DG0807
Demo Guide
PolarFire Imaging and Video Kit MIPI CSI-2

Microsemi
Power Matters.™

Microsemi Corporate Headquarters
One Enterprise, Aliso Viejo,
CA 92656 USA
Within the USA: +1 (800) 713-4113
Outside the USA: +1 (949) 380-6100
Fax: +1 (949) 215-4996
Email: sales.support@microsemi.com
www.microsemi.com

About Microsemi

Microsemi Corporation (Nasdaq: MSCC) offers a comprehensive portfolio of semiconductor and system solutions for aerospace & defense, communications, data center and industrial markets. Products include high-performance and radiation-hardened analog mixed-signal integrated circuits, FPGAs, SoCs and ASICs; power management products; timing and synchronization devices and precise time solutions, setting the world's standard for time; voice processing devices; RF solutions; discrete components; enterprise storage and communication solutions, security technologies and scalable anti-tamper products; Ethernet solutions; Power-over-Ethernet ICs and midspans; as well as custom design capabilities and services. Microsemi is headquartered in Aliso Viejo, California, and has approximately 4,800 employees globally. Learn more at www.microsemi.com.

50200807. 1.0 3/18

Contents

Figures

Tables

1 Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

1.1 Revision 1.0

Revision 1.0 is the first publication of this document.

2 PolarFire Imaging and Video MIPI CSI-2

This document describes how to run the PolarFire™ video and imaging demo using the PolarFire Evaluation Board and PolarFire Imaging and Video MIPI CSI-2 Daughter Card. A fully integrated video solution with an easy-to-use GUI is provided to design prototypes quickly and to demonstrate the following functions:

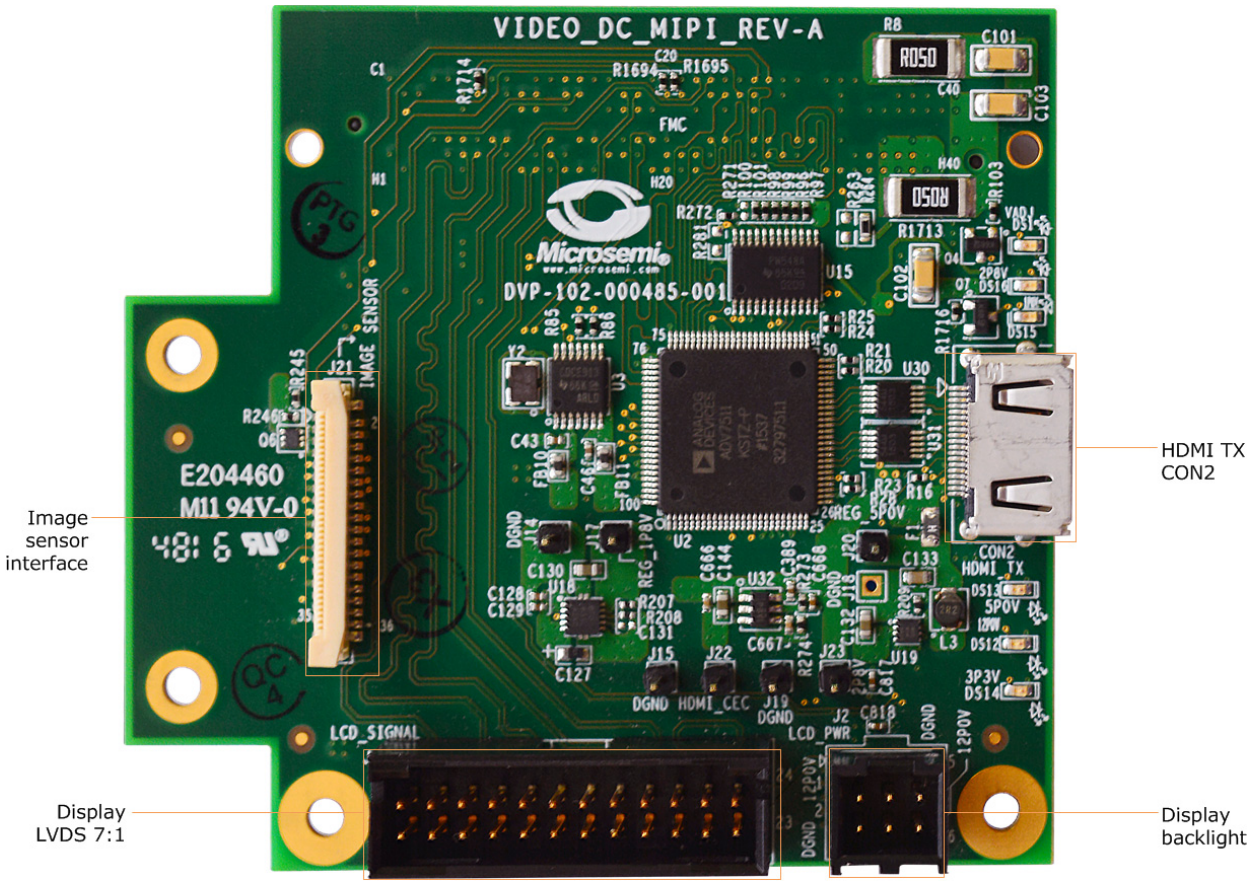
- CFA to RGB conversion
- Display timing generator
- Edge detection
- Image enhancements (such as sharpening, brightness, contrast, hue, and saturation)

Microsemi PolarFire Evaluation Kit offers high-performance evaluation across a broad class of applications. This kit supports high-speed transceiver evaluation, 10Gb Ethernet, IEEE1588, JESD204B, SyncE, CPRI and more. The kit connections include a high pin count (HPC) FPGA mezzanine card (FMC), numerous SMAs, PCIe, Dual Gigabit Ethernet RJ45, SFP+ and USB. A 300K logic element (LE) with DDR4, DDR3, and SPI-flash enable a broad class of high-performance designs to be developed. For more information, see *https://www.microsemi.com/products/fpga-soc/fpga/polarfire-fpga#overview*.

As shown in Figure 1, page 2, the video daughter card provides the following features:

- HDMI transmitter (ADV7511) chip set and the corresponding connector
- LVDS 7:1 interface to connect the LCD
- Image sensor interface that supports MIPI CSI-2
- Low pin count (LPC) FMC connector to connect to an FPGA device and the necessary circuitry

Figure 1 • **MIPI CSI-2 Daughter Card**



For detailed information about these features, visit:
http://www.microsemi.com/products/fpgasoc/imaging#getting-started

2.1 Design Requirements

The following table lists the design requirements.

