National *Semiconductor*

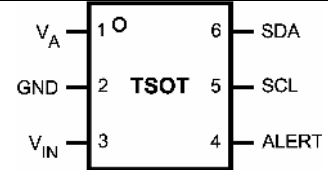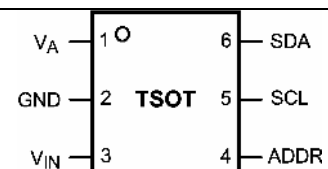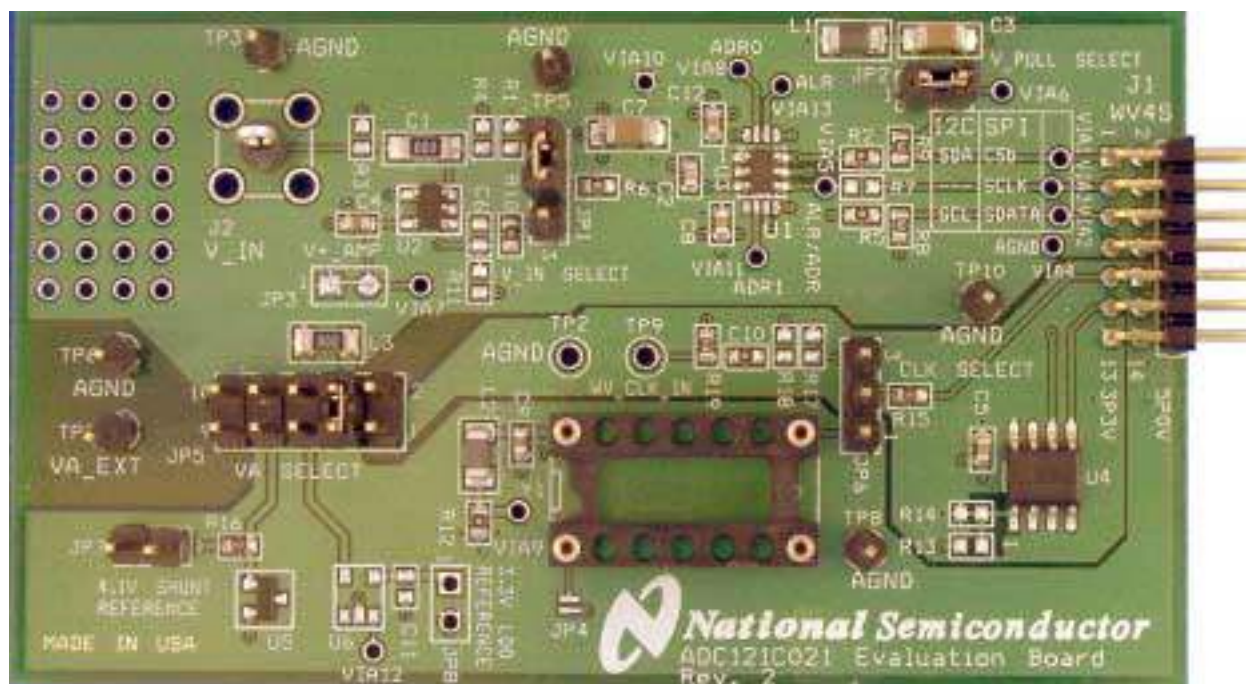January 3, 2008
Rev – 1.1/CC
RoHS Compliant

Evaluation Board User's Guide

I^2C-Compatible, 12-Bit, 10-Bit, or 8-Bit
Analog-to-Digital Converter (ADC) with Alert Function

	12-bit	10-bit	8-bit
ALERT Option V_A —1 SDA—6, GND—2 TSOT SCL—5, V_{IN}—3 ALERT—4	**ADC121C021**	**ADC101C021**	**ADC081C021**
ADDRESS Option V_A —1 SDA—6, GND—2 TSOT SCL—5, V_{IN}—3 ADDR—4	**ADC121C027**	**ADC101C027**	**ADC081C027**

NOTE: The Evaluation Board is shipped with the Alert Option of the ADC. To evaluate the Address Option, please order samples from www.national.com.

Table of Contents

1.0 Introduction

This Design Kit (consisting of the ADC Evaluation Board and this User's Guide) is designed to ease evaluation and design-in of National Semiconductor's ADC121C021 family of Analog-to-Digital Converters. The ADCs can operate at speeds up to 188.9 kSPS. The converter features an I^{2}C interface and an Alert function. This User's Guide supports all three resolutions and both package options of the ADC121C021 ADC family. All the devices in the family (ADC121C021, ADC121C027, ADC101C021, ADC101C027, ADC081C021, and ADC081C027) will be referred to as the ADC121C021 in this document. The ADCXX1C021 options offer an ALERT output pin, whereas, the ADCXX1C027 offers an address selection pin. The board comes stuffed with the ALERT option (ADCXX1C021). To evaluate the Address Option (ADCXX1C027) with this board, please go to www.national.com and order samples. Use care when de-soldering the ADC to ensure the pads of U3 are not damaged.

The evaluation board can be used in either of two modes. In Stand Alone, suitable test equipment such as a logic analyzer with a pattern generator can be used with the board to evaluate the ADC121C021's performance.

