MachXO™ Mini Development Kit

User's Guide

March 2012
Revision: EB41_01.4

Introduction

Thank you for choosing the Lattice Semiconductor MachXO Mini Development Kit!

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

Note: Static electricity can severely shorten the life span of electronic components. See the MachXO Mini Development Kit QuickSTART Guide for handling and storage tips.

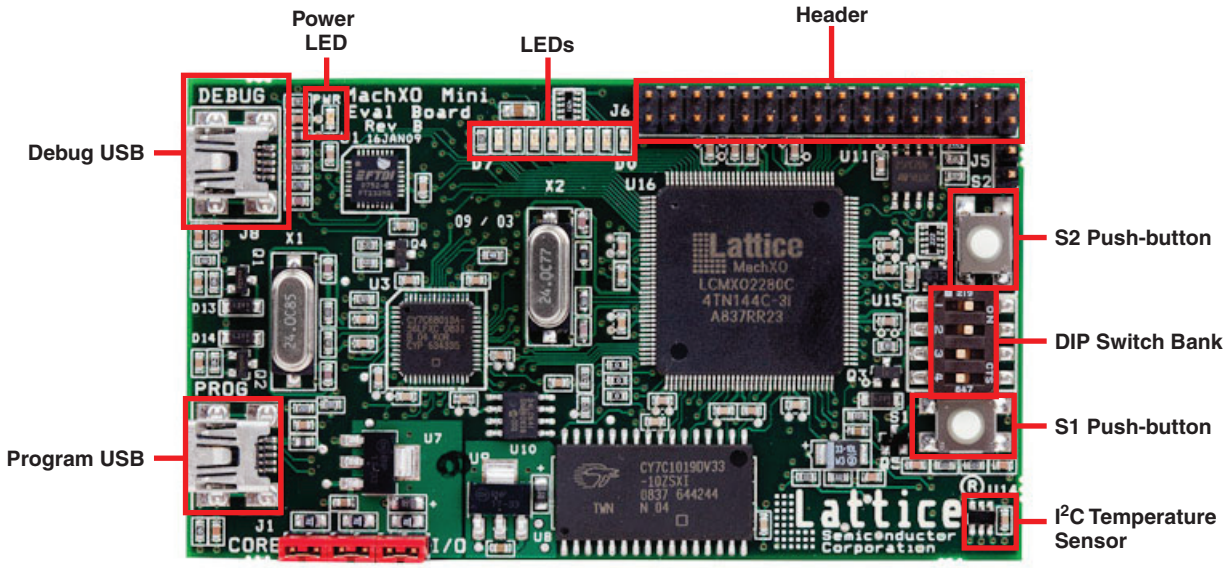
Features

The MachXO Mini Development Kit includes:

- **MachXO Mini Evaluation Board** – The Mini board is a small board (about the size of a business card) with the following on-board components and circuits:
  - MachXO LCMXO2280C-4TN144C CPLD
  - 2-Mbit SPI Flash memory
  - 1-Mbit SRAM
  - I^2C temperature sensor
  - USB connectors (JTAG, RS-232)
  - 2x16 expansion header for general I/O, I^2C, and SPI
  - Push-buttons for sleep mode and global set/reset
  - 4-bit DIP switch
  - DAC/ADC circuit
  - MachXO Sleep Mode circuit
  - Eight status LEDs
- **Pre-loaded Reference Designs and Demos** – The kit includes a pre-loaded demo design (Mini SoC) that integrates several Lattice reference designs including the LatticeMico8 microcontroller, SRAM controller, I^2C controller, SPI Flash memory controller, and a UART peripheral. Firmware supports a temperature monitor demo and, when connected to a host PC, allows you to use a terminal program to use advanced demonstrations.
- **Two USB Connector Cables** – The Mini board is powered from the mini B USB port (DEBUG) when connected to a host PC. The DEBUG port provides a general communication and debug port via a USB-to-RS-232 physical channel. A second USB channel (PROG) provides a programming interface to the MachXO JTAG port.
- **QuickSTART Guide** – The MachXO Mini Development Kit QuickSTART Guide provides information on connecting the Mini board, installing Windows hardware drivers, and running the basic temperature monitor demo.
- **MachXO Mini Development Kit Web Page** — The MachXO Mini 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 Mini board.

Figure 1. MachXO Mini Evaluation Board, Top Side



MachXO Device

This board features a MachXO PLD with a 3.3V core supply. It can accommodate all pin-compatible MachXO devices in the 144-pin TQFP (20x20 mm) package. A complete description of this device can be found in the MachXO Family Data Sheet.

Note: The connections referenced in this document refer to the LCMXO2280C-4TN144C device. Available I/Os and associated sysIO™ banks may differ for other densities within this device family. However, only the LCMXO2280C-4TN144C device offers full functional use of the entire evaluation board.

Demonstration Designs

Lattice provides three demos that illustrate key applications of the MachXO device:

- **Mini SoC** – Illustrates use of the LatticeMico8 microcontroller, firmware, and peripherals (UART communication, SPI Flash memory controller, SRAM controller, and I²C peripheral controller). The Mini SoC demo design is pre-programmed into the MachXO Mini Evaluation Board by Lattice.
- **MachXO Sleep Mode** – Shows application of an external "sleep circuit" to cycle the low-power, sleep mode input of the MachXO PLD.
- **TransFR** – Shows the Lattice transparent field reconfiguration (TransFR™) technology with the MachXO.

Note: It is very likely that you will obtain your Mini board after it has been reprogrammed. To restore the factory default demo or program it with other Lattice-supplied examples see the Download Demo Designs and Programming Demo Designs with ispVM™ sections of this document.

Mini SoC Demo

The Mini SoC demo is pre-programmed into the non-volatile Flash memory of the MachXO PLD and is operational upon power-up. The design provides the following features:

- Reads the on-board I²C temperature sensor and displays real-time results as a level meter onto the LED bank (D0-D7).
- Logs temperature measurements into the on-board SRAM or non-volatile SPI Flash memory.

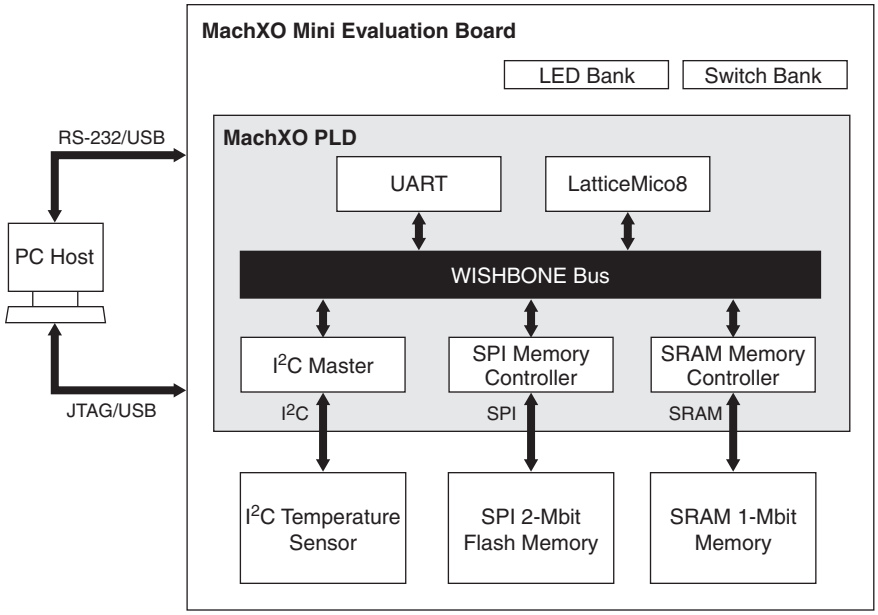
- Displays current temperature and the most recent transaction results of the Mini board onto a host PC running a terminal program.

The demo design integrates the following Lattice reference designs:

- RD1026, LatticeMico8 Microcontroller User's Guide
- RD1042, WISHBONE UART
- RD1044, SPI WISHBONE Controller
- RD1046, I²C Master with WISHBONE Bus Interface
- RD1043, LatticeMico8 to WISHBONE Interface Adapter

Firmware running on the LatticeMico8 demonstrates control logic for the peripherals connected to a shared on-chip WISHBONE bus and communication between the Mini board and a host PC connected to the USB-to-RS232 debugging path.

Figure 2. Mini SoC Block Diagram



Download Windows Hardware Drivers

Before you begin, you will need to obtain the necessary hardware drivers for Windows from the Lattice web site.

To download Windows Hardware Drivers:

1. From the MachXO Mini Development Kit web page, locate the hardware device drivers for the RS-232/USB debug interface.
2. Download the ZIP file to your system and unzip it to a location on your PC.

Linux Support:

The debug interface drivers for the evaluation board are included in Linux kernel v.2.4.20 or greater including distributions compatible with Lattice Diamond® design software (Red Hat Enterprise v.5, v.4 or Novell SUSE Enterprise v.10).

Download and Program the Mini SoC Demo Design

The Mini SoC Demo is preprogrammed into the Mini board, however over time it is likely that your board will be modified.

To download the Mini SoC Demo source files and reprogram the Mini board:

1. See the Download Demo Designs and Programming Demo Designs with ispVM sections of this document.
2. Use **.\Demo_MachXO_Mini_SoC\project\impl1\mini_soc_demo_impl1.jed** to restore the Mini SoC demo design.

Connect to the MachXO Mini Evaluation Board

Use the USB cables provided to connect the evaluation board to your PC:

1. Connect one USB cable from a USB port on your PC to the board's RS-232/USB Debug socket (DEBUG-J8) on the top-left side of the board as shown in Figure 2. After connection is made, a blue Power LED (PWR) will light up indicating the board is powered on.
2. If you are prompted, "Windows may connect to Windows Update" select **No, not this time** from the available options and click **Next** to proceed with the installation. Choose the **Install from specific location (Advanced)** option and click **Next**.
3. Select **Search for the best driver in these locations** and click the **Browse** button to browse to the Windows driver folder that has been created (see the Download Windows Hardware Drivers section of this document). Select the **CDM 2.04.06 WHQL Certified** folder and click **OK**.
4. Click **Next**. A screen will display as Windows copies the required driver files. Windows will display a message indicating that the installation was successful.
5. Click **Finish** to install the USB driver. A second "Found New Hardware" screen will appear.
6. Repeat instructions 2-4 to install the USB-to-Serial Port driver.

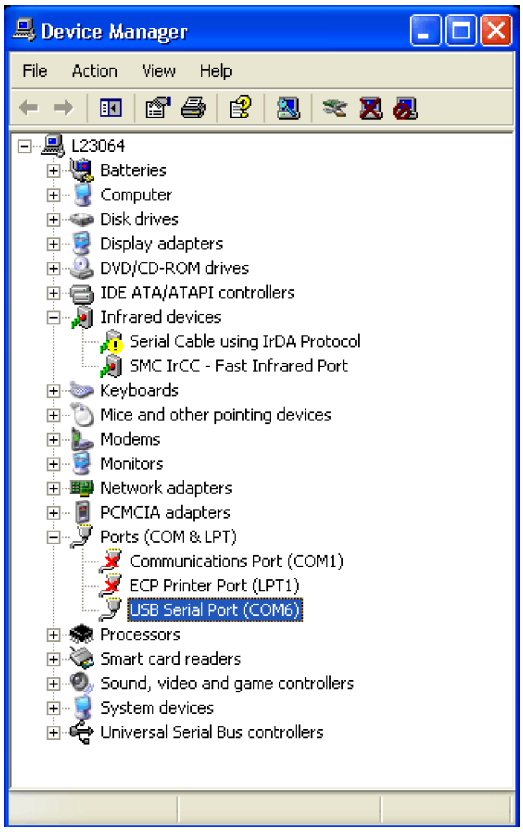
Setup Windows HyperTerminal

Windows HyperTerminal is a terminal program found on most PCs that can be used to communicate with the Mini board.

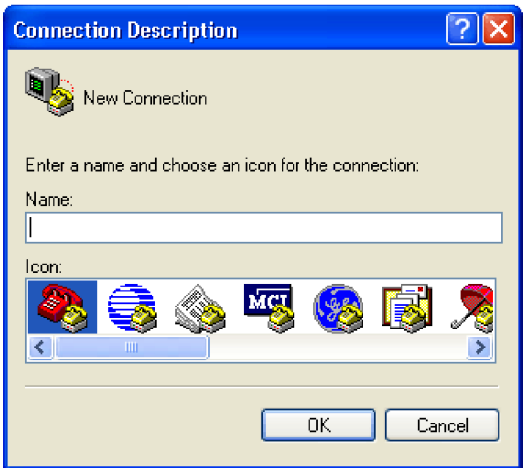
To set up Windows HyperTerminal:

1. From the **Start** menu, select **Control Panel > System**. The System Properties dialog appears.
2. Select the **Hardware** tab and click **Device Manager**. The Device Manager dialog appears.

