ADS54J69EVM

This user's guide describes the function and use of the ADS54J69 evaluation module. Included in this document are a quick-start guide, instructions for optimizing evaluation results, software description, alternate hardware configurations, and jumper, connector, and LED descriptions.

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1 Overview

The ADS54J69EVM is an evaluation module (EVM) designed to evaluate the ADS54J69 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 0.4 MHz to 800 MHz
- LMK04828 system clock generator that generates field-programmable gate array (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 FPGA Mezzanine Card (FMC) interface connector

The ADS54J69EVM 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 ADS54J69EVM 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:

- ADS54J69 Evaluation Board (EVM)
- Power supply 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
- Computer running Microsoft® Windows® 8, Windows 7, or Windows XP
- One Low-Noise Signal Generator. Recommendations:
  - RF generator, > +17 dBm, < –40 dBc harmonics, < 500 fs jitter 20 kHz–20 MHz, 10-MHz to 2-GHz frequency range
  - Examples: TSW2170EVM, HP HP8644B, Rohde & Schwarz SMA100A
- Bandpass filter for desired analog input. Recommendations:
  - Bandpass 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 ADS54J69EVM and available online. See References, Section 1.4 for links.

- ADS54Jxx EVM GUI

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

- High Speed Data Converter Pro software, version 4.1 or higher
- HSDC Pro GUI Updates (Rev. I) for High Speed Data Converter Pro Software, version 4.0 or lower

1.3 Evaluation Board Feature Identification Summary

The EVM features are labeled in Figure 1.

