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EVB-USB3813 Evaluation Board User's Guide

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Object of Declaration: EVB-USB3813 Evaluation Board

EU Declaration of Conformity

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

Derek Carlson
VP Development Tools

16-July-2013
Date

NOTES:

Table of Contents

NOTES:

Preface

NOTICE TO CUSTOMERS

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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 "DSXXXXXA", where "XXXXX" 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 EVB-USB3813 Evaluation Board. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- The Microchip Web Site
- Development Systems Customer Change Notification Service
- Customer Support
- Document Revision History

DOCUMENT LAYOUT

This document describes how to use the EVB-USB3813 Evaluation Board as a demonstration platform optimized for portable applications. The manual layout is as follows:

- **Chapter 1. "Overview"** – Shows a brief description of the EVB-USB3813 Evaluation Board.
- **Chapter 2. "Hardware Configuration"** – Includes information about the hardware configuration of the EVB-USB3813 Evaluation Board.
- **Chapter 3. "Battery Charging Support"** – Provides information about the EVB-USB3813 Evaluation Board battery charging features.
- **Appendix A. "EVB-USB3813 Evaluation Board"** – This appendix shows the EVB-USB3813 Evaluation Board.
- **Appendix B. "EVB-USB3813 Evaluation Board Schematic"** – This appendix shows the EVB-USB3813 Evaluation Board schematic.
- **Appendix C. "Bill of Materials (BOM)"** – This appendix includes the EVB-USB3813 Evaluation Board Bill of Materials (BOM).

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) { ... }`

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- **Emulators** – The latest information on Microchip in-circuit emulators.This includes the MPLAB REAL ICE and MPLAB ICE 2000 in-circuit emulators.
- **In-Circuit Debuggers** – The latest information on the Microchip in-circuit debuggers. This includes MPLAB ICD 3 in-circuit debuggers and PICkit 3 debug express.
- **MPLAB IDE** – The latest information on Microchip MPLAB IDE, the Windows Integrated Development Environment for development systems tools. This list is focused on the MPLAB IDE, MPLAB IDE Project Manager, MPLAB Editor and MPLAB SIM simulator, as well as general editing and debugging features.
- **Programmers** – The latest information on Microchip programmers. These include production programmers such as MPLAB REAL ICE in-circuit emulator, MPLAB ICD 3 in-circuit debugger and MPLAB PM3 device programmers. Also included are nonproduction development programmers such as PICSTART Plus and PIC-kit 2 and 3.

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- Field Application Engineer (FAE)
- Technical Support

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

DOCUMENT REVISION HISTORY

Revision A (September 2013)

- Initial Release of this Document.

Chapter 1. Overview

1.1 INTRODUCTION

The USB3813 is a low-power, full-featured and OEM configurable Multi-Transaction Translator (MTT) USB 2.0 hub controller with three downstream ports optimized for portable applications. The USB3813 is fully compliant with the USB 2.0 Specification, USB 2.0 Link Power Management (LPM) Addendum, High-Speed Inter-Chip (HSIC) USB Electrical Specification Revision 1.0 and attaches to an upstream port as a high-speed hub. The 3-port hub supports low-speed, full-speed and high-speed downstream devices on all of the enabled (non-HSIC) downstream ports. The HSIC port supports only high-speed operation. The USB3813 supports both upstream and downstream battery charging (BC1.2) detection. The EVB-USB3813BC Evaluation Board demonstrates a stand-alone application for the USB3813 device with advanced power saving options and configurable port assignments. See **Section 1.2 "Features"** for more information.

