

AFE707xEVM Evaluation Module

This is the user's guide for the AFE707xEVM evaluation module (EVM). The AFE7070/71 is a dual 14-bit 65-MSPS digital-to-analog converter with an integrated quadrature modulator. The NCO and LVDS output functions are not available with the AFE7071 but the AFE7070 has both functions. This is the sole difference between the AFE7070 and the AFE7071. Hereafter, the AFE707x is referred to as AFE7070. The EVM also includes the CDCM7005 clock synchronizer, which provides the necessary clocks for the AFE and pattern generator. This EVM is ideally suited for mating with the TSW3100 pattern generation card for evaluating WCDMA, LTE, or other high-performance modulation schemes.

Contents

1	Hardware Overview	2
1.1	EVM Block Diagram	2
1.2	Parallel Input Data	2
1.3	Analog Inputs/Outputs	2
1.4	Clocking Options	3
1.5	Power Supply Options	4
2	Software Control	5
2.1	Installation Instructions	5
2.2	Software Operation	5
3	Basic Test Procedure	7
3.1	Test Block Diagram	7
3.2	Test Setup Connections	8
3.3	TSW3100 Quick-Start Operation	8
3.4	AFE7070 Software Quick-Start Guide	10
3.5	AFE7070 Performance Results	11

List of Figures

1	EVM Block Diagram	2
2	EVM Power Architecture	4
3	Screen Shot of AFE7070 Tab	5
4	Screen Shot of CDCM7005 Tab	7
5	Test Setup Block Diagram	8
6	TSW3100 MultiTonePattern Programming GUI.....	9
7	TSW3100 CommsSignalPattern (WCDMA) Programming GUI	10
8	Two-Tone IMD Performance: LO = 2 GHz, DAC Rate = 65 MSPS, IF = 1.5 MHz and 2.5 MHz	11
9	WCDMA ACPR: LO = 2 GHz, DAC Rate = 57.6 MHz, 0-MHz Offset	11

1 Hardware Overview

This section describes the EVM hardware and how it can be modified to evaluate the AFE7070 in various configurations.

1.1 EVM Block Diagram

Figure 1 shows a simplified block diagram of the EVM in its default configuration.

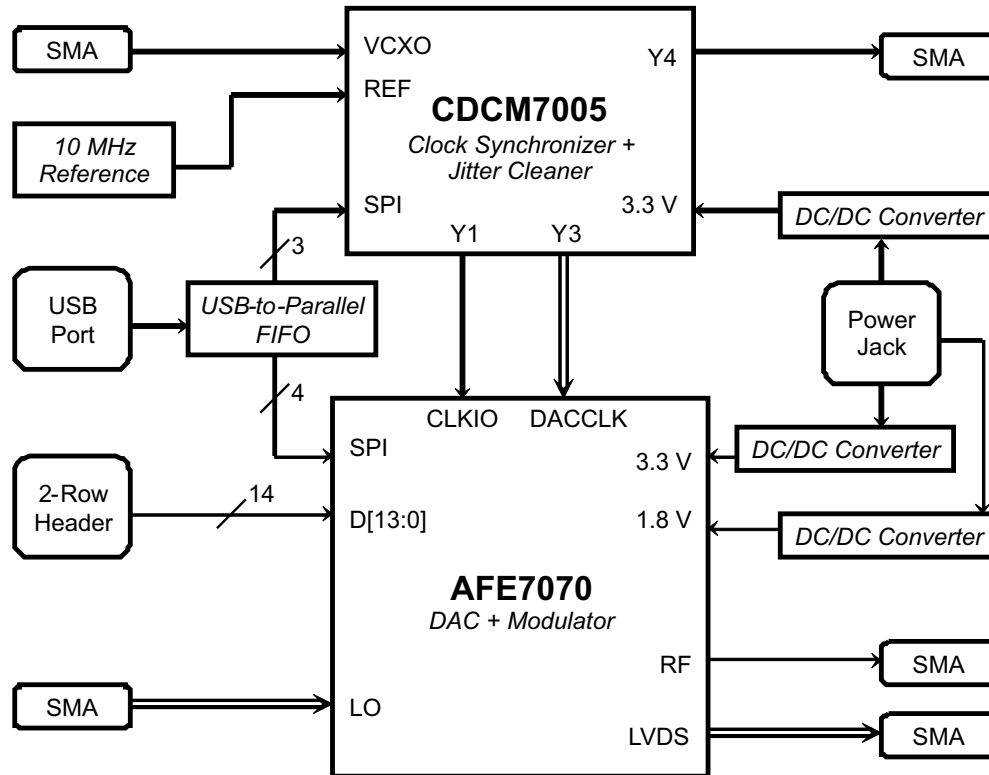


Figure 1. EVM Block Diagram

1.2 Parallel Input Data

Parallel input data is supplied to the EVM by header J8. This header can be connected to the TSW3100 CMOS outputs by a parallel CMOS connector board.

1.3 Analog Inputs/Outputs

1.3.1 Local Oscillator

A local oscillator (LO) signal must be provided via the SMA connector J10. This signal's amplitude must be between -5 dBm and 5 dBm with a frequency between 100 MHz and 2.7 GHz. The signal at the SMA connector is ac-coupled into the AFE7070's LOP pin; LON is ac-terminated with $50\ \Omega$.

1.3.2 External Clock Input

Provide an external clock signal by the SMA connector J4. By default, this signal is ac-coupled by a $0.01\ \mu\text{F}$ capacitor and then rebias to a common-mode dc voltage of $1.3\ \text{V}$ at the CDCM7005's VCXO_IN input. The ac load impedance is $50\ \Omega$. The input signal level can be between $1\ \text{V}$ and $2.6\ \text{V}$ peak-to-peak.

