ADS5XJ6X Evaluation Module

This user's guide describes the characteristics, operation, and use of the ADS5XJ6X evaluation module (EVM). This document also provides a quick start guide, evaluation procedures, a description of the software, some alternate hardware configurations, and descriptions of the jumpers, connectors, and LEDs.

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1 Overview

This document is intended to serve as a user's guide for the ADS5XJ6x EVM. The ADS5XJ6XEVM is an evaluation module (EVM) designed to evaluate the ADS58J63 and ADS54J66 high-speed, JESD204B interface ADCs. The EVM includes an onboard clocking solution (LMK04828), transformer coupled inputs, full power solution, and easy-to-use software GUI and USB interface.

The following features apply to this EVM:

- Transformer-coupled signal input network allowing a single-ended signal source from 0.25 MHz to 750 MHz
- LMK04828 system clock generator that generates FPGA reference clocks for the high-speed serial interface and may be used to generate the ADC sampling clock (default setting)
- Transformer-coupled clock input network to test the ADC performance with a very low-noise clock source
- High-speed serial data output over a standard FMC interface connector

The ADS5XJ6XEVM is designed to work seamlessly with the TSW14J56EVM, Texas Instruments' JESD204B data capture/ pattern generator card, through the High Speed Data Converter Pro (HSDC Pro) software tool for high-speed data converter evaluation. The ADS5XJ6XEVM was also designed to work with many of the development kits from leading FPGA vendors that contain an FMC connector.

1.1 Required Hardware

The following equipment is **included** in the EVM evaluation kit.

- ADS5XJ6X Evaluation Board (EVM)
- +5-V DC power cable
- Mini-USB cable

The following list of equipment are items that are **not included** in the EVM evaluation kit but are items required for evaluation of this product in order to achieve the best performance:

- TSW14J56EVM Data Capture Board, two 5-V power supplies, and Mini-USB cable
- +5-V DC power supply with a minimum current source of 3 Amps
- Computer running Microsoft® Windows® 8, 7, or XP
- One low-noise signal generator. Recommendations:
  - RF generator, > +17 dBm, < –40 dBc harmonics, < 500 fs jitter 20 kHz–20 MHz, 10 MHz–2 GHz frequency range
  - Examples: TSW2170EVM, HP HP8644B, Rohde & Schwarz SMA100A
- Band-pass filter for desired analog input. Recommendations:
  - Band-pass filter, ≥ 60-dB harmonic attenuation, ≤ 5% bandwidth, > +18-dBm power, < 5-dB insertion loss
  - Examples: Trilithic 5VH-series Tunable BPF, K&L BT-series Tunable BPF, TTE KC6 or KC7-series Fixed BPF
- Signal path cables, SMA and/or BNC with BNC-to-SMA adapters

1.2 Required Software

The following software is required to operate the ADS5XJ6XEVM and is available online. See References, Section 1.4 for links.

- ADS54Jxx EVM GUI

The following software is required to operate the TSW14J56EVM and is available online. See References, Section 1.4 for links:

- High Speed Data Converter Pro software

1.3 Evaluation Board Feature Identification Summary

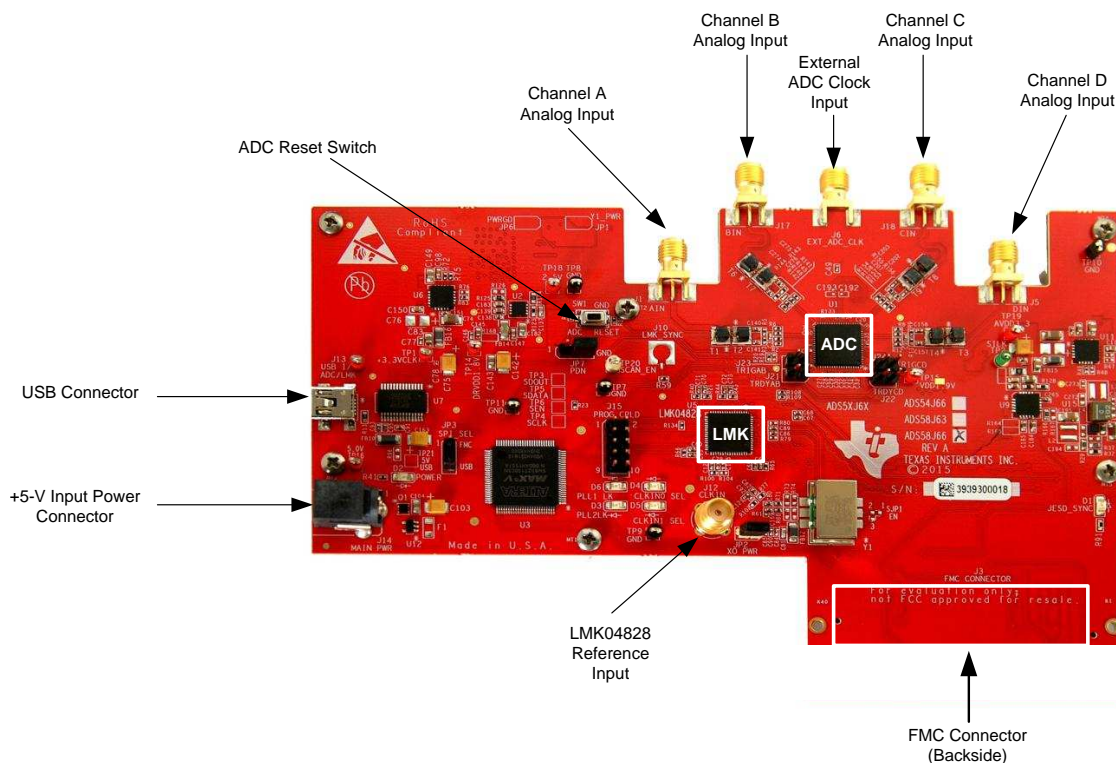Figure 1 illustrates the locations of the EVM features:

Figure 1. EVM Feature Locations

1.4 References

The following links provide convenient references:

- ADS5XJ6XEVM software, schematics, layout, BOM, available at: www.ti.com/tool/ADS58J63evm and www.ti.com/tool/ADS54J66evm
- ADS58J63 datasheet, available at www.ti.com/product/ADS58J63
- ADS54J66 datasheet, available at www.ti.com/product/ADS54J66
- LMK04828 datasheet, available at www.ti.com/product/lmk04828
- TSW14J56EVM User's Guide, available at www.ti.com/tool/TSW14J56EVM
- High Speed Data Converter Pro User's Guide, available at www.ti.com/tool/dataconverterpro-sw

> **NOTE:** Schematics, layout, and BOM are available on the ADS54J66EVM and ADS58J63EVM product page on www.ti.com.

2 Quick Start Guide

This section provides a guide through the EVM test procedure to obtain a valid data capture from the ADS5XJ6XEVM using the TSW14J56EVM capture card. This should be the starting point for all evaluations.

2.1 *Software Installation*

The proper software must be installed before beginning evaluation. See Required Software, *Section 1.2* for a list of the required software. References *Section 1.4* of this document contains links to find the software on the TI website.

> **NOTE:** The software must be installed before connecting the ADS5XJ6XEVM and TSW14J56 to the computer for the first time.

2.1.1 ADS54Jxx GUI Installation

The ADS54Jxx GUI is used to control the ADS5XJ6XEVM. It must be used to properly configure the devices on the EVM.

1. Download the ADS54Jxx GUI from the TI website. The *References* section of this document contains link to find the software on the TI website.
2. Extract the files from the zip file.
3. Run *setup.exe* and follow the installation prompts.

2.1.2 High Speed Data Converter Pro GUI Installation

High Speed Data Converter Pro (HSDC Pro) is used to control the TSW14J56EVM and analyze the captured data. Please see the HSDC Pro user's guide for more information.

1. Download HSDC Pro from the TI website. The *References* section of this document contains the link to find the software on the TI website.
2. Extract the files from the zip file.
3. Run *setup.exe* and follow the installation prompts.

2.2   *Hardware Setup Procedure*

A typical test setup using the ADS5XJ6XEVM and TSW14J56EVM is shown in Figure 2. This is the test setup that will be used for the quick start procedure. The rest of this section will describe the hardware setup steps.
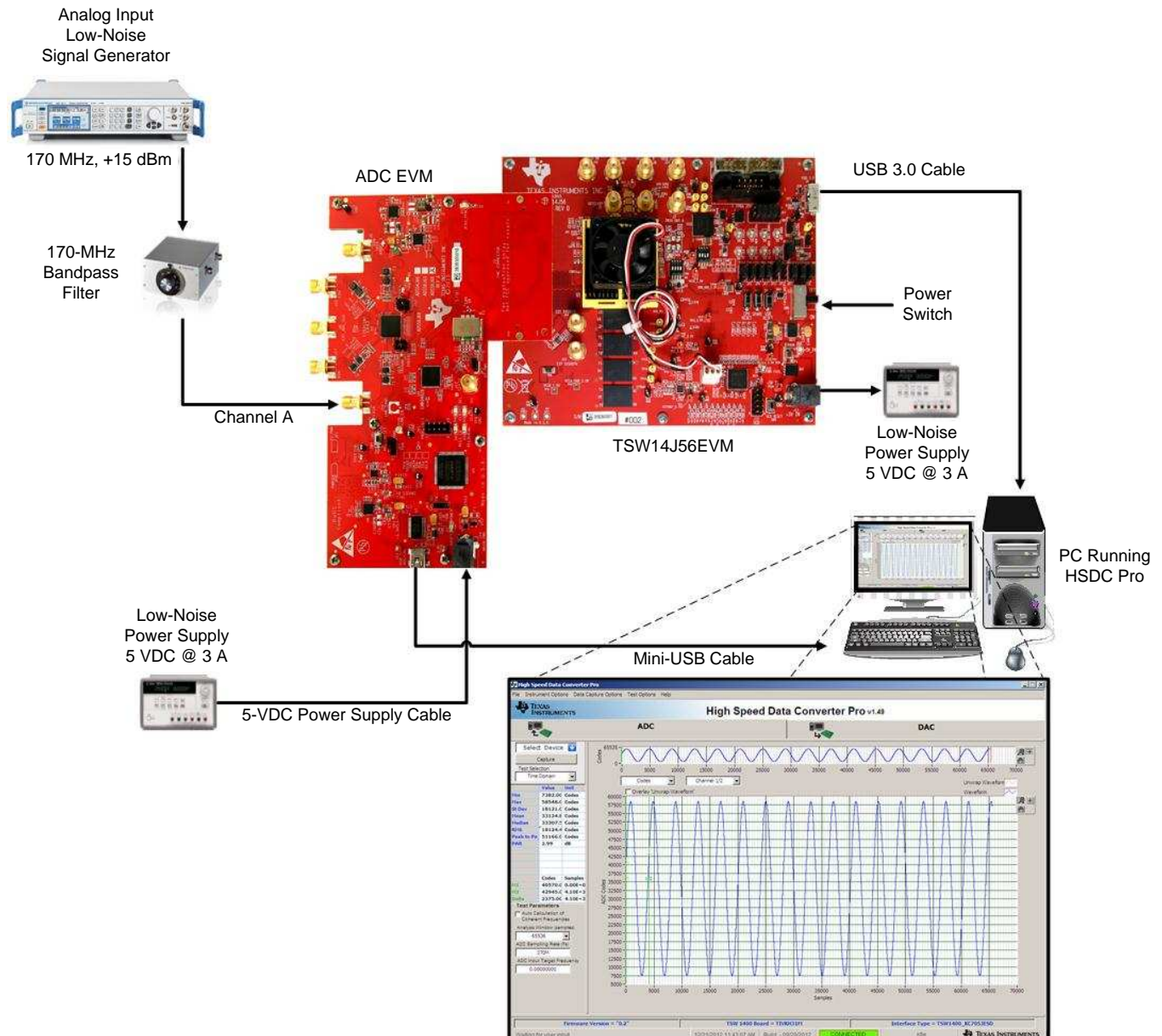

