



CertusPro-NX Voice and Vision Machine Learning Board

Evaluation Board User Guide

FPGA-EB-02050-1.0

October 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 |
| DDR | Double Data Rate |
| DSI | Display Serial Interface |
| FTDI | Future Technology Devices International |
| GPIO | General Purpose Input/Output |
| I ² C | Inter-Integrated Circuit |
| I ² S | Inter-IC Sound |
| JTAG | Joint Test Action Group |
| LDO | Low Dropout |
| LVDS | Low-Voltage Differential Signaling |
| MIPI | Mobile Industry Processor Interface |
| ML | Machine Learning |
| MSPI | Master SPI |
| PMOD | Peripheral Module |
| SMA | SubMiniature version A |
| SPI | Serial Peripheral Interface |
| SSPI | Slave SPI |
| VIP | Video Interface Platform |
| VTT | Tracking Termination Voltage |

1. Introduction

This document describes the Lattice Semiconductor CertusPro™-NX Voice and Vision Machine Learning Board. The board's key component is the CertusPro-NX FPGA, which receives input from high or low-resolution cameras and microphones, and sends video output over USB3. This board is ideal for machine learning applications and features onboard HyperRAM as well as PMOD (Peripheral Module) connectors for off board support.

The content of this user guide includes descriptions of onboard settings, connectors, programming circuit, a complete set of schematics, and bill of materials for the CertusPro-NX Voice and Vision Machine Learning Board.

The key features of the CertusPro-NX Voice and Vision Machine Learning Board include:

- CertusPro-NX FPGA (LFCPNX-100-BBG484)
 - Four-lane MIPI CSI-2 receiver (Soft D-PHY) interface for high resolution camera data
 - Serial interface for low resolution camera data
 - I²S interface for audio data from two microphones
 - SPI flash configuration
 - General Purpose Input/Output
- Board Resources
 - 2 × 64 Mb HyperRAM available for ML (Machine Learning) applications
 - Cypress CYUSB3014 for Video Output to PC over USB3
 - Four PMOD connectors expansion headers available
 - Expansion header for Soft MIPI DPHY connectivity
- Programming Circuit
 - From programming software through USB/FTDI interface (JTAG or SPI)
 - From onboard Flash
 - SPI external programmer using header

[Figure 1.1](#) and [Figure 1.2](#) show the top and bottom views of the CertusPro-NX Voice and Vision Machine Learning Board and its key components.

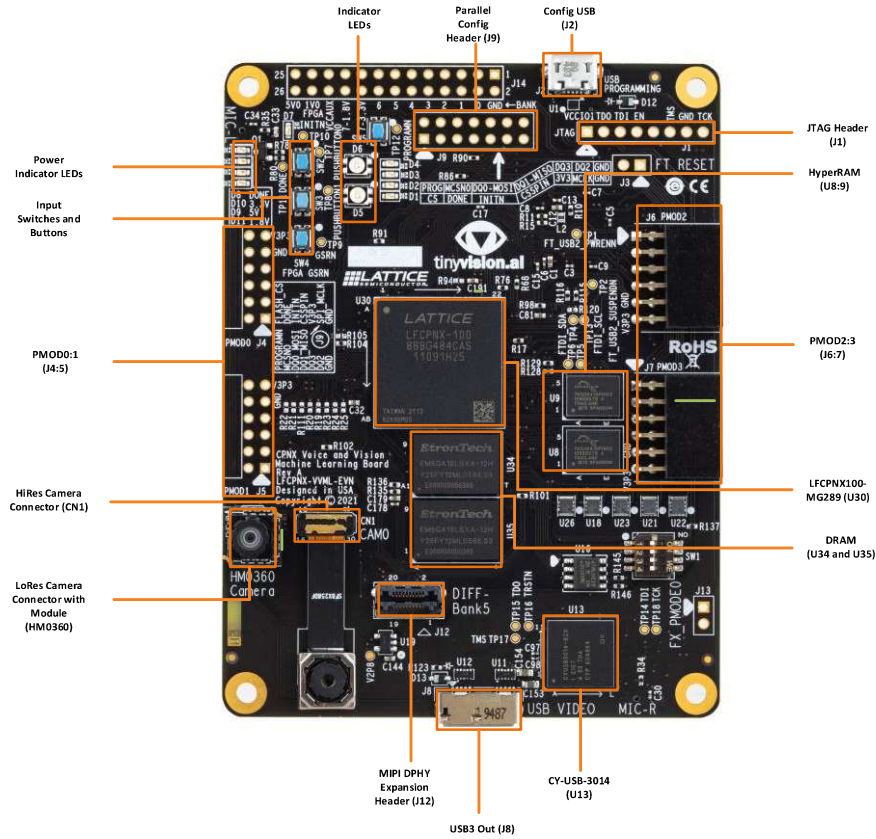


Figure 1.1. Top View of CertusPro-NX Voice and Vision Machine Learning Board

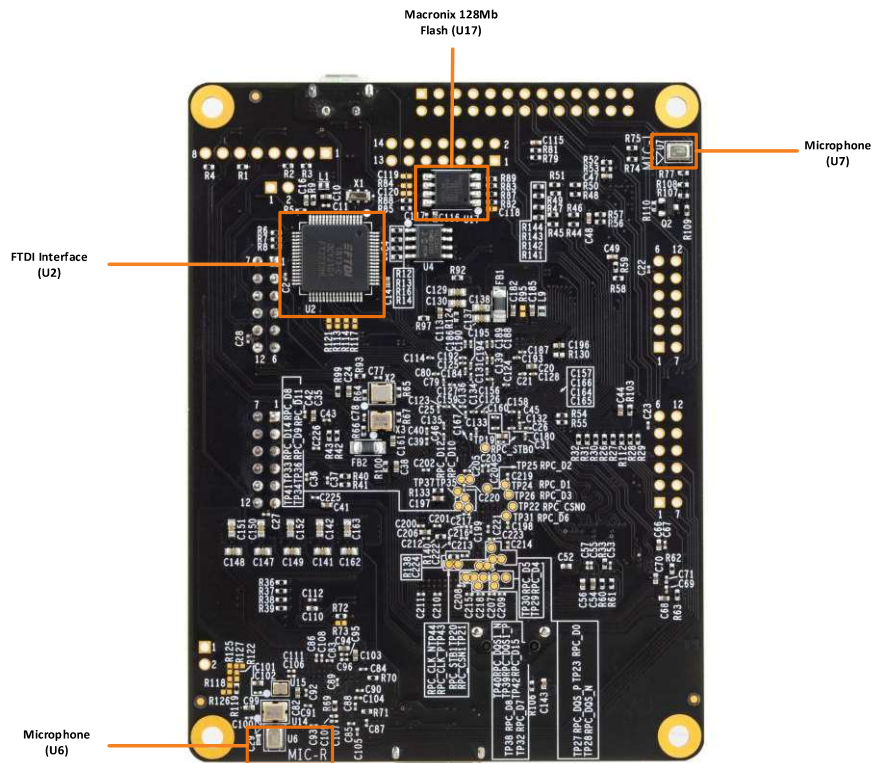


Figure 1.2. Bottom View of CertusPro-NX Voice and Vision Machine Learning Board

1.1. Further Information

The following references provide detailed information on the CertusPro-NX Voice and Vision Machine Learning Board and the CertusPro-NX FPGA device:

- [Appendix A. CertusPro-NX Voice and Vision Machine Learning Board Schematics](#)
- [Appendix B. CertusPro-NX Voice and Vision Machine Learning Board Bill of Materials](#)
- www.latticesemi.com/boards for more information on boards and kits
- [CertusPro-NX Family Data Sheet \(FPGA-DS-02086\)](#) for details on the CertusPro-NX FPGA

2. Headers and Jumpers

Table 2.1 lists the headers and jumpers as shown in Figure 1.1 and Figure 1.2.

Table 2.1. Headers and Test Connectors

| Part | Description | Settings (Default first) |
|----------------|-------------------------------|--|
| J1 | JTAG Header | — |
| J3 | FTDI Reset Jumper | Open (active FTDI)/Short (reset FTDI) |
| J4, J5, J6, J7 | PMOD Headers | — |
| J9 | Parallel Configuration Header | — |
| J12 | MIPI DPHY Expansion Header | — |
| J13 | USB3 Chip Mode | Open (FX_PMODE0=HiZ)/Short (FX_PMODE0=V3P3) |
| J14 | Current Measurement Headers | Open (functional, attach measurement probes) |

3. Board Programming

3.1. Programming Circuit

CertusPro-NX can be programmed with USB through the FTDI/JTAG interface using Lattice Radiant™ programmer software, or by an external programmer connected to Header J9.

Figure 3.1 shows the programming block of CertusPro-NX Voice and Vision Machine Learning board.

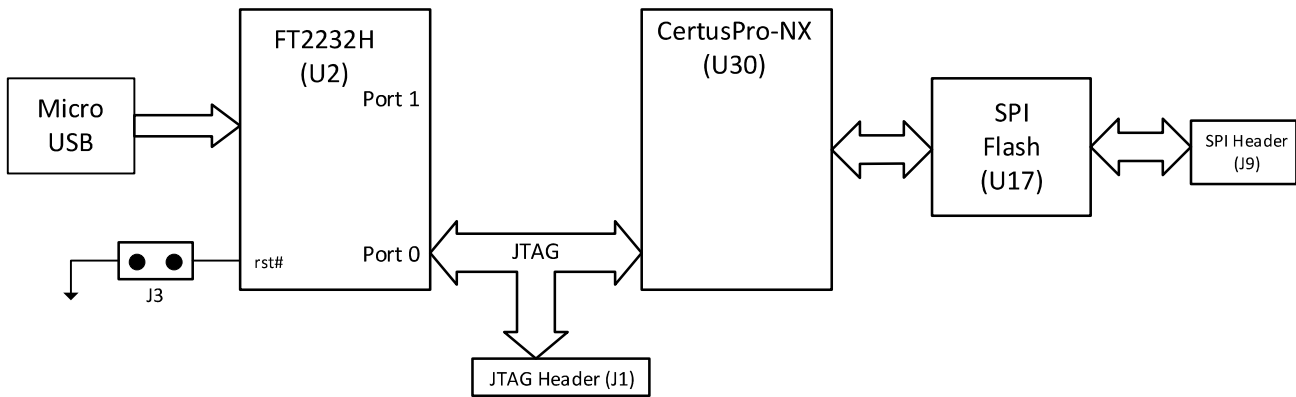


Figure 3.1. Programming Block

The FTDI/JTAG interface is used to program both CertusPro-NX and SPI Flash Memory (Macronix 25L12833 128Mb).

3.2. Programming the Board

This section describes the procedure for programming a pattern to the SRAM (volatile) configuration memory of CertusPro-NX. The CertusPro-NX can be programmed through the JTAG, I²C, or SPI interfaces. This section focuses on JTAG programming through the USB/FTDI interface. For details on the other configuration modes, refer to the [sysCONFIG Usage Guide for Nexus Platform \(FPGA-TN-02099\)](#).

The board is programmed using Lattice Radiant Programmer software, which can be started as a stand-alone tool or from a Lattice Radiant project.

To program the board:

1. Power ON the board by connecting the USB cable.
2. Start a programming project by launching the tool and initiating a board scan, as shown in Figure 3.2.

