One Technology Way • P.O. Box 9106 • Norwood, MA 02062-9106, U.S.A. • Tel: 781.329.4700 • Fax: 781.461.3113 • www.analog.com

# Evaluation Board for the Dual, Continuous Time Sigma-Delta Modulator

## EVALUATION BOARD DESCRIPTION

The AD9267 evaluation board serves two purposes: as an evaluation platform for the 16-bit, dual, continuous time sigma-delta (Σ-Δ) modulator and as a direct conversion demonstration platform. Table 1 lists the product features of all the Analog Devices, Inc., components in the demonstrator.

The AD9267 is a dual continuous time Σ-Δ modulator with −88 dBc of dynamic range over 10 MHz real or 20 MHz complex bandwidth. The combination of high dynamic range, wide bandwidth, and characteristics unique to the continuous time Σ-Δ modulator architecture makes the AD9267 an ideal solution for wireless communication systems.

Direct conversion architectures, as shown in Figure 1, use a single frequency translation step to convert the RF channel directly to baseband without any intermediate frequency stages. The frequency translation in this direct conversion demonstrator is accomplished by the ADL5382, which is a quadrature demodulator. The ADL5382 covers the frequency range between 700 MHz and 2.7 GHz.

The AD9267 has passive inputs, therefore allowing the ADL5382 to directly drive the modulator. The AD9267 does not require a filter preceding the converter because the continuous time Σ-Δ architecture possesses inherent antialiasing capabilities. Therefore, minimal or no filtering is required between the demodulator and the AD9267. A prototype area for a fourth-order filter is provided in which additional filtering can be tested.

To achieve optimal performance from the AD9267, a low jitter differential clock is necessary, and the AD9516 family of parts offers superior clock performance. The AD9516-0 and a crystal oscillator footprint are included on the evaluation board. In addition to providing a clock option to the modulator, the many outputs from the AD9516 can be used to drive other external capture devices. AD9516 is used throughout to refer to all the members of the AD9516 family. However, the use of AD9516-0 refers to that specific device.

The ADR130B offers the option of using an external 0.5 V band gap reference voltage for the AD9267. The ADP3339 provides a quiet and reliable voltage source to each of the Analog Devices components.

In addition to offering system-level evaluation of the direct conversion architecture, the evaluation board offers the flexibility of isolating the AD9267 from the surrounding components, enabling a detailed evaluation of only the AD9267. The modulator inputs can be disconnected from the ADL5382 and be driven with an external source. The analog inputs of the AD9267 can be driven from either a differential transformer or the ADA4937-2, which is a very low noise, high linearity differential amplifier.

Complementing the AD9267 evaluation board are additional hardware and software to capture and process digital data from the output of the modulator. The AD9267 can only be evaluated using the HSC-ADC-EVALCZ high speed ADC data capture card in conjunction with the VisualAnalog™ data capture and analysis software. The SPIController™ software is used to read and write to the AD9267.

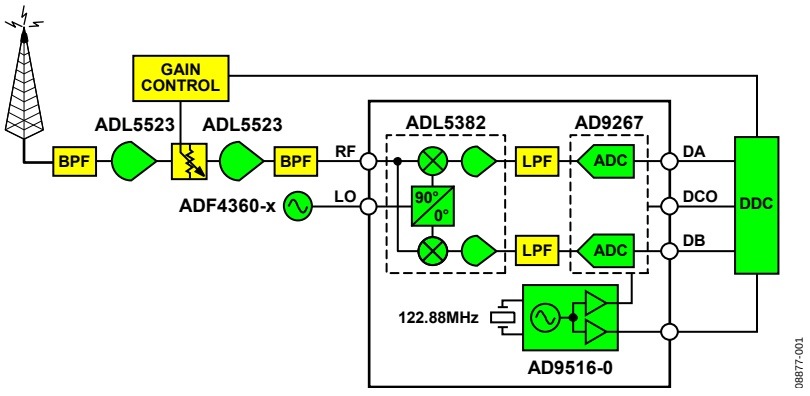



*Figure 1. Direct Conversion Receiver Block Diagram*

# TABLE OF CONTENTS

Evaluation Board Description ..... 1
Revision History ..... 2
Product Features ..... 3
Getting Started ..... 4
Configuring the Evaluation Board ..... 5
Clock ..... 5
Receiver Input Configuration ..... 5
Modulator Only Input Configuration ..... 5
Differential Transformer Path ..... 6
Amplifier Driver Path ..... 6
Power-Down Settings ..... 6
Digital Output ..... 6
Supporting Hardware and Software ..... 7
Software ..... 7
Hardware ..... 7
AD9267 SPI Controller ..... 7
AD9516 SPI Controller ..... 7
AD9516 Register Settings ..... 8
VisualAnalog Overview ..... 9
Loading Binary Files into the FPGA ..... 9
Schematics ..... 11
Layout ..... 16
Ordering Information ..... 20
Bill of Materials ..... 20
Related Links ..... 23

## REVISION HISTORY

**3/10—Revision 0: Initial Version**

# PRODUCT FEATURES

**Table 1.**

| AD9267 | ADL5382 | AD9516-0 |
|---|---|---|
| SNR: 83 dB (85 dBFS) to 10 MHz input<br>SFDR: −88 dBc to 10 MHz input<br>Noise figure: 15 dB<br>Input impedance: 1 kΩ<br>Power: 416 mW<br>10 MHz real or 20 MHz complex bandwidth<br>1.8 V analog supply operation<br>On-chip PLL clock multiplier<br>On-chip voltage reference<br>Twos complement data format<br>640 MSPS, 4-bit LVDS data output<br>Serial control interface (SPI) | I-Q demodulator<br>Operating RF frequency: 700 MHz to 2.7 GHz<br>IIP3: 33.5 dBm at 900 MHz<br>IIP2: >70 dBm at 900 MHz<br>Input P1dB: 14.7 dBm at 900 MHz<br>Noise figure: 14 dB at 900 MHz<br>Voltage conversion gain: ~4 dB<br>Quadrature demodulation accuracy<br>Phase accuracy: ~0.2°<br>Amplitude balance: ~0.05 dB<br>LO input: −6 dBm to +6 dBm<br>Demodulation bandwidth: ~370 MHz<br>I/Q drive 2 V p-p into 200 Ω<br>Programmable power consumption | Low phase noise, phase-locked loop<br>On-chip VCO tunes from 2.55 GHz to 2.95 GHz<br>External VCO/VCXO to 2.4 GHz (optional)<br>One differential or two single-ended reference inputs<br>Reference monitoring capability<br>Auto and manual reference switchover/holdover modes<br>Autorecover from holdover<br>Accepts references to 250 MHz<br>Programmable delays in path to PFD<br>Digital or analog lock detect, selectable<br>Three pairs of 1.6 GHz LVPECL outputs<br>Each pair shares one to 32 dividers with coarse phase delay<br>Additive output jitter: 225 $f_S$ rms<br>Channel-to-channel skew paired outputs: <10 ps<br>Two pairs of 800 MHz LVDS clock outputs<br>Each pair shares two cascaded one-to-32 dividers with coarse phase delay<br>Additive output jitter: 275 $f_S$ rms<br>Fine delay adjust (ΔT) on each LVDS output<br>Eight 250 MHz CMOS outputs (two per LVDS output)<br>Automatic synchronization of all outputs on power-up<br>Manual synchronization of outputs as needed<br>Serial control port<br>64-lead LFCSP |
| **ADR130B** | **ADP3339** | **ADA4937-2** |
| Initial accuracy<br>A grade: ±0.70% (maximum)<br>B grade: ±0.35% (maximum)<br>Maximum temperature coefficient<br>A grade: 50 ppm/°C<br>B grade: 25 ppm/°C<br>$C_{LOAD}$: 50 nF to 10 µF<br>Output current: +4 mA/−2 mA<br>Low operating current: 80 µA (typical)<br>Output noise: 6 µV p-p at 1.0 V output<br>Input range: 2.0 V to 18 V<br>Temperature range: −40°C to +125°C<br>Tiny, Pb-free TSOT package | High accuracy over line and load: ±0.9% at 25°C, ±1.5% over temperature<br>Ultralow dropout voltage: 230 mV (typical) at 1.5 A<br>Requires only $C_O$ = 1.0 µF for stability<br>anyCAP® regulators: stable with any type of capacitor (including MLCC)<br>Current and thermal limiting<br>Low noise<br>2.8. V to 6 V supply range<br>−40°C to +85°C ambient temperature range<br>SOT-223 package | Extremely low harmonic distortion<br>−112 dBc HD2 at 10 MHz<br>−84 dBc HD2 at 70 MHz<br>−77 dBc HD2 at 100 MHz<br>−102 dBc HD3 at 10 MHz<br>−91 dBc HD3 at 70 MHz<br>−84 dBc HD3 at 100 MHz<br>Low input voltage noise: 2.2 nV/√Hz<br>High speed<br>−3 dB bandwidth of 1.9 GHz, G = 1<br>Slew rate: 6000 V/µs, 25% to 75%<br>0.1 dB gain flatness to 200 MHz<br>Fast overdrive recovery of <1 ns<br>±0.5 mV typical offset voltage<br>Externally adjustable gain<br>Differential-to-differential or single-ended–to-differential operation<br>Adjustable output common-mode voltage<br>Single-supply operation: 3.3 V to 5 V<br>Pb-free, 3 mm × 3 mm 16-lead LFCSP |

# GETTING STARTED

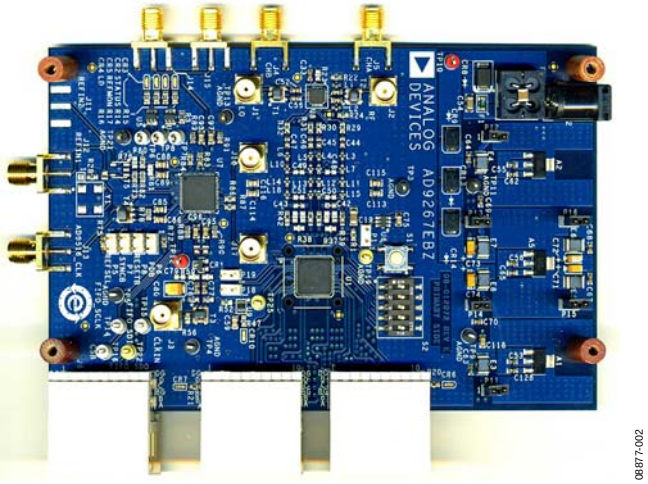



Figure 2. Evaluation Board Front

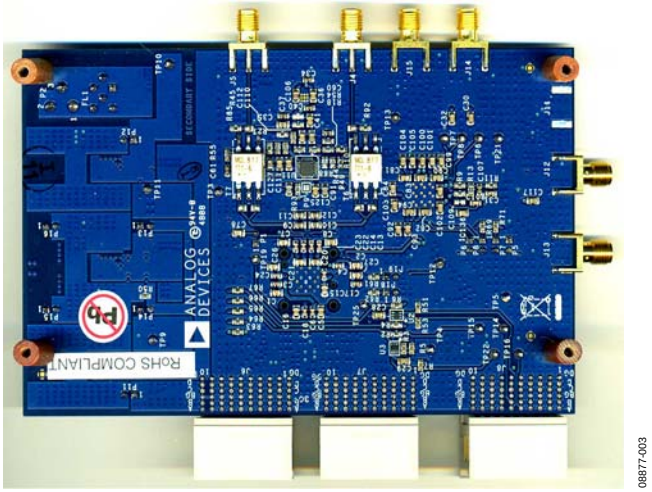



Figure 3. Evaluation Board Back

The default configuration of the AD9267 evaluation board allows a quick and easy start to evaluating the direct conversion receiver subsystem. The default configuration interfaces the ADL5382 directly with the AD9267. Table 2 and Figure 4 show the hardware required to start the evaluation.

