# EVAL-AD7172-4SDZ User Guide
## UG-763

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# Evaluating the AD7172-4 Low Power 24-Bit, 31.25 kSPS, Sigma-Delta ADC with True Rail-to-Rail Buffers

## FEATURES

**Full featured evaluation board for the AD7172-4**
**PC control in conjunction with the system demonstration platform (SDP), see the EVAL-SDP-CB1Z from Analog Devices, Inc., for additional information**
**PC software for control and data analysis (time domain)**
**Standalone capability**

## EVALUATION KIT CONTENTS

**EVAL-AD7172-4SDZ evaluation board**
**Evaluation software CD**
**7 V to 9 V ac to dc adapter**
**Plastic screw washer set**

## EQUIPMENT NEEDED

**DC signal source**

## GENERAL DESCRIPTION

The EVAL-AD7172-4SDZ evaluation kit features the AD7172-4, a 24-bit, 31.25 kSPS analog-to-digital converter (ADC) with integrated rail-to-rail analog input buffers, on-board power supply regulation, and an external amplifier section for amplifier evaluation. A 7 V to 9 V ac to dc adapter is regulated to 5 V and 3.3 V; this voltage supplies the AD7172-4 and support components. The EVAL-AD7172-4SDZ connects to a USB port of a PC via the EVAL-SDP-CB1Z (SDP-B)controller board.

The EVAL-AD7172-4SDZ evaluation software fully configures the AD7172-4 device functionality via a user accessible register interface and provides dc time domain analysis in the form of waveform graphs, histograms, and associated noise analysis for ADC performance evaluation.

## EVAL-AD7172-4SDZ BLOCK DIAGRAM

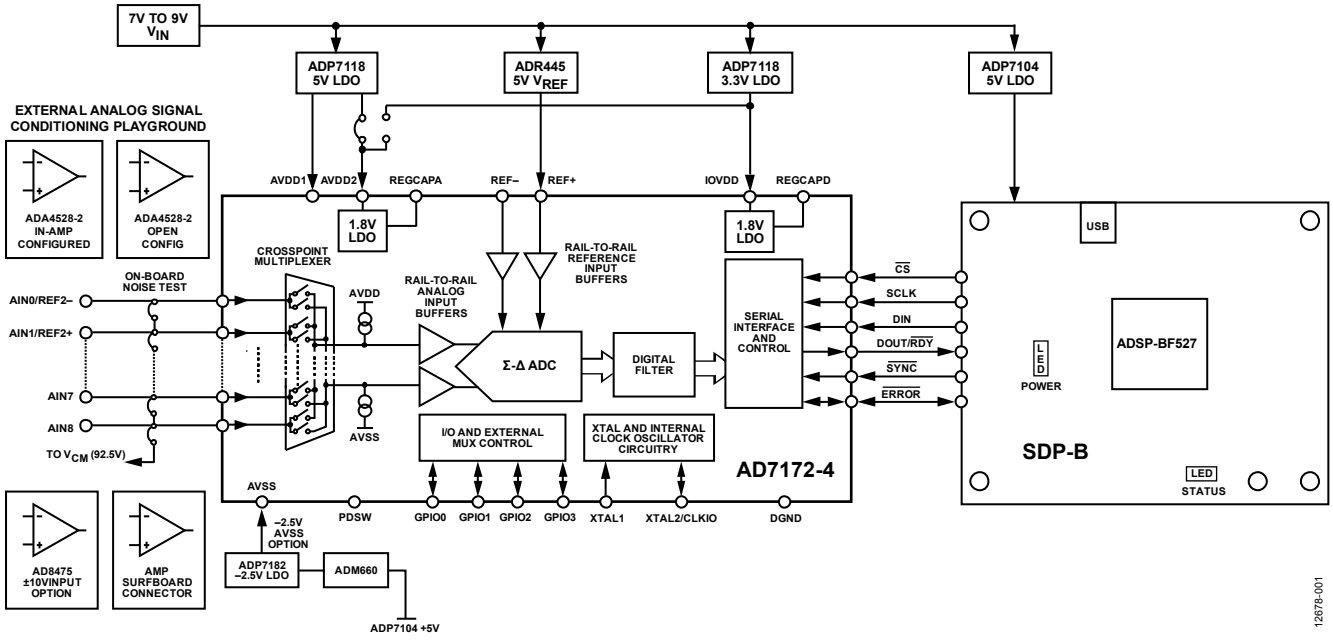


*Figure 1.*

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**10/2017—Rev. 0 to Rev. A**

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**8/2015—Revision 0: Initial Version**

# EVAL-AD7172-4SDZ QUICK START GUIDE

## RECOMMENDED QUICK START GUIDE

Follow these steps to set up the board:

1. Disconnect the SDP-B board from the USB port of the PC. Install the software AD717x Eval+ from the enclosed CD. After the AD717x Eval+ installs, the AD717x Eval+ dependencies installer runs and installs the required drivers. Restart the PC after installation.
2. Connect the SDP-B board to the EVAL-AD7172-4SDZ board, as shown in Figure 2.
3. Fasten the two boards with the enclosed plastic screw washer set.
4. Connect the external 9 V power supply to the J5 connector of the evaluation board, as shown in Figure 2. Set LK2 to Position B.
5. Connect the SDP-B to the PC via the USB cable. For Windows® XP, the user may need to search for the SDP-B drivers.
6. Choose to automatically search for the drivers for the SDP-B board if prompted by the Windows operating system.
7. Launch the AD717x Eval+ software from the Analog Devices subfolder in the **Programs** menu.

## QUICK START NOISE TEST

Use the following procedure to test the noise performance:

1. Insert Link LK8 to Link LK16 to initiate the noise performance test mode. In this mode, analog input channels short to $V_{CM}$, which is equal to 2.5 V.
2. Click **Sample** to acquire samples from the ADC (see Figure 15).

The **Samples** numeric control in the top right corner of the main window sets the number of samples collected in each batch (see Figure 15).

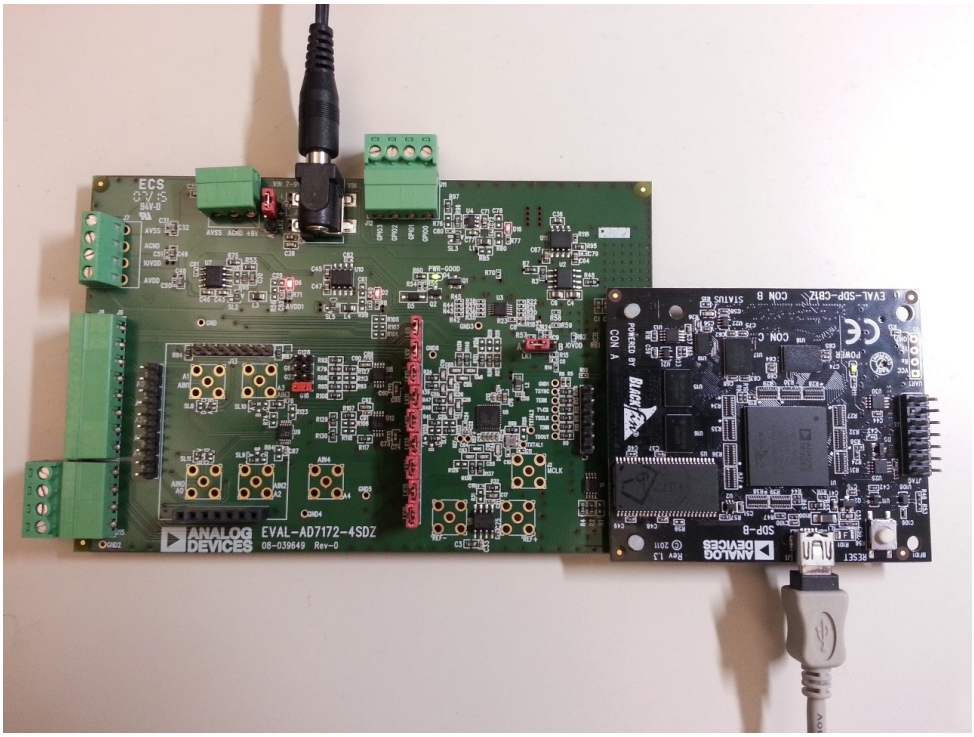


*Figure 2. Hardware Configuration, Setting Up the EVAL-AD7172-4SDZ*

# EVALUATION BOARD HARDWARE

## DEVICE DESCRIPTION

The AD7172-4 is a highly accurate, high resolution, multiplexed, 4-/8-channel (fully differential/single-ended) Σ-Δ ADC. The AD7172-4 has a maximum channel to channel scan rate of 6.21 kSPS (161 µs) for fully settled data. The output data rates range from 1.25 SPS to 31.25 kSPS. The device includes integrated rail-to-rail analog input and reference input buffers, and an integrated oscillator.

See the AD7172-4 data sheet for complete specifications. Consult the data sheet in conjunction with this user guide when using the evaluation board. Full details for the SDP-B are available on the Analog Devices website.

## HARDWARE LINK OPTIONS

See Table 1 for default link options. By default, the evaluation board is configured to operate from the supplied 9 V ac to dc adapter connected to the J5 connector. The 5 V supply required for the AD7172-4 comes from the on-board low dropout (LDO) regulator. The ADP7118, with a 5 V output voltage, receives its input voltage from the J3 connector or the J5 connector (depending on the position of LK2) and generates a 5 V output.

**Table 1. Default Link and Solder Link Options**

| Link | Default Option | Description |
|---|---|---|
| LK1 | A | Selects the voltage applied to the power supply sequencer circuit (U3); dependent on AVDD1. Place in Position A if using 5 V AVDD1, or Position B if using 2.5 V AVDD1 and – 2.5 V AVSS. |
| LK2 | B | Selects the external power supply from Connector J3 (Position A) or Connector J5 (Position B). |
| LK3 to LK7 | Not inserted | Inserting these links sets up the on-board noise test prior to SL8 to SL11 to allow the inputs to the on-board amplifiers, U8 and U9, to be shorted. In this mode, all inputs short to $V_{CM}$, which is equal to 2.5 V. |
| LK8 to LK16 | Inserted | Inserting these links sets up the on-board noise test close to the ADC analog inputs. In this mode, all inputs short to $V_{CM}$, which is equal to 2.5 V. |
| SL1 | A | Selects the voltage applied to the AVDD2 pin. SL1 is positioned on the bottom side of the board. Position A is located at the lower end of SL1 and Position B is at the upper end. Position A selects AVDD1 (default). Position B selects an external 3.3 V supply from the ADP7118 (3.3 V) (U10) regulator. |
| SL2 | A | Selects between an external or on-board AVDD1 source. Position A selects the on-board supply for AVDD1 set from the ADP7118 (5 V) (U7) (default). Position B selects the external supply voltage connected to J7, Pin 4. |
| SL3 | A | Selects between an external or on-board AVSS source. Position A selects the on-board supply for AVSS from the ADP7182 (−2.5 V) (U4) (default). Position B selects the external supply voltage connected to J7, Pin 1. |
| SL4 | C | Connects AIN8 to Pin 6 on J6 (Position A); $V_{CM}$, which is equal to 2.5 V (Position B); or AVSS (Position C). Position B and Position C are used to simplify the use of a single-ended input source. |
| SL5 | B | Selects between an external or on-board IOVDD source. Position B selects the on-board supply for IOVDD from the ADP7118 (3.3 V) (U10) (default). Position B selects the external supply voltage connected to J7, Pin 3. The evaluation board operates with a 3.3 V logic. |
| SL8 | A | Routes A1 input to the AIN5 pin on the AD7172-4 (Position A), Buffer/In-Amp U8 (Position B), Funnel Amp U9 with gain of 0.8× (Position C), or J10-1 (Position D). |
| SL9 | A | Routes A2 to the AIN6 pin on the AD7172-4 (Position A), Buffer U12 (Position B), or Funnel Amp U9 gain of 0.4× (Position C). |
| SL10 | A | Routes A3 to the AIN7 pin on the AD7172-4 (Position A), Buffer U12 (Position B), or Funnel Amp U9 gain of 0.4× (Position C). |
| SL11 | A | Routes A0 to the AIN4 pin on the AD7172-4 (Position A), Buffer/In-Amp U8 (Position B), Funnel Amp U9 with gain of 0.8× (Position C), or J10-7 (Position D). |
| G16 | Inserted | Sets the on-board U8 in-amp to a gain of 16. Insert only one of G16, G32, G64, or G128 at a time. |
| G32 | Not Inserted | Sets the on-board U8 in-amp to a gain of 32. Insert only one of G16, G32, G64, or G128 at a time. |
| G64 | Not Inserted | Sets the on-board U8 in-amp to a gain of 64. Insert only one of G16, G32, G64, or G128 at a time. |
| G128 | Not Inserted | Sets the on-board U8 in-amp to a gain of 128. Insert only one of G16, G32, G64, or G128 at a time. |
| R49 to R51 | Inserted | Connects AVSS and AGND for single-supply operation. To operate in split supply mode, remove these links. |

## SOCKETS AND CONNECTORS

**Table 2. Connector Details**

| Connector | Function | Connector Type | Manufacturer | Manufacturer Number | Order Code[1] |
|---|---|---|---|---|---|
| J1 | Connector to the SDP-B | 120-way connector, 0.6 mm pitch | Hirose | FX8-120S-SV(21) | FEC1324660 |
| J2 | External MCLK input | Straight PCB mount SMB/SMA jack | TE Connectivity | 1-1337482-0 | Not applicable |
| J3 | External bench top voltage supply for the EVAL-AD7172-4SDZ | Power socket block, 3-pin, 3.81 mm pitch | Phoenix Contact | MC 1,5/ 3-G-3,81 | FEC3704737 |
| J5 | External ac to dc adapter input for the EVAL-AD7172-4SDZ, 7 V to 9 V | DC power connectors, 2 mm SMT power jack | Kycon | KLDX-SMT2-0202-A | MOUSER 806-KLDX-SMT20202A |
| J6 | Analog input terminal block; wired connection to external source or sensor | Power socket block, 8-pin, 3.81 mm pitch | Phoenix Contact | MC 1,5/ 8-G-3,81 | FEC3704774 |
| J9 | External bench top voltage supply option for AVDD1/AVDD2, IOVDD, and AVSS inputs on the AD7172-4 | Screw terminal block, 3.81 mm pitch | Phoenix Contact | MKDS 1/4-3.81 | FEC3704592 |
| J10 | Optional header | 7-way, 2.54 mm pin header | Samtec | SSW-107-01-T-S | FEC1803478 |
| J13 | Optional header | 7-way, 2.54 mm socket | Samtec | TLW-107-05-G-S | FEC1668499 |
| A0 to A4 | Analog inputs to ADC | Straight PCB mount SMB/SMA jack | TE Connectivity | 1-1337482-0 | Not applicable |
| A7 | Pmod™-compatible header | 6-pin single inline header (0.1 inch pitch) | Harwin | 20-9990646 | FEC 1022255 |

[1] Order codes starting with FEC are for Farnell.

