

EVM User's Guide: TPSI88XXEVM

TPSI88XX Evaluation Module



Description

The TPSI88XXEVM is a hardware evaluation module to evaluate the performance of devices in the TPSI88XX family. Use the TPSI88XXEVM to evaluate application requirements, like thermostats, and PLC digital output modules. The EVM is populated with TPSI8830ZB (DFP package).

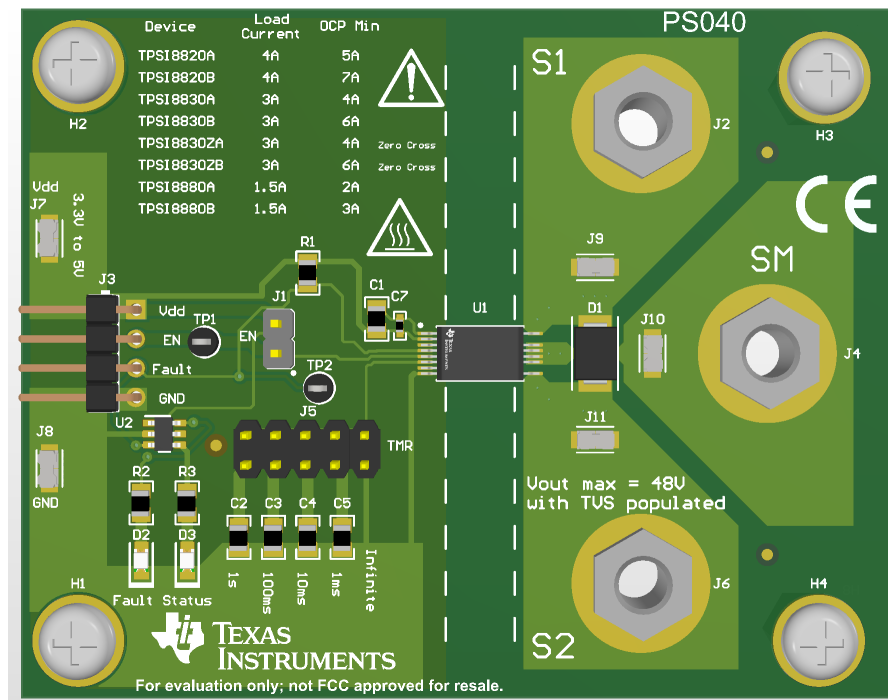
Features

- Integrated Back-Back MOSFETs with $\pm 80V$ operation
- Wide supply range from 3.0V to 5.5V

- Configurable Fault Retry timer (TMR)
- Functional Isolation
 - 200V_{RMS}, 250V_{DC} working voltage
 - 570V_{RMS}, 800V_{DC} transient voltage (60s)
- Device SSOP 14-pin (DFP) package with 8mm of creepage and clearance

Applications

- [Solid state relay](#)
- Thermostats
- PLC - digital output modules



TPSI88XXEVM

1 Evaluation Module Overview

1.1 Introduction

The TPSI88XX device family are isolated solid-state relays designed for high voltage industrial applications. TI's high reliability capacitive isolation technology in combination with back-to-back MOSFETs form a completely integrated solution requiring no secondary side power supply.

The primary side consists of a driver which delivers power and enable logic information to each of the internal MOSFETs on the secondary side. When the enable pin is brought HI and the VDD voltage is above the UVLO threshold, the oscillator starts and the driver sends power and a logic HI across the isolation barrier. When the enable pin is brought LO or the VDD voltage falls below the UVLO threshold, the driver is disabled.

1.2 Kit Contents

Item	Quantity
TPSI88XXEVM	1

1.3 Specification

This section summarizes the performance specifications of the TPSI88XXEVM in the default configuration.

		MIN	MAX	UNIT
$V_{S1,S2}$	Switch input voltage	-80	80	V
V_{VDD}	Primary side supply voltage	3.0	5.5	V
V_{FAULT}	FAULT pin voltage	0	5.5	V
V_{TMR}	TMR pin voltage	0	5.5	V
V_{EN}	Enable voltage	0	5.5	V
$I_{S1,S2}$	Switch current, S1/S2		4	A

1.4 Device Information

Device Specifications	Values
Primary side supply current	6.5mA ON state, 30uA OFF state
Transient Isolation Voltage (t = 60s)	AC = 500V _{RMS} , DC = 800V _{DC}
VDD undervoltage threshold	Rising = 2.9V, Falling 2.8V
Package	DFP (SOIC 14) 5.4mm × 10.5mm

1.5 General Texas Instruments High Voltage Evaluation (TI HV EVM) User Safety Guidelines



Always follow TI's setup and application instructions, including use of all interface components within their recommended electrical rated voltage and power limits. Always use electrical safety precautions to help ensure your personal safety and those working around you. Contact TI's Product Information Center for further information.

