User's Manual

RENESAS

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Linux Interface Specification Device Driver Display

User's Manual: Software

R-Car H3/M3/M3N/E3/D3/V3U/V3H Series

Renesas Electronics
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How to Use This Manual

- **[Readers]**

  This manual is intended for engineers who develop products which use the R-Car H3 / M3 / M3N / E3 / D3 / V3U / V3H processor.

- **[Purpose]**

  This manual is intended to give users an understanding of the functions of the R-Car H3 / M3 / M3N / E3 / D3 / V3U / V3H processor device driver and to serve as a reference for developing hardware and software for systems that use this driver.

- **[How to Read This Manual]**

  It is assumed that the readers of this manual have general knowledge in the fields of electrical

  — engineering, logic circuits, microcontrollers, and Linux.

  → Read this manual in the order of the CONTENTS.

  — To understand the functions of a multimedia processor for R-Car H3 / M3 / M3N / E3 / D3 / V3U / V3H

  → See the R-Car H3 / M3 / M3N / E3 / D3 / V3U / V3H User's Manual.

  — To know the electrical specifications of the multimedia processor for R-Car H3 / M3 / M3N / E3 / D3 / V3U / V3H

  → See the R-Car H3 / M3 / M3N / E3 / D3 / V3U / V3H Data Sheet.

- **[Conventions]**

  The following symbols are used in this manual.

  Data significance: Higher digits on the left and lower digits on the right

  Note: Footnote for item marked with Note in the text

  Caution: Information requiring particular attention

  Remark: Supplementary information

  Numeric representation: Binary ... ××××, 0b××××, or ××××B

  Decimal ... ××××

  Hexadecimal ... 0x×××× or ××××H

  Data type: Double word ... 64 bits

  Word … 32 bits

  Half word ... 16 bits

  Byte ... 8 bits

Table of Contents

1. Overview

1.1 Overview

This manual explains the display driver module (this module) that controls the Display Unit and VSPD on R-Car H3 / M3 / M3N / E3 / D3 / V3U / V3H.

1.2 Function

This module controls VSPD to be equipped with R-Car H3 / M3 / M3N / E3 / D3 / V3U / V3H and blends an image.

A blended image is outputted through Display module. A function list supported to a Display driver is as follows.

- Multi plane

  It's possible to blend at maximum five plane per VSPD 1ch. one plane is used a desktop, and another of four plane can be used overlays.

- Multi display

  It's possible to be displayed in independence per channel.

- Pixel format

  RGB332, RGB565, ARGB4444, XRGB4444, ARGB1555, XRGB1555, BGR888, RGB888, BGRA8888, BGRX8888, ARGB8888, XRGB8888, UYVY, YUYV, YVYU, NV12, NV21, NV16, NV61, YUV420, YVU420, YUV422, YVU422, YUV444, YVU444, RGBX1010102[*1], RGBA1010102[*1], ARGB2101010[*1]

  Note: 1. RGBX1010102, RGBA1010102, ARGB2101010 formats are supported only in R-Car V3U

- Alpha blend

  This is the function to change the transmitted color of plane. There is plane alpha (layer uniform transmission) and pixel alpha (transmission in pixels).

  Plane alpha: RGB332, RGB565, XRGB4444, XRGB1555, BGR888, RGB888, BGRX8888, XRGB8888, RGBX1010102[*1], RGBA1010102[*1], ARGB2101010[*1]

  Pixel alpha: ARGB1555, ARGB4444, BGRA8888, ARGB8888, RGBA1010102[*1], ARGB2101010[*1]

  Plane alpha and pixel alpha: ARGB4444, BGRA8888, ARGB8888, RGBA1010102[*1], ARGB2101010[*1]

  Note: 1. RGBX1010102, RGBA1010102, ARGB2101010 formats are supported only in R-Car V3U

- Clipping

  This is the function to clip an image of a frame buffer area.

- Plane Order

  This is the function to change the display priority of the plane.

- VSPD0, VSPD1 and VSPD2 are supported (Please refer to 1.6 Section for more details)

- Hot plug (HDMI connection)

- Display List support

  This function automatically downloads the register settings without CPU intervention from external memory.

- Screen shot (Write back function) support

- Vmute function

- Color key support

  Note: 1. RGBX1010102, RGBA1010102, ARGB2101010 formats are not supported

- The LVDS-IF supports the Dual-link output by using vertical stripe output function.(R-Car E3 only)
- DSI/CSI-2-TX-IF Connection (R-Car V3U only)
- Safe Rendering Support

1.2.1 Display Resolution

Supported display resolution of this module is as follows.

If there is no explanation below, each resolution is an output in progressive mode.

If the monitor supports interlaced mode, interlaced mode can also be displayed.

Refer to "4.1.6 Resolution Change" and “5.2.3 Kernel Parameters” to change resolution.

Table 1.1 Supported resolution (R-Car H3 / M3 / M3N system evaluation board)

Display resolution	HDMI *1	Analog RGB *2	LVDS
VGA (640x480)	yes	yes	no *5
WVGA (800x480)	yes	yes *4	no *5
SVGA (800x600)	yes	yes	no *5
WSVGA (1024x600)	yes	yes *4	no *5
XGA (1024x768)	yes	yes	yes
FWXGA (1280x720)	yes	yes *4	no *5
WXGA (1280x768)	yes	yes*4	no *5
1080i (1920x1080i)	yes	yes *4	no *5
1080p (1920x1080)	yes	no	no *5
WUXGA (1920x1200)	yes	no	no
4k (3840x2160) *3	yes	no	no

Table 1.2 Supported resolution (R-Car E3 / D3 system evaluation board)

Display resolution	HDMI *1	Analog RGB *2	LVDS
VGA (640x480)	yes	yes	no *5
WVGA (800x480)	yes	yes *4	no *5
SVGA (800x600)	yes	yes	no *5
WSVGA (1024x600)	yes	yes*4	no *5
XGA (1024x768)	yes	yes	yes
WXGA (1280x768)	yes	no	no *5
SXGA (1280x1024)	yes	no	no *5
(1920x720)	yes	no	no *5

Interlaced mode is not supported in R-Car D3 / E3.

Table 1.3 Supported resolution (R-Car V3U system evaluation board)

Display resolution	DSI/CSI-2-TX
VGA (640x480)	yes
SVGA (800x600)	yes
XGA (1024x768)	yes
FWXGA (1280x720)	yes
WXGA (1280x768)	yes
1080p (1920x1080)	yes
WUXGA (1920x1200)	yes

Interlaced mode is not supported in R-Car V3U.

Table 1.4 Supported resolution (R-Car V3H system evaluation board – Condor & Condor-I)

Display resolution	HDMI *1
VGA (640x 480)	yes
WVGA (800x 480)	yes
SVGA (800x 600)	yes
WSVGA (1024x 600)	yes
XGA (1024x 768)	yes
SXGA (1280x1024)	yes
1080p (1920x 1080)	yes

Interlaced mode is not supported in R-Car V3H.

Notes:
1. the initial value is set as the recommendation resolution which a display monitors requires (The start-up in HDMI cable connection). the resolution of HDMI cannot be displayed about resolution that a display monitor does not support. The resolution of HDMI can set the supported resolution to the display monitor.
2. The initial value is XGA (1024x768). When you want to display more than XGA size, please specify resolution size as a kernel parameter and boot kernel. Please refer to 5.2.3 Kernel Parameters in detail.
3. The refresh rate of 4k is supported 30Hz only.
4. About the default resolution of Analog RGB, these resolutions can be displayed by modifying the driver source code or bootargs. Please refer to [Analog RGB] in “4.1.7 Add Resolution Setting” and “5.2.3 Kernel Parameters”.
5. About the resolution of LVDS, these resolutions other than XGA is not supported in this driver. However, these resolutions may be possible to display in LVDS panel dependent, please refer to [LVDS output] in “4.1.7 Add Resolution Setting”.

1.2.2 Pixel Format

Supported pixel format of this module is as follows.

Refer to "4.1.8 Pixel Format Change" to change pixel format in DRM access.

Table 1.5 Supported pixel format

Pixel format	DRM FourCC macro name	Support
RGB332	DRM_FORMAT_RGB332	yes
ARGB4444	DRM_FORMAT_ARGB4444	yes
XRGB4444	DRM_FORMAT_XRGB4444	yes
ARGB1555	DRM_FORMAT_ARGB1555	yes
XRGB1555	DRM_FORMAT_XRGB1555	yes
RGB565	DRM_FORMAT_RGB565	yes
BGR888	DRM_FORMAT_BGR888	yes
RGB888	DRM_FORMAT_RGB888	yes
BGRA8888	DRM_FORMAT_BGRA8888	yes
BGRX8888	DRM_FORMAT_BGRX8888	yes
ARGB8888	DRM_FORMAT_ARGB8888	yes
XRGB8888	DRM_FORMAT_XRGB8888	yes
RGBX1010102	DRM_FORMAT_RGBX1010102	yes *1
RGBA1010102	DRM_FORMAT_RGBA1010102	yes *1
ARGB2101010	DRM_FORMAT_ARGB2101010	yes *1
UYVY	DRM_FORMAT_UYVY	yes
YUYV	DRM_FORMAT_YUYV	yes
YVYU	DRM_FORMAT_YVYU	yes
NV12	DRM_FORMAT_NV12	yes
NV21	DRM_FORMAT_NV21	yes
NV16	DRM_FORMAT_NV16	yes
NV61	DRM_FORMAT_NV61	yes
YUV420	DRM_FORMAT_YUV420	yes
YVU420	DRM_FORMAT_YVU420	yes
YUV422	DRM_FORMAT_YUV422	yes
YVU422	DRM_FORMAT_YVU422	yes
YUV444	DRM_FORMAT_YUV444	yes
YVU444	DRM_FORMAT_YVU444	yes

Notes: 1. RGBX1010102, RGBA1010102, ARGB2101010 formats are supported only in R-Car V3U.

1.2.3 Connector

Supported connector of this module is as follows.

Table 1.6 Supported connector (R-Car H3 / M3 / M3N system evaluation board)

Output signal	Connector's number
Analog RGB	CN15
HDMI0	CN16
HDMI1 (R-Car H3 only)	CN17
LVDS *1	CN18/CN19

Note: 1. The backlight of LVDS is controlled by a GPIO terminal (GPIO6_07). The backlight is ON when kernel starting. If you dynamically want to control, please use the GPIO of API. Please refer to Linux Interface Specification Device Driver GPIO user's manual for details.

Table 1.7 Supported connector (R-Car E3 system evaluation board)

Output signal	Connector's number
Analog RGB	CN15
HDMI	CN37
LVDS0*2	CN18/CN19, CN40/CN50(TFT)
LVDS1*2	CN38/CN39

Note: 2. The backlight of LVDS is directly connected to 3.3V DC and cannot be controlled using GPIOs.

Table 1.8 Supported connector (R-Car V3U system evaluation board)

Output signal	Connector's number
DSI-TX-IF0	CN5

Table 1.9 Supported connector (R-Car V3H system evaluation board – Condor & Condor-I)

Output signal	Number of connector
HDMI*3	CN5

Note: 3. The LVDS interface is connected to a HDMI output. The LVDS signals from the R-CarV3H are converted to digital RGB signals by the THC63LVD1024 LVDS receiver, and these in turn are converted to HDMI signals by the ADV7511WBSWZ HDMI transmitter.

Table 1.10 Supported connector (R-Car D3 system evaluation board)

Output signal	Connector's number
Analog RGB	CN15
HDMI	CN37
LVDS0*4	CN18/CN19
LVDS1*4	CN38/CN39

Note: 4. The backlight of LVDS is controlled by a GPIO terminal (D3:GP2_31 (LVDS0)/GP4_00 (LVDS1)) . The backlight is ON when kernel starting. If you dynamically want to control, please use the GPIO of API. Please refer to Linux Interface Specification Device Driver GPIO user's manual for details.

1.3 Related Document

The related document to this module is as follows.

Table 1.10 Related document (R-Car H3 / M3 / M3N / E3 / D3 / V3U / V3H)

Number	Issue	Title	Edition	Date
-	Renesas Electronics	R-Car Series, 3rd Generation User's Manual: Hardware	Rev.2.20	Jun. 30, 2020
	Renesas Electronics	R-Car V3U Series User's Manual	Rev.0.5	Jul. 31, 2020
-	Renesas Electronics	R-CarH3-SiP System Evaluation Board Salvator-X RTP0RC7795SIPB0011S	Rev.1.09	May. 11, 2017
-	Renesas Electronics	R-CarM3-SiP System Evaluation Board Salvator-X RTP0RC7796SIPB0011S	Rev.0.04	Oct. 3, 2016
-	Renesas Electronics	R-CarH3-SiP/M3-SiP/M3N-SiP System Evaluation Board Salvator-XS Hardware Manual	Rev.2.04	Jul. 17, 2018
-	Renesas Electronics	R-CarE3 System Evaluation Board Ebisu Hardware Manual RTP0RC77990SEB0010S	Rev.0.03	Apr. 11, 2018
-	Renesas Electronics	R-CarE3 System Evaluation Board Ebisu-4D (E3 board 4xDRAM) Hardware Manual	Rev.1.01	Jul. 19, 2018
	Renesas Electronics	R-CarV3U System Evaluation Board Falcon Hardware Manual	Rev.0.01	Sep. 11, 2020
-	Renesas Electronics	R-Car V3H_2: Additional Document for User's Manual: Hardware	Rev.0.50	Jul 31, 2020
-	Renesas Electronics	R-CarV3H System Evaluation Board Condor-I Hardware Manual	Rev.0.02	Nov 11, 2020
-	Renesas Electronics	R-CarD3 System Evaluation Board Hardware Manual RTP0RC77995SEB0010S	Rev.1.20	Jun. 25, 2017

1.4 Restrictions

There is no restriction.

1.5 Notice

- FBDev access is not supported. However, it supports only to draw the image to the framebuffer with FBDev. Other FBDev access control does not support. If you do not want to use the FBDev access, please do the setting of the configuration regarding 5.2.1 Kernel Configuration.
- A lengthwise parameter is corrected irrespective of the format at the time of interlaced mode. The clipping starting height, the clipping lengthwise width, the display starting height and the display lengthwise width will be 2 pixels aligning by pixel format. (It's because the progressive picture input to VSPD is changed to an interlace picture, and it's outputting.)
- In R-Car E3, TVM1 bit in DSYSR1 register is Master Mode only by H/W specification, so the sync signal of DU1 can not be stopped.

1.6 Plane access

An access related figure of the plane by each device is indicated below.

Please refer to “4.1 External Interface for DRM/KMS Driver ” about method control of plane. Plane1 and Plane3 will be common H/W plane of DU0 / DU1 or DU2 / DU3. VSPD uses one of H/W plane of DU and displays a blended image through BRU/BRS and WPF0/WPF1. The number of RPF is multi-plane number.

