EZ-USB™ FX20 USB MIPI Camera Demo Kit guide

DEMO_FX20_MIPI_001

About this document

Scope and purpose

This document is a user guide for the DEMO_FX20_MIPI_001 EZ-USB™ FX20 USB MIPI Camera Demo Kit. This kit supports development of applications based on the EZ-USB™ FX20 USB 3.2 Gen 2x2 device controller (CYUSB402x) for streaming UVC video from an external MIPI source directly into a PC. Infineon's EZ-USB™ CYUSB402x devices are referred to as "FX20" in this document. Refer to the relevant sections based on your requirements:

- Introduction – Provides basic information on the kit
- Installing the kit software – Explains the installation of software required to program the kit
- Kit hardware – Explains the kit architecture and system design details
- Kit programming – Describes the procedure to program the kit
- Run application – Explains the procedure to operate the kit

Intended audience

This document is intended for the users of DEMO_FX20_MIPI_001 EZ-USB™ FX20 USB MIPI camera demo kit.

Important notice

“Evaluation Boards and Reference Boards” shall mean products embedded on a printed circuit board (PCB) for demonstration and/or evaluation purposes, which include, without limitation, demonstration, reference and evaluation boards, kits and design (collectively referred to as “Reference Board”).

Environmental conditions have been considered in the design of the Evaluation Boards and Reference Boards provided by Infineon Technologies. The design of the Evaluation Boards and Reference Boards has been tested by Infineon Technologies only as described in this document. The design is not qualified in terms of safety requirements, manufacturing and operation over the entire operating temperature range or lifetime.

The Evaluation Boards and Reference Boards provided by Infineon Technologies are subject to functional testing only under typical load conditions. Evaluation Boards and Reference Boards are not subject to the same procedures as regular products regarding returned material analysis (RMA), process change notification (PCN) and product discontinuation (PD).

Evaluation Boards and Reference Boards are not commercialized products, and are solely intended for evaluation and testing purposes. In particular, they shall not be used for reliability testing or production. The Evaluation Boards and Reference Boards may therefore not comply with CE or similar standards (including but not limited to the EMC Directive 2004/EC/108 and the EMC Act) and may not fulfill other requirements of the country in which they are operated by the customer. The customer shall ensure that all Evaluation Boards and Reference Boards will be handled in a way which is compliant with the relevant requirements and standards of the country in which they are operated.

The Evaluation Boards and Reference Boards as well as the information provided in this document are addressed only to qualified and skilled technical staff, for laboratory usage, and shall be used and managed according to the terms and conditions set forth in this document and in other related documentation supplied with the respective Evaluation Board or Reference Board.

It is the responsibility of the customer’s technical departments to evaluate the suitability of the Evaluation Boards and Reference Boards for the intended application, and to evaluate the completeness and correctness of the information provided in this document with respect to such application.

The customer is obliged to ensure that the use of the Evaluation Boards and Reference Boards does not cause any harm to persons or third party property.
The Evaluation Boards and Reference Boards and any information in this document is provided "as is" and Infineon Technologies disclaims any warranties, express or implied, including but not limited to warranties of non-infringement of third party rights and implied warranties of fitness for any purpose, or for merchantability.

Infineon Technologies shall not be responsible for any damages resulting from the use of the Evaluation Boards and Reference Boards and/or from any information provided in this document. The customer is obliged to defend, indemnify and hold Infineon Technologies harmless from and against any claims or damages arising out of or resulting from any use thereof.

Infineon Technologies reserves the right to modify this document and/or any information provided herein at any time without further notice.

Safety precautions

Note: *Please note the following warnings regarding the hazards associated with development systems.*

Table 1 Safety precautions

	**Caution:** *The evaluation or reference board contains parts and assemblies sensitive to electrostatic discharge (ESD). Electrostatic control precautions are required when installing, testing, servicing or repairing the assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with electrostatic control procedures, refer to the applicable ESD protection handbooks and guidelines.*

Table of contents

1 Introduction

The EZ-USB™ FX20 USB MIPI Camera Demo Kit (DEMO_FX20_MIPI_001) is based on the Infineon EZ-USB™ FX20 USB 20 Gbps peripheral controller, which is targeted at next-generation USB applications in camera, video, imaging, and data acquisition markets. EZ-USB™ FX20 consists of the following:

- Dual Arm® Cortex®-M4 and M0+ core CPUs
- 512 KB flash
- 128 KB SRAM
- 128 KB ROM
- Seven Serial Communication Blocks (SCBs)
- A cryptography accelerator
- A high-bandwidth data subsystem providing DMA data transfers between LVDS/LVCMOS and USB ports at speeds up to 20 Gbps

An additional 1 MB SRAM is included in the high-bandwidth data subsystem to provide buffering for USB data. EZ-USB™ FX20 also supports USB Type-C plug orientation detection and flip-mux function without the need for external logic. See the device datasheets to understand and compare the various features supported by EZ-USB™ FX20 controllers.

This kit is intended to be a solution demo kit for video streaming from up to four external MIPI sources directly into a PC. The DEMO_FX20_MIPI_001 kit supports the following key features:

- UVC video streaming up to
  - 8K 30 fps from a single MIPI camera
  - 4K 60fps from two MIPI cameras
  - 4K 30fps from four MIPI cameras
- USB bus-powered operation
- Onboard microphones

For the FX20 controller details, see the webpage.

1.1 Kit contents

The DEMO_FX20_MIPI_001 kit consists of the following:

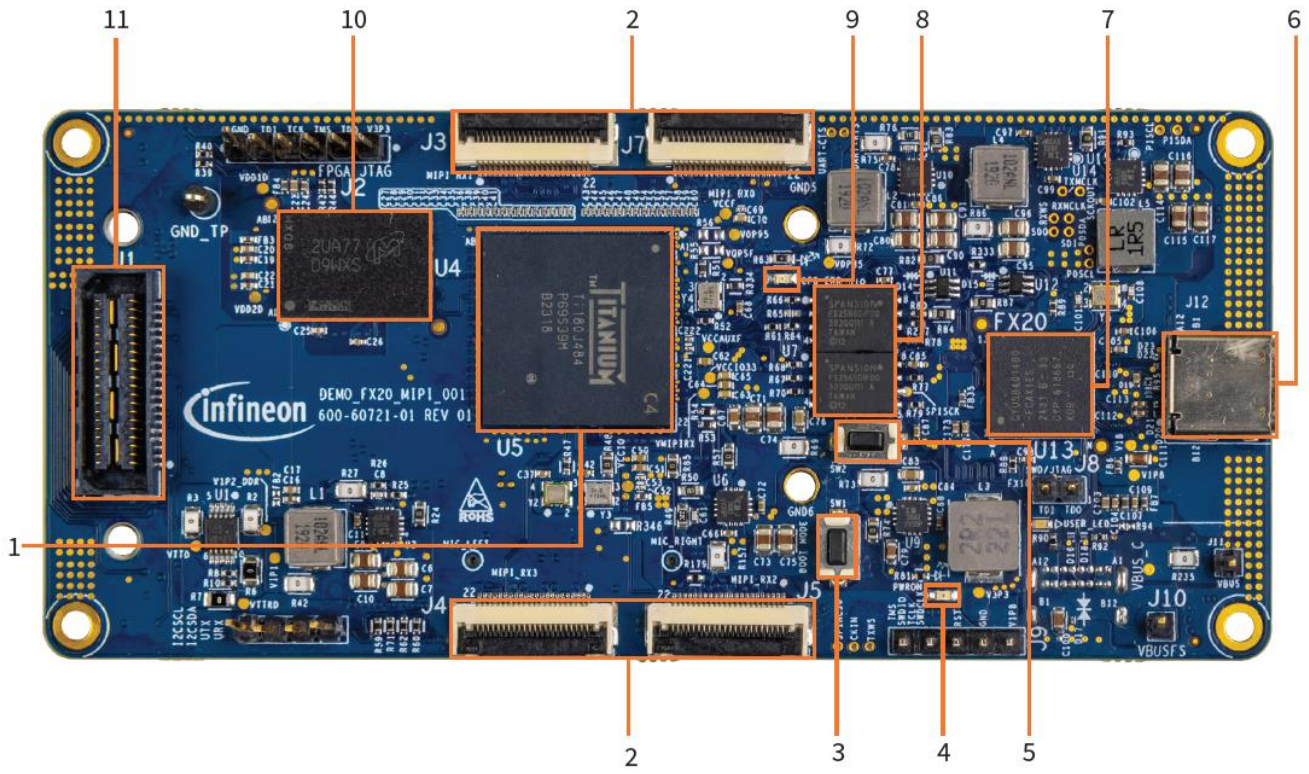
Table 2 Kit contents

Item	Type	Comments
DEMO_FX20_MIPI_001 board	Hardware	–
USB-C cable	Cable	–
Hard copy of the quick-start guide (QSG)	Documentation	–
Kit casing	Package	–
Foam	Package	To protect and maintain proper placement in the kit container

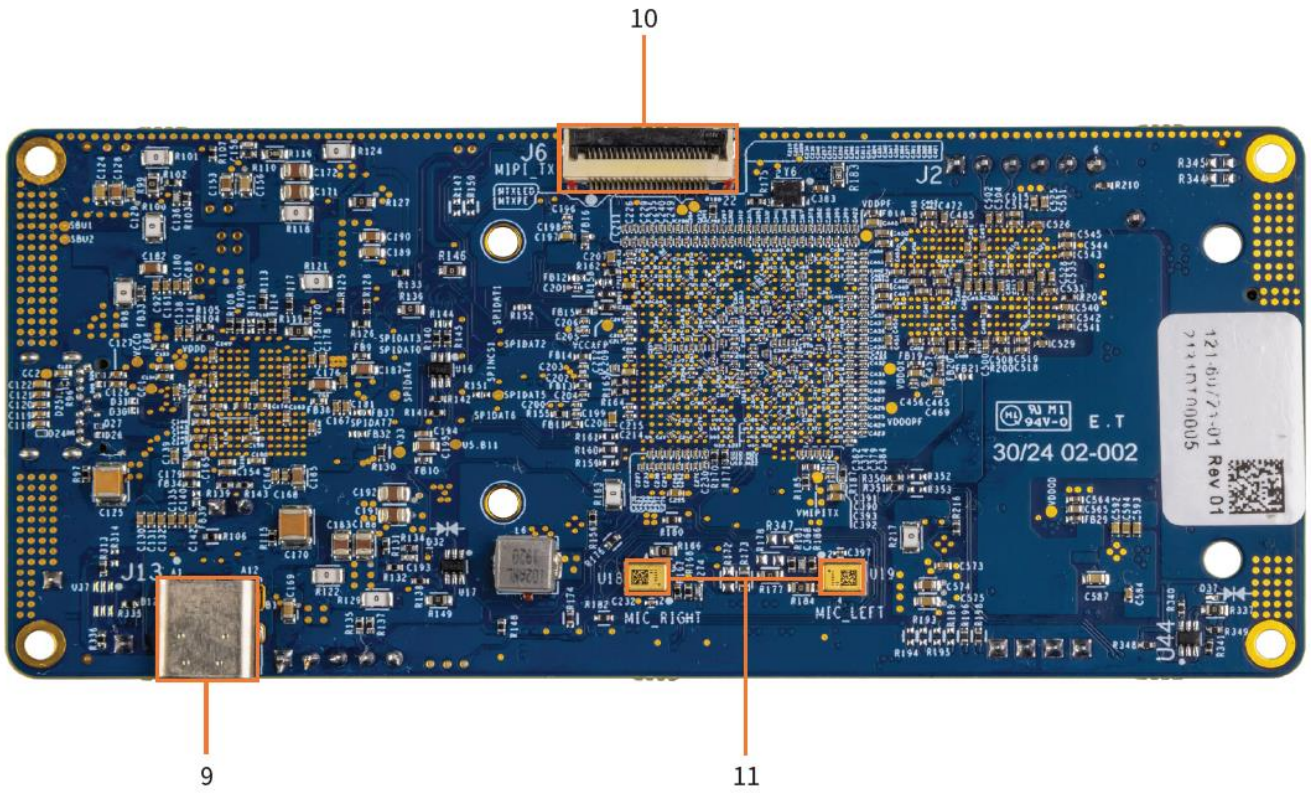
1.2 Download kit documents and hardware design files

Download the documents and the hardware design files for the DEMO_FX20_MIPI_001 kit from the kit webpage. The documents include a QSG, kit user guide (this document), and release notes. The hardware design files include schematic, bill of materials (BOM), and layout files.

