



AN 020: Using the Raspberry Pi Camera to HDMI Example Designs (T120 BGA324)

AN020-v2.2
May 2021
www.efinixinc.com



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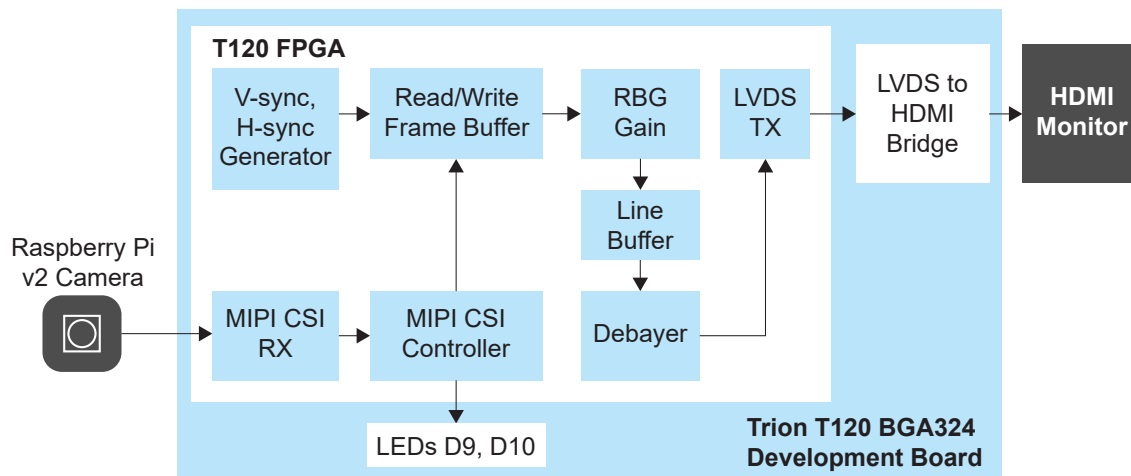
Introduction

Efinix provides two Raspberry Pi to HDMI example designs that demonstrate how the Trion® T120 FPGA can receive a high-speed video data from a camera, process it with a filter, and then display the video to a monitor. The designs use the Trion® T120 BGA324 Development Board, a Raspberry Pi v2 camera module, and a monitor.

Raspberry Pi to HDMI with Debayer Filter

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.

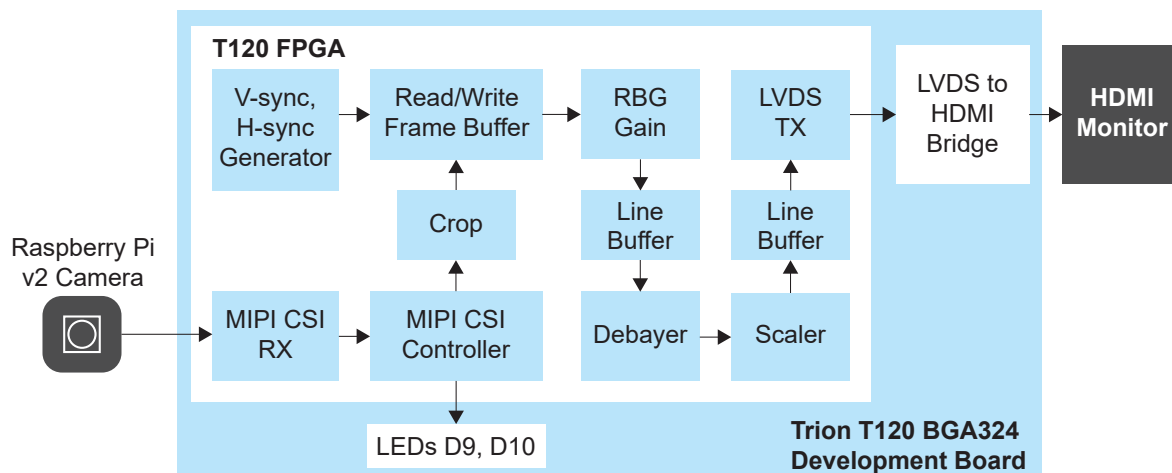
Figure 1: Raspberry Pi to HDMI with Debayer Filter Design Block Diagram



