RZ/A1LU Group

SDK for Camera Sample Program

R01AN4312EJ0201
Rev.2.01
Oct. 31, 2018

Introduction

This document describes the functional specifications of a SDK for Camera sample program running on the RZ/A1LU Software Package that supports Stream it! RZ V2.0 with an RZ/A series RZ/A1LU group MCU.

Note that “RZ/A1” in this document means “all of RZ/A1H Group, RZ/A1M Group, RZ/A1LU Group, RZ/A1L Group, and RZ/A1LC Group”.

Target Device

RZ/A1LU

Target Board

YSTREAM-IT-RZ-V2.3

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1. Introduction

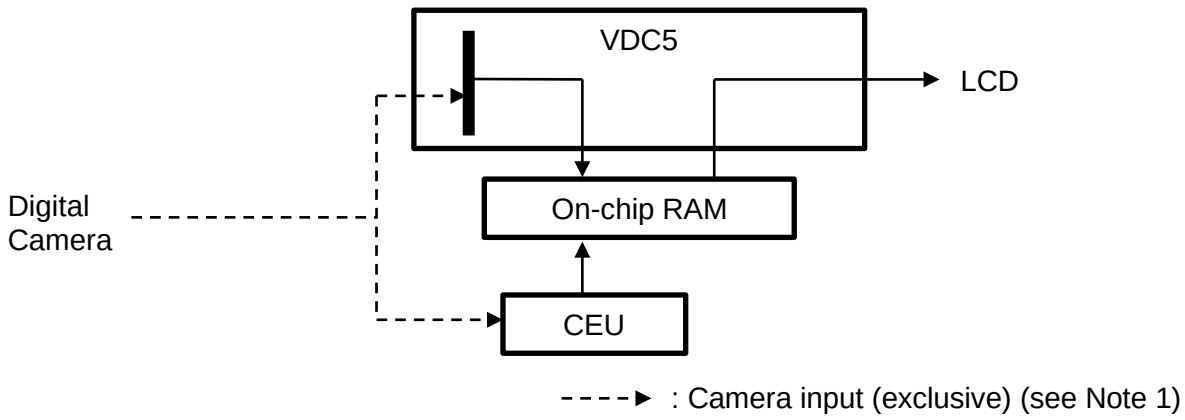
The SDK for Camera is an application program for cameras, that supports functionality to capture an image from the camera, adjust the image, and display the adjusted image. This sample program allows the user to confirm the image adjustment functionality of the RZ/A1LU in real time and check if the adjusted image suits the user's development environment. After image data is adjusted, the application software can obtain the data which can be subjected to image processing by software (such as recognition processing and JPEG compression for storing JPEG-compressed data).

Also, only when using e2 studio, this sample program can cooperate with the development support tool for RZ "QE for Display" and "QE for Camera". "QE for Display" enables simple adjustment of image collection and display device parameters. "QE for Camera" enables easy access to set the camera module via RIIC commands containing camera device parameters. Refer to Section 6 for details.

2. Features

2.1 Camera Input

The RZ/A1 which supports camera input has peripheral devices VDC5, and CEU. The VDC5 and CEU are for digital camera input. The VDC5 also supports image output to display devices. This sample program offers sample applications for camera input which involves using those peripheral devices. For details about these peripheral devices, refer to “RZ/A1L Group, RZ/A1LU Group, RZ/A1LC Group User's Manual: Hardware (R01UH0437)”.



Note 1. RZ/A1 can support camera 2 input. This sample program supports only camera 1 input.

Figure 2.1 Data Flow for RZ/A1 Camera Input

2.2 Image Adjustment

By using the RZ/A1’s peripheral devices VDC5, this sample program adjusts an image from the camera as shown in Table 2-1. The adjustment results are reflected in the LCD display, allowing the user to confirm the adjustment effects in real time. The user can directly change the register values related to each adjustment. So, the user can review or test the adjustment values to see if they suit the user’s environment. For information on the image adjustment methods, refer to Section 5 Image Adjustment Effects and Adjustment Methods. Please refer to Section 6 in case of adjusting images with QE for Display.

Table 2-1 Image Adjustments Supported by This sample program

Peripheral device	Adjustments	Description
VDC5	Brightness (Note 1)	Adjusts brightness by changing the luminance components.
	Contrast (Note 1)	Adjusts contrast by changing the color components.
	Sharpness	Sharpens the outline of an edge by adjusting overshoot and undershoot.
	Gamma adjustment	Makes a gamma adjustment with a preset value (four types of preset gamma adjustments are enabled with preset values).
	Dithering process	Performs dithering with random patterns.
	Rotation and Horizontal Mirroring (Note 2)	Rotate an image 180 degree or flip horizontally.

Note 1. The adjustment timing is limited for camera input through the CEU (see Section 2.4).
Note 2. This sample code does not support this function.

2.3 Applying Image Adjustment results

In this sample program, it is easy to apply the image adjustment results as initial setting of program after adjustment. Adjusted parameter will be output to Terminal Application as header format of C source code. For details, refer to section 3.4.

In case of adjusting images with QE for Display, it can output the adjusted parameters as header file. Please refer to Section 6 for details.

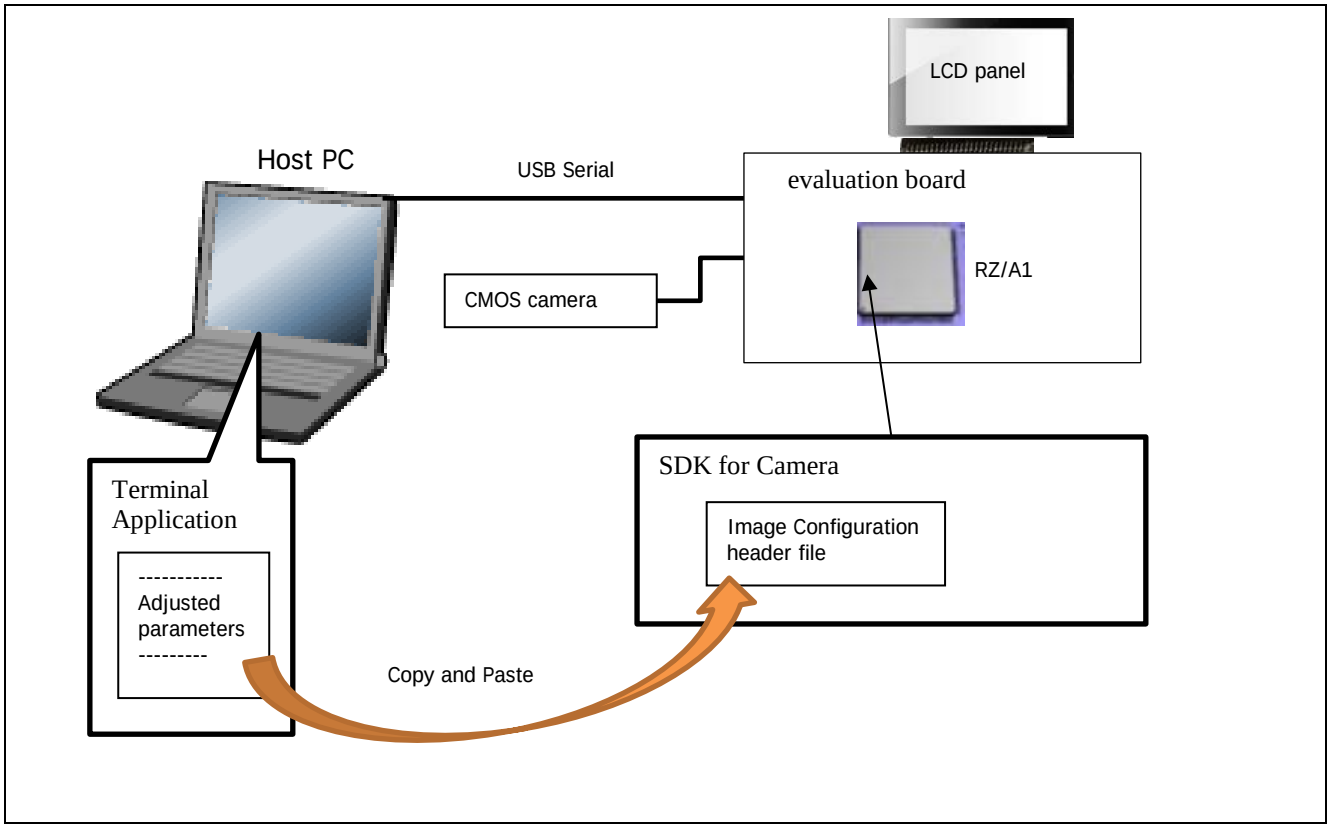


Figure 2.2 Obtaining image adjustment result and applying to SDK for Camera

2.4 Adjusted-Image Capture

Figure 2.3 shows the adjustment timing for each adjusted image.

All of image adjustments are done by hardware. In this sample program, the software can get an adjustment image at the timing indicated in red in Figure 2.3.

In case of doing an image processing (such as recognition processing and JPEG compression for storing JPEG-compressed data), the processing can perform on an adjusted image of "Brightness 1", "Contrast 1", "Rotation and Horizontal Mirroring". Result of image processing will be reflected to "Image quality improver block" and "Output controller block".

But in the case of camera input with CEU, "Brightness 1", "Contrast 1", "Rotation and Horizontal Mirroring" are unusable. And, it is not able to be captured by software that an adjusted image after the timing indicated in red in Figure 2.3.

For details about the hardware blocks of the VDC5 such as “Input control block”, “Scaler block” and so on, refer to Section 5.1.

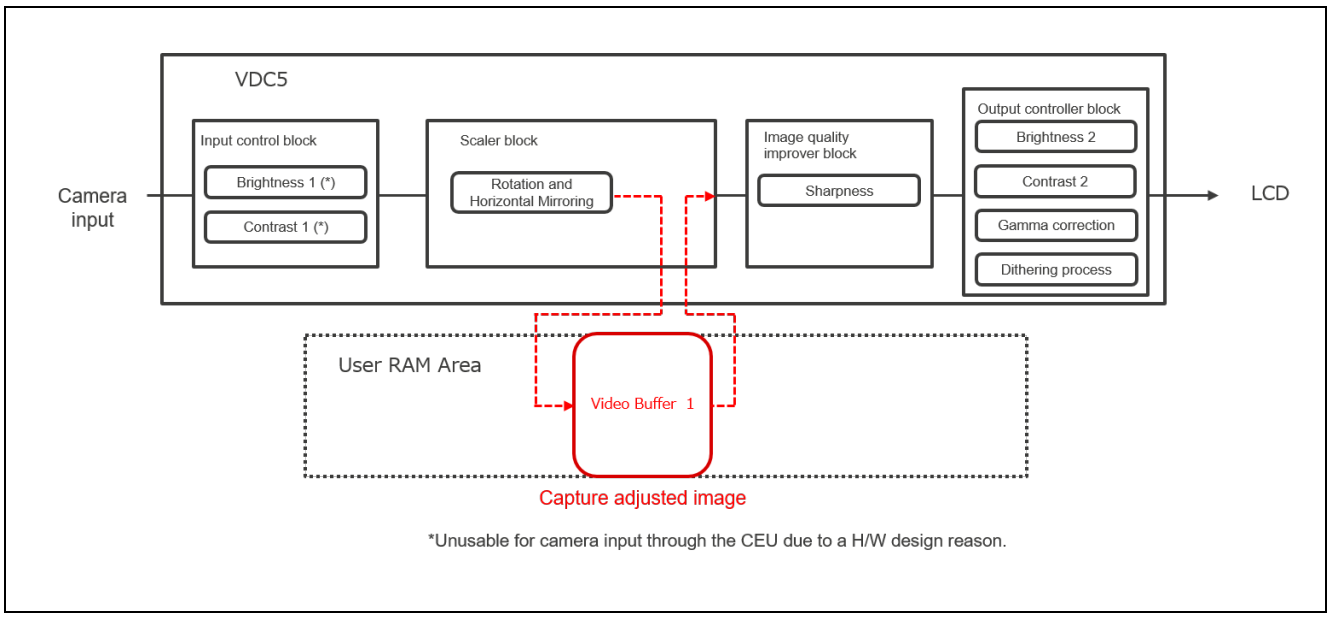


Figure 2.3 Get an adjustment image

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3. Software Description

The content described in this chapter is adapted for RZ/A1LU.

3.1 Software Blocks

Figure 3-1 SDK for Camera System Block Diagram shows the SDK for Camera system blocks.

This sample program has two tasks, Graphics processing task that performs initial setting of camera input, display output, and image adjustment, and CUI (Character User Interface) task for performing image adjustment shown in Table 2-1. For details of CUI task features, Chapter 3.4.

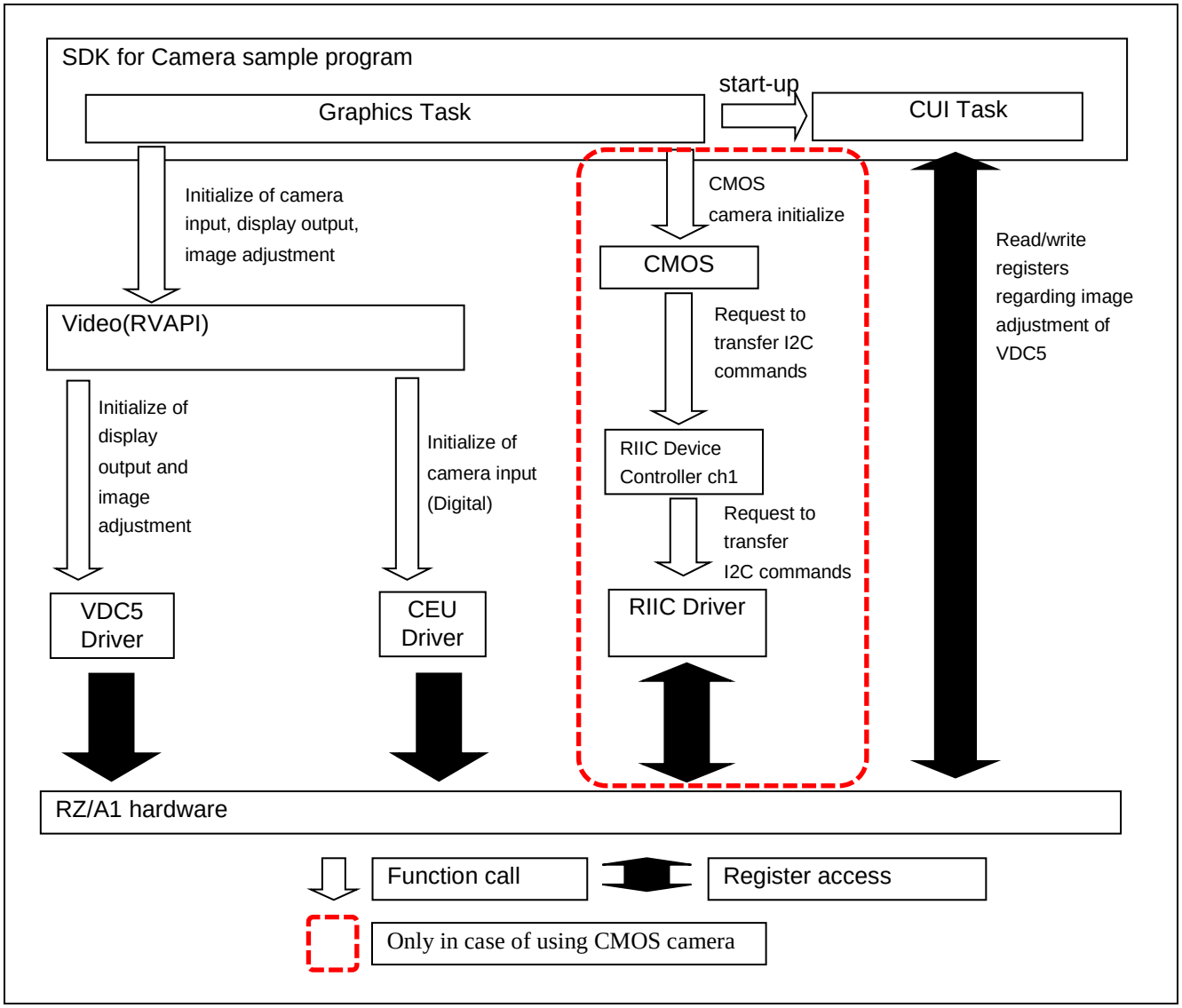


Figure 3-1 SDK for Camera System Block Diagram

3.2 Basic Data Types

Table 3-1 lists the basic data types that are used by the software products included in this package.