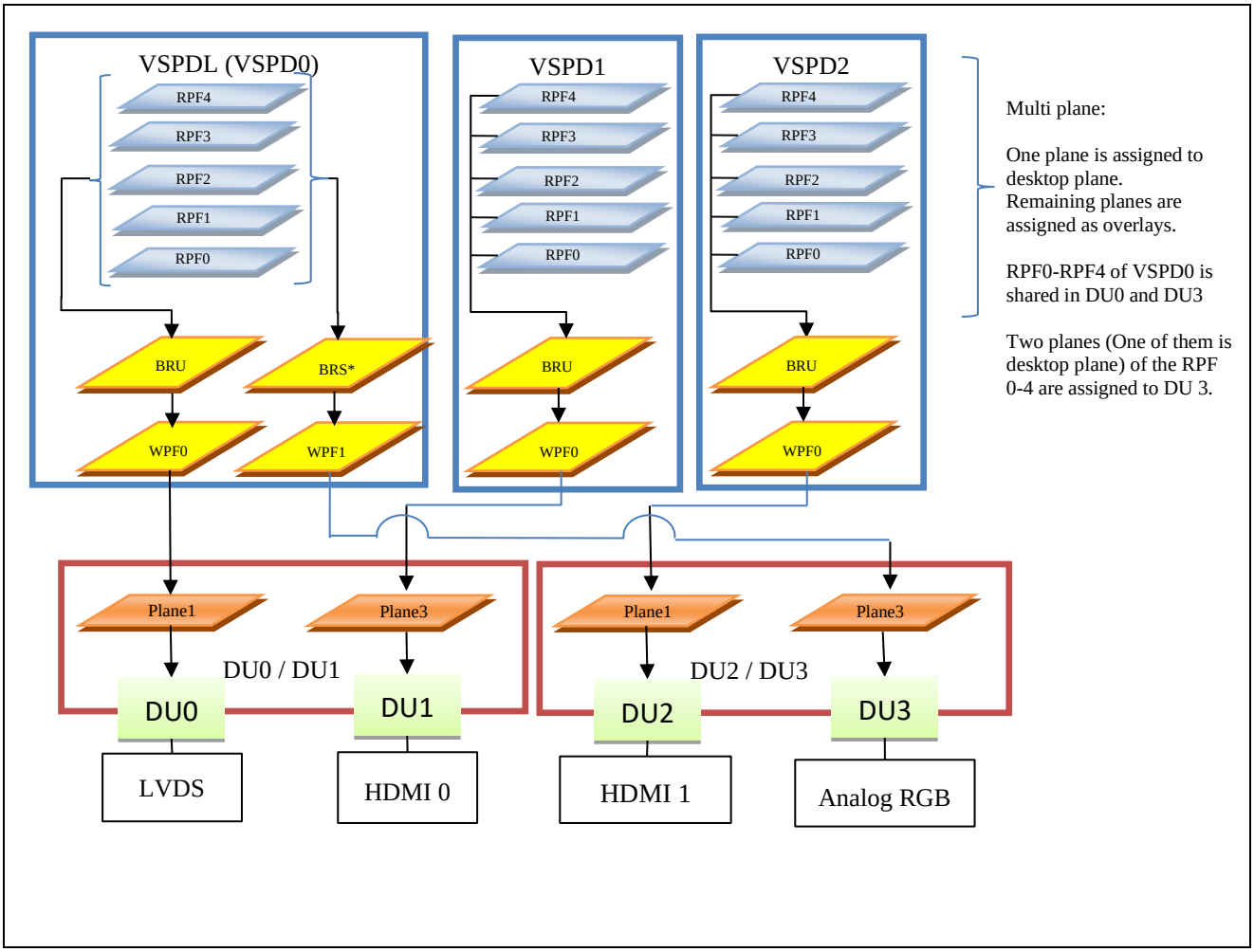


Figure 1-1 accesses of layers (R-Car H3)

* The number of RPFs used in BRS can be selected with dtsi file. Please refer to 4.5 BRS number settingfor details.

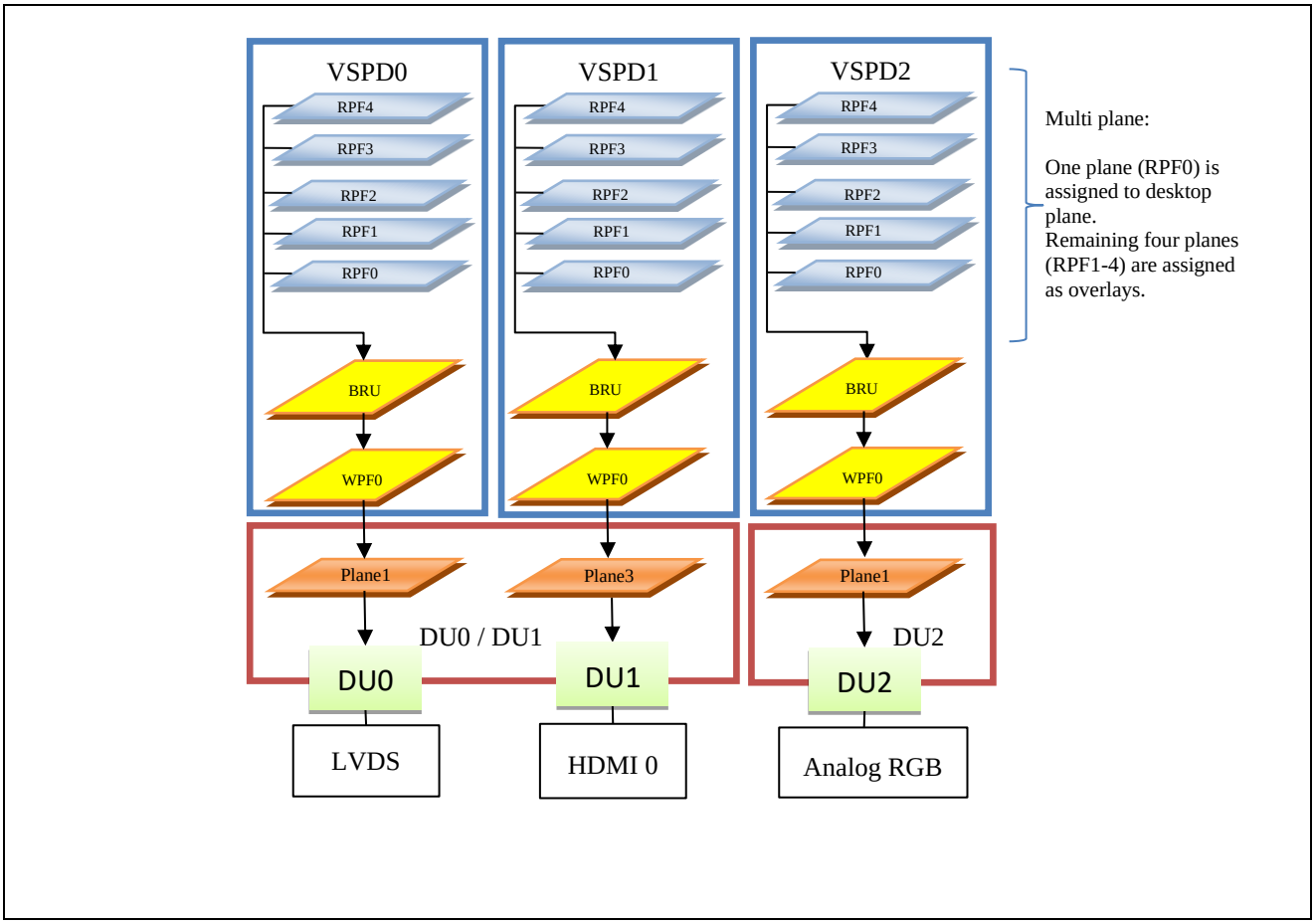


Figure 1-2 accesses of layers (R-Car M3)

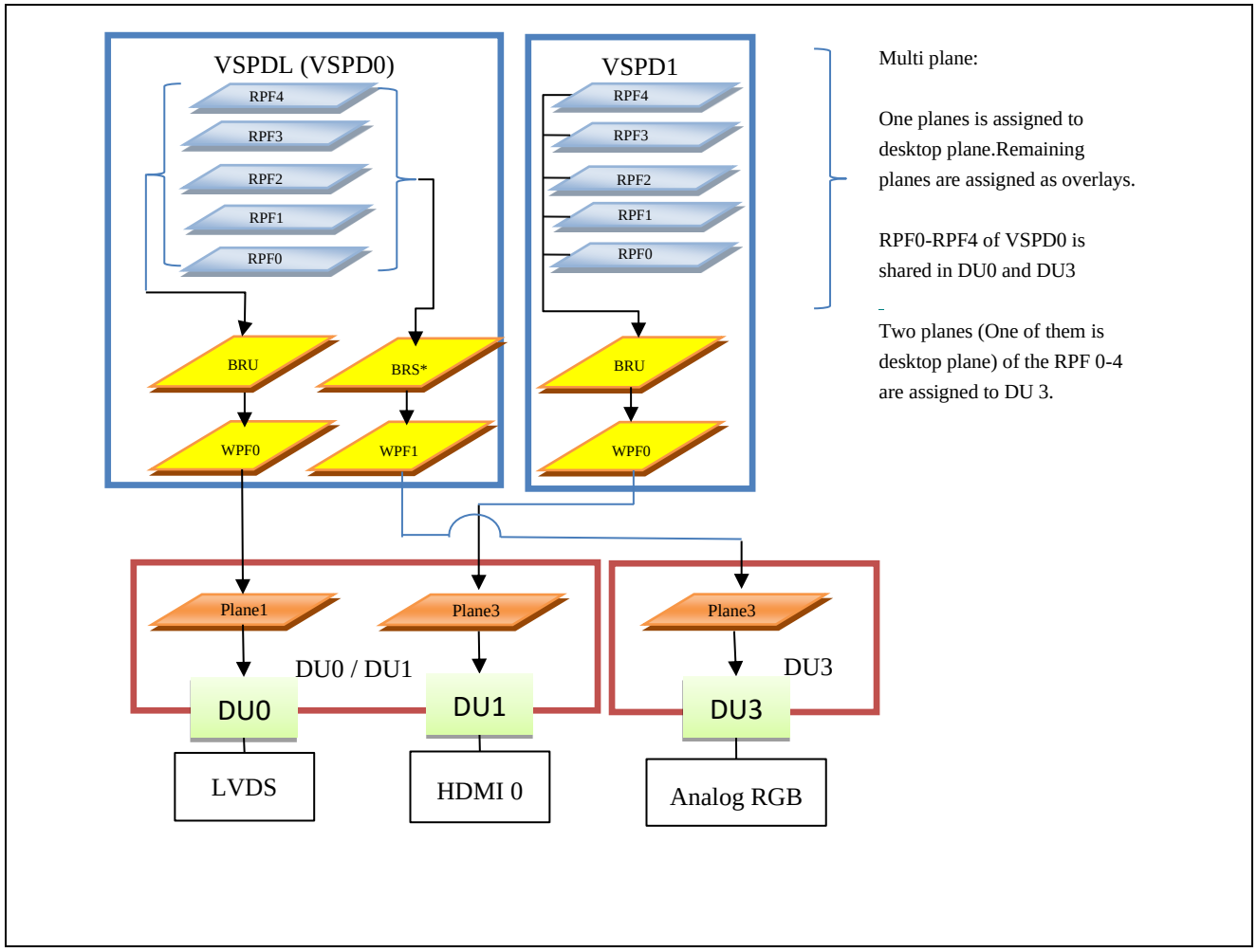


Figure 1-3 accesses of layers (R-Car M3N)

* The number of RPFs used in BRS can be selected with dtsi file. Please refer to 4.5 BRS number settingfor details.

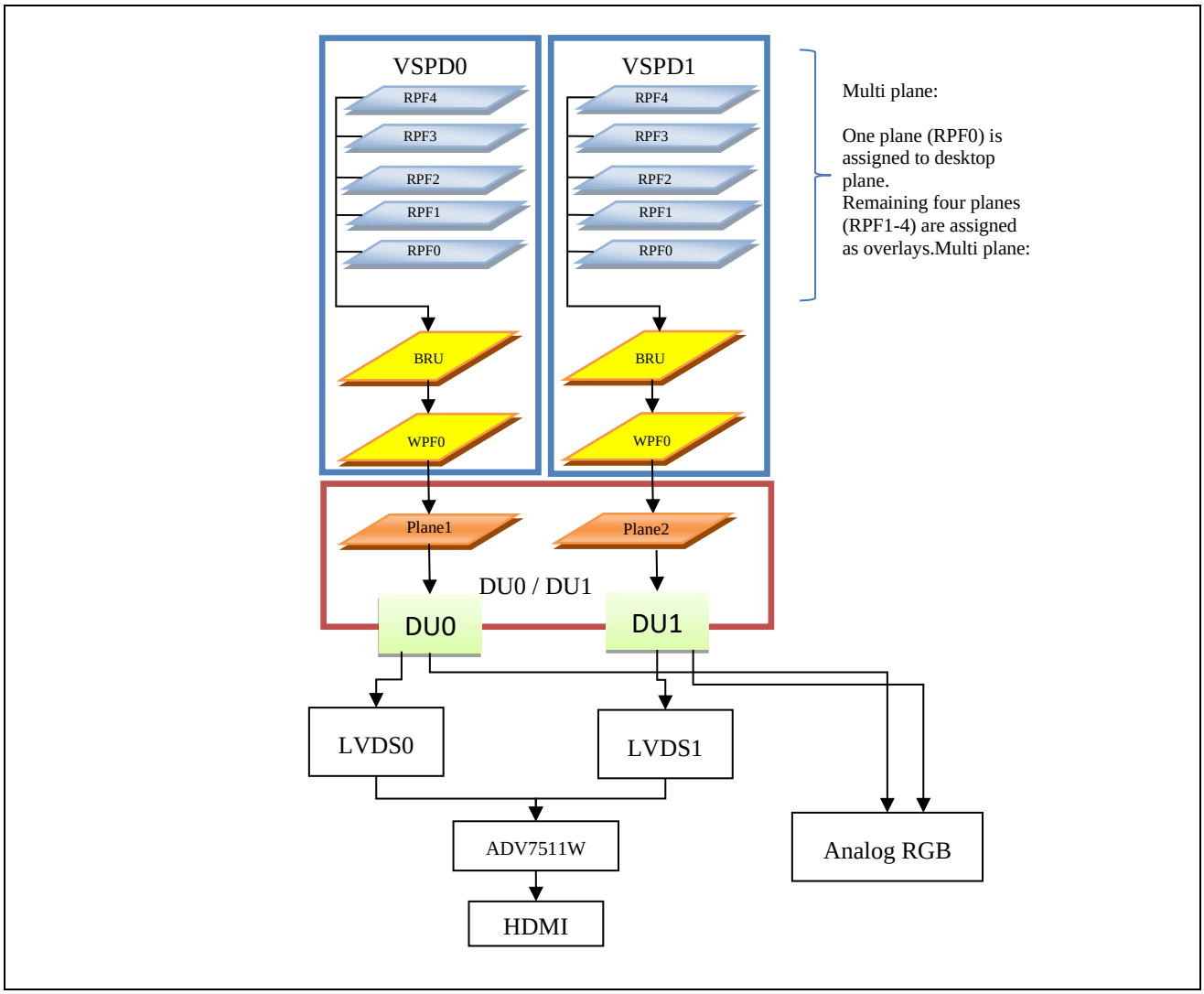


Figure 1-4 accesses of layers (R-Car E3 / D3)

