LatticeXP2 Brevia 2 Development Kit

User's Guide

November 2011
Revision: EB67_01.0

Introduction

Thank you for choosing the Lattice Semiconductor LatticeXP2™ Brevia 2 Development Kit!

This user's guide describes how to start using the LatticeXP2 Brevia 2 Development Kit, an easy-to-use platform for evaluating and designing with LatticeXP2 FPGAs. Along with the evaluation board and accessories, this kit includes a pre-loaded Brevia System-on-Chip (SoC) demonstration design based on the LatticeMico8™ microcontroller.

Note: Static electricity can severely shorten the life span of electronic components.

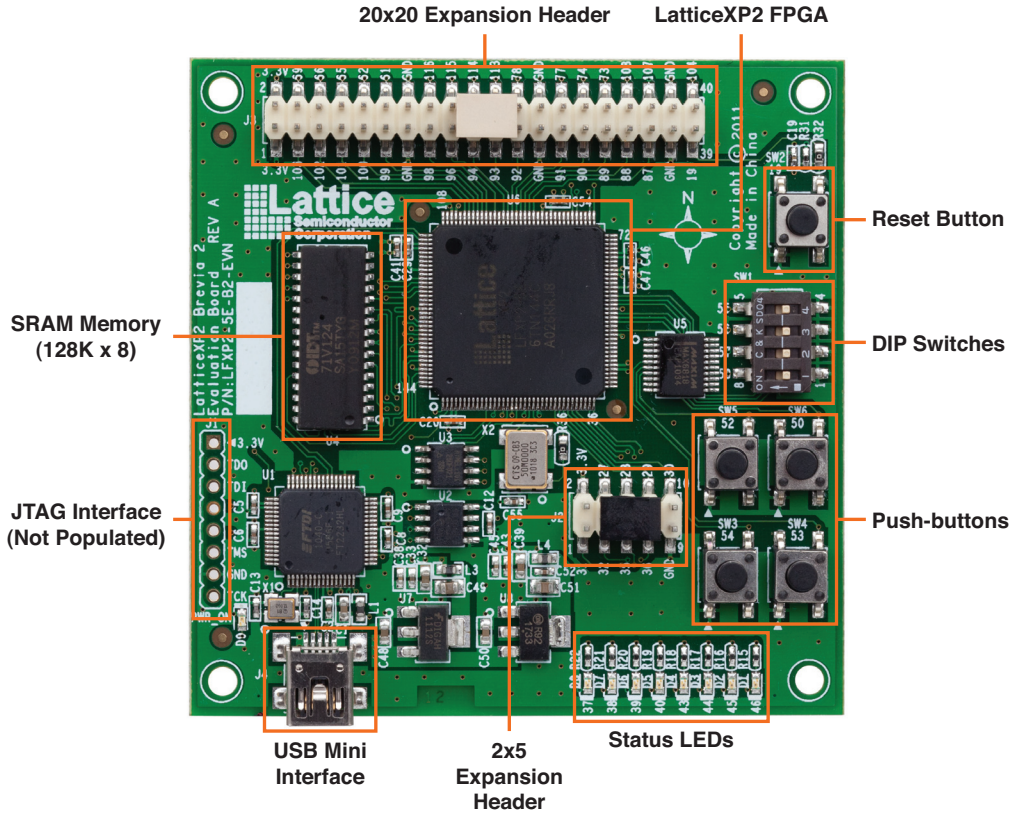
Features

The LatticeXP2 Brevia 2 Development Kit includes:

- **LatticeXP2 Brevia 2 Evaluation Board** with the following on-board components and circuits:
  - LatticeXP2-5E 6TN144C
  - 2-Mbit SPI Flash memory
  - 128K by 8-bit SRAM
  - On-board USB controller for JTAG programming (FTDI - FT2232H)
  - 2x20 expansion header for general I/O
  - 1x8 JTAG programming header (unpopulated)
  - 2x5 expansion header for general I/O
  - Four debounced general purpose pushbuttons
  - One debounced reset pushbutton
  - 4-bit DIP switch (with 3 of 4 switches debounced)
  - Eight status LEDs
- **Pre-loaded Demo** – The kit includes a pre-loaded demo design that integrates several Lattice reference designs including the LatticeMico8 microcontroller, SRAM controller, SPI Flash memory controller, and a UART peripheral.
- **USB Mini Cable** – For power and JTAG programming.
- **LatticeXP2 Brevia 2 Development Kit Web Page** — The LatticeXP2 Brevia 2 Development Kit web page on the Lattice web site provides access to the latest documentation, demo designs and drivers for the kit.

The contents of this user's guide include demo operation, top-level functional descriptions of the various portions of the evaluation board, descriptions of the on-board connectors, switches and a complete set of schematics of the LatticeXP2 Brevia 2 Evaluation Board.

Figure 1. LatticeXP2 Brevia 2 Evaluation Board, Top Side



LatticeXP2 Device

This board features a LatticeXP2 FPGA with a 1.2V core supply. It can accommodate all pin-compatible LatticeXP2 devices in the 144-pin TQFP (20x20 mm) package. A complete description of this device can be found in the LatticeXP2 Family Data Sheet.

Demonstration Design

Lattice provides a demo that illustrates key applications of the LatticeXP2 device.

Demo_LatticeXP2_Brevia_SoC

The Demo_LatticeXP2_Brevia_SoC is pre-programmed into the non-volatile Flash memory of the LatticeXP2 FPGA and is operational upon power-up. The design provides the following features:

