

NileCAM21\_CUXVR

# Getting Started Manual



**e-con Systems**

Your Product Development Partner

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### **Disclaimer**

The specifications of NileCAM21\_CUXVR board and instructions on how to use this board with Jetson™ Xavier™ development kit is provided as reference only and e-con Systems reserves the right to edit/modify this document without any prior intimation of whatsoever.

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# Introduction to NileCAM21\_CUXVR

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NileCAM21\_CUXVR is a family of NileCAM camera module from e-con Systems with high-speed unified serial interface that carries video data, control data and power in a single coaxial cable. It uses serializer-deserializer (SerDes) technology that allows single coaxial cable interface for the camera. With coaxial cable lengths of up to 15m, NileCAM21\_CUXVR offers greater flexibility for the system architects to place the cameras in mechanically challenging designs of new generation embedded, automotive and autonomous driving applications. The flexibility of coaxial cable and the ability to carry video data, control data and power in a single cable makes NileCAM21\_CUXVR fast (low latency), flexible and yet reliable.

NileCAM21\_CUXVR uses Maxim's Gigabit Multimedia Serial Link (GMSL) interface technology for the serial interface to the camera. This serial interface uses coaxial cable that carries high-speed video data from the camera, bidirectional control data between the camera and host controller, and power supply for the camera. The power to the camera is supplied from the host processor through this coaxial cable. NileCAM21\_CUXVR embeds the Maxim's serializer which serializes the high-speed image data and transmits over coaxial cable. The serializer also supports the bidirectional control data communication between the camera and host controller. The on-board electronics of NileCAM21\_CUXVR serializer recovers the power supplied from the host controller without contaminating the data transfers.

NileCAM21\_CUXVR board has been designed and developed by e-con Systems for the NVIDIA® Jetson™ Xavier™ development kit. NileCAM21\_CUXVR is a 2 MP GMSL camera contains a 1/2.5" AR0233AT CMOS image sensor from ON Semiconductor® along with on-board ISP. The coaxial cable is connected to Camera module enclosure through a rugged FAKRA connector. NileCAM21\_CUXVR is interfaced to the J509 connector on the Xavier™ using the NileCAM21\_CUXVR Deserializer board.

The NVIDIA® Jetson™ Xavier™ developer kit is a full-featured development platform for visual computing. It is ideal for applications requiring high computational performance in a low power envelope. The Jetson™ Xavier™ developer kit is pre-flashed with a Linux environment which includes support for many common APIs. This kit is supported by NVIDIA® complete development tool chain.

e-con Systems provides the sample applications that demonstrate the features of this camera. However, this camera can also be utilized by any V4L2 application.

This document describes how to interface NileCAM21\_CUXVR board on Jetson™ Xavier™ development kit and to check the image preview.

## Prerequisites

The prerequisites are as follows:

- A Host PC running Ubuntu 18.04 Operating System
- Necessary accessories such as keyboard, mouse, HDMI monitor and so on, are required for connecting with NVIDIA® Jetson™ Xavier™ development kit
- A Jetson™ Xavier™ development kit pre-flashed with L4T32.4.3

## Parts Supplied

The following table lists the parts supplied with the kit.

**Table 1: Parts Supplied and its Quantity**

Parts Supplied	Image	Quantity
Camera module board and Serializer board (with metal spacers)		X
Deserializer board		1
Coaxial cable (3m/15m length)		X
FIFO Lens		X
12V 2A power adapter (for the Deserializer board)		1

8GB Micro SD card		1
Bumpers		3

**Note:** Quantity X depends on the part number ordered as listed in below table.

**Table 2: Parts Numbers and its Quantity**

Part Number	X
NileCAM21_CUXVR_SOLO	1
NileCAM21_CUXVR_HEX	6

## Description

The NileCAM21\_CUXVR board is designed to interface one or six 2 MP camera modules with the Jetson™ Xavier™ development kit.

NileCAM21\_CUXVR is a multi-board solution, which has three boards as follows:

- e-CAM213\_CU0233\_MOD (Camera Module Board)
- e-CAM20\_CUXVR\_SER\_BRD (Serializer Board)
- e-CAM20\_HEXCUXVR\_DESER\_BRD (Deserializer Board)

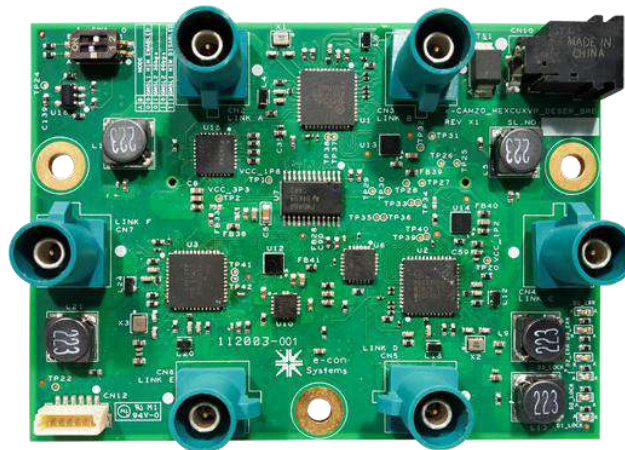
The front view of camera module board, serializer board and deserializer boards are shown in below figures.



