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# PAC1921
# High-Side Current/Power Sensor Evaluation Board User's Guide

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**Object of Declaration: PAC1921 High-Side Current/Power Sensor Evaluation Board**

EU Declaration of Conformity

Manufacturer: Microchip Technology Inc.
2355 W. Chandler Blvd.
Chandler, Arizona, 85224-6199
USA

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

Derek Carlson
VP Development Tools

12-Sep-14
Date

**NOTES:**

# 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 "XXXXXXXX" 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 on-line help. Select the Help menu, and then Topics to open a list of available on-line help files.**

## INTRODUCTION

This chapter contains general information that will be useful to know before using the PAC1921 High-Side Current/Power Sensor Evaluation Board. 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 PAC1921 High-Side Current/Power Sensor 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 PAC1921 High-Side Current/Power Sensor Evaluation Board.
- **Chapter 2. "Installation and Operation"** – Includes instructions on installing and starting the application.
- **Chapter 3. "Hardware Description"** – Shows hardware details of the PAC1921 High-Side Current/Power Sensor Evaluation Board.
- **Chapter 4. "Software Description"** – Describes the main operations in the software.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the PAC1921 High-Side Current/Power Sensor Evaluation Board.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the PAC1921 High-Side Current/Power Sensor 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) { ... }` |

## WARRANTY REGISTRATION

Please complete the enclosed Warranty Registration Card and mail it promptly. Sending in the Warranty Registration Card entitles users to receive new product updates. Interim software releases are available at the Microchip web site.

## RECOMMENDED READING

This user's guide describes how to use PAC1921 High-Side Current/Power Sensor Evaluation Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

### PAC1921 Data Sheet (DS20005293)

This data sheet describes the operation and features of the PAC1921 high-side power/current monitor device with a configurable analog output.

## THE MICROCHIP WEB SITE

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- **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

## CUSTOMER SUPPORT

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- 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 (June 2015)

- Initial Release of this Document.

**NOTES:**

# Chapter 1. Product Overview

## 1.1 INTRODUCTION

The PAC1921 is a dedicated power monitoring device with a configurable output. The PAC1921 High-Side Current/Power Sensor Evaluation Board package provides users with the means to exercise device functionality while connected either to target systems (Sys mode) or while utilizing on-board sources (Demo mode).

## 1.2 PAC1921 EVALUATION SYSTEM

The evaluation system has three major parts, as shown in Figure 1-1:

- Customer-provided Windows® PC with an available USB port
- Microchip PAC1921 Graphical User Interface (GUI) (based on National Instruments™ LabVIEW™ software)
- Microchip PAC1921 High-Side Current/Power Sensor Evaluation Board
- USB Cable for GUI communications (Standard-A plug to Mini-B plug)

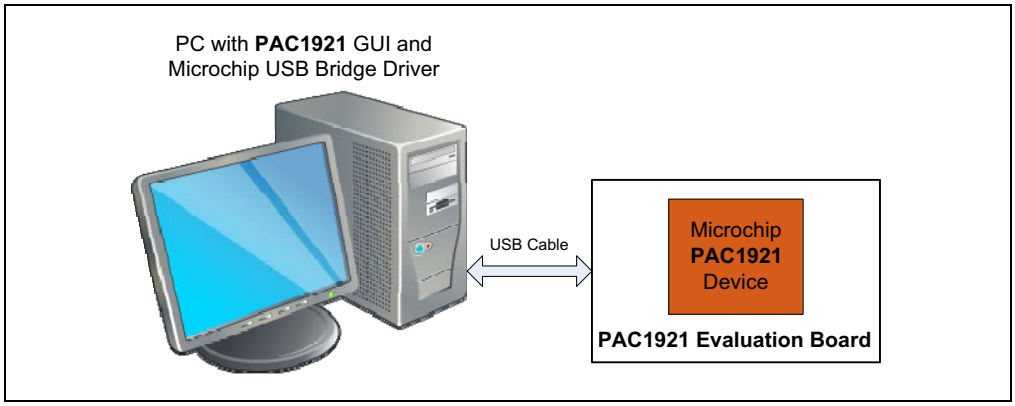



***FIGURE 1-1:*** *PAC1921 Evaluation System.*

**Note:** Screen captures in this document were taken on a PC with Windows® 7 Professional using the default desktop colors. The colors on your screen may vary, especially if a Windows theme has been applied on the PC.

## 1.3 WHAT IS THE PAC1921 HIGH-SIDE CURRENT/POWER SENSOR EVALUATION BOARD?

The evaluation system is comprised of the ADM00592 and a LabVIEW software-based application which allows the user to do the following:

- View and change register values
- Saving settings of all registers allowing for quick configuration at a later time
- Graphing registers

The hardware platform provides the following features to the user:

- Headers for connecting a sense resistor
- USB-to-SMBus bridge for communications
- Capability to connect directly to an external SMBus master

### 1.3.1 Board Layout

The evaluation board was designed for ease of use and user experimentation. Figure 1-2 shows the top silkscreen for the board.

