ANALOG DEVICES

Evaluation Board For 22-Bit Data Acquisition System

EVAL-AD7716EB

FEATURES

4-Channel Data Acquisition Board

22-Bit Resolution

**PC Printer Port Compatible**

PC-Compatible Software

INTRODUCTION

The EVAL-AD7716EB demonstrates the AD7716, 4-channel, 22-bit A/D Converter. This high-resolution ADC is ideally suited for biomedical data acquisition systems such as ECG and EEG as will as general data acquisition applications. Full data on the AD7716 is available in the AD7716 data sheet availale from Analog Devices and should be consulted in conjuction with this document when using the evaluation board.

Included on the evaluation board with the AD7716 are 4 input buffers, a voltage reference, a crystal oscillator, output interface circuitry and a 25-Way D-Type connector. The board comes complete with a cable for connecting directly to the printer port of a PC.

Software is provided to allow simple demonstration and evaluation of the AD7716.

FUNCTIONAL BLOCK DIAGRAM
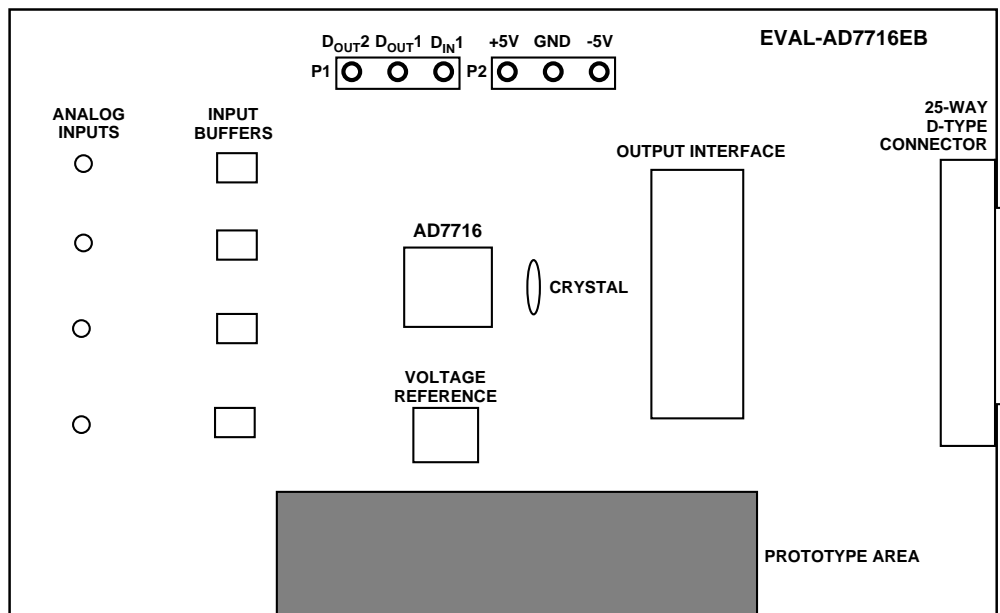
REV. B

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HARDWARE DESCRIPTION

The circuit diagram for the EVAL-AD7716EB is shown in Figure 1. The circuit is powered by +/- 5V supplies which are connected to V_{DD} and V_{SS}. All analog and digital circuitry on the board is powered from these supplies.

Analog Section

The OP-07 input buffers are low noise, low-bandwidth op-amps and are ideal for buffering the low-bandwidth signals which the AD7716 will digitise. They have a specified noise spectral density of 11nV/Root Hz at 600Hz. This corresponds to an rms noise of 0.25µV in the band, which is more than adequate for the AD7716.

The AD780 reference is the recommended reference for these low-noise applications. It provides the necessary +2.5V reference for the device. It is chosen for its very low noise in the programmed passband. The AD780 has a typical noise spectral density of 100nV/Root Hz at 600 Hz. This corresponds to an rms noise of 2.5µV in this band, which is more than adequate for the AD7716.

Digital Section

The AD7716 will accept one digital input to the $D_{IN}1$ pin and allow transmission back to the host processor. The $D_{IN}1$ input is clearly identified at P1 on the board.

The device also allows the user to program two digital outputs. These outputs are available on $D_{OUT}1$ and $D_{OUT}2$ and the state of these output is displayed on the two LED's, D1 and D2. Note that $D_{OUT}1$ and $D_{OUT}2$ are also available on P1.

The EVAL-AD7716EB has an on-board 8Mhz crystal oscillator to run the device. This is a standard parallel resonance crystal and has two 15pF capacitors connected for stable operation.

On the digital side of the AD7716, the circuitry is designed to simplify the printer port interface. The SDATA pin of the device is separated into two (SDATAIN AND SDATAOUT). The $\overline{DRDY}$ output pin is used as the handshake signal for the printer port.

CASCIN and CASCOUT are made available on J2. These signals allow multiple AD7716's to be hooked together simply in multi-device applications.

Links and Switches

There are a number of links and switches on the board and their functions are described below.

LK1: **Normally Not Connected.** This link connects the CASCOUT pin to the CASCIN pin of the AD7716. When the device is operated in this fashion, a reset must be applied after every write to the control register.

LK2: **Normally Connected.** This link connects the inverse of $\overline{DRDY}$ to the CASCIN pin of the AD7716. When used in this fashion, only one reset is needed at the start of operation is needed. The control register may be written to without further resets.

LK3: **Normally Not Connected.** This link allows IC8 to be bypassed in applications where the user wishes to keep a common SDATA line.

LK4: **Normally Not Connected.** This link, in association with LK14, allows IC8 to be bypassed.

