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# 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.

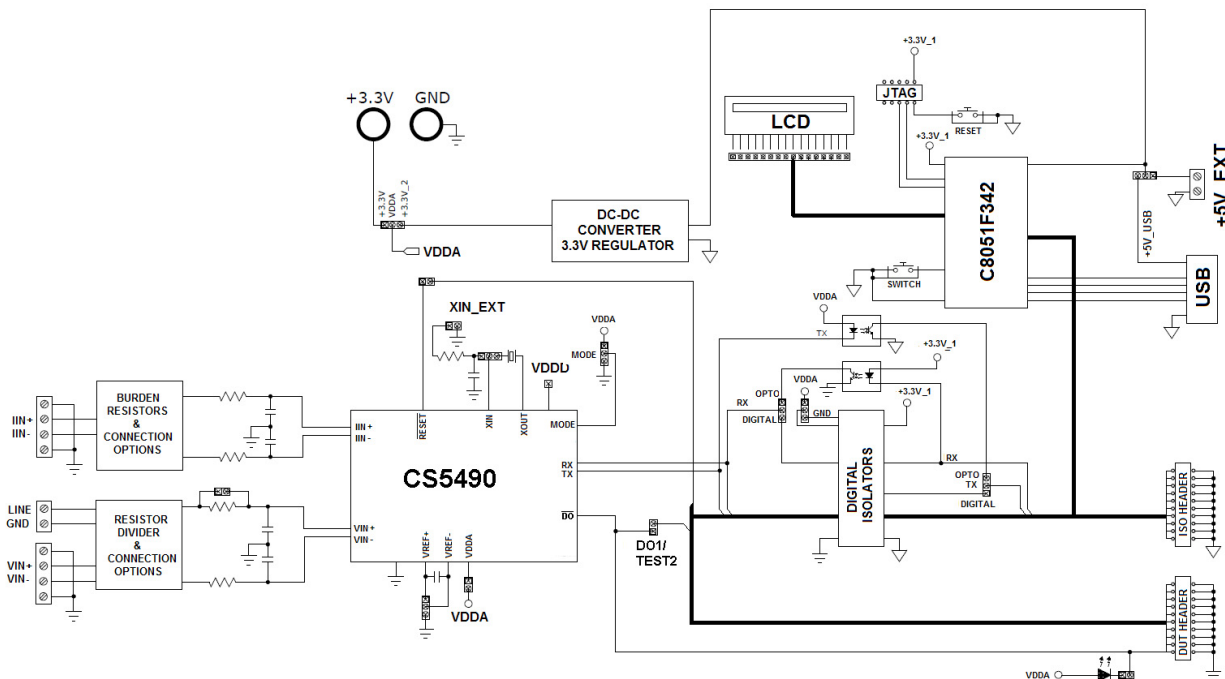
Multiple analog input connection options, configuration input filters, direct and isolated digital interfaces, multiple power supply options, an onboard programmable microcontroller, visual LEDs with an LCD panel make the board a flexible and powerful customer development tool for various power measurement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

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## Contacting Cirrus Logic Support

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## 1. HARDWARE

### 1.1 Introduction

The CDB5490U evaluation board provides a convenient means of evaluating the CS5490 energy measurement IC. The CDB5490U evaluation board operates from a single USB or 5V power supply. An optional 3.3V power supply input is available for powering the CS5490 directly. The evaluation board interfaces the CS5490 to a PC via a USB cable. To accomplish this, the board comes equipped with a C8051F342 microcontroller and a USB interface. Additionally, the CDB5490U GUI software provides easy access to the internal registers of the CS5490. The software provides a means to display the on-chip ADC performance in the time domain or frequency domain.

### 1.2 Evaluation Board Overview

The board is partitioned into two main sections: analog and digital. The analog section consists of the CS5490, passive anti-aliasing filters, and a high-voltage section with an attenuation resistor network. The digital section consists of the C8051F342 microcontroller, LCD, test switches, reset circuitry, and USB interface. The board also has a user-friendly power supply connection. The assembly information and default configurations for jumpers are shown below.

