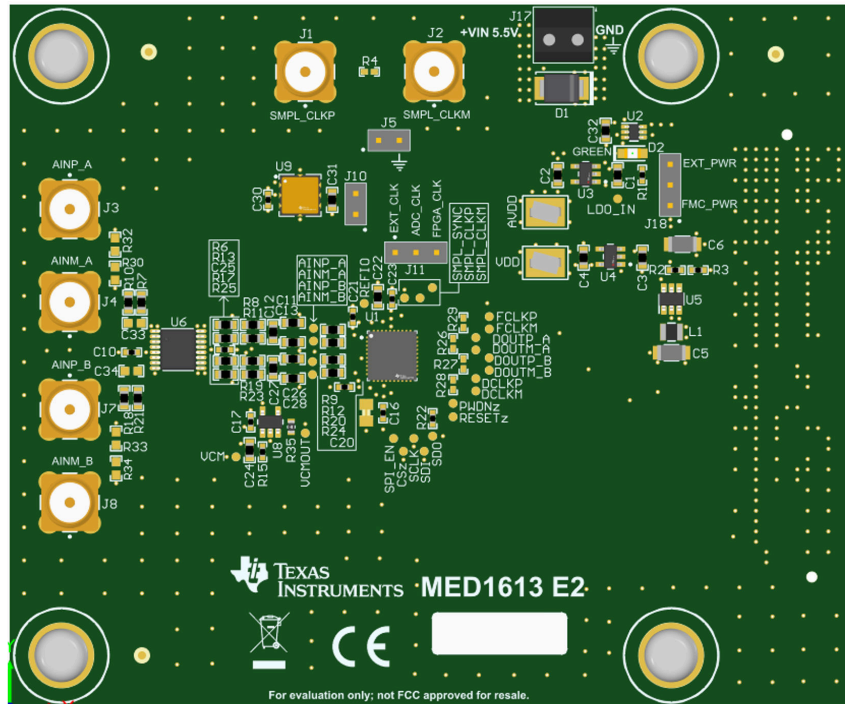


# ADS9218EVM-PDK Evaluation Module



## ABSTRACT



This user's guide describes the characteristics, operation, and use of the ADS9218EVM-PDK evaluation module (EVM) performance demonstration kit (PDK). This kit is an evaluation platform for the ADS9218, which is an 18-bit, 10-MSPS, fully differential input, successive approximation register (SAR) analog-to-digital converter (ADC) that features a low-voltage differential signaling (LVDS) digital interface. The EVM-PDK also includes an adapter printed circuit board (PCB) that facilitates connection to a standard FPGA mezzanine card (FMC) connector used in many field-programmable gate array (FPGA) kits. The EVM-PDK eases the evaluation of the ADS9218 device with hardware, software, and computer connectivity through the universal serial bus (USB) interface. This user's guide includes complete circuit descriptions, schematic diagrams, and a bill of materials (BOM). Throughout this document, the terms *demonstration kit*, *evaluation board*, *evaluation module*, *EVM*, and *EVM-PDK* are synonymous with the ADS9218EVM-PDK.

## Table of Contents

<b>1 Overview</b> .....	3
1.1 ADS9218EVM-PDK Features.....	3
1.2 ADS9218EVM Features.....	4
<b>2 Analog Interface</b> .....	5
2.1 ADS9218 Device Connections.....	5
2.2 ADC Differential Input Fully Differential Amplifier (FDA).....	6
2.3 Common Mode Amplifier Drive.....	7
2.4 Voltage Reference.....	7
<b>3 Digital Interface</b> .....	8
3.1 Clock Connection.....	9
<b>4 Power Supplies</b> .....	10
<b>5 ADS9218EVM Software Installation</b> .....	11
<b>6 EVM Operation</b> .....	13
6.1 USB Driver Installation.....	13
6.2 Connecting the Hardware and Starting Software.....	14
6.3 Optional Connections to the EVM.....	16
6.4 Initial Required Setup on the <i>Config</i> Tab.....	17
6.5 Initial Required Setup on the <i>Capture</i> Tab.....	18
<b>7 Bill of Materials, Schematics, and Layout</b> .....	19
7.1 Bill of Materials (BOM).....	19
7.2 Schematics.....	21
7.3 Layout.....	24
<b>8 Revision History</b> .....	25

## List of Figures

Figure 1-1. System Using GUI and TSWDC155EVM.....	3
Figure 1-2. System Using FMC to VITA57 and FPGA Kit.....	4
Figure 1-3. ADS9218EVM Block Diagram.....	4
Figure 2-1. Connections to ADS9218.....	5
Figure 2-2. FDA Driver Schematic.....	6
Figure 2-3. Common-Mode Amplifier Drive.....	7
Figure 2-4. Voltage Reference.....	7
Figure 3-1. FMC Connector Signals Definition.....	8
Figure 3-2. Clock Connection.....	9
Figure 4-1. Boost Converter, LDO, and Input Polarity Protection.....	10
Figure 5-1. Initial Software Installation.....	11
Figure 5-2. Installation Process.....	12
Figure 6-1. Open Windows Device Manager.....	13
Figure 6-2. Update Driver with Device Manager.....	13
Figure 6-3. Connecting the Hardware.....	14
Figure 6-4. Start the Software GUI.....	15
Figure 6-5. Optional Connections.....	16
Figure 6-6. Initial Required Setup on the <i>Config</i> Tab.....	17
Figure 6-7. Initial Required Setup on the <i>Capture</i> Tab.....	18
Figure 7-1. ADS9218EVM ADC Connections, Amplifiers, and Reference Schematic.....	21
Figure 7-2. ADS9218EVM Power Section.....	22
Figure 7-3. ADS9218EVM Connector to TSWDC155EVM.....	23
Figure 7-4. ADS9218EVM Layout.....	24

## List of Tables

Table 1-1. Related Documentation.....	3
Table 7-1. Bill of Materials.....	19

## Trademarks

Microsoft® and Windows® are registered trademarks of Microsoft Corporation.  
All trademarks are the property of their respective owners.

## 1 Overview

The ADS9218EVM-PDK is a platform for evaluating the performance of the ADS9218 SAR ADC, which is a fully differential input, 18-bit, 10-MSPS device. The evaluation kit includes the ADS9218EVM board and an FMC connector adapter board used to interface the ADC with many FPGA kits. The TSWDC155EVM (sold separately) is a digital controller board that can be used with this evaluation kit and the EVM software GUI to communicate with the device, graph measured results, and compute common figures of merit (such as SNR and THD).

The following related documents are available for download through the Texas Instruments web site at [www.ti.com](http://www.ti.com).

**Table 1-1. Related Documentation**

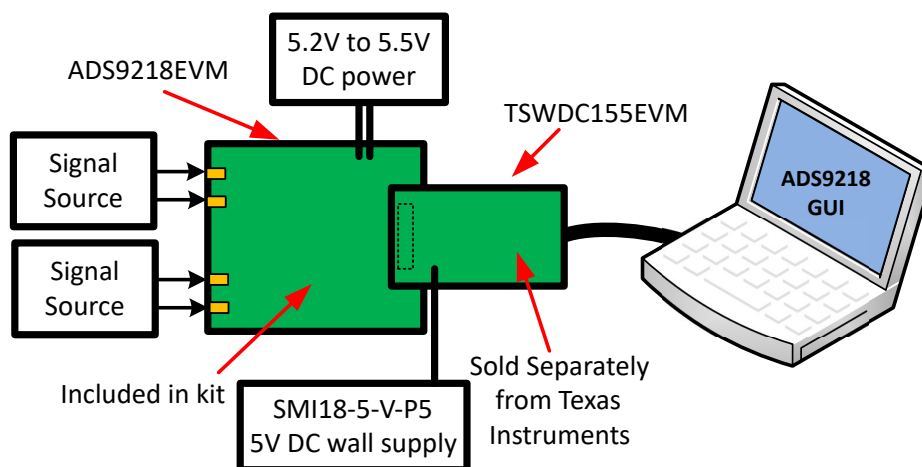
Device	Literature Number
THS4552	<a href="#">SBOS831</a>
REF7040	<a href="#">SNAS781</a>
TPS61070	<a href="#">SLVS510</a>
TPS7A20	<a href="#">SBVS338</a>
LM66100	<a href="#">SLVSEZ8</a>

### 1.1 ADS9218EVM-PDK Features

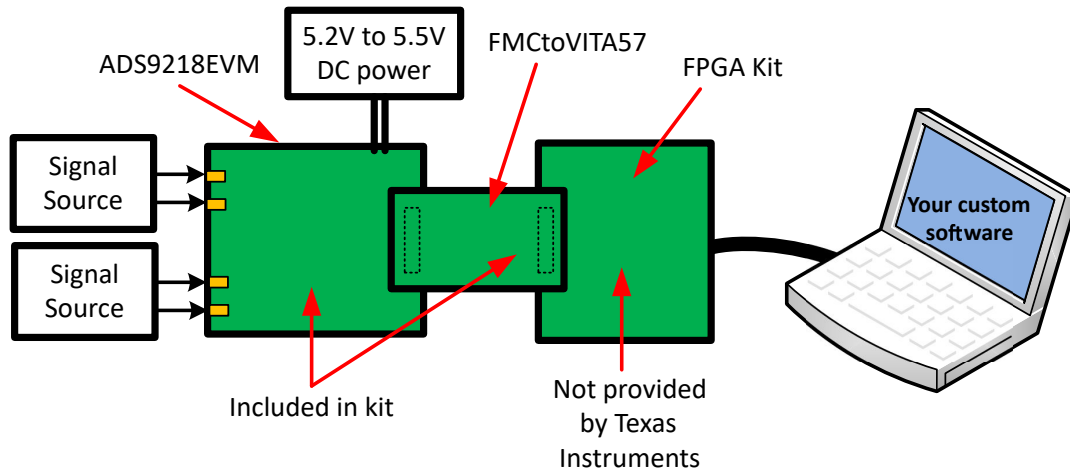
The ADS9218EVM-PDK includes the following features:

- Hardware and software required for diagnostic testing and accurate performance evaluation of the ADS9218 ADC
- The FMC connector adapter board facilitates connection to common FPGA kits
- The TSWDC155EVM controller (sold separately) requires a separate 5-V, 2-A power source; the ADS9218EVM requires a separate 5.5-V, 1-A power source
- The TSWDC155EVM controller (sold separately) provides a convenient communication interface to the ADS9218 ADC over USB 3.0 (or higher) for power delivery and for digital inputs and outputs
- Easy-to-use evaluation software (no cost) for Microsoft® Windows® 10, 64-bit operating systems requires the TSWDC155EVM (sold separately) for operation
- The software suite (no cost) includes graphical tools for data capture, histogram analysis, spectral analysis, SNR, and THD

Figure 1-1 and Figure 1-2 illustrate two different system configurations available for use.



