EVM User's Guide: ADS9324EVM

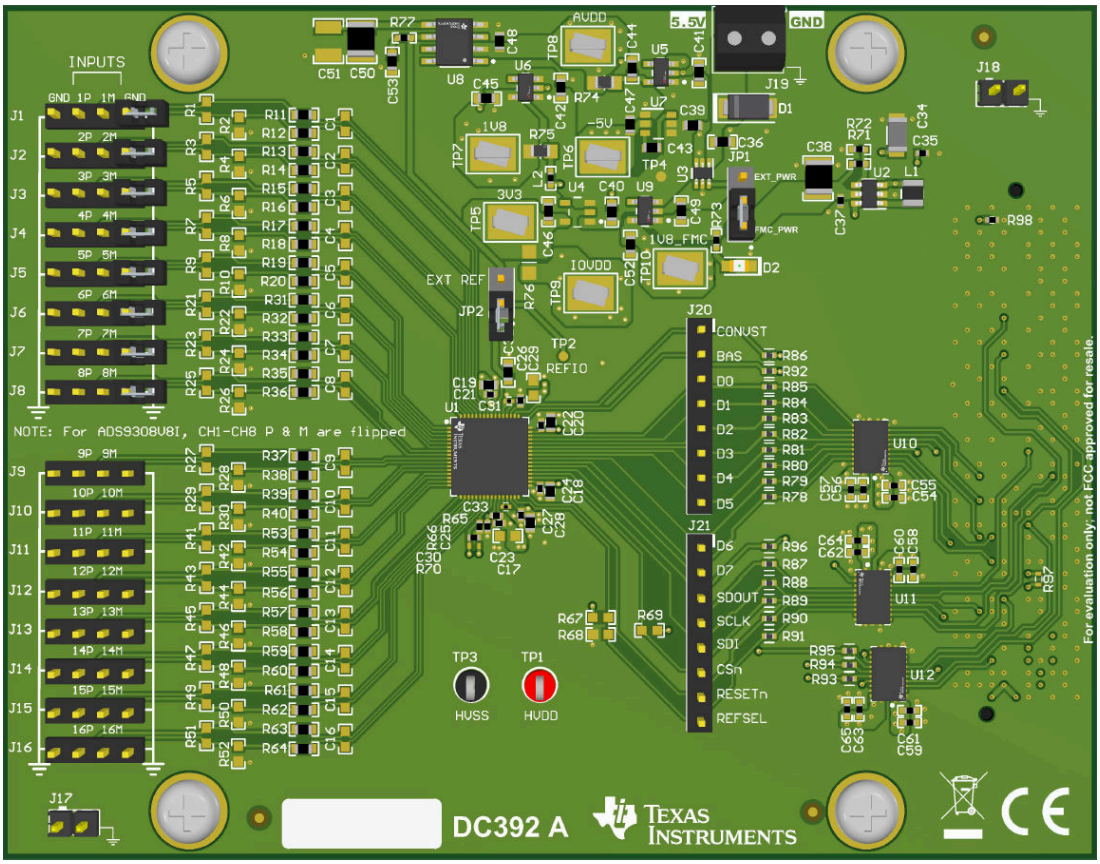
ADS9324 Evaluation Module

Description

The ADS9324 evaluation module (EVM) is a platform for evaluating the performance of the ADS9324, 16-channel, 16-bit, 1-MSPS/channel SAR ADC with integrated analog front-end and ADC reference. The ADS9324EVM includes a standard FMC connector that can interface with standard FPGA development boards. Computer software that works with the TSWDC155EVM (sold separately) is provided to enable the user to communicate with the ADC over universal serial bus (USB), capture data, and perform data analysis.

Features

- EVM hardware features all required support circuitry for ADS9324, including power tree and ADC reference voltage options
- Easy-to-use evaluation software for Windows® 10 64-bit operating systems; software suite includes graphical tools for data capture and analysis
- Software for communications is facilitated with TSWDC155EVM data capture card (sold separately)



ADS9324EVM

1 Evaluation Module Overview

1.1 Introduction

This EVM eases the evaluation of the ADS9324 device with hardware, software, and computer connectivity through the universal serial bus (USB) interface. This user guide includes complete circuit descriptions, schematic diagrams, and a bill of materials (BOM). Throughout this document, the terms *demonstration kit*, *evaluation board*, *evaluation module*, *and EVM* are synonymous with the ADS9324EVM.

1.2 Kit Contents

The ADS9324EVM kit comes with an evaluation module for ADS9324. The TSWDC155EVM controller card is sold separately.

1.3 Specification

The ADS9324EVM include the following features:

- ADS9324EVM has the hardware required for diagnostic testing and accurate performance evaluation of the ADS9324 ADC.
- Easy-to-use evaluation GUI for Microsoft® Windows® 10, 64-bit operating systems requires the TSWDC155EVM (sold separately) for operation.

Figure 1-2 depicts the connections and basic subsystems of the EVM.

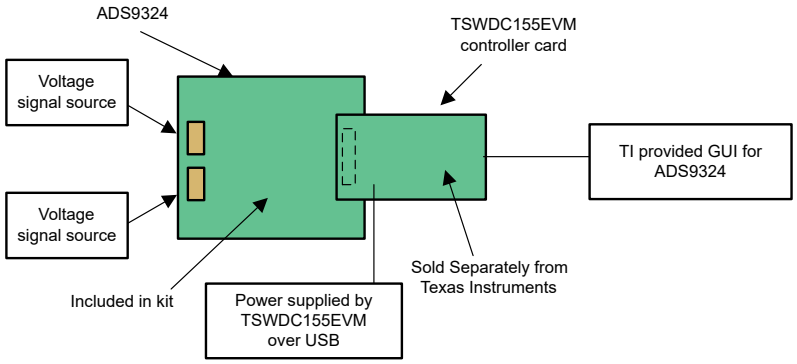


Figure 1-1. System Using GUI and TSWDC155EVM

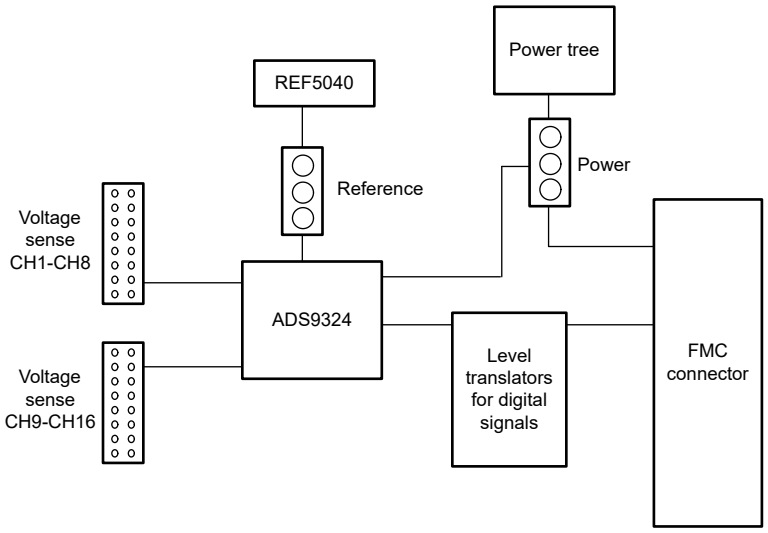


Figure 1-2. ADS9324EVM Block Diagram

1.4 Device Information

The ADS9324EVM is a platform for evaluating the performance of the ADS9324 ADC. The ADS9324 is a 16-channel, integrated data acquisition (DAQ) system based on a simultaneous sampling, 16-bit successive approximation (SAR) analog-to-digital converter (ADC) operating at a maximum of 1-MSPS per channel. The device features a complete analog front-end for each channel, including a programmable gain amplifier (PGA) with input impedance of 1MΩ, input clamp, low-pass filter, and an ADC input driver. The device also features a low-drift, precision reference with a buffer to drive the ADC. A flexible digital interface supporting serial and parallel byte communication enables the device to be used with a variety of host controllers.

The ADS9324 can be configured to accept ±12.5V true bipolar inputs using a single 5V supply. The high input impedance allows direct connection with sensors and transformers, thus eliminating the need for external driver circuits.

The 16 channels have the following input ranges: ±12.5V, ±10V, ±6.25V, ±5V, ±2.5V. Each channel range can be set individually.

2 Hardware

2.1 ADS9324EVM Quick Start Guide

The following instructions are a step-by-step guide to connecting the ADS9324EVM to the computer and evaluating the performance of the ADS9324.

1. Review the default jumper settings in Figure 2-1 and the power guidelines in Section 2.4.1.
2. **IMPORTANT**: Set the J5 jumper on the TSWDC155EVM to the +1.8V option.
3. Physically connect J1 of the TSWDC155EVM to J22 of the ADS9324EVM. This component is the digital communications and power signal connection in default configuration.
4. Set jumper JP1 to the FMC_PWR position so the TSWDC155EVM provides power. Otherwise, set JP1 to EXT_PWR and connect an external 5.2V to 5.5V supply on screw terminal connection J7.
5. Bypass any external USB hub and connect the USB on the TSWDC155EVM directly to the computer.

