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PAC1934
Evaluation Board (ADM00805)
User's Guide

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Trademarks

Object of Declaration: PAC1934 Evaluation Board (ADM00805) User's Guide

EU Declaration of Conformity

This declaration of conformity is issued by the manufacturer.
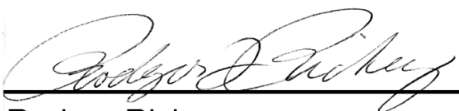
The development/evaluation tool is designed to be used for research and development in a laboratory environment. This development/evaluation tool is not a Finished Appliance, nor is it intended for incorporation into Finished Appliances that are made commercially available as single functional units to end users under EU EMC Directive 2004/108/EC and as supported by the European Commission's Guide for the EMC Directive 2004/108/EC (8th February 2010).

This development/evaluation tool complies with EU RoHS2 Directive 2011/65/EU.

This development/evaluation tool, when incorporating wireless and radio-telecom functionality, is in compliance with the essential requirement and other relevant provisions of the R&TTE Directive 1999/5/EC and the FCC rules as stated in the declaration of conformity provided in the module datasheet and the module product page available at www.microchip.com.

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Signed for and on behalf of Microchip Technology Inc. at Chandler, Arizona, USA.

Rodger Richey
Director of Development Tools

4/4/17

Date

NOTES:

PAC1934 EVALUATION BOARD (ADM00805) USER'S GUIDE

Table of Contents

Preface

NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXXXXA", where "XXXXXXX" is the document number and "A" is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE online help. Select the Help menu, and then Topics, to open a list of available online help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the ADM00805. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Warranty Registration
- Recommended Reading
- The Microchip Web Site
- Customer Support
- Document Revision History

DOCUMENT LAYOUT

This document describes how to use the ADM00805 Evaluation Board as a development tool to emulate and debug firmware on a target board. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the ADM00805 Evaluation Board.
- **Chapter 2. "Installation and Operation"** – Includes instructions on installing and starting the PAC193X Demo Application.
- **Chapter 3. "Software GUI Description"** – Includes details about the GUI.
- **Chapter 4. "Hardware Description"** – Detailed information about the PAC1934 device and the ADM00805 Evaluation Board.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the ADM00805 Evaluation Board.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the ADM00805 Evaluation Board.

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	*MPLAB® IDE User's Guide*
	Emphasized text	...is the *only* compiler...
Initial caps	A window	the Output window
	A dialog	the Settings dialog
	A menu selection	select Enable Programmer
Quotes	A field name in a window or dialog	"Save project before build"
Underlined, italic text with right angle bracket	A menu path	*File>Save*
Bold characters	A dialog button	Click **OK**
	A tab	Click the **Power** tab
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.	4'b0010, 2'hF1
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier New font:		
Plain Courier New	Sample source code	`#define START`
	Filenames	`autoexec.bat`
	File paths	`c:\mcc18\h`
	Keywords	`_asm, _endasm, static`
	Command-line options	`-Opa+, -Opa-`
	Bit values	`0, 1`
	Constants	`0xFF, 'A'`
Italic Courier New	A variable argument	`file`.o, where `file` can be any valid filename
Square brackets [ ]	Optional arguments	`mcc18 [options] file [options]`
Curly brackets and pipe character: { | }	Choice of mutually exclusive arguments; an OR selection	`errorlevel {0|1}`
Ellipses...	Replaces repeated text	`var_name [, var_name...]`
	Represents code supplied by user	`void main (void) { ... }`

RECOMMENDED READING

This user's guide describes how to use the ADM00805. Other useful documents are listed below. The following Microchip document is available and recommended as a supplemental reference resource:

PAC1934 Data Sheet – *"DC Power/Energy Monitor with Accumulator"* *(DS20005850A)*

THE MICROCHIP WEB SITE

Microchip provides online support via our web site at www.microchip.com. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

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To register, access the Microchip web site at www.microchip.com, click on **Product Change Notification** and follow the registration instructions.

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Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at: http://www.microchip.com/support.

DOCUMENT REVISION HISTORY

Revision A (September 2017)

- Initial Release of this Document.

NOTES:

PAC1934 EVALUATION BOARD (ADM00805) USER'S GUIDE

Chapter 1. Product Overview

1.1 INTRODUCTION

The ADM00805 Evaluation Board for PAC1934 provides a flexible platform for evaluating PAC1934 and demonstrating the features of the PAC1934. A PAC1934 device in a wafer level chip scale package (WLCSP) is mounted to the board.

The ADM00805 has a USB connector to connect to a computer for device communication. The PAC1934 device may be powered directly by V_{BUS} from the USB connector or by an external connection for V_{DD}.

I^2C communication can be provided over USB using the on-board MCP2221 USB to I^2C Bridge. There is also a header that facilitates direct I^2C communication by connecting the V_{DD_IO}, Ground, SDA and SCL to an external source such as a PC motherboard or a Linux system. See **Section 4.9 "Direct External I2C Connection"** for important details if using direct I^2C connection.

The shorting shunts and the switch on the board facilitate either simple demonstration of the device functions using on-board current sources or detailed evaluation of function and performance with external sources, including prototyping the system.

1.2 PAC1934 DEVICE FEATURES

The PAC1934 is a four-channel DC power/energy monitor with accumulator. There is a 16-bit ADC for monitoring power rail voltages connected by a multiplexer to the positive (+) input pin of each channel, producing results named V_{BUS}. There is a second 16-bit ADC for measuring the voltage across a current sense resistor. This ADC is connected by a differential multiplexer to the +input and –input pins for each channel, producing results called V_{SENSE}. Channel selection for the multiplexers is controlled in sequential fashion to scan all four channels up to 1024 samples per second (sps).

The device also computes V_{POWER} by multiplying V_{BUS} by V_{SENSE} and accumulates these power results in an Accumulator. The device registers also hold eight times averaged V_{BUS} and V_{SENSE} results for very accurate low noise voltage and current measurements. All the results are stored in registers. The values in the Results Registers only change when a REFRESH or a REFRESH_V command is sent. Software applications are available for plotting, displaying and logging data. These applications also calculate energy based on the accumulated power and accumulation time.

1.3 ADM00805 EVALUATION BOARD FOR PAC1934

1.3.1 Hardware Overview

The ADM00805 Evaluation Board has a PAC1934 device mounted on the board and enables direct control of all device pins and easy measurements of on-board or external voltages and currents. The I^2C address is connected as 0x20 by default. Removing a shunt gives 0x22. Other addresses are possible by replacing R22 with a new value. Sampling rate is 1024 sps by default, due to the shorting shunt on the SLOW pin connector (J23) tying the SLOW pin to ground. Remove this shunt for the SLOW sampling rate of 8 sps.

An on-board current source provides a 0.5 Hz square wave current signal for functionality testing and demo purposes. There are also on-board current sense resistors, provisions for external sources and loads, and provisions for both USB control and direct I^{2}C connection.

See **Chapter 4. "Hardware Description"** for more details.

