

CDB5490U Engineering Board and GUI Software

Features

- Standalone Power Meter Application
- Voltage and Current Interfaces
- Low- and High-voltage Sensor Connections
- Adaptable Sensor Filters Onboard
- USB Communication with PC
- Isolated UART Communication
- Onboard C8051F342 Microcontroller
- Single Supply Operation from USB or an External +5V DC Supply
- Onboard DC-DC Converter and Regulator
- LCD Power Monitor Display
- LabWindows® / CVI® GUI Software
 - Full Register Setup and Chip Control
 - Simplified Register
 - Quick Calibration Control
 - FFT Analysis
 - Time Domain Analysis
 - Noise Histogram Analysis
- Voltage Reference Access

General Description

The CDB5490U is an extensive tool designed to evaluate the functionality and performance of Cirrus Logic's CS5490 power measurement device.

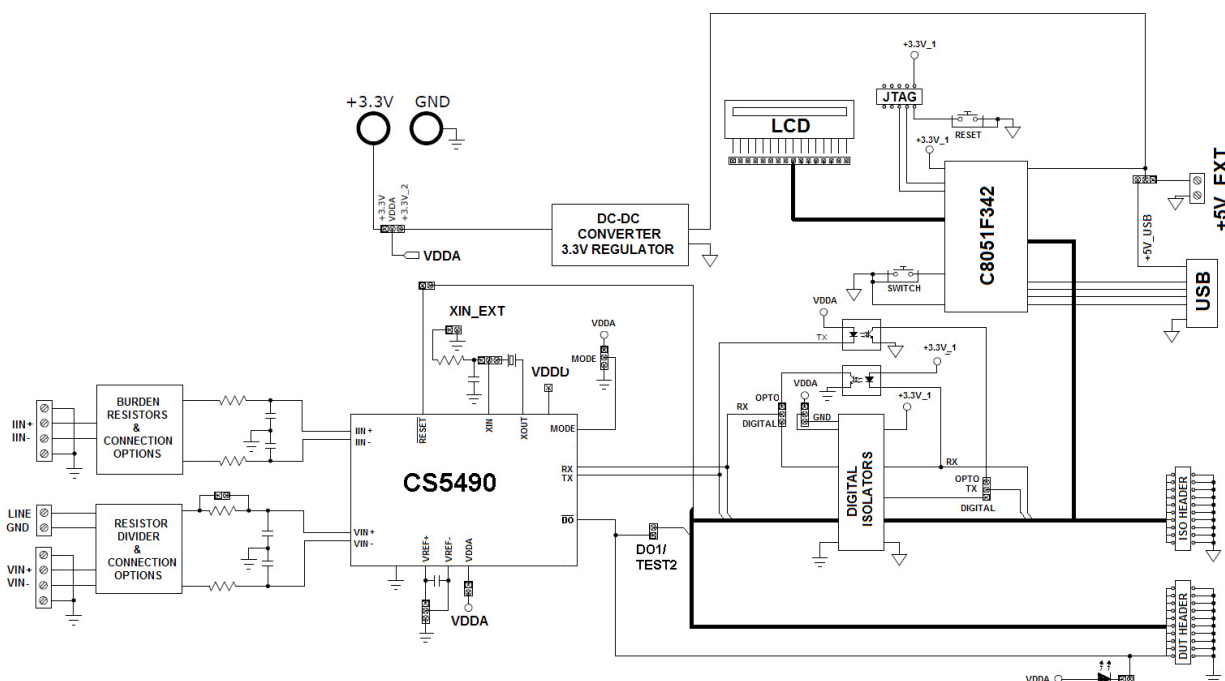
Multiple analog input connection options, configuration input filters, direct and isolated digital interfaces, multiple power supply options, an onboard programmable microcontroller, visual LEDs with an LCD panel make the board a flexible and powerful customer development tool for various power measurement applications.

The GUI software provides easy and complete access and control to the onboard CS5490 device. In addition, it includes the function of raw ADC data collection with time domain, frequency domain, and histogram analysis.

Schematics in PADST[™] PowerLogic[™] format are available for download at <http://www.cirrus.com/en/support>.

ORDERING INFORMATION

CDB5490U-Z Evaluation Board





IMPORTANT SAFETY INSTRUCTIONS

Read and follow all safety instructions prior to using this demonstration board.

This Engineering Evaluation Unit or Demonstration Board must only be used for assessing IC performance in a laboratory setting. This product is not intended for any other use or incorporation into products for sale.

This product must only be used by qualified technicians or professionals who are trained in the safety procedures associated with the use of demonstration boards.

DANGER Risk of Electric Shock

- The direct connection to the AC power line and the open and unprotected boards present a serious risk of electric shock and can cause serious injury or death. Extreme caution needs to be exercised while handling this board.
- Avoid contact with the exposed conductor or terminals of components on the board. High voltage is present on exposed conductor and it may be present on terminals of any components directly or indirectly connected to the AC line.
- Dangerous voltages and/or currents may be internally generated and accessible at various points across the board.
- Charged capacitors store high voltage, even after the circuit has been disconnected from the AC line.
- Make sure that the power source is off before wiring any connection. Make sure that all connectors are well connected before the power source is on.
- Follow all laboratory safety procedures established by your employer and relevant safety regulations and guidelines, such as the ones listed under, OSHA General Industry Regulations - Subpart S and NFPA 70E.

 **WARNING** Suitable eye protection must be worn when working with or around demonstration boards. Always comply with your employer's policies regarding the use of personal protective equipment.

 **WARNING** All components and metallic parts may be extremely hot to touch when electrically active.

Contacting Cirrus Logic Support

For all product questions and inquiries contact a Cirrus Logic Sales Representative. To find the one nearest to you go to www.cirrus.com

IMPORTANT NOTICE

Cirrus Logic, Inc. and its subsidiaries ("Cirrus") believe that the information contained in this document is accurate and reliable. However, the information is subject to change without notice and is provided "AS IS" without warranty of any kind (express or implied). Customers are advised to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgment, including those pertaining to warranty, indemnification, and limitation of liability. No responsibility is assumed by Cirrus for the use of this information, including use of this information as the basis for manufacture or sale of any items, or for infringement of patents or other rights of third parties. This document is the property of Cirrus and by furnishing this information, Cirrus grants no license, express or implied under any patents, mask work rights, copyrights, trademarks, trade secrets or other intellectual property rights. Cirrus owns the copyrights associated with the information contained herein and gives consent for copies to be made of the information only for use within your organization with respect to Cirrus integrated circuits or other products of Cirrus. This consent does not extend to other copying such as copying for general distribution, advertising or promotional purposes, or for creating any work for resale.

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). CIRRUS PRODUCTS ARE NOT DESIGNED, AUTHORIZED OR WARRANTED FOR USE IN PRODUCTS SURGICALLY IMPLANTED INTO THE BODY, AUTOMOTIVE SAFETY OR SECURITY DEVICES, LIFE SUPPORT PRODUCTS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF CIRRUS PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK AND CIRRUS DISCLAIMS AND MAKES NO WARRANTY, EXPRESS, STATUTORY OR IMPLIED, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE, WITH REGARD TO ANY CIRRUS PRODUCT THAT IS USED IN SUCH A MANNER. IF THE CUSTOMER OR CUSTOMER'S CUSTOMER USES OR PERMITS THE USE OF CIRRUS PRODUCTS IN CRITICAL APPLICATIONS, CUSTOMER AGREES, BY SUCH USE, TO FULLY INDEMNIFY CIRRUS, ITS OFFICERS, DIRECTORS, EMPLOYEES, DISTRIBUTORS AND OTHER AGENTS FROM ANY AND ALL LIABILITY, INCLUDING ATTORNEYS' FEES AND COSTS, THAT MAY RESULT FROM OR ARISE IN CONNECTION WITH THESE USES.

Cirrus Logic, Cirrus, the Cirrus Logic logo designs, EXL Core, and the EXL Core logo design are trademarks of Cirrus Logic, Inc. All other brand and product names in this document may be trademarks or service marks of their respective owners. LabWindows and CVI are registered trademarks of National Instruments, Inc.

Windows, Windows 2000, Windows XP, and Windows 7 are trademarks or registered trademarks of Microsoft Corporation.

PADS and PowerLogic are trademarks of Mentor Graphics Corporation.

TABLE OF CONTENTS

1. HARDWARE	5
1.1 Introduction	5
1.2 Evaluation Board Overview	5
1.3 Analog Section	6
1.4 Digital Section	9
1.5 Power Supply Section	11
1.6 Typical Sensor Connections	12
1.7 Standalone Meter Application	15
2. SOFTWARE	16
2.1 Installation Procedure	16
2.2 Using the Software	16
2.3 Start-up Window	17
2.4 Connect Menu	18
2.5 System Menu	19
2.6 Calibration Window	23
2.7 Conversion Window	25
2.8 Cirrus Test Window	27
Appendix A. Bill Of Materials	37
Appendix B. Schematics.....	39
Appendix C. Layer Plots	42

LIST OF FIGURES

Figure 1. CDB5490U Assembly Drawing and Default Configuration	5
Figure 2. Voltage Channel — Low-voltage Input	6
Figure 3. Voltage Channel — High-voltage Input	7
Figure 4. Current Channel — Low-voltage Input	8
Figure 5. MCU Connection Window	9
Figure 6. Shunt Sensor Power Meter	12
Figure 7. Current Transformer Power Meter	13
Figure 8. Rogowski Coil Power Meter	14
Figure 9. Standalone Power Meter Measurements	15
Figure 10. GUI Start-up Window	17
Figure 11. <i>Connect Menu Showing Successful USB Connection</i>	18
Figure 12. <i>Connect Menu Showing Successful USB Connection</i>	18
Figure 13. <i>USB Error Message</i>	18
Figure 14. Unknown Chip ID Error Message	19
Figure 15. System Pull-down Options	19
Figure 16. Setup Window	20
Figure 17. Calibration Window	23
Figure 18. Setup Window with 510638 Baud Rate	25
Figure 19. Conversion Collection Baud Rate Error	25
Figure 20. Conversion Window	26
Figure 21. Cirrus Test Pull-down Options	27
Figure 22. Data Collection Window	28
Figure 23. Data Collection UART Error Message	28
Figure 24. Data Collection Output Window	29
Figure 25. Data Collection Configuration Window	30
Figure 26. Histogram Analysis	32
Figure 27. FFT Analysis	33
Figure 28. Data Collection Window - Time Domain Analysis	34
Figure 29. Data Collection to File Window	35
Figure 30. Setup and Test Window	36
Figure 31. Bill of Materials (Page 1 of 2)	37
Figure 32. Bill of Materials (Page 2 of 2)	38
Figure 33. Schematic - Analog Inputs	39
Figure 34. Schematic - CS5490 and Isolation	40
Figure 35. Schematic - Microcontroller and USB Interface	41
Figure 36. Top Silkscreen	42
Figure 37. Top Routing	43
Figure 38. Bottom Routing	44
Figure 39. Solder Paste Mask	45

1.3 Analog Section

The analog section of the CDB5490U is highly configurable. Onboard signal conditioning options for the voltage and current channels enable most applications to interface directly to the sensors. The following two sections define the voltage and current channel configurations.

1.3.1 Voltage Sensor Connection

There are three input signal options for the voltage channel input (VIN±): an external low-voltage signal (via screw terminals or XLR connections), high-voltage line inputs, or GND. Figure 1 illustrates the options available.

Table 1. Voltage Channel Input Signal Selection

INPUT	Description	J11	J6
VIN±	Selects External Low-voltage Fully Differential Signal	VIN- ☒ VIN- GND ☐ VIN- (Default)	GND ☐ VIN+ Line ☐ VIN+ VIN+ ☒ VIN+ (Default)
VIN±	Selects External Low-voltage Single-ended Signal	VIN- ☐ VIN- GND ☒ VIN-	GND ☐ VIN+ Line ☐ VIN+ VIN+ ☒ VIN+
GND	Selects Grounding the Input	VIN- ☐ VIN- GND ☒ VIN-	GND ☒ VIN+ Line ☐ VIN+ VIN+ ☐ VIN+
High-Voltage Line	Selects External High-voltage AC Line Signal	VIN- ☐ VIN- GND ☒ VIN-	GND ☐ VIN+ Line ☒ VIN+ VIN+ ☐ VIN+

The CDB5490U evaluation board provides screw-type terminals (J3) or XLR connectors (J30) to connect low-voltage input signals to the voltage channel (see Figure 2). The screw terminals are labeled as VIN+ / VIN-. An R-C network at the channel input provides a simple, configurable anti-alias filter. By installing jumpers on J6 to position VIN+ and J11 to position VIN-, the input voltage signal is supplied from the screw terminals or XLR connections.

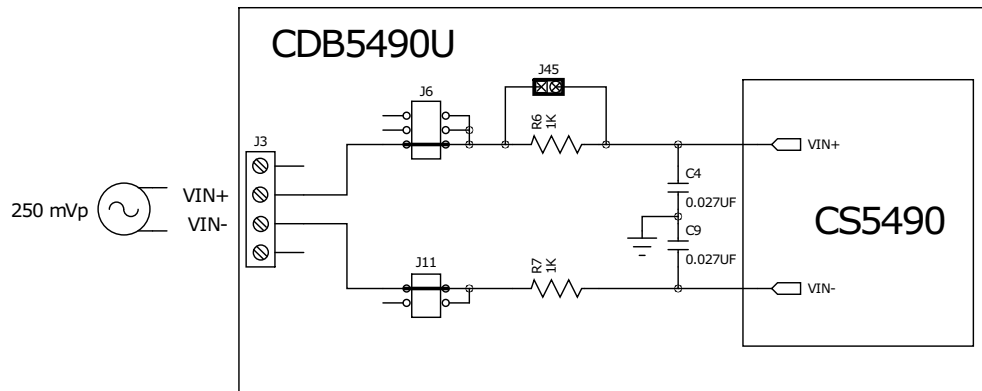


Figure 2. Voltage Channel — Low-voltage Input

The CDB5490U evaluation board provides screw-type terminals (J4) to connect a high-voltage line input. By installing jumpers on J6 to position LINE and J11 to position GND, the input voltage signal is supplied from the high-voltage input. Extreme care should be used when connecting high-voltage signals to the CDB5490U evaluation board (see Figure 3).

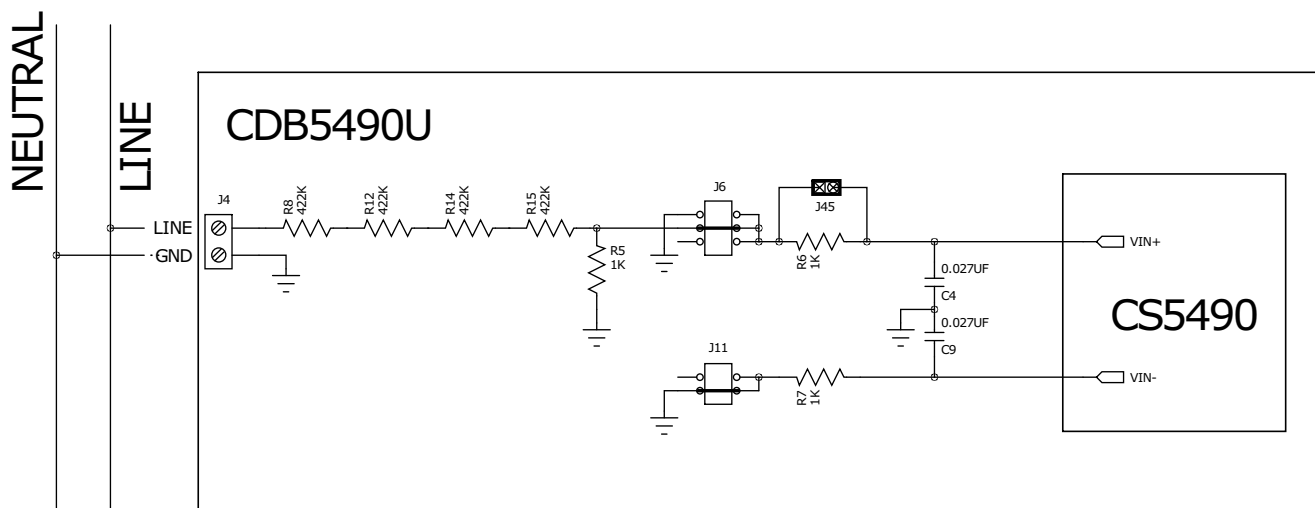


Figure 3. Voltage Channel — High-voltage Input

The default attenuation network provides the following attenuation:

$$\frac{1k}{(4 \times 422k) + 1k} = \frac{1}{1689}$$

With the CS5490 input range of 250mVp at maximum AC line input of:

$$300V_{rms} = \frac{250mV_p}{\sqrt{2}} \times 1689$$

is acceptable. It is recommended to apply a 10% margin for the AC line input (270Vrms).

The CDB5490U evaluation board provides input shorting options for calibration and noise performance measurements. With a jumper on J6 and J11 in the GND position, the inputs are connected to analog ground (GND).

1.3.2 Current Sensor Connection

Current input options include an external signal (via screw terminals or XLR connectors) or GND. Table 2 illustrates the options available.

Table 2. Current Channel Input Signal Selection

INPUT	Description	J8	J7
IIN±	Selects External Low-voltage, Fully Differential Signal	IIN+  IIN+ GND  IIN+ (Default)	GND  IIN- IIN-  IIN- (Default)
IIN±	Selects External Low-voltage, Single-ended Signal	IIN+  IIN+ GND  IIN+	GND  IIN- IIN-  IIN-
GND	Selects Grounding the Input	IIN+  IIN+ GND  IIN+	GND  IIN- IIN-  IIN-

There are two input signal options for the current channel (IIN±). The CDB5490U evaluation board provides screw-type terminals (J1) or XLR connectors (J28) to connect an input signal to the current channel. The screw terminals are labeled as IIN+ / IIN-. An R-C network at the channel input provides a simple, configurable anti-alias filter (see Figure 4).