**Figure 1: NileCAM21\_CUXVR Module Board**



**Figure 2: NileCAM21\_CUXVR Serializer Board**



**Figure 3: NileCAM21\_CUXVR Deserializer Board**

The camera board is based on AR0233AT, 1/2.5" CMOS image sensor from ON Semiconductor® along with Image Signal Processor (ISP). The camera is available with M12 lens holder allowing customers to choose the lens as per their requirements. The Serializer board is based on Maxim GMSL serializer and has all the circuitry required for bidirectional data communication, power and data separation and so on. FAKRA connectors are used for the coaxial cable interface. The Deserializer board needs external power supply, which supplies the power to the Serializer board over coaxial cable using FAKRA connector. The Deserializer board has six FAKRA connectors, through which you can connect six cameras at the same time.

NileCAM21\_CUXVR is a three-board solution. The camera module and serializer boards are each of size is 30 mm x 30 mm. The dimension of Deserializer board is 75 mm x 55 mm. NileCAM21\_CUXVR is available with both 3m and 15m coaxial cable options for power over coax applications.



# Board Handling Procedure

This section describes how to connect NileCAM21\_CUXVR to the Jetson™ Xavier™ developer kit. The steps required to set up NileCAM21\_CUXVR board with Jetson™ Xavier™ developer kit is explained below.

- Connecting Coaxial Cable between Boards
- Connecting NileCAM21\_CUXVR with Jetson™ Xavier Developer Kit
- Powering ON NileCAM21\_CUXVR Camera Modules
- Powering ON NileCAM21\_CUXVR with Xavier Platform

## Connecting Coaxial Cable between Boards

The procedure to assemble camera board is as follows:

1. Deserializer board has an SW1 switch for selecting GMSL mode. Select GMSL2 6Gbps mode by selecting 10 for A & B position. The location of SW1 is shown below,

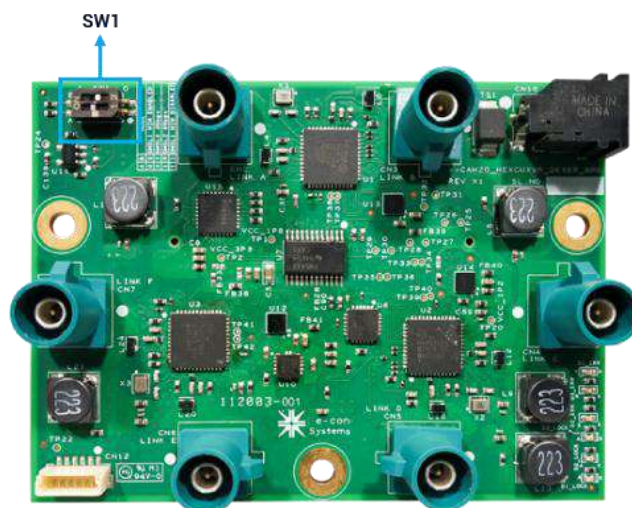


Figure 4: Position of SW1 Switch

The below table describes the different modes in the switch.

A	B	Mode
0	0	GMSL 1 HIM Enabled
0	1	GMSL 2 3Gbps
1	0	GMSL 2 6Gbps (default)
1	1	GMSL 1 HIM Disabled

Table 3: Modes in Switch

2. Identify the FAKRA connector on board.

Both the serializer and deserializer boards are provided with high frequency FAKRA straight plug in water-blue color. The FAKRA connectors are neutrally



coded, enabling FAKRA jacks of variable coding to be used in coaxial cable, if required.

The following figure shows the FAKRA plug on serializer and deserializer boards.

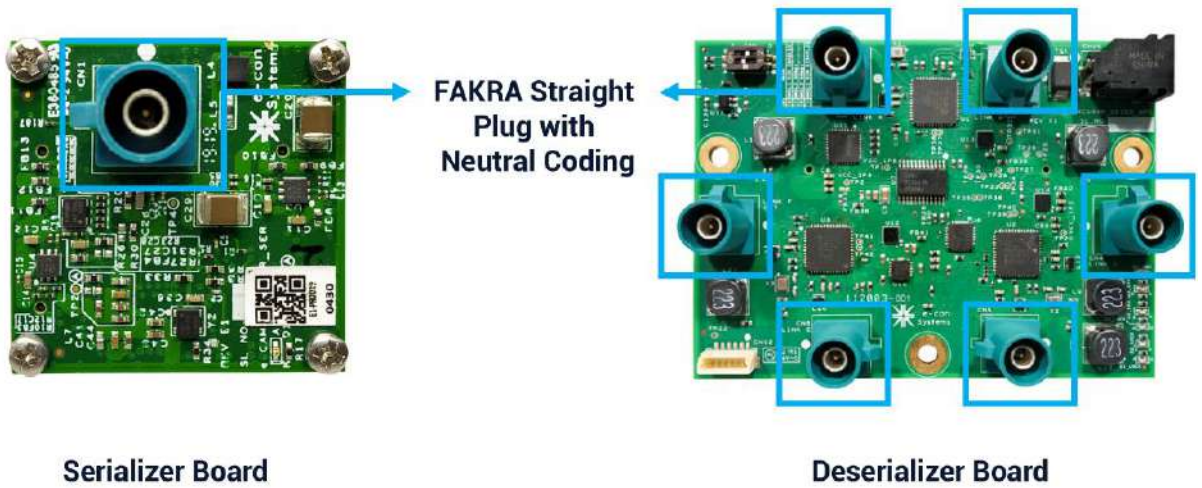


Figure 5: FAKRA Plug on Serializer and Deserializer Boards

3. Stick the provided bumper to mounting holes location before inserting coaxial cable to deserializer board, for avoiding board slanting issues, when mated with Xavier development kits.