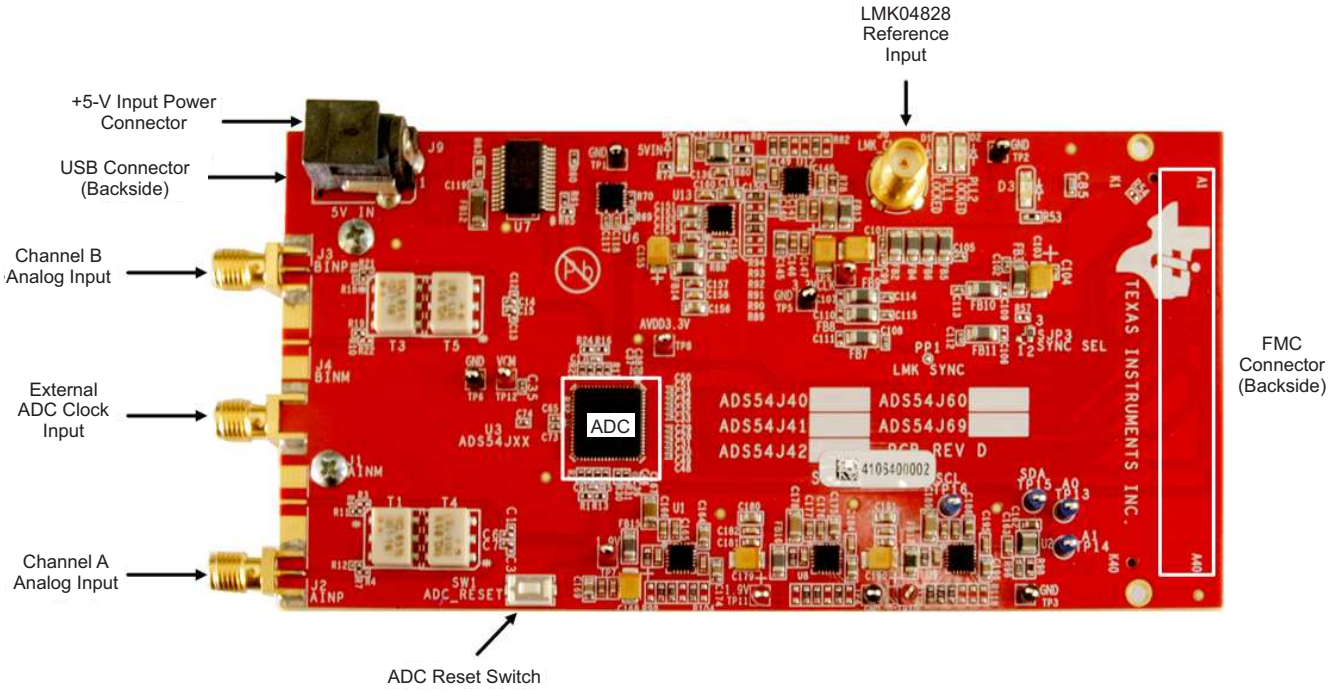

Figure 1. EVM Feature Locations

1.4 References

- ADS54Jxx EVM software, available at: www.ti.com/tool/ADS54J69EVM
- ADS54J69 datasheet (SBAS713), available at www.ti.com/product/ADS54J69
- LMK04828 datasheet (SNAS605), available at www.ti.com/product/lmk04828
- TSW14J56EVM User's Guide (SLWU086), available at www.ti.com/tool/TSW14J56EVM
- High Speed Data Converter Pro software (SLWC107) and User's Guide (SLWU087), available at www.ti.com/tool/dataconverterpro-sw
- HSDC Pro GUI Updates (SLWC106), available at www.ti.com/tool/dataconverterpro-sw

NOTE: Schematics, layout, and BOM are available on the ADS54J69EVM product page on www.ti.com.

2 Quick Start Guide

This section guides the user through the EVM test procedure to obtain a valid data capture from the ADS54J69EVM 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 Section 1.2 for a list of the required software. The References section of this document contains links to find the software on the TI website.

Important: The software must be installed before connecting the ADS54J69EVM and TSW14J56 to the computer for the first time.

2.1.1 ADS54Jxx EVM GUI Installation

The ADS54Jxx EVM GUI is used to control the ADS54J69EVM. It must be used to properly configure the devices on the EVM.

1. Download the ADS54Jxx EVM GUI from the TI website. The References section of this document contains links 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 (SLWU087) 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.
4. If the version of HSDC Pro is 4.0 or lower, download HSDC Pro GUI Updates from the TI website. The References, Section 1.4 section of this document contains the link to find the software on the TI website.
5. Extract the files from the zip file, run HSDC Pro Patch vx.xx.exe and follow the installation instructions.

2.2 Hardware Setup Procedure

A typical test setup using the ADS54J69EVM and TSW14J56EVM is shown in Figure 2. This is the test setup used for the quick start procedure. The rest of this section describes the hardware setup steps.