By installing jumpers on J8 to position IIN+, J7 to position IIN-, the input current signal is supplied from the screw terminals or XLR connectors.

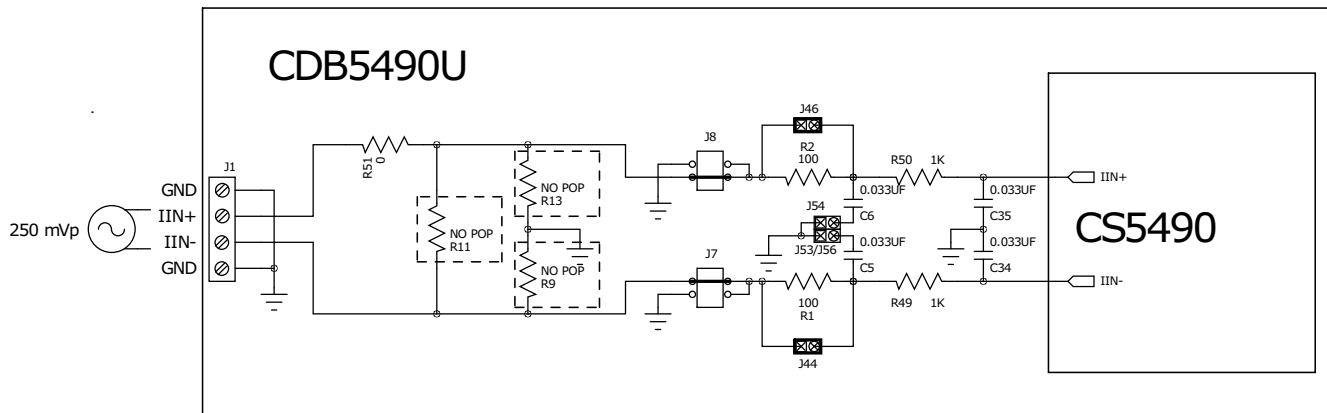


Figure 4. Current Channel — Low-voltage Input

The CDB5490U evaluation board provides input shorting options for calibration and noise performance measurements. With a jumper on J8 and J7 in the GND position, the inputs are connected to analog ground (GND).

1.4 Digital Section

The digital section contains the microcontroller, USB interface, LCD, optical isolation, JTAG header, reset circuitry, and external interface headers (J17 and J19). The microcontroller interfaces the UART of the CS5490 with the USB connection to the PC, enabling the GUI software to access all of the CS5490 registers and functions.

1.4.1 Serial Port Selection

Communication to the CS5490 is provided through a standard UART. It is necessary to establish communication with the MCU before serial port communication with the CS5490 (see Figure 5).

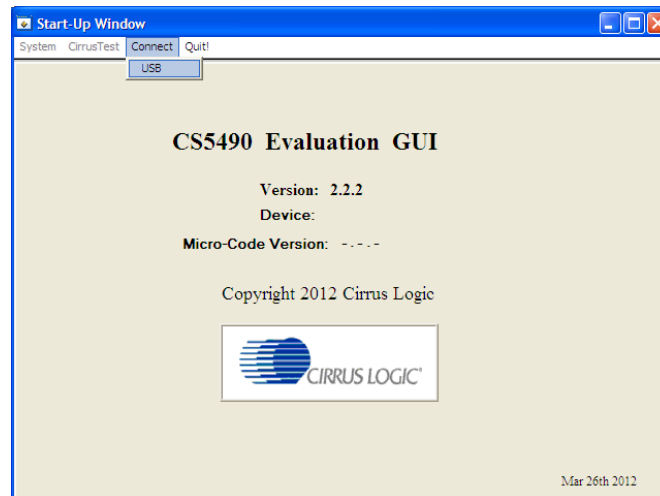


Figure 5. MCU Connection Window

The CDB5490U board provides two UART communication options - normal speed and low speed. Table 3 provides the serial communication options for the UART.

Table 3. Serial Communication Options

	J18	J20	J50
UART via MCU	☐ OPTO ☒ RX ☒ DIGITAL (default)	☐ OPTO ☒ TX ☒ DIGITAL (default)	☒ VDDA ☒ EN2 ☐ GND (default)
Low speed UART	☒ OPTO ☒ RX ☐ DIGITAL	☒ OPTO ☒ TX ☐ DIGITAL	☒ VDDA ☒ EN2 ☐ GND

1.4.2 Interface to Microcontroller

Interface headers J17 and J19 are provided to allow the CDB5490U to be connected to an external energy registration device or an external microcontroller. Interface header J17 provides direct access to the CS5490 pins while interface header J19 provides an isolated connection. It is imperative to use the isolated connection (J19) when high-voltage signals are used. Failure to use isolation can result in damage to components or electrical shock. Refer to section 1.4.3 *Digital Isolation* for details on signal isolation.

Interface header J19 can be used to connect to the external microcontroller. To connect the CS5490 to an external microcontroller, R37, R42, and R43 must be removed from the board.

1.4.3 Digital Isolation

Two types of isolation are provided: a low-speed optical coupler and high-speed digital isolation for UART communication. Default jumper settings provide high-speed digital isolators. To enable high-speed digital isolators, place jumpers (J18 and J20) in the RX-to-DIGITAL position and TX-to-DIGITAL position. To enable the high-speed digital isolators, it is also necessary to install jumper (J50) in the VDDA position. To enable the low-speed optical UART communication, place jumpers (J18 and J20) in the RX-to-OPTICAL position and TX-to-OPTICAL position.

The high-speed digital isolators operate from DC to 150Mbps. The low-speed optical couplers operate to a maximum speed of about 4.8kHz. All the signals supplied to the isolators are available to the MCU.

1.4.4 Additional Device Pin Access

The CS5490's digital output pin (DO) is routed to a LED, which provides a simple visual check of the digital output. Jumper J39 is equipped at the factory to enable the LED. The DO digital output pin is supplied to the digital isolation using jumper J49.

The MODE pin jumper (J15) should be installed in the *VDDA to MODE* position.

The CS5490 system clock can be connected to an onboard quartz crystal, or an external clock can be supplied to the CS5490 XIN pin through jumper J48. To connect the onboard quartz crystal, install jumper J43 in the *XIN to CRYSTAL* position. To connect XIN to an external clock, install jumper J43 in the *XIN to XIN_EXT* position.

1.5 Power Supply Section

Table 4 illustrates the power supply connections on the evaluation board. The positive analog (VDDA) for the CS5490 can be supplied using the +3.3V binding post (J36 and J37) or the onboard +3.3V regulator. Jumper J38 allows the VDDA supply to be sourced from the +3.3V binding post (J37) or the regulated +3.3V supply. The DC-DC converter (U8) powers the onboard +3.3V regulator. Jumper J26 allows the +5V supply to be sourced from either the +5V *EXT* screw connector (J27) or the +5V *USB* supply. The +5V supplies the power for the microcontroller (8051_REGIN) and the DC-DC converter (U8). Jumper J21 is used to measure the CS5490 analog supply current and **must** be installed.

When connecting the CDB5490U board to the AC line through non-isolated sensors, it is strongly recommended that the CS5490 GND reference is connected to the neutral, the non-isolated current sensor is connected on neutral, and the CS5490 is supplied by +3.3V isolated from AC line. The DC-DC converter (U8) provides 1kVDC isolation, while no isolation is provided for the 3.3V binding post connections. If +3.3V is used from the binding post, then the external 3.3VDC power supply must be isolated from the AC line. To prevent electric shock and damages, always use an isolated power source.

Table 4. Power Supply Selection

Supply Source	CS5490 Source	Binding post J36&J37	USB Supply J24	5V Terminals J27	VDDA		+3.3V_1 J26
					J21	J38	
USB	On-board 3.3 V Regulator	NC	+5V	NC	☒ VDDA ☒ VDDA (default)	☐ +3.3V ☒ VDDA ☒ +3.3V_2 (default)	☐ +5V EXT ☒ +5V ☒ +5V USB (default)
External +3.3V & USB	Binding Post	+3.3 V	+5V	NC	☒ VDDA ☒ VDDA	☒ +3.3V ☒ VDDA ☐ +3.3V_2	☐ +5V EXT ☒ +5V ☒ +5V USB
External +5V	On-board 3.3V regulator	NC	NC	+5V	☒ VDDA ☒ VDDA	☐ +3.3V ☒ VDDA ☒ +3.3V_2	☒ +5V EXT ☒ +5V ☐ +5V USB

1.6 Typical Sensor Connections

The CDB5490U evaluation board provides connections directly to several types of sensors. Flexible on-board filter networks provide a convenient configuration for three common transducers: current shunt, current transformer (CT), or Rogowski coil.

1.6.1 Shunt Power Meter Example

An inexpensive current shunt configuration is easily achievable with the CDB5490U evaluation board. Figure 6 depicts the voltage and current connections for a shunt sensor and its associated filter configurations.

It is strongly recommended that a low-side (neutral path) current shunt is used — especially in high-voltage situations. Make sure that all signals are well connected before the power source is turned on. Extreme care should be taken when connecting high-voltage signals to the CDB5490U evaluation board.

In this configuration it is unnecessary to use a burden resistor. A single anti-alias filter is all that is required for the current channel. Below the filter corner frequency, the CS5490 inputs will see the same voltage that is across the shunt. Therefore the shunt voltage should be kept below the maximum of 50mVp with I-Channel PGA = 50x. A 10% margin is recommended for the shunt voltage (45mVp).

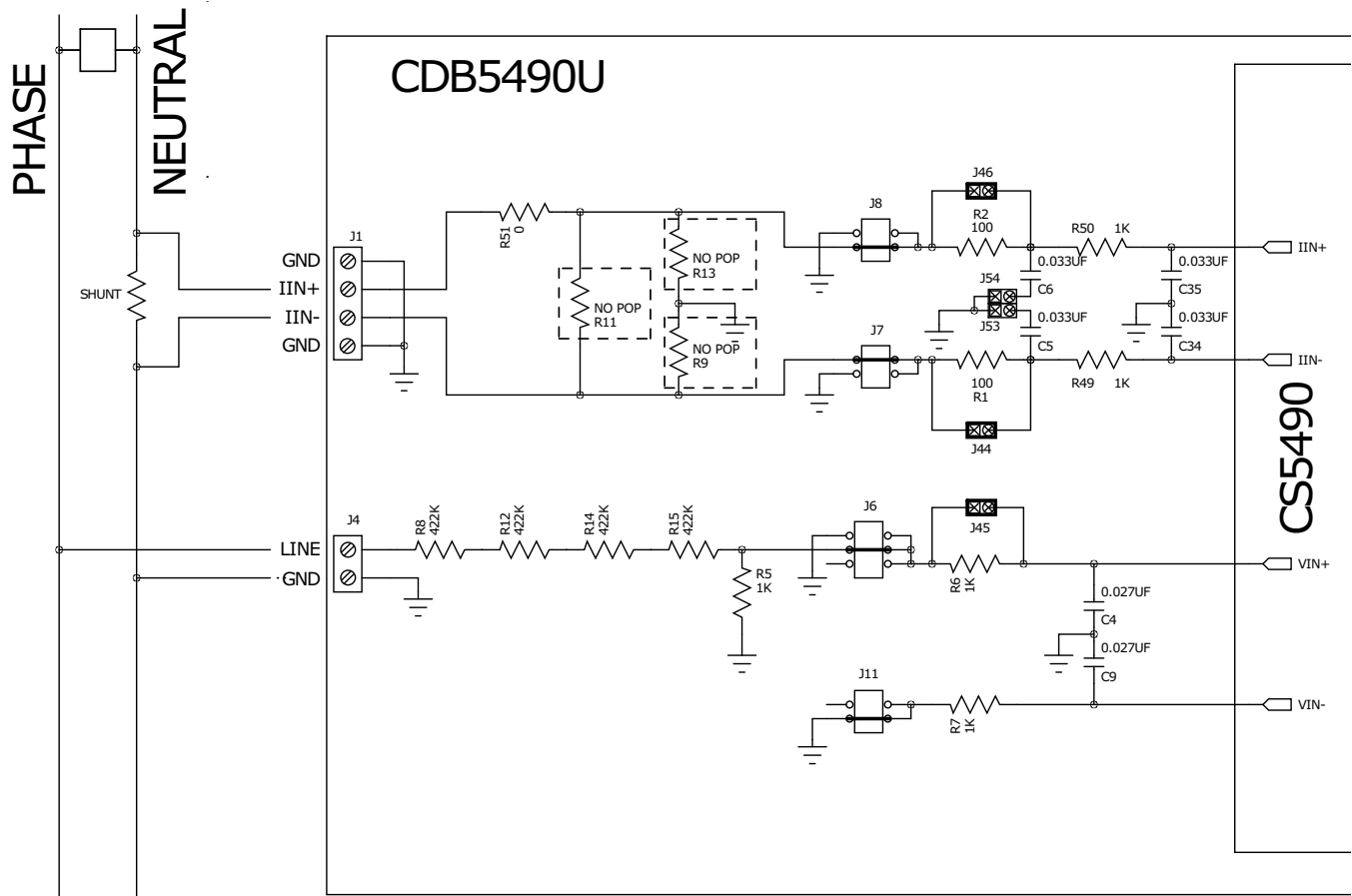


Figure 6. Shunt Sensor Power Meter

1.6.2 Current Transformer Power Meter Example

A slightly more expensive option is to use a current transformer (CT) to connect the AC current to the CDB5490U evaluation board. Figure 7 depicts the voltage and current connections for a CT sensor and its associated filter configurations.

NEVER “open circuit” a CT. Make sure that all signals are well connected before the power source is turned on. Extreme care should be taken when connecting high-voltage signals to the CDB5490U evaluation board.

The burden resistor (R11) is necessary in a CT application to convert the secondary current into voltage. Knowledge of the current transformer turns ratio (N) is key to determining the proper CS5490 input voltage (V_{burden}) that the meter places on the system. The optimum secondary voltage (V_{burden}) at the maximum current input should be 10% less than the maximum channel voltage of 250mVp with I-channel PGA = 10x. The secondary voltage (V_{burden}) is determined by converting the primary current to the secondary current. Then the secondary current (I_{burden}) can be converted into a voltage by Ohm's Law.

$$V_{\text{burden}} = I_{\text{burden}} \times R_{\text{burden}} = \frac{I_{\text{primary}}}{N} \times R_{\text{burden}}$$

The secondary voltage (V_{burden}) is sourced to the CS5490 through a simple low-pass, anti-alias filter, and this voltage should not exceed the 250mVp.

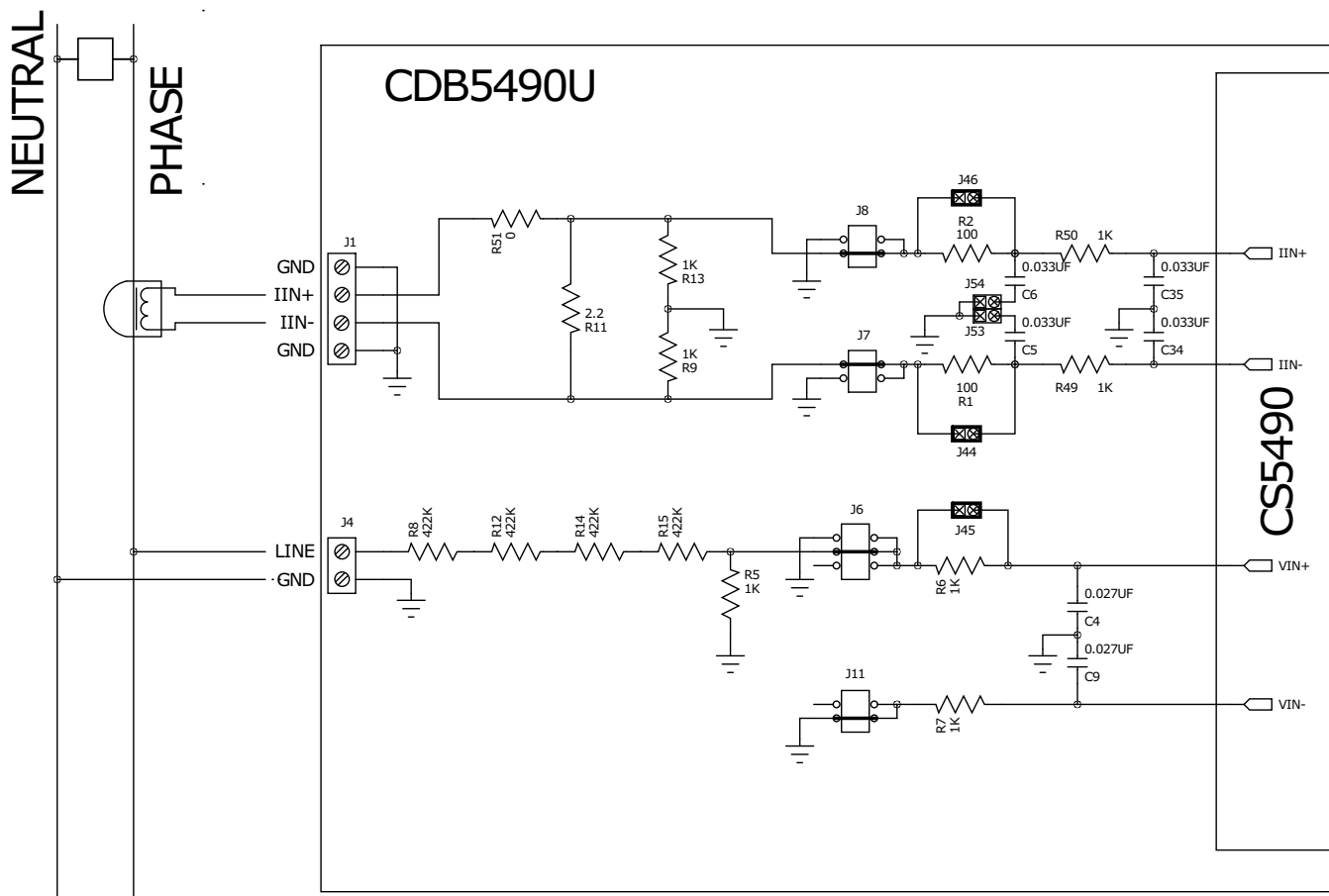


Figure 7. Current Transformer Power Meter

1.6.3 Rogowski Coil Power Meter Example

Rogowski coil power meter can be easily connected to the CDB5490U evaluation board. Figure 8 shows the voltage and current connections for the Rogowski sensor and its associated filter configurations.

