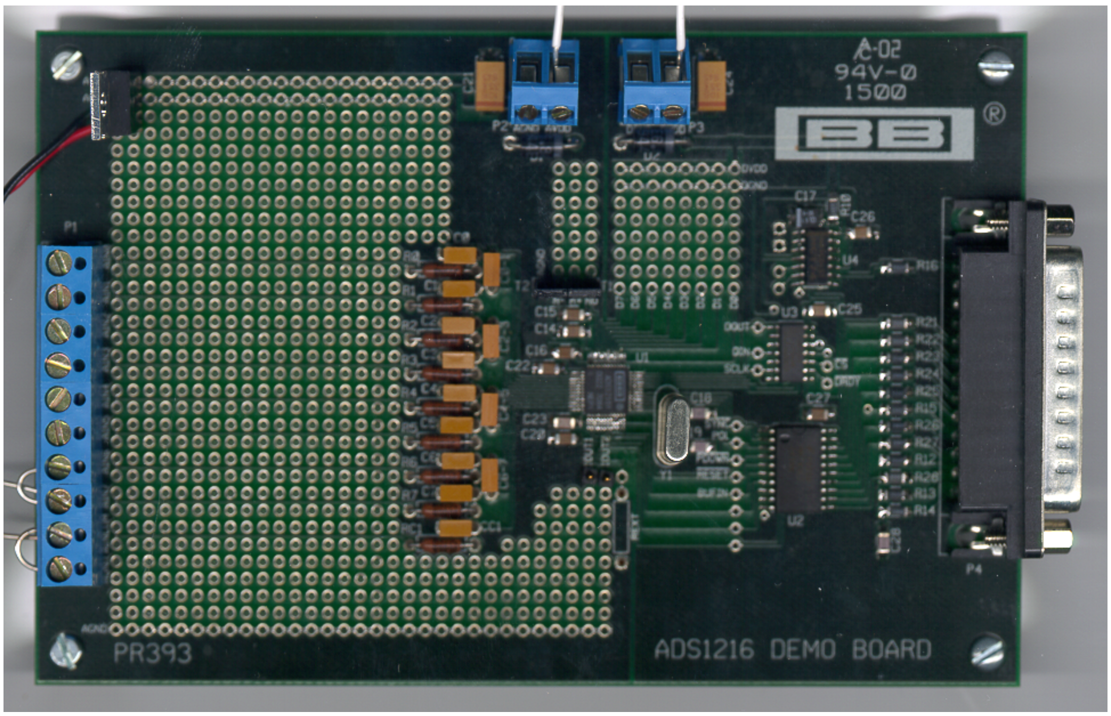
DEM-ADS1216 User Guide



Features:

- Provides Fast and Easy Performance Testing for ADS1216
- Separate Analog and Digital Power
- PC Printer Port Control
- Microsoft Windows® 95/98 Software

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1 Description

The DEM-ADS1216 demo board is designed for ease of use when evaluating the ADS1216 high-resolution analog-to-digital (A/D) converter. The ADS1216 offers 24-bits, no missing code performance. It has eight input channels that can be configured as up to eight differential channels. The multiplexer is followed by a programmable gain amplifier with selectable gains of up to 128.

Hardware options include user-defined clock frequency, internal or external reference, and input biasing.

All of the features and functionality of the ADS1216 can be exercised using the pull-down menus available from the DEM-ADS1216 software. Throughout this document, the terms *demo board* and *EVM* are used interchangeably to mean *evaluation module*.

2 Initial Configuration

The DEM-ADS1216 is designed to be operational without any user configuration except connecting the power supplies and the communications cable to an available PC printer port. To use the internal reference voltage, jumpers T1 and T2 should be installed.

2.1 Power Supply

The analog and digital supplies should be connected together at the power supply. This condition means that a pair of wires should go from V_{CC} and AGND to the power supply, and a separate pair of wires should go from V_{DD} and DGND to the same +5Vpower supply.

2.2 Voltage Reference

With jumpers T1 and T2 installed, the DEM-ADS1216 EVM uses the internal reference. To use an external reference, these jumpers can be replaced and connections made to the pins.

2.3 Clock

A 2.4576MHz crystal is connected to the XIN and XOUT pins to provide a convenient frequency for 60Hz rejection.

2.4 PCB Layout

The DEM-ADS1216 demo board consists of a two-layer printed circuit board (PCB). To achieve the highest level of performance, surface-mount components are used wherever possible. This architecture reduces the trace length and minimizes the effects of parasitic capacitance and inductance. The EVM has a divided ground with all the analog signals over one portion and the digital signals in the other. Keep in mind that this approach may not necessarily yield optimum performance results when designing the ADS1216 into different individual applications. In any case, thoroughly bypassing the power supply and reference pins of the converter is strongly recommended.

The breadboard area is provided so that input filters can be added. As shipped, the board includes an R-C filter (49.9Ω and 47pF) on each input with a 0.1µF differential capacitor between adjacent channels.

3 Windows Software

The ADS1216 uses registers and a 1-byte opcode to control the operation. The evaluation software provides a convenient method to issue the commands and receive the results. It also can display the results of acquired data, as shown in Figure 1, and perform a frequency analysis, as shown in Figure 2.

