ADS540x and ADS54T0x Evaluation Module (EVM)

This user's guide describes the operation of the Texas Instruments ADS540x or ADS54T0x evaluation module (EVM). The EVM provides a platform for evaluating the ADS540x or ADS54T0x, a two-channel, 12-bit ADC operating at sampling rates of up to 800 MSPS with the digital data output on two 12-bit LVDS parallel busses on a Samtec connector.

This EVM is ideally suited for mating with the TSW1400 or TSW1405 Capture Card for performing a data capture into a capture buffer, uploading the sample data to a PC, performing a Fast Fourier Transform (FFT), and reporting on signal-to-noise ratio (SNR), spurious-free dynamic range (SFDR), and other performance metrics.

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1 Introduction

1.1 EVM Block Diagram

Figure 1 shows a simplified block diagram of the default configuration of the EVM. Each analog input is supplied to the EVM through a single-ended SMA connection, then transformer coupled to turn the single-ended signal into a balanced differential signal, and then input to the ADS540x. A dual transformer input circuit is used for better phase and amplitude balance of the input signal than would typically be produced by a single transformer input circuit.

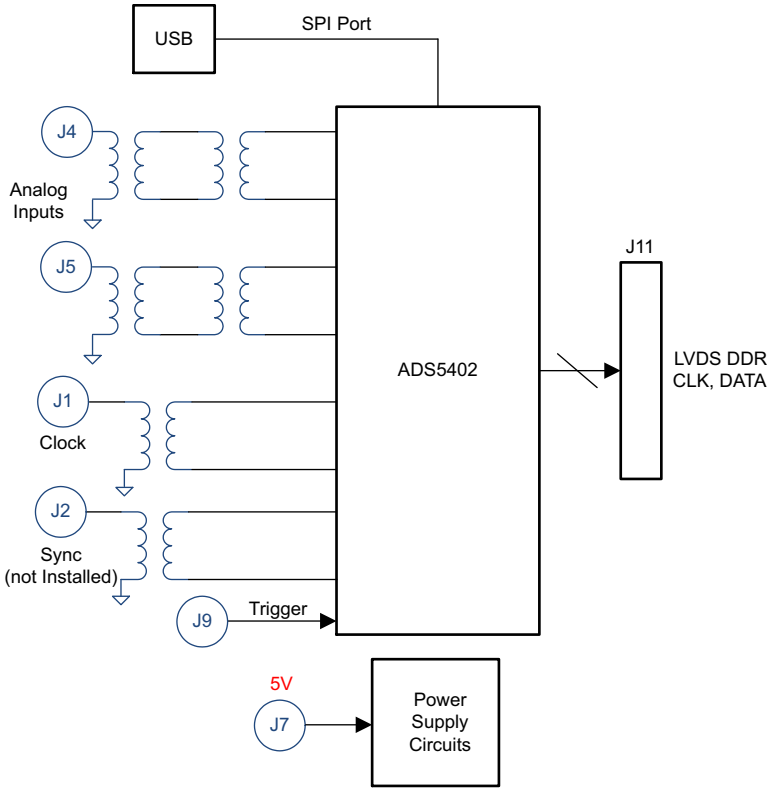


Figure 1. Simplified EVM Block Diagram

The clock input is supplied by way of a single-ended signal to an SMA connector and transformer coupled to produce a differential clock signal for the ADS540x.

Power to the EVM is supplied using a single 5-V connection by way of banana jacks. All necessary voltages for the ADS540x are derived from the 5-V input connection.

For the ADS54T0x EVM, a trigger signal may be input to the trigger SMA connector to trigger the burst of high resolution sample data from the ADC. This trigger signal may be sourced by the TSW1400 Capture Card.

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1.2 EVM Power Supply

Figure 2 illustrates the power supply options available on the EVM. Jumpers are used to choose the power supply options, with the default jumper positions indicated by the darker portion of the jumper that represents the presence of the jumper.

The EVM requires a 5-V input supply, input directly to the banana jack, J7. From the 5-V supply rail, linear low dropout (LDO) regulators are used to generate the 1.8 V for the analog and digital supplies for the ADS540x, the 3.3 V for the 3.3-V analog supply of the ADS540x, and the 3.3-V supply needed for an LVDS buffer to buffer the optional trigger signal into the ADS540x.