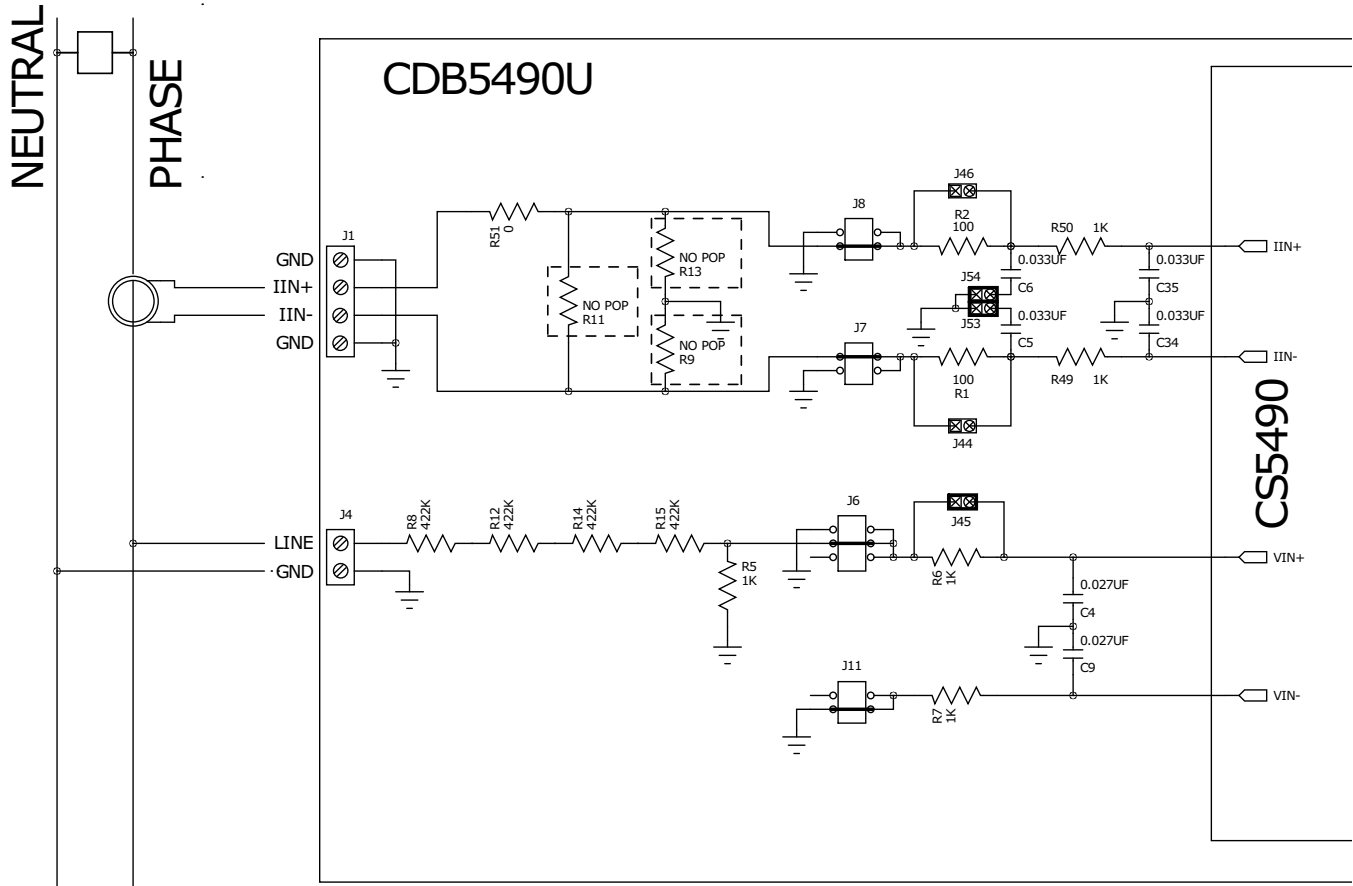


Figure 8. Rogowski Coil Power Meter

For more information, see AN365: *Using the CS5480/84/90 Energy Measurement IC with Rogowski Coil Current Sensors*.

1.7 Standalone Meter Application

The CDB5490U evaluation board provides a standalone power meter using the CS5490, MCU, and LCD. The user can enable the power meter by connecting the sensors to the analog inputs, providing power to the board, and resetting the MCU by pressing the *RESET* switch. Refer to “Typical Sensor Connections” on page 12 for details on the sensor connections and “Power Supply Section” on page 11 for details on supply options.

The user should not use the GUI to connect the CDB5490U board. Once the GUI is connected to the CDB5490U board, the standalone power meter function is disabled, and the LCD on the CDB5490U will read "Cirrus Logic CS5490 Eval GUI". To re-enable the standalone power meter feature, close the GUI software. The standalone power meter feature will initially show the voltage channels' RMS register values:

$$V1_{rms} = N.NNNNN \text{ and } V2_{rms} = N.NNNNN.$$

By clicking the onboard switch S2, the standalone power meter will display the following measurement results:

1. RMS Voltage
2. RMS Current
3. Average Active Power
4. Average Reactive Power
5. Average Apparent Power
6. Power Factor
7. Total Active Power
8. Total Reactive Power
9. Total Apparent Power
10. Fundamental Frequency
11. CS5490 Die Temperature

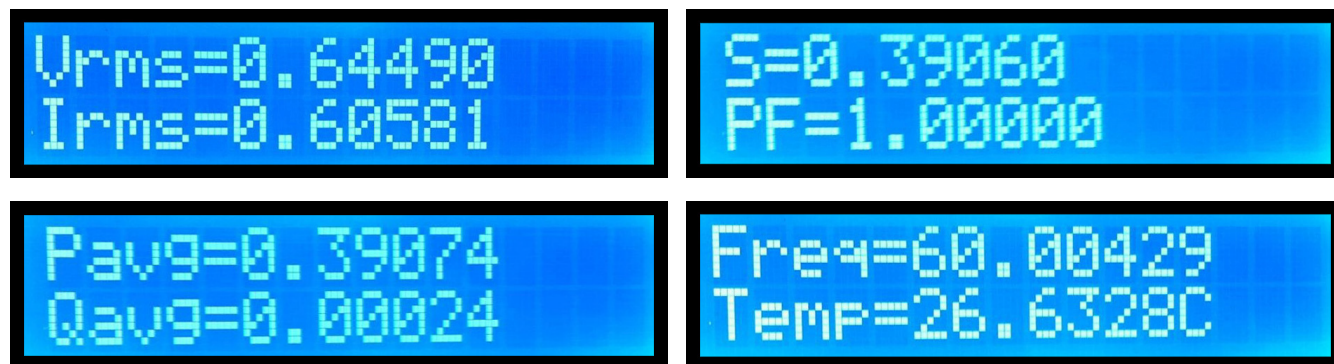


Figure 9. Standalone Power Meter Measurements

2. SOFTWARE

The evaluation board comes with software and a USB cable to link the evaluation board to the PC. The evaluation software was developed with LabWindows®/CVI®, a software development package from National Instruments. The evaluation software is designed to run with Windows XP™ and Windows 7™. The following procedure is based on Windows XP.

2.1 Installation Procedure

Follow the steps below to install the GUI:

1. Access the following web site: <http://www.cirrus.com/en/support>.
2. Navigate to the **CDB5490U** software link under Energy Measurement. The Software License web page is displayed.
3. To agree with the terms and conditions, click the **Agree** button. The File Download window is displayed.
4. Click the **Save** button. The Save As window is displayed.
5. Select a location to store the compressed folder.
6. Click the **Save** button. The Download complete window is displayed.
7. Click the **Open Folder** button. The location where the compressed folder is stored is displayed.
8. Right-click on the compressed folder, and click **Extract All**.
9. Select a location to extract the files.
10. Navigate to the location where the extracted files are stored and double-click on the **setup.exe** file.
11. Click the **Install** button, and follow the installation instructions.
12. Execute the GUI using 2.1.1 *Executing the GUI*.

2.1.1 Executing the GUI

1. From the Start menu, click **All Programs**.
2. Click **Cirrus Energy Measurement Evaluation (CDB5490U)**.
3. Click **CDB5490U**. The GUI is launched.

2.2 Using the Software

Before launching the software, check all jumper settings on the CDB5490U evaluation board, as described in “Evaluation Board Overview” on page 5, and connect the board to an open USB port on the PC using the provided cable. Once the board is powered on, the software program can be launched.

2.3 Start-up Window

When the software is launched, the Start-Up Window is displayed. This window contains information about the software, including its title, revision number, and copyright date. The Start-Up Window is displayed (see Figure 10).

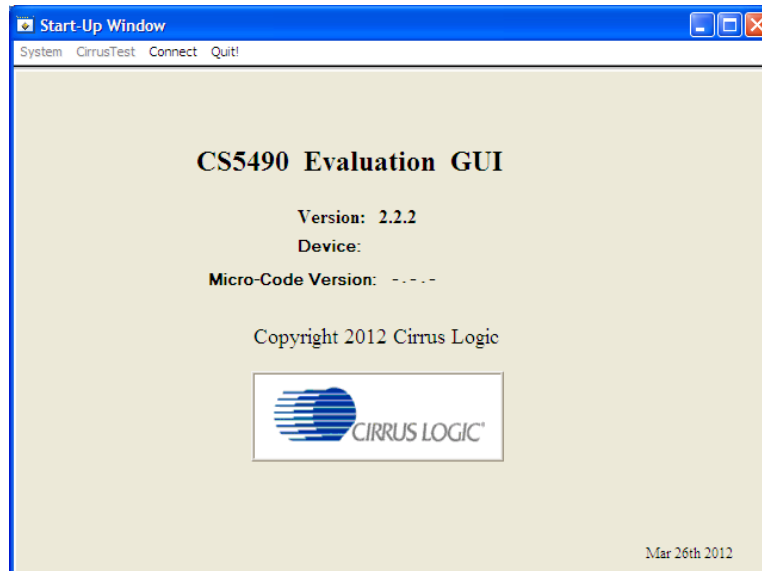


Figure 10. GUI Start-up Window

At the top of the window, a menu bar with menu items is displayed. The menu bar has four menu items: *System*, *Cirrus Test*, *Connect*, and *Quit*. Initially, *System* and *Cirrus Test* are disabled. After establishing a link to a data source, the *System* and *Cirrus Test* items will become available.

2.4 Connect Menu

The *Connect* menu allows the user to establish a USB communication link with CDB5490U board. After selecting the USB connect command, a popup will prompt to reset the CRD5490. The user must wait a few seconds after resetting the CRD5490 and before selecting OK on the popup. After the USB communication has been established, the CS5490 serial port is functional, as shown in Figure 12.

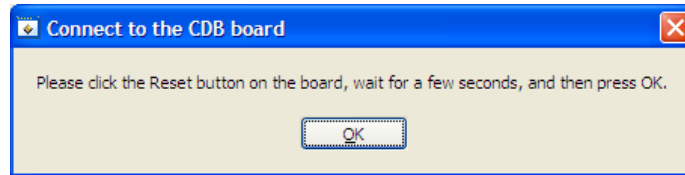


Figure 11. Connect Menu Showing Successful USB Connection

2.4.1 USB and Serial Port Connection

In the *Connect* menu item, selecting USB allows the user to establish USB communication, which allows the evaluation software to poll the C8051F342 microcontroller, verifying the serial communication link is ready. At this point, the USB menu item is checked, indicating that the PC has successfully communicated with the CDB5490U evaluation board. The micro-code version and device information are read from the board and displayed on the screen (see Figure 12). Due to improvements to the software or new features being added, the version displayed may be different than the image shown here.



Figure 12. Connect Menu Showing Successful USB Connection

If the evaluation software is unable to establish a communication link with the CDB5490U board, a message is displayed, indicating that the initial communication has failed (see Figure 13).

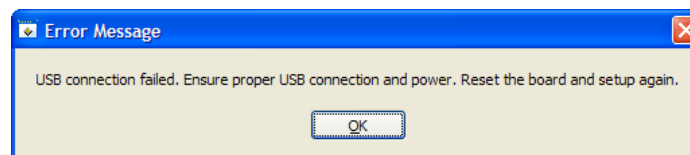


Figure 13. USB Error Message

Verify that the USB cable is connected properly and that the power supply is on and connected properly to the CDB5490U. Reset the board (press the *RESET* button on the board) and try to set up the USB connection again.

After the serial port has been selected, the MCU will read the chip ID from the CS5490. The chip revision number will be displayed in the Device field in the Start-Up Window. If the red "Unknown CHIP ID" is displayed, the user should check the power supply and clock to the CS5490, *MODE* jumper J15, and the isolation jumpers J18 and J20, click the *RESET* button, and go back to the USB connection process.

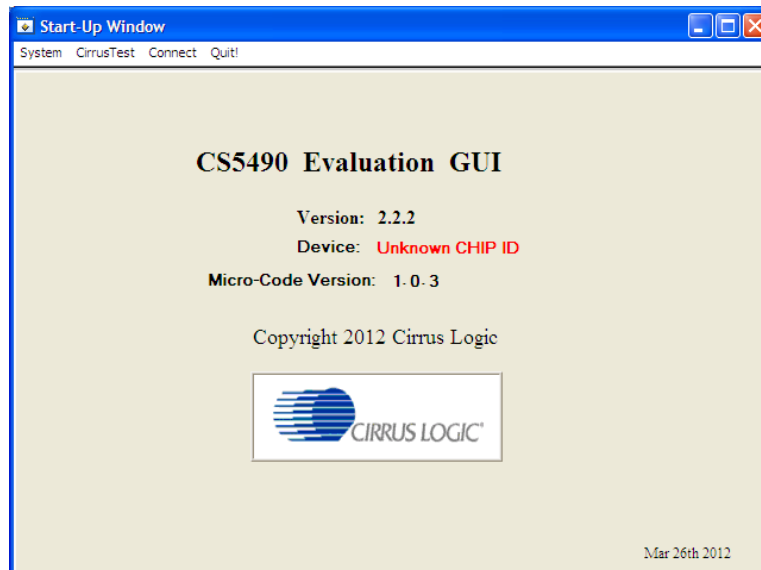


Figure 14. Unknown Chip ID Error Message

2.5 System Menu

The *System* pull-down provides three options: *Setup CS5490*, *Calibration*, and *Conversion*. Each window provides a means to evaluate the different functions and performance of the CS5490 (see Figure 15).

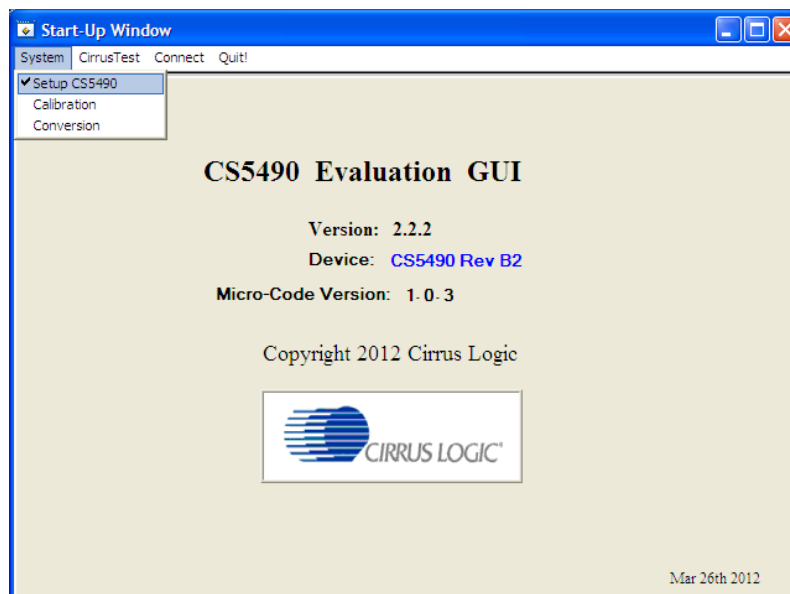
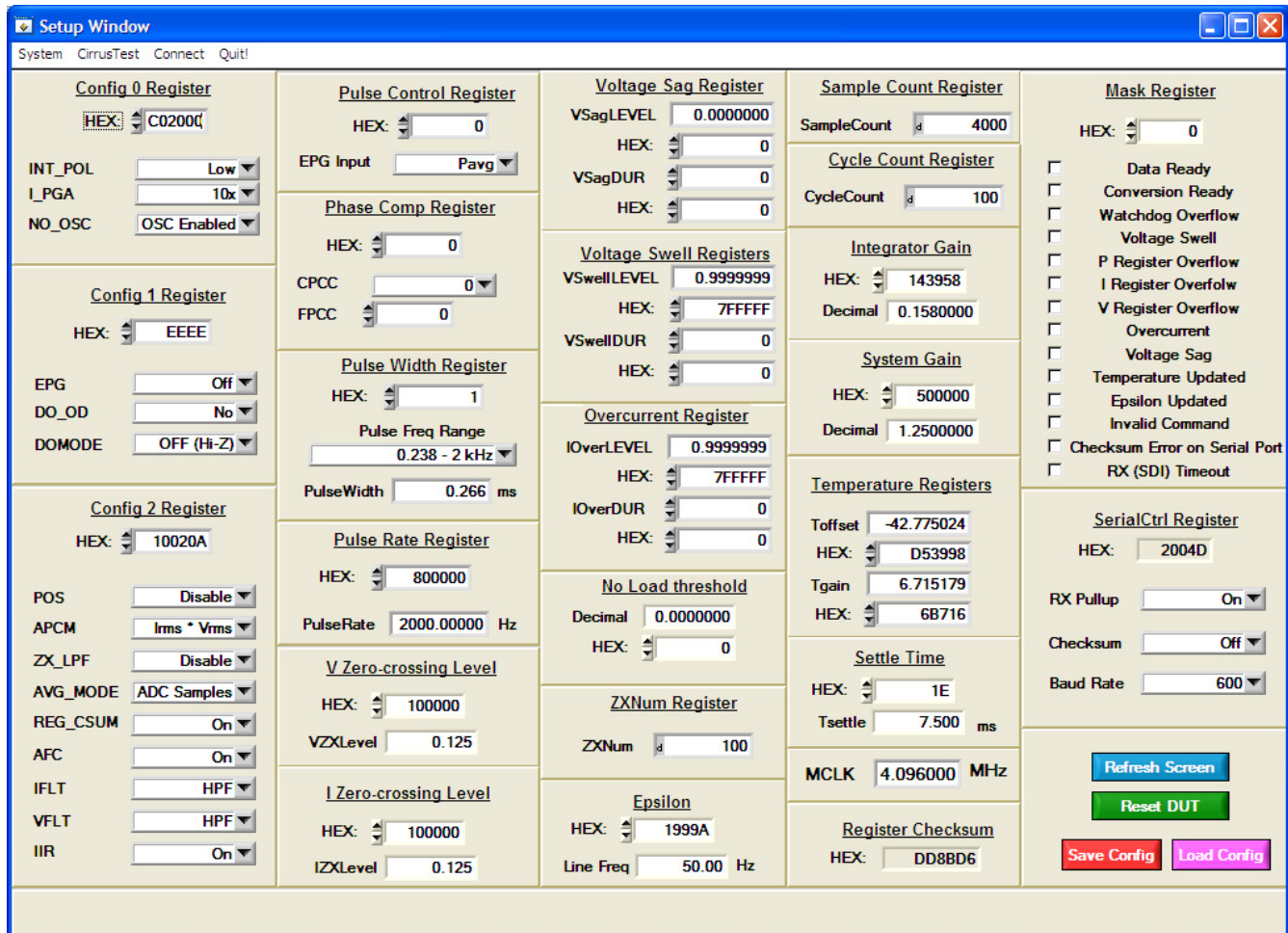


