



DisplayPort, Scaler, and Local Dimming Demo with CertusPro-NX Evaluation Board

User Guide

FPGA-UG-02189-1.0

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Acronyms in This Document

A list of acronyms used in this document.

Acronym	Definition
DPI	Display Parallel Interface
eDP	Embedded Display Port
FALD	Full Array Local Dimming
FMC	FPGA Mezzanine Card
FPGA	Field Programmable Gate Array
FPS	Frame Per Second
GPIO	General Purpose Input / Output
I ² C	Inter-Integrated Circuit
SPI	Serial Peripheral Interface
USB	Universal Serial Bus
UART	Universal Asynchronous Receiver-Transmitter
UHD	Ultra High Definition

1. Introduction

This document describes the design and setup procedure for the Display Port, scaler, and local dimming demonstration with Lattice CertusPro™-NX Evaluation Board. This demonstration uses Modular FMC Adapter with Embedded Display Port Transmitter Daughter Card to drive an eDP panel. Below are the Lattice boards used to build the demo.

- CertusPro-NX Evaluation Board
- Modular FMC Adapter
- Embedded DisplayPort Transmitter Daughter Card

Figure 1.1 shows the Lattice CertusPro-NX Evaluation Board with the Modular FMC Adapter.

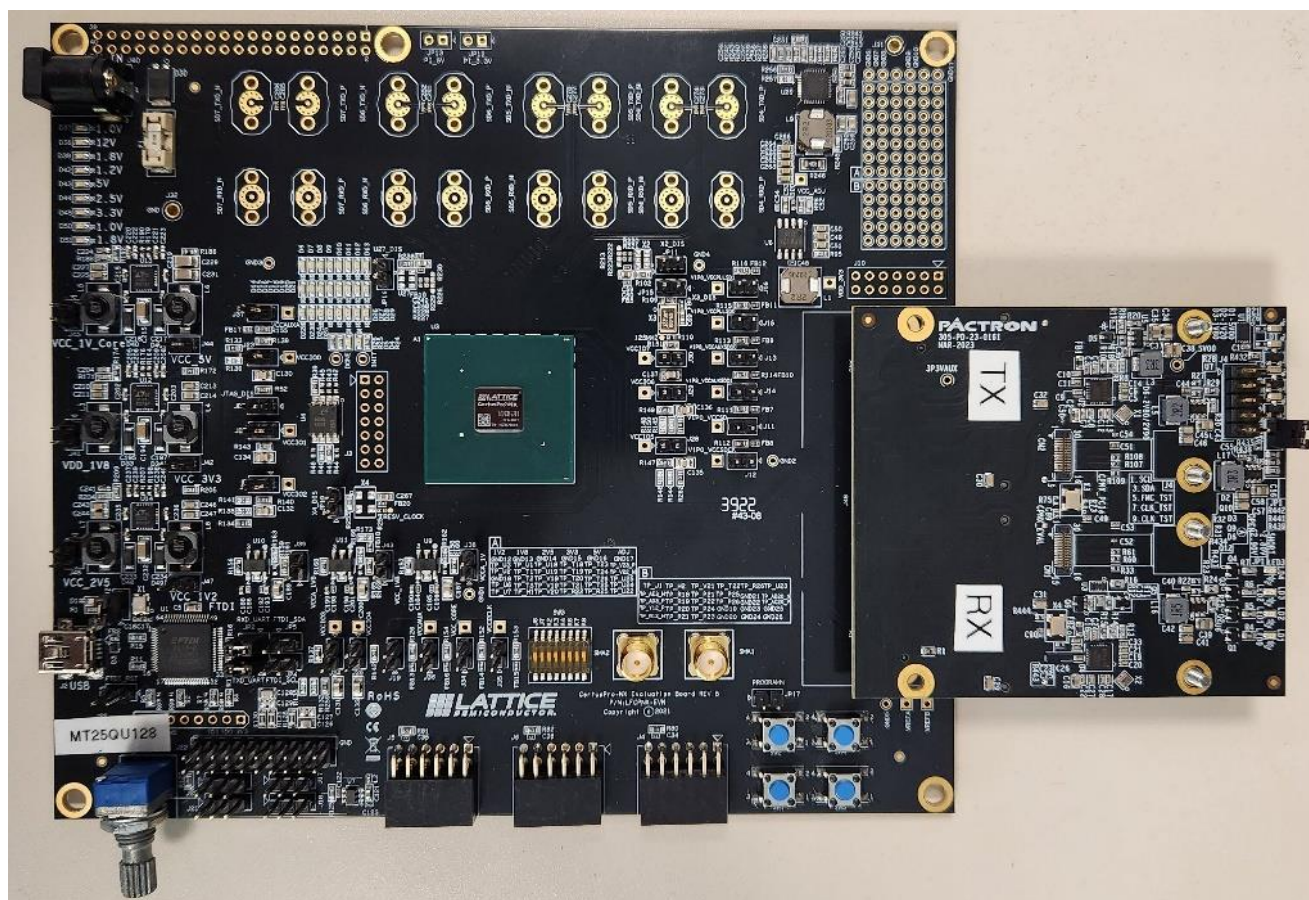


Figure 1.1. CertusPro-NX Evaluation Board

2. Functional Description

The DisplayPort, Scaler and Local Dimming demonstration showcases the capabilities of the newly introduced Lattice Drive Solution Stack IPs in a single real-life design example. The design has been created with our design partner Parretto and our display partner Lincoln Technology Solutions.

In this design demonstration, we are using a Raspberry Pi Zero as a source to stream 720p with 50 frames per second (FPS) video using GPIOs to the CertusPro-NX device on the CertusPro-NX Evaluation Board. The Video Scaler IP takes the 720p with 50 FPS video and upscales it to 2160p (UHD, 3840 x 2160) with 50 Hz using a polyphase scaling algorithm.

The Local Dimming IP dynamically controls the full LED array backlight of the panel depending on the content of the video stream. The backlight in this demonstration contains 1296 zones. Finally, the DisplayPort transmitter IP takes the 2160p video and streams it through eDP at HBR2 data rates with four lanes to the panel. The UHD 4k panel displays the 2160p with 50 Hz video while the full LED array backlight is dynamically adjusted.

