TPS55288EVM-045 Evaluation Module

This user's guide describes the characteristics, operation, and the use of the TPS55288EVM-045 evaluation module (EVM). The EVM contains the TPS55288, which is a high performance, high efficiency synchronous buck-boost converter which integrates two 16-A MOSFETs at the boost leg. The user's guide includes EVM specifications, recommended test setup, test result, schematic diagram, bill of materials, and the board layout.

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Trademarks

1 Introduction

1.1 Performance Specification

Table 1 provides a summary of the TPS55288 EVM performance specifications. All specifications are given for an ambient temperature of 25°C.

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Table 1. Performance Specification Summary

PARAMETER	TEST CONDITION	VALUE	UNIT
Input Voltage	N/A	2.7 - 36	V
Output Voltage	N/A	0.8 - 20	V
Maximum Output Current	Vin ≥ 5 V, Vout = 10 V;	5	A
	Vin ≥ 6 V, Vout = 12 V;		
	Vin ≥ 12 V, Vout = 20 V;		
Default Switching Frequency	N/A	400	kHz

1.2 Modification

The printed-circuit board (PCB) for this EVM is designed to accommodate some modifications by the user. The external component can be changed according to the real application.

1.2.1 Modification

This EVM requires an appropriate I2C interface, such as the TI USB2ANY, to configure the TPS55288.

2 Connector, Test Point and Jumper Descriptions

This section describes how to properly connect, set up, and use the TPS55288EVM-045.

2.1 Connector and Test Point Descriptions

This EVM includes I/O connectors and test points as shown in Table 2. The power supply must be connected to input connectors, J1 and J2. The load must be connected to output connectors, J3 and J4.

Table 2. Connectors and Test Points

REFERENCE DESIGNATOR	DESCRIPTION
J1	Input voltage positive connection
J2	Input voltage return connection
J3	Output voltage connection
J4	Output voltage return connection
J7	I²C Connector

2.2 Jumper Configuration

2.2.1 JP1 (ENABLE)

The JP1 jumper enables the device. By default, this jumper is set to the ON position. Put this jumper in the OFF position to disable the output.

2.2.2 JP2 and JP3 (External Feedback and Internal Feedback Selection)

The JP2 jumper is for the external feedback or the internal feedback selection. By default, this jumper is set to the FB_INT position. Place this jumper in the FB_EXT position for the external output voltage feedback.

The JP3 jumper is for the external feedback connection. Placing a jumper across JP3 when uses external feedback. Left JP3 opens when uses internal feedback.

When using external output voltage feedback, the output voltage is determined by the following equation:

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R_{FB_UP}}{R_{FB_BT}}\right) \quad (1)$$

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It is recommended to use 100 kΩ for the up resistor RFB_UP. The reference voltage VREF at the FB/INT pin is programmable from 45 mV to 1.2 V by writing a 10-bit data into the register 00H and 01H.

2.2.3 JP4 (SYNC)

The JP4 jumper is for the frequency dithering selection. Placing a jumper across JP4 disables the frequency dithering function. Left JP4 opens when using frequency dithering function.

3 Test Procedure

Step 1: Set the power supply current limit to 20 A. Set the power supply to something around 10 V. Turn off the power supply. Connect the positive output of the power supply to J1 and the negative output to J2.

Step 2: Connect the load to J3 for the positive connection and J4 for the negative connection.

Step 3: Turn on the power supply.

Step 4: Enable the IC with GUI. The default output voltage is 5 V.

Step 5: Set the output voltage to the target value on the GUI user interface page.

Step 6: Slowly increase the load while monitoring the output voltage between J3 and J4. It must remain in regulation when the load current is lower than 5 A.

Step 7: Slowly sweep the input voltage from 5 V to 20 V. The output voltage must remain in regulation when the load current is lower than the maximum load current specified in Table 2.

Step 8: Turn off the load, turn off the power supply. Then turn on the load to discharge the output capacitors.

4 Software User Interface

4.1 Install USB2ANY Explorer

Download and install the USB2ANY explorer from: http://www.ti.com/tool/USB2ANY. Upgrade the firmware version to 2.8.2.0.

4.2 GUI Installation

A graphical user interface (GUI) is available from ti.com website (http://www.ti.com/tool/TPS55288-EVM-GUI) which allows simple and convenient programming of the device through the TI USB2ANY device.

- Download the zip file for the desired platform.
- Download GUI Composer Runtime.
- Extract the zip folder and install the GUI.
- Run through the installation steps. The installation wizard might prompt for GUI Composer Runtime. This should be done automatically.
- Open the GUI – TPS55288.

4.3 Interface Hardware Setup

Connect the USB2ANY adapter to your PC using the supplied USB cable. Connect the TPS55288EVM connector J7 to the USB2ANY adapter using the supplied 10-pin ribbon cable. The connectors on the ribbon cable are keyed to prevent incorrect installation.

Figure 1 shows a quick connection overview.