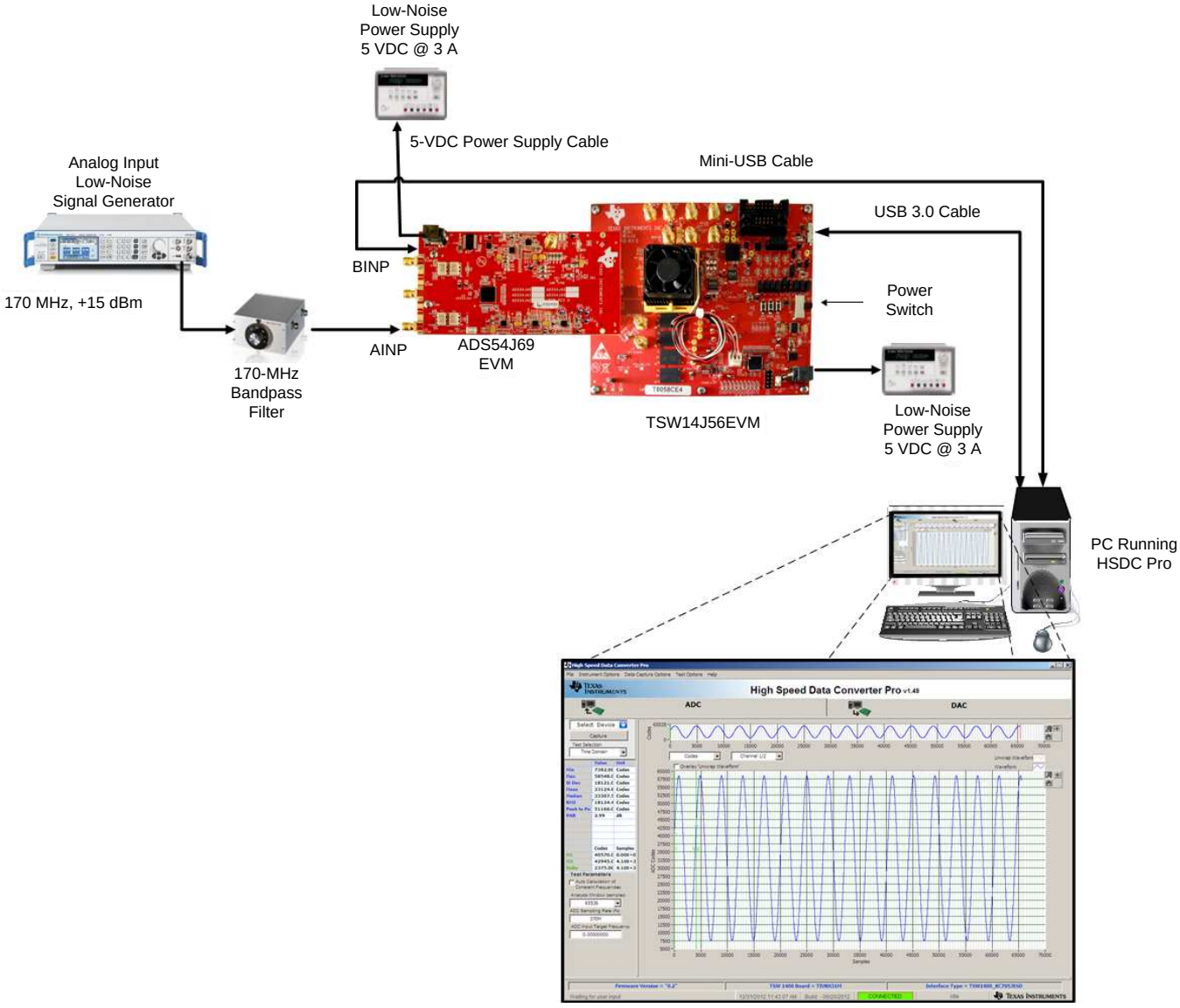

Figure 2. Quick Start Test Setup

2.2.1 TSW14J56EVM Setup

First, setup the TSW14J56EVM using the following steps:

1. Connect the ADS54J69EVM to the TSW14J56EVM using the FMC connectors.
2. Connect one end of the provided 5-V power supply cable to connector J11 (+5 V IN) and the other end to a +5 VDC source with a minimum current rating of 3 A. Turn on the power supply.
3. Connect the included USB cable between the host computer and USB connector (J9).
4. Flip the power switch (SW6) to the *ON* position.

2.2.2 ADS54J69EVM Setup

Next, setup the ADS54J69EVM using the following:

1. Connect the included 5-V power supply cable to connector J9 of the EVM. Connect the red wire to +5 VDC ±0.1 VDC of a power supply rated for at least 3 A. Connect the black wire to GND of the power supply.
2. Turn on the 5-VDC power supply. The power draw should be around 0.66 A. When the board is configured, it will draw approximately 1.12 A.
3. Connect one end of the included mini-USB cable to a host computer and the other end to the USB connector J8, located on the backside of the board.
4. Set an analog input signal generator for 170 MHz, and about +15 dBm of power.
5. Place a narrow pass-band bandpass filter at the output of the signal generator to remove noise and harmonics.
6. Connect the output of the filter to SMA connector AINP (J2) of the EVM.

2.3 Software Setup Procedure

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

2.3.1 ADS54J69 GUI Configuration for Decimate-by-2 Low Pass Filter Mode

1. Open the ADS54Jxx EVM GUI by going to *Start Menu* → *All Programs* → *Texas Instruments ADCs* → *ADS54Jxx EVM 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 EVM GUI\Configuration Files*, select the file called *LMK_Config_Onboard_983p04_MSPS.cfg*, then click *OK*. This programs the LMK04828 to provide a 983.04 MHz clock to the ADC.
5. Verify that the LMK04828 phase lock loop (PLL) is locked by checking that the *PLL2 LOCKED* LED (D2) 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 on the bottom left of the EVM.
7. In the *Low Level View* tab, click *Load Config*. Select the file called *ADS54J69_2x_dec_lowpass_4222.cfg* and click *OK*. The ADS54J69EVM is now configured for decimation by 2 and using 4 JESD204B lanes.