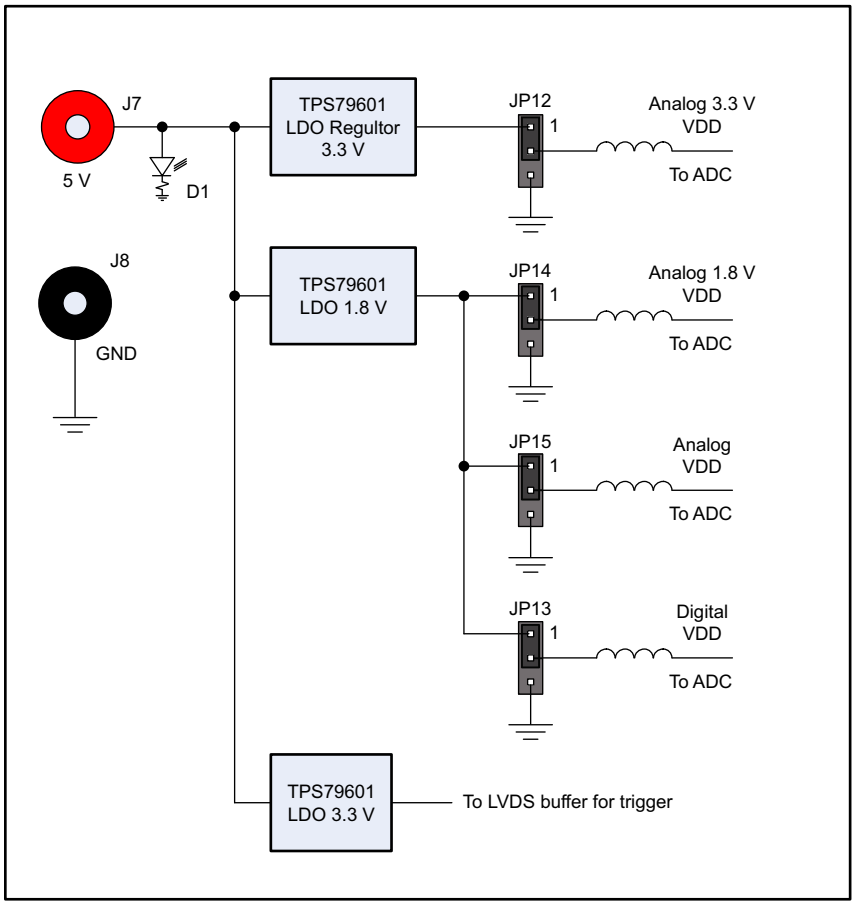


Figure 2. Simplified EVM Power Supply

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1.3 EVM Jumpers and Switches

There are a number of jumpers on the EVM for selecting operational modes of the ADC, power supply options, and SPI port options. Many of the jumper selections that involve DC inputs or static control signals are by way of push-on square post jumpers. Figure 3 illustrates the position of the jumpers relative to the more recognizable features of the EVM such as the banana jacks or SMA inputs. Jumper selections that involve high-speed switching signals are implemented by way of surface mount 0-Ω jumper resistors, and these are represented in Figure 4. In both figures, default positions of the jumpers as the EVM is normally shipped are indicated. Note that some of the jumpers are, by default, left open circuit. The surface-mount jumper resistors require soldering to change from default to any other desired configuration.

The functions of the connectors, LEDs and pushbutton switches are described by their labels in Figure 2. The presence of the 5-V supply voltages to the EVM is indicated by LED D1 lighting.

