ANALOG DEVICES

AD9670EBZ User Guide
UG-1459

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Evaluating the AD9670 Octal Ultrasound AFE with Digital Demodulator

FEATURES

Fully featured evaluation board for the AD9670
PC software for controlling the AD9670 via a USB interface

EVALUATION KIT CONTENTS

AD9670EBZ evaluation board
1 switching power supply (6.0 V, 2.5 A), CUI EPS060250UH-PHP-SZ (provided)

EQUIPMENT NEEDED

Analog signal source and antialiasing filter
Linear benchtop dc voltage source (0 V to 1.6 V), not required for CW Doppler mode
PC running Microsoft Windows® 7 and Windows 10 operating system
USB 2.0 port, recommended (USB 1.1 compatible)
HSC-ADC-EVALCZ FPGA-based data capture kit
1 switching power supply (6.0 V, 2.5 A), CUI EPS060250UH-PHP-SZ (provided with data capture kit)
Spectrum analyzer for CW Doppler mode

DOCUMENTS NEEDED

AD9670 data sheet

SOFTWARE NEEDED

VisualAnalog
SPIController

GENERAL DESCRIPTION

The AD9670EBZ evaluation board assists in evaluating all features of the AD9670 octal ultrasound analog front end (AFE) device. The AD9670 is low cost, low power, compact, and easy to use with medical ultrasound applications. The device provides eight voltage gain amplifier (VGA) channels, each with a low noise amplifier (LNA), a continuous wave (CW) harmonic rejection I/Q demodulator with programmable phase rotation, an antialiasing filter, an analog-to-digital converter (ADC), and a digital demodulator and decimator for both data processing and bandwidth reduction.

The evaluation board provides eight Subminiature Version A (SMA) connector inputs for all eight AD9670 channels. The evaluation board mates with a field-programmable gate array (FPGA) data capture board (HSC-ADC-EVALCZ) that enables data capture through a USB connection to a computer.

The SPIController software provides flexible configuration of the AD9670 and the VisualAnalog® software offers powerful data capture and signal analysis tools.

EVALUATION BOARD PHOTOGRAPH

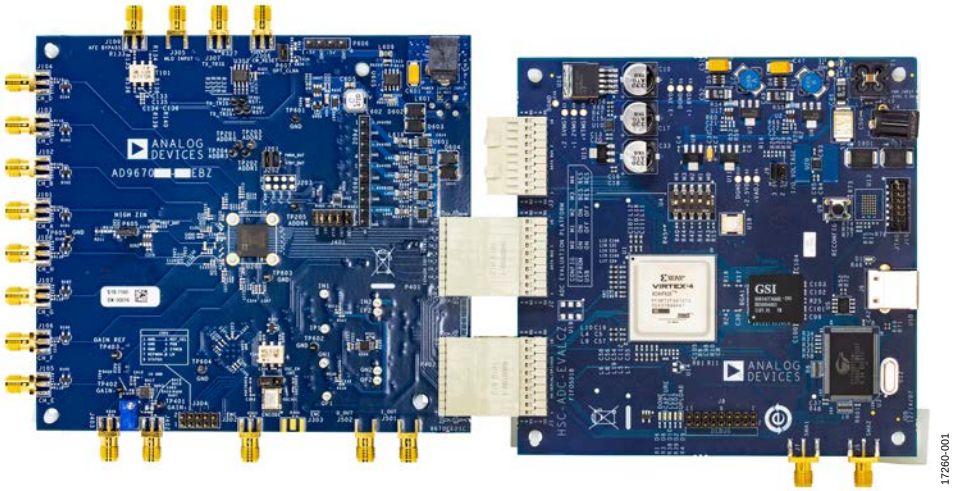


Figure 1.

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REVISION HISTORY

1/2019—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

POWER SUPPLIES

A switching power supply (6.0 V, 2.5 A) powers up the AD9670EBZ board.

INPUT SIGNALS

The AD9670EBZ board provides eight SMA connector inputs for the eight AFE channels. The SMA channel inputs directly connect to the AD9670 LNA input. An optional, external clock SMA input bypasses the default on-board 40 MHz crystal by changing the J301 jumper. Figure 1 shows an image of all inputs.

Other SMA inputs include the VGA V_{GAIN} control, the CW Doppler MLO±, RESET±, and an optional TX_TRIG± input. The V_{GAIN} single-ended signal is the default but a differential input configuration is also possible. The FPGA provides the TX_TRIG± signal on the HSC-ADC-EVALCZ data capture board.

OUTPUT SIGNALS

The data capture board receives low voltage differential signaling (LVDS) digital output signals from the AD9670EBZ board through the on-board connectors (P401 and P402) (see Figure 1). The J501 jumper and J502 jumper SMA outputs are the CW Doppler summed in-phase quadrature (I/Q) outputs.

EVALUATION BOARD SOFTWARE

SOFTWARE INSTALLATION PROCEDURES

To install the VisualAnalog and SPIController software packages, and configure and test the AD9670, take the following steps:

1. Install the VisualAnalog software.
2. Install the SPIController software.
3. Plug the 6 V adapters into the AD9670EBZ evaluation board and the data capture board to power them up. Connect the data capture board to the PC with the USB cable that is provided with the data capture board.
4. Launch the SPIController software to open the window shown in Figure 2 and select the **AD9670.cfg** file from the dropdown list (under **File** > **Cfg Open Menu**). After the **Open File** dialog appears, browse for and select the **AD9670_14bit_ 125MSspiR03.cfg** file. The chip ID reads **AD9670** (see Figure 2) after loading the **AD9670.cfg** file.

