



# AN 027: Using the Raspberry Pi to HDMI Example Designs

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## Trion T120 BGA576 Development Kit

AN027-v1.5

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[www.efinixinc.com](http://www.efinixinc.com)



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# Introduction

Efinix provides two Raspberry Pi to HDMI example designs that demonstrate how the Trion T120 FPGA can receive high-speed video data from a camera, process it with a filter, and then display the video on a monitor. The designs use the Trion® T120 BGA576 Development Board, a Raspberry Pi v2 camera module, and a monitor.

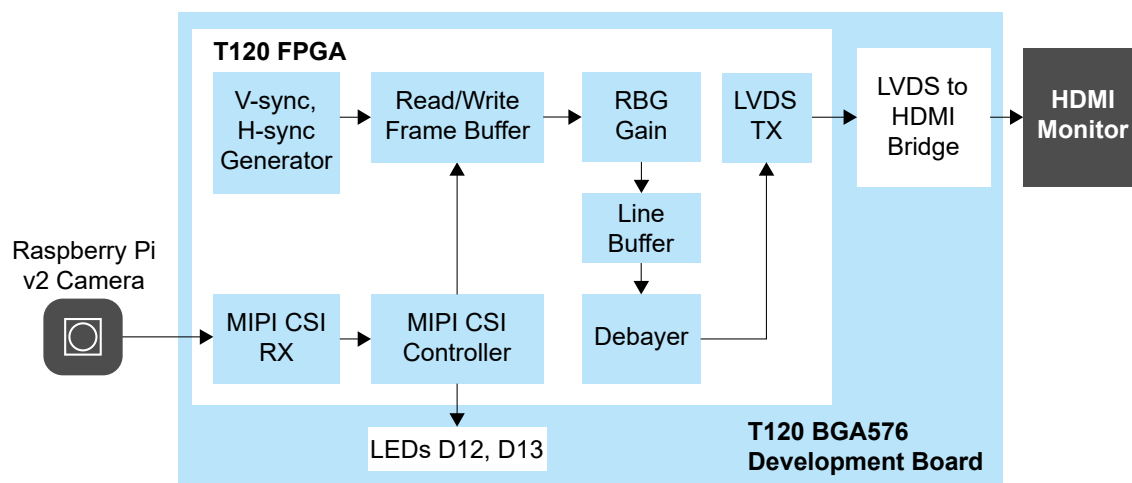
## Raspberry Pi to HDMI with Debayer Filter



**Note:** This design is an updated version of the design preloaded into the Trion® T120 BGA576 Development Board.

A Raspberry Pi v2 camera captures video and sends it through the Trion® T120 FPGA's RX interface. The interface processes the video (1920 x 1080 resolution, RAW 10) using 2 MIPI lanes. The T120 FPGA manipulates the image data using an RGB gain filter and debayer filter. The T120 sends the resulting image to the HDMI interface, which you can view using an HDMI monitor.

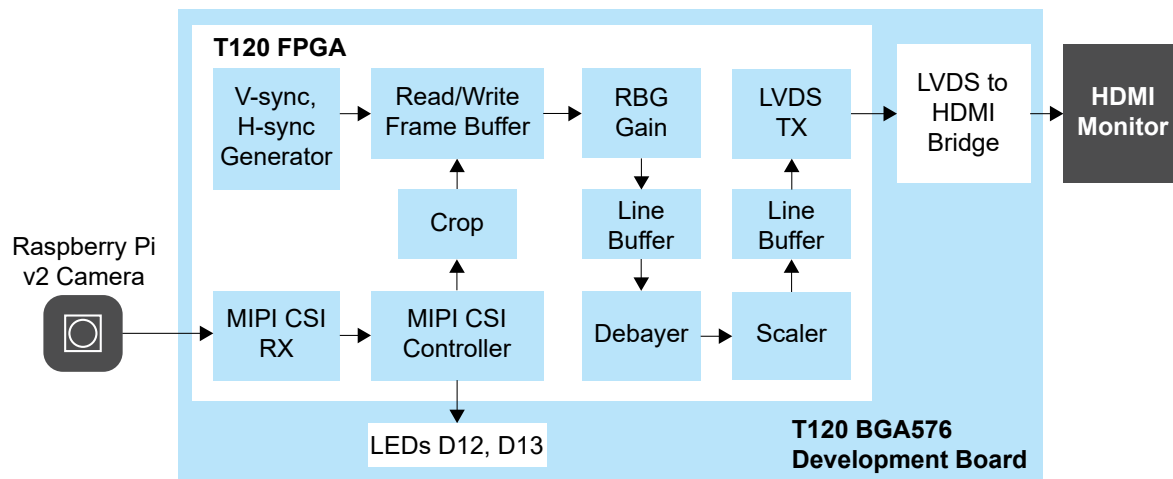
*Figure 1: Raspberry Pi to HDMI with Debayer Filter Design Block Diagram*