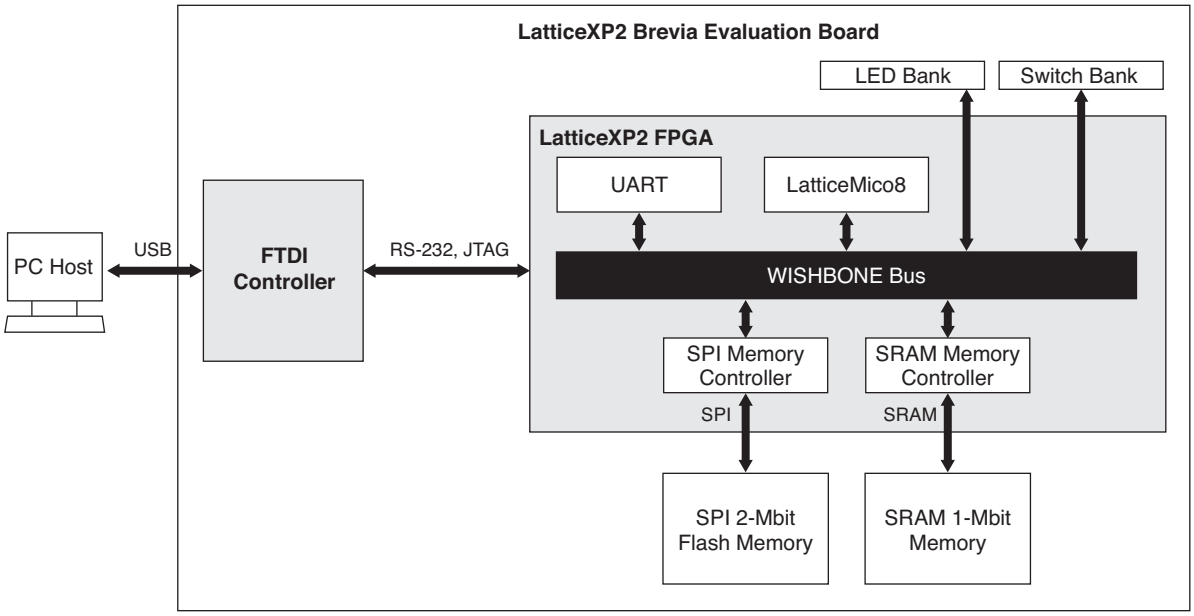
- Prints the ASCII representation of any characters received by the UART on the eight LEDS (D0-D7).
- Prints the SPI memory ID code on demand.
- Displays the current DIP switch setting on demand.
- Logs Read ID and Read Switch commands, along with their results, into the asynchronous SRAM.
- Stores the contents of the SRAM into the SPI ROM on demand.
- Restores the SRAM contents from the SPI ROM on demand.

The demo design integrates the following Lattice reference designs:

- LatticeMico8 Microcontroller (RD1026)
- WISHBONE UART (RD1042)
- SPI WISHBONE Controller (RD1044)
- LatticeMico8 to WISHBONE Interface Adapter (RD1043)

Firmware running on the LatticeMico8 demonstrates control logic for the peripherals connected to a shared on-chip WISHBONE bus and communication between the LatticeXP2 Brevia 2 Evaluation Board and a host PC connected to the USB cable.

Figure 2. Demo_LatticeXP2_Brevia_SoC Block Diagram



Set Up a VT100/ANSI Terminal Emulator

The Demo_LatticeXP2_Brevia_SoC preloaded in the LatticeXP2 Brevia 2 Evaluation Board is operated by interacting with a monitor program. The monitor program sends and receives data across the RS232 communications port on the LatticeXP2 Brevia 2 Evaluation Board. It is necessary to start and configure a VT100 or ANSI style terminal emulator program like PuTTY, PuTTY Portable, Tera Term Pro (Windows) or Minicom (Linux).

Follow these steps to interact with the monitor program:

1. Connect the Brevia 2 Evaluation Board to your computer using the supplied USB cable.
2. Install the required device drivers
   a. Install the FTDI USB driver during the installation of Lattice Diamond or standalone ispVM programming software. If you have already installed Diamond or ispVM without the driver, you can run the Diamond or ispVM installation again and install only the driver.
   b. Configure a Virtual COM port driver as described in the FTDI installation guide available on the FTDI website.
3. Start a terminal emulation program. The RS232 UART on the LatticeXP2 Brevia Evaluation Board is configured to operate at 115.2bps, 8 data bits, 1 stop bit, no parity, and no flow control.

4. Press the **RESET** button on the evaluation board.

When configured correctly you will see a banner displayed, like the one shown below.

```
========================================================================

Welcome to the LatticeXP2 Brevia Development Kit
SoC Demonstration Rev 1.0, April 2010

Main Menu
------------------------------------------------------------
  0: Re-display Main Menu
  1: Read SPI Flash Memory IDCode
  2: Read DIP Switch Bank
  3: Read Data History from SRAM
  4: Copy Data History from SRAM to SPI Flash Memory
  5: Read Data History from SPI Flash Memory
  6: Write Data to SRAM (Specified Address and Data)
  7: Read Data from SRAM (Specified Address)
  8: Write Data to SPI (Specified Address and Data)
  9: Read Data from SPI (Specified Address)
  a: SRAM Auto-Test
  b: SPI Auto-Test

Press 0-b to select an option.
========================================================================
```

SoC Command Monitor Features

The LatticeXP2 Brevia 2 Evaluation Board, after it powers up or is reset, begins running a command interpreter monitor under the control of the LatticeMico8 microcontroller. The monitor code waits for a keypress and immediately performs the requested function.

When the Read ID and Read Switch Bank commands are executed the ASCII output from the command is stored into the SRAM. The LatticeMico8 stores the next address to write in three of its general purpose registers. After power up the registers are cleared to 0x000000. Commands that have their results logged to the SRAM print out the address of the next available SRAM location.

Read SPI Flash Memory IDCode Command

The SPI ROM device on the LatticeXP2 Brevia 2 Evaluation Board can be queried and will return the ID code implemented by the ROM manufacturer. The LatticeMico8 initiates memory transactions using the SPI Memory controller to acquire the data.

To scan the SPI Flash Memory IDCode:

1. From the terminal Main Menu, press **1**.

   The LatticeMico8 performs the manufacturer specific SPI memory transactions to acquire the ID code. The ID number is returned as a hex value. This command logs the result to the SRAM.

   Example:

   ```
   ID:0x44
              (SRAM ADDR:0x00006)
   ```

   Note: The ID for your board may differ.

Read DIP Switch Bank

The LatticeMico8 has the ability to read the state of switches 1-4 on the DIP switch bank. The pushbutton switches are can also be read. Each pushbutton press toggles the internal state of a register in the FPGA. The current state of the register is displayed on the high nibble of the output. The hexadecimal representation of the switches is printed and logged to the SRAM. A DIP switch that is set ON has a '0' value, and one that is OFF has a value of '1'.

To read the DIP switch:

1. From the terminal window press **2**.

   Example:

```
SW:0x00
            (SRAM ADDR:0x0000C)
```

Read Data History from SRAM

Use the Read Data History from SRAM command to see the results from each command that is logged to the SRAM memory. The output from this command does not get written into the SRAM.

To read data history from SRAM:

1. From the terminal window press **3**. The transaction log is listed.

   Example:

```
SRAM:
  0x44
  0x00
```

Copy Data History from SRAM to SPI Flash Memory

This command erases a portion of the SPI ROM, and stores the command results logged in the SRAM. The LatticeMico8 starts writing from SRAM address 0x000000 and continues writing values into the SPI ROM until it reaches the last valid entry in the SRAM.

To copy data history from SRAM to SPI Flash memory:

1. From the terminal window press **4**. The data log is transferred and the terminal indicates "Done".

   Example:

```
SRAM => SPI:
  0x44
  0x00
Done.
```

Read Data History From SPI Flash Memory

This command copies the Data History from the SPI ROM into the SRAM. After power is supplied, or RESET asserted the SRAM Data History log information is no longer available. Running this command permits the history to be restored from the non-volatile SPI ROM.

