EVM User's Guide: ULN2003A ULN2003ADEVM

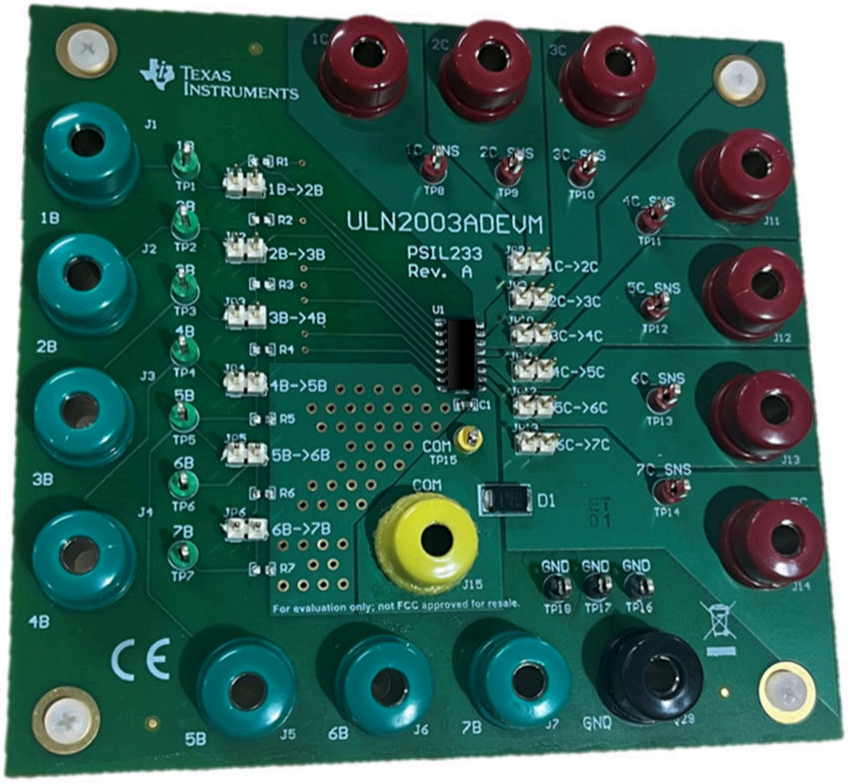
ULN2003AD Evaluation Module

Description

The ULN2003ADEVM is a hardware evaluation module (EVM) used to enable hardware engineers to evaluate the full performance and functionality of the ULN2003A Darlington Transistor Arrays. The ULN2003ADEVM is designed to be used as a standalone board with an attached voltage supply and output load to test and assess the ULN2003A before designing into part of a greater application's power system. This EVM is populated with the SOIC (D version) of ULN2003A.

Features

- Pull-down resistors at each control input to make sure INx signals are not floating.
- Jumpers to parallel channels for higher current capability.
- Additional diode from OUT7 to COM to suppress the kick-back voltage from an inductive load that is excited when the NPN drivers are turned off on OUT7.



1 Evaluation Module Overview

1.1 Introduction

The Texas Instruments' ULN20003ADEVM is an evaluation module that is used to demonstrate and showcase all of the features of the underlying ULN2003A Darlington Transistor Arrays. This evaluation board provides a seamless way to connect power supplies to the collector inputs of the device and turn on and off the device using the base control pins of the chip. Pull-down resistors on the base control channels make sure the control signal is never floating. Jumpers are included to short input channels together for increased current capability. Refer to the *Maximum Collector Current vs Duty Cycle* plots in the data sheet (SLRS027) to determine the maximum collector current given the number of outputs conducting simultaneously.

1.2 Kit Contents

Table 1-1 lists the contents of the EVM kit. Contact the Texas Instruments' Product Information Center nearest if any component is missing.

Table 1-1. Kit Contents

Item	Quantity
ULN2003ADEVM	1

1.3 Specification

The ULN2003ADEVM is compatible with the SOIC (D version) of the ULN2003A device. The distinction between packages is in the thermal properties. Please refer to the *Thermal Information* section of the device data sheet (SLRS027) for more detailed specifications.

1.4 Device Information

The ULx200xA devices are high-voltage, high-current Darlington transistor arrays. Each consists of seven NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diodes for switching inductive loads. The collector-current rating of a single Darlington pair is 500mA. The Darlington pairs can be paralleled for higher current capability. Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED and gas discharge), line drivers, and logic buffers. This EVM is populated with the SOIC (D version) of ULN2003A.