The software does not directly use the C language basic data types but uses only the basic data types listed below.

Table 3-1 Basic Data Types

type	type definition
typedef char	char_t
typedef int	int_t
typedef unsigned int	bool_t
typedef signed long	long_t
typedef unsigned long	ulong_t
typedef signed char	int8_t
typedef unsigned char	uint8_t
typedef signed short	int16_t
typedef unsigned short	uint16_t
typedef signed int	int32_t
typedef unsigned int	uint32_t
typedef signed long long	int64_t
typedef unsigned long long	uint64_t
typedef float	float32_t
typedef double	float64_t
typedef long double	float128_t

3.3 Launching SDK for Camera application

Type “sdk” to the RZ/A1LU Software Package command interface, then SDK for Camera application will be launched.

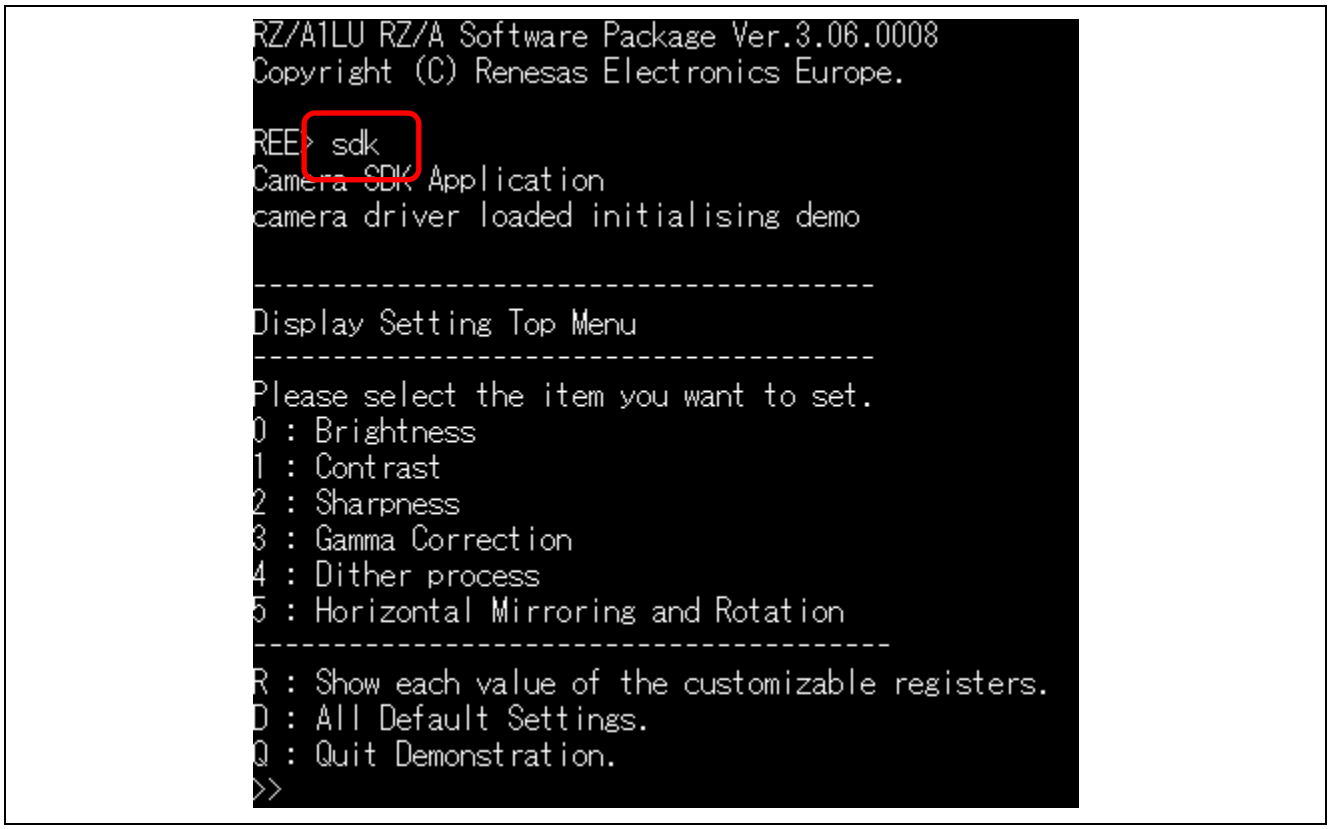


Figure 3-2 Launching SDK for Camera application

3.4 CUI (Character User Interface)

This sample program implements CUI which can perform image adjustment in real time with Terminal Application on PC. The CUI task operates the register value of VDC5 by command input from PC's Terminal Application to realize image adjustment.

This chapter describes the screen operation method and commands from Terminal Application. For details of various adjustment contents and presets, refer to Section 5 Image Adjustment Effects and Adjustment Methods.

Note, however, that in case of adjusting images with QE for Display, it is not allowed to combine use of CUI and QE for Display. Please refer to Section 6 regarding cooperation of this sample program and QE for Display.

3.4.1 Menu

Display menu of Terminal Application and operation overview shown in Figure 3-3. Please refer to Chapter 3.4.2 regarding detail of any commands in Figure 3-3.

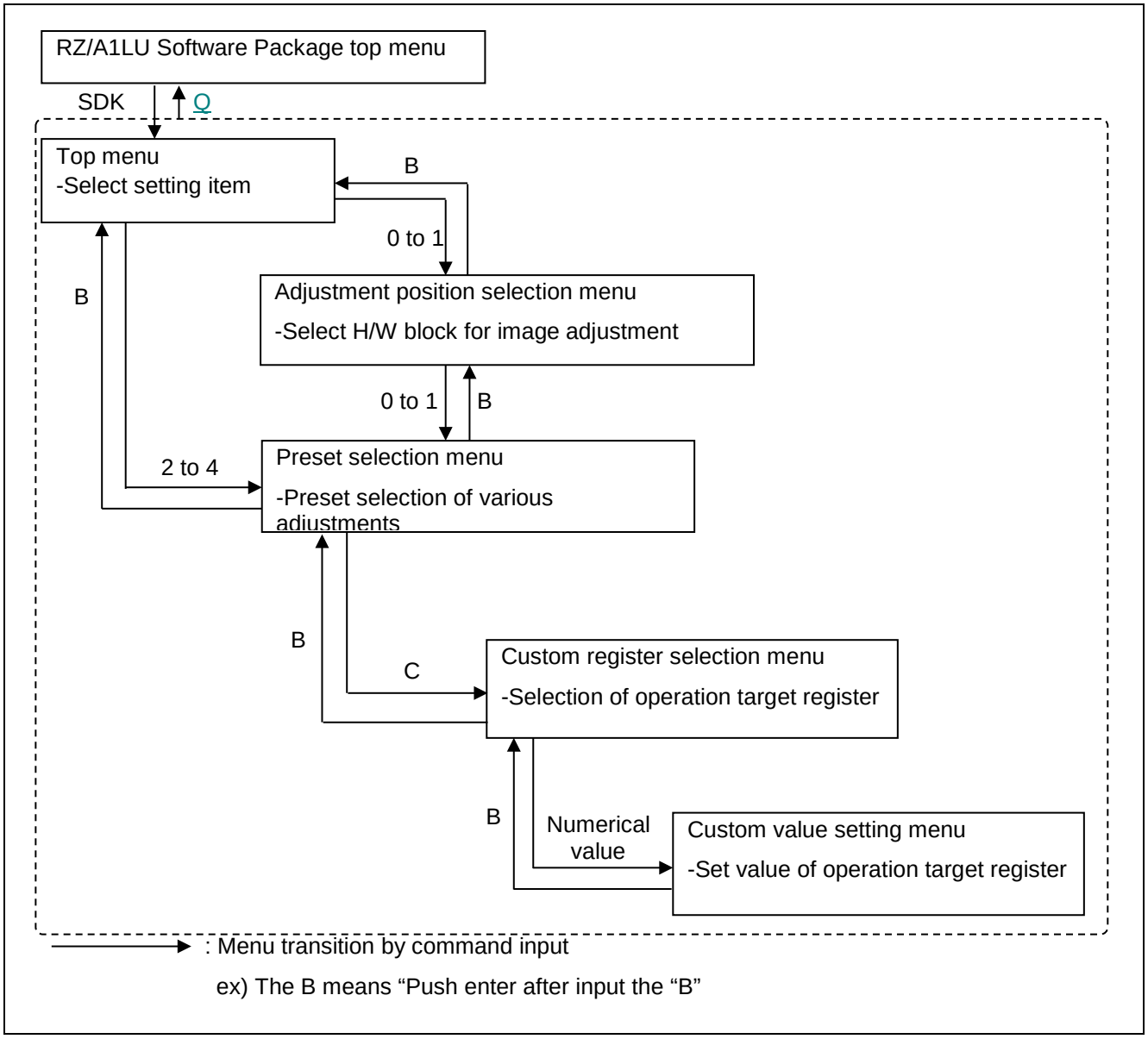


Figure 3-3 Display menu and operation overview

3.4.2 Commands

Table 3-2 lists the CUI operation commands on the Terminal Application.

Table 3-2 CUI operation command on Terminal Application

Command	Operation
Numerical value	Operations in each menu - Selection of image adjustment content - Selection of image adjustment position (selection of H/W block for image adjustment) - Selection of presets - Input custom value
C, c	Custom setting selection (Selected when user want to set a preset other than the various adjustment items)
D, d	Set image adjustment to default (Default value of each register described in H/W manual)
B, b	Return to the previous menu
R, r	Output current image adjustment value
T, t	Return to the Top menu
Q, q	Quit SDK for Camera application
Enter	Determine contents inputted
Delete/ Back space	Delete one character from the input character

3.4.3 Acquisition of image adjustment value

The user can acquire various image adjustment values set by preset selection or custom by executing the R command. When the R command is executed, the current values of the various adjustment parameters are output on the Terminal Application in a format that can be directly applied to the C language source code. (header format) To apply the output setting value when initializing this sample, overwrite the contents outputted on the Terminal Application to the following file the CUI operation commands on the Terminal Application.

(Top)\RZA1LU_Sample\src\renesas\application\graphics\inc\r_image_config.h

4. Process Sequence

Figure 4.1 shows the process sequence of this sample program.

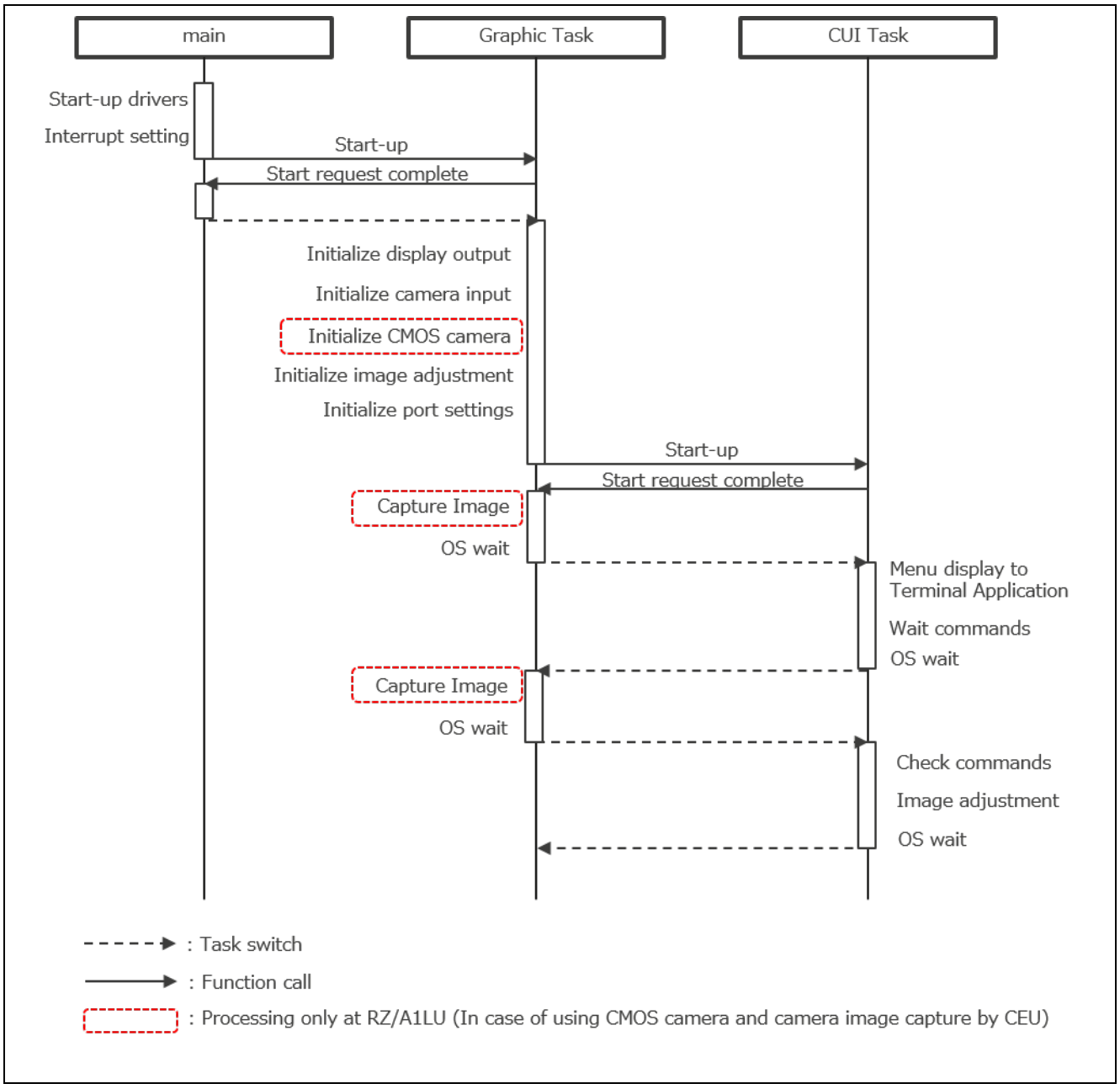


Figure 4.1 Process Sequence of SDK for Camera

5. Image Adjustment Effects and Adjustment Methods

This sample program provides preset values for various possible image adjustments. This section describes the adjustment effects and preset values. It also shows which blocks in the H/W configuration for RZ/A1 image input/output are responsible for adjustments.