**Table 2. Quick Start Hardware Requirements**

| Name | Board | Value | Reference Designator |
|---|---|---|---|
| Power | AD9267EBZ | +6.0 V | P2 |
| | HSC-ADC-EVALCZ | +5.0 V | |
| Clock | AD9267EBZ | 640 MHz | J3 |
| RF Input | AD9267EBZ | 700 MHz to 2.7 GHz | J2 |
| LO Input | AD9267EBZ | −6 dBm to +6 dBm | J1 |
| USB | HSC-ADC-EVALCZ | N/A | |

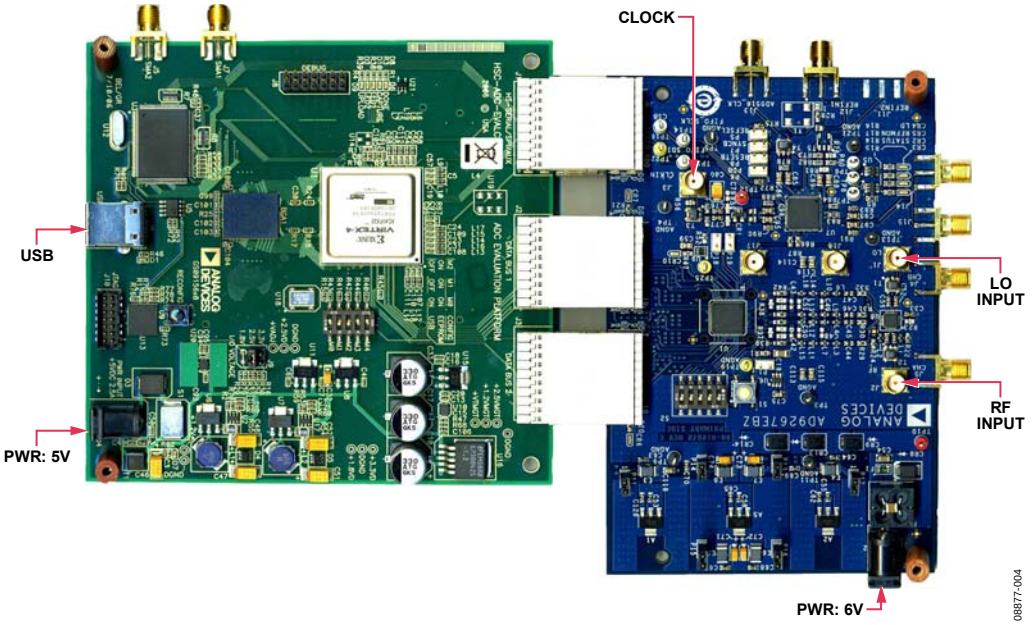



Figure 4. Quick Start Configuration

# CONFIGURING THE EVALUATION BOARD

Power is provided to the evaluation board by a single +6.0 V source applied to P2. The power source is regulated down to the appropriate levels by the ADP3339 voltage regulators. Table 3 shows the necessary voltage levels for each component.

**Table 3. Component Power Supplies**

| Component | Power Supply |
|---|---|
| AD9267 | 1.8 V |
| ADL5382 | 5.0 V |
| AD9516-0 | 3.3 V |

## CLOCK

The AD9267 evaluation board offers many clocking options: a high frequency external clock can be applied directly to the modulator; the AD9516-0 LVPECL or CMOS clock can be used; and a low frequency clock, in conjunction with the integrated PLL from either the AD9516-0 or AD9267, can provide the necessary input clock frequency. The default clock option is configured for an external clock rate of 640 MHz.

The AD9267 evaluation board includes the footprint for a Valpey Fisher VFAC3 crystal oscillator. The crystal oscillator can serve as the reference clock to the AD9516-0, and the chip's internal PLL can be used to generate a clock closest to the desired frequency for the modulator. For example, a 122.88 MHz reference produces a VCO frequency of 2.580 GHz.

The AD9516-0 possesses an integrated VCO. The VCO frequency is further divided down by 4 to generate an output clock of 645 MHz, which serves as the input clock to the modulator. To optimize the AD9516-0 for this particular frequency, the loop filter must be configured as shown in Figure 5.

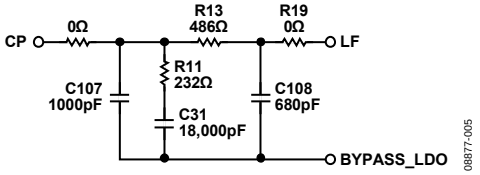



*Figure 5. AD9516-0 Loop Filter*

If the user chooses an alternative crystal oscillator frequency, the loop filter components must be configured appropriately. Some common crystal oscillators and the corresponding loop filter components are shown in Table 4. Refer to the ADIsimCLK software for design guidance.

**Table 4. AD9516-0 Clock Configuration**

| Crystal (MHz) | Loop Filter | | | | | AD9267 Clock |
|---|---|---|---|---|---|---|
| | C107 | R11 | C31 | R13 | C108 | |
| 134.4 | 1000 pF | 232 Ω | 18,000 pF | 486 Ω | 680 pF | 672 MHz |
| 122.88 | 1000 pF | 280 Ω | 15,000 pF | 576 Ω | 560 pF | 645.12 MHz |
| 39.3216 | 1500 pF | 221 Ω | 22,000 pF | 453 Ω | 680 pF | 648.8 MHz |

To configure the evaluation board for either the external clock source or the AD9516-0 requires modifying the JP5 and JP6 solder jumpers. The AD9267 sets the common-mode level of the input clock to 450 mV; therefore, the clock source should be ac-coupled to the modulator input clock pins. Use the AD9516-0 software to configure the chip to the appropriate divide ratios.

## RECEIVER INPUT CONFIGURATION

The default configuration uses the complex output signals of the I/Q demodulator as the input signals to the AD9267. In this configuration, the RF input signal should be applied to J2 and the LO signal to J1. The RF input range of the ADL5382 is limited to between 700 MHz and 2.7 GHz. The single-ended RF and LO signals are converted to differential signals using the RF transformers, T2 and T1. The resulting output signals of the demodulator are differential I and Q signals that can be directly applied to the resistive inputs of the AD9267, and no driver amplifiers are required.

Between the output of the ADL5382 and the input to the AD9267 are space holders for a fourth-order filter (see Figure 6). This filter may or may not be necessary depending on the application.

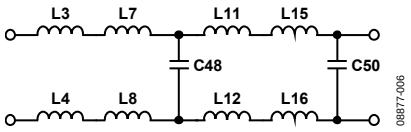



*Figure 6. Fourth-Order Filter*

## MODULATOR ONLY INPUT CONFIGURATION

In addition to using the ADL5382 as an input source to the modulator, the AD9267 can be driven with an external source through either the ADA4937-2 or a differential transformer.

To configure the evaluation board for an external source, follow the hardware configuration shown in Table 5. The SMA connectors, labeled J5 and J4, correspond to the input signals to Channel A and Channel B, respectively, of the AD9267.

Additionally, short TP17, TP23, TP2, and TP24 to the appropriate pads to route the external signals to the input pins of the AD9267 (see Figure 7). This configuration requires careful attention to ensure that the output signals of the ADL5382 are disconnected and only the signals from the transformer or ADA4937-2 are routed to the modulator.

**Table 5. External Modulator Input Configuration**

| Connector | Setting | Notes |
|---|---|---|
| J4, J5 | N/A | J4: Channel B<br>J5: Channel A |
| R33 to 42 | DNP | Disconnect ADL5382 outputs from the AD9267 |
| TP17 | Short to the closest pad on R40 | Connect A+ path |
| TP23 | Short to the closest pad on R39 | Connect A− path |
| TP2 | Short to the closest pad on R42 | Connect B+ path |
| TP24 | Short to the closest pad on R41 | Connect B− path |

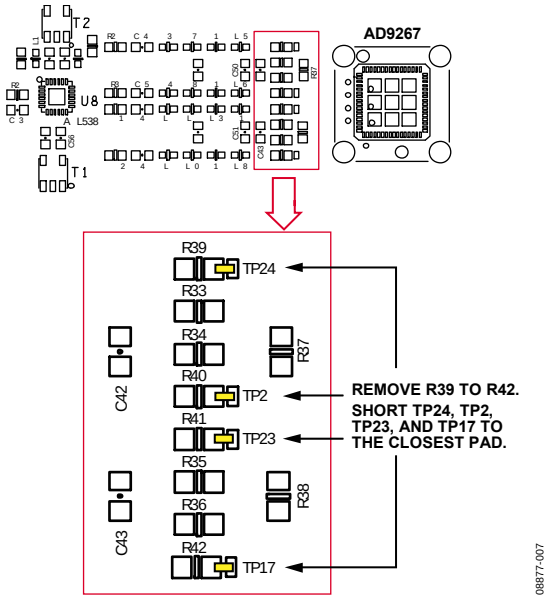



*Figure 7. External Modulator-Only Jumper Settings*

## DIFFERENTIAL TRANSFORMER PATH

To activate the differential transformer path, follow the jumper configuration shown in Table 6.

**Table 6. Differential Transformer Configuration**

| Jumper | Setting | Notes |
|---|---|---|
| JP1, JP2 | Short Position 1 and Position 2 | Configure SMA connectors for transformer inputs |
| JP3 to JP6 | Short Position 2 and Position 3 | Configure differential transformer outputs to modulator inputs |

## AMPLIFIER DRIVER PATH

Follow the jumper settings shown in Table 7.

**Table 7. ADA4937-2 Configuration**

| Jumper | Setting | Notes |
|---|---|---|
| JP1, JP2 | Short Position 2 and Position 3 | Configure SMA connectors for ADA4937-2 inputs |
| JP3 to JP6 | Short Position 1 and Position 2 | Configure outputs from the ADA4937-2 to modulator inputs |

## POWER-DOWN SETTINGS

To power down the AD9267, Pin 3 and/or Pin 4 of the DUT must be tied high. This is accomplished on the evaluation board by shorting P18 and P19.