SW2-1: This switch when positioned as in Figure 2, sets the MODE pin of the AD7716 to a "high". This sets up the device for the Slave Mode Interface, which is the interface mode employed when connected to the PC. In this mode, the AD7716 is the slave in the system and the processor is the master.

SW2-2,3,4: These three switches,when positioned as in Figure 2, set the device address pins A0, A1, A2 of the AD7716 to "000", respectively. This information is contained in the data stream going back to the processor. In a multi-device system, it is possible to have eight discrete addresses for eight AD7716, thus making a 32-channel data acquisition system. Please consult the AD7716 data sheet for further details.
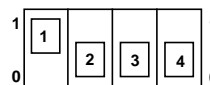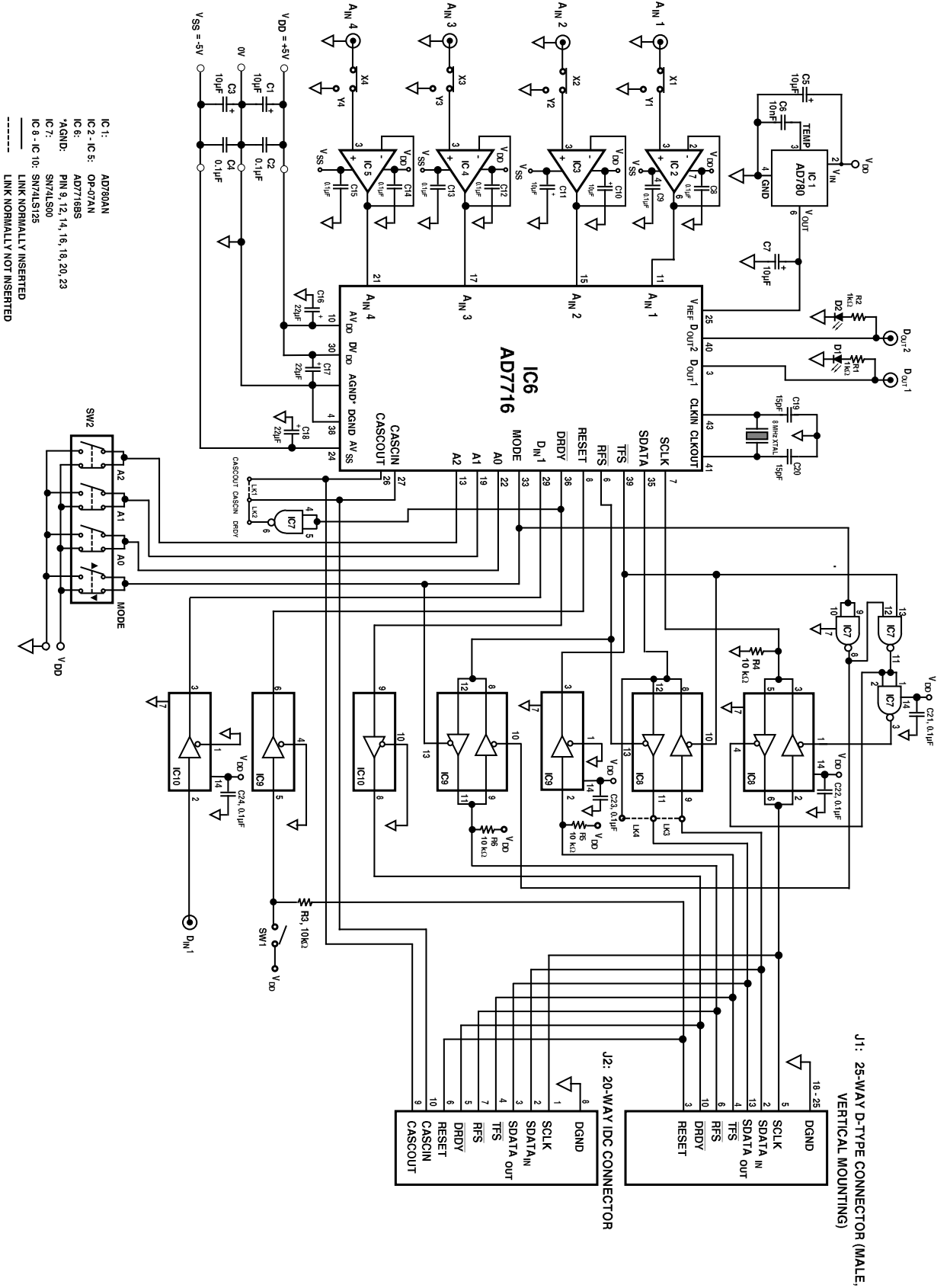
Figure 2. SW2 Default Settings

Figure 1. EVAL-AD7716EB Circuit Diagram

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SOFTWARE DESCRIPTION

The EVAL-AD7716EB comes complete with PC-compatible software. This software runs under WINDOWS and is largely button-driven. It consists of several pop-up screens which are easily navigated. It allows the user to control and evaluate the AD7716 over the printer port of the PC.