Save all warnings and instructions for future reference.

WARNING

Failure to follow warnings and instructions may result in personal injury, property damage or death due to electrical shock and burn hazards.

The term *TI HV EVM* refers to an electronic device typically provided as an open framed, unenclosed printed-circuit board assembly. It is intended strictly for use in development laboratory environments, solely for qualified professional users having training, expertise and knowledge of electrical safety risks in development and application of high-voltage electrical circuits. Any other use or application are strictly prohibited by Texas Instruments. If you are not suitable qualified, you should immediately stop from further use of the HV EVM.

1. Work Area Safety:

- a. Keep work area clean and orderly.
- b. Qualified observers must be present any time circuits are energized.
- c. Effective barriers and signage must be present in the area where the TI HV EVM and its interface electronics are energized, indicating operation of accessible high voltages may be present, for the purpose of protecting inadvertent access.
- d. All interface circuits, power supplies, evaluation modules, instruments, meters, scopes, and other related apparatus used in a development environment exceeding 50 Vrms and 75 VDC must be electrically located within a protected Emergency Power Off (EPO) protected power strip.
- e. Use stable and non-conductive work surface.
- f. Use adequately insulated clamps and wires to attach measurement probes and instruments. No freehand testing whenever possible.

2. Electrical Safety:

- a. As a precautionary measure, it is always good engineering practice to assume that the entire EVM may have fully accessible and active high voltages.
- b. DE-energize the TI HV EVM and all its inputs, outputs, and electrical loads before performing any electrical or other diagnostic measurements. Re-validate that the TI HV EVM power has been safely DE-energized.
- c. With the EVM confirmed de-energized, proceed with required electrical circuit configurations, wiring, measurement equipment hook-ups and other application needs, while still assuming the EVM circuit and measuring instruments are electrically live.
- d. Once EVM readiness is complete, energize the EVM as intended.

WARNING

High voltages of DC are present on this evaluation board during operation and even for a while after powering off. To evaluate this module, the individuals involved must be qualified with adequate knowledge and skills of high voltage from electrical engineering practice. Severe injury, including death, can occur from insufficient personal capability.

The DC voltage source with isolation should meet the IEC60950 reinforced insulation standards are suggested to be necessary for performing evaluation on this EVM.

Extreme caution should be taken to eliminate the possibility of an electric shock and heat burn. Please see [General Texas Instruments High Voltage Evaluation \(TI HV EVM\) User Safety Guidelines](#) for safety concerns and precautions.

Read and understand this user's guide thoroughly before starting any physical evaluation.

a.

1. Personal Safety:

- a. Wear personal protective equipment, for example, latex gloves or safety glasses with side shields or protect the EVM in an adequate lucent plastic box with interlocks from accidental touch.

Limitation for safe use:

EVMs are not to be used as all or part of a production unit.

2 Hardware

2.1 Recommended Test Equipment

The following list includes the recommended equipment to test the TPSI88XXEVM

- Adjustable power supplies
- Oscilloscope
- Digital multimeter
- *Optional:* function generator or microcontroller to toggle the enable (EN) pin of the TPSI8830ZB

2.2 Jumper Information

Connector	Label	Description
J1	EN	Jumper connecting EN pin to VDD when closed
J2	S1	Jumper for S1 connection
J3	Vdd, EN, Fault, and GND	GPIO connection for primary side pins
J4	SM	Jumper for SM connection
J5	TMR	Jumper to configure retry timing
J6	S2	Jumper for S2 connection

2.3 Test Points

Test Point, Jumper	Label	Description
TP1	EN	Enable test point
TP2	Fault	Fault pin test point
J7	Vdd	Primary side supply test point
J8	GND	Primary side GND test point
J9	S1	S1 pin test point
J10	SM	SM pin test point
J11	S2	S2 pin test point

3 Implementation Results

3.1 Setup

Verify that the TPSI88XXEVM has the following setting on the jumpers:

1. TMR 1s - Set retry time to 1s

The example below is in reference to a thermostat application where the TPSI8830ZB drives a relay.