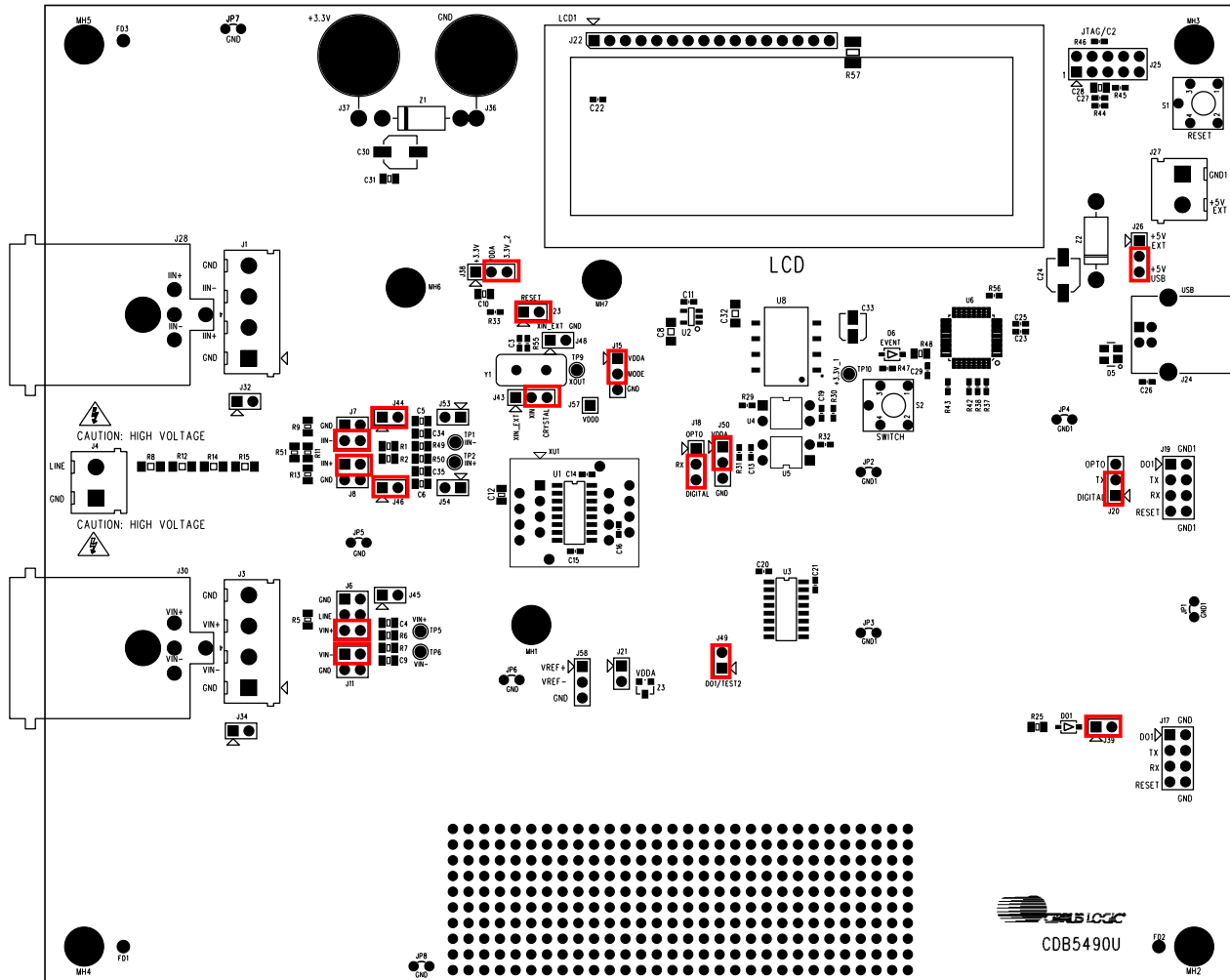


Figure 1. CDB5490U Assembly Drawing and Default Configuration

### 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.

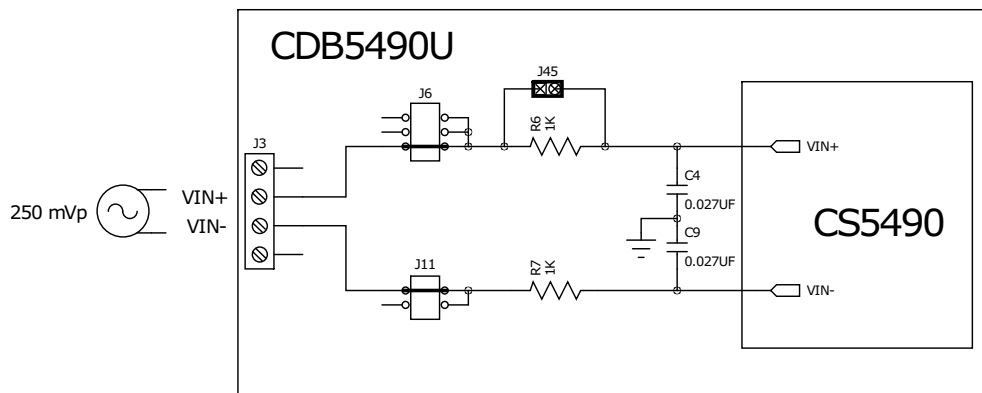
#### 1.3.1 Voltage Sensor Connection

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**

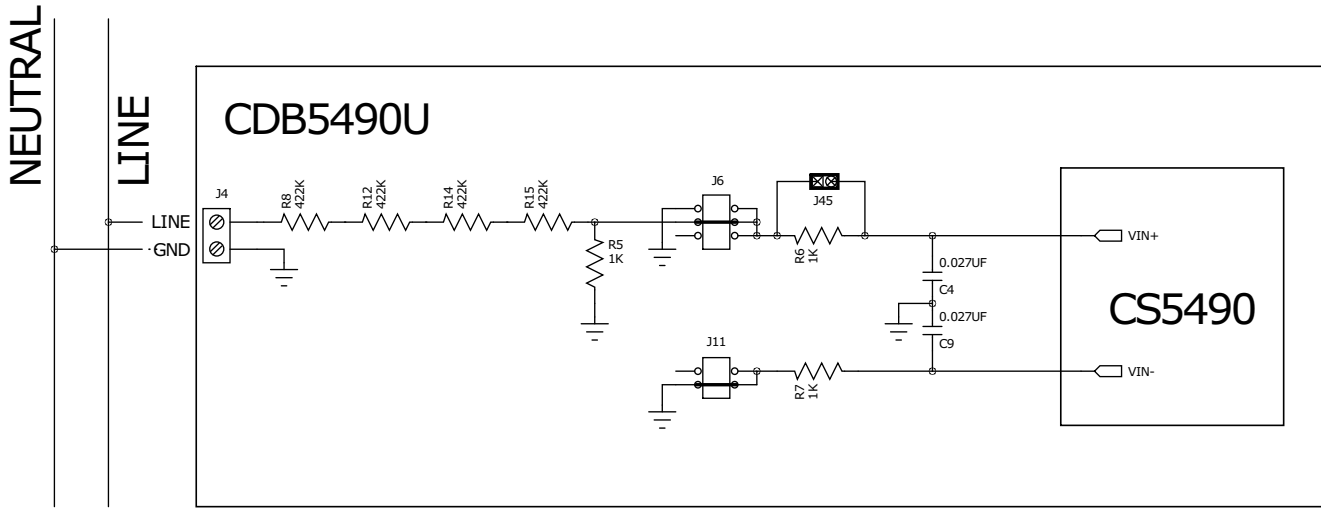
INPUT	Description	J11	J6
VIN±	Selects External Low-voltage Fully Differential Signal	VIN- <input checked="" type="checkbox"/> VIN- GND <input type="checkbox"/> VIN- <i>(Default)</i>	GND <input type="checkbox"/> VIN+ Line <input type="checkbox"/> VIN+ VIN+ <input checked="" type="checkbox"/> VIN+ <i>(Default)</i>
VIN±	Selects External Low-voltage Single-ended Signal	VIN- <input type="checkbox"/> VIN- GND <input checked="" type="checkbox"/> VIN-	GND <input type="checkbox"/> VIN+ Line <input type="checkbox"/> VIN+ VIN+ <input checked="" type="checkbox"/> VIN+
GND	Selects Grounding the Input	VIN- <input type="checkbox"/> VIN- GND <input checked="" type="checkbox"/> VIN-	GND <input checked="" type="checkbox"/> VIN+ Line <input type="checkbox"/> VIN+ VIN+ <input type="checkbox"/> VIN+
High-Voltage Line	Selects External High-voltage AC Line Signal	VIN- <input type="checkbox"/> VIN- GND <input checked="" type="checkbox"/> VIN-	GND <input type="checkbox"/> VIN+ Line <input checked="" type="checkbox"/> VIN+ VIN+ <input type="checkbox"/> 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:

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

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

$$300\text{Vrms} = \frac{250\text{mVp}}{\sqrt{2}} \times 1689$$

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

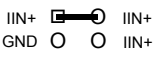
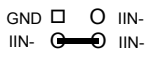
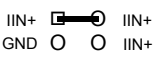
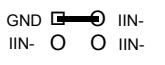

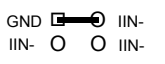
The CDB5490U evaluation board provides input shorting options for calibration and noise performance measurements. With a jumper on J6 and J11 in the GND position, the inputs are connected to analog ground (GND).



### 1.3.2 Current Sensor Connection

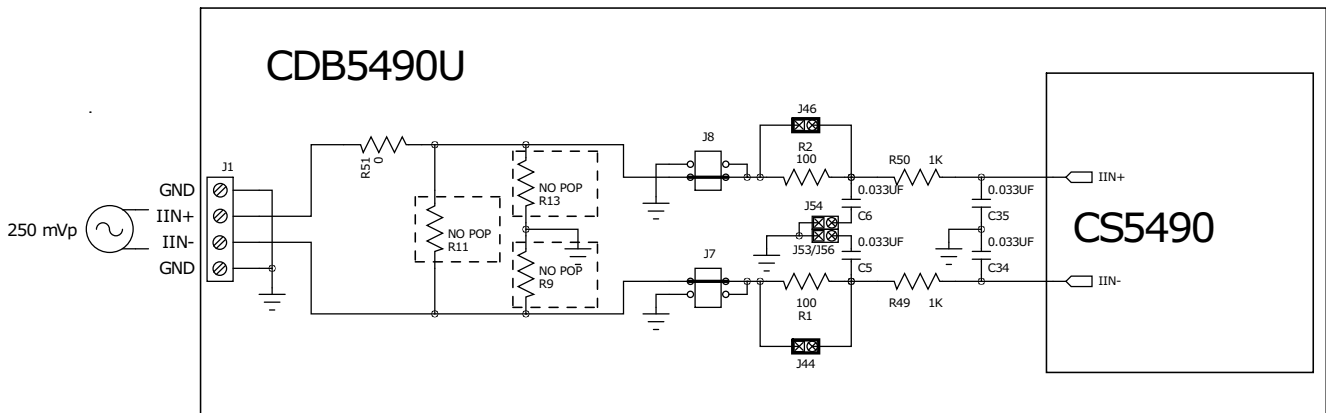
Current input options include an external signal (via screw terminals or XLR connectors) or GND. Table 2 illustrates the options available.

**Table 2. Current Channel Input Signal Selection**

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

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**

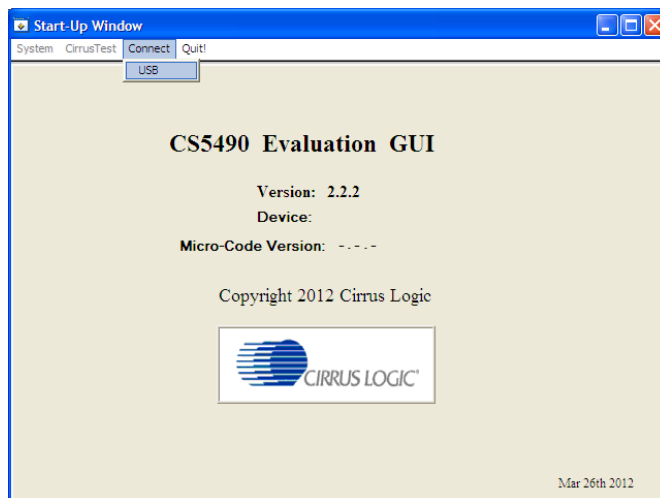
The CDB5490U evaluation board provides input shorting options for calibration and noise performance measurements. With a jumper on J8 and J7 in the GND position, the inputs are connected to analog ground (GND).