1.3.3 RF Out

The AFE7070's RF output (pin RFOUT) is ac-coupled by a 100 pF capacitor to the SMA connector J3. This output can be connected directly to a 50-Ω spectrum analyzer or other test equipment.

1.3.4 LVDS Output

In the EVM's default configuration, the AFE7070's LVDS_P and LVDS_N outputs are routed directly to SMA connectors J1 and J2, respectively. If desired, onboard termination can be added by populating resistor R53; otherwise, properly terminate the signal with 100-Ω differential impedance at its sink.

The complementary LVDS outputs also can be converted to a single-ended signal for ease of measurement. To do this, remove resistors R17 and R50, and place 0-Ω resistors at R21 and R38. This routes the LVDS outputs to transformer T6 (connected to SMA connector J14) and disconnects them from connectors J1 and J2. Place a resistor at position R53 to make the differential impedance **seen** by the LVDS outputs equal to 100 Ω. If the SMA connector J14 is connected to 50-Ω test equipment, the value of R53 must be 200 Ω, because the 50-Ω impedance is transformed to 200 Ω on the primary side due to transformer T6's 4-to-1 impedance ratio.

The AFE7071 does not have this function.

1.4 Clocking Options

This EVM accommodates a wide range of clocking options. The AFE7070 has four clocking modes: Dual Input Clock, Dual Output Clock, Single Differential DDR Clock, and Single Differential SDR Clock. See the device data sheet for a detailed description of these four modes. The clock signals on the EVM can be generated with the CDCM7005 or supplied externally. Similarly, the reference and VCXO inputs to the CDCM7005 can come from onboard oscillators or other sources.

1.4.1 Default Configuration

By default, the CDCM7005 is configured to use an onboard 10-MHz reference and external VCXO input signal to generate the AFE7070's DACCLK and CLKIO signals. This is suitable for evaluating the AFE7070's Dual Input Clock, Single Differential DDR, and Single Differential SDR modes. A third CDCM7005 output is routed to SMA connector J5. This signal can be sent to the TSW3100's CMOS clock input to align and synchronize the input data bus. Note that external equipment may be needed to add a delay to this clock signal such that proper setup and hold times are maintained.

1.4.2 Dual Output Clock Mode

In Dual Output Clock mode, the AFE7070's CLKIO pin becomes an output that can be used to drive a digital source such as the TSW3100. To use this mode, the user must remove resistor R18 connecting CLKIO to the CDCM7005's output and instead populate resistor R25. This routes the CLKIO signal to SMA connector J11. This output then can be connected to the TSW3100 CMOS clock input.

1.4.3 Onboard VCXO

If desired, a VCXO can be installed on the board at position VCXO1 to provide an input clock source to the CDCM7005. In addition to populating the VCXO, remove resistor R13 and populate C29 with a 0-Ω resistor. This allows for dc-coupling a differential LVPECL-output VCXO (such as the TCO-2111) to the VCXO_IN and VCXO_INB inputs of the CDCM7005.

1.4.4 External Reference Clock

The CDCM7005's reference clock can be supplied externally as well. Because the CDCM7005 has two reference inputs (primary and secondary), it is possible to simply connect an external CMOS-level clock to SMA connector J6. The applied signal is ac-coupled and rebased to a dc common-mode voltage of 1.65 V (midsupply), then applied to the CDCM7005's PRI_REF input. If required, add a termination resistor to position R26. Depending on the software settings, the CDCM7005 may automatically switch to the external clock signal (automatic mode), or require the use of jumper JP3 to select it (manual mode).

1.4.5 Bypass CDCM7005

Bypassing the CDCM7005 entirely and simply supplying external clocks to the AFE7070 is possible. You can use the SMA connector J12 to supply the LVPECL-level DACCLK signal if you install capacitors C129 and C130 and remove C102 and C103. A termination resistor may be placed at position R54, although resistor R55 provides 100-Ω differential termination at the AFE7070's DACCLK P and N inputs. When setting the external clock's amplitude, keep in mind the 2-to-1 impedance ratio of the transformer used for single-ended-to-differential conversion.

Note that depending on the AFE7070's clock mode, you may need to send separate clock signals to CLKIO or to the digital source as well. The SMA connector J11 can supply CLKIO, providing that you install resistor R25 and remove R18. Connecting the TSW3100 CMOS clock input to an external clock source is possible as well. Ensure that these various clock signals are synchronized and do not drift with respect to one another.

1.5 Power Supply Options

The EVM provides multiple options for powering the AFE7070 and CDCM7005 integrated circuits (IC). By default, users can power the board with a 6-Vdc adapter. Switched-mode dc/dc (buck) converters step down this voltage to the necessary 3.3-V and 1.8-V rail voltages. If desired, users can use LDOs or bench supplies rather than switching power supplies. Figure 2 provides a simplified block diagram of the EVM's power architecture showing how jumper settings can be used to enable and disable various power supply ICs. Also, disconnecting all jumpers and providing the necessary rail voltages directly to test points TP7, TP6, and TP8 is possible.

