Linux Interface Specification GStreamer

User's Manual: Software

RZ/G2L Group and RZ/V2L Group

Renesas Electronics

www.renesas.com

Rev.2.02   Mar. 27, 2026

Credit

These following platforms and projects were used to build this document.

1. Platforms

   - Architecture: `x86_64`
   - Docker: `Docker version 29.1.4, build 0e6fee6`
   - Container OS: `Ubuntu 22.04.5 LTS`

2. Projects

   - Python: `3.12.12`
   - pip: `25.3`
   - PDFtk:

     ```
     pdftk port to java 3.2.2 a Handy Tool for Manipulating PDF Documents
     Copyright (c) 2017-2018 Marc Vinyals - https://gitlab.com/pdftk-java/pdftk
     Copyright (c) 2003-2013 Steward and Lee, LLC.
     pdftk includes a modified version of the iText library.
     Copyright (c) 1999-2009 Bruno Lowagie, Paulo Soares, et al.
     This is free software; see the source code for copying conditions. There is
     NO warranty, not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
     ```

   - pdfgrep:

     ```
     This is pdfgrep version 2.1.2.

     Using poppler version 22.02.0
     Using libpcre version 8.39 2016-06-14
     ```

   - Table Generator: https://www.tablesgenerator.com/
   - Kroki!: https://kroki.io/

3. Python Libraries (pip)

> **NOTE**
>
> The table below was created using `pip-licenses`, combined with information gathered manually from each project's website.
>
> Each license is provided as a link to where it is stored.

Index	Python Libraries (pip)

1	`Markdown` | 3.9 | BSD3 License
	https://Python-Markdown.github.io/
	
	`Copyright 2007, 2008 The Python Markdown Project (v. 1.7 and later)`
	`Copyright 2004, 2005, 2006 Yuri Takhteyev (v. 0.2-1.6b)`
	`Copyright 2004 Manfred Stienstra (the original version)`

Index	Python Libraries (pip)
2	`PyYAML` | 6.0.3 | MIT License https://pyyaml.org/ Copyright (c) 2017-2021 Ingy döt Net Copyright (c) 2006-2016 Kirill Simonov
3	`beautifulsoup4` | 4.14.2 | MIT License https://www.crummy.com/software/BeautifulSoup/bs4/ Beautiful Soup is made available under the MIT license: Copyright (c) Leonard Richardson Beautiful Soup incorporates code from the html5lib library, which is also made available under the MIT license. Copyright (c) James Graham and other contributors Beautiful Soup depends on the soupsieve library, which is also made available under the MIT license. Copyright (c) Isaac Muse
4	`markdown-exec` | 1.11.0 | ISC License https://pawamoy.github.io/markdown-exec Copyright (c) 2022, Timothée Mazzucotelli
5	`markdown-include` | 0.8.1 | GNU General Public License v3 (GPLv3) https://github.com/cmacmackin/markdown-include Copyright 2015 Christopher MacMackin
6	`markdown_grid_tables` | 0.6.0 | GNU General Public License v3 (GPLv3) https://gitlab.com/WillDaSilva/markdown_grid_tables
7	`mike` | 2.1.3 | BSD License https://github.com/jimporter/mike Copyright (c) 2017-2024, Jim Porter All rights reserved.
8	`mkdocs` | 1.6.1 | BSD License https://github.com/mkdocs/mkdocs Copyright © 2014, Tom Christie. All rights reserved.
9	`mkdocs-awesome-pages-plugin` | 2.10.1 | MIT License https://github.com/lukasgeiter/mkdocs-awesome-pages-plugin/ Copyright (c) 2018 Lukas Geiter

Index	Python Libraries (pip)
10	`mkdocs-caption` | 1.3.0 | MIT License https://github.com/tobiasah/mkdocs-caption `Copyright (c) 2023 Tobias Ahrens`
11	`mkdocs-exclude` | 1.0.2 | Apache Software License https://github.com/apenwarr/mkdocs-exclude `Copyright [yyyy] [name of copyright owner]`
12	`mkdocs-glightbox` | 0.5.1 | MIT License https://blueswen.github.io/mkdocs-glightbox/ `Copyright (c) 2022 Blueswen`
13	`mkdocs-include-markdown-plugin` | 7.2.0 | Apache Software License https://github.com/mondeja/mkdocs-include-markdown-plugin `Copyright 2017-2025 Joe Rickerby and contributors`
14	`mkdocs-kroki-plugin` | 0.7.1 | MIT License https://github.com/AVATEAM-IT-SYSTEMHAUS/mkdocs-kroki-plugin `Copyright (c) 2018 Benjamin Bittner`
15	`mkdocs-macros-plugin` | 1.4.0 | MIT License https://github.com/fralau/mkdocs_macros_plugin `Copyright (C) 2018-2024 Laurent Franceschetti`
16	`mkdocs-material` | 9.6.21 | MIT License https://github.com/squidfunk/mkdocs-material `Copyright (c) 2016-2025 Martin Donath`
17	`mkdocs-material-extensions` | 1.3.1 | MIT License https://github.com/facelessuser/mkdocs-material-extensions `Copyright (c) 2021 Isaac Muse`
18	`mkdocs-minify-html-plugin` | 0.3.4 | MIT License https://github.com/monosans/mkdocs-minify-html-plugin `Copyright (c) 2023 monosans`

Index	Python Libraries (pip)
19	`mkdocs-minify-plugin` | 0.8.0 | MIT License https://github.com/byrnereese/mkdocs-minify-plugin Copyright (c) 2018 Your Name Here
20	`mkdocs-table-reader-plugin` | 3.1.0 | MIT License https://github.com/timvink/mkdocs-table-reader-plugin Copyright (c) 2019 Tim Vink
21	`mkdocs-with-pdf` | 0.9.3 | MIT License https://github.com/orzih/mkdocs-with-pdf Copyright (c) 2020, orzih
22	`pandas` | 2.3.3 | BSD License https://pandas.pydata.org Copyright (c) 2008-2011, AQR Capital Management, LLC, Lambda Foundry, Inc. and PyData Development Team All rights reserved. Copyright (c) 2011-2023, Open source contributors.
23	`pillow` | 11.3.0 | MIT-CMU License https://python-pillow.github.io The Python Imaging Library (PIL) is Copyright © 1997-2011 by Secret Labs AB Copyright © 1995-2011 by Fredrik Lundh and contributors Pillow is the friendly PIL fork. It is Copyright © 2010 by Jeffrey A. Clark and contributors.
24	`pip-licenses` | 5.0.0 | MIT License https://github.com/raimon49/pip-licenses Copyright (c) 2018 raimon
25	`weasyprint` | 64.1 | BSD License https://weasyprint.org/ Copyright (c) 2011-2021, Simon Sapin and contributors. All rights reserved.

Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.

2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.

3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.

4. You shall be responsible for determining what licenses are required from any third parties, and obtaining such licenses for the lawful import, export, manufacture, sales, utilization, distribution or other disposal of any products incorporating Renesas Electronics products, if required.

5. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.

6. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.
    "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.
    "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.
    Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user's manual or other Renesas Electronics document.

7. No semiconductor product is absolutely secure. Notwithstanding any security measures or features that may be implemented in Renesas Electronics hardware or software products, Renesas Electronics shall have absolutely no liability arising out of any vulnerability or security breach, including but not limited to any unauthorized access to or use of a Renesas Electronics product or a system that uses a Renesas Electronics product. RENESAS ELECTRONICS DOES NOT WARRANT OR GUARANTEE THAT RENESAS ELECTRONICS PRODUCTS, OR ANY SYSTEMS CREATED USING RENESAS ELECTRONICS PRODUCTS WILL BE INVULNERABLE OR FREE FROM CORRUPTION, ATTACK, VIRUSES, INTERFERENCE, HACKING, DATA LOSS OR THEFT, OR OTHER SECURITY INTRUSION ("Vulnerability Issues"). RENESAS ELECTRONICS DISCLAIMS ANY AND ALL RESPONSIBILITY OR LIABILITY ARISING FROM OR RELATED TO ANY VULNERABILITY ISSUES. FURTHERMORE, TO THE EXTENT PERMITTED BY APPLICABLE LAW, RENESAS ELECTRONICS DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO THIS DOCUMENT AND ANY RELATED OR ACCOMPANYING SOFTWARE OR HARDWARE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE.

8. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.

9. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.

10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.

11. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.

12. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.

13. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.

14. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.

(Note2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.5.0-1   October 2020)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Contact information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:
www.renesas.com/contact/

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

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 VIL (Max.) and VIH (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 VIL (Max.) and VIH (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 document is designed to provide the user with an understanding of the software development environment for RZ/G2L Group and RZ/V2L Group MPU(s). It is intended for users developing software incorporating the MPU(s). A basic knowledge of software development and Linux systems is necessary 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 and RZ/V2L Group MPU(s). 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	RZ/G2L Group, RZ/G2LC Group User's Manual: Hardware	-
		RZ/V2L Group User's Manual: Hardware	-
User's manual for Software	Describes all basic steps to use Yocto build environment with Verified Linux Package	SMARC EVK of RZ/G2L, RZ/G2LC and RZ/G2UL Linux Start-up Guide	-
		SMARC EVK of RZ/V2L Linux Start-up Guide	-
Renesas Technical Update	Describes all basic steps to use Yocto build environment with AI SDK for RZ/V2L	Available from AI SDK GitHub page	-

2. List of Abbreviations and Acronyms

Abbreviation	Description
ALSA	Advanced Linux Sound Architecture
API	Application Programming Interface
BSP	Board Support Package
CRU	Camera Data Receive Unit
CSI	Camera Serial Interface
DU	Display Unit on RZ/G Series and RZ/V Series
EVK	Evaluation Kit
FB	Framebuffer
FPS	Frames per second
ISU	Image Scaling Unit
MCU	Micro Controller Unit
MIPI	Mobile Industry Processor Interface
MPU	Micro Processor Unit
OSS	Open-Source Software
RTP	Real-time Transport Protocol
SDK	Software Development Kit
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
V4L2	Video for Linux 2
VLP	Verified Linux Package
VSP	Video Signal Processor
VSPD	VSP for DU

3. Conventions

Command line run on Linux host PC will be shown as below:

```
$    echo "This is command line run on x86-64 Linux PC"
```

Command line run on target board's linux kernel will be shown as below:

```
#    echo "This is command line run on ARM board"
```

Command line run on target board's bootloader will be shown as below:

```
=>    echo "This is command line run on ARM board"
```

File content will be shown as below:

FILENAME

```bash
#!/bin/bash
echo "This is content in a file"
```

Table of Contents

List of Figures

List of Tables

1. Overview

This document explains the expanded specification of GStreamer Plug-in and explains how to run the GStreamer Plug-in and GStreamer on Linux on RZ/G2L Group and RZ/V2L Group MPU(s).

1.1 Related Documents

The following table shows the document related to this module.

Table 1-1 Related Documents

Index	Document Name	Remarks
1	SMARC EVK of RZ/G2L, RZ/G2LC and RZ/G2UL Linux Start-up Guide	-
2	SMARC EVK of RZ/V2L Linux Start-up Guide	-
3	Getting Started of RZ/V AI SDK	See: • RZ/V2L AI SDK v7.00 https://renesas-rz.github.io/rzv_ai_sdk/7.00/getting_started.html

1.2 Terminology

The following table shows the terminology related to this module.

Table 1-2 Terminology

Terms	Explanation
GStreamer	It provides functionality based on multimedia applications such as Audio/Video in multimedia framework open source URL: http://gstreamer.freedesktop.org/
GStreamer Plug-in	It is various Plug-in of GStreamer framework, provides other functionality and various codec

Terms	Explanation
OpenMAX	It is general multimedia API for embedded devices such as image, audio,…, it consists of three layers as below: • OpenMAX AL (Application Layer) • OpenMAX IL (Integration Layer) • OpenMAX DL (Development Layer) URL: http://www.khronos.org/openmax/
gst-omx	GStreamer Plug-in that allows communication with OpenMAX IL component
Wayland	Wayland is a protocol that specifies the communication between the display server (called Wayland compositor) and its clients, as a replacement for the X Window System
Weston	Weston is the reference implementation of a Wayland compositor (typical elements of a window)

2. Operating Environment

2.1 Hardware and Software Environment

The following table lists the hardware (EVK) and software (BSP/VLP/SDK) needed to use this module.

Table 2-1 Hardware and Software Environment

Index	EVK	BSP/VLP/SDK	Remarks
1	RZ/G2L Evaluation Board Kit: • RZ/G2L SMARC Module Board • RZ SMARC Series Carrier Board	VLP/G v3.0.7 (or later) *Kernel 5.10-CIP, Yocto-3.1 (Dunfell)*	-
		VLP v4.0.0 (or later) *Kernel 6.1-CIP, Yocto-5.0 (Scarthgap)*	
2	RZ/V2L Evaluation Board Kit[1]: • RZ/V2L SMARC Module Board • RZ SMARC Series Carrier Board	VLP/V v3.0.7 (or later) *Kernel 5.10-CIP, Yocto-3.1 (Dunfell)*	-
		RZ/V2L AI SDK v7.00 (or later) *Kernel 6.1-CIP, Yocto-5.0 (Scarthgap)*	

1. The CMOS sensor (OV5645) in the Coral camera is no longer available and should not be used for mass production. Any software support provided is for evaluation purposes only.

