DEMO_FX3_U3V_CAM01 EZ-USB™ FX3 camera kit guide

About this document

Scope and purpose

This document is a user guide for the DEMO_FX3_U3V_CAM01 EZ-USB™ FX3 camera kit. This kit enables you to stream U3V video directly from the onboard camera and an external camera module. You can refer to the relevant sections based on your requirement:

- **Introduction** – Provides basic information on the kits
- **Installing the kit software** – Explains the installation of software needed to program the kit
- **Kit hardware** – Explains the kit architecture and system design details
- **Kit programing** – Describes the procedure to program the kit
- **Kit operation** – Explains the procedure to operate the kit

Intended audience

This document is intended for users of the DEMO_FX3_U3V_CAM01 EZ-USB™ FX3 camera kit.

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1 Introduction

The DEMO_FX3_U3V_CAM01 EZ-USB™ FX3 camera kit is based on the FX3 product family of Infineon's configurable SuperSpeed USB controllers.

FX3 has a fully programmable general programmable interface (GPIF™ II) that can interface with any processor, ASIC, image sensor or FPGA. It provides easy and effortless connectivity to popular industry interfaces such as synchronous slave FIFO and image sensor interfaces. The EZ-USB™ FX3 camera kit combines hardware, software, and documentation that enable customers to evaluate the FX3 device. This user guide describes the steps to install the software required by the kit and to operate the development board provided with the kit.

This kit is intended to be a solution demo kit for UVC, UAC, and U3V video streaming applications.

See the device datasheets **[4]** to understand and compare the various features supported by the EZ-USB™ FX3 controllers.

The DEMO_FX3_U3V_CAM01 EZ-USB™ FX3 camera kit supports the following key features:

- Video streaming up to 1080p @30fps in YUV format from the onboard image sensor module
- USB bus-powered operation
- External off-the-shelf MIPI camera interface from Raspberry Pi
- Compatible with FX3 explorer kit interconnect boards
- Onboard regulators
- Firmware-controlled LED and user switch
- GPIO headers

To view the FX3 controller details, see the **webpage**.

1.1 Kit contents

The DEMO_FX3_U3V_CAM01 EZ-USB™ FX3 camera kit consists of the following:

Table 1 Kit contents

Item	Type	Comments
FX3 baseboard	Hardware	
Camera add-on board	Hardware	
SuperSpeed USB - C cable	Cable	
Hard copy of quick start guide	Documentation	
Kit casing	Package	
Foam	Package	To protect and maintain proper placement in the kit container

The following items may be required for developing applications with this kit. Note that the following are not included in the kit:

- Off-the-shelf (OTS) MIPI camera module - MPN# 410-358 from Raspberry Pi
- 22-pin to 15-pin ribbon cable (CAB0306)
- FX3 explorer kit interconnect boards from Altera and Xilinx

1.2 Downloading kit documents and hardware design files

The documents and the hardware design files for DEMO_FX3_U3V_CAM01 EZ-USB™ FX3 camera kit can be downloaded from the kit webpage [3]. The documents include a quick start guide, kit guide (this document), and release notes. The hardware design files include the schematic, BoM, and layout files.

1.3 Board details

This section lists the key interfaces of the DEMO_FX3_U3V_CAM01 kit.

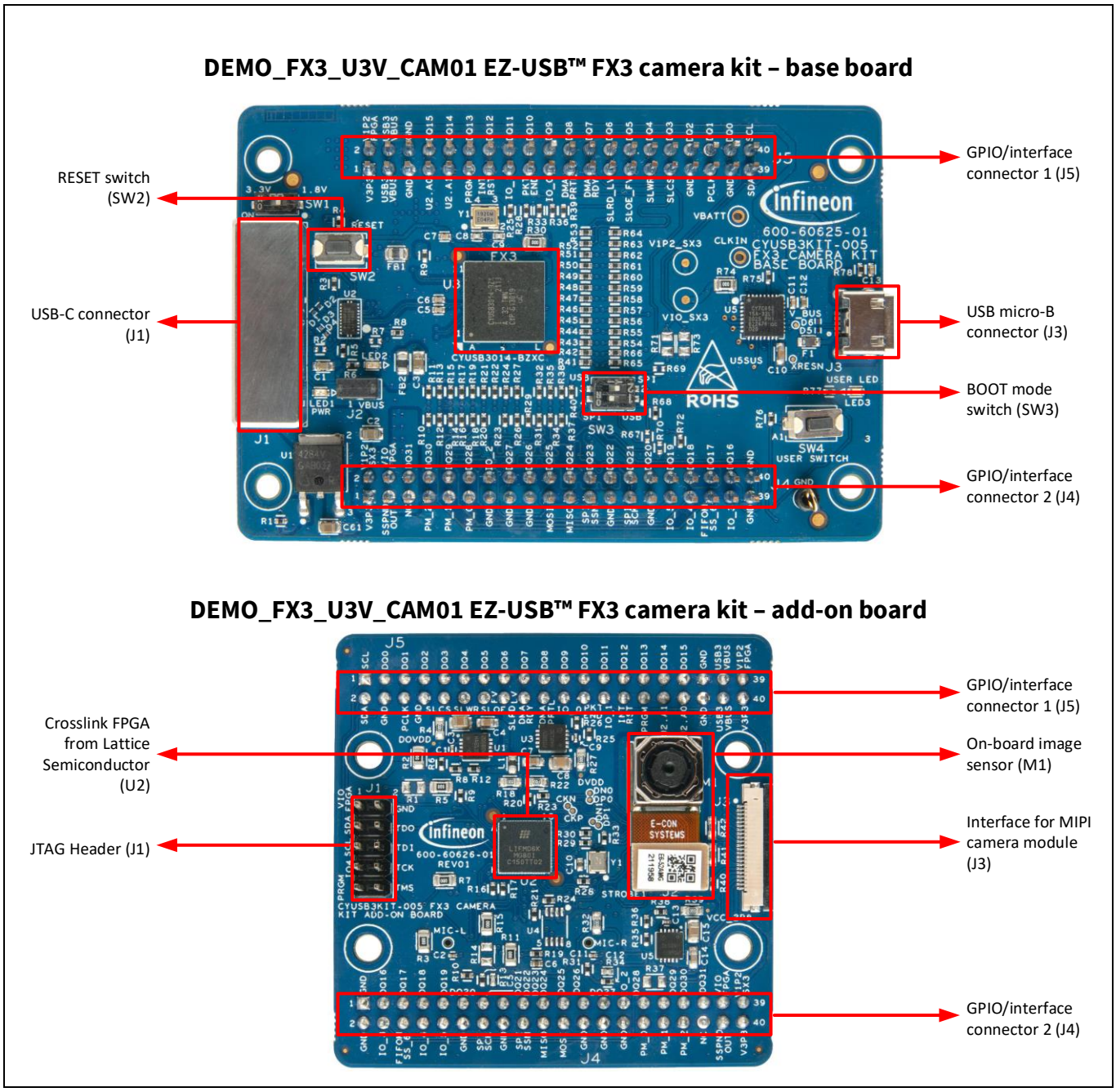


Figure 1 DEMO_FX3_U3V_CAM01 EZ-USB™ FX3 camera kit

Note:

1. *Photos are taken without stand-offs.*
2. *The baseboard is mounted with the camera add-on board during manufacturing and delivered pre-mounted in this kit.*

1.4 Kit features

The kit features an onboard camera that can be programmed using the provided firmware image to stream U3V videos. Additionally, the DEMO_FX3_U3V_CAM01 kit provides an option to interface with the external off-the-shelf MIPI camera module from Raspberry Pi for streaming video. This kit is designed keeping the compatibility of FX3 explorer kit interconnect boards in mind. See Kit operation for more details.

1.5 Kit removal

The kit operation does not need the user to detach the boards at any point in time. However, if the user wants to interface the base board with other custom-made add-on boards, ensure to remove the boards using a rocking mechanism as shown in **Figure 2**.

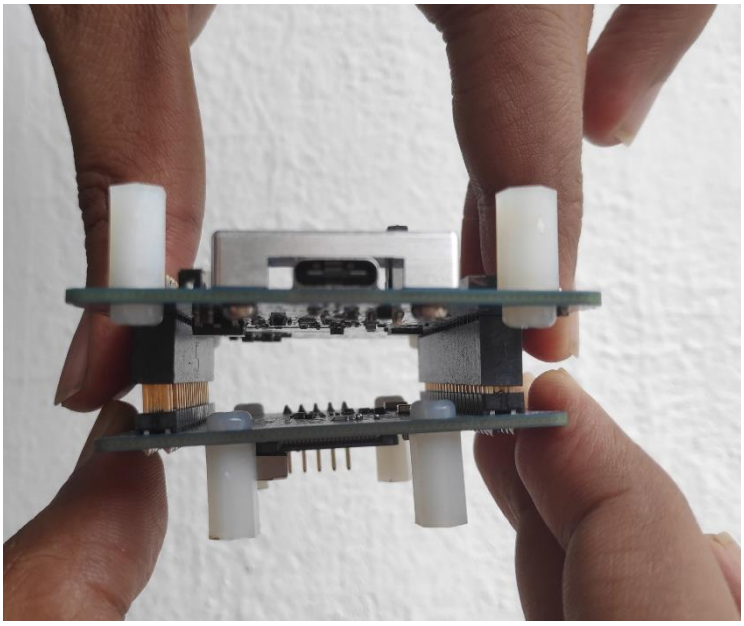


Figure 2 Detaching the boards

2 Installing the kit software

This chapter describes the procedure to install software for the DEMO_FX3_U3V_CAM01 solution demo kit.

2.1 Before you start

The installation of the FX3 SDK and other Infineon software may require administrator privileges. However, privileges are not required to run the software once it is installed.