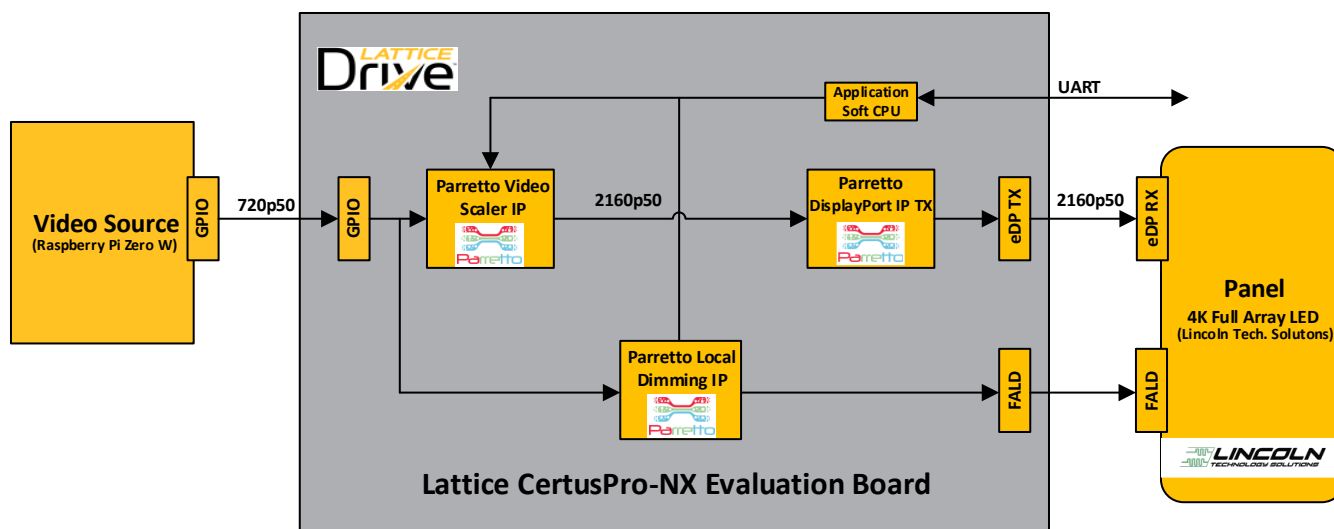


Figure 2.1. Local Dimming System Diagram

Utilizing the Display Parallel Interface (DPI) from Raspberry Pi Zero (RPI), 720p video contents in RGB24 format are streamed to CertusPro-NX Eval Board through JP14 40-pin Raspberry Pi GPIO Header.

The demonstration has two operation modes; colorbar and RPI. In colorbar mode, the test pattern is transmitted by the eDP IP to the eDP panel. In RPI mode, the video contents coming from the Raspberry Pi Zero is captured by the CertusPro-NX and scaled to 2160p using a polyphases scaling algorithm. The video data is then sent to the UHD panel.

The Local Dimming IP analyses the video contents and controls the LED backlight array through FALD interface dynamically. The latency for local dimming algorithm is 40 lines and it is programmed through FALD interface which takes effect on the next video frame.

3. Demo Requirements

The following components are required for the demo:

- LFCPNX-EVN CertusPro-NX Evaluation Board
- LF-BB-FMC-EVN Modular FMC Adapter
- LF-EDP-FMCTX-EVN Embedded DisplayPort Transmitter Daughter Card
- Raspberry Pi Zero
- LCD111-133NT 13.3" UHD panel by Lincoln Technology Solutions
- CAB40-LCD126-762 40-pin crossover shielded eDP cable
- CAB15-LCD096 15-pin FALD data cable
- CAB6-LCD096 6-pin backlight power cable
- DC power adapter (12 V)
- DC power adapter (24 V)
- Laptop/PC †*
- USB 2.0 Type A to Mini-B cable †*
- Bit/JED file *
- Lattice Radiant® Programmer version 3.0 or higher *

† **Note:** Required only in UART console command control

* **Note:** Required only in re-programming

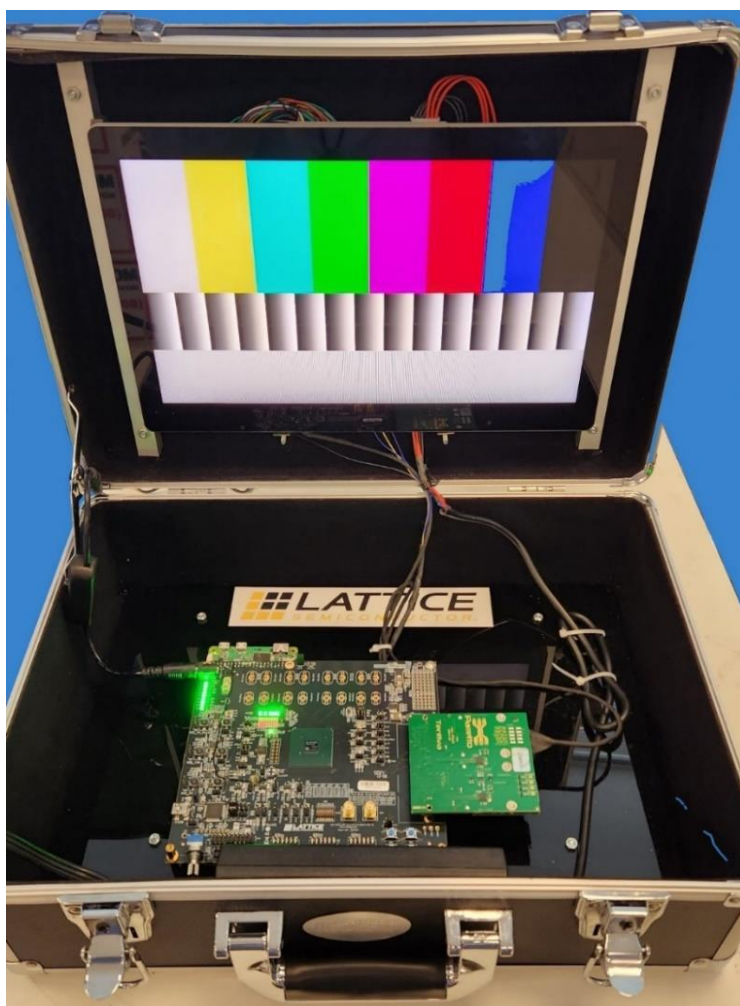


Figure 3.1. Backlight Local Dimming Demo Setup

3.1. Raspberry Pi Zero

Raspberry Pi Zero (RPI) is connected to CertusPro-NX Evaluation Board through the 40-pin GPIO header. Pin assignment and definition can be found from Raspberry Pi Hardware web site:

<https://www.raspberrypi.com/documentation/computers/raspberry-pi.html#gpio-and-the-40-pin-header>

3.2. CertusPro-NX Evaluation Board

The CertusPro-NX Evaluation Board provides one UART communication interface by providing a flexible connection between the CertusPro-NX device and the FTDI chip. This demo uses UART as optional communication and control. To interface with the host PC, close the JP1 and JP2 jumpers, then connect to two general-purpose I/O in Bank 1, as shown in [Table 3.1](#)

Table 3.1. UART Bus Connections

Signal Name	Jumper	CertusPro-NX Ball Location	FTDI Chip Ball Location	Position
TXD_UART	JP1	L2	38	Close
RXD_UART	JP2	L1	39	Close

FALD local dimming control is programmed through a serial protocol with a pair of clock and data lines. [Table 3.2](#) shows the signal connection between CertusPro-NX Evaluation board and panel connector S801 using a 15-pin FALD data cable.

