User's Guide

AMC1400 and AMC1411 Evaluation Module

ABSTRACT

The AMC1400 and AMC1411 are precision isolation amplifiers with an output separated from the input circuitry by a silicon dioxide (SiO2) barrier that is highly resistant to magnetic interference. This barrier has been certified to provide reinforced galvanic isolation of up to 10.5 kV_{PEAK} per DIN V VDE V 0884-11 (VDE V 0884-11): 2017-01.

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Trademarks

1 Introduction

For use in high-resolution, current-measurement applications, the AMC1400 is optimized for connection to low-ohmic-value shunt resistors or other voltage signal sources with low-output resistance.

For use in high-resolution, voltage-measurement applications, the high-impedance input of the AMC1411 is optimized for connection to high-voltage resistive dividers or other voltage signal sources with high-output resistance.

Throughout this document, the abbreviation *EVM* and the term *evaluation module* are synonymous with the AMC1400EVM or AMC1411EVM.

1.1 Features

This EVM has the following features:

- Full-featured evaluation module for the AMC1400 or AMC1411 single-channel precision isolation amplifier
- Screw terminals for easy access to high- and low-side power supplies, analog inputs, and analog outputs

2 Analog Interface

The analog input to the EVM is routed from a three-wire screw terminal screw at J3.1, which provides access to the INP terminal, referenced to J3.3, GND1. J3.2 provides access to either the INN terminal for the AMC1400 or the SHTDN terminal for the AMC1411. By default, J3.2 is shorted to GND1 by a 0-Ω resistor, R5.

2.1 Analog Input

The analog input of the EVM is accessible to the user by connector J3. The passive components of the analog input section are comprised of R1, R3, and C8 that form a simple differential antialiasing filter with a corner frequency of 796 kHz. The input of the AMC1411 is single-ended; therefore, R3 is not installed. R1 and C8 on the AMC1411EVM form a simple antialiasing filter with a corner frequency of 1.6 MHz. An antialiasing cutoff frequency between 200 kHz and 2 MHz is recommended. By default, INN (pin 3) of the AMC1400 and SHTDN (pin 3) of the AMC1411 is tied to GND1 (pin 4) by a 0 Ω resistor (R5). Figure 2-1 shows the input circuit for the AMC1400EVM.

Using a signal generator or other voltage source, the user can apply an input signal directly to J3.1. The linear input voltage range of the AMC1400 by J3.1 is –250 mVDC to 250 mVDC, whereas the linear input voltage range of the AMC1411 is 0 VDC to 2 VDC referenced to J3.3, GND1. If measuring across an external shunt resistor, tie J3.1 to the positive Kelvin connection terminal and tie J3.3 to the negative Kelvin connection terminal of the shunt resistor.

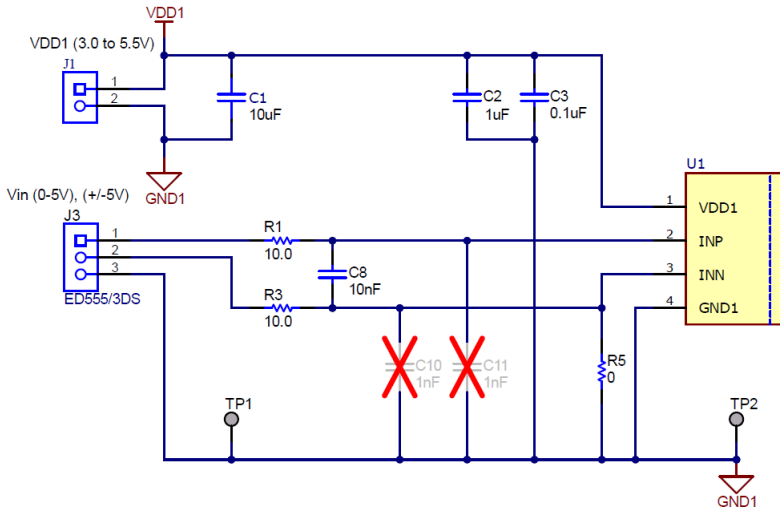

Figure 2-1. AMC1400EVM Schematic – Analog Input Section

2.2 Shutdown

The AMC1411 features a shutdown option which is an active high input. Resistor R5 is installed by default and allows for normal operation of the AMC1411. When the resistor is removed, the SHTDN pin can be controlled externally via J3.2 to shutdown the AMC1411. When shutdown, the AMC1411 enters into a low-power mode by means of an internal pullup resistor for battery-powered or other power-sensitive applications.