## DIGITAL OUTPUT

The digital output of the AD9267 consists of a 4-bit LVDS data line at an output data rate of 640 MSPS. The output data is available directly from the continuous time Σ-Δ modulator, and there is no postprocessing of the digital data. Unlike the AD9262, the AD9267 does not have integrated decimation filters or a sample rate converter; therefore, the output is constrained to the high output data rate of 640 MSPS.

As an evaluation tool, decimation filters or any additional digital postprocessing can be coded into the FPGA available on the HSC-ADC-EVALCZ high speed ADC data capture card. The high speed ADC capture card currently supports Xilinx Virtex 4. Included in the evaluation board package are two binary files: the default file allows the modulated output data to be captured at 640 MSPS, and the second file incorporates the decimation filters within the FPGA code.

# SUPPORTING HARDWARE AND SOFTWARE

The AD9267 can only be evaluated using the HSC-ADC-EVALCZ high speed ADC data capture card in conjunction with the VisualAnalog data capture and analysis software. The SPIController software is used to configure the AD9267 and the AD9516 to the appropriate register settings.

## SOFTWARE

Manuals for VisualAnalog, the SPIController software, and the HSC-ADC-EVALCZ data capture hardware are included on the CD in the evaluation board package. It is recommended that the software be installed before connecting the hardware. VisualAnalog relies on the Microsoft .NET Framework Version 2, which is also included on the package CD. The .NET framework should be installed before installing VisualAnalog. The SPIController software should also be installed.

## HARDWARE

The AD9267 evaluation board and the HSC-ADC-EVALCZ data capture card are powered from a wall-connected switching power supply. The switching power supplies have different output voltages; connect the 6.0 V power supply to the AD9267 evaluation board and the 5.0 V power supply to the HSC-ADC-EVALCZ data capture board. With the HSC-ADC-EVALCZ data capture board powered on and the VisualAnalog software installed, connect the USB cable to the PC and follow all the **Found new hardware** prompts, using the default driver each time.

## AD9267 SPI CONTROLLER

Upon successful software installation and hardware setup, start the AD9267 SPIController software. By default, the software recognizes the AD9267 evaluation board and loads the correct SPIController profile. If it does not, from the **File** menu, click **Open**, then **Browse** to select the following file: **AD9267_16Bit_10MSspiR03.cfg**.

The AD9267 SPIController has four tabs. When correctly configured, a message appears in the **CHIP ID** section, under the **Global** tab, reporting that the AD9267 is interfaced (see Figure 8).

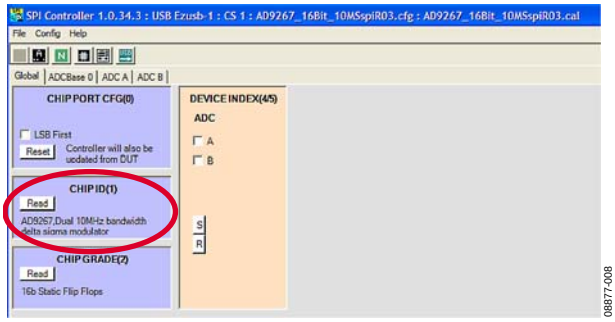



*Figure 8. AD9267 SPIController*

## AD9516 SPI CONTROLLER

Double-click the SPIController icon to open another instance of the SPIController for control of the AD9516. If a box titled **Read Test Failure** appears, click **Ignore** to open the SPIController. This error occurs because the software has not been configured correctly to read from the chip. Use the following procedure to appropriately configure the SPIController to read and write to the AD9516:

1. From the **File** menu, select **CfgOpen**; then select **AD9516spiengR03.cfg**.
2. When a **Calibration File Error!** message appears, as shown in Figure 9, click **OK**.

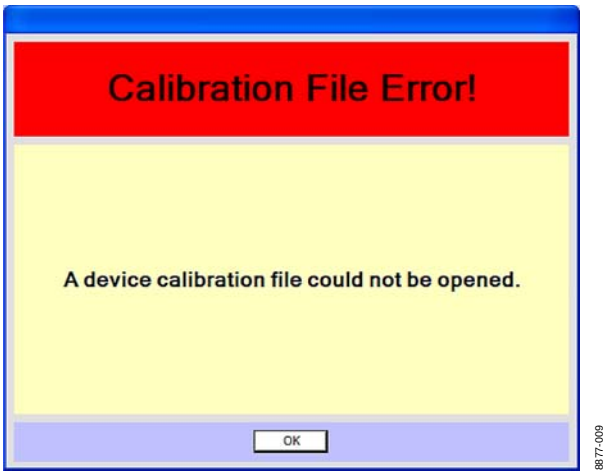



*Figure 9. Calibration File Error*

3. Select **Config** and then **Controller Dialog**. In the **AD9516 SPI Controller Cfg Dialog** window, make sure that **FIFO Chip Sel** is set to **2** and that **USB Chan #** is set to the same value as in the AD9267 SPIController (see Figure 10).

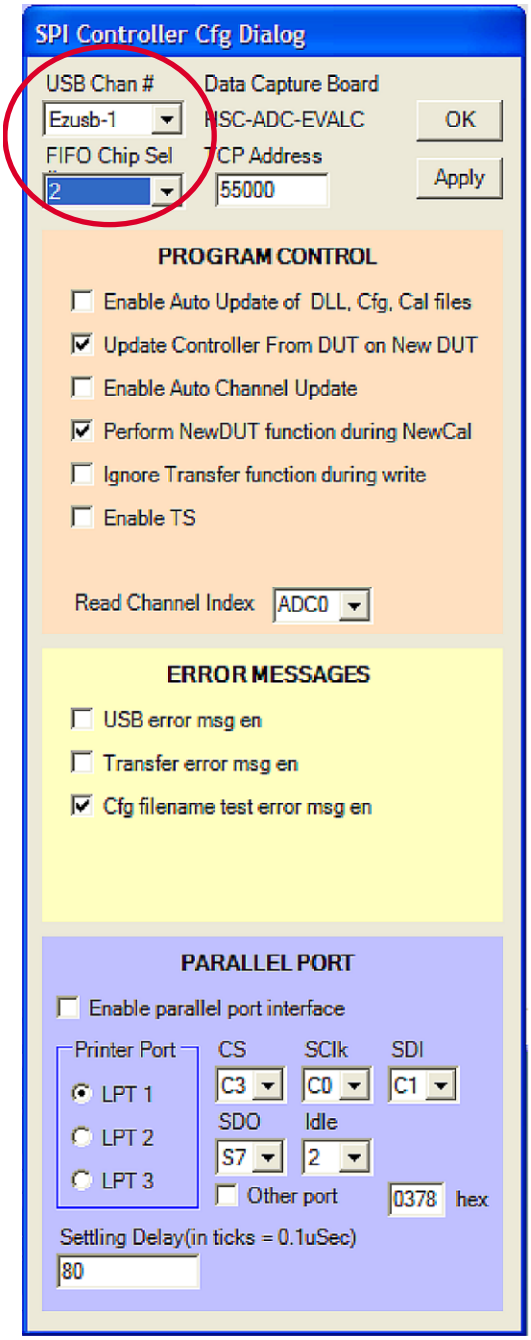



*Figure 10. AD9516 SPIController*

## AD9516 REGISTER SETTINGS

The SPIController uses a 4-wire interface; therefore, the AD9516 must be configured for this interface before any further writes can take effect. To configure the AD9516, select the **SDO Enable** box, as shown in Figure 11.

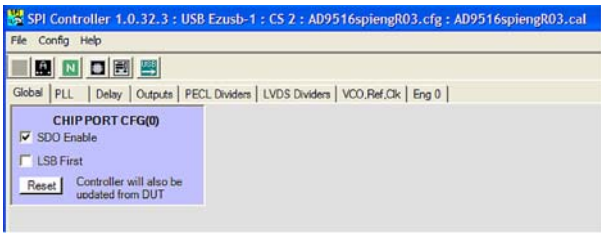



*Figure 11. AD9516 Configuration*

The AD9516 register settings depend on the particular clock option chosen. Table 8 provides a list of register settings for some common crystal oscillators. The configuration sequence (1 to 9) shown in Figure 12 and Figure 13 are for the 122.88 MHz crystal oscillator.

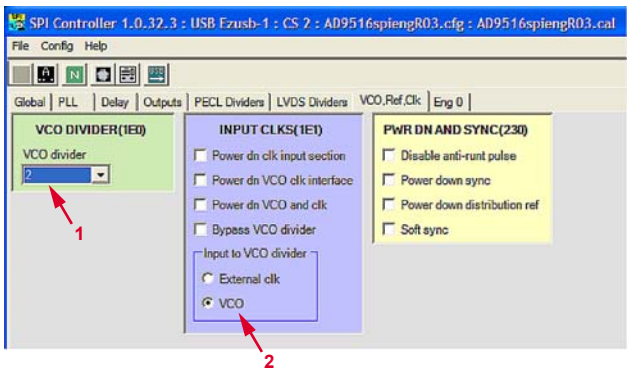



*Figure 12. VCO and Clock Configuration for the 122.88 MHz Crystal Oscillator*

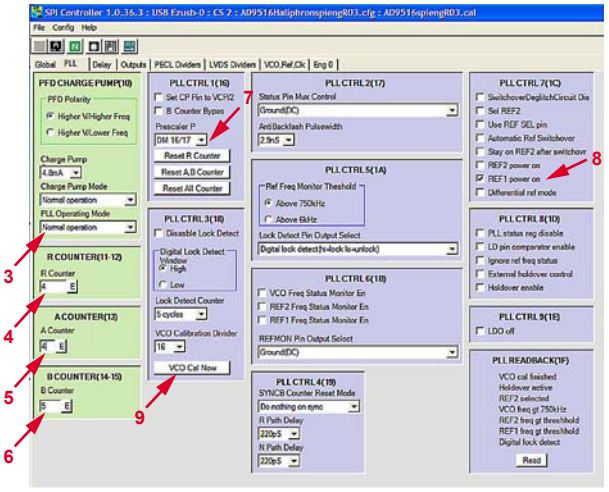



*Figure 13. PLL Configuration for the 122.88 MHz Crystal Oscillator*

**Table 8. AD9516 Register Settings**

| Register | 134.4 MHz | 122.88MHz | 39.3216MHz |
|---|---|---|---|
| VCO | 2.688 GHz | 2.580 GHz | 2.595 GHz |
| R Divider | 4 | 4 | 1 |
| A/B Counter | 0/5 | 4/5 | 2/4 |
| Prescaler | 16/17 | 16/17 | 16/17 |
| Output CLK | 672 MHz | 645.12 MHz | 648.81 MHz |

## VisualAnalog OVERVIEW

Open VisualAnalog and choose a template from the AD9267 folder (see Figure 14).