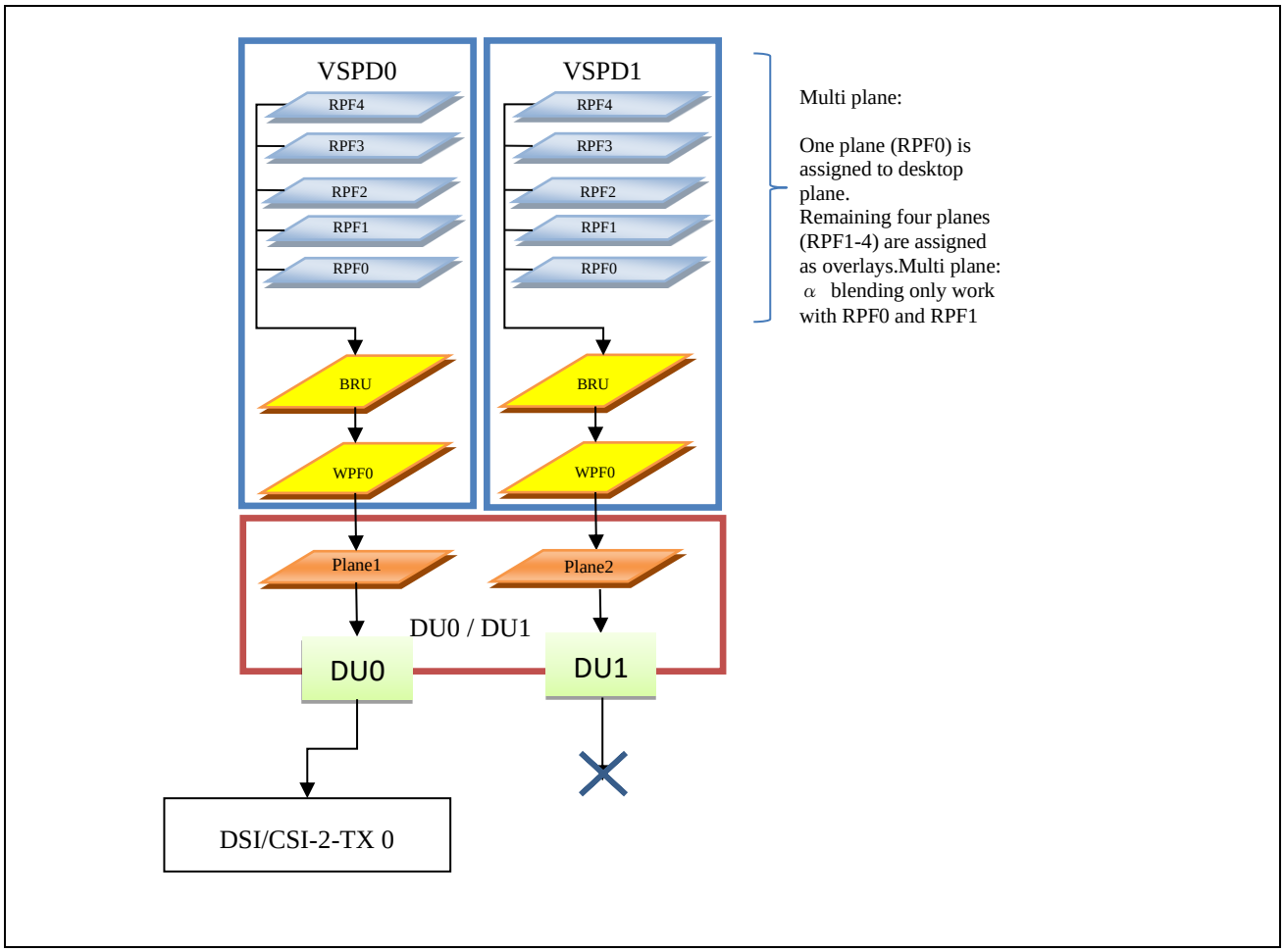


Figure 1-6 accesses of layers (R-Car V3U)

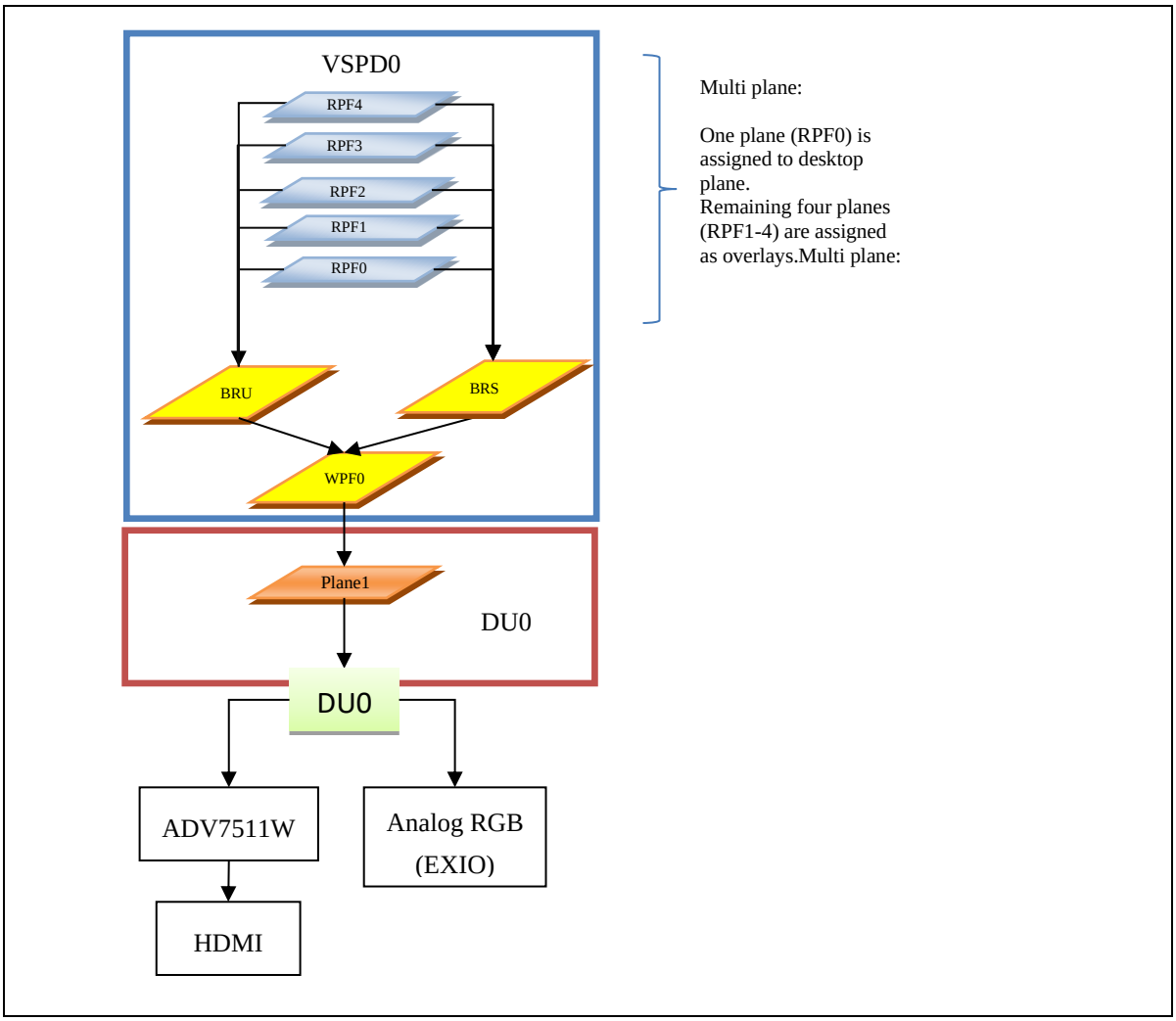


Figure 1-7 accesses of layers (R-Car V3H)

1.7 Progressive / Interlace (P/I) conversion

One input progressive image is divided into two image. One is an even field and other is an odd field at the time of interlaced mode display. A schematic of P/I conversion is indicated below.

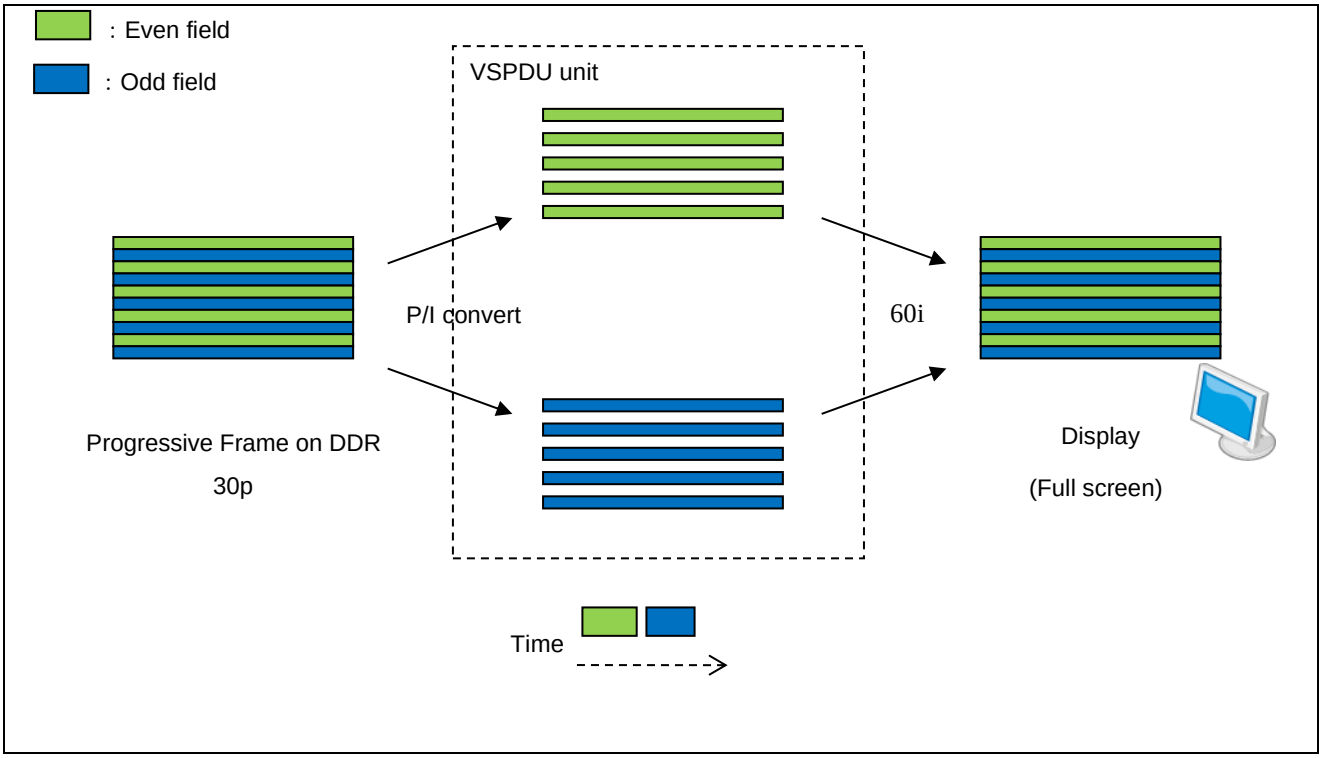


Figure 1-6 P/I conversion

1.8 LVDS Dual-Link (R-Car E3/D3)

Supports the Dual-link output by using vertical stripe output function.

During dual-link operation, the PLL1 in the LVDS1-IF can output the dotclock to DU1.

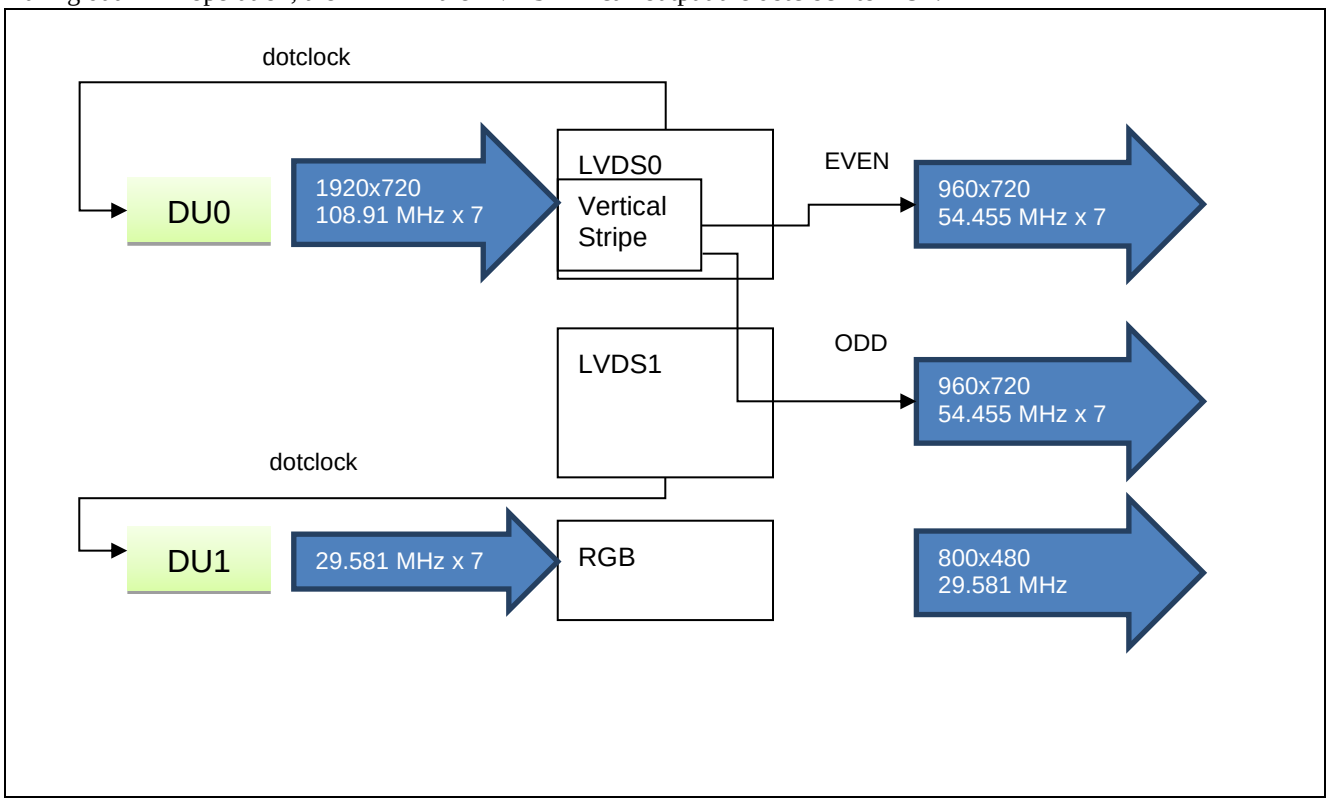


Figure 1-7 LVDS Dual-Link

2. Terminology

The following table shows the terminology related to this module.