Table 3.2 FALD Control

Wire color	FALD Signal Name	Panel connector	Thru-hole Pin Name	LFPCPX Ball Location
Yellow	PWR_EN	pin 13	TP_J1	J1
Blue	LED_CLK_IN	pin 7	TP_H2	H2
Blue	LED_DATA_IN	pin 8	TP_H1	H1
Black	GND	pin 9	GND24	-

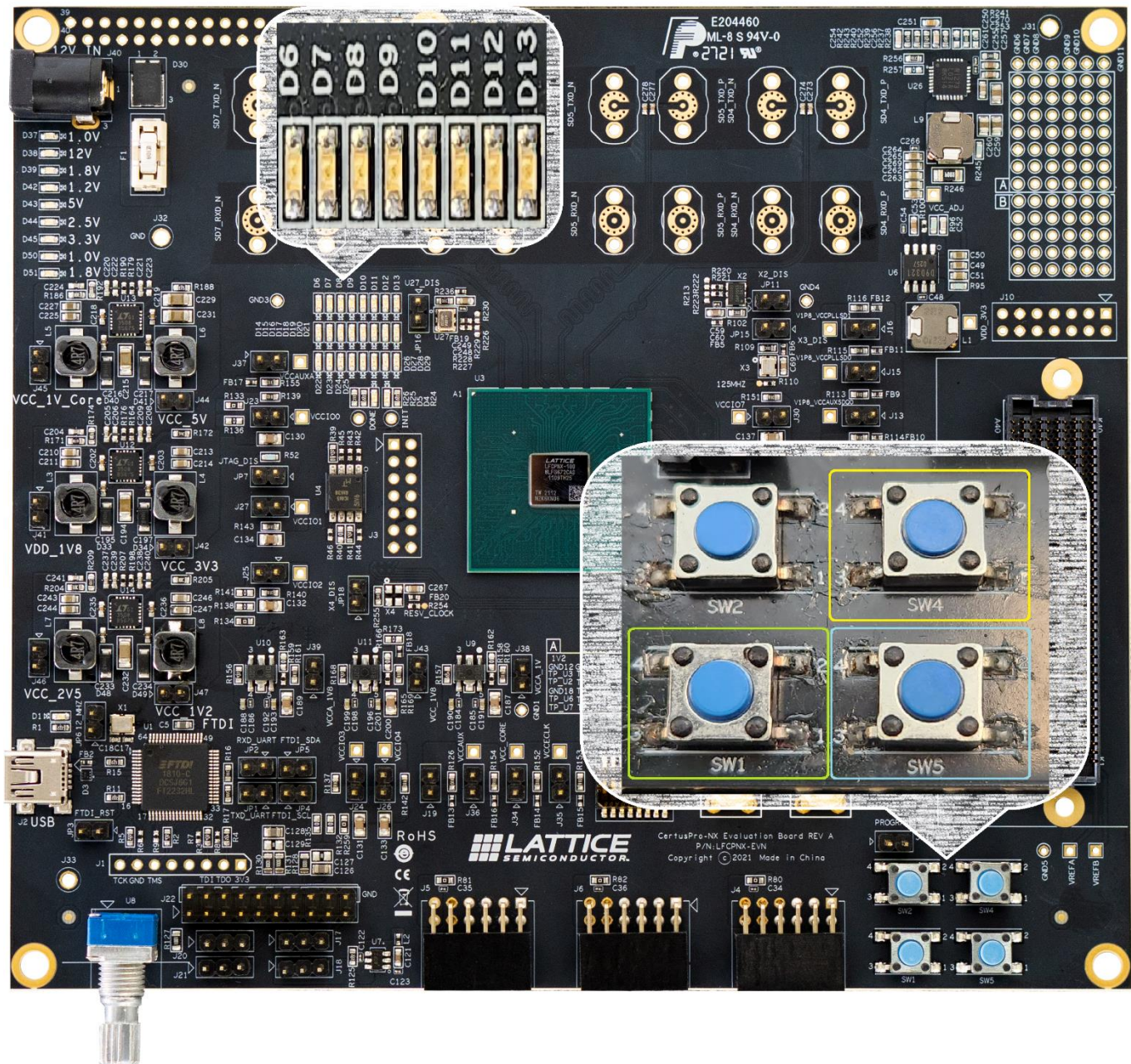


Figure 3.2. LEDs and Push Buttons of CertusPro-NX Evaluation Board

3.3. Modular FMC Adapter and eDP Transmitter Daughter Card

The Modular FMC Adapter has two plug-in slots, J2 and J3. In this demo, J3 is used for eDP transmission. Insert the eDP Transmitter Daughter Card into J3 firmly and securely to ensure stable operation.