In the Computer mode, data capture and evaluation are simplified by connecting the evaluation board to National Semiconductor's WaveVision 4 Data Capture Board (order number WAVEVSN BRD 4.1 or higher) which connects to a personal computer through a USB port and runs WaveVision 4 software revision 4.4 or higher.

The latest version of the WaveVision 4 software should be downloaded from the web at http://www.national.com/adc.

Note: WaveVision software version 4.4 or higher is required to evaluate this part with the WV4 Evaluation System.

The WaveVision 4 software operates under Microsoft Windows. The signal at the analog input is digitized, captured, and displayed on a PC monitor in the time and frequency domains.

The software will perform an FFT on the captured data upon command. This FFT plot shows the dynamic performance in the form of SNR, SINAD, THD, SFDR, and ENOB. A software histogram of the captured data is also available. WaveVision also provides control of the ADC's internal registers through the WaveVision4 software.

The signal at analog input J2 is digitized by U3, the ADC121C021.
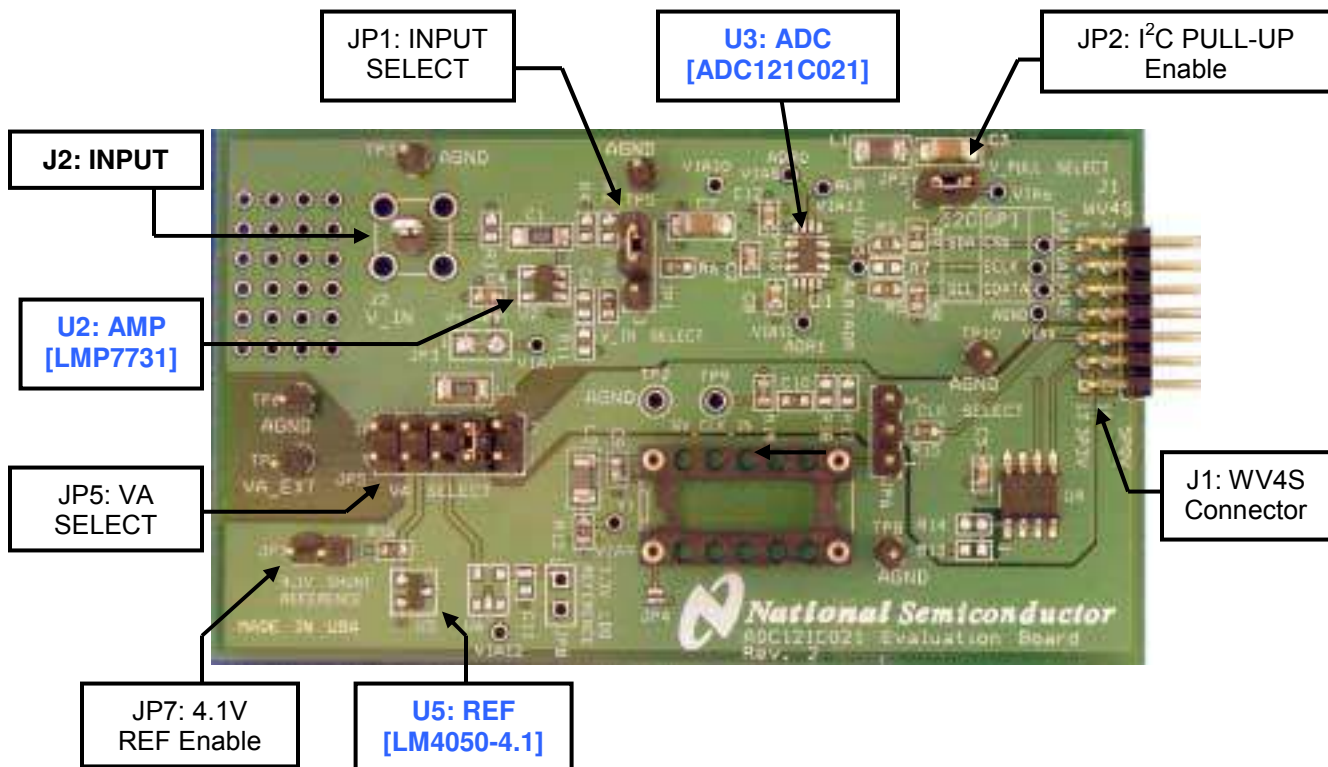

Figure 1: Component Locations

JP1: INPUT SELECT

U3: ADC [ADC121C021]

JP2: I^{2}C PULL-UP Enable

J2: INPUT

U2: AMP [LMP7731]

JP5: VA SELECT

JP7: 4.1V REF Enable

U5: REF [LM4050-4.1]

J1: WV4S Connector

2.0 Board Assembly

The ADC121C02XEB evaluation board comes fully assembled and ready for use. The provided jumpers are in their recommended locations and suit the needs of most users. Refer to the Bill of Materials for a description of components, to *Figure 1* for major component placement, and to *Figure 10* for the evaluation board schematic.