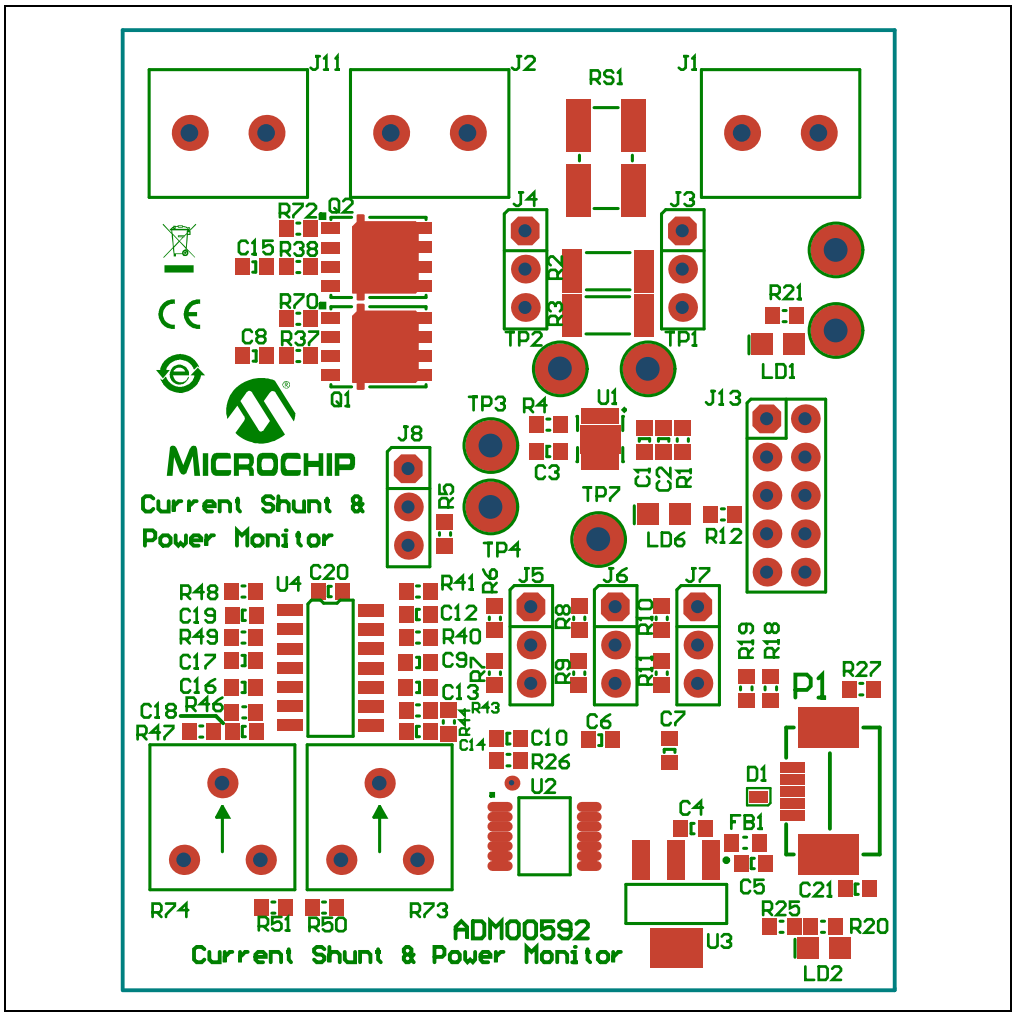



***FIGURE 1-2:*** *PAC1921 High-Side Current/Power Sensor Evaluation Board – Top Silkscreen.*

## 1.4 WHAT THE PAC1921 HIGH-SIDE CURRENT/POWER SENSOR EVALUATION BOARD KIT CONTAINS

This PAC1921 High-Side Current/Power Sensor Evaluation Board kit includes:

- PAC1921 High-Side Current/Power Sensor Evaluation Board (ADM00592)
- Supplied USB Mini Connector Cable
- Important Information Sheet

**NOTES:**

# Chapter 2. Installation and Operation

## 2.1 GETTING STARTED

### 2.1.1 System Requirements

To use the PAC1921 High-Side Current/Power Sensor Evaluation Board, the following are required:

- A PC running the Microsoft® Windows® operating system
- A display resolution of 800x600 or larger, for viewing several windows simultaneously
- An available USB port

## 2.2 INSTALLING THE EVALUATION BOARD SOFTWARE

Follow these steps in order to install the board's Graphical User Interface (GUI):

1. Download the software archive from the board's web page, unzip it and double-click the `Setup.exe` to start the installation. Figure 2-1 shows the initial installation screen, which displays briefly as the setup program loads.


***FIGURE 2-1:*** *Software Installation – Initialize Window.*

2. Click **Next** in the Destination Directory window, shown in Figure 2-2. For proper operation, the files must be installed in the default locations. The default location for the software files is `C:\Program Files (x86)\Microchip\PAC1921` and for the LabVIEW™ software is `C:\Program Files\National Instruments`.