The following figure shows the bumper location.

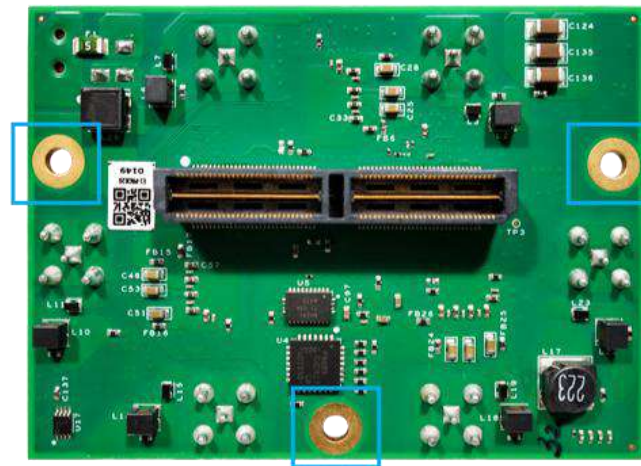


Figure 6: Bumper Placing Locations in Deserializer Board

**Note:** Customer can use his own spacers or standoffs with 8mm height for more board stability.

4. Insert the coaxial cable to FAKRA connector.

The coaxial cable is provided along with the kit. The cable has a neutrally coded FAKRA straight jack in water-blue color on either end, to be inserted into the FAKRA plug on the serializer/deserializer boards.

Insert the FAKRA jack of the coaxial cable over the plug, such that the pink marking on the jack slides over the mechanical key of the plug. Push the cable such that it locks properly with jack on board.

The following figure shows the cable inserted to the FAKRA plug.

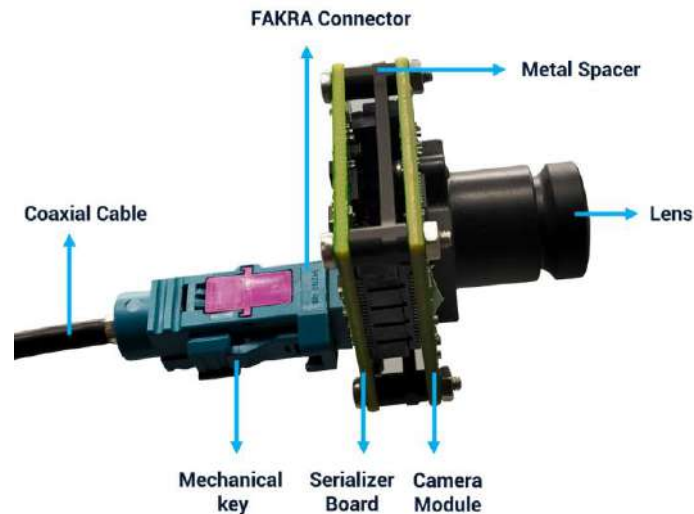


Figure 7: Inserting Coaxial Cable to FAKRA Plug

**Note:**

- Any end of the cable can be inserted in any order to the plugs of serializer and deserializer boards.
- For more details in removing coaxial cable from FAKRA plug, refer to *FAQ* section.

The following figure shows the coaxial cable connected to serializer and deserializer boards.

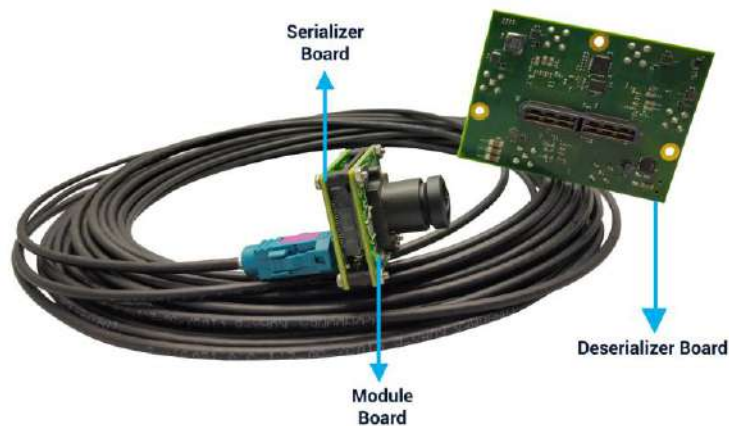


Figure 8: Individual Board of NileCAM21\_CUXVR

## Connecting NileCAM21\_CUXVR with Jetson Xavier Developer Kit

The NileCAM21\_CUXVR board must be mounted to J509 camera interface connector of Xavier™ development kit as follows:

1. Insert the CN9.1 pin of NileCAM21\_CUXVR with J509.1 pin of Xavier™ development kit.

The NileCAM21\_CUXVR base board location in Jetson AGX Xavier™ development kit is shown in following figure.