To read data history from the SPI ROM into SRAM:

1. From the terminal window press **5**. The transaction log is listed.

   Example:

```
SPI Flash:
  0x44
  0x00
```

Write Data to SRAM (Specified Address and Data)
This command allows you to write a single data value to any location in the SRAM memory space.

1. From the terminal window press 6.

   Example:

```
Please Enter the Address(17 bits,Hex), eg: 1f26a, no Spaces, then Press ENTER:
10000
Please Enter the Data(8 bits,Hex), eg: b7, no Spaces, then Press ENTER:
93
SRAM Write Done.
```

Read Data from SRAM (Specified Address)
This command allows you to read the data value from any address in the SRAM.

1. From the terminal window press 7.

   Example:

```
Please Enter the Address(17 bits,Hex), eg: 1f26a, no Spaces, then Press ENTER:
10000
Read Data: 93
SRAM Read Done.
```

Write Data to SPI (Specified Address and Data)
This command allows you to write a single data value to any location in the SPI memory space.

1. From the terminal window press 8.

   Example:

```
Please Enter the Address(18 bits,Hex), eg: 1f26a, no Spaces, then Press ENTER:
10000
Please Enter the Data(8 bits,Hex), eg: b7, no Spaces, then Press ENTER:
93
SPI Write Done.
```

Read Data from SPI (Specified Address)
This command allows you to read the data value from any address in the SPI.

1. From the terminal window press 9.

   Example:

```
Please Enter the Address(18 bits,Hex), eg: 1f26a, no Spaces, then Press ENTER:
10000
Read Data: 93
SPI Read Done.
```

Perform SRAM Auto-test
This command automatically tests SRAM.

1. From the terminal window press a.

   Example:

```
> a
Starting SRAM Auto-Test.....................................................
.............................................................................
SRAM Test Done: Successful.
```

Perform SPI Auto-test
This command automatically tests SPI.

1. From the terminal window press b.

   Example:

```
>b
Starting SPI Auto-Test......................................................
.............................................................................
SPI Test Done: Successful.
```

Download Demo Designs

Lattice distributes source and programming files for a variety of demonstration designs compatible with the LatticeXP2 Brevia 2 Evaluation Board.

To download demo designs:

1. Browse to the LatticeXP2 Brevia 2 Development Kit web page of the Lattice web site. Select the Demo Applications download and save the file.
2. Extract the contents of **Demo_LatticeXP2_Brevia_Soc_vhdl.zip** or **Demo_LatticeXP2_Brevia_Soc_verilog.zip** to an accessible location on your hard drive. One or more designs will be extracted and each will follow the following basic form.

Demo	Directories
Demo1	Demo1 .\project .\source .\LatticeMico8_Vx_y_Verilog .\RD1042 .\project .\source .\RD1043 .\project .\source .\RD1044 .\project .\source .\RD1046 .\project .\source

Where:

- **\project** – Lattice Diamond® project (.ldf), preferences (.lpf), and programming file (.jed). This directory may contain intermediate results of the Diamond build process.
- **\source** – HDL source for the Diamond project.
- **.\LatticeMico8_Vx_y_Verilog** – LatticeMico8 Microcontroller Reference Design (RD1026).
- .\RDxxxx – Reference designs integrated by the demo.

Programming a Demo Design with the Lattice Diamond Programmer

Demo_LatticeXP2_Brevia_SoC is pre-programmed into the LatticeXP2 Brevia Evaluation Board by Lattice. To restore a LatticeXP2 Brevia 2 Evaluation Board to factory settings, use the procedure described below.

To program the LatticeXP2 FPGA:

1. Connect the USB cable to the host PC and the LatticeXP2 Brevia Evaluation Board.
2. From Diamond, click on the Programmer icon. Select **Create a new Project from a Scan** and browse for the .XCF file to import.
3. Click on **Detect Cable**. The Programmer will detect the cable (Cable: USB2, Port: FTUSB-0).
4. Click on the **Program** icon. When complete, **PASS** is displayed in the Status column.

Recompile a Demonstration Project with Lattice Diamond® Design Software

Use the procedure described below to recompile a demo project for the LatticeXP2 Brevia 2 Evaluation Board.

1. Install and license Lattice Diamond software.
   See www.latticesemi.com/latticediamond for download and licensing information.
2. Download the demo source files from the LatticeXP2 Brevia 2 Development Kit web page.
3. Run Lattice Diamond.
4. Use **File > Open Project** and open the Diamond <demo>.ldf.
5. From the Process view, select **JEDEC File** from the **Export Files** process.
6. Choose **Export Files**, right-click and choose **Run**.

After a few moments the JEDEC programming file is output.

7. See the Programming a Demo Design with the Lattice Diamond Programmer section for details on how to download the demo design to the board.

Reassembling the Demo LatticeMico8 Firmware

Use this procedure to reassemble and download changes to the LatticeMico8 microcontroller firmware.

1. Install the LatticeMico8 Tool Code.

   Note: The LatticeMico8 tool executables are also provided in the
   . \Demo_LatticeXP2_Brevia_SoC\LatticeMico8_Vx_y_Verilog\utils *directory and*
   . \Demo_LatticeXP2_Brevia_SoC\LatticeMico8_Vx_y_VHDL\utils *directory*

2. The C source code for the LatticeMico8 Assembler and Simulator is included in the tools package. An optional step you can perform is to compile this source instead of using the pre-compiled versions supplied by Lattice.

3. Modify the Assembly source (.s) file, if desired, and recompile to a memory image (.hex). Source for Demo_LatticeXP2_Brevia_SoC is provided as Demo_LatticeXP2_Brevia_SoC.s. The assembler and simulator are command line applications. The tools display their invocation syntax if they are started without command line parameters.

4. Once the assembly code has been recompiled it is necessary to update the LatticeMico8 PROM contents. The fastest way to update the PROM contents is to use the Diamond Memory Initialization tool. The tool updates the PROM contents without modifying the connectivity of the design.

   Launch the Memory Initialization tool, and select the isp8_prom component, choose the new memory initialization file, click on the **Apply Changes** button, and save the new NCD file.