5.1 Overall Configuration

Figure 5.1 shows the H/W configuration for RZ/A1 image input/output. Table 5-1 lists the functionalities of the VDC5 blocks.

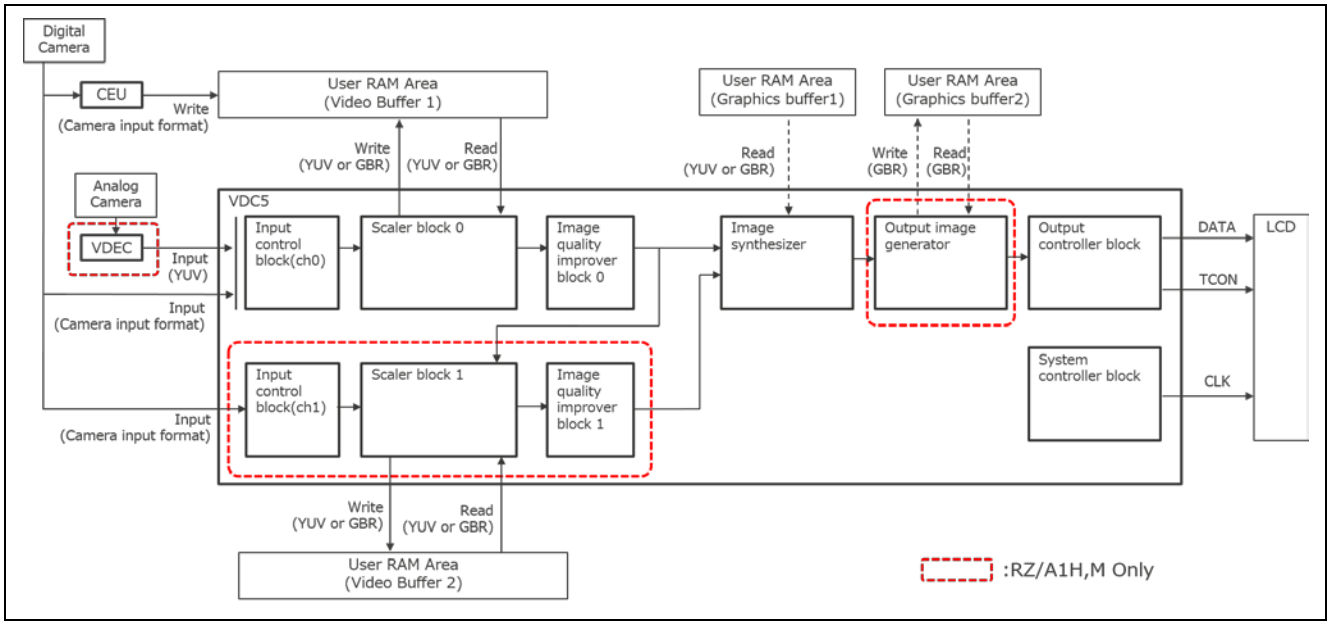


Figure 5.1 Block Diagram of the H/W Configuration for RZ/A1 Image Input/Output

Table 5-1 Functionalities of the VDC5 Blocks

Block	Functionality
Input control block (ch0)	Captures an image from the VDEC or digital camera. Converts the format through a color matrix and adjusts brightness/contrast. Adjusts contrast with the DRC (see Note 1).
Scaler block 0	Writes/reads an image (YCbCr or RGB) to/from the RAM after format conversion. Performs zoom in/out.(see Note 4) Performs rotation/horizontal inversion. Adjusts distortions with the IMR-LS2 (see Note 1).
Image quality improver block 0	Improves sharpness.
Image synthesizer	Synthesizes camera images and graphics data stored in the RAM.
Output image generator (Note 1)	Writes/reads graphics data (only RGB) to/from the RAM after synthesization (see Note 2). Adjusts distortions with the IMR-LS2.
Output controller block	Outputs the DATA and TCON signals to the LCD. Performs brightness/contrast adjustment, gamma adjustment, and dithering.
System controller block	Outputs the panel clock signal.
Input control block (ch1) (Note 1)(Note 3)	Captures an image from the digital camera. Converts the format through a color matrix and adjusts brightness/contrast.
Scaler block 1 (Note 1)(Note 3)	Functions the same as scaler block 0 (except that it performs zoom in differently than scaler block 0).
Image quality improver block 1 (Note 1)(Note 3)	Functions the same as image quality improver 0.

[Note 1] This functionality is only provided by the RZ/A1H and RZ/A1M.
[Note 2] This sample code unsupported the RAM read/write functionality of the output image generator.
[Note 3] This functionality is unavailable in this sample program. (It is available in ch0 only).
[Note 4] This sample code unsupported zoom in/out of VDC5.

5.2 Brightness

The user can adjust brightness of the entire screen. The user can make a dark area on the screen lighter and a light area on the screen lighter.

The user can adjust brightness with the input control block (ch0) and output controller block of this sample program. If the user adjusts brightness with the input control block (ch0), then the brightness-adjusted image data is stored in the RAM, and the user can use the adjusted images stored in the RAM. If the user adjusts brightness with the output controller block, then the brightness-adjusted data is not stored in the RAM. It is only reflected in the display panel.

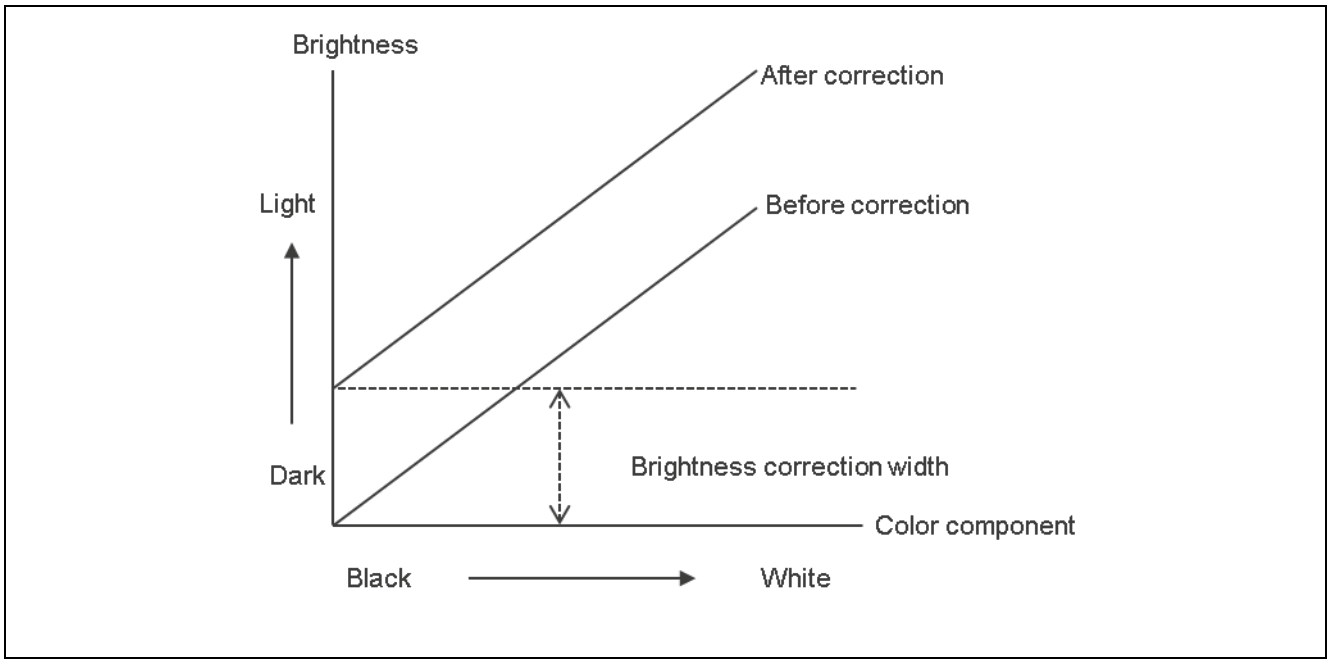


Figure 5.2 Effects of Brightness Adjustment

5.2.1 Preset Values

This sample program provides the values listed in Table 5-2 as preset values of brightness. The user can select a preset value for each adjustment block. The user can adjust brightness with the input control block (ch0) and output controller block.

Table 5-2 Preset Values of Brightness

Adjustment block	Preset value	Description
Input control block (ch0)	High	Makes the entire screen lighter.
	Middle	Makes the entire screen a little bit lighter.
	Low	Makes the entire screen darker.
Output controller block	High	Makes the entire screen lighter.
	Middle	Makes the entire screen a little bit lighter.
	Low	Makes the entire screen darker.

5.2.2 Custom Settings

With this sample program, the user can configure custom settings for brightness adjustment. Table 5-3 lists target register information.

Table 5-3 Custom Settings for Brightness Adjustment

Adjustment block	Target register	Target bit	Initial value	Setting range	Remarks
Input control block (ch0)	IMGCNT_MTX_YG_ADJ0	IMGCNT_MTX_YG [7:0]	128	0 to 255	Increasing the value makes the screen lighter.
Output controller block	OUT_BRIGHT1	PBRT_G[9:0]	512	0 to 1023	Increasing the value makes the screen lighter. For brightness adjustment, set the three values equal to each other.
	OUT_BRIGHT2	PBRT_B[9:0]	512	0 to 1023	
	OUT_BRIGHT2	PBRT_R[9:0]	512	0 to 1023	

5.3 Contrast

By increasing the adjustment factor, the user can leave a dark part of the screen as it is and make a light part of the screen lighter, emphasizing contrast.

The user can adjust contrast with the input control block (ch0) and output controller block of this sample program. If the user adjusts contrast with the input control block (ch0), then the contrast-adjusted image data is stored in the RAM, and the user can use the adjusted images stored in the RAM. If the user adjusts contrast with the output controller block, then the contrast-adjusted data is not stored in the RAM. It is only reflected in the display panel.

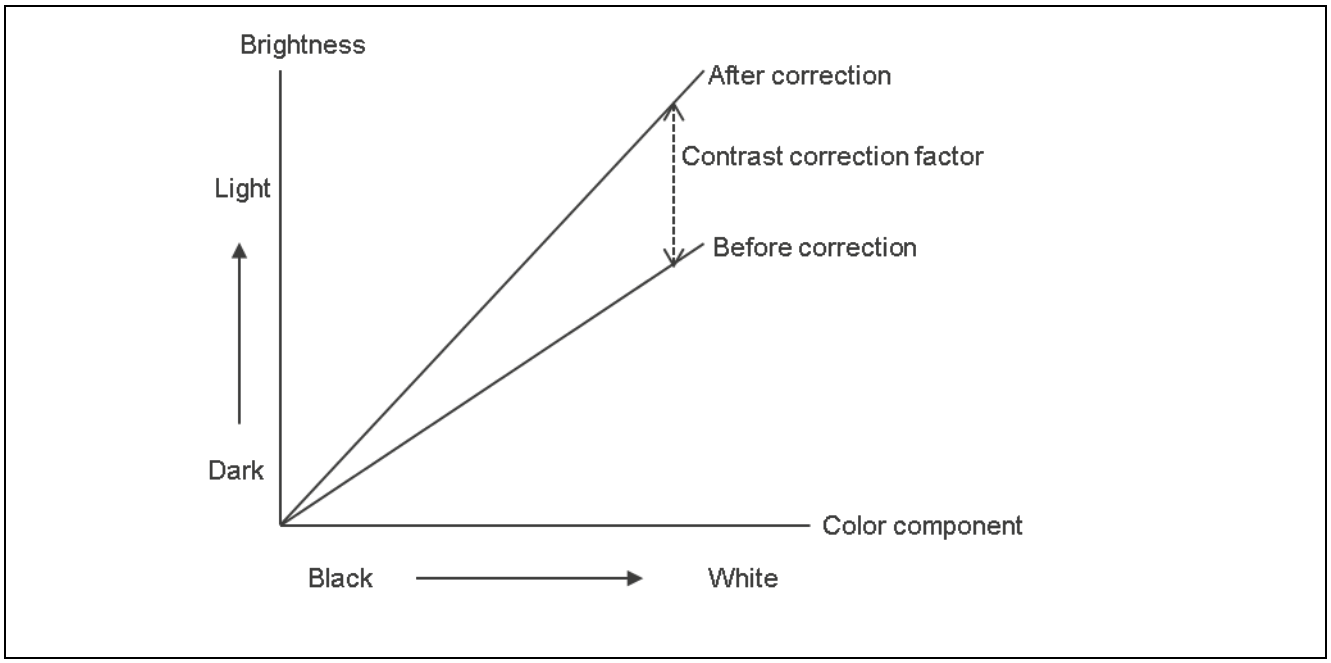


Figure 5.3 Effects of Contrast Adjustment

5.3.1 Preset Values

This sample program provides the values listed in Table 5-4 as preset values of contrast. The user can select a preset value for each adjustment block. The user can adjust contrast with the input control block (ch0) and output controller block.

Table 5-4 Preset Values of Contrast

Adjustment block	Preset value	Description
Input control block (ch0)	High	Emphasizes the light and shade in the entire screen.
	Middle	Slightly emphasizes the light and shade in the entire screen.
	Low	Deemphasizes the light and shade in the entire screen.
Output controller block	High	Emphasizes the light and shade in the entire screen.
	Middle	Slightly emphasizes the light and shade in the entire screen.
	Low	Deemphasizes the light and shade in the entire screen.

5.3.2 Custom Settings

With this sample program, the user can configure custom settings for contrast adjustment. Table 5-5 lists target register information.

Table 5-5 Custom Settings for Contrast Adjustment

Adjustment block	Target register	Target bit	Initial value	Setting range	Remarks
Input control block (ch0)	IMGCNT_MTX_YG_ADJ0	IMGCNT_MTX_GG[10:0]	256	-1024 to 1023	Increasing the value places greater emphasis on the contrasts of light and shade.
Output controller block	OUT_CONTRAST-	CONT_G[7:0]	128	0 to 255	Increasing the value places greater emphasis on the contrasts of light and shade. For contrast adjustment, set the three values equal to each other.
	OUT_CONTRAST-	CONT_B[7:0]	128	0 to 255	
	OUT_CONTRAST-	CONT_R[7:0]	128	0 to 255	

5.4 Sharpness

By increasing the brightness difference between adjacent pixels (LTI adjustment) and improving the brightness overshoot and undershoot (sharpness), the user can emphasize the contour.

With this sample program, the user can adjust sharpness by using the image quality improver block. Sharpness-adjusted data is not stored in the RAM. It is only reflected in the display panel.

