Range

EVM	Output Voltage Range
TPSM84A21EVM-808	0.55 V to 1.3 V
TPSM84A22EVM-809	1.2 V to 2.05 V

2 Getting Started

Figure 1 highlights the user interface items associated with the EVM. The polarized VIN power terminal block (TB1) is used for connection to the host input supply and the polarized VOUT power terminal block (TB2) is used for connection to the load. These terminal blocks can accept up to 16-AWG wire.

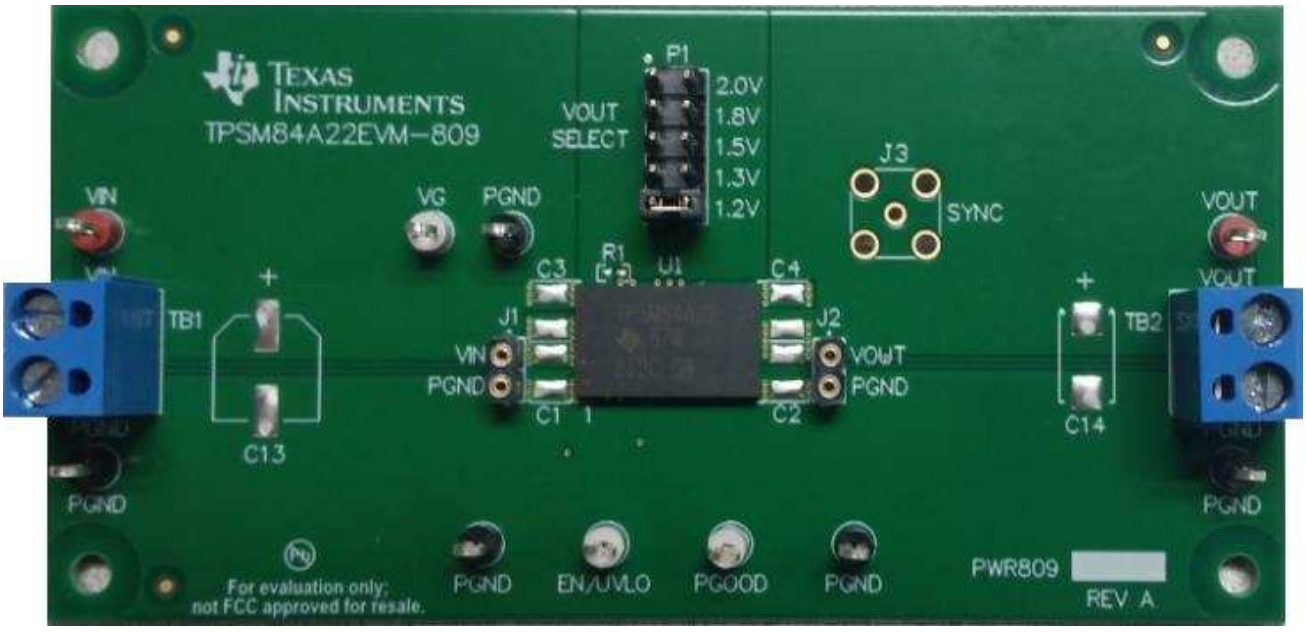


Figure 1. EVM User Interface

The VIN monitor and VOUT monitor test points 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. The voltmeter references should be connected to the PGND test points located beneath the power terminal blocks. Do not use these VIN and VOUT 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.

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The VIN scope (J1) and VOUT scope (J2) 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 barrel. The two sockets of each test point are on 0.1-inch centers. The scope probe tip should be connected to the socket labeled VIN or VOUT, and the scope ground lead should be connected to the socket labeled PGND.

The test points located directly below the device are made available to test the features of the device. Any external connections made to these test points should be referenced to one of the PGND test points located along the bottom of the EVM. Refer to *Test Point Descriptions* for more information on the individual control test points.

The VOUT SELECT jumper (P1) is provided for selecting the desired output voltage. Before applying power to the EVM, ensure that the jumper is present and properly positioned for the intended output voltage.

3 Test Point Descriptions

Wire-loop test points and scope probe test points are provided as convenient connection points for digital voltmeters (DVM) or oscilloscope probes to aid in the evaluation of the device. A BNC connector footprint (J3) is available if a synchronization clock is required. Table 2 lists a description of each test point.

Table 2. Test Point Descriptions

Pin	Description
VIN	Input voltage monitor. Connect DVM to this point for measuring efficiency.
VOUT	Output voltage monitor. Connect DVM to this point for measuring efficiency, line regulation, and load regulation.
PGND	Input and output voltage monitor grounds. Reference the previously mentioned DVMs to any of these four analog ground points.
VIN Scope (J1)	Input voltage scope monitor. Connect an oscilloscope to this set of points to measure input ripple voltage.
VOUT Scope (J2)	Output voltage scope monitor. Connect an oscilloscope to this set of points to measure output ripple voltage and transient response.
EN/UVLO	Connect this point to control ground to disable the device. Allow this point to float to enable the device. An external resistor divider can be connected between this point, control ground, and VIN to adjust the undervoltage lockout of the device.
PGOOD	Monitors the power good signal of the device. This is an open-drain signal that requires an external pullup resistor if monitoring is desired. A 10- to 100-kΩ pullup resistor is recommended. PWRGD is high if the output voltage is within 95% to 105% of its nominal value.
SYNC (J3)	Connects to the RT/CLK pin of the device. An external clock signal can be applied to this point to synchronize the device to an appropriate frequency.
VG	Gate driver supply pin. If supplying an external 5-V supply, connect to this test point.