5. Run the Generate Data File (JEDEC) process.

6. Download the new JED file to the FPGA. You will see the effects of your assembly code changes.

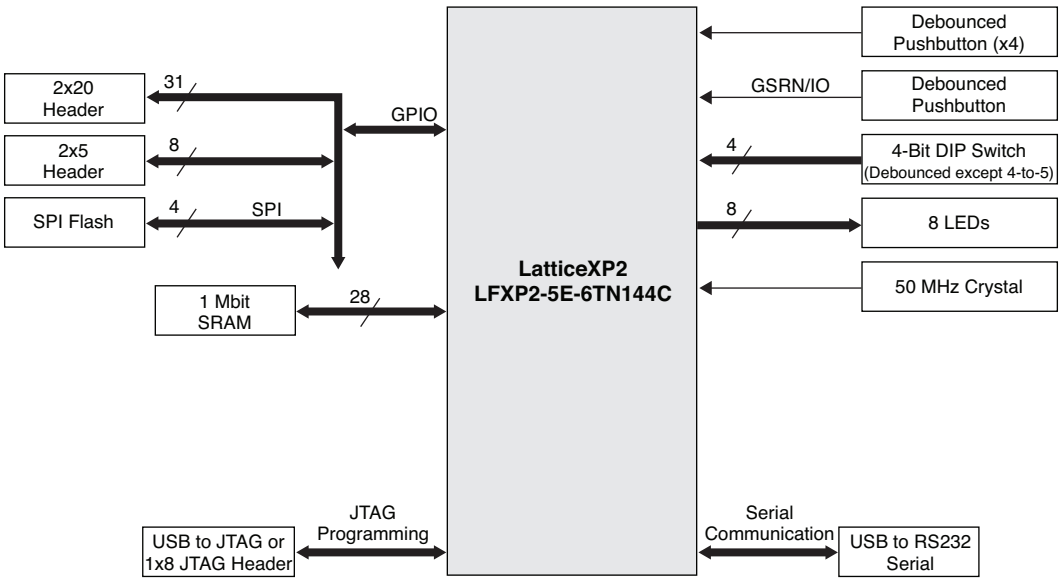
LatticeXP2 Brevia 2 Evaluation Board

This section describes the features of the LatticeXP2 Brevia 2 Evaluation Board in detail.

Overview

The LatticeXP2 Brevia 2 Evaluation Board is a complete development platform for the LatticeXP2 FPGA. The board includes on-board SRAM and SPI Flash memory, and SPI microcontroller communication interfaces, a USB port, and an expansion header to support test connections.

Figure 3. LatticeXP2 Brevia 2 Evaluation Board Block Diagram



I/O Mapping Details

Expansion Header 1 Interface

Access to 40 I/Os are available to the user via the expansion header J3. The connector type is a 2x20 0.100" center-to-center Berg stick, male. The interface details are included in Table 1.

Table 1. Expansion Header 1 Interface

Expansion Connector Pin Number	Expansion Connector/FPGA Pin Name	FPGA Pin Number	Pin Functionality
Expansion Connector J3			
1	3.3V		Power
2	3.3V		Power
3	EXP_IO15	103	I/O
4	EXP_IO31	69	I/O
5	EXP_IO14	102	I/O
6	EXP_IO30	66	I/O
7	EXP_IO13	101	I/O
8	EXP_IO29	65	I/O
9	EXP_IO12	100	I/O
10	EXP_IO28	62	I/O
11	EXP_IO11	99	I/O
12	EXP_IO27	61	I/O
13	GND		Ground
14	GND		Ground
15	EXP_IO10	98	I/O
16	EXP_IO26	116	I/O
17	EXP_IO9	96	I/O
18	EXP_IO25	115	I/O
19	EXP_IO8	94	I/O
20	EXP_IO24	114	I/O
21	EXP_IO7	93	I/O
22	EXP_IO23	113	I/O
23	EXP_IO6	92	I/O
24	EXP_IO22	78	I/O
25	GND		Ground
26	GND		Ground
27	EXP_IO5	91	I/O
28	EXP_IO21	77	I/O
29	EXP_IO4	90	I/O
30	EXP_IO20	74	I/O
31	EXP_IO3	89	I/O
32	EXP_IO19	73	I/O
33	EXP_IO2	88	I/O
34	EXP_IO18	108	I/O
35	EXP_IO1	87	I/O
36	EXP_IO17	107	I/O
37	GND		Ground

Table 1. Expansion Header 1 Interface (Continued)

Expansion Connector Pin Number	Expansion Connector/FPGA Pin Name	FPGA Pin Number	Pin Functionality
38	GND		Ground
39	XP2_RESET	19	Reset
40	EXP_IO16	104	I/O

Expansion Header 2 Interface

The connector is a 10-pin dual-row Berg stick, male. The interface details are included in Table .

Table 2. Expansion Header 2 Interface

Expansion Connector Pin Number	Expansion Connector Pin Name	FPGA Pin Number	Pin Functionality
Expansion Connector J2			
1	EXP_IO36	31	I/O
2	3.3V		Power
3	EXP_IO37	32	I/O
4	EXP_IO32	27	I/O
5	EXP_IO38	35	I/O
6	EXP_IO33	28	I/O
7	EXP_IO39	36	I/O
8	EXP_IO34	29	I/O
9	GND		Ground
10	EXP_IO35	30	I/O

LEDs and Switches

Eight LEDs, four debounced pushbutton switches and one DIP (4) switch are provided. All DIP switches are debounced except the SW1D connection (4-to-5, #55 on the silkscreen).

Table 3. LED Interface

LED	FPGA Pin Number
D1	46
D2	45
D3	44
D4	43
D5	40
D6	39
D7	38
D8	37

Table 4. Switch Interface

Switch	FPGA Pin Number
SW1A	58
SW1B	57
SW1C	56
SW1D[1]	55
SW3	54
SW4	53
SW5	52
SW6	50

1. SW1D is not debounced.

Flash Interface

The LatticeXP2 Brevia 2 Evaluation Board provides 2 Mbits of non-volatile Flash memory. The Flash uses the four-wire SPI communication interface.

Table 5. Flash Interface

Flash Signal Name	FPGA Pin Number
FPGA Flash 2 Mbit (U1)	
XP2_SPI_CS0	11
XP2_SPI_CLK	13
XP2_SPI_IN	15
XP2_SPI_OUT	16
FLASH_RSTn	17
FLASH_Wn	18

SRAM Interface

The LatticeXP2 Brevia 2 Evaluation Board provides 1Mbit of asynchronous SRAM memory in a 128K x 8-bit configuration.

Table 6. SRAM Interface

SRAM Signal Name	FPGA Pin Number
FPGA SRAM 1 Mbit (U2)	
Data_0	1
Data_1	2
Data_2	5
Data_3	6
Data_4	7
Data_5	8
Data_6	9
Data_7	10
Addr_0	119
Addr_1	120
Addr_2	121
Addr_3	122

SRAM Signal Name	FPGA Pin Number
Addr_4	123
Addr_5	124
Addr_6	125
Addr_7	127
Addr_8	129
Addr_9	130
Addr_10	131
Addr_11	132
Addr_12	133
Addr_13	134
Addr_14	137
Addr_15	138
Addr_16	141
SRAM_CSb	142
SRAM_OEb	143
SRAM_WEb	144

Please note the JTAG header is not populated by default. It is recommended to use the USB mini cable and on-board USB configuration circuit as described elsewhere in this document.