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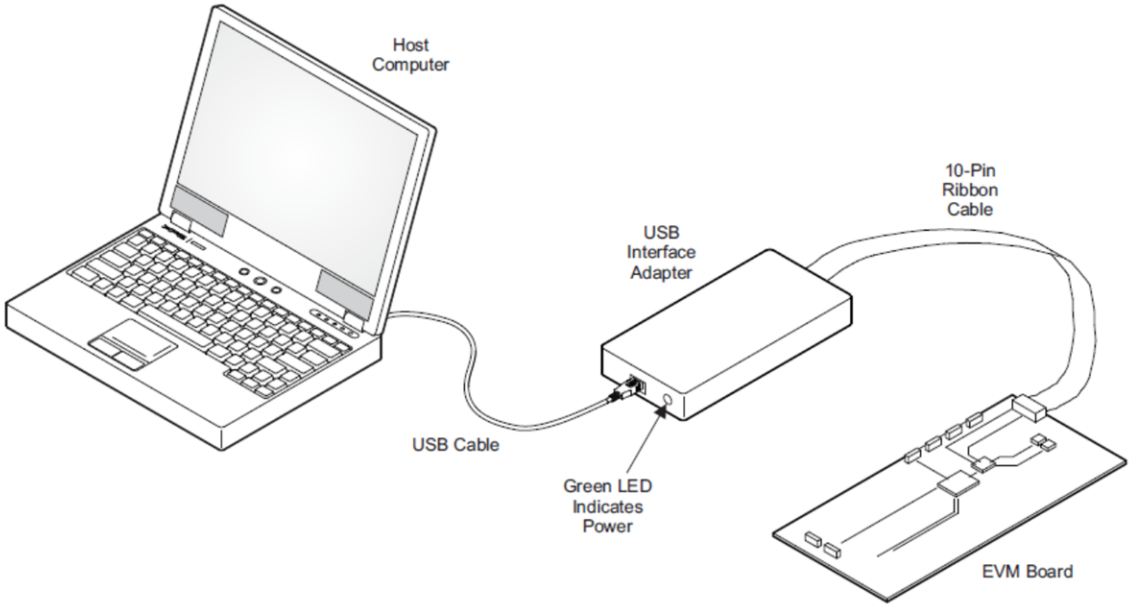


Figure 1. Quick Connection Overview

4.4 User Interface Operation

The TPS55288EVM board can be enabled to work by the following steps:

Step 1: Set JP1 to the ON position. Turn on the power supply.

Step 2: Open the TPS55288EVM GUI.

Step 3: Click the auto connect button on the slave address widget (Figure 2). It will automatically check for slave addresses (0x74, 0x75) and connect the GUI with device. Once after connection, GUI will read all the 8 registers and show a notification (Figure 3).



Figure 2. GUI Auto Connect Button



Figure 3. GUI Auto Connect Notification

Step 4: Click the start button. It will show the GUI user interface of TPS55288EVM-045 (Figure 4).

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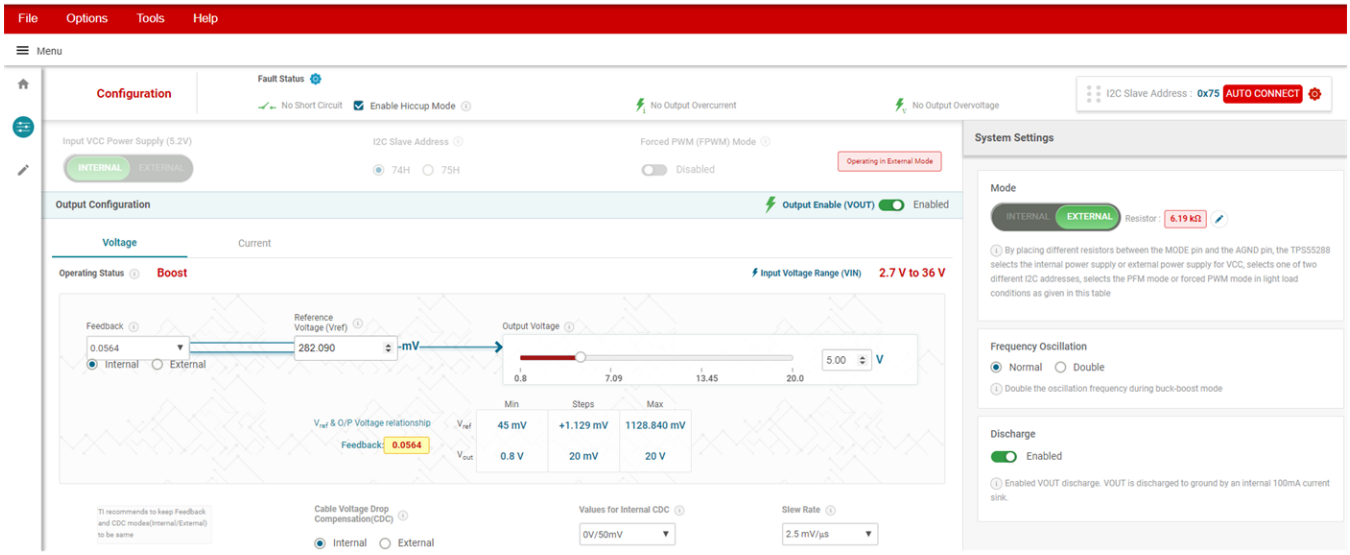


Figure 4. GUI User Interface of TPS55288EVM-045

Step 5: Click the Enable button (Figure 5). The default output voltage is 5 V.

