

High Speed Data Converter System Evaluation Kit 10 MHz (HSDC-SEK-10)

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1 Introduction

1.1 Overview

This is the User's Guide for the HSDC-SEK-10. The kit includes five released Texas Instruments (TI) Evaluation Modules (EVM): TSW4806, TSW1405, TSW1406, TSW2110, and a TSW2200. Together, these five EVMs provide a low-cost solution for evaluating new and existing High Speed TI ADC and DAC EVMs. The five EVMs are shown in [Figure 1](#).

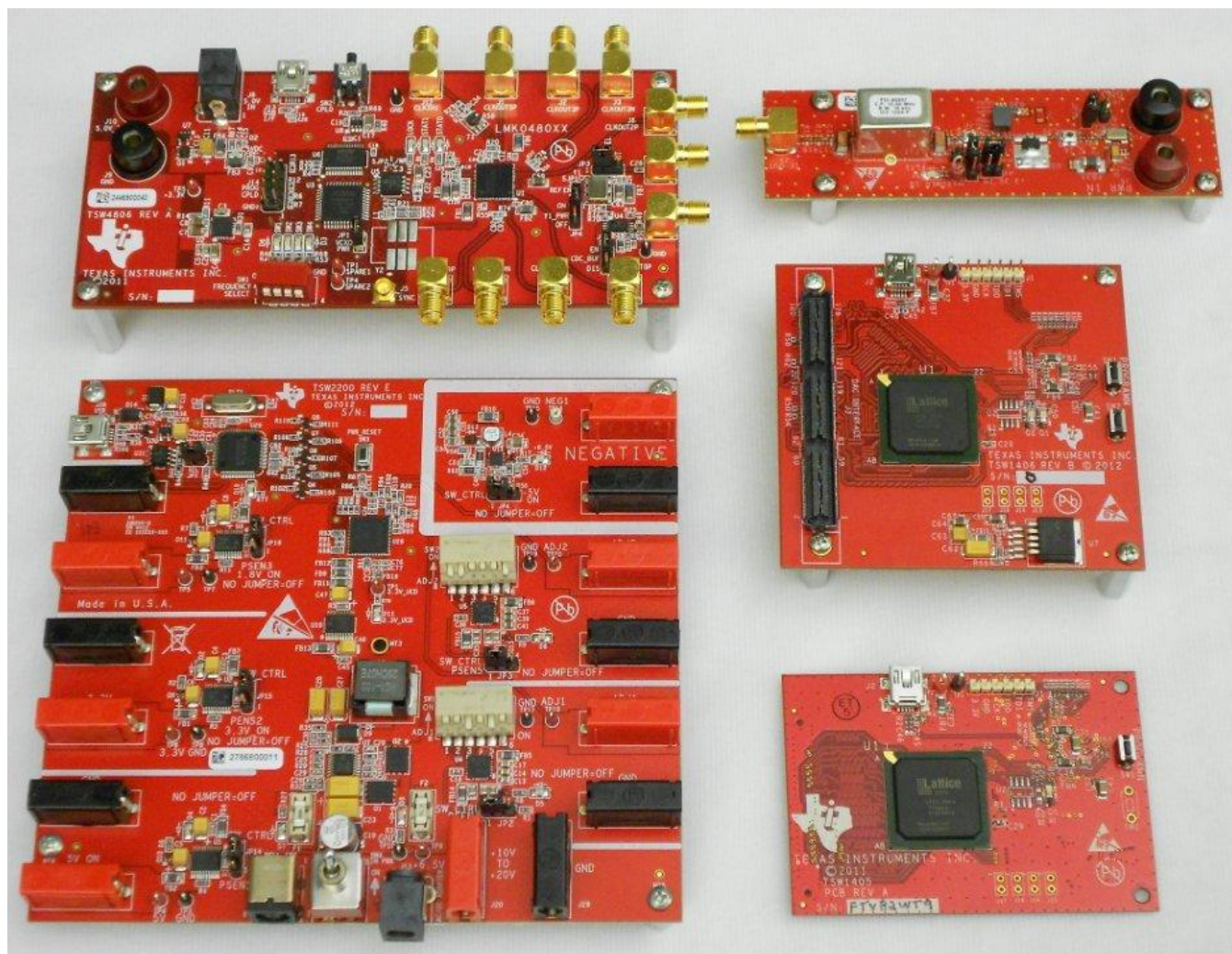


Figure 1. EVMs Included in the HSDC-SEK-10 EVM

For more information regarding the individual EVMs, refer to [Table 1](#) for the respective EVM User's Guide.

Table 1. HSDC-SEK-10 Reference Material

EVM	User's Guide
TSW4806EVM	SLAU454
TSW2110EVM	SLAU438
TSW1405EVM	SLWU079B
TSW1406EVM	SLWU079B
TSW2200EVM	SLWU081A

The TSW4806EVM has an LMK04806 dual-PLL clock jitter cleaner and generator to provide a low-cost, low-noise, portable clocking solution that can be used with TI high-speed data converter EVMs. Together with the accompanying LabVIEW™-based Graphic User Interface (GUI), it is a complete clocking tool.

The TSW1405EVM is a pattern capture card which supports most LVDS-format TI ADC EVMs, with a capture buffer of 64K samples. Together with the accompanying Labview-based GUI, it is a complete system that captures and evaluates data samples from ADC EVM's. The TSW1405 draws its power from the USB connection to the PC for easy setup and operation.

The TSW1406EVM is a pattern generator card which supports pattern generation for most LVDS-format TI DAC EVMs, with a pattern size up to 64K samples. Together with the accompanying Labview-based GUI, it is a complete system that generates and sends desired test patterns to DAC EVMs. The TSW1406 draws its power from the USB connection to the PC for easy setup and operation.

