

## CDB5534U Evaluation Board and Software

### Features

- USB Communication with PC
- On-board Microcontroller
- On-board Voltage Reference
- Evaluation Software
  - Register Setup & Chip Control
  - FFT Analysis
  - Time Domain Analysis
  - Noise Histogram Analysis
- Interface Header for External Microcontroller

### General Description

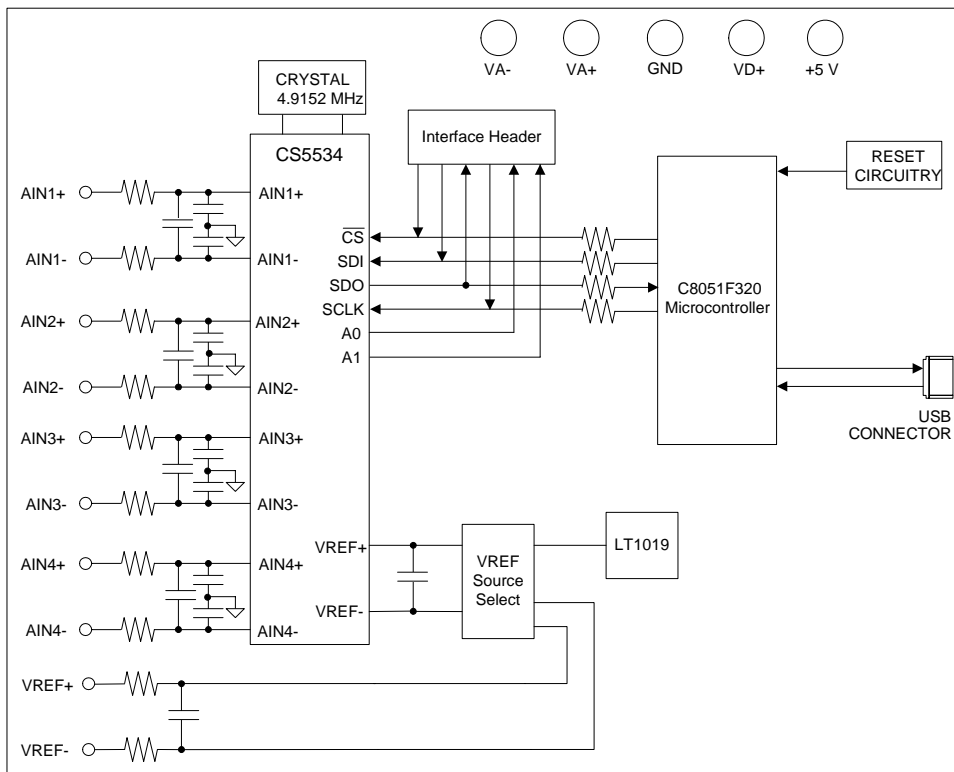
The CDB5534U is an inexpensive tool designed to evaluate the functionality and performance of the CS5534. The CS5534 datasheet should be read and consulted when using the CDB5534U evaluation board.

The evaluation board includes a C8051F320 microcontroller with a USB interface. The microcontroller controls the serial communication between the evaluation board and the PC via the firmware, enabling quick and easy access to all of the CS5534's registers and functions.

The CDB5534U includes software for Data Capture, Time Domain Analysis, Histogram Analysis, and Frequency Domain Analysis.

**ORDERING INFORMATION**  
CDB5534U

Evaluation Board



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## 1. HARDWARE

### 1.1 Introduction

The CDB5534U evaluation board provides a quick means of evaluating the CS5534 Analog-to-Digital Converter (ADC). The CS5534 is a highly integrated  $\Delta\Sigma$  ADC which uses charge-balance techniques to achieve 24-bit performance. The CS5534 includes a very low noise chopper-stabilized instrumentation amplifier (6 nV/sqrt(Hz) @ 0.1 Hz) with selectable gains of 1x, 2x, 4x, 8x, 16x, 32x, and 64x. This ADC also includes a fourth order  $\Delta\Sigma$  modulator followed by a digital filter which provides twenty selectable output word rates of 6.25 Hz, 7.5 Hz, 12.5 Hz, 15 Hz, 25 Hz, 30 Hz, 50 Hz, 60 Hz, 100 Hz, 120 Hz, 200 Hz, 240 Hz, 400 Hz, 480 Hz, 800 Hz, 960 Hz, 1.6 kHz, 1.92 kHz, 3.2 kHz and 3.84 kHz (XIN = 4.9152 MHz).

The CDB5534U is shipped with a CS5534 device soldered at U2. However, the CS5531, CS5532, or CS5533 can be soldered in this same location. The CDB5534U software supports all four devices.

### 1.2 Evaluation Board Overview

The CDB5534U evaluation board is partitioned into two main sections: analog and digital. The analog section consists of the CS5534 and a precision voltage reference. The digital section consists of the microcontroller, the reset circuitry, and the USB interface. The board also has power supply connections which accommodate all of the various supply options of the CS5534.

The evaluation board's analog section operates from either a single +5 V, dual  $\pm 2.5$  V, or dual  $\pm 3$  V power supply. The evaluation board interfaces the CS5534 to an IBM® compatible PC with a USB interface. To accomplish this, the board comes equipped with a microcontroller and a USB cable which physically interfaces the evaluation board to the PC. The software provides easy access to the internal registers of the CS5534, and provides a means to display and evaluate the performance of the ADC in the time domain or the frequency domain.

#### 1.2.1 Analog Section

The CS5534 is a high precision  $\Delta\Sigma$  converter designed to accurately measure up to four fully-differential analog voltage inputs while operating from a 4.9152 MHz crystal.

The evaluation board provides separate screw terminals to connect signals to each of the four input channels. The input screw terminals are labeled as AIN1 through AIN4, which correspond to physical input channels 1 through 4 respectively. A simple RC network on each channel filters the sensor's output to reduce any interference picked up by the input leads. The 3 dB corner of the filter is approximately 52 kHz differential and 56 kHz common mode. Figure 1 illustrates the schematic of the analog section.

The evaluation board provides three voltage reference options for VREF+ and VREF-. The three reference options for VREF+ include: VA+, the on-board LT1019 voltage reference, and external input (J12). Table 1 illustrates the options available. With the J17 jumper in position VA+, the reference is supplied by the VA+ analog supply. With the J17 jumper in position LT1019, the LT1019 provides a +2.5 V reference (the LT1019 was chosen for its low drift, typically 5ppm/°C). By setting the J17 jumper to position VREF+, the user can supply an external voltage reference to J12's VREF+ input.

The three reference options for VREF- include: VA-, GND, and external input (J12). Table 2 illustrates the options available. With the J18 jumper in position VA-, the reference is supplied by the VA- analog supply. With the J18 jumper in position GND, the VREF- pin is connected to the board ground. By setting the J18 jumper to position VREF-, the user can supply an external voltage reference to J12's VREF- input.