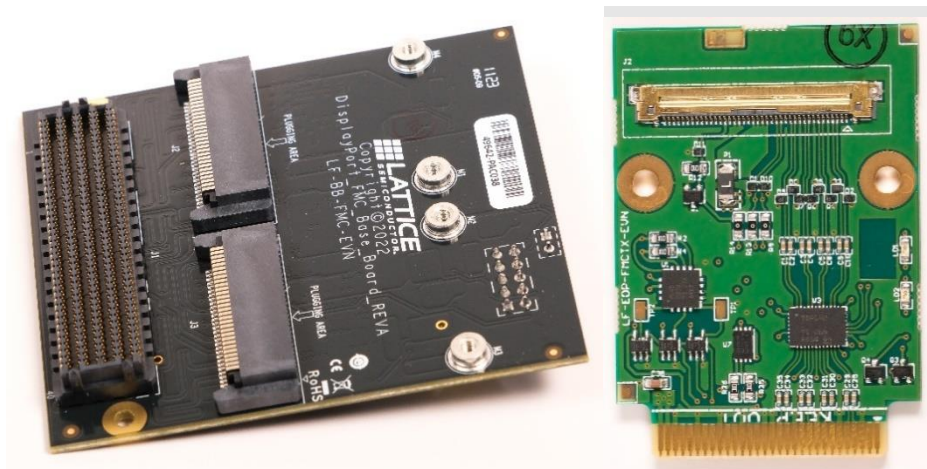


Figure 3.3. Modular FMC Adapter Board and eDP Transmitter Daughter Card

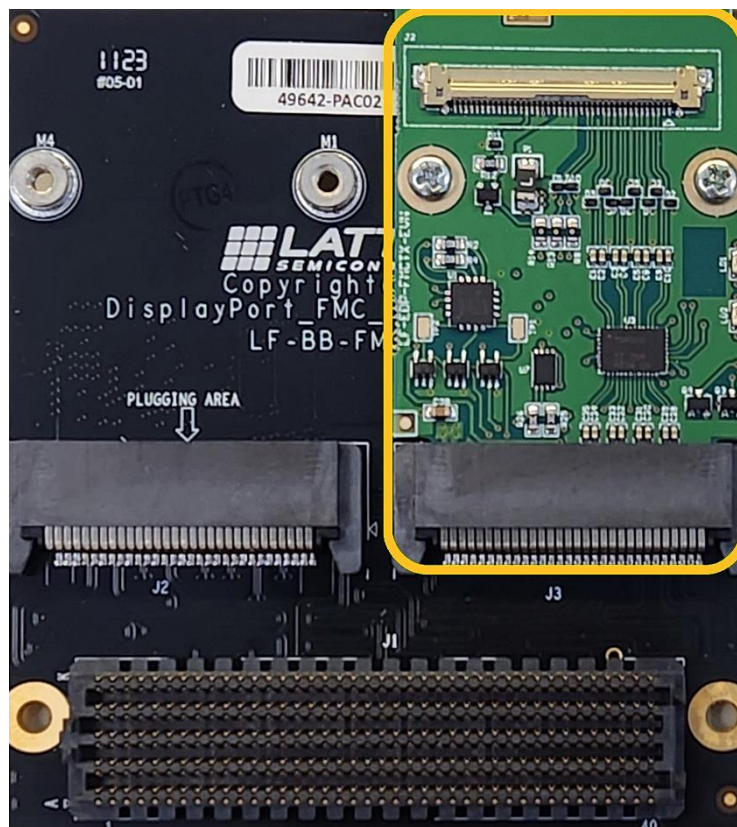


Figure 3.4. eDP Transmitter Daughter Card on Modular FMC Adapter

4. Demo Procedure

To set up the demonstration:

1. Connect the CertusPro-NX Evaluation Board to the wall socket using a 12 V power adapter.
2. Connect the panel backlight power with a 24 V power adapter.
3. Bring up the system by following the instructions in the Power On section.

4.1. Power On

After powering up the CertusPro-NX Evaluation Board and panel, four breathing LEDs start blinking upon completion of loading the bitstream. To maintain proper synchronization after power up, a system reset is recommended by pressing SW1 followed by SW4 which will display the colorbar pattern on the panel. Alternatively, a demo video can be displayed by pressing SW5 to select the RPI mode. Two demo modes can be switched at any time by pressing SW4 and SW5 respectively. The three buttons are described below and shown in [Figure 3.2](#).

- SW1: system reset
- SW4: colorbar mode
- SW5: RPI / video mode

Four status LEDs represent the operation of various functional blocks in the system as described below:

- D6: system clock is running
- D7: DP Tx is running
- D9: SerDes Tx clock is running
- D11: video clock is running

The local dimming demo will run as a standalone unit without any user intervention. However, additional demonstration options can be selected by connecting the system to a host PC through a USB cable.

4.2. Local Dimming UART Demo Control

For a manual local dimming demo control as listed in [Table 4.1](#), connect the host PC to CertusPro-NX Eval Board via USB port (J2). Open a serial terminal (such as PuTTY or equivalent) on the host PC by checking the Device Manager for corresponding COM port and set the baud rate to 115200 as shown in [Figure 4.1](#).

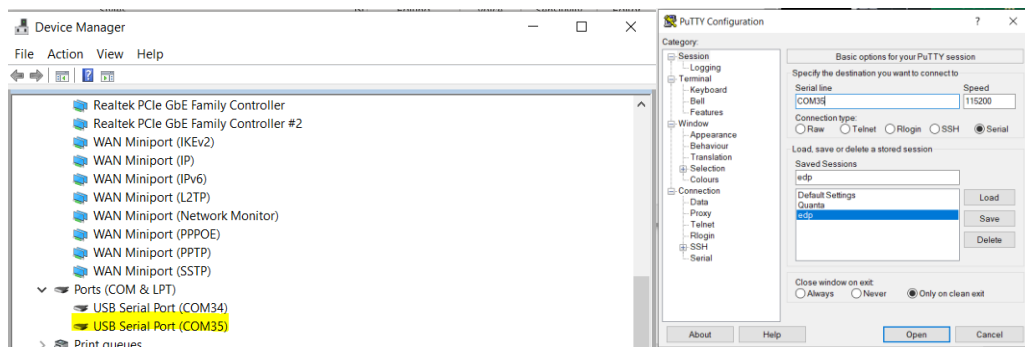


Figure 4.1. Serial Terminal Setup

A welcome message, as shown in [Figure 4.2](#), will appear after the system reset by pressing SW1. Additional information will also be displayed after selecting colorbar mode (SW4) and RPI mode (SW5). In the RPI mode, Raspberry Pi may take up to 75 seconds to boot up after power on.

```

COM10 - PuTTY

PARRETTO SW1

DP Raspberry PI demo v1.0
(c) 2022 - 2023 by Parretto B.V.
www.parretto.com
Date: 'Mar 2 2023'
Time: '09:35:03'

FALD dynamic
FALD: Start
Board: Lattice LFCPNX
Pixels per clock: 4
Tentiva base board: found
Tentiva slot 0: DPRX
Tentiva slot 1: EDPTX
Tentiva config... ok
Initialize DPTX ROM...done
Initialize DPTX RAM...done

DPTX: Ping...ok
DPTX: Config...ok
DPTX: HPD plug
DPTX: Training pass
DPTX: Link up | lanes: 4 | rate: 5.4 Gbps

Show colorbar
Scaler: stop
RPI: stop
VTB: Start test pattern
DPTX: Set MSA
DPTX: Start video... ok
DPTX: Video up

Show Raspberry PI
Scaler: start
RPI: run
DPTX: Set MSA
DPTX: Start video... ok
DPTX: Video up
  
```

Figure 4.2. Welcome Message on Host PC

[Table 4.1](#) provides a list of keyboard commands for UART local dimming demo control through the serial terminal on the host PC. The power up default is set to dynamic mode.

