Camera Module Connection Guide for Embedded Devices

1. Introduction

- This document gives a reference setup for evaluation and PoC (Proof of Concept).

  The setup uses our Linux camera driver.

- The hardware, software, and steps in this document use one test environment. We tested this environment.

- Renesas Electronics Corporation may update its software, tools, and development environments. It may also change the configuration. Check the official Renesas Electronics Corporation documents for these changes. You must decide if each change applies to your system.

- This document does not define an official specification or the official support scope. Use it as reference information for the first test of our camera driver.

- You need basic knowledge of Linux systems and embedded software development to use this document.

1.1. Target Readers

This document is for these engineers:

- Embedded software engineers

- Embedded hardware engineers

1.2. Important Notes

- The software in this document includes open-source software (OSS), such as Linux. Follow each OSS license, such as GPL, MIT, or Apache.

- For commercial use or redistribution, check each license. Add the required notices.

- Important notes are in the main text and at the end of each chapter. Read all notes.

1.3. Revision History

The revision history shows the main changes and additions. See the main text for details.

Rev.	Issue Date	Changes
1st ed.	May 2026	

1.4. Related Documents

This document adds information for the test of our Linux camera driver. It uses official documents from Renesas Electronics Corporation as its base.

Use the official Renesas Electronics Corporation documents for the specifications, limits, and official support information for its MPUs, evaluation boards, and Linux software environments. For RZ/G2L and RZ/G2LC software and test environments, read the "RZ/G2L, RZ/G2LC Easy Download Guide" before you start.

This document does not cover all configurations and software in the official documents. It covers only the test environment that we used.

2. Hardware Configuration

This chapter shows one hardware configuration for evaluation and PoC of our Linux camera driver. We tested this configuration.

You can select the MPU, evaluation board, or SBC for your test. The interface specifications of the camera module and the target hardware must match. A mismatch can cause a malfunction or damage.

Check the pin count, pinout, voltage levels, clock, and synchronization signals. A wrong connection can cause a short circuit, communication error, or image capture error.

The requirements are stricter for a high-speed interface such as MIPI CSI-2®. Check all interface conditions with care.

Before connection and evaluation, read the specifications for the camera module and the target hardware. Check compatibility before you connect them.

If the interface specifications or voltage levels do not match, use an interface conversion board or level shifter.

We provide only the camera module as a mass-production product. You must prepare the interface conversion board, evaluation board, power supply unit, and cables. We cannot answer questions about evaluation board compatibility or other configurations. The next section shows the hardware configuration that we tested.

Table 2-1. Hardware Used

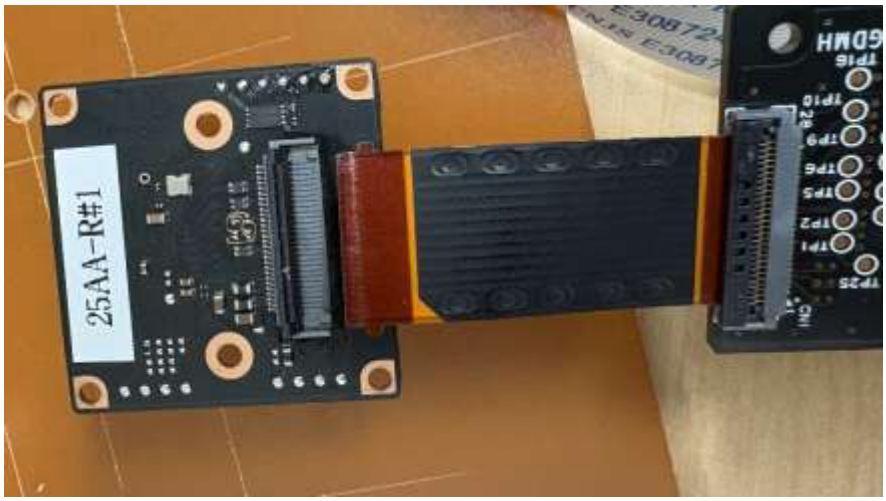
Equipment	Type	Manufacturer
RZ/G2L Evaluation Board Kit	Evaluation board	Renesas Electronics Corporation
NCM25-AA	2.5-megapixel camera module	Nippon Chemi-Con
NCM-CES-RZ	Interface conversion board	Nippon Chemi-Con
Power supply unit	—	Prepare this item.

