

PAC1952-2 Evaluation Board User's Guide

© 2023 Microchip Technology Inc. and its subsidiaries

Note the following details of the code protection feature on Microchip products:

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is secure when used in the intended manner, within operating specifications, and under normal conditions.
- Microchip values and aggressively protects its intellectual property rights. Attempts to breach the code protection features of Microchip product is strictly prohibited and may violate the Digital Millennium Copyright Act.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of its code. Code protection does not
 mean that we are guaranteeing the product is "unbreakable". Code protection is constantly evolving. Microchip is committed to
 continuously improving the code protection features of our products.

This publication and the information herein may be used only with Microchip products, including to design, test, and integrate Microchip products with your application. Use of this information in any other manner violates these terms. Information regarding device applications is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. Contact your local Microchip sales office for additional support or, obtain additional support at https://www.microchip.com/en-us/support/design-help/client-support-services.

THIS INFORMATION IS PROVIDED BY MICROCHIP "AS IS". MICROCHIP MAKES NO REPRESENTATIONS OR WAR-RANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE, OR WARRANTIES RELATED TO ITS CONDITION, QUALITY, OR PERFORMANCE.

IN NO EVENT WILL MICROCHIP BE LIABLE FOR ANY INDI-RECT, SPECIAL, PUNITIVE, INCIDENTAL, OR CONSE-QUENTIAL LOSS, DAMAGE, COST, OR EXPENSE OF ANY KIND WHATSOEVER RELATED TO THE INFORMATION OR ITS USE, HOWEVER CAUSED, EVEN IF MICROCHIP HAS BEEN ADVISED OF THE POSSIBILITY OR THE DAMAGES ARE FORESEEABLE. TO THE FULLEST EXTENT ALLOWED BY LAW, MICROCHIP'S TOTAL LIABILITY ON ALL CLAIMS IN ANY WAY RELATED TO THE INFORMATION OR ITS USE WILL NOT EXCEED THE AMOUNT OF FEES, IF ANY, THAT YOU HAVE PAID DIRECTLY TO MICROCHIP FOR THE INFORMATION.

Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

For information regarding Microchip's Quality Management Systems, please visit www.microchip.com/quality.

Trademarks

The Microchip name and logo, the Microchip logo, Adaptec, AnyRate, AVR, AVR logo, AVR Freaks, BesTime, BitCloud, CryptoMemory, CryptoRF, dsPIC, flexPWR, HELDO, IGLOO, JukeBlox, KeeLoq, Kleer, LANCheck, LinkMD, maXStylus, maXTouch, MediaLB, megaAVR, Microsemi, Microsemi logo, MOST, MOST logo, MPLAB, OptoLyzer, PIC, picoPower, PICSTART, PIC32 logo, PolarFire, Prochip Designer, QTouch, SAM-BA, SenGenuity, SpyNIC, SST, SST Logo, SuperFlash, Symmetricom, SyncServer, Tachyon, TimeSource, tinyAVR, UNI/O, Vectron, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

AgileSwitch, APT, ClockWorks, The Embedded Control Solutions Company, EtherSynch, Flashtec, Hyper Speed Control, HyperLight Load, IntelliMOS, Libero, motorBench, mTouch, Powermite 3, Precision Edge, ProASIC, ProASIC Plus, ProASIC Plus logo, Quiet-Wire, SmartFusion, SyncWorld, Temux, TimeCesium, TimeHub, TimePictra, TimeProvider, TrueTime, WinPath, and ZL are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, Augmented Switching, BlueSky, BodyCom, CodeGuard, CryptoAuthentication, CryptoAutomotive, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, Espresso T1S, EtherGREEN, GridTime, IdealBridge, In-Circuit Serial Programming, ICSP, INICnet, Intelligent Paralleling, Inter-Chip Connectivity, JitterBlocker, Knob-on-Display, maxCrypto, maxView, memBrain, Mindi, MiWi, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, NVM Express, NVMe, Omniscient Code Generation, PICDEM, PICDEM.net, PICkit, PICtail, PowerSmart, PureSilicon, QMatrix, REAL ICE, Ripple Blocker, RTAX, RTG4, SAM-ICE, Serial Quad I/O, simpleMAP, SimpliPHY, SmartBuffer, SmartHLS, SMART-I.S., storClad, SQI, SuperSwitcher, SuperSwitcher II, Switchtec, SynchroPHY, Total Endurance, TSHARC, USBCheck, VariSense, VectorBlox, VeriPHY, ViewSpan, WiperLock, XpressConnect, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

 $\ensuremath{\mathsf{SQTP}}$ is a service mark of Microchip Technology Incorporated in the U.S.A.

The Adaptec logo, Frequency on Demand, Silicon Storage Technology, Symmcom, and Trusted Time are registered trademarks of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2023, Microchip Technology Incorporated and its subsidiaries.

All Rights Reserved.

ISBN: 978-1-6683-2094-5



PAC1952-2 EVALUATION BOARD USER'S GUIDE

Table of Contents

Preface	5
Introduction	5
Document Layout	5
Conventions Used in this Guide	6
Recommended Reading	7
The Microchip Website	7
Product Change Notification Service	7
Customer Support	7
Document Revision History	7
Chapter 1. Product Overview	
1.1 Introduction	9
1.2 PAC1952-2 Device Features	9
1.3 PAC1952-2 Evaluation Board (EV99K19A)	9
1.4 Software and System Control Overview	10
1.5 Contents of the PAC1952-2 Evaluation Board Kit	10
Chapter 2. Installation and Operation	
2.1 Introduction	11
2.2 System Requirements	11
2.3 Installing the Software	11
Chapter 3. Software GUI Description	
3.1 First Launch	15
3.2 Detailed GUI Description	18
Chapter 4. Hardware Description	
4.1 Introduction	35
4.2 Demo Mode and EVB Mode	36
4.3 Default Connections	37
4.4 VBUS and VSENSE Connections – Using External Sources for System Mode	37
4.5 Address Selection	37
4.6 Hardware for I2C/SMBus Communication over USB or External I2C Connection	38
4.7 Signal Description in Demo Mode	38
4.8 Additional Hardware Details	39
4.9 Direct External I2C Connection	39

Appendix A. Schematic and Layouts

A.1 Introduction	41
A.2 Board – Schematic 1	42
A.3 Board – Schematic 2	43
A.4 Board – Schematic 3	44
A.5 Board – Top Silk	45
A.6 Board – Top Copper and Silk	45
A.7 Board – Top Copper	46
A.8 Board – Bottom Silk	46
A.9 Board – Bottom Copper and Silk	47
Appendix B. Bill of Materials (BOM)	49
Worldwide Sales and Service	53



PAC1952-2 EVALUATION BOARD USER'S GUIDE

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 website (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 "DSXXXXXXA", 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 PAC1952-2 Evaluation Board. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Website
- Product Change Notification Service
- Customer Support
- Document Revision History

DOCUMENT LAYOUT

This document describes how to use the PAC1952-2 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 PAC1952-2 Evaluation Board.
- Chapter 2. "Installation and Operation" Includes instructions on installing the application.
- Chapter 3. "Software GUI Description" Includes details about the Graphical User Interface.
- **Chapter 4. "Hardware Description"** Includes hardware details about the PAC1952-2 Evaluation Board.
- Appendix A. "Schematic and Layouts" Shows the schematic and layout diagrams for the PAC1952-2 Evaluation Board.
- Appendix B. "Bill of Materials (BOM)" Lists the parts used to build the PAC1952-2 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	<u>File>Save</u>			
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></f1></enter>			
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	OxFF, 'A'			
Italic Courier New	A variable argument	<i>file.</i> o, where <i>file</i> can be any valid filename			
Square brackets []	Optional arguments	mcc18 [options] <i>file</i> [options]			
Curly brackets and pipe character: { }	Choice of mutually exclusive arguments; an OR selection	errorlevel {0 1}			
Ellipses	Replaces repeated text	<pre>var_name [, var_name]</pre>			
	Represents code supplied by user	<pre>void main (void) { }</pre>			

RECOMMENDED READING

This user's guide describes how to use the PAC1952-2 Evaluation Board. Another useful document is listed below. The following Microchip document is available and recommended as a supplemental reference resource:

PAC195X Data Sheet – "Single/Multi-Channel Power Monitor with Accumulator, 32V Full-Scale Range" (DS20006539)

THE MICROCHIP WEBSITE

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

PRODUCT CHANGE NOTIFICATION SERVICE

Microchip's customer notification service helps keep customers current on Microchip products. Subscribers will receive e-mail notifications whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, access the Microchip website at <u>www.microchip.com</u>, click on **Product Change Notification** and follow the registration instructions.

CUSTOMER SUPPORT

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 website at: http://www.microchip.com/support.

DOCUMENT REVISION HISTORY

Revision A (March 2023)

• Initial release of this document.

NOTES:



PAC1952-2 EVALUATION BOARD USER'S GUIDE

Chapter 1. Product Overview

1.1 INTRODUCTION

The PAC1952-2 Evaluation Board (EV99K19A) provides a flexible platform for evaluating the PAC1952-2 device and demonstrating the feature set.

The PAC1952-2 Evaluation Board is provided with a USB connector for computer-to-device communication. The PAC1952-2 device can 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 by using the on-board MCP2221A USB to the I^2C bridge. There is also a header that facilitates direct I^2C communication by connecting the V_{IO}, Ground, SLOW, ALERT2, SDA and SCL to an external source such as a PC motherboard, a Linux[®] system or a SAM E54 Curiosity Ultra Development Board (DM320210).

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 to prototype the user's system.

1.2 PAC1952-2 DEVICE FEATURES

The PAC1952-2 is a two-channel DC power/energy monitor with accumulator. There is a 16-bit ADC for monitoring power rail voltages connected by a multiplexer to the V_{BUS} input pins, 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 V_{SENSE+} and V_{SENSE-} pins for each channel, producing V_{SENSE} results. Channel selection for the multiplexers is controlled in sequential fashion to scan both channels up to 1024 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 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 value in the results registers only changes when a REFRESH or a REFRESH_V command is sent. A software application is available for plotting, displaying and logging data. This application also calculates energy based on the accumulated power and accumulation time, as well as controlling all the registers and alerts.

1.3 PAC1952-2 EVALUATION BOARD (EV99K19A)

1.3.1 Hardware Overview

The EV99K19A evaluation board has a PAC1952-2 device and enables direct control of all device pins and easy measurements of on-board or external voltages and currents. The I²C address is connected as 0x20 (8-bit) by default. Multiple addresses can be done simply by removing resistors in the ADDR Selection area on the PCB (see **Section 4.5 "Address Selection"**). The sampling rate is 1024 SPS with adaptive accumulation by default. Pressing the **SLOW** button results in SLOW sampling rate of 8 SPS, while pressing the **PWRDWN** button will do a hardware reset.

An on-board DAC will provide for various current signals 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 I²C connection. See **Chapter 4. "Hardware Description**" for more details.

1.4 SOFTWARE AND SYSTEM CONTROL OVERVIEW

The PAC194X/5X demo application, described in detail in **Chapter 2. "Installation and Operation**", provides USB control of the PAC1952-2 with the EV99K19A evaluation board.

The application provides an easy way to control the registers and read out the results for the device. To use this software application with the PAC1952-2 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 SW300 is set to bridge (see **Chapter 2. "Installation and Operation**").

1.5 CONTENTS OF THE PAC1952-2 EVALUATION BOARD KIT

The PAC1952-2 Evaluation Board kit includes:

- PAC1952-2 Evaluation Board (EV99K19A)
- USB Cable
- Load Resistor and Wire
- Important Information Sheet



PAC1952-2 EVALUATION BOARD USER'S GUIDE

Chapter 2. Installation and Operation

2.1 INTRODUCTION

This section describes how to power-up and interface with the PAC1952-2 Evaluation Board. Items discussed in this chapter include:

- System requirements
- Downloading and installing the software.

2.2 SYSTEM REQUIREMENTS

The PAC1952-2 Evaluation Board is designed to be used with a personal computer (desktop or laptop), running Microsoft[®] Windows[®] 7 or later. For USB connectivity, the minimum physical requirement for the PC is a standard Type-A USB 2.0 port.

2.3 INSTALLING THE SOFTWARE

To install the software, follow the steps below:

1. Double click the installer and you will be alerted to uninstall any previous versions of the software before the new version is installed.

Import	ant Information Prior to Installation	×
	IMPORTANT: If any previous versions of the PAC194x5x are installed please remove them prior to continuing this installation.	ł,
	OK	



Click **OK** to start the installation process.