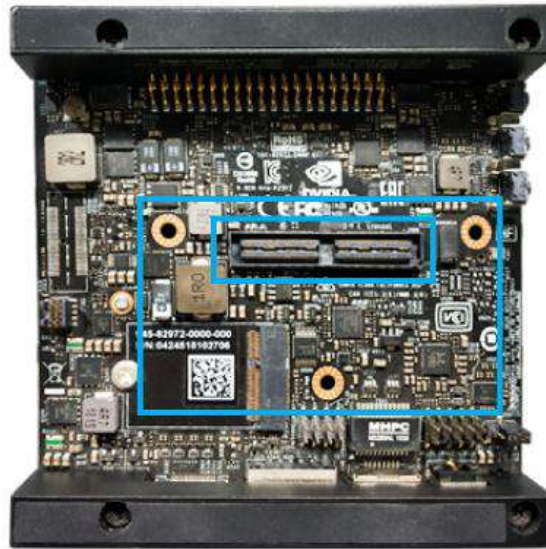


Figure 9: NileCAM21\_CUXVR Base Board Location in Jetson AGX Xavier Development Kit

2. Insert the pin 1 of CN9 connector of adapter board with pin 1 of 509 connector of Jetson™ kit.

The location of pin 1 of CN9 connector and pin 1 of 509 connectors is shown in following figure.

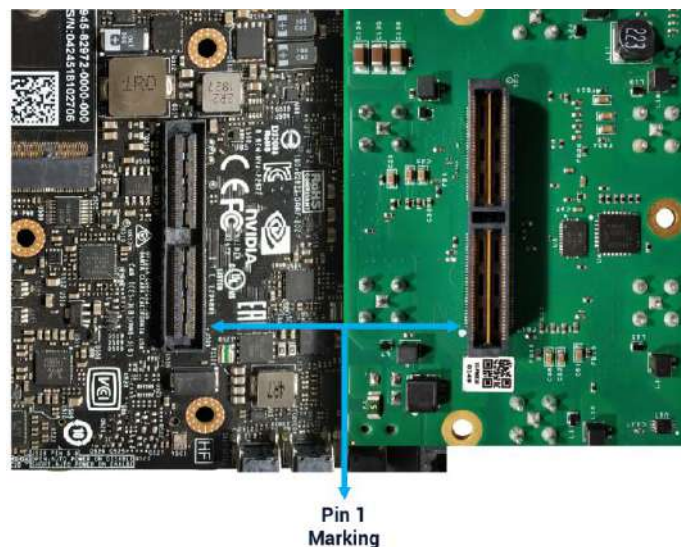


Figure 10: Location of Pins on Deserializer Board and Jetson Xavier Development Kit

NileCAM21\_CUXVR is connected with Jetson AGX Xavier™ developer kit as shown in following figure.



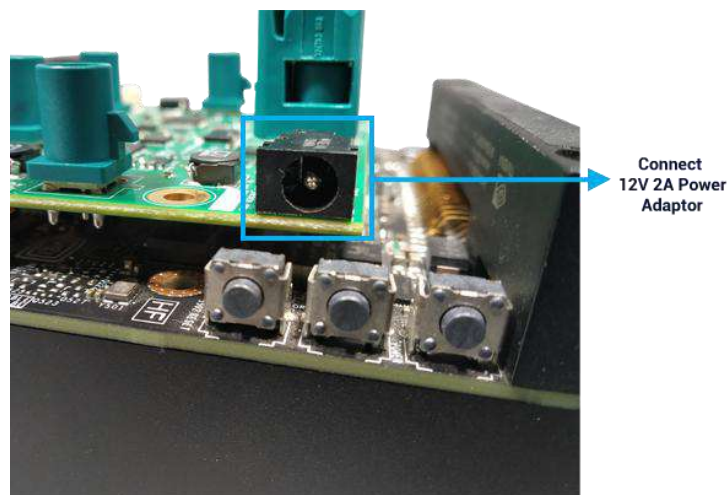
**Figure 11: NileCAM21\_CUXVR connected with Jetson AGX Xavier Development Kit**

**Note:** the actual coaxial cable may differ from cable shown in the image.

## Powering ON NileCAM21\_CUXVR Camera Module

With NileCAM21\_CUXVR connected to Jetson™ Xavier™ development kit, connect the e-con provided 12V 2A power supply to DC jack of NileCAM21\_CUXVR deserializer board for powering camera modules.

The location of DC jack on NileCAM21\_CUXVR deserializer board is shown in following figure.



**Figure 12: DC Jack Connector location in NileCAM21\_CUXVR Deserializer Board**



The power supply connected to DC jack of NileCAM21\_CUXVR deserializer board is shown in following figure.