To use the software, the user must have an IBM-compatible PC and Windows 3.1 must be installed. Start Windows and using either the RUN command or the File Manager, start the program called SETUP.EXE on the distribution disk. This automatically installs the application and sets up a Windows Group called "ANALOG DEVICES". The application icon is found here. To start the application, double click on the icon. When the program starts, the user is asked to select a printer port. The correct selection depends on the type of computer being used (Desktop, Laptop, etc,). LPT1 works for most machines. LPT2 can be used for machines which have two printer ports. When using a Compaq laptop, select PRN. Once the printer port has been selected, the user can move to the MAIN MENU. Once here, the program allows the following functions:

Program the AD7716 Control Register

Reset the AD7716

Gather Data

Graph the Data

Do Noise Analysis

Do a Noise Histogram

Write to a File

Read from a File

BOARD CAPABILITIES

The EVAL-AD7716 allows the digital filter in the AD7716 to be programmed for three cut-off frequencies. These are 36.5Hz, 73Hz and 146Hz. The device itself is capable of operating at two other cut-off frequencies: 292Hz and 584Hz. However, at these higer cut-off frequencies it is not possible to transfer all the device data (128 bits) in the time available, given the speed of the printer port interface. That is why the feature is not offered with this package. If operation at these higher cut-off frequencies is desired, then it is recommended that the user interface the EVAL-AD7716EB to a microcontroller or a DSP micro-computer over a faster serial port.

Because of the many calculations taking place in the program, a situation can arise where the program can run out of stack memory. This stack memory stores the variables that are being used at that particular time. When this happens, either a message comes up on the screen ("Out Of Stack Space") or the program buttons cease to function. To resume normal operation, simply quit by double-clicking on the top left-hand corner of the window, and restart the application.

Note that this is confined to the AD7716 program and does not affect any other Windows program.

AD7716 Evaluation Software
User Manual

The basic system requirements for running the software supplied with the AD7716 Evaluation Board are as follows:

- Microsoft Windows 3.0 or later, running in standard or enhanced mode.
- 80286 or higher microprocessor.
- CGA, EGA, VGA, 8514 Hercules, or other display compatible with Windows.
- At least 2Mb of RAM

The software is distributed on a single 1.44Mbyte diskette. The diskette contains 13 files, 11 of which are installed onto the users system. The files that may be found on the diskette are as follows.

1. AD7716.EXE
2. GRAPH.VBX
3. GSW.EXE
4. GSWDLL.DLL
5. PORT7716.DLL
6. READ.ME
7. SETUP.EXE
8. SETUP.LST
9. SETUPKIT.DLL
10. THREED.VBX
11. VBRUN300.DLL
12. VER.DL_
13. SETUP1.EXE

The Evaluation Software is distributed with a setup program called SETUP.EXE. This program simplifies the installation procedure by copying the files on the distribution disk to the correct directories and making a new program group (called ANALOG DEVICES) in the PROGRAM MANAGER. The application may be found in this group. The setup program must be started from either the PROGRAM MANAGER   or the FILE MANAGER in Windows. To start from the PROGRAM MANAGER simply select the RUN option in the FILE menu and type A:SETUP.EXE and click on OK. If you are using the FILE MANAGER you can simply click on SETUP.EXE. The setup program will prompt you to select a directory in which to place the program files. You can use the default selection or type in your own and click on CONTINUE to proceed with the installation. When the installation is complete the Evaluation Software can be started by double clicking on the application icon in the program group called ANALOG DEVICES.

PARALLEL PORT SELECTION

The AD7716 evaluation software allows the user to program and gather samples from the AD7716 evaluation board via the printer port of a PC using the cable supplied. When the program starts up a window called Select A Parallel Port appears (See Fig.1). The user can select the port they wish to use by clicking on the appropriate option button and then clicking OK. The hexadecimal numbers displayed beside each option correspond to the memory address of the port in question. The default selection LPT1 will work in most cases.
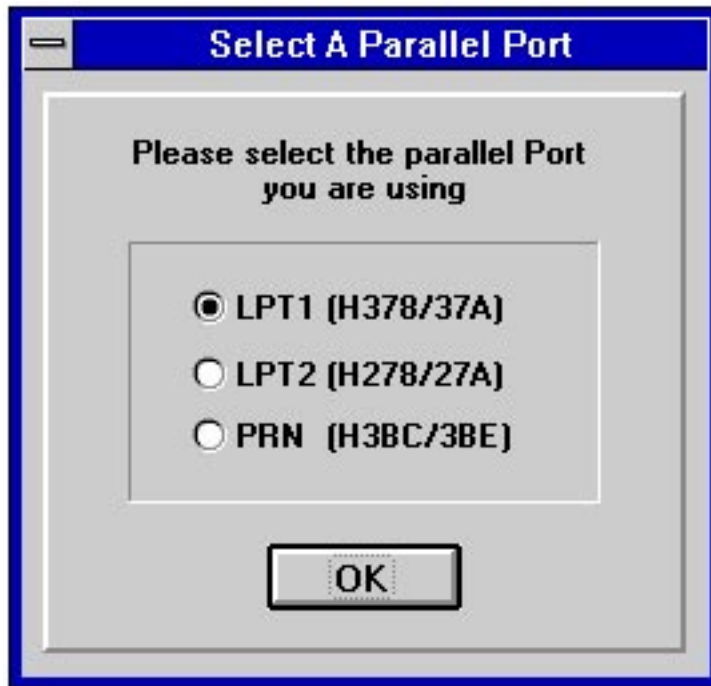

Fig. 1 Parallel Port Selection

THE MAIN MENU WINDOW

Once the OK button of the Port Selection window has been pressed the user is presented with the Main Menu window for the application. The window is called AD7716 Evaluation Software and is shown in Fig. 2 below. From it the user may :

- Select the Filter Cutoff Frequency.
- Program the states of the digital output pins Dout1 and Dout2.
- Program these selections to the AD7716 Evaluation Board.
- Read Data from the AD7716 Evaluation Board.
- Save the data gathered to a file.
- Load data saved at an earlier date.
- Graph the data gathered.
- Do Noise Analysis on the gathered data.
- Display a Histogram of codes on the data gathered.
- Quit the program.