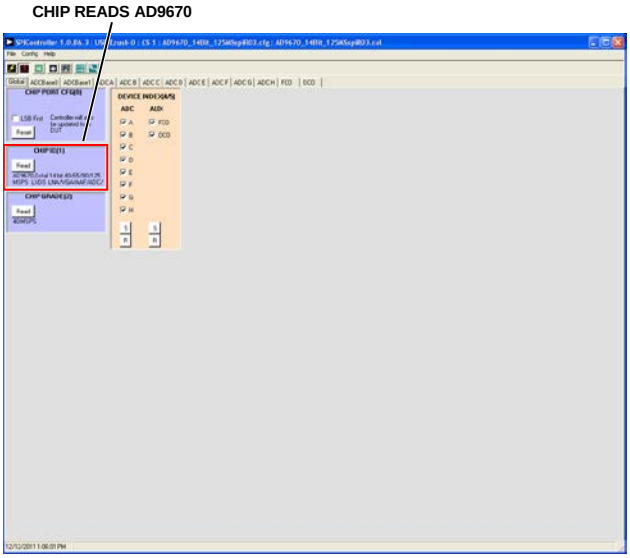


Figure 2. SPIController Main Window

5. From the **Config** menu, click **Launch Memory Map Dialog** to open the **Memory Map** window, as shown in Figure 3. Click the **Load File** button to open the **AD9670_14bit_125MSspiR03.mmp** file, which loads the coefficient and profile memory data into the AD9670.

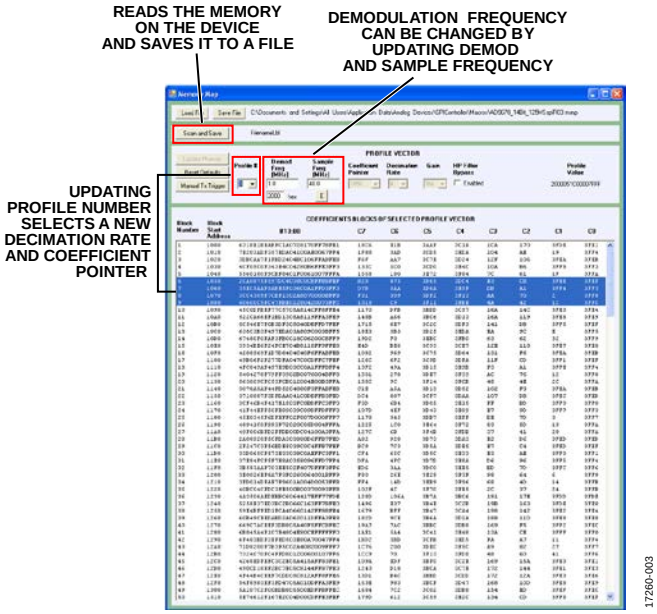


*Figure 3. **Memory Map** Window*

6. In the main SPIController window, open the **File** menu and click **Open Macrogroup**. Select the **AD9670_ Initialization.mgp** macro file to open the **MacroEditor** window shown in Figure 4. The macro file is an .XML file that lists the serial peripheral interface (SPI) command macros in the **D6970_Initializaion_v2.mg** dropdown box (see Figure 4). Each command macro includes SPI writes that configure the AD9670 for specific operating modes. The **MacroEditor** conducts a batch write of SPI registers to set up the AD9670. The macro file contains the following two macros: **Real Mode, 40Msps** and **IQ Mode, 40Msps.** It is possible to add unique configuration macros to the .XML macro file and load the macros into the **MacroEditor** window.

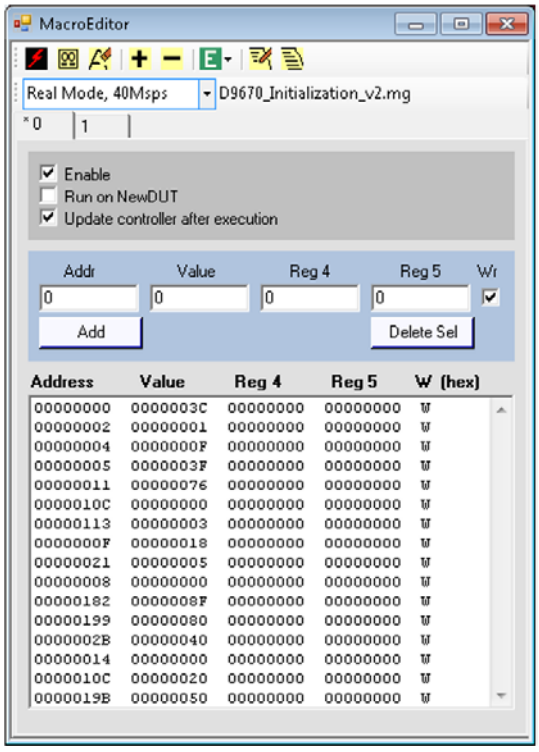


*Figure 4. **MacroEditor** Window and **D6970_Initializaion_v2.mg** Dropdown Box*

Table 1. Procedural List of SPI Commands Configuring the AD9670

Register	Function
0x000	SPI reset.
0x002	Set speed mode.
0x004, 0x005	Set local registers to all channels.
0x011	Set LNA, VGA, and PGA gain.
0x10C	Set SPI TX_TRIG± and Index Profile 1.
0x113	Enable/bypass digital filters, demodulator, and decimator.
0x00F	Set low-pass filter cutoff frequency and mode.
0x021	16-bit, 8-lane, frame clock output (FCO) covers entire frame.
0x008	Time gain compensation (TGC) run mode.
0x182	Autoconfigure phase-locked loop (PLL).
0x199	Autoset FCO and data clock output (DCO).
0x02B	Set analog low-pass filter and high-pass filter to defaults and tunes filters.
0x014	Set output data format.
0x188	Enable start code.
0x10C	Set SPI TX_TRIG± and Index Profile 1.
0x19B	Serial format.

7. Select either the **Real Mode** or the **IQ Mode** macro from the dropdown box (see Figure 5) and select the **Enable** checkbox. To run the selected macro, click the **Run** button to conduct a write operation (see Figure 5).

