ANALOG DEVICES

Evaluation Board for 1MSPS, 12-/10-Bit ADCs

EVAL-AD7476/77CB

FEATURES

Full-Featured Evaluation Board for the AD7476/ AD7477
EVAL-CONTROL BOARD Compatible
Stand Alone Capability
On-Board Analog Buffering and Reference
Various Linking Options
PC Software for Control and Data Analysis when used with EVAL-CONTROL BOARD

INTRODUCTION
This Technical Note describes the evaluation board for the AD7476/77. The AD7476/77 are, respectively, 12 bit and 10 bit, high speed, low power, successive-approximation ADC's. The parts operate from a single 2.35 V to 5.25 V power supply and feature throughtput rates up to 1MSPS. The parts contain a low-noise, wide bandwidth track/hold amplifier which can handle input frequencies in excess of 1MHz. Full data on the AD7476/77 is available in the AD7476/77 data sheet available from Analog Devices and should be consulted in conjunction with this Technical Note when using the Evaluation Board.

On-board components include an AD780 which is a pin programmable +2.5 V or +3 V ultra high precision bandgap reference, an OP467 quad op-amp used to buffer the analog inputs and the REF195 precision bandgap, voltage reference, providing a 5 V reference voltage. There are various link options which are explained in detail on page 2.

Interfacing to this board is through a 96-way connector. This 96-way connector is compatible with the EVAL-CONTROL BOARD which is also available from Analog Devices. External sockets are provided for the AIN input, the VIN input and the VBIASED input.

OPERATING THE AD7476/77 EVALUATION BOARD

Power Supplies
When using this evaluation board with the EVAL-CONTROL BOARD all supplies are provided from the EVAL-CONTROL BOARD through the 96 way connector.

When using the board as a stand alone unit external supplies must be provided. This evaluation board has seven power supply inputs: AV_{DD}, A_{GND}, +12 V, -12 V, A_{GND}, DV_{DD} and D_{GND}. +5 V must be connected to the AV_{DD} input to supply the AD780 and the Ref195 voltage reference. The V_{DD} for the AD7476/77 can be supplied from either the AVDD external supply or from the selected voltage reference chip. +12 V and -12 V are used to supply the OP467 quad op-amp. 0V is connected to one or both of the A_{GND} inputs. The DV_{DD} input can be used to supply a separate +5V for the 74LS04 DV_{DD} pin. The D_{GND} input must be tied to 0V. The supplies are decoupled to the relevant ground plane with 10µF tantalum and 0.1µF multilayer ceramic capacitors at the point where they enter the board. The supply pins of the quad op-amp and references are also decoupled to A_{GND} with 10µF tantalum and a 0.1µF ceramic capacitors. The AD7476/77 AV_{DD} supply pin is decoupled to A_{GND} with 10uF tantalum and 0.1µF multilayer ceramic capacitors.

Extensive ground planes are used on this board to minimize the effect of high frequency noise interference. There are two ground planes, A_{GND} and D_{GND}. These are connected at one location close to the AD7476/77.

Figure 1. FUNCTIONAL BLOCK DIAGRAM
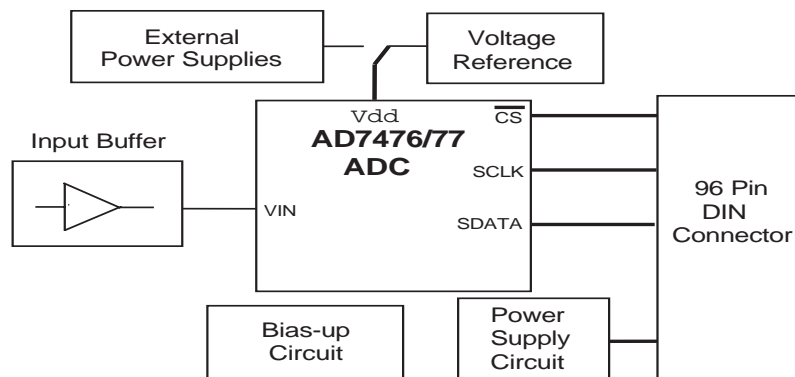
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LINK AND SWITCH OPTIONS

There are 12 link options which must be set for the required operating setup before using the evaluation board. The functions of these options are outlined below.