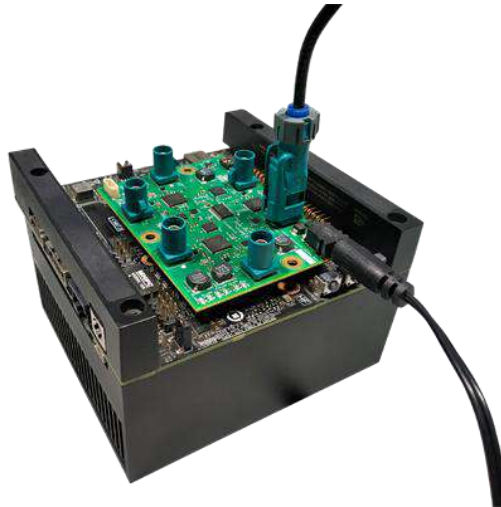


Figure 13: 12V Power Adapter connected to DC Jack of NileCAM21\_CUXVR Deserializer Board

## Powering ON NileCAM21\_CUXVR with Xavier Platform

With NileCAM21\_CUXVR connected to Jetson AGX Xavier™ development kit, the steps to power up and configure the Xavier™ setup are as follows:

1. Connect 19V, 3.42A supply to DC jack to power ON the Jetson™ Xavier development kit.
2. Press the power switch of Jetson™ development kit to boot the device.

The location of power switch on the Jetson AGX Xavier™ development kit is shown in following figure.

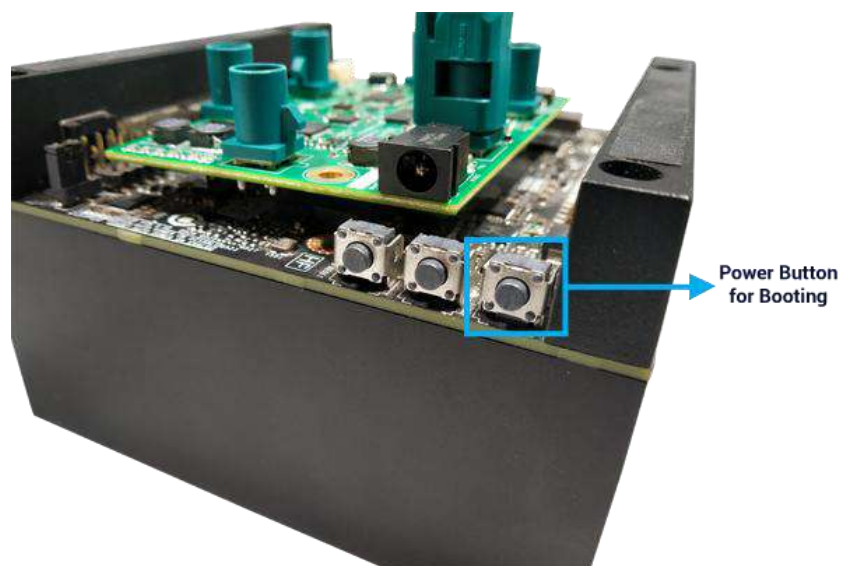
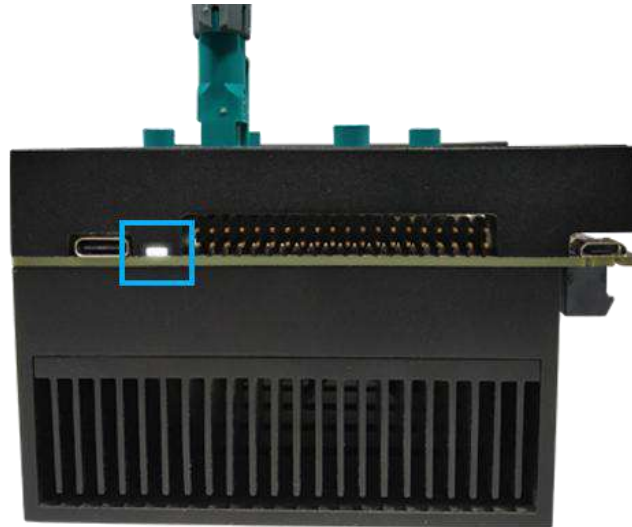


Figure 14: Location of Power Switch on Jetson AGX Xavier Development Kit

After powering ON the Jetson AGX Xavier™ development kit, the white color LED on Jetson AGX Xavier™ development kit will glow. This serves as an indication for power-up of base board as shown in following figure.



**Figure 15: Power ON Indication White LED glowing on Jetson AGX Xavier Development Kit**

# Software Quick Setup

This section describes the extracting and flashing of e-con Systems provided binaries.

The commands and output messages in this manual are represented by different colors as listed in following table.

**Table 3: Notation of Colors**

Color	Notation
Blue	Commands running in Development PC
Red	Commands running in Jetson Board
Orange	Output messages in the Jetson Board

Before extracting and flashing the e-con provided binaries in Jetson™ Xavier™ development kit, flash the Jetpack 4.4.0(L4T32.4.3) provided by NVIDIA®, using the SDK manager.

The steps to flash the Jetpack are as follows:

1. Download the SDK manager using this <https://developer.nvidia.com/nvidia-sdk-manager> link.
2. Sign up to an account in NVIDIA® developer site to use the SDK manager.
3. Run the following command to install the SDK Manager in the host PC.

```
sudo apt-get install ./sdkmanager-  
[version].[build#].deb
```

After installing the SDK manager in the host PC, follow the instructions in the link <https://docs.nvidia.com/sdk-manager/install-with-sdcm-jetson/index.html>.