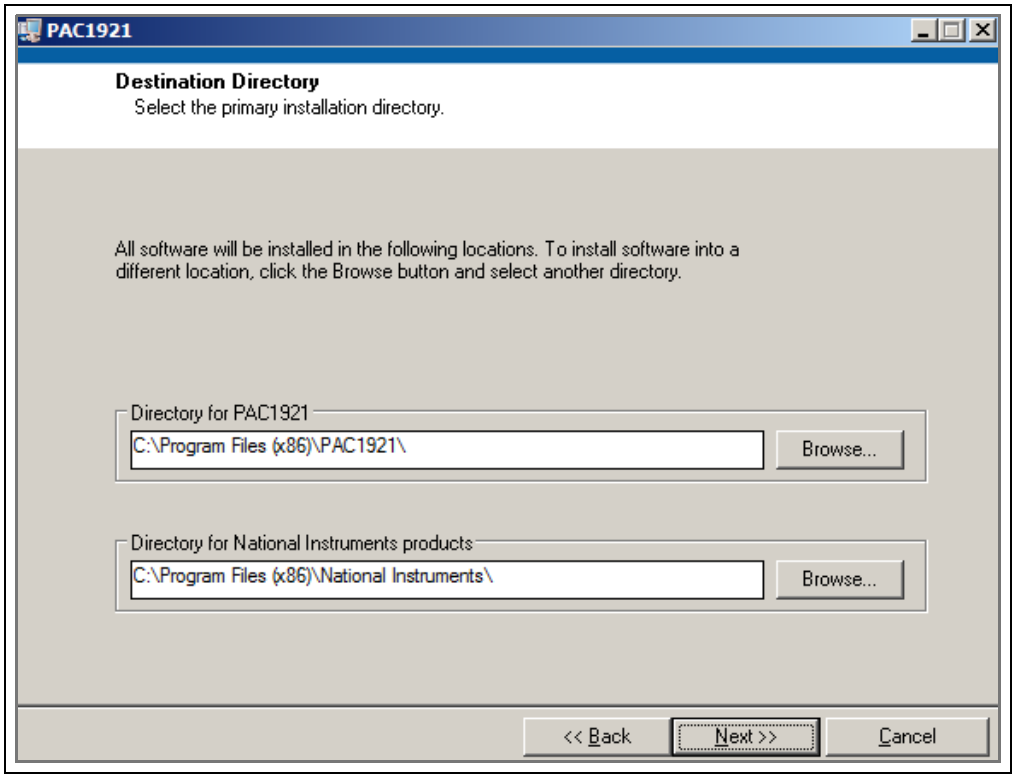



***FIGURE 2-2:*** *Software Installation – Setting the Destination Directory.*

3. Read and accept the license agreement, then click **Next**.

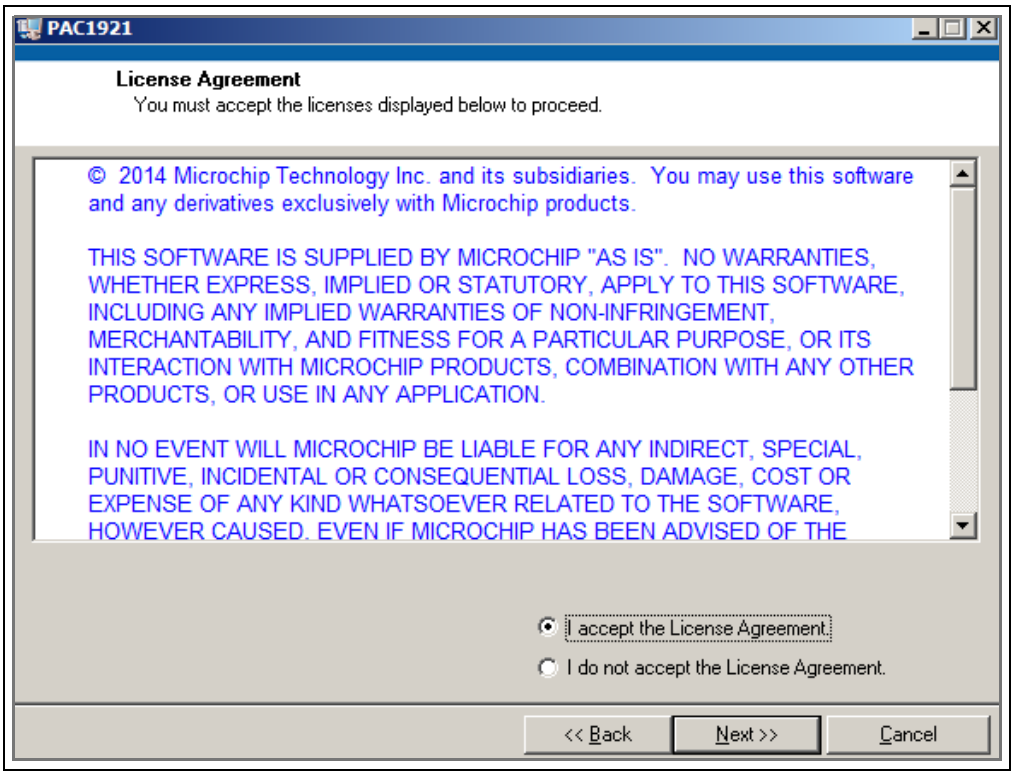



***FIGURE 2-3:*** *Software Installation – Software License Agreement.*

4. To use the LabVIEW software, read and accept the license agreement, then click **Next**.