## SERIAL INTERFACE

The EVAL-AD7172-4SDZ evaluation board connects via the serial peripheral interface (SPI) to the Blackfin® ADSP-BF527 on the SDP-B. There are four input signals: $\overline{CS}$, SCLK, DIN, and $\overline{SYNC}$, and one output signal from the ADC, DOUT/$\overline{RDY}$ (see Figure 1).

To operate the evaluation board in standalone mode, disconnect the evaluation board from the SDP-B controller board. Use the test points labeled on the evaluation board to connect the signals to an alternative digital capture setup or the Pmod-compatible header (A7).

## POWER SUPPLIES

Power the evaluation board from the ac to dc adapter connected to J5, or from an external bench top supply applied to J3 or J9. Linear LDO regulators generate the required voltages from the applied input voltage ($V_{IN}$) rail when using J3 or J5. Use J9 to bypass the on-board regulators. An ADP7118 regulator generates the 5 V (single-supply) and 2.5 V (split supply) supplies for the AVDD1 and AVDD2 rails to the ADC; a second ADP7118 generates 3.3 V for the IOVDD rail. The ADP7104 supplies 5 V for the SDP-B controller board as well as 5 V for the ADM660 voltage converter to generate −5 V to supply the ADP7182. The ADP7182 generates the −2.5 V supply for AVSS when operating in split supply mode. Each supply is decoupled where it enters the board and again at each device (evaluation board files, including schematics and bill of materials, are available for download at http://www.analog.com/EVAL-AD7172-4).

Table 3 shows the various power supply configurations available, including split supply operation.

**Table 3. Power Supply Configurations[1]**

| Configuration | Input Voltage Range | Description |
|---|---|---|
| Single Supply (Regulated) | 7 V to 9 V | The 7 V to 9 V input is regulated to 5 V for AVDD1/AVDD2 and 3.3 V for IOVDD. This also powers the external 5 V reference. See the Single-Supply (Regulated) section. |
| Single Supply (Unregulated) | 7 V to 9 V, 5 V, and 3.3 V | The input is unregulated and connects directly to AVDD1/AVDD2 and IOVDD from J5. The 7 V to 9 V input powers the external 5 V reference. See the Single Supply (Unregulated) section. |
| Split Supply (Regulated) | 7 V to 9 V | The 7 V to 9 V input is regulated to 2.5 V for AVDD1/AVDD2, −2.5 V for AVSS and 3.3 V for IOVDD. The 7 V to 9 V input powers the external 5 V reference, See the Split Supply (Regulated) section. |
| Split Supply (Unregulated) | 7 V to 9 V, ±2.5 V, and 3.3 V | The input is unregulated and connects directly to AVDD1/AVDD2 and IOVDD from J5. The 7 V to 9 V input powers the external 5 V reference. See the Split Supply (Unregulated) section. |

[1] Only one configuration can be used at a time.

## POWER SUPPLY CONFIGURATIONS

### *Single-Supply (Regulated)*

There are two available power supply options for the single supply (regulated) configuration.

- Connect the ac to dc adapter (included) to J5 and set LK2 to Position B or Connect the bench top power supply to J3, set LK2 to Position A, and ensure that AVSS = AGND = 0 V.
- Set all other links and solder links to the default settings as outlined in Table 1.

### *Single Supply (Unregulated)*

To set up the board, use the following procedure:

1. Move SL2 to Position B and SL5 to Position A.
2. Connect the two terminals of J9 (AGND and AVSS).
3. Connect the 0 V input (GND) to J9 at the AGND terminal.
4. Connect the 5 V input to J9 at the AVDD terminal.
5. Connect the 3.3 V input to J9 at the IOVDD terminal.
6. Connect the 7 V to 9 V input to J5.

Set all other links and solder links to the default settings as outlined in Table 1.

### *Split Supply (Regulated)*

To set up the board, use the following procedure:

1. Remove R49 to R51. These links connect AVSS to AGND.
2. Insert a 0 Ω resistor at R67 and R85.
3. Set LK1 to Position B, which sets the input to the power monitor circuitry to work with the lower AVDD1 supply of 2.5 V.
4. Connect the 7 V to 9 V input to J5 and set LK2 to Position B.

Set all other links and solder links to the default settings as outlined in Table 1.

### *Split Supply (Unregulated)*

To set up the board, use the following procedure:

1. Move SL2 and SL3 to Position B, and SL5 to Position A.
2. Remove R49 to R51.
3. Insert a 0 Ω resistor at R67 and R85.
4. Connect the 0 V input (GND) to J9 at the AGND terminal.
5. Connect the 2.5 V input to J9 at the AVDD terminal.
6. Connect the −2.5 V input to J9 at the AVSS terminal.
7. Connect the 3.3 V input to J9 at the IOVDD terminal.
8. Set LK1 to Position B, which sets the input to the power monitor circuitry to work with the lower AVDD1 supply of 2.5 V.
9. Connect the 7 V to 9 V input to J5.

Set all other links and solder links to the default settings as outlined in Table 1.

## ANALOG INPUTS

The primary analog inputs of the EVAL-AD7172-4SDZ evaluation board can be applied in two separate ways.

- At the J6 connector on the left side of the board
- At the A0 to A4 SMB/SMA footprints on the evaluation board

The analog inputs route directly to the associated analog input pins on the AD7172-4 provided that the LK3 to LK16 links are removed. The AD717x Eval+ software is set up to analyze dc inputs to the ADC. The AD7172-4 input buffers work for dc input signals.

## REFERENCE OPTIONS

The EVAL-AD7172-4SDZ includes an external 5 V reference, the ADR445. This reference connects to the REF+ input, and the REF− input is connected to AVSS. The AD7172-4 has a second reference input, AIN0/REF2− and AIN1/REF2+. There are also two SMB/SMA footprints for connecting an external voltage reference source in place of the ADR445.

# EVALUATION BOARD SOFTWARE

## SOFTWARE INSTALLATION

The EVAL-AD7172-4SDZ evaluation kit includes software on a CD. Double click the **setup.exe** file from the CD to run the installer. The default installation location for the software is **C:\Program Files\Analog Devices\ AD7172-4 Eval+\.**

Install the AD717x Eval+ software before connecting the evaluation board and the SDP-B to the USB port of the PC to ensure that the evaluation system is correctly recognized when connected to the PC.

There are two parts to the installation.

1. AD717x Eval+ software installation.
2. AD717x Eval+ Dependencies
   a) SDP-B board drivers
   b) Ssrc SVG plug in

### *Warning*

To ensure the PC correctly recognized the evaluation system, the evaluation software drivers must be installed before connecting the EVAL-AD7172-4SDZ evaluation board and SDP-B boards to the USB port of the PC.

### *Installing the AD717x Eval+ Software*

To install the AD717x Eval+ software, take the following steps:

1. With the SDP-B board disconnected from the USB port of the PC, insert the CD into the CD-ROM drive.
2. Double click the **setup.exe** file from to begin the evaluation board software installation. The default installation location for the software is **C:\Program Files\Analog Devices\ AD7172-4 Eval+\.**
3. A dialogue box appears asking for permission to allow the program to make changes to the PC (See Figure 3). Click **yes**.

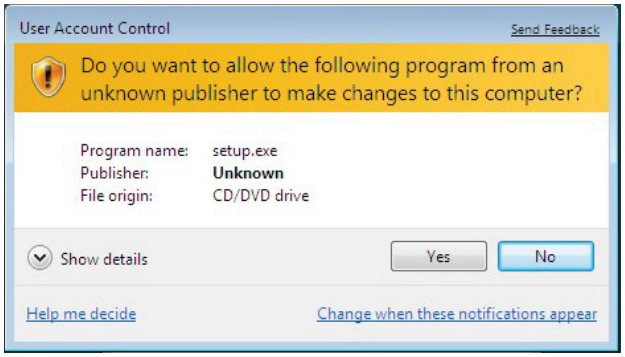


*Figure 3. AD7172-4* ***User Account Control*** *Permission Dialog Box*

4. Select a location to install the software and click **Next**. Figure 4 shows the default locations displayed when the dialogue box opens. To select another location click **Browse**.

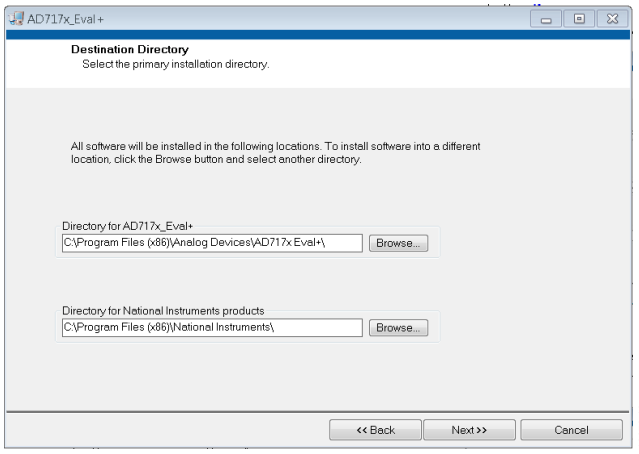


*Figure 4.* ***AD717x Eval+ Installation*** *Selecting the Location for Software Installation*

5. A license agreement appears. Read the agreement, select **I accept the License Agreement**, and click **Next**.

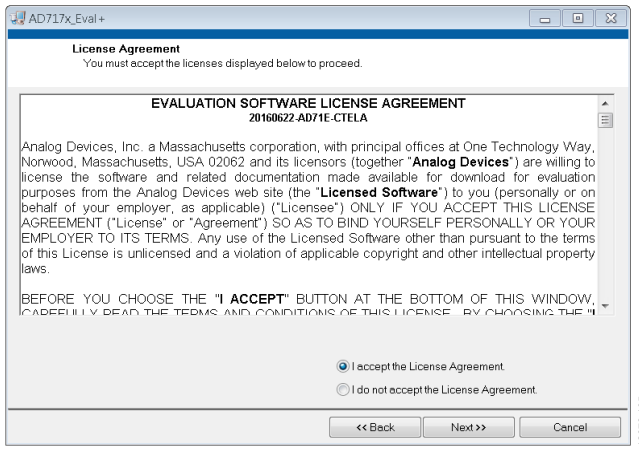


*Figure 5.* ***AD717x Eval+ Installation*** *Accepting the License Agreement*

6. A summary of the installation displays. Click **Next** to continue.

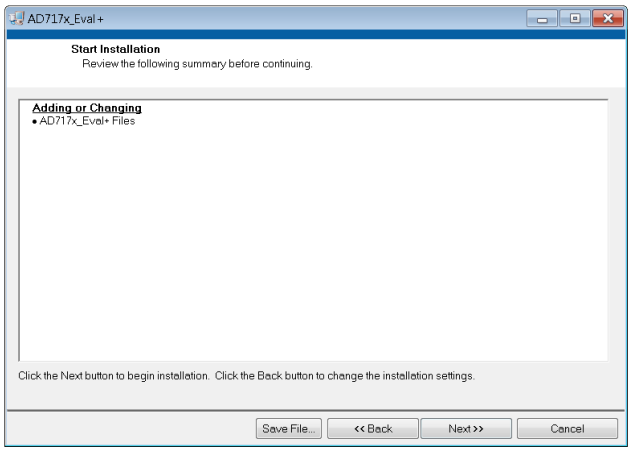


*Figure 6.* ***AD717x Eval+ Installation*** *Reviewing a Summary of the Installation*

7. The message in Figure 7 appears when the installation is complete.

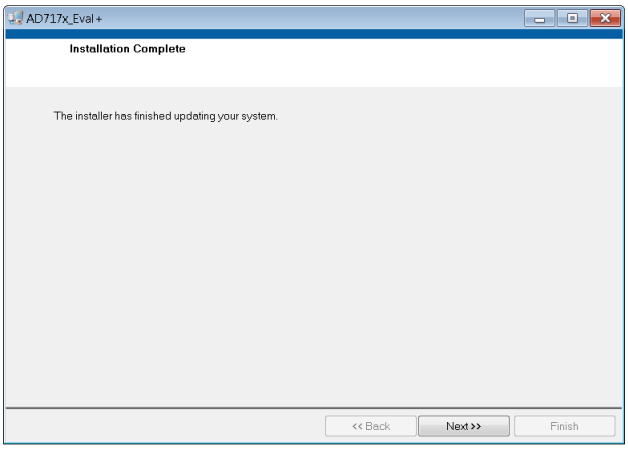


*Figure 7. **AD717x Eval+** Installation Complete*

### *Installing the Eval+ Dependencies*

After the installation of the evaluation software is complete, a welcome window displays to install the **Eval+ Dependencies**.

1. With the SDP-B board still disconnected from the USB port of the PC, make sure all other applications are closed, and then click **Install**.

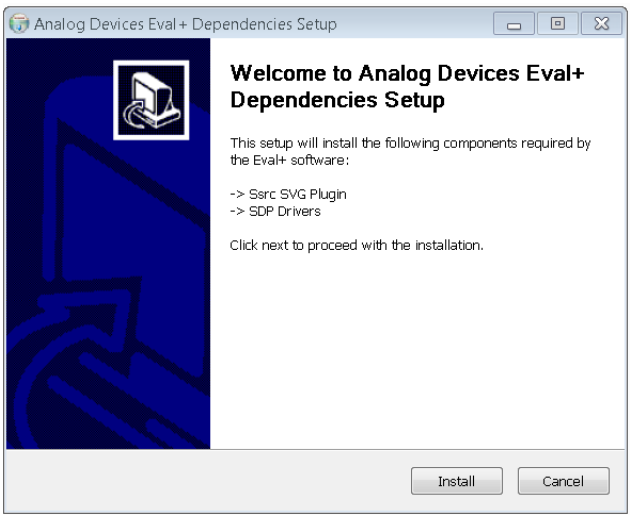


*Figure 8. **Eval+ Dependencies Setup** Beginning the Drivers Installation*

2. To complete the drivers installation, click **Close**. This closes the installation setup wizard

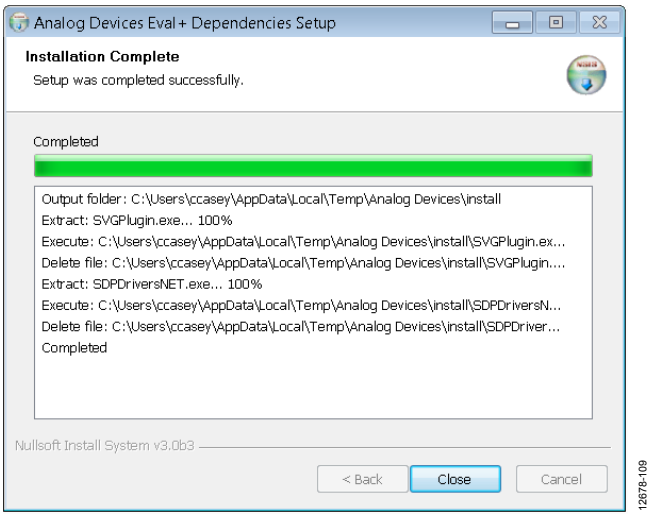


*Figure 9. **Eval+ Dependencies Setup** Completing the Drivers Setup Wizard*

3. Before using the evaluation board, you must restart the PC.

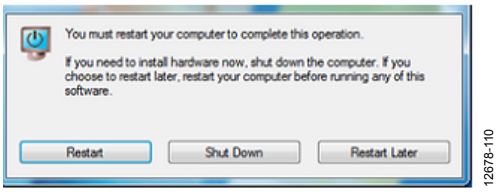


*Figure 10. Restarting the PC*

## SETTING UP THE SYSTEM FOR DATA CAPTURE

After completing the steps in the Software Installation section and the Evaluation Board Hardware section, set up the system for data capture using the following:

1. Allow the **Found New Hardware Wizard** to run after the SDP-B board is connected to the PC. (If using Windows XP, search for the SDP-B drivers, Choose to automatically search for the drivers if prompted by the operating system.)
2. Check that the board is connecting to the PC correctly using the **Device Manager**.
3. Access the **Device Manager** by completing the following steps:
   a) Right-click **My Computer** and then click **Manage**.
   b) A dialog box appears asking for permission to allow the program to make changes to the PC. Click **Yes**.
   c) The **Computer Management** box appears. Click **Device Manager** from the list of **System Tools** (See Figure 11).
   d) The SDP-B board appears under **ADI Development Tools**, this indicates that the driver software has installed and the board is connecting to the PC correctly.

