EVB-USB3503 QFN Evaluation Board User's Guide

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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

Table of Contents

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-USB3503 QFN Evaluation Board. Items discussed in this chapter include:

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

DOCUMENT LAYOUT

This document describes how to use the EVB-USB3503 QFN 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-USB3503 QFN Evaluation Board
- **Chapter 2. "Hardware Configuration"** – Includes information about the hardware configuration of the EVB-USB3503 QFN Evaluation Board.
- **Chapter 3. "Operation"** – Provides information about installing and operating the EVB-USB3503 QFN Evaluation Board and Evaluation Software.
- **Appendix A. "EVB-USB3503 QFN Evaluation Board Schematics"** – Provides information about known issues and limitations associated with EVB-USB3503.

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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- 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 (March 2014)

- Initial Release of this Document.

NOTES:

Chapter 1. Overview

1.1 EVB-USB3503 QFN OVERVIEW AND FEATURES

The USB3503 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 USB3503 is fully compliant with the USB 2.0 Specification, 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 downstream ports. The upstream HSIC port supports only high-speed operation. The EVB-USB3505 QFN Evaluation Board demonstrates a stand-alone application for the USB3503 device. See **Section 1.2 "Features"** for additional information.

1.2 FEATURES

- USB3503 in a 32-pin QFN RoHS compliant package
- One upstream HSIC port
- Three USB 2.0 downstream ports with ganged port power and overcurrent sense (OCS)
- High-Speed (480 Mbps), Full-Speed (12 Mbps) and Low-Speed (1.5 Mbps) compatible on downstream USB ports
- Multi-Transaction Translator is enabled
- Supports internal default hub configuration. Optionally supports external configuration via I^2C
- I^2C interface header available
- Self-Powered operation
- Operates from one single voltage (+5.0 VDC, 4 Amp regulated) external power supply
- On Board +3.3 VDC and +1.8 VDC regulators
- Interrupt LED indicator
- Single 26 MHz oscillator clock source
- Schematics, layout and bill of materials are available to minimize new product development time

1.3 GENERAL DESCRIPTION

The EVB-USB3503 QFN is an evaluation and demonstration platform featuring the USB3503 Ultra Fast USB 2.0 Hub on an RoHS compliant Printed Circuit Board (PCB).

The EVB-USB3503 QFN is designed to demonstrate the unique features of this device using a low-cost PCB implementation with ganged port power control for the three downstream USB 2.0 ports.

The EVB-USB3503 QFN is designed to support internal default configuration settings or external configuration through I^2C via the SDA and SCL header pins. Figure 2-6 details the top and bottom level silk screen and copper layers. A block diagram of the evaluation board can be seen in Figure 2-7.

Chapter 2. Hardware Configuration

2.1 HARDWARE DESCRIPTION

2.1.1 Port Assignment

The USB 2.0 downstream ports are numbered 1 through 3. All downstream ports have USB 2.0 connectors with USB 2.0 compliant decoupling and separate shield grounds. Power to all downstream ports is controlled through the MIC2026-1B device U4. When port power is enabled via the PRTPWR pin on the USB3503, port power is delivered to all 3 downstream USB ports.

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

The EVB-USB3503 QFN must be connected to an HSIC upstream host via the DATA (J5) and STROBE (J4) connectors using the provided U.FL coaxial cables. When removing these cables from the EVB for any reason, the provided HSIC Extraction tool must be used. Figure 2-1shows the recommended usage of the HSIC extraction tool per the Hirose U.FL data sheet on proper use of the plugs.

FIGURE 2-1: RECOMMENDED USAGE OF THE HSIC EXTRACTION TOOL

Usage Precautions

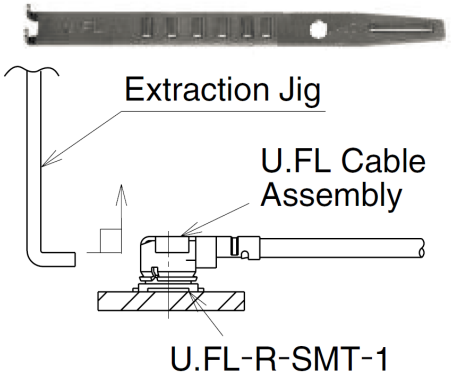
1. Plugs

(1) Mating/Unmating

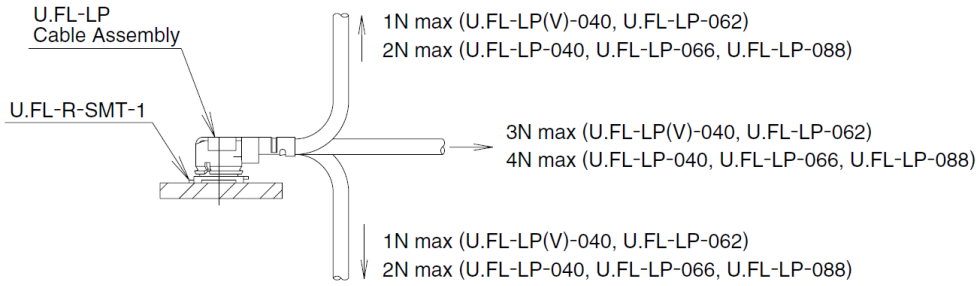
1) To disconnect the connectors, insert the end portion of U.FL-LP-N-2 under the connector flanges and pull off vertically, in the direction of the connector mating axis.

