RX Family

QE for Display [RX] Application Note

Summary

QE for Display [RX] is a plug-in for the e^2 studio integrated development environment with support for suitable Renesas RX microcontrollers and provides a graphical interface for display control to assist in the development of embedded systems incorporating display devices.

QE for Display [RX] 2.0.0 and later versions are capable of supporting emWin GUIs, which are based on a high-performance graphics library from SEGGER Microcontroller. QE for Display [RX] 2.1.0 and later versions are also capable of supporting GUIs created by using Aeropoint® GUI for RX, which is GUI middleware from CRI Middleware. This enables selecting the GUI drawing tool that best suits your needs.

The emWin library is a high-reliability embedded GUI solution which has been adopted in various fields. It supports all kinds of displays, achieves high performance while minimizing the footprint in memory, and allows embedding of the GUIs in a great variety of systems. In addition, the emWin bundle incorporates AppWizard, which makes it easy to configure an excellent GUI through intuitive operations.

For Aeropoint GUI, the GUI design can be implemented by simply using PowerPoint® to configure the screen and set up the layout of GUI components to be seamlessly confirmed on the actual machine. Furthermore, the system employs an excellent subtractive color technology, which allows the drawing of fine images from 256-color (8-bit) image data, thus enabling the creation of GUIs to be run on larger displays even from microcontrollers with relatively little memory.

Earlier versions of QE for Display [RX] (up to V1.1.0) consisted of the display adjustment facilities provided for the graphics LCD controller (GLCDC) which is in several RX-family products and sample programs that were added to QE for Display [RX] to ease the adjustment of displays in user project.

QE for Display [RX] covers everything from the initial adjustment of the display to the creation of designs for screens. It can also be interlinked with various GUI development solutions to provide total support for the development of GUIs within short timeframes.

This application note describes the procedures for development with the use of QE for Display and tools with which its operation can be interlinked.

Target Devices

- RX65N and RX651 groups (ROM capacity: 1.5 MB to 2 MB)
- RX72N group
- RX72M group
- RX66N group

For the procedures described in this application note, operation in one of the following environments is assumed.

- Renesas Starter Kit+ for RX72N
- Renesas Envision KIT RPBRX72N
- Renesas Starter Kit+ for RX65N-2MB
- Renesas Envision KIT RPBRX65N

When you apply this application note with a different device or board, adjust the settings to be appropriate and thoroughly evaluate the results.

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1. Overview

As shown in Figure 1-1, the GLCDC has multiple blocks, so simply checking the display attributes requires an understanding of the GLCDC specifications and a large number of settings. However, QE for Display [RX] makes it possible to prepare an environment in which the connection of the display device can be checked in a short time without needing a full understanding of the GLCDC specifications. QE for Display [RX] is a tool that provides a graphical interface for display control and a facility for adjusting the timing in real time with the display device connected. After timing adjustment, a header file containing the corresponding information for display control is output. Settings for the GLCDC are then made on the basis of this header file.

The AppWizard GUI drawing tool or PowerPoint allows you to design an interactive GUI in a short time by combining prepared resources and settings without having to spend a long time for reading manuals or coding programs. These tools also allow the efficient implementation of detailed specifications in response to various demands by using the API functions provided by the emWin library or Aeropoint GUI.

QE for Display [RX] can also be used with the Smart Configurator, which simplifies embedding of the Renesas drivers, and Firmware Integration Technology (FIT), which provides drivers and middleware for the RX family. These tools can further simplify display control and the creation and display of GUIs.

This application note mainly concerns the use of the following FIT modules and the Smart Configurator that are provided with QE for Display [RX], which serves as the nucleus.

- Firmware Integration Technology (GLCDC FIT) module for the graphics LCD controller
- emWin Firmware Integration Technology (emWin FIT) module
- Aeropoint GUI Firmware Integration Technology (Aeropoint GUI FIT) module

The flowchart on the following page describes the basic procedure for developing systems with the use of QE for Display [RX].

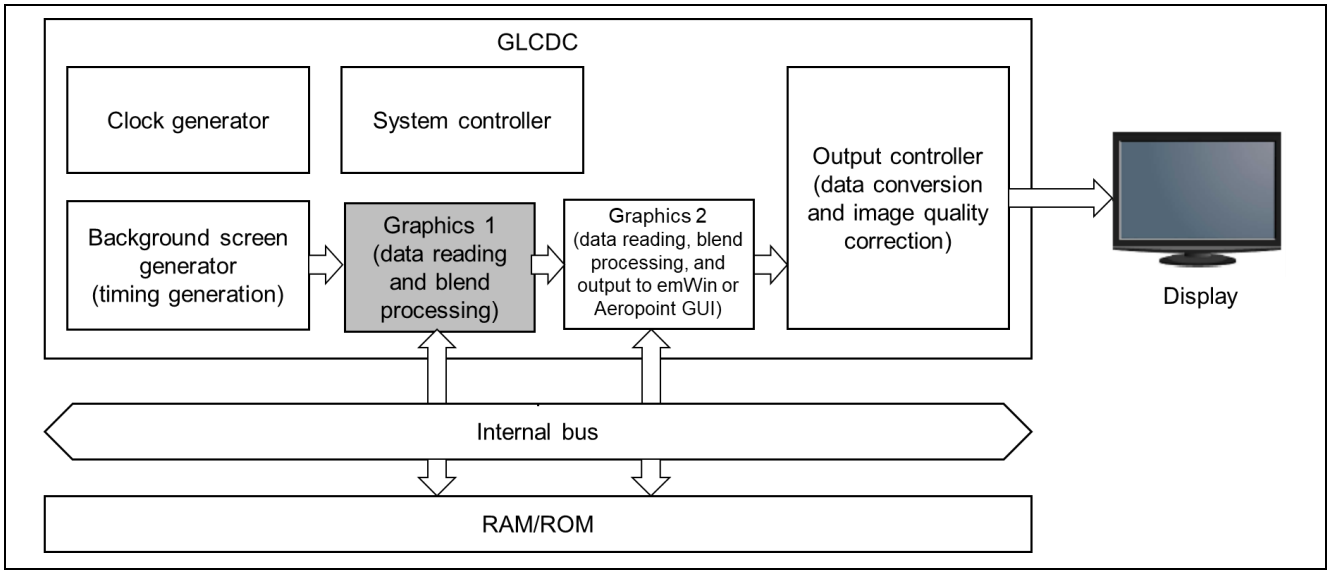


Figure 1-1 Block Configuration of the GLCDC

1.1 Flow of System Development with QE for Display [RX]

Figure 1-2 shows a flow of system development with the use of QE for Display [RX].

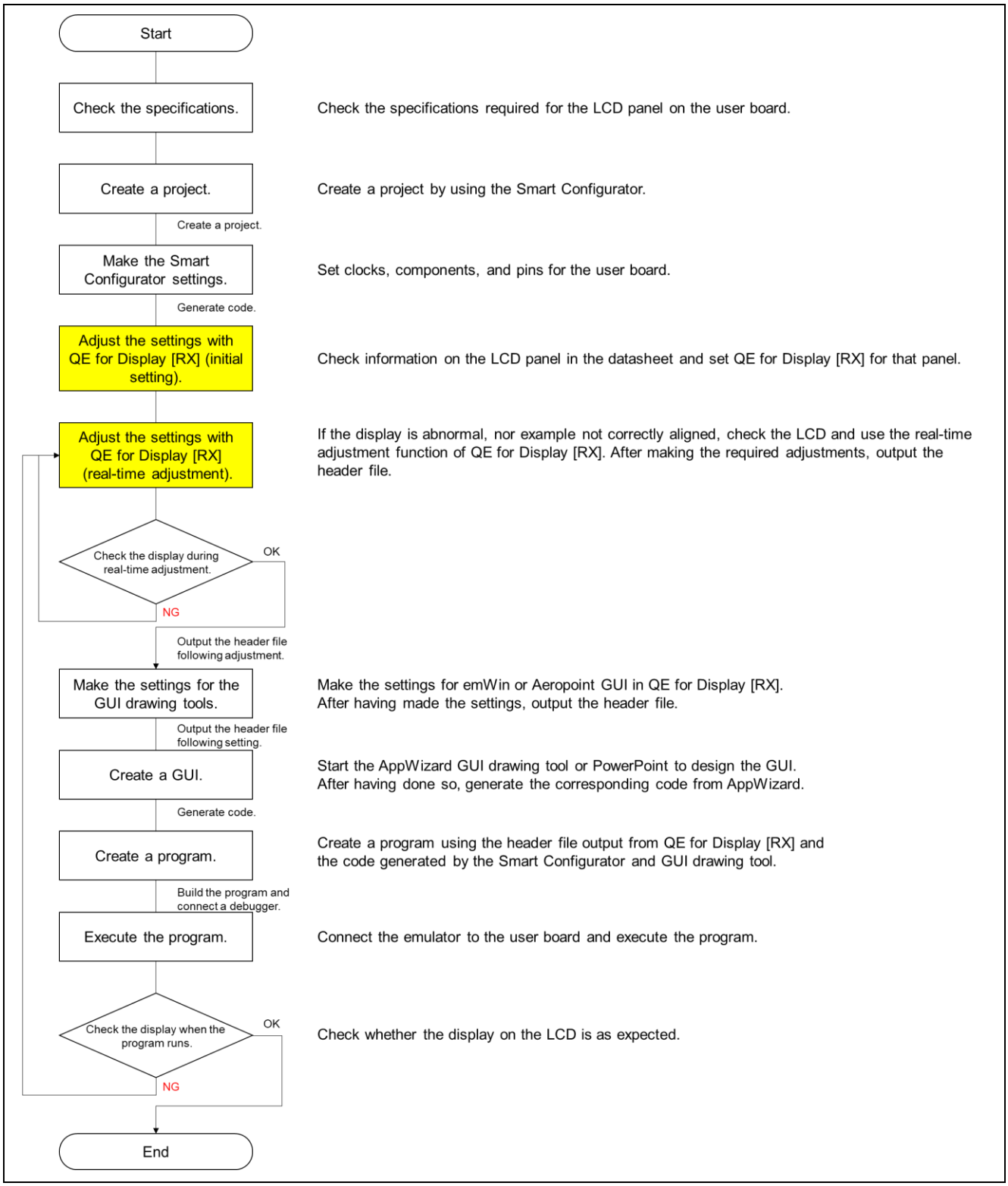


Figure 1-2 System Development by Using QE for Display [RX]

2. Operating Environment

The procedures described in this application note assume operation on the Renesas Starter Kit+ for RX72N (RSK RX72N), the Renesas Envision Kit RPBRX72N (Envision RX72N), the Renesas Starter Kit+ for RX65N-2MB (RSK RX65N) and the Renesas Envision Kit RPBRX65N (Envision RX65N). Table 2-1 shows the development environment for this application note.

Table 2-1 Development Environment

Item	Contents
Integrated development environment	Renesas Electronics e² studio 2021-04
C compiler	Renesas Electronics C/C++ Compiler Package for RX Family V.3.02.00
	Compiler option -lang = C99

Table 2-2 to Table 2-5 list the conditions used in confirming operations on each of the boards.

Table 2-2 Conditions for Confirming Operation (RSK RX72N)

Item	Contents
MCU used	R5F572NNDDBD (RX72N Group)
Operating frequency	• Main clock: 24 MHz • PLL: 240 MHz (main clock x 1/1 x 10) • System clock (ICLK): 240 MHz (PLL x 1/1) • Peripheral module clock A (PCLKA): 120 MHz (PLL x 1/2) • Peripheral module clock B (PCLKB): 60 MHz (PLL x 1/4) • LCD panel clock (LCD_CLK): 10 MHz (PLL x 1/24)
Endian	Little endian or big endian
Emulator	E2 Lite
Connection type	JTAG or FINE
Board used	Renesas Starter Kit+ for RX72N (product No.: RTK5572NNxxxxxxxxx)

Table 2-3 Conditions for Confirming Operation (Envision RX72N)

Item	Contents
MCU used	R5F572NNHDFB (RX72N Group)
Operating frequency	• Main clock: 16 MHz • PLL: 240 MHz (main clock x 1/1 x 15) • System clock (ICLK): 240 MHz (PLL x 1/1) • Peripheral module clock A (PCLKA): 120 MHz (PLL x 1/2) • Peripheral module clock B (PCLKB): 60 MHz (PLL x 1/4) • LCD panel clock (LCD_CLK): 10 MHz (PLL x 1/24)
Endian	Little endian or big endian
Emulator	E2 OB (E2 emulator On Board)
Connection type	FINE
Board used	Renesas Envision KIT RPBRX72N (product No.: RTK5RX72N0CxxxxxBJ)
Board settings (jumper/switch)	<SW1> Pin 1: don't care Pin 2: OFF (The debugger is used.) <Others> Default settings

Table 2-4 Conditions for Confirming Operation (RSK RX65N)

Item	Contents
MCU used	R5F565NEDDFC (RX65N Group)
Operating frequency	• Main clock: 24 MHz • PLL: 240 MHz (main clock x 1/1 x 10) • System clock (ICLK): 120 MHz (PLL x 1/2) • Peripheral module clock A (PCLKA): 120 MHz (PLL x 1/2) • Peripheral module clock B (PCLKB): 60 MHz (PLL x 1/4) • LCD panel clock (LCD_CLK): 10 MHz (PLL x 1/24)
Endian	Little endian or big endian
Emulator	E2 Lite
Connection type	JTAG or FINE
Board used	Renesas Starter Kit+ for RX65N-2MB (product No.: RTK50565Nxxxxxxxxx)
Board settings (jumper/switch)	<SW4> Pin 3: OFF Pin 4: ON (The LCD is used.) <Others> Default settings

Table 2-5 Conditions for Confirming Operation (Envision RX65N)

Item	Contents
MCU used	R5F565NEDDFB (RX65N Group)
Operating frequency	• Main clock: 12 MHz • PLL: 240 MHz (main clock x 1/1 x 20) • System clock (ICLK): 120 MHz (PLL x 1/2) • Peripheral module clock A (PCLKA): 120 MHz (PLL x 1/2) • Peripheral module clock B (PCLKB): 60 MHz (PLL x 1/4) • LCD panel clock (LCD_CLK): 10 MHz (PLL x 1/24)
Endian	Little endian or big endian
Emulator	E2 OB (E2 emulator On Board)
Connection type	JTAG or FINE
Board used	Renesas Envision KIT RPBRX65N (product No.: RTK5RX65N2CxxxxxBR)
Board settings (jumper/switch)	<SW1> Pin 1: ON Pin 2: OFF (The debugger is used.) <SW4> Pin 1: OFF Pin 2: don't care (The debugger is used.) <Others> Default settings

3. Related Documents

Also refer to the following documents which are related to this application note.

