TSW4200 Demonstration Kit

Contents

List of Figures

List of Tables

1 Introduction

1.1 Overview

This is the user's guide for the TSW4200 Demonstration Kit. The kit includes two EVMs: TSW4200-DAC and TSW4200-ADC, and they provide evaluation to TI's DAC3283 and ADS62P49, respectively. Through the included FMC adapter boards, the EVMs are ideally suited for mating with a FPGA development board to evaluate the DAC and the ADC as a basic transmitter and receiver system. For more information regarding the individual device or EVM, refer to Table 1 for the respective device's datasheet and EVM user's guide.

Table 1. TSW4200 Demonstration Kit Reference Materials

	Device	Data Sheet	EVM	User's Guide
TSW4200-DAC	DAC3283	SLAS693	DAC328xEVM	SLAU311
TSW4200-ADC	ADS62P49	SLAS635	ADS62PxxEVM	SLAU237

The included FMC adapters are the FMC-DAC-Adapter and the FMC-ADC-Adapter. They are a type of passive interconnect board enabling direct connection of the output of TI's LVDS high speed DACs or ADCs to a standard FMC interconnect header. The FMC interconnect header is a typical input on the latest Xilinx FPGA EVMs. The TSW4200-DAC EVM uses the FMC-DAC-Adapter, and the TSW4200-ADC uses the FMC-ADC-Adapter.

Note: Use the adapters with the latest revision update:

FMC-DAC-Adapter (rev. A or later)
FMC-ADC-Adapter (rev. C or later)
HSMC-ADC-Bridge (rev. B or later)

1.2 TSW2400 Demonstration Kit Block Diagram

Figure 1 shows the configurations of the TSW4200-DAC and TSW4200-ADC EVM with the FPGA development board. Section 3 covers the setup information of the EVMs.