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.

U.FL-LP-N-2 Plug Extraction Tool



(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

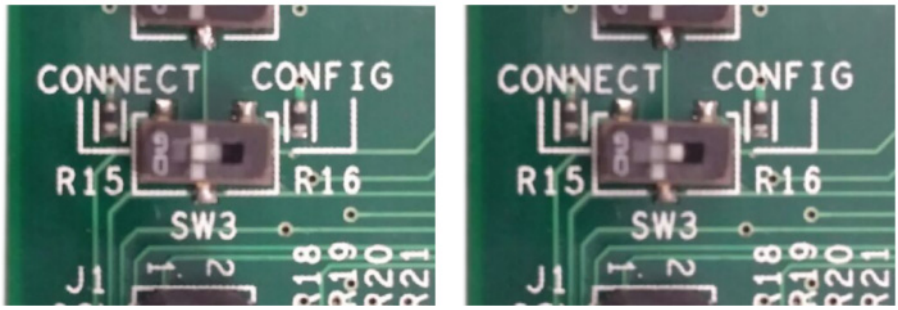
Do NOT forcefully twist or deform wires.

2.1.2 USB3503 Configuration

Default: I^2C configuration is bypassed by default on the EVB-USB3503 QFN evaluation board. The hub will use the internal default configuration and automatically transition to the hub communication stage when it is powered on.

I^2C Option: SW3 must be switched to the 1-2 (see Figure 2-2) position before powering on the hub. SW3 in position 1-2 pulls HUB_CONNECT to ground and will hold the hub in its configuration stage. The hub will not transition to the hub communication stage until CONNECT_N bit of SP_ILOCK register is negated or until SW3 is switched back to position 2-3. Additional hardware capable of two-wire I^2C communication is required for I^2C operation. For additional information regarding I^2C communication protocol on the USB3503, see the USB3503 data sheet.

FIGURE 2-2: HUB_CONNECT SWITCH POSITIONS



2-3 Position (default)

1-2 Position

2.1.3 Clock Source – 26 MHz Oscillator

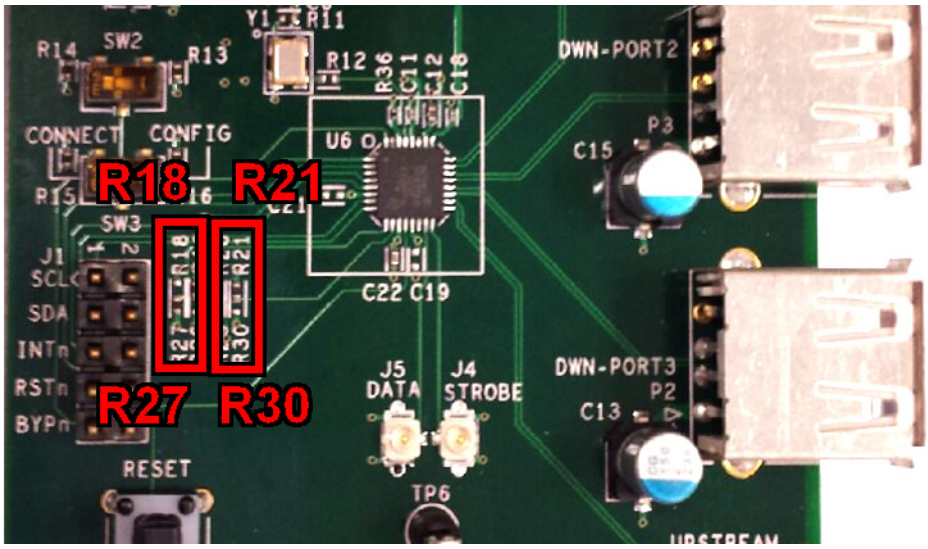
By default, a 26 MHz oscillator (Y1) is populated on the evaluation board as the clock source for the USB3503. The REFSEL[1:0] pins are used to select the frequency of the clock. The board is configured by default to select a 26 MHz clock source by both pulling the REF_SEL0 pin high to +3.3 VDC and pulling the REF_SEL1 pin low to ground.

