MachXO3 Starter Kit User Guide

EB95 Version 1.1, May 2015

Introduction

Thank you for choosing the Lattice Semiconductor MachXO3 Starter Kit!

This user's guide describes how to start using the MachXO3 Starter Kit, an easy-to-use platform for evaluating and designing with the MachXO3 ultra-low density FPGA. Along with the board and accessories, this kit includes a pre-loaded demonstration design. You may also reprogram the on-board MachXO3 device to review your own custom designs.

The MachXO3 Starter Kit currently features the MachXO3L-6900C (NVCM Based) or the MachXO3LF-6900C (Flash Based) device in the 256-ball 0.8 mm pitch caBGA package. The kit also includes a Serial Flash Memory for demonstrating external SPI boot-up. The external Flash Memory also supports a dual-boot mode in addition to Golden boot/fail-safe boot options.

See the Ordering Information section for more information.

Note: Static electricity can severely shorten the lifespan of electronic components. See the Storage and Handling section of this document for handling and storage tips.

Features

The MachXO3 Starter Kit includes:

- **MachXO3L/LF Board** – The board is a 3" x 3" form factor that features the following on-board components and circuits:
  - MachXO3 FPGA – LCMXO3L-6900C-5BG256C (NVCM Based) or LCMXO3LF-6900C-5BG256C (Flash Based)
  - USB mini-B connector for power and programming
  - 4-Mb Serial Flash Memory for boot image and dual-boot support.
  - Eight LEDs
  - 4-position DIP switch
  - Momentary push button switch
  - 40-hole prototype area
  - Four 2 x 20 expansion header landings for general I/O, JTAG, and external power
  - 1 x 8 expansion header landing for JTAG
  - 1 x 6 expansion header landing for SPI/I^2C
  - 3.3 V and 1.2 V supply rails
- **Pre-loaded Demo** – The kit includes a pre-loaded counter design that highlights use of the embedded MachXO3 oscillator and programmable I/Os configured for LED drive.
- **USB Connector Cable** – The board is powered from the USB mini-B socket when connected to a host PC. The USB channel also provides a programming interface to the MachXO3 JTAG port.
- **Lattice Development Kits and Boards Web Page** – Visit www.latticesemi.com/breakoutboards for the latest documentation (including this guide) and drivers for the kit.

The content of this user's guide includes demo operation, programming instructions, top-level functional descriptions of the Starter Kit, descriptions of the on-board connectors, and a complete set of schematics.

Figure 1. MachXO3 Board (MachXO3L Version), Top Side

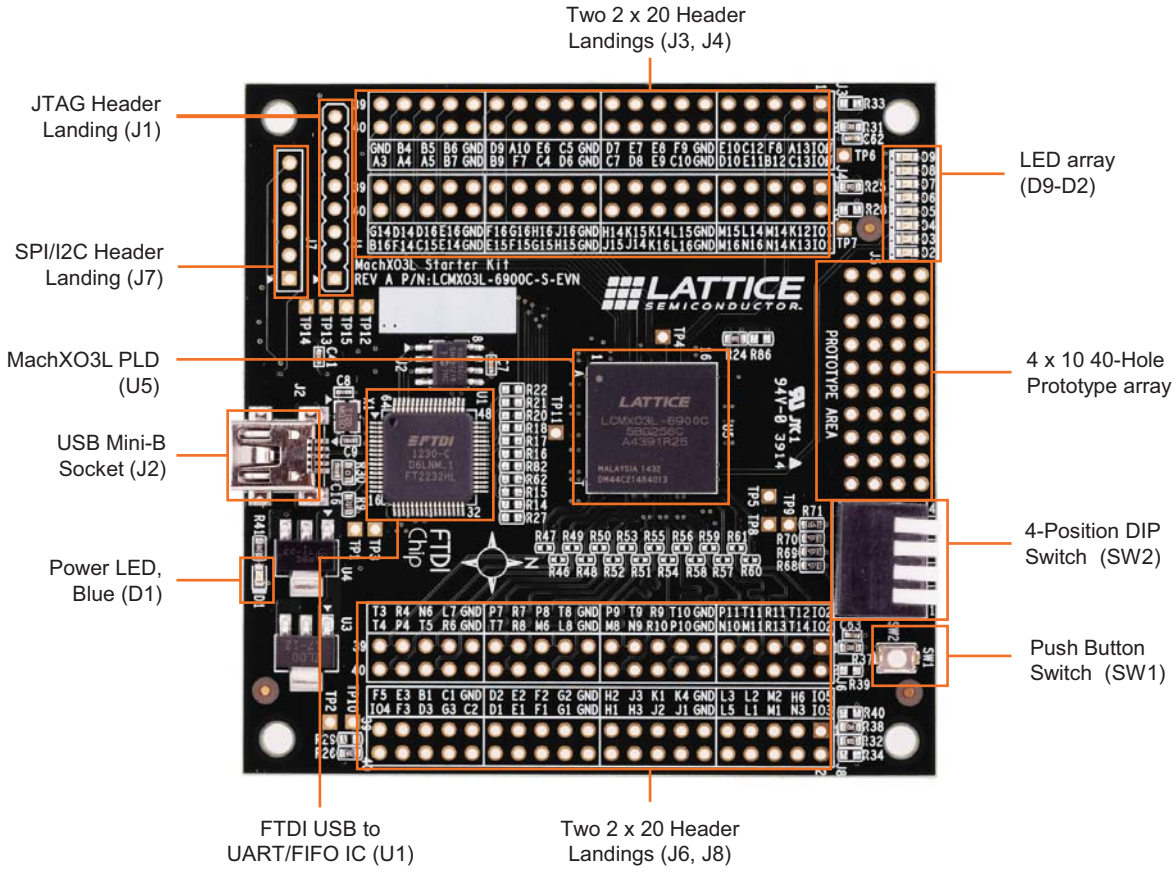
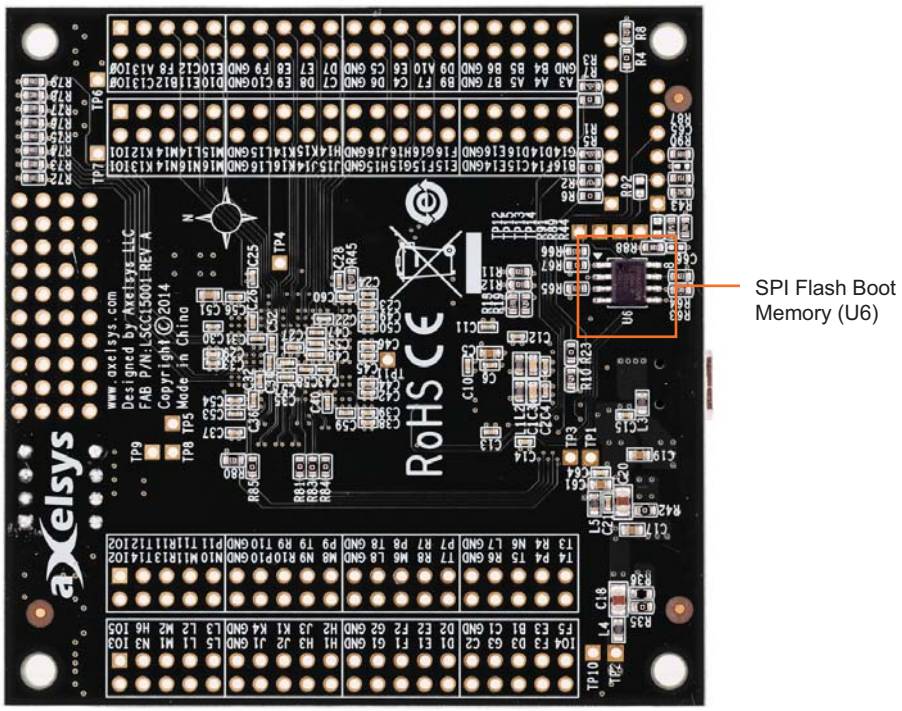


Figure 2. MachXO3 Board (MachXO3L Version), Bottom Side



Storage and Handling

Static electricity can shorten the lifespan of electronic components. Please observe these tips to prevent damage that could occur from electro-static discharge:

- Use anti-static precautions such as operating on an anti-static mat and wearing an anti-static wrist-band.
- Store the evaluation board in the packaging provided.
- Touch a metal USB housing to equalize voltage potential between you and the board.

Software Requirements

You should install the following software before you begin developing new designs for the Starter Kit:

- Lattice Diamond® design software
- FTDI Chip USB hardware drivers (installed as an option within the Diamond installation program)

MachXO3 Device

This board currently features the MachXO3L-6900C FPGA which offers embedded Non-Volatile Configuration Memory (NVCM) technology or the MachXO3LF-6900C FPGA which offers embedded Non-Volatile Flash technology for instant-on operation in a single chip. Numerous system functions are included, such as two PLLs and 256 kbits of embedded RAM plus hardened implementations of I^2C and SPI. Flexible, high performance I/Os support numerous single-ended and differential standards including LVDS. The 256-ball BGA package provides up to 206 user I/Os in a 14 mm x 14 mm form factor. A complete description of this device can be found in the MachXO3 Family Data Sheet.

Demonstration Design

Lattice provides a simple, pre-programmed demo to illustrate basic operation of the MachXO3 device. The design integrates an up-counter with the on-chip oscillator. The pre-programmed design resides in the external SPANSION S25FL204K Serial Flash Memory.

