Evaluation Board for Single Supply, 12/16-Bit 312.5/468.75 kHz Σ-Δ ADC

EVAL-AD7721CB

FEATURES

Full-Featured Evaluation Board for the AD7721
EVAL-CONTROL BOARD Compatible
Stand Alone Capability
On-board Analog Filtering 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 AD7721. The AD7721 is a complete, low power, 12/16-bit, sigma-delta ADC which operates from a 5V power supply. The device consists of a modulator and 2 FIR filters which filter and decimate the modulator output. Its versatile interface structure allows both serial and parallel connection to a microprocessor, the device connecting directly to Analog Devices, Motorola and Texas Instruments DSPs. Full data on the AD7721 is available in the AD7721 data sheet available from Analog Devices. The data sheet should be consulted in conjunction with this Technical Note when using the Evaluation Board.

OPERATING THE AD7721 EVALUATION BOARD

The EVAL-AD7721CB can be used as a stand-alone unit or with the EVAL-ControlBoard which is available from Analog Devices under the order entry "EVAL-CONTROL BRD2". A 96-way DIN connector (J3) interfaces the EVAL-AD7721CB directly to the Eval-Control Board. Software is provided with the evaluation board package to allow analysis of the ADCs performance when using the Eval-Control board.

AD7721 EVALUATION BOARD FEATURES

On-board components include an AD780 precision bandgap voltage reference and opamps to condition the analog input and configure it to drive the AD7721 with single-ended or complimentary input signals.

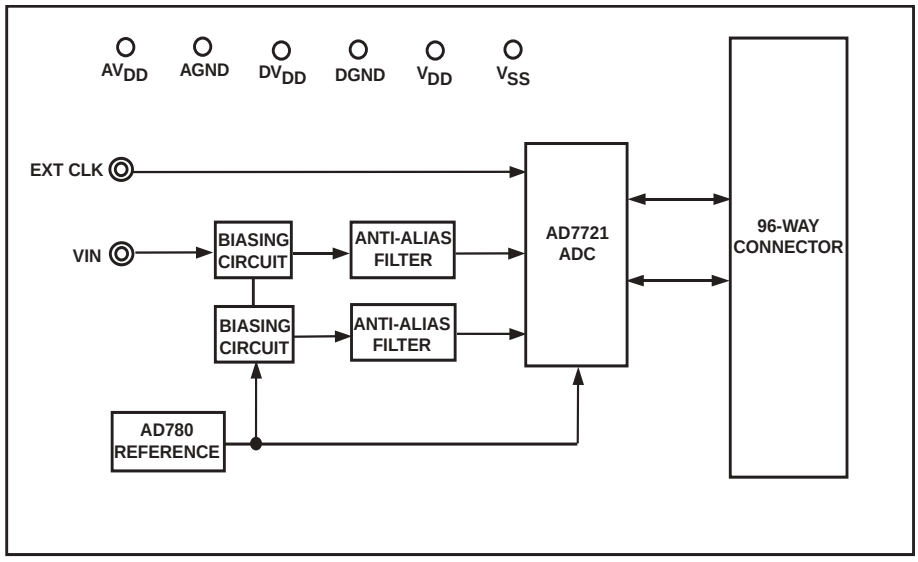
Power Supplies

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 four analog power supply inputs: AV_{DD}, A_{GND}, V_{DD} and V_{SS}. AV_{DD} is used to provide 5 V for the AD7721 and VIN for the AD780 voltage reference. The V_{DD} and V_{SS} power supplies are used to power the operational amplifiers which form the anti-alias filters. These power supplies can be applied externally by the user or they can be obtained from the Eval-Control board via the 96-way edge connector. The supplies available from the Eval-Control board are +5 V to power the AD7721 and reference and +12 V/-12 V to drive the operational amplifiers. D_{GND} and DV_{DD} connections are also available. The DV_{DD} is used to provide the DV_{DD} for the AD7721. D_{GND} and A_{GND} are connected at the AD7721 so it is not recommended to connect them else where in the system.

All power supplies are decoupled to ground. The power supplies are decoupled using 22µF tantalum capacitors in parallel with 10nF ceramic capacitors.