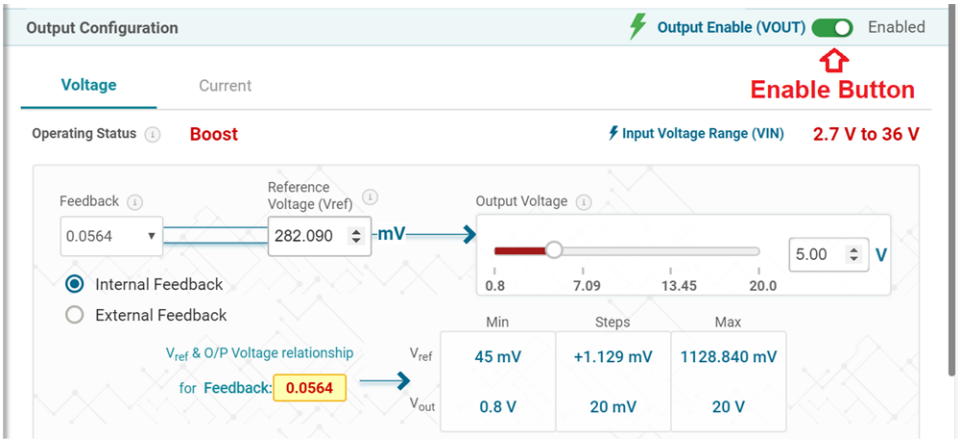


Figure 5. ENABLE Button

Step 6: Set the output voltage, current limit point, etc. according to the design target. If the maximum load current is ≥ 5 A, untick the 'Enable Current Limit' check box or increase the current limit value (Figure 6).

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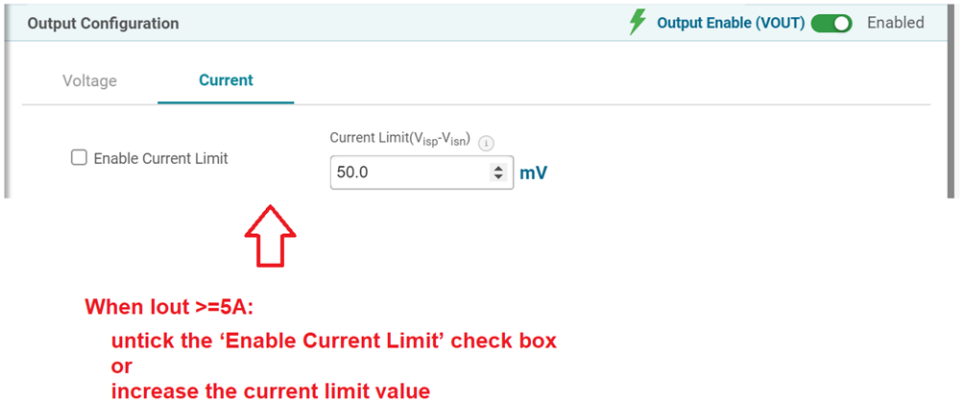


Figure 6. Output Current Limit Point Setting

4.5 Register Map Screen

The Register Map screen shows a register-wise view of all parameters. Here, single registers can be read or written to the device (if applicable). Refer to the TPS55288 data sheet for a detailed description of the TPS55288 registers.