Note: To restore the factory default demo and program it with other Lattice-supplied examples see the Download Demo Designs section of this document.

Run the Demonstration Design

Upon power-up, the preprogrammed demonstration design automatically loads and drives the LED array in a 1-hertz pattern. The program shows a clock divider driven either by the MachXO3 internal oscillator or the external FTDI clock chip. The divider modules (heartbeat.v and kitcar.v) are clocked at the default frequency of 12 MHz which divides the clock to cycle the LED display approximately once per second. The resulting light pattern is determined by the DIP Switch (SW2) setting as shown in Table 1.

Figure 3. Demonstration Design Block Diagram

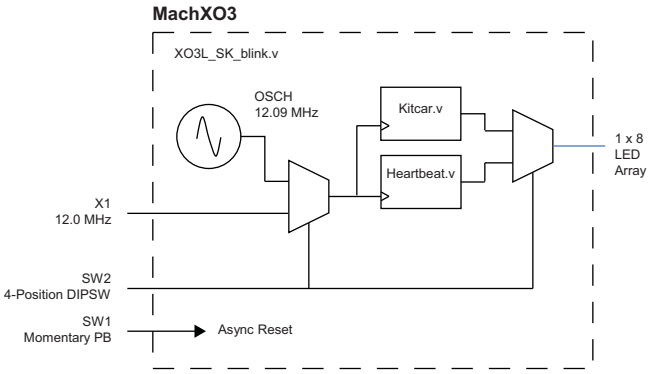


Table 1. DIP Switch Setting and LED Behavior

Switch	Setting	LED Behavior
DIP_SW[1]	0 (Down)	External 12.0 MHz (X1)
	1 (Up)	Internal 12.09 MHz (OSCH)
DIP_SW[2:4]	001	1 Hz Sweep
	011	1 Hz Left-Right
	111	1 Hz Blink
	Others	1 Hz Alternating

WARNING: Do not connect the board to your PC before you follow the driver installation procedure of this section.

Communication between the board and a PC via the USB connection cable requires installation of the FTDI chip USB hardware drivers. Loading these drivers enables the computer to recognize and program the board. Drivers can be loaded as part of the installation of Lattice Diamond design software or Diamond Programmer, or as a stand-alone package.

To load the FTDI Chip USB hardware drivers as part of the Lattice Diamond installation:

1. Select **Programmer Drivers** in the Product Options of Lattice Diamond Setup.
2. Select **FTDI Windows USB Driver** or **All Drivers** in the LSC Drivers Install/Uninstall dialog box.
3. Click **Finish** to install the USB driver.
4. After the driver installation is complete, connect the USB cable from a USB port on your PC to the board's USB mini-B socket (J2). After the connection is made, a blue Power LED (D1) will light indicating the board is powered on.
5. The demonstration design will automatically load and drive the LED array in a repeating pattern.

To load the FTDI chip USB hardware drivers via the stand-alone package on a Windows system:

1. Browse to www.latticesemi.com/breakoutboards and download the FTDI Chip USB Hardware Drivers package.
2. Extract the FTDI chip USB Hardware driver package to your PC hard drive.
3. Connect the USB cable from a USB port on your PC to the board's USB mini-B socket (J2). After the connection is made, a blue Power LED (D1) will light indicating the board is powered on.
4. 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**.
5. Search for the best driver in these locations and click the **Browse** button to browse to the Windows driver folder created in the Download Windows USB Hardware Drivers section. Select the **CDM 2.04.06 WHQL Certified** folder and click **OK**.
6. Click **Next**. A screen will display as Windows copies the required driver files. Windows will display a message indicating that the installation was successful.
7. Click **Finish** to install the USB driver.
8. The demonstration design will automatically load and drive the LED array in a repeating pattern.

See the Troubleshooting section of this guide if the board does not function as expected.

Download Demo Designs

The counter demo is preprogrammed into the board, however over time it is likely your board will be modified. Lattice distributes source and programming files for demonstration designs compatible with the Starter Kit. The demo design for the board is available on the web.

To download demo designs:

1. Browse to the Lattice Development Kits and Boards web page (www.latticesemi.com/breakoutboards) of the Lattice web site. Select **MachXO3L Starter Kit Demo Source** or the **MachXO3LF Starter Kit Demo Source** and save the file.
2. Extract the contents of MachXO3L_Starter_Kit.zip or the MachXO3LF_Starter_Kit.zip to an accessible location on your hard drive.
3. Open the Blink.ldf project file in the Lattice Diamond design software.
4. Run the Process Flow and regenerate the Bitstream file.

Continue to Programming a Demo Design with the Lattice Diamond Programmer.

Programming a Demo Design with the Lattice Diamond Programmer

The demonstration design is pre-programmed into the MachXO3 board by Lattice. If you have changed the design but now want to restore the board to factory settings, use the procedure described below.

To program the MachXO3 device:

1. Install, license and run Lattice Diamond software. See www.latticesemi.com/latticediamond for download and licensing information.
2. Connect the USB cable to the host PC and the MachXO3 board.
3. From Diamond, open the Blink.ldf project file.
4. Click the **Programmer** icon.
5. Click **Detect Cable**. The Programmer will detect the cable (Cable: USB2, Port: FTUSB-0). If the cable is not detected, see the Troubleshooting section.
6. Click **Device Properties**.
7. Change Access Mode to **SPI Flash Programming**.
8. Choose **SPI Flash Background Erase, Program, Verify** operation.
9. Select **Blink_impl1.bit** programming file.
10. Under SPI Flash Options, change Vendor to **SPANSION** and change Device to **SPI-S25FL004D** or **SPI-S25FL204K**. Click **OK**.
11. Click the **Program** icon. When complete, **PASS** is displayed in the Status column.
12. Change Access mode to **NVCM Programming Mode** and **NVCM Refresh**, then click **Program** (or power-cycle the Starter Kit board) to initiate a re-boot from the SPI flash.

MachXO3 Starter Kit

This section describes the features of the MachXO3 Starter Kit in detail.

Overview

The Starter Kit is a complete development platform for the MachXO3 FPGA. The board includes a prototyping area, a USB program/power port, an LED array, switches, and header landings with electrical connections to most of the FPGA's programmable I/O, power, and configuration pins. The board is powered by the PC's USB port or optionally with external power. You may create or modify the program files and reprogram the board using Lattice Diamond software.

Figure 4. MachXO3L/LF-6900C Block Diagram

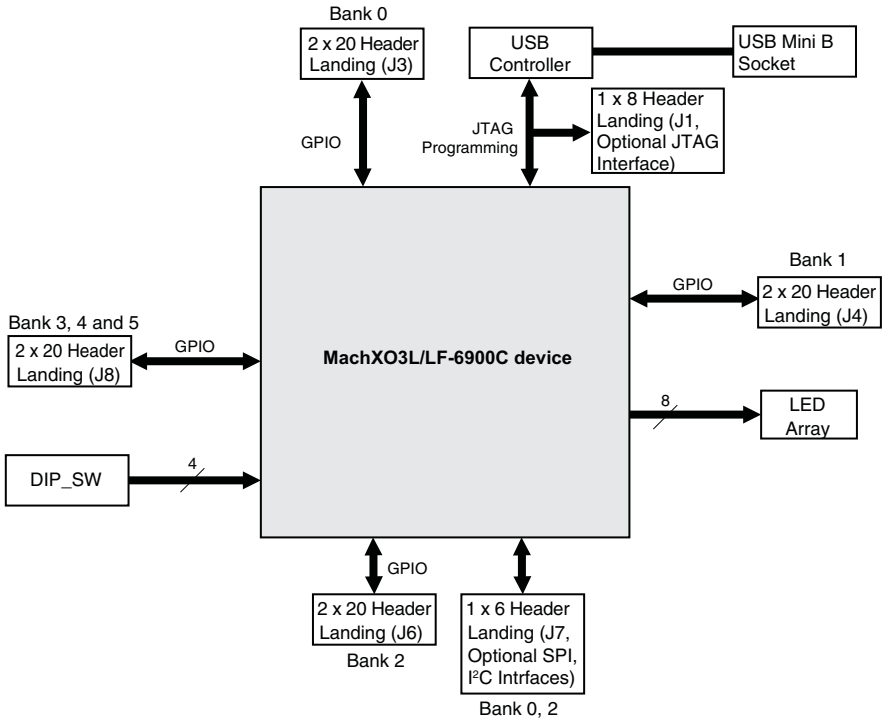


Table 2 describes the components on the board and the interfaces it supports.

Table 2. Starter Kit Components and Interfaces

Component/Interface	Type	Schematic Reference	Description
Circuits			
USB Controller	Circuit	U1: FT2232H	USB-to-JTAG interface and dual USB UART/FIFO IC
USB Mini-B Socket	I/O	J2:USB_MINI_B	Programming and debug interface
Components			
LCMXO3L or LCMXO3LF	FPGA	U5: LCMXO3L-6900C-5BG256C or LCMXO3LF-6900C-5BG256C	6900-LUT device packaged in a 14 mm x14 mm, 256-ball caBGA
Interfaces			
LED Array	Output	D9-D2	Red LEDs
Push Button Switch	Input	SW1	Momentary User Input
4-position DIP Switch	Input	SW2	User inputs
Four 2 x 20 Header Landings	I/O	J3: header_2x20 J4: header_2x20 J6: header_2x20 J8: header_2x20	User-definable I/O
1 x 8 Header Landing	I/O	J1: header_1x8	Optional JTAG interface
1 x 6 Header Landing	I/O	J7: header_1x6	Optional SPI/I^2C interfaces
4 x 10 40-Hole Prototype Area			Prototype area 100 mil centered holes.
Test Points	Power	TP1: +3.3 V TP2: +1.2 V TP3: GND	Power and ground reference points

Subsystems

This section describes the principle sub systems for the Starter Kit in alphabetical order.

