Machine Vision: Barcode Detection Demonstration

User Guide

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Acronyms in This Document

A list of acronyms used in this document.

Acronym	Definition
CNN	Convolutional Neural Network
EVDK	Embedded Vision Development Kit
FPGA	Field-Programmable Gate Array
LED	Light-emitting diode
MLE	Machine Learning Engine
NN	Neural Network
NNC	Neural Network Compiler
SD	Secure Digital
SDHC	Secure Digital High Capacity
SDXC	Secure Digital extended Capacity
SPI	Serial Peripheral Interface
USB	Universal Serial Bus
VIP	Video Interface Platform
VVML	Voice and Vision Machine Learning Board

1. Introduction

This document describes the Barcode Detection Demo running process using the CertusPro™-NX Voice and Vision Machine Learning (VVML) platform.

2. Functional Description

Figure 2.1 shows the top view of the CertusPro-NX VVML, Rev A, board used in this demonstration.

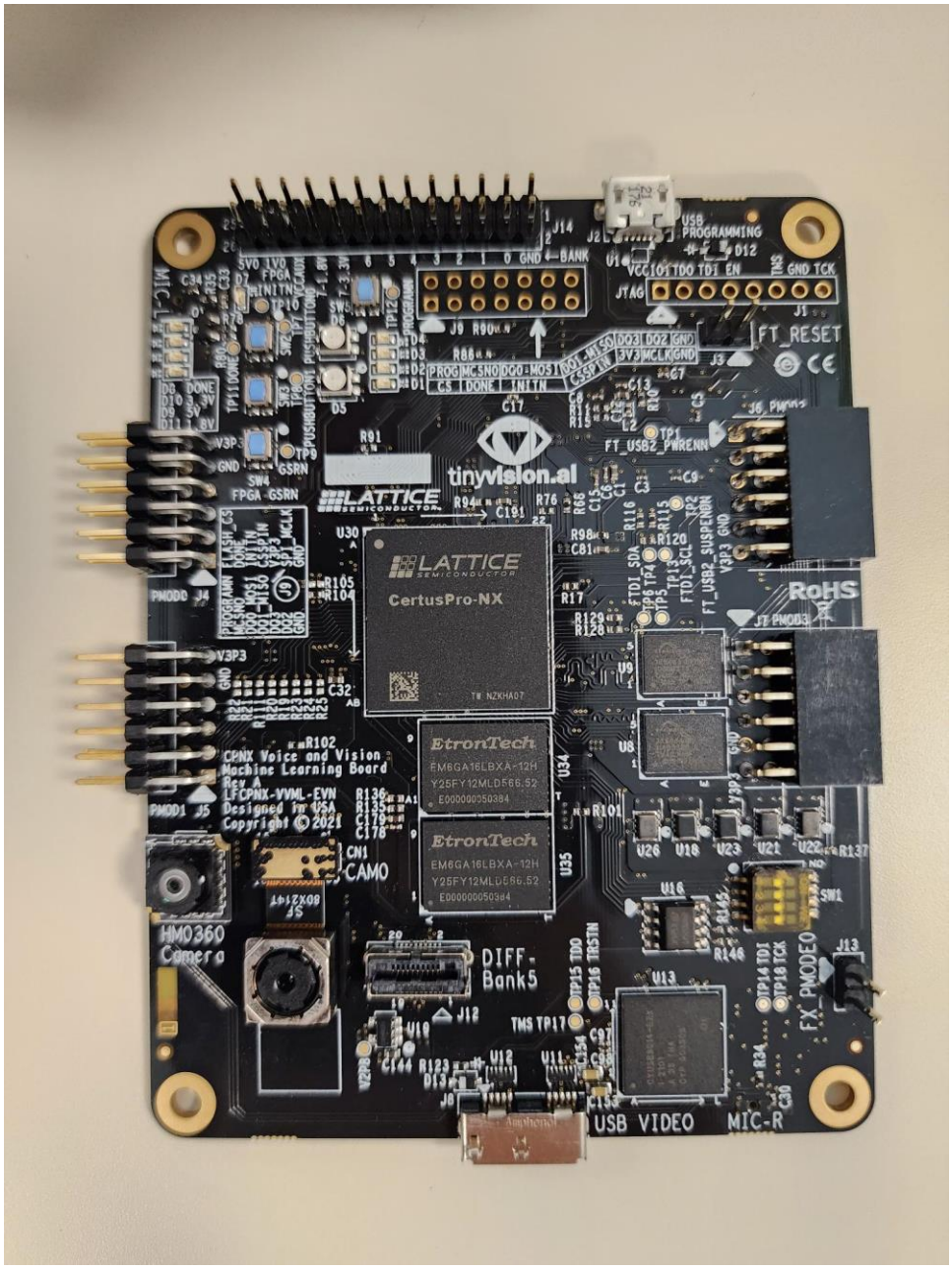

Figure 2.1. CertusPro-NX VVML Rev-A Board – Top View

3. Demo Setup

This section describes the demo setup.

3.1. Hardware Requirements

This section shows the hardware required for this design and how they are connected.