Figure 2. Quick Start Test Setup

2.2.1   TSW14J56EVM Setup

First, setup the TSW14J56EVM with following the instructions:

1. Connect the ADS54J/58J6XEVM to the TSW14J56EVM using the FMC connectors.
2. Connect the included power supply cable to connector J11 (+5 V IN) and the other end to a +5 VDC ±0.3 VDC, 3-A power supply.
3. Connect the included USB 3.0-to-USB 2.0 cable to the USB 3.0 connector (J9)
4. Turn on the power supply. Flip the power switch (SW6) to the "ON" position

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2.2.2 ADS54J/58J6XEVM Setup

Next, setup the ADS5XJ6XEVM with the following instructions:

1. Connect the included 5-V power supply cable to connector J14 of the EVM. Connect the red wire of the power cable to +5 VDC ±0.1 VDC of a power supply rated for at least 3 A. Connect the black wire to the GND terminal of the power supply.

2. Connect the included mini-USB cable to the USB connector J13

3. Set the analog input signal generator for 170 MHz, and about +15 dBm of power

4. Place a narrow passband band-pass filter at the output of the analog signal generator to remove noise and harmonics from the signal generator

5. Connect the analog input signal generator to the EVM though SMA connector AIN (J1)

2.3 Software Setup Procedure

The software can be opened and configured once the hardware is properly setup.

2.3.1 ADS54J/58J6X GUI Configuration, Mode 0

1. Open the ADS54Jxx GUI by going to *Start Menu → All Programs → Texas Instruments ADCs → ADS54Jxx GUI*

2. Verify that the green USB Status indicator is lit in the top right corner of the GUI. If it is not lit, click the *Reconnect USB* button and check the *USB Status* indicator again. If it is still not lit then verify the EVM is connected to the computer through the included mini-USB cable.

3. Click on the *Low Level View* tab then click the *Load Config* button.

4. Navigate to "C:\Program Files(86)\Texas Instruments\ADS54Jxx GUI\Configuration Files", select the file called "LMK_Config_LMF_4841_491p52_MSPS.cfg", then click "OK". This will program the LMK04828 to provide a 491.52-MHz clock to the ADC.

5. Verify that the LMK04828 PLL is locked by checking that the "PLL2 LOCKED" LED (D3) is lit.

6. Once the LMK04828 PLL is locked, press SW1 (*ADC RESET*) to provide a hardware reset to the ADC. This switch is located in the middle of the EVM.

7. In the *Low Level View* tab, click *Load Config*. Select the file called "ADS5xJ6x_2x_Fs_4_mode_0.cfg" and click "OK". The ADS5XJ6XEVM is now configured for a fixed frequency Fs/4 complex digital mixer and decimate by 2 digital filter mode using 4 JESD204B lanes.
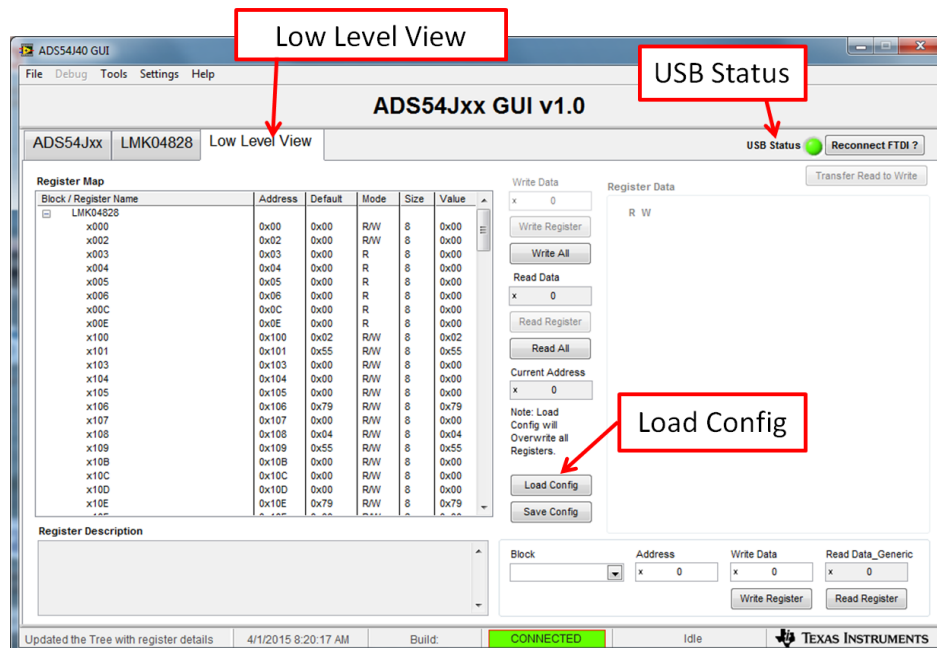