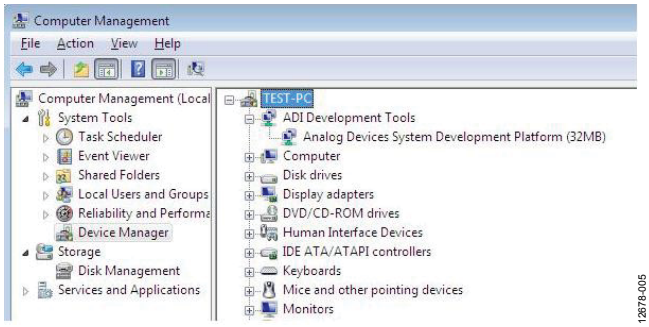


*Figure 11. Device Manager, Checking the Board Connected to the PC Correctly*

### *Launching the Software*

After completing the steps in the Setting Up the System for Data Capture section, launch the AD717x Eval+ software using the following steps:

1. From the **Start** menu, click **Programs** > **Analog Devices** > **AD717x EVAL+** > **AD717x Eval+**.
2. The dialogue box in Figure 12 appears; select **AD7172-4 Evaluation Board**. The main window of the software box displays as shown in Figure 15.

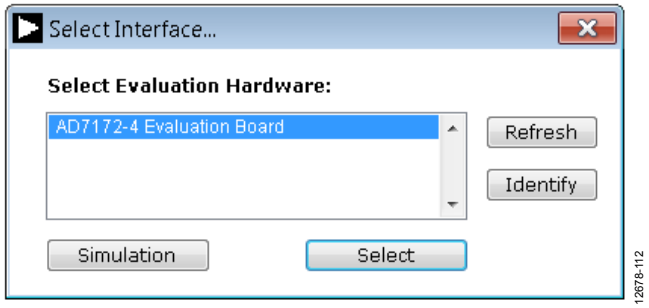


*Figure 12. AD717x Evaluation Board Selection*

3. If the EVAL-AD7172-4SDZ evaluation system is not connected to the USB port via the SDP-B when the software is launched, the software displays the dialog box shown in Figure 13. Connect the evaluation board to the USB port of the PC; wait a few seconds, click **Refresh** and the option shown in Figure 12 appears.

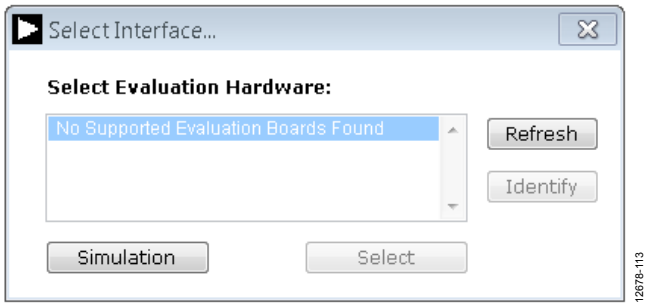


*Figure 13.Evaluation Board Selection, No Board Connected*

4. The AD717x Eval+ can also be used without connecting hardware. Click the **Simulation** button and the options shown in Figure 14 appear. This uses a software model and allows the AD7172-2, AD7172-4, AD7173-8, AD7175-2, AD7175-8, AD7176-2 or AD7177-2 to be evaluated.

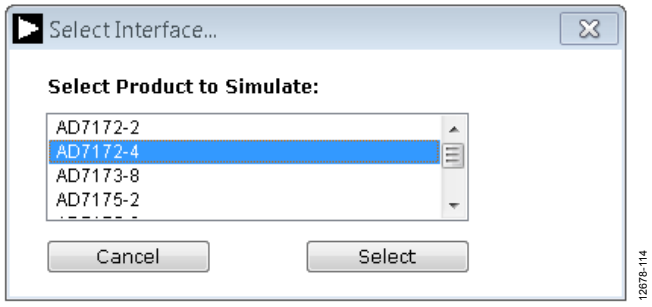


*Figure 14. Evaluation Board Selection Simulation*

# EVALUATION BOARD SOFTWARE OPERATION

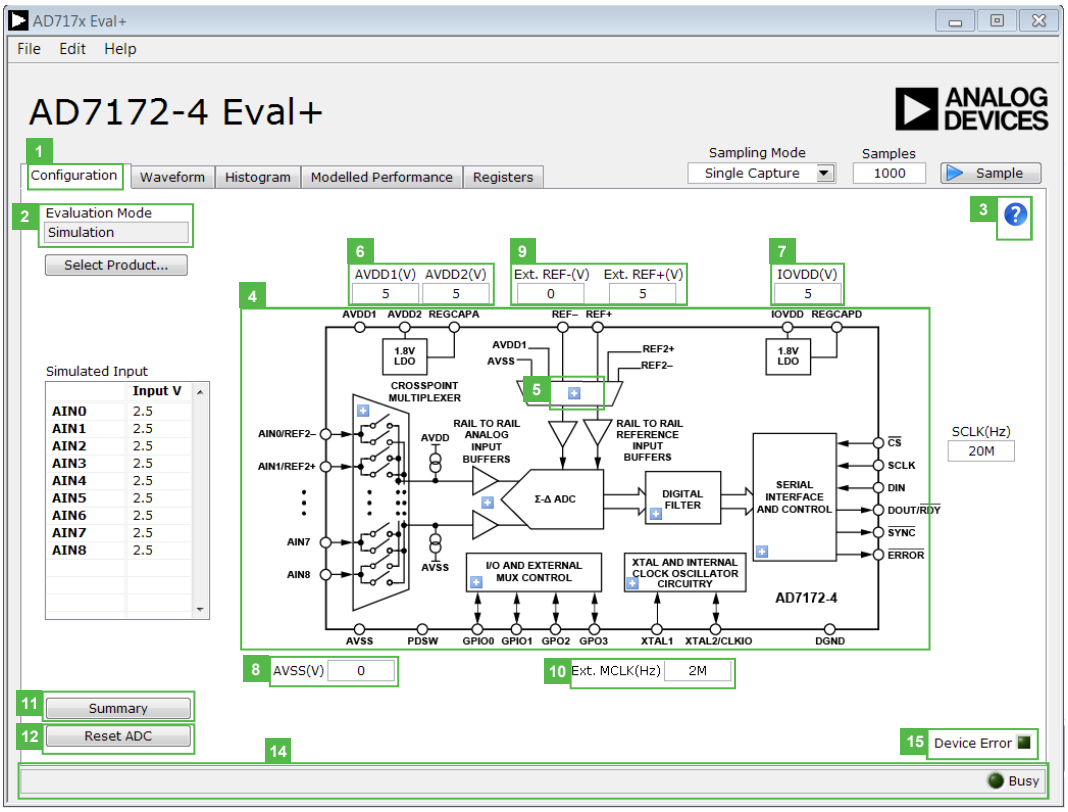


*Figure 15. **Configuration** Tab of the AD7172x Eval+ Software in Hardware Mode*

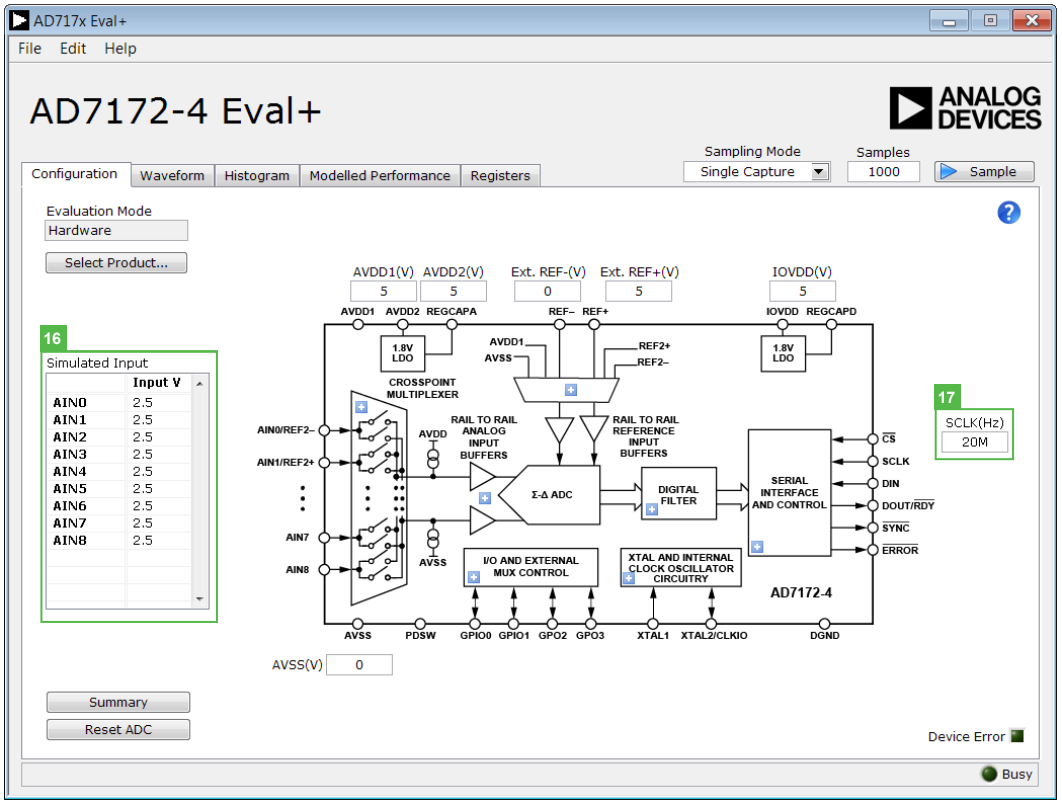


*Figure 16. **Configuration** Tab of the AD7172-4 Evaluation Software in Simulation Mode*

## OVERVIEW OF THE MAIN WINDOW

The main window of the AD717x Eval+ software displays the significant control buttons and analysis indicators of the AD717x Eval+ software. This window is divided into five tabs.

- Configuration
- Waveform
- Histogram
- Modelled Performance
- Registers

## CONFIGURATION TAB (1)

Figure 15 shows the **Configuration** tab when **Hardware** mode is selected and Figure 16 shows the **Configuration** tab when **Simulation** mode is selected. The controls highlighted in Figure 16 are only available in **Simulation** mode.

### *Select Product/Evaluation Mode (2)*

The Evaluation Mode indicator displays the current evaluation mode. To switch between modes, click the **Select Product** button and the dialog box shown in Figure 12 appears.

### *Tutorial Button (3)*

Click the tutorial button to open a tutorial and additional information on using the AD717x Eval + software.

### *Functional Block Diagram (4)*

The functional block diagram of the ADC shows each of the separate functional blocks within the ADC. Clicking a C**onfiguration** button on any of the functional blocks opens the configuration pop-up window for the block selected. Not all blocks have a configuration button.

### *Configuration Pop-Up Button (5)*

Each configuration pop-up button opens a different window that allows the configuration of the relevant functional block.

### *Analog and Digital Supply Voltage (6, 7, and 8)*

These input fields are used to take the supply voltage levels selected for the AD7172. Checks are performed to ensure that the power supply voltage levels entered are within the specified limits. These power supply voltage levels are also used for the modelled performance to calculate the power dissipation.

### *External Reference (Ext. REF) (9)*

The **Ext. REF** input fields set the positive and negative external reference voltage values. The difference is used in calculating the results for both the **Waveform** and **Histogram** tabs. The evaluation board has an external 5 V ADR445 reference, this can be bypassed by removing R32. Change the external reference voltage value in **Ext. REF** to ensure correct calculation of results in the **Waveform** and **Histogram** tabs.

### *External MCLK Frequency (10)*

This field sets the external MCLK frequency. It is only visible on the front panel when an external clock source is selected by the ADC. It is used by the functional model for **Modelled Performance** (31).

### *Register Configuration Summary (11)*

Click the **Summary** button to display the selected configuration of the AD7172-4, this includes channel configuration, information on each of the individual setups, as well as, information on any error present.

### *Reset ADC (12)*

Click the **Reset ADC** button to perform a software reset of the AD7172-4 . The AD7172-4 does not have a hardware reset pin, to perform a hard reset the power must be removed from the board. The software reset has the same effect as a hard reset.

### *Menu Bar (13)*

The menu bar has three sections: **File**, **Edit,** and **Help**.

**File**

There are three options available in the File Menu. Save, Load, and Generate.

**Save**

Save allows the user to save register configurations or waveform data. Register configurations can be saved as a JSON file or a header file. If the configuration is only used in the AD717x Eval+ software environment then it is recommended to use the JSON setting. Waveforms are saved as .csv files and the user is prompted to save the register configuration as well.

**Load**

Load allows the user to load saved register configurations or waveform data. In order to load a header file intoAD717x Eval+ it must be in the same format as one that is saved from AD717x Eval+. The header file can be used when developing firmware. When loading the waveform data the user is prompted to load the register configuration. This is so the software can correctly analyze the data.

**Generate**

Generate offers two options: No-OS Drivers and Communication drivers. No-OS drivers are used by a microcontroller to interact with the AD7172-4. The Communications drivers provide a template for SPI and $I^2C$ methods that are used with the No-OS drivers. The implementation of the communication is not included; this is what allows the driver to be used with any microcontroller. More information on these drivers can be found in the Help section.

### Edit

There are two options available in the **Edit** dropdown menu, Change Product Selection and Reset ADC. Change Product Selection performs the same action as the **Select Product (2)** and Reset ADC performs the same action as the **Reset ADC (12)** controls.