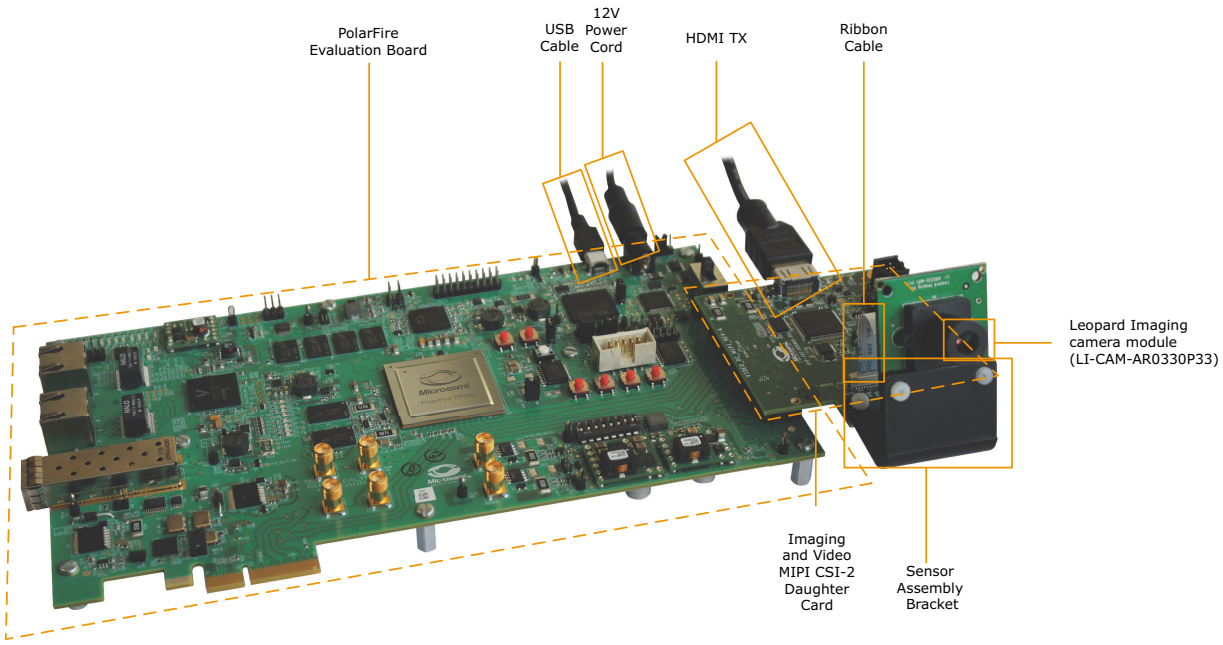
Table 1 • **Design Requirements**

Design Requirement	Description
Hardware	
Imaging and Video MIPI-CSI2 Daughter Card	VIDEO-DC-MIPI
PolarFire Evaluation Kit[1]	MPF300TS-1FCG1152EES Device
Image sensor module	ONSemi AR0330 Image Sensor from Leopard Imaging (LI-AR0330-MIPI v1.1)
Image sensor ribbon cable	
Mini USB to Type A USB cable[2]	
HDMI cable	HDMI A Male to Male Cable
HDMI monitor[3]	Any 21-inch display with HDMI input
USB micro AB connector[2]	
Power adapter (T1121-P5P-ND)[2]	
Operating system	Windows 7 or later
Software	
Libero SoC PolarFire	v2.0
SoftConsole	v5.2
FlashPro programming software	PolarFire v2.0

1. Not shipped with the Imaging and Video MIPI CSI-2 Daughter Card; must be purchased separately.
2. Included with PolarFire Evaluation Kit.
3. If the display does not support HDMI input, use an adapter that converts the HDMI out from the imaging card to a protocol supported by the display.

Figure 2, page 4 shows the complete setup of the Imaging and Video MIPI-CSI2 Daughter Card and the PolarFire Evaluation Board.

Figure 2 • **Full Setup**



2.2 Prerequisites

Before you start:

1. Download the design files from *http://soc.microsemi.com/download/rsc/?f=mpf_dg0807_liberosocpolarfirev2p0_df*
2. Download the programming file from *http://soc.microsemi.com/download/rsc/?f=mpf_dg0807_liberosocpolarfirev2p0_pf*
3. Download the GUI from *http://soc.microsemi.com/download/rsc/?f=mpf_dg0807_liberosocpolarfirev2p0_gui*
4. Download and install Libero SoC PolarFire v2.0 from https://www.microsemi.com/products/fpga-soc/design-resources/design-software/libero-soc-polarfire#downloads

2.3 Demo Design

The design files folder contains the demo Libero and SoftConsole projects.

This demo requires the programming of the onboard PolarFire device and onboard Micron SPI Flash device. These two onboard devices can be programmed using Libero SoC PolarFire. Alternately, the onboard PolarFire device can be programmed using FlashPro. In any case, the onboard Micron SPI Flash device must be programmed using Libero SoC PolarFire.

The user application executable (the .hex file) is programmed on the onboard SPI Flash. After the PolarFire device power-up, the LSRAM block is initialized with the user application stored in the SPI Flash.

2.4 Installing the Demo GUI

To install the GUI:

5. Open the `mpf_dg0807_liberosocpolarfirev2p0_df\Installer` folder, extract the `Installer.rar` file and run the **setup.exe**. Click **Yes** for any message from User Account Control. The Setup window is displayed with the default locations.
6. Accept the license agreement, and click **Next**.
7. Confirm the installation location in the installation dialog box, and click **Next**. A progress bar appears that shows the progress of the installation. Upon successful installation, a confirmation message is displayed.
8. Click **Finish** to exit the installation wizard.
9. Restart the host PC.

The PF_Video_Demo_GUI is successfully installed.

2.5 Setting Up the Demo

Setting up the demo involves the following steps:

1. Setting Up the Hardware, page 5
2. Setting Up the Video Daughter Card, page 5
3. Setting Up the PolarFire Evaluation Board, page 6
4. Programming the Onboard PolarFire Device, page 7
5. Programming the Onboard PolarFire Device, page 7

2.5.1 Setting Up the Hardware

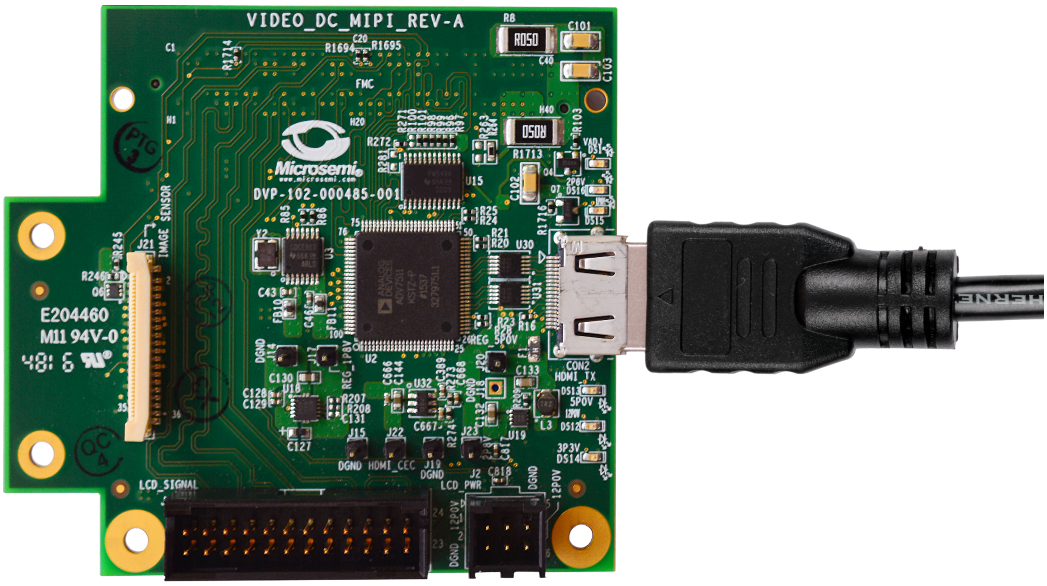
The hardware setup for the demo design involves establishing appropriate hardware connections between the Imaging and Video MIPI CSI-2 Daughter Card and the PolarFire Evaluation Board.