2.2 Install FX3 SDK

Download and install **EZ-USB™ FX3 software development kit** to configure and evaluate the example templates on the CY-RB4111 kit.

Installable packages are available for Windows, Linux, and macOS.

After the installation is complete, the contents are available at *<Install Directory>\ EZ-USB FX3 SDK.*

Note:

1. *The default <Install Directory> is C:\Program Files(x86)\Cypress.*
2. *See **GettingStartedWithFX3SDK.pdf** available in the installation directory for more details.*

2.3 Install Pleora eBUS Player

Download and install Pleora eBUS Player from the following links:

- For **Windows 64-bit**
- For **Windows 32-bit**

3 EZ-USB™ FX3 camera kit system design

This section provides design details of the DEMO_FX3_U3V_CAM01 EZ-USB™ FX3 camera kit. The kit is bus-powered and supports SuperSpeed USB-C cables to connect to the PC.

3.1 Top-level hardware design

The DEMO_FX3_U3V_CAM01 EZ-USB™ FX3 camera kit consists of two boards:

- Baseboard: Consists of the FX3 device, an external SPI flash module, power supplies, USB-C connector, and interface connectors for add-on modules.
- Camera add-on board: Consists of the Crosslink FPGA from Lattice Semiconductor, onboard image sensor module, power supplies, and external interface connector for Raspberry Pi.

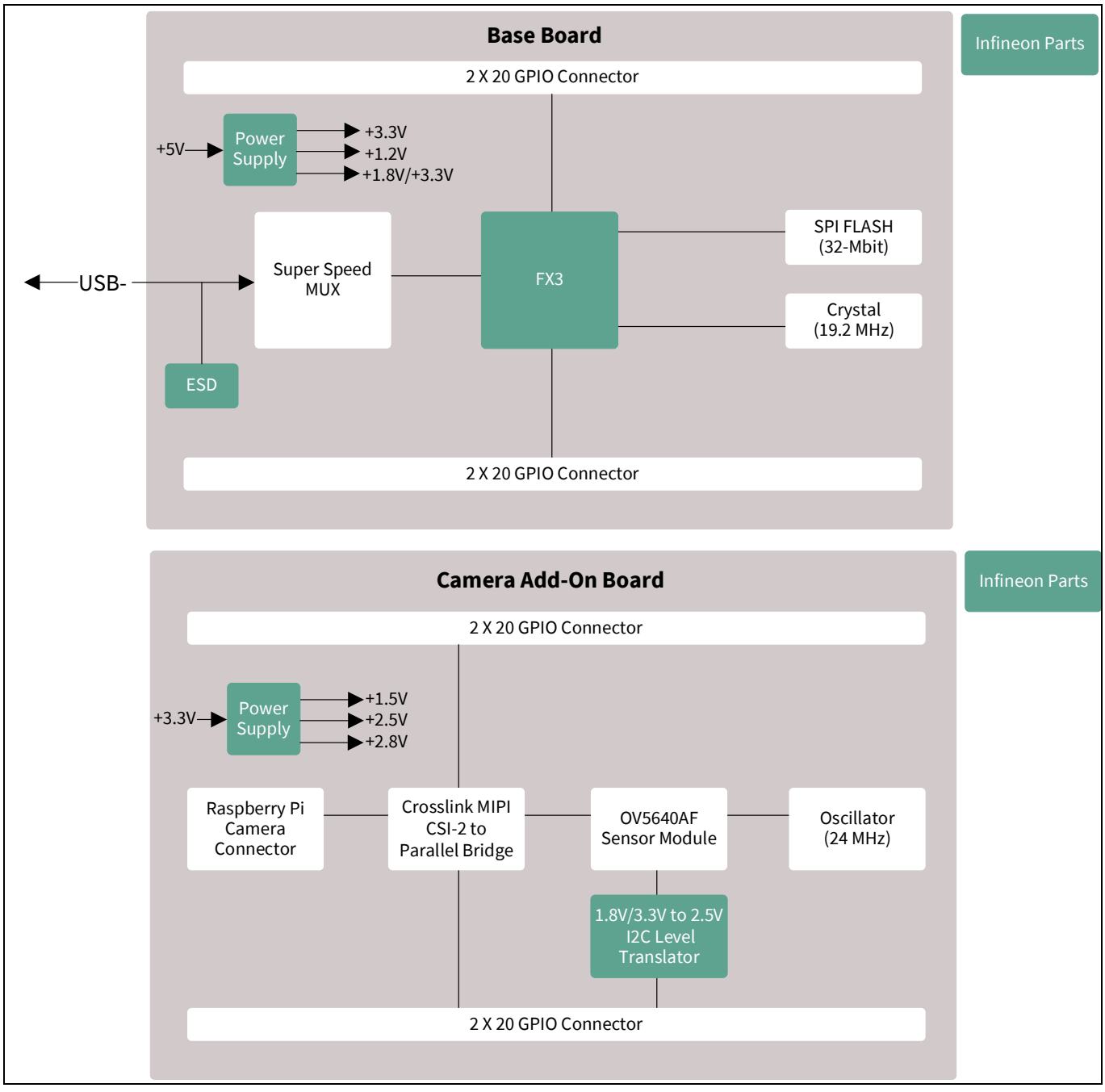


Figure 3 DEMO_FX3_U3V_CAM01 EZ-USB™ FX3 camera kit architecture

3.2 DEMO_FX3_U3V_CAM01 baseboard design details

The DEMO_FX3_U3V_CAM01 baseboard consists of the FX3 silicon (CYUSB3014-BZXI), USB-C connector, SuperSpeed MUX, and SPI flash. The board is bus-powered and uses a 19.2-MHz crystal for operation. The development board provides convenient access to FX3 interfaces, such as GPIOs, I2C, SPI, and JTAG. The two 40-pin headers (on the reverse PCB side in **Figure 3**) provide FX3 signals to connect to external boards using the GPIO interface. Note that for convenience, the headers have long pins that extend above the top side of the PCB for use as test points or attachment to mating connectors. All I/O signals, which include the 32-bit data bus, 13 control lines, and a 100-MHz clock, are available to connect to external devices such as FPGAs, CPLDs, image sensors, or microcontrollers.

The baseboard contains the following key components:

3.2.1 USB connector (J1)

The FX3 capture kit provides one USB 3.0 Type-C receptacle that brings out FX3 USB signals. This receptacle accepts a Type-C connection, and the other end of the cable connects to a USB host PC via either a Type-A or a Type-C port as well. A SuperSpeed USB-C cable is included in the kit. Use this port to test FX3 applications that communicate with a host PC. Using the Type-C interface allows access to FX3 debug interface using serial terminal messages.

3.2.2 Jumpers and switches

Jumper (J2): This is a power ON jumper. When closed, it allows USB VBUS for powering the board.

J2 close: Power ON (Default)

J2 open: Power OFF

Power switch (SW1): This is used to switch the add-on board power from 1.8 V to 3.3 V and vice-versa. This allows compatibility with FX3 camera kit interconnect modules, which typically require 1.8 V. The camera add-on board supplied with this kit can operate at both 1.8 V and 3.3 V; however, to connect an external Raspberry Pi MIPI camera board, 3.3 V is required.

SW1 ON: 3.3 V (Default)

SW1 OFF: 1.8 V

Reset switch (SW2): Reboots the silicon. Press the switch and release to boot from the selected mode set by SW3.

Mode selection switch (SW3): Selects the mode in which FX3 has to boot upon reset or power ON. The FX3 camera kit can boot in two modes based on the position of this switch.

Table 2 Boot modes

Boot mode	PMODE1	PMODE2
USB	SW3.2 ON	SW3.1 OFF
SPI	SW3.2 OFF	SW3.1 ON

To program the device, set SW3 in USB mode. After programing, setting the mode switch in SPI mode and rebooting the device allows FX3 to boot from the SPI flash.

User switch (SW4): Allows to achieve user-defined functions such as still capture. Pressing this switch sends an I2C command to FX3.

3.2.3 Baseboard power supply

The baseboard consists of three regulators. Each power rail has corresponding test points on the board for probing. Make sure no external voltages are applied at the test points as it may permanently damage the kit functionality.

3.2.3.1 5 V to 3.3 V regulator (U1)

This is an LDO that provides a 3.3 V output at 1 A. TLE4284DVATMA1 from Infineon Technologies is used on this board.

3.2.3.2 5 V to 1.2 V regulator (U6)

This is a buck regulator that provides 1.2 V for powering the FX3 core. It also provides power to the FPGA present on camera add-on board. IR3883MTRPBF from Infineon Technologies is used on board.

3.2.3.3 5 V to 1.8 V / 3.3 V regulator (U8)

This is an LDO that provides a 1.8 V or 3.3 V output at 1 A. This regulator features a switch SW1 that changes the output voltage based on the switch status.

Mode 1: SW1 = OFF → V_{OUT} = 1.8 V

Mode 2: SW1 = ON → V_{OUT} = 3.3 V

TLE4284DVATMA1 from Infineon Technologies is used on this board.

3.2.4 FX3 (U3)

This is a USB 3.1 Gen 1 SuperSpeed controller with a 32-bit ARM926EJ core CPU and 512 kB embedded SRAM. It supports UVC, UAC, U3V, and USB vendor class protocols. With GPIF II of 8-, 16-, 24-, and 32-bit data bus at 100 MHz, FX3 supports slave FIFO and parallel camera interface features. It has dedicated interfaces for SPI Flash and I^2C. FX3 supports selectable clock input frequencies at 19.2, 26, 38.4, and 52 MHz. Additionally, a dedicated 19.2 MHz crystal input support is also available. It is a 121-ball, 10- × 10-mm, 0.8-mm pitch Pb-free ball grid array (BGA).

3.2.5 SPI flash (U7)

The kit configuration is stored on the 32-Mbit SPI flash. After power ON, FX3 fetches the required details from the configuration image, stores it in its RAM and starts executing from it.