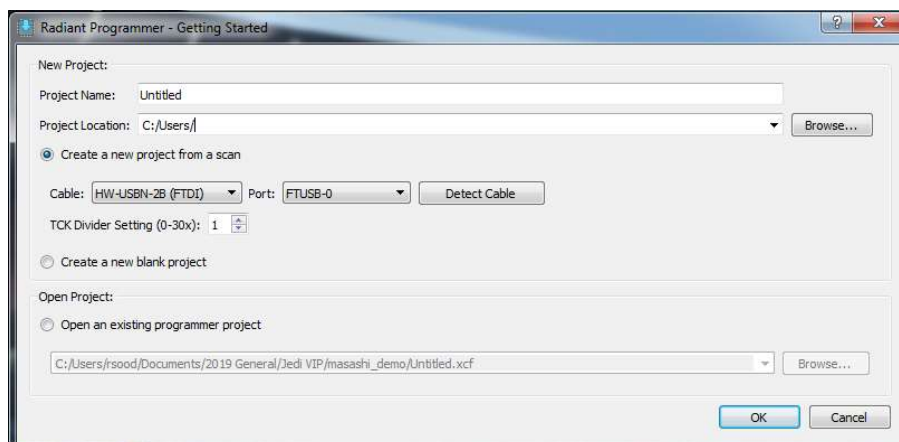


Figure 3.2. Starting Programmer

- When the board is successfully scanned, the window shown in [Figure 3.3](#) appears. This interface allows you to enter the file name.

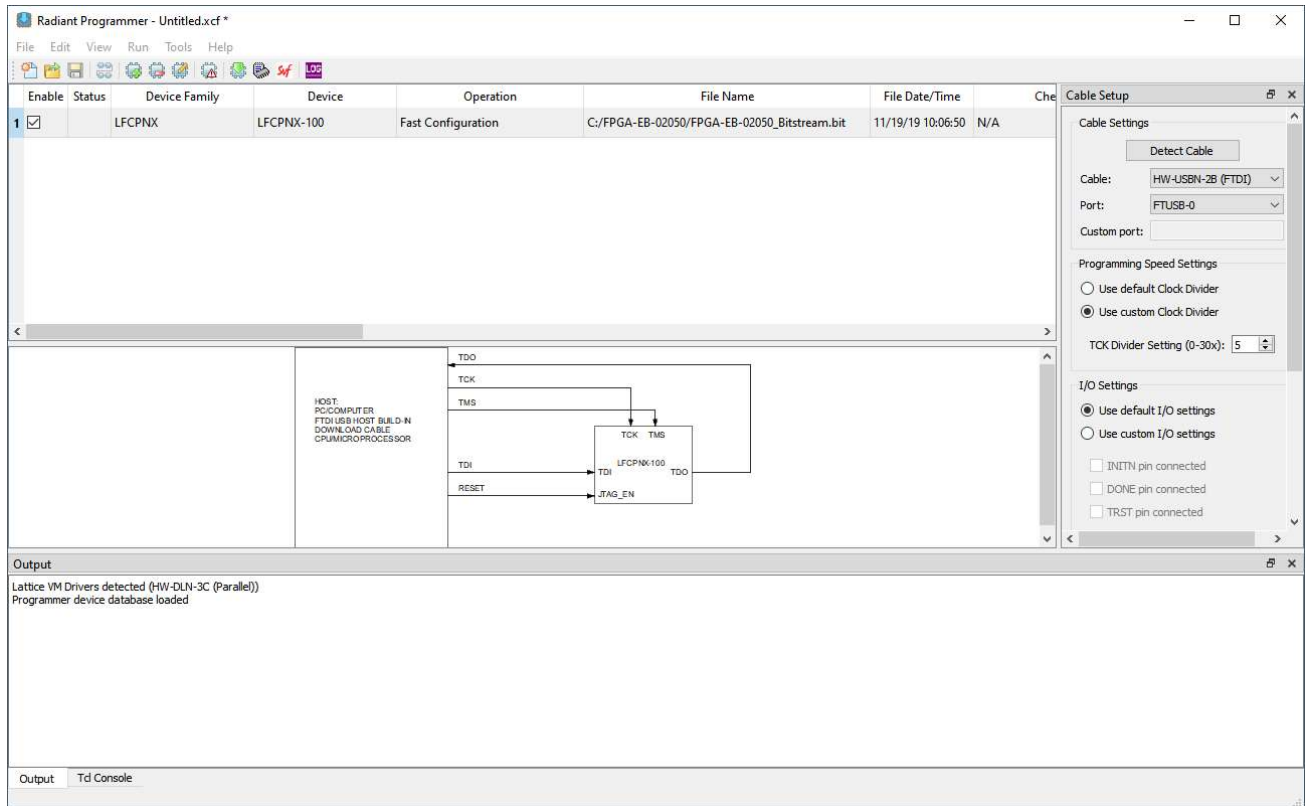


Figure 3.3. Entering File Name

- Double-click on the **Operation** field and select the appropriate programming mode. In this example, **Fast Configuration** of the SRAM array through JTAG is selected.

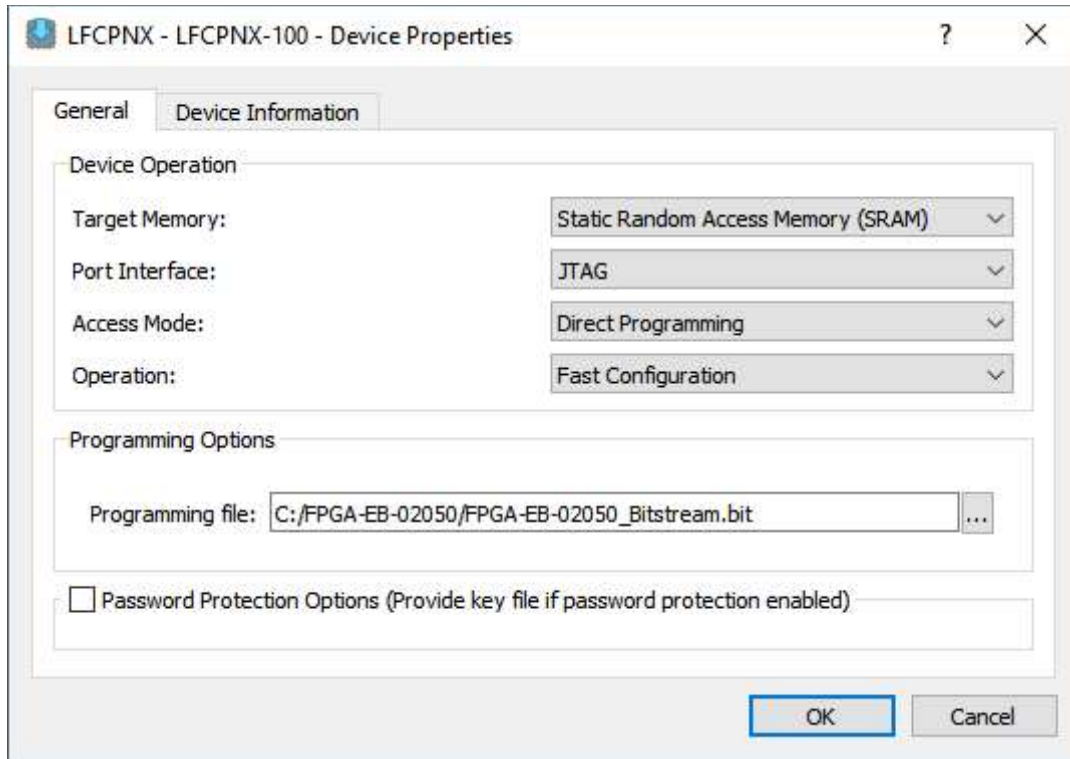


Figure 3.4. Entering Programming Mode

5. Click the **Program** button to configure the CertusPro-NX on the board.

4. CertusPro-NX Interface Support

The CertusPro-NX Voice and Vision Machine Learning board supports various onboard interfaces and external interfaces. The sections below describe key onboard interfaces supported on CertusPro-NX Voice and Vision Machine Learning board.

4.1. HiRes Camera Sensor Interfaces

Figure 4.1 shows the block diagram of the camera sensor interface. The Sony IMX258 image sensor is used as the input source on the camera sensor connector. The data path interface between the camera sensor module and CertusPro-NX is CSI-2. The cameras are configured using I²C interface from the CertusPro-NX.

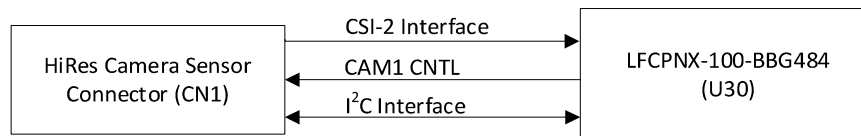


Figure 4.1. HiRes Camera Sensor Interface

4.2. LoRes Camera Sensor Interface

Figure 4.2 shows the block diagram of the camera sensor interface. The HiMax HM360 image sensor is used as the input source on the camera sensor connector. The data path interface between the camera sensor module and CertusPro-NX is serial differential. The cameras are configured using I²C interface from the CertusPro-NX.

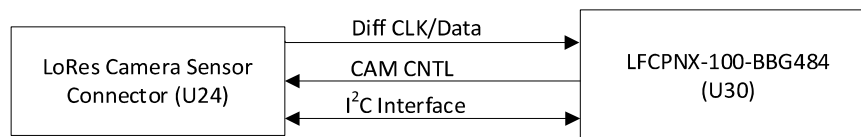


Figure 4.2. Upstream Connector Interface

4.3. Microphone Sensor Interface

Figure 4.3 shows the block diagram of the microphone sensor interface. The microphone sensors are Knowles SPH0645LM4H. There are two sensors on opposite sides of the board. The sensors share the I²S bus to the CertusPro-NX, which is the I²S master.

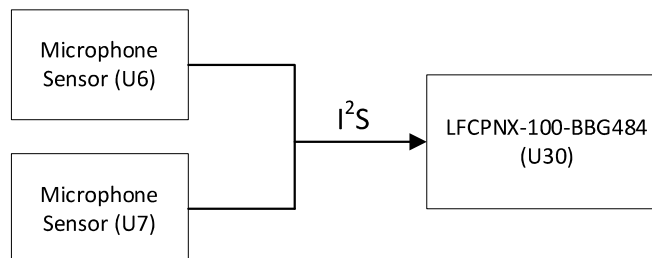


Figure 4.3. Microphone Sensor Interface

4.4. Video Out Interface

Figure 4.4 shows the block diagram of the video out interface. The video data from the CertusPro-NX is sent to the CYUSB3014, which processes the data and sends it out through the USB3.

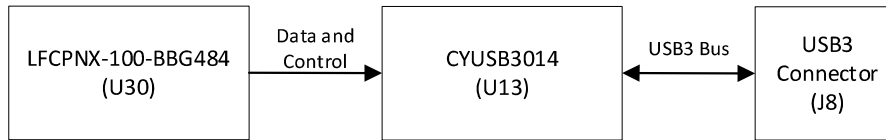


Figure 4.4. Video Out Interface

5. Power Supply

The power supply to the CertusPro-NX Voice and Vision Machine Learning Board is provided from the J2 or J8 USB connectors. If either or both USB ports are connected to a powered cable, the board powers up.

Figure 5.1 shows the power supply block of CertusPro-NX Voice and Vision Machine Learning Board. The 5 V is supplied through the USB, and then board converters create the remaining 3.3 V, 2.8 V, 1.8 V, 1.2 V, and 1.0 V supplies required by the board components. Each I/O and core voltage rail on the board is accessible by a test point on the board.