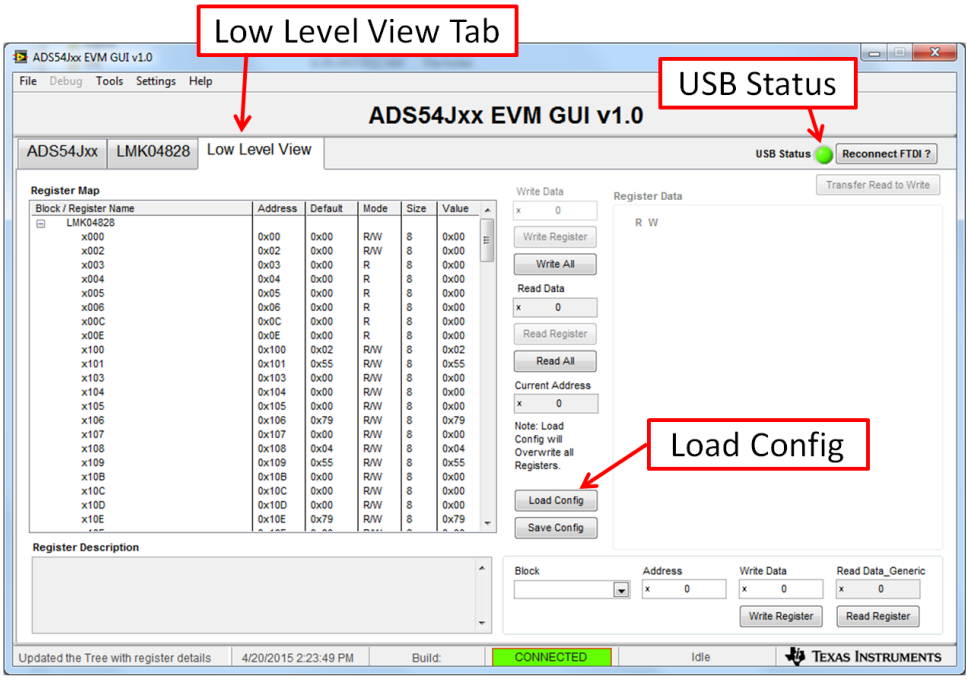

Figure 3. ADS54Jxx GUI Low Level View Tab

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.

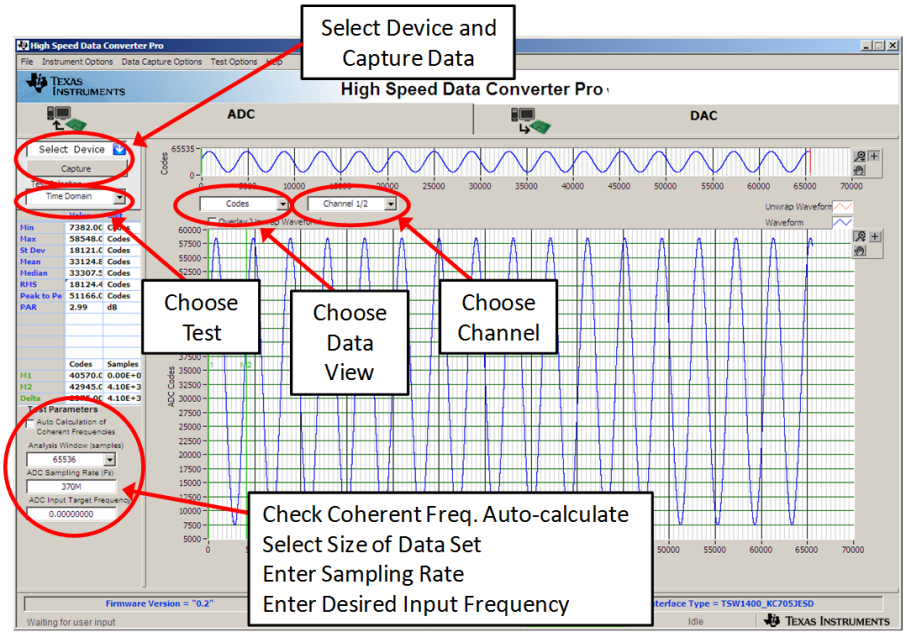

Figure 4. HSDC Pro GUI Main Panel

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 is 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 *ADS54J69_2x_4222*.
6. When prompted to update the firmware for the ADC, click *Yes* and wait for the firmware to download to the TSW14J56. This takes about 3 seconds.
7. 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.
8. The GUI displays 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*.
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.