The USB3503 can accept several clock frequencies. If the clock source on the EVB is changed, the resistors connected to the REF_SEL[1:0] pins must be reconfigured to select the appropriate frequency. Table 2-1 shows the resistors that are required in order to select the compatible frequency. The location of the resistors on the EVB can be seen in Figure 2.1.4.

TABLE 2-1: CLOCK FREQUENCY SELECTION RESISTOR CONFIGURATION

REFSEL[1:0]	Clock Frequency	R18	R21	R27	R30
00	38.4 MHz	Empty	Empty	**Install**	**Install**
01	26.0 MHz (default)	Empty	**Install**	**Install**	Empty
10	19.2 MHz	**Install**	Empty	Empty	**Install**
11	12.0 MHz	**Install**	**Install**	Empty	Empty

FIGURE 2-3: CLOCK FREQUENCY SELECTION REGISTERS



2.1.4 Power Source – Self-Powered

The EVB-USB3503 QFN only supports self-powered operation and is powered by one +5 VDC regulated external power supply. The +5 VDC, 4 A power supply plugs into the board via a 2.1 mm connector (J3). The external power supply controls the on board +3.3 VDC voltage regulator and on board +1.8 VDC voltage regulator. The on board +3.3 VDC voltage regulator feeds VBAT on the USB3503. The on board +1.8 VDC voltage regulator feeds VDD_CORE_REG on the USB3503. The USB3503 also has an internal on-chip1.2 V regulator to power the digital logic core.

To supply 3.3 VDC externally, remove resistor R1 and connect a 3.3 VDC voltage supply to test point TP2.

To supply 1.8 VDC externally, remove resistor R8 and connect a 1.8 VDC voltage supply to test point TP3.

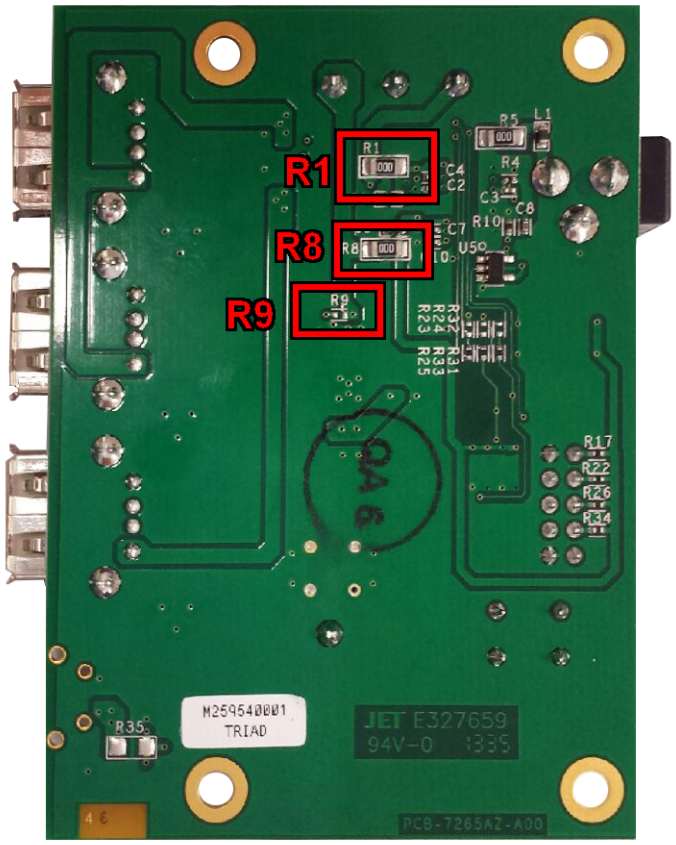
The USB3503 can also function with a single power supply; to do this remove R8 and place a 0 Ohm resistor on R9. This connects the VDD_CORE_REG pin to the VDD33_BYP pin allowing the USB3503's internal 3.3V regulator to supply the VDD_CORE_REG voltage.

Table 2-2 summarizes the different power options and defines what resistors must be populated for each configuration. Figure 2.1.5 shows the locations of the back-side resistors that are used to configure the different power options.

TABLE 2-2: VBAT AND VDD_CORE_REG VOLTAGE SOURCE CONTROL

VBAT Source	VDD_CORE_REG Source	R1	R8	R9
On Board Regulator	On Board Regulator	**Install**	**Install**	Empty
External (TP2)	On Board Regulator	Empty	**Install**	Empty
External (TP2)	External (TP3)	Empty	Empty	Empty
On Board Regulator	VDD33_BYP	**Install**	Empty	**Install**
External (TP2)	VDD33_BYP	Empty	Empty	**Install**

FIGURE 2-4: VOLTAGE SOURCE CONTROL RESISTORS



2.1.5 Interrupt LED

LED1 shows the status of the INT_N pin and allows the user to monitor interrupts. The behavior of the INT_N pin is user-configurable and can be changed by writing to a configuration register.