Figure 15. System Pull-down Options

2.5.1 Setup Window

The evaluation software provides access to the common CS5490's internal registers through the Setup Window (see Figure 16). The user can enter the Setup Window by selecting the *Setup CS5490* item from the *System* menu.



The Setup Window is a software interface for configuring the CS5490. It is divided into several sections, each containing a register name, its hexadecimal value, and various configuration options.

- Config 0 Register:** HEX: C0200C. Options: INT_POL (Low), I_PGA (10x), NO_OSC (OSC Enabled).
- Config 1 Register:** HEX: EEEE. Options: EPG (Off), DO_OD (No), DOMODE (OFF (Hi-Z)).
- Config 2 Register:** HEX: 10020A. Options: POS (Disable), APCM (Irms * Vrms), ZX_LPF (Disable), AVG_MODE (ADC Samples), REG_CSUM (On), AFC (On), IFLT (HPF), VFLT (HPF), IIR (On).
- Pulse Control Register:** HEX: 0. Options: EPG Input (Pavg).
- Phase Comp Register:** HEX: 0. Options: CPCC (0), FPCC (0).
- Pulse Width Register:** HEX: 1. Options: Pulse Freq Range (0.238 - 2 kHz), PulseWidth (0.266 ms).
- Pulse Rate Register:** HEX: 800000. Options: PulseRate (2000.00000 Hz).
- V Zero-crossing Level:** HEX: 100000. Options: VZXLevel (0.125).
- I Zero-crossing Level:** HEX: 100000. Options: IZXLevel (0.125).
- Voltage Sag Register:** VSagLEVEL (0.000000), HEX: 0, VSagDUR (0), HEX: 0.
- Voltage Swell Registers:** VSwellLEVEL (0.999999), HEX: 7FFFFFFF, VSwellDUR (0), HEX: 0.
- Overcurrent Register:** IOverLEVEL (0.999999), HEX: 7FFFFFFF, IOverDUR (0), HEX: 0.
- No Load threshold:** Decimal (0.000000), HEX: 0.
- ZXNum Register:** ZXNum (100).
- Epsilon:** HEX: 1999A, Line Freq (50.00 Hz).
- Sample Count Register:** SampleCount (4000).
- Cycle Count Register:** CycleCount (100).
- Integrator Gain:** HEX: 143958, Decimal (0.1580000).
- System Gain:** HEX: 500000, Decimal (1.2500000).
- Temperature Registers:** Toffset (-42.775024), HEX: D53998, Tgain (6.715179), HEX: 6B716.
- Settle Time:** HEX: 1E, Tsettle (7.500 ms).
- MCLK:** 4.096000 MHz.
- Register Checksum:** HEX: DD8BD6.
- Mask Register:** HEX: 0. Options: Data Ready, Conversion Ready, Watchdog Overflow, Voltage Swell, P Register Overflow, I Register Overflow, V Register Overflow, Overcurrent, Voltage Sag, Temperature Updated, Epsilon Updated, Invalid Command, Checksum Error on Serial Port, RX (SDI) Timeout.
- SerialCtrl Register:** HEX: 2004D. Options: RX Pullup (On), Checksum (Off), Baud Rate (600).

Buttons at the bottom: Refresh Screen, Reset DUT, Save Config, Load Config.

Figure 16. Setup Window

In the Setup Window, all of the common CS5490 registers are displayed in hexadecimal notation and are decoded. Refer to the CS5490 data sheet for information on register functionality and definitions. The Setup Window is segmented by function. Each subsection may contain more than one CS5490 register in order to configure a particular function. Updating the hexadecimal value of a register will change the definitions display according to the new hexadecimal value of the register(s). Likewise, updating the definitions displayed from the list boxes will update the hexadecimal value(s) of the associated register(s).

2.5.1.1 Refresh Screen Button

The *Refresh Screen* button will update the contents of the screen by reading all the register values from the CS5490. It is a good idea to press the *Refresh Screen* button when entering the *Setup* window, or after modifying any registers, to reflect the current status of the CS5490.

2.5.1.2 Reset DUT Button

The *Reset DUT* button will software-reset the CS5490. The CS5490 will perform a software-reset, as discussed in the CS5490 data sheet. After the software reset to the CS5490 device, the screen contents will be automatically refreshed with the updated status of the CS5490.

2.5.1.3 Save Config and Load Config Buttons

Clicking the *Save Config* button will save the current setup window's configuration to a .txt file. Clicking the *Load Config* button will recall a saved configuration and store values into the CS5490.

2.5.1.4 CS5490 MCLK Frequency

The CS5490 accepts a wide range of MCLK input frequencies, and can therefore run at many different sample rates. The frequency being used on the CS5490 should be entered in this box to provide accurate frequency calculation in the FFT window. This will also help the software decide which functions the evaluation system can perform reliably.

2.5.1.5 Configuration Registers

In the *Config0*, *Config1*, and *Config2* register boxes, the contents of the CS5490's configuration registers can be modified by typing a hexadecimal value in the *HEX* field, or by changing any of the values below the *HEX* field to the desired settings. Although the CDB5490U software allows the user to modify any of the bits in the configuration registers, changing certain reserved bits, such as the *NO_OSC* bit of *Config0*, may cause the software and board to behave erratically. This applies only to the CDB5490U evaluation system, and not to the CS5490 chip itself.

2.5.1.6 Pulse Control Register

The *Pulse Control Register* section is used to make changes to and display the contents of the CS5490's *PulseCtrl* register. The *PulseCtrl* register contains various bits that are used to select the input to each energy pulse generation block within the CS5490. Refer to the CS5490 data sheet for descriptions of the bits. The value of the *PulseCtrl* register is displayed in hexadecimal format. Most of the *PulseCtrl* register bits are reserved or unused. Only the usable bits are displayed in the Setup Window.

2.5.1.7 Pulse Width and Pulse Rate Registers

The *Pulse Width Register* section is used to make changes to and display the contents of the CS5490's *PulseWidth* register. The *PulseWidth* register is used to define the frequency range and pulse width of the energy pulses generated by the CS5490. The *PulseWidth* register should be configured before setting the *PulseRate* register. The *Pulse Rate Register* section is used to make changes to and display the contents of the CS5490's *PulseRate* register. The *PulseRate* register defines the full-scale frequency of the energy pulses generated by the CS5490.

2.5.1.8 Phase Compensation

The *Phase Comp Register* section is used to make changes to and display the contents of the CS5490's *PC* (Phase Compensation Control) register. The *PC* register allows coarse- and fine-phase adjustment on each channel of the CS5490 data path. Refer to the CS5490 data sheet for descriptions of the *PC* register bits.

2.5.1.9 Integrator Gain, System Gain

The *Integrator Gain* and *System Gain* sections display the signal path gain in both hexadecimal and decimal format. Each register can be modified by typing a value in the corresponding *Decimal* or *HEX* field.

2.5.1.10 Sample Count, Cycle Count, Settle Time

The *Sample Count Register*, *Cycle Count Register*, and *Settle Time* sections provide fields to display the values of registers associated with low-rate calculations. The *SampleCount* and *CycleCount* registers are entered or displayed in decimal format by default. The user may select to enter or view other number formats of the register by selecting the "d" within the field. The value of the T_{Settle} register is displayed in both hexadecimal and decimal format. Each register can be modified by typing a value in the corresponding field.

2.5.1.11 ZX_{NUM}

When Automatic Frequency Update is enabled, the ZX_{NUM} section is used to adjust the number of zero crossings used in the Epsilon calculation. The update rate of *Epsilon* is increased by reducing the zero crossings. The register can be modified by typing the number of zero crossings.

2.5.1.12 Epsilon

The *Epsilon* section is used to display and adjust the *Epsilon* register (the ratio of the AC line frequency to the output word rate). The *Epsilon* register can be updated either through entering the AC line frequency in the *Line Freq* field or by entering the direct register value in the *HEX* field.

2.5.1.13 Mask Register

The *Mask Register* box displays the value for the *Mask* register in hexadecimal format and decodes them to indicate each bit's function. The *Mask* register can be modified by typing a value in the *HEX* field, or by checking the appropriate boxes for the bits that are to be masked. The value present in the *Mask* register may be changed by the GUI software during certain operations to provide correct functionality of the CDB5490U board.

2.5.1.14 Temperature Registers

The *Temperature Registers* box is used to adjust the temperature offset register (T_{OFF}) and temperature gain register (T_{GAIN}) to convert the temperature register (T) from the Celsius scale to the Fahrenheit scale or vice versa and to improve temperature measurement accuracy. Refer to the CS5490 data sheet for details of the on-chip temperature sensor.

2.5.1.15 Zero-crossing Level and No Load Threshold

The *Zero-crossing Level* and *No Load Threshold* boxes display the values for these registers in hexadecimal and decimal. Each register can be modified by typing a value in the corresponding *Decimal* or *HEX* field.

2.5.1.16 V Sag, V Swell, and I Overcurrent Registers

The registers for voltage sag, voltage swell, and overcurrent are displayed in the *V Sag*, *V Swell*, and *I Overcurrent Register* sections. These sections display the level and duration values of the corresponding registers in both hexadecimal and decimal format. Each register can be modified by typing a value in the corresponding decimal or *HEX* field. Refer to the CS5490 data sheet for detailed descriptions of these registers.

2.5.1.17 Register Checksum, SerialCtrl Registers

The *Register Checksum* and *SerialCtrl Register* boxes provide control and status of critical serial port communication parameters and the register checksum. The *SerialCtrl Register* section provides control over RX pin, baud rate, and enabling checksum protection for serial communication. The *Register Checksum* section provides the calculated checksum of the critical registers inside the CS5490. The register checksum updates automatically after single or continuous conversion has been performed. The *RegChk* and *SerialCtrl* registers are displayed in hexadecimal form. Please note that if the opto-couplers are selected as the isolation (J18, J20), the maximum baud rate is 2400.

The baud rate field applies only to UART serial communication and can be changed by the pull-down field. It is recommended to set the baud rate to the highest setting possible. The default setting of 600 baud will cause some GUI functions to overflow the communication buffer and not function correctly.

2.6 Calibration Window

The Calibration Window is used to display and write to the CS5490 offset and gain calibration registers. The user is also able to initiate the CS5490's calibration sequences that are used to set the calibration values. AC offset, DC offset, and gain calibrations can be performed on the voltage channel, current channel, or both channels simultaneously. The user should refer to the CS5490 data sheet for more details on calibration (see Figure 17).

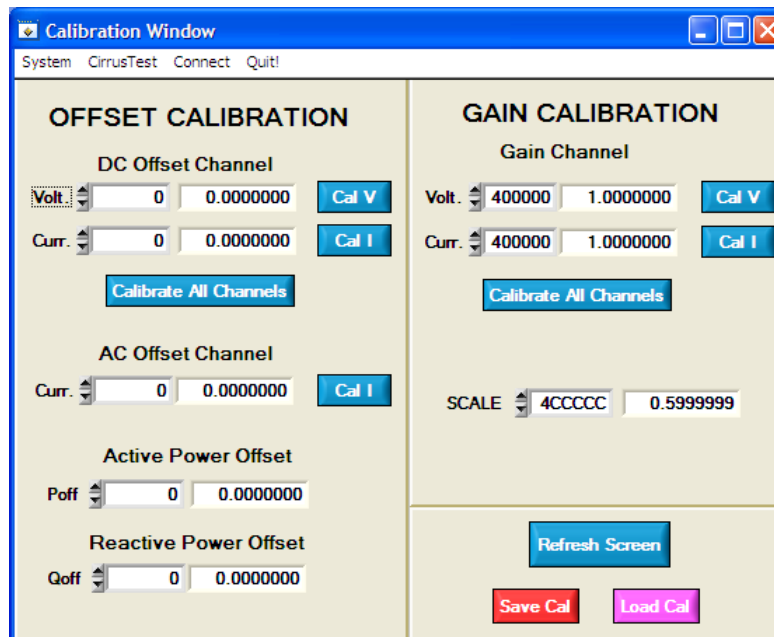


Figure 17. Calibration Window

The *Refresh Screen* button will update the contents of the screen by reading all the register values from the part. It is recommended to click the *Refresh Screen* button when entering the Calibration Window, or after modifying any registers to reflect the current status of the CS5490.

2.6.1 Save Cal and Load Cal Buttons

Clicking the *Save Cal* button will save the calibration widow's configuration to a .txt file. Clicking the *Load Cal* button will recall a saved configuration and store values into the CS5490.

2.6.2 Offset/Gain Register

In the *Offset* and *Gain Calibration* boxes, the offset and gain registers for all channels are displayed in hexadecimal and decimal formats. These registers can be modified directly by typing the desired value in the display boxes. There are three types of offset registers: DC offset, AC offset and power offset. The AC offset registers only affect the RMS register values. The active and reactive power offset registers only affect the active and reactive power register values, respectively. The DC, AC, and power offset registers are two's complement numbers whose values ranges from -1 to +1. The gain register value ranges from 0 to 4.

2.6.3 Performing Calibrations

AC/DC offset and gain calibrations can be performed on both the voltage and current channels of the CS5490. It is recommended to software-reset the CS5490 before running calibrations, because the initial values in the calibration registers will affect the results of the calibration. A software-reset will reset these registers back to the default values of zero offset and unity gain. AC/DC offset calibration should be performed before gain calibration to ensure accurate results.

2.6.3.1 Offset Calibrations

1. Ground the channel(s) you want to calibrate directly at the channel header(s), J6 and J11 for the voltage channel and J7 and J8 for the current channel. The channel(s) could also be grounded directly at the screw-type terminals.
2. Press the corresponding AC or DC offset calibrate button (*Cal V*, *Cal I*, or *Calibrate All Channels*) in the corresponding *Offset Calibration* box(es).
3. The offset register value(s) will automatically update when the calibration is completed.