FUNCTIONAL BLOCK DIAGRAM



REV. A

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LINK OPTIONS

There are 13 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 selects the V_{DD} supply for the operational amplifiers. When using the Eval-Control Board, +12V can be provided by the Eval-Control Board by inserting this link. Alternatively, the V_{DD} supply can be provided by the user via a PCB mounting terminal block. In this case, this link is removed.
LK2	This link selects the DV_{DD} supply for the AD7721 and AND gate. When using the Eval-Control Board, DV_{DD} can be provided by the Eval-Control Board by inserting this link. Alternatively, the DV_{DD} supply can be provided by the user via a PCB mounting block. In this case, this link should be removed.
LK3	This link selects the V_{SS} supply for the operational amplifiers. When using the Eval-Control Board, V_{SS} can by provided by the Eval-Control Board by inserting this link. Alternatively, the V_{SS} supply can be provided by the user via a PCB mounting terminal block. In this case, this link is removed.
LK4	This link selects the bias voltage for the analog input, VIN1. VIN2 is hardwired to $V_{REF}/2$. With this link in position A, VIN1 is biased up by V_{REF}. When a signal of value $\pm V_{REF}/2$ is applied to the SMB connector VIN, biasing of this signal by V_{REF} will be equivalent to applying a unipolar signal of value 0 V to V_{REF}. If the analog input signal, VIN1, can by biased by the user, then this link can be removed so that no biasing of VIN1 is performed on the AD7721 evaluation board.
LK5	This link should not be used. It should be removed permanently.
LK6	This link selects the reference for the AD7721. With this link removed, the reference voltage is 2.5 V. With this link inserted, the reference voltage is 3 V.
LK7	This link is used to connect the $\overline{WR}$ line to ground for serial operation.
LK8	This link selects the AV_{DD} supply for the AD7721 and the reference. When using the Eval-Control Board, AV_{DD} can be provided by the Eval-Control Board by inserting this link. Alternatively, the AV_{DD} supply can be provided by the user via a PCB mounting terminal block.
LK9	This link is used to connect the $\overline{RD}$ line to ground for serial operation.
LK10	This link is used to select the logic state of the $\overline{SYNC}$/DB5 pin. In serial mode, this pin operates as a $\overline{SYNC}$ pin. $\overline{SYNC}$ needs to be tied to DV_{DD}. With this link in position B, $\overline{SYNC}$ is pulled to DV_{DD} via a pull-up resistor.
LK11	This link is used to connect $\overline{DRDY}$ to $\overline{RFS}$. In serial mode, $\overline{DRDY}$ drives the $\overline{RFS}$ input. This is achieved by inserting this link.
LK12	This link is used to select the source for the master clock to the AD7721 (CLK). When using the Eval-Control board, a clock of 8MHz is available from serial port 1. With this link inserted, this 8MHz clock can be used.
LK13	This link sets the state of the $\overline{UNI}$/DB2 pin when in serial mode. When this link is in position B, the $\overline{UNI}$/DB2 line is pulled to DV_{DD} so that the analog input to be used is bipolar with an amplitude of ±1.25 V. When this link is in position A, the, the $\overline{UNI}$/DB2 line is pulled to D_{GND} so that the analog input to be used is unipolar of magnitude 0 V to 2.5 V.

SETUP 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 packaged.

Table I. Initial Link Positions

Link No.	Position	Function.
LK1	IN	This link is inserted so that the V_{SS} for the Operational Amplifiers is provided by the Eval-Control Board via the 96-way edge connector.
LK2	IN	This link is inserted so that the DV_{DD} for the AD7721 is provided by the Eval-Control Board via the 96-way edge connector.
LK3	IN	This link is inserted so that the V_{DD} supply for the Operational Amplifiers is provided by the Eval-Control Board via the 96-way edge connector.
LK4	B	The input signal is biased up around $V_{REF}/2$.
LK5	OUT	This link is not used.
LK6	OUT	This link is removed so that V_{REF} = 2.5V.
LK7	IN	This link is inserted so that $\overline{WR}$ is tied to $D_{GND.}$
LK8	IN	This link is inserted so that AV_{DD} for the AD780 and the AD7721 is provided by the Eval-Control Board via the 96-way Edge Connector.
LK9	IN	This link is inserted so that $\overline{RD}$ is tied to ground.
LK10	B	$\overline{SYNC}$ is tied to DV_{DD} via a pull-up resistor.
LK11	IN	This link is inserted so that $\overline{DRDY}$ is tied to $\overline{RFS}$.
LK12	IN	This link is inserted so that the master clock is provided by the Eval-Control Board via the 96-way edge connector.
LK13	B	The AD7721 is setup to accept a bipolar analog input.