Clock Sources

Clock sources for the LED demonstration designs originate from the MachXO3 on-chip oscillator or the 12 MHz crystal X1. You may use an expansion header landing to drive a FPGA input with an external clock source.

Expansion Header Landings

The expansion header landings provide access to user GPIOs, primary inputs, clocks, and VCCO pins of the MachXO3. The remaining pins serve as power supplies for external connections. Each landing is configured as one 2 x 20 100 mil.

Table 3. Expansion Connector Reference

Item	Description
Reference Designators	J3, J4, J6, J8
Part Number	header_2x20

Table 4. Expansion Header Pin Information (J3)

Header Pin Number	–6900C Function	MachXO3 Ball
1	VCCIO0	D5,D12,G8,G9
2	VCCIO0	D5,D12,G8,G9
3	PT36C/INITn	A13
4	PT36D/DONE	C13
5	PT22A	F8
6	PT35B	B12
7	PT35A	C12
8	PT26B	E11
9	PT27B	E10
10	PT27A	D10
11	GND	—
12	GND	—
13	PT26A	F9
14	PT27C/JTAGENB	C10
15	PT17B	E8
16	PT21B	E9
17	PT14B	E7
18	PT21A	D8
19	PT16B	D7
20	PT15B	C7
21	GND	—
22	GND	—
23	PT10B	C5
24	PT14A	D6
25	PT16A	E6
26	PT9A	C4
27	PT25B	A10
28	PT17A	F7
29	PT22B	D9
30	PT25A	B9
31	GND	—
32	GND	—
33	PT11B	B6
34	PT15A	B7
35	PT9B	B5
36	PT11A	A5
37	PT12B	B4
38	PT10A	A4
39	GND	—
40	PT12A	A3

Table 5. Expansion Header Pin Information (J4)

Header Pin Number	–6900C Function	MachXO3 Ball
1	VCCIO1	E13,H10,J10,M13
2	VCCIO1	E13,H10,J10,M13
3	PR19D	K12
4	PR19C	K13
5	PR23A	M14
6	PR24B	N14
7	PR18B	L14
8	PR24A	N16
9	PR23B	M15
10	PR21B	M16
11	GND	—
12	GND	—
13	PR21A	L15
14	PR18A	L16
15	PR17A	K14
16	PR16B	K16
17	PR17B	K15
18	PR15B	J14
19	PR12A/PCLKT1_0	H14
20	PR16A	J15
21	GND	—
22	GND	—
23	PR15A	J16
24	PR11B	H15
25	PR12B/PCLKC1_0	H16
26	PR9A	G15
27	PR11A	G16
28	PR5B	F15
29	PR7B	F16
30	PR2B/R_GPLLC_FB	E15
31	GND	—
32	GND	—
33	PR5A	E16
34	PR3B/R_GPLLC_IN	E14
35	PR3A/R_GPLLT_IN	D16
36	PR2C	C15
37	PR2A/R_GPLLT_FB	D14
38	PR7A	F14
39	PR9B	G14
40	PR2D	B16

Table 6. Expansion Header Pin Information (J6)

Header Pin Number	–6900C Function	MachXO3 Ball
1	VCCIO2	K8,K9,N5,N12
2	VCCIO2	K8,K9,N5,N12
3	PB35B	T12
4	PB34B	T14
5	PB35A	R11
6	PB34A	R13
7	PB31A	T11
8	PB28B	M11
9	PB31B	P11
10	PB28A	N10
11	GND	—
12	GND	—
13	PB26B	T10
14	PB29A	P10
15	PB26A	R9
16	PB29B	R10
17	PB23A/PCLKT2_1	T9
18	PB21B	N9
19	PB23B/PCLKC2_1	P9
20	PB21A	M8
21	GND	—
22	GND	—
23	PB18B	T8
24	PB15B	L8
25	PB18A	P8
26	PB15A	M6
27	PB13A	R7
28	PB16B/PCLKC2_0	R8
29	PB13B	P7
30	PB16A/PCLKT2_0	T7
31	GND	—
32	GND	—
33	PB10B	L7
34	PB9B	R6
35	PB10A	N6
36	PB9A	T5
37	PB7B	R4
38	PB4A	P4
39	PB7A	T3
40	PB4B	T4

Table 7. Expansion Header Pin Information (J8)

Header Pin Number	–6900C Function	MachXO3 Ball
1	VCCIO5	E4
2	VCCIO3	M4
3	PL9D	H6
4	PL25B	N3
5	PL25A	M2
6	PL22B/PCLKC3_0	M1
7	PL22A/PCLKT3_0	L2
8	PL19A	L1
9	PL19B	L3
10	PL19D	L5
11	GND	—
12	GND	—
13	PL19C	K4
14	PL12A/PCLKT4_0	J1
15	PL15B	K1
16	PL15A	J2
17	PL12B/PCLKC4_0	J3
18	PL11A	H3
19	PL10B	H2
20	PL11B	H1
21	GND	—
22	GND	—
23	PL9A	G2
24	PL10A	G1
25	PL6B/PCLKC5_0	F2
26	PL8B	F1
27	PL4A/L_GPLLT_IN	E2
28	PL6A/PCLKT5_0	E1
29	PL4D	D2
30	PL3B/L_GPLLC_FB	D1
31	GND	—
32	PL2D	C2
33	PL4C	C1
34	PL9B	G3
35	PL2C	B1
36	PL3A/L_GPLLT_FB	D3
37	PL4B/L_GPLLC_IN	E3
38	PL8A	F3
39	PL9C	F5
40	VCCIO4	H7,J7

Figure 5. J3/J4 Header Landing Callout

J3

1	2
VCCIO0	VCCIO0
A13	C13
F8	B12
C12	E11
E10	D10
GND	GND
F9	C10
E8	E9
E7	D8
D7	C7
GND	GND
C5	D6
E6	C4
A10	F7
D9	B9
GND	GND
B6	B7
B5	A5
B4	A4
GND	A3
39	40

J4

1	2
VCCIO1	VCCIO1
K12	K13
M14	N14
L14	N16
M15	M16
GND	GND
L15	L16
K14	K16
K15	J14
H14	J15
GND	GND
J16	H15
H16	G15
G16	F15
F16	E15
GND	GND
E16	E14
D16	C15
D14	F14
G14	B16
39	40

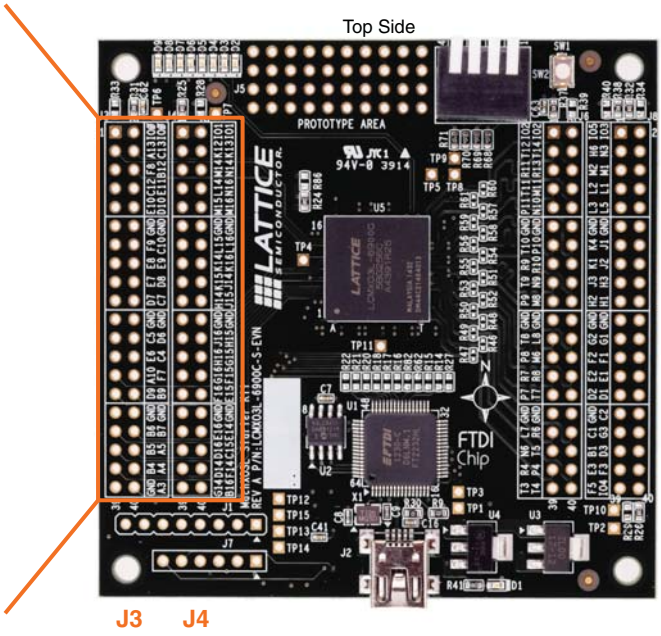
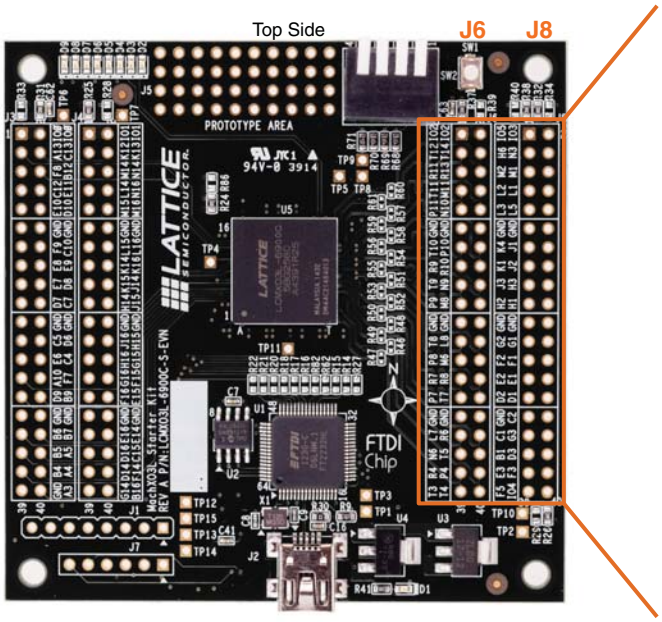