## 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	<input type="checkbox"/> OPTO <input checked="" type="checkbox"/> RX <input checked="" type="checkbox"/> DIGITAL (default)	<input type="checkbox"/> OPTO <input checked="" type="checkbox"/> TX <input checked="" type="checkbox"/> DIGITAL (default)	<input checked="" type="checkbox"/> VDDA <input checked="" type="checkbox"/> EN2 <input type="checkbox"/> GND (default)
Low speed UART	<input checked="" type="checkbox"/> OPTO <input checked="" type="checkbox"/> RX <input type="checkbox"/> DIGITAL	<input checked="" type="checkbox"/> OPTO <input checked="" type="checkbox"/> TX <input type="checkbox"/> DIGITAL	<input checked="" type="checkbox"/> VDDA <input checked="" type="checkbox"/> EN2 <input type="checkbox"/> 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	
<b>USB</b>	On-board 3.3 V Regulator	NC	+5V	NC	<input checked="" type="checkbox"/> VDDA <input checked="" type="checkbox"/> VDDA (default)	<input type="checkbox"/> +3.3V <input checked="" type="checkbox"/> VDDA <input checked="" type="checkbox"/> +3.3V_2 (default)	<input type="checkbox"/> +5V EXT <input checked="" type="checkbox"/> +5V <input checked="" type="checkbox"/> +5V USB (default)
<b>External +3.3V &amp; USB</b>	Binding Post	+3.3 V	+5V	NC	<input checked="" type="checkbox"/> VDDA <input checked="" type="checkbox"/> VDDA	<input checked="" type="checkbox"/> +3.3V <input checked="" type="checkbox"/> VDDA <input type="checkbox"/> +3.3V_2	<input type="checkbox"/> +5V EXT <input checked="" type="checkbox"/> +5V <input checked="" type="checkbox"/> +5V USB
<b>External +5V</b>	On-board 3.3V regulator	NC	NC	+5V	<input checked="" type="checkbox"/> VDDA <input checked="" type="checkbox"/> VDDA	<input type="checkbox"/> +3.3V <input checked="" type="checkbox"/> VDDA <input checked="" type="checkbox"/> +3.3V_2	<input checked="" type="checkbox"/> +5V EXT <input checked="" type="checkbox"/> +5V <input type="checkbox"/> +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).

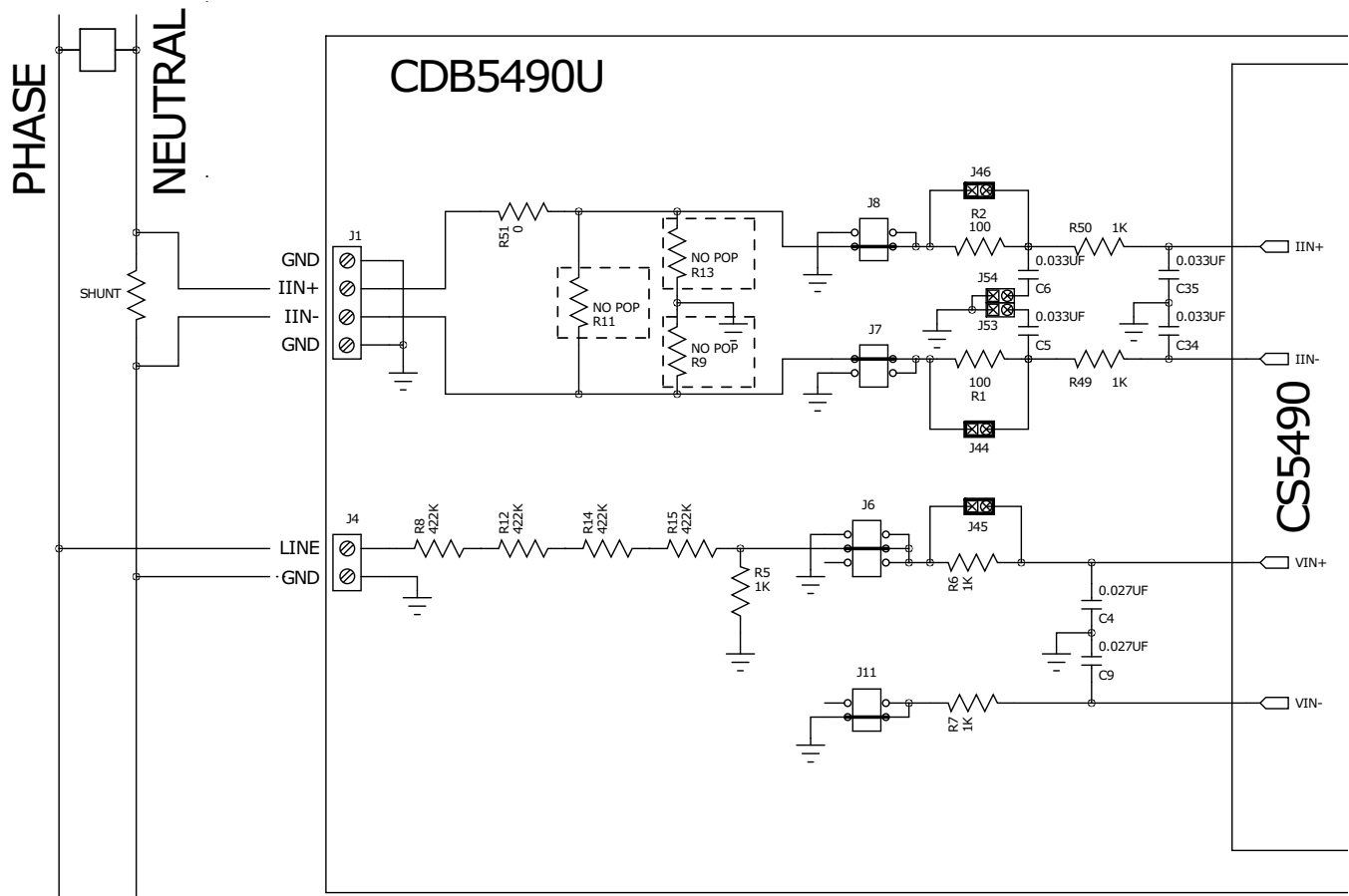


Figure 6. Shunt Sensor Power Meter

### 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.

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

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.