Table 7. JTAG Programming Interface

JTAG Connector Pin Number	JTAG Connector Pin Name	FPGA Pin Number	FPGA Pin Name	Pin Functionality
JTAG Connector J1				
1	3.3V	—	—	VCC
2	TDO	82	TDO	TDO
3	TDI	80	TDI	TDI
4	—	—	—	None
5	—	—	—	None
6	TMS	79	TMS	TMS
7	GND	—	—	GND
8	TCK	81	TCK	TCK

FPGA

The Lattice XP2 Brevia 2 Evaluation Board is based on the LatticeXP2 non-volatile FPGA. The board is populated with a 5K LUT device in a 144 TQFP package. A complete description of the device can be found in the LatticeXP2 Family Data Sheet and on the LatticeXP2 web page.

Software Requirements

Install the Lattice Diamond software before you begin developing designs for the evaluation board.

Mechanical Specifications

Dimensions: 3 in (L) x 3 in (W) x 1/2 in (H)

Environmental Requirements

The evaluation board must be stored between -40° C and 100° C. The recommended operating temperature is between 0° C and 55° C. The evaluation board can be damaged without proper anti-static handling.

Glossary

DIP: Dual In-line Package

FPGA: Field-Programmable Gate Array

LED: Light Emitting Diode

LUT: Look-Up Table

PCB: Printed Circuit Board

RoHS: Restriction of Hazardous Substances Directive

PLL: Phase Locked Loop

SPI: Serial Peripheral Interface

SRAM: Static Random Access Memory

UART: Universal Asynchronous Receiver/Transmitter

WDT: Watchdog Timer

Troubleshooting

The LatticeXP2 Brevia 2 Evaluation Board is not responsive.

- Verify the LatticeXP2 device is programmed.

The functionality displayed by the board does not match the demo features described.
It is possible the LatticeXP2 Brevia 2 Evaluation Board has been reprogrammed. You can either reprogram the FPGA with the demonstration bitstream, or read the checksum of the bitstream loaded in the FPGA. To restore the LatticeXP2 Brevia 2 Evaluation Board to the factory default, see the Download Demo Designs section of this document for details on downloading and reprogramming the device.

You can use Diamond Programmer to read the checksum of the bitstream programmed into the FPGA. This value can be compared against the checksum stored in the JEDEC file. The JEDEC file checksum value is the last line in the file. This may allow you to determine the contents of the FPGA.

A final option is to use Diamond Programmer to read the current bitstream in the FPGA, and then to reprogram the FPGA with your desired bitstream.

Ordering Information

Description	Ordering Part Number	China RoHS Environment-Friendly Use Period (EFUP)
LatticeXP2 Brevia 2 Development Kit	LFXP2-5E-B2-EVN	

Technical Support Assistance

Hotline: 1-800-LATTICE (North America)
+1-503-268-8001 (Outside North America)
e-mail: techsupport@latticesemi.com
Internet: www.latticesemi.com

Revision History

Date	Version	Change Summary
November 2011	01.0	Initial release.

