MachXO Control Development Kit

User's Guide

June 2010
Revision: EB46_01.4

Introduction

Thank you for choosing the Lattice Semiconductor MachXO™ Control Development Kit!

This guide describes how to start using the MachXO Control Development Kit, an easy-to-use platform for rapidly prototyping system control designs using MachXO PLDs. Along with the evaluation board and accessories, this kit includes a pre-loaded control system-on-chip (Control SoC) design that demonstrates board diagnostic functions including fan speed control based on temperature monitoring, LCD control, complete power supply monitoring and reset distribution in conjunction with the Power Manager II ispPAC®-POWR1014A and 8-bit LatticeMico8™ microcontroller.

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

Features

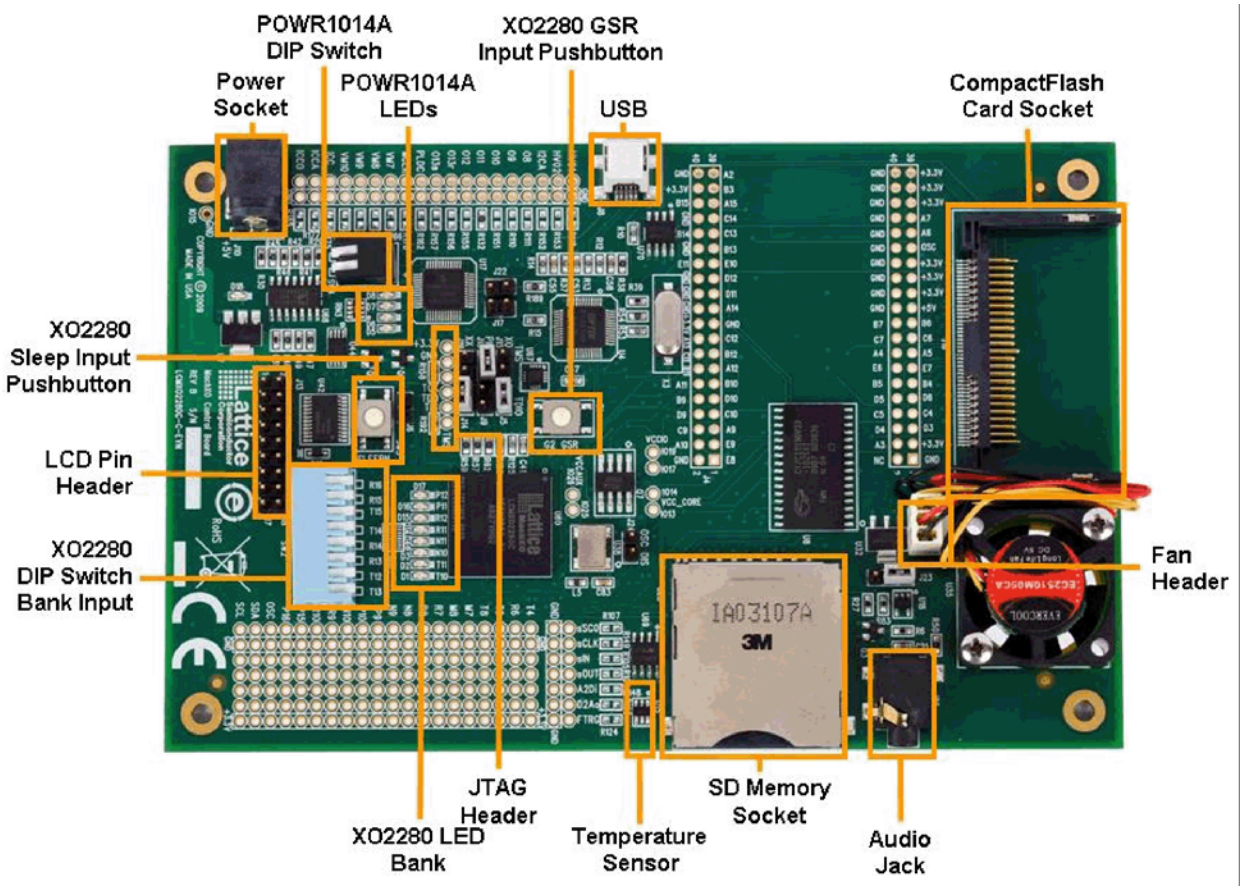
The MachXO Control Development Kit includes:

- **MachXO Control Evaluation Board** – The MachXO Control Evaluation Board features the following on-board components and circuits:
  - MachXO LCMXO2280C-4FT256C PLD (www.latticesemi.com/products/cpldspld/machxo)
  - Power Manager II ispPAC-POWR1014A mixed-signal PLD (www.latticesemi.com/products/powermanager)
  - 2 Mbit SPI Flash memory
  - 1 Mbit SRAM
- **Interface to 16 x 2 LCD Panel***
  - Secure Digital (SD) and CompactFlash memory card sockets*
  - I^2C temperature sensor
  - Current and voltage sensor circuits
  - Voltage ramp circuits
  - Fan and controller circuitry
  - USB connector (JTAG, RS-232)
  - GPIO expansion header landings
  - 3" x 1", 140-hole prototyping area
  - Push-buttons for sleep mode and global set/reset
  - 8-bit DIP switch
  - PWM analog output circuit
  - 8 status LEDs
- **Pre-loaded Reference Designs and Demo** – The kit includes a pre-loaded demo design (Control SoC) that integrates several Lattice reference designs including: the LatticeMico8 microcontroller, PWM fan controller, LCD controller, SRAM controller, I^2C controller, SPI Flash memory controller, and a UART peripheral. Firmware supports a temperature, current, and voltage monitoring demo and when connected to a host PC allows you to use a terminal program to interact with the MachXO Control Evaluation Board.
- **USB connector Cable** – A mini B USB port provides a communication and debug port via a USB-to-RS-232 physical channel and programming interface to the MachXO JTAG port.
- **AC Adapter** (international plugs)
- **Quick Start Guide** – Provides information on connecting the MachXO Control Evaluation Board, installing Windows hardware drivers, and running the Control SoC demo.
- **MachXO Control Development Kit Web Page** – www.latticesemi.com/machxo-control-kit provides access to the latest documentation, demo designs, and drivers for the kit.

* Note: LCD panel, SD and Compact Flash memory not included in the MachXO Control Development 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 MachXO Control Evaluation Board.

Figure 1. MachXO Control Evaluation Board, Top Side



Lattice Semiconductor Devices

MachXO Device

This board features a MachXO PLD with a 3.3V core supply. It can accommodate all pin-compatible MachXO devices in the 256-ball ftBGA (17x17 mm) package. A complete description of this device can be found in the MachXO Family Handbook.

Note: The connections referenced in this document refer to the LCMXO2280C-4F256C device. Available I/Os and associated sysI/O™ banks may differ for other densities within this device family. However, only the LCMXO2280C-4F256C device offers full functional use of the entire evaluation board.

Power Manager II Device

This board features a Power Manager II mixed-signal PLD. It serves as general-purpose power-supply monitor, reset generator, sequence controller, and high-voltage FET drivers. More information about Lattice Power Management devices can be found on the Lattice website.

Software Requirements

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

- ispLEVER Starter or ispLEVER/Pro 7.2
- ispVM System 17.5

Demonstration Designs

Lattice provides four demos to illustrate key applications of the MachXO (XO2280) and Power Manager II (POWR1014A) devices in the context of control applications.

- **Control SoC** – The Control System-on-Chip (SoC) demo illustrates the use of the LatticeMico8 (LM8) microcontroller, peripherals, and firmware integrated to provide system control features such as power supply sequencing, temperature monitoring, and fan control. The Control SoC design is the default, pre-programmed demo of the MachXO Control Evaluation Board.
- **Voltage Monitoring Using Delta-Sigma ADC** – Monitor sensors and power rails for free by replacing discrete ADCs in your system. This demo implemements a Delta-Sigma Analog-to-Digital Conversion (ADC) technique to monitor an analog voltage and convert it into a digital value with the XO2280.
- **Memory-Audio** – CompactFlash memory is commonly found in system control designs to provide simple plug memory. This demo showcases the LatticeMico8 microcontroller, CompactFlash memory controller, and a PWM-based digital-to-analog conversion to drive the audio jack of the MachXO Control Evaluation Board. A Hyperterminal interface allows you to load a wave format file onto the board and play it back using the audio jack output.
- **Power Supply Fault Logging** – Maximize system reliability by monitoring devices for marginal power supply failures. This demo continuously monitors the supply rails of the MachXO Control Evaluation Board. If a power supply failure occurs, the POWR1014A and XO2280 systems will issue a diagnostic log to the on-board SPI memory that includes supply identity and level.

Note: You may obtain your MachXO Control Evaluation 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.

Control SoC Demo

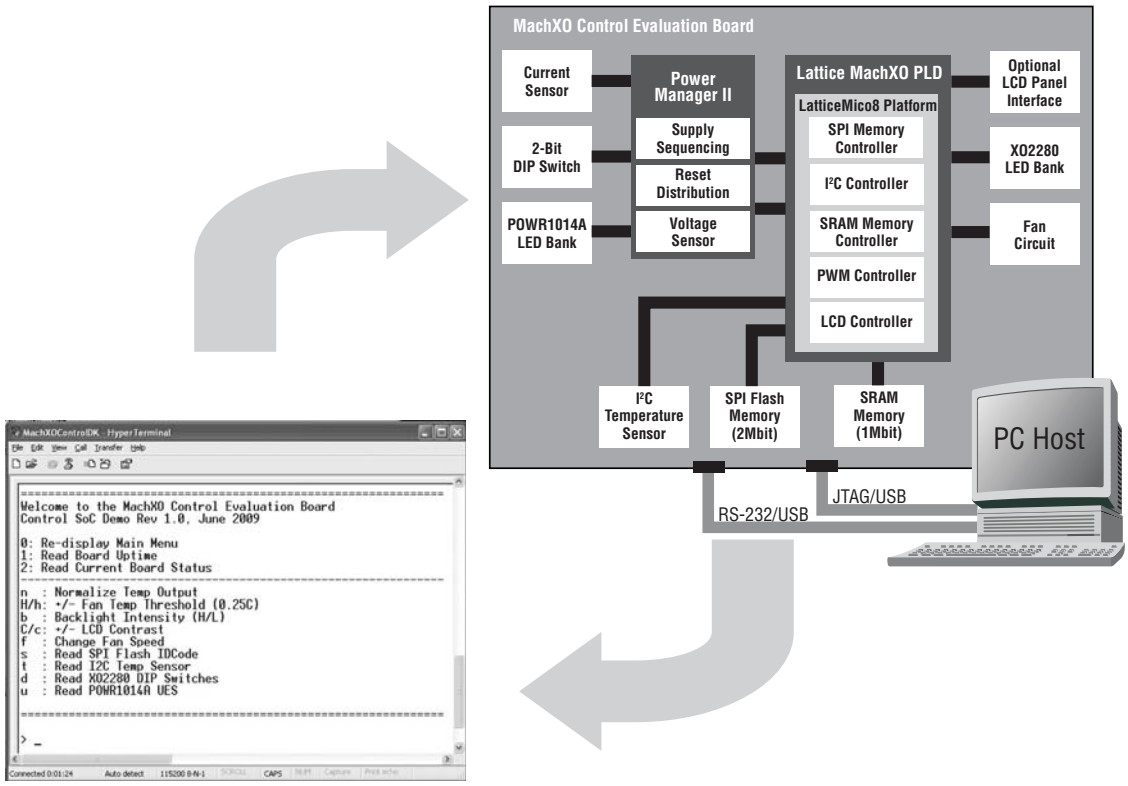
This demo illustrates how the MachXO and Power Manager II devices can be used to address a variety of system control design issues including:

- Power supply sequencing
- Reset distribution
- Power supply monitoring
- Temperature monitoring and fan control

Power management is handled in two phases by the MachXO Control Evaluation Board system:

1. **Power On** – After power is supplied to the board and the 3.3V rail is stable, the Power Manager II POWR1014A sequences four supply rails. Two circuits demonstrate the voltage ramp of 2N7002E power MOSFETs using the high-voltage (HVOUT) outputs and two demonstrate power rail enable of Vcccore and Vccaux of the MachXO2280 using digital outputs. Next the POWR1014A asserts the MachXO reset. Finally the POWR1014A enters a supply monitoring state.
2. **Post Power On** – During the second phase of power management the board's "condition" is monitored. Power supply rail voltage, current, and board temperature is monitored by the MachXO2280 and POWR1014A. If any supply rail fails, the POWR1014A asserts a reset for the LCMXO2280.

Figure 2. PC Board Control and Power Management



The MachXO LCMXO2280C is a general purpose 2280-LUT PLD programmed with a small System-on-Chip design based on the LatticeMico8 8-bit microcontroller. The LatticeMico8 platform provides board management functions for temperature sensing, fan and LCD control, and monitoring of the Power Manager II POWR1014A I^2C interface. The system is designed to continuously monitor the condition of the board. You can interact with the platform through a menu-driven terminal program running on a PC host. Switches and jumpers can be adjusted to emulate reset, Sleep, and supply interruptions.

The LatticeMico8 platform integrates Lattice reference designs for SRAM and SPI Flash memory control, pulse-width modulation (PWM) fan control, LCD control, and a Power Manager II POWR1014A communication interface. All peripherals communicate across a WISHBONE-compatible bus. LatticeMico8 firmware written in Assembly language manages communication between peripherals and provides a menu-driven user interface layer for a terminal program running on a host PC.

The Power Manager II POWR1014A is a 10-input, 14-output, mixed-signal PLD with integrated analog voltage comparators, timer/counter circuits, and a PLD core. The POWR1014A is programmed to cover supply sequencing, reset distribution, and voltage supervision functions. The POWR1014A will trap supply faults and assert MachXO2280 reset when appropriate. It disables MachXO2280 supplies input supplies are not stable. An I^2C slave interface to the POWR1014A allows the MachXO2280 to extract status and read/write control registers for the board status.

Board Monitoring and Fan Control

The MachXO2280 design performs monitoring functions for the on-board temperature sensor and supply status issued by the POWR1014A device. A rolling board status log is maintained in the on-board SRAM. The on-board DC fan motor is activated whenever the programmed temperature threshold is exceeded.

The MachXO2280 design provides the following features:

- Menu-driven user interface for Windows or Linux PC-based terminal program via USB-to-Serial channel.

- Board "uptime" clock
- Programmable temperature threshold via the PC terminal program.
- Programmable LCD (not included) backlight and contrast via the PC terminal program.
- Programmable 0-5V ADC input voltage via the PC terminal program.
- Issues a periodic log of time, temperature, voltage level, and fan speed readings to on-board SRAM memory.
- Enables on-board fan during over-temperature conditions.

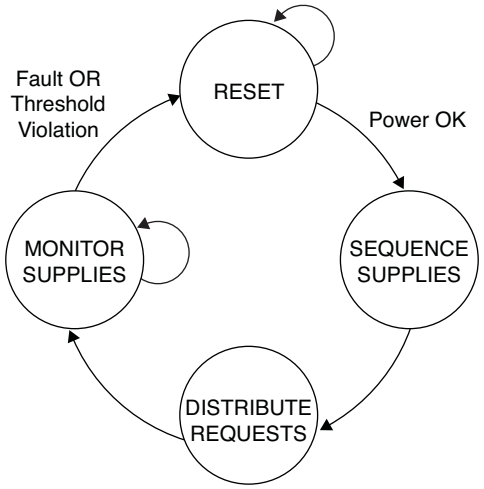
Power Supply Sequencing and Reset Distribution

The POWR1014A design shows the Power Manager II in the PC board management role to sequence multiple power supplies, distribute reset signals, and monitor power supply voltage/current levels. The POWR1014A's embedded I^2C slave interface provides a variety of status registers for basic status polling while the board is operational.

The state diagram in Figure 3 illustrates the control logic embedded in the POWR1014A. The following states define the control logic:

- **RESET** – After the MachXO Control Evaluation Board is powered and power-on reset occurs the POWR1014A waits until its own supply rail is stable (Power OK).
- **SEQUENCE SUPPLIES** – After power is applied to the board and the 3.3V and Vccio supply rails are stable the POWR1014A will sequence the MachXO2280 supply rails: Vcccore and Vccaux using two transistor switches. In addition two voltage ramp circuits are provided on-board to demonstrate safe operating area (SOA) operation of two 2N7002E PNP-type power MOSFETs. LEDs D5-D6 of the POWER1014A LED bank are binary encoded to represent the four supply sequence. The minimum value for each VMON input can be set independently by modifying the PAC-Designer® software project.
- **DISTRIBUTE RESETS** – After all supplies are powered the POWR1014A will release three reset signals. Reset control of multiple microprocessor/DSP reset circuits is emulated by displaying the Reset state on the POWR1014A LED bank. When lit, LEDs D7-D8 represent the reset release state.
- **MONITOR SUPPLIES** – After the power-on phase (supply sequencing and reset distribution) the MachXO Control Evaluation Board is operational and a LatticeMico8 8-bit microcontroller based design runs its firmware the MachXO2280. The POWR1014A then continuously monitors all input supplies. In this state the MachXO2280 polls the POWR1014A I^2C registers for the evaluation board's status and makes voltage and current measurements available to the PC terminal interface.

Figure 3. Power Manager II POWR1014A Embedded Logic



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

1. Browse to the www.latticesemi.com/machxo-control-kit and locate the hardware device drivers for the USB interface.
2. Download the ZIP file to your system and unzip it to a location on your PC.

Linux Support:

The USB interface drivers for the evaluation board are included in Linux kernel 2.4.20 or greater including distributions compatible with ispLEVER® 7.2 (Red Hat Enterprise v3, v4 or Novell SUSE Enterprise V10).

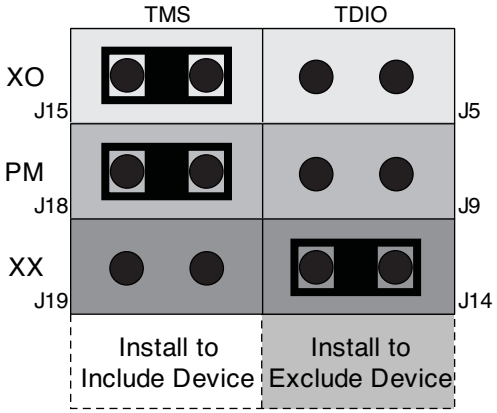
Download and Program the Demo Designs
The Control SoC Demo is preprogrammed into the MachXO Control Evaluation Board, however over time it is likely that your board will be modified.

