

# AN14376

i.MX Camera Software Pack

Rev. 1.0 — 11 September 2024

Application note

## Document information

Information	Content
Keywords	AN14376, ISP, BSP, i.MX 8M Plus, camera software pack
Abstract	i.MX camera software pack helps customers quickly enable off-the-shelf camera modules on i.MX 8M Plus-EVK using the ISP.



## 1 Introduction

i.MX camera software pack includes camera drivers, libraries, calibration files, and Yocto recipes to enable customers to use selected off-the-shelf camera modules out of the box while using the i.MX 8M Plus internal image signal processor (ISP).

This document outlines the contents of the i.MX camera software pack for the i.MX 8M Plus. It describes steps for using supported camera modules with the i.MX 8M Plus ISP, which supports the If-6.6.3\_1.0.0 BSP release.

## 2 Hardware and software requirements

[Table 1](#) describes the hardware and software requirements for using the software pack.

**Table 1. Hardware and software details**

Category	Description
Hardware	<ul style="list-style-type: none"> <li>• NXP i.MX 8M Plus Evaluation Kit (EVK)</li> <li>• Supported camera modules</li> <li>• XRPI-CAM-MINISAS adaptor board</li> <li>• Raspberry Pi camera connector FPC cable</li> <li>• Display output (Monitor) and HDMI cable</li> <li>• Personal computer</li> </ul>
Software	<ul style="list-style-type: none"> <li>• Ubuntu 22.04 LTS (If building an image using Yocto)</li> <li>• Serial Terminal: TeraTerm setup for Windows OS</li> </ul>

### 2.1 XRPI-CAM-MINISAS adaptor board

This adaptor board connects cameras using RPI 22 pin 0.5 mm pitch FPC camera cable and mini-SAS connector for MIPI-CSI connection to the i.MX 8M Plus EVK board. It is going to be launched soon and available for purchase on the NXP website.

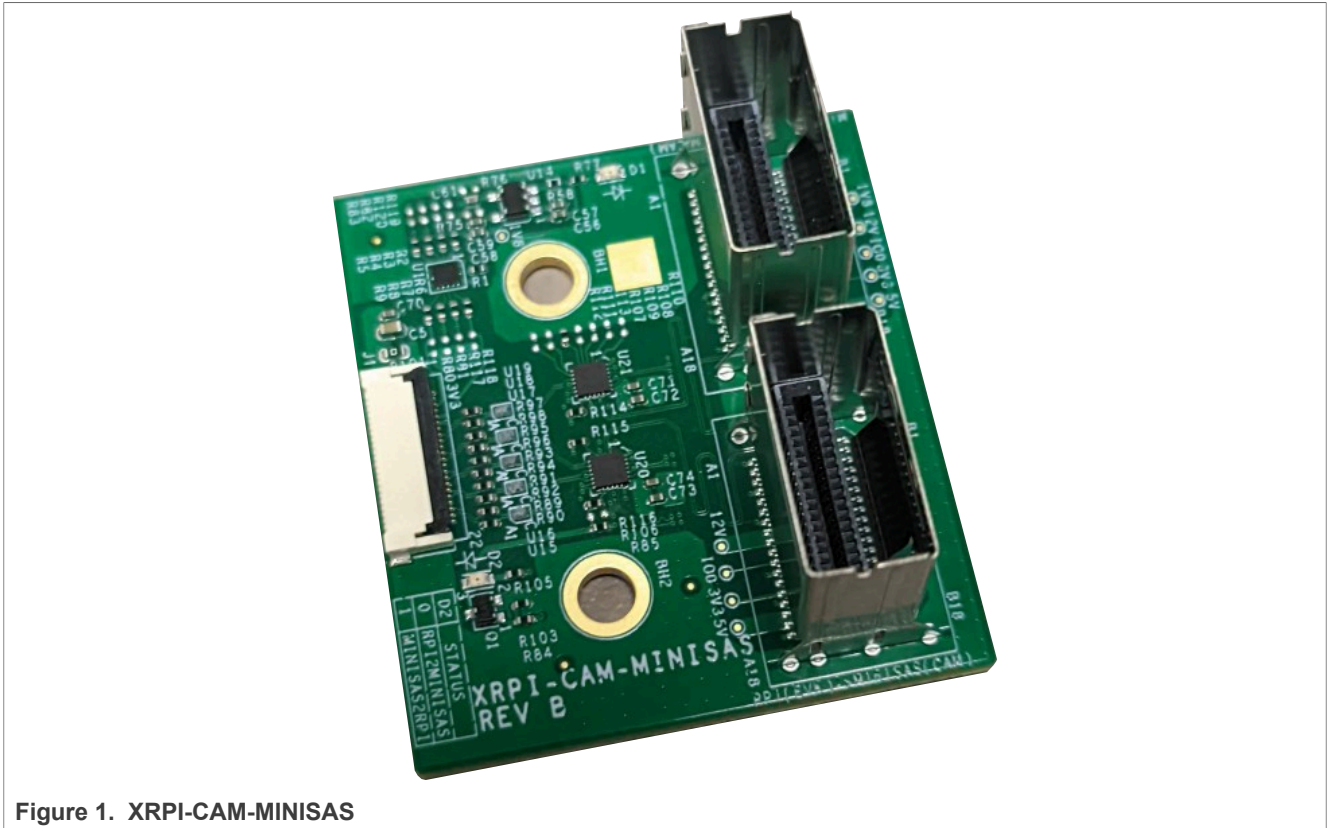


Figure 1. XRPI-CAM-MINISAS

## 2.2 Supported camera modules

The currently supported camera modules include a wide variety of features from Raspberry Pi compatible modules, which can be purchased on any online store. The modules come with the following sensors and lens combinations, along with the online links to purchase them:

- [PiBiger Sony IMX 219](#):
  - 8 MP (3280 × 2464 active resolution)
  - Current enabled resolution 1920 x 1080 30 fps

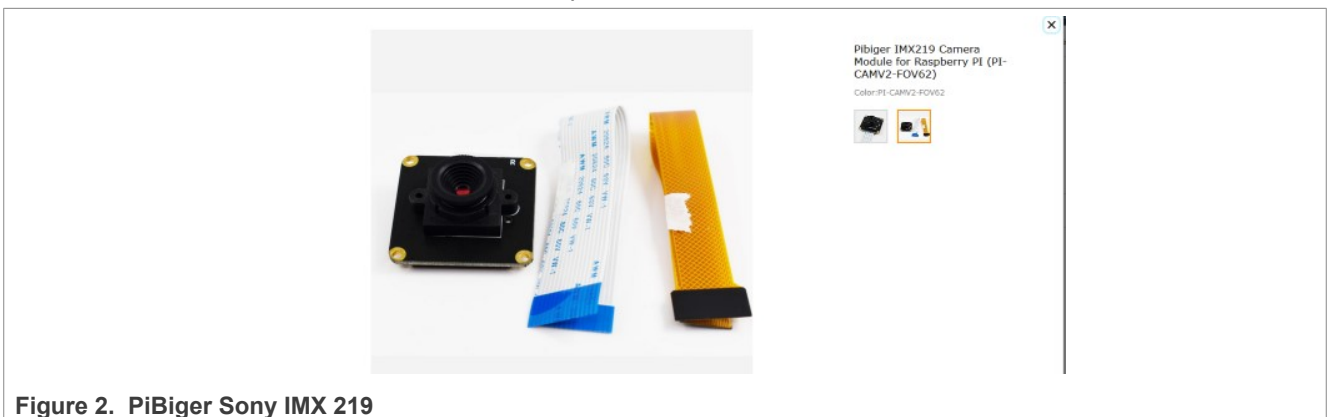


Figure 2. PiBiger Sony IMX 219

- [InnoMaker OmniVision OV5647](#)
  - 5MP (2592 × 1944, 1920 x 1080)
  - Currently enabled resolution
  - 1920 x 1080 30 fps BGGR10



Figure 3. InnoMaker OmniVision OV5647

- [ON Semiconductor AR0144](#):
  - 1MP (1280 x 800)
  - Currently enabled as a monochrome sensor for i.MX 8M Plus ISP at 1280 x 800



Figure 4. ON Semiconductor AR0144

### 2.3 Raspberry Pi camera FPC cable

22 pin (0.5 mm pitch) to 15 pin (1 mm pitch) FPC cable comes included with Raspberry Pi camera modules.





Figure 5. 22 pin (0.5 mm pitch) to 15 pin (1 mm pitch) FPC cable

AR0144 camera module board connects to the i.MX 8M Plus EVK board through the 22 pin (0.5mm pitch) FPC cable.



Figure 6. 22 pin (0.5 mm) to 22 pin (0.5 mm)

### 3 Using the software pack

This section explains the two different methods for enabling the camera module using the software pack and describes the prerequisite setup for both methods:

1. [Local build](#)
2. [Use precompiled binaries](#)

#### 3.1 Local build

The software pack includes patches in the form of Yocto recipes for the ISP module, drivers, and calibration files necessary to enable each sensor camera module. It allows users to build a flashable BSP image locally using Yocto.

The Yocto recipes can be obtained from the link: <https://github.com/nxp-imx-support/imx-camera-sw-pack>

##### 3.1.1 Prerequisite

These steps are required if compiling recipes locally using the camera software pack. These steps setup the base Yocto build environment.