Figure 3. ADS54Jxx GUI Low Level View Tab

2.3.2 HSDC Pro GUI Configuration

1. Open High Speed Data Converter Pro by going to *Start Menu → All Programs → Texas Instruments → High Speed Data Converter Pro*. The GUI main page looks as shown in Figure 4.
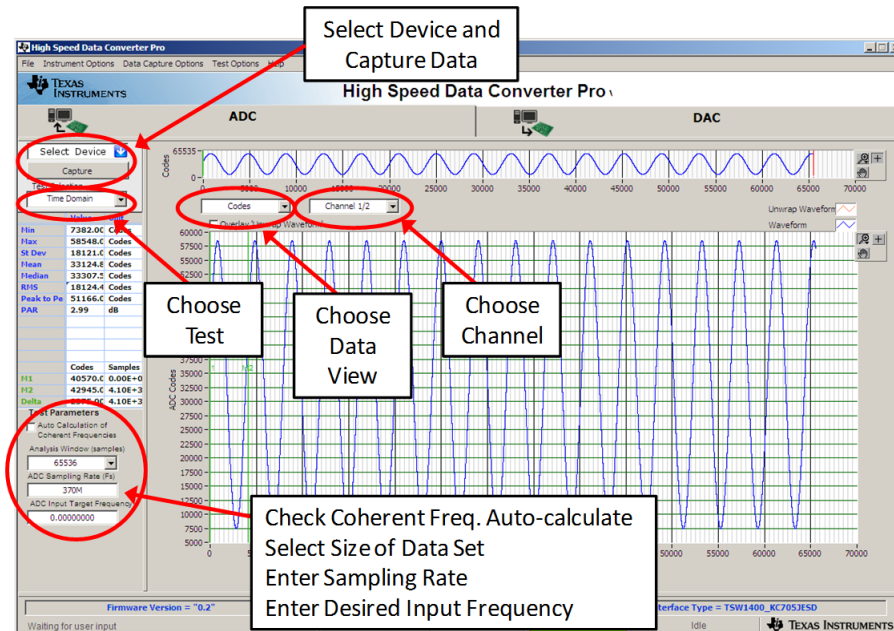

Figure 4. HSDC Pro GUI Main Panel

2. When prompted to select the capture board, select the TSW14J56 whose serial number corresponds to the serial number on the TSW14J56EVM and click "OK". This popup can be accessed through the *Instrument Options* menu.

3. If no firmware is currently loaded, there will be a message indicating this. Click on "OK".

4. Verify the *ADC* tab at the top of the GUI is selected.

5. Use the *Select ADC* drop-down menu at the top left corner to select *ADS54J66_LMF_4841*.

6. When prompted to update the firmware for the ADC, click "Yes" and wait for the firmware to download to the TSW14J56. This will take about 3 seconds.

7. Enter "245.76M" into the *ADC Output Data Rate* field at the bottom left corner then click outside this box or press return on the PC keyboard.

8. The GUI will display the new lane rate of the SerDes interface based off of the sample rate and other parameters from the loaded configuration files. Click 'OK".

9. Click the *Instrument Options* menu at the top of HSDC Pro and select *Reset Board*. Change the default setting display mode from "Real FFT" to "Complex FFT". This button is located near the top left of the GUI main page. In this mode, channel 1 (I) data and channel 2 (Q) data will be used to generate the complex waveform. This waveform will be duplicated on both channels 1 and 2 when in the complex mode. Data from channel B input will be on channels 3 and 4, and so on for inputs C and D.

10. Click "Capture" in HSDC Pro to capture data from the ADC.

11. The results from the captured data of Channel 1 should look like Figure 5 and the performance should be similar to Table 1. If this result is not achieved, then see the Quick Start Troubleshooting section of this document.
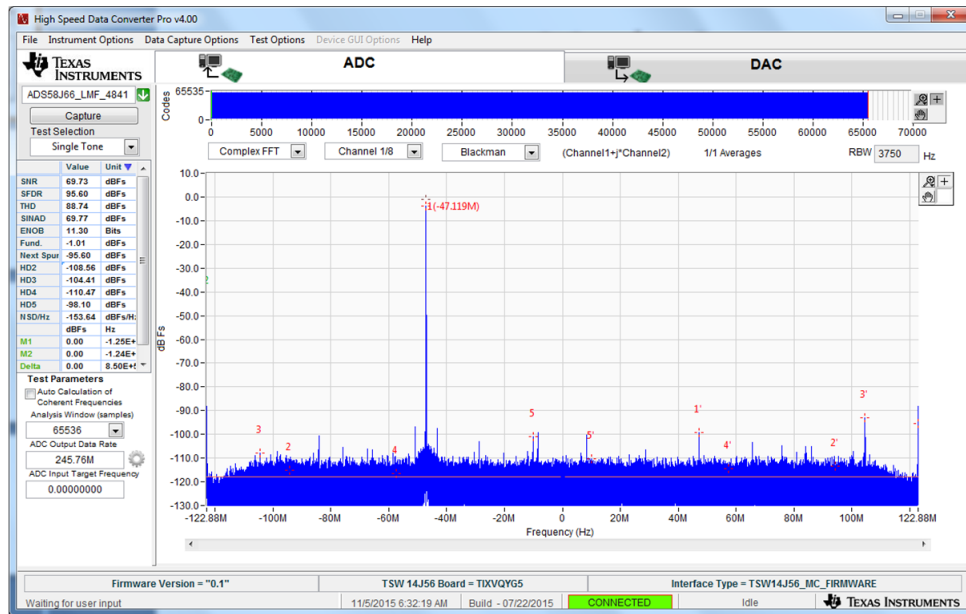
Mixing with Fs/4 inverts the spectrum causing the 170MHz input tone location to be located at -Fin + Fs/4 = -170 MHz + [491.52/4] = -47.12 MHz

