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# CDB5521/22/23/24/28 Evaluation Board and Software

## Features

- Evaluation Board and Software Supports All Chips: CS5521, CS5522, CS5523, CS5524, and CS5528
- Direct Thermocouple Interface
- RS-232 to PC With Test Modes
- On-board 80C51 Microcontroller
- On-board Voltage Reference
- Lab Windows/CVI™ Evaluation Software
  - Register Setup & Chip Control
  - Data Capture
  - FFT Analysis
  - Time Domain Analysis
  - Noise Histogram Analysis
- On-board Charge Pump Drive Circuitry

## General Description

The CDB5521/22/23/24/28 is an inexpensive tool designed to evaluate the performance of the CS5521, CS5522, CS5523, CS5524, and CS5528 Analog-to-Digital Converters (ADC).

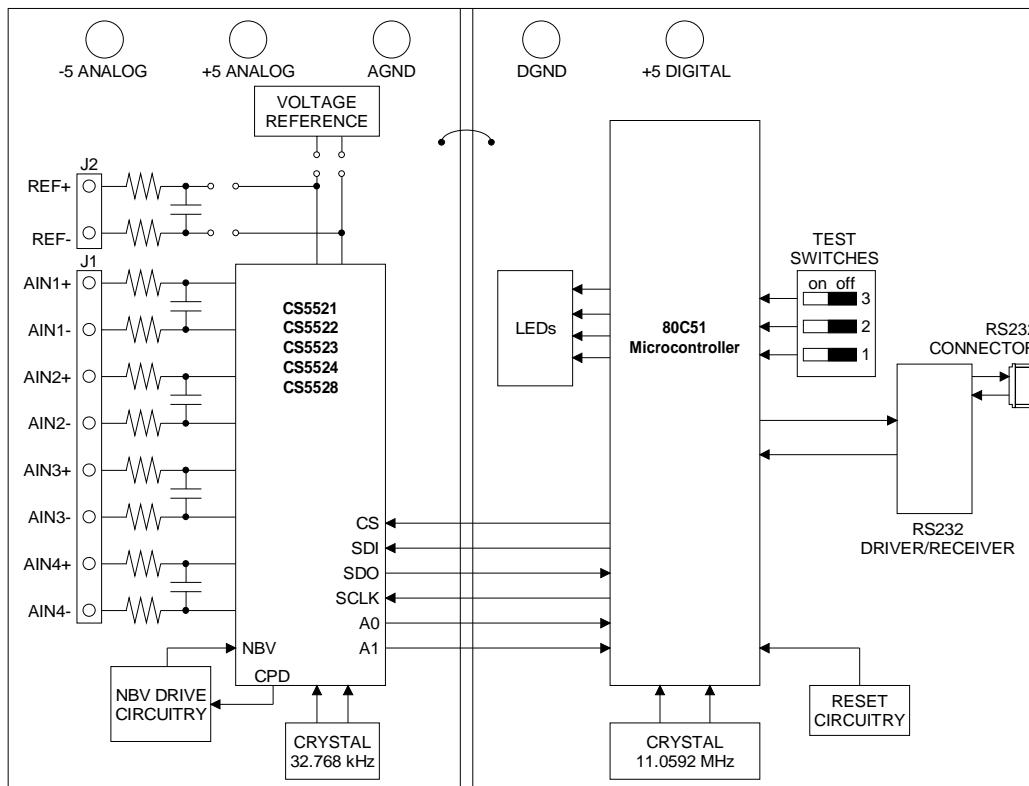
The evaluation board includes a 2.5 V voltage reference, an 80C51 microcontroller, an RS232 driver/receiver, and firmware. The 8051 controls the serial communication between the evaluation board and the PC via the firmware, thus, enabling quick and easy access to all of the CS5521/22/23/24/28's registers.

The CDB5521/22/23/24/28 also includes one installed ADC sample, and software for Data Capture, Time Domain Analysis, Histogram Analysis, and Frequency Domain Analysis.

## ORDERING INFORMATION

CDB5521/22/23/24/28

Evaluation Board



## Preliminary Product Information

This document contains information for a new product. Cirrus Logic reserves the right to modify this product without notice.

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## 1. PART I: HARDWARE

### 1.1 Introduction

The CDB5521/22/23/24/28 evaluation board provides a means of testing the CS5521/22/23/24/28 Analog-to-Digital Converters (ADCs). The board interfaces the converters to an IBM<sup>™</sup> compatible PC via an RS-232 interface while operating from a +5 V and -5 V power supply. To accomplish this, the board comes equipped with an 80C51 microcontroller and a 9-pin RS-232 cable, which physically interfaces the evaluation board to the PC. Additionally, analysis software provides easy access to the internal registers of the converters and provides a means to capture data and display the converters' time domain, frequency domain, and noise histogram performance.

### 1.2 Evaluation Board Overview

The board is partitioned into two main sections: analog and digital. The analog section consists of either the CS5521, CS5522, CS5523, CS5524 or CS5528, a precision voltage reference, and the circuitry to generate a negative voltage. The digital section consists of the 80C51 microcontroller, the hardware test switches, the reset circuitry, and the RS-232 interface.

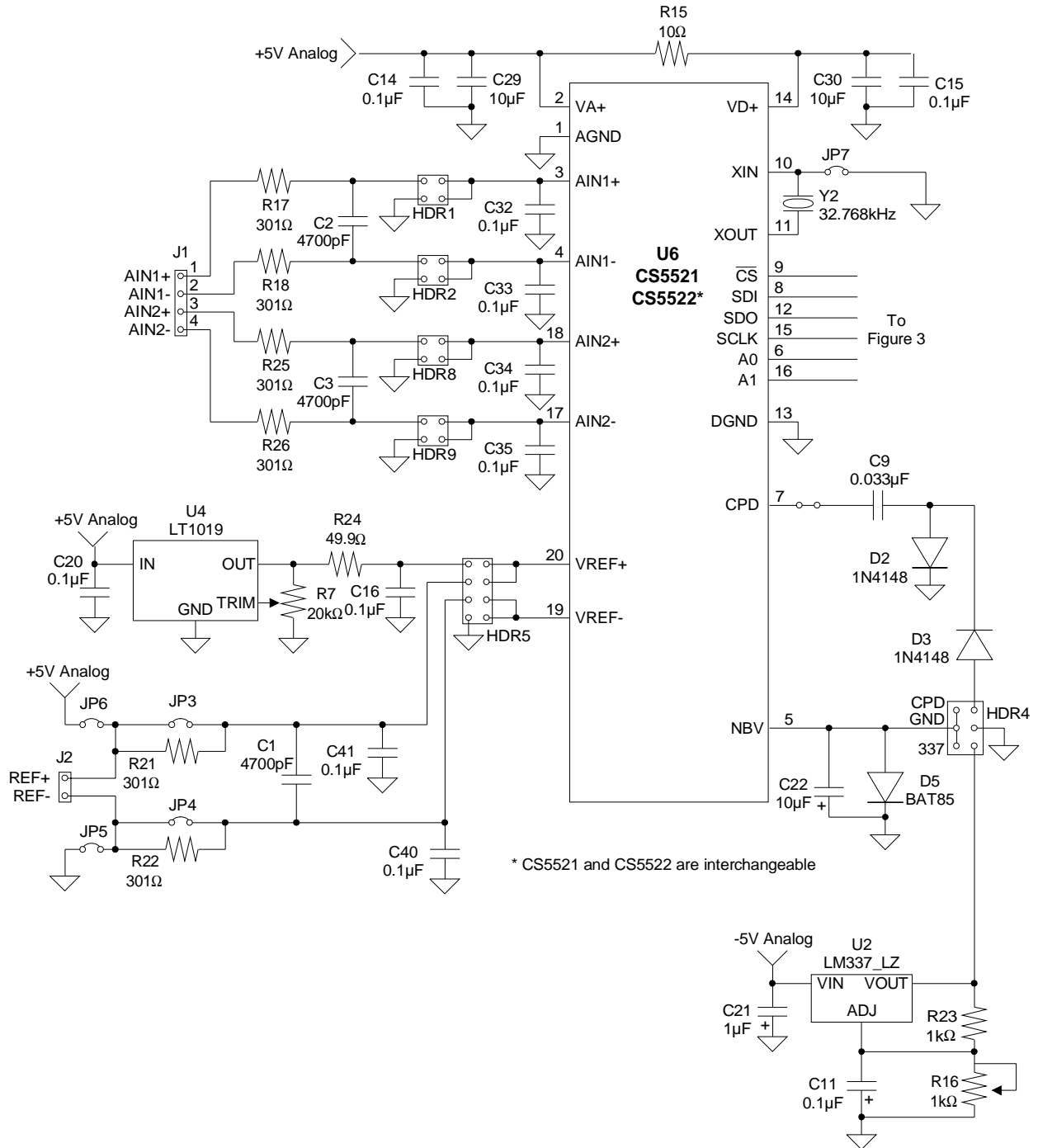
The CS5521/22/23/24/28 is designed to digitize low level signals while operating from a 32.768 KHz crystal. As shown in Figures 1 and 2, a thermocouple can be connected to the converter's inputs via J1's AIN+ and AIN- inputs. Note, a simple RC network filters the thermocouple's output to

reduce any interference picked up by the thermocouple leads.