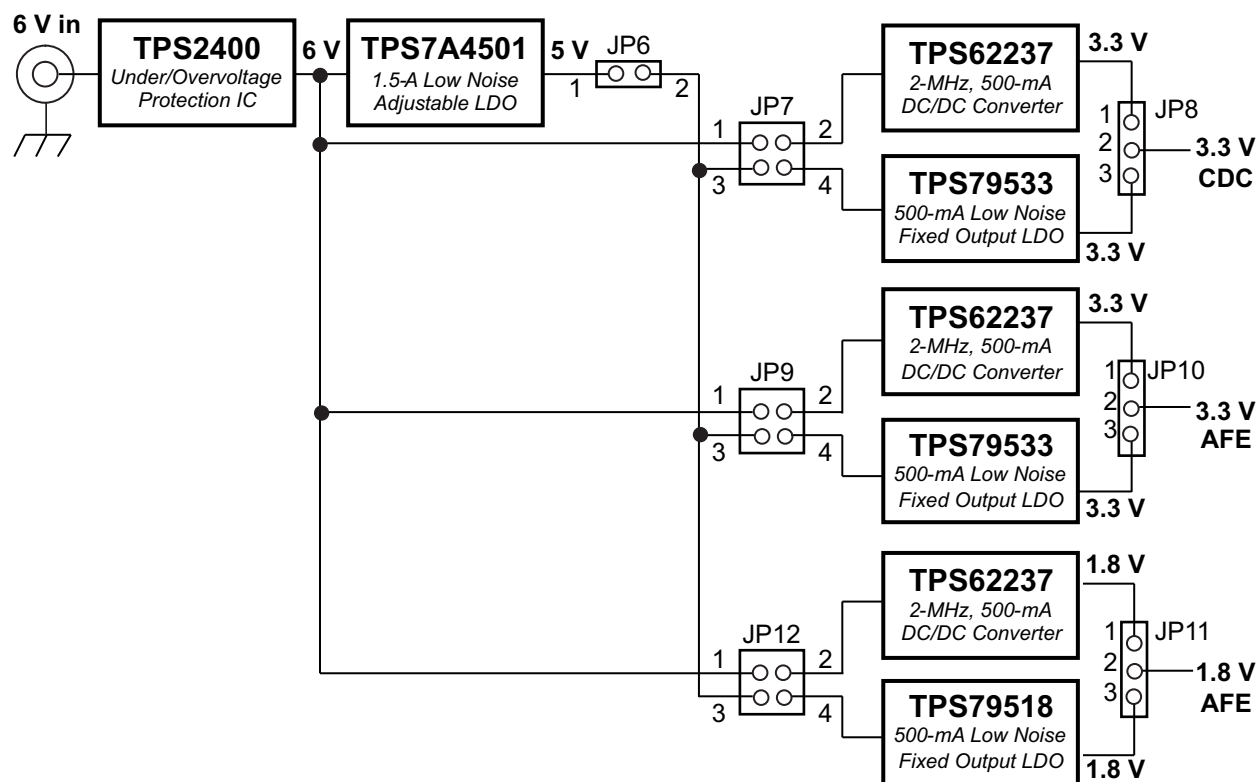


Figure 2. EVM Power Architecture

For a detailed illustration of the EVM's power supplies, see the circuit schematic at the end of this document.

2 Software Control

2.1 Installation Instructions

- Open the folder named AFE7070_Installer_vxpx (xpx represents the latest version).
- Run Setup.exe.
- Follow the on-screen instructions.
- Once installed, launch the software by clicking on the AFE7070_GUI_vxpx program in Start → Texas Instruments DACs
- When plugging in the USB cable for the first time, you are prompted to install the USB drivers.
 - When a pop-up screen opens, select *Continue Downloading*.
 - Follow the on-screen instructions to install the USB drivers
 - If needed, you can access the drivers directly in the install directory

2.2 Software Operation

The user interface is divided into two tabs, one containing controls for the AFE7070 and the other containing controls for the CDCM7005.

2.2.1 AFE7070 Controls

A screen shot of the AFE7070 tab is shown in [Figure 3](#).

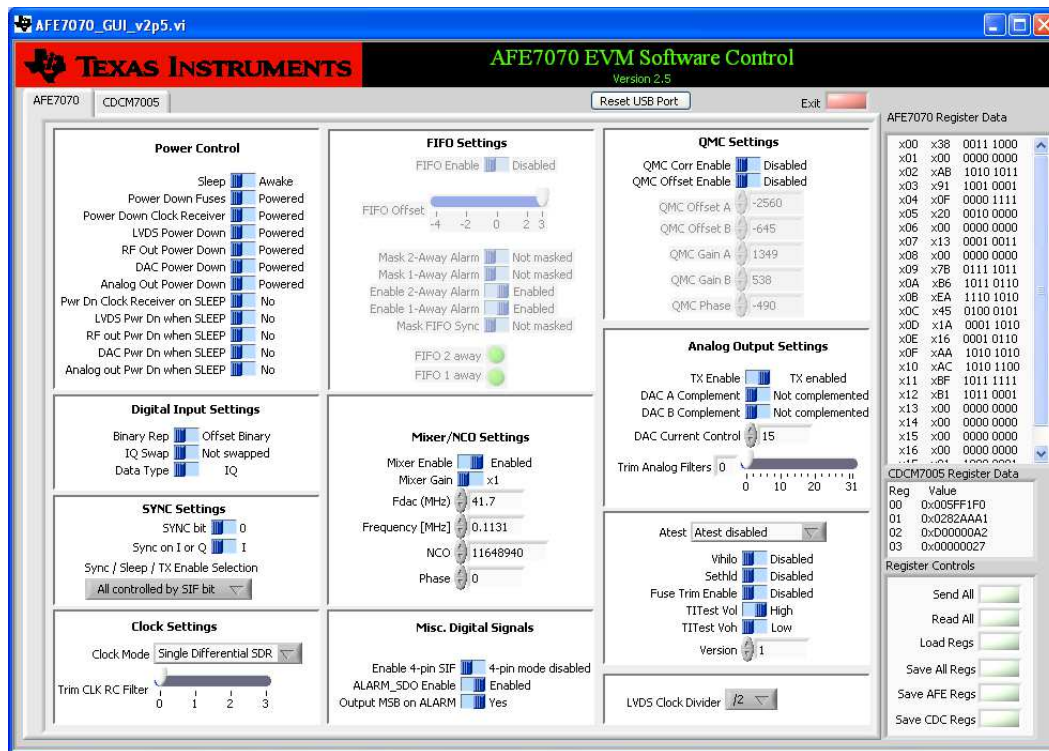


Figure 3. Screen Shot of AFE7070 Tab

The controls for the AFE7070 are divided into the following sections:

- **Power.** These controls consist of binary switches that toggle various power-down and sleep states.
- **SYNC Settings.** These settings control the device synchronization. The switch marked *Synchronize* corresponds to the SYNC bit in the AFE7070 register map, and activating this switch writes a 1 to this bit.
- **FIFO Settings.** This section is only active when the device is in Dual Input Clock mode. It controls the

FIFO pointer offset and various FIFO alarms.

- **Clock Settings.** This section allows the user to specify which clock mode is desired as well as trim the clock RC filter. Ensuring that the other AFE7070 settings and CDCM7005 settings are consistent with the choice of clock mode is important. For reference, the following is a summary of the relevant settings for each mode:
 - **Dual Input Clock** – Configure CLKIO on the CDCM7005 tab to be an active CMOS signal at either 1x or 2x the desired sampling rate. Set DACCLK to active, LVPECL levels, and 2x the desired sampling rate. Set the data type in the AFE7070 tab's *Digital Input Settings* section to either IQ or Phase data. Configure the FIFO as desired. Connect the CDC OUT output via the SMA to the TSW3100, and configure as an active CMOS output at the same frequency as DACCLK.
 - **Dual Output Clock** – In this mode, CLKIO is an output and must not be connected to the CDCM7005 (see [Section 1.4.2](#) for the necessary hardware modifications). DACCLK must be an active LVPECL clock at 2x the desired sampling rate. Set the data type in the AFE7070 tab's *Digital Input Settings* section to either IQ or Phase data. In this mode, the FIFO is disabled automatically.
 - **Single Differential DDR Clock** – CLKIO is not used in this mode, so it can be disabled in the CDCM7005 settings. An LVPECL-level DACCLK must be provided at 1x the desired sampling rate. Either IQ or Phase data is allowed, and the FIFO is disabled automatically. Connect the CDC OUT output to the TSW3100 by way of the SMA, and configure it as an active CMOS output at 2x the DACCLK frequency.
 - **Single Differential SDR Clock** – CLKIO is unused and can be disabled. Provide an LVPECL-level DACCLK at 1x the desired sampling rate. Only use this mode for Phase data. Connect the CDC OUT output to the TSW3100 by way of the SMA, and configure it as an active CMOS output at 1x the DACCLK frequency.
- **Mixer/NCO Settings.** Use these controls to enable or disable the AFE7070's mixer stage as well as adjust its frequency and initial phase. Note that the frequency values input must be the actual desired NCO frequency in MHz, not the value to be stored in the frequency registers. The AFE7071 does not have this function.
- **Digital Input Settings.** These controls affect the way the AFE7070 interprets its input data.
- **Misc. Digital Signals.** These controls affect the way the AFE7070 interprets other digital data. Note that the GUI generates SPI commands based on a 3-wire serial interface (SIF).
- **QMC Settings.** These controls allow the user to adjust QMC offset (to reduce carrier feedthrough) and gain/phase (to improve sideband suppression).
- **LVDS Clock Divider.** This section sets the divide ratio for the LVDS output. Note that this output's frequency can range from 100 MHz to 800 MHz.
- **Analog Output Settings.** These controls affect the internal DAC outputs. The full-scale current setting is 15. The *Trim Analog Filters* slider can adjust the corner frequency of the baseband low-pass filter. The maximum filter corner is 10 MHz.
- **Atest.** These controls activate various test modes and are not useful to most users.

2.2.2 CDCM7005 Controls

The CDCM7005 tab provides full programming control of the CDCM7005 device. [Figure 4](#) displays a screen shot of this tab. . Not all of the functions may be of interest in evaluating AFE7070 performance. The tab is divided into three sections:

- **Advanced Options.** These settings provide advanced control of the CDCM7005 device. Their functions are beyond the scope of this document. For a detailed description of these settings, consult the CDCM7005 data sheet ([SCAS793](#)).
- **Clock & PLL Options.** This section is only enabled when the CDCM7005 is in PLL mode and allows the user to specify (manually or automatically) the necessary M and N divider settings to produce a desired VCXO frequency output.
- **Output Options.** These controls allow configuration for various CDCM7005 outputs. The only outputs of interest are Y1 (the AFE7070's CLK_IO), Y3 (the AFE7070's DACCLK), and Y4 (CDC OUT, which can be used to provide a clock to the TSW3100). The user can specify the output levels (LVPECL or LVCMOS), a divide ratio, and whether or not each signal is active or high-impedance.

