

Linux Interface Specification Video Capture

User's Manual: Software

RZ/G2L Group, RZ/V2L Group,
RZ/V2N Group, RZ/V2H Group and RZ/G3E Group

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(Rev.1.15 Mar 2026)

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General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)

A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.

2. Processing at power-on

The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.

3. Input of signal during power-off state

Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.

4. Handling of unused pins

Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.

5. Clock signals

After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.

6. Voltage application waveform at input pin

Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).

7. Prohibition of access to reserved addresses

Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.

8. Differences between products

Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

How to Use This Manual

1. Purpose and Target Readers

This manual is designed to provide the user with an understanding of the hardware functions and electrical characteristics of the MPU. It is intended for users designing application systems incorporating the MPU.. It is intended for users developing software incorporating the processors. A basic knowledge of software development and Linux systems is necessary in order to use this document.

Particular attention should be paid to the precautionary notes when using the manual. These notes occur within the body of the text, at the end of each section, and in the Usage Notes section.

The revision history summarizes the locations of revisions and additions. It does not list all revisions. Refer to the text of the manual for details.

The following documents apply to the RZ/G2L Group, RZ/V2L Group, RZ/V2N Group, RZ/V2H Group and RZ/G3E Group. Make sure to refer to the latest versions of these documents. The newest versions of the documents listed may be obtained from the Renesas Electronics Web site.

Document Type	Description	Document Title	Document No.
User's manual for Hardware	Hardware specifications (pin assignments, memory maps, peripheral function specifications, electrical characteristics, timing charts) and operation description Note: Refer to the application notes for details on using peripheral functions.	RZ/G2L Group User's Manual: Hardware	---
		RZ/V2L Group User's Manual: Hardware	---
		RZ/V2N Group User's Manual: Hardware	---
		RZ/V2H Group User's Manual: Hardware	
		RZ/G3E Group User's Manual: Hardware	---
User's manual for Software	Description of Video Capture Linux interface Specification	Linux interface Specification Device Driver Video Capture	This user's manual
Application Note	Information on using peripheral functions and application examples Sample programs Information on writing programs in assembly language and C	Available from Renesas Electronics Web site.	
Renesas Technical Update	Product specifications, updates on documents, etc.		

2. Notation of Numbers and Symbols

3. Register Notation

4. List of Abbreviations and Acronyms

Abbreviation	Full Form
CRU	Camera data Receiving Unit
V4L2	Video For Linux Two
MIPI CSI-2	MIPI Camera Serial Interface 2
VC	Virtual Channel

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1. Overview

1.1 Overview

This manual explains the Linux Video capture (CRU) device driver in the RZ/G2L Group, RZ/V2L Group, RZ/V2N Group, RZ/V2H Group and RZ/G3E Group.

Note: Currently, this device is supported in two kernel versions v5.10 and v6.1 with the information below:

- v5.10: RZ/G2L Group, RZ/V2L Group.
- v6.1: RZ/G2L Group, RZ/V2L Group, RZ/V2N Group, RZ/V2H Group and RZ/G3E Group.

1.2 General Function

The CRU consists of a MIPI CSI-2 block and an Image Processing block.

1.2.1 MIPI CSI-2

The MIPI CSI-2 is a MIPI Camera Serial Interface 2 receiver module.

RZ/G2L Group and RZ/V2L:

Supports Link MIPI CSI-2 v2.1 and MIPI D-PHY v2.1 (80Mbps ~ 1500Mbps)

RZ/G3E, RZ/V2H and RZ/V2N:

Supports Link MIPI CSI-2 v2.1 and MIPI D-PHY v1.2 (80Mbps ~ 2100Mbps)

The image signal received by the MIPI-CSI2 is output to the Image Processing module with following features:

- Support 1/2/4 lanes.
- Support some available input data format:
 - YCbCr/YUV422 8-bit
 - YCbCr/YUV422 10-bit
 - RGB565
 - RGB666
 - RGB888
 - RAW8/10/12/14/16
- Support 4 Virtual Channels.

1.2.2 Image Processing Block

- This block can receive video data received from the external Digital Parallel Interface (including ITU-R BT.656) or MIPI CSI-2 block and perform appropriate image processing for each.

Table 1-1 Features support on RZ/G2L Group, RZ/V2L Group, RZ/V2N Group, RZ/V2H Group and RZ/G3E Group

Features	RZ/G2L Group and RZ/V2L Group	RZ/V2N Group, RZ/V2H Group and RZ/G3E Group
Available input formats	Bayer, RGB, YUV	Bayer, RGB, YUV
Digital Parallel Interface	YCbCr, 16-bit binary.	Not Supported
Color space conversion	YCbCr422 ⇔ RGB888	YCbCr422 ⇔ RGB888
Demosaicing	Bilinear Method to demosaic RAW8/10/12/14/16 formats to RGB888 format.	Not Supported.
Linear Matrix	Supported	Not Supported
Statistics (Statistical processing operation)	Horizontal detection area 320~2048 pixels and vertical detection area 240~4080. Accumulate from RAW8, 10, 12, 14 and 16 data in the area (16x16, 32x32, 64x64, 128x128) Absolute sum operation of G adjacent pixel value difference from RAW8,10,12,14,16 data)	Not Supported
Output data formats (Only little endian is supported)	YCbCr422 Y component extraction from YCbCr422 RGB-888 (24 bits/pixel) RGB-888 (32 bits/pixel) ARGB-8888 (32 bits/pixel) RAW8,10,12,14,16 16-bit binary (parallel input only)	YCbCr422 Y component extraction from YCbCr422 RGB-888 (24 bits/pixel) RGB-888 (32 bits/pixel) ARGB-8888 (32 bits/pixel) RAW8,10,12,14,16
Pattern Generator (for debugging):	Output Y, U, V values.	Output Y, U, V values.

