Evaluating the AD4111 with ±10 V and 0 mA to 20 mA Inputs and Integrated Analog Front End for Industrial Automation Systems

FEATURES
Fully featured evaluation board for the AD4111
PC control in conjunction with Analog Devices, Inc., SDP-B system demonstration platform (EVAL-SDP-CB1Z)
PC software for control and data analysis (time domain)

EVALUATION KIT CONTENTS
EVAL-AD4111SDZ evaluation board

SOFTWARE NEEDED
AD411x Eval+ evaluation software

EQUIPMENT NEEDED
EVAL-SDP-CB1Z system demonstration platform
DC signal source
PC running Windows® with USB 2.0 port

GENERAL DESCRIPTION
The EVAL-AD4111SDZ is a full featured evaluation board that can be used to evaluate all the features of the AD4111. The AD4111 is a 24-bit, 31.25 kSPS analog-to-digital converter (ADC) with a ±10 V input voltage range (eight single-ended or four differential channels) with open wire detection and four current channels operating from 0 mA to 20 mA. All channels have on-board overvoltage and overcurrent protection.

The EVAL-AD4111SDZ board includes voltage reference, power, and data insulation and can be connected to the Analog Devices, Inc., SDP-B system demonstration platform (EVAL-SDP-CB1Z). The SDP-B board provides connection to a PC via a USB port and can provide power for the EVAL-AD4111SDZ board from the PC USB port.

The AD411X Eval+ evaluation software configures the AD4111 device functionality and provides open wire detection, dc time domain analysis in the form of waveform graphs, histograms, and associated noise analysis for ADC performance evaluation.

Full specifications for the AD4111 are available in the AD4111 data sheet, which must be consulted in conjunction with this user guide when working with this evaluation board.
Figure 2. Evaluation Board Block Diagram
EVAL-AD4111SDZ QUICK START GUIDE

RECOMMENDED QUICK START GUIDE

Use the following procedure to set up the evaluation board:

1. Disconnect the SDP-B board from the USB port of the PC. Install the AD411x Eval+ software (available for download from the EVAL-AD4111SDZ product page). Restart the PC after installation.
2. Connect the SDP-B board to the EVAL-AD4111SDZ board, as shown in Figure 3.
3. Fasten the two boards together with the enclosed plastic screw washer set.
4. Connect the SDP-B board to the PC via the USB cable. For Windows® XP, the user may need to search for the SDP drivers. Choose to automatically search for the drivers for the SDP-B board if prompted by the operating system.
5. Launch the AD411x Eval+ software from the Analog Devices subfolder in the Programs menu.

QUICK START MEASUREMENT

Use following procedure to quickly capture data and test open wire detection:

1. Connect the dc signal source to the selected voltage input (for example, VIN0 and VIN1 for differential input).
2. Launch the AD411x Eval+ software and select Quickstart mode.
3. In the Configuration tab, under Demo Mode, click All Single-Ended, and click Sample (see Figure 16).
4. In the Voltage Waveform tab, the user can evaluate the measured data and see the open wire error flag for unconnected inputs.

The Samples numeric control in the top right corner of the main window sets the number of samples collected in each batch.

Figure 3. Hardware Configuration
EVALUATION BOARD HARDWARE

DEVICE DESCRIPTION

The AD4111 is a highly accurate, high resolution, multiplexed, Σ-Δ ADC with eight single-ended or four differential voltage inputs and four current inputs, a voltage range of ±10 V, and four current channels operating from the standard range of 0 mA to 20 mA (with an overrange of −0.5 mA to +24 mA). The AD4111 features an open wire detection for voltage channels. The maximum channel to channel scan rate is 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 analog reference buffers, an integrated precision 2.5 V reference, and an integrated oscillator.

See the AD4111 data sheet for complete specifications. Full details on the EVAL-AD4111SDZ are available on the product page on the Analog Devices website.

HARDWARE LINK OPTIONS

See Table 1 for the default link options. By default, the board is powered from the SDP-B board connected to J8 (EVAL-SDP-CB1Z). The isolated voltage regulator (U3) output is set to 5 V.

EVALUATION BOARD SETUP PROCEDURE

After following the instructions in the Software Installation Procedures section, set up the evaluation board and the SDP-B board as detailed in this section.