3.2.6 Interface/GPIO connectors (J4, J5)

The baseboard has two 20-pin interfaces/GPIO female connectors. All the signals required for interfacing FX3 with external add-on modules are routed to the connectors. Pin 5 of J4 in the connector is removed (i.e., cut) to polarise the connector to avoid connecting the add-on boards in incorrect orientation.

Note: *Do not connect any external voltage source to these pins as it may permanently damage the kit. The pins are available only for probing purpose.*

3.2.7 Crystal (Y1)

FX3 needs a 19.2-MHz crystal to generate the clock for its operation.

3.2.8 Reset switch (SW2)

The reset switch (SW2) is provided for debug purpose. The RC circuit provides a clean reset signal every time after power up. The RC circuit formed by R1 and C72 gives a 10-ms pulse width because it assumes the worst 3.3 V supply ramp up time and FX3 crystal POR reset time. On pressing SW2, FX3 starts rebooting based on the mode selection switch SW3.

3.2.9 LEDs (LED1, LED2, LED3)

- LED1 (power ON LED) is a GREEN color LED used for 3.3-V power supply indication
- LED2 is a RED color LED to indicate fault on VBUS
- LED3 is a BLUE color application-driven user LED connected to GPIO_4 of FX3

3.3 DEMO_FX3_U3V_CAM01 camera add-on board design details

3.3.1 Add-on board power supply

The camera add-on board consists of three regulators. Each power rail has corresponding test points on board for probing. Make sure no external voltages are applied at the test points as it may permanently damage the kit functionality.

3.3.1.1 3.3 V to 1.5 V regulator (U3)

This is an LDO that generates 1.5 V from 3.3 V coming from the baseboard. TLS205B0LDVXUMA1 from Infineon Technologies is used on the board. It is rated to provide maximum current of 300 mA.

3.3.1.2 3.3 V to 2.5 V regulator (U1)

This is an LDO that generates 2.5 V from 3.3 V coming from the baseboard. TLS205B0LDVXUMA1 from Infineon Technologies is used on the board. It is rated to provide maximum current of 300 mA.

3.3.1.3 3.3 V to 2.8 V regulator (U5)

This is an LDO that generates 2.8 V from 3.3 V coming from the baseboard. TLS205B0LDVXUMA1 from Infineon Technologies is used on the board. It is rated to provide maximum current of 300 mA.

3.3.2 Crosslink FPGA (U2)

The camera add-on board uses CrossLink FPGA from Lattice Semiconductor. It is a programmable video bridging device that supports a variety of protocols and interfaces for mobile image sensors and displays. CrossLink supports video interfaces including MIPI DPI, MIPI DBI, CMOS camera and display interfaces, OpenLDI, FPD-Link, FLATLINK, MIPI D-PHY, MIPI CSI-2, MIPI DSI, SLVS200, subLVDS, HiSPi, and more.

This kit uses the two MIPI CSI-2 interface ports of the CrossLink FPGA to communicate with the onboard camera module and external camera module. The FPGA converts the received MIPI signals to a 16-bit parallel interface thus allowing FX3 to communicate with the image sensors / camera module directly. This kit uses the 80-ball ctfBGA package with 37 I/Os.

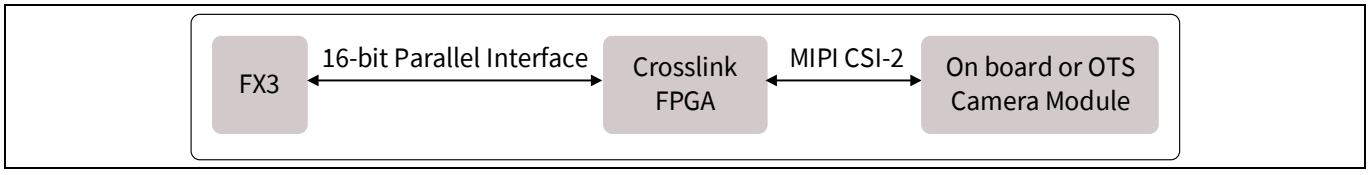


Figure 4 Crosslink FPGA interfaces

3.3.3 Image sensor connector (J2) and onboard camera module (M1)

The camera add-on board uses a 5-MP MIPI camera module, e-CAM52A_MI5640_MOD from E-Con Systems that features Omnivison OV5640 CMOS image sensor. This MIPI CSI camera module streams VGA @ 60 fps, HD (720p) @ 60 fps and full HD (1080p) @ 30 fps. It is an auto focus camera that provides output at YUV422 format. The camera module is mounted on the image sensor connector assembly present on the add-on board.

3.3.4 Crystal (Y1)

SG-210STF 24.0000ML0 is used to provide 24-MHz clock for the camera module.

3.3.5 External camera module connector for Raspberry Pi (J3)

The camera add-on board allows you to interface external off-the-shelf Raspberry Pi MIPI camera module such as PCAM-5C. This is a 22-pin FPC connector. You need a 22-pin to 15-pin flex cable (CAB0306) to connect the off-the-shelf Raspberry Pi MIPI camera module with the DVK camera add-on board.

3.3.6 GPIO interface connectors (J4, J5)

The camera add-on board also has two 20-pin mating interface/GPIO connectors to interface the camera add-on board with the FX3 baseboard.

Note: *Do not connect any external voltage source to these pins as it may permanently damage the kit. The pins are available only for probing purpose.*

4 Programming the EZ-USB™ DEMO_FX3_U3V_CAM01 FX3 controller

The EZ-USB™ FX3 controller on the DEMO_FX3_U3V_CAM01 EZ-USB™ FX3 camera kit is pre-programmed with the latest firmware at the time of manufacturing.

DEMO_FX3_U3V_CAM01 kit is pre-programed with the firmware to stream U3V video from the onboard camera. Use the USB Control Center application available in the FX3 SDK to change the program.

1. Set switch SW1 on the kit to boot in USB mode as per **Table 2**.
2. Connect the kit to the PC using a SuperSpeed USB-C cable.

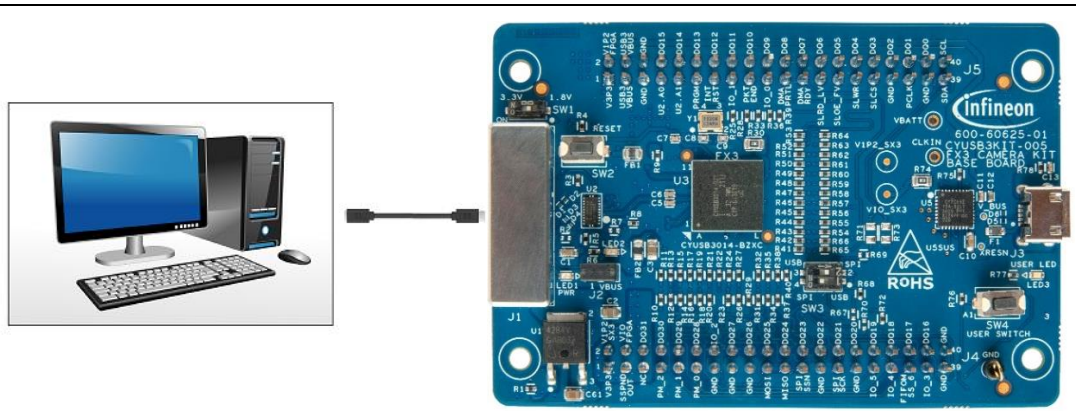


Figure 5 Kit connected to PC using USB-C cable

3. Open the EZ-USB™ Control Center application. If the application is not present on the desktop, browse to the FX3 SDK installation directory (*C:\Program Files (x86)\Cypress\EZ-USB FX3 SDK*).
4. The board should appear as “Cypress FX3 USB Bootloader Device” in the left pane of the USB Control Center application.