To download the demo source files and reprogram the MachXO Control Evaluation Board:

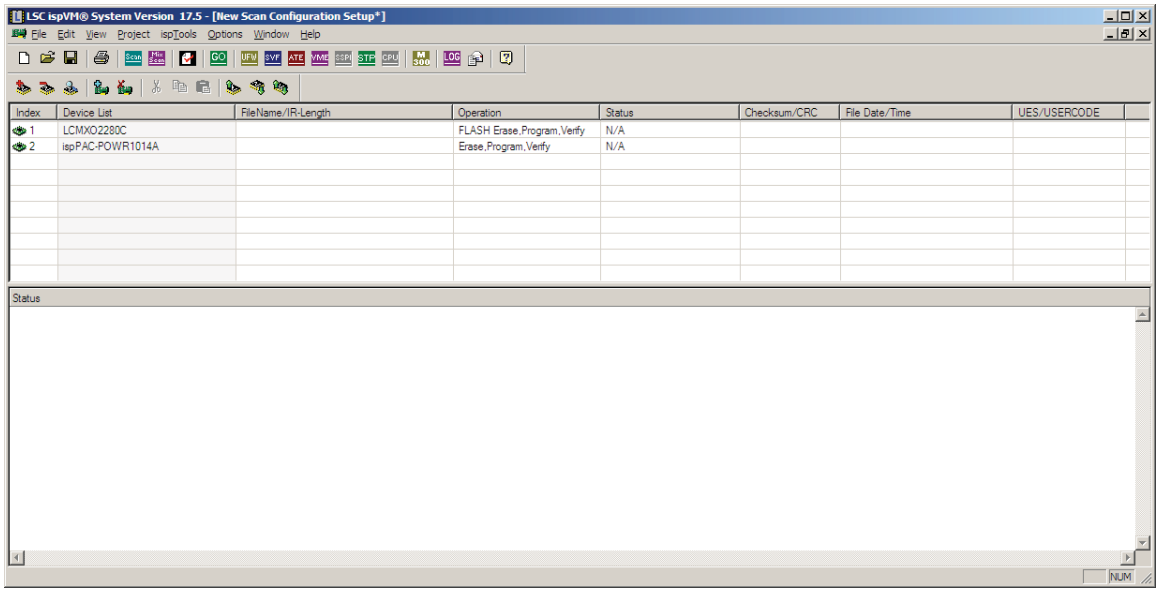
1. See the Download Demo Designs and Programming Demo Designs with ispVM sections of this document.
2. Use **.\Demo_MachXO_Control_SoC\project\control_soc_demo.jed** to restore the MachXO2280 Control SoC demo design.
3. Use **.\Demo_PM_Control_BM\project\bm_demo.jed** to restore the POWR1014A Board Management demo design.

Connect to the MachXO Control Evaluation Board

In this step, power the board, and connect the evaluation board to your PC using the USB cable provided.



Notes:
1. Install exactly one device per row to include or exclude each device.
2. Shown with MachXO and POWR1014A enabled.



1. Adjust the following jumpers to include the MachXO2280 and POWR1014A devices in the JTAG programming chain and exclude the "Other JTAG" option.

   Install Jumpers
   J14 – Excludes Other JTAG TDI-TDO
   J15 – Includes MachXO2280 JTAG TMS
   J18 – Includes POWR1014A JTAG TMS

   Remove Jumpers
   J19 – Excludes Other JTAG TMS
   J5 – Includes MachXO2280 JTAG TDI-TDO
   J9 – Includes POWR1014A JTAG TDI-TDO

   See Schematic 1 of 10 for details on the MachXO Control Evaluation Board jumper settings.

2. Adjust the following jumpers to connect the on-board supply monitor circuits.

   Install Jumper
   J17 – Enable MachXO2280 Vccio monitor circuit

   Remove Jumper
   J22 – Enable MachXO2280 Vccaux monitor circuit

   See Schematic 8 of 10 for details of the voltage monitor input circuits.

3. Ensure SW 4, position 2, of the POWR1014A DIP Switch is in the raised position. When in the lowered position it will assert manual reset to the system.

4. Plug in the power supply to an outlet and the Power Socket. After a connection is made, a red Power LED (D18) will light up indicating the board is powered on.

5. Connect the USB cable provided from a USB port on your PC to the board's USB interface socket (J8) on the side of the board as shown in the layout diagram below.

6. If you are prompted, **Windows may connect to Windows Update** select **No, not this time** from available options and click **Next** to proceed with the installation. Choose the **Install from specific location (Advanced)** option and click **Next**.

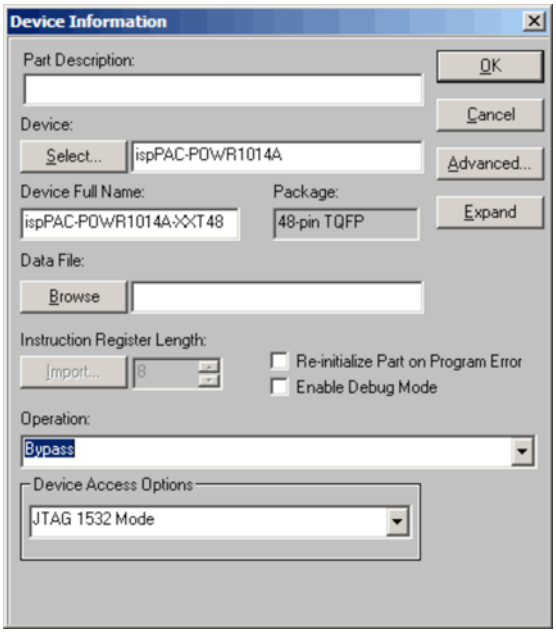
7. Select **Search for the best driver in these locations** and click the **Browse** button to browse to the Windows driver folder created earlier. Select the **CDM 2.04.06 WHQL Certified** folder and click **OK**.

8. Click **Next**. A screen will display as Windows copies the required driver files. Windows will display a message indicating that the installation was successful.

9. Click **Finish** to install the USB driver.

10. Right-click the **ispPAC-POWR1014A** entry and choose **Edit Device…** The Device Information dialog appears.

11. From the Operation list, select **Bypass.**



Set Up Windows HyperTerminal

You will use a terminal program to communicate with the evaluation board. The following instructions describe the Windows HyperTerminal program which is found on most Windows PCs. You may use another terminal program if you wish although setup will be somewhat different. For Linux, Minicom is a good alternative.

Note: This step uses the procedure for Windows XP users. Steps may vary slightly if using another Windows version.

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.

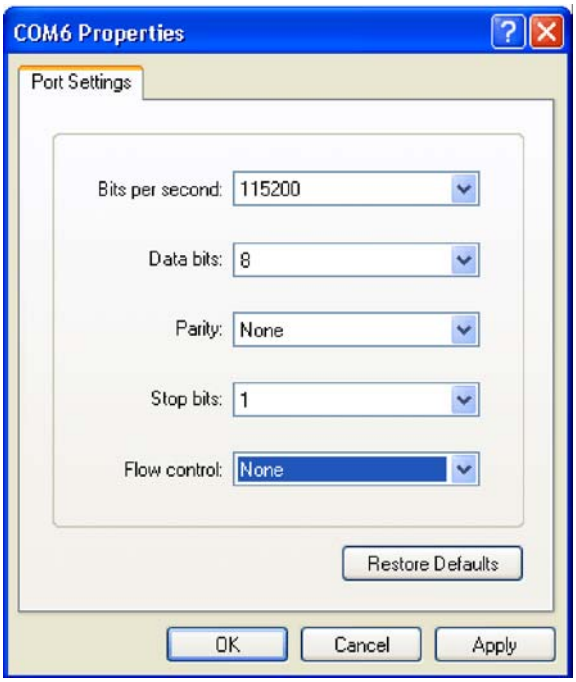
3. Expand the Ports (COM & LPT) entry and note the COM port number for the USB Serial Port.

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**.

7. The "COMn Properties" dialog appears where n is the COM port selected from the list.
8. Select the following Port Settings and click **OK**.

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



The HyperTerminal window appears.

9. From the MachXO Control Evaluation Board, press the MachXO2280 GSR Input push-button. The Control SoC demo Main Menu appears.

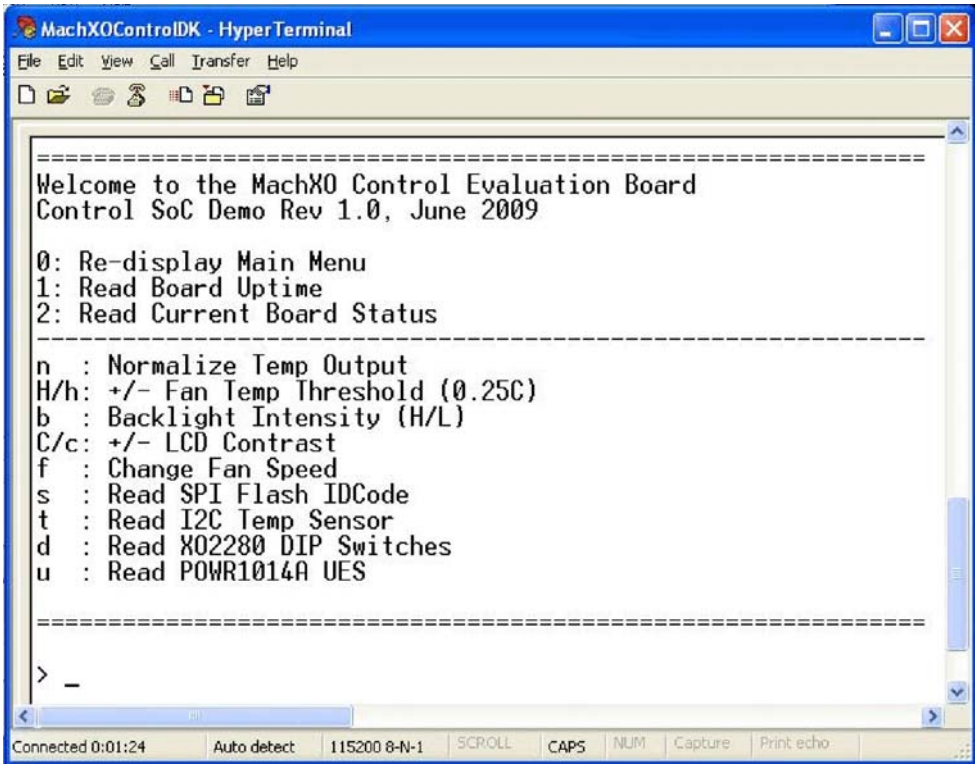
   The user interface will provide the menu-driven interface shown in Table 1.

Table 1. Main Menu

```
================================================================
Welcome to the MachXO Control Evaluation Board
Control SoC Demo Rev 1.0, June 2009

0: Re-display Main Menu
1: Read Board Uptime
2: Read Current Board Status
----------------------------------------------------------------
n  : Normalize Temp Output
H/h: +/- Fan Temp Threshold (0.25C)
b  : Backlight Intensity (H/L)
C/c: +/- LCD Contrast
f  : Change Fan Speed
s  : Read SPI Flash IDCode
t  : Read I2C Temp Sensor
d  : Read XO2280 DIP Switches
u  : Read POWR1014A UES

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



Set Up Linux Minicom

Minicom is a terminal program found with most Linux distributions. It can be used to communicate with the MachXO Control Evaluation 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 evaluation board, press the **G2** push-button (GSR).
    The Control SoC demo Main Menu appears.

Power Supply Sequencing

Supply sequencing by the POWR1014A can be visualized on the MachXO Control Evaluation Board with the POWR1014A LED bank.

To cycle the manual reset and observe power-on management:

1. Press toggle switch position 2 of SW4.

   An evaluation board manual reset is continuously cycled.

   Upon each reset event, the POWR1014A sequences five supply rail circuits of the MachXO Control Evaluation Board: Vccio, Vcccore, Vccaux, and two high-voltage ramp circuits (see Schematic Sheet 7 of 10). LEDs D5-D6 of the POWER1014A LED bank are binary encoded to represent the three Vcc supply sequence, in order: Vccio, Vcccore, and Vccaux.

LEDs D7-D8 of the POWER1014A LED bank light when the voltage ramp circuits monitored by VMON7 and VMON8 are enabled by the high-voltage outputs (HVOUT1 and HVOUT2) of the POWR1014A.

Supplies Enabled	D5	D6	D7	D8
None				
Vccio	X			
Vccio AND Vcccore		X		
Vccio AND Vcccore AND Vccaux	X	X		
HVOUT1/VMON7			X	
HVOUT1/VMON7 AND HVOUT2/VMON8			X	X

2. Raise toggle switch position 2 of SW4.

   A MachXO Control Evaluation Board manual reset is released.

Read Current Board Status

Board status is monitored continuously by the MachXO2280 and POWR1014A after the power-on stage of the evaluation board logic.

To read board status:

In the terminal window press **2**. Status of the board appears including uptime since last reset, board temperature, fan speed (a relative speed number), and voltage/current measurements of three supply rails.

Example:

```
Uptime:   000h54m50s

Temp:29.50oC
Fan Speed:000

Core: 3.103V / 55.2mA
Aux : 3.187V / 13.2mA
I/O : 3.247V / 24.6mA
```

To measure supply rail variations:

1. To disconnect the Vccio rail connection to the MachXO2280, remove jumper J17 from the MachXO Control Evaluation Board. The Vccio supply rail is disconnected.

2. From the terminal window, press **2**. Status of the board appears.

   Example:

   ```
   Uptime:   000h55m05s

   Temp:29.50oC
   Fan Speed:000

   Core: 3.103V / 55.2mA
   Aux : 3.187V / 13.2mA
   I/O : 0.007V / 24.6mA
   ```

   The Vccio supply rail measurement indicates ~0V.

   Note: Vccio current (ICCIO_Sense) is not affected by removing the jumper at J17. See Schematic Sheet 8 of 10 for details.

3. Install a jumper at J22. The Vccaux voltage divider circuit is connected. From the terminal window, press **2**. Status of the board appears.

   Example:

   ```
   Uptime:   000h56m30s

   Temp:29.25oC
   Fan Speed:000

   Core: 3.103V / 55.2mA
   Aux : 1.597V / 14.9mA
   I/O : 0.007V / 24.6mA
   ```

   The Vccaux supply rail measurement indicates ~1.5V.

   Note: Vccaux current (ICCAUX_Sense) is not affected by installing the J22 jumper. See Schematic Sheet 8 of 10 for details.

To read PCB temperature:

1. Place your finger on the on-board Temperature Sensor (U15) for 2-5 seconds. Depending on your skin temperature, the level should influence the temperature monitor (1 LED=0.25C).

2. From the terminal window, press **2**. Status of the board appears.

Example:

```
Uptime:   000h56m30s

Temp:29.75oC
Fan Speed:000

Core: 3.103V / 164.4mA
Aux : 1.597V / 14.9mA
I/O : 0.007V / 24.6mA
```

The temperature monitor varies over time depending on the I^2C temperature sensor reading.

Normalize PCB Temperature Output

You can calibrate the Control SoC temperature sense logic to account for the ambient conditions of the PCB. The MachXO2280 LED bank displays relative temperature of the PCB as a level meter. The normalize feature will reset the median temperature level and light 4 of 8 LEDs.

To normalize the temperature output:

From the terminal window, press **n**. The Control SoC normalizes the meter output for the ambient temperature and lights 4 (D1-D4) of the MachXO2280 LED bank.

Adjust Fan Temperature Threshold

The Control Evaluation Board includes a small fan controlled by a pulse width modulated (PWM) output module of the Control SoC design. The fan enable is a function of a temperature threshold setting. By default, the threshold is set at the median of the normalized ambient temperature. You may increase or decrease the threshold in steps of ~0.25C.

To adjust fan temperature threshold:

1. Note the fan operation.
2. If the fan is on, from the terminal window, press **H**. The control design raises the temperature threshold by +0.25C. If the fan does not turn off, continue pressing **H** until the threshold is higher than the PCB temperature.

   If the fan is off, from the terminal window, press **h**. The control design drops the temperature threshold by -0.25C. If the fan does not turn on, continue pressing **h** until the threshold is lower than the PCB temperature.

Change Fan Speed

When the evaluation board fan is operational as determined by the fan temperature threshold, the Fan speed can be set to one of the following fan speeds:

None:	000
Low:	~175
Medium:	~222
High:	~234

To adjust fan speed:

1. Note the fan operation.

   If the fan is off, from the terminal window, press **h**. The control design drops the temperature threshold by -0.25C. If the fan does not turn on, continue pressing **h** until the threshold is lower than the PCB temperature and the fan turns on.
2. From the terminal window, press **f**. The Fan speed setting appears.

   Example:

   ```
   Fan: Off
   ```

   The fan is turned off.
3. Press **f**. The Fan speed setting appears.

   Example:

   ```
   Fan: Low
   ```

   The fan is turned on with the low (175) speed.

4. Press **f**. The Fan speed setting appears.

   Example:

   ```
   Fan: Med
   ```

   The fan is turned on with the medium (222) speed.

Adjust LCD Backlight Intensity
If an LCD panel (not included in the Control Development Kit) with a backlight feature is installed to header J13, you may adjust the backlight intensity.

To adjust LCD panel backlight intensity:

From the terminal window, press **b**. The backlight intensity increases.

Adjust LCD Contrast
If an LCD panel (not included) is installed to header J13, you may adjust the LCD contrast between the display segments and the background.

To adjust LCD panel contrast:

From the terminal window, press **C** to increase or **c** to decrease.

Read the SPI Flash Memory IDCode
This demo uses SPI Flash Memory Controller and UART modules of the Control 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:

From the terminal Main Menu, press **s**. The IDCode is returned as a hex value.

Example:

```
ID:0x12
```

Note: The IDCode for your board may differ.

Read the I^2C Temperature Sensor
This demo uses the I^2C Controller and UART modules of the Control SoC to read the on-board I^2C temperature sensor, convert the raw data to Celsius units and display it on the terminal output.

To monitor temperature:

From the terminal window press t. The current temperature in degrees Celsius appears.

Example:

```
Temp:30.50°C
```

Read MachXO2280 DIP Switch Inputs
This demo uses the UART module of the Control SoC to read the user-input switch inputs 8-1 (MSB-LSB) of the DIP Switch Bank (SW2) and output it to the terminal as a hex value. Switch numbers are marked on the DIP switch body. A raised switch indicates a logical True (1).

To read the DIP Switch:

From the terminal window press **d**. The switch setting is returned as a hex value.

Example:

```
SW:0xFF
```

Read POWR1014A UES

This demo uses the I^2C module of the Control SoC to read the UES (User Electronic Signature) of the POWR1014A. The UES consists of 32 bits that can be configured to store unique data such as inventory control data.

To read the POWR1014A UES:

From the terminal window press **u**.

The UES is returned as a hex value.

Example:

```
UES:CB1014A1
```

Note: The POWR1014A UES for your board may differ.

Read Board Uptime

Board uptime is the period in hours, minutes, and seconds elapsed since the last MachXO2280 power-on or global reset event. Board uptime can be a useful metric for system reliability.

To read board uptime:

In the terminal window press **1**. Uptime status of the board appears.

Example:

```
Uptime:   000h40m18s
```

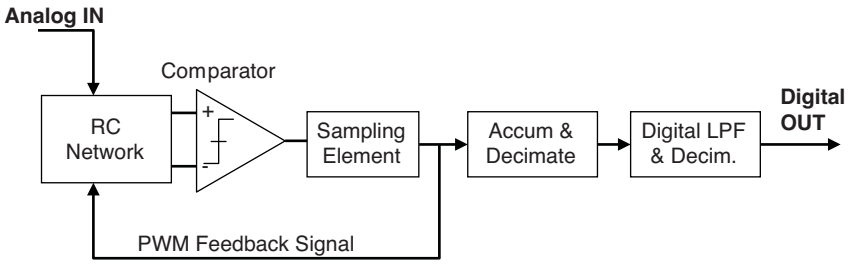
Re-Display the Main Menu

During the demo session the main menu will scroll off screen. To redisplay the menu, press **0**.

Voltage Monitoring Demo

This demo showcases RD1066, Simple Sigma Delta ADC Reference Design, to monitor an analog voltage and convert it to a digital value using only two passive external components. The demo board must be modified to demonstrate this unique ability (please refer to the section "Modifying the MachXO Control Evaluation Board" for detailed instructions). Alternatively, the design may be evaluated using the control board without modification (please refer to the section "Alternate 'No-Rework' Voltage Monitoring Demo" below).

Figure 4. SSD ADC Functional Block Diagram



Referencing the functional block diagram in Figure 4, the following logic blocks are implemented in the PLD:

- Comparator (External implementation option)
- Sampling Element

- Accumulator with decimation
- Digital Low-Pass Filter with decimation

An 8-bit ADC with sampling frequency of 7.63KHz has been implemented for this demo. For detailed technical information on the ADC converter, reference RD1066, Simple Sigma Delta ADC Reference Design.

The demo asks the user to download the configuration pattern of the MachXO device from the following directory:

…\Demo_MachXO_Control_ADC_Voltage_Monitor\Project

The configuration pattern is in JEDEC file XO_Voltage_Monitoring_Demo_Int.jed

Connect a voltage source to pin 'ProtoP9' of the new header. Make sure the ground of the voltage source is connected to the GND pin of the new header (or a ground pad on the board). The voltage source must be between 0V and 3.2V.

Press reset switch SW1. The LEDs will display the digital value of the analog voltage provided by the voltage source. The LED field will read out a value 0-255 in proportion to the input voltage.

Vary the analog voltage source and observe the digital output on the LEDs, which will track the analog voltage source.

Alternate 'No-Rework' Voltage Monitoring Demo

RD1066 may be implemented utilizing the existing on-board external comparator, U16. This allows the characterization of the digital filters without board modification, if desired.

For this version of the demo, the configuration pattern is in JEDEC file XO_Voltage_Monitoring_Demo_Ext.jed

Connect a voltage source to pin 2 of header J23. Make sure the ground of the voltage source is connected to a ground pad on the board.

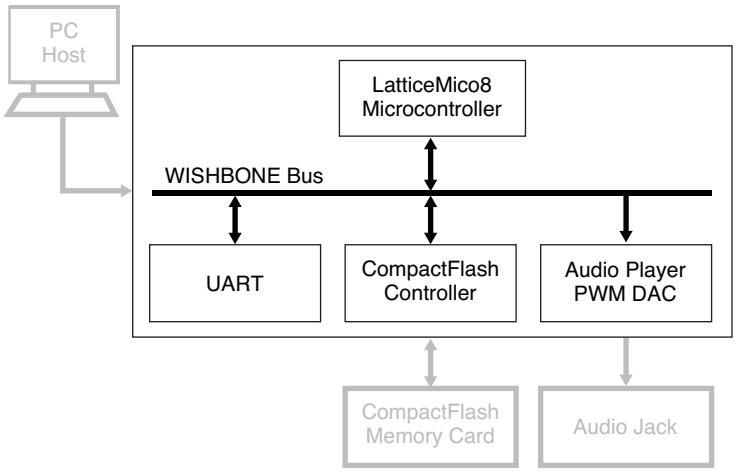
Memory-Audio Demo

The Memory-Audio Demo showcases the LatticeMico8 and two new peripherals that Lattice has developed. These peripherals are a CompactFlash memory controller and the Audio Player PWM DAC.

This exciting demo asks users to connect the MachXO Control Evaluation Board to the USB port of a personal computer and download wave files (filename.wav) to CompactFlash memory through the USB port. During this transaction, LatticeMico8 plays a crucial role in receiving the stream of data and writing it to the CompactFlash memory.

With a computer, users are able to send commands to the LatticeMico8 and select the wave file they would like to be played by the Audio Player PWM DAC. During this transaction, the LatticeMico8 interprets user keystroke commands, reads data from the CompactFlash memory and sends the data to Audio Player PWM DAC.

Figure 5. Functional Block Diagram



The darker blocks of the diagram highlight the embedded resources in the MachXO device.

PC Host
Users employ a HyperTerminal program to communicate with the MachXO Control Evaluation Board. From the HyperTerminal, they are able to:

- Transfer a wave file to the CompactFlash memory card
- Select the wave file, which the LatticeMico8 will read from the CompactFlash memory card and send ito the Audio Player PWM DAC

LatticeMico8 Microcontroller
The LatticeMico8 is an 8-bit microcontroller optimized for Field Programmable Gate Arrays (FPGAs) and Programmable Logic Device architectures from Lattice. In this demo, it performs the following tasks:

- Receives wave files and writes them to the CompactFlash memory card. (User transfers the wave files through the HyperTerminal program).
- Receives commands from the user, indicating the wave file to be played. (User provides commands through the HyperTerminal program).
- Reads a specific wave file from the CompactFlash memory card and sends it to the Audio Player PWM DAC.

UART
The Lattice WISHBONE UART provides an interface between the WISHBONE UART system bus and an RS232 serial communication channel. Reference Design RD1042, WISHBONE UART has been implemented in this demo.

CompactFlash Memory Controller
This embedded controller has wishbone interface and it is a peripheral component to the LatticeMico8 microcontroller. Reference Design RD1040, CompactFlash Controller has been implemented in this demo.

Audio Player PWM DAC

This is an embedded digital-to-analog converter with WISHBONE interface and it is a peripheral component to the LatticeMico8 microcontroller.

Memory-Audio Demo

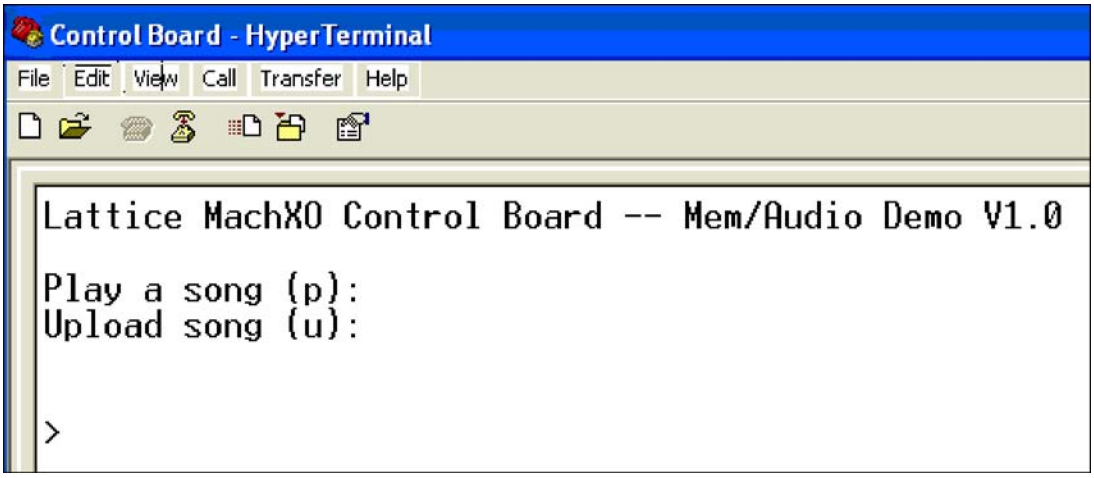
Before you start, ensure that you have:

- A MachXO Control Evaluation Board connected to your computer through a USB connection and programmed with JED file control_soc_demo.jed.
- A CompactFlash card plugged into the MachXO Control Evaluation Board CF connector J16
- Headphones or speakers plugged into the MachXO Control Evaluation Board Audio connector Q3
- Wave file mono <5 MB, 8 bit, mono

To run the demo:

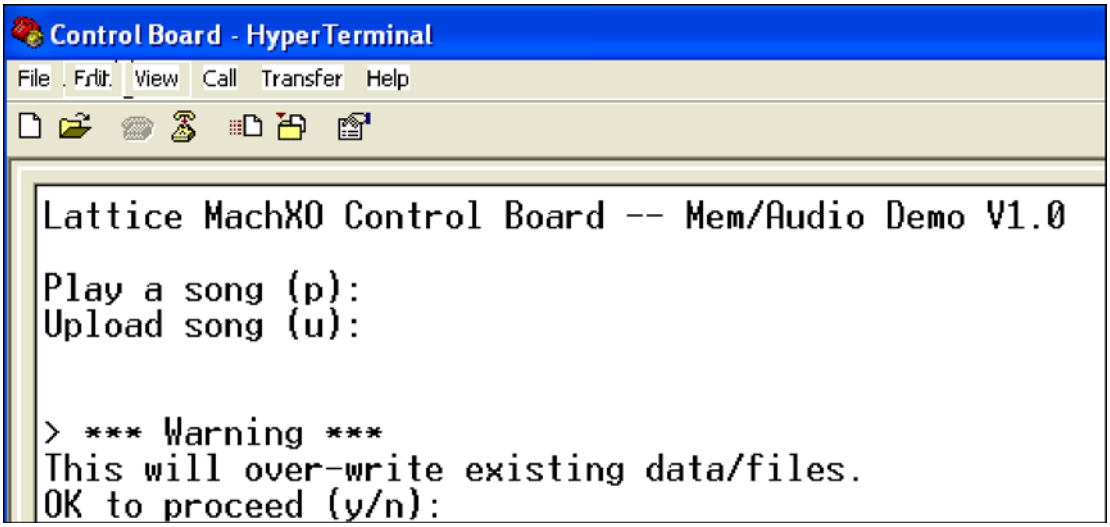
1. Using a HyperTerminal program, connect to the MachXO Control Evaluation Board.

Figure 6. Startup Screen



2. Press **u** to begin uploading a song.
3. You will be prompted that existing data on the CompactFlash card will be overwritten. Press **y** to continue.

Figure 7. Uploading a Song/Wave File



4. Select a number to be associated with the song (1-9).

5. Ensure the protocol to transfer the file is **Xmodem** then select the file to upload. Toggle any switch on SW2 to begin uploading the file. The File progress window will update and the LEDs on the MachXO Control Evaluation Board will toggle.

Figure 8. Upload a File

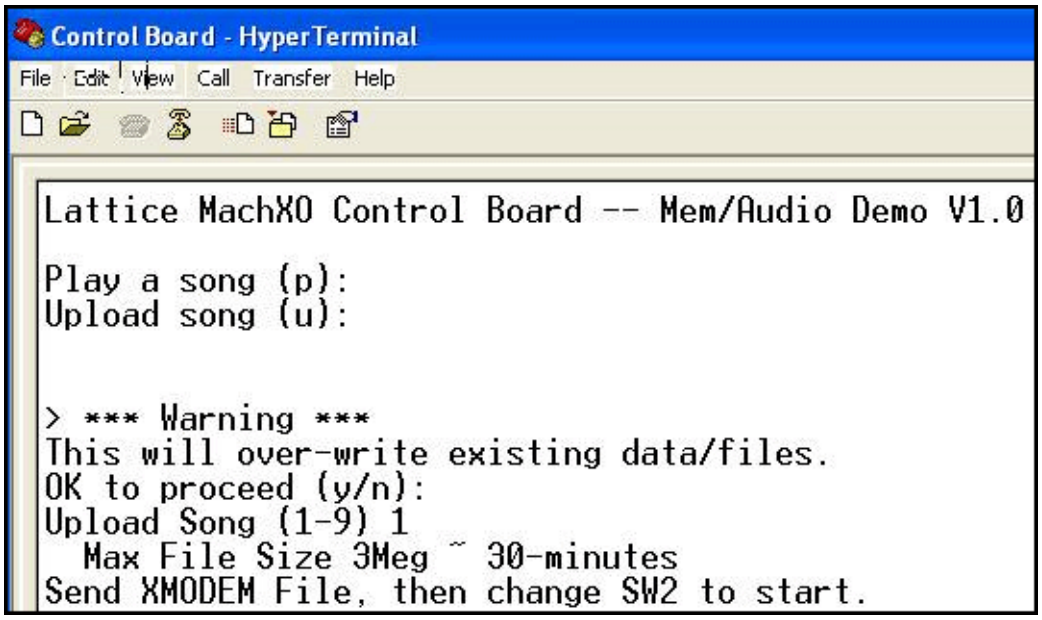
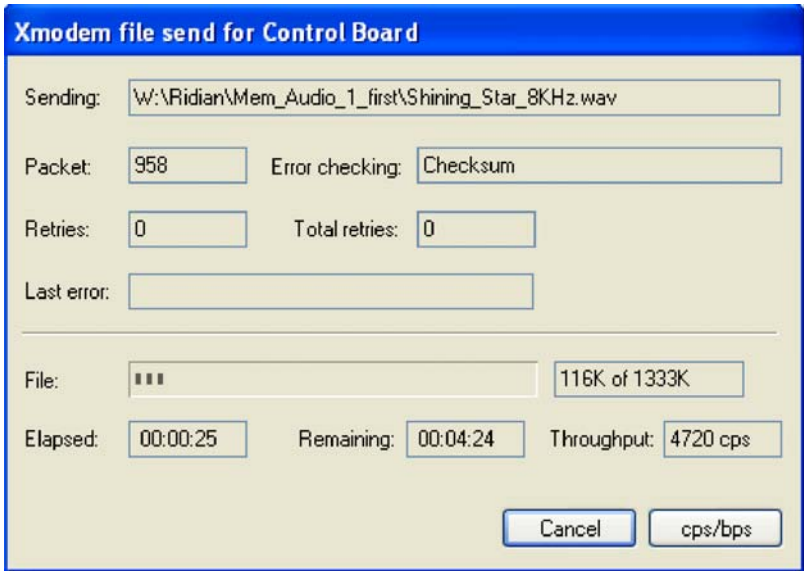


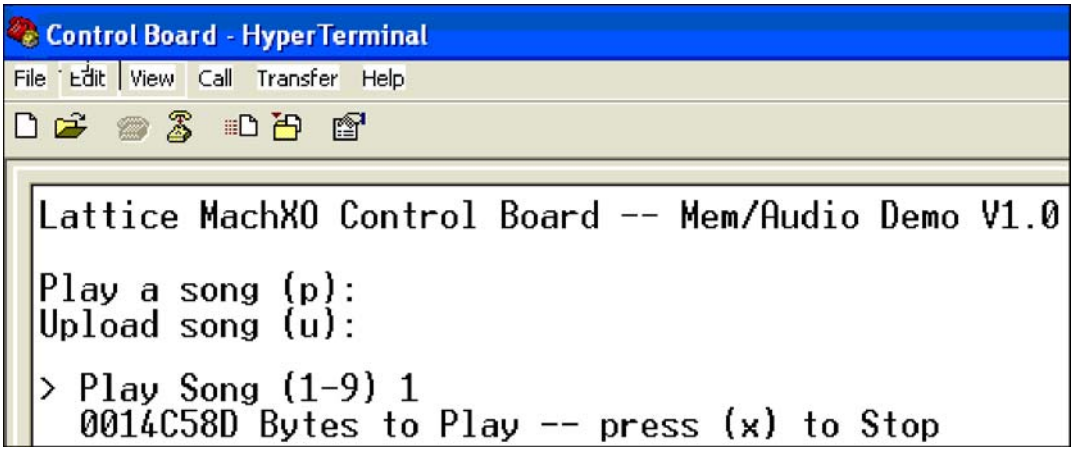
Figure 9. Select File to Upload with Xmodem Protocol

Figure 10. File Upload Status



6. The file is uploaded and ready to be played. Press **p** then a number to select the song to play. At any time, press **x** to stop the playing of the song.

Figure 11. Select a Song to Play

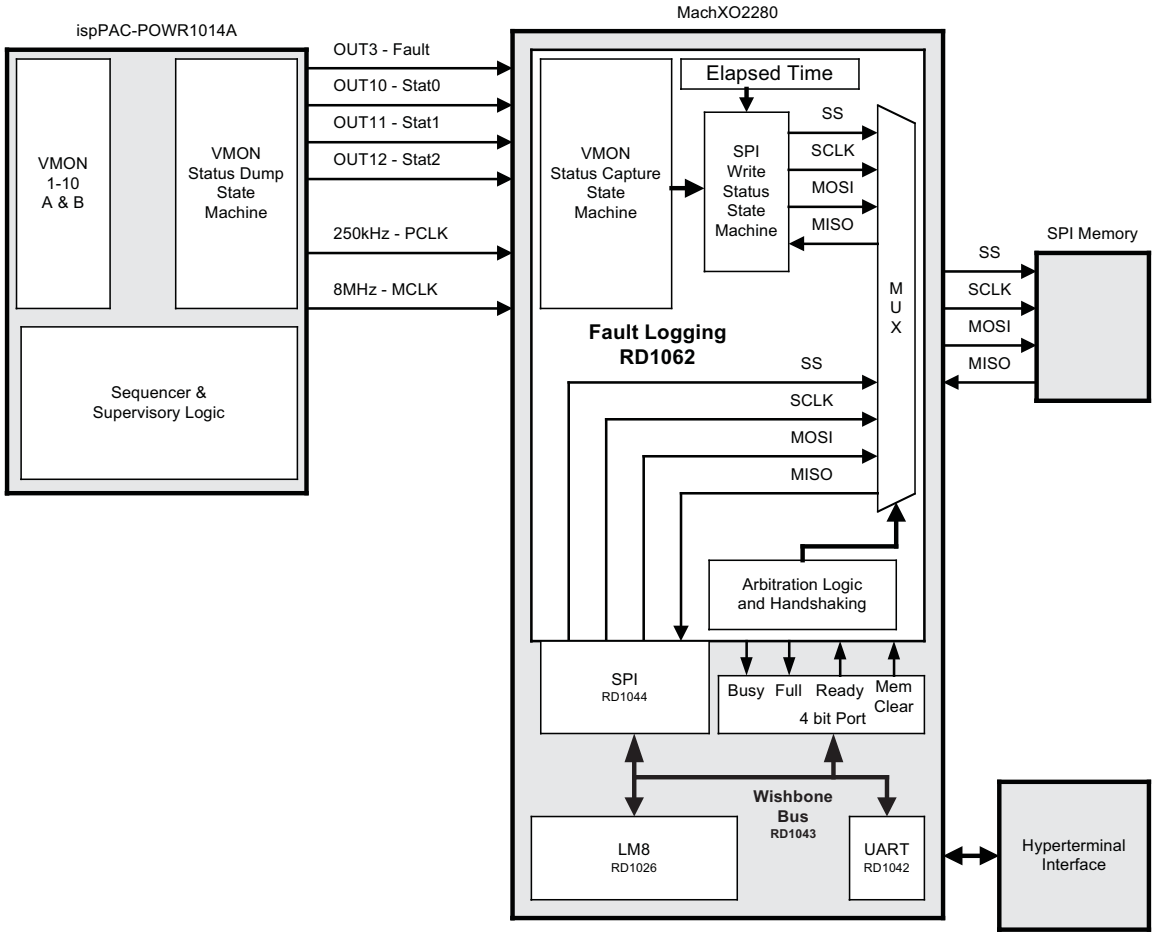


Power Supply Fault Logging Demo

This demo showcases a solution for detecting and logging power supply fault conditions in non-volatile memory. The demo is based on the reference design Power Supply Fault Logging (RD1062). Additional reference designs to build the system include:

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

Figure 12. Power Supply Fault Logging Demo Block Diagram



Arbitration logic and handshaking between the LatticeMico8 microcontroller and the Power Supply Fault Logging reference design (RD1062) is implemented to prevent contention with the interface signals of the SPI memory.

During this demo, the user will trigger faults in voltage rails monitored by Power Manager II ispPAC-POWR1014A, which will detect the faults and enable a dump of VMON status to the MachXO. The dump of VMON status is implemented using supervisory logic equations and happens automatically using outputs and clock pins of the Power Manager II. The MachXO will log the VMON status to SPI memory. The user is able to read the logged VMON status from SPI memory using the HyperTerminal interface of a personal computer.

Demo Environment Setup

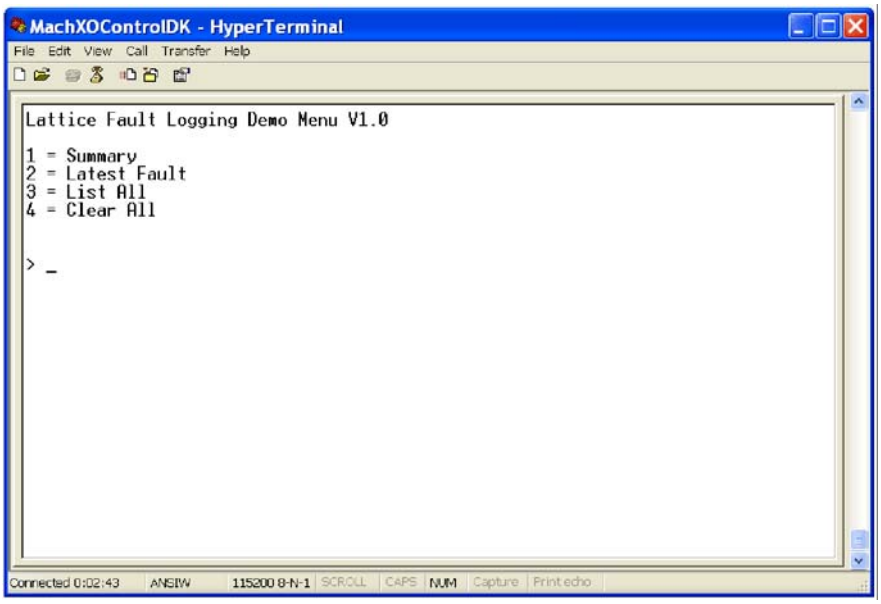
The user will first set up the MachXO Control Evaluation Board by populating jumpers in headers J17 and J22. These jumpers will later be used to trigger a fault condition during the demonstration. Next, program the Power Manager II and MachXO devices with the configuration patterns of this demo. The JEDEC files with the configuration patterns are located in the following directories:

…\MachXO_Control_PowerSupplyFaultLogging_Demo\project\MachXO

…\MachXO_Control_PowerSupplyFaultLogging_Demo\project\POWR1014A

Establish a HyperTerminal communication between the personal computer and the MachXO Control Evaluation Board as previously described in this document. Press on the pushbutton S1 to reset the board. Upon release of the reset line, the LatticeMico8 will transmit a menu of options through the UART to the HyperTerminal as shown in Figure 13.

Figure 13. HyperTerminal Window