CONNECTORS

There are five connectors on the AD7721 evaluation board as outlined below in Table II.

Table II. Connector Functions

Connector	Function
J1	PCB Mounting Terminal Block. The Analog Power Supply for the Operational Amplifiers can be provided via this connector.
J2	PCB Mounting Terminal Block. The Analog Power Supply to the AD7721 can be provided via this connector.
J3	96-way Connector for Serial Interface Connections.
J4	PCB Mounting Terminal Block. The Digital Power Supply for the AD7721 can be provided via this connector

SWITCHES

There is one switch on the AD7721 evaluation board. This switch is a normally open push button switch. This switch can be used to initiate a calibration as an alternative to using a flage from the microprocessor.

SOCKETS

There are two sockets relevant to the operation of the AD7721 on this evaluation board. The function of these is shown in Table III.

Table III. Socket Functions

Socket	Function
VIN	Sub-miniature BNC socket for VIN1
EXT CLK	Sub-miniature BNC socket for an externalMaster Clock input

INTERFACING TO THE EVAL-AD7721CB

The Eval-AD7721CB evaluation board is designed to be interfaced to the Eval-Control Board or to operate as a stand alone unit in serial mode.

Eval-Control Board

The Eval-Control Board is available from Analog Devices under the order entry "EVAL-CONTROL BRD2". When operated with this control board, all supplies and control signals to operate the AD7721 are provided by the Eval-Control Board when it is run under control of the AD7721 software, which is provided with the AD7721 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-AD7721CB 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-AD7721CB. The Eval-Control Board is powered from a 12V ac transformer. This is a standard 12V ac transformer capable of supplying 1A current and is available as an accessory from Analog Devices under the following part numbers:

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

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

EVAL-220VAC-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.

Interfacing the EVAL-AD7721CB to the Eval-Control Board

Interfacing the Eval-AD7721CB to the Eval-Control Board is via a 96-way connector, J3. The 96-way connector on the evaluation board plugs directly into the 96-way connector on the Eval-Control Board. The pinout for the J3 connector is shown in Figure 1, the used pin descriptions are in Table IV and the pin designations are given in Table V.

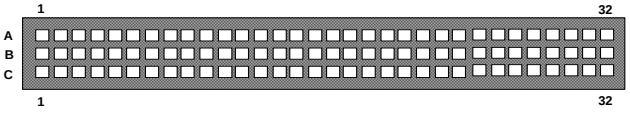

Figure 1. Pin Configuration for the 96-Way Connector, J3

Table IV. 96-Way Connector Pin Description

Pin	Description
DGND	Digital Ground. These lines are connected to the digital ground plane on the evaluation board. This allows the user to provide the digital supply via the connector along with other digital signals.
AGND	Analog Ground. These lines are connected to the analog ground plane on the evaluation board.
AVDD	Analog +5V Supply. These lines can be connected to the AV_{DD} and the DV_{DD} supply lines on the evaluation board via links, if required.
$\overline{SYNC}$	Synchronization Input. This input can be driven by a flag from the Eval-Control Board.
STBY	Standby. When STBY is taken low, the AD7721 will be placed in standby mode. This pin can be driven by a flag output pin from the Eval-Control Board.
CLK	Master Clock Input. The master clock to the AD7721 can be provided on this input. When the evaluation board is being interfaced to the Eval-Control Board, the serial clock of serial port 1 of the Digital Signal Processor can be input on this pin. Alternatively by removing LK12, the user can provide the master clock via the SMB connector EXT CLK if a higher master clock frequency is required.

Pin	Description
SDATA	Serial Data Ouput. The digital word from the A/D conversion is available on this pin. In serial mode, the digital word will be 16-bits wide. The serial data is clocked out by the rising edg of SCLK and is valid on the falling edge of SCLK for 16-edges following the $\overline{DRDY}$ pulse.
$\overline{DRDY}$	Data Ready. When a conversion has been completed and a digital word is available to be read from the AD7721, $\overline{DRDY}$ goes high for one CLK cycle. $\overline{DRDY}$ can be used to drive the $\overline{RFS}$ pin of the Digital Signal Processor. In serial mode, $\overline{DRDY}$ is connected to pin $\overline{RFS}$ of the AD7721 also by inserting LK11.
SCLK	Serial Clock. The serial clock, which has a frequency equal to CLK, is available on this pin. This clock is used as the serial clock when interfacing to the serial port of the Digital Signal Processor.
CAL	Calibration. To initiate a calibration, the CAL pin is taken high. A flag output can be used to drive this pin. When using the Eval-Control Board, a flag output pin is used to control the CAL pin.
DVAL	Data Valid. This pin is used to indicate that an overvoltage has been applied to the AD7721. When the analog input to the AD7721 exceeds the permissable range, DVAL goes low. This output remains low while the modulator of the AD7721 is reset. When using the Eval-Control Board, DVAL is connected to an interrupt so that when invalid data is being output from the AD7721, the Digital Signal Processor will stop reading the digital data. DVAL is also available on another pin, this pin being connected to a flag input when the Eval-Control Board is used. The purpose for this is to allow the Eval-Control Board to monitor the status of the DVAL pin so that the Digital Signal Processor can commence reading the digital data once the modulator has reset and begun outputting valid data.