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Appendix A. Schematics

Figure 4. LatticeXP2 Brevia 2 Evaluation Board Block Diagram

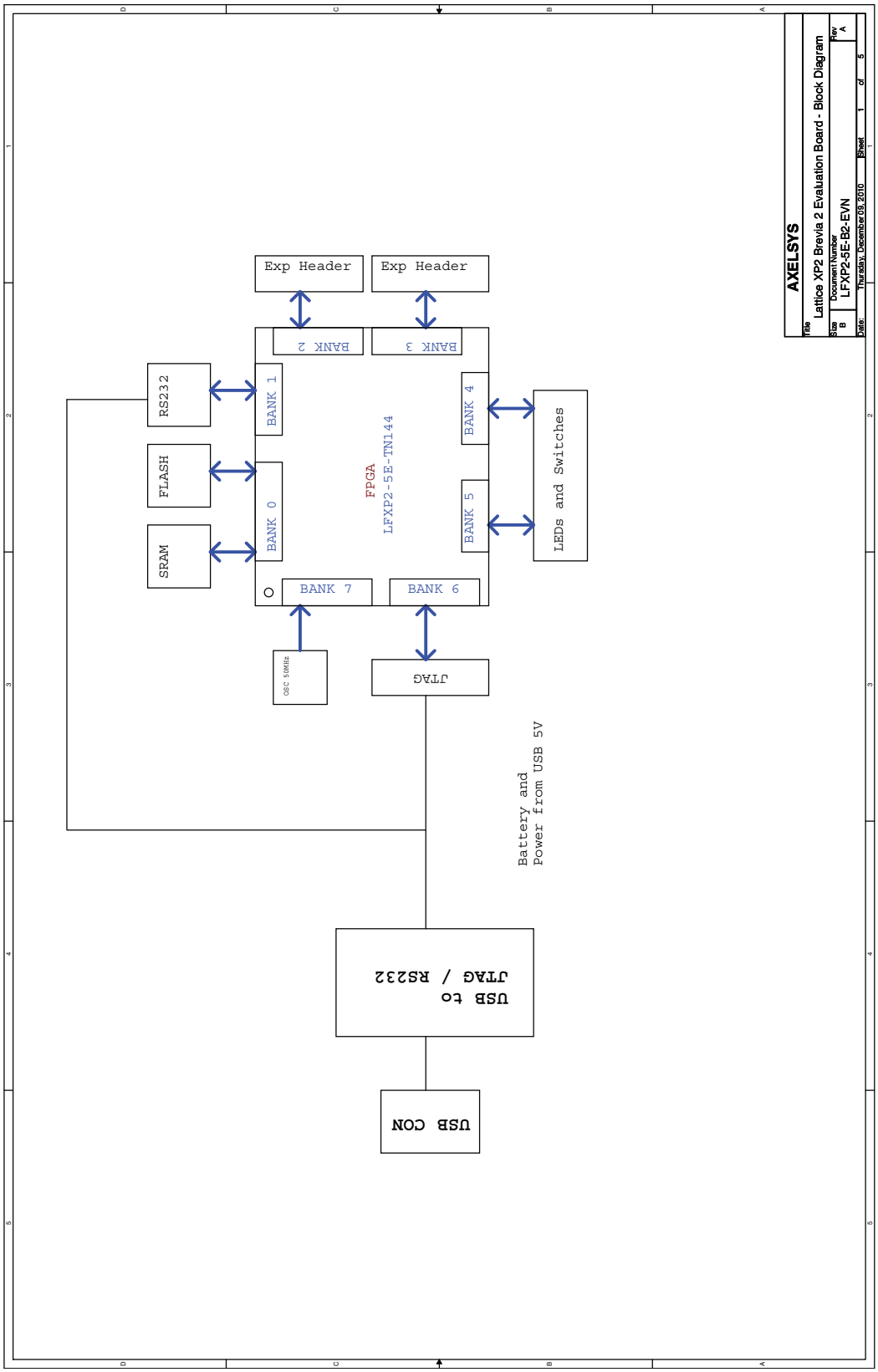


Figure 5. USB to JTAG/RS232