2. Click the Next button and the License Agreement window will appear.

FIGURE 2-2:

Installation Window.

3. Read the agreement and select "I accept the agreement" when you are ready to proceed. Selecting "I do not accept the agreement" will stop the installation. Click **Next**.

	PAC194x5x v1.0.1.1 Setup − □ ×
	License Agreement
	Please read the following License Agreement. You must accept the terms of this agreement before continuing with the installation.
	Do you accept this license? I accept the agreement O I do not accept the agreement BitRock Installer
	< Back Next > Cancel
FIGURE 2-3:	License Agreement.

4. Verify the installation directory and click **Next**.

👺 PAC194x5x v1.0.1.1	Setup	-	\times
Installation Directory			S
Please specify the dire	ectory where the PAC194x5	x will be installe	ed.
Installation Directory	C:\Program Files (x86)\Mi	crochip\PAC194	łx5x
BitRock Installer			
	< Back No	ext > Ca	ancel

FIGURE 2-4: Installation Directory.

5. The setup is now ready. Click Next to install the application. A green progress bar indicates when the installation is complete.

	👺 PAC194x5x v1.0.1.1 Setup		-	×
	Ready to Install			
	Setup is now ready to begin in	stalling the PAC194	x5x on your c	omputer.
	BitRock Installer			
		< Back Nex	xt > (Cancel
FIGURE 2-5:	Ready to Install.			

FIGURE 2-5:

 In the Install Complete window, click **Finish**. The program is now installed and is ready to use. A shortcut on the Windows Start menu is created under the Microchip menu and is called PAC194x5x. Software builds are available from local Sales and ESE contacts.



FIGURE 2-6:

Install Complete.



PAC1952-2 EVALUATION BOARD USER'S GUIDE

Chapter 3. Software GUI Description

3.1 FIRST LAUNCH

When the installation is complete, go to Start and double click the PAC194x5x icon in order to launch the PAC194x/PAC195x Demo Application.

 Connect the board to the PC with the provided USB cable and ensure Jumper 112 is shorted (IVDD jumper) and the SW300 is switched to bridge while SW301 is switched to Extern. The J112 jumper is located near the IC and the two switches are on the right side of the board. Once they are connected, LED activity can be seen on the board – D300: Green LED for +5V USB power from the USB connection. Figure 3-1 shows the GUI for the PAC194x/PAC195x Demo Application.

ttings Help							a.				
evice: PAC1952_2 (0x20)) - SN000045315: ▼	Start A	cquisition	Log to file Op	en Last Log 💈	Show Plots	Sefresh		Refresh	lype Refresh	
no Configuration Alert	s Config 12C Script	CHANNEL							·c		
PAC1952_2 (0x20) - SN00	00453153	CHAININEL	Over Current	Under Current	Over Voltage	Under Voltage	Over Power	Acc	Count	Any Alert	
EMO SETTINGS Average Sampling		CH1	۲	۲	۲	۲	۲	(Overnow)	Overnow	•	
Display Values	Refresh period (ms)	CH2									
Average N Samples:	30 ~		-		-	-		SLOW PIN TR	ANSITIONS		
•		CH3		•				Low to High	High to Low	Slow	
GPIO Status Glow 1: - G	PIO2: High	CH4	۲	۲	۲	۲	۲	۲	۲	۲	
REAL DATA		Ch2			-Ch3			Ch4			
Vbus (V)	0.0010	Vbus (V)		2.4463	Vbus (V)		8.9999	Vbus (V)		8.9999	
Vbus Avg (V)	0.0000	Vbus Avg	(/)	2.4443	Vbus Avg (V)	8.9999	Vbus Avg (V)		8.9999	
Vsense (mV)	0.0000	Vsense (m	V)	0.0641	Vsense (m	/)	99.9985	Vsense (mV)		99.9985	
Vsense Avg (mV)	0.0000	Vsense Av	rg (mV)	0.0732	Vsense Av	g (mV)	99.9985	Vsense Avg (m)	/)	99.9985	
Current (mA)	0.0000	Current (m.	A)	0.0336	Current (m/	N	21.2763	Current (mA)	24	,999.6173	
Current Avg (mA)	0.0000	Current Av	g (m.A)	0.0383	Current Ave	g (m.A)	21.2763	Current Avg (mA) 24	,999.6173	
Power (W)	0.0000	Power (W)		0.0001	Power (W)		00	Power (W)		00	
Accumulator (W)	0.0005	Accumulat	or (W)	0.0231	Accumulate	or (W)	00	Accumulator (W)	00	
Energy (pWh)	0.1072	Energy (pV	Vh)	0.0098	Energy (pV	/h)	0.0000	Energy (pWh)		0.0000	
Count	240	Count		240	Count		240	Count		240	
Sense resistor (mOhm)	4	Sense resist	tor (mOhm)	1910	Sense resist	or (mOhm)	4700	Sense resistor (n	nOhm)	4	

FIGURE 3-1:

Software GUI Main Window.

On the bottom left side of the window, there is a field called "Status". If the board is connected and the device installed, the status will be "Board connected". The Product ID will contain the part type, the I^2C address and the serial number on the left top of the window, under **Device**.



2. Click **Show Plots** to open the Demo Plots window.

Note 1: Channel selection – Choose between CH1 and CH2.

- Register selection Select Count (ACCUM), V_{BUS}, V_{SENSE}, Current, Power, Accumulator or Energy.
- **3:** Display of the chosen data.
- 4: Plot style Choose between Single Plot and Multiple Plots (multiple channels on each plot).
- 5: Option to display one plot or multiple plots in one window.
- **6:** Plot control Choose between manual and automatic Y-axis values, select the time interval from seconds to hours.

FIGURE 3-2: Demo Plots Window.



Four plot instances may run at the same time.



- Multiple Plots.
- 1. The first time the GUI is run, the resistor values near the bottom on the Demo Application window must be populated. See Figure 3-5 to determine where to enter the resistor values.
- 2. Click Start Acquisition to start generating the default waveforms. After 10 seconds, click the tab again to stop the acquisition and freeze the waveforms. The waveforms above were generated using the Demo software with the DAC enabled and set to various voltages (thus the CH1 current peak changing).

3.2 DETAILED GUI DESCRIPTION

This section provides a detailed description of the GUI and a few scenarios that explain how to change various settings and see the results.

ettings Help	(1)	2)	3	\mathbf{D}	4	5		6)	
evice: PAC1952_2 (0	<20) - SN000045315: •	Start Ac	quisition 📗	Log to file Op	en Last Log 🖉	Show Plots	🤹 Refresh		Refresh	Type Refresh	
mo Configuration A	erts Config I2C Script	- J						-			
PRODUCT ID		CHANNEL A	LERTS			(1	1	DEVICE ALERT	rs		
PAC1952_2 (0x20) - SN	0000453153		Over Current	Under Current	Over Voltage	Under Voltage	Over Power	Acc Overflow	Count Overflow	Any Alert	
DEMO SETTINGS Average Sampling		CH1	۲	۲	۲	۲	۲	۲	۲	•	
Display Values Average N Samples	Refresh period (ms)	CH2	۲	۲	۲	۲	۲	SLOW PIN TRANSITIONS			
1]	СНЗ	۲	۲	۲	۲	۲	Low to High	High to Low	to Low Slow	
GPIO Status Slow1: - GPIO2: High		CH4	۲	۲	۲	۲	۲	۲	۲	۲	
REAL DATA								Ch.A.			
Ch1	0 0000	Ch2 Vhus (V)		2 4429	Ch3		8 9999	Vbus (V)		8,9999	
Vous Ava (V)	0.0000	Vous Avg (2,4414	Vous Ava (V	0	8,9999	Vbus Avg (V)		8.9999	
Vsense (mV)	0.0458	Vsense (mV)		17.9932 Vsense (r			99.9985	Vsense (mV)		99.9985	
Vsense Avg (mV)	0.0000	Vsense Avg	(mV)	18.0023	Vsense Avg	(mV) 99.9985		Vsense Avg (m)	0	99.9985	
Current (mA)	11.4441	Current (mA)		9.4205	Current (mA)		21.2763	Current (mA)	24	,999.6173	
Current Avg (mA)	0.0000	Current Avg	(mA)	9.4253	Current Avg	vg (mA) 21.2763		Current Avg (m.4	A) 24	,999.6173	
Power (W)	0.0000	Power (W)		0.0230	Power (W)		00	Power (W)		00	
Accumulator (W)	0.0000	Accumulato	r (W)	5.8928	Accumulator	(W)	00	Accumulator (W	0	00	
Energy (pWh)	0.0000	Energy (pW	h)	2.4942	Energy (pWh	n)	0.0000	Energy (pWh)		0.0000	
Count	256	Count		256	Count		256	Count		256	
Sense meistor (mOhm)	4	Sense resisto	r (mOhm)	1910	Sense resistor	r (mOhm)	4700	Sense resistor (r	nOhm)	4	

Note 1: Current device (may have more than one connected).

- 2: Start Acquisition Starts the data logging function. When started, the tab will display Stop Acquisition to stop the function.
- 3: Log to file/Open Last Log Clicking Log to file starts the logging to a CSV file (see Figure 3-5). The user can stop the logging at any time. Data are collected only while the Start Acquisition is running. The files are saved to PAC194x5x Files in the user's Documents folder. Click Open Last Log to open the last CSV file as configured on the user's system.
- 4: Show Plots Enables the visualization window; more than one may be open at a time with different registers selected.
- 5: Refresh Manual refresh which is based on the type of refresh selected in the Refresh Type drop-down menu.
- 6: Refresh Type The user can select one of the three refresh types (Regular, Global and V). Changes can be made while acquisitions are made.
- 7: Tabs for various setup including current data values, register setup, alert setup or manual I²C commands.
- 8: PRODUCT ID Displays device information, the I²C address and the MCP2221A serial number.
- **9:** DEMO SETTINGS Displays how fast the SW requests data and for how long the data are shown in the plots. Select Display Values to show the 8x averaged values in the V_{SENSE} Avg and V_{BUS} Avg area (as well as plots). Click the Average N Samples and change the value to use software averaging using the application.
- **10:** GPIO Status Shows the status of the GPIO pins when selected to be an Input or an Output. Notes configuration if it is set for Alerts or Slow functionality.
- 11: CHANNEL ALERTS Status of all the channel specific alerts (set the alerts in the Alters Config tab).
- **12:** DEVICE ALERTS Accumulator alerts and global Any Alert.
- 13: SLOW PIN TRAINSITIONS Shows if the SLOW pin is asserted/deasserted and if SLOW is currently asserted.
- 14: REAL DATA All the data associated with each channel.
- 15: Sense resistor Resistor used to calculate current based on the V_{SENSE} value.
- 16: Status: Board connected Displays if the SW senses the device correctly or not.

FIGURE 3-4: Main GUI Tab.