**Table 1. Voltage Reference Selection for VREF+**

Reference	Description	J17
VA+	Selects Positive Analog Power Supply	VA+ <input checked="" type="radio"/> VREF+ LT1019 <input type="radio"/> VREF+ REF+ <input type="radio"/> VREF+
LT1019	Selects on-Board LT1019 Reference (5ppm/°C)	VA+ <input type="radio"/> VREF+ LT1019 <input checked="" type="radio"/> VREF+ REF+ <input type="radio"/> VREF+
VREF+	Selects External Reference Source (J12)	VA+ <input type="radio"/> VREF+ LT1019 <input type="radio"/> VREF+ REF+ <input checked="" type="radio"/> VREF+

**Table 2. Voltage Reference Selection for VREF-**

Reference	Description	J18
VA-	Selects Negative Analog Power Supply	VA- <input checked="" type="radio"/> VREF- GND <input type="radio"/> VREF- REF- <input type="radio"/> VREF-
GND	Selects Board Gnd	VA- <input type="radio"/> VREF- GND <input checked="" type="radio"/> VREF- REF- <input type="radio"/> VREF-
VREF-	Selects External Reference Source (J12)	VA- <input type="radio"/> VREF- GND <input type="radio"/> VREF- REF- <input checked="" type="radio"/> VREF-

### 1.2.2 Digital Section

Figure 2 illustrates the schematic of the digital section. It contains the microcontroller, USB interface, EEPROM, JTAG header, reset circuitry, and an external interface header. The microcontroller interfaces the SPI™ and MICROWIRE™ compatible serial port of the CS5534 with the USB connection to the PC. Note that the SCLK and SDI signals are level shifted to support both +3.3 V and +5 V digital operation.

The microcontroller EEPROM is used to store firmware. An external interface header, J19, is provided to allow the CDB5534U to be interfaced with an external microcontroller. To use this serial interface, the 0 ohm resistors R9, R10, R23, and R27 should be removed to disconnect the on-board microcontroller from the serial interface.

### 1.2.3 Power Supply Section

Figure 3 illustrates the power supply connections to the evaluation board. VA+ supplies the positive analog supply for the CS5534 and the LT1019 reference. Header J14 allows the VA+ supply to be sourced from either the VA+ binding post (J2), or from the +5 V binding post (J3). VA- supplies the negative analog supply for the analog section. Header J13 allows the VA- supply to be sourced from either the VA- binding post (J1), or connected to the board ground. Note that the VA- supply should be connected to ground when powering the CDB5534U from a single +5 V analog supply. VD+ supplies the digital section of the ADC and level shifters. Header J15 allows the VD+ supply to be sourced from the VD+ binding post (J5),

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the +5 V binding post (J3), or the regulated +3.3 V supply derived from the microcontroller. The +5 V binding post supplies the microcontrollers internal regulator.

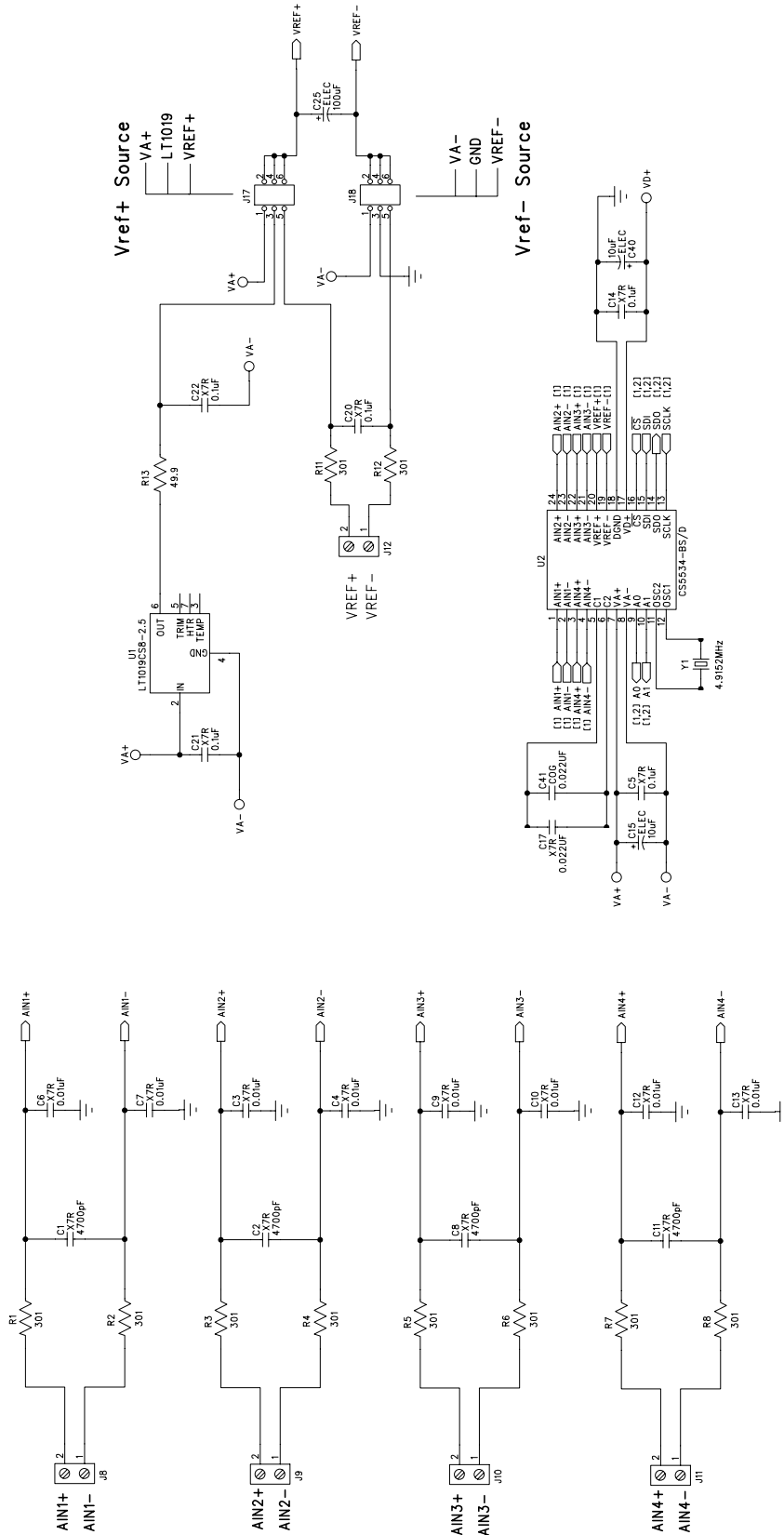
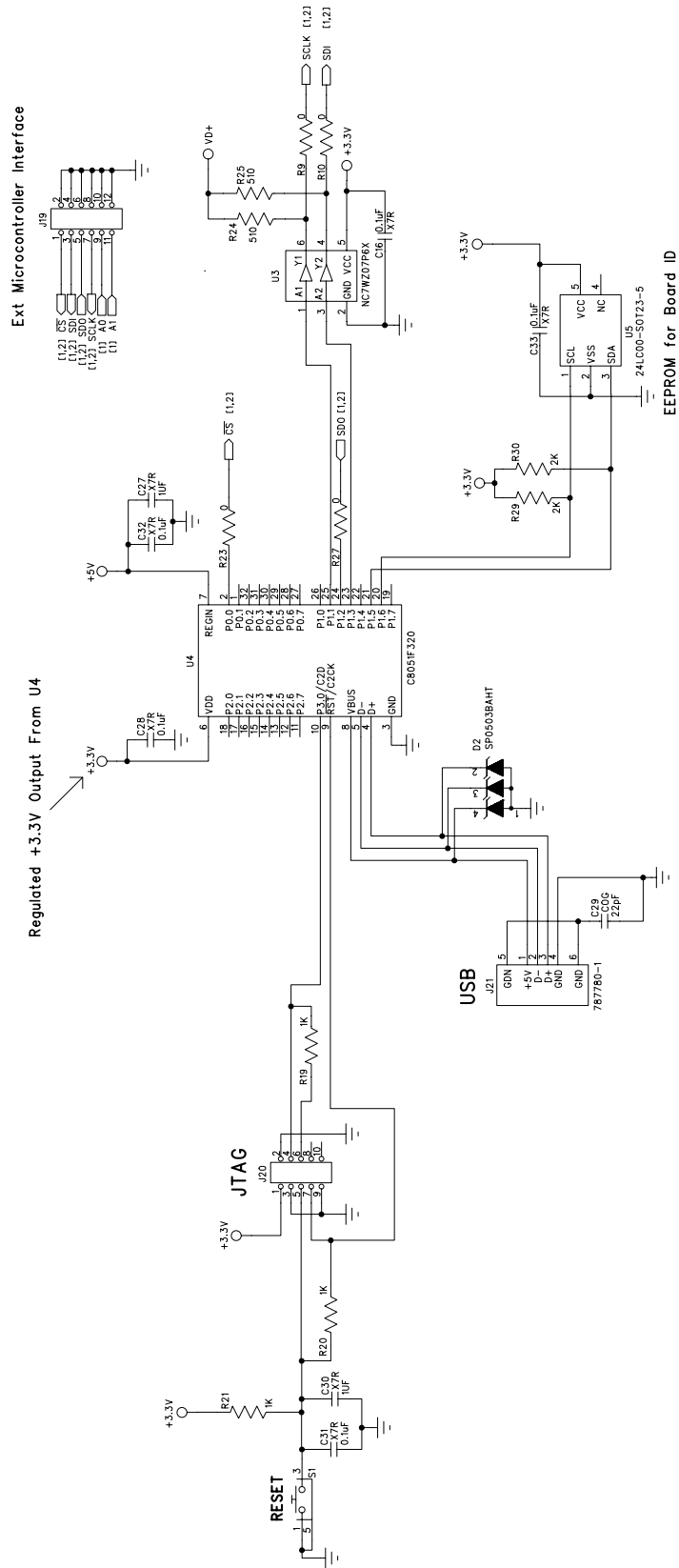