Table 2.1 Terminology

Terms	Explanation
DU	Display Unit on R-Car Series, 3rd Generation
VSP2	Video Signal Processing
VSPD	VSP2 for Display
FBDev	Framebuffer Device
DRM	Direct Rendering Manager
KMS	Kernel Mode Setting
DRI	Direct Rendering Infrastructure
FB	Framebuffer
LIF	LCDC Interface (VSP-DU connect mode)
RPF	Read Pixel Formatter
WPF	Write Pixel Formatter
BRU	Blend ROP Unit
BRS	Blend ROP Sub Unit
ROP	Raster Operation
CRTC	Cathode Ray Tube Controller
VESA	Video Electronics Standards Association
CVT	Coordinated Video Timings
GTF	General Timing Formula
5P49V5923A/ 5P49V6901A	Programmable PLL Clock Generator (IDT Co., Ltd.)
DSI	Display Serial Interface
CSI	Camera Serial Interface

3. Operating Environment

3.1 Hardware Environment

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

Table 3.1 Hardware specification (R-Car H3 / M3 / M3N / E3 / D3 / V3U / V3H)

Name	Version	Manufacture
R-CarH3-SiP System Evaluation Board Salvator-X	-	Renesas Electronics
R-CarM3-SiP System Evaluation Board Salvator-X	-	Renesas Electronics
R-CarH3-SiP/M3-SiP/M3N-SiP System Evaluation Board Salvator-XS	-	Renesas Electronics
R-CarE3 System Evaluation Board Ebisu	-	Renesas Electronics
R-CarE3 System Evaluation Board Ebisu-4D	-	Renesas Electronics
R-CarV3U System Evaluation Board Falcon	-	Renesas Electronics
R-CarV3H System Evaluation Board Condor-I	-	Renesas Electronics
R-CarD3 System Evaluation Board Draak	-	Renesas Electronics

3.2 Module Configuration

The following figure shows the configuration of this module.

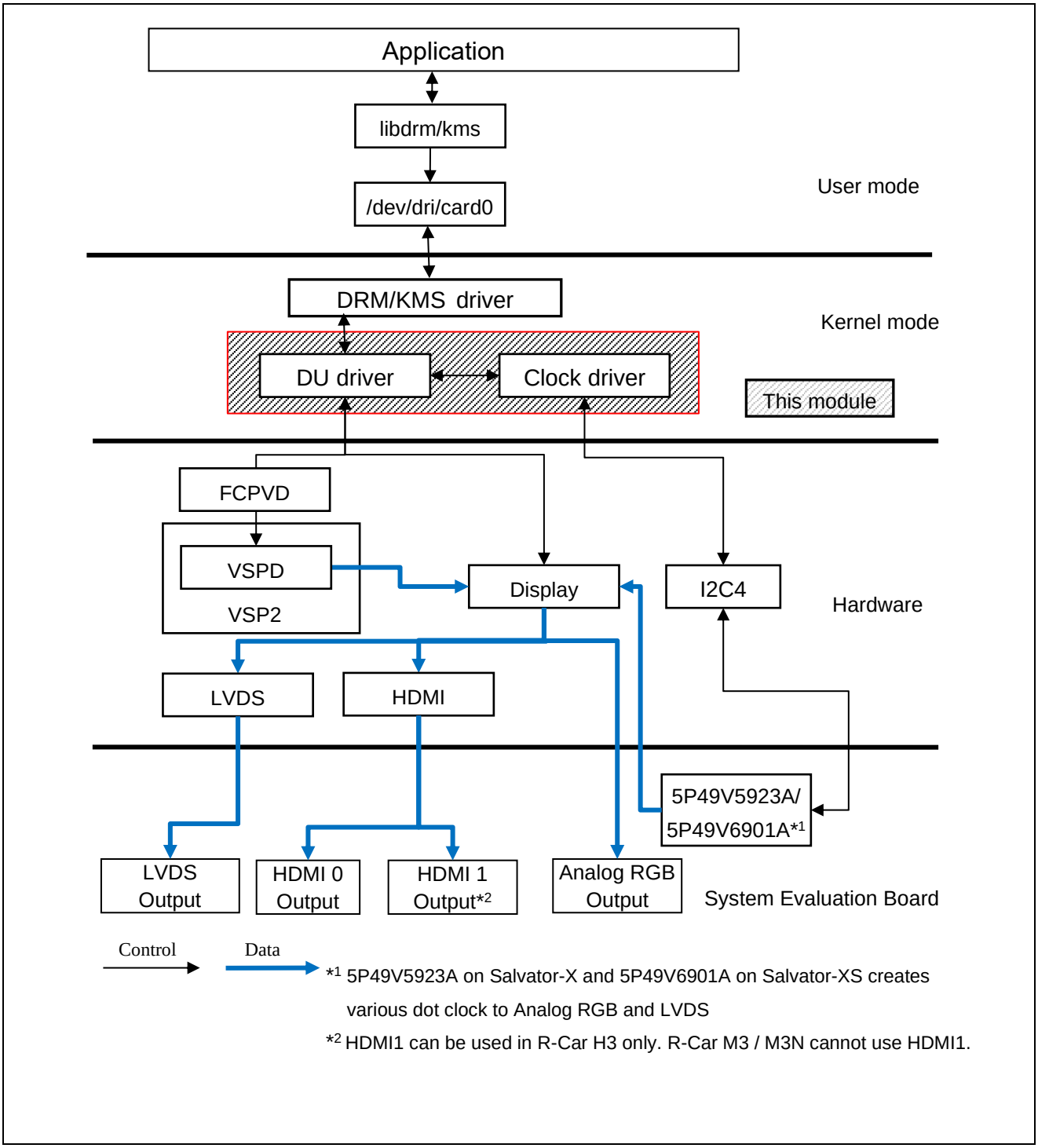


Figure 3-1 Module configuration (R-Car H3 / M3 / M3N)

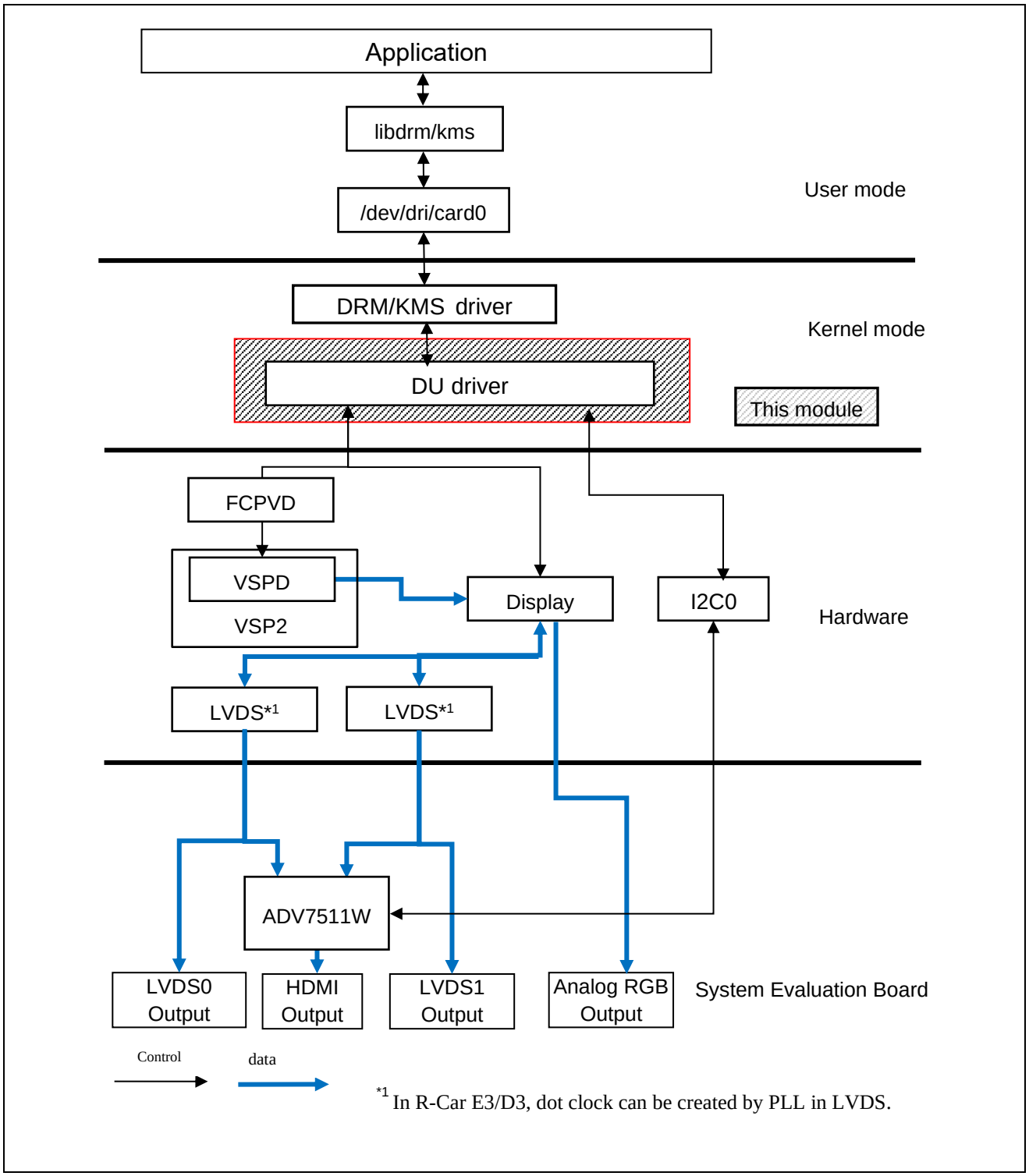


Figure 3-2 Module configuration (R-Car E3/D3)

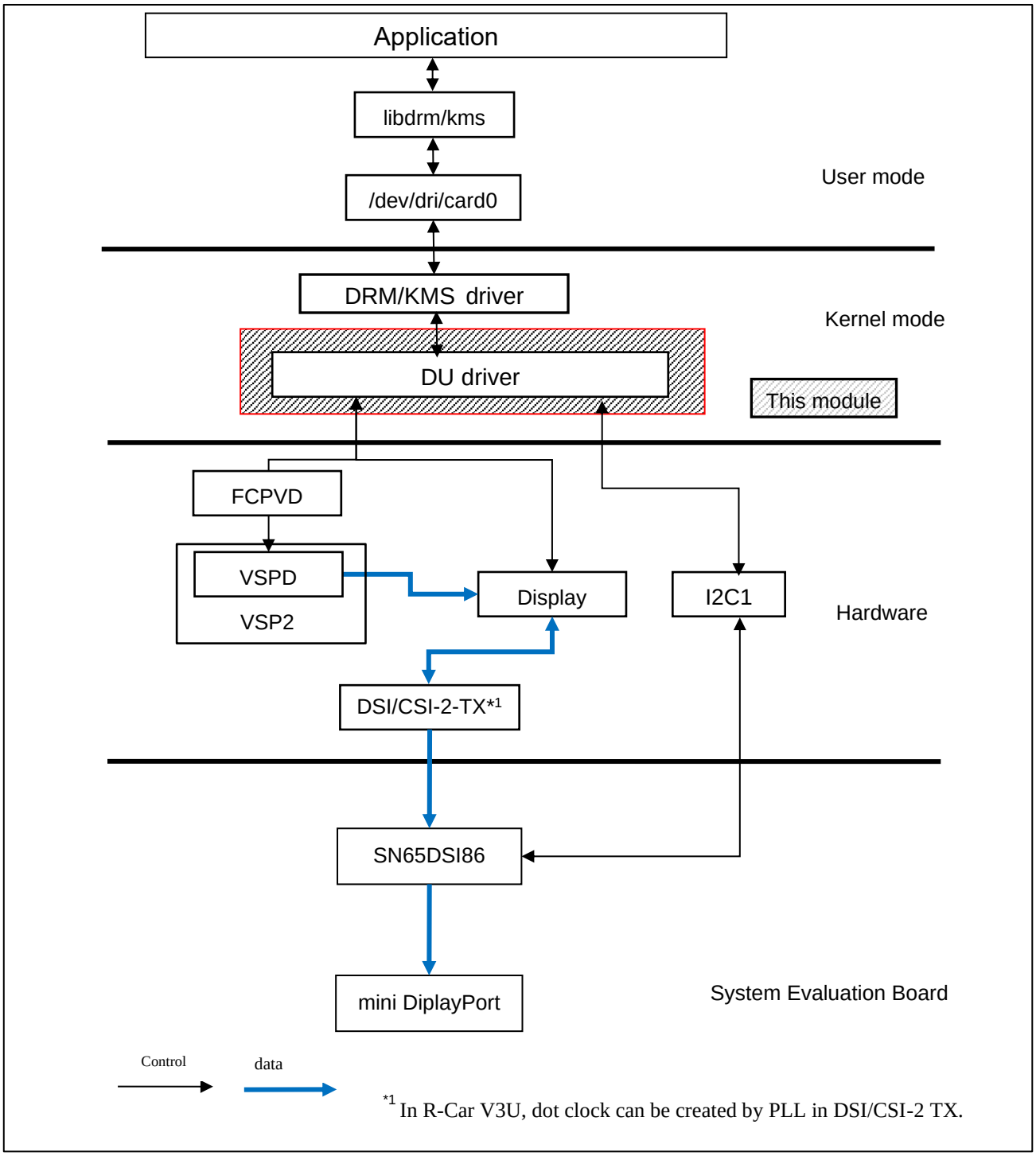


Figure 3-3 Module configuration (R-Car V3U)