3. Expand the **Ports (COM & LPT)** entry and note the COM port number for the **USB Serial Port**.

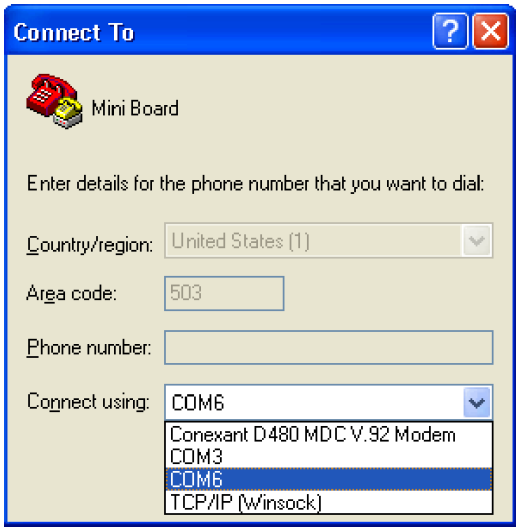


4. From the **Start** menu, select **Programs > Accessories > Communications > HyperTerminal**. The HyperTerminal application and a Connection Description dialog appear.



5. Specify a Name and Icon for the new connection. Click **OK**. The Connect To dialog appears.

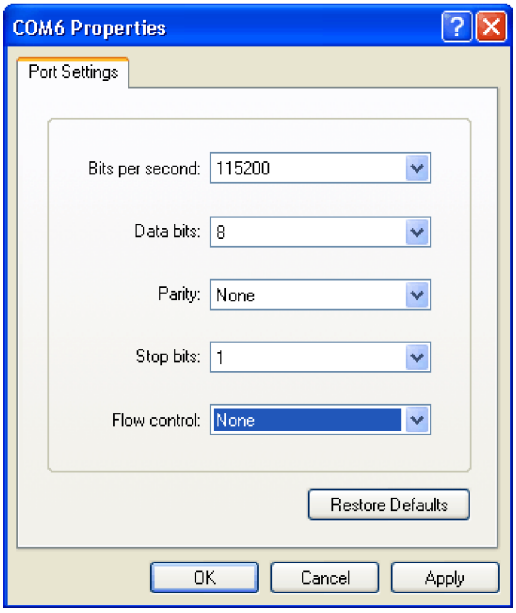
6. Select the **COM** port identified in Step 3 from the **Connect using:** list. Click **OK**. The COM*n* Properties dialog appears where *n* is the COM port selected from the list.



7. Select the following Port Settings.

   Bits per second: **115200**
   Data bits: **8**
   Parity: **None**
   Stop bits: **1**
   Flow control: **None**

   Click **OK**. The HyperTerminal window appears.



8. From the Mini board, press the **S1** push-button (Reset). The Mini SoC demo Main Menu appears in HyperTerminal.

```
==========================================================================
Welcome to the MachXO Mini Evaluation Board
Mini SoC Demonstration Rev 1.0, February 2009

Main Menu
------------------------------------------------------------
  0: Re-display Main Menu
  1: Read SPI Flash Memory IDCode
  2: Read I2C Temperature Sensor
  3: Read DIP Switch Bank
  4: Normalize Temperature Output
  5: Read Data History from SRAM
  6: Copy Data History from SRAM to SPI Flash Memory
  7: Read Data History from SPI Flash Memory

Press 0-7 to select an option.
==========================================================================
```

Set Up Linux Minicom

Minicom is a terminal program found with most Linux distributions. It can be used to communicate with the Mini board.

To setup Minicom:

1. Check active serial ports:

   ```
   #dmesg | grep tty
   ```

   Note the tty label assigned to the USB port.

2. From a command prompt, start Minicom:

   ```
   #minicom -s
   ```

   The configuration menu appears.

3. Highlight **Serial port setup** and press **Enter**. Serial port settings appear.
4. Press **A** (Serial Device). Specify the active serial device noted in Step 1 and press **Enter**.
5. Press **E** (Bps/Par/Bits). Specify **115200**, **None**, **8** and press **Enter**.
6. Press **F** (Hardware Flow Control). Specify **None** and press **Enter**.
7. Press **Esc**. The configuration menu appears.
8. Select **Save setup as dfl**. Minicom saves the port setup as the new default.
9. Select **Exit**. The Minicom interface appears.
10. From the Mini board, press the **S1** push-button (Reset). The Mini SoC demo Main Menu appears.

Scan the SPI Flash Memory IDCode

This demo uses the SPI Flash Memory Controller and UART modules of the Mini SoC to scan the memory device identification code of the on-board SPI Flash Memory and display it on the terminal output. The transaction is logged to the on-board SRAM through the SRAM controller module.

To scan the SPI Flash Memory IDCode:

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

   The ID number is returned as a hex value and the transaction is logged to the on-board SRAM and the current address pointer is indicated.

   Example:

```
ID:0x12
          (SRAM ADDR:0x00010)
```

   Note: The ID for your board may differ.

Reading the I²C Temperature Sensor

This demo uses the I²C Controller and UART modules of the Mini SoC to read the on-board I²C temperature sensor, convert the raw data to Celsius units and display it on the terminal output. The transaction is logged to the on-board SRAM through the SRAM controller module.

To monitor temperature:

1. From the terminal window press **4**. The Mini SoC normalizes the meter output for the ambient temperature and lights 4 (D0-D3) of the LED bank (D0-D7).
2. Place your finger on the on-board **I²C Temperature Sensor (U14)** for 2 to 5 seconds. Depending on your skin temperature, the level should influence the temperature monitor (1 LED = 0.25°C).
3. From the terminal window, press **2**. The current temperature in degrees Celsius appears and the transaction is logged to the on-board SRAM and the current address pointer is indicated.

   Example:

```
Temp:30.50°C
           (SRAM ADDR:0x0000B)
```

Reading the DIP Switch Bank

This demo uses the UART module of the Mini SoC to read the user-input switch inputs 1-3 of the DIP Switch Bank (SW1) and output it to the terminal as a hex value. The transaction is logged to the on-board SRAM through the SRAM controller module.

Note: SW1D (Schematic Sheet 3 of 8) of SW1: SW_SPST_4 is reserved to enable/disable the on-board Sleep Mode circuit.

To read the DIP Switch:

1. From the terminal window press **3**. The switch setting is returned as a hex value and the transaction is logged to the on-board SRAM.

   Example:

```
SW:0x0
           (SRAM ADDR:0x0000A)
```

Reading the Transaction Data History from On-Board SRAM

This demo uses the SRAM controller module of the Mini SoC to read the transaction history logged to on-board SRAM during the period the Mini board has been powered.

To read data history from SRAM:

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

   Example:

```
SRAM:
  Temp:30.50°C
  ID:0x12
  SW:0X0
```

Copy Data History from On-Board SRAM to SPI Flash Memory
This demo uses both the SRAM and SPI Flash Memory controller modules of the Mini SoC to copy the transaction history logged to the volatile on-board SRAM to the non-volatile on-board SPI Flash Memory.

To copy data history from SRAM to SPI Flash memory:

1. From the terminal window press **6**. The data log is transferred and the terminal indicates "Done".

   Example:

```
Done.

SPI Flash:
  Temp:30.50°C
  ID:0x12
  SW:0X0
```

Read SPI Flash Memory
This demo uses the SPI Flash Memory controller module of the Mini SoC to read the on-board SPI Flash Memory. To illustrate the non-volatile nature of the Flash memory, you may power-off the Mini board at any time by disconnecting both USB cables. Reattach the cables, restart the terminal application, and then perform the memory read to confirm the data is intact.

To read data history from SRAM:

1. From the terminal window press **7**. The transaction log is listed.

   Example:

```
SPI Flash:
  Temp:30.50°C
  ID:0x12
  SW:0X0
```

   *Note: To clear the Flash memory, press **SW1** to reset the Mini board and clear the on-board SRAM. Copy data history (currently cleared) from the SRAM to the Flash memory.*

Re-Display the Main Menu
During the demo session the main menu will scroll off-screen. To redisplay the menu, press **0**.

You may confirm that the SPI Flash memory will retain data in a power-off condition by removing both USB cables to power-down the Mini board. Rerun the memory read to confirm the data is intact.

While the Mini board is powered, a running log of all transactions is logged to the on-board SRAM.

MachXO Sleep Mode Demo

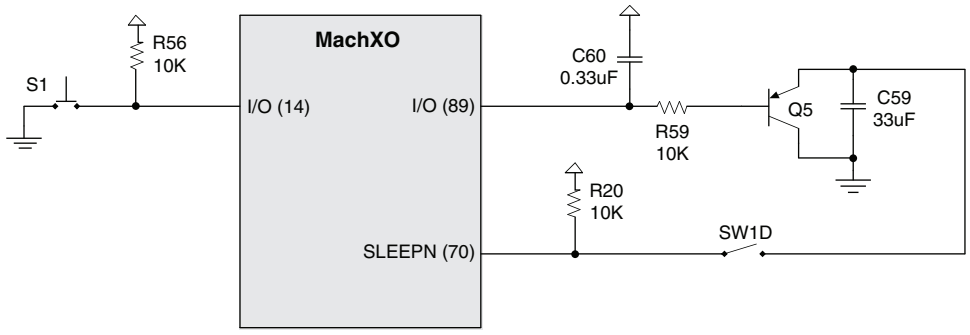
The MachXO sleep mode demo illustrates one possible implementation for power savings. Using this method, the MachXO device provides supervisory logic to control its own SLEEPN pin. Periodically, the device becomes active to monitor a trigger event. If the event is not present, it deactivates to save power.

When the SLEEPN pin is asserted (low), the following occur:

- The device powers down internally, dropping power consumption to less than 100µA
- All I/Os are tristated

When the SLEEPN pin is de-asserted (high), power is restored and the MachXO is reconfigured and ready to operate in 1ms or less. Due to the dramatic reduction in power consumption and the fast "instant-on" capability, a scheme can be implemented with a few simple, inexpensive external components deactivate the device and reactivate with a duty cycle ratio that saves substantial power.

Figure 3. Sleep Circuit (Abbreviated)



When I/O pin 89 goes low, C60 discharges. PNP transistor Q5 then conducts, discharging C59. Provided SW1D is closed, this value is forced onto the SLEEPN pin of the MachXO device, putting it into low power sleep mode.

Once in sleep mode, all I/O pins are tristated, allowing C60 to slowly charge. This then turns off Q5 and allows C59 to charge. Once the amount of charge is sufficient to place a logic high level on SLEEPN, the device returns to normal operating mode.

The MachXO begins operating, as defined by its programmed function. In this demonstration, I/O pin 89 is driven high initially to allow the device an opportunity to remain active long enough to check whether switch S1 is pressed.

If S1 is not pressed, I/O pin 89 is driven low and the cycle repeats.

If S1 is pressed at that moment, the device remains operational for the entire cycle of an internal counter (~3 sec) and the LEDs are illuminated during this time. S1 is then checked after each subsequent cycle.

To exit sleep mode or to reprogram the device, open switch SW1D (SW1-4).

Download and Program the MachXO Sleep Mode Demo Design

To download the MachXO Sleep Mode Demo source files and reprogram the Mini board:

1. See the Download Demo Designs and Programming Demo Designs with ispVM sections of this document.
2. Use **.\Demo_MachXO_Mini_Sleep\project\impl1\mini_auto_sleep_impl1.jed** to restore the MachXO Sleep Mode demo design.

Operating the Sleep Mode Demo
To operate the Sleep Mode Demo:

1. To observe the sleep/wake power savings, place voltmeter leads across J2 (VCC CORE) or J3 (VCC AUX). Each number attaches across a 0.2 ohm resistor between the +3.3V supply rail and VCC_CORE or VCC_AUX. The average voltage level will drop significantly during the sleep/wake cycle. You may estimate current consumption with Ohm's Law where I = V / 0.2 ohms.

2. Toggle SW1_1 (A), SW1_2 (B), and SW1_3 (C) to the OFF position. All user LEDs D7-D2 are dim and user LED D1-D0 are lit. The DIP switch inputs 1-3 are tied directly to the LED bank according to the table below.

SW1	LED
N/A	0, 1 (ON)
_1 (A)	2, 5
_2 (B)	3, 6
_3 (C)	4, 7

3. Adjust DIP switches 1-3 and note the pattern on the LED array.

4. Enable the MachXO Sleep Mode circuit, toggle the SW1D (4) to the ON position. The MachXO enters a sleep/wake cycle.

   According to the parameters of the external Sleep Mode circuit the MachXO will periodically wake to check for user input and drive the LED bank. If no inputs have changed it will return to the sleep state. The LED bank will flicker during the sleep/wake cycle.

5. Depress SW1. The MachXO wakes for ~3s and the LED array is lit according the SW1 values. Once the SW1 is released the Mini board reverts to the sleep/wake cycle.

   To exit sleep mode or to reprogram the device, open switch SW1D (4).

   Note: Pressing push-button SW2 will assert the dedicated MachXO SLEEPN input with any design.

TransFR Demo

This demo illustrates the TransFR (TransparentFieldReconfiguration) feature of the MachXO PLD. The TransFR solution uniquely allows logic to be updated in the field without interrupting system operation.

The demo first programs the MachXO device with a count-up function, which drives eight LEDs. It then freezes these outputs while a count-down function is loaded into the device's SRAM configuration space. The demo then concludes by releasing the outputs to display the count-down function.

The TransFR feature allows the MachXO to lock its I/Os in a deterministic state while a new configuration is loaded into the device's SRAM configuration space. This minimizes system interruption by dynamically configuring the MachXO with a new pattern without tri-stating its output pins.

The inputs for the incrementing and decrementing design are:

- **CLK**: Clock to drive the counter and internal logic
- **RSTn**: Resets counter to 0, asserted low.
- **CNTEN**: Enables counting when asserted high.
- **CAP_EN**: Captures the counter value on LEDs when asserted high.
- **LOADn**: When asserted high, enables the counter values to be displayed on LEDs. When asserted low, this input tristates the pins that drive the LEDS, and forces a synchronous load of the values captured by the CAP_EN.