- CertusPro-NX Voice and Vision Machine Learning Board, Rev. A
- USB3.0 Type A cable to Micro USB Type B (to load firmware in FX3 and to run demo using video visualizing tool)
- USB2.0 Type A to Type Micro B cable (to program CertusPro-NX VVML board)
- SonyIMX-214 MIPI Interface camera.

Figure 3.1. Sony IMX214 Camera

- Personal computer

3.2. Software Requirements

- Lattice Radiant™ Programmer version 2022.1. Refer to http://www.latticesemi.com/programmer.
- Cypress – EZ-USB FX3 Software Development Kit. Refer to https://www.cypress.com/documentation/software-and-drivers/ez-usb-fx3-software-development-kit.
- Video Visualizing tool to see the output. User can use one of the tools below:
  - VLC Media Player – https://www.videolan.org/vlc/download-windows.html
  - Windows Camera Application – To use the windows camera app, user must change the default webcam if the other camera device is connected to the system. For more information, user can follow the steps mentioned in https://answers.microsoft.com/en-us/windows/forum/all/how-to-change-default-webcam-in-windows-10/1e8377c8-4fd5-4e9c-8ab6-67913c5c8e0c.
  - AMCap – http://noeld.com/programs.asp?cat=video.

4. Programming the Demo

This section describes the Barcode Detection demo running the process using the CertusPro-NX Voice and Vision platform. To run the demo, user needs prebuilt *.mcs* and *.bit* file to program the CertusPro-NX VVML board.

4.1. Package Folder Structure

Figure 4.1 shows the demo directory structure.

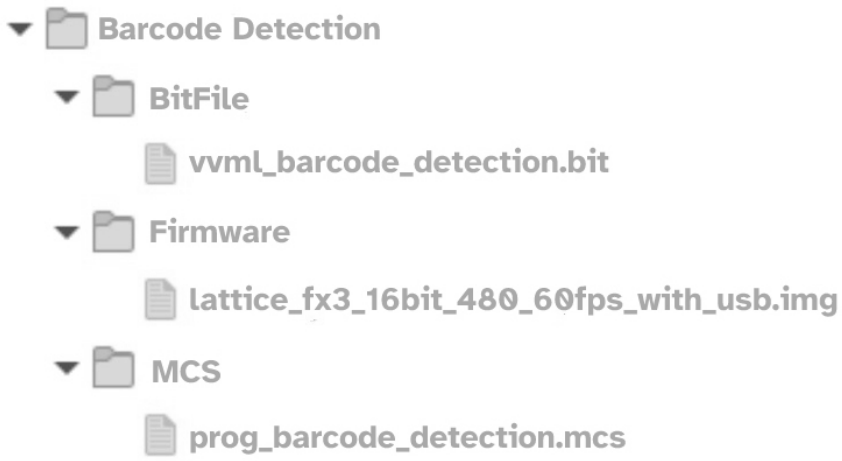

Figure 4.1. Demo Package Folder Structure

4.2. Load Firmware in FX3 I²C EEPROM

To load the firmware in the FX3 I²C EEPROM:

1. Connect the USB3 port of the CertusPro-NX Voice and Vision Machine Learning (VVML) Board, Rev A to PC using the USB3 cable.
2. Open the USB Control Centre application. Make sure the Cypress FX3 SDK is installed in the PC.
3. Use the CertusPro-NX Voice and Vision Machine Learning board (Rev A) and put the jumper on J13 to make it FX3 firmware programmable.
4. Connect the FX3 cable to PC.
5. Press the **Push** button and switch the SW2 on the board to reset the FX3 chip.
6. The screen shows the boot loader device as shown in Figure 4.2.

