UCS81003
Evaluation Board
User's Guide

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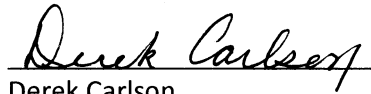
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Derek Carlson

Derek Carlson
VP Development Tools

16-July-2013

Date

NOTES:

UCS81003 EVALUATION BOARD USER'S GUIDE

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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 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 UCS81003 Evaluation Board. Items discussed in this chapter include:

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

DOCUMENT LAYOUT

This document describes how to use the UCS81003 Evaluation Board. The manual layout is as follows:

• **Chapter 1. "Product Overview"** – Important information about the UCS81003 Evaluation Board.
• **Chapter 2. "Installation and Operation"** – Includes instructions on how to configure the board.
• **Chapter 3. "Hardware Description"** – Describes the UCS81003 Evaluation Board features and functionalities.
• **Chapter 4. "Software Description"** – Describes the PC Graphical User Interface that operates the UCS81003 Evaluation Board.
• **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the UCS81003 Evaluation Board.
• **Appendix B. "Bill of Materials"** – Lists the parts used to build the UCS81003 Evaluation Board.

UCS81003 Evaluation Board User's Guide

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

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

	Represents code supplied by user	`void main (void)`
		`{ ...`
		`}`

RECOMMENDED READING

This user's guide describes how to use UCS81003 Evaluation Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

- **UCS81003 Data Sheet -** *"Automotive USB Port Power Controller with Charger Emulation"* **(DS20005334)**
- **MCP2221 Data Sheet -** *"USB 2.0 to I²C™/UART Protocol Converter with GPIO"* **(DS200005292)**
- **AN24.14 -** *"UCS1002 Fundamentals of Custom Charger Emulation"* **(DS200005234)**

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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

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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 (September 2014)

- Initial Release of this Document.

NOTES:

Chapter 1. Product Overview

1.1   INTRODUCTION

This document provides a description of the software and hardware used to evaluate the features of the UCS81003.

1.2   UCS81003 EVALUATION SYSTEM

The evaluation system has several components, as shown in Figure 1-1:

- Customer-provided Windows® PC
- UCS81003 graphical user interface (GUI) program
- UCS81003 Evaluation Board
- USB Cable for GUI communications (Standard-A plug to mini-B plug)
- 5V power source (V_S)
- Customer-provided portable device and OEM USB charging cable (with Standard-A plug at board's end)
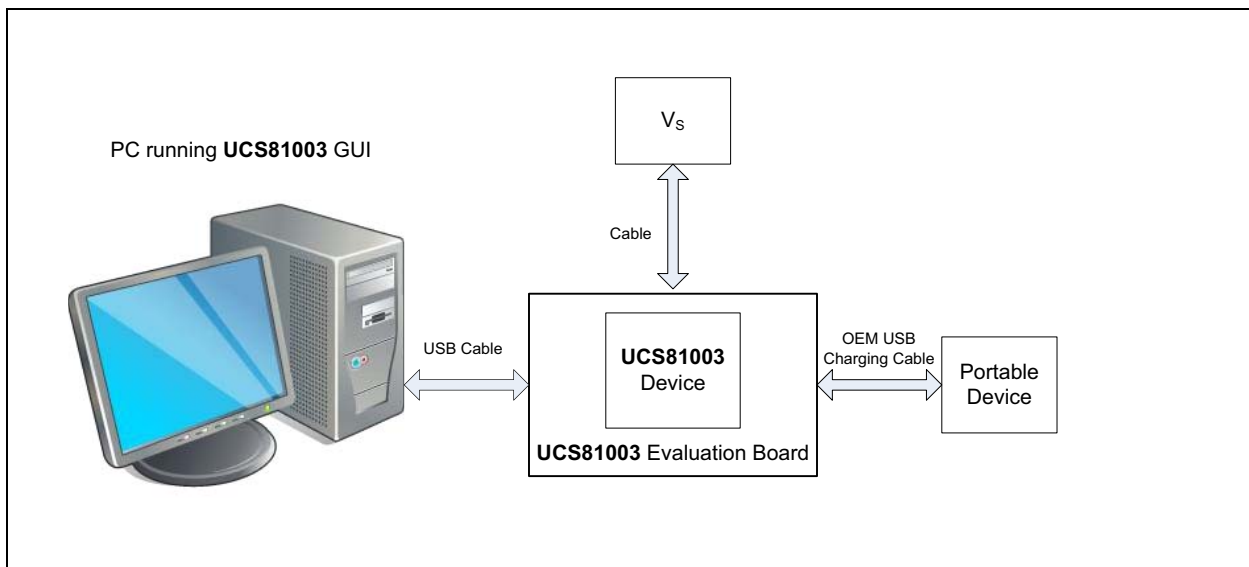
FIGURE 1-1:   *UCS81003 Evaluation System.*

UCS81003 Evaluation Board User's Guide

A block diagram of the UCS81003 Evaluation Board is shown in Figure 1-2 below:
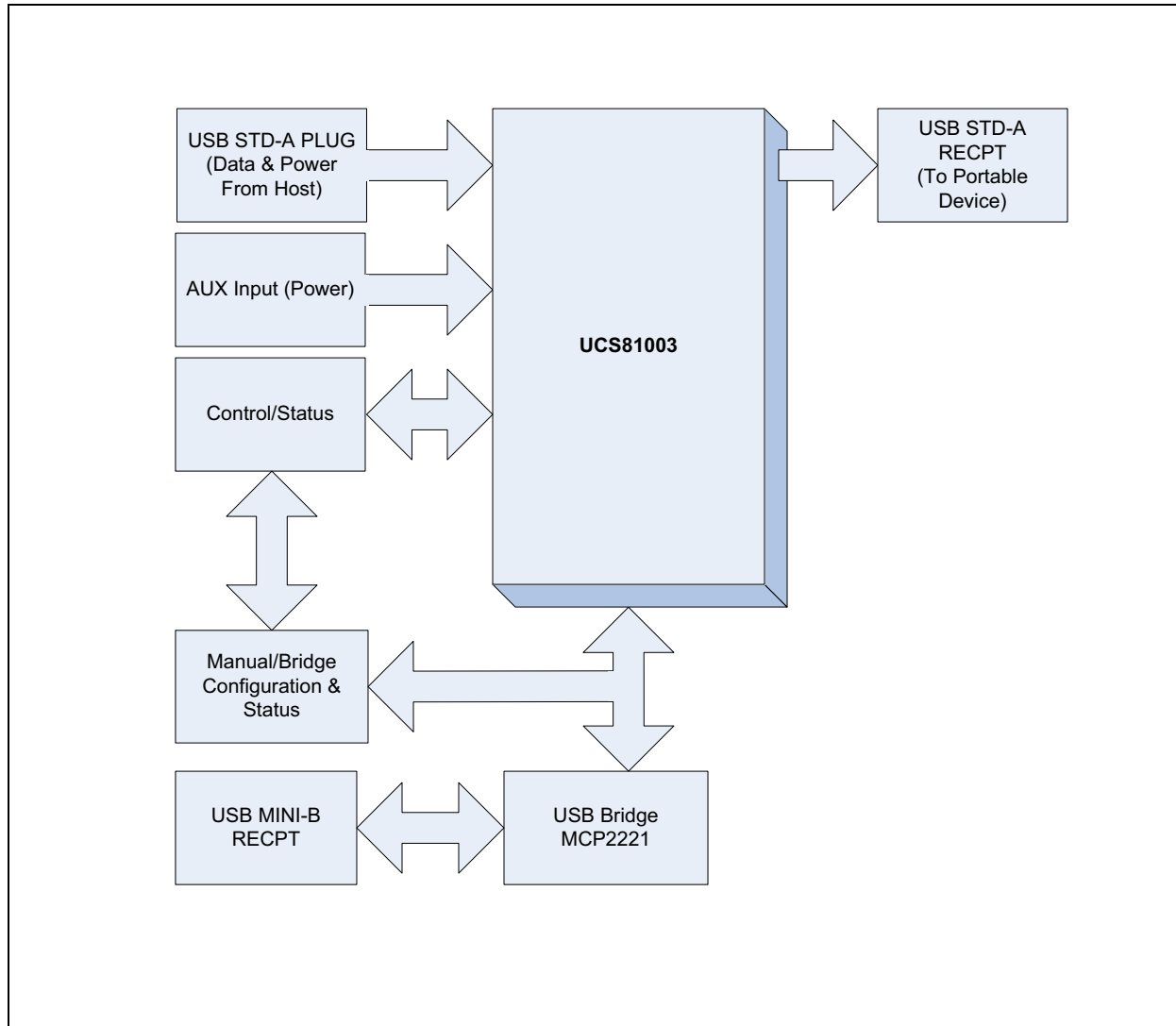
FIGURE 1-2:   *UCS81003 Evaluation Board Block Diagram.*

1.3   WHAT THE UCS81003 EVALUATION BOARD KIT CONTAINS

This UCS81003 Evaluation Board kit includes:

• UCS81003 Evaluation Board (ADM00561)
• Important Information Sheet
• 5V AC-DC Wall Adapter
• Standard-A plug to mini-B plug USB Cable

Chapter 2. Installation and Operation

2.1   INTRODUCTION

This chapter identifies the main connectors, LEDs, jumpers and test points that can be found on the UCS81003 Evaluation Board. It also explains the steps to install the board's graphical user interface.

2.2   CONNECTORS ON THE EVALUATION BOARD

Figure 2-1 shows the top of the evaluation board and highlights the connectors.
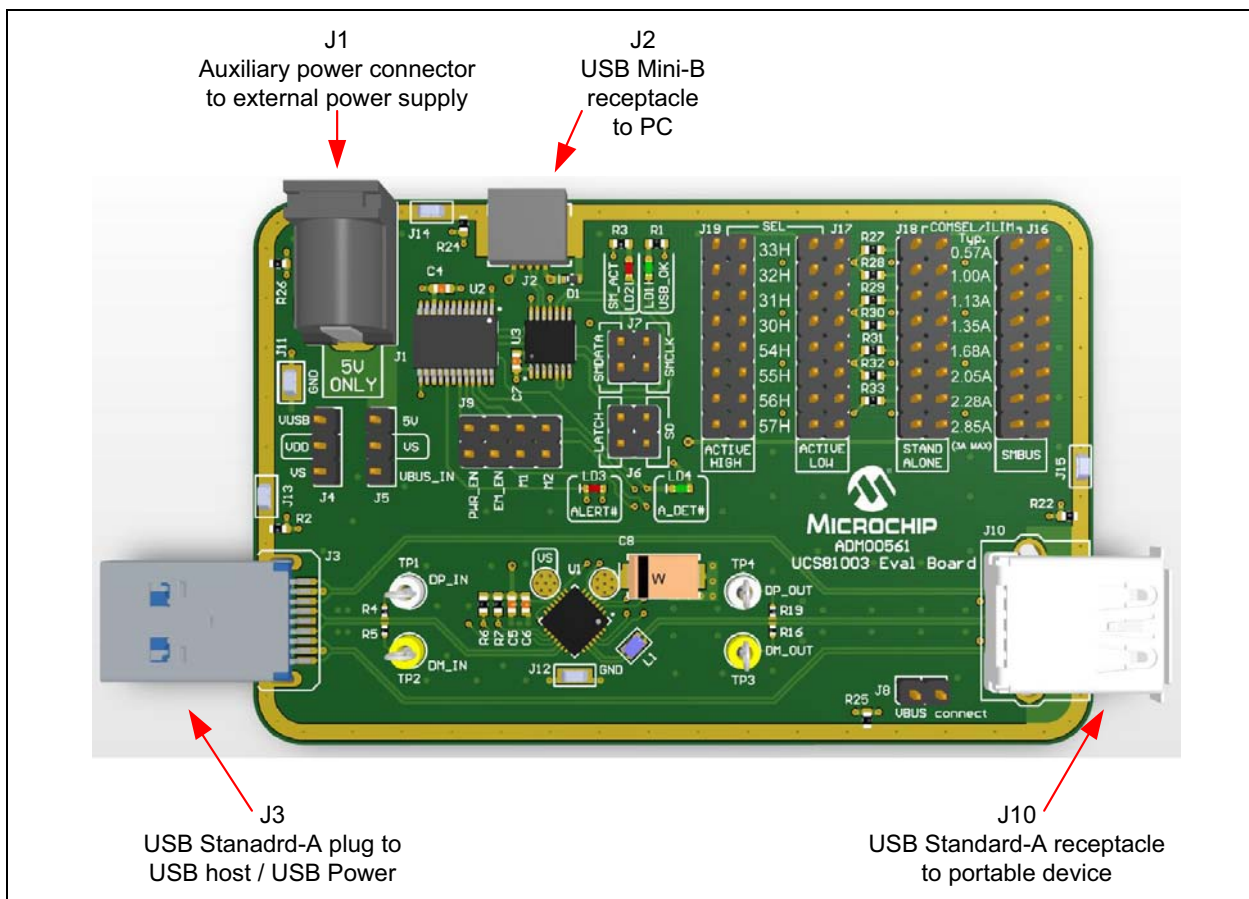
FIGURE 2-1:   *UCS81003 Evaluation Board Top View – Connectors.*

TABLE 2-1:   **CONNECTOR DESCRIPTIONS**

Designator	Connector Type	Description
J1	Power jack	External 5V power supply
J2	USB Mini-B receptacle	This connects the board to the PC with the GUI software
J3	USB Standard-A plug	This connects the evaluation board to the USB host
J10	Right-Angle USB Standard-A receptacle	This connects the board to the portable device

2.3   LEDS ON THE EVALUATION BOARD

Figure 2-2 shows the top of the Evaluation Board and highlights the LEDs.
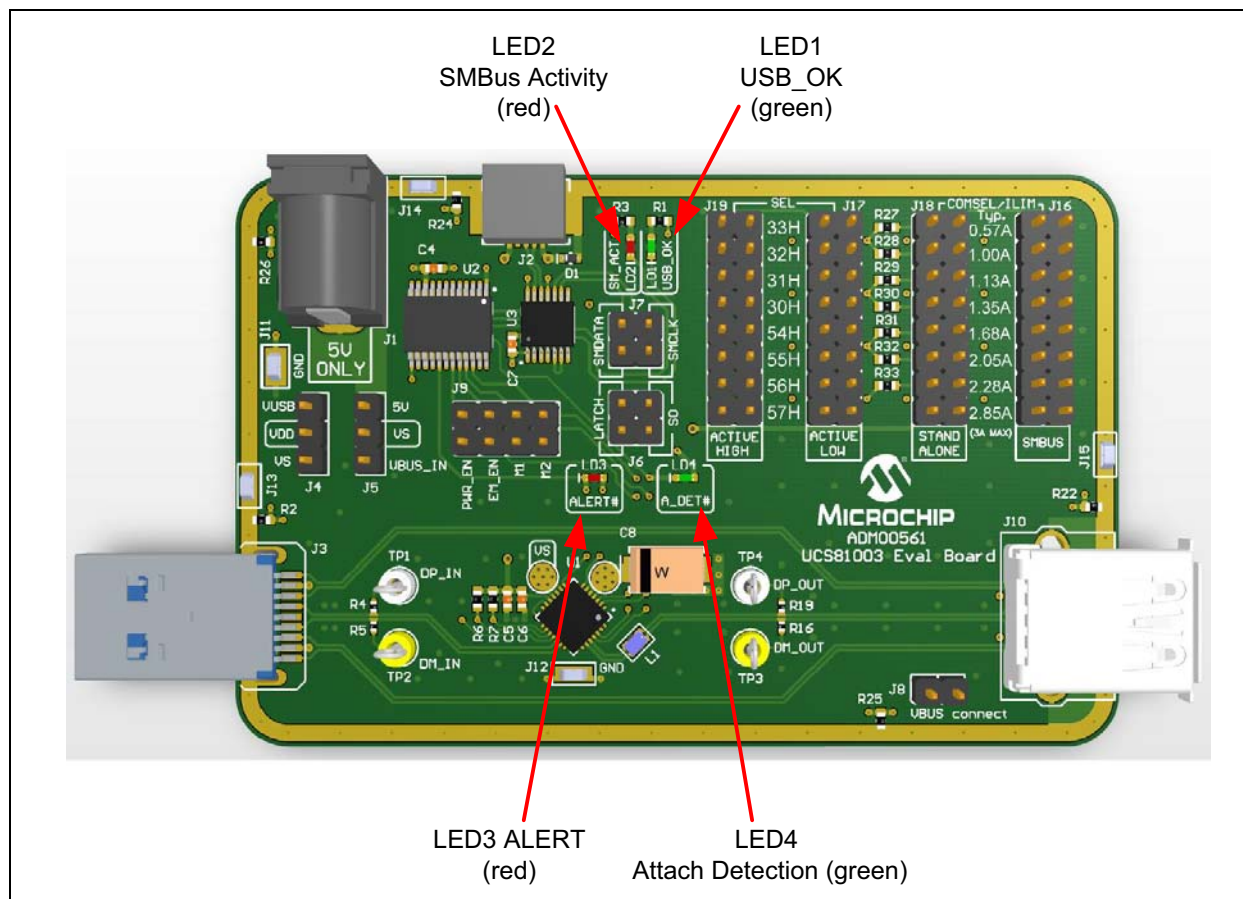
FIGURE 2-2:   *Evaluation Board Top View – LEDs.*

TABLE 2-2:   LED DESCRIPTIONS

Designator	Function	Description
LD1	USB OK	When lit, this green LED means the MCP2221 USB bridge is connected to the PC.
LD2	SMBus Activity	When flashing, this green LED indicates SMBus communication activity.
LD3	ALERT#	When lit, this red LED indicates an alert signal is active.
LD4	A_DET#	When lit, this green LED indicates a device is attached for the UCS81003.