The CLK connects directly to the oscillator on the board. The RSTn (global reset) is connected to user push-button (S1) of the Mini board. The other three inputs come from the SW1 DIP switch bank at the right hand side of the Mini board.

The outputs of the MachXO device are as follows:

- **LED_OUT[7:0]**: Most significant eight bits of the counter to be displayed through eight LEDs to show the counter values in binary format.

Download the TransFR Demo Design
To download the TransFR Demo source files, see the Download Demo Designs section of this document.

Programming the Initial Up-Counter Design
To program the up-counter design JEDEC file:

1. Set the control signals with the Mini board SW1 DIP switches as follows:

   • LOADn (SW1_1) is set to **1** (OFF)
   • CNTEN (SW1_2) is set to **0** (ON)
   • Cap_en (SW1_3) is set to **0** (ON)

2. Use ispVM to download the Mini board with the **.\Demo_MachXO_Mini_TransFR_Up_Counter\project\up_count.jed** file.

   See the Programming Demo Designs with ispVM section of this document for details on programming the Mini board with ispVM.

   The up-counter design is first loaded into Flash then immediately into SRAM space. In doing so, the LEDs will light up, showing the initial value of the counter (all 1s). The SRAM and Flash configuration spaces are now both programmed with the count-up function.

3. Toggle SW1_2 CNTEN to the **OFF** (1) position. The LEDs show the up-counter values.

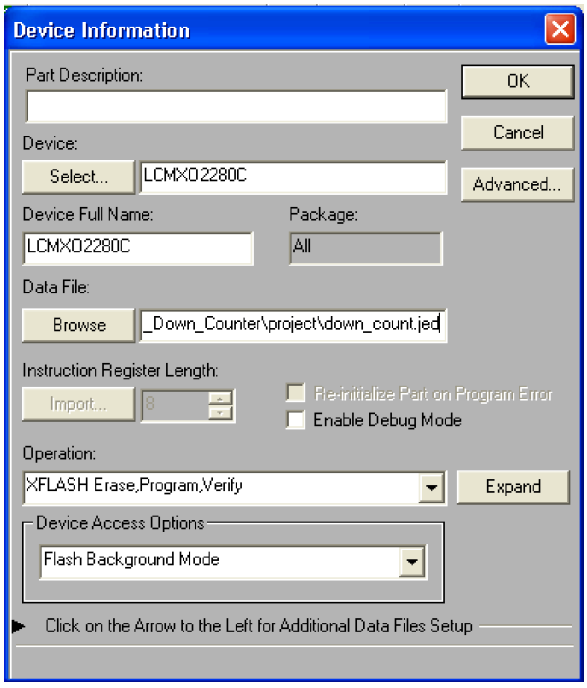
   In the following procedure you will load a down-count function into the MachXO Flash program space. After the TransFR operation is complete, the down-counter results will be displayed on LEDs.

4. Toggle SW1_2 CNTEN to the **ON** (0) position. Note the up-counter value.

Download the Down-Counter Design to the MachXO Flash Space
To program the down-counter design JEDEC file:

1. From ispVM System, choose **ispTools > Scan Chain**. The New Scan Configuration Setup window appears.
2. Double-click the **LCMXO2280C** entry in the **Device List**. The Device Information dialog appears.
3. From the **Data File** section click the **Browse** button. The Open Data File dialog appears.
4. Browse to the **.\Demo_MachXO_Mini_TransFR_Down_Counter\project** folder, select **down_count.jed**, and click the **Open** button.
5. From the **Device Access Option** section, choose **Flash Background Mode**.

6. From the **Operation** section, choose: **XFLASH Erase, Program, Verify**, and click **OK**.



7. Choose **Project > Download**. ispVM reprograms the Mini board.

   Programming requires about 20 to 40 seconds. A small timer window will appear to show elapsed programming time. At the end of programming, the configuration setup window should show a "PASS" in the "Status" column.

   The down-counter program is now loaded into the Flash configuration space. Since the up-counter function is still programmed into the SRAM configuration space, the count up function still appears on the LED bank. The count-down function will be loaded in the SRAM space when the TransFR operation is performed in the next procedure.

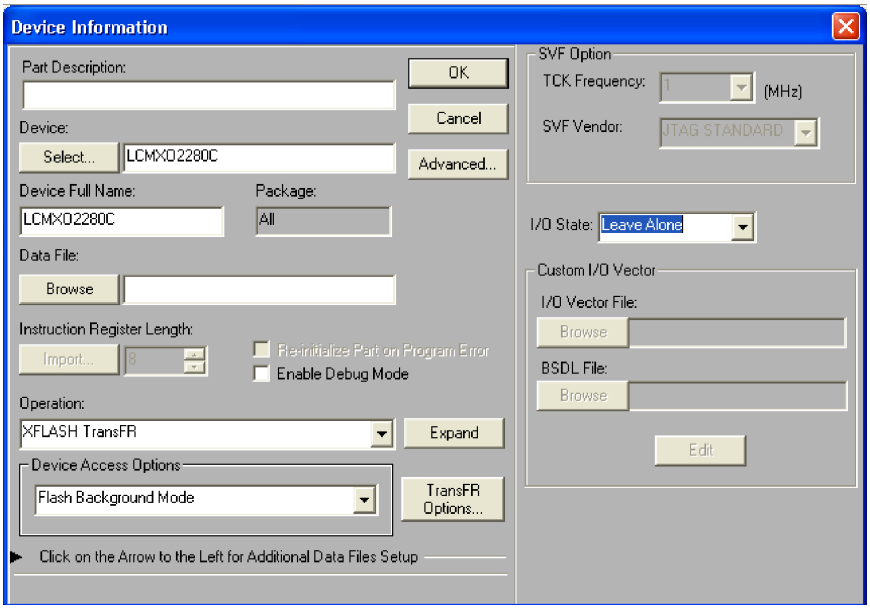
Transfer the MachXO Flash to SRAM Space

At this point in the demo, the down-counter function is loaded into the Flash configuration space, and the up-counter function is loaded into the SRAM space. In this section, an *.svf file is generated and used in the ispVM SVF debugger tool. The debugger tool steps through the SVF file to lock the I/Os at their current state (via TransFR technology), load the Flash configuration space into the SRAM space, then release the I/Os. This allows the loading of a new configuration without the I/Os ever having been tri-stated.

To prepare the transfer of Flash configuration contents to the SRAM space of the MachXO:

1. From ispVM System, choose **ispTools > Scan Chain**. The New Scan Configuration Setup window appears.
2. Double-click the **LCMXO2280C** entry in the Device List. The Device Information dialog appears.
3. From the Device Access Options section select **Flash Background Mode**.
4. From the Operation section select **XFLASH TransFR**.
5. Click on the **Expand** button.

6. From the I/O State section, select **Leave Alone**. Click **OK**.



7. Choose **File > Save As...** The Save As .XCF File dialog appears.
8. Browse to the **.\Demo_MachXO_Mini_TransFR_Down_Counter\project** directory, specify **TransFR.xcf** and choose **Save**.
9. Choose **Project > Generate SVF File...** The Generate SVF File dialog appears.
10. From Source File (*.xcf) section, choose the **Browse** button. The Browse Source *.XCF file dialog appears.
11. Browse to the **.\Demo_MachXO_Mini_TransFR_Down_Counter\project** directory, choose the **TransFR.xcf** file and click **Open**.
12. From the Save SVF File as: section, choose the **Browse** button. The Browse SVF File dialog appears.
13. Specify **TRANSFR.svf** file and choose the **Save** button.
14. Click the **Generate** button. ispVM reports: Build Single SVF File: Successful.
15. Click **OK** and click the **Close** button.

You have now built the TransFR serial vector format (SVF) file that you will use in the ispVM SVF Debugger program.

To transfer the Flash configuration contents to the SRAM space of the MachXO:

1. Choose **ispTools > SVF Debugger...** The SVF Debugger application initial Svf File1 screen appears.
2. Choose **File > Open**. The Open Data File dialog appears.
3. Browse to the to the **.\Demo_MachXO_Mini_TransFR_Down_Counter\project** directory, choose the **TransFR.svf** file, and click **Open**. The TransFR.svf code appears in the SVF Debugger window.
4. **Choose Configuration > Cable and IO Port Setup...** The Cable and IO Port Setup dialog appears.
5. Click the **Auto-Detect** button. The SVFDebugger detects the EzUSB port and USB cable.

6. Click **OK**.

7. Place the cursor at the top of the file, above the first instruction. This will ensure that you step through all the instructions in order.

8. Press the Step key **F11** (**Command > Step**). The SVF Debugger advances to the next line of executable code.

9. Step 2-3 more times. Each time you click the **STEP** button, it executes an instruction, then advances to the next instruction. Each time you step through an instruction, it is translated, goes through the USB download cable, and is executed in the MachXO device.

10. Continue to slowly step through the code and stop just before getting to the instruction that reads (about Line 51):

```
! Shift in ISC ERASE(0x03) instruction
SIR 8   TDI   (03);
```

    Note that LEDs are still counting up. Now step once while watching the displays. Note that the displays have stopped. The device outputs are now under boundary scan control. A TransFR operation (embedded in the just executed instruction) has locked the outputs at whatever count values they were at when the TransFR action occurred.

11. From the Mini board, toggle the SW1_2 CNTEN to the **ON** (0) position. This will stop the counter from counting once the device is out of the boundary scan mode.

12. Press **F11** until the cursor highlights the BYPASS instruction:

```
! Shift in BYPASS(0xFF) instruction
SIR   8     TDI   (FF);
```

13. Press **F11** once more. The cursor highlights:

```
RUNTEST IDLE...;
```

    At this point, the new pattern has been loaded into the SRAM memory space and the switch inputs are monitored, but the outputs are still controlled by boundary scan and are still frozen at the same values.

14. Press **F11**. SVFDebugger reports "Process Done. No Error". Click **OK**.

    The MachXO I/Os are now released from boundary scan control and counter's initial value (0xFF) is driven to the LED displays. The displays do not start counting yet because the CNTEN is deasserted.

15. From the Mini board, toggle the SW1_2 CNTEN to the **OFF** (1) position. The LED display starts counting down from the initial value.

    The MachXO has exchanged the up-counter for the down-counter function, without disrupting the output PIOs.

Another variation of the demo is to initialize the down-counter with the current state of the up-counter. After step 12 in the procedure, toggle CAP_EN (SW1_3) up and down once (toggle from 'ON' (0) to 'OFF' (1) and back to 'ON' (0)), then toggle LOADn (SW1_1) down and up once (go from 'OFF' (1) to 'ON' (0) and back to 'OFF' (1)). Following step 14, the counter value displayed on the LEDs will not change. Following Step 15, the down-counter will begin from the value displayed on the LED bank.

Note: See TN1087, Minimizing System Interruption During Configuration Using TransFR Technology for more information.

Download Demo Designs

Lattice distributes source and programming files for a variety of demonstration designs compatible with the Mini board.

To download demo designs:

1. Browse to the MachXO Mini Development Kit web page of the Lattice web site. Select the Demo Applications download and save the file.
2. Extract the contents of **MachXO_Mini_Dev_Kit.zip** to an accessible location on your hard drive. Four demo design directories (Demo_MachXO_Mini_<demo>) are unpacked.

Demo	Directories
Mini SoC Demo	Demo_MachXO_Mini_SoC .\project .\source .\LatticeMico8_V3_0_Verilog .\RD1042 .\project .\source .\RD1043 .\project .\source .\RD1044 .\project .\source .\RD1046 .\project .\source
MachXO Sleep Mode	Demo_MachXO_Mini_Sleep .\project .\source
TransFR	Demo_MachXO_Mini_TransFR_Down_counter .\project .\source Demo_MachXO_Mini_TransFR_Up_counter .\project .\source

Where:

- **\project** – 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_V3_0_Verilog** – LatticeMico8 Microcontroller User's Guide (RD1026).
- .\RDxxxx – Reference designs integrated by the Mini SoC Demo.

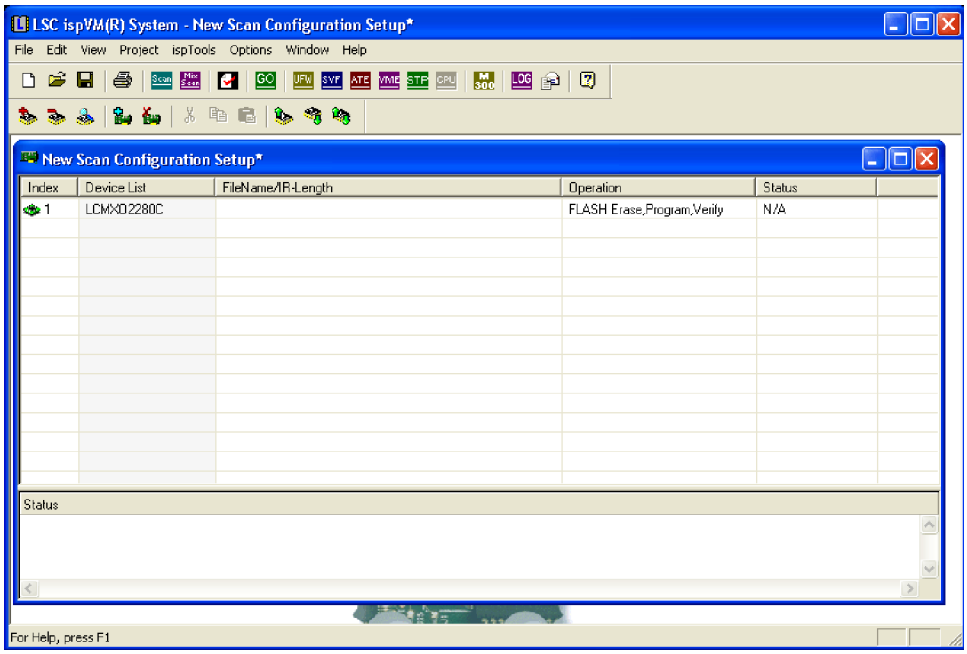
Programming Demo Designs with ispVM

This section describes the programming procedure to program the MachXO device using ispVM. If you have Lattice Diamond 1.3 installed, then you must download the latest version of the ispVM System device programming software. Click here to install the latest version of the ispVM System software. Diamond 1.3 comes with a programming tool called Diamond Programmer. This tool does not have a SVF debugger (see Release Notes on the Lattice website).