1.3.2   Software and System Control Overview

The PAC193X Demo Application, described in detail in **Chapter 2. "Installation and Operation"**, provides USB control of the PAC193X with the ADM00805 Evaluation Board.

The application provides an easy way to control all of the programmable registers and read all of the results for the PAC1934 device on the ADM00805 Evaluation Board. To use this software application with the ADM00805 Evaluation Board, download the software and launch the application. Then connect the provided USB cable to the computer and ensure that the USB/I2C switch is set ON. **Chapter 2. "Installation and Operation"** provides details on getting started.

1.4   EVALUATION BOARD KIT CONTENTS

The PAC1934 Evaluation Board Kit contains:

• The ADM00805 Evaluation Board (EVB)
• USB cable
• Important Information Sheet

Chapter 2. Installation and Operation

2.1   GETTING STARTED

This section describes how to power-up and interface with the ADM00805 Evaluation Board. Items discussed in this chapter include:

- System requirements
- Downloading and installing the software

2.2   SYSTEM REQUIREMENTS

The ADM00805 Evaluation Board is designed to be used with a personal computer (desktop or laptop) running Microsoft® Windows® 7 or later. For USB connectivity, the minimal physical requirement for the PC is a standard type-A USB 2.0 port.

2.3   INSTALLING THE SOFTWARE

Go to www.microchip.com and search for PAC1934. Select the PAC193X Demo Application and double-click the executable program to download the ZIP file. Extract the files from the ZIP archive. Once the files have been extracted, double-click the application file to begin installing the software. Follow the next steps to proceed with the installation:

1. Figure 2-1 shows the Installer window. Click the **Run** button.
2. If the used antivirus software presents a warning, allow the file to run in order to proceed with the installation.

FIGURE 2-1:   INSTALLER WINDOW:

3. Figure 2-2 shows the Application Install window. Click the **Next** button.

FIGURE 2-2: **SETUP WIZARD - APPLICATION INSTALL WINDOW**
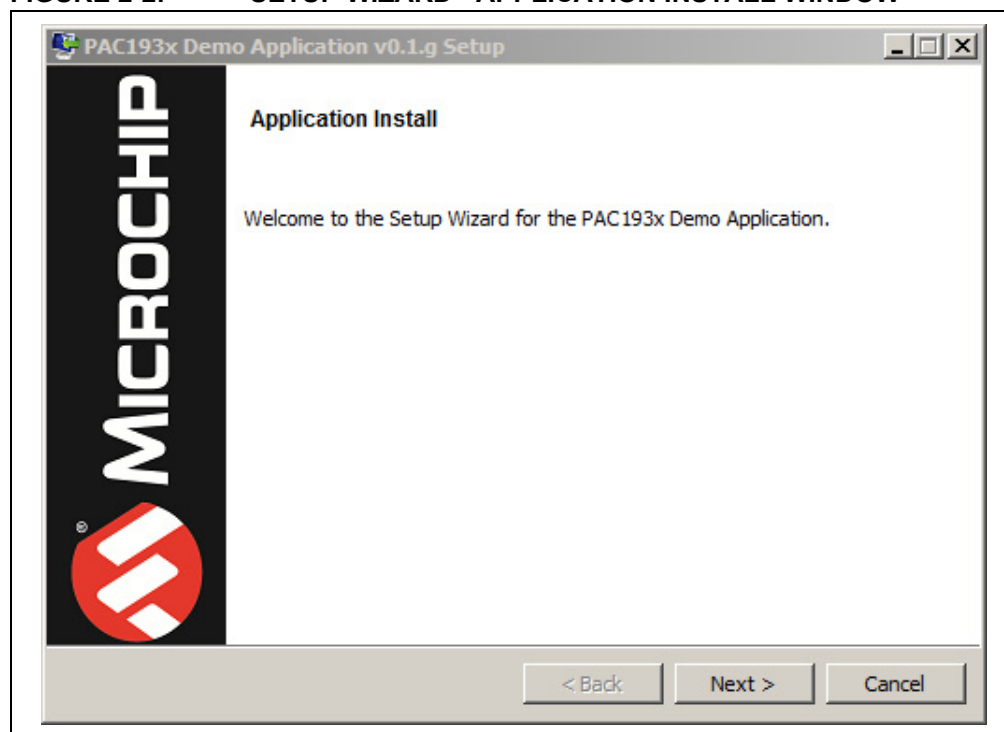
4. Read and accept the License Agreement and click **Next**.

FIGURE 2-3: **LICENSE AGREEMENT WINDOW**
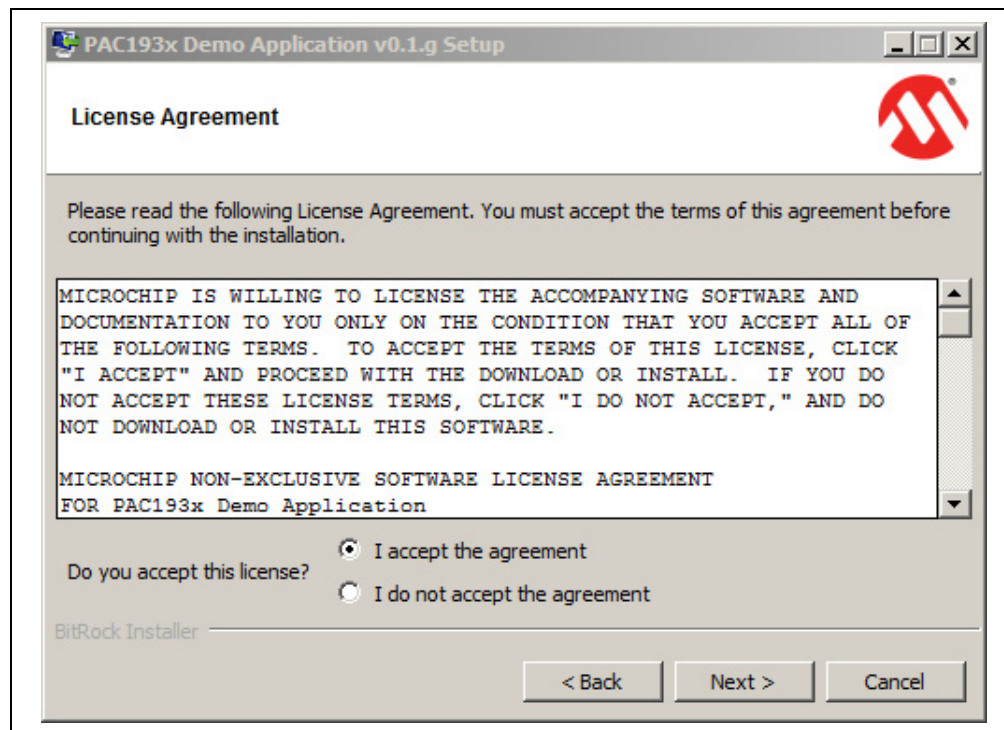
5. Select the desired installation directory and click **Next**.