Figure 1. Analog Section


**Figure 2. Digital Section**

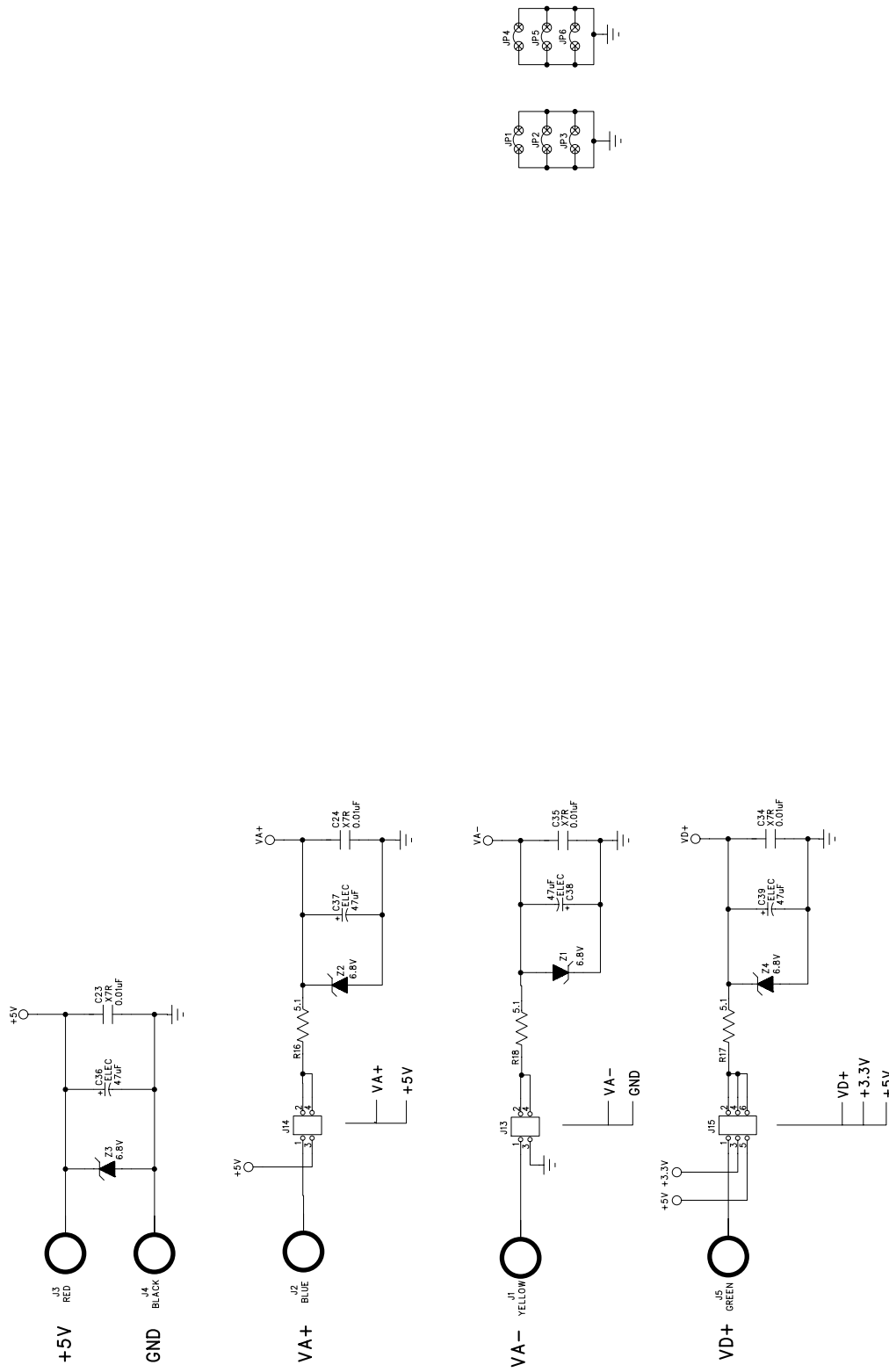


Figure 3. Power Supply



## 2. SOFTWARE

The evaluation board comes with software and a USB cable to link the evaluation board to the PC. The software is designed to run under Windows® 2000 or later.

### 2.1 Installation Procedure

#### 2.1.1 CDB5530U GUI Software Installation Instructions

1. Ensure the CDB5534U USB cable is disconnected from the PC.
2. Open GUI software installation folder *CDB553x\_cvidistkit.Eval5534U* ⇒ *Volume1*.
3. Run *SETUP.EXE* by double clicking on the filename.
4. Select *Next, I Accept License Agreement, Next, Next, Finish*.