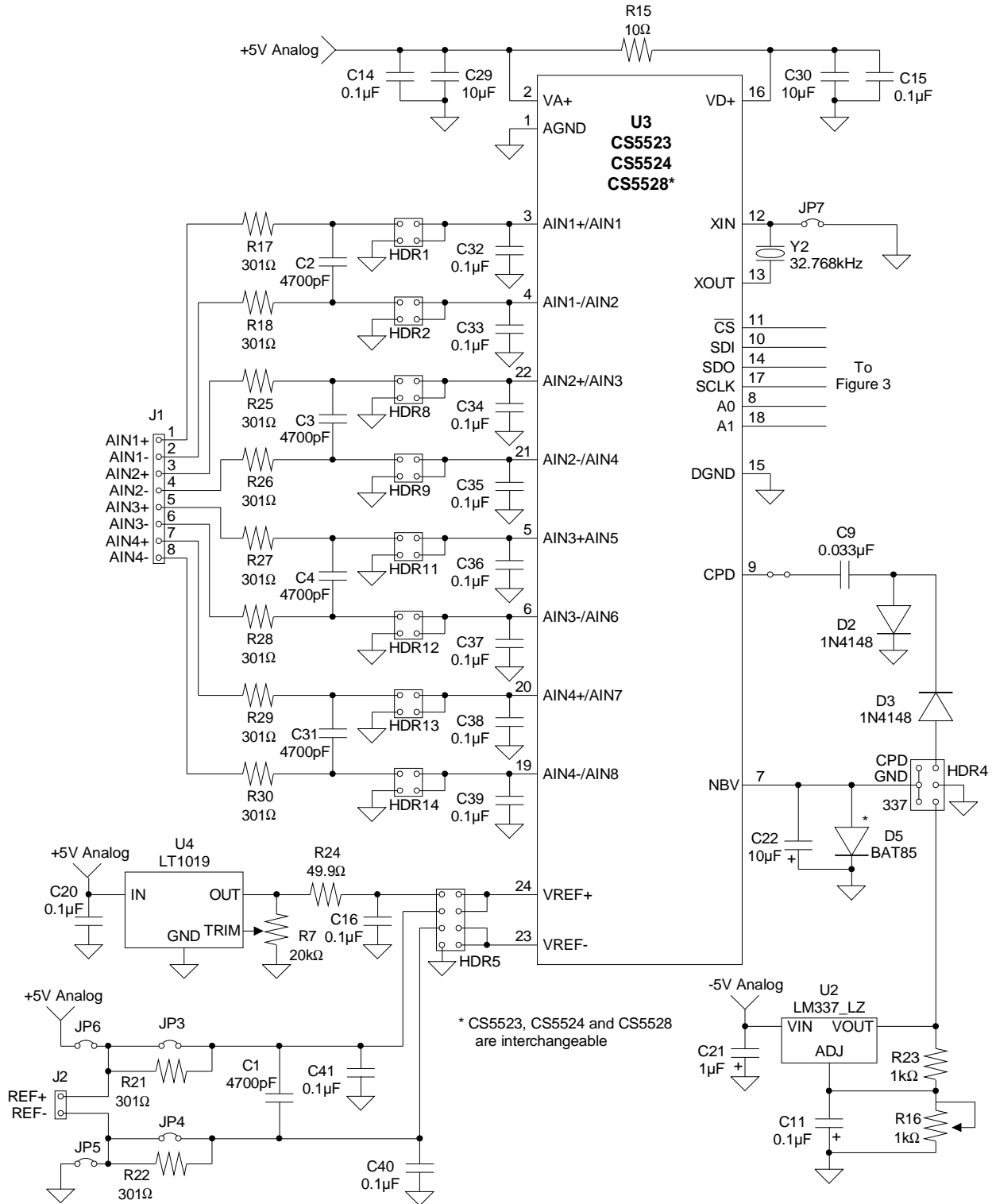
The evaluation board provides two voltage reference options, on-board and external. With HDR5's jumpers in positions 1 and 4, the LT1019 provides 2.5 volts (the LT1019 was chosen for its low drift, typically 5ppm/°C). By setting HDR5's jumpers to position 2 and 3, the user can supply an external voltage reference to J2's REF+ and REF- inputs (Application Note 4 on the web details various voltage references).

The A/D converters' serial interfaces are *SPI*<sup>™</sup> and *MICROWIRE*<sup>™</sup> compatible. The interface control lines ( $\overline{CS}$ , SDI, SDO, and SCLK) are connected to the 80C51 microcontroller via port one. To interface a different microcontroller to the ADC chip, the control lines to the ADC are available at HDR6 (Header 6). However, to connect an external microcontroller to the header, the evaluation board must be modified in one of three ways: 1) cut the interface control traces going to the on-board 80C51 microcontroller, 2) remove resistors R1-R6, or 3) remove the 80C51 microcontroller from its socket on the evaluation board.

Figure 3 illustrates the schematic of the digital section. It contains the microcontroller, a Motorola MC145407 interface chip, and test switches. The test switches aid in debugging communication problems between the CDB5521/22/23/24/28 and the PC. The microcontroller derives its clock from an 11.0592 MHz crystal. From this, the controller is configured to communicate via RS-232 at 9600 baud, no parity, 8-bit data, and 1 stop bit.