### Help

The Help dropdown menu provides links to extra information about the AD7172-4, which includes links to the product page, evaluation board user guide, datasheet, and No-OS Drivers. Selecting the AD717x Eval+ Tutorial opens the tutorial outlined in the **Tutorial Button (3)**. For details on the version of the software the About option opens a dialog box displaying the current version of the software and the relevant licenses.

#### *Status Bar (14)*

The status bar displays the busy indicator and status updates, such as **Analysis Completed** and **Reset Completed** during software use.

#### *Device Error (15)*

The Device Error LED icon illuminates when a when an ADC error is detected or when a cyclic redundancy check (CRC) error occurs. The CRC functionality on the AD7172-4 is disabled by default and must be enabled for this indicator to work. More specific information on the error can be found in the **Register Configuration Summary (11)**.

#### *Analog Input Voltage (16)*

These input fields are only available when the AD717x Eval+ software in executed in simulation mode. These inputs allow the analog input voltages to be set and can be changed at any time while in simulation mode.

#### *External SCLK Frequency (17)*

This input field sets the external SCLK frequency for the SPI interface. This field is only available in simulation mode to determine if the SCLK frequency is within the permitted range.

## WAVEFORM TAB (18)

Figure 17 shows the **Waveform** tab of the AD717x Eval+ Software.

#### *Sampling Mode (19)*

This control is unrelated to the ADC mode. You can capture a defined sample set, single capture. Or continuously gather batches of samples, repeated capture. You can also select data logging that runs like repeated capture but posts the results to a .csv file. When saving, the .csv file prompts you to save the register configuration, this is necessary for the analysis of the data in order to load it back into the software.

#### *Samples (20)*

The Samples numeric control sets the number of samples gathered per batch. Single capture returns the number entered in the Samples control. Repeated capture keeps returning batches of the number in Samples until stopped by the user

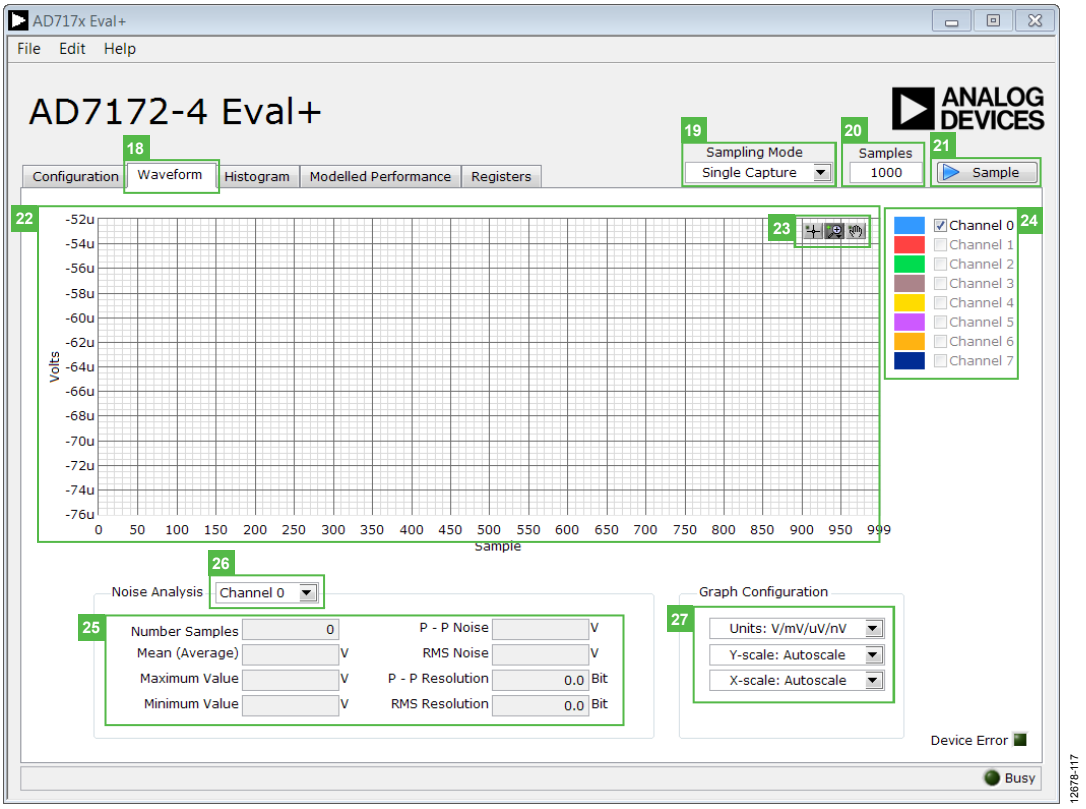


*Figure 17. **Waveform** Tab of the AD7172-4 Evaluation Software*

### *Sample (21)*

Click the **Sample** button to start gathering ADC results. Results appear in the waveform graph (22).

### *Waveform Graph and Controls (22 and 23)*

The data waveform graph shows each successive sample of the ADC output. Zoom in on the data using the control toolbar (23). Click the x-axis and y-axis to change the scales on the graph.

### *Channel Selection (24)*

The channel selection control allows you to choose which channels display on the data waveform graph (23). These controls only affect the display of the channels and do not have any effect on the channel settings in the ADC register map.

### *Noise Analysis (25)*

The Noise Analysis section displays the results of the noise analysis for the selected analysis channel; this includes both noise and resolution measurements.

### *Analysis Channel (26)*

The Noise Analysis section and histogram graph show the analysis of the channel selected via the Analysis Channel dropdown menu.

### *Display Units and Axis Controls (27)*

Click the Units dropdown menu to select the unit the data displays in the graph. This control affects both the waveform graph and the histogram graph. The axis controls can be switched between dynamic and fixed. When dynamic is selected, the axis automatically adjusts to show the entire range of the ADC results after each batch of samples. When fixed is selected, the user can program the axis ranges; the axis ranges do not automatically adjust after each batch of samples.

## HISTOGRAM TAB (18)

Figure 18 shows the **Histogram** tab of the AD717x Eval+ software.

### *Histogram Graph and Controls*

The data histogram graph (20) shows the number of times each sample of the ADC output occurs. The control toolbar (21) in the histogram graph allows you to zoom in on the data (see Figure 18). Click the x-axis and y-axis to change the scales on the graph (see Figure 18).

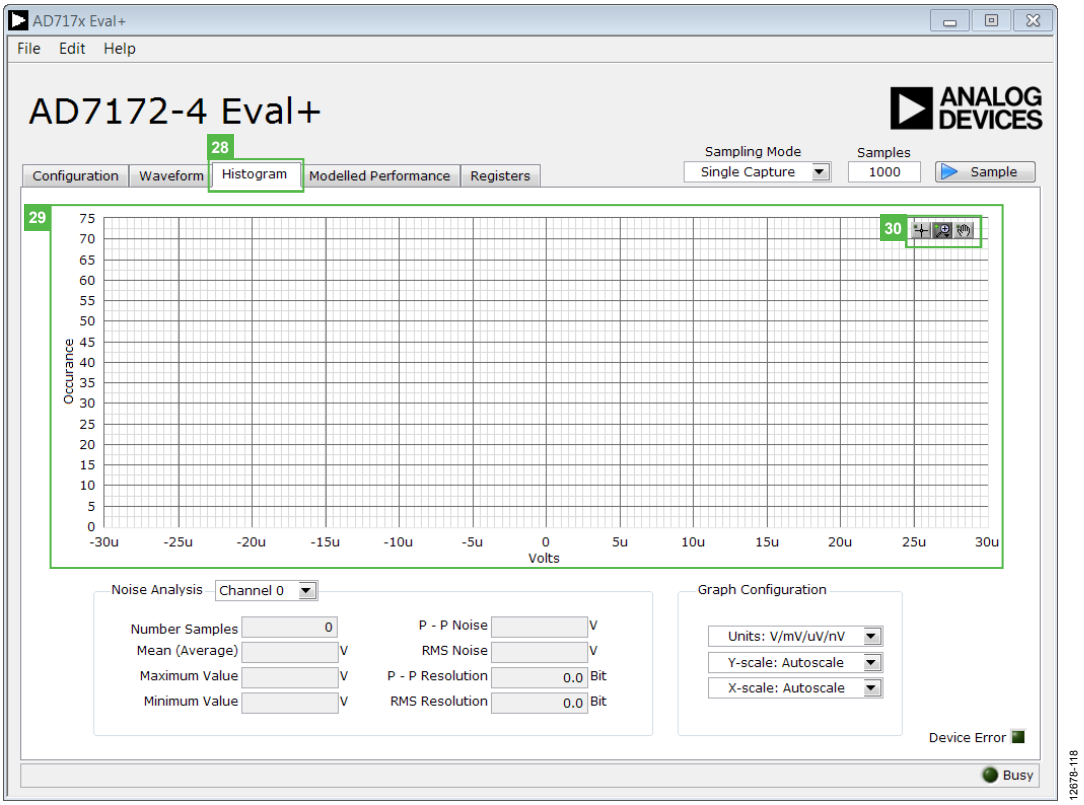


*Figure 18. **Histogram** Tab of the AD7172-4 Evaluation Software*

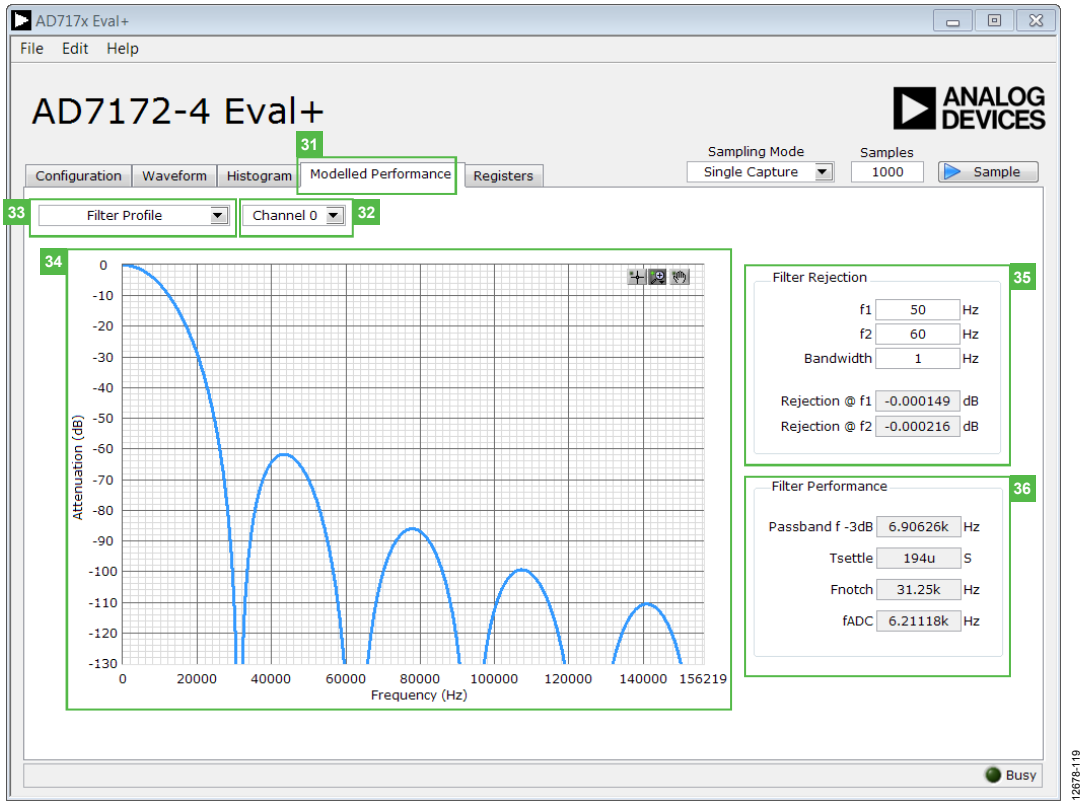


*Figure 19. Filter Profiles of the AD7172-4 Evaluation Software*

## MODELLED PERFORMANCE TAB (31)

The **Modelled Performance** tab shows a number of ADC performance parameters, which are calculated using the ADC functional model. There are three main sections to the **Modelled Performance** tab: Filter Profile, Filter Step Response, and Timing Diagram/Power. These can be selected using the drop down menu (33).

### *Analysis Channel (32)*

The Analysis Channel dropdown menu selects the channel to be evaluated by the functional model.

### *Filter Profile (33)*

This drop down menu allows the user to switch between the three sections of the **Modelled Performance**. Figure 19 shows the tab when filter profile is selected.

### *Filter Profile Graph (34)*

This graph shows the frequency response for the selected digital filter. The graph controls allow you to zoom in on the data. Click the x-axis and y-axis to change the scales on the graph.

### *Filter Rejection (35)*

This section shows the rejection/attenuation of the digital filter over the rejection bandwidth (Rej BW) for f1 and f2 in decibels; f1, f2 and Bandwidth can be changed.

### *Filter Performance (36)*

This section shows timing information about the data rate of the selected output. It shows the ADC initial settling time, Tsettle, the first frequency notch (Fnotch), and the actual sampling frequency (fADC).

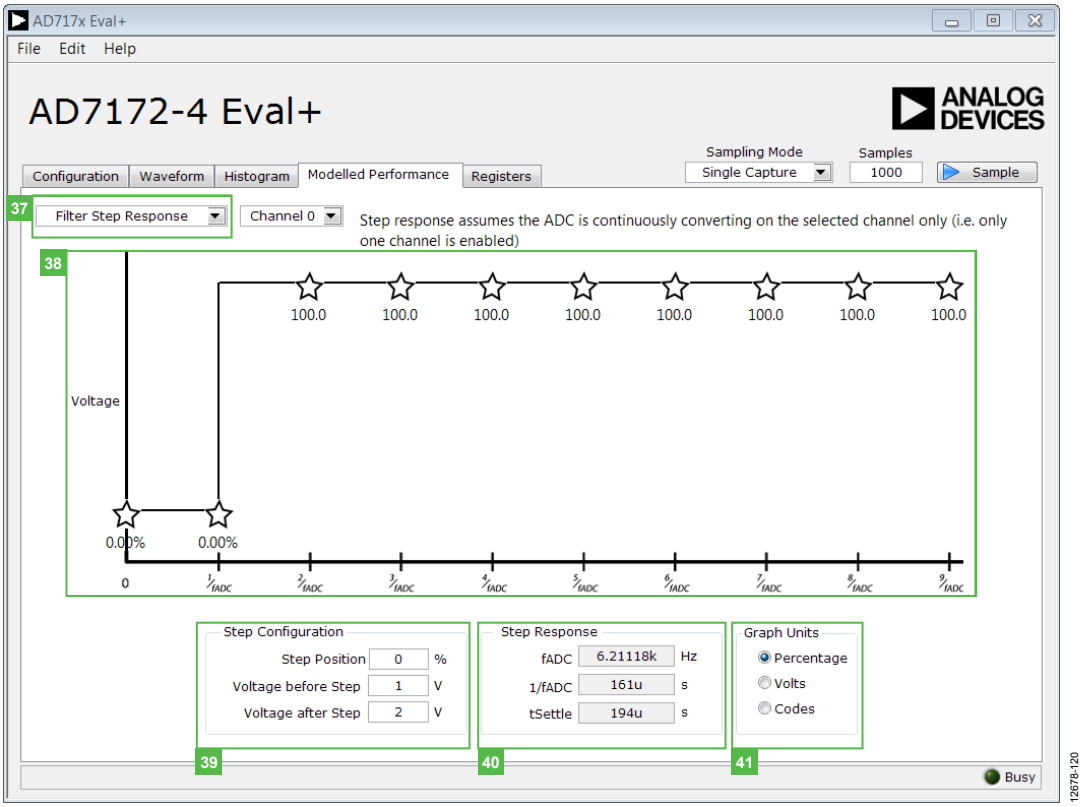


*Figure 20. Filter Step Response of the AD7172-4 Evaluation Software*

### *Filter Step Response (37)*

This drop down menu allows the user to switch between the three sections of the **Modelled Performance** tab. Figure 20 shows the tab when Filter Step Response is selected.