2.4 JUMPERS ON THE EVALUATION BOARD

Figure 2-3 shows the top of the Evaluation Board and highlights the jumpers.
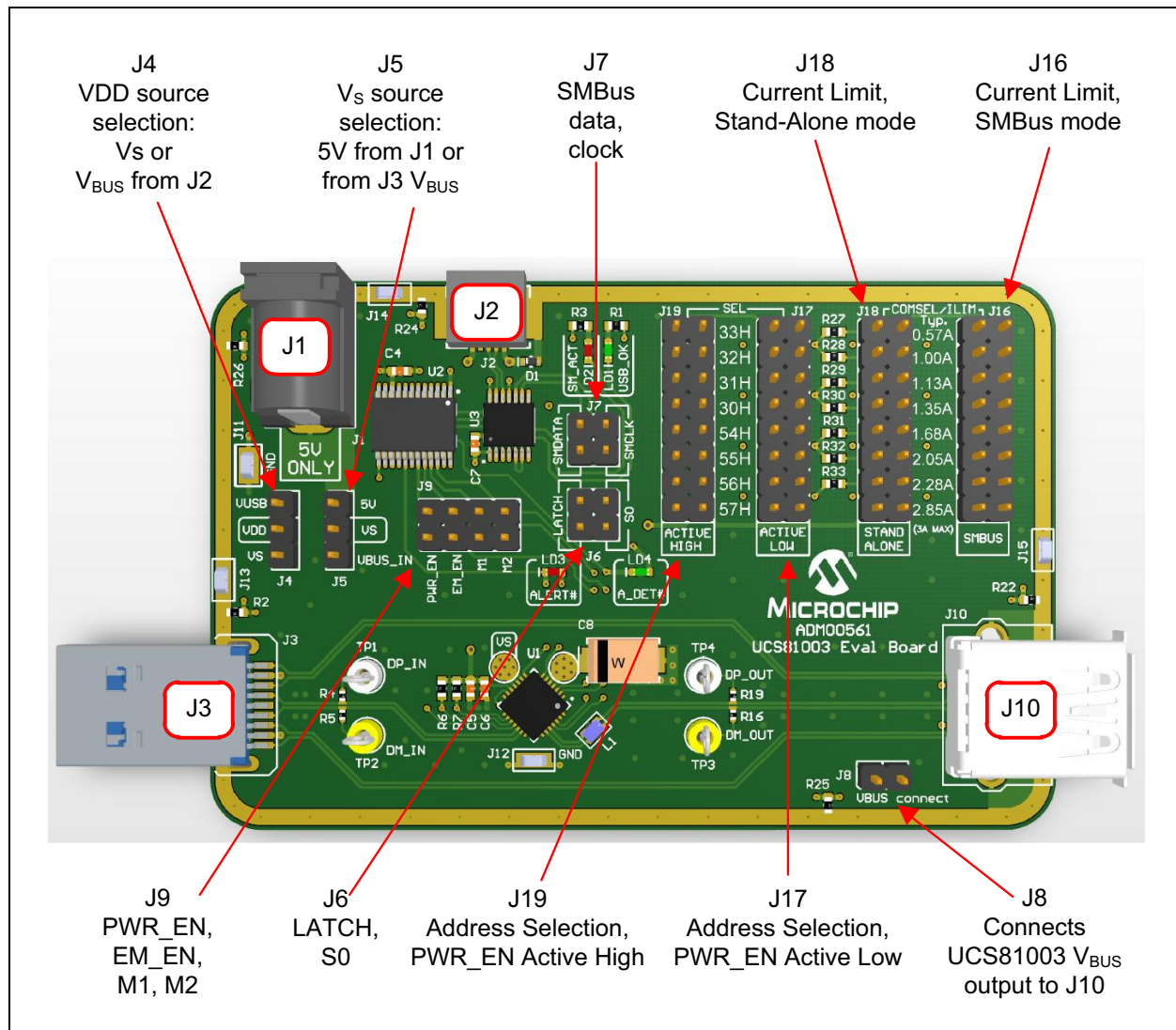
FIGURE 2-3: *Evaluation Board Top View – Jumpers.*

TABLE 2-3: JUMPER DESCRIPTIONS

Designator	Function	Jumper Position	Description
J4	V_{DD} source selection		The jumper populated on this header selects the V_{DD} supply source for the digital circuits on the board.
		1-2	V_{DD} is connected to V_{BUS} pin of the J2 USB connector
		2-3	V_{DD} is connected to V_S. This is the recommended configuration when evaluating the Attach Detection feature of the UCS81003. If the board is evaluated with a PC running the GUI, then the V_S must be supplied after the USB cable is plugged into the J2 connector.

TABLE 2-3:   JUMPER DESCRIPTIONS (CONTINUED)

Designator	Function	Jumper Position	Description
J5	V_S source selection		The jumper populated on this header selects the voltage input source for the power switch inside the UCS81003.
		1-2	V_S source is the J1 power connector (external 5V power supply).
		2-3	V_S is connected to V_{BUS} of the J3 USB connector. Use this configuration only if the USB host can deliver the necessary current for charging.
J6	LATCH, S0 Logic Inputs settings		The jumpers must be left off for SMBus communication to be enabled. If the UCS81003 is in Stand-Alone mode (as selected by using J18 instead of J16), then the header pins have the following functions:
		1-2	Jumper placed S0=Logic Low - Detect Power state disabled No jumper S0=Logic High - Detect Power state enabled
		3-4	Jumper placed LATCH=Logic Low - "Auto-retry" fault handler enabled No jumper LATCH=Logic High - "Latch" fault handler enabled
J7	SMBus data and clock lines		If the UCS81003 is in SMBus mode (as selected by using J16 instead of J18), then two jumpers must be populated in 1-2 and 3-4 positions to connect the clock and data lines to the MCP2221 USB bridge. The jumpers must be left off if UCS81003 is in Stand-alone mode.
J8	V_{BUS} output connection		This jumper connects the 5V pin of connector J10 to the UCS81003 V_{BUS} power output pins. A current probe or a multimeter can be connected to this header for measuring the charging current and the voltage, close to the USB connector.
J9	PWR_EN, EM_EN, M1, M2 Logic Inputs settings		When a jumper is installed, the corresponding UCS81003 input pin will be in Logic Low state. Otherwise, the corresponding pin will be in Logic High state.
		1-2	PWR_EN
		3-4	EM_EN
		5-6	M1
		7-8	M2
J16	Current Limit SMBus mode		Placing one jumper on this header selects the current limit and sets the UCS81003 in SMBus mode. In this case, no jumper must be populated on J18 header.
J18	Current Limit Stand-alone mode		Placing one jumper on this header selects the current limit and sets the UCS81003 in Stand-alone mode. In this case, no jumper must be populated on J16 header.
J17	SMBus Address PWR_EN active low		Placing one jumper on this header selects the SMBus address and sets the PWR_EN control to be active low. In this case, no jumper must be populated on J19 header.

TABLE 2-3: **JUMPER DESCRIPTIONS (CONTINUED)**

Designator	Function	Jumper Position	Description
J19	SMBus Address PWR_EN active high		Placing one jumper on this header selects the SMBus address and sets the PWR_EN control to be active high. In this case, no jumper must be populated on J17 header.

Note: The following headers must be populated with one jumper for the UCS81003 Evaluation Board to be functional:

- J4, J5, J8
- J16 or J18
- J17 or J19
- If UCS81003 is configured in SMBus mode (as selected by using J16 instead of J18), two jumpers must be populated on J7 and J6 must be left unpopulated. If UCS81003 is configured in Stand-Alone mode, the jumpers on J7 must be left off.

2.5   DATA TEST POINTS ON THE EVALUATION BOARD

Figure 2-4 shows the top of the board and highlights the USB data line test points.
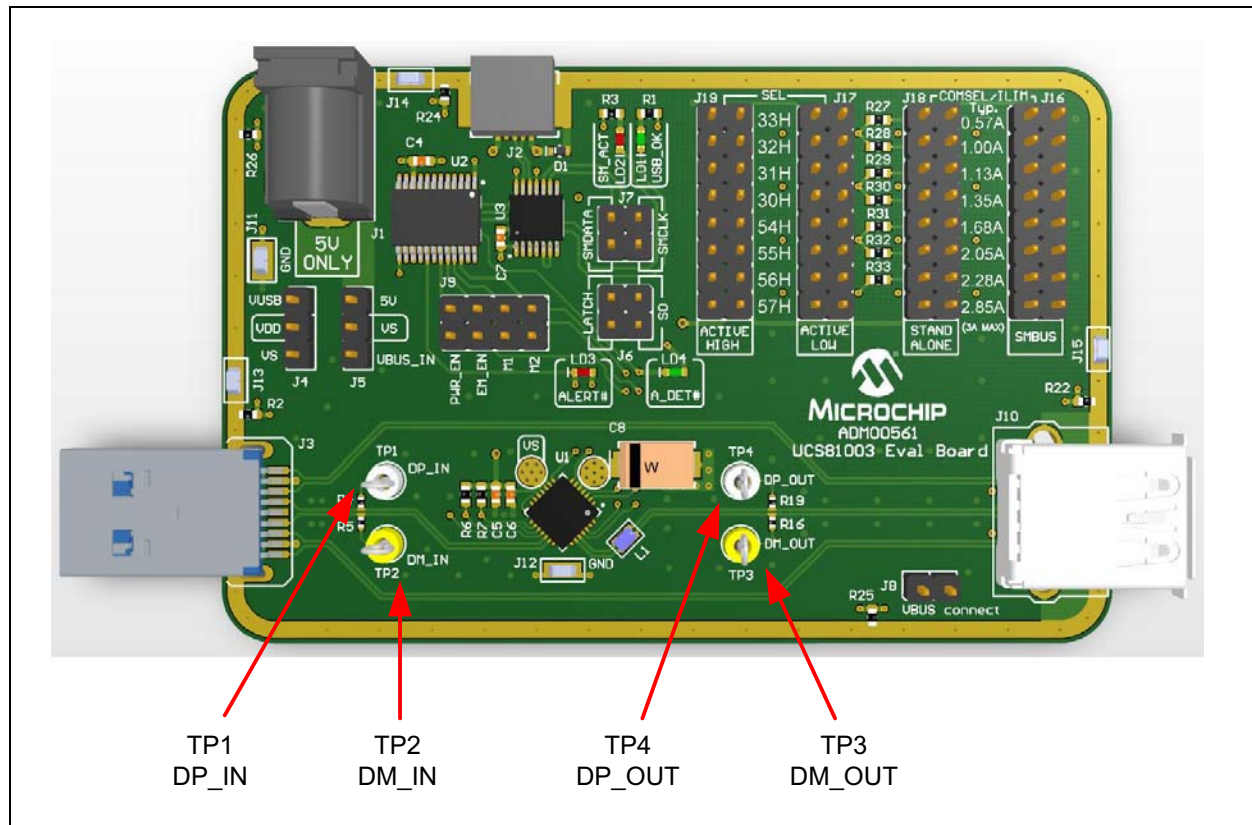
FIGURE 2-4:   *Evaluation Board Top View – Data Test Points.*

TABLE 2-4:

Designator	Assigned Pin	Description
TP1	DP_IN	This test point connects to the D_{PIN} data line through a 1 MΩ series resistor.
TP2	DM_IN	This test point connects to the D_{MIN} data line through a 1 MΩ series resistor.
TP3	DM_OUT	This test point connects to the D_{MOUT} data line through a 1 MΩ series resistor.
TP4	DP_OUT	This test point connects to the D_{POUT} data line through a 1 MΩ series resistor.

2.6   GROUND TEST POINTS ON THE EVALUATION BOARD

Figure 2-5 shows the top of the board and highlights the ground test points.
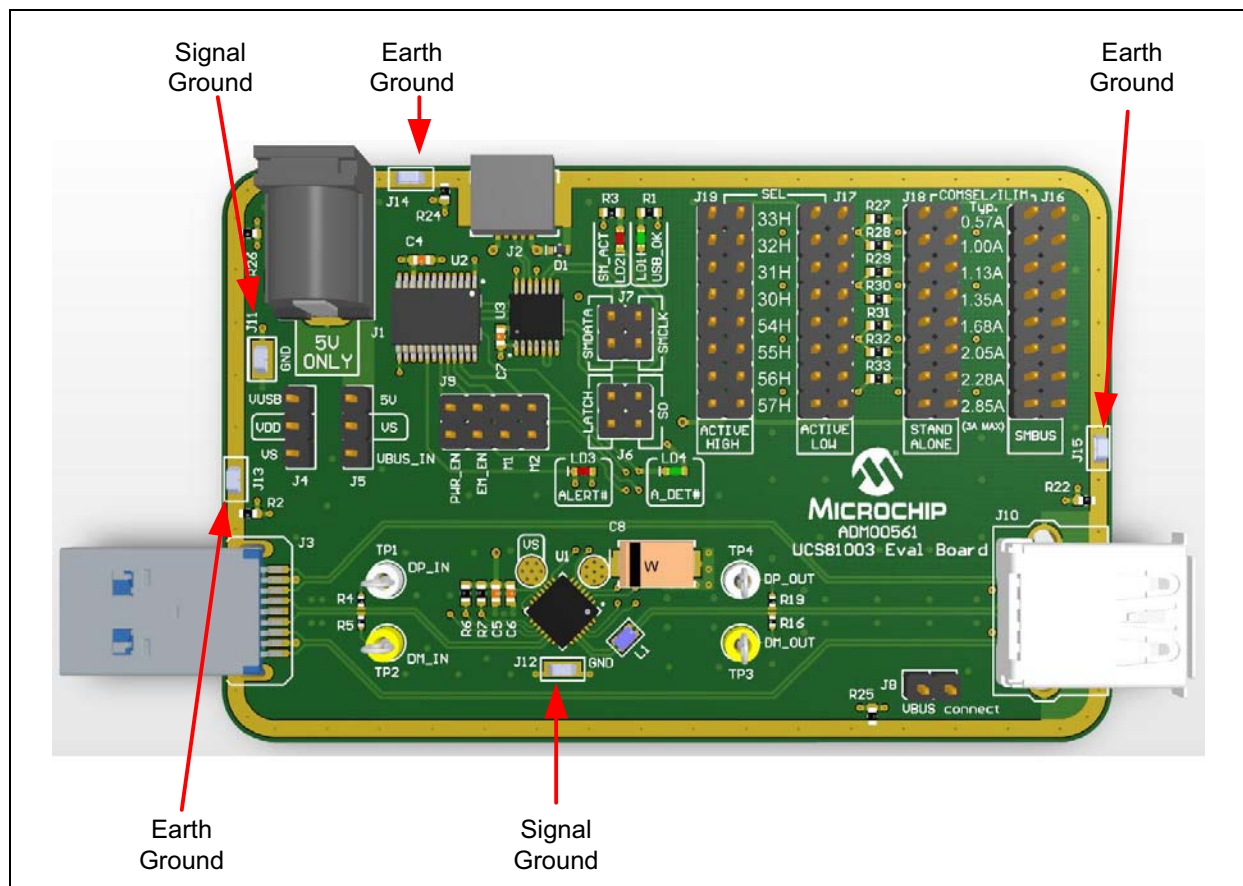
FIGURE 2-5:   *Evaluation Board Top View – Ground Test Points.*

TABLE 2-5:

Designator	Test Point Type	Description
J11, J12	Signal Ground	These test points connect to the signal ground of the board. These are the ground reference for the UCS81003.
J13, J14, J15	Earth Ground	These test points connect to the earth ground of the board (the shield of the USB connectors).

2.7   SOFTWARE INSTALLATION

To begin using the UCS81003 Evaluation Board, software must be installed on a Windows®-based computer with a USB port.

