DG0884
Demo Guide
PolarFire CoaXPress GenICam 12G Video Kit

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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 2.0

The following is a summary of the changes in revision 2.0 of this document

- Added GenICam functions in the PolarFire 12.5G Video Over CoaXPress, page 2
- Added GenICam GUI Features, page 14 section
- Updated GUI for GenICam support

1.2 Revision 1.0

Revision 1.0 was the first publication of this document.

2 PolarFire 12.5G Video Over CoaXPress

This document describes how to run the CoaXPress 12.5 Gbps video demo using the PolarFire Video Kit and CXP-12 Host board, Dual Camera sensor module and CXP-12 Device board and a HDMI monitor. The demo design features a fully integrated solution developed using Microsemi Libero SoC software to help customers evaluate PolarFire in smart embedded vision applications and to build prototypes quickly. For more information, see *Smart Embedded Vision page*.

The demo demonstrates the following functions:

- MIPI CSI-2 RX to read the 4K dual camera input
- CoaXPress IP configured as the CXP Device to transmit 4K video data from 2 cameras to the CXP host
- CoaXPress IP configured as the CXP Host to receive 4K video data from 2 cameras from the CXP device
- CFA (Color Filter Array) to RGB (Red, Green, Blue) conversion
- Display controller
- Picture In Picture (PIP)
- 4K image panning through 1920x1080 output via HDMI 1.4 TX port
- Edge detection
- Image enhancements such as contrast, brightness, or color balance
- Send GenICam commands from the CXP Host to CXP Device to control camera settings.
- Fetch XML file from the CXP Device to CXP Host to save it on the host computer and displaying on the user interface (GUI).

Note: The solution includes a user-friendly GUI to control these image/video settings and support for GenICam commands.

The PolarFire Video Kit (DVP-102-000512-001) features:

- A 300K LE FPGA (MPF300T, FCG1152)
- HDMI 1.4 transmitter (ADV7511) chipset and corresponding connector
- HDMI 2.0 with rail clamps, ReDrivers and corresponding connectors
- Dual camera sensor featuring IMX334 Sony image sensor
- Image sensor interface to support upto two MIPI CSI-2 cameras
- DSI Interface
- NVIDIA Jetson Interface (MIPI CSI-2 TX connector)
- A High Pin Count (HPC) FMC connector to connect to high-speed interfaces (like 12G-CXP, 12G-SDI and USXGMII)

For more information about the video kit, see
https://www.microsemi.com/existing-parts/parts/150747.

The following figure highlights the PolarFire Video Kit features:

Figure 1 • **PolarFire Video Kit (DVP-102-000512-001)**
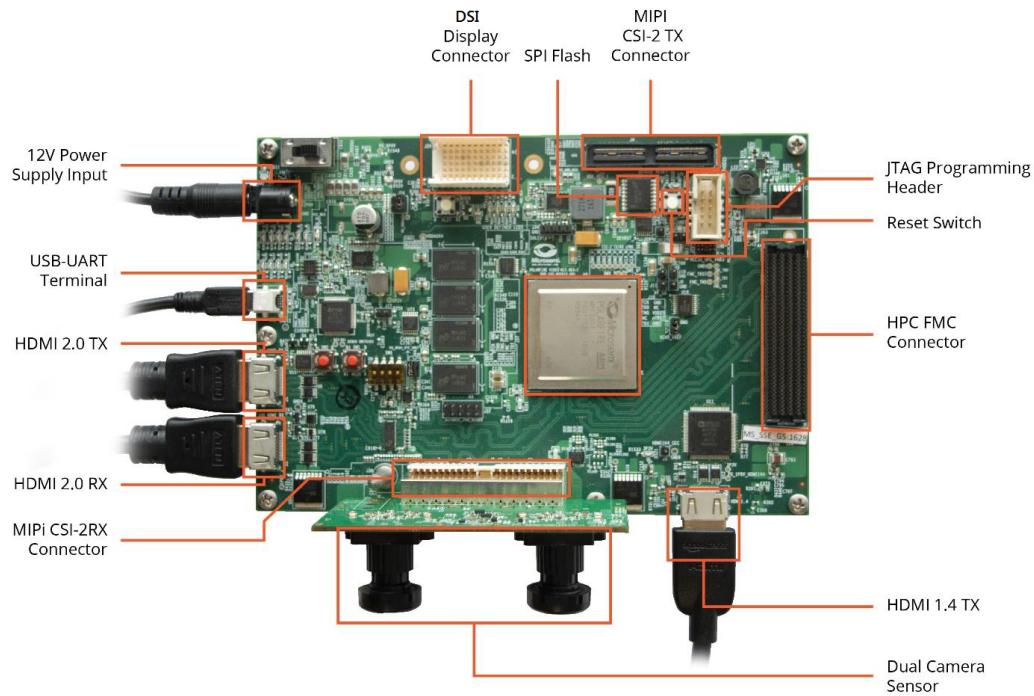
2.1 Design Requirements

The following table lists the hardware and software required to run the demo.

Table 1 • **Design Requirements**

Design Requirement	Description
Hardware	
-PolarFire VIDEO KIT	DVP-102-000512-001 REV 1.0
-Image Sensor module -CXP-12 DEVICE BOARD -Coaxial HD-BNC to HD-BNC Male to Male -CXP-12 HOST BOARD	LI-IMX334-MIPI-MICRO v1.0 DVP-102-000521-001 REV 1.0 95-850-188-006 DVP-102-000522-001 REV 1.0
-USB 2.0 A to mini-B cable and FlashPro4	USB 2.0 A to mini-B required for: -Programming the FPGA on the PolarFire Video kit FlashPro4 required for: -CXP-12 DEVICE BOARD programming
-HDMI cable	HDMI A Male to Male cable
-HDMI monitor	-A 1920x1080 60Hz resolution monitor for the HDMI 1.4 TX port.
-Power Adapter	12V, 5A
-Host PC	A host PC with USB port
Software	
-Program_Debug_v12.2_win.exe	This executable file installs FlashPro Express, used to program the FPGA.

