User's Manual

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RH850/D1x Device Family

RGL-D1x_User-Manual

User’s Manual: Software

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How to Use This Manual

1. Purpose and Target Readers

This manual is designed to provide the user with an understanding of the functions of the RGL (Renesas Graphics Library). This manual is written for engineers who use RGL.

The Renesas Graphic Library (RGL) is an API for the functions of the 2D/3D-Drawing engine, for the serial flash as well as for the Video Output and Video Input Interface of the RH850/D1L/D1M microcontrollers driver. Industry standard APIs (EGL, OpenVG) are not described in this manual.

> 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.

Please refer to documents of drivers and hardware for a target system implementing RGL as necessary.

The following documents are related documents. Make sure to refer to the latest versions of these documents.

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	RH850/D1L/D1M Group User's Manual: Hardware	R01UH0451EJ0220
User's manual for Software	Description of RGL overview	Renesas Graphics Library User's Manual: Software	R01US0181ED0400 (This manual)
	Description of WM	Renesas Graphics Library Window Manager (WM) Driver User's Manual: Software	LLWEB-10035990
	Description of SPEA	Renesas Graphics Library Sprite Engine A (SPEA) Driver User's Manual: Software	LLWEB-10035991
	Description of VDCE	Renesas Graphics Library Video Data Controller E (VDCE) Driver User's Manual: Software	LLWEB-10035992
	Description of VOWE	Renesas Graphics Library Video Output Warping Engine (VOWE) Driver User's Manual: Software	LLWEB-10035993
	Description of JCUA	Renesas Graphics Library JPEG Codec Unit A (JCUA) Driver User's Manual: Software	LLWEB-10035994
	Description of SFMA	Renesas Graphics Library Serial Flash Memory Interface A (SFMA) Driver User's Manual: Software	LLWEB-10064753
	Description of HYPB	Renesas Graphics Library HyperBus Controller (HYPB) Driver User's Manual: Software	LLWEB-10064754
	Description of OCTA	Renesas Graphics Library OctaBus Controller (OCTA) Driver User's Manual: Software	LLWEB-10064755
	Description of VOCA	Renesas Graphics Library Video Output Checker (VOCA) Driver User's Manual: Software	LLWEB-10063801

	Description of DISCOM	Renesas Graphics Library Display Output Comparator (DISCOM) Driver User's Manual: Software	LLWEB-10063802
	Description of DRW2D	Renesas Graphics Library 2D Graphics (DRW2D) Driver User's Manual: Software	LLWEB-10059472
Porting Layer Guide	Description of porting layer of RGL	Renesas Graphics Library Porting Layer Guide	LLWEB-10035995

2. Notation of Numbers and Symbols

This manual uses the following notation.

Binary	0bXXXXXXXX	(X=0 or 1)
Decimal	XXX	(X=0-9)
Hex	0xXXXXXXXX	(X=0-9,A-F)

3. List of Abbreviations and Acronyms

Abbreviation	Full Form
Context	An internal state machine of the single framework
CPU	Central Processing Unit. The microprocessor core of the LSI.
DHD	Dave HD. This is H/W which controls 2D graphics rendering.
DISCOM	Display Output Comparator. This is H/W, which calculates CRC.
Drw2D	Draw 2D. This is a driver stack, which enables an abstract access to DHD driver.
Framebuffer	A region in the memory attached to a window that can be shown on the screen; A region in the memory holding the bitmap as the result of GPU rendering activities
GPU	Graphics Processing Unit. This is H/W which controls 2D graphics rendering.
H/W	Hardware
HYPB	HyperBus Controller. This is H/W which enables direct connection of the HyperRAM or HyperFlash memory.
Layer	A HW concept of the stackable visual area on the display
MCU	Minimum Coded Unit
OCTA	OctaBus Controller. This is H/W which enables direct connection of the OctaRAM or OctaFlash memory.
Pitch	(a.k.a. stride) Distance in pixels between two adjacent pixel rows of the framebuffer in the memory
RLE	TARGA run-length encoded image standard, for easy image compression, supported by Drw2D.
Screen	A physical display surface; a SW abstraction of the attached physical display
SFMA	Serial Flash Memory Interface A. This is H/W which enables direct connection of the serial flash memory.
Sprite	A graphical entity which can be moved on the screen independently.
Surface	A concrete (i.e. physical) implementation of the window's area
S/W	Software
TARGA	Truevision Graphics Adapter
Texture	A binary image registered with the GPU driver that can be transformed and drawn to the framebuffer in a HW accelerated way
VOCA	Video Output Checker A. This is H/W, which monitors video output signal.
VOUT	Video output HW
Window	A SW abstraction of the rectangular visual area that can be shown on the display
WM	Window Manager. This is a driver stack, which enables an abstract access to VDCE driver and SPEA driver.