**Figure 1-1. System Using GUI and TSWDC155EVM**



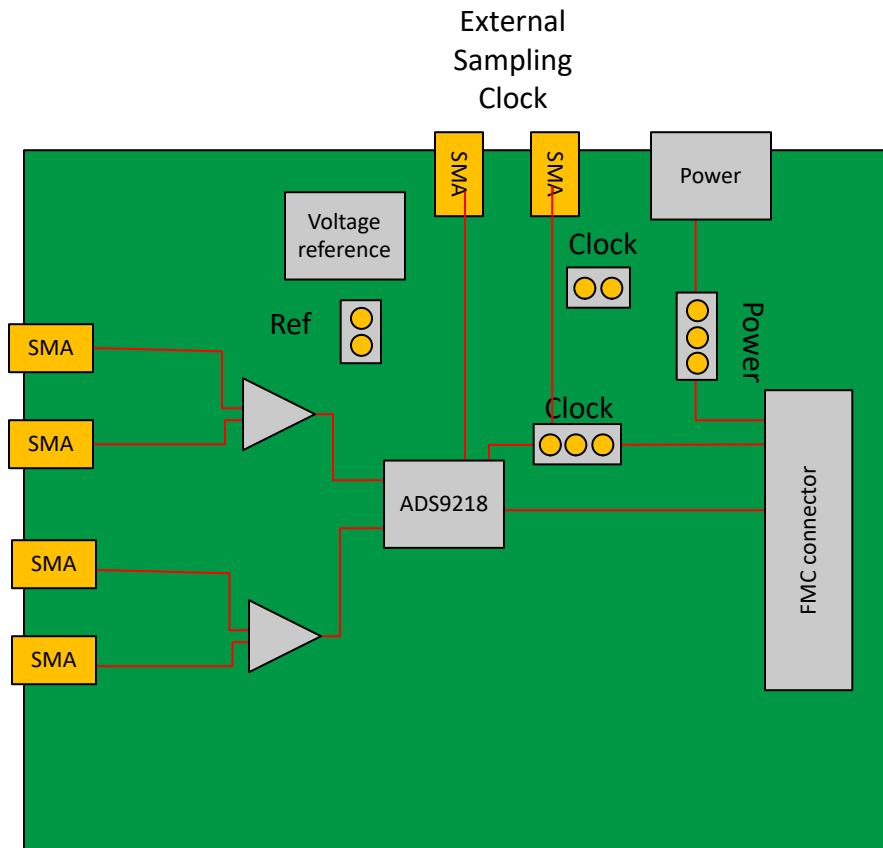
**Figure 1-2. System Using FMC to VITA57 and FPGA Kit**

## 1.2 ADS9218EVM Features

The ADS9218EVM includes the following features:

- Onboard low-noise and low-distortion ADC input drivers optimized to meet ADC performance
- Onboard precision 4.096-V voltage reference onboard ultra-low noise low-dropout (LDO) regulators for 5.0-V analog supply and 1.8 V for the digital supply
- Subminiature version A (SMA) connections for external clock or clock provided via FMC connector

Figure 1-3 shows a block diagram for the ADS9218EVM.



**Figure 1-3. ADS9218EVM Block Diagram**

## 2 Analog Interface

As an analog interface, the evaluation board uses fully differential amplifiers (FDAs) to drive the ADS9218 input signals. The ADS9218 includes an integrated voltage reference, but an external reference can be used and is jumper selectable on the hardware. This section covers driver details, including jumper configuration for different input signal options.

### 2.1 ADS9218 Device Connections

The digital communications lines for the ADC (shown in Figure 2-1) all follow the low-voltage differential signaling (LVDS) standard and are connected with optional termination resistors. A digital serial peripheral interface (SPI) port is used to configure registers in the device. The SDO output line includes a termination.

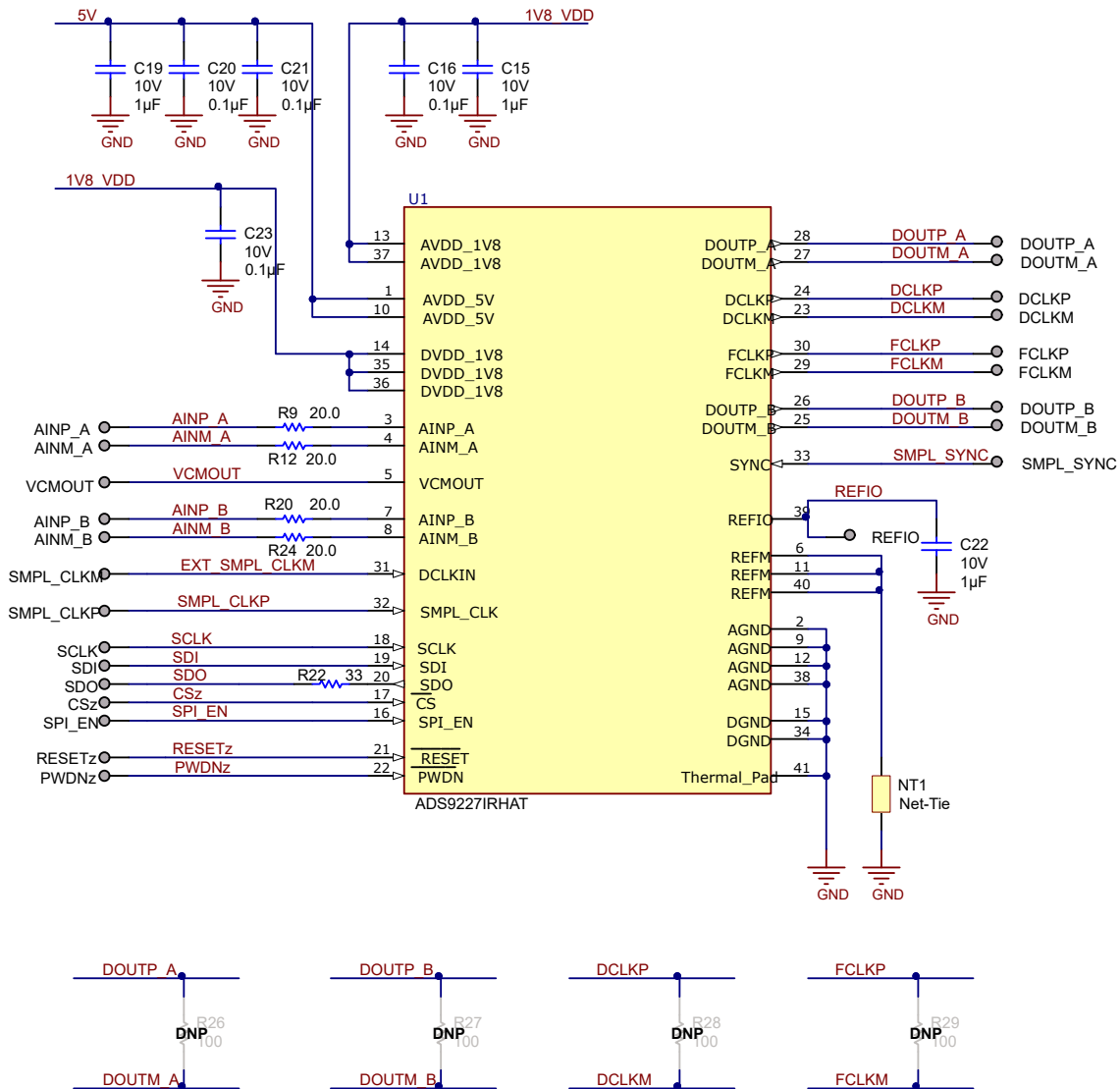


Figure 2-1. Connections to ADS9218

## 2.2 ADC Differential Input Fully Differential Amplifier (FDA)

The THS4552 FDA is used to amplify the input signals applied to the SMA connector. The amplifier is a dual configuration for the two different ADC channels. Each channel is configured with the same discrete feedback components. The amplifier gain is set to 1 V/V and the bandwidth is set to 500 kHz for good performance up to 100 kHz. The [ADS9218 Power Optimized Signal Chain Circuit](#) reference design covers component selection and can help adjust component values for different optimizations.

Figure 2-2 shows a schematic of the FDA driver components.

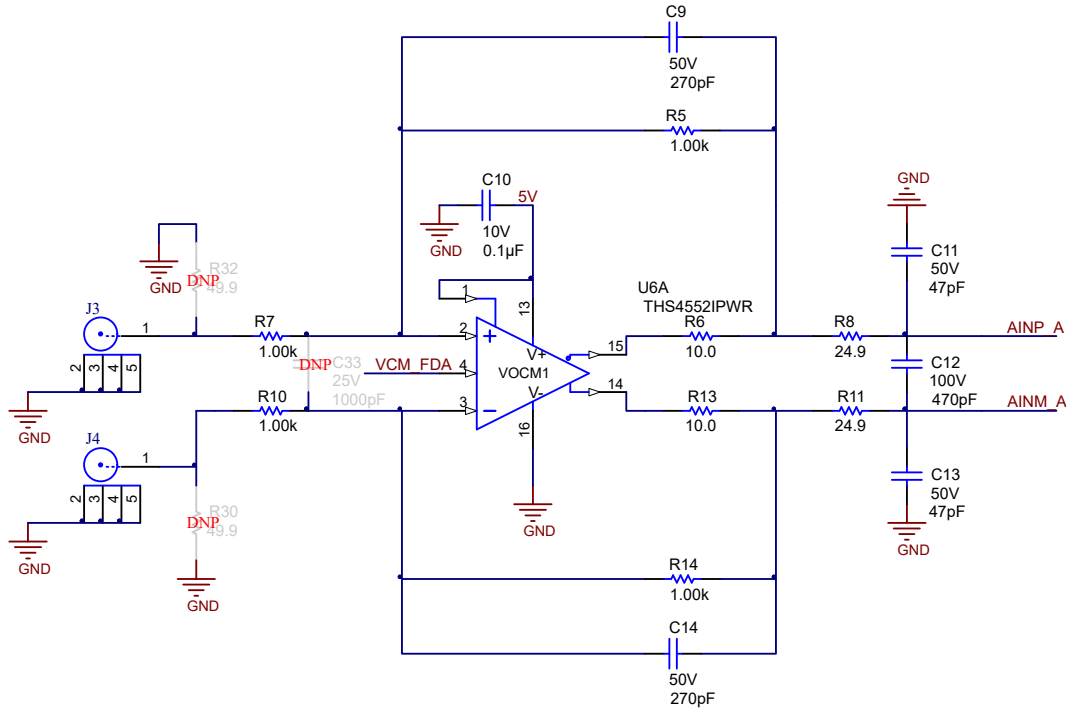


Figure 2-2. FDA Driver Schematic

### 2.3 Common Mode Amplifier Drive

The ADS9218 has a common-mode output pin (VCMOUT). The common-mode signal must be buffered to drive the THS4552 common-mode input pin. Figure 2-3 shows an example of the buffer circuit. R35 bypasses the amplifier and is not populated. When R35 is populated, U8 is unpopulated so that the ADC VCMOUT pin directly drives the FDA VCM input.

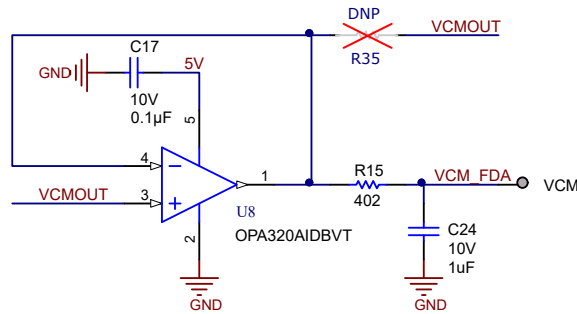


Figure 2-3. Common-Mode Amplifier Drive

### 2.4 Voltage Reference

As shown in Figure 2-4, the REF7040 is a very low-drift, low-noise, highly stable 4.096-V reference. This reference can externally drive the REFIO pin of the ADS9218 by installing jumper J10. Alternatively, J10 can be removed and the ADS9218 can use the internal voltage reference.

