# CrossLinkPlus LIF-MDF6000 Master Link Board - Revision B

# Evaluation Board User Guide

FPGA-EB-02041-1.1

August 2021

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# Acronyms in This Document

A list of acronyms used in this document.

| Acronym | Definition |
|---|---|
| CMOS | Complementary Metal-Oxide Semiconductor |
| CSI-2 | Camera Serial Interface |
| DSI | Display Serial Interface |
| FTDI | Future Technology Devices International |
| $I^2C$ | Inter-Integrated Circuit |
| I/O | Input/Output |
| LVDS | Low-Voltage Differential Signaling |
| MIPI | Mobile Industry Processor Interface |
| SPI | Serial Peripheral Interfa 4321ce |

# 1. Introduction

This document describes the Lattice Semiconductor CrossLinkPlus™ LIF-MDF6000 Master Link Board – Revision B that supports a variety of demos, encompassing different signaling logic standards bridging with MIPI® CSI-2/DSI interface. The board's key component is the CrossLinkPlus family device that features built in MIPI D-PHY Hardened blocks to support different bridging solutions.

For the latest information about this board, including optional Tx/Rx Link boards, demo files, further documentation and more, see the CrossLinkPlus Master Link Board web page.

For details about the CrossLinkPlus device, refer to CrossLinkPlus Family Data Sheet (FPGA-DS-02054).

The content of this user guide includes descriptions of onboard jumper settings, programming circuit, a complete set of schematics, and bill of materials for LIF-MDF6000 Master Link Rev B board.

Refer to Appendix A, B, C, D, E, F for the schematic and BOM of the CrossLinkPlus LIF-MDF6000 Master Link Rev B board and the schematics and BOMs of the Breakout I/O Link and SMA I/O Link boards that are included in the demo kit.

Circuits on the development kit board:

- Programming Circuit
  - Mini USB Type-B connector to FTDI
  - FTDI to CrossLinkPlus using SPI
  - FTDI to CrossLinkPlus using $I^2C$
  - FTDI to MachXO3LF device using JTAG
- CrossLinkPlus
  - MIPI CSI-2/DSI Hardened blocks
  - Bridging of multiple signaling standards
  - Reconfigurable embedded Flash
  - General Purpose Input/Output
  - LED display
- LCMXO3LF-1300E
  - $I^2C$ muxing

Figure 1.1 shows the top view of the LIF-MDF6000 Master Link Rev B board and its key components. Figure 1.2 shows the bottom view of the board.

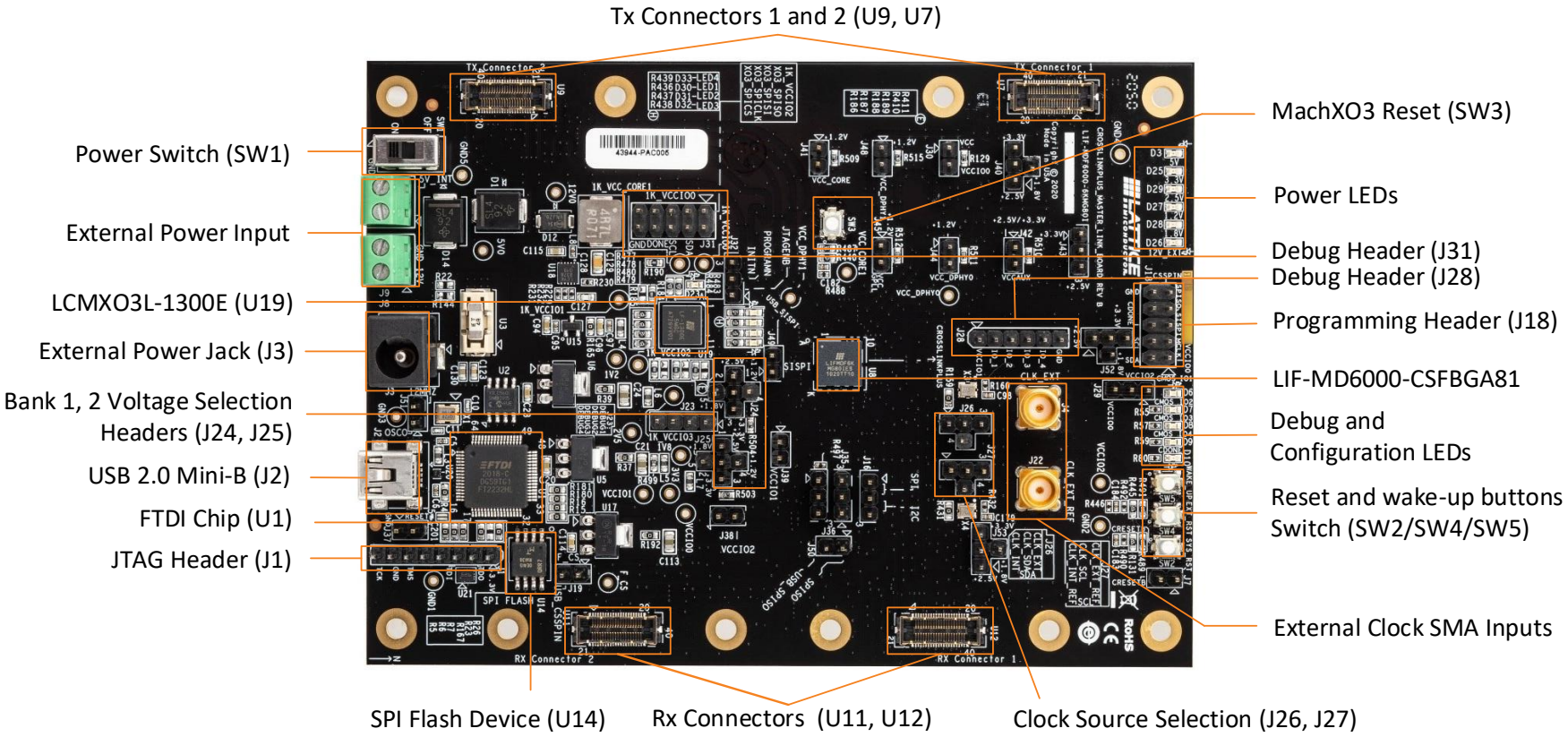


**Figure 1.1. Top View of Master Link Rev B Board and its Key Components**

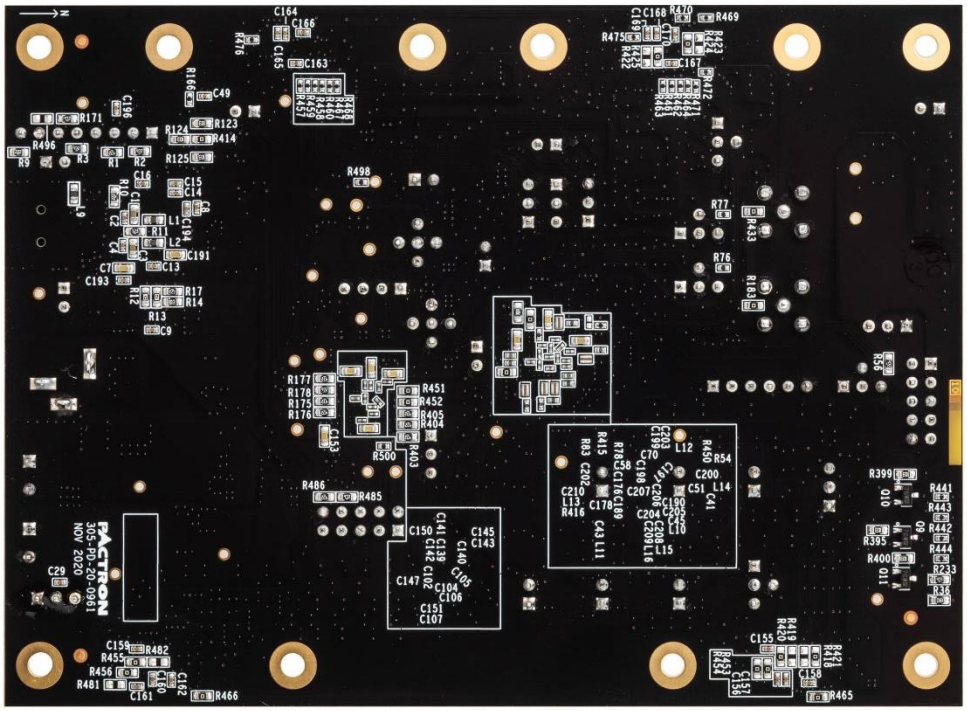

**Figure 1.2. Bottom View of Master Link Rev B Board**

# 2. Headers and Test Connections

Figure 1.1 shows the top view of the Master Link Rev B board. The headers and test connections on the board provide access to LIF-MDF6000 Master Link Rev B board circuits. Table 2.1 lists the headers and test connectors.

**Table 2.1. Headers and Test Connectors**

| Part | Description | Setting |
|---|---|---|
| J1 | External JTAG interface - For LCMX03 only | — |
| J2 | mini-B USB connector | — |
| J3 | External 12V power jack | — |
| J4 | External clock input for MIPI D-PHY reference clock | — |
| J7 | SW2 selector | OPEN-NOP, SHORT-CONFIGURATION RESET |
| J8 | External 12 V terminal block | Open |
| J9 | External 5 V terminal block | Open |
| J16 | SPI/$I^2C$ programming selector for LIF-MDF6000 | 1-2 (SPI), 2-3 ($I^2C$) |
| J18 | External SP/$I^2C$ access for LIF-MDF6000 | — |
| J19 | SPI Flash chip select | OPEN-OFF, SHORT-ON |
| J22 | External reference clock input for MIPI D-PHY reference clock | — |
| J23 | LCMXO3L debug header | — |
| J24 | VCCIO1 Bank voltage selector | 1-2 (2.5 V), 2-3 (3.3 V), 2-4 (1.2 V), 2-5 (1.8 V) |
| J25 | VCCIO2 Bank voltage selector | 1-2 (2.5 V), 2-3 (3.3 V), 2-4 (1.2 V), 2-5 (1.8 V) |
| J26 | Internal/External clock and $I^2C$ SDA Mux | 1-2 (CLK_INT), 2-3 (CLK_EXT), 2-4 (SDA) |
| J27 | Internal/External reference clock and $I^2C$ SCL Mux | 1-2 (CLK_INT_REF), 2-3 (CLK_EXT_REF), 2-4 (SCL) |
| J28 | Reveal Analyzer signal connector | — |
| J29 | Reset signal voltage selector | 1-2 (VCCIO2), 2-3 (VCCIO0) |
| J30 | VCCIO0 Header | — |
| J31 | External SPI/$I^2C$ access for LCMXO3L | — |
| J32 | LCMXO3L configuration header | — |
| J35 | SPI/$I^2C$ programming selector for LIF-MDF6000 | 1-2 ($I^2C$), 2-3 (SPI) |
| J36 | SPI/$I^2C$ programming selector for LIF-MDF6000 | 1-2 ($I^2C$), 2-3 (SPI) |
| J37 | FT2232H reset | OPEN-NORMAL OP, SHORT-RESET |
| J38 | VCCIO2 Header | — |
| J39 | VCCIO1 Header | — |
| J40 | VCCIO0 Bank voltage select | 1-2 (2.5 V), 2-3 (3.3 V), 2-4 (1.8 V) |
| J41 | VCC_CORE Header | — |
| J42 | VCCAUX Header | — |
| J43 | VCCAUX voltage selector | 1-2 (3.3 V), 2-3 (2.5 V) |
| J44 | VCC_DPHY0 Header | — |
| J45 | VCC_GPLL Header | — |
| J48 | VCC_DPHY1 Header | — |
| J49 | MOSI to External Flash | Open |
| J50 | MISO to External Flash | Open |
| J51 | 12 MHz clock from oscillator | SHORT – Route 12 MHz clock to MachXO3 |
| J52 | 25 MHz oscillator power | 1-2 (2.5 V), 2-3 (3.3 V), 2-4 (1.8 V) |
| J53 | 27 MHz oscillator power | 1-2 (2.5 V), 2-3 (3.3 V), 2-4 (1.8 V) |
| SW1 | External adaptor power ON/OFF | — |
| SW2 | Configuration reset for LIF-MDF6000 | — |
| SW3 | External reset for LCMXO3L | — |
| SW4 | External reset for LIF-MDF6000 | — |
| SW5 | PMU WAKEUP Switch for LIF-MDF6000 | — |

| Part | Description | Setting |
|---|---|---|
| U7 | Tx Connectors for external interface | — |
| U9 | Tx Connectors for external interface | — |
| U11 | Rx Connectors for external interface | — |
| U12 | Rx Connectors for external interface | — |

# 3. Programming Circuit

The Mini-B USB connector is used for programming the board by using Lattice Diamond® Programmer software. Figure 3.1 shows the programming block of LIF-MDF6000 Master Link Rev B board.

The Mini-B USB connector interfaces to the FTDI FT2232H IC. The FTDI IC works with Diamond Programmer software to provide interfaces for:

- JTAG – to program MachXO3 LCMXO3LF-1300E
- SPI – to program CrossLinkPlus and/or SPI Flash Memory
- $I^2C$ – to program CrossLinkPlus

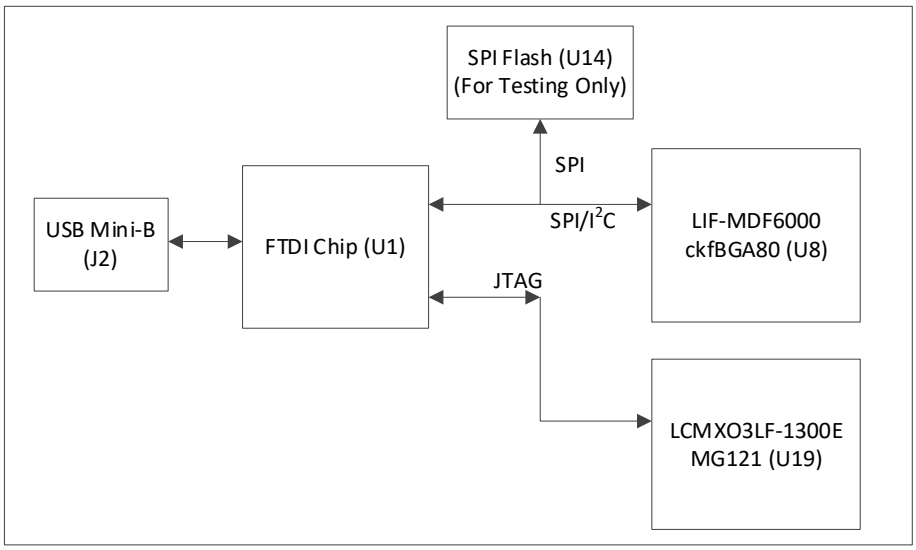


**Figure 3.1. Programming Block**

**Table 3.1. Jumper Settings for CrossLinkPlus Embedded Flash Programming**

| Jumper | CrossLinkPlus Flash SPI Programming | CrossLinkPlus Flash $I^2C$ Programming |
|---|---|---|
| J16 | 1-2 | 2-3 |
| J19 | OPEN | OPEN |
| J35 | 2-3 | 1-2 |
| J36 | OPEN | 1-2 |
| J49 | OPEN | OPEN |
| J50 | OPEN | OPEN |