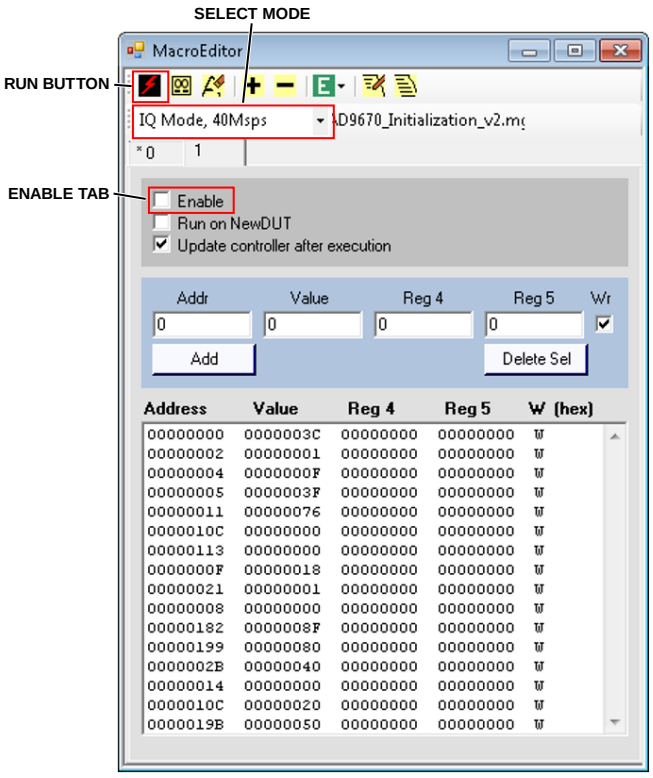


*Figure 5. Select, Enable, and Run Commands in **MacroEditor***

8. Launch the VisualAnalog software to use the canvas templates listed in the AD9670 directory in the **Categories** pane (see Figure 6). The **Samples** canvas shows time domain output samples vs. sample count.

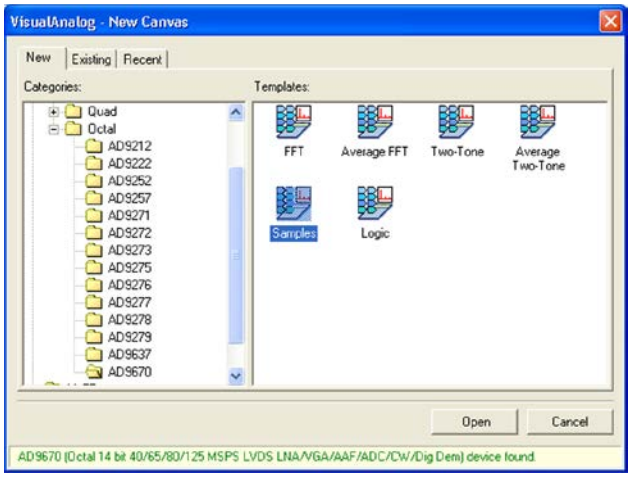


Figure 6. VisualAnalog Canvas Selection Window

9. If the VisualAnalog software opens and only shows the task bar, as shown in Figure 7, click the down arrow on the right side of the window to expand the **AD9670 Samples** canvas (shown in Figure 8) to see the signal processing flow.

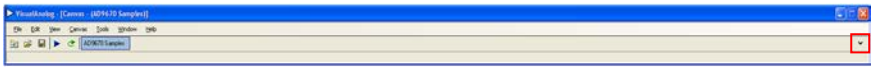


Figure 7. VisualAnalog in Window Collapse Mode

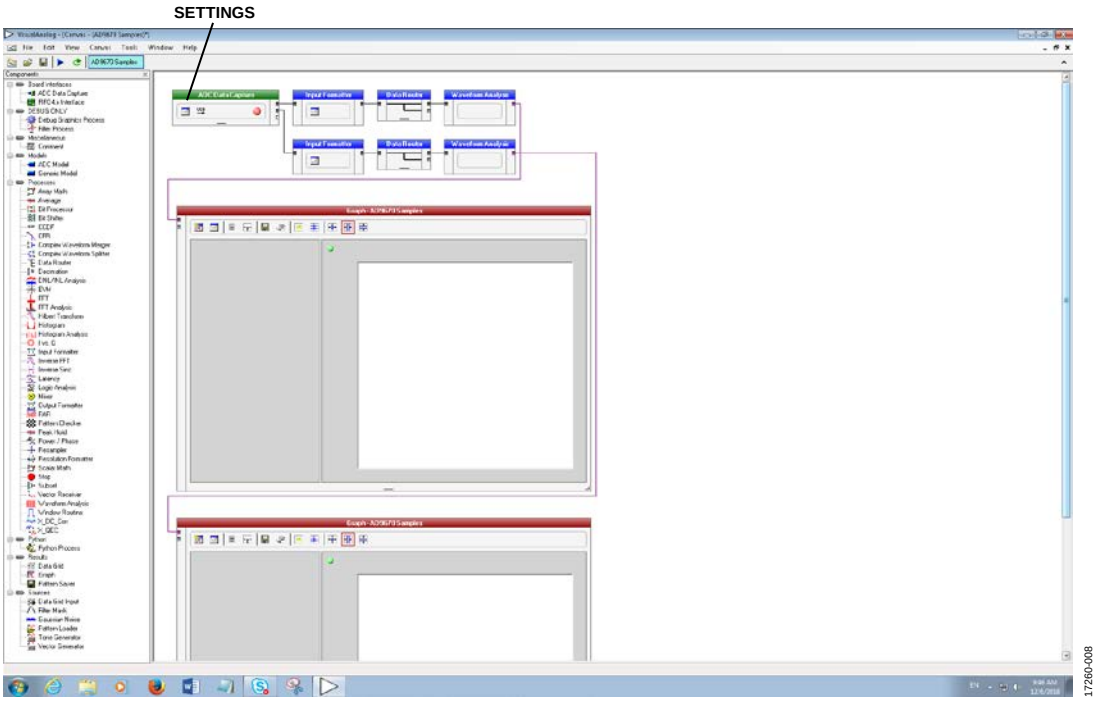


Figure 8. VisualAnalog Sample Canvas

10. Next, load the FPGA binary file into the hardware. To load the file, click the **Settings** button in the **ADC Data Capture** block (see Figure 8).

11. When the **ADC Data Capture Settings** window opens, click the **Capture Board** tab and then click the **Browse…** button. Select the **ad9670_lvds_mar2012.bin** file and click **Program**, which illuminates the **Done** LED D6 indicator on the HSC-ADC-EVALCZ board. Click **OK** to close the window.