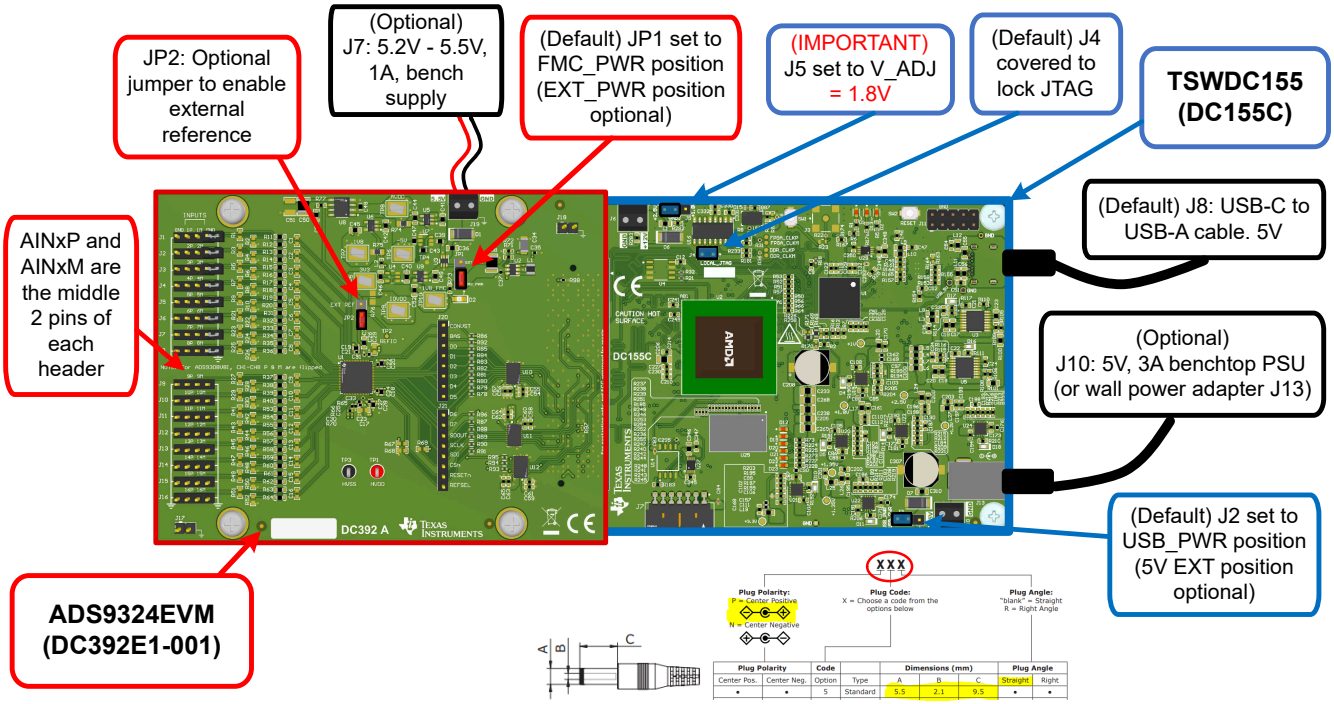


Figure 2-1. Connecting the Hardware

1. Install the GUI as described in Section 3.1.
2. Install the necessary USB drivers as described in Section 3.1.1.
3. Launch the GUI.
4. For ADS9324EVM and GUI, press the *Board Startup* and *Initialize Device* buttons, in order, on the *Configuration* tab to power up and configure the EVM, (see Section 3.2.1 for details).
5. Connect a $9V_{PP}$, differential sine wave signal to any voltage sense channel (CH1–CH16 on EVM) using the two middle pins of J1 through J16 headers.
6. Select the number of samples to be at least 32k points, and choose the Hanning window type for best frequency domain results.
7. Press the *Start Capture* button to collect and analyze the data displayed on the appropriate channel; see Section 3.2 for more details.

2.2 Analog Interface

This section details the analog input connections to the ADS9324EVM.

2.2.1 ADC Input SMA Connections

Each ADC voltage channel is connected to the center pins of headers J1 through J16. The polarity of the channel pins are denoted by P and M above the respective channel header. Shunt jumpers can be placed on the headers to tie the P or M pins together, or short each to GND. 0402 footprints are provided to add a first-order, low-pass filter network on all ADC channels. By default, the filter capacitors are uninstalled and the filter resistors are populated with 0Ω. Use NP0 or C0G type capacitors and low-tolerance resistors to maintain AC performance when choosing to populate these footprints with a low-pass filter circuit.

Additionally, resistors (like R1) can be populated to short AINxP and AINxM. Other resistors (like R2) can be populated to short inputs to GND.

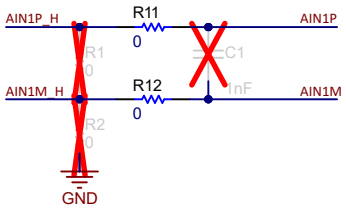


Figure 2-2. Input Channel

2.2.2 Voltage Reference

The ADS9324 uses an internal 4.096V reference voltage, which can be measured on the REFIO pin when configured as an output (default). For applications which require improved drift performance, configure the REFIO pin as an input and apply an external reference voltage to the pin. The REFIO pin can be configured by the REFSEL pin or by configuring an ADC register. To use the REFSEL pin, connect REFSEL to GND for the external reference or connect REFSEL to IOVDD for the internal reference. This can be done by the J21 header of the R67 and R68 resistors.

The ADS9324EVM include a provision for evaluating the REF5040 reference IC. The REF50xx family of high precision series voltage references offers low noise (3μV_{PP}/V), very low temperature drift coefficient (2.5ppm/°C), and high accuracy (±0.025%). To connect the REF5040 to the ADS9324, configure the REFIO pin as an input using the GUI and then install a shunt on jumper JP2.

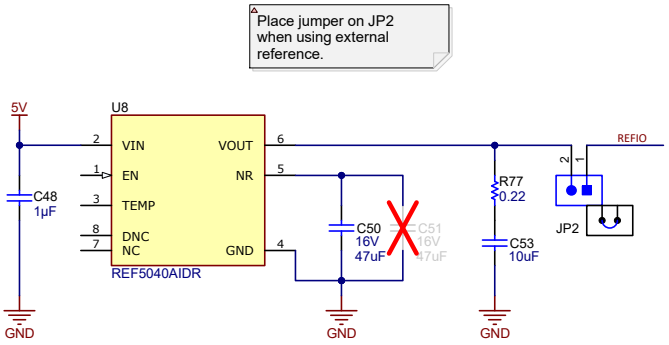


Figure 2-3. REF5040

2.3 Digital Interface and Clock Inputs

This section details the digital interface connections for the ADS9324EVM.

2.3.1 Digital Interface Connections

The ADS9324 uses SPI to configure the internal device registers using pins SCLK, SDI, SDOUT, and CSn. The data interface can be configured to be output in 1, 2, 4, or 8 lanes. The EVM and GUI software allows evaluation of the 8-lane data interface mode. These SPI signals, CONVST, DRDY, and D0-D7 signals are available using test points on J20 and J21 for scope measurements as indicated in PCB silkscreen.

Note

The DRDY pin is marked on the J20 header as *BAS*.

The FMC connector pinout below can also be interfaced with standard FPGA development kits. Note that the TI-provided software GUI is only compatible with the TSWDC155EVM and third-party software development is not supported.

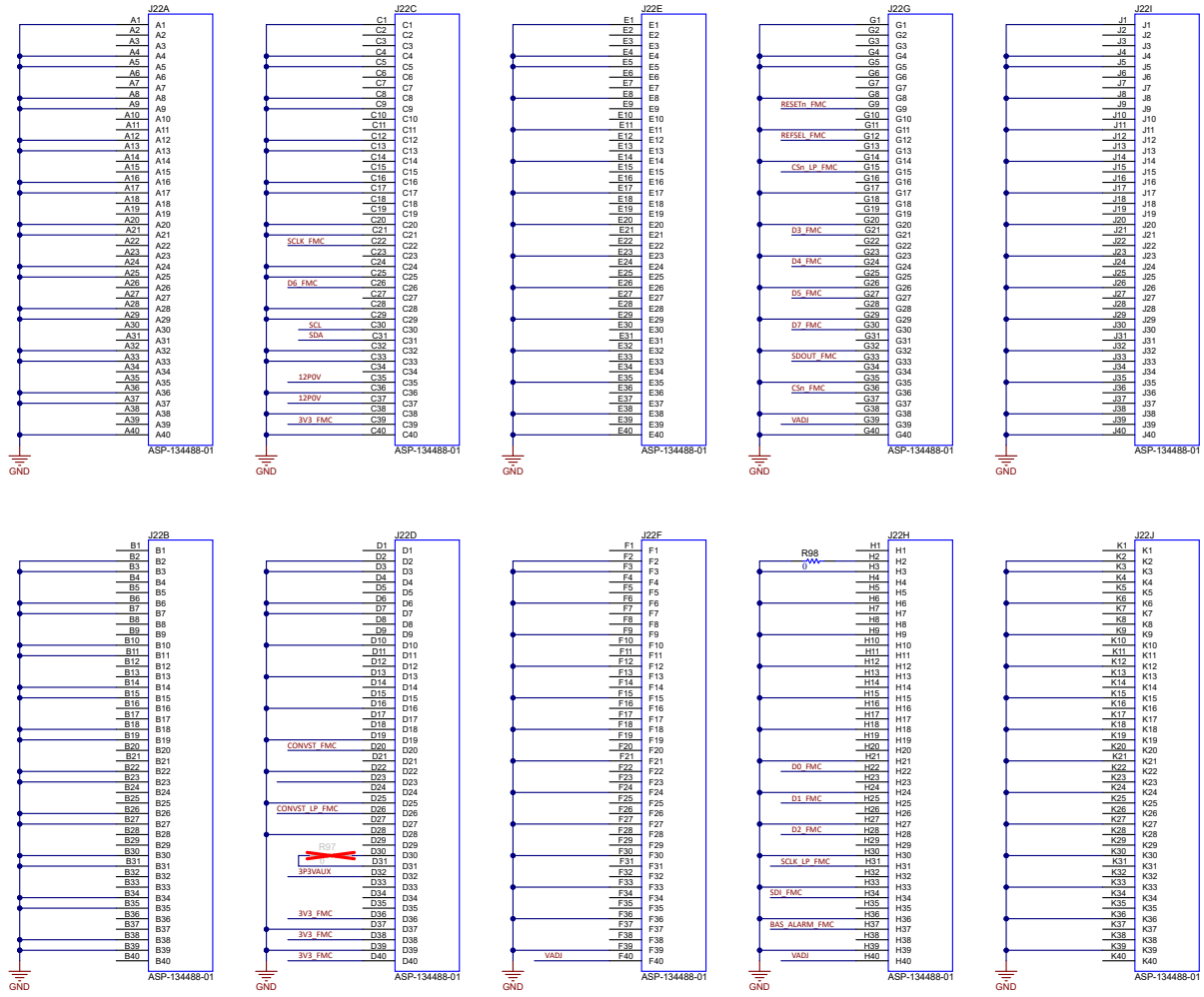


Figure 2-4. Digital I/O

Figure 2-5 shows the necessary decoupling capacitors for analog supplies, digital supplies, and ADC reference voltages.