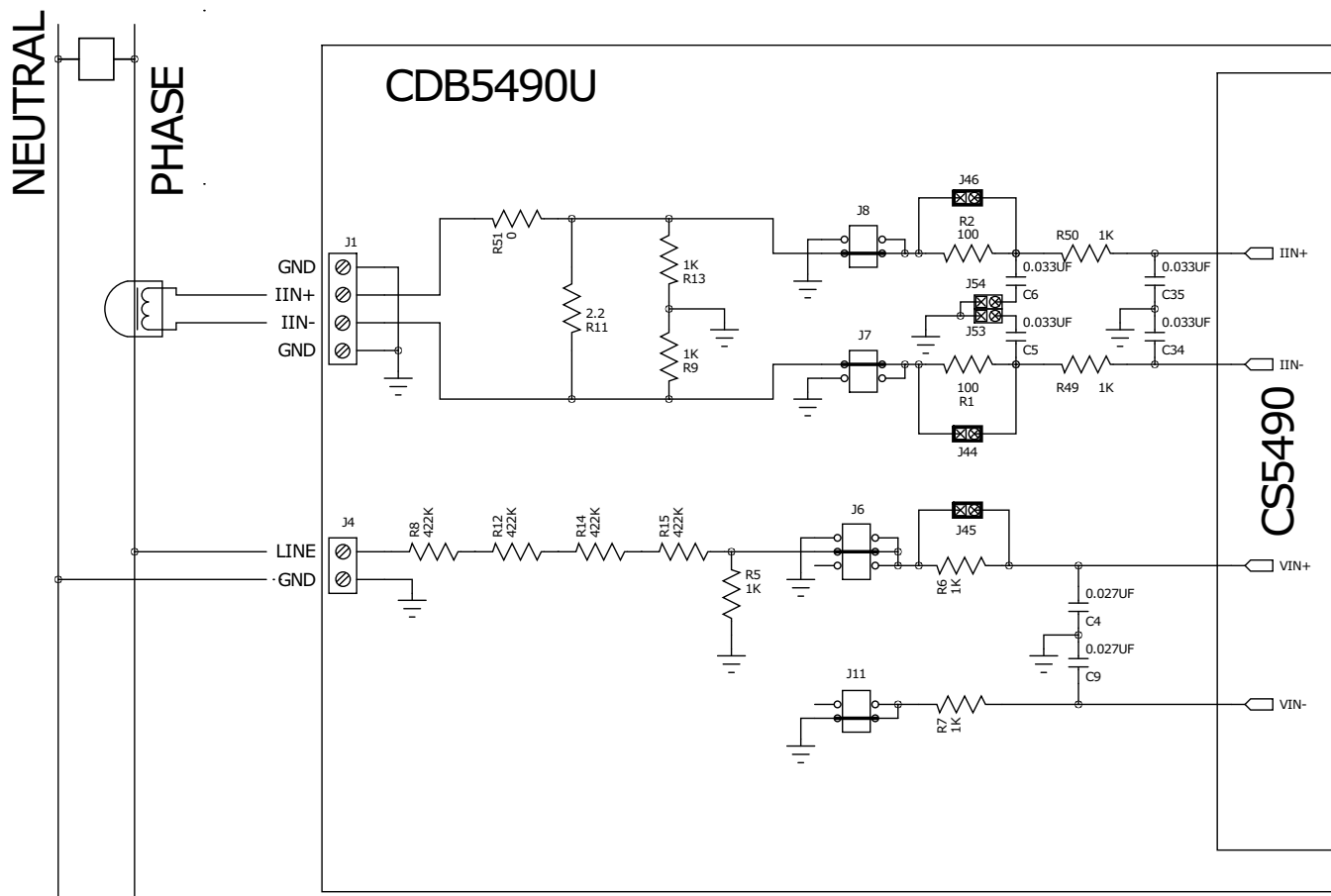
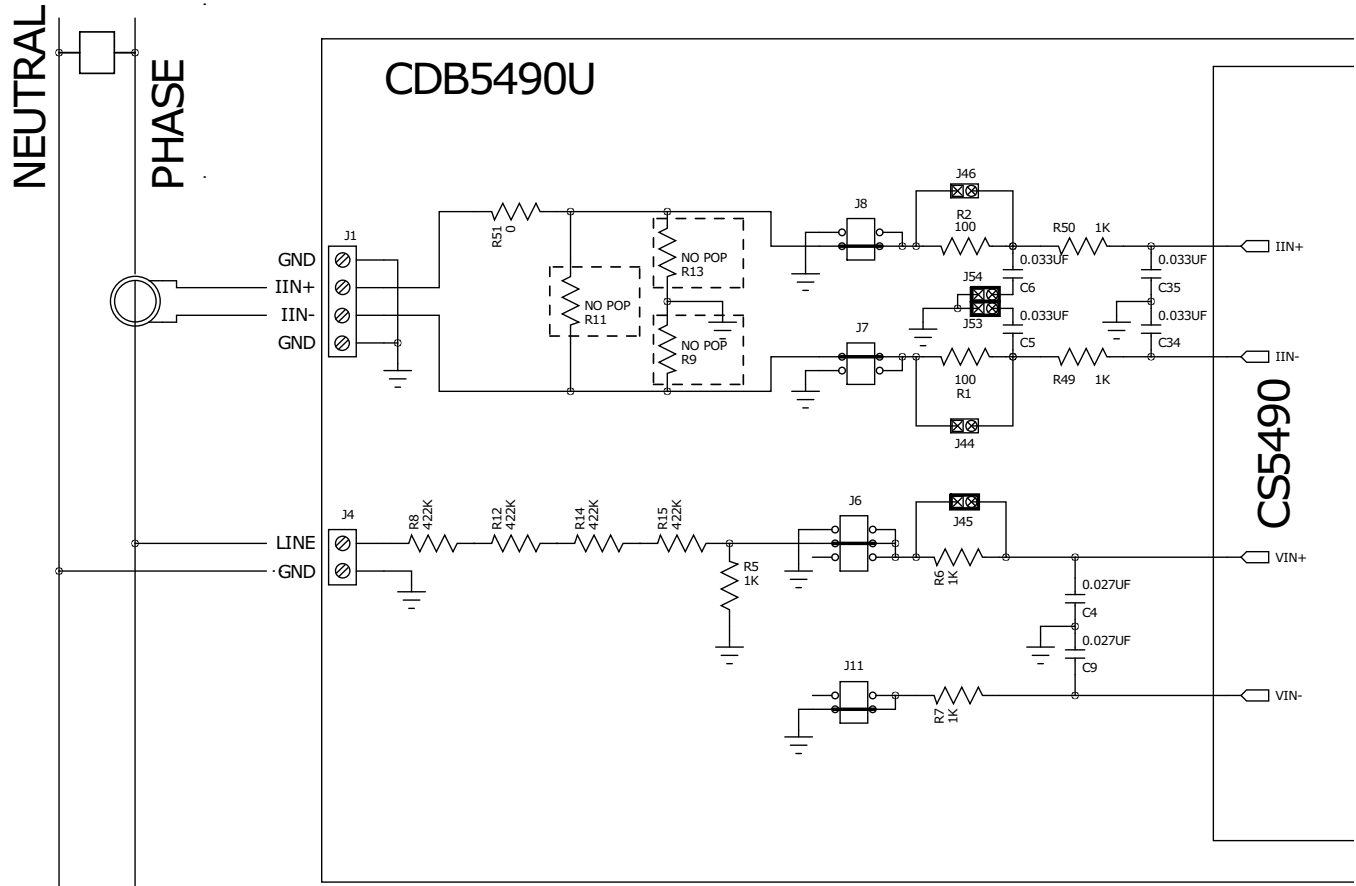