1.3 Reference

1.3.1 Standard

The following table shows the standard that this module corresponds.

<https://linuxtv.org/downloads/v4l-dvb-apis/userspace-api/index.html>

Table 1-2 Standard of V4L2 API

Title	Edition	Link
Linux Media Infrastructure userspace API		https://linuxtv.org/downloads/v4l-dvb-apis/userspace-api/index.html

1.3.2 Related document

The following table shows the document related to this module.

Table 1-3 Related documents

Issue	Title	Edition	Date
Coral Camera Datasheet	Camera Datasheet	Rev.1.1	Oct. 2020
Camera Sensor OV5645	OmniVision_OV5645	Rev.1.0	Oct. 2012

1.4 Restrictions

There is no restriction in this module

2. Terminology

The following table shows the terminology related to this module.

Table 2-1 Terminology

Terms	Explanation
CRU	Camera data Receiving Unit
V4L2	Video For Linux Two
MIPI CSI-2	MIPI Camera Serial Interface 2
VC	Virtual Channel

3. Operating Environment

3.1 Hardware Environment

The following table lists the hardware needed to use this module.

Table 3-1 Hardware Environment

Name	Product number
RZ/G2L Evaluation Board Kit	RTK9744L23S01000BE
RZ/G2LC Evaluation Board Kit	RTK9744C22S01000BE
RZ/G2UL Evaluation Board Kit	RTK9743U11S01000BE
RZ/V2L Evaluation Board Kit	RTK9754L23S01000BE
RZ/V2N Evaluation Board Kit V1.0	RTK0EF0186C03000BJ
RZ/V2N Evaluation Board Kit V2.0	RTK0EF0186C03001BJ
RZ/V2H Evaluation Board Kit	RTK0EF0168C04000BJ
RZ/G3E Evaluation Board Kit	RTK9947E57S01000BE

3.2 Module Configuration

The following figures show the configuration of this module on RZ/V2L, RZ/G2L Group, RZ/V2N, RZ/V2H and RZ/G3E

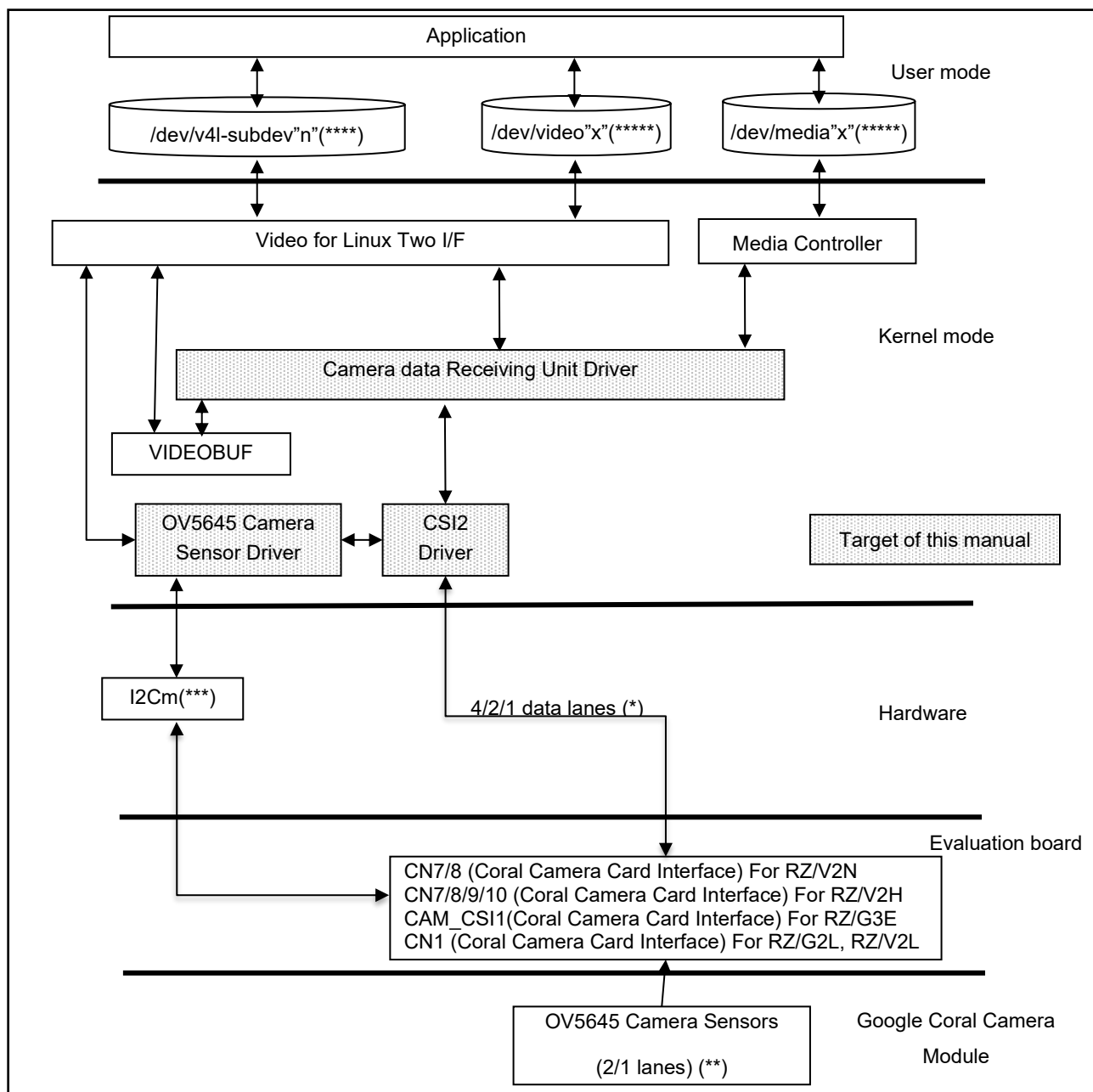


Figure 3-1 Module Configuration

Note:

- (*) MIPI CSI2 module can support 4/2/1 data lanes.
- (**) OV5645 camera sensor can support 2/1 data lanes.
- (***) $m = 0$ to 1 for RZ/V2N, $m = 0, 1, 6, 7$ for RZ/V2H and $m = 0$ for RZ/G3E, RZ/G2L and RZ/V2L.
- (****) $n = 0$ to 5 for RZ/V2N, $n = 0$ to 11 for RZ/V2H and $n = 0$ to 2 for RZ/G3E, RZ/G2L Group and RZ/V2L since rz-5.10-cip54 and later, $n = 0$ to 1 for RZ/G2L Group and RZ/V2L from rz-5.10-cip41 and earlier.
- (*****) $x = 0$ to 1 for RZ/V2N, $x = 0$ to 3 for RZ/V2H and $x = 0$ for RZ/G3E, RZ/G2L and RZ/V2L.

3.3 State Transition Diagram

There is no state transition diagram for this module.

4. Function

This module controls the Image processing module and CSI2 on RZ/G2L, RZ/V2L, RZ/V2N, RZ/V2H and RZ/G3E supports the camera data receiving function. This module supports signal from the OV5645 camera sensor in RZ/G2L, RZ/V2L, RZ/V2N, RZ/V2H and RZ/G3E Evaluation Board Kit.

4.1 Connected Device

The following tables specify connectors connected to CRU on RZ/G2L Evaluation Board Kit, RZ/V2N Evaluation Board Kit, RZ/V2H Evaluation Board Kit and RZ/G3E SMARC Evaluation Board Kit.

Table 4-1 CRU connection (RZ/G2L Group, RZ/V2L, RZ/V2N, RZ/V2H and RZ/G3E)

Device	Interface	Camera Input Connector	Supporting Status
RZ/V2N	MIPI CSI2	CN7/8 (Coral Camera Card Interface)	Yes
RZ/V2H	MIPI CSI2	CN7/8/9/10 (Coral Camera Card Interface)	Yes
RZ/G3E	MIPI CSI2	CAM_CSI1 (Coral Camera Card Interface)	Yes
RZ/G2L Group, RZ/V2L	MIPI CSI2	CN1 (Coral Camera Card Interface)	Yes

4.2 Input / Output Format

The following table shows the Input/output format for this module.

Table 4-2 Input/output format

Input format for CSI2/CRU		Output formats from OV5645	Media bus pixel code that this module supports
Width of bits	Data format		
8bit	YCbCr422	Yes	MEDIA_BUS_FMT_UYVY8_2X8/ MEDIA_BUS_FMT_UYVY8_1X16(*)

(*) MEDIA_BUS_FMT_UYVY8_2X8 for rz-5.10, MEDIA_BUS_FMT_UYVY8_1X16 for rz-6.1

Table 4-3 Output format

Output formats from CRU	Output formats for this module	Pixel format definition macro in V4L2
YUYV	Yes	V4L2_PIX_FMT_YUYV
UYVY	Yes	V4L2_PIX_FMT_UYVY
GREY	Yes	V4L2_PIX_FMT_GREY
BGR24	Yes	V4L2_PIX_FMT_BGR24
XBGR32	Yes	V4L2_PIX_FMT_XBGR32
ABGR32	Yes	V4L2_PIX_FMT_ABGR32
ARGB32	Yes	V4L2_PIX_FMT_ARGB32
NV16	Yes	V4L2_PIX_FMT_NV16

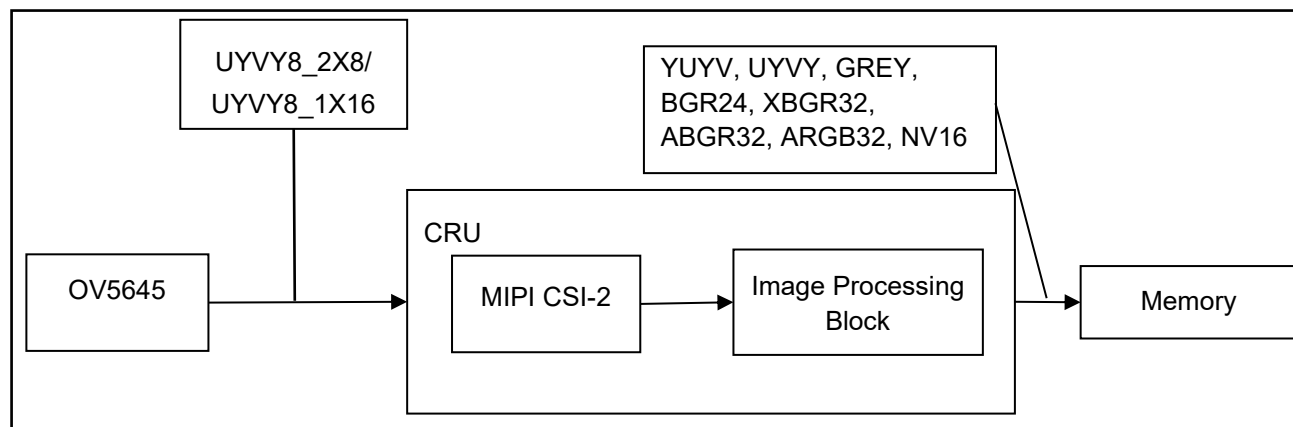


Figure 4-1 Flow of data

4.3 Input Resolution

The following table shows the input resolution for this module which outputs from all available resolution of OV5645 camera sensor.