2.3 Analog Output

The analog output from the EVM is a fully-differential signal centered at 1.44 V. Figure 2-2 shows that the differential output of U1 is available on the two screw terminals of J4. OUTP is available at J4.3 and swings from 0.5 V to 2.5 V when a –250-mV to 250-mV signal is applied to the input of the AMC1400 or from 1.44 V to 2.5 V when a 0-V to 2-V signal is applied to the input of the AMC1411. OUTN is available at J4.2 and swings from 2.5 V to 0.5 V when a –250-mV to 250-mV signal is applied to the input of the AMC1400 or from 1.44 V to 0.5 V when a 0-V to 2-V signal is applied to the input of the AMC1411. The pads of R2, R4, C9, C7, and C12 allow users to install their own output filtering. Table 2-1 lists a few example filters. Common-mode filter capacitors C7 and C12 are recommended to be at least 20 times less than the differential filter capacitor.

Table 2-1. Analog Output Filter Examples

Cutoff Frequency	Resistance	Differential Capacitor
100 kHz	R2 = R4 = 100 Ω	C9 = 8.2 nF
300 kHz	R2 = R4 = 100 Ω	C9 = 2.7 nF
600 kHz	R2 = R4 = 100 Ω	C9 = 1.3 nF

Use the differential output if the application allows. If a single-ended output is desired, consult the *Interfacing a Differential-Output (Isolated) Amplifier to a Single-Ended Input ADC* application brief for help with designing the differential to single-ended circuit.

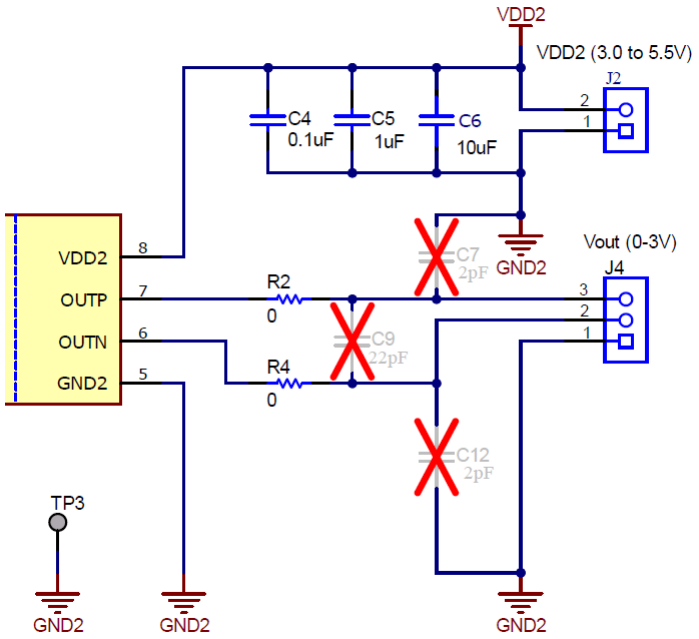

Figure 2-2. AMC1400EVM Schematic: Analog Output Section

3 Power Supplies

The EVM requires two separate power rails, VDD1 and VDD2. VDD1 is on the high-voltage side of the amplifier. VDD2 is on the user side of the amplifier.

3.1 VDD1 Input

The EVM provides access to VDD1 by J1.1. The VDD1 supply must be between 3 VDC and 5.5 VDC with respect to GND1, where J1.2 and J3.3 provide direct access to GND1.

3.2 VDD2 Input

The EVM provides access to VDD2 by J2.2. The VDD2 supply must be between 3 VDC and 5.5 VDC with respect to GND2, where J2.1 and J4.1 provide direct access to GND2.

4 EVM Operation

The following sections describe the general operation of the EVM.

4.1 Analog Input and VDD1 Power: J3 and J1

The analog input voltage to the EVM can be applied directly to J3 pin 1.

Table 4-1 lists the details of J3.

Table 4-1. J3: Analog Input

Pin Number	Signal	Description
J3.1	INP/IN	Analog positive input to the AMC1400 or input to the AMC1411 (pin 2)
J3.2	INN/SHTDN	Analog negative input to the AMC1400 or SHTDN to the AMC1411 (pin 3)
J3.3	GND1	Connection to the GND1 terminal (pin 4)

The isolated power input to the EVM printed circuit board (PCB) can be applied directly to J1 pins 1 and 2. Table 4-2 lists the details of J1.

Table 4-2. J1: VDD1 Power

Pin Number	Signal	Description
J1.1	VDD1	Connection to the VDD1 terminal (pin 1)
J1.2	GND1	Connection to the GND1 terminal (pin 4)

CAUTION

Carefully review the AMC1400 data sheet or AMC1411 data sheet for the limitations of the analog input range, and ensure that the appropriate analog and digital voltages are applied prior to connecting any analog input to the EVM. The board is not certified for high-voltage operation.