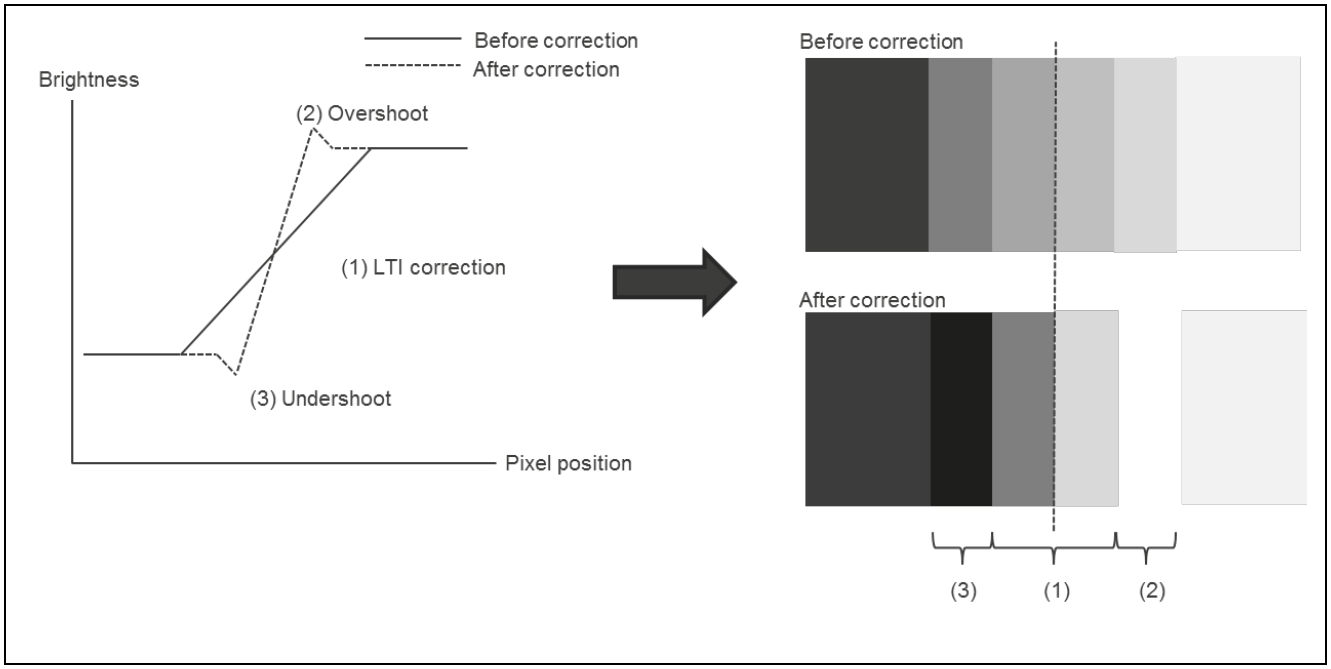


Figure 5.4 Effects of Sharpness Adjustment

5.4.1 Preset Values

This sample program provides the values listed in Table 5-6 as preset values of sharpness.

Table 5-6 Preset Values of Sharpness

Adjustment block	Preset value	Description
Image quality improver block	Strong	Puts maximum emphasis on the contour.
	Semi-strong	Puts medium emphasis on the contour.
	Weak	Puts minimum emphasis on the contour.

5.4.2 Custom Settings

With this sample program, the user can configure custom settings for sharpness adjustment. Table 5-7, Table 5-8, and Table 5-9 list target register information.

Table 5-7 Custom Settings for Sharpness Adjustment (1/3)

Adjustment block	Target register	Target bit	Initial value	Setting range	Remarks
Image quality improver block	ADJ0_ENH_SHP1	SHP_H_ON	0	0 to 1	0: Sharpness ON 1: Sharpness OFF
	ADJ0_ENH_SHP1	SHP_H1_CORE [6:0]	0	0 to 127	Used to specify the range of available sharpness settings for the horizontal sharpness band (H1). The contour is emphasized when the edge amplitude value is greater than or equal to this setting.
	ADJ0_ENH_SHP2	SHP_H1_CLIP_O [7:0]	0	0 to 255	Used to adjust the clip value of overshoot for the horizontal sharpness band (H1).
	ADJ0_ENH_SHP2	SHP_H1_CLIP_U [7:0]	0	0 to 255	Used to adjust the clip value of undershoot for the horizontal sharpness band (H1).
	ADJ0_ENH_SHP2	SHP_H1_GAIN_O [7:0]	0	0 to 255	Gain value for the edge amplitude value of overshoot for the horizontal sharpness band (H1). 0 (0x) - 64 (+1x) - 255 (+4x)
	ADJ0_ENH_SHP2	SHP_H1_GAIN_U [7:0]	0	0 to 255	Gain value for the edge amplitude value of undershoot for the horizontal sharpness band (H1). 0 (0x) - 64 (+1x) - 255 (+4x)
	ADJ0_ENH_SHP3	SHP_H2_LPF_SEL	0	0 to 1	LPF settings for the horizontal sharpness band (H2) 0: LPF not present 1: LPF present
	ADJ0_ENH_SHP3	SHP_H2_CORE [6:0]	0	0 to 127	Used to specify the range of available sharpness settings for the horizontal sharpness band (H2). The contour is emphasized when the edge amplitude value is greater than or equal to this setting.
	ADJ0_ENH_SHP4	SHP_H2_CLIP_O [7:0]	0	0 to 255	Used to adjust the clip value of overshoot for the horizontal sharpness band (H2).

Table 5-8 Custom Settings for Sharpness Adjustment (2/3)

Adjustment block	Target register	Target bit	Initial value	Setting range	Remarks
Image quality improver block	ADJ0_ENH_SHP4	SHP_H2_CLIP_U [7:0]	0	0 to 255	Used to adjust the clip value of undershoot for the horizontal sharpness band (H2).
	ADJ0_ENH_SHP4	SHP_H2_GAIN_O [7:0]	0	0 to 255	Gain value for the edge amplitude value of overshoot for the horizontal sharpness band (H2) 0 (0x) - 64 (+1x) - 255 (+4x)
	ADJ0_ENH_SHP4	SHP_H2_GAIN_U [7:0]	0	0 to 255	Gain value for the edge amplitude value of undershoot for the horizontal sharpness band (H2) 0 (0x) - 64 (+1x) - 255 (+4x)
	ADJ0_ENH_SHP5	SHP_H3_CORE [6:0]	0	0 to 127	Used to specify the range of available sharpness settings for the horizontal sharpness band (H3) The contour is emphasized when the edge amplitude value is greater than or equal to this setting.
	ADJ0_ENH_SHP6	SHP_H3_CLIP_O [7:0]	0	0 to 255	Used to adjust the clip value of overshoot for the horizontal sharpness band (H3)
	ADJ0_ENH_SHP6	SHP_H3_CLIP_U [7:0]	0	0 to 255	Used to adjust the clip value of undershoot for the horizontal sharpness band (H3)
	ADJ0_ENH_SHP6	SHP_H3_GAIN_O [7:0]	0	0 to 255	Gain value for the edge amplitude value of overshoot for the horizontal sharpness band (H3) 0 (0x) - 64 (+1x) - 255 (+4x)
	ADJ0_ENH_SHP6	SHP_H3_GAIN_U [7:0]	0	0 to 255	Gain value for the edge amplitude value of undershoot for the horizontal sharpness band (H3) 0 (0x) - 64 (+1x) - 255 (+4x)
	ADJ0_ENH_LTI1	LTI_H_ON	0	0 to 1	0: LTI ON 1: LTI OFF
	ADJ0_ENH_LTI1	LTI_H2_LPF_SEL	0	0 to 1	LPF settings for the horizontal LTI (H2) band 0: LPF present 1: LPF not present

Table 5-9 Custom Settings for Sharpness Adjustment (3/3)

Adjustment block	Target register	Target bit	Initial value	Setting range	Remarks
Image quality improver block	ADJ0_ENH_LTI1	LTI_H2_INC_ZERO [7:0]	10	0 to 255	LTI adjustment threshold value for the median filter (for noise elimination). LTI is not adjusted if the frequency difference from the adjacent pixel is less than or equal to this setting.
	ADJ0_ENH_LTI1	LTI_H2_GAIN [7:0]	0	0 to 255	Gain value for the edge amplitude value of the LTI for the horizontal LTI (H2) band. 0 (0x) - 64 (+1x) - 255 (+4x)
	ADJ0_ENH_LTI1	LTI_H2_CORE [7:0]	0	0 to 255	Coring for the LTI for the horizontal LTI (H2) band. Coring is processed for amplitudes which are less than or equal to this setting.
	ADJ0_ENH_LTI2	LTI_H4_MEDIAN_TAP_SEL	0	0 to 1	Used to select a reference pixel for the median filter (for noise elimination) for the horizontal LTI (H4) band. 0: References the second adjacent pixel. 1: References the first adjacent pixel.
	ADJ0_ENH_LTI2	LTI_H4_INC_ZERO [7:0]	10	0 to 255	Adjustment threshold setting for median filter (for noise elimination) for the horizontal LTI (H4) band.
	ADJ0_ENH_LTI2	LTI_H4_GAIN [7:0]	0	0 to 255	Gain value for the edge amplitude value of the LTI for the horizontal LTI (H4) band. 0 (0x) - 64 (+1x) - 255 (+4x)
	ADJ0_ENH_LTI2	LTI_H4_CORE [7:0]	0	0 to 255	Coring for the LTI for the horizontal LTI (H4) band. Coring is processed for amplitudes which are less than or equal to this setting.

5.5 Gamma Adjustment

This sample program can apply gamma adjustments shown in Figure 5.5 to 256-tone input signals. The output control block makes gamma adjustments, and the results are only reflected in the display panel.

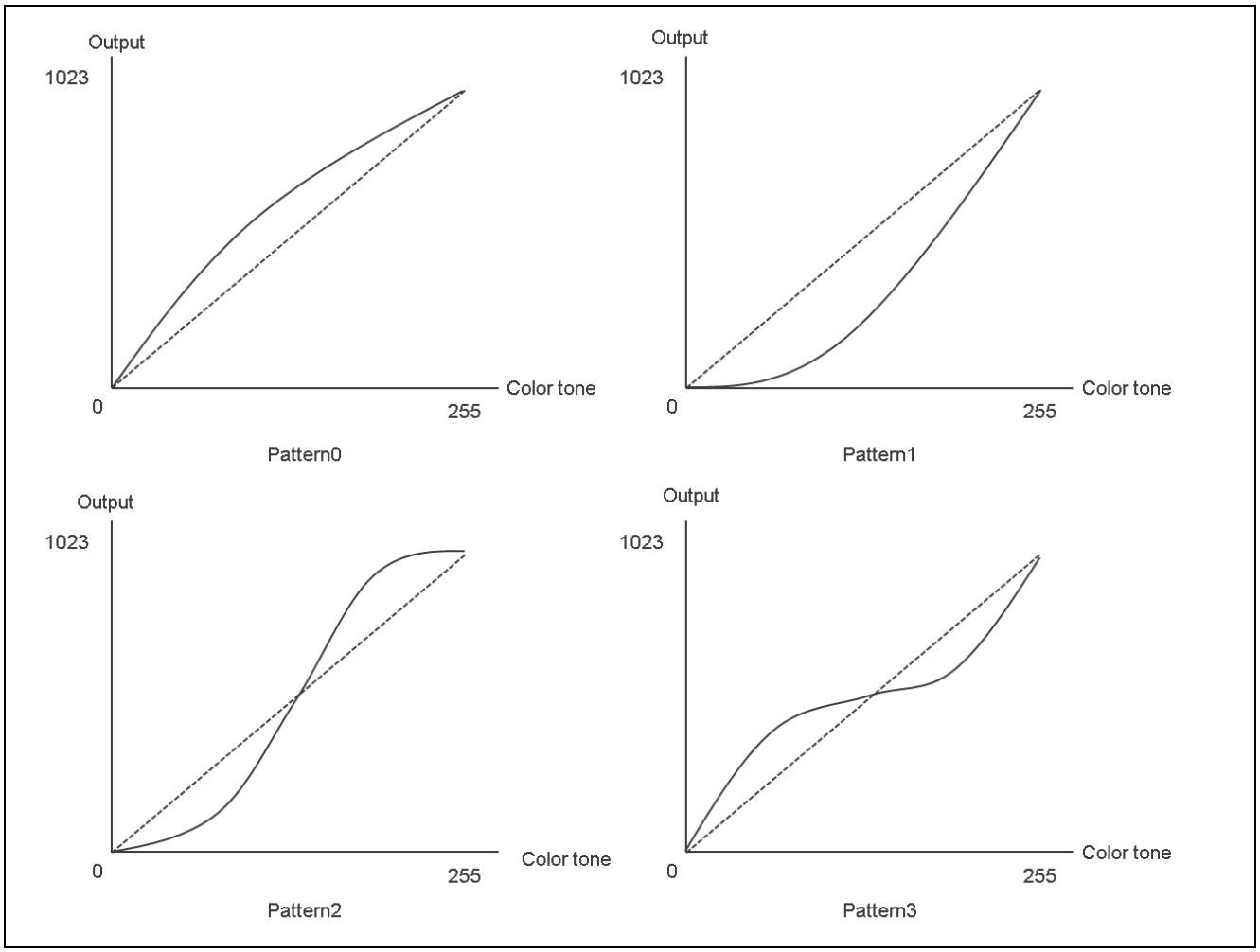


Figure 5.5 Gamma Adjustments Which Can Be Applied by This sample program

5.5.1 Preset Values

This sample program provides the values listed in Table 5-10 as preset values for gamma adjustments.

Table 5-10 Preset Values for Gamma Adjustments

Adjustment block	Preset value	Description
Output controller block	Pattern0	Gamma adjustment with γ=0.81. Makes the entire screen slightly lighter (see Note).
	Pattern1	Gamma adjustment with γ=1.98. Makes the entire screen slightly darker (see Note).
	Pattern2	Gamma adjustment with an S-shaped curve. Slightly increases contrast.
	Pattern3	Gamma adjustment with an inverse S-shaped curve. Slightly decreases contrast.

Note: Maximum and minimum values which can be set with the RZ/A1.

5.5.2 Custom Settings

This sample program does not support custom settings for gamma adjustments.

5.6 Dithering Process

Dithering process can prevent color banding. Color banding occurs if the number of bits for processing images with the RZ/A1 exceeds that of bits output to the display panel.

If, for example, image data processed in the RGB888 (24-bit) format is output in the RGB565 (16-bit) format, then the number of tones which can be expressed is reduced. As a result, a smooth gradation pattern might look like a striped pattern. This problem is called color banding. It can be fixed by dithering.

Note that if the number of bits for processing images with the RZ/A1 is less than or equal to that of bits output to the display panel, then dithering is ineffective.

5.6.1 Preset Values

This sample program provides the mode values listed in Table 5-11 as preset values for dithering.