The Mini SoC demo design is pre-programmed into the Mini board by Lattice. To restore a Mini board to factory settings or load an alternative demo design, use the procedure described in this section.

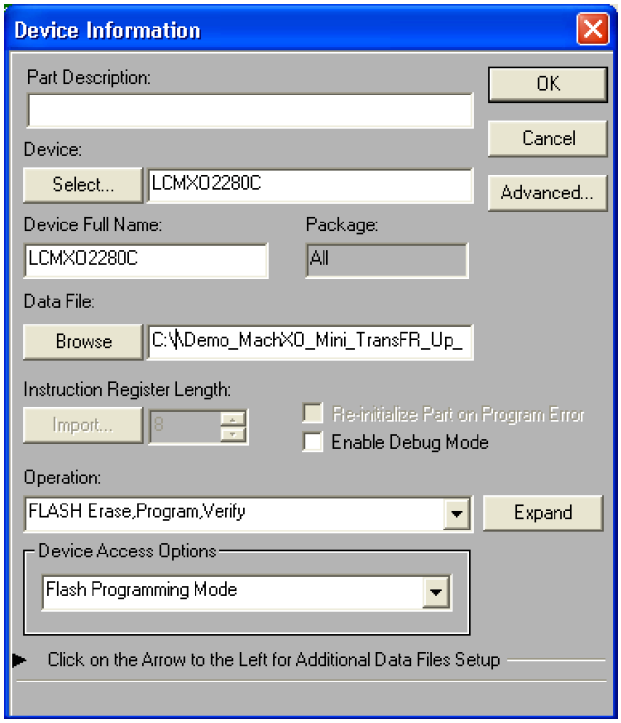
To program a demo programming file:

1. Connect the Mini board to a host PC using both USB DEBUG and PROG ports.
2. From the Mini board toggle SW1D to the **OFF** position.
3. From the Start menu run **ispVM System**. ispVM appears.
4. Choose **Options > Cable and IO Port Setup...** The Cable and I/O Port Setup dialog appears.
5. Click **Auto Detect**. ispVM will detect Cable Type USB and Port Setting EzUSB.
6. Click **OK**.
7. Choose **ispTools > Scan Chain**. The New Scan Configuration Setup window appears. The LCMXO2280C appears in the device list.



8. Right-click the LCMXO2280C entry and choose **Edit Device...** The Device Information dialog appears.
9. From the **Data File** section, click the **Browse** button. The Open Data File dialog appears.

10. Browse to the **<Demo Dir>\project** folder, select **<Demo>.jed**, and click **Open**. From the **Operation** list choose **Flash Erase, Program, Verify** and click **OK**.



11. Choose **Project > Download**. ispVM reprograms the Mini Board.

    Programming requires about 20-40 seconds. A small timer window will appear to show elapsed programming time. At the end of programming, the configuration setup window should show a "PASS" in the "Status" column.

Rebuilding a Demo Project with Lattice Diamond Design Software

Use the procedure described below to rebuild any of the demo projects for the MachXO Mini Evaluation Board.

1. Install and license Diamond software
2. Install and license ispVM System software.
3. Download the demo source files from the MachXO Mini Development Kit web page.
4. Run the Diamond design tool.
5. Create a new project and add the HDL files from the **<demo>\source** directory. Note that some demos provide a **<demo>.ldf** project file.
6. Import the logical preference file (**<demo>.lpf**) with I/O plan and timing requirements.
7. Run the Generate Data File (JEDEC) process.
8. See the MachXO Sleep Mode Demo section of this document for details on downloading a programming file to the Mini 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 Revision 3.0.

   Note: The LatticeMico8 tool executables are also provided in the ***. \Demo_MachXO_Mini_SoC\LatticeMico8_V3_0_Verilog\utils*** *directory.*

2. Optional Compile the LatticeMico8 Assembler and Simulator
3. Modify the Assembly source (.s) file and recompile to a memory image (.hex). Source for the Mini SoC demo is provided as mini_soc_demo.s.
4. Use the Memory Initialization tool of the Diamond design software to update the physical database NCD.
5. Rerun Generate Data File (JEDEC) process.
6. See the Programming Demo Designs with ispVM section of this document for details on downloading a programming file to the Mini board.

MachXO Mini Evaluation Board

This section describes the features of the MachXO Mini Evaluation Board in detail.

Overview

The Mini board is a complete USB-powered development platform for the Lattice MachXO PLD. The board includes on-board SRAM and SPI Flash memory, I²C and SPI microcontroller communication interfaces, a USB program/debug port, and an expansion header to support test connections.

Figure 4. MachXO Mini Evaluation Board Block Diagram

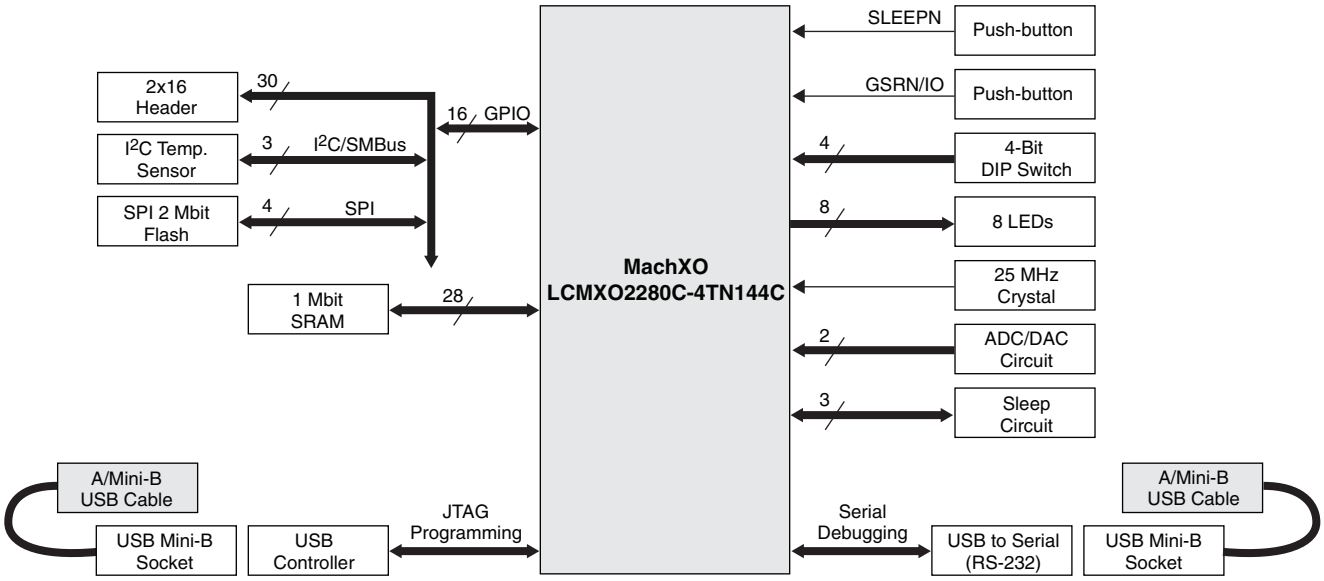


Table 1 describes the components on the board and the interfaces it supports.

Table 1. MachXO Mini Evaluation Board Components and Interfaces

Component/Interface	Type	Schematic Reference	Description
Circuits			
USB Controller	Circuit	U3:CY7C68013A-QFN56	USB-to-JTAG interface
USB to Serial (RS-232)	Circuit	U1:FT232R / 32-QFN	USB-to-Serial interface
Components			
25 MHz Crystal	Clock	X2:25 MHz	MachXO clock source
1Mbit SRAM	Memory	U8:CY128X8TSOP	1Mb of SRAM
MachXO PLD	PLD	U16:MachXO_2280_TQ144	LCMXO2280T144
I^2C Temperature Sensor	I/O	U14:TMP101	Measures board temperature
2Mbit SPI Flash Memory	Memory	U11	2Mb FLASH memory
8 LEDs	Output	D7-D0	User-definable LEDs
Interfaces			
2x16 Header	I/O	J6	User-definable I/O
USB Mini B Sockets	I/O	J1, J8	Programming and debug interface
Push-button switches	I/O	S1, S2	GSR and Sleep push buttons
Jumper	I/O	J2	MachXO Core current
Jumper	I/O	J3	MachXO AUX current
Jumper	I/O	J4	MachXO I/O current
Jumper	I/O	J5	MachXO TSALL input

Subsystems

This section describes the principle subsystems for the Mini board in alphabetical order.

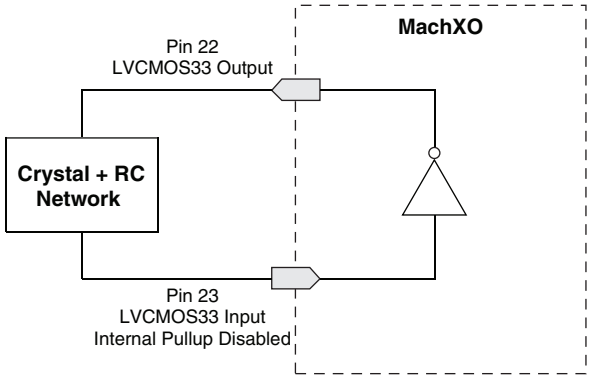
Clock Sources

Three clock sources are available to the MachXO, an unconditioned input from a 25MHz crystal or a 48MHz originating from the FTDI USB Device controller.

Table 2. Clock Sources Pin Information

Source	Frequency (MHz)	Description	MachXO Pin
FTDI USB Device U1	48	Available only when DEBUG connector J8 is connected to a USB host.	124
Cypress USB Device U3	48	Available only when PROG connector J1 is connected to a USB host.	127
Crystal X2	25	Crystal 25MHz. See Figure 5 for MachXO logic required for the X2 connection.	23, 22

Figure 5. MachXO Logic for Crystal X2 Connection



DIP Switch

The evaluation board includes a 4-bit input toggle switch located on the right side of the board. Three are available as general purpose inputs. When in the ON position, a connection to ground is made for a logical low input to the corresponding MachXO pin. When open, the line is pulled high through external resistors.

Table 3. DIP Switch Reference

Item	Description
Reference Designators	SW1
Part Number	219-4MST
Manufacturer	CTS
Web Site	www.ctscorp.com

Table 4. DIP Switch Pin Information

SW1	Description	MachXO Pin
A/1	User-defined.	92
B/2	User-defined.	91
C/3	User-defined.	90
D/4	Connected to MachXO sleep circuit.	70

Expansion Header

The expansion header provides 25 user I/Os connected to the MachXO, five for the on-board SPI bus, and three for the on-board I^2C/SMBus. The remaining pins serve as power and clock supplies for expansion boards. The expansion connector is configured as one 2x16 100mil centered pin header.

Eight pins of the MachXO top bank (which provides PCI clamp support) and eight pins of the left or right bank (differential output support) are connected to the connector.

Table 5. Expansion Connector Reference

Item	Description
Reference Designators	J6
Part Number	90131-0800
Manufacturer	Molex/Waldom Electronics
Web Site	www.molex.com

Table 6. Expansion Header Pin Information

J6 Pin	Function	MachXO Pin	Other Connections	Notes
1	+3.3V	—		
2	+3.3V	—		
3	8	80		
4	0	119		
5	9	78		
6	1	116		
7	10	79		
8	2	114		
9	11	76		
10	3	113		
11	12	77		
12	4	112		
13	13	74		
14	5	111		
15	14	75		
16	6	110		
17	15	73		
18	7	109		
19	I^2C Alert	120	Temp Sensor U14	2.2K external pull-up.
20	Clock	127		48MHz clock from Cypress USB device.
21	I^2C Data	122	Temp Sensor U14	2.2K external pull-up.
22	SPI Chip Select	87		SPI CS signal for expansion header.
23	I^2C Clock	121	Temp Sensor U14	2.2K external pull-up.
24	SPI Clock	85	SPI Flash U11	Shared SPI Interface.
25	Reserved			
26	SPI Data Output	81	SPI Flash U11	Shared SPI Interface.
27	Reserved			
28	SPI Data Input	84	SPI Flash U11	Shared SPI Interface.
29	GND	—		
30	GND	—		
31	Analog Input	—	Comparator U15	
32	PWM Output	—	Transistor Q3	Output as high as 5V[1].