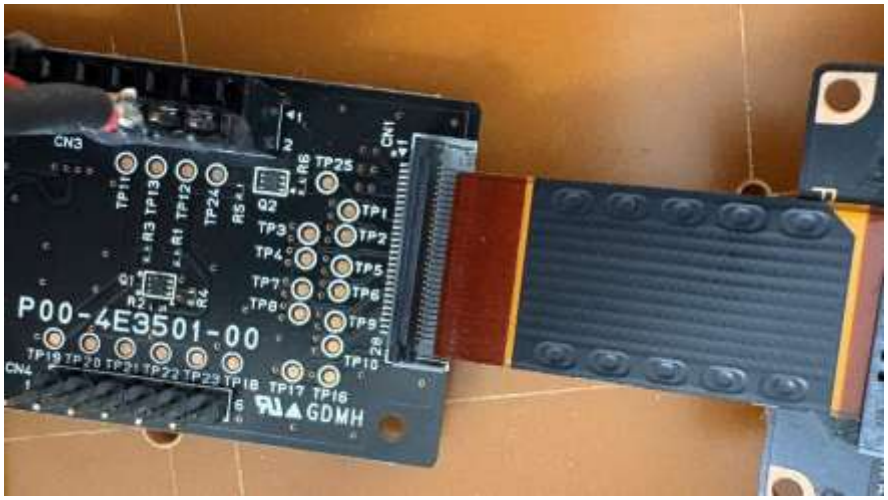
2.1. Evaluation Board Connection Steps

Use these steps to connect the Renesas Electronics Corporation evaluation board.

① Connect the NCM25AA to the NCM-CES-RZ

Put the cable between the NCM25AA and NCM-CES-RZ. Put the metal contacts toward the inside of the connector. Lock the cable in the connector.

