EVM User's Guide: IO-EXP-ADAPTER-EVM

IO-EXP-ADAPTER Evaluation Module

Description

The IO-EXP-ADAPTER-EVM is an evaluation module that can break away into four separate PCBs for testing and debugging. The IO-EXP-ADAPTER-EVM supports many package types from TI's I^2C and SPI IO expander portfolio.

Get Started

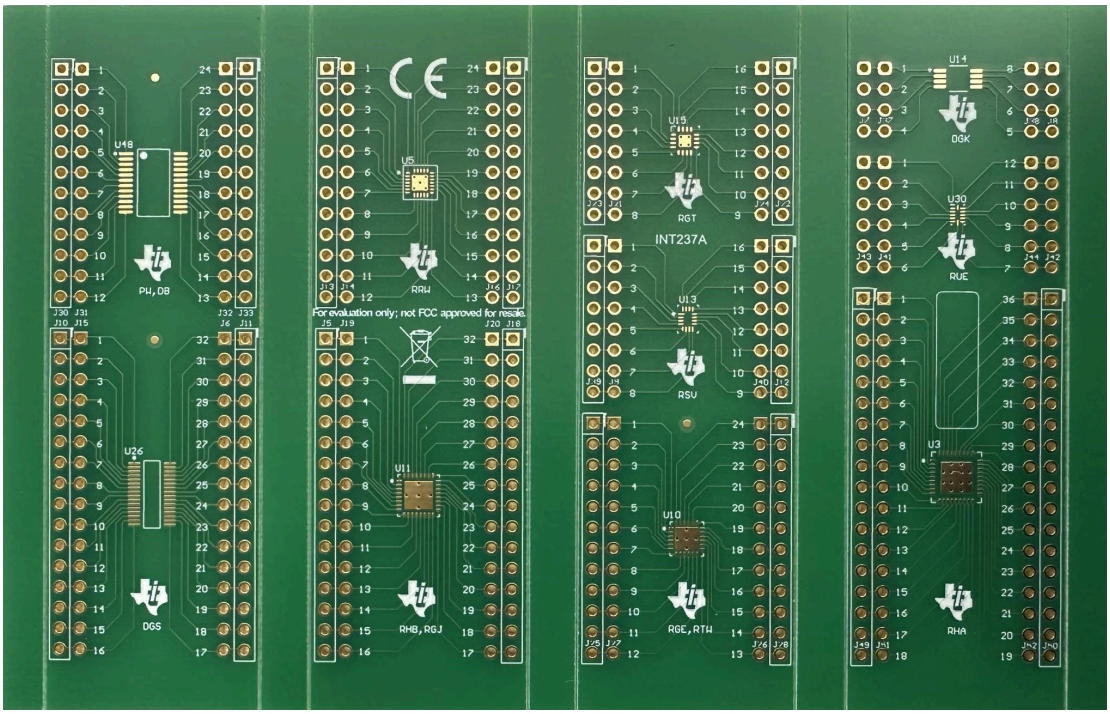
1. Order the EVM
2. Break away the desired IC package (use of a mechanical tool is recommended)
3. Solder down the IC and headers
4. Use PCB with standard breadboard or as a standalone unit

Features

- Can break away into four separate PBCs for quick testing and debugging
- Supports leaded and non-leaded quad flat packaging types
- Has 10 unique IC footprints that can support:
  - 8-pin DGK packages
  - 12-pin RUE packages
  - 16-pin RGT and RSV packages
  - 24-pin PW, DB, RRW, RHB, RGJ, RGE, and RTW packages
  - 32-pin DGS packages
  - 36-pin RHA packages

Applications

- Enterprise Systems
- Automotive
- Personal Electronics
- Industrial
- Wireless Infrastructure



1 Evaluation Module Overview

1.1 Introduction

The IO-EXP-ADAPTER-EVM supports several devices across TI's I^{2}C and SPI IO expander portfolio. This includes the newly released SPI IO expander TXE81xx as well as the I^{2}C TCAL agile IO expanders. The EVM supports both leaded and non-leaded quad flat packaging types, and can be used with a standard breadboard and jumper wires for quick testing.

1.2 Kit Contents

This kit includes:

- 1 blank PCB with unpopulated IC footprints and headers
- 1x24 pin headers (10 count)

1.3 Specification

The IO-EXP-ADAPTER-EVM has 10 unique IC footprints that accommodate several package types for TI's I^{2}C / SPI IO expander portfolio. The EVM can break away into four separate smaller PCBs as cost-optimized, quick applications for testing and debug purposes.

The following figure shows a PCB layout for the PW/DB package type. Pin 1 is always located in the top-left column. Both pins in the yellow box are connected to pin 1 of the IC. The next two pins in the row 2 correspond to pin 2 of the IC and so on. The order of pins goes in counter-clockwise fashion.