- Option 1 of the menu will display the total number of faults logged in SPI memory.
- Option 2 of the menu will display the latest fault that was logged in SPI memory.
- Option 3 of the menu will step one-by-one through all the faults that were logged in SPI memory.
- Option 4 of the menu will clear all the faults that were logged in SPI memory.

The demo design is configured to capture and log up to 251 faults in SPI memory. A message indicating that the SPI memory is full will be displayed in the HyperTerminal window in case the maximum number of faults is reached.

Trigger Fault Conditions
Below is a list of fault conditions that users can cause on the board. After a fault condition is caused, the user can use menu options 1-3 to read the faults logged in SPI memory.

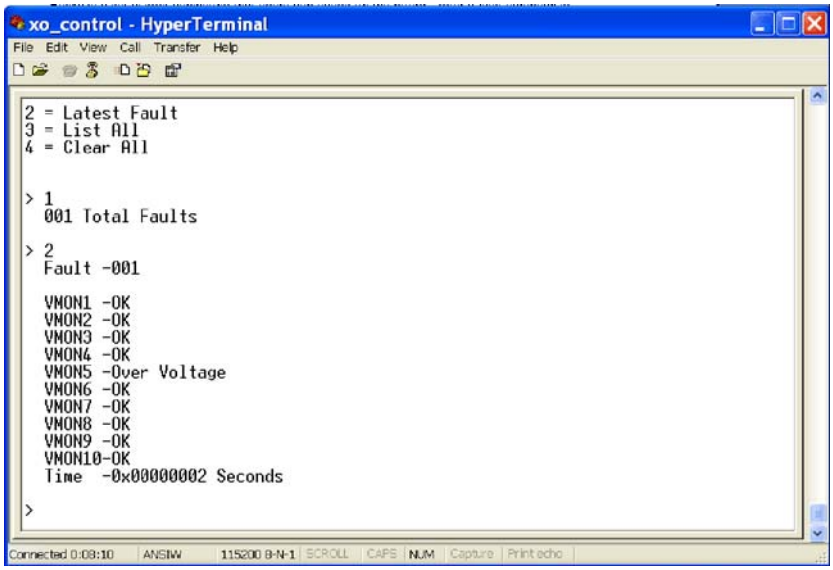
Fault conditions:

1. VMON2: Under volt if test point I/O 25 is shorted to test point I/O 26.
2. VMON2: Over volt if a 1KOhm resistor is shorted from test point I/O 26 to GND.
3. VMON3: Under volt if test point I/O 17 is shorted to test point I/O 19
4. VMON3: Over volt if a 1KOhm resistor shorts test point I/O 19 to GND
5. VMON4: Under volt if jumper J17 is removed. Remove jumper for less than two seconds.
6. VMON5: Over volt if jumper J22 is removed. Remove jumper for less than two seconds.
7. VMON7: Under voltage if 1KOhm resistor shorts HVO1 to GND.
8. VMON8: Under voltage if 1KOhm resistor shorts HV02 to GND.

When any of the above faults happen VMON9 and VMON 10 will have faults based on the settings of SW4: SW4.1 emulates comparator A status and SW4.2 emulates comparator B status.

There is a 2-second delay after a fault to prevent double faults before the sequence restarts.

The image below shows the HyperTerminal window after an over volt fault was caused on VMON5 and the user selected options 1 and 2 of the menu.



If desired, users can modify the assembly program for this demo by using the updated LatticeMico8_V3.01 assembler from the following directory:

…\MachXO_Control_PowerSupplyFaultLogging_Demo\LatticeMico8_V3_01_Util\

Download Demo Designs

Lattice distributes source and programming files for a variety of demonstration designs compatible with the MachXO Control Evaluation Board.

To download demo designs:

1. Browse to the MachXO Control Development Kit web page at www.latticesemi.com/machxo-control-kit. Select the Demo Applications download and save the file.
2. Extract the contents of **MachXO_Control_Dev_Kit.zip** to an accessible location on your hard drive.

Five demo design directories are unpacked.

Demo	Directories	Revision
MachXO2280 Control SoC Demo	Demo_MachXO_Control_SoC .\LatticeMico8_V3_0_Verilog .\project .\RD1042 .\RD1043 .\RD1044 .\RD1046 .\RD1053 .\RD1060 .\source	1.0
POWR1014A Board Management (BM) Demo	Demo_PM_Control_BM	1.0
Voltage Monitoring Demo	Demo_MachXO_Control_ADC_Voltage_Monitor .\project .\RD1066 .\source .\testbench	1.1
Memory-Audio Demo	Demo_MachXO_Control_Mem_Audio .\project .\RD1040 .\RD1042 .\RD1043 .\RD1044 .\RD1048 .\RD1053 .\Wave_Files	1.0
Power Supply Fault Logging Demo	Demo_MachXO_Control_FaultLogging .\LatticeMico8_V3_0_Verilog .\LatticeMico8_V3_01_Util .\project .\RD1042 .\RD1043 .\RD1044 .\source	1.0

Where:

- **.\project** – ispLEVER project (.syn) or PAC-Designer project (.pac), preferences (.lpf), and programming file (.jed). This directory may contain intermediate results of the ispLEVER/PAC-Designer build process.
- **.\source** – HDL source for the ispLEVER project.
- **.\LatticeMico8_V3_0_Verilog** – RD1026, LatticeMico8 Microcontroller User's Guide
- **.\rdxxxx** – Reference designs integrated by a demo.

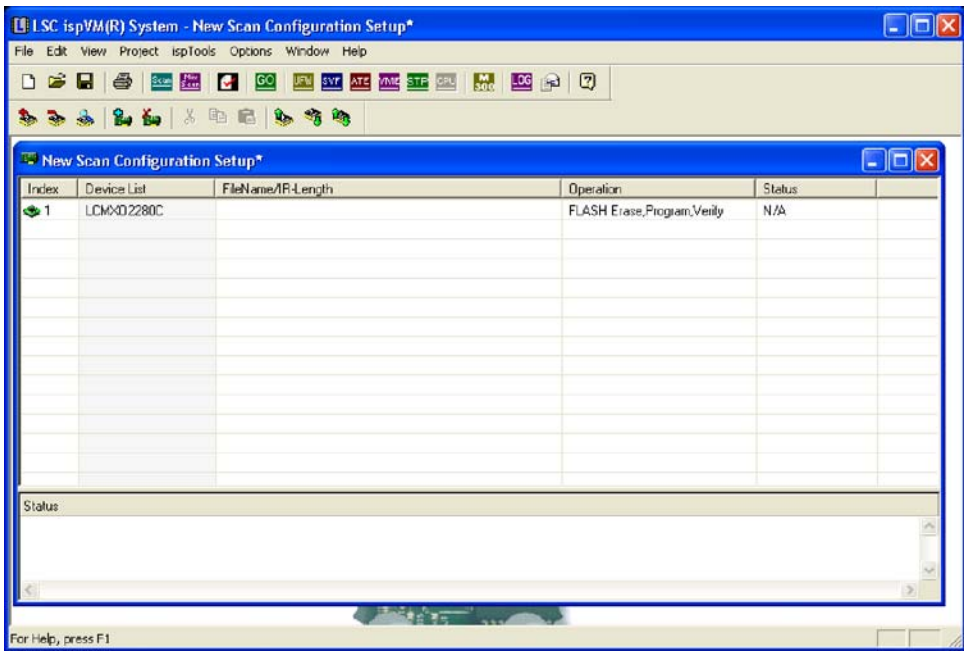
Programming Demo Designs with ispVM

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

To program a demo programming file:

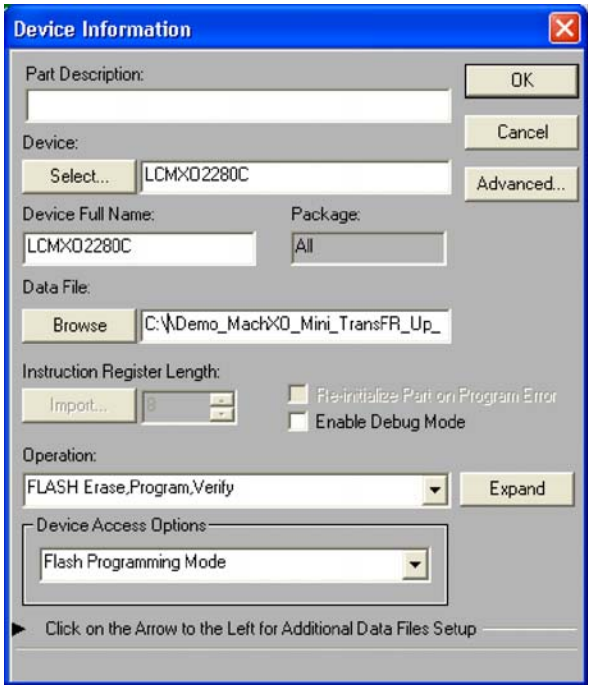
1. Connect the MachXO Control Evaluation Board USB connector (J8) to a host PC.
2. Connect the included 5V adapter to the MachXO Control Evaluation Board power connector (J10).
3. Ensure the JTAG chain jumpers are set properly to include the MachXO and POWR1014A devices (See Figure X).

4. From the Start menu run ispVM System. ispVM appears.
5. Choose **Options > Cable and IO Port Setup…** The Cable and I/O Port Setup dialog appears.
6. Click **Auto Detect**. ispVM will detect Cable Type USB and Port Setting USB2.
7. Click **OK**.
8. Choose **ispTools > Scan Chain**. The New Scan Configuration Setup window appears. Bot the LCMXO2280 and POWR1014A appear in the device list.



9. Right-click the LCMXO2280C entry and choose **Edit Device…** The Device Information dialog appears.
10. From the **Data File** section, click the **Browse** button. The Open Data File dialog appears.
11. 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**.



12. Choose **Project > Download**. ispVM reprograms the MachXO Control Evaluation 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 MachXO Demo Project with ispLEVER

Use this general procedure here to rebuild any of the MachXO2280 demo projects for the MachXO Control Evaluation Board.

1. Install and license ispLEVER software
2. Install and license ispVM System software.
3. Download the demo source files from the MachXO Control Development Kit Webpage at www.latticesemi.com/machxo-control-kit.
4. Run the ispLEVER Project Navigator.
5. Create a new project and add the HDL files from the **<demo>\source** directory. Note that some demos provide a **<demo>.syn** 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 Programming Demo Designs with ispVM section of this document for details on downloading a programming file to the board.

Reassembling the Demo LatticeMico8 Firmware

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

1. Install the LatticeMico8 Tool Code Revision 3.0 from www.latticesemi.com/products/intellectualproperty/referencedesigns/8bitmicrocontrollermico8.cfm

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

2. Compile the LatticeMico8 Assembler and Simulator (optional)
3. Modify the Assembly source (.s) file and recompile to a memory image (.hex). Source for the Control SoC demo is provided as control_soc_demo.s.
4. Use the Memory Initialization tool of the ispLEVER Project Navigator 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 MachXO Control Evaluation Board.

Recompiling a Power Manager II Demo Project with PAC-Designer

Use the general procedure here to rebuild any of the POWR1014A demo projects for the MachXO Control Evaluation Board.

1. Install and license PAC-Designer software
2. Install and License ispVM System software.
3. Download the demo source files from the MachXO Control Development Kit Webpage at www.latticesemi.com/machxo-control-kit.
4. Run PAC-Designer.
5. Open the PAC-Designer project file (**<demo>.pac**) from the **<demo>\source** directory.
6. Double-click the **Sequence Controller** block.
7. Choose **Tools > Compile LogiBuilder Design**.

Note: To program the POWR1014A device, the MachXO device must be removed from the JTAG chain by setting the JTAG jumpers (see Figure X). Because the power to the MachXO device is controlled by the POWR1014A, it cannot be in the JTAG chain during POWR1014A updates.

MachXO Control Evaluation Board

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

Overview

The MachXO Control Evaluation Board is an AC-powered development platform for the MachXO PLD. The board includes on-board SRAM and SPI Flash memory, I^2C and SPI microcontroller communication interfaces, a USB program/debug port, and an expansion header to support test connections.

Figure 14. MachXO Control Evaluation Board Block Diagram

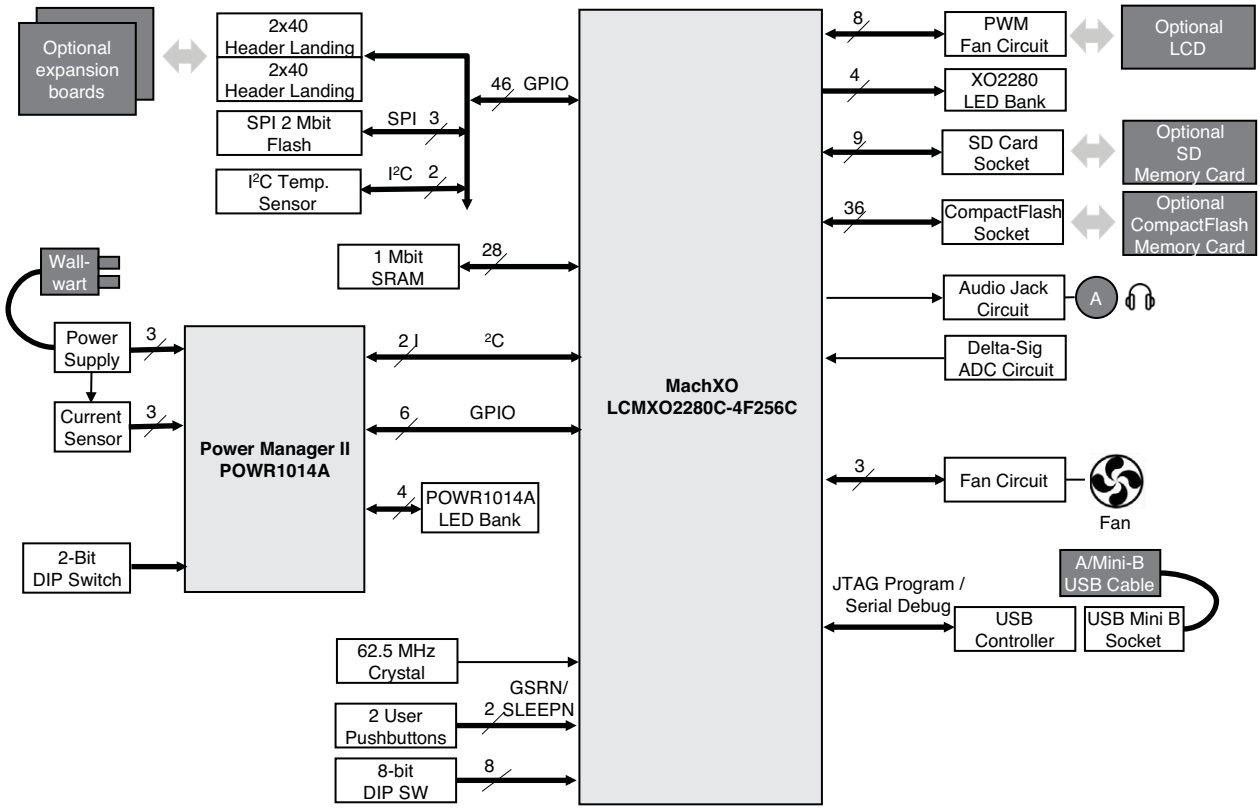


Table 2 describes the components on the board and the interfaces it supports.

Table 2. MachXO Control 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			
62.5 MHz Oscillator	Clock	U38	MachXO clock source
1Mbit SRAM	Memory	U8:CY128X8TSOP	1Mb of SRAM
MachXO PLD	PLD	U60:MachXO_2280_FN256	LCMXO2280FN256
POWR1014A	PLD	U17:ispPAC-POWR1014A	ispPAC-POWR1014A
I^2C Temperature Sensor	I/O	U15:TMP101	Measures board temperature
2Mbit SPI Flash Memory	Memory	U4	2Mb FLASH memory
8 LEDs	Output	D7-D0	User-definable LEDs
Interfaces			
2X16 Header	I/O	J6	User-definable I/O
USB Control 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	J6	MachXO TSALL input

Table 2. MachXO Control Evaluation Board Components and Interfaces (Continued)

Jumper	I/O	J17	Connects Vccio
Jumper	I/O	J22	Grounds Vccaux

Subsystems

This section describes the principle subsystems for the MachXO Control Evaluation Board in alphabetical order.

CompactFlash Card Socket

A CompactFlash card socket (J16 - Schematic Sheet 2 of 10) will accept both Type I and Type II cards.

Table 3. CompactFlash Socket Reference

Item	Description
Reference Designators	J16
Part Number	CF_Socket