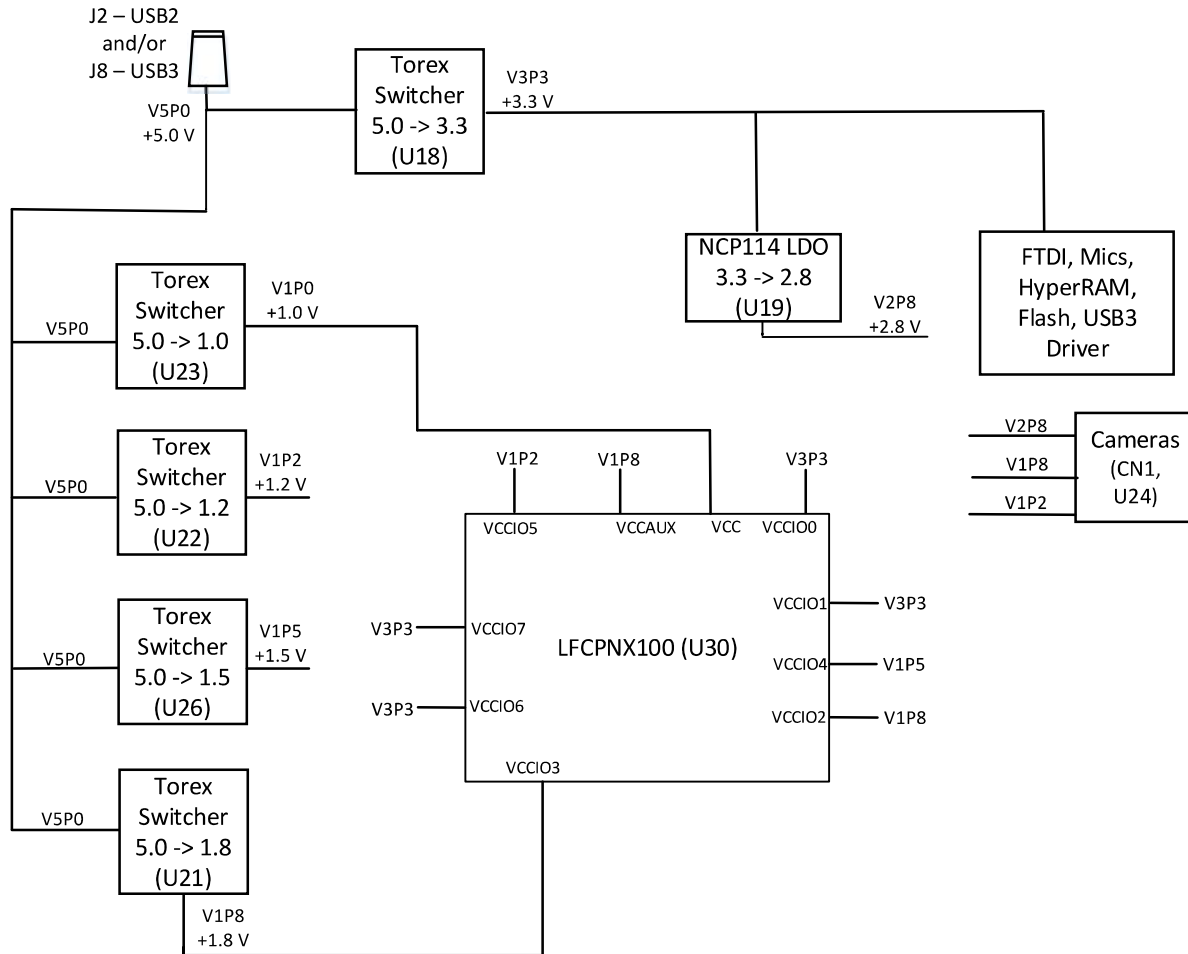


Figure 5.1. Power Supply Block

Table 5.1 lists the board voltage rails, including the rail source voltage, test point number, and voltage on net.

Table 5.1. Device Power Rail Summary

| Voltage Rail | Source Rail | Voltage on Net (V) | Status LED | LED Color |
|--------------|-------------|--------------------|------------|-----------|
| V5P0 | USB | 5.0 | D9 | Blue |
| V3P3 | V5P0 | 3.3 | D10 | Blue |
| V2P8 | V3P3 | 2.8 | — | — |
| V1P8 | V5P0 | 1.8 | D11 | Green |
| V1P5 | V5P0 | 1.5 | — | — |
| V1P2 | V5P0 | 1.2 | — | — |
| V1P0 | V5P0 | 1.0 | — | — |

6. CertusPro-NX I/O Ball Mapping to Connectors

Table 6.1. Camera Sensor Connector Pin Mapping

| CN1 | | | U24 | | |
|---------|----------------|----------|---------|-------------|----------|
| Pin Num | Net Name | Ball Num | Pin Num | Net Name | Ball Num |
| 1 | — | — | 1 | V2P8 | — |
| 2 | CAM0_CLKN | AB3 | 2 | GND | — |
| 3 | CAM0_CLKP | AB2 | 3 | HM_CP | U3 |
| 4 | GND | — | 4 | HM_CN | T3 |
| 5 | CAM0_3N | Y3 | 5 | GND | — |
| 6 | CAM0_3P | W3 | 6 | HM_DP | T1 |
| 7 | GND | — | 7 | HM_DN | U1 |
| 8 | CAM0_1N | Y5 | 8 | GND | — |
| 9 | CAM0_1P | W5 | 9 | — | — |
| 10 | GND | — | 10 | — | — |
| 11 | CAM0_ON | Y6 | 11 | GND | — |
| 12 | CAM0_OP | W6 | 12 | V1P8 | — |
| 13 | GND | — | 13 | V1P2 | — |
| 14 | CAM0_2N | Y2 | 14 | GND | — |
| 15 | CAM0_2P | W2 | 15 | HM_MCLK | N18 |
| 16 | GND | — | 16 | HM_PCLK | L12 |
| 17 | GND | — | 17 | HM_CTX_SELO | M17 |
| 18 | V2P8 | — | 18 | HM_INT | M16 |
| 19 | — | — | 19 | HM_SDA | P14 |
| 20 | CAM0_MCLK | P19 | 20 | HM_SCL | N13 |
| 21 | CAM_FRAME_SYNC | R21 | 21 | HM_HSYNC | N12 |
| 22 | I2CO_SDA | P18 | 22 | HM_VSYNC | N14 |
| 23 | I2CO_SCL | R20 | 23 | HM_TRIG | L13 |
| 24 | CAM_RESET | N17 | 24 | GND | — |
| 25 | V1P2 | — | 25 | HM_CLK_SEL | M15 |
| 26 | V1P8 | — | 26 | HM_CLK_RTC | N11 |
| 27 | GND | — | 27 | HM_FAE | R22 |
| 28 | GND | — | 28 | HM_XSDN | M14 |
| 29 | V2P8 | — | 29 | HM_XSLEEPN | M13 |
| 30 | GND | — | 30 | HM_STROBE | M12 |

Table 6.2. PMOD Connector Pin Mapping

| PMOD0 (J4) | | | PMOD1 (J5) | | | PMOD2 (J6) | | | PMOD3 (J7) | | |
|------------|----------|----------|------------|----------|----------|------------|----------|----------|------------|----------|----------|
| Pin Num | Net Name | Ball Num | Pin Num | Net Name | Ball Num | Pin Num | Net Name | Ball Num | Pin Num | Net Name | Ball Num |
| 1 | PMOD0_1 | L6 | 1 | PMOD1_1 | L1 | 1 | PMOD2_1 | L4 | 1 | PMOD3_1 | J7 |
| 2 | PMOD0_2 | L8 | 2 | PMOD1_2 | K2 | 2 | PMOD2_2 | H1 | 2 | PMOD3_2 | K6 |
| 3 | PMOD0_3 | L10 | 3 | PMOD1_3 | K3 | 3 | PMOD2_3 | G5 | 3 | PMOD3_3 | H5 |
| 4 | PMOD0_4 | K10 | 4 | PMOD1_4 | J1 | 4 | PMOD2_4 | J9 | 4 | PMOD3_4 | K4 |
| 5 | GND | — | 5 | GND | — | 5 | GND | — | 5 | GND | — |
| 6 | V3P3 | — | 6 | V3P3 | — | 6 | V3P3 | — | 6 | V3P3 | — |
| 7 | PMOD0_7 | J6 | 7 | PMOD1_7 | L2 | 7 | PMOD2_7 | L3 | 7 | PMOD3_7 | K8 |
| 8 | PMOD0_8 | H6 | 8 | PMOD1_8 | M1 | 8 | PMOD2_8 | J2 | 8 | PMOD3_8 | J8 |
| 9 | PMOD0_9 | H7 | 9 | PMOD1_9 | M2 | 9 | PMOD2_9 | H4 | 9 | PMOD3_9 | L9 |
| 10 | PMOD0_10 | H8 | 10 | PMOD1_10 | K1 | 10 | PMOD2_10 | G7 | 10 | PMOD3_10 | K9 |
| 11 | GND | — | 11 | GND | — | 11 | GND | — | 11 | GND | — |
| 12 | V3P3 | — | 12 | V3P3 | — | 12 | V3P3 | — | 12 | V3P3 | — |

Table 6.3. HyperRAM Pin Mapping

| HyperRAM0 (U8) | | | HyperRAM1 (U9) | | |
|----------------|----------|----------|----------------|----------|----------|
| Pin Name/Num | Net Name | Ball Num | Pin Name/Num | Net Name | Ball Num |
| RFU1/A2 | — | — | RFU1/A2 | — | — |
| RFU2/A5 | — | — | RFU2/A5 | — | — |
| CS#/A3 | HR0_CS | AA18 | CS#/A3 | HR1_CS | AA19 |
| RESET#/A4 | HR0_RST | AB17 | RESET#/A4 | HR1_RST | U18 |
| CK#/B1 | HR0_CKN | Y18 | CK#/B1 | HR1_CKN | W21 |
| CK/B2 | HR0_CK | Y19 | CK/B2 | HR1_CK | W22 |
| VSS/B3 | GND | — | VSS/B3 | GND | — |
| VSSQ/C1 | GND | — | VSSQ/C1 | GND | — |
| VSSQ/E5 | GND | — | VSSQ/E5 | GND | — |
| VCC/B4 | VCCIO3 | — | VCC/B4 | VCCIO3 | — |
| VCCQ/E4 | VCCIO3 | — | VCCQ/E4 | VCCIO3 | — |
| VCCQ/D1 | VCCIO3 | — | VCCQ/D1 | VCCIO3 | — |
| RFU3/B5 | — | — | RFU3/B5 | — | — |
| RFU4/C2 | — | — | RFU4/C2 | — | — |
| RFU5/C5 | — | — | RFU5/C5 | — | — |
| RWDS/C3 | HR0_RW | V19 | RWDS/C3 | HR1_RW | Y21 |
| DQ0/D3 | HR0_DQ0 | V18 | DQ0/D3 | HR1_DQ0 | V22 |
| DQ1/D2 | HR0_DQ1 | W19 | DQ1/D2 | HR1_DQ1 | AA20 |
| DQ2/C4 | HR0_DQ2 | AB19 | DQ2/C4 | HR1_DQ2 | V21 |
| DQ3/D4 | HR0_DQ3 | AB20 | DQ3/D4 | HR1_DQ3 | U21 |
| DQ4/D5 | HR0_DQ4 | AB21 | DQ4/D5 | HR1_DQ4 | U20 |
| DQ5/E3 | HR0_DQ5 | AB18 | DQ5/E3 | HR1_DQ5 | Y22 |
| DQ6/E2 | HR0_DQ6 | AA17 | DQ6/E2 | HR1_DQ6 | AA22 |
| DQ7/E1 | HR0_DQ7 | W18 | DQ7/E1 | HR1_DQ7 | AA21 |