Two display operations are switchable at any time: colorbar mode can be selected by pressing SW4 or enter 'z' from the keyboard. The RPI mode can be selected by pressing SW5 or enter 'x' from the keyboard.

Table 4.1. Local Dimming Control Menu

Key	Definition	Result
i	RPI video info	Display video mode info
z	Show colorbar	Colorbar mode
x	Show RPI desktop	Video mode (Raspberry Pi)
0	FALD dynamic	Default demo mode
1	FALD static 1 (darkest)	All backlight array in low power setting
2	FALD static 2	—
3	FALD static 3	—
4	FALD static 4 (brightest)	All backlight array in high power setting
5	FALD split (off/on)	Left screen LD OFF, right screen LD ON
9	FALD pong	LD focus on pong
,	Move paddle up	Paddle up control for pong
.	Move paddle down	Paddle down control for pong
0	Exit pong	Exit pong mode, back to FALD dynamic

5. Ordering Information

Table 5.1. Ordering Information

Description	Ordering Part Number
CertusPro-NX Evaluation Board	LFPCNX-EVN
Modular FMC Adapter	LF-BB-FMC-EVN
Embedded DisplayPort Transmitter Daughter Card	LF-EDP-FMCTX-EVN
Raspberry Pi Zero	Raspberry Pi Zero
13.3" UHD-4k FALD panel from Lincoln Technology Solutions	LCD111-133NT
40-pin eDP shielded crossover cable from Lincoln Technology Solutions	CAB40-LCD126-762
15-pin FALD data cable from Lincoln Technology Solutions	CAB15-LCD096-609
6-pin backlight power cable from Lincoln Technology Solutions	CAB6-LCD096-609

Appendix A – Programming the Lattice CertusPro-NX Evaluation Board

Using Lattice Radiant Programmer with Lattice CertusPro-NX Evaluation Board

The Lattice Radiant Programmer can be used to program the bitstream to the internal SRAM or an external SPI flash. The Radiant Programmer is integrated into the Lattice Radiant software and is also available as a stand-alone version.

To program the CertusPro-NX device:

1. Connect the PC installed with Radiant Programmer to the CertusPro-NX Evaluation Board (J2) using the USB cable.
2. Plug in power jack (J40) and observe that all power status LEDs are on.
3. In the Lattice Radiant software, click the **Programmer** button, as shown in [Figure A.1](#).

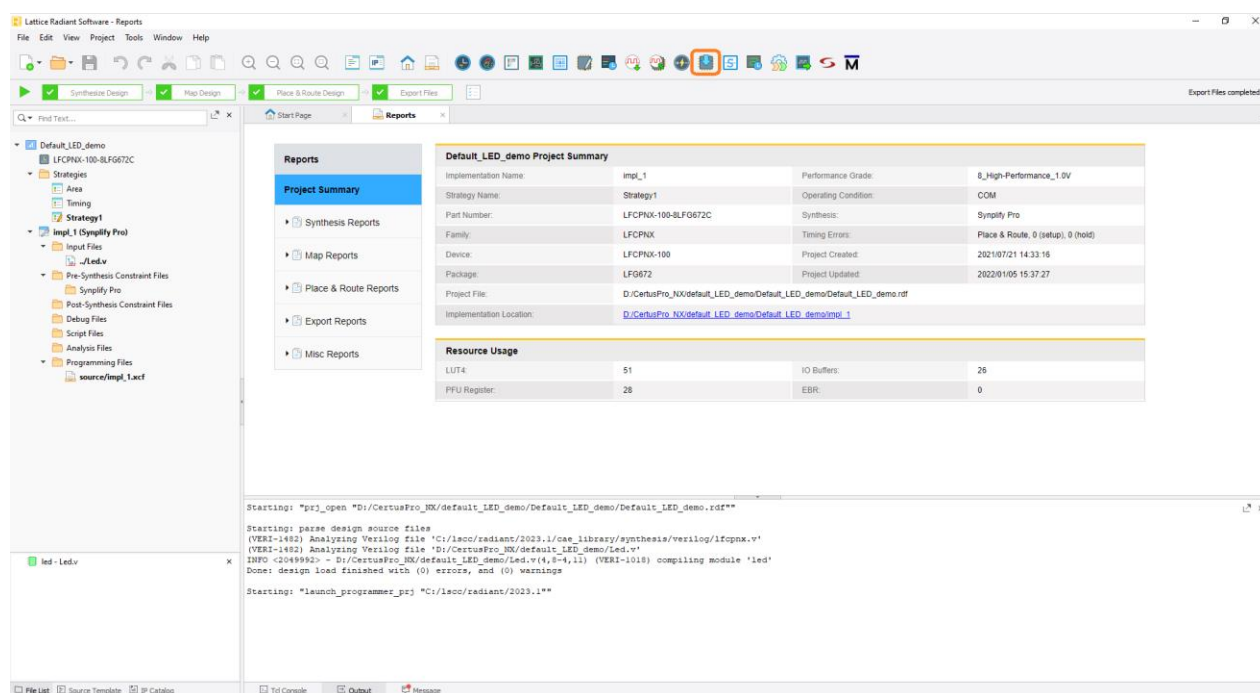


Figure A.1. Radiant Software – Radiant Programmer

4. Radiant Programmer opens as shown in [Figure A.2](#). Click the **Scan Device** button and under **Device**, choose **LFCPNX-100**.