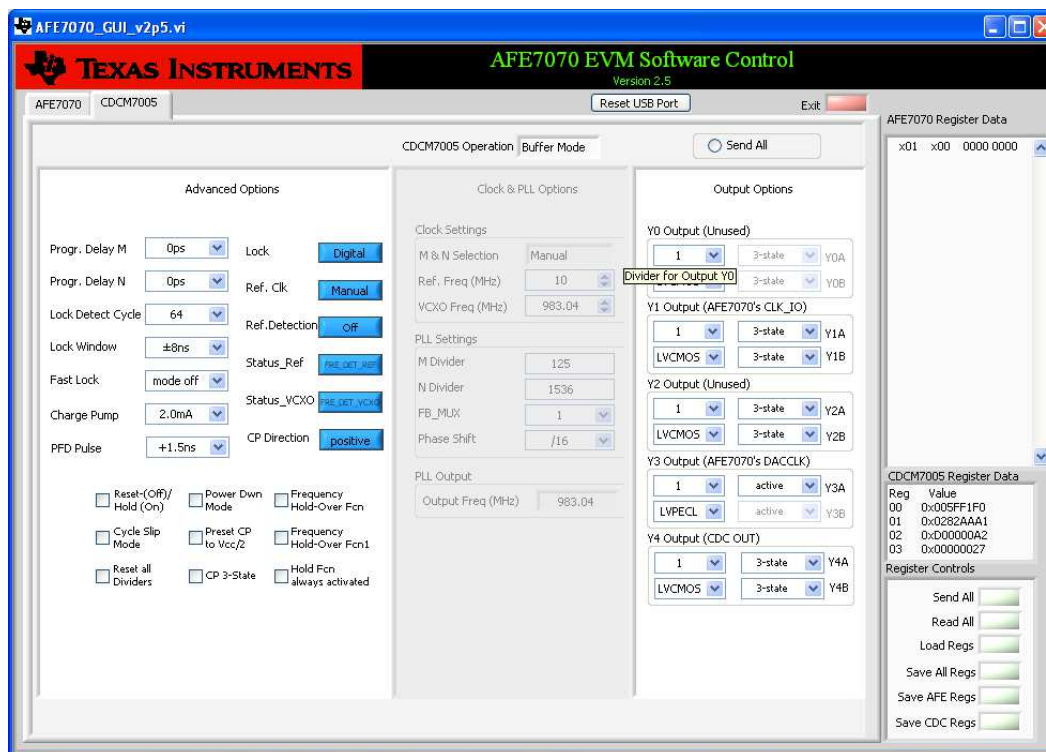


Figure 4. Screen Shot of CDCM7005 Tab

2.2.3 General GUI Controls

The following is a summary of the various other GUI controls:

- **Reset USB Port.** This button assigns a new handle for the USB connection. Use it whenever a device communication failure occurs.
- **One Shot.** This button can be enabled to run the program only once rather than as a loop.
- **Exit.** This button exits the GUI.
- **Display Pane.** This pane takes up most of the right side of the GUI and is used to display which register settings are being written to or read from the AFE7070.
- **Register Controls**
 - **Send All.** This command sends all the GUI settings to the AFE7070 and CDCM7005 registers.
 - **Read All.** This command reads back the register values of the AFE7070 and displays them in the display pane.
 - **Load Regs.** This command loads the contents of a text file into both the AFE7070 and CDCM7005 registers (as applicable).
 - **Save All Regs.** This command saves the AFE7070 and CDCM7005 register settings to a text file.
 - **Save AFE Regs.** This command saves the AFE7070 register settings to a text file.
 - **Save CDC Regs.** This command saves the CDCM7005 register settings to a text file.

3 Basic Test Procedure

This section outlines the basic procedure for testing the EVM.

3.1 Test Block Diagram

Figure 5 displays the test setup for general testing of the AFE7070 with the TSW3100 pattern generation card.

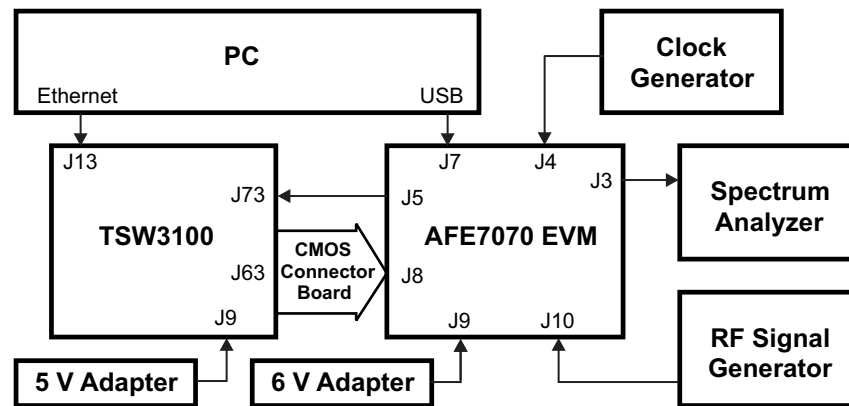


Figure 5. Test Setup Block Diagram

3.2 Test Setup Connections

- Connect the AFE7070EVM to the TSW3100:
 - Connect parallel CMOS outputs of TSW3100 to parallel CMOS inputs of the AFE7070EVM by way of a CMOS connector board such that J63 on TSW3100 connects to J8.
 - Connect the AFE7070EVM's CDC output (J5) to the TSW3100 CMOS clock input (J73).
- Connect proper dc power supplies to the TSW3100 and AFE7070EVM.
- Connect the TSW3100 to a personal computer's Ethernet port, and connect the AFE7070EVM to a USB port.
- Connect a clock signal to the AFE7070EVM's External Clock input (J4)
 - The frequency must be less than or equal to 65 MHz (or 130 MHz if a double-rate clock is needed such as in Dual Input Clock mode).
 - The signal amplitude must be between 1 V and 2.6 V peak-to-peak.
- Connect a signal generator to the AFE7070EVM's LO input (J10).
 - The frequency must be between 100 MHz and 2.7 GHz.
 - The input power must be between –5 dBm and 5 dBm.
- Connect RF output (J3) to spectrum the analyzer.