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

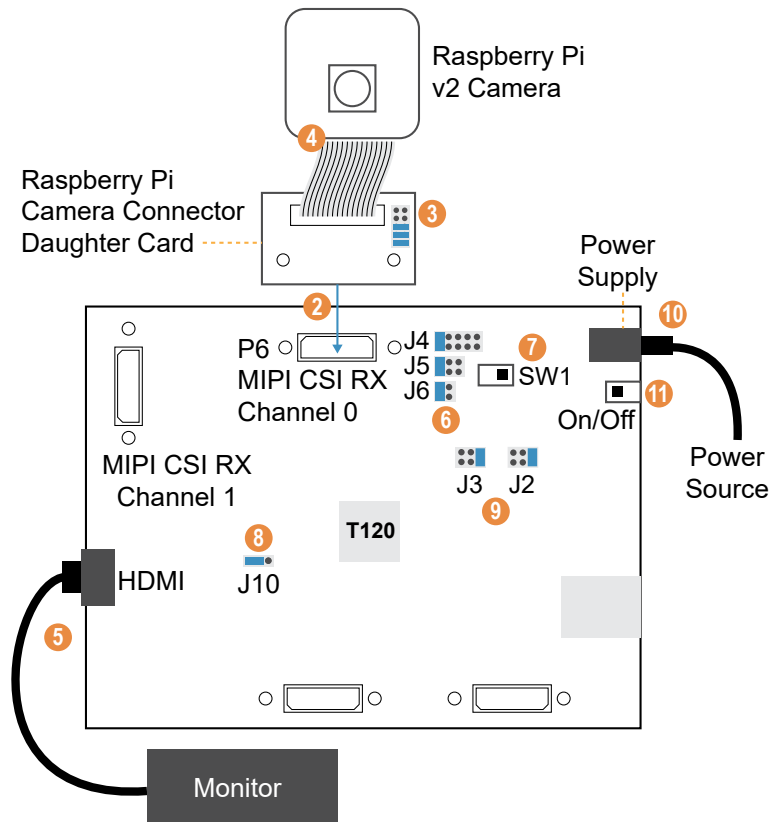
The example design uses the following hardware:

- Trion® T120 BGA324 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



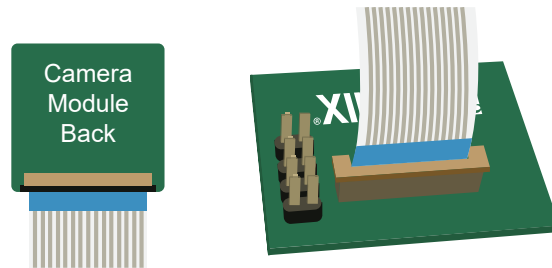
1. Attach standoffs to the board if you have not already done so.
2. Connect the Raspberry Pi Camera Connector Daughter Card to the board.
3. On the daughter card, connect the following pins with jumpers: 1 - 2, 3 - 4, and 5 - 6.
4. Connect the Raspberry Pi v2 camera module to the daughter card using 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 camera 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 a jumper to connect pins 2 and 3 on J10 to enable the on-board 10 MHz oscillator.
9. Connect jumpers to set the VCCIO supplies:
 - *VCCIO1B_1C (J2)*—Connect pins 1 - 2 (default)
 - *VCCIO2F (J3)*—Connect pins 1 - 2 (default)
10. Connect the 12 V power cable to the board connector and to a power source.
11. Turn on the board's power switch.

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 4: Connecting Raspberry Pi Cable



Program the Trion® T120 BGA324 Development Board

The Trion® T120 BGA324 Development Board ships pre-loaded with an example design that sends color bars to an HDMI monitor. To use the Raspberry Pi to HDMI example design, you must program the Raspberry Pi to HDMI design into the board.



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

1. Turn on the Trion® T120 BGA324 Development Board.
2. Download the example design file, **T120F324-mipi-rpi-hdmi-v<version>.zip** or **T120F324-mipi-rpi-crop-scale-v<version>.zip**, from the Support Center.
3. Unzip the file into your working directory.
4. Open the project (**mipi_pi_cam_debayer_top.xml**) 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_debayer_top.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 **it6263_reg.mem** file that contains the register mapping for the 1080p resolution. To use a different resolution, modify the 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
1D
66
```

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

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

Revision History

Table 1: Revision History

Date	Version	Description
May 2021	2.2	Updated document title by adding camera. Updated hardware setup diagram and description to include jumper J2 and J3 settings.
November 2020	2.1	Updated document title by adding T120 BGA324. Corrected J10 settings in hardware setup figure.
August 2020	2.0	Updated example design block diagram. Added content for crop and scale example design.
August 2020	1.3	Updated example design's register map description and example.
July 2020	1.2	Added a step to connect a jumper on J12 when setting up the example design hardware.
June 2020	1.1	Corrected jumper settings. Added instructions for connecting the Raspbnerry Pi camera cable.
June 2020	1.0	Initial release.