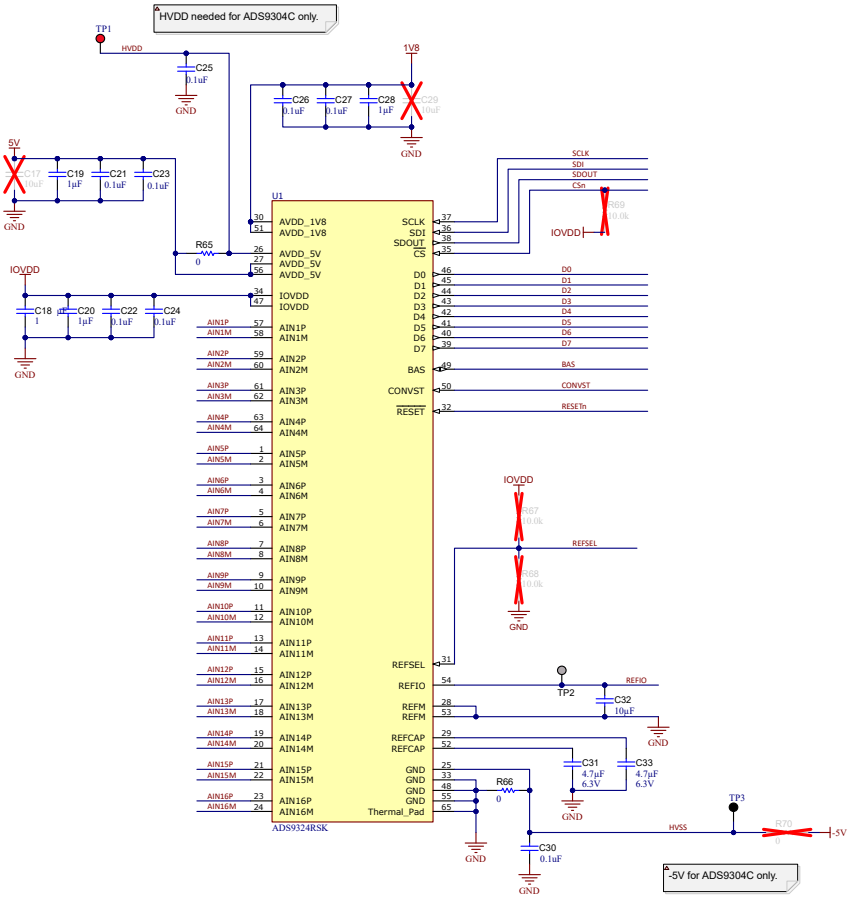


Figure 2-5. Connections to ADS9324

2.3.2 Level Translators

The ADS9324EVM has level translators to shift 3.3V digital signals to 1.8V for use with the FPGA on the TSWDC155EVM. This is done for testing purposes. By default, the EVM IOVDD is set to 1.8V, so the level shifters are not necessary. The IOVDD voltage can be changed to 3.3V to interface with an MCU. Instructions on how to configure the IOVDD voltage on the EVM can be found in Power Supplies.

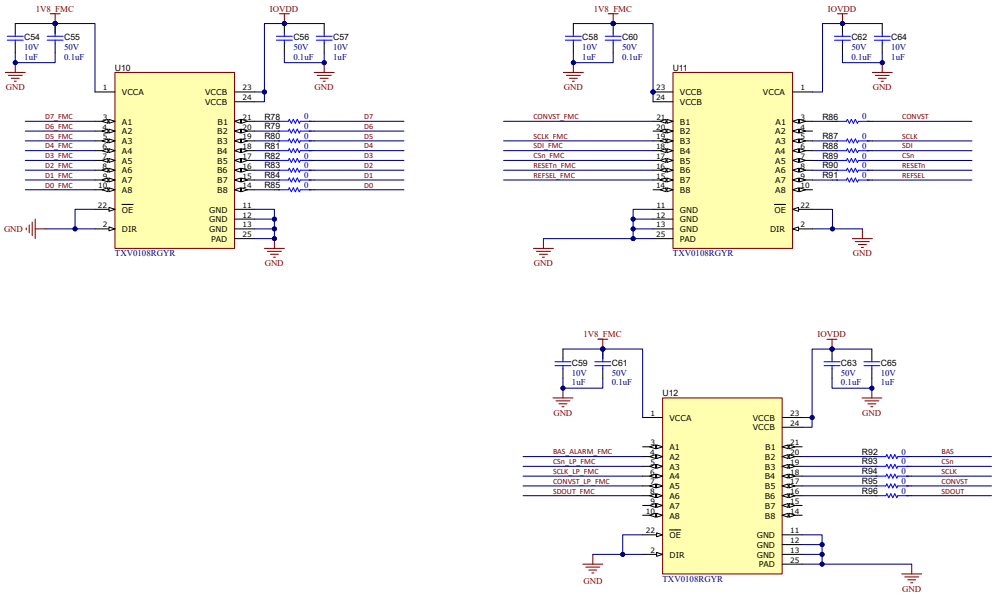


Figure 2-6. Level Translators

2.4 Power Supplies

By default, the TSWDC155EVM provides the ADS9324EVM with a 3.3V supply (*3P3V*). The ADS9324EVM has a TPS61070 boost converter that boosts the 3.3V supply to 5.4V. By default, this voltage is applied to low-dropout regulators (LDOs) to derive the AVDD_5V, AVDD_1V8, and IOVDD supplies when JP1 is in the [1-2] position. U5 (TPS7A2050) provides the 5V AVDD_5V supply, U6 (TPS7A2018) provides the AVDD_1V8 supply, and U4 (TPS7A2033) provides 3.3V for IOVDD, respectively. The LDO input voltage can be changed to an external source (5.2V to 5.5V) applied to terminal block J19 by placing a shunt on JP1 in the [2-3] position. In this case, U3 (LM66100) provides reverse polarity protection if the connection is wired incorrectly.

IOVDD can be either 1.8V or 3.3V. This allows ADS9324 the interface with both FPGAs and MCUs.

To set the IOVDD = 1.8V on the EVM:

- Populate R75 and depopulate R76

To set the IOVDD = 3.3V on the EVM:

- Populate U4 with TPS7A2033
- Populate R76 and depopulate R75

Figure 2-7 shows the power tree schematic for the ADS9324EVM.

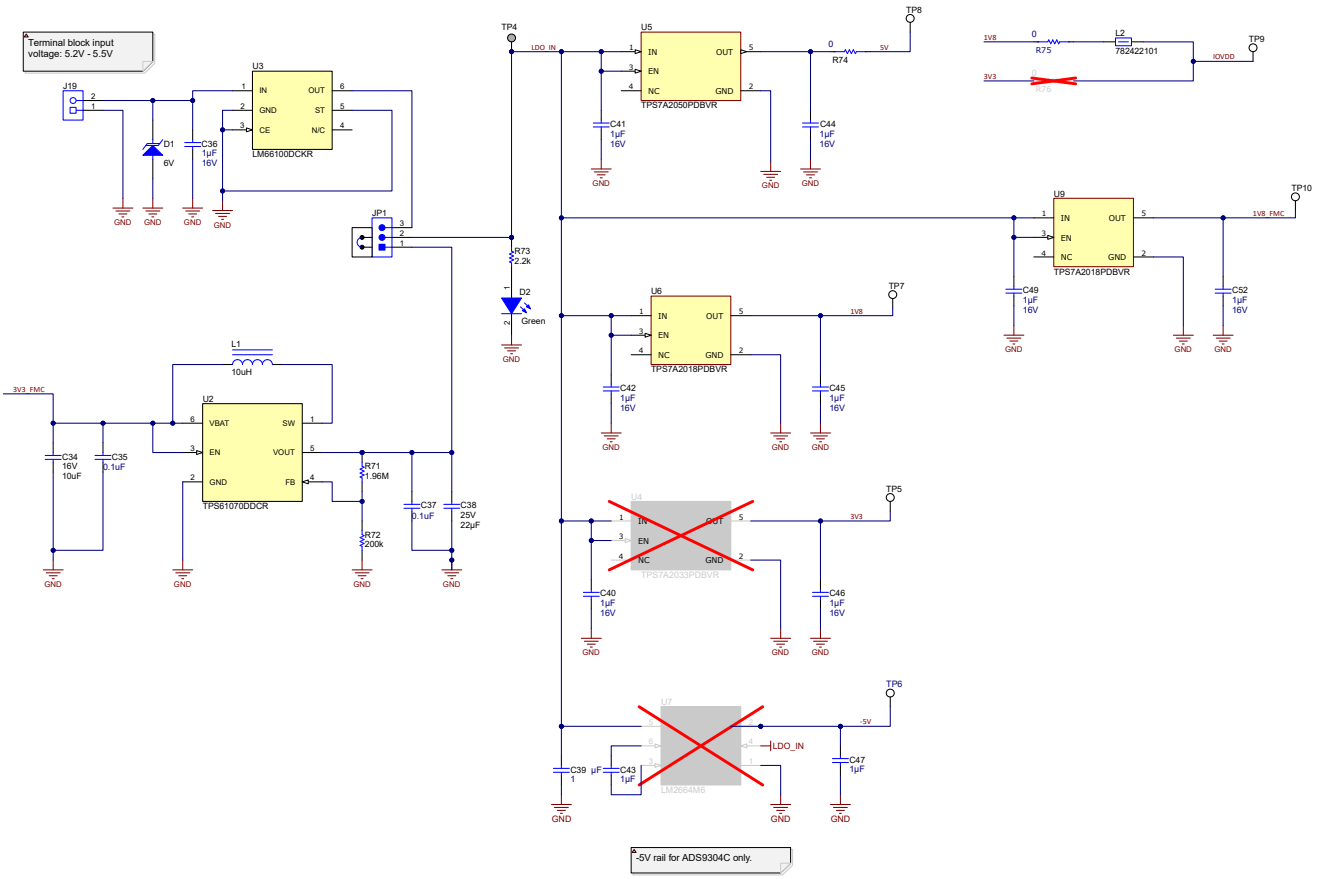


Figure 2-7. Power Entry and Regulators

2.4.1 USB Power and When to Power the Board Externally

As discussed in Section 2.1, the USB-C™ connector is able to provide power to the TSWDC155EVM and ADS9324EVM using the default configuration.

The TWDC155EVM is a high-power SuperSpeed® (Certified USB 3.0) device. This means a PC supplies up to 900mA from a compliant USB 3.0 port. However, many PC USB port configurations allow much less than this limit depending on the unit load handshake process, usually resulting from other devices on the bus. Tripping the current limit on a USB can result in cutting power to the USB port, excessive power dissipation or heating, depending on the PC port configuration. As a result, TI highly recommends to consider switching to an externally powered ADS9324EVM or TSWDC155EVM if:

- Only USB 1.0 or USB 2.0 ports are available.
- There are multiple devices connected to the PC by USB at the same time.
- The USB 3.0 port configuration for the PC is unknown.

To switch to the external power configuration on the ADS9324EVM, move the jumper on JP1 to the EXT_PWR [2-3] position and use the J19 terminal block to provide the required 5.2V to 5.5V supply. To switch to the external power configuration on TSWDC155EVM, move the jumper on J2 to the 5V (external) position and use the J10 terminal block or barrel jack connector to provide the required 5V supply.

USB hubs can cause possible device enumeration issues and are not recommended when communicating through the TSWDC155EVM.

3 Software

3.1 ADS9324EVM Software Installation

This section details the installation and operation of the ADS9324EVM software graphical user interface (GUI). This software requires the TSWDC155EVM (sold separately) controller to operate. The first step to installing the software (as shown in Figure 3-1) is to download the latest version of the EVM GUI installer as per Table 3-1.

Table 3-1. EVM GUI Installers

EVM	Software Download Link
ADS9324EVM	ADS9324EVM-GUI

Accept all the license agreements and choose the destination location, project directory, and start menu. Typically, the default values work, but these values can be customized as needed based on the user's requirements.

Note

The GUI installer and GUI buttons can differ slightly depending on which specific GUI is being installed.