	Α	В	С	D	E	F	G	Н	I	J
1	Count	Vbus_Ch1	VbusAve_Ch1	Vsense_Ch1	VsenseAve_Ch1	Current_Ch1	CurrentAve_Ch1	Power_Ch1	Acc_Ch1	Energy_Ch1
2	[N]	[V]	[V]	[mV]	[mV]	[mA]	[mA]	[W]	[W]	[mWh]
3	35126	5.159317	5.160965	0.03204346	0.04119873	0.006817757	0.008765687	3.52E-05	8.473948456	5.90E-12
4	461	5.159729	5.161789	0.05340576	0.04577637	0.011362928	0.009739653	5.86E-05	0.123873655	8.63E-14
5	407	5.164261	5.163025	0.05645752	0.0579834	0.012012238	0.012336893	6.20E-05	0.105746821	7.37E-14
6	404	5.161789	5.163025	0.06256104	0.06256104	0.013310859	0.013310859	6.87E-05	0.108764314	7.58E-14
7	407	5.162338	5.161514	0.04272461	0.05187988	0.009090342	0.011038273	4.69E-05	0.108678308	7.57E-14
8	401	5.158905	5.16124	0.03509521	0.04882813	0.007467067	0.010388963	3.85E-05	0.10423998	7.26E-14
9	399	5.162476	5.161926	0.06866455	0.05493164	0.014609479	0.011687583	7.54E-05	0.11035761	7.69E-14
10	426	5.161789	5.161789	0.04272461	0.05493164	0.009090342	0.011687583	4.69E-05	0.114062923	7.95E-14
11	411	5.162613	5.161514	0.08392334	0.06408691	0.01785603	0.013635514	9.22E-05	0.112372222	7.83E-14

FIGURE 3-5:

Portion of the CSV LOG File.

etting	gs Help							U										
vice	PAC1952	2_2 (0x20)) - SN00	00045315:	🕶 🗼 Sta	art Acqui	ition	🕜 Log to fi	le <u>Open Last</u>	Log 🔀	Shov	v Plots 🛛 🥩 Refre	sh			Refresh Type	Refresh	h
mo	Configuratio	n Alerts	Config	I2C Script														
PAC	ETTINGS	0			FULL CC		`F					CMDUC	Ê	REGISTER LIST	_()		
COF	TRUL	C			FULL SUP	ALE RANG		0110	0110	C114		SMBUS		Save Register L	ist	Import Re	gister List	
Sam	ple Mode	1024sps,	adaptiv	e acci 🗸	16	СН		CH2	CH3	CH4	_	POR		Name	Addr	Data	Save	^
	CUI	CUD	CUD	CILLA	(mV)	0-100m	/~ 0-	100mV ~	0-100mV ~	0-100mV	~	NO SKIP		Refresh	0x00	0x00		
					Vbus	0-32V	× 0-:	32V ~	0-32V ~	0-32V	~			Control	0x01	0x730		
Disa					(V)					-	_			Acc Count	0x02	0xA4		
GPI	D EPT1						SLOW P	n	EALLING	EDGE		_		Vacc1 Acc	0x03	0x70		
Set	As SLOV	N	~	Set As G	PIO input	~	Fisiliud	EDGE	Enab	le Refresh		BYTE COUNT		Vacc2 Acc	0x04	0x81A519B8		
0	High	Low		() High	Olow			la Refrech		le Refrech V	,			Vacc3 Acc	0x05	0xFFFFFFF		
	riigii 🕑	LOW		I night	0 2011			he Heiresh_		ic richean_v				Vacc4 Acc	0x06	OxFFFFFFF		1
SRO	N REFRES	SH				CON	TROL RE	GISTER ON	REFRESH	AC		ONFIGURATION		Vbus1	0x07	0x00		
3)		U	AT		ACT			LAT	ACT	СН		power ~		Vbus2	0x08	0x138D		
2						Sam	ole Mode	1024sps-	AC 1024sps	s-AC				Vbus3	0x09	0xFFFF		
H1	Vsense	un	idir	L	unidir		IO Bin1	Claur	Clau	CH	12 V	power ~		Vbus4	0x0A	0xFFFF		
	Vbus	un	idir		unidir		10 min	JIOW	JION	СН	13 V	power ~		Vsense1	0x0B	0×00		
_						GF	IO Pin2	Input	Inpu	t				Vsense2	0x0C	0x23		
CH2	vsense	un	ICIL		Iniair	Ina	ctive Ch	3,4	3,4	Ch	4 V	power		Vsense3	0x0D	OxFFFF		
	Vbus	un	idir	U	unidir			DR CONFIC				ILLNESS LIMITS		Vsense4	0x0E	0xFFFF		
	Veenee		idir		midir	ACC	UMULATO	IN CONFIG		AL		1E (10 6 IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII		Vbus1 Avg	0x0F	0x00		
снз	1901190	un	run	-				LAT	ACT	Ch				Vbus2 Avg	0x10	0x138D		
	Vbus	un	idir	U	unidir		CH1	Vpower	Vpow	er CH	12	15/16 full ~		Vbus3 Avg	0x11	0xFFFF		
-						-	CH2	Vpower	Vpow	er CH	13	15/16 full 🗸 🗸		Vbus4 Avg	0x12	0xFFFF		
	Vsense	un	idir	L L	unidir		cua	Vegue	Veen	er CH	44	15/16 full V		Vsense1 Avg	0x13	0x00		
							LIDA	VDUVUM	VININ			10/10/01						
CH4	Voue		idir		midir			vpower	vpow	Col	unt	15/10/18		Vsense2 Avg	0x14	0x2E		

Note 1: See Figure 3-4.

- 2: Various settings for I/O type, disabling channels, unidirectional or bidirectional, etc. See the data sheet for the various operations. Pin functions selectors are used to control the MCP2221A GPIOs that are connected to both the SLOW pin and the PowerDown pin. Activating the box for either one of them will set the MCP2221A to assert the logic high on these pins. Unchecked GPIOs are set as inputs.
- **3:** Latch and actual status, as well as accumulator configuration settings.
- 4: REGISTER LIST Contains the current settings for each register. The registers can be saved to a CSV file and reloaded at a later time. The GUI loads the register values from the device when connected to the USB bridge. This overwrites what was previously in the GUI. A reload of the registers is necessary if the user wants a specific setup for the registers.

FIGURE 3-6:	Configuration	Tab
	ooninguruuon	Tub.

PAC1952-2 Evaluation Board User's Guide

PAC194x/PAC	195x Demo Applica	tion								-	
Settings Help					1						
Device: PAC195	2_2 (0x20) - SN0000	45315: 🝷 🗼 St	art Acquisition	Vog to file Oper	n Last Log 🛛 🖄 Sho	w Plots 🛛 🧐 Re	fresh			Refresh T	ype Refresh
emo Configuratio	on Alerts Config 12	C Script									
OVER CURRENT	2			2	UNDER CURREN	Т					
	CH1	CH2	CH3	CH4		CH1	C	H2	CH3		CH4
Limit (m.A)	0.00	0.00	0.00	-0.76	Limit (mA)	0.00	0.00	÷	0.00	÷ -0.7	76 🖨
Nsamples	1 ~	1 ~	1 ~	1 ~	Nsamples	1	/ 1	~	1	~ 1	~
Enable Alert					Enable Alert						
Alert 1					Alert 1						
Alert 2					Alert 2						
OVER VOLTAGE					UNDER VOLTAGE						
	CH1	CH2	CH3	CH4		CH1	C	H2	CH3		CH4
Limit (V)	0.00	0.00	0.00	0.00	Limit (V)	0.00	0.00	-	0.00	\$ 0.0	0 🗘
Nsamples	1 ~	1 ~	1 ~	1 ~	Nsamples	1	/ 1	~	1	~ 1	~
Enable Alert					Enable Alert						
Alert 1					Alert 1						
Alert 2					Alert 2						
OVER POWER					GENERAL ALERT	S					
	CH1	CH2	CH3	CH4		Acc O	verflow	Ac	cc Count	, i	Alert CC
Limit (W)	0.000	0.000	0.000 🗘	0.000 ≑							
Nsamples	1 ~	1 ~	1 ~	1 ~	Enable Alert	[
Enable Alert					Alert 1		1				
Alert 1											6
Alert 2					Alert 2	1					

Note 1: See Figure 3-4.

- **2:** Alert settings including enable and limits:
- a) Set the limit for the desired alert. For current, use mA (mV for V_{SENSE} for initial builds), V_{BUS} in V and power in W.
- b) Select the number of consecutive failures before the alert occurs (1,4, 8 or 16).
- c) Enable the alert. When enabled, the light on the Demo window turns green (enabled and no alert) and it turns red when limit is exceeded.
- d) Select which <u>ALERT</u> pin (1 or 2) the alert should appear on. Any combination is allowed, as well as not setting the <u>ALERT</u> pins at all. The alert is still noted in the Alerts Status register (26h).
- e) The GENERAL ALERTS for Acc Overflow, Acc Count and Alert CC (Conversion Complete) are also enabled here.

FIGURE 3-7: Alerts Config Tab.