2.2 Prerequisites

Before you start:

1. Download the design files from:
   http://soc.microsemi.com/download/rsc/?f=mpf_dg0884_cxp_genicam_df
2. Download the programming job file from:
   http://soc.microsemi.com/download/rsc/?f=mpf_dg0884_liberosoc_jb
3. Download and install the GUI from:
   http://soc.microsemi.com/download/rsc/?f=mpf_dg0884_liberosoc_gui
4. Download and install the Program and Debug software from:
   http://soc.microsemi.com/download/reg/download.aspx?p=f=ProgramDebug_v12_4_WIN

Note: On this web page, download the `Program_Debug_v12.4_win.exe` binary file. Installation of this executable file installs FlashPro Express and SmartDebug used for FPGA programming and debugging. FlashPro Express is used in this demo.

Note: The **Program and Debug** Software also installs the drivers on the host PC to detect the COM port for running the demo. Install this software whenever the demo is run on a different host PC.

2.3 Demo Resources

The `mpf_dg0884_liberosoc_jb` folder contains CXP HOST BOARD and CXP DEVICE BOARD job files the following resources:

- **A job file (JOB file)**: This file includes the FPGA bitstream and the SPI Flash image to be programmed.

For programming the FPGA using the job file, see Programming the PolarFire FPGAs, page 6.

2.4 Installing the Demo GUI

To install the GUI:

1. Extract the contents of the `mpf_dg0884_liberosoc_gui.zip` file and run the `setup.exe` file.
2. Click **Yes** for any message from User Account Control.
   The **CoaXPress - GenICam GUI** installation wizard is displayed.
3. Confirm the installation directory locations for the GUI and the National Instruments products and click **Next**.
4. Accept the license agreement, and click **Next**.
5. Review the summary and click **Next**.
   The installation proceeds with a progress bar. After the installation, a confirmation message is displayed.
6. Click **Next.** To exit the installation wizard.
7. Restart the host PC if prompted.

The CoaXPress - GenICam GUI is installed.

2.5 Setting Up the Demo

Setting up the demo involves the following processes:

- Setting Up the Hardware, page 5
- Programming the PolarFire FPGAs, page 6

2.5.1 Setting Up the Hardware

The following figure shows hardware setup.

Figure 2 • **Setting Up the Hardware**

Setting up the hardware involves:

- Interfacing the camera sensor module with the CXP-12 DEVICE BOARD. This part is called the CXP Device side.
- Interfacing the CXP-12 HOST BOARD with the video kit through FMC. This part is called the CXP host side.
- Connecting the CXP device side and Host side.

Follow these steps:

1. Connect the **J1** connector of the dual camera sensor module to **J1** connector of the cxp-12 device board.
2. Connect the **J11 (FMC)** connector of the cxp-12 host board to **J14 (FMC)** connector of the video kit.
3. Connect the CXP-12 DEVICE BOARD and the CXP-12 HOST BOARD using the Coaxial HD-BNC to HD-BNC Male to Male cable.
4. Connect the HDMI monitor to **J2** (HDMI 1.4 TX port) of the video kit using the HDMI cable.
5. Connect the host PC and the video kit through **J12** of the video kit using the USB mini cable.
6. Connect the FlashPro4 and CXP-12 device board through **J21** of the CXP-12 device board.
7. Connect the power supply cable to **J20** of the video kit.
8. Ensure that the following jumper settings are set on the video kit.

Table 2 •   **Jumper and Switch Settings PolarFire VIDEO KIT**

Jumper	Default Position	Functionality
J15	Open	SPI Slave and Master mode selection. By default, SPI master.
J17	Open	100K PD for TRSTn. By default, 1K PD is connected.
J19	Pin 1&2	Default: XCVR_VREF is connected to GND.
J28	Pin 1&2	Default: Programming through the FTDI.
J24	Pin 2&4	Default: VDDAUX4 voltage is set to 3V3.
J25	Pin 3&4	Bank4 voltage is set to 2V5.
J36	Pin 1&2	Default: Board power up through the SW4.
SW4	OFF/ON	Power ON\OFF slide switch.
SW6	OFF	User slide switch. Default position: OFF.
J20	12 Volts Input	12V input to the board.

9. Ensure that the following jumper settings are set on the CXP-12 DEVICE and the CXP-12 HOST boards.

Table 3 •   **Jumper Settings - CXP-12 Host and Device Board**

Board Name	Jumper	Position
CXP-12 HOST BOARD	J20 J19 J14	Pin 2 & 3: Closed Open Open
CXP-12 DEVICE BOARD	J7	Pin 2 & 3: Closed

10. Power-up the HDMI monitor.
11. Power-up the board using the **SW4** slide switch.

The PolarFire dual camera video and imaging hardware is set up. See the following section to program the FPGAs.