1.2 FEATURES

- USB3813 in a 30-pin WLCSP RoHS compliant package
- Two USB 2.0 downstream ports with ganged port power and overcurrent sense (OCS)
- One downstream HSIC port (downstream port 1)
- High-Speed (480 Mbps), Full-Speed (12 Mbps) and Low-Speed (1.5 Mbps) compatible
- USB Battery Charging is supported on all downstream USB ports up to 2A (BC1.2 CDP, SDP and DCP)
- Multi-Transaction Translator is enabled
- Supports internal default hub configuration. Optionally supports configuration from external SPI or EEPROM
- SMBus interface header available
- Low-Cost, 4-Layer space saving design with two outer signal layers, a power inner layer and a ground inner layer
- Self-Powered operation
- Operates from one single voltage (+5.0 VDC, 4 Amp regulated) external DC power supply
- On Board MCP1725 +3.3 VDC. 0.5 Amp regulator
- +5V, Reset, Hub Connect and port power LED indicators
- ESD/EMI component footprints provided (optional)
- Single 12 MHz crystal clock source
- External GPIO pin headers
- Schematics, layout and bill of materials are available to minimize new product development time

1.3 GENERAL DESCRIPTION

The EVB-USB3813 is an evaluation and demonstration platform featuring the USB3813 Ultra Fast USB 2.0 Hub on a 4-layer RoHS compliant Printed Circuit Board (PCB).

The EVB-USB3813 is designed to demonstrate the unique features of this device using a low-cost PCB implementation with ganged port power control for the two downstream USB 2.0 ports. Both downstream USB 2.0 ports include a high current port power controller to fully support USB battery charging as a high current walk-up port.

Note: Do not exceed 4A total current consumption from 5 VDC.

The EVB-USB3813 is designed to support internal default configuration settings and an external I^2C^{TM} EEPROM (optional) for custom configured functionality. A location is provided for an external I^2C EEPROM device for configuration at U8. Alternatively, a firmware can be downloaded onto a dual-output SPI Flash device located at U17. Figure 2-2 shows the top and bottom level silk screen and copper layers. A block diagram of the EVB-USB3813 is shown in Figure 2-3.

Chapter 2. Hardware Configuration

2.1 HARDWARE DESCRIPTION

The EVB-USB3813 has one on board regulator. The MCP1725 (U6) generates +3.3 VDC for the hub device circuitry and performs voltage supervisor and RESETn functions. The USB3813 generates its own +1.2 VDC for internal use with on-chip +1.2 VDC regulators. The internal +1.2 VDC regulator tied to the oscillator and Phase-Locked Loop (PLL) is turned off during suspend to minimize suspend current. Downstream port power is distributed by two independent power switches at up to 2A per port via U1 and U2.

Note: Do not exceed 4A total current consumption from +5 VDC.

Downstream port 2 and port 3 have USB 2.0 connectors with USB 2.0 compliant decoupling and separate shield grounds. Downstream port 1 has U.FL connectors (J16 and J17) to support Data and Strobe HSIC signals.

2.1.1 Port Assignment

The downstream ports are numbered 1 through 3. Downstream port 1 is an HSIC port and downstream port 2 and port 3 are the USB 2.0 ports. The USB3813 allows downstream port 2 and/or port 3 to be configured for high current battery USB charging. Power to downstream port 2 and port 3 is controlled through the AP2111 devices U1 and U2. Each device provides up to 2A to the corresponding downstream port. Both of these port power controllers are enabled via a shared PRTPWR pin on the USB3813. Overcurrent sensing of both port power controllers is also monitored on the same PRTPWR pin.

Note: There is only a maximum of 4A provided across the entire evaluation board.

The EVB-USB3813 must be connected to a USB upstream host via the J0 USB 2.0 micro AB connector using the provided USB 2.0 cable. When using downstream port 1, the provided HSIC cables must be inserted into the U.FL connectors J16 (STROBE1) and J17 (DATA1). When removing these cables from the evaluation board for any reason, the provided HSIC Extraction tool must be used. Figure 2-1 shows the recommended usage of the HSIC extraction tool per the Hirose U.FL data sheet on proper use of the plugs.