##### 3.1.2 Set up build environment for Yocto project

To build the Yocto image for the i.MX 8M Plus running the Linux 6.6.3-1.0.0 BSP, perform the following steps:

1. Install the essential Yocto project host packages as follows:

```
$ sudo apt install gawk wget git diffstat unzip texinfo gcc build-essential \
chrpath socat cpio python3 python3-pip python3-pexpect xz-utils debianutils \
iputils-ping python3-git python3-jinja2 libegl1-mesa libsdl1.2-dev \
python3-subunit mesa-common-dev zstd liblz4-tool file locales -y
```

```
$ sudo locale-gen en_US.UTF-8
```

2. To set up repo utility, perform the following steps:

a. Create a bin folder in the home directory, as follows:

```
$ mkdir ~/bin (this step may not be needed if the bin folder already
exists)
$ curl https://storage.googleapis.com/git-repo-downloads/repo > ~/bin/repo
$ chmod a+x ~/bin/repo
```

b. To ensure that the ~/bin folder is in your PATH variable, add the following command line to the .bashrc file:

```
$ export PATH=~/bin:$PATH
```

3. Set up the Git as follows:

```
$ git config --global user.name "Your Name"
$ git config --global user.email "Your Email"
$ git config -list
```

4. Set up the Yocto for Linux 6.6.3-1.0.0 BSP as follows:

```
$ mkdir imx-yocto-bsp
$ cd imx-yocto-bsp
$ repo init -u https://github.com/nxp-imx/imx-manifest
-b imx-linux-nanbiel -m imx-6.6.3-1.0.0.xml
$ repo sync
```

**Note:**

*imx-yocto-bsp directory is referred as the Yocto\_Directory.*

*Yocto directory contains a "sources" directory, containing various recipes used to build one or more build directories.*

5. Image configuration:

```
DISTRO=fsl-imx-xwayland MACHINE=imx8mp-lpddr4-evk source imx-setup-release.sh
-b build
```

Where:

- DISTRO=<distro name> fsl-imx-xwayland is the distro configuration
- MACHINE=<machine name> imx8mp-lpddr4-evk is the board configuration
- -b <build\_directory> specifies the name of the build directory

**Note:** *The "build" directory is referred as the build\_directory in the next section.*

6. Build the image using the following command:

```
$ bitbake imx-image-full
```

Now, your Yocto build environment is set up, allowing you to add and compile the recipes for individual camera modules into the final image build.

For more information on Yocto build setup instructions, refer to the *i.MX Yocto Project User's Guide* (document IMXLXOCTOUG) on [IMXLINUX](#) webpage. See [Figure 7](#).

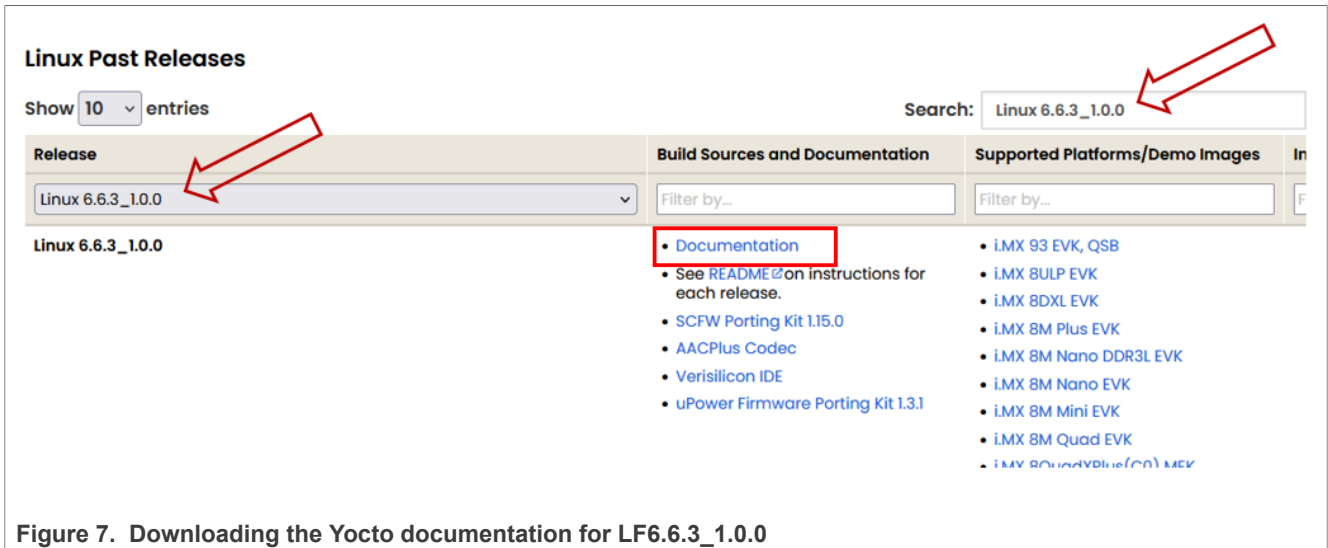


Figure 7. Downloading the Yocto documentation for LF6.6.3\_1.0.0

### 3.2 Use precompiled binaries

The software pack also includes precompiled ISP modules, drivers, and libraries for each sensor. This content can be directly copied onto the i.MX 8M Plus Linux 6.6.3\_1.0.0 BSP image.

The binaries directory for each camera sensor contains precompiled drivers, kernel modules, and libraries required to enable the camera sensor to use the i.MX 8M Plus ISP. It also contains the camera calibration files (.xml), dewarp calibration files (.json), and sensor-configuration files (.cfg) to get the ISP read and set the required parameters for streaming camera data. Binaries can be downloaded using the following link:

[https://www.nxp.com/downloads/en/software/imx-camera-sw-pack-LF6.6.3\\_P24.1-Binaries.zip](https://www.nxp.com/downloads/en/software/imx-camera-sw-pack-LF6.6.3_P24.1-Binaries.zip)

[Table 2](#) lists the contents of the binaries directory.

Table 2. Contents of binaries directory

Directory	Content
Kernel	Device tree file to enable sensor
imx-isp	<ul style="list-style-type: none"> <li>• Compiled libraries</li> <li>• Sensor calibration and dewarp files</li> <li>• Modified scripts to run ISP on board bootup</li> </ul>
isp-vvcam	Sensor driver kernel module
copy_binaries.sh	Script to copy binaries to the right location on the board

#### 3.2.1 Prerequisite

This section includes steps to use the precompiled binaries with pre-built image for i.MX 8M Plus EVK.

Download a pre-built image from [IMXLINUX](#).

#### 3.2.2 Use the precompiled binaries with prebuilt image

1. Select and download the right Image package for i.MX 8M Plus EVK marked for the kernel version Linux 6.6.3-1.0.0.

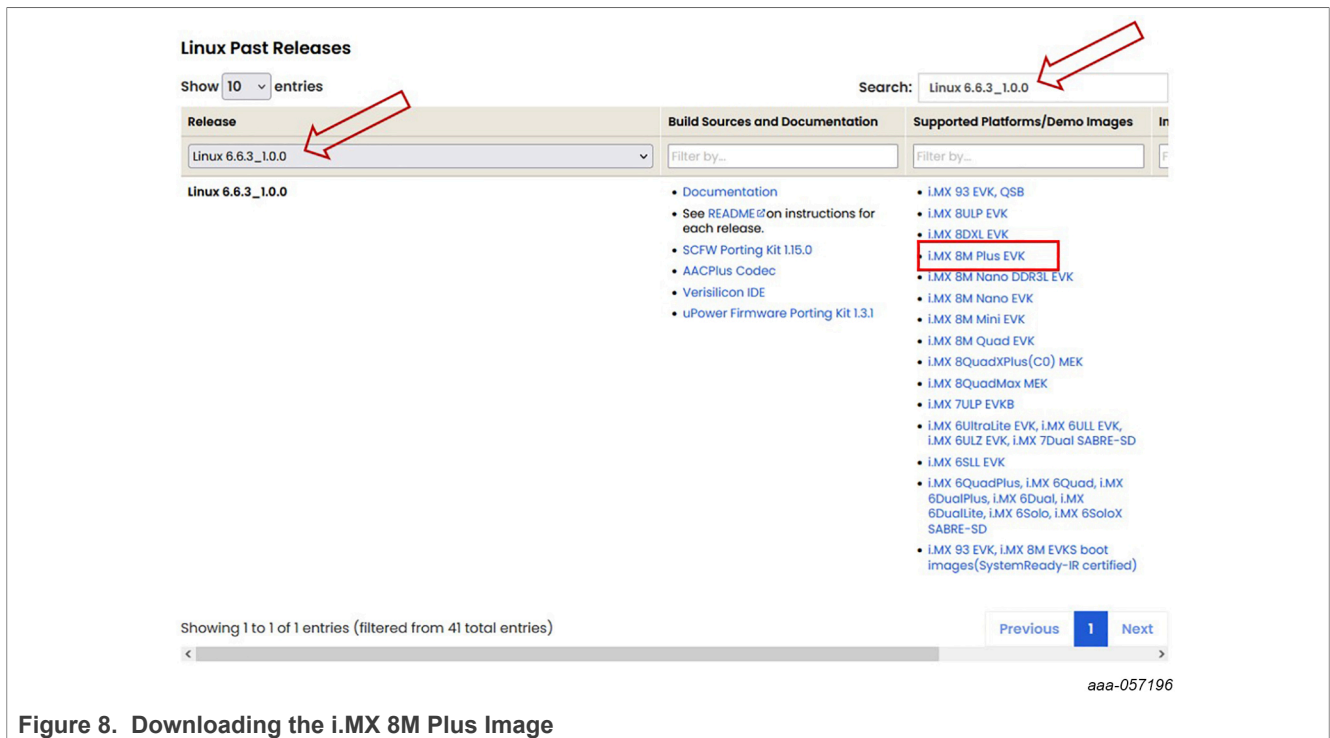


Figure 8. Downloading the i.MX 8M Plus Image

2. Extract the contents of the downloaded zip file LF\_v6.6.3-1.0.0\_images\_IMX8MPEVK.zip.
3. After extracting, select the imx-image-full-imx8mpevk.wic image file and flash it onto an SD card using the Rufus.exe application on the Windows PC.  
If using Ubuntu, run `sudo dd if=imx-image-full-imx8mpevk.wic of=/dev/sd<partition> bs=1M conv=fsync.`