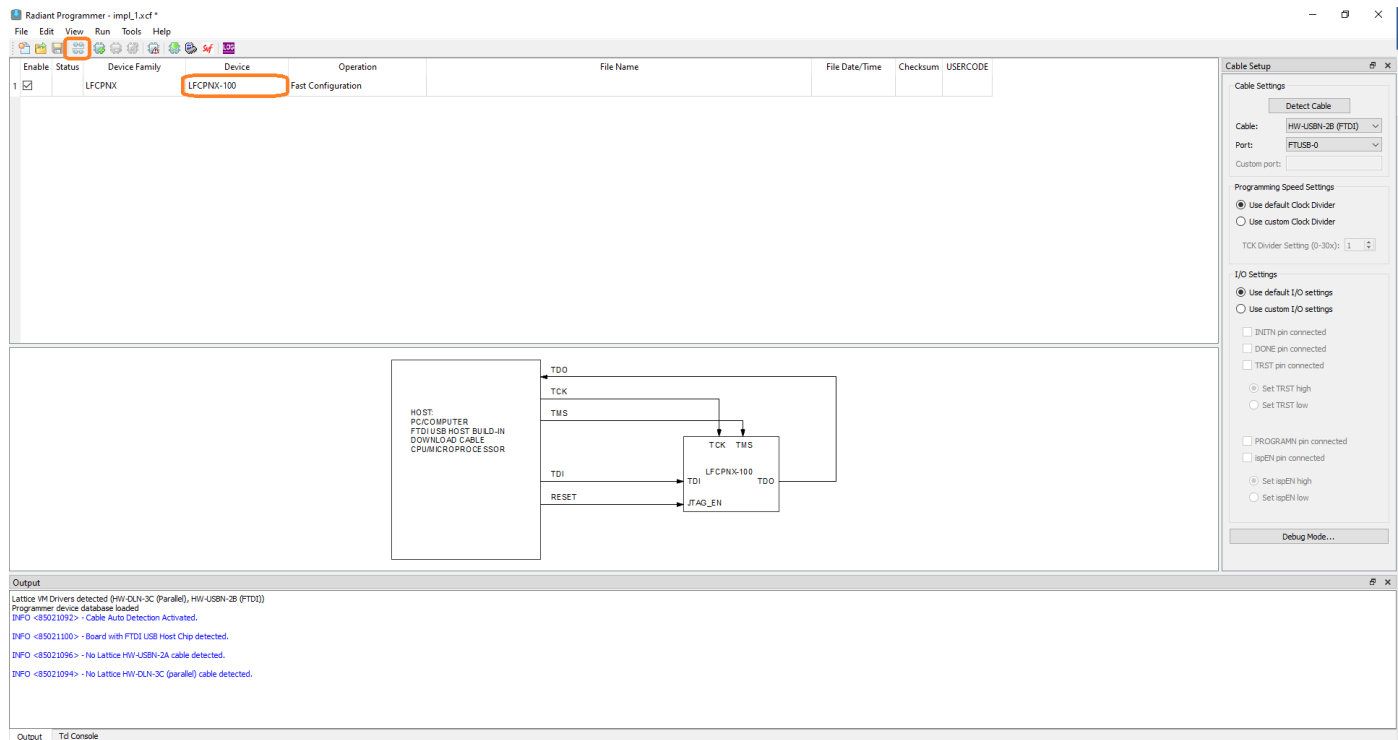


Figure A.2. Radiant Programmer

5. Download the bitstream into the internal SRAM or to an external Flash.
To download the bitstream into the internal SRAM:
 - a. Under **Operation**, double-click **Fast Configuration** as shown in [Figure A.3](#).

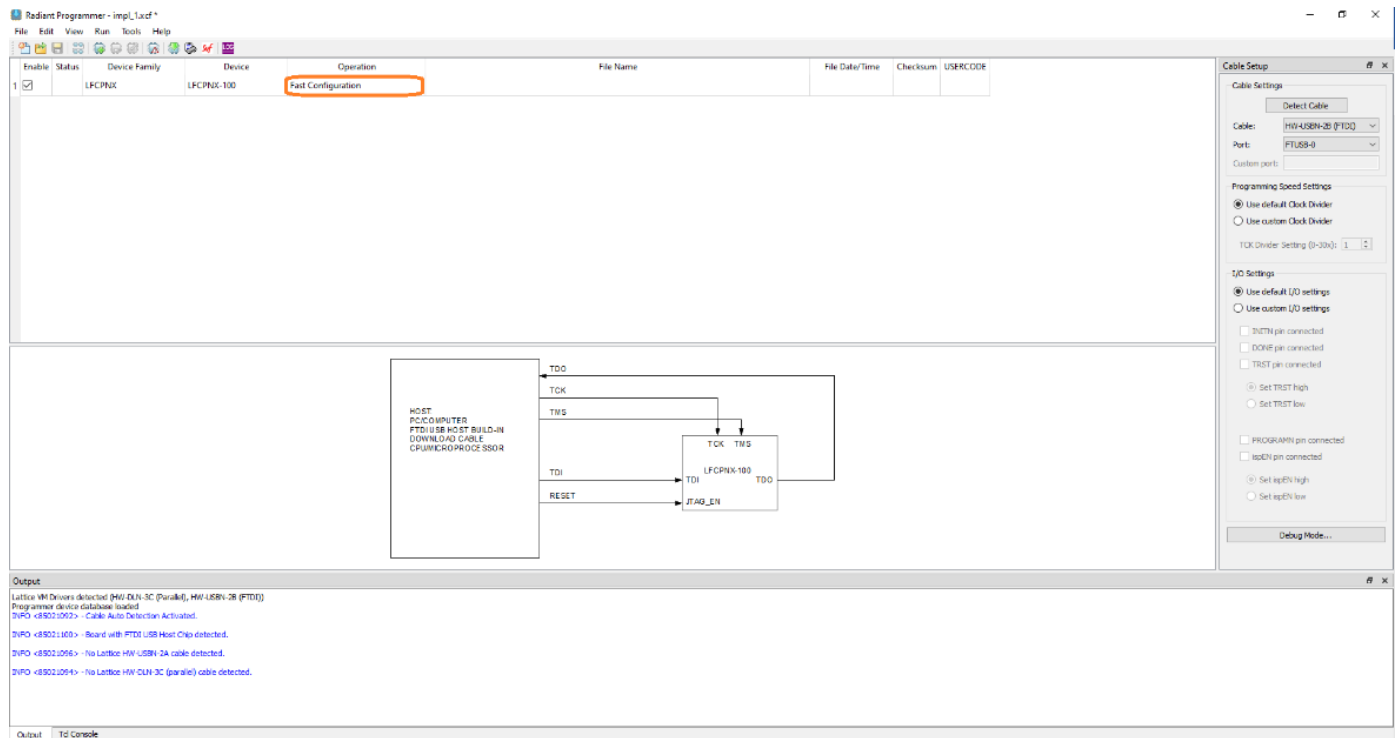


Figure A.3. Radiant Programmer – Fast Configuration Dialog

- b. The **Device Properties** dialog box opens as shown in, [Figure A.4](#). Select the following options:
- **Target Memory – Static Random Access Memory (SRAM)**
 - **Port Interface – JTAG**
 - **Access Mode – Direct Programming**
 - **Operation – Fast Configuration**
 - **Programming file – Choose the bitstream file to be programmed**

