

TPS7A94EVM-046 Evaluation Module

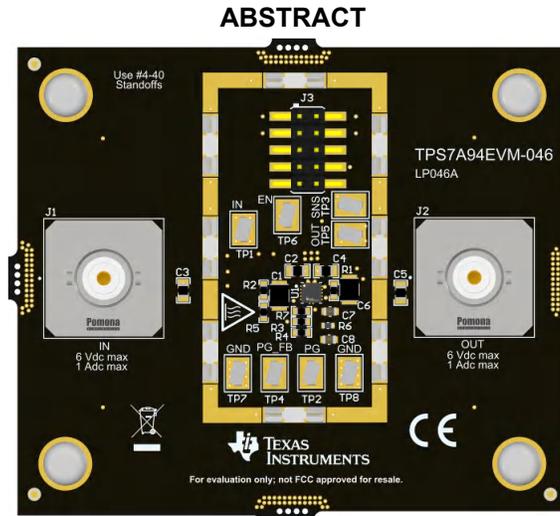


Figure 1-1. TPS7A94EVM-046 Evaluation Module

This user's guide describes the operational use of the TPS7A94EVM-046 evaluation module (EVM) as a reference design for engineering demonstration and evaluation of the TPS7A9401DSC, an ultra-low noise, ultra-high PSRR, RF low-dropout (LDO) linear regulator. Included in this user's guide are setup and operating instructions, thermal and layout guidelines, a printed circuit board (PCB) layout, a schematic diagram, and a bill of materials (BOM).

Throughout this document the terms *demonstration kit*, *evaluation board*, and *evaluation module* are synonymous with the TPS7A94EVM-046.

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Trademarks

All trademarks are the property of their respective owners.

1 Introduction

Texas Instruments' TPS7A94EVM-046 helps design engineers evaluate the operation and performance of the TPS7A94 linear regulator for possible use in their own circuit application. This particular EVM configuration contains a single high-accuracy, small size, adjustable linear regulator for a wide range of applications. The regulator is capable of delivering up to 1 A to the load with low V_{IN} to V_{OUT} dropout voltage. For stability, use a minimum capacitor of 4.7 μ F at the input and output.

Table 1-1 lists the related documentation available through the Texas Instrument web site at www.ti.com.

Table 1-1. Related Documentation

Device	Literature Number
TPS7A94	SBVS336

1.1 Before You Begin

The following warnings and cautions are noted for the safety of anyone using or working close to the TPS7A94EVM-046. Observe all safety precautions.



Warning

Warning Hot surface. Contact may cause burns. Do not touch.

CAUTION

The circuit module can be damaged by overtemperature. To avoid damage, monitor the temperature during evaluation and provide cooling, as needed, for your system environment.

CAUTION

Some power supplies can be damaged by application of external voltages. If you are using more than one power supply, check your equipment requirements and use blocking diodes or other isolation techniques, as needed, to prevent damage to your equipment.

CAUTION

The circuit module is not a finished product or electrical appliance. The module does not contain current or voltage thresholds for circuit protection. It must be used by qualified personnel with additional equipment for evaluation only.

2 EVM Setup

This section describes how to properly connect and set up the TPS7A94EVM-046, including the jumpers and connectors on the EVM board.

2.1 Inputs/Outputs Connectors and Jumper Descriptions

2.1.1 J1 – IN

Input power-supply voltage connector with ground connection.

2.1.2 J2 – OUT

Regulated output voltage with ground connection.

2.1.3 J3

10-pin header connector with all input and output signals.

2.1.4 TP1 – IN

Input power-supply sense.

2.1.5 TP2 – PG

Power-good sense connection.

Note

If the EVM is implemented as described in [Section 5](#) with R3 and R7 set to 10 k Ω , the PG pin is thus programmed to indicate a valid output when the output reaches 50% of the targeted value. This operating mode is valid because the device is set for 100% current limit. See the [TPS7A94 data sheet](#) to set the PG_FB resistor divider.

2.1.6 TP3 – SNS

Sense pin test-point connection.

2.1.7 TP4 – PG_FB

Feedback pin test-point connection.

Note

As implemented in [Section 5](#), with R3 and R7 set to 10 k Ω , and with the programmable current limit set to 100% of I_{LIMIT} , the PG pin goes up when the output voltage reaches 50% of the targeted value. For a complete implementation of both the PG pin and the current limit, see the [TPS7A94 data sheet](#).