Table V. 96-Way Connector Pin Functions.

.	RowA	RowB	RowC
1	STBY	$\overline{SYNC}$	DVAL
2			
3	CLK		
4	DGND	DGND	DGND
5			SDATA
6			$\overline{DRDY}$
7			SCLK
8			
9			
10			
11			
12	DGND	DGND	DGND
13			
14			
15			
16	DGND	DGND	DGND
17	CAL		$\overline{DVAL}$
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	VSS	AGND	VDD
31			
32	AVDD	AVDD	AVDD

Note: Unused pins 0f the 96-way connector ar not shown

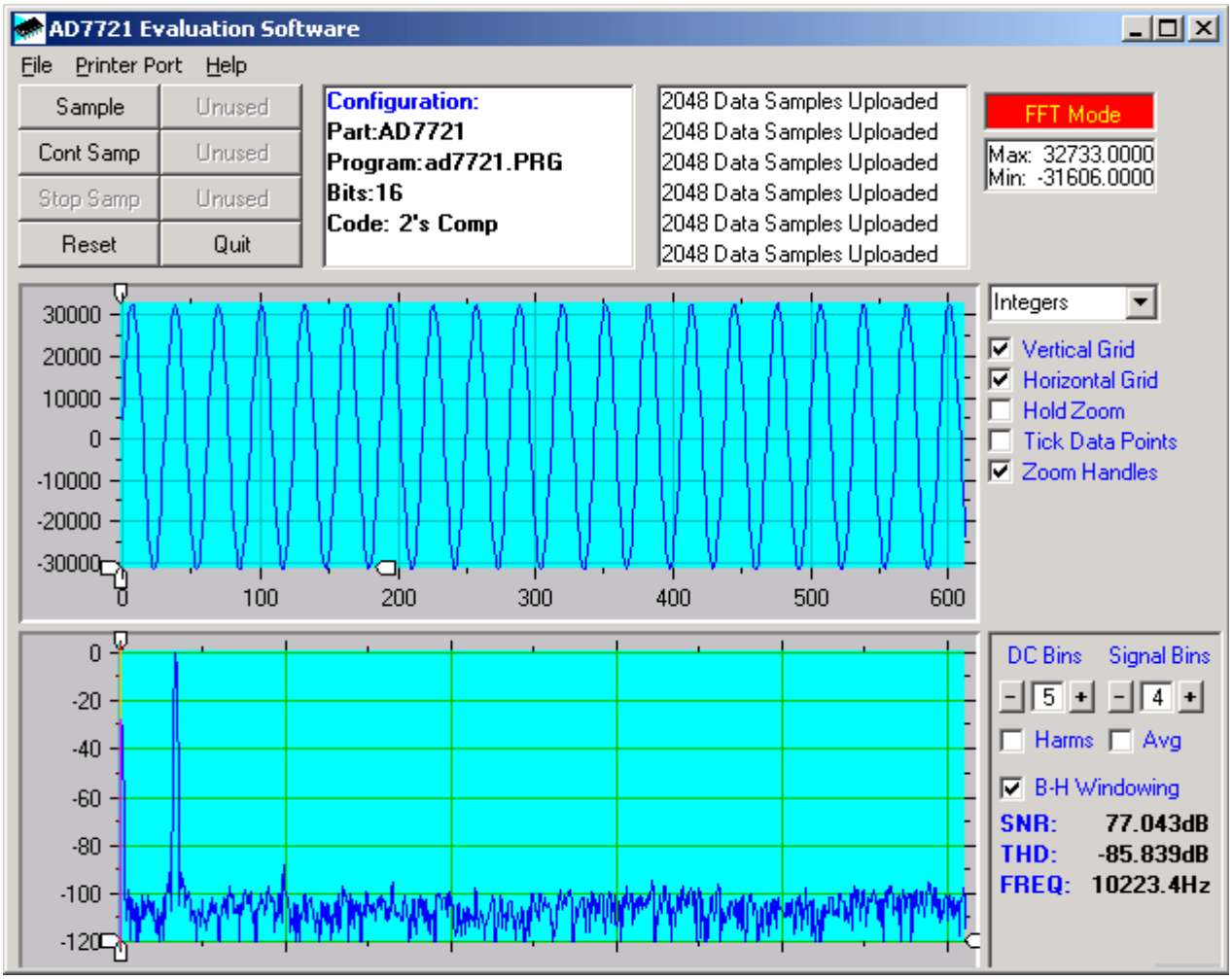

Figure 2. Main Screen - FFT Mode

SOFTWARE DESCRIPTION

The software which controls the Eval-Control Board and hence the AD7721 evaluation board has three main screens. The screen shown in Figure 2 is the screen which appears when the software is run. The main function of this screen is to allow the user to read a predetermined number of samples from the AD7721 evaluation board and display them in both the time and frequency domain.

The screen can be divided into three sections. The upper third of the screen contains the control buttons, the menu bar and various status windows. The **control buttons** allow the user to take samples, reset the part and quit the program. The **menu bar** allows the user to enter the setup menu, select which printer port is being used to control the Eval-Control Board, load and save samples, get information about the software etc. The **status windows** indicate the setup of the AD7721 evaluation board/device, number of samples taken, and any information/error messages that are generated.