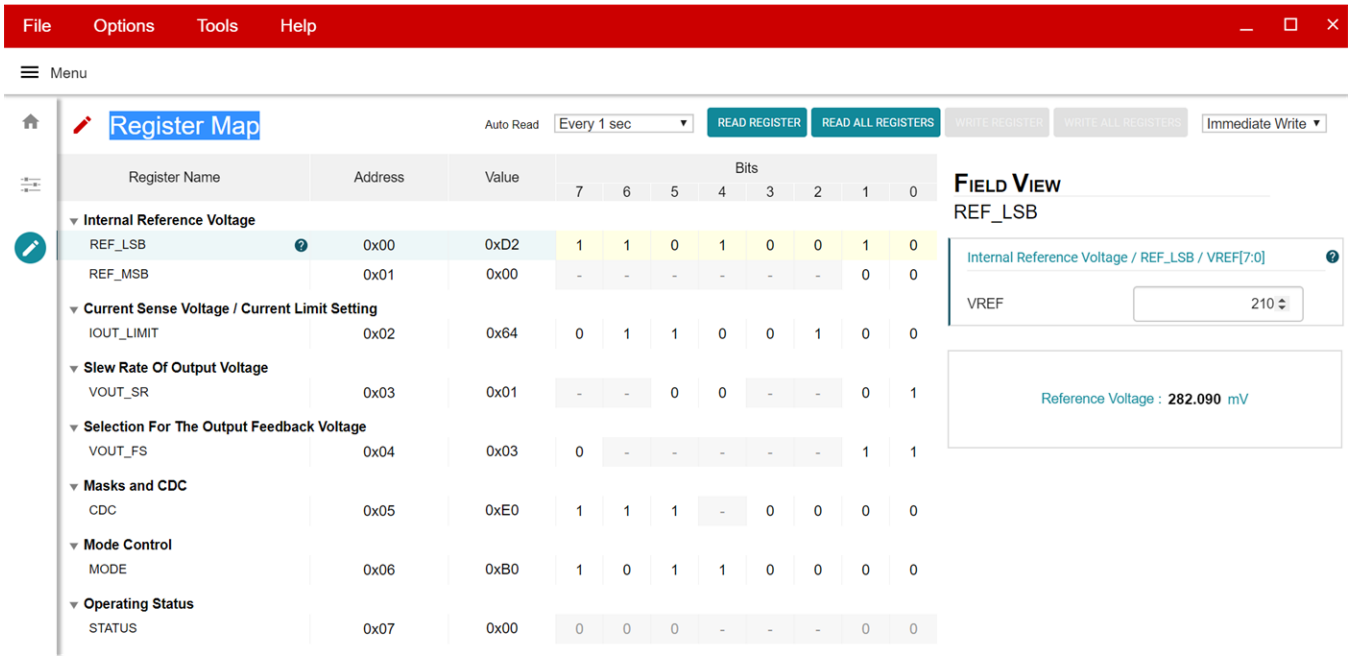


Figure 7. GUI Register Map Screen

5 Schematic, Bill of Materials, and Board Layout

This section provides the TPS55288EVM-045 schematic, bill of materials (BOM), and board layout.