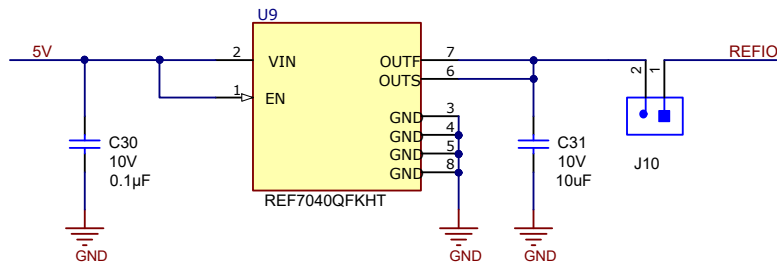


Figure 2-4. Voltage Reference

### 3 Digital Interface

The ADS9218 uses an SPI interface to configure the registers (SCLK, SDI, SDO, CS, and SPI\_EN). The ADS9218 uses two LVDS interfaces for capturing conversion data for each ADC channel (DOUTP\_A, DOUTM\_A, DOUTP\_B, and DOUTM\_B). The SPI and LVDS signals connect to the FMC connector. The FMC connector signal definition is given in Figure 3-1. These signals are also available on tented via test points for scope measurements. Top overlay text indicates the location of these test points.

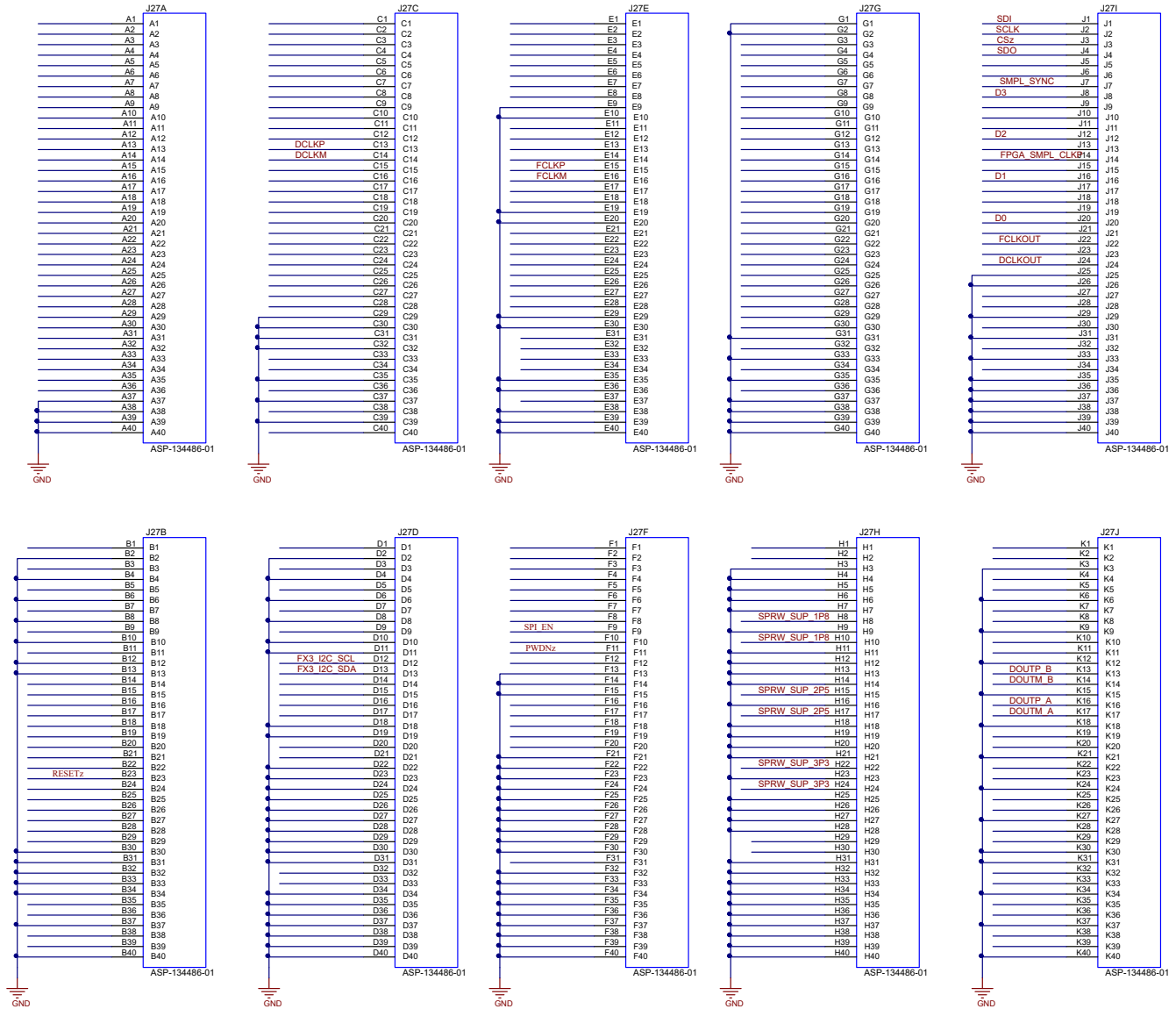
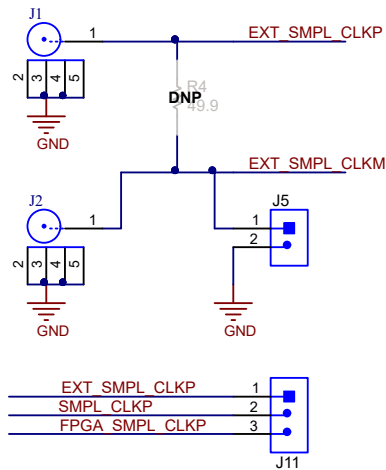


Figure 3-1. FMC Connector Signals Definition



### 3.1 Clock Connection

The EVM allows for an external differential clock, an external single-ended clock, or a clock signal from the TSWDC155EVM controller card. Jumper J11 selects either the external clock or a clock from the TSWDC155EVM. J5 grounds the negative clock if a single-ended clock is applied. Figure 3-2 shows the clock connection circuit.



**Figure 3-2. Clock Connection**

## 4 Power Supplies

The TSWDC155EVM can provide power using the 3.3-V supply, but is not enabled by default on the TSWDC155EVM. Typical use requires external power on J17. The TSWDC155EVM provides the ADS9218EVM with a 3.3-V supply. The ADS9218EVM has a TPS61070 boost converter that boosts the 3.3-V supply to 5.4 V. This voltage is applied to low-dropout regulators (LDOs) to derive the AVDD and the DVDD supply. The TPS7A2050 provides the 5-V AVDD supply and the TPS7A2018 provides the 1.8-V DVDD supply. The required power connection is made through jumper J18 can be set to allow external power to be applied on screw terminal J17. In this case U2, an LM66100 device, provides reverse polarity protection if the connection is miswired. Figure 4-1 shows a schematic for various protection circuits.

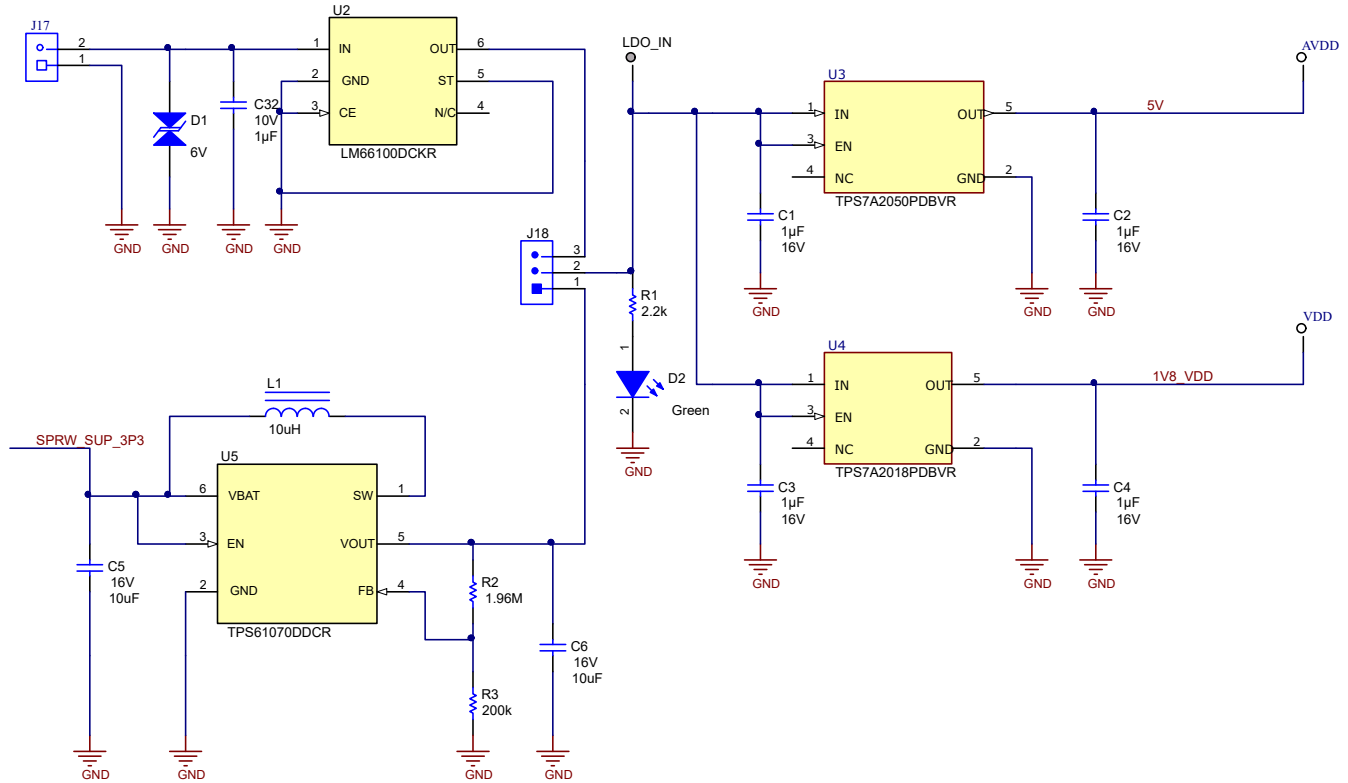
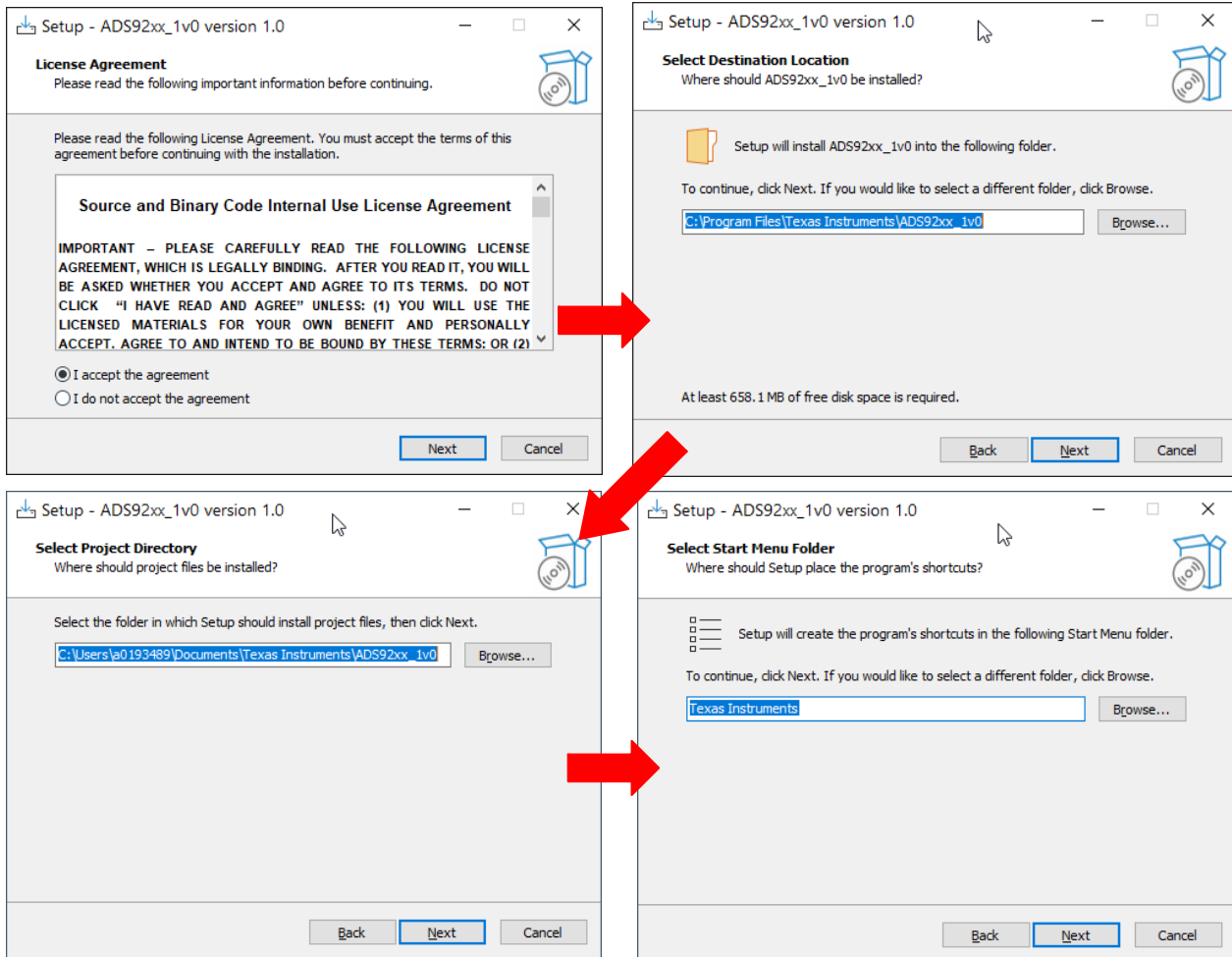


