AN 012: Using the Trion® T20 Raspberry Pi Bridge Example Design

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Contents

Introduction

The Trion® T20 Raspberry Pi bridge example design demonstrates a complete video processing application targeting the Trion® T20 MIPI Development Board. At the center of the application is the T20 FPGA, which receives video data from a Raspberry Pi v2 camera, processes it, and sends the processed video to a monitor. Two pushbuttons on the Trion® T20 MIPI Development Board control the video processing.

Figure 1: T20 Raspberry Pi Bridge Application
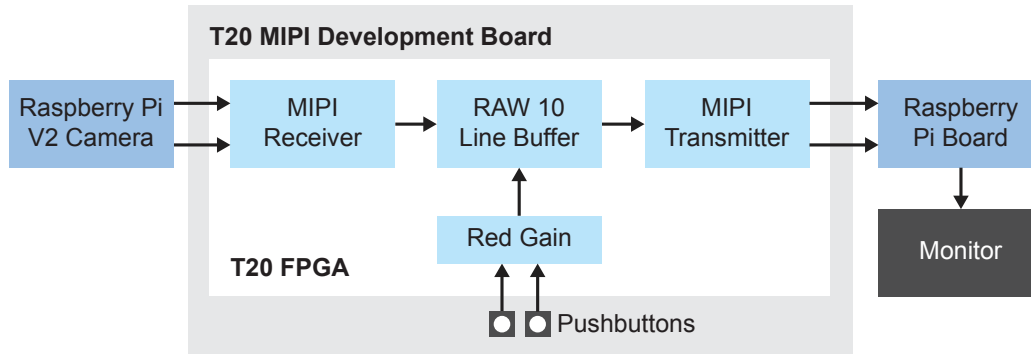
Required Hardware

The design uses the following hardware from the Trion® T20 MIPI Development Kit:
- Trion® T20 MIPI Development Board
- 2 Raspberry Pi Camera Connector Daughter Cards
- USB cable
- 15-pin flat cable

Additionally, the design uses hardware that you need to supply yourself:
- Raspberry Pi 4 board

> **Note:** Efinix recommends using the Raspberry Pi v4 model B board; however, the version 3 B+ board also works.

- Raspberry Pi v2 camera
- Another 15-pin flat cable
- HDMI cable:
  - *Raspberry Pi v4 model B*—Micro-HDMI to HDMI cable (or, HDMI to HDMI cable and micro-HDMI to HDMI adapter)
  - *Raspberry Pi v3 B+*—HDMI to HDMI cable
- Monitor with an HDMI input
- USB keyboard and mouse
- Power supply for Raspberry Pi board
- 6 jumpers
- Laptop or personal computer with the Efinity® software installed

Tip: You may want to use a Raspberry Pi kit that contains extra cables and hardware.

Set Up the Hardware

Follow these steps to set up the hardware.

⚠ **Important:** Make sure that the Trion® T20 MIPI Development Board is turned off before connecting any cards or cables.

📖 **Learn more:** Refer to the T20 MIPI Development Kit User Guide for information on the components available on the Trion® T20 MIPI Development Board.

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1. If you have not already done so, attach standoffs to the Trion® T20 MIPI Development Board and Raspberry Pi Camera Connector Daughter Cards.

2. Set up the Trion® T20 MIPI Development Board:

   a. On header J2, connect pins 5 and 6 with a jumper (remove any other jumpers on J2). This connection sets voltage power supply 1 to 3.3 V with power-up sequence. Leave the jumpers on J3 and J4 at the defaults.

   b. Connect a USB cable to the board and to your computer.

3. Set up the camera:

   a. Attach a Raspberry Pi Camera Connector Daughter Card to P1 (MIPI RX channel 0) on the Trion® T20 MIPI Development Board.

   b. Connect pins 1-2, 3-4, and 5-6 on daughter card header J2 with jumpers. Connecting these pins bridges the I^{2}C communication between the Raspberry Pi board and the camera.

   c. Attach a 15-pin flat cable to the daughter card and to the Raspberry Pi v2 camera.

4. Set up the Raspberry Pi board:

   a. Attach a Raspberry Pi Camera Connector Daughter Card to P2 (MIPI TX channel 0) on the Trion® T20 MIPI Development Board.

   b. Connect pins 1-2, 3-4, and 5-6 on daughter card header J2 with jumpers. Connecting these pins bridges the I^{2}C communication between the Raspberry Pi board and the camera.

   c. Attach a 15-pin flat cable to the daughter card and to the Raspberry Pi board.

   d. Connect the HDMI cable to the Raspberry Pi board and to a monitor.

   ℹ **Note:** For Raspberry Pi v4 boards, connect the HDMI cable to the HDMI0 jack.

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   e. Connect a USB mouse and USB keyboard to the USB jacks.

   f. Connect the Raspberry Pi power supply to the board and to a power source.