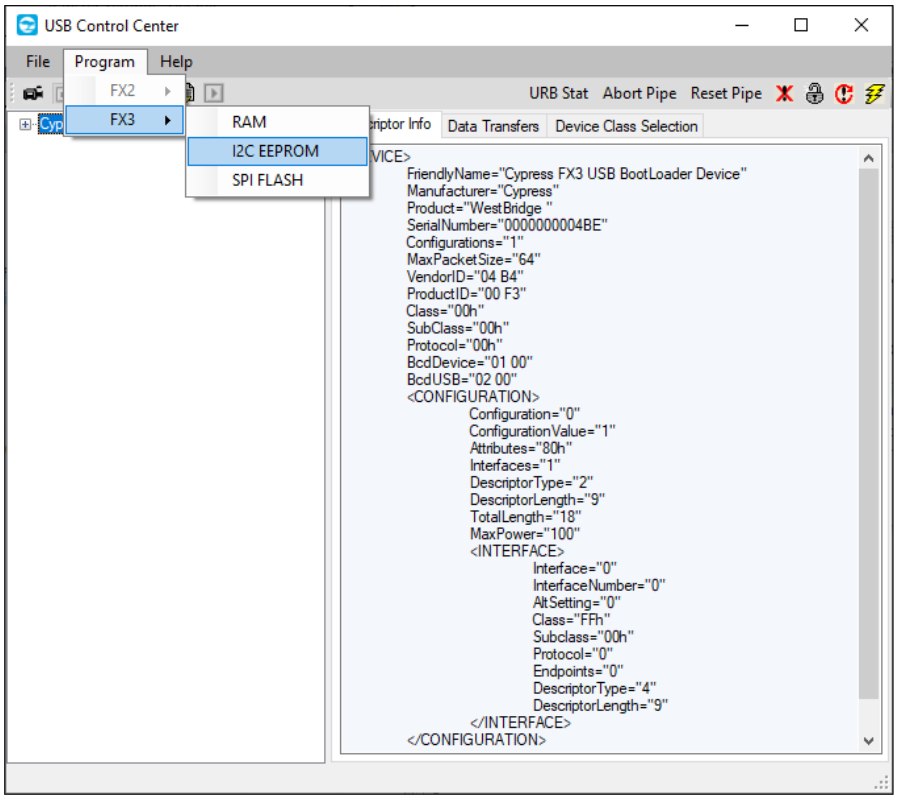

Figure 4.2. Cypress USB Bootloader – Default Screen

7. Select the Cypress USB Bootloader
8. In the menu bar, select **Program > FX3 > I²C E2PROM**.
9. Browse and select the FX3 image file for the **640x480p60 16-bit configuration**. The firmware is programmed in the I²C E2PROM.
10. Wait for the programming successful message in bottom taskbar.
11. After successfully programming the files, remove the J13 jumper.
12. Power off and power on the board. The FX3 boots from the I²C E2PROM.

4.3. Programming the CertusPro-NX Voice and Vision SPI Flash

4.3.1. Erasing the CertusPro-NX Voice and Vision SRAM Prior to Reprogramming

Note: Erase the board if board is already programmed with different demo.

To erase CertusPro-NX Voice and Vision:

1. Launch Lattice Radiant Programmer with **Create a new blank** project.

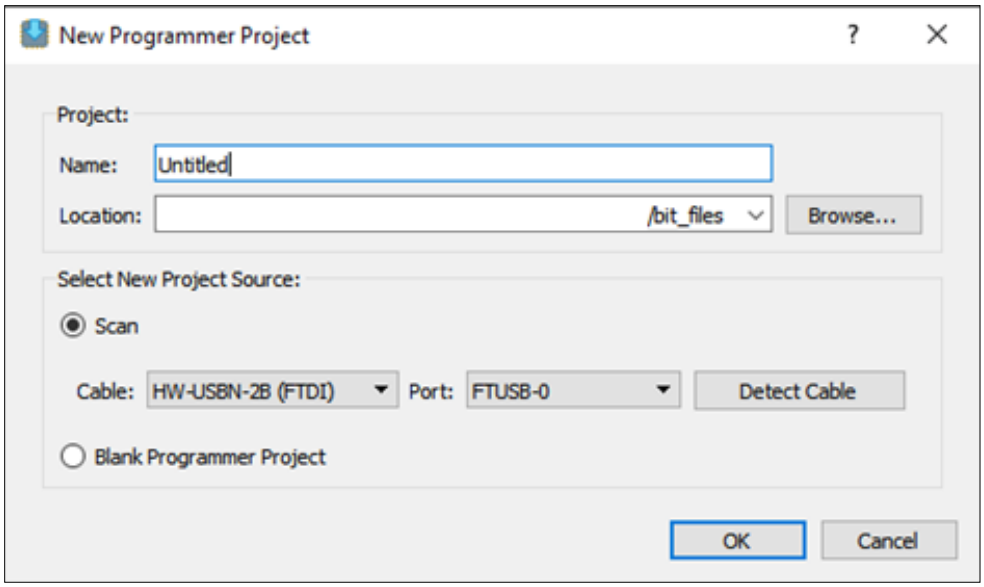

Figure 4.3. Radiant Programmer – Default Screen

2. Select **LFCPNX** for Device Family and **LFCPNX-100** for Device as shown in Figure 4.4.

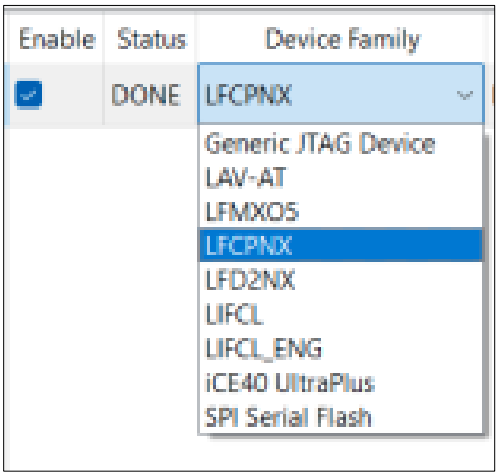

Figure 4.4. Radiant Programmer – Device Selection

3. Right-click and select **Device Properties**.
4. Select **JTAG** for Port Interface, **Direct Programming** for Access Mode, and **Erase Only** for Operation as shown in Figure 4.5.