Settings		95x Demo Application		~				- 🗆 🗙
-	Help	••		(1)				
Device: PA	AC1952	_2 (0x20) - SN000045315:	- > Start Acquisition	Log to file Open Last I	og 🛛 🖄 Show Plots	🤣 Refresh	Re	fresh Type Refresh
Demo Conf	figuration	n Alerts Config 12C Script	E					
COMMANE	DS					(10)		
4	n Ope	eration 7b	Reg Address Data		Delay (ms)	Pause Comments		Send
• 🗹	3	· 6		8				Send
		5)	(7)		(9)		(11)	(12)
			\smile		\smile		Ŭ	Ŭ
					\sim			
					(14)	(15)	(16)	(17)
Save		Import			Save Log	Clear Output Window	Send All	Send Continuously
RECEIVED	D/SENT	DATA						
								3
								3
Nete								3
Note:	A	Il values are hex	adecimal.					3
Note: Note	A 1:	Il values are hex. See Figure 3-	adecimal. -4.					3
Note: Note	A 1: 2:	Il values are hex See Figure 3- COMMANDS so	adecimal. -4. .ection – Contains	all the commands	to manually so	end to device.		3
Note: Note	A 1: 2: 3:	Il values are hex See Figure 3- COMMANDS se RECEIVED/SEI	adecimal. -4. ection – Contains NT DATA – Conta	all the commands	to manually se	end to device. om the IC on a pe	r command	3 basis.
Note: Note	A 1: 2: 3: 4:	Il values are hex See Figure 3- COMMANDS se RECEIVED/SEI On – If the chec	adecimal. -4. ection – Contains NT DATA – Conta ck box is activated	all the commands ins the sent and re d, the command wi	to manually so eceived data fro	end to device. om the IC on a pe it, the command v	r command	3 basis. ent.
Note: Note	A 1: 2: 3: 4: 5:	Il values are hexi See Figure 3- COMMANDS so RECEIVED/SEI On – If the chec Operation – The	adecimal. -4. ection – Contains NT DATA – Conta ck box is activated e Operation is to r	all the commands ins the sent and re d, the command wi read or write (Senc	to manually se eceived data fro Il be sent. If no I option when i	end to device. om the IC on a pe it, the command v nothing is provide	r command vill not be se d in the Dat	3 basis. ent. a section).
Note: Note	A 1: 2: 3: 4: 5: 6:	Il values are hex See Figure 3- COMMANDS so RECEIVED/SEI On – If the chec Operation – The Address 7b – I ²	adecimal. -4. NT DATA – Contains NT DATA – Conta ck box is activated e Operation is to r ² C address in 7-bi	all the commands ins the sent and re d, the command wi read or write (Send t.	to manually se eceived data fr Il be sent. If no d option when i	end to device. om the IC on a pe ot, the command v nothing is provide	r command vill not be se d in the Dat	3 basis. ent. a section).
Note: Note	A 1: 2: 3: 4: 5: 6: 7:	Il values are hex. See Figure 3- COMMANDS se RECEIVED/SEI On – If the chec Operation – The Address 7b – I ² Reg Address –	adecimal. -4. NT DATA – Contains NT DATA – Conta ck box is activated e Operation is to r ² C address in 7-bi Device register a	all the commands ins the sent and re d, the command wi read or write (Senc t. ddress.	to manually se eccived data fr Il be sent. If no I option when i	end to device. om the IC on a pe t, the command v nothing is provide	r command vill not be se d in the Dat	3 basis. ent. a section).
Note: Note	A 1: 2: 3: 4: 5: 6: 7: 8:	Il values are hex. See Figure 3- COMMANDS se RECEIVED/SEI On – If the chec Operation – The Address $7b - 1^2$ Reg Address – Data – For read	radecimal. -4. ection – Contains NT DATA – Conta ck box is activated e Operation is to r ² C address in 7-bi Device register an I, it contains the n	all the commands ins the sent and re d, the command wi read or write (Senc t. ddress. umber of bytes retu	to manually so eccived data fro Il be sent. If no I option when r rned. For write	end to device. om the IC on a pe it, the command v nothing is provide , it contains the da	r command vill not be se d in the Dat	3 basis. ent. a section). tten. For multiby
Note: Note	A 1: 2: 3: 4: 5: 6: 7: 8:	Il values are hexi See Figure 3- COMMANDS se RECEIVED/SEI On – If the chec Operation – The Address 7b – I ² Reg Address – Data – For read writes, use a co	adecimal. -4. wection – Contains NT DATA – Contains ck box is activated e Operation is to r ² C address in 7-bi Device register and l, it contains the nu omma between by Windowc [®] is perf	all the commands ins the sent and re d, the command wi read or write (Senc t. ddress. umber of bytes retu tes.	to manually se eccived data fro Il be sent. If no I option when n rned. For write	end to device. om the IC on a pe of, the command v nothing is provide , it contains the da	r command vill not be se d in the Dat ta to be writ	3 basis. ent. a section).
Note: Note	A 1: 2: 3: 4: 5: 6: 7: 8: 9:	Il values are hexi See Figure 3- COMMANDS so RECEIVED/SEI On – If the chec Operation – The Address 7b – I ² Reg Address – Data – For read writes, use a co Delay – In ms (I	adecimal. -4. NT DATA – Contains NT DATA – Conta ck box is activated e Operation is to r ² C address in 7-bi Device register and I, it contains the nu comma between by Windows [®] is not a victor a dialog between	all the commands ins the sent and re d, the command wi read or write (Senc t. ddress. umber of bytes retu rtes. a real-time OS, so	to manually se eccived data fro Il be sent. If no I option when i rned. For write delays are app	end to device. om the IC on a pe t, the command v nothing is provide , it contains the da proximate).	r command vill not be se d in the Dat ta to be writ	3 basis. ent. a section). tten. For multiby
Note: Note	A 1: 2: 3: 4: 5: 6: 7: 8: 9: 10:	Il values are hex. See Figure 3- COMMANDS se RECEIVED/SEI On – If the chec Operation – The Address 7b – I ² Reg Address – Data – For read writes, use a co Delay – In ms (Pause – If activ	adecimal. -4. ection – Contains NT DATA – Conta ck box is activated e Operation is to r ² C address in 7-bi Device register ad l, it contains the nu omma between by Windows [®] is not a vated, a dialog box	all the commands ins the sent and re d, the command wi read or write (Send t. ddress. umber of bytes retu rtes. a real-time OS, so k will open and con	to manually se eccived data fro Il be sent. If no doption when n rned. For write delays are app nmands will be	end to device. om the IC on a pe it, the command v nothing is provide , it contains the da proximate).	r command vill not be se d in the Dat ta to be writ is clicked.	3 basis. ent. a section). tten. For multiby
Note: Note	A 1: 2: 3: 4: 5: 6: 7: 8: 9: 10: 11:	Il values are hex. See Figure 3- COMMANDS se RECEIVED/SEI On – If the chec Operation – The Address 7b – I ² Reg Address – Data – For read writes, use a co Delay – In ms (' Pause – If activ Comments – Ma	adecimal. -4. ection – Contains NT DATA – Conta ck box is activated e Operation is to r ² C address in 7-bi Device register an I, it contains the nuo omma between by Windows [®] is not a vated, a dialog boo lanual comments.	all the commands ins the sent and re d, the command wi read or write (Senc t. ddress. umber of bytes retu rtes. a real-time OS, so c will open and con	to manually so ecceived data fro Il be sent. If no doption when n rned. For write delays are app nmands will be	end to device. om the IC on a pe it, the command v nothing is provide , it contains the da proximate). e paused until OK	r command vill not be se d in the Dat ta to be writ is clicked.	3 basis. ent. a section). tten. For multiby
Note: Note	A 1: 2: 3: 4: 5: 6: 7: 8: 9: 10: 11: 12:	Il values are hex. See Figure 3- COMMANDS se RECEIVED/SEI On – If the chec Operation – The Address 7b – I ² Reg Address – Data – For read writes, use a co Delay – In ms (' Pause – If activ Comments – M: Send – Singles	adecimal. -4. ection – Contains NT DATA – Conta ck box is activated e Operation is to r ² C address in 7-bi Device register ar l, it contains the nu omma between by Windows [®] is not a vated, a dialog box lanual comments. send. When clicke	all the commands ins the sent and re d, the command wi read or write (Senc t. ddress. umber of bytes retu tes. a real-time OS, so k will open and con	to manually se eccived data fro Il be sent. If no doption when n rned. For write delays are app nmands will be	end to device. om the IC on a pe ot, the command v nothing is provide , it contains the da proximate). e paused until OK ill be done.	r command vill not be se d in the Dat ita to be writ is clicked.	3 basis. ent. a section). tten. For multiby
Note: Note	A 1: 2: 3: 4: 5: 6: 7: 8: 9: 10: 11: 12: 13:	Il values are hexi See Figure 3- COMMANDS so RECEIVED/SEI On – If the chec Operation – The Address 7b – I ² Reg Address – Data – For read writes, use a co Delay – In ms (' Pause – If activ Comments – Mi Send – Single so Save/Import –	adecimal. -4. NT DATA – Contains NT DATA – Contains ck box is activated e Operation is to r ² C address in 7-bi Device register and t, it contains the nu pomma between by Windows [®] is not a vated, a dialog box lanual comments. send. When clicke Save the comman	all the commands ins the sent and re d, the command wi read or write (Senc t. ddress. umber of bytes retu rtes. a real-time OS, so k will open and con ed, that line (and ou nds above or impo	to manually se eccived data fro I be sent. If no I option when n rned. For write delays are app nmands will be nhy that line) w rt a set of com	end to device. om the IC on a pe it, the command v nothing is provide , it contains the da proximate). e paused until OK ill be done. mands previously	r command vill not be se d in the Dat ita to be writ is clicked. saved.	3 basis. ent. a section). tten. For multib
Note: Note	A 1: 2: 3: 4: 5: 6: 7: 8: 9: 10: 11: 12: 13: 14:	Il values are hex. See Figure 3- COMMANDS so RECEIVED/SEI On – If the chec Operation – The Address 7b – I ² Reg Address – Data – For read writes, use a co Delay – In ms (' Pause – If activ Comments – M: Send – Single s Save/Import – Save Log – Sa	adecimal. -4. NT DATA – Contains NT DATA – Contains ck box is activated e Operation is to r ² C address in 7-bi Device register and t, it contains the nu pomma between by Windows [®] is not a vated, a dialog box lanual comments. send. When clicke Save the comman	all the commands ins the sent and re d, the command wi read or write (Senc t. ddress. umber of bytes retu rtes. a real-time OS, so k will open and con ed, that line (and of nds above or impo RECEIVED/SENT	to manually se ecceived data fro Il be sent. If no I option when i rned. For write delays are app nmands will be nly that line) w rt a set of com	end to device. om the IC on a pe it, the command v nothing is provide , it contains the da proximate). e paused until OK ill be done. mands previously	r command vill not be se d in the Dat ita to be writ is clicked. saved.	3 basis. ent. a section). tten. For multib
Note: Note	A 1: 2: 3: 4: 5: 6: 7: 8: 9: 10: 11: 12: 13: 14: 15:	Il values are hex. See Figure 3- COMMANDS se RECEIVED/SEI On – If the chec Operation – The Address 7b – I ² Reg Address – Data – For read writes, use a co Delay – In ms (' Pause – If activ Comments – M: Send – Single s Save/Import – Save Log – Sa' Clear Output V	adecimal. -4. NT DATA – Contains NT DATA – Contains ck box is activated e Operation is to r ² C address in 7-bi Device register and ti contains the nu omma between by Windows [®] is not a vated, a dialog box lanual comments. send. When clicke Save the comman we the data in the Nindow – Clear th	all the commands ins the sent and re d, the command wi read or write (Send t. ddress. umber of bytes retur tes. a real-time OS, so k will open and com ed, that line (and or nds above or impo RECEIVED/SENT the RECEIVED/SENT	to manually se ecceived data fro Il be sent. If no I option when i rned. For write delays are app nmands will be nly that line) w rt a set of com DATA below.	end to device. om the IC on a pe it, the command v nothing is provide , it contains the da proximate). e paused until OK ill be done. mands previously v.	r command vill not be se d in the Dat ita to be writ is clicked. saved.	3 basis. ent. a section). tten. For multiby
Note: Note	A 1: 2: 3: 4: 5: 6: 7: 8: 9: 10: 11: 12: 13: 14: 15: 16:	Il values are hex. See Figure 3- COMMANDS se RECEIVED/SEI On – If the chec Operation – The Address 7b – I ² Reg Address – Data – For read writes, use a co Delay – In ms (' Pause – If activ Comments – Ma Send – Single se Save/Import – Save Log – Sar Clear Output V Send All – Sen	adecimal. -4. NT DATA – Contains NT DATA – Contains ck box is activated e Operation is to r ² C address in 7-bi Device register ac d, it contains the nu- omma between by Windows [®] is not a vated, a dialog box lanual comments. send. When clicke Save the comman we the data in the Nindow – Clear the d all the comman	all the commands ins the sent and re d, the command wi read or write (Senc t. ddress. umber of bytes retu tes. a real-time OS, so k will open and con ed, that line (and of nds above or impo RECEIVED/SENT ne RECEIVED/SEN ds in the COMMAN	to manually so ecceived data fro Il be sent. If no doption when n rned. For write delays are app nmands will be nly that line) w rt a set of com DATA below. NT DATA below.	end to device. om the IC on a pe it, the command v nothing is provide , it contains the da proximate). e paused until OK ill be done. mands previously v. ne after another.	r command vill not be se d in the Dat ita to be writ is clicked. saved.	3 basis. ent. a section). tten. For multiby



PAC1952-2 Evaluation Board User's Guide



Note 1: Channel selection – Choose between CH1 and CH2.

- Register selection Select Count (ACCUM), V_{BUS}, V_{SENSE}, Current, Power, Accumulator or Energy.
- **3:** Display of the chosen data.
- 4: Plot style Choose between Single Plot or Multiple Plots (multiple channels on each plot).
- **5**: Option to display one plot or multiple plots in one window.
- **6:** Plot controls Choose between manual and automatic Y-axis values, select the time interval from seconds to hours.

FIGURE 3-9: Demo Plots – Multiple Charts, Single Plot Option.



FIGURE 3-10: Demo Plots – Multiple Charts, Multiple Plots Option.

ettings Help											
evice: PAC 1952_2 (0x2	20) - SN000045315: •	Start Acq	uisition 🛛 📗	Log to file Op	en Last Log 🛛 🐰	Show Plots	🤹 Refresh		Refresh	Type Refresh	
emo Configuration Aler	ts Config I2C Script										
PRODUCT ID		CHANNEL AL	ERTS					DEVICE ALERT	s		
PAC1952_2 (0x20) - SN0	000453153		Over Current	Under Current	Over Voltage	Under Voltage	Over Power	Acc Overflow	Count Overflow	Any Alert	
DEMO SETTINGS Average Sampling		CH1		۲	۲	۲				۲	
Display Values Average N Samples:		CH2	CH2		•						
1	30 ~		-					SLOW PIN TR	ANSITIONS		
		СНЗ						Low to High	High to Low	Slow	
GPIO Status Slow1: - (GPIO2: High	CH4		۲	۲	۲	۲	۲	۲	۲	
REAL DATA		Ch2			-Ch3			Ch4			
Vbus (V)	0.0010	Vbus (V)		2.4463	Vbus (V)		8.9999	Vbus (V)		8.9999	
Vbus Avg (V)	0.0000	Vbus Avg (V)		2.4443	Vbus Avg (V)	8.9999	Vbus Avg (V)		8.9999	
Vsense (mV)	0.0000	Vsense (mV)		0.0641	Vsense (m)	/)	99.9985	Vsense (mV)		99.9985	
Vsense Avg (mV)	0.0000	Vsense Avg	mV)	0.0732	Vsense Av	g (mV)	99.9985	Vsense Avg (m)	0	99.9985	
Current (mA)	0.0000	Current (mA)		0.0336	Current (m.	4)	21.2763	Current (mA)	24	,999.6173	
Current Avg (mA)	0.0000	Current Avg	mA)	0.0383	Current Avg	g (m.A)	21.2763	Current Avg (m.A) 24	,999.6173	
Power (W)	0.0000	Power (W)		0.0001	Power (W)		00	Power (W)		00	
Accumulator (W)	0.0005	Accumulator	(W)	0.0231	Accumulate	or (W)	00	Accumulator (W)	00	
Energy (pWh)	0.1072	Energy (pWh)	0.0098	Energy (pV	/h)	0.0000	Energy (pWh)		0.0000	
Count	240	Count		240	Count		240	Count		240	
Sense resistor (mOhm)	4	Sense resistor	(mOhm)	1910	Sense resist	or (mOhm)	4700	Sense resistor (r	nOhm)	4	

3.2.1 Settings

FIGURE 3-11: Settings.

The Settings drop-down menu contains three items:

- Demo Board Settings
- Rename Channels
- Voltage Ratios



FIGURE 3-12:

Settings Options.

 Demo Board Settings – This is used in Demo configuration to control an on-board FET. It currently produces a pulsed current waveform, as seen in Figure 3-10. The DAC Settings enable the DAC output on the MCP2221A and the amplitude is determined by the value entered in "Max".