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5.1 Schematic

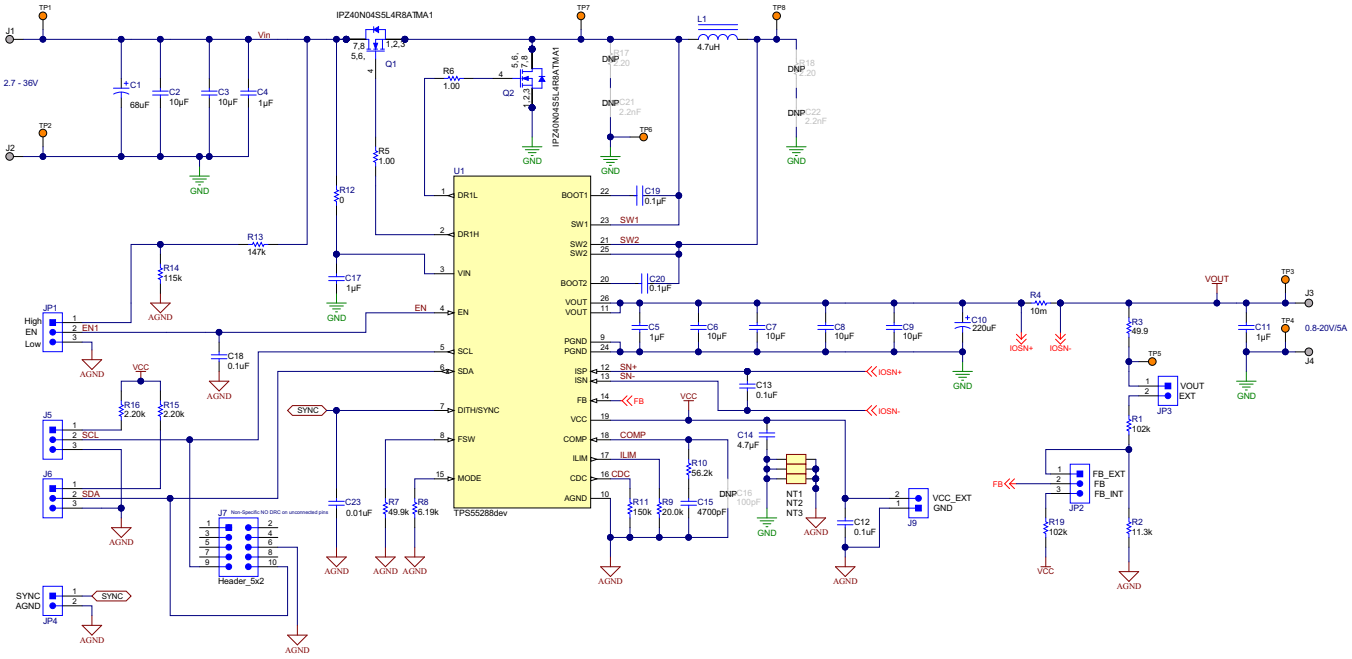


Figure 8. TPS55288EVM-045 Schematic

5.2 Bill of Materials

Table 3. Bill of Materials

Designator	QTY	Value	Description	Package	Part Number	Manufacturer
C1	1	68 uF	CAP, Polymer Hybrid, 68 uF, 50 V, +/- 20%, 30 ohm, 8 × 10 SMD	8 × 10	EEHZA1H680P	Panasonic
C2, C3	2	10 uF	CAP, CERM, 10 µF, 75 V, +/- 20%, X7R, AEC-Q200 Grade 1, 1210	1210	CGA6P1X7R1N106M250AC	TDK
C4, C5, C11, C17	4	1 uF	CAP, CERM, 1 µF, 50 V, +/- 20%, X5R, AEC-Q200 Grade 3, 0603	0603	GRT188R61H105ME13D	MuRata
C6, C7, C8, C9	4	10 uF	CAP, CERM, 10 µF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 1206	1206	CGA5L1X7R1H106K160AC	TDK
C10	1	220 uF	CAP, Polymer Hybrid, 220 uF, 25 V, +/- 20%, 27 ohm, 8 × 10 SMD	8 × 10	EEHZA1E221P	Panasonic
C12, C13, C18	3	0.1 uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	0402	CGA2B3X7R1H104K050BB	TDK

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Table 3. Bill of Materials (continued)

Designator	QTY	Value	Description	Package	Part Number	Manufacturer
C14	1	4.7 uF	CAP, CERM, 4.7 µF, 16 V, +/- 10%, X5R, AEC-Q200 Grade 3, 0603	0603	GRT188R61C475KE13D	MuRata
C15	1	4700 pF	CAP, CERM, 4700 pF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	0402	CGA2B2X7R1H472K050BA	TDK
C19, C20	2		0.1 µF ±10% 50-V Ceramic Capacitor X8L 0603 (1608 Metric)	0603	GCM188L81H104KA57D	Murata Electronics North America
C23	1	0.01 uF	CAP, CERM, 0.01 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	0402	CGA2B3X7R1H103K050BB	TDK
J1, J2, J3, J4	4		Terminal, Turret, TH, Double	Keystone 1502-2	1502-2	Keystone
J5, J6, JP1, JP2	4		Header, 100 mil, 3 × 1, Tin, TH	Header, 3 PIN, 100 mil, Tin	PEC03SAAN	Sullins Connector Solutions
J7	1		Header (shrouded), 100 mil, 5 × 2, Gold, TH	5 × 2 Shrouded header	5103308-1	TE Connectivity
J9, JP3, JP4	3		Header, 100 mil, 2 × 1, Tin, TH	Header, 2 PIN, 100 mil, Tin	PEC02SAAN	Sullins Connector Solutions
L1	1	4.7 uH	Inductor, Shielded, Composite, 4.7 uH, 24 A, 0.01 ohm, SMD	Inductor, 11.3 × 10 × 10 mm	XAL1010-472MEB	Coilcraft
Q1, Q2	2	40 V	MOSFET, N-CH, 40 V, 40 A, AEC-Q101, SON-8	SON-8	IPZ40N04S5L4R8ATMA1	Infineon Technologies
R1, R19	2	102 k	RES, 102 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402102KFKED	Vishay-Dale
R2	1	11.3 k	RES, 11.3 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040211K3FKED	Vishay-Dale
R3	1	49.9	RES, 49.9, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040249R9FKED	Vishay-Dale
R4	1		10 mOhms ±1% 1-W Chip Resistor 1206 (3216 Metric) Automotive AEC-Q200, Current Sense, Moisture Resistant Metal Element	1206	CRF1206-FZ-R010ELF	Bourns

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Table 3. Bill of Materials (continued)

Designator	QTY	Value	Description	Package	Part Number	Manufacturer
R5, R6	2	1.00	RES, 1.00, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06031R00FKEA	Vishay-Dale
R7	1	49.9 k	RES, 49.9 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040249K9FKED	Vishay-Dale
R8	1	6.19 k	RES, 6.19 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04026K19FKED	Vishay-Dale
R9	1	20.0 k	RES, 20.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040220K0FKED	Vishay-Dale
R10	1	56.2 k	RES, 56.2 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040256K2FKED	Vishay-Dale
R11	1	150 k	RES, 150 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402150KFKED	Vishay-Dale
R12	1	0	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0ED	Vishay-Dale
R13	1	147 k	RES, 147 k, 1%, 0.1 W, 0603	0603	RC0603FR-07147KL	Yageo
R14	1	115 k	RES, 115 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402115KFKED	Vishay-Dale
R15, R16	2	2.20 k	RES, 2.20 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04022K20FKED	Vishay-Dale
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8	8		Test Point, Miniature, Orange, TH	Orange Miniature Testpoint	5003	Keystone
U1	1		36 V, 16-A Buck-Boost Converter, RPM0026A (VQFN-HR-26)	RPM0026A	TPS55288dev	Texas Instruments
C16	0	100 pF	CAP, CERM, 100 pF, 50 V, +/-5%, C0G/NP0, AEC-Q200 Grade 1, 0402	0402	CGA2B2C0G1H101J050BA	TDK
C21, C22	0	2200 pF	CAP, CERM, 2200 pF, 250 V, +/- 10%, X7R, 0805	0805	GRM21AR72E222KW01D	MuRata
R17, R18	0	2.20	RES, 2.20, 1%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	ERJ-8RQF2R2V	Panasonic