The evaluation software and drivers must be installed before connecting the EVAL-AD4111SDZ and the SDP-B board to the USB port of the PC to ensure that the PC correctly recognizes the evaluation system.

Configuring the Evaluation and SDP Boards

Use the following procedure to configure the boards:

1. Connect the SDP-B board to Connector A or Connector B on the EVAL-AD4111SDZ board. Screw the two boards together using the plastic screw and washer set included in the evaluation board kit to connect the boards firmly together.
2. Ensure that LK3 is in Position B (SDP).
3. Connect the SDP-B board to the PC using the USB cable.

<table>
<thead>
<tr>
<th>Link</th>
<th>Default Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LK1</td>
<td>Inserted</td>
<td>Connects the on-board external reference ADR4525ARZ (U2) to AD4111BCPZ (U1). Remove LK1 if using a different single-ended external reference.</td>
</tr>
<tr>
<td>LK2</td>
<td>Inserted</td>
<td>Connects VCOM to GND_ISO. This configuration is typical for single-ended measurement. Remove LK2 to set the custom common analog input for single-ended channels. VCOM is available on Pin 5 of J1 or J4.</td>
</tr>
<tr>
<td>LK3</td>
<td>B (SDP)</td>
<td>Selects the power supply voltage. A: board is powered from the external dc power supply connector, J6 or J7. B: board is powered from the SDP connector, J8.</td>
</tr>
<tr>
<td>R37</td>
<td>Open</td>
<td>Sets the ADuM5411 (U3) isolated regulator output voltage. Open: +VA_ISO = 5 V. Short: +VA_ISO = 3.3 V.</td>
</tr>
</tbody>
</table>
SERIAL INTERFACE

The EVAL-AD4111SDZ connects via the serial peripheral interface (SPI) to the Blackfin® ADSP-BF527 on the SDP-B board. There are four primary signals: CS, SCLK, DIN (all inputs), and DOUT/RDY (output from the ADC).

The EVAL-AD4111SDZ can be connected to the EVAL-ADuCM3029 EZ-KIT in the same way. Connecting the evaluation board to the EVAL-ADuCM3029 EZ-KIT allows the user to develop their own C code rather than using the provided evaluation software.

To operate the EVAL-AD4111SDZ in standalone mode, disconnect any board connected to J8 and use J10 to access all SPI signals and set the input/output voltage levels.

POWER SUPPLIES

By default, the board is powered from the SDP-B connector. The board can be also powered from J6 and J7 (set LK3 to Position A) or from Pin +5V on J10 (see Table 2).

The ADuM5411 isoPower® digital isolator is used to isolate power and data lines up to 2.5 kV rms.

ANALOG INPUTS

There are two types of analog inputs: voltage and current.

Eight voltage inputs are available on J1 and J2. Four current inputs are available on J3.

If a different common voltage must be set for single-ended measurement, remove LK2 and connect the desired voltage to VCOM on J1.

REFERENCE OPTIONS

The EVAL-AD4111SDZ includes an external 2.5 V reference, the ADR4525ARZ. By default, LK1 is inserted, connecting the external reference to the REF+ pin of the AD4111.

Remove LK1 if using a different single-ended external reference.

In the evaluation software, click the blue pop-up button associated with Setup 0 to Setup 7 to select the reference used for conversions by the AD4111. The pop-up button is located below the external reference controls in the block diagram (Label 9 in Figure 16).

