

# ***TIOL111-5 and TIOS101-5 Evaluation Modules***

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This user guide describes the TIOL111-5 and TIOS101-5 evaluation modules (EVM). This EVM will help designers evaluate device performance, support fast development, and analyze IO-Link transmission systems using TIOL111-5 and TIOS101-5 IO-Link physical layer devices.

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### **Trademarks**

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## 1 Introduction

### 1.1 Features

- Support for TIOL111-5 IO-Link transceiver with 5V-LDO
- Support for TIOS101-5 digital output driver with 5V-LDO
- EVM supports TIOL111-5, TIOL111-3, or TIOL111 IO-Link transceivers
- EVM supports TIOS101-5, TIOS101-3, or TIOS101 digital output (SIO) driver
- Configurable output current via on-board POT
- Headers and LEDs for individual signal measurements and activity monitoring
- Multiple setup options and configurations possible

### 1.2 TIOL111-5 and TIOS101-5 Description

The TIOL111-5 EVM provides users with the ability to evaluate TI's TIOL111x family of IO-Link transceivers. The EVM includes the TIOL111-5 which provides full IO-Link functionality and an on-chip 5-V LDO. With pin-to-pin compatibility throughout the TIOL111 family, the EVM can also support the TIOL111 (no LDO) or the TIOL111-3 (3.3-V LDO). The EVM includes the ability to measure and monitor numerous signals including L+, L-, CQ, TX, RX, and more, while also being able to adjust the device output current via an on-board potentiometer. Although the TIOL111 family of devices include on-chip ESD (IEC61000-4-2) and surge protection, which eliminates or reduces the size of any TVS diodes, pads for these diodes are included for modification to meet user's requirements.

The TIOS101-5 EVM provides users with the ability to evaluate TI's TIOS101x family of *Digital Output* (SIO) drivers. The EVM includes the TIOS101-5 which includes an on-chip 5-V LDO. With pin-to-pin compatibility throughout the TIOS101 family, the EVM can also support the TIOS101 (no LDO) or the TIOS101-3 (3.3-V LDO). The EVM includes the ability to measure numerous signals including VCC, GND, OUT, EN, and IN while also being able to adjust the device output current via an on-board potentiometer. Additionally, the TIOS101 devices can be configured for PNP, NPN, or push-pull output. Although the TIOS101 family of devices include on-chip ESD (IEC61000-4-2) and surge protection, which eliminates or reduces the size of any TVS diodes, pads for these diodes are included for modification to meet user's requirements.

Note that the PCB labeling follows the pin naming of the TIOL111. When using a TIOS101 device, the following signal translations should be made:

- "CQ" is used for "OUT"
- "L+" is used for "VCC"
- "L-" is used for "GND"
- "TX" is used for "IN"
- "WAKE" and "RX" signals are not used

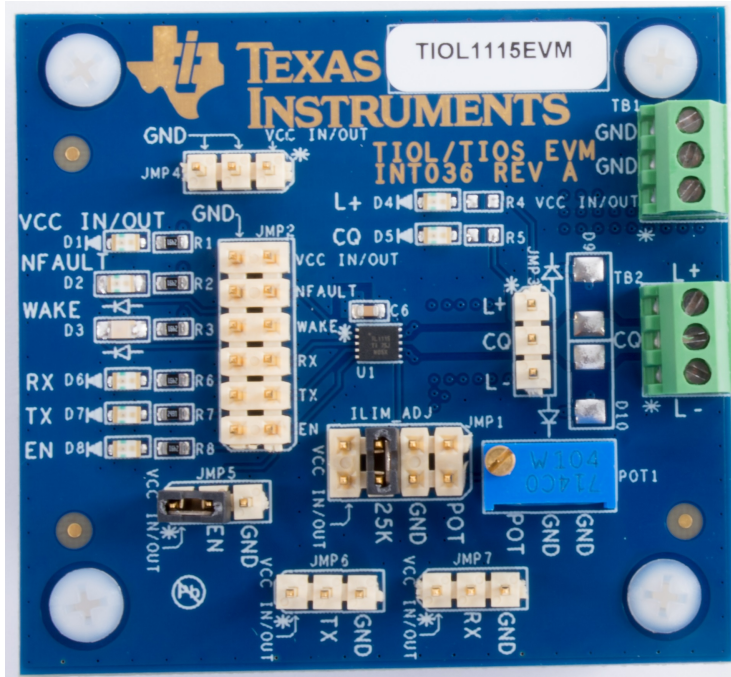


Figure 1. EVM Board

## 2 EVM Setup and Requirements

The following equipment may be used to evaluate the performance of the TIOL111 and TIOS101 device(s).