2.2 Software Requirement

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

Table 2-2 Software Requirement

Index	Name	Remarks
1	RZ/G2L, RZ/V2L Linux VLP[1]	• Memory Manager MMNGR • UVCS Driver • Audio codec (faac; faad) • Video Signal Processor Manager VSPM
2	RZ MPU Graphics Library[1]	• Wayland/Weston
3	RZ MPU Video Codec Library[1]	• OMX (Video)

Index	Name	Remarks
4	RZ/V2L AI SDK[2]	• Memory Manager MMNGR • UVCS Driver • Audio Codec (`faac` / `faad`) • Video Signal Processor Manager VSPM • Wayland/Weston • Video Codec Library (OpenMAX)

1. These packages are used for VLP.

2. This package is used for AI SDK.

2.3 Module Configuration

This section shows the software configuration in which GStreamer is used.

2.3.1 Video Decode and Display
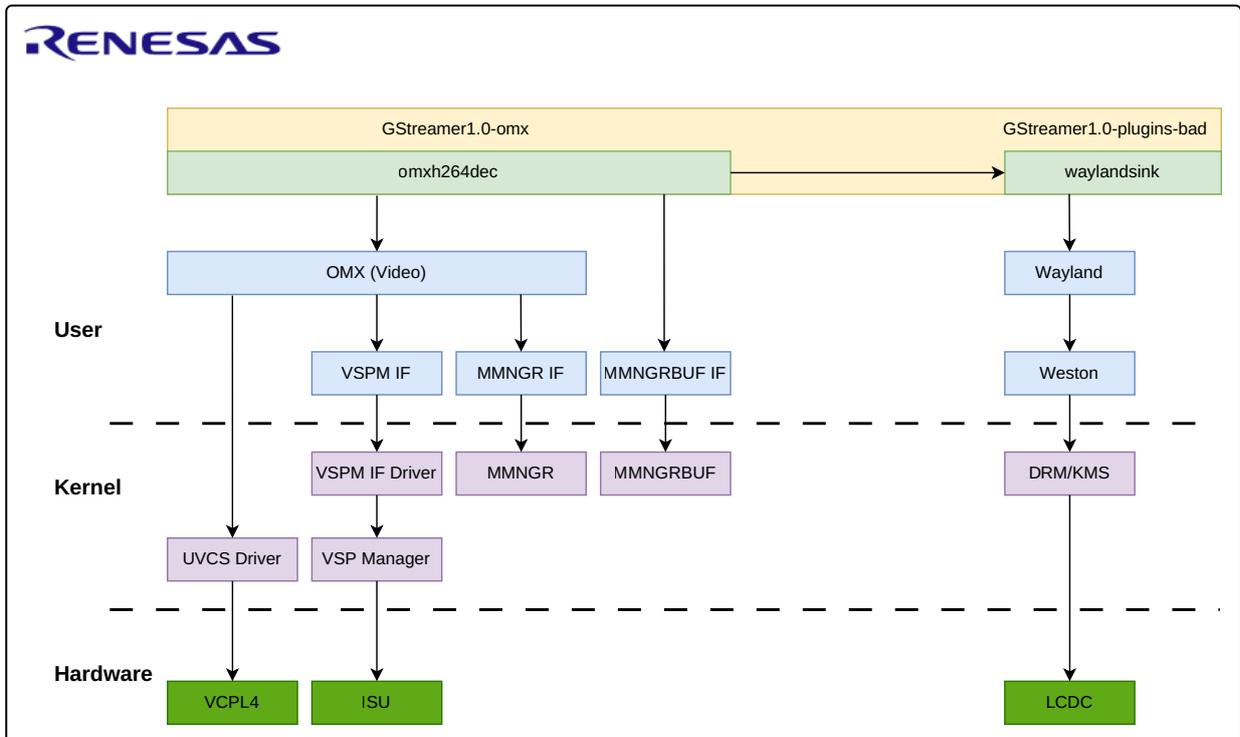
Figure 2-1: Video Playback
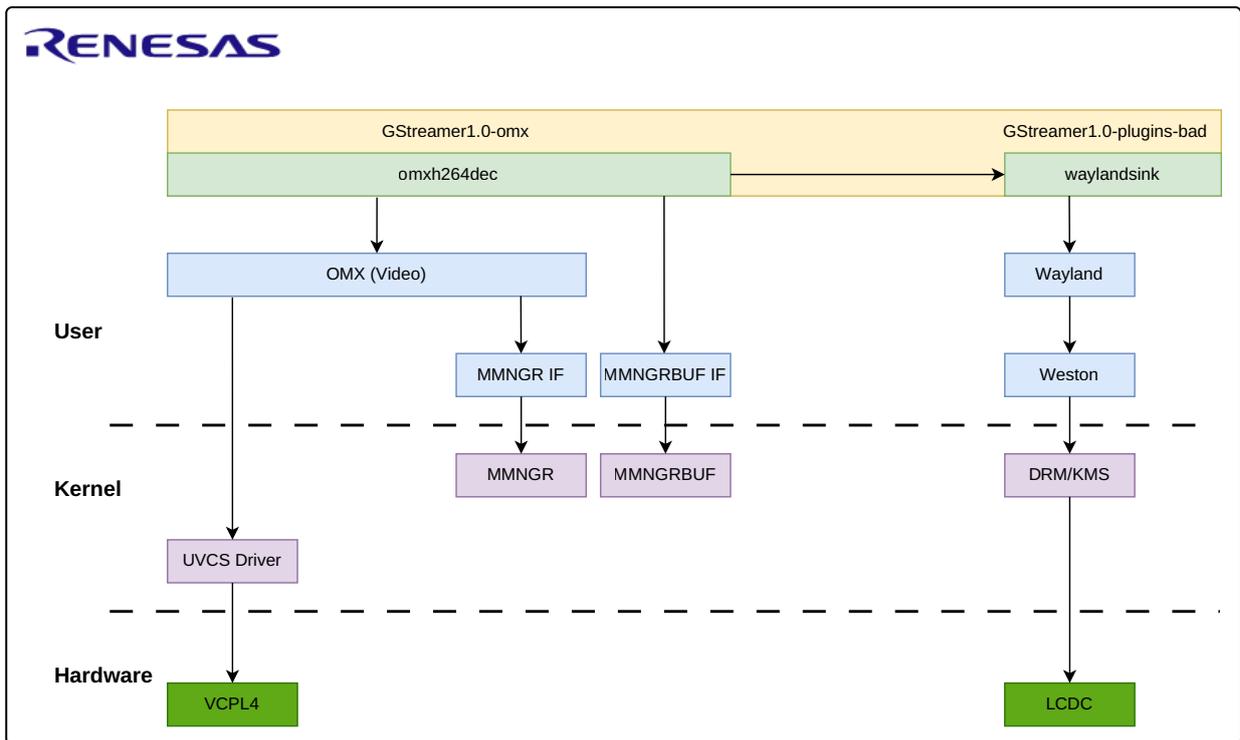
Figure 2-2: Video Playback (bypass mode)
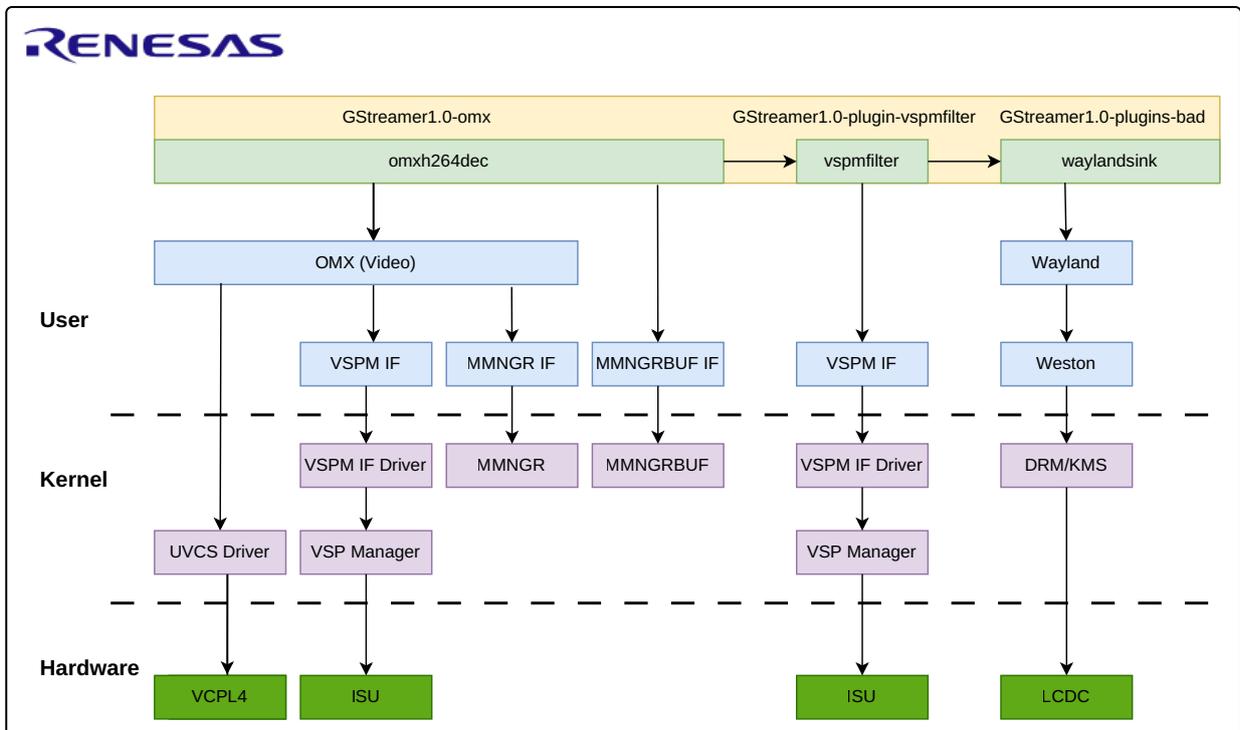
Figure 2-3: Video Playback (scaling and format conversion)

2.3.2 Video Capture and Display
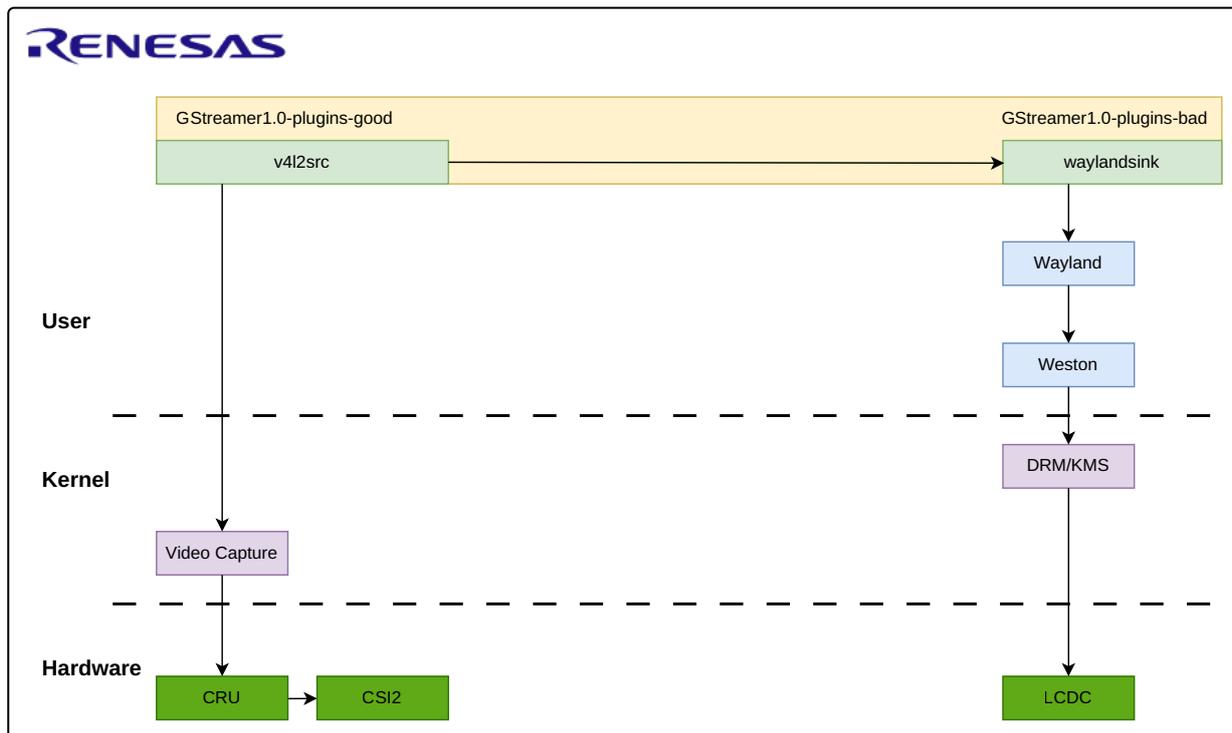
Figure 2-4: Video Capture and Display
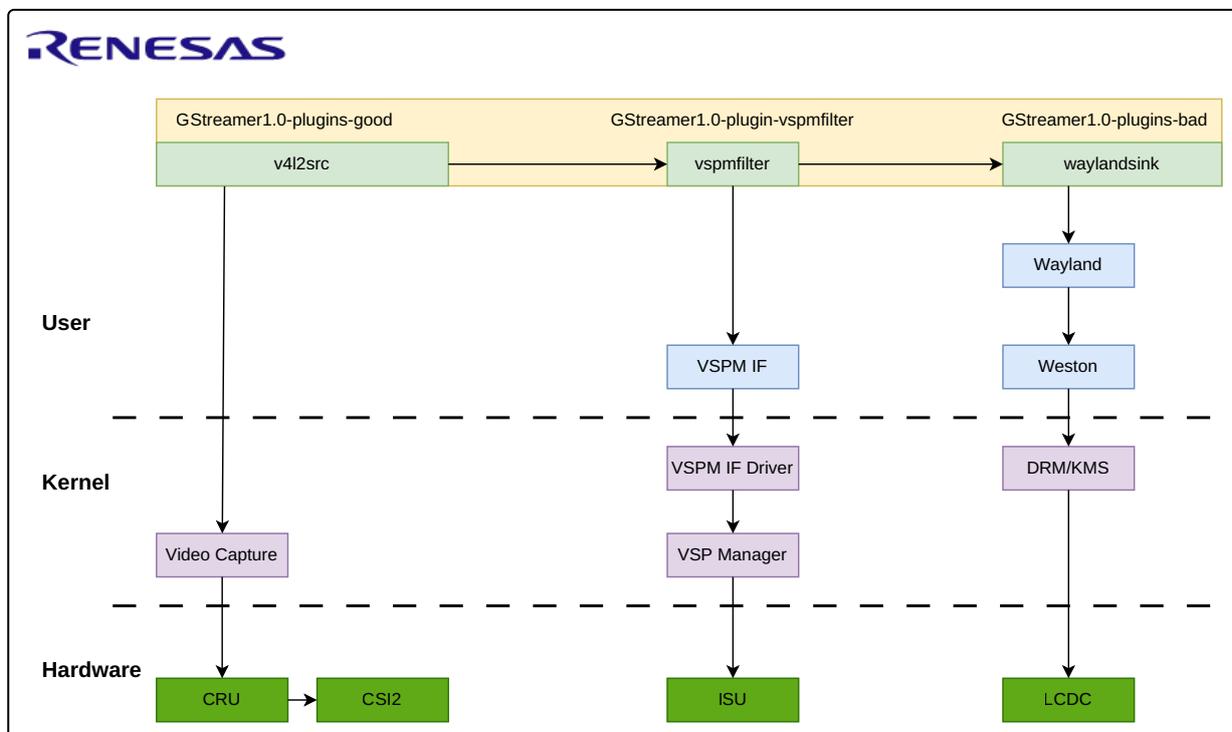
Figure 2-5: Video Capture and Display (scaling and format conversion)