NOTE: Refer to the appropriate product data sheet for absolute maximum ratings associated with the previously-listed features:

- *TPSM84A21, 8V to 14V Input, 0.55V to 1.35V Output, 10-A SWIFT Power Module* (SLVSDF7)
- *TPSM84A22, 8V to 14V Input, 1.2V to 2.05V Output, 10-A SWIFT Power Module* (SLVSDF8)

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4 Operation Notes

In order to operate the EVM, the input voltage must increase above the UVLO threshold of the device. The UVLO threshold of the EVM is approximately 7.65 V with 200 mV of hysteresis. To adjust the UVLO threshold to a higher voltage, the values of R8 and R9 on the EVM can be adjusted as described in the product datasheet. The maximum operating input voltage for the device is 14 V. Refer to the product datasheet for further information on the input voltage range and UVLO operation.

The minimum input voltage for the TPSM84A22 is 8 V or (VOUT x 5.3), whichever is greater.

The soft start time is a fixed value and cannot be adjusted. After application of the proper input voltage, the output voltage of the device will ramp to its final value in approximately 4.1 ms.

The Power Good (PGOOD) indicator of the EVM will assert high when the output voltage is within ±5% of the programmed output voltage value. A 100-kΩ pull-up resistor (R11) is populated between the PGOOD pin and the VG pin. The voltage on the VG pin is 4.8 V (typ). The VG and corresponding PGND test points are not loaded on the EVM. If driving the VG pin is required, test points can be added to the EVM.

The current limit of the device can be set to 11.25 A (typ) by placing a 47-kΩ resistor between ILIM and PGND. The EVM has a footprint for this resistor, R10, if needed.

The TPSM84A21 and TPSM84A22 nominal switching frequency is 4 MHz with a range of 3.7 MHz to 4.3 MHz when free-running. If an exact switching frequency is required, both devices can be synchronized to an external clock over the frequency range of 3.6 MHz to 4.4 MHz. Refer to the product datasheet for further information on synchronization.

The TPSM84A21 and TPSM84A22 both include input and output capacitors internal to the device. For most applications, no additional output capacitors are required. The EVM includes footprints for adding input and output capacitors to the EVM. Adding additional capacitance will improve transient response. The actual capacitance required will depend on the input and output voltage conditions of the particular application, along with the desired transient response. Refer to the product datasheet for further information on input and output capacitance and transient response.

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5 Performance Data

The graphs and waveforms in Figure 2 to Figure 7 demonstrate the performance of the TPSM84A22EVM.

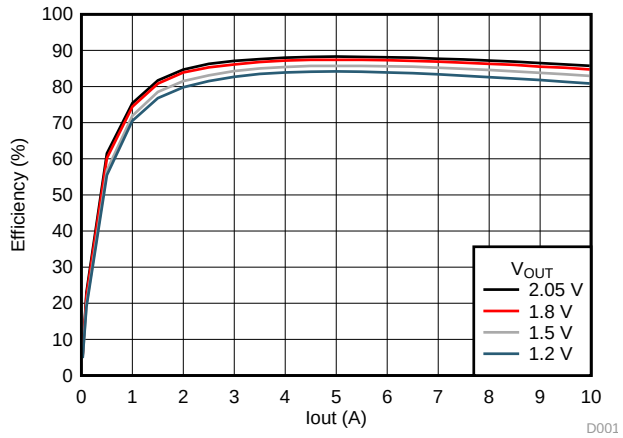


Figure 2. TPSM84A22EVM Efficiency (VG = OPEN)

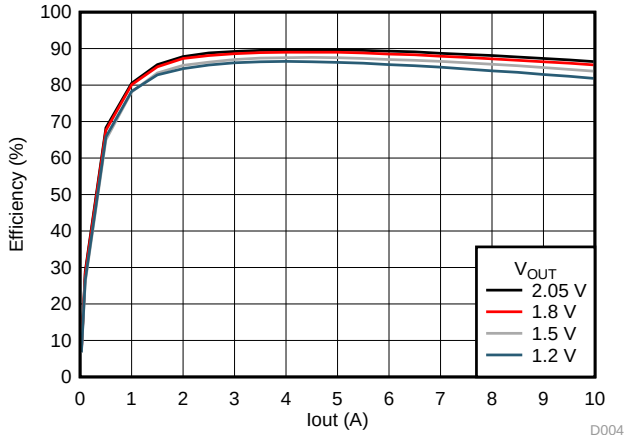


Figure 3. TPSM84A22EVM Efficiency (VG = 5V)