Figure 2, page 4 shows the complete hardware setup for the demo. The following sections show the hardware setup for the Imaging and Video MIPI CSI-2 Daughter Card and the PolarFire Evaluation Board separately.

2.5.1.1 Setting Up the Video Daughter Card

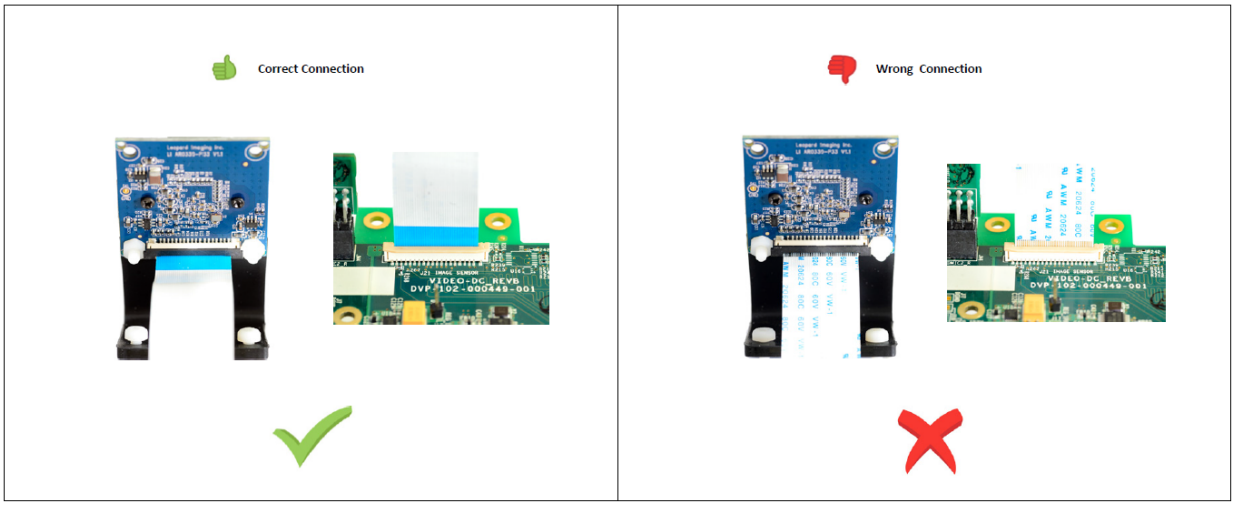
1. Connect the video daughter board to HPC (**J34**) FMC connector of PolarFire Evaluation Board, as shown in Figure 2, page 4.
2. Connect one end of the HDMI cable to HDMI Connector (**CON2**) of video daughter board and the other end to the monitor, as shown in Figure 3, page 5.

Figure 3 • **Video Daughter Card Setup**



3. Connect one end of the image sensor ribbon cable to the image sensor interface (J21) on the video daughter board and the other end to the MIPI sensor (AR0330), as shown Figure 4, page 6.

Figure 4 • **Camera Ribbon Cable Connection**



2.5.1.2 Setting Up the PolarFire Evaluation Board

1. Connect the power supply cable to the **J9** connector, as shown in Figure 5, page 7.
2. Close pins 3-4 of **J12** to select the 2.5V core voltage.
3. Connect the USB cable from the Host PC to **J5** (FTDI port).
4. Make sure the default jumper settings shown in the following table are retained.

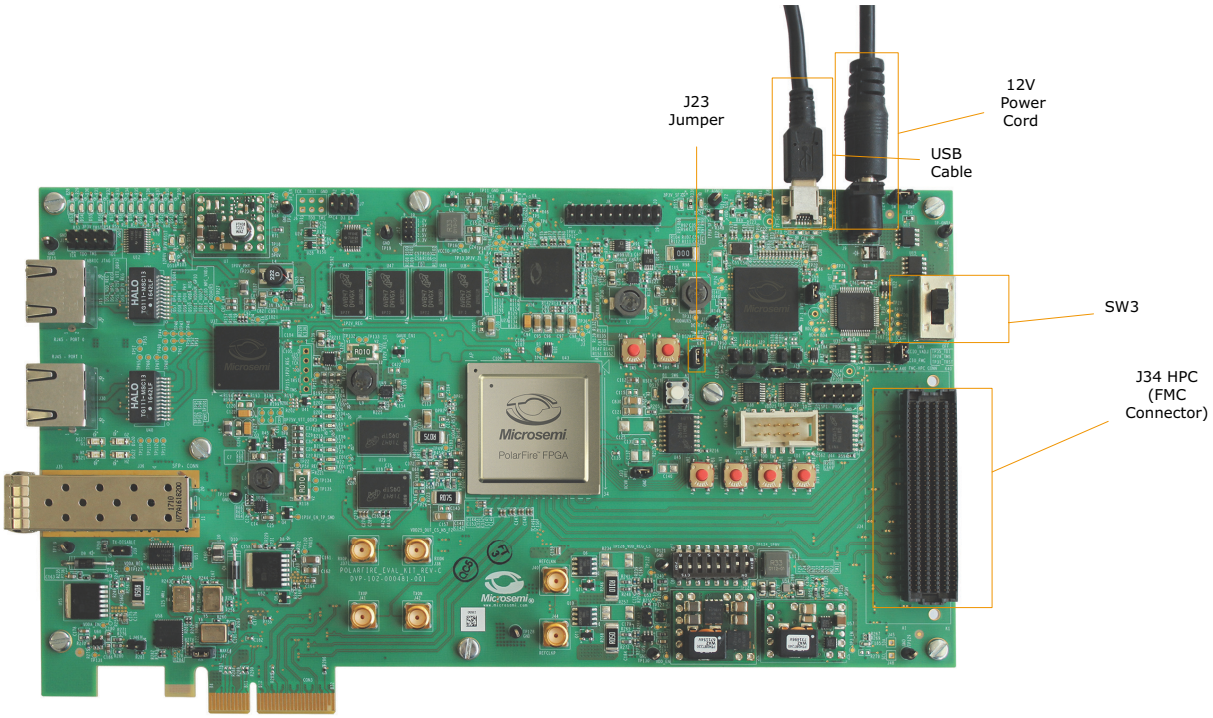
Table 2 • **Jumper and Resistor Settings for MPF300TS Device**

Jumper/Resistor	Setting
J18, J19, J20, J21, J22	Closed
J28	Closed
J26	Open
J4	Closed
J12	Closed
J23	Closed

5. Power-up the Board using the **SW3** slide switch.

Figure 5, page 7 shows the PolarFire Evaluation Board setup.