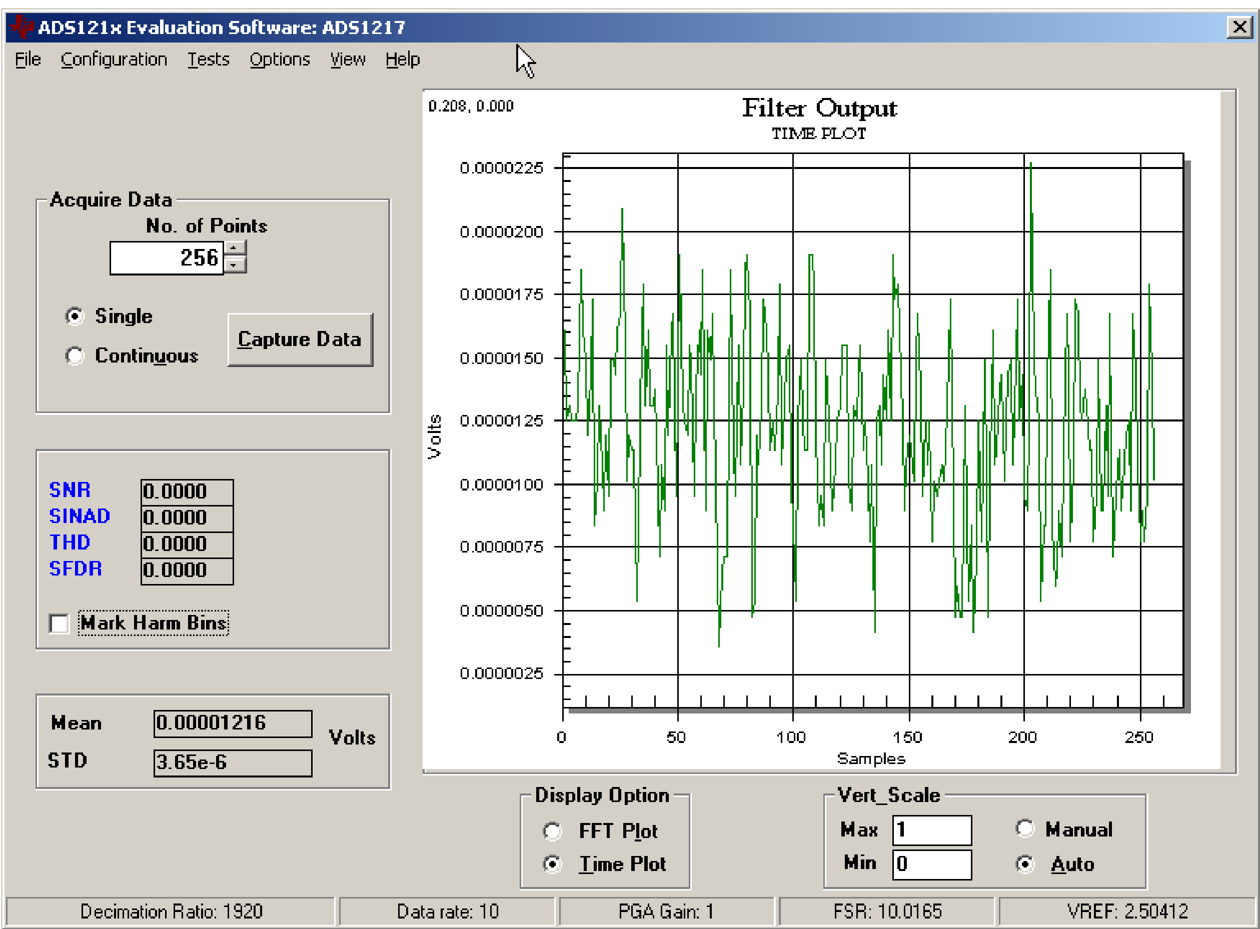


Figure 1. Sample Time Plot

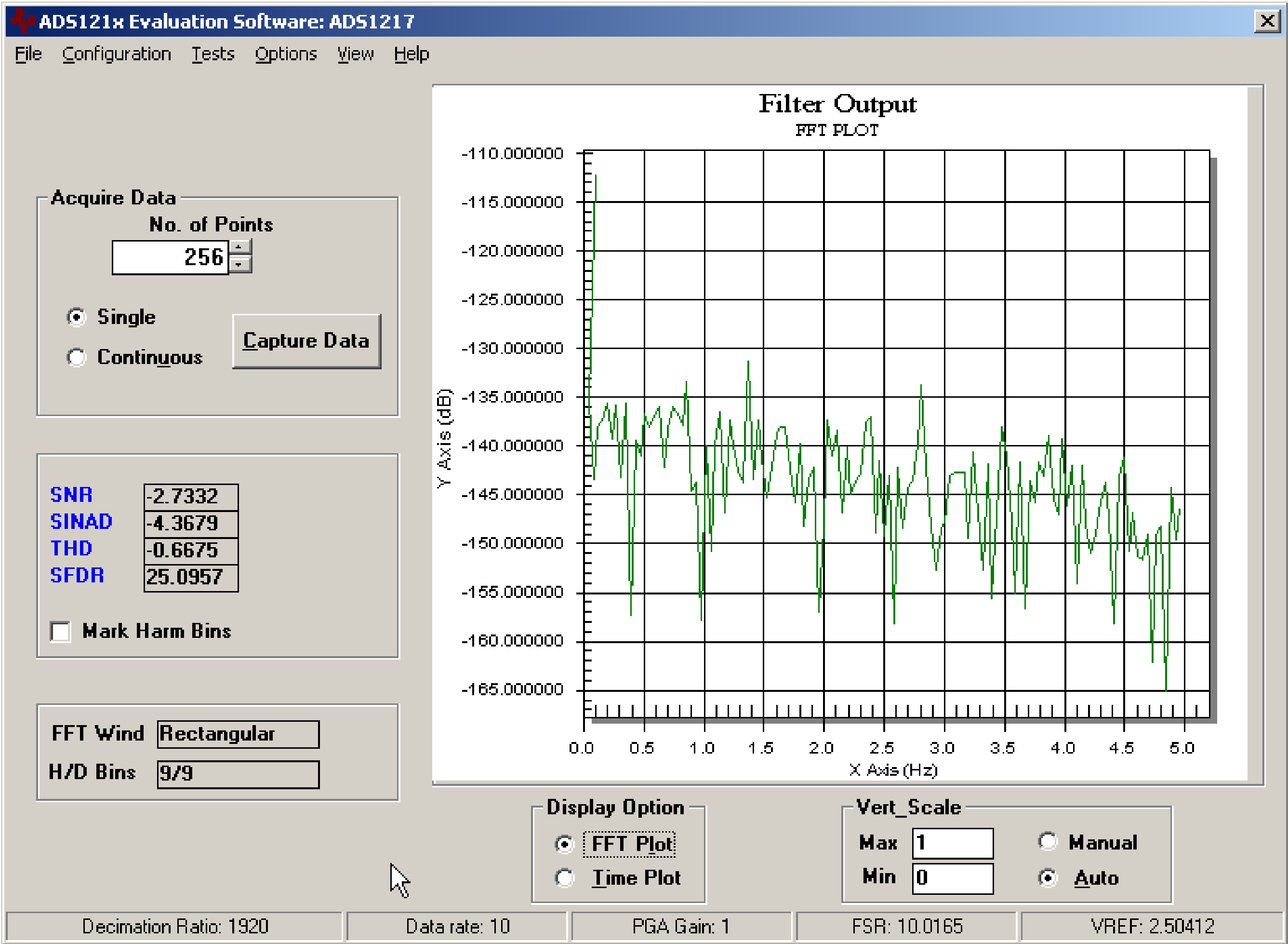


Figure 2. Sample FFT Frequency Plot

The software program is organized with the following pull-down menus:

- **F**ile:
  - **D**isplay Data List
  - **S**ave Data
  - Save **F**FT Data
  - **P**rint Data
  - E**x**it
- **C**onfiguration:
  - **C**onfigure Digital Filter
  - **S**elect Input Channel
  - Set **I**DACs/PGA/V_{REF}
- **T**ests:
  - **O**pcode Test
  - **R**AM R/W Test
  - **N**oise Test

- **O**ptions:
  - **D**ata List Format:
    - **V**oltage
    - Raw **H**ex
    - Raw **D**ecimal
  - Set **F**FT Window:
    - **R**ectangular
    - **H**amming
    - **B**lackman
    - Blac**k**man Harris
    - **C**ontinuous 5th Derivative
  - FFT **H**armonic Bins:
    - Number of **H**armonic Bins
    - Number of **D**C Bins
- **H**elp:
  - **A**bout ADS1216 Demo SW

3.1 Save Data

The Save Data List (see Figure 3) displays the individual data values as well as the mean and standard decimation of the data.