Figure 6. J6/J8 Header Landing Callout



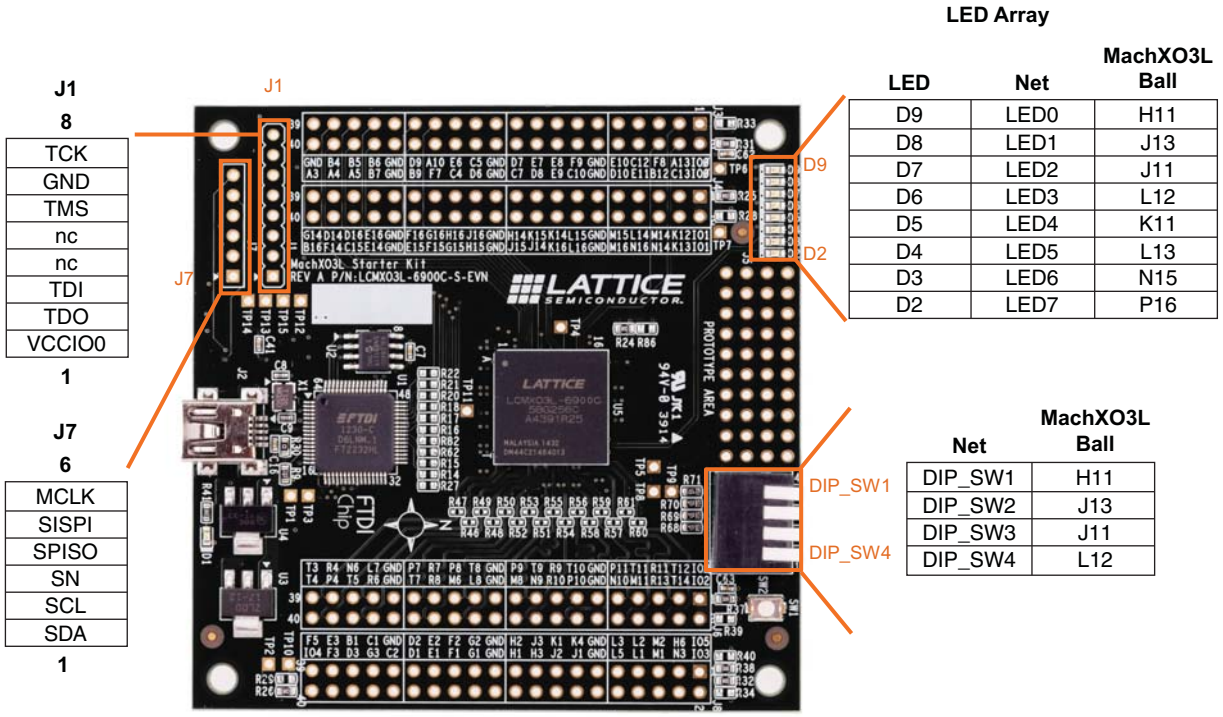
J6

1	2
VCCIO2	VCCIO2
T12	T14
R11	R13
T11	M11
P11	N10
GND	GND
T10	P10
R9	R10
T9	N9
P9	M8
GND	GND
T8	L8
P8	M6
R7	R8
P7	T7
GND	GND
L7	R6
N6	T5
R4	P4
T3	T4
39	40

J8

1	2
VCCIO5	VCCIO3
H6	N3
M2	M1
L2	L1
L3	L5
GND	GND
K4	J1
K1	J2
J3	H3
H2	H1
GND	GND
G2	G1
F2	F1
E2	E1
D2	D1
GND	C2
C1	G3
B1	D3
E3	F3
F5	VCCIO4
39	40

Figure 7. J1 Header Landing and LED Array Callout



MachXO3 FPGA

The LCMXO3L/LF-6900C-5BG256C is a 256-ball caBGA package FPGA device which provides up to 206 usable I/Os in a 14 mm x 14 mm package. 150 I/Os are accessible from the board headers, switches and LEDs.

Table 8. MachXO3 FPGA Interface Reference

Item	Description
Reference Designators	U5
Part Number	LCMXO3L-6900C-5BG256C (NVCM) or LCMXO3LF-6900C-5BG256C (Flash)
Manufacturer	Lattice Semiconductor
Web Site	www.latticesemi.com

Programming Interface Circuits

For power and programming an FTDI USB UART/FIFO IC converter provides a communication interface between a PC host and the JTAG programming chain of the Starter Kit. The USB 5 V supply is also used as a source for the 3.3 V supply rail. A USB mini-B socket is provided for the USB connector cable.

Table 9. USB/JTAG Interface Reference

Item	Description
Reference Designators	U1
Part Number	FT2232HL
Manufacturer	Future Technology Devices International (FTDI)
Web Site	www.ftdichip.com

Table 10. JTAG Programming Pin Information

Description	MachXO3 Pin
Test Data Output	C6:TDO
Test Data Input	A6:TDI
Test Mode Select	B8:TMS
Test Clock	A7:TCK

Table 11. SPI Programming Pin Information

Description	MachXO3 Pin
Master Clock/Config Clock	P6:MCLK/CCLK
Serial Data Input	P13: SI/SISPI
Serial Data Output	T6: SO/SPISO
SPI Slave Select	R12: SN

Table 12. I²C Programming Pin Information

Description	MachXO3 Pin
Serial Data	C9:SDA
Serial Clock	A9:SCL

LEDs

A blue LED (D1) is used to indicate USB 5V power. Eight red LEDs are driven by I/O pins of the MachXO3 device.

Table 13. Power and User LEDs Reference

Item	Description
Reference Designators	Red LEDs (D2, D3, D4, D5, D6, D7, D8, D9) Blue LEDs (D1)
Part Number	LTST-C190KRKT (D2-D9) LTST-C190TBKT (D1)
Manufacturer	Lite-On It Corporation
Web Site	www.liteonit.com

Power Supply

3.3 V and 1.2 V power supply rails are converted from the USB 5 V interface when the board is connected to a host PC.

Test Points

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

- TP1: +3.3 V
- TP2: +1.2 V
- TP3: GND

USB Programming and Debug Interface

The USB mini-B socket of the Starter Kit serves as the programming and debug interface.

JTAG Programming: For JTAG programming, a preprogrammed USB PHY peripheral controller is provided on the Starter Kit to serve as the programming interface to the MachXO3 FPGA.

Programming requires the Lattice Diamond or ispVM System software.

Table 14. USB Interface Reference

Item	Description
Reference Designators	U1
Part Number	FT2232HL
Manufacturer	Future Technology Devices International (FTDI)
Web Site	www.ftdichip.com

Board Modifications

This section describes modifications to the board to change or add functionality.

Bypassing the USB Programming Interface

The USB programming interface circuit (USB Programming and Debug Interface section) may be optionally bypassed by removing the 0 Ohm resistors: R4, R5, R6, R7 (See Appendix A. Schematics, Sheet 2 of 8). Header landing J1 provides JTAG signal access for jumper wires or a 1 x 8 pin header.

Applying External Power

The Starter Kit is powered by the circuit of Schematic Sheet 3 of 8 based on the 5 V USB power source. You may disconnect this power source by removing the 0 Ohm resistors: R35 (VCC_1.2 V) and R42 (VCC_3.3 V). Power connections are available from the test points, TP1 (+3.3 V) and TP2 (+1.2 V).

Measuring Bank and Core Power

Test points (TP1, TP2) provide access to power supplies of the MachXO3 FPGA. Inline 1 Ohm resistors: R31 (VCCIO0, +3.3 V, Bank 0), R25 (VCCIO1, +3.3 V, Bank 1), R37 (VCCIO2, +3.3 V, Bank 2), R32 (VCCIO3, +3.3 V, Bank 3), R26 (VCCIO4, +3.3 V, Bank 4), R38 (VCCIO5, +3.3 V, Bank 5), R24 (VCC core, +1.2 V) can be used to measure current for the power supplies.

Mechanical Specifications

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

Environmental Requirements

The evaluation board must be stored between –40° C and 100° C. The recommended operating temperature is between 0° C and 90° C.

The board can be damaged without proper anti-static handling.

Glossary

FPGA: Field Programmable Gate Array

DIP: Dual in-line package

LED: Light Emitting Diode.

LUT: Look Up Table

PCB: Printed Circuit Board

RoHS: Restriction of Hazardous Substances Directive

USB: Universal Serial Bus

WDT: Watchdog Timer

Troubleshooting

Use the tips in this section to diagnose problems with the Starter Kit.

LEDs Do Not Flash

If power is applied but the board does not flash according to the preprogrammed counter demonstration then it is likely the board has been reprogrammed with a new design. Follow the directions in the Demonstration Design section to restore the factory default.

USB Cable Not Detected

If Lattice Diamond Programmer or ispVM System does not recognize the USB cable after installing the Lattice USB port drivers and rebooting, the incorrect USB driver may have been installed. This usually occurs if you attach the board to your PC prior to installing the Lattice-supplied USB driver.