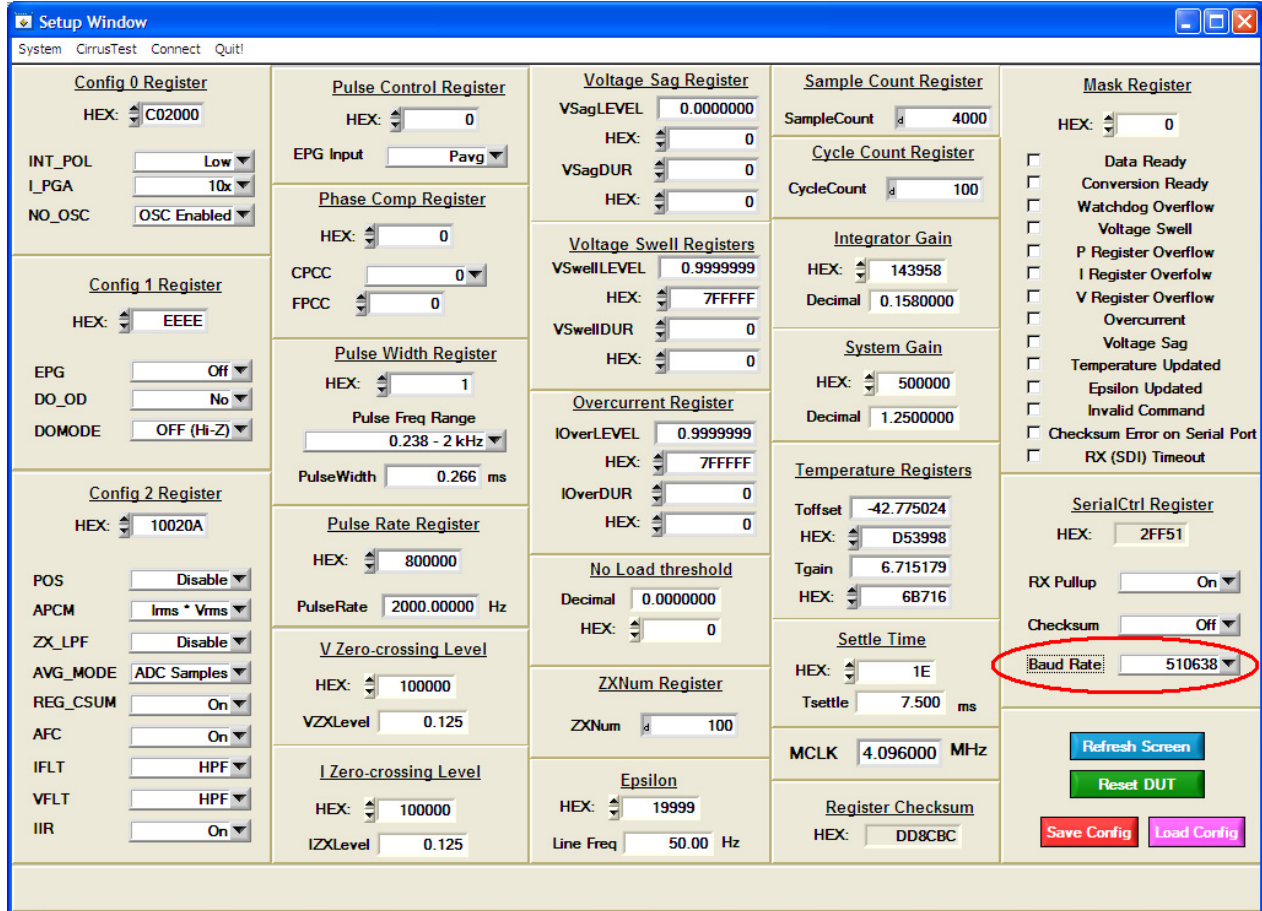
2.6.3.2 Gain Calibrations

1. Attach an AC or DC calibration signal to the screw-type terminals, and make sure the corresponding channel headers (J6, J7, J8, and J11) are set to the desired input position.
2. Press the corresponding gain calibrate button (*Cal V*, *Cal I*, or *Calibrate All Channels*) in the corresponding *Gain Calibration* box(es).
3. The gain register value(s) will automatically update when the calibration is completed.

The *Calibration* window also contains the *Active* and *Reactive Power Offset Register* display and adjustment. The user can read and write the value in the CS5490 active and reactive power offset registers (P_{OFF} and Q_{OFF}).

2.7 Conversion Window

The Conversion Window can be accessed from the *System* menu pull-down, *Conversion* menu item. The *Conversion* option requires the CS5490 device to be configured for 2400 or greater baud rate from the Setup Window (see Figure 18).



The Setup Window displays the following configuration registers and settings:

- Config 0 Register:** HEX: C02000, INT_POL: Low, I_PGA: 10x, NO_OSC: OSC Enabled
- Config 1 Register:** HEX: EEEE, EPG: Off, DO_OD: No, DOMODE: OFF (Hi-Z)
- Config 2 Register:** HEX: 10020A, POS: Disable, APCM: Irms * Vrms, ZX_LPF: Disable, AVG_MODE: ADC Samples, REG_CSUM: On, AFC: On, IFLT: HPF, VFLT: HPF, IIR: On
- Pulse Control Register:** HEX: 0, EPG Input: Pavg
- Phase Comp Register:** HEX: 0, CPCC: 0, FPCC: 0
- Pulse Width Register:** HEX: 1, Pulse Freq Range: 0.238 - 2 kHz, PulseWidth: 0.266 ms
- Pulse Rate Register:** HEX: 800000, PulseRate: 2000.00000 Hz
- V Zero-crossing Level:** HEX: 100000, VZXLevel: 0.125
- I Zero-crossing Level:** HEX: 100000, IZXLevel: 0.125
- Voltage Sag Register:** VSagLEVEL: 0.0000000, HEX: 0, VSagDUR: 0, HEX: 0
- Voltage Swell Registers:** VSwellLEVEL: 0.9999999, HEX: 7FFFFF, VSwellDUR: 0, HEX: 0
- Overcurrent Register:** IOverLEVEL: 0.9999999, HEX: 7FFFFF, IOverDUR: 0, HEX: 0
- No Load threshold:** Decimal: 0.0000000, HEX: 0
- ZXNum Register:** ZXNum: 100
- Epsilon:** HEX: 19999, Line Freq: 50.00 Hz
- Sample Count Register:** SampleCount: 4000
- Cycle Count Register:** CycleCount: 100
- Integrator Gain:** HEX: 143958, Decimal: 0.1580000
- System Gain:** HEX: 500000, Decimal: 1.2500000
- Temperature Registers:** Toffset: -42.775024, HEX: D53998, Tgain: 6.715179, HEX: 6B716
- Settle Time:** HEX: 1E, Tsettle: 7.500 ms
- MCLK:** 4.096000 MHz
- Register Checksum:** HEX: DD8CBC
- Mask Register:** HEX: 0, Data Ready, Conversion Ready, Watchdog Overflow, Voltage Swell, P Register Overflow, I Register Overflow, V Register Overflow, Overcurrent, Voltage Sag, Temperature Updated, Epsilon Updated, Invalid Command, Checksum Error on Serial Port, RX (SDI) Timeout
- SerialCtrl Register:** HEX: 2FF51, RX Pullup: On, Checksum: Off
- Baud Rate:** 510638 (circled in red)
- Buttons:** Refresh Screen, Reset DUT, Save Config, Load Config

Figure 18. Setup Window with 510638 Baud Rate

When the UART is configured for a baud rate of less than 2400, the resulting error message is displayed (see Figure 19.)

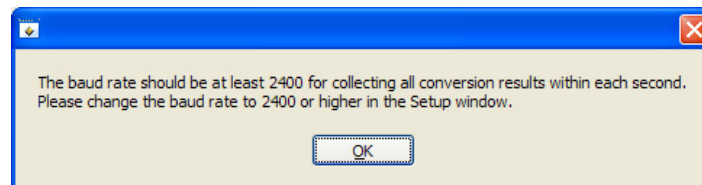


Figure 19. Conversion Collection Baud Rate Error

The *Conversion* window allows the user to see the results of single and continuous conversions and the CS5490 status, perform data averaging, and use the power-saving modes of the CS5490. The Conversion Window can be accessed from the *System* menu pull-down, *Conversion* menu item. The Conversion Window provides the active, apparent, and reactive energy calculations register results for each channel. In addition, the RMS, power factor, and peak signal amplitudes for each analog-to-digital converter channel, chip temperature, AC line frequency (converted from the Epsilon register), and the values of each

status register (Status0, 1, 2) are also displayed. The Conversion Window also provides the total active, apparent and reactive power register results.

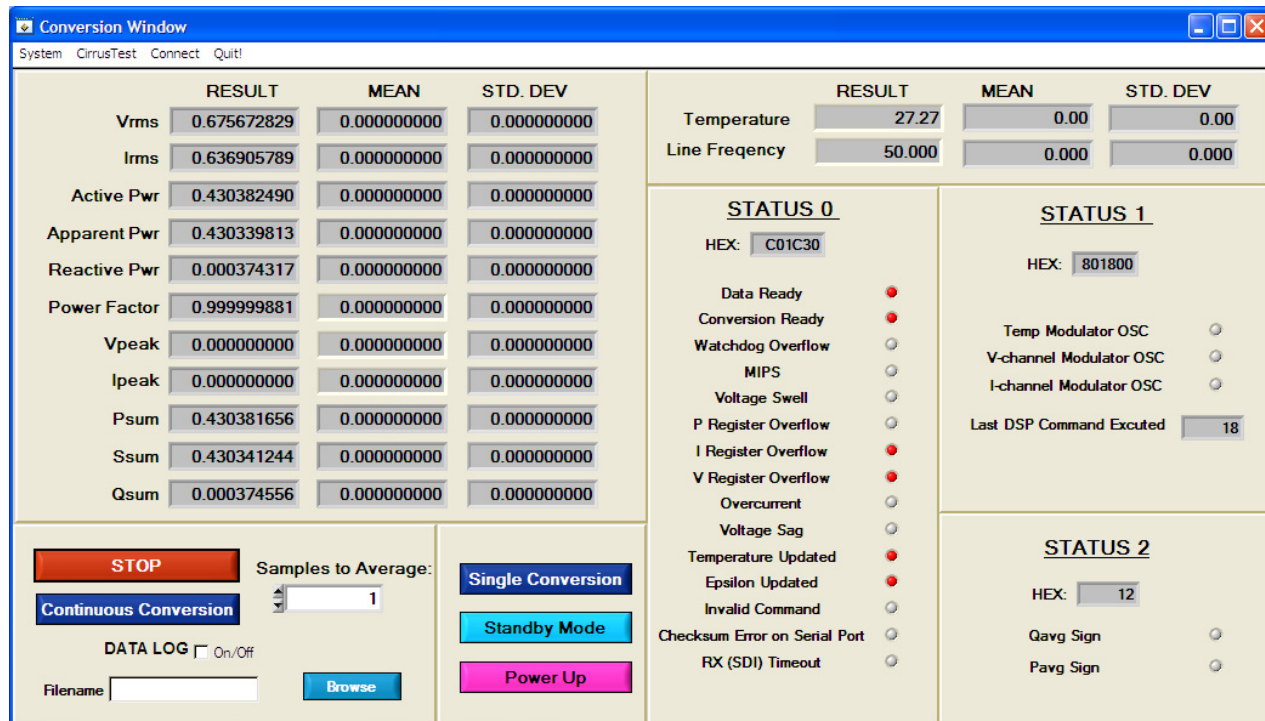


Figure 20. Conversion Window

2.7.1 Single Conversion Button

Pressing the *Single Conversion* button will cause a single conversion to be performed. After a single conversion is complete, the *Result* column will be updated with the values present in each data register.

2.7.2 Continuous Conversion Button

Pressing this button will cause continuous conversions to be performed until the user clicks the *Stop* button. After each conversion is complete, the *Result* column will be updated with the values present in each data register. The *Mean* and *STD. DEV* columns will be updated every N cycle, where N is the number in the *Samples to Average* field. The user should stop continuous conversion before leaving this window. The *Continuous Conversion* button should not be used with BAUD rates less than 1200Hz in UART mode. Using lower BAUD rates (including the default 600 baud) will result in overflowing the communication buffer and cause other window errors, communication failure, or both.

Data logging can be enabled using the *DATALOG* On/Off check box and *Filename* field.

2.7.3 Standby Mode Button

When this button is clicked, the CS5490 will enter a standby power-saving mode. To return to normal mode, press the *Power Up* button. The user should power up the device before leaving this window.

2.7.4 Power Up Button

The *Power Up* button is used to send the wake-up command to the CS5490. The CS5490 will return to normal operating mode.

2.7.5 Line Frequency Result

When the AFC bit in the *Config2* register is set, the *Epsilon* register will be calculated automatically by the CS5490 and the *Line Frequency* fields will be updated automatically in continuous conversion mode. If the AFC bit in the *Config2* register is not set and the line frequency is other than the default value (50Hz), the line frequency must be set manually here to make *Epsilon* the ratio of line frequency to the output word rate (OWR). This ensures the accuracy of the quadrature power (Q) and the reactive power (Q_{AVG}) calculations. Refer to the CS5490 data sheet for more details.

2.7.6 Temperature Result

The *Temperature* fields will display the current CS5490 die temperature in the top right corner of the Conversion Window.

2.7.7 Samples to Average

The *Samples to Average* field allows the user to average a number of measurement results.

2.8 Cirrus Test Window

The *Cirrus Test* window provides three options: *Test and Debug*, *ADC Data Collection*, and *ADC Data Collection to File*. Each window provides a means to evaluate the different functions and performance of the CS5490 (see Figure 21).

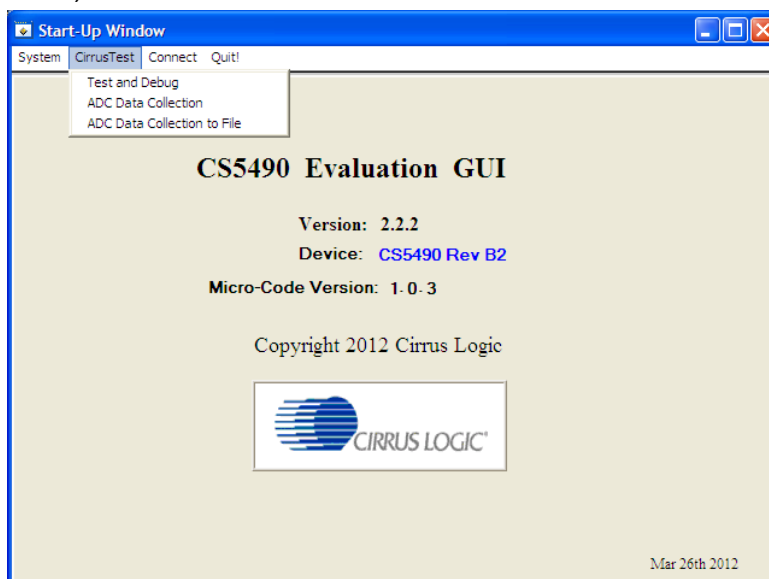


Figure 21. Cirrus Test Pull-down Options

2.8.1 Data Collection Window

The Data Collection Window allows the user to collect sample sets of data from the CS5490 and analyze them using time domain, FFT, and histogram plots. The *Data Collection* window can be accessed by pulling down the *CirrusTest* menu, and selecting the *ADC Data Collection* item (see Figure 22).

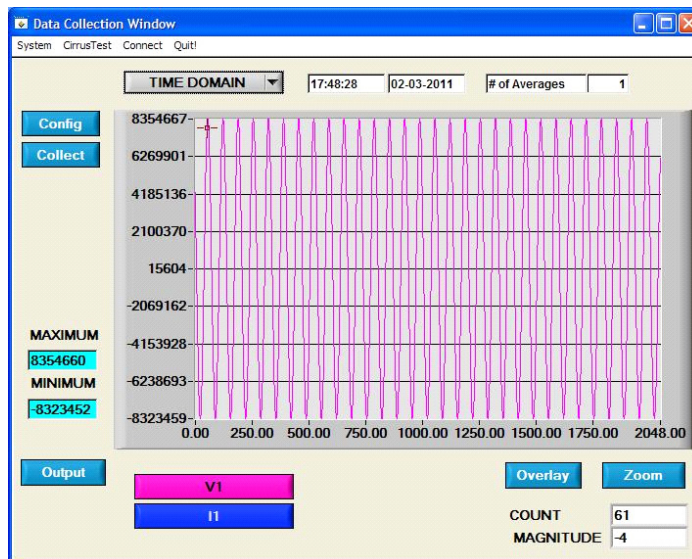


Figure 22. Data Collection Window

The Data Collection Window can only be accessed when the UART is operating at 510638 baud. When UART serial communication is enabled, an error window is displayed (see Figure 23). The baud rate is selected within the Setup Window (see Figure 18).

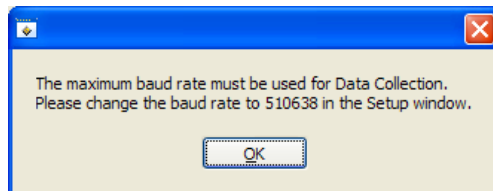


Figure 23. Data Collection UART Error Message

2.8.1.1 Time Domain / FFT/ Histogram Selector

The *Time Domain/FFT/Histogram* selector selects the type of data processing to perform on the collected data and displays the results in the plot area. Refer to “Analyzing Data” on page 31 for more information.

2.8.1.2 Config Button

The *Config* button will bring up the *Configuration* window, in which the user can modify the data collection specifications. Refer to “Configuration Window” on page 30 for more information.

2.8.1.3 Collect Button

The *Collect* button will collect data from the part, to be analyzed in the plot area. See “Collecting Data Sets” on page 31 for more information.

2.8.1.4 Output Button

The *Output* button will bring up a window in which the user can output the data to a file for later use, print out a plot, or print out the entire screen. When saving data, only the data channel being displayed on the plot will be saved to a file.

2.8.1.5 Zoom Button

The *Zoom* 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 farther.

2.8.1.6 Channel Select Button

After data collection, the two buttons labeled as "No Data" will be replaced with *Current* and *Voltage* buttons, allowing the user to choose the appropriate channel for display. In the time domain mode, an additional *Overlay* button will be present, which allows the user to display all the channels on the same plot.

2.8.1.7 Output Button and Window

The *Output* button allows the user to:

1. Output Time Domain File
2. Output FFT File
3. Output Histogram
4. Print Screen
5. Print Graph

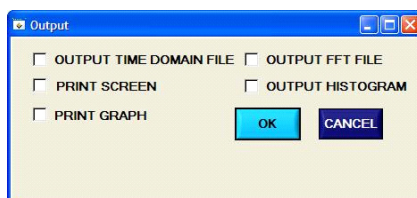


Figure 24. Data Collection Output Window

2.8.1.8 Configuration Window

The *Configuration* window allows the user to set up the data collection and analysis parameters (see Figure 25).