1. Download the software archive from the board's web page, unzip it and double-click the `Setup.exe`, to start the installation. Figure 2-6 shows the initial installation screen, which displays briefly as the setup program loads.
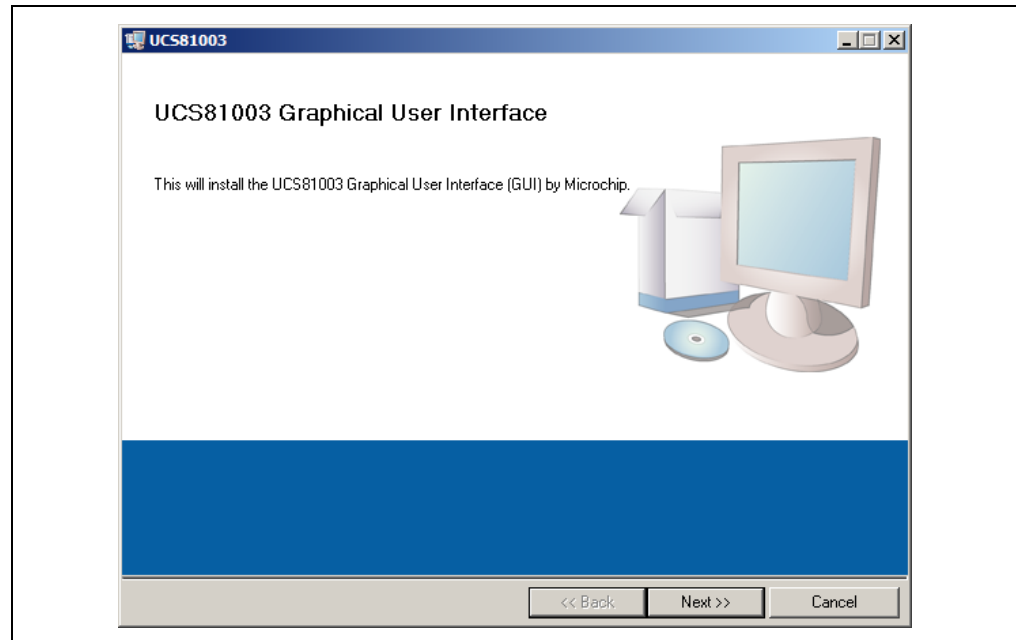
FIGURE 2-6:   *Software Installation – Initialize Window.*

2. Click **Next** in the Destination Directory window, as shown in Figure 2-7. 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\UCS81003\`, while for the LabVIEW software is `C:\Program Files(x86)\National Instruments`.
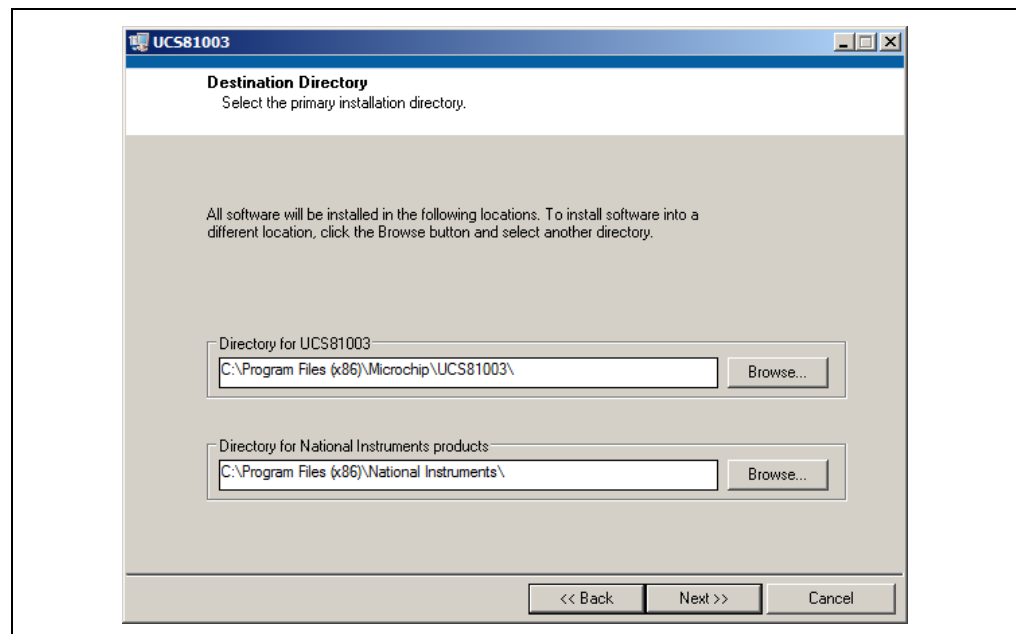
FIGURE 2-7:   *Software Installation – Setting the Destination Directory.*

3. Read and accept the license agreement, then click **Next**.
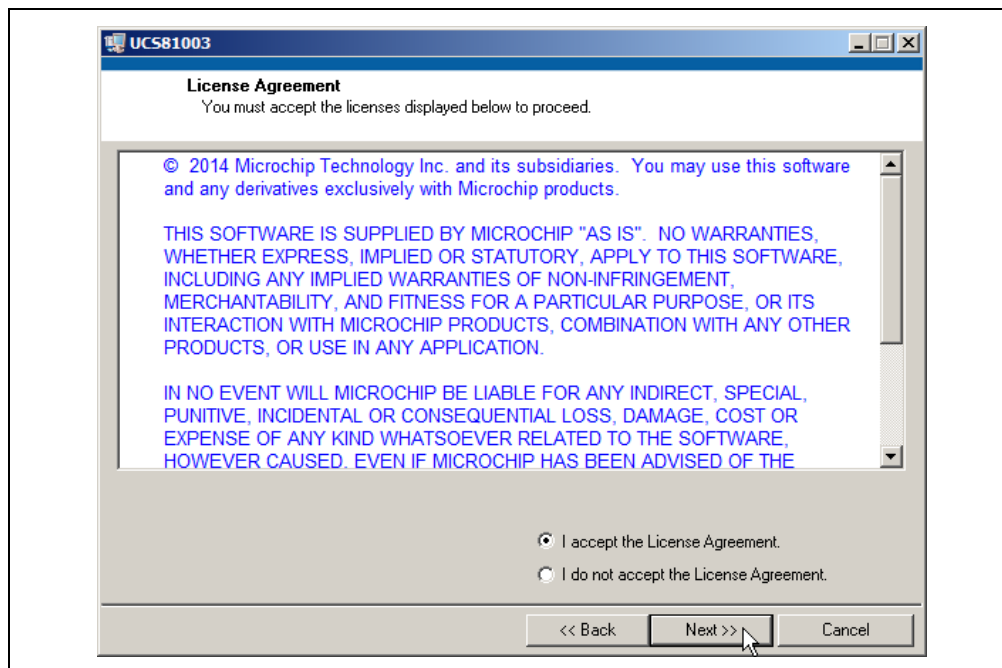
FIGURE 2-8: *Software Installation – Software License Agreement.*

4. To use the LabVIEW software, read and accept the license agreement, then click **Next**.
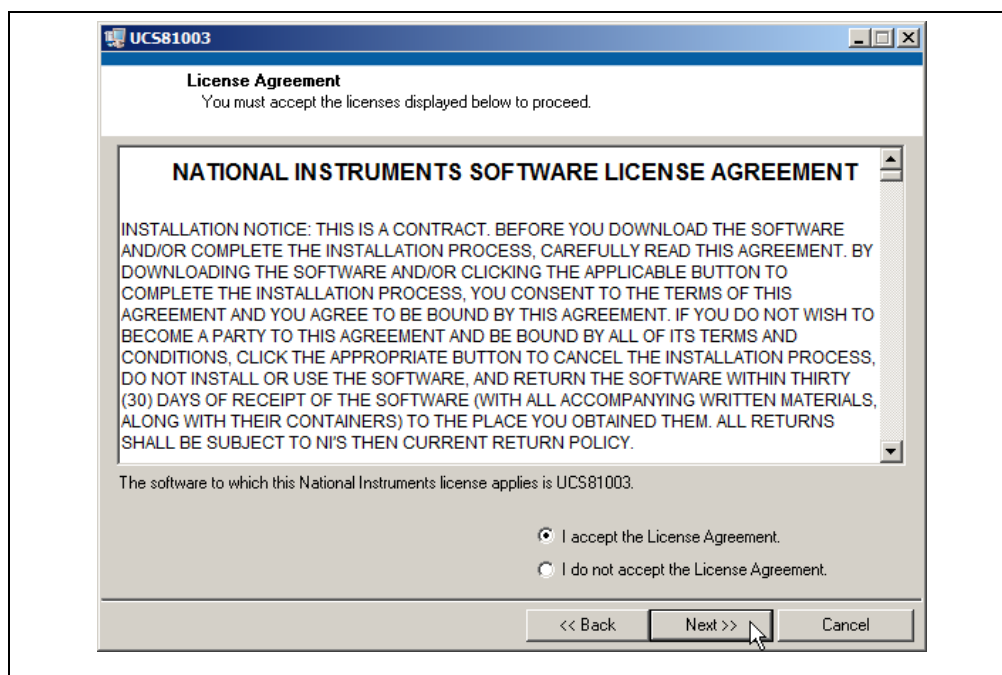
FIGURE 2-9: *Software Installation – LabVIEW License Agreement.*

On the following screens, select **Next** and follow the on-screen instructions to complete the installation. When installation is complete, the program will automatically run. If a screen appears requiring a restart for the changes to take effect, reboot the computer.

The UCS81003 interface will start with the SMBus communications.

Chapter 3. Hardware Description

3.1 UCS81003 DEVICE

The UCS81003 provides a single USB port power switch for precise control of up to 3.0A continuous current (2.85A typical) with overcurrent limiting, dynamic thermal management, latch/auto-recovery upon fault, selectable active low or high enable, under and overvoltage lockout, and back-drive protection.

USB Charging Port profiles are integrated into the UCS81003 to assure compliance to multiple standards. In addition to power switching and USB Charging Port profiling, the UCS81003 provides automatic and configurable USB data line handshaking to enable charging of USB-IF Battery Charging 1.2 (CDP or DCP modes), Chinese Telecommunications Industry Standard YD/T 1591-2009, Apple® Inc., RIM® and many other mobile devices.

The UCS81003 provides a device attachment detection output, as well as a dedicated alert output, with current monitoring, charge rationing for controlled delivery of current regardless of a host's power state. When the limit is reached, the UCS81003 will perform the user-programmed behavior (report and disconnect is the default).

3.2 EVALUATION BOARD POWER SOURCE

The UCS81003 has split power supply support:

- V_S is the voltage input to Power Switch. This supply rail is required to charge the portable device. V_S source is selected by populating a jumper on J5 header, as follows:

Jumper Position	Definition
1-2	V_S is supplied from the external 5V power supply connected to J1 power jack.
2-3	V_S is supplied from the V_{BUS} pin of the J3 USB connector. Use this option only if the USB host port can supply the charging current for the portable device.

- V_{DD} is the power supply for chip functionality. The UCS81003 Evaluation Board contains two additional ICs, MCP2221 USB bridge and MCP23018 I/O expander, which are also powered from the V_{DD} supply rail. V_{DD} source is selected by populating a jumper on the J4 header, as follows:

Jumper Position	Definition
1-2	V_{DD} is supplied from V_{BUS} pin of the J2 USB connector. When using the board in this configuration and the Attach Detection feature of the UCS81003 is used, the V_S voltage must not exceed V_{DD} + 150 mV, as specified in the data sheet.
2-3	V_{DD} is connected to V_S. This configuration is recommended when using the Attach Detection feature. If the board is evaluated with a PC running the GUI, then the V_S must be supplied after the USB cable is plugged into the J2 connector.

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3.3   MCP2221 USB-TO-SMBUS BRIDGE

The MCP2221 is a USB-to-UART/I^{2}C bridge that supports SMBus communication. It is controlled through USB interface by the GUI running on the PC. It is the master device on the SMBus/I2C bus. It is used to read and write the registers of the two devices connected to the SMBus/I^{2}C interface: UCS81003 and MCP23018 I/O expander.

3.4   MCP23018 I/O EXPANDER

MCP23018 is a 16-bit I/O Expander with open-drain outputs and I^{2}C interface. Its I^{2}C address is configured to `0100_000(R/W)`, different than all possible addresses of the UCS81003.

The I/O pins used in this application are configured as inputs. They are used to read the logic state of the following UCS81003 pins: ALERT#, ADET#, PWR_EN, EM_EN, M1, M2.

3.5   DIRECT SMBUS CONNECT OPTION

It is also possible to connect an external SMBus master to the UCS81003 Evaluation Board. Remove the jumpers on J7 and connect the SMBus master to the header pins that are linked directly to UCS81003 pins SMDATA/LATCH and SMCLK/S0. Note that ground must be connected to one of the test point grounds or header pins on the EVB. See Figure 3-1 for header pins description.
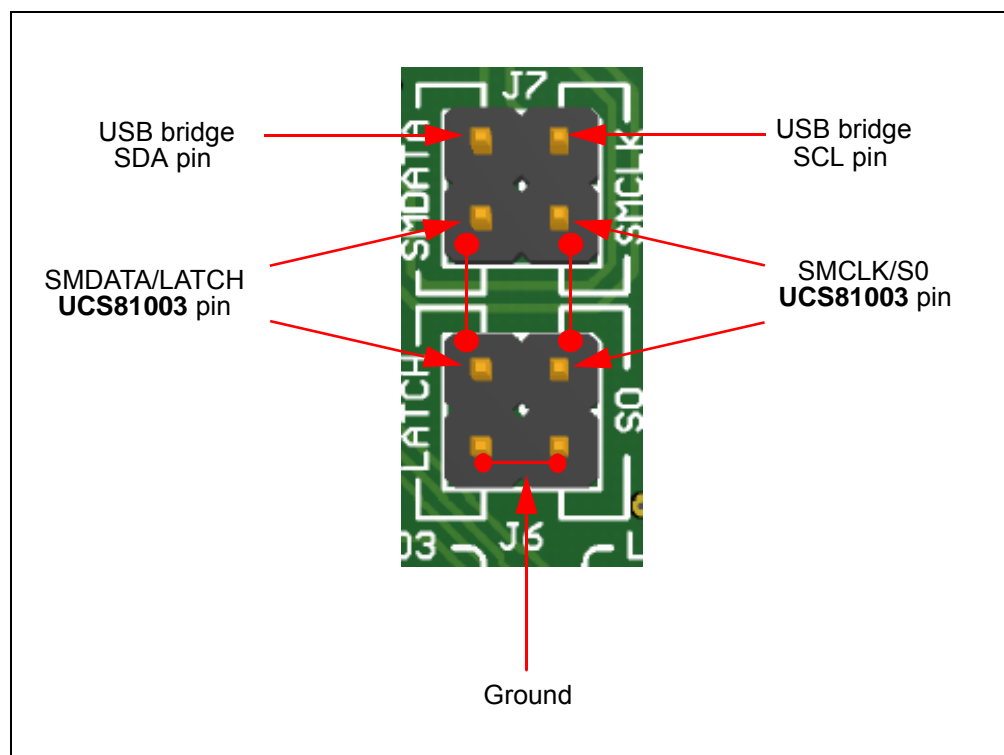

FIGURE 3-1:   *UCS81003-to-SMBus Bridge Jumpers.*

Chapter 4. Software Description

4.1 OVERVIEW

To get the graphical interface and the evaluation board running, follow these instructions:

1. Start the UCS81003 GUI software: from the Windows Start menu, select *Programs > Microchip > UCS81003*.

2. Connect the USB mini connector end of the cable to the board and the standard USB connector of the cable to any available USB port on the PC. If the V_{DD} supply is connected to VS (the jumper on J4 header is populated on position 2-3), then connect the VS supply. The USB Activity LED should light, indicating that the MCP2221 USB bridge is connected to the PC.

The UCS81003 Evaluation Board interface (Figure 4-1), consists of five tabs (**Main**, **Configuration & General Status**, **Custom Charging**, **Register Set** and **Demo**) as well as the right side sections that are always visible (**Panel Controls**, **Pin State & Attach Status** and **Active Mode Selection**).
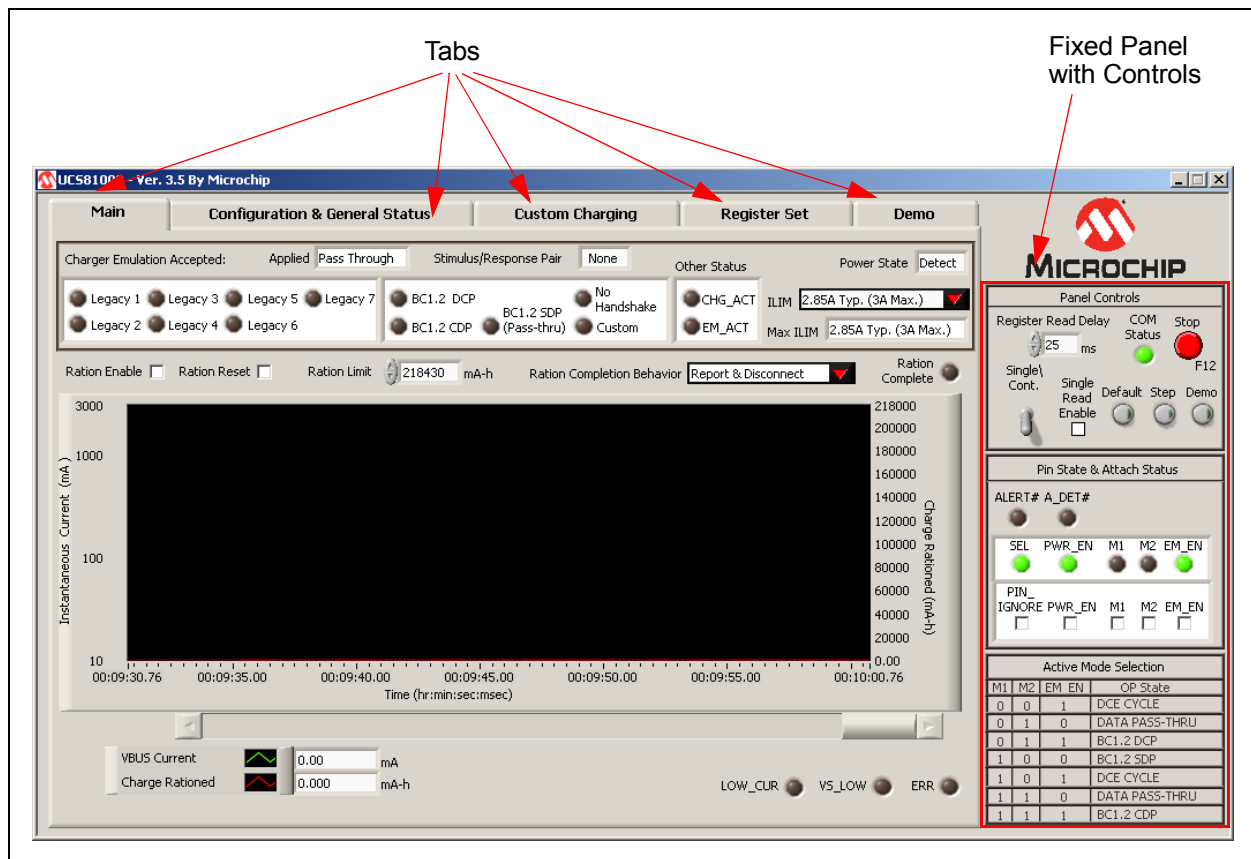

FIGURE 4-1: *UCS81003 Evaluation Board Initial Window.*

4.1.1 Tips for Using the EVB GUI

- For many controls on the GUI panel, placing the mouse cursor over a control will pop up context help that indicates the register address or provides a description.
- After a power up of the evaluation board, the default settings are loaded. Users can save setting configurations to user-named files which can be reloaded at any time for quick reconfiguration (see **Section 4.3.4.3 "Configuration Save and Load"**).
- The GUI cannot be used to demonstrate UCS81003 behavior in Stand-Alone mode since SMBus communication is required.

4.1.2 GUI Abbreviations

Abbreviation	Description
BC	Battery charging
CDP	Charging downstream port
DCE	Dedicated charger emulation
DCP	Dedicated charging port
EM	Emulation
EM_EN	Emulation enable
M1	Mode control pin number one
M2	Mode control pin number two

4.1.3 Keyboard Shortcuts

Some GUI controls have keyboard shortcuts, as shown in Table 4-1.