1. MachXO I/O pins are not 5V tolerant. This signal should not be connected to any MachXO pins.

I^2C Temperature Sensor

The temperature sensor is a TI TMP101NA/250 device. It uses an I^2C/SMBus interface to provide the temperature reading on the board. The temperature sensor is located in the lower-right corner of the board.

Table 7. I^2C Temperature Sensor Reference

Item	Description
Reference Designators	U14
Part Number	TMP101NA/250
Manufacturer	TI
Web Site	www.ti.com

Table 8. I²C Temperature Sensor Pin Information

Function	Direction	U14 Pin	Description	MachXO Pin
SCL	I/O	1	Pulled high through 2.2K resistor pack RN2.	121
SDA	I/O	6	Pulled high through 2.2K resistor pack RN2.	122
ALERT	O	3	Pulled high through 2.2K resistor pack RN2.	120
ADD0	I	5	Hard-wired high.	—

JTAG Programming Interface

A USB B-type mini socket on the board serves as the JTAG programming interface.

For JTAG programming, a preprogrammed Cypress CY7C68013A USB peripheral controller, and boot PROM are provided on the Mini board to serve as the programming interface to the MachXO PLD. Programming requires the ispVM System software. The programming connection will appear to the ispVM System software as if a regular USB-based ispDOWNLOAD cable is connected to the PC.

Table 9. JTAG Programming Reference

Item	Description
Reference Designators	U2
Part Number	CY7C68013A-56LFXC
Manufacturer	Cypress
Web Site	www.cypress.com

Table 10. JTAG Programming Pin Information

Signal Name	Description	MachXO Pin
XO_TDO	Test Data Output	47
XO_TDI	Test Data Input	51
XO_TMS	Test Mode Select	39
XO_TCK	Test Clock	42

Jumpers

One jumper is provided on the right side of the board for general use. When a jumper is installed, a connection to ground is made. When the jumper is removed, the line is pulled high through an external resistor.

Table 11. Jumper Reference

Item	Description
Reference Designators	J5
Part Number	Jumpers Red 1x2
Manufacturer	Tyco Electronics AMP
Web Site	www.tycoelectronics.com

Table 12. Jumper Pin Information

Item	Notes	MachXO Pins
J5	MachXO TSALL pin, can also be used as general-purpose I/O.	24
J4	VCCIO current	135, 117, 98, 82, 38, 63, 10, 26
J3	VCCAUX current	53, 128
J2	VCCCORE current	21, 52, 93, 129

MachXO PLD

The MachXO PLD device (LCMXO2280C-4TN144C) on the board provides 2280 LUTs, 7.5 Kbits of distributed RAM, 27.6 Kbits of EBR SRAM and 101 user I/Os in an 8x8 mm chip scale package.

Table 13. MachXO PLD Reference

Item	Description
Reference Designators	U1
Part Number	LCMXO2280C-4TN144C
Manufacturer	Lattice Semiconductor
Web Site	www.latticesemi.com

Power Supply

A single 3.3V supply voltage for the board components is provided from the USB DEBUG connection.

Push-buttons

The board has two user push-button switches (S1 and S2). S1 connects to the GSRN pin which asserts the Global Set/Reset input on the MachXO. In order for the GSR to operate, it is necessary to instantiate the GSR macro in the VHDL/Verilog HDL source, otherwise it may be used as a general input pin. S2 is routed to the SLEEPN pin which asserts the MachXO Sleep Mode. Both push-buttons are normally pulled high, and when pressed are asserted to ground.

Table 14. Push-button Reference

Item	Description
Reference Designators	S1, S2
Part Number	EVQ-Q2K03W
Manufacturer	Panasonic ECG
Web Site	www.panasonic.com/industrial/components/components.html

Table 15. Push-button Pin Information

Button	Description	MachXO Pin
S1	MachXO GSRN or general-purpose I/O.	14
S2	Connected to MachXO SLEEPN pin.	70

RS-232 Interface

For serial communications and on-chip debugging a FTDI USB-RS232 converter provides an RS-232-like serial communication interface between a PC host and an embedded system running in the MachXO.

Table 16. RS-232 Interface Reference

Item	Description
Reference Designators	U1
Part Number	FT232R
Manufacturer	FTDI (Future)
Web Site	www.ftdichip.com

Table 17. RS-232 Interface Pin Information

Function	Direction	U1 Pin	Description	MachXO Pin
TXD	O	30	Transmit Data	7
RXD	I	2	Receive Data	6
RTS#	O	32	Request to Send	5
CTS#	I	8	Clear to Send	4
DTR#	O	31	Data Terminal Ready	1
DSR#	I	6	Data Set Ready	2
DCD#	I	7	Data Carrier Detect	3
RI#	I	3	Ring Indicator	8

SPI Flash Memory

The board is populated with a Numonyx/ST Micro non-volatile 2-Mbit SPI Flash memory located near the upper-right corner of the board.

Table 18. SPI Flash Memory Reference

Item	Description
Reference Designators	U11
Part Number	M25PE20-VMN6TP
Manufacturer	Numonyx/ST Micro
Web Site	www.numonyx.com

Table 19. SPI Flash Memory Pin Information

Function	Dir	U11 Pin	Description	MachXO Pin
S#	I	1	SPI Flash chip select.	86
C	I	6	SPI Flash dlock input.	85
D	I	5	SPI Flash data input.	84
Q	O	2	SPI Flash data output.	81
W#	I	3	Hard-wired high.	—
RESET#	I	7	Hard-wired high.	—

SRAM

The board is populated with a Cypress 1-Mbit (128K x 8) Static RAM with a data bus width of 8 bits. The 15-bit address bus, the data bus and the control signals are connected directly to the CPLD. The 15-bit address bus, named MEMORY_A0 through MEMORY_A14, addresses 1-byte locations.

A 1Mb asynchronous SRAM is located at the bottom-center of the board.

Table 20. SRAM Reference

Item	Description
Reference Designators	U8
Part Number	CY7C1019DV33-10ZSXI
Manufacturer	Cypress
Web Site	www.cypress.com

Table 21. SRAM Pin Information

Function	Direction	U8 Pin	Description	MachXO Pin
A0	I	1	Address Inputs to SRAM	50
A1	I	2		54
A2	I	3		55
A3	I	4		56
A4	I	13		57
A5	I	14		58
A6	I	15		60
A7	I	16		61
A8	I	17		62
A9	I	18		65
A10	I	19		66
A11	I	20		67
A12	I	21		69
A13	I	29		68
A14	I	30		71
A15	I	31		72
A16	I	32		36
IO0	I/O	6	Data to/from SRAM	40
IO1	I/O	7		41
IO2	I/O	10		43
IO3	I/O	11		44
IO4	I/O	22		45
IO5	I/O	23		46
IO6	I/O	26		48
IO7	I/O	27		49
CE#	I	5	Chip Enable to SRAM	17
OE#	I	28	Output Enable to SRAM	18
WE#	I	12	Write Enable to SRAM	19

User LEDs

Eight red LEDs can be used for custom status signaling. The LEDs are located at the top of the board, next to the expansion header. Each LED illuminates when the corresponding pin on the MachXO is driven low.

Table 22. User LEDs Reference

Item	Description
Reference Designators	D7-D0
Part Number	LTST-C190CKT
Manufacturer	Lite-On
Web Site	www.liteonit.com

Table 23. User LED Pin Information

Signal Name	Description	MachXO Pin
D7	User-defined	144
D6	User-defined	143
D5	User-defined	142
D4	User-defined	141
D3	User-defined	140
D2	User-defined	139
D1	User-defined	138
D0	User-defined	137

Programming

Programming for the MachXO device is controlled using the ispVM System software. Refer to the ispVM System software for help regarding operation of this software.

The MachXO Mini Evaluation Board is equipped with a built-in USB-based programming circuit. This consists of a USB PHY and a USB connector. When the board is connected to a PC with a USB cable, it is recognized by the ispVM System software as a "USB Download Cable". The MachXO PLD can then be scanned and programmed using the ispVM System software.

Software Requirements

You should install the following software before you begin developing designs for the evaluation board:

- Lattice Diamond design software
- Latest version of ispVM System software
  (Click here to install the latest version of the ispVM System software)

Mechanical Specifications

Dimensions: 3 1/2 in. [L] x 2 in. [W] x 3/8 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.

Pin Information and Bank Summary

Table 24 describes pin information for the LCMXO2280TN144 device and board connections.

Table 24. MachXO Pin Information and Bank Summary

LCMXO2280TN144			Board Connection Mini SoC Demo
Pin #	Pin Function	Bank	
1	PL2A	Bank7	
2	PL2B	Bank7	
3	PL3A	Bank7	
4	PL3B	Bank7	
5	PL3C	Bank7	
6	PL3D	Bank7	uart_tx
7	PL4A	Bank7	uart_rx

Table 24. MachXO Pin Information and Bank Summary (Continued)

LCMXO2280TN144			Board Connection Mini SoC Demo
Pin #	Pin Function	Bank	
8	PL4B	Bank7	
9	PL4C	Bank7	
10	VCCIO7	Bank7	
12	PL6C	Bank7	
13	PL7A	Bank7	
14	PL7B	Bank7	rst_n
15	PL7D	Bank7	
17	PL9C	Bank7	sram_cen
18	PL9D	Bank7	sram_oen
19	PL13A	Bank6	sram_wen
20	PL13B	Bank6	
22	PL13D	Bank6	xout
23	PL14D	Bank6	xin
24	PL14C	Bank6	
25	PL15B	Bank6	
26	VCCIO6	Bank6	
28	PL16D	Bank6	
29	PL17A	Bank6	
30	PL17B	Bank6	
31	PL17C	Bank6	
32	PL17D	Bank6	
33	PL18A	Bank6	
34	PL18B	Bank6	
35	PL19A	Bank6	
36	PL19B	Bank6	sram_addr_16
38	VCCIO5	Bank5	
39	TMS	Bank5	
40	PB2A	Bank5	sram_data_0
41	PB2B	Bank5	sram_data_1
42	TCK	Bank5	
43	PB3A	Bank5	sram_data_2
44	PB3B	Bank5	sram_data_3
45	PB4A	Bank5	sram_data_4
46	PB4B	Bank5	sram_data_5
47	TDO	Bank5	
48	PB4D	Bank5	sram_data_6
49	PB5A	Bank5	sram_data_7
50	PB5B	Bank5	sram_addr_0
51	TDI	Bank5	
54	PB8F	Bank5	sram_addr_1
55	PB10F	Bank4	sram_addr_2
56	PB10C	Bank4	sram_addr_3
57	PB10D	Bank4	sram_addr_4

Table 24. MachXO Pin Information and Bank Summary (Continued)

LCMXO2280TN144			Board Connection Mini SoC Demo
Pin #	Pin Function	Bank	
58	PB10B	Bank4	sram_addr_5
60	PB12A	Bank4	sram_addr_6
61	PB12B	Bank4	sram_addr_7
62	PB12E	Bank4	sram_addr_8
63	VCCIO4	Bank4	
65	PB13A	Bank4	sram_addr_9
66	PB13B	Bank4	sram_addr_10
67	PB13C	Bank4	sram_addr_11
68	PB13D	Bank4	sram_addr_13
69	PB14D	Bank4	sram_addr_12
71	PB16C	Bank4	sram_addr_14
72	PB16D	Bank4	sram_addr_15
73	PR20B	Bank3	
74	PR20A	Bank3	
75	PR19B	Bank3	
76	PR19A	Bank3	
77	PR17D	Bank3	
78	PR17C	Bank3	
79	PR17B	Bank3	
80	PR17A	Bank3	
81	PR16D	Bank3	spi_miso
82	VCCIO3	Bank3	
84	PR15B	Bank3	spi_mosi
85	PR15A	Bank3	spi_sclk
86	PR14B	Bank3	spi_csn
87	PR14A	Bank3	
89	PR13B	Bank3	
90	PR13A	Bank3	sw_2
91	PR10B	Bank2	sw_1
92	PR10A	Bank2	sw_0
94	PR8B	Bank2	
95	PR8A	Bank2	
96	PR7B	Bank2	
97	PR7A	Bank2	
98	VCCIO2	Bank2	
100	PR5C	Bank2	
101	PR5B	Bank2	
102	PR5A	Bank2	
103	PR4D	Bank2	
104	PR4C	Bank2	
105	PR4B	Bank2	
106	PR4A	Bank2	
107	PR3B	Bank2	

Table 24. MachXO Pin Information and Bank Summary (Continued)

LCMXO2280TN144			Board Connection Mini SoC Demo
Pin #	Pin Function	Bank	
108	PR3A	Bank2	
109	PT16D	Bank1	
110	PT16C	Bank1	
111	PT16B	Bank1	
112	PT16A	Bank1	
113	PT15D	Bank1	
114	PT15C	Bank1	
115	PT14B	Bank1	
116	PT14A	Bank1	
117	VCCIO1	Bank1	
119	PT12F	Bank1	
120	PT12E	Bank1	
121	PT12D	Bank1	scl
122	PT12C	Bank1	sda
124	PT10B	Bank1	
125	PT9D	Bank1	
126	PT9C	Bank1	
127	PT9B	Bank1	
130	PT7B	Bank0	
131	PT7A	Bank0	
132	PT6D	Bank0	
133	PT6E	Bank0	
134	PT6F	Bank0	
135	VCCIO0	Bank0	
137	PT4B	Bank0	led_0
138	PT4A	Bank0	led_1
139	PT3B	Bank0	led_2
140	PT3A	Bank0	led_3
141	PT2D	Bank0	led_4
142	PT2C	Bank0	led_5
143	PT2B	Bank0	led_6
144	PT2A	Bank0	led_7
16	GND		
21	VCC		
52	VCC		
53	VCCAUX		
59	GND		
88	GND		
93	VCC		
123	GND		
128	VCCAUX		
129	VCC		
11	GNDIO7		

Table 24. MachXO Pin Information and Bank Summary (Continued)

LCMXO2280TN144			Board Connection Mini SoC Demo
Pin #	Pin Function	Bank	
27	GNDIO6		
37	GNDIO5		
64	GNDIO4		
70	SLEEPN/NC		83
GNDIO3			99
GNDIO2			118
GNDIO1			136
GNDIO0			

Note: Data sheet version: 2.0, November 2007.