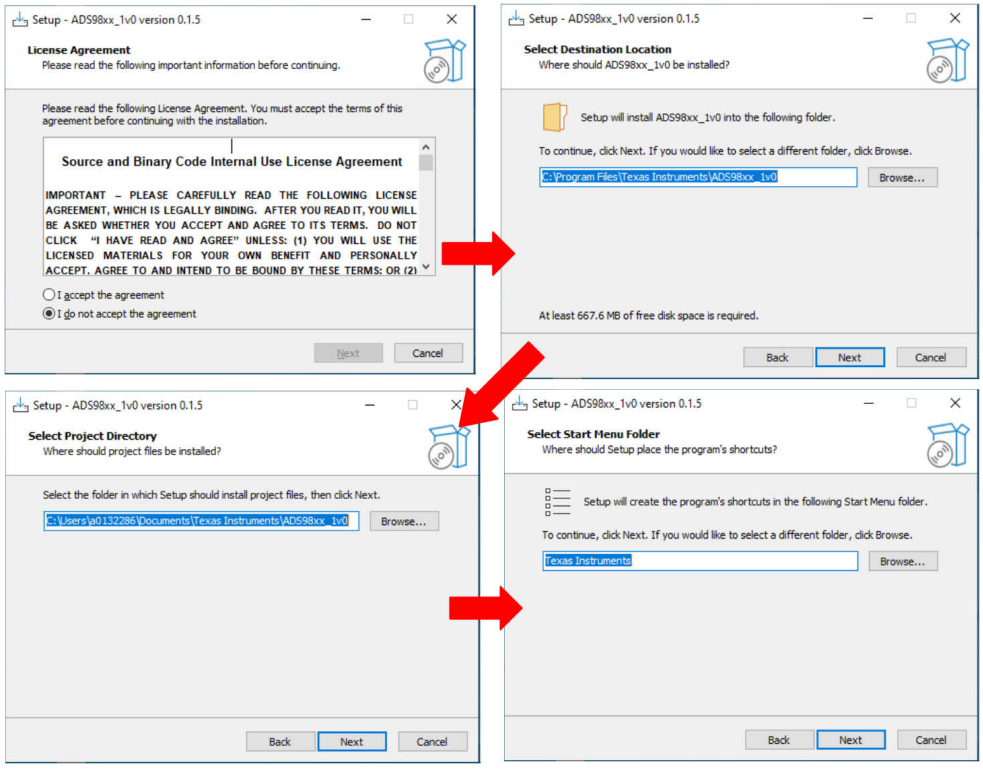


Figure 3-1. Initial Software Installation

Next, the installer prompts the user to create a desktop icon and summarize the installation plan. Clicking **Install** begins copying software onto the computer. This process takes a few minutes. At completion, the user can launch a readme text file and the application. Figure 3-2 shows these steps.

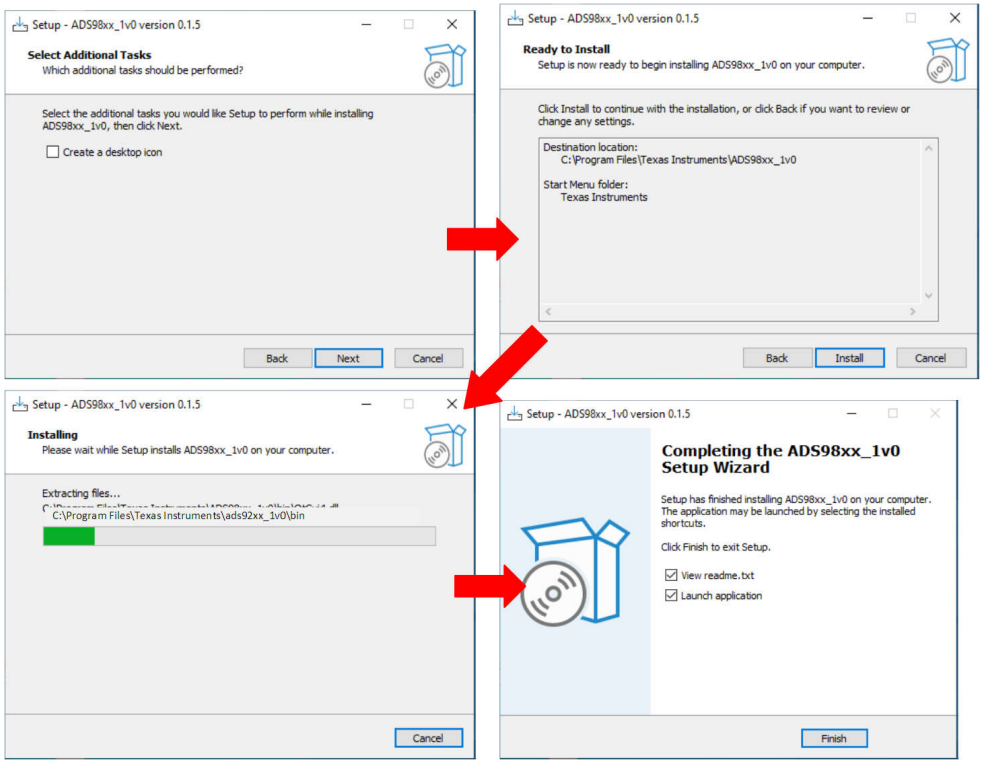


Figure 3-2. Installation Process

3.1.1 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. Bypass any USB hub and connect directly to the computer.
3. Open the Windows® Device Manager, as shown in Figure 3-3, and right-click on the *WestBridge* folder in the Device Manager window and select the *Update Driver* button (see Figure 3-4).
4. In the next window that appears, select *Browse my computer for driver software*.
5. Then select *Let me pick from a list of available drivers on my computer* in the next pop-up window.
6. Click on *Have Disk* in the pop-up window and navigate to: *C:\Program Files\Texas Instruments\ADS9324EVM-GUI\extras\Sparrow\Bootloader*

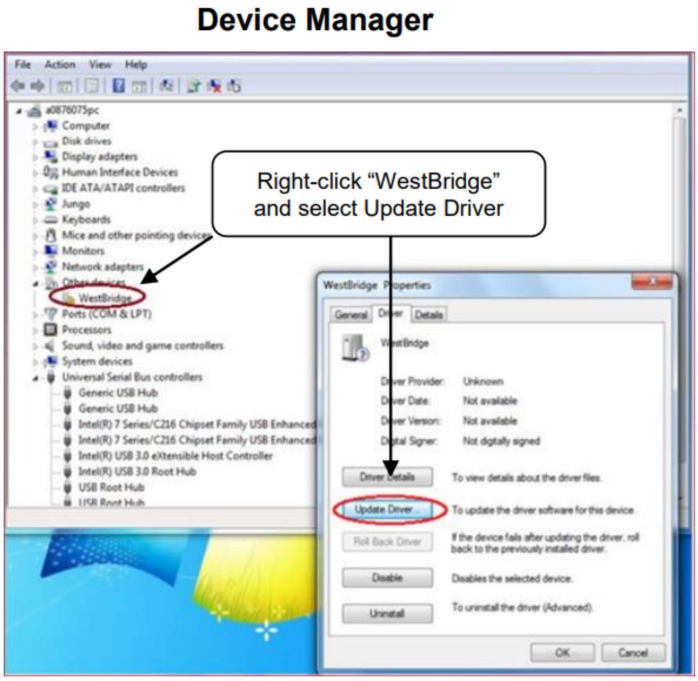


Figure 3-3. Open Device Manager

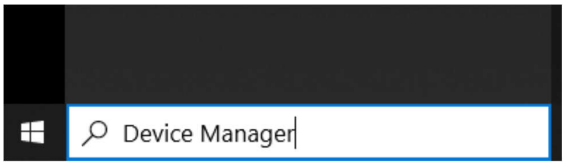


Figure 3-4. Update Driver With Device Manager

3.2 ADS9324EVM Software

3.2.1 Using Configuration Tab

After the EVM GUI is started, press the following buttons in the order shown below. After selecting the desired ADC from the drop-down menu, in this case ADS9324, click *BOARD STARTUP*. After the *USB Status*, *FPGA Power*, and *FPGA Program* lights are green, click *INITIALIZE DEVICE*.

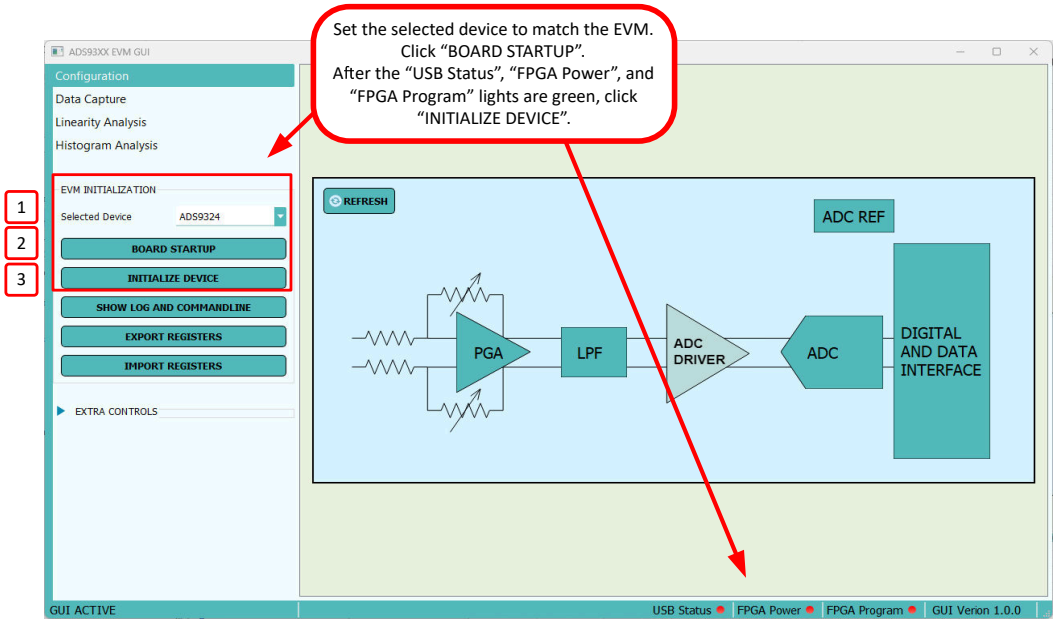


Figure 3-5. FPGA and ADC Initialization

The block diagram figures can be used to configure certain settings of the device. The *Device Registers* Tab can be used for more comprehensive device configuration. Press *REFRESH* on the block diagram to reflect updated device register settings.

The ADC data output length is 24-bit in the EVM GUI during oversampling. This is set automatically—the user need only set OSR as desired.