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5.3 Board Layout

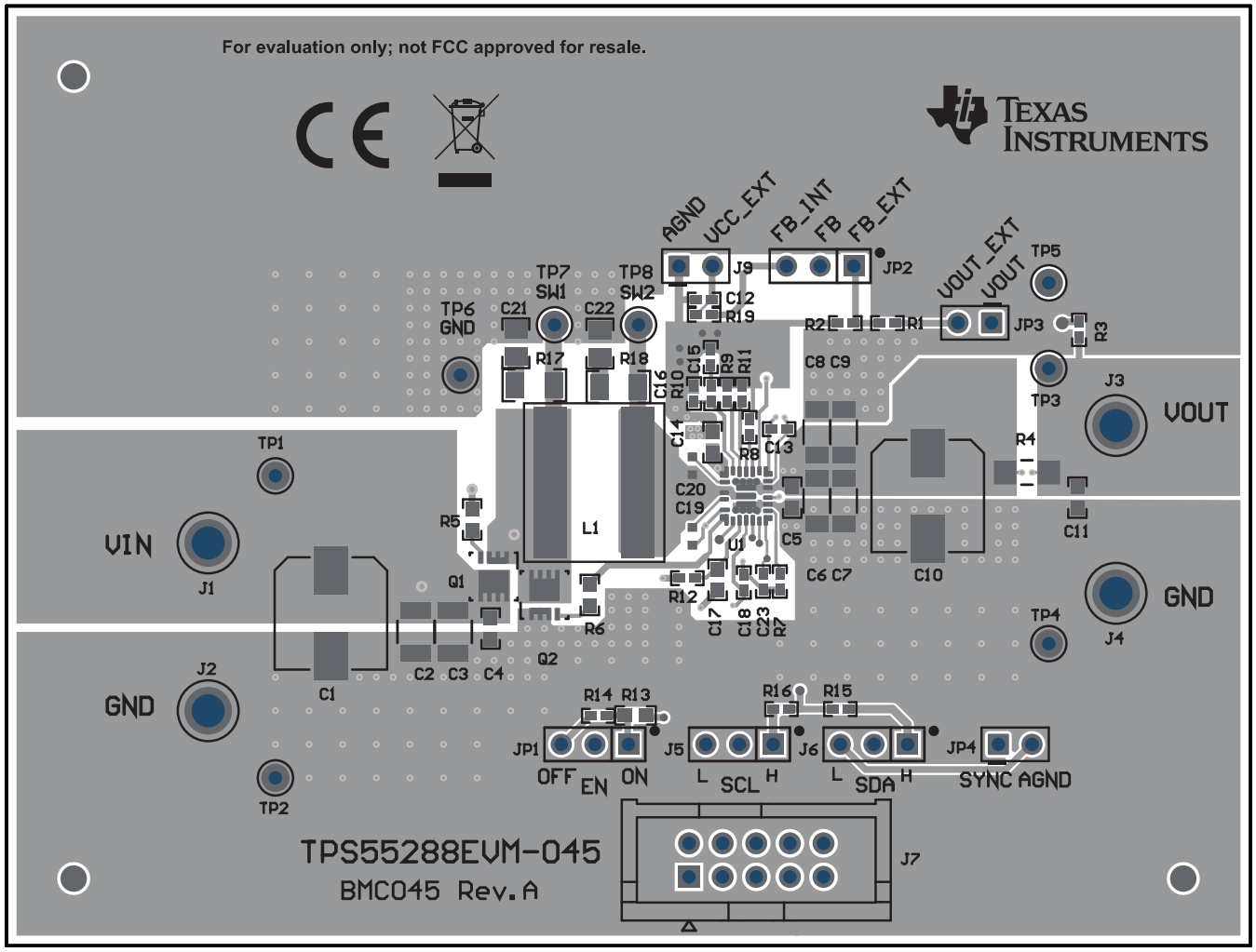


Figure 9. TPS55288EVM-045 Top-Side Layout

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