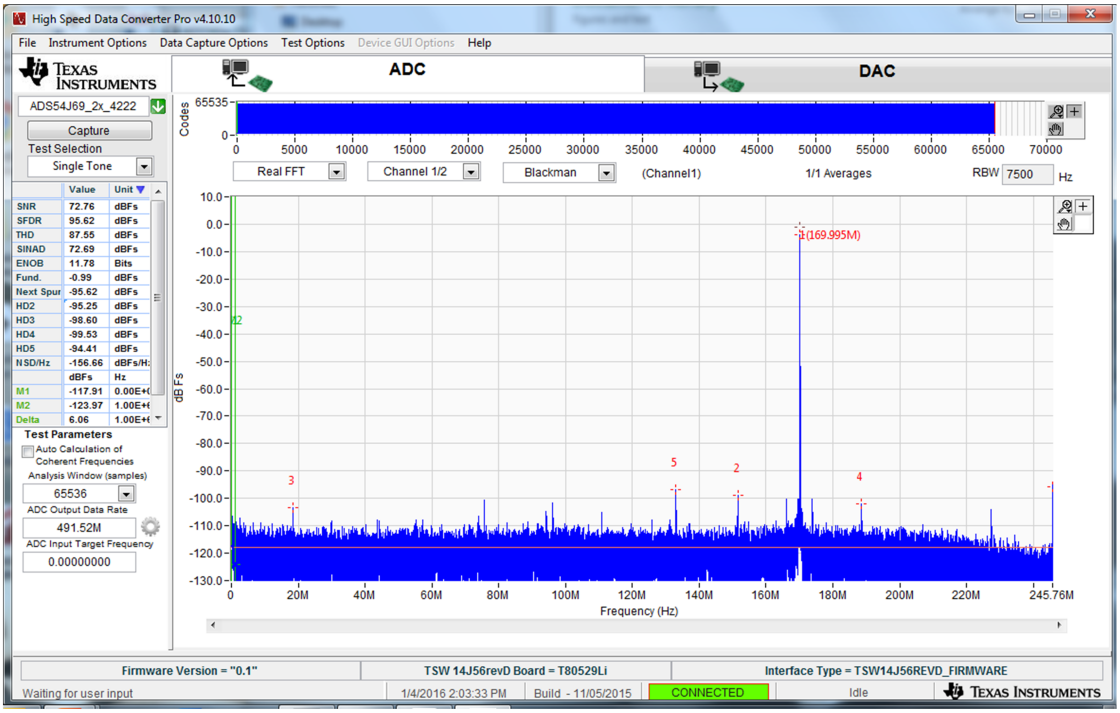

Figure 5. Channel 1 Data Capture Results Using Decimate-by-2 Low Pass Filter Mode

Table 1. Quick Start Performance Measurements

Result	Measured Value	Units
SNR	72.76	dBFs
SFDR	95.62	dBFs

2.4 Quick Start Trouble Shooting

Use Table 2 to assist with problems that may have occurred during the quick start procedure.

Table 2. 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 EVMs. Verify that the power switches are in the ON position.
	Check signal and clock connections to the 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 reprogram the LMK and ADC devices.
TSW14J56 LEDs are not correct: **D1, D5 – N/A** **D2, D4 – *Blinking*** **D3, D6, D7 – *OFF*** **D8, 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) Reprogram 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 *Reconnect FTDI* button.
	Try restarting the configuration GUI.
	Check default jumper connections as shown in 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 an USB cable and that the board serial number is properly identified by the HSDC Pro software.
	Check that the proper ADC device is selected. In default conditions, ADS54J69_2x_4222 should be selected.
	Check that the analysis parameters are properly configured.
	Check that the fundamental power is no larger than –1 dBFs.
HSDC Pro Software gives a Time-Out error when capturing data	Try to reprogram 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 bandpass filters are used in the clock (external ADC Clock Mode) and input signal paths and that low-noise signal sources are used.