Figure 7. Current Transformer Power Meter

### 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

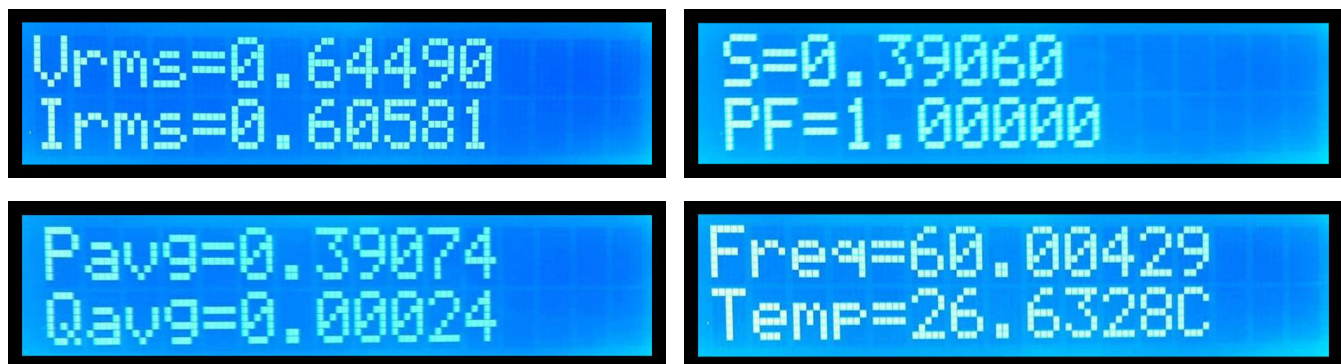


Figure 9. Standalone Power Meter Measurements



## 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.

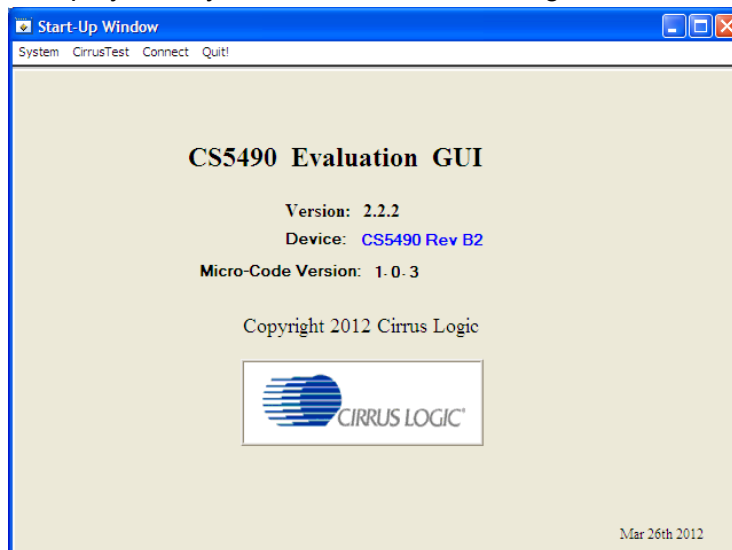


Figure 12. Connect Menu Showing Successful USB Connection

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).

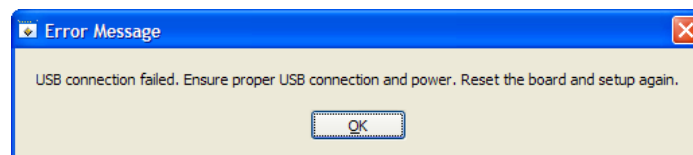


Figure 13. USB Error Message

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.