Link No.	Function.
LK1	This link option is used to select a 50Ω termination on the analog input buffer circuit. When this link is "inserted" the 50Ω termination is applied. When this link is "removed" the 50Ω termination is removed.
LK2	This link option controls the program pin of the AD780 voltage reference. When this link is "inserted" the AD780 output voltage is set to +3.0 V. When this link is "removed" the AD780 output voltage is set to +2.5 V.
LK3	This link is used to select a 50Ω termination on the input of the bias-up circuit. When this link is "inserted" the 50Ω termination is applied. When this link is "removed" the 50Ω termination is removed.
LK4	This link option is used to connect the output of either the REF195 or the AD780 to the V_{DD} pin of the AD7476/77 (if link 12 is in position C). When this link is in position A the AD780 supplies the V_{DD} voltage for the AD7476/77. When this link is in position B the REF195 supplies the V_{DD} voltage for the AD7476/77.
LK5	This link option sets the DC bias voltage that is applied to the optional bias-up/filter circuit. When this link is in position "A", the bias voltage is set to the same level as the voltage that is applied to the AD7476/77 V_{DD} pin. In this configuration a bipolar analog input applied to the Vin SMB socket is biased up by the bias circuit and is presented at the Vbiased SMB as a uni-polar signal biased around $V_{DD}/2$. When this link option is placed in position "B", the bias voltage is set to A_{GND}. In this configuration the bias-up circuit is not used.
LK6	This link option is used to select the source of the +12 V supply. In position A, the +12 V is supplied from the EVAL-CONTROL BOARD through the 96 way connector. In position B, the +12 V is supplied from an external source through the power connector, J6.
LK7	This link option is used to select the source of the -12 V supply. In position A, the -12 V is supplied from the EVAL-CONTROL BOARD through the 96 way connector. In position B, the -12 V is supplied from an external source through the power connector, J6.
LK8-9	These links control the transfer of data from the AD7476/77 during a conversion for various frequencies of SCLK. Link 8 and 9 should be in position "A" for slower SCLK frequencies, giving valid data on the rising edge. Link 8 and 9 should be in position "B" for fast SCLK frequencies, giving valid data on the following edge.
LK10	This link selects the source of the Vcc +5 V supply for the 74LS04. When this link is in position "A", Vcc power is supplied from the same power source supplying the AD7476/77 V_{DD} pin. When this link is in position "B", V_{CC} power must be must be supplied from an external source via the power connector, J5.
LK11	This link option is used to connect the input of the VIN analog buffer to the AIN input socket or to A_{GND}. When this link is in position "A" the AIN socket is tied to the input of the VIN buffer. In this configuration, an analog signal applied to the Ain input socket is buffered and presented at the AD7476/77 VIN input. When this link is in position "B" the VIN buffer input is tied to A_{GND}.
LK12	This link selects the source of the V_{DD} supplied to the AD7476/77. When this link is in position "A" the V_{DD} must be supplied from an external source via J5. When this link is in position "B" the V_{DD} is supplied from the EVAL-CONTROL BOARD. When this link is in position "C" the V_{DD} is supplied from either the AD780 or the REF195 references.

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SET-UP CONDITIONS

Care should be taken before applying power and signals to the evaluation board to ensure that all link positions are as per the required operating mode. Table I shows the position in which all the links are set when the evaluation board is sent out.

Table I. Initial Link and Switch Positions

Link No.	Position	Function.
LK1	Removed	50W termination resistor is not applied to the input of the VIN circuit.
LK2	Removed	AD780 is set to provide a +2.5V reference.
LK3	Removed	50W termination resistor is not applied to the input of the bias-up circuit.
LK4	Removed	This is not relevant due to the position of LK12.
LK5	A	EVAL-CONTROL BOARD is selected as the DC bias voltage for the optional bias-up/filter circuit.
LK6	A	+12V supplied from EVAL-CONTROL BOARD via J4.
LK7	A	-12V supplied from EVAL-CONTROL BOARD via J4.
LK8	B	SCLK signal from EVAL-CONTROL BOARD is not inverted, (for faster values of SCLK).
LK9	B	SCLK signal from EVAL-CONTROL BOARD is not inverted, (for faster values of SCLK).
LK10	Removed	This is not relevant due to the position of LK8 and LK9, (As 74LS04 is not in use).
LK11	A	Ain SMB is connected to the input of the analog input buffer.
LK12	B	VDD for the AD7476/77 is supplied from the EVAL-CONTROL BOARD via J4.

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EVALUATION BOARD INTERFACING
Interfacing to the evaluation board is via a 96-way connector, J4. J4 is used to connect the evaluation board to the EVAL-CONTROL BOARD or other system. The pinout for the J4 connector is shown in Figure 2 and its pin designations are given in Table II.
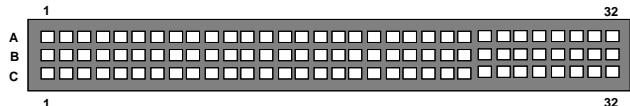

Figure 2. Pin Configuration for the 96-Way
Connector, J1

96-Way Connector Pin Description

DR0   Data Receive Zero. This input is connected to the SDATA pin of the AD7476/77.

TFS0/RFS0 Transmit/Receive Frame Sync Zero. These two outputs are connected to the $\overline{CS}$ pin of the AD7476/77.

SCLK0   Serial Clock Zero. This serial clock is connected to the SCLK pin of the AD7476/77 with the option of an inverting buffer.

DGND   Digital Ground. These lines are connected to the digital ground plane on the evaluation board. It allows the user to provide the digital supply via the connector along with the other digital signals.

AGND   Analog Ground. These lines are connected to the analog ground plane on the evaluation board.

AV_{DD} Analog +5 V Supply. These lines are connected to the AV_{DD} supply line on the board.

+12V   +12 V Supply. This line is connected to the +12 V supply line on the board via LK6.

-12V   -12 V Supply. This line is connected to the -12 V supply line on the board via LK7.

Table II. 96-Way Connector Pin Functions.

	Row A	RowB	RowC
1			
2			
3			
4	DGND	DGND	DGND
5			DR0
6	TFS0		RFS0
7	SCLK0		SCLK0
8			
9			
10			
11			
12	DGND	DGND	DGND
13			
14			
15			
16	DGND	DGND	DGND
17			
18			
19			
20	DGND	DGND	DGND
21	AGND	AGND	AGND
22	AGND	AGND	AGND
23	AGND	AGND	AGND
24	AGND	AGND	AGND
25	AGND	AGND	AGND
26	AGND	AGND	AGND
27		AGND	
28		AGND	
29	AGND	AGND	AGND
30	-12 V	AGND	+12 V
31			
32	AVDD	AVDD	AVDD

Note : The unused pins of the 96-way connector are not shown.

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SOCKETS

There are three input sockets relevant to the operation of the AD7476/77 on this evaluation board. The function of these sockets is outlined in Table III.

Table III. Socket Functions

Socket	Function
J1	Sub-Miniature BNC Socket for AIN analog input.
J2	Sub-Miniature BNC Socket for analog input to bias-up circuit.
J3	Sub-Miniature BNC Socket for analog output from bias-up circuit.

CONNECTORS

There are three connectors on the AD7476/77 evaluation board as outlined in Table IV.