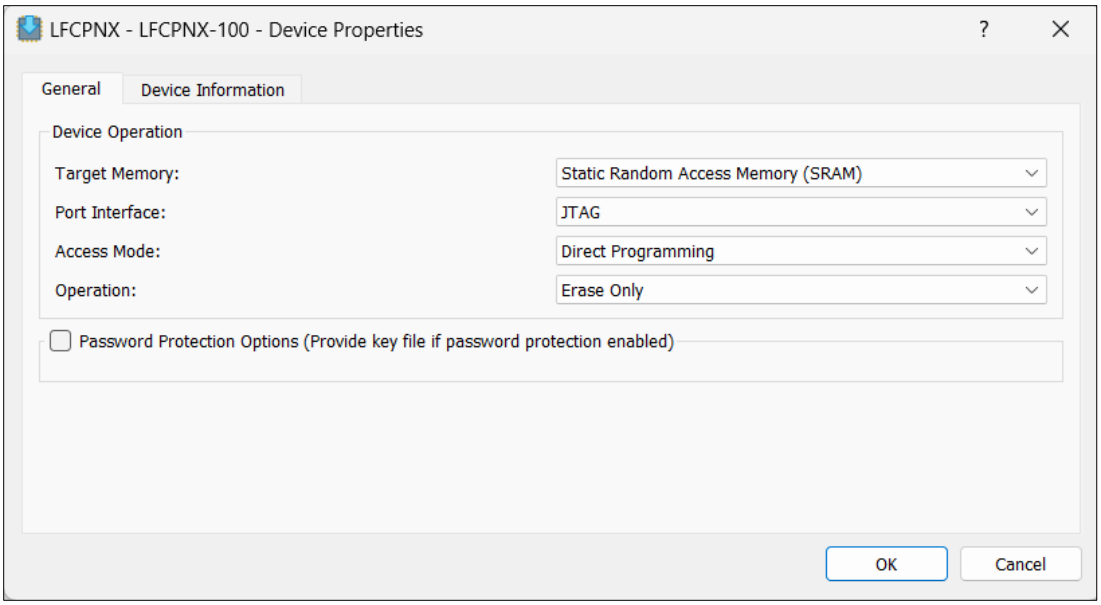

Figure 4.5. Radiant Programmer – Device Operation

5. Click **OK** to close the Device Properties dialog box.
6. Press the **SW5** push button and click the **Program** button. Keep it pressed until the **Successful** message in the Radiant log window is displayed.
7. In the Radiant Programmer main interface, click the **Program** button to start the erase operation.

4.3.2. Programming the CertusPro-NX Voice and Vision Board

To program the CertusPro-NX Voice and Vision SPI flash:

1. Ensure that the CertusPro-NX Voice and Vision device SRAM is erased by performing the steps in Erasing the CertusPro-NX Voice and Vision SRAM Prior to Reprogramming.
2. In the Radiant Programmer main interface, right-click the **CertusPro-NX Voice and Vision** row and select **Device Properties**.
3. In the Device Properties dialog box, configure the options as shown in Figure 4.6.
   a. Select **SPI FLASH** for Target Memory, **JTAG2SPI** for Port Interface, and **Direct Programming** for Access Mode.
   b. In Programming File, browse and select the CertusPro-NX Voice and Vision bit file (*.bit).
   c. For SPI Flash Options, select the configurations as shown in Figure 4.6 to select the **Macronix 25L12833F** device.
   d. Click **Load from File** to update the Data file size (Bytes) value.
   e. Ensure that the following addresses are correct:
      - **Start Address (Hex) – 0x00000000**
      - **End Address (Hex) – 0x002A0000**