FIGURE 2-1: U.FL COAXIAL CABLE EXTRACTION GUIDELINES

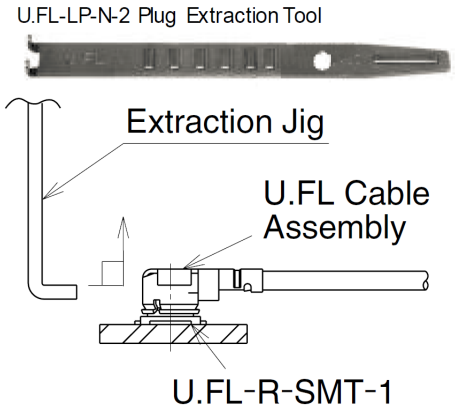
Usage Precautions

1. Plugs

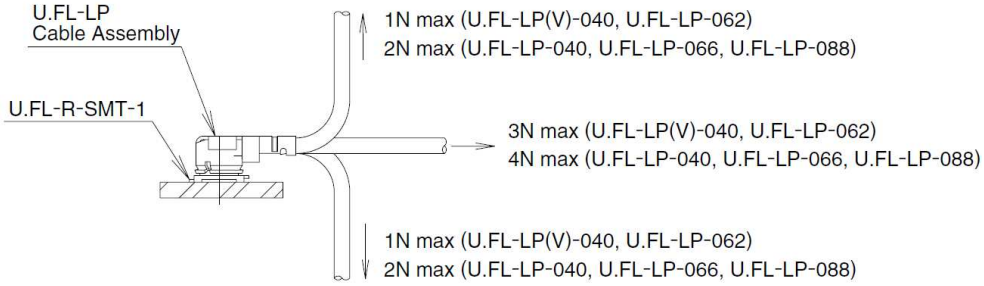
(1) Mating/Unmating

1) To disconnect the connectors, insert the end portion of U.FL-LP-N-2 under the connector flanges and pull off vertically, in the direction of the connector mating axis.

2) To mate the connectors, the mating axes of both connectors must be aligned. The "click" confirms a fully-mated connection. Do not attempt to insert on an extreme angle.



(2) Pull forces on the cable after the connectors are mated. Do not apply a load to the cable in excess of the values indicated in the diagram below.



(3) Precautions

Do NOT forcefully twist or deform wires.

When an upstream USB 2.0 host is attached and detected, the HUB_CONN pin on the USB3813 asserts and the green "HubConn" LED D18 lights up.

The EVB-USB3813 is designed to allow flexible configuration options. It can be configured with default internal register settings through an SMBus or through a downloadable external firmware to an SPI Flash. It supports “Quad-Page” configuration OTP flash (four consecutive 200-byte configuration pages). The following sections detail the various configuration methods and features.

2.1.2 USB3813 Configuration

Default: Upon power-up, the USB3813 searches for an external SPI Flash device that contains a valid signature. If an SPI device is not present, the firmware checks to see whether SMBus is enabled. If the SMBus is disabled, the USB3813 attempts to load the configuration from an external I^2C EEPROM. If no external options are detected, the USB3813 will operate using the internal default register settings. It also sets the vendor ID, product ID, language ID, device ID and additional settings from internal ROM code.

SPI Flash Option: If upon power-up an external SPI Flash device is present, the external ROM is enabled and code execution is initiated from the external SPI device. The SPI Flash device on the EVB-USB3813 is populated by default. To hold this device in reset, the J33 “SPI Hold” two-pin header can be shorted together, thereby tying the HOLD signal low.

SMBus Option: The SMBus interface is disabled by default via the 100 kOhm pull down resistor on SMBCLK. To enable SMBus, the SMBCLK pin must be pulled high to +3.3 VDC with a strong pull up resistor. This is often embedded within the external SMBus tool (not included) when inserted onto the J13 SMBus header. All device configuration must be performed via the Pro-Touch Programming Tool. For information on this tool, contact your local sales representative. When SMBus is enabled, the firmware configures the GPIOs to act as an SMBus slave. As an SMBus slave, the firmware waits indefinitely for the SMBus configuration.