The TSW2110EVM uses a temperature-controlled crystal oscillator (TCXO) to generate a low-noise, 10-MHz sinewave. Using amplification, attenuation, and filtering, a 10-MHz signal is generated with low harmonic distortion output set to +10 dBm (2 Vpp), which can be used as an IF input to an ADC board.

The TSW2200EVM provides a multiple output power supply solution for powering other EVMs. This EVM provides fixed and adjustable supplies that can be used as simple on or off supplies or sequenced supplies for power-critical EVM setups.

This document outlines the basic steps and functions that are required to ensure the proper operation of HSDC-SEK-10, when used with ADC and DAC EVMs. The kit includes the five EVMs mentioned above along with power supplies and cables.

This guide shows how to quickly evaluate a typical TI ADC and DAC EVM (not included) with only a PC required for the ADC demo and a PC and spectrum analyzer required for the DAC demo. The EVM schematics, bill of materials (BOM), and layout files can be found in the design packages under the EVM product folder on www.ti.com.

2 HSDC-SEK-10 DAC Demonstration

This section describes the HSDC-SEK-10 pattern generator operation when testing with a TI DAC3162 EVM that has an LVDS input interface. [Figure 2](#) shows the HSDC-SEK-10 configured for testing a DAC3162EVM.

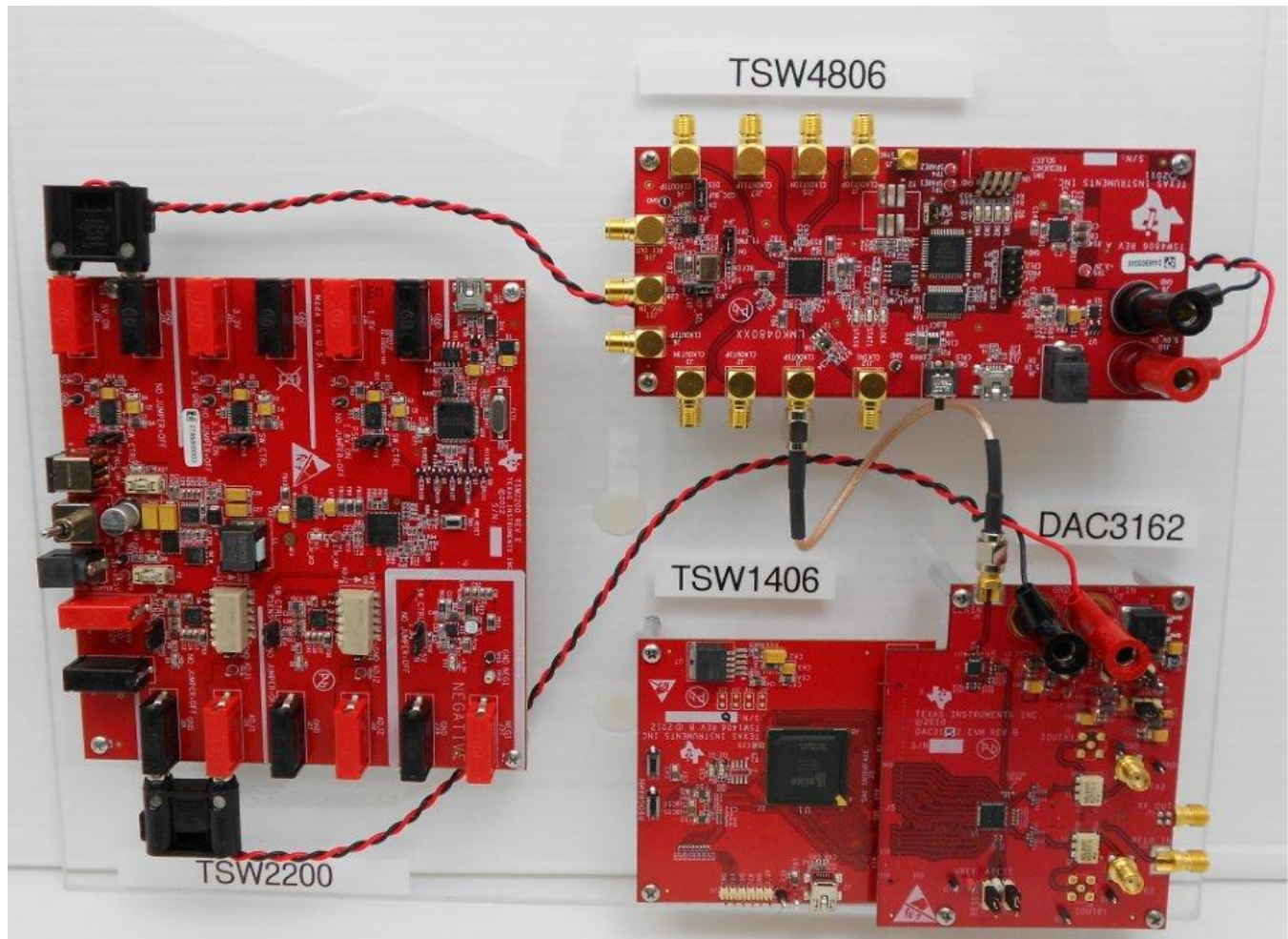


Figure 2. HSDC-SEK-10 DAC Demonstration

The block diagram for the HSDC-SEK-10 demo is shown in [Figure 3](#)