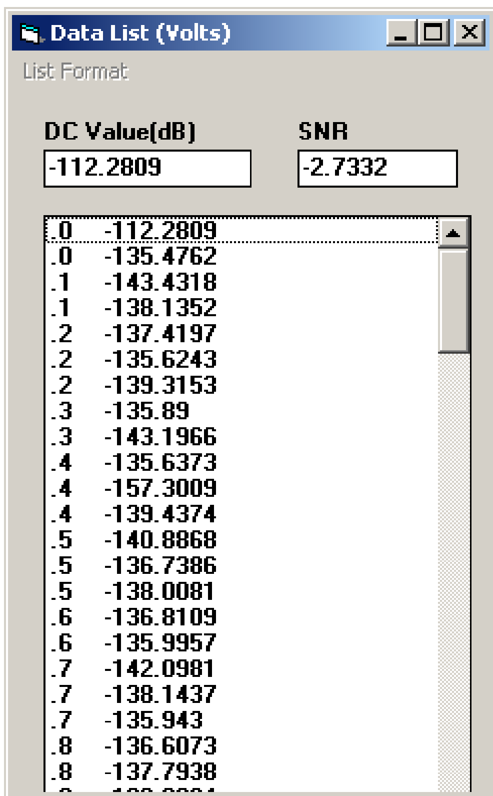


Figure 3. Data List

3.2 Configuration

The Configure Digital Filter opens a window that provides many options, as shown in Figure 4.

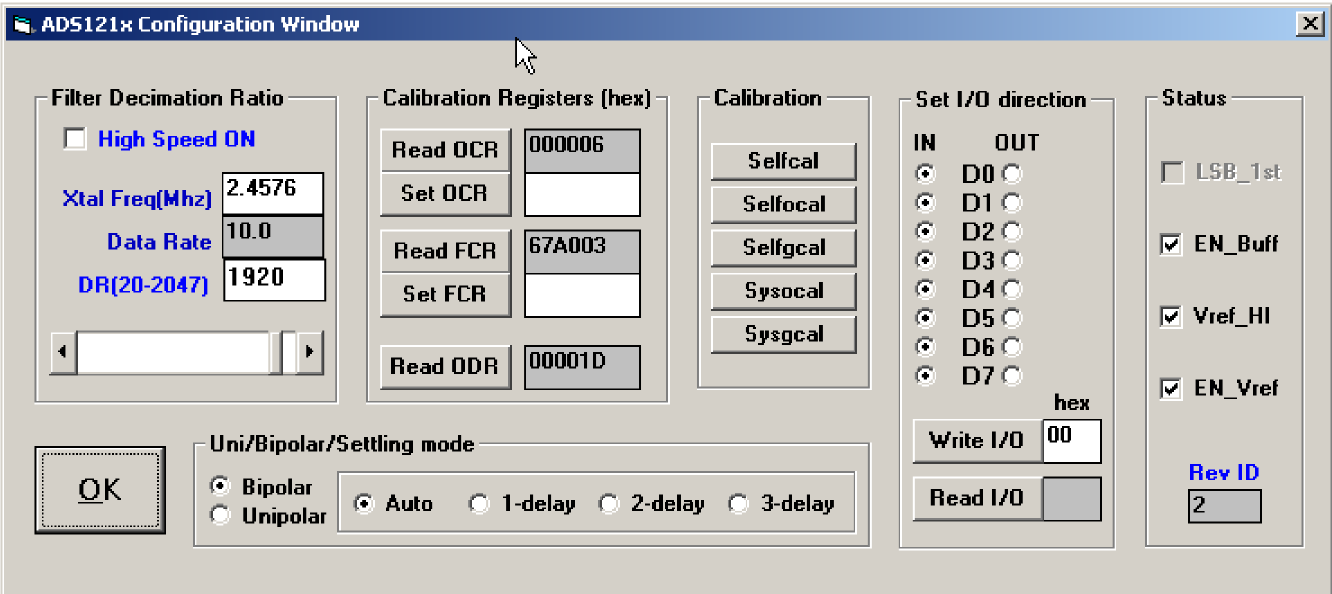


Figure 4. Configuration Window

3.2.1 Filter Decimation Ratio

The Filter Decimation Ratio box allows you to adjust the decimation ratio with the scroll bar or by entering a value in the box at the bottom. Additionally, as you change the decimation ratio, you can observe the resulting data rate.

3.2.2 Calibration Registers

The current values of the Offset and Full-Scale Output Data registers can be read and displayed. Additionally, these values can be changed by entering a new HEX value in the field and pushing the ***Set*** button.

3.2.3 Calibration

Five types of calibration can be performed. When the calibration button is pushed, the ADS1216 performs the calibration; then it reads back and displays the results in the calibration registers. The five types of calibration are:

1. **Selfcal**—Both Offset and Gain Calibration
2. **Selfocal**—Only Offset Calibration
3. **Selfgcal**—Only Gain Calibration
4. **Sysocal**—Offset Calibration, Input = 0V
5. **Sysgcal**—Gain Calibration, Input = V_{REF}

3.2.4 Set I/O Direction

The eight I/O pins can be individually set for output or input. The output pins will be set to the HEX value entered in the **Write I/O** field when the *Write I/O* button is selected. The value of all pins will be displayed in the box next to the *Read I/O* button when it is selected.

3.2.5 Status

The various control bits can be set and monitored in the status box. Additionally, the revision ID of the ADS1216 device will be displayed. The status bits and their respective functions are shown in Table 1.

Table 1. DEM-ADS1216 Control Bits

Status Bit	0	1
LSB 1st	Send MSB first	Send LSB first
EN_Buff	No input buffer	Input buffer enabled
V_{REF}_HI	V_{REF} = 1.25V	V_{REF} = 2.5V
EN_V_{REF}	V_{REF} OFF	V_{REF} ON

3.2.6 Unipolar/Bipolar

The results of the unipolar/bipolar selection are shown in Table 2.

Table 2. DEM-ADS1216 Unipolar/Bipolar Selection Results

Selection	Analog Input	Digital Output
Bipolar	+FSR	0x7FFFFF
	Zero	0x000000
	–FSR	0x800000
Unipolar	+FSR	0xFFFFFF
	Zero	0x000000
	–FSR	0x000000

3.2.7 Settling Mode

Three Sinc filters can be selected. When the input changes, the fast-settling filter settles in one data output interval, $Sinc^2$ settles in two periods, and $Sinc^3$ takes three periods to fully settle. However, the $Sinc^3$ filter has the highest resolution. The desired filter can be selected. Auto mode selects the fast-settling filter when the input changes, then it changes to the $Sinc^2$ filter for the second period, and on the third data out period it uses the output of the $Sinc^3$ filter. This approach gives fast settling when the input channel changes, but the same high-resolution results after the necessary number of conversion periods.