Table 1-2. Device Information

Part Number	Package	Body Size (nom)
ULN2003A	SOIC (16)	9.90mm × 3.91mm

2 Hardware

2.1 Jumper Information

The ULN2004ADEVM jumpers are used to parallel channels for additional current capability. Table 2-1 shows the relevant configuration jumpers of the ULN2003ADEVM as well as the associated values. Please refer to the ULN2003A data sheet for detailed information on each pin's functionality.

Note

A white mark on the jumper silkscreen is reflecting the position 1 of the jumper.

Table 2-1. Jumper Configurations

Jumper	Function, Settings
JP1	Connect 1 and 2 to connect 1B and 2B Darlington base inputs.
JP2	Connect 1 and 2 to connect 2B and 3B Darlington base inputs.
JP3	Connect 1 and 2 to connect 3B and 4B Darlington base inputs.
JP4	Connect 1 and 2 to connect 4B and 5B Darlington base inputs.
JP5	Connect 1 and 2 to connect 5B and 6B Darlington base inputs.
JP6	Connect 1 and 2 to connect 6B and 7B Darlington base inputs.
JP8	Connect 1 and 2 to connect 1C and 2C Darlington collector outputs.
JP9	Connect 1 and 2 to connect 2C and 3C Darlington collector outputs.
JP10	Connect 1 and 2 to connect 3C and 4C Darlington collector outputs.
JP11	Connect 1 and 2 to connect 4C and 5C Darlington collector outputs.
JP12	Connect 1 and 2 to connect 5C and 6C Darlington collector outputs.
JP13	Connect 1 and 2 to connect 6C and 7C Darlington collector outputs.

2.2 Test Points

Table 2-2 shows the test points populated on the board as well as the signal connectors.

Table 2-2. Connections and Test Points

Connector and Test Point	Description
J1, TP1	1B Darlington base input
J2, TP2	2B Darlington base input
J3, TP3	3B Darlington base input
J4, TP4	4B Darlington base input
J5, TP5	5B Darlington base input
J6, TP6	6B Darlington base input
J7, TP7	7B Darlington base input
J8, TP8	1C Darlington collector output
J9, TP9	2C Darlington collector output
J10, TP10	3C Darlington collector output
J11, TP11	4C Darlington collector output
J12, TP12	5C Darlington collector output
J13, TP13	6C Darlington collector output
J14, TP14	7C Darlington collector output
J15, TP15	COM Common cathode node for flyback diodes
J29, TP16, TP17, TP18	Ground test point