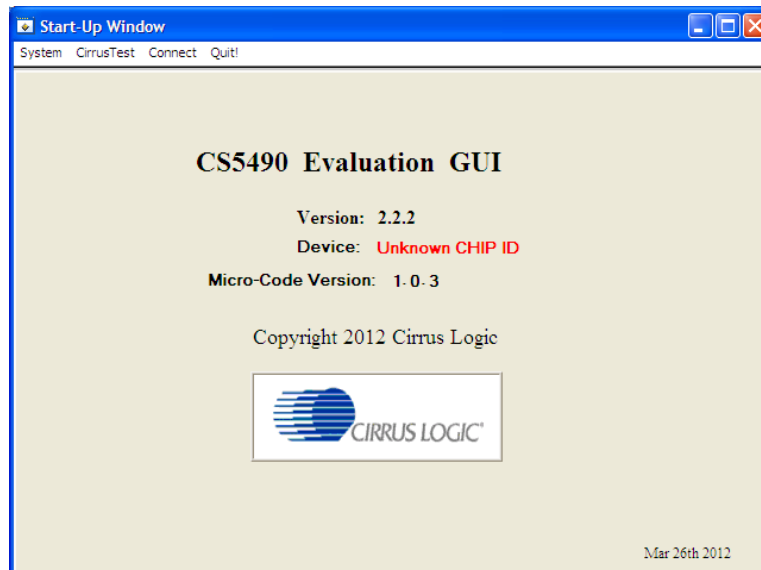


Figure 14. Unknown Chip ID Error Message

## 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).

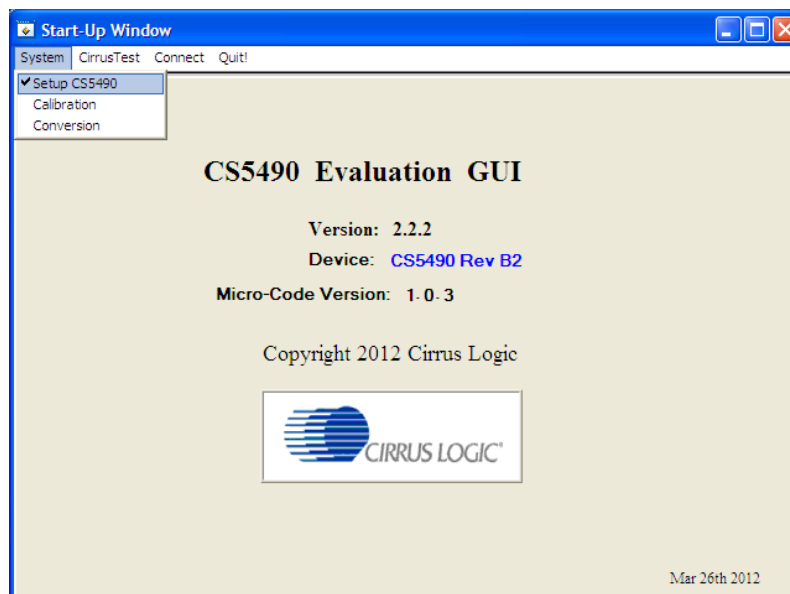


Figure 15. System Pull-down Options

### 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.

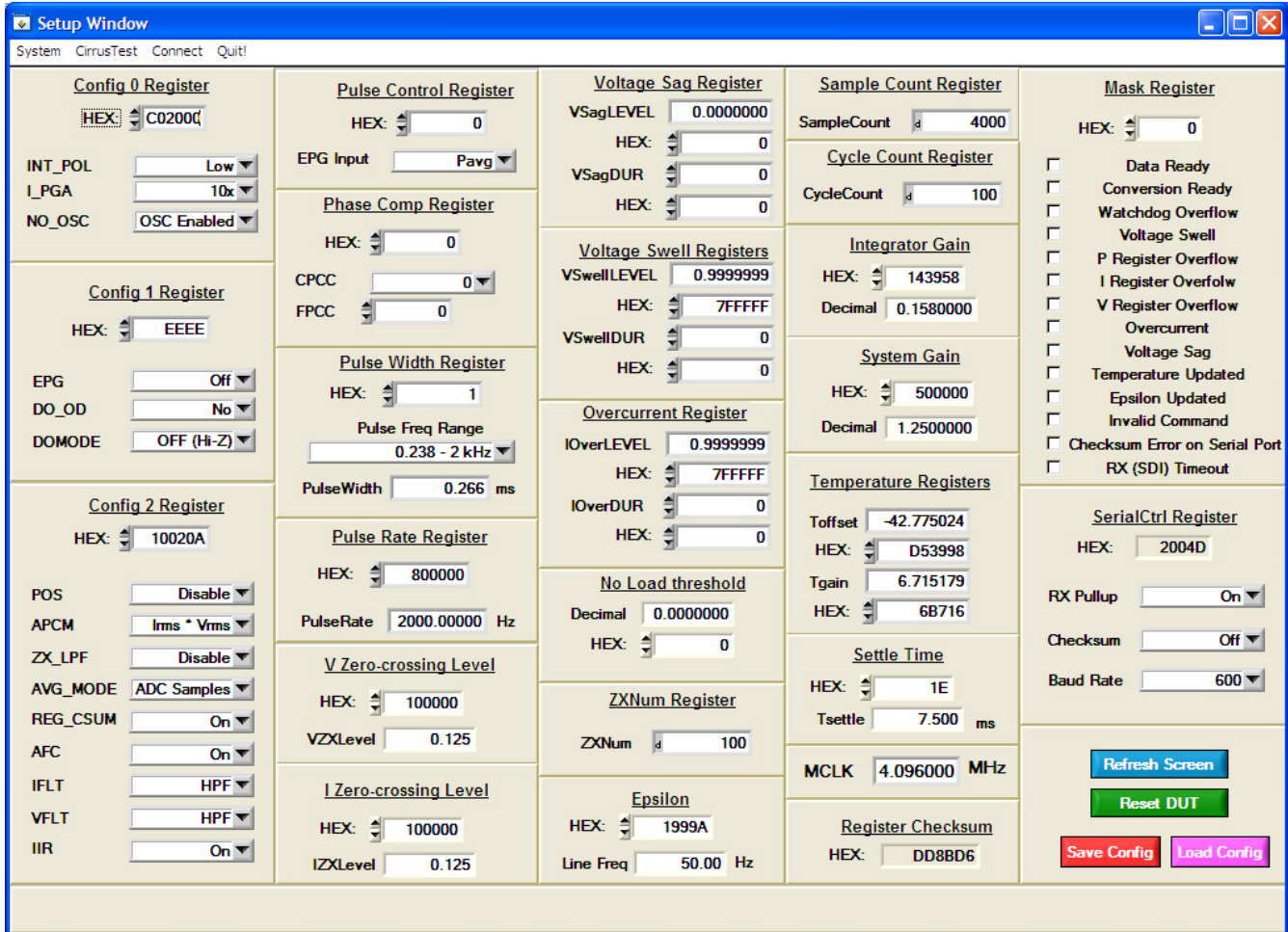


Figure 16. Setup Window

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).