_		
DAC Settings Enable DAC Max Value	Description The DAC of MCP2221 can be enabled or disabled from the Enable button. If the DAC is enabled, it will generate a square signal and its amplitude can be set from the Max field. When Data Acquisition is running, DAC value will be displayed in the Value field.	Pin Functions Enable SLOW Power Down

FIGURE 3-13: Demo Board Settings.

 Rename Channels – This setting allows the user to change the name of a channel from CH1 to "Ch1 - Text". The new name will be visible in the Demo Application window, as well as the Demo Plots (see Figure 3-16 and Figure 3-17).

2	_	_		×
F	Renam	ne Cha	annels	
CH1:	Ch1-			
CH2:	Ch2-			
CH3:	Ch3-			
CH4:	Ch4-			
		Save		



3. Voltage Ratios – This setting allows the user to set the resistor divider ratio (when selected with J106 or J104). The GUI will translate the measured voltage to the value before the divider.

🐼 Vo	Itage Ratios		_		\times
The v availa To ob voltag	oltage ratio filed: ble channels. tain the correct e percentage m	s will be enabled of values for the bus ust be provided in	or disabled accordin voltage, power and the corresponding	g to the numb d accumulator field.	er of the
	CH1	CH2	CH3	CH4	
	1	1	1		1

FIGURE 3-15:



PAC1952-2 Evaluation Board User's Guide



FIGURE 3-16:

Channel Renaming Example.



FIGURE 3-17: Plots with Renamed Channels.

3.2.2 Help

The Help drop-down menu contains one item:

• About – Contains the software revision number and the Microchip base warranty information.





3.2.3 Other GUI Descriptions

Here are some general hints and tricks to improve the usability of the GUI:

- If the user has multiple PAC1952-2 devices connected to the I²C bus, the GUI will see them and the user can control them via <u>PAC194x/PAC195x Demo</u> <u>Application>Device</u>.
- 2. Disabling channels in the **Configuration** tab and then choosing Fast or Burst will speed up the device operation on the enabled channels. The MCP2221A cannot support the data rate, so while the chip is operating at a higher speed, the user will not be able to get each sample out with the on-board bridge.
- 3. On the **Configuration** tab, a REFESH is done after any selection. The user will see the GUI change the LAT/ACT values after selecting the setting for this reason.
- 4. Right click Save in the REGISTER LIST to select or deselect all registers.





- 5. Each writable register can be changed by clicking Data for that register and changing the value. This only works for writable registers.
- 6. Change the color of the trace:
- right click on the plot (anywhere) to get the menu below:

	-		
Ch1 V		Viewing Style	>
		Border Style	>
		Font Size	>
	~	Show Legend	
		Numeric Precision	>
		Plotting Method	>
		Data Shadows	>
		Grid Options	>
		Include Data Labels	
		Mark Data Points	
		Undo Zoom	
		Maximize	
		Customization Dialog	
		Export Dialog	

FIGURE 3-20: Changing Colors.

- Customization... General Plot Subsets Axis Font Color Style Ch1 Vbus Ch1 Vbus Average Point Type: • • Line Type: • OK Cancel Maximize. Export. Customization.
- · Select Customization Dialog and then select Style.

- FIGURE 3-21:
- · Change the color to one of the 16 options and set the "Point Type" and "Line Type".
- 7. Choose between hardware averaging, 8x (Display Values) and software averaging (Average N Samples). See Figure 3-4. If the user selects Average N Samples, the values in the REAL DATA section for average V_{BUS} Avg and V_{SENSE} Avg, as well as the Plot data will be the software averaged value.

3.2.4 Scenario 1: Changing the Sampling Rate/Mode

The PAC1952-2 supports several sampling rates (8, 64, 256 and 1024 SPS) along with variations on accumulation. This scenario describes how to change the settings for a couple of different options.

The first selection moves from the default sampling speed of 1024 SPS to 8 SPS, as well as from the sampling mode Adaptive Accumulation to the regular Accumulation Method (see the data sheet for differences).

Under the **Configuration** tab, go to <u>CONTROL>Sample Mode</u> and select the eighth element, labeled "8sps". This triggers a Refresh and the ACT register for the CONTROL REGISTER ON REFRESH will show 8 SPS while the LAT will show the previous setting of 1 ksps.

Settin														
-	ngs Help)					100							
Devic	e: PAC195	4 (0x20) - SN0000)770469 -	Start Acquisit	ion 🎼 Log t	o file <u>Open La</u>	i <u>st Log</u> 🛃 Sh	ow Plots 👘 😂 Refres	h		Refresh Type	.efresh		
Demo	Configurat	on Alerts Config	I2C Script											
PAC	SETTINGS		510.1					CMDUC	REGISTER LIST	Т				
-00	NTROL		FULL	SCALE RANGE	0110			POR	Save Regis	ster List	Import Regis	Import Register List		
San	nple Mode	8sps	~	CH1	CH2	CH3	CH4	NO SKIP	Name	Addr	Data	Save ^		
	0.11	0110 0110	(mV	e 0-100mV	 ✓ 0-100mV 	0-100mV ~	0-100mV ~	TIMEOUT	Refresh	0x00	0x00			
-			Vbu	0-32V	- 0-32V -	0-32V ~	0-32V ~	BYTE COUNT	Control	0x01	0x7700			
Disa	able		M M					I2C_HISPEED	Acc Count	0x02	0x1E81			
GP	0		5072	SLOW	Pin	FALLING	FROF	PIN FUNCTIONS	Vacc1 Acc	0x03	0x2CA3FABB			
Se	As SLO	N V Se	As GPIO input		la EDGE	FALLING Enabl	e Refrech	Enable Slow	Vacc2 Acc	0x04	0x9ED3C652D			
	High @	low	High Low		able Defrech V	Enabl	a Rafrash V	Power Down	Vacc3 Acc	0x05	0x110E5A3A161			
) night (e				able rielfesti_v		e Nellesil_v		Vacc4 Acc	0x06	0x2AC1AE14			
FSR	ON REFRE	SH		CONTR	ROL REGISTER (ON REFRESH	ACC	CONFIGURATION	Vbus1	0x07	0x291E			
		LAT	ACT		LA	T AC	T CH1	Vpower ~	Vbus2	0x08	0x291E			
	Veenee	unidia		Sample	Mode 1024sp	is-AC 8s	ps	14	Vbus3	0x09	0x2921			
CH1	vsense	uniuir	uniar	GPIO	Pin1 Slo	w Sk	w CH2	vpower ~	Vbus4	0x0A	0x291B			
	Vbus	unidir	unidir	CRIO	Dia 2 las		CH3	Vpower ~	Vsense1	0x0B	0x3E 0x7E9			
	Vsense	unidir	unidir	GFIU	rinz inp	ut inp	CH4	Vpower ~	Vsense2	0x0C				
CH2				Inactiv	ve Ch -			-	Vsense3	0x0D	0xDF2C			
	Vbus	unidir	unidir	ACCUN	ULATOR CONF	G	ACC	FULLNESS LIMITS	Vsense4	0x0E	0x27			
	Vsense	unidir	unidir		LA	T AC	T CH1	15/16 full 🗸	Vbus1 Avg	0x0F	0x292C			
					11 14-1		CH2	15/16 full	Vbus2 Avg	0x10	0x292C			
СНЗ	Vbus	unidir	unidir		11 Vpov	ver vpo	wer		Vbus3 Avg	0,10	0x292B			
СНЗ				CL	12 Vpov	ver Vpo	wer CH3	15/16 full V	Vbus4 Avg	UX 12	UX292B			
СНЗ	Vsense	unidir	unidir	- Cr					Manage 1 Ave	0.12	0.25			

FIGURE 3-22:

Changing Sample Mode to 8 SPS.

In the PAC194x/PAC195x Demo Application window, click **Start Acquisition** and the data will be collected at the new rate. This can be seen in the Acc Count register, as a much lower rate. The MCP2221A and the GUI collect data a little over two times per second. Thus the user will see a count of 3 as the device does 3 samples during the time the GUI sends the next Refresh command.

3.2.5 Scenario 2: Changing the Refresh Type to Refresh_V

The PAC1952-2 supports three Refresh options:

- Refresh (regular) This Refresh causes the device to load all changes and become the active setup.
- Refresh_G This is the same as a regular Refresh but it is a Global Refresh for the bus.
- Refresh_V This does not reset the Acc Count or Load registers, it simply moves the data to the I²C domain for reading.

Changing the Refresh Type to Refresh_V allows the Count to continue to go up while still allowing the user to read the latest data.

Settings Help										-
Device: PAC1952_2 (0x20	0) - SN000045315: •	Start A	cquisition	Log to file Op	en Last Log 💈	Show Plots	Sefresh		Refresh	Type Refresh_V
Demo Configuration Alert	s Config 12C Script									
PRODUCT ID PAC1952 2 (0x20) - SN00	00453153	CHANNEL	ALERTS		a 111			Acc	Count	
			Over Current	nt Under Current	Over Voltage	Under Voltage	Over Power	Overflow	Overflow	Any Alert
Average Sampling		CH1	۲		۲	۲	۲		۲	•
 Display Values Average N Samples: 	Refresh period (ms)	CH2	۲	۲	۲	۲	۲	- SLOW PIN TR	ANSITIONS	
1	30 🗸	СНЗ	۲	۲	۲	۲	۲	Low to High	High to Low	Slow
GPIO Status Slow1: - G	iPIO2: High	CH4	۲	۲	۲	۲	۲	۲	۲	۲
REAL DATA	5									
Ch1]	Ch2			Ch3			Ch4		
Vbus (V)	0.0000	Vbus (V)		2.4443	Vbus (V)		8.9999	Vbus (V)		8.9999
Vbus Avg (V)	0.0000	Vbus Avg	(V)	2.4434	Vbus Avg (V)	8.9999	Vbus Avg (V)		8.9999
Vsense (mV)	0.0000	Vsense (mV)		17.9657	Vsense (m	0	99.9985	Vsense (mV)		99.9985
Vsense Avg (mV)	0.0000	Vsense Av	rg (mV)	17.9718	Vsense Av	g (mV)	99.9985	Vsense Avg (m	V)	99.9985
Current (mA)	0.0000	Current (m.	A)	9.4061	Current (m/	N)	21.2763	Current (mA)	24	,999.6173
Current Avg (mA)	0.0000	Current Av	g (mA)	9.4093	Current Ave	g (mA)	21.2763	Current Avg (m/	A) 24	,999.6173
Power (W)	0.0000	Power (W)		0.0230	Power (W)	00		Power (W)		00
Accumulator (W)	0.0000	Accumulat	or (W)	1,856.9267	Accumulat	or (W)	00	Accumulator (W	/)	00
Energy (pWh)	0.0003	Energy (pV	Vh)	100,604.8765	Energy (pV	/h)	0.0000	Energy (pWh)		0.0000
Count	161628	Count		161628	Count		161628	Count		161628
Sense resistor (mOhm)	10000	Sense resist	or (mOhm)	1910	Sense resist	or (mOhm)	4700	Sense resistor (r	mOhm)	4

FIGURE 3-23:

Refresh Type.

Click the drop-down menu and select Refresh_V.

Refresh Type	Refresh	•
	Refresh Refresh_G Refresh_V	6

FIGURE 3-24: Refresh_V.

Click **Start Acquisition** and the data will be collected using the Refresh_V method. This option is available while the GUI collects data. With the GUI still running, use the drop-down to select the Refresh and see the Count being reset regularly.

3.2.6 Scenario 3: Setting Limits and Alerts

A new feature of the PAC1952-2 is the additional alert functionality, including limits for overcurrent, undercurrent, overvoltage, undervoltage and overpower. These limits are selectable per channel and able to drive one of the two ALERT pins.

	Over Current	Under Current	Over Voltage	Under Voltage	Over Power	Acc Overflow	Count Overflow	Any Alert
CH1	۲	۲	۲	۲	۲	۲	۲	۲
CH2	۲	۲	۲	۲	۲	SLOW PIN TR	ANSITIONS	
CH3	۲	۲	۲	۲	۲	Low to High	High to Low	Slow
CH4	•		۲	٠	۲			

FIGURE 3-25: Channel Alerts.

The alert is green when the limit is enabled. If the data value is within the limits (or condition), the alert is green. If the data value is outside the limit, the alert turns red.

EXAMPLE 3-1: SETTING LIMITS

Select the **Alerts Config** tab and note the options for the various limits. Limits are set on CH4 and Limit, Nsamples and Enable <u>Alert</u> are modified. The user may also select the Alert to be visible on one of the two <u>ALERT</u> pins.