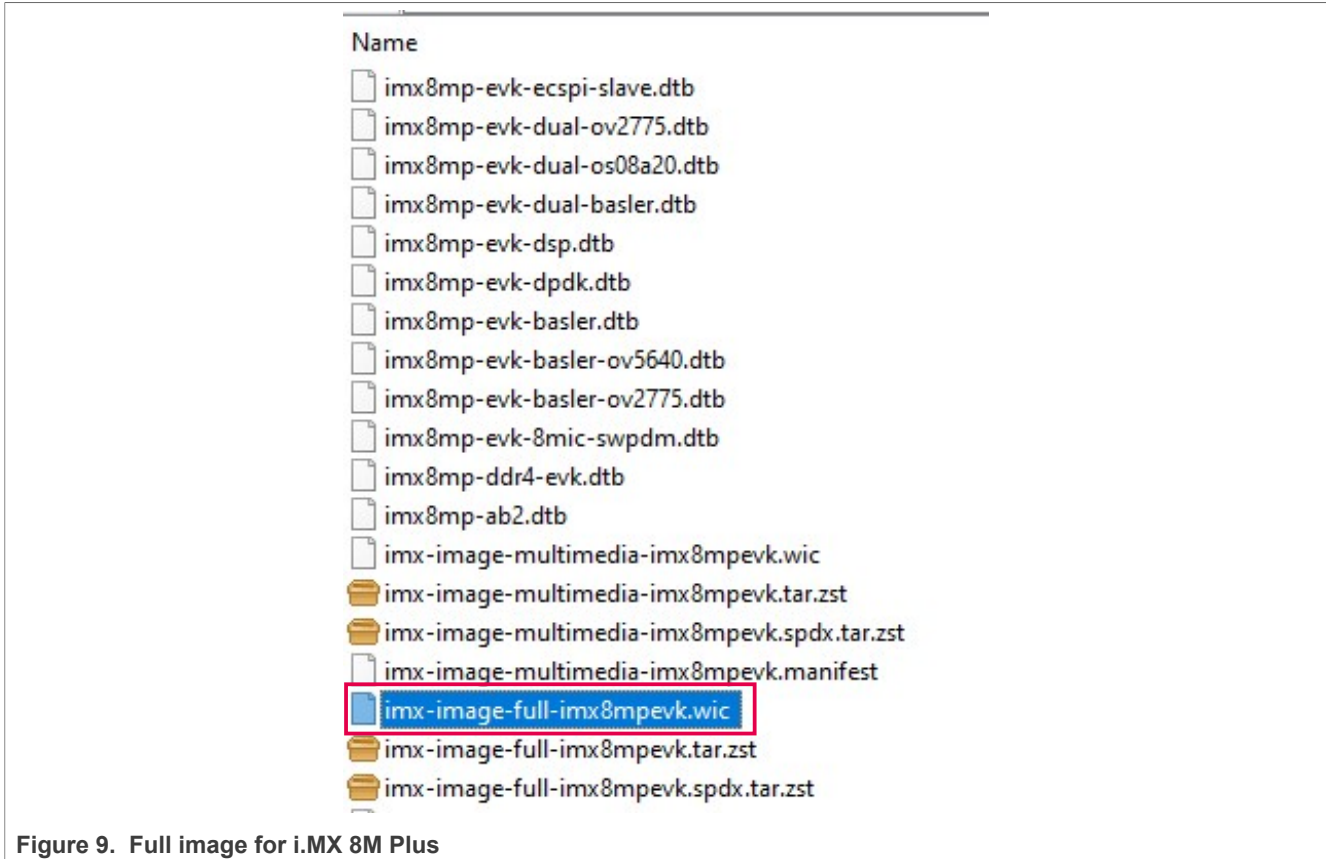


Figure 9. Full image for i.MX 8M Plus

4. Boot up the i.MX 8M Plus EVK with the flashed SD card while connected to the serial console terminal on your PC.

## 4 Enable Sony IMX 219 camera module

This section describes the two ways to enable the IMX 219 camera module and steps to connect it with the i.MX 8M Plus EVK board via the XRPI-CAM-MINISAS adaptor board:

- [Build an i.MX 8M Plus EVK Yocto Image with Sony IMX 219 camera module enabled](#)
- [Enable IMX 219 using pre-compiled binaries](#)

### 4.1 Build an i.MX 8M Plus EVK Yocto image with Sony IMX 219 camera module enabled

To build an i.MX 8M Plus EVK Yocto image with Sony IMX 219 camera module enabled, perform the following steps:

1. Perform the [Prerequisite](#) for [Local build](#).
2. To set up software pack repo, perform the following steps:
  - a. Clone and checkout LF6.6.3\_P24.1 branch:

```
$ git clone https://github.com/nxp-imx-support/imx-camera-sw-pack.git
$ git checkout LF6.6.3_P24.1
```

- b. Copy only `meta-imx8mp-isp-imx219` into the `sources` directory in your `Yocto_Directory`:

```
$ cp -r imx-camera-sw-pack/sony_imx219_sensor/i.MX8MPLUS/meta-imx8mp-isp-
imx219 imx-yocto-bsp/sources/
```

3. To build and flash the image enabled with the IMX 219 camera module, perform the following steps:

- a. Navigate to the `Yocto_Directory`:

```
$ cd imx-yocto-bsp
```

- b. Source the setup script to configure Yocto build system to enable the IMX 219 camera module and build the image:

```
$ source sources/meta-imx8mp-isp-imx219/setup/setup-env-imx8mp-imx219 -b
build
$ bitbake imx-image-full
```

- c. After the build process is completed, the image file `imx-image-full-imx8mp-lpddr4-evk.rootfs.wic.zst` is available at the following location:

```
$ imx-yocto-bsp/build/tmp/deploy/images/imx8mp-lpddr4-evk/ imx-image-full-
imx8mp-lpddr4-evk.rootfs.wic.zst
```

- d. Flash this image on to the SD card:

```
$ zstdcat imx-image-full-imx8mp-lpddr4-evk.rootfs.wic.zst | sudo dd of=/
dev/sd<partition> bs=1M conv=fsync
```

4. The following set of commands are executed on the i.MX 8M Plus EVK board using a serial console terminal:

- a. Now, boot up the i.MX 8M Plus EVK board with the serial console terminal open.

While the board is booting up, press any key on the keyboard when you see the prompt shown in [Figure 10](#) on your terminal to pause U-Boot execution.

```
switch to partitions #0, OK
mmc1 is current device
flash target is MMC:1
Net: eth0: ethernet@30be0000, eth1: ethernet@30bf0000 [PRIME]
Fastboot: Normal
Normal Boot
Hit any key to stop autoboot: 0
u-boot=> █
```

Figure 10. U-Boot prompt

- b. Set the U-Boot environment variable to set the device tree that enables IMX 219 `imx8mp-evk-imx219.dtb`:

```
u-boot=> setenv fdtfile imx8mp-evk-imx219.dtb
u-boot=> saveenv
Saving Environment to MMC... Writing to MMC(1)... OK
u-boot=> boot
```

As a result, the board is rebooted with the IMX 219 sensor enabled. At this point, the board is ready to run the selected camera module.

For information on connecting the IMX 219 camera module to i.MX 8M Plus EVK board via the XRPI-CAM-MINISAS adaptor board, see [Section 4.3](#).

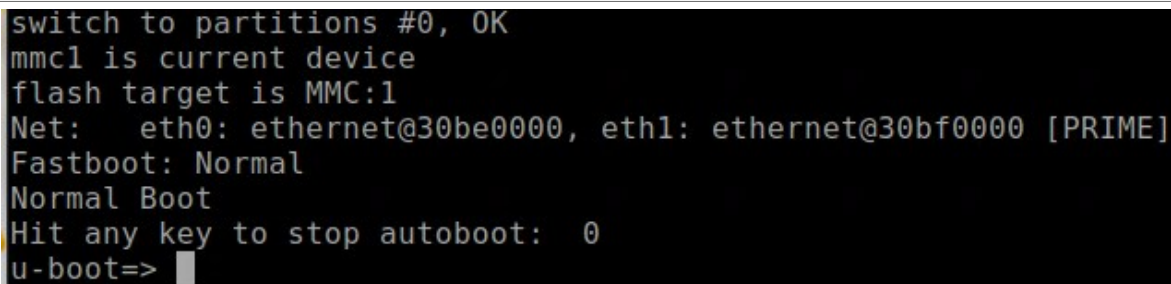
## 4.2 Enable IMX 219 using precompiled binaries

To enable IMX 219 using precompiled binaries, perform the following steps:

1. Download the software pack binaries from this [link](#) and extract its contents.
2. Perform [Prerequisite](#) for [Use precompiled binaries](#).
3. Copy the binaries directory for the selected camera module onto the i.MX 8M Plus EVK board.
4. The following set of commands are executed on the i.MX 8M Plus board using a serial console terminal:
  - a. Once the binaries directory has been copied onto the board, give execution permission to the `copy_binaries.sh` script and run the script. This script copies the binaries to the required locations on the board.

```
root@imx8mp-lpddr4-evk:~# cd sony_imx219_sensor\i.MX8MPLUS\Binaries\
root@imx8mp-lpddr4-evk:~# chmod +x copy_binaries.sh
root@imx8mp-lpddr4-evk:~# ./copy_binaries.sh
```

- b. Reboot the board and press any key on your keyboard when you see the prompt shown in [Figure 11](#) on your terminal to pause U-Boot execution.



```
switch to partitions #0, OK
mmc1 is current device
flash target is MMC:1
Net: eth0: ethernet@30be0000, eth1: ethernet@30bf0000 [PRIME]
Fastboot: Normal
Normal Boot
Hit any key to stop autoboot: 0
u-boot=> █
```

Figure 11. U-Boot prompt

- c. Set the U-Boot environment variable to set the device tree to enable IMX 219 `imx8mp-evk-imx219.dtb`:

```
u-boot=> setenv fdtfile imx8mp-evk-imx219.dtb
u-boot=> saveenv
Saving Environment to MMC... Writing to MMC(1)... OK
u-boot=> boot
```

As a result, the board is rebooted with the selected sensor enabled. At this point, the board is fully enabled to run the selected camera module.