#### 2.1.2 Installing the USB Drivers

1. Apply power to the CDB5534U. Press and release the Reset switch, S1.
2. Use the included USB cable to connect the CDB5534U to the PC. The PC operating system should automatically launch the *Found New Hardware* wizard.
3. From the installation wizard, select *Install from a list or specific location (Advanced)*. Select *Search for the best driver in these locations*.
4. Select *Include this location in the search*.
5. Click the *Browse...* button.
6. Go to folder *C:/Program Files/Eval5534U/Driver* and click *OK*.
7. Press the *Next* button.
8. A *Hardware Installation* dialog will appear. Press *Continue Anyway*.
9. Select *Browse...* and go to folder *C:/Program Files/Eval5534U/Driver*. Press *Open*.
10. A *Files Needed* dialog will appear. Press *OK*.
11. The *Found New Hardware* wizard will appear. Press the *Finish* button.

#### 2.1.3 Running the GUI

Run the program by selecting *Start* ⇒ *All Programs* ⇒ *Eval5534U* ⇒ *Eval5534\_U*.

### 2.2 Using the Software

Before launching the evaluation program, the user should set up the CDB5534U evaluation board, select the proper jumper settings as described in Section 1, ensure the board is connected to an open USB port on the PC, and apply power to the board.

## 2.2.1 Start-Up Window

When the evaluation program is launched, the Start-Up window will appear. This window contains information concerning the software's title, revision number, copyright date, etc.

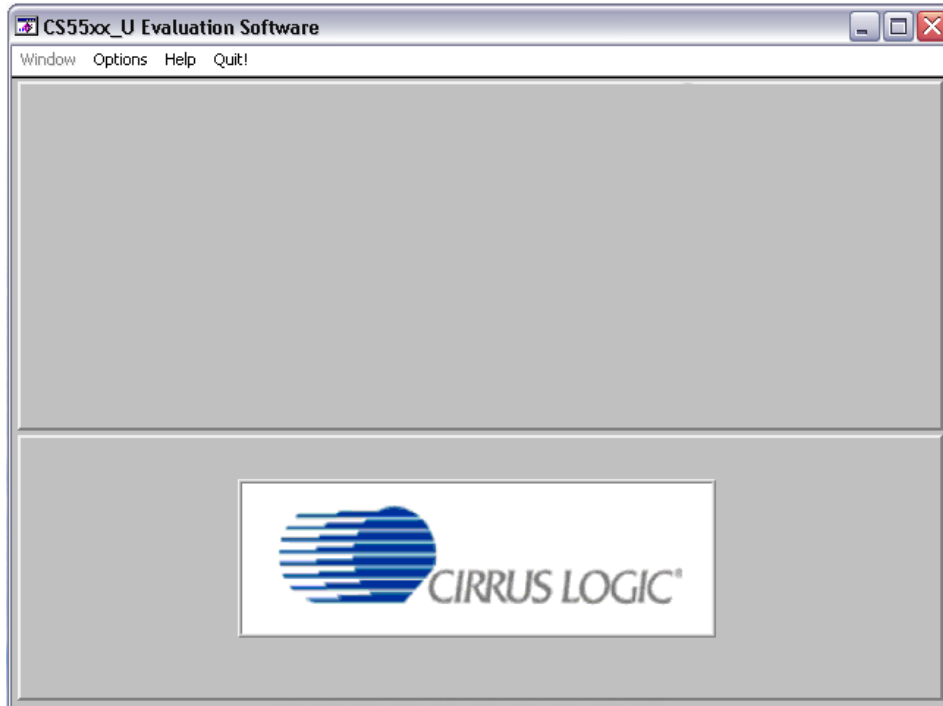


Figure 4. CDB5534U Start-Up Screen

At the top of the screen is a menu bar which displays user options. The menu bar item *Window* is initially disabled to prevent conflicts with other serial communications devices. After selecting the data source in the *Options* menu, the *Window* menu item will become available.

### 2.2.1.1 Options

The *Options* menu item allows the user to select the source of the data and to configure the appearance of the graphs. The user has two options for the data source: USB and File. If the USB setup is selected, the evaluation software will be ready to communicate with the CDB5534U via the USB connection. At this point, the *Part* menu item is active and the appropriate CS553x device can be selected. If the File source is selected, the evaluation software will prompt the user to select the appropriate data file. This option allows the user to view previously captured data without having a CDB5534U connected to the PC. See Section 2.5 for more details.

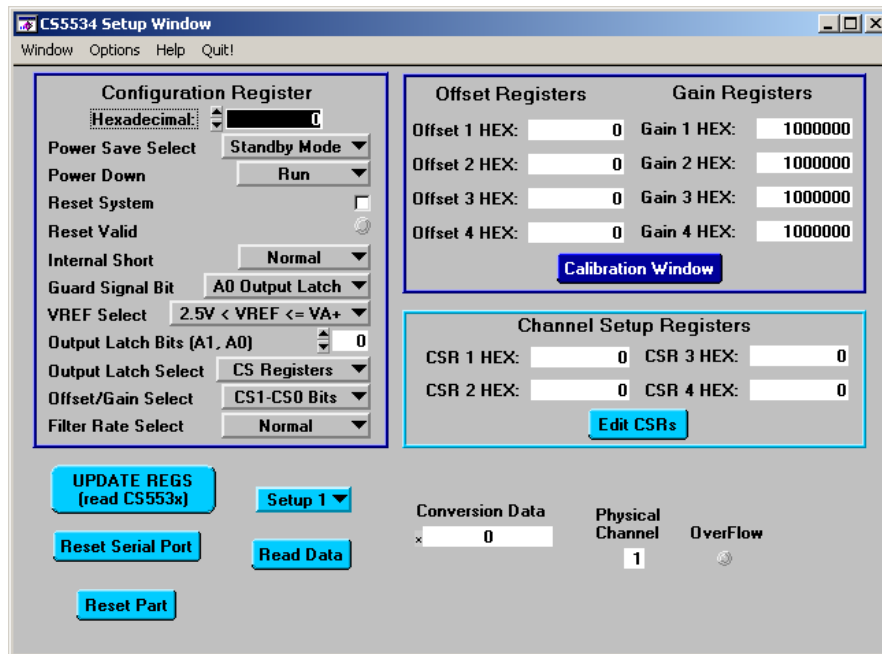
The plot options window can be accessed by pulling down the *Options* menu and clicking on *Plot Options*. In this window, the user can change the background color, the plot line color, and the peak indicator color. The harmonic and peak indicators can also be turned on or off in this window.

### 2.2.1.2 Window

After the user selects the appropriate setup, the *Window* option becomes available in the Start-Up window. The Window pull-down has three options: Start-Up Window, Setup Window, and Data Collection Window.

### 2.2.2 Setup Window

The Setup Window allows the user to access the internal registers of the CS5534. See Figure 5.



**Figure 5. CDB5534U Setup Window**

In the Setup Window, all of the ADC's registers are displayed as hexadecimal values. The Configuration Register's settings are also defined in this window.

**Update Registers:** The Update Registers button will read all the register values from the CS5534 and update the hexadecimal values displayed on the screen. It is a good idea to press the Update Registers button when entering the Setup Window, or after modifying any registers to reflect the current status of the part.

**Reset Serial Port:** When this button is selected, the software will send the synchronization sequence discussed in the CS5534 datasheet to the ADC. This sequence brings the CS5534's serial port back to the command mode, but does not reset any of the registers in the part.

**Reset Part:** When this button is selected, a '1' is written to the RS bit in the Configuration Register to reset the part. After a reset, the registers will all return to their default values as discussed in the CS5534 datasheet.