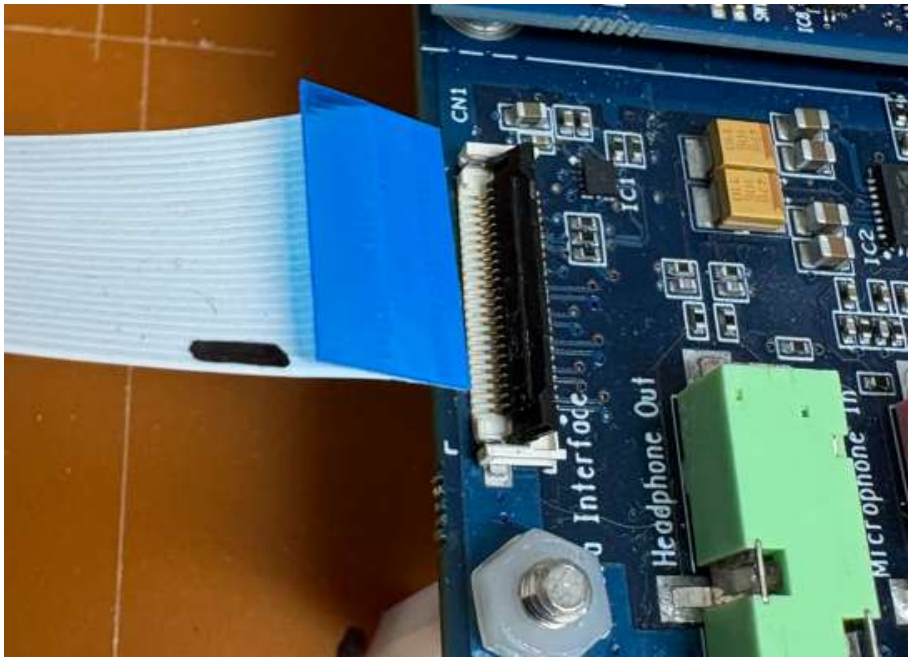




② Connect the NCM-CES-RZ to the RZ/G2L Evaluation Board Kit

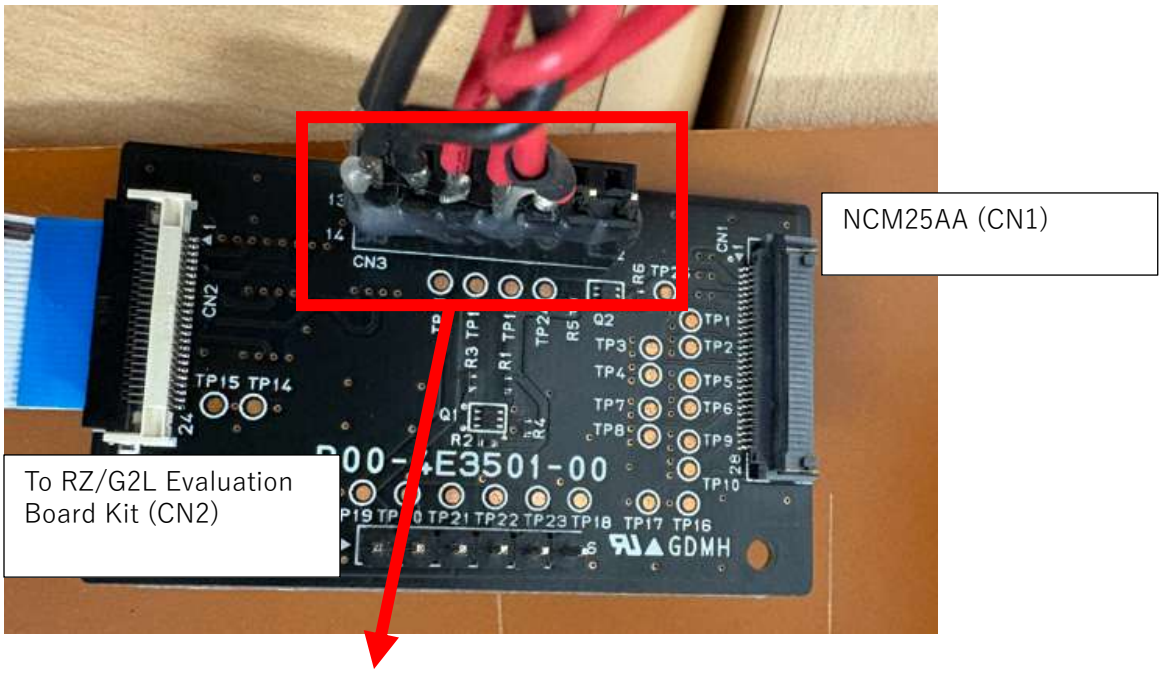
Put the cable between the NCM-CES-RZ and the RZ/G2L Evaluation Board Kit. Put the

metal contacts toward the inside of the connector. Lock the cable in the connector.



③ Connect power to the NCM-CES-RZ

Set the power supply as shown above. Use a twisted pair for +3.3 V and GND.