Figure 4-1. Boost Converter, LDO, and Input Polarity Protection

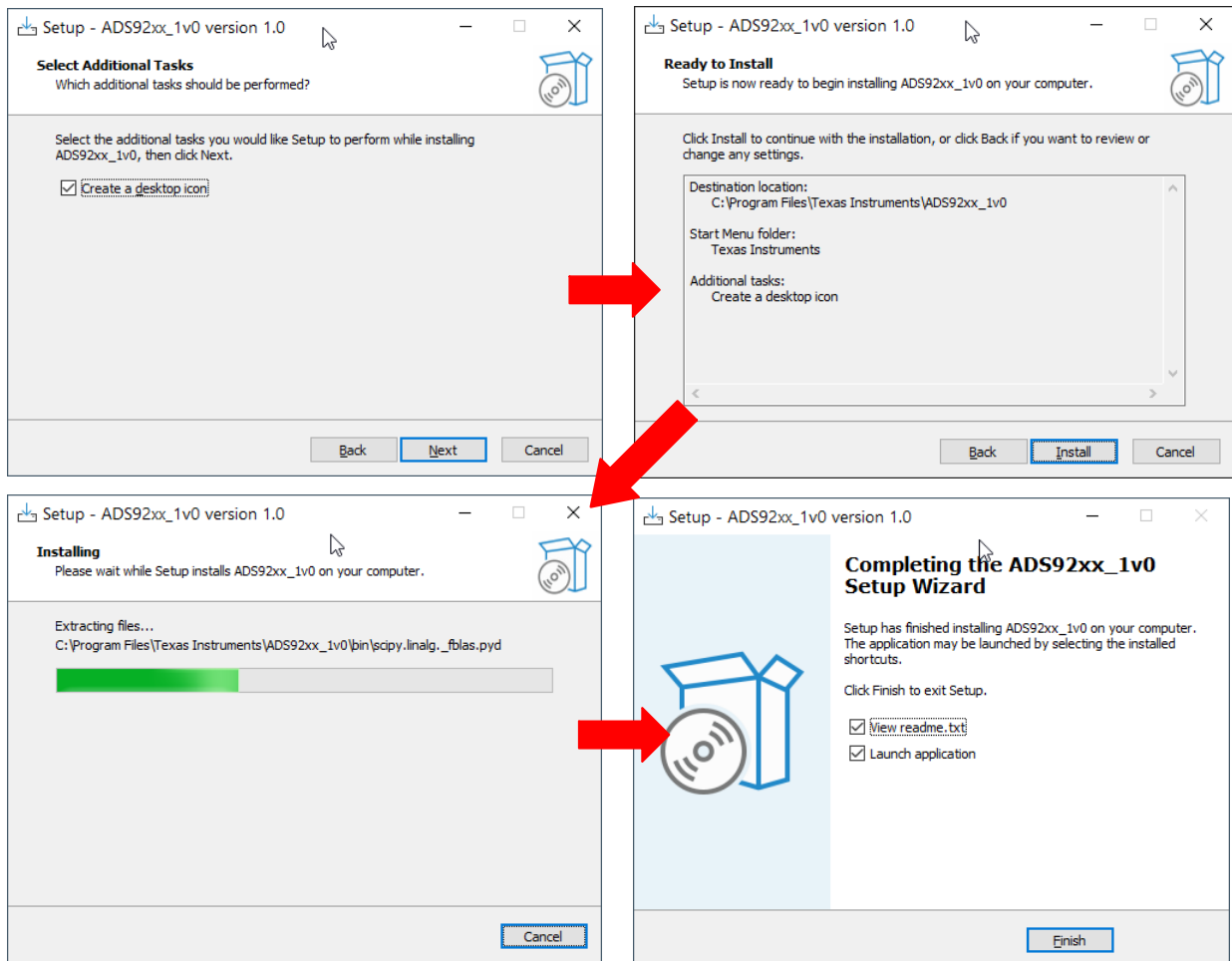
## 5 ADS9218EVM Software Installation

This section covers the installation and operation of the ADS9218EVM software graphical user interface (GUI). This software requires the TSWDC155EVM (sold separately) controller to operate. The first steps to installing the software (as shown in [Figure 5-1](#)) is to download the latest version of the EVM GUI installer from the *Tools and Software* folder of the ADS9218EVM, and run the GUI installer to install the EVM GUI software on your computer. Accept all the license agreements and choose the destination location, project directory, and start menu. Typically, the default values work, but you can customize these values as needed based on your requirements.



**Figure 5-1. Initial Software Installation**

Next, the installer prompts you to create a desktop icon and summarize the installation plan. Pressing **Install** begins copying software onto your computer. This process takes a few minutes. At completion, you can launch a readme text file and the application. [Figure 5-2](#) shows these steps.



**Figure 5-2. Installation Process**

## 6 EVM Operation

### 6.1 USB Driver Installation

This section describes the steps for installing the USB driver.

1. For the TSWDC155, connect J8 to the workstation using a USB-C to USB-A cable
2. Open the Windows® Device Manager, as shown in Figure 6-1, and right-click on the *WestBridge* folder in the Device Manager window and select the *Update Driver* button (see Figure 6-2)
3. In the next window that appears, select *Browse my computer for driver software*
4. Then select *Let me pick from a list of available drivers on my computer* in the next pop-up window
5. Click on *Have Disk* in the pop-up window and navigate to *C:\Program Files\Texas Instruments\ADS92xx\bin\proj\_lib\Sparrow\Bootloader* (see Figure 6-2).



Figure 6-1. Open Windows Device Manager

### Device Manager

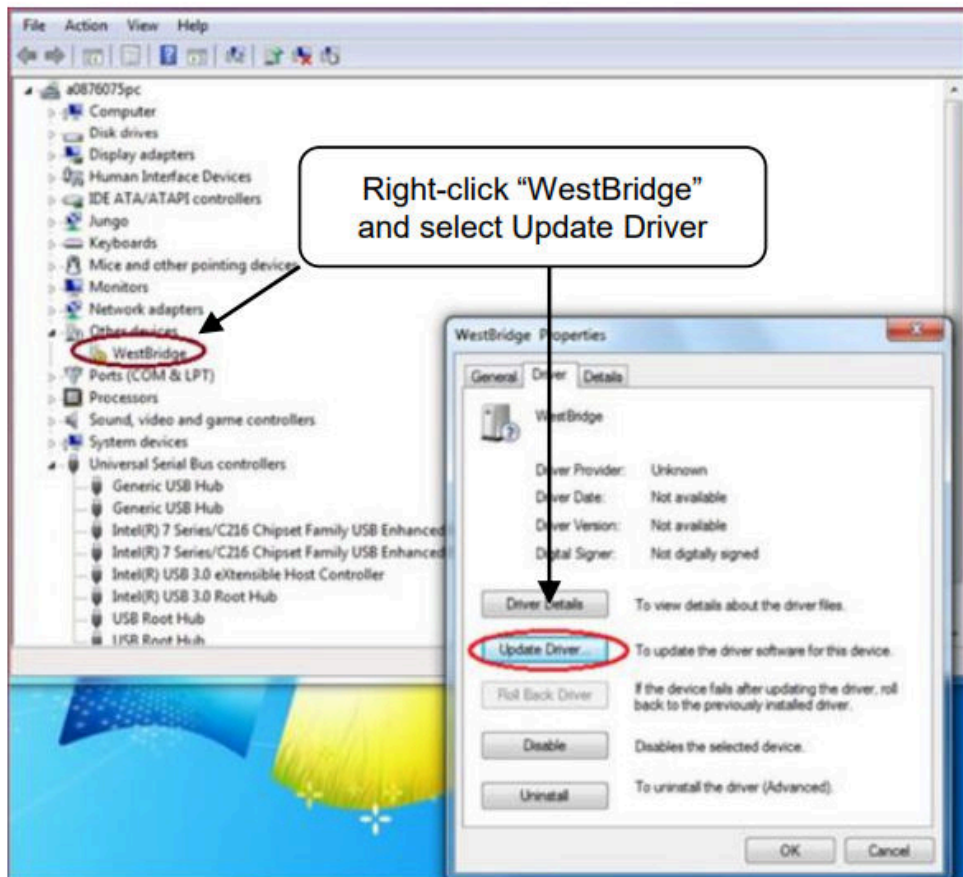


Figure 6-2. Update Driver with Device Manager

## 6.2 Connecting the Hardware and Starting Software

1. Connect the EVM and set the jumpers as shown in Figure 6-3 after installing the software.
2. Connect a 5-V wall-wart connector or other power source for the TSWDC155EVM (sold separately). The TSWDC155EVM user guide provides information on this power source.
3. Physically connect J1 of the TSWDC155EVM to J27 of the ADS9218EVM. This component is the digital communications and power signal connection.
4. Connect the USB on the TSWDC155EVM to the computer.
5. Set jumper J18 to the EXT\_PWR position to allow for an external power connection. Connect an external 5.2-V to 5.5-V supply on screw terminal connection J17.
6. Start the software GUI as described in Figure 6-4.
7. Press the **Initialize USB**, **Power Up**, **Program FPGA**, and **Initialize ads92xx** buttons on the *Config* tab to power up and configure the EVM (see Figure 6-6 for details).
8. Connect a differential signal generator. The maximum input range is  $\pm 3.2$  V and the common-mode input is 2.048 V.