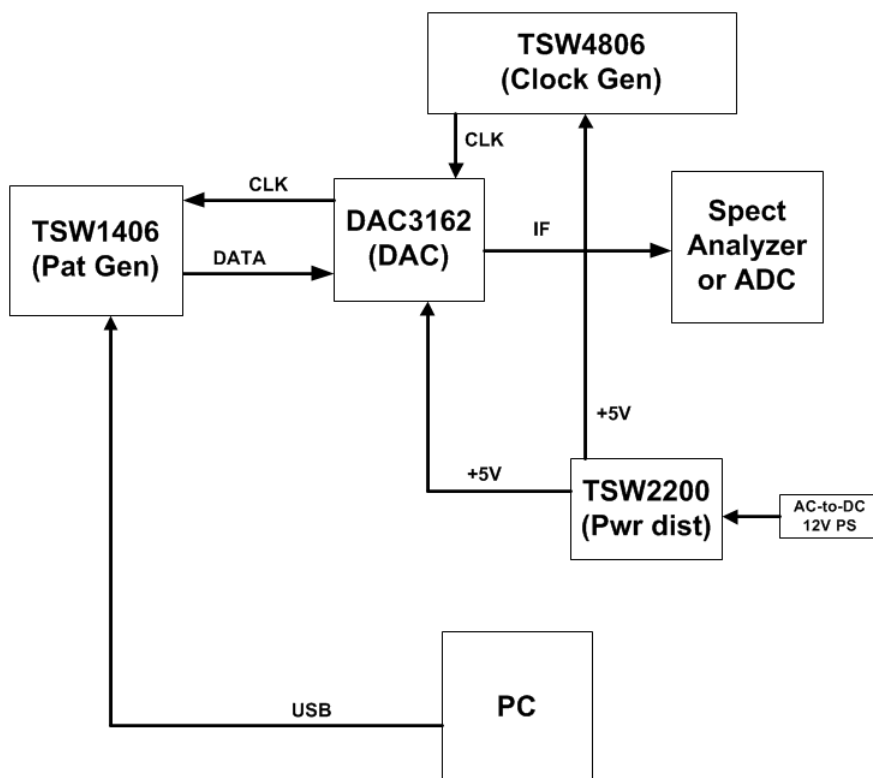


Figure 3. HSDC-SEK-10 DAC Demonstration Block Diagram

3 DAC Test with DAC3162EVM

Section 3.1 and Section 3.2 describe the setup and pattern generation test using the DAC3162EVM

3.1 Setup

- Connect the provided 12-VDC power supply to J13 of the TSW2200EVM.
- Set switches 1, 2, 4, and 6 to the *Open* position on SW1 to set J18 (adjustable output) of the TSW2200EVM to +5 VDC. Connect this output to J10 of the TSW4806EVM. Provide the return by connecting J19 of the TSW2200EVM to J9 of the TSW4806EVM.
- Connect J5 of the DAC3162EVM to connector J3 of the TSW1406EVM.
- Provide +5 VDC from J31 of the TSW2200EVM to J12 of the DAC3162EVM. Provide the return by connecting J26 of the TSW200EVM to J13 of the DAC3162EVM.
- Provide a 0.5-Vrms, 245.76-MHz clock to the DAC3162EVM by connecting a SMA cable from J1 of the TSW4806EVM to J9 of the DAC3162EVM.
- Connect IOUTA2 (J2) to a spectrum analyzer.
- Connect a USB cable from J2 of the TSW1406EVM to a host computer. D1 on the TSW1406 should illuminate, indicating the board is powered up from the USB source.
- Power up the TSW2200EVM using SW4.
- Download the latest version of the TSW140x High Speed Data Capture/Pattern Generator Card software files and User's Guide manual to a local location on a host PC. These can be found on the TI website by entering *TSW1400EVM* in the search parameter window at www.ti.com.
- Start the High Speed Data Converter Pro GUI as described in the User's Guide ([SLWU079B](http://www.ti.com/lit/zip/slwu079b)).

3.2 Pattern Generation Test

The TSW140x GUI will first attempt to connect to the EVM USB interface. If the GUI identifies a valid board serial number, a pop-up will open displaying this value, as shown in Figure 4. The serial number also has an EVM type number attached to it. This indicates to the GUI which of the three TSW140x boards is being used. It is possible to connect several TSW1400 EVMs to one host PC but the GUI can only connect to one at a time. If multiple boards are connected to the PC, the pop-up displays all of the serial numbers found. It is then up to the user to select which board the GUI will be associated.

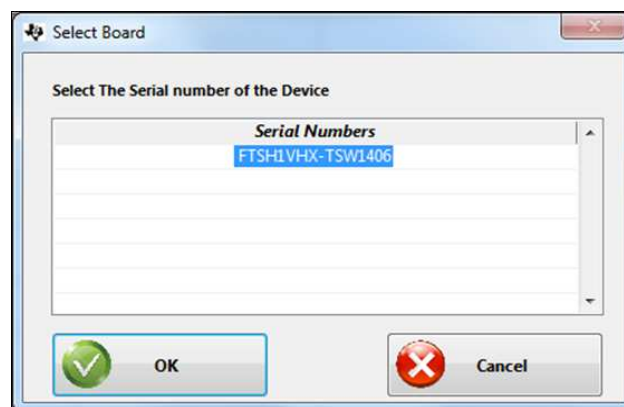


Figure 4. TSW1406EVM Serial Number

- Click the **OK** button to connect the GUI to the board.