FIGURE 2-4: **INSTALLATION DIRECTORY WINDOW**
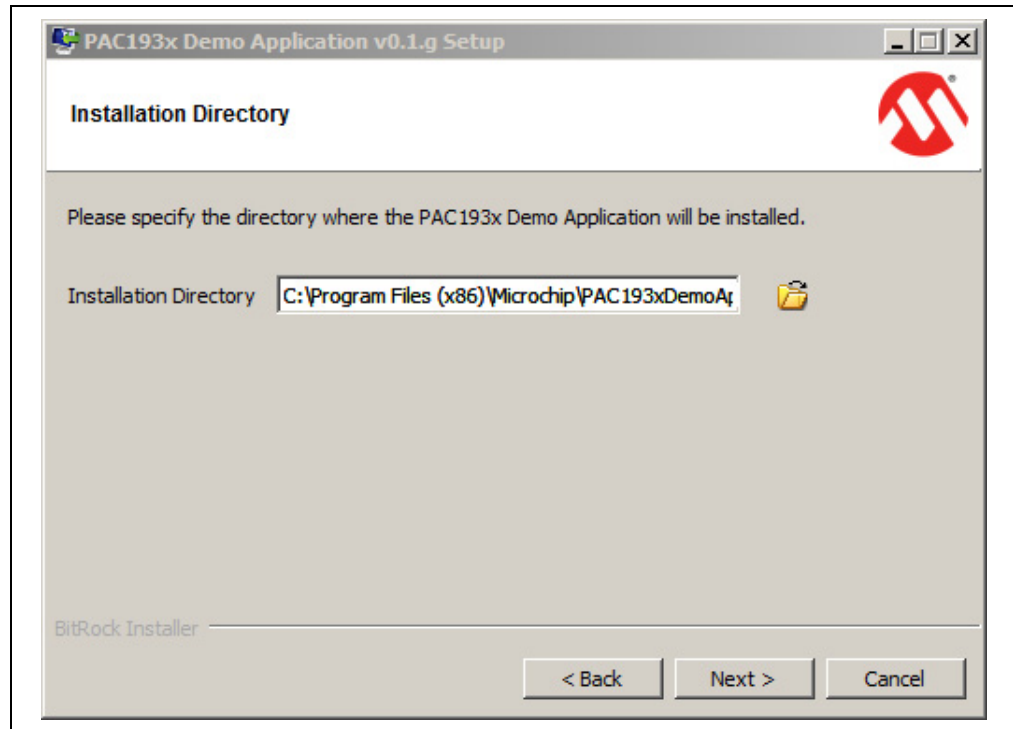
6. Figure 2-5 shows the Ready to Install window. Select **Next** to proceed with the installation.

FIGURE 2-5: **READY TO INSTALL WINDOW**
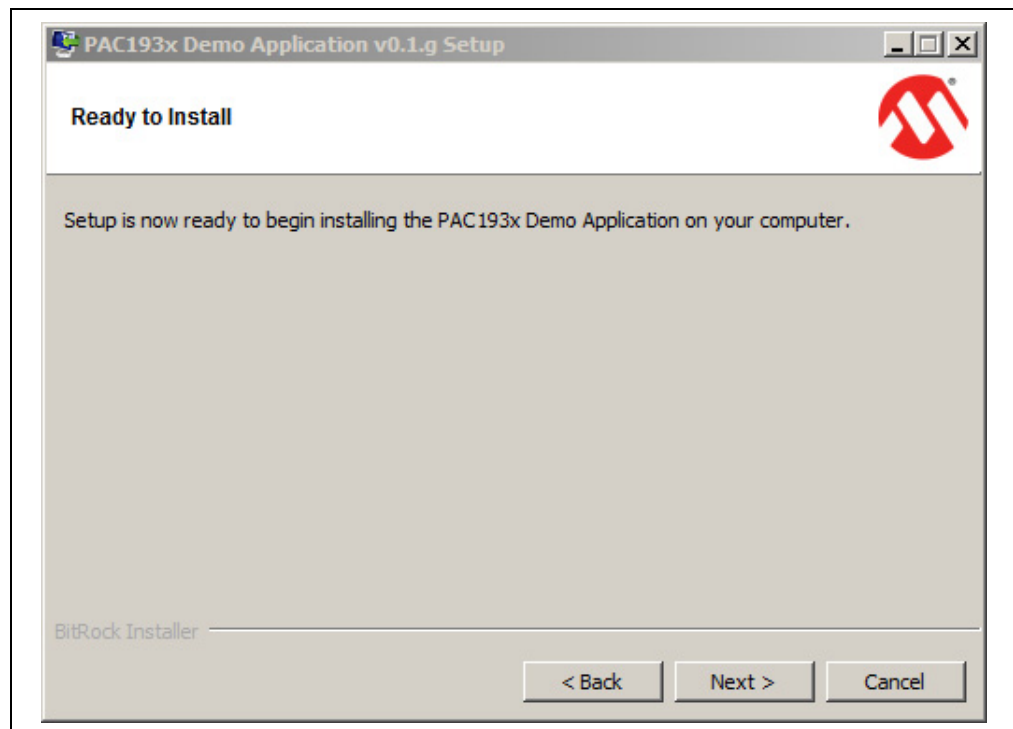
7. Once the setup wizard has finished installing the software, the Install Complete window will appear. Click the **Finish** button to begin using the application.

FIGURE 2-6:   **INSTALL COMPLETE WINDOW**
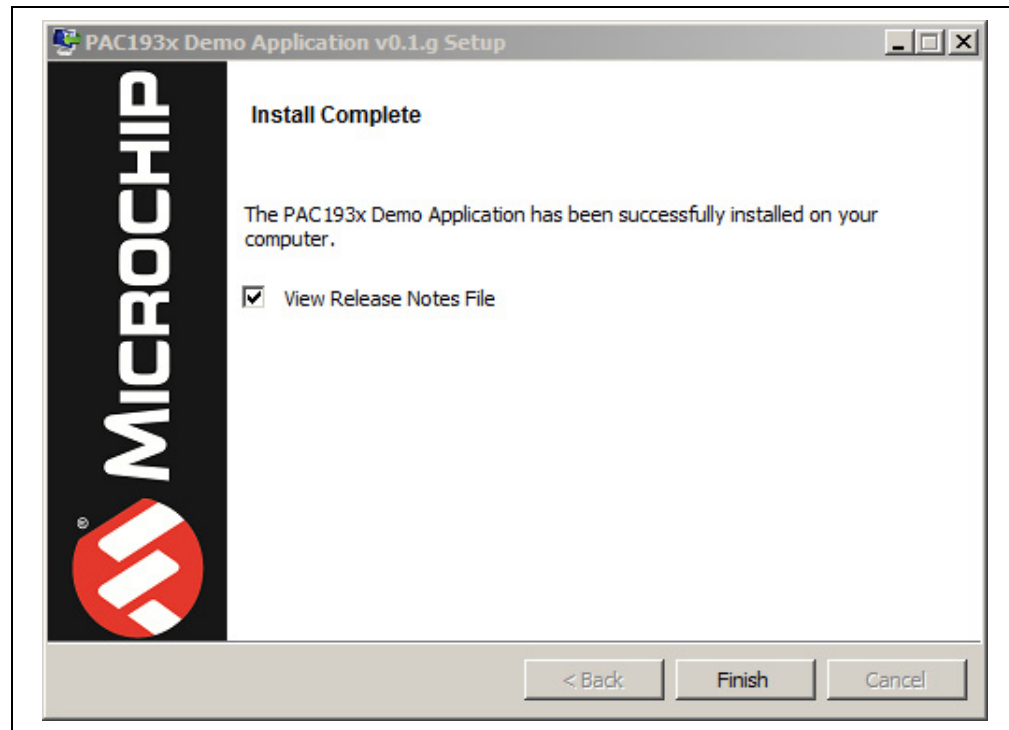
Figure 2-7 shows the desktop icon created by the installer. Hovering over it with the cursor will show the title PAC193X Demo Application.