Table 6.4. CYUSB3014 Pin Mapping

| CYUSB3014 (U13) | | | CYUSB3014 (U13) | | |
|---------------------|-------------------|----------|-----------------|------------|---------------|
| Pin Name/Num | Net Name | Ball Num | Pin Name/Num | Net Name | Ball Num |
| PCLK_CLK | FX_PCLK | M10 | SSTX- | USB3_SSTXN | USB3:SSTX- |
| RESETN | FX_RSTN | N8 | SSTX+ | USB3_SSTXP | USB3:SSTX+ |
| CTL0_SLCSN | FX_CTL0_SLCSN | L1 | D+ | USB3_DP | USB3:D+ |
| CTL1_SLWRN | FX_CTL1_SLWRN | K2 | D- | USB3_DN | USB3:D- |
| CTL2_SLOEN | FX_CTL2_SLOEN | K3 | FSLC0 | GND | — |
| CTL3_SLRDN | FX_CTL3_SLRDN | J1 | FSLC1 | GND | — |
| CTL4_FLAGA | — | — | FSLC2 | V3P3 | — |
| CTL5_FLAGB | FX_CTL5_FLAGB | L2 | CLKIN | MSTCLK_FX3 | OSC_19M2:OUT |
| CTL6_GPIO | — | — | CLKIN_32 | CLK_32MHZ | OSC_32768:OUT |
| CTL7_PKTENDN | FX_CTL7_PKTENDN | M1 | TDI | — | TP14 |
| CTL8_GPIO | FX_CTL8_GPIO | M2 | TDO | — | TP15 |
| CTL9_GPIO | — | — | TRSTN | — | TP16 |
| CTL10_GPIO | — | — | TMS | — | TP17 |
| CTL11_A1 | FX_LV | N4 | TCK | — | TP18 |
| CTL12_A0 | FX_FV | N7 | O60_CHGDET | — | — |
| INTN_CTL15 | FX_INTN_CTL15 | K1 | PMODE0 | FX_PMODE0 | — |
| GPIO_I2SCLK | FX_GPIO_I2SCLK | N3 | PMODE1 | FX_PMODE1 | — |
| GPIO_I2SSD | FX_GPIO_I2SSD | M11 | PMODE2 | FX_PMODE2 | — |
| GPIO_I2SWS | FX_GPIO_I2SWS | P10 | R_USB2 | GND | — |
| SPISCK_UARTRTS_GPIO | — | — | R_USB3 | GND | — |
| SPISSN_UARTCTS_GPIO | — | — | NC | — | — |
| SPIMISO_UARTTX_GPIO | FX_SPIMISO_UARTTX | P8 | VBATT | V5P0 | — |
| SPIMOSI_UARTRX_GPIO | FX_SPIMOSI_UARTRX | P9 | VBUS | V5P0 | — |
| GPIO_I2SMCLK | FX_GPIO_I2SMCLK | K28 | AVDD | V1P2 | — |
| GPIO | — | — | CVDDQ | V3P3 | — |
| I2C_SCL | FX_I2C_SCL | R1 | U3TXVDDQ | V1P2 | — |
| I2C_SDA | FX_I2C_SDA | R2 | U3RXVDDQ | V1P2 | — |
| DQ0 | FX_D0 | J14 | VDD-1:VDD-8 | V1P2 | — |
| DQ1 | FX_D1 | K15 | VIO1-1:VIO5 | V3P3 | — |
| DQ2 | FX_D2 | J13 | VSS1:VSS14 | GND | — |
| DQ3 | FX_D3 | L20 | AVSS | GND | — |
| DQ4 | FX_D4 | K17 | U3VSSQ | GND | — |
| DQ5 | FX_D5 | K14 | | | |
| DQ6 | FX_D6 | L19 | | | |
| DQ7 | FX_D7 | K19 | | | |
| DQ8 | FX_D8 | J20 | | | |
| DQ9 | FX_D9 | G18 | | | |
| DQ10 | FX_D10 | J19 | | | |
| DQ11 | FX_D11 | H17 | | | |
| DQ12 | FX_D12 | J17 | | | |
| DQ13 | FX_D13 | N9 | | | |
| DQ14 | FX_D14 | N10 | | | |
| DQ15 | FX_D15 | M9 | | | |
| DQ16:DQ31 | — | — | | | |
| XTALIN | — | — | | | |

| CYUSB3014 (U13) | | | CYUSB3014 (U13) | | |
|-----------------|------------|------------|-----------------|----------|----------|
| Pin Name/Num | Net Name | Ball Num | Pin Name/Num | Net Name | Ball Num |
| XTALOUT | — | — | | | |
| OTG_ID | USB_OTG | USB3:OTG | | | |
| SSRX- | USB3_SSRXN | USB3:SSRX- | | | |
| SSTX+ | USB3_SSRXP | USB3_SSRX+ | | | |

Table 6.5. MIPI DPHY Expansion Header

| J12 | | |
|---------|--------------|----------|
| Pin Num | Net Name | Ball Num |
| 1 | GND | — |
| 2 | GND | — |
| 3 | DIFF_CKP | A4 |
| 4 | DIFF_DP1 | A5 |
| 5 | DIFF_CKN | B4 |
| 6 | DIFF_DN1 | B5 |
| 7 | GND | — |
| 8 | GND | — |
| 9 | DIFF_DP0 | A3 |
| 10 | DIFF_DP2 | A2 |
| 11 | DIFF_DN0 | B3 |
| 12 | DIFF_DN2 | B2 |
| 13 | GND | — |
| 14 | GND | — |
| 15 | I2C_DIFF_SCL | T17 |
| 16 | DIFF_DP3 | A6 |
| 17 | I2C_DIFF_SDA | T16 |
| 18 | DIFF_DN3 | B6 |
| 19 | V3P3 | — |
| 20 | GND | — |
| SH1 | GND | — |
| SH2 | GND | — |

7. Status Indicators

The LED status indicators on the board show the application status. [Table 7.1](#) lists the status LED I/O map.

Table 7.1. Status LED I/O Map

| Net Name | LED | Connector/Pin | Color |
|--------------|-----|---------------|-------|
| LED0 | D1 | M6 | Green |
| LED1 | D2 | M7 | Green |
| LED2 | D3 | N6 | Green |
| LED3 | D4 | N5 | Green |
| LED4 – Red | D5 | P2 | RGB |
| LED4 – Green | | P1 | |
| LED4 – Blue | | P3 | |
| LED5 – Red | D6 | R3 | RGB |
| LED5 – Green | | R4 | |
| LED5 – Blue | | P4 | |

8. Input Switches and Pushbuttons

[Table 8.1](#) lists all the input switches and pushbuttons. This board has one 4 input slider switch and 5 pushbuttons.

Table 8.1. Switch and Pushbutton I/O Map

| Net Name | Component | Connector/Pin |
|-------------|-----------|---------------|
| SWITCH0 | SW1 | AA15 |
| SWITCH1 | SW1 | AB16 |
| SWITCH2 | SW1 | AA16 |
| SWITCH3 | SW1 | W16 |
| PUSHBUTTON0 | SW2 | N1 |
| PUSHBUTTON1 | SW3 | N2 |
| GSRN | SW4 | R5 |
| PROGRAMN | SW5 | C20 |

9. Ordering Information

This board is included as part of a kit, and not available as a separate item. The part number in [Table 9.1](#) is for reference only, so it is clear which board is described in this document. Visit www.latticesemi.com/boards for the latest ordering information.

Table 9.1. Reference Part Number

| Description | Ordering Part Number |
|--|----------------------|
| CertusPro-NX Voice and Vision Machine Learning Board | LFCPNX-VVML-EVN |

References

For more information, refer to [CertusPro-NX Family Data Sheet \(FPGA-DS-02086\)](#).

Technical Support Assistance

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

Appendix A. CertusPro-NX Voice and Vision Machine Learning Board Schematics

| | | | | | | | | | | | |
|---|----------------------------------|------------|--|---------|--------------------------------|------|----------------------------------|-------|----------------|-------|---------|
| CPNX Voice and Vision Machine Learning Board | | | | | | | | | | | |
| Rev - A | | | | | | | | | | | |
| 01 - Title Page | | | | | | | | | | | |
| 02 - Block Diagram | | | | | | | | | | | |
| 03 - FTDI/USB Interface | | | | | | | | | | | |
| 04 - PMOD Conn | | | | | | | | | | | |
| 05 - HyperRAM and GPIO | | | | | | | | | | | |
| 06 - EVDK and Himax Cameras | | | | | | | | | | | |
| 07 - USB3 Out, Mics | | | | | | | | | | | |
| 08 - Flash Interface | | | | | | | | | | | |
| 09 - Power Banks | | | | | | | | | | | |
| 10 - Unused Banks | | | | | | | | | | | |
| 11 - Power Distribution/VCCIO | | | | | | | | | | | |
| 12 - RPC DRAM | | | | | | | | | | | |
| 13 - Power Diagram | | | | | | | | | | | |
| <p>COMPONENT DEFAULTS:</p> <p>Resistors: 0402, 1%</p> <p>Ferrite beads: 0.1uF 0201</p> <p>Capacitors: <=10uF 0402, >= 10V 10uF 0603, >= 10V</p> | | | | | | | | | | | |
|  | | | | | | | | | | | |
| <p>Lattice Semiconductor Applications http://www.latticesemi.com/Support</p> | | | | | | | | | | | |
| <table border="1"> <tr> <td colspan="2">Title Page</td> </tr> <tr> <td>Project</td> <td>CPNX Voice and Vision ML Board</td> </tr> <tr> <td>Size</td> <td>Schematic Rev 1.0 Board Rev A</td> </tr> <tr> <td>Date:</td> <td>April 28, 2021</td> </tr> <tr> <td>Sheet</td> <td>1 of 13</td> </tr> </table> | | Title Page | | Project | CPNX Voice and Vision ML Board | Size | Schematic Rev 1.0 Board Rev A | Date: | April 28, 2021 | Sheet | 1 of 13 |
| Title Page | | | | | | | | | | | |
| Project | CPNX Voice and Vision ML Board | | | | | | | | | | |
| Size | Schematic Rev 1.0 Board Rev A | | | | | | | | | | |
| Date: | April 28, 2021 | | | | | | | | | | |
| Sheet | 1 of 13 | | | | | | | | | | |