- In the *Select DAC* box, select *DAC3162*, as shown in [Figure 5](#)

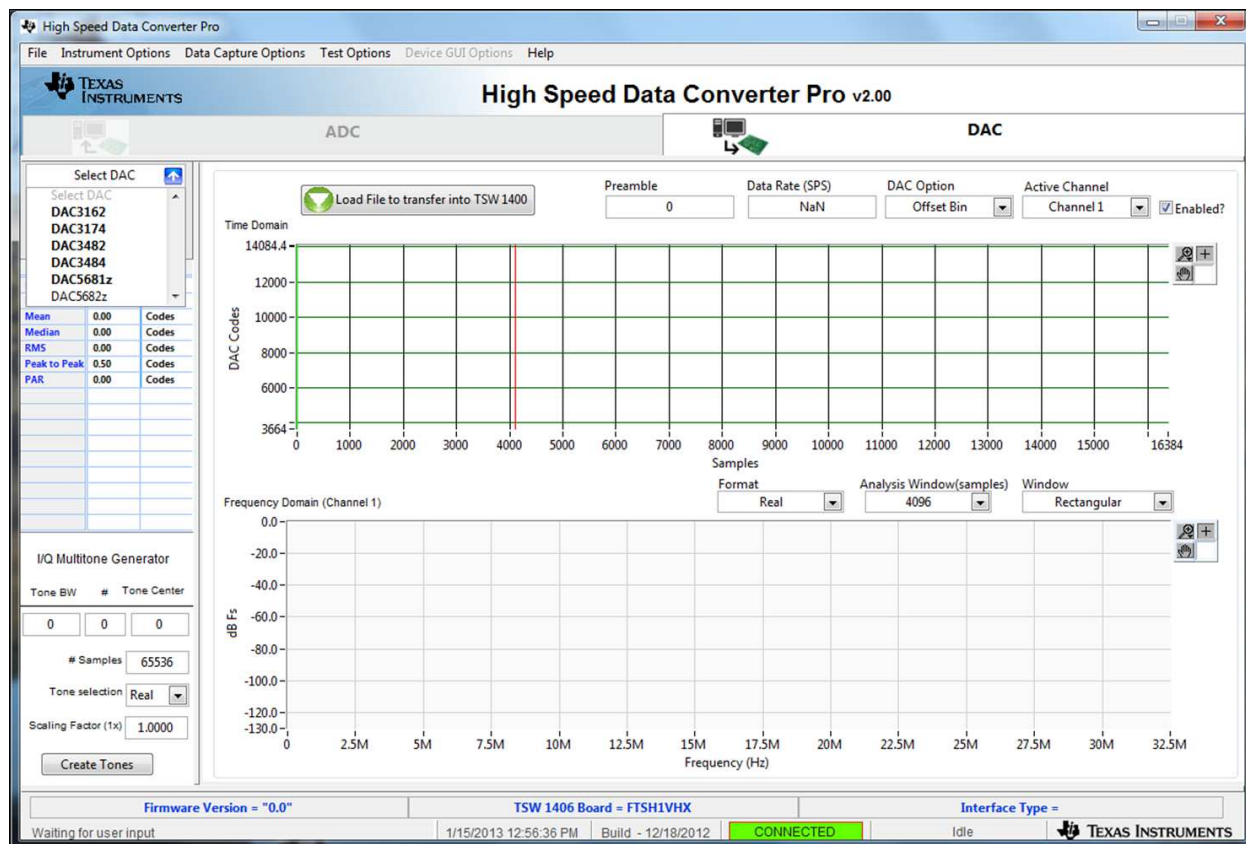


Figure 5. Selecting Device Firmware

- The following message appears: *Do you want to update the firmware for DAC*. Clicking the **Yes** button loads the firmware.
- After the firmware is loaded, LED D1 on the TSW1406EVM will turn on.
- In the top center of the GUI, set the *Data Rate* to *245.76M* (for 245.76 megahertz).

- In the *I/Q Multi-tone Generator* section of the GUI, located in the lower left of the GUI, set the parameters to generate a single tone centered at 25 MHz. After the parameters are entered click the **Create Tones** button. The GUI now looks as shown in [Figure 6](#).