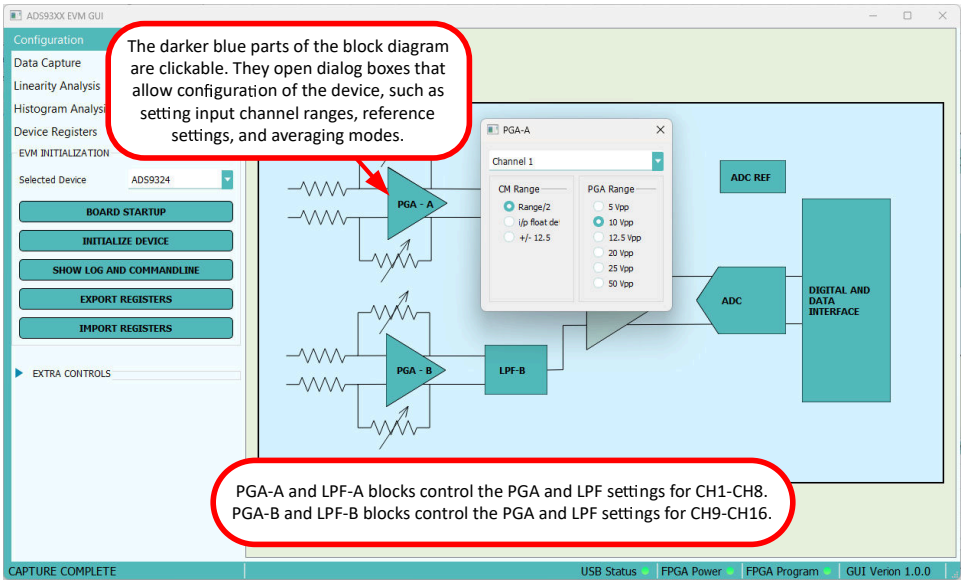


Figure 3-6. GUI Block Diagram

3.2.2 Using the Data Capture Tab

Figure 3-7 and Figure 3-8 show example data capture time-domain display and FFT display, respectively. In this step, the necessary updates to the *Data Capture* settings are made to capture the time domain data and to get a good frequency domain result. First, 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). The *Input Frequency* needs to be set to the frequency of the applied input signal.

When these changes are made, press the *Start Capture* button to collect time domain and frequency domain data. The *Data Plot* tab shows the time domain data and the FFT Plot tab shows the frequency domain data. The FFT plot window also shows the SNR, THD and SINAD performance measurements. Different channel data can be shown or hidden using the *Channels* tab above the plot.

Figure 3-7. Time Domain Data

Figure 3-8. FFT Data

3.2.3 Using the Linearity Analysis Tab

The INL and DNL tool measures the linearity of the of the ADS9324EVM by applying a full-scale, low-distortion sinusoidal input signal. The accuracy improves if the number of *hits per code* is increased at the cost of extra test time. Select the channel to measure and the *hits per code*. An input signal greater than full-scale is required to verify that all ADC codes are tested. An input signal of +0.1dBFS is sufficient. Then press the *GET INL/DNL* button to run this tool as shown in Figure 3-9. Users can use the listed coherent sampling frequency from the input signal for best INL and DNL performance.

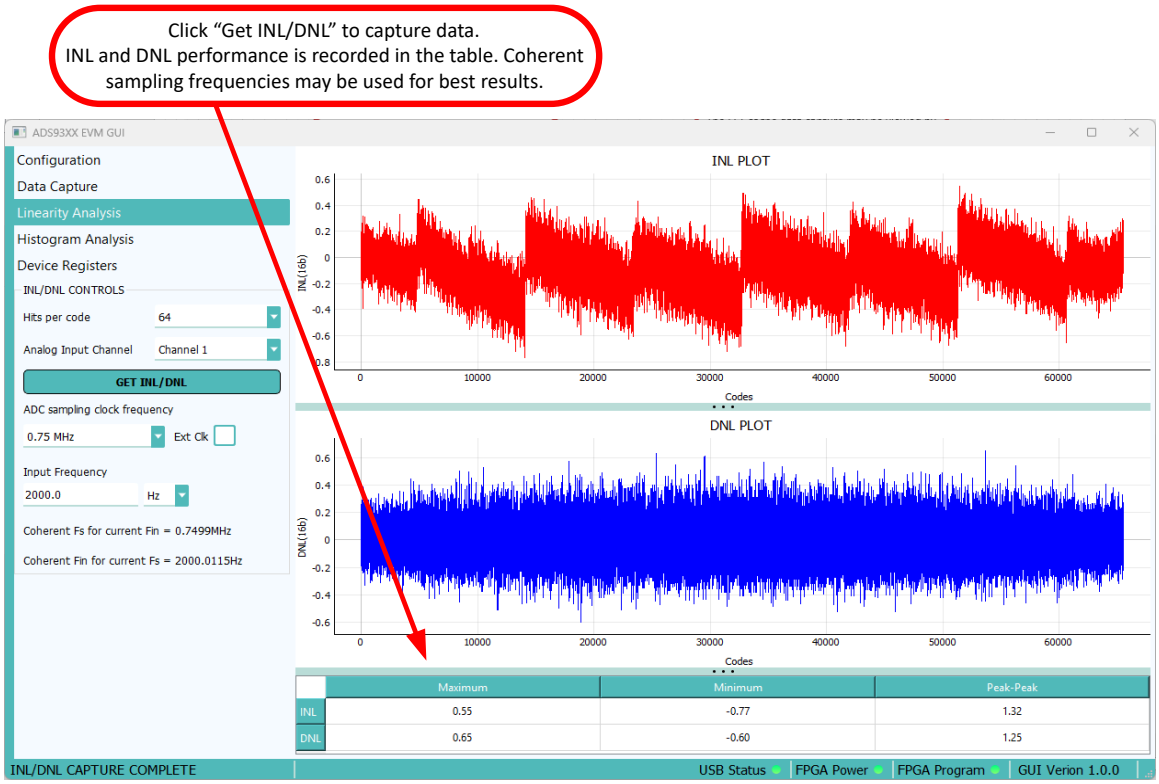


Figure 3-9. INL, DNL Data

3.2.4 Using the Histogram Analysis Tab

The histogram tool represents the distribution of ADC output codes for a given sample set. The accuracy of the statistical summary can be improved by increasing *number of samples*, which increases the sample size at the cost of extra test time. Select the channel to measure and configure the *number of samples*, *Vref*, and *ADC Full-scale*. Then, press the *GET HISTOGRAM* button as shown in Figure 3-10.

The cumulative effect of noise coupling to the ADC output comes from sources such as the input drive circuits, the reference drive circuit, the ADC power supply, and the ADC. The total noise is reflected in the standard deviation of the ADC output code histogram that is obtained by performing multiple conversions of a DC input applied to a given channel. Selecting the correct reference voltage gives the result in units of voltage instead of codes.

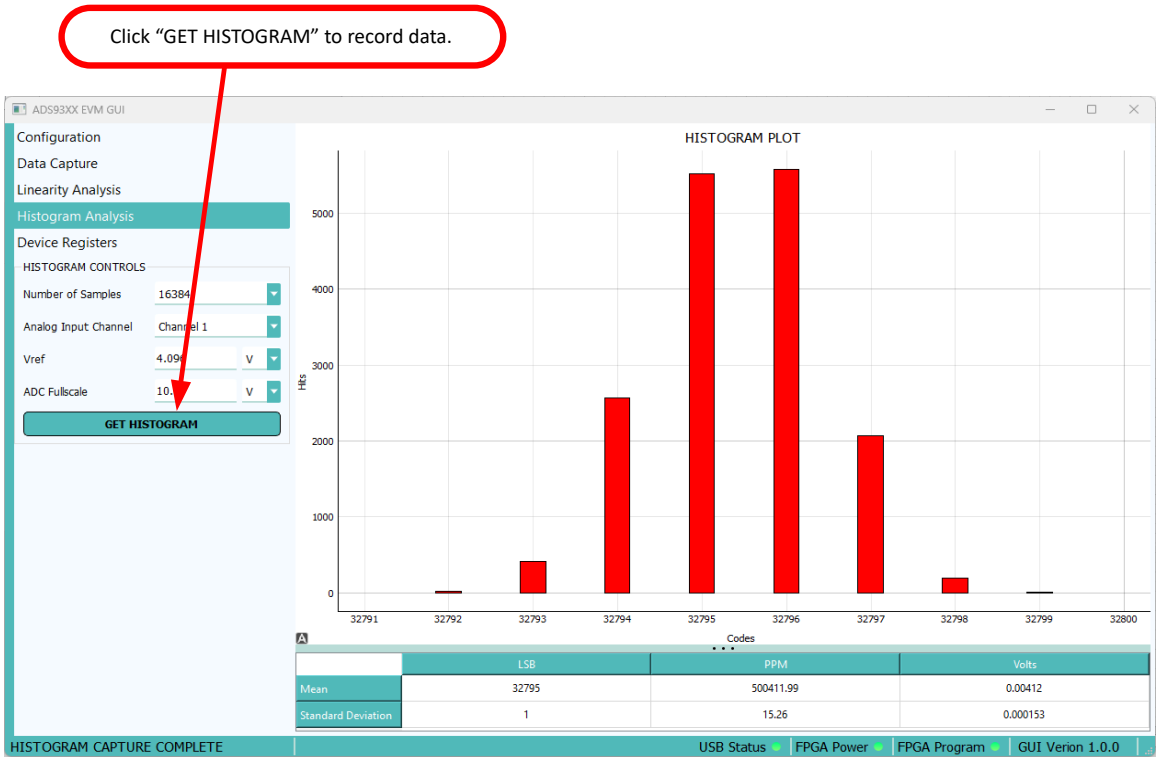


Figure 3-10. Histogram Data

4 Hardware Design Files

4.1 Schematics

4.1.1 ADS9324EVM Schematics

The schematics below show the various connections to the ADS9324 device. The digital signals connect to J22, as shown in Figure 4-5, and the analog signals connect to headers and input filtering. Figure 4-1 also shows the decoupling for the device.