2.3.3 Video Capture and Encode
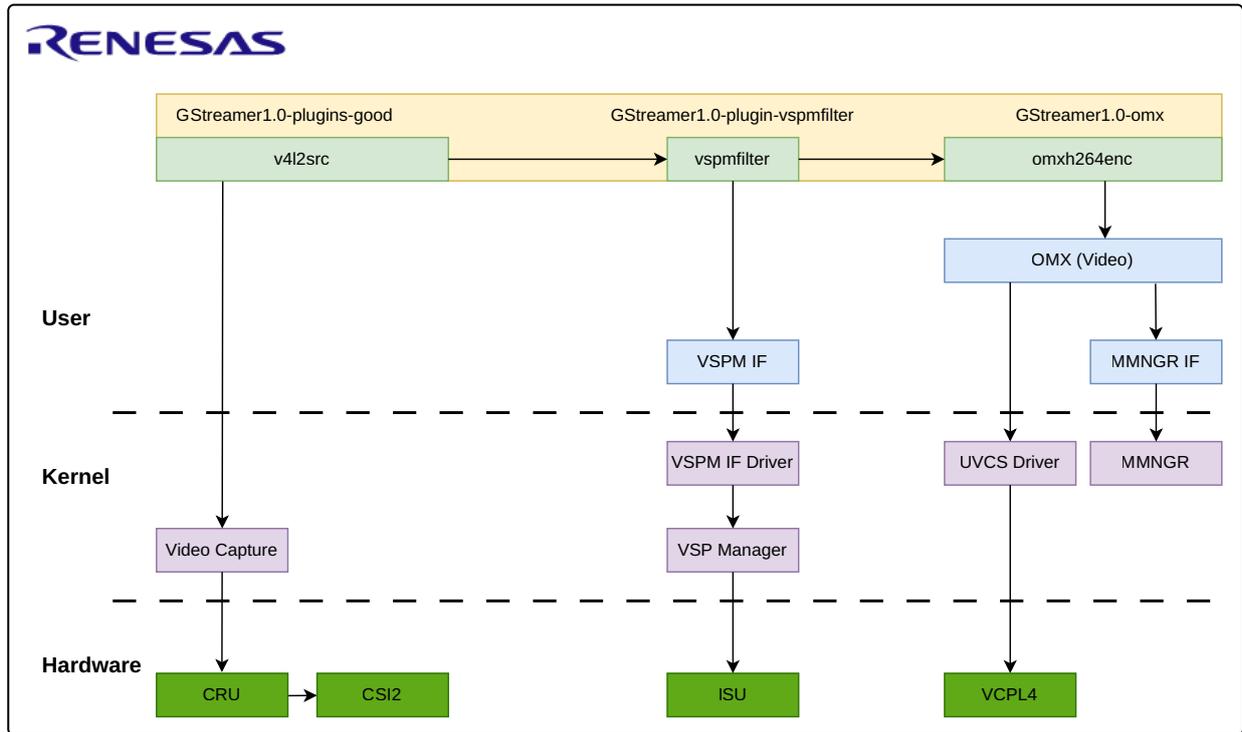
Figure 2-6: Video Capture and Encode

3. GStreamer Tool, Plug-in and Element

3.1 GStreamer Tool

3.1.1 `gst-launch-1.0`

`gst-launch-1.0` - build and run a GStreamer pipeline.

This tool accepts a textual description of a pipeline, instantiates it, and sets it to the PLAYING state. It allows you to quickly check if a given pipeline works, before going through the actual implementation using GStreamer API calls.

```
#      gst-launch-1.0 [OPTIONS] PIPELINE-DESCRIPTION
```

3.1.2 `gst-inspect-1.0`

`gst-inspect-1.0` - print info about a GStreamer plugin or element.

`gst-inspect-1.0` is a tool that prints out information on available GStreamer plugins, information about a particular plugin, or information about a particular element.

When executed with no `PLUGIN` or `ELEMENT` argument, `gst-inspect-1.0` will print a list of all plugins and elements together with a summary.

```
#      gst-inspect-1.0
```

When executed with a `PLUGIN` or `ELEMENT` argument, `gst-inspect-1.0` will print information about that plug-in or element.

```
#      gst-inspect-1.0 omxh264dec
```

3.1.3 `gst-discoverer-1.0`

`gst-discoverer-1.0` - Display file metadata and stream information.

`gst-discoverer-1.0` is a tool that can be used to print basic metadata and stream information about a media file. It can be run on individual files or whole directories. It will recurse into sub-directories in that case.

```
#      gst-discoverer-1.0 MP4_file.mp4
```

3.2 GStreamer Plug-in and Element

Table 3-1 GStreamer and GStreamer Plugins

Index	Name	Yocto Version	License	Version	Remarks
1	GStreamer core plugins	Dunfell	GPL-2.0	1.16.3	Downloaded by Yocto [1]
		Scarthgap	LGPL-2.1	1.22.12	
2	GStreamer Base plugins	Dunfell	GPL-2.0	1.16.3	Downloaded by Yocto [1]
		Scarthgap	LGPL-2.1	1.22.12	
3	GStreamer Good plugins (Include change for `v4l2src`)	Dunfell	LGPL-2.1	1.16.3	Downloaded by Yocto [1]
		Scarthgap		1.22.12	
4	GStreamer Bad plugins (Include change for `waylandsink`, `bayersink`, `bayerconvert`)	Dunfell	GPL-2.0	1.16.3	Downloaded by Yocto [1]
		Scarthgap	LGPL-2.1	1.22.12	
5	GStreamer Ugly plugins	Dunfell	LGPL-2.1	1.16.3	Downloaded by Yocto
		Scarthgap		1.22.12	
6	GStreamer gst-omx plugins (Include change for `omxh264dec`, `omxh264enc`)	Dunfell	LGPL-2.1	1.16.3	Downloaded by Yocto [1]
		Scarthgap		1.22.12	
7	gst-plugin-vspmfilter (Include `vspmfilter`)	Dunfell	GPL-2.0	1.16.3	Downloaded by Yocto [2]
		Scarthgap		1.22.12	

1. URL: https://github.com/renesas-rcar for VLP v3 (or later).
   URL: https://github.com/renesas-rz for VLP v4 (or later) and AI SDK v7.00 (or later).

2. URL: https://github.com/renesas-rz/rzg_gstreamer_vspmfilter/tree/rz_g2l.

3.2.1 `playbin` and `playbin3`

`playbin` and `playbin3` provides a stand-alone everything-in-one abstraction for an audio and/or video player.

`playbin` and `playbin3` can handle both audio and video files and features.

- automatic file type recognition and based on that automatic selection and usage of the right audio/video/ subtitle demuxers/decoders.
- visualisations for audio files.
- subtitle support for video files. Subtitles can be stored in external files.
- stream selection between different video/audio/subtitles streams.
- meta info (tag) extraction.
- easy access to the last video sample.
- buffering when playing streams over a network.
- volume control with mute option.

Table 3-2 `playbin` and `playbin3`

Element Name	Package	Description
`playbin`	`gst-plugins-base`	Various playback elements
`playbin3`	`gst-plugins-base`	Various playback elements

NOTE	The default video filter of the `playbin` and `playbin3` for RZ/G2L and RZ/V2L Linux VLP(s) is set by `/etc/gstpbfilter.conf` , for changing default video filter please see How to Change the Default Video Filter In `playbin` and `playbin3` Elements.

3.2.2 Video Decode Plugin

Video decoders are utilized to convert encoded video into raw video and establish a connection with a destination sink, such as a display or file storage.

Table 3-3 Video Decode Plugins

Element Name	Package	Description
`decodebin`	`gst-plugins-base`	Autoplug and decode video
`avdec_h264`	GStreamer FFmpeg Plugins	libav H.264 decoder
`omxh264dec`	`gst-omx`	OpenMAX H.264 Video Decoder

CAUTION	In VLP v4 (or later) and AI SDK v7.00 (or later), `avdec_h264` is no longer included in the default installation. Users who wish to use `avdec_h264` must install it manually and assume all associated risks and responsibilities.

3.2.3 Video Capture Plugin

Table 3-4 Video Capture Plugin

Element Name	Package	Description
v4l2src	gst-plugins-good	Reads frames from a Video4Linux2 device

3.2.4 Video Conversion Plugin

Table 3-5 Video Conversion Plugins

Element Name	Package	Description
videoconvert	gst-plugins-base	Converts video from one colorspace to another
videoscale	gst-plugins-base	This element resizes video frames
vspmfilter	gst-plugin-vspmfilter	This is a GStreamer plugin that can use the color conversion and scaling with the hardware acceleration on RZ/G2L and RZ/V2L MPU(s)

3.2.5 Video Encode Plugin

Table 3-6 Video Encode Plugin

Element Name	Package	Description
omxh264enc	gst-omx	OpenMAX H.264 Video Encoder

3.2.6 Video Sink Plugin

Table 3-7 Video Sink Plugins

Element Name	Package	Description
autovideosink	gst-plugins-good	A video sink that automatically detects an appropriate video sink to use
fbdevsink	gst-plugins-bad	Linux framebuffer videosink
glimagesink	gst-plugins-base	glimagesink renders video frames to a drawable on a local or remote display using OpenGL
fpsdisplaysink	gst-plugins-bad	Can display the current and average framerate as a testoverlay or on stdout
waylandsink	gst-plugins-bad	The waylandsink is creating its own window and renders the decoded video frames to that

> **NOTE**
> RZ/G2L and RZ/V2L Linux VLP(s) enable waylandsink as the highest rank video sink. This causes the autovideosink, playbin and/or playbin3 to utilize the waylandsink. To use another video sink, you need to specify it with the video-sink=<video_sink_element> options.

3.2.7 Demux Plugin

Table 3-8 Demux Plugins

Element Name	Package	Description
qtdemux	gst-plugins-good	Demuxes a .mov/mp4 file into raw or compressed audio and/or video streams
matroskademux	gst-plugins-good	Demuxes a Matroska file into the different contained streams
flvdemux	gst-plugins-good	Demuxes a FLV file into the different contained streams
avidemux	gst-plugins-good	Demuxes an AVI file into raw or compressed audio and/or video streams

3.2.8 Mux Plugin

Table 3-9 Mux Plugins

Element Name	Package	Description
qtmux	gst-plugins-good	Merges streams (audio and video) into QuickTime(.mov) file
matroskamux	gst-plugins-good	Muxes different input streams into a Matroska file
flvmux	gst-plugins-good	Muxes different streams into a FLV file
avimux	gst-plugins-good	Muxes raw or compressed audio and/or video streams into an AVI file
mp4mux	gst-plugins-good	Merges streams (audio and video) into ISO MPEG-4 (.mp4) file

3.2.9 Audio Plugin

Audio plugins are used to convert or translate different formats of audio data such as wav, ogg, aac, mp3, etc.