2.1.8 TP5 – OUT

Regulated output test-point connection.

2.1.9 TP6 – EN

Enable voltage test-point connection.

2.1.10 TP7 – GND

Ground pin test-point connection.

2.1.11 TP8 – GND

Ground pin test-point connection.

2.2 Soldering Guidelines

To avoid damaging the device, use a hot-air system for any solder rework to modify the EVM for the purpose of repair or other application reasons.

2.3 Equipment Connections

Connect the equipment in the following steps:

1. Set the input power supply to 6 V (maximum), and turn the power supply off
2. Connect a BNC connector jack from the input power supply to the J1 V_{IN} connector on the EVM
3. Connect a 0-A to 1-A load between OUT and GND

3 Operation

Operate the equipment using the following steps:

1. Turn on the power supply
2. Vary the respective loads and input voltages, as necessary, for test purposes

4 PCB Layout

Figure 4-1 to Figure 4-5 illustrate the PCB layout for this EVM.

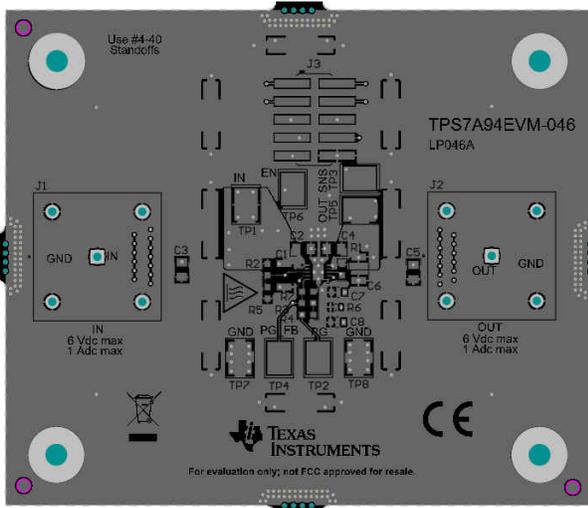


Figure 4-1. Assembly Layer

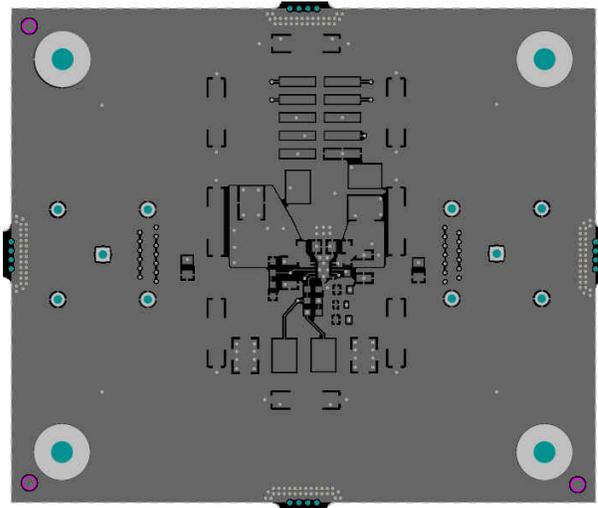


Figure 4-2. Top Layer Routing

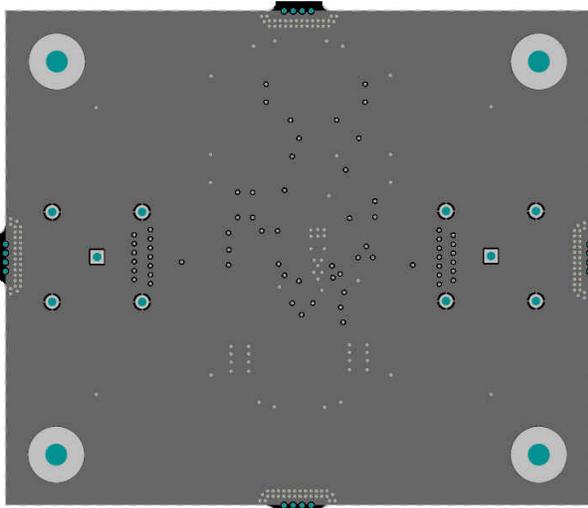


Figure 4-3. First Middle Layer

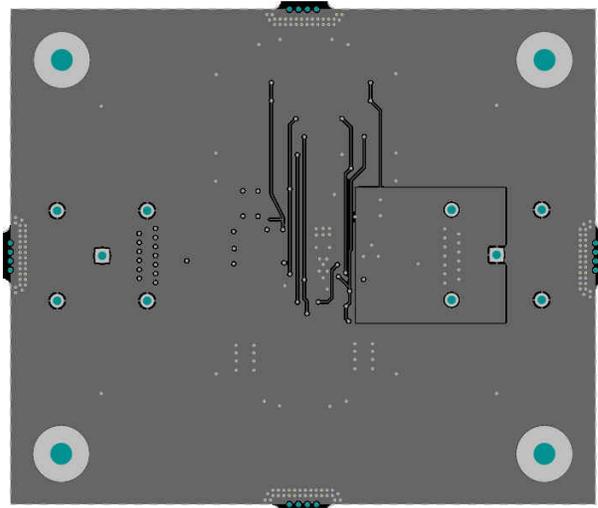


Figure 4-4. Second Middle Layer

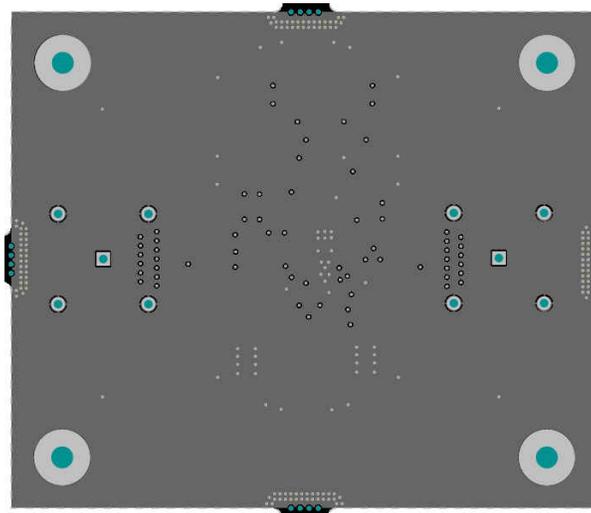


Figure 4-5. Bottom Layer Routing

5 Schematic

Figure 5-1 shows the schematic for this EVM.