TABLE 4-1:   UCS81003 EVALUATION BOARD GUI KEYBOARD SHORTCUTS

GUI Control	Shortcut	Control Description
Run	CTRL + R	**Section 4.2.1.1 "Stop and Run Buttons"**
Stop	F12	**Section 4.2.1.1 "Stop and Run Buttons"**

4.2 INTERFACE DESCRIPTION AND OPERATION

4.2.1 Panel Controls

The Panel Controls section on the right side of the GUI, shown in Figure 4-2, affects GUI operation. This section is always displayed.
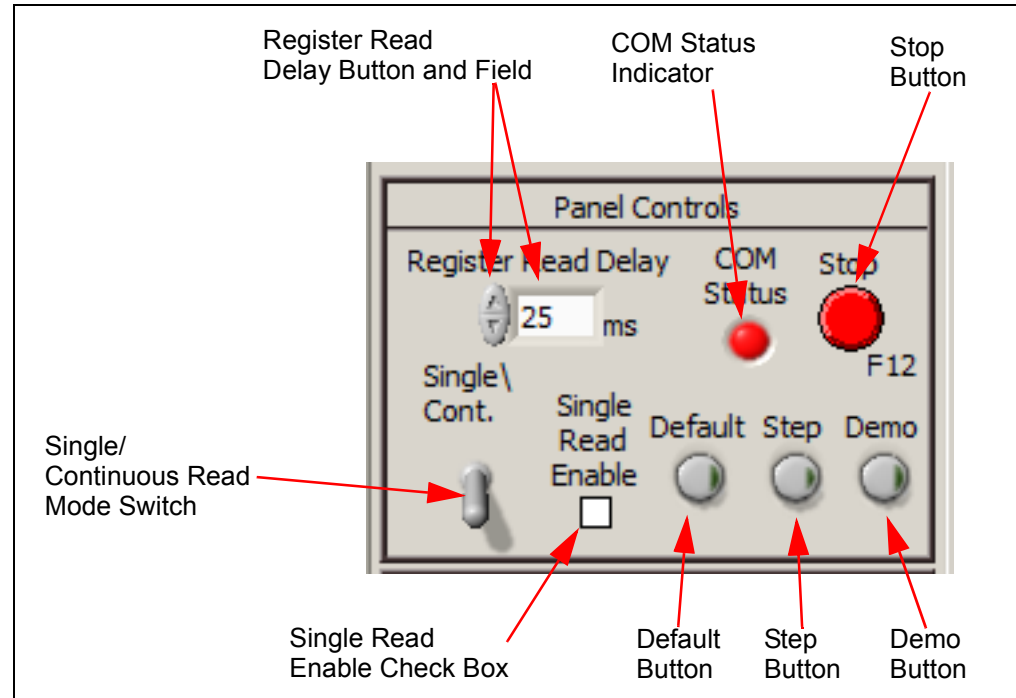

FIGURE 4-2: Panel Controls.

4.2.1.1 STOP AND RUN BUTTONS

Pressing the **Stop** button, shown in Figure 4-2, interrupts GUI software communication with the evaluation board. When this button is clicked, the **Run** button appears under an extended menu bar, as shown in Figure 4-3.
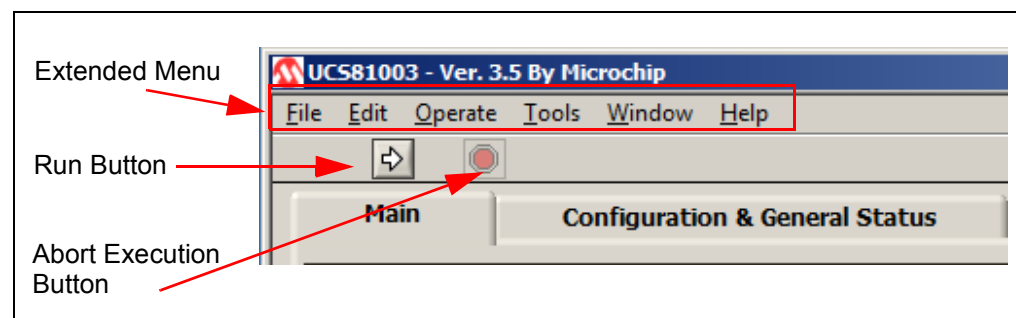

FIGURE 4-3: Stop and Run Button.

4.2.1.2   RUN BUTTON

To restart communication between the software and the evaluation board, click the **Run** button. This button disappears when communication resumes.

> **Note:**   Stopping and restarting the GUI does not affect register settings. To restore default register settings, disconnect power from the board, then reconnect power.

To close the program, press the **Close** (**X**) button on the upper right corner of the window.

4.2.1.3   COM STATUS INDICATOR

The **COM Status** indicator shows the status of communications over the SMBus. During normal operation, COM Status is green. If SMBus communications fails, COM Status turns red (or alternates red and green).

4.2.1.4   REGISTER READ DELAY

The **Register Read Delay** sets the GUI control panel update speed. It affects the speed that the software reads the registers, but will not affect the device's sampling time. The default is 25 ms. This number can range from 0 to 5000 ms in increments of 25 ms.

4.2.1.5   SINGLE/CONTINUOUS READ

The panel defaults to continuous register reads (toggle switch in down position, as shown in Figure 4-2). To stop continuous register reads, check the "Single Read Enable" box. In order to capture the register values at a given time, click the switch, which will briefly flip to Single Read.

4.2.1.6   DEFAULT

When this button is pressed, it loads the defaults to all registers of the UCS81003.

4.2.1.7   STEP

When selected, **Step** will go through the Emulation Profiles in sequence, from Legacy 1 through 7, then BC1.2 DCP, and finally Custom. The actual DCE cycle is slightly different, please see product's data sheet for more information.

4.2.1.8   DEMO

The **Demo** button enables an automated routine to cycle through a user-defined set of profiles and selects the highest current profile. This feature emulates an external controller and is not part of the UCS81003 device.

4.2.2 Pin State and Attach Status Panel

The Pin State & Attach Status section on the right side of the GUI, shown in Figure 4-4, provides a quick graphical status reference and allows physical control pin override. This section is always displayed.

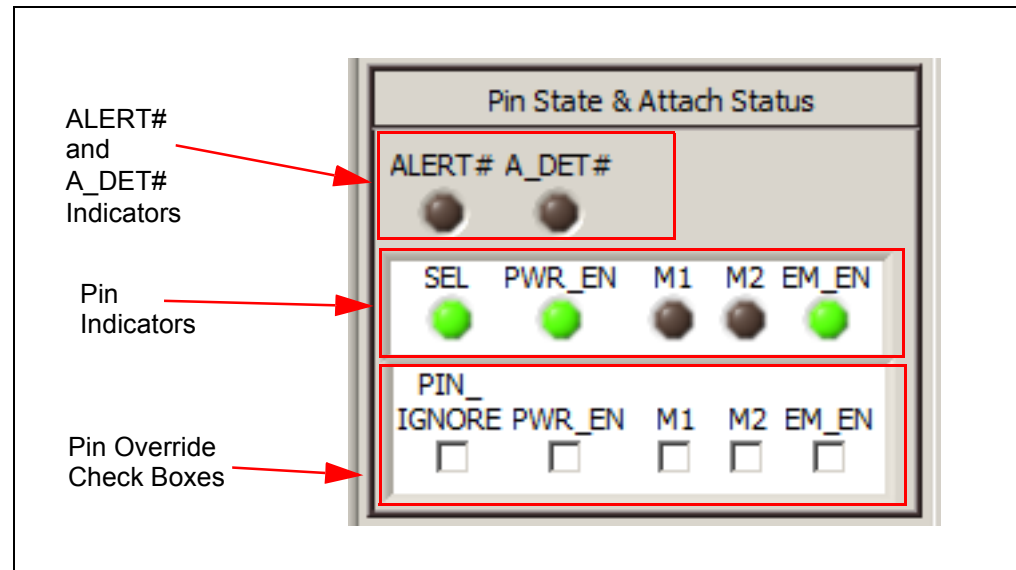**FIGURE 4-4:** *Pin State and Attach Status.*

4.2.3 Pin State & Attach Status Panel

4.2.3.1 ALERT# AND A_DET# INDICATORS

When the ALERT# and A_DET# indicators are green, the signals at the device's respective pin are low and the corresponding condition has occurred (alert or device attached, respectively). When the indicators are dark, the pin states are high.

4.2.3.2 PIN INDICATORS

The pin indicators (SEL, PWR_EN, M1, M2 and EM_EN) shown in Figure 4-4 are green if the signal on the corresponding pin on the UCS81003 device is high, and dark if the signal is low. If the "Pin Ignore" box is checked (see **Section 4.2.3.3 "Pin Override"**), these indicators will reflect the GUI overrides for these pins.

4.2.3.3 PIN OVERRIDE
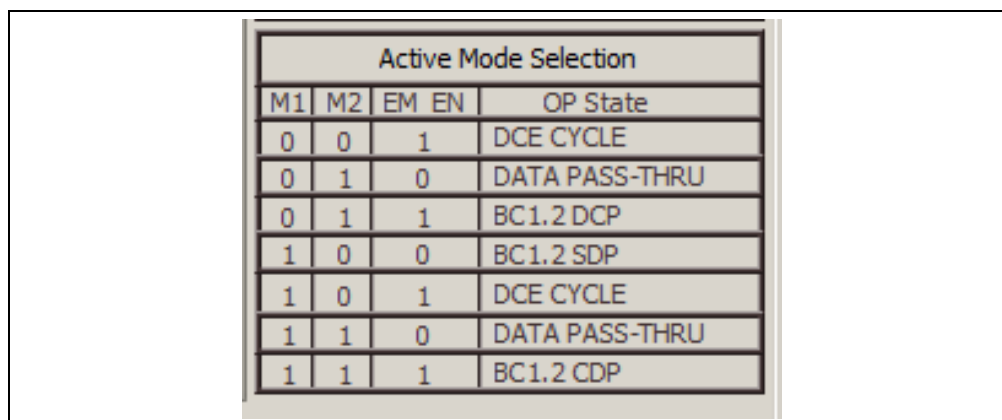
For evaluation convenience, the GUI can override the setting of the following pins on the UCS81003 device: PWR_EN, M1, M2 and EM_EN. Check the "Pin Ignore" box (see Figure 4-4) to enable pin override. Then, check in the corresponding pin box to set the value high.

Note 1: Pin override does not affect the actual signal on the pin. It only affects the register values.

2: The SEL pin is only read once by the UCS81003 at power up, so there is no pin override for it. To close the port power switch, the PWR_EN state must match the SEL state (e.g., SEL = high and PWR_EN = high).

4.2.4   Active Mode Selection

The Active Mode Selection section on the right side of the GUI, shown in Figure 4-5, provides a quick reference regarding operating state based on the values of M1, M2 and EM_EN. This section is always displayed.

M1	M2	EM_EN	OP State
0	0	1	DCE CYCLE
0	1	0	DATA PASS-THRU
0	1	1	BC1.2 DCP
1	0	0	BC1.2 SDP
1	0	1	DCE CYCLE
1	1	0	DATA PASS-THRU
1	1	1	BC1.2 CDP

FIGURE 4-5:   *Charger Emulation Selection.*

4.3   TAB DESCRIPTIONS

4.3.1   Main Tab

The **Main** tab (Figure 4-6) shows key parameters related to the port power switch, including the maximum current limit, the present current limit (always equal to or less than maximum current limit), and power state (e.g. detect, active, error, etc.). When a portable device has been successfully attached, the screen shows the power state change from Detect to Active and shows the various handshakes applied. Once it is determined that the device is charging, the screen shows which emulation profile was successful, and the graph shows the charging current. Optionally, the user may monitor the charge delivered or ration the charge delivered to the attached device.
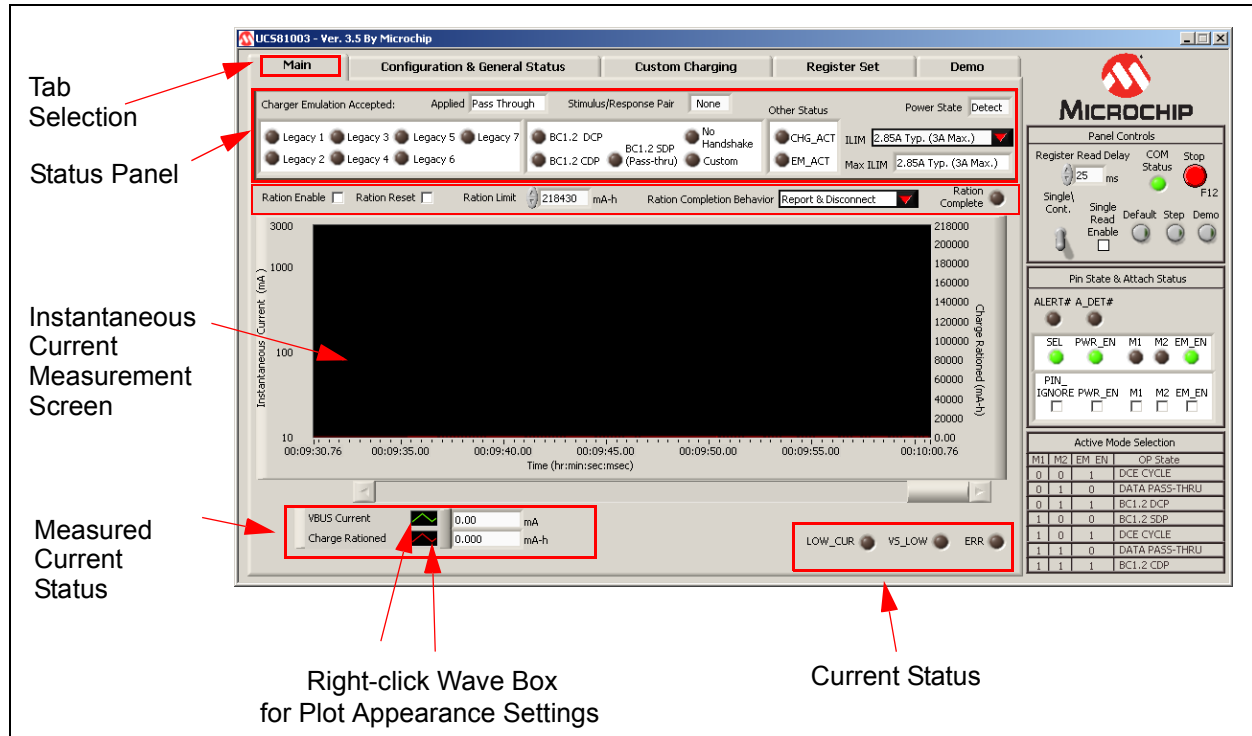
FIGURE 4-6:   *Main Tab Window Overview.*

4.3.1.1   DEDICATED CHARGER EMULATION (DCE) CYCLE

As shipped, the UCS81003 is ready to function as a dedicated charger, which will be applied when there is an attach detection. To view this behavior, perform the following:

1. Connect V_S to the evaluation board (see **Section 2.4 "Jumpers on the Evaluation Board"**). The VS_LOW indicator on the bottom of the Main Tab must be dark. If the color is red, the voltage is not high enough to charge a portable device.
2. Connect a portable device to the board. Use the OEM USB charging cable that comes with the portable device.
3. The UCS81003 should detect an attachment, switch to the Active Power state, apply an emulation profile and deliver a charge. Figure 4-7 shows the interface after charging has started.

FIGURE 4-7: *Main Tab - Charging Started.*

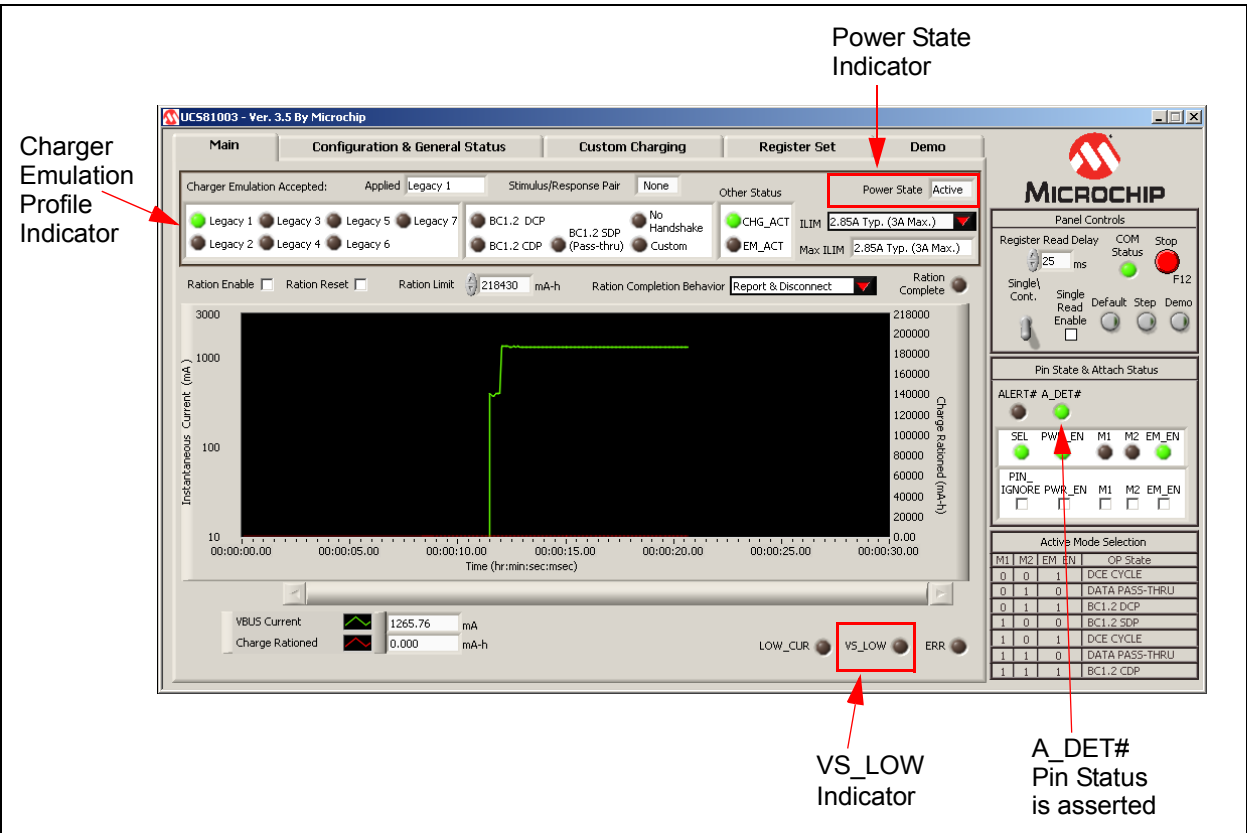4. Disconnect the portable device from the board.