Before data can be gathered from the AD7716 Evaluation Board the AD7716 Control Register must be programmed and the device must be reset. If ,on the Evaluation Board, the Cascin is connected to the Cascout via LK1 then the AD7716 must be reset each time the Control Register is programmed. If the Cascin is connected to the inverted DRDY via LK2 then resetting the AD7716 is only required once. When this has been done data can be gathered and examined. Note that changing the "System Options" will not result in a change in the Control Register of the AD7716 and it is only when the "Program AD7716" button is pressed that these options are loaded to the AD7716.
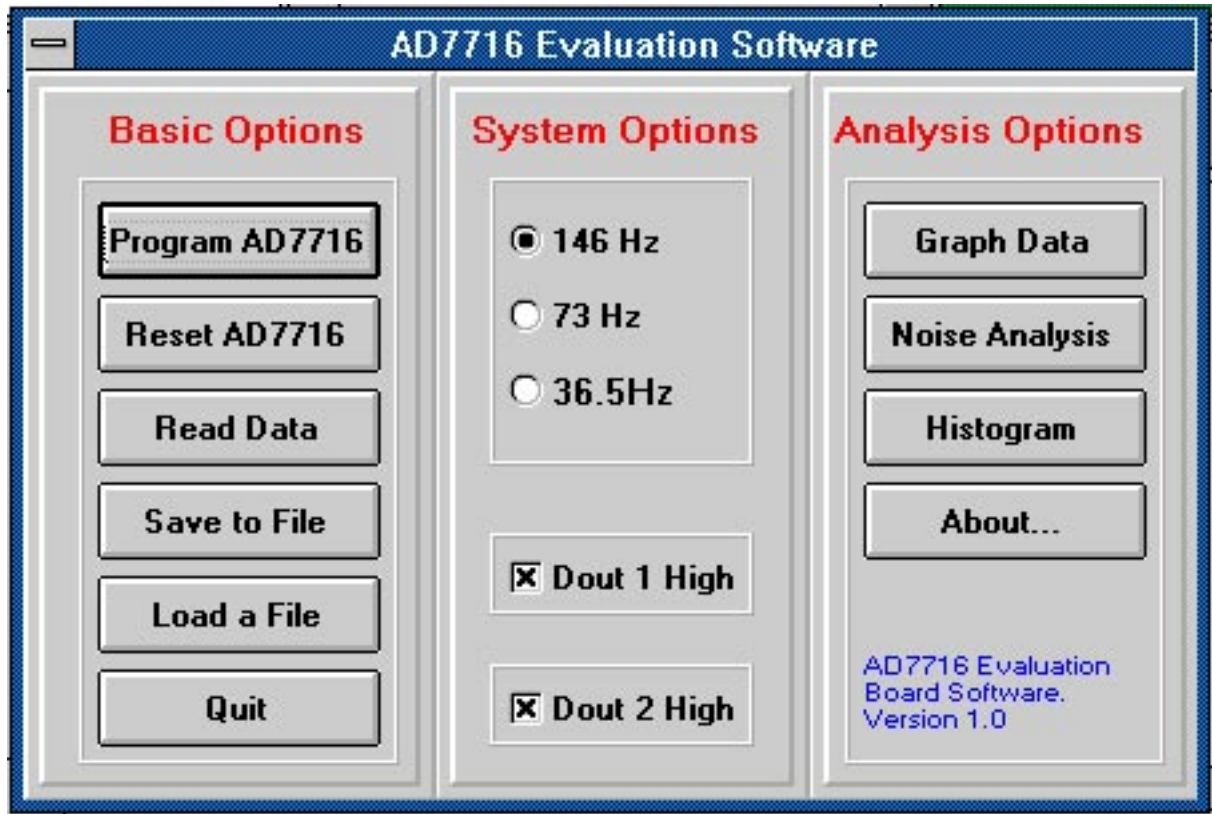
Fig. 2   Main Menu

READING DATA FROM THE EVALUATION BOARD

When the "Read Data" button is pressed the READ DATA menu is displayed. This menu allows the user to enter the number of samples required to be gathered and start the acquisition or return to the main menu. The READ DATA menu is shown in Fig. 3 below.

Once data has been gathered any of the data analysis functions can be used. Note that these options are not available until data has either been gathered or a data file has been loaded. A brief description of each of the Data Analysis functions follows.
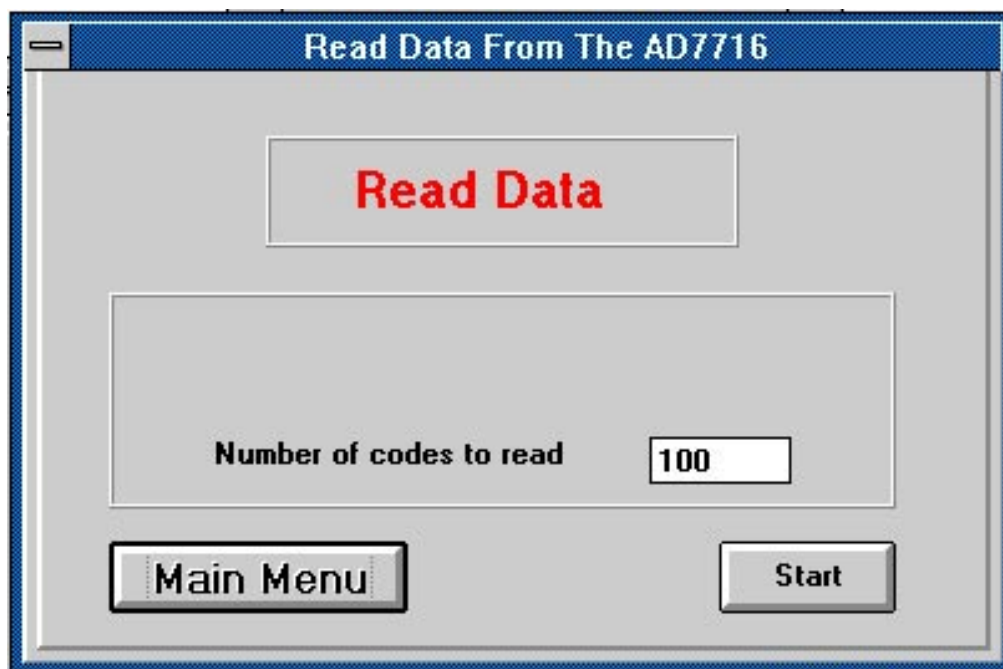
Fig.3   Read Data Menu