3 Optimizing Evaluation Results

This section assists the user in optimizing the performance during evaluation of the product.

3.1 Clocking Optimization

The sampling clock provided to the ADC needs to have very low phase 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 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 5.2 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 3.

Table 3. 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 Fast-Fourier Transform (FFT) analysis. If more than 65,536 samples are required, the setting in the *Data Capture Options* needs 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 and *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 ADS54Jxx EVM GUI

Figure 6 shows the front page of the ADS54Jxx EVM GUI as it should be seen upon opening the GUI. Descriptions for each of the tabs of the GUI are shown in Table 4.

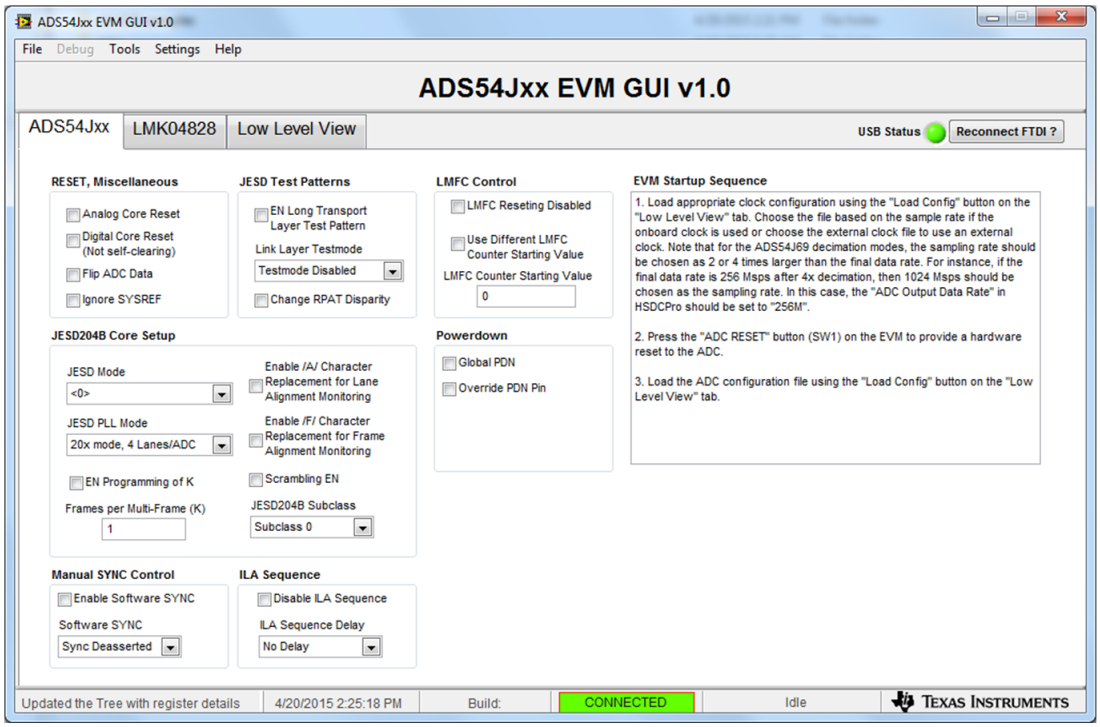

Figure 6. ADS54Jxx GUI

Table 4. ADS54Jxx 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, shown in Figure 7, allows configuration of the devices at the bit and field level. At any time, the controls described in Table 5 may be used to configure or read from the device.