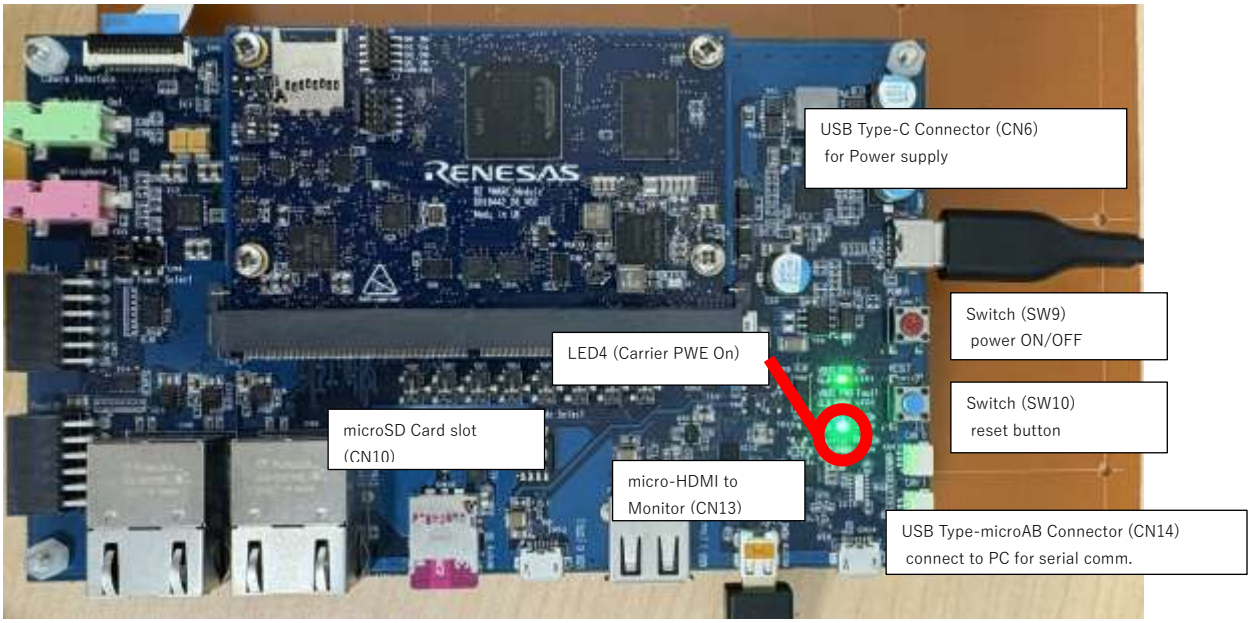
■CN3 Pin Assignment on NCM-CES-RZ

13	①						1
14	②	③	④	⑤	⑥		2

①	GND	④	+1.1V
②	GND	⑤	+1.8V
③	GND	⑥	+3.3V

④ Power and start the RZ/G2L Evaluation Board Kit

Supply 5 V through the USB Type-C connector on CN6. LED4 (Carrier PWR On) turns on. Press the red SW9 button for 2 seconds to start the board. Press SW9 for 2 seconds to turn off the board. For other start steps, see the "RZ/G2L Evaluation Board Kit Quick Start Guide" from Renesas Electronics Corporation.



3. Required Software Configuration for Camera Driver Evaluation

This chapter shows the software configuration and package requirements that we used to test our Linux camera driver.

This section only shows our test configuration. It does not explain how to build or use Linux, the Yocto Project, or the Verified Linux Package from Renesas Electronics Corporation.

For software files, build steps, and detailed use, see the official Renesas Electronics Corporation documents.

Table 3-1 shows our camera driver and related files. This document uses Verified Linux Package version 3.0.0. File names and locations can be different in a newer version. Check the latest official information.

Table 3-1. Camera Driver Files

Name	Description	Notes
Linux camera driver - ncm25aa.c Device tree files - rzg2l-smarc.dtsi	Uses the Video for Linux 2 (V4L2) framework	Download these files from our website.

3.1. Prerequisites

Before you start, check these items:

- The Yocto build environment is ready on the development host.
- The camera module is connected to the target evaluation board. Video output works.
- Back up the target system before you start. Without a backup, recovery can be difficult.

3.2. About the Driver

We made the camera module driver with information from the image sensor manufacturer.

We provide this driver for camera module evaluation and operation tests. It is one part of the test setup in this document.

For your product, check if the driver fits your system configuration and requirements. Make the required changes. For example, modularize the metadata or make a patch file.

4. Evaluation Environment Setup

This chapter shows the basic setup flow and requirements for the test of our Linux camera driver.

This section is only an example of our setup. It does not give the full build steps for the Yocto Project build environment or Verified Linux Package (VLP) from Renesas Electronics Corporation.

For the full setup and configuration steps, see the official documents.

We use the Yocto Project reference image core-image-weston. It includes Wayland/Weston. We use it to show camera video and check operation.

Enable the RZ MPU Graphics Package and RZ MPU Video Codec Package. Without these packages, you cannot check the camera video. Check the package configuration before the test.

The package configuration depends on your test environment, display method, and test purpose. For example, you can add OpenCV or AI packages. Select the packages for your system.

Table 4-1. Software Packages

File	Description
RTK0EF0045Z0021AZJ-v3.0.0.zip (VLP Version 3.0.0)	Verified Linux Package. This file includes the Yocto recipe packages and required documents.
rzg_bsp_v3.0.0.tar.gz	Yocto recipe packages
oss_pkg_v3.0.0.7z (2.2GB)	Open-source software packages
RTK0EF0045Z13001ZJ-v1.2_EN.zip	RZ MPU Graphics Library for RZ/G2L and RZ/G2LC. It provides graphics functions that follow the OpenGL ES standard.

RTK0EF0045Z15001ZJ-v0.58_EN.zip	RZ MPU Video Codec Library for RZ/G2L.

4.1.1. Set Up the Yocto Project Build Environment

These are the build environment requirements for VLP version 3.0.0. Set up the environment for the version that you use.

Table 4-2. Yocto Project Build Environment Requirements

Equipment		Description
Linux Host PC		Use it as the build and debug environment. The HDD needs at least 100 GB of free space.
	OS	Use Ubuntu 20.04 LTS 64-bit.
	TFTP Server	Use it to download the Linux kernel to the board.
	NFS server	Use it to mount the root filesystem through NFS.
Windows Host PC		Use it as a debug environment. Use terminal software to control the target board.
	OS	Windows 10
	Terminal software	Use it to control the serial console of the target board. We recommend the latest Tera Term. Get it from https://ttssh2.osdn.jp/index.html.en.
	VCP Driver	A Virtual COM Port (VCP) driver lets the Windows host PC use USB as a serial port to communicate with the target board. Get the driver from: - http://www.ftdichip.com/Drivers/VCP.htm (for ek874 and the RZ/G2L, RZ/G2LC, and RZ/G2UL Evaluation Board Kits) Install the VCP driver for your target board.