Table IV. Connector Functions

Connector	Function
J4	96-Way Connector used to Interface to EVAL-CONTROL BOARD.
J5	External V_{DD} & A_{GND} power connector.
J6	External +12 V, -12 V & A_{GND} power connector.

OPERATING WITH THE EVAL-CONTROL BOARD

The evaluation board can be operated in a stand-alone mode or operated in conjunction with the EVAL-CONTROL BOARD. This EVAL-CONTROL BOARD is available from Analog Devices under the order entry "EVAL-CONTROL BOARD". When operated with this control board, all supplies and control signals to operate the AD7476/77 are provided by the EVAL-CONTROL BOARD when it is run under control of the AD7476/77 software which is provided with the AD7476/77 evaluation board package. This EVAL-CONTROL BOARD will also operate with all Analog Devices evaluation boards which end with the letters CB in their title.

The 96-way connector on the EVAL-AD7476/77CB plugs directly into the 96-way connector on the EVAL-CONTROL BOARD. No power supplies are required in the system. The EVAL-CONTROL BOARD generates all the required supplies for itself and the EVAL-AD7476/77CB. The EVAL-CONTROL BOARD is powered from a 12 V ac transformer. This is a standard 12 V ac transformer capable of supplying 1A current and is available as an accessory from Analog Devices under the following part numbers:

EVAL-110 VAC-US: For use in the U.S. or Japan

EVAL-220 VAC-UK: For use in the U.K.

EVAL-220 VAC-EU: For use in Europe

These transformers are also available for other suppliers including Digikey (U.S.) and Campbell Collins (U.K.).

Connection between the EVAL-CONTROL BOARD and the serial port of a PC is via a standard RS-232 cable which is provided as part of the EVAL-CONTROL BOARD package. Please refer to the manual which accompanies the EVAL-CONTROL BOARD for more details on the EVAL-CONTROL BOARD package.
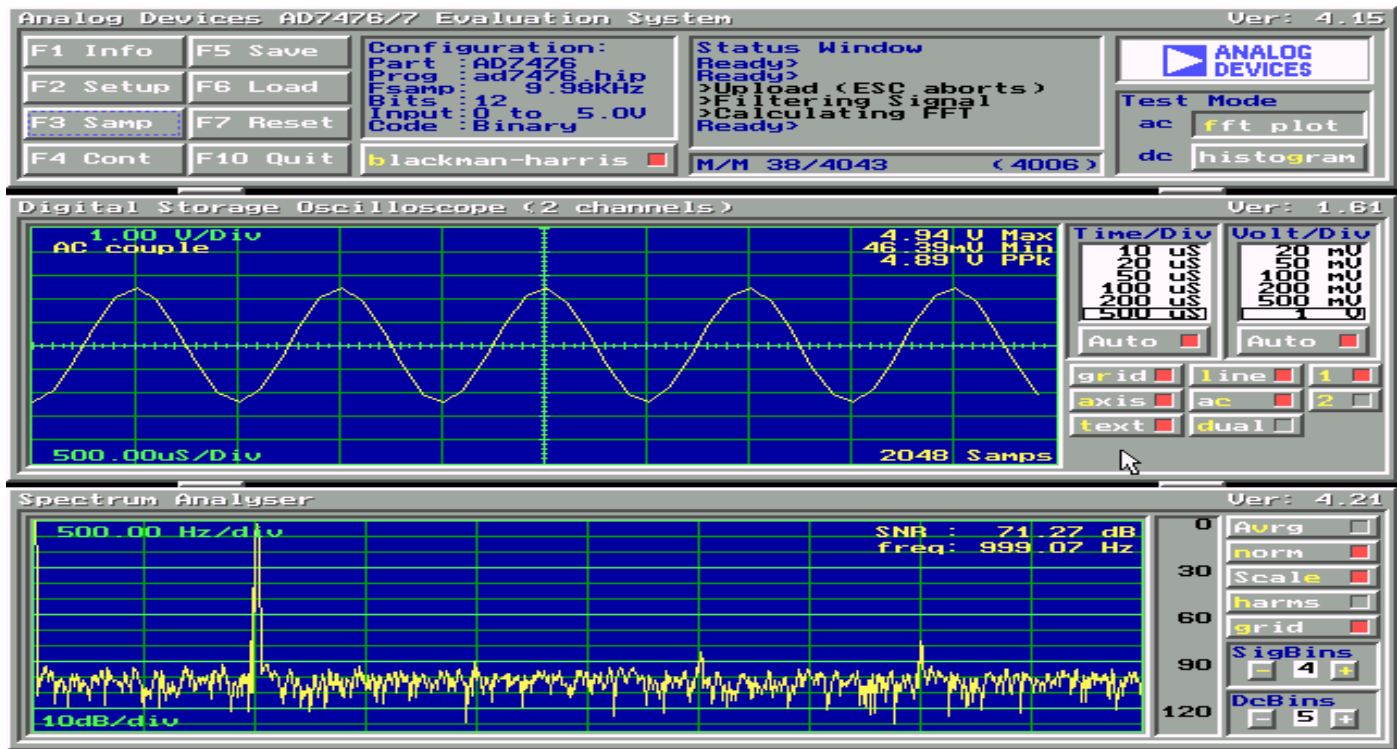
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Figure 3. Main Screen

SOFTWARE DESCRIPTION

Included in the EVAL-AD7476/77CB evaluation board package is a PC-compatible disk which contains software for controlling and evaluating the performance of the AD7476/77 when it is operated with the EVAL-CONTROL BOARD. The EVAL-AD7476/77CB Demonstration/Evaluation Software runs under DOS 4.0 or later and requires a minimum of a 386-based machine with 400kB of base RAM and 500kB of free hard disk space. The user interface on the PC is a dedicated program written especially for the AD7476/77.