Figure A.1. Title Page

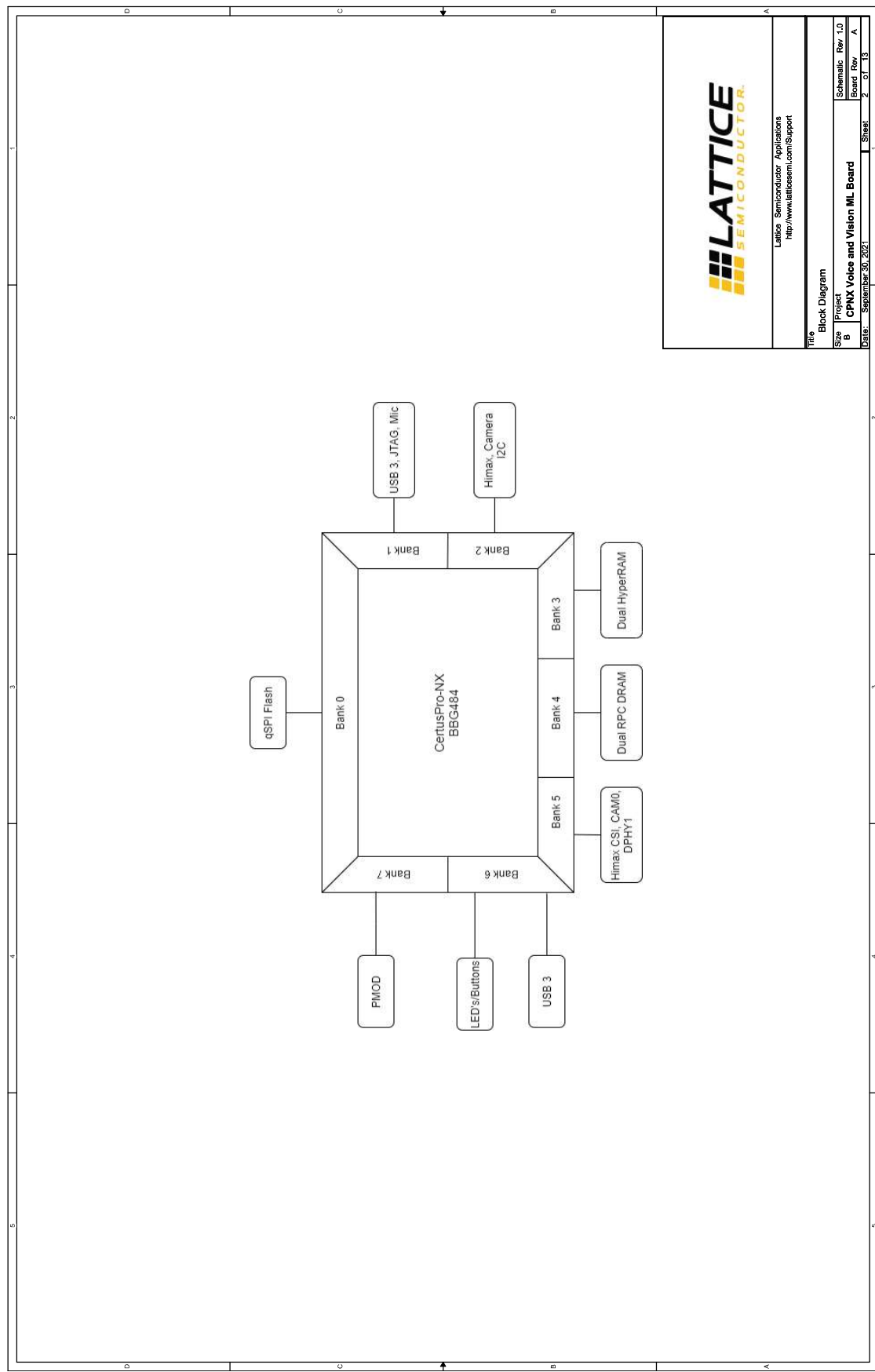


Figure A.2. Block Diagram

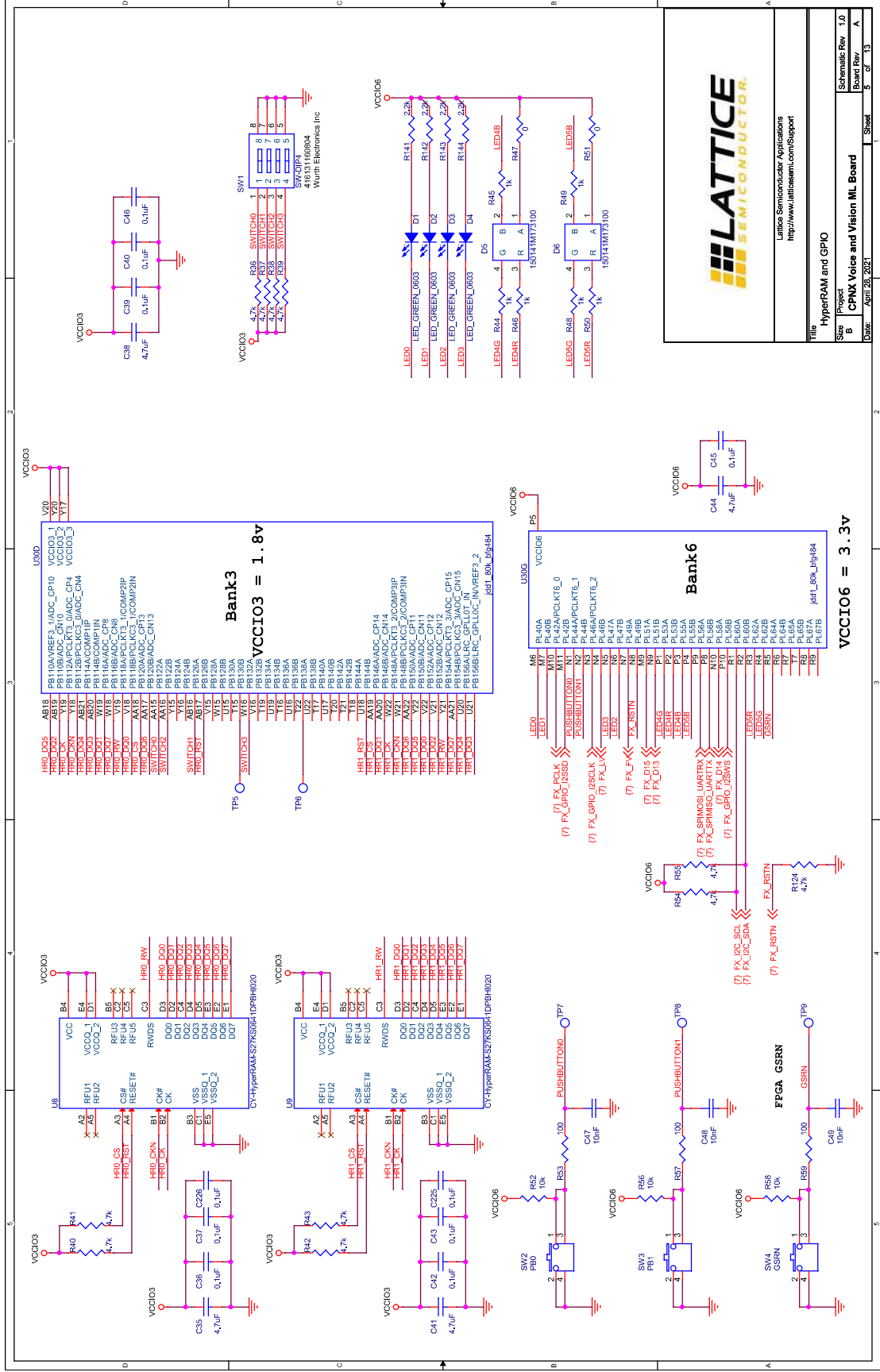


Figure A.5. HyperRAM and GPIO

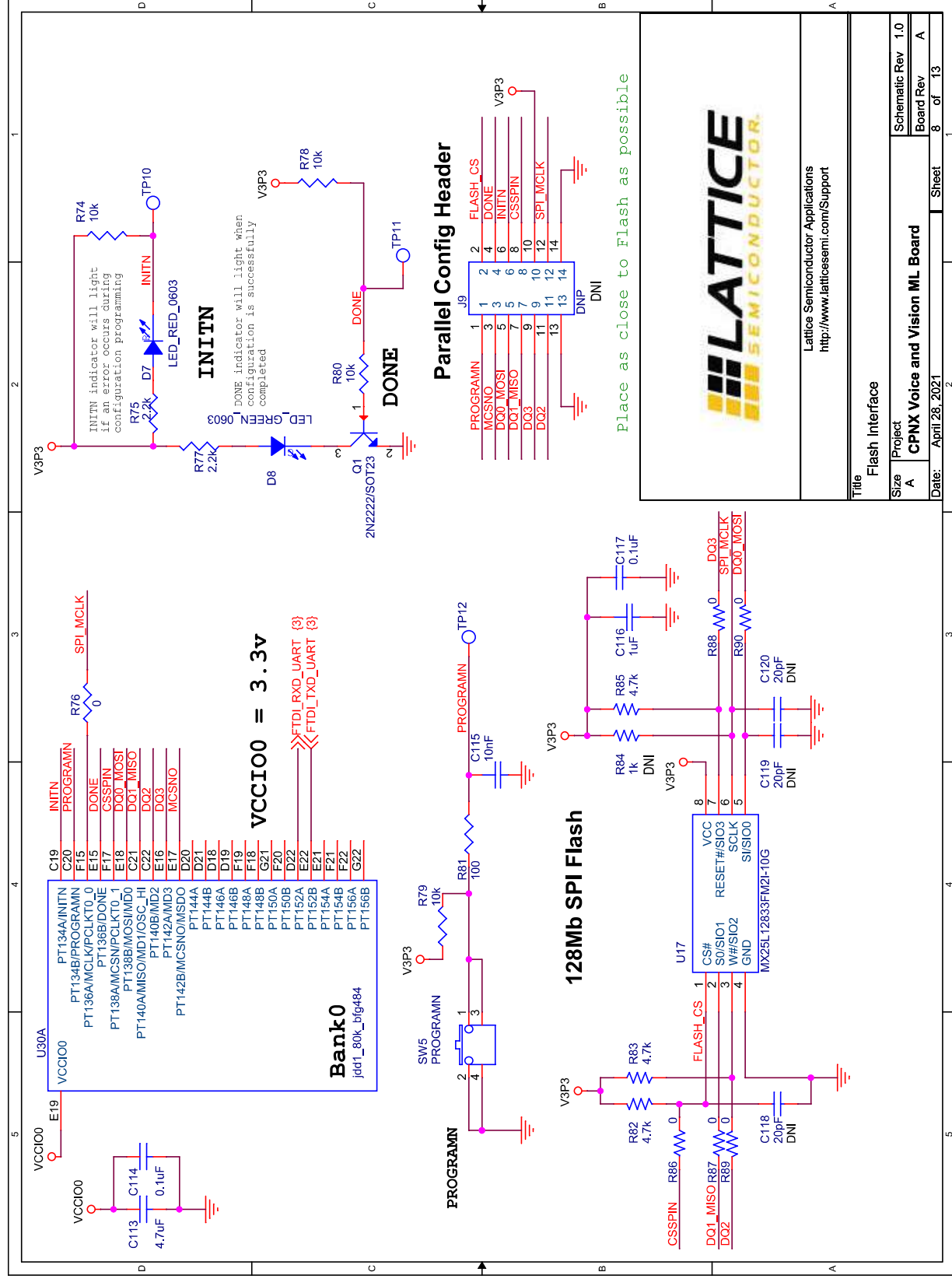


Figure A.8. Flash Interface

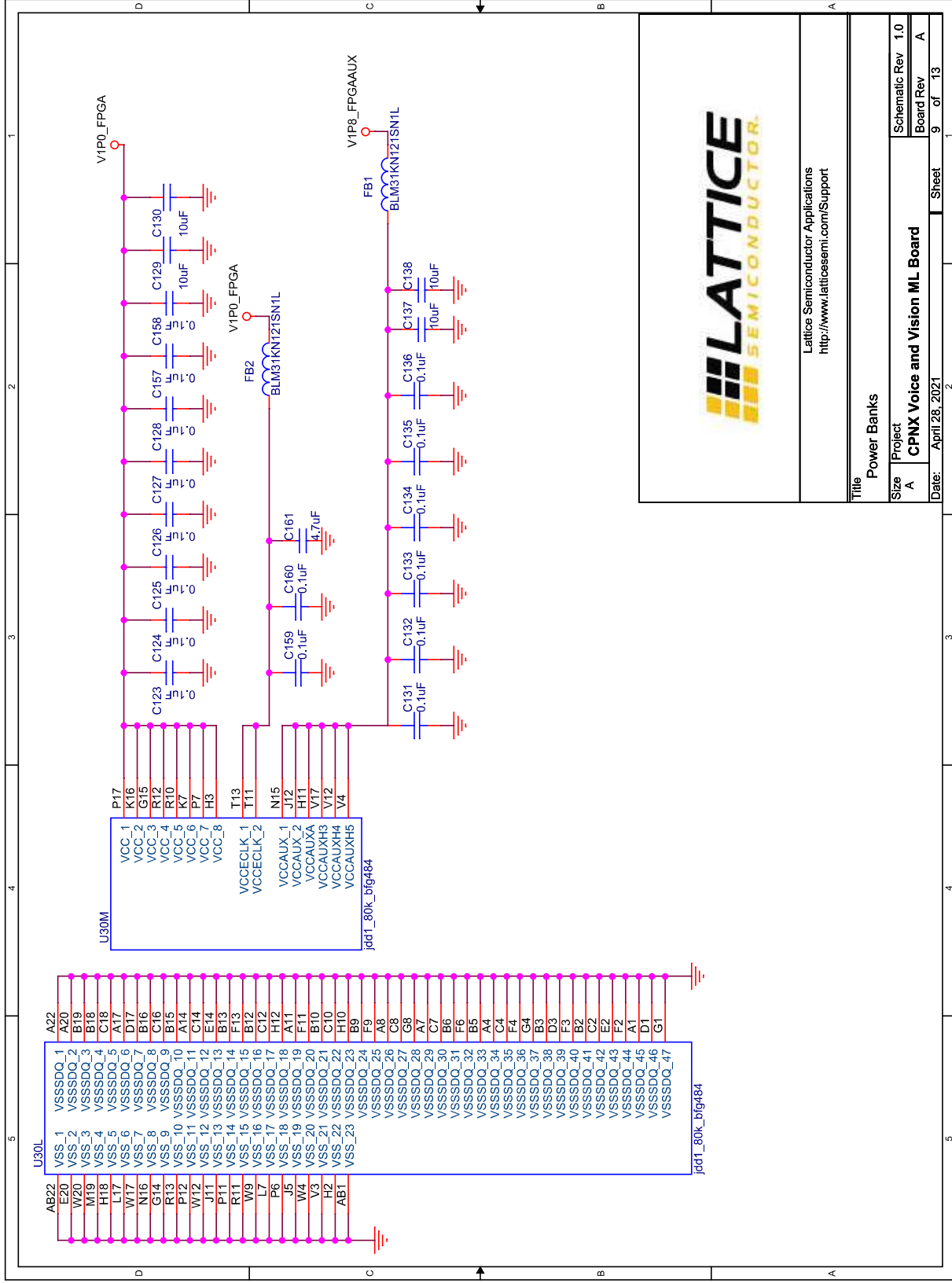


Figure A.9. Power Banks

Lattice Semiconductor Applications
<http://www.latticesemi.com/Support>

| | |
|---------------|--------------------------------|
| Title | |
| Project | CPNX Voice and Vision ML Board |
| Size | A |
| Date: | April 28, 2021 |
| Sheet | 9 of 13 |
| Schematic Rev | 1.0 |
| Board Rev | A |