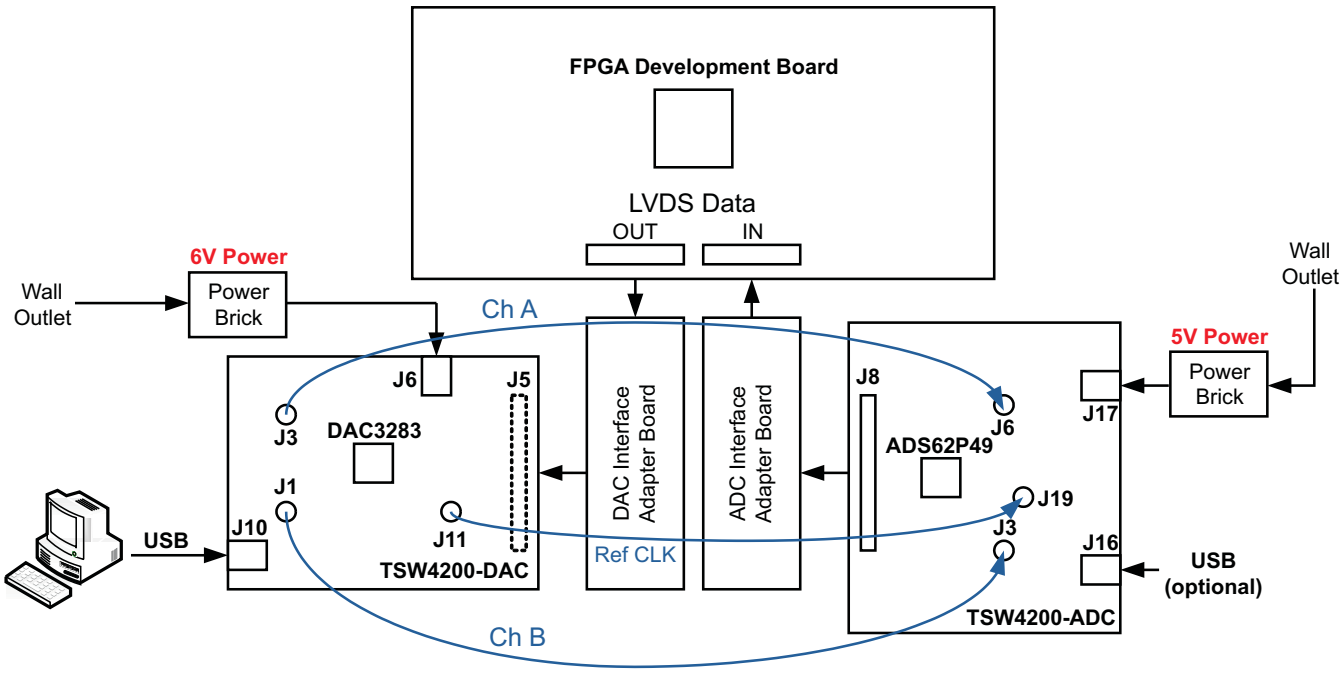

Figure 1. TSW4200 Demonstration Kit

1.3 TSW4200-DAC Configuration

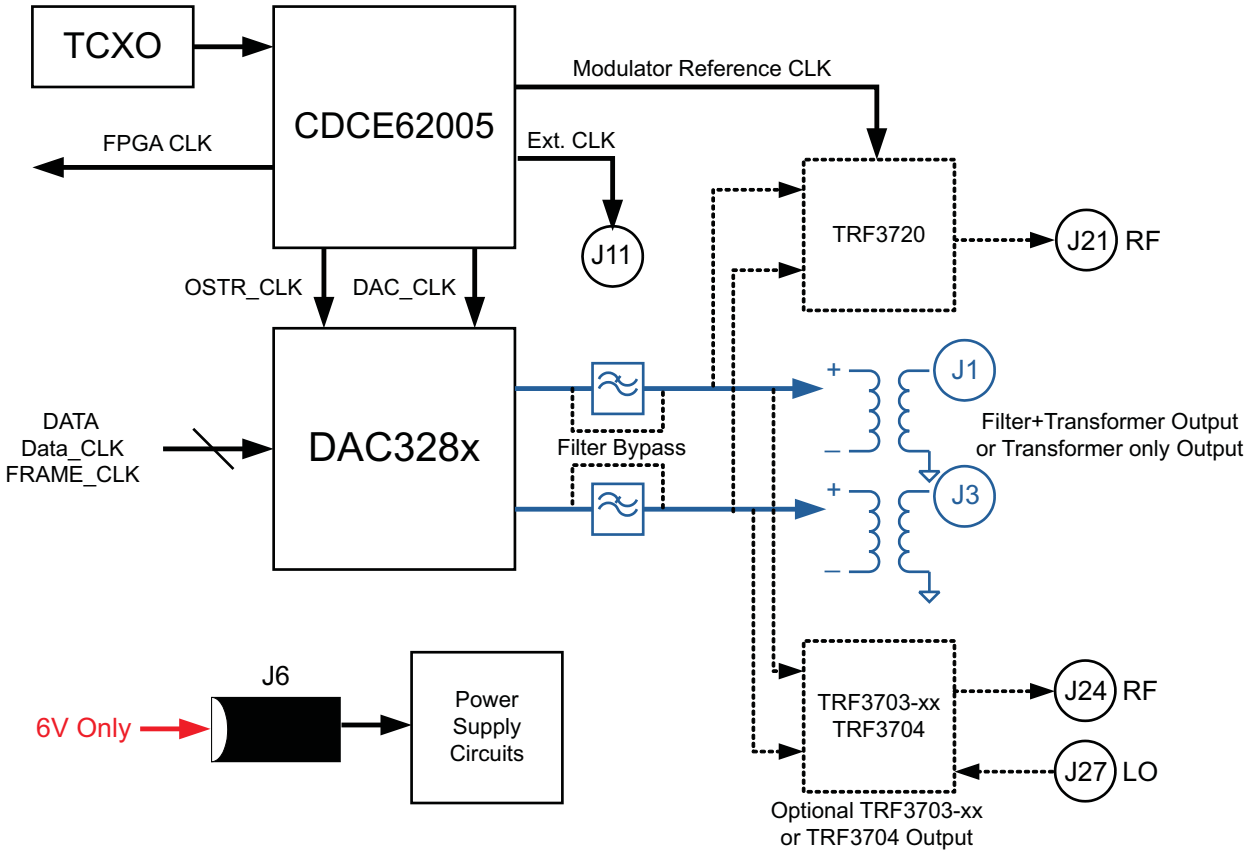

Figure 2. DAC3283 EVM Block Diagram

1. The TSW4200-DAC kit is a DAC3283EVM configured as follow:
   (a) Power Supply Option: The kit includes a **6-V power supply** input to power supply jack J6. For proper EVM operation and to prevent damage to the EVM, only use a 6-V power supply.
   (b) Analog Output Option: The on-board DAC3283 has dual-channel outputs that go through a filter network and transformer to J3 (Ch. A) and J1 (Ch. B).
   (c) Clock Option: The on-board CDCDE62005 provides clocks to all the on-board devices.
      (i) The default DAC clock is configured at 614.4 MHz. The DAC interpolation, FPGA clock (TSW3100 CLK), and the FIFO OSTR clock can be configured based on the data rate, FPGA configuration, and system requirement. For more information, please refer to the DAC3283 datasheet.
      (ii) The TSW4200-DAC has a clock output at J11 that provides the reference clock for the CDCE72010 on the TSW4200-ADC at J19. The default reference clock should be configured as 19.2 MHz.
2. The EVM has the default jumper setting listed on Table 2.
3. For more details, refer to the DAC3283EVM User's Guide (SLAU311).

Table 2. TSW4200-DAC Default Jumper Setting

Jumper	Default Position	Purpose
JP22	2-3	CDCE62005 (U4) external reference clock bias
JP19	Shorted	Enable TCXO (U7)
JP9	1-2	DAC3283 (U1) TXENABLE
JP20	1-2	CDCE62005 (U4) power down
JP21	1-2	CDCE62005 (U4) reference select
JP13	2-3	TRF3720 (U3) power save
JP17	1-2 (TRF3720)	TRF3720 (U3) or TRF3703 (U10) Power Path