Manufacturer	AVX
Part Number	AVX-31-5620-050-116-871

Tested CF Flash Memory Card: SanDisk 64MB

Current Sensor Circuits

The MachXO Control Evaluation Board provides three resistive current sensing circuits (Schematic Sheet 7 of 10) using the technique described in AN6049, High-side Current Sensing Techniques for Power Manager Devices. You may measure current consumption of the MachXO2280 Vcccore, Vccaux, or Vccio through the POWR1014A voltage supervisor function.

Digital Potentiometer Circuit

An I^2C addressable digital potentiometer (U44 – Schematic Sheet 4 of 10) is programmable to adjust the LCD backlight and contrast and optionally provide a variable input voltage for the Delta-Sigma ADC circuit.

Fan Circuit

A 3-pin fan motor header and circuit supports a DC fan motor (Schematic Sheet 3 of 10).

GPIO Expansion Header Land Patterns

The MachXO Control Evaluation Board provides land patterns for two 40-pin general purpose I/O (GPIO) expansion headers (J4 and J7 – Schematic Sheet 2 of 10), a 38-pin header for MachXO2280 GPIO access, and one 14-pin header for debug access. All land patterns are organized for 100mil centered pin headers.

J4 and J7 Land Patterns: J4 and J7 patterns are for two 40-pin expansion headers. The combination provides 46 user I/Os connected to the MachXO2280. The remaining pins serve as power and clock supplies for expansion boards. I/Os are shared with the CompactFlash socket. The connector spacing, orientation, and I/O connections match expansion board from Gleichmann Engineering. See the Gleichmann Hpe Expansion board page at (http://www.ger-fae.com/hpe_expansion.html) for an example.

Table 4. Header J4 Pin Information

Function	J4 Pin	MachXO Pin	CompactFlash Socket Pin
GPIO_RST	1	E8	
GND	2		
IO0	3	E9	2
IO1	4	A10	3
IO2	5	A9	4
IO3	6	C9	5
IO4	7	C10	6

Table 4. Header J4 Pin Information (Continued)

Function	J4 Pin	MachXO Pin	CompactFlash Socket Pin
IO5	8	D9	7
IO6	9	D10	8
IO7	10	B9	9
IO8	11	B10	10
IO9	12	A11	11
IO10	13	A12	12
IO11	14	B11	14
IO12	15	B12	15
IO13	16	C11	16
IO14	17	C12	17
IO15	18	A13	18
GND	19		
+3.3V	20		
IO16	21	A14	19
GND	22		
IO17	23	D11	20
GND	24		
IO18	25	D12	21
GND	26		
IO19	27	E10	22
IO20	28	E11	23
IO21	29	B13	24
GND	30		
IO22	31	C13	25
IO23	32	B14	26
IO24	33	C14	27
GND	34		
IO25	35	A15	28
IO26	36	B15	29
IO27	37	B3	30
GPIO_CARDSEL#	38	B2	
IO28	39	A2	31
GND	40		

Table 5. Header J7 Pin Information

Function	J7 Pin	MachXO Pin	CompactFlash Socket Pin
GND	1		
NC	2		
3.3V	3		
IO29	4	A3	32
IO30	5	D3	33
IO31	6	D4	34
IO32	7	C4	35

Table 5. Header J7 Pin Information (Continued)

Function	J7 Pin	MachXO Pin	CompactFlash Socket Pin
IO33	8	C5	36
IO34	9	D6	37
IO35	10	D5	39
IO36	11	B4	40
IO37	12	B5	41
IO38	13	E7	42
IO39	14	E6	43
IO40	15	A5	44
IO41	16	A4	45
IO42	17	C6	46
IO43	18	C7	47
IO44	19	B6	48
IO45	20	B7	49
5V	21		
GND	22		
3.3V	23		
GND	24		
3.3V	25		
GND	26		
3.3V	27		
GND	28		
OSC_CLK	29		
GND	30		
IO46	31	A6	
GND	32		
IO47	33	A7	
GND	34		
3.3V	35		
GND	36		
3.3V	37		
GND	38		
3.3V	39		
GND	40		

38-Hole Land Pattern: The MachXO Control Evaluation Board provides a 38-hole landing area with connections to POWR1014A and MachXO2280 support circuits (Schematic Sheet 8 of 10).

Table 6. 38-Pin Landing Pattern Pin Information

Function	Pin	POWR1014A Pin	Other Connections
HVOUT1	IO9	15	
HVOUT2	IO54	14	
PM_I2C_ALERT	IO55	13	
PM_OUT8	IO33	8	
PM_OUT9	IO11	6	
PM_OUT10	IO56	5	
PM_OUT11	IO53	4	
PM_OUT12	IO57	3	
XO_RESET	IO59	2	XO2280 GSR push-button circuit
XO_Sleepn	IO60	1	XO2280 Sleep push-button circuit
PM_PLDCLK	IO61	42	
PM_MCLK	IO85	43	
VMON7	IO65	34	
VMON8	IO66	35	
VMON9	IO67	36	
VMON10	IO68	37	
ICC_Sense	IO69	25	
ICCAUX_Sense	IO70	26	
ICCIO_Sense	IO71	27	

14-Hole Land Pattern: The MachXO Control Evaluation Board provides a 14-hole landing area with connections to key SPI bus and DAC/ADC circuit nets (Schematic Sheet 3 of 10).

Table 7. 14-Hole Landing Pattern Pin Information

Function	Pin
XO_SPI_CS0	IO7
	GND_6
XO_SPI_CLK	IO52
	GND_50
XO_SPI_OUT	IO30
	GND_29
XO_SPI_IN	IO8
	GND_7
A2D_DS_IN	IO50
	GND_51
D2A_OUT	IO28
	GND_30
Fan_Trigger	IO28
	GND_33

JTAG Jumpers

Two jumper circuits (Schematic Sheet 1 of 10) allow you to define the MachXO Control Evaluation Board's JTAG chain of installed devices. You may specify the Installed/Removed state for the MachXO2280 and POWR1014A of the board. Additionally you can connect an external JTAG circuit by attaching to IO20, IO22, and IO24 test points. See the Jumper Settings table of Schematic Sheet 1 for details.

LCD Panel Support Circuit

The MachXO Control Evaluation Board provides support circuitry and connector (Lumex LCM-S02002DSR. Note: Assembly to generic 16-pin (2x8) header is required, for example, Sullins Connector Solutions PPPC082LFBN-RC), Schematic Sheet 4 of 10. The LCD is connected to GPIOs of the MachXO and backlight/contrast controls.

Table 8. LCD Connector Pin Information

Function	J13 Pin
LCD_BACKLIGHT	1
GND	2
GND	3
+5V	4
LCD_CONTRAST	5
LCD_RS	6
LCD_RW	7
LCD_E	8
LCD_D0	9
LCD_D1	10
LCD_D2	11
LCD_D3	12
LCD_D4	13
LCD_D5	14
LCD_D6	15
LCD_D7	16
LCD_BACKLIGHT	17
GND	18

MachXO PLD (MachXO2280)

The MachXO PLD device (LCMXO2280C-4F256C) on the board provides 2280 LUTs, 7.5 Kbits of distributed RAM, 27.6 Kbits of EBR SRAM, 211 user I/Os in a 17x17 mm ftBGA package.

Table 9. MachXO2280 Reference

Item	Description
Reference Designators	U60A, U60B, U60C, U60D, U60E
Part Number	LCMXO640/1200/2280-FT256/FTN256
Manufacturer	Lattice Semiconductor Corporation
Web Site	www.latticesemi.com

This following sections describe user access to the LCMXO2280FTN256 device.

MachXO2280 DIP Switch Bank Input: The MachXO Control Evaluation Board includes an eight-bit input toggle switch tied to GPIOs of the MachXO (SW2 – Schematic Sheet 4 of 10). When in the open position, the switch is pulled to 3.3V via a 10K resistor. When in the down position, the switch is tied to ground.

Table 10. DIP Switch Pin Information

Function	SW2 Pin	MachXO Pin
SW7	1	T13
SW6	2	T12
SW5	3	R13
SW4	4	R14
SW3	5	T14
SW2	6	T15
SW1	7	R15
SW0	8	R16
GND	9	
GND	10	
GND	11	
GND	12	
GND	13	
GND	14	
GND	15	
GND	16	

MachXO2280 LED Bank: The evaluation board includes an eight LED tied to GPIOs of the MachXO (Schematic Sheet 4 of 10). Driving logic low '0' will light an LED.

Table 11. LED Bank Pin Information

Function	RN1_8_470	MachXO Pin
LED0	D1	T10
LED1	D2	T11
LED2	D3	N10
LED3	D4	N11
LED4	D14	R11
LED5	D15	R12
LED6	D16	P11
LED7	D17	P12

MachXO2280 GSR Input Push-button: A global RESET (GSR) push-button circuit (Schematic Sheet 5 or 10) connects to the dedicated pad for the MachXO2280 global RESET signal (GSRN). The push-button circuit can also be driven from a POWR1014A output.

MachXO2280 Sleep Input Push-button: A temporary push-button switch connects to the MachXO2280 SLEEPN input pin. When depressed the MachXO2280 enters Sleep Mode. Note that during sleep all I/Os of the device are tri-stated. The push-button circuit can also be driven from a POWR1014A output.

MachXO2280 TSALL Input Jumper: A tri-state all (TSALL) jumper circuit (Schematic Sheet 5 or 10) connects to the dedicated pad for the MachXO2280 global output enable signal. When TSALL is high all the outputs are tristated.

Oscillator Circuit

A 62.5MHz oscillator circuit (Schematic Sheet 5 of 10) fans out to a primary clock input of the MachXO USB controller PHY, prototype area, and GPIO Expansion Connector. You may disable the oscillator circuit by installing jumper J24.

Power Manager II Mixed Signal PLD (ispPAC-POWR1014A)

The Power Manager II (ispPAC-POWR1014A-01TN48I) (U17 – Schematic Sheet 8 of 10) provides a programmable power supply supervisor, reset generation, and sequencing control features for the MachXO Control Evaluation Board. By default the POWR1014A is programmed to monitor current and voltage levels of the MachXO2280 Icccore, Iccaux, Iccio, Vcccore, Vccaux, and Vccio using VMON inputs 1-6.

Table 12. POWR1014A Reference

Item	Description
Reference Designators	U17
Part Number	ispPAC-POWR1014A
Manufacturer	Lattice Semiconductor Corporation
Web Site	www.latticesemi.com

POWR1014A DIP Switch Input: The MachXO Control Evaluation Board includes a two-bit input toggle switch tied to digital inputs of the POWR1014A (SW4 – Schematic Sheet 8 of 10). When in the open position, the switch is pulled to 3.3V via a 10K resistor. When in the down position, the switch is tied to ground.

Table 13. POWR1014A DIP Switch Pin Information

Function	U17 Pin	Description	MachXO Pin	Other Connection

POWR1014A LED Bank: The MachXO Control Evaluation Board includes four LEDs tied to digital outputs of the POWR1014A (Schematic Sheet 8 of 10). Driving logic low '0' will light a LED.

Table 14. POWR1014A LED Bank Pin Information

Function	RN2_4_470	POWR1014A Pin
PM_LED0	D5	12
PM_LED1	D6	11
PM_LED2	D7	10
PM_LED3	D8	9

Power Supplies, Supply Control, and Fault Circuits