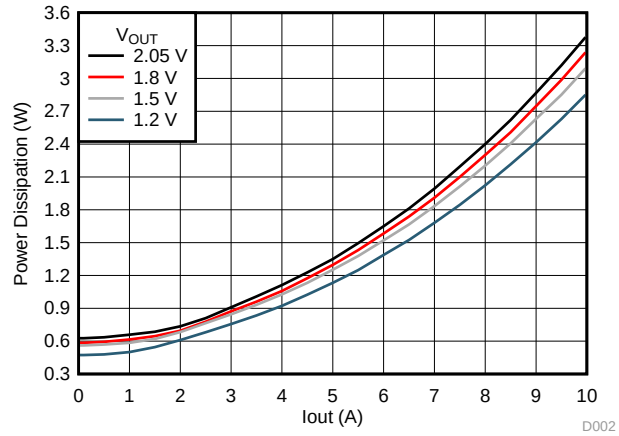


Figure 4. TPSM84A22EVM Power Dissipation

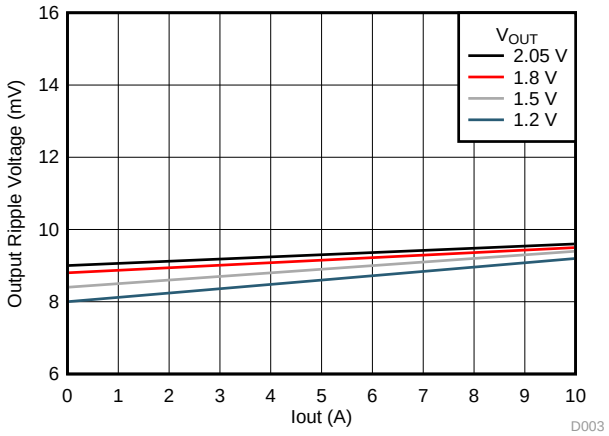
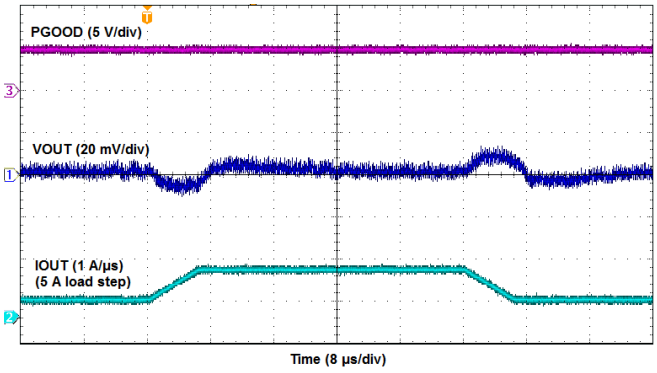
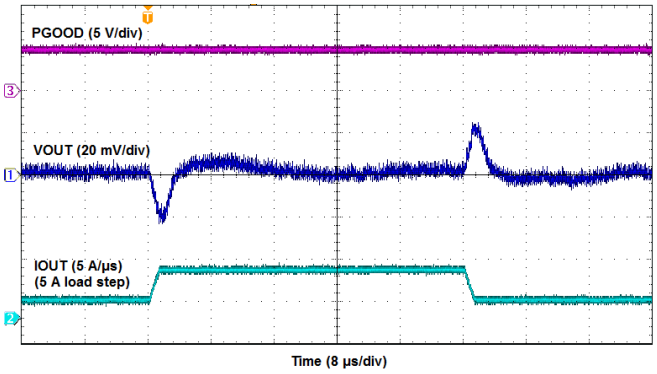


Figure 5. TPSM84A22EVM Output Voltage Ripple



VIN = 12 V, VOUT = 1.2 V, Load Step = 5 A, COUT = 0 µF, Slew Rate = 1 A/µs

Figure 6. Output Current Transient Waveforms



VIN = 12 V, VOUT = 1.2 V, Load Step = 5 A, COUT = 0 µF, Slew Rate = 5 A/µs

Figure 7. Output Current Transient Waveforms

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6 Schematic

Figure 8 illustrates the TPSM84A21 EVM schematic.