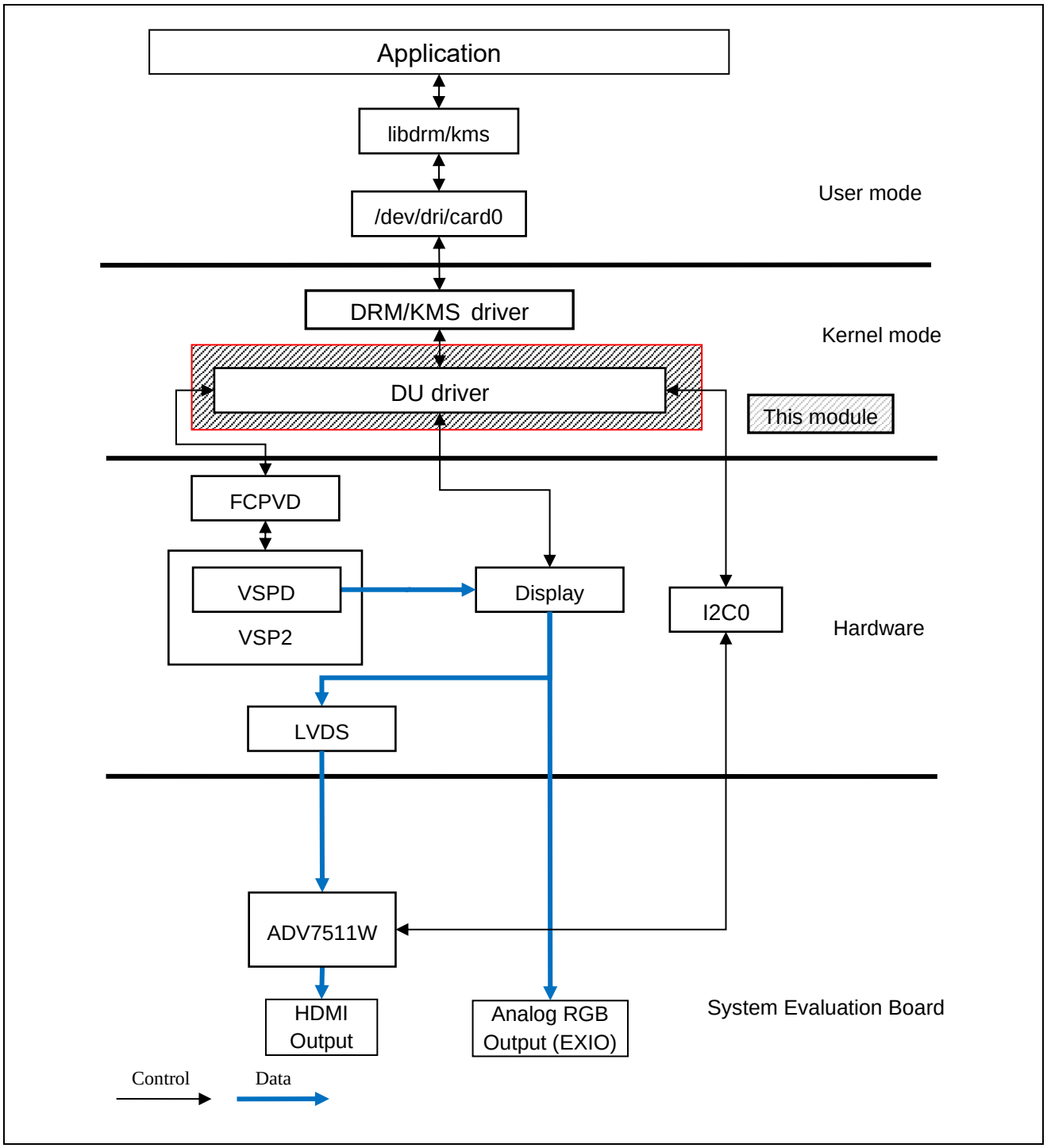


Figure 3-4 Module configuration (R-Car V3H)

3.3 State Transition Diagram

There is no state transition diagram for this module.

4. External Interface

The external interface of this module is based on Linux.

Device node of this module is shown below.

Table 4.1 DRM device node (R-Car H3 / M3 / M3N / E3 / D3 / V3U / V3H)

Device node	Major number	Minor number
/dev/dri/card0	226	0

4.1 External Interface for DRM/KMS Driver

This driver corresponds to the v2.4.104 of libdrm/libkms library.

This driver supports libdrm/libkms library. For details, please refer to the following.

- libdrm library (libdrm/libkms library download site.)
  http://cgit.freedesktop.org/mesa/drm/

  "tests/modetest/modetest.c" attached to libdrm/libkms library is a sample test program which becomes reference of how to call libdrm/libkms interface.
- DRI Wiki (Information of DRI. Documentation and build information of libdrm/libkms library.)
  http://dri.freedesktop.org/wiki/
- Linux GPU Driver Developer's Guide
  https://www.kernel.org/doc/html/v5.10/index.html

4.1.1 Driver name to use libdrm interface

drmOpen() is called when using a libdrm interface.

Please specify the argument of drmOpen() as follows.

drmOpen

*name	rcar-du
busid	NULL

Note in using Display driver:
If user cannot execute the API with master authority, please use drmDropMaster API.

4.1.2 External Interface supported Function for DRM/KMS Driver

It will describe only the necessary interface to the control of the VSPD and DU.

libkms library is supported all.

Table 4.2 List of external interfaces supported function for DRM/KMS driver

Support interface name	summary
drmOpen / drmClose	File Descriptor with a master authorization is acquired / released
drmSetMaster / drmDropMaster	Master authority is set / released
drmModeGetResources / drmModeFreeResources	DRM resource information is acquired / released
drmModeGetConnector / drmModeFreeConnector	Connector information is acquired / released
drmModeGetEncoder / drmModeFreeEncoder	Encoder information is acquired / released
drmModeGetPlaneResources / drmModeFreePlaneResources	Plane resource information is acquired / released
drmModeGetPlane / drmModeFreePlane	Plane information is acquired / released
drmModeGetCrtc / drmModeFreeCrtc	CRTC information is acquired / released
drmModeAddFB2 / drmModeRmFB	FB object is created / released
drmModeSetPlane	Overlay display
drmModeSetCrtc	Setting and displaying of desktop
drmModePageFlip	Page flipping
drmModeAtomicCommit	Update display by atomic
drmModeAtomicAlloc / drmModeAtomicFree	Atomic object is allocated / released
drmModeAtomicAddProperty	Add property by atomic
drmModeObjectGetProperties / drmModeFreeObjectProperties	Object property information is acquired / released
drmModeGetProperty / drmModeFreeProperty	property information is acquired / released
drmModeObjectSetProperty	Object property setting
drmModeConnectorSetProperty	Connector property setting
kms_create / kms_destroy	KMS is created / released
kms_bo_create / kms_bo_destroy	Buffer object is created / released
kms_bo_map / kms_bo_unmap	Buffer is mapped in the user space / unmapped
kms_bo_get_prop / kms_get_prop	Handle and property of buffer object and is acquired

4.1.3 External Interface Unsupported Function for DRM/KMS Driver

The libdrm/libkms library in which this driver is not supported is described.

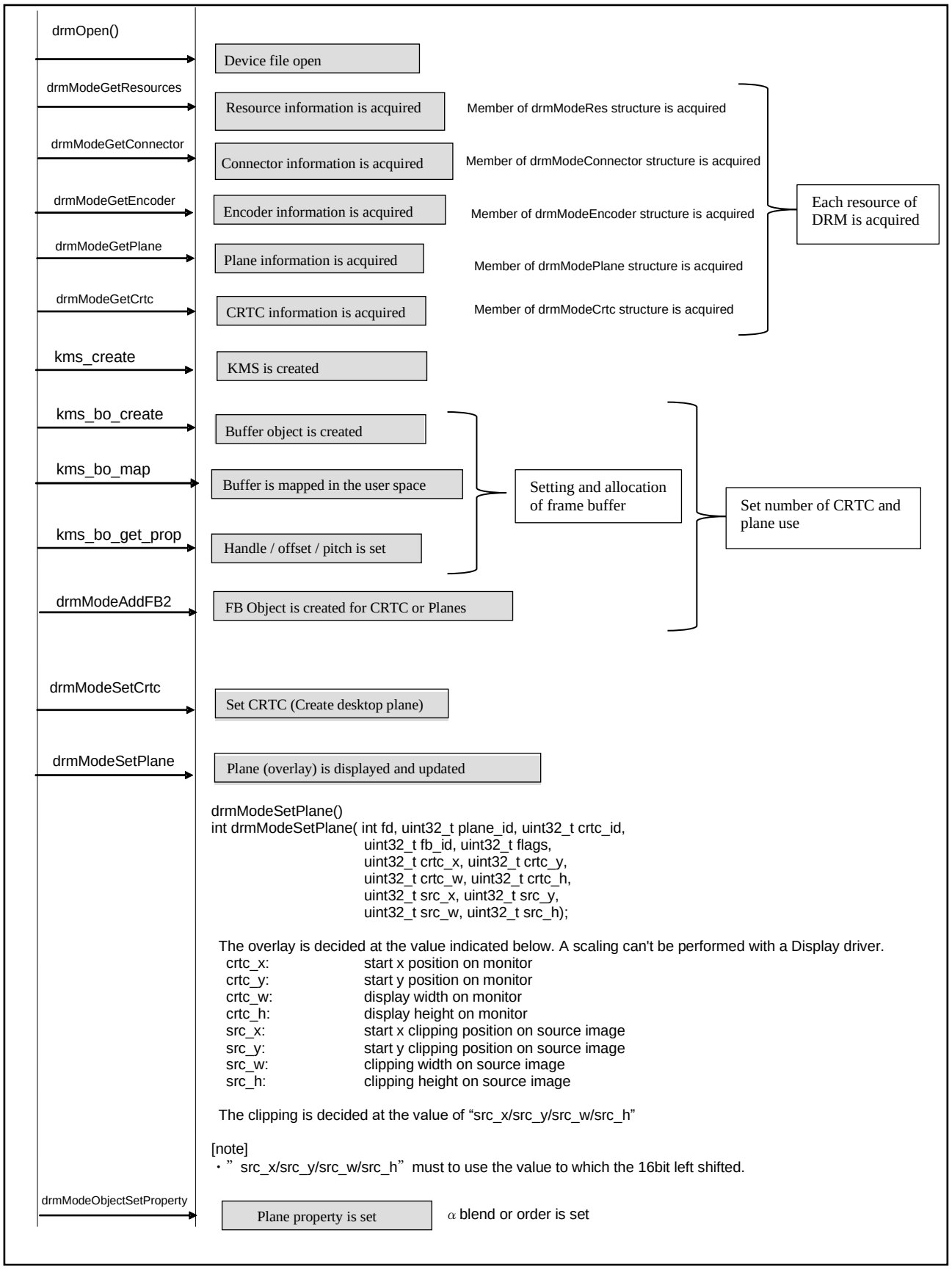
Please do not use the interface of the following contained to a libdrm library.

Table 4.3 List of external interface unsupported function for DRM/KMS driver

Function name
drmModeCrtcGetGamma, drmModeCrtcSetGamma
drmModeSetCursor, drmModeSetCursor2
drmSetContextFlags, drmGetContextFlags
drmCreateDrawable, drmDestroyDrawable
drmUpdateDrawableInfo
drmAgp*
drmFinish
drmGetInterruptFromBusID

4.1.4 The display method example of overlay by DRM access

Please confirm modetest.c with libdrm/kms library for more information.



drmModeSetPlane()

```
int drmModeSetPlane( int fd, uint32_t plane_id, uint32_t crtc_id,
                     uint32_t fb_id, uint32_t flags,
                     uint32_t crtc_x, uint32_t crtc_y,
                     uint32_t crtc_w, uint32_t crtc_h,
                     uint32_t src_x, uint32_t src_y,
                     uint32_t src_w, uint32_t src_h);
```

The overlay is decided at the value indicated below. A scaling can't be performed with a Display driver.

crtc_x:	start x position on monitor
crtc_y:	start y position on monitor
crtc_w:	display width on monitor
crtc_h:	display height on monitor
src_x:	start x clipping position on source image
src_y:	start y clipping position on source image
src_w:	clipping width on source image
src_h:	clipping height on source image

The clipping is decided at the value of “src_x/src_y/src_w/src_h”

[note]

・” src_x/src_y/src_w/src_h” must to use the value to which the 16bit left shifted.

4.1.5 Setting of plane property

Please use drmModeObjectSetProperty() as API for setting of layer order and alpha blend which are the optional functions of overlay.
Please refer to "tests/modetest/modetest.c :set_property ()" of libdrm for detail procedure. The notes on use are explained as follows.

[The setting method about the value specified as the 5th argument of a drmModeObjectSetProperty() function]

When alpha blend setting

symbol name	alpha

A layer alpha blending (uniformly alpha blending of plane whole) rate is set up at the time of RGB332, XRGB4444, XRGB1555, RGB565, BGR888, RGB888, XRGB8888, BGRX8888, XRGB1555, RGBX1010102, RGBA1010102 and ARGB2101010 format specification.
The pixel alpha blend is performed at the time of ARGB1555, ARGB4444, BGRA8888, ARGB8888, RGBA1010102 and ARGB2101010 format specification.

Please use ARGB4444, BGRA8888, ARGB8888, RGBA1010102 and ARGB2101010 when you use a pixel transparent. The pixel value bit on a drawing buffer can perform alpha blend per pixel. In addition, while using the pixel alpha, ARGB4444, BGRA8888, ARGB8888, RGBA1010102 and ARGB2101010 can be used at the same time of plane alpha and pixel alpha by setting alpha in drmModeObjectSetProperty().

Nontransparent value = 255, Semitransparent value = 128, Full transparent value = 0
This value is common to each plane. The default value of each planes is "255". The value can be specified from 0 to 255.

Notice: Once a value sets up, a value will be kept within a Display driver. When you display multiplane, please be sure to check a value. Please perform a re-setup, if required.

Moreover, a setup of alpha bit function of ARGB1555 can be set according to a kernel configuration. The function transparent by either alpha bit = 0 or alpha bit = 1. Please refer to chapter 5.2.1 in detail.

When plane order setting

symbol name	zpos

A value of each layer is compared with specified value. A layer with a large value turns into a high priority layer. When the value of "zpos" is the same, the plane which a plane id is larger becomes a high priority plane. The value can be specified from 1 to 4.
A related figure is shown below.

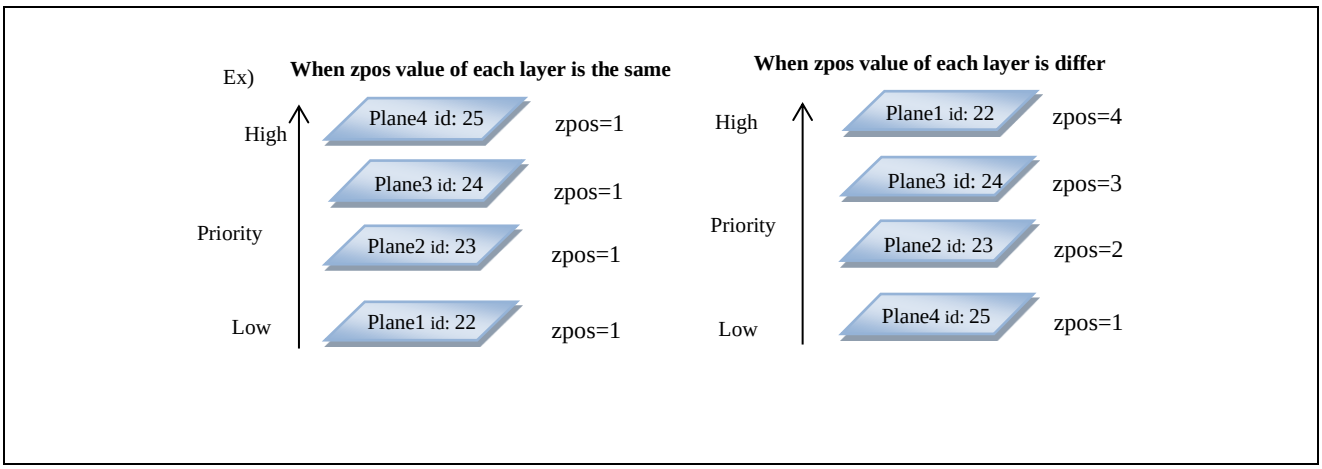


Figure 4-1 Figure of plane priority relation

When color key and color key alpha setting

symbol name	colorkey
symbol name	colorkey_alpha

The 24th bit of value is bit of colorkey ON/OFF. 1'b24: ON, 0'b24: OFF
23 to 0 bit of value specifies colors. (R [23:16], G [15:8], B [7:0])
In case of 24BPP, all of 8 bits is used, but in case of 16BPP, upper side bits are used.
The YUV format compares Y values and enables color key.