4. Copy the release package into the HOME directory of the flashed Jetson™ Xavier™ development kit.

To extract and flash the binaries, follow these steps:

1. Run the following commands to extract the release package in the Jetson™ development kit to obtain the binaries.

```
tar -xzf  
NileCAM21_CUXVR_JETSON_<L4T>_<RELEASE_DATE>_<VERSION>.  
tar.gz  
cd  
NileCAM21_CUXVR_JETSON_<L4T>_<RELEASE_DATE>_<VERSION>
```

The package contains the necessary tools to immediately flash the binaries in Jetson™ Xavier™ with the kernel, camera drivers, and application.

2. Run the following commands in the Jetson™ kit to install the binaries.



```
sudo chmod +x ./install_binaries_<version>.sh  
sudo ./install_binaries_<version>.sh
```

The Jetson™ reboots automatically after the installation of binaries.

The steps to be followed in the development board for launching the application are as follows:

1. Run the following command to check whether all the cameras are initialized properly.

```
dmesg | grep -i 'Detected ar0233 sensor'
```

The output message appears as shown below.

```
Detected AR0233 sensor
```

The number of times the above message displayed corresponds to the number of cameras connected to the Jetson™ development kit.

2. Run the following command to check the presence of video nodes.

```
ls /dev/video*
```

The output message appears as shown below.

```
/dev/video*
```

Where (\*) denotes the number of cameras connected to the Jetson™ development kit.

3. Run the following command to set the power mode to maximum for better performance.

```
sudo nvpmodel -m 0
```

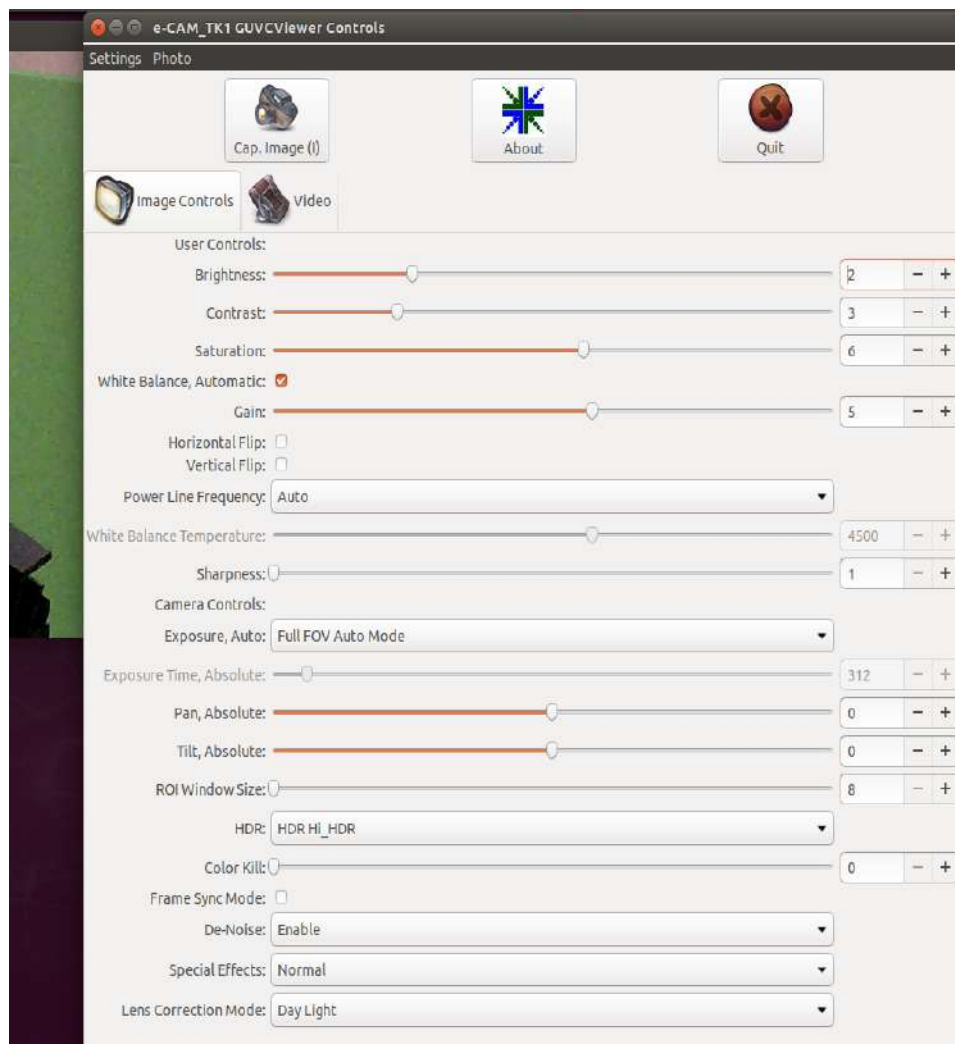
4. Run the following Jetson clocks command before launching the ecam\_tk1\_guvcview application in Jetson™ development kit.

```
sudo jetson_clocks
```

5. Run the following command to launch the application.

```
ecam_tk1_guvcview
```

When the application is launched, you can view the screen similar to the screen shown below.