Glossary

CPLD: Complex Programmable Logic Device

DIP: Dual In-line Package.

I²C: Inter-Integrated Circuit.

LED: Light Emitting Diode.

PCB: Printed Circuit Board.

RoHS: Restriction of Hazardous Substances Directive.

PLL: Phase Locked Loop.

SPI: Serial Peripheral Interface.

SRAM: Static Random Access Memory.

TransFR: Transparent Field Reconfiguration.

UART: Universal Asynchronous Receiver/Transmitter.

USB: Universal Serial Bus.

WDT: Watchdog Timer

Troubleshooting

Mini Board is Not Responsive or ispVM Reports Programming Errors
Ensure SW1D (4) is toggled to the OFF position. This will disable the MachXO Sleep Mode circuit.

Determine the Source of a Pre-Programmed Part
It is likely that you will receive your Mini board after it has been reviewed and reprogrammed by someone else. To restore the Mini board to the factory default, see the Download Demo Designs section of this document for details on downloading and reprogramming the device.

You can also determine which demo design is currently programmed onto the Mini board by comparing the JEDEC checksums against of the programming file with what is read from the programmed part.

To compare JEDEC file checksum:

1. Connect the Mini board to a host PC using both USB DEBUG and PROG ports.

2. From the Mini board toggle SW1D to the **OFF** position.
3. Start ispVM and choose **ispTools > Scan**. The LCMXO2280C appears in the Device List.
4. From the **Operation** list choose **FLASH Calculate Checksum** and click **OK**.
5. Choose **Project > Download**. ispVM reads the Flash contents from the MachXO and displays a hexadecimal checksum value in the Status column.
6. Open the original JEDEC file into a text editor and page to the bottom of the file. Note the hexadecimal checksum at the line above the User Electronic Data note line. Compare this value against the checksum reported by ispVM.

Ordering Information

Description	Ordering Part Number	China RoHS Environment-Friendly Use Period (EFUP)
MachXO Mini Development Kit	LCMXO2280C-M-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
February 2009	01.0	Initial release.
August 2011	01.1	Updated for Lattice Diamond design software support.
February 2012	01.2	Updated document with new corporate logo.
		Added new table to Appendix A: MachXO Pin Function Cross Reference - LCMXO640TN144 and LCMXO2280TN144.
February 2012	01.3	Updated Appendix A with new schematic.
March 2012	01.4	Corrected title of Appendix A.