**Figure 1. CS5522 Analog Section**



**Figure 2. CS5524/28 Analog Section**

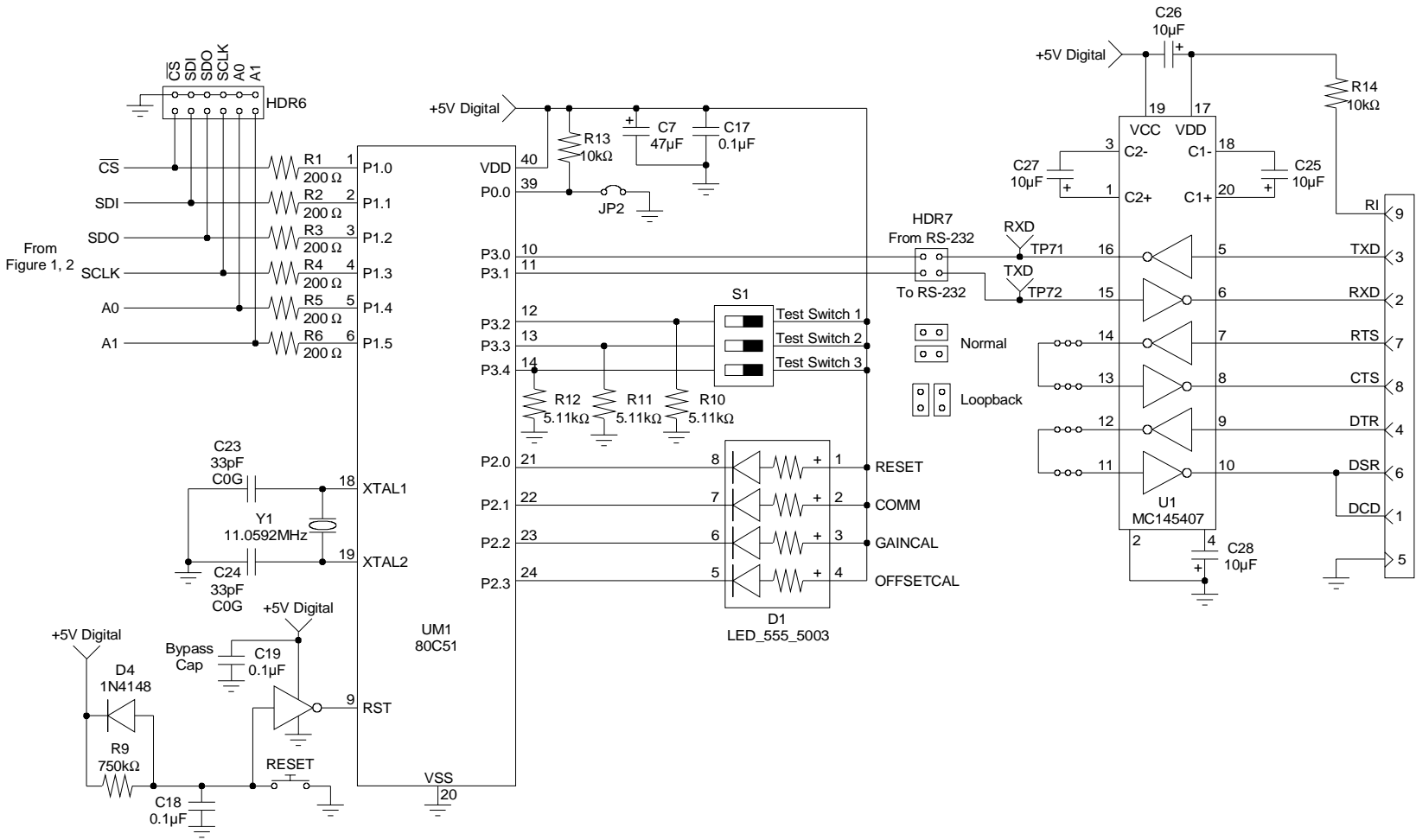


Figure 3. Digital Section



### 1.3 Using the Evaluation Board

The CS5521/22/23/24/28 are highly integrated ADCs. They contain a multiplexer, an instrumentation amplifier (IA), a programmable gain amplifier (PGA), an on-chip charge pump drive (CPD), and programmable output word rates (OWR). The IA provides a set gain of 20 while the PGA sets the input levels of the ADC at either 25 mV, 55 mV, 100 mV, 1 V, 2.5 V, or 5 V (for  $V_{REF} = 2.5$  V). The CPD provides a square wave output. This output, along with two diodes and two capacitors, is used to supply the negative supply to the IA, enabling measurements of ground referenced signals. The ADC's digital filter allows the user to select output word rates (OWR's) from 1.88 Hz up to 101 Hz. Higher output word rates can be attained when a faster clock source is used. Since the CS5521/22/23/24/28 have such a high degree of integration and flexibility, the CS5521/23 or CS5522/24/28 data sheet should be read thoroughly before and consulted during the use of the CDB5521/22/23/24/28. Table 1 lists the different headers on the CDB5521/22/23/24/28 and their functions. The locations of these headers are marked on the top of the board, and the silkscreen and layout of the board can also be found at the end

of this document in Figures 12, 13, and 14 for reference.

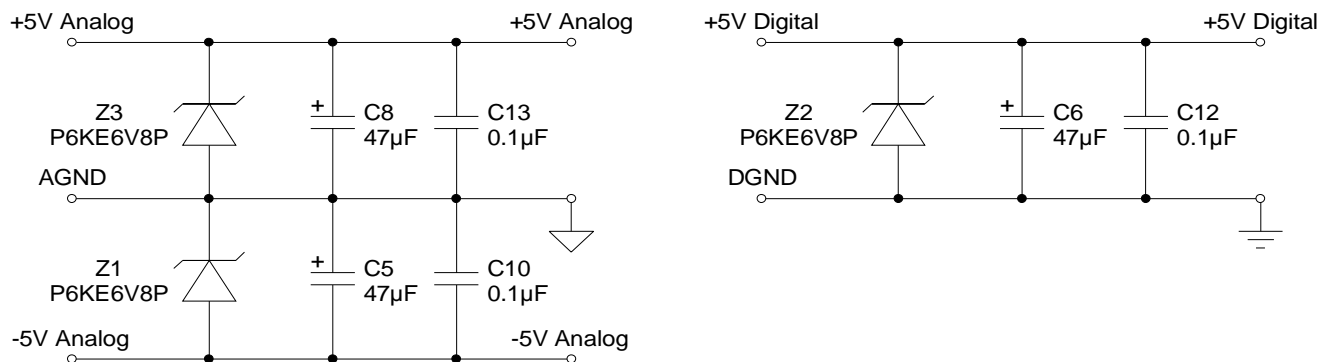
### 1.4 Power Connections

Figure 4 illustrates the power supply connections to the evaluation board. The +5 V Analog supplies the analog section of the evaluation board, the LT1019 and the ADC. The -5 V Analog supplies the negative bias voltage circuitry. The +5 V Digital supplies a separate five volts to the digital section of the evaluation board, the 80C51, the reset circuitry, and the RS-232 interface circuitry.

### 1.5 Negative Bias Voltage

The evaluation board provides three means of supplying the Negative Bias Voltage (NBV). HDR4 (Header 4) selects between them. When HDR4 is in position one, the LM337 supplies NBV with an adjustable voltage. R16 is used to adjust this voltage between -1.25 V and -5 V. When in position two, HDR4 grounds NBV. And by setting HDR4 to position three, the converter's Charge Pump Drive provides NBV with a dc rectified voltage, nominally -2.1 V.

Note: NBV should not exceed a voltage more negative than -3.0 V.



**Figure 4. Power Supplies**

## 1.6 Software

The evaluation board comes with software and an RS-232 cable to link the evaluation board to the PC. The executable software was developed with Lab Windows/CVI™ and meant to run under Windows™ 3.1 or later. After installing the software, read the readme.txt file for last minute changes in the software. Additionally, *Section 2., Part II: Software* further details how to install and use the software

Name	Function Description
HDR1	Used to switch AIN1+ (AIN1 on CS5528) between J1 and AGND.
HDR2	Used to switch AIN1- (AIN2 on CS5528) between J1 and AGND.
HDR3	Does not exist.
HDR4	Used to switch the power for NBV from the LM337, CPD, or AGND.
HDR5	Used to switch VREF+ and VREF- pins from external J2 header to the on board LT1019 reference.
HDR6	Used to connect an external microcontroller.
HDR7	Used in conjunction with the self test modes to test the UART/RS232 communication link between the microcontroller and a PC.
HDR8	Used to switch AIN2+ (AIN3 on CS5528) between J1 and AGND.
HDR9	Used to switch AIN2- (AIN4 on CS5528) between J1 and AGND.
HDR10	Does not exist.
HDR11	Used to switch AIN3+ (AIN5 on CS5528) between J1 and AGND.
HDR12	Used to switch AIN3- (AIN6 on CS5528) between J1 and AGND.
HDR13	Used to switch AIN4+ (AIN7 on CS5528) between J1 and AGND.
HDR14	Used to switch AIN4- (AIN8 on CS5528) between J1 and AGND.

**Table 1. Header Descriptions**

## 1.7. Writing Your Own Interface Software

Tables 2 through 5 list the RS-232 commands used to communicate between the PC and the microcontroller. To develop additional code to communicate to the evaluation board via RS-232, the following applies: to write to an internal ADC register, choose the appropriate write command byte (See Table 2), and transmit it LSB first. Then, transmit the three data bytes lowest order byte (bits 7-0) first with the LSB of each byte transmitted first. These three data bytes provide the 24-bits of information to be written to the desired register. To read from an internal register, choose the appropriate read command byte and transmit it LSB first. Then, the microcontroller automatically acquires the ADC's register contents and returns the 24-bits of information. The returned data is transmitted lowest order byte first with the LSB of each byte transmitted first.