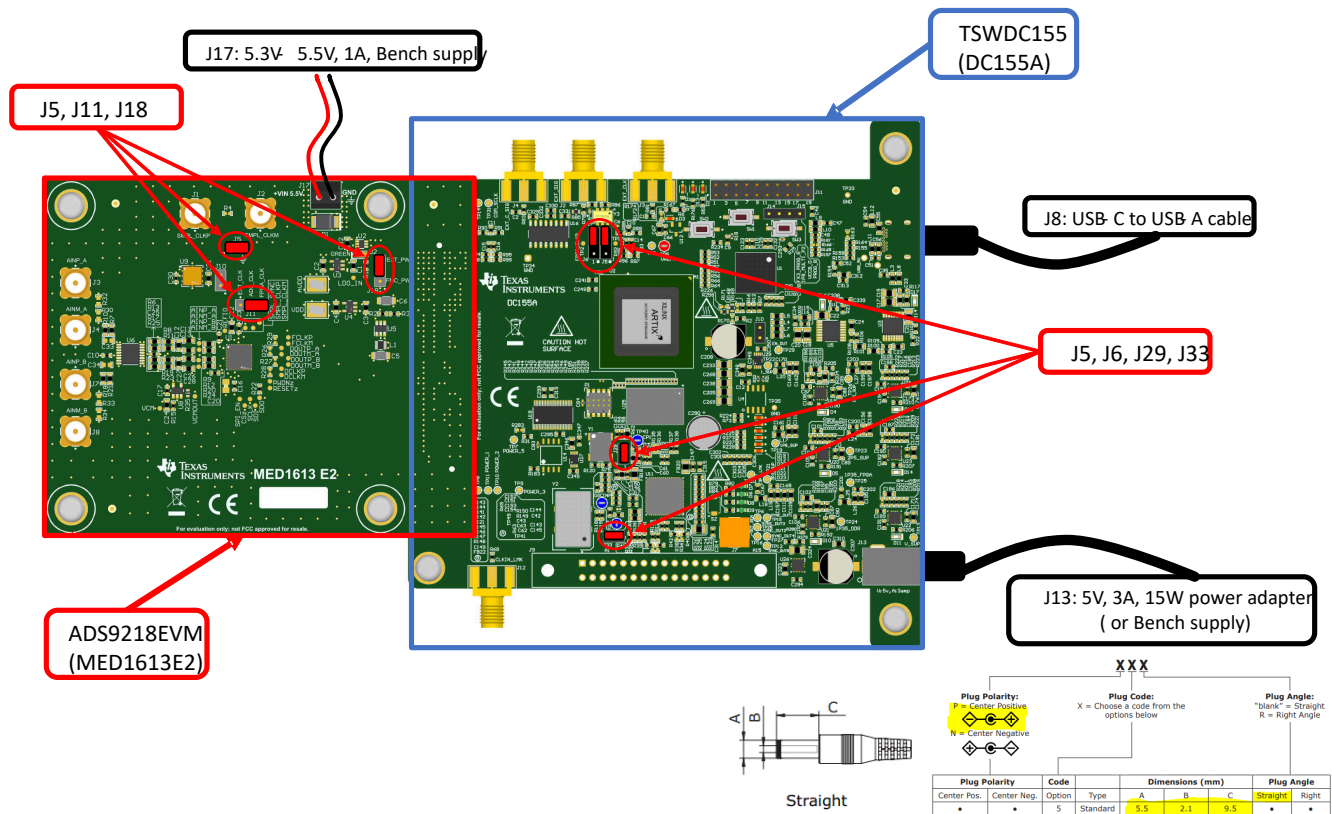


Figure 6-3. Connecting the Hardware

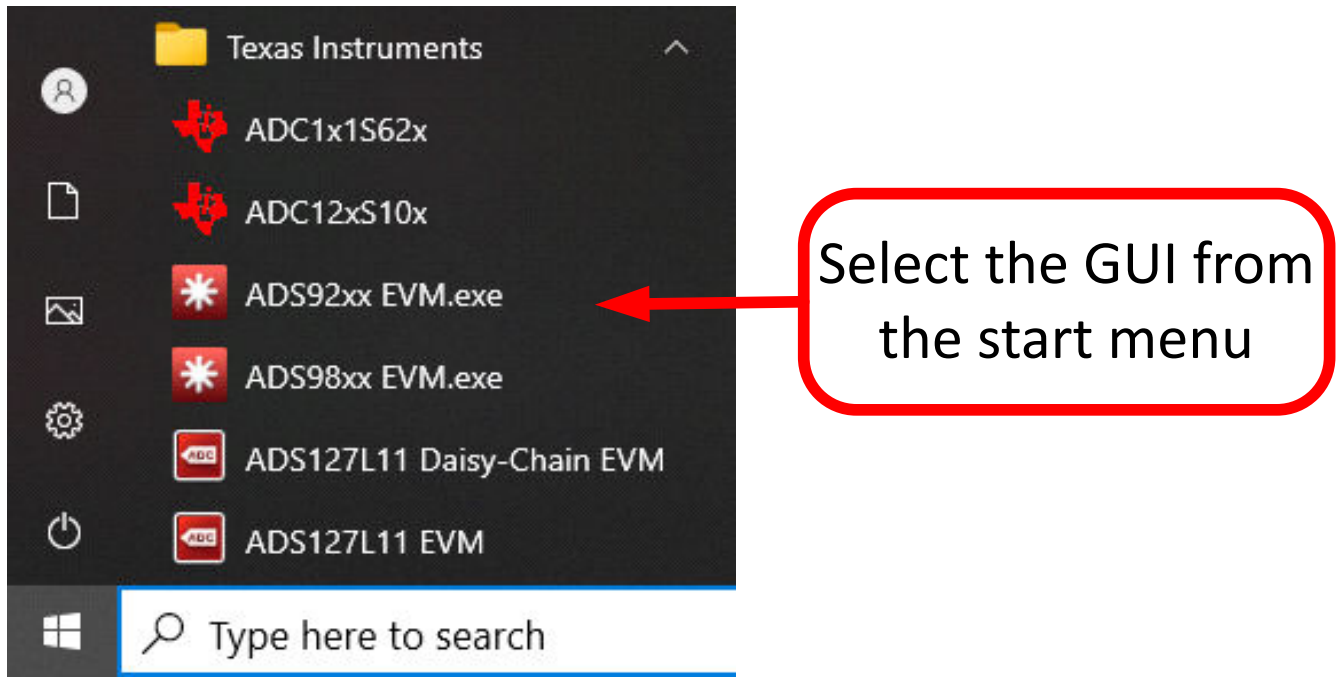


Figure 6-4. Start the Software GUI

### 6.3 Optional Connections to the EVM

Figure 6-5 shows optional connections to the clock. These connections are not required for initial setup of the EVM but can be helpful to configure the EVM more closely to your end application. Review the [Schematic](#) to understand how these connections are used.