Table 3-1 Documents Related to FIT Modules

Document Title	Document No.
Firmware Integration Technology User's Manual	R01AN1833
RX Family Board Support Package Firmware Integration Technology Module	R01AN1685
RX Family Graphic LCD Controller Module Using Firmware Integration Technology	R01AN3609
RX Family emWin v.6.14g module Using Firmware Integration Technology	R01AN5533
RX Family Aeropoint Module Firmware Integration Technology	R01AN5793

Table 3-2 Document Related to Tools

Document Title	Document No.
Renesas e^2 studio Smart Configurator User Guide	R20AN0451

Table 3-3 Documents Related to Boards

Document Title	Document No.
RX65N Group Renesas Starter Kit+ for RX65N-2MB User’s Manual	R20UT3888
RX65N Group RX65N Envision Kit User's Manual	R01UH0761
RX72N Group Renesas Starter Kit+ for RX72N User’s Manual	R20UT4443
RX72N Group RX72N Envision Kit User's Manual	R20UT4788

Table 3-4 Documents Related to Devices

Document Title	Document No.
RX65N Group, RX651 Group User's Manual: Hardware	R01UH0590
RX72N Group User’s Manual: Hardware	R01UH0824

Please use the latest versions that are available. Visit the Renesas Electronics Web site to check and obtain the latest versions.

4. Procedures for Execution

This chapter describes the procedures for creating a new project in the e^2 studio, using QE for Display [RX] to adjust the display in real-time, designing the GUI, and displaying the resulting project.

The results of adjusting the display produced by the GLCDC and of emWin or Aeropoint GUI which enables the efficient creation of the GUI, are generated as FIT modules for embedding in the project by using the Smart Configurator. Since the settings for GLCDC and emWin or Aeropoint GUI can be made from the GUI of QE for Display [RX], the user can smoothly proceed with GUI development according to the workflow.

Before starting this project, be sure to make the jumper settings stated in chapter 2, Operating Environment, if this is required.

For the usage of QE for Display [RX], refer to chapter 6, Using QE for Display [RX].

Preparation

1. Installing QE for Display [RX]

Procedure

2. Creating a new project
3. Making the board, clock, and heap size settings
4. Making the GLCDC and emWin or Aeropoint GUI settings according to the workflow of QE for Display [RX]
5. Building the project
6. Connecting a debugger and executing the program

4.1 Installing QE for Display [RX]

Install QE for Display [RX] in the e² studio integrated development environment. Use the following procedure to install this product.

4.1.1 Installing QE for Display [RX]

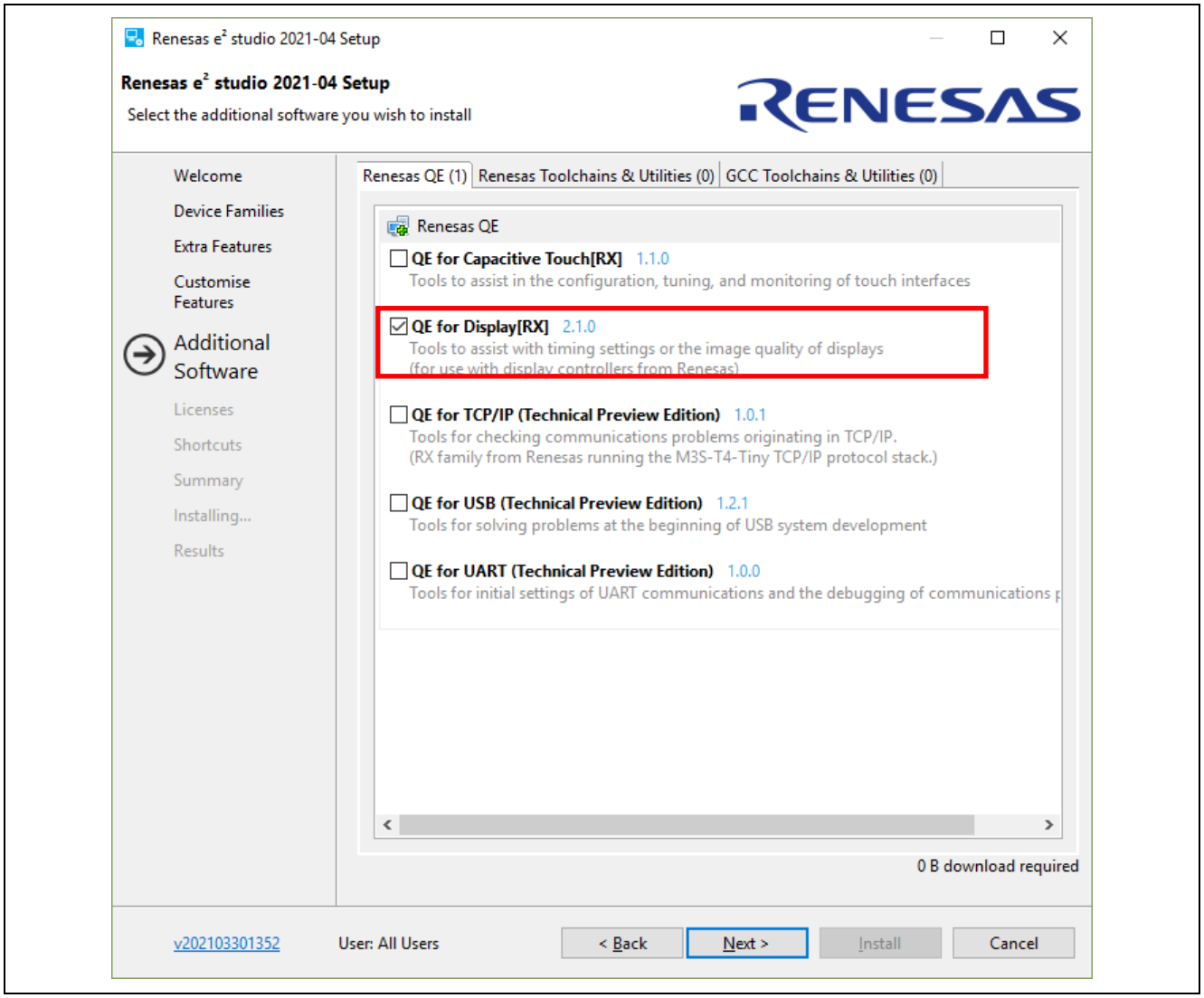
4.1.1.1 Updating the e² studio by using its installer

For updating the e² studio, refer to section 3, Updating Your Product, described in "[Upgraded to version] e² studio 2021-04" in Renesas Tool News (document No. R20TS0685EJ0100).

https://www.renesas.com/search/keyword-search.html#genre=document&q=r20ts0685

Select "QE for Display [RX]" for "Additional Software" in the installer of the e² studio.

Note: Since this step is not possible in situations where an Internet connection is not available, update QE for Display [RX] with the method described in section 4.1.1.3, Installing QE for Display [RX] by downloading the installer from the Web site.



4.1.1.2 Installing QE for Display [RX] by using Renesas Software Installer of the e² studio

Refer to the following for how to install QE for Display [RX].

1. Start the e² studio.
2. Select the “Renesas Software Installer” menu item from “Renesas Views” to open the “Renesas Software Installer” dialog box.
3. Select “Renesas QE” and click on the “Next” button.
4. Select the “QE for Display[RX] (v2.1.0)” checkbox and click on the “Finish” button.
5. Confirm that the “Renesas QE for Display[RX]” checkbox has been selected in the “Install” dialog box and click on the “Next” button.
6. Confirm that “Renesas QE for Display[RX]” is selected as the target of installation and click on the “Next” button.
7. After confirming the license agreement, select the “I accept the terms of the license agreements” radio button if you agree with the license agreement, and click on the “Finish” button.
8. If the dialog box for the trust certificate is displayed, confirm the certificate and click on the “OK” button to continue installation.
9. Restart the e² studio by following the instructions on the screen.
10. Start this product from the “Renesas QE” menu under “Renesas Views” of the e² studio.

Note: Since this step is not possible in situations where an Internet connection is not available, download the installer of QE in a different environment and update QE for Display [RX] with the method described in section 4.1.1.3, Installing QE for Display [RX] by downloading the installer from the Web site.

4.1.1.3 Installing QE for Display [RX] by downloading the installer from the Web site

Download QE from the following URL for installation.

- QE for Display V2.1.0: Development Assistance Tool for Display
  https://www.renesas.com/qe-display#downloads

Refer to the following for how to install QE for Display [RX].

1. Start the e² studio.
2. Select the “Install New Software...” menu item from the “Help” menu to open the “Install” dialog box.
3. Click on the “Add...” button to open the “Add Repository” dialog box.
4. Click on the “Archive” button, select the zip file for installation in the dialog box for selecting a file that has opened, and click on the “Open” button.
5. Click on the “OK” button in the “Add Repository” dialog box.
6. Expand the “Renesas QE” item shown in the “Install” dialog box, select the “Renesas QE for Display[RX]” checkbox, and then click on the “Next” button.
   *You can deselect the “Contact all update sites during install to find required software” checkbox to shorten the installation time.
7. Confirm that the target of installation is correctly selected and click on the “Next” button.
8. After confirming the license agreement, select the “I accept the terms of the license agreements” radio button if you agree with the license agreement, and click on the “Finish” button.
9. If the dialog box for the trust certificate is displayed, confirm the certificate and click on the “Accept selected” button to continue installation.
10. Restart the e² studio by following the instructions on the screen.
11. Start this product from the “Renesas QE” menu under “Renesas Views” of the e² studio.

