TLIN1021 EVM User's Guide

This user guide describes the TLIN1021-Q1 evaluation module (EVM). This EVM helps designers evaluate device performance, support fast development, and analyze automotive local interconnect network (LIN) systems using TLIN1021-Q1 and TLIN1027-Q1 LIN physical layer transceiver devices.

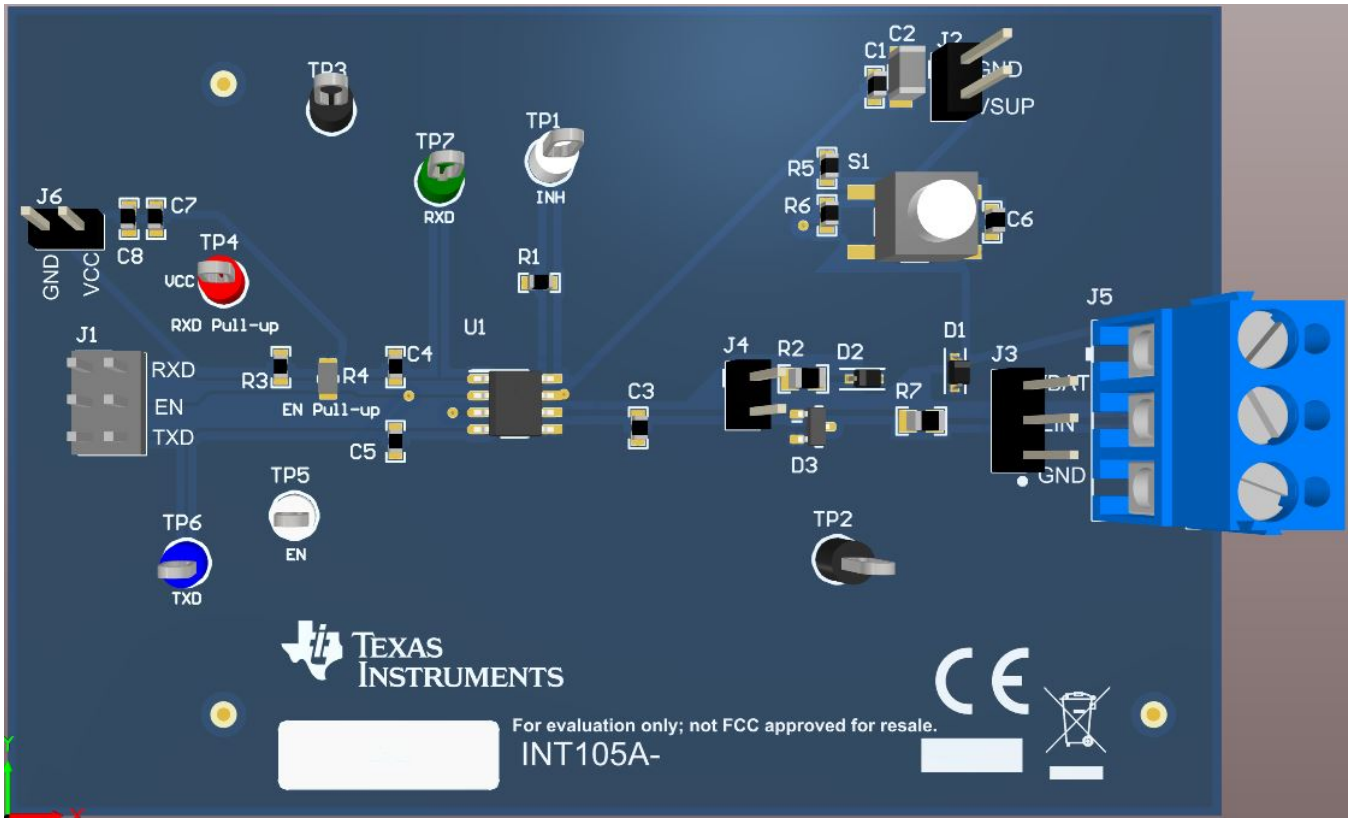

Figure 1. TLIN1021DEVM Board Image

Trademarks

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1 Introduction

1.1 Features

This EVM supports the following features:

- Master mode and Slave mode configurations
- Terminal block and headers pins are available on all power and LIN bus connections
- Optional VCC rail and pull-up resistors for EN input and RXD output
- A pushbutton circuit to engage local wake on the WAKE pin (TLIN1021)

1.2 Description

The TLIN1021-Q1 EVM provides users with the ability to evaluate the TI TLINx021-Q1 and TLINx027-Q1 single-channel, LIN transceivers. The EVM allows both master and slave mode applications to be evaluated through the use of a single jumper that connects or disconnects the external 1-kΩ pullup resistor and series diode required in master mode from the LIN bus.

The EVM has a low-voltage VCC rail that provides the voltage to the pullup resistors on the received data (RXD) open-drain output, and enable (EN) control input pins. The TLINx021-Q1 and TLINx027-Q1 supports a V_{IH} from 2 V to 5.5 V, allowing operation with a variety of microcontrollers with common IO voltage levels such as 2.5 V, 3.3 V, and 5 V. Non-populated capacitor pads are available on the TXD and RXD pins to accommodate a variety of different tests requiring various capacitive load conditions.