EEPROM Option: If the USB3813 does not detect an SMBus interface, it will check for an I^2C EEPROM (not populated by default). The EVB-USB3813 loads configuration from an external two-wire I^2C EEPROM when present. The EEPROM must be installed either directly or through a DIP socket located at the U8 footprint and the “Manual I^2C Enable” headers J11 and J12 must be set to enable this option. By default, J11 and J12 are left open so that the I^2C interface are only enabled by pull ups in the external EEPROM device. When both J11 and J12 are jumpered, SDA and SCL on the I^2C interface are pulled high to +3.3 VDC externally. The EEPROM must be pre-programmed before installation as the EVB-USB3813 is tied to an HSIC host. The EVB-USB3813BC is compatible with I^2C EEPROMs from several manufacturers. The memory capacity must be at least 512 bytes.

2.1.3 Clock Source – 12 MHz Oscillator

By default, a 12 MHz oscillator OSC1 is populated on the evaluation board as the clock source for the USB3813. An alternative clock source can be injected into the J54 SMA “External Clock Input” connector if desired. The REFSEL[1:0] pins are both pulled high to +3.3 VDC by default to configure the USB3813 to have an input reference clock frequency of 12 MHz.

2.1.4 Power Source – Self-Powered

The EVB-USB3813 only supports self-powered operation and is powered by one +5 VDC regulated external DC power supply. The +5 VDC, 4A external DC power supply plugs into the on board 2.1 mm connector J8. The external power supply controls the on board +3.3 VDC MCP1725 voltage regulator. The evaluation board is setup so that the +5 VDC feeds VBAT on the USB3813 which feeds the internal +3.3 VDC regulator. The +3.3 VDC comes out on the VDD33 power pin which then feeds the internal +1.2

VDC regulator via the VDDCRREG pin. A +1.2 VDC is then output onto the VDDCR12 pin of the USB3813. Therefore, the USB3813 is powered completely by the +5 VDC output of the external power supply.

2.1.5 Power State LED

The LED D5 indicates when +5 VDC power is present.

2.1.6 RESETn LED

The LED D6 indicates when the RESETn signal is driven low and the USB3813 is held in the Reset state.

2.1.7 Port Power LEDs

LEDs D2 and D3 indicate when +5 VDC port power is available to the associated downstream USB port(s).

2.1.8 Hub Connect LED

The LED D18 indicates when an upstream USB 2.0 host is present.

2.1.9 Connector Description

The EVB-USB3813 has two standard USB style A connectors for downstream port 2 and port 3. The upstream port has a USB micro AB connector. Power is supplied via 2.1 mm power jack. See Table 2-1 for the list of connectors. For more details, please see **Appendix A. "EVB-USB3813 Evaluation Board"**.

TABLE 2-1: CONNECTOR DESCRIPTION

Connector	Type	Description
J0	USB uAB	Upstream USB Port 0
J2	USB A	Downstream USB Port 2
J3	USB A	Downstream USB Port 3
J7	1x2 header	External Reset Control
J8	Power Jack 2.1 mm	+5 VDC Regulated Power Supply
J9	1x2 header	VBUS 5V Optional Header
J11, J12	1x2 headers	I^2C™ External/Manual Enable
J13	2x5 header	SMBus I/F connection
J16	U.FL	Downstream HSIC Port 1 STROBE
J17	U.FL	Downstream HSIC Port 1 DATA
J18, J19	1x2 headers	Charge Detect [1:0]
J22	1x2 header	Suspend/IRQ#/Interrupt
J33	1x2 header	SPI HOLD (to hold SPI in reset)
J54	SMA	External Clock Input

Component side top and bottom layers are shown in Figure 2-2 with silk screen information to identify component locations.