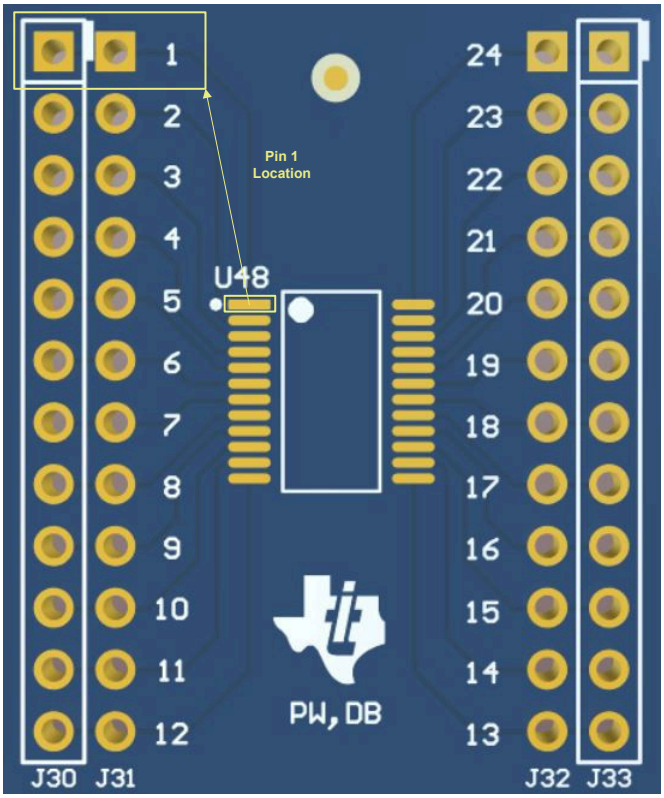


Figure 1-1. Pin 1 Location

1.4 Device Information

The RHB, RGE, and DGS package types support the newly released SPI IO expander family. TXE8124 is the 24-bit version and TXE8116 is the 16-bit version.

The rest of the package types included in this EVM help support most of the I^{2}C IO expander portfolio, including the agile IO family denoted as *TCAL*. For example, TCAL6416 is an I^{2}C Agile IO expander. TCA6416A is the predecessor device and does not have agile IO capability.

2 Hardware

2.1 Evaluation Setup

The unboxed EVM contains one blank PCB with unpopulated IC footprints and headers. Also included in the EVM kit are 10 pcs of 1x24 headers (100 mil).

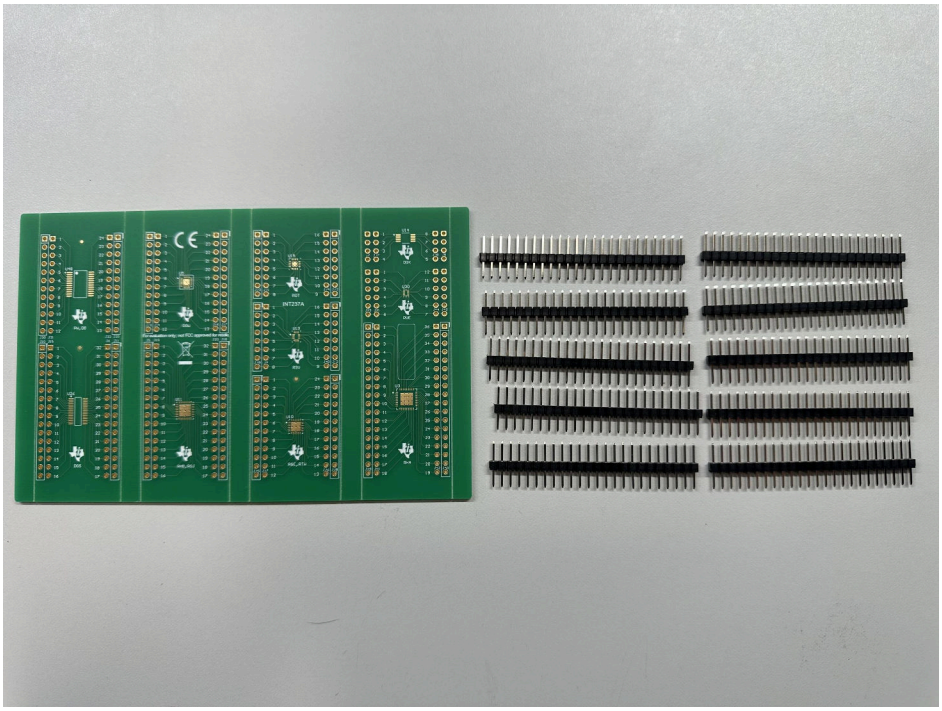


Figure 2-1. Unboxed EVM

Each PCB has two columns of through-hole connections made for standard 100mil headers. The idea is to place one of the column header pairs face down so that the PCB can connect to a standard breadboard. The other column pair is to be used with headers facing up so that jumper wires, power supply leads, oscilloscope probes, I^2C/SPI driver connections, or other equipment can connect easily to the PCB with jumper wires. The break-apart PCBs are also small enough to allow for an additional connections on the standard breadboard in case various load resistors or capacitors are required for testing.

To use the EVM, break away the desired IC package from the main PCB. You can use some type of mechanical tool to break away the package.