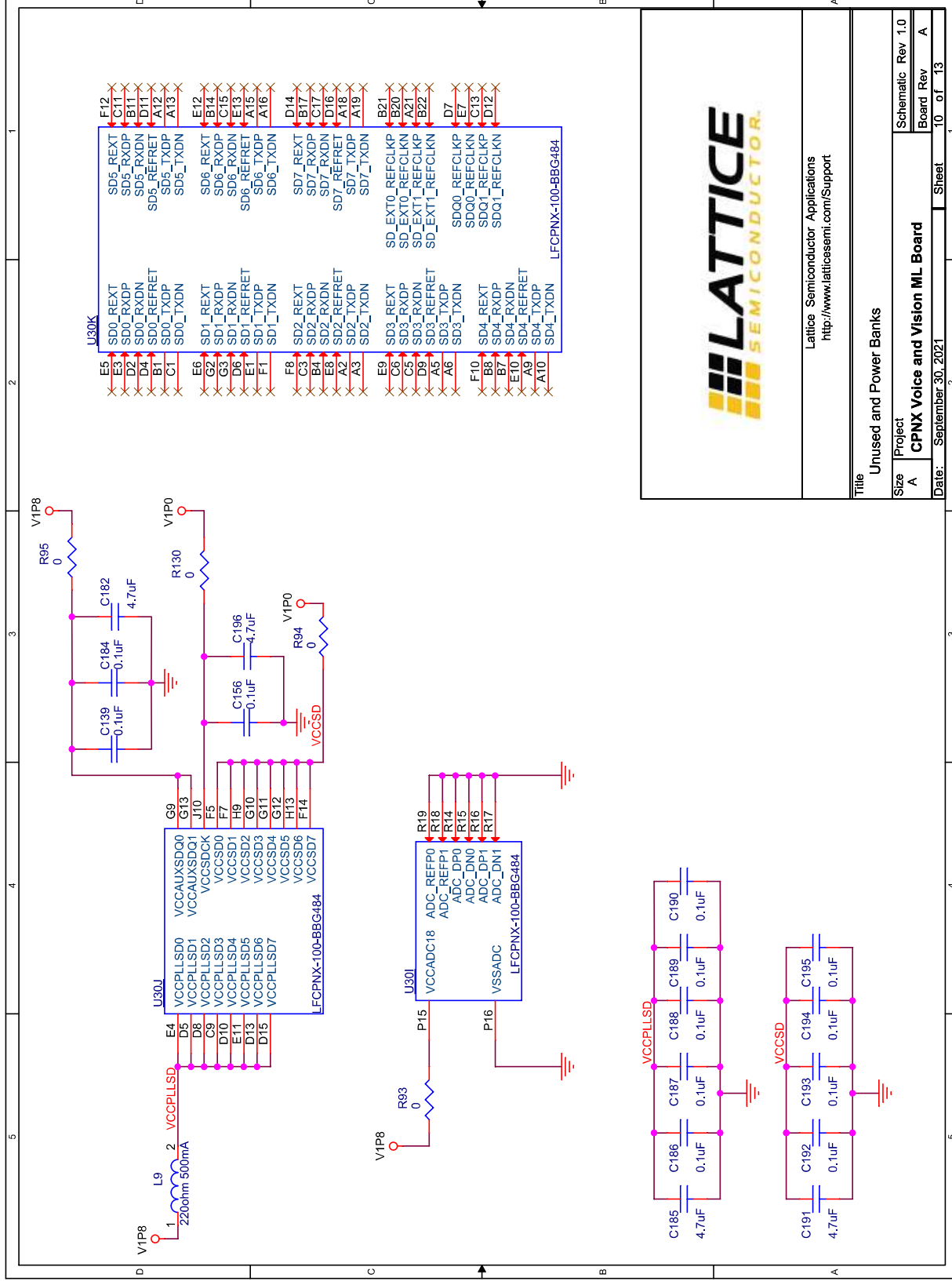


Figure A.10. Unused and Power Banks

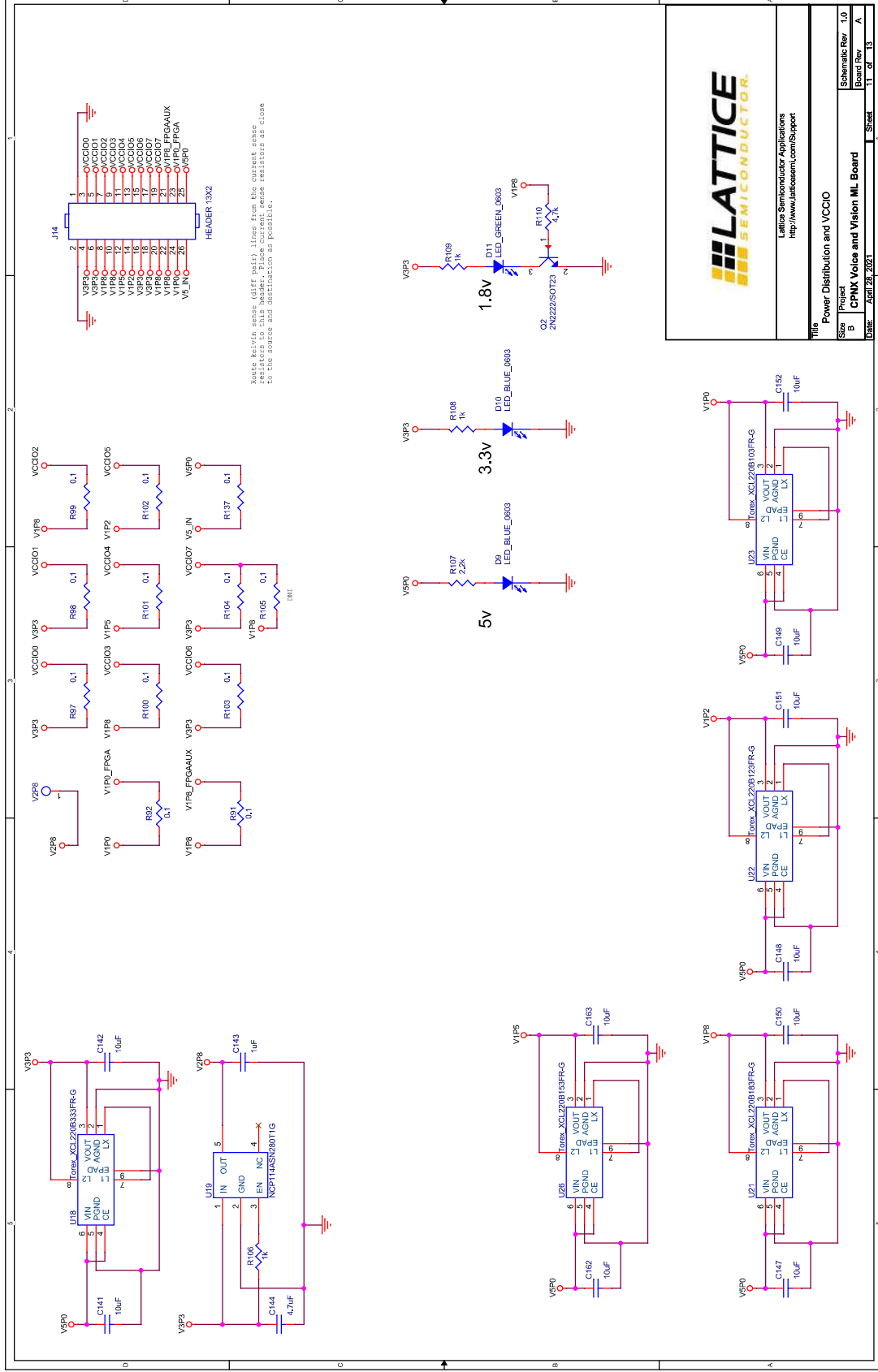


Figure A.11. Power Distribution and VCCIO

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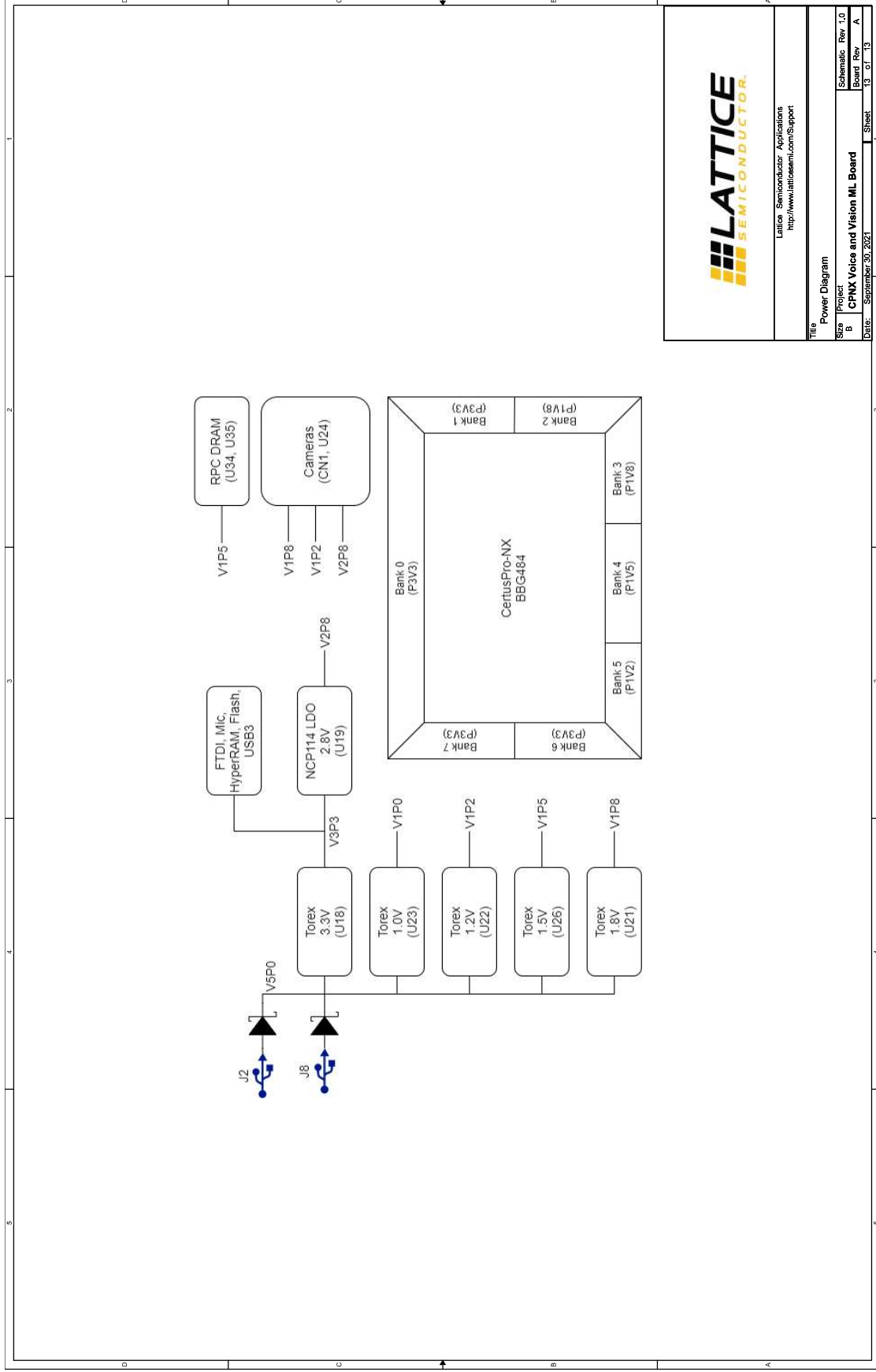


Figure A.13. Power Diagram

Appendix B. CertusPro-NX Voice and Vision Machine Learning Board Bill of Materials

| Item | Reference | Qty | Part | Supplied By | PCB Footprint | Digikey P/N | Part Number | Manufacturer | Description |
|------|--|-----|----------------------|-------------|---------------|--------------------|---------------------------|---------------------------------|---------------------------------|
| 1 | CN1 | 1 | 24580403000082 9+ | — | camconn | 478-12013-2- ND | 2458040300008 29+ | Kyocera International Inc | CONN RCPT 30POS SMD |
| 2 | C1,C10,C12,C14,C20,C24,C32, C35,C38,C41,C44,C54,C68,C81 ,C82,C94,C103,C113,C144,C16 1,C164,C179,C182,C185,C191, C196,C197,C206 | 28 | 4.7uF | — | C0402 | 445-13820-2- ND | C1005X5R1A475 K050BC-T | TDK | CAP CER 4.7UF 10V X5R 0402 |
| 3 | C2,C3,C4,C5,C6,C7,C8,C9,C11, C13,C15,C17,C21,C22,C23,C25 ,C26,C27,C28,C30,C31,C34,C3 6,C37,C39,C40,C42,C43,C45,C 46,C53,C55,C57,C67,C69,C71, C77,C78,C79,C80,C83,C84,C85 ,C86,C87,C88,C89,C90,C91,C9 2,C93,C95,C96,C97,C98,C100, C102,C104,C105,C106,C107,C 108,C109,C111,C112,C114,C1 17,C123,C124,C125,C126,C12 7,C128,C131,C132,C133,C134, C135,C136,C139,C156,C157,C 158,C159,C160,C165,C166,C1 67,C178,C180,C181,C186,C18 7,C188,C189,C190,C192,C193, C194,C195,C198,C199,C200,C 201,C202,C203,C204,C205,C2 07,C208,C209,C210,C211,C21 2,C213,C214,C215,C216,C217, C218,C219,C220,C221,C222,C 223,C224,C225,C226 | 128 | 0.1uF | — | C0201 | 445-7313-2-ND | C0603X5R1C104 K030BC | TDK | CAP CER 0.1UF 16V X5R 0201 |
| 4 | C16,C52,C56,C66,C70,C99,C10 1,C110,C116, C143 | 10 | 1uF | — | C0402 | 587-3709-2-ND | EMK105BJ105KV HF | Taiyo Yuden | CAP CER 1UF 16V X5R 0402 |
| 5 | C29,C33 | 2 | 220pF | — | C0402 | 399-17376-2- ND | C0402C221J5GA CAUTO | KEMET | CAP CER 220PF 50V NPO 0402 |
| 6 | C47,C48,C49,C115 | 4 | 10nF | — | C0402 | 445-7386-2-ND | C1005X5R1E103 K050BA | TDK | CAP CER 10000PF 25V X5R 0402 |

| Item | Reference | Qty | Part | Supplied By | PCB Footprint | Digikey P/N | Part Number | Manufacturer | Description |
|------|---|-----|--------------------|-------------|--------------------------------|---------------------------|-------------------------|--------------------------|--|
| 7 | C118,C119,C120 | 3 | 20pF | — | C0402 | 399-7773-2-ND | C0402C200J5GA CTU | KEMET | CAP CER 20PF 50V COG/NPO 0402 |
| 8 | C129,C130,C137,C138,C142,C 150,C151,C152,C163,C141,C1 47,C148,C149,C162 | 14 | 10uF | — | C0603 | 445-9065-2-ND | C1608X5R1C106 M080AB | TDK Corporation | CAP CER 10UF 16V X5R 0603 |
| 9 | C153, C154 | 2 | 22uF | — | C0603 | 1276-1193-6- ND | CL10A226MQ8N RNC | Samsung | CAP CER 22UF 6.3V X5R 0603 |
| 10 | D1,D2,D3,D4,D8,D11 | 6 | LED_GREEN_060 3 | — | APT1608 | 754-1116-2-ND | APT1608CGCK | Kingbright | LED GREEN CLEAR CHIP SMD |
| 11 | D5, D6 | 2 | 150141M173100 | — | RGBOPT2 | 732-4998-2-ND | 150141M17310 0 | Würth | LED RGB CLEAR 3528 SMD |
| 12 | D7 | 1 | LED_RED_0603 | — | APT1608 | 754-1123-2-ND | APT1608SURCK | Kingbright | LED RED CLEAR CHIP SMD |