Table of Contents

1. RGL package

1.1 Overview

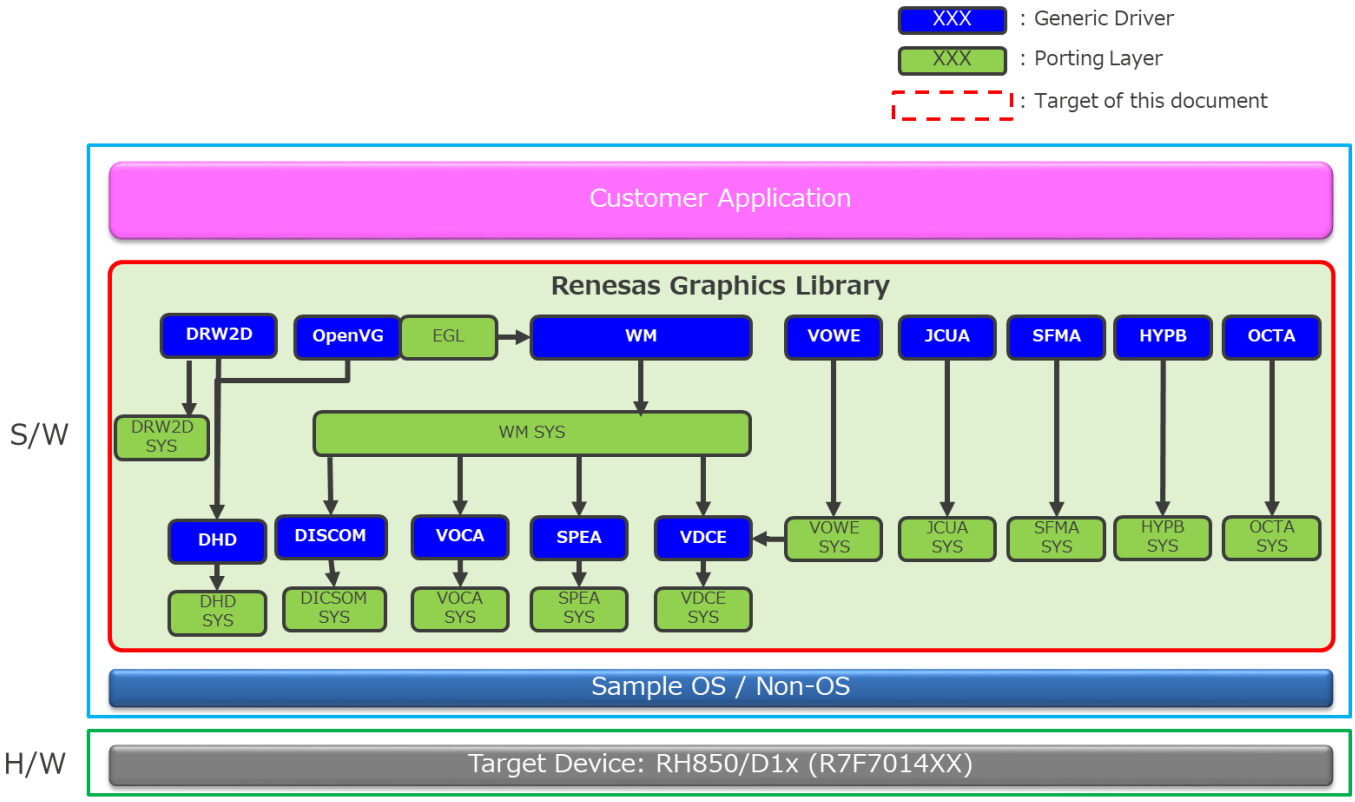
The RGL (Renesas Graphics Library) package bundles several drivers as well as sample applications. It is bound to a specific hardware (RH850/D1Lx, RH850/D1Mx) and compiler (GHS Multi).