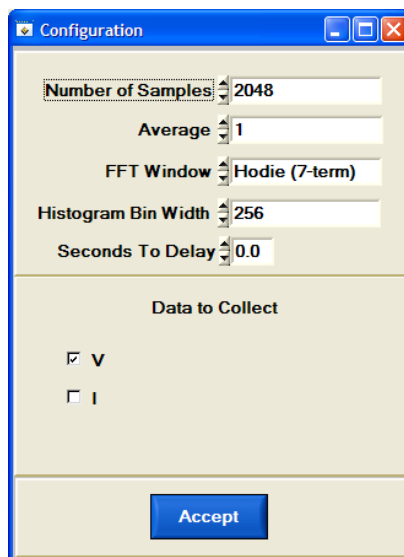


Figure 25. Data Collection Configuration Window

2.8.1.8.1 Number of Samples

The *Number of Samples* field allows the user to select the number of samples to collect, between 16 and 524288.

2.8.1.8.2 Average

When performing FFT analyses, the *Average* field determines the number of FFTs to average. FFTs will be collected and averaged when the *Collect* button is clicked.

2.8.1.8.3 FFT Window

The *FFT Window* 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 Crystal Semiconductor, now called Cirrus Logic.

2.8.1.8.4 Histogram Bin Width

This field determines the "bin width" when plotting histograms of the collected data. Each vertical bar in the histogram plot will contain the number of output codes entered in this field. Increasing this number may allow the user to view histograms with larger input ranges.

2.8.1.8.5 Seconds to Delay

This field specifies the amount of time the system waits to begin data collection after the CS5490 starts continuous conversions.

2.8.1.8.6 Data to Collect

The *Data to Collect* check boxes allow the user to select the data types that will be collected and returned to the PC for processing.

2.8.1.8.7 Accept Button

When the *Accept* button is pressed, the current settings will be saved and the user will return to the *Data Collection* window.

2.8.1.9 Collecting Data Sets

To collect a sample data set:

1. In the *Data Collection* window, press the *Config* button to bring up the *Configuration* window and view the current settings.
2. Select the appropriate settings from the available options (see “Configuration Window” on page 30) and press the *Accept* button.
3. The *Data Collection* window should still be visible. Press the *Collect* button to begin collecting data.
4. Once the data has been collected, it can be analyzed, printed, or saved to disk.

2.8.1.10 Analyzing Data

The evaluation software provides three types of analysis tests: Time Domain, Frequency Domain, and Histogram. The Time Domain analysis processes acquire conversions to produce a plot of magnitude versus conversion sample number. The Frequency Domain analysis processes acquired conversions to produce a plot of magnitude versus frequency 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 processes acquired conversions to produce a histogram plot. Statistical noise calculations are also calculated and displayed.

2.8.1.11 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 analysis type pull-down menu to *Histogram* (see Figure 26). The histogram plot information includes:

- **BIN:** Displays the x-axis value of the cursor on the histogram.
- **MAGNITUDE:** Displays the y-axis value of the cursor on the histogram.
- **MEAN:** Indicates the mean of the data sample set. The mean is calculated using the following formula:

$$\text{MEAN} = \frac{\sum_{i=0}^{n-1} X_i}{n}$$

- **STD_DEV:** Indicates the standard deviation of the collected data set. The standard deviation is calculated using the following formula:

$$\text{STDDEV} = \sqrt{\frac{\sum_{i=0}^{n-1} (X_i - \text{Mean})^2}{n}}$$

- **VARIANCE:** Indicates the variance of the current data set. The variance is calculated using the following formula:

$$\text{VARIANCE} = \frac{\sum_{i=0}^{n-1} (X_i - \text{Mean})^2}{n}$$

- **MAXIMUM:** Indicates the maximum value of the collected data set.
- **MINIMUM:** Indicates the minimum value of the collected data set.

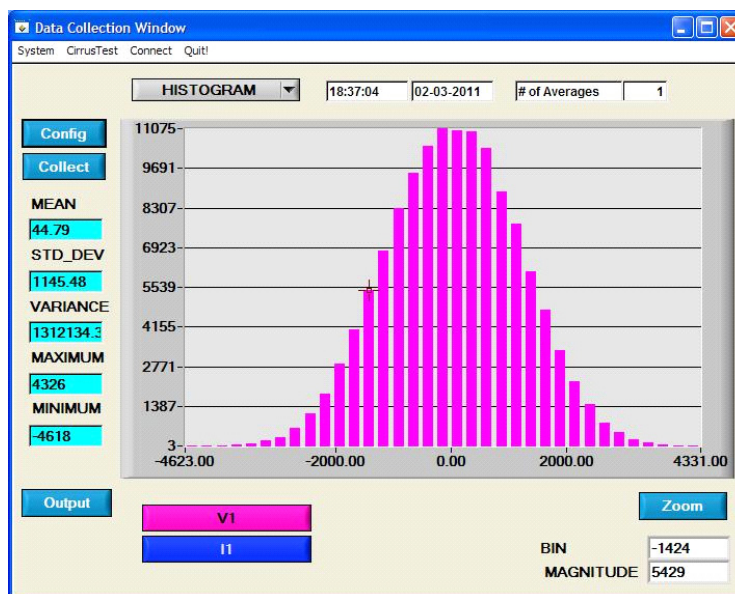


Figure 26. Histogram Analysis

2.8.1.12 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 analysis type selector to *FFT* (see Figure 27). The FFT information includes:

- **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/PN:** Indicates the signal-to-peak noise ratio (decibels).
- **SINAD:** Indicates the signal-plus-noise-plus-distortion to noise-plus-distortion ratio (decibels).
- **S/D:** Indicates the signal-to-distortion ratio, 4 harmonics are used in the calculations (decibels).
- **SNR:** Indicates the signal-to-noise ratio, first 4 harmonics are not included (decibels).
- **FS-PdB:** Indicates the full-scale to signal Ratio (decibels).

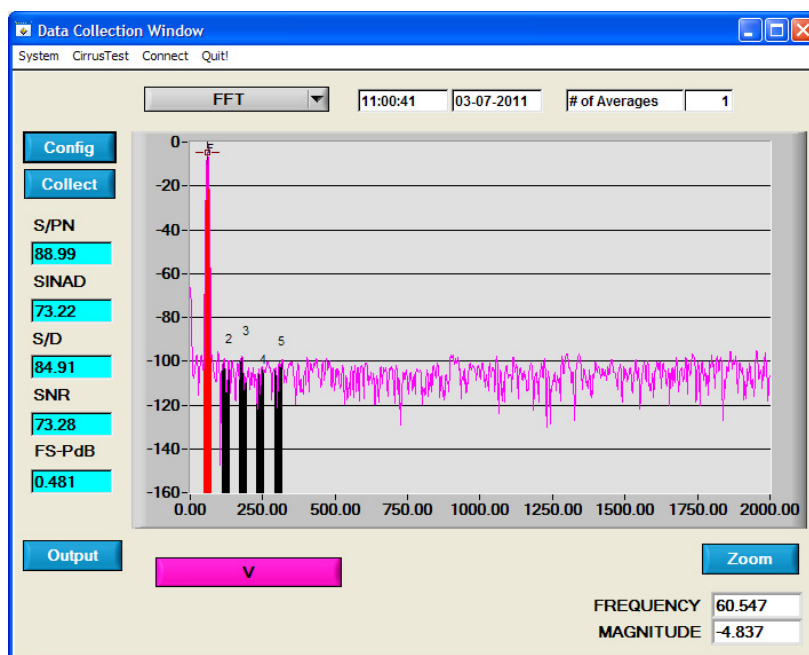


Figure 27. FFT Analysis

2.8.1.13 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 analysis type selector to *Time Domain* (see Figure 28). The Time Domain plot includes:

- 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: Indicates the maximum value of the collected data set.
- MINIMUM: Indicates the minimum value of the collected data set.

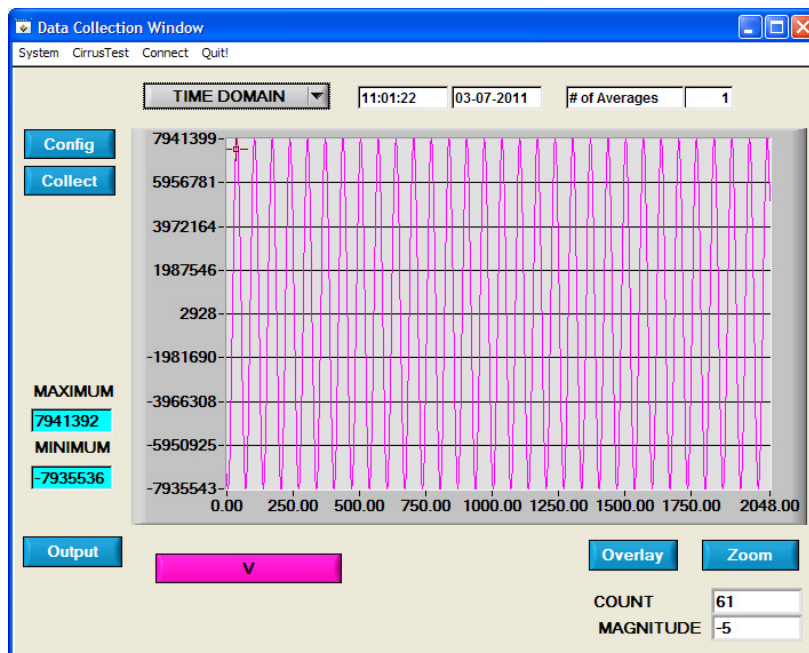


Figure 28. Data Collection Window - Time Domain Analysis

2.8.2 Data Collection to File Window

The *Data Collection to File* window allows the user to collect instantaneous voltage and current register data over an extended period of time to a data file (see Figure 29). The *Data Collection to File* option requires the CS5490 device to be configured at the maximum baud rate set from the within the Setup Window (see Figure 18). The following steps are necessary for data collection to a file:

1. Provide the *Time to Collect* in seconds.
2. If a delay before data collection is needed, enter the time in seconds for the *Delay*.
3. Select the voltage and current channel (V and I).
4. Browse to a directory and enter the file name of the desired file to save.
5. Start the data collection by pressing the *START* button.
6. The data collection status will be provided in *Samples Collected* and *Time Remaining*.
7. The collection will complete without any further interaction by the user or the user may stop the data collection at any time by pressing the *STOP* button.

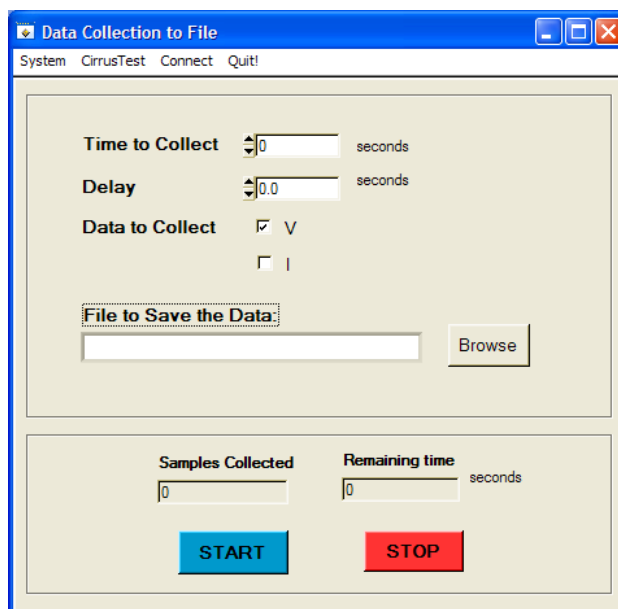


Figure 29. Data Collection to File Window

2.8.3 Setup and Test Window

The *Setup and Test* window allows the user a way to access CS5490 registers and send commands to the CS5490 directly (see Figure 30).

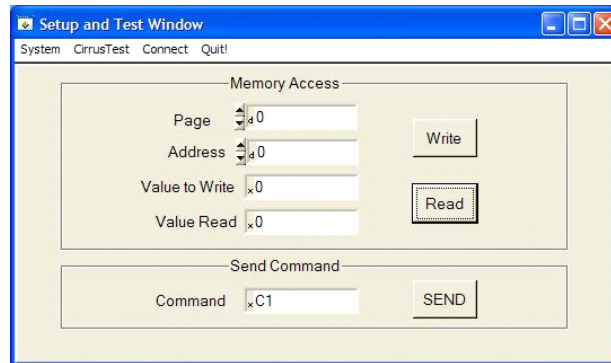


Figure 30. Setup and Test Window

There are three types of transactions: Write register, Read register, and Send command. The CS5490 memory is organized by pages. In order to properly write a register, it is necessary to set the *Page*, *Address*, and *Value to Write* field and then press the *WRITE* button. To read a register it is necessary to set the *Page* and *Address* and then press the *READ* button. The register result will be displayed in the *Value Read* field. To send a command to the CS5490, enter the command in the *Command* field and press the *SEND* button. Refer to the CS5490 data sheet for more details on registers and commands.

APPENDIX A. BILL OF MATERIALS

CIRRUS LOGIC
CDB5490U_REV_B.bom

BILL OF MATERIAL

Item	Cirrus P/N	Rev	Description	Qty	Reference Designator	MFG	MFG P/N	Notes	Status
1	001-02194-Z1	A	CAP 0.1uF ±10% 25V X7R NPb 0603	0	C1 C2 C7	MURATA	GRM188R71E104KA01D	NO POP	A
2	001-10064-Z1	A	CAP 15pF ±5% 50V C0G NPb 0603	1	C3	KEMET	C0603C150J5GAC		A
3	001-04187-Z1	A	CAP 0.027uF ±5% 50V X7R NPb 0805	6	C4 C5 C6 C9 C34 C35	KEMET	C0805C27J5RAC		A
4	001-10233-Z1	A	CAP 4.7uF ±20% 25V X7R NPb 1206	2	C8 C32	TDK	C3216X7R1E475M		A
5	001-04345-Z1	A	CAP 0.1uF ±10% 50V X7R NPb 0805	2	C10 C31	KEMET	C0805C104K5RAC		A
6	001-02194-Z1	A	CAP 0.1uF ±10% 25V X7R NPb 0603	1	C11	KEMET	C0603C104K3RAC		A
7	001-04523-Z1	A	CAP 1uF ±10% 16V X7R NPb 0805	2	C12 C28	KEMET	C0805C105K4RAC		A
8	001-01994-Z1	A	CAP 0.01uF ±10% 16V X7R NPb 0603	2	C13 C19	MURATA	GRM188R71C103KA01D		A
9	001-02194-Z1	A	CAP 0.1uF ±10% 25V X7R NPb 0603	3	C14 C15 C16	MURATA	GRM188R71E104KA01D		A
10	001-10226-Z1	A	CAP 1uF ±10% 25V X5R NPb 0603	2	C20 C21	MURATA	GRM188R61E105KA12		A
11	001-02189-Z1	A	CAP 0.1uF ±10% 16V X7R NPb 0603	5	C22 C23 C25 C27 C29	KEMET	C0603C104K4RAC		A
12	012-00010-Z1	A	CAP 47uF ±20% 16V NPb ELEC CASE C	2	C24 C30	PANASONIC	EEE1CA470WR		A
13	001-10127-Z1	A	CAP 22pF ±10% 50V C0G NPb 0603	1	C26	KEMET	C0603C220K5GAC		A
14	012-00013-Z1	A	CAP 4.7uF ±20% 25V ELEC NPb CASE B	1	C33	PANASONIC	EEE1EA4R7SR		A
15	070-00055-Z1	A	DIODE ARRAY 5V (TVS) ESD NPb SOT143	1	D5	LITTELFUSE	SP0503BAHTG		A
16	165-00004-Z2	A	LED SUP RED 100mcd NPb SMD	2	D6 DO1	EVERLIGHT	28-21SRC/TR8		A
17	110-00055-Z1	A	CON TERM BLCK 4 POS 5mm NPb BLU TH	2	J1 J3	ON-SHORE TECHNOLOGY	ED 100/4DS		A
18	110-00056-Z1	A	CON TERM BLOCK 2POS 5mm NPb BLU TH	2	J4 J27	ON-SHORE TECHNOLOGY	ED 100/2DS		A
19	115-00016-Z1	A	HDR 3x2 ML .1"CTR 062 S GLD NPb	1	J6	SAMTEC	TSW-103-07-G-D		A
20	115-00257-Z1	A	HDR 2x2 ML .1" 093BD ST GLD NPb TH	3	J7 J8 J11	SAMTEC	TSW-102-08-G-D		A
21	115-00009-Z1	A	HDR 3x1 ML .1" 062 ST GLD NPb TH	8	J15 J18 J20 J26 J38 J43 J50 J58	SAMTEC	TSW-103-07-G-S		A
22	115-00012-Z1	A	HDR 4x2 ML .1"CTR S GLD NPb	2	J17 J19	SAMTEC	TSW-104-07-G-D		A
23	115-00014-Z1	A	HDR 2x1 ML .1" 062BD ST GLD NPb TH	10	J21 J23 J39 J44 J45 J46 J48 J49 J53 J54	SAMTEC	TSW-102-07-G-S		A
24	115-00276-Z1	A	HDR 16X1 ML .1" 062 S GLD NPb TH	1	J22	SAMTEC	TSW-116-07-G-S	SOLDER J22 TO LCD1 AND PRINTED CIRCUIT BOARD SEE ASSEMBLY DRAWING	A
25	110-00041-Z1	A	CON RA USB BLK NPb TH	1	J24	AMP	292304-1		A
26	115-00003-Z1	A	HDR 5x2 ML .1"CTR S GLD NPb	1	J25	SAMTEC	TSW-105-07-G-D		A
27	110-00014-Z1	A	CON XLR CHASSIS 3P FML SILV NPb	0	J28 J30	NEUTRIK	NC3FD-H	NO POP	A
28	115-00014-Z1	A	HDR 2x1 ML .1" 062BD ST GLD NPb TH	0	J32 J34	SAMTEC	TSW-102-07-G-S	NO POP	A
29	110-00008-Z1	A	CON BPOST 2" SILV NYLON INS BLK NPb	1	J36	JOHNSON COMPONENTS	111-0103-001	REQUIRES WIRE, 1.5L X 0.25T X 0.25T TYPE E 24/19 BLU SQUIRES ELEC. INC.	A
30	110-00010-Z1	A	CON BPOST 2" SILV NYLON INS RED NPb	1	J37	JOHNSON COMPONENTS	111-0102-001	REQUIRES WIRE, 1.5L X 0.25T X 0.25T TYPE E 24/19 BLU SQUIRES ELEC. INC.	A
31	115-00024-Z1	A	HDR 1x1 ML .1"CTR S NPb GLD	1	J57	SAMTEC	TSW-101-07-G-S		A
32	080-00004-Z1	A	WIRE JUMPER 2P 0.1" BRASS NPb TH	8	JP1 JP2 JP3 JP4 JP5 JP6 JP7 JP8	COMPONENTS CORPORATION	TP-101-10		A
33	160-00012-Z1	A	LCD MODULE 3.3V 16x2 16x64mm NPb	1	LCD1	TOPWAY	LMB162AFC-2	NEED HDR16X1-SSW-116-01-G-S	A
34	304-00022-Z1	A	SPCR STANDOFF NYL HEX 1.0/4-40 NPb	7	MH1 MH2 MH3 MH4 MH5 MH6 MH7	KEYSTONE	1902E	REQUIRES SCREW 4-40X5X16" PH STEEL 300-00025-Z1	A