Appendix A. Schematic

Figure 6. MachXO Banks 0-1

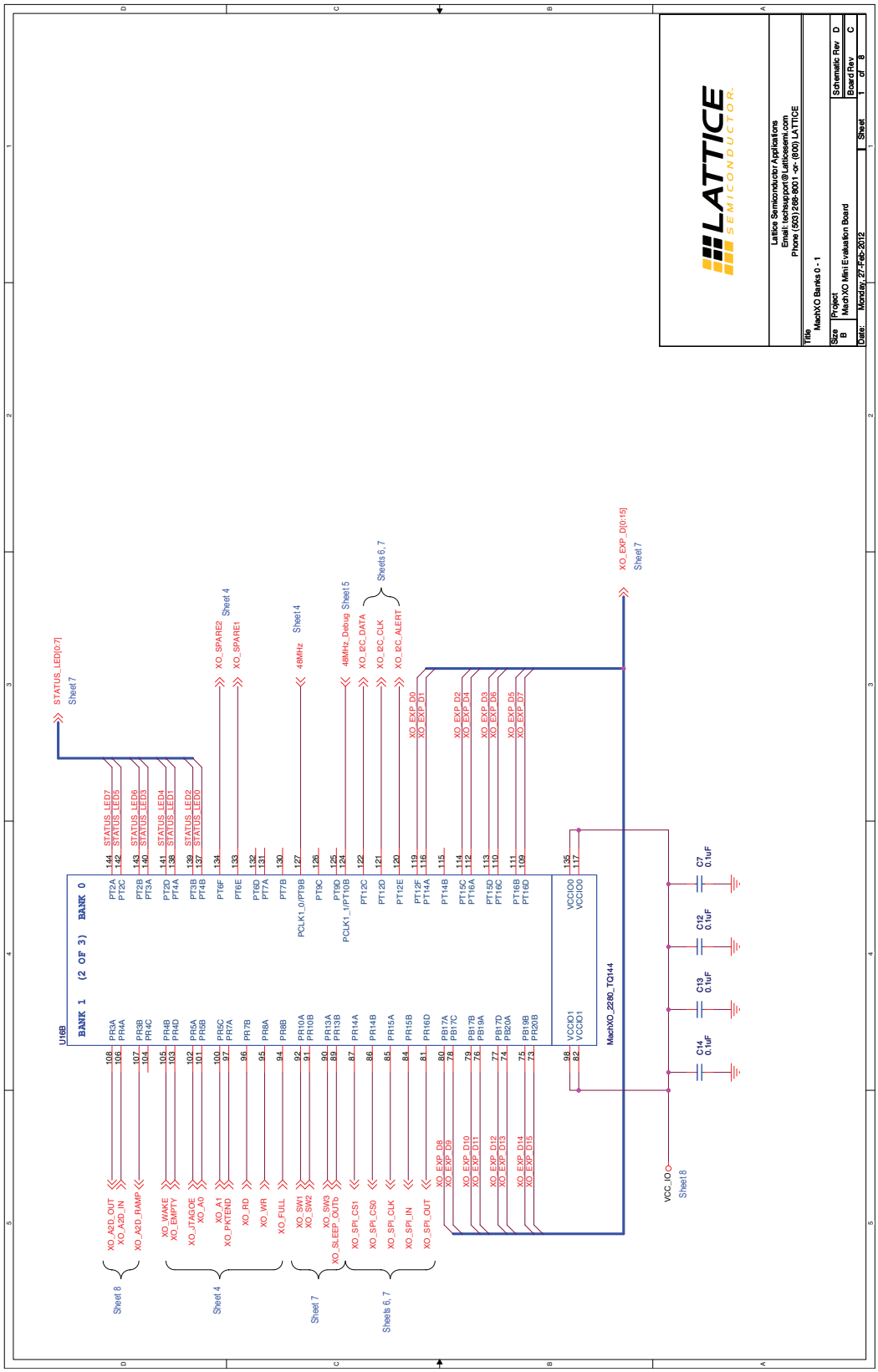


Figure 7. MachXO Banks 2-3

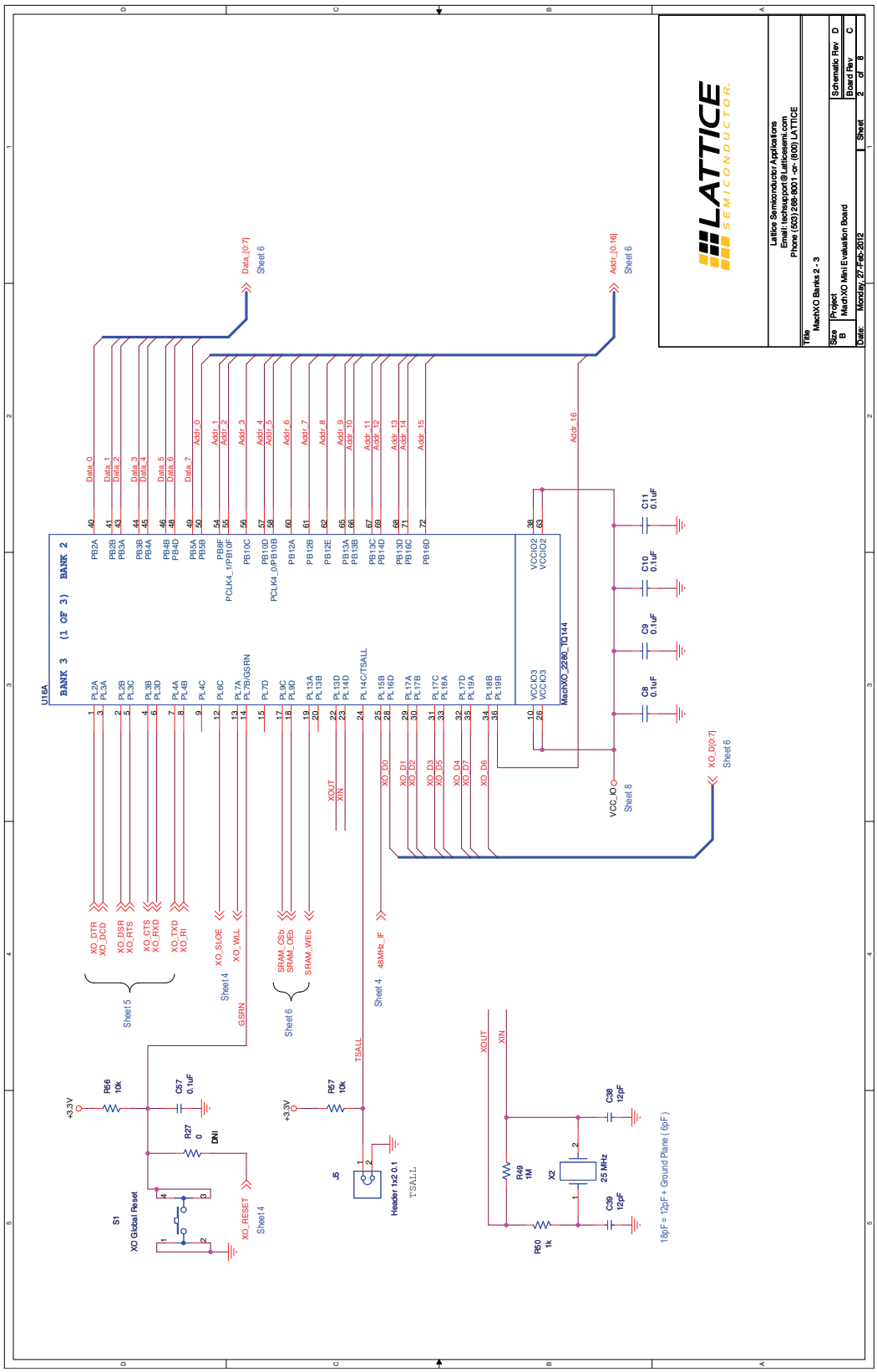


Figure 8. Power, Decoupling, and JTAG

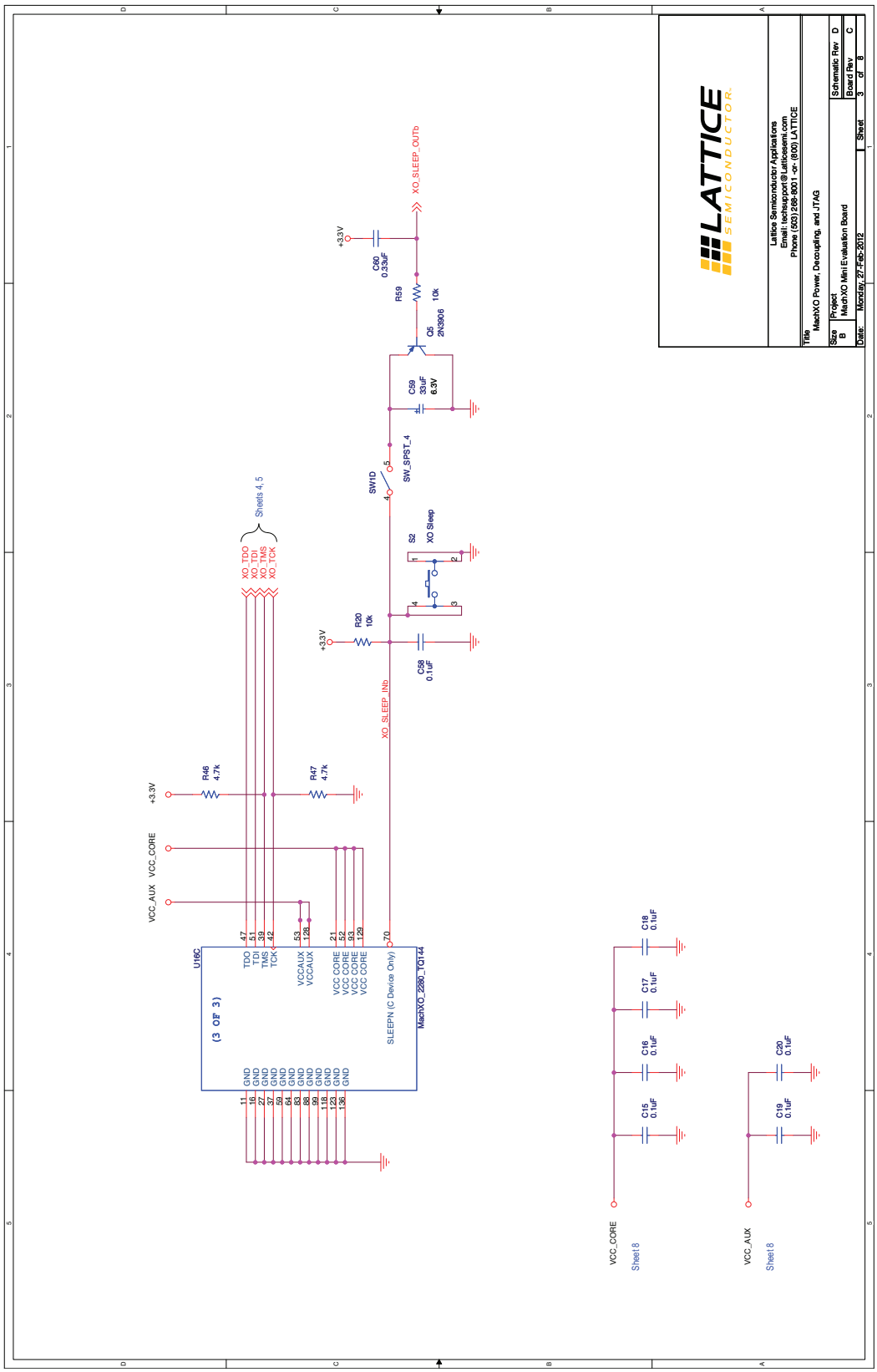


Figure 9. USB Programming Interface to MachXO JTAG

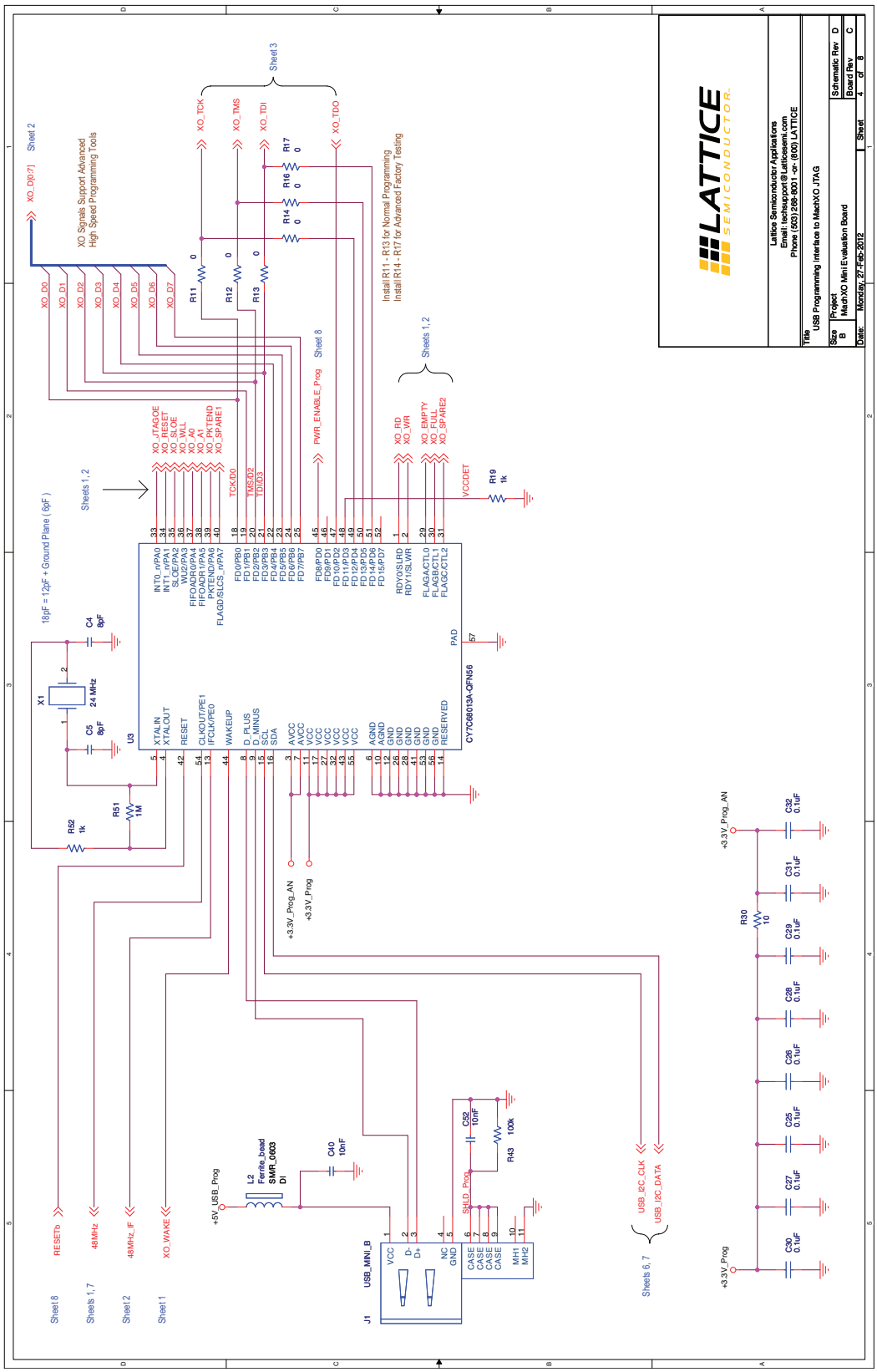


Figure 10. USB Debug-UART & Optional Program

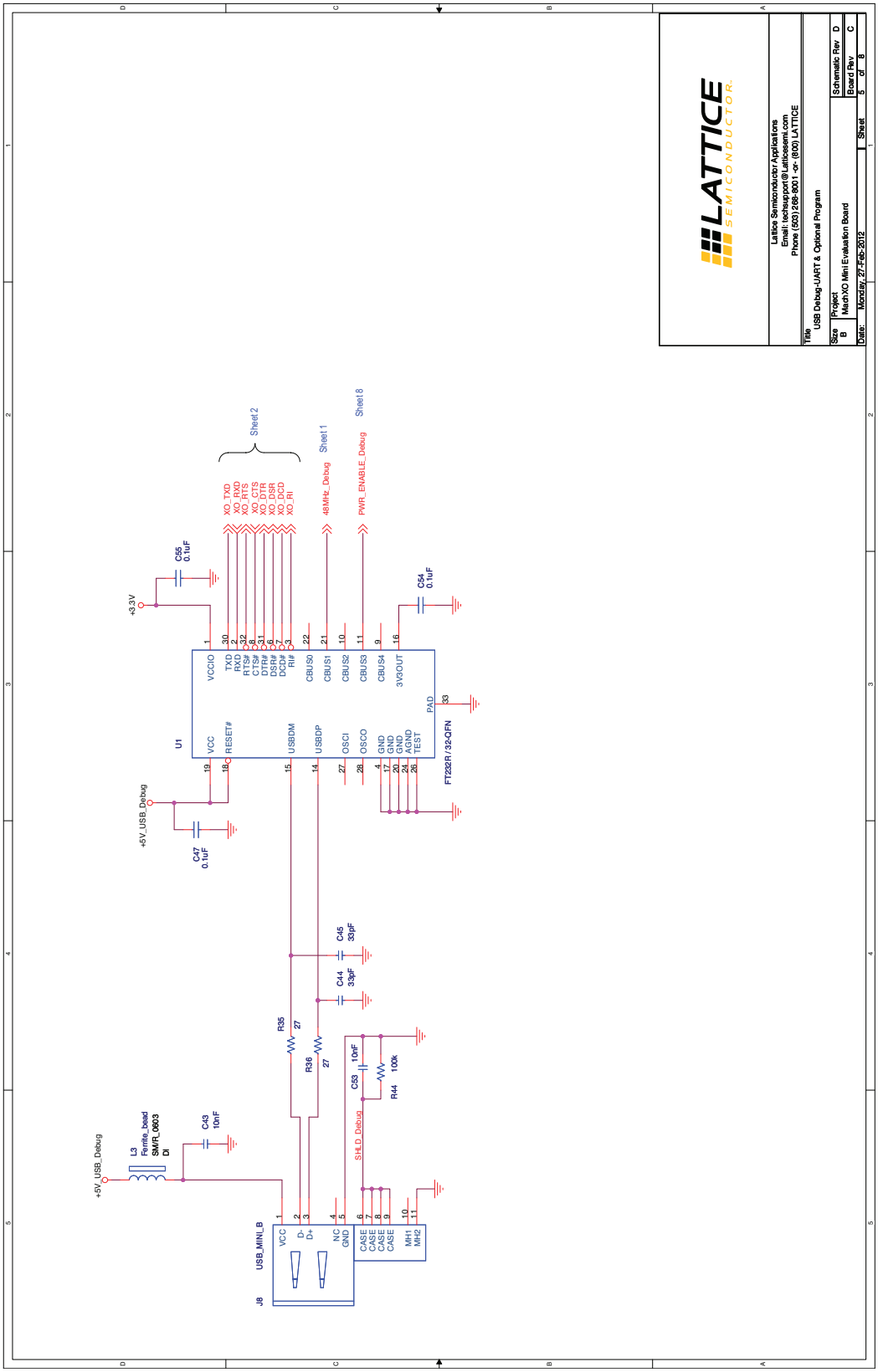


Figure 11. Memory – SRAM, SPI, and I²C

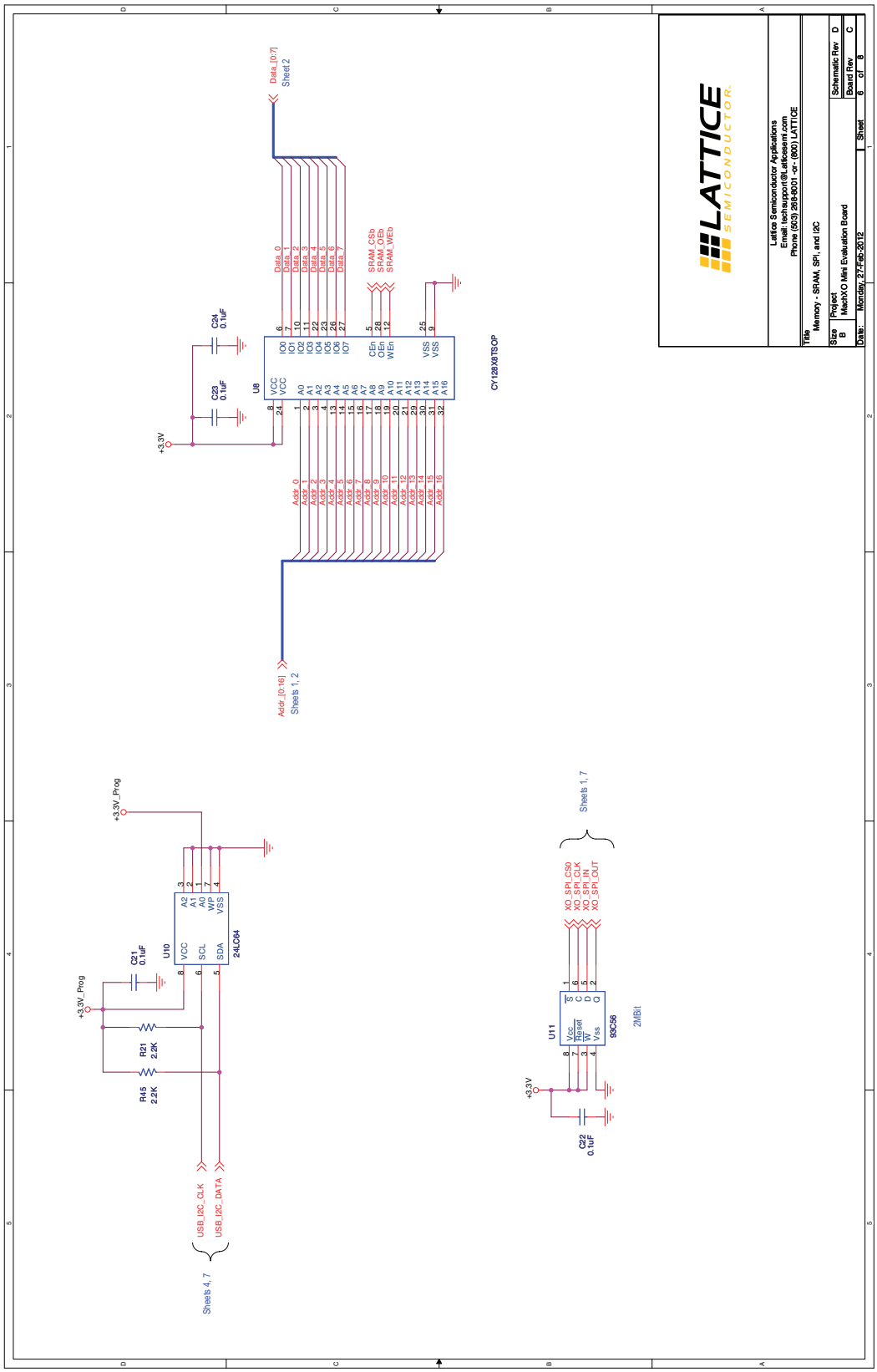


Figure 12. Status LEDs, DIP-SW, Temp Sensor, and Expansion Header

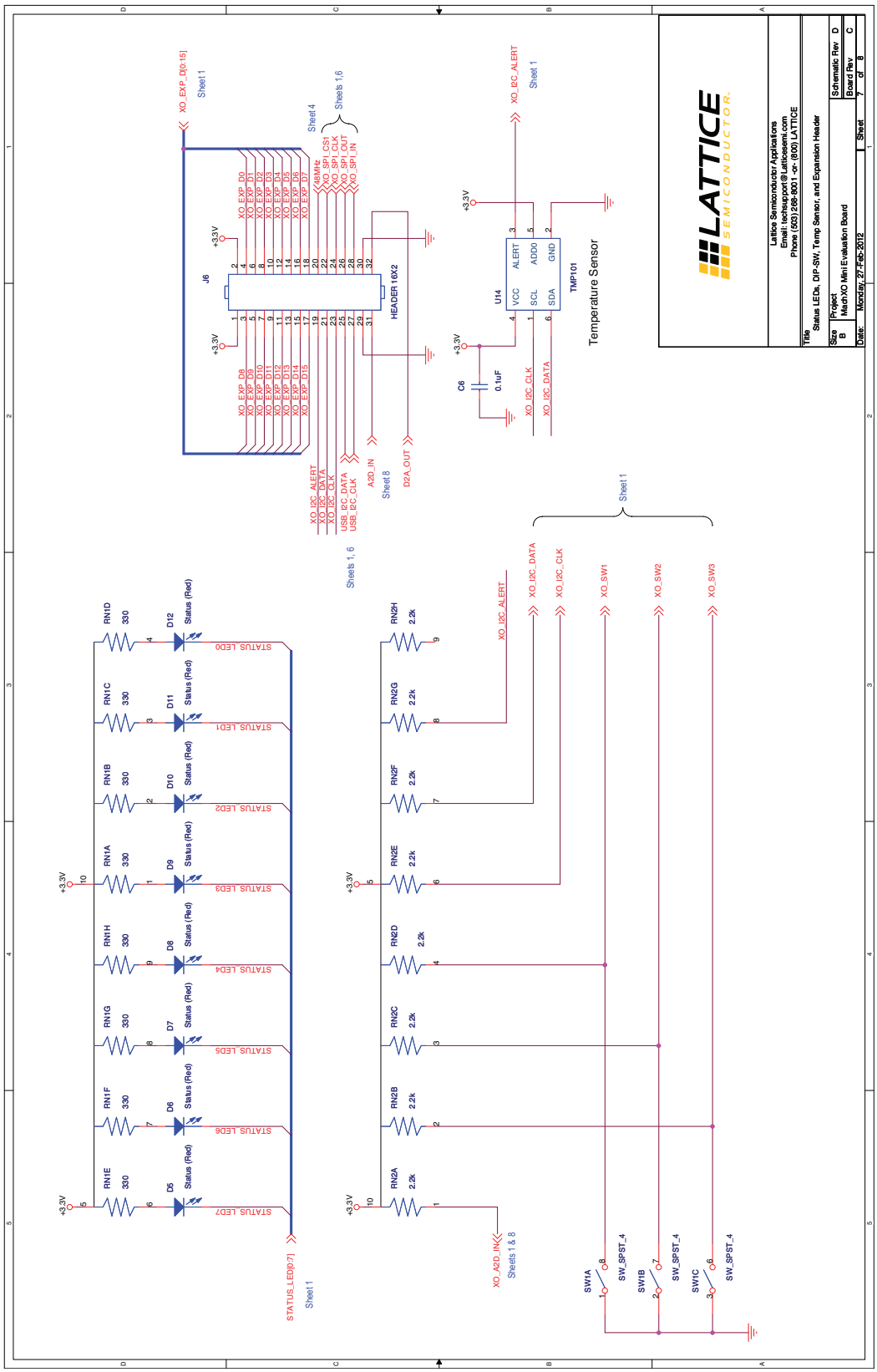
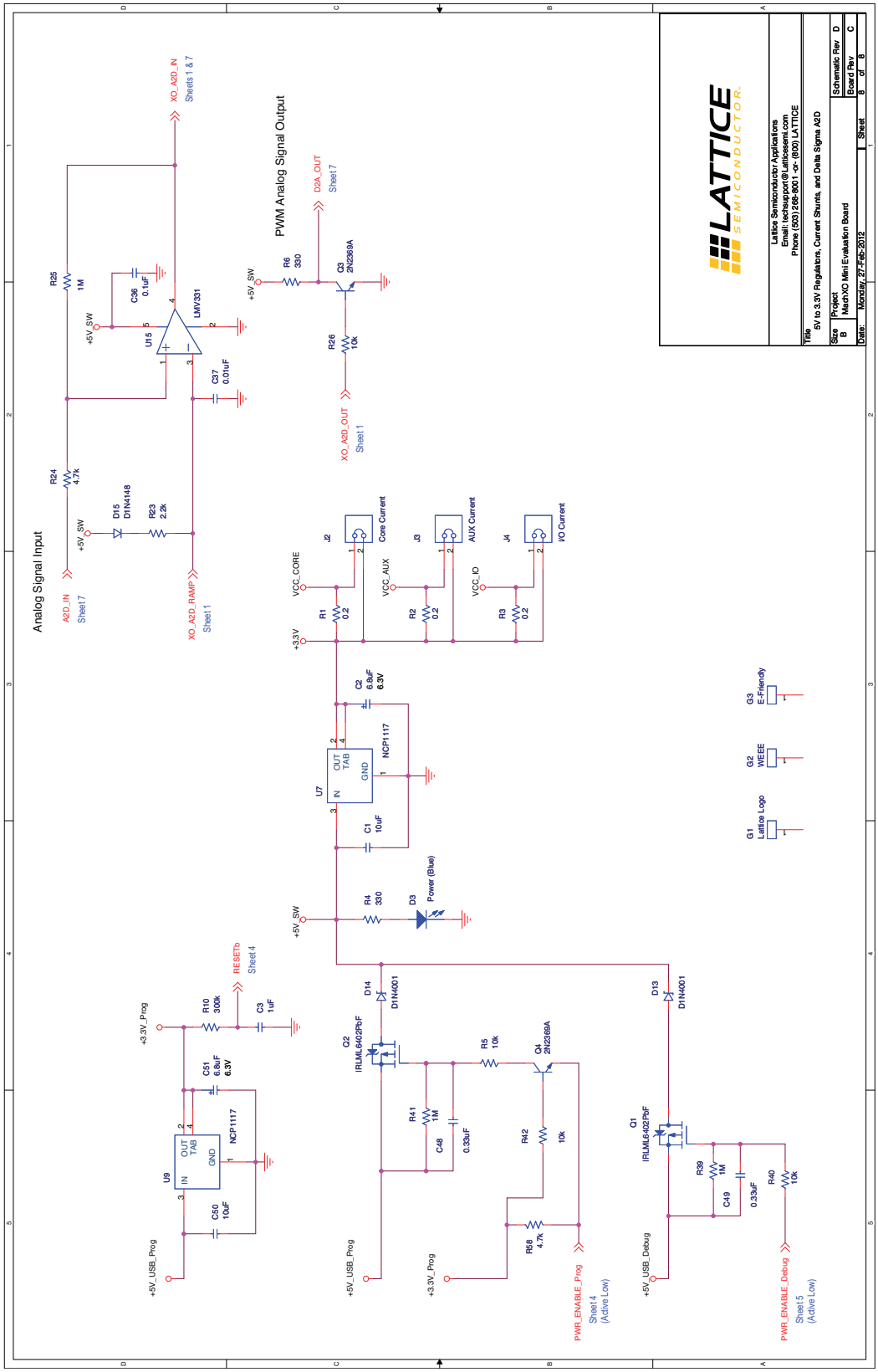


Figure 13. 5V to 3.3V Regulators, Current Shunts, and Delta Sigma A2D



Appendix B. Bill of Materials

Table 25. Bill of Materials

Item	Quantity	Reference	Part	Part Number	Description
1	3	C1,C50,C60	0.33µF		
2	2	C2,C51	10µF		
3	1	C3	1µF		
4	2	C4,C5	12pF		
5	33	C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19, C20, C21, C22, C23, C24, C25, C26, C27, C28, C29, C30, C31, C32, C36, C47, C48, C49, C54, C55	0.1µF		
6	1	C37	0.01µF		
7	2	C38, C39	8pF		
8	6	C40, C43, C52, C53, C57, C58	10nF		
9	2	C44, C45	33pF		
10	1	C59	33µF		
11	1	D3	Power (Blue)		
12	8	D5, D6, D7, D8, D9, D10, D11, D12	Status (Red)		
13	2	D13, D14	1N4448		
14	1	D15	D1N4148		
15	1	G1	Lattice Logo		
16	1	G2	WEEE		
17	1	G3	E-Friendly		
18	2	J1, J8	USB_MINI_B		
19	1	J2	Core Current		
20	1	J3	AUX Current		
21	1	J4	I/O Current		
22	1	J5	TSALL		
23	1	J6	HEADER 16X2		
24	2	L2, L3	Ferrite_bead		
25	2	Q1, Q2	IRLML6402PbF		
26	2	Q3, Q4	2N2369A		
27	1	Q5	2N3906		
28	4	RN1, R4, R6, R55	330		
29	4	RN2, R21, R23, R45	2.2K		
31	3	R1, R2, R3	0.2		
32	7	R8, R20, R26, R42, R56, R57, R59	10k		
33	4	R9, R19, R40, R52	1k		
34	1	R10	300k		
35	8	R11, R12, R13, R14, R16, R17, R27, R50	0		
36	4	R24, R46, R47, R58	4.7k		
37	2	R25, R51	1M		
38	1	R30	10		
39	2	R35, R36	27		
40	5	R39, R41, R43, R44, R49	100K		
41	1	SW1	SW_SPST_4		

Table 25. Bill of Materials (Continued)

Item	Quantity	Reference	Part	Part Number	Description
42	1	S1	XO Global Reset		
43	1	S2	XO Sleep		