3.2.8 OK

Selecting ***OK*** saves the selected setup.

3.3 Select Input Channels

Figure 5 gives a graphical method of selecting the multiplexer channel. This option also shows the full flexibility of the ADS1216 multiplexer, allowing any input to be selected as the positive or negative input for a given measurement. Use a mouse to select which switch to close. Additionally, the internal diode can be connected, turning on the burnout current sources. By measuring the voltage on the diode, a temperature measurement can be made. IDAC1 can also drive this sensing diode.

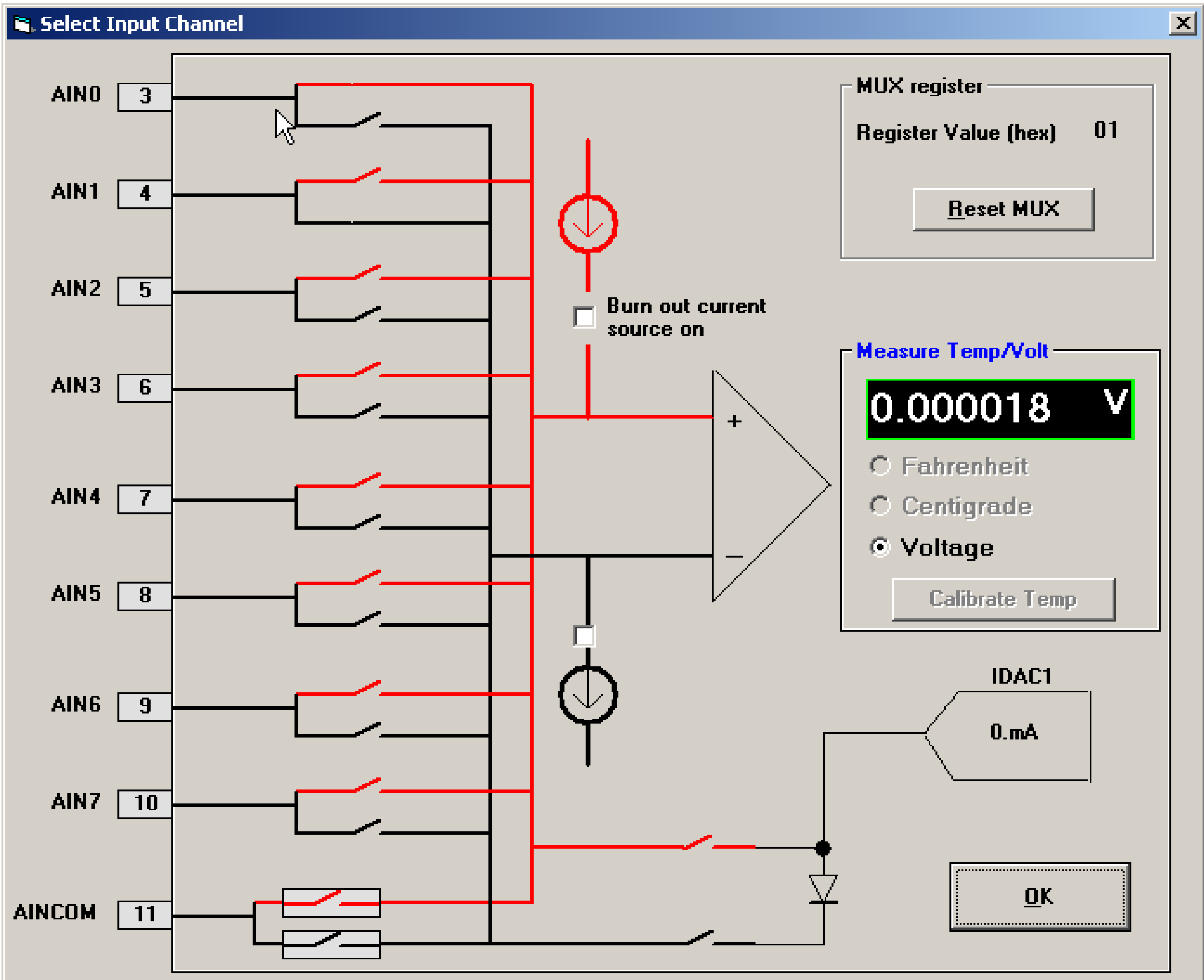


Figure 5. Input Multiplexer

3.3.1 Calibrate Internal Temp Sensor

The ***Calibrate Temp*** button opens the Internal Temp Sensor Calibration window (see Figure 6) for calibration of the internal temperature diode. This window allows you to force the temperature readout to match the temperature you enter. This option is not intented to give a high-accuracy temperature readout, but gives a reading that is reasonable for a single diode voltage measurement.

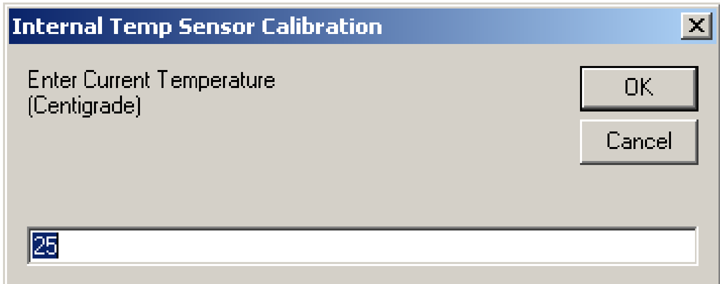


Figure 6. Temperature Calibration

3.4 Set $IDAC_S$/PGA/V_{REF}

The screen shown in Figure 7 provides a means to observe the interaction of the IDAC settings, R_{EXT} and V_{REF}. Additionally, the PGA can be set from this screen.