While the board has been populated in a manner that is most advantageous for typical usage, the board can be customized by adding components to meet the user's specific needs. The board comes ready to use with a DC coupled input signal (*Figure 2*). However, by adding DC bias resistors R1 and R4 (value 4.99kΩ), and changing C1 to a 1.0uF capacitor, the board can be used with an AC coupled input signal (*Figure 3*).
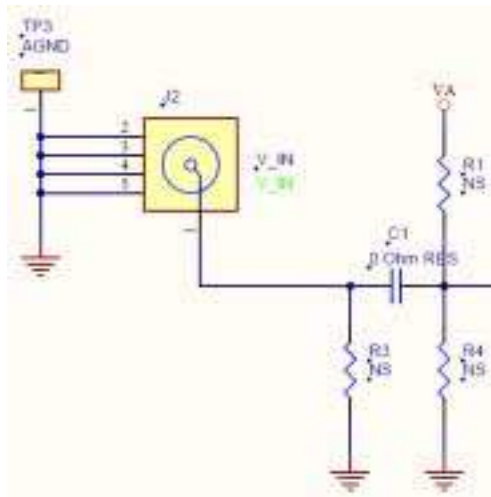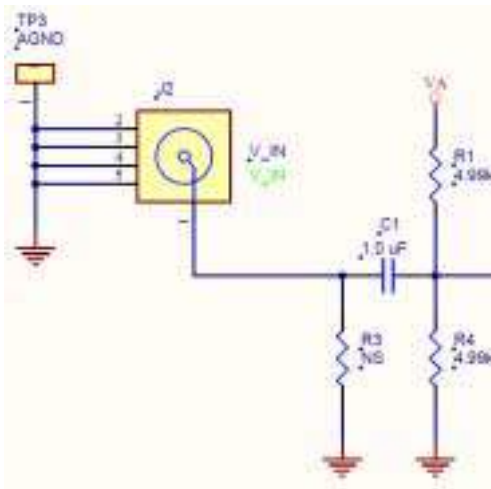
If needed, the input can be terminated by adding an appropriate termination resistor at R3. The V_IN footprint (J2) has been stuffed with a single-pin header for testing typical, slow-moving DC input signals. An SMA footprint is also included on the PCB and should be used for precise dynamic performance evaluation. The Bill of Materials (*Section 10*) lists an appropriate SMA connector to use.

The LMP7731 Low-noise, Precision Operational Amplifier is included on the ADC121C02XEB for convenient buffering of the analog input. By default, it is configured as a simple voltage follower (*Figure 4*). Resistors R10 and R11 can be modified to add non-inverting gain to the circuit. Adding capacitance at C6 configures the amplifier as a low-pass filter. To incorporate the input buffer into the signal path, short pins 2 and 3 of JP1.
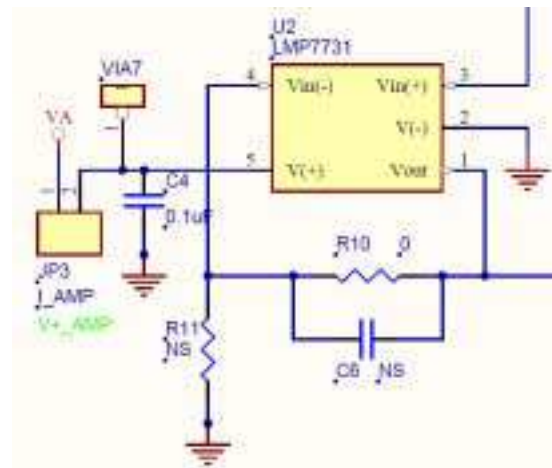

Figure 2: DC Coupled Input Configuration

Figure 4: Input Buffer Configuration

Figure 3: AC Coupled Input Configuration

The LM4050-4.1 Precision, Micropower, Shunt Voltage Reference is included on the ADC121C02XEB as a clean reference solution for the ADC. To evaluate the ADC using the LM4050, simply short pins 1 & 2 of JP7, and move the VA_SELECT jumper to pins 7 & 8 of JP5 (*Figure 5*).
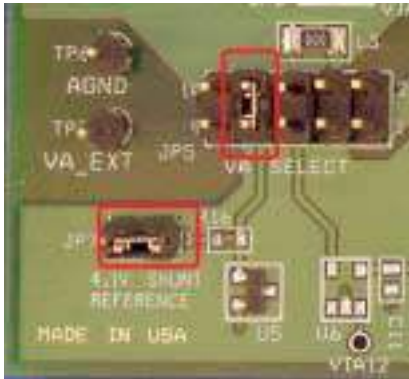

Figure 5: LM4050 Jumper Configuration

3.0 Quick Start

The ADC121C02XEB evaluation board may be used in the Stand Alone mode to capture data with a logic analyzer or third party equipment, or it may be used in the Computer Mode with a WaveVision 4 Data Capture Board, referenced throughout the remainder of this document as WV4. In both cases, the data may be analyzed with the WaveVision software.

3.1 Stand Alone Mode

Refer to *Figure 1* for locations of test points and major components.

1. The I^{2}C interface signals (SCL and SDA) may be driven directly at **J1** or with wires soldered to VIA1 and VIA2 (step 7). A fully-compliant I^{2}C interface analyzer should be used to drive SCL and SDA while monitoring the data output (SDA).