### *Step Response Graph (38)*

This graph shows how long the filter takes to settle when the voltage is stepped from one voltage to the next. For this analysis, it is assumed the ADC is continuously converting on only one channel.

### *Step Configuration (39)*

Step Configuration allows the user to set the voltage before and after the step and the step position. Step position is set as a percentage where 0% is 1/fADC and 100% is 2/fADC.

### *Step Response (40)*

This section shows timing information about the data rate of the output selected output. It shows the actual sampling frequency, fADC, the ADC initial settling time (Tsettle), and the settling time between conversions, 1/fADC.

### *Graph Units (41)*

Use this control to switch the step response between percentages, volts, and codes.

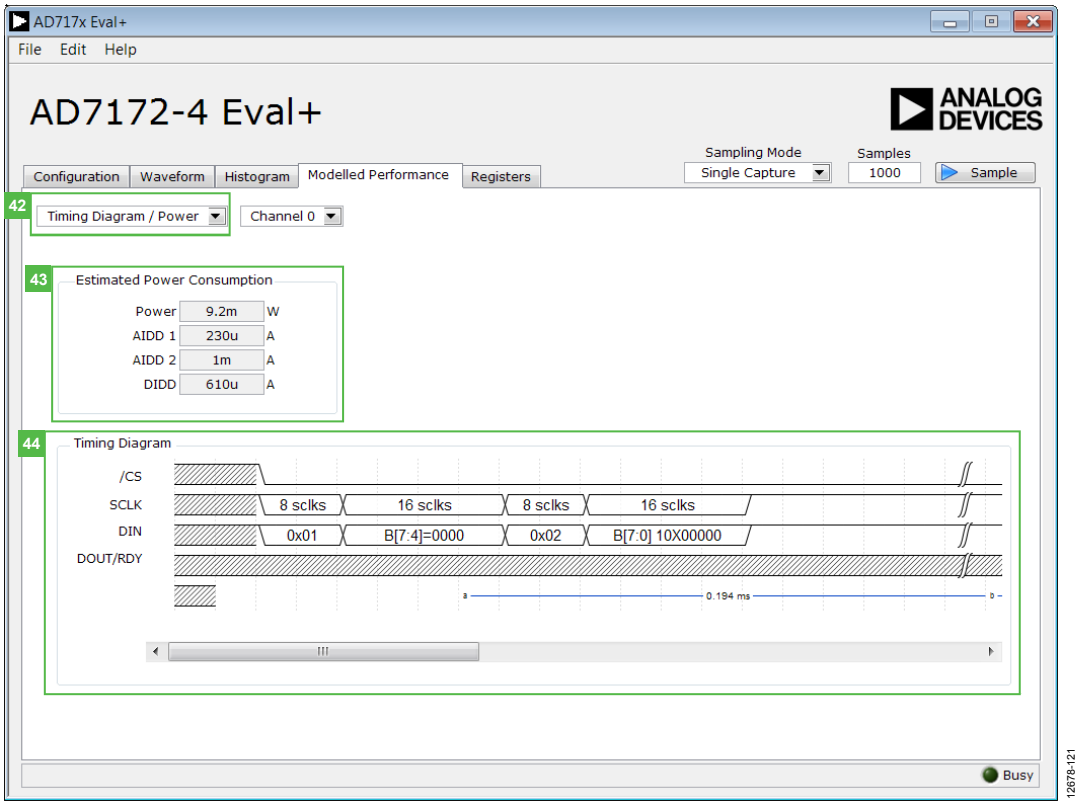


*Figure 21. Timing Diagram/Power of the AD7172-4 Evaluation Software*

### *Timing Diagram/ Power (42)*

This drop down menu allows the user to switch between the three sections of the **Modelled Performance**. Figure 21 shows the tab when Filter Step Response is selected.

### *Estimated Power Consumption (43)*

This section shows the total power consumption of the part in the current configuration as well as the current consumption on each of the power supply rails.

### *Timing Diagram (44)*

This graph shows the digital interface timing diagram for the current configuration. The graph shows the timing for both the configuration of the ADC, and the subsequent data reads from the ADC.

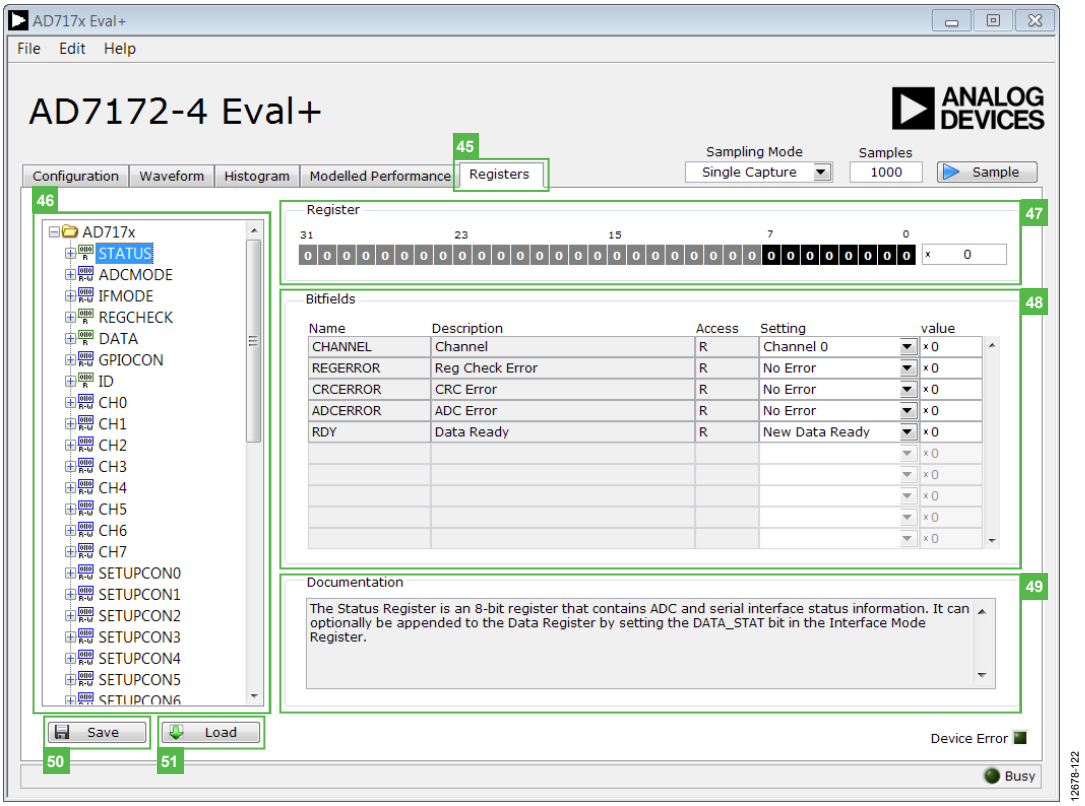


*Figure 22. **Registers** Tab of the AD7172-4 Evaluation Software*

## REGISTERS TAB

Figure 22 shows the **Registers** tab.

### *Register Tree (46)*

This control shows the full register map in a tree control. Each register is shown; click the expand button next to each register to show all the bit fields contained within that register.

### *Register (47)*

The **Register** control allows you to change the individual bit of the register selected in the register tree (46) by clicking the bits, or by programming the register value directly into the number control field on the right.

### *Bitfields (48)*

This list shows all the bit fields of the register selected in the register tree (46). Change the values by using the dropdown menu or by directly entering a value into the number control field on the right.

### *Documentation*

The Documentation field contains the documentation for the register or bit field selected in the register tree (46).

### *Save (50) and Load (51)*

The **Save** (50) and **Load** (51) buttons allow you to save the current register map setting to a file and load the setting from that same file. When using these buttons the register configurations are saved and loaded as JSON files.

## EXITING THE SOFTWARE

To exit the software, click the close button at the top right corner of the AD717x Eval+ software.