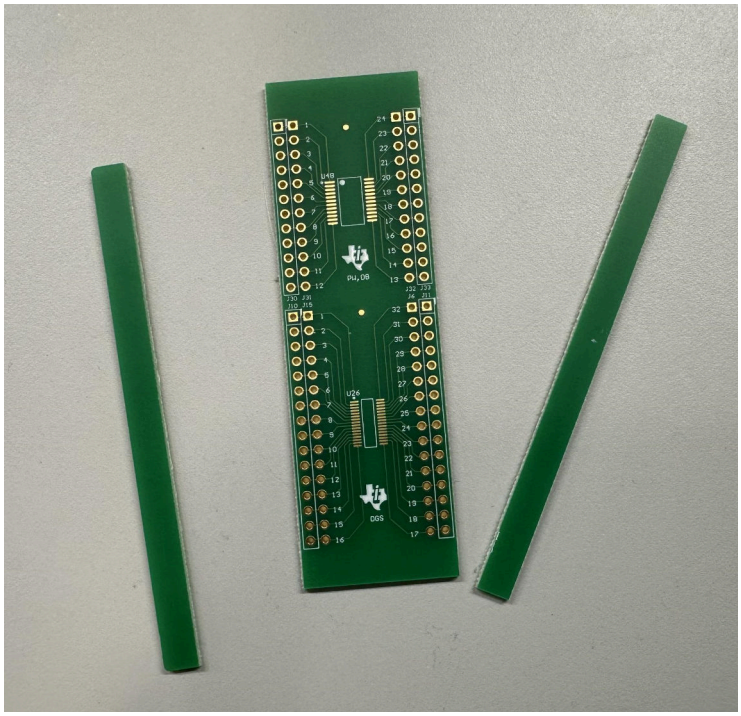


Figure 2-2. Break Apart Desired Package Type

The next step is to solder the headers for the desired test setup. When the PCB is soldered and the headers are in place, the PCB can be used with a standard breadboard for additional IO connections.

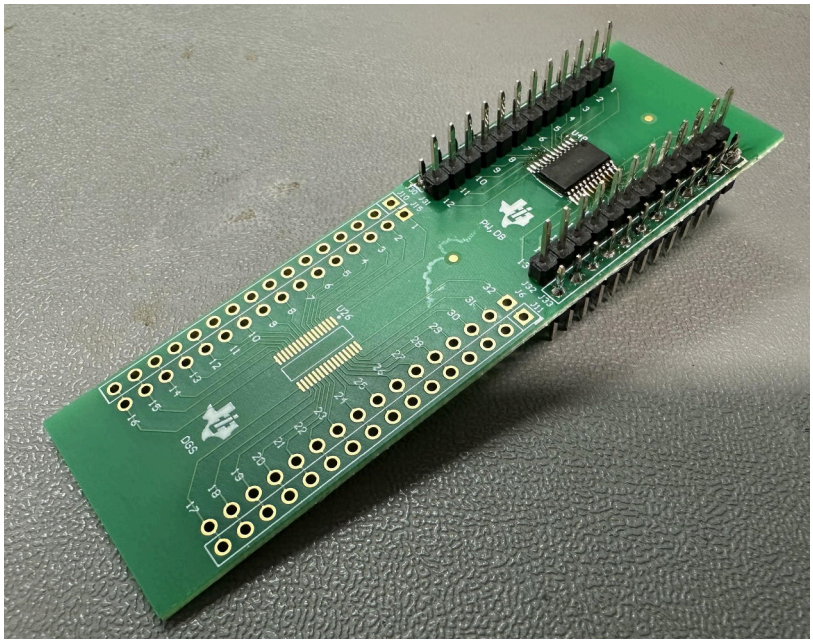


Figure 2-3. Example Breakout Board with IC and Headers Soldered

In this example setup, column 1 is reserved for breadboard connections. Column 2 (outer-most column) can connect directly to the breadboard. Column 3 (inner-most column) has the headers facing up for external connections like jumper wires, o-scope probes, power supplies connections, and so forth.

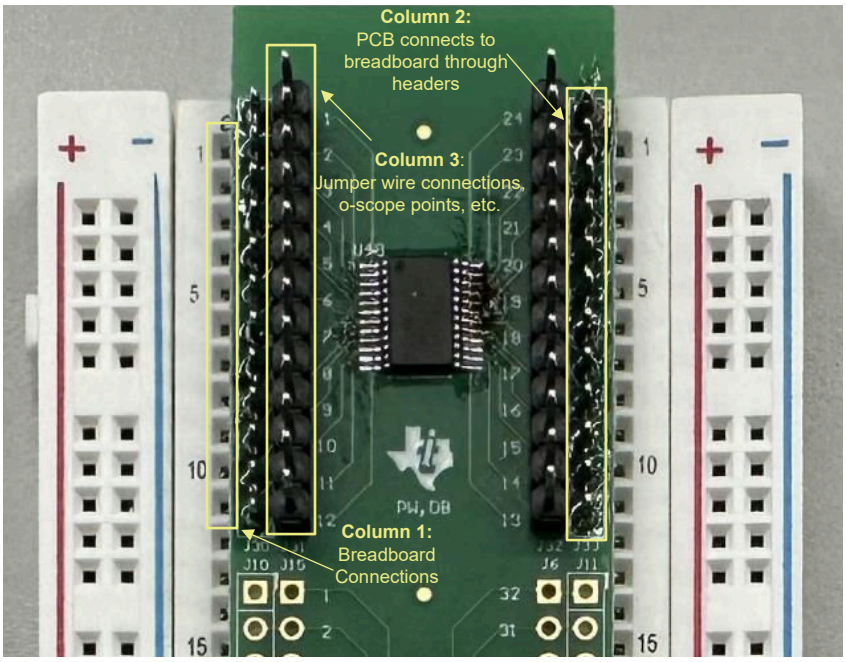


Figure 2-4. Example of EVM with Standard Breadboard

The final step is to complete all necessary connections for the desired testing setup. In this example, an Arduino Mega is used as the I^2C driver. The I^2C SDA and SCL lines are level translated from 5 V to 3.3 V using the TCA39306EVM. The DUT on the IO-EXP-ADAPTER-EVM is the TCA9539-Q1 16-bit Automotive Grade I2C IO Expander. Various scope probes are used to monitor the SDA and SCL channels on the IO expander in the test. Power supply connections are made with various hook clip and jumper connections to and from the breadboard.