2.5.2   Programming the PolarFire FPGAs

This chapter describes how to program the PolarFire device with the job files using Flashpro Express. The job files are available at the following design files folder location:
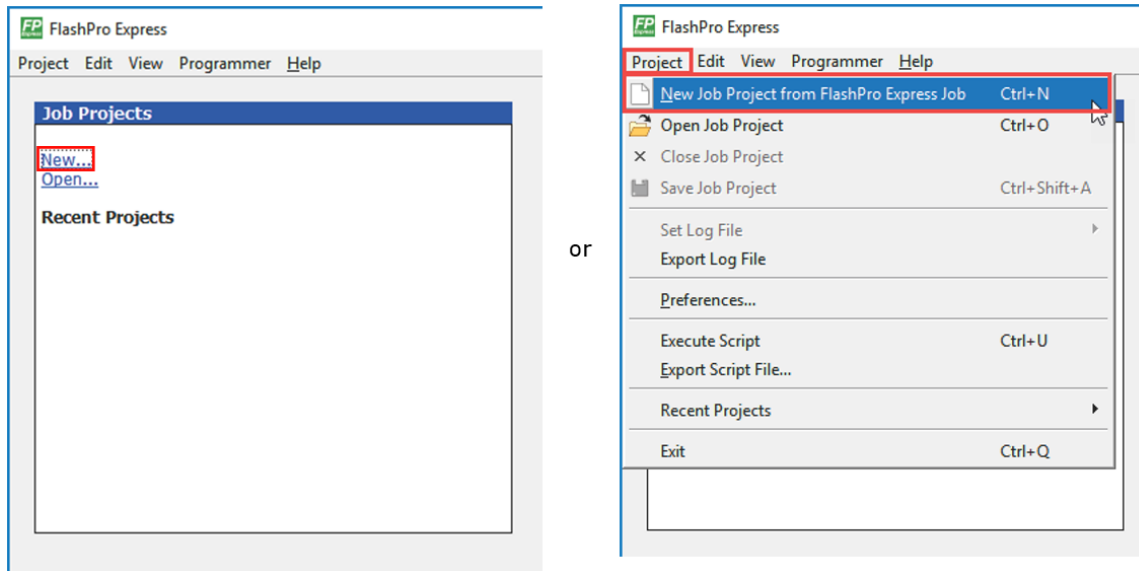
<$Download_Directory>\mpf_dg0884_liberosoc_jb

### 2.5.2.1 Programming the FPGA on the Video Kit

Follow these steps:

1. On the host PC, start the FlashPro Express software from its installation directory.
2. Select **New** or **New Job Project from FlashPro Express Job** from Project menu to create a new job project, as shown in Figure 3, page 7.

*Figure 3 •* **FlashPro Express Job Project**

3. Enter the following in the New Job Project from FlashPro Express Job dialog box:
   - **Programming job file**: Click **Browse** and navigate to the location where the job file is located and select the file. The default location is:

     `<$Download_Directory>\mpf_dg0884_liberosoc_jb\CXP12_host.job`
   - **FlashPro Express job project location**: Select **Browse** and navigate to the location where you want to save the project.

*Figure 4 •* **New Job Project from FlashPro Express Job**
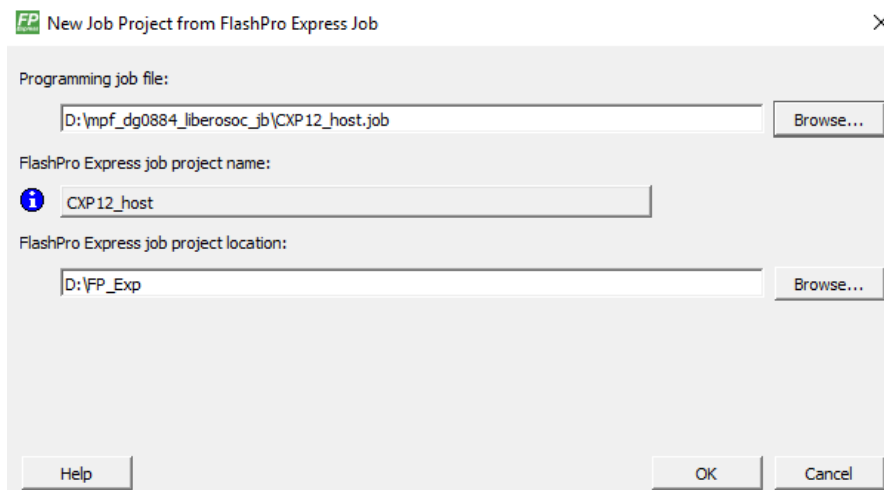
4. Click **OK**. The required programming file is selected and ready to be programmed in the device.
5. Connect the USB 2.0A to mini cable with J12 of the PolarFire video kit.
6. The FlashPro Express window appears as shown in Figure 5, page 8. Confirm that a programmer number appears in the Programmer field. If it does not, confirm the board connections and click **Refresh/Rescan Programmers**.

Figure 5 • **Programming the Device**
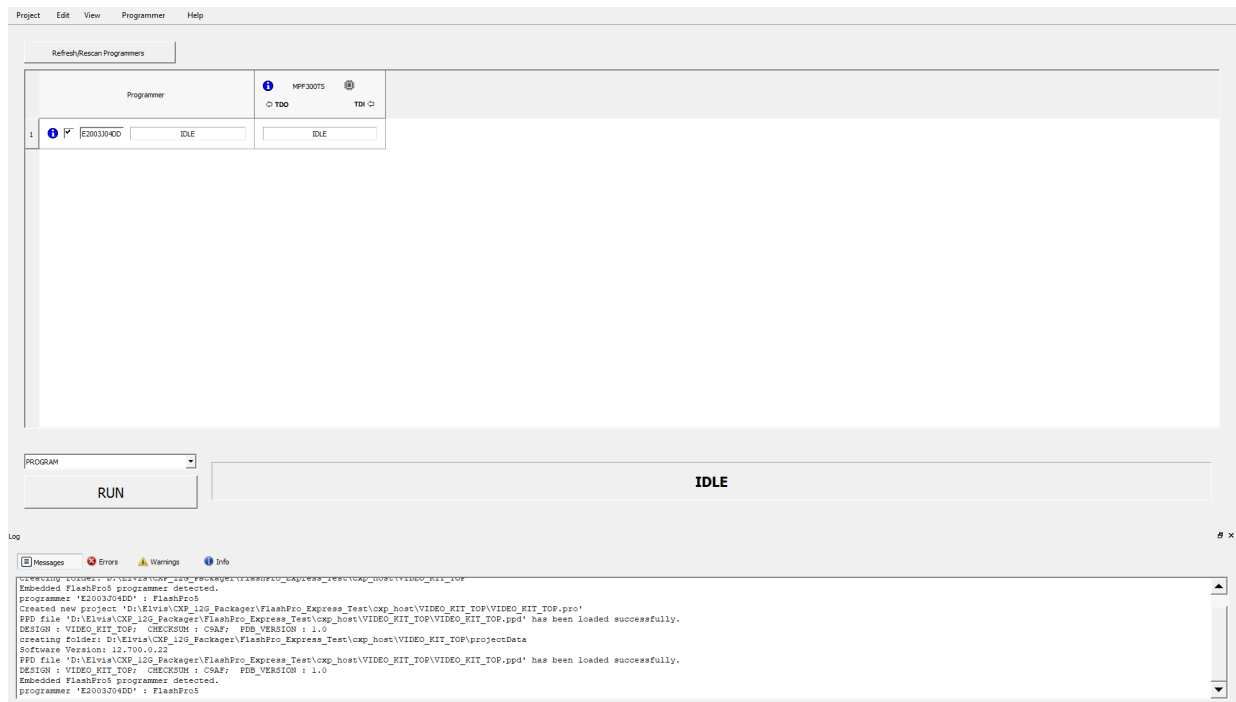
7. Click **RUN** to program the device. When the device is programmed successfully, a **RUN PASSED** status is displayed as shown in Figure 6, page 9. See Running the Demo, page 11.