# EVALUATION BOARD SCHEMATICS AND ARTWORK

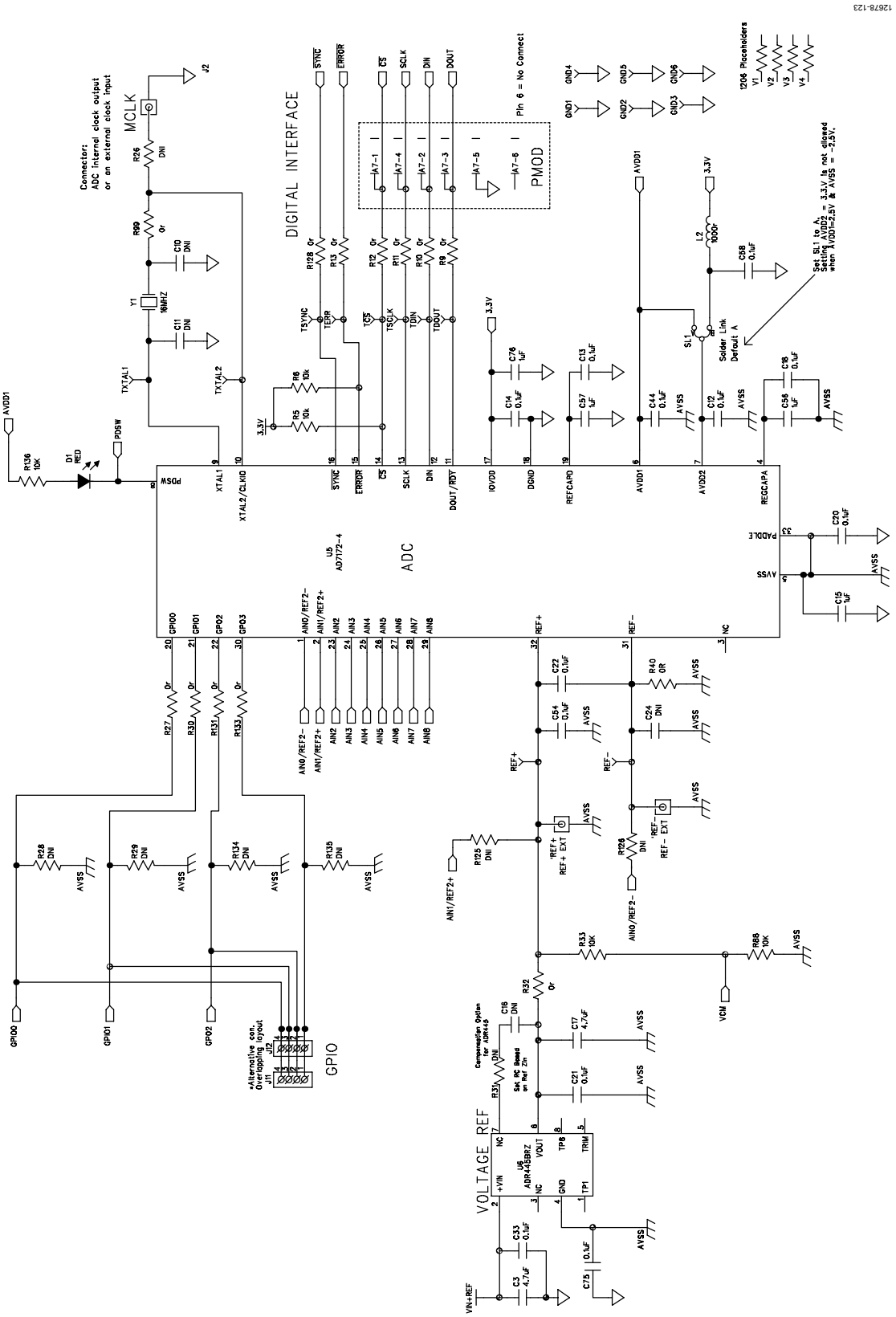


*Figure 23. AD7172-4 Schematic*

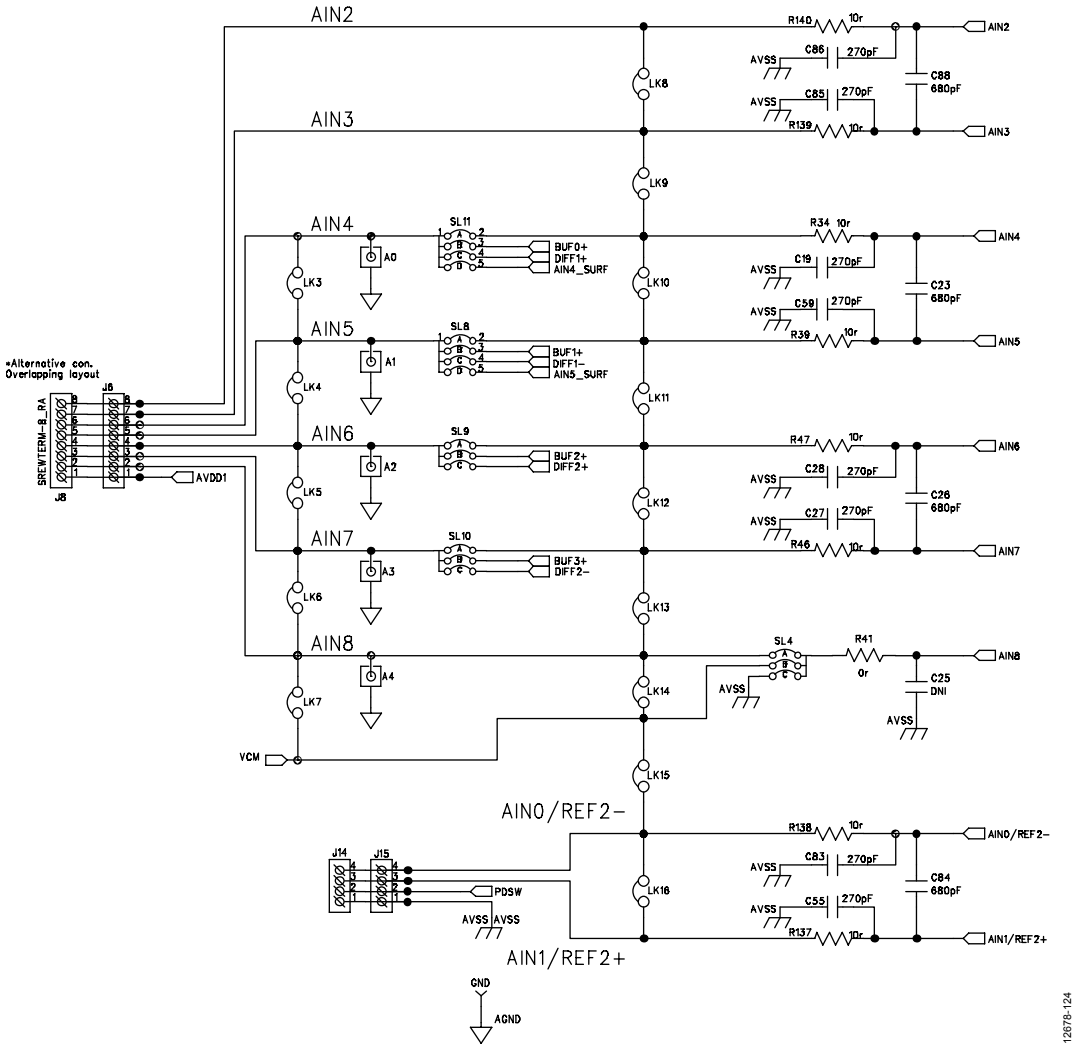


*Figure 24. Input Schematic*

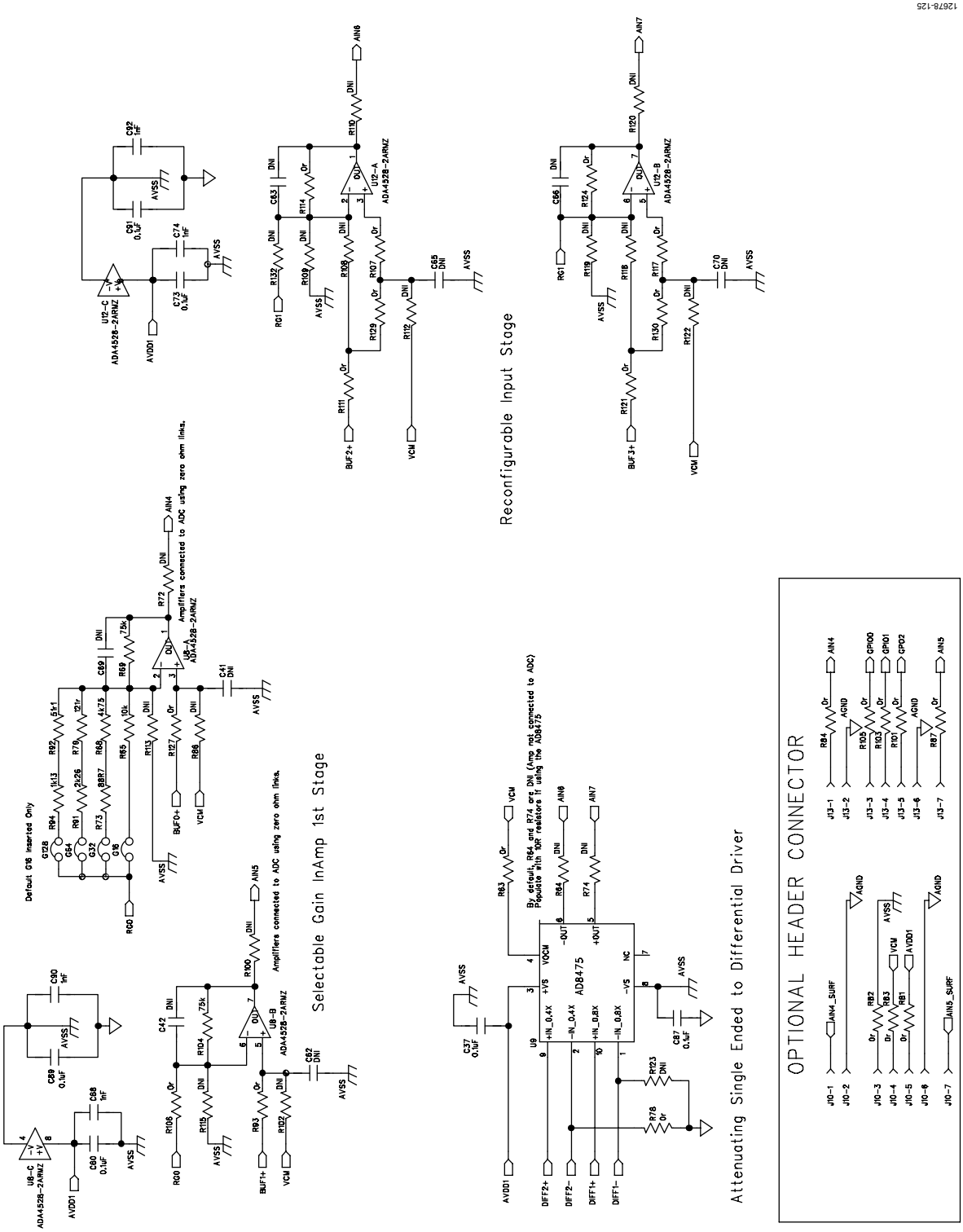


*Figure 25. Amplifier Schematic*

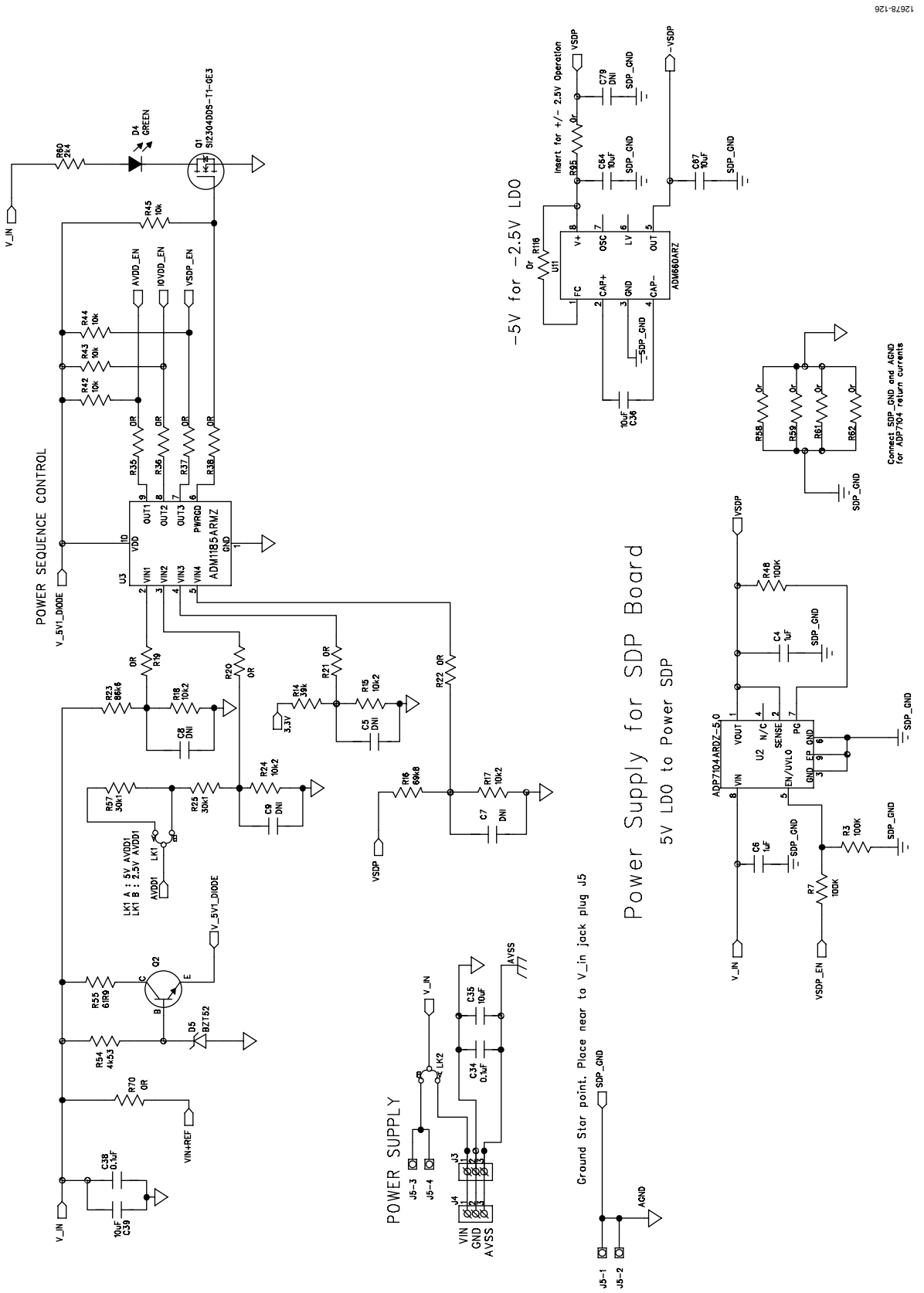


*Figure 26. Power Supply Sequencing Schematic*

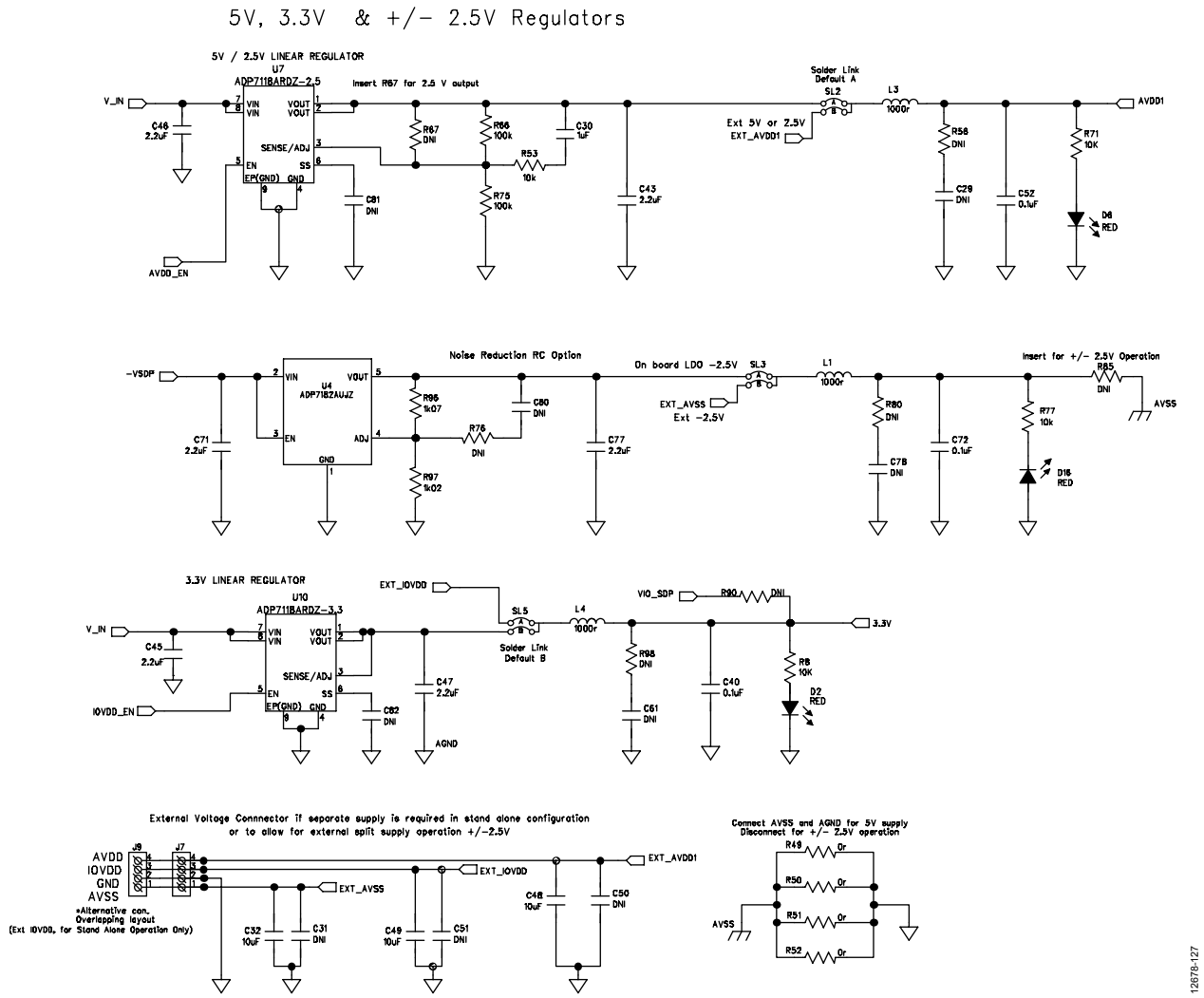


*Figure 27. Regulator Schematic*

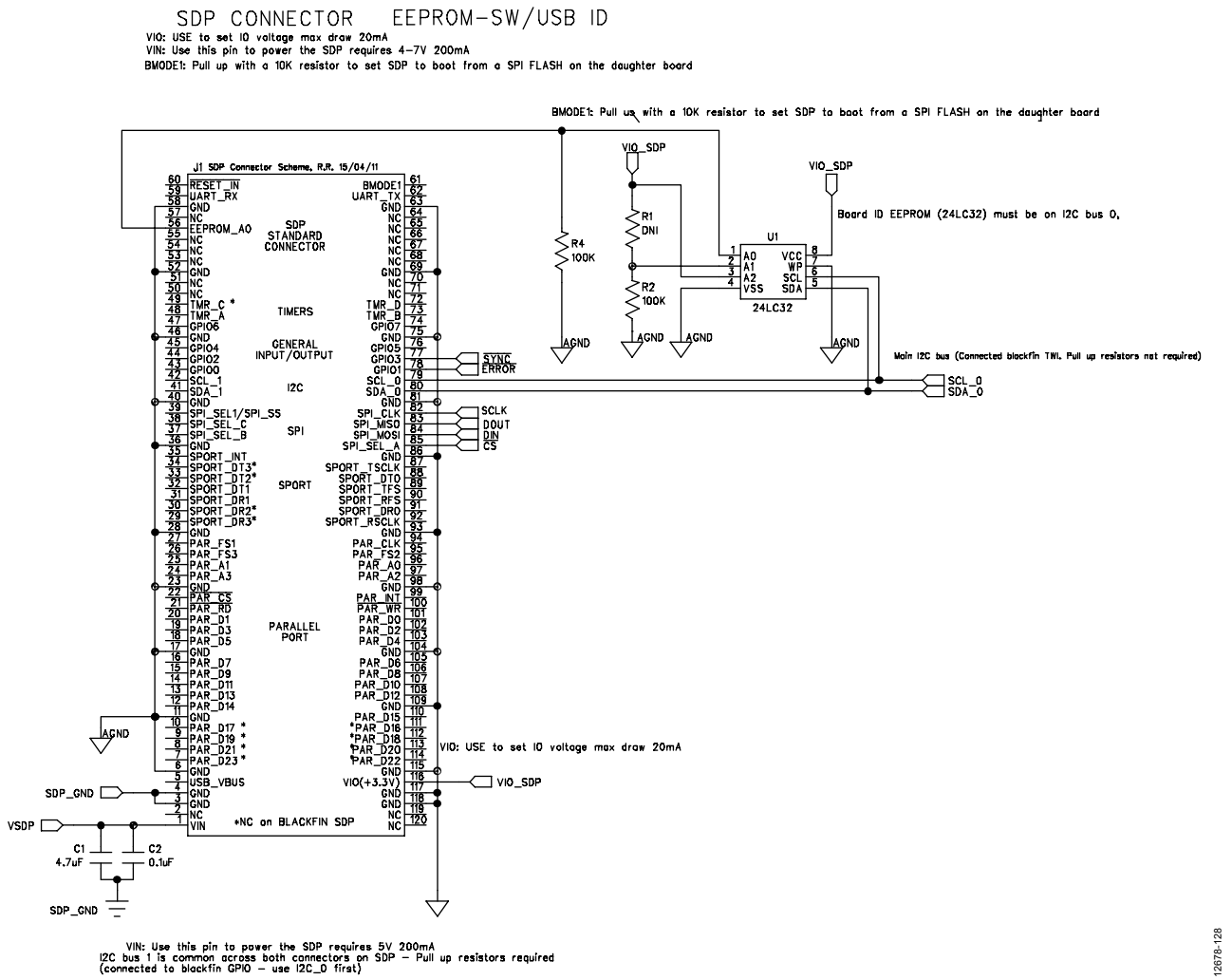


*Figure 28. SDP-B Connector Schematic*

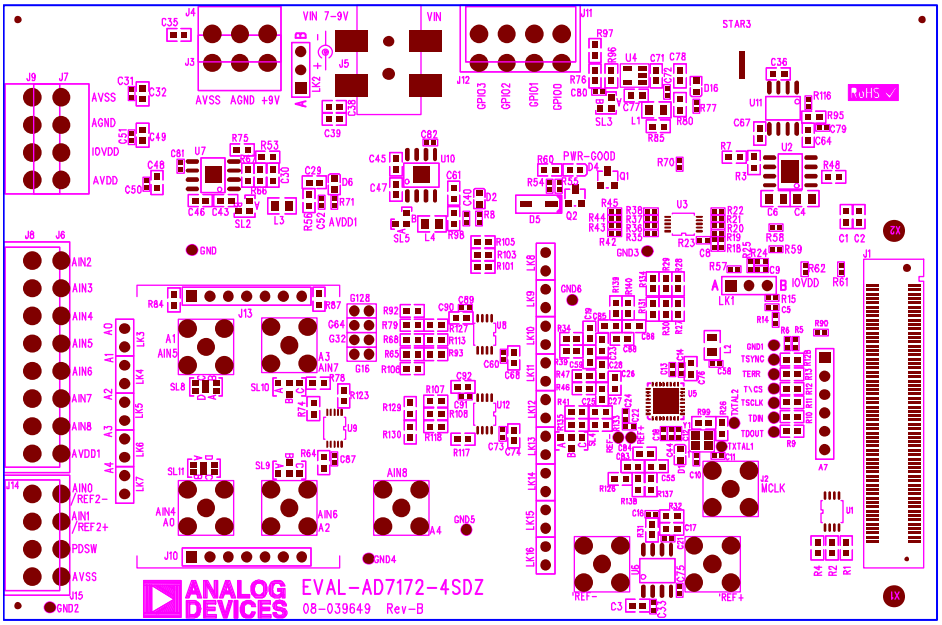


Figure 29. Top Printed Circuit Board (PCB) Silkscreen

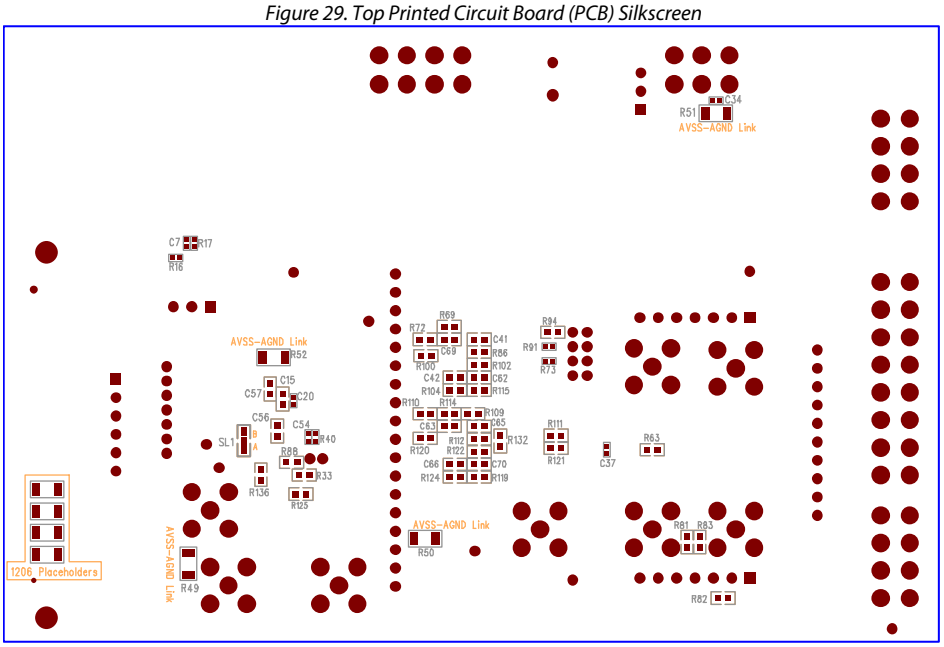


Figure 30. Bottom PCB Silkscreen

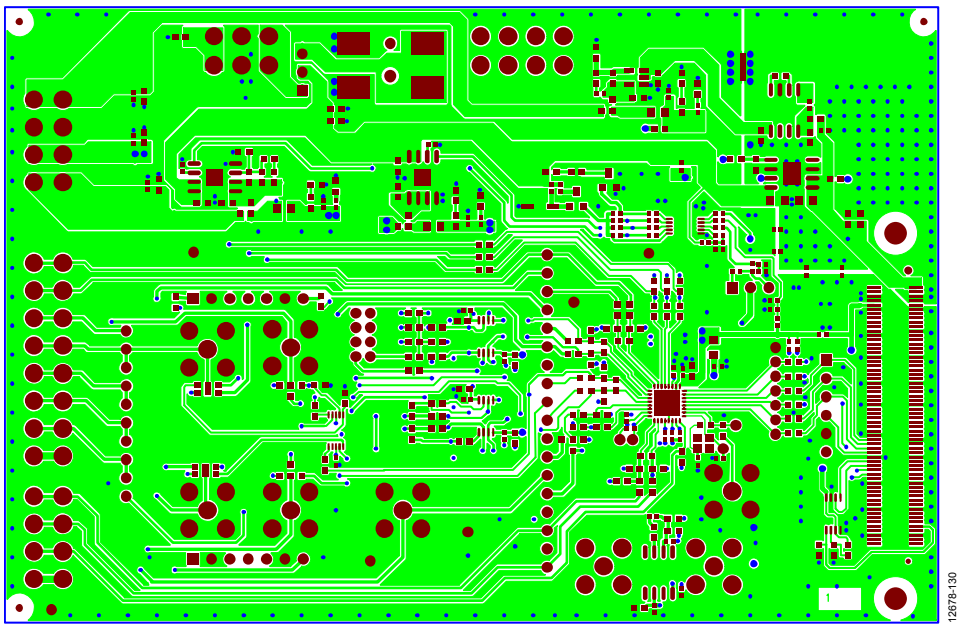


Figure 31. Layer 1 Component Side

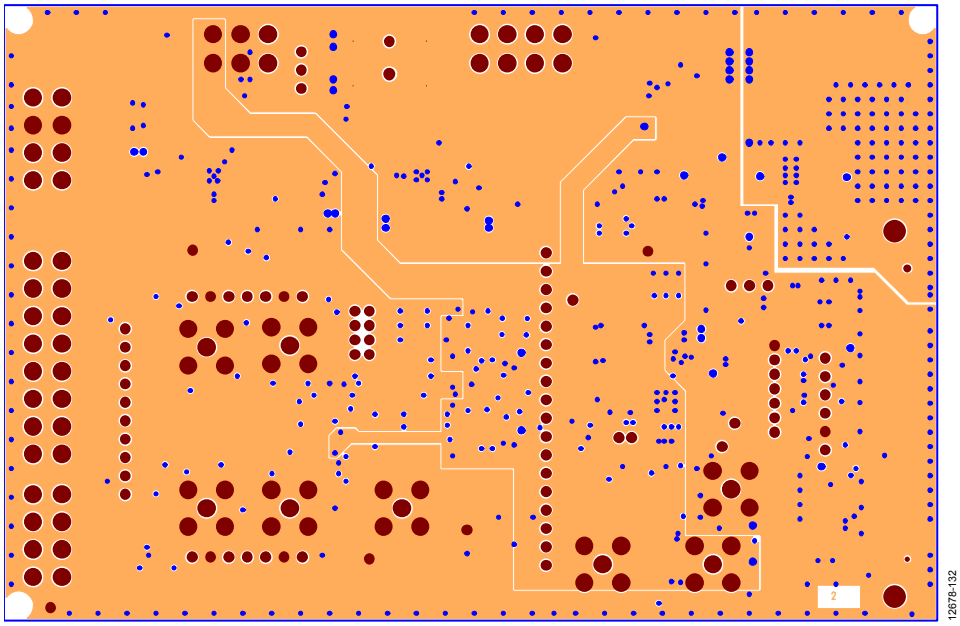


Figure 32. Layer 2 Ground Plane

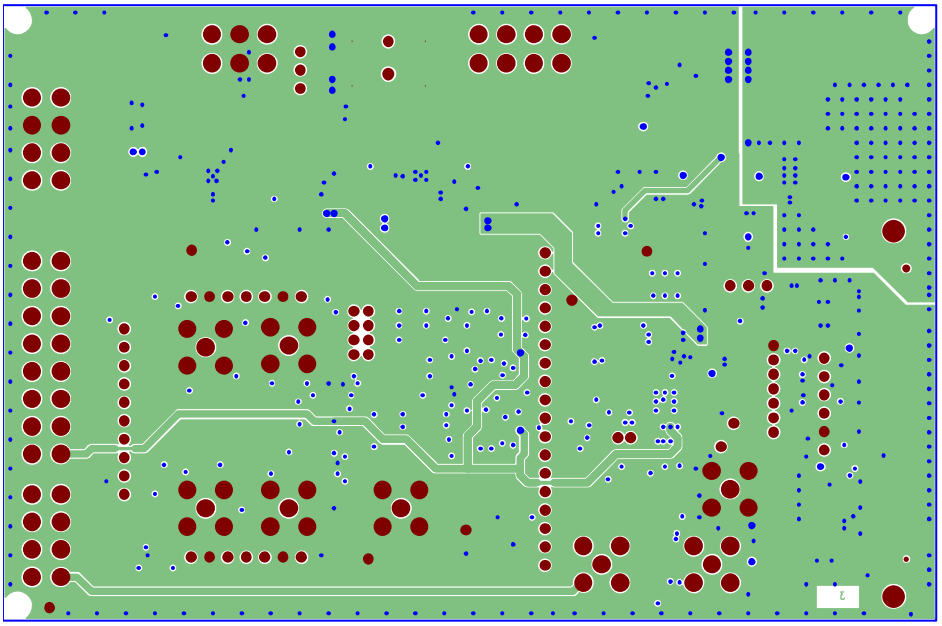


Figure 33. Layer 3 Power/Ground Plane

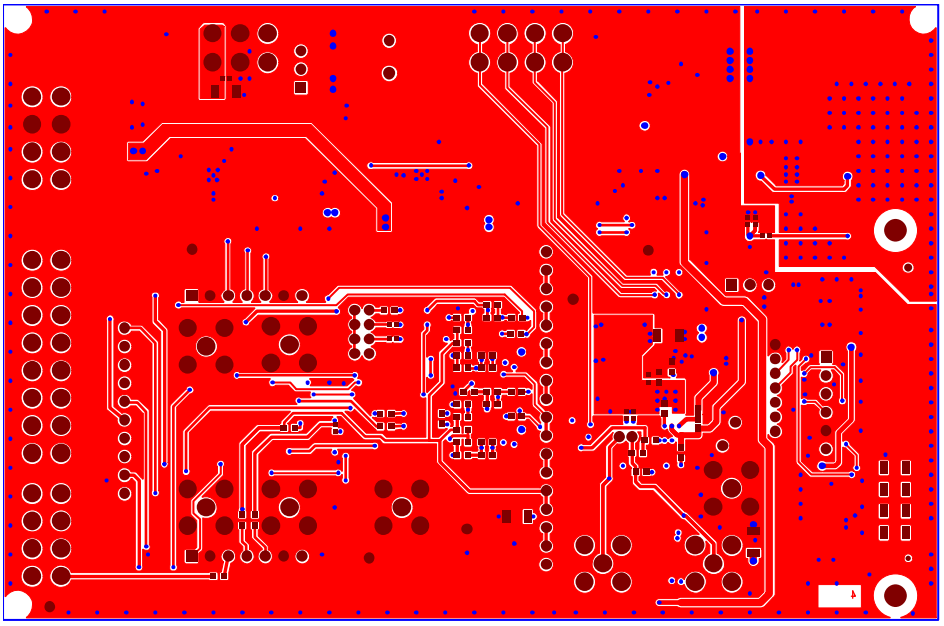


Figure 34. Layer 4 Solder Side

# ORDERING INFORMATION

## BILL OF MATERIALS

**Table 4.**

| Name | Part Description | Manufacturer | Part Number | Stock Code |
|---|---|---|---|---|
| A0 through A4 | Straight PCB mount SMB jack, keep hole clear of solder. Do not insert. | TE Connectivity | 1-1337482-0 | Do not insert |
| A7 | 6-pin SIL header (0.1" pitch) | Harwin | 20-9990646 | FEC 1022255 |
| C1, C17 | Ceramic capacitor, 6.3 V, X5R, 0603, 4.7 µF | Murata | GRM188R60J475K | FEC 173-5527 |
| C2, C38 | Ceramic capacitor, 50 V, X7R, 0603, 0.1 µF | Murata | GRM188R71H104K | FEC 882-0023 |
| C3 | Ceramic capacitor, 10 V, X5R, 0603, 4.7 µF | KEMET | C0603C475K8PACTU | FEC 157-2625 |
| C4, C6 | Capacitor, 0805, 50 V, X7R, 1 µF | Murata | GRM21BR71H105KA12L | FEC 1735541 |
| C5, C7 through C9, C16, C24 through C25, C29, C41 through C42, C61 through C63, C65 through C66, C69 through C70, C78 through C82 | Ceramic capacitor, not inserted, 0402 | Not applicable | Not applicable | Do not insert |
| C10-C11 | Ceramic capacitor XTAL, not inserted, 0402 | Not applicable | Not applicable | Do not insert |
| C12 through C14, C18, C20 through C22, C33 through C34, C37, C40, C44, C52 through C54, C58, C60, C72 through C73, C75, C87, C89, C91 | Capacitor ceramic, 16 V, X7R, 0402 | Murata | GRM155R71C104K | FEC 881-9742 |
| C15, C30, C56 through C57, C76 | Capacitor, 0603, 1 µF, 6.3 V | Murata | GRM188R70J105KA01D | FEC 184-5765 |
| C19, C27 through C28, C55, C59, C83, C85 through C86 | Ceramic capacitor, 50 V, C0G/NPO, 0603 | AVX | 06035A271JAT2A | FEC 1734627 |
| C23, C26, C84, C88 | Ceramic capacitor, 50 V, NPO, 0603 | KEMET | C0603C681J5GACTU | FEC 1414648 |
| C31, C50 through C51 | Ceramic capacitor, 16 V, X7R, 0402, do not insert | Not applicable | Not applicable | Do not insert |
| C32, C35 through C36, C39, C48 through C49, C64, C67 | Capacitor, MLCC (multilayer ceramic capacitor) X5R, 10 µF, 10 V, 0603 | TDK | C1608X5R1A106K080AC | FEC 221-1164 |
| C43, C45 through C47, C71, C77 | Capacitor, MLCC (multilayer ceramic capacitor), X5R, 2.2 µF, 10 V, 0603 | MCM Electronics | MC0603X225K100CT | FEC 232-0817 |
| C68, C74, C90, C92 | 50 V X7R multilayer ceramic capacitor | Yageo | 2238 586 15623 | FEC 722170 |
| D1 through D2, D6, D16 | Red LED, high intensity (>90 mCd), 0603 | Broadcom Ltd. | HSMC-C191 | FEC 855-4528 |
| D4 | LED, SMD green | OSRAM | LGQ971 | FEC 1226372 |
| D5 | Zener Diode, 0.5 W, 5.1 V | Vishay | BZT52B5V1-V-GS08 | FEC 1617767 |
| G16 | 2-pin (2 mm pitch) header and shorting shunt | Harwin | M22-2010205 & M22-1920005 | FEC 671915 and 510944 |
| G32, G64, G128 | 2-pin (2 mm pitch) header | Harwin | M22-2010205 | FEC 671915 |

| Name | Part Description | Manufacturer | Part Number | Stock Code |
|---|---|---|---|---|
| GND, GND1 through GND6, REF+, REF-, TDIN, TDOUT, TERR, TCLK, TSYNC, TXTAL1, TXTAL2, T\CS | Test point, not inserted, keep hole clear of solder | Not applicable | Not applicable | Do not insert |
| J1 | 120-way connector, 0.6 mm pitch | Hirose | FX8-120S-SV(21) | FEC 1324660 |