FIGURE 2-7:   **DESKTOP ICON**
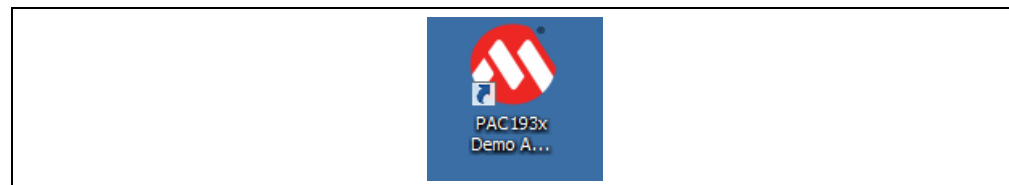
Chapter 3. Software GUI Description

3.1 FIRST LAUNCH

After the installation, double-click the desktop icon in order to launch the PAC193X Demo Application. Connect the board to the computer with the provided USB cable and ensure the USB/I2C switch is set ON. The SW1 switch is in the upper right corner of the board. Once they are connected, LED activity can be seen on the board:

- LD1: shows I^2C activity from the USB bridge
- LD2: +5V USB power from the USB connection
- LD3: Shows the period of the square wave generated by the on-board current source

Figure 3-1 shows the GUI for the PAC193X Demo Application:

1. Device identification
2. **Start Acquisition** button

Click the **Start Acquisition** button to start generating the default waveforms. After 10 seconds, click the button again to stop the acquisition and freeze the waveforms. Figure 3-2 displays the default waveforms in DEMO mode.

FIGURE 3-1: GUI WINDOW - FIRST LAUNCH
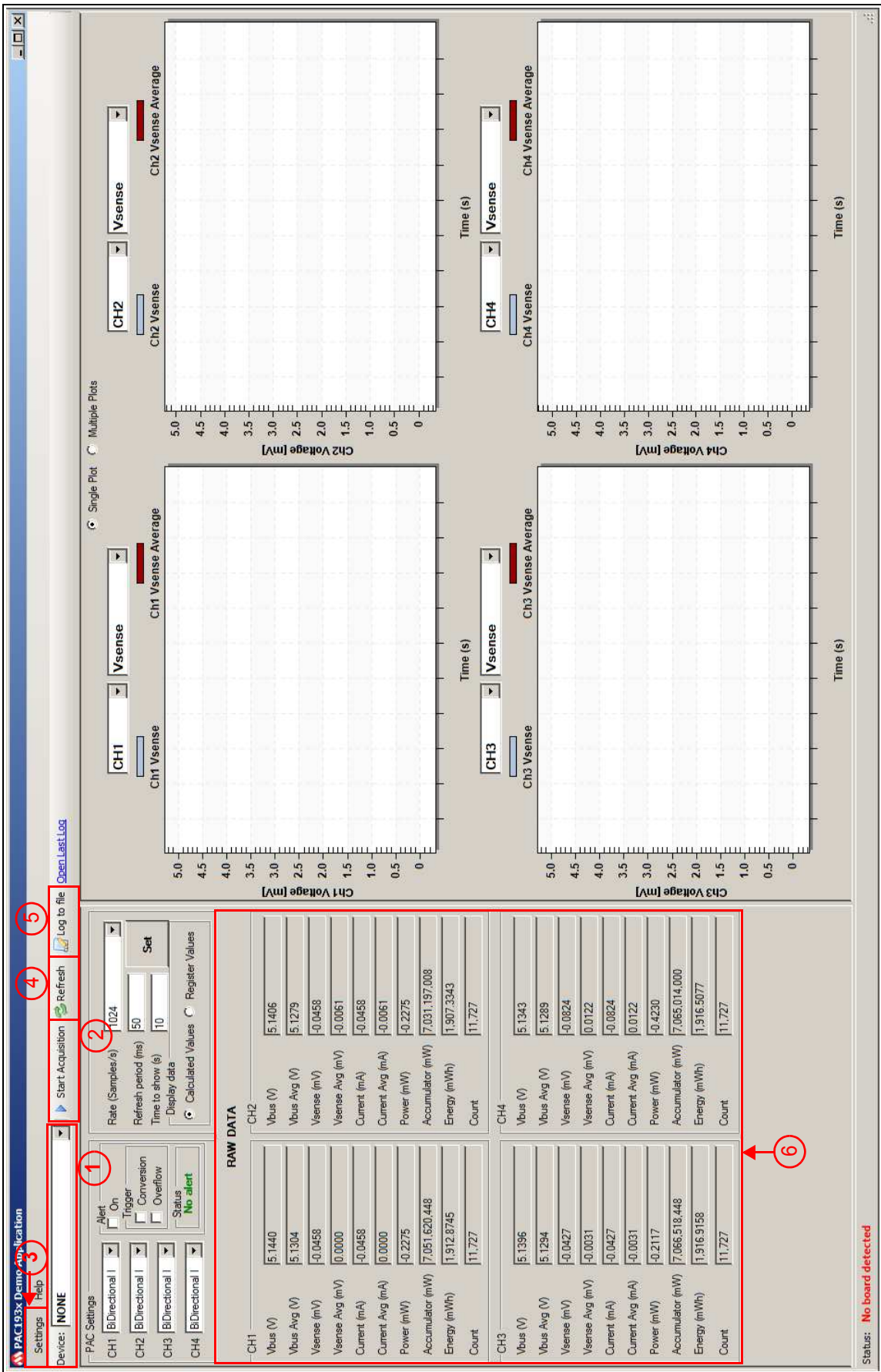
FIGURE 3-2: GUI WINDOW - DEFAULT WAVEFORMS
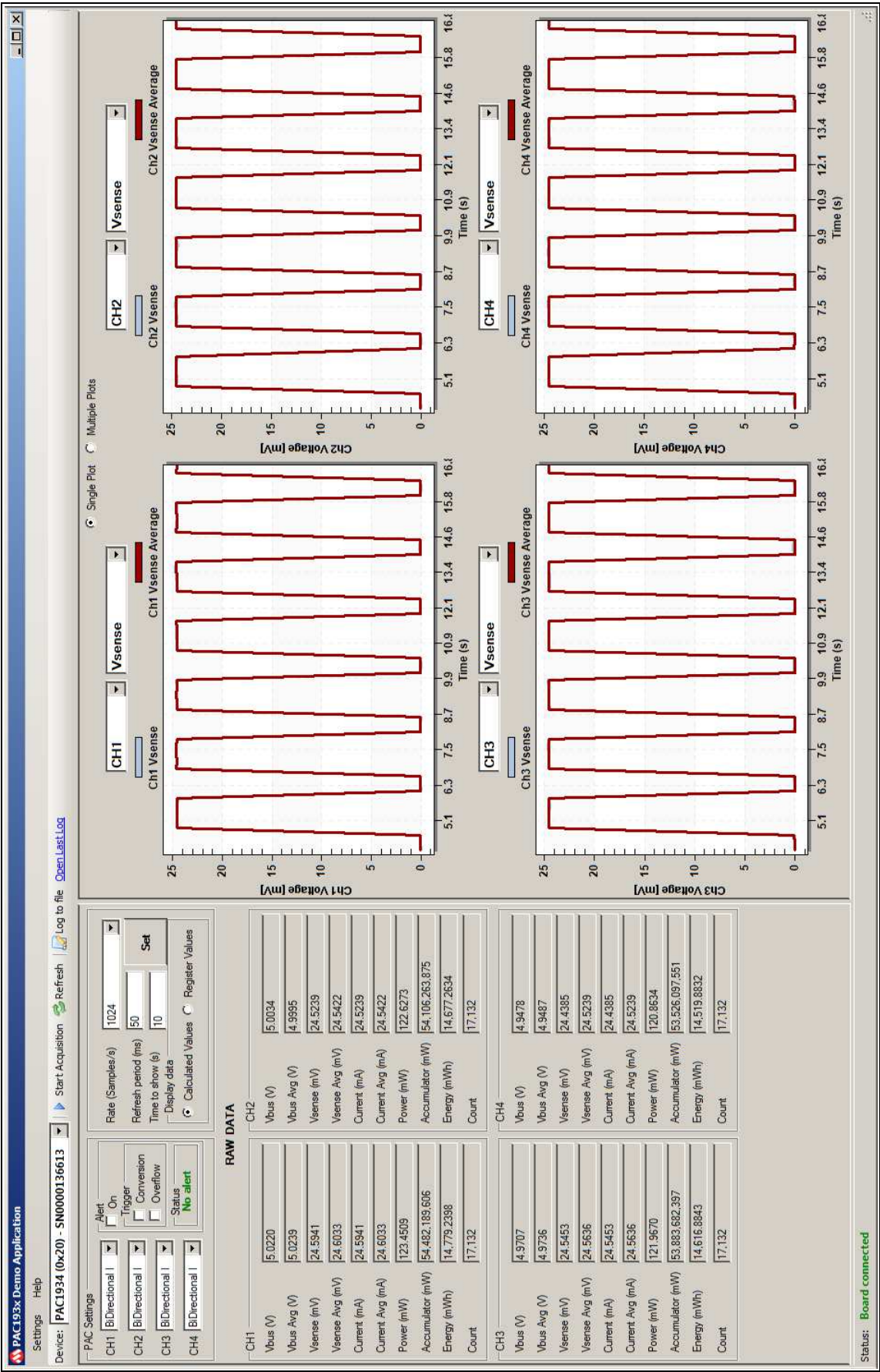
3.2 TOP MENU