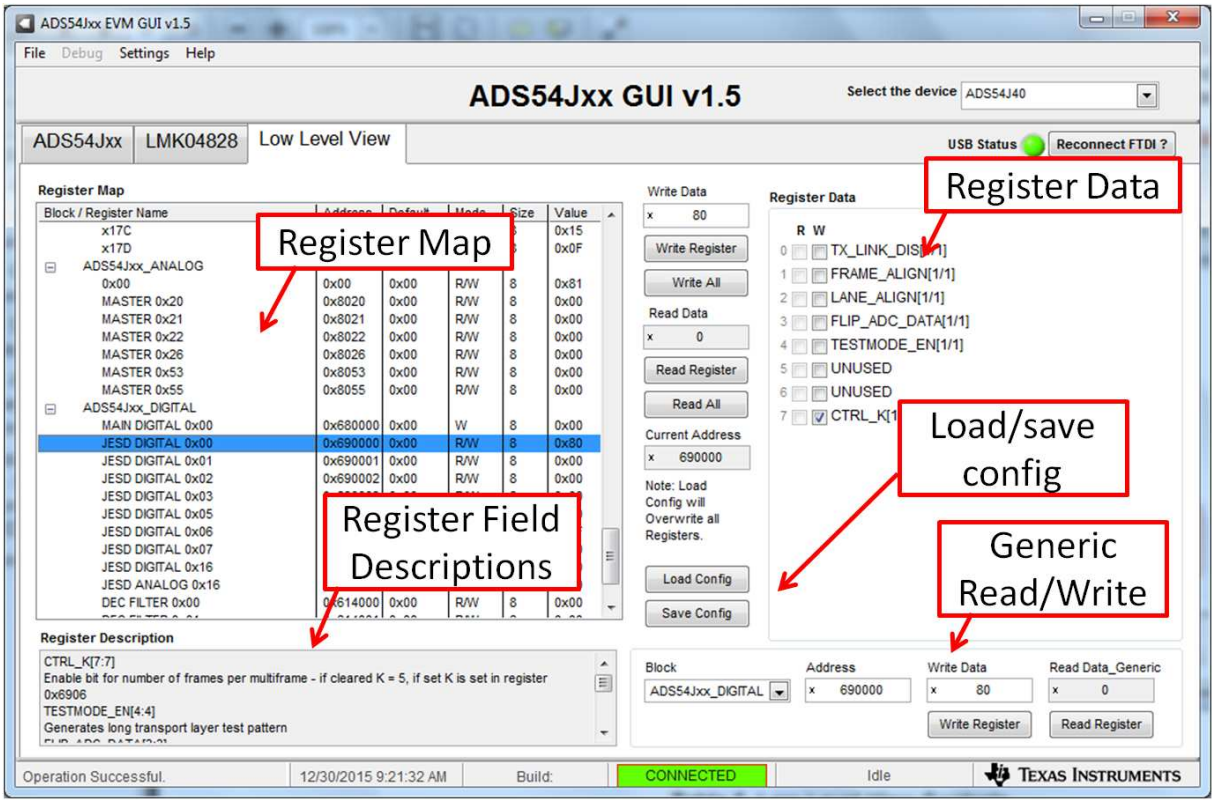

Figure 7. Low Level View Tab

Table 5. 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 hardware. Also updates the controls in the other tabs.
Load Config button	Write the ADC and LMK registers with data from the selected configuration file.
Save Config button	Create and save a configuration file that contains the current register information of both the ADC and LMK devices.
Register Data	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 the following sections.

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 *ADC CLK* connector (J5). For this option, C65 and C73 need to be uninstalled and installed at C64 and C72. The LMK04828 must still be used to provide the device clock to the TSW14J56 and the SYSREF signals to both boards. This option provides 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 J6 (LMK_CLKIN1) of the ADS54J69EVM. This causes LED D1 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. If D1 does not illuminate, the signal from the outside source may be to low. To correct for this, click on the LMK04828 tab at the top of the GUI. When the LMK04828 page opens, click on the "PLL1 Configuration" tab. On the left middle side of the GUI, change the Buffer Type of CLKin1 from "Bipolar" to "CMOS" as shown in Figure 8.

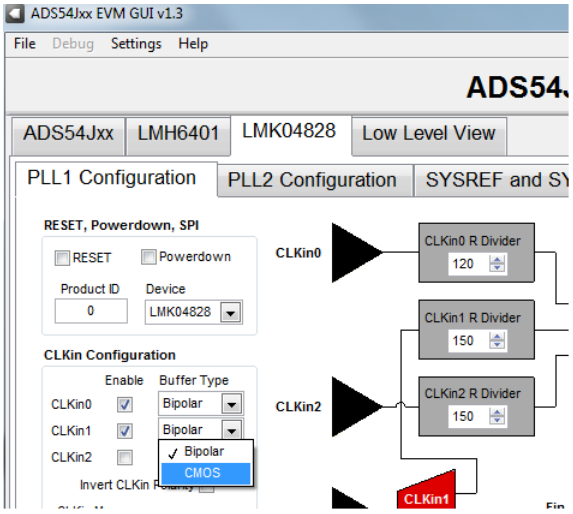

Figure 8. GUI CMOS Selection

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 *CLKout 2 and 3*, as shown in Figure 9.