Figure 6 • **FlashPro Express—RUN PASSED**
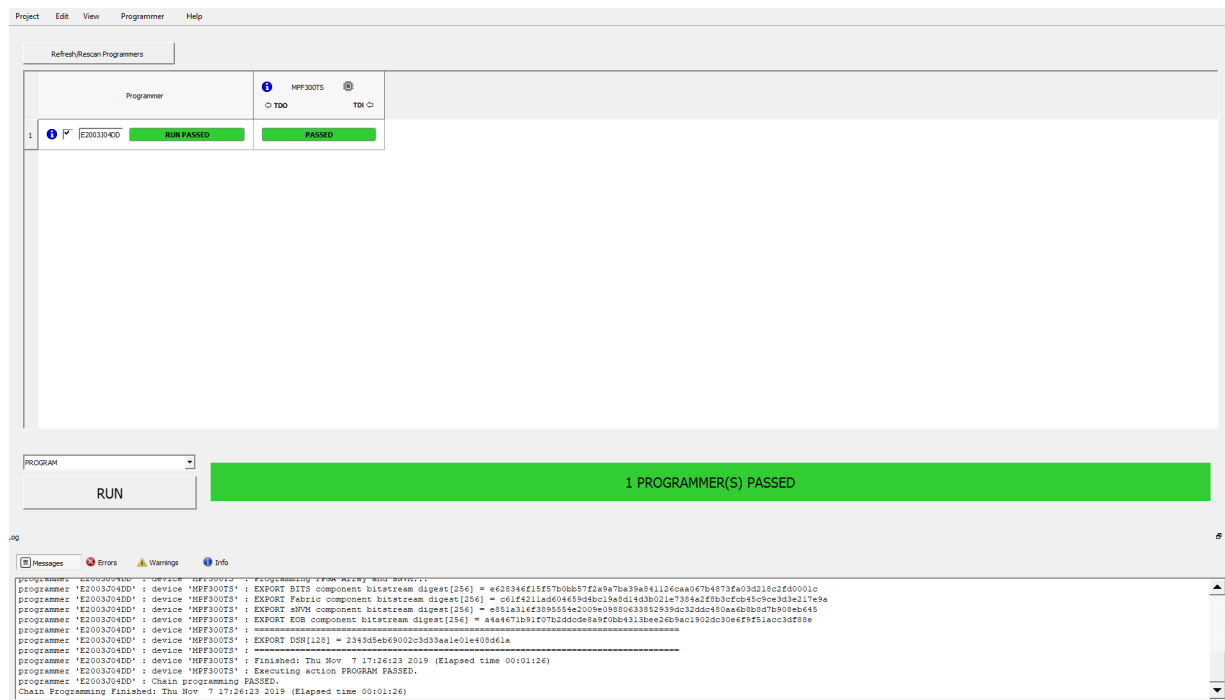
8. Close FlashPro Express.

The PolarFire device and SPI Flash on the CXP-HOST is programmed.

2.5.2.2 Programming the FPGA on the CXP-12 Device Board

Follow these steps:

1. On the host PC, start the FlashPro Express software from its installation directory.
2. Select **New** or **New Job Project from FlashPro Express Job** from Project menu to create a new job project, as shown in Figure 3, page 7.
3. Enter the following in the New Job Project from FlashPro Express Job dialog box:
   - Programming job file: Click **Browse** and navigate to the location where the job file is located and select the file. The job file is located at:

   `<$Download_Directory>\mpf_dg0884_liberosoc_jb\CXP12_device.job`

   - **FlashPro Express job project location**: Select **Browse** and navigate to the location where you want to save the project.

Figure 7 • **New Job Project from FlashPro Express Job**
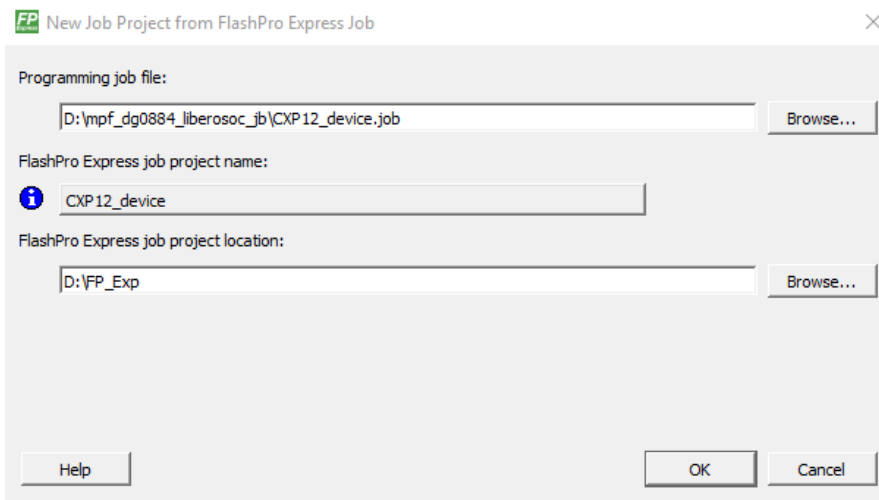
4. Click **OK**. The required programming file is selected and ready to be programmed in the device.
5. Disconnect the mini USB cable from **J12** of the PolarFire video kit and connect the mini USB cable to FlashPro4.
6. Connect FlashPro4 with **J21(JTAG)** of the CXP-12 DEVICE BOARD.
7. The FlashPro Express window appears as shown in Figure 5, page 8. Confirm that a programmer number appears in the Programmer field. If it does not, confirm the board connections and click **Refresh/Rescan Programmers**.
8. Click **RUN**. When the device is programmed successfully, a RUN PASSED status is displayed as shown in Figure 6, page 9. See Running the Demo, page 11.
9. Close FlashPro Express or in the Project tab, click **Exit**.