Table 3-10 Audio Plugins

Element Name	Package	Description
mpg123audiodec	gst-plugins-good	Audio decoder for MPEG-1 layer 1/2/3 audio data
vorbisdec	gst-plugins-base	Decodes a Vorbis stream to raw float audio
vorbisenc	gst-plugins-base	Encodes raw float audio into a Vorbis stream
faac	gst-plugins-bad	Encodes raw audio to AAC (MPEG-4 part 3) streams
faad	gst-plugins-bad	Decodes AAC (MPEG-4 part 3) stream
alsasink	gst-plugins-base	Renders audio samples using the ALSA audio API

3.2.10 Network Protocol Plugin

Table 3-11 Network Protocol Plugins

Element Name	Package	Description
udpsink	gst-plugins-good	`udpsink` is a network sink that sends UDP packets to the network. It can be combined with RTP payloaders to implement RTP streaming
multiudpsink	gst-plugins-good	`multiudpsink` is a network sink that sends UDP packets to multiple clients
udpsrc	gst-plugins-good	`udpsrc` is a network source that reads UDP packets from the network
tcpserversink	gst-plugins-base	A sink element that sends data as a server over the network via TCP
tcpclientsrc	gst-plugins-base	A source element that receives data as a client over the network via TCP
tcpclientsink	gst-plugins-base	A sink element that send data as a client over the network via TCP
tcpserversrc	gst-plugins-base	A source element that receive data as a server over the network via TCP

3.2.11 Payload/Depayload Plugin

Table 3-12 Payload/Depayload Plugins

Element Name	Package	Description
rtph264pay	gst-plugins-good	Payload-encode H.264 video into RTP packets
rtph264depay	gst-plugins-good	Extracts H.264 video from RTP packets
rtpmpapay	gst-plugins-good	Payload MPEG audio as RTP packets
rtpmpadepay	gst-plugins-good	Extracts MPEG audio from RTP packets

3.3 Renesas Extended Element

The main elements customized by Renesas are explained below. The properties added by Renesas are explained as "Expansion Properties".

3.3.1 Video H.264 Decode Element: `omxh264dec`

Table 3-13 `omxh264dec` *Pad Templates*

SINK	SRC
Capabilities: video/x-h264 alignment: Au stream-format: byte-stream width: [80, 1920] height: [80, 1080]	Capabilities: video/x-raw format: { NV12 } width: [80, 1920] height: [80, 1080]

Table 3-14 `omxh264dec` *Expansion Properties*

Element Name	Element Explanation	Expansion Properties	
		Property	**Property Explanation**
`omxh264dec`	• Support NV12 as the output format • Support video downscaling and cropping (if video has crop information)[6] • Supported resolution • 80x80 to 1920x1080	`no-copy` [1]	Share output buffer with element of downstream Export userptr to downstream for buffer sharing <table><tr><td>TRUE</td><td>Copyless</td></tr><tr><td>FALSE (default[2])</td><td>Copy (general purpose)</td></tr></table>
		`use-dmabuf` [2]	Use DMA buffer sharing framework (DMABUF) Export DMABUF to downstream for buffer sharing <table><tr><td>TRUE (default[2])</td><td>Use DMABUF</td></tr><tr><td>FALSE</td><td>Does not use DMABUF (Same as `no-copy=FALSE`)</td></tr></table>
		`enable-crop` [3]	Deprecated
		`bypass` [3]	Whether or not to enable scaling if Bypass mode is disabled <table><tr><td>TRUE</td><td>Enable</td></tr><tr><td>FALSE (default)</td><td>Disable</td></tr></table>
		`enable_scale` [4]	Deprecated
		`num-outbufs` [5]	Number of buffers that are required on output port Unsigned Integer. Range: 0 - 32 Default: 4 (`bypass=FALSE`) or 5 (`bypass=TRUE`)
		`sizebytes`	Change the size of allocation buffer for the input port Unsigned Integer. Range: 0 - 4294967295 Default: 0

1. Select one, either `no-copy` or `use-dmabuf` option. When you specify neither `no-copy` nor `use-dmabuf` option, `omxh264dec` works as `use-dmabuf=TRUE` .

2. Default value can be changed by `gstomx.conf` .

3. `enable-crop` is unused for `omxh264dec` . If `bypass=TRUE` , then `enable-crop=FALSE` and vice versa. This property is supported from VLP 3.0.7 with codec v3.1.3.0. From RZ/V2L AI SDK v7.00 with codec v4.1.3.1 and later, this option is deprecated.

4. If `enable_scale` is TRUE, you need to set desire output resolution. This property is supported from VLP 3.0.7 with codec v3.1.3.0. From RZ/V2L AI SDK v7.00 with codec v4.1.3.1 and later, this option is deprecated.

5. If `num-outbufs` is set smaller than default value, it will be round up to default value.

6. Crop information can be set via the omxh264enc crop property (see Video H.264 Encode Element).

3.3.2 Video H.264 Encode Element: `omxh264enc`

Table 3-15 `omxh264enc` *Pad Templates*

SINK	SRC

Capabilities: video/x-raw
        format: { NV12, I420 }
         width: [80, 1920]
        height: [80, 1920]
	Capabilities: video/x-h264
	stream-format: byte-stream
	          width: [80, 1920]
	         height: [80, 1920]

Table 3-16 `omxh264enc` *Expansion Properties*

Element Name	Element Explanation	Expansion Properties		
		Property	**Property Explanation**	
`omxh264enc`	• Support NV12 and I420 as the input formats. • Supported resolution: • 80x80 to 1920x1080 (1080x1920 for vertical encoding)	`no-copy`	Do not copy input data in gst-omx Share input buffer with element of upstream Export userptr to upstream for buffer sharing<table><tr><td>TRUE</td><td>Copyless</td></tr><tr><td>FALSE (default)</td><td>Copy (general purpose)</td></tr></table>	
		`use-dmabuf`	Do not copy input data in gst-omx Use DMA buffer sharing framework (DMABUF) Import DMABUF from upstream for buffer sharing<table><tr><td>TRUE</td><td>Use DMABUF</td></tr><tr><td>FALSE (default)</td><td>Does not use DMABUF (Same as `no-copy=FALSE`)</td></tr></table>	
		`scan-type`	Set encode scan type<table><tr><td>0</td><td>Progressive</td></tr><tr><td>-1</td><td>OMX default (Progressive)</td></tr></table>	
		`crop` [1]	Set output crop information. The encoder does not perform cropping as pre-processing. The crop information is added to SPS header of output video `crop=crop_left:crop_right:crop_top:crop_bottom` String. Default: "0:0:0:0"	
		`send-eos`	Send EOS/EOF stream data downstream<table><tr><td>TRUE</td><td>Send</td></tr><tr><td>FALSE (default)</td><td>NOT send</td></tr></table>	
		`ref-frames`	Number of reference frames. (0-2) Default: 0	
		`b-frames`	Number of b-frames. (0-3) Default: 0	
		`sizebytes`	Change the size of allocation buffer for the output port Unsigned Integer. Range: 0 - 4294967295 Default: 0	

Element Name	Element Explanation	Expansion Properties	
		Property	**Property Explanation**
		interval_intraframes [2]	Interval of coding Intra frames. (0 - 4294967295) Default: 4294967295
		control-rate	Bitrate control method

Within the control-rate row:

(0): disable	Disable
(1): variable	Variable
(2): constant	Constant
(3): variable-skip-frame	Constant Skip Frames
(4): constant-skip-frames	Variable
(-1): default	Component Default

Element Name	Element Explanation	Expansion Properties	
		target-bitrate	Target bitrate in bits per second. (0 - 4294967295) Default: 4294967295
		periodicty-idr	Periodicity of IDR frames. (0 - 4294967295) Default: 4294967295

1. To set crop information in SPS header of output video, you need to add option
   `crop=crop_left:crop_right:crop_top:crop_bottom` to the pipeline. These parameters must satisfy the following conditions:

   - `crop_left`, `crop_right`, `crop_top`, `crop_bottom`, must be even numbers greater than or equal to 0;
   - The sum of `crop_left` and `crop_right` must be less that the width of video size;
   - The sum of `crop_top` and `crop_bottom` must be less that the height of video size.

   For example pipeline, please see Video Encode Pipeline. This property is supported from VLP 3.0.7 with codec v3.1.3.0.

2. When `interval_intraframes` is set to 255 and `b-frames` is 0, the frame number in the GOP becomes unlimited. In this case, the first frame is encoded as an IDR frame, and all subsequent frames are encoded as P-frames.

3.3.3 Source Element: `v4l2src`

Table 3-17 `v4l2src` Pad Templates

SRC

<pre>Capabilities: video/x-raw
       format: { BGR, GRAY8, YUY2, UYVY, NV16, ARGB, BGRA, BGRx }
        width: [80, 2592]
       height: [80, 1944]
    framerate: [0/1, 60/1]</pre>

Table 3-18 `v4l2src` Expansion Properties

Element Name	Element Explanation	Expansion Properties	
		Property	**Property Explanation**
`v4l2src`	• `v4l2src` can be used to capture video from v4l2 devices, like webcams and tv cards • Support BGR, GRAY8, YUY2, UYVY, NV16, ARGB, BGRA, BGRx as the output formats	`io-mode`	This property is standard implementation The available settings are as follows <table><tr><td>auto (default)</td><td>Auto</td></tr><tr><td>`mmap` [2]</td><td>Use mmap</td></tr><tr><td>`dmabuf` [1]</td><td>Use dmabuf</td></tr><tr><td>`userptr`</td><td>Use userptr</td></tr><tr><td>`dmabuf-import`</td><td>Use dmabuf-import</td></tr><tr><td>`rw`</td><td>Use rw</td></tr></table>
		`no-resurect-buf` [3]	This property is that skip resurrect buffer when all buffers in queue used up Please set true when sharing buffers with downstream such as encoder <table><tr><td>TRUE</td><td>Enable</td></tr><tr><td>FALSE (default)</td><td>Disable</td></tr></table>
		`num-alloc-buffer`	Change number of buffers in `v4l2src` It is used for debugging purpose
		`disable-dynamic-buffer-alloc`	Flag for handling dynamic buffer allocation <table><tr><td>TRUE</td><td>Enable</td></tr><tr><td>FALSE (default)</td><td>Disable</td></tr></table>

1. If device supports DMA-BUF, it selects `dmabuf` mode. This mode is highly efficient for systems that support DMA and can significantly reduce CPU load and increase throughput.

2. If device does not support DMA-BUF, it selects `mmap` mode. This mode is the preferred mode for most applications that require fast data processing and minimal latency.

3. `no-resurect-buf` is unused and deprecated option in VLP v4 and AI SDK v7.00. Please use `disable-dynamic-buffer-alloc` instead.

NOTE	To identify active cameras and obtain their details, refer to Section How to Detect Active Camera While USB cameras can be directly integrated with a GStreamer pipeline, MIPI cameras necessitate the preliminary configuration of the CRU/CSI2 driver. For more details, please refer to the manual of the CRU/CSI2 driver. Example for OV5645 MIPI camera is at Section How to Configure and Utilize MIPI Camera.