| J2 | Straight PCB mount SMB jack, keep hole clear of solder, do not insert | TE Connectivity | 1-1337482-0 | Do not insert |
| J3 | Socket terminal block, 3.81 mm pitch | Phoenix Contact | MC 1.5/3-G-3.81 | FEC 370-4737 |
| J4 | Screw terminal block, 3.81 mm pitch, do not insert | Phoenix Contact | 1727023 | Do not insert |
| J5 | DC power connectors 2 mm SMT power jack | Lumberg | 161314 | FEC 1243245 |
| J6 | 8-pin terminal header, 3.81 mm pitch, vertical | Phoenix Contact | MC 1,5/ 8-G-3,81 | FEC 3704774 |
| J7 | Connector, pitch 3.81 mm, right angle | Phoenix Contact | MC 1,5/ 4-G-3,81 and 180-3594 | Do not insert |
| J8 | 8-pin screw terminal, 3.81 mm pitch, vertical | Phoenix Contact | 1727078 | Do not insert |
| J9 | Screw terminal block, 3.81 mm pitch | Phoenix Contact | 1727036 | FEC 370-4592 |
| J10 | 7-way SSW 2.54 mm vertical socket (make sure to line up with connector on surf board) | Samtec | SSW-107-01-T-S | FEC 1803478 |
| J11, J14 | Screw terminal block, 3.81 mm pitch | Phoenix Contact | MKDS1/4-3.81 | Do not insert. |
| J12 | 4-way power socket block, 3.81 mm pitch | Phoenix Contact | MC1.5/4-G-3.81 | FEC 370-4749 and FEC 370-4920 |
| J13 | 7-way SIP 2.54 mm TH Header (make sure to line up with connector on surf board) | Samtec | TLW-107-05-G-S | FEC 1668499 |
| J15 | 4- way power socket block, 3.81 mm pitch | Phoenix Contact | MC1.5/4-G-3.81 | FEC 370-4749 and FEC 370-4920 |
| L1 through L4 | Ferrite bead, 0.3 Ω at dc, 1000 Ω at 100 MHz, 350 mA, 0805 | TE Connectivity | BMB2A1000LN2 | FEC 119-3421 |
| LK1 through LK2 | 3 pin (3 × 1) 0.1" header and shorting block in A | Harwin | M20-9990346 & M7566-05 | FEC 1022249 and 150-411 |
| LK3 through LK7 | 2-pin (0.1" pitch) header | Harwin | M20-9990246 | FEC 1022247 |
| LK8 through LK16 | 2-pin (0.1" pitch) header and shorting shunt | Harwin | M20-9990246 | FEC 1022247 and 150-411 |
| Q1 | SI2304DDS-T1-GE3 MOSFET, N CH,30 V,3.6 A, diode, SOT-23 | Vishay | SI2304DDS-T1-GE3 | FEC 1858939 |
| Q2 | Transistor, NPN, SOT-23 | ON Semiconductor | MMBT3904LT1G | FEC 1459100 |
| R1 | Resistor, not inserted, 0603 | Not applicable | Not applicable | Do not insert. |
| R2 through R4, R7, R48, R66, R75 | Resistor, 100 K, 0.063 W, 1%, 0603 | MCM Electronics | MC0063W06031100K | FEC 9330402 |
| R5, R6, R77 | Resistor, 10 K, 0.063 W, 1 %, 0402 | MCM Electronics | MC00625W0402110K | FEC 1358069 |
| R8, R71 | Resistor, 1 %, 0402 | Yageo | CRCW040210K0FKEAHP | FEC 173-8864 |

| Name | Part Description | Manufacturer | Part Number | Stock Code |
|---|---|---|---|---|
| R9 through R13, R27, R30, R32, R41, R63, R78, R81 through R84, R87, R95, R99, R101, R103, R105, R107, R111, R114, R117, R121, R124, R128 through R131, R133 | Resistor, 0603 1 % 0R | MCM Electronics | MC0063W06030R | FEC 9331662 |
| R14 | Resistor, 0402, 1 %, 39 K | MCM Electronics | MC 0.0625W 0402 1% 39K | FEC 1358085 |
| R15, R17, R18, R24 | SMD Resistor | MCM Electronics | MC 0.0625W 0402 1% 10K2 | FEC 1803137 |
| R16 | Resistor, 0402, 1 %, 69K8 | MCM Electronics | MC 0.0625W 0402 1% 69K8 | FEC 1803735 |
| R19 through R22, R35 through R38, R40, R58, R59, R61, R62, R70, R116 | Resistor, 0402 | Vishay | CRCW04020000Z0ED | FEC 146-9661 |
| R23 | Resistor, 0402, 1 %, 86K6 | MCM Electronics | MC 0.0625W 0402 1% 86K6 | FEC 1803744 |
| R25, R57 | Resistor, 0402, 1 %, 30k1 | MCM Electronics | MC 0.0625W 0402 1% 30k1 | FEC 1803699 |
| R26, R28, R29, R31, R33, R56, R64, R67, R72, R74, R76, R80, R85, R86, R88, R98, R100, R102, R108 through R110, R112, R113, R115, R118 through R120, R122, R123, R125, R126, R132, R134, R135 | SMD Resistor 0603 | Not applicable | Not applicable | Do Not Insert |
| R34, R39, R46, R47, R137 through R140 | Resistor, 10 R, 0.063 W, 1 %, 0603 | MCM Electronics | MC0063W0603110R | FEC 9330429 |
| R42 through R45 | Resistor, Thick Film, 10 kΩ, 62.5 mW, 5 % | Yageo | RC0402JR-1310KL | FEC 179-9316 |
| R49 through R52 | Resistor, 1206 | MCM Electronics | MC 0.125W 1206 0R | FEC 9336974 |
| R53, R65, R136 | Resistor, 10 K, 0.063 W, 1 %, 0603 | MCM Electronics | MC0063W0603110K | FEC 9330399 |