**Figure 16: Initial Window Appearance when Application is launched**

# Reference Documents

This section describes the software and hardware documents of NileCAM21\_CUXVR. You can download the software and hardware documents from [Developer Resources](#) website.

## Software Documents

The software documents and its description are listed in following table.

**Table 4: Description of Software Documents**

S.NO	What I need	Documents to Refer
1	View the single camera stream and change the camera controls using GUI.	NileCAM21_CUXVR_Linux_App_User_Manual_<REV>.pdf
2	Build and install the GUI based ecam_tk1_guvview camera application.	e-CAM_TK1-GUVView_Build_and_Install_Guide_<REV>.pdf
3	Use gstreamer to control the NileCAM21_CUXVR camera on the Jetson™ development kit.	NileCAM21_CUXVR_Gstreamer_Usage_Guide_<REV>.pdf
4	Build custom kernel with support for using NileCAM21_CUXVR.	NileCAM21_CUXVR_Developer_Guide_<REV>.pdf
5	Stream and view all the cameras of NileCAM21_CUXVR in Synchronous mode.	NileCAM21_CUXVR_e-multicam_App_User_Manual_<REV>.pdf
6	Information about the directory structure and contents of the release package for NileCAM21_CUXVR.	NileCAM21_CUXVR-Release_Package_Manifest_<REV>.pdf
7	Integrate e-con's NileCAM21_CUXVR with any host system other than what is supported by e-con Systems directly.	e-CAM213_CU0233_MCU_Protocol_AppNote_<REV>.pdf

## Hardware Documents

The hardware documents and its description are listed in following table.

**Table 5: Description of Hardware Documents**

S.NO	Documents Name	Description
1	NileCAM21_CUXVR_Datasheet_<REV>.pdf	Describes the features, connector pin-out details and mechanical dimensions of NileCAM21_CUXVR.
2	NileCAM21_Datasheet_<REV>.pdf	Describes the features, connector pin-out details and mechanical dimensions of NileCAM21.
3	NileCAM21_CUXVR_Lens_Datasheet_<REV>.pdf	Describes the optical specification of lenses used in NileCAM21_CUXVR.
4	NileCAM21_PCB_3D.stp	3D drawing of camera module and serializer board.
5	E-CAM20_HEXCUXVR_DESER_BRD_RE VX_3D.stp	3D drawing of Deserializer board.

# Troubleshooting

In this section, you can view the list of commonly occurring issues and their troubleshooting steps.

***The systems are running in low-graphics mode error log appears on screen. How to solve this issue?***

This error may occur in Jetson™ Xavier™ when complete package is flashed. To solve this issue, reset the board.

**Why the camera is not detected, even if the device is connected and powered ON?**

This may occur on the deserializer board when it is not powered ON. Make sure that the deserializer board is powered ON, before the Jetson™ development kit.

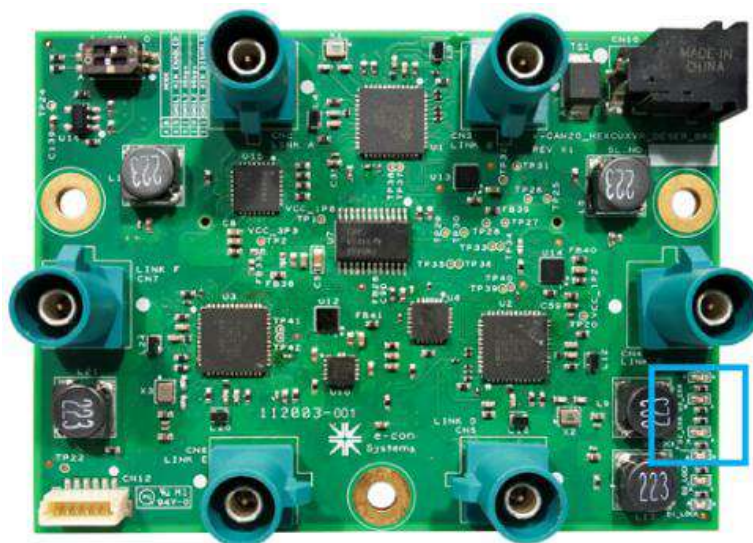
**Why power ON indication LED of serializer is OFF, even if the device is connected?**

When the power indicator LED of Serializer (D2) is OFF (with status LED of base board is ON), it means that power is not applied from base board. Check if the coaxial cable is inserted properly on either end.

**Why error LED of deserializer is ON, if device is connected?**

Apart from Lock LED, the deserializer board has a Red error LED (D1). The LED glows, when the error in the GMSL data exceeds the set threshold. The glowing of Red LED does not affect the camera streaming.

The following figure shows the Error LED (Blue) on Deserializer board.



# FAQ

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**1. Does NileCAM21\_CUXVR camera work with any coaxial GMSL cable available in the market?**

Currently, e-con Systems provide a very flexible and robust 3m/15m coaxial GMSL cable along with this kit. For more lengths and customizations, please write to [camerasolutions@e-consystems.com](mailto:camerasolutions@e-consystems.com) with your requirement.

**2. Can I boot the Jetson™ Xavier™ development kit directly from the SD card shipped with the product?**

The SD card shipped with the product is not bootable SD Card. And the release package will be available in .tar.gz format.