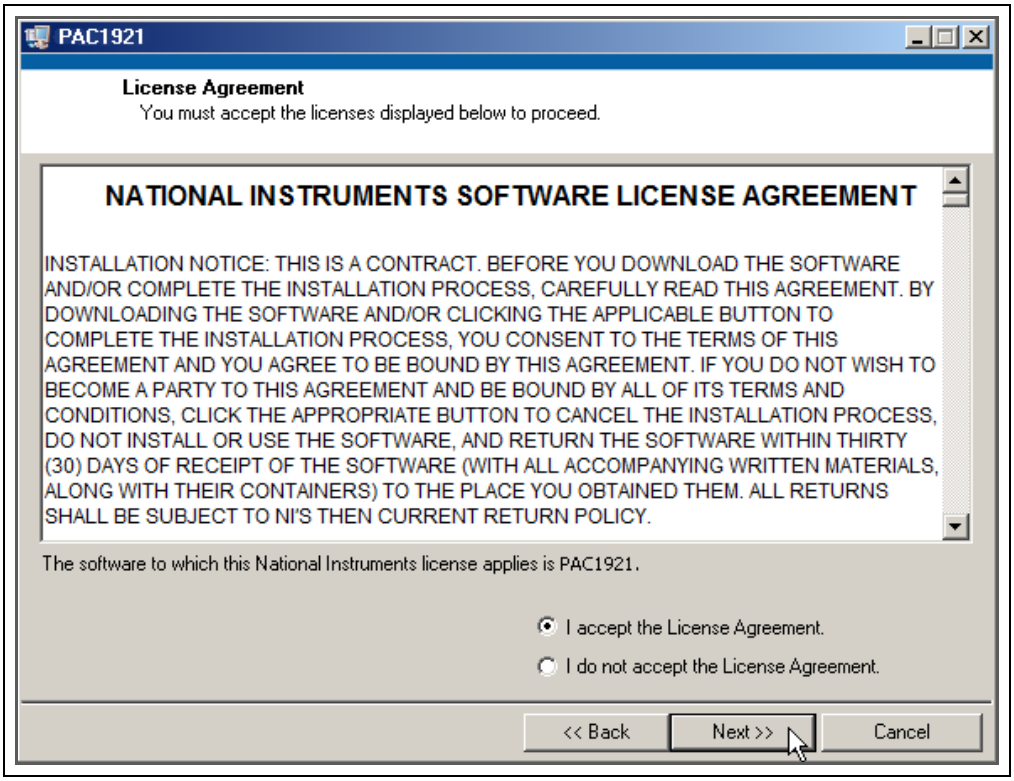



***FIGURE 2-4:*** *Software Installation – LabVIEW™ Software License Agreement.*

5. Follow the on-screen instructions to complete the installation. During installation, shortcuts will be created on the Windows Start Menu under *Programs>PAC1921* and on the desktop.