FIGURE 2-2: EVB-USB3813 TOP AND BOTTOM LEVEL SILK SCREEN AND COPPER LAYERS

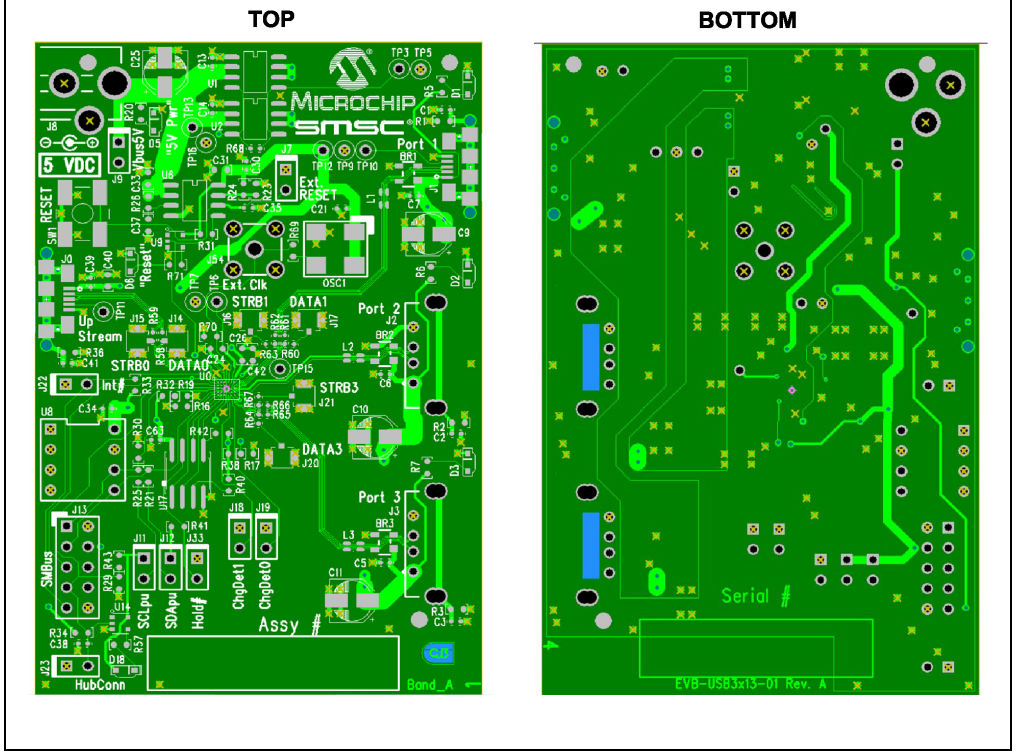
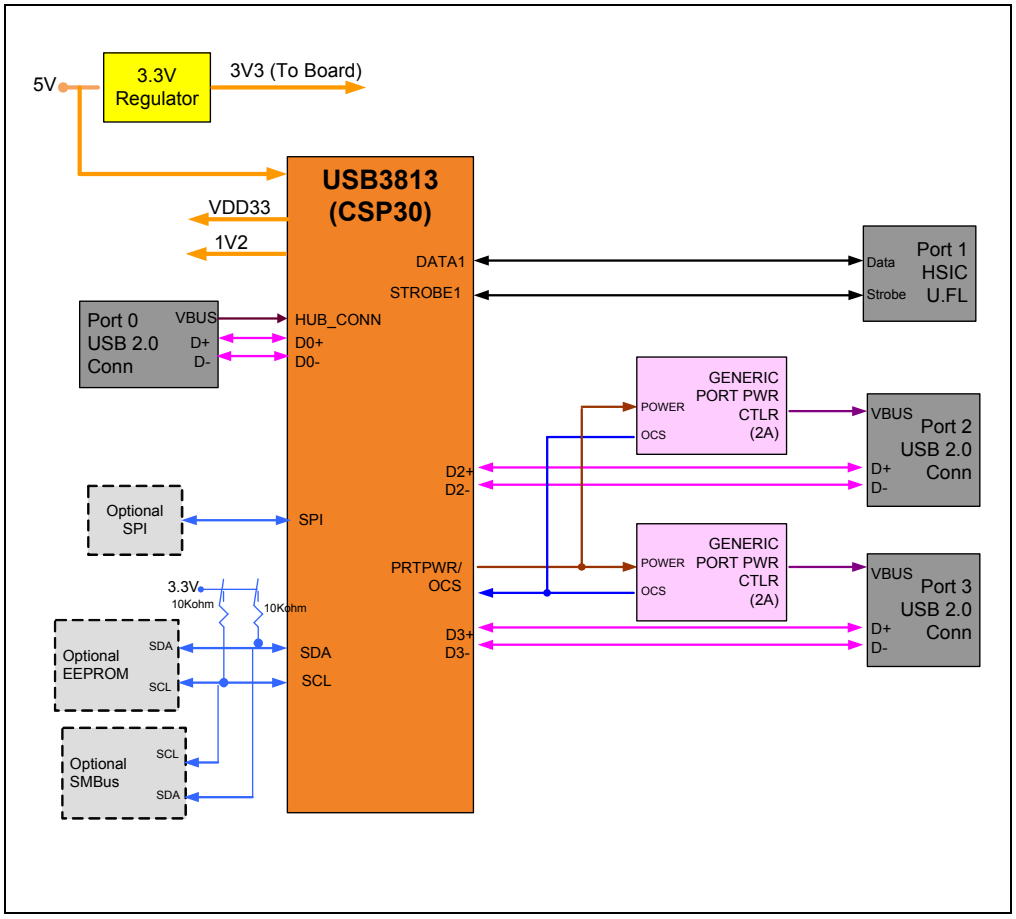