The MachXO Control Evaluation Board features a single coaxial input connector to apply power (Schematic Sheet 7 of 10). A 5V DC source must be applied to power the board.

A low dropout voltage regulator converts +5V to +3.3V. Two MOSFET power switch circuits controlled by the POWR1014A enable the MachXO2280 Vcccore and Vccaux supplies. For more information on using power MOSFETs with Power Manager and Power Manager II devices see AN6048, Using Power MOSFETs with Power Manager Devices.

To emulate a supply failure on the MachXO Control Evaluation Board, you may remove either unplug the power supply to disable the 5V input or remove Vccaux or Vccio jumpers connected to the voltage monitor inputs to the POWR1014A (Schematic 8 of 10). When programmed with the default PC Board Control and Power Management demo design the supply rail failure and time will be recorded to a diagnostic log of the on-board SPI Flash Memory.

Prototyping Area

The MachXO Control Evaluation Board provides 1" x 3", 140-hole prototyping area with connections to MachXO2280 GPIOs (Schematic Sheet 8 and 9 of 10), +3.3V, and GND. The area is organized as 7 columns of 100-mil spaced holes.

Table 15. Prototype Area Column Organization

	Column						
	1	2	3	4	5	6	7
Function	+3.3V	Proto Area (NC)				GND	Proto I/Os

Table 16. Column 7 Proto I/O Pin Information

Function	Proto I/O Pin	MachXO2280 Pin
ProtoT4	IO12	T4
ProtoR6	IO80	R6
ProtoT6	IO34	T6
ProtoT8	IO18	T8
ProtoM7	IO35	M7
ProtoM8	IO31	M8
ProtoR7	IO76	R7
ProtoR8	IO79	R8
ProtoN8	IO83	N8
ProtoN9	IO62	N9
ProtoP9	IO63	P9
ProtoP10	IO64	P10
ProtoM10	IO82	M10
ProtoR9	IO72	R9
ProtoR10	IO73	R10
ProtoP15	IO74	P15
ProtoP16	IO75	P16
OSC_CLK	IO77	
XO_SDA	IO78	K5
XO_SCL	IO84	K4

PWM Analog Output Circuit

A pulse width modulated type circuit (Schematic Sheet 3 of 10) is provided to serve a digital to analog conversion (DAC). A stereo phonejack (J26) allow you to connect external speakers or headphones to the MachXO Control Evaluation Board.

SD Flash Memory Card Socket

A 9 pin SD card socket is provided (U23 – Schematic Sheet 3 of 10) with the ability to interface to SD card memory cards.

SPI Flash Memory

The board is populated with an Atmel non-volatile 2 M-bit SPI Flash memory (U69 – Schematic Sheet 3 of 10).

Table 17. SPI Flash Memory Reference

Item	Description
Reference Designators	U69
Part Number	M25PE20-VMN6TP
Manufacturer	Numonyx/ST Micro
Web Site	www.numonyx.com

SRAM
The board is populated with 1 Mbit of SRAM from Cypress (U8 – Schematic Sheet 3 of 10) with a data bus width of 8 bits. The 17-bit address bus, the data bus and the control signals are connected directly to the CPLD. The 17-bit address bus, named MEMORY_A0 through MEMORY_A16, addresses 1 byte locations.

Table 18. SRAM Reference

Item	Description
Reference Designators	U8
Part Number	CY128X8TSOP
Manufacturer	Cypress Semiconductor
Web Site	www.cypress.com

Status LEDs
One red power OK status LED is provided.

Temperature Sensor
The temperature sensor on the MachXO Control Evaluation Board is a TI TMP101NA/250 device (U15 – Schematic Sheet 3 of 10). It uses an I^2C bus slave interface to provide the temperature reading on the board.

Test Points
In order to check the various voltage levels used, several test points are provided:

- VCC (1.2V, 2.5V, and 3.3V)
- VCCAUX
- VCCIO of all banks
- GND
- Clock source
- ADC GND
- ADC Vin
- DAC Vout
- DAC Fdbk

USB Programming and RS-232 Interface
The USB programming and data interface circuit (Schematic Sheet 10 of 10) provides clocking, boot memory, a FTDI Chip dual USB UART/FIFO device.

By default, the MachXO Control Evaluation Board's pre-programmed PC Board Control and Power Management demo design provides a user interface layer to a PC-based terminal program.

Voltage Ramp Circuit
The evaluation board includes two voltage ramp circuits (Schematic Sheet 8 of 10) tied to the high-voltage outputs of the POWR1014A. Vishay N-channel MOSFETs are included so test equipment can be attached to examine controlled FET ramp rate. FET source pins are attached to voltage monitor inputs of the POWR1014A.

Ramp the voltage of two simulated supplies up using the HVOUT1 and HVOUT2 outputs. Each circuit will be ramped up at a different rate. The HVOUT outputs will each be connected to a circuit using a MOSFET controlling a resistor and capacitor network. The voltage output of this circuit will be monitored by the VMON7 and VMON8 inputs. When the voltage on each of these inputs reaches the preset value, an LED on the POWR1014A LED bank will be lit.

Programming

Programming for the MachXO and Power Manager II devices are controlled using the ispVM® System software, available for download from the Lattice website at www.latticesemi.com/ispvm.

Refer to the ispVM System software for help regarding operation of this software.

The MachXO Control 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 17.5 or later software.

Mechanical Specifications

Dimensions: 6 ¼ in. [L] x 4 in. [W] x 5/8 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.

Modifying the MachXO Control Evaluation Board

The MachXO Control Evaluation Board provides a prototyping area to support extensions of its functionality.

Note: Modifying your board requires good electronics handling and PCB fabrication techniques to avoid damage.

This section describes how to modify the MachXO Control Evaluation Board to support the Voltage Monitoring Demo using internal LVDS buffers.

1. Add a two-pin header (such as Samtech TSW-102-07-G-S, or equivalent) in the prototyping area, occupying the ProtoP9 and the adjacent GND thru-holes. (Schematic: sheet 9 of 10)
2. Add a 3.3k resister between ProtoP10 and ProtoM10 thru-holes.
3. Add a 820p capacitor between Proto P10 and the adjacent GND thru-holes.

In this configuration, the two-pin header is used to facilitate the connection of a bench voltage supply and ground. The input voltage must be limited between +3.2 volts and ground.

Note: Exercise good electronics handling to avoid ESD damage to the MachXO device when making bench connections.

Glossary

CPLD: Complex Programmable Logic Device

DIP: Dual in-line package.

I^2C: 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

Board Does Not Power On Completely
If jumper is not installed at J17, when power is initially applied to the board, the POWR1014A will stop the power-on sequence of the board. Install a jumper at J17 to enable the power-on sequence.

Board Continuously Resets
If position 2 of the POWR1014A DIP Switch (SW4) is depressed the board will continuously cycle the reset input of the system. Raise position 2 of SW4 for normal operation.

Other JTAG Devices are Ignored by ispVM Software

- See Schematic Sheet 1 of 10 to ensure the TDI-TDO and TMP jumper settings enable the Other JTAG option.
- All JTAG devices attached to the MachXO Control Evaluation Board JTAG chain, must use a 3.3V supply rail to be recognized by ispVM System software.

Determine the Source of a Pre-Programmed Part
It's likely you will receive your MachXO Control Evaluation Board after it has been reviewed and reprogrammed by someone else. To restore the 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 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 MachXO Control Evaluation Board to a host PC using the USB ports.
2. Start ispVM and choose **ispTools > Scan**. The LCMXO2280C appears in the Device List.
3. Double-click the **LCMXO2280C** row. The Device Information dialog appears.
4. Click the **Browse** button. The Save as Data File dialog appears.
5. Specify a new JEDEC Data File name and click the **Save** button.
6. From the Operation list choose **FLASH Read and Save** and click **OK**.
7. Choose **Project > Download**. ispVM reads the Flash contents from the MachXO and writes the results to the JEDEC file specified.

   Open the JEDEC file into a text editor and page to the bottom of the file.

   Note the hexidecimal checksum at the line above the User Electronic Data note line. Compare this value against the checksum of the original JEDEC demo programming files.

Ordering Information

Description	Ordering Part Number	China RoHS Environment-Friendly Use Period (EFUP)
MachXO Control 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
August 2009	01.0	Initial release.
August 2009	01.1	Added Appendix A - Schematic.
		Updated Appendix B - Bill of Materials.
October 2009	01.2	Included support for the Power Supply Fault Logging, Voltage Monitoring and Memory-Audio demos.
April 2010	01.3	Updated Appendix A - Schematic.
June 2010	01.4	Updated "Voltage Monitoring Demo" section.
		Added "Modifying the MachXO Control Evaluation Board" section.

Appendix A. Schematic

Figure 15. Configuration

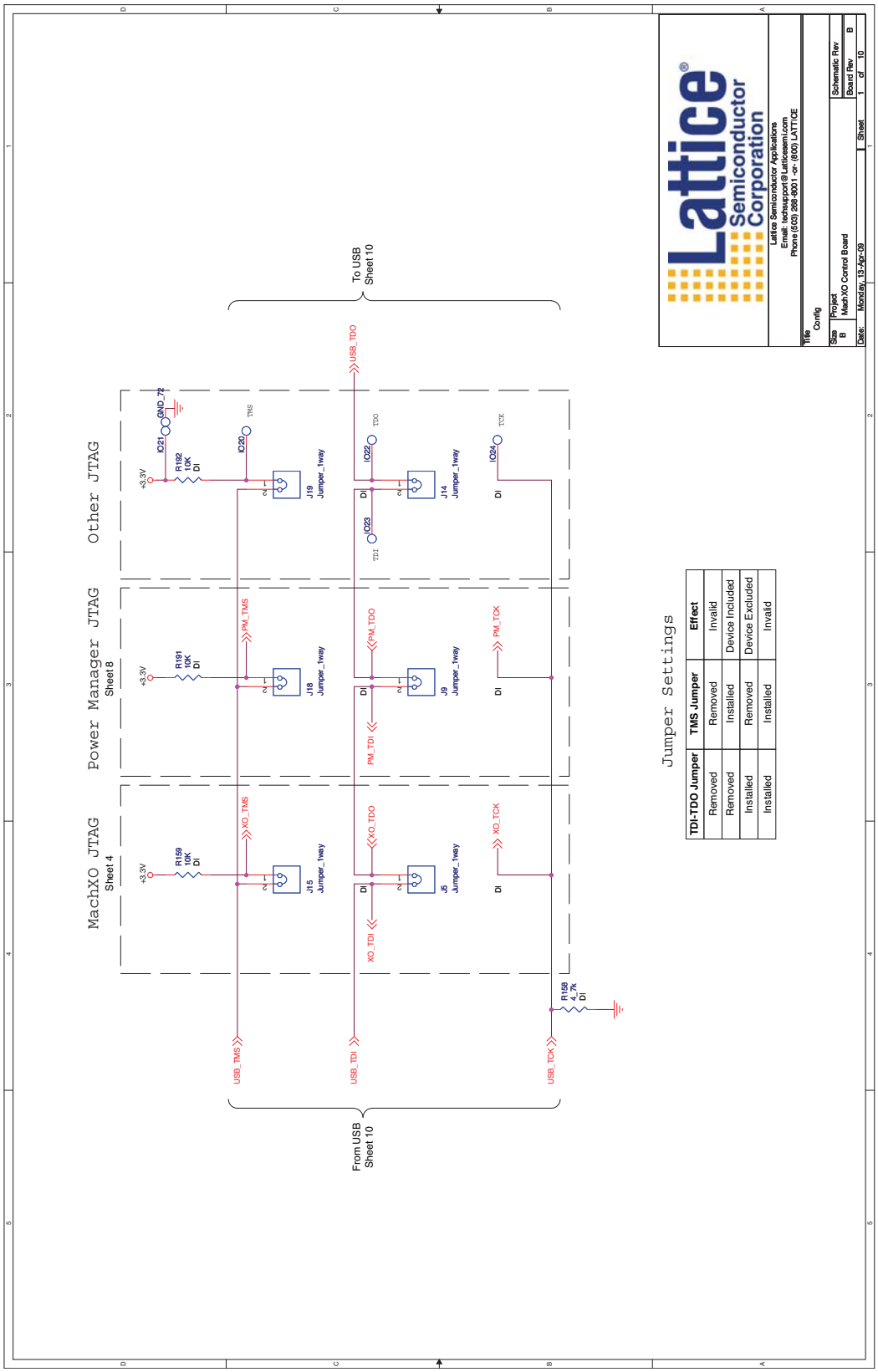


Figure 16. MachXO Banks 0 and 1