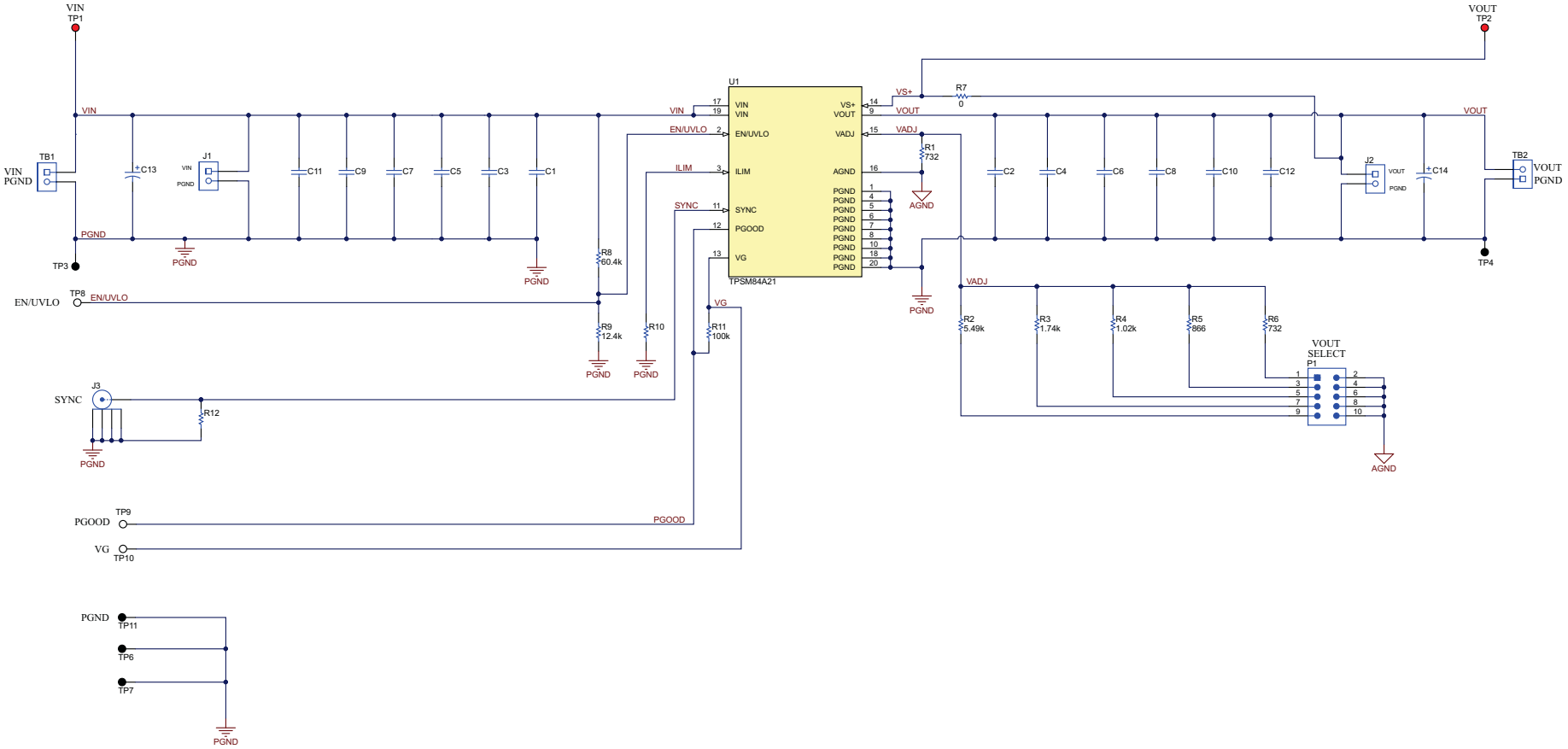


Figure 8. TPSM84A21EVM Schematic

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7 Bill of Material

Table 3 lists the EVM bill of materials.

Table 3. Bill of Material

DESIGNATOR	QUANTITY		DESCRIPTION	PART NUMBER	MANUFACTURER
	PWR808	PWR809			
PCB	1	1	Printed Circuit Board	PWR808	Any
U1	1	0	TPSM84A21, 10A, SWIFT Power Module	TPSM84A21MOJ	Texas Instruments
	0	1	TPSM84A22, 10A, SWIFT Power Module	TPSM84A22MOJ	Texas Instruments
C1, C3, C5, C7, C9, C11	0	0	CAP, CERM, 22 µF, 25 V, +/- 10%, X5R, 1210	GRM32ER61E226KE15L	MuRata
C2, C4, C6, C8, C10, C12	0	0	CAP, CERM, 47 µF, 10 V, +/- 10%, X5R, 1210	GRM32ER61A476KE20L	MuRata
C13	0	0	CAP, Aluminum Polymer, 100 µF, 25 V, +/- 20%, 0.024 ohm, 8.0x7.0mm SMD	25SVPF100M	Panasonic
C14	0	0	CAP, Tantalum Polymer, 220 µF, 10 V, +/- 20%, 0.025 ohm, 7343-30 SMD	10TPE220ML	Panasonic
J1, J2	2	2	Socket Strip, 2x1, 100mil, Black, Tin, TH	310-43-102-41-001000	Mill-Max
J3	0	0	Connector, SMB,Vertical RCP 0-4GHz, 50 ohm, TH	131-3701-261	Emerson Network Power
P1	1	1	Header, 100mil, 5x2, Tin, TH	PEC05DAAN	Sullins Connector Solutions
R1	0	0	RES, 732, 1%, 0.063 W, 0402	CRCW0402732RFKED	Vishay-Dale
R2	1	0	RES, 5.49 k, 1%, 0.1 W, 0603	CRCW06035K49FKEA	Vishay-Dale
	0	1	RES, 732, 1%, 0.1 W, 0603	CRCW0603732RFKEA	Vishay-Dale
R3	1	0	RES, 1.74 k, 1%, 0.1 W, 0603	CRCW06031K74FKEA	Vishay-Dale
	0	1	RES, 649, 1%, 0.1 W, 0603	CRCW0603649RFKEA	Vishay-Dale
R4	1	0	RES, 1.02 k, 1%, 0.1 W, 0603	CRCW06031K02FKEA	Vishay-Dale
	0	1	RES, 511, 1%, 0.1 W, 0603	CRCW0603511RFKEA	Vishay-Dale
R5	1	0	RES, 866, 1%, 0.1 W, 0603	CRCW0603866RFKEA	Vishay-Dale
	0	1	RES, 392, 1%, 0.1 W, 0603	CRCW0603392RFKEA	Vishay-Dale
R6	1	0	RES, 732, 1%, 0.1 W, 0603	CRCW0603732RFKEA	Vishay-Dale
	0	1	RES, 340, 1%, 0.1 W, 0603	CRCW0603340RFKEA	Vishay-Dale
R7	1	1	RES, 0, 5%, 0.1 W, 0603	CRCW06030000Z0EA	Vishay-Dale
R8	1	1	RES, 60.4 k, 1%, 0.1 W, 0603	CRCW060360K4FKEA	Vishay-Dale
R9	1	1	RES, 12.4 k, 1%, 0.1 W, 0603	CRCW060312K4FKEA	Vishay-Dale
R10	0	0	RES, 47 k, 5%, 0.1 W, 0603	CRCW060347K0JNEA	Vishay-Dale
R11	1	1	RES, 100 k, 5%, 0.063 W, 0402	CRCW0402100KJNED	Vishay-Dale
R12	0	0	RES, 49.9, 1%, 0.75 W, AEC-Q200 Grade 0, 2010	CRCW201049R9FKEF	Vishay-Dale
SH-P1	1	1	Shunt, 2mm, Gold plated, Black	2SN-BK-G	Samtec
TB1, TB2	2	2	Terminal Block, 5.08 mm, 2x1, Brass, TH	ED120/2DS	On-Shore Technology
TP1, TP2	2	2	Test Point, Multipurpose, Red, TH	5010	Keystone
TP3, TP4, TP6, TP7, TP11	5	5	Test Point, Multipurpose, Black, TH	5011	Keystone
TP8, TP9, TP10	3	3	Test Point, Multipurpose, White, TH	5012	Keystone