Figure 5 • **PolarFire Evaluation Board Setup**



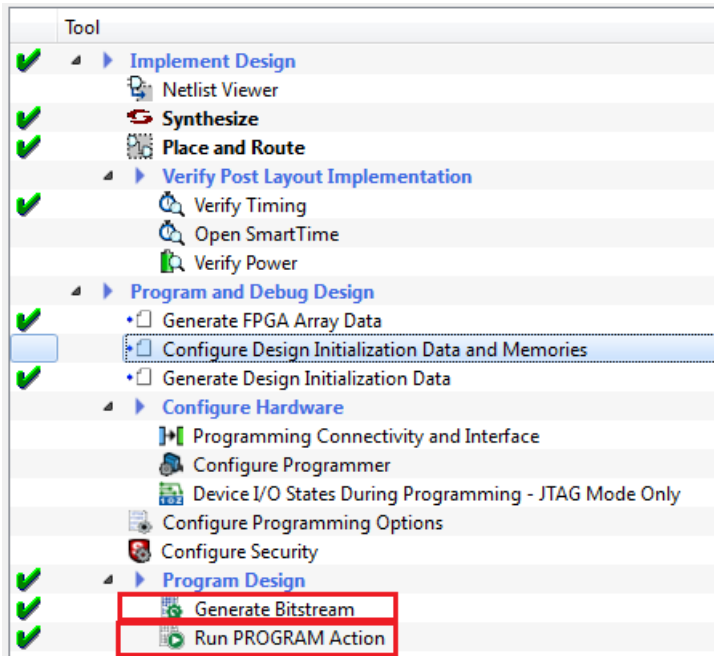
2.5.2 Programming the Onboard PolarFire Device

After setting up the hardware, the onboard PolarFire device must be programmed with the video and imaging design. Libero SoC PolarFire is used to generate the programming bitstream and to program the device. The demo design includes the Libero design project, which must be opened in Libero SoC PolarFire. The Libero Design Flow is already run on the demo design. Only the Generate Bitstream and the Run PROGRAM Action options must be run.

To program the PolarFire device:

1. Start Libero SoC PolarFire v2.0.
2. Double the Libero project from the following location:
   mpf_dg0807_liberosocpolarfirev2p0_df\Solution\Libero_prj
3. From the Libero Design Flow window, double-click **Generate Bitstream** as shown in Figure 6, page 8.

Figure 6 • **Generate Bitstream**



After the bitstream is successfully generated a green tick mark appears next to the **Generate Bitstream** option.

4. Double-click **Run PROGRAM Action**.
   After the device is successfully programmed a green tick mark appears next to the Run PROGRAM Action option.

Note: To program the device using FlashPro, see Appendix: Programming the PolarFire Device Using FlashPro, page 17.

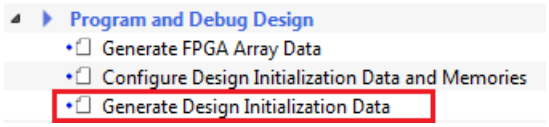
2.5.3 Generating and Programming the SPI Flash Client

After programming the PolarFire device, the onboard SPI Flash must be programmed with the video and imaging user application. Libero SoC PolarFire is used to generate the SPI Flash Image and to program the SPI Flash.

To generate SPI Image and program SPI Flash:

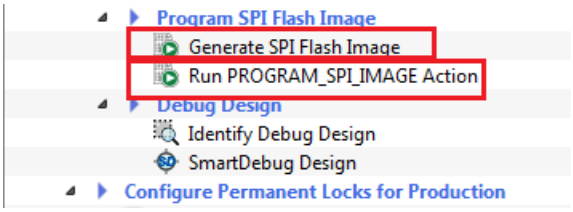
1. From the Libero Design Flow window, double-click **Generate Design Initialization Data** to create the SPI Flash client as shown in Figure 7, page 8.

Figure 7 • **Generate Design Initialization Data**



2. From the Libero Design Flow window, double-click **Generate SPI Flash Image** as shown in Figure 8, page 8.

Figure 8 • **Generate SPI Flash Image**



After the SPI Flash image is successfully generated a green tick mark appears next to the Run SPI Flash Image option.

3. Double-click **Run PROGRAM_SPI_IMAGE Action**.
   After the SPI Flash is successfully programmed a green tick mark appears next to the **Run PROGRAM_SPI_IMAGE Action** option.

For more information about how to generate an SPI Flash client in Libero SoC PolarFire, see Appendix: Generating an SPI Flash Client, page 14.

After programming the SPI Flash, the following things must be done on the PolarFire Evaluation Board:

- Power-down the board
- Remove the USB cable
- Remove the **J23** jumper
- Connect the USB cable
- Power-up the board

After the PolarFire device power-up:

1. The LSRAM blocks are initialized with the user application stored in the SPI Flash.
2. The Mi-V soft processor starts executing the user application and initializes the camera sensor and HDMI ports to display the video on the HDMI monitor.

Note: After the device power-up, if the video is not displayed on the monitor, power cycle the PolarFire Evaluation board to reset the design. The camera sensor and the HDMI monitor starts functioning after few seconds.

2.6 Running the Demo

Running the demo involves the following steps:

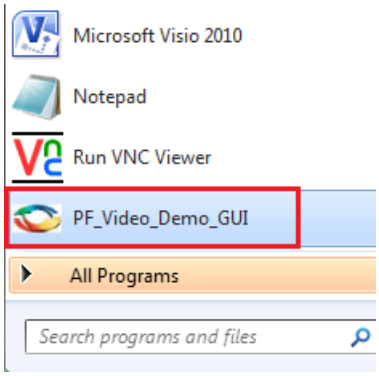
- Starting the GUI, page 9
- Running the Camera Sensor Demo, page 10
- Running the Edge Detection Demo, page 12

2.6.1 Starting the GUI

The following steps describe how to start the Video Demo GUI.

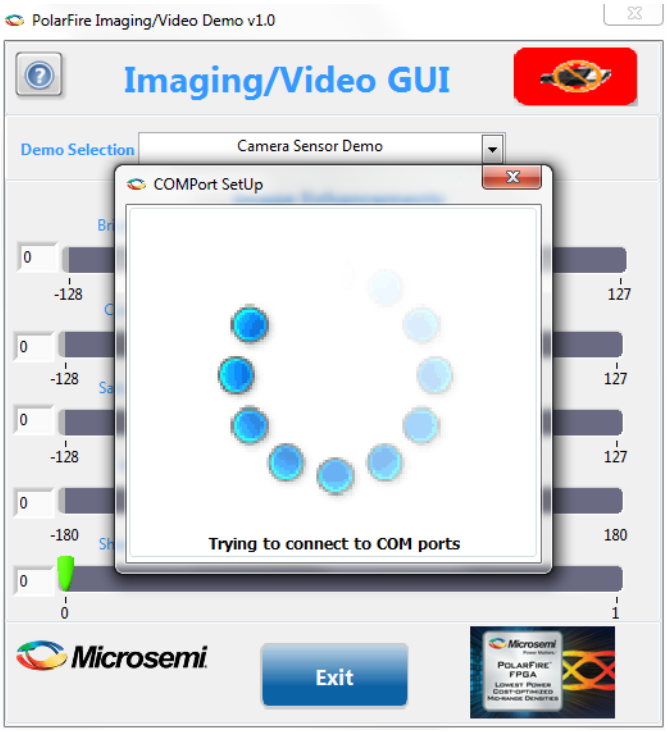
1. Go to **Start** menu, and select **PF_Video_ Demo _GUI** to open the GUI, as shown in Figure 9, page 9.

Figure 9 • **PolarFire Video Demo GUI in Windows Start Menu**



2. The GUI starts connecting to the COM Port as shown in Figure 10, page 10.

Figure 10 • **PolarFire Video Demo GUI Launch Window**



After successfully connecting to the COM port, the Connect button turns green and the text changes to Connected, as shown in Figure 11, page 11.

2.6.2 Running the Camera Sensor Demo

To run the Camera Sensor Demo:

- Select the **Camera Sensor Demo** from the **Demo Selection** drop-down, as shown in Figure 11, page 11. The video is displayed on the monitor, thus demonstrating the alpha blending feature.