2. The board provides the option of adding 2kΩ pull-up resistors to the I^{2}C bus, SCL and SDA. To enable the pull-up resistors, short pins 1 & 2 of **JP2**. Assuming the I^{2}C analyzer has built-in pull-up resistors, the jumper at **JP2** must be removed to disable the on-board pull-up resistors. If the I^{2}C analyzer doesn't have built-in pull-up capability, leave **JP2** shorted.

3. Connect a clean analog (not switching) +5.0V power source with a 300mA current limit to power connector **TP7**. Ground **TP6**.

4. Move the shorting jumper at **JP5 to pins 9 & 10.** NOTE: only two consecutive pins may be shorted on JP5 at a time.

5. Turn on the power supply.

6. Connect the input signal to the test-point at J2. The input signal return can be connected to ground at TP3. Please note the evaluation board is assembled for a DC-coupled input source. The board is designed for an AC coupled input as well. Modifying the board for an AC coupled input is described above in *Section 2.0*. If the source has a 50 ohm output impedance, install a 51 ohm resistor at R3. To accurately evaluate the dynamic performance of the ADC121C021, the source must be better than 90dB THD.

7. If evaluating the ADC121C027, configure the I^{2}C slave address. The address is controlled by VIA5. With VIA5 left floating, the slave address of the ADC121C027 will be set to 50hex. Grounding VIA5 sets the address to 51hex. Connecting VIA5 to V$_A$ sets the address to 52hex.

8. If evaluating the ADC121C021, the slave address is permanently set to 54hex.

9. If evaluating the ADC121C021, the ALERT pin can be monitored at VIA5.

3.2 Computer Mode

Refer to *Figure 1* for locations of test points and major components. The board comes configured for "plug-and-play" WaveVision evaluation.

1. Run the WaveVision 4 program, version 4.4 or higher is required to interface to the WV4 board. While the program is loading, continue below.

2. Connect a USB cable between the WV4 board and the PC running the WaveVision 4 software.

3. Make the following required jumper connections, see *table 1* for more details:
   - **JP1** - pins 1 & 2
   - **JP2** - pins 1 & 2
   - **JP5** - pins 3 & 4 (All other pins of JP5 must be left open)

4. Connect the **J1** header on the ADC121C021 evaluation board to the WV4 serial connector (**J7**) on the WV4 board. Refer to *Figure 6* for the serial connection and *Figure 7* for the J1 header pin out.

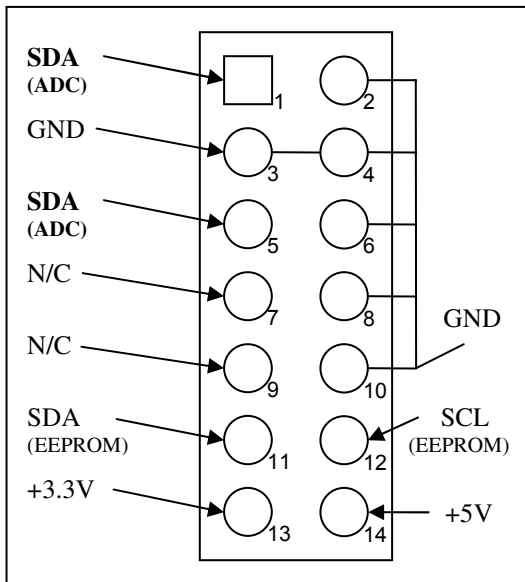**Figure 6: WV4 to ADC121C02XEB Connection**

Figure 7: J1 (WV4S) Header Pin Out

5. Perform step 6 of section 3.1 to drive the analog input. For information on changing the configuration of the analog input section, read S*ection 2.0* Board Assembly for details. The board comes ready for a DC coupled input signal.

6. Connect a clean (not switching) +5.0V power source with a 350mA current limit to power connector **J1** on the WV4 board. Turn on the power supply.

7. Refer to *Section 5.0* on Software Operation and Settings to setup the WaveVision 4 software.

4.0 Functional Description

4.1 Jumper Settings

Table 1 describes the function of the various jumpers on the ADC121C021 evaluation board. The evaluation board schematic is shown in *Figure 10*.

Jumper	Pins 1 & 2	Pins 2 & 3
JP1	Select direct V_{IN} circuit	Select Amplified V_{IN} circuit [LMP7731]
JP2	Enable I^{2}C Pull-up resistors	
JP3	*Permanently shorted*	
JP5	VA SELECT *(See Below)*	
JP6	*Not Used*	
JP7	Enable 4.1V Shunt Reference [LM4050-4.1]	

	Jumper JP5 (VA SELECT)
Pins 1 & 2	Select 3.3V regulated supply from WV4S connector. [LM1117MPX-3.3 on the WV4 board]
Pins 3 & 4	Select 5.0V supply from WV4S connector.
Pins 5 & 6	*Not Used*
Pins 7 & 8	Select 4.1V shunt reference supply. [LM4050-4.1]
Pins 9 & 10	Select external supply from TP7.

Table 1: Jumper Configurations

4.2 Analog Input Signal

There are three basic options for connecting an input signal to the ADC. The three options facilitate AC-coupled and DC-coupled input signals.