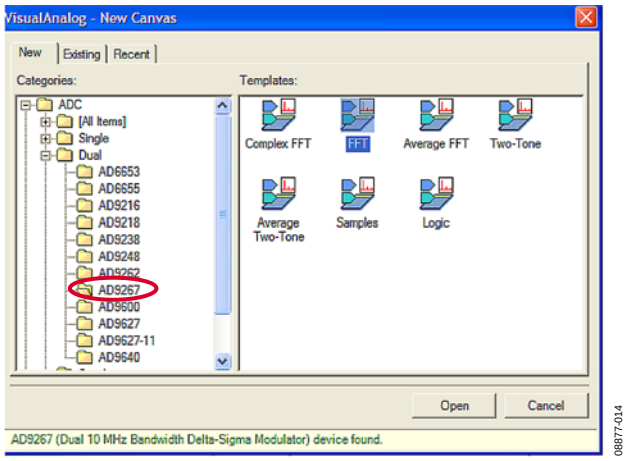



*Figure 14. VisualAnalog Template*

## LOADING BINARY FILES INTO THE FPGA

Two binary files are available for the AD9267 on the evaluation package CD. The default file, **AD9267.bin**, allows the FPGA to capture data directly from the modulator at 640 MSPS; the second file, **AD9267_filter.bin**, incorporates decimation filters from the FPGA.

At the startup of VisualAnalog, you are prompted to load the default binary file into the FPGA. To load a different binary file, make sure the switches on U4 on the HSC-ADC-EVALCZ high speed ADC data capture card are configured to M0 = on, M1 = off, and M2 = off. In addition, configure the **ADC Data Capture** block on the VisualAnalog software by first clicking the icon as shown in Figure 15.

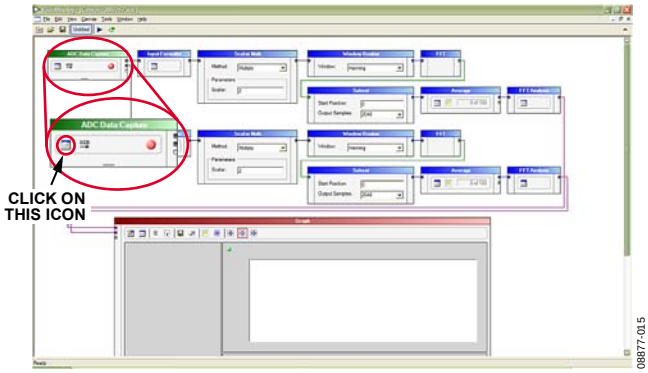



*Figure 15. VisualAnalog ADC Data Capture Block*

A new window opens (see Figure 16).

1. Click the **Browse** button to locate the desired bin file and then click **Program**.
2. After the file is loaded, click **OK**.




*Figure 16. Loading the .bin File*

After the binary file is loaded, make the following changes:

1. Select the **DCO Invert** box in the SPIController software of the AD9267 (see Figure 17).
2. Choose one of the following VisualAnalog templates to process the data:
   - **AD9267_Filter_FFT.vac**
   - **AD9267_Filter_ComplexFFT.vac**