The middle third of the screen is a Digital Storage Oscilloscope (DSO). When samples are uploaded from the Eval-Control Board, they are displayed here. The samples can be displayed as either integer values or as voltages. Once samples have been displayed, clicking at any point in the graph will display the sample number and the value of the point directly beneath the cursor. Along the axis of the graph are the **Zoom Handles**. These allow the user to zoom in and out to get a closer look at a particular sample if required. When another set of samples is taken, the graph will attempt to display all values collected unless the **Hold Zoom** check box is ticked. In this case, the graph will keep the same axis settings as for the previous set of data samples. Additional check boxes are provided to give the user control over the vertical and horizontal grids and data points.

The lower third of the screen will show either a Fast Fourier Transform (FFT) of the data or a Histogram which shows the number of occurrences of each particular code read back. The FFT (the default option) is typically used when the user is concerned with examining an ADC's performance in the frequency domain. When performing a Fourier Transform, the data can be windowed by a Blackman-Harris window before the transform by clicking the B-H box. When the B-H box is not clicked on, the data is not windowed. The Histogram will give an indication of the ADC's performance to DC signals. The option displayed can be toggled by clicking on the FFT Mode/Histogram Mode button in the top right of the screen. Figure 3 shows how the main screen looks when the Histogram option is selected.