The disk which accompanies the EVAL-AD7476/77CB contains several files. The user should create a new directory on the main PC drive and label this "AD7476/77". Then, all files on the EVAL-AD7476/77CB disk should be copied into this directory. The Mouse Driver on the PC should be enabled before running the software. If this has not been loaded, the program will not run.

To run the software, simply make the AD7476/77 directory the current directory and type "go". When the evaluation program starts, the user sees the screen shown on Figure 3 (without any FFT or scope waveforms). This is the main screen and it is divided into three parts. The top part provides the main control interface for the AD7476/77 evaluation software. The middle part of the main screen functions as a Digital Storage Oscilloscope and the bottom part of the main screen operates as either a Digital Spectrum Analyzer or a Histogram analyzer.

Each part of the screen has several buttons that can be pressed by using the mouse or the keyboard. To press a button using the mouse, simply use it to move the on-screen pointer to the button to be activated and click. To use the keyboard, simply press the appropriate key as highlighted on the button. Lower case letters must be used. When a button is pressed, it is highlighted on the screen. The next button can be highlighted by using the Tab key or the previous button by holding down the shift key and the Tab key together. The highlighted button can also be pressed by pressing the space bar. Pressing the ESC key halts any operation currently in progress. In this document, if a button can be activated from the keyboard then the key used is shown in bold in the button name. For example, "no **p**rog" has the "p" highlighted in bold, indicating that the button can be activated by pressing the p key.

Some buttons have a red indicator. A red indicator on the button means that the function associated with that button is on. Absence of the red indicator light means that the function associated with the button is off. The on/off status of these buttons is changed simply by selecting the button.

Setting up the EVAL-CONTROL BOARD

When the software is run, the **"F2** Setup" button in the top left of the screen should be selected to pop up the setup menu (see fig. 4). This menu sets up the EVAL-CONTROL BOARD for use with the EVAL-AD7476/77CB.

Firstly, a configuration file must be chosen. The configuration file contains the default configuration information for the EVAL-CONTROL BOARD, the Digital Spectrum Analyzer and the Digital Storage Oscilloscope. It also tells the AD7476/77.EXE software which .HIP file to download to the ADSP-2111. The .HIP file contains the DSP code which is executed by the ADSP-2111. Normally, the "no **p**rog" button is off, so when the configuration file is loaded, the .HIP file is automatically downloaded to the ADSP-2111. However, if the "no **p**rog" button is on, then the .HIP file is not downloaded to the ADSP-2111.

There are two configuration files for the AD7476. (these are AD7476 and AD7476D) and two for the AD7477 (these are AD7477 and AD7477D). Each file is particular to a certain mode of operation for the device. See modes of operation selection in the AD7476/77 datasheet. The AD7476 file is the normal mode program for the AD7476. This should execute when the **F3** button is pressed after the AD7476 configuration file has been loaded. When the button is pressed the conversion result will be output on to the screen as either an fft plot or as a historgram.

The AD7476 program also offers the user the option of entering the "**power down**" mode. This can done by entering the setup screen (see figure 4) and using the Power down button. As there will be no valid data from this operation, there will be no result on screen. To exit the **"powerdown"** mode the user must "**Power up**" the part before preforming a valid conversion. This can be done by again entering the setup screen and pressing the **"Power up"** button. As there is no valid data from this dummy conversion there is no result to be output on screen.

The AD7477 program offers the same options as the AD7476 program but it is configured for a 10 bit part (AD7477).

When the AD7476D configuration file is loaded it offers the user a "power up - convert - powerdown" sequence option. This program is ideal for use when the device is not being operated constantly, as it saves on power. The 12 bit result from the conversion is output on the screen as either an fft plot or a histogram.

To perform the same sequence (power up - convert - powerdown) on the 10 bit AD7477 part, the AD7477D configuration file should be used.

MAIN SCREEN

Figure 4. Setup Menu Screen

The top left part of the main screen contains eight buttons which are selected using the mouse or by using the function keys from the keyboard. These buttons and the actions they perform are:

F1: Info. This button shows information on the software.

F2: Setup. This button activates the setup menu.

F3: Samp. When this key is pressed, the software causes the AD7476/77 to perform a number of conversions as determined by the setup menu (see above). The data from these conversions is then analyzed by the AD7476/77 evaluation software. Another set of samples may be taken by pressing the **F3** key again.

F4: Cont. Pressing this button causes the software to repeatedly perform conversions and analyze them. Once the conversions and analysis has been done for one set of samples, the software automatically repeats

the process. It continues to do this until the ESC key is pressed.

F5: Save. This saves a set of samples to a file for use either at a later date or with other software. The samples can be saved either as "volts", "ints" or "binary". The format of all these files is ASCII text. Note that the AD7476/77 software can only load files saved in the "ints" format. Files saved in the "volts" and "ints" formats can be used with packages such as Mathcad. Files saved in the "binary" format are for viewing purposes only.

F6: Load. This allows the user to load data from a file with a .DAT extension. Only data that was saved as ints can be loaded and analyzed. A configuration file must be loaded via the **"F2** Setup" menu before the data file can be analyzed. If there is no EVAL-CONTROL BOARD connected to the PC, then the "no **p**rog" button in the **"F2** Setup" menu must be on. Once a configuration file has been loaded, the data loaded from the .DAT file is analyzed according to the settings in the **"F2** Setup" menu.

F7: Reset. Choosing this option resets the EVAL-CONTROL BOARD.

F10: Quit. This quits the AD7476/77 evaluation software and returns control to the operating system.