4.1.2. Install Packages on the Linux Host PC

Use these commands to set up the Yocto Project build environment on Ubuntu.

```
$ sudo apt-get update
$ sudo apt-get install gawk wget git-core diffstat unzip texinfo gcc-multilib build-essential chrpath socat cpio python3 python3-pip python3-pexpect xz-utils debianutils iputils-ping python3-git python3-jinja2 libegl1-mesa libsdl1.2-dev pylint3 xterm python3-subunit mesa-common-dev
```

Set the Git user information to prevent build errors.

```
$ git config --global user.email "you@example.com"
$ git config --global user.name "Your Name"
```

4.1.3. Create a Working Directory and Extract the Yocto Recipe Package

Extract the Yocto recipe package from Renesas.

You can use a different working directory.

```
$ mkdir ~/rzg_bsp_v3.0.0
$ cd ~/rzg_bsp_v3.0.0
$ tar zxvf ~/rzg_bsp_v3.0.0.tar.gz
```

4.1.4. Enable the GPU

To enable the GPU for core-image-weston on the RZ/G2L, use these steps. Copy the RZ MPU Graphics Package from Renesas to the working directory. Use RTK0EF0045Z13001ZJ-v1.2_EN.zip or RTK0EF0045Z13001ZJ-v1.2_JP.zip. Then run these commands.

```
$ cd ~/rzg_bsp_v3.0.0
$ unzip RTK0EF0045Z13001ZJ-v1.2_EN.zip
$ tar zxvf RTK0EF0045Z13001ZJ-v1.2_EN/meta-rz-features.tar.gz
```

4.1.5. Enable the Video Codec

To enable the video codec for core-image-weston or core-image-bsp on the RZ/G2L, use these steps. Copy the RZ MPU Video Codec Package from Renesas to the working directory. Use RTK0EF0045Z15001ZJ-v0.58_EN.zip or RTK0EF0045Z15001ZJ-v0.58_JP.zip. Then run these commands.

```
$ cd ~/rzg_bsp_v3.0.0
$ unzip RTK0EF0045Z15001ZJ-v0.58_EN.zip
$ tar zxvf RTK0EF0045Z15001ZJ-v0.58_EN/meta-rz-features.tar.gz
```

4.1.6. Set the Video Output

The default video output is LVDS. To use HDMI output, apply the patch with this command.

```
$ cd ~/rzg_bsp_v3.0.0/meta-renesas
$ patch -p1 < ../extra/0001-Add-HDMI-support-for-RZ-G2.patch
```

4.1.7. Set Up the Build Environment

Use the source command to set up the build environment.

```
$ cd ~/rzg_bsp_v3.0.0
$ source poky/oe-init-build-env
```

4.1.8. Prepare the Default Configuration Files for the Target Board

Prepare the default configuration files for the target board. Run these commands.

```
$ cd ~/rzg_bsp_v3.0.0/build
$ cp ../meta-renesas/docs/template/conf/smarc-rzg2l/*.conf ./conf/
```

4.1.9. Extract the OSS Files

To extract all OSS packages, run these commands. You can skip this step if the next step downloads the packages from the network.

```
$ cd ~/rzg_bsp_v3.0.0/build
$ 7z x ~/oss_pkg_v3.0.0.7z
```

4.1.10. Start the Build

Run this command to start the build. The image build can take several hours. The time depends on the host system.

```
$ bitbake core-image-weston
```

This build environment can build these images.

Table 4-3. Image Types Supported by VLP

Image name	Purpose
core-image-minimal	Minimal set of components
core-image-bsp	Minimal set of components, audio support, and useful tools
core-image-weston	Standard image with graphics support
core-image-qt	Enables the Qt LGPL version

The build puts the output files in the build/tmp/deploy/images directory.

The build makes these files.

Table 4-4. Generated Files

Type	File name
Linux kernel	Image-smarc-rzg2l.bin
Device tree file	Image-r9a07g044l2-smarc.dtb
Root filesystem	<image name>-smarc-rzg2l.tar.bz2
Bootloader	- bl2_bp-smarc-rzg2l_pmic.srec - fip-smarc-rzg2l_pmic.srec
Flash Writer	Flash_Writer_SCIF_RZG2L_SMARC_PMIC_DDR4_2GB_1PCS.mot

4.1.11. Build the SDK

Run this command to build the SDK. You need the SDK to make custom applications.

```
$ cd ~/rzg_bsp_v3.0.0/build
$ bitbake core-image-weston -c populate_sdk
```

The SDK installer is in build/tmp/deploy/sdk. Run the installer.

```
$ sudo sh poky-glibc-x86_64-core-image-weston-aarch64-smarc-rzg2l-toolchain-3.1.14.sh
```

The Yocto Project environment is now ready. For more information, see the official Renesas "RZ/G Verified Linux Package" document.