As seen in Figure 3-1, the **Device** window (1) shows the device on the board and its I^2C address; some parts have a serial number that is displayed.

When clicked, the **Settings** button (3) displays a drop-down menu with two options: **Set Constants** and **Slow Register**, as shown in Figure 3-3.

Note that you need to stop the acquisition process in order to have access to the **Slow Register.** It is recommended that the acquisition process is stopped before changing the values in the Set Constants Menu. Any changes to these values do not take effect until the start of the acquisition.

FIGURE 3-3: SETTINGS DROP-DOWN MENU
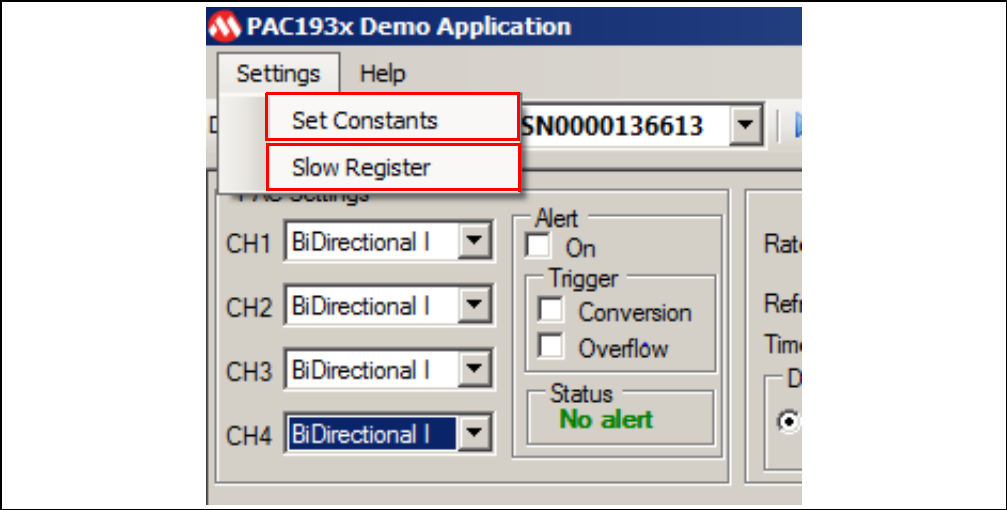
The Set Constants option opens the Sense Resistor Values dialog box when clicked, displayed in Figure 3-4. The default values shown are the sense resistor values in DEMO mode. Enter a new value in ohms if the SYSTEM/SHUNT mode is used or if a different value of sense resistor is used (see **Section 3.3 "PAC Settings section"**).

FIGURE 3-4: SENSE RESISTOR VALUES DIALOG BOX
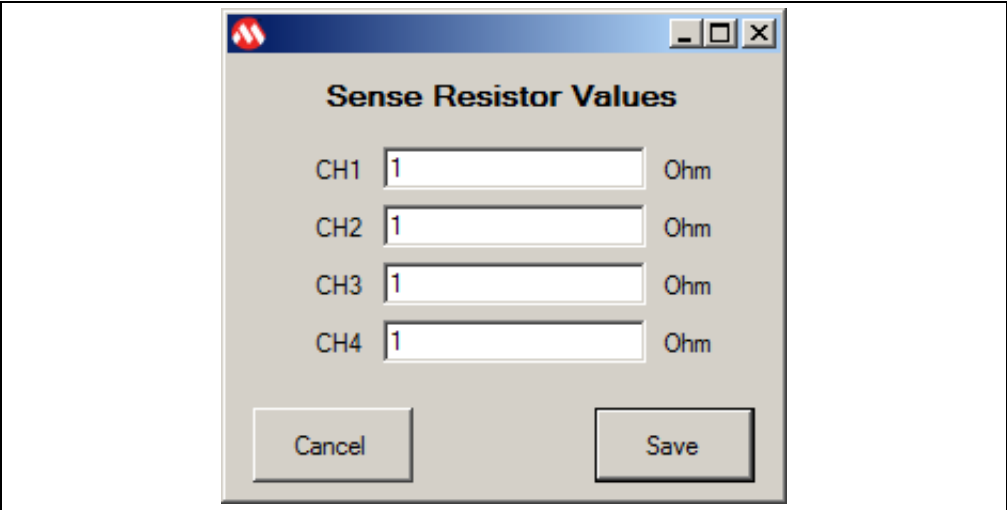
Selecting the Slow Register option opens the Refresh Commands dialog box, displayed in Figure 3-5, which allows the user to select which type of refresh commands, if any, occur on the rising and falling edge of the SLOW pin transitions. Select the desired options and the GUI programs the Slow Register (0x20) in the PAC1934 appropriately (see the