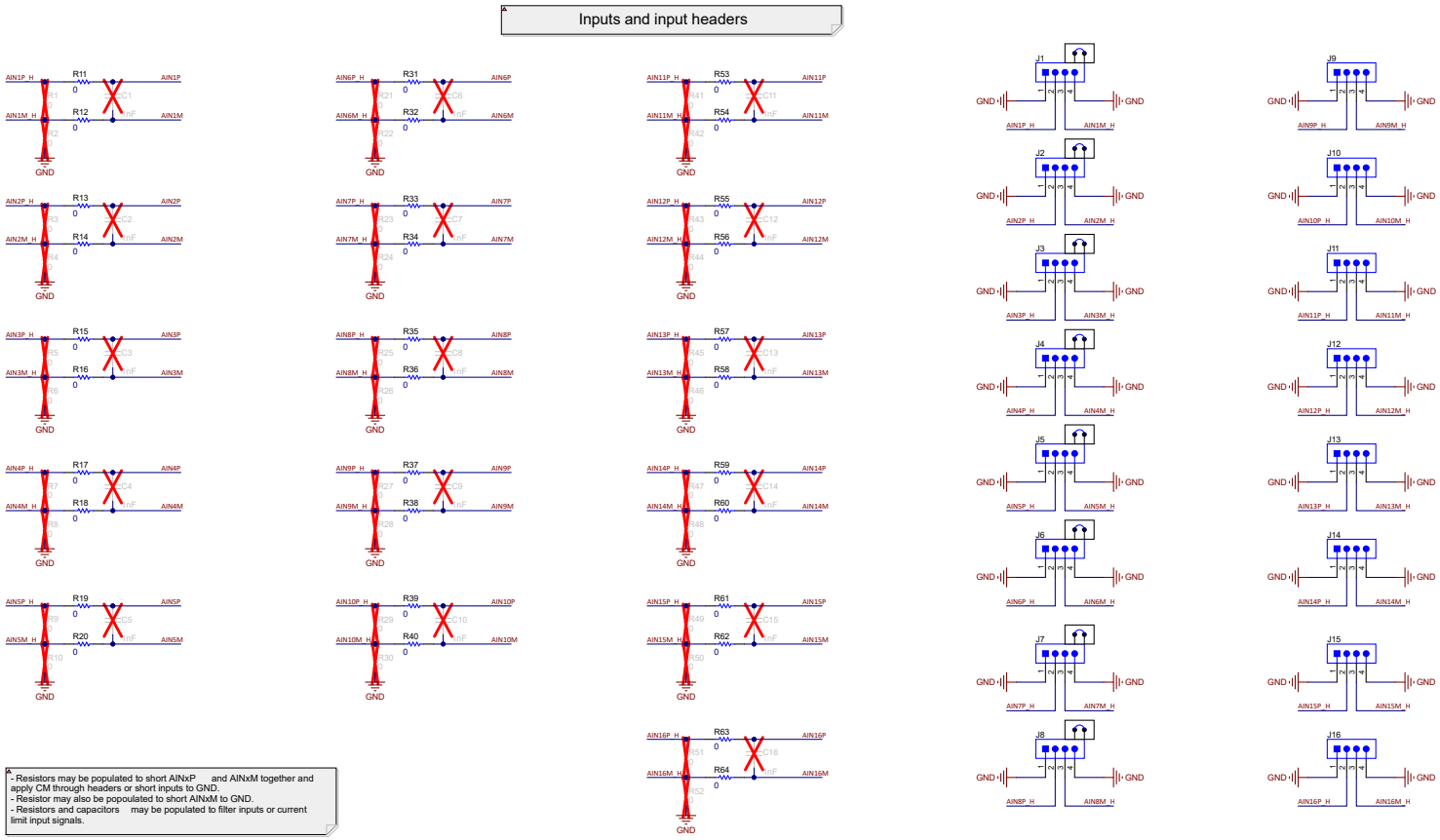


Figure 4-1. Inputs Schematic

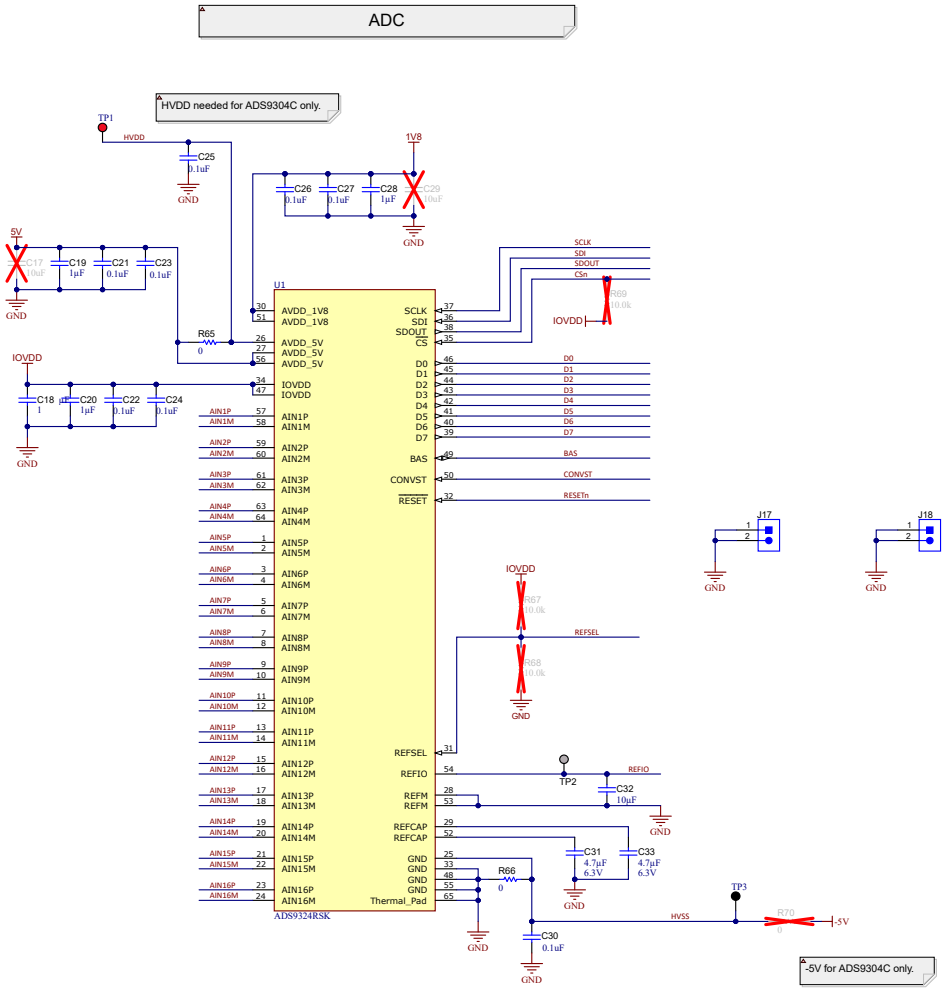


Figure 4-2. ADS9324 ADC Connections

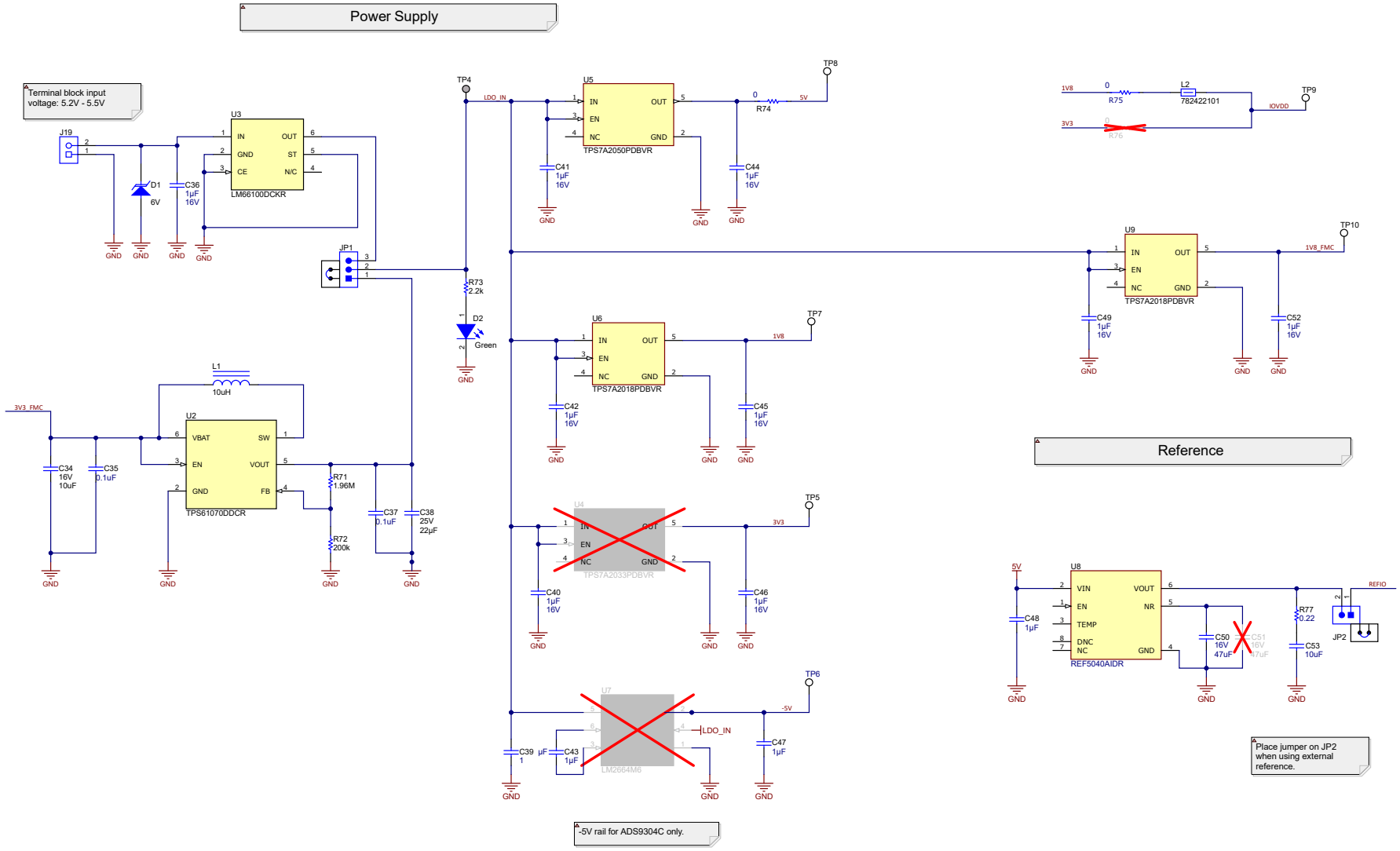


Figure 4-3. Power Connections and Regulators Schematic

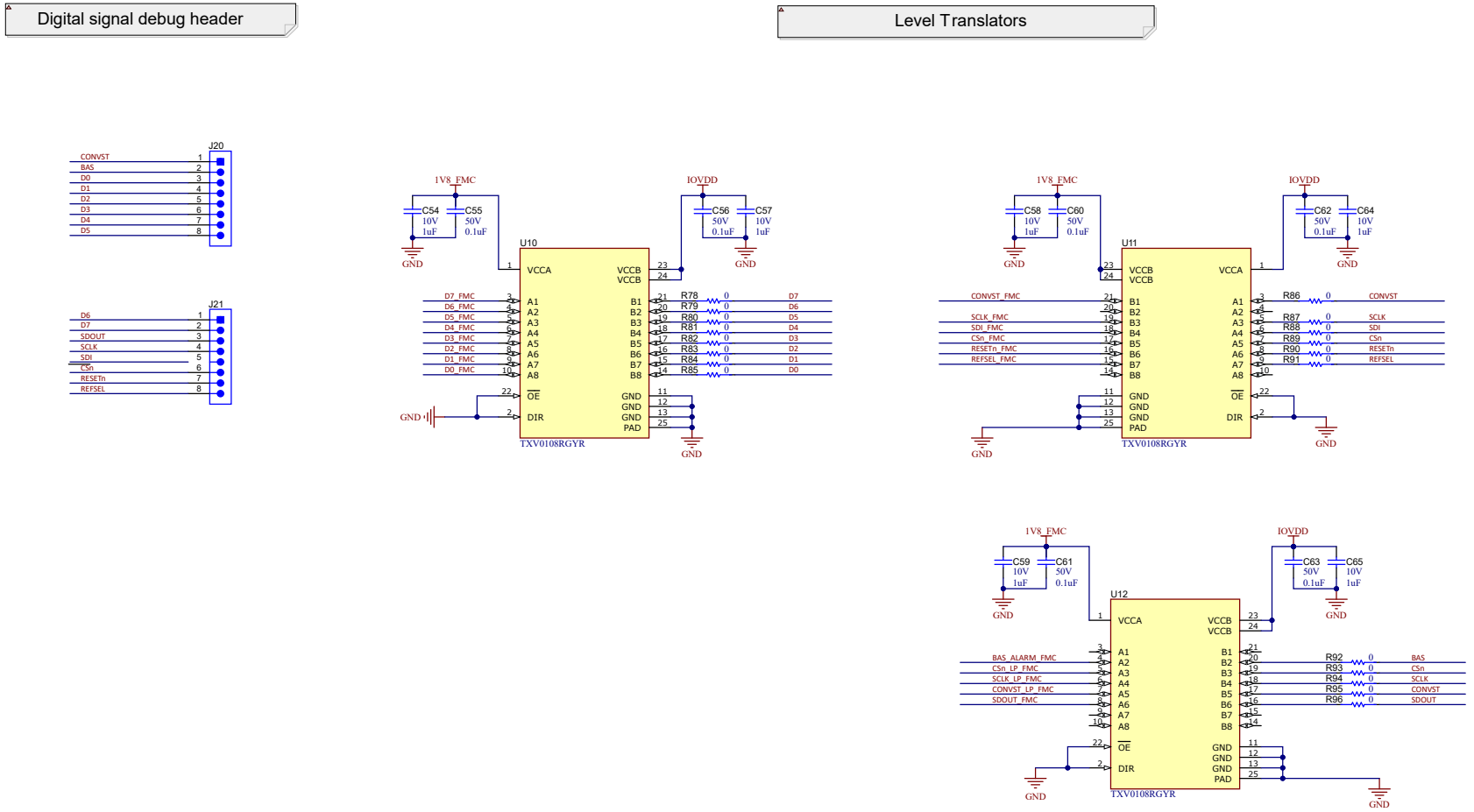


Figure 4-4. Level Translators

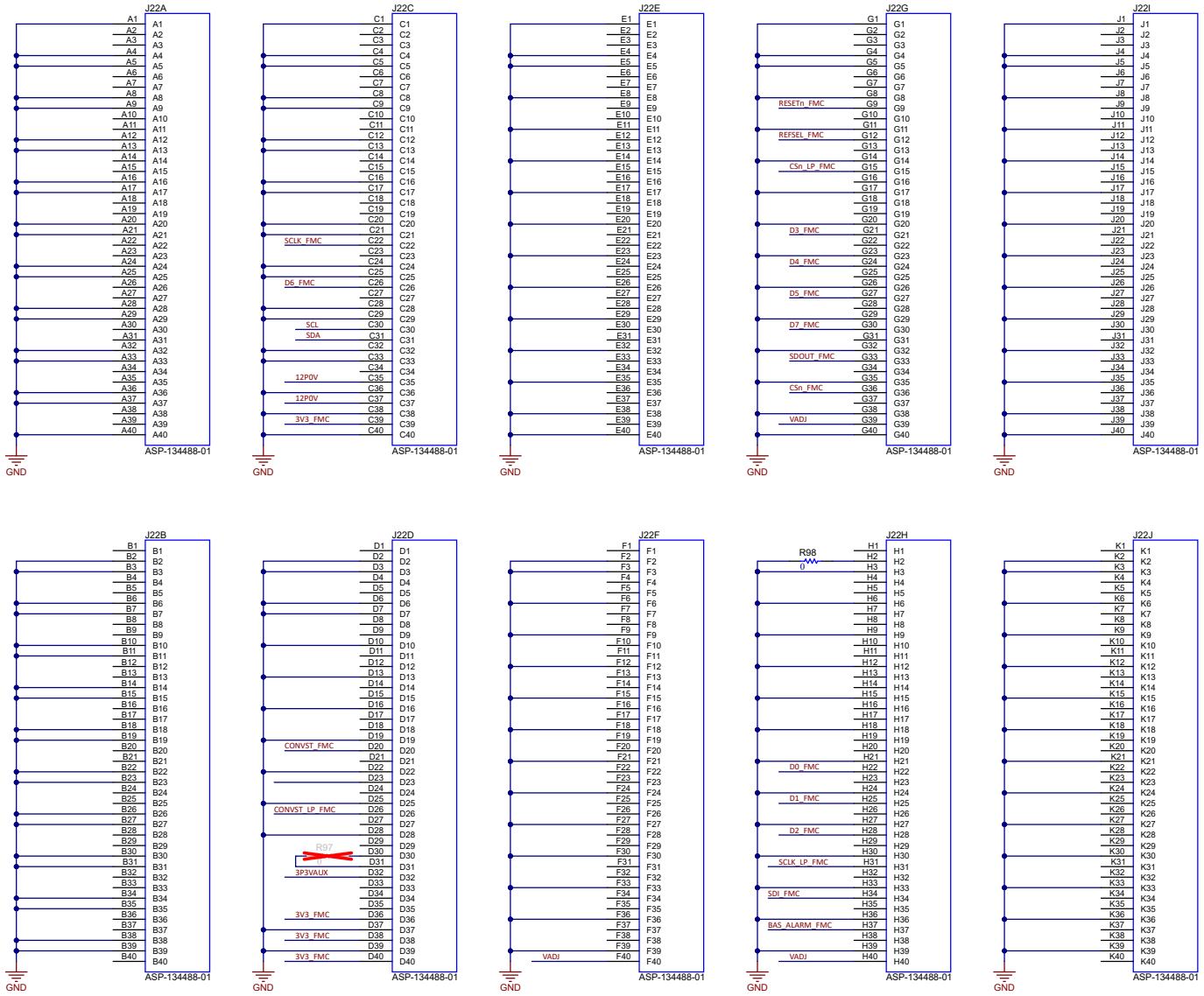


Figure 4-5. Digital Connector Schematic

4.2 Layout

Figure 4-6 through Figure 4-11 show the PCB layer plots for the ADS9324EVM.