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Register	Read Command (HEX)	Write Command (HEX)
Offset Register Physical Channel 1	09	01
Offset Register Physical Channel 2	19	11
Offset Register Physical Channel 3	29	21
Offset Register Physical Channel 4	39	31
Offset Register Physical Channel 5	49	41
Offset Register Physical Channel 6	59	51
Offset Register Physical Channel 7	69	61
Offset Register Physical Channel 8	79	71
Gain Register Physical Channel 1	0A	02
Gain Register Physical Channel 2	1A	12
Gain Register Physical Channel 3	2A	22
Gain Register Physical Channel 4	3A	32
Gain Register Physical Channel 5	4A	42
Gain Register Physical Channel 6	5A	52
Gain Register Physical Channel 7	6A	62
Gain Register Physical Channel 8	7A	72
Configuration Register	0B	03
Conversion Data FIFO	0C	---
Channel Setup Registers	0D	05

**Table 2. Microcontroller Read/Write Commands via RS-232**

Perform Conversion	Conversion Command (HEX)
Normal Conversion on Setup 1	80
Normal Conversion on Setup 2	88
Normal Conversion on Setup 3	90
Normal Conversion on Setup 4	98
Normal Conversion on Setup 5	A0
Normal Conversion on Setup 6	A8
Normal Conversion on Setup 7	B0
Normal Conversion on Setup 8	B8
Normal Conversion on Setup 9	C0
Normal Conversion on Setup 10	C8
Normal Conversion on Setup 11	D0
Normal Conversion on Setup 12	D8
Normal Conversion on Setup 13	E0
Normal Conversion on Setup 14	E8
Normal Conversion on Setup 15	F0
Normal Conversion on Setup 16	F8

**Table 3. Microcontroller Conversion Commands via RS-232**

<b>Self-Offset Calibration</b>	<b>Calibration Command (HEX)</b>
Self-Offset Calibration on Setup 1	81
Self-Offset Calibration on Setup 2	89
Self-Offset Calibration on Setup 3	91
Self-Offset Calibration on Setup 4	99
Self-Offset Calibration on Setup 5	A1
Self-Offset Calibration on Setup 6	A9
Self-Offset Calibration on Setup 7	B1
Self-Offset Calibration on Setup 8	B9
Self-Offset Calibration on Setup 9	C1
Self-Offset Calibration on Setup 10	C9
Self-Offset Calibration on Setup 11	D1
Self-Offset Calibration on Setup 12	D9
Self-Offset Calibration on Setup 13	E1
Self-Offset Calibration on Setup 14	E9
Self-Offset Calibration on Setup 15	F1
Self-Offset Calibration on Setup 16	F9
<b>Self Gain Calibration</b>	<b>Calibration Command (HEX)</b>
Self-Gain Calibration on Setup 1	82
Self-Gain Calibration on Setup 2	8A
Self-Gain Calibration on Setup 3	92
Self-Gain Calibration on Setup 4	9A
Self-Gain Calibration on Setup 5	A2
Self-Gain Calibration on Setup 6	AA
Self-Gain Calibration on Setup 7	B2
Self-Gain Calibration on Setup 8	BA
Self-Gain Calibration on Setup 9	C2
Self-Gain Calibration on Setup 10	CA
Self-Gain Calibration on Setup 11	D2
Self-Gain Calibration on Setup 12	DA
Self-Gain Calibration on Setup 13	E2
Self-Gain Calibration on Setup 14	EA
Self-Gain Calibration on Setup 15	F2
Self-Gain Calibration on Setup 16	FA

**Table 4. Microcontroller Self Calibration Commands via RS-232**

<b>System-Offset Calibration</b>	<b>Calibration Command (HEX)</b>
System-Offset Calibration on Setup 1	85
System-Offset Calibration on Setup 2	8D
System-Offset Calibration on Setup 3	95
System-Offset Calibration on Setup 4	9D
System-Offset Calibration on Setup 5	A5
System-Offset Calibration on Setup 6	AD
System-Offset Calibration on Setup 7	B5
System-Offset Calibration on Setup 8	BD
System-Offset Calibration on Setup 9	C5
System-Offset Calibration on Setup 10	CD
System-Offset Calibration on Setup 11	D5
System-Offset Calibration on Setup 12	DD
System-Offset Calibration on Setup 13	E5
System-Offset Calibration on Setup 14	ED
System-Offset Calibration on Setup 15	F5
System-Offset Calibration on Setup 16	FD
<b>System Gain Calibration</b>	<b>Calibration Command (HEX)</b>
System-Gain Calibration on Setup 1	86
System-Gain Calibration on Setup 2	8E
System-Gain Calibration on Setup 3	96
System-Gain Calibration on Setup 4	9E
System-Gain Calibration on Setup 5	A6
System-Gain Calibration on Setup 6	AE
System-Gain Calibration on Setup 7	B6
System-Gain Calibration on Setup 8	BE
System-Gain Calibration on Setup 9	C6
System-Gain Calibration on Setup 10	CE
System-Gain Calibration on Setup 11	D6
System-Gain Calibration on Setup 12	DE
System-Gain Calibration on Setup 13	E6
System-Gain Calibration on Setup 14	EE
System-Gain Calibration on Setup 15	F6
System-Gain Calibration on Setup 16	FE
<b>Miscellaneous Commands</b>	<b>Command</b>
Variable # of Normal Conversions	1F
Serial Port Initialization	3F
Reset Converter	4F
Arbitrary Read SDO	EF
Arbitrary Write SDI	FF

**Table 5. Microcontroller System Calibration Commands via RS-232**

## 2. PART II: SOFTWARE

### 2.1 Installation Procedure

To install the software:

- 1) Turn on the PC, running Windows 95™ or later.
- 2) Insert the Installation Diskette #1 into the PC.
- 3) Select the Run option from the Start menu.
- 4) At the prompt, type: A:\SETUP.EXE <enter>.
- 5) The program will begin installation.
- 6) If it has not already been installed on the PC, the user will be prompted to enter the directory in which to install the CVI Run-Time Engine™. The Run-Time Engine™ manages executables created with Lab Windows/CVI™. If the default directory is acceptable, select OK and the Run-Time Engine™ will be installed there.
- 7) After the Run-Time Engine™ is installed, the user is prompted to enter the directory in which to install the CDB5521/22/23/24/28 software. Select OK to accept the default directory.
- 8) Once the program is installed, it can be run by double clicking on the Eval5522 icon, or through the Start menu.

Note: Thesoftwareiswrittentorunwith640x480resolution; however, it will work with 1024 x 768 resolution. If the user interface seems to be a little small, the user might consider setting the display settings to 640 x 480. (640x480 was chosen to accommodate a variety of computers).

### 2.2 Using the Software

At start-up, the window Start-Up appears first (Figure 5). This window contains information concerning the software's title, revision number, copyright date, etc. Additionally, at the top of the screen is a menu bar which displays user options. Notice, the

menu bar item Menu is initially disabled. This eliminates any conflicts with the mouse or concurrent use of modems. Before proceeding any further, the user is prompted to select the serial communication port. To initialize a port, pull down option Setup from the menu bar and select either COM1 or COM2. After a port is initialized, it is a good idea to test the RS-232 link between the PC and the evaluation board. To do this, pull down the Setup menu from the menu bar and select the option TESTRS232. The user is then prompted to set the evaluation board's test switches to 011 and then reset the board. Once this is done, proceed with the test. If the test fails, check the hardware connection and repeat again. Otherwise, set the test switches to 000 (normal mode) and reset the board. The option Menu is now available and performance tests can be executed.

The evaluation software provides three types of analysis tests - Time Domain, Frequency Domain, and Histogram. The Time Domain analysis processes acquired conversions to produce a plot of Conversion Sample Number versus Magnitude. The Frequency Domain analysis processes acquired conversions to produce a magnitude versus frequency plot using the Fast-Fourier transform (results up to  $F_s/2$  are calculated and plotted). Also, statistical noise calculations are calculated and displayed. The Histogram analysis test processes acquired conversions to produce a histogram plot. Statistical noise calculations are also calculated and displayed (see Figures 4 through 9).

The evaluation software was developed with Lab Windows/CVI™, a software development package from National Instruments. More sophisticated analysis software can be developed by purchasing the development package from National Instruments (512-794-0100).

## 2.3 Menu Bars Overview

The menu bar controls the link between windows and allows the user to exit the program. It also allows the user to initialize the serial port and load presaved data conversions from a file. The six principal windows are the Start-Up, the Setup Window, the Power Spectrum Window (also referred to as the FFT window), the Histogram Window, the Time Domain Window, and the Calibrate Window.

Specifically, the menu bar has the following control items:

- **Menu**

To select, click on option Menu from the menu bar, or use associated hot keys. The items associated with MENU are listed and described below.

- *Start-Up Window* (F1)
- *Setup Window* (F2)
- *Power Spectrum Window* (F3)
- *Histogram Window* (F4)
- *Time Domain Window* (F5)
- *Calibrate Window* (F6)

These six menu items allow the user to navigate between the windows. They are available at all times via the menu bar or hot keys.