The PolarFire device and SPI Flash on the CXP-DEVICE is programmed. Now, both HOST and DEVICE are programmed.

Power cycle the board using switch SW4. After power cycling:

- The Full HD HDMI monitor displays the camera feed from the 2 cameras as Picture in Picture.

2.6 Running the Demo

The demo features receiving the MIPI Rx data from the two cameras with 4K resolution at 30 frames per second (fps). The 4K MIPI video data from the 2 cameras is converted to CoaXPress data using the CoaXPress IP and transmitted over the coaxial cable. The CoaXPress data received from the host board is converted in to video data using the CoaXPress IP. The received video frames from CoaXPress are stored in DDR and passed on to the display as per the display controller timing parameters. The image processing IPs are enabled on the display side of the video pipeline.

In the demo design, display controller is used to provide the Full HD output (1920x1080 60 Hz resolution). The Full HD output supports PIP, panning, Edge Detection, and Image enhancements such as contrast, brightness, color balance, and alpha blending.

Running the demo involves adjusting the imaging and video settings using the CoaXPress - GenICam GUI and then observing the result on the HDMI monitor.
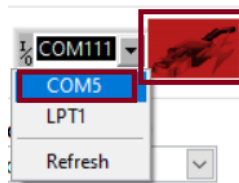
To use the demo GUI:

1. Start the **CoaXPress - GenICam GUI** from the Program menu.
   The GUI is displayed as shown in the following figure.

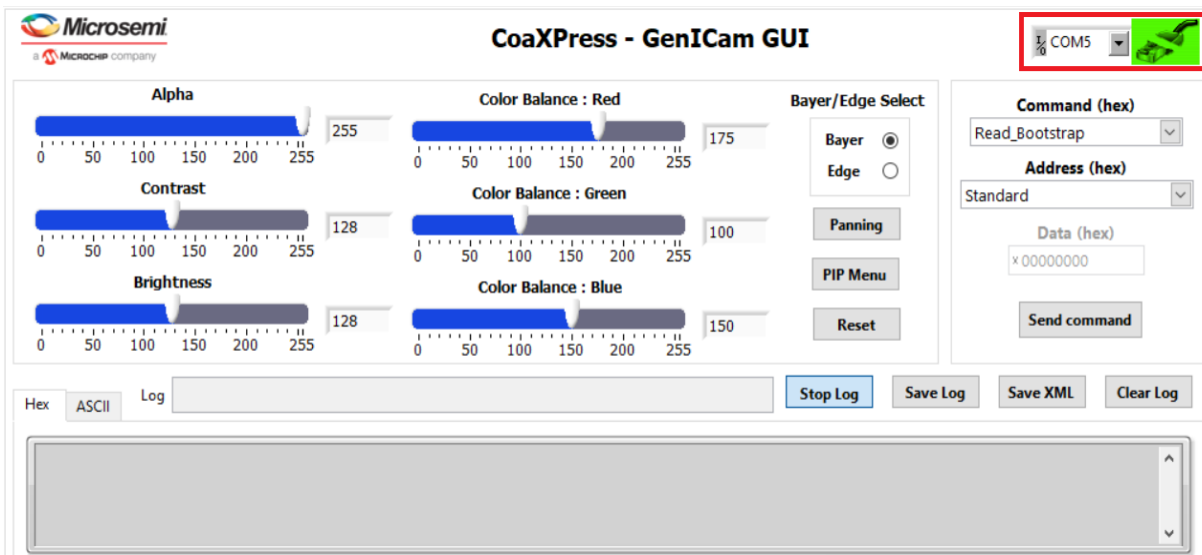*Figure 8 •*   **CoaXPress - GenICam GUI**
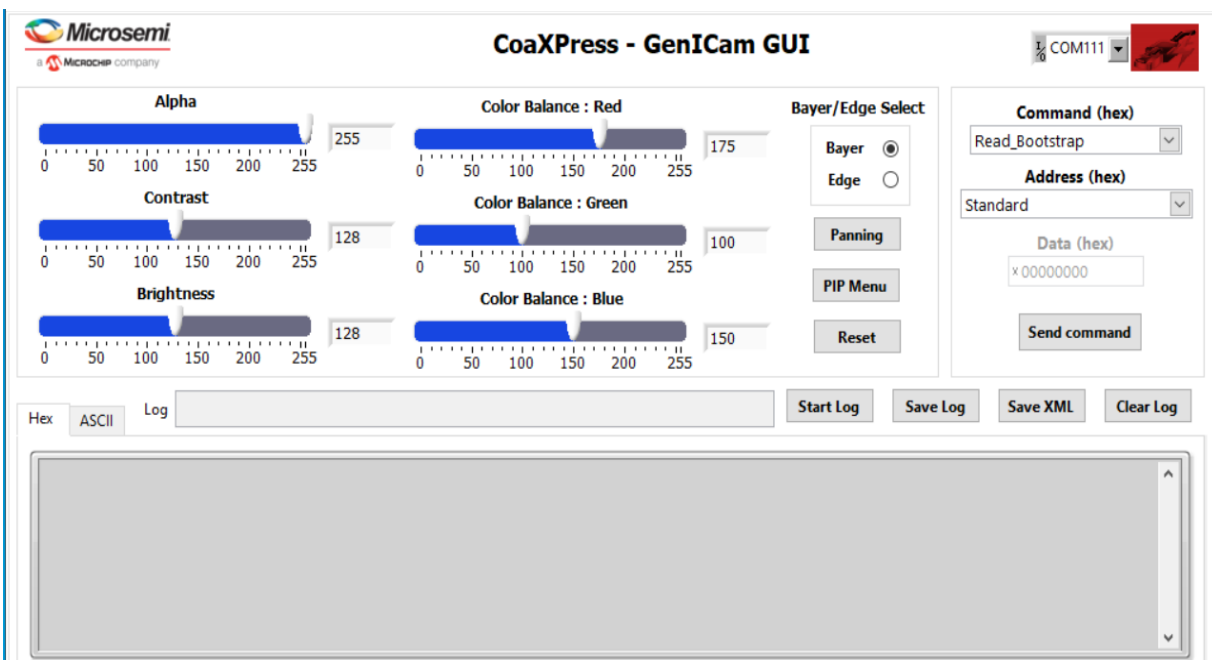
2. Select the second largest **COM** port on the GUI and select the **Connect** option.