**3. Does NileCAM21\_CUXVR camera support OpenCV?**

NileCAM21\_CUXVR works using V4L2 APIs and is V4L2 compliant. So, any V4L2 based application can be used to access this camera. OpenCV is also compatible since it uses V4L2 to access the camera.

Please refer to [https://www.e-consystems.com/Articles/Camera/accessing\\_cameras\\_in\\_opencv\\_with\\_high\\_performance.asp](https://www.e-consystems.com/Articles/Camera/accessing_cameras_in_opencv_with_high_performance.asp) for detailed information about OpenCV support in e-con Systems cameras.

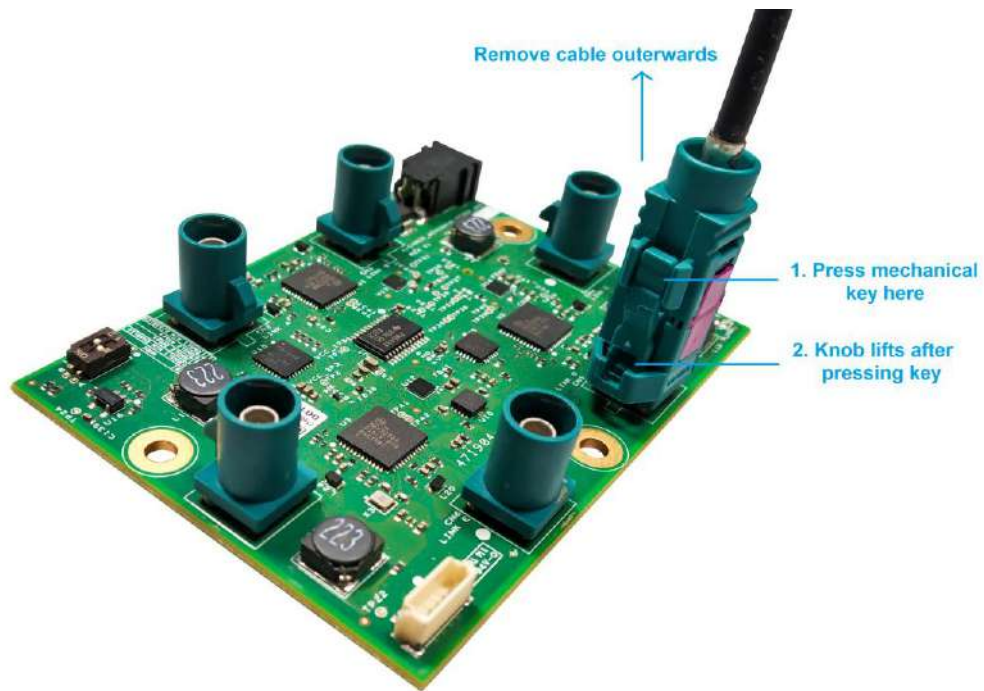
**4. How can I get the updated package?**

Please login to the [Developer Resources](#) website and download the latest release package.

**5. How to remove the coaxial cable from FAKRA plug?**

Care need to be taken while removing the coaxial cable from the PCB. The FAKRA jack on coaxial cable locks with mechanical key of the FAKRA plug on board. The lock between plug and jack needs to be released, to remove the cable. On pressing the jack at the specified location below, the knob lifts and the cable can be removed.

The following figure shows the stages of removing FAKRA jack (coaxial cable) from PCB.





# What's Next?

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After understanding the specifications of camera daughter board and instructions on how to use this daughter board with Jetson™ Xavier™ development kit, you can refer to the following documents to understand more about NileCAM21\_CUXVR.

- *NileCAM21\_CUXVR Developer Guide*
- *NileCAM21\_CUXVR Linux App User Manual*

# Glossary

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**API:** Application Program Interface.

**CMOS:** Complementary Metal Oxide Semiconductor.

**CSI:** Camera Serial Interface.

**GMSL:** Gigabit Multimedia Serial Link.

**GUI:** Graphical User Interface.

**HDMI:** High Definition Multimedia Interface.

**ISP:** Image Signal Processor.

**LED:** Light-Emitting Diode.

**MCU:** Micro Controller Unit.

**MIPI:** Mobile Industry Processor Interface.

**PCB:** Printed Circuit Board.

**USB:** Universal Serial Bus.

**V4L2:** Video4Linux2 is a collection of device drivers and API for supporting real-time video capture on Linux systems.

# Support

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## **Contact Us**

If you need any support on NileCAM21\_CUXVR product, please contact us using the Live Chat option available on our website - <https://www.e-consystems.com/>

## **Creating a Ticket**

If you need to create a ticket for any type of issue, please visit the ticketing page on our website - <https://www.e-consystems.com/create-ticket.asp>

## **RMA**

To know about our Return Material Authorization (RMA) policy, please visit the RMA Policy page on our website - <https://www.e-consystems.com/RMA-Policy.asp>

## **General Product Warranty Terms**

To know about our General Product Warranty Terms, please visit the General Warranty Terms page on our website - <https://www.e-consystems.com/warranty.asp>

## Revision History

Rev	Date	Description	Author
1.0	22-October-2020	Initial Draft	Camera Team
1.1	30-March-2021	Images updated	Camera Team