1.2 Definition of sample / example

Sample code or example code is mentioned in this document as well as all files containing copyright headers in the RGL package. Sample/Example code is not qualified for usage in mass-production. When qualified at customer site it can be used partly or completely in the user application if not stated differently in the signed contract.

1.3 Package contents

The RGL consists of the following modules/API's:



The different drawing API's are shown. Drw2D is a simple and slim abstraction layer to render primitives and textures. Its underlying graphics stack is the hardware-accelerated DaveHD GPU or CPU drawing.

Another way to render is to use OpenVG directly. This implementation is Khronos conformant.

The Windows Manager can be used to control the Video-Out, Video-In, Video checker and the sprite engine.

The JCUA driver is the interface to the hardware JPEG decoding unit.

The VOWE driver is the interface to the hardware warping engine. It can be used for head-up displays or other warping use-cases.

The SFMA, HYPB and OCTA driver provides access to the high-speed flash with read/write/delete functionality.

1.3.1 Applications content

There are several applications, delivered in source code, which can be built for RH850/D1x targets. One of it is:

Simple Draw

Demonstrates drawing the simple graphic primitives (triangles and rectangles), with a solid color or textured, and using the sprite engine as well as the warping engine.

For other sample applications please check the README.txt of your RGL package.

1.4 Folder structure

When installing the library package, the files are copied into a folder *rgl_xx_yy* where *xx* stands for the compiler and *yy* for the library version. In this folder you will find the *vlib* folder containing the library files, and a *doc* folder where the HTML API documentation and this user manual are located.

The *vlib* folder is divided into:

- *app*
  The source code for the application
- *compiler*
  The rules for different compilers
- *bsp*
  The device independent source code for the board set up
- *device*
  The device dependent source code for the board set up and graphic libraries
- *cdi*
  The source code for the common driver interface library, e.g. memory manager
- *macro*
  The files specific to different HW macros found on the target device
- *grape*
  The implementation of the Graphics Application Programming Environment, a higher-level programming framework
- *os*
  The source code of the Renesas OS
- *middleware*
  The source code of middleware for application

1.5 Integration of the library into a user project

If the RH850/D1x device has to be ported to a non-Renesas board the following table gives basic information which directories and files to port, i.e. which are optional, which are necessary to port and which have to be adapted.

Directory	**Description**	**Integration comments**
app	Application examples. Integration optional	
bsp	Board support package: Example BSP for RH850/D1x Mango board. Integration **necessary**	Start here for H/W bringup (clocks, memories, PLL, etc.)
cdi	Example Memory manager. Integration optional	If a different memory manager should be used: 1) Adapt r_wm_sys.c 2) Adapt davehd_os_libc.c 3) CDI can be removed
compiler	Example Build system for GHS with Makefiles: Integration optional	
device/d1mx/src/	Example Integration layer for RH850/D1M specific macros. Integration **necessary**	Has to be taken as-is or implemented for RGL
device/d1x_common/src	Example Integration layer for RH850/D1x generic macros. Integration **necessary**	Has to be taken as-is or implemented for RGL
device/d1mx/lib/libd1mx_rh850_ghs.a	**This** is the RGL	Take as-is
device/d1mx/macro_cfg	Example configuration for RH850/D1M specific macros. Integration optional	
device/d1x_common/macro_cfg	Example Integration layer for RH850/D1x generic macros. Integration optional	
grape	Example higher-Level API for RGL. Integration optional	
macro/*/lib	RGL macro header files. Integration not necessary	Take as-is
macro/*/src	Example macro source. Integration optional	In case of RGL_SRC product, the full source of the RGL is here, too

middleware	Example middleware for application examples. Integration optional	
os	Example operating system. Integration optional	If O/S is not necessary, the project "simple_draw" provides an example without ROS. If O/S is necessary, the other bundled sample applications provide an example how to use ROS