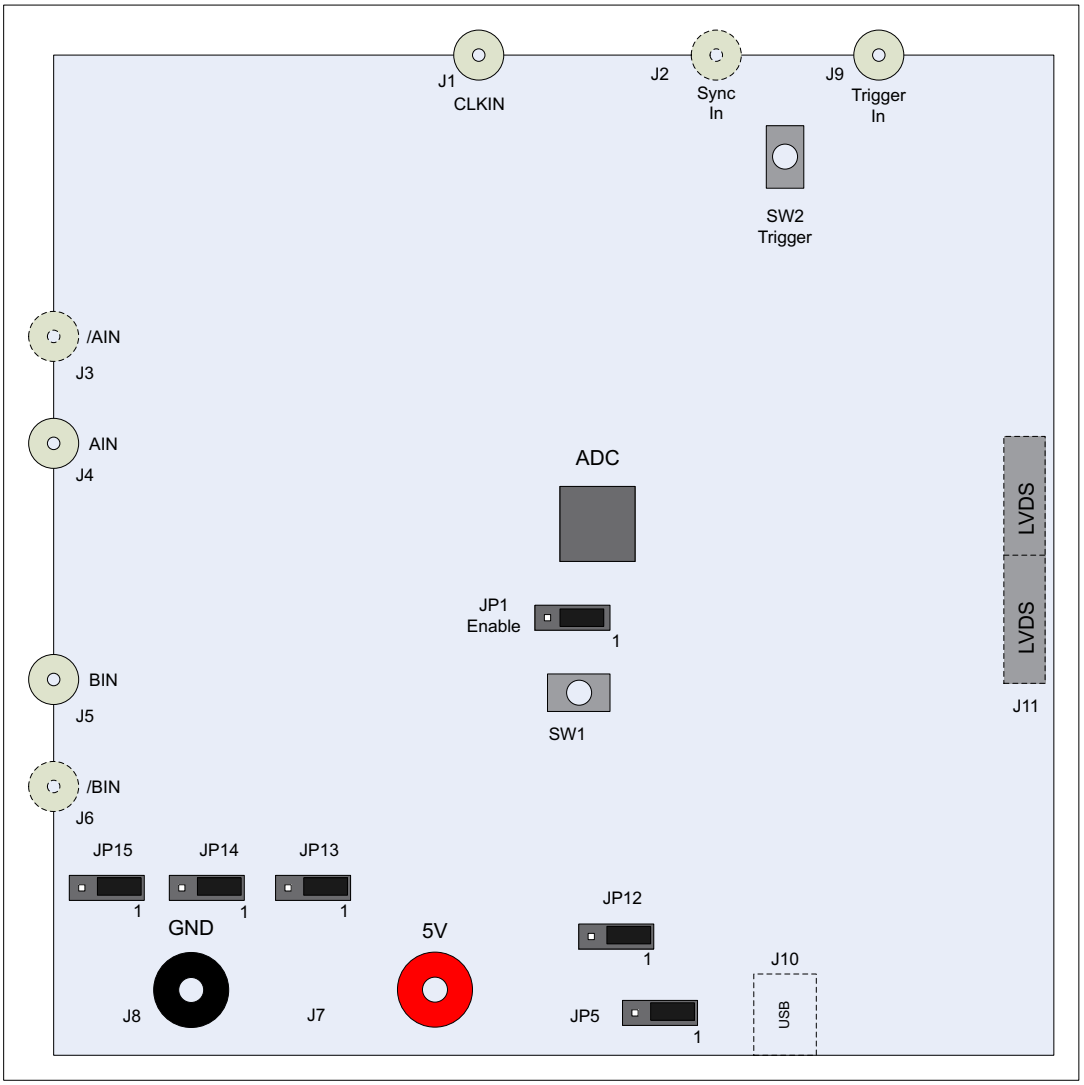


Figure 3. EVM Jumpers and Switches

There are two pushbutton switches on the EVM. Pushbutton switch SW1 is used to assert a reset signal to the ADS540x. The ADS540x requires a reset before it is configured for use, but it is not necessary to use SW1. The ADS540x SPI GUI may be used to toggle the reset register bit in the ADS540x register map.

The trigger signal to the ADS54T0x may be sourced by the SMA connector J9, the Samtec connector J11, or the pushbutton SW2 depending on the position of the surface mount jumper SJP1.