Table 4-4 Input resolution

Input resolution for this module	RZ/G2L and RZ/V2L	RZ/V2N, RZ/V2H and RZ/G3E
2592x1944	Yes	No (*)
1920x1080	Yes	Yes
1280x960	Yes	Yes

(*) The Image Stride must be aligned with 128.

4.4 Hardware Parameters

This module supports VIDIOC_S_CTRL for CRU and OV5645 camera sensor.

Hardware control parameters of camera sensor OV5645 can be set as following table.

Table 4-5 Hardware input control of camera sensor OV5645

Item	V4L2 Command ID	Default	Range
Exposure	V4L2_CID_EXPOSURE_AUTO	Auto	Auto / Manual
Gain	V4L2_CID_AUTOGAIN	Auto	Auto / Manual
Auto white balance	V4L2_CID_AUTO_WHITE_BALANCE	Auto	Auto / Manual
Saturation	V4L2_CID_SATURATION	64	0 - 255
Test pattern	V4L2_CID_TEST_PATTERN	None	- Vertical Color Bars - Pseudo-Random Data - Color Square - Black Image

Hardware control parameters of CRU can be set as following table.

Table 4-6 Hardware input control of CRU

Item	V4L2 Command ID	Default	Range
Minimum buffers for capture ⁽¹⁾	V4L2_CID_MIN_BUFFERS_FOR_CAPTURE	3	2 - 8
Skipping Frames Enable/Disable ⁽²⁾	V4L2_CID_CRU_FRAME_SKIP	0	0 - 127
Statistics Feature Enable/Disable ⁽³⁾	V4L2_CID_CRU_STATISTICS	0	0 - 1
Statistics Data Unit Blocksize ⁽³⁾	V4L2_CID_CRU_SD_BLKSIZE	0	0 – 3 with below values: (0: 16x16; 1: 32x32; 2: 64x64; 3: 128x128)
Statistics Horizontal Start Position ⁽³⁾	V4L2_CID_CRU_SD_STHPOS	0	0 – 376
Statistics Input Data Bit Position ⁽³⁾	V4L2_CID_CRU_SD_STSADPOS	0	0 - 8
Linear Matrix Processing Enable/Disable ⁽⁴⁾	V4L2_CID_CRU_LINEAR_MATRIX	0	0 - 1
Linear Matrix R/G/B offset ⁽⁴⁾	V4L2_CID_CRU_LINEAR_MATRIX_ROF, V4L2_CID_CRU_LINEAR_MATRIX_GOF, V4L2_CID_CRU_LINEAR_MATRIX_BOF	0	(-128) - 127
Linear Matrix RR/RG/RB coefficient ⁽⁴⁾	V4L2_CID_CRU_LINEAR_MATRIX_RR, V4L2_CID_CRU_LINEAR_MATRIX_RG, V4L2_CID_CRU_LINEAR_MATRIX_RB	0	(-4096) - 4095
Linear Matrix GR/GG/GB coefficient ⁽⁴⁾	V4L2_CID_CRU_LINEAR_MATRIX_GR, V4L2_CID_CRU_LINEAR_MATRIX_GG, V4L2_CID_CRU_LINEAR_MATRIX_GB	0	(-4096) - 4095
Linear Matrix BR/BG/BB coefficient ⁽⁴⁾	V4L2_CID_CRU_LINEAR_MATRIX_BR, V4L2_CID_CRU_LINEAR_MATRIX_BG, V4L2_CID_CRU_LINEAR_MATRIX_BB	0	(-4096) - 4095

⁽¹⁾ This parameter presented for the available amount of hardware buffers that CRU can support.

Note:

To ensure stable performance, please set the number of capture buffers in userspace higher than value of CRU Hardware buffers. Usually, we should set as below formula:

$$\text{num_bufs_capture_userapp} = \text{minimum_buffers_for_capture} + 2$$

⁽²⁾ This parameter presented for the skipping frames feature that CRU can support to wait stability state from camera sensor. When set this control to n: 1~127, first n frames are skipped and CRU will get frames after that.

⁽³⁾ All these parameters presented for Statistics feature. To enable this feature, user needs to set V4L2_CID_CRU_STATISTICS to 1 then adjust all remained statistics parameters.

⁽⁴⁾ All these parameters presented for Linear Matrix color correction feature. To enable this feature, user needs to set V4L2_CID_CRU_LINEAR_MATRIX to 1 then adjust all remained RGB offset parameters.

4.5 Field order

This module supports interlaced image in addition to progressive image. The setting value shown in the

The setting value can be specified to use VIDIOC_S_FMT interface.