The UCS81003 should detect a removal, switch to the Detect power state, and stop delivering a charge. Figure 4-8 shows the interface after a removal was detected.
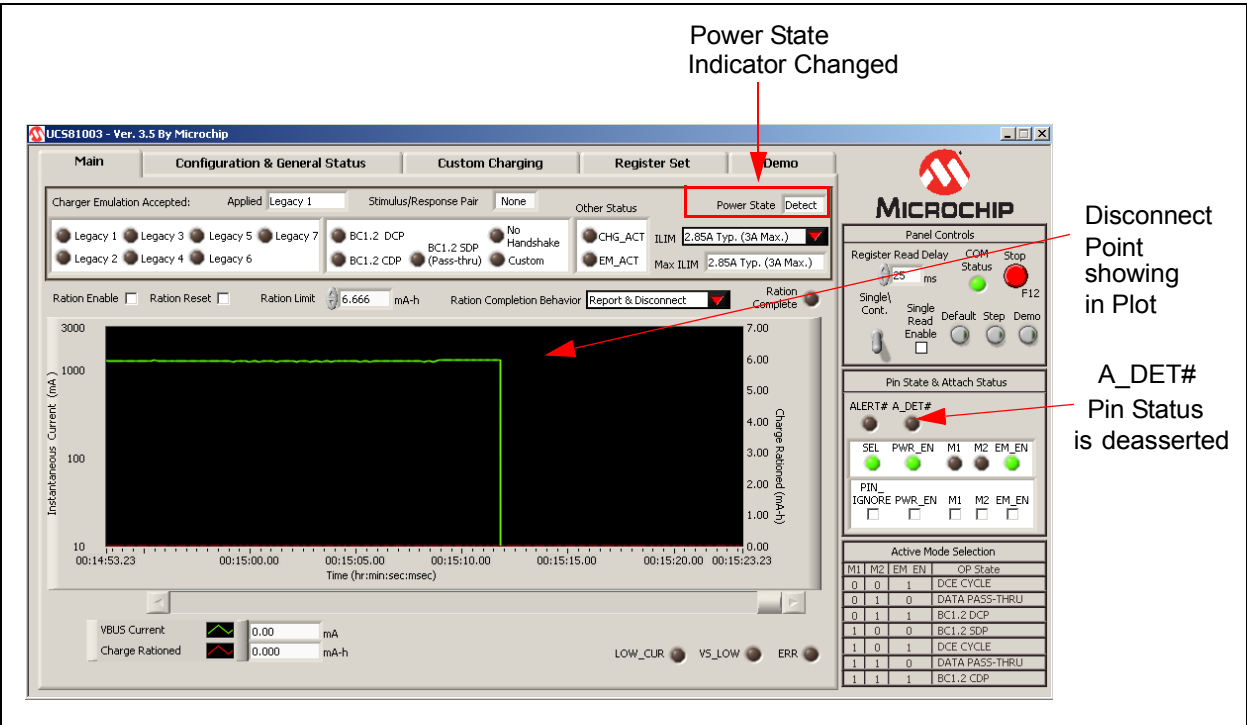

FIGURE 4-8: *Main Tab - Removal Detected.*
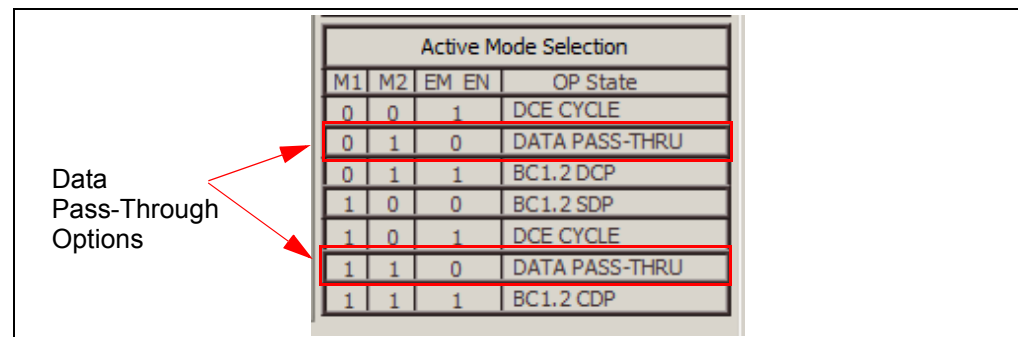
4.3.1.2   CHARGING DOWNSTREAM PORT (CDP)

The CDP charging profile is based on the "*USB Battery Charging Specification v1.x*". When a BC1.x-compliant portable device attachment is detected, the UCS81003 and the portable device do handshaking based on the standard. If handshaking is successful, charging occurs up to the set current limit.

To select the CDP port power profile, M1, M2 and EM_EN must all be high. This can be done by removing the jumpers for these pins (from J9 header) or by using the pin override in the GUI (see **Section 4.2.3.3 "Pin Override"**).

4.3.1.3   PASS-THROUGH

Data Pass-Through does not apply any type of charger emulation. When selected, it closes the USB high-speed data switch and supplies current up to the current limit.

To select Data Pass-Through, M1, M2 and EM_EN can be set to any one of the two DATA PASS-THRU combinations (`010` and `110`), as shown in Figure 4-9. This can be done by setting the jumpers for these pins (from J9 header –
see **Section 2.4 "Jumpers on the Evaluation Board"**) or by using the pin override in the GUI (see **Section 4.2.3.3 "Pin Override"**).

FIGURE 4-9:   *Data Pass-Through Selection Options.*

4.3.1.4   CURRENT MONITORING AND CHARGE RATIONING

To view current monitoring and current rationing, perform the following on the **Main** tab:

1. Set a Ration Limit. The ration limit is expressed in mAh (electric charge).
2. Set rationing behavior. The Ration Completion Behavior defaults to "Report & Disconnect". Once the ration limit is reached, portable device charging will cease, the ALERT# pin will assert, and the `Ration Complete` bit will be set. If you do not want the system to behave in this fashion, select one of the other three options from the Ration Completion Behavior drop-down list: Report, Report & Sleep or Take No Action.
3. Connect V_S to the evaluation board (see **Section 2.4 "Jumpers on the Evaluation Board"**). The VS_LOW indicator on the bottom of the Main Tab must be dark. If the VS_LOW indicator is red, the voltage is not high enough to charge a portable device.
4. Connect a portable device to the evaluation board. Use the OEM USB charging cable that comes with the portable device.
5. Enable rationing by checking the Ration Enable check box on the Main Tab.
6. Watch the GUI as the device starts charging. Figure 4-10 shows the interface after the ration limit was reached (for "Report & Disconnect" behavior setting).

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> **Note:** As shown in Figure 4-10, the green trace is the instantaneous current, while the red diagonal line is the charge being delivered in mAh. Both are also presented in numeric format in the bottom left boxes. Trace color and characteristics can be changed by clicking on the waveform boxes to the left of these numerical values.
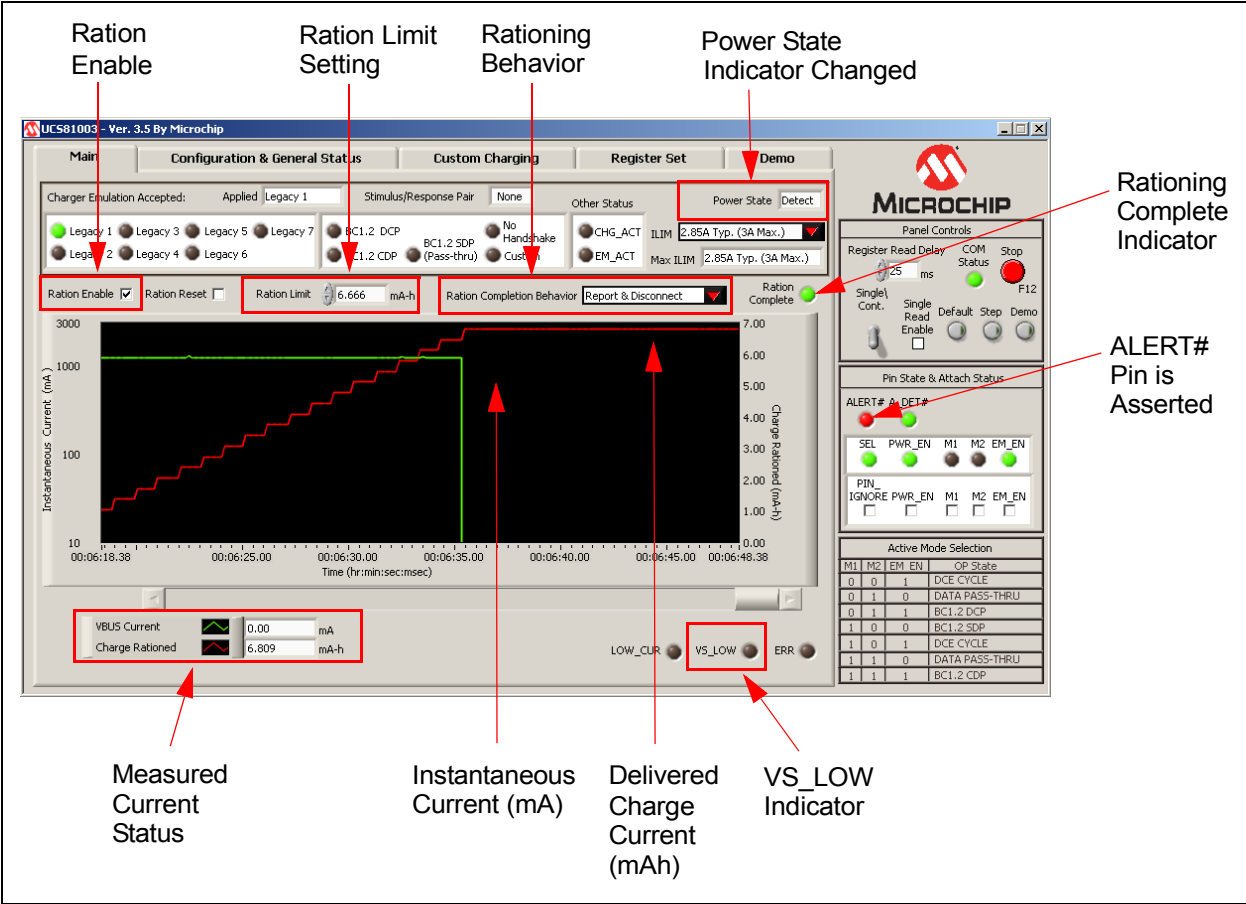
FIGURE 4-10: *Main Tab - Ration Limit Reached.*

4.3.2 Configuration and General Status Tab

The **Configuration & General Status** tab (Figure 4-11), includes various status indicators and configuration controls. Items are grouped by function, detailed in the following sections.
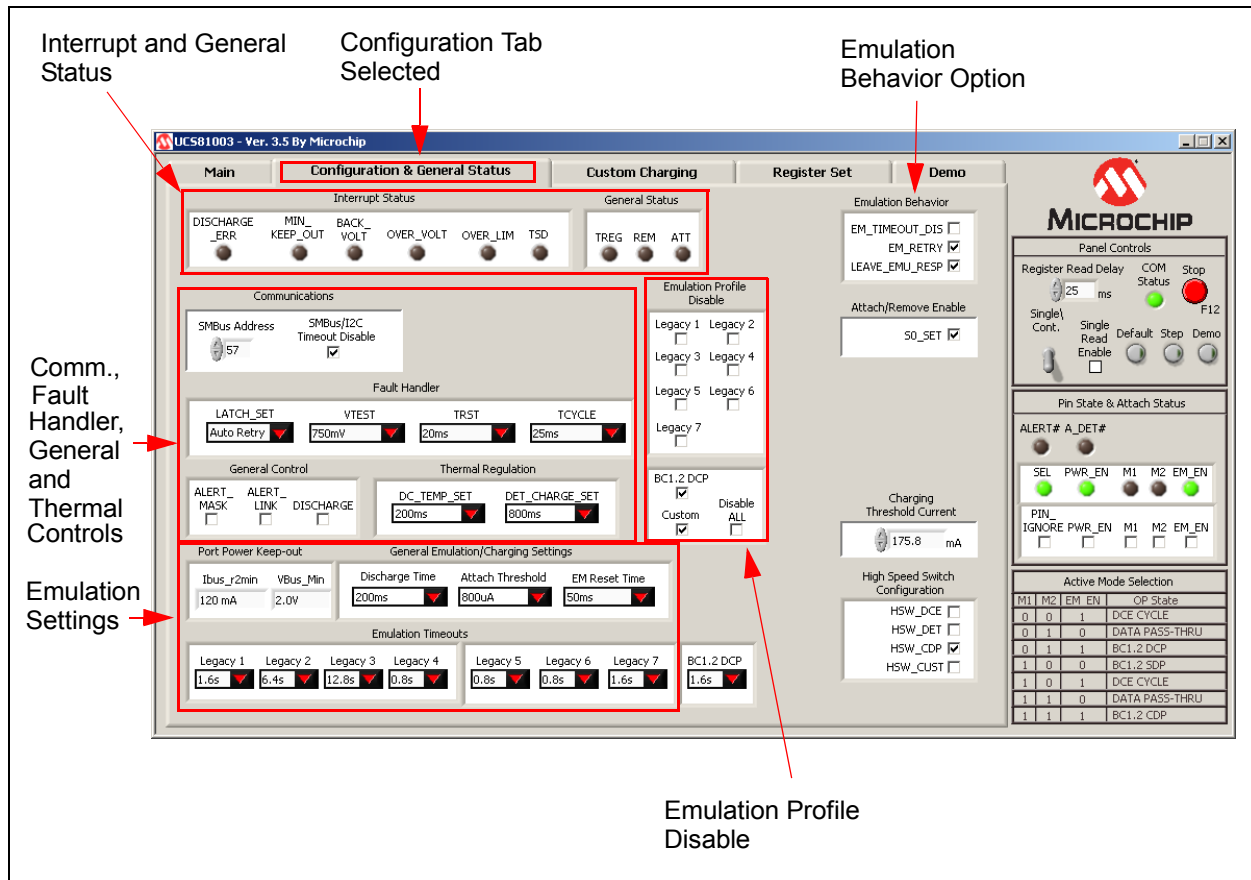
FIGURE 4-11: *Configuration & General Status Tab.*

4.3.2.1 INTERRUPT STATUS

The indicators in the Interrupt Status section turn green when the corresponding bit is high, and are dark when the bit is low.

4.3.2.2 GENERAL STATUS

Indicators in the General Status section turn green when the corresponding bit is high and are dark when the bit is low.

4.3.2.3 EMULATION BEHAVIOR

Check the necessary check box to enable the corresponding emulation behavior.

4.3.2.4 COMMUNICATIONS

SMBus address is displayed. SMBus timeout can be disabled.

4.3.2.5 EMULATION PROFILE DISABLE

Check the Profiles boxes to disable them. They will not be used during emulation. By selecting the "Disable ALL" will toggle all profile check boxes.

4.3.2.6 ATTACH/REMOVE ENABLE

Click the S0_SET box to remove the check mark and disable the function.

4.3.2.7 FAULT HANDLER

These are controls related to fault handling.

4.3.2.8 GENERAL CONTROL

Controls for general parameters.

4.3.2.9 THERMAL REGULATION

Controls for thermal and detection delay parameters.

4.3.2.10 PORT POWER KEEP-OUT

Displays values for the port power parameters.

4.3.2.11 GENERAL EMULATION/CHARGING SETTINGS

Controls for emulation and charging.

4.3.2.12 EMULATION TIMEOUTS

Sets the emulation timeout period for each profile. These timeout periods are not used if the EM_TIMEOUT_DIS control in the Emulation Behavior section is checked.

4.3.2.13 CHARGING THRESHOLD CURRENT

Controls charging threshold current setting.

4.3.2.14 HIGH SPEED SWITCH CONFIGURATION

Controls the high-speed switch parameters.