4.2. Integrate the NCM25AA Camera Driver

This section shows how to add the NCM25AA camera driver to this RZ/G2L Yocto Project build environment:
~/RZG2L/rzg_bsp_v3.0.0u1/
Put the ncm25aa.c source file in a directory. Then copy it to the build tree and build it.

Do these tasks:

1. Place ncm25aa.c
2. Edit the Makefile
3. Edit Kconfig
4. Edit defconfig
5. Edit .config

```
// Move to the build directory
$ cd ~/RZG2L/rzg_bsp_v3.0.0u1/build

// 1. Place ncm25aa.c
$ cp /(any directory)/ncm25aa.c ./tmp/work-shared/smarc-rzg2l/kernel-source/drivers/media/i2c/ncm25aa.c

// 2. Edit the Makefile
$ nano ./tmp/work-shared/smarc-rzg2l/kernel-source/drivers/media/i2c/Makefile
// Add obj-$(CONFIG_VIDEO_NCM25AA) += ncm25aa.o
```

```
// 3. Edit Kconfig
 $ nano ./tmp/work-shared/smarc-rzg2l/kernel-source/drivers/media/i2c/Kconfig
// Add the VIDEO_NCM25AA configuration to Kconfig
 config VIDEO_NCM25AA
tristate "Nippon Chemi-Con NCM25AA sensor support"
                depends on OF
depends on I2C && VIDEO_V4L2
select MEDIA_CONTROLLER
select VIDEO_V4L2_SUBDEV_API
select V4L2_FWNODE
help
  This is a Video4Linux2 sensor driver for the Nippon Chemi-Con NCM25AA camera.
  To build this driver as a module, select M here.
  The module name is ncm25aa.

// 4. Edit defconfig
$ nano ./tmp/work-shared/smarc-rzg2l/kernel-source/.kernel-meta/configs/defconfig
// Add CONFIG_VIDEO_NCM25AA=y to defconfig

// 5. Edit .config
$ nano ./tmp/work-shared/smarc-rzg2l/kernel-source/.meta/cfg/.config
// Add CONFIG_VIDEO_NCM25AA=y to .config
```

4.3. Edit the Device Tree (Includes the MIPI CSI-2 Two-Lane Setting)

Put rzg2l-smarc.dtsi and rz-smarc-common.dtsi in a directory. Then copy them to the RZ/G2L build tree.

```
// Copy rzg2l-smarc.dtsi
$ cp /(any directory)/rzg2l-smarc.dtsi tmp/work-shared/smarc-rzg2l/kernel-source/arch/arm64/boot/dts/renesas/

// Copy rz-smarc-common.dtsi
$ cp /(any directory)/rz-smarc-common.dtsi tmp/work-shared/smarc-rzg2l/kernel-source/arch/arm64/boot/dts/renesas/
```

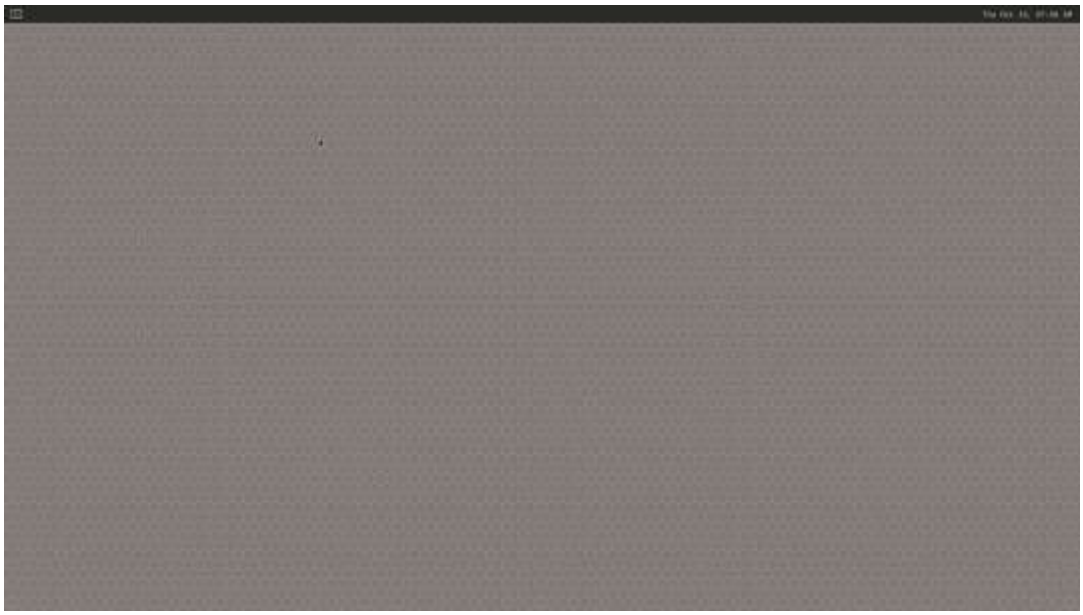
4.4. Rebuild the Kernel and Write Files to the SD Card