4.1.2 Uninstalling QE for Display [RX]

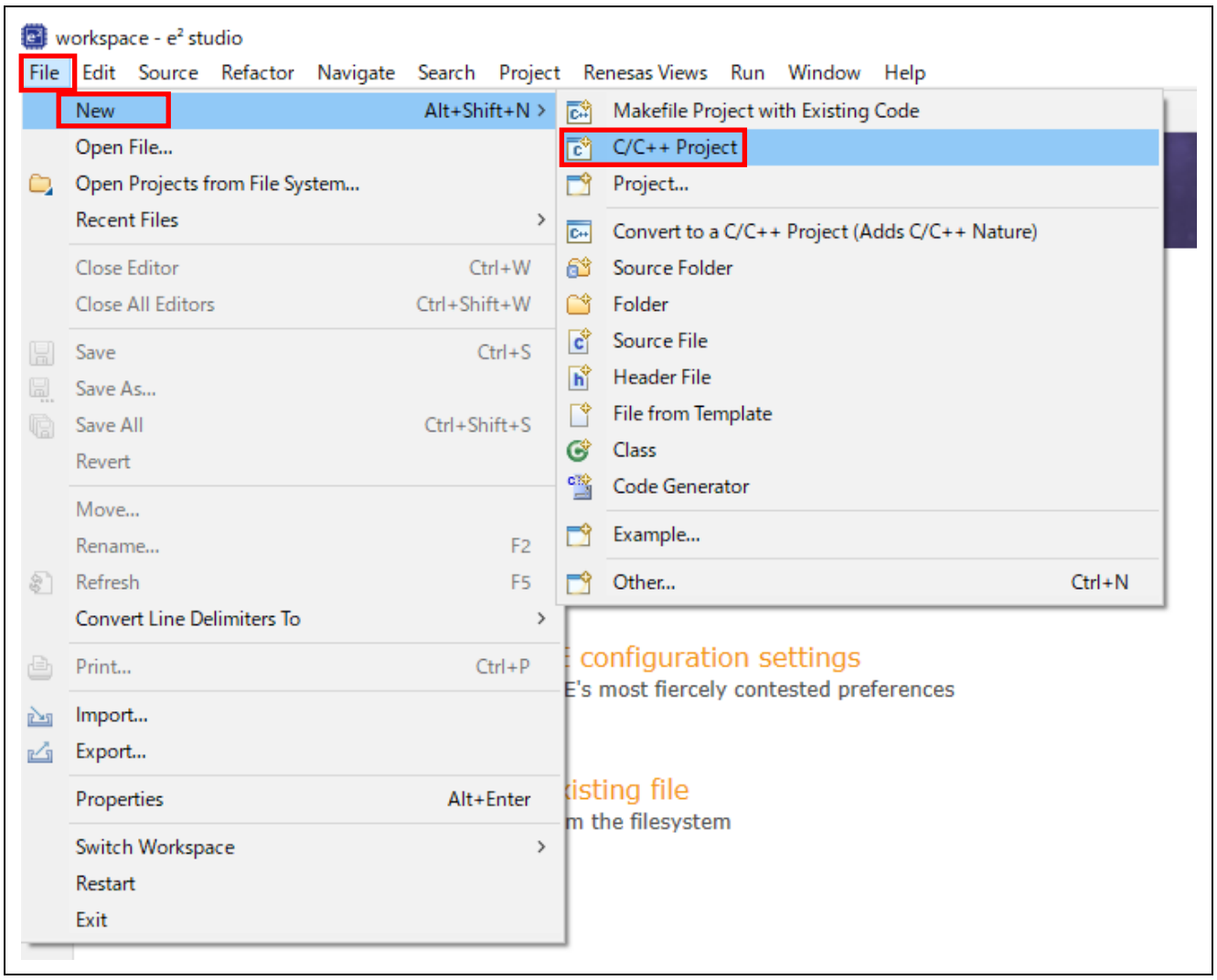
To uninstall QE for Display [RX], follow the procedure below.

1. Start the e^2 studio.
2. From the “Help” menu, select the “About e^2 studio” menu item, click on the “Installation Details” button to open the “e^2 studio Installation Details” dialog box.
3. Select “Renesas QE for Display[RX]” displayed on the “Installed Software” tabbed page and click on the “Uninstall...” button to open the “Uninstall” dialog box.
4. Confirm the displayed information and click on the “Finish” button.
5. Restart the e^2 studio by following the instructions on the screen.

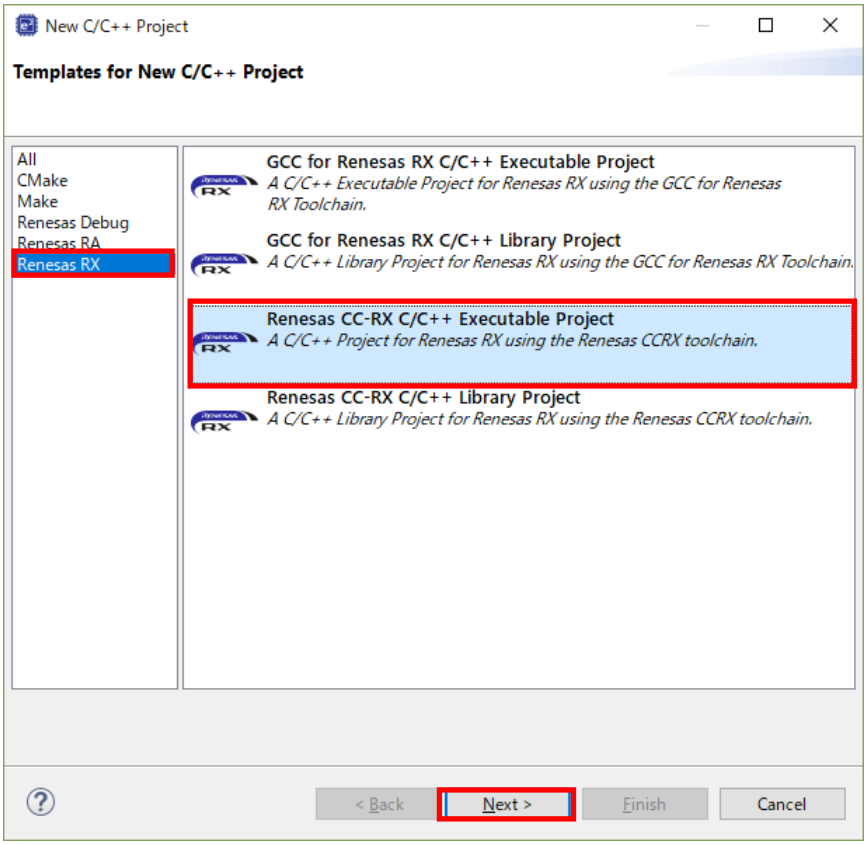
4.2 Creating a New Project

Create a project with the e² studio.

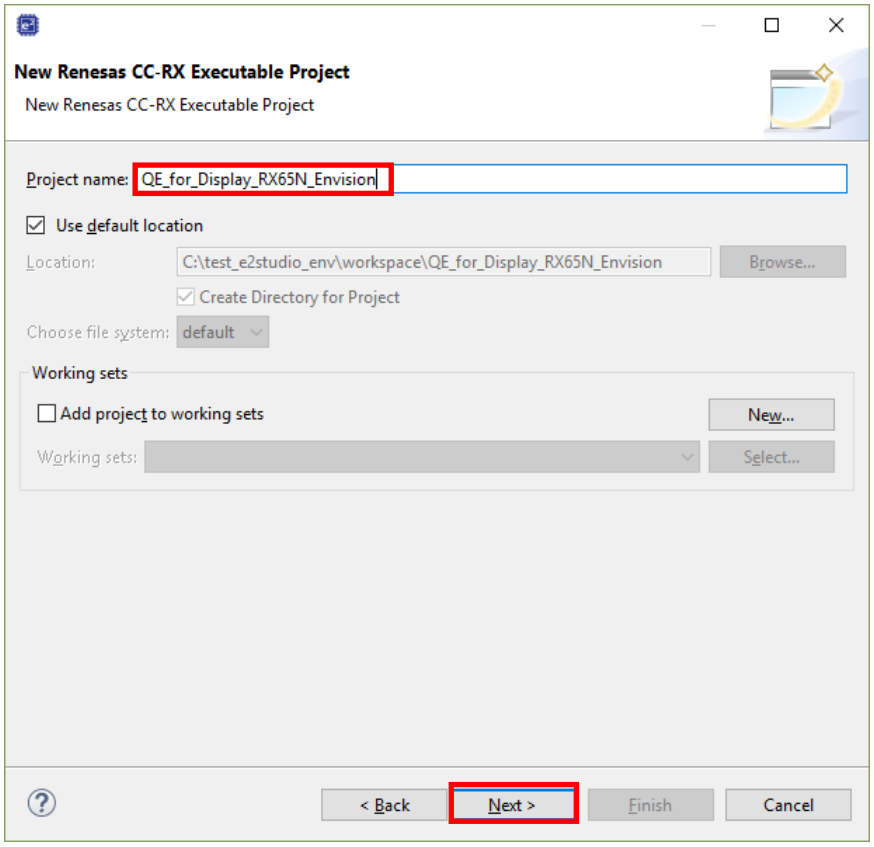
1. Click on “File” -> “New”, and then “C/C++ Project”.



2. Select “Renesas RX” -> “Renesas CC-RX C/C++ Executable Project” and click on “Next”.



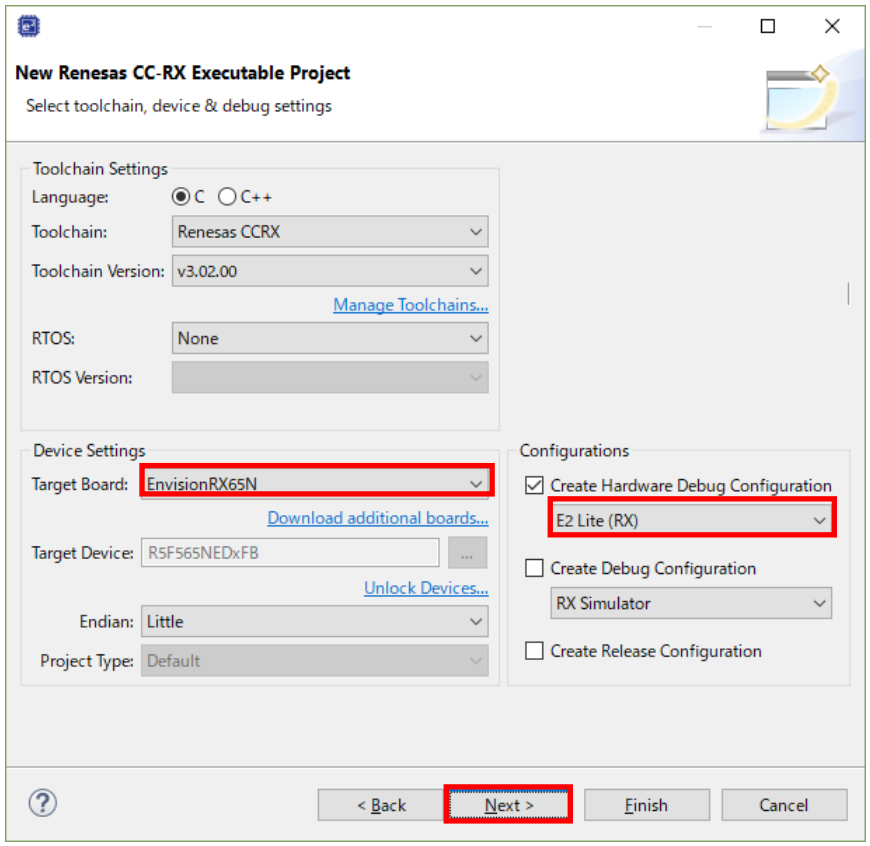
3. Enter the name of the project in the “Project name:” text box and click on “Next”.



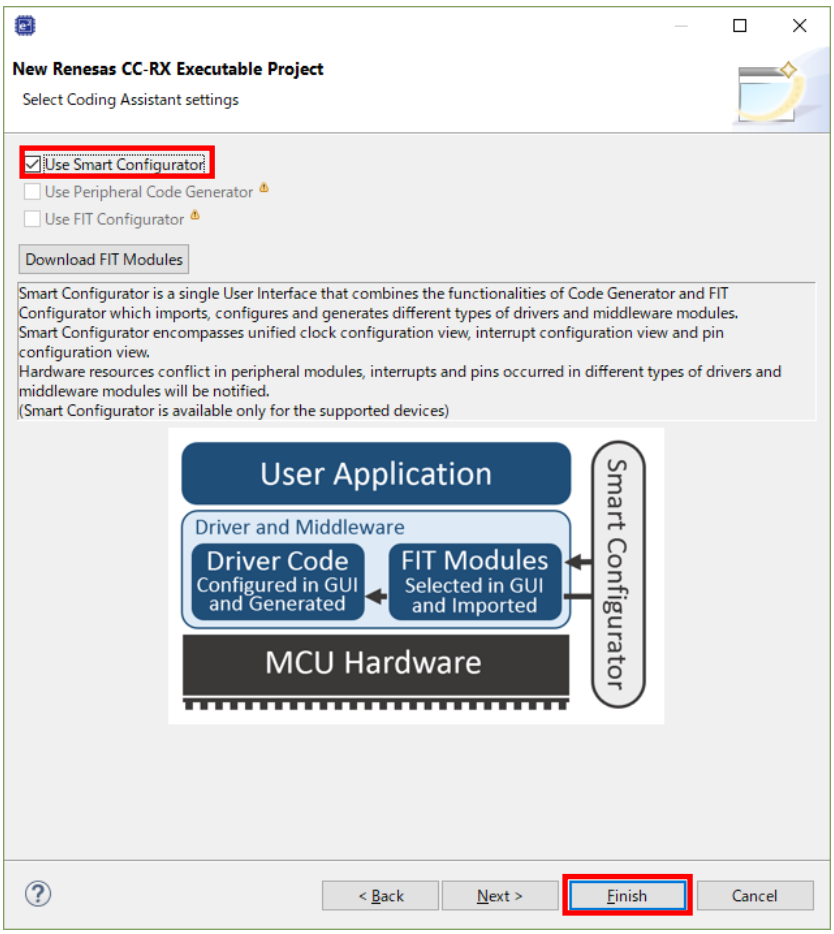
4. Select the board to be used from the “Target Board:” combo box. After selecting the target board, the selection from the “Target Device:” combo box is automatically made.
   If the board to be used is not among the available selections, downloading a board description file (BDF) is required when the Smart Configurator is set after the project has been created.
   In such cases, select “Custom” for “Target Board:” and select the MCU to be used from “Target Device:”.
5. Confirm that the checkbox for “Create Hardware Debug Configuration” is selected and select the emulator to be used from the combo box below it. Click on “Next”.