GRAPHING DATA

The GRAPH DATA window will allow the user to display the acquired data from any one of the four channels of the AD7716. The required channel is selected by using the option buttons and when the PLOT GRAPH button is pressed the data from that channel is displayed.

There are three graphs in this window, the top one displays the 22 bit conversion result, the middle one displays the status of the Overflow bit and the bottom one shows the status of the digital input pin Din1.

The GRAPH DATA window also has the options for the user to return to the Main Menu or to move to either of the other two data analysis windows.

Note that when the data from the conversion is displayed the MSB is inverted so that the data is displayed in straight binary rather than 2's complement. This is done to make the graphing routine quicker to execute.

Fig. 4 shows the GRAPH DATA window as it might appear after reading from the AD7716 Evaluation Board.
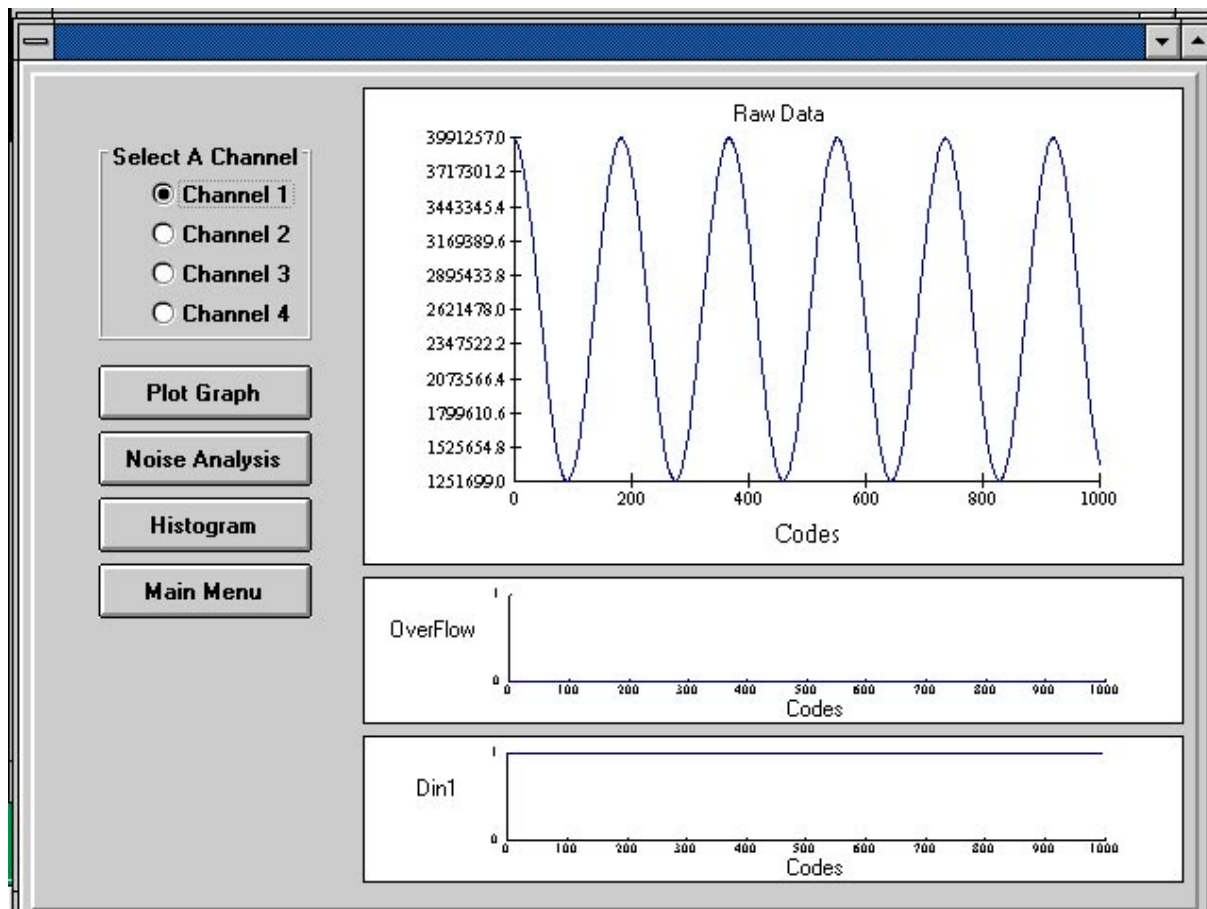

Fig.4   GRAPH DATA Window

THE NOISE ANALYSIS WINDOW

The NOISE ANALYSIS window, which is shown below in Fig.5, displays information from each of the four channels of the AD7716. The information displayed includes the standard deviation (in µV) of the data acquired, the maximum and minimum code acquired (in hexadecimal format), the average code (in hexadecimal format) and the spread of codes.