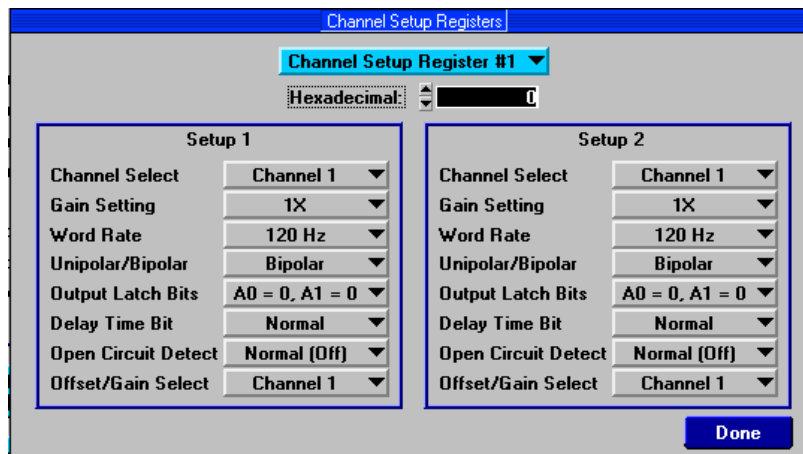
**Read Data:** This button will instruct the ADC to begin performing repeated single (fully-settled) conversions on the setup channel specified by the Setup Register box. The results of the most recent conversion

are displayed in the “Last Conversion” box, as well as the Channel and Overflow indicator bits for each conversion. The software will halt the data collection process when the user selects the Stop button.

**Configuration Register:** In the Configuration Register box, the contents of the Configuration Register are displayed, and can be modified by typing a hexadecimal value in the *Hexadecimal:* box, or by changing any of the values below the *Hexadecimal:* box to the desired settings. Note: When changing the value of the reset system bit to ‘1’ (RS, bit 29 in the Configuration Register), the part will be reset, and all registers will return to their default values. It is a good idea to select the Update Registers button after performing a reset to update the screen with the new register values.

**Channel Setup Registers:** In the Channel Setup Registers box, all four Channel Setup Registers are displayed in hexadecimal. These registers can be modified from the Channel Setup Register Window, which is accessed by selecting the *Edit CSRs* button.

**Channel Setup Register Window:** In the Channel Setup Register Window (Figure 6), each of the four CSRs can be decoded and modified. The blue box at the top of the window allows the user to switch between CSRs. Each 32-bit CSR contains two 16-bit “Setups” which are decoded in the two boxes below the hexadecimal value. The currently displayed CSR can be modified by either typing a value directly in the Hexadecimal: box or by changing the decoded values in the individual Setup boxes.

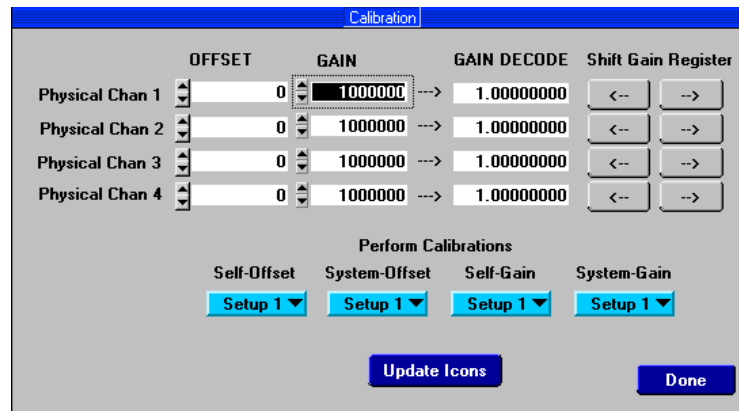


**Figure 6. CDB5534U Channel Setup Register Window**

**Offset / Gain Registers:** In the Offset Registers / Gain Registers box, the offset and gain registers for all channels are displayed in hexadecimal. These registers can all be modified in the Calibration Window, which is accessed when the user selects the Calibration Window button.

**Calibration Window:** The Calibration Window (Figure 7) permits the user to access the calibration registers for each channel of the CS5534 and also perform self and system offset or gain calibrations on any of the channels. Prior to performing calibrations however, the Channel Setup Registers should be modified to configure the part for the desired operating mode (see the section on the Channel Setup Register

Window for more details). Note that offset calibration should be performed before gain calibration to ensure accurate results. Refer to the CS5534 datasheet for more details.



**Figure 7. CDB5534U Calibration Window**

*Self Offset or Gain Calibrations:*

- 1) Pull down the Self Offset or Self Gain box, and select the setup number you want to use to calibrate the channel.
- 2) The offset and gain register values will automatically update when the calibration is completed.

*System Offset Calibrations:*

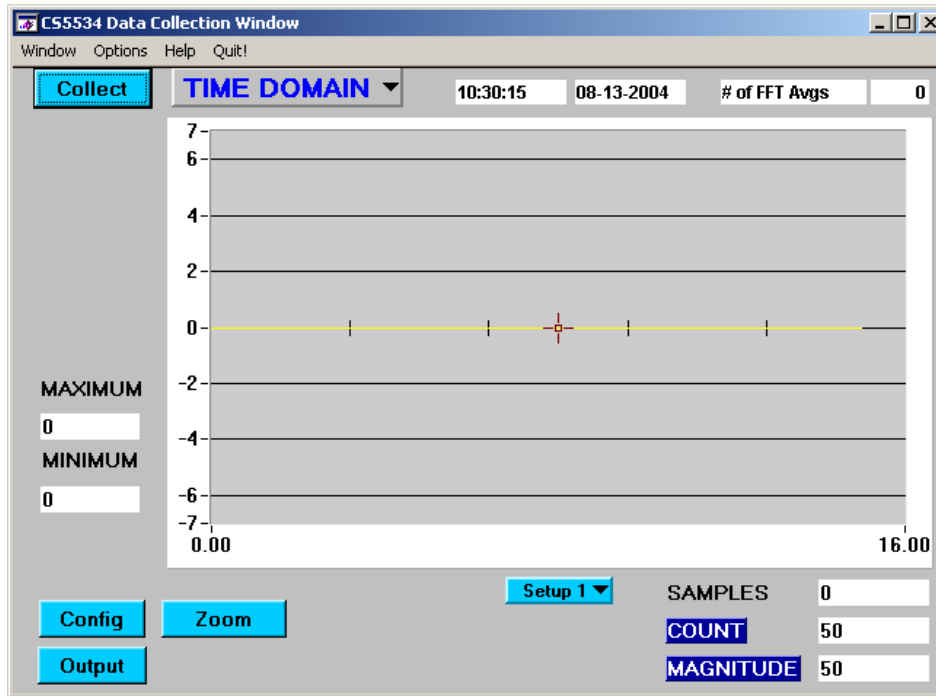
- 1) Attach a grounded input to the physical channel you want to calibrate. Note that the grounded input must be within the common mode range of the particular amplifier (1X-64X) for proper operation.
- 2) Pull down the System Offset box, and select the setup number you want to use to calibrate the channel.
- 3) When the calibration is complete, the screen will automatically update the offset and gain registers with the new values.

*System Gain Calibrations:*

- 1) Attach a full-scale input to the physical channel you want to calibrate.
- 2) Pull down the System Gain box, and select the setup number you want to use to calibrate the channel.
- 3) When the calibration is complete, the screen will automatically update the offset and gain registers with the new values.