Table 4-1 Correspondence between Target Board, Target Device, and Emulator

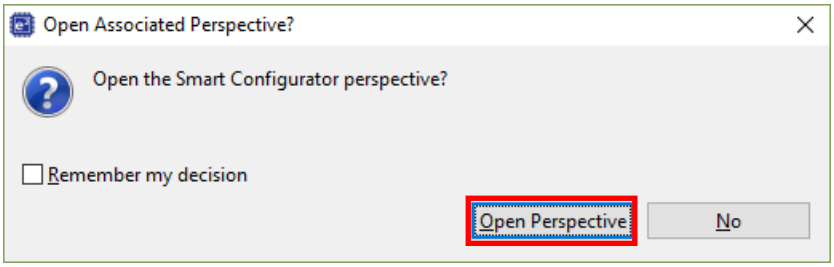
Target Board	Target Device	Emulator
EnvisionRX65N	R5F565NEDxFB	E2 Lite (RX)
RSKRX65N-2MB	R5F565NEDxFC	E2 Lite (RX)
EnvisionRX72N	R5F572NNHxFB	E2 Lite (RX)
RSKRX72N	R5F572NNDxBD	E2 Lite (RX)



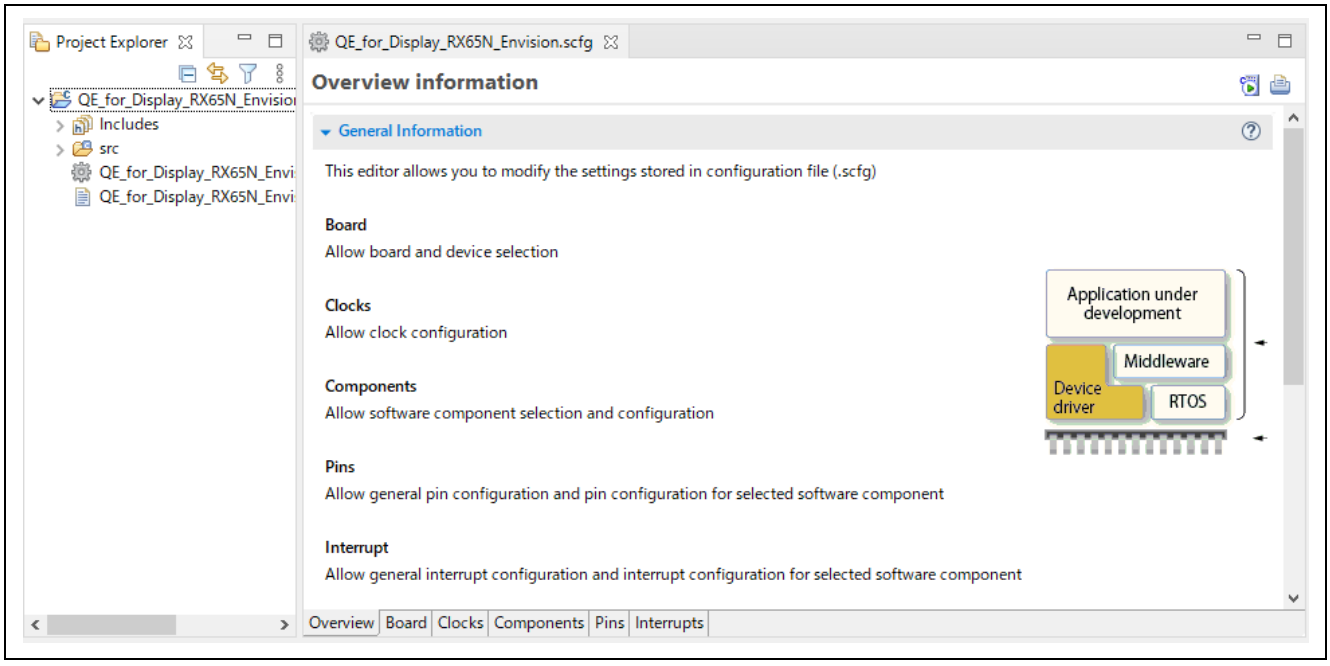
6. Select the “Use Smart Configurator” checkbox.
7. Click on “Finish”.



8. When the following message is displayed, click on “Open Perspective”.



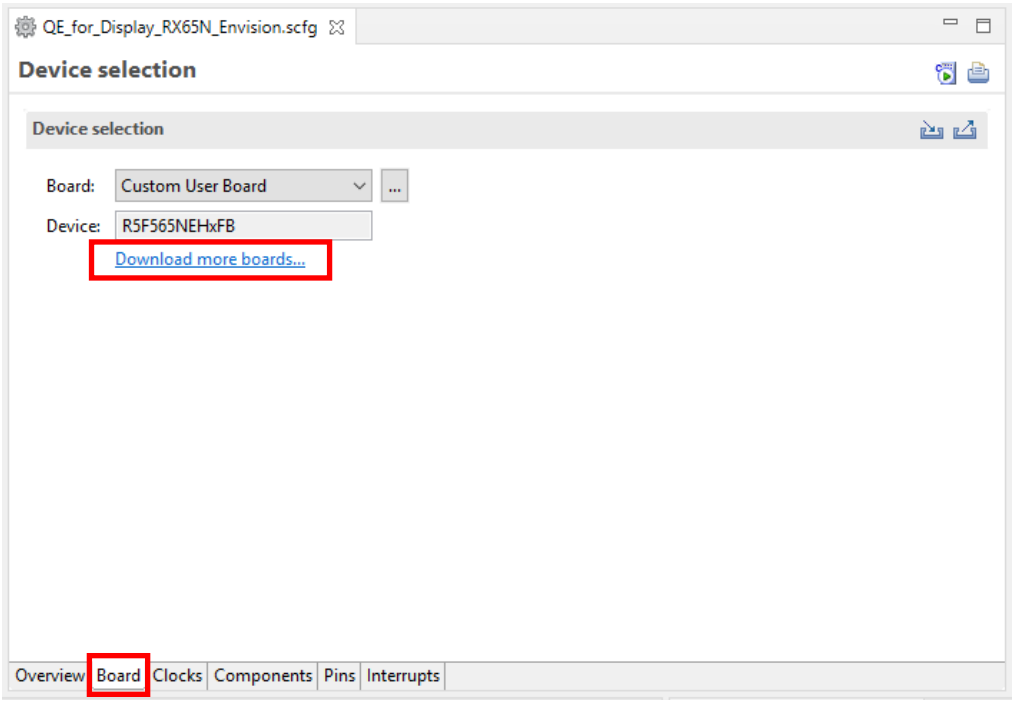
9. The project is created and the Smart Configurator is opened.



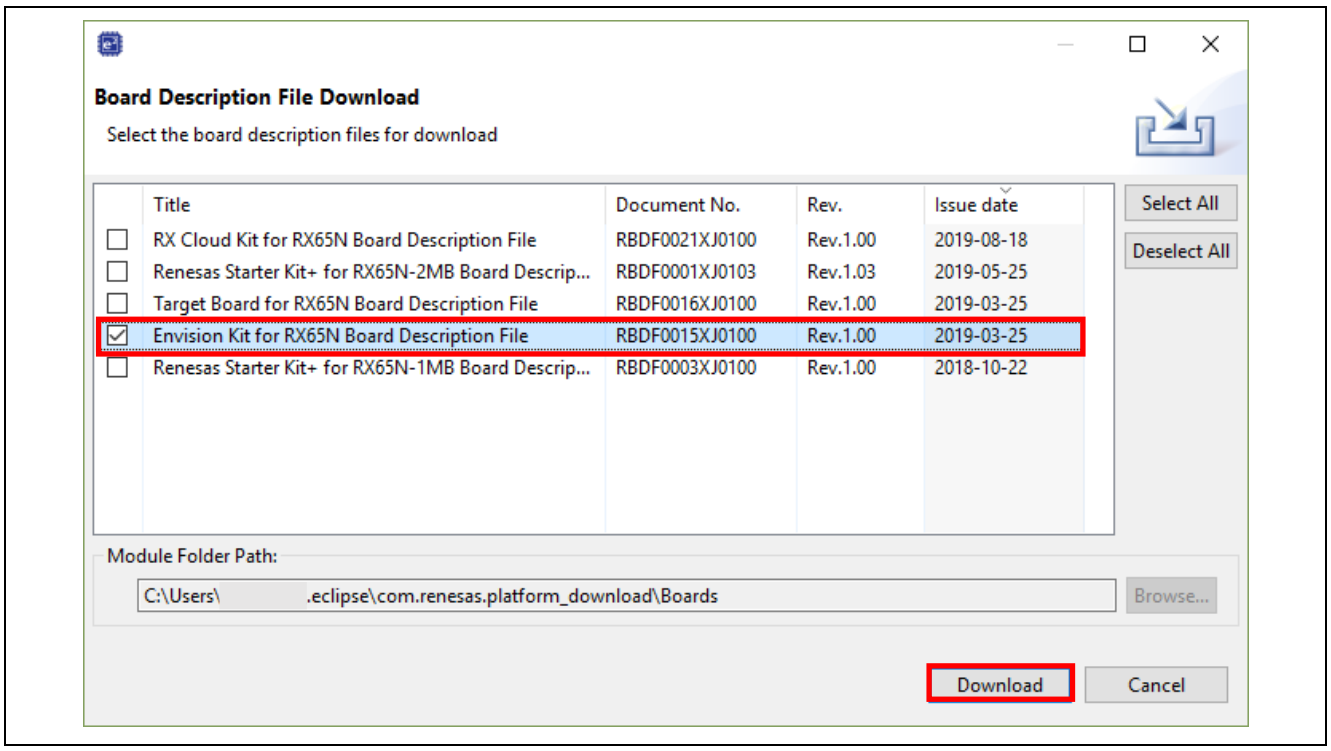
4.3 Making the Board, Clock, and Heap Size Settings

If the name of the board which is to be used for creating a project is not among those available for selection, download the board description file (BDF) by using the Smart Configurator and set the board.

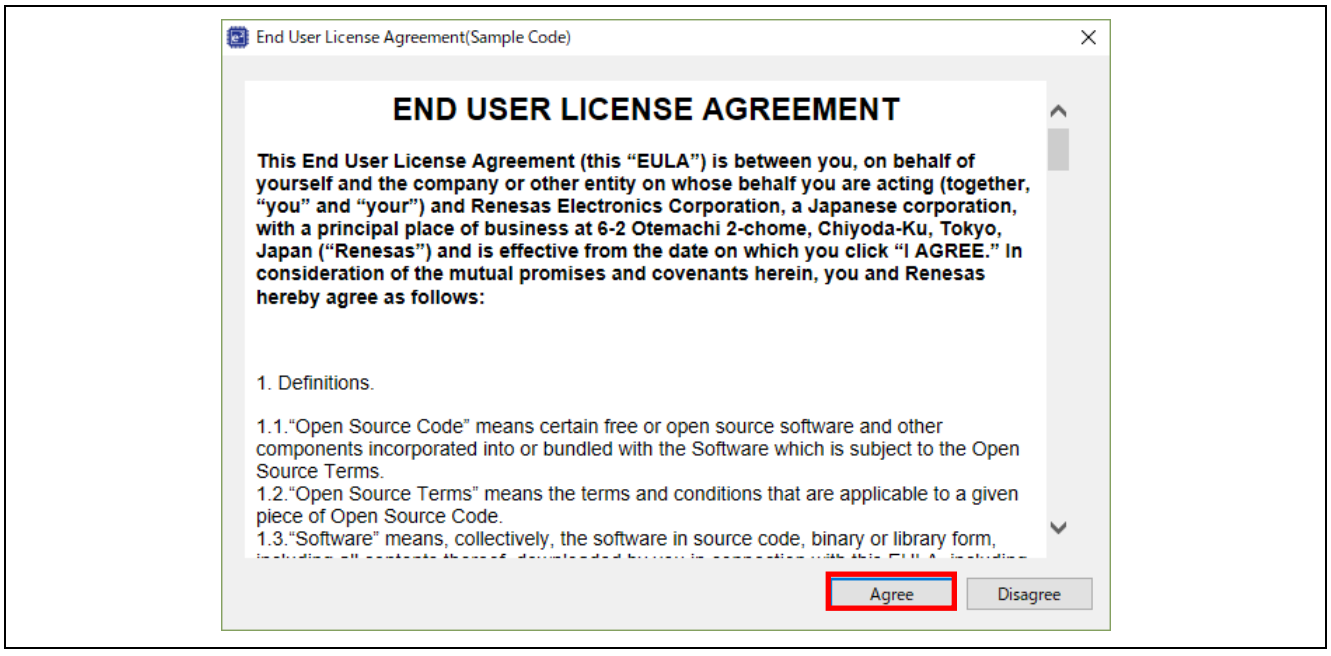
1. Select the “Board” tab of the Smart Configurator and click on “Download more boards…”.