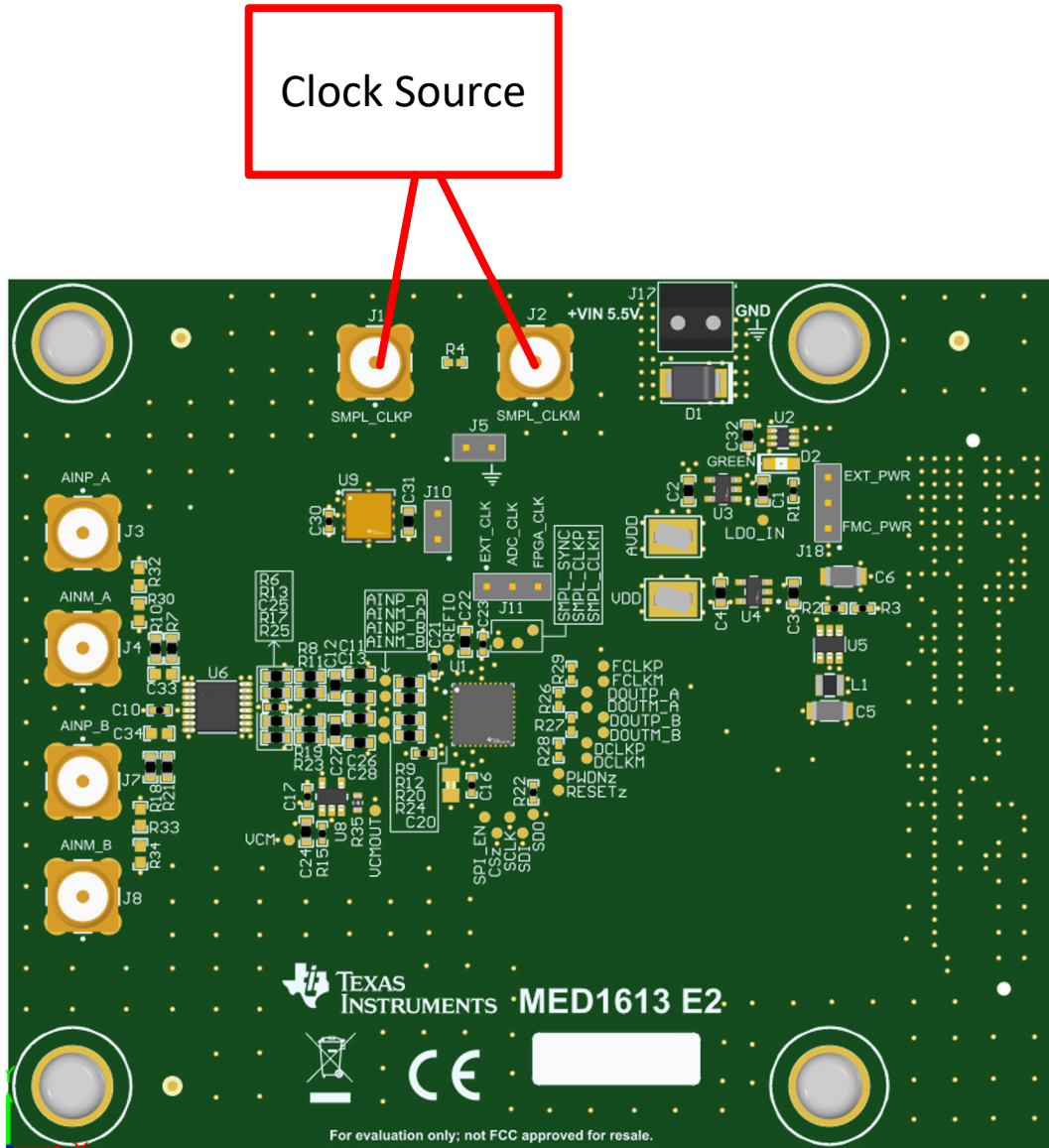
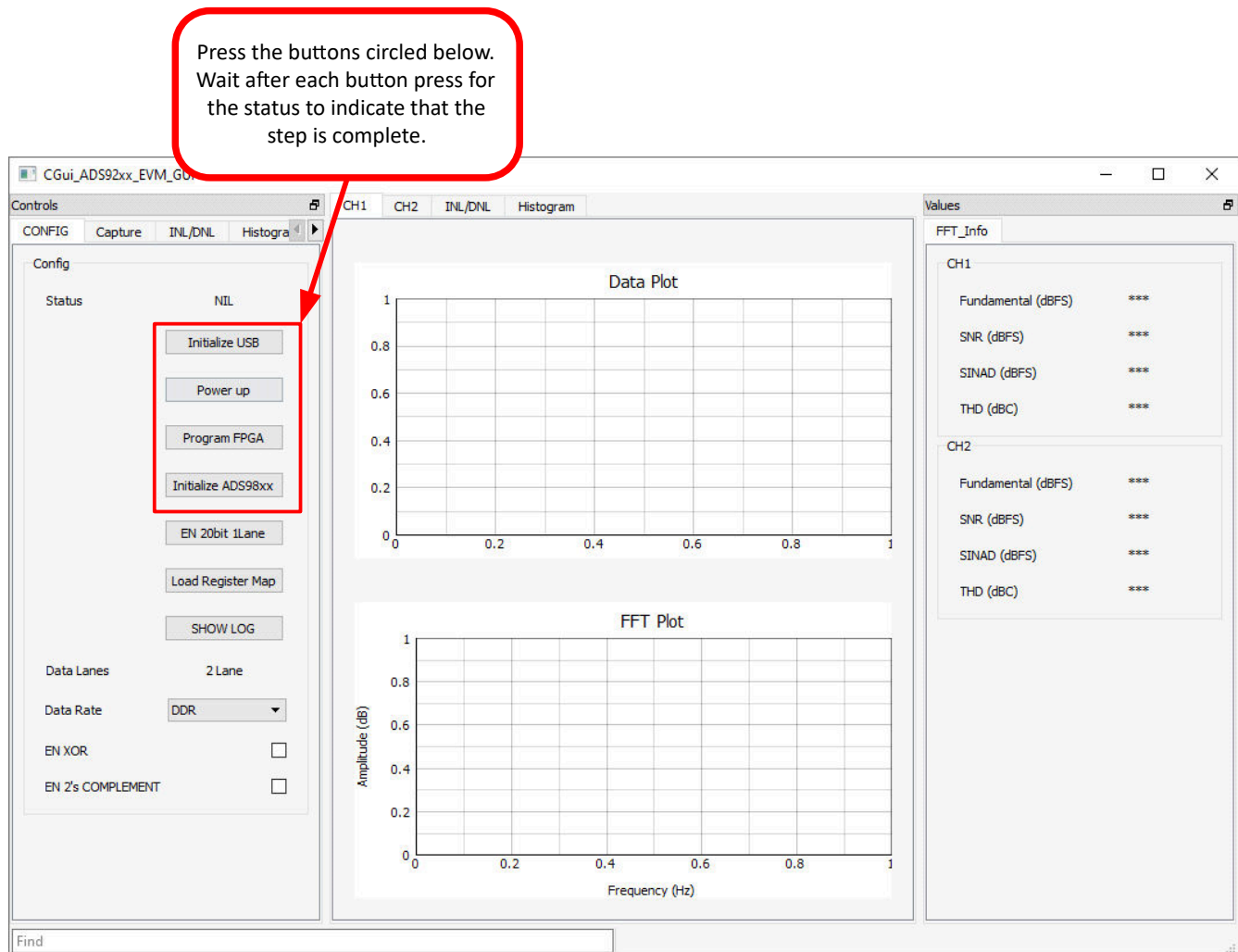


Figure 6-5. Optional Connections



## 6.4 Initial Required Setup on the *Config* Tab

After the EVM GUI is started, you must press some buttons (**Initialize USB**, **Power Up**, **Program FPGA**, and **Initialize ADS98xx**) to perform the initial configurations. As shown in [Figure 6-6](#), press these buttons in order from top to bottom. Wait after each button press for the status to indicate that the step is complete. For the **Power Up** and **Program FPGA** buttons, some status LEDs on the hardware illuminate. The power-up step takes the longest time (approximately 30 seconds). After all four buttons are pressed, the power on the ADS9218EVM is on and the ADS9218 device registers are configured.



**Figure 6-6. Initial Required Setup on the *Config* Tab**

## 6.5 Initial Required Setup on the Capture Tab

In Figure 6-7, the device and EVM are powered up and configured. In this step, the necessary updates to the *Capture* settings are made to capture the time domain data and to get a good frequency domain result. First, the **EN SYNC** button is pressed to synchronize the communication channel. Next, update the number of samples to at least 32k to get good frequency domain results (for example, accurate FFT display, SNR data, and THD data). Finally, select the Hanning type window to eliminate spectral leakage in the FFT result.

When these changes are made, press the **Start Capture** button to collect time domain and frequency domain data. To view data for channel 1 or channel 2, select the appropriate tab.

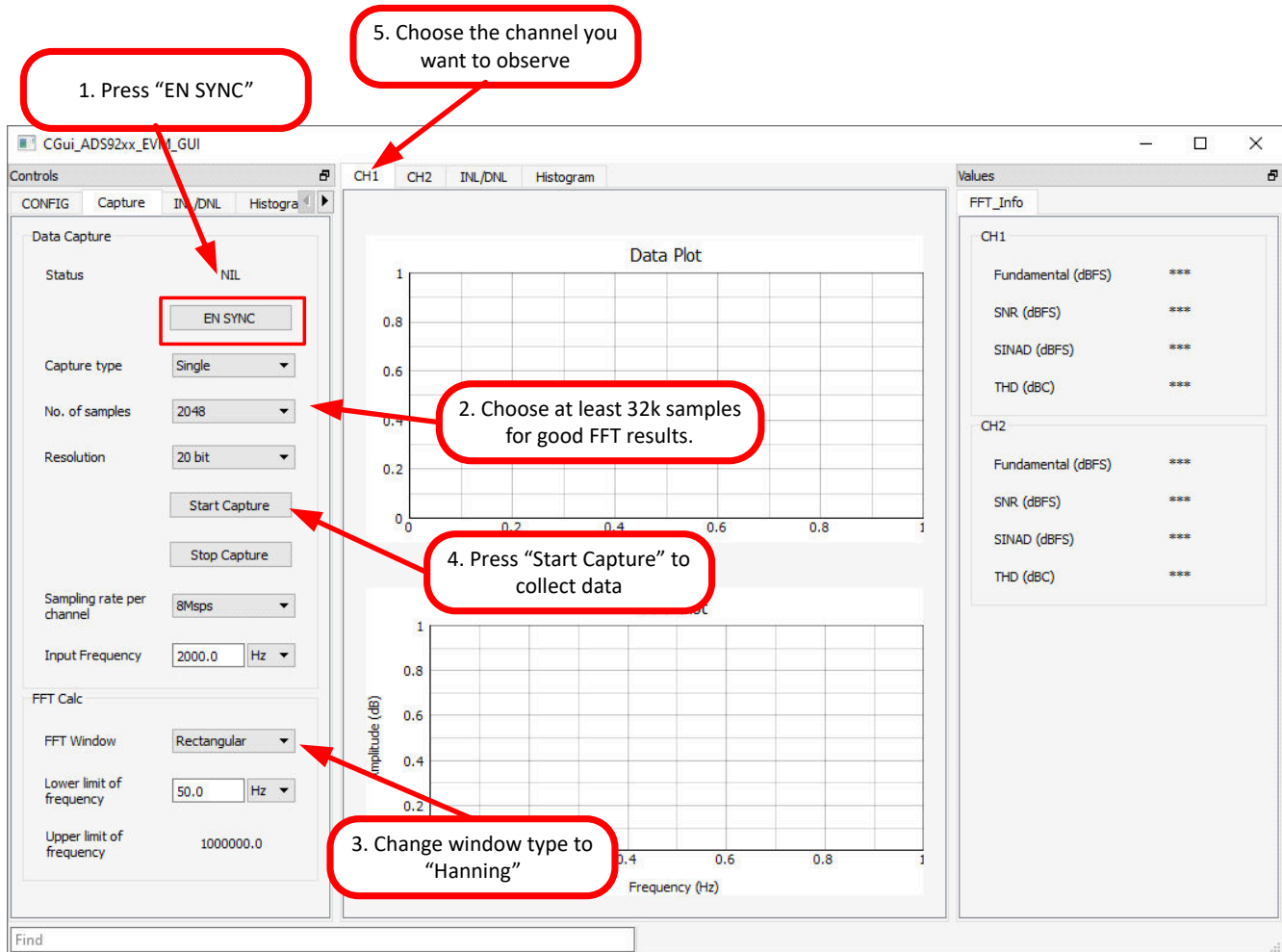


Figure 6-7. Initial Required Setup on the Capture Tab

## 7 Bill of Materials, Schematics, and Layout

### 7.1 Bill of Materials (BOM)

Table 7-1 lists the BOM for the ADS9218EVM-PDK.