### 2.2.3 Data Collection Window

The Data Collection Window (Figure 8) allows the user to collect sample sets of data from the CS5534 and analyze them using time domain, FFT, and histogram plots. The Data Collection Window is accessible through the *Window* option, or by pressing F3.



**Figure 8. CDB5534U Data Collection Window**

**Time Domain / FFT / Histogram Selector:** This menu selects the type of data processing to perform on the collected data and display in the plot area. Refer to the section on Analyzing Data for more information.

**Collect Button:** This button will collect data from the part, to be analyzed in the plot area. See the section on Collecting Data Sets for more information.

**Config Button:** This button will bring up the configuration window, in which the user can modify the data collection specifications. See the discussion of the Config Window in this document.

**Output Button:** This button will bring up a window in which the user can output the data to a data file for later use, print out a plot, or print out the entire screen.

**Zoom Button:** This button allows the user to zoom in on the plot by selecting two points in the plot area. Press the Restore button to return to the normal data plot, or press the Zoom button again to zoom in even further.

**Setup Select Box:** This box determines the setup number to use when performing conversions. See the CS5534 datasheet for more details on the functionality of the Channel Setup Registers.

## 2.2.4 Configuration Window

The Configuration Window allows the user to set up the data collection and analysis parameters. See Figure 9.

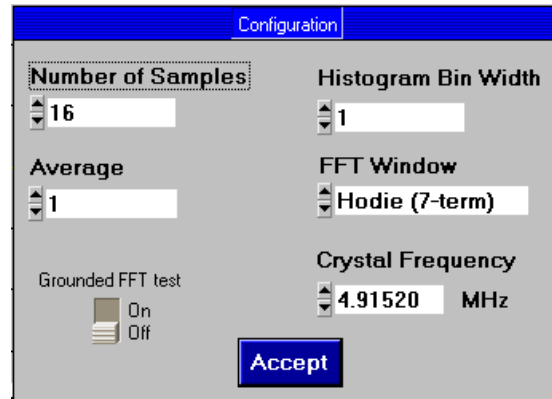


Figure 9. CDB5534U Configuration Window

**Number of Samples:** This box allows the user to select the number of samples to collect, between 16 and 32,768.

**Average:** When doing FFT processing, this box will determine the number of FFTs to average. FFTs will be collected and averaged when the Collect button is pressed.

**FFT Window:** This box allows the user to select the type of windowing algorithm for FFT processing. Windowing algorithms include the Blackman, Blackman-Harris, Hanning, 5-term Hodie, and 7-term Hodie. The 5-term Hodie and 7-term Hodie are windowing algorithms developed at Cirrus Logic. This selection has no effect on Time Domain or Histogram analysis.

**Histogram Bin Width:** This box allows for a variable "bin width" when plotting histograms of the collected data. Each vertical bar in the histogram plot will contain the number of output codes contained in this box. Increasing this number may allow the user to view histograms with larger input ranges.

**Crystal Frequency:** The CDB5534U evaluation board comes equipped with a 4.9152 MHz crystal. If the user chooses to replace this with a crystal of a different frequency, the number in this box can be modified to provide more accurate timing and FFT information.

**Grounded FFT Test:** When turned on, this function will generate an ideal full-scale sine wave for calculation purposes. This will enable the software to calculate the signal-to-distortion and signal-to-noise of the converter with a simulated ideal full-scale sine wave source, although the converter is grounded.

**Accept:** When this button is selected, the current settings will be saved, and the user will return to the Data Collection Window.

## 2.3 Collecting Data Sets

To collect a sample data set:

- 1) In the Data Collection Window, select the Config button to bring up the Configuration Window and view the current settings.
- 2) Select the appropriate settings from the available options (see the section on the Configuration Window) and select the Accept button.
- 3) The Data Collection Window should still be visible. In the Setup box, select the Setup number you want to use to perform conversions.
- 4) Select the Collect button to begin collecting data.
- 5) Data is sent directly to the PC through the USB cable. Depending on the value of the WR bits in the selected Setup and the number of samples being collected, this process may take several minutes. The process can be terminated by pressing the Stop button, but if this is done, the user should also press Reset on the CDB5534U board to bring the microcontroller out of the collection routines.
- 6) Once the data has been collected, it can be analyzed, printed, or saved to disk.

## 2.4 Saving and Printing Data

Once collected, data can be printed or saved to a file for later use. To save or print data, click on the Output button in the Data Collection Window. A small panel will pop up with three options:

- 1) Output Data File: Brings up the File Save dialog box, which allows the data to be saved to a file.
- 2) Print Screen: Prints the entire display, including the calculated statistics.
- 3) Print Graph: Prints the information in the plot area. The statistical information is not printed.

## 2.5 Retrieving Saved Data From a File

To load a previously saved file:

- 1) Pull down the Setup option and select Disk. A file menu will appear.
- 2) Find the data file in the list and select it. Press the Select button to return.
- 3) Go to the Data Collection Window, and press the Collect button.
- 4) The data from the file should appear on the screen. To select a different file, repeat the procedure.

## 2.6 Analyzing Data

The evaluation software provides three types of analysis - 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, performance parameters are also calculated and displayed. The Histogram analysis test processes acquired conversions to produce a histogram plot. Statistical noise calculations are also calculated and displayed. For more information on Histograms, refer to Application Note 37.



## 2.7 Histogram Information

The following is a description of the indicators associated with Histogram Analysis. Histograms can be plotted in the Data Collection Window by setting the Time Domain / FFT / Histogram selector to Histogram.

**BIN:** Displays the x-axis value of the cursor on the Histogram.

**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 average of the data sample set.

**MINIMUM:** Indicator for the minimum value of the collected data set.

**STD. DEV.:** Indicator for the Standard Deviation of the collected data set.

**VARIANCE:** Indicates the Variance for the current data set.

## 2.8 Frequency Domain Information

The following describe the indicators associated with FFT (Fast Fourier Transform) Analysis. FFT data can be plotted in the Data Collection Window by setting the Time Domain / FFT / Histogram selector to FFT.