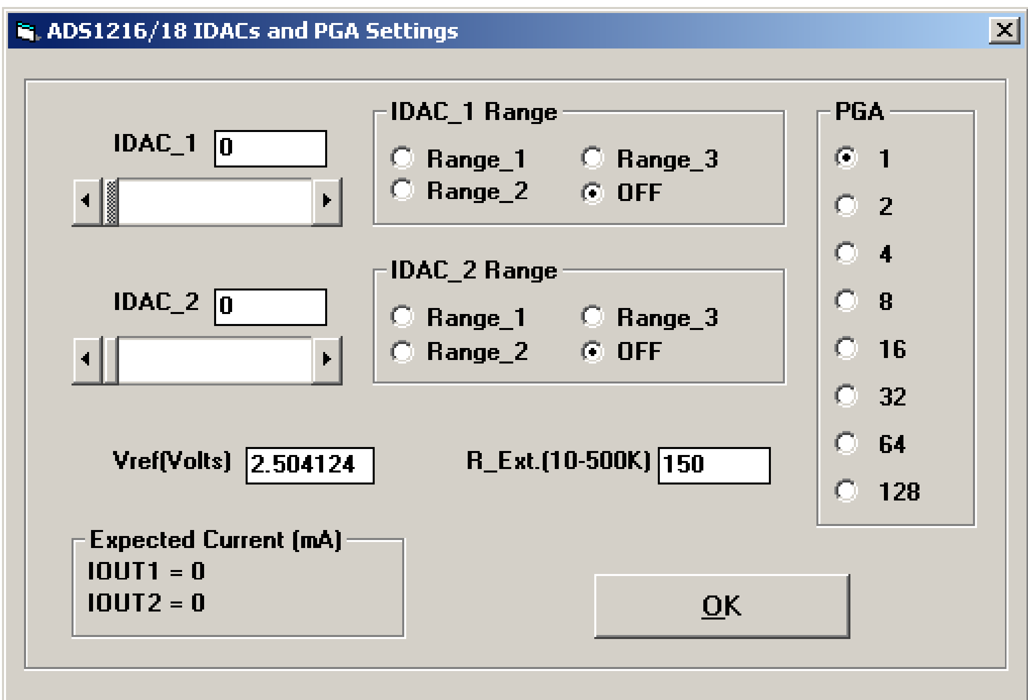


Figure 7. PGA Settings

3.5 Test Screens

3.5.1 OpCode Test

The screen in Figure 8 allows the opcodes to be tested and the results observed.

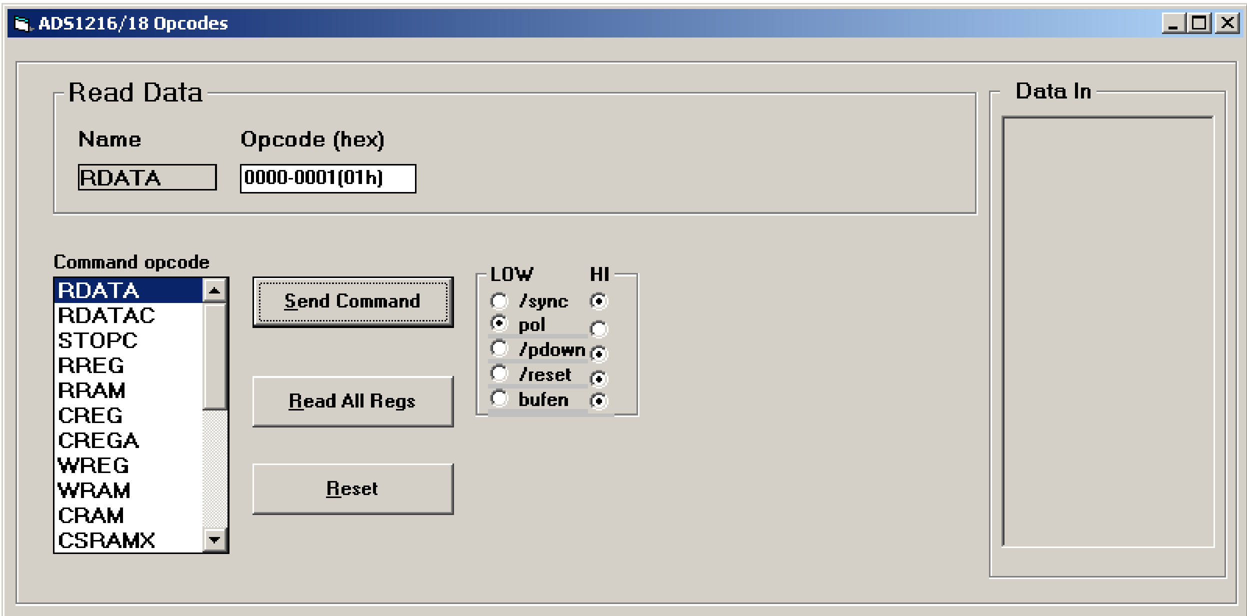


Figure 8. Opcode Control

One convenient way to test the communications and operations of the ADS1216 demo software is to go to this screen, select *Reset*, and then *Read all Regs*. You should end up with a register dump that looks similar to that shown in Figure 9.

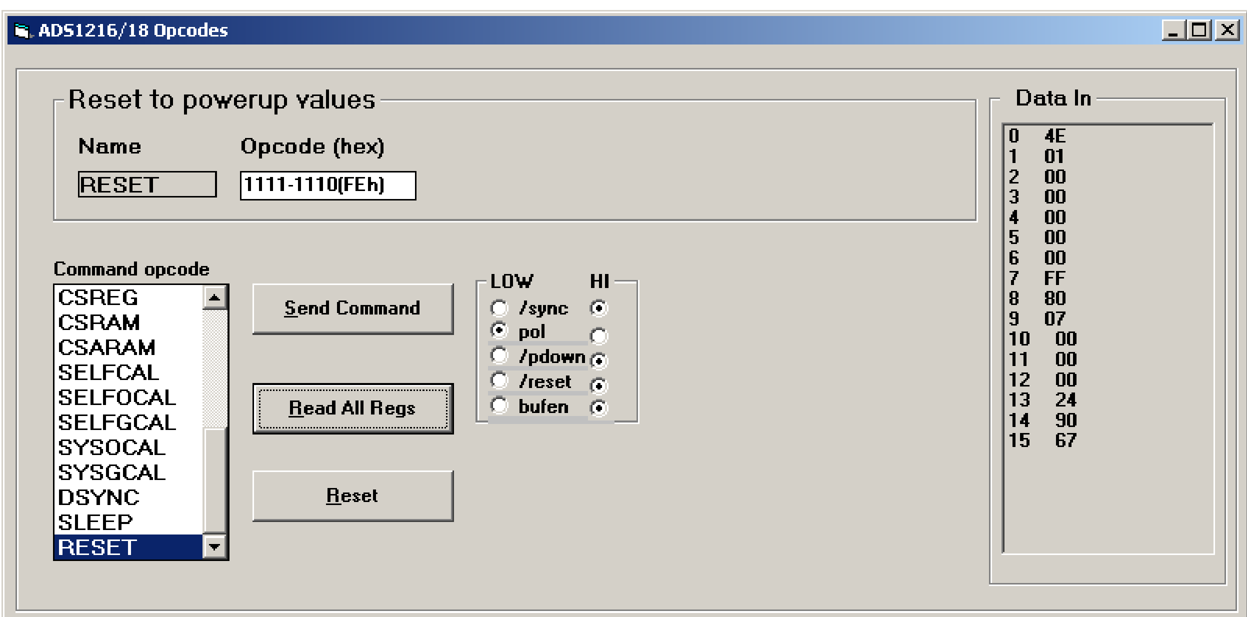


Figure 9. Reset Condition

You can observe that the reset state of the registers are: F6, 10, 00, 00, 00, 00, 00, FF, F0, 00, 00, 00, 00, 22, 90, 67. This screen also shows the state of the digital control signals. Any opcode can be entered and tested to observe the results.