## Raspberry Pi to HDMI with Debayer Filter (Crop and Scale)

This design is very similar to the Raspberry Pi to HDMI with Debayer Filter design. In addition to the other processing functions, it crops and scales the image.

*Figure 2: Raspberry Pi to HDMI with Debayer Filter (Crop and Scale) Design Block Diagram*



## Required Hardware

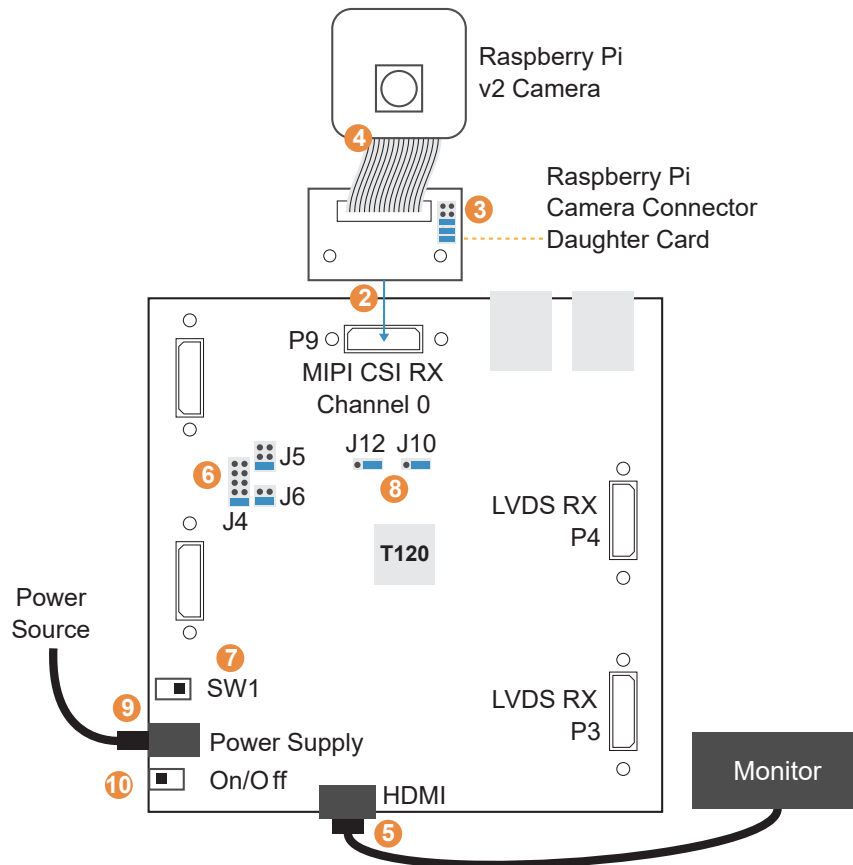
The example design uses the following hardware:

- Trion® T120 BGA576 Development Board
- Raspberry Pi Camera Connector Daughter Card
- Raspberry Pi v2 camera module
- 15-pin flat cable
- 1080p monitor with HDMI connector
- HDMI cable
- 12 V power adapter