- Power supply capable of supplying 3.3 V and 5 V (if a device without an internal LDO is used)
- Power supply capable of supplying 24 V across L+, VCC (supply) and L-, GND (ground)
- If the field interface is to be observed on an oscilloscope, probes capable of tolerating voltages as large as L+/VCC should be used
- If connecting to an IO-Link master node, an appropriate three-wire cable with Lp, Ln, and CQ signals should be used (TIOL111 only)
- If connecting to a digital field input device, an appropriate three-wire cable with VCC, OUT, and GND signals should be used (TIOS101 only)
- The logic interface pins (TX, EN, RX, NFAULT, and WAKE) may interface to a microcontroller, pattern generator, or logic analyzer using 3.3-V or 5-V logic levels (to match the VCC IN/OUT voltage)

### 2.1 TIOL111 Setup

With an appropriate IO-Link cable, connect the L+, L-, and CQ pins from TB2 on the EVM board to an IO-Link master node. Alternatively, L+ and L- can be connected to a DC power supply and the CQ signal can be monitored on an oscilloscope or connected to a test load.

JMP2 can be used for driving the TX and EN inputs and measuring the RX, WAKE, and NFAULT outputs. For system-level IO-Link testing, these pins should connect to a microcontroller implementing the IO-Link protocol stack. For convenience, extra connection ports are provided for EN, TX, and RX on JMP5, JMP6, and JMP7, respectively.

If the TIOL111-3 or -5 are used (LDO), the 3.3-V or 5-V output will be available on JMP4 and on JMP2; this can be used to power a microcontroller, sensor front-end, or other device as needed. If the non-LDO version is used, a 3.3-V or 5-V supply is required on VCC IN/OUT.

The output current limit of the device can be changed by adjusting the resistance between ILIM\_ADJ and L- using JMP1. Shorting ILIM\_ADJ to ground sets the maximum current limit of 350 mA. Lower limits can be achieved by using JMP1 to connect ILIM\_ADJ to either a 25-k $\Omega$  resistor ("25K" selection) or 100-k $\Omega$  potentiometer ("POT" selection).

### 2.2 TIOS101 Setup

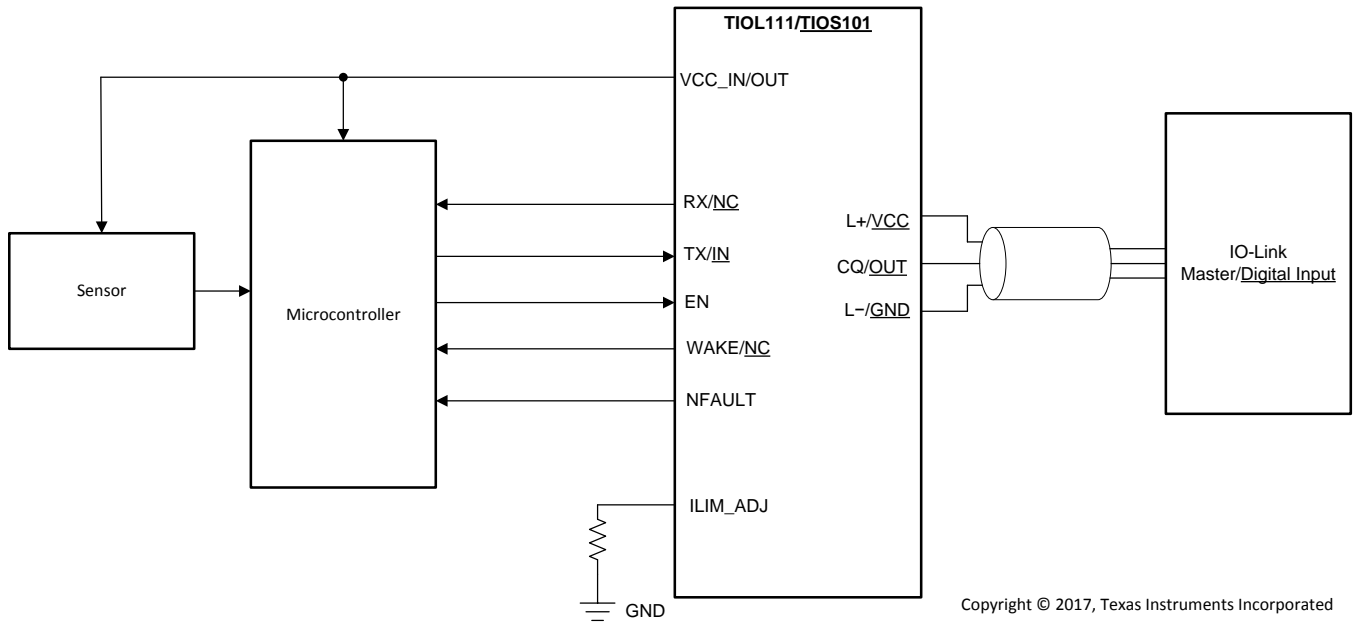
With an appropriate cable, connect the VCC, GND, and OUT pins from TB2 on the EVM board to a load; the load can be resistive, capacitive, or inductive.