## 3.1. Bridging Circuit

Figure 3.2 shows the block diagram of bridging of different standard interfaces. The CrossLinkPlus device is used as a bridging device that supports a variety of I/O standards. This demo boards supports the development of some of these example interface bridges:

- 1:1 MIPI DSI Display Interface Bridge
- 1:2 MIPI DSI Display Interface Bridge
- 2:1 MIPI CSI-2 Image Sensor Aggregator Bridge
- CMOS to MIPI CSI-2 Image Sensor Interface Bridge
- MIPI CSI-2 to CMOS Image Sensor Interface Bridge
- MIPI DSI to CMOS Display Interface Bridge
- OpenLDI LVDS to MIPI DSI Display Interface Bridge
- CMOS to MIPI DSI Display Interface Bridge

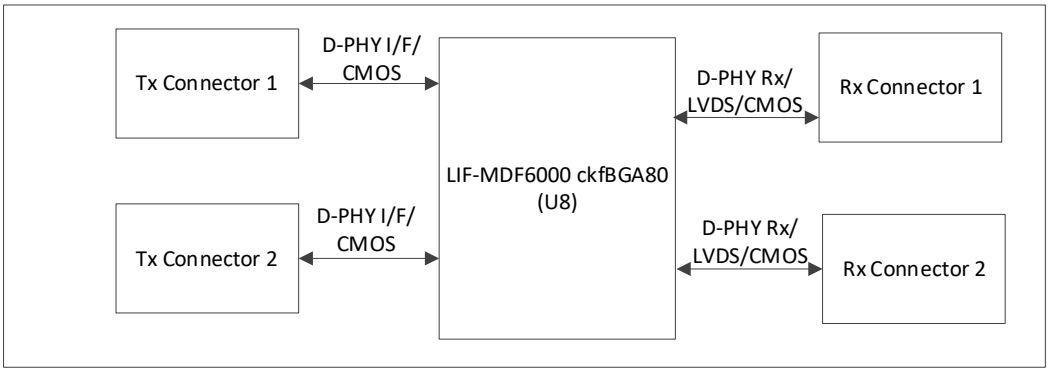


**Figure 3.2. Bridging Block**

## 3.2. I²C Expander

Figure 3.3 shows the block diagram of the I²C expander. The LCMXO3LF-1300E device is used as an I²C expander and it supports a single master and multiple slave devices connected to the board. The master I²C interface is connected to the Tx header and the slave device I²C interface is connected to the Rx connectors supporting any slave device access from the master based on the slave address.

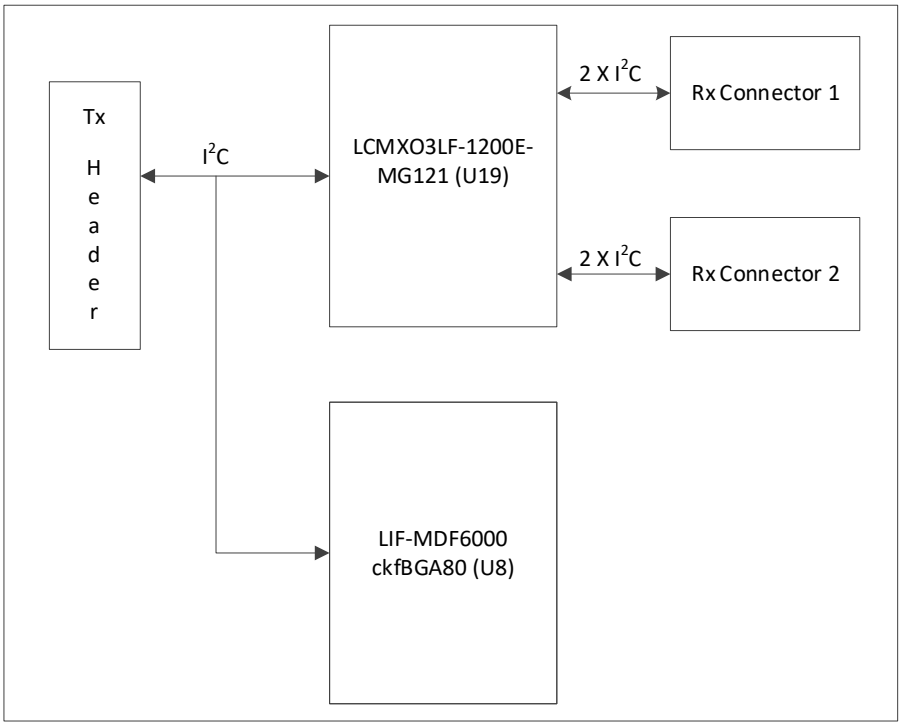


**Figure 3.3. I²C Expander Block**

# 4. Generating the Programming File

The demo project on the LIF-MDF6000 Master Link Rev B board can be downloaded from the Lattice website (https://www.latticesemi.com/products/developmentboardsandkits/crosslinkplusmasterlinkboard).

To generate the JEDEC (.jed) file:

1. Open the Diamond software.
2. From the **File** menu, choose **Open > Project**.
3. In the **Open Project** dialog box, select the *gpio_toggle.ldf* file and click **Open**, as shown in Figure 4.1. This opens the demo project.

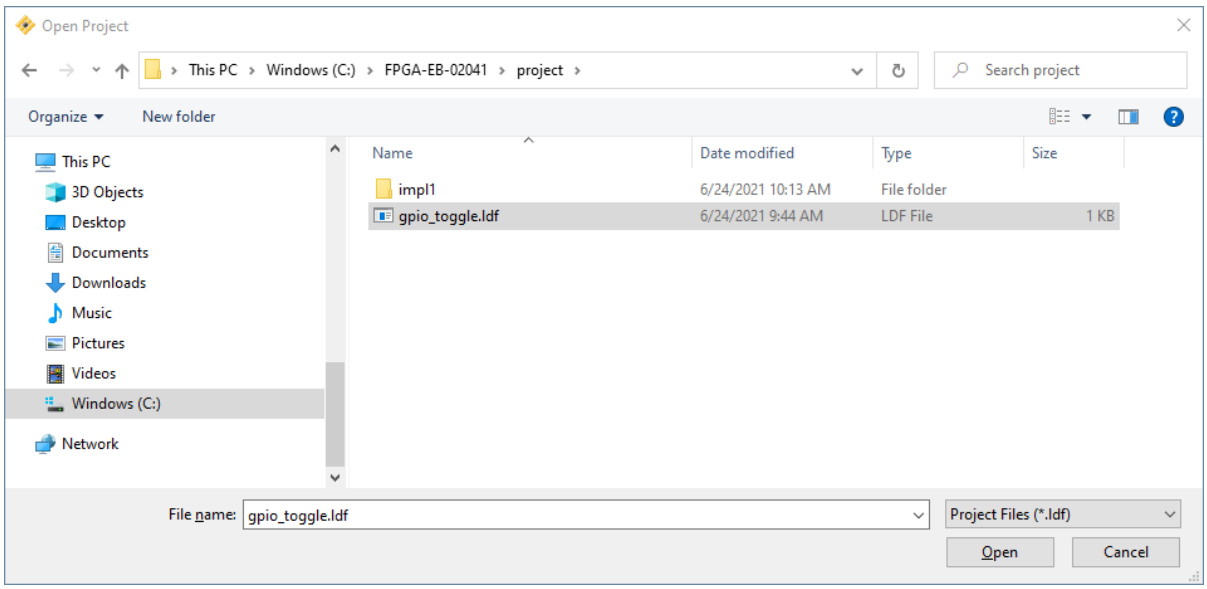


**Figure 4.1. Diamond Software – Open Project Dialog Box**

4. In the **Process** pane, select the **JEDEC File** option under **Export Files**, as shown in Figure 4.2.

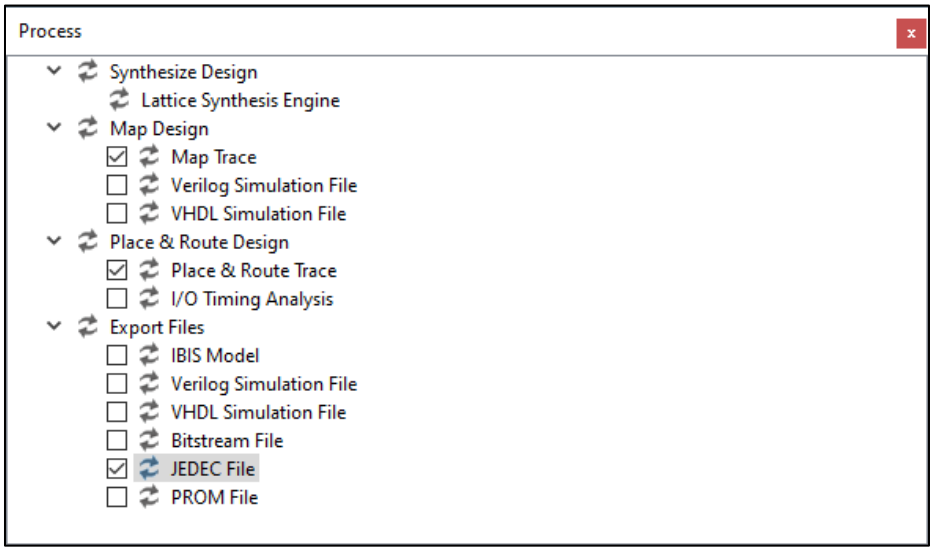


**Figure 4.2. Diamond Software – Process Pane**

5. Click **Process** > **Run**. Green checkmarks appear on each successfully completed step, including the generation of the JEDEC file, as shown in Figure 4.3.

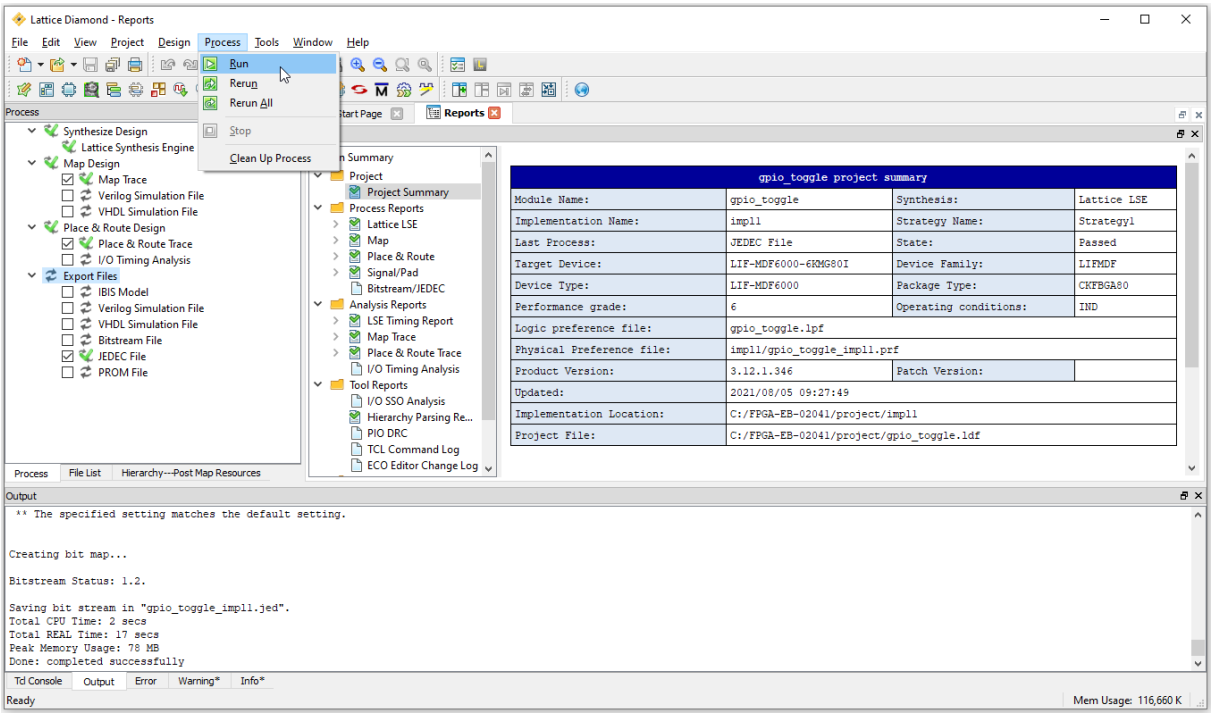


**Figure 4.3. Diamond Software – Run Processes**

The *.jed* file is located in the *impl1* folder

# 5. Programming the CrossLinkPlus Device

Diamond Programmer can be used to program the JEDEC file to the CrossLinkPlus embedded flash after the JEDEC data file is generated, as shown in the Generating the Programming File section. Diamond Programmer is integrated into the Diamond software and is also available as a standalone version.

To program the CrossLinkPlus embedded flash:

1. Connect the PC and CrossLInkPlus Master Link Rev B Board (J2) using the USB cable.
2. In Diamond Software, click **Tools** > **Programmer**, as shown in Figure 5.1.

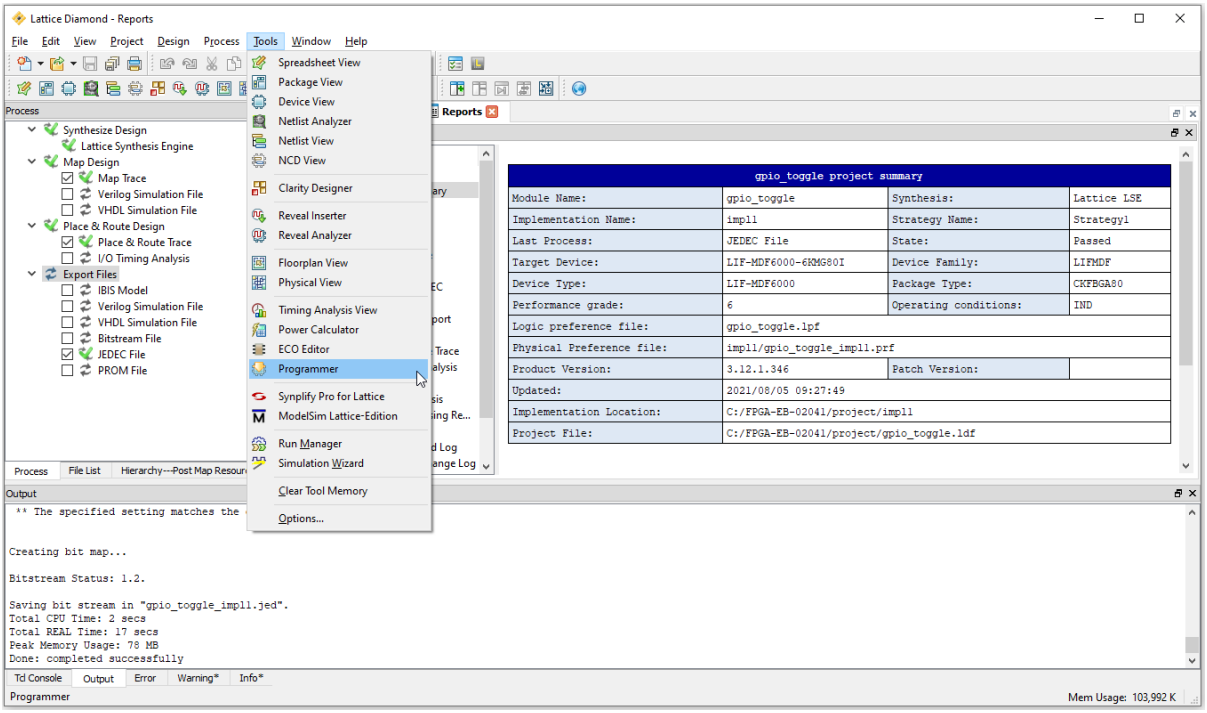


**Figure 5.1. Diamond Software – Diamond Programmer**

3. `The Diamond Programmer interface opens, as shown in Figure 5.2. Double-click the **Operation** field.