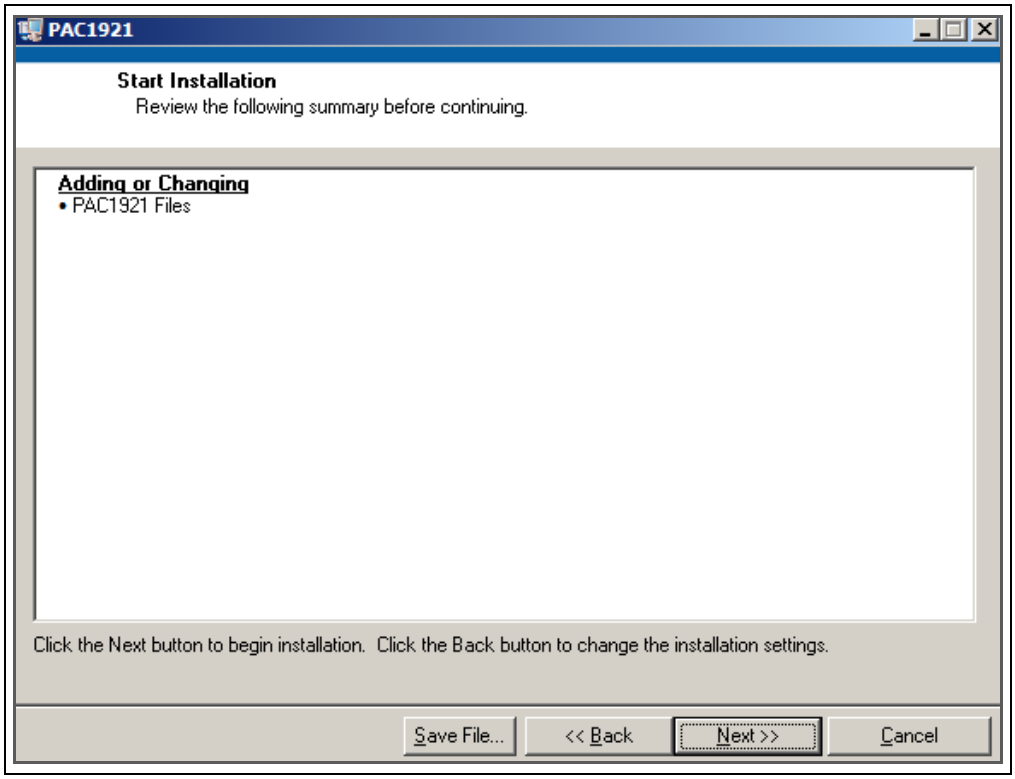



***FIGURE 2-5:*** *Software Installation – LabVIEW™ Software Installation Screen.*

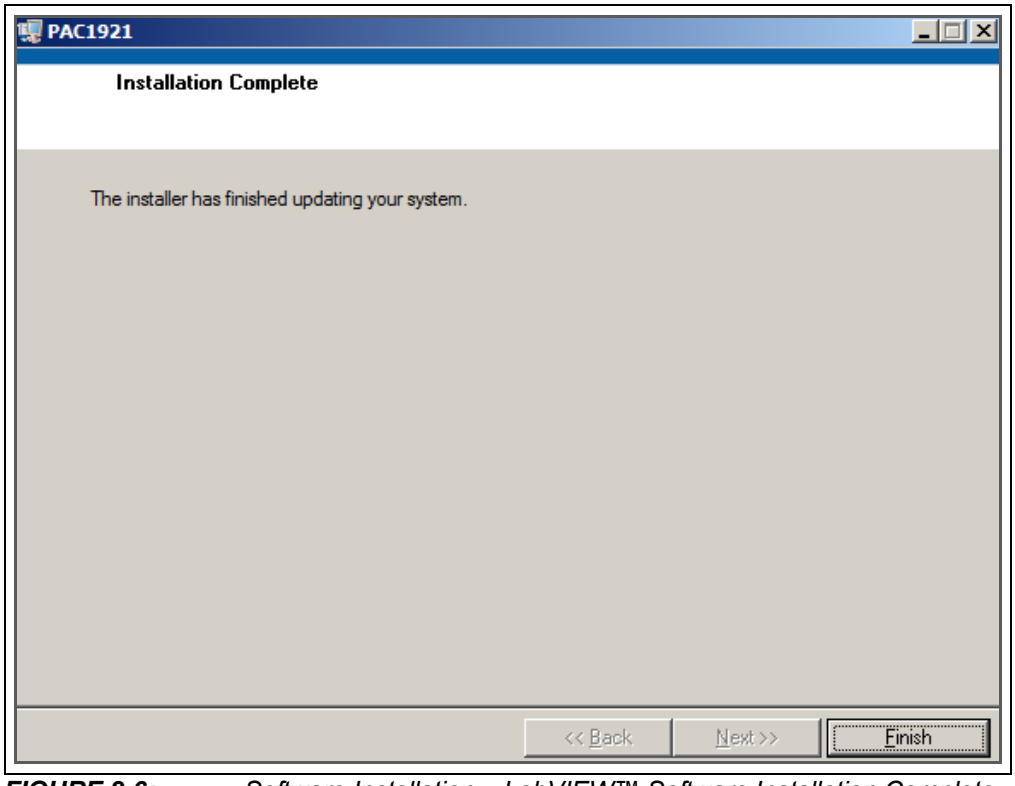



***FIGURE 2-6:*** *Software Installation – LabVIEW™ Software Installation Complete.*

When the installation is complete, the program will automatically run (see Figure 2-7).