Figure 11 • **Camera Sensor Demo Selection**

Properties such as brightness, contrast, saturation, hue, and sharpness can be adjusted to enhance the clarity of the video, as shown in Figure 12, page 11.

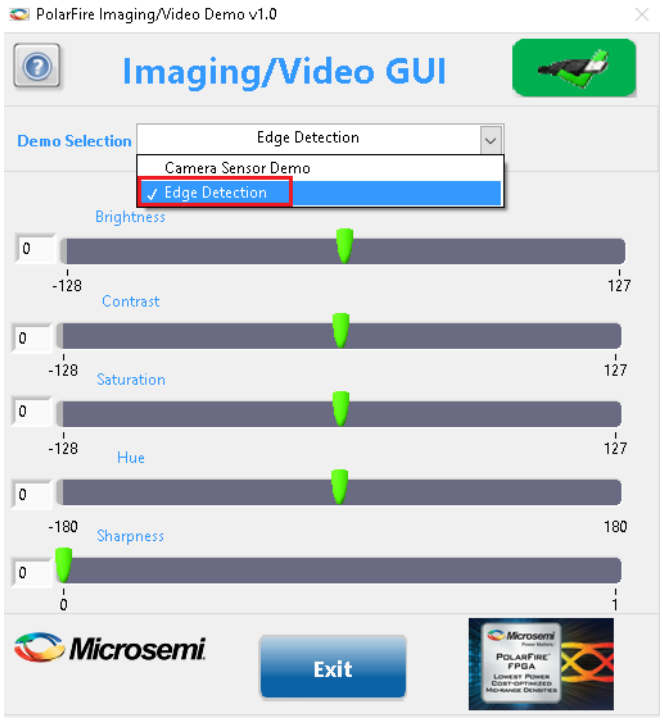
Figure 12 • **Image Enhancement Features**

2.6.3 Running the Edge Detection Demo

To run the Edge Detection Demo:

- Select the **Edge Detection** option from **Demo Type Selection** drop-down list, as shown Figure 13, page 12.

Figure 13 • **Edge Detection Demo Selection**



The edges of the image currently appearing on the monitor are highlighted.

Figure 14, page 12 and Figure 15, page 13 show two regular images and the corresponding edge-detected images.

Figure 14 • **Normal Image vs. Edge-Detected Image—Example 1**

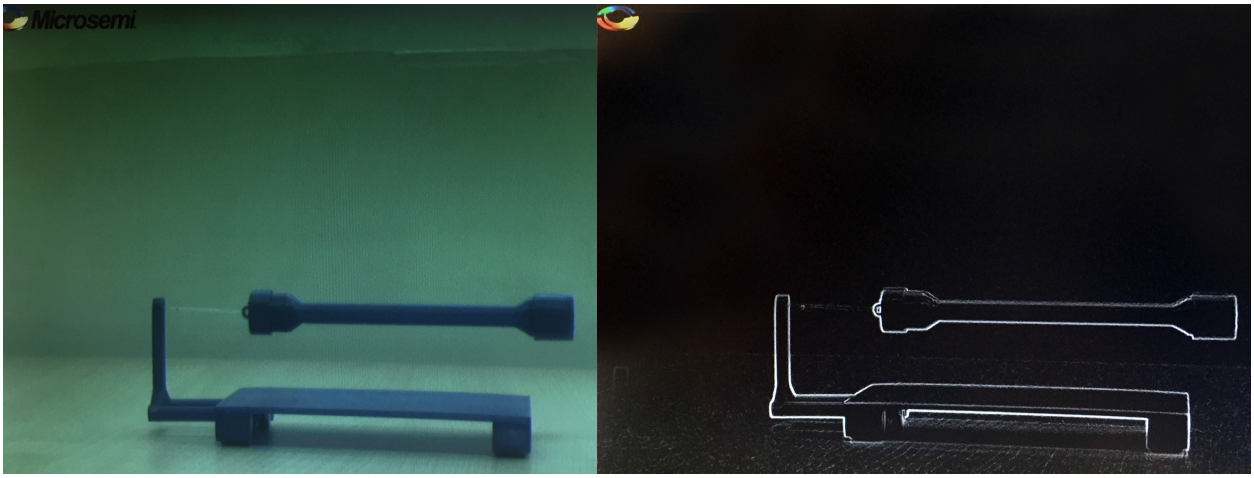
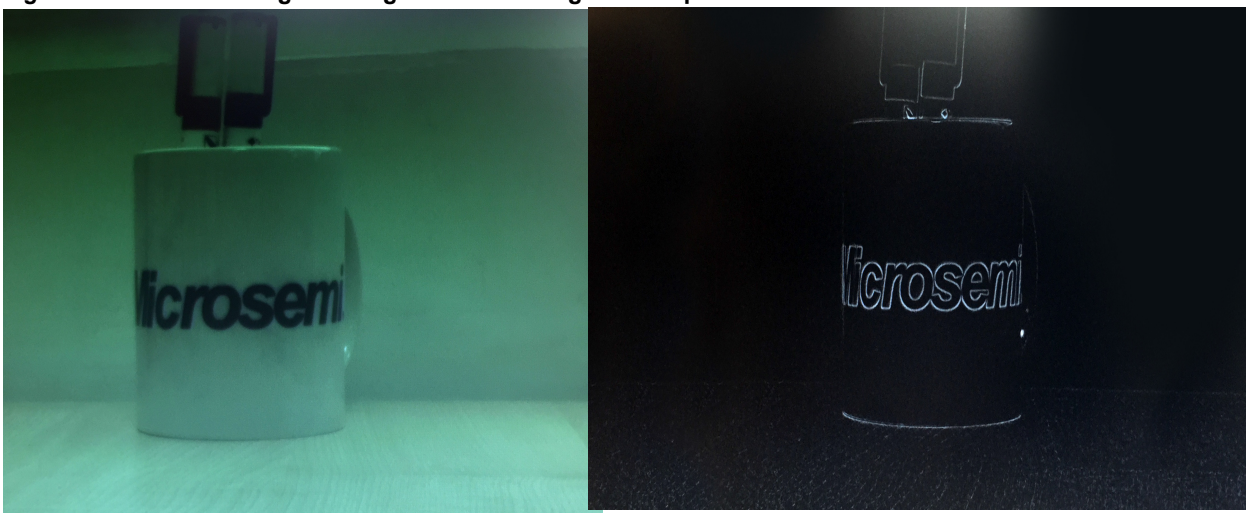


Figure 15 • **Normal Image vs. Edge-Detected Image—Example 2**



This concludes the PolarFire video and imaging demo.