Below, Over Current (V_{SENSE}), Over Voltage (V_{BUS}) and Under Voltage (V_{BUS}) are set, limits are set and the Alert is enabled for those limits (see Figure 3-27). 2.0V are applied on the SENSE4+ pin.

PAC194x/PAC	195x Demo Ap	oplica	tion														-		
ettings Help																			
evice: PAC195	2_2 (0x20) - SN	10000	45315: -	> Sta	art Acquisitio	on	og to fi	ile <u>Open</u>	Last Log 🛛 🖄 Shi	ow Plot	ts 🛛 🦈 Ref	resh				Refr	esh Type	Refre	.sh_\
emo Configurati	on Alerts Conf	ig 12	C Script																
OVER CURRENT	·								UNDER CURREN	T							-		_
	CH1		CH2		CH3		CH	4			CH1		CH2		(CH3		CH4	
Limit (mA)	10.00	-	0.00	-	0.00	-	-0.76	-	Limit (m.A)	0.00	\$	0.00		-	0.00	\$	-0.76		*
Nsamples	1	~	1	~	1	~	1	~	Nsamples	1	~	1		~	1	~	1		~
Enable Alert									Enable Alert										
Alert 1									Alert 1										
Alert 2									Alert 2										
OVER VOLTAGE									UNDER VOLTAG	E					2				_
	CH1		CH2		CH3		CH	4			CH1		CH2		(CH3	1	CH4	
Limit (V)	5.50	-	0.00	\$	0.00	-	0.00	-	Limit (V)	4.50	¢	4.50		-	0.00	\$	0.00		*
Nsamples	1	~	1	~	1	~	1	~	Nsamples	1	~	1		~	1	~	1		~
Enable Alert									Enable Alert										
Alert 1									Alert 1										
Alert 2									Alert 2										
OVER POWER									GENERAL ALER	TS									
	CH1		CH2		CH3		CH	4			Acc Ov	erflow		Ac	c Count		Alert	CC	
Limit (W)	0.000	-	0.000	÷	0.000	\$	0.000	-											_
Nsamples	1	~	1	~	1	~	1	~	Enable Alert										
Enable Alert									Alert 1									1	
Alert 1													_		_				
Alart 2									Alert 2								Г	1	

FIGURE 3-26: Alerts Config Tab.

PAC1952-2 Evaluation Board User's Guide

In the PAC194x/PAC195x Demo Application window, click **Start Acquisition**. The CHANNEL ALERTS are set based on the setup in the **Alerts Config** tab and will be green when the calculated values are within the limits, and red when the values exceed the limits.

ttings Heip vice: PΔC1952-2 (0x2)	0) - SN000045315: -	Stop A	cauisition	Log to file Op	en Last Log 🚺	Show Plots	🐟 Refresh		Refresh	Type Refresh
no Configuration Alert	s Config 12C Script					2	2			.ype neresi
RODUCT ID		CHANNEL	ALERTS					DEVICE ALERT	rs	
AC1952_2 (0x20) - SN00	00453153		Over Current	Under Current	Over Voltage	Under Voltage	Over Power	Acc	Count	Any Alert
EMO SETTINGS		CUI						Overnow	Overnow	
Nerage Sampling	Defeats a start (see)	CHI								-
Average N Samples:	30 V	CH2	۲	۲	۲	۲	۲	SLOW PIN TR	ANSITIONS	
1	30 .	CH3	۲	۲	۲	۲	۲	Low to High	High to Low	Slow
iPIO Status ilow 1: - G	PIO2: High	CH4	۲	۲	۲	۲	۲		۲	۲
EAL DATA	L	Ch2			Ch2			-Ch4		
Vbus (V)	5.1646	Vbus (V)		2.4453	Vbus (V)		8.9999	Vbus (V)		8.9999
Vbus Avg (V)	5.1641	Vbus Avg	V)	2.4429	Vbus Avg	V)	8.9999	Vbus Avg (V)		8.9999
Vsense (mV)	0.0443	Vsense (m	v)	17.9886	Vsense (m	v)	99.9985	Vsense (mV)		99.9985
Vsense Avg (mV)	0.0015	Vsense Av	g (mV)	17.9932	Vsense Av	g (mV)	99.9985	Vsense Avg (m)	/)	99.9985
Current (mA)	0.0044	Current (m/	A)	9.4181	Current (m)	A)	21.2763	Current (mA)	24	,999.6173
Current Avg (mA)	0.0002	Current Av	g (mA)	9.4205	Current Av	g (mA)	21.2763	Current Avg (mA	A) 24	,999.6173
Power (W)	0.0000	Power (W)		0.0230	Power (W)		00	Power (W)		00
Accumulator (W)	0.0000	Accumulate	or (W)	0.3857	Accumulat	or (W)	00	Accumulator (W)	00
Energy (pWh)	0.0000	Energy (pV	Vh)	0.1632	Energy (pV	Vh)	0.0000	Energy (pWh)		0.0000
Count	207	Count		207	Count		207	Count		207
Sense resistor (mOhm)	10000	Sense resist	or (mOhm)	1910	Sense resist	or (mOhm)	4700	Sense resistor (n	nOhm)	4

FIGURE 3-27:

Note that Any Alert (top right corner) is also green. This signifies that alerts are not sensed. If you lower the voltage that is applied to the SENSE1+ to 0.0V (under the previous limit of 4.5V), the limit fails and the Under Voltage alert is red, as well as Any Alert. The V_{SENSE} value in the REAL DATA section will show 0.0V. See Figure 3-28.

Limits Set.

ettings Help	Chicoco (5315)	Chan A	andatan 🖂	1 + - 61- O-	a fast an UN	Chan Diata	Pafaah		Defease	True D.C. I
10 Configuration Alex	a Confin 12C Soriet	July 2000 H		Log to file Op		Show Plots	- Keiresn		Keiresn	type Kerresh
RODUCT ID	is coming ize script	CHANNEL	ALERTS					DEVICE ALERT	rs	
PAC1952_2 (0x20) - SN00	00453153		Over Current	Under Current	Over Voltage	Under Voltage	Over Power	Acc	Count	Any Alert
EMO SETTINGS		0.14						Overriow	Overnow	
Average Sampling Display Values	Defensible and and (ma)	СНІ				-		•		-
Average N Samples:	30 V	CH2	۲	۲	۲	۲	۲	SLOW PIN TRANSITIONS		
1	30	СНЗ	۲	۲	۲	۲	۲	Low to High	High to Low	Slow
GPIO Status Glow 1: - C	SPIO2: High	CH4	۲	۲	۲	۲	۲	۲	•	۲
REAL DATA		Ch2			-Ch3			Ch4		
Vbus (V)	0.0000	Vbus (V)		2.4443	Vbus (V)		8,9999	Vbus (V)		8,9999
Vbus Avg (V)	0.0015	Vbus Avg	(V)	2.4453	Vbus Avg (V)	8,9999	Vbus Avg (V)		8.9999
Vsense (mV)	0.0305	Vsense (m	V)	0.0610	Vsense (m	0	99,9985	Vsense (mV)		99.9985
Vsense Avg (mV)	0.0031	Vsense Av	/g (mV)	0.0717	Vsense Av	g (mV)	99.9985	Vsense Avg (m)	V)	99.9985
Current (mA)	0.0031	Current (m	A)	0.0320	Current (m/	A)	21.2763	Current (mA)	24	,999.6173
Current Avg (mA)	0.0003	Current Av	rg (mA)	0.0375	Current Av	g (m.A)	21.2763	Current Avg (m.A	A) 24	,999.6173
Power (W)	0.0000	Power (W)	0.0001	Power (W)		00	Power (W)		00
Accumulator (W)	0.0000	Accumula	tor (W)	4.1040	Accumulate	or (W)	00	Accumulator (W	0	00
Energy (pWh)	0.0000	Energy (p)	Wh)	1.7371	Energy (pV	/h)	0.0000	Energy (pWh)		0.0000
Count	196	Count		196	Count		196	Count		196
Sense resistor (mOhm)	10000	Sense resis	tor (mOhm)	1910	Sense resist	or (mOhm)	4700	Sense resistor (r	nOhm)	4

FIGURE 3-28:

Limits Failing.

3.2.7 Scenario 4: Go Fast

The PAC1952-2 default sampling rate is 1024 SPS and it can sample all channels (and offset correction) at that rate. In order to sample faster than that rate, the Fast and Burst options are available. Reducing the number of channels sampled leads to an increase in the sampling speed for the remaining channels, up to 5120 SPS (see the data sheet for a detailed explanation). The MCP2221A cannot support the communication speeds necessary to capture all the data, so an alternative Host is required to capture the data.

Select the **Configuration** tab, set the Sample Mode to Fast and disable CH2. You can see the results in the CONTROL REGISTER ON REFRESH section. Sample at a Fast rate of 2560 SPS (because you are still doing offset correction). To go to the full 5120 SPS, select Burst from the Sample Mode drop-down menu.

The chip is now in that mode, the GUI is not capturing/refreshing the data until you **Start Acquisition**. When you **Start Acquisition**, you can see the count going up faster than the previous settings.