4.3.3 Custom Charging Tab

The **Custom Charging** tab (Figure 4-12), provides the means for users to create custom charger emulator configurations. These configurations include signaling on the USB data lines, as well as what method of current limiting to employ (Constant Current or Trip). For more information, refer to the UCS81003 Data Sheet and AN24.14 - *"UCS1002 Fundamentals of Custom Charger Emulation"* (DS200005234).
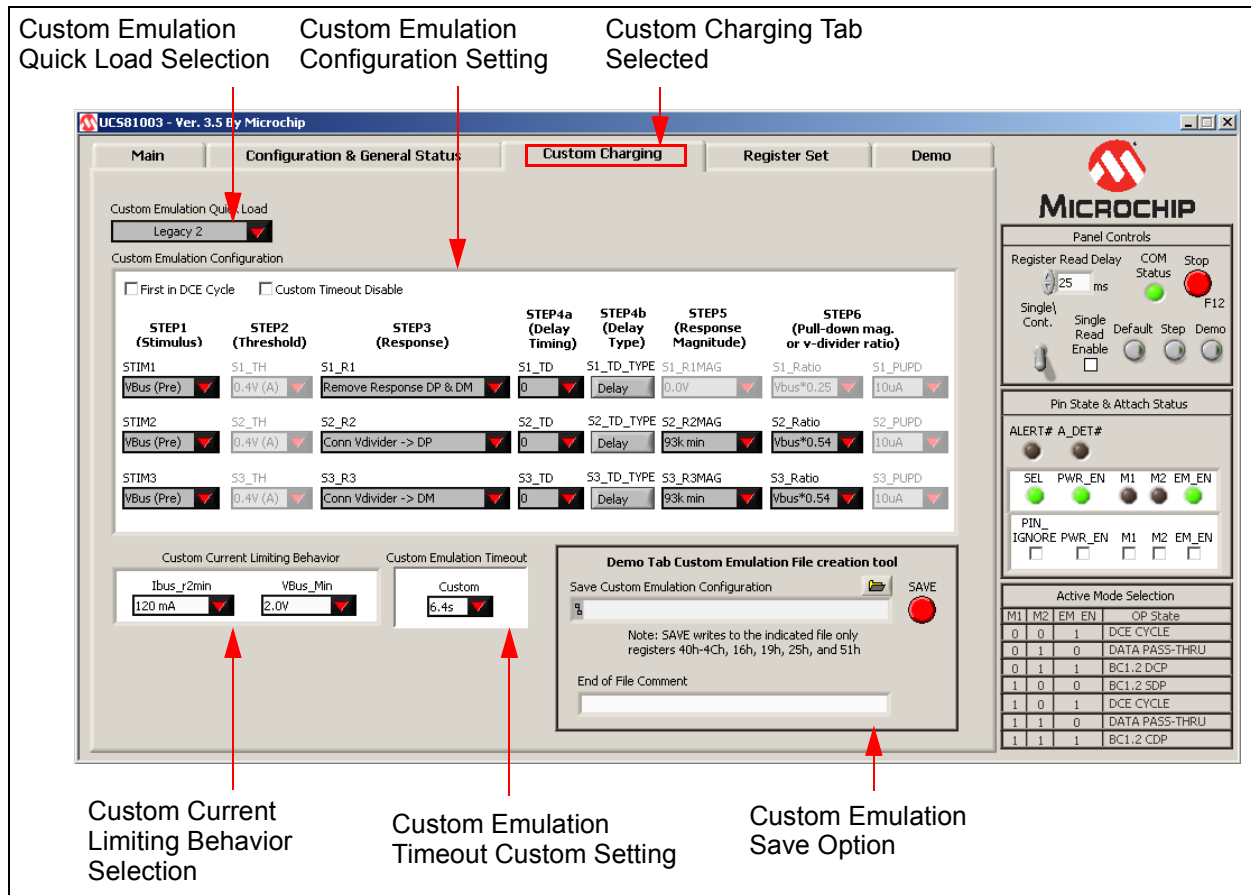
FIGURE 4-12: *Custom Charging Tab.*

4.3.3.1 CUSTOM EMULATION CONFIGURATION

Creating a custom emulation profile is a two-part process of entering the appropriate stimulus-response pairs in the provided fields, as well as the desired current limiting behavior (after emulation is applied, and the portable device starts to draw current).

4.3.3.1.1 Example

Settings shown in Figure 4-12 will apply the Legacy 2 stimulus pair. This includes a voltage divider on DP and on DM with the values shown under STEP 5 column.

If the portable device draws bus current greater than the charging threshold being used, it will always operate in Current Limiting Trip mode (with trip point based on the current limit setting).

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4.3.3.2 CUSTOM CURRENT LIMITING BEHAVIOR

The second part of creating custom profiles is to specify the behavior of current limiting and minimum voltage output. This is accomplished using the Ibus_r2min and VBus_Min drop-down lists, as shown in Figure 4-13.
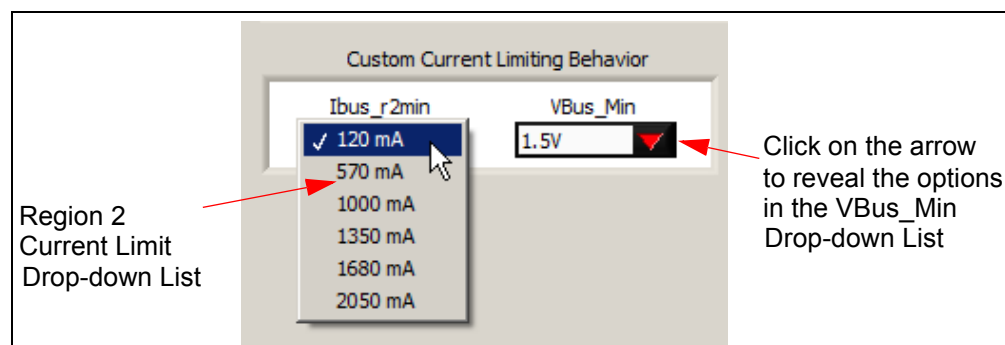
FIGURE 4-13:   *Current-Voltage Behavior Selection.*

4.3.3.3 CUSTOM EMULATION QUICK LOAD

The Custom Emulation Quick Load drop-down menu allows single-click loading of the Custom Emulation Configuration registers. Simply select the profile to load from the menu and registers 41h – 4Ch will be loaded with that profile.

4.3.3.4 SAVE CUSTOM EMULATION CONFIGURATION

Customs Emulation Configuration allows for a quick way to save the necessary registers to configure the UCS81003 for a custom profile to a file. Enter the path and press the **SAVE** button. Files will be overwritten if duplicate file names are used.

Registers 40h – 4Ch (Custom Emulation Configuration - **Custom Charging** tab), 16h (Emulation Behavior - **Configuration** tab), 19h (ILIM - **Main** tab), 25h (High Speed Switch Configuration – **Configuration** tab) and 51h (Custom Current Limiting Behavior – **Custom Charging** tab) will be saved in a two-column format. Comments can be added at the end of the file for documentation.

4.3.4   Register Set Tab

The **Register Set** tab (Figure 4-14), allows viewing and updating of the UCS81003 registers, identifies the device on the evaluation board and manages configuration files.
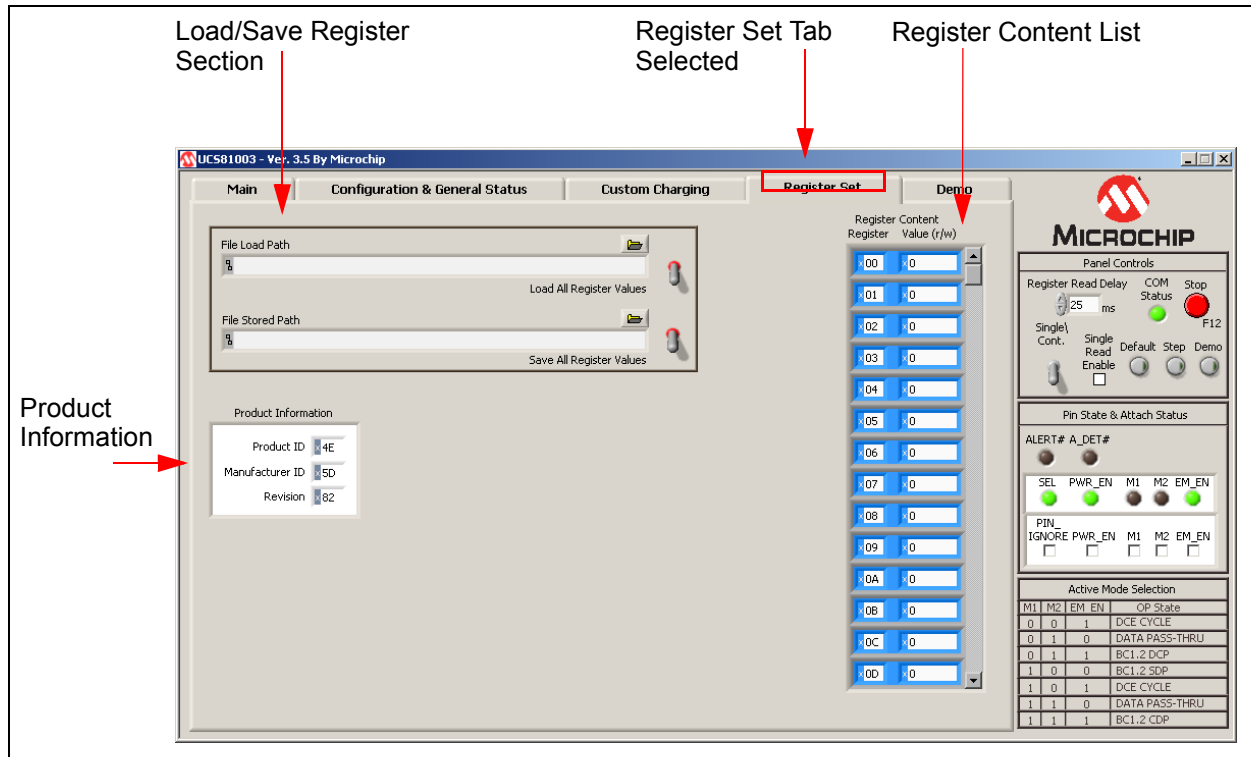
FIGURE 4-14:   *Register Set Tab.*

4.3.4.1   REGISTER CONTENT

Register Content shown in Figure 4-14 is a scrollable list of the UCS81003 registers and the current value. It is important to note that not all addresses are physical memory locations on the device; these registers will read '0'. Likewise, some registers shown, that are undocumented in the data sheet, may contain data. Editing these registers can cause unexpected results.

To update a register value, locate the register address in the left column, type the new value in the corresponding cell in the right column, and press **Enter** on the keyboard or click outside the editable field to complete the action.

4.3.4.2   PRODUCT INFORMATION

Product Information panel shows the values of three registers (FDh, FEh and FFh) which identify the device on the evaluation board.

4.3.4.3   CONFIGURATION SAVE AND LOAD

The **Register Set** tab contains controls (Figure 4-15) which save the settings currently configured in the UCS81003 to allow quick reconfiguration at any time.
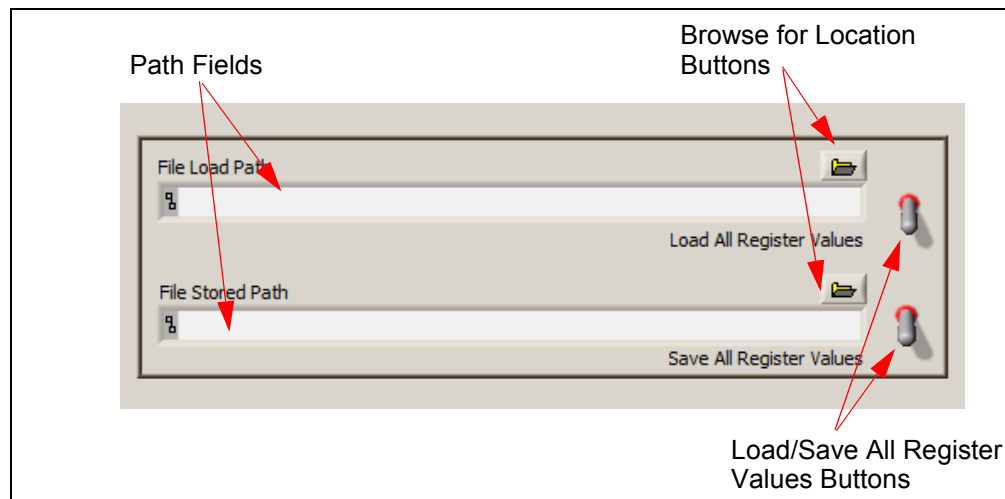
FIGURE 4-15:   *Save/Load Section.*

To save configuration settings, configure the UCS81003 as desired, then display the **Register Set** tab. Type a path in the "File Stored Path" field or press the **Browse** button to select the folder where the configuration file will be saved. The file should be named with the `.txt` extension or with a similar text file format. Once a file name and location has been chosen, click the **Save All Register Values** switch, and the file is saved.

> **Note:** If a file with the same name already exists, it will be overwritten and the old data will be lost.

The data is saved in two columns separated by tabs. The first column is the register address and the second column is the register data.

Once a file is saved, it can be recalled at any time by selecting the file in the "File Load Path" field and clicking the **Load All Register Values** switch.

4.3.5   Demo Tab

The **Demo** tab (Figure 4-16) demonstrates external controller logic to apply custom emulation profiles and optimize charging current. This feature uses the LabView engine to step through the selected files and store the current drawn by the device. Several options are available to customize the operation of the demo and explore the potential of the UCS81003.
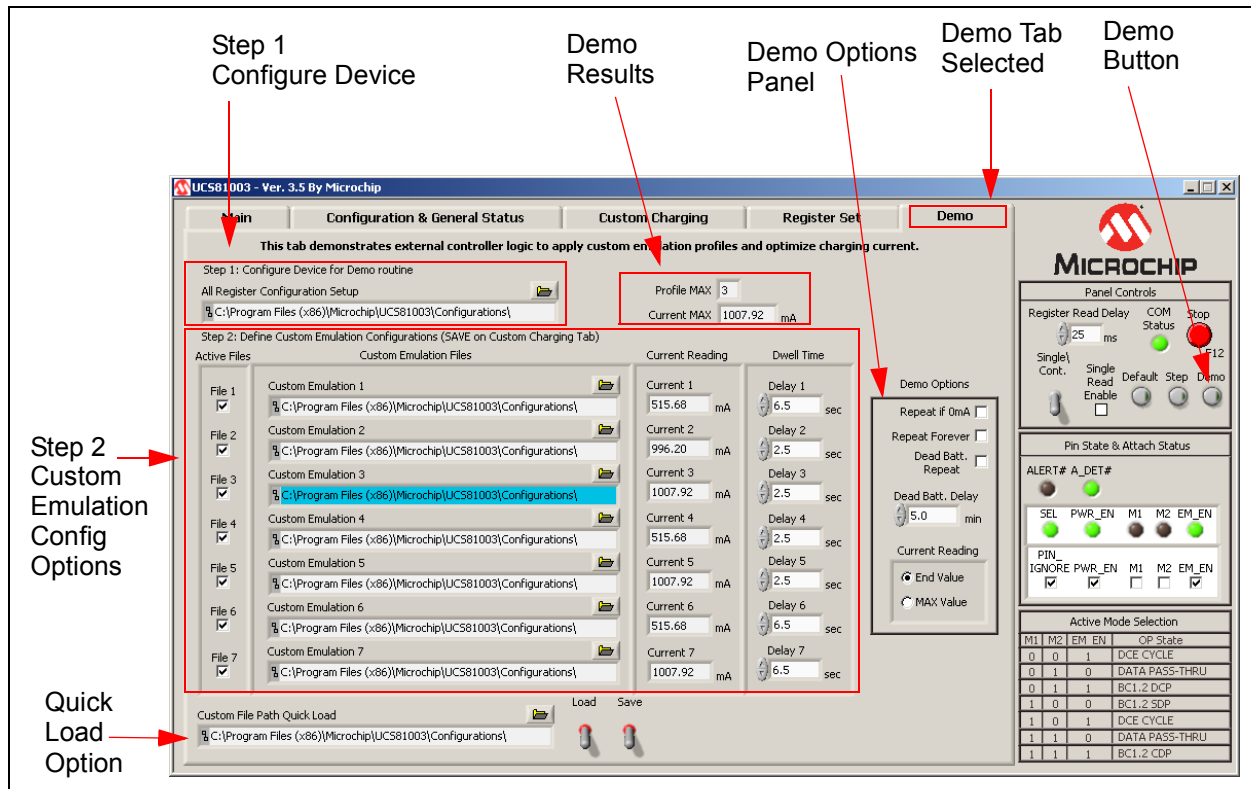
FIGURE 4-16:   *Demo Tab.*

4.3.5.1   STEP 1: CONFIGURE DEVICE FOR DEMO ROUTINE

The first step in preparing to run the Demo feature is to configure the device to the desired starting configuration. A file has been preloaded at installation and is ready to be used, or a new configuration can be created. Each time the **Demo** button (in the **Panel Control** section) is toggled, the `Setup.txt` file will be loaded.

4.3.5.2   STEP 2: DEFINE CUSTOM EMULATION CONFIGURATIONS

At installation, a set of files are preloaded on the users system (`profile1.txt` – `profile7.txt`) with the default profiles of the UCS81003. These files can be changed easily by using the **Custom Charging** tab.

4.3.5.2.1   Active Files

Check the corresponding check box to activate the desired profile in the demo routine.

4.3.5.2.2   Custom Emulation Files

This column contains the full path to the profile file to be loaded. This file should contain registers 40h – 4Ch, 16h and 25h. This file can be created with the GUI on the **Custom Charging** tab.

4.3.5.2.3   Current Reading

This column displays the current being drawn from the attached device. If End Value is selected (from the Demo Options section, Current Reading features), this will update continuously. If MAX Value is selected, this will store the highest value of current during the dwell time.

4.3.5.2.4   Dwell Time

Dwell Time column defines the amount of time from PWR_EN set to PWR_EN unset. Each profile can have a different Dwell Time.

4.3.5.3   DEMO OPTIONS

TABLE 4-2:   DEMO OPTIONS DESCRIPTION

Options	Description
Repeat if 0 mA	When this option is set, it will repeat if all of the profiles read 0 mA, i.e. no device connected
Repeat Forever	When set, it will repeat the set of files until unchecked
Dead Batt. Repeat	When set, it will start the demo after the initial cycle after the specified Dead Batt. Delay time. This is useful when the battery is completely discharged and the device OS is unable to handshake with UCS81003.
Dead Batt. Delay	This option is defined in minutes. Minimum is 0 minutes, maximum is 10 minutes.
Current Reading	Displays either the End Value (last value before PWR_EN set low) or MAX Value (highest value during Dwell Time)

4.3.5.4   CUSTOM FILE PATH QUICK LOAD

When starting the UCS81003 interface, the file paths are reset to a default path. If desired, the user may save the files in an alternate location. This quick load feature saves the paths of the Setup.txt and all seven profile locations to quickly return or change files with one click.

4.3.5.5   RUNNING THE DEMO

Once the files and settings are configured as desired, enable the Demo routine by pressing the **Demo** switch within the Panel Controls area. The routine begins and the results are displayed in Profile MAX and Current MAX. By default, the Demo routine will enable the profile that is indicated by Profile MAX.