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1.4 EVM Solder Options

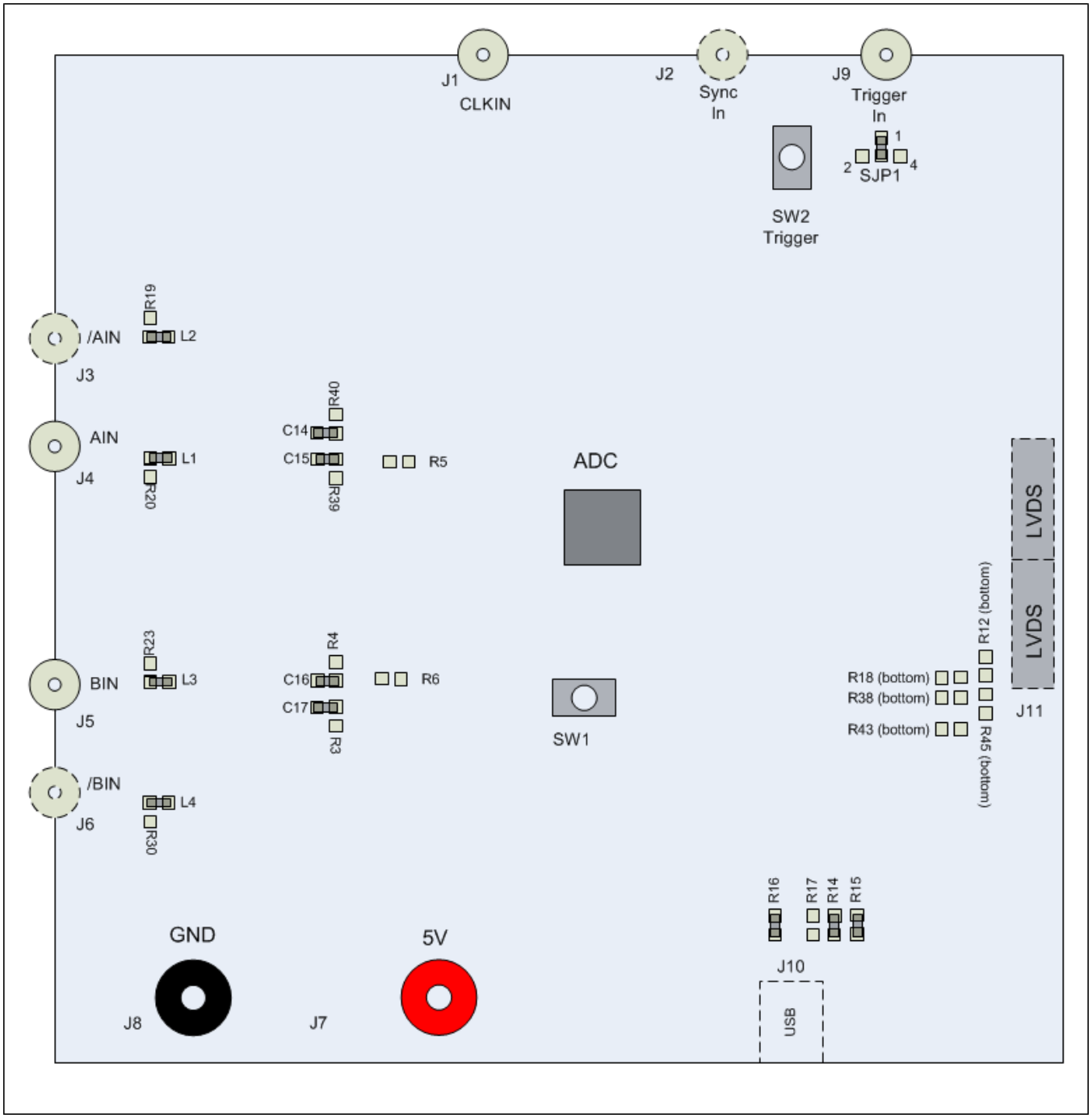


Figure 4. EVM Solder Options

Table 1 lists the jumper options of the EVM by category, the default position of the jumper, and a description of what the jumper does in the possible positions that the jumper might be set. Three pin jumpers have an indication of pin 1 position both in Figure 2 and in the silkscreen on the top of the EVM itself. A jumper installed between pins 1 and 2 is designated by 1-2 while a jumper installed between pins 2 and 3 is designated by 2-3. For more detailed information on the function of each jumper position, consult the ADS540x datasheet.

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Table 1. Square Post Jumpers

Jumper	Default	Description
Power Supply		
JP12	1-2	Connects 3.3-V supply to analog 3.3-V supply of ADS540x
JP13	1-2	Connects 1.8-V supply to digital 1.8-V supply of ADS540x
JP14	1-2	Connects 1.8-V supply to analog 1.8-V supply of ADS540x
JP15	1-2	Connects 1.8-V supply to analog 1.8-V supply AVDDC of ADS540x
(Jumpers JP12, JP13, JP14, JP15 have a ground connection on post 3 allowing use of a 2-post external supply cable connected to posts 2 and 3, if the different ADC supply domains are driven individually)		
ADC Control Pins		
SJP1	1-3	Position 1-3 connects trigger input to SMA J9
		Position 2-3 connects trigger input to pushbutton switch SW2
		Position 4-3 connects trigger input to Samtec connector for trigger from the capture card
JP1	1-2	Connects Enable pin to DVDD. (Position 2-3 connects Enable to Gnd)
USB Port Power		
JP5	1-2	IO Supply Selection (1-2 power from USB port) (2-3 power from EVM)

Surface mount 0-Ω resistor jumpers are described in Table 2. The four SPI lines to the ADC (SCLK, SEN, SDATA, SDO) are, by default, driven by the USB port on the EVM under the control of the ADS540x SPI GUI software. Alternatively, drive the SPI signals into the ADC by a field-programmable gate array (FPGA) located on the capture card that connects to the Samtec connector, in which case four surface mount resistors must be removed from their default positions and soldered in the alternate positions.

The ADS540x outputs a common mode voltage that may be used to bias the common mode level of the analog signal. Since the ADS540x has a buffered analog input and the input signal is internally biased to VCM if the signal is AC coupled, the VCM pin is, by default, unconnected. Install a 0-Ω jumper resistor to connect the VCM to the analog input termination network.

Table 2. Surface Mount Jumpers

Jumper	Default	Description
R5	open	Connects VCM to transformer termination mid-point for channel 1
R6	open	Connects VCM to transformer termination mid-point for channel 2
R12	open	Connects the optional trigger signal to the Samtec connector for trigger sourced from the capture card FPGA
R18	open	Connects SEN to TSW140x
R16	installed	Connects SEN to USB port
R15	installed	Connects SDATA to USB port
R38	open	Connects SDATA to TSW140x
R14	installed	Connects SCLK to USB port
R43	open	Connects SCLK to TSW140x
R17	open	Connects SDO to USB port
R45	open	Connects SDO to TSW140x
Analog Input Channel Single Ended vs. Differential Option		
R20	open	Connects SMA Channel A + input to bypass input transformers
L1	0-Ω R	Connects SMA Channel A + input to input transformers
R19	open	Connects SMA Channel A - input to GND
L2	0-Ω R	Connects SMA Channel A - input to bypass input transformers
R39	open	Connects Channel A + input bypassing transformers
C14	1 µF	Connects Channel A + input from transformers
R40	open	Connects Channel A – input bypassing transformers
C15	1 µF	Connects Channel A – input from transformers
R23	open	Connects SMA Channel B + input to bypass input transformers