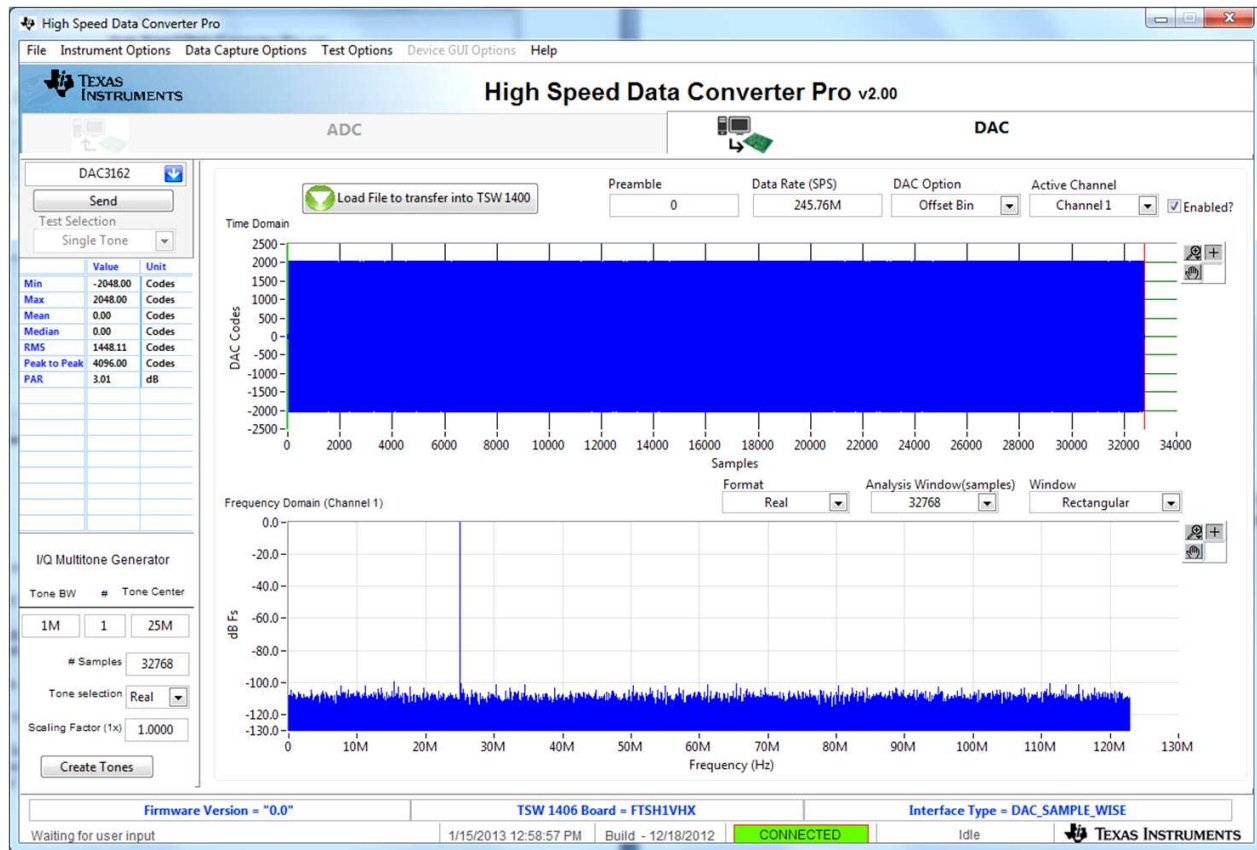


Figure 6. Loaded Test Pattern Time and Frequency Domain Plots

- In the top left of the GUI, click the **Send** button to start the Pattern Generator. The IOUTA2 and IOUTB2 SMA's now have a 25-MHz output tone, as shown in [Figure 7](#).
- End of pattern generation test.

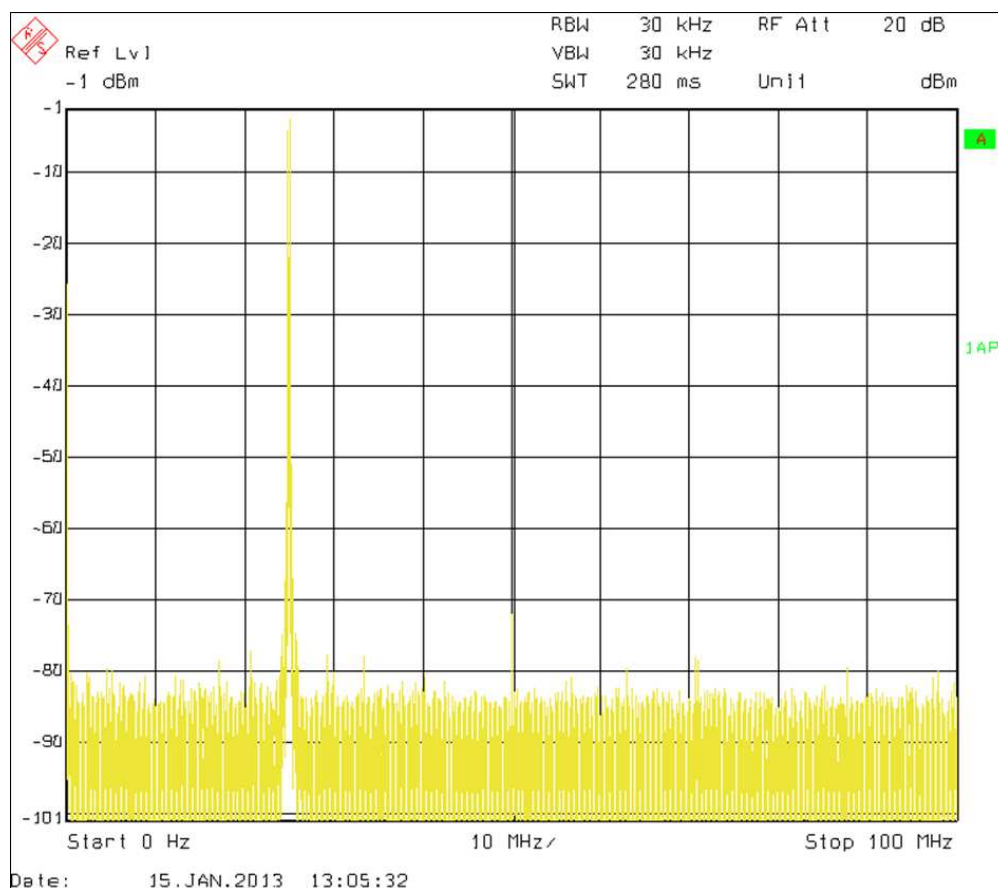


Figure 7. DAC3162EVM Output

4 HSDC-SEK-10 ADC Demonstration

This section describes the HSDC-SEK-10 data capture operation when testing with a TI ADS4249EVM that has an LVDS output interface. [Figure 8](#) shows the HSDC-SEK-10 configured for testing an ADS4249EVM.