| R54 | Resistor, Thick Film, 4.53 kΩ, 63 mW, 1 % | Vishay | CRCW04024K53FKED | FEC 1151244 |
| R55 | Resistor, 0402, 1 %, 61R9 | MCM Electronics | MC 0.0625W 0402 1% 61R9 | FEC 1802915 |
| R60 | Resistor, Thick Film, 2.4 kΩ, 0603, 100 mW, 1 % | Yageo | RC0603FR-072K4L | FEC 1799329 |
| R68 | Resistor, 0603, 4K75, 0.1 %, 0.1 W | Panasonic | ERA3ARB4751V | FEC 209-4611 |
| R69, R104 | Resistor, 0603, 0.1 %, 0.1 W, 75K | Panasonic | ERA3ARB753P | FEC 171-7620 |
| R73 | Resistor, 88R7, 0.063 W, 0.1 %, 0402 | TE Connectivity | RN73C1E88R7B | FEC 173-7900 |
| R79 | Resistor, 121R, 0.063 W, 0.1 %, 0603 | TE Connectivity/ Holsworthy | RN73C1J121RBTG | FEC 114-0465 |
| R90 | Resistor, not inserted, 0402 | Not applicable | Not applicable | Do Not Insert |
| R91 | Resistor, 2K26, 0.063 W, 0.1 %, 0402 | TE Connectivity | RN73C1E2K26B | FEC 173-8050 |
| R92 | Resistor, 51R1, 0.063 W, 0.1 %, 0603 | TE Connectivity/ Holsworthy | RN73C1J51R1BTG | FEC 114-0446 |
| R93, R106 | Resistor, 0603 | Vishay | CRCW06030000Z0EA | FEC 146-9739 |
| R94 | Resistor, 0603, 1K13, 0.1 %, 0.1 W | Panasonic | ERA3ARB1131V | FEC 209-4485 |

| Name | Part Description | Manufacturer | Part Number | Stock Code |
|---|---|---|---|---|
| R96 | Resistor, 1K07, 0.063 W, 1 %, 0603 | MCM Electronics | MC0063W060311K07 | FEC 1170792 |
| R97 | Resistor, 1K02, 0.063 W, 1 %, 0603 | MCM Electronics | MC0063W060311K02 | FEC 1170789 |
| R127 | Resistor, 0603 | Vishay | CRCW06030000Z0EA | FEC 146-9739 |
| SL1 | 2-way Resistor Link Option | MCM Electronics | MC 0.063W 0603 0R | FEC 9331662 |
| SL2, SL3 | 2-way Solder Link (Use 0r 0603 Resistor) | Not applicable | Insert in Link Position "A" | FEC 933-1662 |
| SL4 | 3-way Solder Link (Use 0r 0603 Resistor) | Not applicable | Insert in Link Position "C" | FEC 933-1662 |
| SL5 | 2-way Solder Link (Use 0r 0603 Resistor) | Not applicable | Insert in Link Position "B" | FEC 933-1662 |
| SL8 | 4-way Solder Link (Use 0r 0603 Resistor) | Not applicable | Insert in Link Position "A" | FEC 933-1662 |
| SL9, SL10 | 3-way Solder Link (Use 0r 0603 Resistor) | Not applicable | Insert in Link Position "A" | FEC 933-1662 |
| SL11 | 4-way Solder Link (Use 0r 0603 Resistor) | Not applicable | Insert in Link Position "A" | FEC 933-1662 |
| STAR3 | Ground Link (Copper Short) | Not applicable | Not applicable | Not applicable |
| U1 | 32 K $I^2C$ Serial EEPROM | Microchip Technology Inc. | 24LC32A-I/MS | FEC1331330 |
| U2 | Linear Regulator 5 V, 20 V, 500 mA, Ultralow Noise, CMOS | Analog Devices, Inc. | ADP7104ARDZ-5.0 | ADP7104ARDZ-5.0 |
| U3 | Quad Voltage Monitor and Sequencer | Analog Devices, Inc. | ADM1185ARMZ-1 | ADM1185ARMZ-1 |
| U4 | 8 V, −200 mA, Low Noise, Linear Regulator | Analog Devices, Inc. | ADP7182AUJZ | ADP7182AUJZ-R7 |
| U5 | ADC | Analog Devices, Inc. | AD7172-4BCPZ | AD7172-4BCPZ |
| U6 | 5 V XFET Reference | Analog Devices, Inc. | ADR445BRZ | ADR445BRZ |
| U7 | Linear Regulator 2.5 V, Ultralow Noise, CMOS | Analog Devices, Inc. | ADP7118ARDZ-2.5 | ADP7118ARDZ-2.5-R7 |
| U8 | 5.0 V Ultralow Noise, Zero-Drift, RRIO, Dual Op-Amp | Analog Devices, Inc. | ADA4528-2ARMZ | ADA4528-2ARMZ |
| U9 | Fully Differential Funnel Amplifier | Analog Devices, Inc. | AD8475ARMZ | AD8475ARMZ |
| U10 | Linear Regulator 3.3 V, Ultralow Noise, CMOS | Analog Devices, Inc. | ADP7118ARDZ-3.3 | ADP7118ARDZ-3.3-R7 |
| U11 | CMOS Switched-Capacitor Voltage Converter | Analog Devices, Inc. | ADM660ARZ | ADM660ARZ |
| U12 | 5.0 V Ultralow Noise, Zero-Drift, RRIO, Dual Op-Amp | Analog Devices, Inc. | ADA4528-2ARMZ | ADA4528-2ARMZ |
| V1 through V4 | 1206 Place Holder | Not applicable | Not applicable | Do Not Insert |
| X1, X2 | 3 mm NPTH Hole | Not applicable | MTHOLE-3 mm | |
| Y1 | Miniature Crystal SMD | Epson | FA-20H, 16 MHz, 10 PPM, 9 PF | FEC 171-2814 |

# NOTES

**ESD Caution**

**ESD (electrostatic discharge) sensitive device**. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.



**UG12678-0-10/17(A)**


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