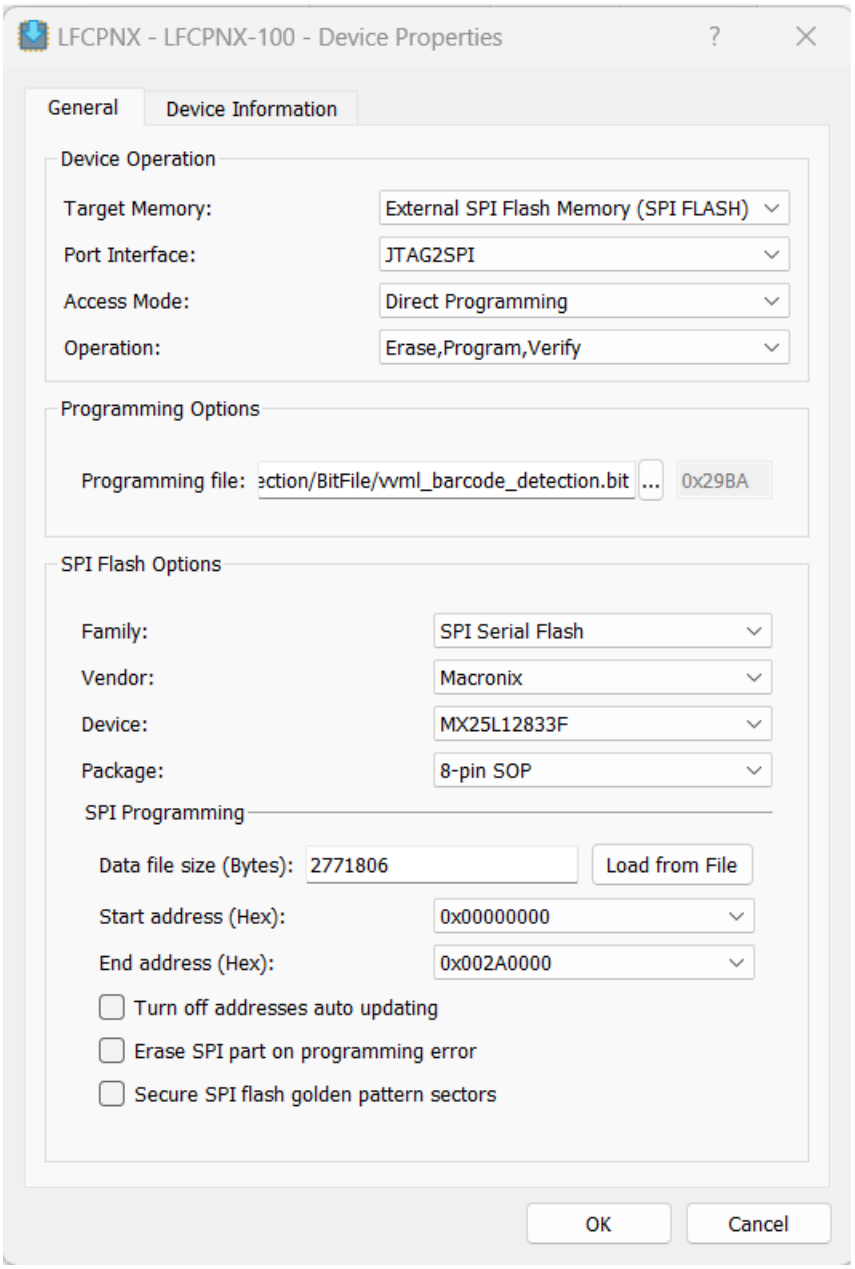

Figure 4.6. Radiant Programmer – Selecting Device Properties Options for CertusPro-NX Flash

4. Click **OK**.
5. Press the **SW5** push button and click the **Program** button. Keep it pressed until the **Successful** message in the Radiant log window is displayed.