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8 PCB Layout

Figure 9 through Figure 14 display the EVM PCB layouts.

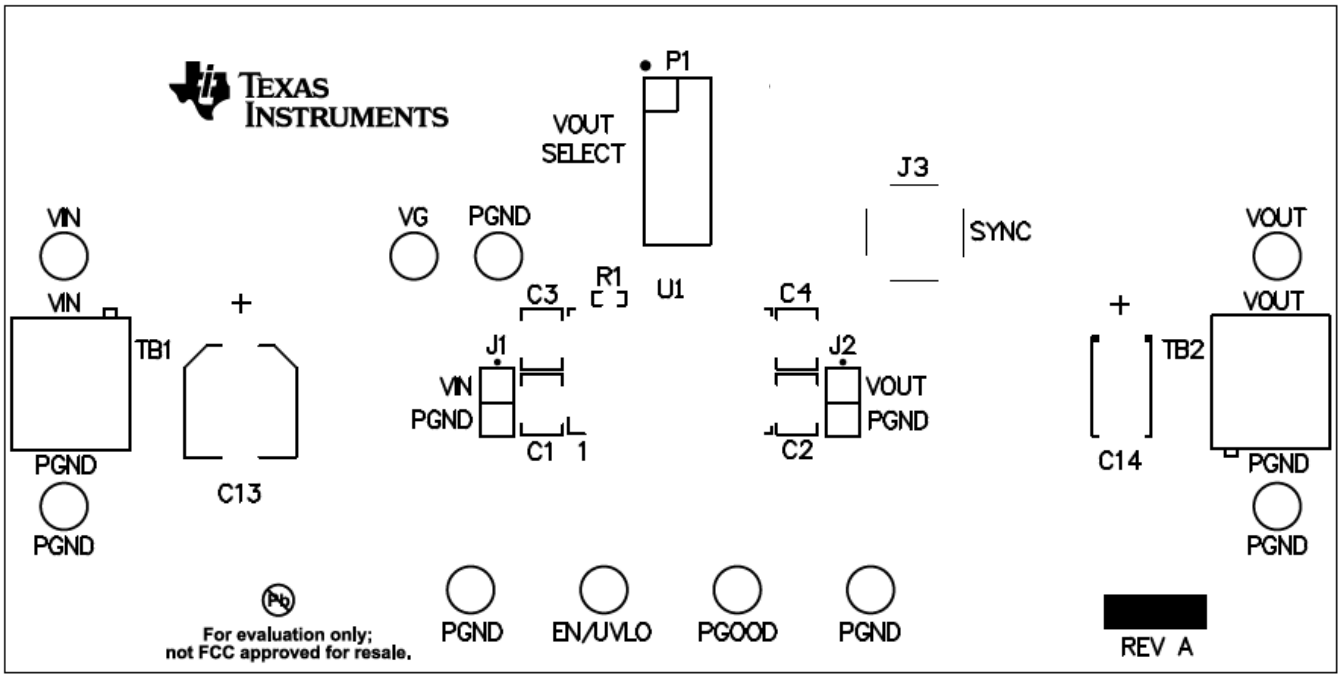


Figure 9. Topside Component Layout