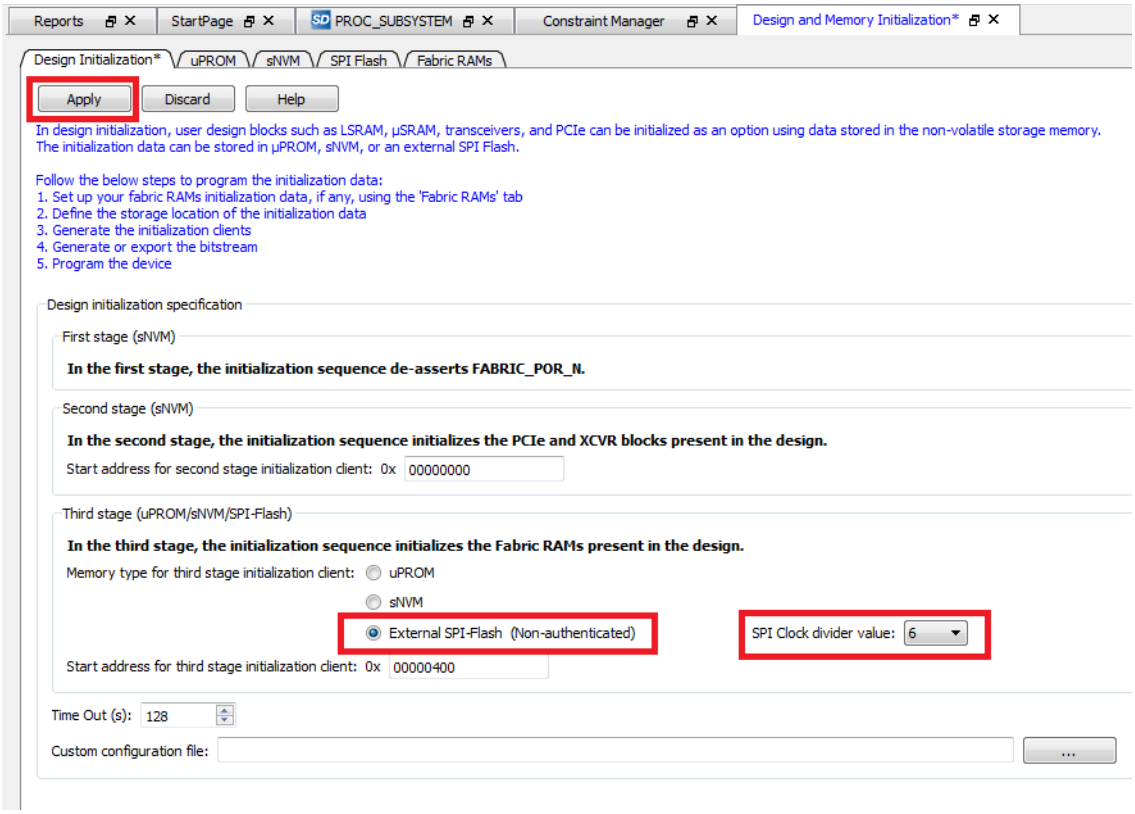
3 Appendix: Generating an SPI Flash Client

Libero SoC PolarFire Design Suite supports the SPI Flash client generation and SPI programming to initialize the LSRAM block at device power-up.

To Generate an SPI Flash Client:

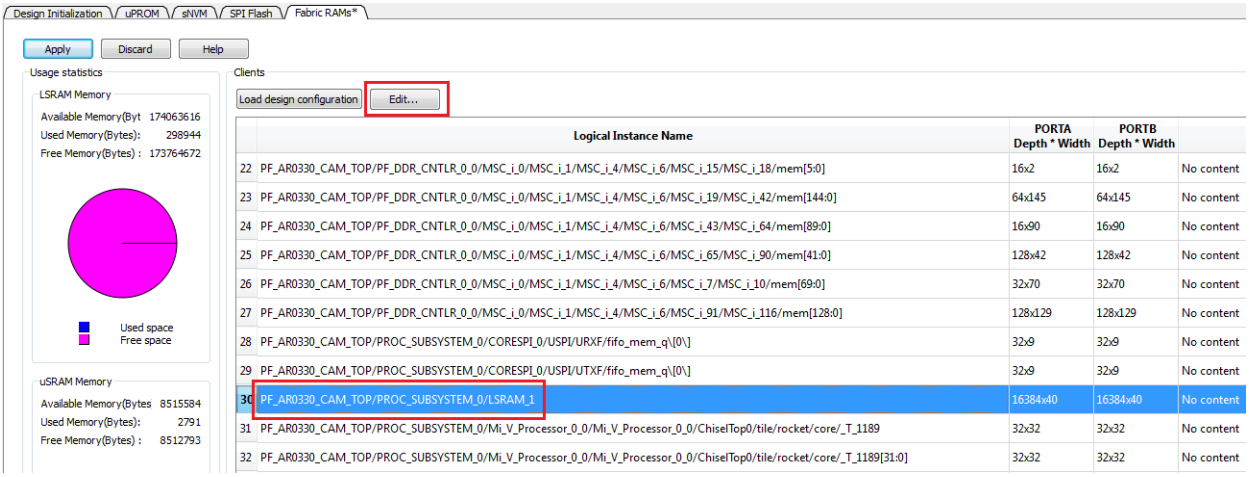
1. Double-click **Configure Design Initialization Data and Memories** on the Design Flow tab. The Design and Memory Initialization window opens.
2. Under **Third stage (uPROM/sNVM/SPI-Flash)**, select **External SPI-Flash**, ensure that the **SPI Clock divider** value is 6, and click **Apply**, as shown in the following figure.

Figure 16 • **Design and Memory Initialization**



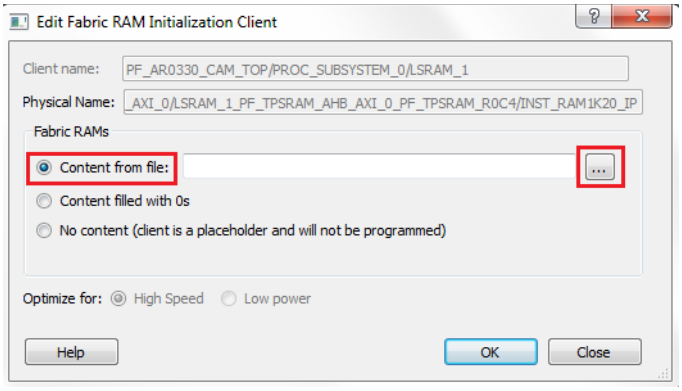
3. On the Fabric RAMs tab, select PROC_SUBSYSTEM/LSRAM from the list of logical instances, and click Edit, as shown in the following figure. The PROC_SUBSYSTEM/LSRAM instance is the Mi-V processor's main memory. The System Controller initializes this instance with the imported client at power-up.

Figure 17 • **Fabric RAMs Tab**



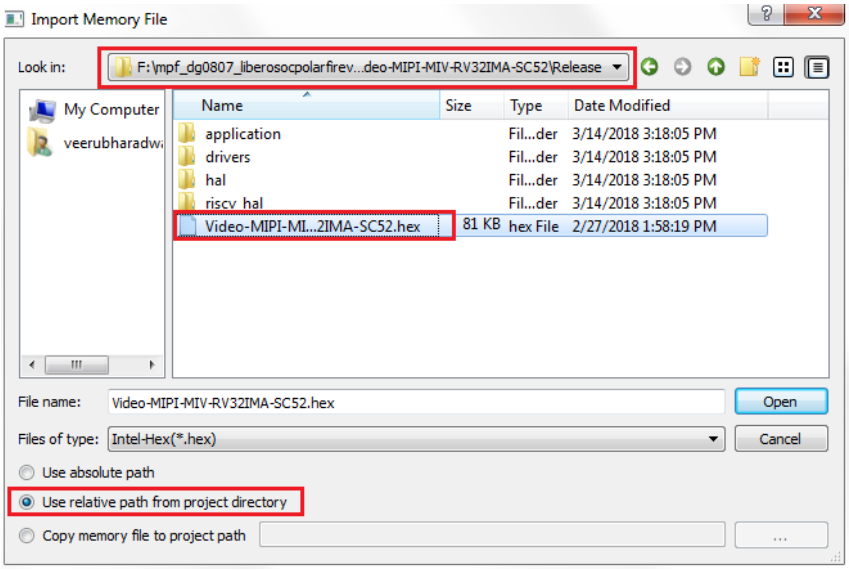
4. In the Edit Fabric RAM Initialization Client dialog box, click the Import button next to Content from file, as shown in the following figure.