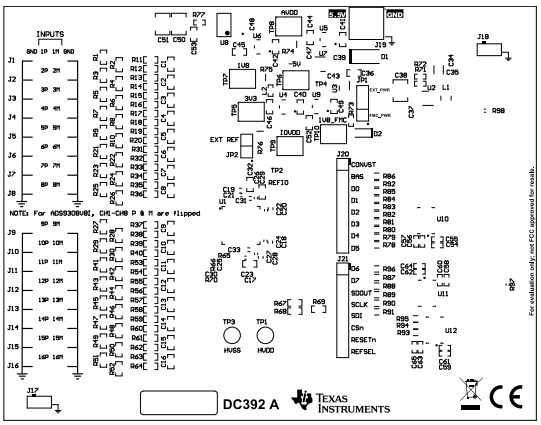


Figure 4-6. Top Overlay

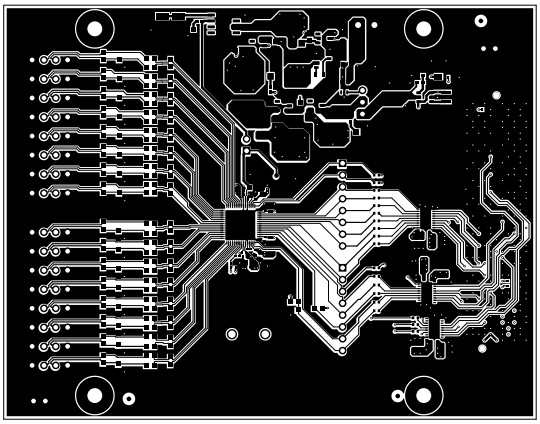


Figure 4-7. Top Layer

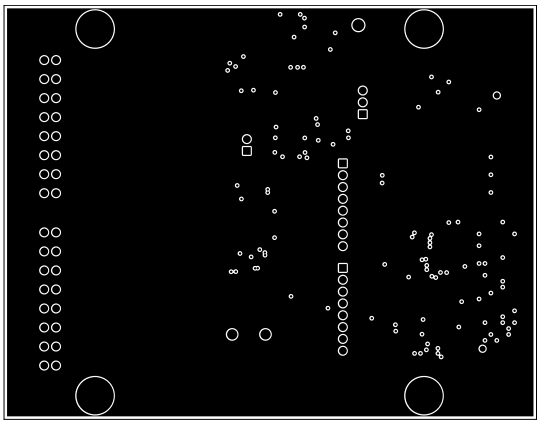


Figure 4-8. GND Layer

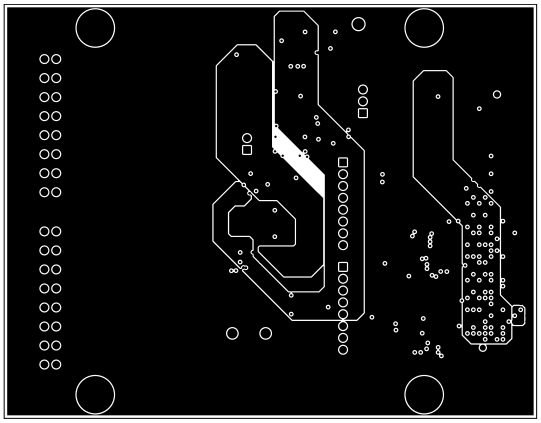


Figure 4-9. SIG Layer

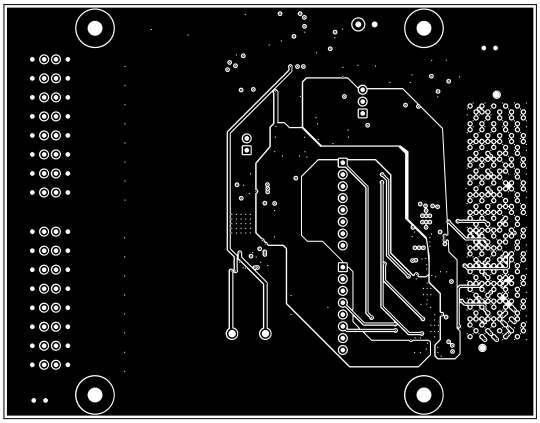


Figure 4-10. Bottom Layer

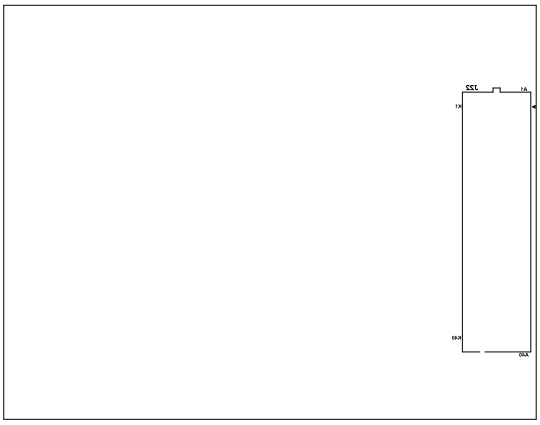


Figure 4-11. Bottom Overlay

4.3 Bill of Materials (BOM)

4.3.1 ADS9324EVM Bill of Materials (BOM)

Table 4-1 lists the ADS9324EVM bill of materials.