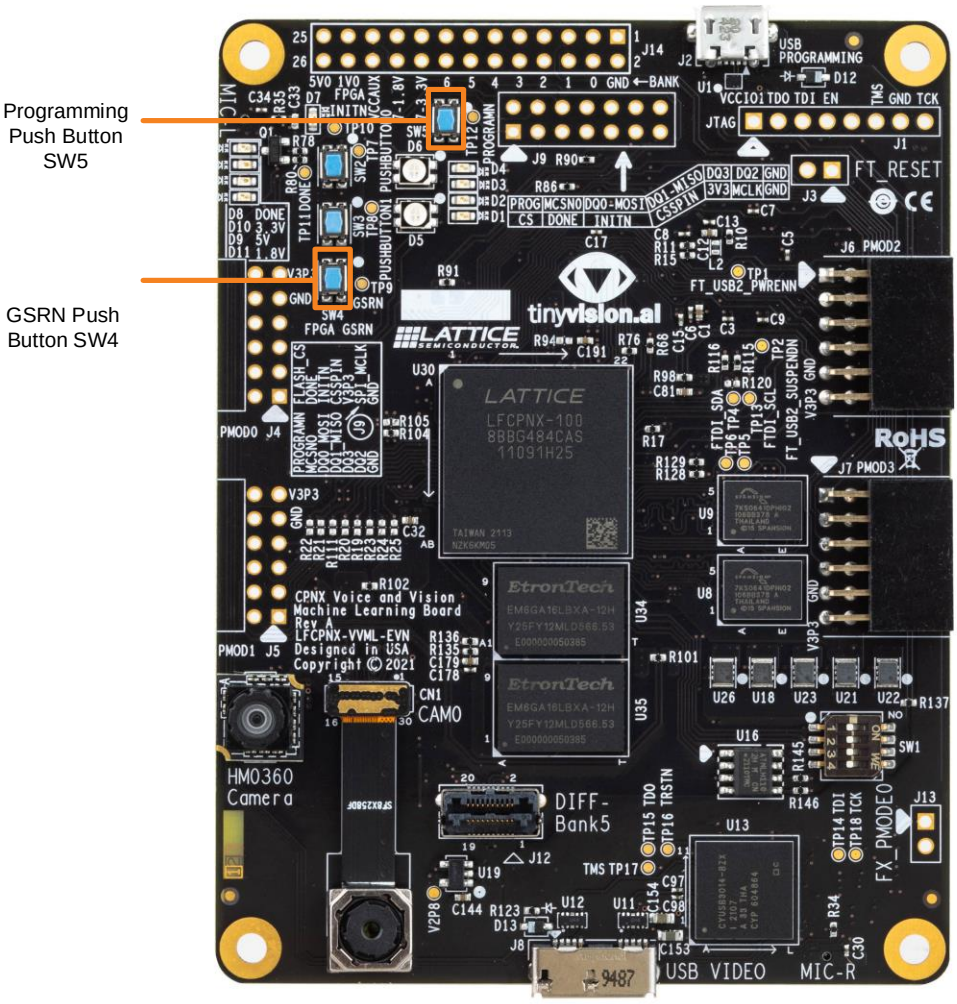

Figure 4.7. CertusPro-NX Voice and Vision Flashing Switch – SW5 Push Button

6. In the Radiant Programmer main interface, click the **Program** button to start the programming operation.

7. Successful programming is displayed in the Radiant Programmer Output console as shown in Figure 4.8.

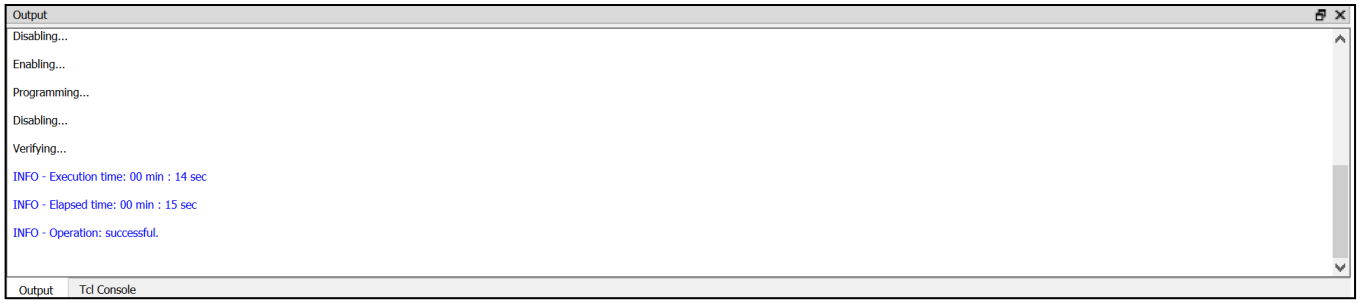

Figure 4.8. Radiant Programmer – Output Console

4.3.3. Programming sensAI Firmware Binary to the CertusPro-NX Voice and Vision SPI Flash

4.3.3.1. Flash sensAI Firmware Hex to CertusPro-NX SPI Flash

To program the CertusPro-NX SPI flash:

1. Ensure that the CertusPro-NX device SRAM is erased by performing the steps in Erasing the CertusPro-NX Voice and Vision SRAM Prior to Reprogramming before flashing bitstream and the Lattice sensAI™ firmware binary.
2. In the Radiant Programmer main interface, right-click the **CertusPro-NX** row and select **Device Properties**.
3. Select **SPI FLASH** for Target Memory, **JTAG2SPI** for Port Interface, and **Direct Programming** for Access Mode.
4. In the Device Properties dialog box, configure the options as shown in Figure 4.9.
   a. For Programming File, browse and select the CertusPro-NX sensAI firmware binary file after converting it to hex (*.mcs).
   b. For SPI Flash Options, select the configurations as shown in Figure 4.9 to select the **Macronix 25L12833F** device.
   c. Click **Load from File** to update the Data file size (Bytes) value.
   d. Ensure that the following addresses are correct:
      - **Start Address (Hex) – 0x00300000**
      - **End Address (Hex) – 0x00330000**