FIGURE 2-3: EVB-USB3813 BLOCK DIAGRAM



Chapter 3. Battery Charging Support

3.1 BATTERY CHARGING MODES

The EVB-USB3813 supports several different Battery Charging modes, providing an array of flexible configuration solutions. Both downstream port 2 and port 3 can be separately configured for Battery Charging via OTP, downloadable external firmware to an on board SPI Flash or through SMBus commands. Each port's configuration is independent of the other ports.

The Battery Charging mechanism automatically switches ports between states that perform the BC1.2 CDP handshake (which allows full USB communication with a USB host while charging), and states that emulate the dedicated chargers from charging device vendors. This allows support for the BC1.2 CDP mode and emulation of dedicated chargers in DCP mode, without interfering with normal USB operation of any USB 2.0 device attached to the port. Battery Charging is supported through the use of standard port power controllers.

Section 3.2 "Charging Port Roles" describes the modes of operation. For more information on battery charging, please refer to the Application Note 34.5 and the USB Battery Charging 1.2 specifications.

3.2 CHARGING PORT ROLES

The EVB-USB3813's Battery Charging enabled downstream ports automatically switches between various roles depending on the USB state of the EVB-USB3813. These roles are:

1. BC1.2 charging downstream port (CDP – 1.5A with data)
2. Standard downstream port (SDP – 0.5A with data)
3. Dedicated charger emulation port (DCP – power brick without data)
4. Custom profiles loaded via SMBus or OTP

When switching between roles, the EVB-USB3813 toggles power to the attached device if appropriate. The power toggle occurs if charger or USB renegotiation is necessary based on the following conditions:

1. If the port is in an SDP role while the hub is disconnected from the host, the port toggles power when switching to a DCP role to allow the downstream device to negotiate with the DCP mechanism.
2. If the port is in a DCP role and the port needs to switch to a CDP or SDP role, the port toggles power to allow the device to renegotiate with a CDP handshake and/or USB attach.

When Battery Charging is disabled for a EVB-USB3813 port, the port acts as a normal USB hub port.

When the EVB-USB3813's upstream port is connected to a USB host and the EVB-USB3813 is not in USB 2.0 suspend and/or USB 2.0 remote wake is enabled, Battery Charging enabled ports follow the BC1.2 specification for a CDP role. In this case, after a USB 2.0 device is attached, the port behaves in SDP role until the device is detached from the hub or the hub is detached from the host.