2.1.6 Connector Descriptions

The EVB-USB3503 features HSIC upstream and 3 downstream USB ports, an I^2C configuration header, and several voltage test points. See Table 2-3 for the complete list of connectors. See Figure 2-2 for an image of the connectors on the EVB. For more details, please see **Appendix A. "EVB-USB3503 QFN Evaluation Board Schematics".**

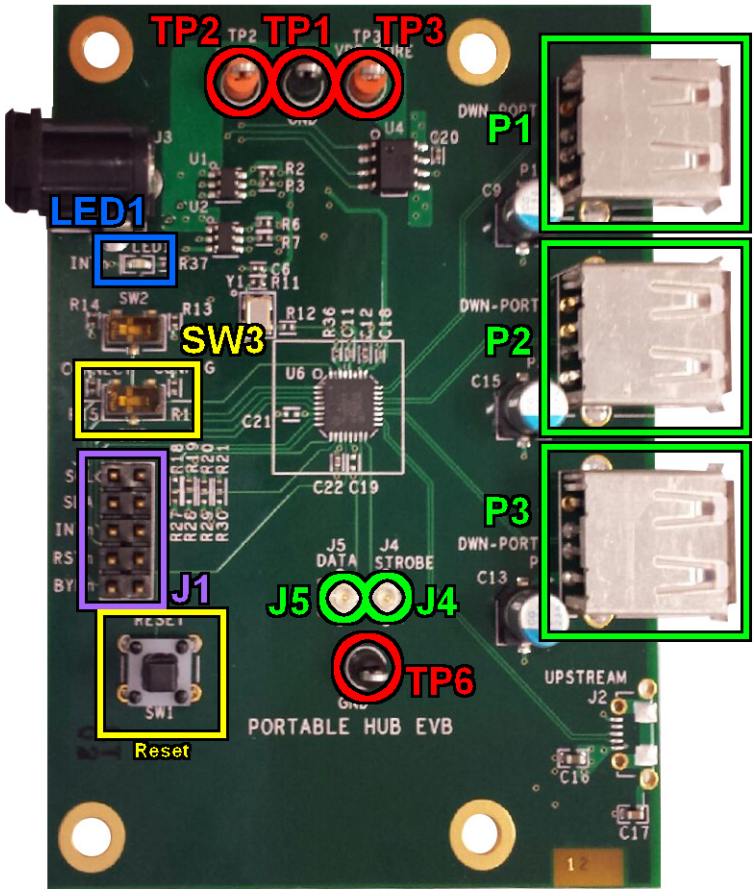
TABLE 2-3: CONNECTOR DESCRIPTION

CONNECTOR	TYPE	DESCRIPTION
J1	2x5 headers	Aardvark I^2C connection
J3	2.1 mm power jack	+5 VDC power supply connection
J4	U.FL connector	Upstream HSIC Data line connection
J5	U.FL connector	Upstream HSIC Strobe line connection
TP1	Test point	Ground test point
TP2	Test point	VBAT +3.3 VDC test point

TABLE 2-3: CONNECTOR DESCRIPTION (CONTINUED)

CONNECTOR	TYPE	DESCRIPTION
TP3	1x3 headers	VDD_CORE +1.8 VDC test point
TP6	1x8 headers	Ground test point
P1	USB-A connector	Downstream port 1 connector
P2	USB-A connector	Downstream port 2 connector
P3	USB-A connector	Downstream port 3 connector
SW1	Push-Button Switch	USB3503 Reset
SW2	2 Position Switch	Not Used
SW3	2 Position Switch	HUB_CONNECT mode (see **Section 2.1.2 “USB3503 Configuration”**)

FIGURE 2-5: CONNECTOR, TEST POINT, AND SWITCH LOCATIONS



Component side top and bottom silk screen layers are shown in Figure 2-6. A block diagram of the EVB is shown in Figure 2-7.