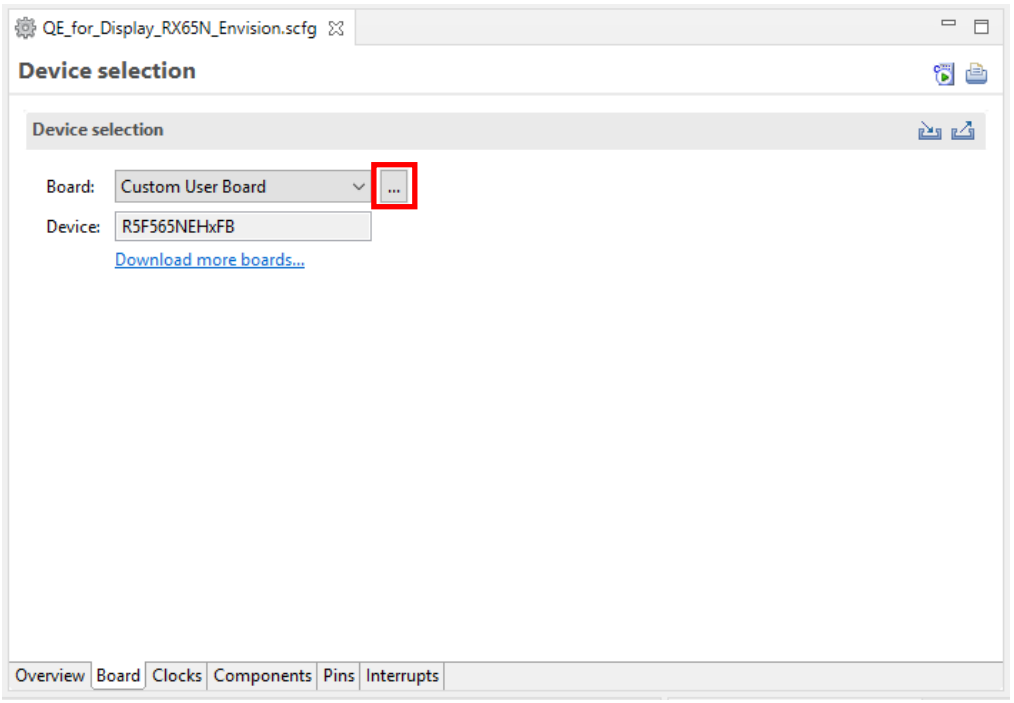
2. Select the board description file for the board to be used and click on “Download”.



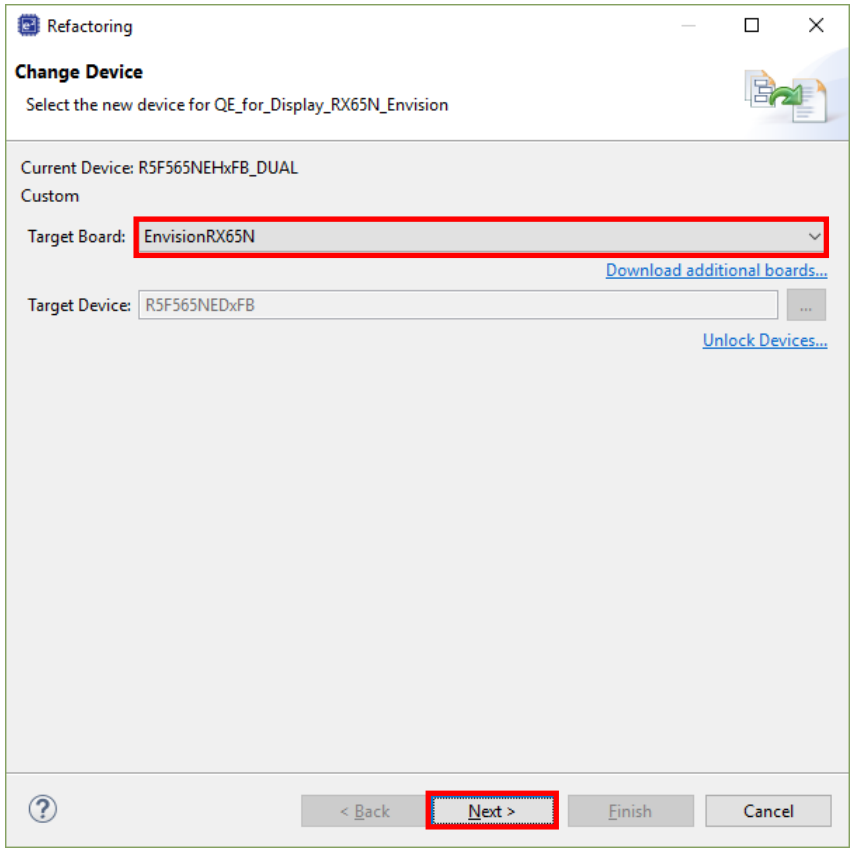
3. Read the description in the “End User License Agreement (Sample Code)” dialog box. If you agree, click on “Agree”.



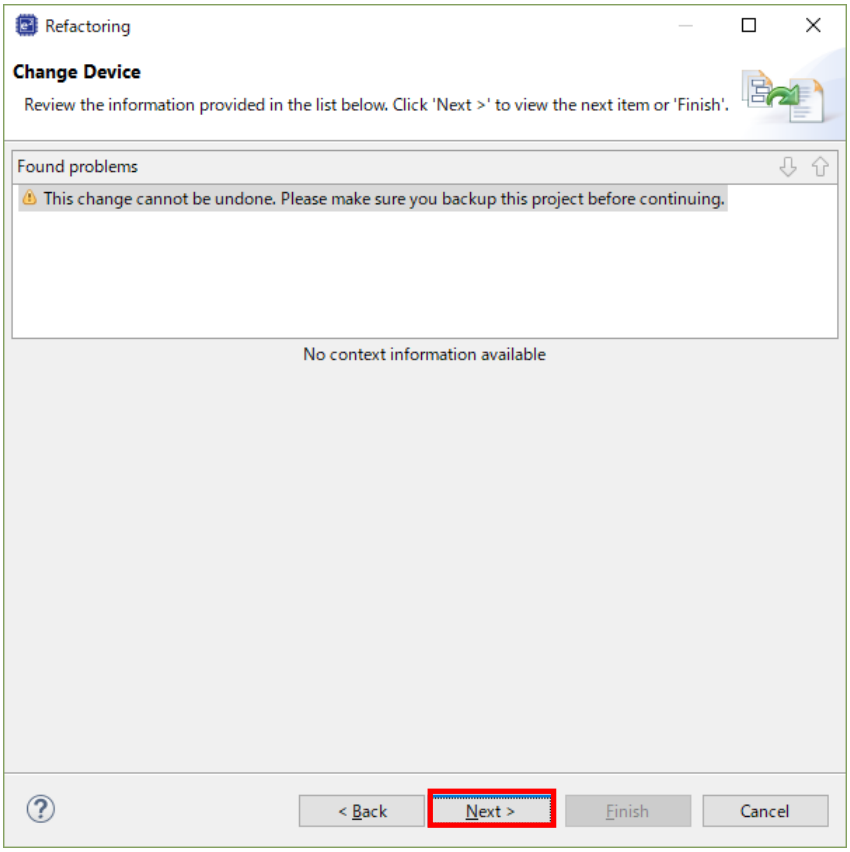
4. Select the board. Click on the “Browse” button for “Board:”.



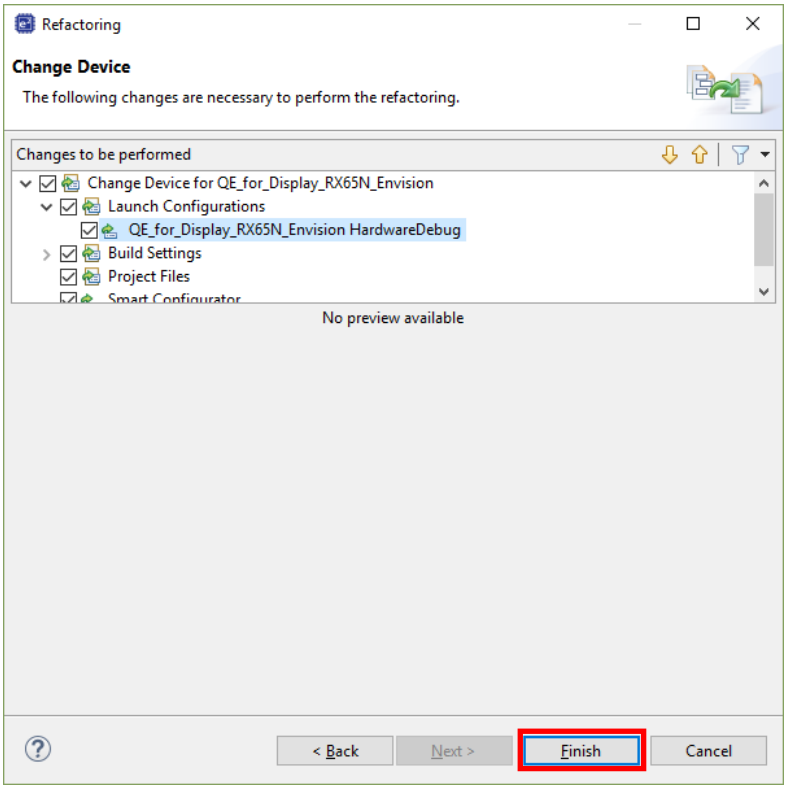
5. Select the board to be used from “Target Board:” in the “Refactoring” dialog box and click on “Next”.



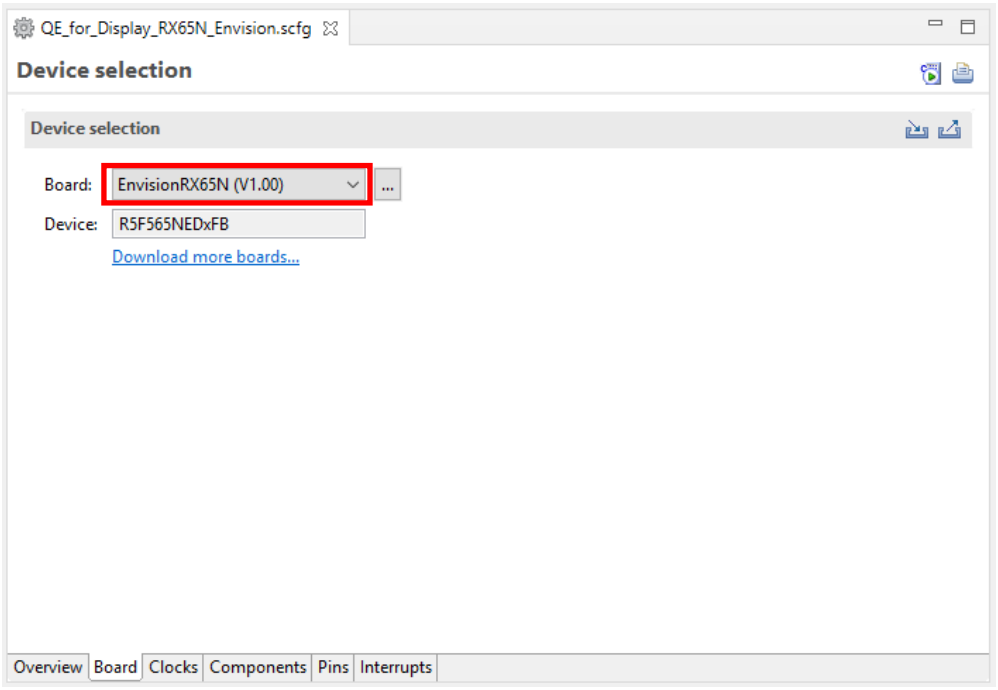
6. Confirm the statement in the dialog box and click on “Next”.