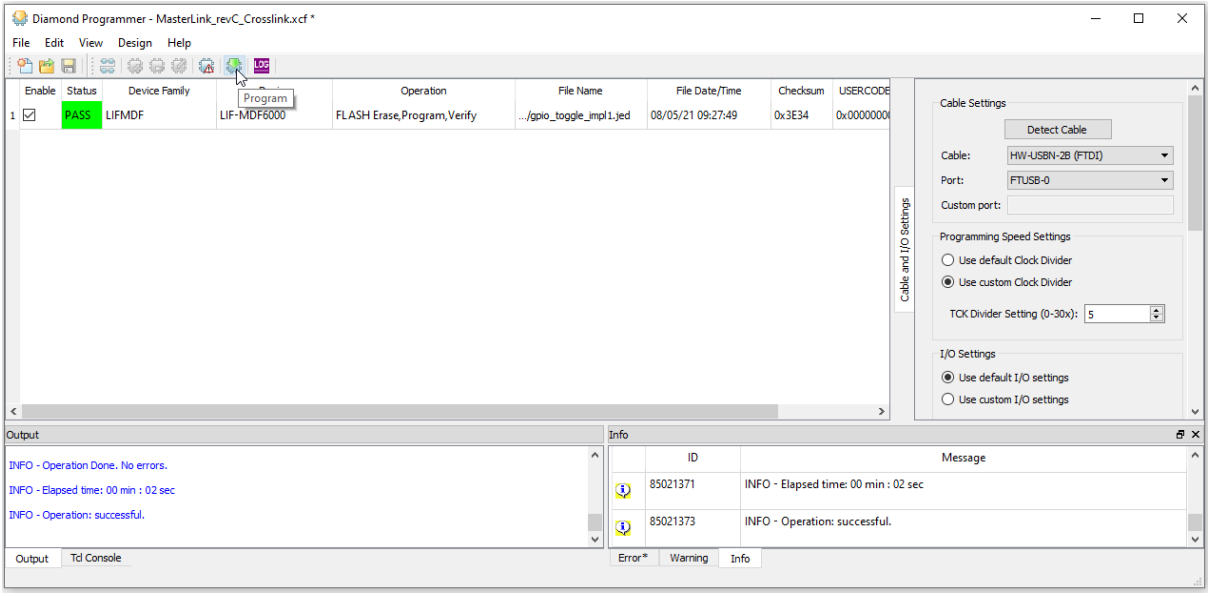


**Figure 5.2. Diamond Programmer**

4. The **Device Properties** dialog box opens, as shown in Figure 5.3. Select the following options:

   **Access mode** – **Flash Programming Mode**

   **Port Interface** – **Slave SPI Interface**

   **Operation** – **FLASH Erase,Program,Verify**

   **Programming file** – Select the *.jed* file to be programmed

5. Click **OK**.

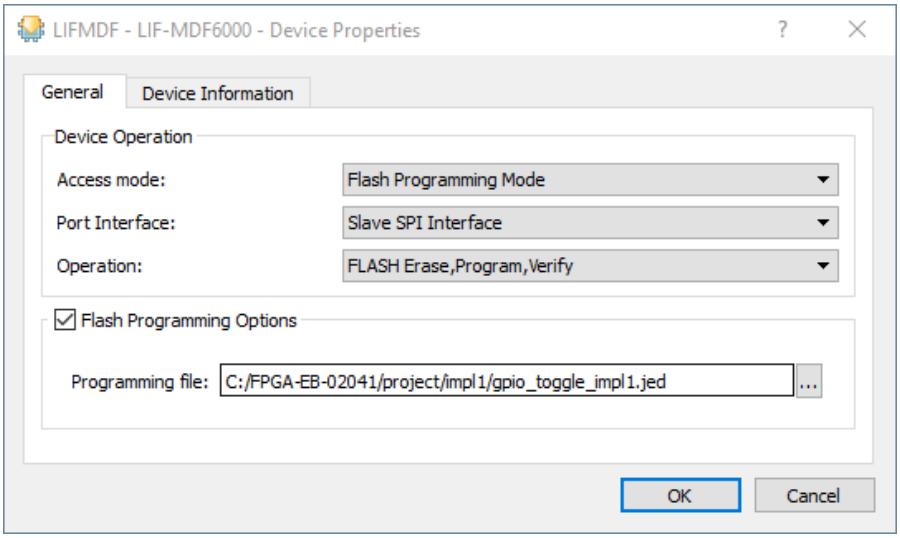


**Figure 5.3. Diamond Programmer – Device Properties**

6. To program the .jed file, click the **Program** button in Diamond Programmer, as shown in Figure 5.2.

If successful, the **Status** column shows **PASS**.

The **Output** pane also shows **INFO – Operation: successful**.

# 6. Power Supply

The power supply to the development kit is provided by the Mini-B USB connector or from an external adaptor.

Figure 6.1 shows the power supply block of the CrossLinkPlus LIF-MDF6000 Master Link Rev B board. The external adaptor provides 12 V power source through voltage regulators on the board to CrossLinkPlus and LCMXO3LF-1300E, as well as to the external boards connected to Tx and Rx Headers. The Mini-B USB connector provides 5 V to the various voltage regulators and is also used for device programming. Each I/O and core voltage rail on the board is accessible by a test point on the board. The current flowing to each rail can be measured using a 1 Ω or 0.1 Ω resistor placed in the path of each voltage rail.

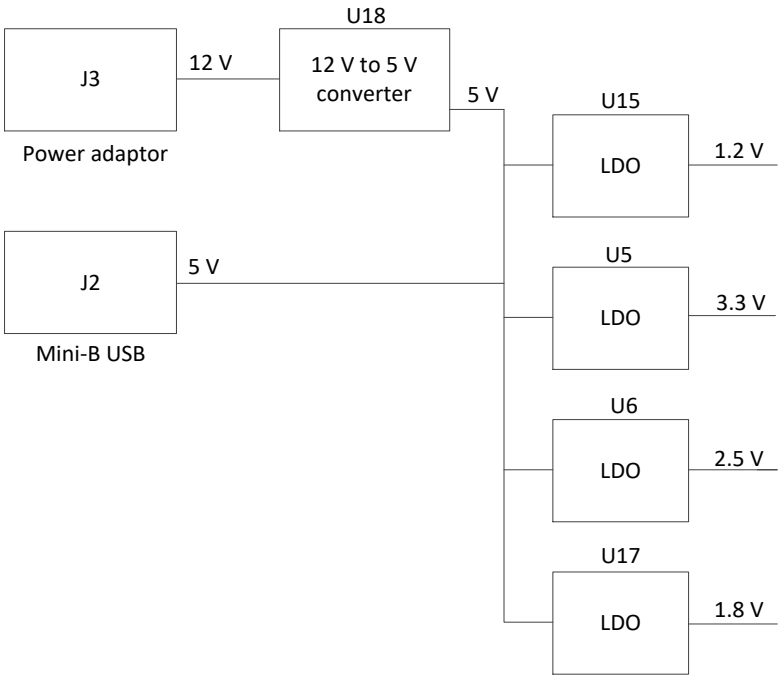


**Figure 6.1. Power Supply Block**

Table 6.1 lists the device power rails. There are five voltage regulators on the board used to supply the 5 V, 3.3 V, 2.5 V, 1.8 V, and 1.2 V rails. The input to these regulators is from either the Mini-B USB connector (J2), an external 12 V adaptor (J3), or an external power supply to the terminal blocks of J8 or J9. Switch SW1 is used to connect/disconnect power to/from the board.

**Table 6.1. Power LEDs**

| Voltage Rail | LED | Color |
|---|---|---|
| 12.0 | D26 | Green |
| 5.0 | D3 | Green |
| 3.3 | D25 | Green |
| 2.5 | D29 | Green |
| 1.8 | D28 | Green |
| 1.2 | D27 | Green |

Table 6.2 lists the board voltage rails, including the rail source voltage, test point number, and current sense resistor number.

**Table 6.2. Device Power Rail Summary and Test Points**

| Voltage Rail | Source Rail | Current Sense Resistor | Test Points |
|---|---|---|---|
| 12 V | — | — | 12V0 |
| 5 V | 12 V | — | 5V0 |
| +3.3 V | 5 V | — | 3V3 |
| +2.5 V | 5 V | — | 2V5 |
| +1.8 V | 5 V | — | 1V8 |
| +1.2 V | 5 V | — | 1V2 |
| VCC_CORE | +1.2 V | R509 | VCC_CORE1 |
| VCCAUX | +2.5 V/+3.3 V | R510 | — |
| VCCIO0 | +1.8 V/+2.5 V/+3.3 V | R129 | VCCIO0 |
| VCCIO1 | +1.2 V/+1.8 V/+2.5 V/+3.3 V | R504 | VCCIO1 |
| VCCIO2 | +1.2 V/+1.8 V/+2.5 V/+3.3 V | R503 | VCCIO2 |
| VCC_GPLL | +1.2 V | R512 | — |
| VCC_DPHY0 | +1.2 V | R511 | VCC_DPHY0 |
| VCC_DPHY1 | +1.2 V | R515 | VCC_DPHY1 |
| 1K_VCC_CORE | +1.2 V | R190 | 1K_VCC_CORE1 |
| 1K_VCCIO0 | +2.5 V/+3.3 V | R410/R411 | 1K_VCCIO0 |
| 1K_VCCIO1 | +2.5 V/+3.3 V | R184/R185 | 1K_VCCIO1 |
| 1K_VCCIO2 | +2.5 V/+3.3 V | R186/R187 | 1K_VCCIO2 |
| 1K_VCCIO3 | +2.5 V/+3.3 V | R188/R189 | 1K_VCCIO3 |

# 7. Status Indicators

The LED status indicators on the board show configuration and application status. Table 7.1 lists the status LED I/O map.

**Table 7.1. Status LED I/O Map**

| Device | LED | Net Name | Color |
|---|---|---|---|
| CrossLinkPlus | D6 | CMOS_IO_1 | Blue |
| CrossLinkPlus | D7 | CMOS_IO_2 | Blue |
| CrossLinkPlus | D8 | CMOS_IO_3 | Blue |
| CrossLinkPlus | D9 | CMOS_IO_4 | Blue |
| CrossLinkPlus | D10 | CDONE | Green |
| LCMX03LF-1300E | D23 | DONE | Red |
| LCMX03LF-1300E | D30 | LED1 | Blue |
| LCMX03LF-1300E | D31 | LED2 | Blue |
| LCMX03LF-1300E | D32 | LED3 | Blue |
| LCMX03LF-1300E | D33 | LED4 | Blue |

# 8. SMA I/O Link Board

The SMA I/O Link board connects to the CrossLinkPlus LIF-MDF6000 Master Link Rev B board's Tx or Rx connectors (U7, U9, U11 or U12) and transfers signals to the respective SMA connectors. Note that pins 19 and 20 on the U1 connector are tied together. This will short the signals on U11 or U12 of the CrossLinkPlus LIF-MDF6000 Master Link Board if the SMA I/O Link Board is connected to either one of these connectors.

**Table 8.1. Headers and Test Connectors**

| Part | Description | Mapping to U1 |
|---|---|---|
| J1 | SMA connector for DCK_TX_P | Pin 1 |
| J2 | SMA connector for DCK_TX_N | Pin 2 |
| J3 | SMA connector for DATA0_TX_P | Pin 4 |
| J4 | SMA connector for DATA0_TX_N | Pin 5 |
| J5 | SMA connector for DATA1_TX_P | Pin 7 |
| J6 | SMA connector for DATA1_TX_N | Pin 8 |
| J7 | SMA connector for DATA2_TX_P | Pin 13 |
| J8 | SMA connector for DATA2_TX_N | Pin 14 |
| J9 | SMA connector for DATA3_TX_P | Pin 16 |
| J10 | SMA connector for DATA3_TX_N | Pin 17 |
| J11 | SMA connector for DATA4_TX_P | Pin 24 |
| J12 | SMA connector for DATA4_TX_N | Pin 25 |
| J13 | SMA connector for DATA5_TX_P | Pin 27 |
| J14 | SMA connector for DATA5_TX_N | Pin 28 |
| U1 | Connector to interface to CrossLinkPlus Master Link Rev B board | N/A |

**Table 8.2. U1 Connector Description**

| Pin | Name |
|---|---|
| 1 | CH4_DCK_P |
| 2 | CH4_DCK_N |
| 3 | GND |
| 4 | CH4_DATA0_P |
| 5 | CH4_DATA0_N |
| 6 | GND |
| 7 | CH4_DATA1_P |
| 8 | CH4_DATA1_N |
| 9 | GND |
| 10 | SN |
| 11 | SCLK |
| 12 | GND |
| 13 | CH4_DATA2_P |
| 14 | CH4_DATA2_N |
| 15 | GND |
| 16 | CH4_DATA3_P |
| 17 | CH4_DATA3_N |
| 18 | GND |
| 19 | 12V |
| 20 | 12V |

| Pin | Name |
|---|---|
| 21 | TBD |
| 22 | RESETN |
| 23 | PWR_5-0V |
| 24 | GND |
| 25 | GND |
| 26 | PWR_3-3V |
| 27 | GND |
| 28 | GND |
| 29 | PWR_1-8V |
| 30 | MOSI |
| 31 | MISO |
| 32 | PWR_1-8V |
| 33 | GND |
| 34 | GND |
| 35 | PWR_3-3V |
| 36 | GND |
| 37 | GND |
| 38 | PWR_5-0V |
| 39 | SDA |
| 40 | SCL |

**Note**: U1 connector pin names may be different from the actual signal depending on which the CrossLinkPlus LIF-MDF6000 Master Link Rev B board connector this daughter board is connected.