When a USB port is in a state in which device-host USB communication is not possible, a Battery Charging enabled port is not required to act as a USB hub port and is therefore free to enter states that emulate dedicated chargers. For the EVB-USB3813, there are two cases where this applies:

1. The EVB-USB3813 upstream port is not connected to a USB host.
2. The EVB-USB3813 is in USB suspend with remote wake on the USB 2.0 portion of the EVB-USB3813 disabled and no USB 2.0 device connected as a USB device on the downstream port. If USB 2.0 remote wake is disabled, the hub cannot generate resume signaling and does not need to detect a USB 2.0 attach.

In case 2, the EVB-USB3813's charging ports do not enter dedicated charging states when there is a USB 2.0 device attached as a USB device. There are two reasons for this behavior:

1. Entering dedicated charging states may involve changing the state of an attached device due to power toggling and/or USB linestate changing. Because the host system is unaware of the Battery Charging mechanism of the EVB-USB3813, the host could find the device in an unexpected state when exiting suspend.
2. The attached device will not be able to signal resume signaling to the host when the port is in a dedicated charging state. Hubs must propagate resume signaling from downstream devices even when remote wake generation is disabled for the hub.

If the EVB-USB3813 is in USB 2.0 suspend with USB 2.0 remote wake disabled and a USB-attached device is removed from a port, the port switches to the DCP role because possible resume propagation is no longer required.

3.2.1 BC1.2 Charging Downstream Port (CDP) Description

Devices that do not follow the BC1.2 CDP specification behave as they normally would when inserted into a standard USB port. The EVB-USB3813 ports in CDP mode allow normal USB operation or communication between normal devices and USB hosts by switching to the SDP role after downstream device detection and absence of a BC1.2 CDP handshake from the device. When a subsequent device detach is detected, the port switches back to the CDP role.

Devices that follow the BC1.2 CDP specification are also allowed to communicate normally with the USB host when inserted into the EVB-USB3813 ports in CDP mode. Additionally, prior to allowing the normal USB connection between the host and the BC1.2 device, the EVB-USB3813 port performs the BC1.2 CDP handshake to inform the BC1.2-compliant device that it may draw current exceeding the USB specified limits. When the handshake is complete, the port switches to the SDP role to allow USB functionality for the device. When a subsequent device detach is detected, the port switches back to the CDP role.

3.2.2 Standard Downstream Port (SDP) Description

When a port is in the SDP role, it behaves as a normal hub port and allow full USB functionality for an attached downstream device.

3.2.3 Dedicated Charger Emulation Port (DCP) Description

The advantage of the EVB-USB3813 dedicated charger emulation port over the BC1.2-specified DCP is that it supports BC1.2 compliant charging devices and many non-BC1.2 compliant charging devices. The following paragraphs describe the EVB-USB3813 modes of operation when its downstream ports are in dedicated charging states (when normal USB connection is not required as described in previous sections).

Dynamic Mode:

The EVB-USB3813 can be configured to dynamically react to devices inserted into the downstream ports and emulate the appropriate type of charger for the inserted device. In this configuration, the port begins in Apple® charger emulation mode and switches to China Charging, Blackberry® or BC1.2 device charger emulation when such devices are detected by the port. When a device is detached, the port starts again in Apple charger emulation mode.

Configurable 1A and 2A Apple modes are available depending on the capabilities of each port's port power controller.

An EVB-USB3813 port with a standard port power controller also supports Samsung® Galaxy Tab™ charger emulation in addition to the above modes.

Static Mode:

The EVB-USB3813 can be configured to keep the downstream ports in a fixed charger emulation state. Currently, Apple and Samsung Galaxy Tab or China Charging fixed charger emulation modes are available.