Figure 31. Bill of Materials (Page 1 of 2)



CIRRUS LOGIC®

CDB5490U

CIRRUS LOGIC
CDB5490U_REV_B.bom

BILL OF MATERIAL

Item	Cirrus P/N	Rev	Description	Qty	Reference Designator	MFG	MFG P/N	Notes	Status
35	020-01702-Z1	A	RES 100 OHM 1/8W ±1% NPb 0805 FILM	2	R1 R2	DALE	CRCW0805100RFKEA		A
36	020-01816-Z1	A	RES 1k OHM 1/8W ±1% NPb 0805 FILM	5	R5 R6 R7 R49 R50	DALE	CRCW08051K00FKEA		A
37	020-06362-Z1	A	RES 422k OHM 1/4W ±1% NPb 1206	4	R8 R12 R14 R15	DALE	CRCW1206422KFKEA		A
38	020-01816-Z1	A	RES 1k OHM 1/8W ±1% NPb 0805 FILM	0	R9 R13	DALE	CRCW08051K00FKEA	NO POP	A
39	021-00347-Z1	A	RES 2.2 OHM 1/8W ±5% NPb 0805 FILM	0	R11	DALE	CRCW08052R20JNEA	NO POP	A
40	021-00407-Z1	A	RES 680 OHM 1/8W ±5% NPb 0805 FILM	2	R25 R48	DALE	CRCW0805680RJNEA		A
41	021-00238-Z1	A	RES 680 OHM 1/10W ±5% NPb 0603 FILM	2	R29 R32	KOA	RK73B1JTDD681J		A
42	021-00259-Z1	A	RES 5.1k OHM 1/10W ±5% NPb 0603 FIL	3	R30 R31 R47	DALE	CRCW06035K10JNEA		A
43	021-00268-Z1	A	RES 10k OHM 1/10W ±5% NPb 0603 FILM	1	R33	DALE	CRCW060310K0JNEA		A
44	020-00673-Z1	A	RES 0 OHM 1/10W ±5% NPb 0603 FILM	4	R37 R38 R42 R43	DALE	CRCW06030000Z0EA		A
45	021-00242-Z1	A	RES 1k OHM 1/10W ±5% NPb 0603 FILM	3	R44 R45 R46	DALE	CRCW06031K00JNEA		A
46	020-01473-Z1	A	RES 0 OHM 1/18W ±1% NPb 0805 FILM	1	R51	DALE	CRCW08050000Z0EA		A
47	020-00914-Z1	A	RES 130 OHM 1/10W ±1% NPb 0603 FILM	1	R55	DALE	CRCW0603130RFKEA		A
48	020-00673-Z1	A	RES 0 OHM 1/10W ±5% NPb 0603 FILM	0	R56	DALE	CRCW06030000Z0EA	NO POP	A
49	021-00718-Z1	A	RES 20 OHM 1/3W ±5% NPb 1210 FILM	1	R57	DALE	CRCW121020R0JNEA		A
50	120-00002-Z1	A	SWT SPST 130G 0/1 5mm TACT ESD NPb	2	S1 S2	ITT INDUSTRIES	PTS645TL50 LFS	INSTALL AFTER WASH PROCESS	A
51	110-00045-Z1	A	CON TEST PT .1"CTR TIN PLAT NPb BLK	6	TP1 TP2 TP5 TP6 TP9 TP10	KEYSTONE	5001		A
52	065-00334-Z4	B2	IC CRUS ENER MEAS NPb SOIC16L	1	U1	CIRRUS LOGIC	CS5490-ISZ/B2	ECO898, ECO935	A
53	060-00319-Z1	A	IC LNR VREG μPWR 150mA NPb SOT23-5	1	U2	NATIONAL	LP2985IM5-3.3/NOPB	ECO813	A
						SEMICONDUCTOR			A
54	060-00570-Z1	A	IC ISOL 4CH 2.5kV 2/2 NPb SOIC16N	1	U3	SILICON LABORATORIES	SI8442BB-D-IS1		A
55	175-00031-Z1	A	OPT COUP TRANS 50-600% NPb DIP4	2	U4 U5	TOSHIBA	TLP781(F)		A
56	062-00229-Z1	A	IC PGM USB 64kB FLAS MCU NPb LQFP32	1	U6	SILICON LABORATORIES INC	C8051F342-GQ	PROGRAM AT TEST	A
57	061-00392-Z1	A	IC DIG DC/DC CONV 5V 1W NPb SMD8	1	U8	V-INFINITY	VBT1-S5-S5-SMT	ECO813	A
58	135-00100-Z1	A	SKT 1.27mmPCH OPEN NPb SOP16	0	XU1	WELLS-CTI	652B0162211-002	NO POP-SOCKET FOR CS5490-SOIC16	A
59	100-00120-Z1	A	XTL 4.096MHZ HC49US 30ppm 20pF NPb	1	Y1	ECS	ECS-41-20-4X	INSTALL PIN SOCKETS	A
60	070-00006-Z1	A	DIODE TR 6.8V 600W NPb AXL	2	Z1 Z2	LITTELFUSE	P6KE6.8		A
61	070-00200-Z1	A	DIODE TVS 3.3V 2LN ESD NPb SOT23	1	Z3	COMCHIP TECHNOLOGY	CTES033V3-G	ECO853	A
62	603-00483-Z1	C	ASSY DWG CDB5490U-Z-NPb	REF		CIRRUS LOGIC	603-00483-Z1	ECO813,ECO853	A
63	240-00483-Z1	C	PCB CDB5490U-Z-NPb	1		CIRRUS LOGIC	240-00483-Z1	ECO813,ECO853	A
64	600-00483-Z1	C2	SCHEM CDB5490U-Z-NPb	REF		CIRRUS LOGIC	600-00483-Z1	ECO813,ECO853,ECO898,ECO935	A
65	422-00013-Z1	D	LBL SUBASSY PRODUCT ID AND REV	1		CIRRUS LOGIC	422-00013-01		A
66	080-00003-Z1	A	WIRE BPOST 1.5X.25 24/19 GA BLU NPb	2	XJ36 XJ37	SQUIRES	L-1.5X.25TX.25T_TYPE_E_	WIRES FOR BINDING POSTS	A
67	135-00003-Z1	A	SKT 1P .100"L .041"DIA GLD NPb	2	XY1	AUGAT	8134-HC-6P2	2 SINGLE PINS SOCKETS FOR Y1	A
68	300-00025-Z1	A	SCREW 4-40X5/16" PH MACH SS NPb	7		BUILDING FASTENERS	PMSSS 440 0031 PH		A
69	110-00013-Z1	D	CON SHUNT 2P .1"CTR BLK NPb	22		MOLEX	15-29-1025	INSTALL SHUNTS DURING TEST	A
70	422-00180-Z1	A	LBL RoHS	1		IMAGE-TEK	LPP0054	PLACE LABEL ON THE SECONDARY SIDE	A

Figure 32. Bill of Materials (Page 2 of 2)