Table 5-11 Preset Values for Dithering

Adjustment block	Preset value	Description
Output control block	Cutoff	Cutoff mode. Truncates the fractional part of the calculation result for bit degeneration.
	Round off	Roundoff mode. Rounds the calculation result to the nearest integer for bit degeneration.
	2x2 Pattern Dither	2x2 pattern dither. Adds a pattern value to the figure in the first decimal place and truncates the fractional part of the result for bit degeneration.
	Random Pattern Dither	Random pattern dither. Adds a random pattern value to the figure in the first decimal place and truncates the fractional part of the result for bit degeneration.

5.6.2 Custom Settings

This sample program does not support custom settings for dithering.

5.7 Rotation and Horizontal Mirroring

Rotation and horizontal mirroring are processed by “scaler block 0” of VDC5 and output the processing result to buffer of camera input (refer to “User RAM Area (Video Buffer 1)” in Figure 5.1).

Rotation and horizontal mirroring are not able to use at same time. The possible values are shown in Table 5-13. In case of set 90 degrees rotation or 270 degrees rotation, need to change size of buffer of camera input because vertical and horizontal of image will change. And this function unusable in the case of camera input with CEU.

5.7.1 Preset Values

This sample program provides the mode values listed in Table 5-12 as preset values for rotation and horizontal mirroring.

Table 5-12 Preset Values for Dithering

Adjustment block	Preset value	Description
Scaler block 0	Horizontal Mirroring ON	Horizontal mirroring
	Rotation (180 Degrees)	180 degrees Rotation

5.7.2 Custom Settings

With this sample program, the user can configure custom settings for rotation and horizontal mirroring. Table 5-13 lists target register information.

Table 5-13 Custom Settings for Brightness Adjustment

Adjustment block	Target register	Target bit	Initial value	Setting range	Remarks
Scaler block 0	SC0_SCL1_WR1	SC0_RES_DS_WR_MD[2:0]	0	0 to 4	0: Normal 1: Horizontal mirroring 2: 90 degrees rotation (Note 1) 3: 180 degrees rotation 4: 270 degrees rotation (Note 1)

Note 1. Need to change buffer size for camera input if use “90 degrees rotation” or “270 degrees rotation” setting.

6. Using the Sample Program and QE (only when using e2 studio)

Only if you use e2 studio, this sample program can be linked with the development support tool QE for RZ/A display and Camera. QE is a plugin of the integrated development environment e2 studio. “QE for Display” can adjust the timing of the LCD panel with GUI. The timing setting value adjusted with QE for Display can be output as a header file, and by replacing it with the header file of this sample program, the setting value in the GUI can be used as initial settings of this sample program (similarly for “QE for Camera”). “QE for Camera” can set camera module via RIIC command and set camera device parameters. Mainly, the procedure for applying the result adjusted by QE for Display to this sample program is described in this section.

For instructions for installing e2 studio and QE for Display or QE for Camera, refer to the manuals of each of these tools.

- Product page

QE for Display : https://www.renesas.com/qe-display

QE for Camera : https://www.renesas.com/qe-camera

6.1 Launching QE for Display

From the e2 studio menu select **Renesas Views → Renesas QE → Camera/Display Tuning RZ(QE)** to launch QE for Display. At first, please change the setting **Maker/Type** and **Device** which placed in Block Image tag like Figure 6.1 .

The block diagram shown in Figure 6.1 indicates H/W block diagram of VDC5 and user can make out the image data flow between camera input and display output. Also, user can make out the positional relationship of various image correction.

Various image correction can be adjusted after clicking some image correction button such as Brightness, Contrast, Sharpness, and so on. The tab will move to “Image Quality Adjustment” tab after clicking image correction buttons. For detail of the way of image adjustment, please refer to Section 6.5.2.

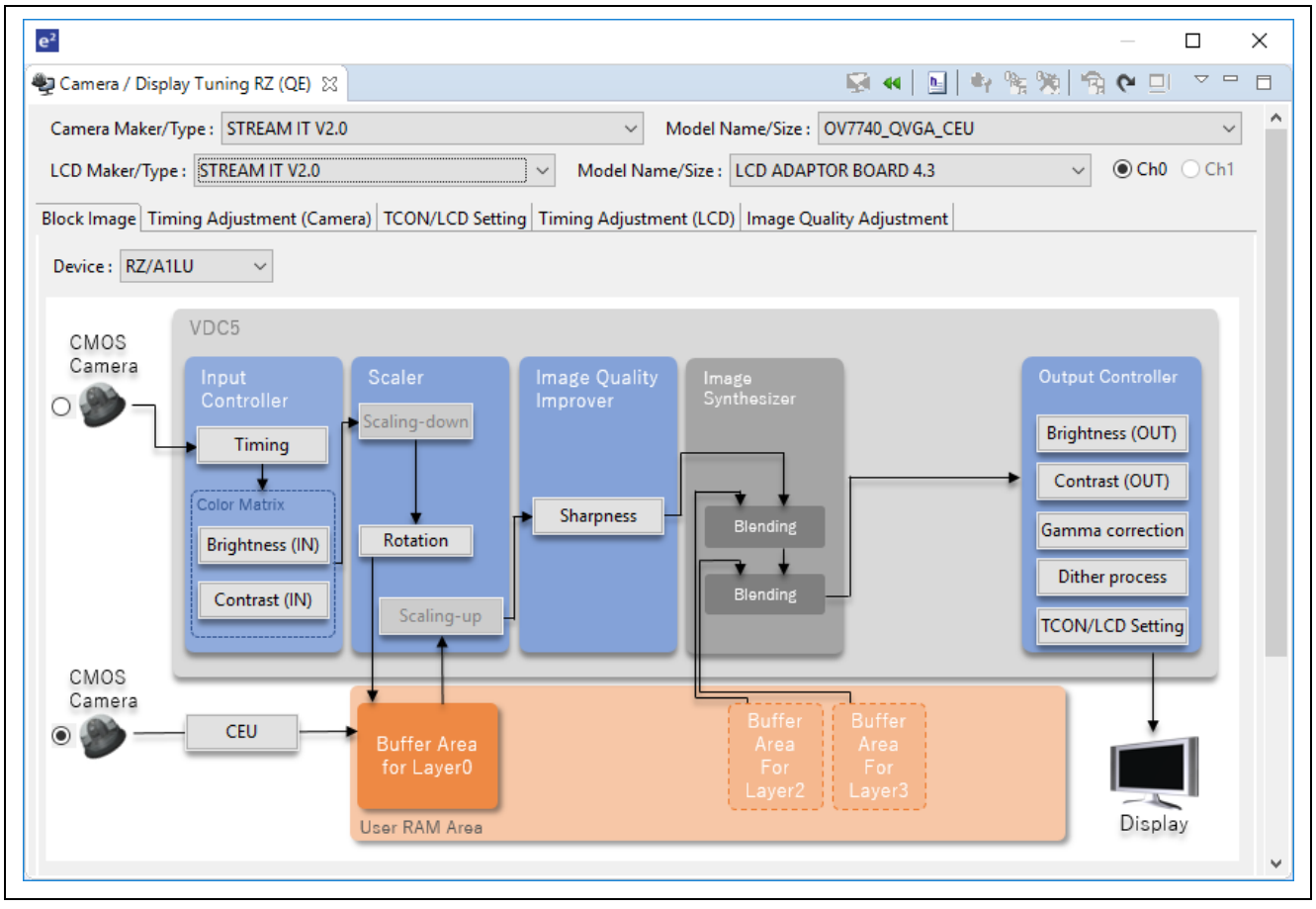


Figure 6.1 QE for Display Launch Screen

6.2 Display Device Information Settings

Select **Custom** from the **Maker/Type** pull-down list at the top of the dialog box shown in Figure 6.1 to display the **Edit Custom Display Data** dialog box (Figure 6.2). The display device information should be input into this dialog box.

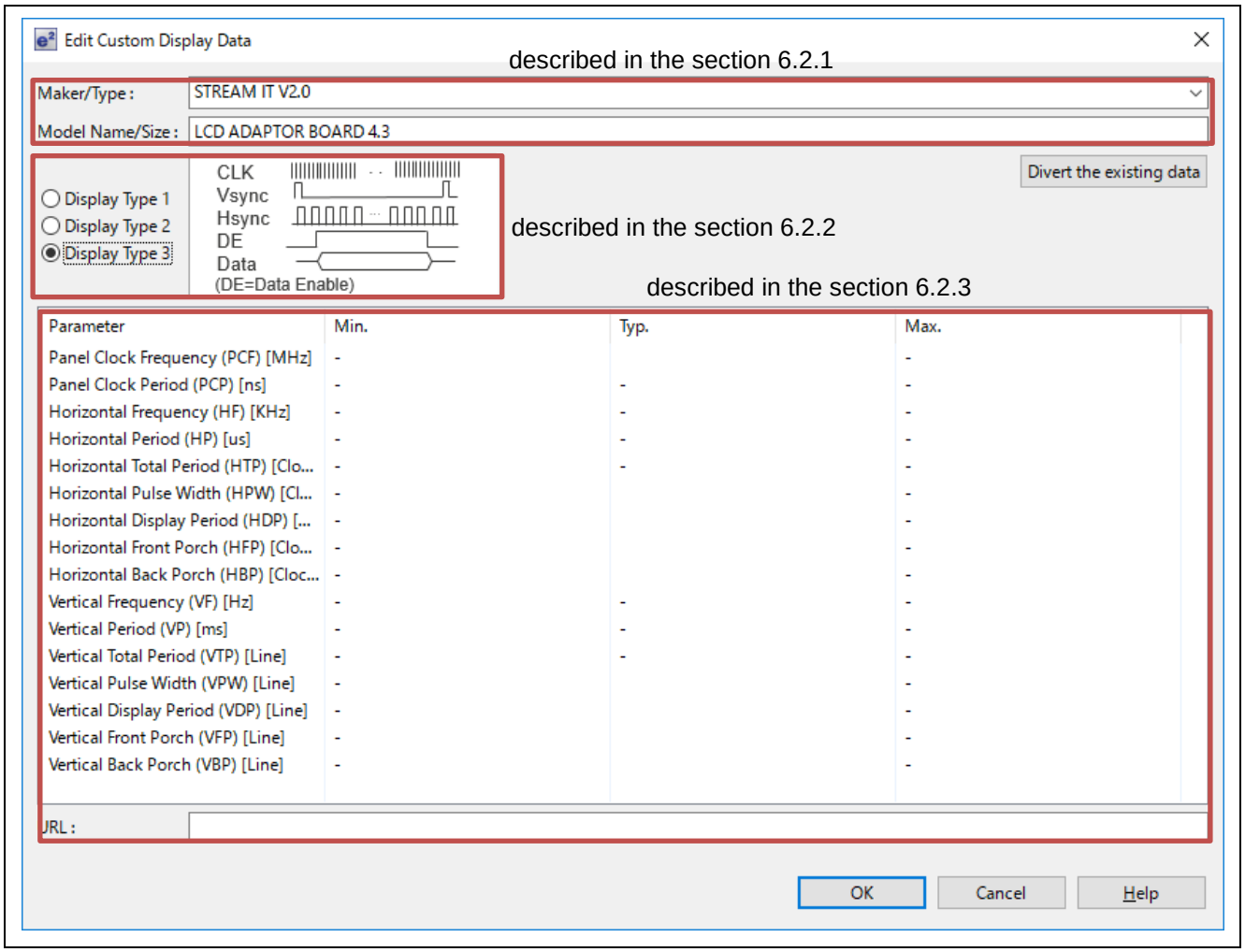


Figure 6.2 Edit Custom Display Data Dialog Box

6.2.1 Entering a Registered Name

Enter any name you wish in the **Maker/Type** and Model/Size fields of the **Edit Custom Display Data** dialog box (Figure 6.3). This name will be registered in the drop-down list and will become selectable.

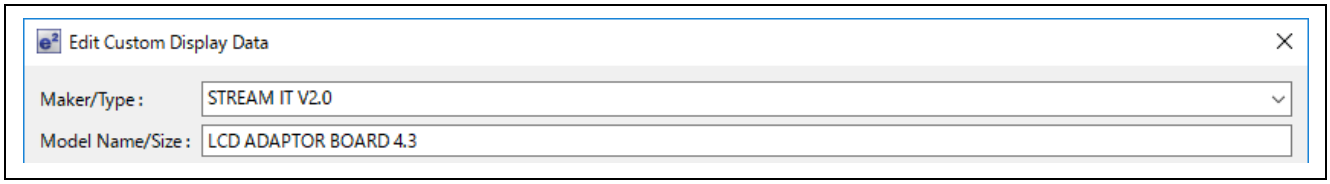


Figure 6.3 Name Registration

6.2.2 Selecting the Display Type

Table 6.1 lists the main control signals required when connecting a display device. In the present case, three display device types combining these control signals are supported by QE for Display.

Table 6.1 Main Control Signals

Name	Function Summary
Horizontal sync signal (Hsync)	Signal that creates timing for displaying one line
Vertical sync signal (Vsync)	Signal that creates timing for displaying one screen
Panel clock (CLK)	Signal that use to sample for displaying one pixel.
Display enable (DE)	Signal indicating that valid data is being output
Data (Data)	Display data

The user must select from the three display types listed in Table 6.2 to determine which control signals are required by the specifications of the display device used.

Table 6.2 Control Signals Used

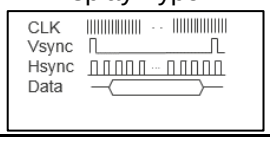
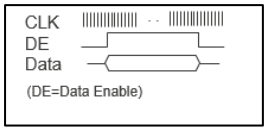
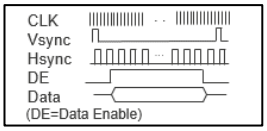
Name	Display Type 1 	Display Type 2 	Display Type 3 
Horizontal sync signal (Hsync)	Used	Not used	Used
Vertical sync signal (Vsync)	Used	Not used	Used
Panel clock (CLK)	Used	Used	Used
Display enable (DE)	Not used	Used	Used
Data (Data)	Used	Used	Used

Figure 6.4 and Figure 6.5 show horizontal and vertical input timing charts for the LCD ADAPTOR BOARD 4.3 of STREAM IT V2.0. The horizontal sync (Hsync) signal, vertical sync (Vsync) signal, and display enable (DE) signal shown in these timing charts are required, so select display type 3 (Figure 6.6).