3.5.2 RAM R/W Test

The test screen in Figure 10 provides tools for testing RAM. Various simple operations have been assigned to a button. Additionally, a full RAM test can be executed with the *Test Ram* button. This button clears the RAM, generates random data, writes to the RAM and verifies that the contents matches the random data.

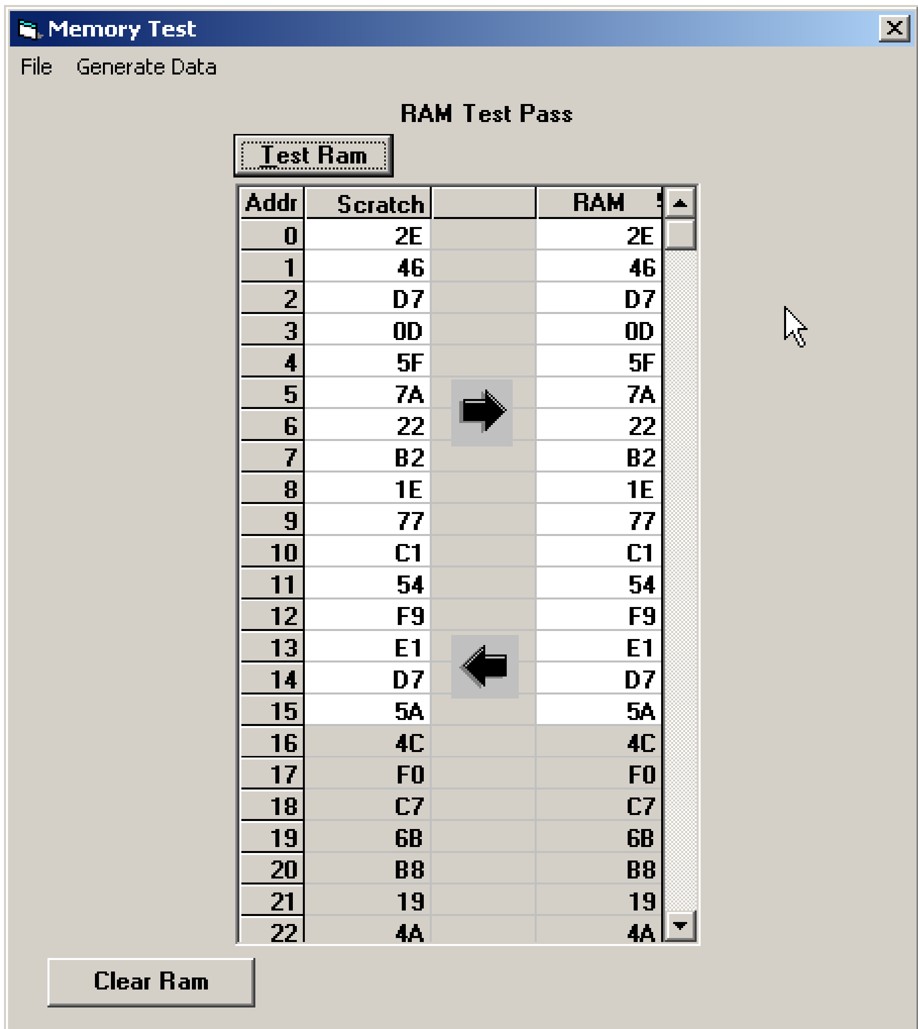


Figure 10. RAM Test Results

3.5.3 Noise Test

This test provides an automated means to verify the performance of the ADS1216 across various decimation ratio values, PGA settings, and with averaging of the results. With all the options selected, this test can take a long time to complete. The results are displayed in a tabular format that shows the PGA settings, Decimation Rate, Average Output, Standard Decmiation, and Effective Number of Bits (ENOB); see Figure 11.

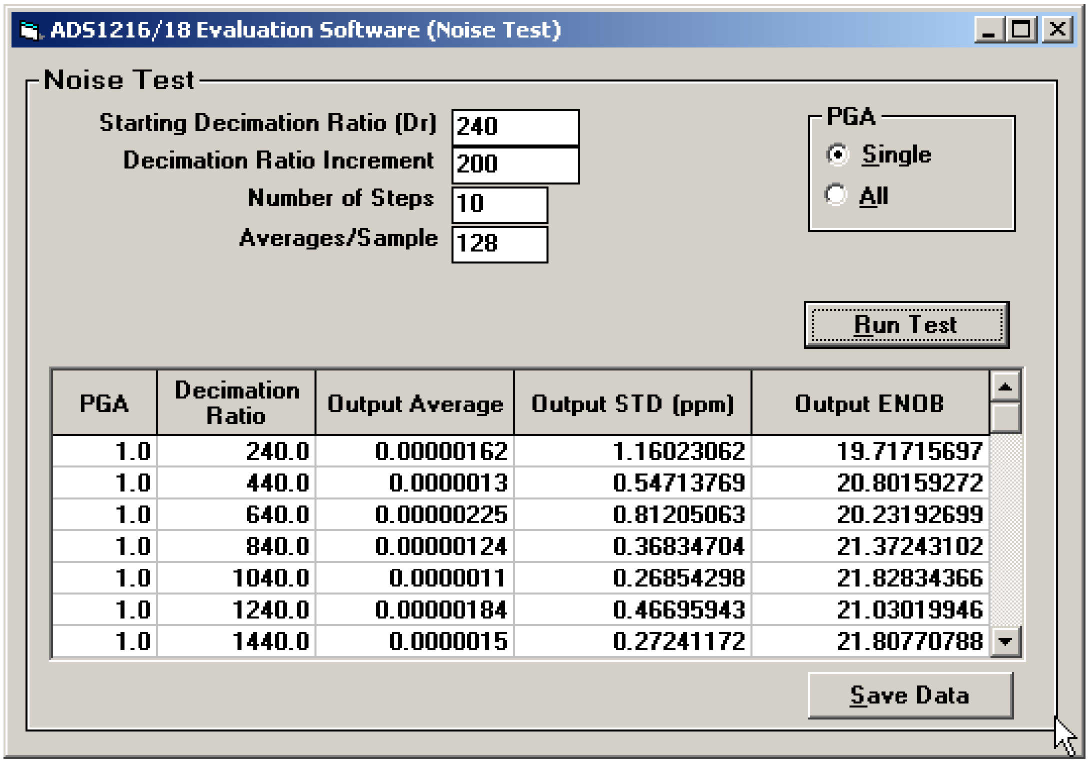


Figure 11. Noise Test Results

The *File* menu selection gives you the option to save your data. All data is saved in a comma-delimited format so that it can be imported into a spreadsheet for further analysis.