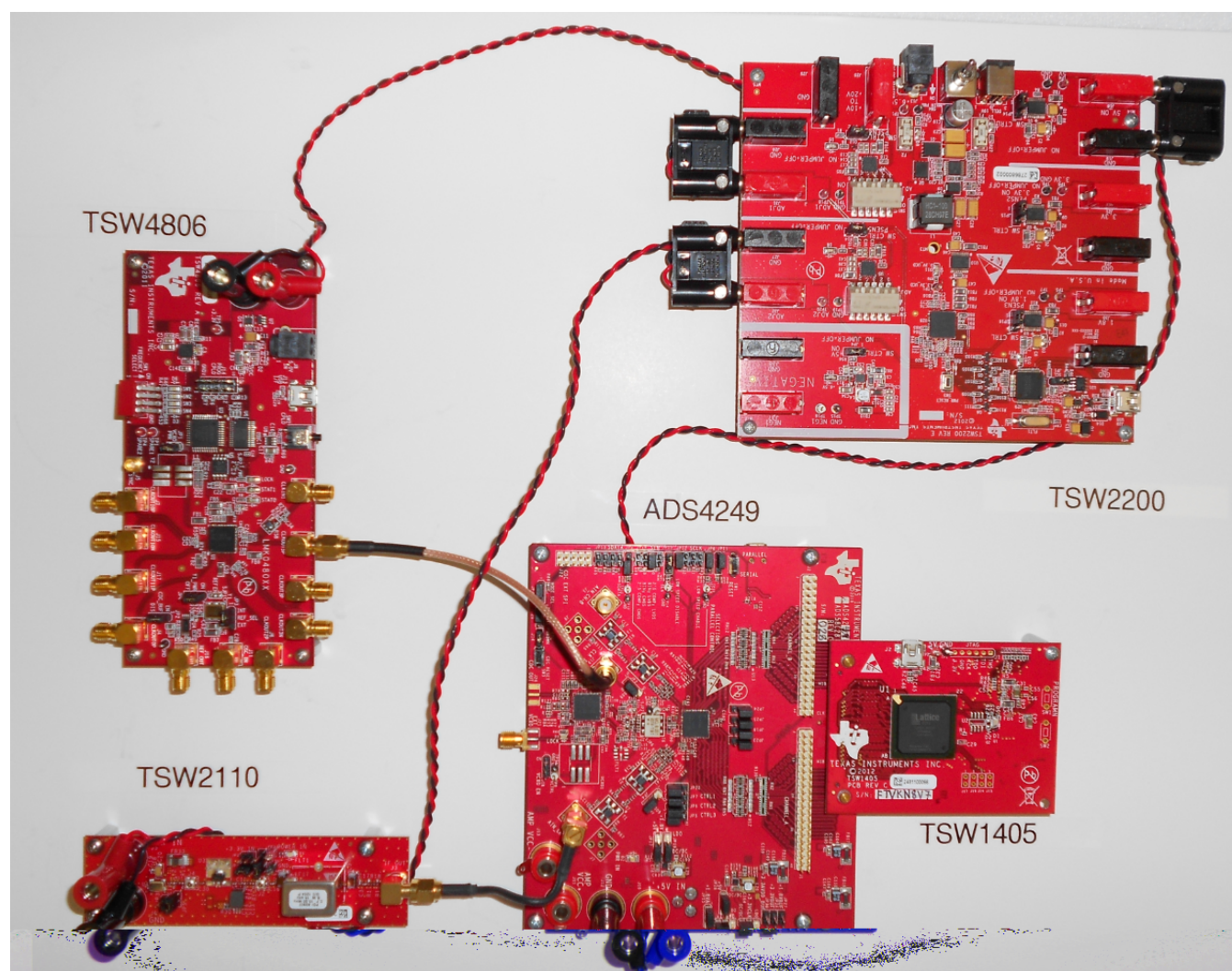


Figure 8. HSDC-SEK-10 ADC Demonstration

The block diagram for the HSDC-SEK-10 demo is shown in [Figure 9](#)

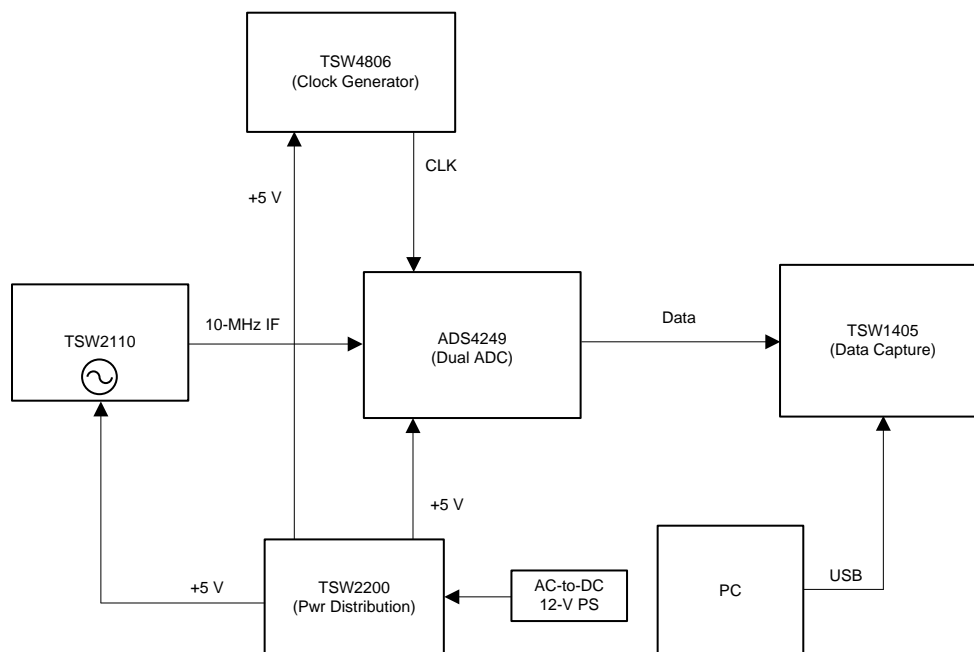


Figure 9. HSDC-SEK-10 ADC Demonstration Block Diagram

5 ADC Data Capture Test with the ADS4249EVM

[Section 5.1](#) describes the setup for the ADC Data Capture Test with the ADS4249EVM