3.3 TSW3100 Quick-Start Operation

See the TSW3100 User's Guide ([SLLU101](#)) for more detailed explanations of the TSW3100 setup and operation. This document assumes the TSW3100 software is installed and functioning properly. The AFE7070EVM requires 16-bit, MSB-justified output from the TSW3100, so software version 2.7 or later is required. The front panel of the TSW3100 is shown in [Figure 6](#) and [Figure 7](#). Change the following registers from the default settings.

Multitone Setup from Default Configuration

- Change Sample Rate to equal DAC clock rate (i.e., 65 MSPS).
- Change the Resolution to 14.
- Select desired Tone Groups (i.e., Group 1: Tone BW = 1, # = 2, Tone Center = 2 for tones at 1.5 MHz and 2.5 MHz).
- Select CMOS output button.
- Check the *LOAD and Run*, *Interleaved*, and *16b MSB Justify* boxes.
- Press the green *Create and Save/Run TSW3100* button.

CommsSignalPattern Setup from Default Configuration (WCDMA)

- Change Interpolation value to DAC Clock Rate / 3.84 (i.e. 57.6 / 3.84 = 15).

- Change the Resolution to 14.
- Enter desired Offset Frequency (i.e., 0 MHz) for each desired carrier.
- Select the CMOS output button.
- Check the *LOAD and Run*, *Interleaved*, and *16b MSB Justify* boxes.
- Press the green *Create* button.