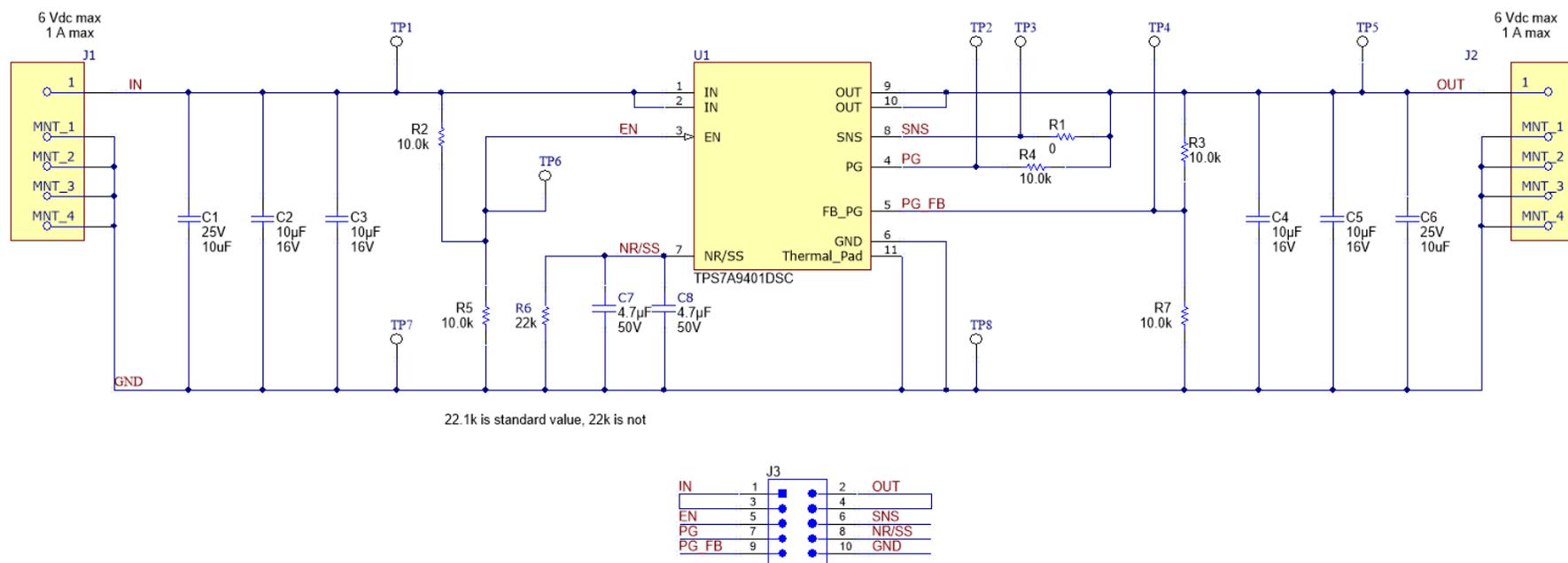


Figure 5-1. TPS7A94EVM-046 Schematic

6 Bill of Materials

Table 6-1 shows the bill of materials (BOM) for this EVM.

Table 6-1. TPS7A94EVM-046 BOM¹²³⁴

DESIGNATOR	QTY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER	ALTERNATE PART NUMBER	ALTERNATE MANUFACTURER
!PCB1	1		Printed Circuit Board		TPS7A9401DSC	Any		
C1, C6	2	10 μ F	CAP, CERM, 10 μ F, 25 V, +/- 20%, X7R, 1210	1210	C3225X7R1E106M250AC	TDK		
C2, C3, C4, C5	4	10 μ F	CAP, CERM, 10 μ F, 16 V, +/- 10%, X7R, 0805	0805	EMK212BB7106KG-T	Taiyo Yuden		
C7, C8	2	4.7 μ F	Cap Ceramic 4.7 μ F 50V X7R 10% Pad SMD 0805 +125°C Automotive T/R	0805	CGA4J1X7R1H475K125AC	TDK Corporation		
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A		
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Phillips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply		
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone		
H9, H10, H11, H12	4		Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon	SJ-5303 (CLEAR)	3M		
H13, H14, H15, H16, H17, H18, H19, H20	8		RFI SHIELD CLIP TIN SMD	RFI SHIELD CLIP TIN SMD	S2711-46R	Harwin		
J1, J2	2		BNC Connector Jack, Female Socket 50Ohm Through Hole Solder	PTH_BNC_JACK_VERT	4578	Pomona Electronics		
J3	1		Header, 2.54mm, 5x2, Gold, Black, SMT	Header, 2.54mm, 5x2, SMT	GBC05DABN-M30	Sullins Connector Solutions		
MP1	1			SMT_RF-SHIELD	S01-50250500	Harwin		
R1	1	0	RES, 0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	RMCF0603ZT0R00	Stackpole Electronics Inc		
R2, R3, R4, R5, R7	5	10.0k	RES, 10.0k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	RMCF0603FT10K0	Stackpole Electronics Inc		
R6	1	22k	RES, 22k Ohms, 1% 0.1W, 1/10W Chip Resistor 0603 Thick Film	0603	CRCW060322K0FKEAC	Vishay		
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8	8		Test Point, Compact, SMT	Testpoint_Keystone_Compact	5016	Keystone		
U1	1		1-A, Ultra-Low Noise, Ultra-High PSRR, RF Voltage Regulator	WSON10	TPS7A9401DSC	Texas Instruments		

1. This assembly is ESD sensitive; observe ESD precautions.
2. This assembly must be clean and free from flux and all contaminants. Use of no-clean flux is not acceptable.
3. This assembly must comply with workmanship standards IPC-A-610 Class 2.
4. Unless otherwise noted in the *Alternate Part Number* or *Alternate Manufacturer* columns, all parts can be substituted with equivalents.

7 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision A (April 2022) to Revision B (August 2022)	Page
• Clarified FB_PG and PG behavior in user guide to match data sheet.....	3
• Changed note in <i>TP2 – PG</i> section.....	4
• Changed note in <i>TP4 – PG_FB</i> section.....	4

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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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 - 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.
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 - 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 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/lstds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required 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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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:*
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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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-

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