*Figure 9 •*   **Connecting the GUI and Video Kit**

3. The Connect button turns green indicating a successful connection.

Figure 10 • **Connection Successful**

4. Use the **Contrast** and **Brightness** sliders to adjust the contrast and brightness and observe the change on the HDMI monitor. The sliders are highlighted in the following figure.

*Figure 11 •* **Adjusting Contrast and Brightness**
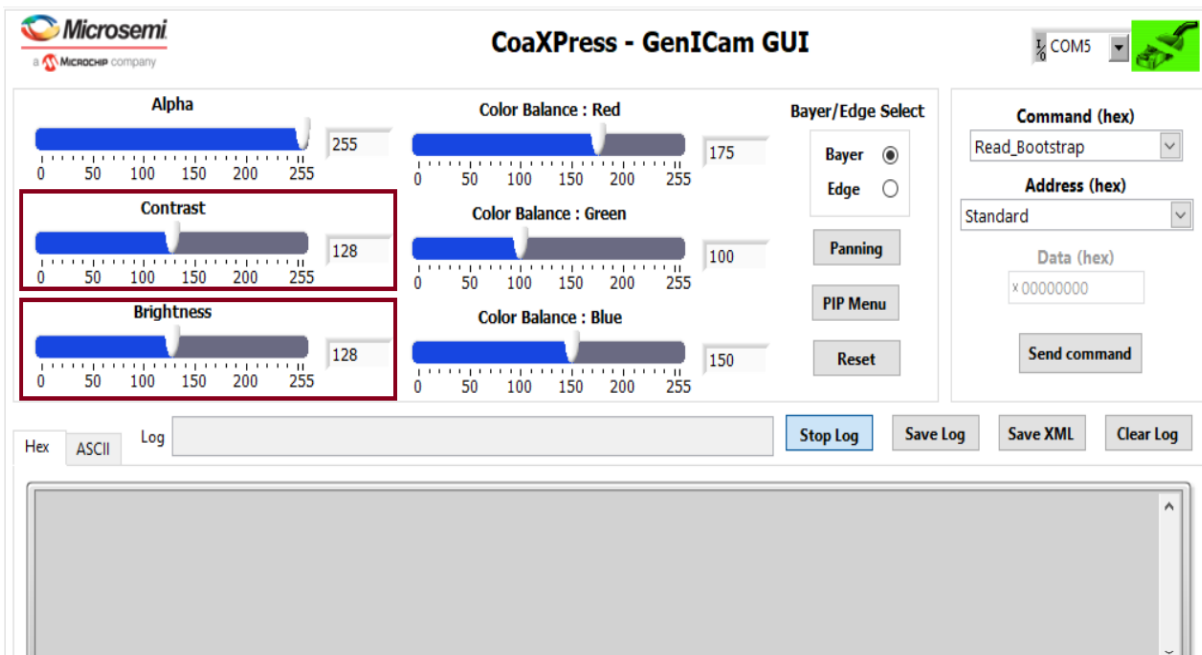
5. Similarly, adjust the color balance of the image using the color balance sliders.
6. Adjust the Alpha slider. The alpha blending feature enables adjusting the transparency of the PIP image. When the alpha value is adjusted to minimum (0), the image disappears.

Note: Default image settings can be reverted by using the **Reset** option.

7. Switch to **Edge Detection** mode using the **Edge** option.
8. Select the **PIP Menu** to change the PIP settings.
9. Select the source of the PIP window between Camera 1 and Camera 2 using **PIP: Source Select**. The position of the PIP window can be moved anywhere within the screen by dragging the pink PIP box. The **Auto Mode Start** option moves the PIP window automatically. The speed of this movement can be controlled using the **Auto Mode Step** slider.

Figure 12 • **PIP Menu**
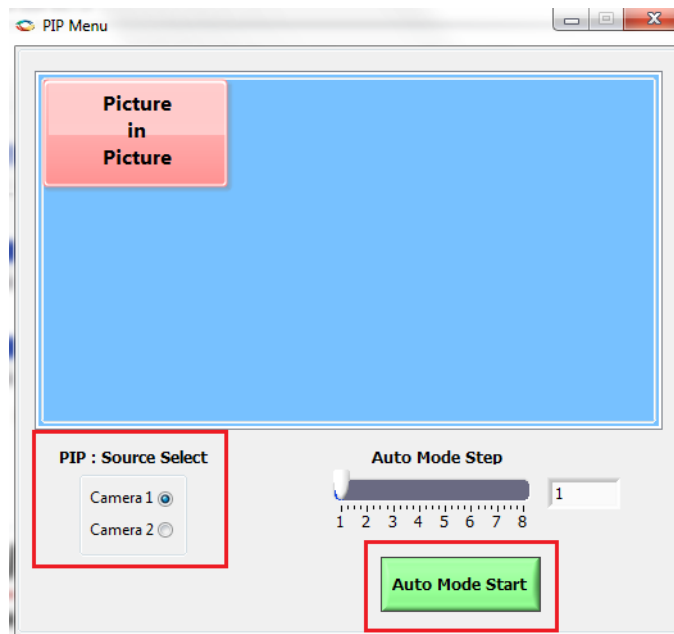
10. Close the **PIP Menu**.
11. In the main video control GUI window, select the **Panning** option to view a particular area of the main or the PIP image within a 4K image.
12. In the **Panning** Menu, use **Image Select** to select the image to be panned (Main image or PIP image). Any area of the 4K camera feed can be viewed by dragging the pink box horizontally or vertically. The **Reset** option sets the view of the **Main image** and **PIP image** to its default center position.