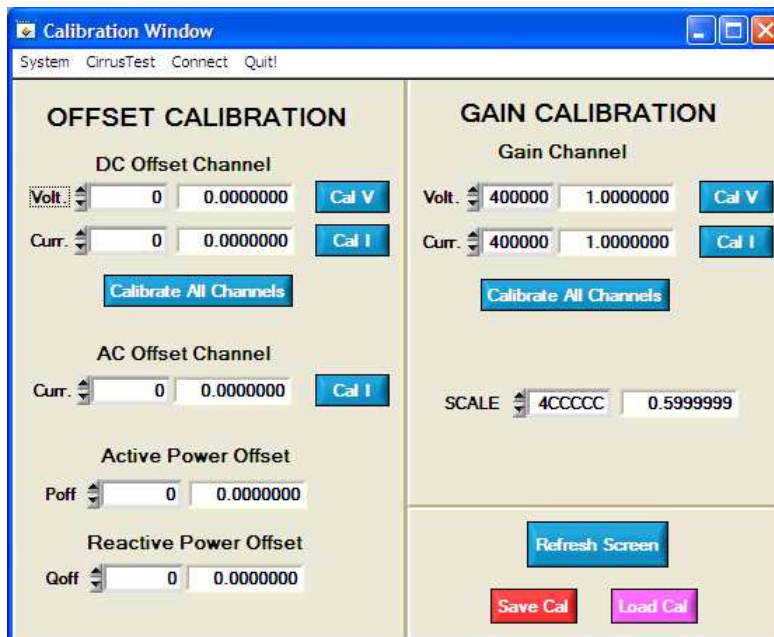


Figure 17. Calibration Window



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.

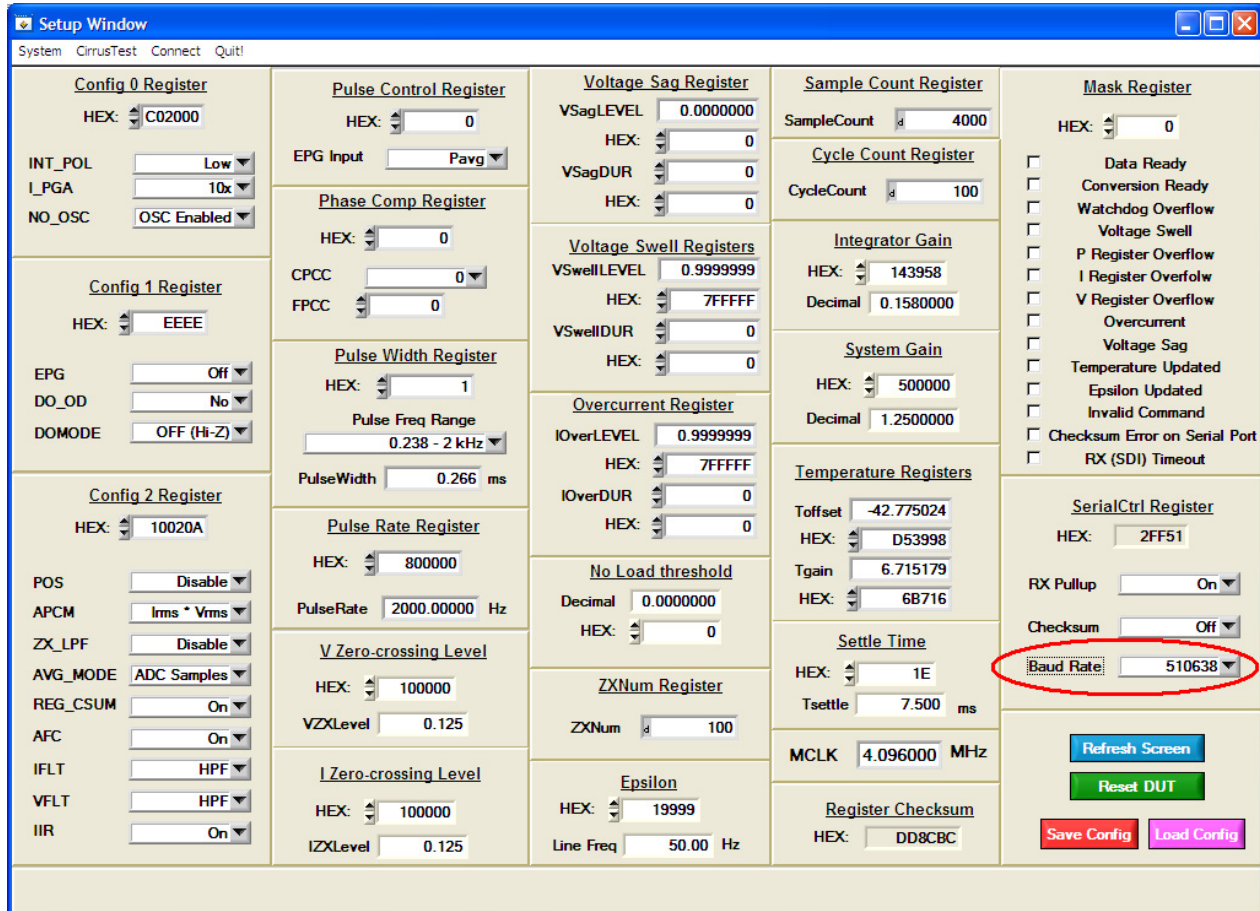
#### 2.6.3.2 Gain Calibrations

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  $Q_{OFF}$ ).

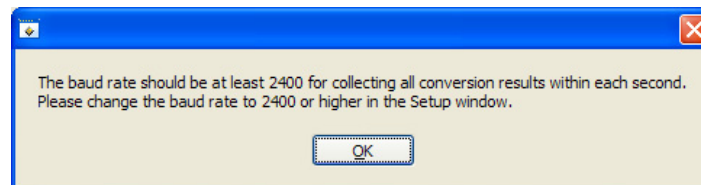
## 2.7 Conversion Window

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).



**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