**Table 7-1. Bill of Materials**

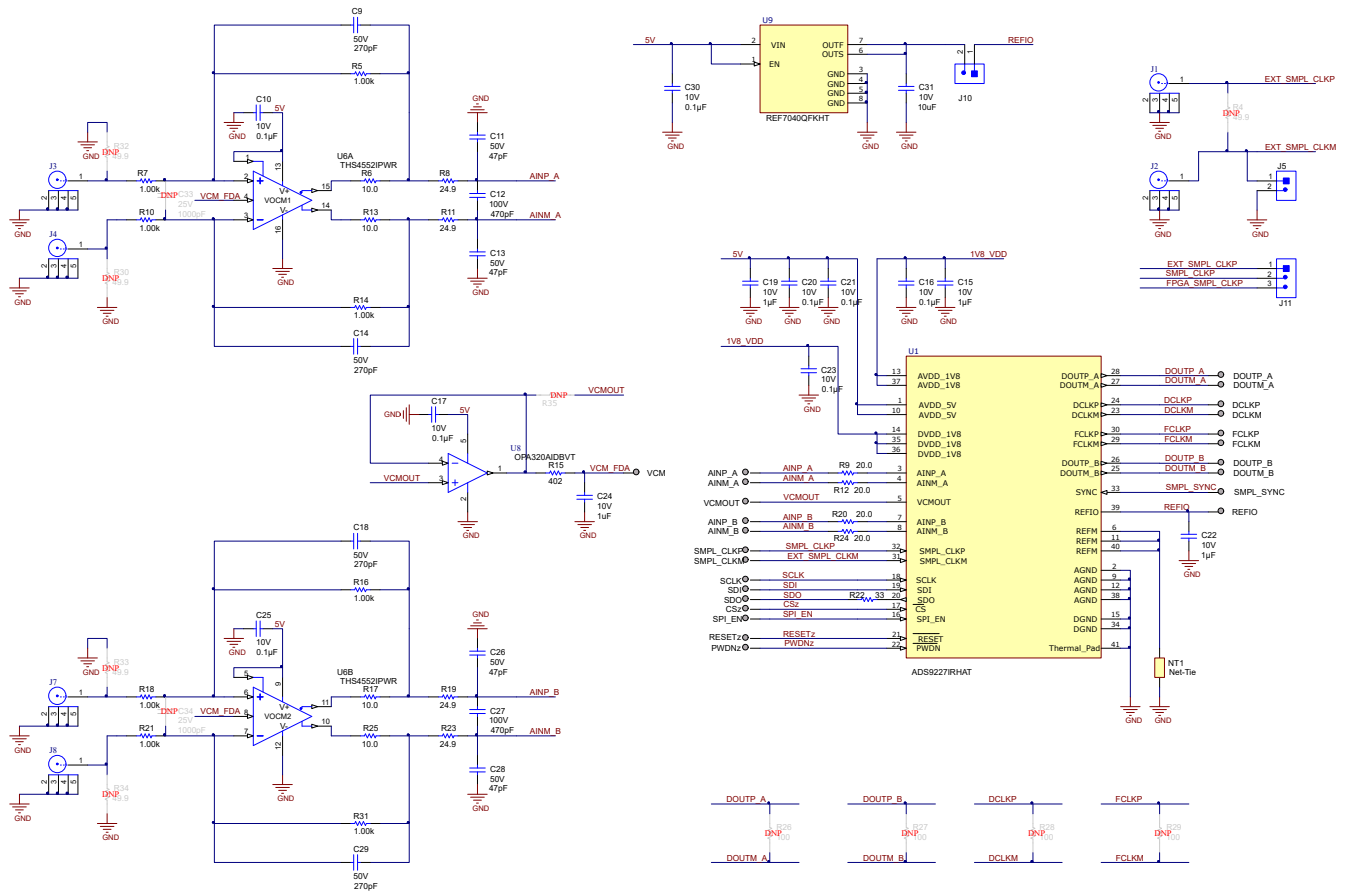
Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
!PCB1	1		Printed Circuit Board		MED1613	Any
AVDD, VDD	2		Test Point, Compact, SMT	Testpoint_Key stone_Compact	5016	Keystone Electronics
C1, C2, C3, C4	4	1 uF	CAP, CERM, 1 uF, 16 V, +/- 10%, X7R, 0603	0603	C1608X7R1C105K080AC	TDK
C5, C6	2	10 uF	CAP, CERM, 10 uF, 16 V, +/- 10%, X7R, 1206	1206	GRM31CR71C106KAC7L	MuRata
C9, C14, C18, C29	4	270 pF	CAP, CERM, 270 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603	06035A271JAT2A	AVX
C10, C16, C17, C20, C21, C23, C25, C30	8	0.1 uF	CAP, CERM, 0.1 uF, 10 V, +/- 10%, X7R, 0402	0402	C0402C104K8RACTU	Kemet
C11, C13, C26, C28	4	47 pF	CAP, CERM, 47 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603	GRM1885C1H470JA01D	MuRata
C12, C27	2	470 pF	CAP, CERM, 470 pF, 100 V, +/- 5%, C0G/NP0, 0603	0603	GRM1885C2A471JA01D	MuRata
C15, C19, C22, C32	4	1 uF	CAP, CERM, 1 uF, 10 V, +/- 10%, X7R, 0603	0603	0603ZC105KAT4A	AVX
C24	1	1 uF	CAP, CERM, 1 uF, 10 V, +/- 10%, X5R, 0603	0603	C0603C105K8PACTU	Kemet
C31	1	10 uF	CAP, CERM, 10 uF, 10 V, +/- 20%, X6S, 0603	0603	GRM188C81A106MA73D	MuRata
D1	1	6 V	Diode, TVS, Bi, 6 V, SMB	SMB	SMBJ6.0CA	Littelfuse
D2	1	Green	LED, Green, SMD	LED_0805	APT2012LZGCK	Kingbright
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
H9, H10, H11, H12	4		Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon	SJ-5303 (CLEAR)	3M
J1, J2, J3, J4, J7, J8	6		SMA Connector Jack, Female Socket 50Ohm Through Hole Solder	CONN_SMA_PTH	60312002114503	Würth Electronics
J5, J10	2		Header, 100mil, 2x1, Gold, TH	Header, 100mil, 2x1, TH	HTSW-102-07-G-S	Samtec
J11, J18	2		Header, 100mil, 3x1, Gold, TH	Header, 100mil, 3x1, TH	HTSW-103-07-G-S	Samtec
J17	1		Terminal Block, 3.5mm Pitch, 2x1, TH	7.0x8.2x6.5mm	ED555/2DS	On-Shore Technology
J27	1		Socket, 1.27mm, 40x10, Black, SMT	Connector, 1.27mm, 40x10, SMT	ASP-134486-01	Samtec
L1	1	10 uH	Inductor, Wirewound, Ceramic, 10 uH, 0.48 A, 0.36 ohm, SMD	2.5x1.8x1.8mm	CBC2518T100M	Taiyo Yuden
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady

**Table 7-1. Bill of Materials (continued)**

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
R1	1	2.2k	RES, 2.2 k, 5%, 0.063 W, 0402	0402	CRCW04022K20JNED	Vishay-Dale
R2	1	1.96Meg	RES, 1.96 M, 1%, 0.063 W, 0402	0402	CRCW04021M96FKED	Vishay-Dale
R3	1	200k	RES, 200 k, 1%, 0.063 W, 0402	0402	CRCW0402200KFKED	Vishay-Dale
R5, R7, R10, R14, R16, R18, R21, R31	8	1.00k	RES, 1.00 k, 0.1%, 0.1 W, 0603	0603	RT0603BRD071KL	Yageo America
R6, R13, R17, R25	4	10.0	RES, 10.0, 0.1%, 0.1 W, 0603	0603	CRT0603-BY-10R0ELF	Bourns
R8, R11, R19, R23	4	24.9	RES, 24.9, 0.1%, 0.1 W, 0603	0603	RT0603BRD0724R9L	Yageo America
R9, R12, R20, R24	4	20.0	RES, 20.0, 0.1%, 0.1 W, 0603	0603	RT0603BRD0720RL	Yageo America
R15	1	402	RES, 402, 1%, 0.063 W, 0402	0402	CRCW0402402RFKED	Vishay-Dale
R22	1	33	RES, 33, 5%, 0.063 W, 0402	0402	CRCW040233R0JNED	Vishay-Dale
R30, R32, R33, R34	0	49.9	RES, 49.9, 0.1%, 0.1 W, 0603	0603	RT0603BRD0749R9L	Yageo America
R35	0	0	CRCW Series 0603 0.1 W 0 Ohm Jumper Surface Mount Thick Film Chip Resistor	0603	CRCW06030000Z0EA C	Vishay
U1	1		+/-6 V, Low IQ Ideal Diode with Input Polarity Protection, DCK0006A (SOT-SC70-6)	DCK0006A	LM66100DCKR	Texas Instruments
U3	1		300-mA, ultra-low-noise, low-IQ, low-dropout (LDO) linear regulator with high PSRR 5-SOT-23 -40 to 125	SOT23-5	TPS7A2050PDBVR	Texas Instruments
U4	1		Linear Voltage Regulator IC Positive Fixed 1 Output 300 mA SOT-23-5	SOT23-5	TPS7A2018PDBVR	Texas Instruments
U5	1		Adjustable, 600-mA Switch, 90% Efficient PFM/PWM Boost Converter in ThinSOT-23, DDC0006A (SOT-23-T-6)	DDC0006A	TPS61070DDCR	Texas Instruments
U6	1		Low-Noise, Precision, 150-MHz, Fully Differential Amplifier, RTW0024A (WQFN-24)	RTW0024A	THS4552IRTWR	Texas Instruments
U8	1		Precision, 20 MHz, 0.9 pA Ib, RRIO, CMOS Operational Amplifier, 1.8 to 5.5 V, -40 to 125 degC, 5-pin SOT23 (DBV5), Green (RoHS & no Sb/Br)	DBV0005A	OPA320AIDBVT	Texas Instruments
U9	1		2 ppm/°C Maximum Drift, 0.23 ppmp-p 1/f Noise, Precision Voltage Reference	LCCC8	REF7040QFKHT	Texas Instruments
C33, C34	0	1000 pF	CAP, CERM, 1000 pF, 25 V, +/- 10%, C0G/NP0, 0603	0603	C0603C102K3GACTU	Kemet
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
R4	0	49.9	RES, 49.9, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040249R9FKED	Vishay-Dale
R26, R27, R28, R29	0	100	RES, 100, 1%, 0.063 W, 0402	0402	CRCW0402100RFKED	Vishay-Dale

## 7.2 Schematics

Figure 7-1 shows the amplifier drive circuit, voltage reference connections, common-mode amplifiers, external clock connections, and ADC decoupling.



**Figure 7-1. ADS9218EVM ADC Connections, Amplifiers, and Reference Schematic**

Figure 7-2 shows the boost converters and the low-dropout regulators for internal and external power connections.