For RGBX1010102, RGBA1010102 and ARGB2101010 pixel format in V3U, the colokey function does not support on those pixel format

colorkey_alpha can be set value from 0 to 255.
(Nontransparent value = 255, Semitransparent value = 128, Full transparent value = 0)
If colorkey alpha and pixel alpha are to be used at the same time, colorkey alpha takes precedence.

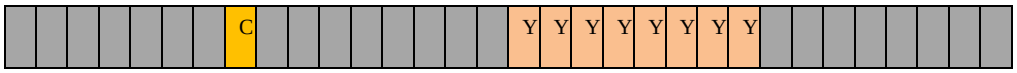
[C: colorkey ON/OFF, R: Red, G: Green, B: Blue, Y: Luminance]

[RGB 32bpp]

[RGB565]

[ARGB1555]

[YUV]



Ex) RGB565 value = 0x0100FC00 (remove green color key), XRGB888 value = 0x0100FF00 (remove green color key)
The default value of each layer is "0". The value can be specified from 0 to 0x1FFFFFF.

4.1.6 Resolution Change

In order to change resolution, drmModeAddFB2() and drmModeSetCrtc() that are defined in xf86drmMode.c are used. xf86drmMode.c is contained in libdrm/libkms library. About the flow and the setting method of processing, please refer to set_mode() of tests/modetest/modetest.c in libdrm/libkms library.

Please refer to “How to set video mode” in Wayland user’s manual if you want to change the resolution when starting Wayland.

[Notice about resolution]

When drmModeSetCrtc is called, a reset occurs once (blackout) to update a display parameter by the specification of H/W. When updating (When the resolution changes) DU0 or DU1, DU0 and DU1 are reset together. Then, the image of screen is flickered momentarily. The combination of DU2 and DU3 is similar.

The divided external clock or internal clock is used to generate the dot clock. However, accuracy of a dot clock may be unable to be fulfilled to the recommended resolution. In this case

- All the resolution displayed in DRM resources may be unable to display.
- The value of a refresh rate displayed in DRM resources may differ from an actual value.

4.1.7 Add Resolution Setting

This chapter describes how to change a resolution in LVDS and Analog output.

[Analog RGB output]

Please refer to 5.2.3 Kernel Parameters.

If user want to add resolution, please add the resolution parameters to the resolution table drm_dmt_modes[] = {) of drivers/gpu/drm/drm_edid.c.

```
static const struct drm_display_mode drm_dmt_modes[] = {
・・・
+/* 1920x1080i@60Hz */
+{ DRM_MODE("1920x1080i", DRM_MODE_TYPE_DRIVER, 74250, 1920, 2008,
+              2052, 2200, 0, 1080, 1084, 1094, 1125, 0,
+              DRM_MODE_FLAG_PHSYNC | DRM_MODE_FLAG_PVSYNC |
+                    DRM_MODE_FLAG_INTERLACE) },
・・・

In case of interlace mode support
drivers/gpu/drm/bridge/dumb-vga-dac.c
static int dumb_vga_attach(struct drm_bridge *bridge)
…
+          vga->connector.interlace_allowed = 1;
…
          drm_connector_helper_add(&vga->connector,
                                   &dumb_vga_con_helper_funcs);
```

[LVDS output]

If you want to change the resolution in LVDS, please modify the following parameters.

arch/arm64/boot/dts/renesas/salvator-common.dtsi for Salvator board (H3/M3/M3N)

arch/arm64/boot/dts/renesas/r8a77990-ebisu.dts, r8a77990-es10-ebisu.dts for Ebisu board (E3)

arch/arm64/boot/dts/renesas/r8a77995-draak.dts for Draak board (D3)

Please refer to Documentation/devicetree/bindings/display/panel/panel-lvds.txt in detail.

```
        lvds {      // lvds0 and lvds1 in case of r8a77990-ebisu.dts, r8a77990-es10-ebisu.dts and r8a77995-draak.dts
                compatible = "panel-lvds";

                width-mm = <210>;                       // monitor width size (mm)
                height-mm = <158>;                      // monitor height size (mm)

                data-mapping = "jeida-24";              // LVDS-IF mode
                                or "jeida-18" or "vesa-24"
                data-mirror;                            // LVDS-IF mode
…
                panel-timing {
                        /* 1024x768 @60Hz */
                        clock-frequency = <65000000>;   // Dotclock (Hz)
                        hactive = <1024>;               // display width size
                        vactive = <768>;                // display height size
                        hsync-len = <136>;              // Hsync lengh
                        hfront-porch = <20>;            // Hsync front porch
                        hback-porch = <160>;            // Hsync back porch
                        vfront-porch = <3>;             // Vsync front porch
                        vback-porch = <29>;             // Vsync back porch
                        vsync-len = <6>;                // Vsync length
                        hsync-active = <1>; *1          // Hsync polarity: low<0> / high<1>
                        vsync-active = <0>; *1          // Vsync polarity: low<0> / high<1>
                };
                .....
        }

                *1 There is no specification in default. When not specified, the setting value is low.
```

4.1.8 Pixel Format Change

In order to change pixel format, drmModeAddFB2() and drmModeSetPlane() that are defined in xf86drmMode.c are used. xf86drmMode.c is contained in libdrm/libkms library.

About the flow and the setting method of processing, please refer to set_plane() of tests/modetest/modetest.c in libdrm/libkms library.

4.1.9 Vmute function (DRM)

It describes the expansion API specifications of the Vmute (VSPD mute) function.

[API specification]

[Function]	drmCommandWrite (int fd, unsigned long drmCommandIndex, struct rcar_du_vmute arg, unsigned long size)		
[Argument]	fd	File descriptor	
	drmCommandIndex	DRM_RCAR_DU_SET_VMUTE (value is 0)	
	arg	Pointer of rcar_du_vmute structure	
	size	Data size of rcar_du_vmute structure	
[Header file]	xf86drm.h		
[Library file]	libdrm.so		
[Returns]	0	Success	
	-1	Error	
[Error value]	EINVAL	Invalid argument	
[Structure]	struct rcar_du_vmute		
	int	crtc_id;	[CRTCs ID] Refer to Table 4.4 about CRTCs ID.
	int	on;	[1: Vmute ON, 0: Vmute OFF]
[Description]	Vmute (VSPD mute) function can be executed per VSPD channel.		
[Remark]			

4.1.10 Write back function (DRM)

It describes the expansion API specifications and use method of the write back function.

[API specification]

[Function]	drmCommandWrite (int fd, unsigned long drmCommandIndex, struct rcar_du_screen_shot arg, unsigned long size)	
[Argument]	fd	File descriptor
	drmCommandIndex	DRM_RCAR_DU_SCRSHOT (value is 4)
	arg	Pointer of rcar_du_screen_shot structure
	size	Data size of rcar_du_screen_shot structure
[Header file]	xf86drm.h	
[Library file]	libdrm.so	
[Returns]	0	Success
	-1	Error
[Error value]	EINVAL	Invalid argument
[Description]	Screen capture of one shot is get	
[Remark]	This API takes at least more than 2 frame end period to perform. (It takes maximum 3 frame end period. In addition, when other display update is executed continuously, this API may become larger than 3 vsync.). Interlaced mode is prohibited by the specification of the H/W. This API is a synchronous API.	

[Structure] struct rcar_du_screen_shot

[member]	[type]	[summary]
buff	unsigned long	Physical address of output buffer
buff_len	unsigned int	Size of output buffer (byte)
crtc_id	unsigned int	CRTC Object ID
fmt	unsigned int	Output format - DRM_FORMAT_RGB565 - DRM_FORMAT_ARGB1555 - DRM_FORMAT_ARGB8888
width	unsigned int	Width of output buffer (pixel)
height	unsigned int	Height of output buffer (pixel)

[Use method]

1. Capture buffer allocation. Please allocate a buffer by using Memory Manager (please refer to “Memory Manager User’s manual” in detail)

2. Please set the rcar_du_screen_shot structure

buff	Set the physical address of the buffer that was allocated in section 1.
buff_len	Set the size of the buffer that was allocated in section 1.
crtc_id	Set the number of CRTC Object ID to get screen shot
fmt	Set output format (Set ARGB8888 or ARGB1555 or RGB565)
width	Set capture width (Pixel size)
height	Set capture height (Pixel size)

3. Execute API

4. After the capture run, please confirm the capture data of buffer that was allocated in section 1.

4.2 DRM resource information

The DRM resource information on Connectors ID and CRTCs ID at the time of a default configuration is indicated. If you want to change the configuration (R-Car DU Gen3 HDMI Encoder Support or R-Car DU LVDS Encoder Support), there are case when the value of the ID does not match the following.

Please refer to the Table 4.4 to specify the 2nd argument (CRTCs ID) and the 6th argument (Connectors ID) of the drmModeSetCrtc() function of libdrm API. Please use reference at the specification of the 3rd argument (CRTCs ID) of drmModeSetPlane() function of libdrm API.

Table 4.4 List of DRM resources ID

	Connectors ID		CRTCs ID	
R-Car H3	Analog: HDMI0: HDMI1: LVDS:	69 71 74 77	DU0: DU1: DU2: DU3:	64 65 66 67
R-Car M3	Analog: HDMI0: LVDS:	68 70 73	DU0: DU1: DU2:	64 65 66
R-Car M3N	Analog: HDMI0: LVDS:	58 60 63	DU0: DU1: DU3:	54 55 56
R-Car E3	Analog: HDMI0: (LVDS)	57 59	DU0: DU1:	54 55
R-Car D3	Analog: HDMI0: (LVDS)	57 59	DU0: DU1:	54 55
R-Car V3U	DSI/CSI-2-TX 0: DSI/CSI-2-TX 1	57 no support	DU0: DU1:	54 no support
R-Car V3H (HDMI0 x1)	HDMI0:	45	DU0:	43

4.3 DRM connector selection

You can control the output selection of the connector by modifying the DT (Device Tree) file

Note: In case of modifying DT file, Connectors ID and CRTCs ID will be changed from the default.

[In case of Salvator board]

Ex)
arch/arm64/boot/dts/renesas/r8a7795-salvator-xs.dts

```
&lvds0 {
#if 0 // LVDS is not output
        ports {
                port@1 {
                        lvds0_out: endpoint {
                                remote-endpoint = <&lvds_in>;
                        };
                };
        };
#endif
};
```

arch/arm64/boot/dts/renesas/r8a7795-salvator-xs.dts

```
&hdmi0 {
-       status = "okay";        // HDMI0 is not output
.......
};

.......

&hdmi1 {
-       status = "okay";        // HDMI1 is not output
.......
};
```

arch/arm64/boot/dts/renesas/salvator-common.dtsi

```
&du {
.......
#if 0 // Analog RGB is not output
        ports {
                port@0 {
                        endpoint {
                                remote-endpoint = <&adv7123_in>;
                        };
                };
        };
#endif
};
```

[In case of Ebisu / Draak board] ***Other than the patterns below is unsupported in this driver**

Ex 1）(HDMI x 1 (Single-link), Analog RGB x 1)

There is no change in the device tree (arch/arm64/boot/dts/renesas/r8a77990-ebisu.dts, r8a77990-es10-ebisu.dts for Ebisu board and arch/arm64/boot/dts/renesas/r8a77995-draak.dts for Draak board), it is the default setting.

In case of this case, also change DIP switch. (R-Car E3/D3)

SW44: All ON, SW 45: ON, SW47: OFF

Ex 2）(HDMI x 1 (Dual-link), Analog RGB x 1)

arch/arm64/boot/dts/renesas/r8a77990-ebisu.dts, r8a77990-es10-ebisu.dts for Ebisu board

arch/arm64/boot/dts/renesas/r8a77995-draak.dts for Draak board

```
lvds-decoder    {
……
        port@1 {
            reg = <1>;
            thc63lvd1024_in_dual_link: endpoint {
+                       remote-endpoint = <&lvds1_out>;
            };
        };
……
};

vga-encoder {
……
        port@0 {
            reg = <0>;
            adv7123_in: endpoint {
-                       remote-endpoint = <&lvds1_out>;
            };
        };
……
};

&lvds1 {
……
        port@1 {
            lvds1_out: endpoint {
-                         remote-endpoint = <&adv7123_in>;
+                        remote-endpoint = <& thc63lvd1024_in_dual_link>;
            };
        };
……
};
```

In case of this case, also change DIP switch. (R-Car E3/D3)

SW44: All ON, SW 45: OFF, SW47: ON

Ex 3）(LVDS x 2 (Single-link))

arch/arm64/boot/dts/renesas/r8a77990-ebisu.dts, r8a77990-es10-ebisu.dts

arch/arm64/boot/dts/renesas/r8a77995-draak.dts for Draak board

```
        lvds-decoder {
        ·····
                        port@0 {
                                thc63lvd1024_in: endpoint {
-                                                       remote-endpoint = <&lvds0_out>;
                                };
                        };
        ·····
        };
        ·····
        lvds0 {
        ·····
                port {
                        lvds0_panel_in: endpoint {
+                               remote-endpoint =<&lvds0_out >
                        };
                };
        };

        lvds1 {
        ·····
                port {
                        lvds1_panel_in: endpoint {
+                               remote-endpoint =<&lvds1_out >
                        };
                };
        };
        ·····
        vga-encoder {
        ·····
                        port@0 {
                                adv7123_in: endpoint {
-                                               remote-endpoint = <&lvds1_out>;
                                };
                        };
        ·····
        };
        ·····
};
·····
&lvds0 {
·····
        ports {
                port@1 {
                        lvds0_out: endpoint {
-                               remote-endpoint = <&thc63lvd1024_in>;
+                               remote-endpoint = <&lvds0_panel_in>;
                        };
                };
        };

&lvds1 {
·····
        ports {
                port@1 {
                        lvds1_out: endpoint {
-                               remote-endpoint = <&adv7123_in>;
+                               remote-endpoint = <&lvds1_panel_in>;
                        };
                };
        };
};
```

In case of this case, also change DIP switch. (R-Car E3/D3)

SW44: All OFF, SW 45: ON, SW47: OFF

Ex 4）(Analog RGB x 1, LVDS x 1 (Single-link))

arch/arm64/boot/dts/renesas/r8a77990-ebisu.dts, r8a77990-es10-ebisu.dts

arch/arm64/boot/dts/renesas/r8a77995-draak.dts for Draak board

```
        lvds-decoder {
        ·······
                        port@0 {
                                thc63lvd1024_in: endpoint {
-                                       remote-endpoint = <&lvds0_out>;
                                };
                        };
        ·······
        };
        ·······
        lvds1 {
        ·······
                port {
                        lvds1_panel_in: endpoint {
+                               remote-endpoint =<&lvds1_out >
                        };
                };
        };
        ·······
        vga-encoder {
        ·······
                        port@0 {
                                adv7123_in: endpoint {
-                                       remote-endpoint = <&lvds1_out>;
+                                        remote-endpoint = <&lvds0_out>;
                                };
                        };
        ·······
        };
        ·······
};
·······
&lvds0 {
·······
        ports {
                port@1 {
                        lvds0_out: endpoint {
-                               remote-endpoint = <&thc63lvd1024_in>;
+                                remote-endpoint = <&adv7123_in>;
                        };
                };
        };
};

&lvds1 {
·······
        ports {
                port@1 {
                        lvds1_out: endpoint {
-                               remote-endpoint = <&adv7123_in>;
+                                remote-endpoint = <&lvds1_panel_in>;
                        };
                };
        };
};
```

In case of this case, also change DIP switch. (R-Car E3/D3)

SW44: All OFF, SW 45: ON, SW47: OFF

[In case of Condor and Condor-I board]

Ex)
arch/arm64/boot/dts/renesas/r8a77980-condor.dts
arch/arm64/boot/dts/renesas/r8a77980-condor-i.dts

```
        lvds-decoder {
        .......
                        port@0 {
                                thc63lvd1024_in: endpoint {
                                        remote-endpoint = <&lvds0_out>;
                                };
                        };

                        port@2 {
                                thc63lvd1024_out: endpoint {
                                        remote-endpoint = <&adv7511_in>;
                                };
                        };
        .......
        };

&lvds0 {
        ports {
                port@1 {
                        lvds0_out: endpoint {
                                remote-endpoint = <&thc63lvd1024_in>;
                        };
                };
        };
};
```

```
&du {
        status = "okay";
.......
};
```

4.4 Hot plug Operation

This driver supports hot plug operation.