3.3.4 Video Conversion Element: `vspmfilter`

Table 3-19 `vspmfilter` *Pad Templates*

SINK	SRC
Capabilities: video/x-raw format: { NV12, RGB16, RGB, BGR, RGBx, BGRx, xRGB, xBGR, BGRA, ARGB, ABGR, UYVY, YUY2, NV16, GRAY8, GRAY10_LE64, RGBA } width: [1, 2800] height: [1, 2047]	Capabilities: video/x-raw format: { NV12, RGB16, RGB, BGR, RGBx, BGRx, xRGB, xBGR, BGRA, ARGB, ABGR, UYVY, YUY2, NV16, GRAY8, GRAY10_LE64, RGBA } width: [1, 1920] height: [1, 1080]

Table 3-20 `vspmfilter` *Expansion Properties*

Element Name	Element Explanation	Expansion Properties	
		Property	**Property Explanation**
`vspmfilter`	• `vspmfilter` controls Colorspace conversion and Video down scaling with VSPM • Support NV12, RGB16, RGB, BGR, RGBx, BGRx, xRGB, xBGR, RGBA, BGRA, ARGB, ABGR, UYVY, YUY2, NV16, GRAY8, GRAY10_LE64 as the input formats • Support NV12, RGB16, RGB, BGR, RGBx, BGRx, xRGB, xBGR, RGBA, BGRA, ARGB, ABGR, UYVY, YUY2, NV16, GRAY8, GRAY10_LE64 as the output formats	`outbuf-alloc`	Whether or not to use `self-allocate` for output buffer | TRUE	`vspmfilter` internally allocates memory for the output buffers | | FALSE (default) | downstream element allocates memory for output buffers |
		`dmabuf-use`	Whether or not to use `dmabuf` for output buffer | TRUE	`vspmfilter` allocates DMA-BUF (Direct Memory Access Buffer Sharing Framework) for the output buffers | | FALSE (default) | downstream element allocates memory for output buffers |

NOTE

To use `vspmfilter` with USB cameras, you need to add option `allocators=1` to `uvcvideo` kernel.

```
#      rmmod uvcvideo

#      insmod /lib/modules/*/kernel/drivers/media/usb/uvc/uvcvideo.ko allocators=1
```

3.3.5 Video Sink Element: `waylandsink`

Table 3-21 `waylandsink` *Pad Templates*

SINK
Capabilities: video/x-raw   format: { BGRx, BGRA, RGB16, YUY2, NV12 }   width: [1, 4096]   height: [1, 4096]

Table 3-22 `waylandsink` *Expansion Properties*

Element Name	Expansion Properties	
	Property	**Property Explanation**
`waylandsink`	`use-subsurface` [1]	When disabled, a subsurface will not be created from an externally supplied surface (e.g., needed for scan out when the application's surface is fullscreen) <table><tr><td>TRUE (default)</td><td>Use subsurface</td></tr><tr><td>FALSE</td><td>NOT use subsurface</td></tr></table>
	`suppress-interlace`	Suppress the buffer flag of interlace (e.g., Use if wayland / weston does not support the interlace flag) <table><tr><td>TRUE (default)</td><td>Suppress the buffer flag of interlace</td></tr><tr><td>FALSE</td><td>Not suppress the buffer flag of interlace</td></tr></table>
	`position-x`	Wayland Position X value from the application Range: 0 - 2147483647 Default: -1
	`position-y`	Wayland Position Y value from the application Range: 0 - 2147483647 Default: -1
	`fullscreen`	Display fullscreen on top of weston bar Position will be at center of screen <table><tr><td>TRUE</td><td>Enable</td></tr><tr><td>FALSE (default)</td><td>Disable</td></tr></table>
	`out-h`	Wayland Height size of application Integer. Range: 0 - 2147483647 Default: -1
	`out-w`	Wayland Width size of application Integer. Range: 0 - 2147483647 Default: -1

1. `use-subsurface` is unused and deprecated option in VLP v4 (or later) and AI SDK v7.00 (or later).

4. Example Pipeline

4.1 `playbin` and `playbin3`

NOTE	The default video filter of the `playbin` and `playbin3` for RZ/G2L and RZ/V2L Linux VLP(s) is set by `/etc/gstpbfilter.conf`, for changing default video filter please see How to Change the Default Video Filter In `playbin` and `playbin3` Elements.

4.1.1 `playbin`

```
#    gst-launch-1.0 playbin uri=file:/MP4_file.mp4
```

4.1.2 `playbin3`

```
#    gst-launch-1.0 playbin3 uri=file:/MP4_file.mp4
```

4.2 Video Decode Pipeline

4.2.1 `decodebin`

1. `decodebin` H.264 file

   ```
   #        gst-launch-1.0 filesrc location=H264_file.264 ! decodebin ! autovideosink
   ```

2. `decodebin` MP4 file

   ```
   #        gst-launch-1.0 filesrc location=MP4_file.mp4 ! decodebin ! autovideosink
   ```

4.2.2 `omxh264dec` (Hardware Accelerated Video Decoder)

1. MP4 container file decode

   ```
   #        gst-launch-1.0 filesrc location=MP4_file.mp4 ! qtdemux ! h264parse ! \
            omxh264dec ! waylandsink
   ```

2. H.264 elementary stream file decode

   ```
   #        gst-launch-1.0 filesrc location=H264_file.264 ! h264parse ! omxh264dec ! \
            waylandsink
   ```

3. MP4 container file decode with bypass mode

   ```
   #        gst-launch-1.0 filesrc location=MP4_file.mp4 ! qtdemux ! h264parse ! \
            omxh264dec bypass=true ! waylandsink
   ```

4. H.264 elementary stream file decode with bypass mode

   ```
   #        gst-launch-1.0 filesrc location=H264_file.264 ! h264parse ! \
            omxh264dec bypass=true ! waylandsink
   ```

5. Multiple MP4 container files decode

   ```
   #        gst-launch-1.0 filesrc location=MP4_file1.mp4 ! qtdemux ! h264parse ! \
            omxh264dec ! waylandsink & \
            gst-launch-1.0 filesrc location=MP4_file2.mp4 ! qtdemux ! h264parse ! \
            omxh264dec ! waylandsink &
   ```

6. Multiple MP4 container files decode with "max-lateness=-1 qos=false"

   ```
   #        gst-launch-1.0 filesrc location=MP4_file1.mp4 ! qtdemux ! h264parse ! \
            omxh264dec ! waylandsink max-lateness=-1 qos=false & \
            gst-launch-1.0 filesrc location=MP4_file2.mp4 ! qtdemux ! h264parse ! \
            omxh264dec ! waylandsink max-lateness=-1 qos=false &
   ```

NOTE	In order to prevent dropped buffers when running multiple streams, it is recommended to add the `max-lateness=-1 qos=false` option after the `waylandsink` command. This will ensure that the system is able to handle the incoming streams without any data loss due to buffer overflow.

7. Down scaling MP4 container file decode

```
#    gst-launch-1.0 filesrc location=MP4_FHD_file.mp4 ! qtdemux ! h264parse ! \
     omxh264dec ! video/x-raw,width=1280,height=720 ! waylandsink
```

8. Decode a video file that contains crop information

```
#    gst-launch-1.0 filesrc location=CROP_file.264 ! h264parse ! \
     omxh264dec ! waylandsink
```

NOTE	Crop information can be set via the omxh264enc crop property (see Video H.264 Encode Element).

4.2.3 `avdec_h264` (Software Decoder)

CAUTION	In VLP v4 (or later) and AI SDK v7.00 (or later), `avdec_h264` is no longer included in the default installation. Users who wish to use `avdec_h264` must install it manually and assume all associated risks and responsibilities.

1. MP4 container file decode

```
#    gst-launch-1.0 filesrc location=MP4_file.mp4 ! qtdemux ! h264parse ! \
     avdec_h264 ! waylandsink
```

2. H.264 elementary stream file decode

```
#    gst-launch-1.0 filesrc location=H264_file.264 ! h264parse ! avdec_h264 ! \
     waylandsink
```

4.3 Video Conversion Pipeline

4.3.1 `vspmfilter`

`outbuf-alloc` and `dmabuf-use` are used in different cases to boost GStreamer pipeline performance.

1. Down scaling video capture

```
#       gst-launch-1.0 -e v4l2src device=/dev/video0 io-mode=mmap ! \
        video/x-raw, width=1280, height=960 ! vspmfilter dmabuf-use=true ! \
        video/x-raw, width=720, height=480 ! waylandsink
```

2. Format conversion video capture

```
#       gst-launch-1.0 -e v4l2src device=/dev/video0 io-mode=mmap ! \
        video/x-raw, width=1280, height=960, format=YUY2 ! vspmfilter dmabuf-use=true ! \
        video/x-raw, format=NV12 ! waylandsink
```

3. Down scaling and format conversion video capture

```
#       gst-launch-1.0 -e v4l2src device=/dev/video0 io-mode=mmap ! \
        video/x-raw, width=1280, height=960, format=YUY2 ! vspmfilter dmabuf-use=true ! \
        video/x-raw, width=720, height=480, format=NV12 ! waylandsink
```

4. Video convert and display

```
#       gst-launch-1.0 filesrc location=FHD_H264_file.264 ! h264parse ! omxh264dec ! \
        vspmfilter dmabuf-use=true ! video/x-raw, format=BGRA, width=1280, height=720 ! \
        waylandsink
```

4.3.2 `videoconvert`

```
#       gst-launch-1.0 filesrc location=FHD_H264_file.264 ! h264parse ! omxh264dec ! \
        videoconvert ! video/x-raw, format=BGRA ! waylandsink
```

4.3.3 `videoscale`

```
#       gst-launch-1.0 filesrc location=FHD_H264_file.264 ! h264parse ! omxh264dec ! \
        videoscale ! video/x-raw, width=1280, height=720 ! waylandsink
```

4.4 Video Encode Pipeline

To avoid unreadable output file when shutting the pipeline down via `^ Ctrl` + `C`, we can use these options below:

`gst-launch-1.0` `-e`, `--eos-on-shutdown` : Force an EOS event on sources before shutting the pipeline down. This option of `gst-launch-1.0` makes sure muxers create readable files when a muxing pipeline is shut down forcefully via `^ Ctrl` + `C`.

`v4l2src` `num-buffers` : specifies the number of buffers to be captured from a `video4linux2` (v4l2) device and then automatically shuts the pipeline down.

> **NOTE**   Below example pipelines are tested on **OV5645** MIPI camera.

4.4.1 `omxh264enc` (Hardware Accelerated Video Encoder)

1. H.264 encode and save to a MP4 container file (format conversion by `vspmfilter`)

```
#    gst-launch-1.0 -e v4l2src device=/dev/video0 ! \
     video/x-raw, format=UYVY, width=1280, height=960, framerate=30/1 ! \
     vspmfilter dmabuf-use=true ! video/x-raw, format=NV12 ! \
     omxh264enc control-rate=2 target-bitrate=10485760 interval_intraframes=14 \
     periodicty-idr=2 use-dmabuf=true ! \
     video/x-h264, profile=\(string\)high, level=\(string\)4 ! h264parse ! \
     video/x-h264, stream-format=avc, alignment=au ! qtmux ! filesink location=MP4_file.mp4
```

2. H.264 encode and save to an elementary file (format conversion by `vspmfilter`)

```
#    gst-launch-1.0 -e v4l2src device=/dev/video0 ! \
     video/x-raw, format=UYVY, width=1280, height=960, framerate=30/1 ! \
     vspmfilter dmabuf-use=true ! video/x-raw, format=NV12 ! \
     omxh264enc control-rate=2 target-bitrate=10485760 interval_intraframes=14 \
     periodicty-idr=2 use-dmabuf=true ! \
     video/x-h264, profile=\(string\)high, level=\(string\)4 ! filesink location=H264_file.264
```

3. H.264 encode 100 frames and save to MP4 container file (format conversion by `vspmfilter`)

```
#    gst-launch-1.0 v4l2src num-buffers=100 device=/dev/video0 ! \
     video/x-raw, format=UYVY, width=1280, height=960 ! vspmfilter dmabuf-use=true ! \
     video/x-raw, format=NV12 ! omxh264enc control-rate=2 target-bitrate=10485760 \
     interval_intraframes=14 periodicty-idr=2 use-dmabuf=true ! \
     video/x-h264, profile=\(string\)high, level=\(string\)4 ! h264parse ! \
     video/x-h264, stream-format=avc, alignment=au ! qtmux ! filesink location=MP4_file.mp4
```

4. H.264 encode with cropping setting and save to an elementary file (format conversion by `vspmfilter`)

```
#    gst-launch-1.0 -e v4l2src device=/dev/video0 num-buffers=300 ! \
     video/x-raw, format=UYVY, width=1920, height=1080, framerate=30/1 ! \
     vspmfilter dmabuf-use=true ! video/x-raw, format=NV12 ! \
     omxh264enc control-rate=2 target-bitrate=10485760 interval_intraframes=14 \
     periodicty-idr=2 crop=0:640:0:120 use-dmabuf=true ! \
     video/x-h264, profile=\(string\)high, level=\(string\)4 ! \
     filesink location=H264_file.264
```

NOTE	This pipeline will capture 10 second (300 frame, 30FPS) from camera with resolution FHD (1920x1080). Then, adding crop information to SPS of output video. The resolution after cropping is HD (1280x960) when playback.