**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.

**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).

**# of AVG:** Displays the number of FFT's averaged in the current display.

## 2.9 Time Domain Information

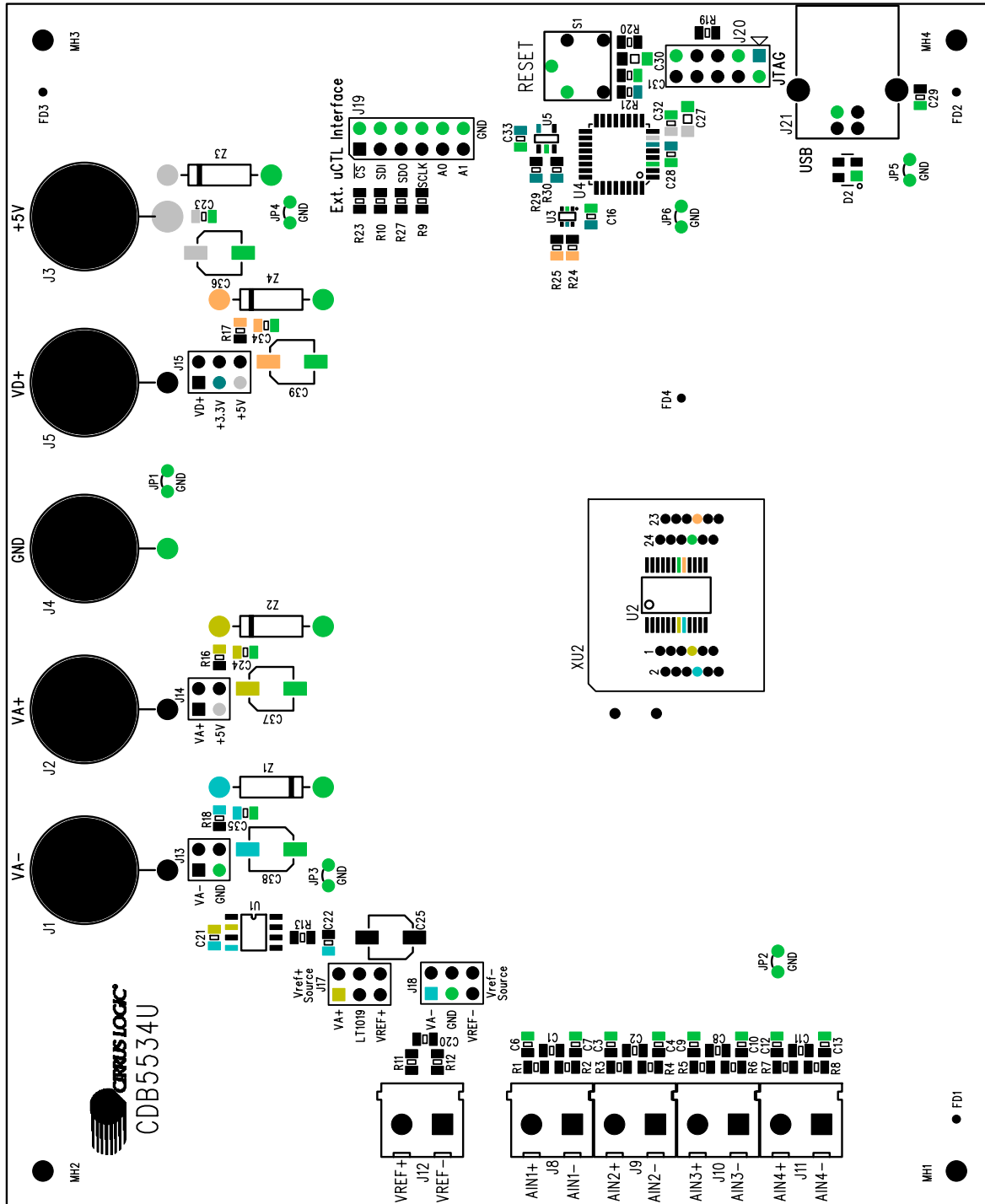
The following controls and indicators are associated with Time Domain Analysis. Time domain data can be plotted in the Data Collection Window by setting the Time Domain / FFT / Histogram selector to Time Domain.