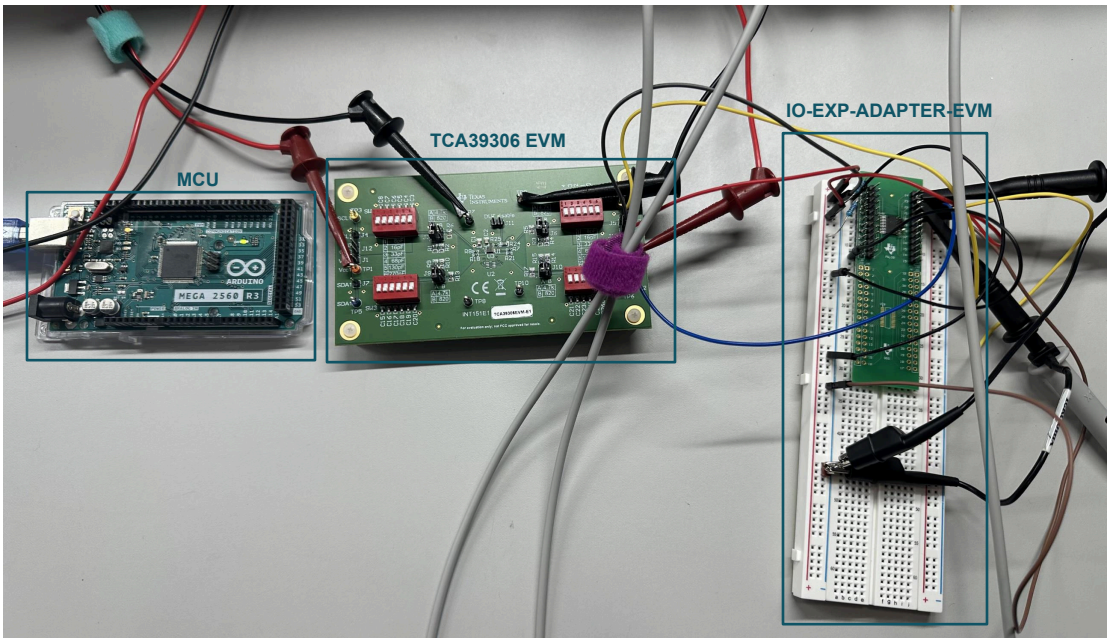


Figure 2-5. Example Test Setup with Arduino Mega, TCA39306EVM, and IO-EXP-ADAPTER-EVM with TCA9539-Q1