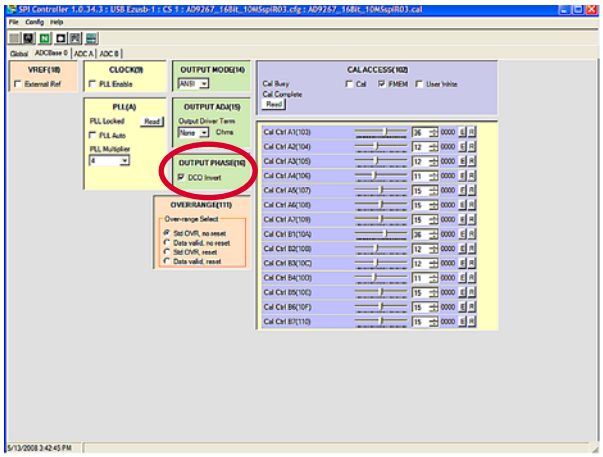



*Figure 17. DCO Invert*

# SCHEMATICS

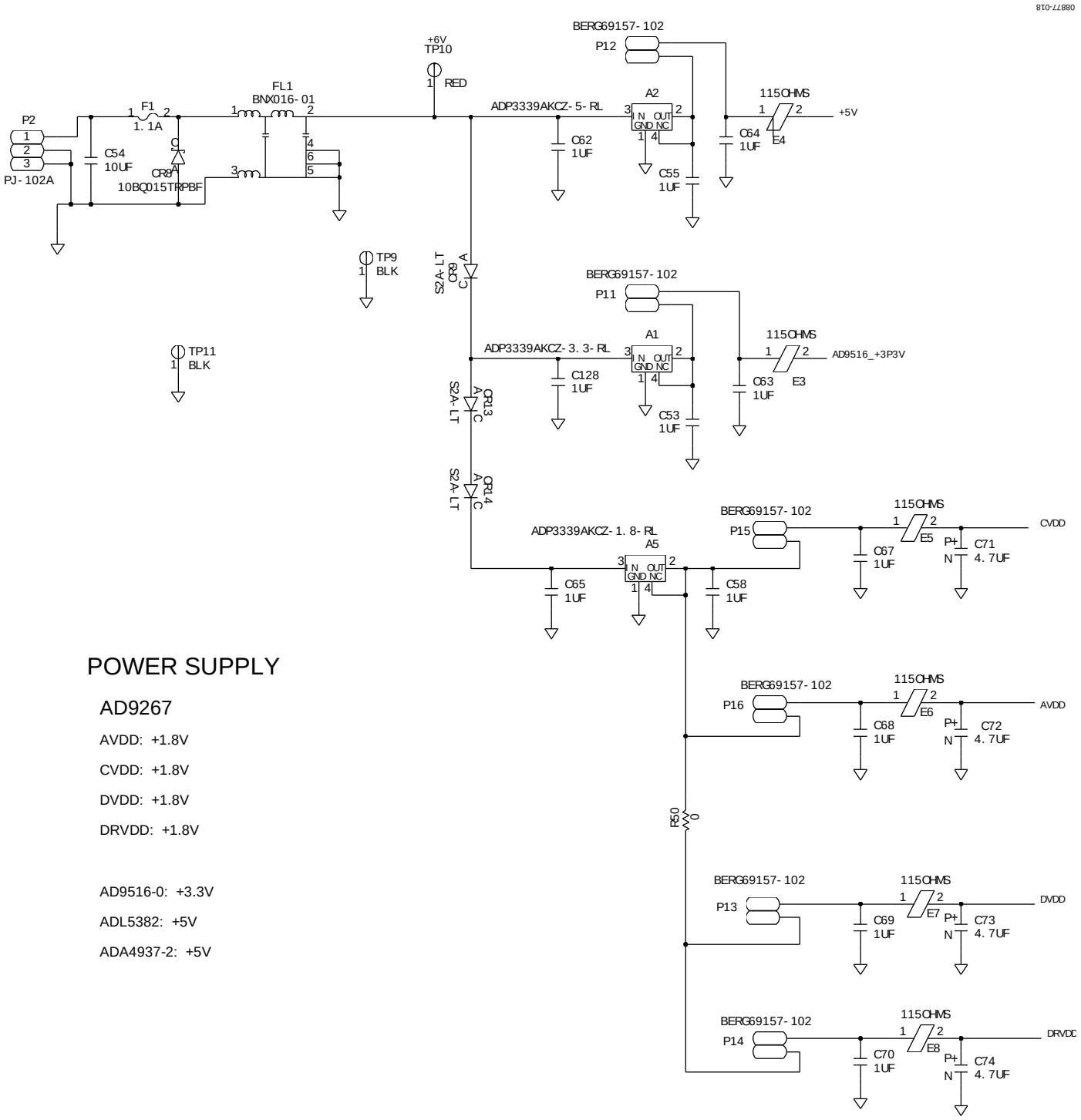



*Figure 18. Power Supply Distribution*

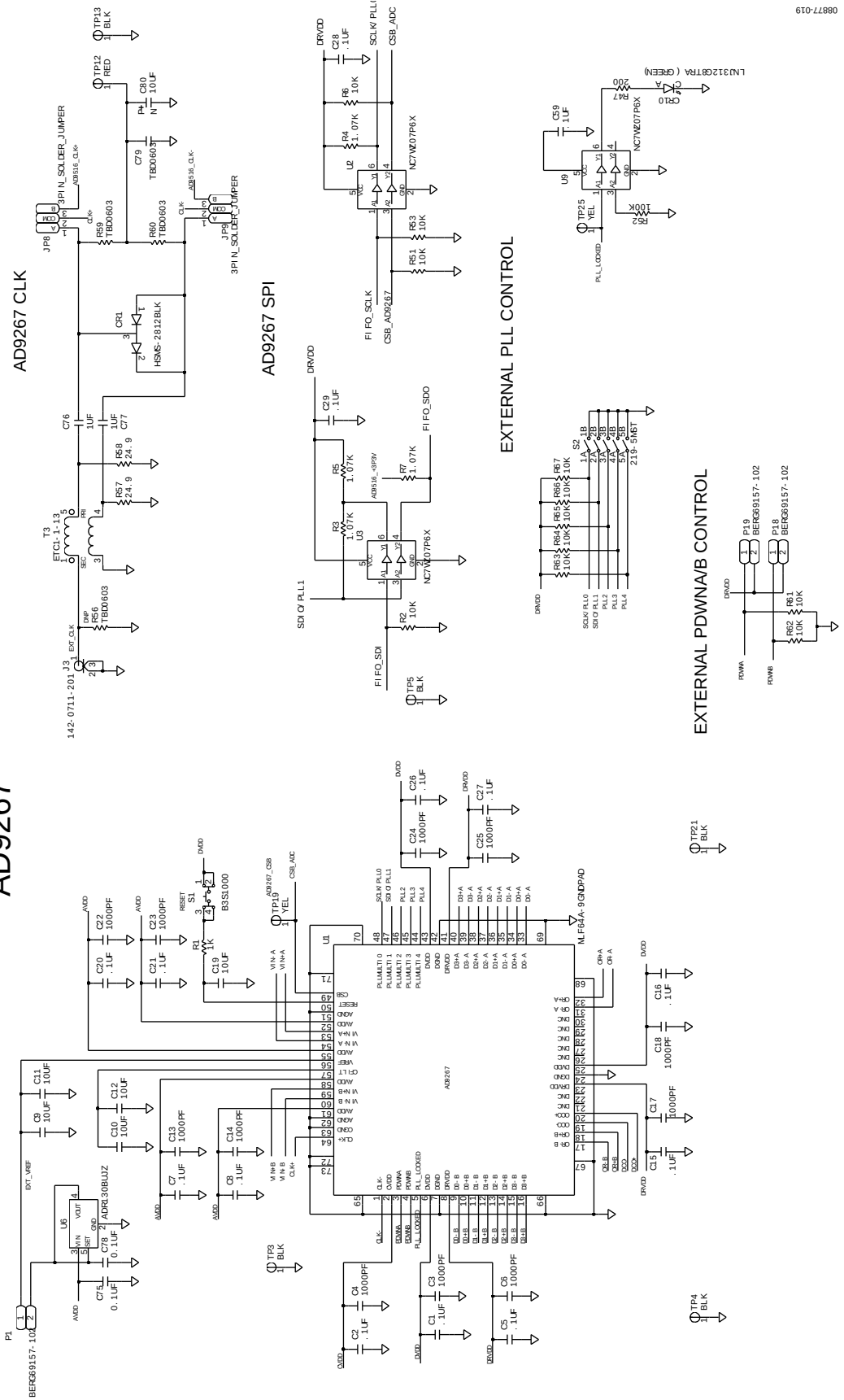



*Figure 19. AD9267 Pinout*

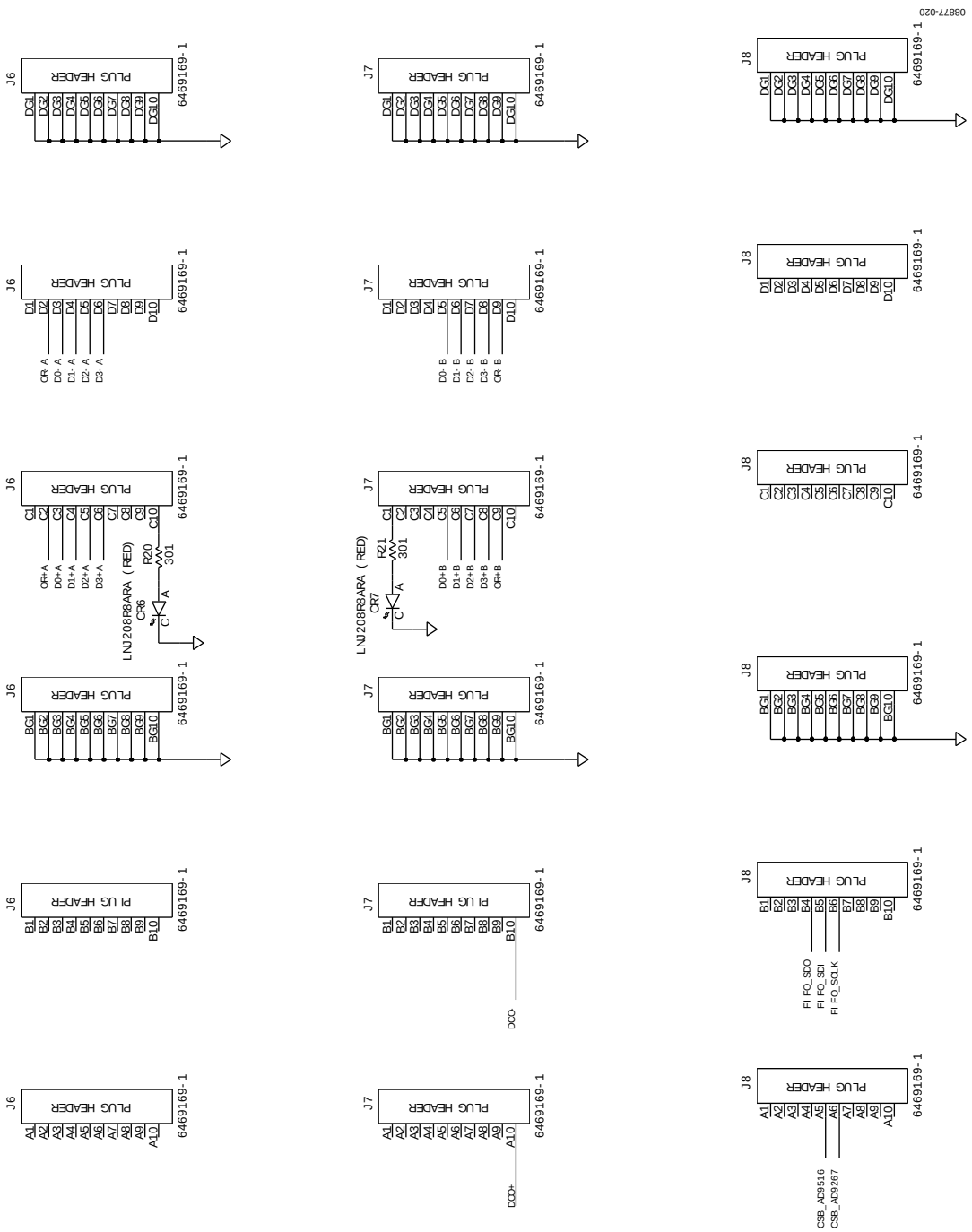



*Figure 20. Data Interface to the HSC-ADC-EVALCZ High Speed ADC Data Capture Card*