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Table 2. Surface Mount Jumpers (continued)

Jumper	Default	Description
L3	0-Ω R	Connects SMA Channel B + input to input transformers
R30	open	Connects SMA Channel B – input to GND
L4	0-Ω R	Connects SMA Channel B – input to bypass input transformers
R42	open	Connects Channel B + input bypassing transformers
C16	Installed	Connects Channel B + input from transformers
R41	Installed	Connects Channel B – input bypassing transformers
C17	Installed	Connects Channel B – input from transformers

2 Software Control

2.1 Installation Instructions

- Open folder named ADS540x_Installer_vxpx (xpx represents the latest version, which is 1.3 at the time of this writing)
- Run Setup.exe
- Follow the on-screen instructions
- Once installed, launch by clicking on the ADS540x_GUI_vxpx program in Start → Texas Instruments ADCs
- When plugging in the USB cable for the first time, the Found-New-Hardware-Wizard prompts for the installation of the USB drivers.
  - When a pop-up screen opens, select *Continue Downloading*.
  - Follow the on-screen instructions for installing the USB drivers
  - If needed, access the drivers directly in the install directory

2.2 Software Operation

The software allows programming control of the ADC device. The front panel provides a tab for full programming of the register map of the ADS540x. The GUI tabs provide a convenient and simplified interface to the most used registers of each device.