The TLINx021-Q1 and TLINx027-Q1 families support both 12 V and 24 V automotive applications and operate with a supply voltage from 4 V to 45 V, plus an extended bus fault protection of ±58 V. Use the EVM to evaluate the TLIN1021-Q1 or TLIN1027-Q1 device for 12-V automotive applications. Use the TLIN2021-Q1 or the TLIN2027-Q1 device for 24-V automotive applications.

Furthermore, the TLINx029-Q1 transceivers include internally-protected bus terminals with greater than ±8-kV HBM and IEC ESD protection levels. If additional ESD protection is desired, a MMBZ27VCL diode is populated on the LIN bus. This can easily be removed to test other ESD diodes as well, as it is the common SOT23 package for ESD diodes. Both headers and wire-terminals are provided on the power and LIN bus connections to allow the EVM to be evaluated in a larger system while still allowing for test equipment to be connected to the signals under test.

2 EVM Setup and Requirements

Use the following equipment to evaluate the performance of the TLINx021-Q1 device:

- Power supply capable of supplying the desired supply voltage. Typical LIN applications use 12 V or 24 V, but the TLIN1021-Q1 operates with any supply voltage from 5.5 V to 36 V. Connect this voltage across the VBAT and GND pins of either the J2, J3, or J5 connectors.
- Power supply capable of supplying the desired IO pin voltage from 2 V to 5.5 V. Connect this voltage across the VCC and GND pins of the J6 connector.
- If the LIN bus interface or the INH pin is to be observed on an oscilloscope, use probes capable of tolerating voltages as large as VBAT.
- The logic interface pins (TXD: TP6, RXD: TP7, and EN: TP5) may interface to a microcontroller, pattern generator, or logic analyzer with logic levels matching the VCC voltage.

2.1 Master Mode

To configure the board for master mode, place a shunt on J7 to connect the external 1-kΩ resistor and series diode to the LIN bus per the LIN specification.

2.2 Slave Mode

To configure the board for slave mode, remove the shunt on J7 to disconnect the external 1-kΩ resistor and series diode from the LIN bus per the LIN specification.

2.3 Pushbutton Wake

To use the pushbutton Wake circuit, push down on the S2 button while the device is in sleep mode to transition it back to standby mode.