Table 2. Connector Details

<table>
<thead>
<tr>
<th>Connector</th>
<th>Function</th>
<th>Connector Type</th>
<th>Manufacturer</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1, J2, J4</td>
<td>Voltage inputs to ADC</td>
<td>Connector, header, 90°, 5-position, 3.81 mm</td>
<td>Phoenix Contact</td>
<td>MC 1, 5/5-G-3, 81</td>
</tr>
<tr>
<td>J3, J4</td>
<td>Current inputs to ADC</td>
<td>Connector, header, 90°, 5-position, 3.81 mm</td>
<td>Phoenix Contact</td>
<td>MC 1, 5/5-G-3, 81</td>
</tr>
<tr>
<td>J5</td>
<td>Earth for electrostatic discharge (ESD) testing</td>
<td>1.25-MS3 ring tongue terminal, M3, No. 5, 16 AWG, 1.65 mm²</td>
<td>Japan Solderless Terminals</td>
<td>1.25-MS3</td>
</tr>
<tr>
<td>J6, J7</td>
<td>External supply voltage (optional)</td>
<td>Connector, header, 90°, 5-position, 3.81 mm</td>
<td>Phoenix Contact</td>
<td>MC1.5/3-G-3.81</td>
</tr>
<tr>
<td>J8</td>
<td>Connector to the EVAL-ADuCM3029 EZ-KIT or EVAL-SDP-CB1Z</td>
<td>120-way connector, 0.6 mm pitch</td>
<td>Hirose</td>
<td>FX8-120S-SV (21)</td>
</tr>
<tr>
<td>J10</td>
<td>SPI and power terminal</td>
<td>Header, in line, 7-position, 100 mil</td>
<td>Wurth Elektronik</td>
<td>61300711121</td>
</tr>
</tbody>
</table>
EVALUATION BOARD SOFTWARE
SOFTWARE INSTALLATION PROCEDURES

The EVAL-AD4111SDZ evaluation kit includes a link to the software that must be installed before using the EVAL-AD4111SDZ.

There are two parts to the installation:

- AD411x Eval+ software installation
- Eval+ Dependencies installation, including SDP-B board drivers

The evaluation software and drivers must be installed before connecting the EVAL-AD4111SDZ and SDP-B board to the USB port of the PC to ensure that the PC correctly recognizes the evaluation system.

**Installing the AD411x Eval+ Software**

To install the AD411x Eval+ software, use the following procedure:

1. With the SDP-B board disconnected from the USB port of the PC, download and unzip the AD411X Eval+ software installer file from the EVAL-AD4111SDZ product page.
2. Double-click the setup.exe file to begin the evaluation board software installation. The software then installs to the following default location: C:\Program Files\Analog Devices\AD411x Eval+.
3. A dialog box appears asking for permission to allow the program to make changes to the PC. Click Yes.
4. Select a location to install the software and click Next. Figure 5 shows the default locations, which are displayed when the dialogue box opens, but another location can be selected by clicking Browse.
5. A license agreement appears. Read the agreement, select I accept the License Agreement, and click Next.
6. A summary of the installation displays. Click Next to continue.
7. The message in Figure 8 appears when the installation is complete. Click Next.

![Figure 8. AD411x Eval+ Software Installation: Indicating When the Installation Is Complete](image1)

**Installing the Eval+ Dependencies Drivers**

After the installation of the evaluation software is complete, a welcome window displays for the installation of the Analog Devices Eval+ dependencies. Perform the following steps to install the dependencies drivers:

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

![Figure 9. Analog Devices Eval+ Dependencies Setup: Beginning the Drivers Installation](image2)

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

![Figure 10. Analog Devices Eval+ Dependencies Setup: Completing the Drivers Setup Wizard](image3)

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

![Figure 11. Analog Devices Eval+ Dependencies Setup: Restarting the PC](image4)
Setting Up the System for Data Capture

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

1. Allow the Found New Hardware Wizard to run after connecting the SDP-B board to the PC. For Windows® XP, the user may need to search for the SDP drivers. Choose to automatically search for the drivers for the SDP-B board if prompted by the operating system.

2. Check that the board is connecting to the PC correctly using the Device Manager of the PC. Access the Device Manager as follows:
   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 12).
   d. The SDP-B board appears under ADI Development Tools, which indicates that the driver software has been installed, and that the board is connected to the PC correctly.

Launching the Software

After completing the steps in the Setting Up the System for Data Capture section, launch the AD411x Eval+ software as follows:

1. From the Start menu, click Programs > Analog Devices > AD411x Eval+ > AD411x Eval+. The dialog box in Figure 13 appears. Select AD4111 Evaluation Board, and the main window of the software appears as shown in Figure 16.

2. If the EVAL-AD4111SDZ 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 14. Connect the evaluation board to the USB port of the PC, wait a few seconds, click Refresh, and the option shown in Figure 13 appears.