44	1	U1	FT232R / 32-QFN		
45	1	U3	CY7C68013A-QFN56		
46	2	U7,U9	NCP1117		
47	1	U8	CY128X8TSOP		
48	1	U10	24LC64		
49	1	U11	M25PE20		
50	1	U14	TMP101		
51	1	U15	LMV331		
52	1	U16	LCMXO2280C-4TN144		
53	1	X1	24 MHz		
54	1	X2	25 MHz		

Appendix C. Mini SoC Demo I/O Plan

LOCATE preferences from mini_soc_demo.lpf.

```
LOCATE COMP "led_0" SITE "137" ;
LOCATE COMP "led_1" SITE "138" ;
LOCATE COMP "led_2" SITE "139" ;
LOCATE COMP "led_3" SITE "140" ;
LOCATE COMP "led_4" SITE "141" ;
LOCATE COMP "led_5" SITE "142" ;
LOCATE COMP "led_6" SITE "143" ;
LOCATE COMP "led_7" SITE "144" ;
LOCATE COMP "rst_n" SITE "14" ;
LOCATE COMP "scl" SITE "121" ;
LOCATE COMP "sda" SITE "122" ;
LOCATE COMP "spi_csn" SITE "86" ;
LOCATE COMP "spi_miso" SITE "81" ;
LOCATE COMP "spi_mosi" SITE "84" ;
LOCATE COMP "spi_sclk" SITE "85" ;
LOCATE COMP "sram_addr_0" SITE "50" ;
LOCATE COMP "sram_addr_1" SITE "54" ;
LOCATE COMP "sram_addr_10" SITE "66" ;
LOCATE COMP "sram_addr_11" SITE "67" ;
LOCATE COMP "sram_addr_12" SITE "69" ;
LOCATE COMP "sram_addr_13" SITE "68" ;
LOCATE COMP "sram_addr_14" SITE "71" ;
LOCATE COMP "sram_addr_15" SITE "72" ;
LOCATE COMP "sram_addr_16" SITE "36" ;
LOCATE COMP "sram_addr_2" SITE "55" ;
LOCATE COMP "sram_addr_3" SITE "56" ;
LOCATE COMP "sram_addr_4" SITE "57" ;
LOCATE COMP "sram_addr_5" SITE "58" ;
LOCATE COMP "sram_addr_6" SITE "60" ;
LOCATE COMP "sram_addr_7" SITE "61" ;
LOCATE COMP "sram_addr_8" SITE "62" ;
LOCATE COMP "sram_addr_9" SITE "65" ;
LOCATE COMP "sram_cen" SITE "17" ;
LOCATE COMP "sram_data_0" SITE "40" ;
LOCATE COMP "sram_data_1" SITE "41" ;
LOCATE COMP "sram_data_2" SITE "43" ;
LOCATE COMP "sram_data_3" SITE "44" ;
LOCATE COMP "sram_data_4" SITE "45" ;
LOCATE COMP "sram_data_5" SITE "46" ;
LOCATE COMP "sram_data_6" SITE "48" ;
LOCATE COMP "sram_data_7" SITE "49" ;
LOCATE COMP "sram_oen" SITE "18" ;
LOCATE COMP "sram_wen" SITE "19" ;
LOCATE COMP "sw_0" SITE "92" ;
LOCATE COMP "sw_1" SITE "91" ;
LOCATE COMP "sw_2" SITE "90" ;
LOCATE COMP "uart_rx" SITE "7" ;
LOCATE COMP "uart_tx" SITE "6" ;
LOCATE COMP "xin" SITE "23" ;
LOCATE COMP "xout" SITE "22" ;
```