The first way to apply an input signal to the ADC is to connect it to pin 2 of JP1. The signal's return (GND) should be connected to TP5. This configuration provides the input circuit seen in Figure 8.
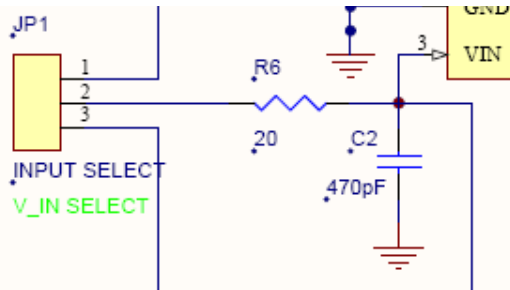

Figure 8: Unbiased input circuit.

The second way is to configure the board for an AC coupled input. DC biasing is available for inputs applied to J2 but is currently not populated on the board. By adding DC bias resistors R1 and R4 (value 4.99kΩ), and changing C1 to a 1.0uF capacitor, the board can be used with an AC coupled input signal (*Figure 3*). To improve the signal integrity of the connection to the board, an SMA connector should be stuffed at J2 (V_IN). If the input source has a 50Ω output impedance, a 51Ω resistor can be installed at R3.

The third way to configure the input is by incorporating the Amplifier into the signal path. The LMP7731 Low-noise, Precision Operational Amplifier is included on the board for convenient buffering of the analog input. By default, it is configured as a simple voltage follower (*Figure 4*). Resistors R10 and R11 can be modified to add non-inverting gain to the circuit. Adding capacitance at C6 configures the amplifier as a low-pass filter. To use the input buffer, simply move the JP1 jumper to pins 2 & 3.

In any case, it is important that the signal stays within the allowable input range of the ADC (0V to V_A). Dynamic input signals should be applied through a bandpass filter to eliminate the noise and harmonics commonly associated with signal sources. To accurately evaluate the performance of the ADC121C021, the source must be better than -90dBc THD.

4.3 ADC Reference Circuitry

The ADC121C021 family is internally referenced. Therefore, the Analog-to-Digital converter gets its reference from the analog supply (V_A). Hence, a clean analog supply must be used to guarantee the performance of the ADC.

4.4 I²C Interface

Please refer to section 1.7 of the ADC121C021 datasheet for a detailed description of the I²C interface.

The board is designed with I²C pull-up resistors on both the SDA and SCL lines (R8 & R9). These resistors are enabled by a single jumper (JP2) and can easily be added or removed from the I²C bus. Also, footprints for series resistors are designed into the board (R2 & R5). The board is shipped with 0Ω resistors which can be modified to provide series resistance if interfacing to a noisy I²C bus.

The SDA signal is accessible by soldering to VIA1 or connecting to pin 1 of the WV4S connector (J1). The SCL signal is accessible by soldering to VIA2 or connecting to pin 5 of J1.

The on-board pull-up resistors can be powered with an external supply by removing the jumper at JP2 and connecting the supply to pin 2 of JP2 or VIA6.

4.5 Alert Function

The ADC121C021 provides a programmable "out-of-range" Alert function. At the end of every conversion, the measured voltage is compared to the values in the V_{HIGH} and V_{LOW} registers. If the measured voltage violates either of these values, an alert condition occurs. The Over Range Alert flag in the Alert Status Register indicates the V_{HIGH} limit has been violated. The Under Range Alert flag indicated the V_{LOW} limit has been violated. If enabled, the alert condition is also propagated to bit15 of the Conversion Result Register and the ALERT output pin.

The Alert function is configured by writing to the ADC's internal registers. Refer to Section 1.6 of the Datasheet for a detailed description of the ADC's internal Registers.

Refer to *Section 1.8* of the Datasheet for a detailed description of the Alert function.

4.6 Automatic Conversion Mode

The Automatic Conversion Mode configures the ADC to continually perform conversions without receiving "read" instructions from the I^{2}C controller. It is activated by writing a non-zero value into the Cycle Time bits "D[7:5]" of the Configuration Register. Various automatic conversion rates are supported.

Refer to *Section 1.9* of the Datasheet for a detailed description of the Automatic Conversion Mode.

4.7 Power Supply Connections

The analog supply voltage (V_A) can range from +2.7V to +5.5V. The Evaluation system provides a handful of power supply options via the JP5 header (*see Table 1*). V_A can be driven by the LM4050-4.1 Shunt Reference, the LM1117MPX-3.3 LDO from the WV4 board, or an external supply. National recommends the LM4050 precision reference for the ADC121C021.

NOTE: In Computer mode, if V_A is driven with less than 3.3V in Computer mode, an external 3.3V pull-up supply is needed. This will ensure the 3.3V CMOS logic thresholds of the WaveVision4 board are met for SDA and SCL.

To use an external pull-up supply, remove the jumper at JP2 and connect the supply to pin 2 of JP2 or VIA6. An external pull-up supply will also improve the dynamic performance of the ADC.

Typical supply currents when applying an external supply to TP7 (VA_EXT) and performing ADC conversions are as follows:

- **For V_A = +3.3V, I = 8mA**
- **For V_A = +5.0V, I = 11mA**

Note: A majority of this current is for powering devices external to the ADC121C021 such as the pull-up resistors and the input amplifier.