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2.2.1 Control Options

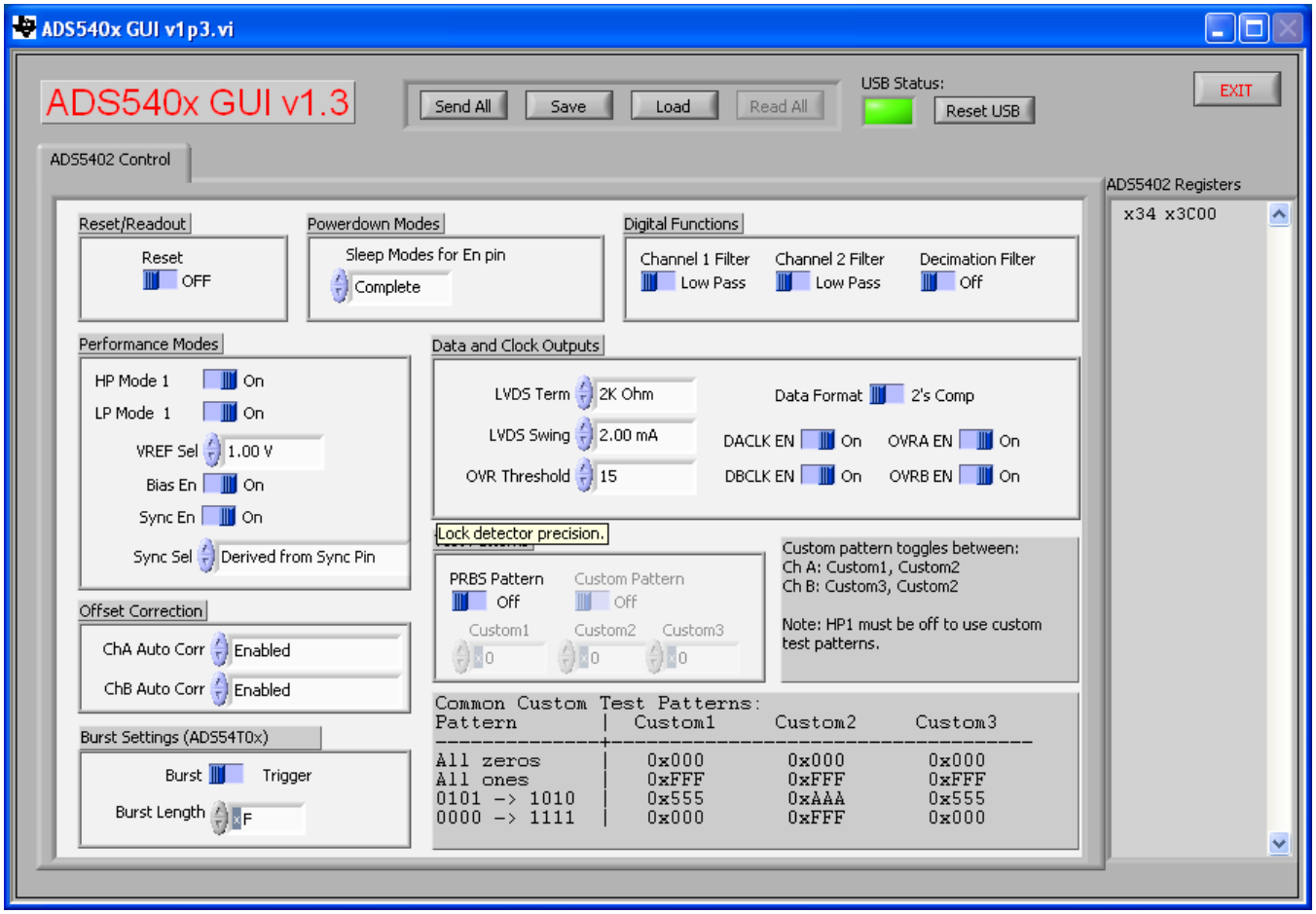


Figure 5. Control Option

2.2.2 Register Control

- **Send All:** Sends the register configuration to all registers
- **Read All:** Reads register configuration from ADS540x registers (Not implemented in v1.3)
- **Save Regs:** Saves the register configuration for all registers
- **Load Regs:** Load a register file for all registers. Sample configuration files for common frequency plans are located in the install directory.
  - Select **Load Regs** button.
  - Double click on the *data* folder.
  - Double click on the desired register file.
  - Click **Send All**, ensuring all of the values are loaded properly.

2.2.3 Misc Settings

- **Reset USB:** Toggle this button if the USB port is not responding. This generates a new USB handle address
  Note: Reset the board after every power cycle and click the **Reset USB Port** button on the GUI.
- **Exit:** Stops the program

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3 Basic Test Procedure

This section outlines the basic test procedure for testing the EVM.

3.1 Test Block Diagram

The test set-up for evaluation of the EVM with the TSW140x Capture Card is shown in Figure 6. As seen in this figure, the evaluation setup involves a clock from a high-quality signal generator and a sine wave for the analog input from a high-quality signal generator. High-order, narrow-bandpass filters are usually required on clock and input frequency for removing phase noise and harmonic content from the input sine waves. If the two signal generators are not synchronized by an external reference signal to make the clock and input frequency coherent, then the resulting FFT first needs to have a windowing function such as Hanning or Blackman-Harris applied to the data.