4.2 Analog Outputs and VDD2 Power: J4 and J2

The differential analog output voltage from the EVM is applied directly to J4.3 and J4.2. Table 4-3 lists the details of J4.

Table 4-3. J4: Differential Analog Output

Pin Number	Signal	Description
J4.3	OUTP	Connection to the noninverting analog output terminal (pin 7)
J4.2	OUTN	Connection to the inverting analog output terminal (pin 6)
J4.1	GND2	Connection to the GND2 terminal (pin 5)

The VDD2 power input to the EVM printed circuit board can be applied directly to J2 pins 1 and 2. Table 4-4 lists the details of J2.

Table 4-4. J2: VDD2 Power

Pin Number	Signal	Description
J2.2	VDD2	Connection to the VDD2 terminal (pin 8)
J2.1	GND2	Connection to the GND2 terminal (pin 5)

4.3 Device Operation

When the VDD1 and VDD2 power is applied to the EVM, the differential analog output is available with a fixed gain of 8.2 for the AMC1400 or 1 for the AMC1411 and a DC offset equal to 1.44 V (typical).

An analog input signal may be applied directly at screw terminal J3. See Figure 2-1 and Table 4-1 for details. The analog input range is specified at –250 mV to 250 mV for the AMC1400 or 0 V to 2 V for the AMC1411.

For the AMC1400 isolation amplifier, the analog output has a nominal gain of 8.2. With an input voltage of –250 mV to 250 mV, the nominal output is –2 V to 2 V differential. For the AMC1411 isolation amplifier, the analog output has a nominal gain of 1. With an input voltage of 0 V to 2 V, the nominal output is 0 V to 2 V differential. For both devices the output is centered on a 1.44-V output common-mode voltage, providing a convenient analog input range to the embedded ADCs of the MSP430 and TMS320C2000 series of digital processors.

5 Board Layout

This section contains the printed-circuit board (PCB) layout of the EVM.

Note

Board layouts are not to scale. These images are intended to show how the board is laid out, and are not intended to be used for manufacturing EVM PCBs.

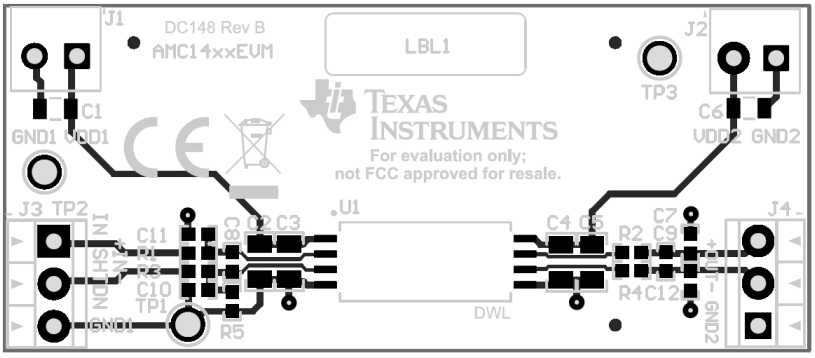

Figure 5-1. AMC14xx Top Silkscreen Drawing

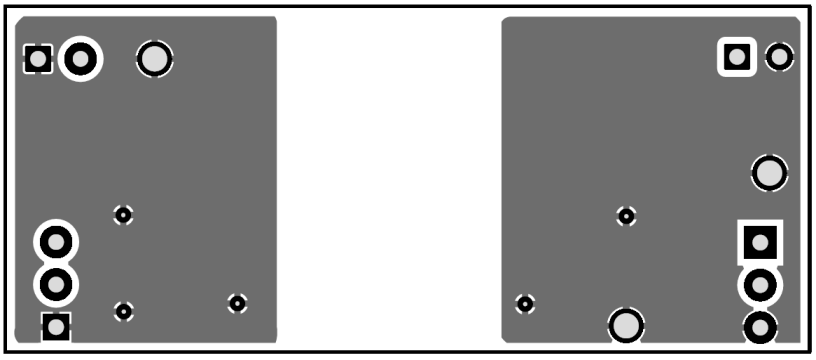

Figure 5-2. AMC14xx Bottom Silkscreen Drawing

6 Bill of Materials and Schematics

This section contains the complete bill of materials and schematic diagrams of the EVM.

6.1 Bill of Materials

Table 6-1 shows the AMC1400EVM bill of materials.