INFORMATION WINDOWS
There are three information windows at the top of the main screen. The left-hand window is the configuration window and gives details about part being evaluated. It shows the name of the program that has been downloaded to the EVAL-CONTROL BOARD, the sampling frequency, the number of bits, the analog input range of the part and the output code format of the part. The right-hand large window is the Status window. This window provides feedback to the user as to what operations are currently being performed by the software and also displays error messages. Directly underneath the status window is a small window that shows the selected conversion sequence and the maximum and minimum values of the most recently captured samples for all channels in the conversion sequence.

Test Mode
At the top right of the main screen are the Test Mode buttons. These buttons determine what sort of testing is done on the samples captured by the software. Both an ac analysis and dc analysis can be performed. The function of these buttons are:

fft plot Choosing this button causes the Digital Spectrum Analyzer to appear at the bottom of the screen.

Histo**g**ram: Choosing this button causes the Histogram Analyzer to be displayed at the bottom of the screen.

There is one other button near the top of the screen, beside the **"F10** Quit" button. This is:

blackman-harris: When performing a Fourier transform of the sampled data, this button determines whether or not the data is windowed by a blackman-harris window before the transform. When this button is on, the data is windowed. When this button is off, the data isn't windowed. See the Digital Spectrum Analyzer section for more details.

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DIGITAL STORAGE OSCILLOSCOPE.
When samples of data are captured, they are displayed on the Digital Storage Oscilloscope. If the **b**lackman-harris button is turned on then the windowed data is also displayed on the oscilloscope. The 'scope has been designed to act in a similar way as a conventional oscilloscope. To the right of the oscilloscope are several buttons that control the manner in which data is displayed on the 'scope. The timebase for the oscilloscope is automatically chosen by the software if the Time/Div "Auto" button is on. The user can also select the timebase by clicking in the Time/Div window and scrolling up and down through the possible timebases. Similarly, the vertical scale of the oscilloscope is chosen automatically if the Volt/Div "Auto" button is on. The user also has the option of selecting the desired vertical scale in a similar manner to selecting the timebase.

The other buttons associated with the oscilloscope are:

grid   This button toggles the grid display of the oscilloscope on and off.

axis   This button toggles the axis display of the oscilloscope on and off

text   This button toggles the text displayed on the oscilloscope screen on and off.

line   When the line button is on, the displayed samples are joined together by lines. When this button is off, the samples are displayed as points.

a**c**   When this button is on, the dc component of the sampled signal is removed and the signal is displayed. This has the effect of centering the signal vertically on the oscilloscope screen. When this button is off, the dc component is not removed and the signal is displayed with its horizontal axis corresponding to a code of 0. The **ac** display option is useful for zooming in on a low-level signal that has a large dc offset.

dual   When the **"d**ual" button is on, the oscilloscope screen is divided into two parts with the sampled data display centered on one horizontal axis and the windowed data display centered on another. When the **"d**ual" button is off, both traces are centered on the same horizontal axis.