PAC1934 Data Sheet).This register is important if the SLOW pin is being used, the user will be able to capture the data for very accurate energy calculation when switching from a programmed sample rate to the eight samples/second rate under control of the SLOW pin. If the SLOW pin is not being used, these settings can be ignored.

FIGURE 3-5: **REFRESH COMMANDS DIALOG BOX**
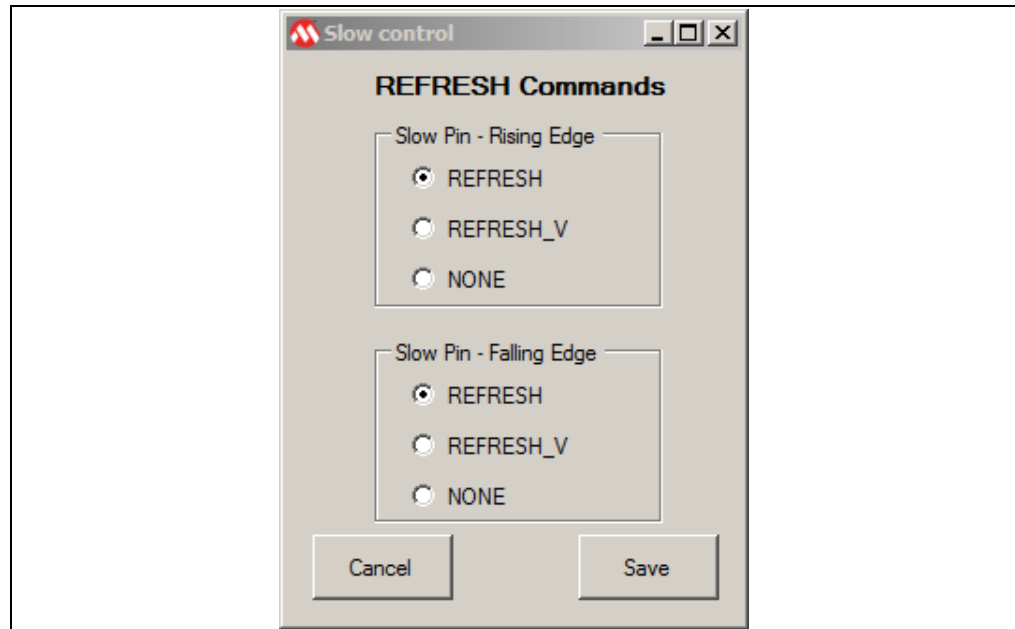
The **Start Acquisition** button, displayed in Figure 3-1 (2), toggles into **Stop Acquisition** when clicked. When the button is clicked, a REFRESH command is sent to the PAC1934 and it starts collecting conversion data in the accumulator. The GUI starts sending REFRESH_V commands to the PAC1934 and reading results data from all of the results registers for data plotting (and logging, if selected).

When clicked, the **Refresh** button, displayed in Figure 3-1 (4), sends a command to the PAC1934, updating the control registers and loading all the results from the ADCs and the accumulator into the readable registers. The refresh command also resets the accumulators and the accumulator count.

The **Log to File** button, displayed in Figure 3-1 (5), toggles when clicked to stop the logging to file process and turns data logging on and off. In order to log the data, the user must be acquiring. The data file is a CSV file created in the directory where the GUI has been installed. There is a link next to this button to open the last log. Stop acquiring data before opening the log file. When the **Open Last Log** button is clicked, the most recent data log is opened. It can be noticed that all of the results data is captured, and each column has a header identifying the data. Figure 3-6 shows one corner of a log file.

FIGURE 3-6: **RECENT LOG FILE WINDOW**

|	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Count	Vbus_Ch1	VbusAve_Ch1	Vsense_Ch1	VsenseAve_Ch1	Current_Ch1	CurrentAve_Ch1	Power_Ch1	Acc_Ch1	Energy_Ch1	Vbus_Ch2	VbusAve_Ch2	Vsense_Ch2
2	[N]	[V]	[V]	[mV]	[mV]	[mA]	[mA]	[mW]	[mW]	[mWh]	[V]	[V]	[mV]
3	120	10432	10440	11	8	0.024414063	0.033569336	119968	755787	0.205020345	10437	10439	0
4	621	10436	10443	5	9	0.02746582	0.015258789	57376	3692790	1.001733398	10440	10444	7
5	982	10334	10327	8090	8092	24.69482422	24.6887207	83553520	1662470671	450.9740318	10271	10274	8068
6	1323	10320	10326	8085	8091	24.69177246	24.67346191	83437200	3441678113	933.6149395	10272	10280	8073
7	1684	10315	10327	8090	8093	24.69787598	24.6887207	83424080	5325649484	1444.674882	10274	10278	8068
8	2015	10444	10449	15	10	0.030517578	0.045776367	161808	6615718764	1794.628571	10444	10452	10
9	2355	10452	10449	7	9	0.02746582	0.021362305	78352	6617758953	1795.182008	10460	10448	2
10	2706	10323	10325	8089	8086	24.67651367	24.68566895	83478480	6718949376	1822.631667	10274	10276	8074
11	3067	10330	10330	8101	8096	24.70703125	24.72229004	83667120	8602680478	2333.626432	10277	10281	8078
12	3408	10326	10330	8100	8095	24.70397949	24.71923828	83597152	10383220695	2816.628878	10264	10278	8074
13	3839	10337	10338	8094	8098	24.71313477	24.70092773	83664752	12634191542	3427.243799	10291	10285	8091
14	4180	10435	10447	4	9	0.02746582	0.012207031	46944	13225945546	3587.767346	10445	10449	7
15	4561	10440	10446	10	9	0.02746582	0.030517578	109616	13228155360	3588.366797	10436	10445	12
16	4891	10325	10328	8100	8093	24.69787598	24.71923828	83592000	14189528595	3849.155977	10272	10278	8090
17	5252	10329	10334	8089	8096	24.70703125	24.68566895	83543184	16074782715	4360.563888	10279	10285	8077
18	5593	10330	10335	8101	8099	24.71618652	24.72229004	83672288	17856906076	4843.995789	10278	10284	8084
19	5924	10325	10327	8090	8089	24.68566895	24.6887207	83493952	19586262273	5313.113681	10276	10278	8066
20	6315	10447	10446	10	9	0.02746582	0.030517578	104400	19823282509	5377.409535	10431	10440	9
21	6656	10442	10443	14	9	0.02746582	0.042724609	146160	19825423953	5377.990439	10448	10447	10
22	7016	10320	10333	8102	8094	24.70092773	24.7253418	83612640	21365768594	5795.835665	10270	10283	8087
23	7367	10346	10334	8107	8100	24.71923828	24.74060059	83858800	23200176796	6293.450737	10293	10282	8088
24	7758	10334	10329	8089	8092	24.69482422	24.68566895	83548352	25242231688	6847.393579	10276	10278	8075
25	8099	10445	10443	8	8	0.024414063	0.024414063	88736	26406378150	7163.188517	10447	10444	11
26	8440	10429	10441	14	8	0.024414063	0.042724609	145936	26408448686	7163.750186	10432	10443	17
27	8781	10334	10333	8089	8093	24.69787598	24.68566895	83548352	26655673008	7230.814076	10285	10280	8070
28	9121	10334	10334	8091	8095	24.70397949	24.69177246	83569008	28431123617	7712.435877	10276	10282	8074
29	9502	10319	10325	8085	8090	24.6887207	24.67346191	83372512	30419421340	8251.796153	10275	10276	8070
30	9843	10328	10327	8093	8088	24.68261719	24.69787598	83584496	32198421716	8734.380891	10276	10274	8078
31	10184	10424	10437	9	7	0.021362305	0.02746582	93808	32976877820	8945.550624	10426	10441	9
32	10565	10449	10451	5	9	0.02746582	0.015258789	52240	32979125411	8946.160322	10454	10449	16