Figure 13 • **Panning Menu**
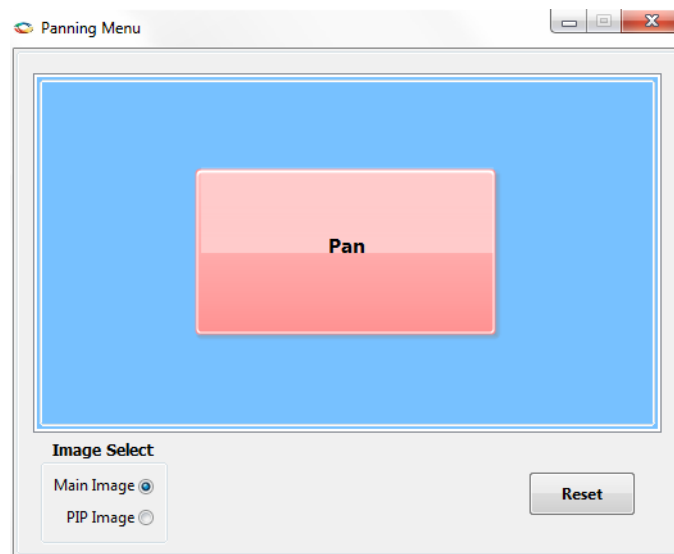
13. Close the **Panning Menu** to return to the main GUI.

2.7　GenICam GUI Features

This allows various GenICam commands to be sent from the Host to Device. The selection is made from the **Command** drop down.

1. Select the command to be sent to the device.
   The address menu will be active for **Read_Bootstrap** and **Write_Bootstrap** command.
2. Select the address to be accessed with the **Read_Bootstrap** or **Write_Bootstrap** command.
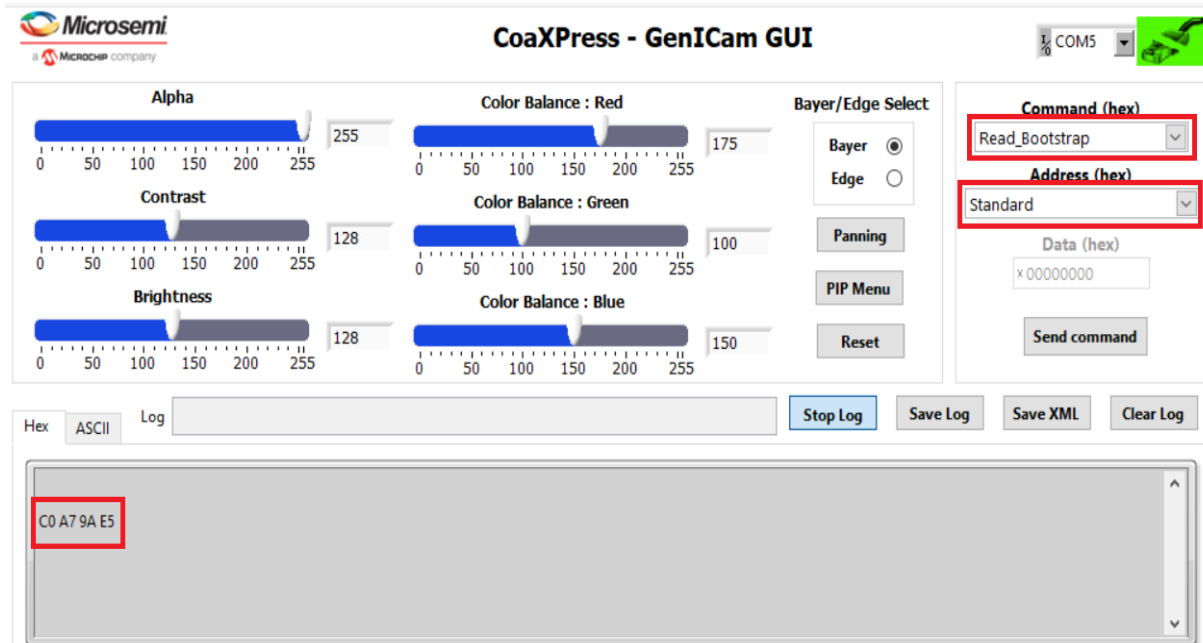
Figure 14 •　**Selecting GenICam Command**
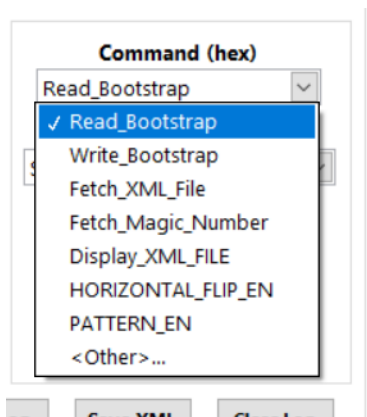
Figure 15 •　**GenICam Address Menu**
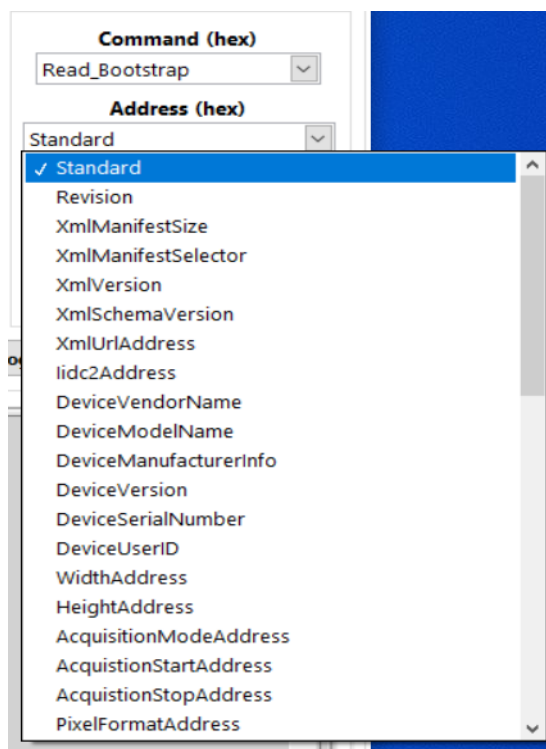
3. Click **Send Command** to read bootstrap register from the device.