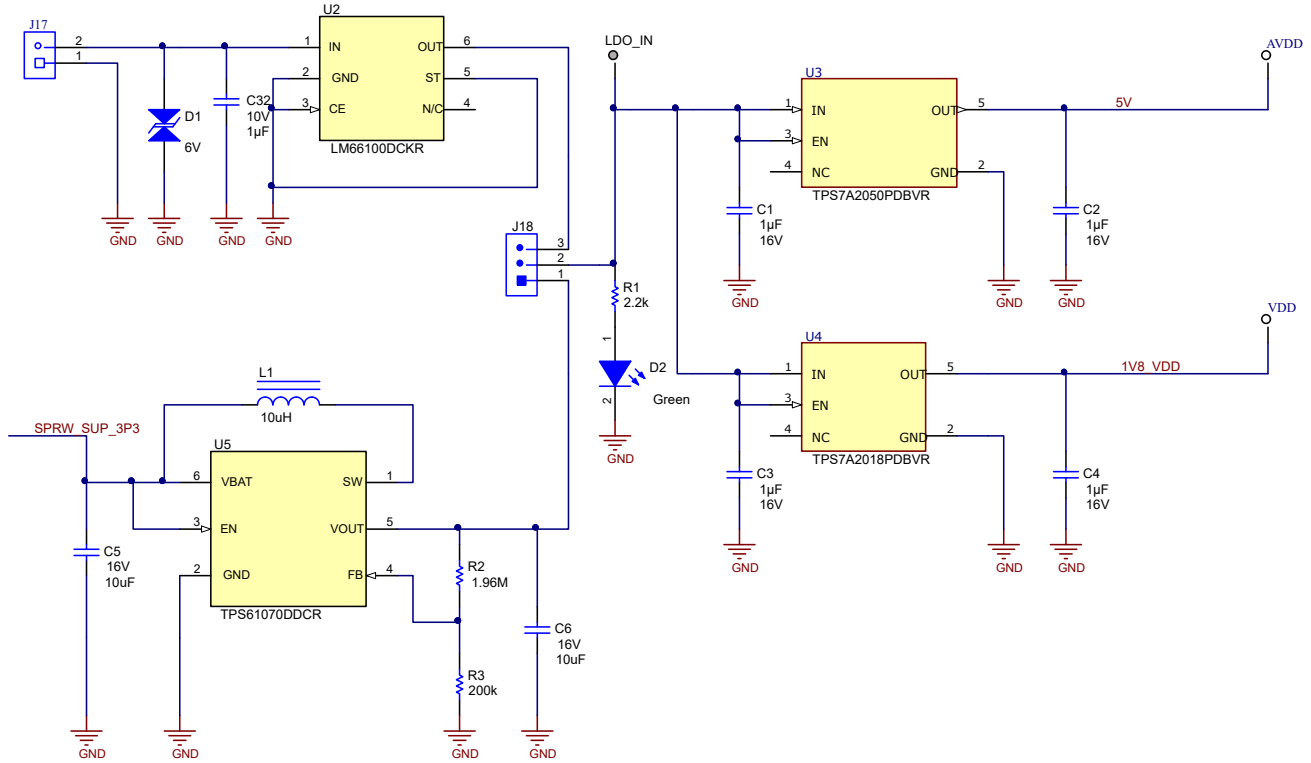


Figure 7-2. ADS9218EVM Power Section

Figure 7-3 shows the connector that connects the ADS9218EVM connector to the TSWDC155EVM. This connector has digital and power connections.

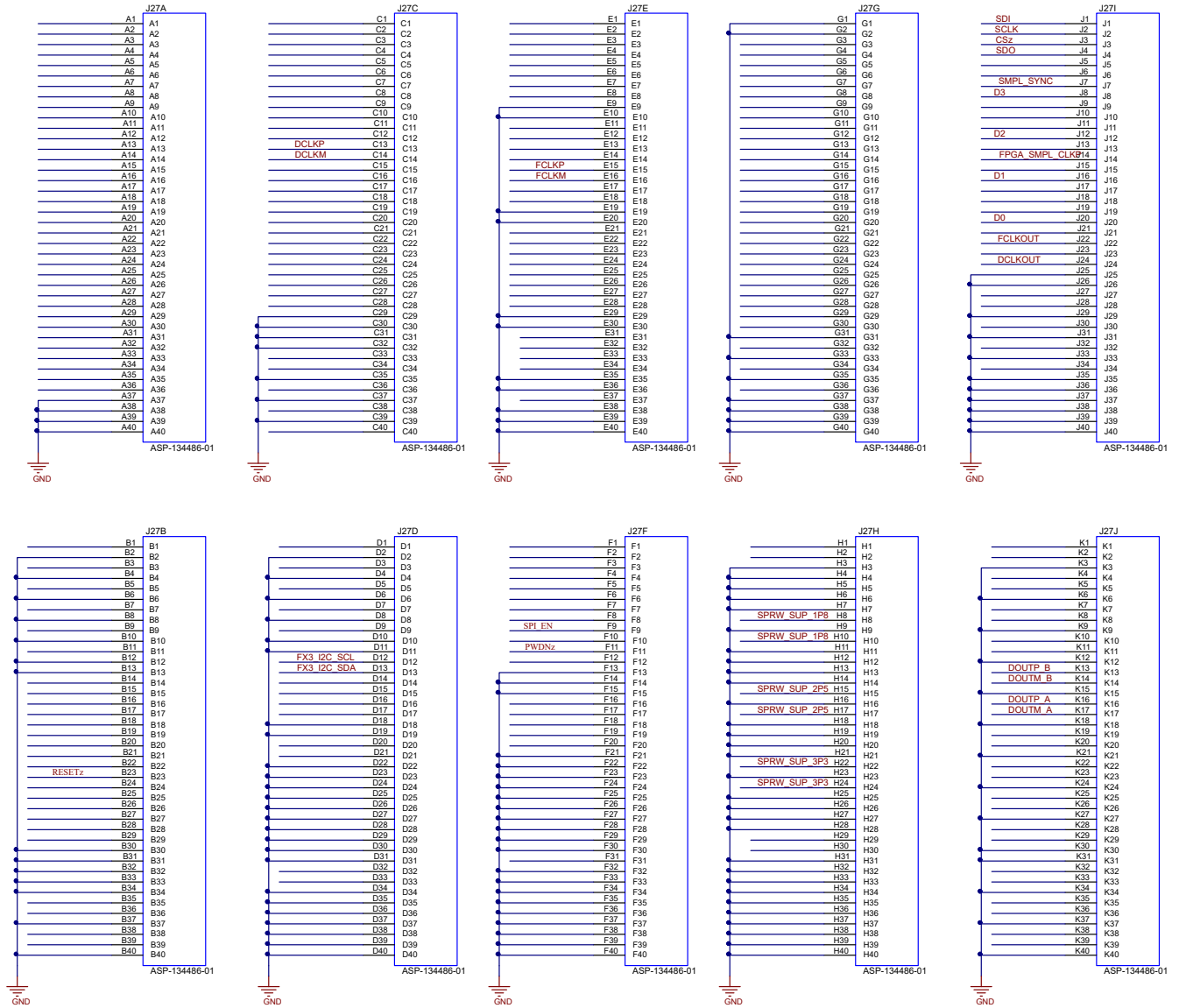


Figure 7-3. ADS9218EVM Connector to TSWDC155EVM

### 7.3 Layout

Figure 7-4 shows a consolidated layout overview. As a legend, the top layer is shown in red, the top overlay in yellow, and the bottom layer in blue.

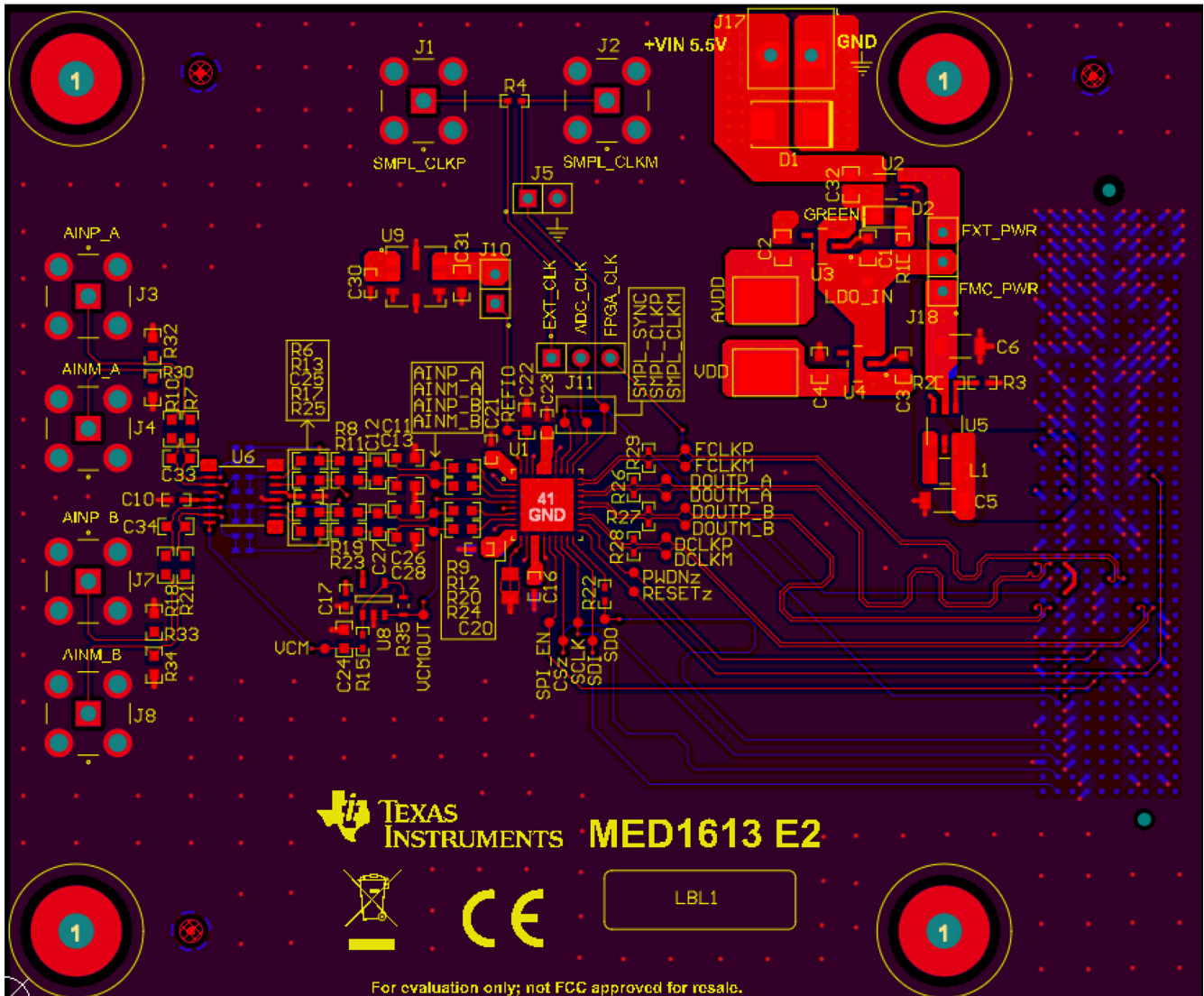


Figure 7-4. ADS9218EVM Layout



## 8 Revision History

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

<b>Changes from Revision * (September 2022) to Revision A (November 2022)</b>	<b>Page</b>
• Added <i>USB Driver Installation</i> section.....	13
• Changed <i>Connecting the Hardware and Starting Software</i> steps: changed <i>FMC_PWR</i> to <i>EXT_PWR</i> in step 5 and deleted step 9.....	14

## STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
  - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductor products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software
  - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
  - 2.1 These terms 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 a nonconforming EVM if (a) the nonconformity was 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, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
  - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, 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.

### **WARNING**

**Evaluation Kits 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 shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.**

**NOTE:**

**EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.**

### 3 Regulatory Notices:

#### 3.1 United States

##### 3.1.1 Notice applicable to EVMs not FCC-Approved:

**FCC NOTICE:** 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 or RSS-247

#### **Concerning EVMs Including Radio Transmitters:**

This device complies with Industry Canada license-exempt RSSs. 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/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/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/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/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 to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

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

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

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。日本テキサス・インスツルメンツ株式会社  
東京都新宿区西新宿 6 丁目 2 4 番 1 号  
西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see [http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/lstds/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/lstds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page)

#### 3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

- 
- 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 MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS 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 EPIDEMIC FAILURE WARRANTY OR 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 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, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.
  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. 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 OR THE USE OF THE EVMS , 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 TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM 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  
Copyright © 2019, Texas Instruments Incorporated

## **IMPORTANT NOTICE AND DISCLAIMER**

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on [ti.com](http://ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2022, Texas Instruments Incorporated