3 Hardware Design Files

3.1 Schematic

Figure 3-1. EVM Schematic

3.2 PCB Layouts

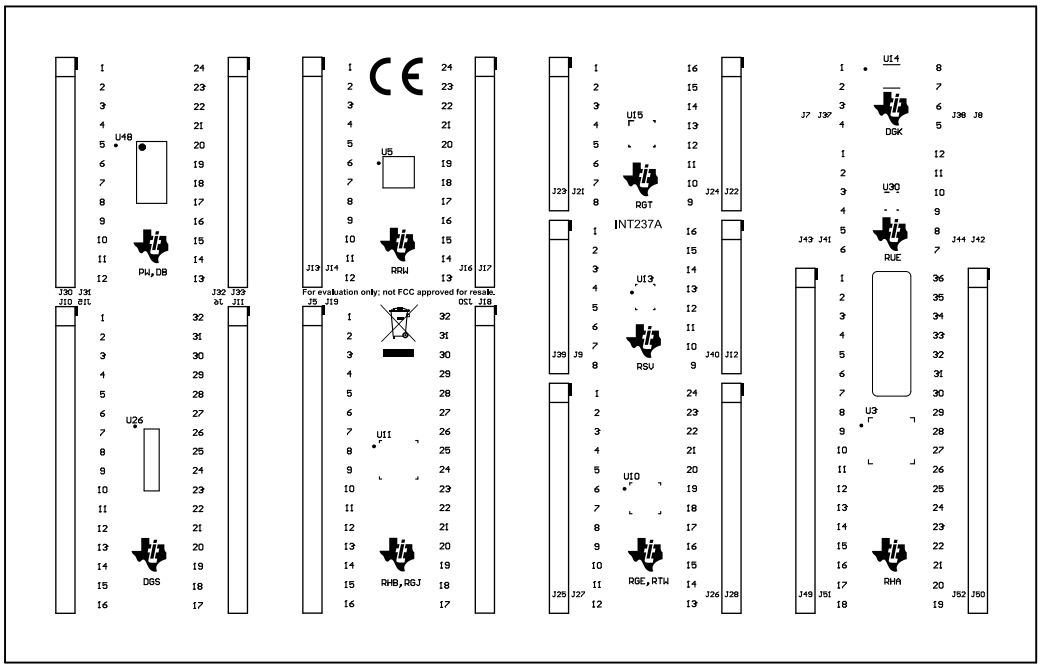


Figure 3-2. Layer 1 - Top Overlay

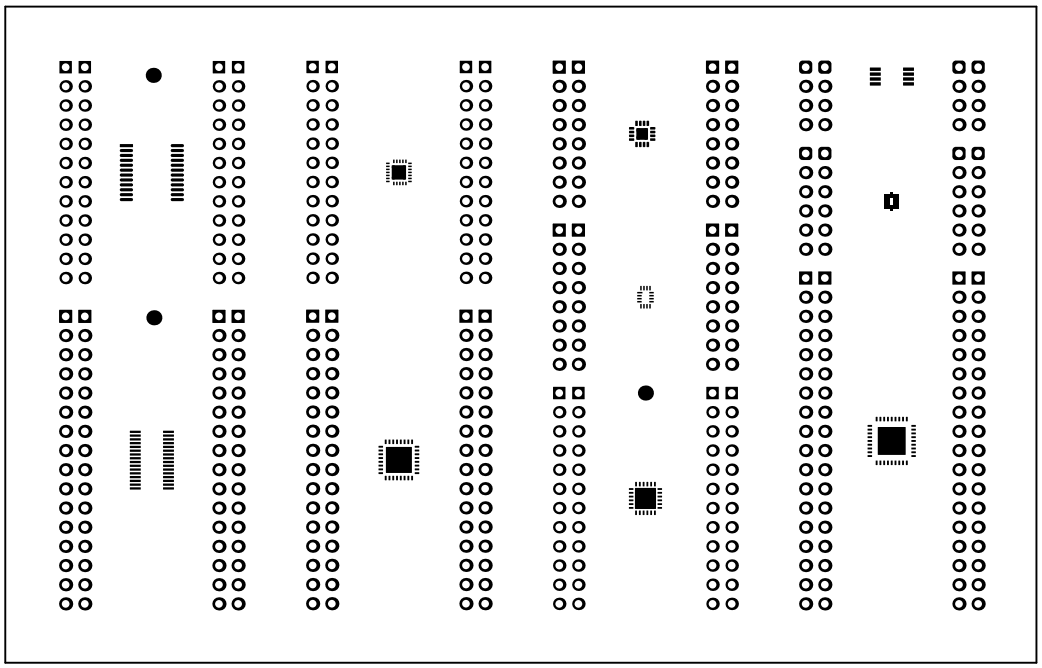