3. If Step 1 was completed correctly, the dialog box shown in Figure 15 appears. Quickstart mode provides a simplified version of the software that can be used as a starting point for evaluating the AD411. This mode provides a graphical user interface (GUI) for setting up inputs, as shown in Figure 16, and allows the user to further configure the device using the blue configuration buttons (Label 8 in Figure 16).

Advanced mode can be used when more configurability of the inputs is required. In this mode, the input GUI is not available. However, the user has access to the Register tab, which provides full control of the AD4111 register map. When operating in advanced mode, the user must consult with and have a good understanding of the AD4111 data sheet.
Figure 16. **Configuration Tab of the AD4111 Eval+ Software in Quickstart Mode**

Figure 17. **Configuration Tab of the AD4111 Eval+ Software in Advanced Mode**
SOFTWARE OPERATION

Overview of the Main Window

After selecting AD411x Evaluation Board, the main window of the evaluation software appears, as shown in Figure 16. The Configuration tab shows the control buttons and analysis indicators of the AD411x Eval+ software. The main window of the AD411x Eval+ software in quickstart mode contains five tabs: Configuration, Voltage Waveform, Current Waveform, Noise Table, and Histogram.

In advanced mode, two additional tabs are available: Ch Waveform and Registers.

CONFIGURATION TAB

The Configuration tab shows a block diagram of the AD4111. This tab allows the user to select inputs, set up the ADC, reset the ADC, and view errors present, as well as configure the device for different demonstration modes. Figure 16 shows the Configuration tab in detail, and the following sections discuss the different elements on the Configuration tab of the software window.

Inputs and Open Wire Detection (Quickstart Mode Only)

The AD4111 has eight voltage inputs, which can be configured as single-ended or fully differential pairs, and four current inputs (Label 1 in Figure 16).

One of the features of the AD4111 is its ability to perform open wire detection on voltage inputs while using a single power supply. This feature can be toggled on and off as required (Label 2 in Figure 16). If seven or all eight of the voltage inputs are enabled as single-ended, current inputs are restricted to two or none, respectively. After an input is selected, the software automatically assigns the input to the correct channel(s). Click Summary (Label 12 in Figure 16) to see what channels an input has been assigned to.

The voltage range can also be set per input to ±10 V, ±5 V, 0 V to 10 V, or 0 V to 5 V. Changing this to the appropriate range gives more realistic values for the P-P Resolution and RMS Resolution shown in the Noise Analysis (see Figure 18).

Output Data Rate (ODR) and Measurement Time

The ODR can be set for all inputs in the Configuration tab (Label 3 in Figure 16). Set the ODR by entering a value in Hz into the ODR(Hz) box or a measurement time in ms into the Time(ms) box. If an ODR is entered, the software calculates the measurement time. If a time is entered, the software calculates the fastest ODR that can achieve the required measurement time.

The device only supports a certain number of ODRs. Therefore, the software rounds up to the closest available value. The ODR values depend on if a single or multiple channels are enabled. The fastest ODRs are available if only one channel is enabled. The values represent the sinc5 + sinc1 filter, which is enabled by default. If the sinc3 filter is enabled instead, refer to the AD4111 data sheet to see the corresponding values.

The value in Time(ms) represents time taken for one sample for one enabled channel. If open wire is enabled, voltage inputs take twice as long.

The value in the Total Time box represents the total time to take one sample for all enabled inputs.

Demo Modes

The AD411x Eval+ software contains a number of demonstration modes in the Demo Modes area (Label 4 in Figure 16). These demonstration modes configure the AD4111 for each of the input types (voltage fully differential, voltage single-ended, and current measurements).

Reset

Click Reset (Label 5 in Figure 16) to perform a software reset of the AD4111. There is no hardware reset pin on the AD4111.

To perform a hard reset, remove power from the board. The software reset has the same effect as a hard reset.

Tutorial Button

Click the tutorial button (Label 6 in Figure 16) to open a tutorial on using the software and additional information on using the AD411x Eval+ software. Click the information buttons for further information on different elements of the Configuration tab.

Functional Block Diagram

The functional block diagram of the AD4111 (Label 7 in Figure 16) shows each of the functional blocks within the AD4111. Clicking a configuration button on this diagram opens the configuration pop-up window for that block.