The window also has the options of returning to the Main Menu window or to display either the Graph Data or the Histogram window.
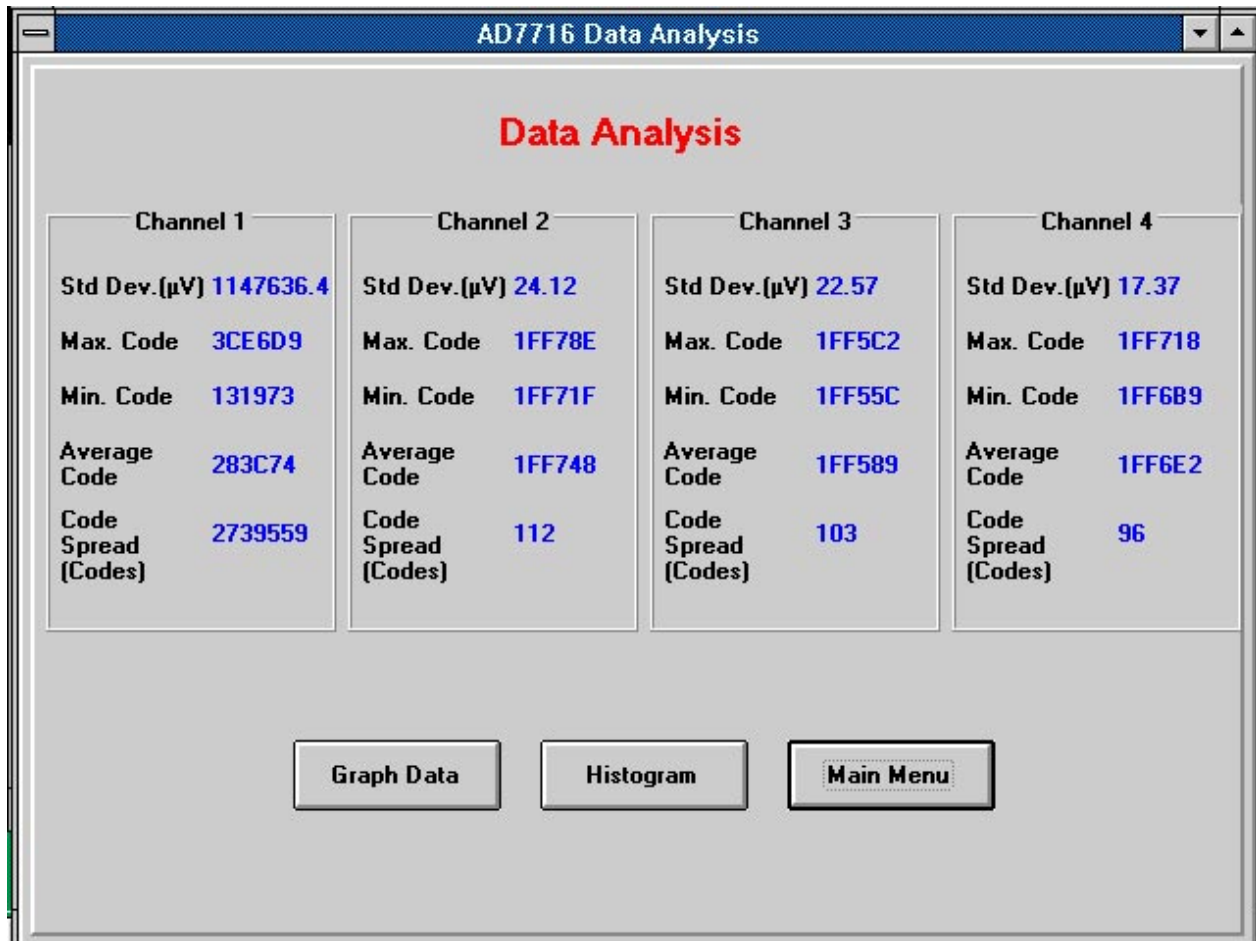