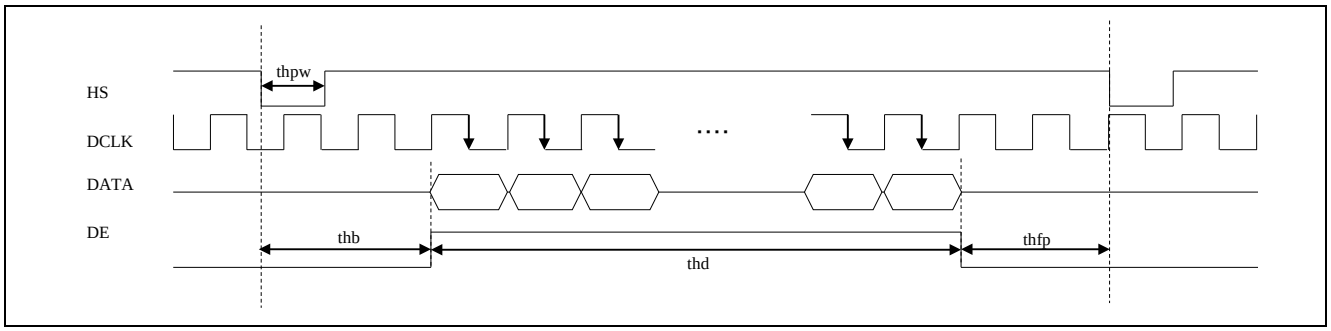


Figure 6.4 Horizontal Input Timing Diagram

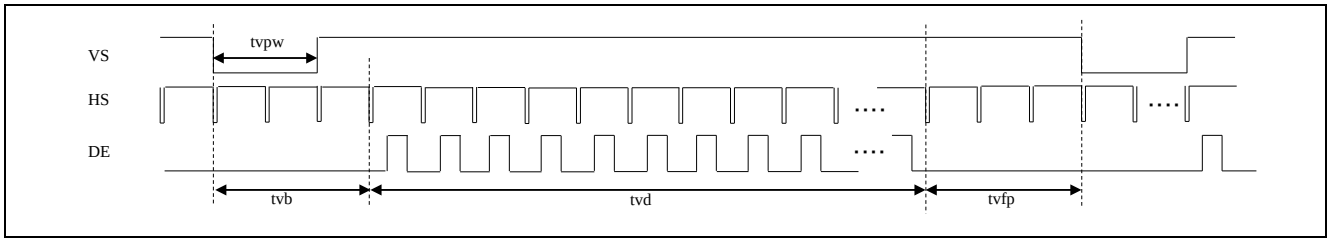


Figure 6.5 Vertical Input Timing Diagram

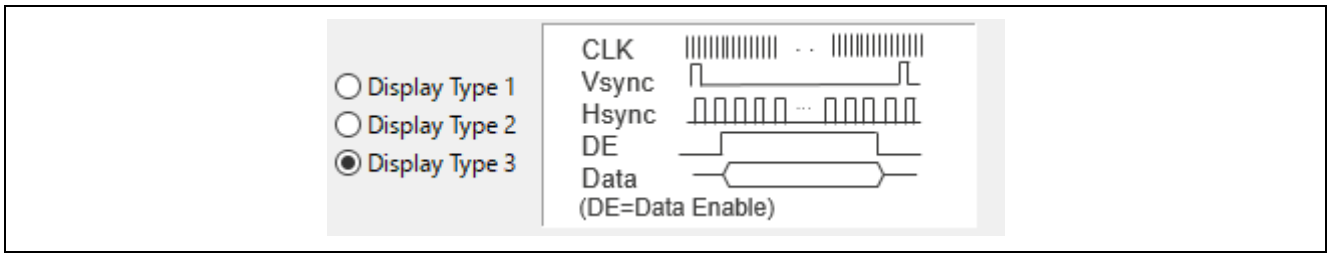


Figure 6.6 Display Type Selection

6.2.3 Inputting Control Timing Values

Figure 6.4 and Figure 6.5 show horizontal and vertical input timing charts for the LCD ADAPTOR BOARD 4.3 of STREAM IT V2.0 used in the present case. Table 6.3 and Table 6.4 list the input timing of the horizontal and vertical sync signals. After inputting these control timing values, the result is as shown in Figure 6.7. The values input under **Typ** are used for timing control, and the values input under **Min** and **Max** are used to confirm that values are within the allowable range when the GUI is used for timing adjustment in QE for Display.

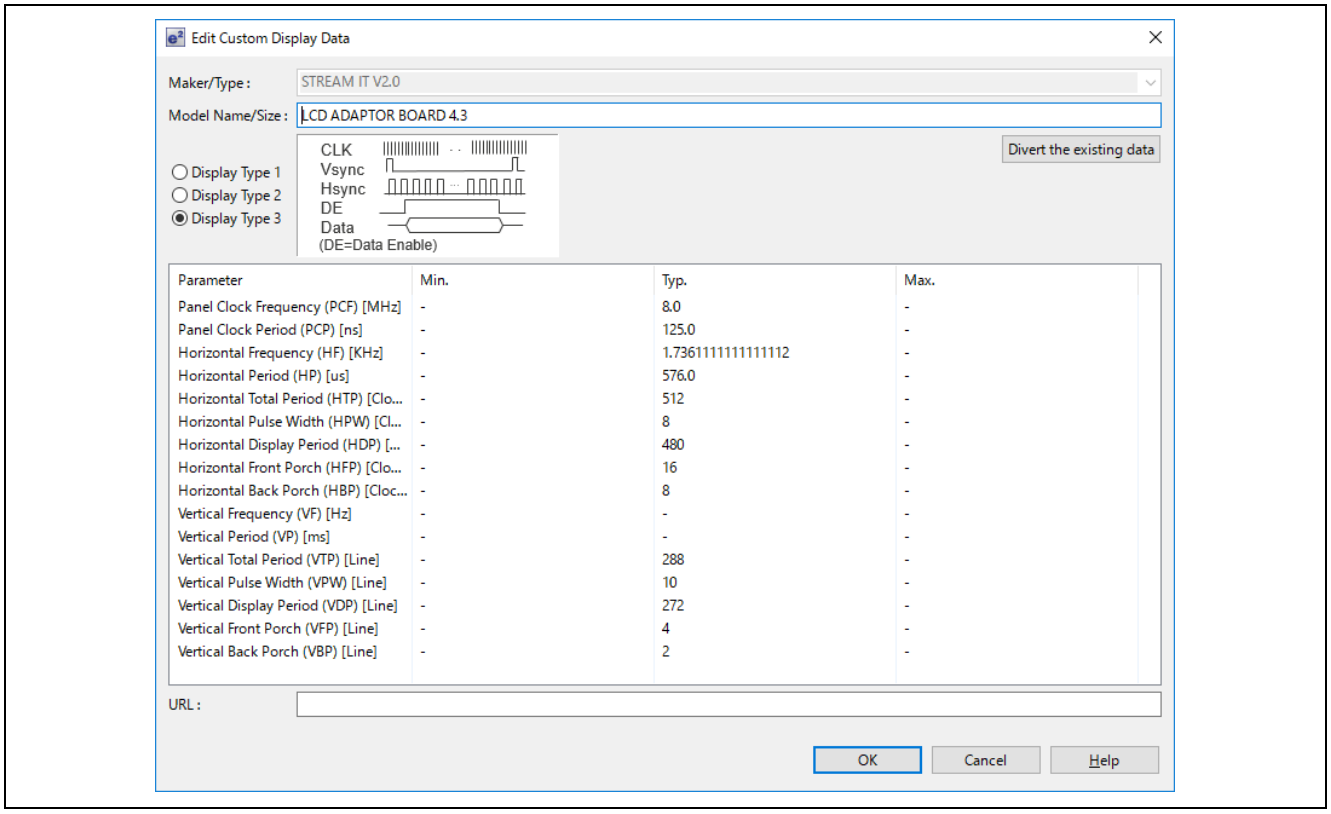


Figure 6.7 Result Inputting Control Timing Values

Refer to Table 6.3 when inputting the following items:

- Panel Clock Frequency
- Horizontal Total Period
- Horizontal Pulse Width
- Horizontal Display Period
- Horizontal Front Porch
- Horizontal Back Porch

Refer to Table 6.4 when inputting the following items:

- Vertical Total Period
- Vertical Pulse Width
- Vertical Display Period
- Vertical Front Porch
- Vertical Back Porch

Note: In Figure 6.7 the **Typ** values for Horizontal Pulse Width and Vertical Pulse Width are midway between the **Min** and **Max** values. Also, the values listed in Table 6.3 and Table 6.4 should be input for HS Blanking and VS Blanking, but since these HS Blanking and VS Blanking values include the HS pulse width and VS pulse width, respectively, the **Typ** values for Horizontal Pulse Width and Vertical Pulse Width are subtracted and the resulting values are input as the **Typ** values for Horizontal Back Porch and Vertical Back Porch, respectively.

Table 6.3 Horizontal Input Timing

Item	Symbol	Value			Unit
		Min.	Typ.	Max.	
Horizontal display area	thd	—	480	—	DCLK
DCLK frequency	fclk	—	8.0	—	MHz
One horizontal line	th	—	1056	—	DCLK
HS pulse width	thpw	—	8	—	DCLK
HS blanking	thb	—	8	—	DCLK
HS front porch	thpf	—	16	—	DCLK

Table 6.4 Vertical Input Timing

Item	Symbol	Value			Unit
		Min.	Typ.	Max.	
Vertical display area	tvd	—	288	—	TH
VS period time	Tv	—	272	—	TH
VS pulse width	tvpw	—	10	—	TH
VS blanking	tvb	—	2	—	TH
VS front porch	tvpf	—	4	—	TH

6.2.4 Control Signal Output Settings

Control signal output will be able to set after clicking the “TCON/LCD Setting” tab in QE for Display (Figure 6.8)

In this dialog box, make output settings for the control signals listed below.

[Panel driver signal (TCON) output selection]

- Output pin selection:
  Output to pins LCD_TCON0 to LCD_TCON6 (TCON0 to TCON6)
- Control signal polarity:
  Positive polarity (high active)
  Negative polarity (low active)

[LCD setting]

- Output data format selection:
  24-bit RGB888 output (24-bit (VDC5_LCD_OUTFORMAT_RGB888))
  18-bit RGB666 output (18-bit (VDC5_LCD_OUTFORMAT_RGB666))
  16-bit RGB565 output (16-bit (VDC5_LCD_OUTFORMAT_RGB565))
- Data output timing:
  Output at rising edge of panel clock (Rising (VDC5_EDGE_RISING))
  Output at falling edge of panel clock (Falling (VDC5_EFGE_FALLING))

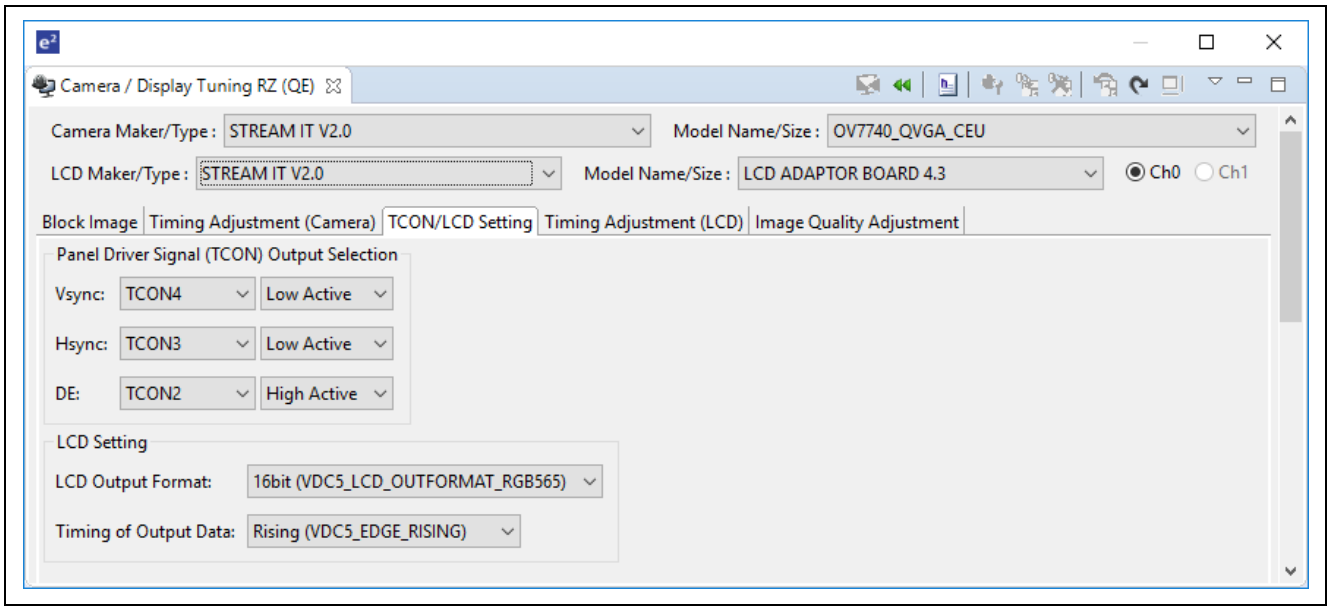


Figure 6.8 TCON and LCD Settings

The output pin selection items matching the specifications of the LCD ADAPTOR BOARD 4.3 of STREAM IT V2.0 used in the present case are listed below.

- Output pin selection
  - Vsync: TCON4
  - Hsync: TCON3
  - DE: TCON2

Based on Figure 6.4 and Figure 6.5, the polarity of the control signals is listed below.

- Polarity of the control signals
  - Vsync: Negative polarity (low active)
  - Hsync: Negative polarity (low active)
  - DE: Positive polarity (high active)

The output data format matching the board specifications is listed below.

- Output data format selection:
  16-bit RGB565 output (16-bit (VDC5_LCD_OUTFORMAT_RGB565))

Regarding the data output timing, since sampling occurs at the falling edge of the DCLK signal, according to Figure 6.4, the timing of data output on the VDC5 side is at the rising edge of the panel clock.

- Data output timing:
  Output at rising edge of panel clock (Rising (VDC5_EDGE_RISING))

This completes the display device information settings.

6.3 Generating a Header File for Timing Settings of Display

A header file reflecting the control timing settings can be generated by clicking the generate header file icon (Figure 6.9) in QE for Display.

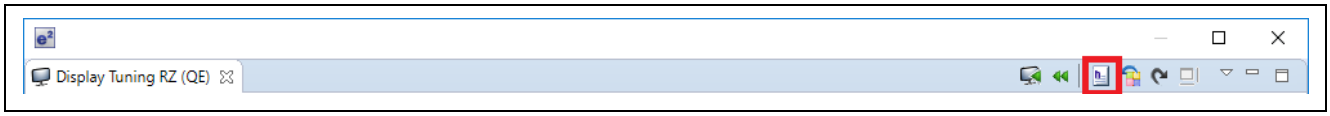


Figure 6.9 Generating a Header File icon

The header file will be generated by clicking “Generate” with checking only “For Timing and TCON Settings”. The header file name and output destination can be specified by the user.

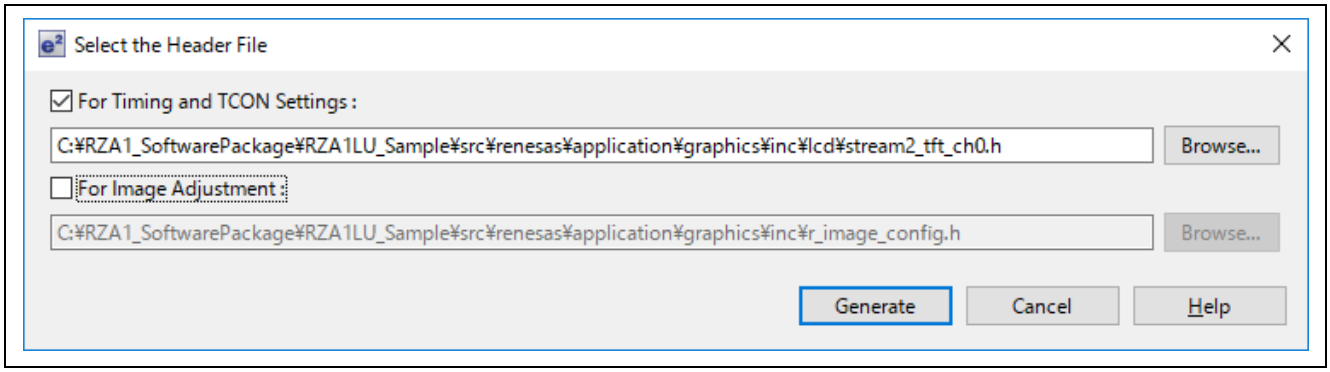


Figure 6.10 Generating a Header File for Timing and TCON Settings

The sample program references the generated header file and makes settings to VDC5. Save the header file using the folder name and file name shown below.