- **Setup**

To select, click on option Setup from the menu bar. The functions available under Setup are:

- *COM1* - When selected, COM1 is initialized to 9600 baud, no parity, 8 data bits, and 1 stop bit.
- *COM2* - When selected, COM2 is initialized to 9600 baud, no parity, 8 data bits, and 1 stop bit.
- *Load From Disk* - Used to load and display previously saved data conversions from a

file. The file must comply with the CDB-CAPTURE file save format. The format is: part number, throughput (or sample rate), number of conversions, maximum range, and the data conversions. The user is prompted to enter the path and file name of previously saved data. To prevent hardware conflicts, this option is deactivated while in the Setup Window.

- *TESTRS232* - This test mode tests the ability of the PC to communicate to the evaluation board. It consists of two subtests:
  - 1) test the link between the PC and the RS-232 interface circuitry; and
  - 2) test the RS-232 link between the PC and the microcontroller.
- HDR7 distinguishes these two subtests. Set HDR7 to Normal to test the complete communication link. Or set HDR7 to Loop Back to test the link between the RS-232 Circuitry and the PC. Then, set the test switches to 110 and reset the evaluation board. The LED's should indicate a binary six signifying that the hardware is ready to initiate the test. To complete the test, the user must initialize the PC. First, use the SETUP menu to select a communications port and then select the TESTRS232 option. From there, user prompts navigate the user through the test. The PC indicates if the test passes or fails. Once either test is complete, the LED's toggle to indicate that the test mode is complete.

- **Part**

Allows user to select a different converter.

- **Quit**

Allows user to exit program.



## 2.4 Setup Window Overview

The *Setup Window* (Figure 6) allows the user to read and write to the internal register of the converter in either binary or hexadecimal, and acquire real-time conversions. It has quick access control icons that quickly reset the converter, reset the converter's serial port, or self-calibrate the converter's offset and gain. The following are controls and indicators associated with this window.

- **Acquire Data**

This is a control icon. When pressed, the PC transmits the collect single conversion command to the microcontroller. The microcontroller in turn collects a conversion from the ADC and returns it to the PC. The PC stores the conversion and collects additional conversions to form a set. From the sample set collected, the high, the low, peak-to-peak, average, and standard deviation, are computed (the size of the data set is set by the Num To Average input) and then the display icons are updated. This process continues until the STOP button is pressed, or until another window is selected.

Note: The quick access control icons are disabled once Acquire is selected. This eliminates potential hardware conflicts.

- **Binary Icons**

Input icons array to set/clear the 24 individual bits in the configuration or channel-setup registers. The respective registers bit is set/cleared as soon as the icon is clicked.

- **Channel**

Selects the Setup that will be accessed to perform conversions when Acquire Data is activated.

- **Register Decode Box**

Text display box that displays the decoded meaning of each bit in the configuration register and the channel setup registers. Use the pull-

down menu above the register decode box to select between the different registers.

- **Hexadecimal Icons**

Nine input/display icons that allow a user to set/clear the 24 bits in the configuration, or channel setup registers via 6 hexadecimal nibbles. If the upper nibbles in the registers are zero's, the leading zero nibbles need not be entered.

- **Num To Average**

Input icon that sets the size of the data conversion set referred to after the Acquire Icon is activated.

- **Reinitialize Port**

This is a control icon. When pressed, 128 logic 1's followed by a logic '0' are sent to the ADC's serial port to reset its port. It does not reset the RS-232 link.

- **Reset A/D**

This is a control icon. When pressed, the microcontroller sends the appropriate commands to return the converter to its initial default state.

- **Stop**

Stops the collection of conversion data.

- **Update Icons**

This is a control icon. When pressed the configuration and channel -setup registers contents are acquired. Then, the configuration text box and the register content icons are updated.

- **Data FIFO Window**

This button opens the Data FIFO Window when pressed.

## 2.5 Data FIFO Window Overview

The following describes the controls available in the *Data FIFO Window* (Figure 7).

- **Acquire Data**

This icon begins a conversion cycle based on the selection of MC, LP, and RC. Depending on the status of these bits, the software will instruct the converter to do single conversions or collect data in the FIFO, and display the information on the screen. Pressing the STOP button will end the conversion cycle. All other icons are disabled during the conversion cycles to avoid hardware conflicts.

- **MC/LP/RC Selection**

This box allows the user to select between the different types of conversion cycles available by modifying the MC, LP, and RC bits in the configuration register (refer to the CS5521/22/23/24/28 data sheet for more information).

- **Channel**

Selects the Setup that will be accessed for single conversions (MC = 0). For MC = 1, this box is ignored.

- **Data FIFO Boxes**

These boxes display the information returned from the data FIFO buffer when MC = 1. For MC = 0, the single conversion will be displayed in box number 1.

- **Channel Data Boxes**

When using the CS5521/23, these boxes will contain the conversion channel information returned with the data word. When using the CS5522/24/28, these boxes will be inactive.

## 2.6 Histogram Window Overview

The following is a description of the controls and indicators associated with the Histogram Window (Figure 11). Many of the control icons are usable from the Histogram Window, the Frequency Domain Window, and the Time Domain Window. For brevity, they are only described in this section.

- **Bin**

Displays the x-axis value of the cursor on the Histogram.

- **Cancel**

Once selected, it allows a user to exit from the COLLECT algorithm. If data conversion sample sets larger than 64 are being collected and the CANCEL button is selected, it is recommended that the user reset the evaluation board. The board will eventually recover from the continuous collection mode, but the recovery time could be as long as 10 minutes.

- **Channel**

Selects the Setup that will be accessed to perform conversions when COLLECT is activated.

- **Collect**

Initiates the data conversion collection process. COLLECT has two modes of operation: collect from file or collect from converter. To collect from a file an appropriate file from the SETUP-DISK menu bar option must be selected. Once a file is selected, its content is displayed in the graph. If the user is collecting real-time conversions to analyze, the appropriate COM port must be selected. The user is then free to collect the preset number of conversions (preset by the CONFIG pop-up menu discussed below). Notice, there is a significant acquisition time difference between the two methods.

- **Config**

Opens a pop-up panel to configure how much data is to be collected, and how to process the data once it is collected. The following are controls and indicators associated with the CONFIG panel.

- *Samples* - User selection of 16, 32, 64, 128, 256, 512, 1024, 2048, 4096, or 8192 conversions.

- *Window* - Used in the Power Spectrum Window to calculate the FFT. Windowing algorithms include the Blackman, Blackman-Harris, Hand, 5-term Hodia, and 7-term Hodia. The 5-term Hodia and 7-term Hodia are windowing algorithms developed at Crystal Semiconductor. If information concerning these algorithms is needed, call technical support.
- *Average* - Sets the number of consecutive FFT's to perform and average.
- *Limited Noise Bandwidth* - Limits the amount of noise in the converters bandwidth. When set to zero, no limited noise calculations are done.
- *FFT Bandwidth* - Used in the Power Spectrum Window to allow user-scalability of the frequency axis. When set to zero, the axis is auto-scaled to one-half the output word rate.
- *OK* - Accept the changes
- **MAGNITUDE**  
Displays the y-axis value of the cursor on the Histogram.
- **MAXIMUM**  
Indicator for the maximum value of the collected data set.
- **MEAN**  
Indicator for the mean of the data sample set.
- **MINIMUM**  
Indicator for the minimum value of the collected data set.
- **Output**  
Control that calls a pop-up menu. This menu controls three options:
  - 1) save current data set to a file with the CDB-CAPTURE format
  - 2) print current screen, or
  - 3) print current graph.
- **RESTORE**  
Restores the display of the graph after zoom has been entered.
- **STD. DEV.**  
Indicator for the Standard Deviation of the collected data set.
- **VARIANCE**  
Indicates the Variance for the current data set.
- **ZOOM**  
Control icon that allows the operator to zoom in on a specific portion of the current graph. To zoom, click on the ZOOM icon, then click on the graph to select the first point (the 1st point is the top left corner of the zoom box). Then click on the graph again to select the second point (the 2nd point is the bottom right corner of the zoom box). Once an area has been zoomed in to, the OUTPUT functions can be used to print a hard copy of that region. Click on RESTORE when done with the zoom function.

## 2.7 Frequency Domain Window (i.e. FFT)

The following describe the controls and indicators associated with the *Frequency Domain Analysis* (Figure 8).

- **CANCEL**  
See description in *Section 2.6, Histogram Window Overview*.
- **Channel**  
See description in *Section 2.6, Histogram Window Overview*.
- **COLLECT**  
See description in *Section 2.6, Histogram Window Overview*.