When operating in the computer mode, the supply voltage for V_A can be applied externally or supplied directly by the WV4 board through J1. The external supply voltage is selected by placing a jumper across pins 9 & 10 of JP5, applying a power source with a 300mA current limit to TP7, and grounding TP6. To use the 5.0V supply directly from the WV4 board, place a shorting jumper across pins 3 & 4 of JP5. To use the 3.3V supply directly from the WV4 board, place a shorting jumper across pins 1 & 2 of JP5. To use the LM4050 4.1V Shunt Reference, place a shorting jumper across pins 7 & 8 of JP5. For the best performance, use a clean external supply.

When operating in Stand Alone mode, always use an external supply. Apply a +5.0V power source with a current limit of 100mA to TP7, ground TP6, and place a shorting jumper across pins 9 & 10 of JP5.

Note: The +3.3V required to power the EEPROM (U4) is obtained through J2 from the WV4 board. The EEPROM is used to identify the type of Eval Board connected to the WaveVision system in Computer Mode.

5.0 Software Operation and Settings

The WaveVision 4 software is included with the WV4 board and the latest version can be downloaded for free from National's web site at http://www.national.com/adc. WaveVision4 software version 4.4 or later is required to evaluate this device with the WaveVision system.

5.1 Software Quick Start

To install this software, follow the procedure in the WV4 Board User's Guide. Once the software is installed, run and set it up as follows:

1. Connect the WV4 board to the host computer with a USB cable.

2. From the WaveVision main menu, go to Settings and then Capture Settings to open the System Settings window (*Figure 9*) and select the following:

    - WaveVision 4 (USB)
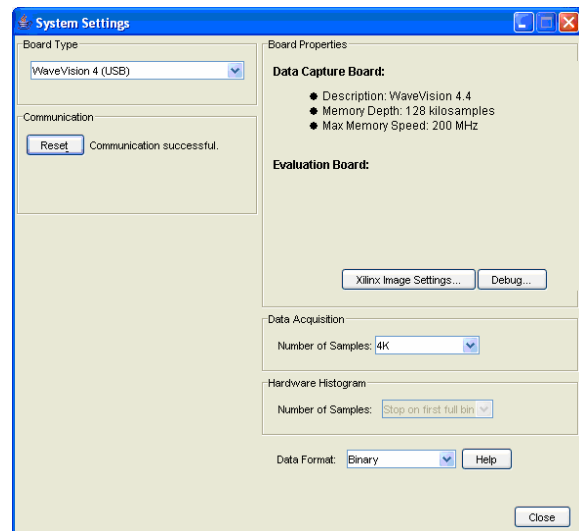   - Number of Samples: 2k to 128k, as desired
    - Data Format: Binary

Figure 9: System Settings window

3. Apply power as specified in Section 4.4, click on the **"Reset"** button and await the firmware to download.

4. Click on the **"Close"** button to close the System Settings window.

5. Navigate to the ADC121C021 Eval Board Window. This is the Control Panel for the device (*Figure 10*).

Figure 10: ADC121C021 Control Panel

6. Select the desired I^2C Speed from the pull-down menu (*Figure 11*).
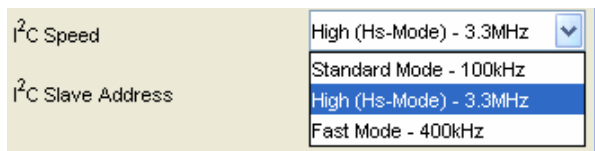

Figure 11: ADC121C021 Control Panel

7. Set the I^2C Slave Address (*Figure 10*). The address will default to the correct address for the ADC121C021 (54hex). If evaluating the ADC121C027, the I^2C address must be changed to reflect the state of the address selection pin (ADDR).

8. Press the "Read Registers" button. All of the register fields will update (*Figure 10*).

9. Configure the ADC's internal registers. The Alert function and Automatic Conversion Mode are setup through the Configuration register. After making changes to a register value, press the Enter key to write the register (*Figure 10*).

10. To capture a dataset from the ADC, navigate back to the main WaveVision window.

11. After the steps outlined in Section 3.2 are completed, click on 'Acquire' then 'Samples' from the Main Menu (you can also press the *F1* shortcut key). If a dialog box opens, select 'Discard' or press the *Escape (Esc)* key to start collecting new samples.

5.2 Data Analysis

WaveVision main menu will display an output plot. Make sure there is no clipping of data samples. Click on the software histogram tab and ensure data does not exceed the limits of the device. The samples may be further analyzed by clicking on the magnifying glass icon, then clicking and dragging across a specific area of the plot for better data inspection (*Figure 12*). See the WaveVision 4 Board User's Guide for more details.
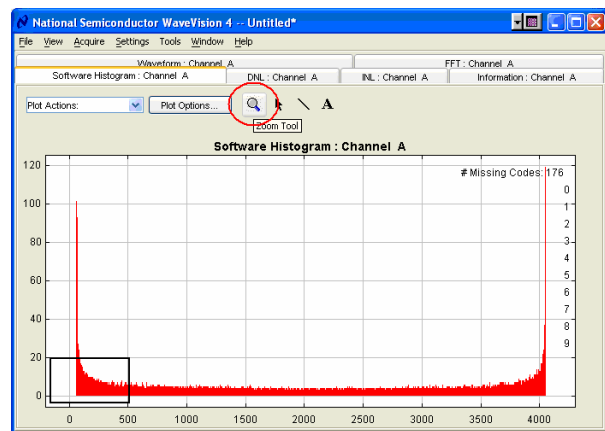