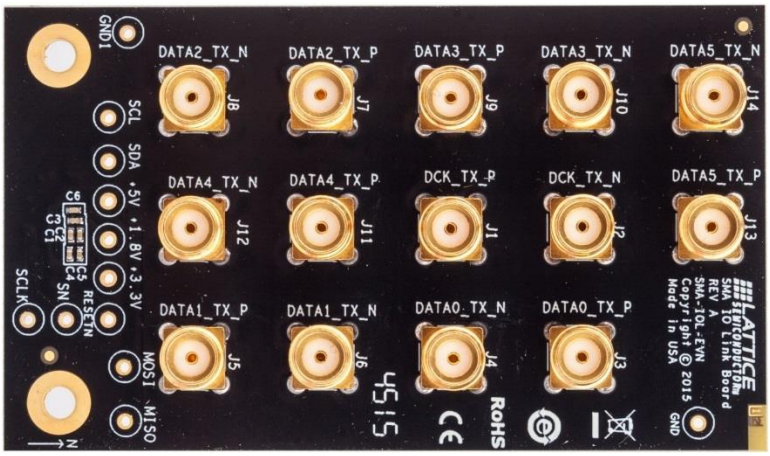


**Figure 8.1. Top View of SMA I/O Link Board**

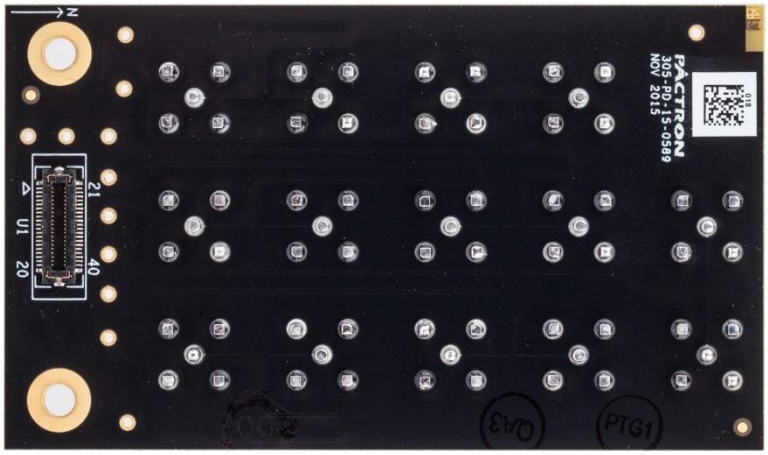


**Figure 8.2. Bottom View of SMA I/O Link Board**

# 9. Breakout I/O Link Board

The Breakout I/O Link board connects to the CrossLinkPlus LIF-MDF6000 Master Link Rev B board's Tx or Rx connectors (U7, U9, U11 or U12) and transfers signals to the 26-pin header (J2).

**Table 9.1. Headers and Test Connectors**

| Part | Description | Setting |
|---|---|---|
| J2 | 13x2 Header | — |
| U1 | Connector to interface to CrossLinkPlus Master Link Rev B board | — |

**Table 9.2. U1 Connector Description**

| Pin | Name |
|---|---|
| 1 | CH4_DCK_P |
| 2 | CH4_DCK_N |
| 3 | GND |
| 4 | CH4_DATA0_P |
| 5 | CH4_DATA0_N |
| 6 | GND |
| 7 | CH4_DATA1_P |
| 8 | CH4_DATA1_N |
| 9 | GND |
| 10 | SN |
| 11 | SCLK |
| 12 | GND |
| 13 | CH4_DATA2_P |
| 14 | CH4_DATA2_N |
| 15 | GND |
| 16 | CH4_DATA3_P |
| 17 | CH4_DATA3_N |
| 18 | GND |
| 19 | 12V |
| 20 | 12V |

| Pin | Name |
|---|---|
| 21 | TBD |
| 22 | RESETN |
| 23 | PWR_5-0V |
| 24 | GND |
| 25 | GND |
| 26 | PWR_3-3V |
| 27 | GND |
| 28 | GND |
| 29 | PWR_1-8V |
| 30 | MOSI |
| 31 | MISO |
| 32 | PWR_1-8V |
| 33 | GND |
| 34 | GND |
| 35 | PWR_3-3V |
| 36 | GND |
| 37 | GND |
| 38 | PWR_5-0V |
| 39 | SDA |
| 40 | SCL |

**Note**: U1 connector pin names may be different than the actual signal depending on which CrossLinkPlus LIF-MDF6000 Master Link Rev B board connector this daughter board is connected.

**Table 9.3. J2 Header Description**

| Pin | Name | Mapping to U1 |
|---|---|---|
| 1 | +3.3V | N/A |
| 2 | +1.8V | N/A |
| 3 | RESETN | Pin 22 |
| 4 | CH4_DCK_TX_P | Pin 1 |
| 5 | SDA | Pin 39 |
| 6 | CH4_DCK_TX_N | Pin 2 |
| 7 | SCL | Pin 40 |
| 8 | GND | N/A |
| 9 | GND | N/A |
| 10 | CH4_DATA0_TX_P | Pin 4 |
| 11 | CH4_DATA3_TX_P | Pin 16 |
| 12 | CH4_DATA0_TX_N | Pin 5 |
| 13 | CH4_DATA3_TX_N | Pin 17 |
| 14 | GND | N/A |
| 15 | GND | N/A |
| 16 | CH4_DATA1_TX_P | Pin 7 |
| 17 | CH4_DATA4_TX_P | Pin 24 |
| 18 | CH4_DATA1_TX_N | Pin 8 |
| 19 | CH4_DATA4_TX_N | Pin 25 |
| 20 | GND | N/A |
| 21 | GND | N/A |
| 22 | CH4_DATA2_TX_P | Pin 13 |
| 23 | CH4_DATA5_TX_P | Pin 27 |
| 24 | CH4_DATA2_TX_N | Pin 14 |
| 25 | CH4_DATA5_TX_N | Pin 28 |
| 26 | GND | N/A |

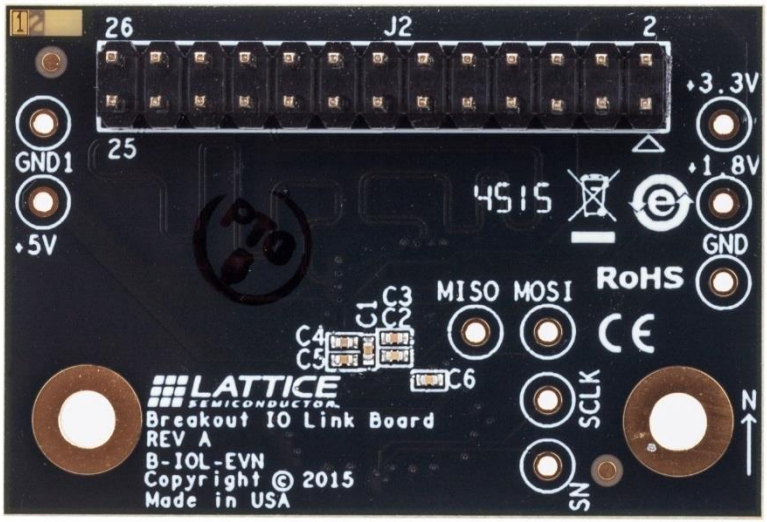


**Figure 9.1. Top View of Breakout I/O Link Board**

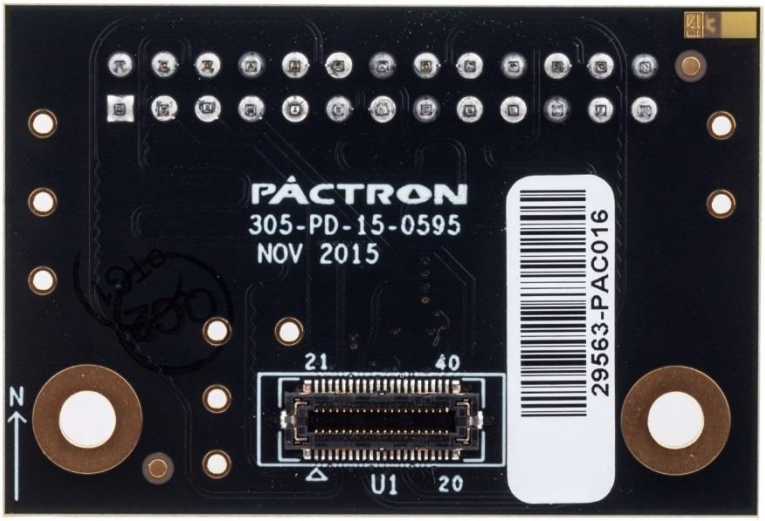


**Figure 9.2. Bottom View of Breakout I/O Link Board**

# 10. Ordering Information

**Table 10.1. Ordering Information**

| Description | Ordering Part Number | China RoHS Environment-Friendly Use Period (EFUP) |
|---|---|---|
| CrossLinkPlus: LIF-MDF6000 Master Link Rev B Board<br>(Includes 1 SMA I/O Link Board and 1 Breakout I/O Link Board) | LIF-MDF6000-ML-EVN |  |
| CrossLink: LIF-MD6000 I/O Link Boards<br>(Includes 1 SMA I/O Link Board and 1 Breakout I/O Link Board) | LIFMD-IOL-EVN | |