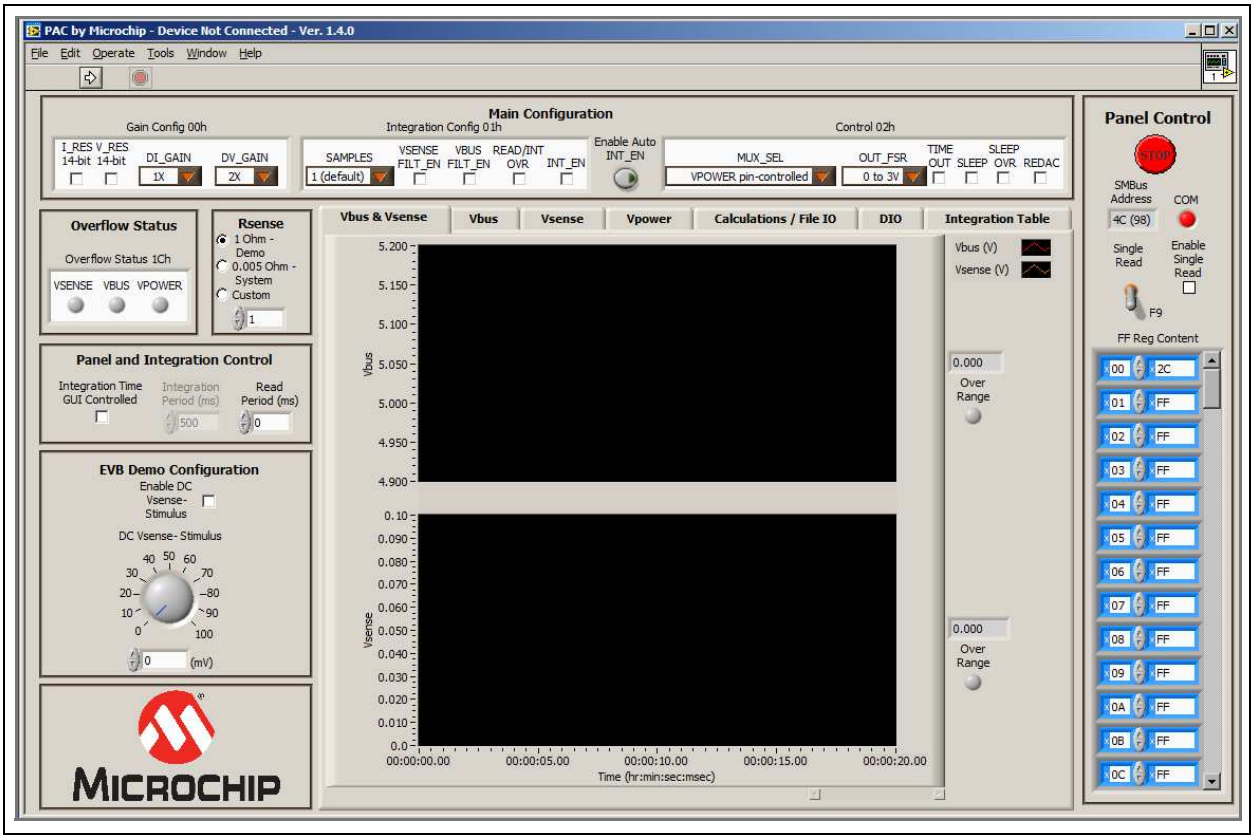



***FIGURE 2-7:*** *PAC1921 GUI Start-up Screen.*

## 2.3 MICROCHIP USB BRIDGE INSTALLATION

Connect the USB mini connector to the evaluation board and the standard USB connector to any available USB port on the PC. If the Microchip USB bridge driver has not previously been installed on the selected USB port, download the MCP2221 Windows driver and installer from www.microchip.com at:

http://www.microchip.com/wwwproducts/Devices.aspx?product=MCP2221

Follow the on-screen instructions to complete the installation process.

**NOTES:**

# Chapter 3. Hardware Description

## 3.1 INTRODUCTION

The PAC1921 High-Side Current/Power Sensor Evaluation Board provides the means to evaluate features, and to view and modify registers. There are two modes for using the evaluation board:

- Demo mode: Monitors an on-board power source
- Sys mode: Monitors an external power source

LEDs indicate status information and test points are included to monitor system voltages with a user-provided voltmeter or oscilloscope.

The PAC1921 device is an SMBus-compliant, high-side current/power monitor in a 10-pin, 3 mm x 3 mm DFN package. For details regarding the PAC1921 device, refer to the *"PAC1921 Data Sheet"* (DS20005293).

### 3.1.1 Power Source

The board requires only one Universal Serial Bus (USB) connection to power the board. USB bus voltage is provided to the on-board test power sources and the USB-to-SMBus bridge. The evaluation board circuitry uses the on-board regulator to regulate the +5V USB power to +3.3V.

## 3.2 USB-TO-SMBus BRIDGE

The USB-to-SMBus is based on the MCP2221 USB-to-I$^2$C™ protocol converter, which provides the interface between the USB and the SMBus. Power is sourced to the microcontroller from the USB interface for device power and communication.

### 3.2.1 Direct SMBus Connect Option

It is also possible to connect an external SMBus master to the PAC1921 High-Side Current/Power Sensor Evaluation Board. A few modifications to the board are required, as explained below:

- Remove the jumpers on J13 and connect the SMBus master to the SMBus_DATA, SMBus_CLK and #READ/INT pins, as well as an external supply for +3.3V. Note that a return is also provided on this header for convenience (GND).
- The +3.3V can be supplied by the SMBus bridge by leaving the +3.3V jumper in place and retaining the USB connection.

## 3.3 OPERATING MODE

### 3.3.1 SMBus Mode

By default, the evaluation board is configured so that the PAC1921 operates in SMBus mode with an SMBus address of, `1001_100xb` (98h). The address can be changed to `1001_101xb` (9Ah) by moving jumper J8 to position 2-3. Cycle power to the evaluation board in order for the change to take effect.

## 3.4 LED INDICATORS

LED locations are indicated in Figure 3-1.