FIGURE 2-6: PCB TOP AND BOTTOM SILK SCREEN IMAGES

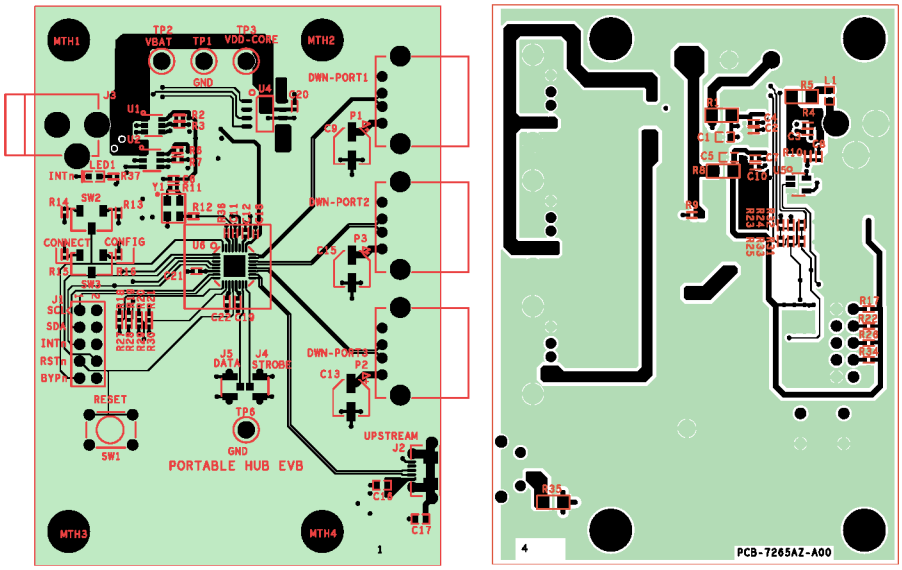
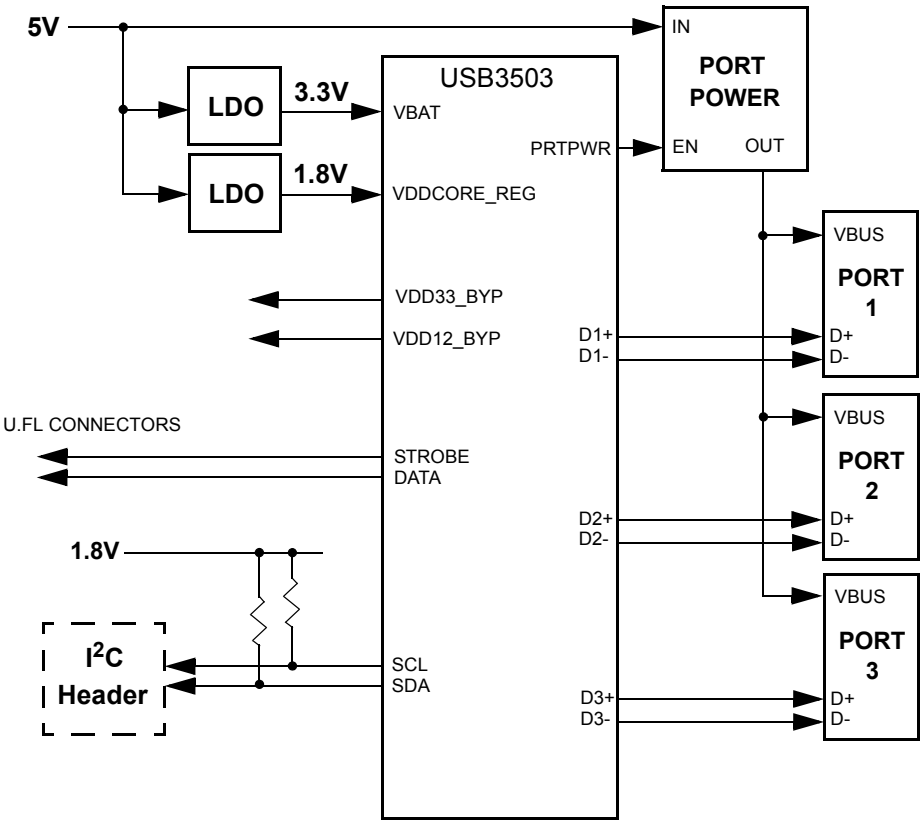


FIGURE 2-7: EVB-USB3503 QFN BLOCK DIAGRAM



Chapter 3. Operation

3.1 CONTENTS OF THE KIT

The USB3503 EVB includes the basic equipment necessary for evaluation. The items included in the kit are:

1. USB3503 QFN EVB
2. 5V DC Power Supply
3. U.FL Extraction Tool
4. Documentation

The kit does not include an HSIC host device, U.FL cables, any downstream USB devices, I^2C master hardware, or other components for board customization.