CIRRUS LOGIC®

CDB5490U

APPENDIX B. SCHEMATICS



CIRRUS LOGIC®

CDB5490U

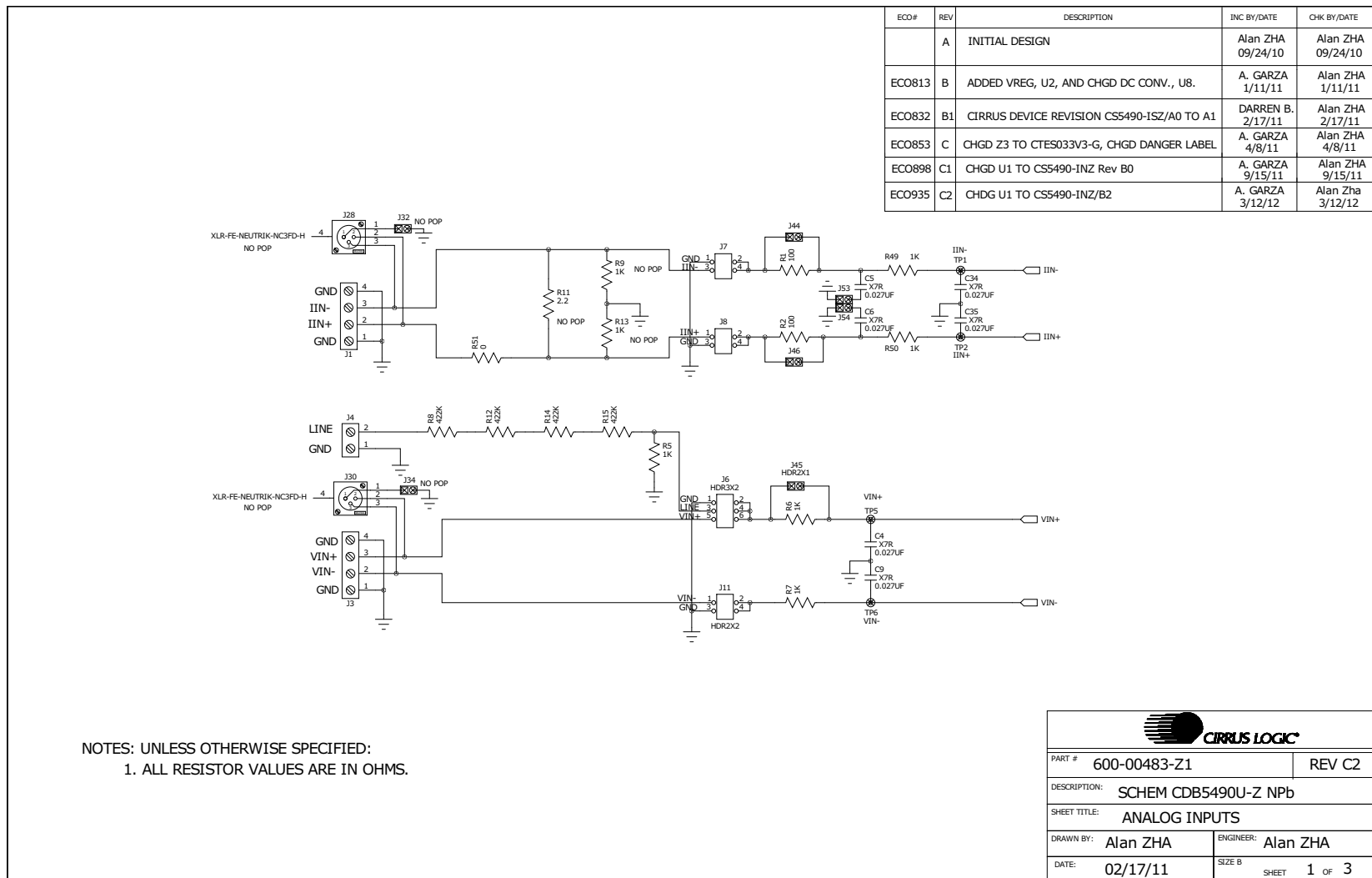


Figure 33. Schematic - Analog Inputs

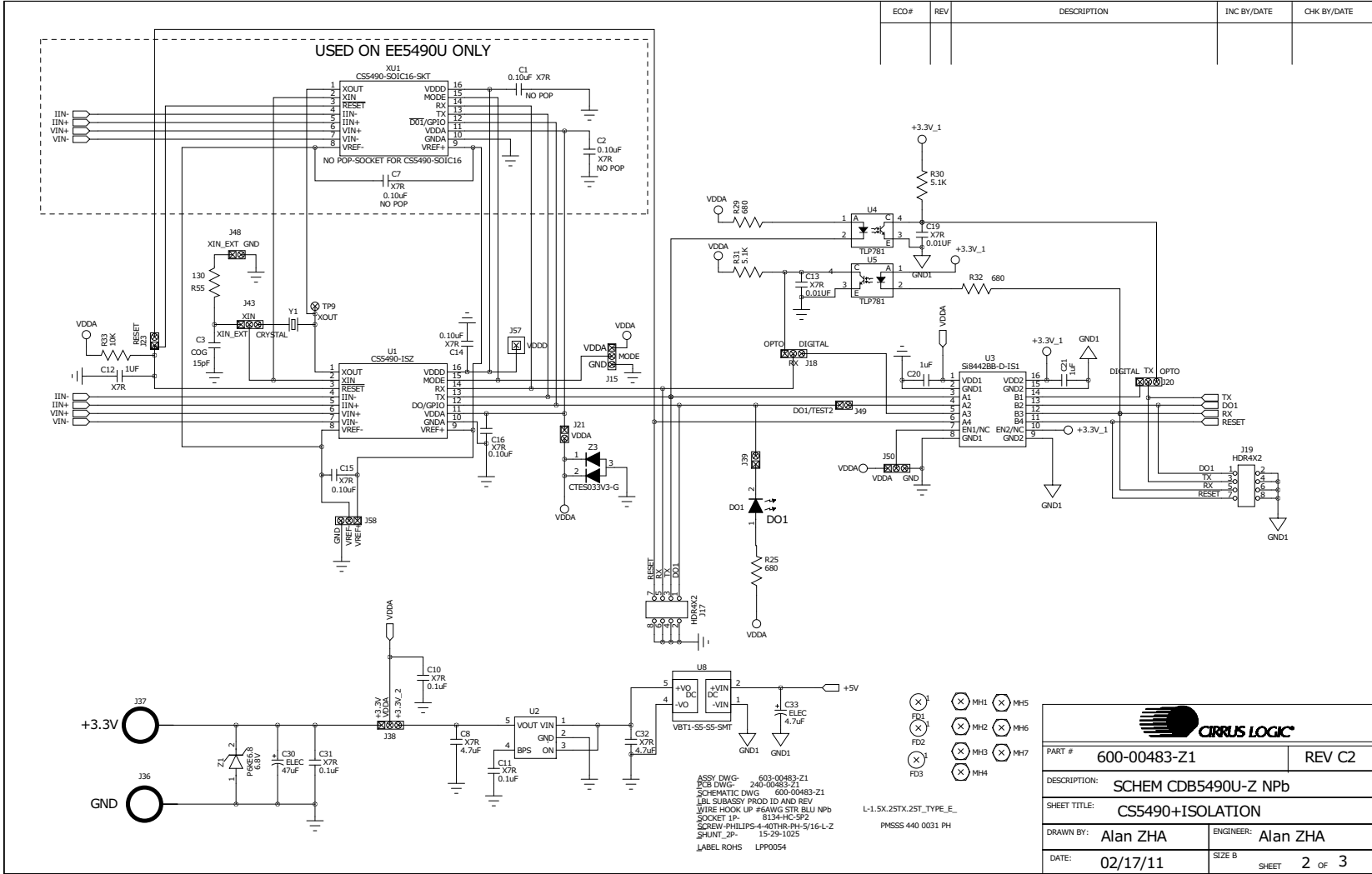


Figure 34. Schematic - CS5490 and Isolation



CIRRUS LOGIC®

CDB5490U

DS923DB5

41

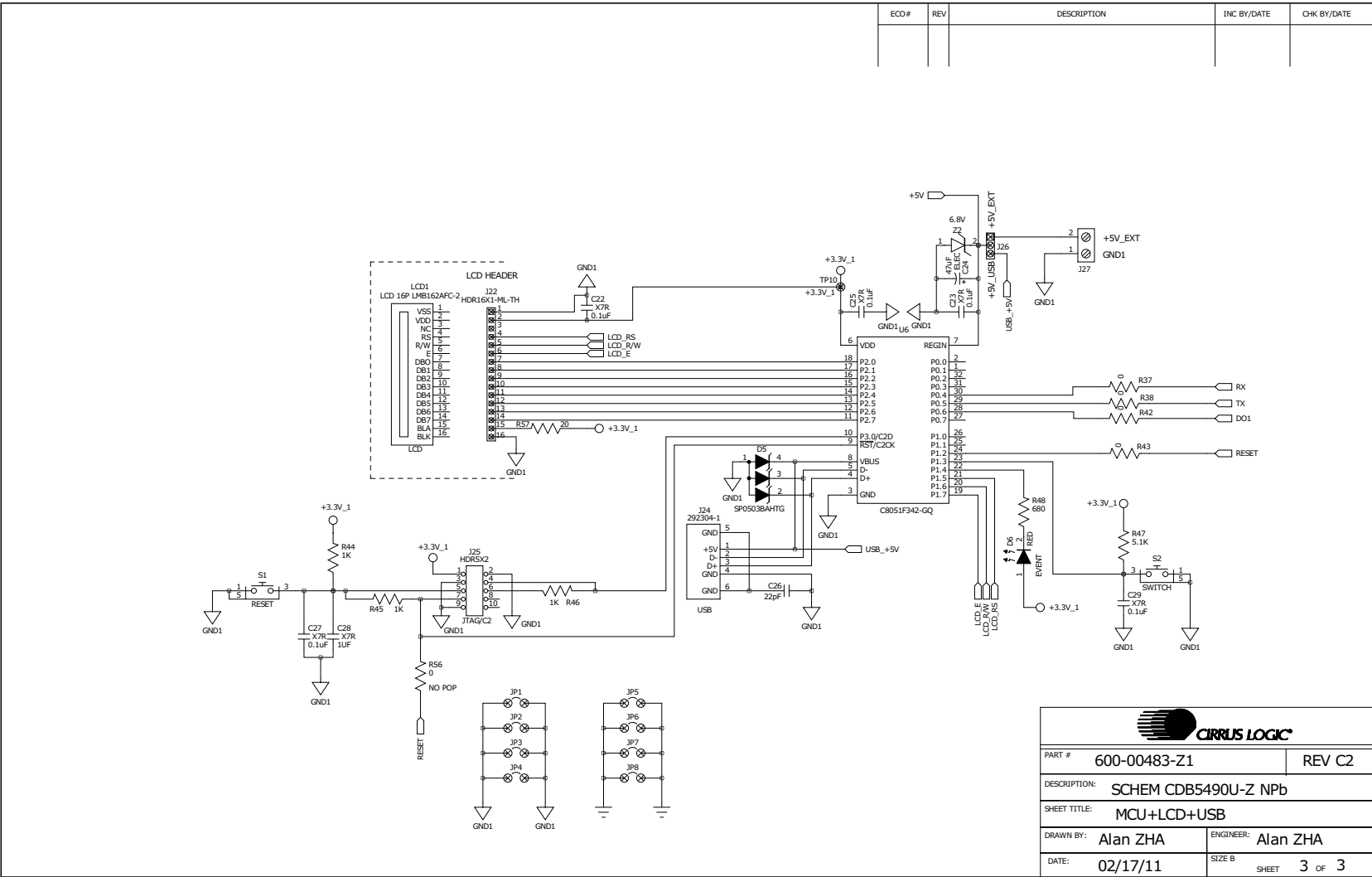


Figure 35. Schematic - Microcontroller and USB Interface

APPENDIX C. LAYER PLOTS

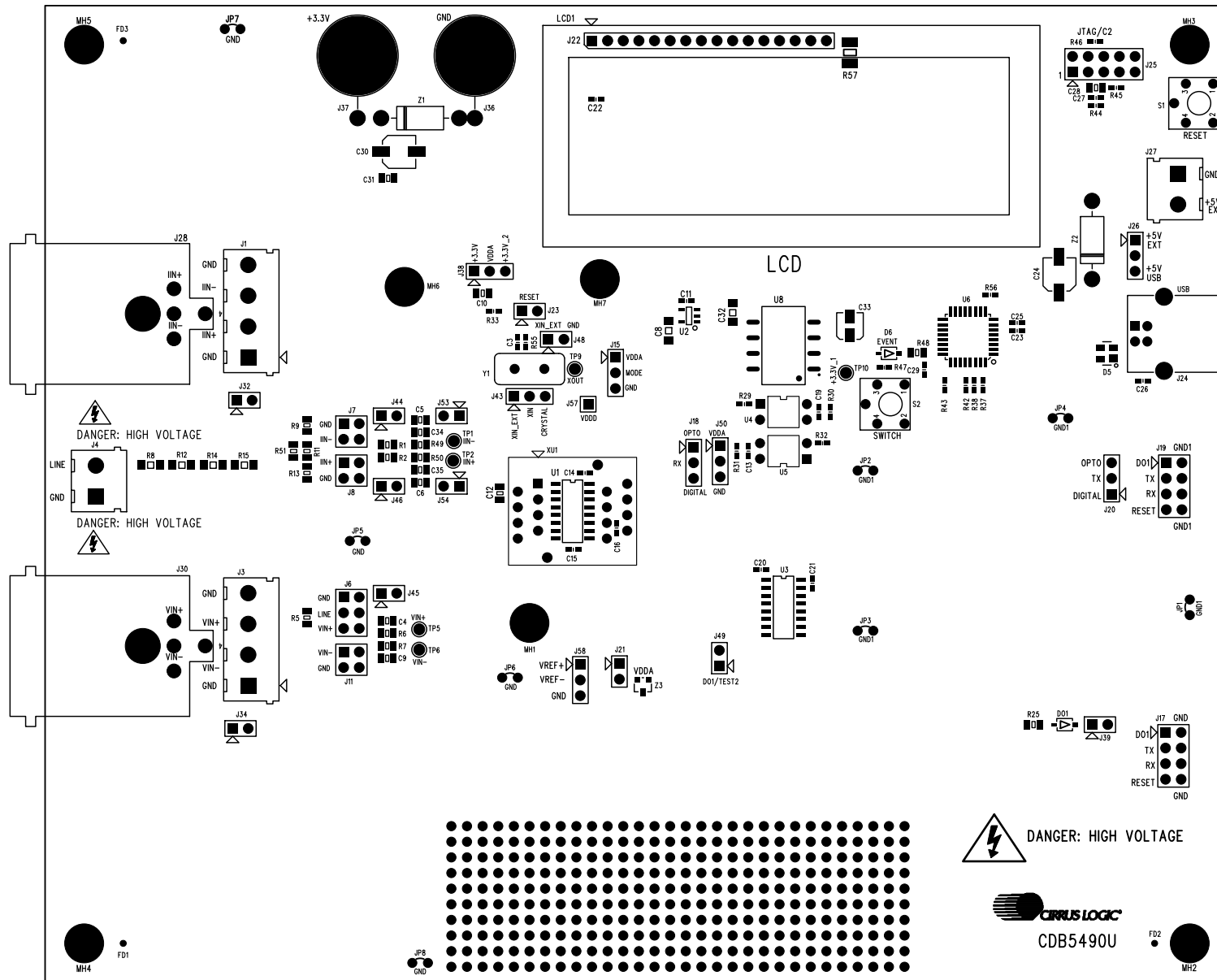


Figure 36. Top Silkscreen

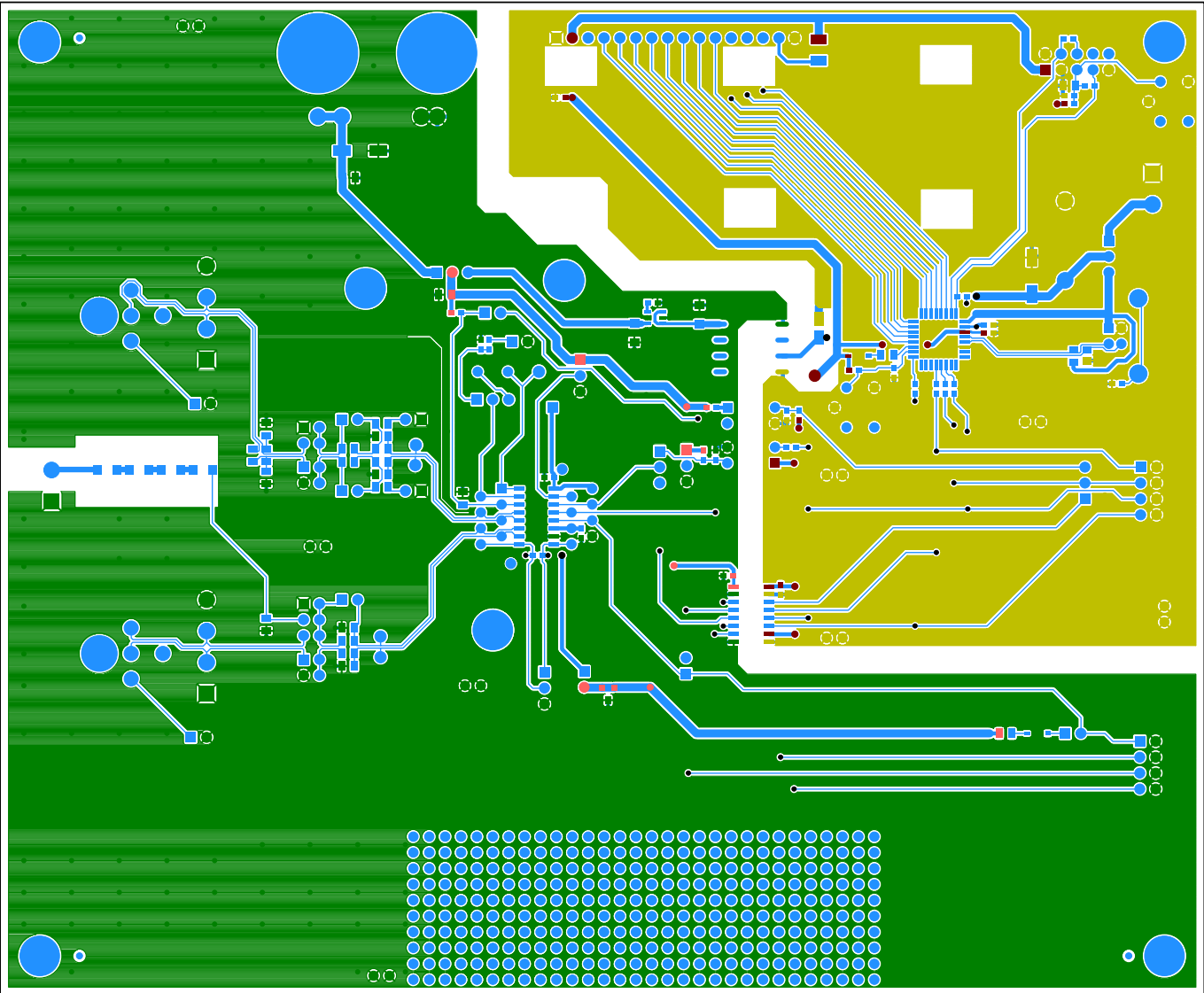


Figure 37. Top Routing

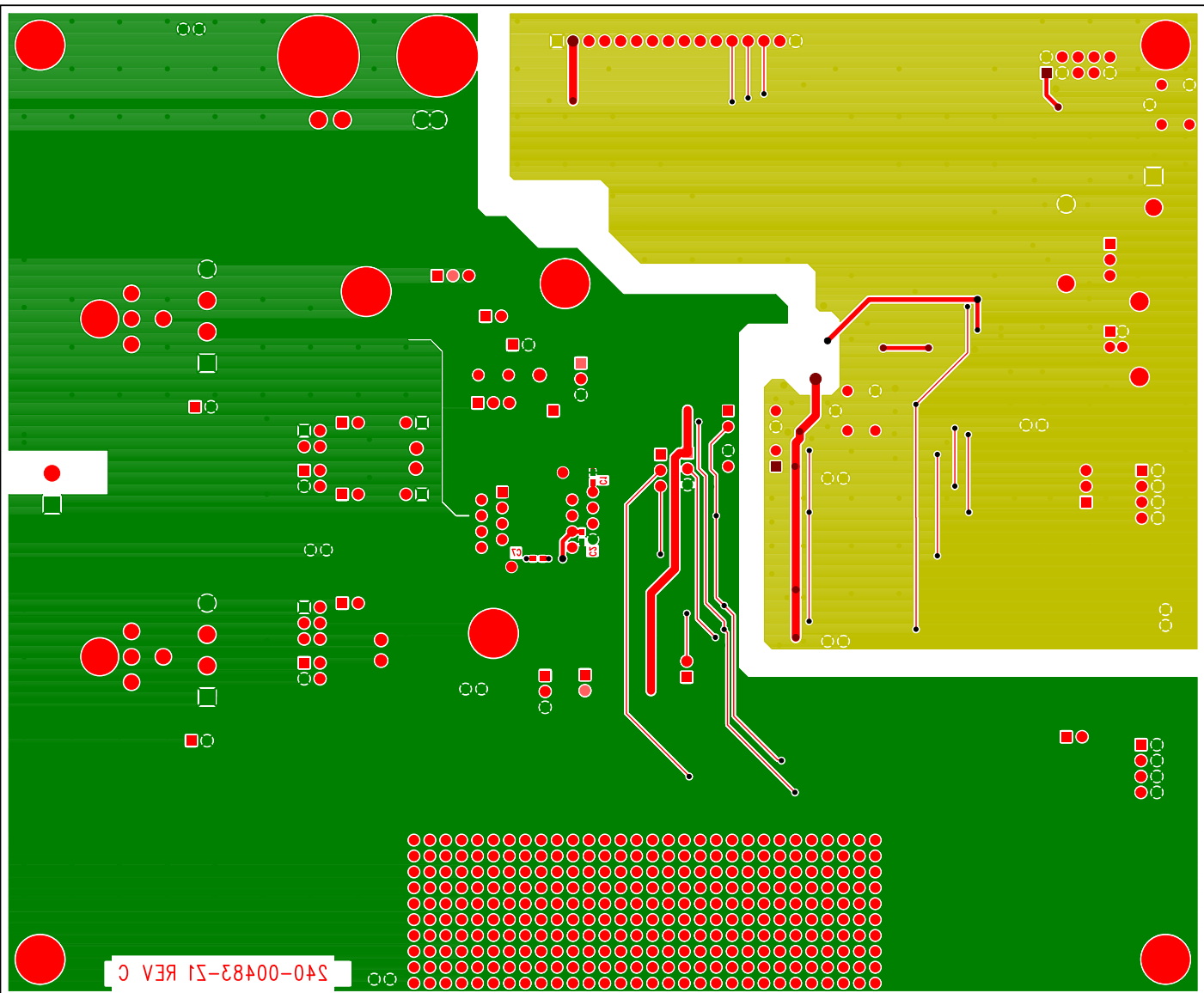


Figure 38. Bottom Routing

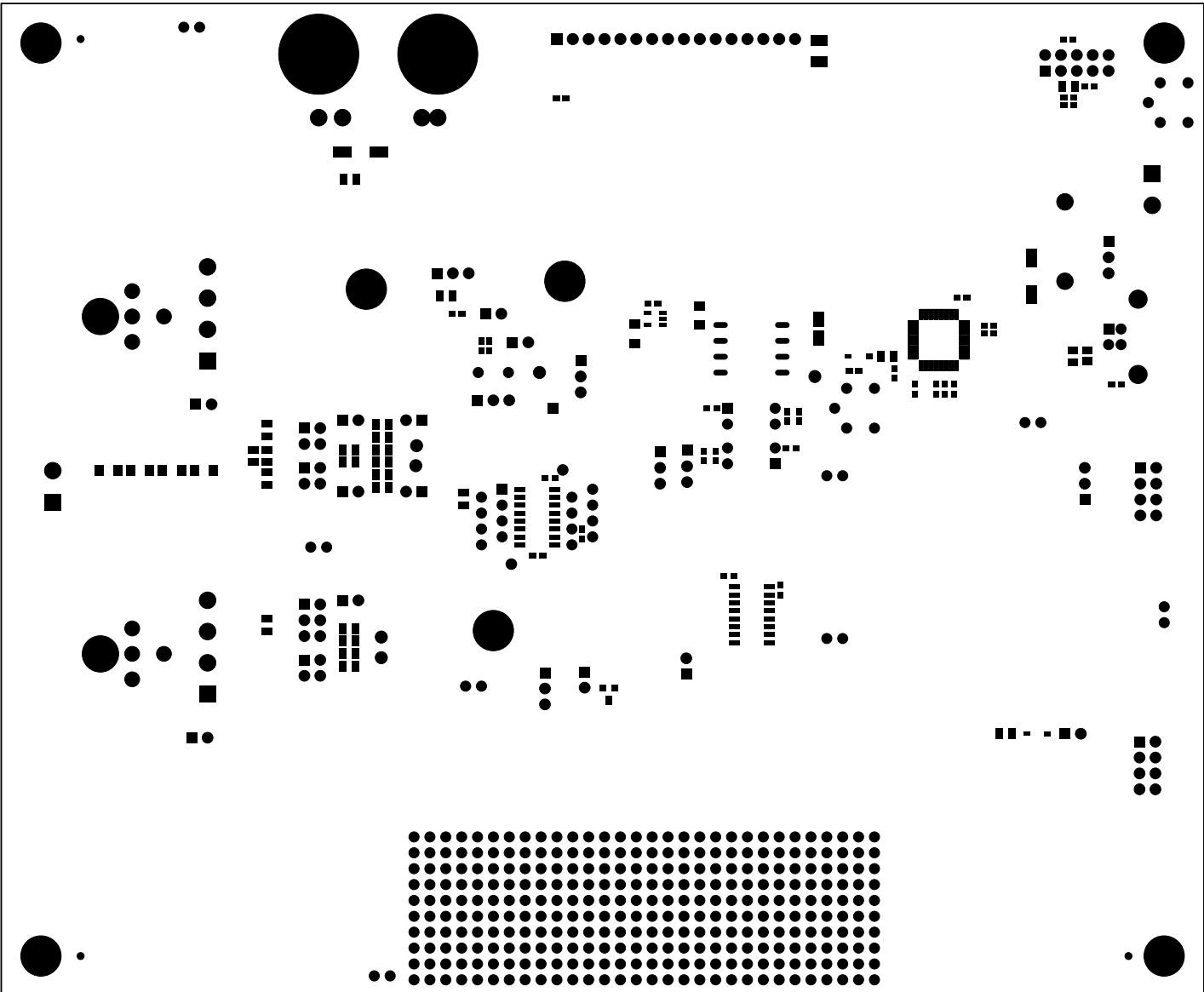


Figure 39. Solder Paste Mask

REVISION HISTORY

Revision	Date	Changes
DB1	APR 2011	Initial Release.
DB2	DEC 2011	Updated screen shots and circuit diagrams to align with B0 silicon.
DB3	JAN 2012	Corrected typographical errors.
DB4	MAR 2012	Updated content.
DB5	APR 2012	Updated screen shots and circuit diagrams to align with B2 silicon.