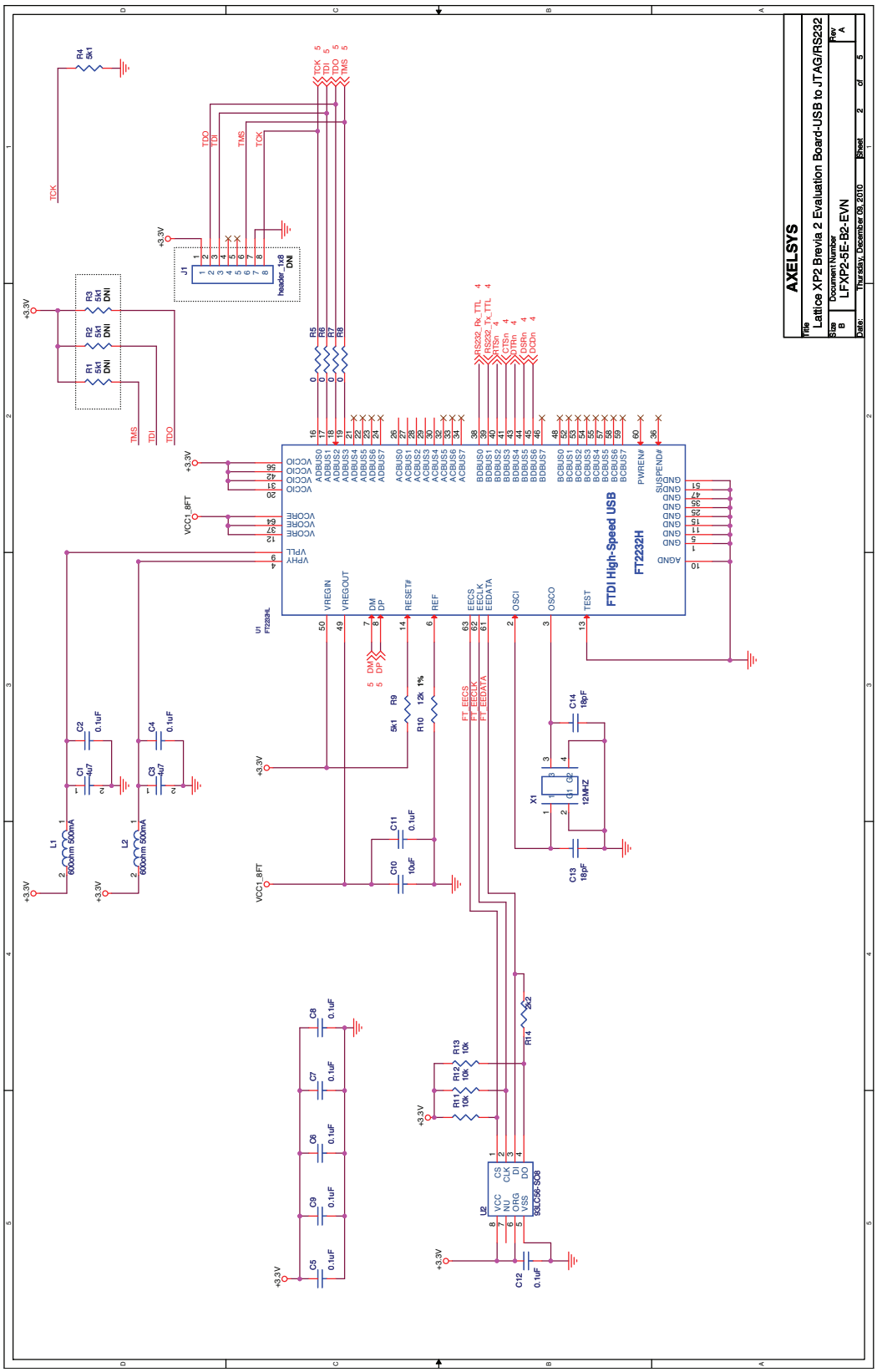


Figure 6. Memory, LEDs, Switching

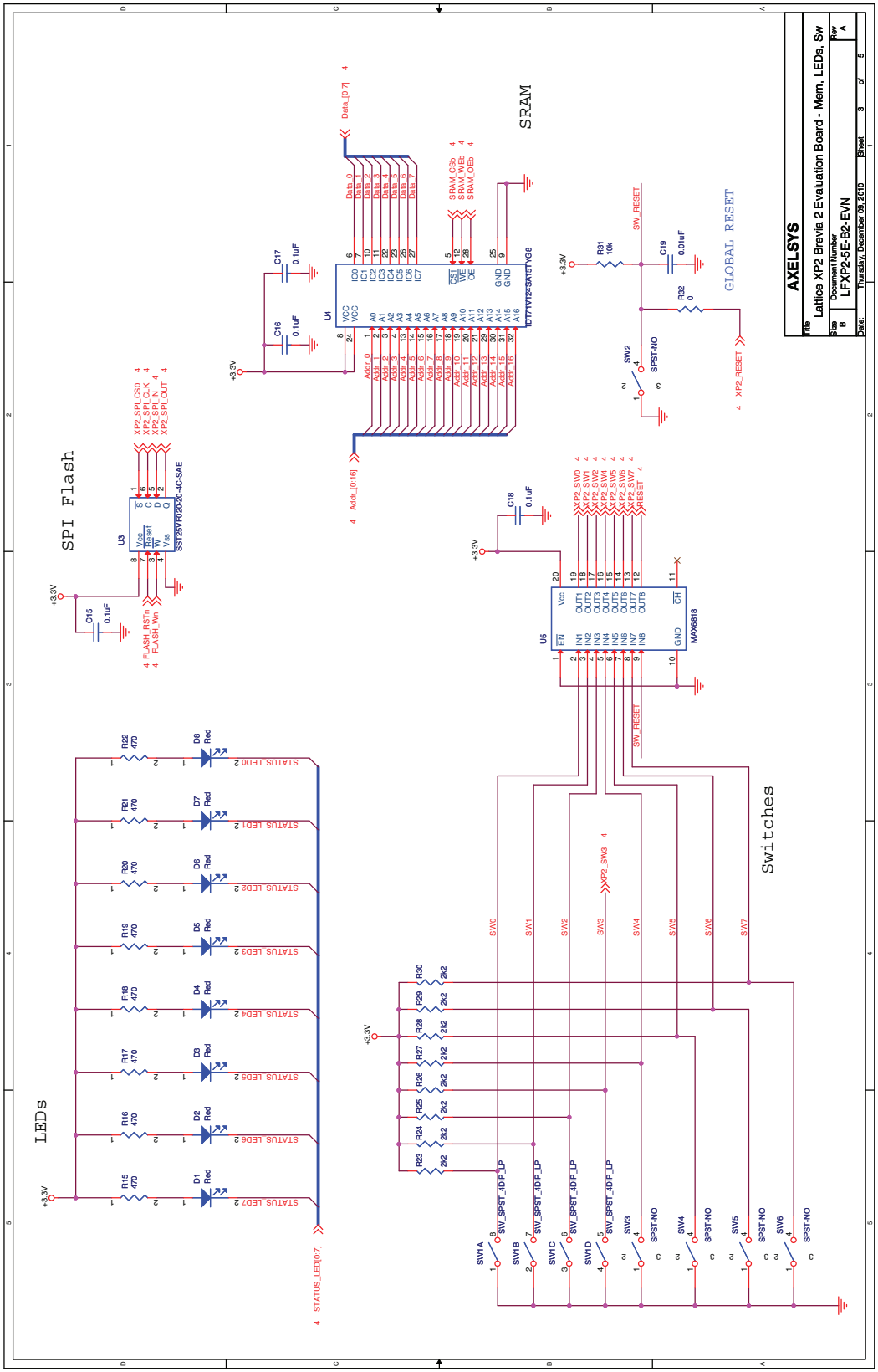


Figure 7. FPGA Banks

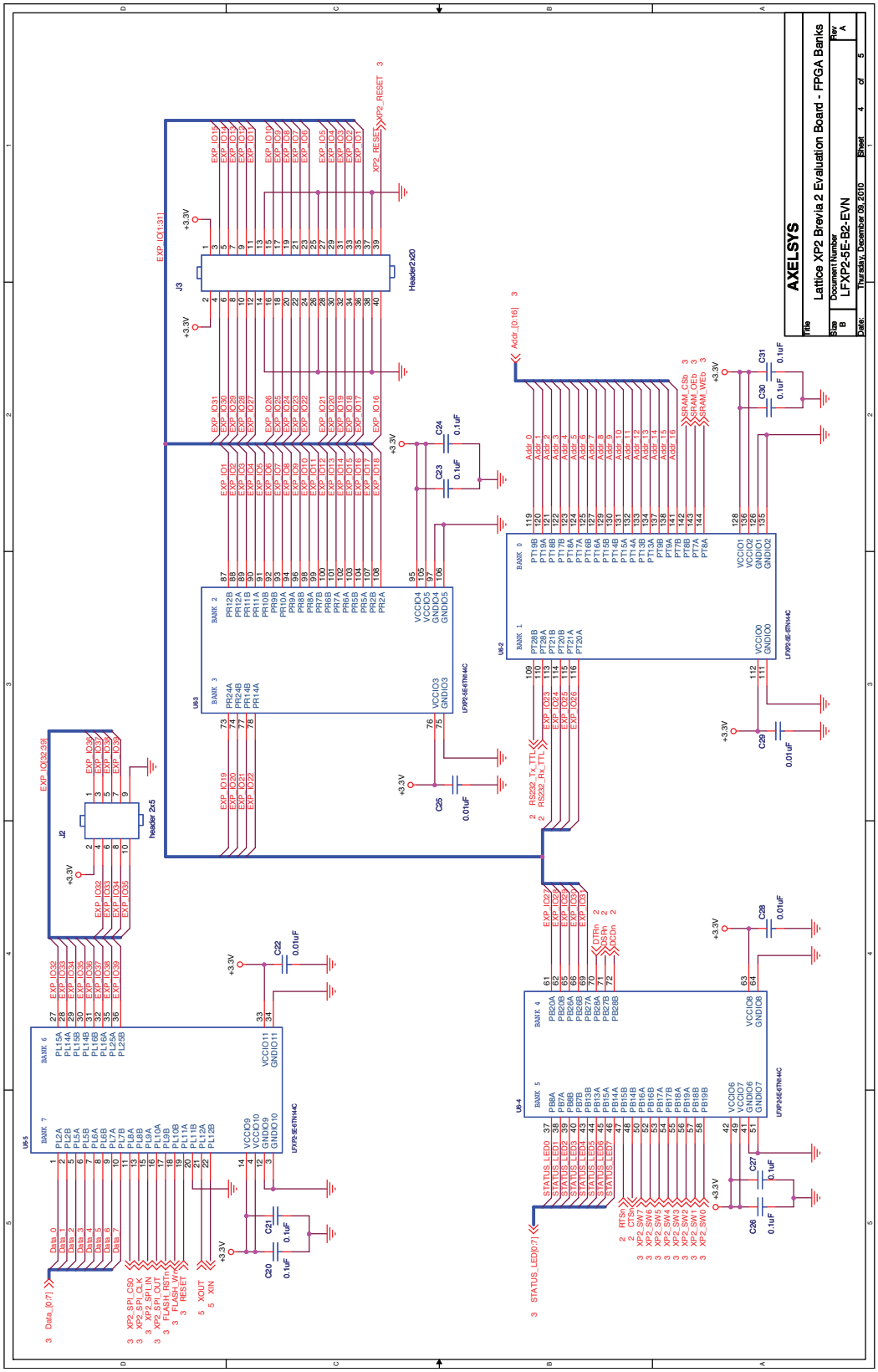
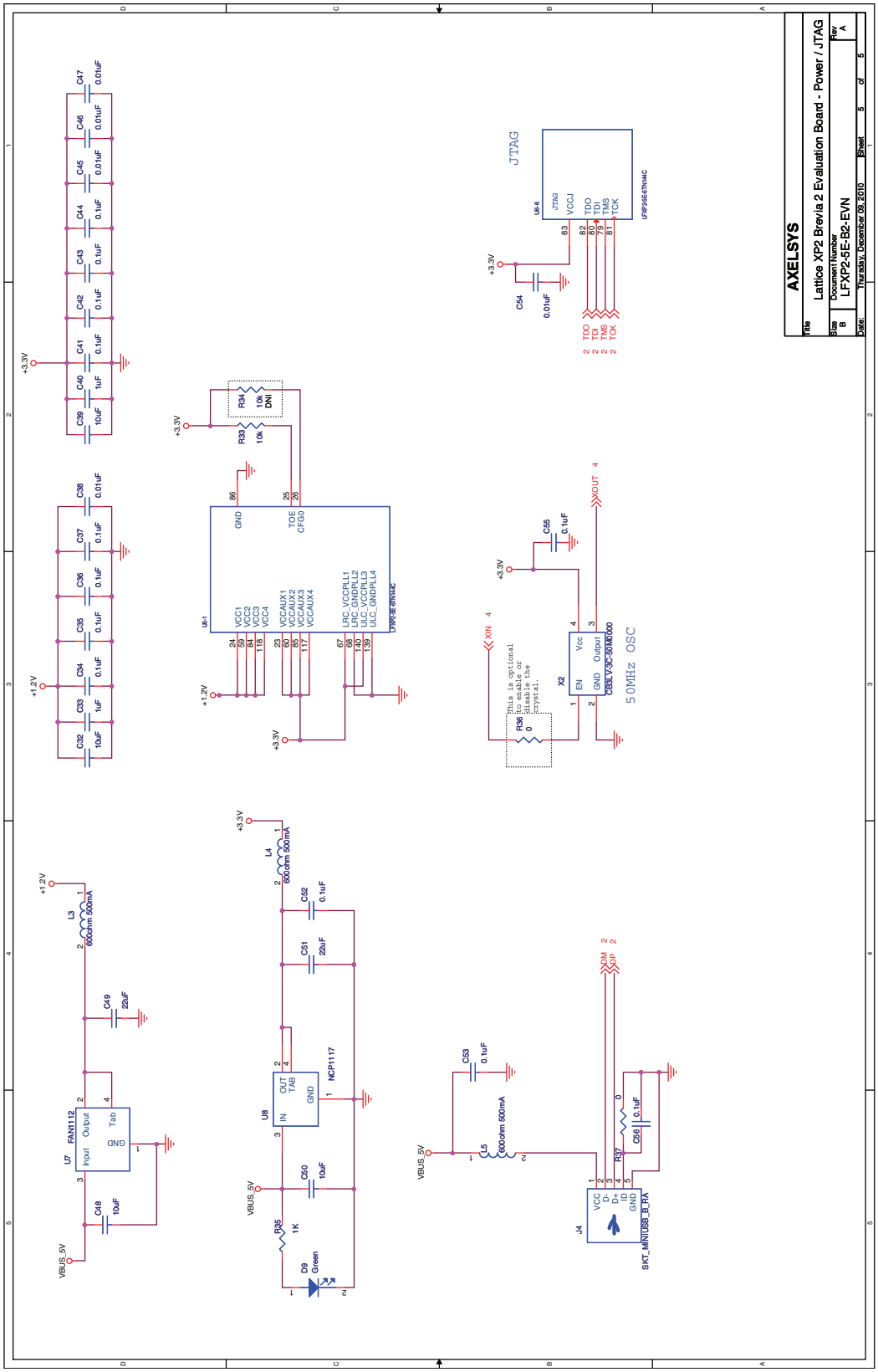