To access the *Troubleshooting the USB Driver Installation Guide*:

For Diamond software and standalone Diamond Programmer:

1. Start Diamond or Diamond Programmer and choose **Help**.
2. Search for **USB driver** or **Troubleshooting**, then select the **Troubleshooting the USB Driver** topic.
3. Follow the directions to install the Lattice USB driver.

For ispVM:

1. Start ispVM System and choose **Options > Cable and I/O Port Setup**.
   The Cable and I/O Port Setup Dialog appears.
2. Click the **Troubleshooting the USB Driver Installation Guide** link.
   The *Troubleshooting the USB Driver Installation Guide* document appears in your system's PDF file reader.
3. Follow the directions to install the Lattice USB driver.

Determine the Source of a Pre-Programmed Device

If the Starter Kit has been reprogrammed, the original demo design can be restored. To restore the board to the factory default, see the Download Demo Designs section for details on downloading and reprogramming the device.

Ordering Information

Description	Ordering Part Number	China RoHS Environment-Friendly Use Period (EFUP)
MachXO3L Starter Kit	LCMXO3L-6900C-S-EVN	
MachXO3LF Starter Kit	LCMXO3LF-6900C-S-EVN	

Technical Support Assistance

Submit a technical support case via www.latticesemi.com/techsupport.

Revision History

Date	Version	Change Summary
May 2015	1.1	Changed document title to MachXO3 Starter Kit User Guide
		Changed instances of MachXO3L to MachXO3.
		Indicated MachXO3L and/or MachXO3LF devices and board versions.
		Indicated MachXO3 NVCM and/or Flash based devices.
		Updated Technical Support Assistance section.
November 2014	1.0	Initial release.