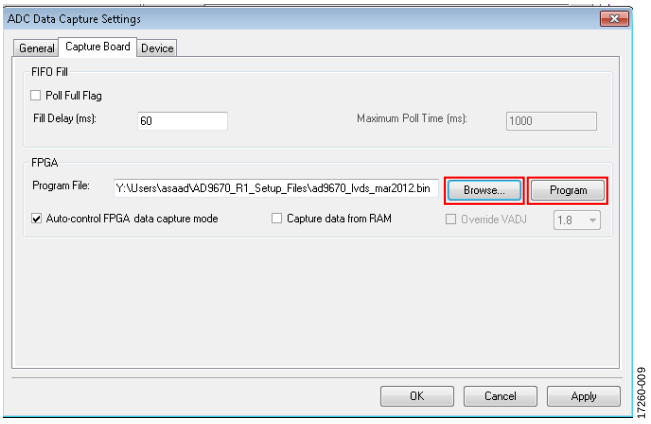


*Figure 9. **ADC Data Capture** Settings Window*

12. The AD9670 is now running and fully configured for data capture mode. The VisualAnalog software offers two data capture modes: onetime and infinite loop. Click the blue right arrow (see Figure 7 or Figure 8) to run the canvas in onetime mode and click the green repeat button (see Figure 7 or Figure 8) to run the canvas in infinite loop mode. The **Samples** canvas then opens two windows showing 8192 time domain samples for Channel A and Channel B (see Figure 10 for the Channel A window).

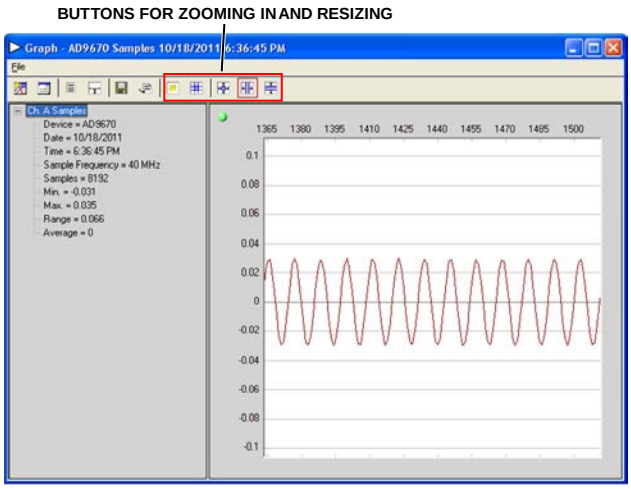


Figure 10. Data Capture Window

13. Another loadable canvas, the **AD9670_Average_FFT.vac** canvas, runs average fast Fourier transform (FFT) calculations of the captured samples. The average count is set to five captures. Therefore, either run the canvas five times to display the first FFT output or leave it in continuous run mode to keep the canvas functioning.
14. Figure 11 shows both the FFT output and how the analog and digital high-pass filters shape the noise floor in the low frequency region.

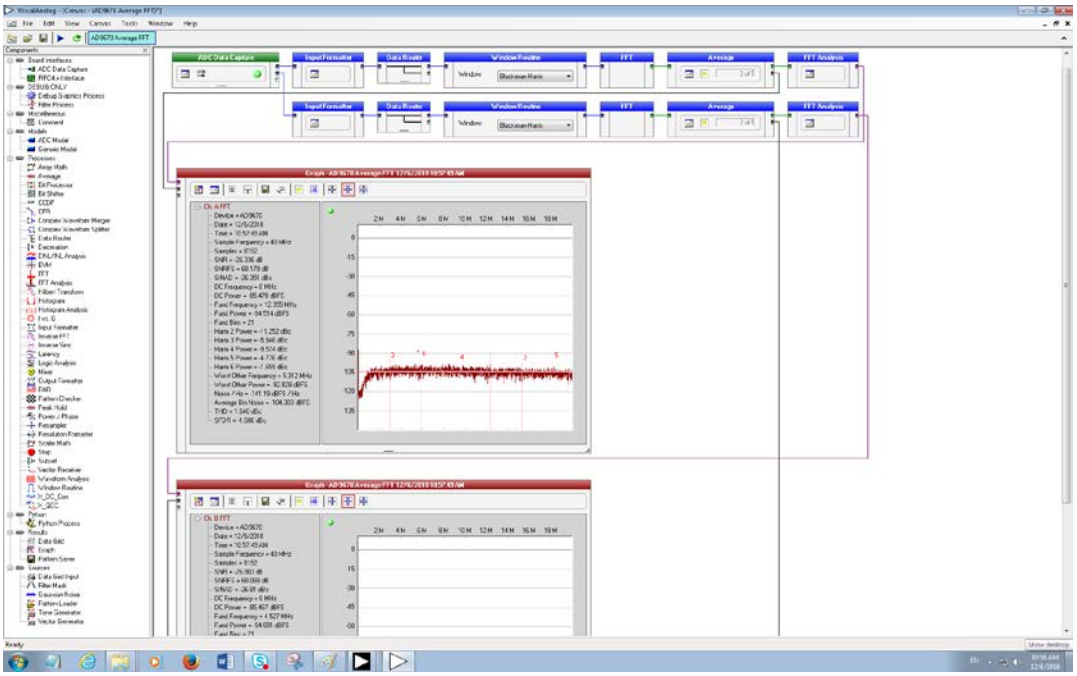


Figure 11. Average FFT Canvas

15. To disable the digital high-pass filter, select the **HP Filter Bypass** checkbox in the **Memory Map** window (see Figure 12) and then click the **Manual Tx Trigger** button (see Figure 12).

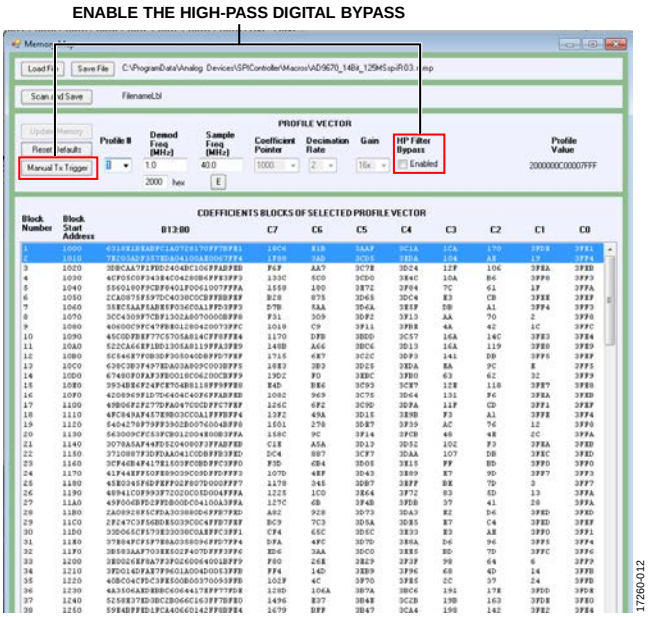


*Figure 12. Disabling the Digital High-Pass Filter Bypass in the **Memory Map** Window*

16. Disabling the digital high-pass filter increases the noise floor shape at low frequencies and results in a flat noise floor (see Figure 13).