3.2 INITIAL BRING-UP

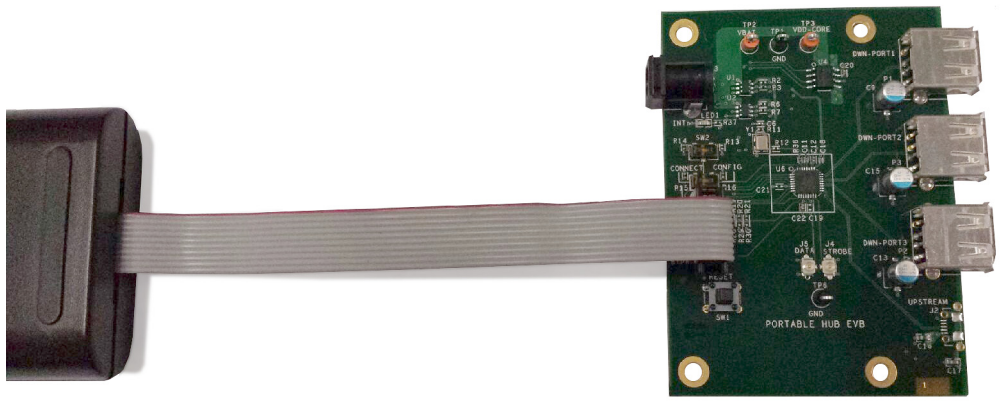
The USB3503 EVB has a default configuration that allows it to operate as a stand alone hub. To begin, connect the U.FL connectors to an HSIC host. Then, plug the evaluation board into the 5V power supply. The USB3503 EVB will enumerate as a Generic USB Hub with the VID and PID equal to the default values found in the USB3503 data sheet.

The default configuration of the USB3503 is to enumerate as a Self Powered Hub. This means that, according to the USB 2.0 specification, the downstream ports are only allowed to provide 500mA of current to the downstream device. Refer to the next section for customization options associated with the evaluation kit.

3.3 EVALUATION SOFTWARE

The USB3503 EVB supports evaluation software available online that can be used to configure the USB3503. This software requires the use of a Total Phase Aardvark USB-I^2C adapter (not included with the Evaluation Kit). To install the software, run **Setup.exe**. This will install the USB3503 Evaluation Software, the LabVIEW Runtime engine (to run the executable), and the Total Phase drivers to communicate with the Aardvark. Once the software has been installed, locate and run the **USB3503 Evaluation.exe** program on the computer. Connect the Aardvark to the USB3503 EVB with the red wire facing the power port, as in Figure .

FIGURE 3-1: AARDVARK CONNECTION



The software allows the user to control the digital input pins RESET_N and CONNECT. It also can monitor the INT_N pin for interrupts. There is a section to communicate with the I^2C serial port, as well as some additional quick configuration and customization options.

FIGURE 3-2: USB3503 EVALUATION SCREEN

3.3.1 Digital Control

The RESET_N and HUB_CONNECT pins can be controlled in real time with the **Digital Control** array. Each button in the array corresponds to the pin with the matching name. When the button is orange, the pin is at logic level high. When the button is black the voltage is a logic level low. Refer to the green box in Figure 3.3.2 for the **Digital Con-**

trol array location. Set the RESET_N pin low to reset the part and place it into the lowest power state. If the CONNECT pin is low when the RESET pin transitions from low to high, the USB3503 will remain in a state that allows the serial interface registers to be manipulated. To enumerate the hub, either write 00h to register E7h, or drive the CONNECT pin high by pressing the **CONNECT** button in the **Digital Control**. Once the USB3503 has enumerated, the serial interface registers should not be modified.

Note:	To prevent the Aardvark from driving against another voltage, the Aardvark is running in an Open/Drain mode. Therefore it is important that all switches on the board pull the pins up to the VCC value.

FIGURE 3-3: DIGITAL CONTROL (GREEN) AND REGISTERS (YELLOW)

3.3.2 I²C Communication

The application also contains a general I²C register read/write section. The **Bit** and **Description** display the serial interface register descriptions found in the USB3503 data sheet. The **Register** display can be used to select the proper serial interface register to manipulate. Click on the **Value** or **Bit** box above to change the value of the register. Once the desired value and register are selected, press the **Write** button to change the value on the part. Click on the **Read** button and the **Value** and **Bit** boxes will update the current value on the part. Refer to the USB3503 data sheet for a detailed description of each register and operation of the device.

3.3.3 Quick Configuration and Customization

The USB3503 Evaluation program also contains some quick configuration and customization options that automatically update the registers to match the desired configuration. The USB3503 can enumerate as a Self Powered or Bus Powered Hub with 1, 2 or 3 downstream ports. The VID, PID, DID and enumeration strings can also be customized to allow the USB3503 to enumerate with whatever identification is desired.

To change these values; update the configuration section to the desired options, then press the **Configure** button. The part will then reset, pull the CONNECT pin low and update the registers as specified. To run with these options, either raise the CONNECT pin, or press the **Connect** button.