Table 4-7 Field order

Setting Value	Content
V4L2_FIELD_NONE ^{*1}	Images are in progressive format, not interlaced. Output the image in 1 frame unit.
V4L2_FIELD_INTERLACED_TB	Images contain both fields, interleaved line by line, top field first. The top field is transmitted first. Top field is set odd field. (Full interlace capture mode)
V4L2_FIELD_INTERLACED_BT	Images contain both fields, interleaved line by line, top field first. The bottom field is transmitted first. Top field is set even field. (Full interlace capture mode)
V4L2_FIELD_INTERLACED	Capture with top field first or bottom field first depending on the input signal. (Full interlace capture mode)

Note: ^{*1} This module prohibits to set the value of V4L2_FIELD_NONE in interlaced input.

Currently, OV5645 camera sensor just only support progressive format (V4L2_FIELD_NONE).

5. External Interface

The external interface of this module is based on V4L2 Two API. The device node of this module is shown below.

Table 5-1 CRU device node (RZ/G2L, RZ/G2LC, RZ/G2UL, RZ/V2L, RZ/G3E)

Camera sensor OV5645 Input	Device node	Major number	Minor number
OV5645	/dev/video0	81	3

Table 5-2 CRU device node RZ/V2N

Camera sensor OV5645 Input	Device node	Major number	Minor number
OV5645	/dev/video0	81	3
OV5645	/dev/video1	81	7

Table 5-3 CRU device node RZ/V2H

Camera sensor OV5645 Input	Device node	Major number	Minor number
OV5645	/dev/video0	81	3
OV5645	/dev/video1	81	7
OV5645	/dev/video2	81	8
OV5645	/dev/video3	81	9

Table 5-4 Media controller device node (RZ/G2L, RZ/G2LC, RZ/G2UL, RZ/V2L, RZ/G3E)

Device node	Major number	Minor number
/dev/media0	252	0

Table 5-5 Media controller device node RZ/V2N

Device node	Major number	Minor number
/dev/media0	252	0
/dev/media1	252	1

Table 5-6 Media controller device node RZ/V2H

Device node	Major number	Minor number
/dev/media0	252	0
/dev/media1	252	1
/dev/media2	252	2
/dev/media3	252	3

Table 5-7 Subdevice nodes (RZ/G2L, RZ/G2LC, RZ/G2UL, RZ/V2L, RZ/G3E)

Device node	Major number	Minor number	Remark
/dev/v4l-subdev0	81	0	for controlling MIPI CSI2
/dev/v4l-subdev1	81	1	for controlling OV5645 camera sensor
/dev/v4l-subdev2(*)	81	2	for controlling Image Processing

Table 5-8 Subdevice nodes RZ/V2N

Device node	Major number	Minor number	Remark
/dev/v4l-subdev0/1/3/4	81	0/1/4/5	for controlling MIPI CSI2
/dev/v4l-subdev2/5	81	2/4	for controlling OV5645 camera sensor

Table 5-9 Subdevice nodes RZ/V2H

Device node	Major number	Minor number	Remark
/dev/v4l-subdev0/3/6/9	81	0	for controlling MIPI CSI2
/dev/v4l-subdev1/4/7/10	81	1	for controlling OV5645 camera sensor
/dev/v4l-subdev2/5/8/11	81	2	for controlling Image Processing

(*) since rz-5.10-cip54 and later for RZ/G2L Group and RZ/V2L Group

5.1 Media Controller API

This ability not only works with a local digital subdevice directly attached to a CRU instance in a 1:1 mapping but to be part of a CSI-2 group which share a set of video decoders and CSI-2.

5.1.1 Show current routing

Examine the current routing setup with '**media-ctl -d /dev/media0 -p**'.

media-ctl -d /dev/media0 -p

Example)

With kernel version rz-5.10-cip41 or earlier

```
Media controller API version 5.10.184

Media device information
-----
driver            rzg2l_cru
model             renesas,cru-r9a07g044
serial
bus info          platform:10830000.video
hw revision       0x0
driver version    5.10.184

Device topology
- entity 1: rzg2l_csi2 10830400.csi2 (5 pads, 5 links)
    type V4L2 subdev subtype Unknown flags 0
    device node name /dev/v4l-subdev0
    pad0: Sink
        [fmt:unknown/0x0]
        <- "ov5645 0-003c":0 [ENABLED,IMMUTABLE]
    pad1: Source
        [fmt:unknown/0x0]
        -> "CRU output":0 []
    pad2: Source
        [fmt:unknown/0x0]
        -> "CRU output":0 []
    pad3: Source
        [fmt:unknown/0x0]
        -> "CRU output":0 []
    pad4: Source
        [fmt:unknown/0x0]
        -> "CRU output":0 []
- entity 7: ov5645 0-003c (1 pad, 1 link)
    type V4L2 subdev subtype Sensor flags 0
    device node name /dev/v4l-subdev1
    pad0: Source
        [fmt:UYVY8_2X8/1920x1080 field:none colorspace:srgb
        crop:(0,0)/1920x1080]
        -> "rzg2l_csi2 10830400.csi2":0 [ENABLED,IMMUTABLE]
- entity 15: CRU output (1 pad, 4 links)
    type Node subtype V4L flags 0
    device node name /dev/video0
    pad0: Sink
        <- "rzg2l_csi2 10830400.csi2":1 []
        <- "rzg2l_csi2 10830400.csi2":2 []
        <- "rzg2l_csi2 10830400.csi2":3 []
        <- "rzg2l_csi2 10830400.csi2":4 []
```

Figure 5-1 Current routing for RZ/G2L Group and RZ/V2L Group

Starting from kernel version rz-5.10-cip54 and rz-6.1-cip28.