Figure 5. Channel 1 Data Capture Results from Quick Start Procedure

Table 1. Quick Start Performance Measurements

Result	Measured Value	Units
SNR	69.73	dBFS
SFDR	95.6	dBFS

2.3.3 ADS54J66 GUI Configuration, Bypass Mode (For the ADS54J66EVM only)

In the ADS54Jxx GUI, click on the *Low Level View* tab then click the *Load Config* button. Navigate to "C:\Program Files(86)\Texas Instruments\ADS54Jxx GUI\Configuration Files", select the file called "LMK_Config_LMF_4841_491p52_MSPS.cfg", then click "OK". This will program the LMK04828 to provide a 491.52-MHz clock to the ADC. Verify that the LMK04828 PLL is locked by checking that the "PLL2 LOCKED" LED (D3) is lit. Once the LMK04828 PLL is locked, press SW1 (*ADC RESET*) to provide a hardware reset to the ADC.

In the *Low Level View* tab, click *Load Config*. Select the file called "ADS54J66_bypass_4421.cfg" and click "OK". The ADS54J66EVM is now configured for bypass mode using 4 JESD204B lanes.

2.3.4   HSDC Pro GUI Configuration

Inside the HSDC Pro GUI, select ADS54J66_LMF_4421. If prompted to update the firmware for the ADC, click "Yes" and wait for the firmware to download to the TSW14J56. This will take about 3 seconds. Enter "491.52M" into the *ADC Output Data Rate* field at the bottom left corner then click outside this box or press return on the PC keyboard. The GUI will display the new lane rate of the SerDes interface based off of the sample rate and other parameters from the loaded configuration files. Click 'OK". Click the *Instrument Options* menu at the top of HSDC Pro and select *Reset Board*. Make sure the display mode is set to "Real FFT". Click "Capture" in HSDC Pro to capture data from the ADC. The results from the captured data of Channel 1 should look like Figure 6 and the performance should be similar to Table 2. If this result is not achieved, then see the Quick Start Troubleshooting section of this document.
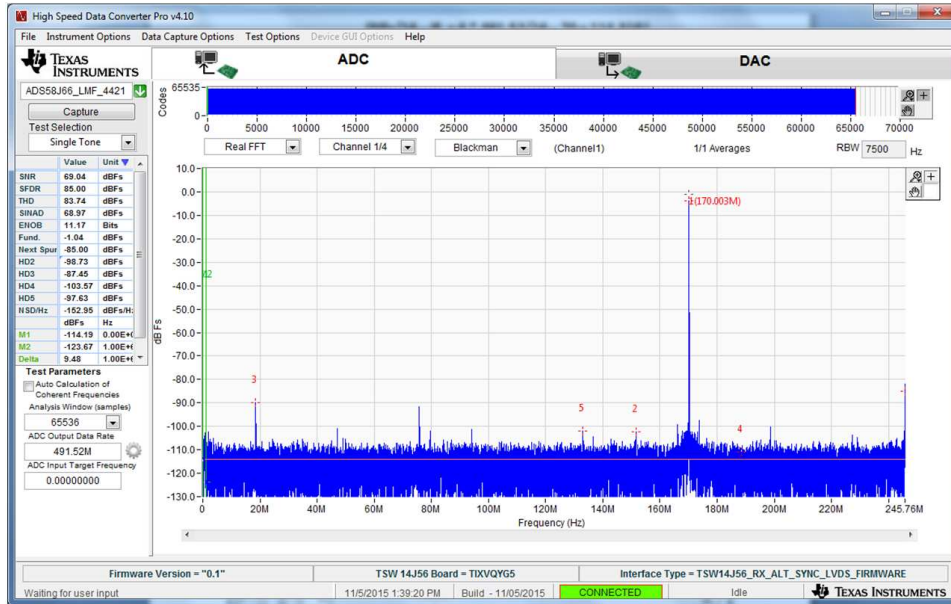

Figure 6. Channel 1 Data Capture Results in Bypass Mode

Table 2. Quick Start Performance Measurements

Result	Measured Value	Units
SNR	69.04	dBFS
SFDR	85	dBFS

2.4 Quick Start Troubleshooting

Use Table 3 to assist with problems that occur during the quick-start procedure.