1.4 TSW4200-ADC Configuration

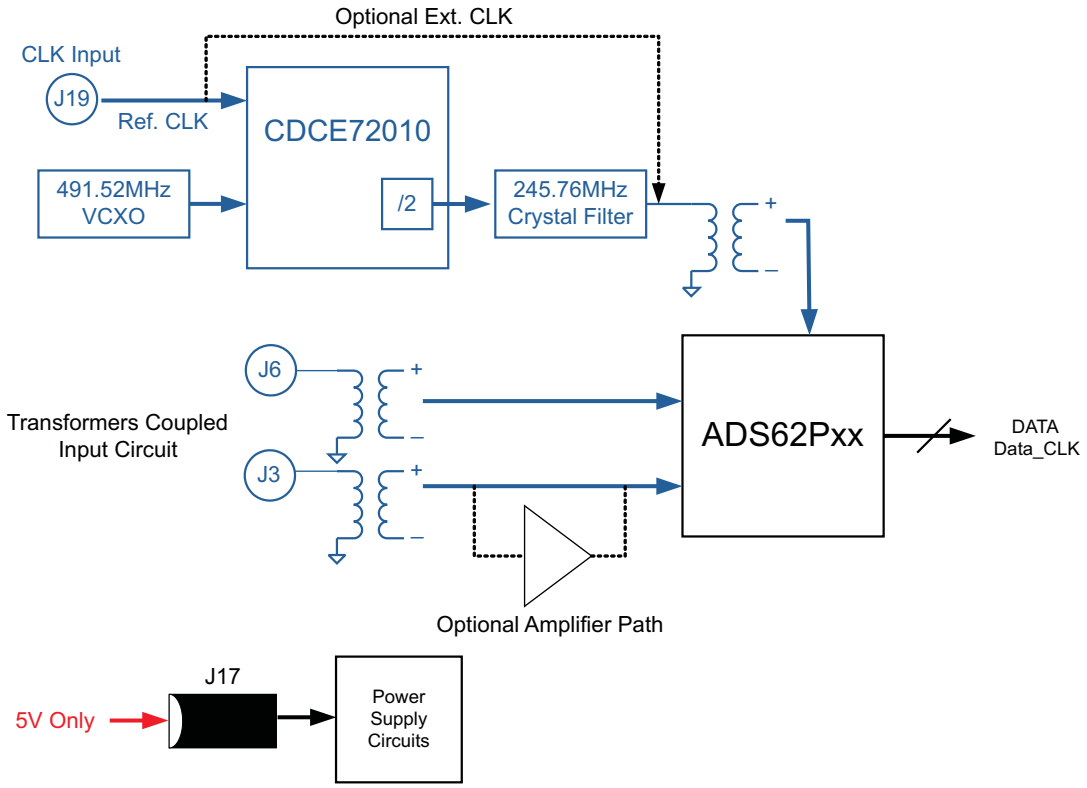

Figure 3. ADS62P49 EVM Block Diagram

1. TSW4200-ADC Configuration:
   (a) Power Supply Option: The kit includes a **5-V power supply** input to power supply jack J17. For proper EVM operation and to prevent damage to the EVM, only use a 5-V power supply.
   (b) Analog Input Option: The on-board ADS62P49 has dual-channel transformer-coupled inputs from J3 (Ch. A) and J6 (Ch. B).
   (c) Clock Option: The on-board CDCE72010 provides a crystal-filtered LVCMOS clock at 245.76 MHz to the on-board ADS62P49. The reference clock input of 19.2 MHz to the TSW4200-ADC is at J19. The CDCE72010 is configured in PLL mode by default using the on-board 491.52-MHz VCXO. The CDCE72010's output has the divider configured to be divide-by-2, dividing the 491.52-MHz VCXO clock to the required 245.76-MHz clock.
2. The EVM has the default jumper setting listed on Table 3.
3. For more details, refer to the ADS62PXXEVM User's Guide (SLAU237).

Table 3. TSW4200-ADC Default Jumper Setting

Jumper	Default Position	Purpose
JP11	1-2 (parallel)	ADS62P49 (U2) parallel or serial mode option
JP8	1-2 (parallel)	SCLK parallel or serial mode option
JP12	1-2 (0dB gain, int. ref.)	SCLK parallel mode select
JP9	1-2 (parallel)	SDATA parallel or serial mode option
JP13	Open	SDATA parallel mode option
JP10	1-2 (parallel)	SEN parallel or serial mode select
JP14	1-2 (2's complement & DDR LVDS)	SEN parallel mode option
JP20	1-2	CDCE72010 (U10) AUX select
JP21	1-2	CDCE72010 (U10) MODE select
J14	Open	CDCE72010 (U10) power down
J15	Open	CDCE72010 (U10) reset
JP3	2-3 (Off)	THS4509 (U1) power down
JP23	1-2	USB microcontroller (U6) power select
J18	Open	VCXO (VCXO1) enable
JP16	1-2	Power option (see schematic or ADS62PXX EVM user's guide)
JP17	Open	Power option (see schematic or ADS62PXX EVM user's guide)
JP19	1-2	Power option (see schematic or ADS62PXX EVM user's guide)
JP15	1-2	Power option (see schematic or ADS62PXX EVM user's guide)
JP18	1-2	Power option (see schematic or ADS62PXX EVM user's guide)
JP22	1-2	FPGA SDOUT path
JP5	1-2 (Low)	ADS62P49 (U2) CTRL3
JP6	1-2 (Low)	ADS62P49 (U2) CTRL2
JP7	1-2 (Low)	ADS62P49 (U2) CTRL1

2 Software

See the DAC3283 and the ADS62P49 EVM user's guide for more detailed explanations of the EVM setup and operation. This document assumes that EVM software applications are installed and functioning properly.

Be sure to use the latest EVM software available at www.ti.com. For the TSW4200 Demonstration Kit evaluation, only the DAC3283 EVM software is needed. The ADS62P49 EVM software is optional since the on-board jumpers provide sufficient control of the ADC.

3 Quick Setup

1. For the DAC EVM, connect the 6-V supply to J6. Connect the EVM to a PC through a USB cable to utilize the EVM software.
   (a) Start the DAC3283 EVM software, select the *Top Level* tab and press the **Reset USB Port** button.
   (b) Configure the *Top Level* tab the same as shown in Figure 4. Set *Test Port Div* to *32* to set the reference frequency of 19.2 MHz. All other settings remain in default values. Configure the DAC interpolation, FPGA clock (TSW3100 CLK), and the FIFO OSTR clock based on the data rate, FPGA configuration, and system requirement. For more information, please refer to the DAC3283 datasheet.