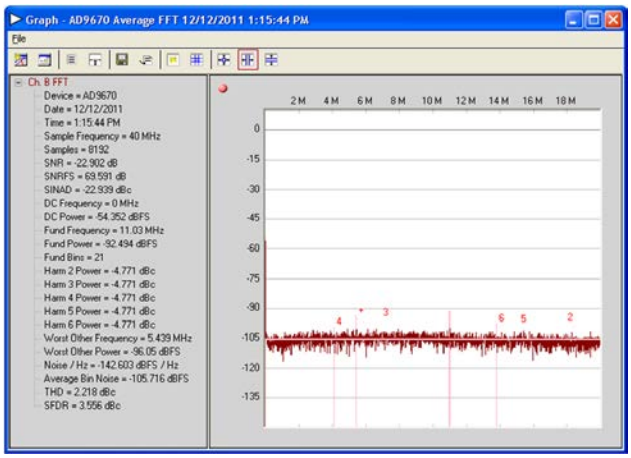


Figure 13. Average FFT Canvas with the Digital High-Pass Filter Disabled

17. To enable the demodulator and decimator, select and run the **IQ Mode, 40Msps** macro in the **MacroEditor** window (see Figure 4).

EVALUATION BOARD SCHEMATICS AND ARTWORK

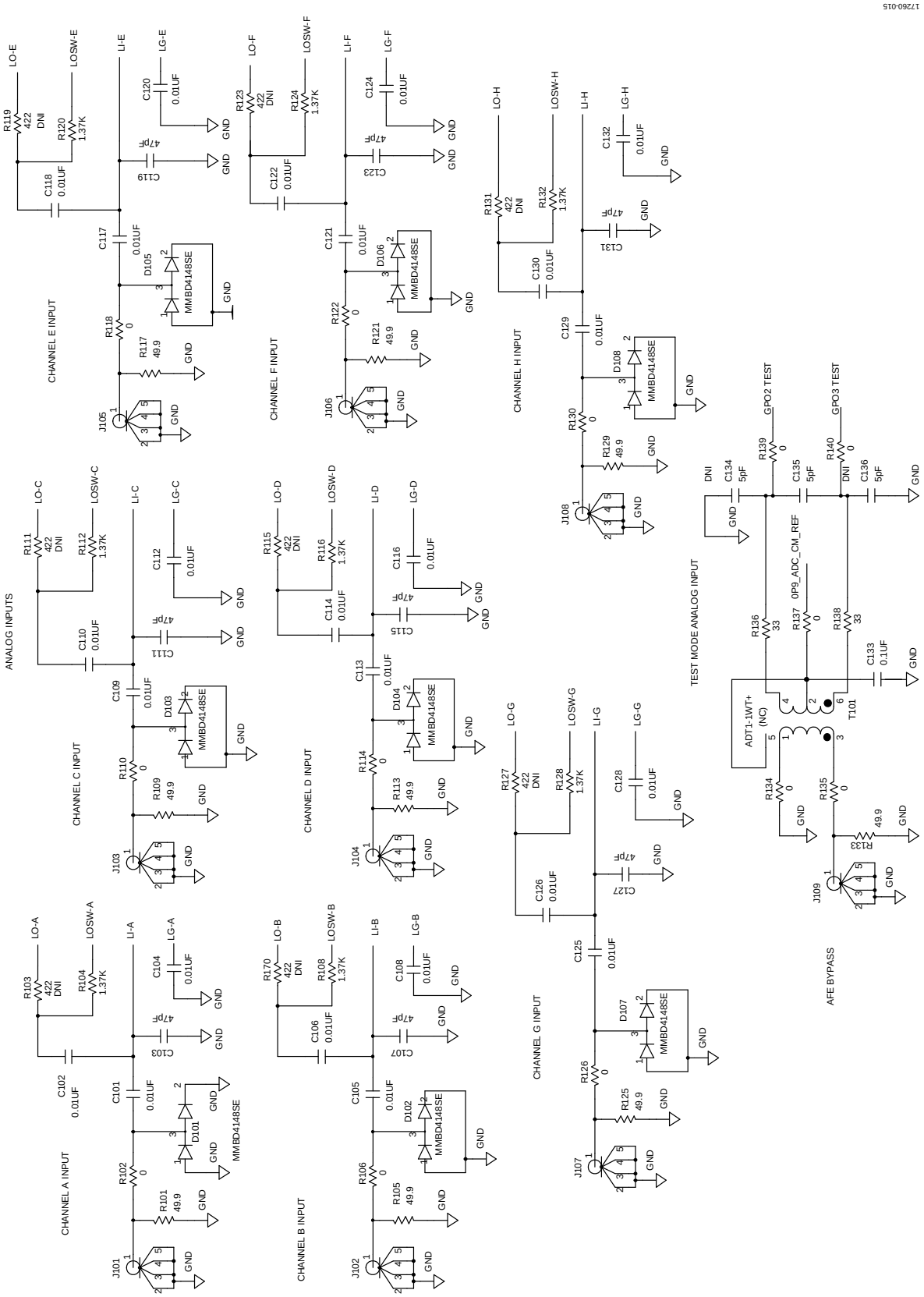


Figure 14. AD9670EBZ Schematics Page 1

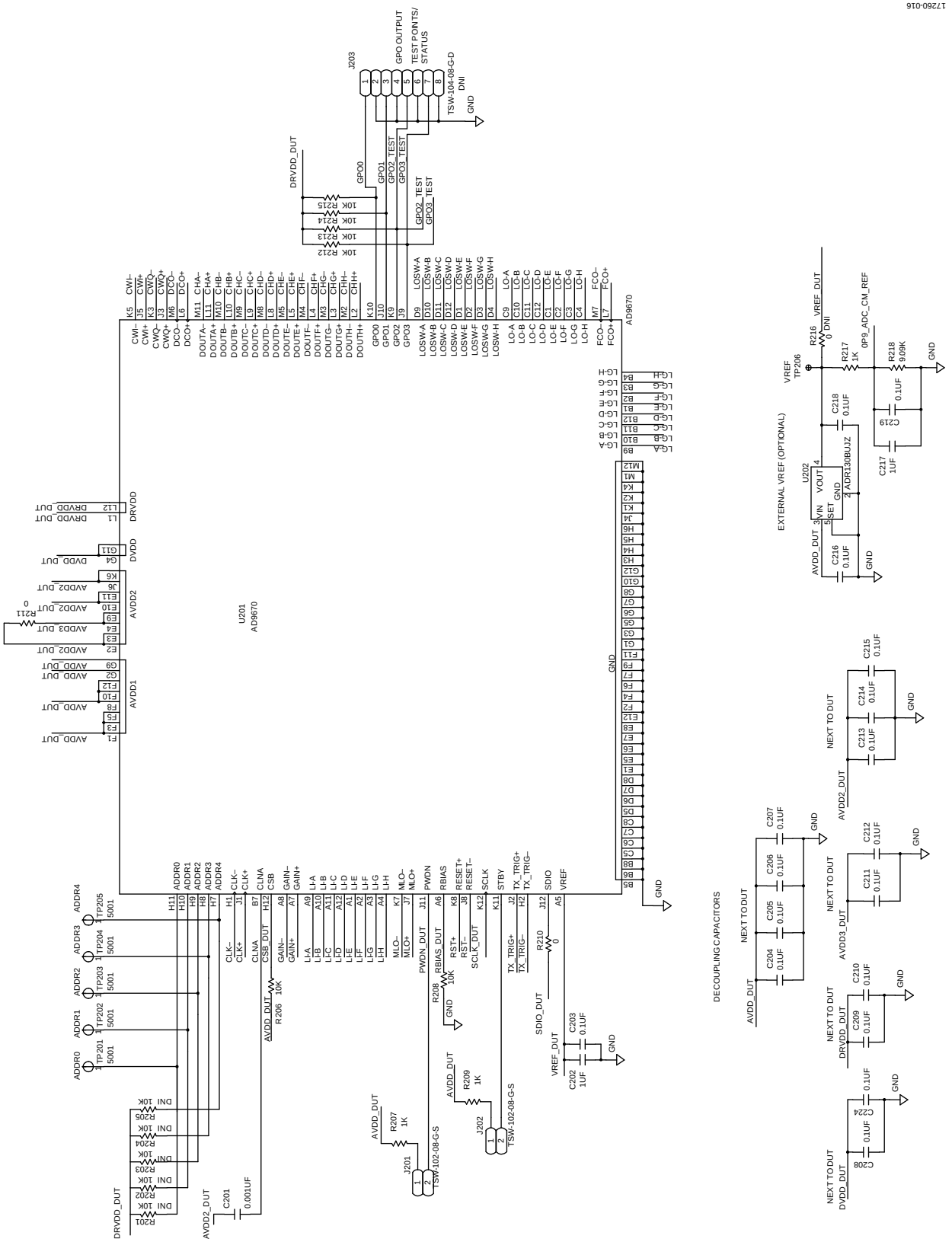


Figure 15. AD9670EBZ Schematics Page 2

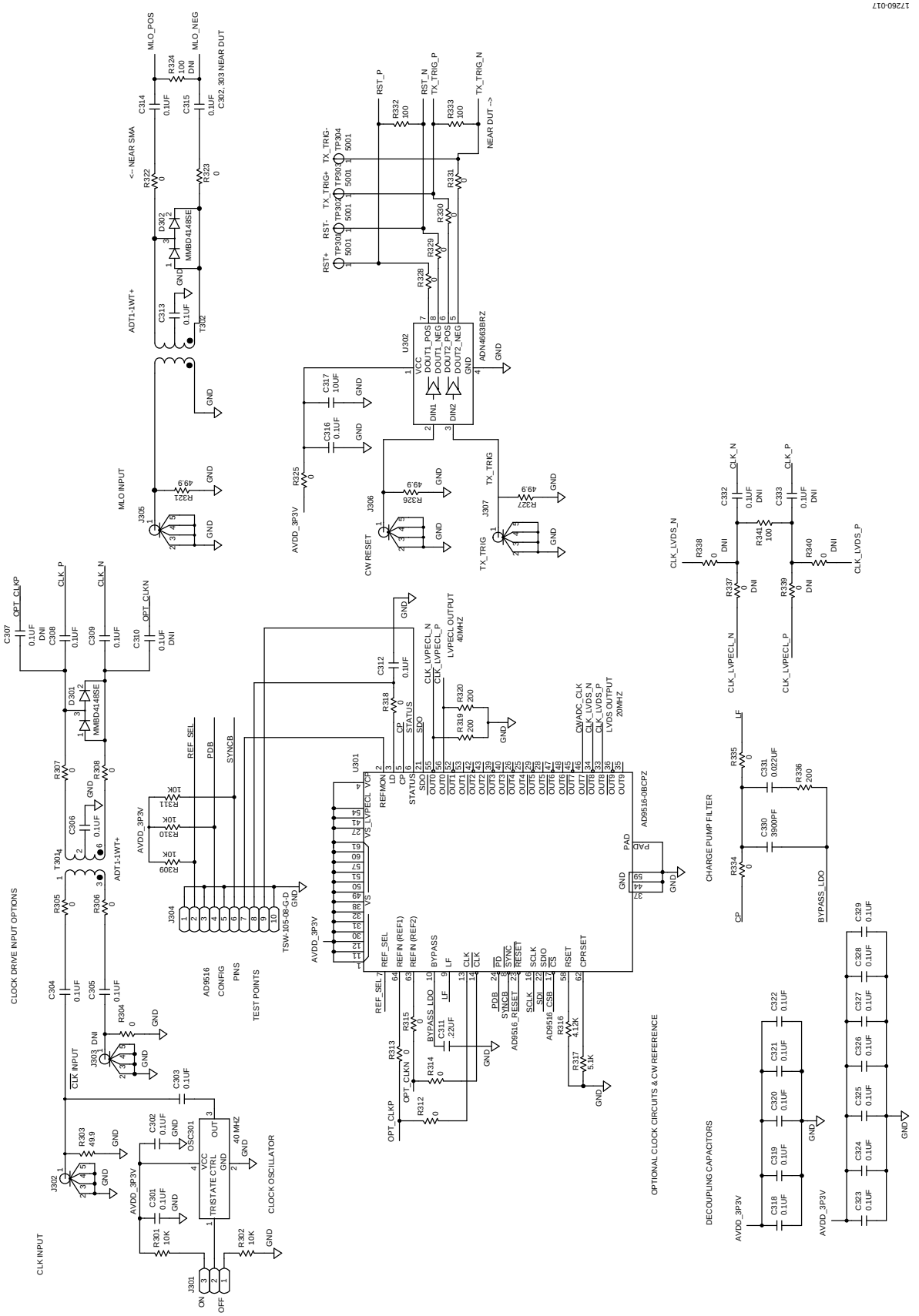