3.3   PAC SETTINGS SECTION

Each input channel of the PAC1934 is internally set for unipolar/unidirectional voltage on V_{BUS} and unidirectional currents on V_{SENSE} by default. However, in the GUI, all four channels are configured for bidirectional currents by default. This bidirectional setting avoids clipping of negative values. For bidirectional currents the V_{SENSE} results are in 16-bit two's complement representation. A drop-down menu allows reconfiguring each channel or turning it off as shown in Figure 3-7 for channel 4 (1). Using the GUI this way programs the appropriate register for the selected channel.

FIGURE 3-7: **PAC SETTINGS WINDOW**
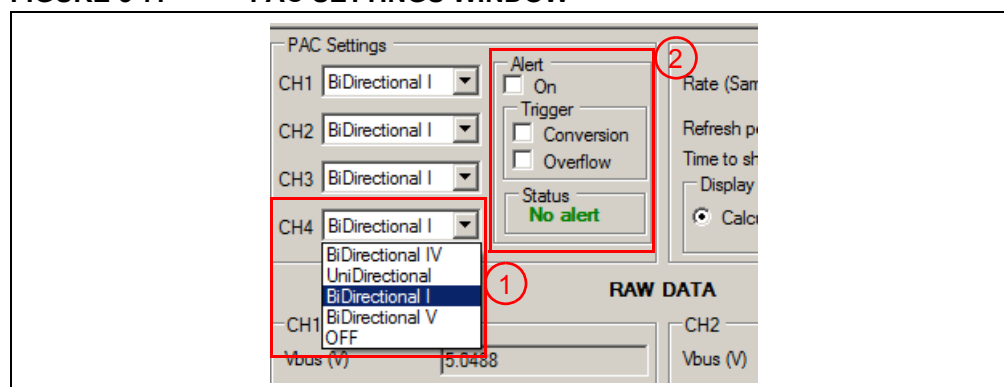

3.3.1   Alert Settings

The check boxes enable turning on the alert function and selecting which type of conditions can trigger the alert function: Conversion Complete or Accumulator Overflow. The alert status is also displayed underneath the check boxes, as shown in Figure 3-7 (2).

The GUI is not fast enough to capture the conversion based $\overline{ALERT}$, which lasts only 5 µS. The SLOW/$\overline{ALERT}$ pin must be monitored with a circuit fast enough to detect the 5 µS wide $\overline{ALERT}$ signal to use this function.

3.4 SAMPLE RATE AND DISPLAY CONTROLS

Figure 3-8 shows the Sample Rate window, located to the right of the Alert window.

FIGURE 3-8: SAMPLE RATE WINDOW
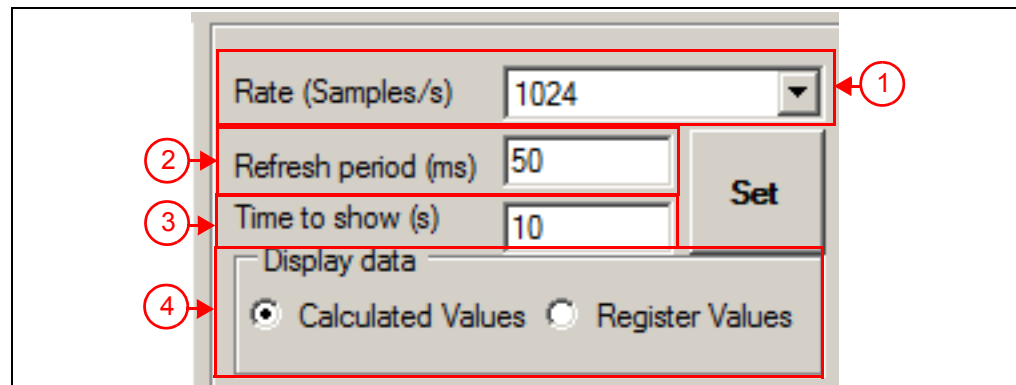
Clicking the value for the Rate (Samples/s) option (1) opens the drop-down menu with the available programmable sample rates for the PAC1934, shown in Figure 3-9.

Sleep mode and One Shot mode are two of the options that can be selected. In One Shot mode, a new round of results are collected when a refresh command is sent with the **Refresh** button right above the Sample Rate window.

FIGURE 3-9: SAMPLE RATE WINDOW - DROP-DOWN MENU
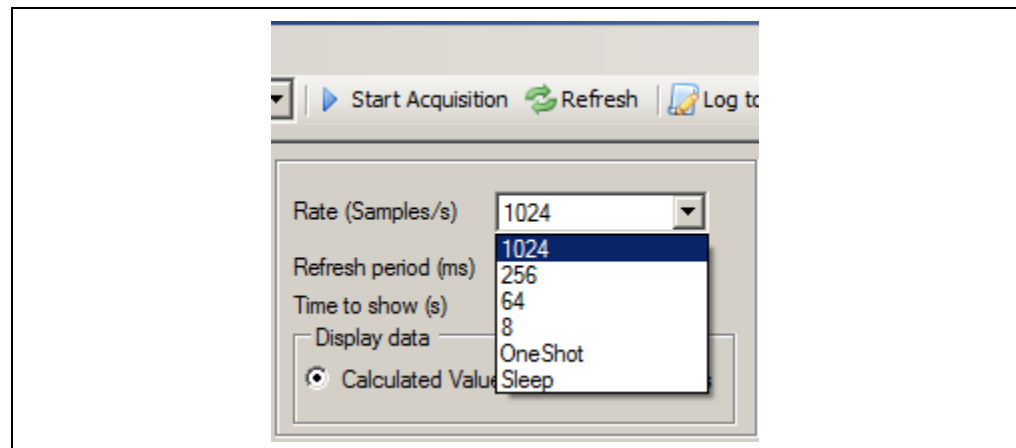
As seen in Figure 3-8, different values can also be entered for Refresh Period (2) and Time to Show (3). Refresh Period determines how often the GUI reads the results from the PAC1934. This is limited to 50 ms maximum by the ADM00805 Evaluation Board hardware, not the PAC1934. The GUI performs the reading by sending a REFESH_V command to the PAC1934 and then reads all of the results registers.