For information on connecting the IMX 219 camera module to i.MX 8M Plus EVK board via the XRPI-CAM-MINISAS adaptor board, see [Section 4.3](#).

## 4.3 Hardware connections for IMX 219 camera module

1. Power off the i.MX 8M Plus EVK board before connecting the camera module.
2. To connect the XRPI-CAM-MINISAS to the IMX 219 camera connector, use the 22 pin (0.5 mm pitch) to 15 pin (1 mm pitch) FPC cable. Match the side of the cable marked as black, as shown in [Figure 12](#).





Figure 12. IMX 219 connection with XRPI-CAM-MINISAS/RPI-CAM-MIPI board

- Currently, only the highlighted MINISAS connector on the XRPI-CAM-MINISAS adaptor board shown in [Figure 13](#) can be used on the XRPI-CAM-MINISAS adaptor.

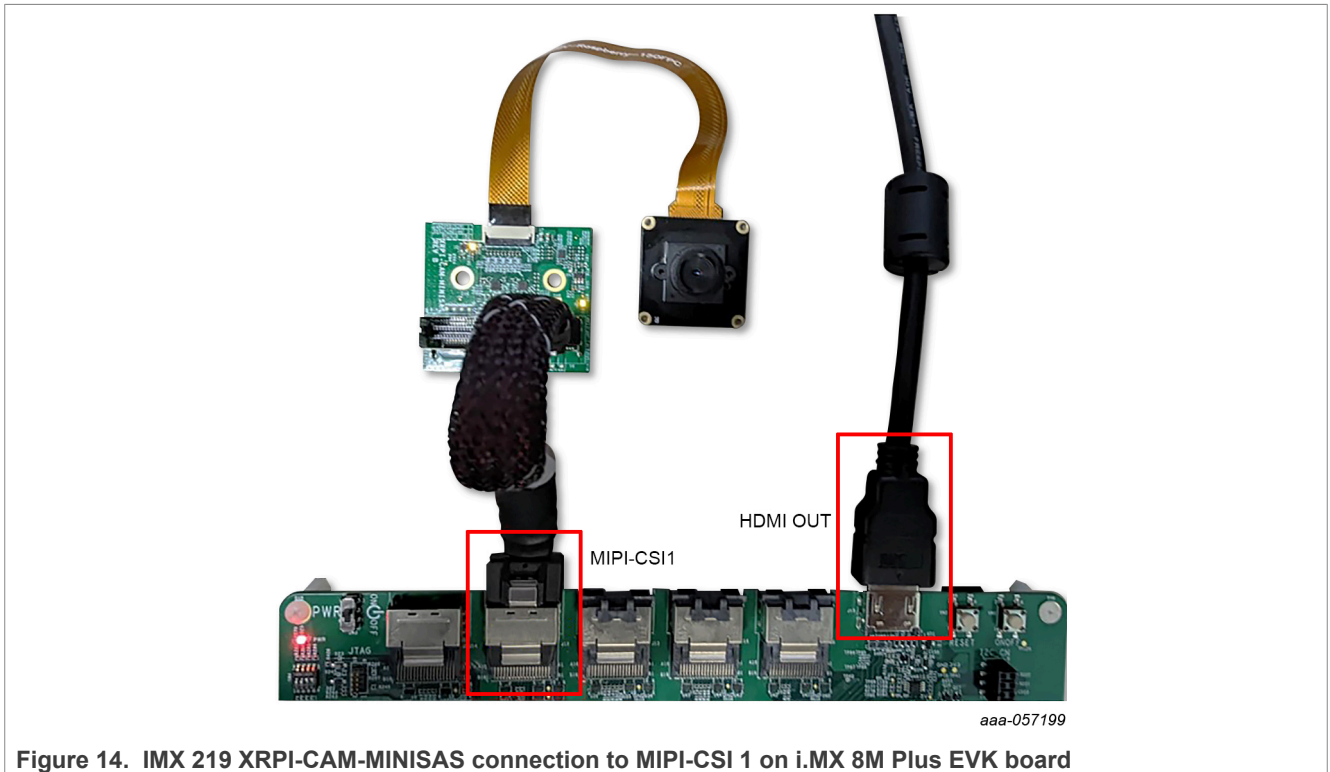


Figure 13. XRPI-CAM-MINISAS adaptor board powered on with IMX 219

- Use the highlighted MIPI-CSI 1 port to connect the i.MX 8M Plus EVK board with the XRPI-CAM-MINISAS adaptor board, as shown in [Figure 14](#).
- Connect using the highlighted HDMI connector on the i.MX 8M Plus EVK board to connect to an external display.



6. Power on the board. When powered on, the two highlighted LEDs must turn on ensuring proper connection with the camera module.



#### 4.4 Test IMX 219 camera module

After connecting the camera module, power on the i.MX 8M Plus EVK board.

To test camera output on the external display, run the following commands:

- To test the IMX 219 camera module, run the following command:

```
root@imx8mp-lpddr4-evk:~# media-ctl -p
```

```

Media controller API version 6.6.3

Media device information
-----
driver          mxc-md
model          FSL Capture Media Device
serial
bus info       platform:32c00000.bus:camera
hw revision    0x0
driver version 6.6.3

Device topology
- entity 1: mxc-mipi-csi2.0 (8 pads, 1 link)
  type Node subtype V4L flags 0
  device node name /dev/v4l-subdev0
  pad0: Sink
    <- "imx219 1-0010":0 [ENABLED,IMMUTABLE]
  pad1: Sink
  pad2: Sink
  pad3: Sink
  pad4: Source
  pad5: Source
  pad6: Source
  pad7: Source

- entity 10: imx219 1-0010 (1 pad, 1 link)
  type V4L2 subdev subtype Sensor flags 0
  device node name /dev/v4l-subdev1
  pad0: Source
    [fmt:unknown/0x0]
    -> "mxc-mipi-csi2.0":0 [ENABLED,IMMUTABLE]

root@imx8mpevk:~#

```

Figure 15. IMX 219 camera sensor is detected

- Identify v4l2 capture device ID for VIV (platform:viv0):

```
root@imx8mp-lpddr4-evk:~# v4l2-ctl --list-device
```

```

root@imx8mp-lpddr4-evk:~# v4l2-ctl --list-devices
[ 37.694433] enter isp_mi_stop
():
  /dev/v4l-subdev0
  /dev/v4l-subdev2
  /dev/v4l-subdev3

(csi0):
  /dev/v4l-subdev1

FSL Capture Media Device (platform:32c00000.bus:camera):
  /dev/media0

mxc-isi-m2m_v1 (platform:32e00000.isi:m2m_devic):
  /dev/video2

VIV (platform:viv0):
  /dev/video3

vsi_v4l2dec (platform:vsi_v4l2dec):
  /dev/video1

vsi_v4l2enc (platform:vsi_v4l2enc):
  /dev/video0

viv_media (platform:vvcam-video.0):
  /dev/media1

```

Figure 16. IMX 219 v4l2 capture device

- Use `v4l2src device=</dev/video#>` as the identified v4l2 capture device ID:

```
root@imx8mp-lpddr4-evk:~# gst-launch-1.0 v4l2src device=/dev/video3 ! "video/x-raw ,format=YUY2, width=1920, height=1080" ! waylandsink
```

- Running the above Gstreamer command sets up pipeline to use the v4l2 API to use the camera device on /dev/video3, with YUV2 format at a resolution of 1920 x 1080 and use waylandsink as the display output.

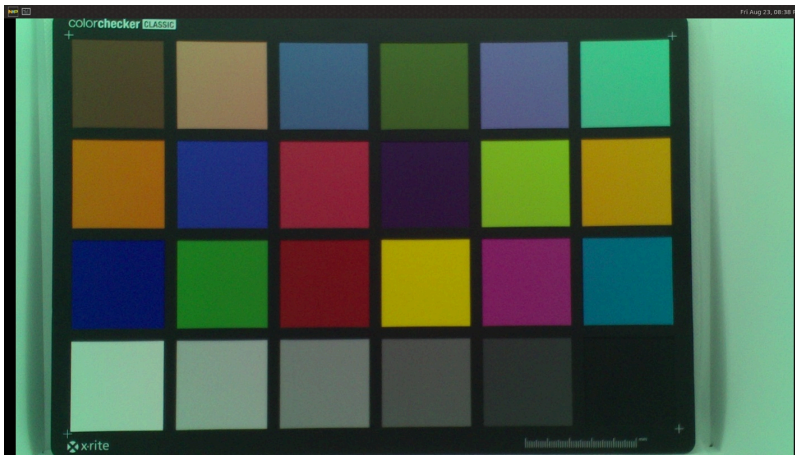


Figure 17. IMX 219 capture output

## 5 Enable OmniVision OV5647 camera module

This section describes the two ways to enable the OmniVision OV5647 camera module and the steps to connect it with the i.MX 8M Plus EVK board via the XRPI-CAM-MINISAS adaptor board:

- [Build an i.MX 8M Plus EVK Yocto image with OmniVision OV5647 camera module enabled](#)
- [Enable OV5647 using pre-compiled binaries](#)

### 5.1 Build an i.MX 8M Plus EVK Yocto image with OmniVision OV5647 camera module enabled

To build an i.MX 8M Plus EVK Yocto image with the OmniVision OV5647 camera module enabled, perform the following steps:

1. Perform [Prerequisite](#) for [Local build](#).
2. To set up a software pack repo, perform the following steps:
  - a. Clone and checkout LF6.6.3\_P24.1 branch:

```
$ git clone https://github.com/nxp-imx-support/imx-camera-sw-pack.git
$ git checkout LF6.6.3_P24.1
```