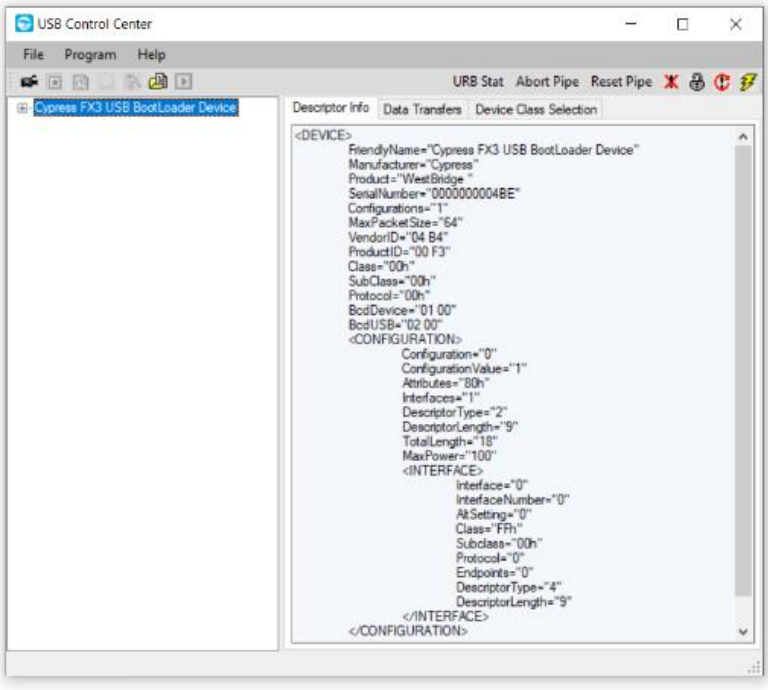


Figure 6 Device enumeration in control center application

Programming the EZ-USB™ DEMO_FX3_U3V_CAM01 FX3 controller

5. Click **Program** → **FX3** → **SPI FLASH**

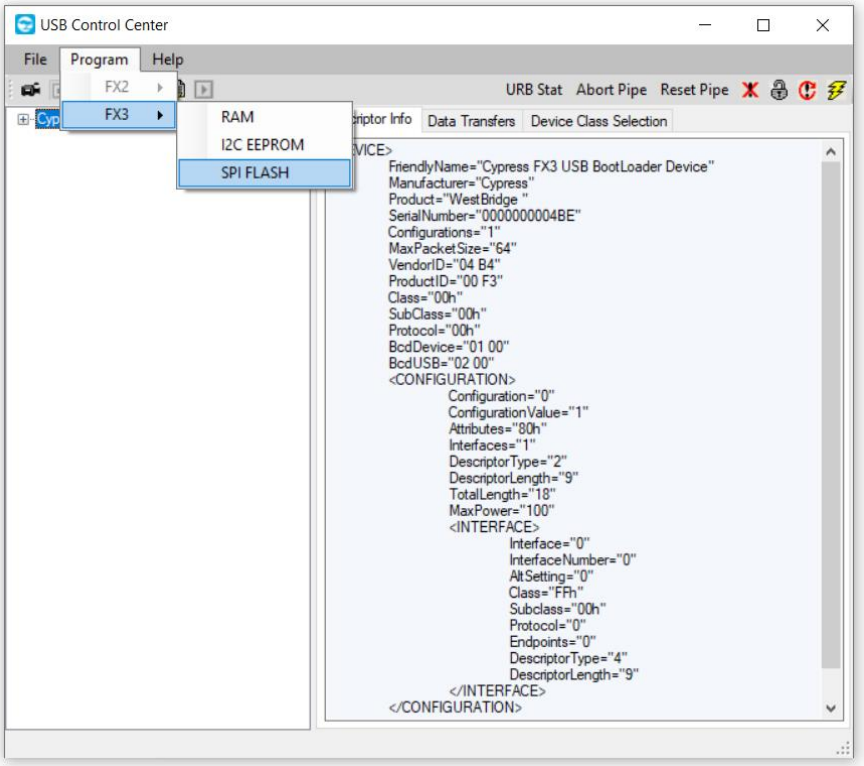


Figure 7 Programming the SPI FLASH

6. Browse to select the downloaded firmware file.

Table 3 Firmware file

S.No	Camera module	Firmware image
1	On-board image Sensor	U3V_IMAGESENSOR_FX3_4defa95_u3v_is_fx3_4defa958 _21Jun22_095508_MERGED.img
2	External MIPI camera module	U3V_PCAM_5C_MERGED_d5484f1.img

7. Wait for programing to complete. The status appears on the bottom left of the window.

5 Kit operation

This chapter describes how to boot the FX3 device after successful programming to demonstrate the kit functionality by streaming video and audio. Two separate demonstrations are covered:

- Streaming video from the onboard camera
- Streaming video from the off-the-shelf Raspberry Pi MIPI camera

Important Note: Before starting the demo, make sure that the kit is loaded with the appropriate firmware per **Table 3**.

5.1 Booting from the SPI flash

1. Set the switch SW3 setting to SPI position as below:
   Move SW3 pin 1 to ON position and pin 2 to OFF position.

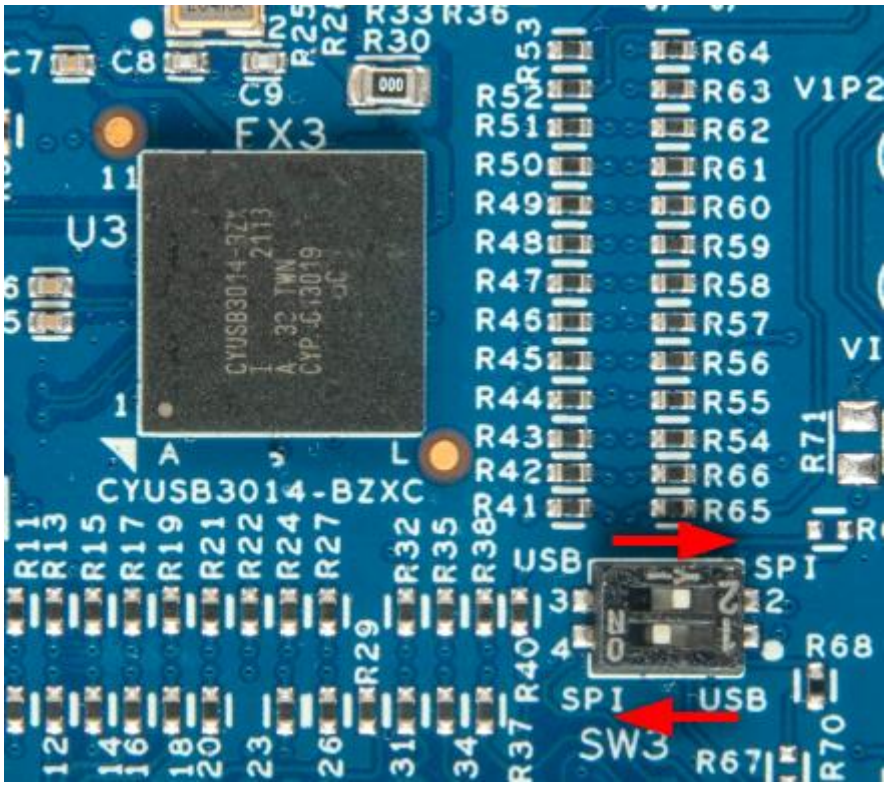


Figure 8 Mode Switch set to SPI Mode

2. Power cycle the kit by removing the USB cable from the PC or pressing the RESET switch (SW2).

5.2 Video streaming from the onboard image sensor

1. Make sure that the kit is programmed with the appropriate firmware image file as mentioned in **Table 3**.
2. Remove the sticker from the onboard camera (M1).