- **Config**  
See description in *Section 2.6, Histogram Window Overview*.
- **FREQUENCY**  
Displays the x-axis value of the cursor on the FFT display.
- **MAGNITUDE**  
Displays the y-axis value of the cursor on the FFT display.
- **Output**  
See description in *Section 2.6, Histogram Window Overview*.
- **S/D**  
Indicator for the Signal-to-Distortion Ratio, 4 harmonics are used in the calculations (decibels).
- **S/N+D**  
Indicator for the Signal-to-Noise + Distortion Ratio (decibels).
- **SNR**  
Indicator for the Signal-to-Noise Ratio, first 4 harmonics are not included (decibels).
- **S/PN**  
Indicator for the Signal-to-Peak Noise Ratio (decibels).
- **ZOOM**  
See description in *Section 2.6, Histogram Window Overview*.
- **# of AVG**  
Displays the number of FFT's averaged in the current display.

## 2.8 Time Domain Window Overview

The following controls and indicators are associated with the *Time Domain Analysis* (Figure 10).

- **CANCEL**  
See description in *Section 2.6, Histogram Window Overview*.
- **Channel**  
See description in *Section 2.6, Histogram Window Overview*.
- **COLLECT**  
See description in *Section 2.6, Histogram Window Overview*.
- **Config**  
See description in *Section 2.6, Histogram Window Overview*.
- **COUNT**  
Displays current x-position of the cursor on the time domain display.
- **MAGNITUDE**  
Displays current y-position of the cursor on the time domain display.
- **MAXIMUM**  
Indicator for the maximum value of the collected data set.
- **MINIMUM**  
Indicator for the minimum value of the collected data set.
- **Output**  
See description in *Section 2.6, Histogram Window Overview*.
- **ZOOM**  
See description in *Section 2.6, Histogram Window Overview*.

## 2.9 Calibration Window Overview

The following controls and indicators are associated with the *Calibration Menu* (Figure 9).

- **GAIN DECODE**

Eight display boxes that displays the decoded meaning of each gain register.

- **Gain Hexadecimal Icons**

Eight input/display icons that allow a user to set/clear the 24 bits in the eight gain registers via 6 hexadecimal nibbles. If the upper nibbles in the registers are zero's, then leading zero nibbles need to be entered.

- **Offset Hexadecimal Icons**

Eight input/display icons that allow a user to set/clear the 24 bits in the eight offset registers via 6 hexadecimal nibbles. If the upper nibbles in the registers are zero's, then leading zero nibbles need to be entered.

- **Self-Gain**

Used to perform a self-gain calibration using the chosen Setup.

- **Self-Offset**

Used to perform a self-offset calibration using the chosen Setup.

- **Shift Gain Register**

Sixteen input icons used to shift the contents on the gain registers either 1 bit left or right. Once shifted the data at the respective gain registers ends is lost.

- **System-Gain**

Used to perform a system-gain calibration using the chosen Setup.

- **System-Offset**

Used to perform a system-offset calibration using the chosen Setup.

- **Update Icons**

This is a control icon. When pressed the offset and gain registers are read. Then, the register content icons are updated.

## 2.10 Trouble Shooting the Evaluation Board

This section describes special test modes incorporated in the microcontroller software to diagnose hardware problems with the evaluation board.

Note: To enter these modes, set the test switches to the appropriate position and reset the evaluation board. To re-enter the normal operation mode, set the switches back to binary zero and reset the board again.

- **Test Mode 0, Normal Mode**

This is the default mode of operation. To enter this mode, set the test switches to 000 and reset the board. The evaluation board allows normal read/writes to the ADC's registers. All the LED's toggle on then off after reset, and then only when communicating with the PC.

- **Test Mode 1, Loop Back Test**

This test mode checks the microcontroller's on-chip UART. To enter this mode, set test switches to 001, set HDR7 for loop back, and then reset the board. If the communication works, all the LED's toggle. Otherwise, only 1/2 of the LED's toggle to indicate a communication problem.

- **Test Mode 2, Read/Write to ADC**

This test mode tests the microcontroller's ability to read and write to the ADC. To enter this mode, set the switches to 010 and reset the board. In this test mode, the ADC's configuration, offset, and gain registers are written to and then read from. If the correct data is read back, all the LED's toggle. Otherwise, only half of them toggle to indicate an error.

- **Test Mode 3, Continuously Acquire Single Conversion**

This test mode repetitively acquires a single conversion. To enter this mode, set the test switches to 011 and press reset. A binary three is indicated on the LED's. By probing HDR6 and using  $\overline{CS}$  as a triggering pin, an oscilloscope or logic analyzer will display in real-time how the microcontroller reads conversion data.

- **Test Mode 4**

Reserved for future modifications.

- **Test Mode 5, Continuously Read Gain Register**

This test mode repetitively acquires the gain registers default contents (0x800000 HEX). To enter this mode, set the test switches to 101 and press reset. The LED's should indicate a binary five. By probing HDR6 and using  $\overline{CS}$  as a triggering pin, an oscilloscope or logic analyzer will display in real-time how the microcontroller acquires a conversion.

- **Test Mode 6, PC to Microcontroller RS-232 Communication Link Test**

This test mode tests the ability of the PC to communicate to the evaluation board. It consists of two subtests:

- 1) test the link between the PC and the RS-232 interface circuitry; and

- 2) test the RS-232 link between the PC and the microcontroller.

HDR7 distinguishes these two subtests. Set HDR7 to Normal to test the complete communication link. Or set HDR7 to Loop Back to test the link between the RS-232 Circuitry and the PC. Then, set the test switches to 110 and reset the evaluation board. The LED's should indicate a binary six signifying that the hardware is ready to initiate the test. To complete the test, the user must initialize the PC. First, use the SETUP menu to select a communications port and then select the TESTRS232 option. From there, user prompts navigate the user through the test. The PC indicates if the test passes or fails. Once either test is complete, the LED's toggle to indicate that the test mode is complete.

- **Test Mode 7, Toggle LED's**

This test mode tests the evaluation board LED's. To enter this mode, set the test switches to 111 and reset the board. If the mode passes, the LED's toggle.

Note: Remember, to return to the normal operating mode, set the test switches to binary zero, return HDR7 to Normal, and reset the evaluation board.