Configuration Pop-Up Button

Each configuration pop-up button (Label 8 in Figure 16) opens a different window to configure the relevant functional block.

External Parameters

There are three external parameters that are set by the EVAL-AD4111SDZ but must be entered into the software: the external reference (Label 9 in Figure 16), AVDD (Label 10 in Figure 16), and AVSS (Label 11 in Figure 16). The external reference on the EVAL-AD4111SDZ is set to 2.5 V by using an ADR4525. If bypassing the ADR4525 on the board, change the external reference voltage value in the software to ensure correct calculation of results in the Voltage Waveform, Current Waveform, and Histogram tabs.

Configuration Summary

Clicking Summary (Label 12 in Figure 16) displays the input configuration, channel configuration, and information on each of the individual setups as well as information on any error present. These tabs can be used to quickly check how the ADC inputs and channels are configured, as well as any errors that are present.

Status Bar

The status bar (Label 13 in Figure 16) displays status updates such as Analysis Completed, Reset Completed, Writing to Registers during software use, and the Busy indicator.
WAVEFORM TABS

The AD411x Eval+ software has three different waveform tabs: for voltage inputs, **Voltage Waveform**; for current inputs, **Current Waveform**; and a per channel **Ch Waveform** tab (advanced mode only). The waveform tabs graph the conversions gathered and processes the data, calculating the peak-to-peak noise, rms noise, and resolution (see Figure 18). The **Voltage Waveform** tab graphs the data at the voltage inputs. This tab is where open wire is flagged (Label 14 in Figure 18). The **Current Waveform** tab graphs the data at the current inputs, which are displayed in amps. Both tabs share the functionalities described in the following sections. The **Ch Waveform** tab displays both voltage and current inputs as voltages.

**Waveform Graph and Controls**

The data waveform graph (Label 15 in Figure 18) shows each successive sample of the ADC output. Zoom in on the data in the graph using the control toolbar (Label 16 in Figure 18). Change the scales on the graph by typing values into the x-axis and y-axis fields.

**Samples**

The **Samples** numeric control and **Sampling Mode** box (Label 17 and Label 18 in Figure 18) set the number of samples gathered per batch. If **Sampling Mode** is set to **Single Capture**, the ADC returns the number of samples specified by the **Samples** control. If **Sampling Mode** is set to **Continuous** mode, the ADC continuously returns samples until stopped by the user. **Samples** specifies the amount of samples to be shown on the data graph. This control is unrelated to the ADC mode.

**Sample**

Click **Sample** (Label 19 in Figure 18) to start gathering ADC results. Results appear in the waveform graph (Label 15 in Figure 18).

**Plot Selection**

The plot selection control (Label 20 in Figure 18) selects which inputs display on the data waveform and shows the name of the input next to the on and off controls. These controls only affect the waveform graphs and have no effect on the channel settings in the ADC register map.

**Display Units and Axis Controls**

Click the **Units** dropdown box (Label 21 in Figure 18) to select whether the data graph displays in units of voltages/amps or codes. This control is independent for each graph. The axis controls switch between autoscale and fixed. When autoscale 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 axis range can be set by the user. However, these ranges do not automatically adjust after each batch of samples.
Device Error

The Device Error indicator (Label 22 in Figure 18) illuminates in the waveform tabs when a cyclic redundancy check (CRC) error or an error in the ADC is detected. More specific information of the error can be found by clicking Summary in the Configuration tab (Label 12 in Figure 16).

Analysis Input

The Noise Analysis box shows the analysis of the input selected via the analysis control (Label 23 in Figure 18).

Noise Analysis

The Noise Analysis section (Label 24 in Figure 18) displays the results of the noise analysis for the selected analysis input, including both noise and resolution measurements.

Input Range

Range (Label 25 in Figure 18) is an indicator in quickstart mode. The value is selected per the inputs on the Configuration tab (Label 1 in Figure 16). In advanced mode, Range is a control that allows the user to select an input range for the input chosen for Noise Analysis (Label 23 in Figure 18).
HISTOGRAM TAB

The Histogram tab generates a histogram using the gathered samples and processes the data, calculating the peak-to-peak noise, rms noise, and resolution (see Figure 19). There is only one histogram tab for current and voltage inputs.