5.1 Setup

- Connect the provided 12-VDC power supply to J13 of the TSW220EVM.
- Set switches 1, 2, 4, and 6 to the *Open* position on SW2 to set J32 (adjustable output ADJ2) of the TSW2200EVM to +5 VDC. Connect this output to J5 of the TSW2110EVM. Provide the return by connecting J27 of the TSW2200EVM to J6 of the TSW2110EVM.
- Set switches 1, 2, 4, and 6 to the *Open* position on SW1 to set J31 (adjustable output ADJ1) of the TSW2200EVM to +5VDC. Connect this output to J10 of the TSW4806EVM. Provide the return by connecting J26 of the TSW2200EVM to J9 of the TSW4806EVM.
- Connect J8 of the ADS4249EVM to connector J3 of the TSW1405EVM.
- Provide +5 VDC from J18 of the TSW2200EVM to J10 of the ADS4249EVM. Provide the return by connecting J19 of the TSW200EVM to J12 of the ADS4249EVM.
- Provide a 0.5-Vrms, 245.76-MHz clock to the ADS4249EVM by connecting a SMA cable from J1 of the TSW4806EVM to J19 of the ADS4249EVM.
- Provide a 10MHz IF analog input by connecting a SMA cable from J3 of the TSW2110EVM to J6 of the ADS4249EVM.
- Connect a USB cable from J2 of the TSW1405EVM to a host computer.
- Power up the TSW2200EVM using SW4.
- Download the latest version of the TSW140x High Speed Data Capture/Pattern Generator Card software files and User's Guide manual to a local location on a host PC. These can be found on the TI website by entering *TSW1400EVM* in the search parameter window at www.ti.com.
- Start the High Speed Data Converter Pro GUI as described in the User's Guide ([SLWU079B](#)).
- Click on the **OK** button to connect the GUI to the board.
- In the Select ADC box, click on the drop-down arrow. A new window opens. Select *ADS424x*, as shown in [Figure 10](#).

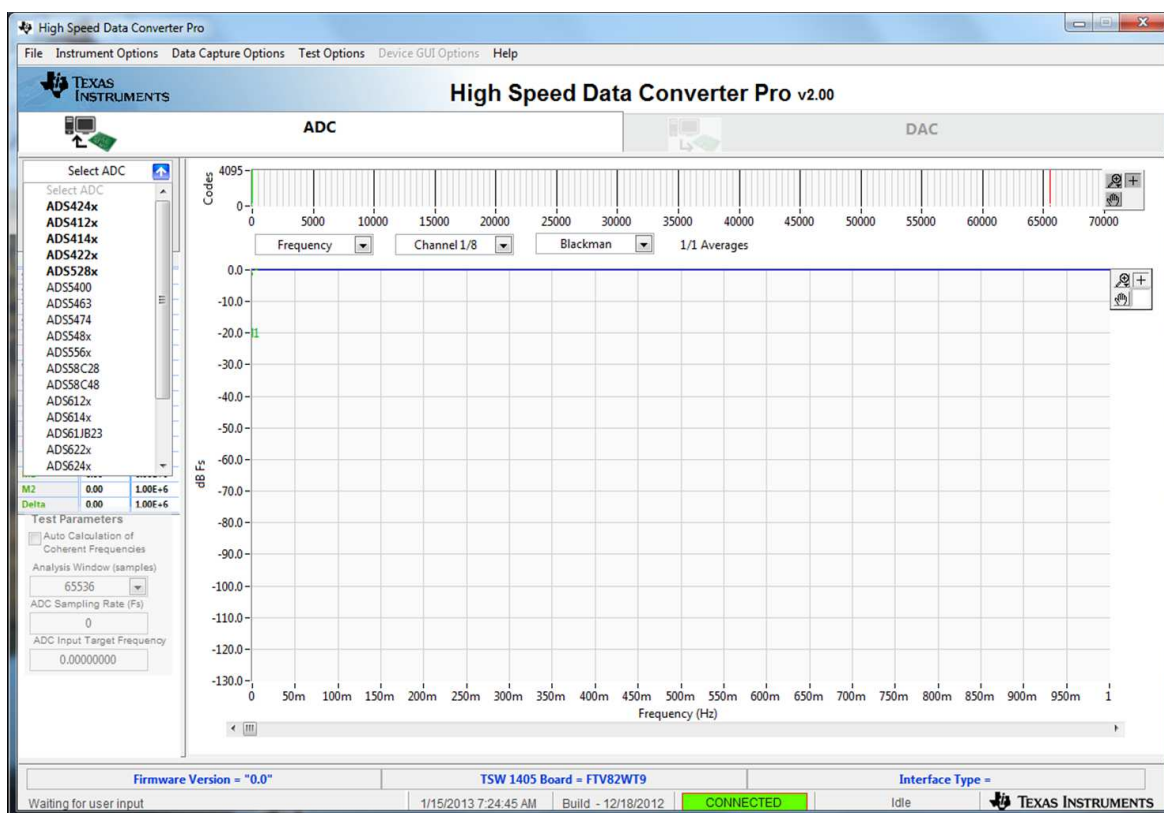


Figure 10. Selecting Device Firmware

- The following message appears: *Do you want to update the firmware for ADC.* Clicking the **Yes** button loads the firmware.
- After the firmware is loaded, LED D1 on the TSW1405EVM will turn on.
- When the firmware is finished downloading, set the *Test Selection* to *Single Tone*.
- Make sure the *Auto Calculation of Coherent Frequencies* setting is unselected. This is located in the lower-left side of the GUI.
- Set the ADC Sampling Rate to *245.76M*.
- Set the ADC Input Target Frequency to *10M*.
- Verify the GUI is set to Capture Channel 1 data.
- Clicking the **Capture** button on the left side of the GUI panel starts the transfer of data into the TSW1405.

- The TSW1405 GUI should now look as shown in Figure 11.