   ℹ **Note:** If you this is the first time you are using your Raspberry Pi board, you need to set it up. Follow the instructions on the Raspberry Pi web site to set up the board.
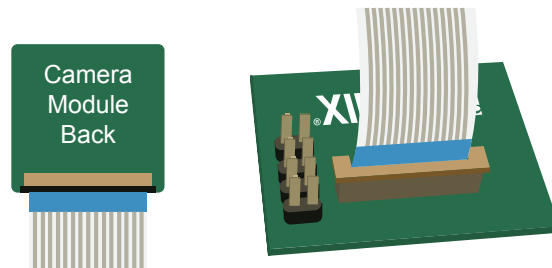
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5. Turn on the monitor.

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 2: Connecting Raspberry Pi Cable*

Enable the Camera

With all of the hardware connected and the Raspberry Pi is powered up, enable the camera and test the Raspberry Pi board's connection to it. (Leave the Trion® T20 MIPI Development Board turned off while you enable the camera.)

> **Note:** The Raspberry Pi camera is disabled by default.

1. Go to the Raspbian Desktop.
2. Choose **Raspberry Pi > Preferences > Raspberry Pi Configuration**.
3. Click the **Interfaces** tab.
4. Set the camera to **Enable** and click **OK**.
5. Reboot the Raspberry Pi.
6. Test the camera connection:

   a. Open a command prompt.
   b. Type the command `vcgencmd get_camera` and press return. The system should respond `supported=1 detected=1`.

      If the system does not detect the camera, check that you have set up the hardware correctly.

Figure 3: MIPI-Raspberry Pi Example Design Set Up
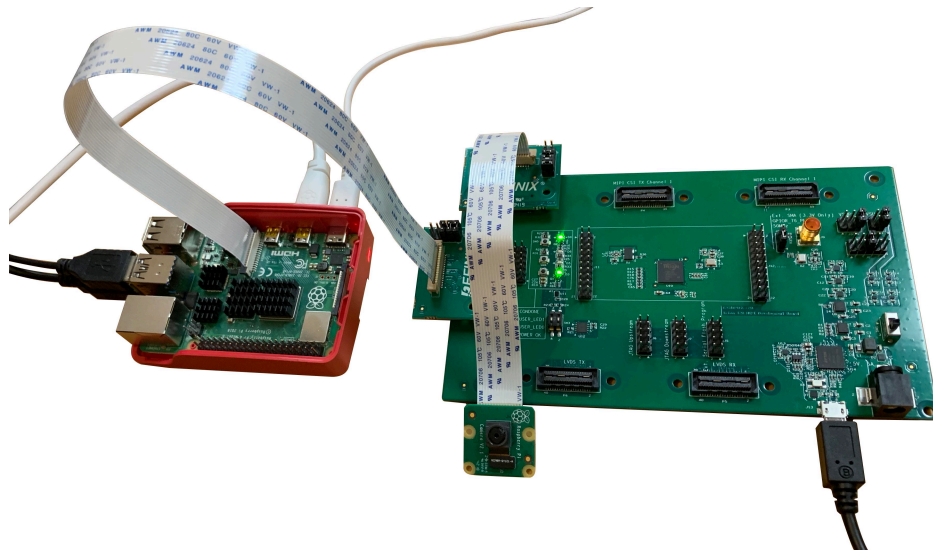
Program the Trion® T20 MIPI Development Board

The Trion® T20 MIPI Development Board ships pre-loaded with a loopback design. To use the MIPI-Paspberry Pi example design, you must program the design into the board.

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

1. Turn on the Trion® T20 MIPI Development Board.
2. Download the example design file, **mipi_raspberry_pi_reference_T20F169_devkit-v<version>.zip**, from the Support Center.
3. Unzip the file into your working directory.
4. Open the project (**mipi_pi_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_top.hex**.

Learn more: Instructions on how to use the Efinity® software is available in the Support Center.

Run the Example Design

With the hardware set up and the Trion® T20 MIPI Development Board programmed you are ready to run the video processing application.

1. Open a command prompt on the Raspbian Desktop.
2. Type the command to capture data:
   - *v4 board*—`raspivid -t 0`
   - *v3 board*—`raspivid -t 0 -ss 33333`

   `raspivid` captures video with a video encoding component.

   `-t 0` captures video until you stop it with a Ctrl+C command.

   `-ss 33333` sets the shutter speed in microseconds.

   The monitor displays video from the camera. The design manipulates the amount of red in the image. There are 8 settings from 0 (no red) to 7 (most red). The default setting is 4, which is normal color mode.
3. Press SW4 to change the red gain. Each press increments the gain until the maximum gain of 7. A subsequent press drops the gain to 0, which is the minimum red setting.
4. Press SW5 on the Trion® T20 MIPI Development Board to go back to the default RGB gain setting (4).
5. Type Ctrl+C on the Raspberry Pi keyboard to stop streaming video.

Revision History

Table 1: Revision History

Date	Version	Description
June 2020	1.1	Added topic on connecting the Raspberry Pi cable.
September 2019	1.0	Initial release.