Figure 18 • **Edit Fabric RAM Initialization Client Dialog Box**



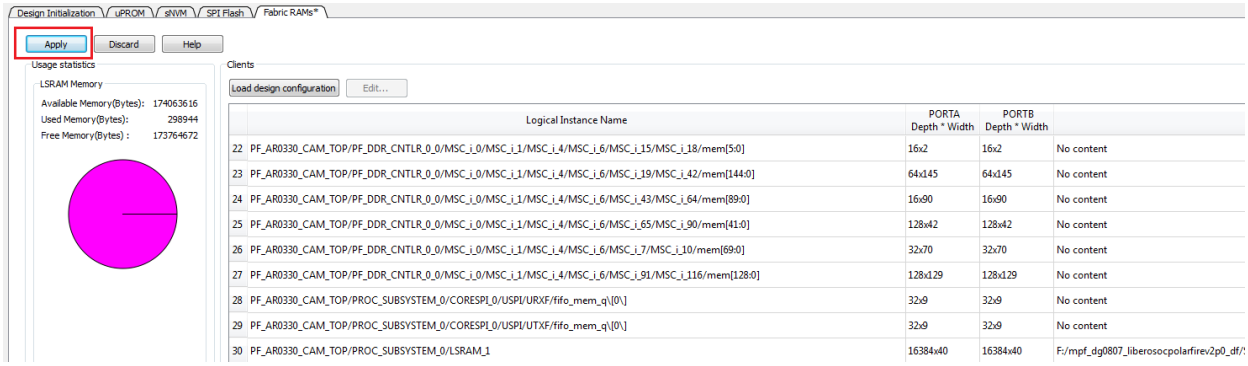
5. In the Import Memory File dialog box, locate the `Video-MIPI-MIV-RV32IMA-SC52.hex` file from the `DesignFiles_directory\mpf_dg0807_liberosocpolarfirev2p0_df\Solution\MiV_Workspace\Video-MIPI-MIV-RV32IMA-SC52\Release` folder.

Figure 19 • **Import Memory File Dialog Box**



6. In the **Edit Fabric RAM Initialization Client** window, click OK.
7. On the **Fabric RAMs** tab, click **Apply**, as shown in the following figure.

Figure 20 • **Fabric RAMs Tab - Apply Button**



8. Double-click **Generate Design Initialization Data** on the Design Flow tab.

When the design initialization data is generated successfully, a green tick mark appears next to Generate Design Initialization Data in the Libero Design flow, and the following messages appear in the Log window:

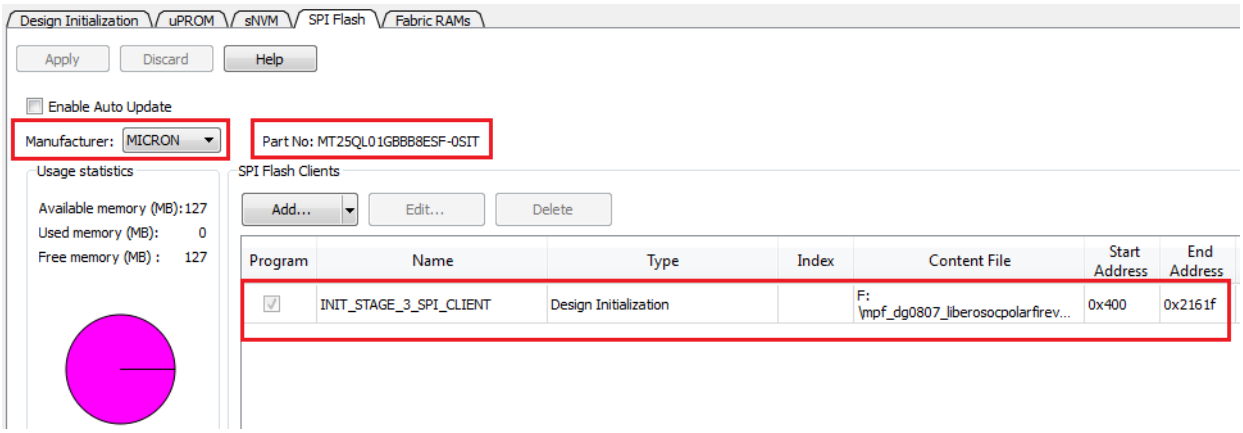
```
Stage 1 initialization client has been added to sNVM

Stage 3 initialization client has been added to SPI
```

9. Click the SPI Flash tab to verify that the bin file has been added, as shown in the following figure.

The PolarFire Evaluation Board uses a Micron SPI flash. Therefore, ensure that Micron is selected in the Manufacturer list.

Figure 21 • **SPI Flash Tab**



4 Appendix: Programming the PolarFire Device Using FlashPro

This chapter describes how to program the PolarFire device with.stp programming file using FlashPro.

The.stp file is available at:

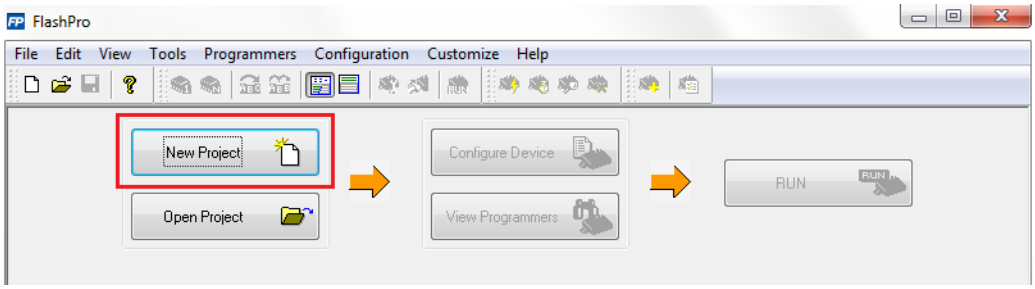
```
mpf_dg0807_liberosocpolarfirev2p0_pf\PF_AR0330_CAM_TOP.stp
```

Before you start, ensure that the PolarFire Evaluation Board is setup. For more information about setting up the hardware, see Setting Up the PolarFire Evaluation Board, page 6.

To program the device:

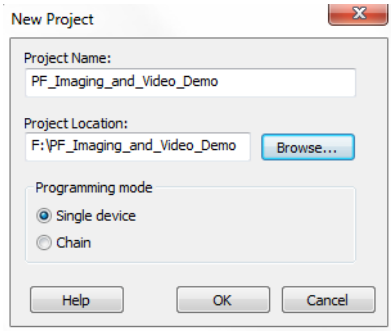
1. On the host PC, start the FlashPro software.
2. Click **New Project** to create a new project as shown in Figure 22, page 17.