Figure 3-3. Layer 2 - Top Solder Mask

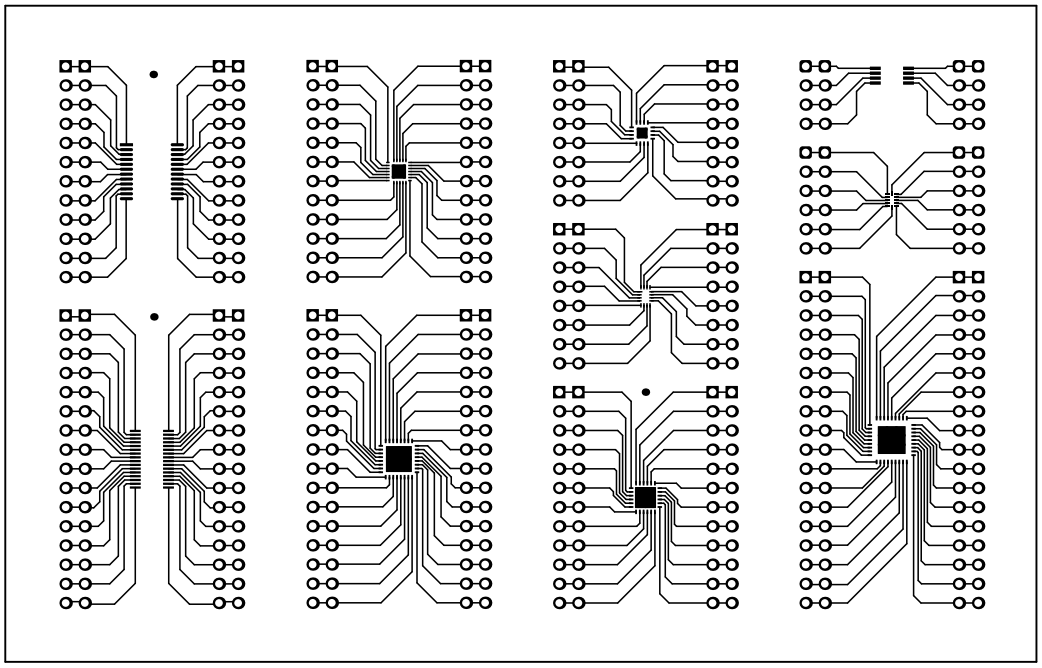


Figure 3-4. Layer 3 - Top Layer

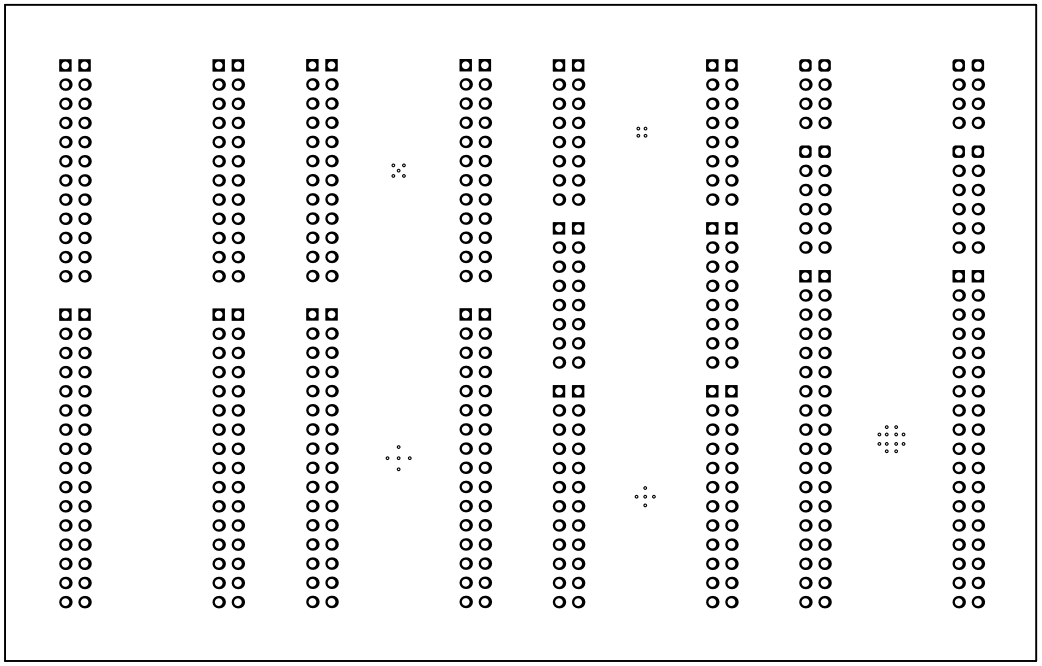


Figure 3-5. Layer 4 - Bottom Layer