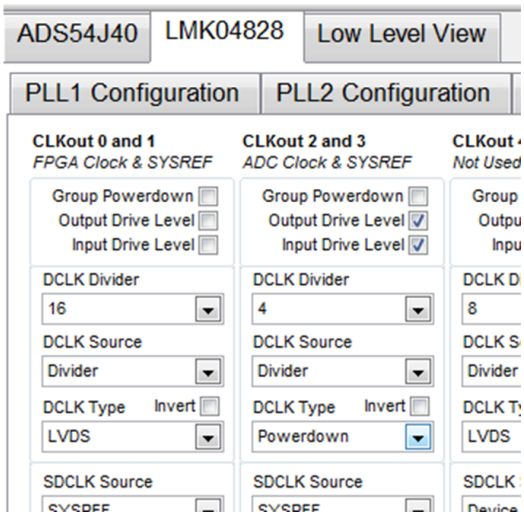

Figure 9. LMK04828 Clock Outputs Tab

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 LMK_CLKIN1 SMA connector (J6). SJP2 (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. SJP2 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_Onboard_xxxx_MSPS.cfg*, where *xxxx* corresponds to the desired ADC sampling rate. A 10-MHz signal can be brought into the LMK_CLKIN1 input to synchronize to external instruments. This is the board default mode of operation.

5.2 Analog Input Options

The ADS54J69EVM allows for a differential analog input configuration in addition to the default using the single-ended transformer-coupled input. This option is described in the following section.

5.2.1 Differential Input

The analog input transformers can be bypassed in favor of a differential input source. This allows for a wider range of input frequencies, including the possibility of DC coupling. To configure the EVM for a differential analog input on Channel A, remove C6, C7, and R7 and install R3, R4, C1, and C3. For channel B, remove R8, C14, and C15 and install R21, R22, C12, and C13. All resistor values are 0 Ohms and capacitor values 0.1uF. For a DC-coupled application, swap the series capacitors with 0-Ω resistors. The input signal must be biased to the required ADC input common mode voltage.

Jumper, Connector, and LED Descriptions

A.1 Jumper Descriptions

The EVM jumpers are shown in Table 6 as well as the default settings for the jumpers. Use this table to reset the EVM in the default configuration, in case of issues.

Table 6. Jumper Descriptions and Default Settings

Jumper	Description	Default setting
SW1	ADC hardware reset (active high)	Logic low
SJP2	Power enable to VCXO oscillator Y1. Default is power on.	Shunt pins 1-2
SJP1	Selects either 3.3 V or GND for Y1 enable. Default is open	Open
SJP3	Selects either diff sync or single-ended sync from FMC. Default is diff.	Shunt pins 2-3

A.2 Connector Descriptions

The EVM connectors and their function are described in Table 7.

Table 7. Connector Descriptions

Connector	Description
J2	Channel A positive analog input
J1 (Not installed)	Channel A negative analog input. Used for differential input mode only.
J3	Channel B positive analog input
J4 (Not installed)	Channel B negative analog input. Used for differential input mode only.
J5	External ADC sample clock input
J6	LMK04828 reference clock input
J7	JESD204B FMC connector. Interfaces to TSW14J56EVM or FPGA evaluation boards
J8 (USB)	USB interface connector. Not used.
J9 (+5V IN)	5-V power supply input

A.3 LED Descriptions

The EVM LEDs are described Table 8.

Table 8. LED Descriptions

Connector	Description
D3	Not used
D4	5 VDC power present
D2	LMK04828 locked to VCXO
D1	VCXO locked to external reference applied to J6

Revision History

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

Changes from A Revision (January 2016) to B Revision **Page**

- Deleted *ADS54J69 GUI Configuration for Decimate-by-4 with Digital Mixer* section from *Software Setup Procedure* section. 6
- Deleted *HSDC Pro GUI Configuration* section from *Software Setup Procedure* section. 6

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   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/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.

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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。

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西新宿三井ビル

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

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。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.

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

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

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

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

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

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