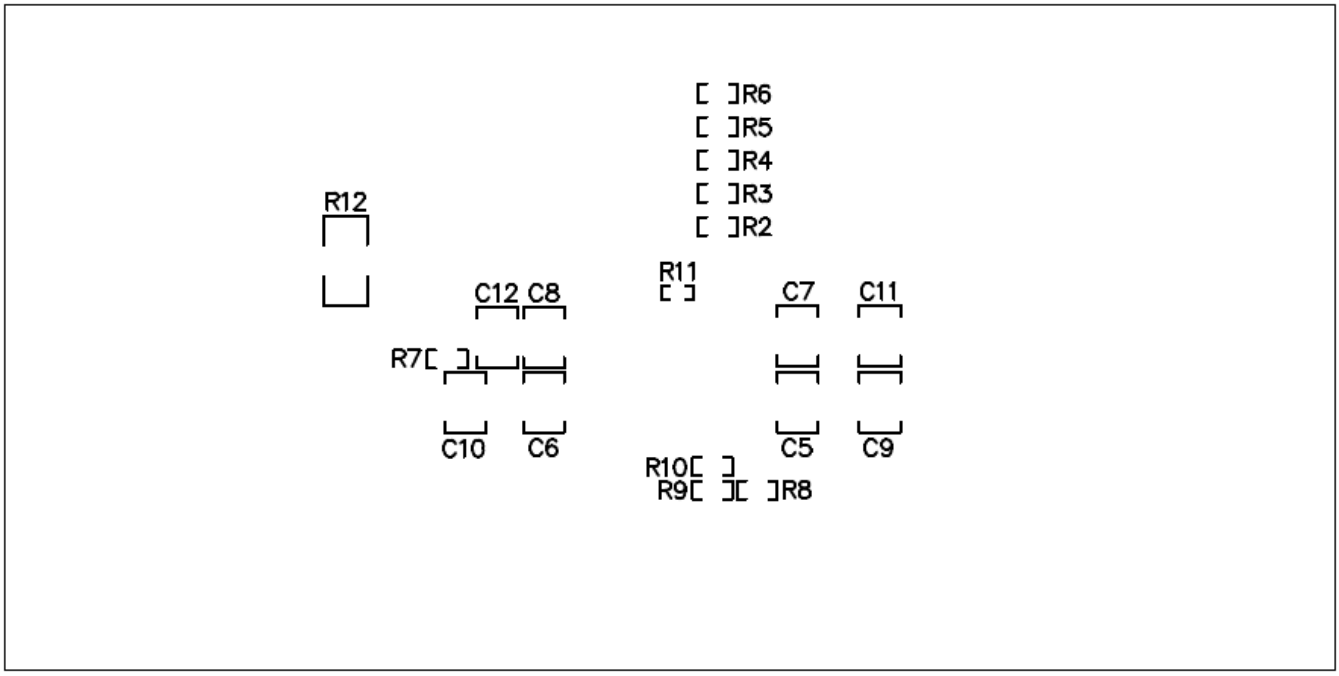


Figure 10. Bottom-Side Component Layout

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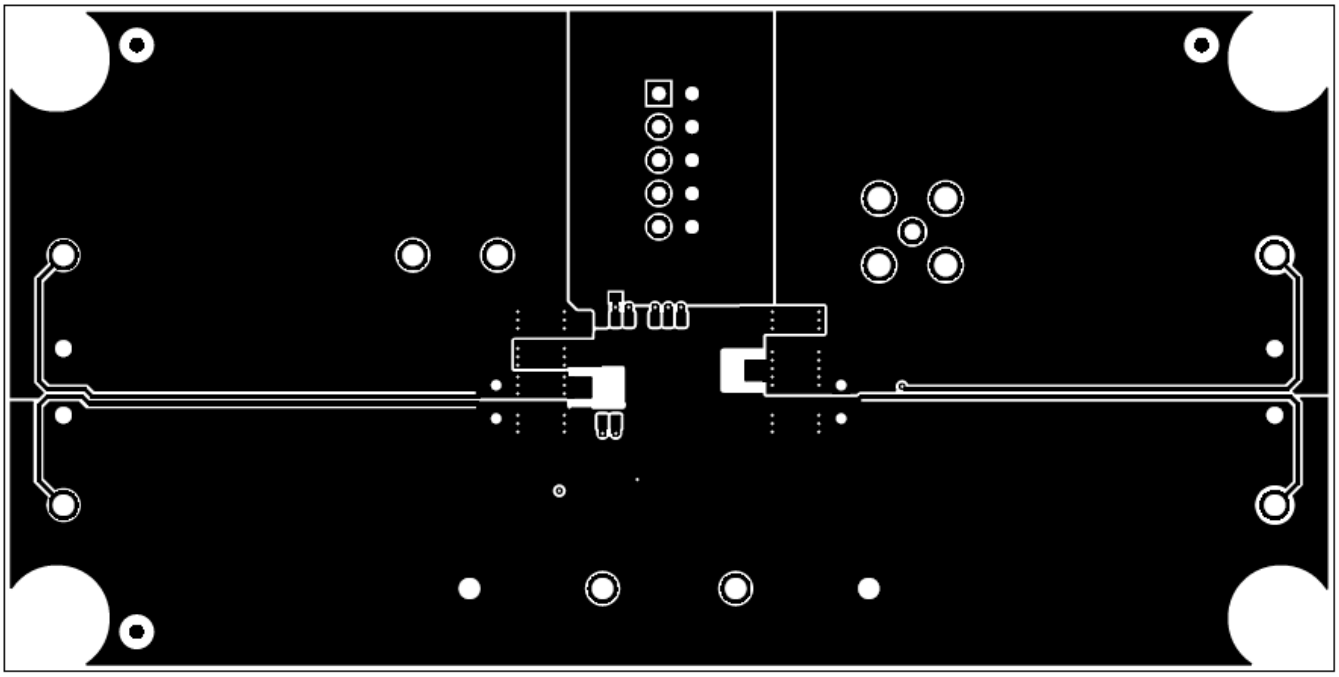