3 Schematic and Bill of Materials

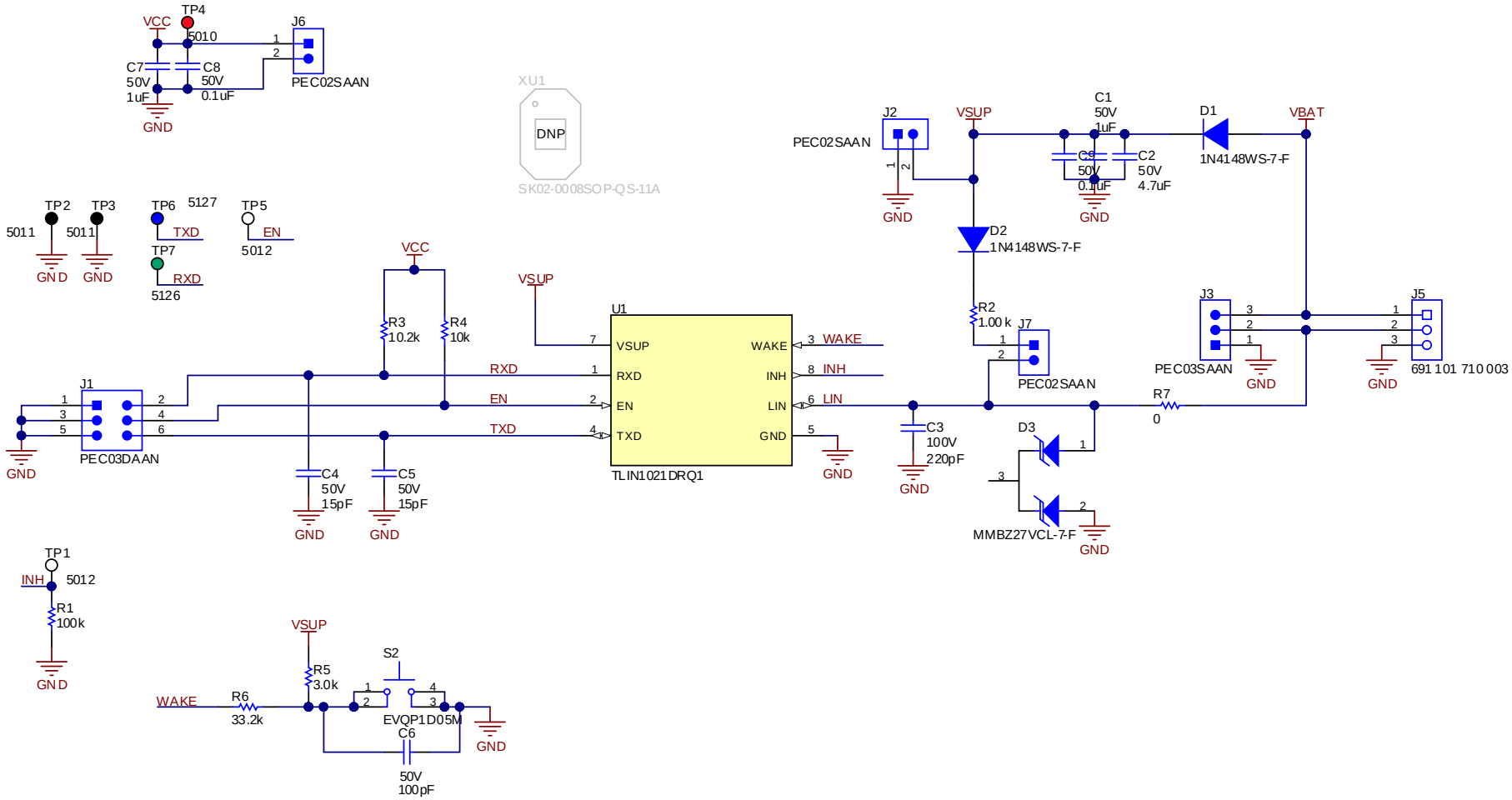

Figure 2. Schematic

Table 1. Bill of Materials

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate[1] Part Number	Alternate Manufacturer
PCB	1		Printed Circuit Board		INT105	Any		
C1, C7	2	1uF	CAP, CERM, 1 uF, 50 V, +/- 10%, X7R, 0603	0603	UMK107AB7105KA-T	Taiyo Yuden		
C2	1	4.7uF	CAP, CERM, 4.7 uF, 50 V, +/- 20%, X7R, 1206_190	1206_190	C3216X7R1H475M160AC	TDK		
C3	1	220pF	CAP, CERM, 220 pF, 100 V, +/- 10%, X7R, 0603	0603	06031C221KAT2A	AVX		
C4, C5	2	15pF	CAP, CERM, 15 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603	885012006052	Wurth Elektronik		
C6	1	100pF	CAP, CERM, 100 pF, 50 V, +/- 1%, C0G/NP0, 0603	0603	06035A101FAT2A	AVX		
C8	1	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	0603	C1608X7R1H104K080AA	TDK		
C9	1	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 5%, X7R, 0805	0805	C0805C104J5RACTU	Kemet		
D1, D2	2	75V	Diode, Switching, 75 V, 0.15 A, AEC-Q101, SOD-323	SOD-323	1N4148WS-7-F	Diodes Inc.		
D3	1	27V	Diode, TVS, Uni, 27 V, 38 Vc, SOT-23	SOT-23	MMBZ27VCL-7-F	Diodes Inc.		
H9, H10, H11, H12	4		Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon	SJ-5303 (CLEAR)	3M		
J1	1		Header, 100mil, 3x2, Tin, TH	3x2 Header	PEC03DAAN	Sullins Connector Solutions		
J2, J6, J7	3		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions		
J3	1		Header, 100mil, 3x1, Tin, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions		
J5	1		Terminal Block, 5 mm, 3x1, Tin, TH	Terminal Block, 5 mm, 3x1, TH	691 101 710 003	Wurth Elektronik		
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady		
R1	1	100k	RES, 100 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	ERJ-3GEYJ104V	Panasonic		
R2	1	1.00k	RES, 1.00 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	ERJ-6ENF1001V	Panasonic		
R3	1	10.2k	RES, 10.2 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060310K2FKEA	Vishay-Dale		
R4	1	10k	RES, 10 k, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW080510K0JNEA	Vishay-Dale		
R5	1	3.0k	RES, 3.0 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06033K00JNEA	Vishay-Dale		
R6	1	33.2k	RES, 33.2 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060333K2FKEA	Vishay-Dale		
R7	1	0	RES, 0, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW08050000Z0EA	Vishay-Dale		
S2	1		Switch, Tactile, SPST-NO, 0.05A, 12V, SMT	6x5x6 mm	EVQP1D05M	Panasonic		
TP1, TP5	2		Test Point, Multipurpose, White, TH	White Multipurpose Testpoint	5012	Keystone		
TP2, TP3	2		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone		
TP4	1		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone		
TP6	1		Test Point, Multipurpose, Blue, TH	Blue Multipurpose Testpoint	5127	Keystone		
TP7	1		Test Point, Multipurpose, Green, TH	Green Multipurpose Testpoint	5126	Keystone		
U1	1		Local Interconnect Network (LIN) Transceiver with Local Wake and Inhibit, D0008B (SOIC-8)	D0008B	TLIN1021DRQ1	Texas Instruments	TLIN1021DQ1	Texas Instruments
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A		
XU1	0		Socket, SOP-8, 1.27 mm	Socket, IC	SK02-0008SOP-QS-11A	RS Tech Incorparated		

(1) Unless otherwise noted in the Alternate PartNumber and/or Alternate Manufacturer columns, all parts may be substituted with equivalents.

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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.

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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.

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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

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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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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.

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.

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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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   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

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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