7. Similarly confirm the statement and click on “Finish”.



8. The board has now been selected.

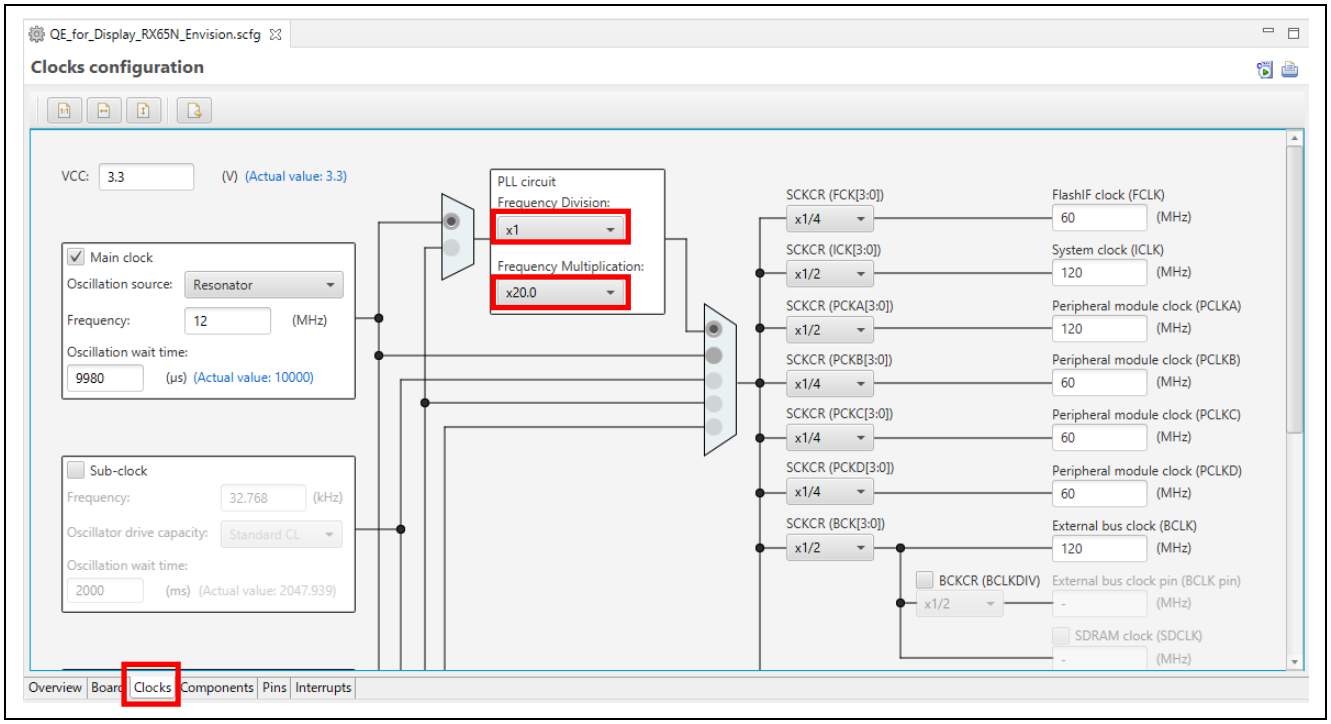


Make clock settings to suit the board to be used.

1. Select the “Clocks” tab of the Smart Configurator.
2. Set the clock to be suitable for the board to be used. The signal at the PLL operating frequency is the clock source for the LCD panel. Here, suppose that the main clock is to be the clock source and set “Frequency Division” and “Frequency Multiplication” for the PLL circuit so that the PLL operating frequency will be 240 MHz.

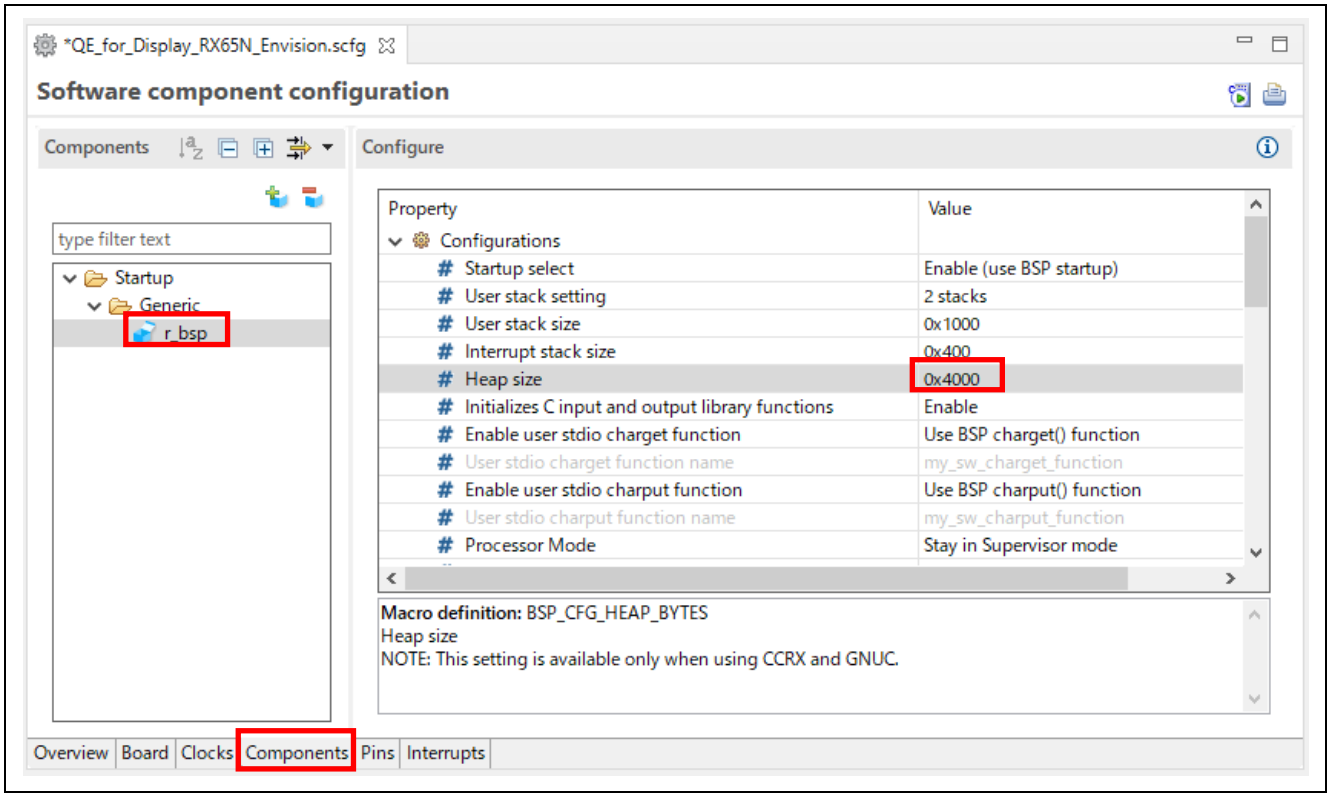
Table 4-2 Setting Clocks

Evaluation Board	Frequency of the Main Clock	PLL Operating Frequency	Division and Multiplication to Obtain the PLL Frequency from the Main Clock
RSK RX72N	24 MHz	240 MHz	1/1 x 10
Envision RX72N	16 MHz	240 MHz	1/1 x 15
RSK RX65N	24 MHz	240 MHz	1/1 x 10
Envision RX65N	12 MHz	240 MHz	1/1 x 20



Specify the size of the heap to be used by the emWin FIT module or Aeropoint GUI FIT module in creating the GUI.

1. Select the “Components” tab and “r_bsp” as the component.
2. Specify the required size for “Heap size”. An emWin FIT module usually requires from several tens to 100 KB. Here, start by specifying “0x4000”. For an Aeropoint GUI FIT module, start by specifying “0x400” as the default size. Increase the size as required.

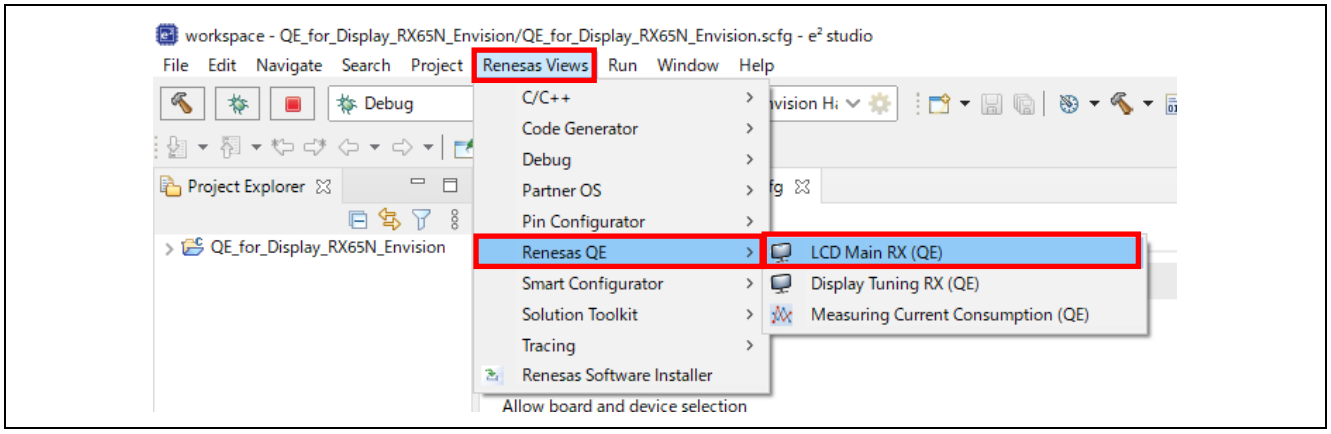


4.4 Setting the LCD According to the Workflow of QE for Display [RX]

Start QE for Display [RX] and set the LCD in the order of “1. Preparation”, “2. LCD Adjustment”, and “3. GUI Creation on LCD” in the workflow view.

Start QE for Display [RX].

1. Select “Renesas Views” -> “Renesas QE” -> “LCD Main RX (QE)”.



4.4.1 Preparation

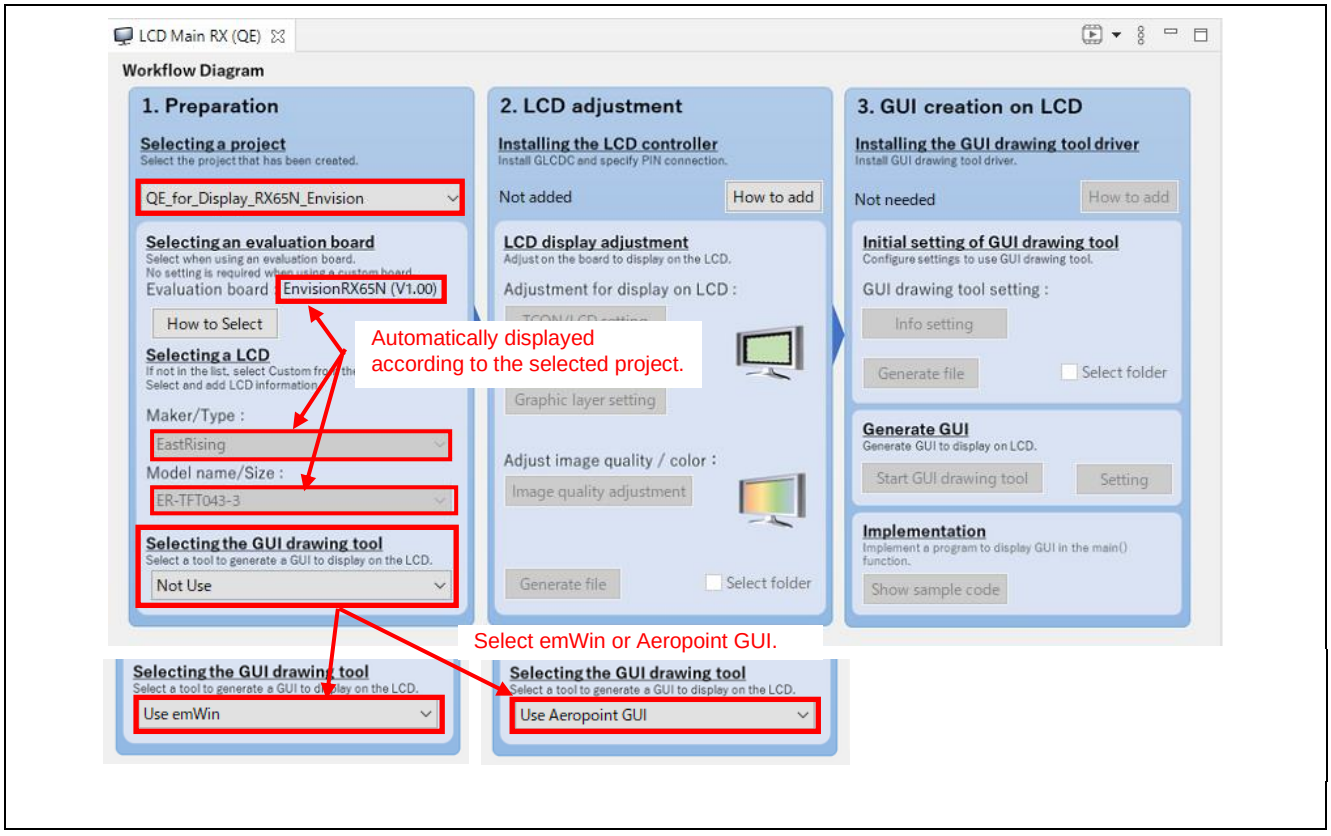
Make the settings for “1. Preparation” in the workflow view of QE for Display [RX].

1. In “Selecting a project”, select the target project. Once the project is selected, the entries for “Evaluation board”, “LCD maker/Type”, and “Model name/Size” are automatically displayed.
   If you are using the board other than one of those listed in Table 4-3, select “Custom” in the “LCD maker/Type” combo box and add the information on the LCD to be used in the “Edit Custom Display Data” dialog box.