# Set Up the Hardware

The following figure shows the hardware setup steps:

**Figure 3: Hardware Setup**



1. Attach standoffs to the board if you have not already done so.
2. Connect the Raspberry Pi Camera Connector Daughter Card to the board.
3. On the daughter card, connect the following pins with jumpers: 1 - 2, 3 - 4, and 5 - 6.
4. Connect the Raspberry Pi v2 camera module to the daughter card using the 15-pin flat cable.
5. Connect the HDMI cable to the HDMI connector and to an HDMI-compatible monitor.
6. Connect jumpers to set the power sequence:
  - *VSUP1 (J4)*—Connect pins 5 - 6 or 9 - 10 (default)
  - *VSUP2 (J5)*—Connect pins 5 - 6 (default)
  - *VSUP3 (J6)*—Connect pins 3 - 4 (default)
7. Slide SW1 to position 3, which enables the power up sequence circuit for the MIPI CSI-2 cameras.
8. Use jumpers to connect pins 2 and 3 on J10 and J12 to enable the on-board 10 MHz oscillator.
9. Connect the 12 V power cable to the board connector and to a power source.
10. Turn on the board's power switch.



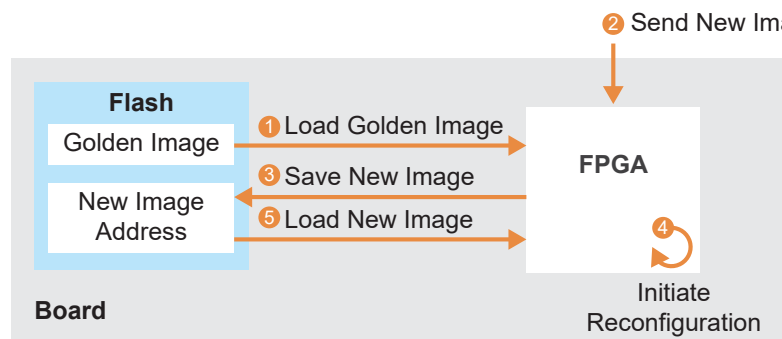
**Note:** There is no HDMI output if the Raspberry Pi camera is not connected.

## About the Internal Reconfiguration Feature

Trion® and Titanium FPGAs have built-in hardware that supports an internal reconfiguration feature in which the FPGA can reconfigure itself from a bitstream image stored in flash memory. This feature is useful for performing system upgrades from a remote location. In these applications, the FPGA is the "brain" that controls the system functionality (that is, there is no microcontroller or CPU).

In a typical reconfiguration flow, the FPGA first configures itself using a "golden" bitstream image as usual. Then, the FPGA receives a new application image remotely, via Ethernet, Wi-Fi, etc., and saves it to flash memory. Then, the FPGA triggers itself to reconfigure using the new image.

Figure 4: Performing Remote Update Using Internal Reconfiguration



**Learn more:** Refer to [AN 010: Using the Internal Reconfiguration Feature to Remotely Update Trion FPGAs](#) for more information.

## Example Design Project Files

There are two example designs available in the Support Center:

- *MIPI\_T120F576\_Pi\_V2\_CAM\_2Port\_FB\_HDMI\_v<version>*—2-ports debayer filter design
- *MIPI\_T120F576\_Pi\_CAM\_2Port\_FB\_crop\_scale-v<version>*—2-ports debayer filter design with crop-and-scale feature

Each of the example design has two projects:

- *mipi\_pi\_cam\_debayer\_i2c\_top*—Golden image for I2C initialization of LVDS-HDMI bridge chip(On board IT6263).
- *mipi\_pi\_cam\_debayer\_wo\_i2c\_top*—Streams data from the Raspberry Pi camera to through the T120 FPGA to the HDMI monitor.

The hex files for these two projects are combined into the **mipi\_pi\_cam\_2Port\_FB\_HDMI.hex** (2-ports debayer filter design), and **MIPI\_T120F576\_Pi\_CAM\_2Port\_FB\_crop\_scale.hex** (2-ports debayer filter design with crop-and-scale feature), which you can use to program onto the development board.