Histogram Graph and Controls

The data histogram graph (Label 26 in Figure 19) shows the number of times each sample of the ADC output occurs. Zoom in on the data using the control toolbar (Label 27 in Figure 19) in the graph. Change the scales on the graph by typing values into the x-axis and y-axis.

Analysis Input

The data used to generate the histogram graph (Label 26 in Figure 19) and the Noise Analysis section (Label 28 in Figure 19) is set by the Noise Analysis box (Label 29 in Figure 19). All the enabled inputs appear here in the Noise Analysis box.

Noise Analysis

The Noise Analysis section (Label 28 in Figure 19) displays the results of the noise analysis for the selected analysis input, including both noise and resolution measurements.

Display Units and Axis Controls

Click the Units dropdown box (Label 30 in Figure 19) to select whether the data graph displays in units of voltages/amps or codes. This control is independent for each graph. The axis controls switch between autoscale and fixed. When autoscale 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 axis range can be set by the user. However, these ranges do not automatically adjust after each batch of samples.

Device Error

The Device Error indicator (Label 31 in Figure 19) illuminates in the Histogram tab when a CRC error or an error in the ADC is detected. More specific information of the error can be obtained by clicking Summary in the Configuration tab (Label 12 in Figure 16).
REGISTER MAP TAB (ADVANCED MODE ONLY)

**Register Tree**

The register maps nested list (Label 32 in Figure 20) shows the full register map in a tree control. Each register is shown. Clicking the expand button next to each register shows all the bit fields contained within that register.

**Register Tree Search**

The register tree search box (Label 33 in Figure 20) allows the user to search the tree for any register or bit field. Enter a value into this field to filter the register tree.

**Register and Bit Field Control**

The register and bit field control section (Label 34 in Figure 20) allows the user to change the individual bit of the register selected in the register tree by clicking the bits or by programming the register value directly into the number control field (Label 35 in Figure 20). This control also shows all bit fields for the selected register. Change the values by using a dropdown box (Label 36 in Figure 20) or by selecting or clearing a checkbox (Label 37 in Figure 20).

**Documentation**

The Documentation field (Label 39 in Figure 20) contains the documentation for the register or the bit field selected. This field can be updated by selecting a register or bit field in the register tree or hovering over the register or bit field in the register tree or register control. This documentation can also be displayed in a separate window by clicking the expand button (Label 38 in Figure 20).

**Save and Load**

Save and Load (Label 40 in Figure 20) allow the user to save the current register map setting to a file and to load the setting from the same file, respectively.

**EXITING THE SOFTWARE**

To exit the software, click the Close button at the top right corner of the main window.
EVALUATION BOARD SCHEMATICS AND ARTWORK

Figure 21. AD4111 Schematic on the EVAL-AD4111SDZ
OVERLAPPING LAYOUT CONNECTS VCOM TO GND_ISO (TYPICAL FOR SINGLE-ENDED MEASUREMENT)

Figure 22. Voltage Input Front End Schematic
Figure 23. Current Input Front End Schematic
**VIN:** Use this pin to power the SDP requires 4-7V 200mA

**VIO:** USE to set IO voltage max draw 20mA

**BMODE1:** Pull up with a 10K resistor to set SDP to boot from a SPI FLASH on the daughter board

**EEPROM-SW/USB ID**

SDP CONNECTOR

**VIN:** Use this pin to power the SDP requires 5V 200mA

**Board ID EEPROM (24LC32)** must be on I2C bus 0, I2C bus 1 is common across both connectors on SDP - Pull up resistors required

**BMODE1:** Pull up with a 10K resistor to set SDP to boot from a SPI FLASH on the daughter board (connected to blackfin GPIO - use I2C_0 first)

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**Figure 24. System Demonstration Platform Connector Schematic**
Figure 25. Insulation and Power Supply Schematic
Figure 26. Printed Circuit Board (PCB), Top
Figure 27. Component Side, Silkscreen, Top
### BILL OF MATERIALS