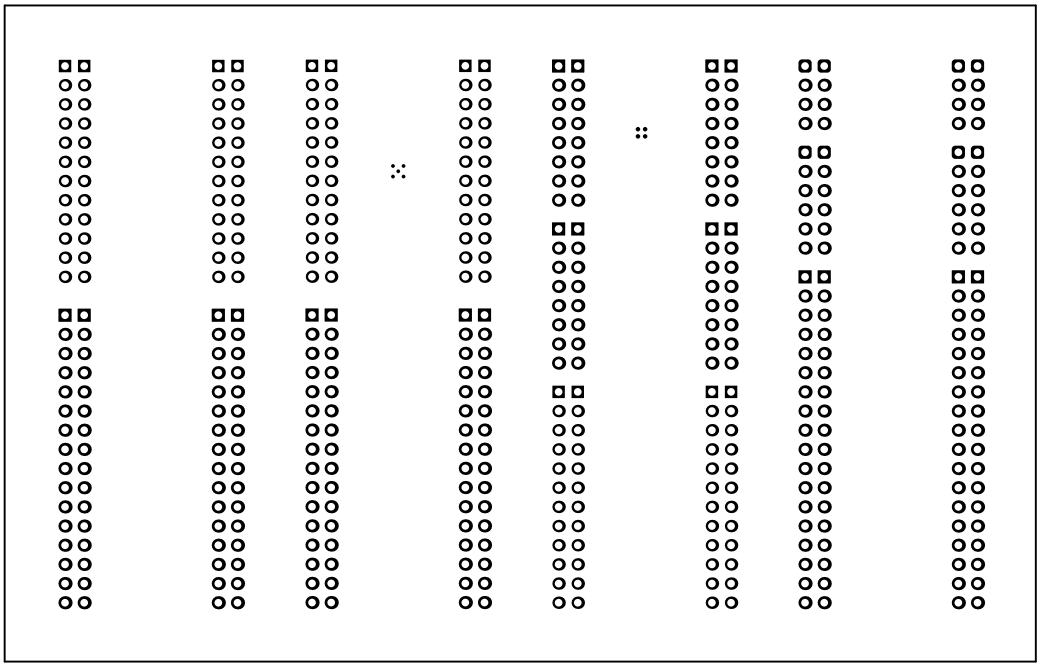


Figure 3-6. Layer 5 - Bottom Solder Mask

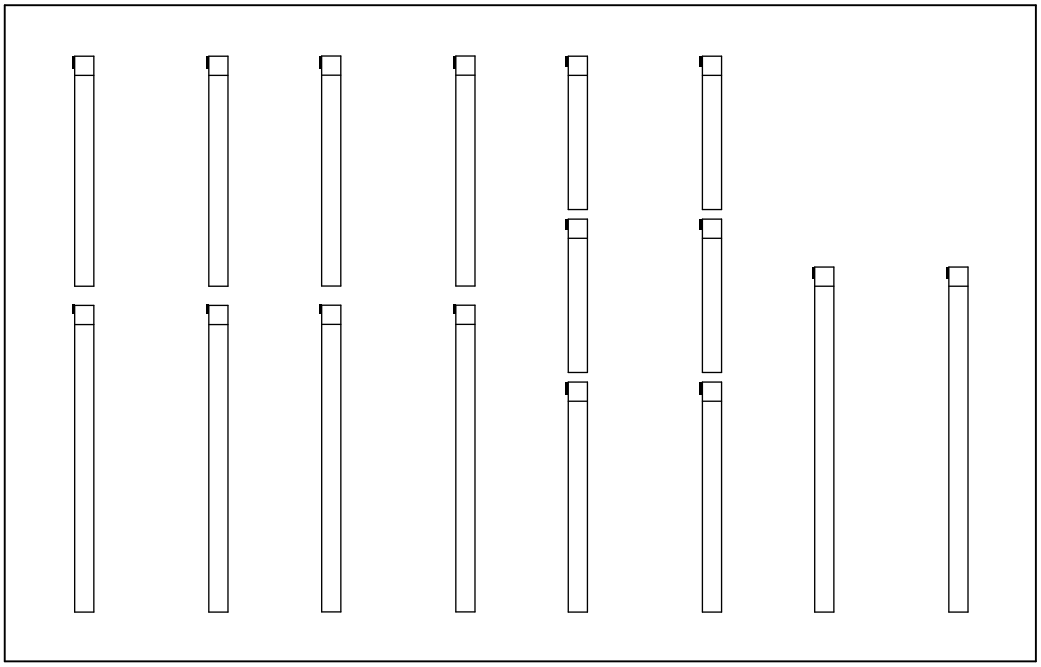
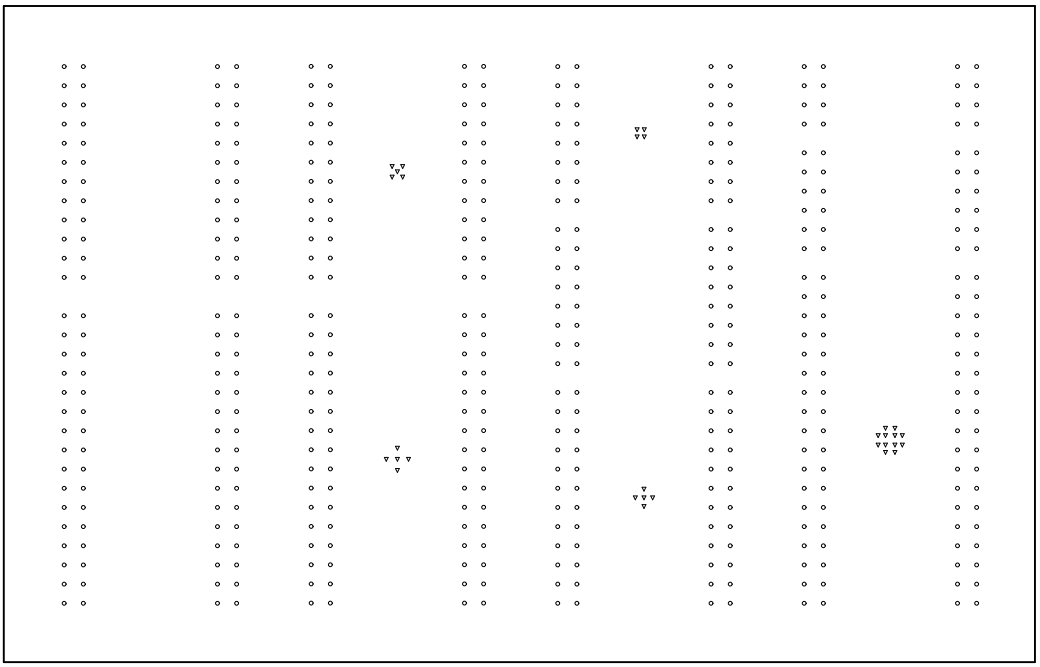
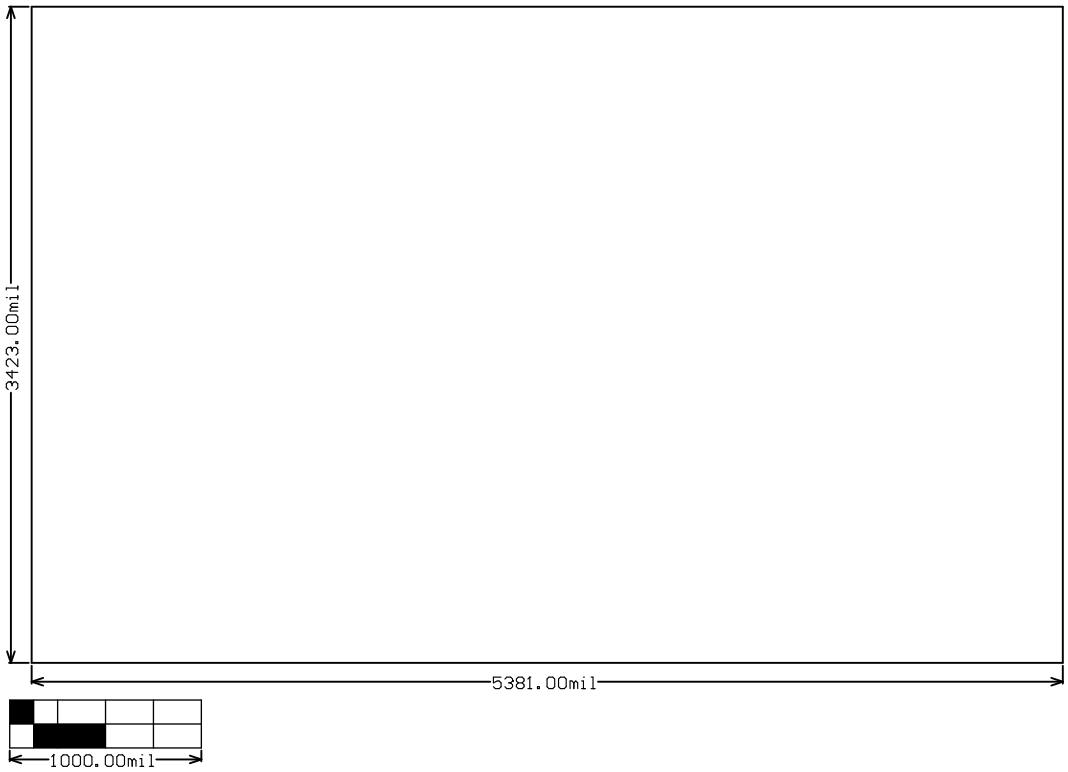