Table 3. Troubleshooting Tips

Issue	Troubleshooting Tips
General Problems	Verify the test setup shown in Figure 2 and repeat the setup procedure as described in this document.
	Check power supplies to the EVM and TSW14J56EVM. Verify that the power switches are in the ON position.
	Check signal and clock connections to EVM.
	Check that all boards are properly connected together.
	Try pressing the CPU_RESET button on the TSW14J56EVM.
	Try power-cycling the external power supply to the EVM and re-program the LMK and ADC devices.
TSW14J56 LEDs are not correct: D1, D2, D5 – N/A D4 – "Blinking" D8, D10, D17, D28 – "ON"	Verify the settings of the configuration switches on the TSW14J56EVM.
	Verify that the EVM configuration GUI is communicating with the USB and that the configuration procedure has been followed.
	(LEDs not blinking) Re-program the LMK device.
	Try pressing the CPU_RESET button on the TSW14J56EVM.
	Try capturing data in HSDC Pro to force an LED status update.
Device GUI is not working properly	Verify that the USB cable is plugged into the EVM and the PC.
	Check the computer's Device Manager and verify that a 'USB Serial Device' is recognized when the EVM is connected to the PC.
	Verify that the green 'USB Status' LED light in the top right corner of the GUI is lit. If it is not lit, press the *Reconnect FTDI* button.
	Try restarting the configuration GUI.
	Check default jumper connections as shown in the Appendix A.
HSDC Pro software is not capturing good data or analysis results are incorrect	Verify that the TSW14J56EVM is properly connected to the PC with a 3.0 USB cable and that the board serial number is properly identified by the *HSDC Pro GUI* software.
	Check that the proper ADC device is selected. In default conditions, 'ADS58J66_LMF_4841' should be selected.
	Check that the analysis parameters are properly configured.
	Check that the fundamental power is no larger than –1 dBFs.
HSDC Pro GUI software gives a time-out error when capturing data	Try to re-program the LMK device and reset the JESD204 Link.
	Verify that the ADC sampling rate is correct in the HSDC Pro software.
Sub-Optimal measured performance	Make sure an ADC hardware reset was issued after loading the LMK but before loading the ADC configuration file.
	Check that the spectral analysis parameters are properly configured.
	Verify that band-pass filters are used in the clock and input signal paths and that low-noise signal sources are used.

3   Optimizing Evaluation Results

This section provides instruction for optimizing the performance during evaluation of the product.

3.1   Clocking Optimization

The sampling clock provided to the ADC needs to have very low noise to achieve optimal results. The default EVM configuration uses the LMK04828 clocking device to generate the sampling clock. There are two options to improve the clock noise performance.

1. To achieve the best performance, the LMK04828 can be bypassed in favor of an externally provided clock that is transformer coupled to the ADC. The clock must have very low noise and must use an external narrow pass-band filter to achieve optimal noise performance. The clock amplitude must be within the datasheet limits. See *Section 5.1* for more information regarding this setup.

2. The LMK04828 can be used as a clock distributor by using an external clock as the input to the LMK04828. Filters should still be used on the clock to optimize the noise performance. See *Section 5.1.2* for more information regarding this setup.

3.2   Coherent Input Source

A Rectangular window function can be applied to the captured data when the sample rate and the input frequency are set precisely to capture an integer number of cycles of the input frequency (sometimes called coherent frequency). This may yield better SNR results. The clock and analog inputs must be frequency locked (such as through 10-MHz references) in order to achieve coherency.

3.3   HSDC Pro Settings

HSDC Pro has some settings that can help improve the performance measurements. These are highlighted in Table 4.

Table 4. HSDC Pro Settings to Optimize Results

HSDC Pro Feature	Description
Analysis Window (samples)	Selects the number of samples to include in the selected test analysis. Collect more data to improve frequency resolution of FFT analysis. If more than 65,536 samples are required, the setting in the Data Capture Options will need to be increased to match this value.
Data Windowing Function	Select the desired windowing function applied to the data for FFT analysis. Select 'Blackman' when sampling a non-coherent input signal or 'Rectangle' when sampling a coherent input signal.
Test Options → Notch Frequency Bins	Select bins to be removed from the spectrum and back-filled with the average noise level. May also customize which Harmonics/Spurs are considered in SNR and THD calculations and select the method for calculating spur power.
Test Options → Bandwidth Integration Markers	Enable markers to narrow the Single-Tone FFT test analysis to a specific bandwidth.
Data Capture Options → Capture Options	Configure the number of contiguous samples per capture (capture depth). May also enable Continuous Capture and FFT Averaging.

4 Software Description

4.1 ADS54JxxGUI

Figure 7 shows the front page of the ADS54Jxx GUI as it should be seen upon opening the GUI. Descriptions for each of the tabs of the GUI are shown inTable 5.
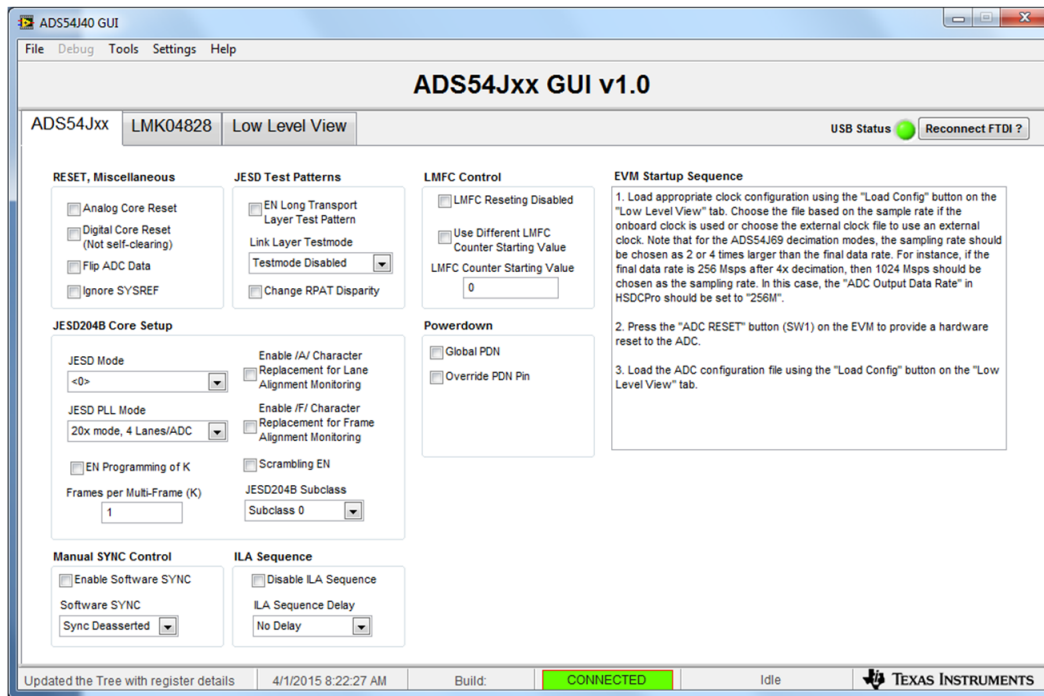