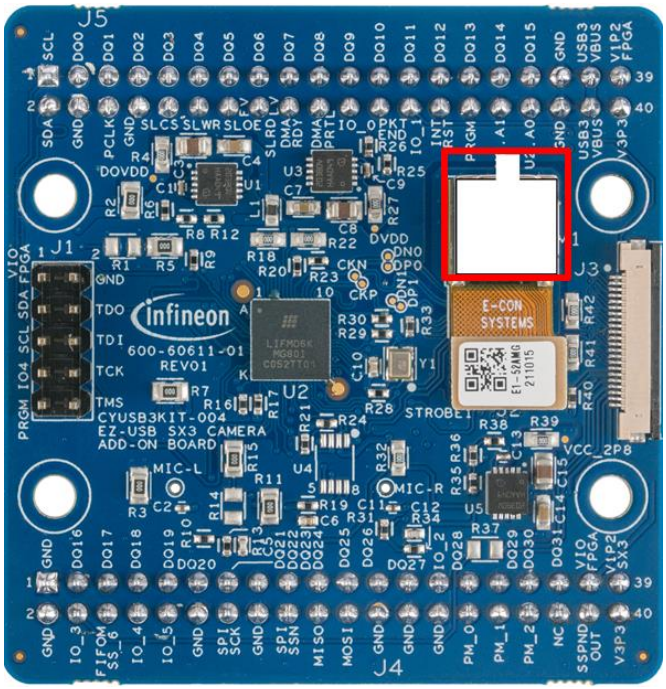


Figure 9 Camera board with on board camera module

3. Make sure that the board is placed as shown below and the camera is pointing to the object of interest:

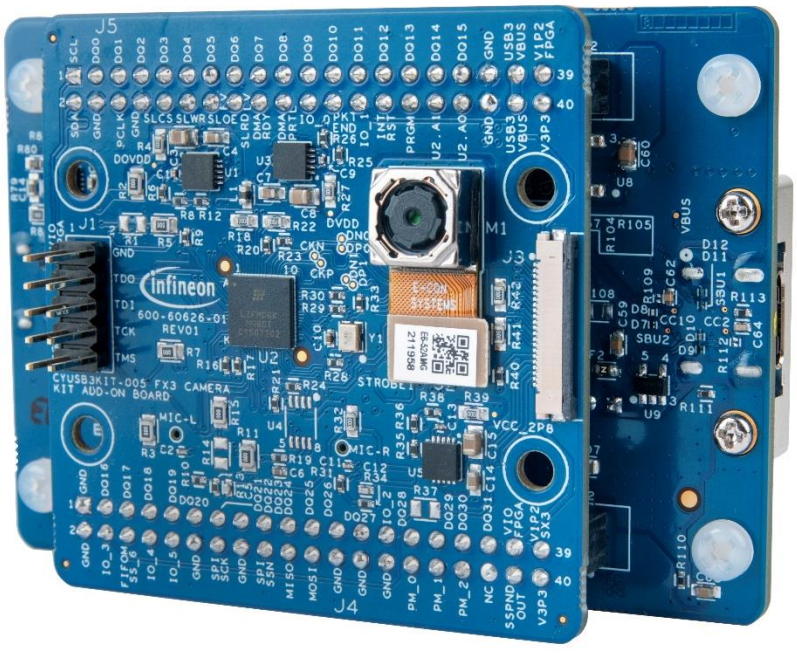


Figure 10 Board placement

4. Open the eBUS Player app.

Kit operation

5. Click Select/Connect from the eBUS Player. Check if FX3 is detected as shown in **Figure 11**.

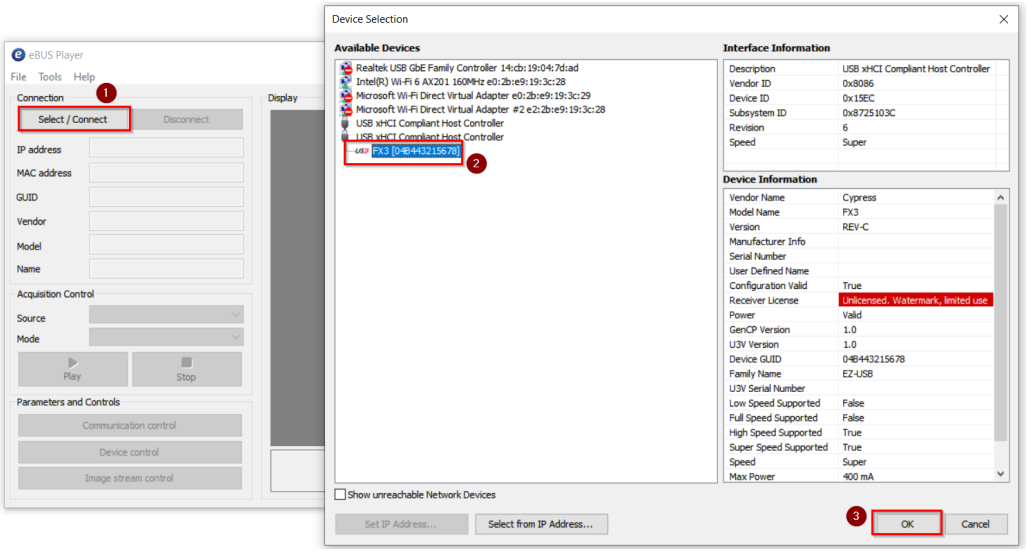


Figure 11 Selecting USB3 Vision device in eBUS Player application

6. If FX3 is not detected, go to "*C:\Program Files\Common Files\Pleora\eBUS SDK\U3V\Certified*" and install the U3V driver as shown in **Figure 12**.

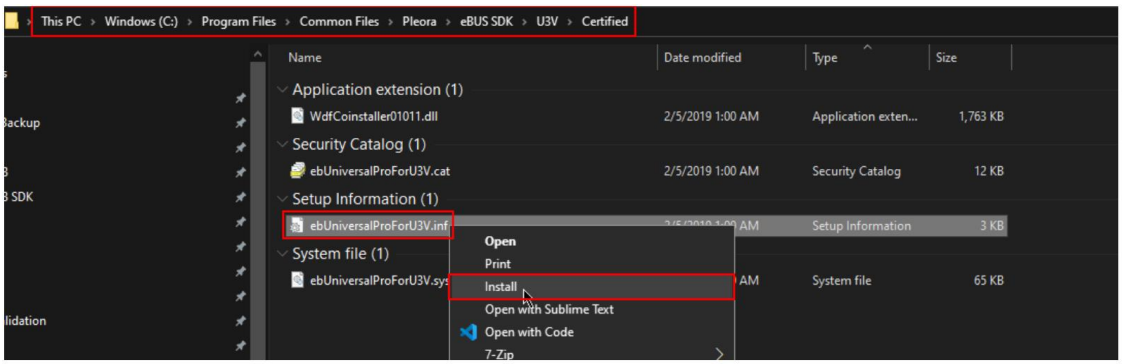


Figure 12 Installing driver for USB3 Vision player (eBUS player)

7. Click **Play** and observe the streaming video in the display pane.
8. You can check the streaming statistics in the status pane below the display pane.

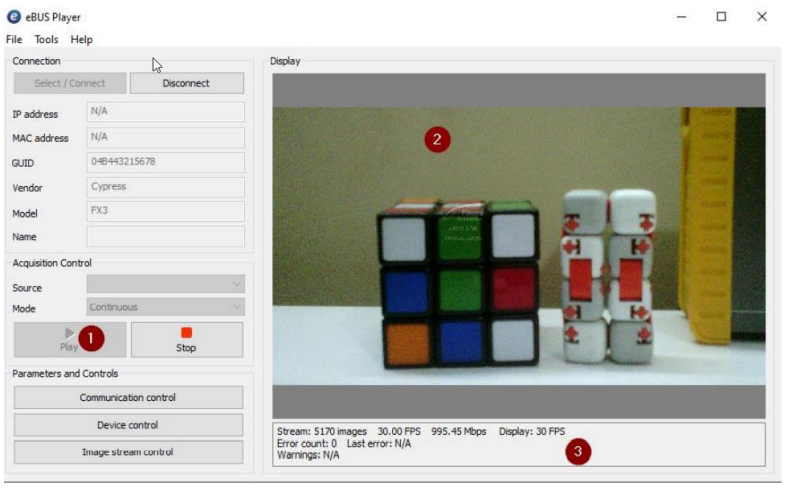


Figure 13 Check the streaming video in the display pane and its statistics in the status pane

Kit operation

9. Click **Device control** and verify the streaming resolution.

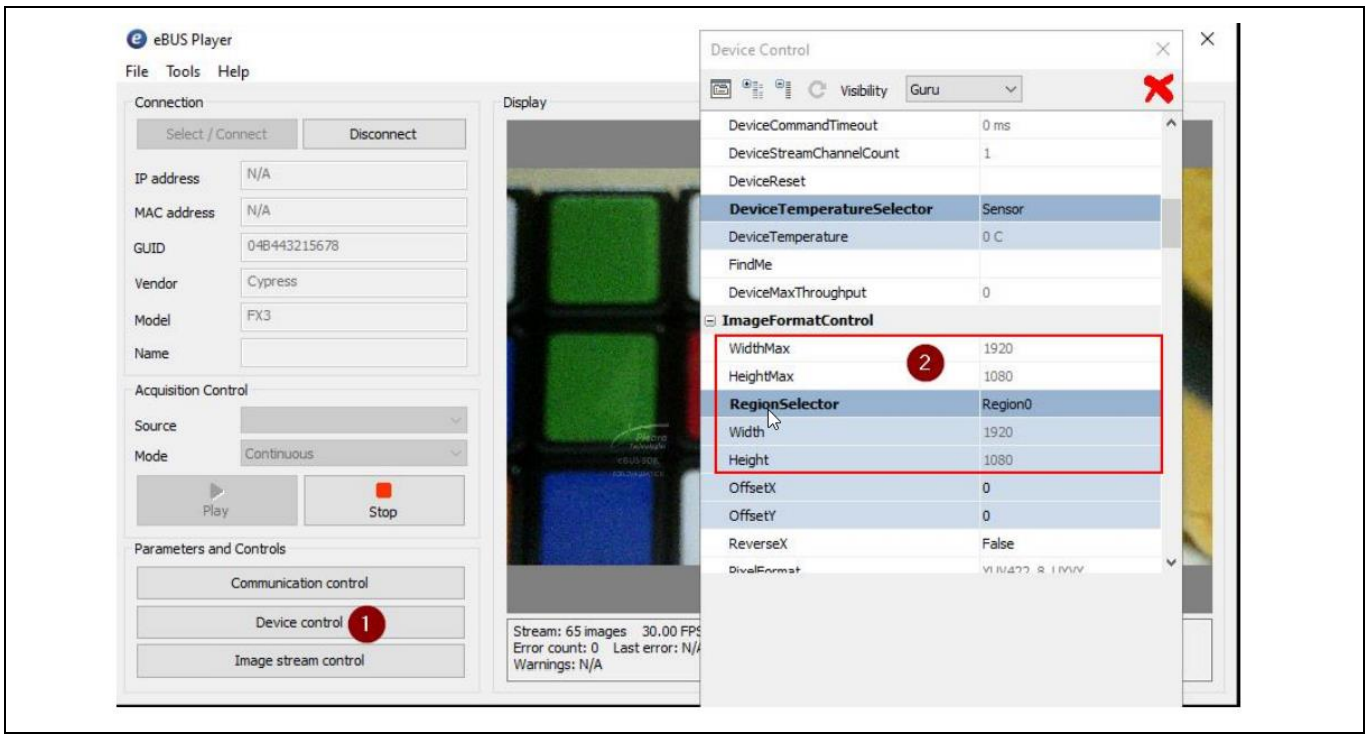


Figure 14 Device control settings

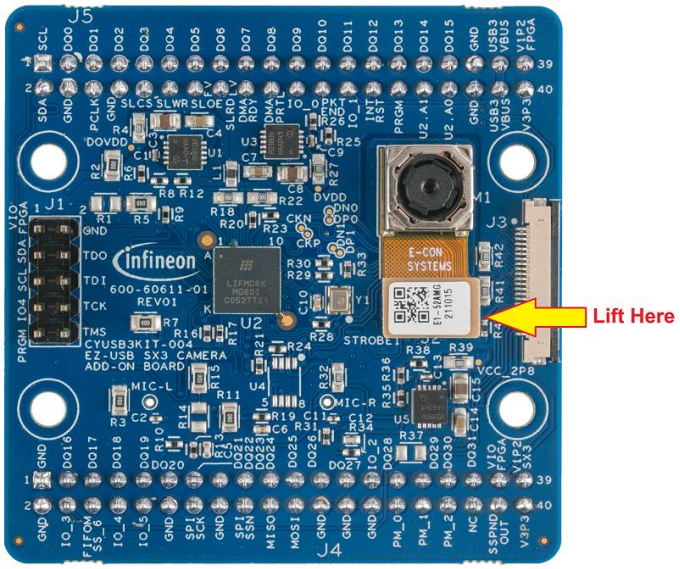
10. Close the eBUS Player to turn off the streaming and put the sticker back on the on-board camera module. Disconnect the USB-C cable from kit and PC.

5.3 Video streaming from the Raspberry Pi camera

1. Make sure that the kit is programmed with the appropriate firmware image file as mentioned in **Table 3**.
2. Disconnect the board from the PC.
3. Disconnect the onboard camera module by lifting the image sensor flex cable connector from J2. Make sure the flex cable does not touch J2 after lifting.

Note: Make sure to lift flex cable slowly in such a way that M1 does not come out of the board. Lift the flex cable such that it only gets disconnected from J2.

Kit operation



4. Connect the Raspberry Pi OV5640 camera module (part# 410-358) to connector J3 on the camera board using a 15- to 22-pin Raspberry Pi zero camera cable part# CAB0306 as shown below.