1   This button toggles the sampled data trace on and off.

2   This button toggles the windowed data trace on and off.

HISTOGRAM ANALYZER
The histogram analyzer counts the number of occurrences of each code in the captured samples and displays a histogram of these counts. The most frequently occurring code is displayed in the center of the histogram. The analyzer is normally used with a dc input signal and calculates the mean and the standard deviation of the sampled data. The mean and standard deviation are displayed in both volts and in units of the lsb size of the converter. The histogram gives a good indication of the dc noise performance of the ADC. The standard deviation shows directly the noise introduced in the conversion process.
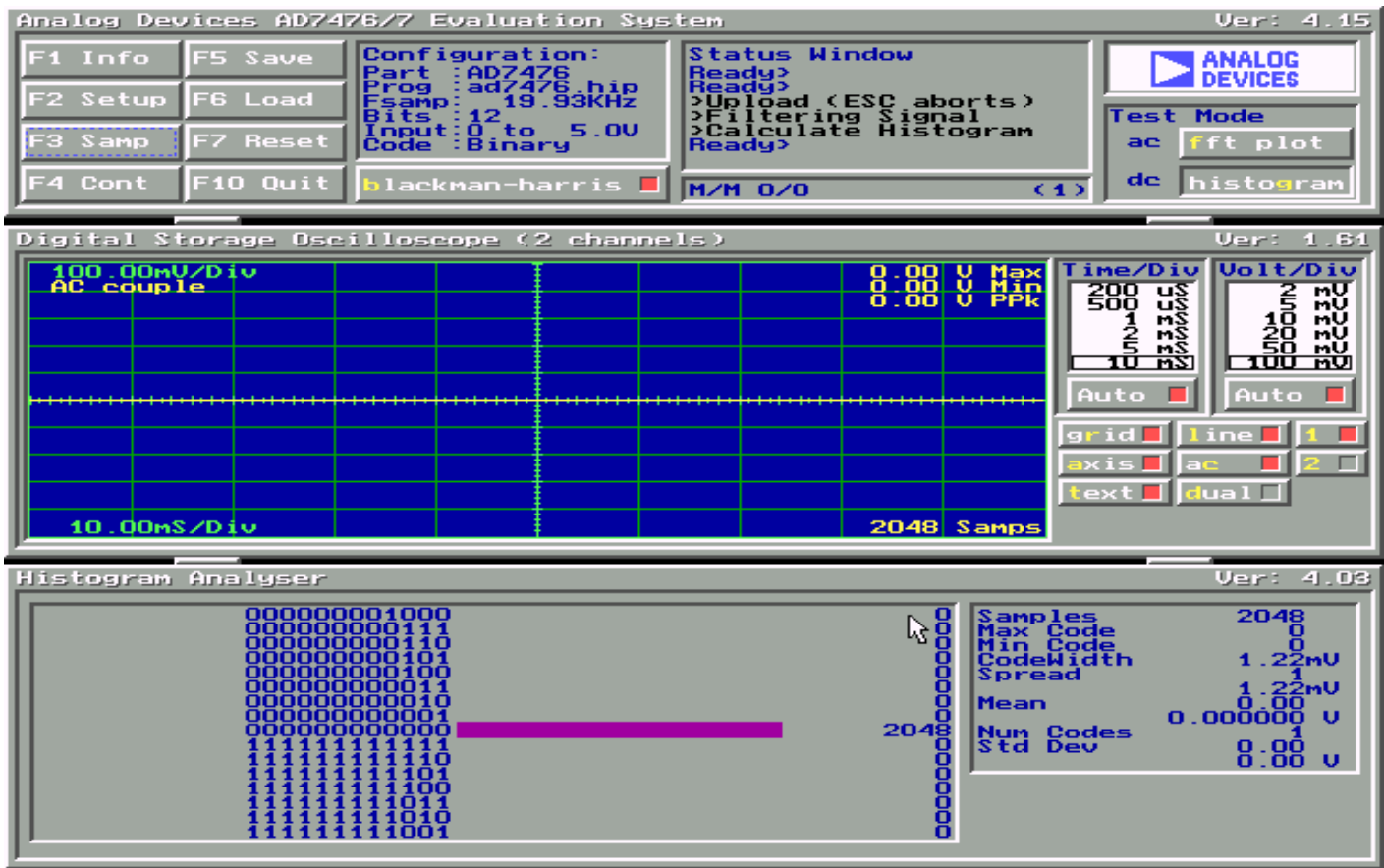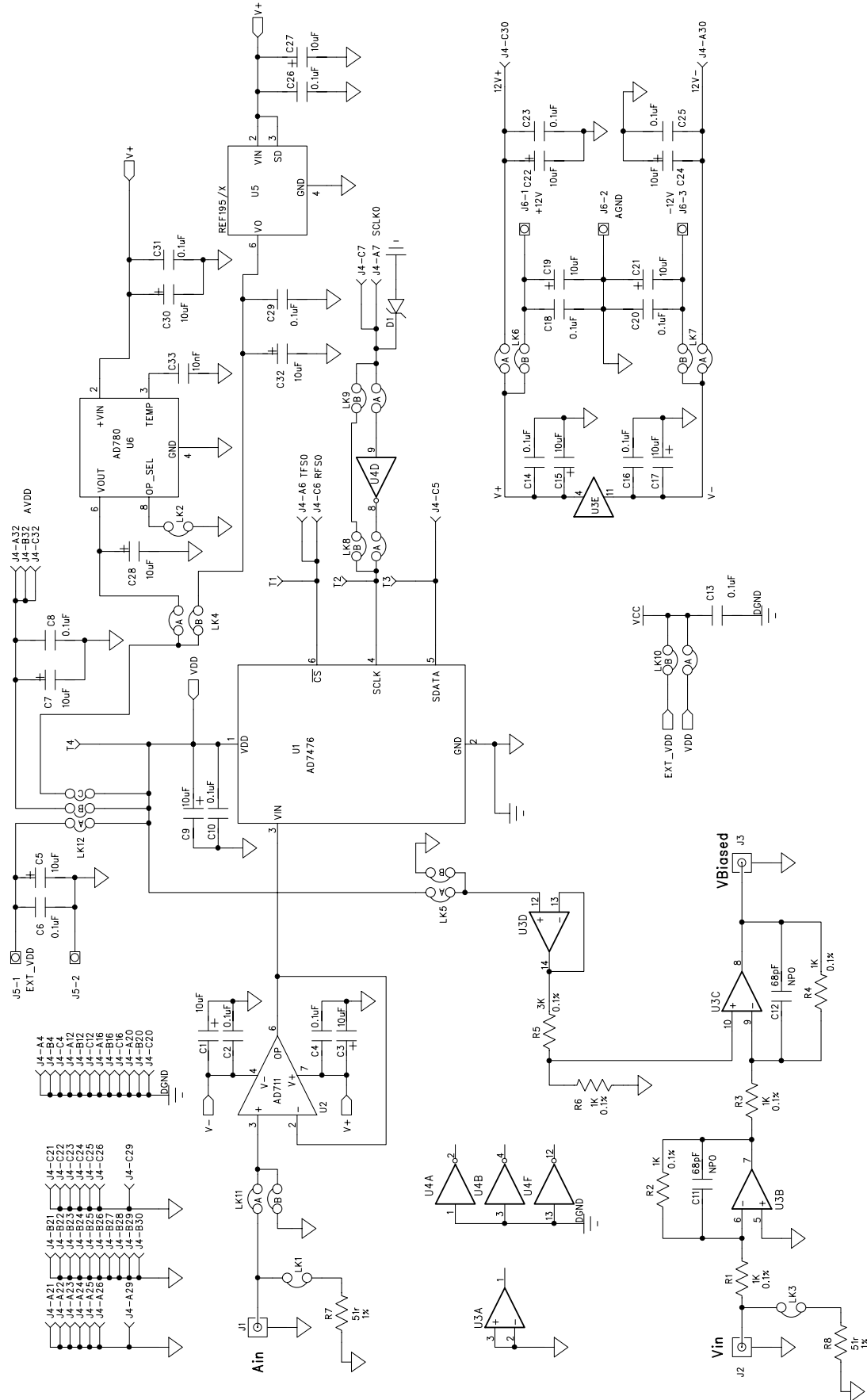

Figure 5 Histogram Screen

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Figure 6. AD7476/77 Evaluation Board Circuit Diagram