The state of a HDMI cable or a Display Port (DP) cable can be checked.

The following sample code is for getting state of connected or disconnected of HDMI and DP cabble via DRM.

```
{
      int i, fd;
      drmModeRes *resources;
      drmModeConnector *connector;

      fd = drmOpen("rcar-du", NULL);
      resources = drmModeGetResources(fd);

      for (i = 0; i < resources->count_connectors; i++) {
            connector = drmModeGetConnector(fd, resources->connectors[i]);
            if (connector->connector_type == DRM_MODE_CONNECTOR_HDMIA) {
                  if (connector->connection == DRM_MODE_CONNECTED)
                        printf("connected\n");
                  else if (connector->connection == DRM_MODE_DISCONNECTED)
                        printf("disconnected\n");
                  else if (connector->connection == DRM_MODE_UNKNOWNCONNECTION)
                        printf("unknown\n");
            }
            if (connector->connector_type == DRM_MODE_CONNECTOR_DisplayPort) {
                  if (connector->connection == DRM_MODE_CONNECTED)
                        printf("connected\n");
                  else if (connector->connection == DRM_MODE_DISCONNECTED)
                        printf("disconnected\n");
                  else if (connector->connection == DRM_MODE_UNKNOWNCONNECTION)
                        printf("unknown\n");
            }
      }
      return 0;
}
```

Figure 4-2 Acquisition method of getting HDMI cable status via DRM

Moreover, the following commands are executed on target.

```
HDMI0

 # cat /sys/class/drm/card0-HDMI-A-1/status

HDMI1 (R-Car H3 only)

 # cat /sys/class/drm/card0-HDMI-A-2/status

Display Port (R-Car V3U only)

 # cat /sys/class/drm/card0-DP-1/status
```

The following information can get.

```
connected
  or
disconnected
```

4.4.1 Notice about hot plug

If you start the kernel with connecting the HDMI or DP cable, the monitor displays the recommended resolution.

If the HDMI or DP cable was inserted after starting the kernel, the monitor would be displayed in XGA resolution.

Basically, please do not change the output destination display. Also, please start up the kernel with the HDMI or DP cable.

4.5 BRS number setting

Shows how to set brs option. By adding the setting, determine the number of planes to use in BRS.

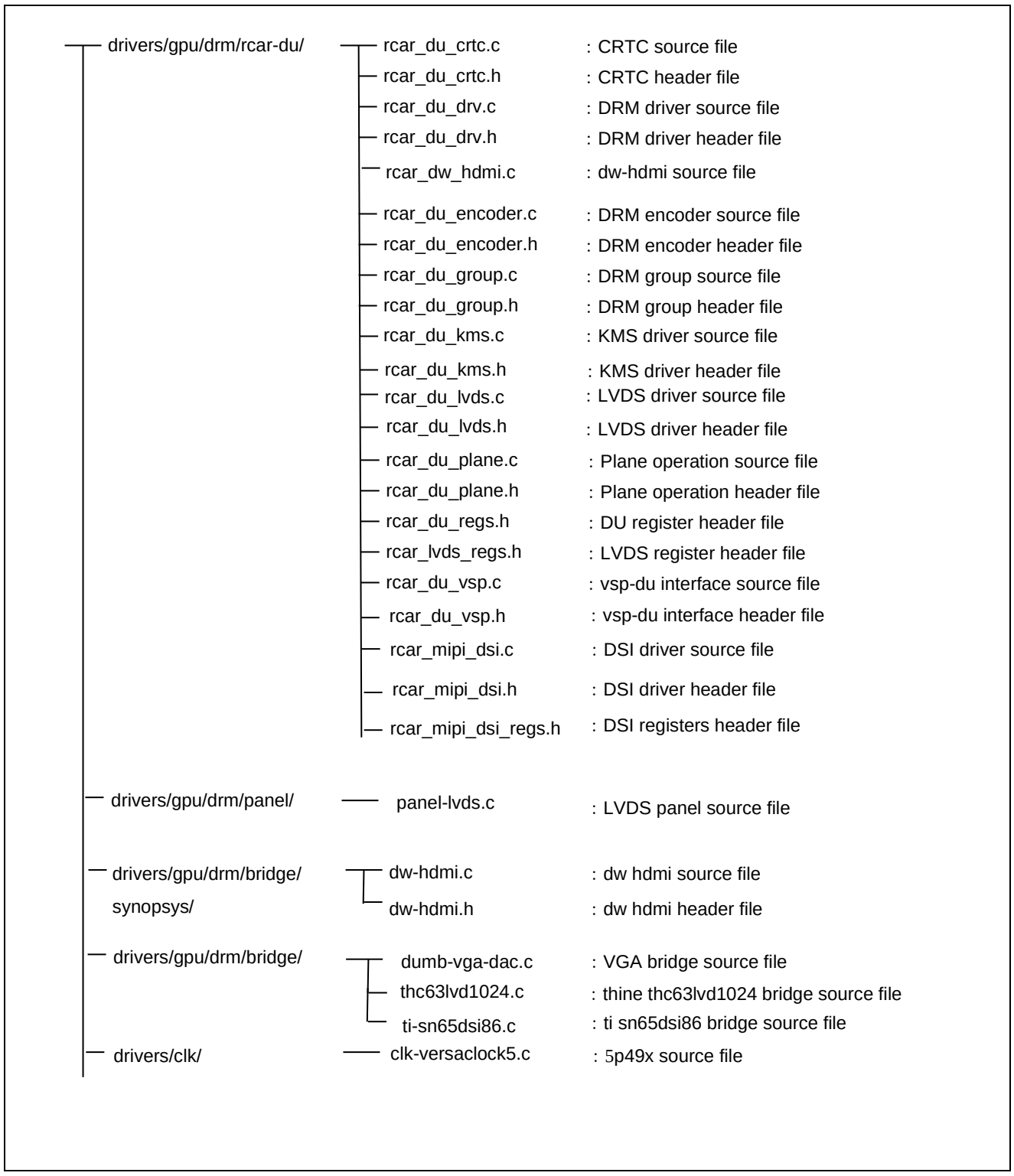
arch/arm64/boot/dts/renesas/r8a7795.dtsi or r8a77965.dtsi

```
                vspd0: vsp@fea20000 {
                        compatible = "renesas,vsp2";
                        reg = <0 0xfea20000 0 0x4000>;
...
                        renesas,#brs = <2>;             // please change number <0> or <1> or <2>.
                                                        // plane assignment is not fixed if it commented out.
                        renesas,fcp = <&fcpvd0>;
                };
```

5.Integration

5.1 Directory Configuration

The directory configuration is shown below.



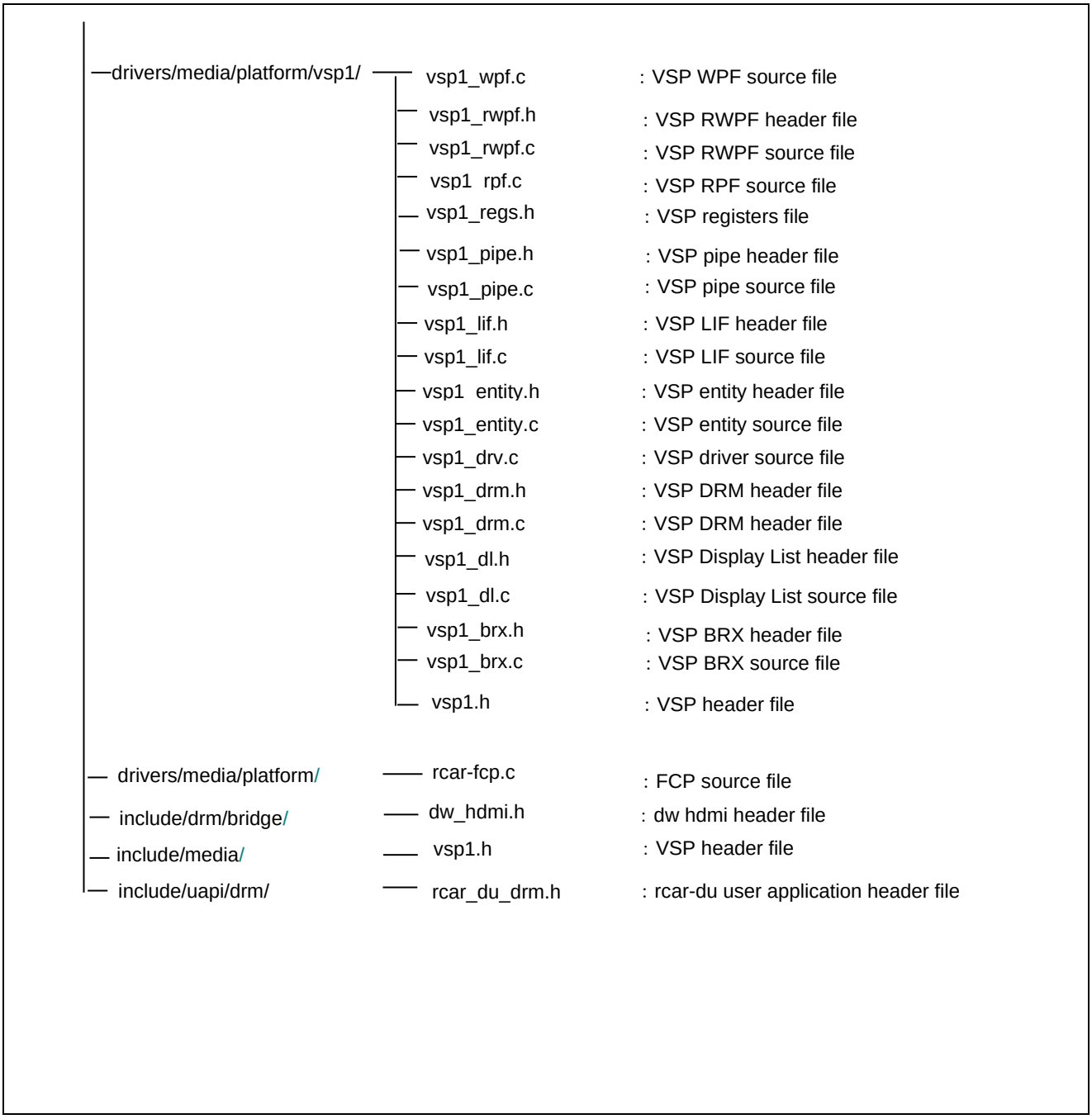


Figure 5-1 Directory configuration

5.2 Integration Procedure

5.2.1 Kernel Configuration

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

```
Device Drivers  --->
        I2C support  --->
                I2C Hardware Bus support  --->
                <*> Renesas R-Car I2C Controller
        <*> Multimedia support  --->
                Media device types --->
                        [*]  Cameras and video grabbers
                Media core support  --->
                        [*]  Media Controller API *7
                Video4Linux options  --->
                        [*]  V4L2 sub-device userspace API
                Media drivers  --->
                        [*]  Memory-to-memory multimedia devices  --->
                             <*>  Renesas Frame Compression Processor
                             <*>  Renesas VSP1 Video Processing Engine
                             [ ]   Renesas VSP1 underrun debug messages  *1
                             (1)   Renesas VSP alpha bit function of ARGB1555  *2
        Graphics support  --->
                <*> Direct Rendering Manager(XFree86 4.1.0 and higher DRI support) --->
                        [*]  Enable legacy fbdev support for your modesetting driver  *3
                <*>  DRM Support for R-Car Display Unit
                <*>  R-Car DU Color Management Module (CMM) Support
                <*>  R-Car Gen3 and RZ/G2 DU HDMI Encoder Support *4
                <*>  R-Car DU LVDS Encoder Support
                <*>  R-Car DU MIPI DSI Encoder Support
                Display Panels  --->
                        <*> Generic LVDS panel driver
                Display Interface Bridges  --->
                        <*> Display connector support
                        <*> Simple DRM bridge support
                        <*> Thine THC63LVD1024 LVDS decoder bridge  *5
                        <*> ADV7511 encoder  *6
                        <*> TI SN65DSI86 DSI to eDP bridge
        Common Clock Framework  --->
                <*> Clock driver for IDT VersaClock 5,6 devices
```

Figure 5-2 Kernel configuration

*1

This configuration is enabled debug message when VSP underrun occurring.
In addition, please step on the following steps after kernel starting.

1. # echo 1 > /sys/module/vsp1/parameters/debug (debug message enable and VSP underrun count starts)
2. # cat /sys/module/vsp1/parameters/underrun_vspd (Check VSP underrun count)
3. # 0,0,0,0 (Left most indicates VSPD0): VSP underrun count) * Please confirm vspd channel for each device.

*2

It sets up about the function of alpha bit of ARGB1555 format.
If 0 is specified by configuration, pixel alpha blending will be performed when the alpha bit is 0.

If 1 is specified by configuration, pixel alpha blending will be performed when the alpha bit is 1.
The default value is 0.

*3

Please remove the check if you do not support the legacy FBDev support.
Note that this support also provides the linux console support on top of your modesetting driver.
The default setting is ON. The console image is drawn to all DU channel.

*4

This configuration is not applicable for R-Car E3 / D3.

*5

This configuration is applicable for R-Car E3 (Ebisu board) / R-Car D3 (Draak board).

*6

The ADV7511 encoder can be used to output HDMI in R-Car E3/D3.

*7

The [Media core support] option is only visible when [Filter media driver] option is unmark, so please uncheck [Filter media driver] option if you want access to Media Control API

5.2.2 Size of CMA Change

About CMA change method, please refer to 7. Memory map of “Yocto recipe Start-Up Guide User’s Manual: Software “.

In DRM access, when using one overlay in Full HD size, CMA is used [1920x1080x4(32bpp) = About 8MB].

Moreover, since a CMA area may be used with other drivers, please set the CMA size in consideration of a system.