1.3 Kit details



1	FPGA (U5)	7	FX20 (CYUSB4024-FCAXI - U13)
2	Camera connectors (J3, J4, J5, J7)	8	SPI Flash (U7, U8)
3	BOOT MODE switch (SW1)	9	FPGA configuration error LED (CFGERR)
4	Power-on LED (PWRON)	10	Frame buffer – LPDDR4 SDRAM (U4)
5	Reset (SW2)	11	GPIO connector (J1)
6	USB-C connector (J12)		



9 USB FS connector for Debug message log (J13)

10 MIPI TX connector (J6)

11 Microphones (U18, UJ6)

Figure 1 DEMO_FX20_MIPI_001 kit

1.4 Kit features

The kit features the FX20 USB 3.2 Gen2x2 controller and Trion T180 FPGA from Efinix Inc. that can be configured to stream UVC video from external MIPI camera sources directly into a PC.

2 Installing the kit software

2.1 Before you start

1. Download and extract the FX20 SDK from the kit webpage
2. Install the *EZ-USB_FX_Control_Center_Setup.exe* application
   The installation may require administrator privileges. However, these privileges are not required to run the software once it is installed
3. Download the firmware *.hex* and FPGA *.bin* files available in the kit webpage

3 System design

The kit is bus-powered and comes with a USB-C cable to connect to the PC.

3.1 Top-level hardware design

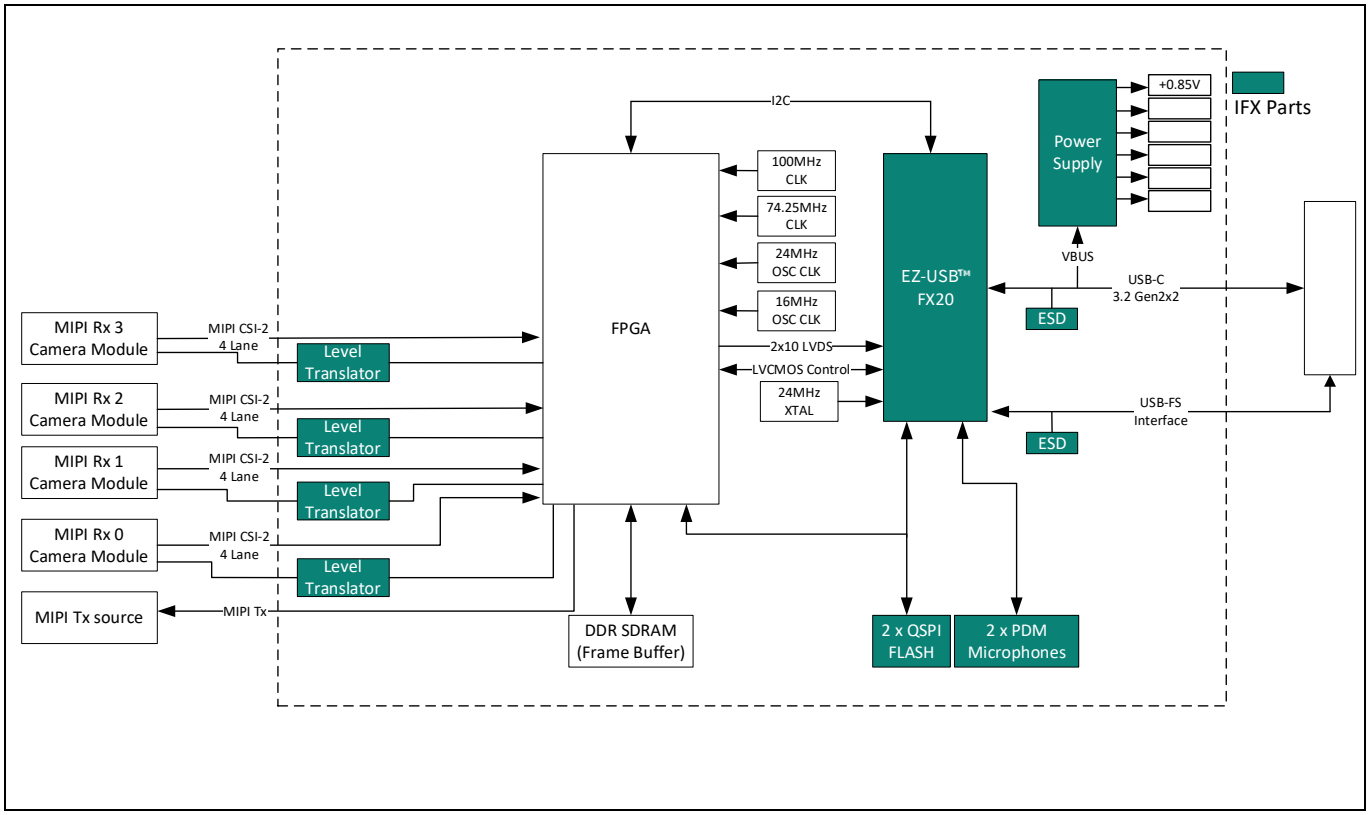


Figure 2 DEMO_FX20_MIPI_001 kit architecture

3.2 DEMO_FX20_MIPI_001 kit design details

The DEMO_FX20_MIPI_001 kit consists of the FX20 silicon (CYUSB402x), two 256 Mbit SPI flash devices, Efinix Ti180 FPGA, and two LPDDR4 SDRAM devices. The kit is bus-powered and uses a 24 MHz crystal for operation. It uses USB-C interface connectors to connect the kit to a PC. Four onboard 22-pin FPC interface connectors allow you to connect four MIPI camera modules with this kit. The kit also has a two PDM microphones that support stereo audio recording.

3.2.1 USB-C connector (J12)

An onboard USB-IF certified Type-C receptacle (J12) allows FX20 to communicate with the PC via USB 3.2 Gen2x2 protocol using a USB-C cable that is provided with the kit.

3.2.2 Boot Mode selection switch (SW1)

This switch selects the mode in which FX20 must boot upon power-on. The kit can boot in two modes based on the position of this switch.

Table 3 Boot modes

Boot mode	SW1
USB	ON - Hold the push button (SW1) and power cycle the kit either by pressing and releasing the RESET button (SW2) or removing and reconnecting the USB-C cable
SPI	OFF

To program the device, set the kit in USB mode. After programming, rebooting the device by power cycling or resetting by pressing and releasing the SW2 button allows FX20 to boot from the internal flash.

3.2.3 Power supply

The kit consists of six IR3883MTRPBF DC-DC buck switching regulators from Infineon. All these regulators provide protection against overvoltage, overcurrent, and overtemperature conditions.