4 PCB Layout

Figure 12 and Figure 13 show the top and bottom layers of the PCB, respectively. The schematic diagram is also provided as a reference.

Note: Board layouts are not to scale. These figures are intended to show how the board is laid out; they are not intended to be used for manufacturing DEM-ADS1216 PCBs.

TOP (TRACES AND GND PLANE)

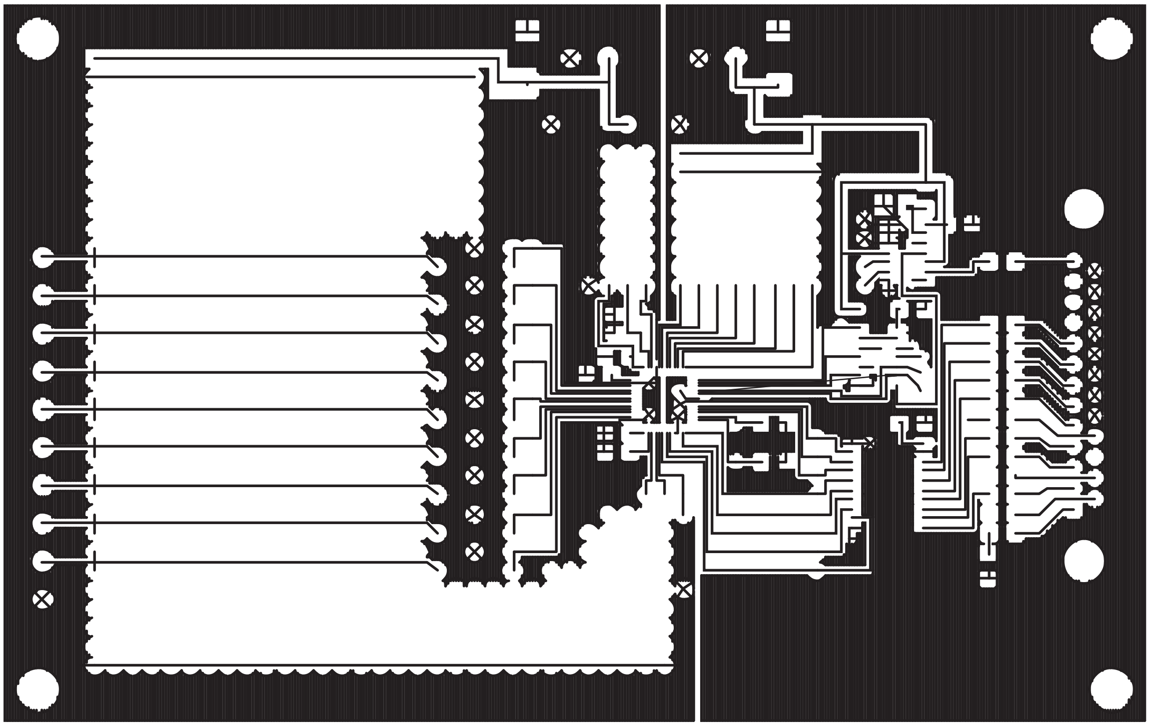


Figure 12. Top Layer Silkscreen

BOTTOM (TRACES AND GND PLANE)