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Table V. AD7476/77 Evaluation Board Bill Of Materials

| Qty.	Reference Designator	Description/Value	Manuf. No.	Supplier No.
1	U1	AD7476ART/AD7477ART	ADI AD7476ART/77ART	ADI
1	U2	AD711KN	ADI AD711KN	ADI
1	U3	ADOP467G	ADI ADOP467G	ADI
1	U4	74LS04	DM74LS04N	FEC 373-450
1	U5	ADREF195G	ADREF195GP	ADI
1	U6	AD780AN	ADI AD780AN	ADI
5	R1 - R4 R6	1K 0.25W 0.1% RC55	Welwyn	FEC 339-179
1	R5	3K 0.25W 0.1% RC55	Welwyn	FEC 339-635
2	R7 R8	51W 0.25W 1%	Multicomp	FEC 543-070
1	C10	0.1uF Ceramic 1206 Case	12065C104KATDA	FEC 895-210
1	C9	10uF 20 V TAJ-C Case	TAJC106K020X	FEC 498-798
2	C11 C12	68pF Ceramic	MR051A680JT0001	FEC 669-714
1	C33	0.01uF Ceramic 50 V	MCDR25103X7RK0050	FEC 750-890
14	C2 C3 C5 C8 C13 C14 C16 C18 C20 C23 C25 C26 C29 C31	0.1uF Ceramic 50 V	MCDR25104X7RK0050	FEC 750-920
15	C1 C4 C6 C7 C9 C15 C17 C19 C21 C22 C24 C27 C28 C30 C32	10uF 35 V Tant.	TAP10K35CCSY	FEC 664-881