Figure 16. AD9670EBZ Schematics Page 3

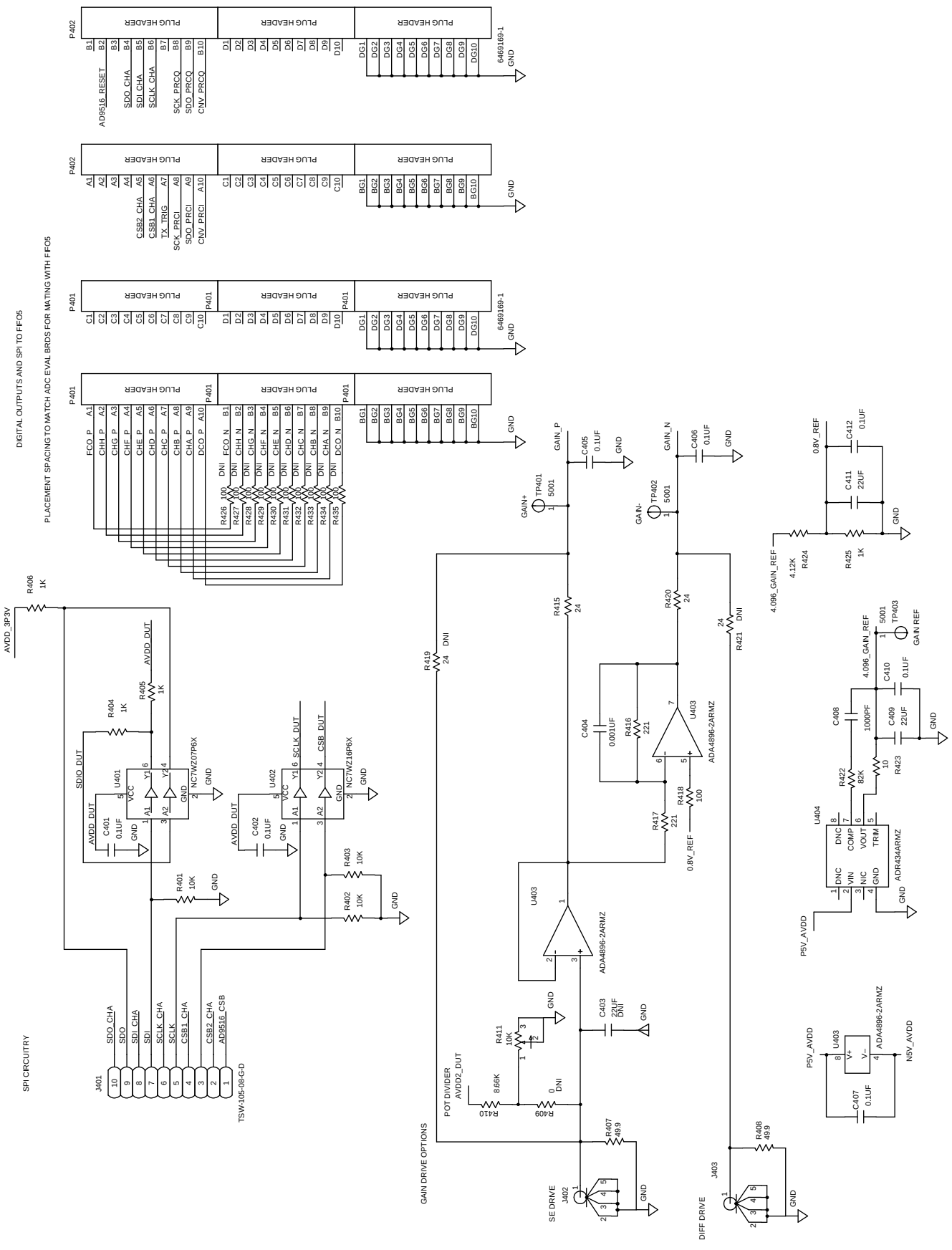


Figure 17. AD9670EBZ Schematics Page 4

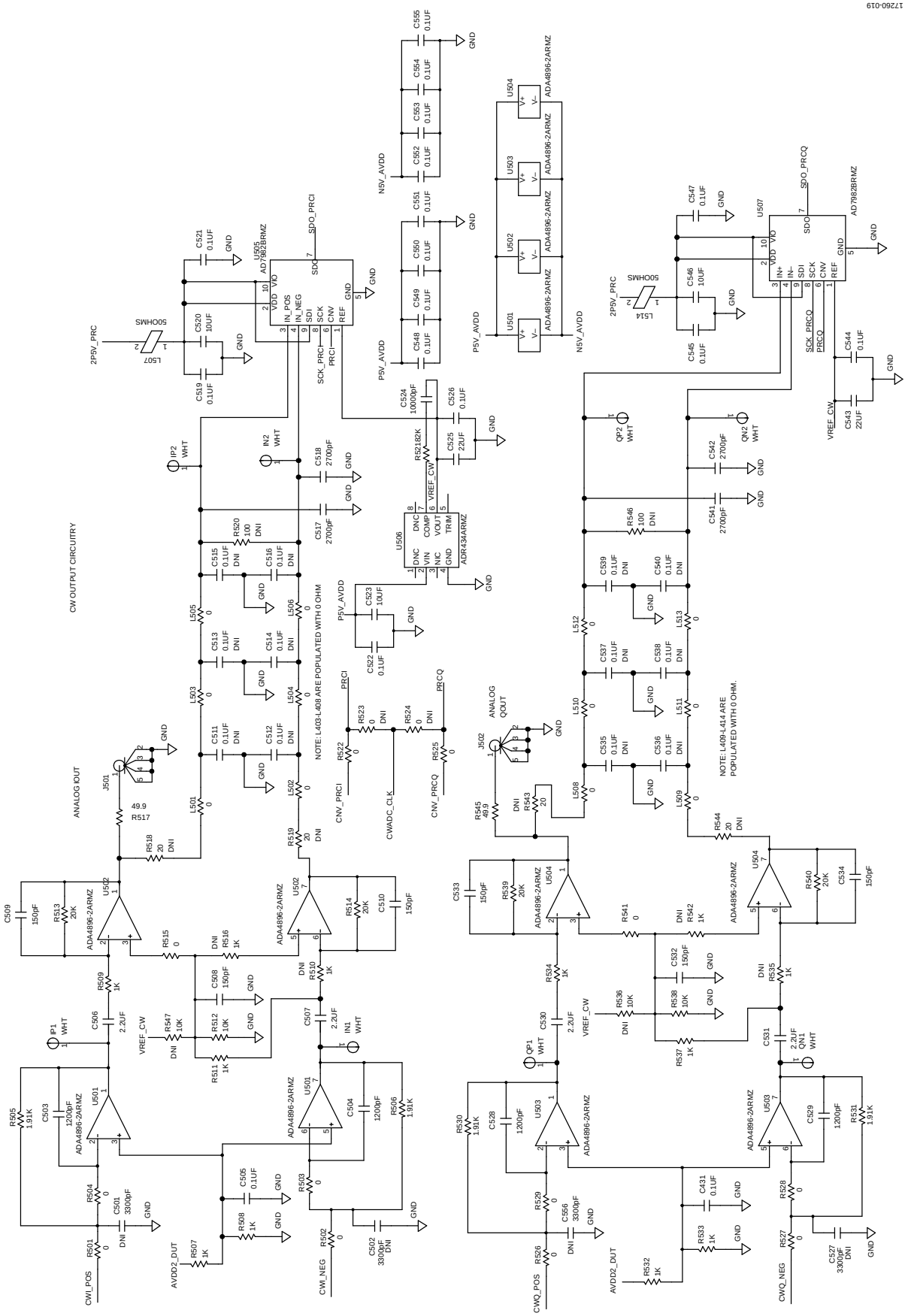


Figure 18. AD9670EBZ Schematics Page 5