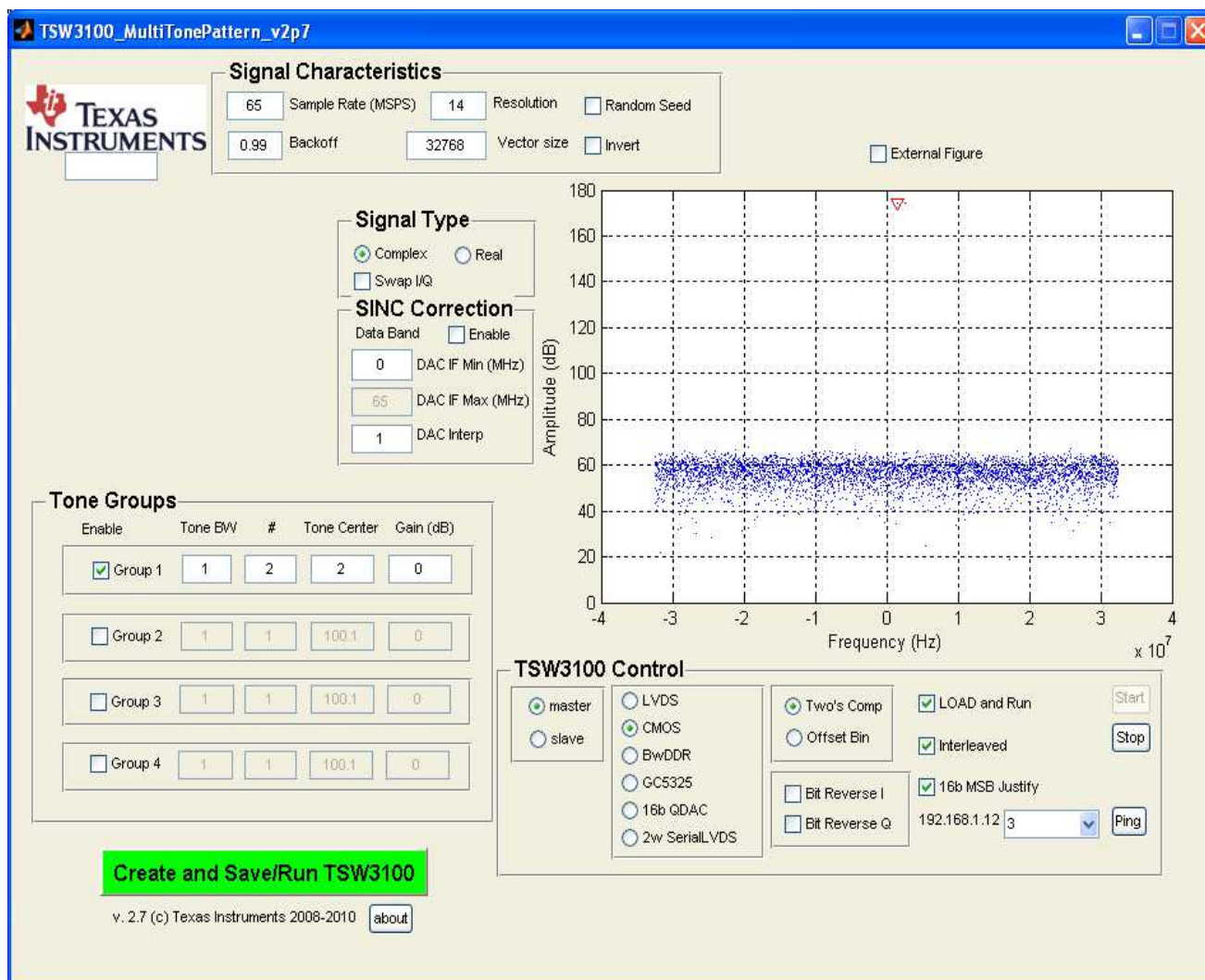


Figure 6. TSW3100 MultiTonePattern Programming GUI

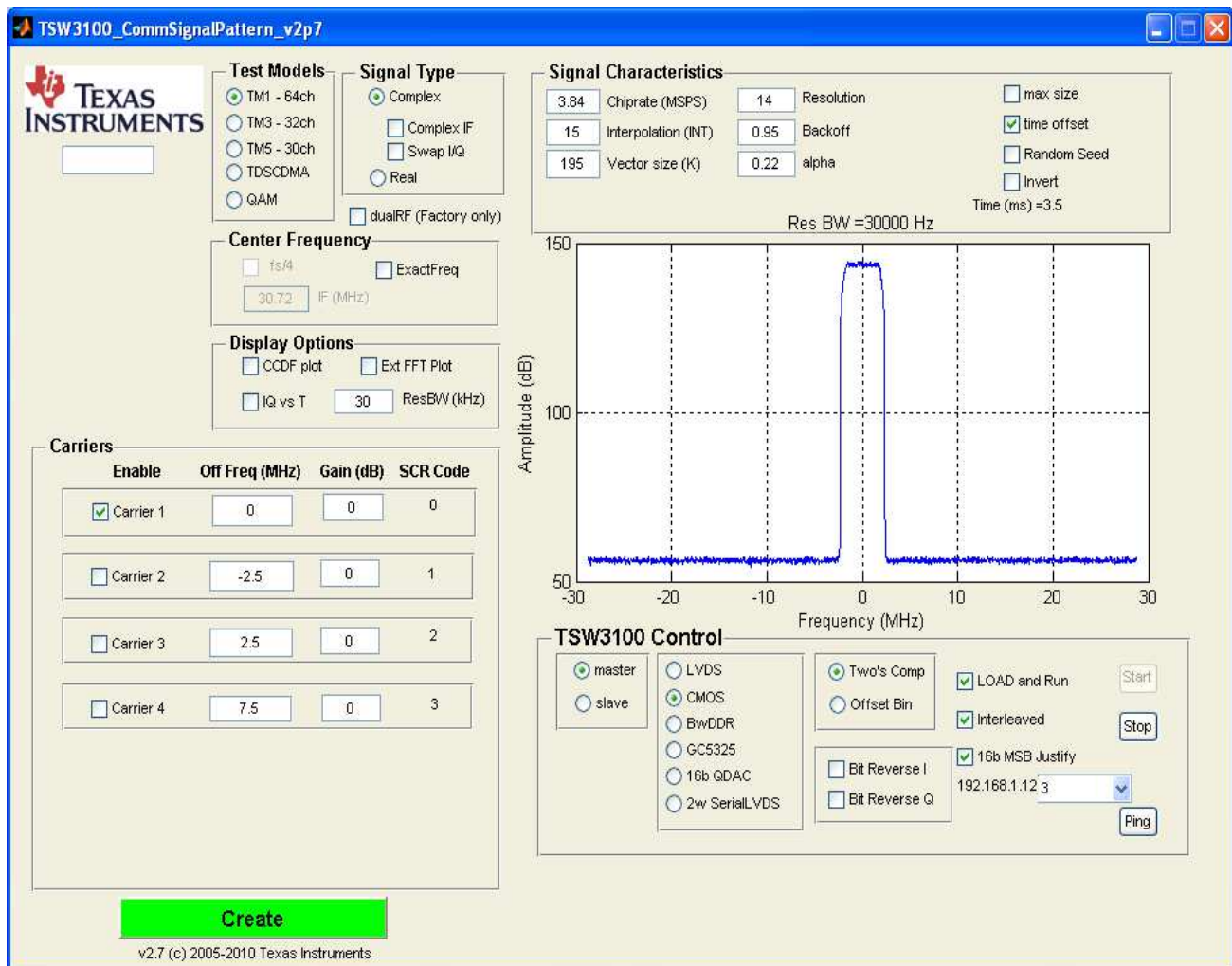


Figure 7. TSW3100 CommsSignalPattern (WCDMA) Programming GUI

3.4 AFE7070 Software Quick-Start Guide

- Select the AFE7070 tab, and press the *Reset USB Port* button.
- In the *Clock Settings* section, set the clock mode to *Dual Input Clock*.
- If the LVDS output is not connected to anything, disable it using the *LVDS Power Down* switch under the *Power* heading.
- Select the CDCM7005 tab to adjust the output clock signals:
 - Y1 (AFE7070's CLK_IO) must be LVCMOS, with Y1A set to active rather than 3-state.
 - Y3 (AFE7070's DACCLK) must be LVPECL, with both Y3A and Y3B set to active.
 - Y4 (CDC Out) must be LVCMOS, with Y4A set to active.
- Press the *Send All* button in the *Register Controls* section.
- Monitor the RF output signal on a spectrum analyzer.
- Monitor the output signal at the RF output connector. If the LO input frequency is set to 2 GHz and the digital inputs are configured to be tones at 1.5 MHz and 2.5 MHz, the RF output looks like two tones placed at 2001.5 MHz and 2002.5 MHz as seen in [Figure 8](#).

3.5 AFE7070 Performance Results

Figure 8 and Figure 9 shows the typical two-tone and ACPR performance of the AFE7070 EVM from the preceding setup.