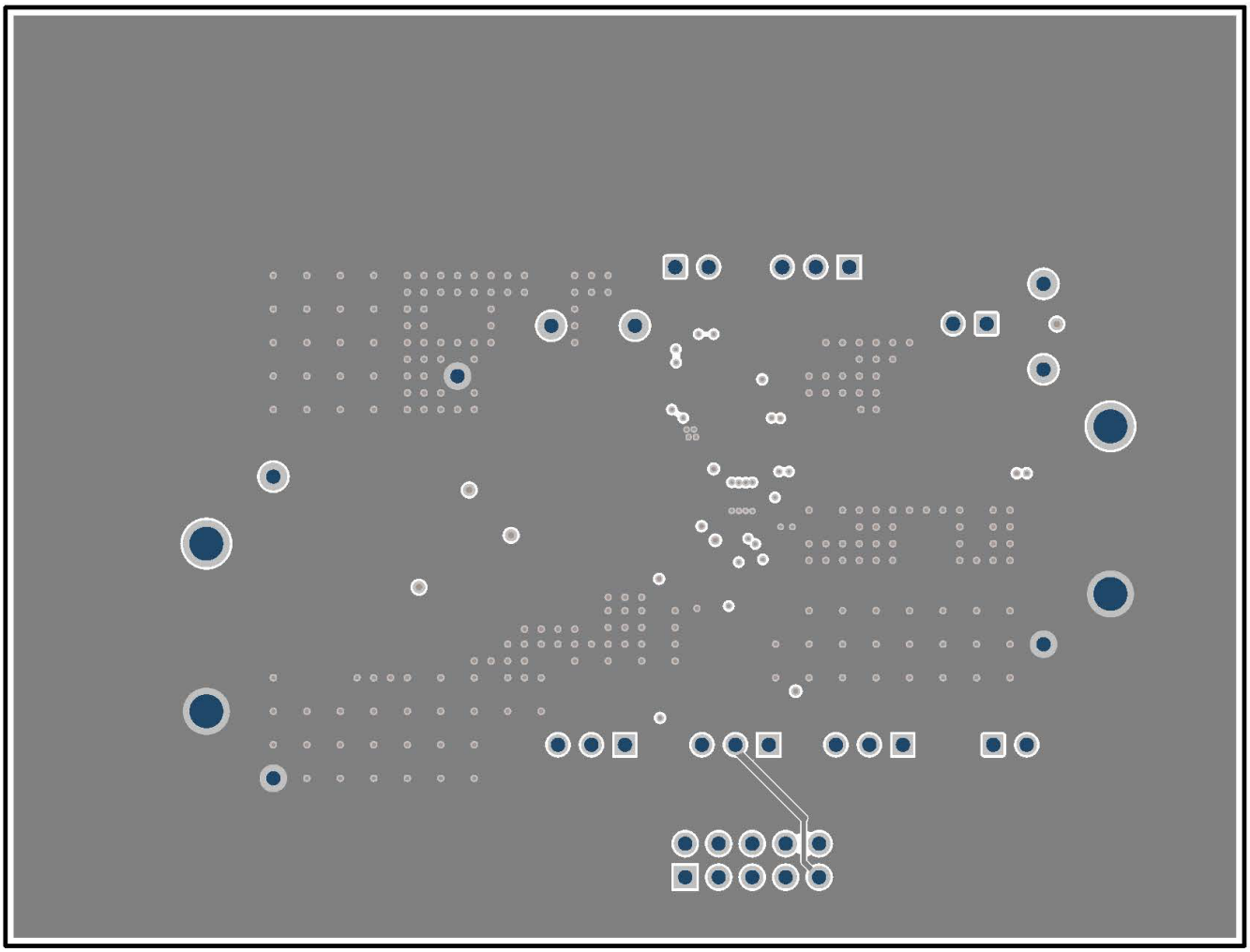


Figure 10. TPS55288EVM-045 Inner Layer1

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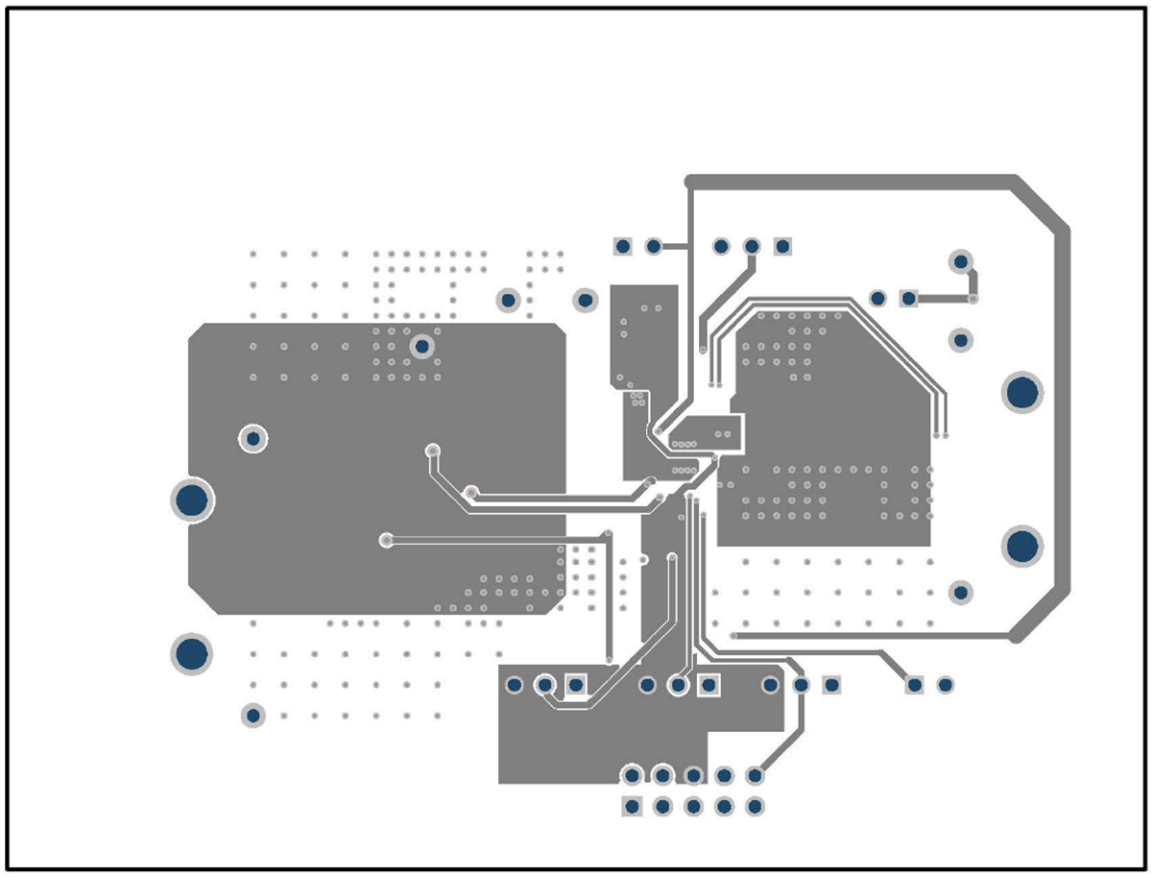