- b. Copy only `meta-imx8mp-isp-ov5647` into the `sources` directory in your `Yocto_Directory`:

```
$ cp -r imx-camera-sw-pack/ov_ov5647_sensor/i.MX8MPLUS/meta-imx8mp-isp-ov5647 imx-yocto-bsp/sources/
```

3. To build and flash the image enabled with the OV5647 camera module, perform the following steps:
  - a. Navigate to the `Yocto_Directory`:

```
$ cd imx-yocto-bsp
```

- b. Source the setup script to configure Yocto build system to enable the OV5647 camera module and build the image:

```
$ source sources/meta-imx8mp-isp-ov5647/setup/setup-env-imx8mp-ov5647 -b
  build
$ bitbake imx-image-full
```

- c. After the build process is completed, the image file `imx-image-full-imx8mp-lpddr4-evk.rootfs.wic.zst` is available at the following location:

```
$ imx-yocto-bsp/build/tmp/deploy/images/imx8mp-lpddr4-evk/ imx-image-full-
imx8mp-lpddr4-evk.rootfs.wic.zst
```

- d. Flash this image to the SD card:

```
$ zstdcat imx-image-full-imx8mp-lpddr4-evk.rootfs.wic.zst | sudo dd of=/
dev/sd<partition> bs=1M conv=fsync
```

4. The following set of commands are executed on the i.MX 8M Plus EVK board using a serial console terminal:

- a. Now, boot up the i.MX 8M Plus EVK board with the serial console terminal open.

While the board is booting up, press any key on the keyboard when you see the prompt shown in [Figure 18](#) on your terminal to pause U-Boot execution.

```
switch to partitions #0, OK
mmc1 is current device
flash target is MMC:1
Net:  eth0: ethernet@30be0000, eth1: ethernet@30bf0000 [PRIME]
Fastboot: Normal
Normal Boot
Hit any key to stop autoboot:  0
u-boot=> █
```

Figure 18. U-Boot prompt

- b. Set the U-Boot environment variable to set the device tree that enables OV5647 `imx8mp-evk-ov5647.dtb`:

```
u-boot=> setenv fdtfile imx8mp-evk-ov5647.dtb
u-boot=> saveenv
Saving Environment to MMC... Writing to MMC(1)... OK
u-boot=> boot
```

As a result, the board with the OV5647 sensor enabled is rebooted. At this point, the board is fully enabled to run the selected camera module.

For information on connecting the OV5647 camera module to i.MX 8M Plus EVK board via the xRPI-CAM-MINISAS adaptor board, see [Section 5.3](#).

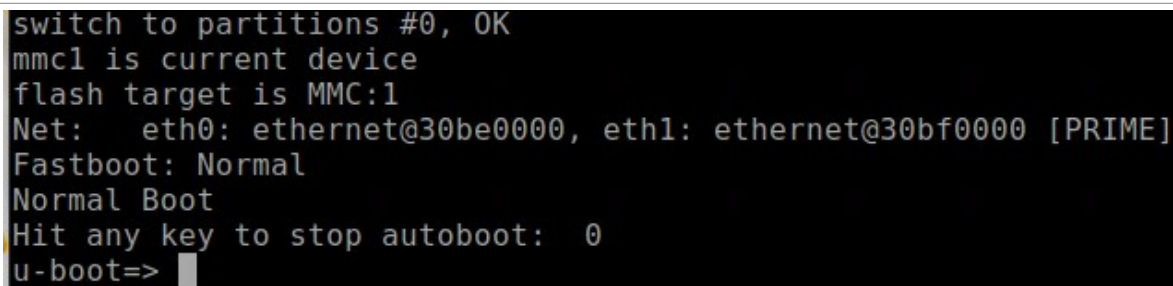
## 5.2 Enable OV5647 using precompiled binaries

1. Download the software pack binaries from this [link](#) and extract its contents.
2. Perform [Prerequisite](#) for [Use precompiled binaries](#).

3. Copy the binaries directory for the selected camera module onto the i.MX 8M Plus EVK board.
4. The following set of commands are executed on the i.MX 8M Plus EVK board using a serial console terminal:
  - a. Once the binaries directory has been copied on the board, give execution permission to the `copy_binaries.sh` script and run the script. This script copies the binaries to the required locations on the board.

```
root@imx8mp-lpddr4-evk:~# cd ov_ov5647_sensor\i.MX8MPLUS\Binaries\  
root@imx8mp-lpddr4-evk:~# chmod +x copy_binaries.sh  
root@imx8mp-lpddr4-evk:~# ./copy_binaries.sh
```

- b. Reboot the board and press any key on your keyboard when you see the prompt shown in [Figure 19](#) on your terminal to pause U-Boot execution.



```
switch to partitions #0, OK  
mmc1 is current device  
flash target is MMC:1  
Net: eth0: ethernet@30be0000, eth1: ethernet@30bf0000 [PRIME]  
Fastboot: Normal  
Normal Boot  
Hit any key to stop autoboot: 0  
u-boot=> █
```

Figure 19. U-Boot prompt

- c. Set the U-Boot environment variable to set the device tree to enable OV5647 `imx8mp-evk-ov5647.dtb`:

```
u-boot=> setenv fdtfile imx8mp-evk-ov5647.dtb  
u-boot=> saveenv  
Saving Environment to MMC... Writing to MMC(1)... OK  
u-boot=> boot
```

As a result, the board is rebooted with the selected sensor enabled. At this point, the board is fully enabled to run the selected camera module.

For information on connecting the OV5647 camera module to i.MX 8M Plus EVK board via the xRPI-CAM-MINISAS adaptor board, see [Section 5.3](#).

### 5.3 Hardware connections for OV5647 camera module

1. Power off the i.MX 8M Plus EVK board before connecting the camera module.
2. To connect the XRPI-CAM-MINISAS to the OV5647 camera connector, use the 22 pin (0.5 mm pitch) to 15 pin (1 mm pitch) FPC cable. Match the side of the cable marked as black, as shown in [Figure 20](#).

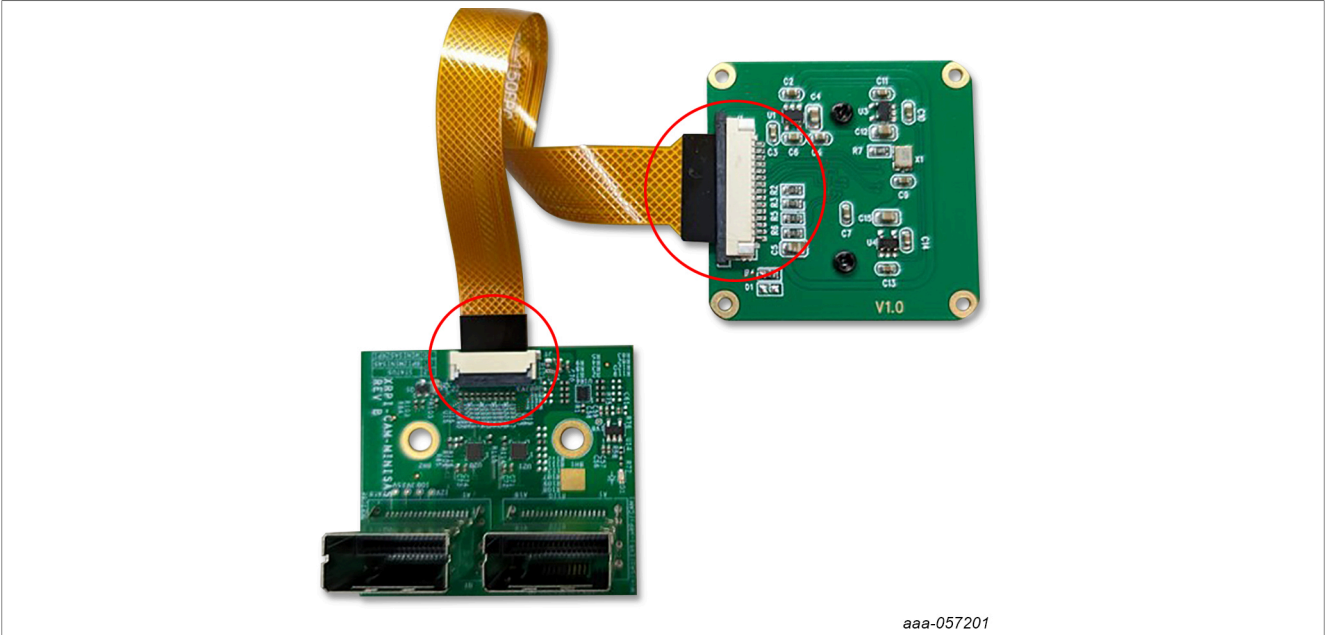


Figure 20. OV5647 connection with XRPI-CAM-MINISAS/RPI-CAM-MIPI board

3. Currently, only the highlighted MINISAS connector on the XRPI-CAM-MINISAS adaptor board shown in [Figure 21](#) can be used on the XRPI-CAM-MINISAS adaptor.