Figure 3-7. Layer 6 - Bottom Overlay



Symbol	Quantity	Finished Hole Size	Plated	Hole Type	Drill Layer Pair	Hole Tolerance
▽	31	7.87mil (0.200mm)	PTH	Round	Top Layer - Bottom Layer	
○	448	40.00mil (1.016mm)	PTH	Round	Top Layer - Bottom Layer	
	479 Total					

Figure 3-8. Layer 7 - Drill Drawing



Note: 3.423 inch × 5.381 inch

Figure 3-9. Layer 8 - Board Dimensions

3.3 Bill of Materials (BOM)

Table 3-1. Bill of Materials (BOM)

Designator	Quantity	Description	Package Reference	Part Number	Manufacturer
!PCB	1	INT237A	Any	Printed Circuit Board	Any
LBL1	1	Thermal Transfer Printable Labels, 0.650" W x 0.200"H, 10,000 per roll	N/A	N/A	N/A
J5, J6, J10, J11, J15, J18, J19, J20, J7, J8, J37, J38, J9, J12, J21, J22, J23, J24, J39, J40, J41, J42, J43, J44, J49, J50, J51, J52	10	Conn Unshrouded Header HDR 24 POS 2.54mm Solder ST Thru-Hole (Included separately in ESD bag)	24x1 Header	TSW-124-08-G-S	Samtec
J5, J6, J10, J11, J15, J18, J19, J20	0	Header, 100mil, 16x1, Gold, TH	16x1 Header	TSW-116-07-G-S	Samtec
J7, J8, J37, J38	0	Header, 100mil, 4x1, Gold, TH	4x1 Header	TSW-104-07-G-S	Samtec
J9, J12, J21, J22, J23, J24, J39, J40	0	Header, 100mil, 8x1, Gold, TH	8x1 Header	TSW-108-07-G-S	Samtec
J13, J14, J16, J17, J25, J26, J27, J28, J30, J31, J32, J33	0	Header, 100mil, 12x1 Gold, TH	12x1 Header	TSW-112-07-G-S	Samtec
J41, J42, J43, J44	0	Header, 100mil, 6x1, Gold, TH	6x1 Header	TSW-106-07-G-S	Samtec
J49, J50, J51, J52	0	Header, 100mil, 18x1 Gold, TH	18x1 Header	TSW-118-07-G-S	Samtec
U3	0	24-Bit SPI IO Expander	VQFN36	TXE8124RHAR	Texas Instruments
U5	0	Three-Phase PWM Motor Driver	QFN24	DRV8311PRRWR	Texas Instruments
U10	0	16-Bit SPI IO Expander	VQFN24	TXE8116QWRGERQ1	Texas Instruments
U11	0	24-Bit SPI IO Expander	VQFN32	TXE8124QWRHBRQ1	Texas Instruments
U13	0	Low-voltage 8-bit I2C-bus/SMBus I/O expander with interrupt, reset and agile I/O configuration	UQFN16	TCAL9538RSVR	Texas Instruments
U14	0	Remote 4-Bit I2C and SMBus I/O Expander with Configuration Registers	VSSOP8	TCA9536DGK	Texas Instruments
U15	0	Low-Voltage 8-Bit I2C and SMBus I/O Expander, 1.65V to 5.5V, -40 to 85 degC, 16-pin QFN (RGT), Green (RoHS & no Sb/Br)	RGT0016A	TCA6408ARGTR	Texas Instruments
U26	0	24-Bit SPI IO Expander	VSSOP32	TXE8124QDGSRQ1	Texas Instruments
U30	0	Low-Voltage 7-Bit I2C and SMBus LED Driver With Intensity Control and Shutdown, 12-pin QFN (RUE12), Green (RoHS & no SB/Br)	RUE0012A	TCA6507RUER	Texas Instruments
U48	0	Low-Voltage 16-Bit I2C and SMBus Low-Power I/O Expander with Interrupt Output and Configuration Registers	SSOP24	TCA9535DBR	Texas Instruments

4 Compliance Information

4.1 Compliance and Certifications

- RoHS Compliant EVM

5 Additional Information

5.1 Trademarks

All trademarks are the property of their respective owners.

6 Related Documentation

- Texas Instruments, *Features of TCAL Agile IO Expanders* application note
- Texas Instruments, *A Basic Guide to I^2C* application note
- Texas Instruments, *How to Debug I^2C* application note
- Texas Instruments, *How to Configure an I^2C Push-Pull IO Expander to Operate as Open Drain* application note
- Texas Instruments, *Understanding the I^2C Bus* application note

6.1 Supplemental Content

- Texas Instruments, *I2C Level Shifters, Buffers, and IO Expanders FAQ*
- Texas Instruments, *Engineer to Engineer (e2e) 24-Hour Response Forum*
- Texas Instruments, *Calculating the Correct Pullup Resistor Value in I^2C Bus Applications* video

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。

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

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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。 技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

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2. 実験局の免許を取得後ご使用いただく。
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西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

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