Table 6-1. Bill of Materials

Designator	Description	Manufacturer	Mfg. Part Number
C1, C6	CAP, CERM, 10 µF, 16 V, ±10%, X7R, 1206	Samsung	CL31B106KOHVPNE
C2, C5	CAP, CERM, 1 uF, 25 V, ±10%, X7R, 1206	AVX	12063C105KAT2A
C3, C4	CAP, CERM, 0.1 uF, 50 V, ±10%, X7R, 1206	Yageo America	CC1206KRX7R9BB104
C8	CAP, CERM, 0.01 uF, 50 V, ±10%, X7R, 0603	MuRata	GCM188R71H103KA37D
J1, J2	Terminal Block, 3.5-mm Pitch, 2x1, TH	On-Shore Technology	ED555/2DS
J3, J4	Terminal Block, 3.5mm Pitch, 3x1, TH	On-Shore Technology	ED555/3DS
R1, R3	RES, 10.0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW060310R0FKEA
R2, R3, R4	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	Panasonic	ERJ-3GEY0R00V
TP1, TP2, TP3	Terminal, Turret, TH, Double	Keystone	1573-2
U1	High CMTI Reinforced Isolated Amplifier for Current Sensing in ultra-wide-body SOIC8 package	Texas Instruments	AMC1400DWL
C10, C11	CAP, CERM, 1000 pF, 50 V,+/- 10%, X7R, 0603	Wurth Elektronik	885012206083
C7, C12	CAP, CERM, 2 pF, 50 V, +/- 12.5%, C0G/NP0, 0603	Kemet	C0603C209C5GACTU
C9	CAP, CERM, 22 pF, 50 V, +/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0603	TDK	CGA3E2C0G1H220J080AA

6.2 Schematics

Figure 6-2 shows the AMC1400EVM schematic.

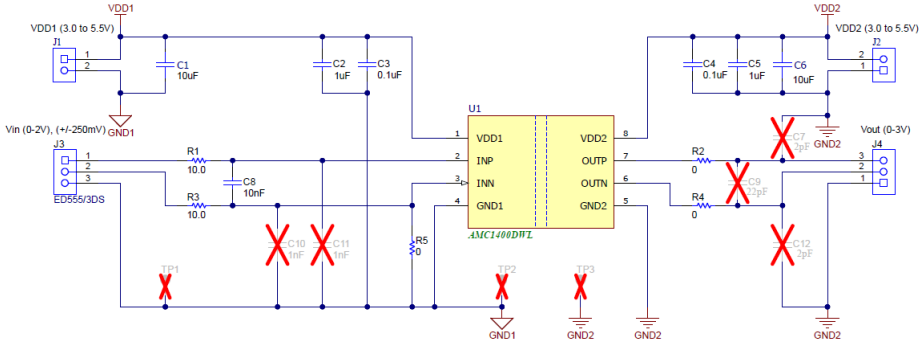

Figure 6-1. AMC1400EVM Schematic

Figure 6-2 shows the AMC1411EVM schematic.

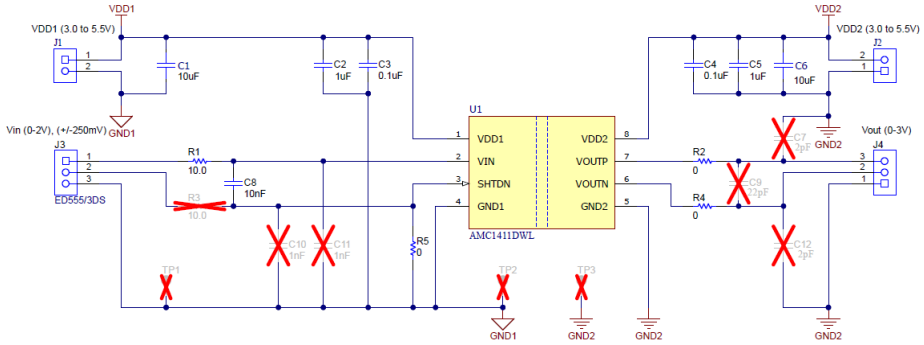

Figure 6-2. AMC1411EVM Schematic

7 Related Documentation

To obtain a copy of any of the following TI documents, call the Texas Instruments Literature Response Center at (800) 477-8924 or the Product Information Center (PIC) at (972) 644-5580. When ordering, please identify this booklet by its title and literature number. Updated documents can also be obtained through our website at www.ti.com.

- Texas Instruments, *AMC1400 Precision, ±250-mV Input, Reinforced Isolated Amplifier* data sheet
- Texas Instruments, *AMC1411 Precision, 2-V Input, Reinforced Isolated Amplifier* data sheet

8 Revision History

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

Changes from Revision * (April 2021) to Revision A (June 2022) **Page**

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 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。
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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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。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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.

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