[Folder]

- (Top)RZA1LU_Sample\src\renesas\application\graphics\inc\lcd

[File name]

- In case of Stream it! RZ V2.0 : stream2_tft_ch0.h

6.4 Apply the Generated Header File

After setting the display device information on the "QE for Display" and outputting the header file, you can apply the generated header file with "clean" and "build" project.

6.5 Real-Time Adjustment Function Using QE for Display

6.5.1 Adjusting the Position of Display

After connecting the debugger and launching the sample program, you can alter the control signal timing by changing the setting values shown in Figure 6.11. Make adjustments while viewing the results on the connected display device, then re-output the header file. Please refer to Section 6.3 regarding the way of generating a header file.

In case of the adjustment value is indicated in red, it means the value outside VDC5 specifications. In this case, adjust so that become the value until within the specification of VDC5. The range of the value that the specification of VDC5 permits can be confirmed by pointing the mouse to the adjustment value indicated in red.

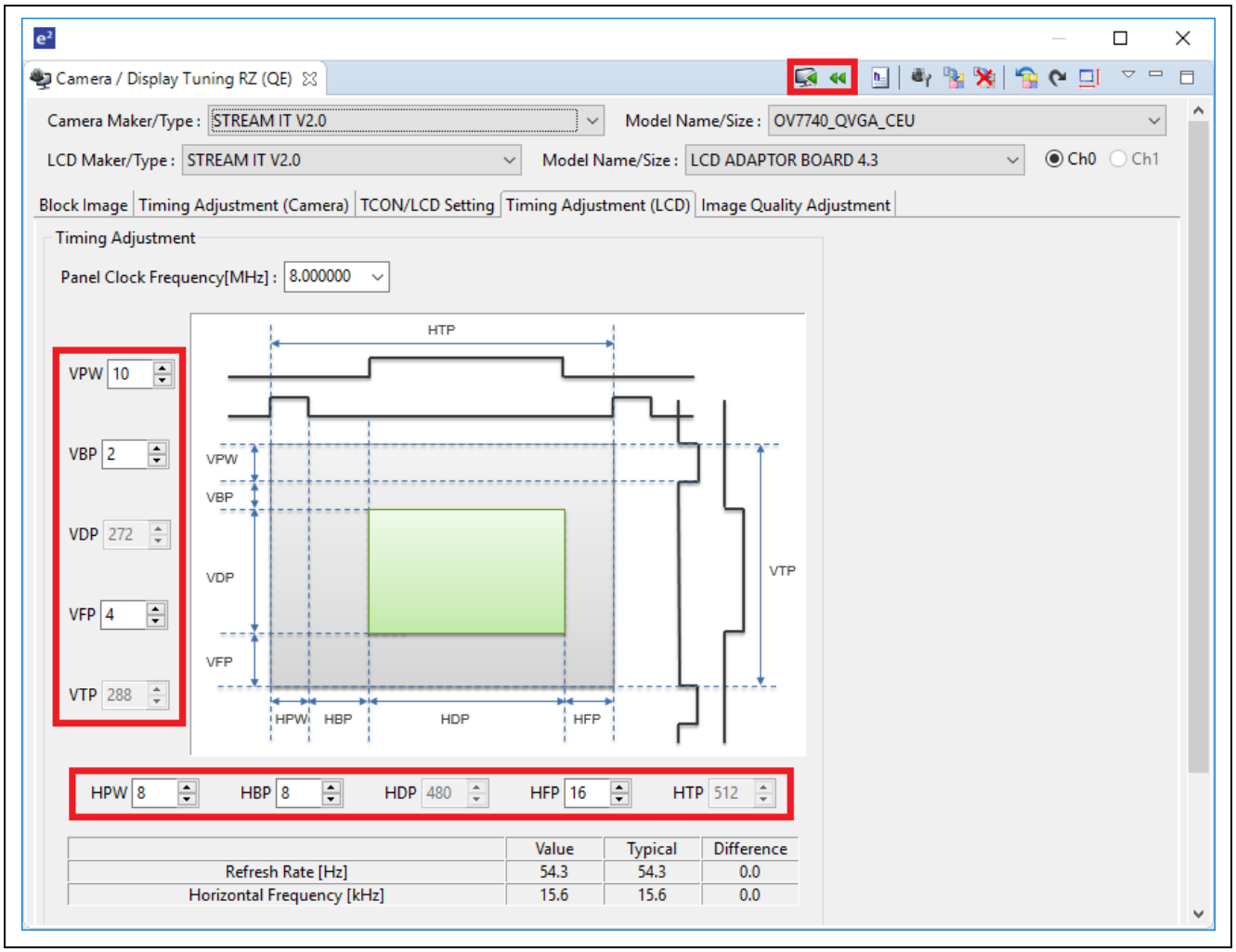


Figure 6.11 Debugging the Control Signal Timing

6.5.2 Various Image Quality Adjustment

(1) The way of Image Quality Adjustment

After connecting the debugger and launching the sample program, you can adjust various image adjustment by clicking on the image adjustment contents indicated by the red frame in Figure 6.12 of the "Select from Block Diagram" tab, you can switch to the image adjustment tab and adjust various images.

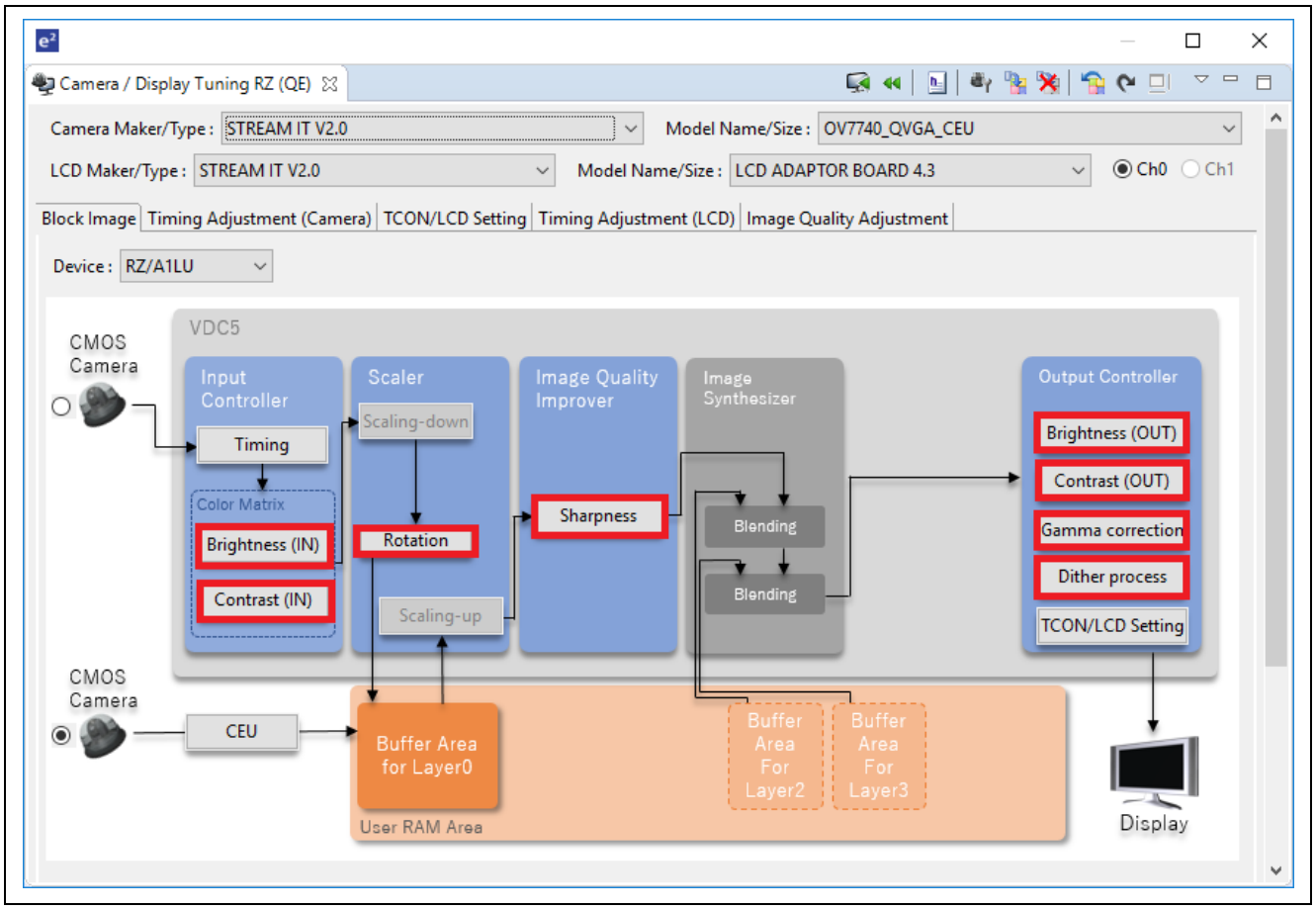


Figure 6.12 Selection of Image Quality Adjustment

You can adjust various image adjustment in “Image Quality Adjustment” tab. The image adjustment will be done with “Quick Setting” or “Custom”. In case of adjusting with “Custom”, please refer to the document “RZ/A1L Group, RZ/A1LU Group, RZ/A1LC Group User's Manual: Hardware (R01UH0437)” and confirm the setting contents and range of values that can be set, of each register.

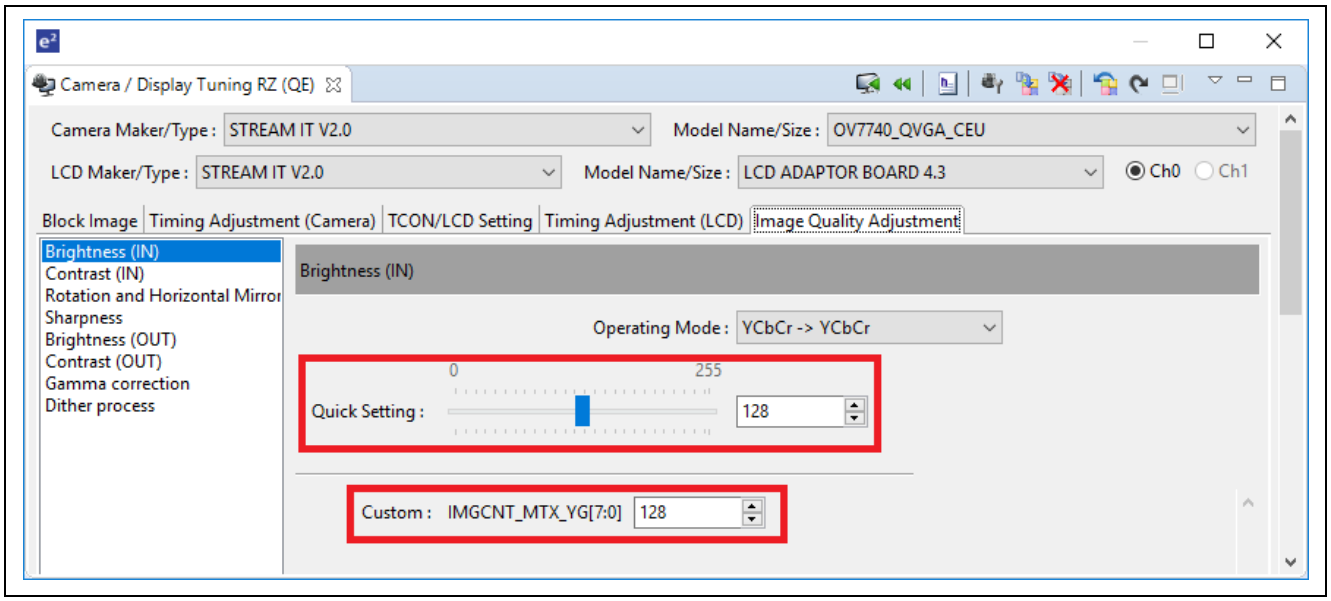


Figure 6.13 Image Quality Adjustment display

(2) Generating a Header File for Image Adjustment

A header file reflecting the control timing settings can be generated by clicking the generate header file icon (Figure 6.9) in QE for Display.

The header file will be generated by clicking “Generate” with checking only “For Image Adjustment”. The header file name and output destination can be specified by the user.

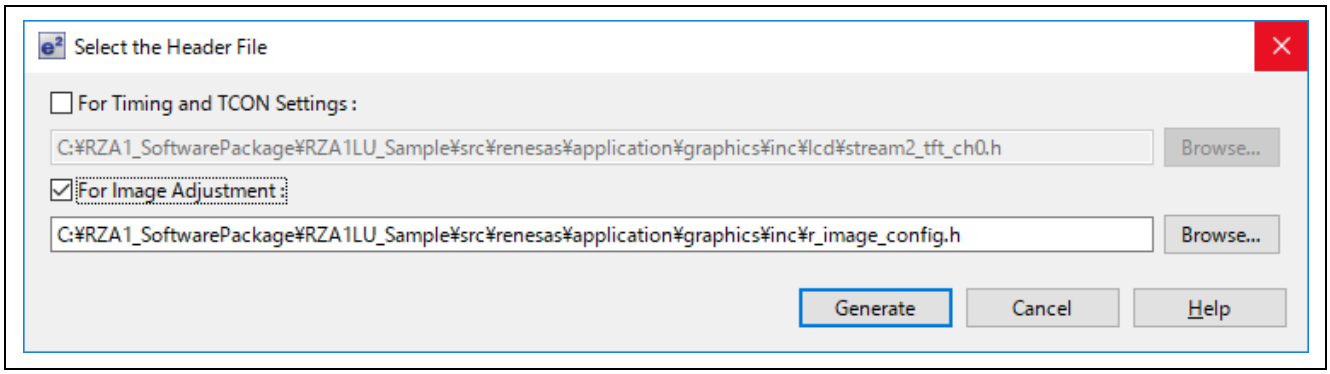


Figure 6.14 Generating a Header File for Image Adjustment

The sample program references the generated header file and makes image adjustment initialize settings to VDC5. Save the header file using the folder name and file name shown below.

[Folder]

- (Top)RZA1LU_Sample\src\renesas\application\graphics\inc

[File name]

- r_image_config.h

6.6 Image Download Function of QE for Display

User can use the image download function of QE for Display to display any image you wish. To download image data with this sample, please break once on the debugger and then download the image in the following procedure. The place to insert a break is as follow.