Figure 22 • **New Project in FlashPro**



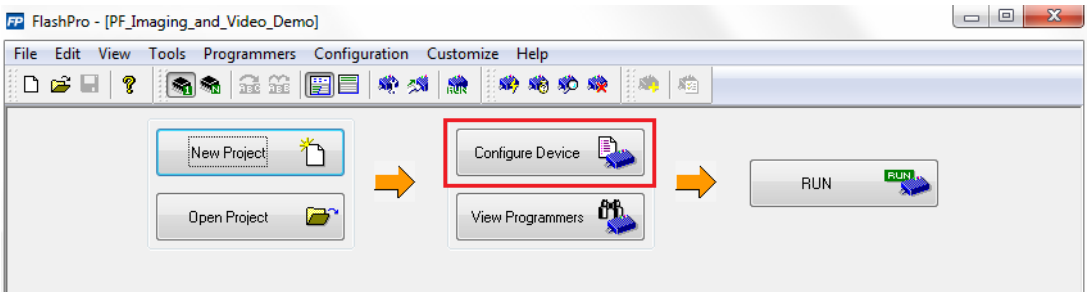
3. In the **New Project** window, complete the following steps, and click OK as shown in Figure 23, page 17.
   - Enter a project name.
   - Select Single device as the programming mode.

Figure 23 • **New Project Details**



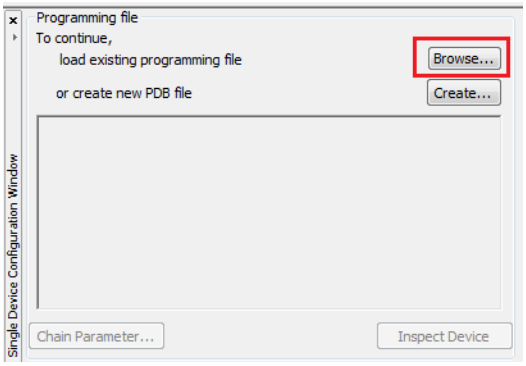
4. Click **Configure Device** as shown in Figure 24, page 17.

Figure 24 • **Configure Device**



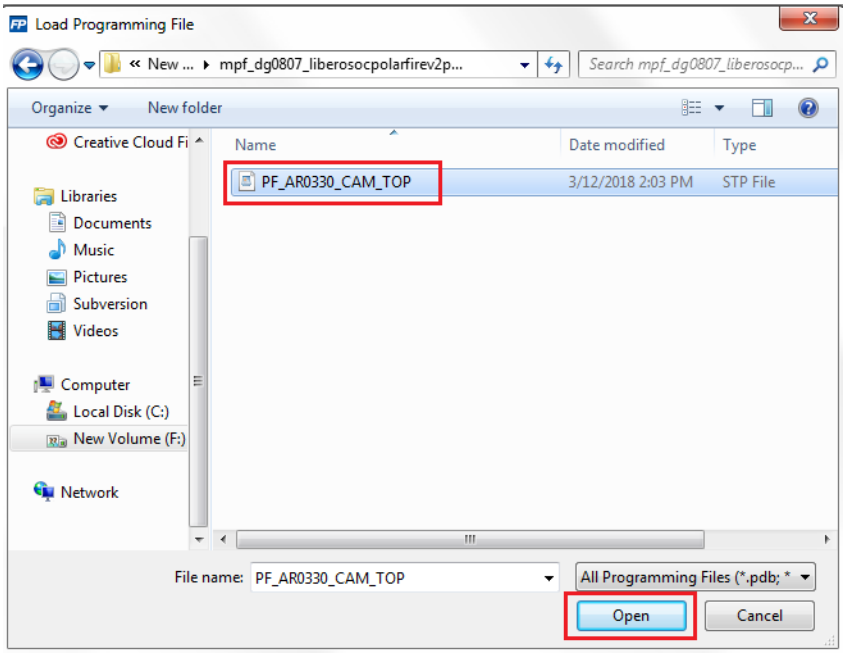
5. Click **Browse** from the Load Programming File window as shown in Figure 25, page 18.

Figure 25 • **Browse Option**



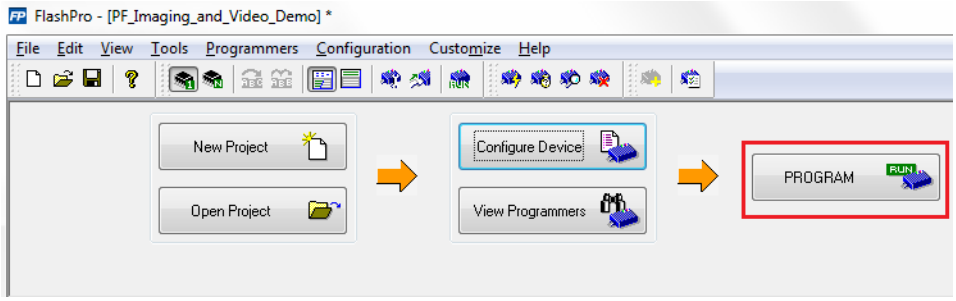
6. In the **Load Programming File** window:
   - Navigate to the `mpf_dg0807_liberosocpolarfirev2p0_pf` folder.
   - Select the `PF_AR0330_CAM_TOP.stp` file and click **Open** as shown in Figure 26, page 18.

Figure 26 • **Load Programming File**



7. Click **PROGRAM** option to program the device as shown in Figure 27, page 18.

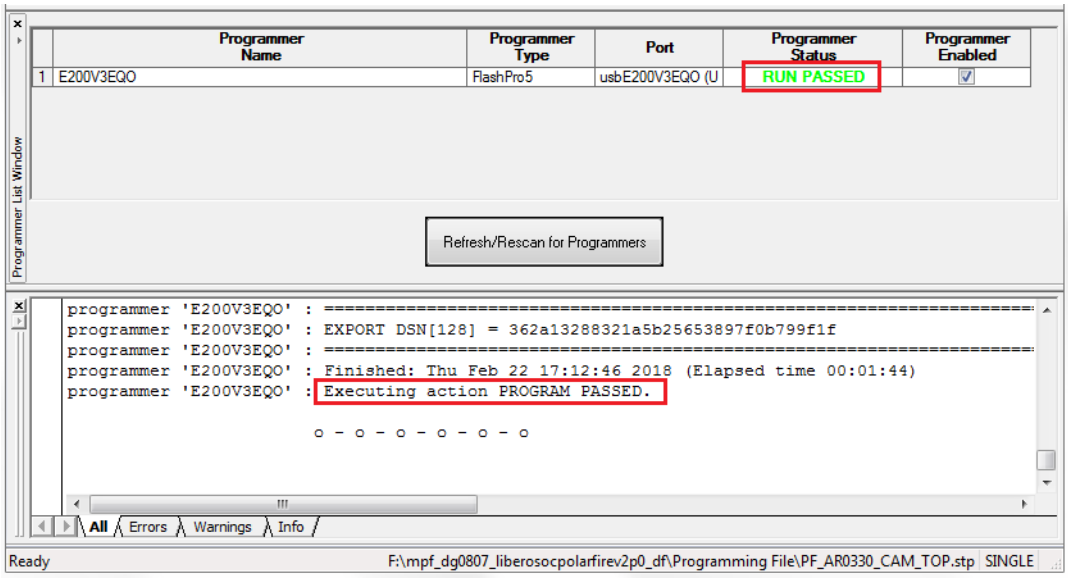
Figure 27 • **Program Option**



The Programmer List window in the FlashPro, shows the Programmer Name, Programmer Type, Port, Programmer Status, and the Programmer Enabled information.

8. After the board is successfully programmed, the **Programmer Status** field shows the **RUN PASSED** status as shown in Figure 28, page 19.

Figure 28 • **RUN PASSED Status**



The PolarFire device is successfully programmed.