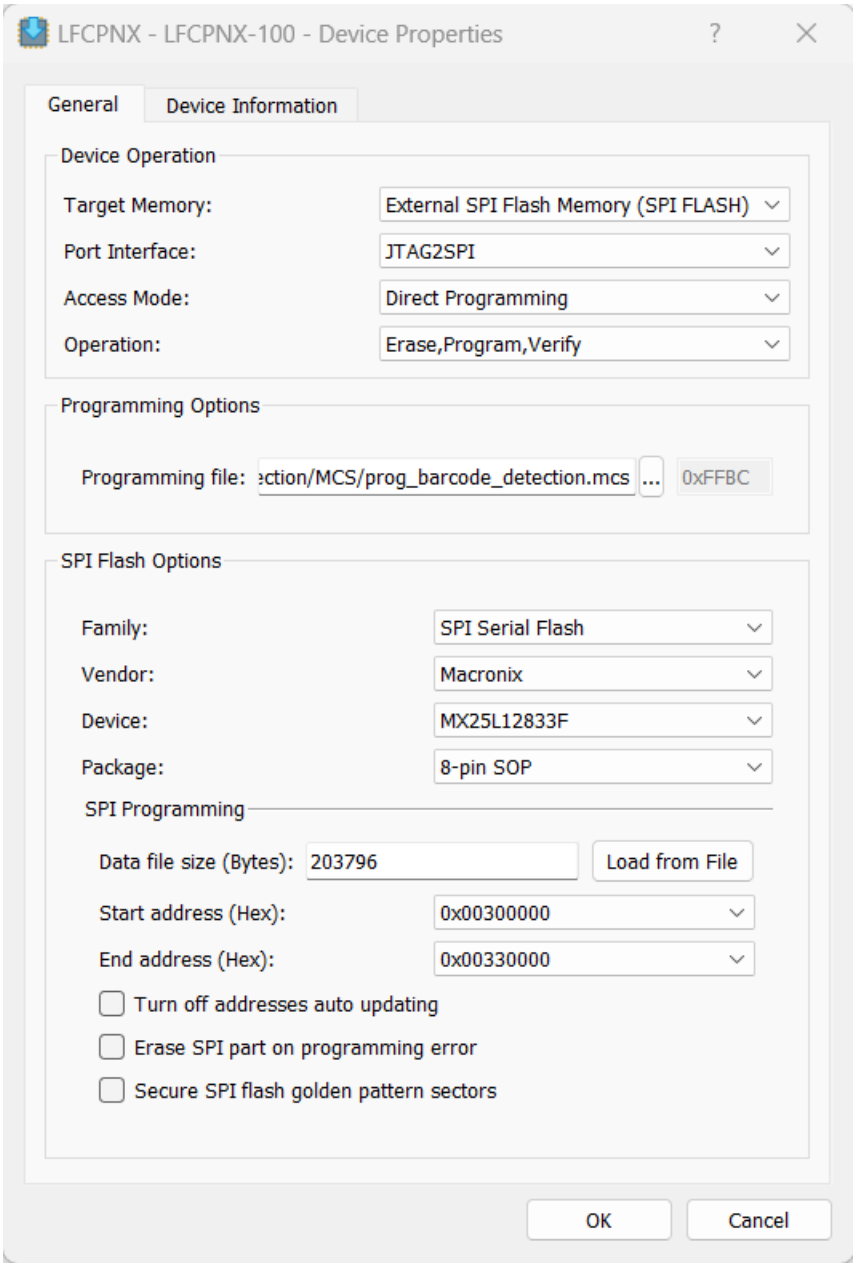

Figure 4.9. Radiant Programmer – Selecting Device Properties Options for CertusPro-NX Flash

5. Click **OK**.
6. Press the **SW5** push button and click the **Program** button. Keep it pressed until the **Successful** message in the Radiant log window is displayed.
7. In the Radiant Programmer main interface, click the **Program** button to start the programming operation.
8. Successful programming is displayed in the Diamond Programmer Output console as shown in Figure 4.10.

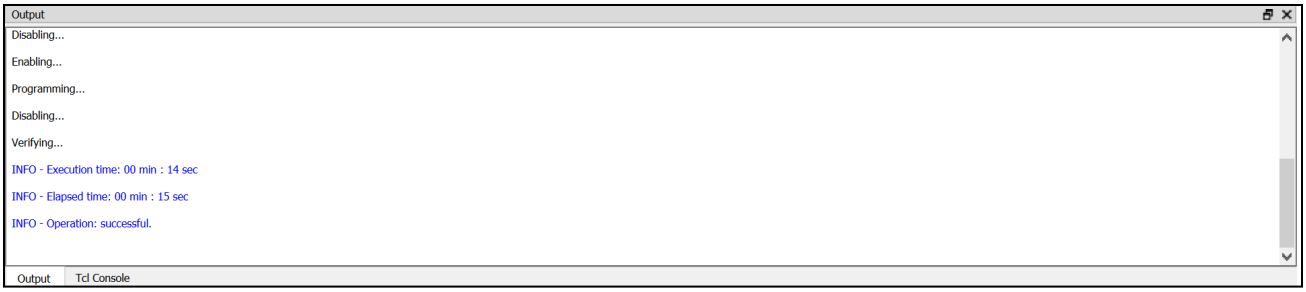

Figure 4.10. Radiant Programmer – Output Console

5. Running the Demo

To run the demo:

1. Power on the Voice and Vision Board.
2. Connect the Voice and Vision board to the PC through the **USB3** port board.
3. Turn ON DIP Switch-4 as shown in Figure 5.1.
4. Open **AMCap** or other video visualizing tool mentioned in Software Requirements section and select the **FX3** device as source and USB port to the maximum number port available.
5. The camera image is displayed in the monitor as shown in Figure 5.2.