Figure 12: Software Histogram: Sine Wave Input

To view an FFT of the data captured, click on the 'FFT' tab. This plot may be zoomed in on the data plot. A display of dynamic performance parameters in the form of SINAD, SNR, THD, SFDR and ENOB will be displayed at the top right hand corner of the FFT plot (*Figure 13*).
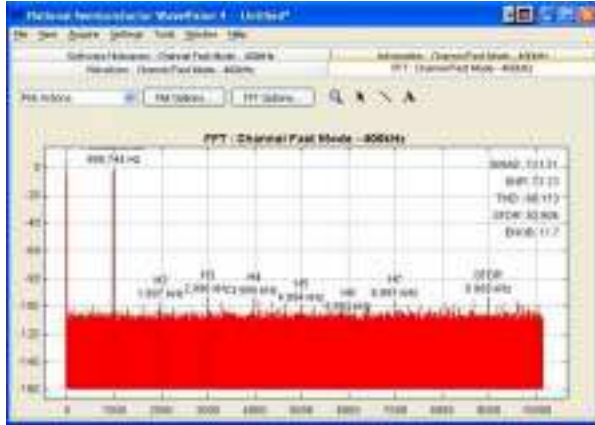

Figure 13: FFT: 1kHz Sine Wave Input

Acquired data may be saved to a file. Plots may also be exported as graphics. See the Data Capture Board User's Guide for details.

5.3 Register Control

The ADC's internal registers are controlled through the ADC121C021 Control Panel (*see Figure 7*). WaveVision allows both read and write access to these registers. To read the registers, simply click the "Read All" button in the Control Panel window. Each of the registers is read and displayed in the control panel. To write to a register, simply type in the 8-bit or 16-bit hex value to be written to the register and press Enter. All hex values are assumed to be right justified. Zeros are written to unspecified bits.

Many functions of the ADC121C021 are enabled through the internal registers. Please refer to *Section 1.6* on Internal Registers in the Datasheet for further details.

For example, the following steps will enable the ALERT pin, set the V_{LOW} threshold to ¾ full-scale, and create an Under Range Alert condition.

-Write 0x04 to the Configuration register.
-Write 0xBFF to the V_{LOW} register.
-Ground the analog input (V_{IN}).
-Click the "Read Registers" button to read all the registers.
-The Alert Status register will read 01hex to indicate that the V_{LOW} value was violated and an Under Range Alert condition has occurred.

5.4 Troubleshooting WaveVision

5.4.1 Problems

Problem 1: The "ADC121C021 Eval Board" Control Panel appears briefly, but disappears after powering on the WaveVision board. Try Solutions A, B, and C. After trying these solutions, the WaveVision system must be hard reset to recover. Press SW1 on the WV4 board to reset the system.

Problem 2: The following error occurs when I try to acquire data samples. Try Solution D.

Problem 3: The following error occurs when I try to read or write registers through the Control Panel. Try Solution D.
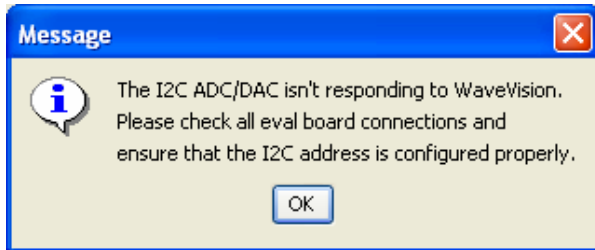
Problem 4: One of the following errors occurs when I try to read or write registers through the Control Panel. "java.lang.Exception: A USB …CMD_REG_RW … while sending bulk read."

"An exception occurred. Control Panel…"

Try Solutions A, B, and C. After trying these solutions, the WaveVision system must be hard reset to recover. Press SW1 on the WV4 board to reset the system.

Problem 5: The Eval Board is not recognized correctly in the System Settings Window (*Figure 9*). Try Solutions D and E.

5.4.2 Solutions

Solution A: Ensure power is supplied to the V_A supply on the board. A **single** jumper must be placed across either pins 1&2, pins 3&4, pins 7&8, or pins 9&10 of JP5 to select the board's power source. If using the Shunt Reference, pins 1&2 of JP7 must be shorted. The V_A supply is measured by probing VIA10.

Solution B: Ensure the pull-up resistors are powered (R8 and R9). In Computer mode, JP2 must be shorted by a jumper for the WaveVision software to work properly.

Solution C: Ensure the board is firmly connected to the WV4 board via the WV4S connector (J1). See *Figure 6*.

Solution D: Ensure the I^2C Slave address is set correctly in WaveVision. If evaluating the ADC121C021, the address must be set to 0x54. If evaluating the ADC121C027, the address will be 0x50 if no user modifications have been made to the board and ADDR is floating. If ADDR is tied to GND, the address must be set to 0x51. If ADDR is tied to V_A, the address must be set to 0x52.