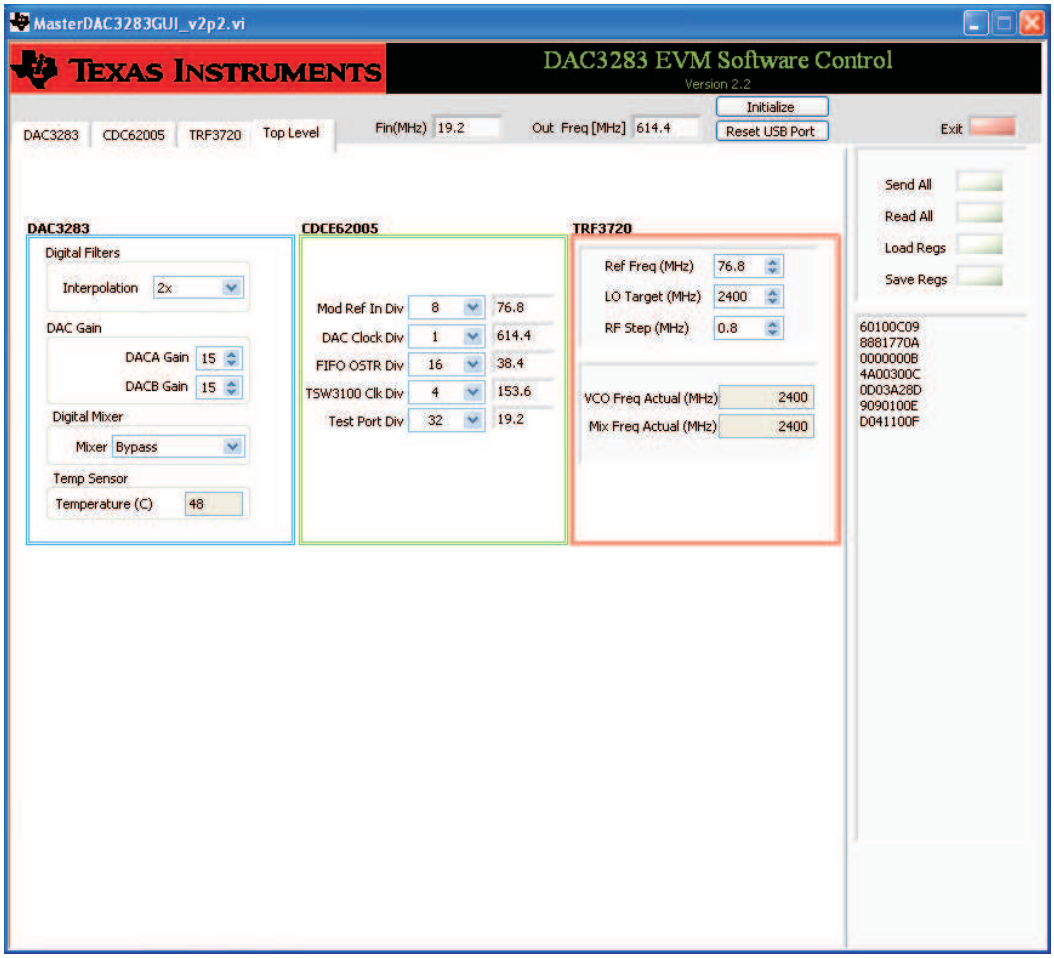

Figure 4. DAC3283 EVM Software Configuration

   (c) Pressing *Send All*, sends all the instructions to the DAC3283 EVM.
   (d) Toggle the **Initialize** button. This initializes the CDCE62005 clock.
   (e) Verify that the CDCE62005 LED (D4) is illuminated, indicating lock.
2. For the ADC EVM, connect the 5-V supply to J17. The USB connection to ADC EVM is optional. The default ADS62P49 operates with internal reference and has 2's complement, LVDS output.
3. Connect the ADC and DAC EVMs to the FPGA solution through the provided adapter boards. See Section 4, the Adapter Reference section, for details.
4. Connect the external reference clock output of the DAC EVM at J11 to the reference clock input of the ADC EVM at J19. The reference clock should be at 19.2 MHz.
5. Connect the DAC EVM output at J1 and J3 to the ADC EVM input at J3 and J6. See Figure 1 for details.