Figure 8. Power/JTAG



Appendix B. Bill of Materials

Table 8. Bill of Materials

Item	Quantity	Reference	Description	Manufacturer	Manufacturer Part Number
1	2	C1,C3	Cap Cer 4.7uF 6.3V 10% X5R 0603	Panasonic	ECJ-1VB0J475K
2	33	C2, C4, C5, C6, C7, C8, C9, C11, C12, C15, C16, C17, C18, C20, C21, C23, C24, C26, C27, C30, C31, C34, C35, C36, C37, C41, C42, C43, C44, C52, C53, C55, C56	CAP CERAMIC 0.1UF 16V X7R 0402	Kemet	C0402C104K4RACTU
3	5	C10, C32, C39, C48, C50	CAP CECAP CER 10UF 10V X5R 20% 0603	Taiyo Yuden	LMK107BJ106MALTD
4	2	C13, C14	CAP CER 18PF 25V C0G 0402	Kemet	C0402C180K3GACTU
5	10	C19, C22, C25, C28, C29, C38, C45, C46, C47, C54	CAP CERAMIC 10nF 16V 5% X7R 0402	Kemet	C0402C103J4RACTU
6	2	C33, C40	CAP CERAMIC 1uF 6.3V X5R 0402	Kemet	C0402C105K9PACTU
7	2	C49, C51	CAP CERAMIC 22uF 10V X5R 0805	Taiyo Yuden	LMK212BJ226MG-T
8	8	D1, D2, D3, D4, D5, D6, D7, D8	LED SUPER RED CLEAR 0603 SMD	LITE-On INC	LTST-C190KRKT
9	1	D9	LED SUPER GREEN CLEAR 0603 SMD	LITE-On INC	LTST-C190KGKT
11	1	J2	CONN HEADER 10POS .100" SMT Align TIN	Samtec	TSM-105-01-T-DV-A
12	1	J3	Header 2x10 .100 20POS Align VER	Samtec	TSM-120-01-T-DV-A-P
13	1	J4	CONN MINI USB RCPT RA TYPE B SMD	Neltron	5075BMR-05-SM-CR
14	5	L1, L2, L3, L4, L5	Ferrite Bead 600ohm@100MHz 500mA 0603	Murata	BLM18AG601SN1D
16	2	R4, R9	Res 1/16W 5.1K 1% 0402	Yageo	RC0402FR-075K1L
17	7	R5, R6, R7, R8, R32, R36, R37	Res 1/10W 0.0 Ohm 5% 0603	Yageo	RC0603JR-070RL
18	1	R10	Res 1/16W 12.0K 1% 0402	Yageo	RC0402FR-0712KL
19	5	R11, R12, R13, R31, R33	Res 1/16W 10.0K 1% 0402	Yageo	RC0402FR-0710KL
20	9	R14, R23, R24, R25, R26, R27, R28, R29, R30	Res 1/16W 2.2K 1% 0402	Yageo	RC0402FR-072K2L
21	8	R15, R16, R17, R18, R19, R20, R21, R22	Res 1/16W 470R 1% 0402	Yageo	RC0402FR-07470RL
23	1	R35	Res 1/16W 1.0K 1% 0402	Yageo	RC0402FR-071KL
24	1	SW1	SWITCH DIP SPST SEALED 4POS SMD	C&K Components	SD04H1SB
25	5	SW2, SW3, SW4, SW5, SW6	SWITCH TACT 6MM MOM SMD H=5.0MM	C&K Components	PTS645SH50SMTRLFS
26	1	U1	USB to UART / FIFO	FTDI	FT2232HL
27	1	U2	IC 93LC56 EEPROM	Microchip	93LC56C-I/SN
28	1	U3	SPI Flash 256Kx8 20Mhz	SST / Microchip	SST25VF020-20-4C-SAE
29	1	U4	SRAM 128Kx8, 15ns	IDT	IDT71V124SA15TYG8
30	1	U5	CMOS Switch Debouncer Octal	Maxim	MAX6818EAP+

Table 8. Bill of Materials (Continued)

Item	Quantity	Reference	Description	Manufacturer	Manufacturer Part Number
31	1	U6	FPGA XP2	Lattice	LFXP2-5E-6TN144C
32	1	U7	IC REG LDO 1A 1.2V SOT-223	Fairchild Semi	FAN1112SX
33	1	U8	IC Reg LDO 3.3V SOT-223	On Semi	NCP1117ST33T3G
34	1	X1	12Mhz Crystal	TXC	7M-12.000MAAJ-T
35	1	X2	OSC 50MHz 3.3V 50ppm	CTS	CB3LV-3C-50M0000