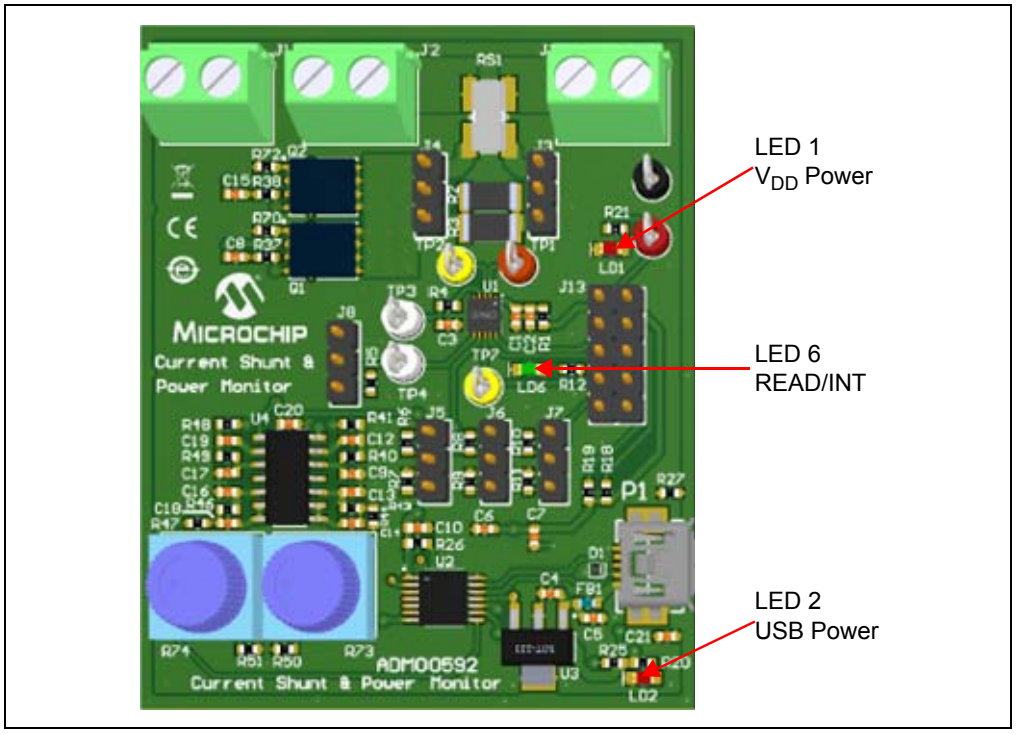



***FIGURE 3-1:*** *LED Indicator Locations.*

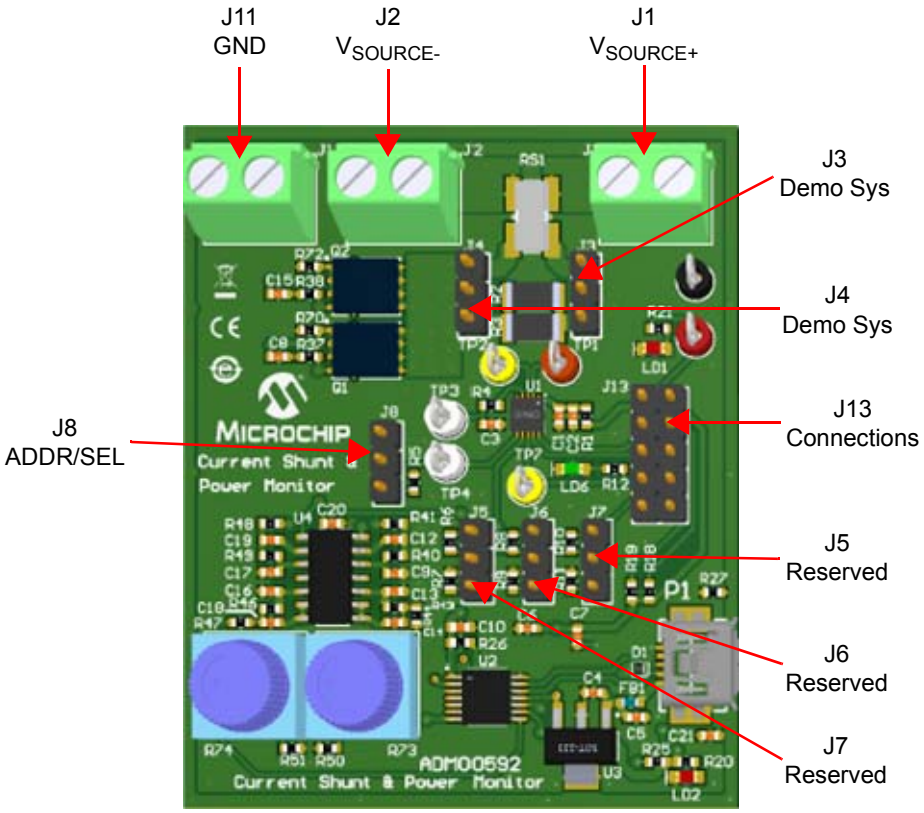
LEDs indicate the status of the signals, as described in Table 3-1:

**TABLE 3-1: LED STATUS INDICATORS**

| LED | Signal | OFF | Green | Red |
|---|---|---|---|---|
| LD1 | $V_{DD}$ Power | $V_{DD}$ is not present | N/A | $V_{DD}$ is present |
| LD2 | +5V USB Power | USB power is not present | N/A | +5V USB power is present |
| LD6 | READ/INT | Pin is not asserted (Read State) | Pin is asserted (Integrate State) | N/A |

## 3.5 JUMPER SETTINGS

This evaluation board has pin headers and jumper configurations to evaluate the features of the PAC1921. Jumper locations are indicated in Figure 3-2.




**Note:** Refer to **Appendix A. "Schematic and Layouts"** to see the connections of each jumper position.

***FIGURE 3-2:*** *Jumper and External Connection Locations.*

Jumper settings are described in Table 3-2.

**TABLE 3-2: JUMPER SETTINGS**

| Pin Header | Label | Default Position | Alternate Position(s) |
|---|---|---|---|
| J1, J2 | Vsource+, Vsource- | External power source terminals. (See **Section 3.8.2 "Load Connection"**.) | |
| J3, J4 | Demo Sys | Select Demo mode $R_{SENSE+/-}$. Positions 3-2 are jumpered on both jumpers. (See **Section 3.7 "Demo Mode Setup and Operation"**.) | Select Sys mode $R_{SENSE+/-}$. Positions 1-2 are jumpered on both jumpers. (See **Section 3.8 "Sys Mode Setup and Operation"**.) |
| J5, J6, J7 | Reserved | Reserved for future use | |
| J8 | J8 (ADDR_SEL) (See **Section 3.3.1 "SMBus Mode"**) | In SMBus mode, sets SMBus address to `1001_100b` at power-up. Positions 1-2 are jumpered. | In SMBus mode, sets SMBus address to `1001_101b` at power-up. Positions 2-3 are jumpered. |
| J11 | GND | | Connect ground from external source for Sys mode. |
| J13 | GND, #READ/INT, SMBus_DATA, SMBus_CLK, VDD | USB bridge generates on-board 3.3V and provides SMBus host. Positions 1-2, 3-4, 5-6, 7-8, 9-10 are all jumpered. | (See **Section 3.2.1 "Direct SMBus Connect Option"**.) |

## 3.6 TEST POINTS

The PAC1921 High-Side Current/Power Sensor Evaluation Board provides test points for ground reference and signal access. Table 3-3 summarizes these test points.