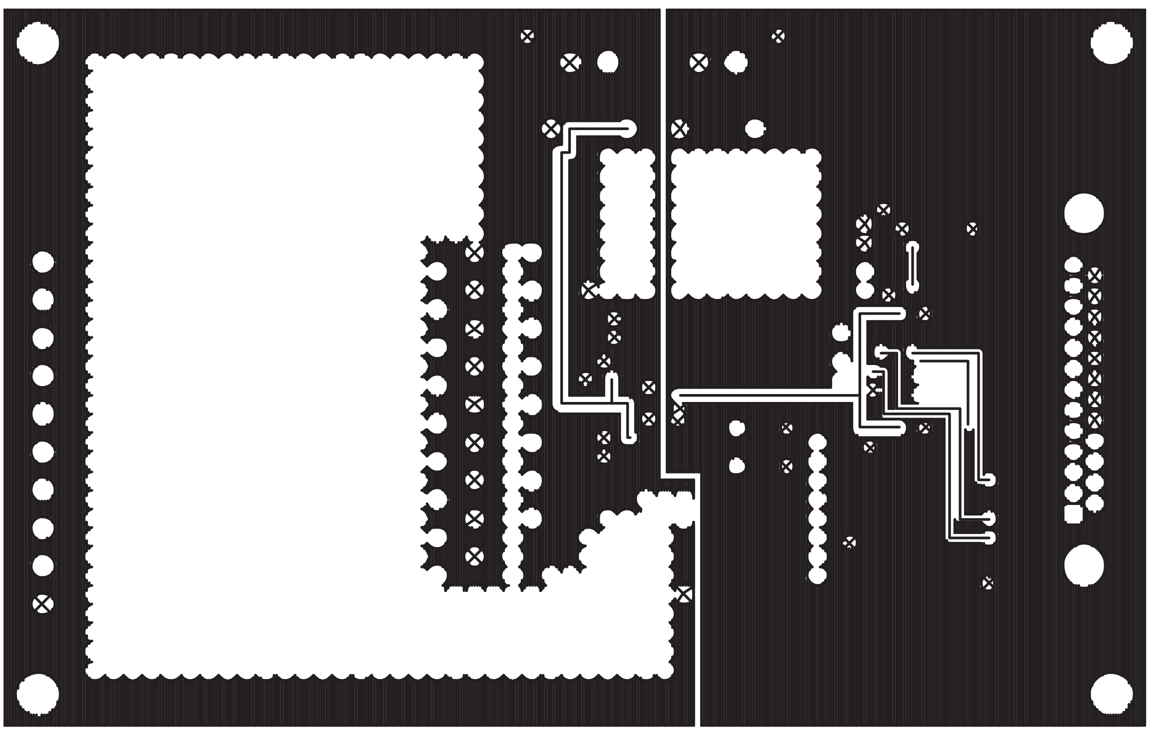


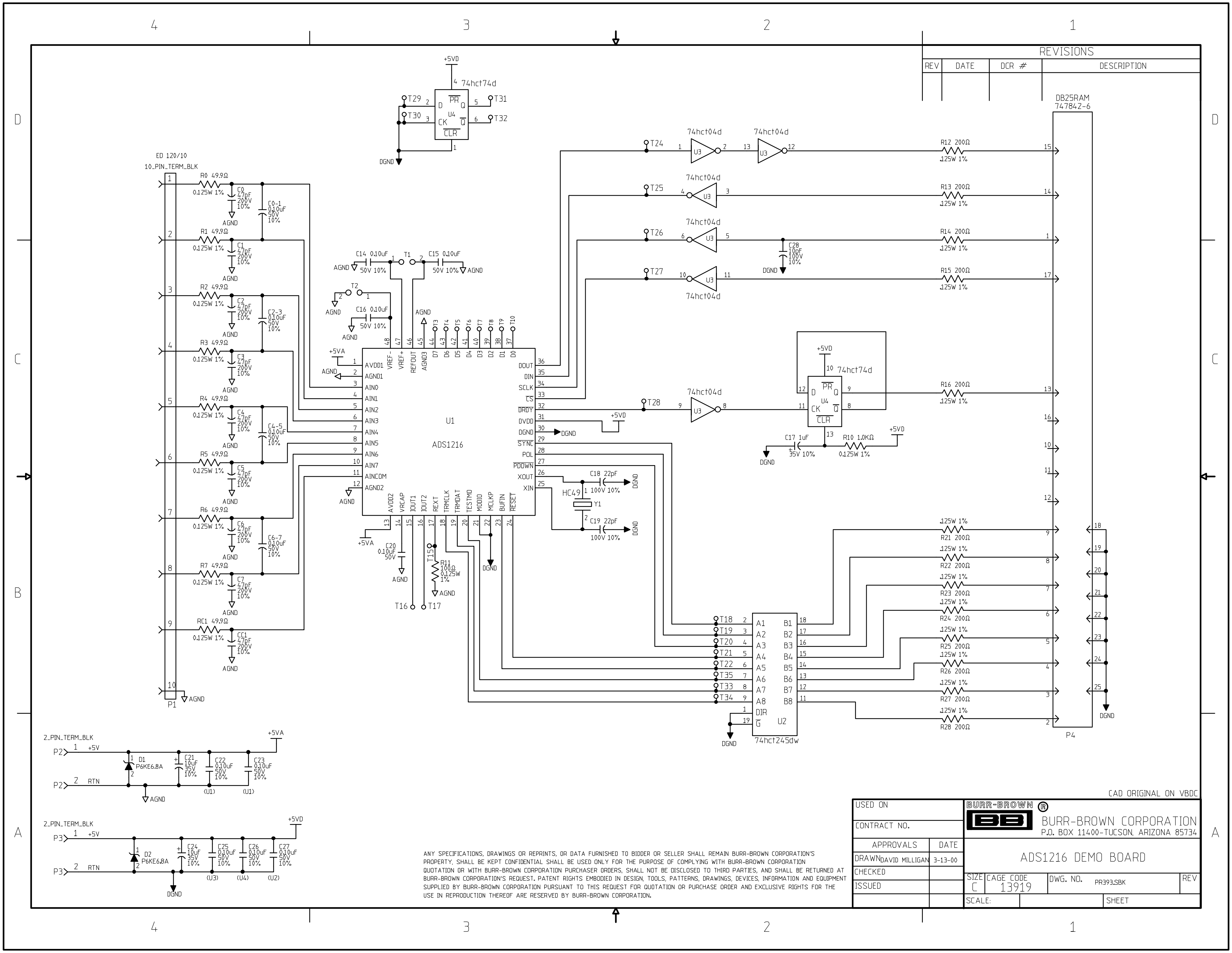
Figure 13. Bottom Layer Silkscreen

5 Component List

Table 3 lists the bill of materials for DEM-ADS1216.

Table 3. DEM-ADS1216 Bill of Materials

Part Number	Description	RefDes	Quantity	Vendor Part No.	MFR
ADS1216	20-bit A/D Converter	U1	1	ADS1216	Texas Instruments
CK05BX104K	Cap, 0.10µF, 50V, 10%, Ceramic X7R	C0–1, C2–3, C4–5, C6–7	4	CK05BX104K	Kemet
CK05BX470K	Cap, 47pF, 200V, 10%, Ceramic X7R	C0, C1, C2, C3, C4, C5, C6, C7, CC1	9	CK05BX470K	Kemet
CRCW12061001F	Res, 1.0kΩ, 0.125W, 1%, Chip-Thick-Film	R10	1	CRCW12061001F	Dale
CRCW12062000F	Res, 200Ω, 0.125W, 1%, Chip-Thick-Film	R12, R13, R14, R15, R16, R21,R22, R23, R24, R25, R26, R27, R28	13	CRCW12062000F	Dale
C1206C100K1GAC	Cap, 10pF, 100V, 10%, Chip-Ceramic COG	C28	1	C1206C100K1GAC	Kemet
C1206C104K5RAC	Cap, 0.10µF, 50V, 10%, Chip-Ceramic X7R	C14, C15, C16, C20, C22, C23, C25, C26, C27	9	C1206C104K5RAC	Kemet
C1206C220K1GAC	Cap, 22pF, 100V, 10%, Chip-Ceramic COG	C18, C19	2	C1206C220K1GAC	Kemet
ED 120/10	OST 10-Pin Term Block; 0.2 OC	P1	1	ED 120/10	
ED 300/2	2-Pin Terminal Block; 5mm Pitch	P2, P3	2	ED 300/2	
HC49	2.4576MHz Crystal; CTS; Cell HC18U	Y1	1	HC49	
P6KE6.8A	Zener 6.8V	D1, D2	2	P6KE6.8A	
REG1117-5	+5V Regulator	Q1	1	REG1117-5	Texas Instruments
RN55C49R9F	Res, 49.9Ω, 0.125W, 1%, Metal-Film	R0, R1, R2, R3, R4, R5, R6, R7, RC1	9	RN55C49R9F	Dale
RN55C1000F	Res, 100Ω 0.125W, 1%, Metal-Film	R11	1	RN55C1000F	Dale
TSW-1-S01-06-S	1-Pin Terminal; CELL TP042	T3, T4, T5, T6, T7, T8, T9, T10, T15, T16, T17, T18, T19, T20, T21, T22, T24, T25, T26, T27, T28, T29, T30, T31, T32, T33, T34, T35	28	TSW-1-S01-06-S	
TSW-102-07-L-S	Conn, 2 POS .1 CTR .025 SQ. Post	T1, T2, T36, T37	4	TSW-102-07-L-S	
T491B105K350AS	Cap, 1µF, 35V, 10%, Tantalum Chip-Molded	C17	1	T491B105K035AS	Kemet
T491D106K035AS	Cap, 10µF, 35V, 10%, Tantalum Chip-Molded	C21, C24	2	T491D106K035AS	Kemet
74hct04d	IC, Inverter, hex	U3	1	74hct04d	
74hct74d	IC, Flip Flop, Dual J-K with clear and pre-set	U4	1	74hct74d	
74hct245dw	IC, Bus Transceiver, Octal, 3-state outputs	U2	1	74hct245dw	
747842-6	25-Pin Right Angle Male D Conn	P4	1	747842-6	



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EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 0V to 5V and the output voltage range of 0V to 5V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than +30°C. The EVM is designed to operate properly with certain components above +50°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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