4.5 Video Sink Pipeline

4.5.1 `waylandsink`

1. Display `videotestsrc` with setting position – Example set `position-x=100` and `position-y=100`

```
#    gst-launch-1.0 videotestsrc ! video/x-raw, format=NV12, width=640, height=480 ! \
     waylandsink position-x=100 position-y=100
```
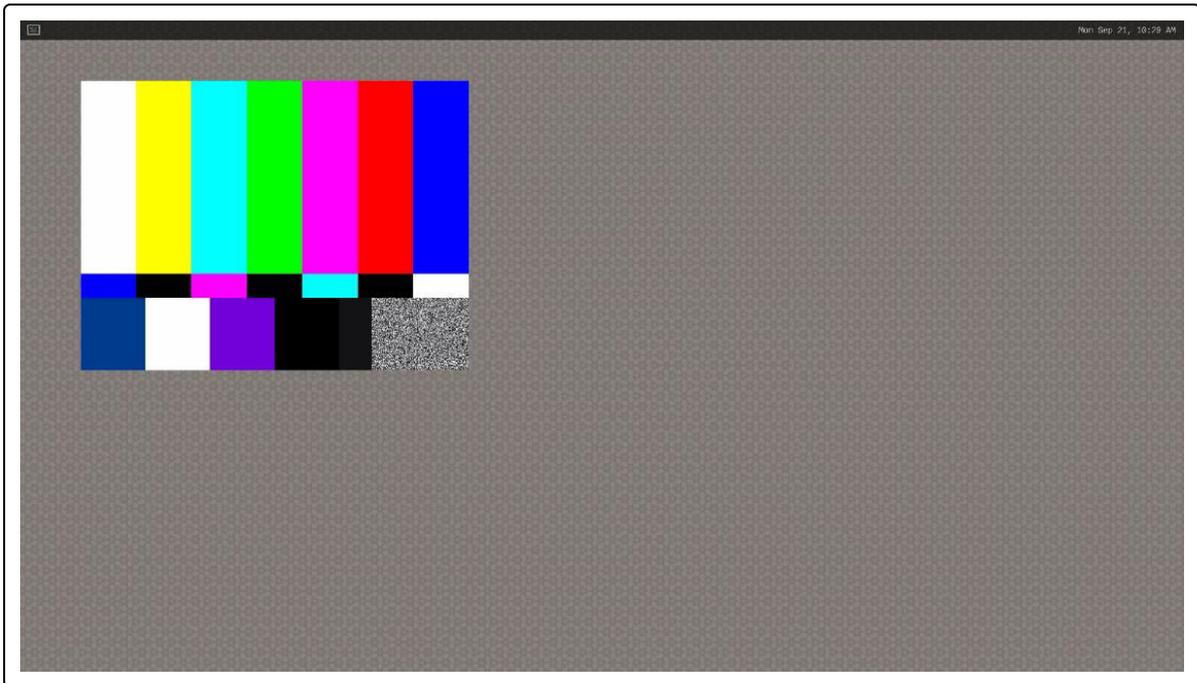

Figure 4-1: Video on Weston Screen With Setting Position

2. Display `videotestsrc` fullscreen

```
#    gst-launch-1.0 videotestsrc ! video/x-raw, format=NV12, width=640, height=480 ! \
     waylandsink fullscreen=true
```
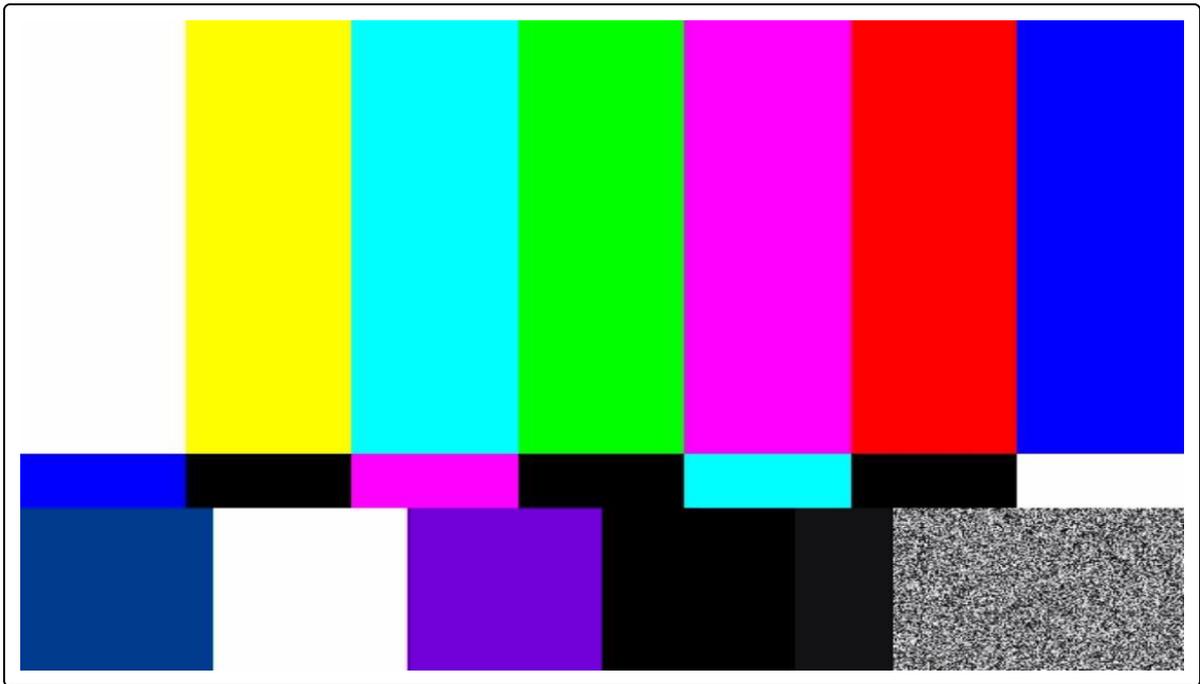
Figure 4-2: Fullscreen Video on Weston Screen

3. Display `videotestsrc` with setting wayland size of application – Example set `out-h=1000` `out-w=1500`

```
#        gst-launch-1.0 videotestsrc ! video/x-raw, format=NV12, width=640, height=480 ! \
         waylandsink out-h=1000 out-w=1500
```
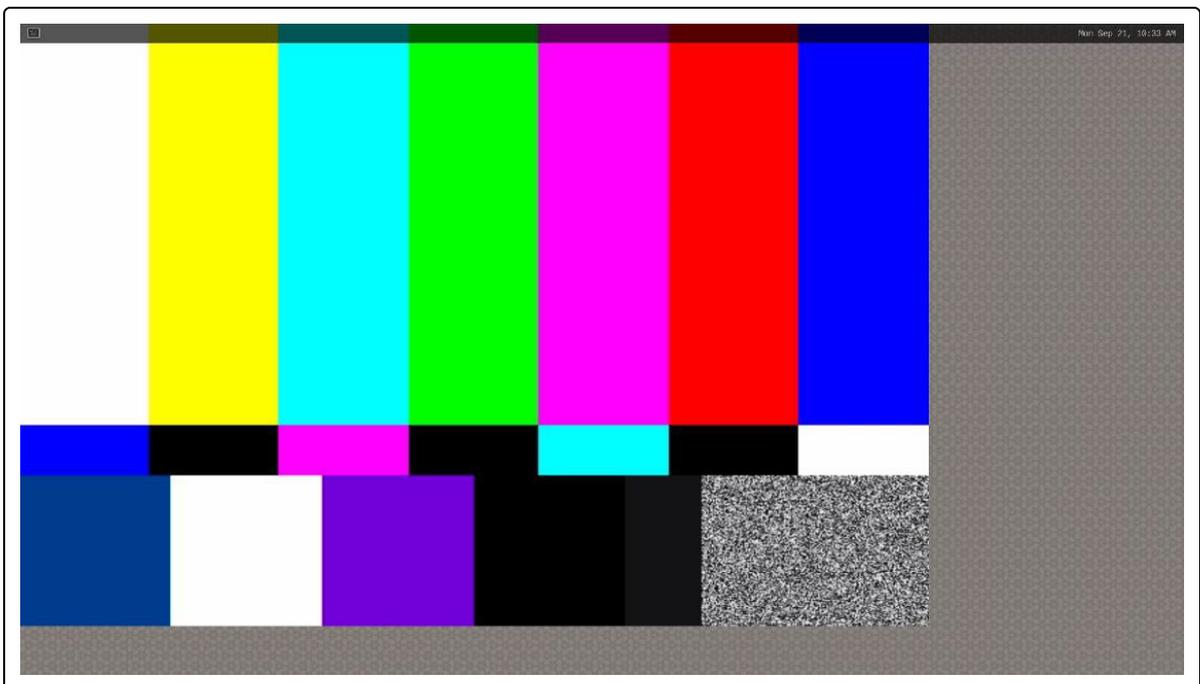

Figure 4-3: Video With Setting Size on Weston Screen

4.5.2 `fbdevsink`

- In case VLP/G v3.0.7 (or later) and VLP/V v3.0.7 (or later) (*Kernel 5.10-CIP, Yocto-3.1 (Dunfell)*):

  - Before using `fbdevsink`, stop Weston interface by `systemctl stop weston@root`

  - After using `fbdevsink`, start Weston interface by `systemctl start weston@root`

- In case VLP v4.0.0 (or later) and AI SDK v7.00 (or later) (*Kernel 6.1-CIP, Yocto-5.0 (Scarthgap)*):

  - Before using `fbdevsink`, stop Weston interface by `systemctl stop weston`

  - After using `fbdevsink`, start Weston interface by `systemctl start weston`

```
#    gst-launch-1.0 videotestsrc ! video/x-raw, width=640, height=480 ! fbdevsink
```

4.5.3 `fpsdisplaysink`

```
#    gst-launch-1.0 videotestsrc ! video/x-raw, width=1280, height=720, framerate=30/1 ! fpsdisplaysink
```
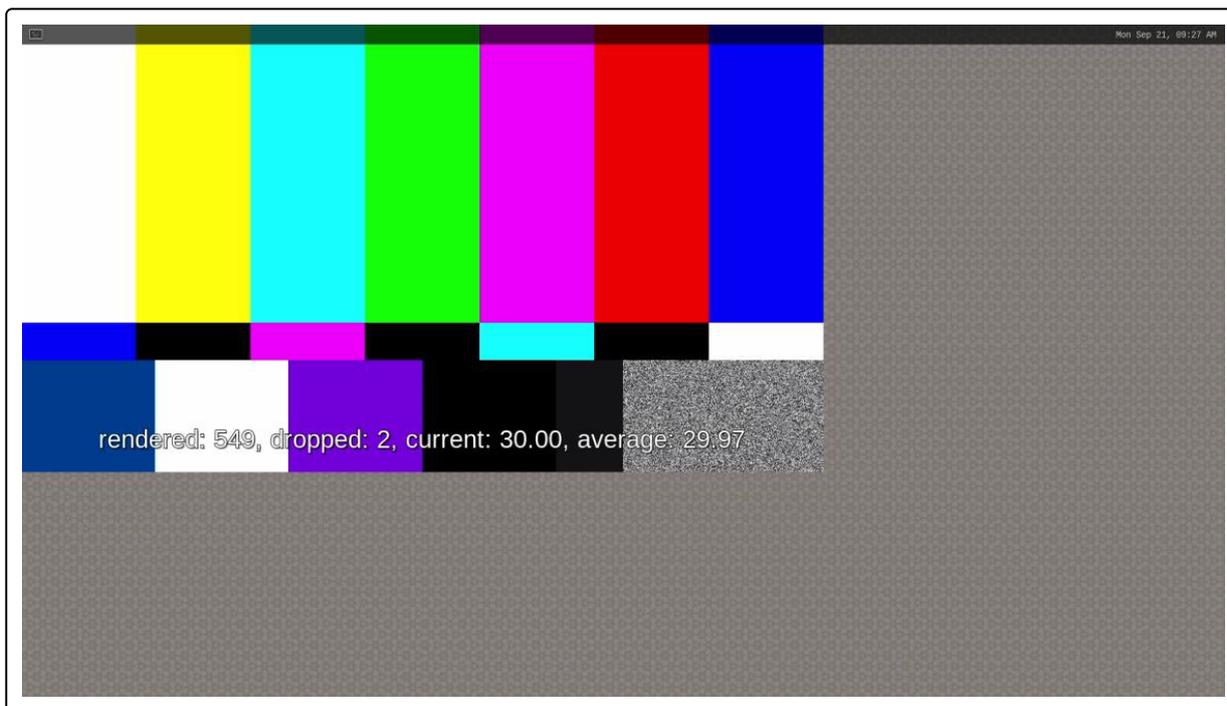

Figure 4-4: `fpsdisplaysink`

4.5.4 `glimagesink`

1. Display scaling video

```
#    gst-launch-1.0 videotestsrc ! video/x-raw, width=640, height=480, framerate=30/1 ! \
     glimagesink max-lateness=-1 render-rectangle='<0, 0, 720, 480>'
```

2. Rotation video

```
#    gst-launch-1.0 videotestsrc ! video/x-raw, width=640, height=480, framerate=30/1 ! \
     glimagesink max-lateness=-1 rotate-method=1
```

4.6 Audio Pipeline

4.6.1 Decode MP3

```
gst-launch-1.0 filesrc location=MP3_file.mp3 ! mpegaudioparse ! mpg123audiodec ! \
audioconvert ! audioresample ! alsasink device=plughw:0,0
```

4.6.2 Decode Vorbis stream

```
gst-launch-1.0 -v filesrc location=OGG_file.ogg ! oggdemux ! vorbisdec ! audioconvert ! \
audioresample ! alsasink device=plughw:0,0
```

4.6.3 Decode AAC

```
gst-launch-1.0 filesrc location=ACC_file.aac ! faad ! audioconvert ! audioresample ! \
alsasink device=plughw:0,0
```

4.6.4 Encode Vorbis stream

```
gst-launch-1.0 -e audiotestsrc wave=sine num-buffers=100 ! audioconvert ! \
vorbisenc ! oggmux ! filesink location=OGG_file.ogg
```

4.7 Network Protocol Pipeline

4.7.1 UDP

1. Receiver

```
#    gst-launch-1.0 udpsrc port=5000 buffer-size=100000000 ! application/x-rtp ! \
     rtph264depay ! h264parse ! omxh264dec ! waylandsink
```

NOTE	In order to prevent dropped buffers when streaming over a network, it is recommended to add the `max-lateness=-1 qos=false` option after the `waylandsink` command. This will ensure that the system is able to handle the incoming streams without any data loss due to buffer overflow.

a. Sender

```
#    gst-launch-1.0 filesrc location=MP4_file.mp4 ! qtdemux ! h264parse ! \
     video/x-h264, stream-format=avc, alignment=au ! rtph264pay config-interval=1 ! \
     udpsink host=RECEIVER_IP port=5000
```

NOTE	A receiver needs to run first.