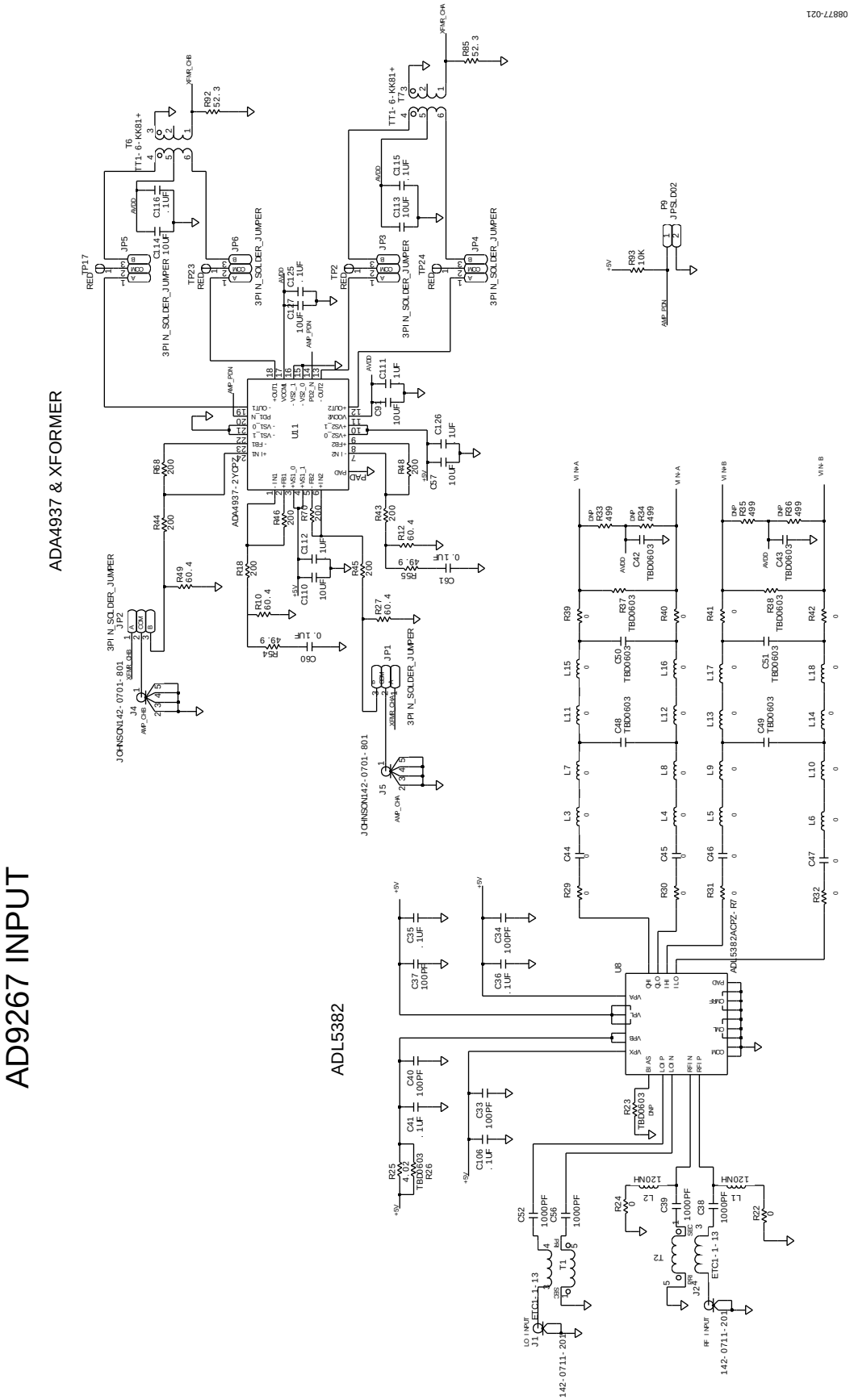



*Figure 21. AD9267 Input Configuration*

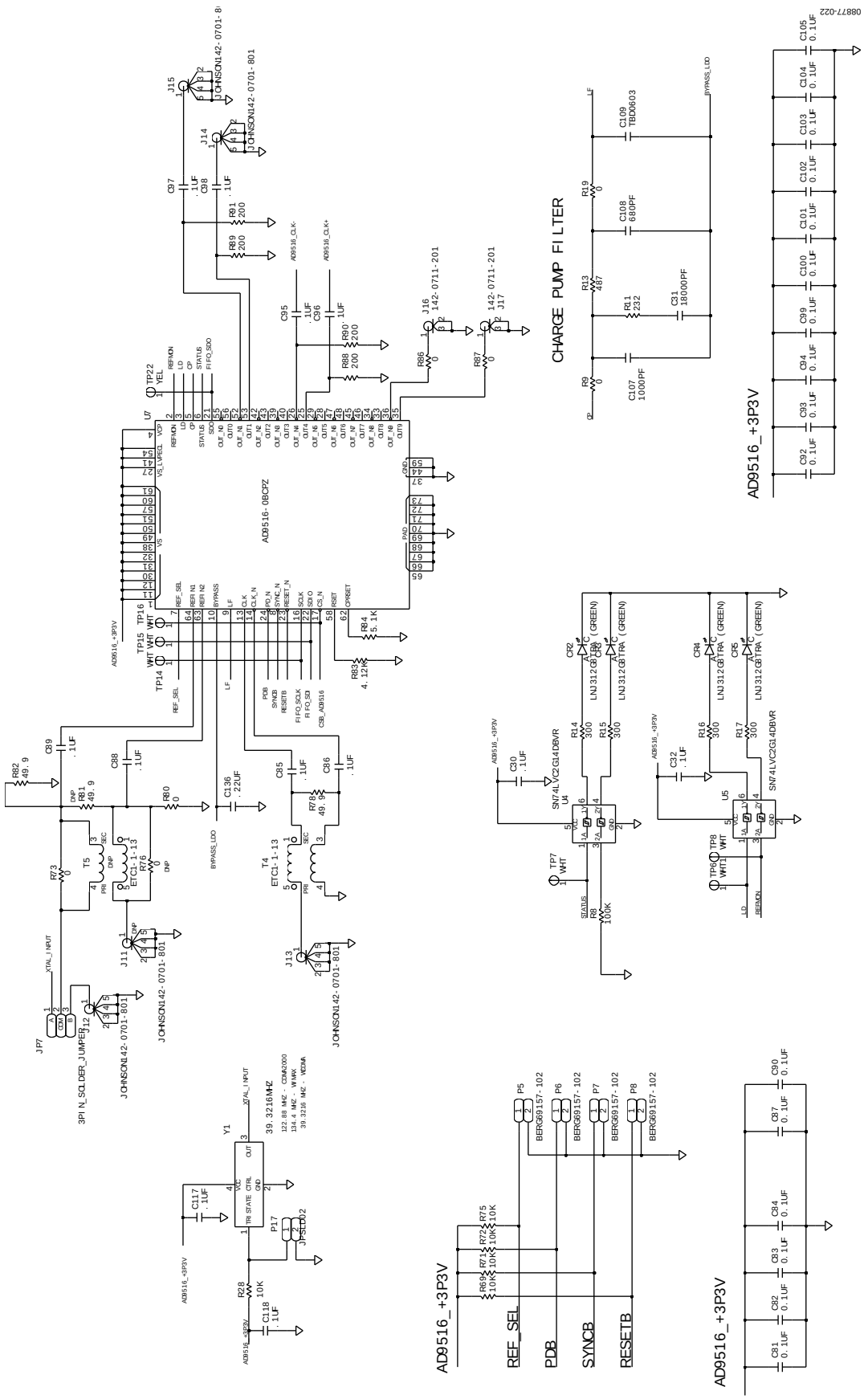



*Figure 22. AD9516-0 Configuration*

# LAYOUT

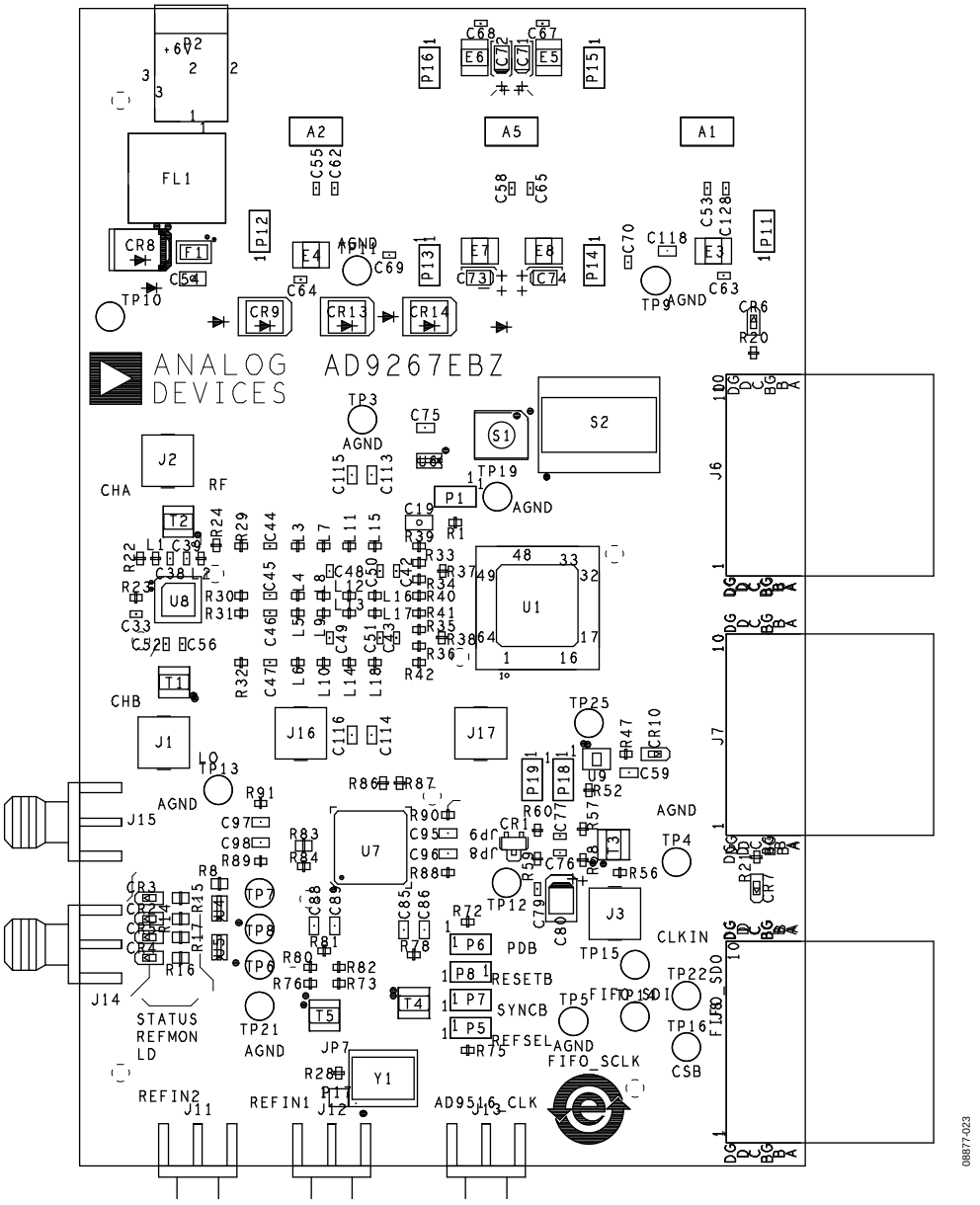



*Figure 23. Top Silk*

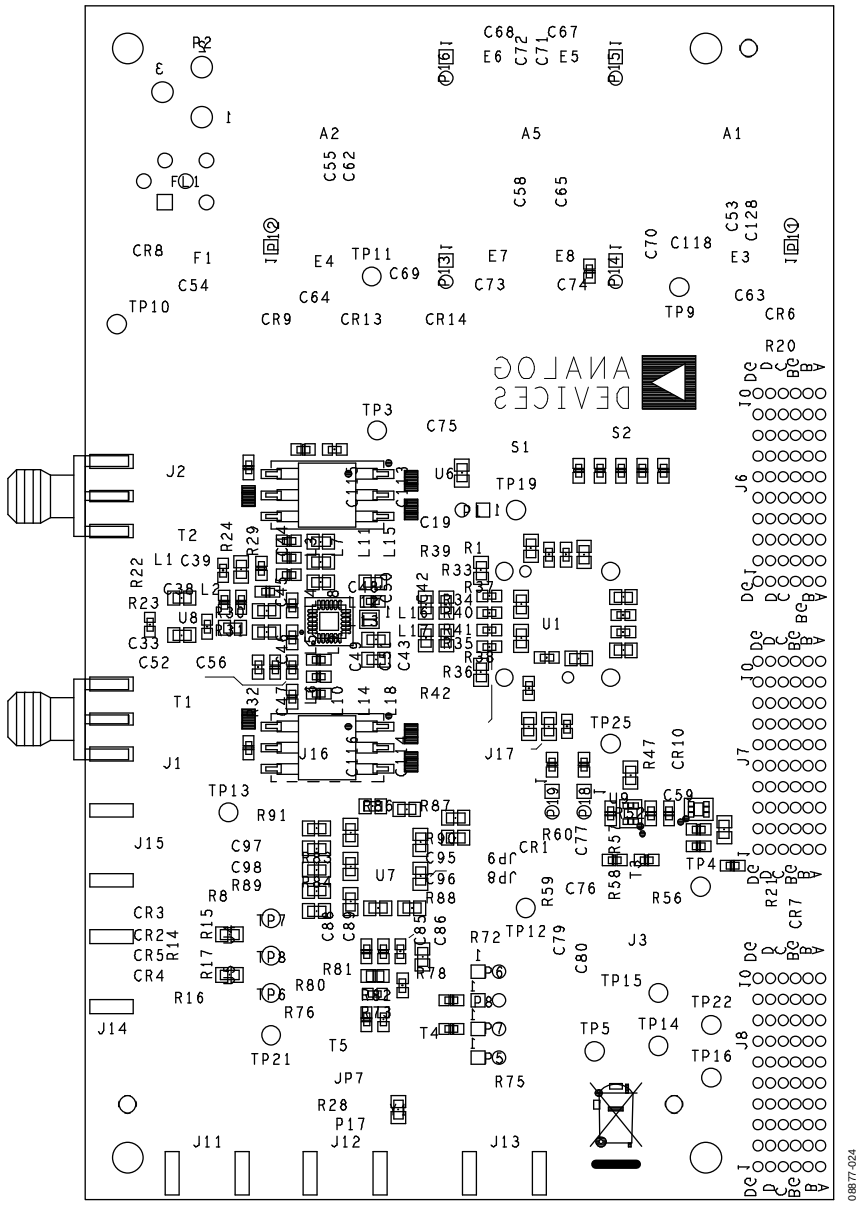



*Figure 24. Bottom Silk*

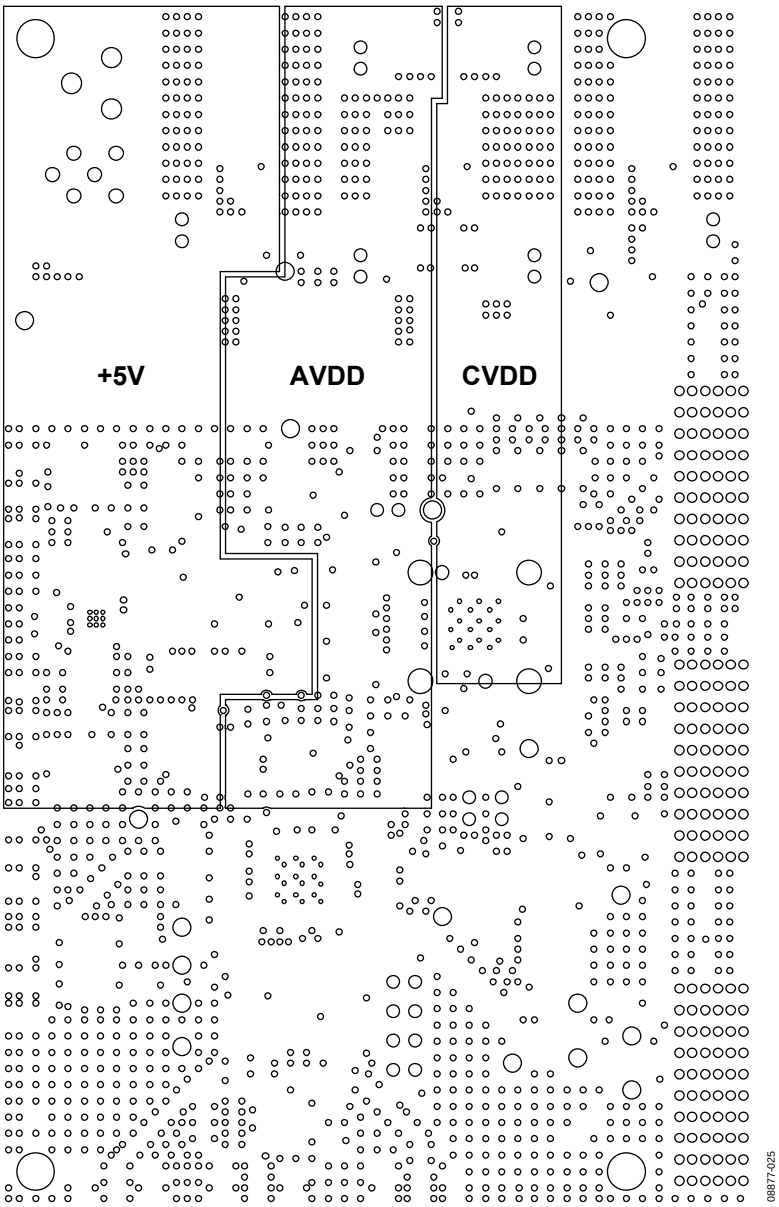



*Figure 25. Power Layer 3*

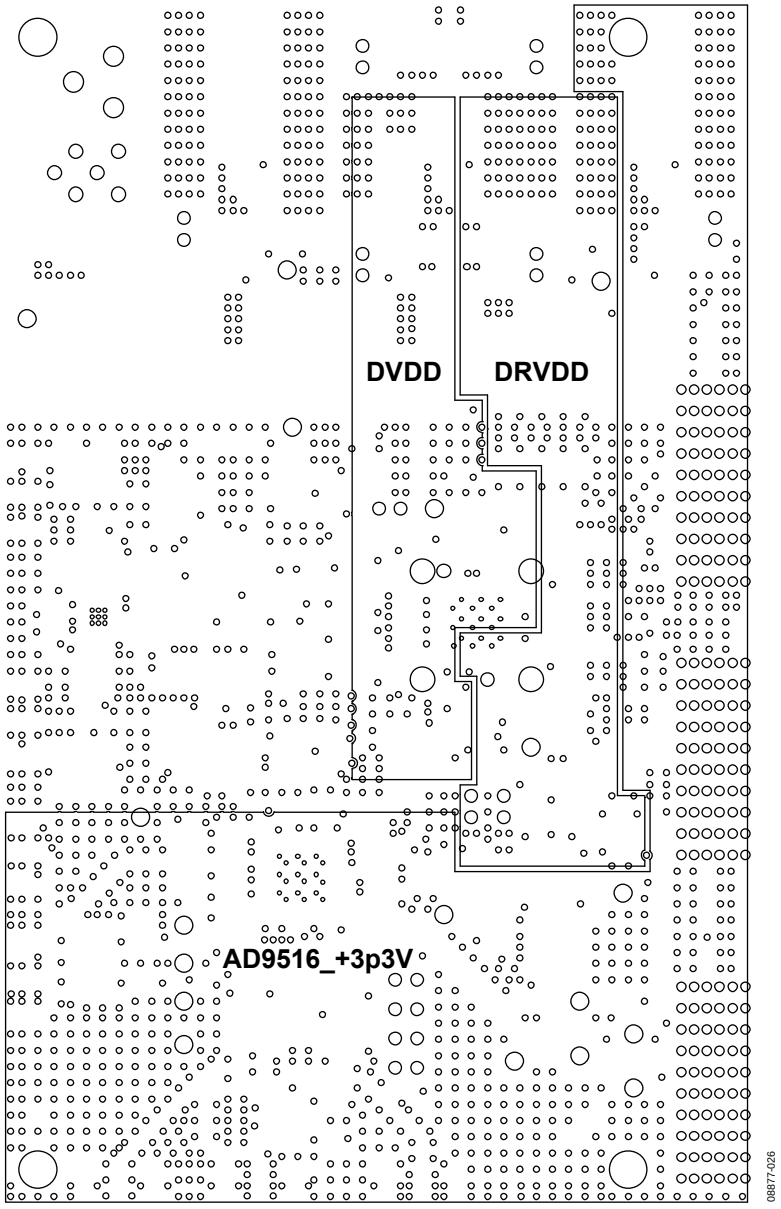



*Figure 26. Power Layer 4*

# ORDERING INFORMATION

## BILL OF MATERIALS

**Table 9.**

| Qty | Reference Designator | Description | Manufacturer | Manufacturer Part No. | Distributor/Part No. |
|---|---|---|---|---|---|
| 1 | A1 | IC, high accuracy ADP3339A | Analog Devices | ADP3339AKCZ-3.3 | |
| 1 | A2 | IC, high accuracy ADP3339A | Analog Devices | ADP3339AKCZ-5 | |
| 1 | A5 | IC, high accuracy ADP3339A | Analog Devices | ADP3339AKCZ-1.8 | |
| 36 | C1, C2, C5, C7, C8, C15, C16, C20, C21, C26, C27, C28, C29, C30, C32, C35, C36, C41, C59, C85, C86, C88, C89, C95, C96, C97, C98, C106, C111, C112, C115, C116, C117, C118, C125, C126 | Capacitor, ceramic, 0.10 µF, 16 V, 10%, X7R, 0805 | Murata Electronics, North America | GRM219R71C104KA01D | Digi-Key 490-1683-1-ND |
| 4 | C9, C10, C11, C12 | Capacitor, 10 µF, 6.3 V, ceramic, X5R, 0805 | Panasonic-ECG | ECJ-2FB0J106M | Digi-Key PCC2225CT-ND |
| 18 | C75, C78, C81, C82, C83, C84, C87, C90, C92 C93, C94, C99, C100, C101, C102, C103, C104, C105 | Capacitor, 0.10 µF, 50 V, ceramic, X7R, 0805 | Panasonic-ECG | ECJ-2YB1H104K | Digi-Key PCC1840CT-ND |
| 1 | C107 | Capacitor, ceramic, 1000 pF, 50 V, NP0, 0603 | Panasonic-ECG | ECJ-1VC1H102J | Digi-Key PCC2151CT-ND |
| 1 | C108 | Capacitor, 680 pF, 50 V, ceramic, X7R, 0603 | Yageo, Panasonic-ECG | CC0603KRX7R9, BB681, ECU-V1H681KBV | Digi-Key 311-1188-1-ND, Digi-Key PCC681BVCT-ND |
| 4 | C44, C45, C46, C47 | Resistor, 0.0 Ω, 1/10 W, 5%, 0603, SMD | ROHM Semiconductor | MCR03EZPJ000 | Digi-Key RHM0.0GDKR-ND |
| 0 | C42, C43, C48, C49, C50, C51, C79, C109 | 0603, not populated | | | |
| 6 | C57, C91, C110, C113, C114, C127 | Capacitor, ceramic, 10 µF, 10 V, 10%, X5R, 0805 | Murata Electronics, North America | GRM21BR61A106KE | Digi-Key 490-1709-1-ND |
| 14 | C53, C55, C58, C62, C63, C64, C65, C67, C68, C69, C70, C76, C77, C128 | Capacitor, 1 µF, 6.3 V, ceramic, X5R, 0603 | Panasonic-ECG | ECJ-1VB0J105K | Digi-Key PCC1915CT-ND |
| 15 | C3, C4, C6, C13, C14, C17, C18, C22, C23, C24, C25, C38, C39, C52, C56 | Capacitor, 1000 pF, 50 V, ceramic, X7R, 0603; Capacitor, 1000 pF, 50 V, ceramic, 0603, SMD | Panasonic-ECG | ECJ-1VB1H102K, ECU-V1H102KBV | Digi-Key PCC1772CT-ND, Digi-Key PCC102BVCT-ND |
| 1 | C136 | Capacitor, 0.22 µF, 25 V, ceramic, X7R, 0805 | Panasonic-ECG | ECJ-2YB1E224K | Digi-Key PCC1832CT-ND |
| 2 | C19, C54 | Capacitor, 10 µF, 16 V, ceramic, X5R, 1206 | Panasonic-ECG | ECJ-3YB1C106M | Digi-Key PCC2227CT-ND |
| 1 | C31 | Capacitor, 18,000 pF, 25 V, ceramic, X7R, 0603 | Panasonic-ECG | ECJ-1VB1E183K | Digi-Key PCC1766CT-ND |
| 4 | C33, C34, C37, C40 | Capacitor, ceramic, 100 pF, 50 V, 0603, SMD | Panasonic-ECG | ECU-V1H101JCV | Digi-Key PCC101ACVCT-ND |
| 2 | C60, C61 | Capacitor, 0.10 µF, 50 V, ceramic, Y5V, 0603 | Panasonic-ECG | ECJ-1VF1H104Z | Digi-Key PCC2153CT-ND |