		sox Demo Application										
ettin	gs Help						. Do a	n. 100 n				
evice	PAC1952	_2 (0x20) - SN0000453	58 👻 🕨 S	tart Acquisition	log to fi	le <u>Open Last</u>	Log K Shov	w Plots 🍲 Refresh			Refresh lype	Refresh
emo	Configuration	n Alerts Config 12C Se	ript									
PAC			EULL SI					SMBLIS	REGISTER LIST			
			1022 3.	CUI	CUD	CUD	CUA		Save Register List		Import Re	gister List
Sam	ple Mode	Fast	×	СПІ			CH4	- POR	Name	Addr	Data	Save ^
	CH1	CH3 CH3 CH	(mV)	0-100mV ~	0-100mV ~	0-100mV ~	0-100mV ~	NO SKIP	Refresh	0x00	0x00	
~			+ Vbus	0-32V ~	0-32V ~	0-32V ~	0-32V ~		Control	0x01	0xA770	
Disa			(V)						Acc Count	0x02	0x783	
GPI	0	ALED.	-n	SLO	W Pin	EALLING	EDGE		Vacc1 Acc	0x03	0x329	
Se		/ V Set As	GPIO input		ING EDGE	FALLING Enab	e Refrech	BYTE COUNT	Vacc2 Acc	0×04	0x27DF971	
	Linh (an io nipar		Enable Neiresn		le Defrech V		Vacc3 Acc	0x05	0xFFFFFFF	
	nigri 🔘		gn 🕕 Low		Enable Refresh_		e helfesh_v		Vacc4 Acc	0x06	0xFFFFFFF	
FSR	ON REFRES	н		CONTROL	REGISTER ON	REFRESH	ACC C	ONFIGURATION	Vbus1	0x07	0x01	
		LAT	ACT		LAT	ACT	CH1 V	/nower 🗸	Vbus2	0x08	0x138E	
				Sample Mo	de 1024sps-/	AC Fast		pono.	Vbus3	0x09	0xFFFF	
	Vsense	unidir	unidir			~	CH2 \	/power ~	Vbus4	0x0A	0xFFFF	
CH1					1 Class						0-00	
CH1	Vbus	unidir	unidir	GPIO Pir	1 Slow	Slow	СНЗ 🚺	/power V	Vsense1	0x0B	uxuu	
CH1	Vbus	unidir	unidir	GPIO Pir GPIO Pir	1 Slow 12 Input	Input	СНЗ	/power ~	Vsense1 Vsense2	0x0B 0x0C	0x00	
CH1	Vbus Vsense	unidir	unidir unidir	GPIO Pir GPIO Pir Inactive (n1 Slow n2 Input Ch 2,3,4	2,3,4	СН3 1	/power ~	Vsense1 Vsense2 Vsense3	0x0B 0x0C 0x0D	0x2D 0xFFFF	
CH1 CH2	Vbus Vsense Vbus	unidir unidir unidir	unidir unidir unidir	GPIO Pir GPIO Pir Inactive (11 Slow 12 Input Ch 2,3,4	Input 2,3,4	CH3 \ CH4 \	/power V	Vsense1 Vsense2 Vsense3 Vsense4	0x0B 0x0C 0x0D 0x0E	0x2D 0xFFFF 0xFFFF	
CH1 CH2	Vbus Vsense Vbus	unidir unidir unidir	unidir unidir unidir	GPIO Pir GPIO Pir Inactive (ACCUMUL	11 Slow 12 Input Ch 2,3,4 ATOR CONFIG	Input 2,3,4	CH3 CH4 CH4 CH4 CH4 CH4	/power Vpower VULLNESS LIMITS	Vsense1 Vsense2 Vsense3 Vsense4 Vbus1 Avg	0x0B 0x0C 0x0D 0x0E 0x0F	0x2D 0xFFFF 0xFFFF 0x00	
CH1 CH2 CH3	Vbus Vsense Vbus Vsense	unidir unidir unidir unidir	unidir unidir unidir unidir	GPIO Pir GPIO Pir Inactive (n1 Slow n2 Input Ch 2,3,4 LATOR CONFIG LAT	2,3,4	CH3 CH4 CH4 CH4 CH4 CH1	/power V /power V ULLNESS LIMITS 15/16 full V	Vsense1 Vsense2 Vsense3 Vsense4 Vbus1 Avg Vbus2 Avg	0x0B 0x0C 0x0D 0x0E 0x0F 0x10	0x2D 0xFFFF 0xFFFF 0x00 0x138C	
СН1 СН2 СН3	Vbus Vsense Vbus Vsense Vbus	unidir un	unidir unidir unidir unidir unidir	GPIO Pir GPIO Pir Inactive (ACCUMUL CH1	n1 Slow n2 Input Ch 2,3,4 ATOR CONFIG LAT Vpower	ACT	ACC FI CH1 CH2 CH2	/power Vpower VULLNESS LIMITS 15/16 full V 15/16 full V	Vsense1 Vsense2 Vsense3 Vsense4 Vbus1 Avg Vbus2 Avg Vbus3 Avg	0x0B 0x0C 0x0D 0x0E 0x0F 0x10 0x11	0x2D 0xFFFF 0xFFFF 0x00 0x138C 0xFFFF	
СН1 СН2 СН3	Vbus Vsense Vbus Vsense Vbus	unidir un	unidir unidir unidir unidir unidir	GPIO Pir GPIO Pir Inactive (ACCUMUL CH1 CH2	n1 Slow n2 Input Ch 2,3,4 LATOR CONFIG LAT Vpower Vpower	ACT Vpow Vpow	CH3 CH3 CH4	Vpower Vpower ULLNESS LIMITS 15/16 full 15/16 full 15/16 full	Vsense 1 Vsense 2 Vsense 3 Vsense 4 Vbus 1 Avg Vbus 2 Avg Vbus 3 Avg Vbus 4 Avg	0x0B 0x0C 0x0D 0x0E 0x0F 0x10 0x11 0x12	0x00 0x2D 0xFFFF 0xFFFF 0x00 0x138C 0xFFFF 0xFFFF	
СН1 СН2 СН3	Vbus Vsense Vbus Vsense Vbus Vsense	unidir un	unidir unidir unidir unidir unidir unidir	GPIO Pir GPIO Pir Inactive (ACCUMUL CH1 CH2	n1 Slow n2 Input Ch 2,3,4 ATOR CONFIG LAT Vpower Vpower	ACT ACT Vpow Vpow	ACC FI CH3 CH4 CH4 CH1 CH1 CH1 CH2 er CH3 cH4	Vpower Vpower ULLNESS LIMITS 15/16 full 15/16 full 15/16 full 15/16 full	Vsense 1 Vsense 2 Vsense 3 Vsense 4 Vbus 1 Avg Vbus 2 Avg Vbus 3 Avg Vbus 4 Avg Vsense 1 Avg	0x0B 0x0C 0x0D 0x0E 0x0F 0x10 0x11 0x12 0x13	0x00 0x2D 0xFFFF 0x00 0x138C 0xFFFF 0xFFFF 0x00	
СН1 СН2 СН3 СН4	Vbus Vsense Vbus Vsense Vsense	unidir un	unidir unidir unidir unidir unidir unidir	GPIO Pir GPIO Pir Inactive (ACCUMUL CH1 CH2 CH3	n1 Slow n2 Input Ch 2,3,4 ATOR CONFIG LAT Vpower Vpower	ACT ACT Vpow Vpow	ACC FI CH3 CH4 CH4 CH1 CH1 CH1 er CH2 er CH3 er CH4	Vpower Vpower ULLNESS LIMITS 15/16 full 15/16 full 15/16 full 15/16 full	Vsense1 Vsense2 Vsense3 Vsense4 Vbus1 Avg Vbus2 Avg Vbus3 Avg Vbus4 Avg Vsense1 Avg Vsense2 Avg	0x0B 0x0C 0x0D 0x0E 0x0F 0x10 0x11 0x12 0x13 0x14	0x2D 0xFFFF 0xFFFF 0x00 0x138C 0xFFFF 0xFFFF 0x00 0x30	

FIGURE 3-29:

Sample Mode: Fast.



PAC1952-2 EVALUATION BOARD USER'S GUIDE

Chapter 4. Hardware Description

4.1 INTRODUCTION

The PAC1952-2 is placed at the center of the board, in a quad flat no-lead package (QFN) with wettable flanks; U1. It is surrounded by probe points with the pin names labeled. There is a provision for an input filter for each pair on the input pins, but these are not populated. The other hardware on the board is described below.

Initial samples will be provided with a Plug-In Module (PIM) that allows easy changing of parts and the update of parts as needed.



FIGURE 4-1:

PAC1952-2 Evaluation Board.

4.2 DEMO MODE AND EVB MODE

The EVB mode is designed to allow an easy demonstration of the board or to be used in a normal evaluation of the four channel inputs. In Demo mode, the inputs are connections to different sense resistors, compared to the EVB mode. They are configured as in Table 4-1.

TABLE 4-1:	DEMO VS.	EVB S	SENSE	RESISTOR	VALUES

Channel Demo		EVB (Headers)
1	R100 = 4 mΩ	R100 = 4 mΩ
2	R104 = 1.9Ω (Demo signal)	R101 = 4 mΩ

The EVB sense resistors are connected to the headers on the edge of the board labeled CH1 (J100), CH2 (J102), CH3 (J103) and CH4 (J107). CH4 is connected to the header in the Demo and EVB configuration. The center pin for each header is Ground to allow easy testing but it is not required to use it.

To change from Demo mode to EVB mode (and back), the following 0Ω resistors must be populated as per Table 4-2.

TABLE 4-2: DEMO VS. EVB SETUP PER CHANNEL

Channel	Demo	EVB		
1	No Change	No Change		
2	R108 and R109 populated R107 and R110 not populated	R108 and R109 not populated R107 and R110 populated		

Figure 4-2 shows the configurations for the Demo and EVB setups.



FIGURE 4-2: Demo and EVB Configuration.

4.3 DEFAULT CONNECTIONS

In Section A.2 "Board – Schematic 1", the USB connector is at the top. This is the default (as shipped) position of the shorting shunts that connect the different pin pairs. SW300 must be set to the bridge position for the USB communication to work properly. SW301 must be switched to Extern for the initial evaluation. A jumper must be on J112 to operate.

4.4 V_{BUS} AND V_{SENSE} CONNECTIONS – USING EXTERNAL SOURCES FOR SYSTEM MODE

To use external sources for V_{BUS} with an external load, the board must be used in the EVB configuration discussed above. The center terminal of each connector is connected to ground for a convenient return connection for the load. Each PAC1952-2 channel has an on-board current sense resistor of 4 m Ω connected between the positive (+) input and the negative (-) input pins, which gives 25A for the full-scale current.

The 4 m Ω resistors can be unsoldered and replaced with a different value at the discretion of the user. The 4 m Ω resistors have very wide metal connecting each end to terminals 1 and 3 of the connector block and it is challenging to remove them cleanly. If they are removed, they will reveal a layout that facilitates soldering this wide metal connection to each end of the new sense resistor and a Kelvin connection for each end that goes to the inputs of the PAC1952-2. Both the wide metal to the connector block and the Kelvin connection need to be soldered to the new sense resistor.

4.5 ADDRESS SELECTION

The PAC194X/5X devices can have up to 16 different I^2C addresses based on the resistor connected to the ADDR_SEL pin (see the data sheet). The EVB has resistors on board that allow the user to select up to four different addresses based on the resistors on board. The default resistor setup is grounded which results in an address of 20h (10h for a 7-bit address). Table 4-3 shows the hardware setting for each address.

Setup	R125	R127	R129	8-bit Address
1	POP	DNP	DNP	20h (default)
2	DNP	POP	DNP	2Eh
3	DNP	DNP	POP	2Ch
4	DNP	POP	POP	2Ah
Generic	DNP	DNP	DNP	Various: connect the desired resistor to the ADDR PIM connection and connect to ground.

TABLE 4-3: ADDR_SEL PIN OPTIONS

PAC1952-2 Evaluation Board User's Guide



4.6 HARDWARE FOR I²C/SMBUS COMMUNICATION OVER USB OR EXTERNAL I²C CONNECTION

U300 is an MCP2221 USB-2 to I²C bridge chip that translates the USB communications into I²C read/write commands to configure the PAC1952-2 and to capture status and results data. To the left of U300 there is U301, a level shifter that matches the I²C signals from the MCP2221 to the V_{IO} voltage used for the PAC1952-2 V_{DD}. On the far right side of the board, there is a SW300 switch and a J303 connector. These are both used when connecting an external I²C connection directly to the board instead of using the USB connection. J303 allows the user to connect the external V_{IO}, SCA and SCL signals directly to the PAC1952-2. SW300 disables the USB bridge and level shifter and connects the pull-up resistors on the SCA and SCL pins to the external V_{IO} voltage.

SW301 is used to select the SLOW and POWER-DOWN pins to either the MCP2221A (bridge selection) or the J303 (external selection).

4.7 SIGNAL DESCRIPTION IN DEMO MODE

In Demo mode, the signals measured are:

- Channel 1: Edge Connector
- Channel 2: PAC1952-2 Demo signal 1.91Ω
 - a) A pulsed waveform using the DAC to control the current level.
 - b) Enable the DAC and change the value to 1.0, 2.0, 3.0 to see different current levels.

All the plots in the GUI description above are made in the default Demo mode configuration using varied DAC settings.

4.8 ADDITIONAL HARDWARE DETAILS

The J112 jumper is available for the use of an external meter to measure the I_{DD} . This provides a place to remove the short and insert a current meter to measure the current in the PAC1952-2 I_{DD} .

4.9 DIRECT EXTERNAL I²C CONNECTION

The EV99K19A can be used with direct I²C control from a PC running Windows[®], Linux[®] or other digital controller. For external I²C use, V_{DD} may need a voltage that is different from the default settings for USB control. This is easily implemented by moving SW300 from the bridge position used for USB control to the external position used for external I²C control. Connecting the external SCA and SCL signals is then required, along with the power (V_{IO}) and ground used for these I²C signals. The PAC194x5x Demo Application cannot be used with direct I²C connection.