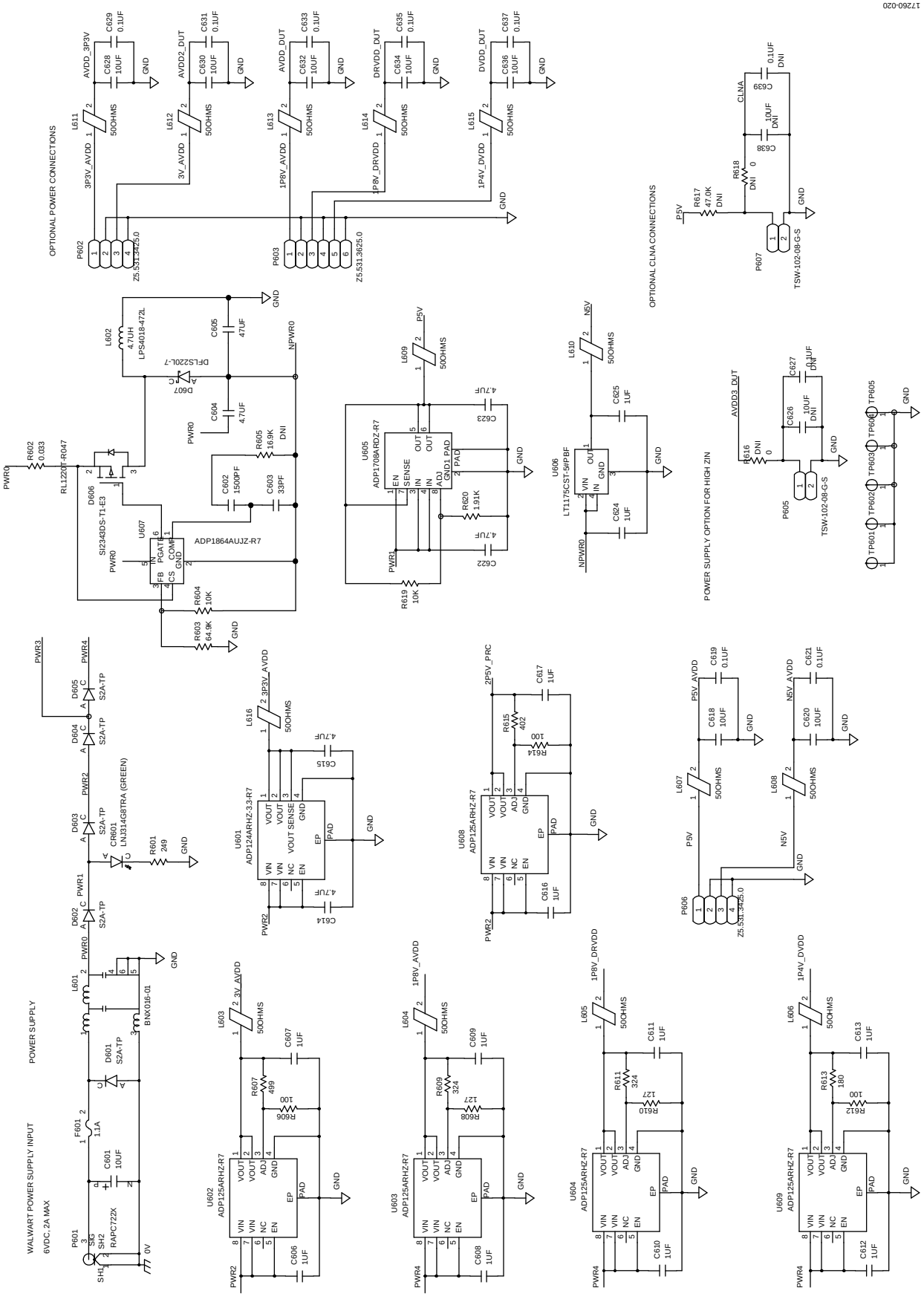


Figure 19. AD9670EBZ Schematics Page 6

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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UG17260-0-1/19(0)

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