3	J1 J2 J3	50W Gold Plated SMB	MA-com	FEC 310-682
1	J4	DIN41612 C96 900 plug	Harting 0903-196-7921	FEC 104-986
1	J5	2 Pin Power Connector	Lumberg KRM2	FEC 151-785
1	J6	3 PIN Power Connector	Lumberg KRM3	FEC 151-786
3	LK1 LK2 LK3	2 Way Jumper	Harwin	FEC 511-705
8	LK4 - LK11	2x2 Way Jumper	Harwin	FEC 511-780
1	LK12	2x3 Way Jumper	Harwin	FEC 511-780
12	LK1 - LK12	Shorting links	Harwin	FEC 150-410
4	T1 T2 T3 T4	White Testpoint	Keystone Cat. No. 5002	Futura Elect.
5	U2 U3 U4 U5 U6	Ultra low profile socket pins	Harwin	FEC 519-959
4	Each Corner	Rubber Stick on feet	3M	FEC 148-922
1		EVAL-AD7476CB		P.C.B.
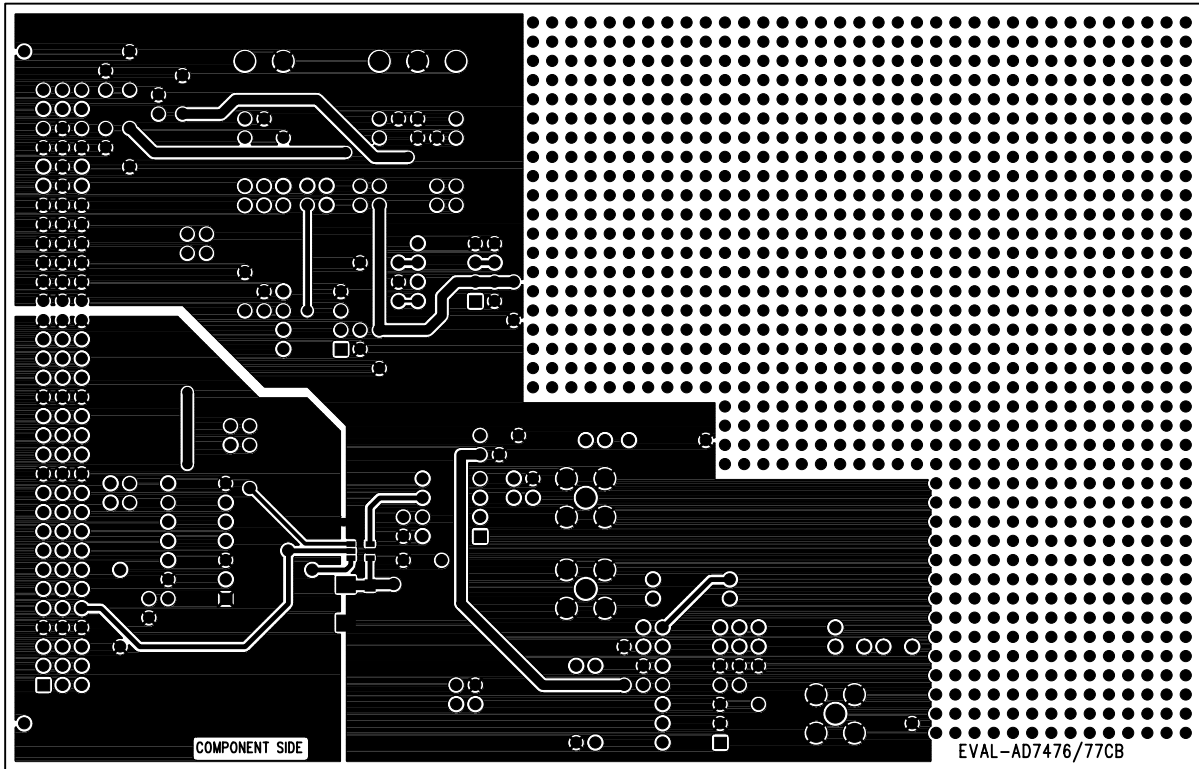
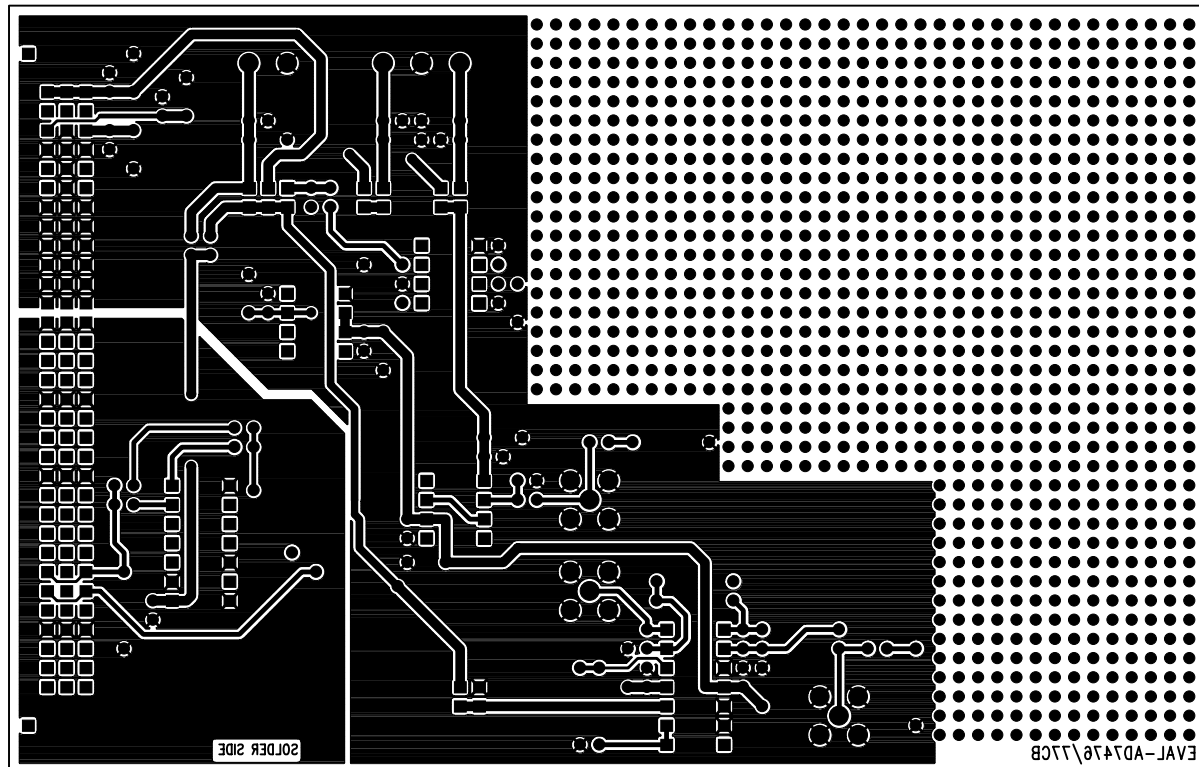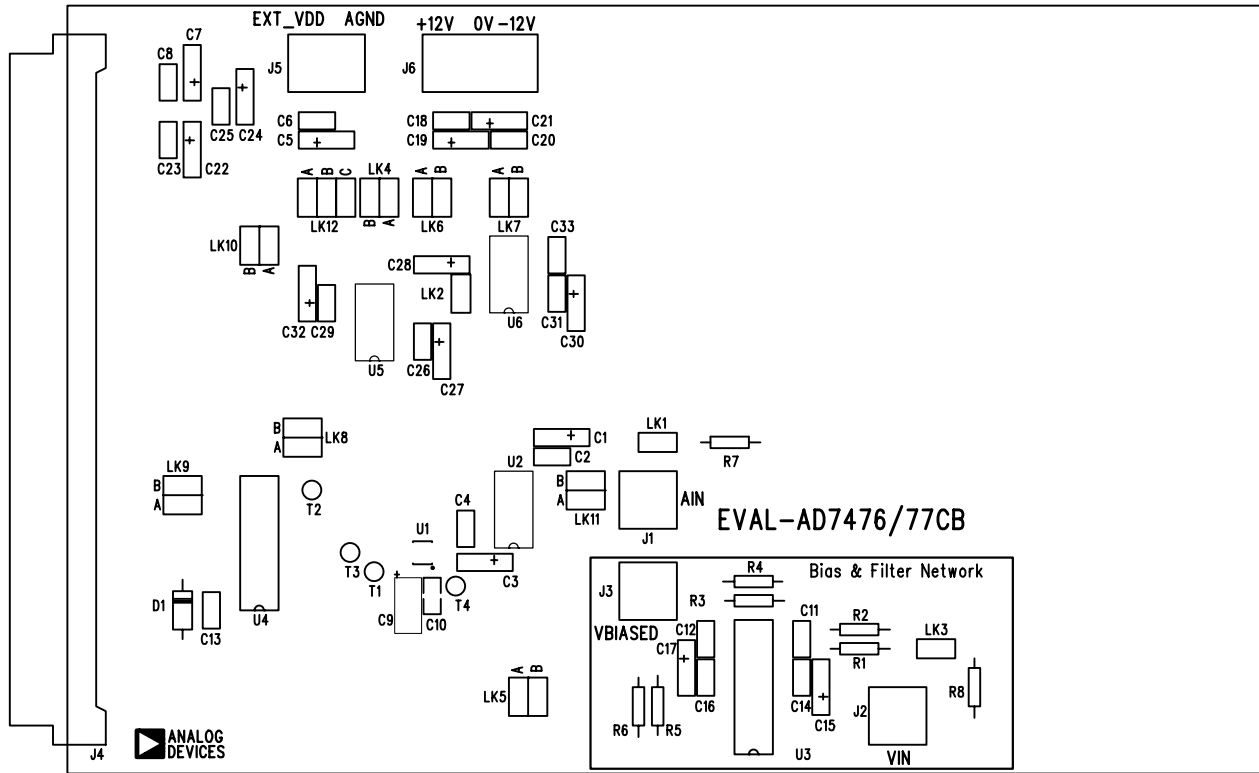*Figure 7. Component Side Artwork*

Figure 8. Solder Side Artwork

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Figure 9. AD7476/77 Component Placement Drawing.

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