The following voltages are generated from VBUS (that is, 5 V ± 0.25 V):

- U9: 3.3 V ±5% at 3 A
- U15: 1.8 V ± 5% at 3 A
- U14: 1.2 V ± 5% at 3 A
- U2: 1.1 V ± 5% at 3 A
- U6: 0.95 V ± 5% at 3 A
- U10: 0.85 V ± 5% at 3 A

3.2.4 EZ-USB™ FX20 (U13)

This is a USB 3.2 Gen 2x2 device controller with the bandwidth to support USB output at speeds up to 20 Gbps for USB 3.2 Gen 2x2 based host systems. It supports USB Video Class (UVC), USB Audio Class (UAC), USB3 Vision (U3V), and USB Vendor Class protocols. The firmware is stored in the internal flash of FX20. The DEMO_FX20_MIPI_001 kit is pre-programmed to stream color bar video generated in the FPGA directly into a PC via USB-C interface. It is a 169-ball, 10 ×10 × 1.2 mm, 13 × 13 ball array, 0.75 mm pitch FBGA.

3.2.5 QSPI flash (U7, U8)

The FPGA FW is stored in two Infineon 256-Mbit SPI flash devices. The kit executes the FW in passive mode. After power-on, FX20 fetches the firmware from the flash and sends it to the FPGA.

3.2.6 LPDDR4-SDRAM (U4)

This kit uses MT53E128M32D2DS-053 WT:A from Micron Technology Inc. for frame buffering. It is a 4 Gb, 32-bit LPDDR4 SDRAM used by the FPGA as the frame buffer to store the processed video data received from MIPI ports.

3.2.7 FPGA (U5)

The kit uses a Titanium family Ti180J484C4 FPGA from Efinix, Inc. It is a high-performance device with hard IP for LPDDR4 RAM interfaces and supports high-speed signaling. It has four MIPI Rx ports that are used to

interface MIPI camera modules using 22-pin FPC connectors. This FPGA acts as a bridge between the MIPI receiver and the FX20 device. It receives RAW12 video from the MIPI source, processes it, and sends the data to FX20 via the LVDS interface.

3.2.8 USB-C Full Speed connector (J13)

EZ-USB™ FX20 has a debug access port (DAP) that acts as the interface for device programming and debugging. An external programmer or debugger (the “host”) communicates with the DAP through JTAG interface pins through the USB-C Full Speed connector.

3.2.9 USB 3.2 Gen 2x2 connector (J13)

This kit is bus-powered and uses a USB-C connector to interface with the PC through a USB-C cable. The latter serves for both power and data transfer from the PC. The USB 3 port of the PC can source a maximum of 5 V @3 A power through VBUS. This interface has TVS diodes for protection against ESD.

3.2.10 Crystal (Y1)

FX20 requires a 24 MHz crystal to generate the clock for its operation having a tolerance of ± 10 ppm and a drive level of 100 µW.

3.2.11 LEDs

This kit has three onboard LEDs:

- **POWER ON LED:** A green LED that turns ON when the kit is powered and stable power is available
- **CFG ERR LED:** A red LED that turns ON when the FPGA configuration fails
- **USER_LED:** A blue LED connected to GPIO4 of FX20. It can also be controlled by the application

4 Kit programming

The DEMO_FX20_MIPI_001 kit is preprogrammed with the latest firmware to boot as four camera devices and stream 4K 30fps color bar video from each. Use the **EZ-USB™ FX Control Center** utility in the FX20 SDK to change the firmware.

4.1 Program FPGA

1. Open the **EZ-USB™ FX Control Center** utility
2. Connect the kit to the PC via the USB-C cable provided with the kit

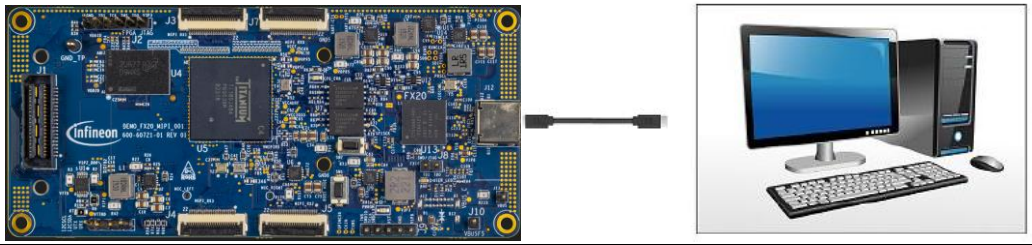


Figure 3 Connecting the kit with the PC

3. Press and hold the PMODE switch (SW1) and reset the device by pressing and releasing the RESET switch (SW2). Release the PMODE switch (SW1)
4. Wait for the **EZ-USB™ FX Control Center** utility to detect the FX20 bootloader

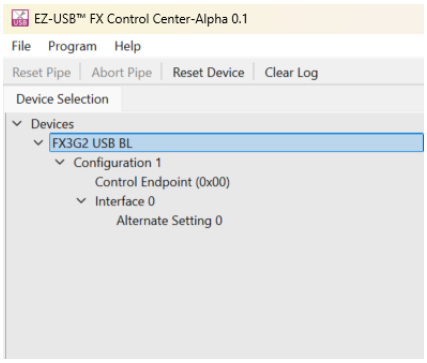


Figure 4 Device enumeration in the Control Center utility

5. Click **FX3G2 USB BL** > **Program** > **External SPI Flash**

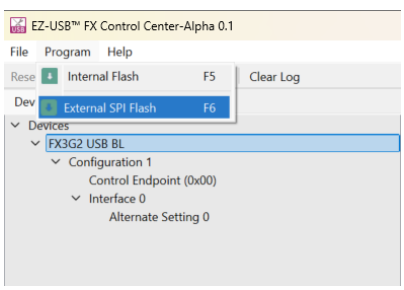


Figure 5 Programming the SPI flash

6. Go to the folder where the *.bin* file is downloaded and program the FPGA by selecting the appropriate *.bin* file. See the following table to select the *.bin* file depending on what you want to stream

Table 4 FPGA bin files

FPGA bin file	Streaming
fxn_ti180_sdk_multi_cam_ref_des_lvds_wl_148m_clbr	Color bar video from FPGA
fxn_ti180_sdk_multi_cam_ref_des_sony_sensor_cis	From Sony IMX715 camera