[Folder]

- (Top)\RZA1LU_Sample\src\renesas\application\app_sdk_camera

[File name]

- r_sdk_camera_graphics.c

[Function name]

- sdk_camera_graphics_sample_task function. The place is inner the while loop.

Click the icon shown in Figure 6.15 to display the **Send the Image** dialog box (Figure 6.16).

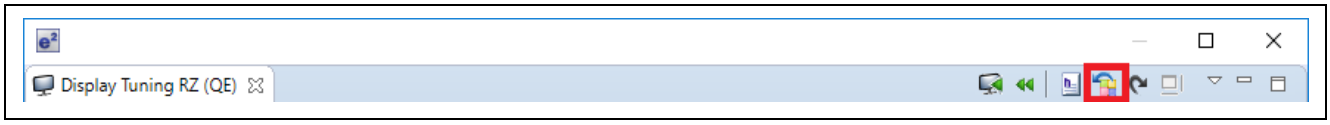


Figure 6.15 Image Download Icon

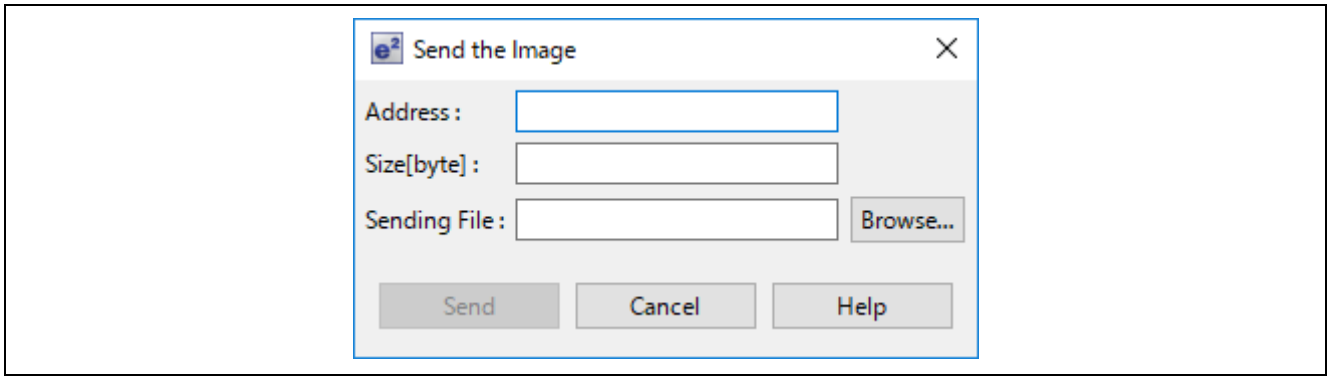


Figure 6.16 Send Image Dialog Box

Address: Specify the address of the buffer for storing display data.

Size [bytes]: Image file size (When not specified, the file size is used.)

Sending File: Image file (binary format)

In the sample program, a buffer for storing display data are secured by array variables (video_buffer) and allocated to the VRAM section (0x60240000 for RZ / A1LU). Set the top address of array variables (video_buffer) to "Address".

For “Sending File”, use a binary image that matches the display data format set in the sample program. The display data format is set to YCbCr422 in the sample program.

7. Adapting the Sample Program to the User Environment

In order to use it for checking LCD displays in the user environment, the sample program must be modified to match that environment. The locations to be modified are listed below.

7.1 CPU and Board Initialization

The sample program performs initialization to match Stream it! RZ V2.0. It is therefore necessary to make modifications to match the user environment.

7.2 VDC5 Operation Settings

Some items related to display device control can be specified using QE for Display and some cannot. The settings that cannot be made using QE for Display are specified by the sample program instead. Therefore, the following three items need to be modified to match the user environment.

- Display device timing control
  The sample program references “stream2_tft_ch0.h” when making settings to VDC5. This header file is generated by QE for Display.
- Panel clock settings
  The sample program references “stream2_tft_clk.h”. This file must be modified to match the user environment. Note that this item cannot be specified using QE for Display.
- GPIO settings
  The sample program uses setting file that is put in following directory. The file must be modified to match the user environment. Note that this item cannot be specified using QE for Display.

[Folder]

- (Top)\RZA1LU_Sample\src\renesas\application\graphics

[File name]

- vdc_portsetting.c

The panel clock settings that cannot be specified using QE for Display is described below.

7.2.1 Panel Clock Settings

(1) Source clock selection

VDC5 allows a variety of input clocks to be used as the source clock to generate the panel clock. The selectable source clocks are listed below. Note that the selected source clock is then frequency divided (1/1 to 1/32).

[Source clocks]

- Video clock (VIDEO_X1)
- Video clock (DV_CLK)
- External clock 0 (LCD0_EXTCLK)
- External clock 1 (LCD1_EXTCLK)
- Peripheral clock 1 (P1ϕ)
- LVDS PLL clock
- LVDS PLL clock × 1/7

The sample program uses the selections listed below to produce a “Panel Clock Frequency” of 8.0 MHz, as set in Figure 6.7, to match the specifications of the LCD ADAPTOR BOARD 4.3 of STREAM IT V2.0.

- Peripheral clock 1 (P1ϕ) 66.6 MHz
- 1/8 division ratio

These settings are located in “stream2_tft_clk.h”.

- #define LCD_CH0_PANEL_CLK (VDC_PANEL_ICKSEL_PERI)
- #define LCD_CH0_PANEL_CLK_DIV (VDC_PANEL_CLKDIV_1_8)

8. Using Sample Program and QE for Camera

This sample program can be linked with the development support tool QE for Camera. QE for Camera is a plugin of the integrated development environment e2 studio. It can adjust the timing of the Camera Input with GUI and can set the registers of camera module via I2C(Figure 8.1)(Figure 8.2).

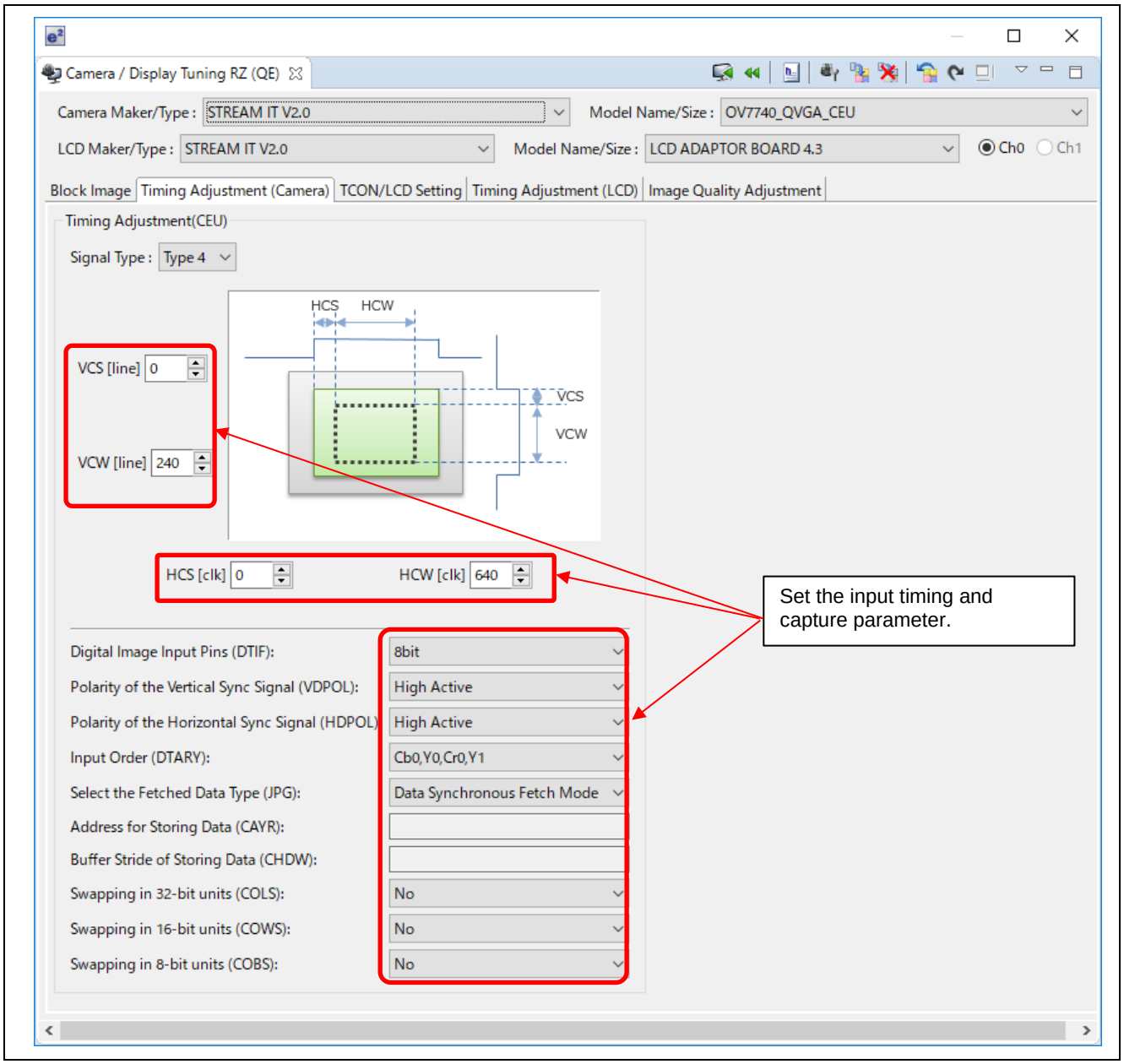


Figure 8.1 Adjusting Camera Input Timing

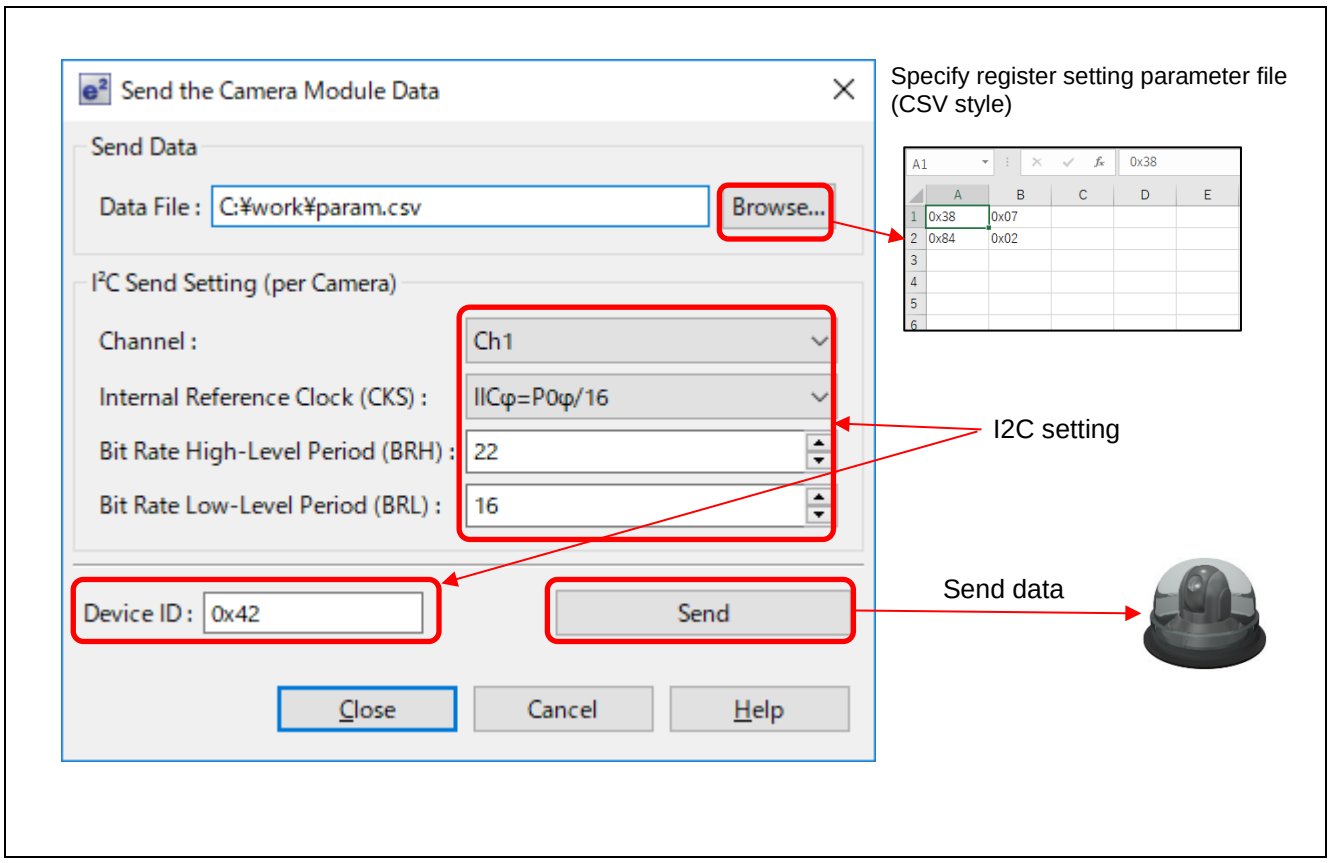


Figure 8.2 Setting of Camera Module Registers via I2C

Also, the timing setting value adjusted with QE for Camera can be output as a header file, and by replacing it with the header file of this sample program, the setting value in the GUI can be used as the initial settings of this sample program.

This sample program refers a header file which is placed in following path as the initial settings of camera input timing. Please refer to following path contents and save / apply as the initial settings when user outputs the setting value in the QE.

[path]

(Top)\Software\App\application_sample\SDKforCamera\sample1\inc\camera

For more detail of how to use QE for Camera, please refer to help documents in e2 studio after installing QE for Camera.

Also, for instructions for installing e2 studio and QE for Camera, refer to the manuals of each of these tools.

- Product page

https://www.renesas.com/qe-camera

Website and Support

Renesas Electronics Website

https://www.renesas.com/

Inquiries

https://www.renesas.com/contact/

Revision History

Rev.	Date	Description	
		Page	Summary
2.01	Oct. 31, 2018	1	Added “Target Device”
		27,33, 36,37	Switched the figure to the recent QE for Display.
		44,45	Added outline of cooperation between this sample program and QE for Camera.
		whole	Modified the typo of “e2 studio”
2.00	Jun. 29, 2018	4	Section 1 Added “QE for Camera” description.
		27	Section 6, Section 6.1 Added “QE for Camera” description.
		whole	Changed notation because “QE for Video Display Controller 5” changed to “QE for Display”
1.00	Apr. 6, 2018	-	First edition issued

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. 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 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. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

   The state of the product is undefined at the moment 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 moment 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 moment 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 moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has 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. Moreover, 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.

5. Differences between Products

   Before changing from one product to another, i.e. to a product with a different part number, confirm that the change will not lead to problems.

   — The characteristics of Microprocessing unit or Microcontroller unit products in the same group but having a different part number may differ in terms of the 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.

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(Rev.4.0-1 November 2017)

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