5.2.3 Kernel Parameters

By adding the following parameters to bootargs which is an environment variable of u-boot, the resolution at a kernel start-up and a setup of a pixel format can be changed. When not setting up, it becomes the value of 32bpp and recommended resolution in HDMI output (VGA output is XGA. LVDS output is XGA). The resolution must set the resolution size to support of the monitor.

Please add to bootargs the command which underline drawn

video=[name of connector]:[width x height][R][-<bpp>][@<refresh rate>][i]

connector name	HDMI-A-1 (HDMI0 output), HDMI-A-2 (HDMI1 output),VGA-1(VGA output), LVDS-1(LVDS output), DP-1 (DSI-TX-IF 0 output)
[width x height]	Please specify resolution which monitor is supported.
bpp	[16] RGB565 / [32] ARGB8888
refresh rate	Please specify refresh rate.
R option	If 'R' is specified, do a 'reduced blanking' calculation for digital displays.
i option	If 'i' is specified, calculate for an interlaced mode.

Notes:

1. If the configuration of “Enable legacy fbdev support for your modesetting driver” is disable, bootargs option is not available.
2. When 'R' option is specified, even if the monitor does not support, the Display driver outputs forcibly.
3. When ‘R’ option is added, specification of a bits/pixel cannot be performed. It becomes an output of ARGB8888.
4. HDMI-A-2 (HDMI1 output) can be used in R-Car H3 only.
5. The resolution parameter is calculated by CVT algorithm or GTF algorithm if the resolution is not in the EDID information.
6. Please refer to “How to set video mode” in Wayland user’s manual if you want to change the resolution when starting Wayland.

Example) Please add the underlined part in the boot command.

[R-Car H3 / M3 / M3N]

[XGA]:RGB565 (HDMI0 connector) bootargs=console=ttySC0,115200 rw root=/dev/nfs nfsroot=192.168.0.1:/export/rfs ip=192.168.0.20 video=HDMI-A-1:1024x768-16@60
[VGA]:ARGB8888 (Analog RGB connector) bootargs=console=ttySC0,115200 rw root=/dev/nfs nfsroot=192.168.0.1:/export/rfs ip=192.168.0.20 video=VGA-1:640x480-32@60
[1080i]:ARGB8888 (Analog RGB connector) * If 4k monitor is connected to HDMI1 monitor, the picture stride at bootup may be disturbed. bootargs=console=ttySC0,115200 rw root=/dev/nfs nfsroot=192.168.0.1:/export/rfs ip=192.168.0.20 video=VGA-1:1920x1080-32@60i
[1080i]: ARGB8888 (HDMI0 connector) * If 4k monitor is connected to HDMI1(HDMI-A-2), the picture stride at bootup may be disturbed. bootargs=console=ttySC0,115200 rw root=/dev/nfs nfsroot=192.168.0.1:/export/rfs ip=192.168.0.20 video=HDMI-A-1:1920x1080-32@60i
[1080p]: ARGB8888 (HDMI1 connector) bootargs=console=ttySC0,115200 rw root=/dev/nfs nfsroot=192.168.0.1:/export/rfs ip=192.168.0.20 video=HDMI-A-2:1920x1080-32@60

[R-Car E3/D3]

[XGA]: ARGB8888 (HDMI connector) bootargs=console=ttySC0,115200 rw root=/dev/nfs nfsroot=192.168.0.1:/export/rfs ip=192.168.0.20 video=HDMI-A-1:1024x768-32@60
[VGA]:ARGB8888 (Analog RGB connector) bootargs=console=ttySC0,115200 rw root=/dev/nfs nfsroot=192.168.0.1:/export/rfs ip=192.168.0.20 video=VGA-1:800x600-32@60

[R-Car V3U]

[XGA]: ARGB8888 (DSI-TX connector) bootargs=console=ttySC0,115200 rw root=/dev/nfs nfsroot=192.168.0.1:/export/rfs ip=192.168.0.20 video=DP-1:1920x1080-32@60

[R-Car V3H]

[XGA]:RGB565 (HDMI0 connector) bootargs=console=ttySC0,115200 rw root=/dev/nfs nfsroot=192.168.0.1:/export/rfs ip=192.168.0.20 video=HDMI-A-1:1024x768-16@60
[SXGA]: ARGB8888 (HDMI0 connector) bootargs=console=ttySC0,115200 rw root=/dev/nfs nfsroot=192.168.0.1:/export/rfs ip=192.168.0.20 video=HDMI-A-1:1280x1024-32@60
[1080p]: RGB565 (HDMI0 connector) bootargs=console=ttySC0,115200 rw root=/dev/nfs nfsroot=192.168.0.1:/export/rfs ip=192.168.0.20 video=HDMI-A-1:1920x1080-16@60

[Example 'R' option]

video=HDMI-A-1:1920x720R@60 Reduce blanking. Resolution of 1920x720 is output to HDMI connection

REVISION HISTORY	Linux Interface Specification Device Driver Display User's Manual: Software

Rev.	Date	Description	
		Page	Summary
0.1	Sep. 25, 2015	-	New creation.
0.2	Oct. 23, 2015	23	4.1 External Interface for DRM/KMS Driver Update the version of libdrm from 2.4.59 to 2.4.65.
0.3	Nov. 20, 2015	4	1.5 Notice Add notice of hang-up workaround when VSP underrun occurs
		20	5.2 Integration Procedure Add Renesas VSP1 underrun debug messages configuration
		20	5.2.2 Size of CMA Change Delete CMA change method of bootargs and described the referenced document
0.4	Mar. 18, 2016	2	Table 1.1 Supported resolution High resolution (1080p, 720p, etc.,) of Analog RGB is supported.
		4	1.4 Restrictions Delete the description of the resolution that are not supported with the Analog RGB.
		4	1.4 Restrictions Add restriction of Vmute function
		5	1.5 Notice Add the information in the chip revision about work-around.
		6	Table 2.1 Terminology Add Terminology of 5P49V5923A
		7	Figure 3.1 Module configuration (R-Car H3) Add VSP2 module and 5P49V5923A (programmable clock generator) module.
		13	4.1.7 Add Resolution Setting Fix Analog RGB resolution change function
		15	Add 4.1.9 Vmute function (DRM)
		19	5.1 Directory Configuration Add clk-5p49v5923a.c and rcar_du_drm.h
		21	5.2.1 Kernel Configuration Add "Clock driver for 5P49V5923A programmable clock generator" configuration
		22	5.2.3 Kernel Parameters Add 1080p setting example method of Analog RGB by bootargs.
0.5	Apr. 15, 2016	All	Add R-Car M3 support.
		4	1.4 Restrictions Delete the restriction of vmute function.
0.6	Aug. 5, 2016	1,3	1.2 Function, Table 1.2 Supported pixel format New pixel format support (YUV420,YVU420,YUV422,YVU422,YUV444,YVU444)
		1,16	1.2 Function, 4.1.5 Setting of plane property The same use of pixel alpha and plane alpha is supported.(ARGB4444, BGRA8888, ARGB8888)
		2,8	1.2.1 Display Resolution, 1.7 P/I conversion Interlaced mode is supported.
		1,20	1.2 Function, 4.1.10Write back function (DRM) Write back is supported.
		1,16	1.2 Function, 4.1.5 Setting of plane property Plane order is supported.
		5	1.5 Notice Add note of caution in interlaced mode
		5,10	Table 1.4, Table 3.1 Add M3 System Evaluation Board information
		14	4.1 External Interface for DRM/KMS Driver Update the version of libdrm from 2.4.65 to 2.4.68.
		21	Table 4.4 List of DRM resources ID Each object ID is corrected by update of kernel v4.6
		24	Add 4.5 IPMMU Setting

		27	Figure 5.1 Add rcar-fcp.c source file
		28	Figure 5.2 Kernel configuration Add “Renesas Frame Compression Processor” configuration
		29	5.2.3 Kernel Parameters Add 1080i setting method in HDMI connector
0.7	Dec. 16, 2016	22	Fix 4.2 DRM resource information by updating to kernel-v4.9
		29	Fix 5.1 Directory Configuration
		31	Fix 5.2.1 Kernel Configuration by updating to kernel-v4.9
		32	5.2.3 Kernel Parameters Add calculation method in Notes
0.8	Mar. 15, 2017	2	Table 1.1 Supported resolution Add notice *6 when R-Car H3 (WS2.0)
		5	Table 1.4 Related document (R-Car H3 / M3) Update revision of H/W manual, and add Salvator-XS manual
		7	Add Figure 1.2 accesses of layers (R-Car H3 (WS2.0))
		22	Table 4.4 List of DRM resources ID Add specification of H3(WS2.0)
		23	Add 4.4 BRS number setting
		29	5.1 Directory Configuration Change file name 5p49v5923a to 5p49x for Salvator-XS board support
		32	Figure 5.2 Kernel configuration Change configuration name 5P49V5923A to 5P49X for Salvator-XS board support
		18, 32	4.1.6 Resolution Change, 5.2.3. Kernel Parameters Add reference document to change the resolution when starting Wayland
0.9	Apr. 14, 2017	25	4.6 IPMMU Setting Add setting of ipmmu_vi1 and fcpvd2 for R-Car H3 (WS2.0)
0.10	Jun. 14, 2017	-	Fix H/W revision notation from WS to Ver.
		5	Table 1.4 Related document (R-Car H3 / M3) Update revision of H/W manual
		5	1.5 Notice Add notice of drmModePageFlip API issue timing
1.00	Aug. 8, 2017	All	Update document format.
		2	Table 1.1 Supported resolution 1080p is not supported in Analog RGB resolution because it does not meet the electrical characteristics
		5	1.5 Notice Delete notice of drmModePageFlip API issue timing
		21	4.1.10 Write back function (DRM) Add notice when other display update was executed.
1.01	Oct. 24, 2017	ALL	Add R-Car M3N support
		5	Table 1.4 Related document (R-Car H3 / M3 / M3N) Update revision of H/W manual
1.50	Jan. 29, 2018	-	Update for Kernel v4.14
		18	Add color key function support
		19	Table 4.2 Add atomic API
		21	Table 4.1 Delete device file of /dev/dri/controlID64 from v4.14
		25	Delete IPMMU setting.
1.51	Mar. 28, 2018	ALL	Add R-Car E3 support
		18	Add Linux GPU Driver Developer’s Guide URL
		19	Table 4.2 Update atomic API
1.52	Apr. 25, 2018	2	Table 1.2 Add 1920x720 resolution for R-Car E3
		29	4.3 DRM connector selection Fix dual-link mode from lvds to hdmi in Ex 2)

		32	Add 4.5 BRS number setting
		35	5.2.1 Kernel Configuration Delete note of Dumb VGA DAC Bridge support because it is wrong.
1.53	Jun. 27, 2018	7	1.6 Plane access Add description of BRS and WPF1
		23	4.1.5 Setting of plane property Add notice of colorkey alpha use
		24	4.1.7 Add Resolution Setting Add method to add resolution table
		30	4.3 DRM connector selection Fix lvds port number in Ex 3)
1.54	Oct, 22, 2018	2	Table 1.1 Add M3N notation
		6	Table 1.6 Related document (R-Car H3 / M3 / M3N / E3) Update Related Documents
1.55	Oct, 29, 2018	6	1.5 Notice Add notice about sync signal of DU1 in E3
		16	Figure 3-2 Add notice about LVDS in E3
		28	Table 4.4 List of DRM resources ID Update Connectors ID of E3 for kernel version up
		29	4.3 DRM connector selection Update for kernel version up
		35	5.1 Directory Configuration Update for kernel version up
		37	5.2.1 Kernel Configuration Modified by kernel version Add Thine THC63LVD1024 LVDS decoder bridge configuration Delete R-Car DU VSP Compositor Support so it is set y by default
		37	5.2.3 Kernel Parameters Fix bootargs example setting from 1080p to 1080i in case of VGA. (Because 1080p in VGA cannot be used.)
2.00	Dec. 25, 2018	-	Update AddressList
		6	Table 1.6 Related document Update reference documents
		14	Table 3.1 Hardware specification Update board name
		31	4.3 DRM connector selection Add Ex 4) for ebisu board
		38	5.2.3 Kernel Parameters Add notice of 1080i setting
2.01	Apr. 17, 2019	-	Update AddressList
		6	Table 1.6 Related document (R-Car H3 / M3 / M3N / E3) Update reference documents
		25,30, 31	4.1.7 Add Resolution Setting, 4.3 DRM connector selection Add description of r8a77990-es10-ebisu.dts
		25	4.1.7 Add Resolution Setting [LVDS output] Add description polarity setting in LVDS panel
2.50	Apr. 24, 2020	-	Add R-Car V3U support
		1	1.2 Function Add new supported pixel format for V3U

		2	1.2 Function Add DSI/CSI-2-TX-IF for V3U
		3	Table 1.3 Supported resolution Add new supported resolution table with DSI/CSI-2-TX connection for V3U
		4	Table 1.4 Supported pixel format Update new pixel formats
		5	Table 1.7 Supported connector Add new supported connector table for V3U
		6	Table 1.8 Related document Update document
		11	Figure 1-5 Accesses of layer Add Layer Access diagram for V3U
		15	Table 3.1 Hardware specification Update document
		18	Figure 3-3 Module configuration Add new image for V3U's module configuration
		29	Table 4-4 List of DRM resources ID Update connector ID and CRTCs ID for V3U
		40	5.2.3 Kernel Parameters Add example command to set bootargs for V3U
2.51	Jun. 24, 2020	32	4.3 DRM connector selection In Example 3 LVDSx2 Single link, setting for dts in case of using 2 LVDS panels is added
		33	4.3 DRM connector selection In Example 4 Analog RGB + LVDS Single link, setting for dts in case of using Analog RGB and LVDS is added
		36	5.1 Directory Configuration Add DSI driver file into directory configuration
2.52	Dec. 1, 2020	5	1.2.3 Connector Change the name of output signal for DSI-TX-IF at Table 1.7 Supported connector for R-Car V3U
		6	1.3 Related Document Add edition and issed date for [R-Car V3U Series User's Manual] and [R-CarV3U System Evaluation Board Falcon Hardware Manual]
		11	1.6 Plane access Due to supporting only DU0 on V3U Falcon Board, the access of layers (Figure 1-5) was modified.
		29	4.2 DRM resource information Add R-Car V3U resource ID (connector's and crtc's ID) to Table 4.4 List of DRM resources ID
		34	4.4 Hot plug Operation Add checking status of DP cabble
		36	5.1 Directory Configuration Add tn-sn65dsi86.c file as bridge source file to directory sources tree
2.53	Jan. 29, 2020	-	Add R-Car V3H v2.0 support.
2.54	Apr. 21, 2021	-	Add R-Car D3 support
		-	Add Kernel 5.10 support
2.55	Aug. 16, 2021	22	Update libdrm v2.4.104

3.00	Dec. 10, 2021	-	Add Kernel v5.10.41 support
3.1.0	Dec. 25, 2023	-	Add Kernel v5.19.194 support for H3, M3, M3N, E3

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Colophon 7.0

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Colophon 3.1

Linux Interface Specification
Device Driver Display

Renesas Electronics Corporation