3 Hardware Design Files

3.1 Schematics

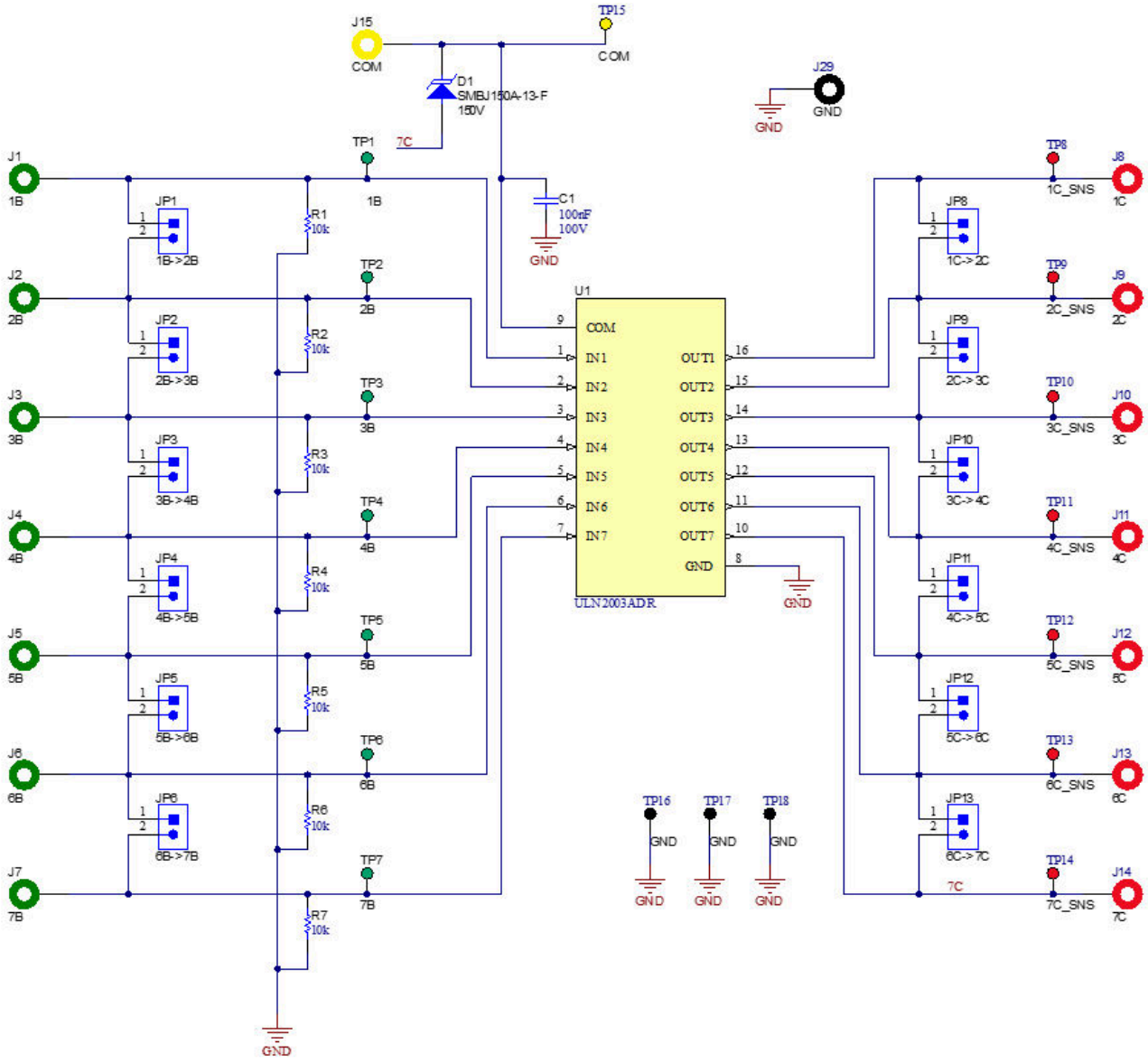


Figure 3-1. ULN2003ADEVM Schematic Drawing

3.2 PCB Layouts

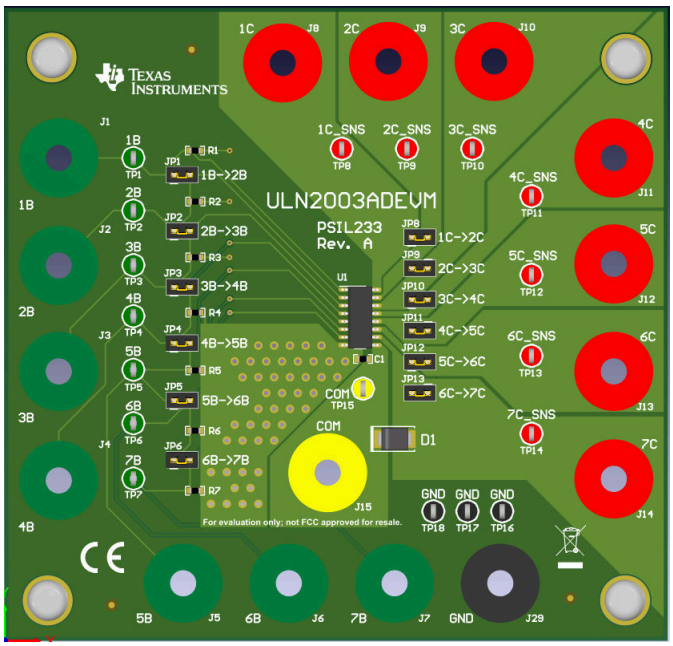


Figure 3-2. 3D Representation

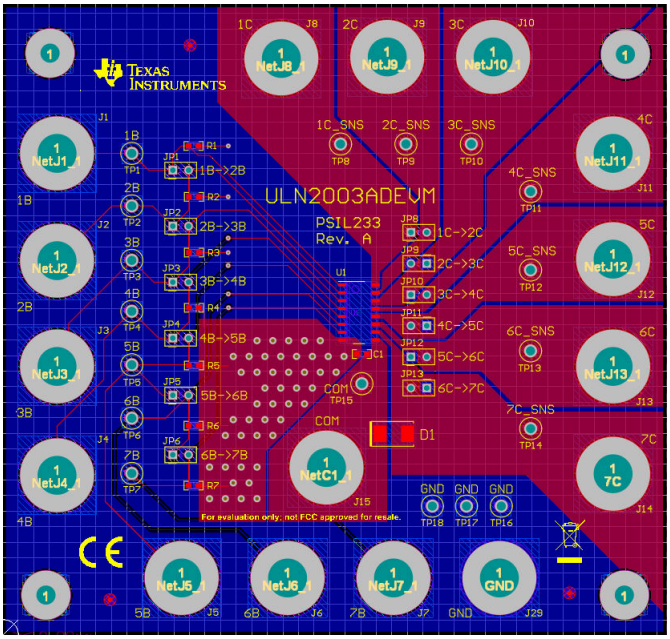


Figure 3-3. Top Layer

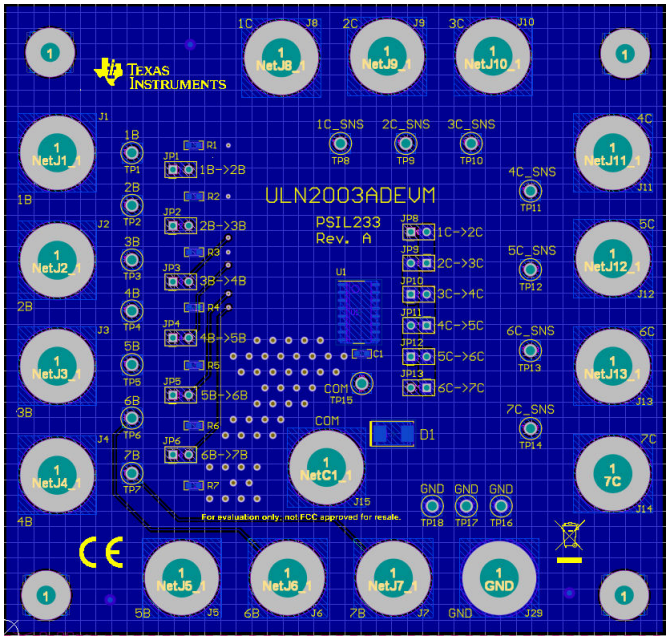


Figure 3-4. Bottom Layer

3.3 Bill of Materials (BOM)

The table below lists the ULN2003ADEVM Bill of Materials

Table 3-1. ULN2003ADEVM Bill of Materials

Designator	Description	PartNumber	Manufacturer
C1	CAP, CERM, 0.1uF, 100V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603	GCJ188R72A104KA01D	MuRata
D1	Diode, TVS, Uni, 150V, 243 Vc, SMB	SMBJ150A-13-F	Diodes Inc.
H1, H2, H3, H4	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	Standoff, Hex, 0.5"L #4-40 Nylon	1902C	Keystone
J1, J2, J3, J4, J5, J6, J7	BANANA JACK, SOLDER LUG, GREEN, TH	SPC15382	Tenma
J8, J9, J10, J11, J12, J13, J14	BANANA JACK, SOLDER LUG, RED, TH	SPC15363	Tenma
J15	BANANA JACK, SOLDER LUG, YELLOW, TH	SPC15390	Tenma
J29	BANANA JACK, SOLDER LUG, BLACK, TH	SPC15354	Tenma
JP1, JP2, JP3, JP4, JP5, JP6, JP8, JP9, JP10, JP11, JP12, JP13	Header, 100mil, 2x1, Tin, TH	PEC02SAAN	Sullins Connector Solutions
R1, R2, R3, R4, R5, R6, R7	RES, 10 k, 5%, 0.1 W, 0603	CRCW060310K0JNEA	Vishay-Dale
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10, SH-J11	Shunt, 100mil, Gold plated, Black	SNT-100-BK-G	Samtec
TP1, TP2, TP3, TP4, TP5, TP6, TP7	Test Point, Multipurpose, Green, TH	5126	Keystone
TP8, TP9, TP10, TP11, TP12, TP13, TP14	Test Point, Multipurpose, Red, TH	5010	Keystone
TP15	Test Point, Compact, Yellow, TH	5009	Keystone
TP16, TP17, TP18	Test Point, Multipurpose, Black, TH	5011	Keystone
U1	High-Voltage, High-Current Darlington Transistor Arrays, D0016A (SOIC-16)	ULN2003ADR	Texas Instruments

4 Additional Information

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All trademarks are the property of their respective owners.

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   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.

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NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

3.1 *United States*

3.1.1 *Notice applicable to EVMs not FCC-Approved:*

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

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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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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.

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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.

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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.

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9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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