# Appendix A. LIF-MDF6000-ML-EVN-BRD Schematics

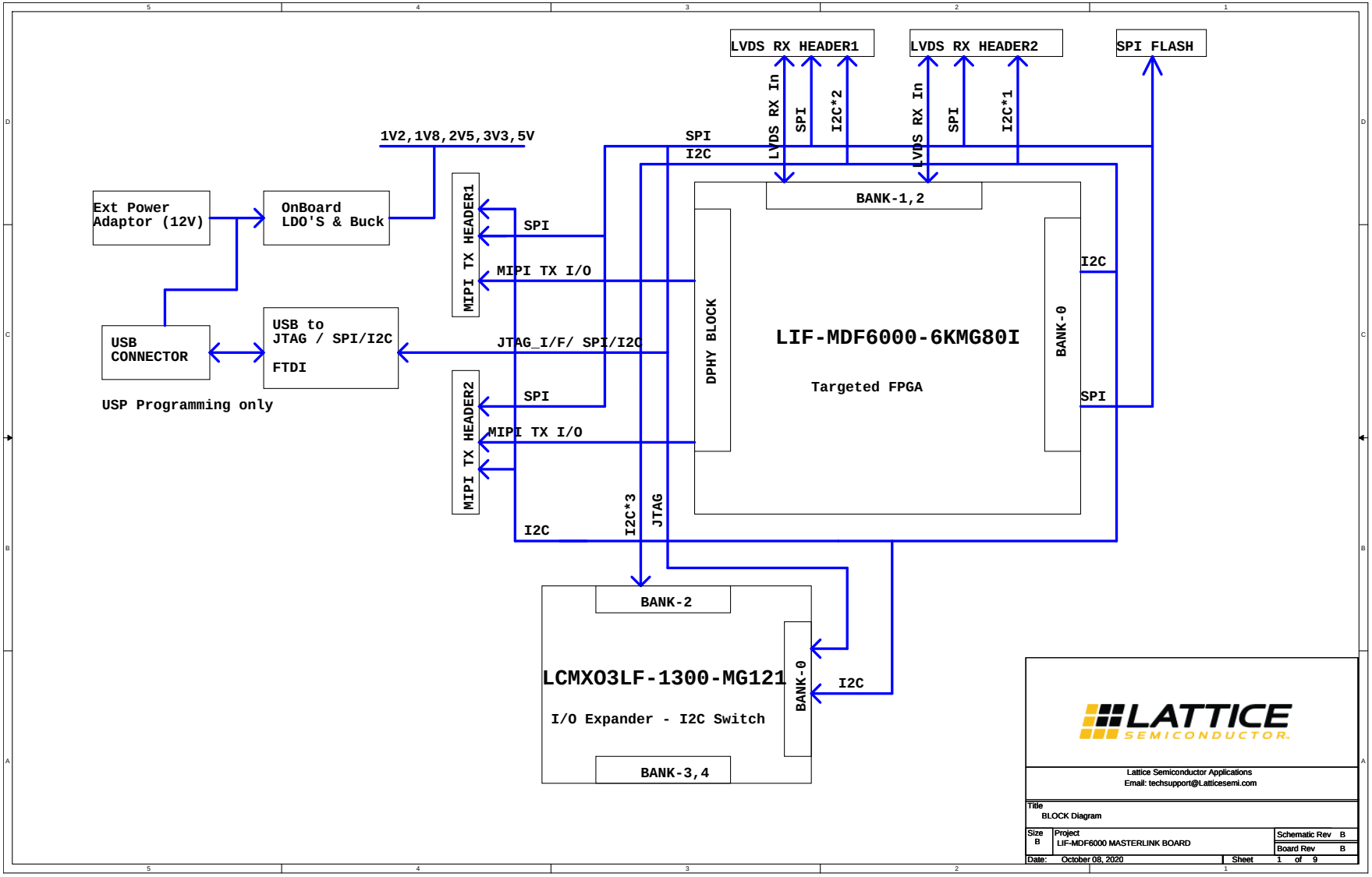


**Figure A.1. LIF-MDF6000 Master Link Rev B Board Block Diagram**

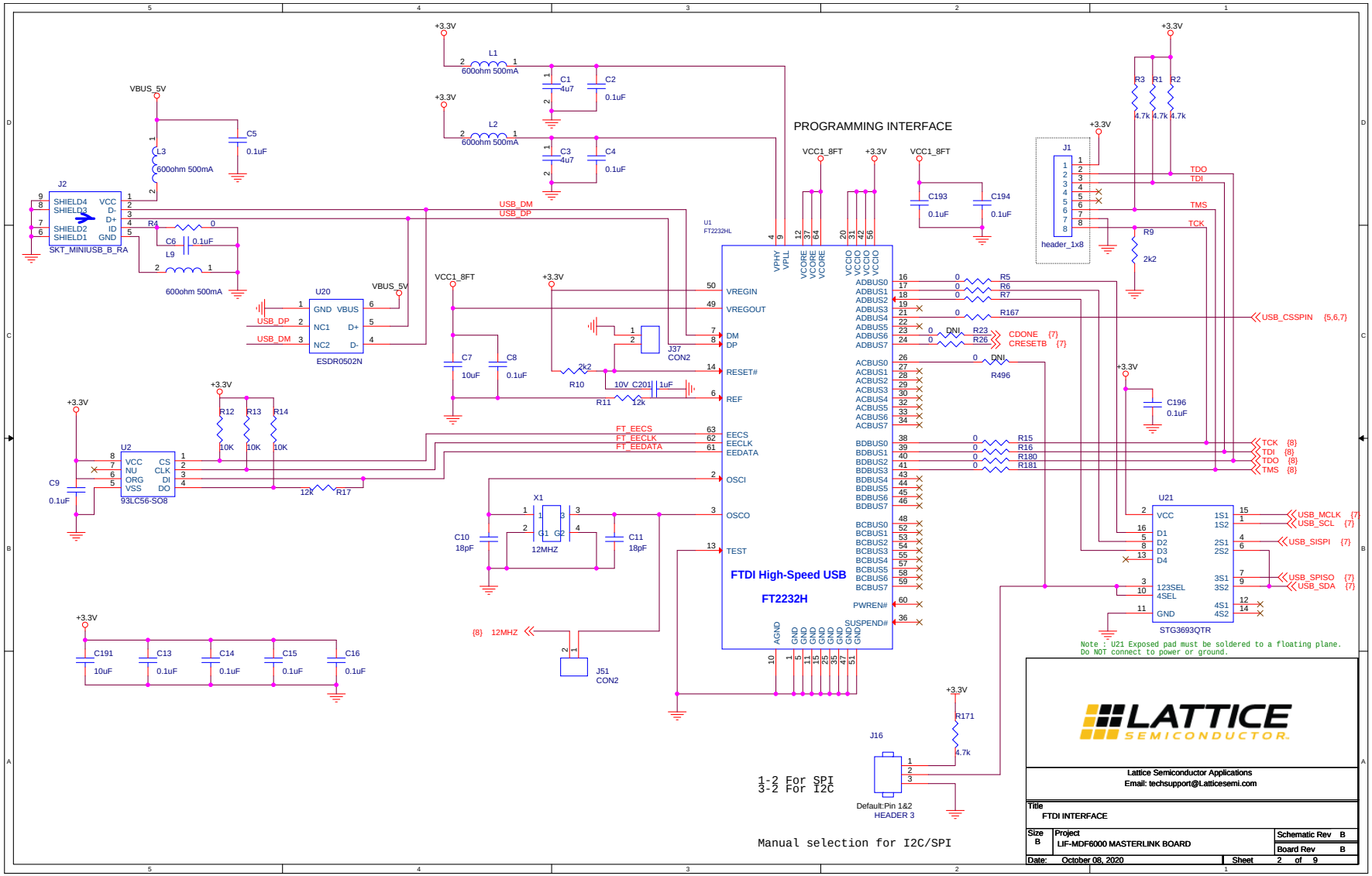


**Figure A.2. FTDI Interface**

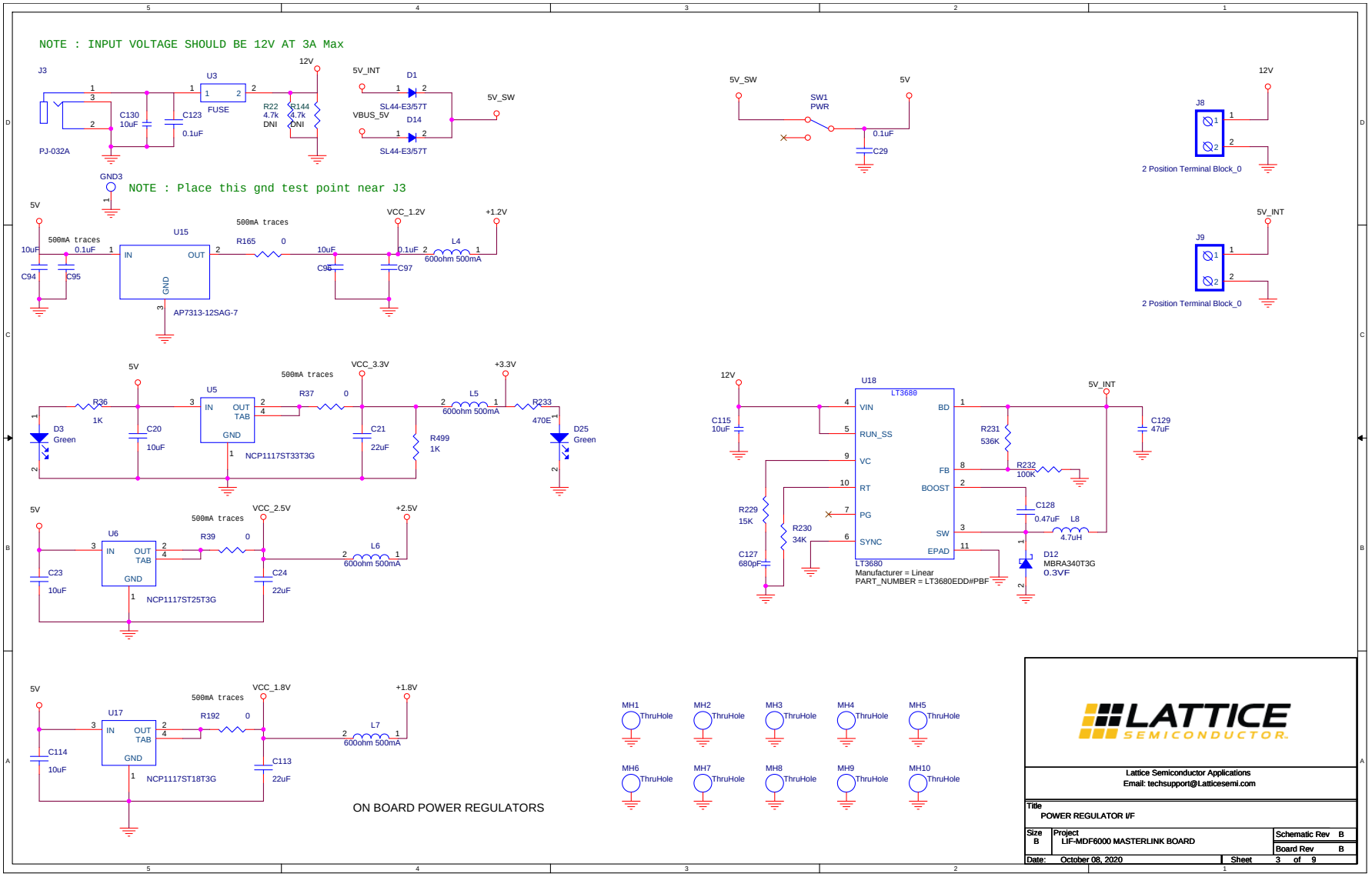


**Figure A.3. Power Regulator Interface**

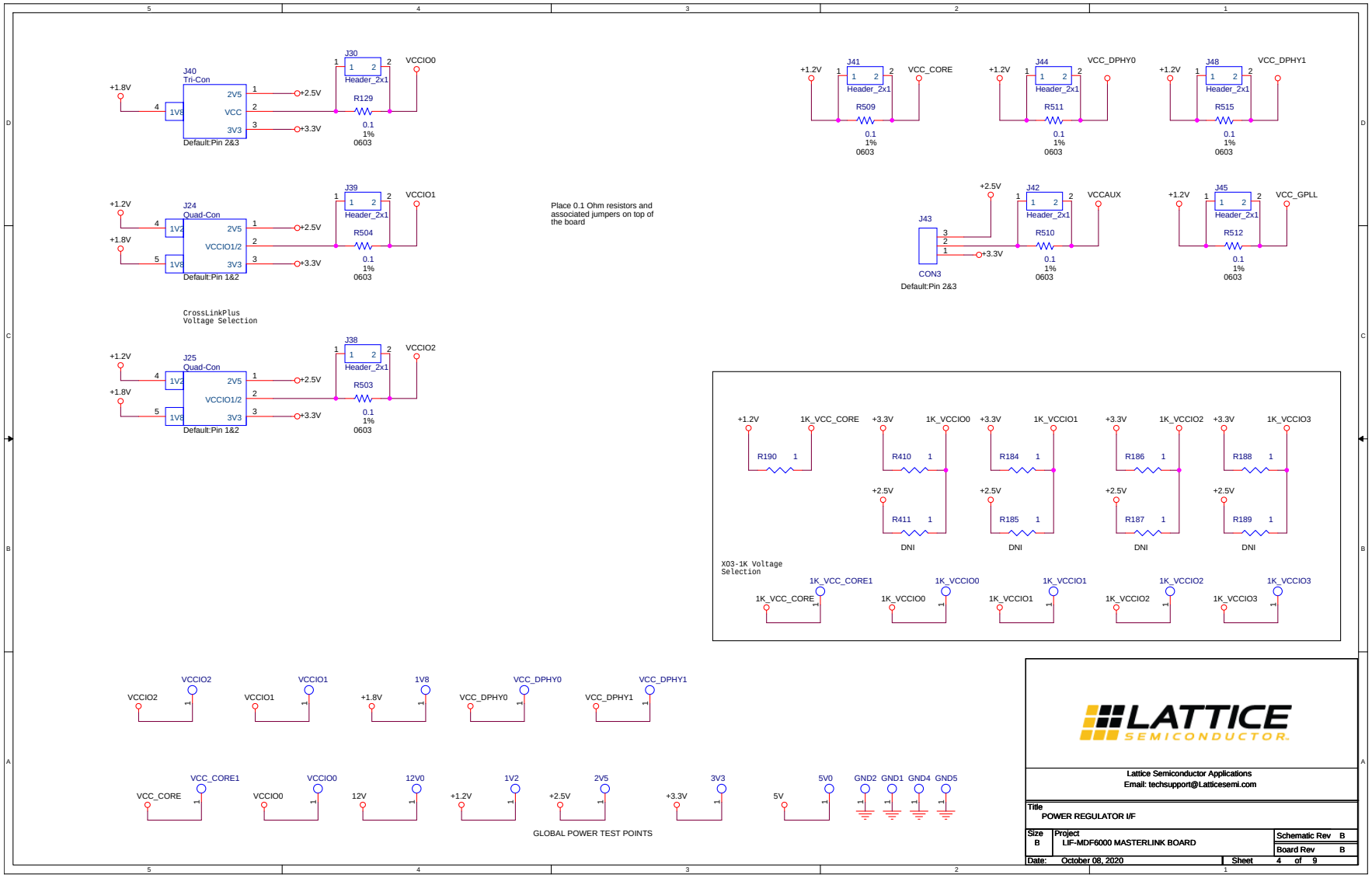


**Figure A.4. Power Regulator Interface**

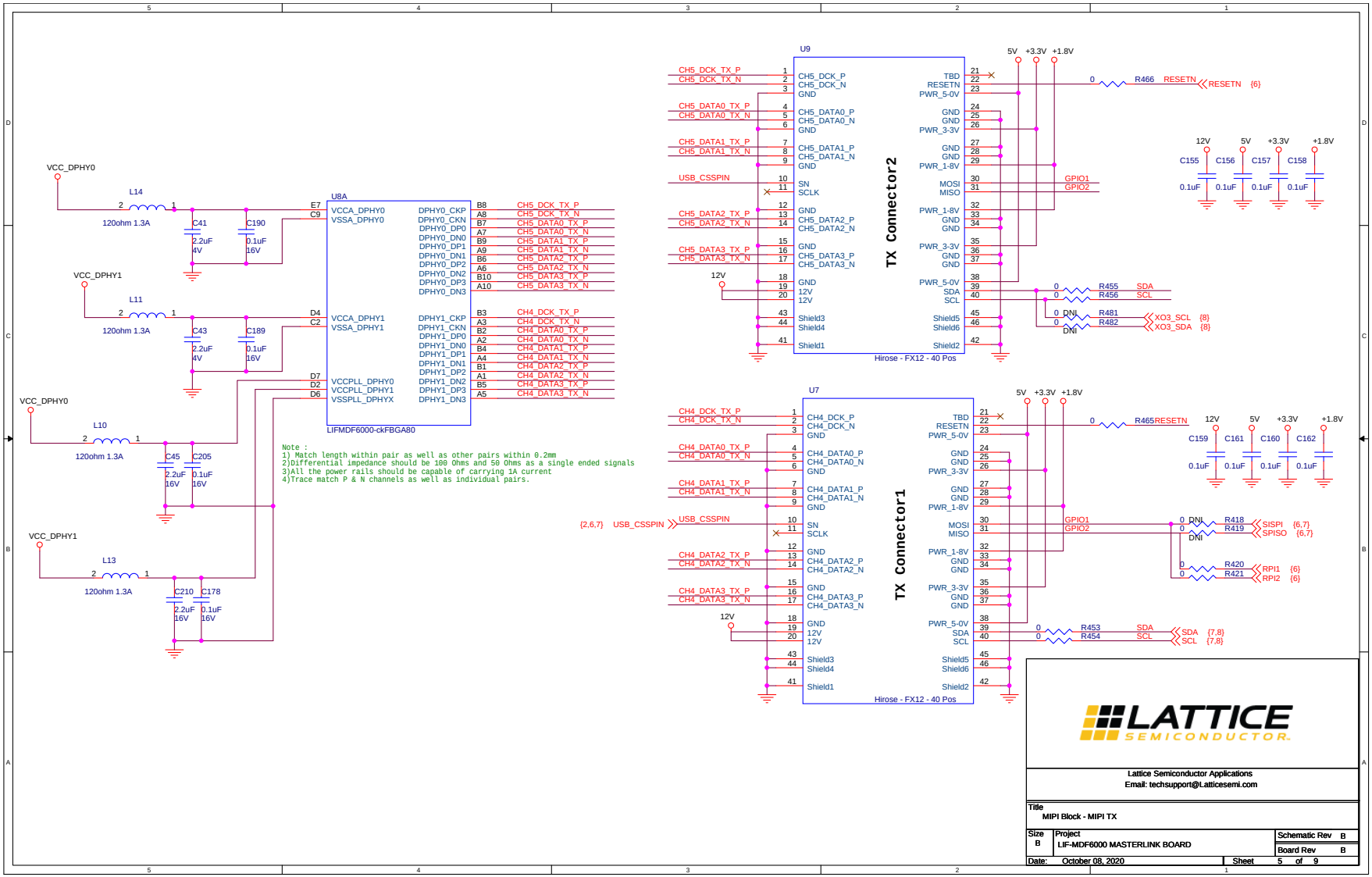


**Figure A.5. MIPI Block – MIPI Tx**

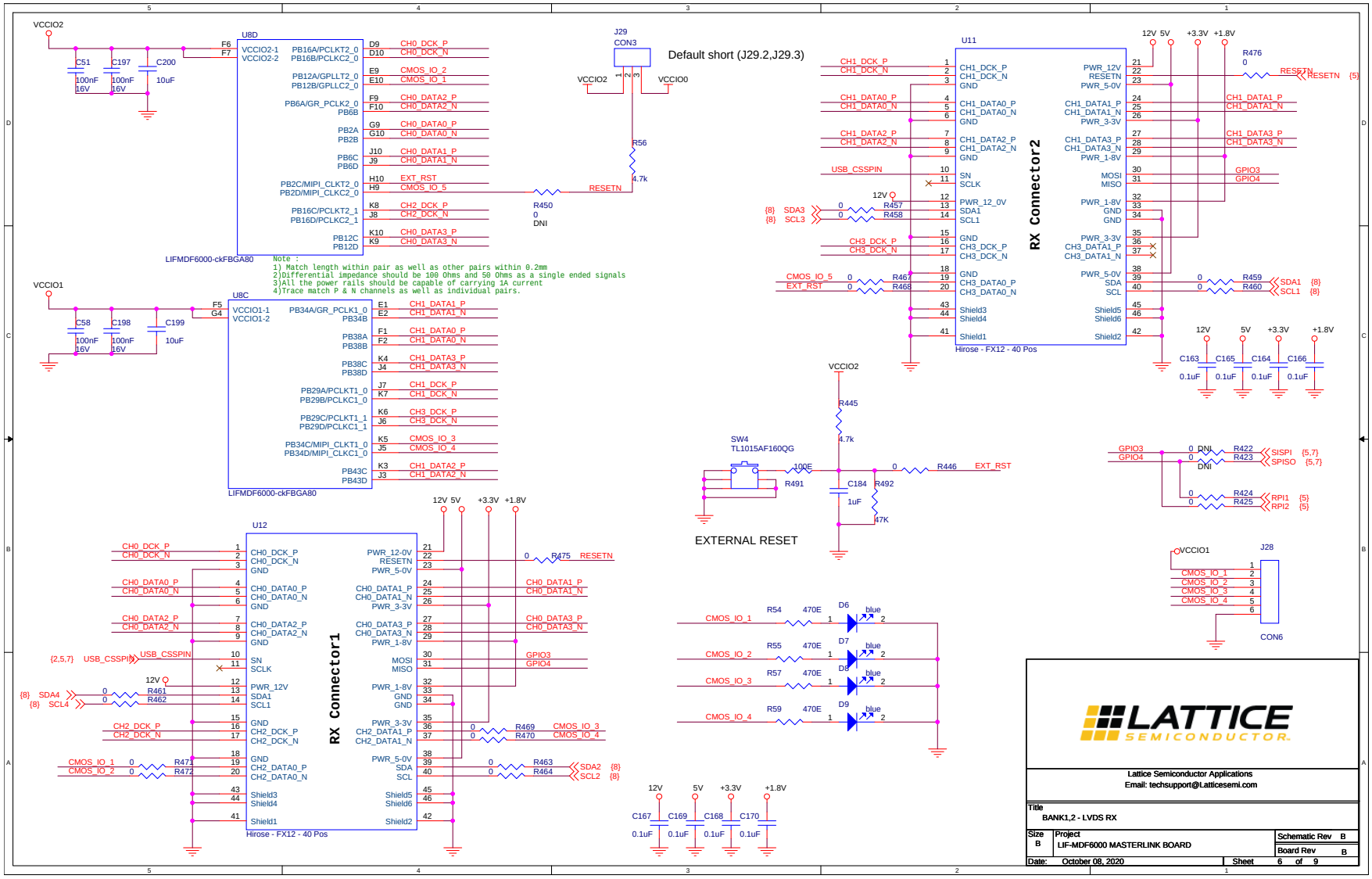


**Figure A.6. Bank 1, 2 – LVDS Rx**

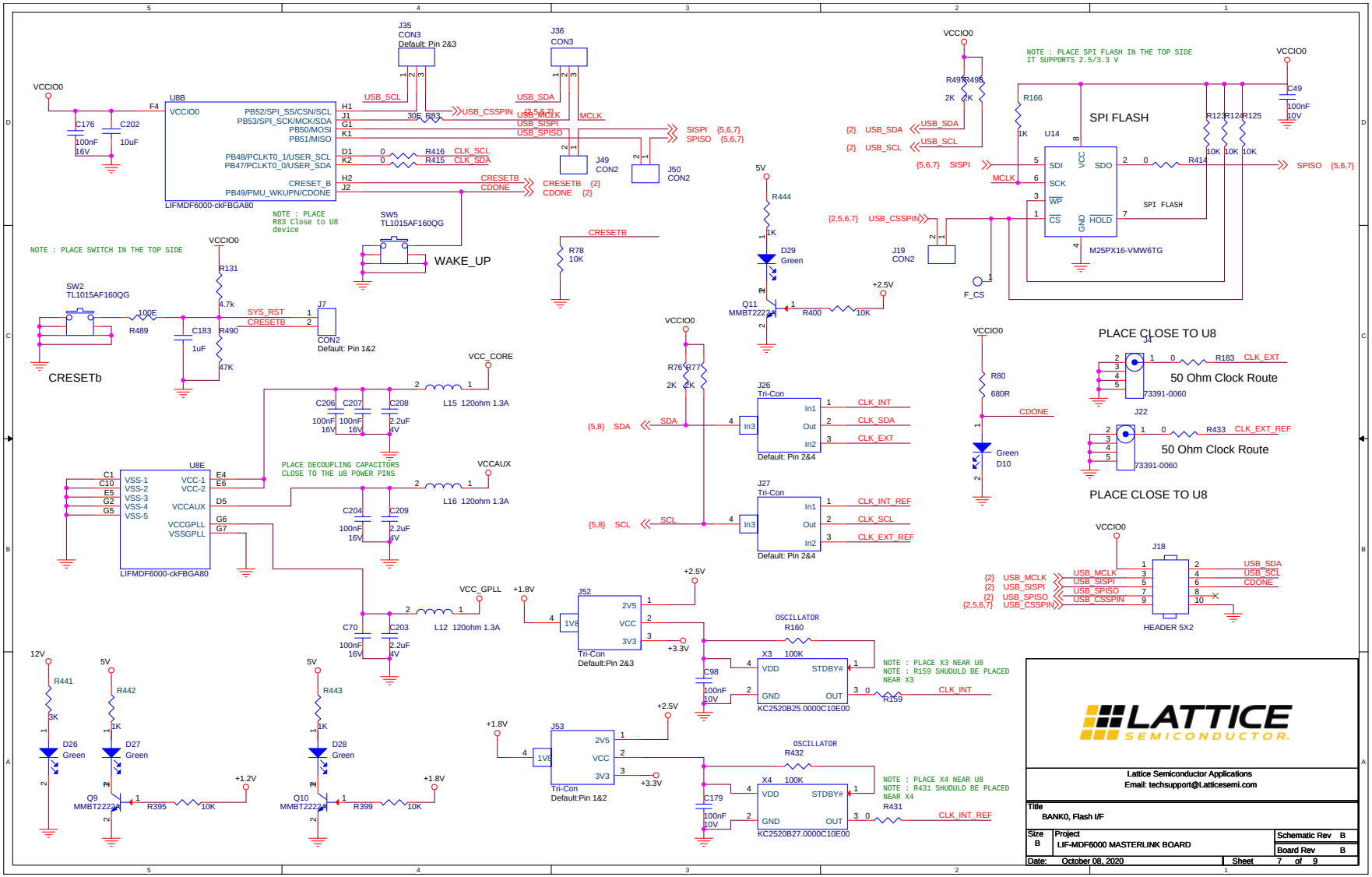


**Figure A.7. Bank0, Flash Interface**

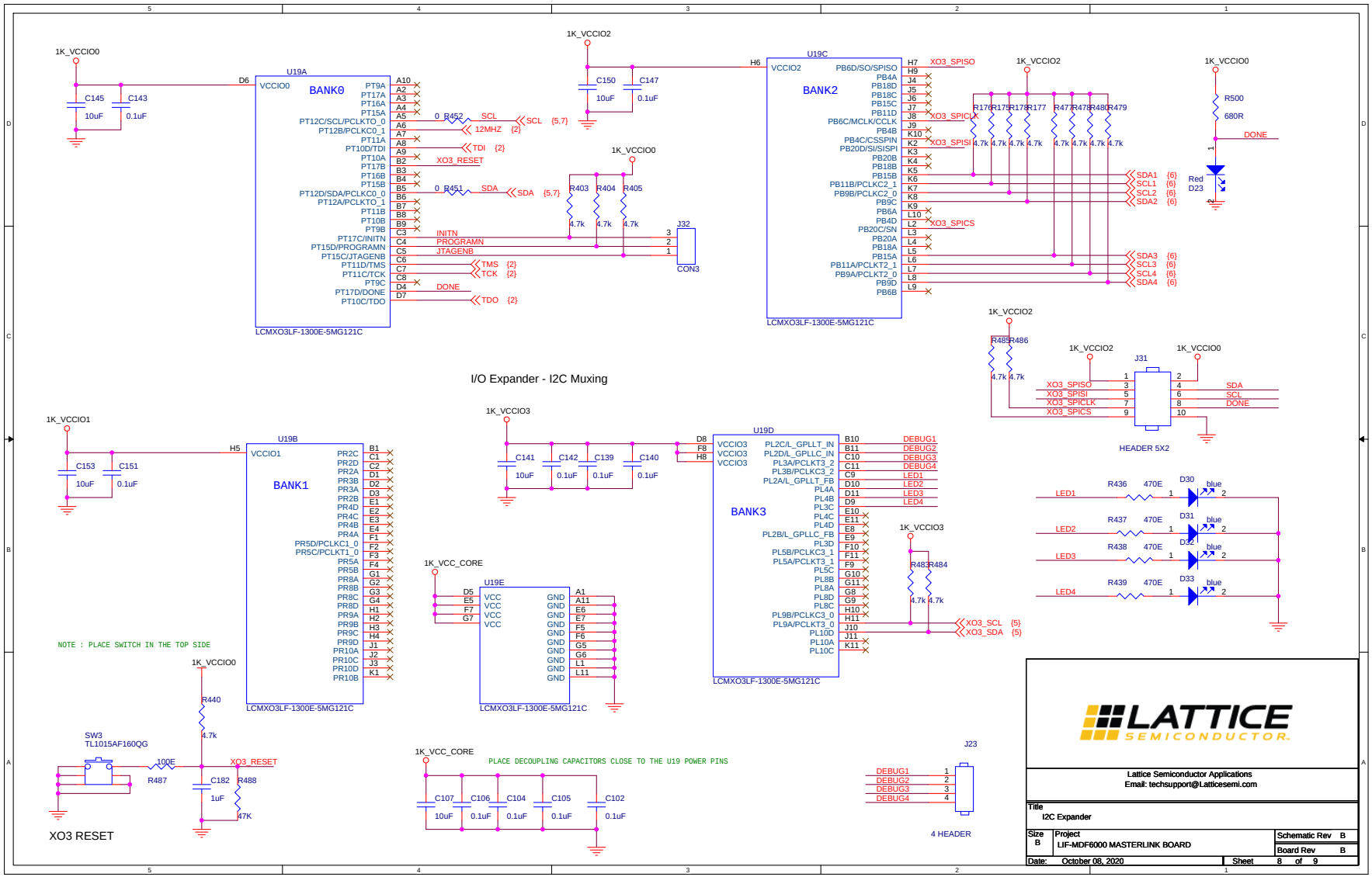


**Figure A.8. I²C Expander**

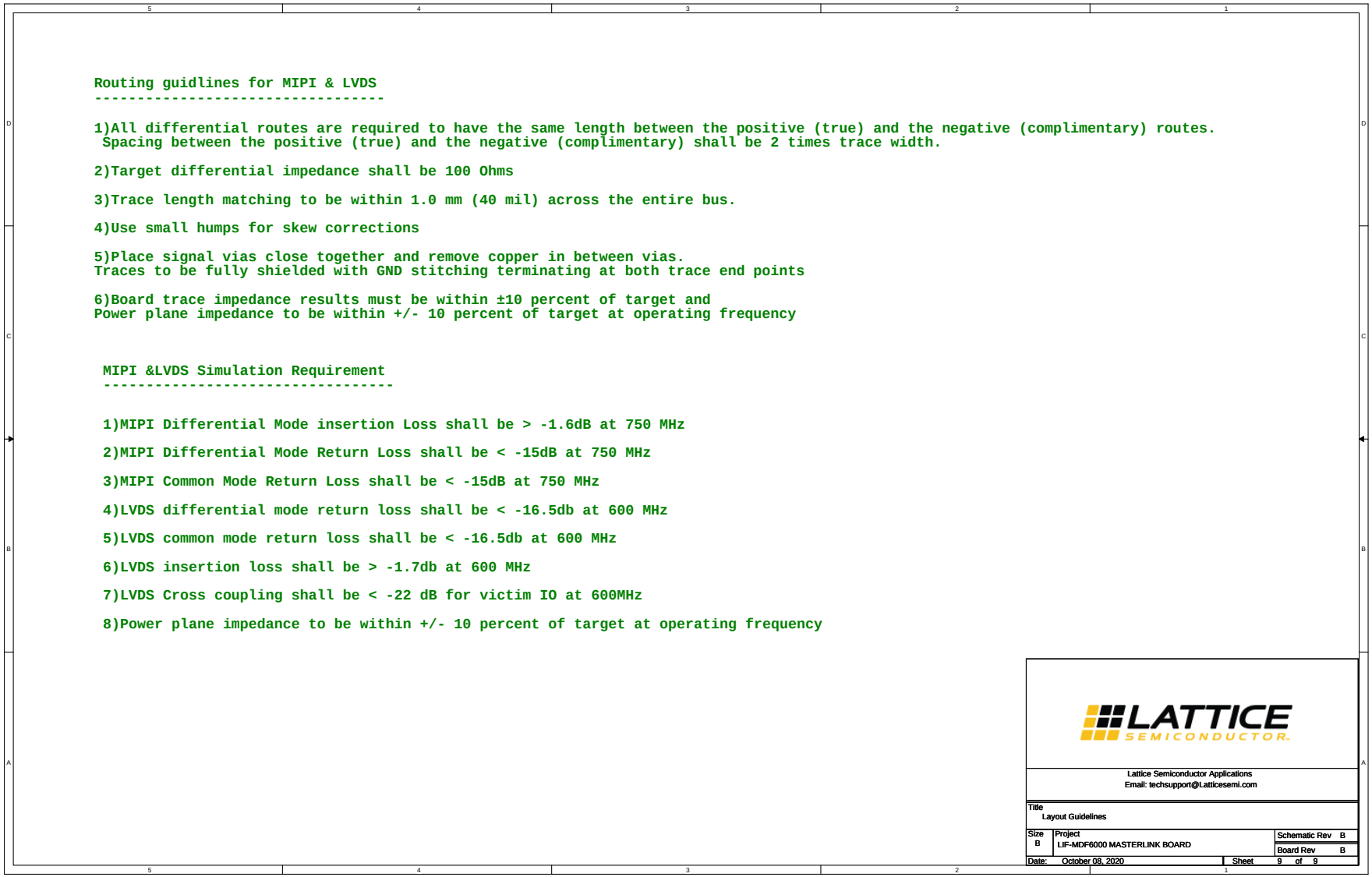


**Figure A.9. Layout Guidelines**

# Appendix B. LIF-MDF6000-ML-EVN-BRD Bill of Materials

| Item | Reference | Qty | Part | PCB Footprint | Comments | PART_NUMBER | Manufacturer | Description |
|---|---|---|---|---|---|---|---|---|
| 1 | C1,C3 | 2 | 4u7 | C0603 | — | ECJ-1VB0J475K | Panasonic | Cap Cer 4.7uF 6.3V 10% X5R 0603 |
| 2 | C2,C4,C5,C6,C8,C9,C13, C14,C15,C16,C29,C95, C97,C155,C156,C157, C158,C159,C160,C161, C162,C163,C164,C165, C166,C167,C168,C169, C170,C193,C194,C196 | 32 | 0.1uF | C0402 | — | GRM155R61H104KE14D | Murata | CAP CER 0.1UF 50V X5R 0402 |