Table 4-3 Correspondences between “Evaluation Board”, “LCD maker/Type”, and “Model name/Size”

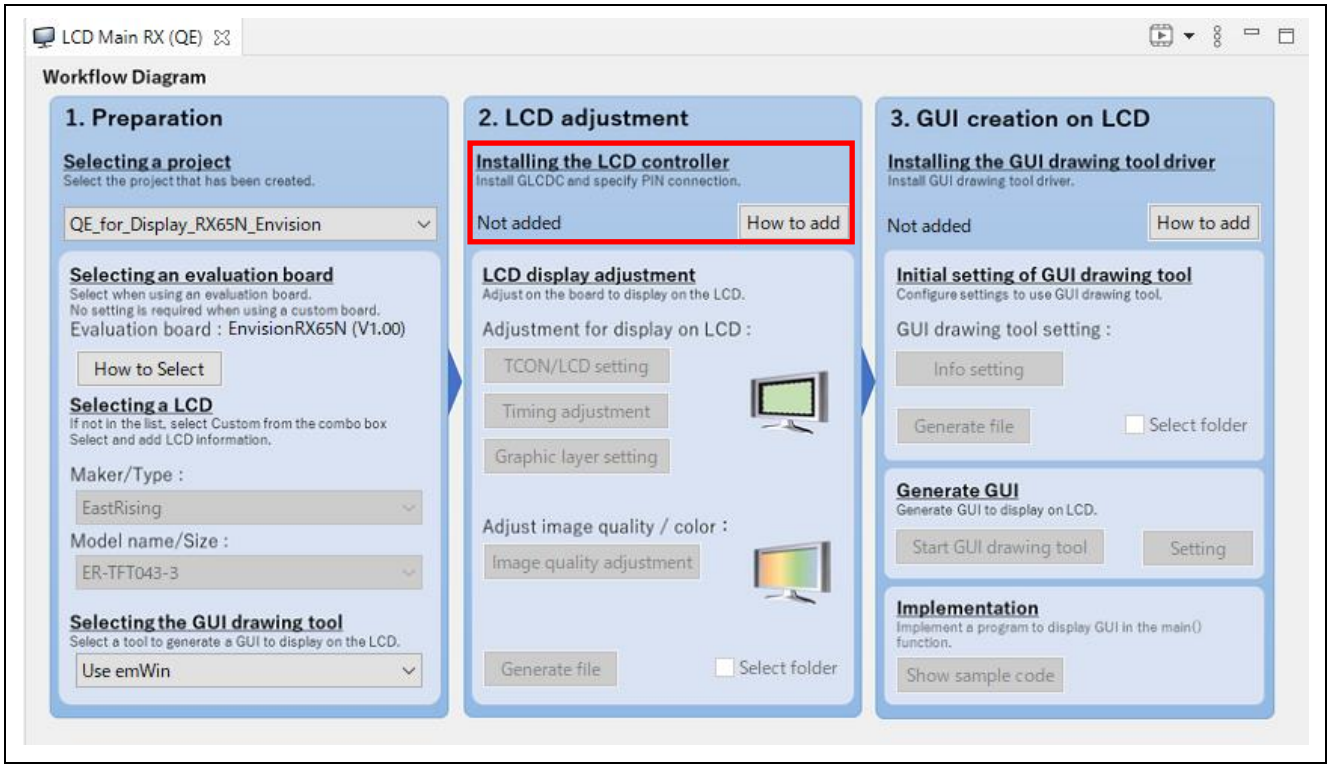
Evaluation Board	LCD maker/Type	Model name/Size
RSKRX72N (V1.01)	Newhaven Display International, Inc.	NHD-4.3-480272EF-ATXL#-CTP
EnvisionRX72N (V1.02)	EastRising	ER-TFT043-3
RSKRX65N-2MB(1.03)	Newhaven Display International, Inc.	NHD-4.3-480272EF-ATXL#-CTP)
EnvisionRX65N (V1.00)	EastRising	ER-TFT043-3

2. Select “Use emWin” or “Use Aeropoint GUI” under “Selecting the GUI drawing tool”.

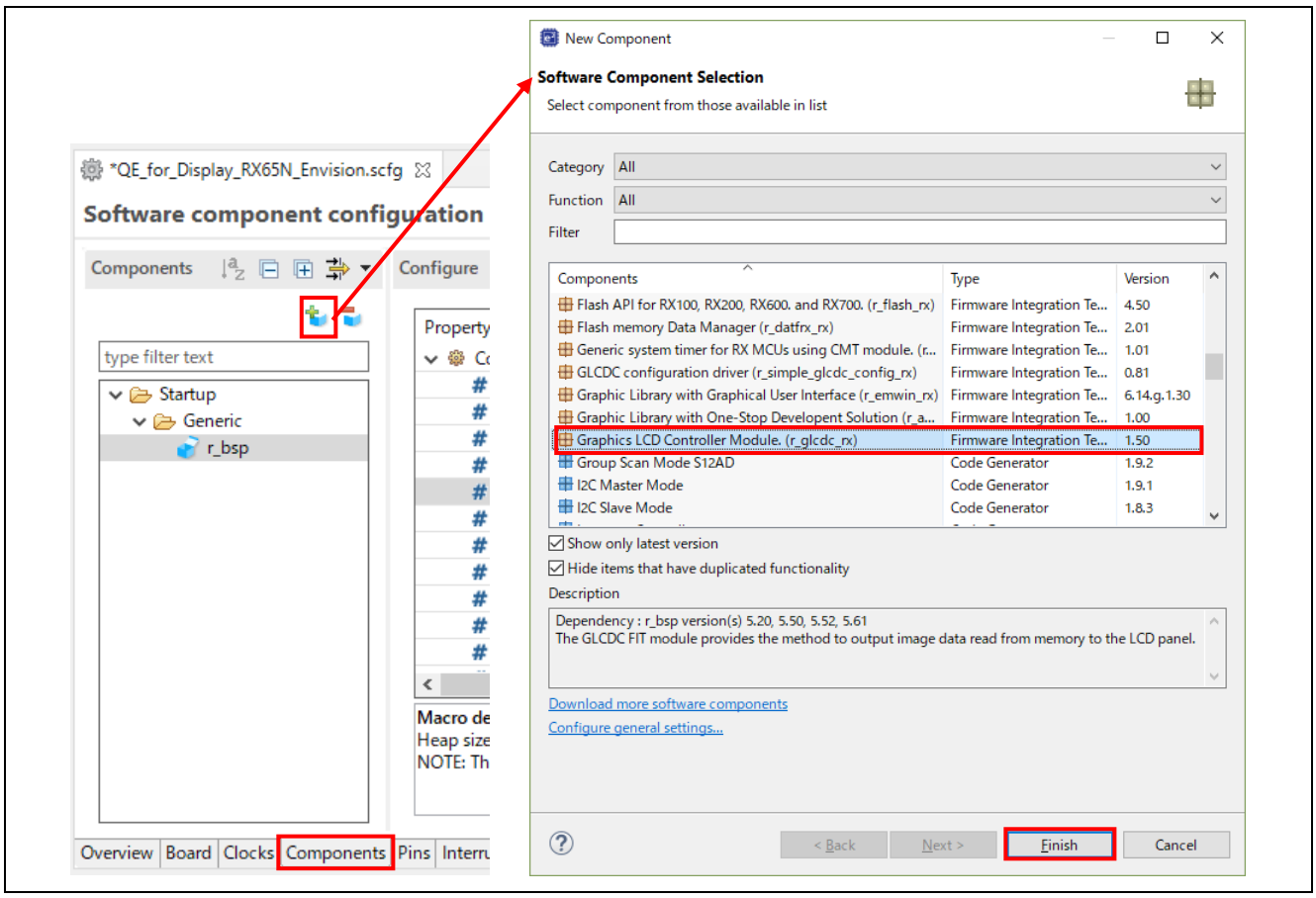


4.4.2 LCD Adjustment

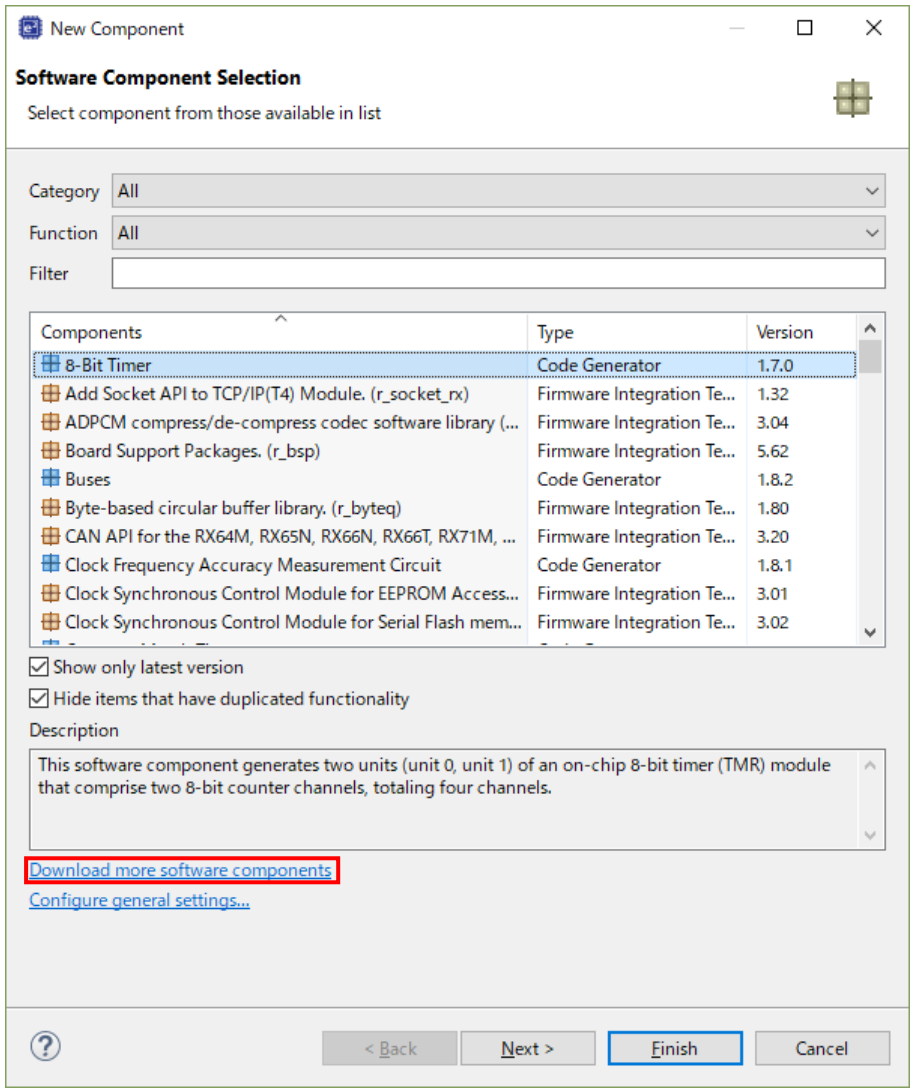
Install the LCD controller by using the Smart Configurator.



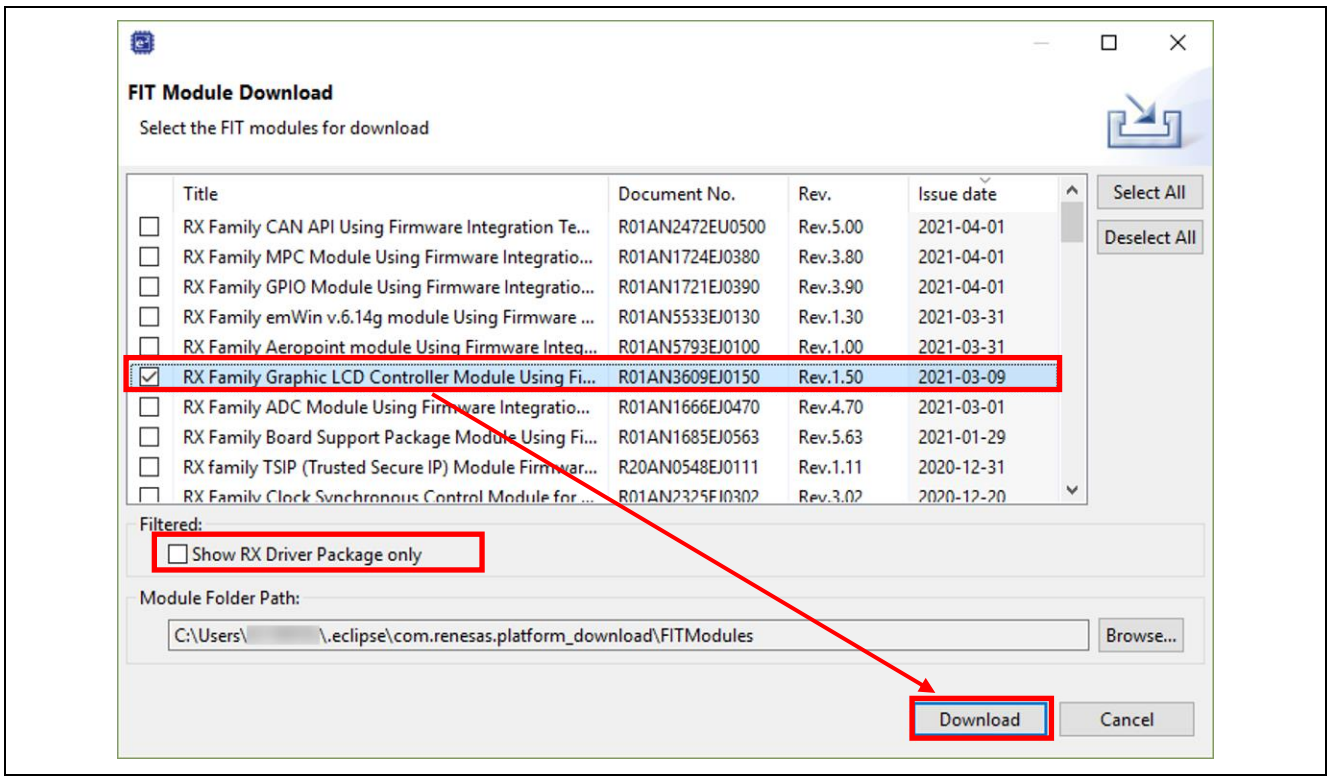
1. Select the “Components” tab of the Smart Configurator and click on the “Add component” icon.
2. In the “New Component” dialog box, select “Graphics LCD Controller Module (r_glcdc_rx)” (version 1.50 or a later version) and click on the “Finish” button.