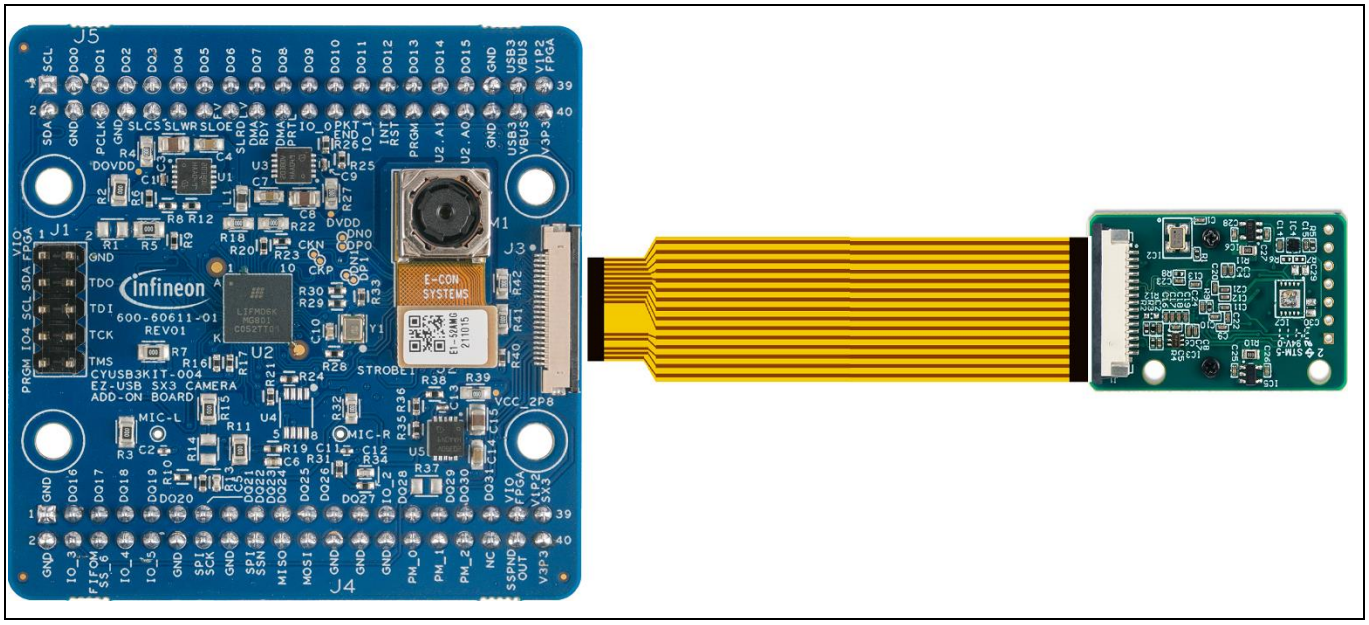


Figure 15 Raspberry Pi camera module interface with image sensor board

Note: Cable and Raspberry Pi camera modules are not part of the kit. Users can buy this directly from the manufacturer. Cable P/N: CAB0306. Raspberry Pi camera module P/N: 410-358 or equivalent.

5. Move the switch SW1 (1.8 / 3.3 V selector switch) on the baseboard to ON position (3.3 V) and plug in the SuperSpeed USB-C cable to the PC.
6. Open the eBUS Player app.
7. Click Select/Connect from the eBUS Player. Check if FX3 is detected as shown in **Figure 16**.

Kit operation

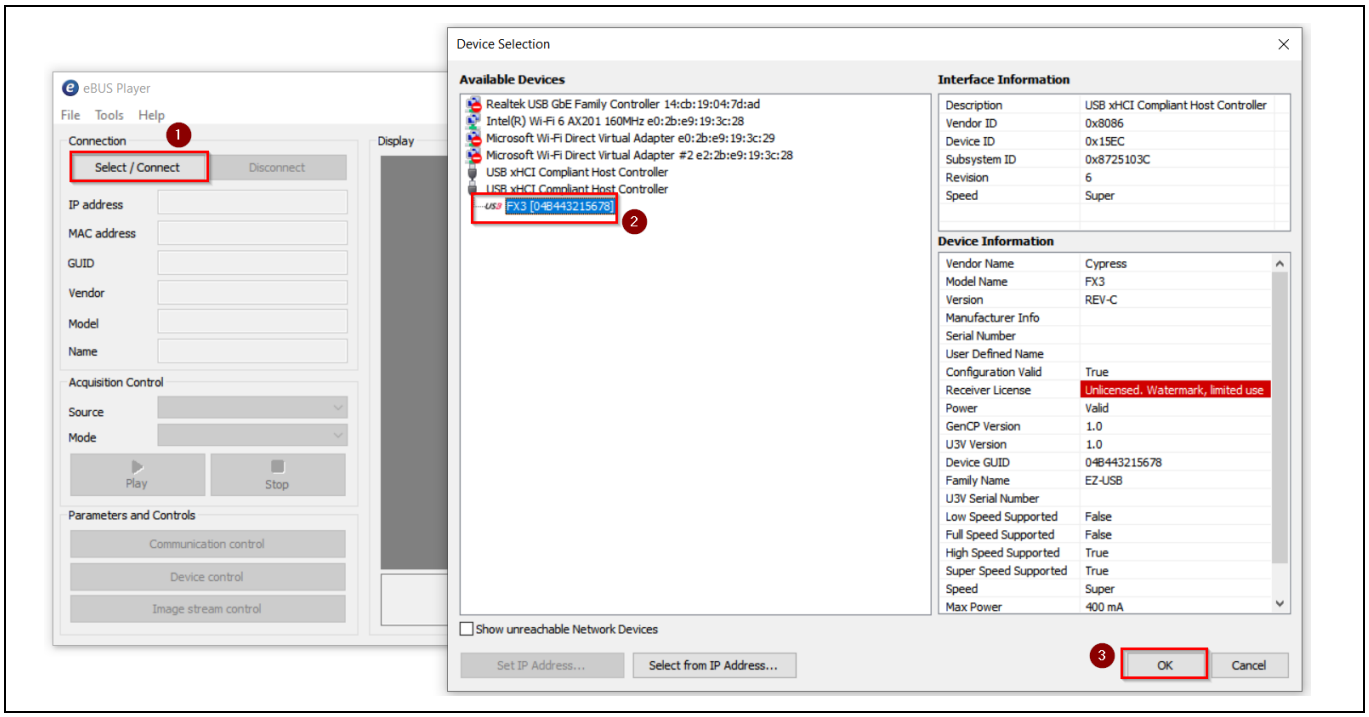


Figure 16 Selecting USB3 Vision device in eBUS Player application

8. If FX3 is not detected, go to "*C:\Program Files\Common Files\Pleora\eBUS SDK\U3V\Certified*" and install the U3V driver as shown in **Figure 17**.

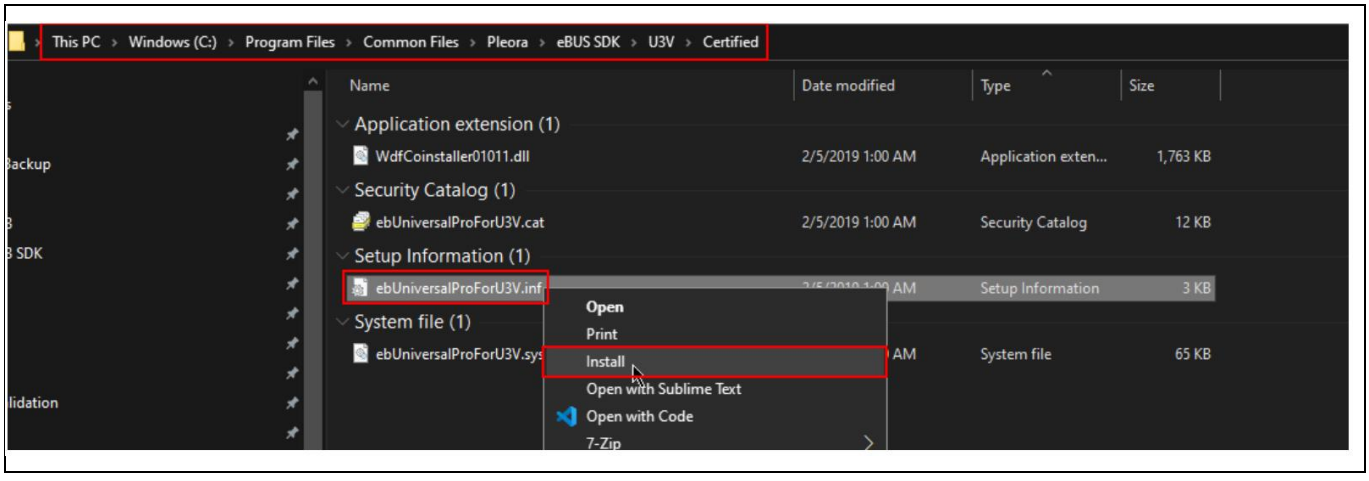


Figure 17 Installing driver for USB3 Vision player (eBUS player)

9. Click **Play** and observe the streaming video in the display pane.
10. You can check the streaming statistics in the status pane below the display pane.