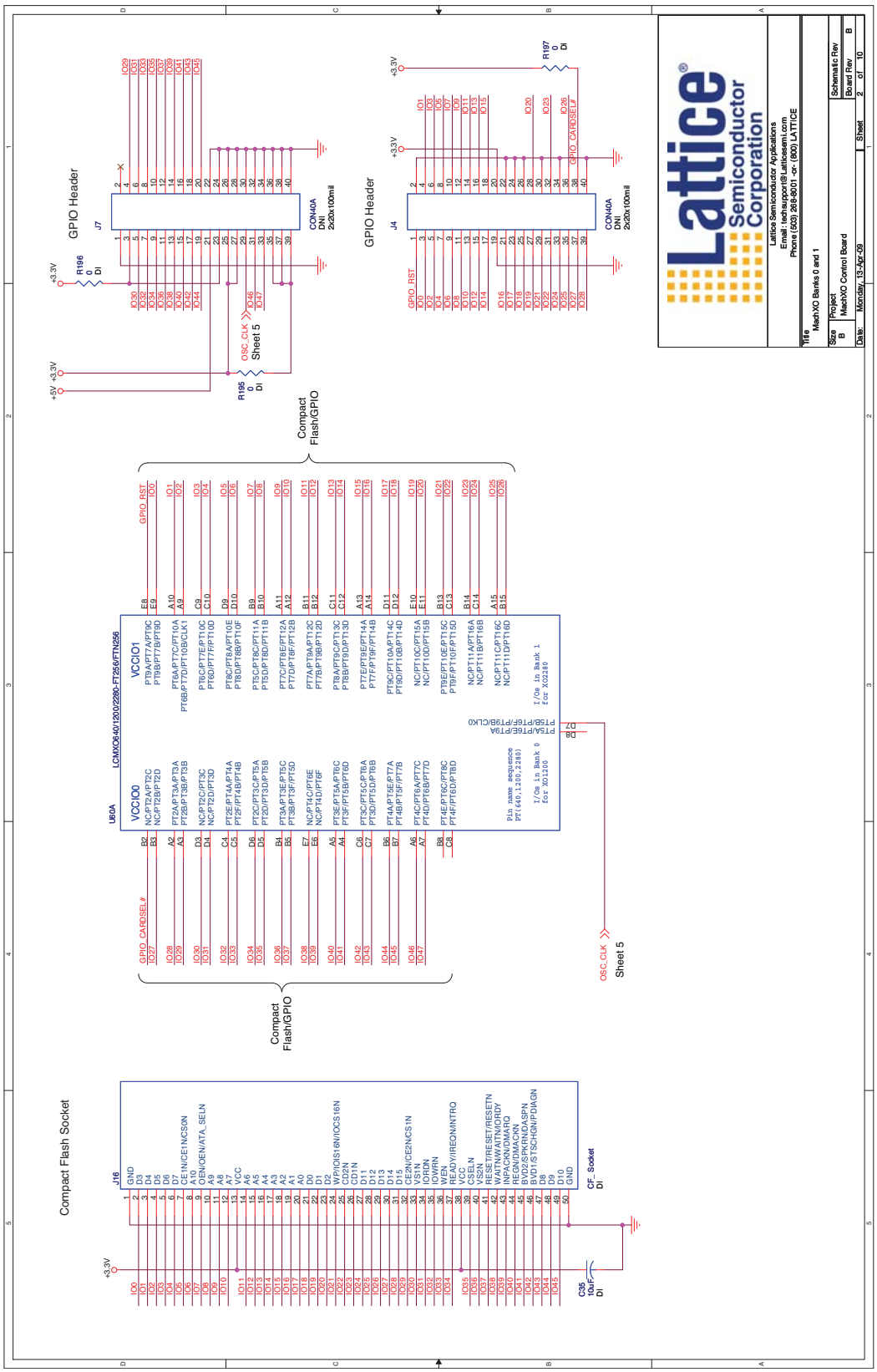


Figure 17. MachXO Banks 2 and 3

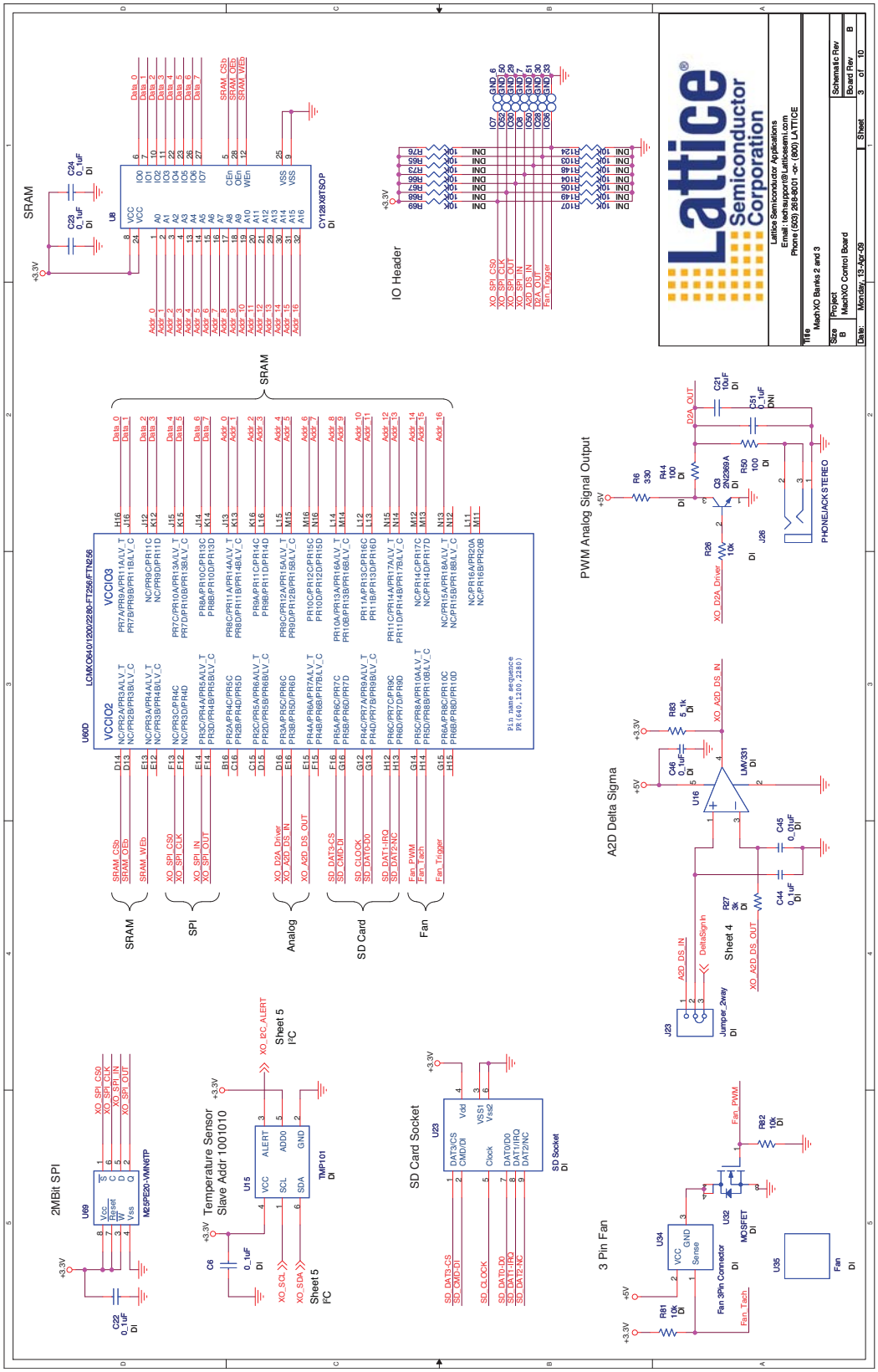


Figure 18. MachXO Banks 4 and 5

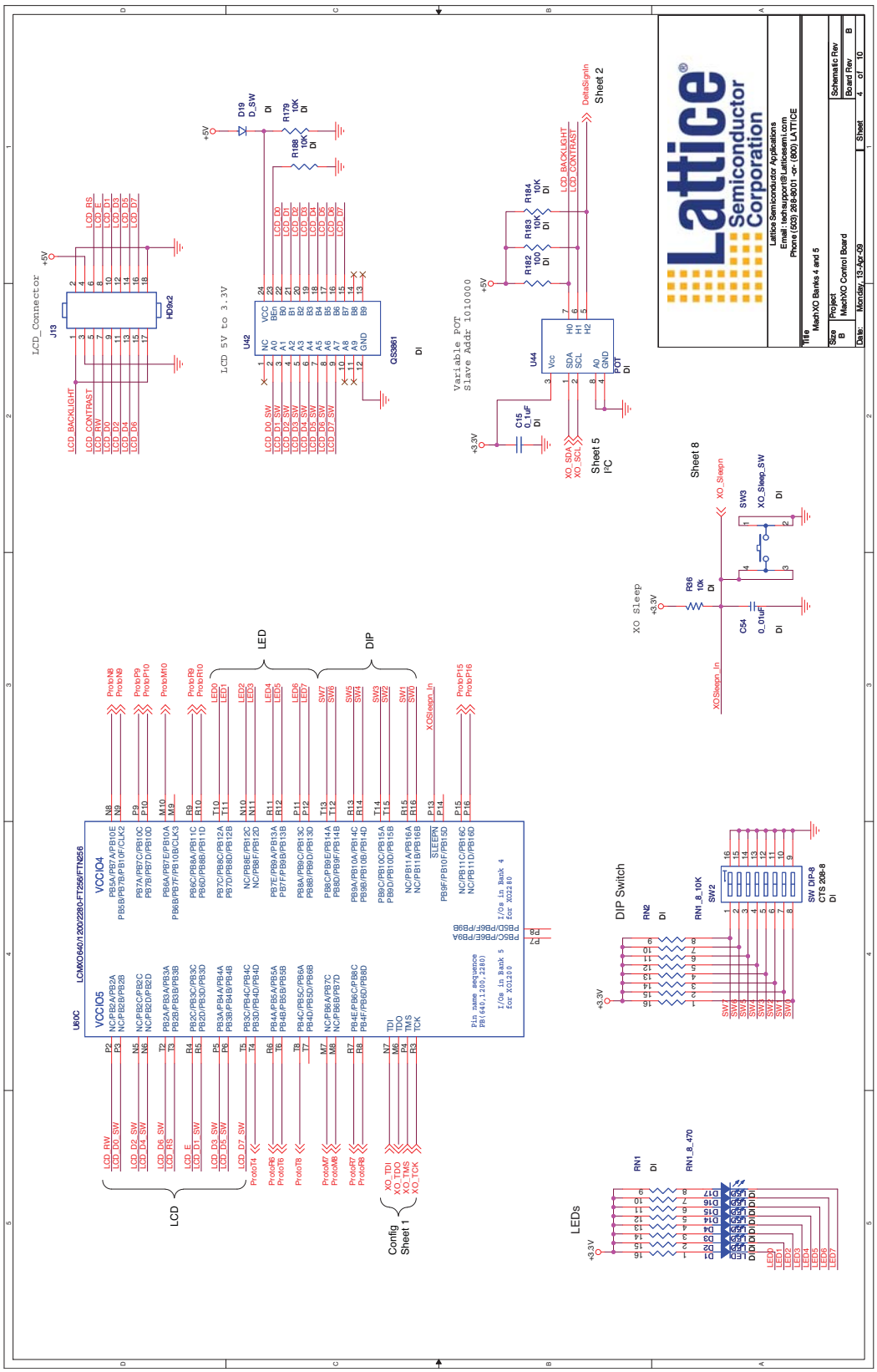


Figure 19. MachXO Banks 6 and 7

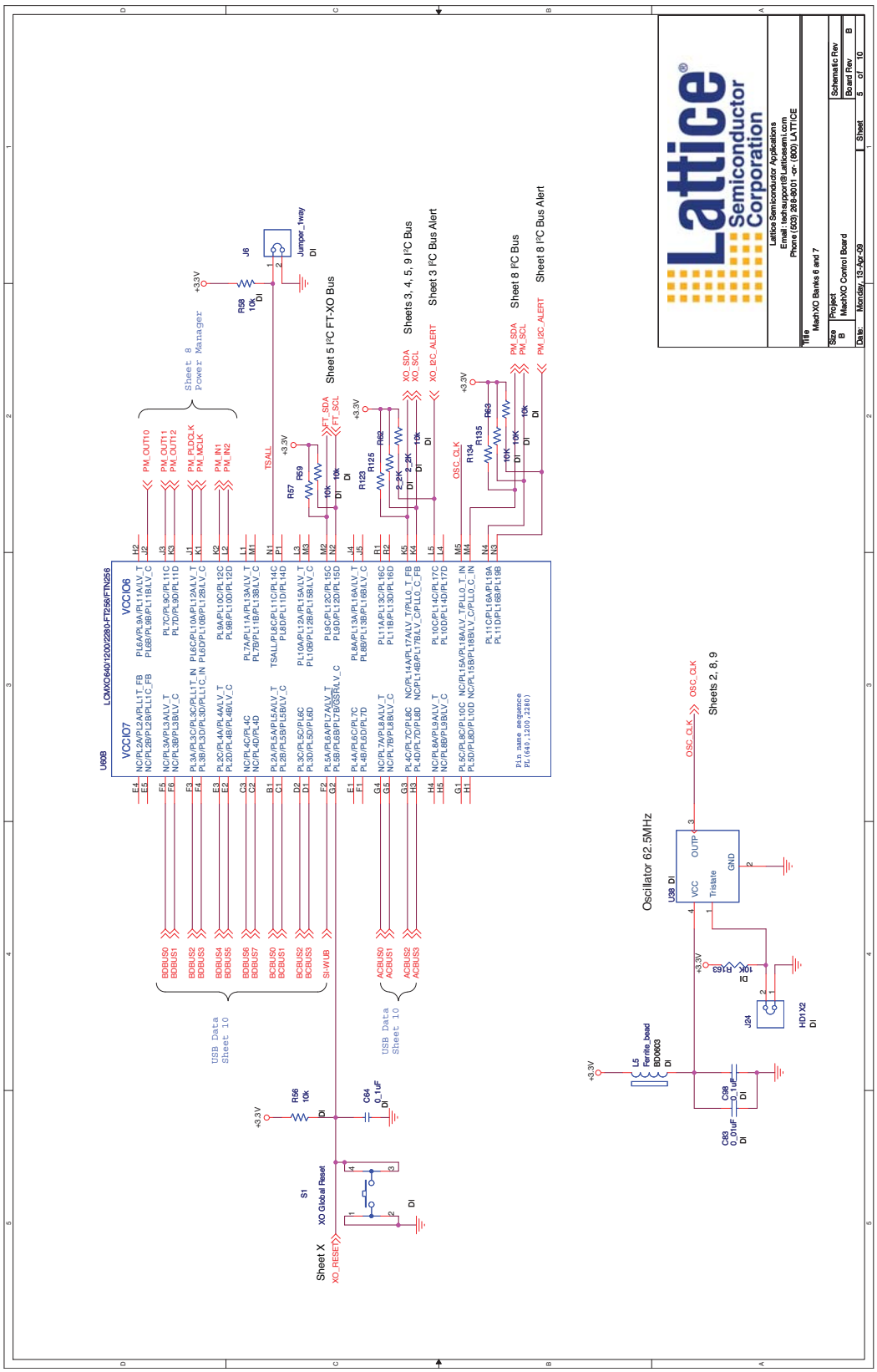


Figure 20. MachXO Power

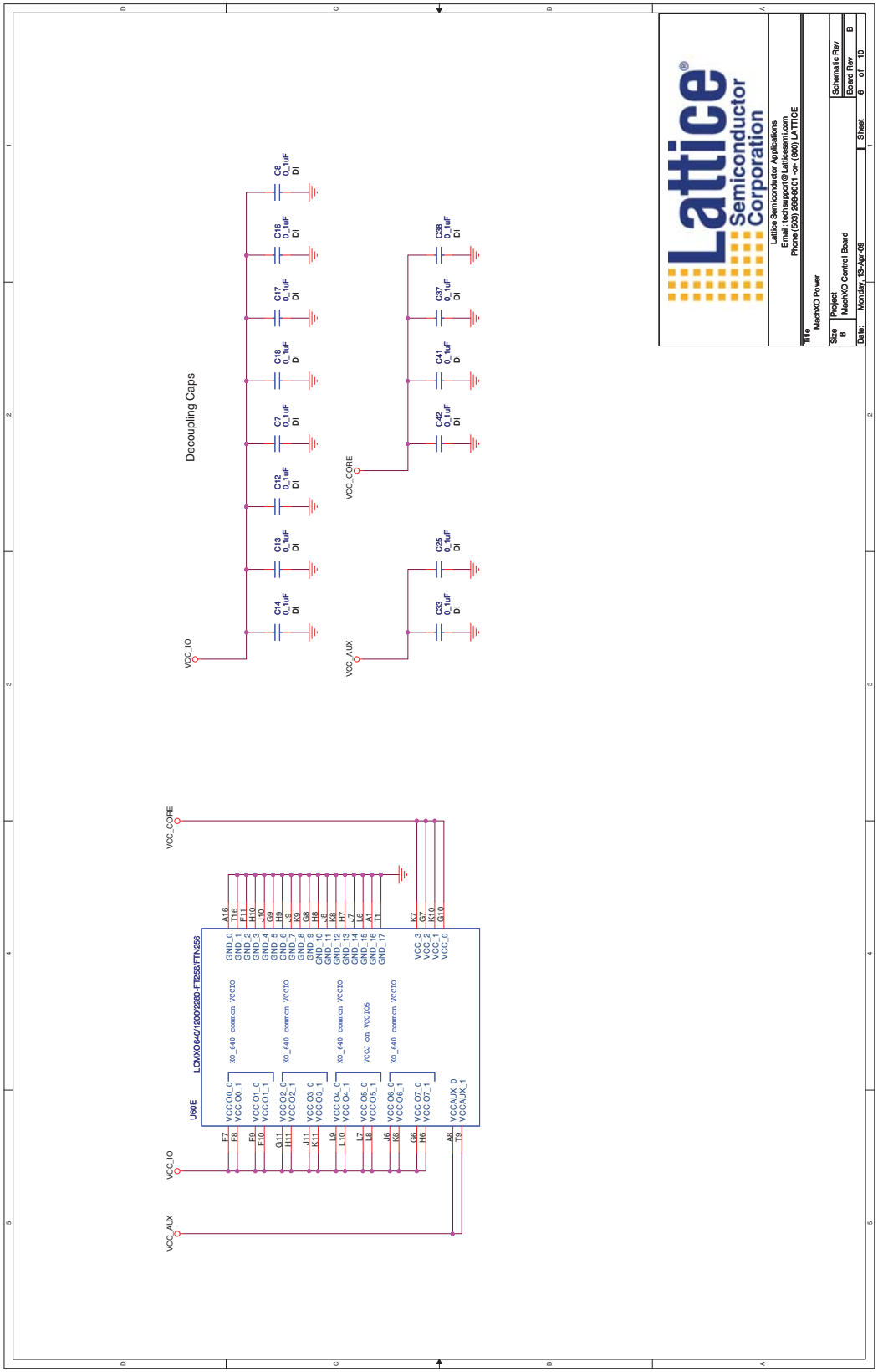


Figure 21. Board Power

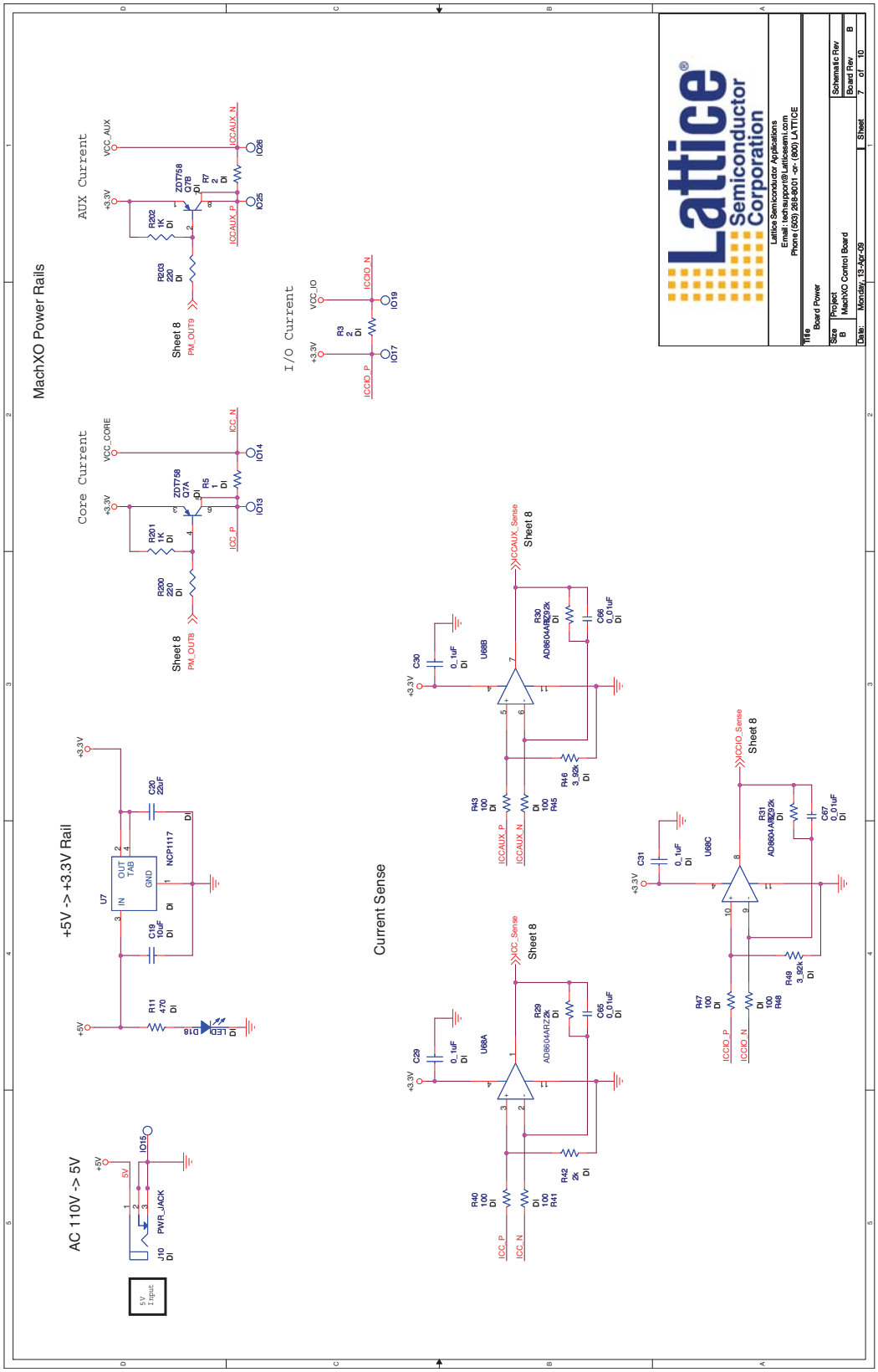


Figure 22. Power Manager II

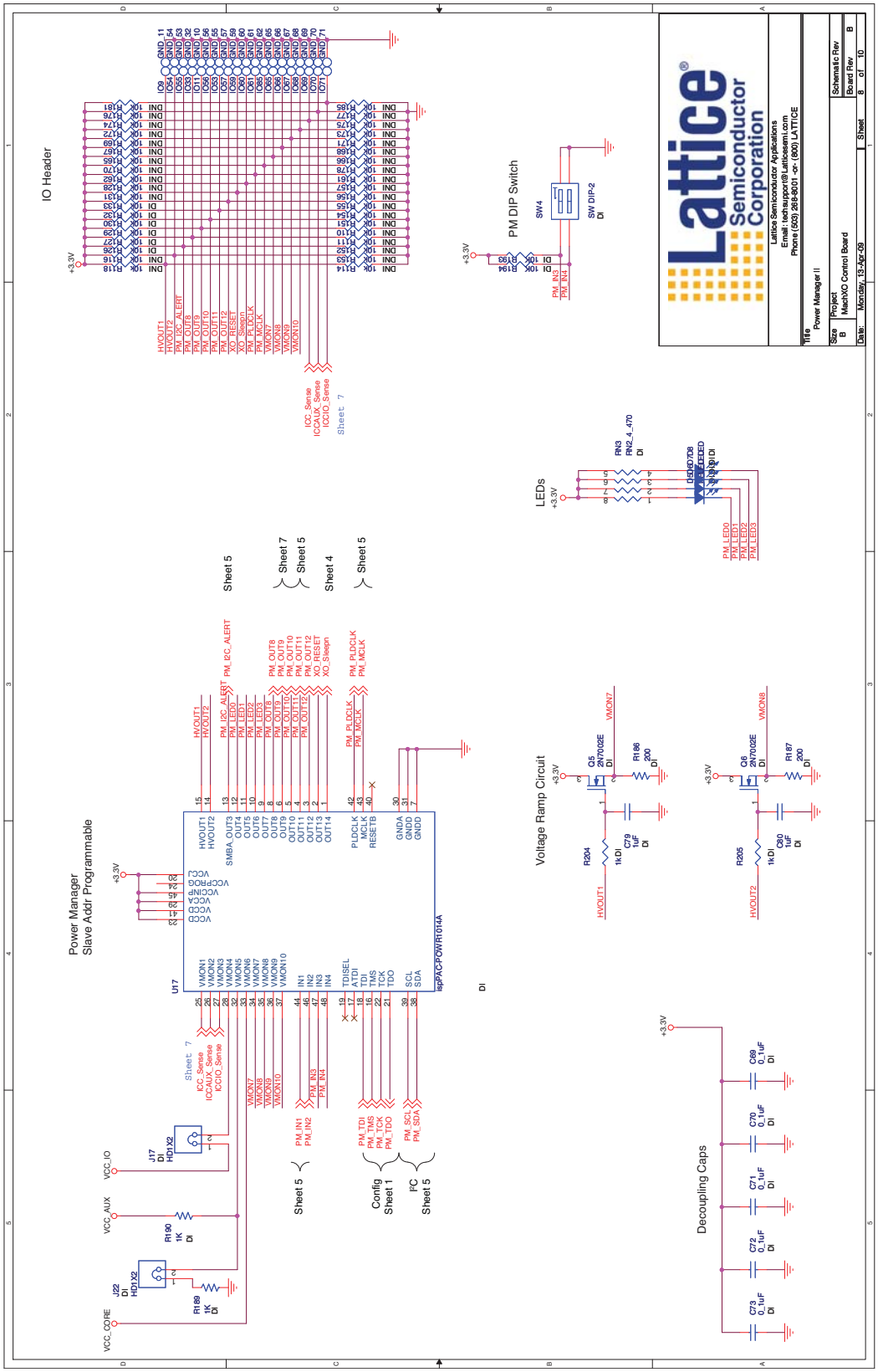


Figure 23. Prototype Area

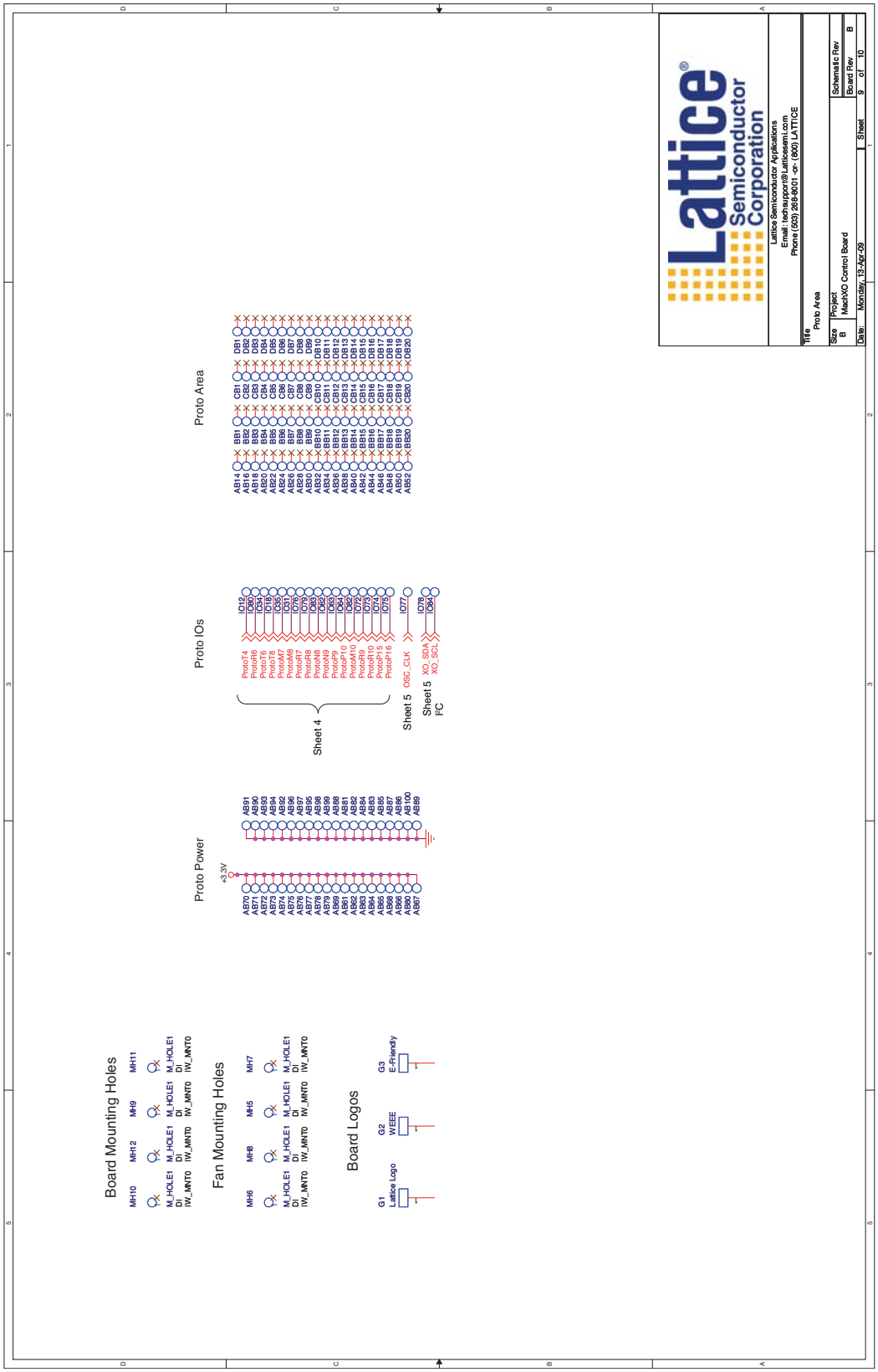
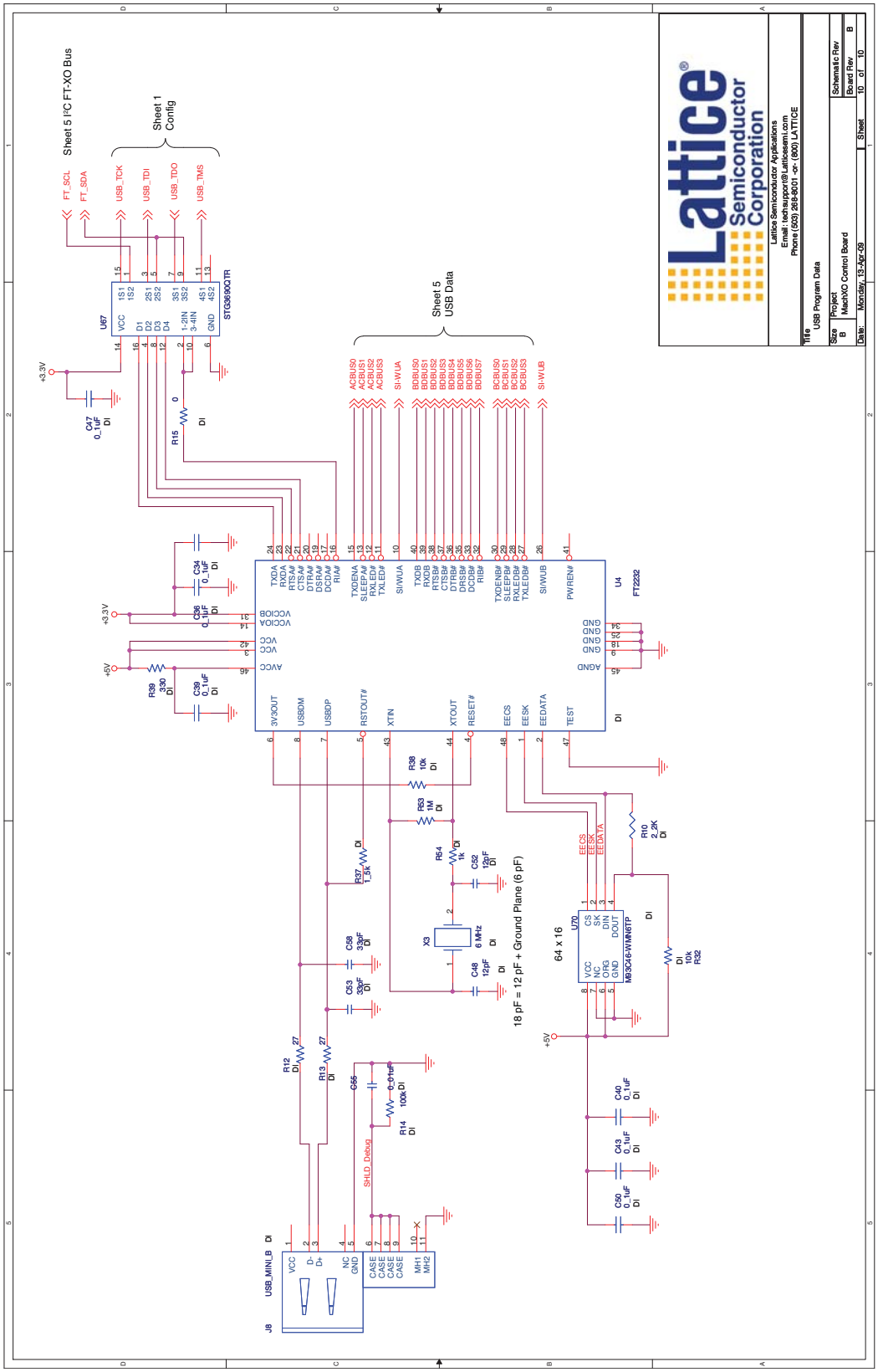


Figure 24. USB Program Data



Appendix B. Bill of Materials

Table 19. Bill of Materials

Item	Quantity	Reference	Part	Footprint	Populate	Vendor	Part Number	Description
1	2	C48, C52	12pF	SM/C_0603	DI	Murata Electronics	ERB1885C2E120JDX5D	12pF surface mount cap
2	38	C6, C7, C8, C12, C13, C14, C15, C16, C17, C18, C22, C23, C24, C25, C29, C30, C31, C33, C34, C36, C37, C38, C39, C40, C41, C42, C43, C44, C46, C47, C50, C64, C69, C70, C71, C72, C73, C98	0_1uF	SM/C_0603	DI	Panasonic	ECJ-1VB1C104K	0.1uF surface mount cap
3	1	C51	0_1uF	SM/C_0603	DNI	Panasonic	ECJ-1VB1C104K	0.1uF surface mount cap
4	3	C19, C21, C35	10uF	SM/C_0603	DI	TDK Corp.	C1608Y5V0J106Z	10uF surface mount cap
5	1	C20	22uF	SM/C_0805	DI	Taiyo Yuden	LMK212BJ226MG-T	22uF surface mount cap
6	7	C45, C54, C55, C65, C66, C67, C83	0_01uF	SM/C_0603	DI	Murata Electronics	GRM188R71H103KA01D	0_01 SMC
7	2	C53, C58	33pF	SM/C_0603	DI	Panasonic	ECJ-1VC2A330J	33pF SMC
8	13	D1, D2, D3, D4, D5, D6, D7, D8, D14, D15, D16, D17, D18	LED	SM/D_0603	DI	Lite-On	LTST-C190CKT	LEDRED
9	1	D19	D_SW	SM/SOD_323	DI	Diodes	1N4148WS	SM-SOD-323
10	1	J8	USB_MINI_B	TYPE_B	DI	Hirose	UX60-MB-5ST	USBType-BMiniConnector
11	7	J5, J6, J9, J14, J15, J18, J19	Jumper_1way	BLKCON.100/VH/ TM1SQ/W.100/2	DI	Samtec Inc.	TSW-102-07-G-S	Jumper with Shunt (929957-08)
12	1	J23	Jumper_2way	JP_2WY	DI	Samtec Inc.	TSW-103-07-G-S	Jumper with Shunt (929957-08)
13	1	J10	PWR_JACK	PWR_CON	DI	Switchcraft	RAPC712	CoaxialDCconnector
14	3	J17, J22, J24	HD1X2	BLKCON.100/VH/ TM1SQ/W.100/2	DI	Samtec Inc.	TSW-102-07-G-S	Jumper with Shunt (929957-08)
15	1	J13	HD9x2	HD9x2	DI	Samtec Inc.	TSW-109-07-G-D	Jumper with Shunt (929957-08)
16	1	J16	CF_ Socket	CF_2X30	DI	AVX	AVX-31-5620-050-116-871	AVXCFconnector
17	1	L5	Ferrite_bead	BD0603	DI	Steward	MI0603J600R-00	SMD0603 Ferrite Bead
18	1	Q3	2N2369A	SM/SOT23	DI	Fairchild Semiconductor	MMBT2369A	Transistor NPN SOT-23
19	1	RN1	RN1_8_470	SMD_0603	DI	Rohm Semiconductor	MNR18E0APJ471	SMD_0602
20	1	RN2	RN1_8_10K	SMD_0603	DI	Rohm Semiconductor	MNR18E0APJ103	SMD_0602
21	2	R6, R39	330	SM/R_0603	DI	Panasonic ECG	ERJ-3EKF3300V	RES 330 OHM 1/10W 1% 0603 SMD
22	4	R15, R195, R196, R197	0	SM/R_0603	DI	Panasonic ECG	ERJ-3GEY0R00V	Resistor 0.0 SMD 0603
23	9	R40, R41, R43, R44, R45, R47, R48, R50, R182	100	SM/R_0603	DI	Vishay/Dale	CRCW0603100RFKEA	SMT resistor
24	7	R54, R189, R190, R201, R202, R204, R205	1k	SM/R_0603	DI	Vishay/Dale	CRCW06031K00FKEA	Resistor 1k SMD 0603
25	3	R10, R123, R125	2_2K	SM/R_0603	DI	Panasonic ECG	ERJ-3GEYJ222V	Resistor 2.2k SMD 0603
26	30	R26, R32, R36, R38, R56, R57, R58, R59, R62, R63, R81, R82, R126, R127, R129, R130, R132, R133, R134, R135, R159, R163, R179, R183, R184, R188, R191, R192, R193, R194	10K	SM/R_0603	DI	Vishay/Dale	CRCW060310K0FKEA	10K 0603 SMT resistor
27	46	R65, R66, R67, R68, R69, R73, R76, R103, R104, R105, R107, R110, R111, R114, R116, R118, R124, R128, R131, R148, R149, R151, R152, R153, R154, R155, R156, R157, R161, R162, R165, R166, R167, R168, R169, R170, R171, R172, R173, R174, R175, R176, R177, R178, R181, R185	10k	SM/R_0603	DNI	Vishay/Dale	CRCW060310K0FKEA	10K 0603 SMT resistor
28	1	R27	3k	SM/R_0603	DI	Panasonic ECG	ERJ-3EKF3001V	RES 3.00K OHM 1/10W 1% 0603 SMD
29	1	R83	5_1k	SM/R_0603	DI	Panasonic ECG	ERJ-3EKF5101V	SMD 0603
30	1	R158	4_7k	SM/R_0603	DI	Panasonic ECG	ERJ-3EKF4701V	RES 4.7K OHM 1/10W 1% 0603 SMD
31	1	SW2	SW DIP-8	CTS 208-8	DI	CTS Corporation Electrocomponents	194-8MST	x8 DIP Switch Piano
32	1	S1	XO Global Reset	SMT_SW	DI	Panasonic ECG	EVQ-Q2K03W	SPST_Switch

Table 19. Bill of Materials (Continued)

Item	Quantity	Reference	Part	Footprint	Populate	Vendor	Part Number	Description
33	1	U8	CY128X8TSOP	32-TSOP	DI	Cypress	CY7C1019DV33-10ZSXI	IC SRAM 128KX8 ASYNC 32-TSOP
34	1	U70	M93C46-WMN6TP	SOIC-8	DI	STMicroelectronics	M93C46-WMN6TP	IC 1K EEPROM 8-SOIC
35	1	U15	TMP101	SM/SOT23_6	DI	TI	TMP101NA/250	IC TEMP SENSOR DIG SOT-23-6
36	1	U23	SD Socket	SM/SD	DI	3M	SD-RSMT-2-MQ-WF	SD socket
37	1	U32	MOSFET	SOT-223-4	DI	Fair Child	NDT3055LCT-ND	MOSFET N-CH
38	1	U34	Fan 3 Pin Connector	SP-10	DI	Molex/Waldom Electronics	WM4201-ND	Molex Connector Corp.
39	1	U35	Fan	Fan	DI	Fantronic	EC2510M05CA,NY PMS 440 0063 PH,NUT HEX 4-40 NYLON	Evercool 25x10mm Fan & two mouting nylon nuts/bolts
40	1	U42	QS3861	TSSOP_24	DI	IDT	IDTQS3861PAG8	TSSOP-24
41	1	J26	PHONEJACK STEREO	SM	DI	CUI	SJ1-3513-SMT	3.5mm_AudioJack
42	1	R11	470	SM/R_0603	DI	Panasonic ECG	ERJ-3EKF4700V	RES470OHM1/10W1%
43	2	R12, R13	27	SM/R_0603	DI	Panasonic ECG	ERJ-3GEYJ270V	Resistor 27 SMD 0603
44	1	R14	100k	SM/R_0603	DI	Panasonic ECG	ERJ-3GEYJ104V	Resistor 100k SMD 0603
45	1	R53	1M	SM/R_0603	DI	Panasonic ECG	ERJ-3GEYJ105V	RES 1.0M1/10W5%
46	1	SW3	XO_Sleep_SW	SMT_SW	DI	Panasonic ECG	EVQ-Q2K03W	SPST_Switch
47	1	U7	NCP1117	SOT-223	DI	ON Semiconductor	NCP1117ST33T3G	Voltage Regulators - Linear
48	1	U16	LMV331	SOT-23-5	DI	TI	LMV331IDBVR	Comparators
49	1	X3	6 MHz	SMD	DI	Citizen America Corp.	HCM49 6.000MABJ-UT	CRYSTAL 6.000 MHz SMT 18PF
50	1	R37	1_5k	SM/R_0603	DI	Panasonic ECG	ERJ-3GEYJ152V	Resistor 1.5k SMD 0603
51	1	U4	FT2232	TQFP_48	DI	Future	FT2232D R	USB UART/FIFO
52	1	U44	POT	8-µSOP	DI	Dallas Semiconductor	DS3904U-020+	Variable POT
53	2	C79, C80	1uF	SM/C_0805	DI	Panasonic ECG	ECJ-2YB1A105K	1uF SMC
54	2	J4, J7	CON40A	2x20x100mil	DNI	Samtec Inc.	TSW-120-07-G-D	Header
55	2	Q5, Q6	2N7002E	SM/SOT23	DI	ON Semiconductor	2N7002ET1G	MOSFET N-CH SGL 60V 310A SOT-23
56	1	Q7	ZDT758	SM-8 DUAL PNP	DI	zetex	ZDT758	SM-8 DUAL PNP
57	1	RN3	RN2_4_470	SMD_0603	DI	Yageo	TC164-JR-07470RL	RES ARRAY 470 OHM
58	2	R186, R187	200	SM/R_0603	DI	Panasonic ECG	ERJ-3GEYJ201V	RES 200 OHM 1/10W 5% 0603 SMD
59	2	R200, R203	220	SM/R_0603	DI	Panasonic ECG	ERJ-3EKF2200V	RES 220 OHM 1/10W 1% 0603 SMD
60	1	SW4	SW DIP-2	SP-75	DI	CTS	195-2MST	SWITCH SIDE ACTUATED 2 SEC
61	1	U38	Oscillator_62_5	SMD	DI	Fox Electronics	FXO-HC735-62.5 MHz	OSC 62.5 MHZ 3.3V SMD
62	1	U17	ispPAC-POWR1014A	48 TQFP	DI	Lattice	POW1014A	Power Manager
63	1	U60	LCMXO640/1200/ 2280-FT256/FTN256	256 ftBGA	DI	Lattice	MachXO_2280	MachXO
64	1	U67	STG3690QTR	QFN	DI	STMicroelectronics	STG3690QTR	Dual Switch
65	1	U68	AD8604ARZ	14 SOIC	DI	Analog Devices Inc.	AD8604ARZ	Quad OP AMP SOIC
66	1	U69	M25PE20-VMN6TP	8 SOIC	DI	Numonyx/ ST Micro	M25PE20-VMN6TP	IC SPI Flash 2MBit 8-SOIC
67	1	R5	1	SM/R_0805	DI	Vishay Dale	CRCW08051R00FKEA	Resistor 1 1%
68	2	R3, R7	2	SM/R_0805	DI	Rohm Semiconductor	MCR10EZHFL2R00	Resistor 2 1% 1/4W
69	8	MH5, MH6, MH7, MH8, MH9, MH10, MH11, MH12	M_HOLE1	IW_MNT0	DI	3M	SJ-5003 (BLACK)	BUMPON HEMISPHERE .44X.20 BLACK
70	4	R30, R31, R46, R49	3_92k	SM/R_0603	DI	Susumu Co. Ltd.	RG1608P-3921-B-T5	RES 3.92K OHM 1/10W .1% 0603 SMD
71	2	R29, R42	2k	SM/R_0603	DI	Susumu Co. Ltd.	RG1608P-202-B-T5	RES 2.0K OHM 1/10W .1% 0603 SMD

Table 19. Bill of Materials (Continued)

Item	Quantity	Reference	Part	Footprint	Populate	Vendor	Part Number	Description
72	205	DB1, CB1, BB1, DB2, CB2, BB2, DB3, CB3, BB3, DB4, CB4, BB4, DB5, CB5, BB5, GND_6, DB6, CB6, BB6, IO7, GND_7, DB7, CB7, BB7, IO8, DB8, CB8, BB8, IO9, DB9, CB9, BB9, GND_10, DB10, CB10, BB10, IO11, GND_11, DB11, CB11, BB11, IO12, DB12, CB12, BB12, IO13, DB13, CB13, BB13, IO14, DB14, CB14, BB14, AB14, IO15, DB15, CB15, BB15, DB16, CB16, BB16, AB16, IO17, DB17, CB17, BB17, IO18, DB18, CB18, BB18, AB18, IO19, DB19, CB19, BB19, IO20, DB20, CB20, BB20, AB20, IO21, IO22, AB22, IO23, IO24, AB24, IO25, IO26, AB26, IO28, AB28, GND_29, IO30, GND_30, AB30, IO31, GND_32, AB32, IO33, GND_33, IO34, AB34, IO35, IO36, AB36, AB38, AB40, AB42, AB44, AB46, AB48, IO50, GND_50, AB50, GND_51, IO52, AB52, IO53, GND_53, IO54, GND_54, IO55, GND_55, IO56, GND_56, IO57, GND_57, IO59, GND_59, IO60, GND_60, IO61, GND_61, AB61, IO62, GND_62, AB62, IO63, AB63, IO64, AB64, IO65, GND_65, AB65, IO66, GND_66, AB66, IO67, GND_67, AB67, IO68, GND_68, AB68, IO69, GND_69, AB69, IO70, GND_70, AB70, IO71, GND_71, AB71, IO72, GND_72, AB72, IO73, AB73, IO74, AB74, IO75, AB75, IO76, AB76, IO77, AB77, IO78, AB78, IO79, AB79, IO80, AB80, AB81, IO82, AB82, IO83, AB83, IO84, AB84, IO85, AB85, AB86, AB87, AB88, AB89, AB90, AB91, AB92, AB93, AB94, AB95, AB96, AB97, AB98, AB99, AB100	T POINT R	TP				
73	1	G1	Lattice Logo	LOGO300_1000				
74	1	G2	WEEE	WEEE_SM				
75	1	G3	E-Friendly	EFRIENDLY_400_SM				

Appendix C. Control SoC Demo I/O Plan