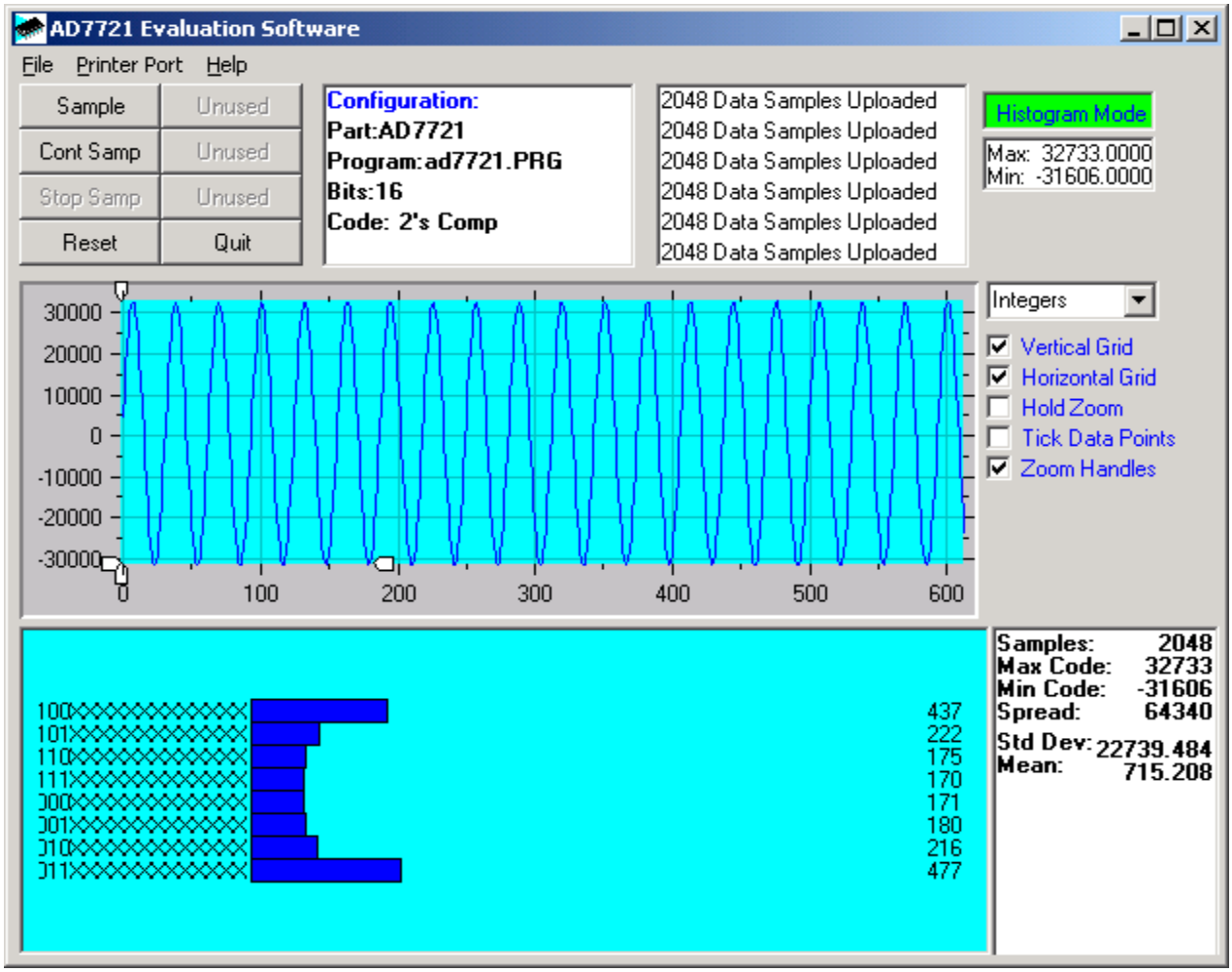

Figure 3. Main Screen - Histogram Mode

SETUP SCREEN

The Setup Screen is responsible for allowing the user to load a configuration file for the evaluation board. The configuration file will give the software detailed information about the evaluation board and the part connected to the Eval-Control Board such as number of bits, maximum sampling rate, power supply requirements, etc. The configuration file also tells the software the name of the DSP program file which it should download to the Eval-Control Board, the default and maximum sample frequencies, the number of samples to take and the power supply settings to use. These files are supplied by Analog Devices with the evaluation board and the AD7721 configuration file (AD7721.cfg) is shown in Listing 1. Figure 4 shows the setup screen.

```
[EVAL-CONTROL BOARD]
partname:AD7721
programname:ad7721.PRG

clockfrequency:10000000
samples:2048


+/-15V:on
dvdd:5:on
avdd:5:on
bus:on
;options 2scomp, binary
dataformat:2scomp
numberofbits:16
inputVmax:1.25
inputVmin:-1.25
[endofcfg]
```

Listing 1. Software configuration File.