JMP2 can be used for driving the TX and EN inputs and measuring the NFAULT output. For convenience, extra connection ports are provided for EN and TX on JMP5 and JMP6, respectively.

If the TIOS101-3 or -5 are used (LDO), the 3.3-V or 5-V output will be available on JMP4 and on JMP2; this can be used to power a microcontroller, sensor front-end, or other device as needed. If the non-LDO version is used a 3.3-V or 5-V supply is required on VCC IN/OUT.

The output current limit of the device can be changed by adjusting the resistance between ILIM\_ADJ and L- using JMP1. Shorting ILIM\_ADJ to ground sets the maximum current limit of 350 mA. Lower limits can be achieved by using JMP1 to connect ILIM\_ADJ to either a 25-k $\Omega$  resistor ("25K" selection) or 100-k $\Omega$  potentiometer ("POT" selection).

Figure 2 illustrates a typical TIOS111 or TIOS101 application example.



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**Figure 2. TIOL111-5 and TIOS101-5 Application Example**

### 3 EVM Jumper Settings

Table 1 lists the EVM jumper settings and Table 2 lists the EVM status LED functions.

**Table 1. EVM Jumper Settings**

Jumper	Description	Setting	Result
JMP1	Current limit adjustment	POT	Connects POT between ILIM_ADJ and L-
		GND	ILIM_ADJ pulled low
		25K	Connects 25 kΩ between ILIM_ADJ and L-
		VCC IN/OUT	ILIM_ADJ pulled high
JMP2	I/O Port (any pin/GND that does not have a jumper will be pulled up to VCC)	EN - GND	Jumper disables the device
		TX - GND	Apply signal or probe
		RX - GND	Connect microcontroller or probe
		WAKE - GND	Connect to microcontroller
		NFAULT - GND	Connect to microcontroller
		VCC IN/OUT - GND	Provides power for microcontroller (LDO versions) Supply 3.3-V or 5-V logic supply (non-LDO version)
JMP3	IO-Link line-in	L+	IO-Link supply voltage (24 V)
		CQ	IO-Link data signal
		L-	IO-Link ground
JMP4	Power supply	VCC IN/OUT	Provides power for microcontroller supply, 3.3-V or 5-V logic supply (non-LDO version)
		GND	
JMP5	Driver enable or disable	VCC IN/OUT	Device enabled
		GND	Device disabled
JMP6	TX input	OPEN	Connect TX to microcontroller
JMP7	RX input	OPEN	Connect RX to microcontroller