Build the kernel in the RZ/G2L build environment. Then copy the kernel image and device tree file to the SD card. Connect the SD card with the Linux kernel to the build host. Replace the Volume ID in the commands with the detected value.

```
// Change directory
$ cd ~/RZG2L/rzg_bsp_v3.0.0u1/build

// Prepare the kernel configuration
$ bitbake linux-renesas -f -c do_kernel_configme

// Build and deploy the kernel
$ bitbake linux-renesas -f -c do_compile
$ bitbake linux-renesas -f -c deploy

// Copy files to the SD card
$ cp ./tmp/deploy/images/smarc-rzg2l/Image-smarc-rzg2l.bin /media/rzg2l/AB09-BB2C/
$ cp ./tmp/deploy/images/smarc-rzg2l/Image-r9a07g044l2-smarc.dtb /media/rzg2l/AB09-BB2C/
```

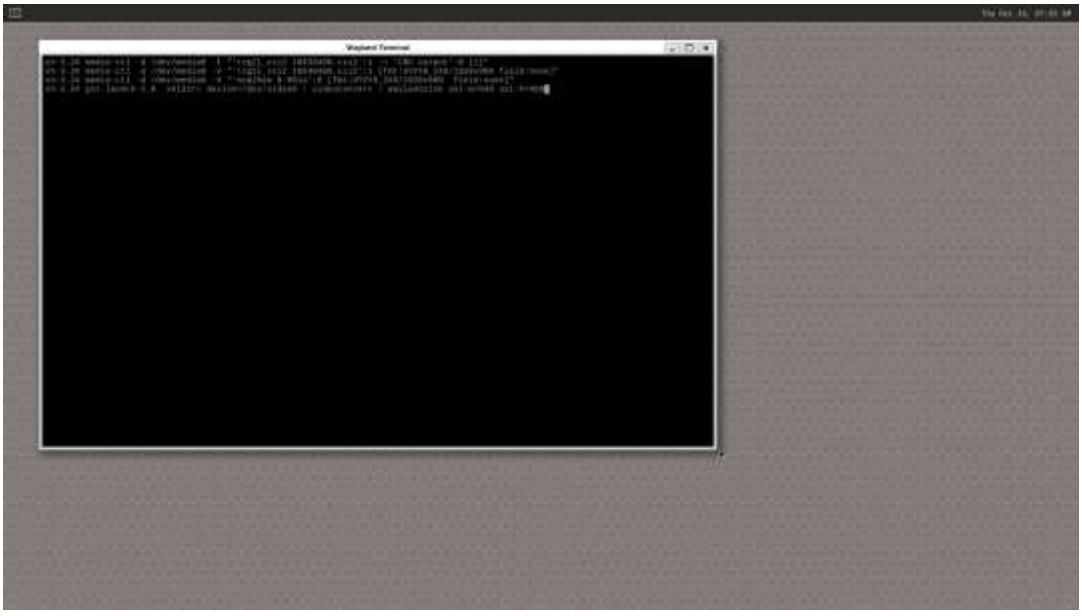
5. Operation Check and Debug

Start the evaluation board with the steps in "Evaluation Board Connection Steps." The screen below appears.