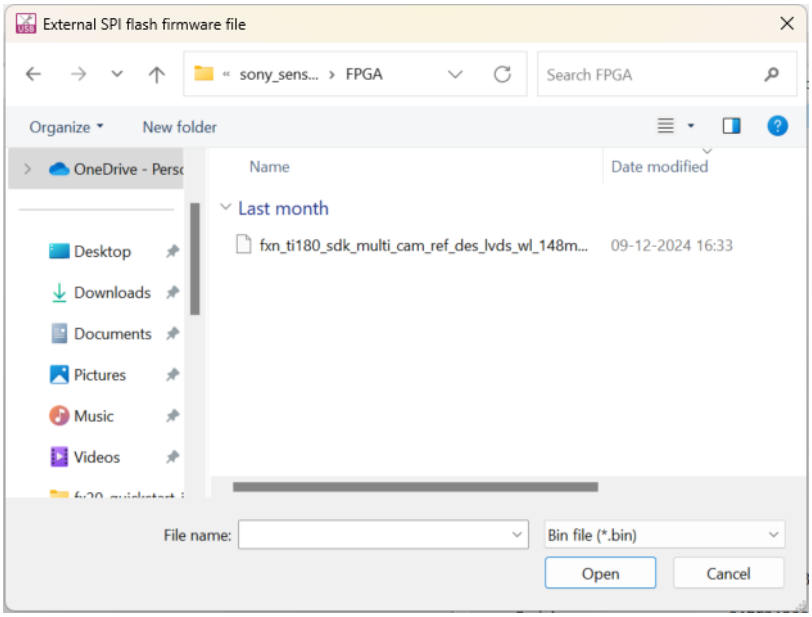


Figure 6 Programming FPGA example window

7. Wait for programing to complete. The status at the bottom left of the window shows **Firmware Download Successful**. This indicates that programming is complete

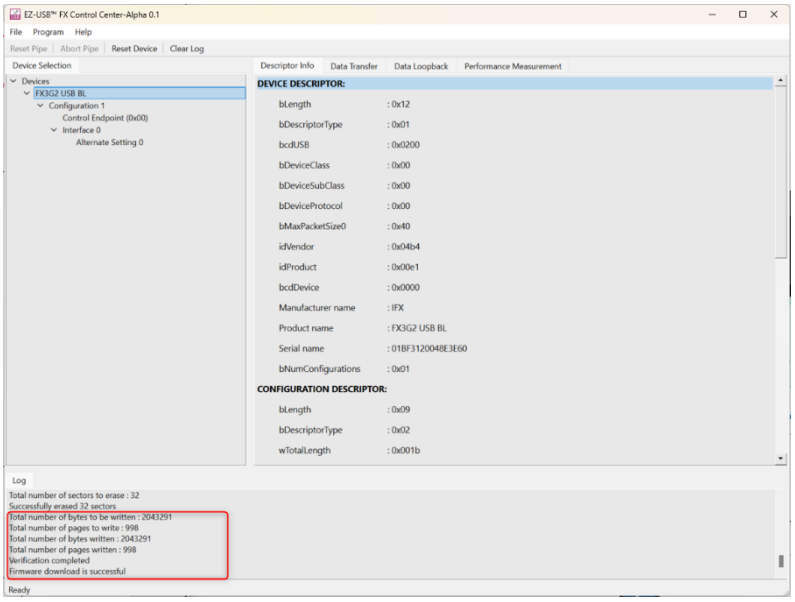


Figure 7 Programming successful log window

4.2 Program FX20

1. After FPGA programming, in the **EZ-USB™ FX Control Center** utility, click **FX3G2 USB BL** > **Program > Internal Flash**

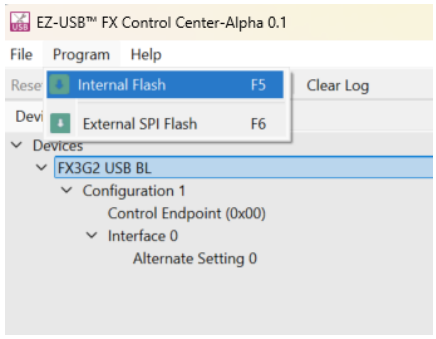


Figure 8 Programming the internal flash

2. Select the appropriate *.hex* file to program FX20 and click **Open**

Table 5 Firmware *.hex* files

FX20 *.hex* file	Streaming
fx20_uvc_fw_lvds_wl_148m_clbr	Color bar video from FPGA
fx20_sony_sensor_cis	From Sony IMX715 camera

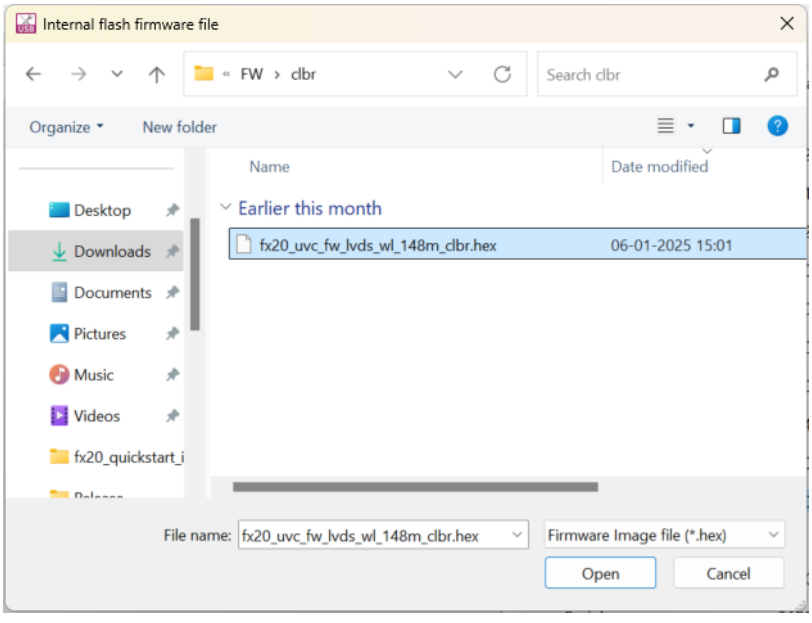


Figure 9 Programming FX20

3. Wait for programing to complete. The status at the bottom left of the window shows **Device detached**. This indicates that programming is complete