Kit operation

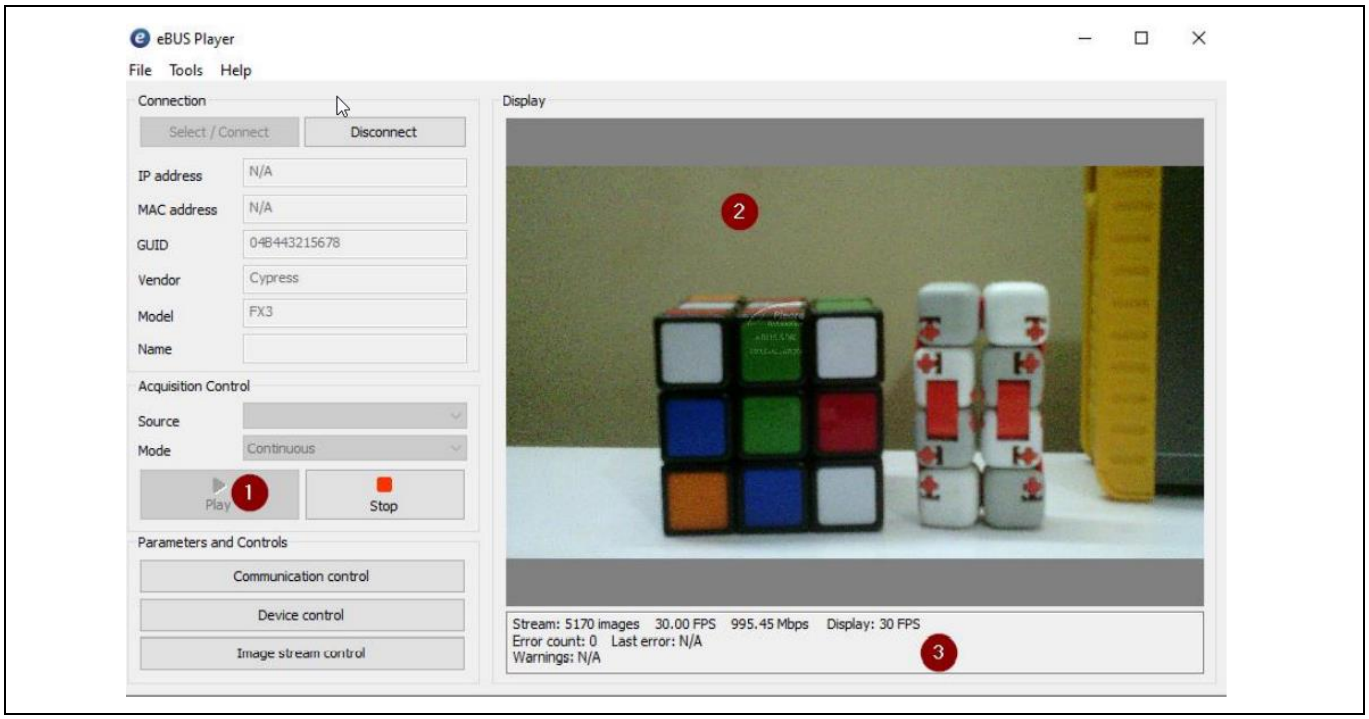


Figure 18 Check the streaming video in the display pane and its statistics in the status pane

11. Click **Device control** and verify the streaming resolution.

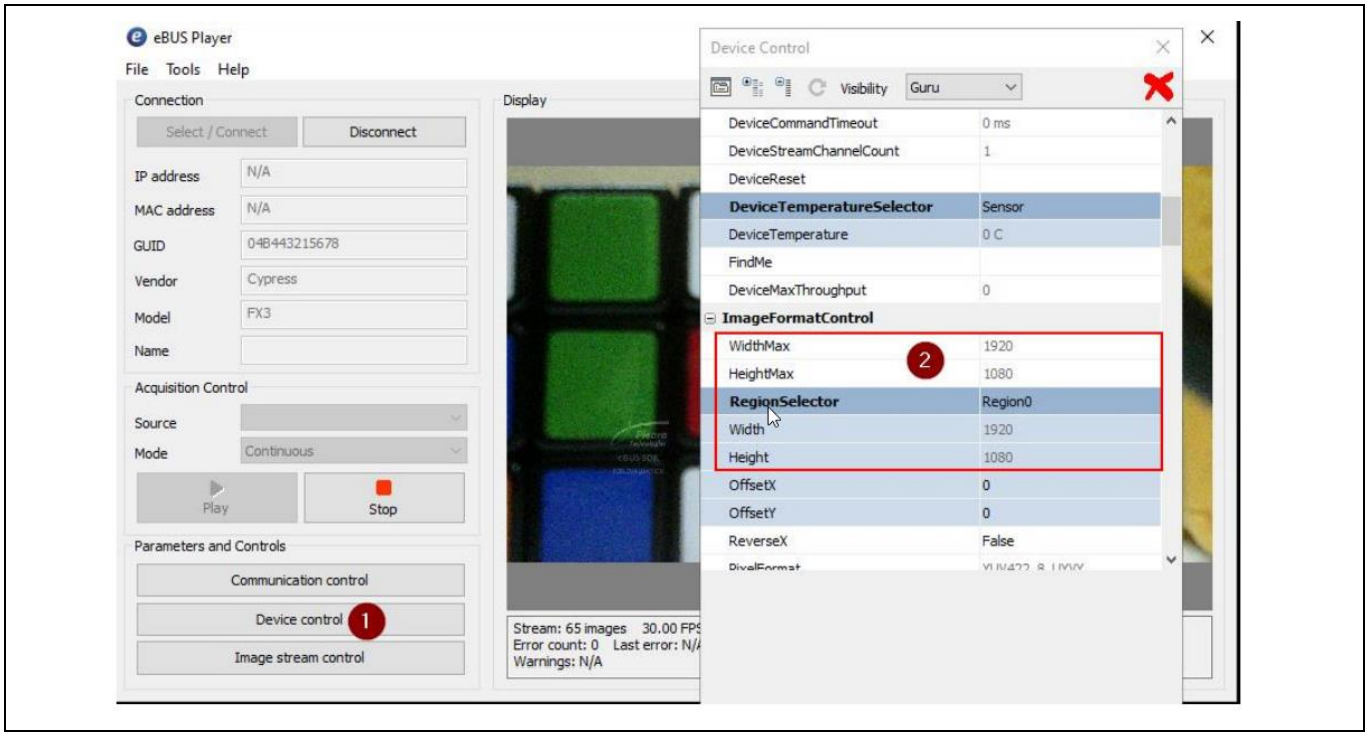


Figure 19 Device control settings

12. Close eBUS Player to turn off the streaming.
13. Disconnect the board from PC.
14. Remove the Raspberry Pi camera module and cable (CAB0306) from J3 and connect the onboard camera module (M1) by pressing the image sensor flex cable connector on J2 till a click sound is heard.

5.4 Streaming other resolutions

This kit supports the following resolutions:

Table 4 Supported resolutions by this kit

Video type	Resolution (width x height)	Frame rate (fps)
1080p	1920 x 1080	30
720p	1280 x 720	60
VGA	640 x 480	15

Streaming resolution can be changed in the **Device Control** setting under **Image Format Control**. Ensure you stop the streaming before doing this.

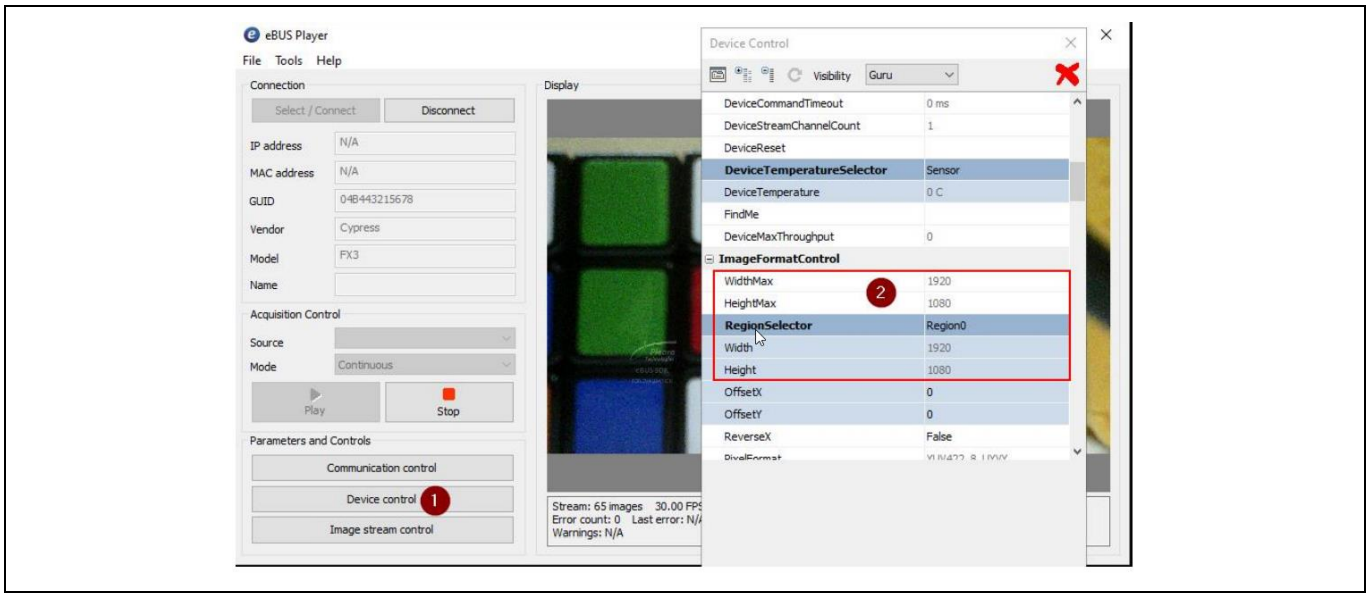


Figure 20 Device control settings

In the **Width** and **Height** fields, type the resolution needed as mentioned in **Table 4** and close the window.