Time to Show determines the time span shown on the X axis for the plots. After changing the Refresh Period of Time to show values, click the **Set** button to ensure that the new values take effect. When new values are typed in, they are displayed in red. When the **Set** button is clicked, the new values change to black.

The two radio buttons (4) at the bottom of the window control the format for the displayed data for both the large Raw Data screen and for the log file. The options show results in one of two ways:

• **Calculated Values**, which takes the Sense Resistor and full scale range values into account for calculating current, voltage and power;

• **Register Values**, which shows the actual values in the registers, converted to decimal.

3.5   RAW DATA DISPLAY

Figure 3-1 shows the Raw Data window (6), which displays the raw data for all results from all of the four channels. As described in **Section 3.4 "Sample Rate and display controls"**, calculated values and the register values can be read here. Count is displayed for all four channels, but there is only one Count Value register so it is always the same for each channel. Energy calculations are also displayed and take the sample rate, the elapsed time between refresh commands, the sense resistor value, and the full scale for voltage and current into account. See the PAC1934 Data Sheet for more information about Power and Energy calculations.

3.6   PLOT WINDOWS

There are four individual plots in the plot window. The plot window may be configured for single plots or multiple plots.

3.6.1   Single Plot option

For the Single Plot option, each plot may be configured to show data from any channel with the channel selection window and drop-down menu on the left side above the plot. Each window may be configured to show any of the results from the selected channel with the results selection drop-down menu. Channel selection and results selection are independent for each window. This is illustrated in Figure 3-10 and Figure 3-11.

Note that when selecting values from the drop-down menus, it works best to move the cursor with the mouse and click the desired value, instead of using the scroll button on the mouse.

FIGURE 3-10:   CHANNEL SELECTION WINDOW - DROP-DOWN MENU
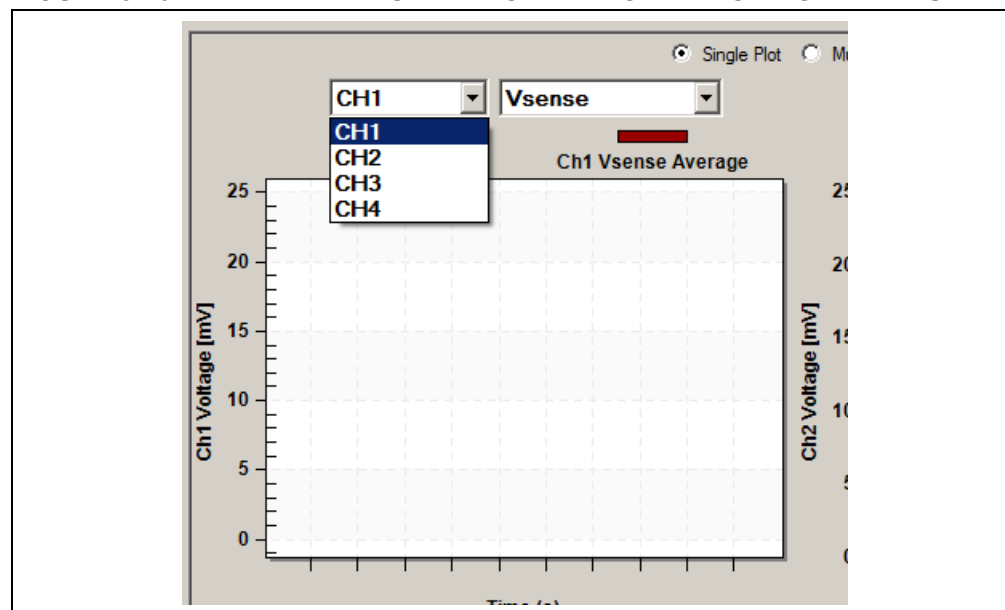
FIGURE 3-11: **RESULTS SELECTION WINDOW - DROP-DOWN MENU**
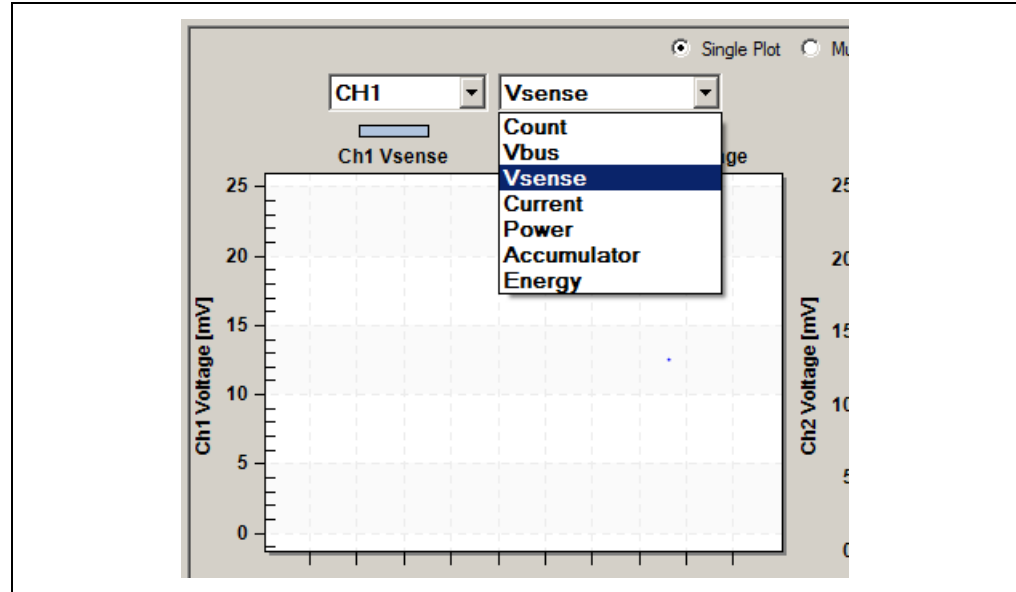
In Figure 3-12, each single plot shows a different channel and a different results register for each channel. Four different results can be displayed for the same channel, the same results for all four channels or any kind of mix and match.

FIGURE 3-12: **PLOTS WINDOW**