Table 4-1. ADS9324EVM Bill of Materials

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
C18, C19, C20, C28, C39, C43, C47, C48	8	1µF	CAP, CERM, 1µF, 25V, ±10%, X7R, AEC-Q200 Grade 1, 0603	0603	CGA3E1X7R1E105K080AC	TDK
C21, C22, C23, C24, C25, C26, C27, C30, C35, C37	10	0.1µF	CAP, CERM, 0.1µF, 16V, ±10%, X5R, 0402	0402	GRM155R61C104KA88D	MuRata
C31, C33	2	4.7µF	CAP, CERM, 4.7µF, 6.3V, ±20%, X5R, 0201	0201	GRM035R60J475ME15D	MuRata
C32	1	10µF	CAP, CERM, 10µF, 10V, ±20%, X7R, 0603	0603	GRM188Z71A106MA73D	MuRata
C34	1	10µF	CAP, CERM, 10µF, 16V, ±10%, X7R, 1206	1206	GRM31CR71C106KAC7L	MuRata
C36, C40, C41, C42, C44, C45, C46, C49, C52	9	1µF	CAP, CERM, 1µF, 16V, ±10%, X7R, 0603	0603	C1608X7R1C105K080AC	TDK
C38	1	22µF	CAP, CERM, 22µF, 25V, ±10%, X7R, AEC-Q200 Grade 1, 1210	1210	TMK325B7226KMHP	Taiyo Yuden
C50	1	47µF	CAP, CERM, 47µF, 16V, ±20%, X6S, 1210	1210	GRM32EC81C476ME15L	MuRata
C53	1	10µF	CAP, CERM, 10µF, 25V, ±20%, X5R, 0603	0603	GRM188R61E106MA73D	MuRata
C54, C57, C58, C59, C64, C65	6	1µF	CAP, CERM, 1µF, 10V, ±10%, X5R, 0402	0402	GRM155R61A105KE15D	MuRata
C55, C56, C60, C61, C62, C63	6	0.1µF	CAP, CERM, 0.1µF, 50V, ±10%, X7R, AEC-Q200 Grade 1, 0402	0402	GCM155R71H104KE02D	MuRata
D1	1	6V	Diode, TVS, Uni, 6V, 10.3Vc, 400W, 38.8A, SMA	SMA	SMAJ6.0A	Littelfuse
D2	1	Green	LED, Green, SMD	LED_0805	APT2012LZGCK	Kingbright
H1, H3, H5, H7	4	-	Standoff, Hex, 1"L #4-40 Nylon	Standoff	1902E	Keystone
H2, H4, H6, H8	4	-	Machine Screw, Round, #4-40x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025PH	B&F Fastener Supply
J1, J2, J3, J4, J5, J6, J7, J8, J9, J10, J11, J12, J13, J14, J15, J16	16	-	Header, 100mil, 4x1, Gold, TH	4x1 Header	TSW-104-07G-S	Samtec
J17, J18	2	-	Header, 2.54mm, 2x1, Gold, TH	Header, 2.54mm, 2x1, TH	TSW-102-08G-S	Samtec
J19	1	-	Terminal Block, 3.5mm Pitch, 2x1, TH	7.0x8.2x6.5mm	ED555/2DS	On-Shore Technology
J20, J21	2	-	Header, 100mil, 8x1, Gold, TH	8x1 Header	TSW-108-07G-S	Samtec
J22	1	-	Connector, 1.27mm, 40x10, Black, SMT	Connector, 1.27mm, 40x10, SMT	ASP-134488-01	Samtec
JP1	1	-	Header, 100mil, 3x1, Gold, TH	Header, 100mil, 3x1, TH	HTSW-103-07G-S	Samtec
JP2	1	-	Header, 100mil, 2x1, Gold, TH	Header, 100mil, 2x1, TH	HTSW-102-07G-S	Samtec
L1	1	10µH	Inductor, Wirewound, Ceramic, 10µH, 0.48A, 0.36ohm, SMD	2.5x1.8x1.8mm	CBC2518T100M	Taiyo Yuden
L2	1	100Ω	Ferrite Bead, 100Ω at 100MHz, 0.3A, 0402	0402	782422101	Wurth Elektronik

Table 4-1. ADS9324EVM Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
R11, R12, R13, R14, R15, R16, R17, R18, R19, R20, R31, R32, R33, R34, R35, R36, R37, R38, R39, R40, R53, R54, R55, R56, R57, R58, R59, R60, R61, R62, R63, R64	32	0	RES, 0, 5%, 0.1W, AEC-Q200 Grade 0, 0603	0603	ERJ-3GEY0R00V	Panasonic
R65, R66, R98	3	0	RES, 0, 5%, 0.063W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0ED	Vishay-Dale
R71	1	1.96Meg	RES, 1.96M, 1%, 0.063W, 0402	0402	CRCW04021M96FKED	Vishay-Dale
R72	1	200k	RES, 200k, 1%, 0.063W, 0402	0402	CRCW0402200KFKED	Vishay-Dale
R73	1	2.2k	RES, 2.2k, 5%, 0.063W, 0402	0402	CRCW04022K20JNED	Vishay-Dale
R74, R75	2	0	0Ω Jumper 0.5W, 1/2W Chip Resistor 0805 (2012 Metric) Automotive AEC-Q200 Metal Foil	0805	HCJ0805ZT0R00	Stackpole
R77	1	0.22	RES, 0.22, 1%, 0.125W, AEC-Q200 Grade 0, 0402	0402	ERJ-2BQFR22X	Panasonic
R78, R79, R80, R81, R82, R83, R84, R85, R86, R87, R88, R89, R90, R91, R92, R93, R94, R95, R96	19	0	Res Jumper Thick Film 0402 0Ω 5% 1/16W Molded SMD Paper T/R	0402	RC0402JR-070RP	Yageo
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10	10	-	Shunt, 2.54mm, Gold, Black	Shunt, 2.54mm, Black	60900213421	Wurth Elektronik
TP1	1	-	Test Point, Multipurpose, Red, TH	Red Multipurpose Test point	5010	Keystone Electronics
TP3	1	-	Test Point, Multipurpose, Black, TH	Black Multipurpose Test point	5011	Keystone Electronics
TP5, TP6, TP7, TP8, TP9, TP10	6	-	Test Point, Compact, SMT	Testpoint_Keystone_Compact	5016	Keystone Electronics
U1	1	-	16-Channel, 16-Bit, 1-MSPS Simultaneous-sampling SAR ADC with Bipolar Inputs on a Single Supply	QFN64	ADS9324RSK	Texas Instruments
U2	1	-	Adjustable, 600mA Switch, 90% Efficient PFM/PWM Boost Converter in ThinSOT-23, DDC0006A (SOT-23T-6)	DDC0006A	TPS61070DDCR	Texas Instruments
U3	1	-	±6V, Low IQ Ideal Diode with Input Polarity Protection, DCK0006A (SOT-SC70-6)	DCK0006A	LM66100DCKR	Texas Instruments
U5	1	-	300mA, ultra-low-noise, low-IQ, low-dropout (LDO) linear regulator with high PSRR 5-SOT-23 –40 to 125	SOT23-5	TPS7A2050PDBVR	Texas Instruments
U6, U9	2	-	Linear Voltage Regulator IC Positive Fixed 1 Output 300mA SOT-23-5	SOT23-5	TPS7A2018PDBVR	Texas Instruments
U8	1	-	REF5040AIDR	SOIC8	REF5040AIDR	Texas Instruments
U10, U11, U12	3	-	Automotive Dual-supply RGMII Buffer with Configurable Voltage Translation and Tri-state Outputs	VQFN24	TXV0108RGYR	Texas Instruments
C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16	0	1000pF	CAP, CERM, 1000pF, 100V, ±10%, X7R, 0603	0603	GRM188R72A102KA01D	MuRata
C17, C29	0	10µF	CAP, CERM, 10µF, 25V, ±20%, X5R, 0603	0603	GRM188R61E106MA73D	MuRata

Table 4-1. ADS9324EVM Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
C51	0	47µF	CAP, CERM, 47µF, 16V, ±20%, X6S, 1210	1210	GRM32EC81C476ME15L	MuRata
R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R21, R22, R23, R24, R25, R26, R27, R28, R29, R30, R41, R42, R43, R44, R45, R46, R47, R48, R49, R50, R51, R52	0	0	RES, 0, 5%, 0.1W, AEC-Q200 Grade 0, 0603	0603	ERJ-3GEY0R00V	Panasonic
R67, R68, R69	0	10.0k	RES, 10.0k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW060310K0FKEA	Vishay-Dale
R70, R97	0	0	RES, 0, 5%, 0.063W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0ED	Vishay-Dale
R76	0	0	0 Ohms Jumper 0.5W, 1/2W Chip Resistor 0805 (2012 Metric) Automotive AEC-Q200 Metal Foil	0805	HCJ0805ZT0R00	Stackpole
U4	0	-	300mA, Ultra-Low-Noise, Low-IQ, High PSRR LDO	SOT23-5	TPS7A2033PDBVR	Texas Instruments
U7	0	-	Switched Capacitor Voltage Converter, 6-pin SOT-23	DBV0006A	LM2664M6/NOPB	Texas Instruments

5 Additional Information

5.1 Trademarks

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All trademarks are the property of their respective owners.

6 Related Documentation

The following related documents are available for download through the Texas Instruments web site at www.ti.com.

Table 6-1. Related Documentation

Device	Literature Number
TSWDC155EVM	SLAU870
TPS61070	SLVS510
TPS7A20	SBVS338
LM66100	SLVSEZ8
REF5040	SBOS410

7 Revision History

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

Changes from August 27, 2025 to October 20, 2025 (from Revision * (August 2025) to Revision A (October 2025)) **Page**

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

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

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.

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

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。

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

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

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:*

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