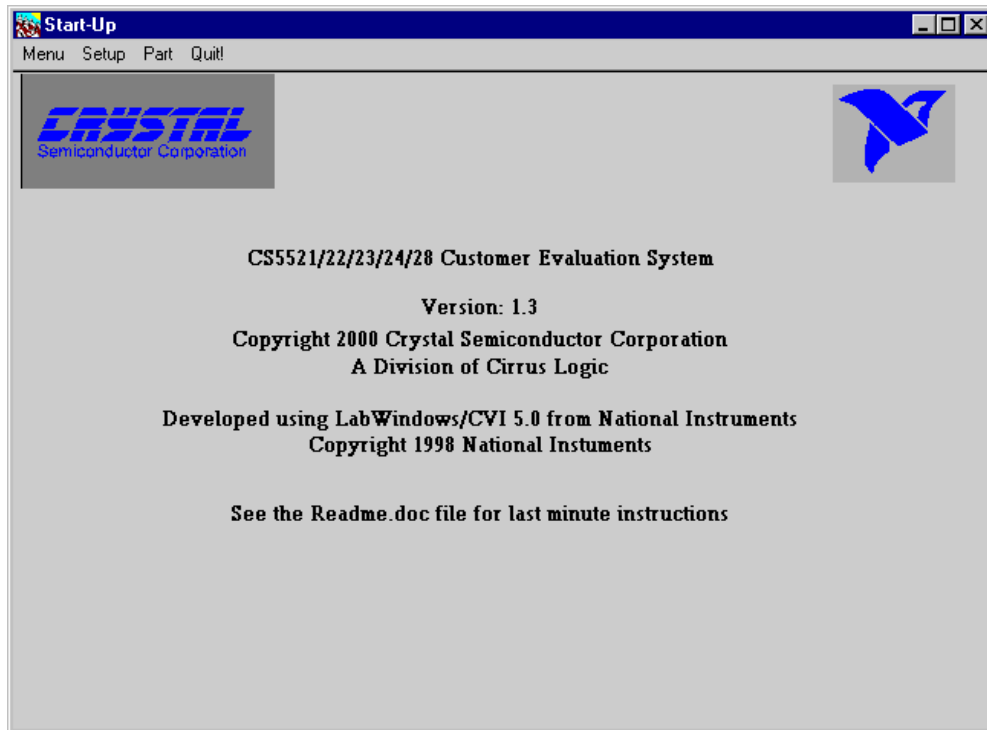


Figure 5. Main Menu

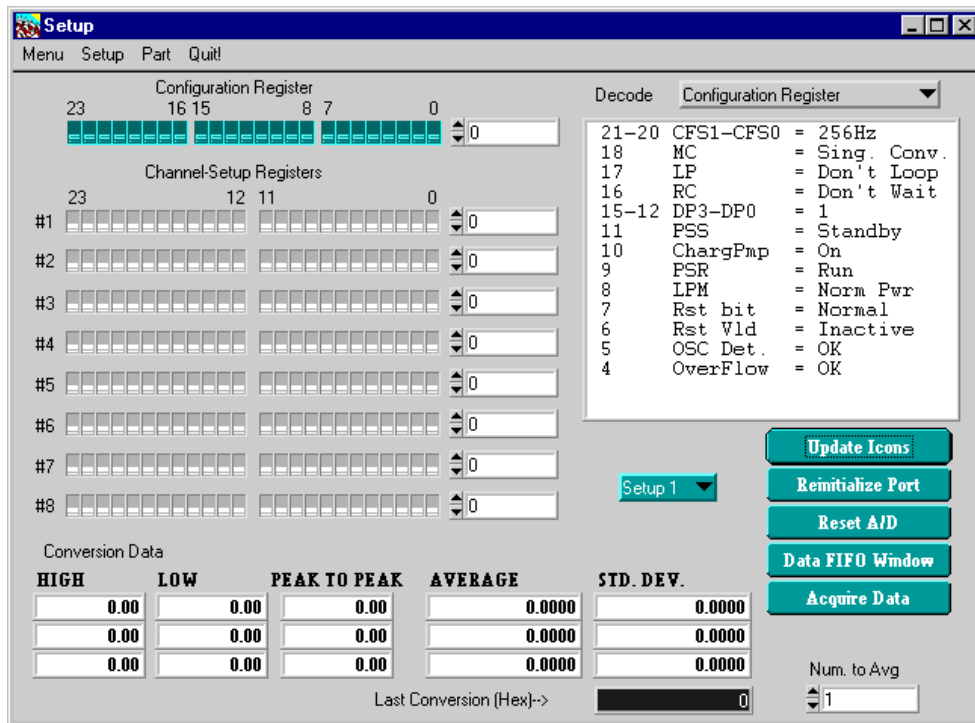


Figure 6. Setup Window



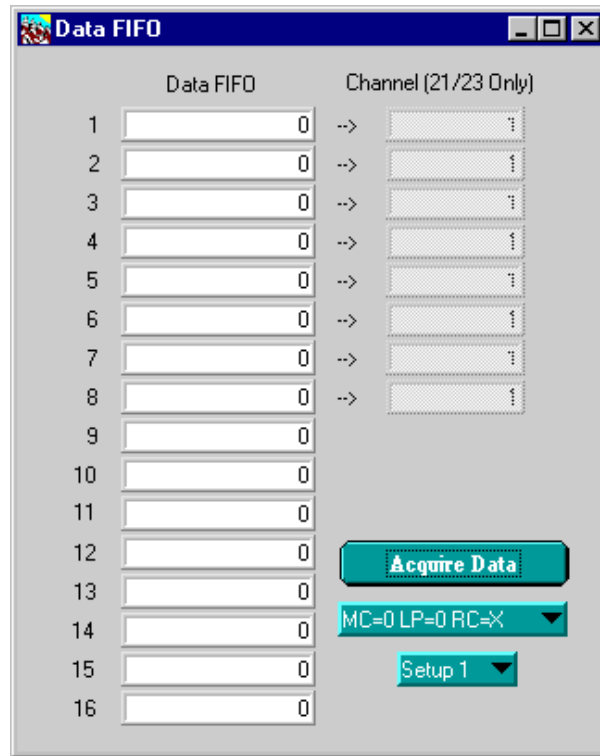


Figure 7. Data FIFO Window

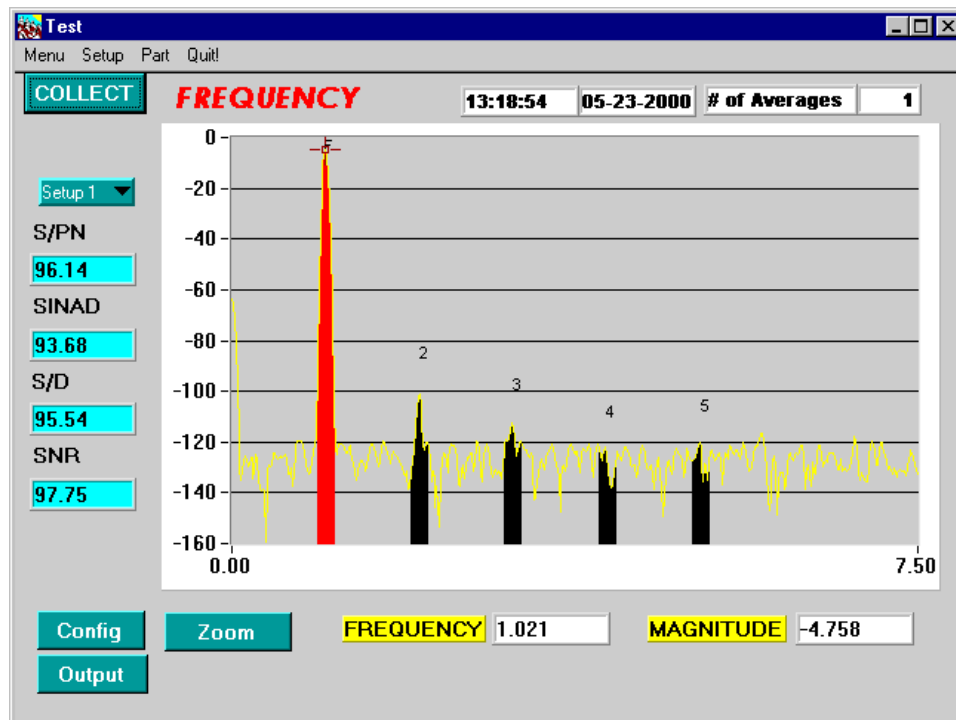


Figure 8. Frequency Domain Analysis

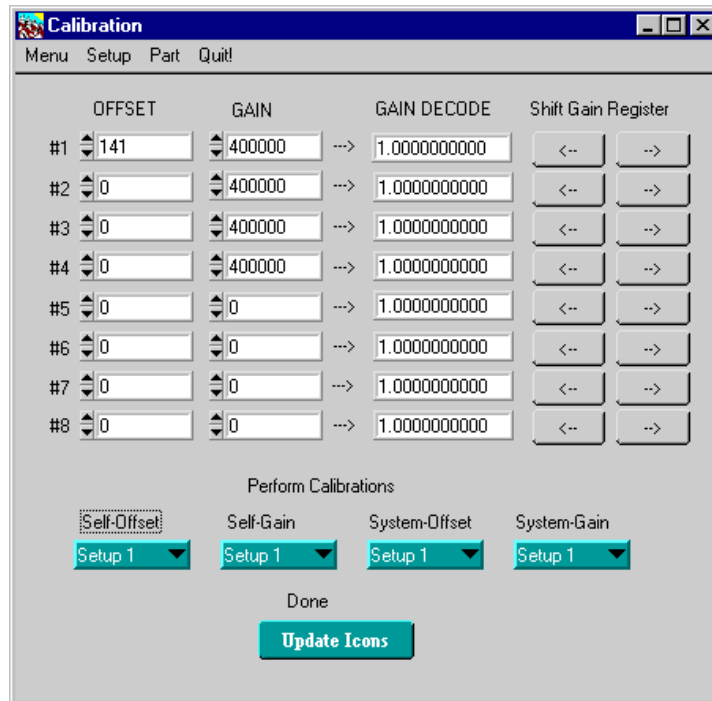


Figure 9. Calibration Menu

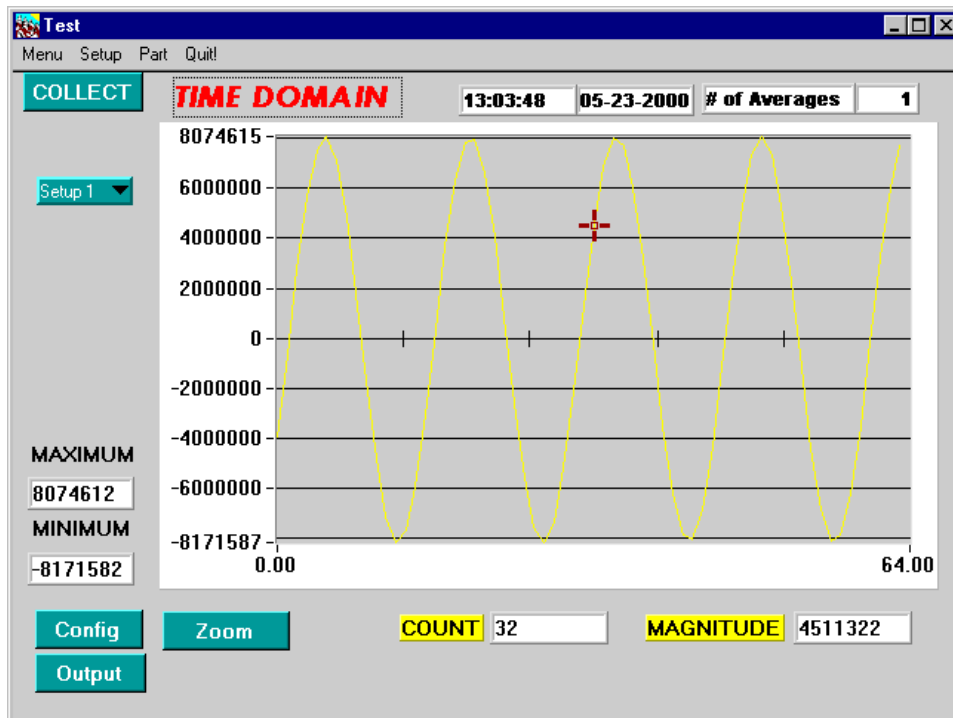