Follow the steps outlined below:

1. Connect a 5V power supply to the test point **J7** with the negative lead connected to **J8** to power the TPSI8830ZB
2. Connect a function generator on **J3 (pin 2)** EN to enable the TPSI8830ZB.
 - a. Set the function generator to a **5V square wave (0.5Hz)**
3. Connect the transformer power line to S1 of the TPSI8830ZB before turning on the function generator channel
4. Connect the Relay to S2 of the TPSI8830ZB
5. Connect GND of Relay and GND of transformer
6. Turn on output of function generator
 - a. The relay switches at the frequency of the function generator

4 Hardware Design Files

4.1 Schematics

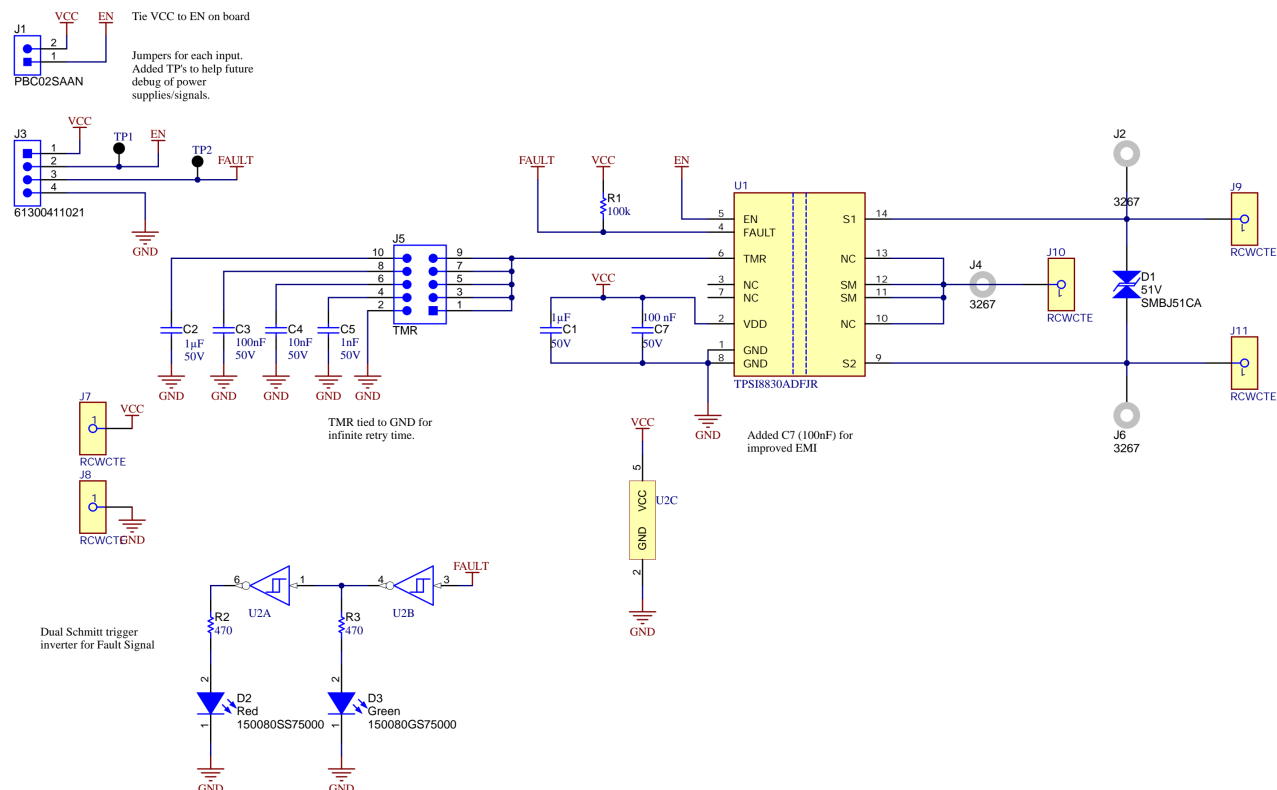


Figure 4-1. TPSI88XXEVM Schematic

4.2 PCB Layouts

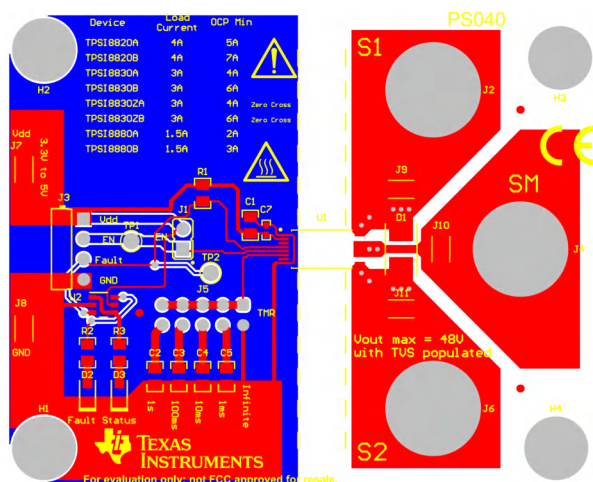


Figure 4-2. TPSI88XXEVM Composite View

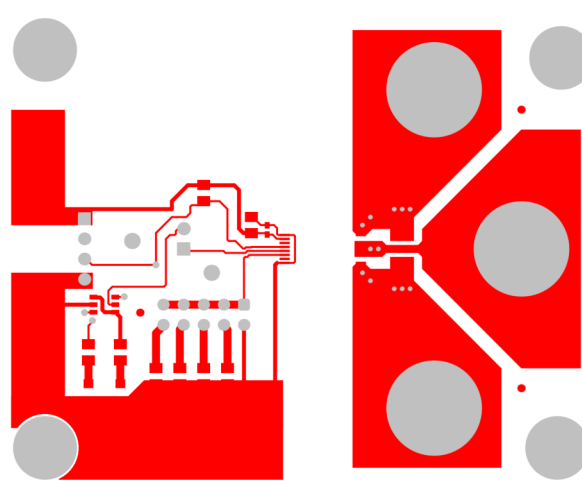


Figure 4-3. TPSI88XXEVM Top Layer

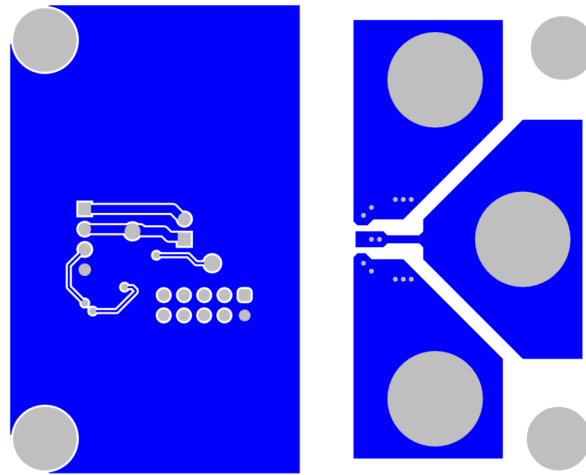


Figure 4-4. TPSI88XXEVM Bottom Layer

4.3 Bill of Materials (BOM)

Designator	Quantity	Value	Description
C1, C2	2	1uF	CAP, CERM, 1 μ F, 50V, $\pm$ 20%, X7R, AEC-Q200 Grade 1, 0805
C3	1	0.1uF	CAP, CERM, 0.1uF, 50V, $\pm$ 10%, X7R, 0805
C4	1	0.01uF	CAP, CERM, 0.01uF, 50V, $\pm$ 10%, X7R, 0805
C5	1	1000pF	CAP, CERM, 1000pF, 50V, $\pm$ 5%, X7R, 0805
C7	1	0.1uF	CAP, CERM, 0.1uF, 50V, $\pm$ 10%, X7R, 0402
D1	1	51V	Diode, TVS, Bi, 51V, 82.4 Vc, SMB
D2	1	Red	LED, Red, SMD