• **Profile MAX**: Stores the profile of the highest value of current draw.
• **Current MAX**: Stores the highest current associated with the Profile MAX #.

Note: The **Demo** tab does not need to be visible to activate the Demo routine.

4.4   TROUBLESHOOTING

Table 4-3 identifies possible problems and their solutions to troubleshoot the UCS81003 software.

TABLE 4-3:   TROUBLESHOOTING THE INTERFACE - COMMON PROBLEMS

Problem	Solution
GUI Controls Unresponsive After Installation	Restart the computer. In some cases, a restart is required after installation.
GUI Freezes	If the GUI freezes for unknown reasons, communications cannot be stopped, and the program cannot be closed, disconnect the USB cable from the evaluation board, then close the program. Reconnect the board, then restart the GUI.
Random Panel Display	When a board is not connected to the PC running the GUI, the panel will be in an all-zero register displayed state. This also occurs when SMBus communications are disconnected. The panel display is not meaningful. Connect the board and establish SMBus communications. If this still does not work, there is a problem with the connection. The cable or the USB port may be defective.
Device Is Not Charging or Not Charging Optimally	• Check if the current limit jumper is set appropriately. • The current source may not have high enough capacity from V_S. • Run the Demo routine to determine highest current profile.

NOTES:

Appendix A. Schematic and Layouts

A.1 INTRODUCTION

This appendix contains the following schematics and layouts for the UCS81003 Evaluation Board:

- Board – Schematic
- Board – Top Silk
- Board – Top Copper and Silk
- Board – Top Copper
- Board – Inner Plans GND 1
- Board – Inner Plans GND 2
- Board – Bottom Copper
- Board – Bottom Copper and Silk
- Board – Bottom Silk

Schematic and Layouts
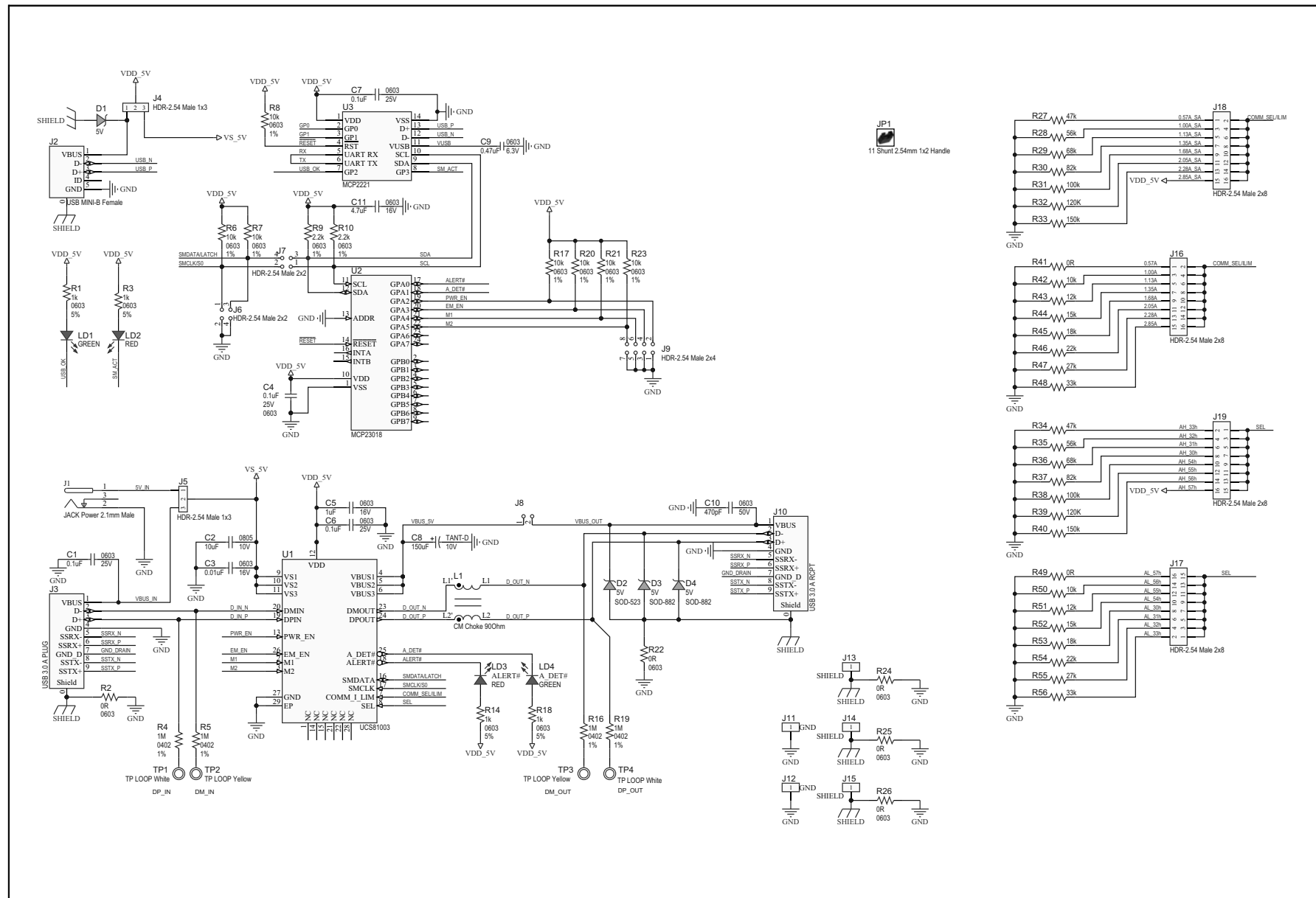
A.3   BOARD – TOP SILK
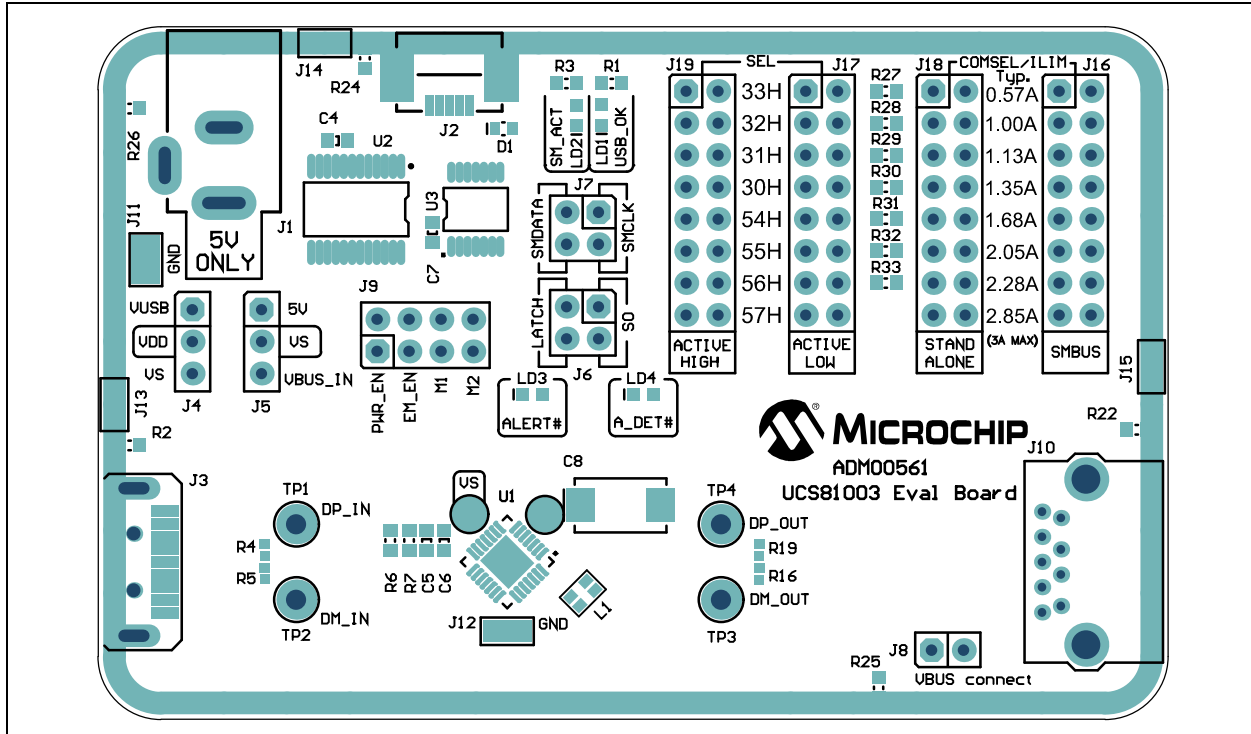
A.4   BOARD – TOP COPPER AND SILK

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A.5   BOARD – TOP COPPER

A.6   BOARD – INNER PLANS GND 1

A.7   BOARD – INNER PLANS GND 2

A.8   BOARD – BOTTOM COPPER

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A.9   BOARD – BOTTOM COPPER AND SILK

A.10   BOARD – BOTTOM SILK

Appendix B. Bill of Materials

TABLE B-1:   BILL OF MATERIALS (BOM)