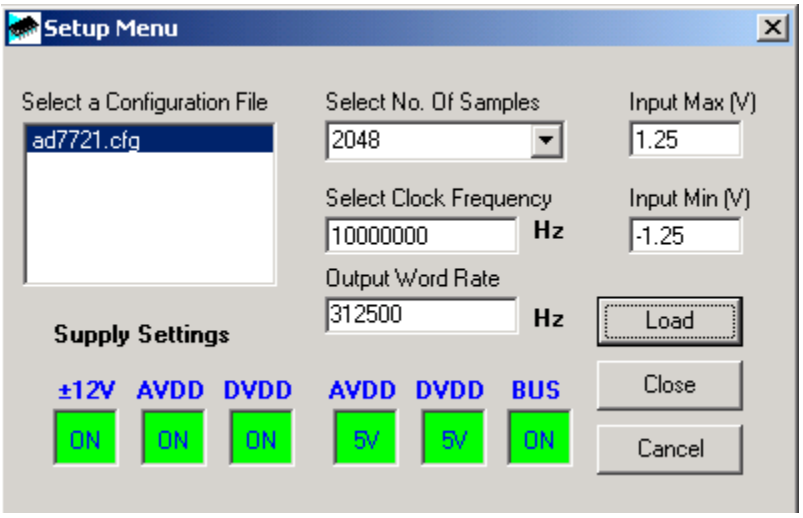

Figure 4. Setup Menu Screen

SETTING UP THE EVAL-CONTROL BOARD

The Eval-Control Board and AD7721 evaluation board should be connected together via the 96-way connector. The power should be applied to the Eval-Control Board. At this stage, the red LED should be flashing which indicates that the Eval-Control Board is functional and ready to receive instructions. The software which should have been installed should be loaded before the printer port cable is connected between the Eval-Control Board and the PC. This will ensure that the printer port has been initialized properly. The printer port cable can then be connected between the PC and the Eval-Control Board.

RUNNING THE SOFTWARE

With the hardware setup, the user is ready to use the AD7721 evaluation board with the Eval-Control Board. In the software, the user should select the **File** menu and click on **Setup**. This will display the setup form. A window on the left of the setup form lists all the available configuration files. The configuration file is a text based file which contains information about the AD7721 evaluation board such as part name, number of samples to be taken, default and maximum sampling frequency power supply settings, etc. The configuration file also contains the name of the DSP program file which is to be downloaded to the Eval-Control Board. The user should select the configuration file and click **Load**. The Eval-Control Board will be reset and the DSP program will be downloaded. During the download, the power supply settings indicated in the configuration file are set and the user may hear some relays clicking. The pulldown menu items such as 'number of samples' and 'sampling frequency' will have been set to the default values specified by the configuration file. The user is free to change these at will. Once the settings have been decided, the user can click **Close** to return to the main form.

TAKING SAMPLES

When the user clicks **Sample**, the software will instruct the Eval-Control Board to take the required number of samples at the required frequency from the AD7721 evaluation board. These samples are then uploaded and displayed. An FFT and Histogram are also calculated and displayed. If the user clicks **Cont Samp**, the software will repeat the process indefinitely until the user clicks **Stop Samp**. While the software is continuously sampling data, the other control buttons are disabled.

OTHER BUTTONS

The **Reset** button will cause the Eval-Control Board to perform a reset function. When this occurs, the power supplies are turned off and the program in DSP memory is lost. The user should repeat the setup instructions to download another configuration file, if required.

The **Quit** button will exit the software. The program running on the Eval-Control Board is not terminated.

MENU BAR ITEMS

The main screen of the program contains a number of options available as pulldown menu items. The functions of these are listed below.

File Menu

Setup Menu: Selecting this option displays the Setup Screen as shown in Figure 4.

Load Raw Data: Selecting this option allows the user to load data which has been saved by the software during a previous session.

Save Raw Data: Selecting this option allows the user to save the current set of sample data points. The data can be reloaded to the Eval-Control Board software at a later date or can be used by other programs for further analysis.

Save Binary Data: Selecting this option allows the user to save the current set of sample data points. The data is saved in binary format as a text file. This method can be useful for examining code flicker, looking for stuck bits, etc.

Save FFT Data: Selecting this option allows the user to save the current set of FFT data points. FFT data cannot be reloaded into the Eval-Control Board software but can be loaded into other software packages for further analysis.

Exit: Quits the program.

Printer Port

This menu item allows the user to select which printer port should be used for communication with the Eval-Control Board.

LPT1: This option selects 0x378 as the printer port address. This is the default option.

LPT2: This option selects 0x278 as the printer port address.

PRN: This option selects 0x3BC as the printer port address.

Help:

This menu item gives information about the current revision of software for the AD7721 evaluation board being used.