4.7.2 TCP (`tcpserversink` to `tcpclientsrc`)

1. Receiver

```
#    gst-launch-1.0 tcpclientsrc host=SENDER_IP ! h264parse ! omxh264dec ! waylandsink
```

2. Sender

```
#    gst-launch-1.0 filesrc location=MP4_file.mp4 ! qtdemux ! h264parse config-interval=1 ! \
     video/x-h264, stream-format=byte-stream ! tcpserversink host=SENDER_IP
```

NOTE	A sender needs to run first.

4.7.3 TCP (`tcpclientsink` to `tcpserversrc`)

1. Receiver

```
#    gst-launch-1.0 tcpserversrc host=RECEIVER_IP port=5000 ! h264parse ! \
     omxh264dec ! waylandsink
```

2. Sender

```
#    gst-launch-1.0 filesrc location=MP4_file.mp4 ! qtdemux ! h264parse config-interval=1 ! \
     video/x-h264,stream-format=byte-stream ! tcpclientsink host=RECEIVER_IP port=5000
```

> **NOTE**   A receiver needs to run first.

5. Debugging Tool

5.1 `GST_DEBUG`

Use `gst-launch-1.0 --gst-debug-help` to show the list of all registered categories.

Add `GST_DEBUG=<category>:<log level>` to enable debug log of category. For example:

```
#     GST_DEBUG=videotestsrc:5 gst-launch-1.0 videotestsrc ! fakesink
```

Table 5-1 Debug Levels

Level	Name	Description
0	none	No debug information is output.
1	ERROR	Logs all fatal errors. These are errors that do not allow the core or elements to perform the requested action. The application can still recover if programmed to handle the conditions that triggered the error.
2	WARNING	Logs all warnings. Typically, these are non-fatal, but user-visible problems are expected to happen.
3	FIXME	Logs all "fixme" messages. Those typically that a code path that is known to be incomplete has been triggered. It may work in most cases but may cause problems in specific instances.
4	INFO	Logs all informational messages. These are typically used for events in the system that only happen once or are important and rare enough to be logged at this level.
5	DEBUG	Logs all debug messages. These are general debug messages for events that happen only a limited number of times during an object's lifetime; these include setup, teardown, change of parameters, etc.
6	LOG	Logs all log messages. These are messages for events that happen repeatedly during an object's lifetime; these include streaming and steady-state conditions. This is used for log messages that happen on every buffer in an element for example.
7	TRACE	Logs all trace messages. Those are message that happen very very often. This is for example is each time the reference count of a GstMiniObject, such as a GstBuffer or GstEvent, is modified.
9	MEMDUMP	Logs all memory dump messages. This is the heaviest logging and may include dumping the content of blocks of memory.

5.2 Pipeline Graph

For those cases where your pipeline starts to grow too large and you lose track of what is connected with what, GStreamer has the capability to output graph files. These are **.dot** files, readable with free programs like **GraphViz**, that describe the topology of your pipeline, along with the caps negotiated in each link.

Requirements:

- Ubuntu 16.04 or later.

- **GraphViz** (detailed information at https://graphviz.org/)

Steps to use it:

1. Define output location for the generated pipeline graphs.

   Export:

   ```
   #         export GST_DEBUG_DUMP_DOT_DIR=/output
   ```

   While running application or pipeline:

   ```
   #         GST_DEBUG_DUMP_DOT_DIR=/output gst-launch-1.0 [OPTIONS] PIPELINE-DESCRIPTION
   ```

   or

   ```
   #         GST_DEBUG_DUMP_DOT_DIR=/output ./gst_application
   ```

2. .dot files are generated in output location

   ```
   0.00.00.078803791-gst-launch.NULL_READY.dot
   0.00.00.087083833-gst-launch.READY_PAUSED.dot
   0.00.00.096721166-gst-launch.PAUSED_PLAYING.dot
   0.00.01.097021958-gst-launch.PLAYING_PAUSED.dot
   0.00.01.100463125-gst-launch.PAUSED_READY.dot
   ```

3. Converting Pipeline dot Files to various format such as PDF, PNG, JPEG, etc.

   This step should be done on Ubuntu PC which has **GraphViz**.

   ```
   $         dot -T{format} INPUT_FILE > OUTPUT_FILE
   ```

   We can use **0.00.00.096721166-gst-launch.PAUSED_PLAYING.dot** as input file.

   Example for pipeline:

   ```
   #         GST_DEBUG_DUMP_DOT_DIR=/output gst-launch-1.0 videotestsrc num-buffers=30 ! waylandsink
   ```
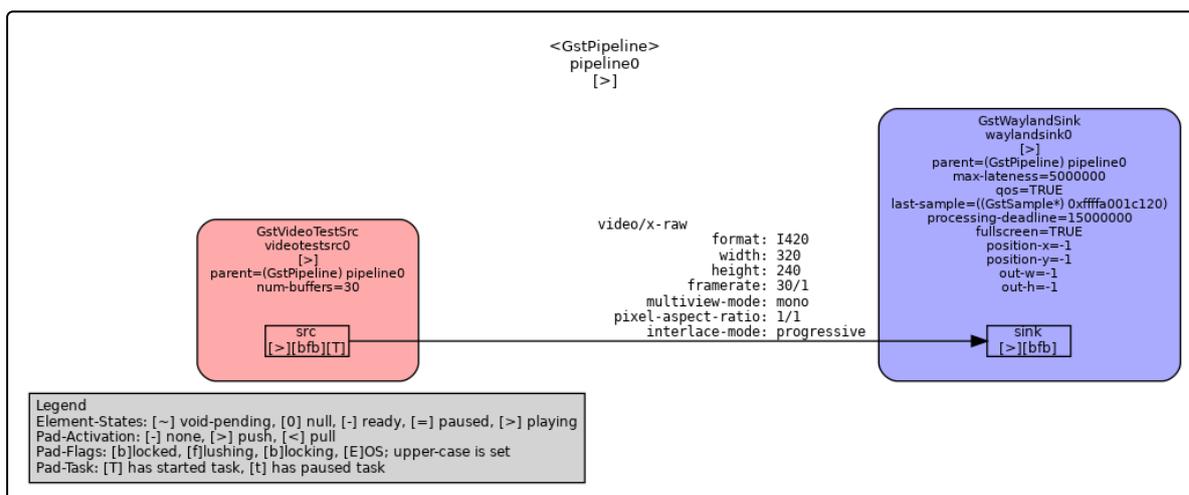

Figure 5-1: Pipeline Graph

6. Performance Comparison

This section provides a detailed analysis of the performance and efficiency of various plugins, along with their properties, to assist you in selecting the options that best meet your requirements.

Method to measure performance:

- Video Framerate: using pad probe tool to measure fps.
- CPU Load: using `top` command.

Performance levels:

- Video Framerate: Best > Good > Poor
- CPU Load: Mild > Moderate > Heavy

6.1 Renesas Hardware Accelerated Decoder vs Software Decoder

File: bbb_sunflower_1080p_30fps_normal.mp4

can be downloaded at: https://mirrors.mit.edu/kodi/demo-files/BBB/bbb_sunflower_1080p_30fps_normal.mp4

File information:

Table 6-1 Decode Input File Information

Video		Audio	
Format	AVC	Format	AAC
Format profile	High@L4.1	Format/Info	Advanced Audio Codec
Format settings, CABAC	Yes	Format profile	LC
Format settings, ReFrames	4 frames	Codec ID	6B
Codec ID	avc1	Duration	10mn 34s
Codec ID/Info	Advanced Video Coding	Bit rate mode	Constant
Duration	10mn 34s	Bit rate	160 Kbps
Bit rate	3,000 Kbps	Maximum bit rate	165 Kbps
Maximum bit rate	16.7 Mbps	Channel(s)	2 channels
Width	1,920 pixels	Channel positions	Front: L R
Height	1,080 pixels	Sampling rate	48.0 KZ
Display aspect ratio	4:3	Compression mode	Lossy
Frame rate mode	Constant	Stream size	12.1 MiB (5%)
Frame rate	30.000 fps	Language	English
Color space	YUV		

Video		Audio	
Chroma subsampling	4:2:0		
Bit depth	8 bits		
Scan type	Progressive		

Pipeline:

- `omxh264dec`

```
# gst-launch-1.0 filesrc location=bbb_sunflower_1080p_30fps_normal.mp4 ! qtdemux ! \
  h264parse ! omxh264dec ! waylandsink -rp waylandsink0:sink
```

> **NOTE**
> Add the `qos=false` option after the `waylandsink` element. This ensures the system can handle incoming streams without data loss caused by buffer overflow. (The video will play at 30 FPS.)

- `avdec_h264`

```
# gst-launch-1.0 filesrc location=bbb_sunflower_1080p_30fps_normal.mp4 ! qtdemux ! \
  h264parse ! avdec_h264 ! waylandsink -rp waylandsink0:sink
```

> **CAUTION**
> In VLP v4 (or later) and AI SDK v7.00 (or later), `avdec_h264` is no longer included in the default installation. Users who wish to use `avdec_h264` must install it manually and assume all associated risks and responsibilities.

Table 6-2 `omxh264dec` and `avdec_h264` Performance Comparison

	`omxh264dec` (`use-dmabuf`)	`avdec_h264`
Video Framerate	Best	Poor
CPU Load	Mild	Moderate
Dropped Frame	Best	Poor

6.2 `omxh264dec` : `use-dmabuf` vs `no-copy`

File: bbb_sunflower_1080p_30fps_normal.mp4

File information is described in Table 6-1

Pipeline:

- `use-dmabuf=true`

```
#    gst-launch-1.0 filesrc location=bbb_sunflower_1080p_30fps_normal.mp4 ! qtdemux ! h264parse ! \
     omxh264dec ! waylandsink -rp waylandsink0:sink & \
     gst-launch-1.0 filesrc location=bbb_sunflower_1080p_30fps_normal.mp4 ! qtdemux ! h264parse ! \
     omxh264dec ! waylandsink -rp waylandsink0:sink &
```

- `no-copy=true`

```
#    gst-launch-1.0 filesrc location=bbb_sunflower_1080p_30fps_normal.mp4 ! qtdemux ! h264parse ! \
     omxh264dec no-copy=true ! waylandsink -rp waylandsink0:sink & \
     gst-launch-1.0 filesrc location=bbb_sunflower_1080p_30fps_normal.mp4 ! qtdemux ! h264parse ! \
     omxh264dec no-copy=true ! waylandsink -rp waylandsink0:sink &
```

NOTE	Add the `qos=false` option after the `waylandsink` element. This ensures the system can handle incoming streams without data loss caused by buffer overflow. (The video will play at 30 FPS.)

Table 6-3 `use-dmabuf` *and* `no-copy` *Performance Comparison*

	`omxh264dec` (`use-dmabuf`)	`omxh264dec` (`no-copy`)
Video Framerate	Best	Good
CPU Load	Mild	Moderate
Dropped Frame	Best	Good

6.3 Renesas Hardware Accelerated Encoder vs Software Encoder

Before using software encoder, we must install it by adding these lines below into `local.conf`

local.conf

```
IMAGE_INSTALL_append = " \
      x264 \
      gstreamer1.0-plugins-ugly \"
PACKAGECONFIG_append_pn-gstreamer1.0-plugins-ugly = " x264"
```

Input information:

Resolution: 1920x1080, fps 30.

Output file information:

File: FHD_H264_file.264

File information:

Table 6-4 Encode Output File Information

Video	
Format	AVC
Format profile	Baseline@L4.1
Format settings, CABAC	No
Format settings, ReFrames	2 frames
Codec ID	avc1
Codec ID/Info	Advanced Video Coding
Duration	12s
Bit rate	6,967 Kbps
Width	1,920 pixels
Height	1,080 pixels
Display aspect ratio	4:3
Frame rate mode	Constant
Frame rate	25.000 fps
Color space	YUV
Chroma subsampling	4:2:0
Bit depth	8 bits
Scan type	Progressive

Pipeline:

- Renesas hardware accelerated encoder `omxh264enc`

```
#    gst-launch-1.0 -e v4l2src device=/dev/video0 num-buffers=300 ! \
     video/x-raw, format=YUY2, width=1920, height=1080, framerate=30/1 ! \
     vspmfilter dmabuf-use=true ! video/x-raw, format=NV12 ! \
     omxh264enc control-rate=1 target-bitrate=6967000 b-frames=0 \
     interval-intraframes=0 use-dmabuf=true name=v ! \
     video/x-h264, profile=\(string\)main, level=\(string\)4 ! \
     filesink location=H264_file.264 -rp v:src
```

- Software encoder `x264enc`

```
#    gst-launch-1.0 -e v4l2src device=/dev/video0 num-buffers=300 ! \
     video/x-raw, format=YUY2, width=1920, height=1080, framerate=30/1 ! \
     vspmfilter dmabuf-use=true ! video/x-raw, format=NV12 ! \
     x264enc bframes=0 speed-preset=faster tune=zerolatency name=v ! \
     video/x-h264, profile=\(string\)main, level=\(string\)4 ! \
     filesink location=H264_file.264 -rp v:src
```

Table 6-5 `omxh264enc` *and* `x264enc` *Performance Comparison*

	omxh264enc	x264enc
Video Framerate	Best	Poor
CPU Load	Moderate	Moderate
Dropped Frame	Best	Poor

7. Limitation

7.1 `vspmfilter`

- `vspmfilter` doesn't work with `fakesink`, `filesink` and `waylandsink` on the default mode.