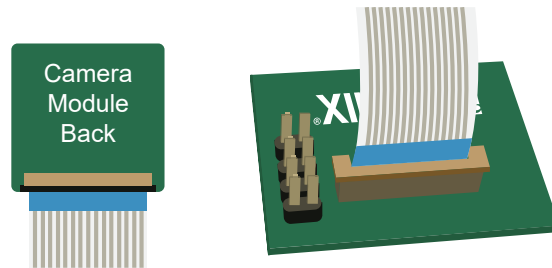
**Download:** You can download the project files from the [Support Center](#).

## Connecting the Raspberry Pi Cable

The 15-pin flat cable for the Raspberry Pi camera has a blue stripe on one side.

- When connecting to the camera, the stripe faces away from the camera.
- When connecting to the Raspberry Pi Camera Connector Daughter Card, the stripe faces away from the Efinix® logo.

*Figure 5: Connecting Raspberry Pi Cable*



## Program the Trion® T120 BGA576 Development Board

The Trion® T120 BGA576 Development Board ships pre-loaded with a single-port frame buffer debayer filter example design. To use the 2-ports frame buffer or the debayer filter with crop-and-scale example design, you must program the design into the board.



**Note:** You can use active, passive, or JTAG programming.

1. Turn on the Trion® T120 BGA576 Development Board.
2. Download the example design files from the Support Center.
3. Unzip the file into your working directory.
4. Open the project in the Efinity software and review it.
5. Use the Efinity® Programmer to download the bitstream file to your board. The example includes a bitstream file, **mipi\_pi\_cam\_2Port\_FB\_HDMI.hex** or **MIPI\_T120F576\_Pi\_CAM\_2Port\_FB\_crop\_scale.hex**.



**Learn more:** Instructions on how to use the Efinity® software is available in the [Support Center](#).

# Run the Example Design

After the FPGA configures, it outputs video to the monitor.

The design includes the following register mapping files:

- *it6263\_reg.mem*—contains the register mapping for the HDMI output resolution.
- *piv2\_1080p\_reg.mem*—contains the register mapping for the Raspberry Pi camera resolution and frame rate.

## HDMI Output Resolution

To use a different HDMI resolution, modify the **it6263\_reg.mem** register map file. Each line represents a register or data.

- Line 1 is the 8-bit register.
- Line 2 is the 8-bit data.
- Line 3 is the next 8-bit register, and so on.

For example:

```
05
40
04
3D
04
1D
0F
00
```

Lines 1 and 2, refer to register 05 and data 40.

Lines 3, and 4 refer to register 04 and data 3D.

## Raspberry Pi Camera Resolution and Frame Rate

To use a different Raspberry Pi camera resolution and frame rate, modify the **piv2\_1080p\_reg.mem** register map file. Each line represents a register or data.

- Line 1 is the MSB of the 8 bit register.
- Line 2 is the LSB of the 8 bit register.
- Line 3 is the 8-bit data.
- Line 4 is the MSB of the next register, and so on

For example:

```
30
00
01
30
05
01
30
06
00
```

Lines 1, 2, and 3 refer to register 3000 and data 01.

Lines 4, 5, and 6 refer to register 3005 and data 01.



# Revision History

*Table 1: Revision History*

Date	Version	Description
March 2023	1.5	Added jumper J10 and J12 connection in Hardware Setup Diagram. (DOC-1201)
November 2022	1.4	Corrected example design filenames and block diagrams (DOC-960)
October 2021	1.3	Corrected LED names in design block diagrams.
October 2021	1.2	Corrected the description about using it6263_reg.mem and piv2_1080p_reg.mem register map files. (DOC-565)
October 2021	1.1	Added a jumper to connection step in the Set Up the Hardware topic. (DOC-480) Added note to state that there is no HDMI signal output if MIPI is not connected. (DOC-480)
September 2020	1.0	Initial release.