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Appendix A. Schematics

Figure 8. Block Diagram

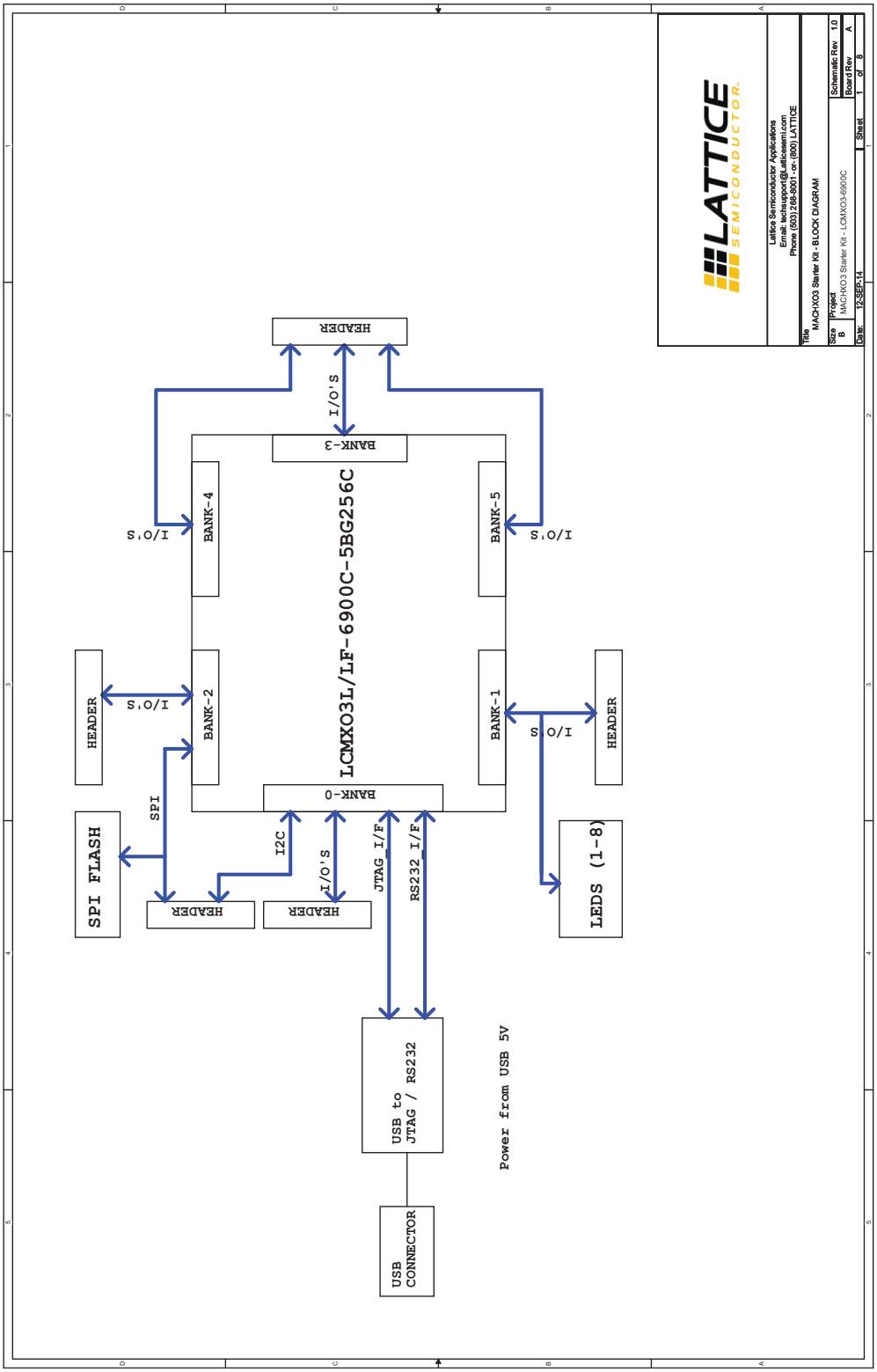


Figure 9. USB Interface to JTAG

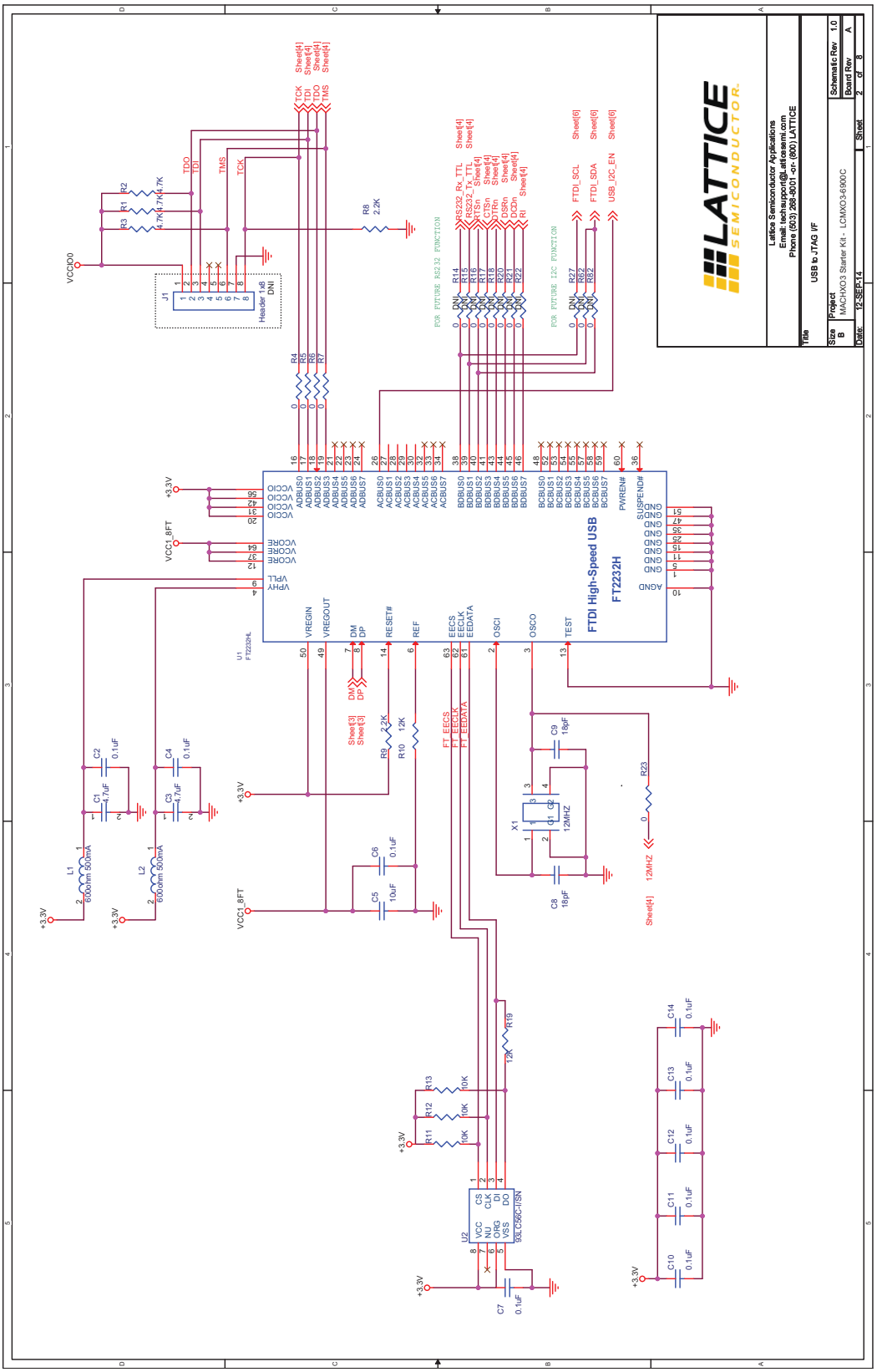


Figure 10. FPGA

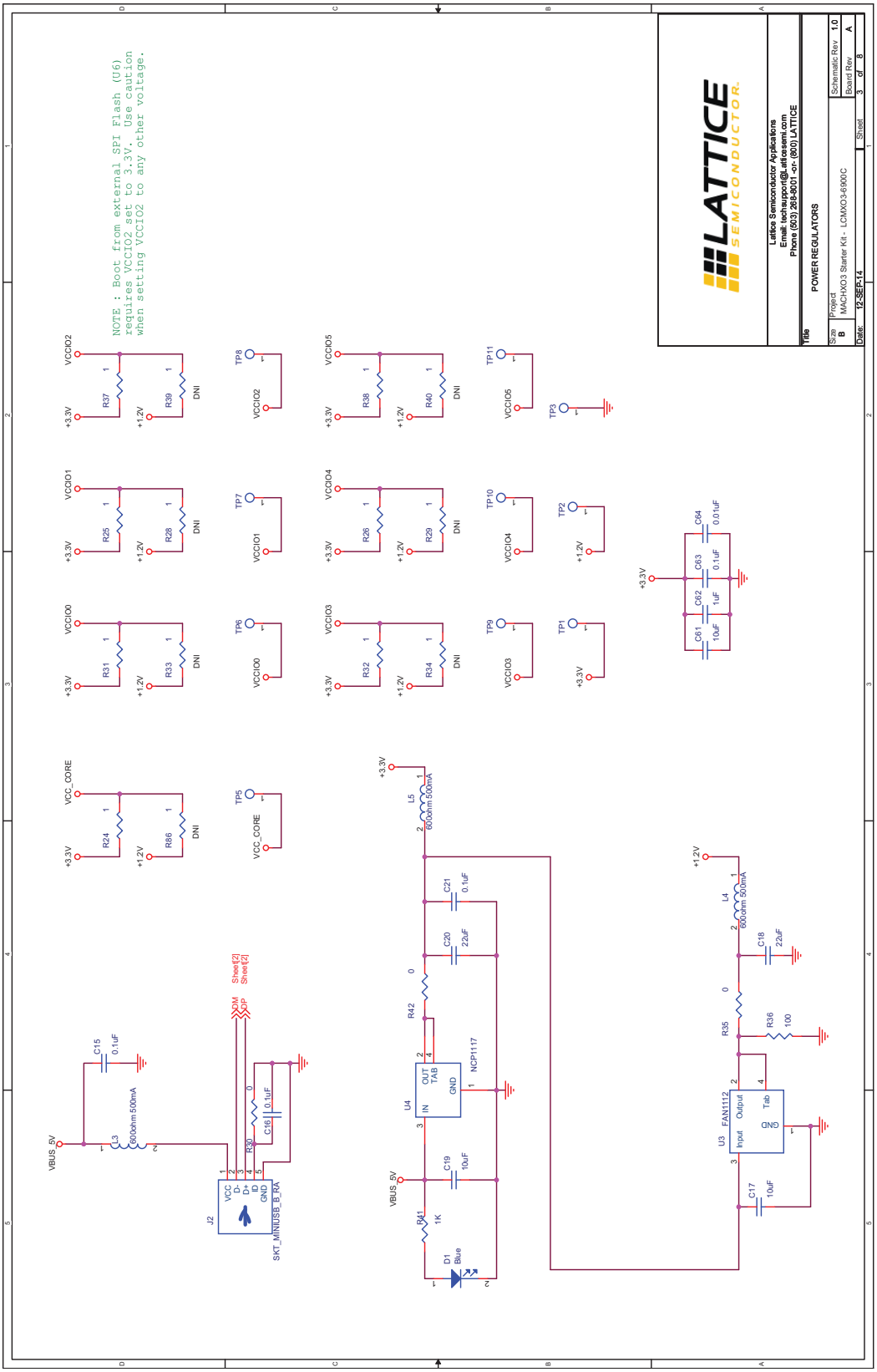


Figure 11. FPGA

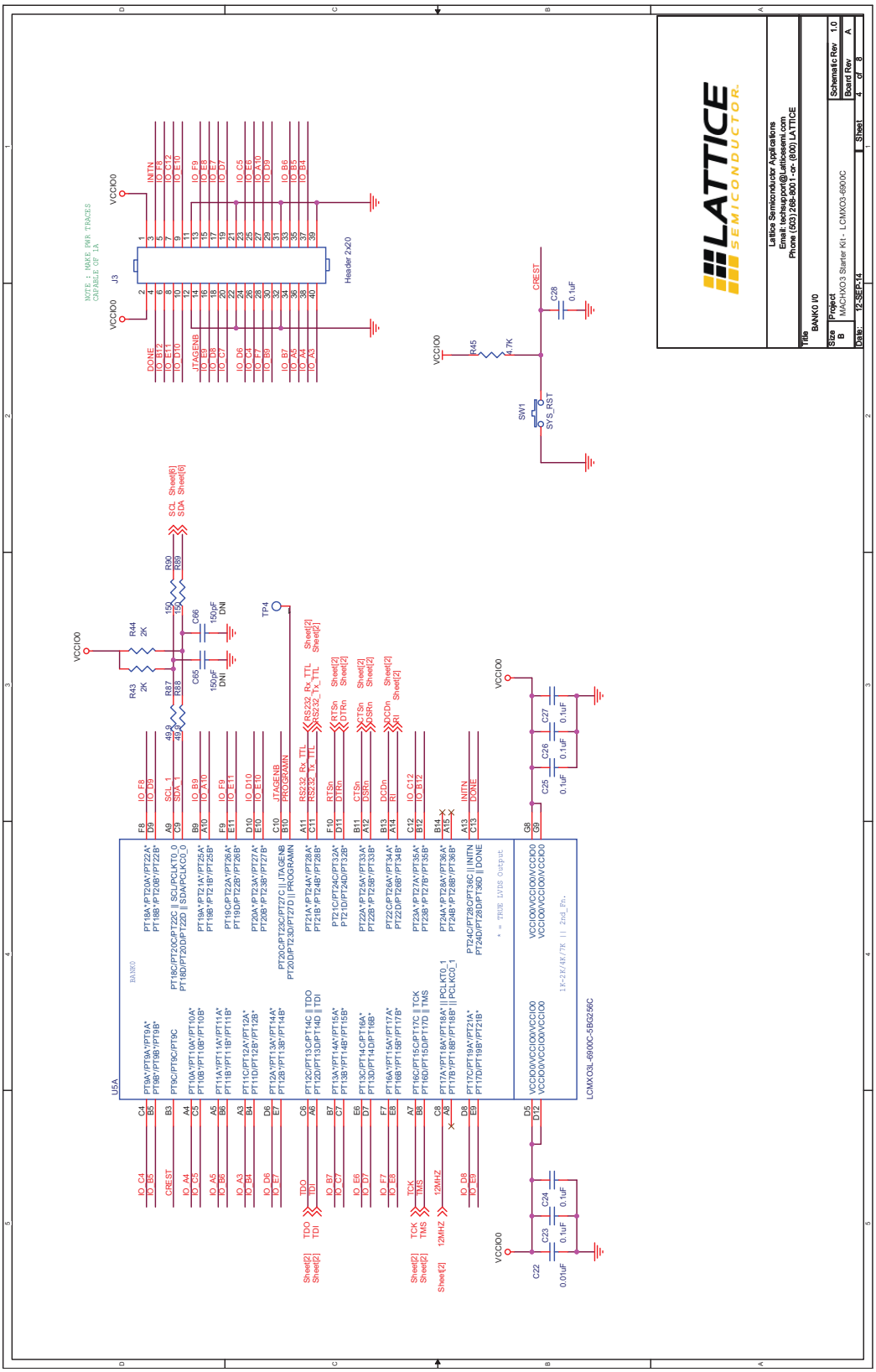


Figure 12. Power LEDs

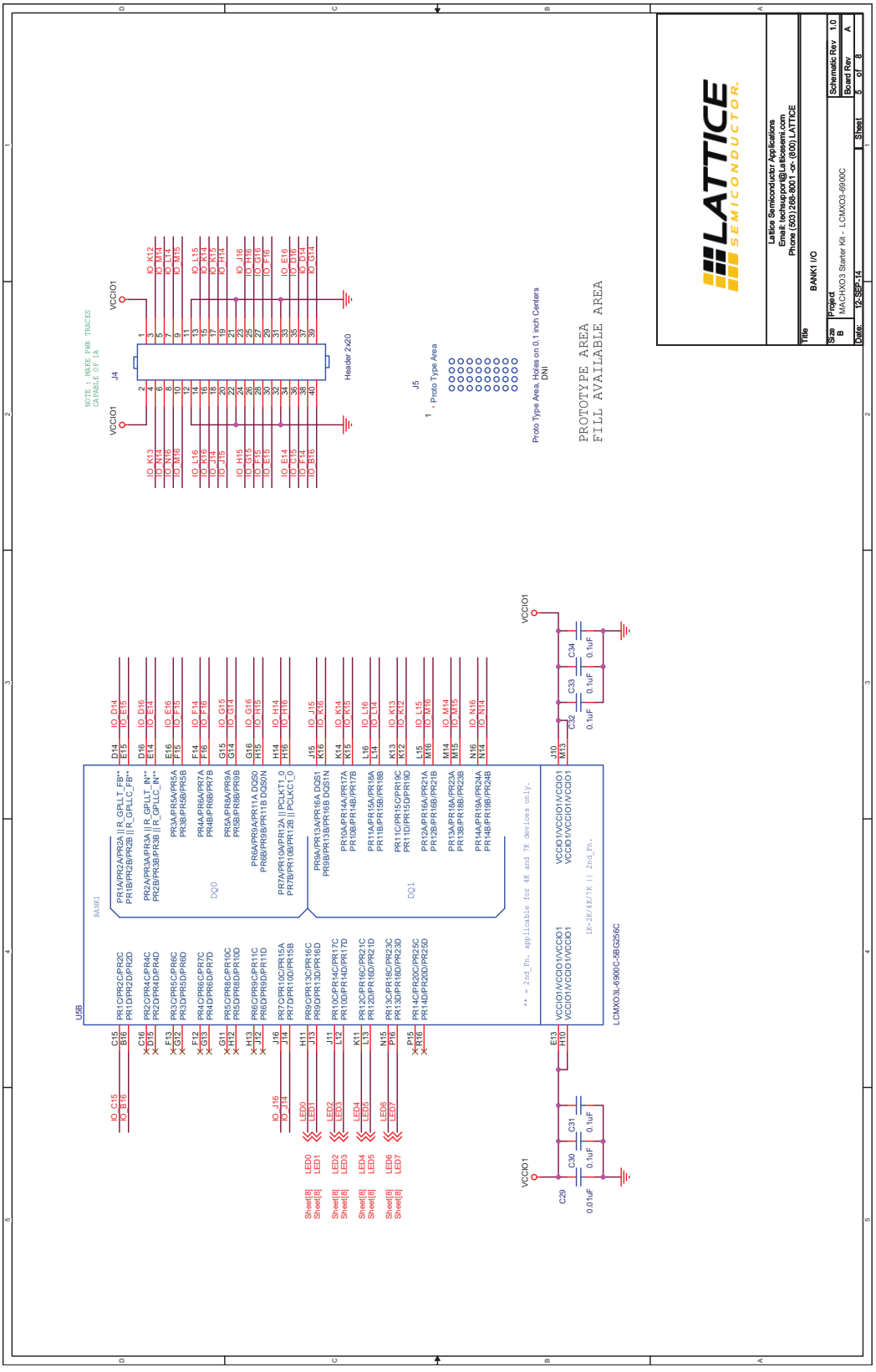


Figure 13. Bank 2 I/O

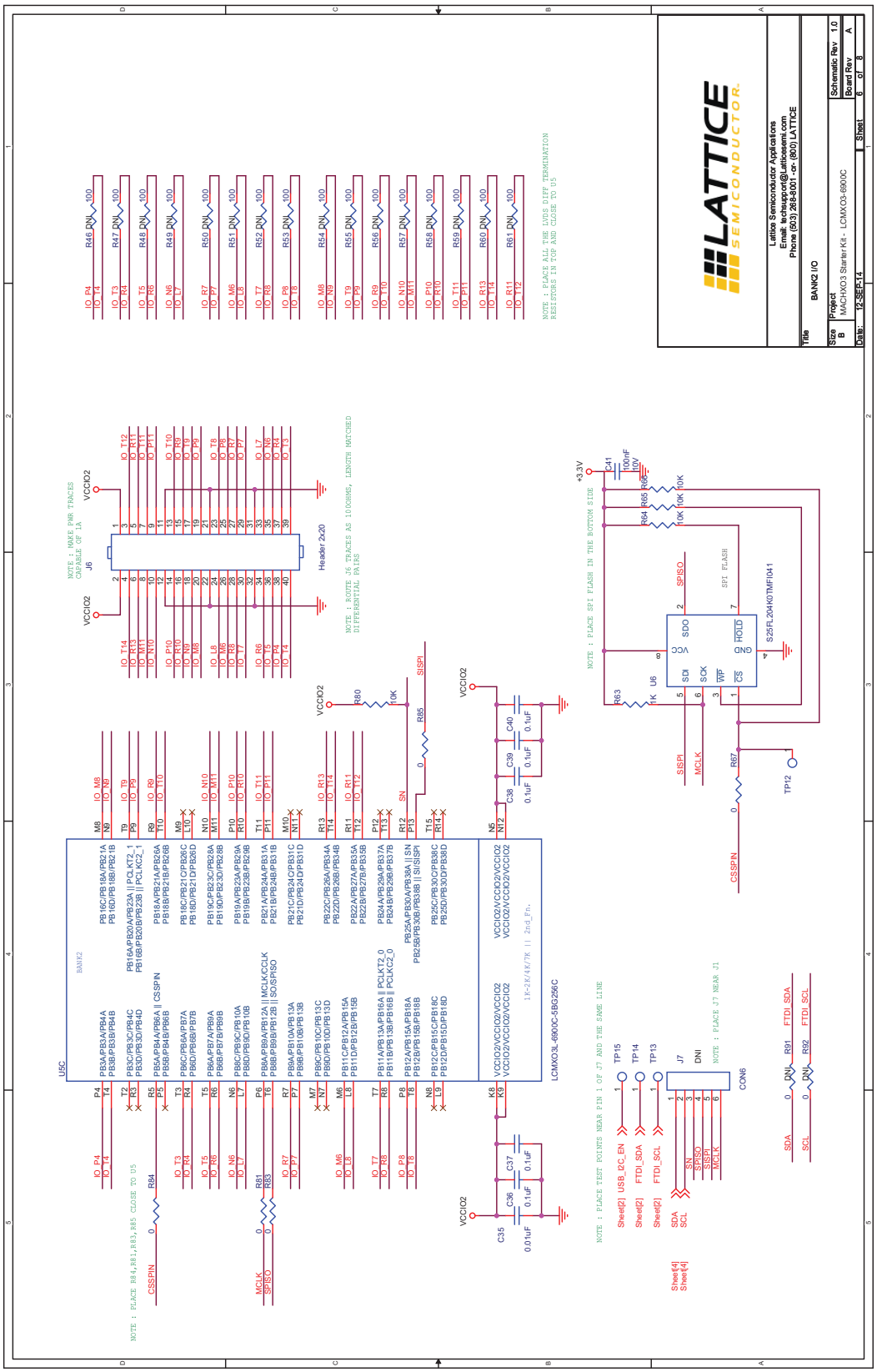


Figure 14. Bank 3, 4, 5 I/O

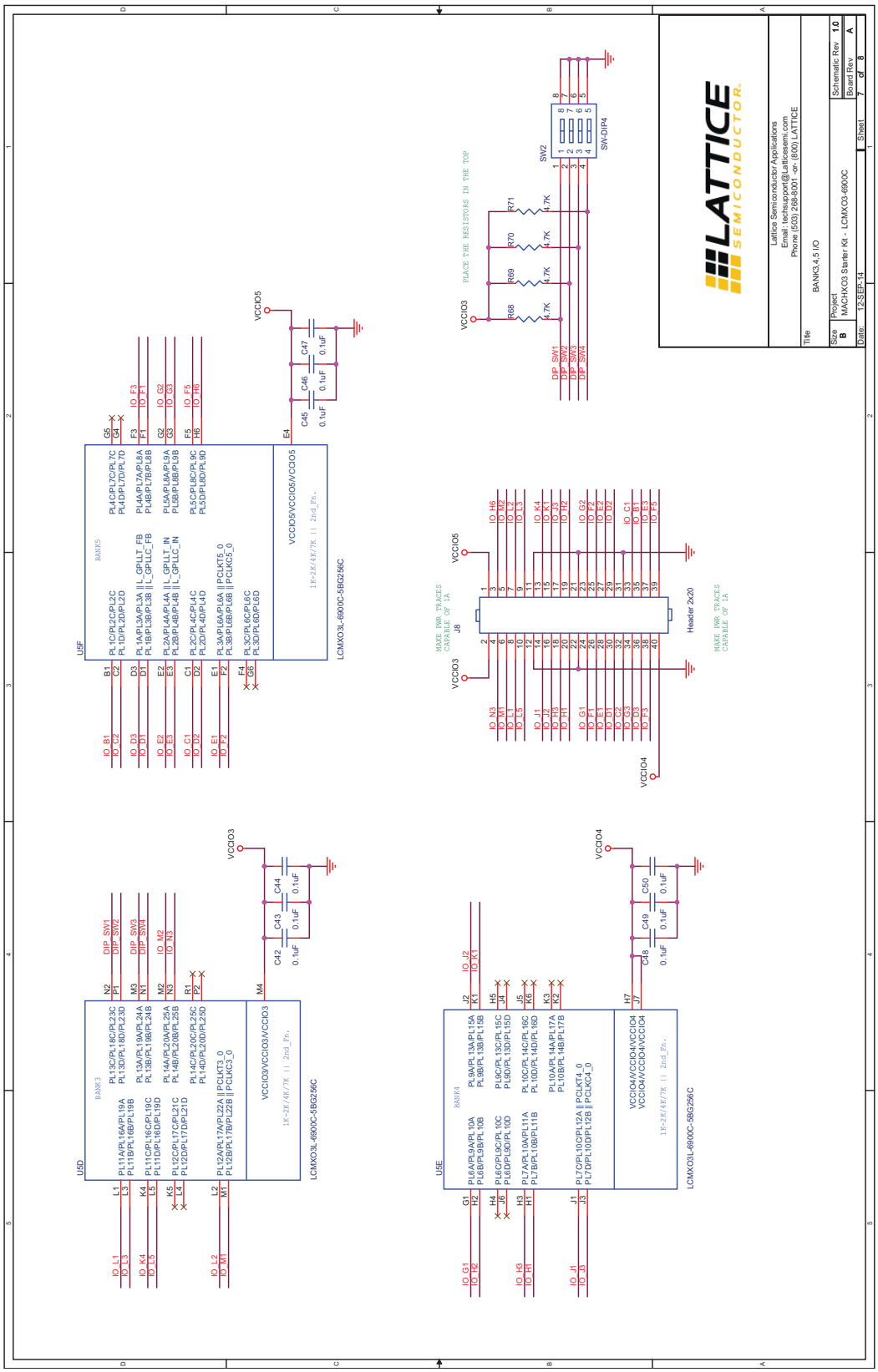
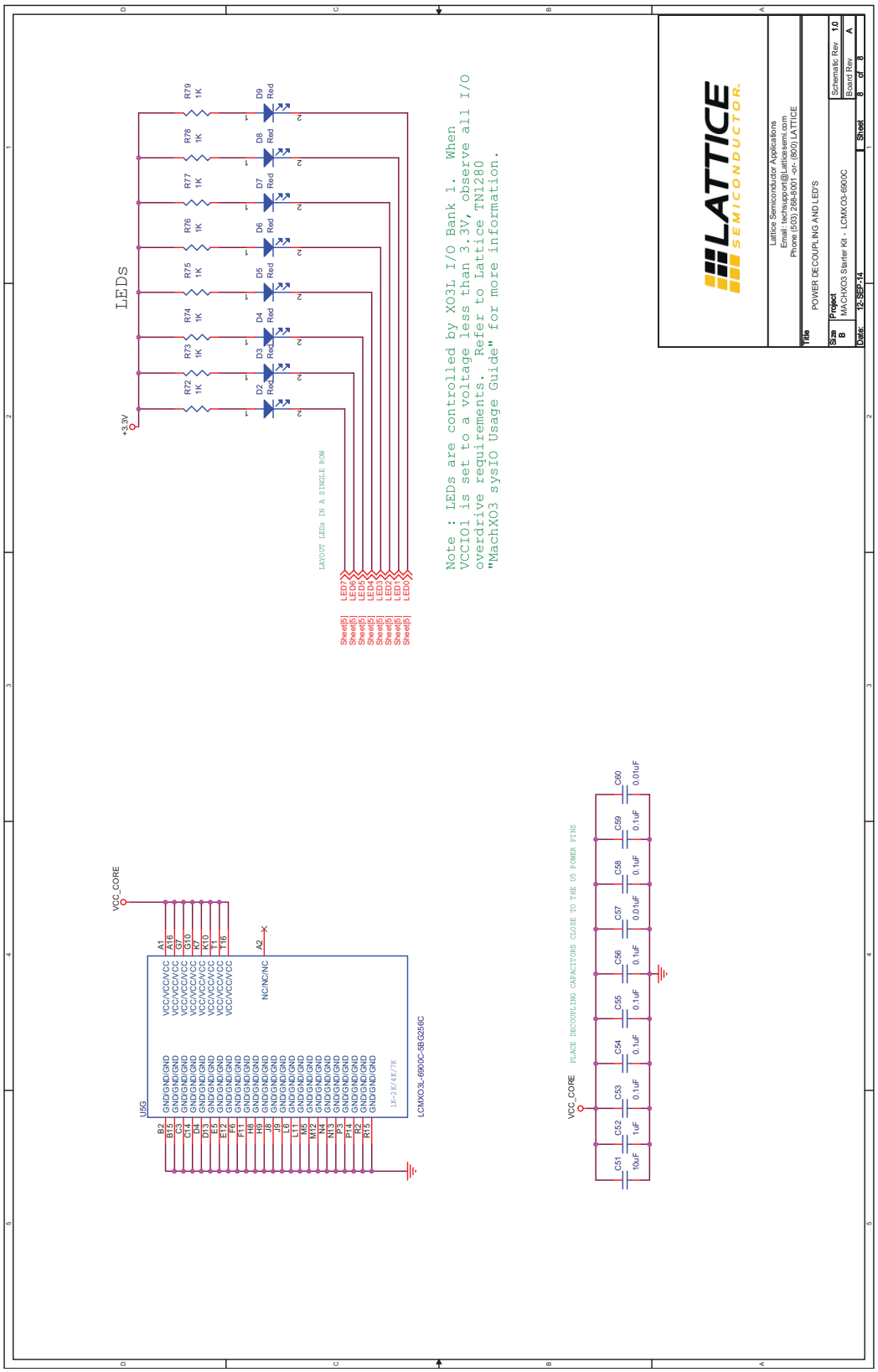


Figure 15. Power Decoupling and LEDs



Appendix B. Bill of Materials

Table 15. MachXO3 Starter Kit Bill of Materials

Item	Quantity	Reference	Value	Manufacturer	MFG Pin
1	2	C1,C3	4.7 uF	Panasonic	ECJ-1VB0J475K
2	44	C2,C4,C6,C7,C10,C11,C12,C13,C14,C15,C16,C21,C23,C24,C25,C26,C27,C28,C30,C31,C32,C33,C34,C36,C37,C38,C39,C40,C42,C43,C44,C45,C46,C47,C48,C49,C50,C53,C54,C55,C56,C58,C59,C63	0.1 uF	Kemet	C0402C104K4RACTU