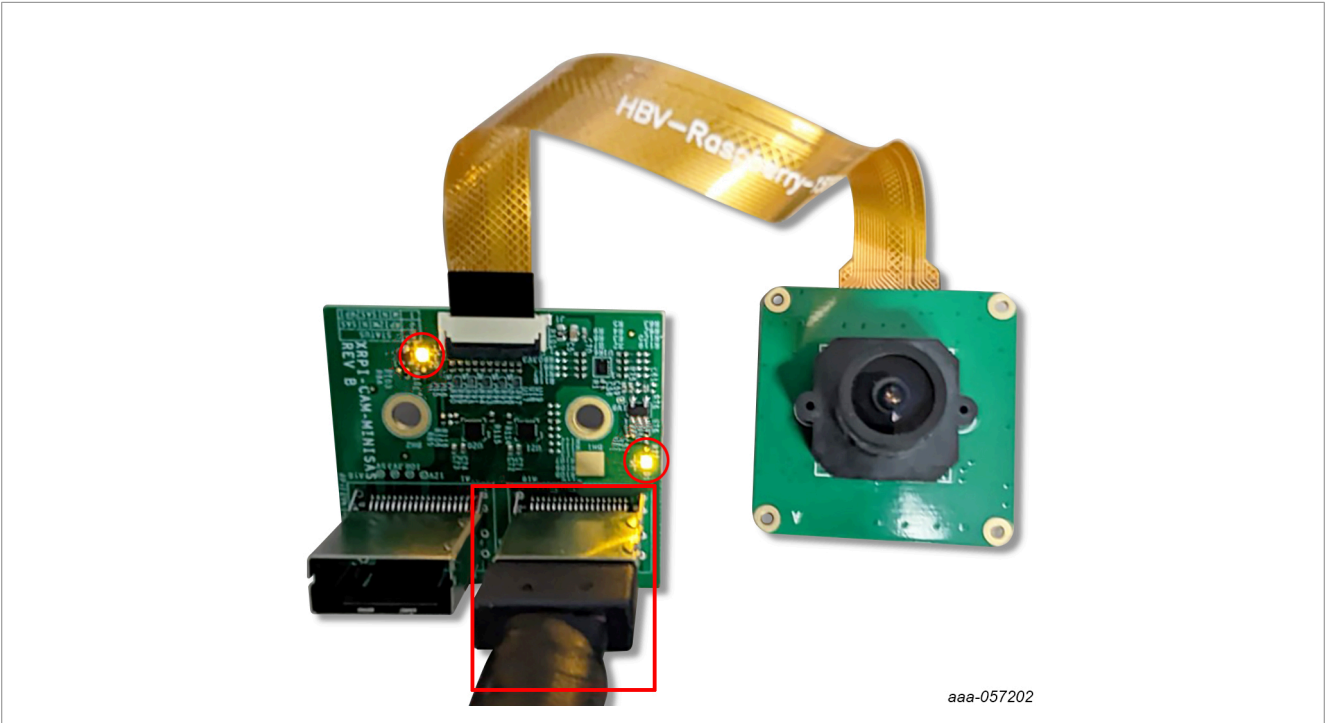
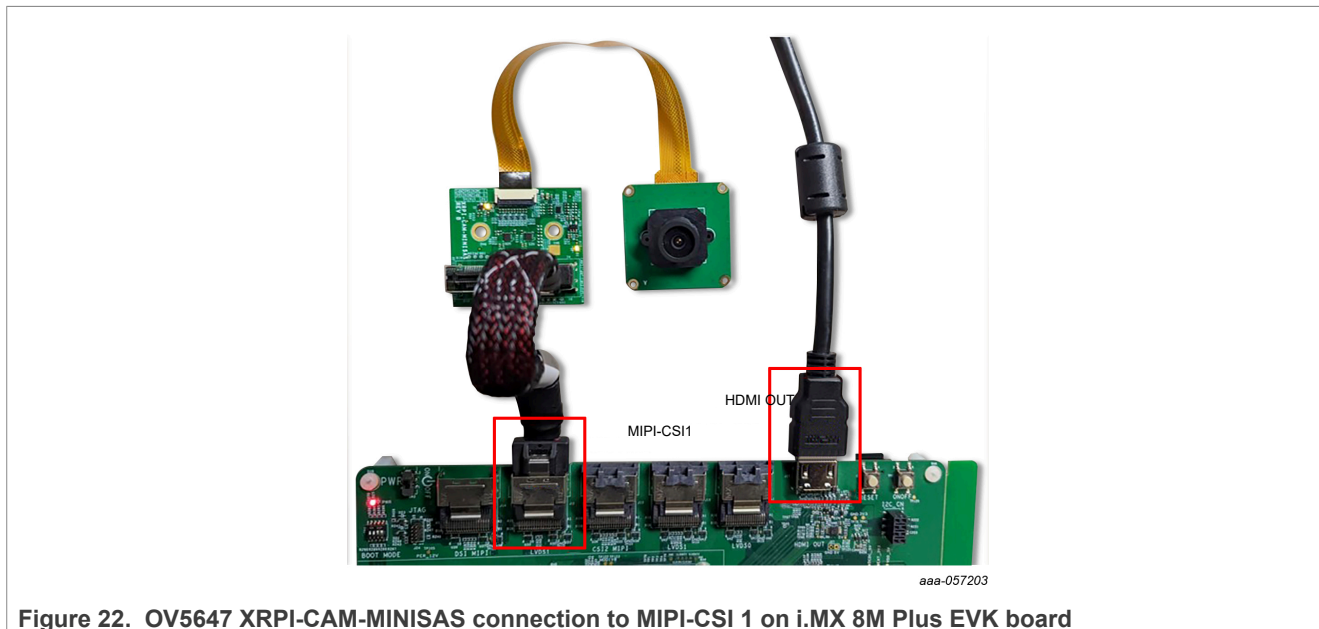


Figure 21. XRPI-CAM-MINISAS adaptor board powered on with OV5647

- 4. Use the highlighted MIPI-CSI 1 port to connect the i.MX 8M Plus EVK board with the XRPI-CAM-MINISAS adaptor board.
- 5. Connect using the highlighted HDMI connector on the i.MX 8M Plus EVK board to connect to an external display.



- Power on the board. When powered on, the two highlighted LEDs must turn on ensuring proper connection with the camera module.



#### 5.4 Test OV5647 camera module

After connecting the camera module, power on the i.MX 8M Plus EVK board.

To test camera output on the external display, run the following commands:

- To test the OV5647 camera module, run the following command:

```
root@imx8mp-lpddr4-evk:~# media-ctl -p
```

```

root@imx8mpevk:~# media-ctl -p
Media controller API version 6.6.3

Media device information
-----
driver          mxc-md
model           FSL Capture Media Device
serial
bus info        platform:32c00000.bus:camera
hw revision     0x0
driver version  6.6.3

Device topology
- entity 1: mxc-mipi-csi2.0 (8 pads, 1 link)
  type Node subtype V4L flags 0
  device node name /dev/v4l-subdev0
  pad0: Sink
    <- "ov5647 1-0036":0 [ENABLED,IMMUTABLE]
  pad1: Sink
  pad2: Sink
  pad3: Sink
  pad4: Source
  pad5: Source
  pad6: Source
  pad7: Source

- entity 10: ov5647 1-0036 (1 pad, 1 link)
  type V4L2 subdev subtype Sensor flags 0
  device node name /dev/v4l-subdev1
  pad0: Source
    [fmt:SBGGR10_1X10/1920x1080 field:none]
    -> "mxc-mipi-csi2.0":0 [ENABLED,IMMUTABLE]
    
```

Figure 23. OV5647 camera sensor is detected

- Identify v4l2 capture device ID for VIV (platform:viv0):

```

root@imx8mp-lpddr4-evk:~# v4l2-ctl --list-device
    
```

```

root@imx8mp-lpddr4-evk:~# v4l2-ctl --list-devices
[ 450.219247] enter isp_mi_stop
():
  /dev/v4l-subdev0
  /dev/v4l-subdev2
  /dev/v4l-subdev3

(csi0):
  /dev/v4l-subdev1

FSL Capture Media Device (platform:32c00000.bus:camera):
  /dev/media0

mxc-isi-m2m_v1 (platform:32e00000.isi:m2m_devic):
  /dev/video2

VIV (platform:viv0):
  /dev/video3

vsi_v4l2dec (platform:vsi_v4l2dec):
  /dev/video1

vsi_v4l2enc (platform:vsi_v4l2enc):
  /dev/video0

viv_media (platform:vvcam-video.0):
  /dev/media1
    
```

Figure 24. OV5647 v4l2 capture device



- Use `v4l2src device=/dev/video#` as the identified v4l2 capture device ID:

```
root@imx8mp-lpddr4-evk:~# gst-launch-1.0 v4l2src device=/dev/video3 ! "video/x-raw ,format=YUY2, width=1920, height=1080" ! waylandsink
```

- Running the above Gstreamer command sets up pipeline to use the v4l2 API to use the camera device on /dev/video3, with YUV2 format at a resolution of 1920 x 1080 and use waylandsink as the display output.



Figure 25. OV5647 capture output

## 6 Enable ON Semiconductor AR0144 camera module

This section describes the two ways to enable the ON Semiconductor (OnSemi) AR0144 camera module and the steps to connect it with the i.MX 8M Plus EVK board via the XRPI-CAM-MINISAS adaptor board:

- [Build an i.MX 8M Plus EVK Yocto image with OnSemi AR0144 camera module enabled](#)
- [Enable AR0144 using pre-compiled binaries](#)

### 6.1 Build an i.MX 8M Plus EVK Yocto image with ONsemi AR0144 camera module enabled

To build an i.MX 8M Plus EVK Yocto image with the ONsemi AR0144 camera module enabled, perform the following steps:

1. Perform the [Prerequisite](#) for [Local build](#).
2. To set up a software pack repo, perform the following steps:
  - a. Clone and checkout LF6.6.3\_P24.1 branch:

```
$ git clone https://github.com/nxp-imx-support/imx-camera-sw-pack.git
$ git checkout LF6.6.3_P24.1
```

- b. Copy only `meta-imx8mp-isp-ar0144` into the `sources` directory in your `Yocto_Directory`:

```
$ cp -r camera-sw-pack/onsemi_ar0144_sensor/i.MX8MPLUS/meta-imx8mp-isp-
imx219 imx-yocto-bsp/sources
```

3. To build and flash the image enabled with the AR0144 camera module, perform the following steps:
  - a. Navigate to the `Yocto_Directory`:

```
$ cd imx-yocto-bsp
```

- b. Source the setup script to configure Yocto build system to enable the AR0144 camera module and build the image:

```
$ source sources/meta-imx8mp-isp-ar0144/setup/setup-env-imx8mp-ar0144 -b  
build  
$ bitbake imx-image-full
```