Fig. 5 The NOISE ANALYSIS Window

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THE HISTOGRAM WINDOW
The HISTOGRAM window is used to display the number of times each code occurred in a low amplitude signal. The user can select which channel is to be displayed as a histogram by using the option buttons and then pressing the "Histogram" button. In order to keep the execution time as short as possible the histogram routine first checks to see if the span of codes (i.e. the Max code - the Min code) is less than 1500. If the span is greater than this the program will display an error message and will not perform the histogram operation.
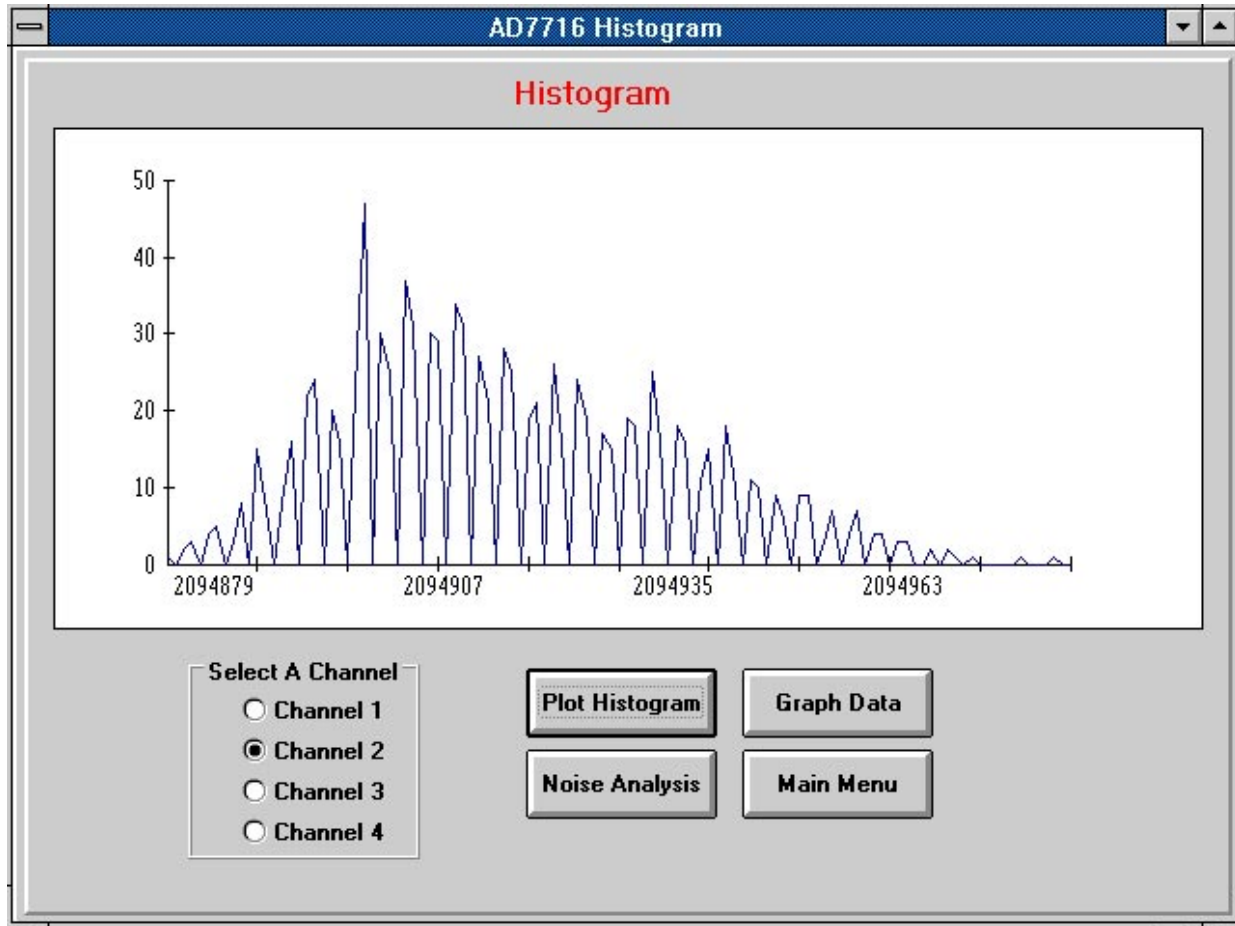The Histogram window is shown in Fig. 6 below.

Fig. 6 The HISTOGRAM Window

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THE SAVE DATA WINDOW
Once data has been acquired from the AD7716 Evaluation Board the user has the option to save the data from any of the four channels to a file. This is done in the SAVE DATA window shown below in Fig. 7 below. The data is saved in text format with each code being terminated by a carriage return-line feed. This data can then be loaded easily into many database or analysis packages for further examination.
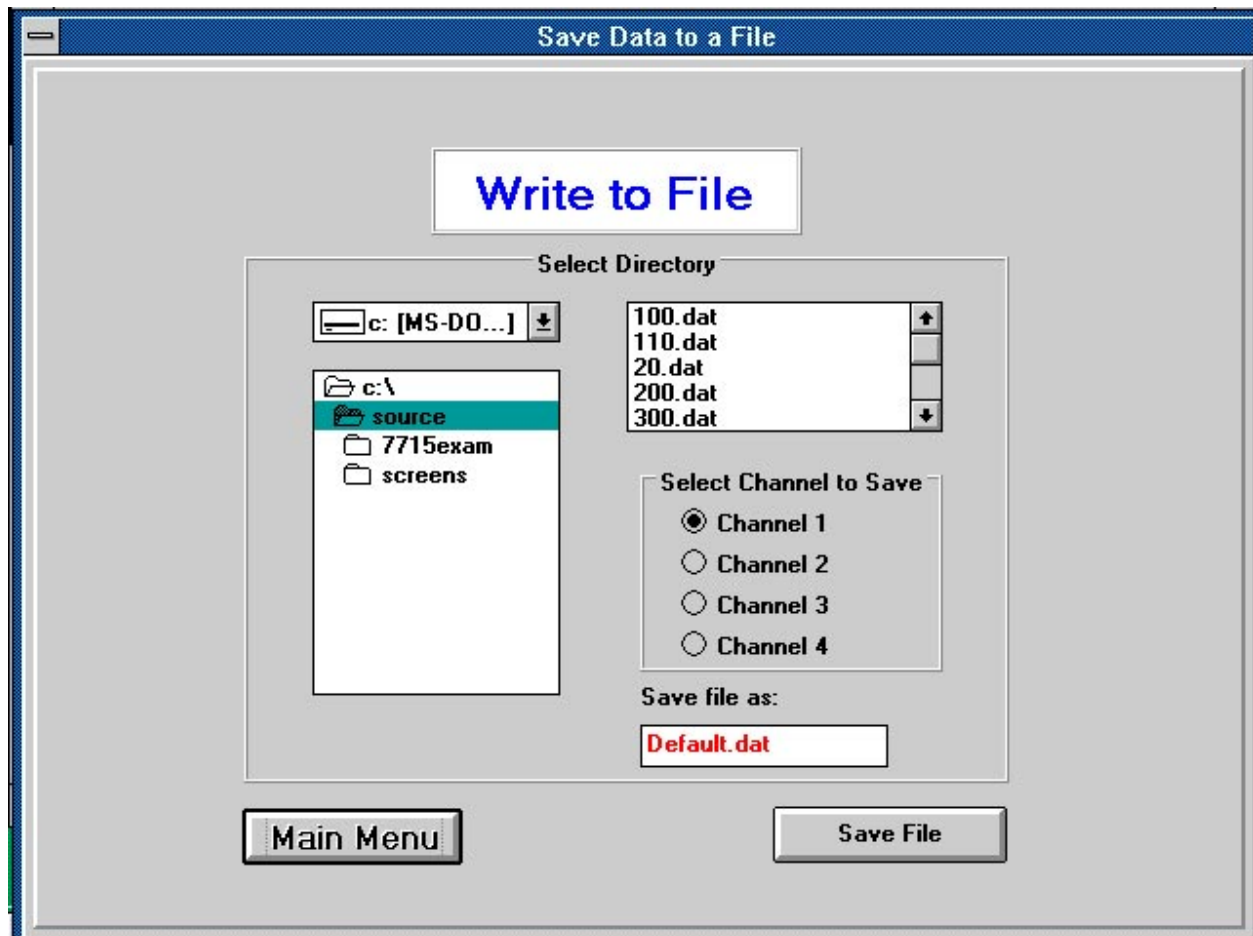