3	5	C5,C17,C19,C51,C61	10 uF	Taiyo Yuden	LMK107BJ106MALTD
4	2	C8,C9	18 pF	Kemet	C0402C180K3GACTU
5	2	C18,C20	22 uF	Taiyo Yuden	LMK212BJ226MG-T
6	6	C22,C29,C35,C57,C60,C64	0.01 uF	Kemet	C0402C103J4RACTU
7	1	C41	100 nF	Murata	GRM155R61A104KA01D
8	2	C52,C62	1 uF	Kemet	C0402C105K9PACTU
9	2	C65,C66	150 pF	Kemet	C0402C104K4RACTU
10	1	D1	Blue	LITE-On INC	LTST-C190TBKT
11	8	D2,D3,D4,D5,D6,D7,D8,D9	Red	LITE-On INC	LTST-C190KRKT
12	1	J1	Header 1 x 8	Molex	0022284081
13	1	J2	Mini USB-B	Neltron	5075BMR-05-SM-CR
14	4	J3,J4,J6,J8	Header 2 x 20	Samtec	TSW-120-07-G-D
16	1	J7	Header 1 x 6	Samtec	TSW-106-07-F-S-ND
17	5	L1,L2,L3,L4,L5	600 Ohm 500 mA	Murata	BLM18AG601SN1D
18	8	R1,R2,R3,R45,R68,R69,R70,R71	4.7 K	Vishay	CRCW06034K70FKEA
19	13	R4,R5,R6,R7,R23,R30,R35,R42,R67,R81,R83, R84,R85	0	Yageo	RC0603JR-070RL
20	2	R8,R9	2.2 K	Vishay	CRCW06032K20FKEA
21	2	R10,R19	12 K	Yageo	RC0603FR-0712KL
22	7	R11,R12,R13,R64,R65,R66,R80	10 K	Stackpole Electronics Inc	RMCF0603JT10K0
23	13	R14,R15,R16,R17,R18,R20,R21,R22,R27,R62, R82,R91,R92	0	Yageo	RC0603JR-070RL