D3	1	Green	LED, Green, SMD
H1, H2, H3, H4	4		Machine Screw, Round, #4-40x 1/4, Nylon, Philips panhead
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon
J1	1		Header, 100mil, 2x1, Gold, TH
J2, J4, J6	3		Standard Banana Jack, Uninsulated
J3	1		Header, 2.54mm, 4x1, Gold, R/A, TH
J5	1		Header, 2.54mm, 5x2, Gold, TH
J7, J8, J9, J10, J11	5		PC Test Point Plating Surface Mount Mounting Type
LBL1	1		Thermal Transfer Printable Labels, 0.650" W $\times$ 0.200" H - 10,000 per roll
R1	1	100k	RES, 100k, 1%, 0.125W, 0805

Designator	Quantity	Value	Description
R2, R3	2	470	RES, 470, 5%, 0.125W, AEC-Q200 Grade 0, 0805
TP1, TP2	2		Test Point, Miniature, Black, TH
U1	1		TPSI8830ADFJR
U2	1		Dual Schmitt-Trigger Inverter, DBV0006A, SMALL T&R

5 Additional Information

5.1 Trademarks

All trademarks are the property of their respective owners.

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 DEGRADATION 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 instructions, 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/sds/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。
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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/sds/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:*

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8. *Limitations on Damages and Liability:*

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