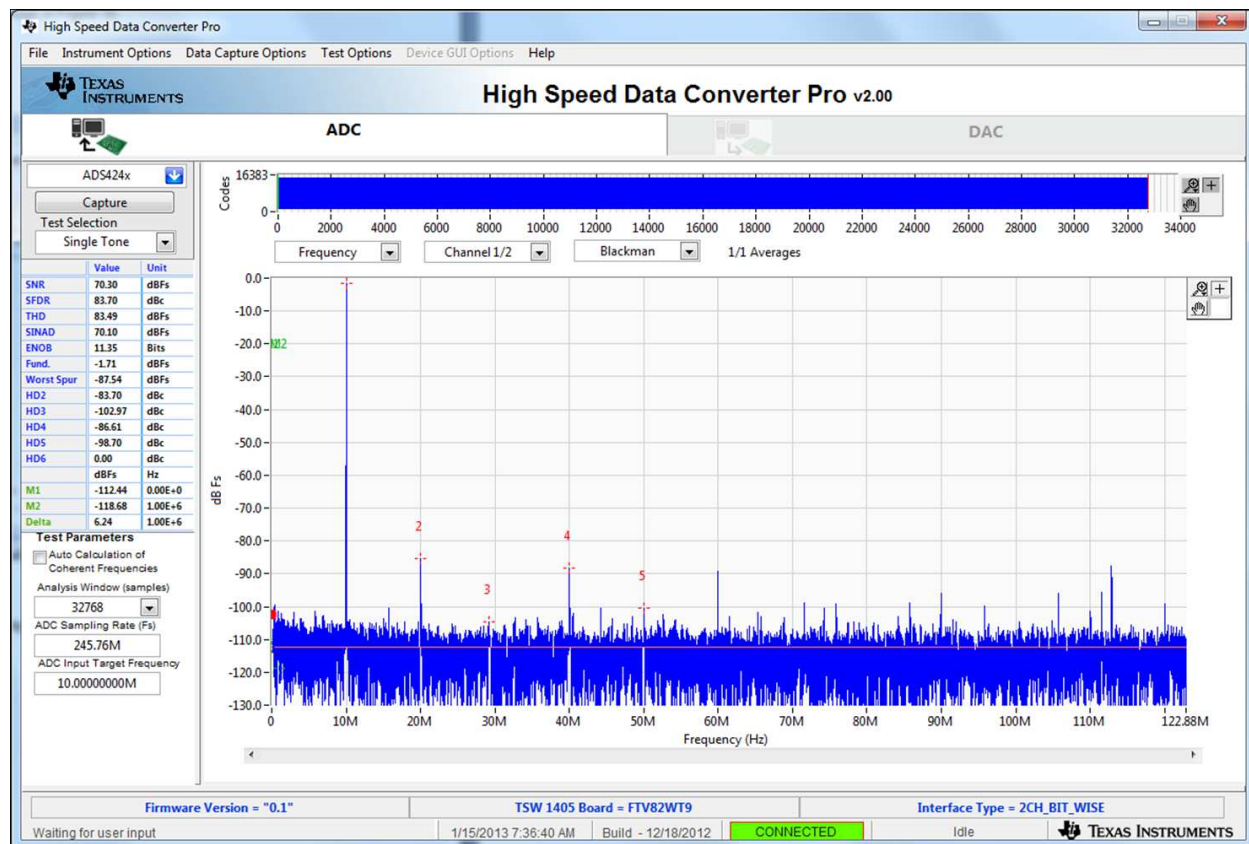


Figure 11. ADS4249 Single Tone FFT Capture Results

- End of ADC data capture test.

6 Summary

Evaluation of ADC and DAC devices can be costly due to requirements such as high speed pattern generator and capture cards, programmable clean-clock source, clean power supplies, and low-noise signal generators. This high-cost lab equipment can create barriers for customers to evaluate devices. Using the HSDC-SEK-10, a low cost evaluation tool solution, removes these equipment and cost barriers.

The five EVMs that come with the HSDC-SEK-10 provide an easy-to-use, low-cost solution for evaluating new and existing High-Speed ADC and DAC EVMs from Texas Instruments. These tools are simple to use, easily portable and require only one 110-120 VAC source for power.

Contact your local TI sales representative or visit www.ti.com for more information regarding existing and new tools.

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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.

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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.

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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.

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Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

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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.

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東京都新宿区西新宿 6 丁目 2 4 番 1 号

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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.

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- 2 *Limited Warranty and Related Remedies/Disclaimers:*

- 2.1 These terms and conditions 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 any defects that are 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. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.
- 2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, 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:*

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

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-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.

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/llds/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/llds/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 by Radio Law of Japan to follow the instructions below with respect to EVMs:

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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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。

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

6. *Disclaimers:*

- 6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY WRITTEN DESIGN MATERIALS PROVIDED WITH THE EVM (AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.
- 6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS AND CONDITIONS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT MADE, CONCEIVED OR ACQUIRED PRIOR TO OR AFTER DELIVERY OF THE EVM.

7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL 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 HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS AND CONDITIONS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

- 8.1 *General Limitations.* IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS AND CONDITIONS OR THE USE OF THE EVMS PROVIDED HEREUNDER, REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN ONE YEAR AFTER THE RELATED CAUSE OF ACTION HAS OCCURRED.
- 8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY WARRANTY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS AND CONDITIONS, OR ANY USE OF ANY TI EVM PROVIDED HEREUNDER, EXCEED THE TOTAL AMOUNT PAID TO TI FOR THE PARTICULAR UNITS SOLD UNDER THESE TERMS AND CONDITIONS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM AGAINST THE PARTICULAR UNITS SOLD TO USER UNDER THESE TERMS AND CONDITIONS SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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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.

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