24	7	R24,R25,R26,R31,R32,R37,R38	1	Vishay	CRCW06031R00JNEAHP
25	7	R28,R29,R33,R34,R39,R40,R86	1	Vishay	CRCW06031R00JNEAHP
26	1	R36	100	Yageo	RC0603FR-07100RL
27	10	R41,R63,R72,R73,R74,R75,R76,R77,R78,R79	1 K	Yageo	RC0603FR-071KL
28	2	R43,R44	2 K	Vishay	CRCW06032K00JNEA
29	16	R46,R47,R48,R49,R50,R51,R52,R53,R54,R55,R56,R57,R58,R59,R60, R61	100	Yageo	RC0402FR07100RL
30	2	R87,R88	49.9	Vishay	CRCW060349R9FKEA
31	2	R89,R90	150	Vishay	CRCW0603150RJNEA
32	1	SW1		E-Switch	TL1015AF160QG
33	1	SW2	DIP	CTS Electrocomponents	195-4MST
35	1	U1		FTDI	FT2232HL
36	1	U2		Microchip	93LC56C-I/SN
37	1	U3		Fairchild Semi	FAN1112SX

Table 15. MachXO3 Starter Kit Bill of Materials (Continued)

Item	Quantity	Reference	Value	Manufacturer	MFG Pin
38	1	U4		On Semi	NCP1117ST33T3G
39	1	U5		Lattice Semiconductor	LCMXO3L-6900C-5BG256C or LCMXO3LF-6900C-5BG256C
40	1	U6		Spansion	S25FL204K0TMFI041
41	1	X1	12 MHz	TXC	7M-12.000MAAJ-T

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