- `vspmfilter` doesn't support scale up due to hardware limitation of ISU. ISU only supports scale down function with bilinear interpolation.

- `vspmfilter` doesn't work when decoding audio.

- `vspmfilter` works with USB cameras, as long as the format and framerate match the selected resolution.

Appendix

A How to Write Output to Raw File Instead of Displaying Using `filesink`

```
#    gst-launch-1.0 filesrc location=FHD_MP4_file.mp4 ! qtdemux ! h264parse ! \
     omxh264dec ! filesink location=FHD_RAW_file.raw
```

B How to Change the Default Video Filter In `playbin` and `playbin3` Elements

`playbin` and `playbin3` provides a stand-alone everything-in-one abstraction for an audio and/or video player.

The default video filter for video chain in **playbin** and **playbin3** is defined in `/etc/gstpbfilter.conf` .

If we want to use `vspmfilter` or other video filter, we can change this default.

Here is how to change the default video filter in **playbin** and **playbin3**:

Please edit `/etc/gstpbfilter.conf` to change the default video filter.

In case of using `vspmfilter` as default video filter.

gstpbfilter.conf

```
video-filter=vspmfilter
```

In case of using `videoconvert` as default video filter.

gstpbfilter.conf

```
video-filter=videoconvert
```

C How to Change the Default Mode In OMX Video Decoder Element

When we specify neither `no-copy` nor `use-dmabuf` option. The default mode of omx video decoder element is `usedmabuf=true` .

Here is how to change the default mode of omx video decoder element.

Please edit `/etc/xdg/gstomx.conf` to change the default mode.

In case of using `no-copy` mode as default, add the following definition to the "hacks".

gstomx.conf

```
hacks=use-no-copy-mode-as-default
```

D How to Detect Active Camera

List all connected cameras:

```
#       v4l2-ctl --list-devices
```

e.g.: Renesas Linux VLP for RZ/G2L with SMARC RZ/G2L EVK

```
root@smarc-rzg2l:~# v4l2-ctl --list-devices
RZG2L_CRU (platform:10830000.video):
        /dev/video0
        /dev/media0

Logicool Webcam C930e (usb-11c70100.usb-1.4):
        /dev/video1
        /dev/video2
        /dev/media1
```

List all supported formats for selected camera

```
#       v4l2-ctl -d <path-to-device;e.g.:/dev/video1> --list-formats-ext
```

e.g.: Device: `/dev/video1` (`Logicool Webcam C930e (usb-11c70100.usb-1.4)`) The terminal output shown here has been selectively truncated.

```
root@smarc-rzg2l:~# v4l2-ctl -d /dev/video1 --list-formats-ext
ioctl: VIDIOC_ENUM_FMT
        Type: Video Capture
        [0]: 'YUYV' (YUYV 4:2:2)
                Size: Discrete 640x480
                        Interval: Discrete 0.033s (30.000 fps)
                        Interval: Discrete 0.042s (24.000 fps)
                        Interval: Discrete 0.050s (20.000 fps)
                        Interval: Discrete 0.067s (15.000 fps)
                        Interval: Discrete 0.100s (10.000 fps)
                        Interval: Discrete 0.133s (7.500 fps)
                        Interval: Discrete 0.200s (5.000 fps)
```

Test with Gstreamer Pipeline:

```
root@smarc-rzg2l:~# gst-launch-1.0 v4l2src device=/dev/video1 io-mode=mmap num-buffers=30 ! video/x-
raw,format=YUY2,width=640,height=480,framerate=30/1 ! waylandsink
Setting pipeline to PAUSED ...
Pipeline is live and does not need PREROLL ...
Setting pipeline to PLAYING ...
New clock: GstSystemClock
Got EOS from element "pipeline0".
Execution ended after 0:00:01.521874382
Setting pipeline to NULL ...
Total time: 1.521878 seconds
Freeing pipeline ...
```

E How to Configure and Utilize MIPI Camera

To utilize a MIPI camera, it is necessary to perform configuration settings prior to its operation.

Example configuration for integrating the **OV5645** MIPI camera with the "**Renesas Linux VLP for RZ/G2L with SMARC RZ/G2L EVK**" (also applicable for "**Renesas Linux VLP for RZ/V2L with SMARC RZ/V2L EVK**"):

Firstly, to determine the initial CSI-2 (Camera Serial Interface 2) and device IP (CRU-IP) sub-device recognized by the system, execute the following command, and assign its output to the variable `csi2` and `ip`:

```
#       export csi2=$(cat /sys/class/video4linux/v4l-subdev*/name | grep "csi2" | head -n 1)
#       export ip=$(cat /sys/class/video4linux/v4l-subdev*/name | grep "cru-ip" | head -n 1)
```

In this example `csi2` is **csi-10830400.csi2** and `ip` is **cru-ip-10830000.video**

Below command resets the media controller state. It clears all existing links and formats on the media device represented by `/dev/media0`.

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

Below command sets up a link between two entities in the media device. It links the output pad 1 of the **csi-10830400.csi2** entity to the input pad 0 of the **cru-ip-10830000.video** entity and activates the link.

```
#       media-ctl -d /dev/media0 -l "'${csi2}':1 -> '${ip}':0 [1]"
```

Below command sets the video format for a specific pad (pad 1) of the **csi-10830400.csi2** entity. The format specified here is **UYVY8_2X8** with a resolution of 1280x960 and no interlaced field.

```
#       media-ctl -d /dev/media0 -V "'${csi2}':1 [fmt:UYVY8_2X8/1280x960 field:none]"
```

Below command sets the video format for pad 0 of the **ov5645 0-003c** entity to **UYVY8_2X8** at 1280x960 resolution with no interlaced field.

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

Below command sets the video format for pad 0 of the **cru-ip-10830000.video** entity to **UYVY8_2X8** at 1280x960 resolution with no interlaced field.

```
#       media-ctl -d /dev/media0 -V "'${ip}':0 [fmt:UYVY8_2X8/1280x960 field:none]"
```

Index

R

Renesas Extended Element

`omxh264dec`	5-6, 9-11, 15-17, 28-30, 38-39, 44-45, 49
`omxh264enc`	8, 10, 12, 17-19, 29, 31, 47
`v4l2src`	7-8, 10, 12, 21-22, 30-31, 47, 52
`vspmfilter`	6-8, 10, 12, 24, 30-31, 47-48, 50
`waylandsink`	5-7, 10, 12, 25-26, 28-30, 33-34, 38-39, 42, 44-45, 48, 52

Revision History	Linux Interface Specification GStreamer User's Manual: Software

Rev.	Date	Description	
		Page	**Summary**
1.00	Jun. 8, 2023	-	Initial revision of RZ/G2L Group and RZ/V2L Group GStreamer User's Manual: Software
1.01	Jul. 30, 2024	7 – 17	Rename "3. Plugins and element information" to "3. GStreamer Tool, Plug-in and Element"
		7	Add "3.1 GStreamer Tool"
		8 – 12	Add "3.2 GStreamer Plug-in and Element"
		13 – 17	Move "3.2 Elements" (on previous revision) to "3.3 Renesas Extended Element" (on this revision) and adding information regarding `SINK` and `SRC` for each Renesas-extended element
		18 – 30	Rename and update "4. Example of how to use the plug-in" (on previous revision) with "4. Example Pipeline" (on this revision) • Re-ordering examples by element rather than use case
		31 – 33	Add "5. Debugging Tool"
		34 – 38	Add "6. Performance Comparison"
		39	Fix format of "7. Limitation" ("5. Limitation" on previous revision)
		40 – 47	Update "8. Appendix" ("6. Appendix" on previous revision) • Re-ordering sub sections content
		43 – 44	Add "8.4 How To Detect Active Camera"
		45 – 47	Add "8.5 How To Configure and Utilize MIPI Camera"
1.02	May 16, 2025	-	Update Revision number to 1.02
		9 – 10	Update NOTE of "3.2.1 `playbin`"
		15 – 16	Update "Table 3-14 `omxh264dec` Expansion Properties" ("Table 18 `omxh264dec` Expansion Properties" on previous revision) • Update properties (and related information) of `enable-crop`, `bypass` and `num-outbufs` • Add new property of `enable_scale`
		18 – 19	Update "Table 3-16 `omxh264enc` Expansion Properties" ("Table 20 `omxh264enc` Expansion Properties" on previous revision) • Add new property of `crop`

Rev.	Date	Description	
		Page	**Summary**
1.02	May 16, 2025	24	Update NOTE of "4.1 `playbin`"
		28	Add decoding example pipelines for "4.4.1 `omxh264enc` (Hardware Accelerated Video Encoder)" • Add example "4. H.264 encode with cropping setting and save to an elementary file (format conversion by `vspmfilter`)"
		45	Update Appendix "B How to Change the Default Video Filter In `playbin` Element" ("8.2 How to Change the Default Video Filter In `playbin` Element" on previous revision)
		48	Update Appendix "E How to Configure and Utilize MIPI Camera" ("8.5 How to Configure and Utilize MIPI Camera" on previous revision)
2.00	May 30, 2025	-	Update Revision number to 2.00 Initial revision for VLP v4 (*Kernel 6.1-CIP, Yocto-5.0 (Scarthgap)*) for RZ/G2L Group
		3, 9, 24	Add information regarding VLP v4
2.01	Jul 30, 2025	-	Update Revision number to 2.01
		3	Update VLP/V v3.0.7 for RZ/V2L Evaluation Board Kit
		9	Update Remarks of `gst-plugin-vspmfilter`
		10	Add `playbin3` to "3.2.1 `playbin` and `playbin3`" and Table 3-2 `playbin` and `playbin3` and Note Add CAUTION `avdec_h264` in "3.2.2 Video Decode Plugin"
		11	Add `playbin3` to NOTE of "3.2.6 Video Sink Plugin"
		15	Update Explanation for Property `enable-crop` and `enable_scale` in "3.3.1 Video H.264 Decode Element: `omxh264dec`"
		18	Add default value for Property `crop` in "3.3.2 Video H.264 Encode Element: `omxh264enc`"
		20 – 22	Update formats of "3.3.3 Source Element: `v4l2src`" Update "Table 3-18 `v4l2src` Expansion Properties" • Add new property `disable-dynamic-buffer-alloc`
		23	Update formats and add NOTE of "3.3.4 Video Conversion Element: `vspmfilter`" Update Explanation of Property `outbuf-alloc`

Rev.	Date	Description	
		Page	Summary
2.01	Jul 30, 2025	24 – 25	Update formats of "3.3.5 Video Sink Element: `waylandsink` " Add table for Property `fullscreen` "
		26	Add new example pipeline and Note of "4.1.2 `playbin3` "
		28	Add CAUTION `avdec_h264` to "4.2.3 avdec_h264 (Software Decoder)"
		34	Add NOTE in "4.5.2 `fbdevsink` "
		37	Update example pipelines for "4.7.2 TCP (`tcpserversink` to `tcpclientsrc`)" Add new example pipelines and NOTE of "4.7.3 TCP (`tcpclientsink` to `tcpserversrc`)"
		42	Add CAUTION `avdec_h264` to "6.1 Renesas Hardware Accelerated Decoder vs Software Decoder
		45	Update pipelines of "6.3 Renesas Hardware Accelerated Encoder vs Software Encoder"
		46	Update "7.1 `vspmfilter` "
		48	Add `playbin3` to Appendix "B How to Change the Default Video Filter In `playbin` and `playbin3` Elements"
2.02	Mar 27, 2026	-	Update Revision number to 2.02

		1, 3	Update and add information regarding RZ/V2H AI SDK v7.00
			
			• Update tables of:
			  • "1.1 Related Documents"
			  • "2.1 Hardware and Software Environment"

		5 - 8	Update software configuration diagrams for GStreamer
			
			• Update diagrams of:
			  • "2.3.1 Video Decode and Display"
			  • "2.3.2 Video Capture and Display"
			  • "2.3.3 Video Capture and Encode"

		10	Update table and Note of "3.2 GStreamer Plug-in and Element" • Update row of "License" and "Version" following new column of "Yocto Version" (Dunfell, Scarthgap) due to different licenses • Update row of "Remarks" for "7. gst-plugin-vspmfilter"

Rev.	Date	Description	
		Page	Summary
2.02	Mar 27, 2026	12	Replace "videosink" with "video-sink" in NOTE of 3.2.6 Video Sink Plugin
		16 - 17	Update "Table 3-13 `omxh264dec` Expansion Properties" • Add new property of `sizebytes` • Add note and description for crop feature
		18 - 20	Update "Table 3-15 `omxh264enc` Pad Templates" and "Table 3-16 `omxh264enc` Expansion Properties" • Update resolution for src and sink pads • Add I420 as input format for omxh264enc • Add new properties: `sizebytes`, `interval_intraframes`, `control-rate`, `target-bitrate`, `periodicity-idr` • Add note for `interval_intraframes` property
		24	Add supported GRAY10_LE64 format to "3.3.4 Video Conversion Element: `vspmfilter`"
		35	Replace NOTE for 4.5.2 `fbdevsink` with simpler explanation
		38	Add a NOTE to prevent dropped buffer when streaming to "4.7.1 `UDP` Receiver"

Linux Interface Specification GStreamer

RENESAS

Renesas Electronics Corporation