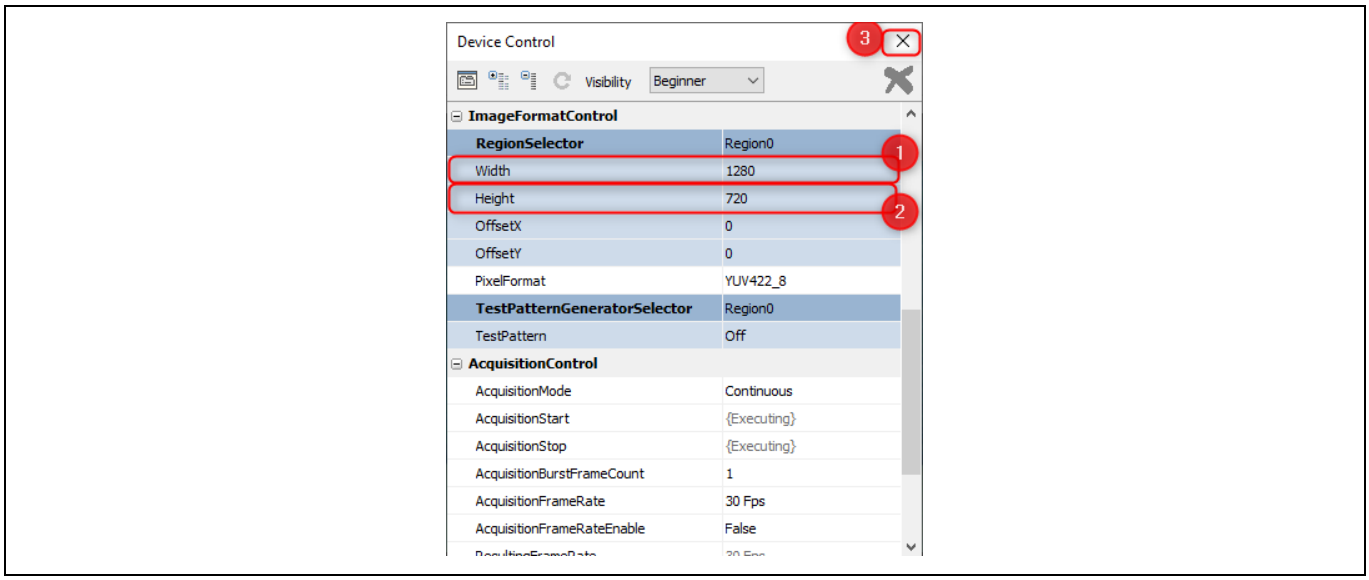


Figure 21 Display resolution changed to 720p

Kit operation

Click **Play** to stream the video.

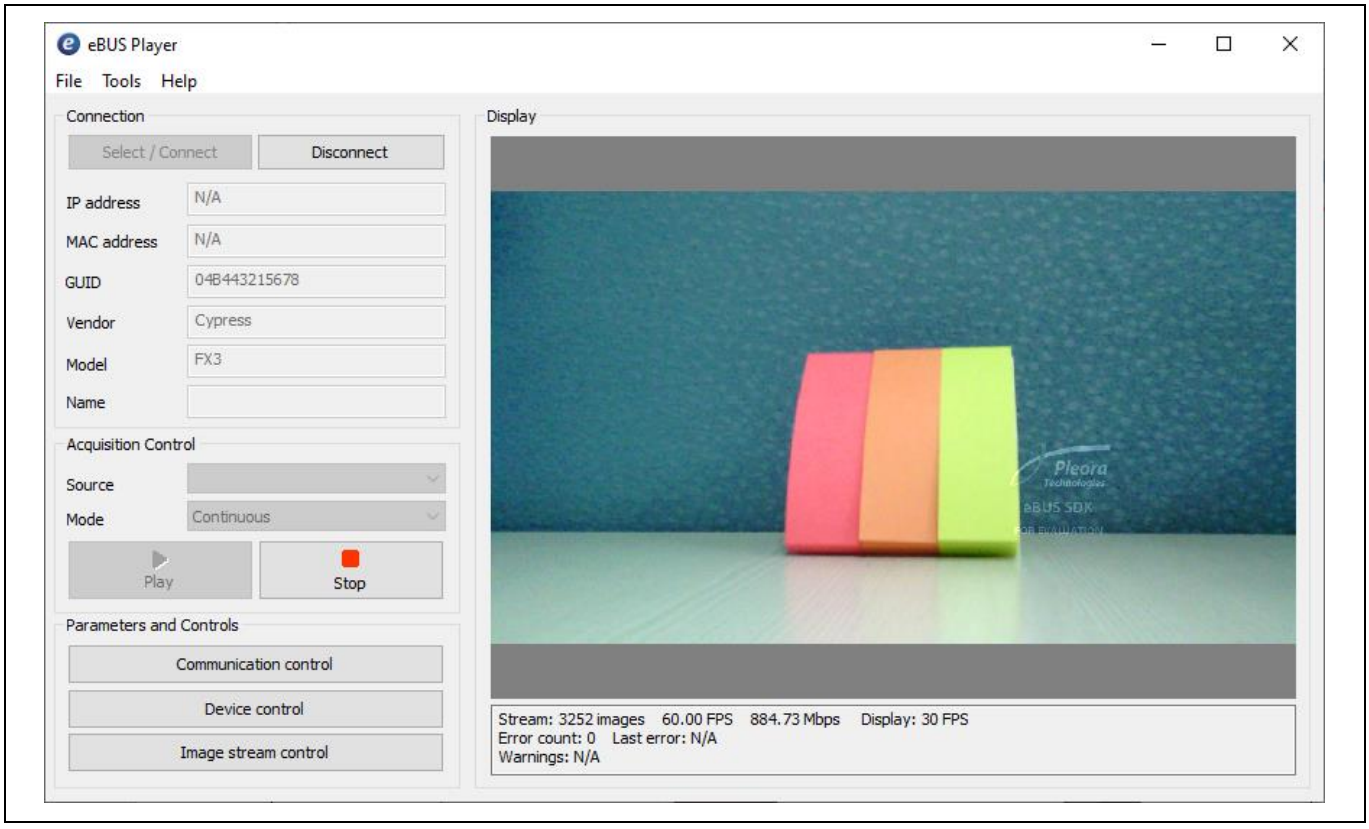


Figure 22 Video streaming at 720p

6 Troubleshooting

6.1 Programming test

6.1.1 No bootloader device detected

If “No Bootloader Device Detected” message appears during programming, verify that the PMODE switch (SW3) is in the “USB” state.

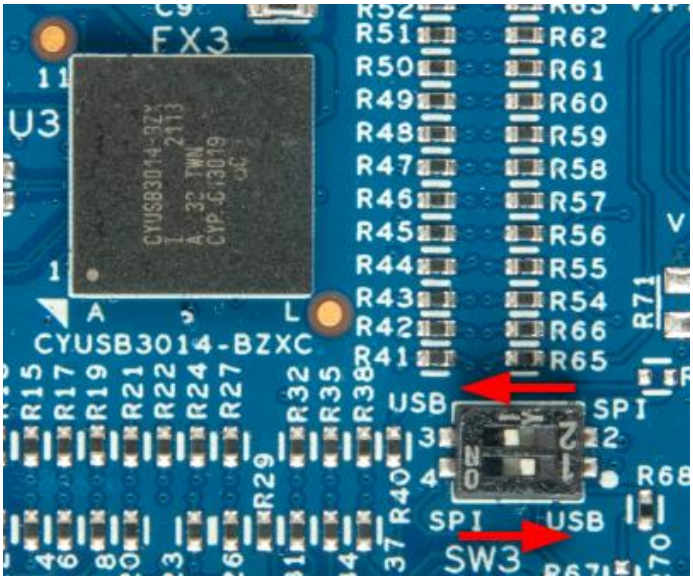


Figure 23 Mode switch setting to USB mode

6.2 Video streaming test

6.2.1 FX3 not displayed in the eBUS Player

Verify that the PMODE switch (SW3) is in the SPI position.

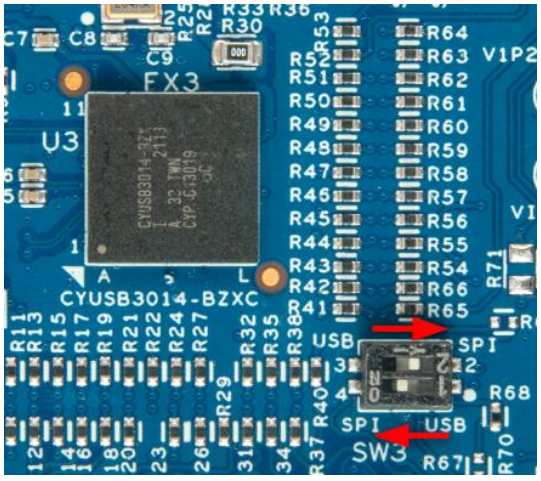


Figure 24 Mode switch setting to SPI mode

6.2.2 Black screen in the camera app

Do the following if a black screen is detected in the camera app:

1. Check whether the image sensor (M1) is connected correctly.
2. Check whether the **GPIO_4** pin (Config.done) in **Jumper J1** on the add-on board is **HIGH**. If GPIO_4 is HIGH, the Crosslink FPGA configuration is done.
3. Check the debug logs:
   a) Open Tera Term.
   b) Connect to the COM port associated with the FX3 device.
   c) Check if any error messages are displayed.

Note: *If the above-mentioned troubleshooting steps do not resolve the problem, please visit the Infineon **Technical Support** page.*

Related documents

[1] Overview: **Infineon USB controller roadmap**

[2] Product webpage: **EZ-USB™ FX3 webpage**

[3] Kit webpages: **DEMO_FX3_U3V_CAM01**

[4] Datasheets: **EZ-USB™ FX3 datasheet**

Technical support

If you have any questions, create a support request on the Infineon **Technical Support** page.

Revision history

Document version	Date of release	Description of changes
**	2022-09-07	Initial release.
*A	2022-09-14	Added Section **5.4** for streaming other resolutions.
*B	2022-12-13	Changed the kit name to DEMO_FX3_U3V_CAM01.

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