**Table 3. Bill of Materials**

<table>
<thead>
<tr>
<th>Reference Designator</th>
<th>Description</th>
<th>Manufacturer</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1 to B6</td>
<td>B0402, 1800 Ω at 100 MHz, 200 mA</td>
<td>Murata</td>
<td>BLM15HD182SN1D</td>
</tr>
<tr>
<td>C2</td>
<td>C0402, do not place</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>C3</td>
<td>C0402, do not place</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>C4, C6, C10, C11, C38, C39, C43, C44</td>
<td>C0402, 0.1 μF, 50 V, X5R</td>
<td>Murata</td>
<td>GRM155R61H104KE19D</td>
</tr>
<tr>
<td>C5, C7, C8, C9, C37, C40, C50, C51</td>
<td>C0402, 1 μF, 16 V, X5R</td>
<td>Taiyo Yuden</td>
<td>EMK105BB105KV-F</td>
</tr>
<tr>
<td>C12 to C19</td>
<td>C0402, 680 pF, 50 V, X7R</td>
<td>Murata</td>
<td>GRT155R71H681KE01D</td>
</tr>
<tr>
<td>C20 to C28</td>
<td>C0402, 4.7 nF, 50 V, X7R</td>
<td>Murata</td>
<td>GRT155R71H472KE01D</td>
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<tr>
<td>C29 to C32</td>
<td>C0603, do not place</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>C33 to C36</td>
<td>C0402, 470 pF, 50 V, C0G/NP0</td>
<td>Murata</td>
<td>GRM155C1H471JA01D</td>
</tr>
<tr>
<td>C41, C42, C45</td>
<td>C0402, 10 μF, 10 V, X7R</td>
<td>Murata</td>
<td>GRM155C1H471JA01D</td>
</tr>
<tr>
<td>C46 to C49</td>
<td>C1812, 4.7 nF, 2 kV, X7R</td>
<td>Wurth Elektronik</td>
<td>88501207026</td>
</tr>
<tr>
<td>D1 to D9</td>
<td>Diode, TVS bipolar, 33 V, 400 W</td>
<td>STMicroelectronics</td>
<td>SMAJ33CA</td>
</tr>
<tr>
<td>D10 to D13</td>
<td>Diode, TVS bipolar, 10 V, 400 W</td>
<td>STMicroelectronics</td>
<td>SMAJ10CA</td>
</tr>
<tr>
<td>D14</td>
<td>Diode, TVS unipolar, 5 V, 400 W</td>
<td>STMicroelectronics</td>
<td>SMAJ5.0A</td>
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<tr>
<td>D15</td>
<td>Diode, Schottky, 30 V, 0.5 A, SOD123</td>
<td>Diodes, Inc.</td>
<td>B030W7-F</td>
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<td>D16</td>
<td>Diode, Schottky, 30 V, 0.5 A, SOD123</td>
<td>Diodes, Inc.</td>
<td>B030W7-F</td>
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<tr>
<td>ERR</td>
<td>Light emitting diode (LED), 0603, red</td>
<td>Osram</td>
<td>LSQ976-Z</td>
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<tr>
<td>F1 to F4</td>
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<td>Bourns</td>
<td>MF-USMF005-2</td>
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<tr>
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<td>Phoenix Contact</td>
<td>MC 1.5/5-G-3.81</td>
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<td>Japan Solderless Terminals</td>
<td>1.25-M53</td>
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<td>J5</td>
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<td>Phoenix Contact</td>
<td>MC1.5/3-G-3.81</td>
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<tr>
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<td>Header, R/A, 3.81 mm, 3-way</td>
<td>Phoenix Contact</td>
<td>MC 1.5/3-G-3.81</td>
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<tr>
<td>J8</td>
<td>120-way connector, 0.6 mm pitch</td>
<td>Hirose</td>
<td>FX8-120S-5V(21)</td>
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<tr>
<td>J10</td>
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<td>Wurth Elektronik</td>
<td>61300711121</td>
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<td>LED, O603, red</td>
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<td>2-pin (0.1&quot;) header and shorting shunt</td>
<td>Harwin</td>
<td>M20-9990246</td>
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<td>LK3</td>
<td>3-pin (3x1) 0.1&quot;, Header B</td>
<td>Harwin</td>
<td>M20-9990346 M7566-05</td>
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<tr>
<td>PWR</td>
<td>LED, green, surface mount device (SMD), 20 mA, 2.1 V, 566 mm</td>