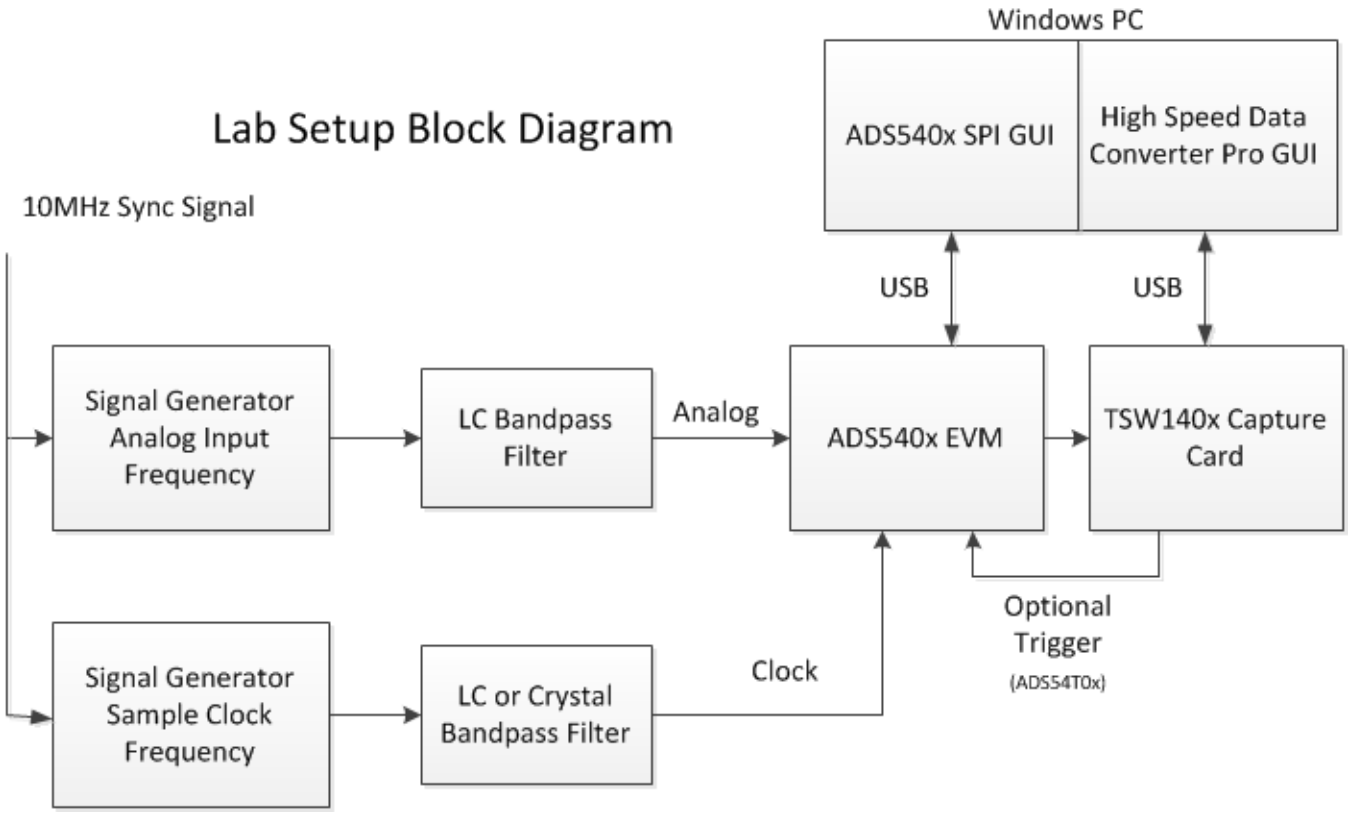


Figure 6. Test Setup Block Diagram

3.2 Test Set-up Connection

- Connect the J11 connector of the EVM to the J3 connector of TSW1400 or the J3 connector of TSW1405
- Connect 5 V to the supply input of the TSW1400 and 5 V to the supply input of the EVM
- Provide sample clock at J1 of the EVM
- Provide analog input sine wave to Channel A, J4, or Channel B, J5
- Connect the USB cable from the TSW140x to a PC for the capture card GUI
- Connect the USB cable from the ADS540x to the computer if using the ADS540x SPI GUI
- Make sure the following jumpers at their default setting
  - Initial jumper setting of ADS540x as per Table 1 (if default usage of the ADC is desired)

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3.3 ADS540x Software Quick Start Guide

Figure 5 introduced the front panel of the ADS540x SPI GUI. This section covers the initial use of the SPI GUI necessary for most evaluations of the ADS540x.

- Press the **Reset USB Port** button if the USB connection has been disrupted since the last use, or if an error message pops up warning that the USB connection is not valid.
- Select the *Reset* position of the reset switch with the mouse. This switch is self-clearing.
- From this point, select digital functions such as test pattern modes, if desired. All commonly used register bits listed in the register map of the ADS540x data sheet have a *switch* on the front panel of the SPI GUI for easy configuration of the ADS540x.
- In most applications, use the SPI GUI to enable the HP Mode 1.
- In most applications, use the SPI GUI to enable the Offset Correction for channel A and Channel B.
- For the ADS54T0x, use the SPI GUI to set burst length to something large enough that the TSW1400 capture will capture all 12-bit resolution data.
- Other GUI switches for Bias, Sync, or LP Mode should be left alone, in most cases.

Note that any *greyed-out* front panel switches are unavailable for use because they have a dependency upon other switch settings. These functions must first be enabled by selection of a different switch, as indicated in the ADS540x datasheet.

TSW140x Quick Start Operation

Reference the High Speed Data Converter Pro User's Guide for more detailed explanations of the TSW1400 or TSW1405 set-up and operation. This document assumes the High Speed Data Converter Pro software is installed and functioning properly.

Single tone FFT test

- Select the ADS5402 as the TI ADC Device Selection. If this device does not appear in the device selection, then the initialization file ADS5402.ini is missing from the ADC Files folder where the High Speed Data Converter Pro User Interface is installed. Close the GUI, copy the ADS5402.ini file into the ADC Files folder and relaunch the GUI.
- Select Single Tone FFT Test
- Select the number of sample points (and resulting number of FFT bins) to use.
- Enter the ADC sampling rate.
- Enter the input frequency desired. If the clock and input frequency signal generators are synchronized, then make sure the checkbox for coherent frequency is checked and set the input frequency signal generator to the input frequency displayed.
- Press the **Capture** button.
- Observe an FFT result similar to that of Figure 8.
- For the ADS54T0x, the TSW1400 may be used to source the trigger to the ADS54T0x EVM by using the Trigger menu in the High Speed Data Converter Pro GUI as shown in Figure 7.