Figure 11. TPS55288EVM-045 Inner Layer2

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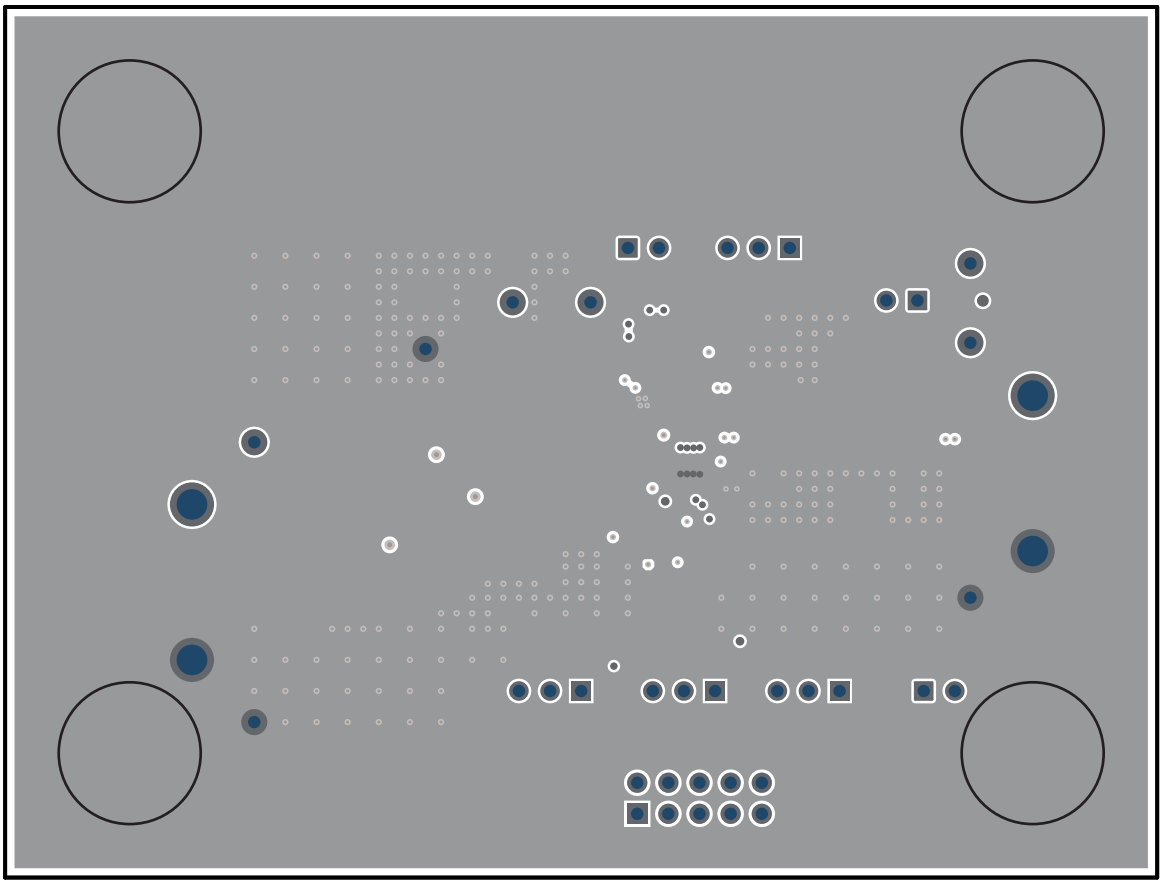


Figure 12. TPS55288EVM-045 Bottom-Side Layout

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STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

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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。
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 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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2. 実験局の免許を取得後ご使用いただく。
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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page
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。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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.

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