- c. After the build process is completed, the image file `imx-image-full-imx8mp-lpddr4-evk.rootfs.wic.zst` is available at the following location:

```
$ imx-yocto-bsp/build/tmp/deploy/images/imx8mp-lpddr4-evk/ imx-image-full-  
imx8mp-lpddr4-evk.rootfs.wic.zst
```

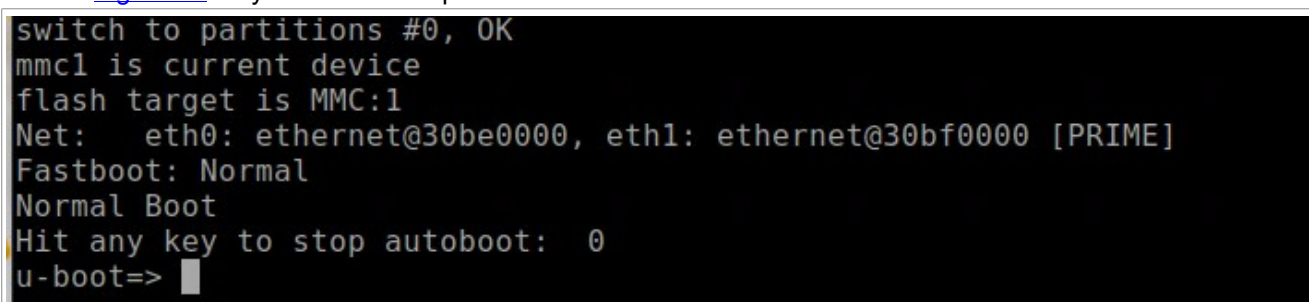
- d. Flash this image to the SD card:

```
$ zstdcat imx-image-full-imx8mp-lpddr4-evk.rootfs.wic.zst | sudo dd of=  
dev/sd<partition> bs=1M conv=fsync
```

4. The following set of commands are executed on the i.MX 8M Plus EVK board using a serial console terminal:

- a. Now, boot up the i.MX 8M Plus EVK board with the serial console terminal open.

While the board is booting up, press any key on the keyboard when you see the prompt shown in [Figure 26](#) on your terminal to pause U-Boot execution.



```
switch to partitions #0, OK  
mmc1 is current device  
flash target is MMC:1  
Net: eth0: ethernet@30be0000, eth1: ethernet@30bf0000 [PRIME]  
Fastboot: Normal  
Normal Boot  
Hit any key to stop autoboot: 0  
u-boot=> █
```

Figure 26. U-Boot prompt

- b. Set the U-Boot environment variable to set the device tree that enables AR0144 `imx8mp-evk-ar0144.dtb`:

```
u-boot=> setenv fdtfile imx8mp-evk-ar0144.dtb  
u-boot=> saveenv  
Saving Environment to MMC... Writing to MMC(1)... OK  
u-boot=> boot
```

As a result, the board with the AR0144 sensor enabled is rebooted. At this point, the board is fully enabled to run the selected camera module.

For information on connecting the AR0144 camera module to i.MX 8M Plus EVK board via the XRPI-CAM-MINISAS adaptor board, see [Section 6.3](#).

## 6.2 Enable AR0144 using precompiled binaries

1. Download the software pack binaries from this [link](#) and extract its contents.
2. Perform [Prerequisite](#) for [Use precompiled binaries](#).

3. Copy the binaries directory for the selected camera module onto the i.MX 8M Plus EVK board.
4. The following set of commands are executed on the i.MX 8M Plus EVK board using a serial console terminal:
  - a. Once the binaries directory has been copied onto the board, give execution permission to the `copy_binaries.sh` script and run the script. This script copies the binaries to the required locations on the board.

```
root@imx8mp-lpddr4-evk:~# cd onsemi_ar0144_sensor\i.MX8MPLUS\Binaries\  
root@imx8mp-lpddr4-evk:~# chmod +x copy_binaries.sh  
root@imx8mp-lpddr4-evk:~# ./copy_binaries.sh
```

- b. Reboot the board and press any key on your keyboard when you see the prompt shown in [Figure 27](#) on your terminal to pause U-Boot execution.

```
switch to partitions #0, OK  
mmc1 is current device  
flash target is MMC:1  
Net: eth0: ethernet@30be0000, eth1: ethernet@30bf0000 [PRIME]  
Fastboot: Normal  
Normal Boot  
Hit any key to stop autoboot: 0  
u-boot=> █
```

Figure 27. U-Boot prompt

- c. Set the U-Boot environment variable to set the device tree to enable AR0144 `imx8mp-evk-ar0144.dtb`:

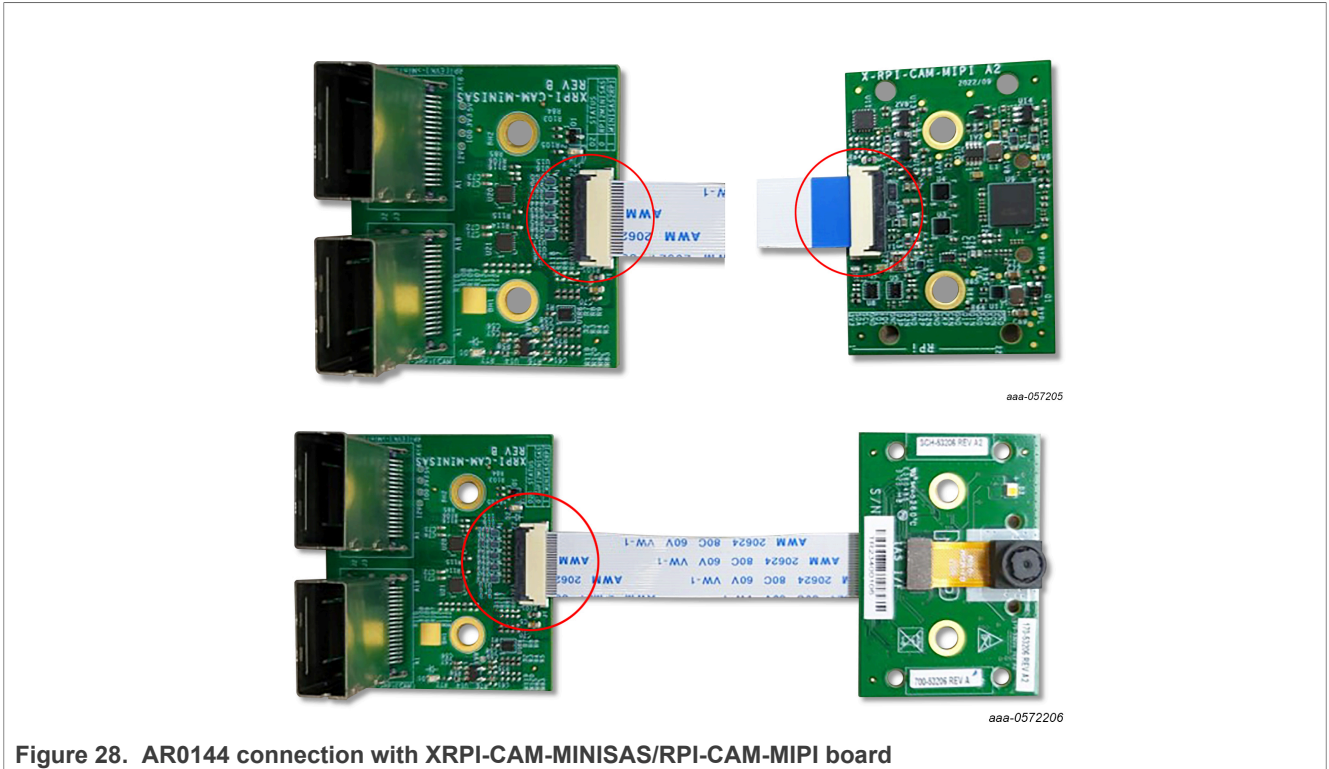
```
u-boot=> setenv fdtfile imx8mp-evk-ar0144.dtb  
u-boot=> saveenv  
Saving Environment to MMC... Writing to MMC(1)... OK  
u-boot=> boot
```

As a result, the board is rebooted with the selected sensor enabled. At this point, the board is fully enabled to run the selected camera module.