2. Appendix

2.1 RH850/D1x optimization hints

- Avoid blitting rotated textures specified in serial flash by Drw2D, copy it first to the RAM
- When rotating, use texture flag R_DRW2D_TEX_VT or R_DRW2D_TEX_SWIZZLE; For swizzling you first need to prepare your textures ('swizzle' them) by an appropriate tool (like swizzle tool from RGBench)
- In case of non-rotated textures, take care when using R_DRW2D_TEX_VT or R_DRW2D_TEX_SWIZZLE texture flags, because they can improve as well as worsen the performance, depending on the use-case
- Using R_DRW2D_TEX_BILINEAR introduces some performance penalty, so use judiciously, i.e. make sure to turn it off if the output quality suffices without it
- Align the texture address to 128 byte boundary (due to bus cache-line)
- For blitting one texture several times: if not already there, make sure to copy it to the RAM first
- Use clipping rectangle feature to restrain the area needed to be updated by the GPU
- Using transformation (rotate, wrap, scale, etc.) or filtering (bilinear filter) on compressed textures (like RLE) will cause a performance penalty

2.2 RH850/D1x graphics programming alignment table

Action	Alignment	Constraint of	Directly affected APIs	Comment
Window framebuffer start address (i.e. HW layer start address)	128 bytes	VDCE	R_WM_WindowCreate	
Window framebuffer stride (a.k.a. pitch)	128 bytes (+ 128 bytes RLE)	VDCE SPEA	R_WM_WindowCreate	
Sprite buffer address	64 bit	SPEA	R_WM_SpriteCreate, R_WM_SpriteBufSet	
Sprite X start position	64 bit	SPEA	R_WM_SpriteCreate	
Sprite width (i.e. X direction dimension)	64 bit	SPEA	R_WM_SpriteCreate	
CLUT start address	32bit	VDCE	R_WM_WindowClutSet R_WM_ScreenColorCurveSet	
Drw2D framebuffer address	128 bytes	DaveHD	R_DRW2D_FramebufferSet	
Drw2D framebuffer pitch	None	DaveHD	R_DRW2D_FramebufferSet	Recommended: 128 bytes
Drw2D texture address	any	DaveHD	R_DRW2D_CtxTextureSet	Recommended: 128 bytes
Drw2D RLE texture address	8 bytes	DaveHD	R_DRW2D_CtxTextureSet	Recommended: 128 bytes

Revision History	Renesas Graphics Library User's Manual: Software

Rev.	Date	Description	
		Page	Summary
0.1	2013-10-04	-	Initial Release
0.2	2013-10-09	-	Added notes to indicate D1Mx vs D1Hx features Replaced VDC5 by VDCE
0.3	2014-01-30	-	Updated Drw2D, WM (Scanline support), JCUA VOWE and SFMA APIs
0.4	2014-05-13	-	Updated Drw2D
0.5	2014-05-15	-	Update WM API
0.6	2014-06-14	-	Completely revised – user/reference manual separation
0.7	2014-06-17	-	2nd draft – expanded + added VOWE, JCUA and SFMA
0.8	2014-09-24	-	Version for RGL V1.0.0 release
0.9	2014-10-29	-	Version for RGL V1.1.0 release
1.0	2014-12-12	-	Version for RGL V1.1.2 release
1.1	2015-03-06	-	Several updates for D1L and D1M releases
1.2	2015-07-27	-	Drw2D Effects update
1.3	2015-09-29	-	Version for RGL V1.4.0 (D1Mx) and V1.1.0 (D1Lx) releases
1.4	2016-03-16	-	Version for RGL V1.5.0 (D1Mx) and V1.2.0 (D1Lx) releases
1.5	2016-04-15	-	Drw2D Transformation Matrices update
1.6	2016-06-28	-	SFMA update
1.7	2016-07-13	-	Delete D1Hx, small adaptions in generic chapters
1.8	2016-12-19	-	Minor typo corrections only
1.9	2017-06-01	-	Add required WM CLUT alignment, add DaveHD chapter regarding DHD working memory, adapt WM chapter regarding D1M1A/D1M1v2, add Drw2D rendering step diagram, various small changes
2.0	2017-06-06	-	Add HYPB and OCTA driver chapter, adapt SFMA chapter regarding D1M1A/D1M1v2. Delete win32.
2.1	2018-01-15	-	Version for RGL V1.9.0 (D1Mx)
2.2	2018-10-31	9, 36	Removed the driver related information (WM, VOWE, JCUA) to support separate User's Manual for each driver.
3.0	2019-06-12	22	Fixed the sample of (d) Add signed effect
4.0	2020-05-13	3	Added DISCOM and VOCA driver. Removed the driver related information (DRW2D, SFMA, OCTA, HYPB) to support separate User's Manual for each driver. Removed the memory manager information to support Porting Layer Guide.

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