| Qty | Reference Designator | Description | Manufacturer | Manufacturer Part No. | Distributor/Part No. |
|---|---|---|---|---|---|
| 4 | C71, C72, C73, C74 | Capacitor, tantalum, 4.7 µF, 16 V, 20%, SMD, A-case; Capacitor, 4.7 µF, 16 V, tantalum TE series, 3216-18 | AVX Corporation, Panasonic-ECG | TAJA475M016R, ECS-T1CY475R | Digi-Key 478-3032-1-ND, Digi-Key PCS3475CT-ND |
| 1 | C80 | Capacitor, tantalum, 10 µF, 16 V, 10%, SMD, B-case 3528 | AVX Corporation | TAJB106K016R | Digi-Key 478-1673-1-ND |
| 1 | CR1 | Schottky diode | Avago Technologies | HSMS-2812-BLKG | Mouser 630-HSMS-2812-BLKG |
| 5 | CR2, CR3, CR4, CR5, CR10 | LED, green, TSS type SMD, 0603 | Panasonic-SSG | LNJ312G8TRA | Digi-Key P11134CT-ND |
| 3 | CR9, CR13, CR14 | Rectifier, SIL, 2 A, 50 V, DO-214AA | Micro Commercial Company | S2A-TP | Digi-Key S2A-TPMSCT-ND |
| 2 | CR6, CR7 | LED red HI BRT SS type LO CUR surface mount, 0603 | Panasonic-SSG | LNJ208R8ARA | Digi-Key P524CT-ND |
| 1 | CR8 | Diode Schottky, 15 V, 1 A SMB, DO-214AA | Vishay IR | 10BQ015TRPBF | Digi-Key 10BQ015PBFCT-ND |
| 6 | E3, E4, E5, E6, E7, E8 | Bead core, 4.5 × 3.2 × 1.8 SMD | Panasonic-ECG | EXC-CL4532U1 | Digi-Key P9812CT-ND |
| 1 | F1 | Polyswitch, 1.10 A, reset fuse SMD | Tyco Electronics Raychem Circuit Protection | NANOSMDC110F-2 | Digi-Key NANOSMDC110FCT-ND |
| 1 | FL1 | Filter EMI, 50 MΩ, 15 A, 0.10 MHz, 1 GHz, SMD | Murata Electronics, North America | BNX016-01 | Mouser 81-BNX016-01 |
| 5 | J1, J2, J3, J16, J17 | Connector SMA jack receptacle VERT gold SMD, SMAUPSMD | Emerson Network Power Connectivity Solutions | 142-0711-201 | Mouser 530-142-0711-201 Digi-Key J819-ND |
| 6 | J4, J5, J12, J13, J14, J15 | Connector jack end launch PCB 0.187" G | Emerson Network Power Connectivity Solutions | 142-0701-801 | Mouser 530-142-0701-801 Digi-Key J502-ND |
| 3 | J6, J7, J8 | Plug header | Tyco Electronics | 6469169-1 | Mouser 571-6469169-1 |
| 0 | J11 | Connector jack end launch PCB 0.187" G, not populated | Emerson Network Power Connectivity Solutions | 142-0701-801 | Mouser 530-142-0701-801 Digi-Key J502-ND |
| 2 | L1, L2 | Inductor, 120 nH, 5%, fixed, 0603, SMD | Panasonic-ECG | ELJ-RER12JFA | Digi-Key PCD1986CT-ND |
| 16 | L3, L4, L5, L6, L7, L8, L9, L10, L11, L12, L13, L14, L15, L16, L17, L18 | Resistors, 0.0 Ω, 1/10 W, 5%, 0603, SMD | ROHM Semiconductor | MCR03EZPJ000 | Digi-Key RHM0.0GDKR-ND |
| 13 | P1, P5, P6, P7, P8, P11, P12, P13, P14, P15, P16, P18, P19 | Connector header 2 POS 0.100 VERT gold | Molex/Waldom Electronics Corporation, BERG | 22-10-2021 69157-102 | Digi-Key WM2722-ND |
| 6 | P11, P12, P13, P14, P15, P16 | Shunt, ECON, PHBR 15 AU, black | Tyco Electronics | 382811-6 | Digi-Key A26227-ND |
| 1 | P2 | Connector jack power, 2.1 mm PCB | CUI, Inc. | PJ-102A | Digi-Key CP-102A-ND |
| 1 | R1 | Resistor, 1.00 kΩ, 1/10 W, 1%, 0603, SMD | ROHM Semiconductor, Panasonic-ECG | MCR03EZPFX1001, ERJ-3EKF1001V | Digi-Key RHM1.00KHCT-ND, Digi-Key P1.00KHCT-ND |
| 4 | R10, R12, R27, R49 | Resistor, 60.4 kΩ, 1/10 W, 1%, 0603, SMD | Panasonic-ECG | ERJ-3EKF60R4V | Digi-Key P60.4HCT-ND |
| 1 | R11 | Resistor, 232 Ω, 1/10 W, 1%, 0603, SMD | Panasonic-ECG | ERJ-3EKF2320V | Digi-Key P232HCT-ND |