Read_Bootstrap command illustration is as shown below for Address **Standard**. The output for the selected command is: **C0 A7 9A E5**.

Figure 16 • **Read Command Output**

4. For write command, enter the value in the **Data (hex)** section that needs to be written to the register. Successful completion of write command displays **01 01 01 01** in the Hex Log window.

*Figure 17 •* **Write Command Output**
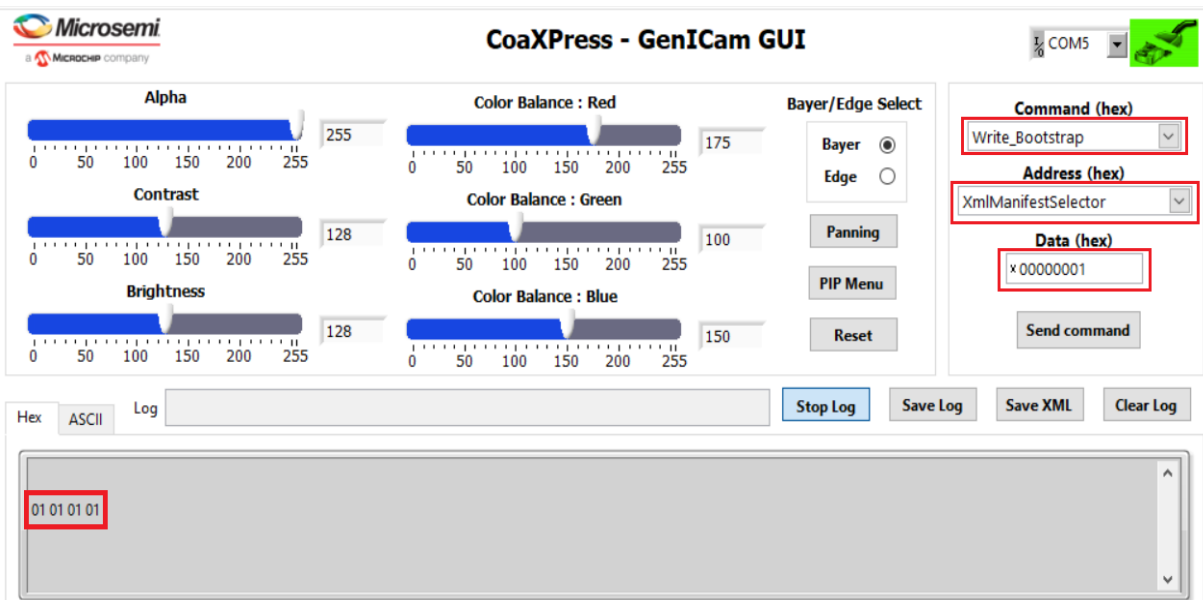
5. **Fetch_XML_File** command reads the XML file from device memory and displays the file in the log window.
   This command performs read on XmlUrlAddress bootstrap register that provide details (Local:xml_mchp_desc.xml;8100;08a8?SchemaVersion=1.0.0) of the file starting address (8100) and the file size (08a8) of this file in the Device Memory. This is displayed first in the log window. It will issue commands to read XML file till the entire file is read.
6. Use **Save XML** to save the last received xml file in the log on to a xml file in the Host PC.

Figure 18 • **Fetch XML Command**

7. **Fetch_Magic_Number** command performs read operation on Bootstrap address 0x0 and displays the data.

8. **Display_XML_FILE** command displays XML file stored in the host memory. For this command to work, **Fetch_XML_File** command should have been issued before.

9. Camera module on device supports flipping the video capture horizontally. The same can be performed by sending the **HORIZONTAL_FLIP_EN** command. Enter value 0x1 to flip and write value 0x0 to revert it back to the normal video. Observe the video on screen.

10. Camera module on device supports sending the pattern instead of video from camera. The same can be performed by sending **PATTERN_EN** command with value in the data as 0x1. Run the same command with the data as 0x0 and it reverts back to the camera video. Observe the changes on screen.

Note: Command outputs can be viewed in Hex or ASCII formats in the respective tab. The XML file is best viewed in the ASCII format tab. Most of the other commands are best viewed in the Hex format tab. There are buttons to **Clear Log** and **Save Log**.

11. The user has the option to access the address, which are not available in the **Address** drop down menu by using the **<Other>...** option.

Figure 19 • **GenICam Address Other**
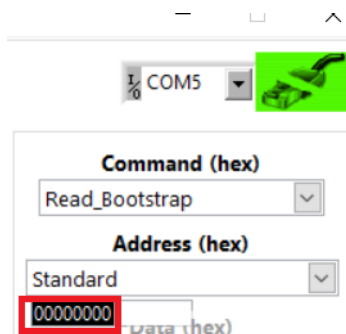
12. Close the GUI to exit from the demo.

This concludes the demo.