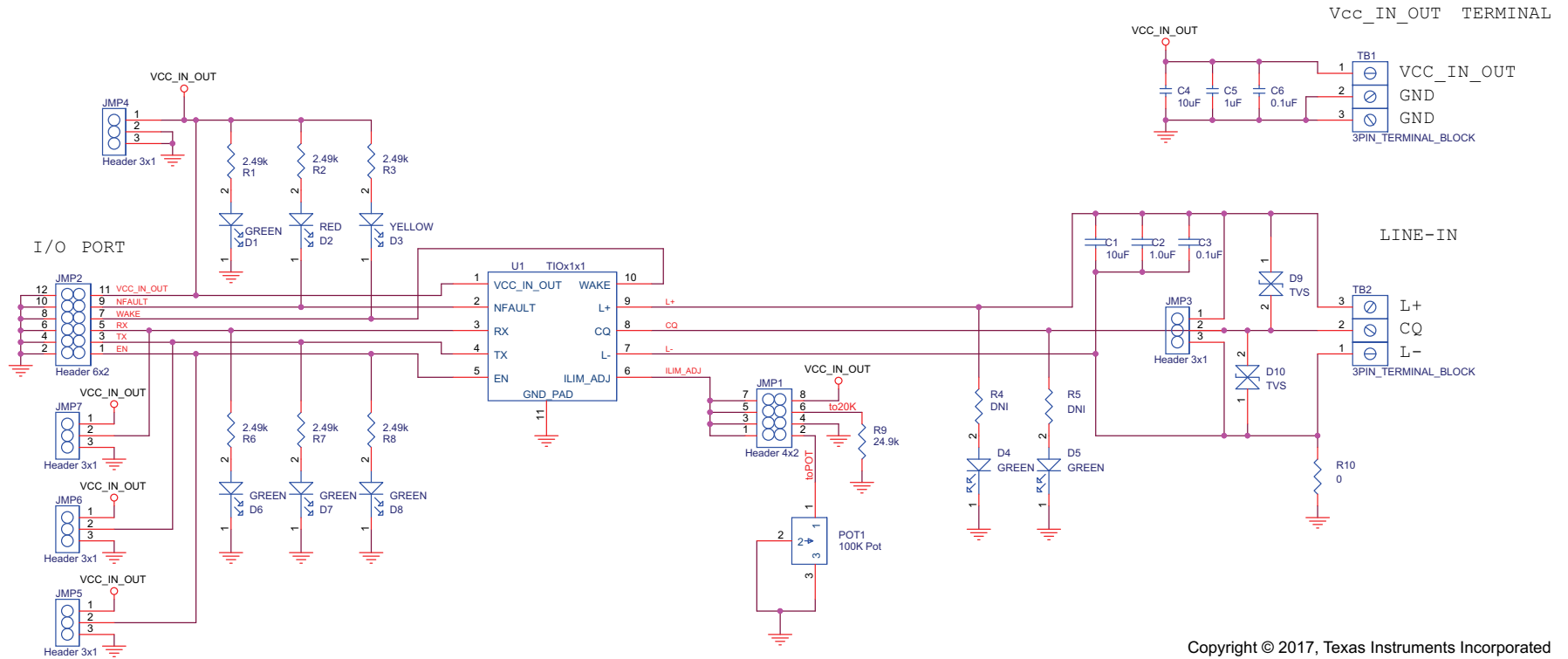
**Table 2. EVM Status LEDs**

LED	Name	Function
D1	VCC IN/OUT	ON – VCC IN/OUT voltage present
		OFF – No VCC IN/OUT voltage present
D2	NFAULT	ON - NFAULT notification from the PHY to the local controller
		OFF – No NFAULT event
D3	WAKE (TIOL only)	ON - WAKE notification from the PHY to the local controller
		OFF – No WAKE event
D4	L+	ON - Supply voltage present
		OFF – No supply voltage present
D5	CQ	ON - CQ voltage present
		OFF – No CQ voltage present
D6	RX (TIOL only)	ON - RX voltage greater than 2 V
		OFF – RX voltage less than 2 V
D7	TX	ON - TX voltage greater than 2 V
		OFF –TX voltage less than 2 V
D8	EN	ON - Transmitter enabled
		OFF – Transmitter disabled

## 4 Schematic and Bill of Materials

### 4.1 Schematic

Figure 3 is the schematic for the TIOL111-5 and TIOS101-5 EVM.



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**Figure 3. TIOL111-5 and TIOS101-5 EVM Schematic**

## 4.2 Bill of Materials

Table 3 lists the TIOL111-5 and TIOS101-5 BOM.

**Table 3. Bill of Materials**

Item	Qty	Reference	Value	Manufacturer	Manufacturer Part Number
1	6	R1, R2, R3, R6, R7, R8	2.49k	Vishay Dale	CRCW06032K49FKEAHP
2	2	R4, R5	DNI	-	DNI
3	1	R9	25k	Panasonic Electronic Components	ERJ-8ENF2002V
4	1	R10	0	Vishay/Dale	CRCW12100000Z0EA
5	6	D1, D4, D5, D6, D7, D8	Green	Lite-On Inc	LTST-C170KGGT
6	1	D3	Yellow	Lumex Opto Components Inc	SML-LXT0805YW-TR
7	1	D2	Red	Lite-On Inc	LTST-C170KRKT
8	2	TB1, TB2	AMP Connector	TE Connectivity	282834-3
9	2	D9, D10	TVS Diode	-	DNI
10	1	C1, C4	10 uF	Taiyo Yuden	TMK316B7106KL-TD
11	1	C2	1 uF	Taiyo Yuden	HMK316B7105KL-T
12	1	C3	0.1 uF	AVX Corporation	12061C104JAT2A
13	1	C5	1 uF	Murata Electronics North America	GMK212B7105KG-T
14	1	C6	0.1 uF	AVX Corporation	0603YC104JAT2A
15	1	POT1	100K	Bourns Inc.	3296W-1-104
16	1	JMP1	Header, 4x2	Samtec Inc	HTSW-104-07-G-D
17	1	JMP2	Header, 6x2	Samtec Inc	HTSW-106-07-G-D
18	5	JMP3, JMP4, JMP5, JMP6, JMP7	Header, 3x1	Samtec Inc	HTSW-103-07-G-S
19	1	U1	TIOL111-5 or TIOS101-5	Texas Instruments	TIOL1115DMWR or TIOS1015DMWR
20	4	H1, H2, H3, H4	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	B&F Fastener Supply	NY PMS 440 0025 PH
21	4	H5, H6, H7, H8	Standoff, Hex, 0.5"L #4-40 Nylon	Keystone Electronics	1902C
22	3	SH1, SH2, SH3	Shunt	TE Connectivity AMP Connectors	382811-6
23	1	PCB		INT036	Any
24	1	LB1	White Sticker	Brady	THT-14-423-10



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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.
  - 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 semiconductor 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.
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](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](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:*

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.

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