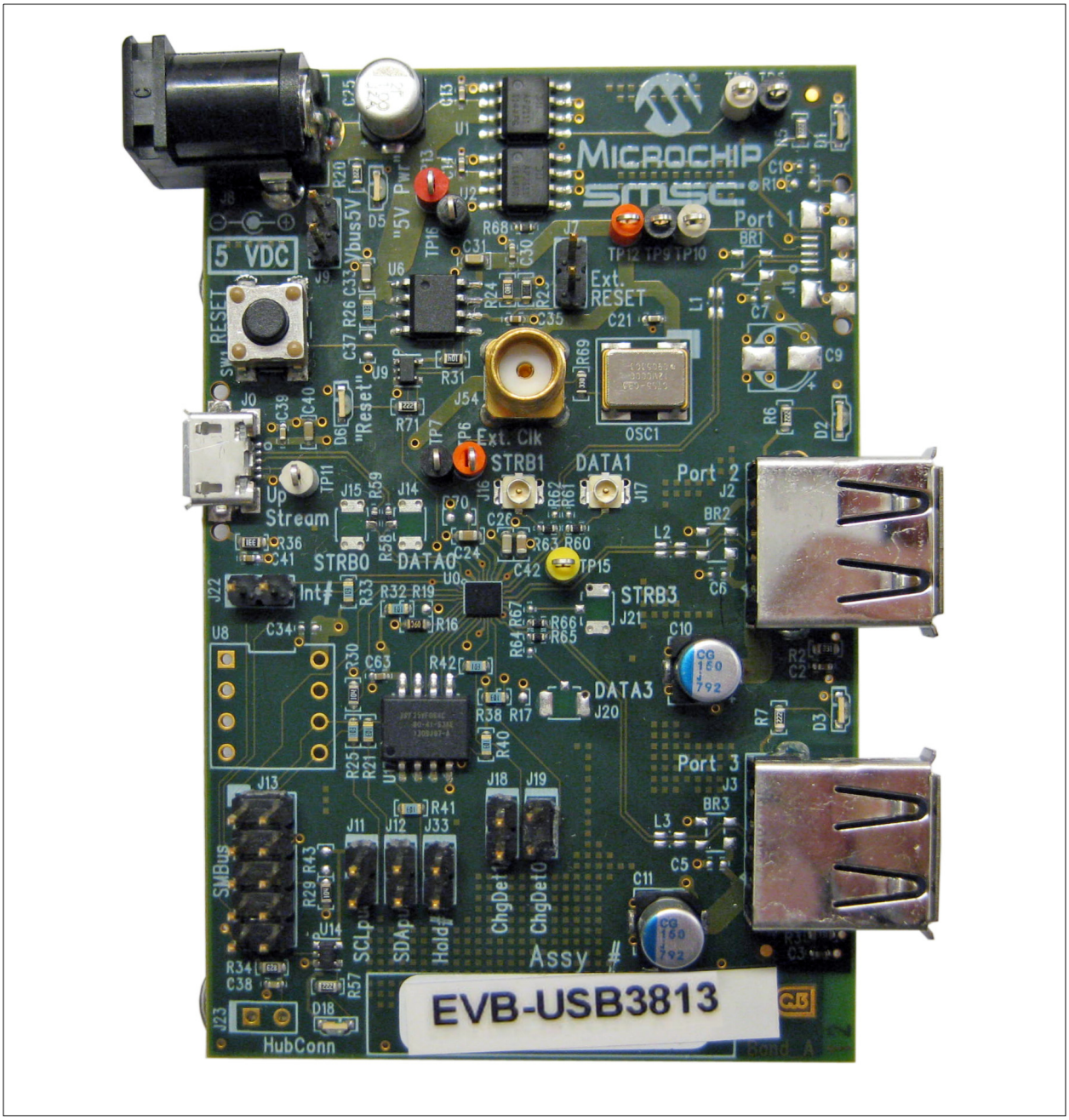
NOTES:

Appendix A. EVB-USB3813 Evaluation Board

A.1 INTRODUCTION

This appendix shows the EVB-USB3813 Evaluation Board.

FIGURE A-1: EVB-USB3813 EVALUATION BOARD



NOTES:

Appendix B. EVB-USB3813 Evaluation Board Schematic

B.1 INTRODUCTION

This appendix shows the EVB-USB3813 Evaluation Board Schematic.