**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.

**3. BOARD LAYOUT**

**Figure 10. Top Silkscreen**

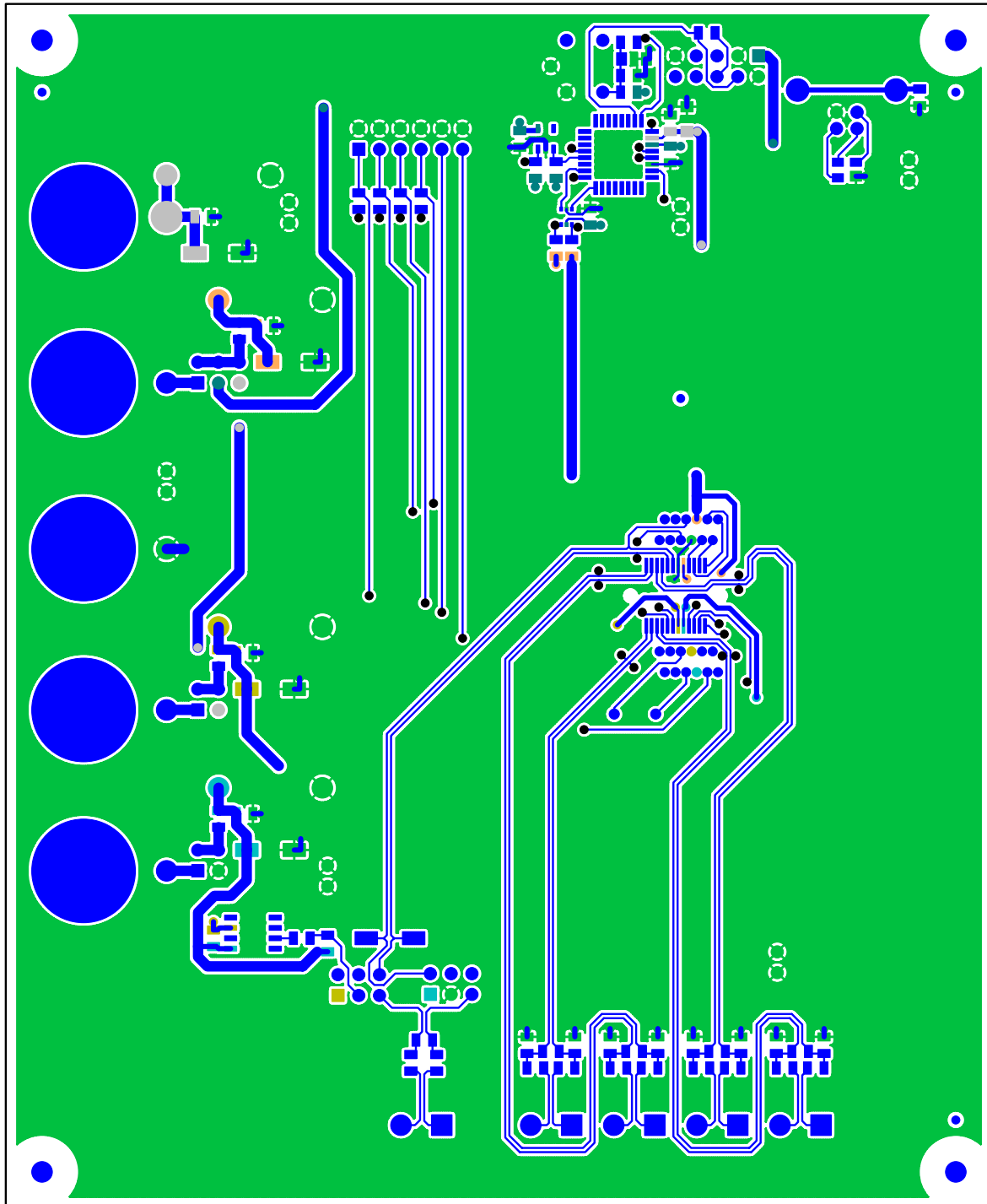


Figure 11. Top Side Layout

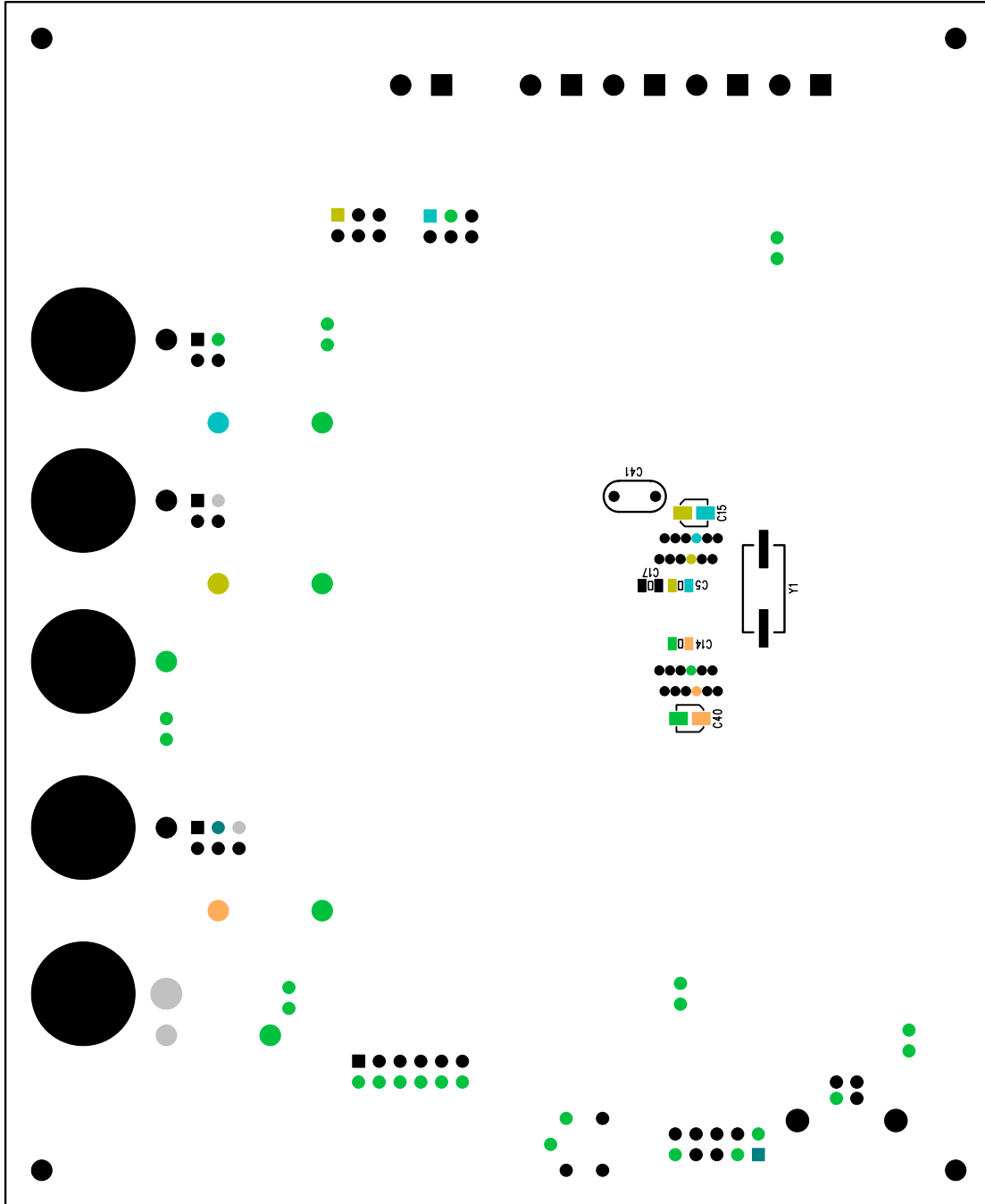


Figure 12. Bottom Silkscreen

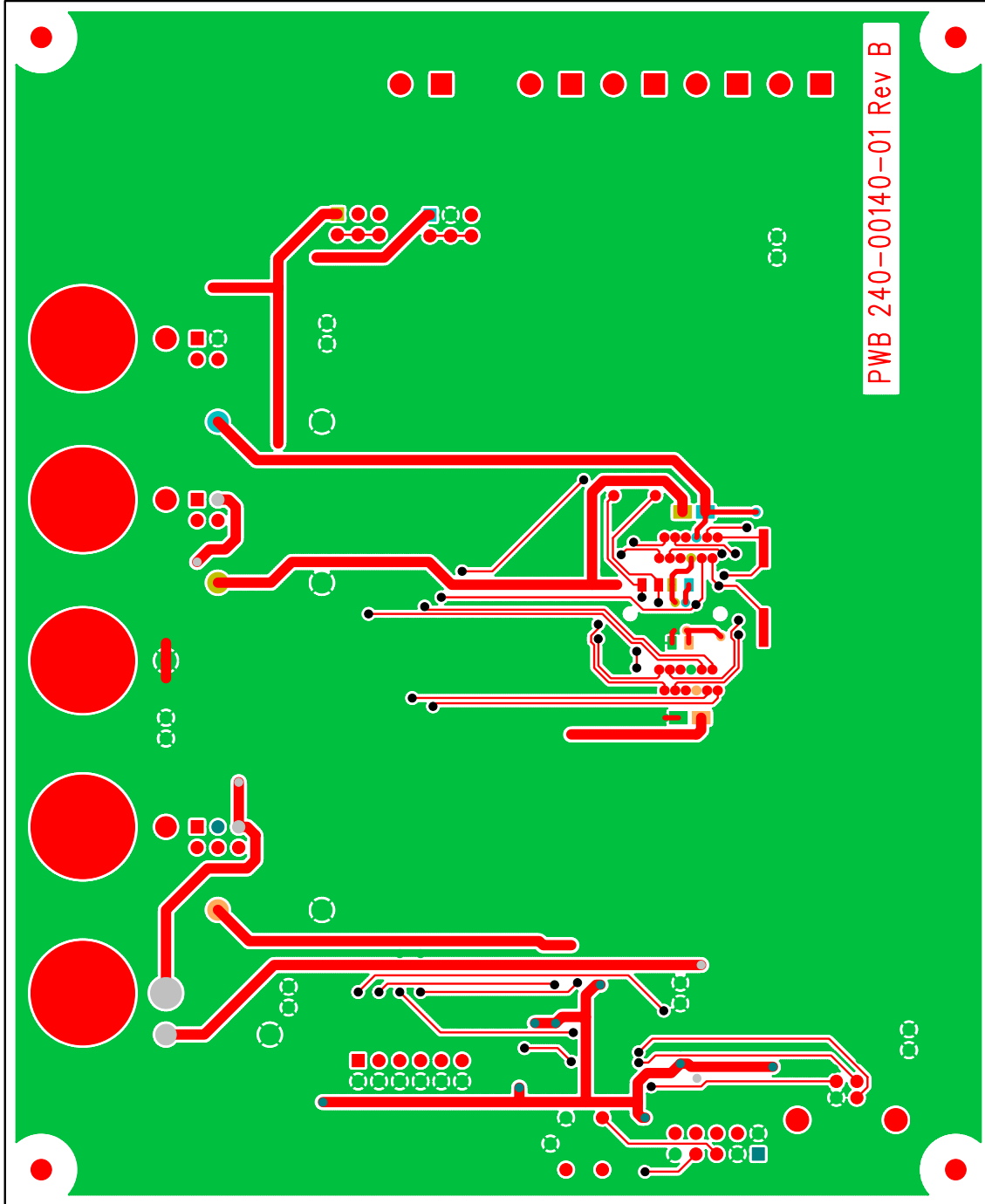


Figure 13. Bottom Side Layout

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