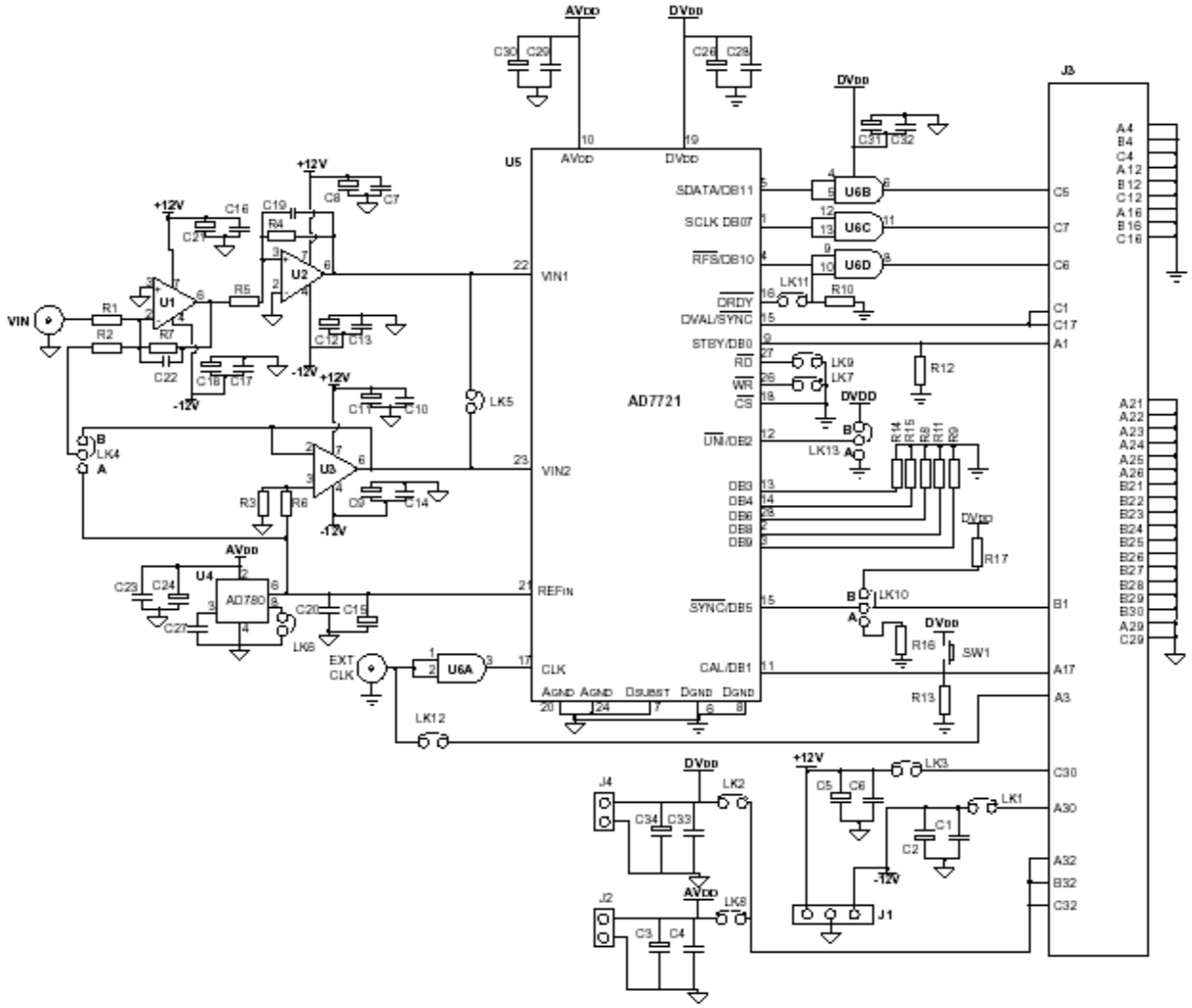

Figure 5. AD7721 Evaluation Board Schematic

AD7721 Bill Of Materials

COMPONENT LIST		Resistors	
Integrated Circuits		R1 - R7	10KΩ Precision Resistor
U1, U2, U3	AD847 Operational Amplifier	R8 - R17	10KΩ Resistor
U4	AD780 Reference	Links	
U5	AD7721	LK1 - LK3, LK5 - LK9, LK11, LK12	Two Pin Link
U6	74HC08 (AND Gate)	LK4, LK10, LK13	Three Pin Link
Capacitors		Switch	
C1, C4, C6, C7, C10, C13, C14, C16, C17, C20, C23, C28, C29, C32, C33	10 nF Ceramic Capacitor	SW1	Normally Open Push Button Switch
C2, C3, C5, C8, C9, C11, C12, C15, C18, C21, C24, C26, C30, C31, C34	22 µF Tantalum Capacitor	Sockets	
		VIN, EXT CLK	Sub-Miniature BNC Connector
C19, C22	68 pF Capacitor	Connectors	
C27	22 nF Ceramic capacitor	J1	3-Pin PCB Mounting Terminal Block
		J2, J4	2-Pin PCB Mounting Terminal Block
		J3	96-Pin (3 Row) EuroConnector