Solution E: Ensure the 3P3V supply is connected to the 3.3V regulated supply from the WV4 board. The 3P3V supply is measured by probing pin 1 of JP5. Test this with a volt-meter. The EEPROM (U4) must be powered with 3.3V for WaveVision to work properly.

6.0 Evaluation Board Specifications

Board Size:	3.1" x 1.85" (7.9 cm x 4.6 cm)	
Power Requirements:	Min: +2.7V, 10mA	Max: +5.5V, 13mA
I2C Interface Speed:	100 kHz, 400kHz, or 3.4 MHz	
Analog Input Range:	GND to V_A	

7.0 Test Points, Connectors, and Jumpers

Test Points on the ADC121C021 Evaluation Board

TP2: AGND	Ground. Located at the center of the board.
TP3: AGND	Ground. Located at the top left of the board.
TP5: AGND	Ground. Located at the top middle of the board.
TP6: AGND	Ground. Located at the left side of the board.
TP7: VA_EXT	External Power supply input. Located at the left side of the board.
TP8: AGND	Ground. Located at the bottom right of the board.
TP9: WV_CLK_IN	*Not Used.*
TP10: AGND	Ground. Located at the right side of the board.

Connectors on the ADC121C021 Evaluation Board

J1: WV4S	14 pin dual row right angle male header: Connects to WV4 board.
J2: V_IN	Analog Input of the Eval Board.

Selection Jumpers on the ADC121C021 Evaluation Board (Refer to *table 1* in Section 4.0 for configuration details)

JP1: V_IN SELECT	Selects buffered or unbuffered signal path.
JP2: V_PULL SELECT	Enables the on-board I^2C pull-up resistors.
JP3: V+_AMP	Permanently shorted. Connects V_A to the V+ supply of the Amplifier.
JP4: OSC_ENABLE	*Not Used.*
JP5: VA SELECT	Selects the V_A source (See section 4.4)
JP6: CLK SELECT	*Not Used.*
JP7: VA_EXT_SHUNT	Enables the 4.1V Shunt Reference. Connects the 5P0V supply to the reference circuit.
JP8: VA_EXT_LDO	*Not Used.*

8.0 Hardware Schematic

Figure 10: ADC121C021 Evaluation Board Schematic

9.0 Evaluation Board Layers

Figure 11: ADC121C021 Evaluation Board: All Layers with Silk Screen

Figure 12: ADC121C021 Evaluation Board: Top Layer

Figure 13: ADC121C021 Evaluation Board: Bottom Layer

10.0 Evaluation Board Bill of Materials

Qty	Reference	Value	Description	Source	Source Part #	Manufacturer	Manufacturer Part #
1	C1	0 Ohm R	0 Ohm RES				
1	C2	470pF	CAP				
2	C3,C7	10.0uF	CAP	Digikey	511-1463-1-ND	Kemet	
5	C4,C5, C8,C12	0.1uF	CAP				
1	C6,C11	NS	CAP				
1	C9	1.0uF	CAP				
1	C10	0 Ohm R	0 Ohm RES				
1	JP1	INPUT SELECT	JUMPER	Digikey	A26513-40-ND		
1	JP2	V_PULL	JUMPER	Digikey	A26513-40-ND		
1	JP3	NS	JUMPER				
1	JP4	NS	JUMPER				
1	JP5	VA SEL	JUMPER	Digikey	A26529-40-ND		
1	JP6	CLK SELECT	JUMPER	Digikey	A26513-40-ND		
1	JP7	VA_EXT_SHUNT	JUMPER	Digikey	A26513-40-ND		
1	JP8	NS	JUMPER				
1	J1	WV4S	HEAD	Digikey	S5803-07-ND	Sullins	PRPN072PARN-RC
1	J2	V_IN	TP Center Via of SMA	Digikey	5011K-ND		
2	L1,L2	100uH	IND	Digikey	490-1056-1-ND	Murata	BLM31PG121SN1L
1	L3	0 Ohm R	0 Ohm RES				
9	R1,R3,R4, R7,R11, R13,R14, R17,R18	NS	RES				
4	R2,R5, R10,R12	0	RES				
1	R6	20	RES				
2	R8,R9	2K	RES				
2	R15,R19	51	RES				
1	R16	500	RES				
1	TP2	AGND	TP		NS		
2	TP3,TP6	AGND	TP	Digikey	5011K-ND		
3	TP5,TP8, TP10	AGND	TP	Digikey	Single-pin Header		
1	TP7	VA_EXT	TP	Digikey	5011K-ND		
1	TP9	WV_CLK_IN	TP		NS		
1	U1	ADC121C021	ADC -TSOT6			NSC	ADC121C021CIMK
1	U2	LMP7731	AMP-SOT23-5			NSC	LMP7731MF
1	U3	NS	MSOP8				
1	U4	24C02	EEPROM				
1	U5	LM4050-4.1	SHUNT REF			NSC	LM4050AIM3-4.1
1	U6	NS	LDO-SOT23-5			NSC	LM4132AMF-3.3
12	VIA1-13	NS					
1	Y1	OSC (Socket)		Digikey	A400-ND	Aries	08-3518-10

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2. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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,

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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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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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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