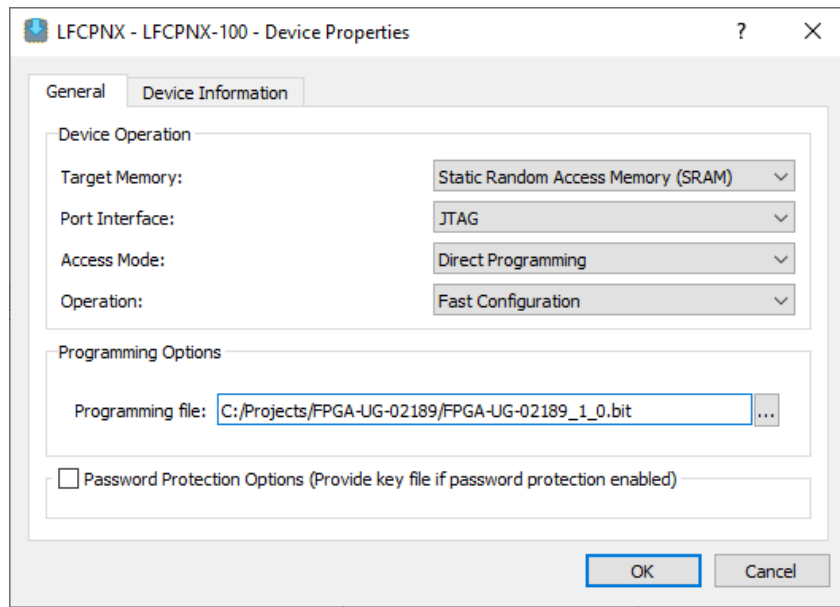


Figure A.4. Radiant Programmer – Fast Configuration Device Properties

- c. Click **OK**.
- d. To program the bitstream file, click the **Program** button in the Lattice Radiant software as shown in Figure A.5. If the programming is completed successfully, the **Status** column shows **PASS**. The **Output** pane also shows **INFO – Operation: successful**. The bitstream is downloaded into internal SRAM.

Note: When re-power or re-program operation is executed, this bitstream file becomes invalid.

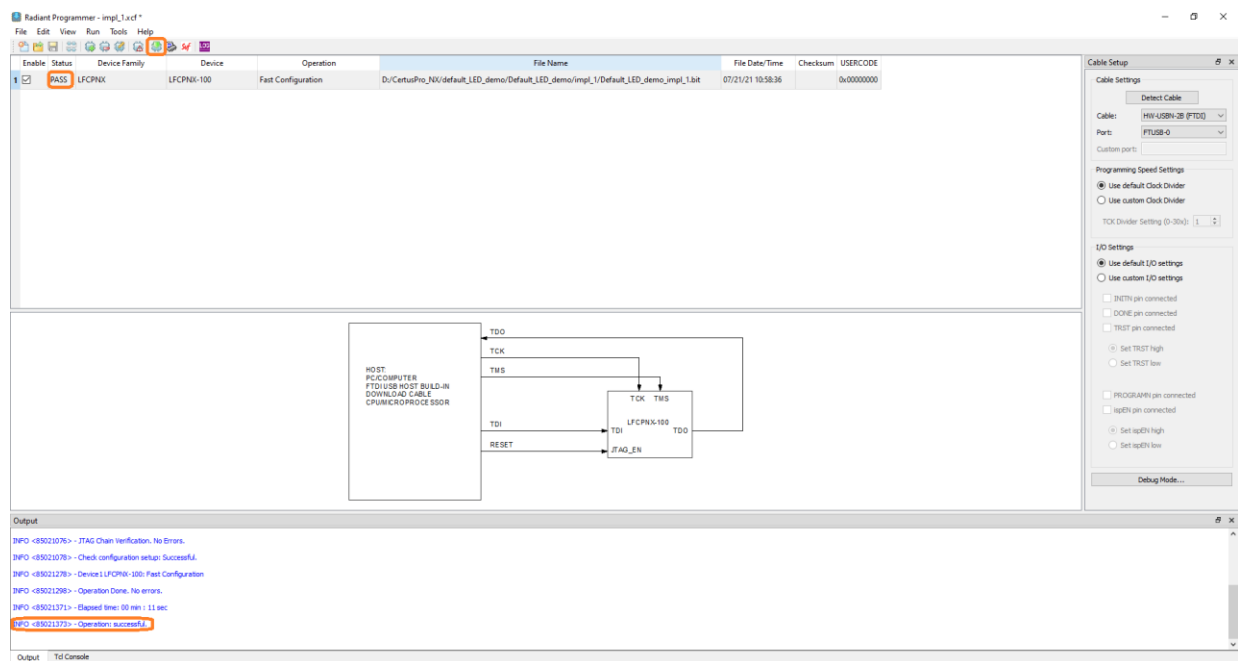


Figure A.5. Radiant Programmer – Fast Configuration Pass

To download the bitstream into the external SPI flash:

- a. Under Operation, double-click Fast Configuration.
- b. The Device Properties dialog box opens as shown in [Figure A.6](#). Select the following options:

- **Target Memory – External SPI Flash Memory (SPI FLASH)**
- **Port Interface – JTAG2SPI**
- **Access Mode – Direct Programming**
- **Operation – Erase, Program, Verify**
- **Programming file** – Choose the bitstream file to be programmed
- **Family – SPI Serial Flash**
- **Vendor – Micron**
- **Device – MT25QU128**
- **Package – 8-pin SOP2**

Note: The Flash device on this board is Micron MT25QU128ABA that powers up with 1.8 V. These options are settled and cannot be changed.

- c. Click **OK**.