Figure 11. Top Copper

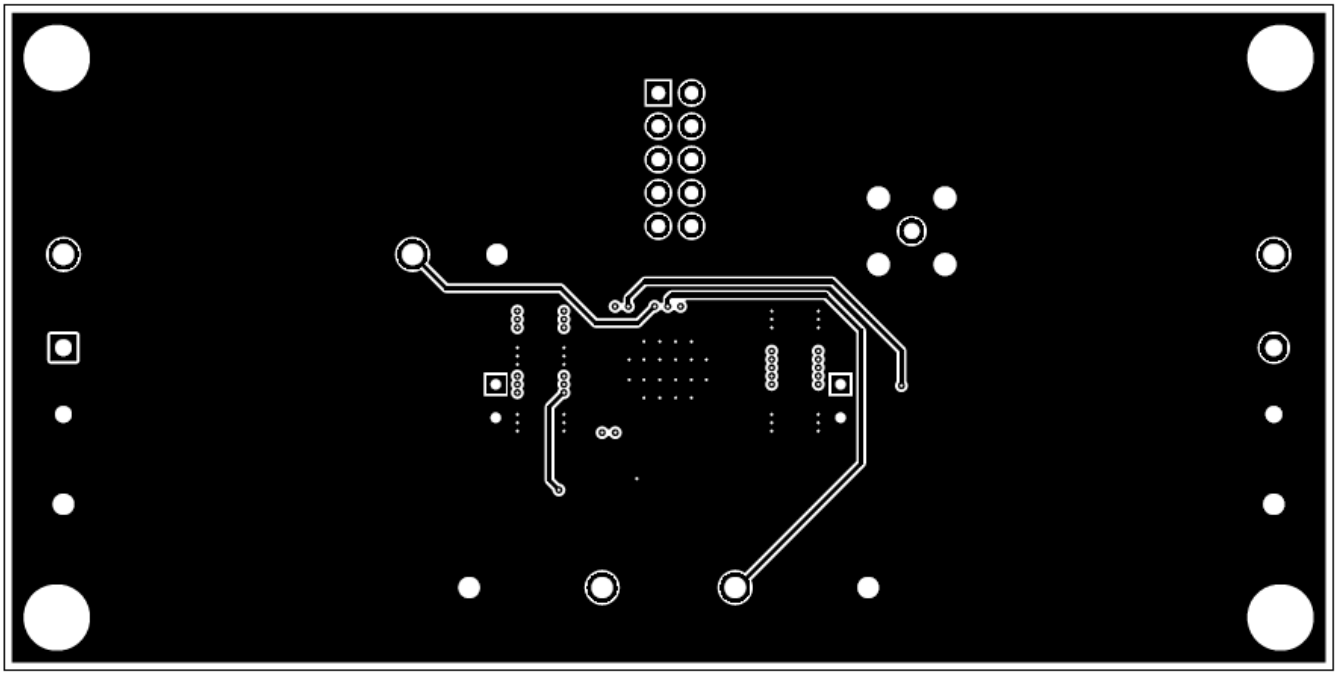


Figure 12. Layer 2 Copper

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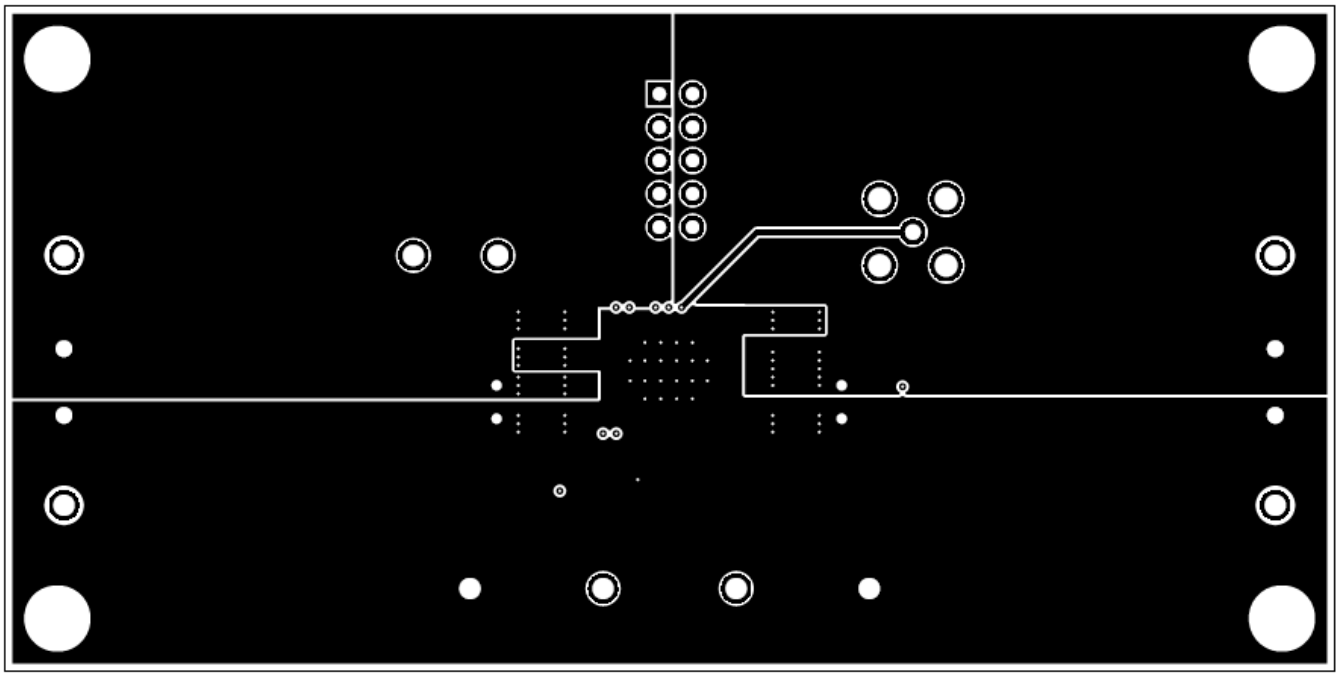


Figure 13. Layer 3 Copper

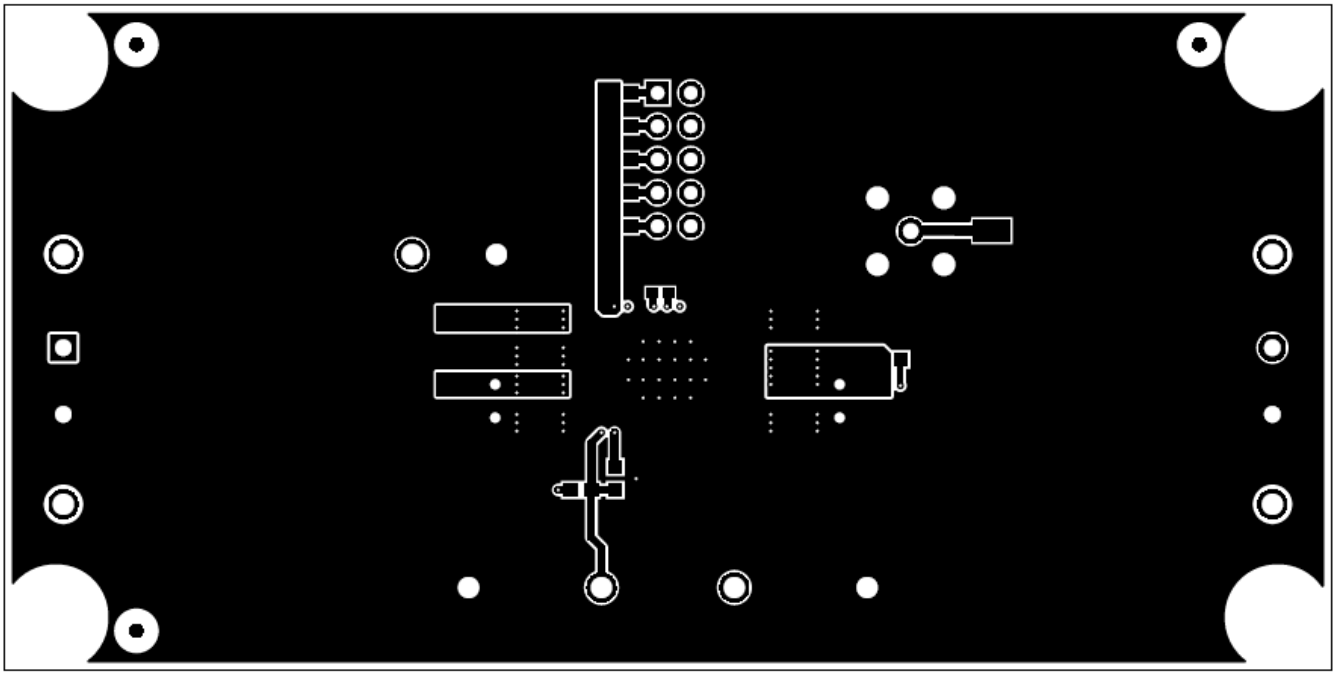


Figure 14. Bottom Copper

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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 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 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/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。
http://www.tij.co.jp/lsds/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/lsds/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:*

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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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