Figure 10. Time Domain Analysis

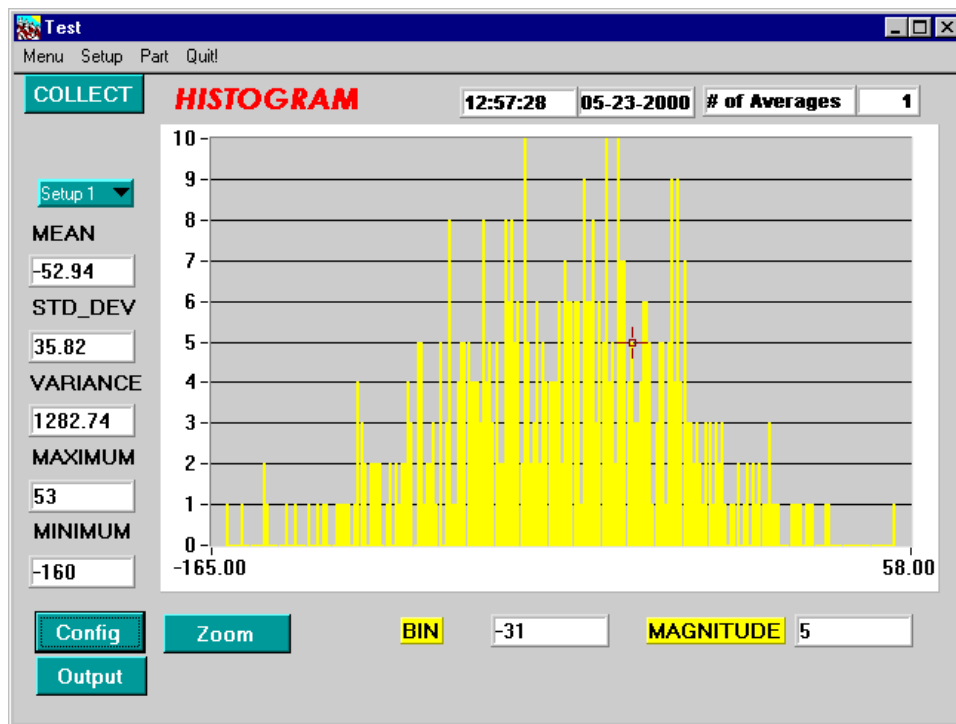
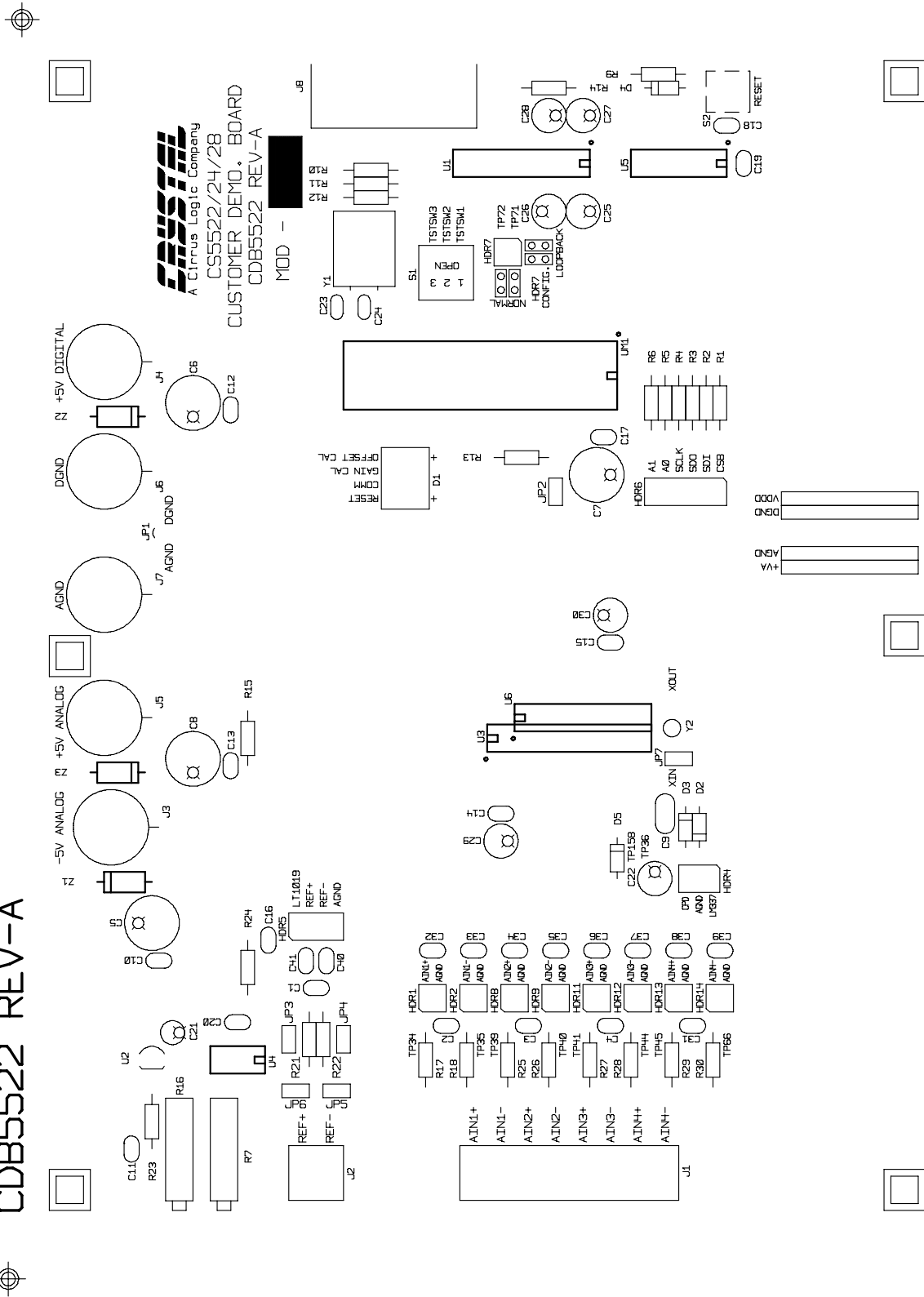


Figure 11. Histogram Analysis (Using the CS5524 with default register settings and 24-bit output words)

**CRYSTAL SEMICONDUCTOR  
CDB5522 CUSTOMER DEMO BOARD  
CDB5522 REV-A**



SILKSCREEN - TOP

Figure 12. CDB5521/22/23/24/28 Component Side Silkscreen