Fig. 7 The SAVE DATA Window

THE LOAD DATA WINDOW
The user has the option of loading a file that was saved previously into the AD7716 Evaluation Board software. The user can select which channel the data is to be loaded into and then by locating the data file using the window options the file will be loaded and all the analysis functions can be used as normal. The LOAD DATA window is shown in Fig. 8 below.
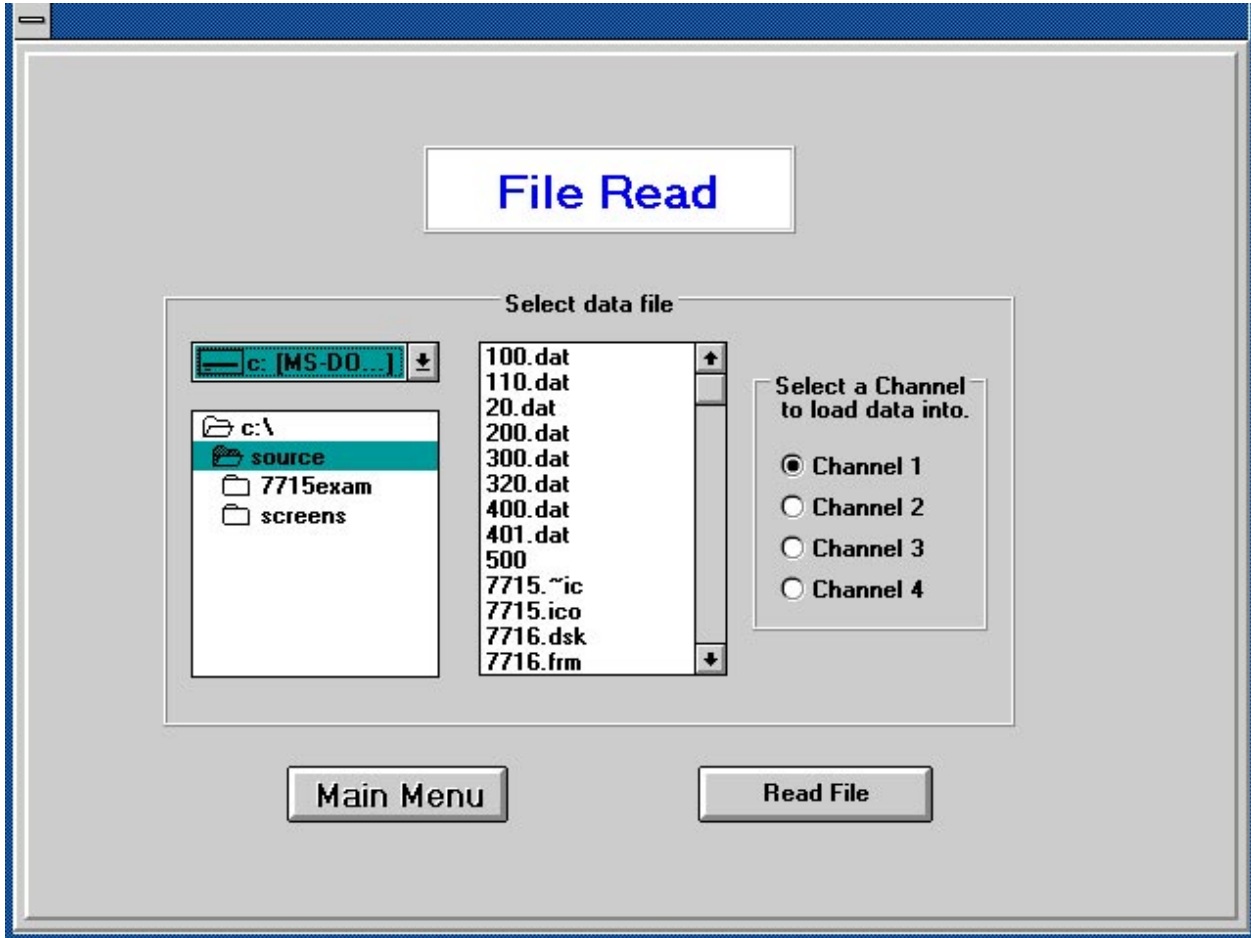

Fig. 8 The LOAD DATA Window

NOTE: When using the Load and Save options only the 22 bit conversion result is saved/loaded. The Overflow and Din1 information is disguarded.