| 3 | C7,C20,C23,C94,C96, C107,C114,C141,C145, C150,C153,C191,C199, C200,C202 | 15 | 10uF | C0603 | — | GRM188R61A106KE69D | Murata | CAP CER 10UF 10V X5R 0603 |
| 4 | C10,C11 | 2 | 18pF | C0402 | — | C0402C180K3GACTU | Kemet | CAP CER 18PF 25V NP0 0402 |
| 5 | C21,C24,C113 | 3 | 22uF | C0805 | — | LMK212BJ226MG-T | Taiyo Yuden | CAP CER 22UF 10V X5R 0805 |
| 6 | C41,C43,C203,C208,C209 | 5 | 2.2uF | C0306 | — | LLL185C70G225ME01L | Murata | CAP CER 2.2UF 4V X7S 0306 |
| 7 | C45,C210 | 2 | 2.2uF | C0402 | — | GRM155R61C225KE44D | Murata | CAP CER 2.2UF 16V X5R 0402 |
| 8 | C49,C98,C179 | 3 | 100nF | C0402 | — | GRM155R61A104KA01D | Murata | CAP CER 0.1UF 10V X5R 0402 |
| 9 | C51,C58,C70,C176,C197, C198,C204,C206,C207 | 9 | 100nF | C0201 | — | C0603X5R1C104K030BC | TDK | CAP CER 0.1UF 16V X5R 0201 |
| 10 | C102,C104,C105,C106, C139,C140,C142,C143, C147,C151,C178,C189, C190,C205 | 14 | 0.1uF | C0201 | — | GRM033R61C104ME84D | Murata | CAP CER 0.1UF 16V X5R 0201 |
| 11 | C115,C130 | 2 | 10uF | C0603 | — | CL10A106MA8NRNC | Samsung | CAP CER 10UF 25V 20% X5R 0603 |
| 12 | C123 | 1 | 0.1uF | C0603 | — | GRM188R71E104KA01D | Murata | CAP CER 0.1UF 25V 10% X7R 0603 |
| 13 | C127 | 1 | 680pF | C0603 | — | C0603C681J3GACTU | Kemet | CAP CER 680PF 25V 5% NP0 0603 |