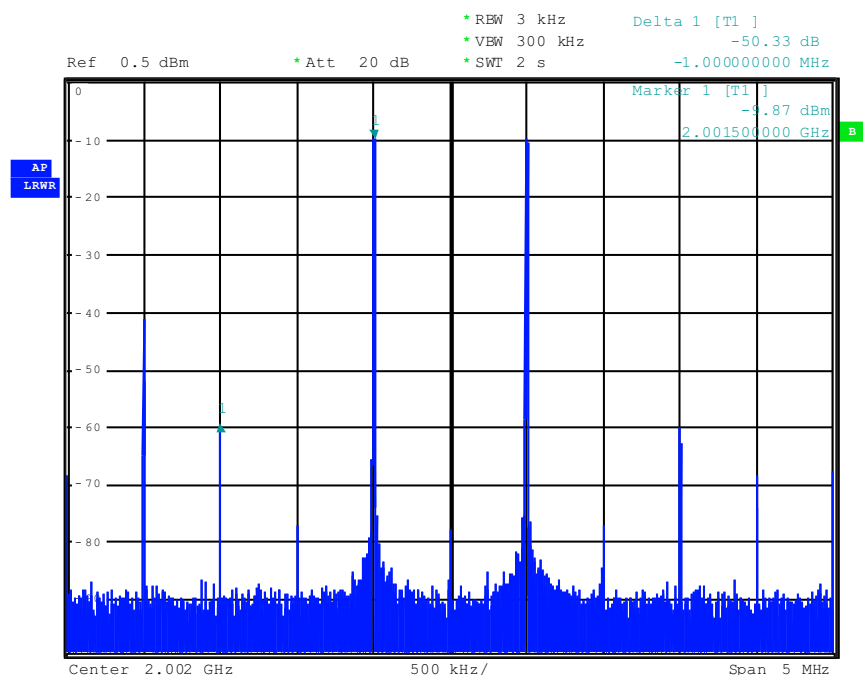


Figure 8. Two-Tone IMD Performance: LO = 2 GHz, DAC Rate = 65 MSPS, IF = 1.5 MHz and 2.5 MHz

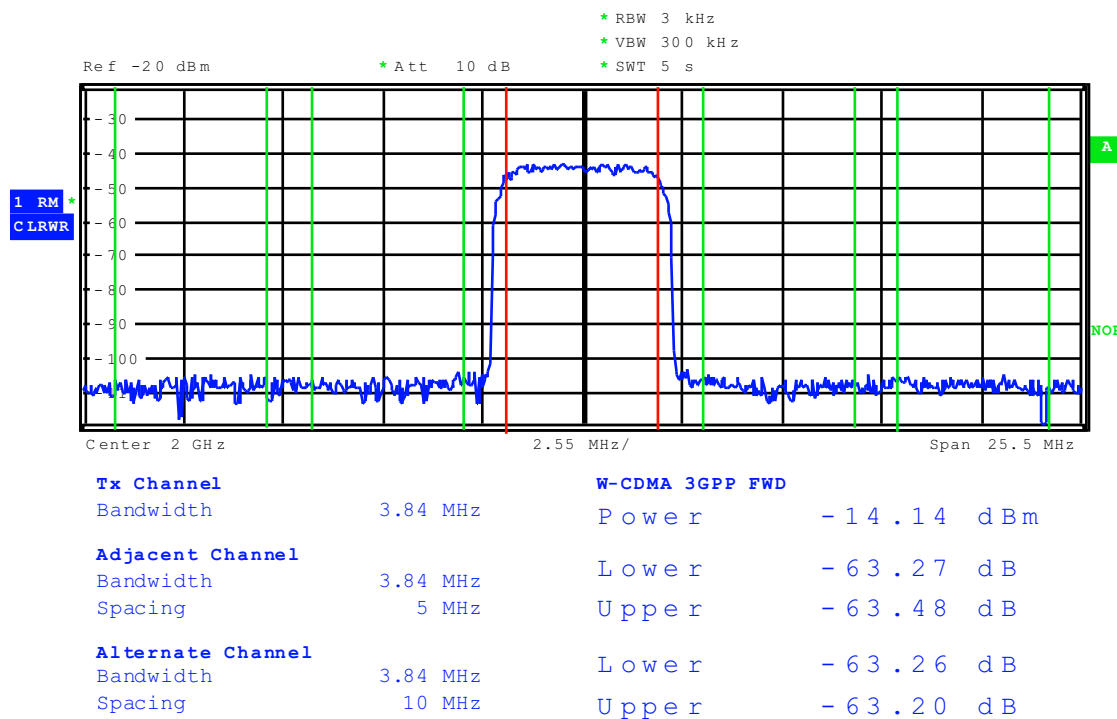


Figure 9. WCDMA ACPR: LO = 2 GHz, DAC Rate = 57.6 MHz, 0-MHz Offset

Note that some part-to-part variations can yield significantly improved two-tone IP3 or ACPR performance. The performance plots in this document show typical responses.

EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

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

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

General Statement for EVMs including a radio

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

For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant

Caution

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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

FCC Interference Statement for Class A EVM devices

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

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

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

Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concerning EVMs including detachable antennas

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

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

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

Concernant les EVMs avec appareils radio

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concernant les EVMs avec antennes détachables

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

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

【Important Notice for Users of this Product in Japan】

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

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

1. Use this product in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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

<http://www.tij.co.jp>

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東京都新宿区西新宿 6 丁目 2 4 番 1 号

西新宿三井ビル

<http://www.tij.co.jp>

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

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

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

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

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

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

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

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EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

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

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

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

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

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REGULATORY COMPLIANCE INFORMATION

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

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

General Statement for EVMs including a radio

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

For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant

Caution

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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

FCC Interference Statement for Class A EVM devices

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

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

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

Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concerning EVMs including detachable antennas

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

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

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

Concernant les EVMs avec appareils radio

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concernant les EVMs avec antennes détachables

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

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

【Important Notice for Users of this Product in Japan】

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

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

1. Use this product in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
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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.
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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 which meet ISO/TS16949 requirements, mainly for automotive use. Components which have not been so designated are neither designed nor intended for automotive use; and TI will not be responsible for any failure of such components to meet such requirements.

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