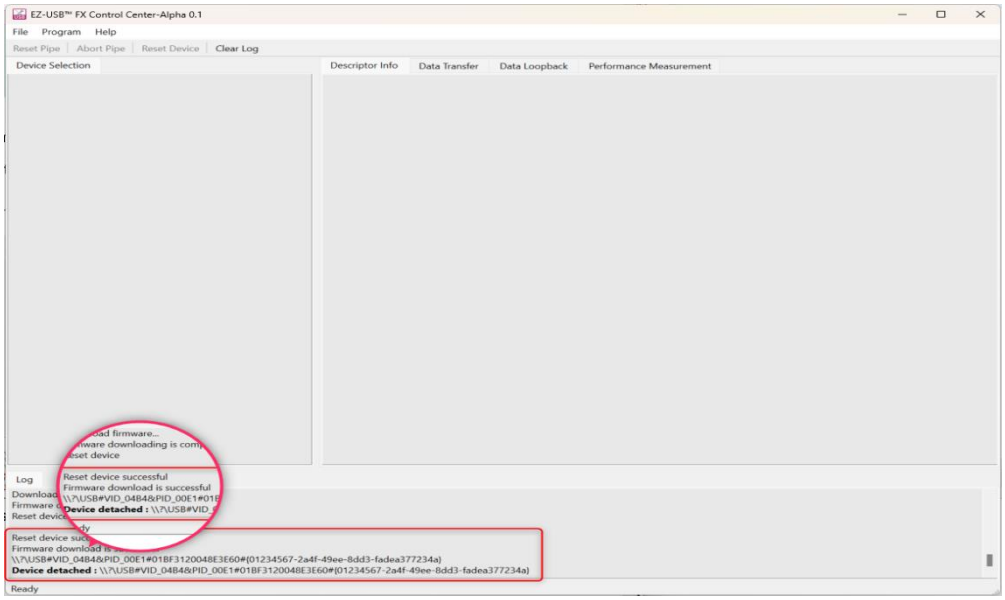


Figure 10 Programming successful log window

5 Streaming UVC video

5.1 Streaming from an external MIPI camera module (Sony IMX715)

The kit can stream 8K 30fps video from a single MIPI camera source. When four cameras are connected, the kit can stream 4K 30fps video from each camera source. The Sony IMX715 can stream video up to 4K 90 fps. Do the following to stream from four Sony IMX715 MIPI camera modules:

1. Ensure that the steps in Section 4.1 are completed and the external flash is programmed with the *fxn_ti180_sdk_multi_cam_ref_des_sony_sensor_cis.bin* file as provided in Table 3
2. Follow the steps in Section 4.2 and ensure that the FX20 internal flash is programmed with *fx20_sony_sensor_cis.hex* as provided in Table 4
3. Ensure that the addresses of Sony IMX715 camera modules are changed per Table 5 and the cameras are connected to their respective ports as shown in Figure 11

Table 6 Sony IMX715 camera address setting and connection to the kit

Camera address	Resistors populated on camera	Resistors not populated	Port connection
0x10	R19, R15	R26, R14	J7
0X36	R26, R14	R19, R15	J3
0X37	R19, R14	R26, R15	J4
0X1A	R26, R15	R19, R14	J5

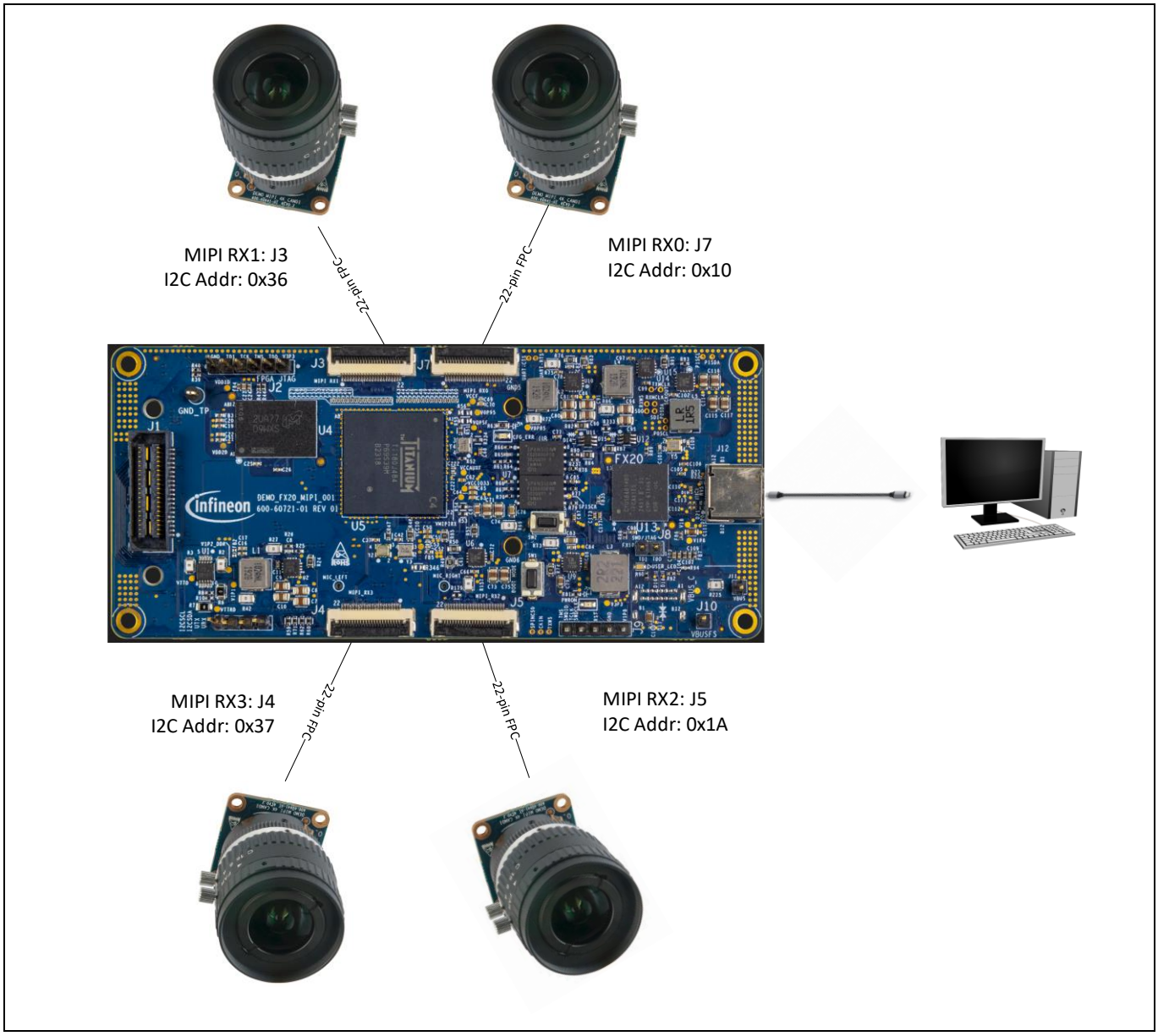


Figure 11 Connecting an external camera module to the kit

4. Open the **Windows Camera** application. Click on the flip camera icon at the top right corner of the window as shown in Figure 12