| Item | Reference | Qty | Part | PCB Footprint | Comments | PART_NUMBER | Manufacturer | Description |
|---|---|---|---|---|---|---|---|---|
| 14 | C128 | 1 | 0.47uF | C0402 | — | CL05A474KA5NNNC | Samsung | CAP CER 0.47UF 25V 10% X5R 0402 |
| 15 | C129 | 1 | 47uF | C0805 | — | C2012X5R1A476M125AC | TDK | CAP CER 47UF 10V 20% X5R 0805 |
| 16 | C182,C183,C184 | 3 | 1uF | C0402 | — | C0402C105K9PACTU | Kemet | CAP CER 1UF 6.3V X5R 0402 |
| 17 | C201 | 1 | 1uF | C0306 | — | LWK107BJ105MVHT | Taiyo Yuden | CAP CER 1UF 10V X5R 0306 |
| 18 | D1,D14 | 2 | SL44-E3/57T | SL44E357T | — | SL44-E3/57T | Vishay semiconductor | DIODE SCHOTTKY 40V 4A DO214AB |
| 19 | D3,D25,D26,D27,D28, D29 | 6 | Green | led_0603 | — | LTST-C190KGKT | LITE-On INC | LED GREEN CLEAR CHIP SMD |
| 20 | D6,D7,D8,D9,D30,D31, D32,D33 | 8 | blue | led_0603 | — | LTST-C193TBKT-5A | LITE-On INC | LED BLUE CLEAR CHIP SMD |
| 21 | D10 | 1 | Green | led_0603 | — | LTST-C190KGKT | LITE-On INC | LED GREEN CLEAR CHIP SMD |
| 22 | D12 | 1 | 0.3VF | MBRA340T3G | — | MBRA340T3G | ON Semi | DIODE SCHOTTKY 40V 3A SMA |
| 23 | D23 | 1 | Red | led_0603 | — | LTST-C193KRKT-5A | LITE-On INC | LED RED CLEAR CHIP SMD |
| 24 | VCC_DPHY1,VCC_CORE1, VCCIO1,GND1,VCCIO2, GND2,GND3,GND4, GND5,1K_VCCIO0, 1K_VCC_CORE1, 1K_VCCIO1,1V2, 1K_VCCIO2,1K_VCCIO3, 1V8,2V5,3V3,5V0,12V0, VCC_DPHY0,VCCIO0, F_CS | 23 | TP_S_40_63 | tp_s_40_63 | DNL | - | - | - |
| 25 | J1 | 1 | header_1x8 | hdr_amp_87220_8_1x8_100 | — | 22-28-4081 | Molex | CONN HEADER VERT 8POS 2.54MM |
| 26 | J2 | 1 | SKT_MINIUSB_B_RA | skt_miniusb_b_ra | — | 5075BMR-05-SM-CR | Neltron | CONN MINI USB RCPT RA TYPE B SMD |
| 27 | J3 | 1 | PJ-032A | PJ-032A | — | PJ-032A | CUI Inc. | CONN PWR JACK 2X5.5MM SOLDER |
| 28 | J4,J22 | 2 | 73391-0060 | 73391-0060 | — | 73391-0060 | Molex | CONN SMA RCPT STR 50 OHM PCB |
| 29 | J7 | 1 | CON2 | CON2 | Default: Pin 1&2 | - | - | General 100 mils 2 Position header |

| Item | Reference | Qty | Part | PCB Footprint | Comments | PART_NUMBER | Manufacturer | Description |
|---|---|---|---|---|---|---|---|---|
| 30 | J8,J9 | 2 | 2 Position Terminal Block_0 | TERM_BLOCK_2 POS_10A | — | 1727010 | Phoenix Contact | TERM BLK 2P SIDE ENT 3.81MM PCB |
| 31 | J16 | 1 | HEADER 3 | header1X3 | Default: Pin 1&2 | — | — | General 100 mils Header 1x3 |
| 32 | J18,J31 | 2 | HEADER 5X2 | header2X5 | — | — | — | General 100 Mils 2*5 header |
| 33 | J19,J37,J49,J50,J51 | 5 | CON2 | CON2 | — | — | — | General 100 mils 2 Position header |
| 34 | J23 | 1 | 4 HEADER | CON4 | — | — | — | General 100 mils 4 Position header |
| 35 | J24,J25 | 2 | Quad-Con | Quad-Con | Default:Pin 1&2 | — | — | General 100 mils header |
| 36 | J26,J27 | 2 | Tri-Con | TriCon | Default: Pin 2&4 | — | — | General 100 mils header |
| 37 | J28 | 1 | CON6 | HDR1X6 | — | — | — | General 100 mils header |
| 38 | J32,J36 | 2 | CON3 | HDR1X3 | — | — | — | General 100 mils header |
| 39 | J30,J38,J39,J41,J42,J44, J45,J48 | 8 | Header_2x 1 | Header_2x1 | — | — | — | General 100 mils header |
| 40 | J29,J35,J43 | 3 | CON3 | HDR1X3 | Default: Pin 2&3 | — | — | General 100 mils header |
| 41 | J40,J52,J53 | 3 | Tri-Con | Tri-Con | Default:Pin 2&3 | — | — | General 100 mils header |
| 42 | L1,L2,L3,L4,L5,L6,L7,L9 | 8 | 600ohm 500mA | FB0603 | — | BLM18AG601SN1D | Murata | FERRITE BEAD 600 OHM 0603 1LN |
| 43 | L8 | 1 | 4.7uH | MPLC0730L4R7 | — | MPLC0730L4R7 | Kemet | FIXED IND 4.7UH 5A 41 MOHM SMD |
| 44 | L10,L11,L12,L13,L14,L15, L16 | 7 | 120ohm 1.3A | FB0402 | — | BLM15PD121SN1D | Murata | FERRITE BEAD 120 OHM 0402 1LN |
| 45 | MH1,MH2,MH3,MH4,M H5,MH6,MH7,MH8,MH9, MH10 | 10 | ThruHole | MTG125 | DNL | — | — | — |
| 46 | Q9,Q10,Q11 | 3 | MMBT222 2A | SM_SOT23-3 | — | MMBT2222A,215 | Nexperia USA Inc. | TRANS NPN 40V 0.6A SOT23 |
| 47 | R1,R2,R3,R56,R131,R171, R175,R176,R177,R178, R403,R404,R405,R440, R445,R477,R478,R479, R480,R483,R484,R485, R486 | 23 | 4.7k | R0603 | — | CRCW06034K70FKEA | Vishay | RES SMD 4.7K OHM 1% 1/10W 0603 |

| Item | Reference | Qty | Part | PCB Footprint | Comments | PART_NUMBER | Manufacturer | Description |
|---|---|---|---|---|---|---|---|---|
| 48 | R4,R5,R6,R7,R15,R16, R26,R37,R39,R159,R165, R167,R180,R181,R183, R192,R431,R433 | 18 | 0 | R0603 | — | RC0603JR-070RL | Yageo | RES SMD 0.0OHM JUMPER 1/10W 0603 |
| 49 | R9,R10 | 2 | 2k2 | R0603 | — | CRCW06032K20FKEA | Vishay | RES SMD 2.2K OHM 1% 1/10W 0603 |
| 50 | R11,R17 | 2 | 12k | R0603 | — | RC0603FR-0712KL | Yageo | RES SMD 12K OHM 1% 1/10W 0603 |
| 51 | R12,R13,R14,R123,R124, R125 | 6 | 10K | R0603 | — | RMCF0603JT10K0 | Stackpole Electronics Inc | RES SMD 10K OHM 5% 1/10W 0603 |
| 52 | R22,R144 | 2 | 4.7k | R0603 | DNL | RC0603JR-074K7L | Yageo | RES SMD 4.7K OHM 5% 1/10W 0603 |
| 53 | R23,R418,R419,R422, R423,R481,R482,R496 | 8 | 0 | R0603 | DNL | RC0603JR-070RL | Yageo | RES SMD 0.0OHM JUMPER 1/10W 0603 |
| 54 | R36,R499 | 2 | 1K | R0603 | — | RC0603FR-071KL | Yageo | RES SMD 1K OHM 1% 1/10W 0603 |
| 55 | R54,R55,R57,R59 | 4 | 470E | R0402 | — | RC0402FR-07470RL | Yageo | RES SMD 470 OHM 1% 1/16W 0402 |
| 56 | R76,R77,R497,R498 | 4 | 2K | R0402 | — | ERJ-2RKF2001X | Panasonic | RES SMD 2K OHM 1% 1/10W 0402 |
| 57 | R78 | 1 | 10K | R0402 | — | RMCF0402JT10K0 | Stackpole Electronics Inc | RES SMD 10K OHM 5% 1/16W 0402 |
| 58 | R80,R500 | 2 | 680R | R0402 | — | RMCF0402JT680R | Stackpole Electronics Inc | RES SMD 680 OHM 5% 1/16W 0402 |
| 59 | R83 | 1 | 30E | R0603 | — | RC0603FR-0730RL | Yageo | RES SMD 30 OHM 1% 1/10W 0603 |
| 60 | R129,R503,R504,R509, R510,R511,R512,R515 | 8 | 0.1 | 603 | — | ERJ-3RSFR10V | Panasonic | RES 0.1 OHM 1% 1/10W 0603 |
| 61 | R160,R232,R432 | 3 | 100K | R0402 | — | ERJ-2RKF1003X | Panasonic | RES SMD 100K OHM 1% 1/10W 0402 |
| 62 | R166,R442,R443,R444 | 4 | 1K | R0402 | — | RMCF0402JT1K00 | Stackpole Electronics Inc | RES SMD 1K OHM 5% 1/16W 0402 |
| 63 | R184,R186,R188,R190, R410 | 5 | 1 | R0603 | — | CRCW06031R00JNEAHP | Vishay | RES SMD 1 OHM 5% 1/4W 0603 |
| 64 | R185,R187,R189,R411 | 4 | 1 | R0603 | DNL | CRCW06031R00JNEAHP | Vishay | RES SMD 1 OHM 5% 1/4W 0603 |
| 65 | R229 | 1 | 15K | R0402 | — | ERJ-2RKF1502X | Panasonic | RES SMD 15K OHM 1% 1/10W 0402 |

| Item | Reference | Qty | Part | PCB Footprint | Comments | PART_NUMBER | Manufacturer | Description |
|---|---|---|---|---|---|---|---|---|
| 66 | R230 | 1 | 34K | R0402 | — | ERJ-2RKF3402X | Panasonic | RES SMD 34K OHM 1% 1/10W 0402 |
| 67 | R231 | 1 | 536K | R0402 | — | ERJ-2RKF5363X | Panasonic | RES SMD 536K OHM 1% 1/10W 0402 |
| 68 | R233,R436,R437,R438, R439 | 5 | 470E | R0603 | — | RC0603FR-07470RL | Yageo | RES SMD 470 OHM 1% 1/10W 0603 |
| 69 | R395,R399,R400 | 3 | 10K | R0603 | — | RMCF0603JT10K0 | Stackpole Electronics Inc | RES SMD 10K OHM 5% 1/10W 0603 |
| 70 | R414,R415,R416,R420, R421,R424,R425,R451, R452,R453,R454,R455, R456,R465,R466 | 15 | 0 | R0603 | — | RC0603JR-070RL | Yageo | RES SMD 0.0OHM JUMPER 1/10W 0603 |
| 71 | R441 | 1 | 3K | R0402 | — | RC0402FR-073KL | Yageo | RES SMD 3K OHM 1% 1/16W 0402 |
| 72 | R446,R457,R458,R459, R460,R461,R462,R463, R464,R467,R468,R469, R470,R471,R472,R475, R476 | 17 | 0 | R0402 | — | RC0402JR-070RL | Yageo | RES SMD 0 OHM JUMPER 1/16W 0402 |
| 73 | R450 | 1 | 0 | R0402 | DNL | RC0402JR-070RL | Yageo | RES SMD 0 OHM JUMPER 1/16W 0402 |
| 74 | R487,R489,R491 | 3 | 100E | R0603 | — | RC0603FR07100RL | Yageo | RES SMD 100 OHM 1% 1/10W 0603 |
| 75 | R488,R490,R492 | 3 | 47K | R0402 | — | RC0402FR-0747KL | Yageo | RES SMD 47K OHM 1% 1/16W 0402 |
| 76 | SW1 | 1 | PWR | TS01CQE_switch | — | TS01CQE | C&K Components | SWITCH SLIDE SPDT 3A 120V |
| 77 | SW2,SW3,SW4,SW5 | 4 | TL1015AF160QG | 2psmd_eswitch | — | TL1015AF160QG | E-Switch | SWITCH TACTILE SPST-NO 0.05A 12V |
| 78 | U1 | 1 | FT2232HL | tqfp64_0p5_12p2x12p2_h1p6 | — | FT2232HL-REEL | FTDI | IC USB HS DUAL UART/FIFO 64-LQFP |
| 79 | U2 | 1 | 93LC56-SO8 | so8_50_244 | — | 93LC56C-I/SN | Microchip | IC EEPROM 2K SPI 3MHZ 8SOIC |
| 80 | U3 | 1 | FUSE | 0154004DRT | — | 0154004.DRT | Littelfuse | FUSE BRD MNT 4A 125VAC/VDC 2SMD |
| 81 | U5 | 1 | NCP1117ST33T3G | sot223_4p | — | NCP1117ST33T3G | On Semi | IC REG LINEAR 3.3V 1A SOT223 |