Figure 7. ADS54Jxx GUI

Table 5. ADS54J/58J6X GUI Tab Descriptions

Tab	Description
ADS54Jxx	Enables control of the ADS54Jxx features. None of these controls need to be touched for basic operation. Instead, use the Low Level View tab to load configuration files.
LMK04828	Enables control of many of the LMK04828 features. Configuration files can be used to setup the LMK04828 in known working configurations; however, this tab can be used to setup more advanced clocking schemes.
Low Level View	Allows write and read access to all device registers. Also allows loading and saving of configuration files. The device configurations can be saved from this tab for use in the user's system. See Section 4.2 for more information.

4.2 Low Level View

The *Low Level View* tab (Figure 8) allows configuration of the devices at the bit and field level. At any time, use the controls described in Table 6 to configure or read from the device.
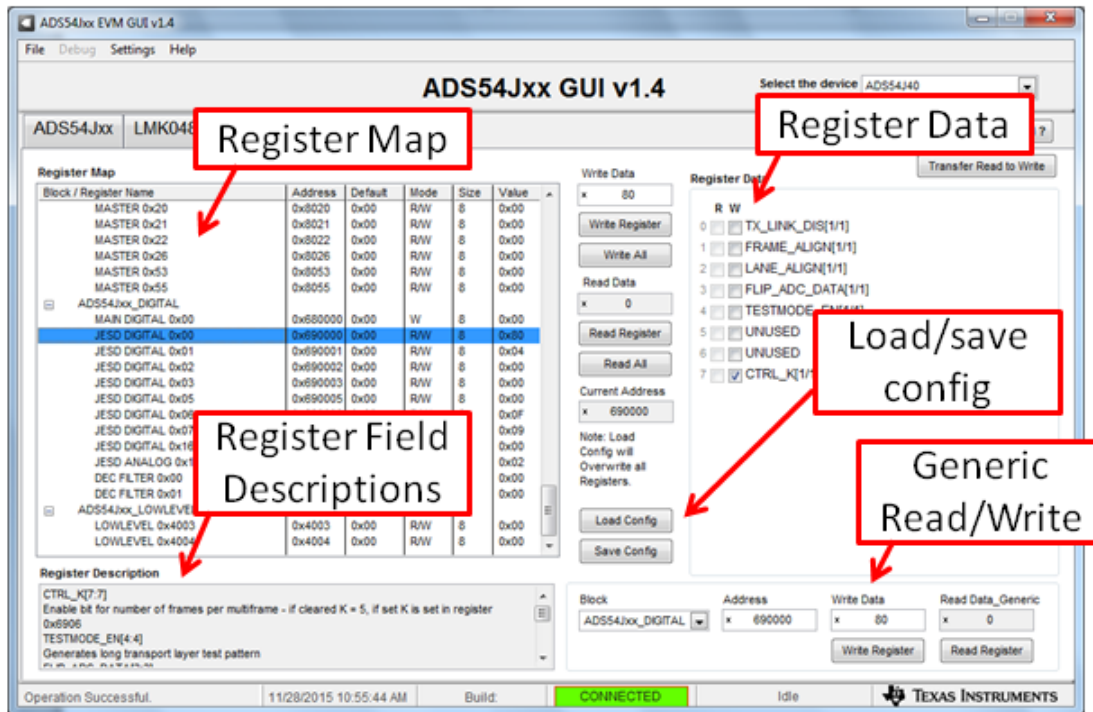

Figure 8. Low Level View Tab

Table 6. Low Level View Controls

Control	Description
Register Map	Displays the devices on the EVM, registers for those devices, and the states of the registers. • Selecting a register field allows bit manipulation in the Register Data section. • The Value column shows the value of the register at the time the GUI was last updated due to a read or write event.
Write Register Button	Write to the register highlighted in the Register Map with the value in the Write Data field. This button must be clicked after changing bits in the register data section.
Write All Button	Update all registers shown in the Register Map with the values shown in the Register Map log. The log can be viewed by double left clicking in the bottom left status bar of this page.
Read Register Button	Read from the register highlighted in the Register Map and display the results in the Value column.
Read All Button	Read from all registers in the Register Map and display the current state of the hardware. Also updates the controls in the other tabs.
Load Config Button	Load a Configuration File from disk and write the registers in the file.
Save Config Button	Save a Configuration File to disk that contains the current register configuration.
Register Data Cluster	Manipulate individual accessible bits of the register highlighted in the Register Map.
Generic Read/Write Register Buttons	Perform a generic read or write command to the device shown in the 'Block' drop-down box using the Address and Write Data information

5   Alternate Hardware Configurations

This section describes alternate hardware configurations in order to achieve better results or to more closely mimic the system configuration.