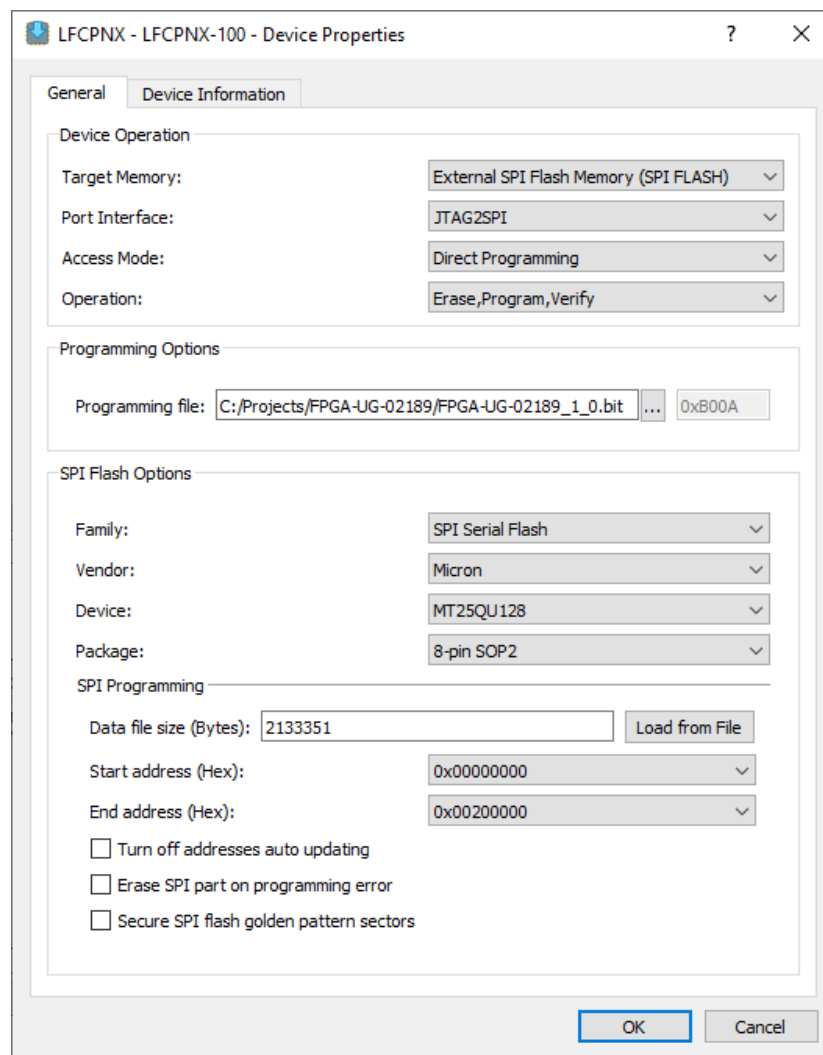


Figure A.6. Radiant Programmer – SPI Flash Operation Device Properties

- Click the **Program** button in the Lattice Radiant software, as shown in Figure A.7. If the programming is completed successfully, the **Status** column shows **PASS**. The Output pane also shows **INFO – Operation: successful**. The bitstream file is downloaded into the external SPI flash.

Note: When re-power or re-program operation is executed, this bitstream file is loaded from SPI flash to FPGA automatically.

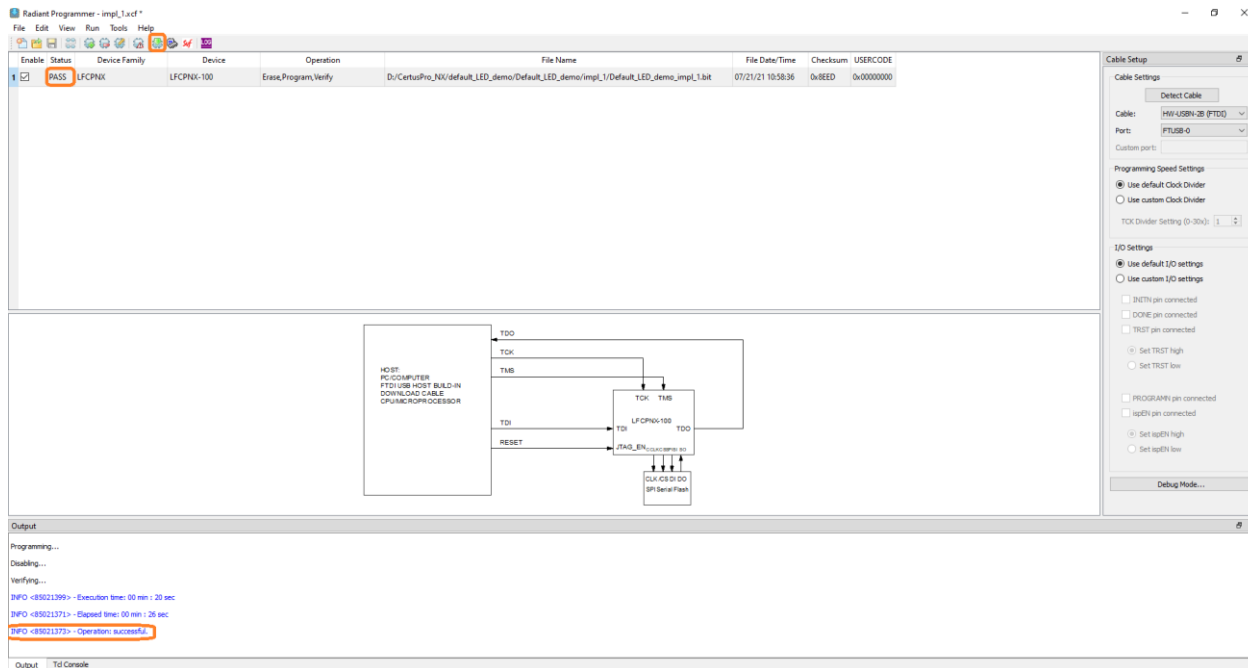


Figure A.7. Radiant Programmer – SPI Flash Operation Pass

References

For more information, refer to:

- [Lattice Drive Solution Stack](#)
- [CertusPro-NX Family Data Sheet \(FPGA-DS-02086\)](#)
- [CertusPro-NX Evaluation Board Quick Start Guide](#)
- [CertusPro-NX website](#)
- [Raspberry Pi Zero website](#)
- [Parretto Github repository for the Local Dimming Design](#)
- [Parretto B. V. website](#)
- [Lincoln Technology Solutions](#)

For schematics, refer to:

- [CertusPro-NX Evaluation Board - User Guide and Schematics \(FPGA-EB-02046-1.2\)](#)
- [Modular FMC Adapter](#)
- [Embedded DisplayPort Transmitter Daughter Card](#)

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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, July 2023

Section	Change Summary
All	Initial release.



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