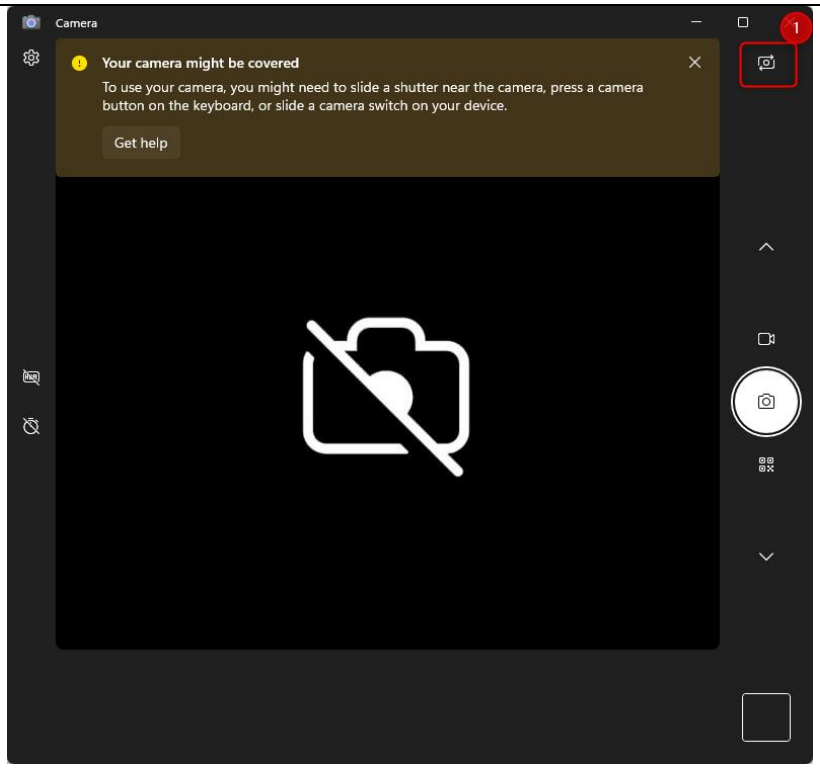


Figure 12 Windows Camera application

5. Observe that the video starts streaming from Camera 1 on the **Windows Camera** application. You can check the resolution as 3840 x 2160 in the **Settings** menu

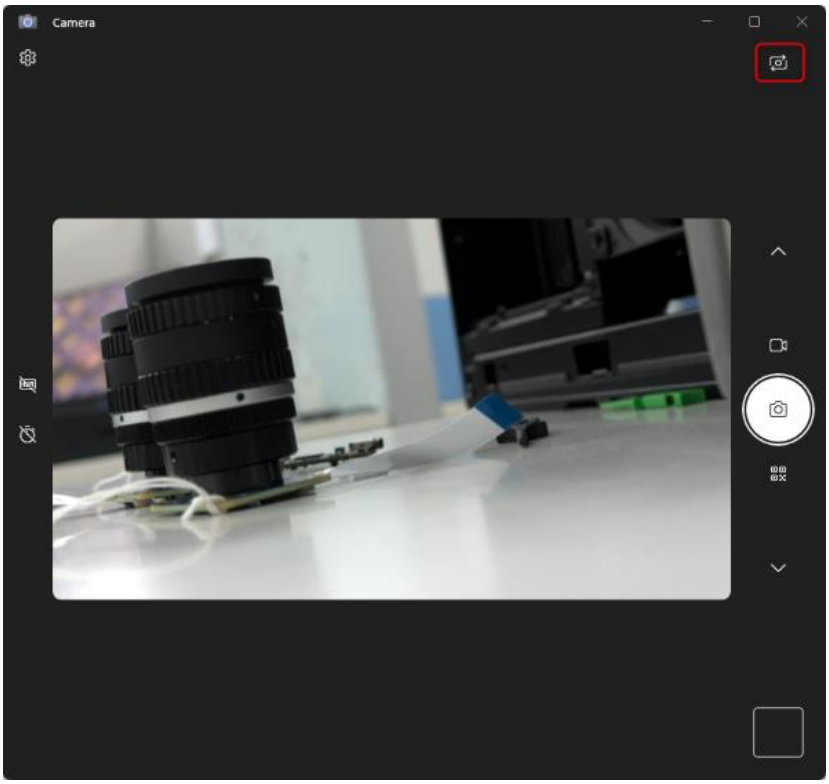


Figure 13 FX20 camera streaming in Windows Camera application

6. Click the flip camera icon at the top right corner of the window again to start streaming from the second camera
7. Flip the camera again to stream from Camera 3 and Camera 4

5.2 Streaming from color bar generated from the FPGA

The kit can stream 4K 60fps video from the color bar source from the FPGA.

1. Follow the steps in Section 4.1 to ensure that the external flash is programed with the *fxn_ti180_sdk_multi_cam_ref_des_lvds_wl_148m_clbr.bin* file as provided in Table 3
2. Follow the steps in Section 4.2 and load the *fx20_uvc_fw_lvds_wl_148m_clbr.hex* file to the internal flash as provided in Table 4
3. Open the **Windows Camera** application. Click the flip camera icon at the top right corner of the window as shown below