Media controller API version 6.1.107

Media device information

```
-----
driver      rzg2l_cru
model      renesas, rzv2n-cru
serial
bus info    platform:16010000.cru1
hw revision 0x0
driver version 6.1.107
```

Device topology

```
- entity 1: csi-16010400.csi21 (2 pads, 2 links, 0 routes)
    type V4L2 subdev subtype Unknown flags 0
    device node name /dev/v4l-subdev3
    pad0: Sink
        [stream:0 fmt:UYVY8_1X16/320x240 field:none colorspace:srgb]
        <- "ov5645 1-003c":0 [ENABLED,IMMUTABLE]
    pad1: Source
        [stream:0 fmt:UYVY8_1X16/320x240 field:none colorspace:srgb]
        -> "cru-ip-16010000.cru1":0 [ENABLED,IMMUTABLE]

- entity 4: ov5645 1-003c (1 pad, 1 link, 0 routes)
    type V4L2 subdev subtype Sensor flags 0
    device node name /dev/v4l-subdev4
    pad0: Source
        [stream:0 fmt:unknown/0x0
        crop:(0,0)/1920x1080]
        -> "csi-16010400.csi21":0 [ENABLED,IMMUTABLE]

- entity 8: cru-ip-16010000.cru1 (2 pads, 2 links, 0 routes)
    type V4L2 subdev subtype Unknown flags 0
    device node name /dev/v4l-subdev5
    pad0: Sink
        [stream:0 fmt:UYVY8_1X16/320x240 field:none colorspace:srgb]
        <- "csi-16010400.csi21":1 [ENABLED,IMMUTABLE]
    pad1: Source
        [stream:0 fmt:UYVY8_1X16/320x240 field:none colorspace:srgb]
        -> "CRU output":0 [ENABLED,IMMUTABLE]

- entity 17: CRU output (1 pad, 1 link)
    type Node subtype V4L flags 0
    device node name /dev/video1
    pad0: Sink
        <- "cru-ip-16010000.cru1":1 [ENABLED,IMMUTABLE]
```

Figure 5-2 Current routing for RZ/V2N Group, RZ/V2H Group and RZ/G3E Group

5.1.2 Activate/Deactivate a link

The Media Controller framework allows user-space to enable/disable a link and that way control the routing of video data. A link is always configured from a CSI-2 instance to a CRU instance, through CRU IP, the same way the video data is flowing. To enable a link, we use the “media-ctl” utility from v4l-utils package:

With kernel version rz-5.10-cip41 or earlier

```
# media-ctl -d /dev/media0 -l "rzg2l_csi2 10830400.csi2":1 -> 'CRU output':0 [1]"
```

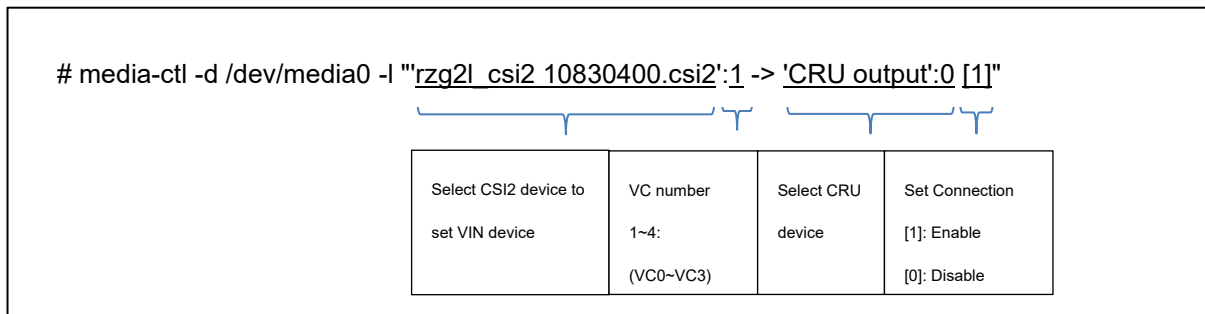


Figure 5-3 Link CSI2 ⇔ CRU

To disable the same link use:

```
# media-ctl -d /dev/media0 -l "rzg2l_csi2 10830400.csi2":1 -> 'CRU output':0 [0]"
```

Starting from kernel version rz-5.10-cip54 and rz-6.1-cip28.

```
# media-ctl -d /dev/media0 -l "rzg2l_csi2 10830400.csi2":1 -> 'cru-ip-10830000.video':0 [1]"
```

```
# media-ctl -d /dev/media0 -l "cru-ip-10830000.video":1 -> 'CRU output':0 [1]"
```