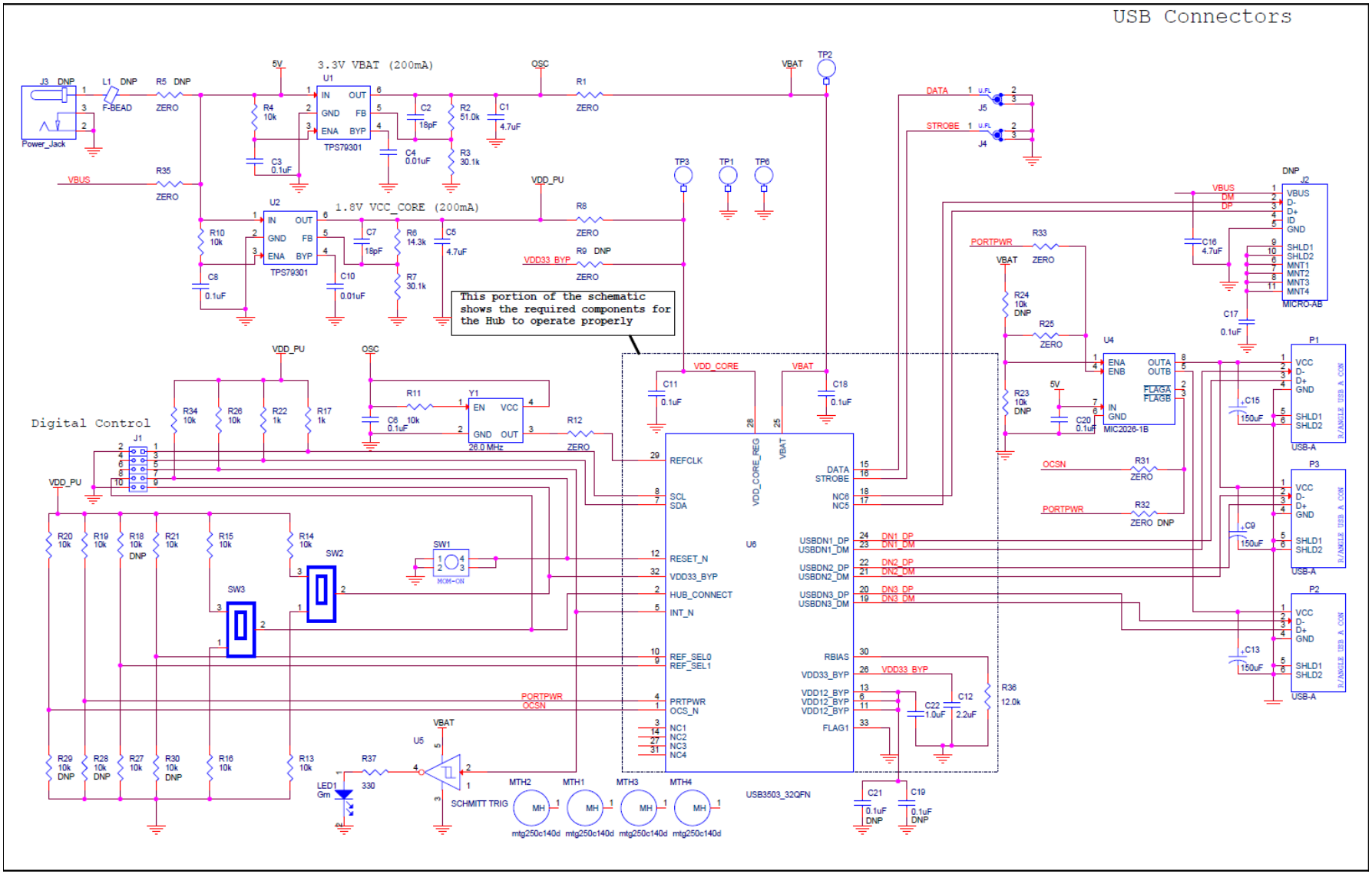
FIGURE 3-4: QUICK CONFIGURATION OPTIONS

Appendix A. EVB-USB3503 QFN Evaluation Board Schematics

A.1 INTRODUCTION

This appendix shows the EVB-USB3503 QFN Evaluation Board schematics.

FIGURE A-1: EVB-USB3503 QFN EVALUATION BOARD SCHEMATIC 1



Appendix B. Bill of Materials (BOM)

B.1 INTRODUCTION

This appendix shows the EVB-USB3503 QFN Evaluation Board Bill of Materials (BOM).