6. Start evaluating the TSW4200 Demonstration Kit by configuring the FPGA to transmit data to the DAC EVM and receive data from the ADC EVM.

4 Adapter Reference

Visit www.ti.com for more information on the following adapter board options.

- FMC-ADC-Adapter, http://focus.ti.com/docs/toolsw/folders/print/fmc-adc-adapter.html
- FMC-DAC-Adapter, http://focus.ti.com/docs/toolsw/folders/print/fmc-dac-adapter.html
- HSMC-ADC-Bridge, http://focus.ti.com/docs/toolsw/folders/print/hsmc-adc-bridge.html

5 Notes on Interfacing with Xilinx 7-Series FPGA

The connections between the TSW4200 kit and FMC (HPC or LPC) connectors on a Xilinx 7-Series FPGA EVM spread the input/output buses of the ADC/DAC over two IO-banks. This makes it necessary to use the BUFMR clock buffer in the FPGA in order to clock data in multiple clock regions.

For detailed information about this clock buffer, refer to the *7-Series FPGA Clocking Resources User Guide* (Xilinx UG472, Multi-Region Clocking). The use case *Driving Multiple BUFRs (with Divide) and BUFIO* in particular, provides extensive details over the implementation.

In an actual end-user system implementation, ADC and DAC connections to the FPGA should utilize a single FPGA IO-bank for a simpler approach.

For an ADC with serial LVDS output implementation, half of an IO-bank can handle all connections from the ADC:

- Connect the bit clock DCLK_p/n to a MRCC differential clock input.
- Connect the frame clock FCLK_p/n to the neighbor SRCC differential clock input.
- Connect all data inputs to normal differential inputs starting from the FCLK_p/n.

For a DAC with parallel LVDS input implementation, connections to the FPGA often use several data buses, and an optimal connection can be made as:

- Connect the clock coming from the DAC, from the VCXO, or other clocking device to a MRCC differential input.
- Connect the clock and data connections to the DAC in the same IO-bank and neighbor (above and below) IO-banks.

EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

Texas Instruments (TI) provides the enclosed Evaluation Board/Kit/Module (EVM) under the following conditions:

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

Please read the User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI's environmental and/or safety programs, please visit www.ti.com/esh or contact TI.

No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which such TI products or services might be or are used. TI currently deals with a variety of customers for products, and therefore our arrangement with the user is not exclusive. TI assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein.

REGULATORY COMPLIANCE INFORMATION

As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs **not** subject to the above rules, this evaluation board/kit/module is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by TI to be a finished end product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

General Statement for EVMs including a radio

User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

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

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

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.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

This Class A or B digital apparatus complies with Canadian ICES-003.

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

Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-exempt RSS standard(s). 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.

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.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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.

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.

【Important Notice for Users of this Product in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

Texas Instruments Japan Limited
(address) 24-1, Nishi-Shinjuku 6 chome, Shinjuku-ku, Tokyo, Japan

http://www.tij.co.jp

【ご使用にあたっての注】

本開発キットは技術基準適合証明を受けておりません。

本製品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。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。

日本テキサス・インスツルメンツ株式会社
東京都新宿区西新宿６丁目２４番１号
西新宿三井ビル
http://www.tij.co.jp

EVALUATION BOARD/KIT/MODULE (EVM)
WARNINGS, RESTRICTIONS AND DISCLAIMERS

For Feasibility Evaluation Only, in Laboratory/Development Environments. Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

Certain Instructions. It is important to operate this EVM within TI's recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's 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, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

Agreement to Defend, Indemnify and Hold Harmless. You agree to defend, indemnify and hold TI, its licensors and their representatives harmless from and against any and all claims, damages, losses, expenses, costs and liabilities (collectively, "Claims") arising out of or in connection with any use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

Safety-Critical or Life-Critical Applications. If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265