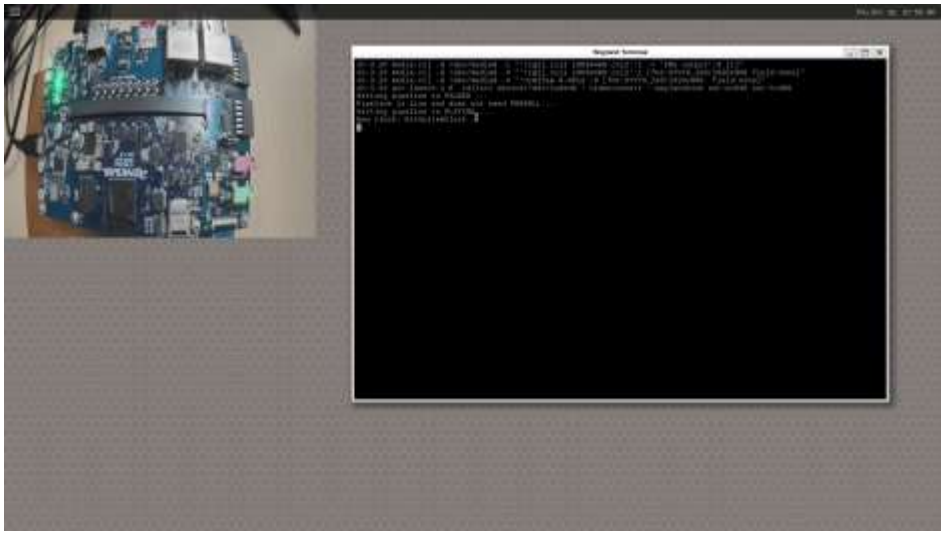
After Linux starts, turn the 3.3 V power OFF and then ON. This resets the camera module.

Click the terminal icon at the upper left. Run these commands to show the camera video.



```
$ media-ctl -d /dev/media0 -l "'rzg2l_csi2 10830400.csi2':1 -> 'CRU output':0 [1]"
$ media-ctl -d /dev/media0 -V "'rzg2l_csi2 10830400.csi2':1 [fmt:UYVY8_2X8/1920x960 field:none]"
$ media-ctl -d /dev/media0 -V "'ncm25aa 0-001a':0 [fmt:UYVY8_2X8/1920x960  field:none]"
$ gst-launch-1.0  v4l2src device=/dev/video0 ! videoconvert ! waylandsink out-w=640 out-h=480
```

The monitor connected by HDMI shows the camera video.



Press Ctrl+Q to stop the command and the camera video.

6. Applications and Extensions

Many edge AI and IoT systems connect a camera module to an embedded device and capture images.

Examples are visual inspection on a production line, smart city monitoring, and crop monitoring. Check these points when you select a camera module:

- Resolution: Select the pixel count for the application. A high-resolution sensor can find small scratches or surface defects.
- Frame rate: Use a high frame rate when the system needs real-time operation.
- Shutter type: A global shutter is good for moving objects.
- Color reproduction: Use an ISP or a high-performance sensor when the system needs accurate color.

Table 6-1. Nippon Chemi-Con Camera Module Examples

Product	Resolution / fps	Application
NCM20-XA	2 megapixels / up to 100 fps	Industrial equipment
NCM25-AA	2.5 megapixels / up to 60 fps	Automotive only, with ISP
NCM30-AA	3 megapixels / up to 30 fps	Industrial and automotive, with
NCM30-AB	2 megapixels / up to 30 fps	Industrial and automotive, with

Product specifications can change. Check our website for the latest product information.

7. Reference Documents and Links

Use these links for more information:
- Renesas official Verified Linux Package page
- Renesas official Evaluation Board Kit for RZ/G2L MPU
- Yocto Project official website: https://www.yoctoproject.org/
- Nippon Chemi-Con technical documents:

8. OSS Notes

This chapter gives important notes about open-source software (OSS).

OSS can help fast development. You must also follow the licenses and manage security risks. If you have a question, ask an OSS license expert.

Check these points when you use OSS:

1. License rules: Use OSS under the license terms from the copyright holder.
2. Security risks: When you find a vulnerability, update the software or apply a patch quickly.
3. Support limits: OSS often has no official support. The user must solve problems.
4. Legal risks: A license violation can be copyright infringement. It can cause legal liability.

Terms of Use

These Terms apply to documents and source code for the design of equipment with Nippon Chemi-Con camera modules. In these Terms, they are called "the Materials." Nippon Chemi-Con Corporation is called "the Company." You must follow these Terms.

Article 1 Prohibited Acts

You must not do these acts:

1. Use the Materials only as reference information for an evaluation environment or PoC (Proof of Concept). Do not use them for another purpose, such as a reliability test.

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You agree to these Terms when you download or use the Materials. We may change these Terms without notice. The Company may end these Terms at any time for any reason. If the Company ends these Terms, you must destroy the Materials. If the Company asks, you must give written proof that you destroyed them.

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Article 6 Court of Jurisdiction

Unless another rule applies, the Tokyo District Court has exclusive jurisdiction as the court of first instance for all disputes about the Materials.