```
LOCATE COMP "led_0" SITE "T10" ;
LOCATE COMP "led_1" SITE "T11" ;
LOCATE COMP "led_2" SITE "N10" ;
LOCATE COMP "led_3" SITE "N11" ;
LOCATE COMP "led_4" SITE "R11" ;
LOCATE COMP "led_5" SITE "R12" ;
LOCATE COMP "led_6" SITE "P11" ;
LOCATE COMP "led_7" SITE "P12" ;
LOCATE COMP "rst_n" SITE "G2" ;
LOCATE COMP "scl" SITE "K4" ;
LOCATE COMP "sda" SITE "K5" ;
LOCATE COMP "spi_csn" SITE "F13" ;
LOCATE COMP "spi_miso" SITE "F14" ;
LOCATE COMP "spi_mosi" SITE "E14" ;
LOCATE COMP "spi_sclk" SITE "F12" ;
LOCATE COMP "sram_addr_0" SITE "J13" ;
LOCATE COMP "sram_addr_1" SITE "K13" ;
LOCATE COMP "sram_addr_2" SITE "K16" ;
LOCATE COMP "sram_addr_3" SITE "L16" ;
LOCATE COMP "sram_addr_4" SITE "L15" ;
LOCATE COMP "sram_addr_5" SITE "M15" ;
LOCATE COMP "sram_addr_6" SITE "M16" ;
LOCATE COMP "sram_addr_7" SITE "N16" ;
LOCATE COMP "sram_addr_8" SITE "L14" ;
LOCATE COMP "sram_addr_9" SITE "M14" ;
LOCATE COMP "sram_addr_10" SITE "L12" ;
LOCATE COMP "sram_addr_11" SITE "L13" ;
LOCATE COMP "sram_addr_12" SITE "N15" ;
LOCATE COMP "sram_addr_13" SITE "N14" ;
LOCATE COMP "sram_addr_14" SITE "M12" ;
LOCATE COMP "sram_addr_15" SITE "M13" ;
LOCATE COMP "sram_addr_16" SITE "N13" ;
LOCATE COMP "sram_data_0" SITE "H16" ;
LOCATE COMP "sram_data_1" SITE "J16" ;
LOCATE COMP "sram_data_2" SITE "J12" ;
LOCATE COMP "sram_data_3" SITE "K12" ;
LOCATE COMP "sram_data_4" SITE "J15" ;
LOCATE COMP "sram_data_5" SITE "K15" ;
LOCATE COMP "sram_data_6" SITE "J14" ;
LOCATE COMP "sram_data_7" SITE "K14" ;
LOCATE COMP "sram_cen" SITE "D14" ;
LOCATE COMP "sram_oen" SITE "D13" ;
LOCATE COMP "sram_wen" SITE "E13" ;
LOCATE COMP "sw_7" SITE "R16" ;
LOCATE COMP "sw_6" SITE "R15" ;
LOCATE COMP "sw_5" SITE "T15" ;
LOCATE COMP "sw_4" SITE "T14" ;
LOCATE COMP "sw_3" SITE "R14" ;
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LOCATE COMP "sw_2" SITE "R13" ;
LOCATE COMP "sw_1" SITE "T12" ;
LOCATE COMP "sw_0" SITE "T13" ;
LOCATE COMP "uart_rx" SITE "F5" ;
LOCATE COMP "uart_tx" SITE "F6" ;
LOCATE COMP "clk" SITE "D7" ;
LOCATE COMP "fan_en" SITE "G14" ;
LOCATE COMP "fan_sense" SITE "H14" ;
LOCATE COMP "lcd_e" SITE "R4" ;
LOCATE COMP "lcd_rs" SITE "T3" ;
LOCATE COMP "lcd_rw" SITE "P2" ;
LOCATE COMP "lcd_db_0" SITE "P3" ;
LOCATE COMP "lcd_db_1" SITE "R5" ;
LOCATE COMP "lcd_db_2" SITE "N5" ;
LOCATE COMP "lcd_db_3" SITE "P5" ;
LOCATE COMP "lcd_db_4" SITE "N6" ;
LOCATE COMP "lcd_db_5" SITE "P6" ;
LOCATE COMP "lcd_db_6" SITE "T2" ;
LOCATE COMP "lcd_db_7" SITE "T5" ;
LOCATE COMP "scl_pm" SITE "N4" ;
LOCATE COMP "sda_pm" SITE "M4" ;
```

Стандарт Электрон Связь

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