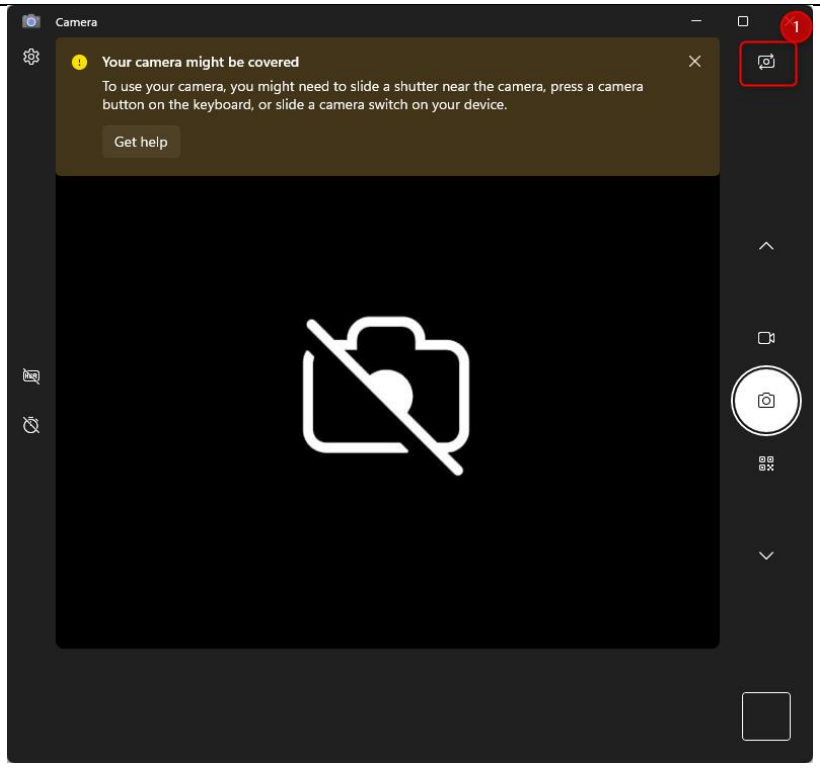


Figure 14 Windows Camera application

4. Observe that the color bar video starts streaming from Camera 1

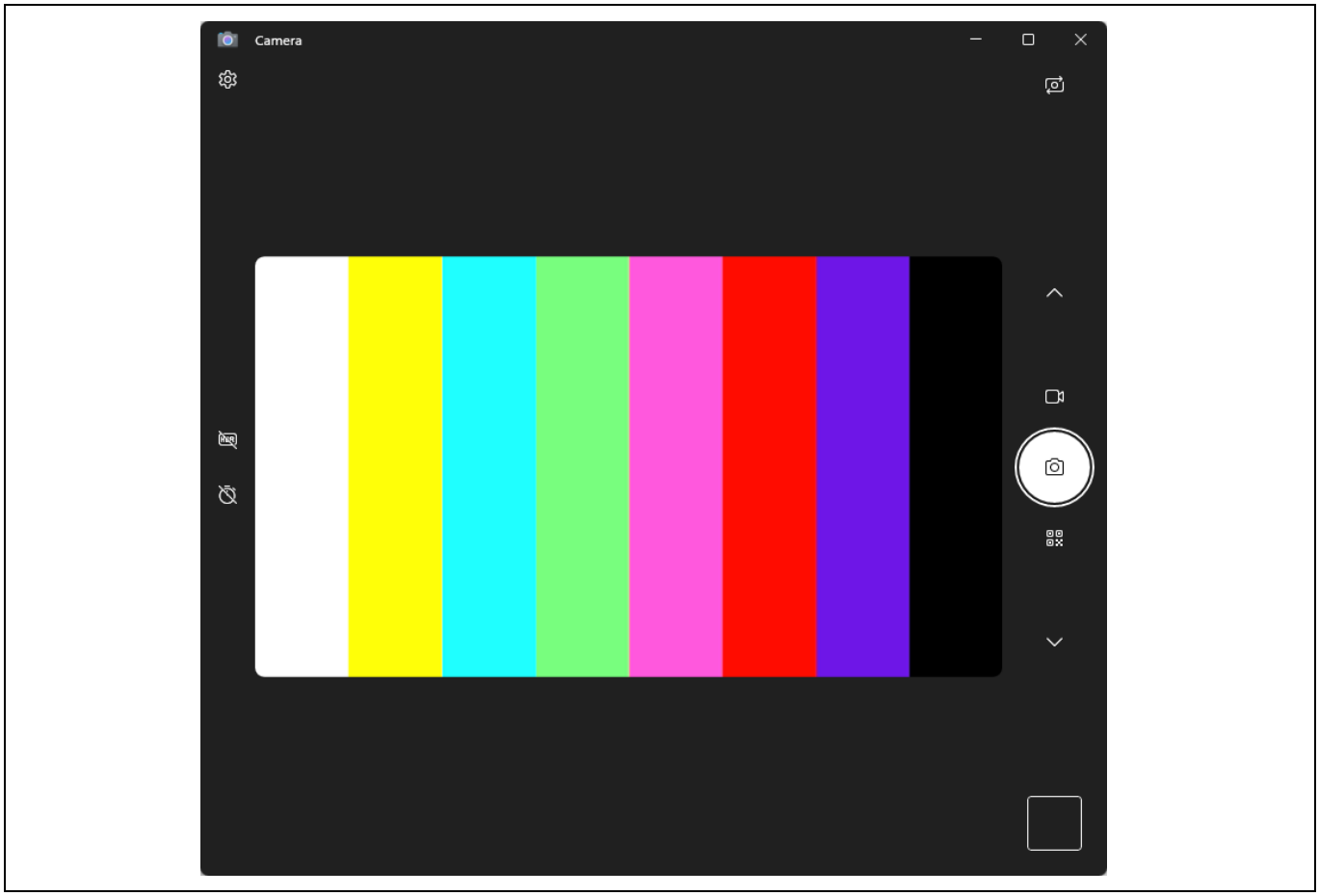


Figure 15 FX20 color bar video streaming in Windows Camera application

5. Click the flip camera icon at the top right corner of the window again to start streaming from the second camera
   Flip the camera again to stream from Camera 3 and Camera 4

References

For queries, contact Infineon support.

[1] Infineon Technologies AG: *EZ-USB™ FX20 datasheet*

[2] Infineon Technologies AG: *AN38689 Implementing a USB Video and Audio composite device using EZ-USB™ FX20*

[3] Infineon Technologies AG: *AN37841 Getting started with EZ-USB™ FX20/FX10/FX5N/FX5*

[4] Infineon Technologies AG: *EZ-USB™ FX family promo page;* Available online

Revision history

Document revision	Date	Description of changes
**	2025-02-12	Initial release
*A	2025-05-15	Publish to web

Trademarks
All referenced product or service names and trademarks are the property of their respective owners.

Edition 2025-05-15
Published by

Infineon Technologies AG
81726 Munich, Germany

© 2025 Infineon Technologies AG. All Rights Reserved.

Do you have a question about this document?
Email:
erratum@infineon.com

Document reference
002-41125 Rev. *A

Important notice
The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics (“Beschaffenheitsgarantie”).

With respect to any examples, hints or any typical values stated herein and/or any information regarding the application of the product, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation warranties of non-infringement of intellectual property rights of any third party.

In addition, any information given in this document is subject to customer’s compliance with its obligations stated in this document and any applicable legal requirements, norms and standards concerning customer’s products and any use of the product of Infineon Technologies in customer’s applications.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of customer’s technical departments to evaluate the suitability of the product for the intended application and the completeness of the product information given in this document with respect to such application.

Warnings
Due to technical requirements products may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies office.

Except as otherwise explicitly approved by Infineon Technologies in a written document signed by authorized representatives of Infineon Technologies, Infineon Technologies’ products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.