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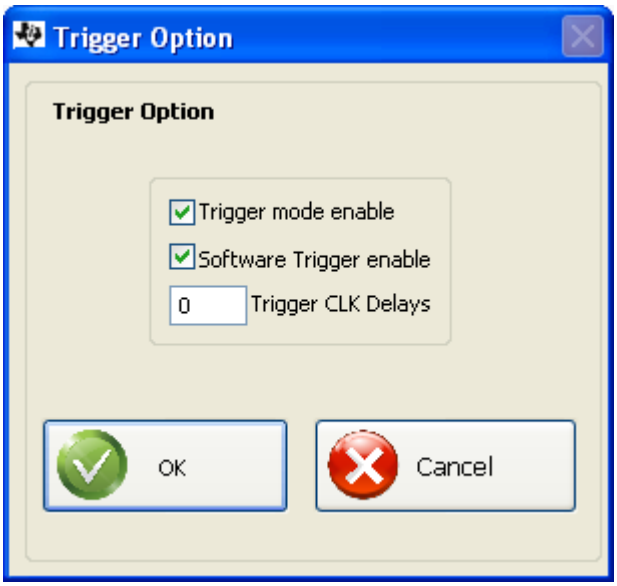


Figure 7. Trigger Option Dialog Window

If the basic capture at this point is correct, then vary the front panel options of the SPI GUI and the front panel options of the High Speed Data Converter Pro GUI for different modes of operation or different operating conditions.

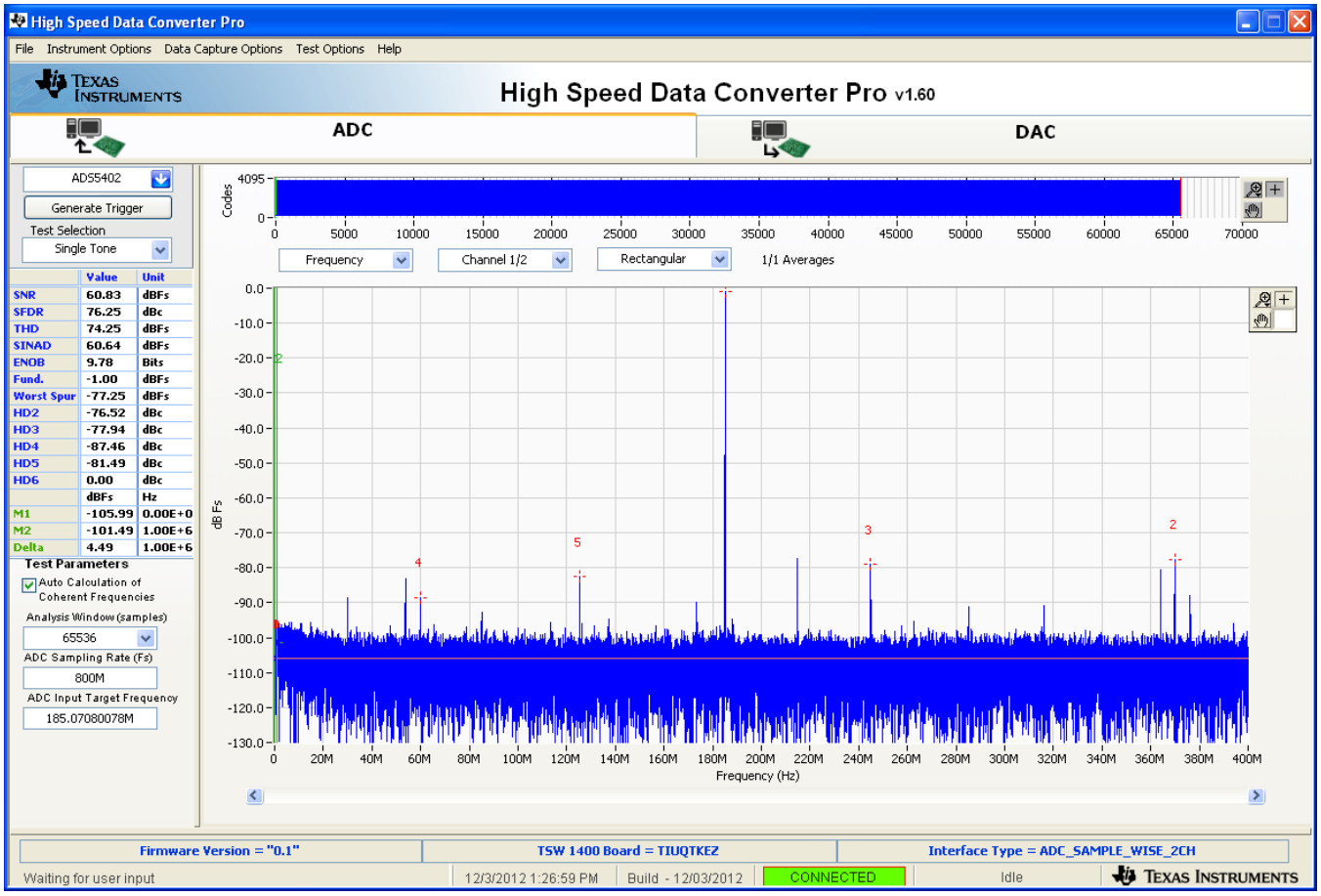


Figure 8. TSW1405 FFT Result

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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.

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.

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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.

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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.

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