| Item | Reference | Qty | Part | PCB Footprint | Comments | PART_NUMBER | Manufacturer | Description |
|---|---|---|---|---|---|---|---|---|
| 82 | U6 | 1 | NCP1117ST25T3G | sot223_4p | — | NCP1117ST25T3G | On Semi | IC REG LINEAR 2.5V 1A SOT223 |
| 83 | U7,U9,U11,U12 | 4 | Hirose - FX12 - 40 Pos | Hirose-FX12 | — | FX12B-40P-0.4SV | Hirose Electric Co Ltd | CONN PLUG 40POS SMD GOLD |
| 84 | U8 | 1 | LIFMDF6000-ckFBGA80 | LIFMDF6000-ckFBGA80 | CUSTOMER SUPPLIED | — | — | — |
| 85 | U14 | 1 | M25PX16-VMW6TG | SOIC8 | — | M25PX16-VMW6TG TR | Micron Technology Inc | IC FLASH 16M SPI 75MHZ 8SO |
| 86 | U15 | 1 | AP7313-12SAG-7 | SOT23 | — | AP7313-12SAG-7 | Diodes Inc | IC REG LINEAR 1.2V 150MA SOT23 |
| 87 | U17 | 1 | NCP1117ST18T3G | sot223_4p | — | NCP1117ST18T3G | On Semi | IC REG LINEAR 1.8V 1A SOT223 |
| 88 | U18 | 1 | LT3680 | LT3680_10QFN | — | LT3680EDD#PBF | Linear Technology | IC REG BUCK ADJ 3.5A 10DFN |
| 89 | U19 | 1 | LCMXO3LF-1300E-5MG121C | LCMXO3LF-1200E-MG121 | CUSTOMER SUPPLIED | LCMXO3LF-1300E-5MG121C | Lattice Semiconductor | IC FPGA 100 I/O 121CSFBGA |
| 90 | U20 | 1 | ESDR0502N | ESDR0502N | — | ESDR0502NMUTBG | ON Semiconductor | TVS DIODE 5.5VWM 6UDFN |
| 91 | U21 | 1 | STG3693QTR | STG3693QTR | — | STG3693QTR | STMicroelectronics | IC SWITCH QUAD SPDT 16QFN |
| 92 | X1 | 1 | 12MHZ | crystal_4p_3p2x2p5 | — | 7M-12.000MAAJ-T | TXC | CRYSTAL 12.0000MHZ 18PF SMD |
| 93 | X3 | 1 | KC2520B25.0000C10E00 | KC2520B | — | KC2520B25.0000C10E00 | Kyocera | XTAL OSC XO 25.0000MHZ CMOS SMD |
| 94 | X4 | 1 | KC2520B27.0000C10E00 | KC2520B | — | KC2520B27.0000C10E00 | Kyocera | XTAL OSC XO 27.0000MHZ CMOS SMD |
| 95 | Shunts for Headers | 12 | | | — | SPC02SYAN | Sullins Connectors | CONN JUMPER SHORTING GOLD FLASH |
| 96 | CrossLinkPlus Master Link Board Rev B PCB | 1 | | | — | 305-PD-20-0961 | PACTRON | |

# Appendix C. SMA-IOL-EVN-BRD Schematics

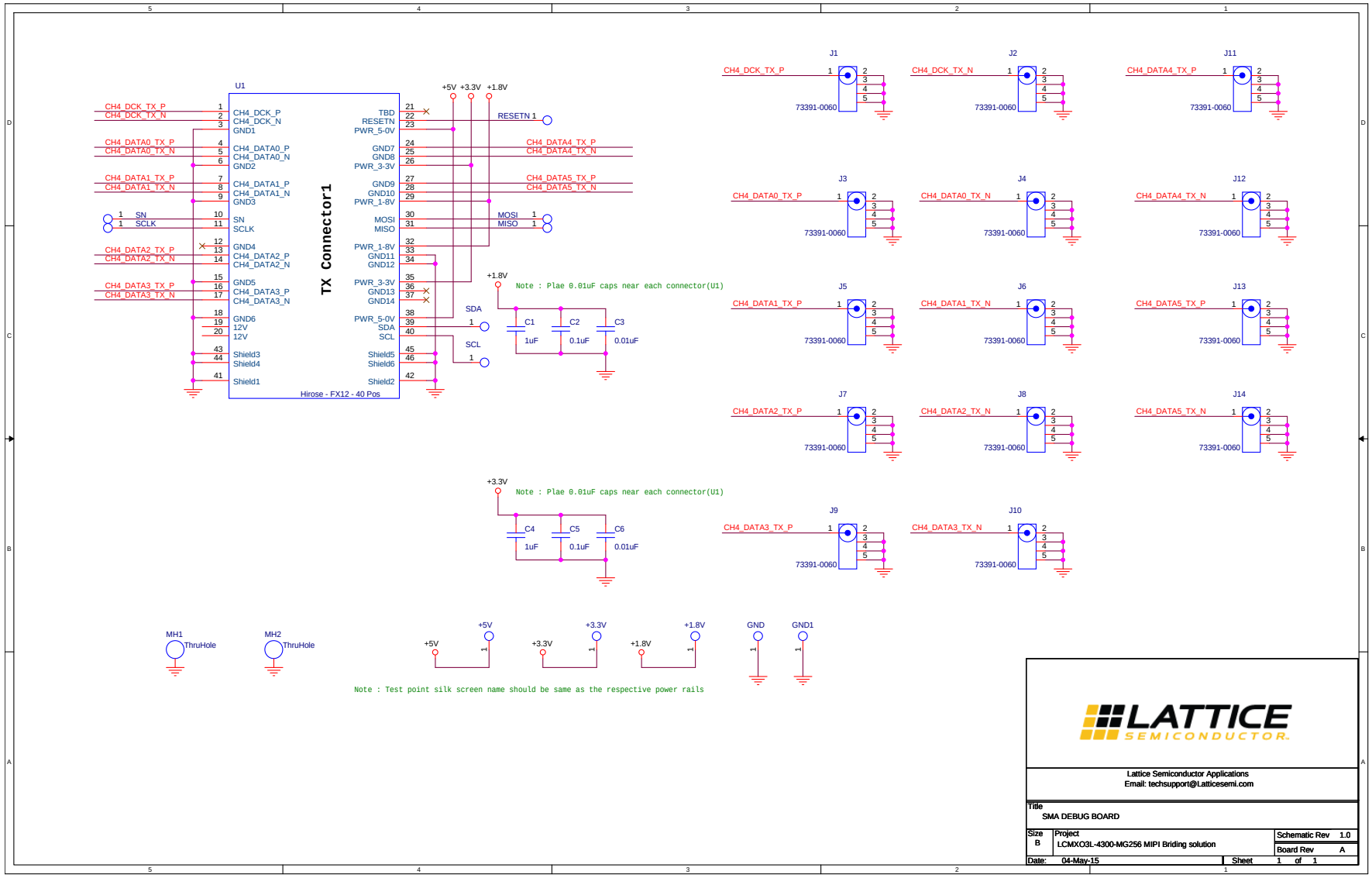


**Figure C.1. SMA Debug Board**

# Appendix D. SMA-IOL-EVN-BRD Bill of Materials

**SMA I/O Link Board Bill of Materials**

| Item | Reference | Qty | Part | PCB Footprint | Comments | PART_NUMBER | Manufacturer | Description |
|---|---|---|---|---|---|---|---|---|
| 1 | GND1, +5 V, +1.8 V, +3.3 V, SN, SDA, SCLK, SCL, RESETN, MOSI, MISO, GND | 12 | TP_S_40_63 | tp_s_40_63 | DNI | — | — | Square test point, 40 mil inner diameter, 63 mil outer diameter |
| 2 | C1, C4 | 2 | 1 µF | C0402 | — | C0402C105K9PACTU | Kemet | CAP CERAMIC 1 µF 6.3 V X5R 0402 |
| 3 | C2, C5 | 2 | 0.1 µF | C0402 | — | C0402C104K4RACTU | Kemet | CAP CERAMIC 0.1 µF 16 V X7R 0402 |
| 4 | C3, C6 | 2 | 0.01 µF | C0402 | — | C0402C103J4RACTU | Kemet | CAP CERAMIC 10 nF 16 V 5% X7R 0402 |
| 5 | J1, J2, J3, J4, J5, J6, J7, J8, J9, J10, J11, J12, J13, J14 | 14 | 73391-0060 | 73391-0060 | — | 73391-0060 | Molex | Molex Straight 50O Through Hole SMA Connector, jack, Solder Termination |
| 6 | MH1, MH2 | 2 | Thru Hole | MTG125 | — | — | — | — |
| 7 | U1 | 1 | Hirose - FX12 - 40 Pos | Hirose-FX12S | — | FX12B-40S-0.4SV | Hirose Electric Co Ltd | Conn Board to Board PL 40 POS 0.4 mm Solder ST SMD T/R |
| 8 | SMA IOLINK BOARD PCB | 1 | — | — | — | 305-PD-15-0589 | PACTRON | — |

# Appendix E. B-IOL-EVN-BRD Schematics

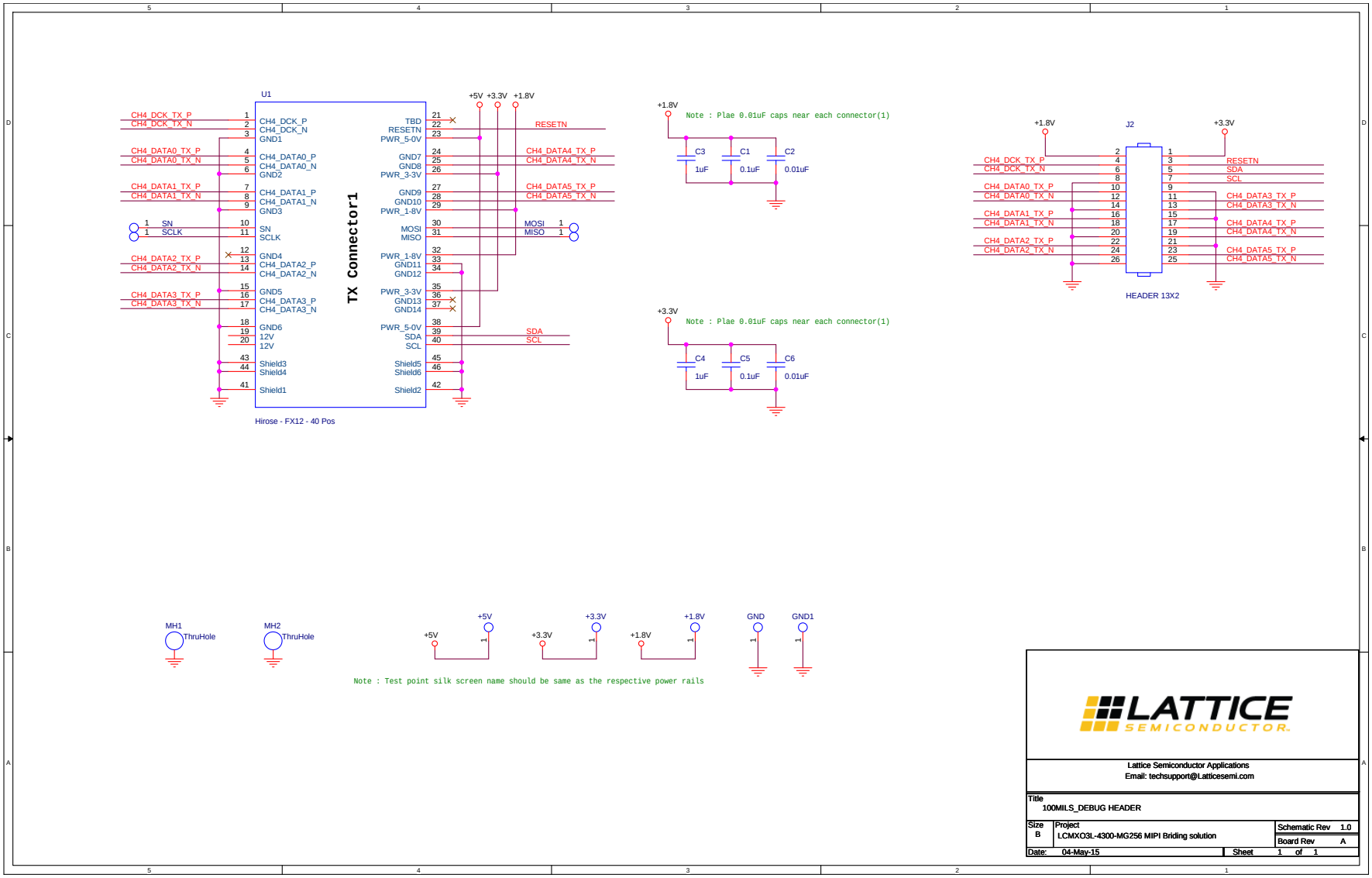


**Figure E.1. 100MILS_DEBUG Header**

# Appendix F. B-IOL-EVN-BRD Bill of Materials

**Breakout I/O Link Board Bill of Materials**

| Item | Reference | Qty | Part | PCB Footprint | Comments | Part_ Number | Manufacturer | Description |
|---|---|---|---|---|---|---|---|---|
| 1 | GND1, +5 V, +1.8 V, +3.3 V, SN, SCLK, MOSI, MISO, GND | 9 | TP_S_40_63 | tp_s_40_63 | DNL | — | — | Square test point, 40 mil inner diameter, 63 mil outer diameter |
| 2 | C1, C5 | 2 | 0.1 µF | C0402 | — | C0402C104K4RACTU | Kemet | CAP CERAMIC 0.1 µF 16 V X7R 0402 |
| 3 | C2, C6 | 2 | 0.01 µF | C0402 | — | C0402C103J4RACTU | Kemet | CAP CERAMIC 10 nF 16 V 5% X7R 0402 |
| 4 | C3, C4 | 2 | 1 µF | C0402 | — | C0402C105K9PACTU | Kemet | CAP CERAMIC 1 µF 6.3 V X5R 0402 |
| 5 | J2 | 1 | HEADER 13X2 | 13X2_HDR | REGULAR 100 MIL HEADER | — | — | — |
| 6 | MH1, MH2 | 2 | ThruHole | MTG125 | DNL | — | — | — |
| 7 | U1 | 1 | Hirose - FX12 - 40 Pos | Hirose-FX12S | — | FX12B-40S-0.4SV | Hirose Electric Co Ltd | Conn Board to Board PL 40 POS 0.4 mm Solder ST SMD T/R |
| 8 | BREAKOUT IOLINK BOARD PCB | 1 | — | — | — | 305-PD-15-0595 | PACTRON | — |

# References

For more information, refer to CrossLinkPlus Family Data Sheet (FPGA-DS-02054).

# Technical Support Assistance

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

# Revision History

**Revision 1.1, August2021**

| Section | Change Summary |
|---|---|
| Generating the Programming File | Added this section. |
| Programming the CrossLinkPlus Device | Added this section. |

**Revision 1.0, April 2021**

| Section | Change Summary |
|---|---|
| All | Initial release. |


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