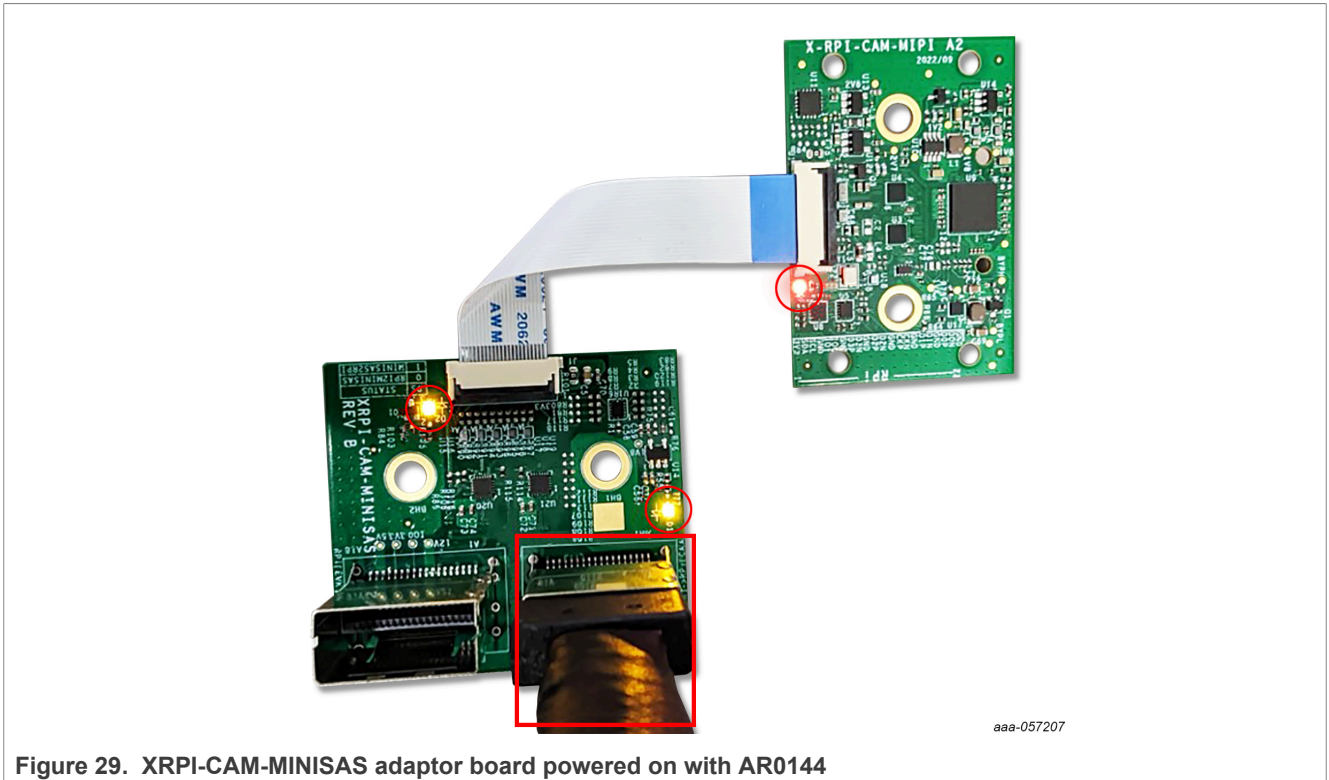
For information on connecting the AR1044 camera module to i.MX 8M Plus EVK Board via the xRPI-CAM-MINISAS adaptor board, see [Section 6.3](#).

### 6.3 Hardware connections for OnSemi AR0144 camera module

1. Power off the i.MX 8M Plus EVK board before connecting the camera module.
2. To connect the XRPI-CAM-MINISAS to the AR0144 camera connector, use the 22 pin (0.5 mm pitch) to 15 pin (1 mm pitch) FPC cable, as shown in [Figure 28](#).

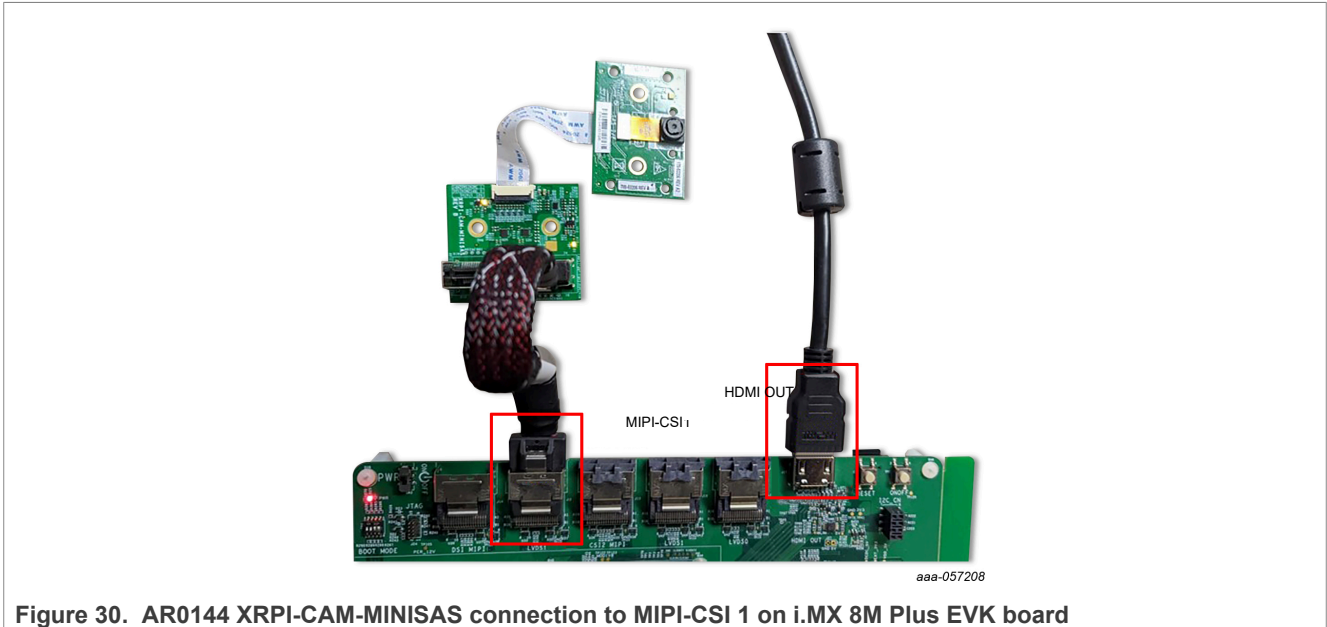


- 3. Currently, only the highlighted MINISAS connector on the XRPI-CAM-MINISAS adaptor board shown in [Figure 29](#) can be used on the XRPI-CAM-MINISAS adaptor.



- 4. Use the highlighted MIPI-CSI 1 port to connect the i.MX 8M Plus EVK board with the XRPI-CAM-MINISAS adaptor board.

5. Connect using the highlighted HDMI connector on the i.MX 8M Plus EVK board to connect to an external display.
6. Power on the board. When powered on, the two highlighted LEDs must turn on ensuring proper connection with the camera module.



### 6.4 Test AR0144 camera module

After connecting the camera module, power on the i.MX 8M Plus EVK board.

To test camera output on the external display, run the following commands:

- To test the AR0144 camera module. run the following command:

```
root@imx8mp-lpddr4-evk:~# mediactl -p
```

```
root@imx8mp-lpddr4-evk:~# mediactl -p
Media controller API version 6.6.[ 481.112937] ar0144 1-0010: get_fmt: code=0x3010, wxh=1280x800
3
Media device information
-----
driver      mxc-md
model      FSL Capture Media Device
serial
bus info    platform:32c00000.bus:camera
hw revision 0x0
driver version 6.6.3

Device topology
- entity 1: mxc-mipi-csi2.0 (8 pads, 1 link)
  type Node subtype V4L flags 0
  device node name /dev/v4l-subdev0
  pad0: Sink
    <- "ar0144 1-0010":0 [ENABLED,IMMUTABLE]
  pad1: Sink
  pad2: Sink
  pad3: Sink
  pad4: Source
  pad5: Source
  pad6: Source
  pad7: Source
- entity 10: ar0144 1-0010 (1 pad, 1 link)
  type V4L2 subdev subtype Sensor flags 0
  device node name /dev/v4l-subdev1
  pad0: Source
    [fmt:SGBRG12_1X12/1280x800 field:none]
    -> "mxc-mipi-csi2.0":0 [ENABLED,IMMUTABLE]
```

Figure 31. AR0144 camera sensor is detected



- Identify v4l2 capture device ID for VIV (platform:viv0):

```
root@imx8mp-lpddr4-evk:~# v4l2-ctl --list-device
```

```
root@imx8mp-lpddr4-evk:~# v4l2-ctl --list-devices
[ 79.408489] enter isp_mi_stop
():
  /dev/v4l-subdev0
  /dev/v4l-subdev2
  /dev/v4l-subdev3

(csi0):
  /dev/v4l-subdev1

FSL Capture Media Device (platform:32c00000.bus:camera):
  /dev/media0

VIV (platform:viv0):
  /dev/video2

vsi_v4l2dec (platform:vsi_v4l2dec):
  /dev/video1

vsi_v4l2enc (platform:vsi_v4l2enc):
  /dev/video0

viv_media (platform:vvcam-video.0):
  /dev/media1

root@imx8mp-lpddr4-evk:~# █
```

Figure 32. AR0144 v4l2 capture device

- Use `v4l2src device=</dev/video#>` as the identified v4l2 capture device ID:

```
root@imx8mp-lpddr4-evk:~# gst-launch-1.0 -v v4l2src device=/dev/video2 !
"video/x-raw,format=YUY2,width=1280,height=800" ! queue ! waylandsink
```

- Running the above Gstreamer command sets up pipeline to use the v4l2 API to use the camera device on /dev/video2, with YUV2 format at a resolution of 1920 x 1080 and use waylandsink as the display output.

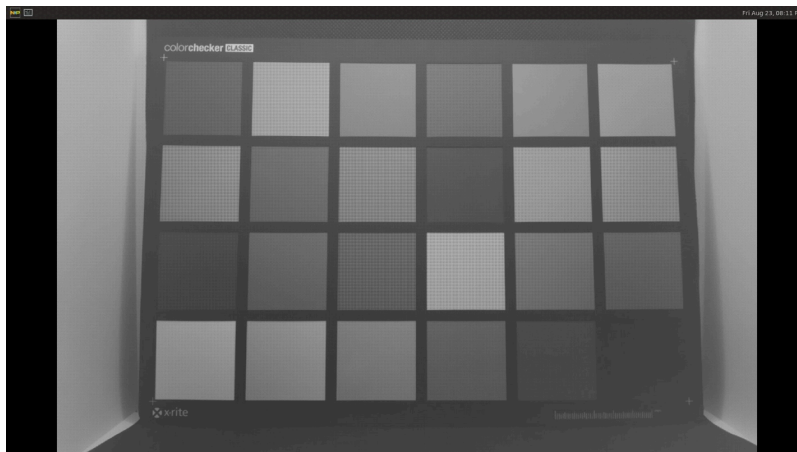


Figure 33. Monochrome capture output

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## 8 Revision history

[Table 3](#) summarizes the revisions to this document.

**Table 3. Revision history**

Document ID	Release date	Description
AN14376 v.1.0	11 September 2024	Initial public release

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