**TABLE 3-3: TEST POINTS**

| Test Point | Marking | Signal Function Monitored |
|---|---|---|
| 1 | Vsense+ (orange) | SENSE+ |
| 2 | Vsense- (yellow) | SENSE- |
| 3 | OUT (white) | OUT Pin |
| 4 | ADDR_SEL | SMBus Address Select |
| 5 | Vdd (red) | $V_{DD}$ |
| 6 | GND (black) | Ground |
| 7 | #READ/INT (yellow) | $\overline{\text{READ}}$/INT Pin |

## 3.7 DEMO MODE SETUP AND OPERATION

Demo mode uses an on-board current source to exercise and demonstrate the features of the PAC1921 power monitor. The 100 mV constant-current source is provided using a +5V USB as the supply. Parallel sense resistors are provided to convert the current to a corresponding voltage for the PAC1921 to read at the SENSE+ and SENSE- inputs. The evaluation board is assembled with jumpers J3 and J4 positioned for Demo mode (see **Section 3.5 "Jumper Settings"**). Current is controlled by the evaluation board Demo Configuration section of the evaluation board GUI (see **Section 4.2.6 "EVB Demo Configuration Panel"**).

## 3.8 SYS MODE SETUP AND OPERATION

Sys mode uses external current sources to exercise and demonstrate the features of the PAC1921 power monitor.

### 3.8.1 Jumper Positions

To use Sys mode, reposition jumpers J3 and J4 (see Table 3-2) to disconnect the on-board demonstration current sources.

### 3.8.2 Load Connection

A 5 milliohm (1% tolerance) sense resistor, connected between J1 and J2, is provided on-board the PAC1921 evaluation board to measure system current.

Load connections to the system can be established, as shown in Figure 3-3.

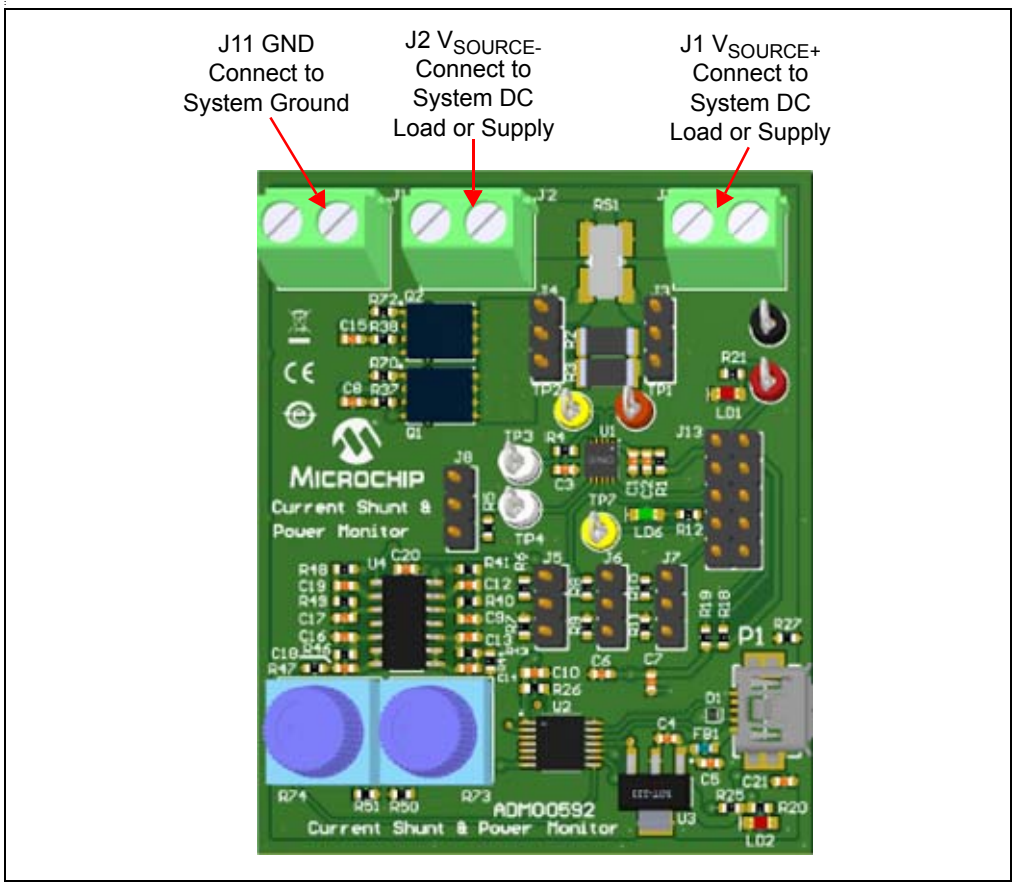



***FIGURE 3-3:*** *Load Connection Location.*