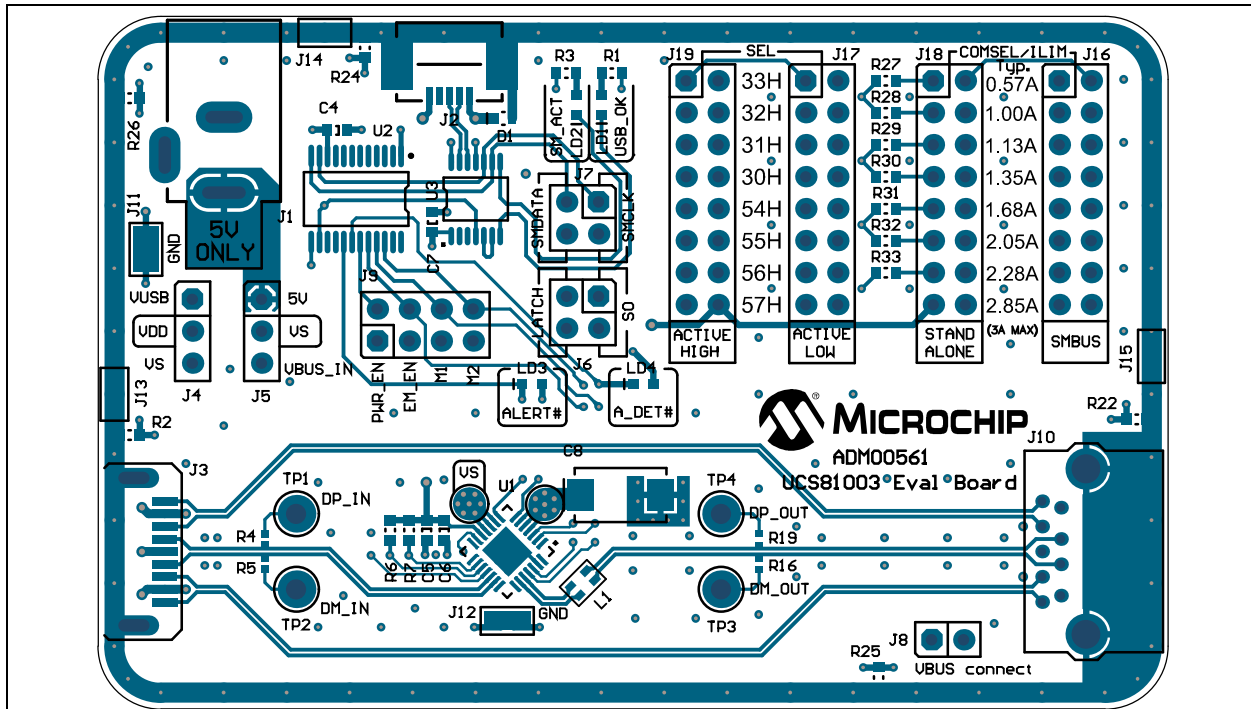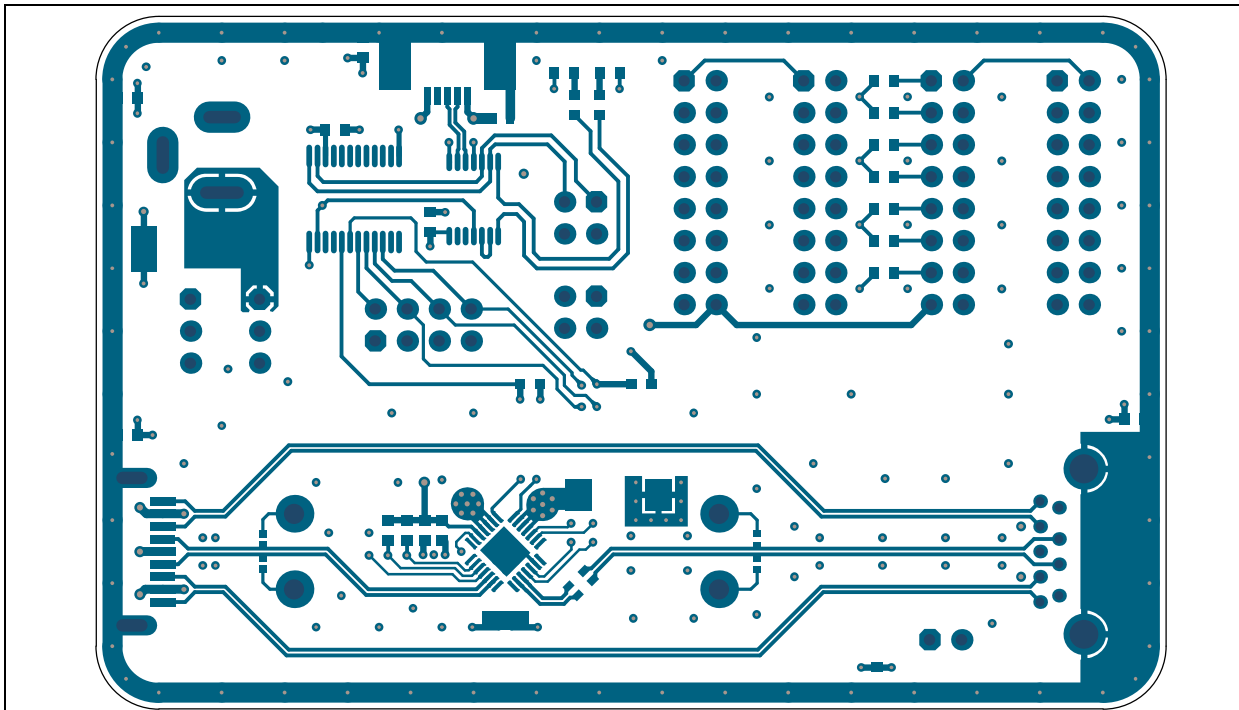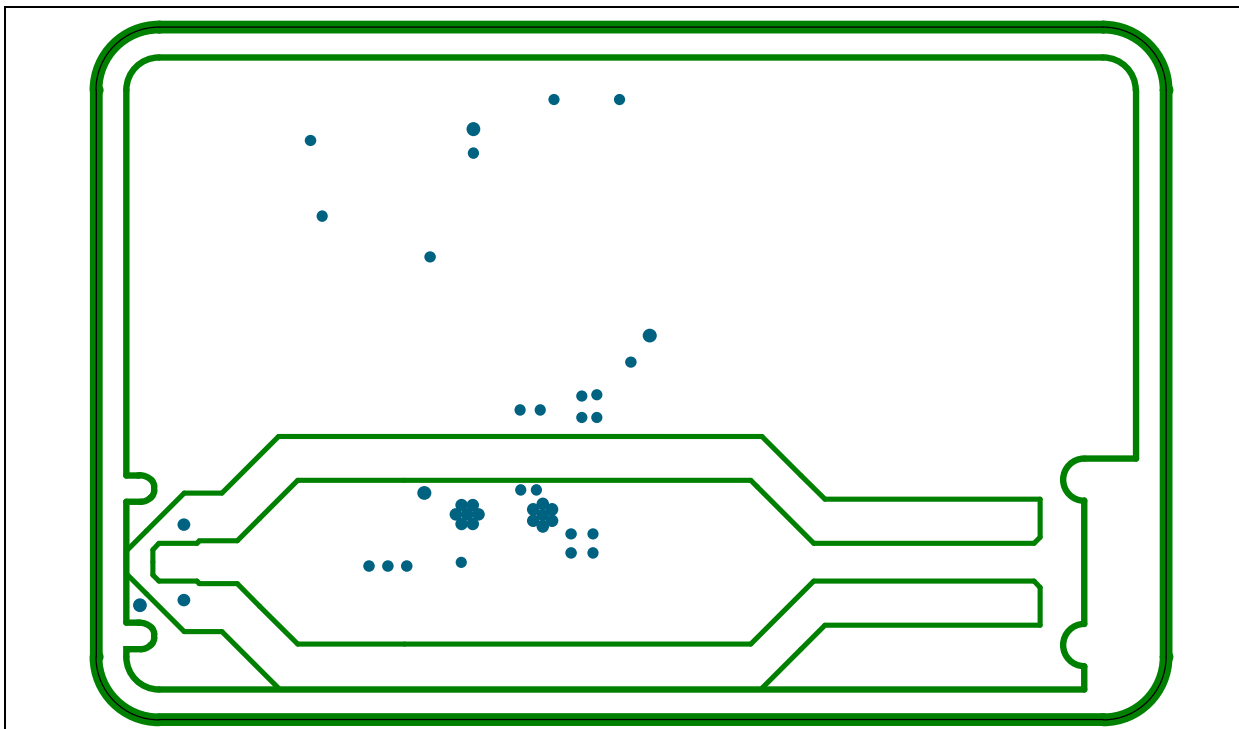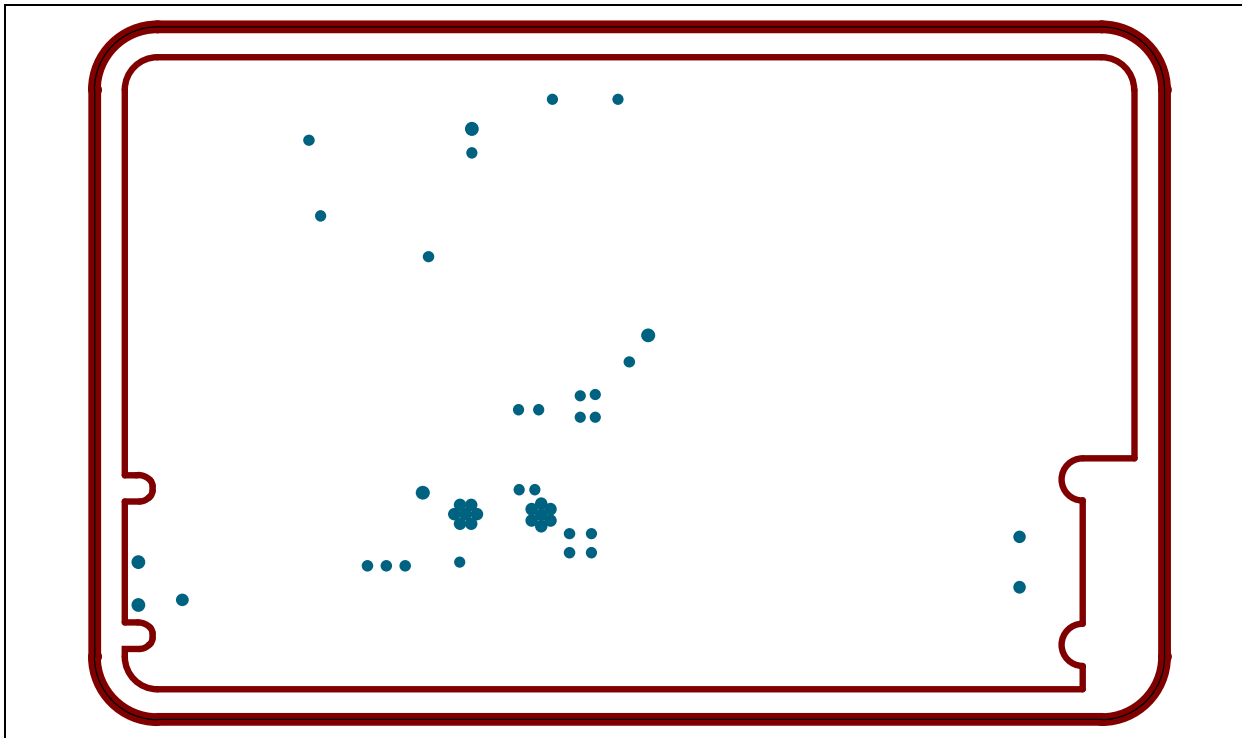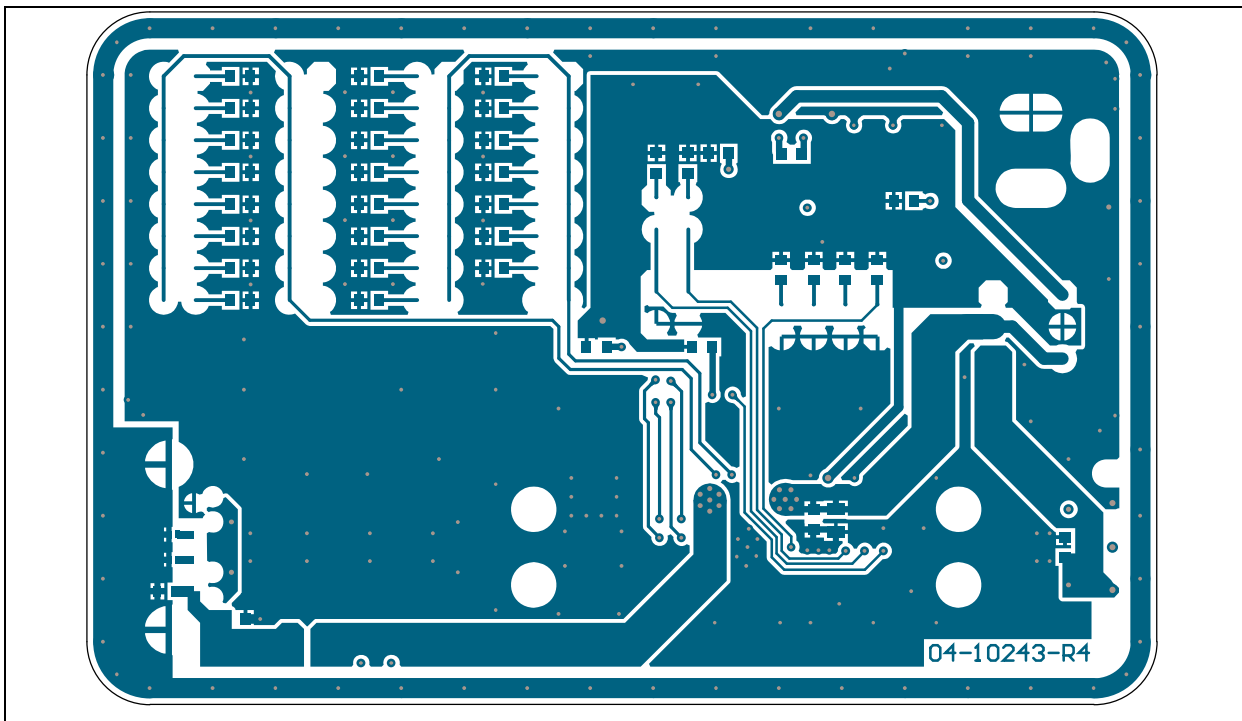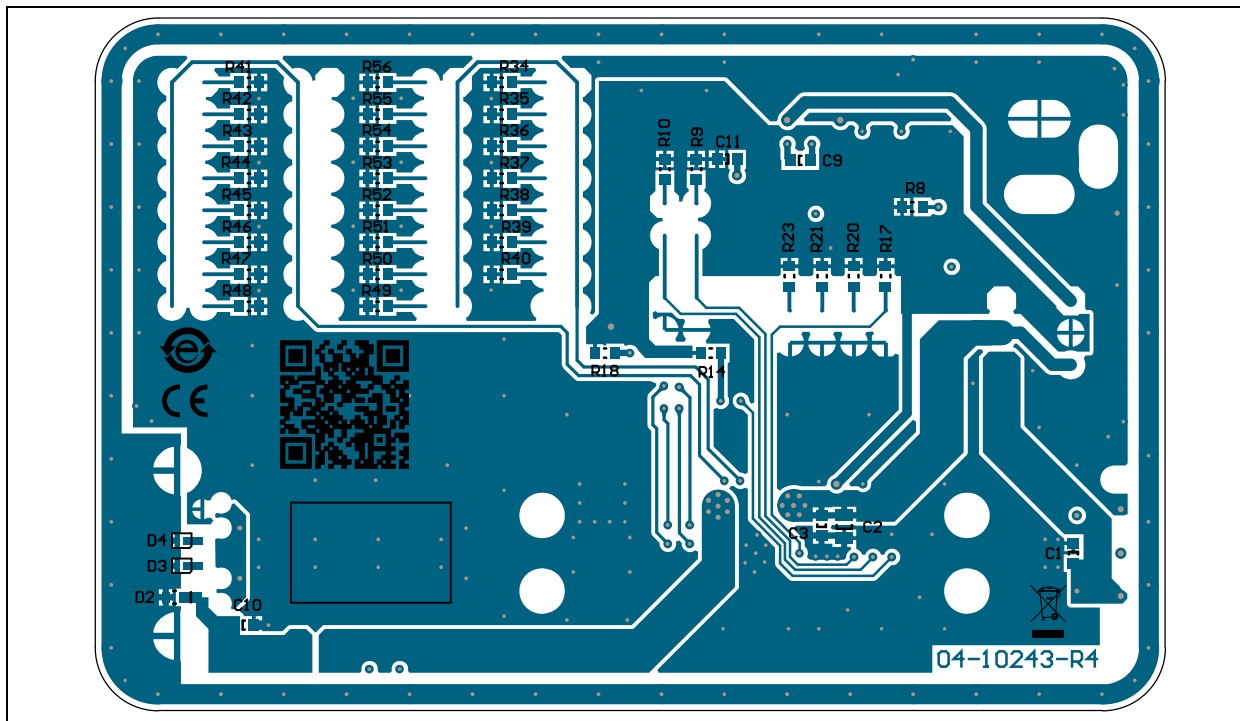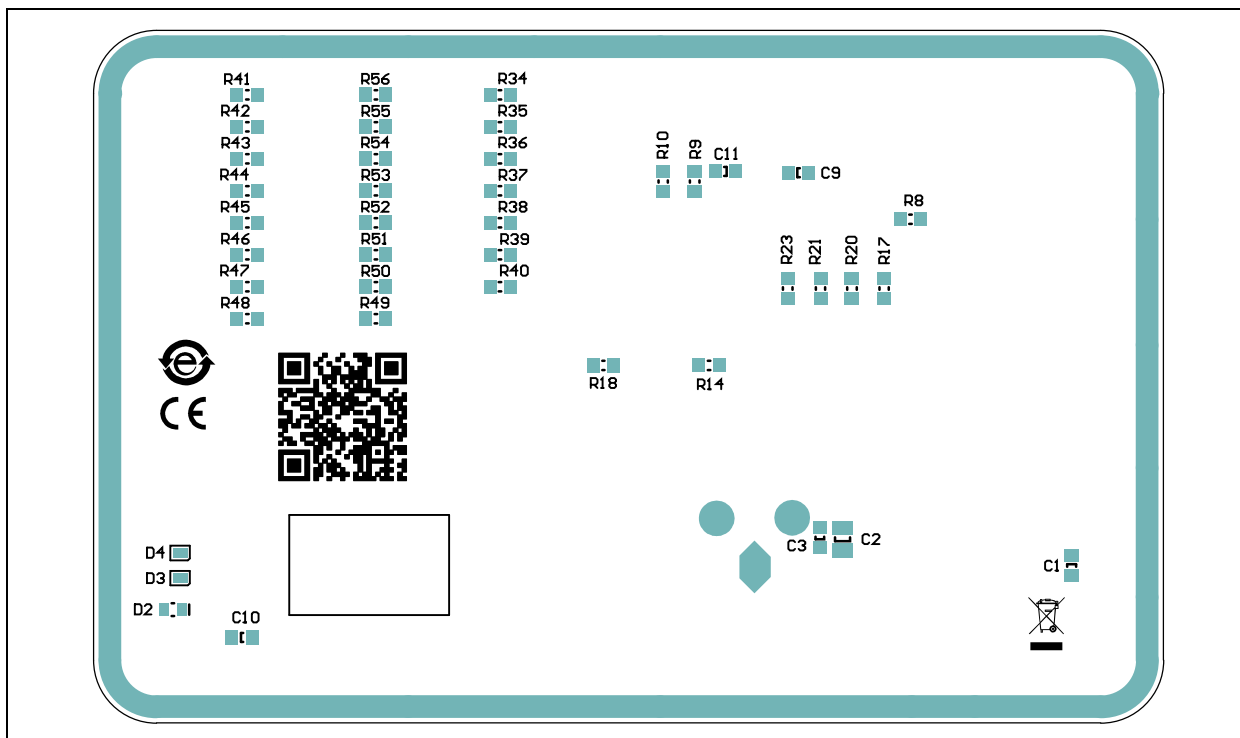| Qty.	Reference	Description	Manufacturer	Part Number
4	C1, C4, C6, C7	Cap. ceramic 0.1 µF 25V 10% X7R SMD 0603	Murata Electronics®	GRM188R71E104KA01D
1	C2	Cap. ceramic 10 µF 10V 10% X7R SMD 0805	Murata Electronics	GRM21BR71A106KE51L
1	C3	Cap. ceramic 0.01 µF 16V 10% X7R SMD 0603	Samsung Group	CL10B103KO8NNNC
1	C5	Cap. ceramic 1 µF 16V 10% X7R SMD 0603	Taiyo Yuden Co., Ltd.	EMK107B7105KA-T
1	C8	Cap. tantalum 150 µF 10V 10% 100m ohm SMD D	AVX Corporation	TPSD157K010R0100
1	C9	Cap. ceramic 0.47 µF 6.3V 10% X5R SMD 0603	Murata Electronics	GRM188R60J474KA01D
1	C10	Cap. ceramic 470 pF 50V 10% X7R 0603	TDK Corporation	C1608X7R1H471K
1	C11	Cap. ceramic 4.7 uF 16V 10% X5R SMD 0603	TDK Corporation	C1608X5R1C475K080AC
2	D1, D2	Diode Zener T5V0S5-7 5V 150 mW SMD SOD-523	Diodes® Incorporated	T5V0S5-7
2	D3, D4	Diode Zener PESD5V0X1BL 5V SMD SOD-882	NXP Semiconductor	PESD5V0X1BL,315
1	J1	Conn. jack power 2.1 mm 16V 2.5A male th. R/A	CUI Inc.	PJ-002A
11	JP1	Mech. hardware jumper 2.54 mm 1x2 handle gold	TE Connectivity, Ltd.	881545-2
1	J2	Conn. USB Mini-B female SMD R/A	Hirose Electric Co., Ltd.	UX60SC-MB-5ST(80)
1	J3	Conn. USB 3.0 Standard-A plug SMD R/A	Wurth Elektronik GmbH & Co.	692112030100
2	J4, J5	Conn. header-2.54 male 1x3 gold 5.84 MH th. vert.	FCI	68000-103HLF
1	J6	Conn. header-2.54 male 2x2 gold 5.84MH th. vert.	Samtec, Inc.	TSW-102-07-G-D
1	J7	Conn. header-2.54 male 2x2 gold 5.84MH th. vert.	Samtec, Inc.	HTSW-102-07-G-D
1	J8	Conn. header-2.54 male 1x2 gold 5.84MH th. vert.	FCI	68001-202HLF
1	J9	Conn. header-2.54 male 2x4 gold 5.84MH th. vert.	Samtec, Inc.	TSW-104-08-L-D
1	J10	Conn. USB 3.0 Standard-A rcpt. th. R/A	Wurth Elektronik GmbH & Co.	692121030100
5	J11, J12, J13, J14, J15	Conn. TP loop tin SMD	FCI	68602-116HLF

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.

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

Qty.	Reference	Description	Manufacturer	Part Number
4	J16, J17, J18, J19	Conn. header-2.54 male 2x8 gold 5.84MH th. vert.	FCI	68602-116HLF
1	L1	Inductor choke Common Mode 90 ohm 0805	Murata Electronics	DLW21HN900SQ2L
2	LD1, LD4	Diode LED green 2.2V 25mA 15 mcd clear SMD 0603	Kingbright Corp.	APT1608SGC
2	LD2, LD3	Diode LED red 1.95V 30 mA 700 mcd clear SMD 0603	Kingbright Corp.	APTD1608SURCK
4	R1, R3, R14, R18	Res. TKF 1k 5% 1/10W SMD 0603	Panasonic®	ERJ-3GEYJ102V
7	R2, R22, R24, R25, R26, R41, R49	Res. TKF 0R 1/10W SMD 0603	NIC Components Corp.	NRC06Z0TRF
4	R4, R5, R16, R19	Res. TKF 1M 1% 1/10W SMD 0402	Panasonic	ERJ-2RKF1004X
9	R6, R7, R8, R17, R20, R21, R23, R42, R50	Res. TKF 10k 1% 1/10W SMD 0603	NIC Components Corp.	NRC06F1002TRF
2	R9, R10	Res. TKF 2.2k 1% 1/10W SMD 0603	Panasonic	ERJ-3EKF2201V
2	R27, R34	Res. TKF 47k 1% 1/10W SMD 0603	Panasonic	ERJ-3EKF4702V
2	R28, R35	Res. TKF 56k 1% 1/10W SMD 0603	Stackpole Electronics, Inc.	RMCF0603FT56K0
2	R29, R36	Res. TKF 68k 1% 1/10W SMD 0603	Stackpole Electronics, Inc.	RMCF0603FT68K0
2	R30, R37	Res. 82K ohm 1/10W 1% 0603 SMD	Panasonic	ERJ-3EKF8202V
2	R31, R38	Res. TKF 100k 1% 1/10W SMD 0603	Panasonic	ERJ-3EKF1003V
2	R32, R39	Res. TKF 120K 1% 1/10W SMD 0603	Panasonic	ERJ-3EKF1203V
2	R33, R40	Res. TKF 150k 1% 1/10W SMD 0603	Panasonic	ERJ-3EKF1503V
2	R43, R51	Res. TKF 12k 1% 1/10W SMD 0603	Yageo Corporation	RC0603FR-0712KL
2	R44, R52	Res. TKF 15k 1% 1/10W SMD 0603	Panasonic	ERJ-3EKF1502V
2	R45, R53	Res. TKF 18k 1% 1/10W SMD 0603	ROHM Semiconductor	MCR03EZPFX1802
2	R46, R54	Res. TKF 22k 1% 1/10W SMD 0603	Stackpole Electronics, Inc.	RMCF0603JT22K0
2	R47, R55	Res. TKF 27k 1% 1/10W SMD 0603	Yageo Corporation	RC0603FR-0727KL
2	R48, R56	Res. TKF 33k 1% 1/10W SMD 0603	Stackpole Electronics. Inc.	RMCF0603FT33K0
2	TP1, TP4	Conn. TP loop white th.	Keystone Electronics Corp.	5012
2	TP2, TP3	Conn. TP loop yellow th.	Keystone Electronics Corp.	5014
1	U1	UCS81003 QFN-28_5X5_EP2.7x3	Microchip Technology Inc.	UCS81003AM-C1A
1	U2	Microchip interface GPIO-port Expand. I2C 16-port MCP23018-E/SS SSOP-24	Microchip Technology Inc.	MCP23018-E/SS
1	U3	MCP2221 TSSOP-14	Microchip Technology Inc.	MCP2221- I/ST

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:

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