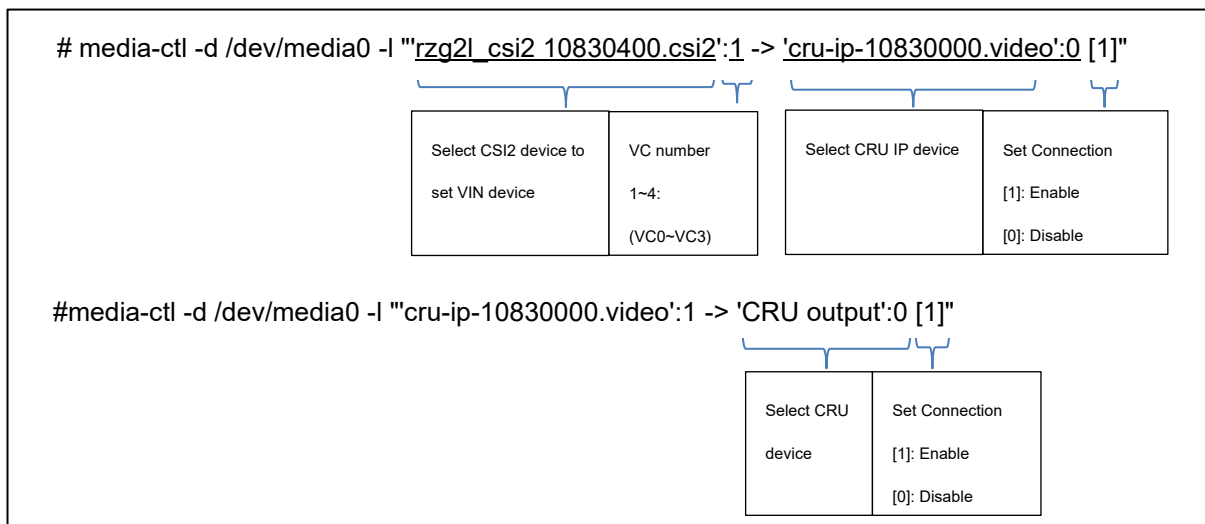


Figure 5-4 Link CSI2 ⇔ CRU-IP ⇔ CRU output

To disable the same link use:

```
# media-ctl -d /dev/media0 -l "rzg2l_csi2 10830400.csi2":1 -> 'cru-ip-10830000.video':0 [0]"
```

```
# media-ctl -d /dev/media0 -l "cru-ip-10830000.video":1 -> 'CRU output':0 [0]"
```

5.1.3 Configuring the pipeline and propagate format

Once the user has configured a pipeline using 'media-ctl' as described 5.1.2 the format needs to be propagated in the pipeline before streaming can start (The capture cannot be performed unless it is set). Please run deactivate all active links as described at 5.1.4 before you run configuring the pipeline and propagate format (The capture cannot be performed unless it is run). The following shows an example of the execution command.

With kernel version rz-5.10-cip41 or earlier

- **1280x960:**

```
# media-ctl -d /dev/media0 -V ""rzg2l_csi2 10830400.csi2':1 [fmt:UYVY8_2X8/1280x960 field:none]"
# media-ctl -d /dev/media0 -V ""ov5645 0-003c':0 [fmt:UYVY8_2X8/1280x960 field:none]"
```

- **1920x1080:**

```
# media-ctl -d /dev/media0 -V ""rzg2l_csi2 10830400.csi2':1 [fmt:UYVY8_2X8/1920x1080 field:none]"
# media-ctl -d /dev/media0 -V ""ov5645 0-003c':0 [fmt:UYVY8_2X8/1920x1080 field:none]"
```

- **2592x1944:**

```
# media-ctl -d /dev/media0 -V ""rzg2l_csi2 10830400.csi2':1 [fmt:UYVY8_2X8/2592x1944 field:none]"
# media-ctl -d /dev/media0 -V ""ov5645 0-003c':0 [fmt:UYVY8_2X8/2592x1944 field:none]"
```

Starting from kernel version rz-5.10-cip54 and rz-6.1-cip28.

- **1280x960:**

```
# media-ctl -d /dev/media0 -V ""rzg2l_csi2 10830400.csi2':1 [fmt:UYVY8_2X8(*)/1280x960 field:none]"
# media-ctl -d /dev/media0 -V ""ov5645 0-003c':0 [fmt:UYVY8_2X8(*)/1280x960 field:none]"
# media-ctl -d /dev/media0 -V ""cru-ip-10830000.video' :0 [fmt:UYVY8_2X8(*)/1280x960 field:none]"
# media-ctl -d /dev/media0 -V ""cru-ip-10830000.video' :1 [fmt:UYVY8_2X8(*)/1280x960 field:none]"
```

- **1920x1080:**

```
# media-ctl -d /dev/media0 -V ""rzg2l_csi2 10830400.csi2':1 [fmt:UYVY8_2X8(*)/1920x1080 field:none]"
# media-ctl -d /dev/media0 -V ""ov5645 0-003c':0 [fmt:UYVY8_2X8(*)/1920x1080 field:none]"
# media-ctl -d /dev/media0 -V ""cru-ip-10830000.video' :0 [fmt:UYVY8_2X8(*)/1920x1080 field:none]"
# media-ctl -d /dev/media0 -V ""cru-ip-10830000.video' :1 [fmt:UYVY8_2X8(*)/1920x1080 field:none]"
```

- **2592x1944:**

```
# media-ctl -d /dev/media0 -V ""rzg2l_csi2 10830400.csi2':1 [fmt:UYVY8_2X8(*)/2592x1944 field:none]"
# media-ctl -d /dev/media0 -V ""ov5645 0-003c':0 [fmt:UYVY8_2X8(*)/2592x1944 field:none]"
# media-ctl -d /dev/media0 -V ""cru-ip-10830000.video' :0 [fmt:UYVY8_2X8(*)/2592x1944 field:none]"
# media-ctl -d /dev/media0 -V ""cru-ip-10830000.video' :1 [fmt:UYVY8_2X8(*)/2592x1944 field:none]"
```

(*) UYVY8_2X8 for rz-5.10, UYVY8_1X16 for rz-6.1

5.1.4 Deactivate all active links

This is a useful command to reset all links before you start enabling new links to make sure you got the biggest possible routing space to start out with.

```
# media-ctl -d /dev/media0 -r
```

6. Integration

6.1 Directory Configuration

The directory configuration is shown below:

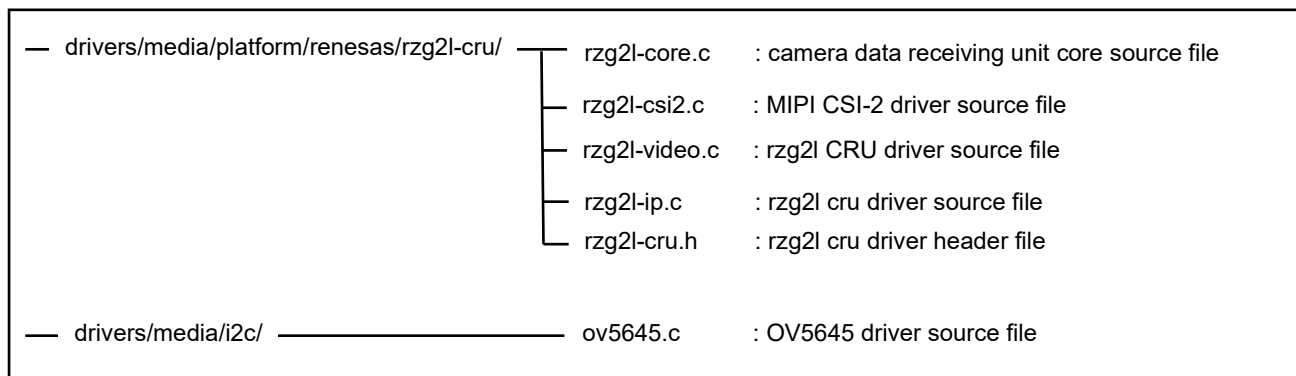


Figure 6-1 Directory configuration

6.2 Integration Procedure

To enable the function of this module, make the following setting with Kernel Configuration.

6.2.1 Camera data Receiving Unit Driver

```
Device Drivers --->
  <*> Multimedia support --->
    Media core support --->
      [*] Media Controller API
    Media drivers --->
      [*] Media platform devices --->
        <*> RZ/G2L MIPI CSI-2 Receiver
        <*> RZ/G2L Camera Receiving Unit (CRU) Driver
    Media ancillary drivers --->
      [*] Camera sensor devices --->
        <*> OmniVision OV5645 sensor support
```

Figure 6-2 Kernel Configuration CRU

6.2.2 I2C Driver

```
Device Drivers --->
  I2C support --->
    I2C Hardware Bus support --->
      <*> Renesas RIIC adapter
```

Figure 6-3 Kernel Configuration I2C Driver

6.3 Option Setting

6.3.1 Module Parameters

There are no module parameters.

6.3.2 Kernel Parameters

There are no kernel parameters.

Revision History	Linux Interface Specification Device Driver Video Capture User's Manual: Software
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Rev.	Date	Description	
		Page	Summary
0.5	May. 25, 2021	—	First Edition issued
1.0	Jul. 15, 2021	—	No modification, keep version to keep consistent with other documents
1.1	Sep. 15, 2021	—	Merge RZ/G2L driver manual with RZ/V2L
1.2	Feb. 15, 2022	—	Add RZ/G2LC, RZ/G2UL device
		6, 7	Add NV16 output formats
		8	Add Hardware input control of CRU (V4L2_CID_MIN_BUFFERS_FOR_CAPTURE)
1.3	Mar. 31, 2022	8	Add Hardware input control of CRU (V4L2_CID_CRU_FRAME_SKIP)
1.4	May. 31, 2022	—	No modification, keep version to keep consistent with other documents
1.5	Jun. 24, 2022	—	No modification, keep version to keep consistent with other documents
1.6	Sep. 15, 2022	—	No modification, keep version to keep consistent with other documents
1.7	Dec. 15, 2022	—	No modification, keep version to keep consistent with other documents
1.8	Mar. 15, 2023	1, 2	Add general information about Demosaicing, Linear Matrix color correction and Statistics Data features.
		9	Add Hardware control Parameters of Demosaicing, Linear Matrix color correction and Statistics Data features.
1.9	Mar. 31, 2025	12,13, 14,15	Restructured driver, replaced rzg2l_dma.c and rzg2l_v4l2.c with rzg2l-ip.c and rzg2l-video.c, leading to changes in Media Controller API and the steps to link the device.
1.10	May. 30, 2025	1	- Add MPU information support for both kernel versions v5.10 and v6.1. - Correct Linux version supported Digital Parallel Interface
		9	- Correct default value of V4L2_CID_MIN_BUFFERS_FOR_CAPTURE
		13,14, 15	- Correct Linux version supported
1.11	Jun. 30, 2025	—	Add RZ/V2N information
1.12	Jul. 22, 2025	—	Add RZ/G3E information
1.13	Nov. 28, 2025	1,2, 7,8,15	Add information of RZ/G2UL and RZ/V2L support for kernel v6.1 Update features support Update format of ov5645
1.14	Dec. 19, 2025	—	Add RZ/V2H information
		9	Add image stride note about not supporting resolution 2592x1944 for RZ/V2H, RZ/V2N and RZ/G3E.
1.15	Mar 27, 2026	5	Update product name for RZ/V2N V1.0 Add product number for RZ/V2N V2.0

Linux Interface Specification Device Driver Video Capture
User's Manual: Software

Publication Date: Rev.1.15 Mar. 27, 2026

Published by: Renesas Electronics Corporation

RZ/G2L Group, RZ/V2L Group, RZ/V2N
Group, RZ/V2H Group and RZ/G3E Group



Renesas Electronics Corporation