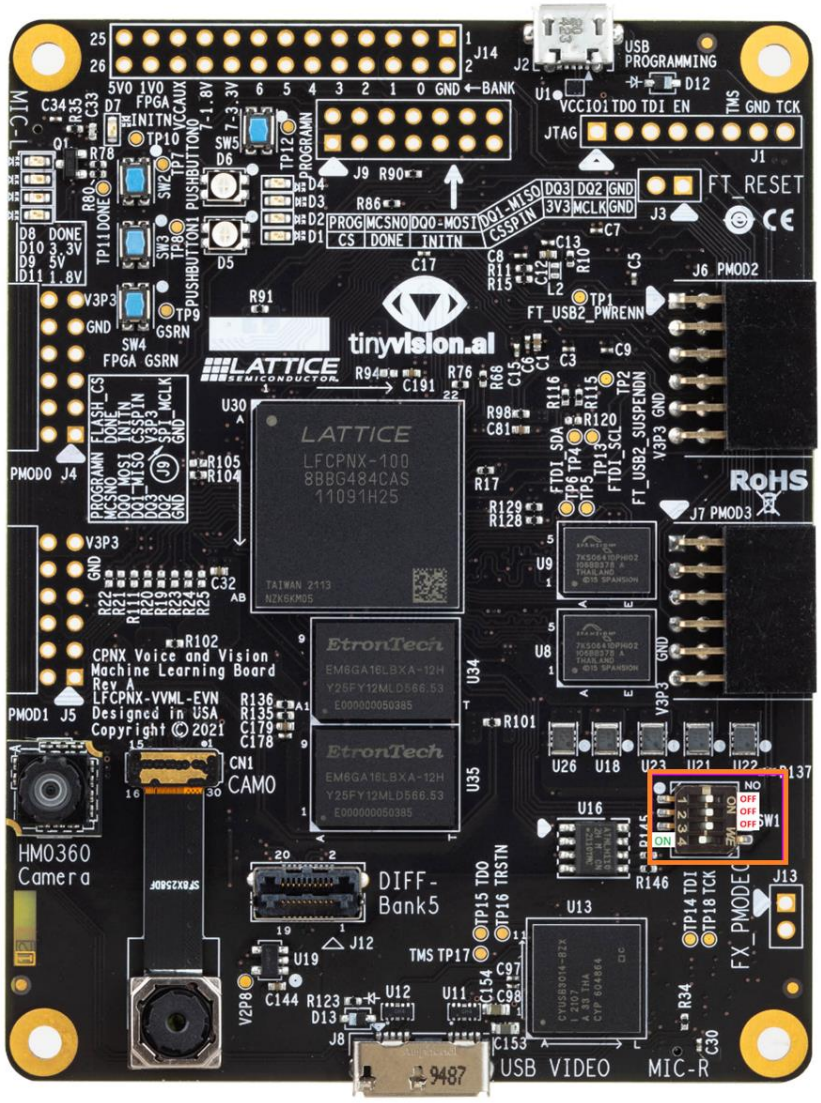

Figure 5.1. DIP Switching Setting

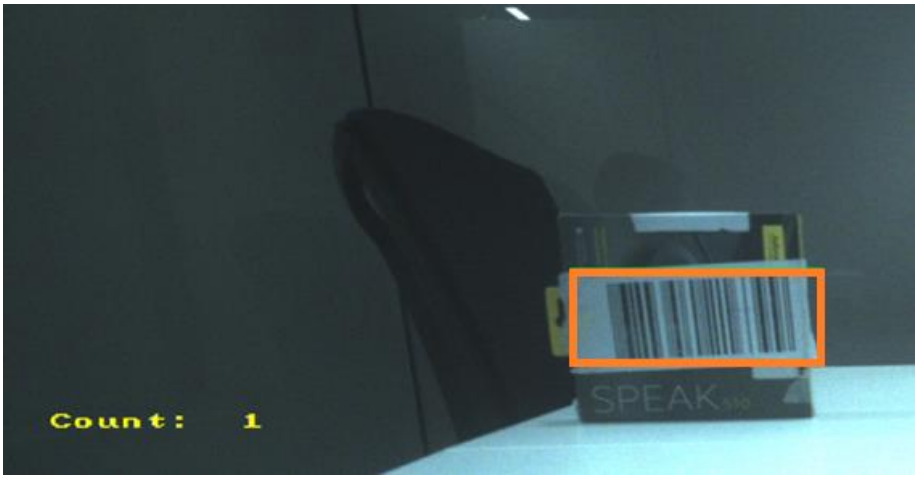

Figure 5.2. Running the Demo

5.1. Ideal Conditions for Testing the Demo

Table 5.1. Distance Based Ideal Condition – Barcode is Static and at Distance

Barcode Size (cm)	Max Detection Distance (cm – room light)	Max Detection Distance (cm – additional light)	Min Detection Distance (cm)
11 × 5.5	185	200+	40
9 × 4.5	190	200+	40
7.5 × 3.5	150	170	35
5 × 4.2	150	180	40

Table 5.2. Motion Based Ideal Conditions – Barcode is in Motion and at Distance

Barcode Size (cm)	Max Detection Distance (cm – room light)	Max Detection Distance (cm – additional light)	Barcode Motion Speed
11 × 5.5	~90	120 -150	1 km/hr
9 × 4.5	~90	120 -150	1 km/hr
7.5 × 3.5	~90	120 -150	1 km/hr
5 × 4.2	~50	<100	1 km/hr

Decent light is needed to run the demo. Too low and direct light on barcodes from the light source may reduce the performance of the demo. Additional light refers to the extra light used to brighten the barcode region. White light table lamps can be the best source for additional light.

References

- CertusPro-NX web page
- Lattice mVision web page
- Lattice sensAI web page

Other references:

- Lattice Insights for Lattice Semiconductor training courses and learning plans
- Lattice Radiant FPGA design software

Technical Support Assistance

Submit a technical support case through www.latticesemi.com/techsupport.
For frequently asked questions, refer to the Lattice Answer Database at www.latticesemi.com/Support/AnswerDatabase.

Revision History

Revision 1.0, December 2023

Section	Change Summary
All	Initial release.

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