<td>Vishay</td>
<td>TLMP1100-G508</td>
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<tr>
<td>R1, R49</td>
<td>Resistors, 4.7 kΩ, 0.063 W, 1%, 0402</td>
<td>Multicomp</td>
<td>MCWR04X4701FTL</td>
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<td>R2</td>
<td>Resistor, 100 kΩ, 0.063 W, 1%, 0402</td>
<td>Multicomp</td>
<td>MC0662SW04021100K</td>
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<tr>
<td>R3</td>
<td>Resistor, 2.2 kΩ, 0.063 W, 1%, 0402</td>
<td>Multicomp</td>
<td>MC0662SW040212K2</td>
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<tr>
<td>R4</td>
<td>Resistor, 100 kΩ, 0.063 W, 1%, 0402</td>
<td>Multicomp</td>
<td>MC0662SW04021100K</td>
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<tr>
<td>R5 to R7</td>
<td>Resistors, 0.0402, 1%, 0</td>
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<tr>
<td>R8 to R15</td>
<td>Resistors, 1 kΩ, 0.063 W, 1%, 0402</td>
<td>Multicomp</td>
<td>MC0662SW0402111K</td>
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<tr>
<td>R16 to R24</td>
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<td>Resistors, 180 Ω, 0.1 W, 1%, 0805</td>
<td>Panasonic</td>
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<td>R29 to R36</td>
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<td>Multicomp</td>
<td>MC0662SW0402133R</td>
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<tr>
<td>R37</td>
<td>Resistor, do not place, 0402</td>
<td>Not applicable</td>
<td>Not applicable</td>
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<tr>
<td>R38</td>
<td>Resistor, 14 kΩ, 0.063 W, 1%, 0402</td>
<td>Multicomp</td>
<td>MC0662SW0402114K</td>
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<td>Multicomp</td>
<td>MC0662SW0402116K9</td>
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<tr>
<td>R40</td>
<td>Resistor, 10 kΩ, 0.063 W, 1%, 0402</td>
<td>Multicomp</td>
<td>MC0662SW0402110K</td>
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<tr>
<td>R41, R42</td>
<td>Resistors, 4.7 MΩ, 0.5 W, 5%, 2010</td>
<td>BOURNS</td>
<td>CHV2010-JW-475ELF</td>
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<tr>
<td>R43</td>
<td>Resistor, 1 kΩ, 0.063 W, 1%, 0402</td>
<td>Multicomp</td>
<td>MC0662SW0402111K</td>
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<tr>
<td>R44</td>
<td>Resistor, 100 kΩ, 0.063 W, 1%, 0402</td>
<td>Multicomp</td>
<td>MC0662SW04021100K</td>
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<tr>
<td>R45</td>
<td>Resistor, do not place, 0402</td>
<td>Not applicable</td>
<td>Not applicable</td>
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### Reference Designators

<table>
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<tr>
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<tr>
<td>U1</td>
<td>±10 V and 0 mA to 20 mA, analog front end for industrial automation systems</td>
<td>Analog Devices</td>
<td>AD4111BCPZ</td>
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<td>U2</td>
<td>2.5 V voltage reference, ±4 ppm/°C ± 0.04%</td>
<td>Analog Devices</td>
<td>ADR4525ARZ</td>
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<tr>
<td>U3</td>
<td>Digital isolator, 4-channel, isoPower</td>
<td>Analog Devices</td>
<td>ADuMS4111BRZ</td>
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<tr>
<td>U4</td>
<td>32 kb I²C serial electronically erasable programmable read-only memory (EEPROM)</td>
<td>Microchip</td>
<td>24LC32A-1/MS</td>
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<tr>
<td>Y1</td>
<td>Miniature crystal, SMD, 16 MHz</td>
<td>Epson Toyocom</td>
<td>FA-20H, 16MHZ, 10PPM</td>
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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.

**I²C** refers to a communications protocol originally developed by Philips Semiconductors (now NXP Semiconductors).