| Qty | Reference Designator | Description | Manufacturer | Manufacturer Part No. | Distributor/Part No. |
|---|---|---|---|---|---|
| 1 | R13 | Resistor, 487 Ω, 1/8 W, 1%, 0805, SMD | Panasonic-ECG | ERJ-6ENF4870V | Digi-Key P487CCT-ND |
| 4 | R14, R15, R16, R17 | Resistor, 300 Ω, 1/8 W, 5%, 0805, SMD | Panasonic-ECG | ERJ-6GEYJ301 | Digi-Key P300ACT-ND |
| 13 | R18, R43, R44, R45, R46, R47, R48, R68, R70, R88, R89, R90, R91 | Resistor, 200 Ω, 1/10 W, 1%, 0603, SMD | Yageo | RC0603FR-07200RL | Digi-Key 311-200HRCT-ND |
| 9 | R9, R19, R22, R24, R50, R73, R80, R86, R87 | Resistor, 0 Ω, 1/10 W, 5%, 0603, SMD | Panasonic-ECG | ERJ-3GEY0R00V | Digi-Key P0.0GCT-ND |
| 0 | R76 | 0603, not populated | Panasonic-ECG | ERJ-3GEY0R00V | Digi-Key P0.0GCT-ND |
| 16 | R2, R6, R28, R51, R53, R61, R62, R63, R64, R65, R66, R67, R69, R71, R72, R75 | Resistor, 10.0 kΩ, 1/10 W, 1%, 0603, SMD | ROHM Semiconductor, Panasonic-ECG | MCR03EZPFX1002, ERJ-3EKF1002V | Digi-Key RHM10.0KHCT-ND, Digi-Key P10.0KHCT-ND |
| 2 | R20, R21 | Resistor, 301 Ω, 1/10 W, 1%, 0603, SMD | Panasonic-ECG | ERJ-3EKF3010V | Digi-Key P301HCT-ND |
| 8 | R29, R30, R31, R32, R39, R40, R41, R42 | Resistor, 0.0 Ω, 1/10 W, 5%, 0603, SMD | ROHM Semiconductor | MCR03EZPJ000 | Digi-Key RHM0.0GDKR- ND |
| 0 | R23, R26, R37, R38, R56, R59, R60 | 0603, not populated | | | |
| 1 | R25 | Resistor, 4.02 Ω, 1/10 W, 1%, 0603, SMD | Yageo | RC0603FR-074R02L | Digi-Key 311-4.02HRCT-ND |
| 4 | R3, R4, R5, R7 | Resistor, 1.07 kΩ, 1/16 W, 0.10%, 0603, SMD | Susumu Company, Ltd. | RR0816P-1071-B-T5-04H | Digi-Key RR08P1.07KBCT-ND |
| 0 | R33, R34, R35, R36 | 0603, not populated | Panasonic-ECG | ERJ-3EKF4990V | Digi-Key P499HCT-ND |
| 1 | R52 | Resistor, 100 kΩ, 1/10 W, 5%, 0603, SMD | Yageo | RC0603JR-07100KL | Digi-Key 311-100KGRCT-ND |
| 4 | R54, R55, R78, R82 | Resistor, 49.9 Ω, 1/10 W, 1%, 0603, SMD | Yageo, Panasonic-ECG | RC0603FR-0749R9L, ERJ-3EKF49R9V | Digi-Key 311-49.9HRCT-ND, Digi-Key P49.9HCT-ND |
| 0 | R81 | 0603, not populated | Yageo, Panasonic-ECG | RC0603FR-0749R9L, ERJ-3EKF49R9V | Digi-Key 311-49.9HRCT-ND, Digi-Key P49.9HCT-ND |
| 2 | R57, R58 | Resistor, 24.9 Ω, 1/10 W, 1%, 0603, SMD | Yageo, Panasonic-ECG | RC0603FR-0724R9L, ERJ-3EKF24R9V | Digi-Key 311-24.9HRCT-ND Digi-Key ND P24.9HCT-ND |
| 1 | R8 | Resistor, 100 kΩ, 1/8 W, 0.10%, 0805, SMD | Panasonic-ECG | ERA-6YEB104V | Digi-Key P100KZCT-ND |
| 1 | R83 | Resistor, 4.12 kΩ, 1/8 W, 1%, 0805, SMD | Panasonic-ECG | ERJ-6ENF4121V | Digi-Key P4.12KCCT-ND |
| 1 | R84 | Resistor, 5.1 kΩ, 1/16 W, 0.1%, 0603, SMD | Panasonic-ECG | ERA-3YEB512V | Digi-Key P5.1KYCT-ND |
| 2 | R85, R92 | Resistor, 52.3 Ω, 1/10 W, 1%, 0603, SMD | Panasonic-ECG | ERJ-3EKF52R3V | Digi-Key P52.3HCT-ND |
| 1 | R93 | Resistor, 10 kΩ, 1/10 W, 0.10%, 0603, SMD | Panasonic-ECG | ERA-3YEB103V | Digi-Key P10KYCT-ND |
| 1 | S1 | Switch, TACT, 6 mm, SMD, MOM, 160GF | Omron Electronics Inc., ECB Division | B3S-1000 | Digi-Key SW415-ND |
| 1 | S2 | Switch, tape seal, 5-position SMD | CTS Corporation Resistor/ Electrocomponents | 219-5MST | Digi-Key CT2195MST-ND |
| 4 | T1, T2, T3, T4 | TC XFMR/surface-mount | Minicircuits | TC1-1-13M+ | |
| 0 | T5 | Not populated | Minicircuits | TC1-1-13M+ | |
| 2 | T6, T7 | RF XFMR/surface-mount | Minicircuits | TT1-6-KK81+ | |

| Qty | Reference Designator | Description | Manufacturer | Manufacturer Part No. | Distributor/Part No. |
|---|---|---|---|---|---|
| 2 | TP10, TP12 | Test point PC compact 0.063" D, red | Keystone Electronics | 5005 TP-104-01-02 | Digi-Key 5005K-ND |
| 7 | TP3, TP4, TP5, TP9, TP11, TP13, TP21 | Test point, PC, compact 0.063" D, black | Keystone Electronics | 5006 TP-104-01-00 | Digi-Key 5006K-ND |
| 6 | TP6, TP7, TP8, TP14, TP15, TP16 | Test point, PC, compact 0.063" D, white | Keystone Electronics | 5007 TP-104-01-09 | Digi-Key 5007K-ND |
| 4 | TP2, TP17, TP23, TP24 | PC test point miniature SMT, red | Keystone Electronics | 5015 TP-108-01 | Digi-Key 5015KCT-ND |
| 3 | TP19, TP22, TP25 | Test point PC compact 0.063" D, yellow | Keystone Electronics Components Corporation | 5009 TP-104-01-04 | Digi-Key 5009K-ND |
| 1 | U1 | Device under test | Analog Devices | AD9267 | |
| 1 | U11 | IC, ultralow distortion DIF ADC driver | Analog Devices | ADA4937-2YCPZ | |
| 3 | U2, U3, U9 | IC buffer dual open-drain output, 6-lead SC70 | Fairchild Semiconductor | NC7WZ07P6X | Mouser 512-NC7WZ 07P6X Digi-Key NC7WZ07P6XCT-ND |
| 2 | U4, U5 | IC inverter, dual SHMT-T, SOT-23-6 | Texas Instruments | SN74LVC2G14DBVR | Digi-Key 296-13010-1-ND Mouser 595-SN74LVC2G 14DBVR |
| 1 | U6 | Precision series, ADR130BU | Analog Devices | ADR130BUJZ | |
| 1 | U7 | IC, 14-output, AD9516-0 | Analog Devices | AD9516-0BCPZ | |
| 1 | U8 | IC, 700 MHz to 2700 MHz quadrature | Analog Devices | ADL5382ACPZ | |
| 0 | Y1 | IC clock OSC, not populated | Valpey Fisher | VFAC3 | |

## RELATED LINKS

| Resource | Description |
|---|---|
| AD9267 | AD9267 data sheet (for technical articles, visit the AD9267 product page technical documentation section) |
| AD9262 | AD9262 data sheet (for technical articles, visit the AD9262 product page technical documentation section) |
| CN0062 | Circuit Note, Interfacing the ADL5382 Quadrature I/Q Demodulator to the AD9262 16-Bit Continuous Time Sigma-Delta ADC as an RF-to-Bits Solution |
| HSC-ADC-EVALCZ | Product Page, High Speed Converter Evaluation Platform (FPGA-based data capture kit) |
| AN-905 | Application Note, VisualAnalog Converter Evaluation Tool Version 1.0 User Manual |
| AN-878 | Application Note, High Speed ADC SPI Control Software |
| AN-877 | Application Note, Interface to High Speed ADCs via SPI |

# 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.

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