TABLE B-1: EVB-USB3503 QFN EVALUATION BOARD BILL OF MATERIALS

Item	Qty	Reference Designator(s)	Description	Manufacturer	Manufacturer Part Number	Notes
1	3	C1 C5 C16	CAPACITOR CERAMIC 4.7UF 10V X5R 0603	TAIYO YUDEN	LMK107BJ475KA-T	
2	2	C2 C7	CAPACITOR CERAMIC 18PF 50V 0402 SMD	PANASONIC	ECJ-0EC1H180J	
3	4	C3 C6 C8 C19 C20 C21	CAPACITOR CERAMIC 0.1UF 10V X5R 0402	PANASONIC	ECJ-0EB1A104K	DNP: C19 C21
4	2	C4 C10	CAPACITOR CERAMIC 0.01UF 10% 16V X7R 040	AVX	0402YC103KAT2A	
5	3	C9 C13 C15	CAP ALUM 150UF 6.3V 20% SMD	NICHICON	PCG0J151MCL1GS	
6	2	C11 C18	CAP CERAMIC .1UF 6.3V X5R 0201	MURATA ERIE	GRM033R60J104KE19D	
7	1	C12	CAPACITOR CERAMIC 2.2UF 6.3V X5R 0402	MURATA ERIE	ECJ-0EB0J225M	
8	1	C17	CAPACITOR CERAMIC 0.1UF 16V 10% X7R 0603	PANASONIC	ECJ-1VB1C104K	
9	1	C22	CAPACITOR CERAMIC 1.0UF 6.3V 20% X5R 040	MURATA ERIE	GRM155R60J105ME19D	
10	1	J1	HEADER, 2 X 5, 0.1 INCH, VERTICAL	SAMTEC	TSW-105-07-L-D	
11	0	J2	CONNECTOR RECEPT MICRO USB TYPE AB SMT	JAE Electronics	DX4R205JJAR1800	DNP: J2
12	1	J3	CONNECTOR POWER JACK 2.1X5.5MM HIGH CURR	CUI STACK	PJ-002AH	
13	2	J4 J5	CONN RECPT ULTRA-MINI COAX SMD	HIROSE	U.FL-R-SMT(10)	
14	1	L1	FERRITE BEAD, 120 OHM, 0.5A, 0.1DCR, 060	PANASONIC	EXC-3BP121H	
15	1	LED1	LED GREEN SMT	STANLEY	BG1111C-TR	
16	3	P1 P2 P3	RECEPTACLE, USB, STYLE B, RIGHT ANGLE	FCI	87520-0010BLF	
17	3	R1 R5 R8 R35	RESISTOR ZERO OHM 1/4W 5% 1206	YAGEO	RC1206JR-070RL	DNP: R35
18	1	R2	RESISTOR 51.0K OHM 1/10W 1% 0402 SMD	PANASONIC	ERJ-2RKF5102X	
19	2	R3 R7	RESISTOR 30.1K OHM 1/10W 1% 0402 SMD	PANASONIC	ERJ-2RKF3012X	
20	13	R4 R10 R11 R13 R14 R15 R16 R18 R19 R20 R21 R23 R24 R26 R27 R28 R29 R30 R34	RESISTOR 10K OHM 1/16W 5% 0402 SMD	PANASONIC	ERJ-2GEJ103X	DNP: R18 R23 R24 R28 R29 R30
21	1	R6	RESISTOR 14.3K OHM 1/10W 1% 0402 SMD	PANASONIC	ERJ-2RKF1432X	
22	4	R9 R12 R25 R31 R32 R33	RESISTOR ZERO OHM 1/16W 5% 0402 SMD	YAGEO	RC0402JR-070RL	DNP: R9 R32
23	2	R17 R22	RESISTOR 1.0K OHM 1/16W 5% 0402 SMD	PANASONIC	ERJ-2GEJ102X	
24	1	R36	RESISTOR 12.0K OHM 1/20W 1% 0201 SMD	PANASONIC	ERJ-1GEF1202C	
25	1	R37	RESISTOR 330 OHM 1/16W 1% 0402 SMD	YAGEO	RC0402FR-07330RL	
26	1	SW1	SWITCH TACTILE 6MM EXTEND ACT 160GF	E-SWITCH	TL1105SPF160Q	

TABLE B-1: EVB-USB3503 QFN EVALUATION BOARD BILL OF MATERIALS (CONTINUED)

Item	Qty	Reference Designator(s)	Description	Manufacturer	Manufacturer Part Number	Notes
27	2	SW2 SW3	SWITCH SLIDE SPDT SMD GULL	COPAL ELECTRONICS	CJS-1200TB	
28	2	TP1 TP6	TEST POINT LOOP COMPACT BLACK	KEYSTONE	5006	
29	2	TP2 TP3	TEST POINT LOOP COMPACT ORANGE	KEYSTONE	5008	
30	2	U1 U2	IC 200MA LDO LINEAR REG SOT23-6	TEXAS INSTRUMENTS	TPS79301DBVRQ1	
31	1	U4	POWER SWITCH USB MIC2026-1B	MICREL	MIC2026-1YM	
32	1	U5	IC SCHMITT-TRG INV GATE SOT23-5	TEXAS INSTRUMENTS	SN74AHC1G14DBVR	
33	1	U6	USB3503	MICROCHIP	USB3503	
34	1	Y1	OSCILLATOR PROG 3.3V +-50PPM SMD	ABRACON	AP3S-26.0MHz	

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