NOTES:



PAC1952-2 EVALUATION BOARD USER'S GUIDE

Appendix A. Schematic and Layouts

A.1 INTRODUCTION

This appendix contains the following schematics and layouts for the PAC1952-2 Evaluation Board:

- Board Schematic 1
- Board Schematic 2
- Board Schematic 3
- Board Top Silk
- Board Top Copper and Silk
- Board Top Copper
- Board Bottom Silk
- Board Bottom Copper and Silk

A.2 BOARD – SCHEMATIC 1



GND

I2C pull-ups

SDA

Address Selection

DEP DR

R127 8.45k 0603 1%

₹R124 0R 0603

R125 0R 0603

 $\begin{array}{ccc} VIO & VIO \\ \Delta & \Delta \end{array}$

R128 4.7k 0603 1% R13 4.7k 0603 1%

ADDR

DNP DR

> ₹R130 5.23K 0603 1%

A.3 BOARD – SCHEMATIC 2



A.4 BOARD – SCHEMATIC 3



A.5 BOARD - TOP SILK



A.6 BOARD – TOP COPPER AND SILK



© 2023 Microchip Technology Inc. and its subsidiaries

PAC1952-2 Evaluation Board User's Guide

A.7 BOARD – TOP COPPER



A.8 BOARD – BOTTOM SILK



A.9 BOARD – BOTTOM COPPER AND SILK



NOTES:



PAC1952-2 EVALUATION BOARD USER'S GUIDE

Appendix B. Bill of Materials (BOM)

Qty.	Reference	Description	Manufacturer	Part Number
0	C100, C101	DO NOT POPULATE , Ceramic capacitor, 10000 pF, 50V, 20%, X7R, SMD, 0603	Kyocera AVX	06035C103KAT2A
1	C102	Ceramic capacitor, 2.2 µF, 10V, 10%, X7S, SMD, 0402	TDK Corporation	C1005X7S1A225K050BC
1	C103	Ceramic capacitor, 0.1 µF, 16V, 10%, X7R, SMD, 0402	Wurth Elektronik	885012205037
1	C200	Ceramic capacitor, 10000 pF, 25V, 10%, X7R, SMD, 0603	Samsung Electro-Mechanics America, Inc.	CL10B103KA8NNNC
7	C201, C300, C301, C303, C305, C306, C307	Ceramic capacitor, 0.1 μF, 16V, 10%, X7R, SMD, 0603	Taiyo Yuden Co., Ltd.	ЕМК107В7104КА-Т
2	C302, C304	Ceramic capacitor, 4.7 µF, 10V, 10%, X5R, SMD, 0805	Samsung Electro-Mechanics America, Inc.	CL21A475KPFNNNE
1	CBL1	Mechanical, hardware, cable USB, Male-A to Male Micro-B, clear 4	Dongguan ZhanXin Electronic Technology Co., Ltd.	A006ZX027
2	D100, D101	Diode, red LED, 2V, 20 mA, 25 mcd, clear, SMD, 0603	Wurth Elektronik	150060RS75000
1	D300	Diode, green LED, 3.2V, 20 mA, 430 mcd, clear, SMD, 0603	Wurth Elektronik	150060GS75000
1	FB300	Ferrite, 2A, 220R, SMD, 0805	Murata Manufacturing Co., Ltd.	BLM21PG221SN1D
4	J100, J101, J102, J103	Connector, terminal, 5 mm, 1x3, Female, 12-30AWG, 16A, Through-Hole, R/A	Wurth Elektronik	691137710003
1	J104	Connector, header-2.54, Male, 2x3, gold, 5.84 MH, Through-Hole, vertical	Samtec, Inc.	TSW-103-07-G-D
4	J105, J107, J112, J302	Connector, header-2.54, Male, 1x2, Gold, 5.84 MH, Through-Hole, vertical	Multicomp Inc.	SPC20481
1	J106	Connector, header-2.54, Male, 2x4, gold, 5.84 MH, Through-Hole, vertical	Wurth Elektronik	61300821121
0	J108, J109, J110, J111	DO NOT POPULATE , Connector, header-2.54, Female, 1x4, gold, Through-Hole, vertical	Samtec, Inc.	SSW-104-01-G-S
1	J300	Connector, USB 2.0, Micro-B, Female, SMD, R/A	Amphenol ICC (FCI)	10118193-0001LF

TABLE B-1: BILL OF MATERIALS (BOM)

Note 1: The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.

Qty.	Reference	Description	Manufacturer	Part Number
1	J301	Connector, header-2.54, Female, 1x2, gold, Through-Hole, vertical	Samtec, Inc.	SSW-102-01-T-S
0	J303	DO NOT POPULATE , Connector, header-2.54, Female, 2x6, gold, Through-Hole, R/A	Sullins Connector Solutions	PPPC062LJBN-RC
5	JP1, JP2, JP3, JP4, JP5	Mechanical, hardware, jumper, 2.54 mm, 1x2 handle, gold	TE Connectivity, Ltd.	881545-2
1	LABEL1	Label, PCBA, 18x6 mm, Datamatrix Assy#/Rev/Serial/Date	ACT Logimark AS	505462
1	LABEL2	Label, assy. with rev level (Small Modules) per MTS-0002		
4	PAD1, PAD2, PAD3, PAD4	Mechanical, hardware, rubber pad, cylindrical, D7.9, H5.3, black	3M	70006431483
1	PCB1	PAC1952-2 Evaluation Board – Printed Circuit Board	Microchip Technology Inc.	04-11184-R2
1	Q200	Transistor FET N-Channel, 20V, 1.9A, 625 mW, SOT-23-3	Diodes Incorporated [®]	ZXMN2A01FTA
2	R100, R101	Resistor, Shunt MF, 0.004R, 1%, 2W, 2512	Stackpole Electronics, Inc.	CSNL2512FT4L00
3	R102, R105, R118	Resistor, Thick Film, 100 kΩ, 1%, 1/10W, SMD, 0603	TE Connectivity, Ltd.	1622827-1
2	R103, R106	Resistor, Thick Film, 49.9 kΩ, 1%, 1/10W, SMD, 0603	Panasonic [®] - ECG	ERJ-3EKF4992V
1	R104	Resistor, Thick Film, 1.91R, 1%, 1/10W, SMD, 0603, AEC-Q200	Stackpole Electronics, Inc.	RMCF0603FT1R91
0	R107, R110, R126, R129	DO NOT POPULATE , Resistor, Thick Film, 0R, 1/10W, SMD, 0603	Stackpole Electronics, Inc.	RMCF0603ZT0R00
9	R108, R109, R111, R112, R115, R116, R124, R125, R304	Resistor, Thick Film, 0R, 1/10W, SMD, 0603	Stackpole Electronics, Inc.	RMCF0603ZT0R00
2	R113, R114	Resistor, Thick Film, 150 kΩ, 1%, 1/8W, SMD, 0603	KOA Speer Electronics, Inc.	SG73S1JTTD1503F
5	R117, R120, R121, R123, R305	Resistor, Thick Film, 10 kΩ, 1%, 1/10W, SMD, 0603	Yageo Corporation	RC0603FR-0710KL
0	R119	DO NOT POPULATE , Resistor, Thick Film, 10 kΩ, 1%, 1/10W, SMD, 0603	Yageo Corporation	RC0603FR-0710KL
1	R122	Resistor, Thick Film, 1 kΩ, 1%, 1/10W, SMD, 0603	Stackpole Electronics, Inc.	RMCF0603FT1K00
1	R127	Resistor, Thick Film, 8.45 kΩ, 1%, 1/10W, SMD, 0603	Yageo Corporation	RC0603FR-078K45L
6	R128, R131, R200, R301, R302, R303	Resistor, Thick Film, 4.7 kΩ, 1%, 1/10W, SMD, 0603	Vishay/Dale	CRCW06034K70FKEA

TABLE B-1: BILL OF MATERIALS (BOM) ((CONTINUED)
--------------------------------	--------	-------------

Note 1: The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.

Qty.	Reference	Description	Manufacturer	Part Number
1	R130	Resistor, Thick Film, 5.23 kΩ, 1%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ-3EKF5231V
1	R201	Resistor, Thick Film, 100R, 1%, 1/4W, SMD, 1206	Yageo Corporation	RC1206FR-07100RL
1	R300	Resistor, Thick Film, 20 kΩ, 1%, 1/10W, SMD, 0603	Yageo Corporation	RC0603FR-0720KL
2	SW300, SW301	Switch, Slide DPDT, 6V, 300 mA, SMD	C&K Components	JS202011SCQN
2	SW302, SW303	Switch, tactile, SPST, 15V, 20 mA	Panasonic - ECG	EVQ-PAC05R
1	U100	Microchip Analog Power Current Sense Monitor, PAC1952-2, QFN-16	Microchip Technology Inc.	PAC1952T-2E/4MX
1	U200	Microchip Analog Op Amp, 2-Ch, 1.2 MHz, SOIC-8	Microchip Technology Inc.	MCP6072-E/SN
1	U300	Microchip Interface USB I ² C, UART, TSSOP-14	Microchip Technology Inc.	MCP2221A-I/ST
1	U301	IC Interface, 2-bit Voltage Translator/Buffer Micropak-8	ON Semiconductor [®] /Fairchild Semiconductor [®]	FXMA2102L8X
1	U302	Microchip Analog LDO, 3.3V, SOT-23A-3	Microchip Technology Inc.	MCP1754ST-3302E/CB

 TABLE B-1:
 BILL OF MATERIALS (BOM) (CONTINUED)

Note 1: The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.

NOTES:



Worldwide Sales and Service

AMERICAS

Corporate Office 2355 West Chandler Blvd. Chandler, AZ 85224-6199 Tel: 480-792-7200 Fax: 480-792-7277 Technical Support: http://www.microchip.com/ support

Web Address: www.microchip.com

Atlanta Duluth, GA Tel: 678-957-9614 Fax: 678-957-1455

Austin, TX Tel: 512-257-3370

Boston Westborough, MA Tel: 774-760-0087 Fax: 774-760-0088

Chicago Itasca, IL Tel: 630-285-0071 Fax: 630-285-0075

Dallas Addison, TX Tel: 972-818-7423 Fax: 972-818-2924

Detroit Novi, MI Tel: 248-848-4000

Houston, TX Tel: 281-894-5983

Indianapolis Noblesville, IN Tel: 317-773-8323 Fax: 317-773-5453 Tel: 317-536-2380

Los Angeles Mission Viejo, CA Tel: 949-462-9523 Fax: 949-462-9608 Tel: 951-273-7800

Raleigh, NC Tel: 919-844-7510

New York, NY Tel: 631-435-6000

San Jose, CA Tel: 408-735-9110 Tel: 408-436-4270

Canada - Toronto Tel: 905-695-1980 Fax: 905-695-2078

ASIA/PACIFIC

Australia - Sydney Tel: 61-2-9868-6733

China - Beijing Tel: 86-10-8569-7000 China - Chengdu

Tel: 86-28-8665-5511 China - Chongqing Tel: 86-23-8980-9588

China - Dongguan Tel: 86-769-8702-9880

China - Guangzhou Tel: 86-20-8755-8029

China - Hangzhou Tel: 86-571-8792-8115

China - Hong Kong SAR Tel: 852-2943-5100

China - Nanjing Tel: 86-25-8473-2460

China - Qingdao Tel: 86-532-8502-7355

China - Shanghai Tel: 86-21-3326-8000

China - Shenyang Tel: 86-24-2334-2829

China - Shenzhen Tel: 86-755-8864-2200

China - Suzhou Tel: 86-186-6233-1526

China - Wuhan Tel: 86-27-5980-5300

China - Xian Tel: 86-29-8833-7252

China - Xiamen Tel: 86-592-2388138 China - Zhuhai

Tel: 86-756-3210040

ASIA/PACIFIC

India - Bangalore Tel: 91-80-3090-4444

India - New Delhi Tel: 91-11-4160-8631 India - Pune

Tel: 91-20-4121-0141 Japan - Osaka

Tel: 81-6-6152-7160 Japan - Tokyo

Tel: 81-3-6880- 3770 Korea - Daegu

Tel: 82-53-744-4301 Korea - Seoul

Tel: 82-2-554-7200 Malaysia - Kuala Lumpur

Tel: 60-3-7651-7906

Malaysia - Penang Tel: 60-4-227-8870

Philippines - Manila Tel: 63-2-634-9065

Singapore Tel: 65-6334-8870

Taiwan - Hsin Chu Tel: 886-3-577-8366

Taiwan - Kaohsiung Tel: 886-7-213-7830

Taiwan - Taipei Tel: 886-2-2508-8600

Tel: 84-28-5448-2100

Netherlands - Drunen Tel: 31-416-690399

EUROPE

Austria - Wels

Tel: 43-7242-2244-39

Tel: 45-4485-5910

Fax: 45-4485-2829

Tel: 358-9-4520-820

Tel: 33-1-69-53-63-20

Fax: 33-1-69-30-90-79

Germany - Garching

Tel: 49-2129-3766400

Germany - Heilbronn

Germany - Karlsruhe

Tel: 49-7131-72400

Tel: 49-721-625370

Germany - Munich

Tel: 49-89-627-144-0

Fax: 49-89-627-144-44

Germany - Rosenheim

Tel: 49-8031-354-560

Israel - Ra'anana

Italy - Milan

Italy - Padova

Tel: 972-9-744-7705

Tel: 39-0331-742611

Fax: 39-0331-466781

Tel: 39-049-7625286

Tel: 49-8931-9700

Germany - Haan

Finland - Espoo

France - Paris

Fax: 43-7242-2244-393

Denmark - Copenhagen

Fax: 31-416-690340

Norway - Trondheim Tel: 47-7288-4388

Tel: 48-22-3325737

Tel: 40-21-407-87-50

Tel: 34-91-708-08-90 Fax: 34-91-708-08-91

Sweden - Gothenberg Tel: 46-31-704-60-40

Sweden - Stockholm Tel: 46-8-5090-4654

UK - Wokingham Tel: 44-118-921-5800 Fax: 44-118-921-5820

Thailand - Bangkok

Tel: 66-2-694-1351 Vietnam - Ho Chi Minh

Poland - Warsaw

Romania - Bucharest

Spain - Madrid