| 13 | D9, D10 | 2 | LED_BLUE_0603 | — | APT1608 | 754-1434-2-ND | APT1608QBC/D | Kingbright | LED BLUE CLEAR CHIP SMD |
| 14 | D12, D13, | 2 | BAT60A | — | SOD323_BAT60 A | BAT60AE6327H TSA1TR-ND | BAT60AE6327HT SA1 | Infineon Technologies | DIODE SCHOTTKY 10V 3A SOD323-2 |
| 15 | FB1, FB2 | 2 | BLM31KN1215N1 L | — | BLM41P | 490-16524-2- ND | BLM31KN1215N 1L | Murata Electronics | FERRITE BEAD 120 OHM 1206 1LN |
| 16 | J1 | 1 | Header 1x8 | — | hdr_amp_87220 _8_1x8_100 | WM50017-08- ND | 0022284081 | Molex | CONN HEADER 8POS .100 VERT TIN |
| 17 | J2 | 1 | 475890001 | — | MOLEX_47589- 0001 | WM17143TR- ND | 0475890001 | Molex | CONN RCPT MICRO USB AB 5P SMD RA |
| 18 | J3, J13, | 2 | CON2 | — | CON2 | 732-5315-ND | 61300211121 | Würth Elektronik | CONN HEADER VERT 2POS 2.54MM |
| 19 | J4, J5 | 2 | PMOD 2x6 | — | skt_sullins_PBC 06DBAN | S2111E-06-ND | PBC06DBAN | Sullins | CONN HEADER R/A 12POS 2.54MM |
| 20 | J6, J7 | 2 | PMOD 2x6 | — | skt_sullins_PPP C062LJBN-RC | S5559-ND | PPPC062LJBN- RC | Sullins | CONN HDR 12POS 0.1 GOLD PCB R/A |

| Item | Reference | Qty | Part | Supplied By | PCB Footprint | Digikey P/N | Part Number | Manufacturer | Description |
|------|--|-----|-----------------------------|-------------|-------------------|------------------------|-----------------------------|-----------------------|----------------------------------|
| 21 | J8 | 1 | USB3.0 | — | USB3_MicroB_Type3 | GSB343K33HRT R-ND | GSB343K33HR | Amphenol | CONN RCPT USB3.0 MICRO B SMD R/A |
| 22 | J9 | 1 | DNP | — | Header_2x7 | — | Header_2x7 | — | — |
| 23 | J12 | 1 | LSHM-110-02-5-L-DV-A-S-K-TR | — | LSHM-110_DV | SAM14955TR-ND | LSHM-110-02-5-L-DV-A-S-K-TR | Samtec Inc. | CONN SELF-MATE 20POS SMD GOLD |
| 24 | J14 | 1 | Header 12x2 | — | HEADER24_100 MIL | SAM1034-12-ND | TSW-112-07-T-D | Samtec Inc. | CONN HEADER VERT 24POS 2.54MM |
| 25 | L1, L2, L9 | 3 | 220ohm 500mA | — | FB0402 | 445-9329-2-ND | MPZ1005S221ET000 | TDK Corporation | FERRITE BEAD 220 OHM 0402 1LN |
| 26 | Q1, Q2 | 2 | 2N2222/SOT23 | — | MMBT2222ALT-1 | MMBT2222ALT1HTSA1TR-ND | MMBT2222ALT1 HTSA1 | Infineon Technologies | TRANS NPN 40V 0.6A SOT-23 |
| 27 | R1,R2,R3,R36,R37,R38,R39,R40,R41,R42,R43,R54,R55,R60,R61,R62,R63,R69,R72,R82,R83,R85,R110,R120,R121,R124,R128,R129,R145,R146 | 30 | 4.7k | — | R0402 | 311-4.7KLRTR-ND | RC0402FR-074K7L | Yageo | RES SMD 4.7K OHM 1% 1/16W 0402 |
| 28 | R4,R9,R16,R75,R77,R107,R141,R142,R143,R144 | 10 | 2.2k | — | R0402 | 311-2.20KLRTR-ND | RC0402FR-072K2L | Yageo | RES SMD 2.2K OHM 1% 1/16W 0402 |
| 29 | R5, R33 | 2 | 33 | — | R0402 | 311-33.0LRTR-ND | RC0402FR-0733RL | Yageo | RES SMD 33 OHM 1% 1/16W 0402 |
| 30 | R6,R7,R8,R19,R20,R21,R22,R23,R24,R25,R26,R27,R28,R29,R30,R31,R32,R47,R51,R73,R76,R86,R87,R88,R89,R90,R93,R94,R95,R111,R112,R113,R114,R115,R116,R117,R119,R126,R130 | 39 | 0 | — | R0402 | 311-0.0JTRTR-ND | RC0402JR-070RL | Yageo | RES SMD 0 OHM JUMPER 1/16W 0402 |
| 31 | R10 | 1 | 12k | — | R0402 | 311-12.0KLRTR-ND | RC0402FR-0712KL | Yageo | RES SMD 12K OHM 1% 1/16W 0402 |
| 32 | R11,R34,R35,R65,R67 | 5 | 22 | — | R0402 | 311-22.0LRTR-ND | RC0402FR-0722RL | Yageo | RES SMD 22 OHM 1% 1/16W 0402 |