5.1   Clocking Options

The default clocking mode uses the LMK04828 to generate the ADC sampling clock and FPGA clocks. There are three additional clocking options that the EVM supports. These options are described in sections *Section 5.1.1* through *Section 5.1.3*:

5.1.1   External ADC Sampling Clock

An external clock can be used as the sampling clock for the ADC. This clock can be provided through a transformer using the *EXT_ADC_CLK* connector (J6). For this option C47 and C48 need to be uninstalled and installed at R35 and R39. The LMK04828 must still be used to provide the device clock to the TSW14J56 and the SYSREF signals to both boards. This option will provide the best performance as long as the clock source has better phase-noise performance than the LMK04828. The source of the EXT ADC clock must be synchronized with the LMK04828. To accomplish this, send the 10-MHz reference output from the signal generator and connect it to J12 (CLKIN) of the ADS5XJ6XEVM. This will cause LED D6 to illuminate indicating the LMK VCXO source is locked to the external reference clock. The provided LMK configuration files will work in this mode as well. To turn off the ADC clock provided by the LMK04828 to reduce switching noise, click on the LMK04828 tab, then click on clock outputs tab, then select "Powerdown" for *DCLK Type* under *Clock Out 2 and 3*, as shown in Figure 9.
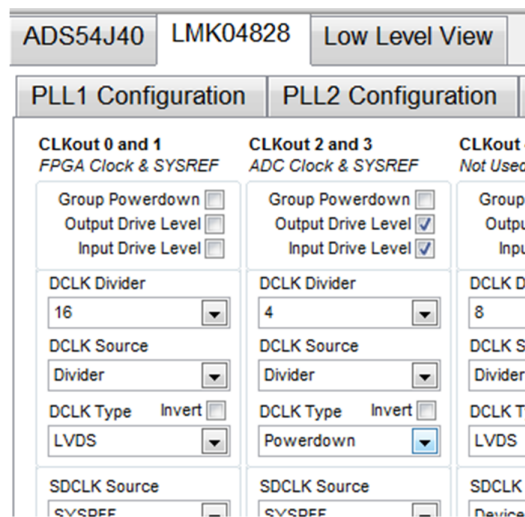

Figure 9. Low Level View Tab

5.1.2   External LMK04828 Clock (Clock Distribution Mode)

The LMK04828 can be used as a clock distributor. In this case, the LMK04828 uses in input clock source from CLKIN SMA connector (J12). JP2 (XO_PWR) can be left open to turn off the onboard VCXO to avoid crosstalk. To use this mode, load the configuration file named *"LMK_Config_External_Clock.cfg"*. This mode allows generation of frequencies that are not possible with the LMK when using the on-board VCXO.

5.1.3   Clock Generator Using Onboard VCXO

The LMK04828 is used as a clock generator using the onboard 122.88-MHz VCXO. JP2 must be shorted to turn on the onboard VCXO. The internal PLLs of the LMK04828 can be used with the onboard VCXO to generate the desired frequencies. To use this mode, load one of the configuration files named *"LMK_Config_LMF_xxxx_yyyy_MSPS.cfg"*, where *xxxx* corresponds to the LMFS settings of the JESD interface and *yyyy* corresponds to the desired ADC sampling rate. A 10-MHz signal can be brought into the CLKIN input to synchronize to external instruments. This is the board default mode of operation.

A.1 Jumper Descriptions

Table 7 shows the EVM jumpers and the default settings for the jumpers. Use this table to reset the EVM in the default configuration in case of issues.

Table 7. Jumper Descriptions and Default Settings

Jumper	Description	Default setting
SW1	ADC hardware reset (active high)	Logic low
JP2	Power enable to VCXO oscillator Y1. Default is power on.	Shunt pins 1-2
JP3	Selects SPI source from USB or FMC. Default is USB.	Shunt pins 2-3
JP7	ADC power down. Default is ADC powered on.	Shunt pins 2-3
SJP1	Selects either 3.3 V or GND for Y1 enable. Default is open	Open

A.2 Connector Descriptions

The EVM connectors and their function described in Table 8.

Table 8. Connector Description

Connector	Description
J1	Channel A analog input
J17	Channel B analog input
J18	Channel C analog input
J5	Channel D analog input
J6	External ADC sample clock input
J10	LMK04828 external sync input
J12	LMK04828 reference clock input
J3	JESD204B FMC connector. Interfaces to TSW14J56EVM or FPGA evaluation boards.
J13 (USB)	USB interface connector
J14 (+5V IN)	5-V power supply input
J15 (JTAG)	JTAG interface to CPLD
J21	TRDYAB test point (pin1) and GND (pin 2). Manual burst mode trigger input.
J22	TRDYCD test point (pin1) and GND (pin 2). Trigger ready output for burst mode.
J23	TRIGAB test point (pin1) and GND (pin 2). Manual burst mode trigger input.
J24	TRIGCD test point (pin1) and GND (pin 2). Trigger ready output for burst mode.

A.3 LED Descriptions

The EVM LEDs are described in Table A.3.

Table 9. LED Descriptions

Connector	Description
D1	Not used
D2	5-VDC power present
D3	LMK04828 locked to VCXO
D6	VCXO locked to external reference applied to J12
D4, D5	Not used

Revision History

Changes from C Revision (December 2015) to D Revision **Page**

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

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    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/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

  3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required 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.

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

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

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page
電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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 ANDCONDITIONS 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.

IMPORTANT NOTICE

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Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
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