| Item | Reference | Qty | Part | Supplied By | PCB Footprint | Digikey P/N | Part Number | Manufacturer | Description |
|------|--|-----|---------|-------------|---------------|------------------|------------------|-----------------------|----------------------------------|
| 33 | R12,R13,R14,R15,R52,R56,R58,R74,R78,R79,R80,R118,R122,R123,R125,R127,R135,R136 | 18 | 10k | — | R0402 | 311-10.0KLRTR-ND | RC0402FR-0710KL | Yageo | RES SMD 10K OHM 1% 1/16W 0402 |
| 34 | R17 | 1 | 18.7k | — | R0402 | YAG3018TR-ND | RC0402FR-0718K7L | Yageo | RES SMD 18.7K OHM 1% 1/16W 0402 |
| 35 | R44,R45,R46,R48,R49,R50,R68,R84,R106,R108,R109 | 11 | 1k | — | R0402 | 311-1.00KLRTR-ND | RC0402FR-071KL | Yageo | RES SMD 1K OHM 1% 1/16W 0402 |
| 36 | R53,R57,R59,R81,R138 | 5 | 100 | — | R0402 | 311-100LRTR-ND | RC0402FR-07100RL | Yageo | RES SMD 100 OHM 1% 1/16W 0402 |
| 37 | R64, R66 | 2 | 100k | — | R0402 | 311-100KLRTR-ND | RC0402FR-07100KL | Yageo | RES SMD 100K OHM 1% 1/16W 0402 |
| 38 | R70 | 1 | 6.04k | — | R0402 | YAG2293TR-ND | RC0402FR-07100KL | Yageo | RES SMD 100K OHM 1% 1/16W 0402 |
| 39 | R71 | 1 | 200 | — | R0402 | 311-200LRTR-ND | RC0402FR-07200RL | Yageo | RES SMD 200 OHM 1% 1/16W 0402 |
| 40 | R91,R92,R97,R98,R99,R100,R101,R102,R103,R104,R105 | 12 | 0.1 | — | R0402 | P.10AKTR-ND | ERJ-2BSFR10X | Panasonic | RES 0.1 OHM 1% 1/6W 0402 |
| 41 | R133, R140 | 2 | 240 | — | R0402 | 311-240LRTR-ND | RC0402FR-07240RL | Yageo | RES SMD 240 OHM 1% 1/16W 0402 |
| 42 | R134,R139 | 2 | 49.9 | — | R0402 | 311-49.9LRTR-ND | RC0402FR-0749R9L | Yageo | RES SMD 49.9 OHM 1% 1/16W 0402 |
| 43 | SW1 | 1 | SW-DIP4 | — | 416131160804 | CT1954MST-ND | 416131160804 | Würth Electronics Inc | SWITCH SLIDE DIP SPST 25MA 24V |
| 44 | SW2 | 1 | PB0 | — | 4psmd_switch | 732-10143-2-ND | 434153017835 | Würth Electronics Inc | SWITCH TACTILE SPST-NO 0.05A 12V |
| 45 | SW3 | 1 | PB1 | — | 4psmd_switch | 732-10143-2-ND | 434153017835 | Würth Electronics Inc | SWITCH TACTILE SPST-NO 0.05A 12V |

| Item | Reference | Qty | Part | Supplied By | PCB Footprint | Digikey P/N | Part Number | Manufacturer | Description |
|------|--|-----|-------------------|-------------|----------------------------|----------------------------|--------------------|-----------------------|----------------------------------|
| 46 | SW4 | 1 | GSRN | — | 4psmd_switch | 732-10143-2-ND | 434153017835 | Würth Electronics Inc | SWITCH TACTILE SPST-NO 0.05A 12V |
| 47 | SW5 | 1 | PROGRAMN | — | 4psmd_switch | 732-10143-2-ND | 434153017835 | Würth Electronics Inc | SWITCH TACTILE SPST-NO 0.05A 12V |
| 48 | TP1, TP2, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20, TP21, TP22, TP23, TP24, TP25, TP26, TP27, V2P8, TP28, TP29, TP30, TP31, TP32, TP33, TP34, TP35, TP36, TP37, TP38, TP39, TP40, TP41, TP42, TP43, TP44 | 44 | Testpoint | — | tp35_smd | — | — | — | — |
| 49 | U1 | 1 | ESDR0502N | — | ESDR0502N | 2156-ESDR0502NMU TBG-OS-ND | ESDR0502NMUT BG | ON Semiconductor | TVS DIODE 5.5VWM 6JDFN |
| 50 | U2 | 1 | FT2232HL | — | tqfp64_0p5_12 p2x12p2_h1p6 | 768-1024-1-ND | FT2232HL | FTDI | IC USB HS DUAL UART/FIFO 64-LQFP |
| 51 | U4 | 1 | 93LC56C-I/SN | — | so8_50_244 | 93LC56C-I/SN-ND | 93LC56C-I/SN | Microchip | IC EEPROM 2KBIT SPI 3MHZ 8SOIC |
| 52 | U6, U7 | 2 | SPH0645LM4H-B | — | SPH0645LM4H-B | 423-1405-2-ND | SPH0645LM4H-B | Knowles | CRAWFORD MIC DGT I'S BOTTOM PORT |
| 53 | U8, U9 | 2 | S27KS0641DPBHI020 | — | 24FBGA_S27KS | 428-3858-ND | S27KS0641DPBH I020 | Cypress | IC ARM9 USB CONTROLLER 121FBGA |
| 54 | U11, U12 | 2 | SP3010-04UTG | — | UDFN10_SP3010-04UTG | F3507TR-ND | SP3010-04UTG | Littlefuse In. | TVS DIODE 6V 12.3V 10JDFN |
| 55 | U13 | 1 | CYUSB3014 | — | 121BGA | 428-3130-ND | CYUSB3014-BZXI | Cypress | IC ARM9 USB CONTROLLER 121FBGA |
| 56 | U14 | 1 | OSC_19M2 | — | 7X-19p200MBA-T | 887-1400-2-ND | 7X-19.200MBA-T | TXC Corporation | XTAL OSC XO 19.2000MHZ CMOS SMD |

| Item | Reference | Qty | Part | Supplied By | PCB Footprint | Digikey P/N | Part Number | Manufacturer | Description |
|------|-----------|-----|----------------------|------------------|----------------------------|---------------------------|----------------------|-------------------------|--|
| 57 | U15 | 1 | OSC_32768 | — | ASAK-32p768KHZ-LRS-T | 535-13275-2-ND | ASAK-32.768KHZ-LRS-T | Abracon LLC | XTAL OSC XO 32.7680KHZ LVC MOS |
| 58 | U16 | 1 | M24M02 | — | SOIC8_M24M02-DWMN3TP_K | 497-16238-2-ND | M24M02-DWMN3TP/K | STMicroelectronics | IC EEPROM 2MBIT 12C 1MHZ 8SO |
| 59 | U17 | 1 | MX25L12833FM2 I-10G | — | S08_MX25L12833FM2110G | 1092-1228-ND | MX25L12833FM2I-10G | Macronix | IC FLASH 128MBIT 104MHZ 8SOP |
| 60 | U18 | 1 | Torex_XCL220B33FR-G | — | XCL220B123FR-G | 893-1279-2-ND | XCL220B33FR-G | Torex Semiconductor Ltd | DC DC CONVERTER 3.3V |
| 61 | U19 | 1 | NCP114ASN280T1G | — | TSOP5_NCP114ASN280T1G | NCP114ASN280T1GOSTR-ND | NCP114ASN280T1G | ON Semiconductor | IC REG LINEAR 2.8V 300MA 5TSOP |
| 62 | U21 | 1 | Torex_XCL220B183FR-G | — | XCL220B123FR-G | 893-1275-2-ND | XCL220B183FR-G | Torex Semiconductor Ltd | DC DC CONVERTER 1.8V |
| 63 | U22 | 1 | Torex_XCL220B123FR-G | — | XCL220B123FR-G | 893-1273-2-ND | XCL220B123FR-G | Torex Semiconductor Ltd | DC DC CONVERTER 1.2V |
| 64 | U23 | 1 | Torex_XCL220B103FR-G | — | XCL220B123FR-G | 893-1272-2-ND | XCL220B103FR-G | Torex Semiconductor Ltd | DC DC CONVERTER 1V 1A |
| 65 | U24 | 1 | HM360 (OK-10F030-04) | — | OK_10F030_04 | — | OK-10F030-04 | Himax | Female Connector to mate with Male connector on Compact Camera Module |
| 66 | U26 | 1 | Torex_XCL220B153FR-G | — | XCL220B123FR-G | 893-1274-2-ND | XCL220B153FR-G | Torex Semiconductor Ltd | DC DC CONVERTER 1.5V |
| 67 | U30 | 1 | LFCPNX-1008BBG484C | Lattice Supplied | lattice-caBGA484_1900X1900 | — | LFCPNX-1008BBG484C | Lattice Semiconductor | CertusPro-NX-100 |
| 68 | U34, U35 | 2 | EM6GA16LBXA-12H | — | FBGA96_900X1300 | 2174-EM6GA16LBXA-12HTR-ND | EM6GA16LBXA-12H | Etron Technology, Inc. | 256M BIT RPC DRAM (FBGA 96 BALLS |

| Item | Reference | Qty | Part | Supplied By | PCB Footprint | Digikey P/N | Part Number | Manufacturer | Description |
|------|-----------|-----|--------------------------|-------------|---------------------------|--------------------|--------------------------|-----------------------|---------------------------------------|
| 69 | X1 | 1 | CSTNE12M0G55Z 000R0 | — | SC_CSTNE12M0 G55Z000R0 | 490-17945-2- ND | CSTNE12M0G55 Z000R0 | Murata Electronics | CERAMIC RES 12.0000MHZ 33PF SMD |
| 70 | X2 | 1 | ASE3-27.000MHz- K-T | — | 27MHZ | 535-9551-2-ND | ASE3- 27.000MHz-K-T | ABRACON | XTAL OSC XO 27.0000MHZ CMOS SMD |
| 71 | X3 | 1 | ASEMB- 24.000MHz-LC-T | — | ASEMB_24p000 MHz_LC_T | 535-11748-2- ND | ASEMB- 24.000MHz-LC-T | ABRACON | MEMS OSC XO 24.0000MHZ CMOS SMD |

Revision History

Revision 1.0, October 2021

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



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