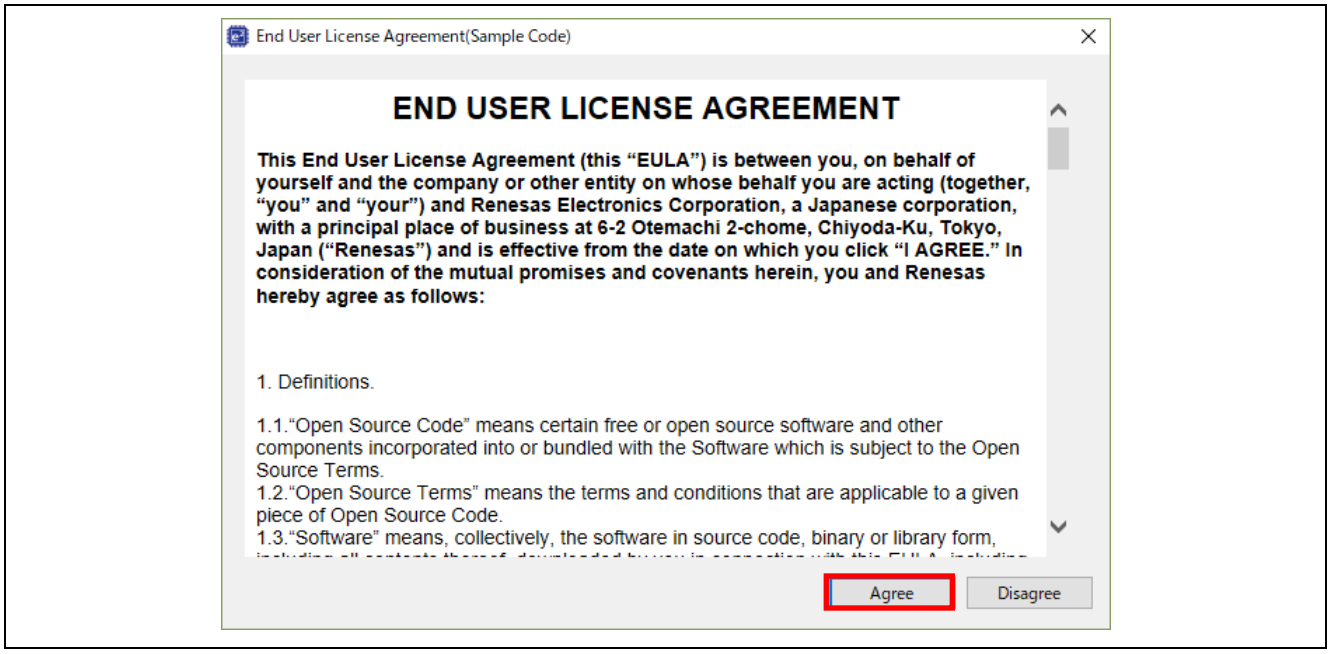
3. If the LCD controller module is not displayed in the list of components in the “New Component” dialog box, click on “Download more software components”.



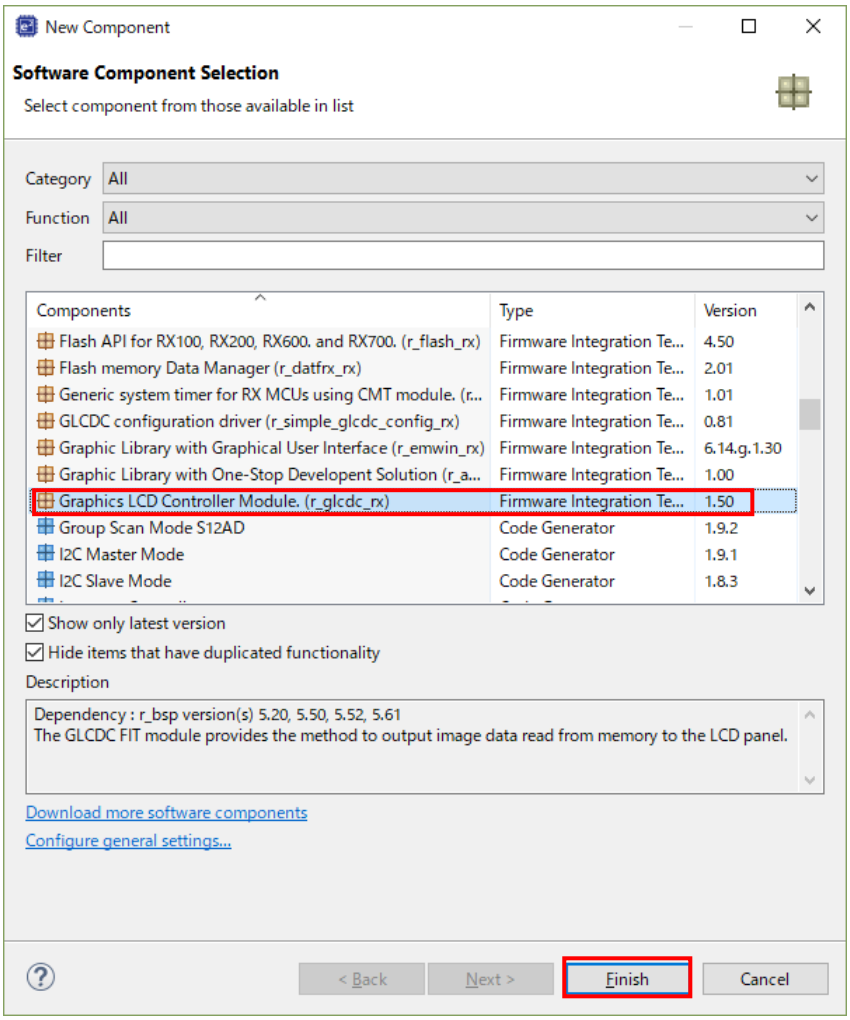
4. In the “FIT Module Download” dialog box, remove the check against “Show RX Driver Package only” and select “RX Family Graphic LCD Controller Module” (Rev. 1.50 or a later revision).
5. Click on “Download”.



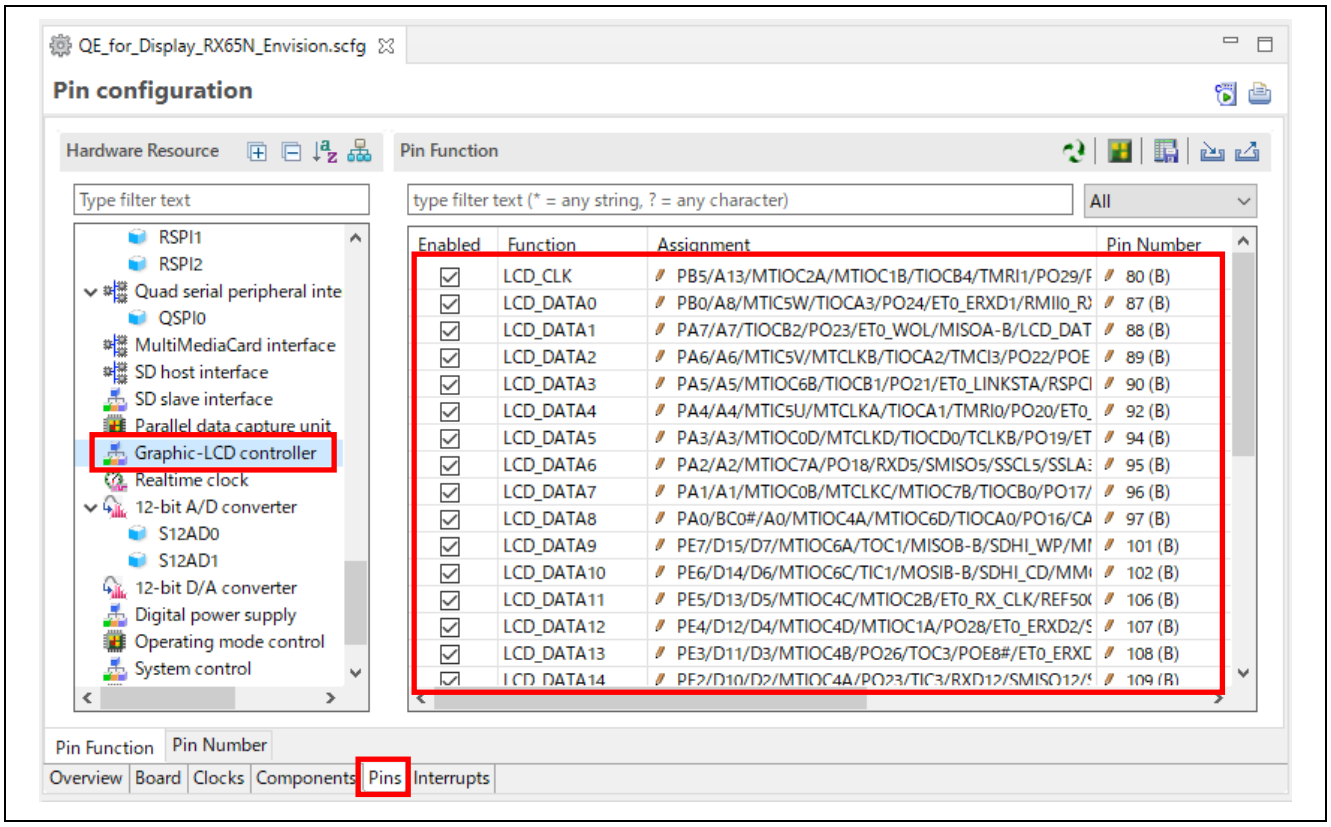
6. Read the description in the “End User License Agreement (Sample Code)” dialog box. If you agree, click on “Agree”.



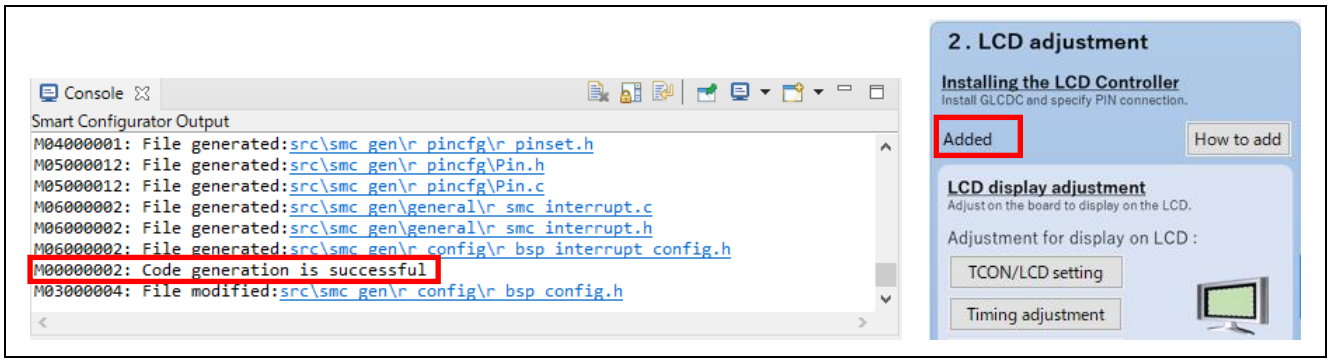
7. When “Graphics LCD Controller Module (r_glcdc_rx)” is displayed in the list of components, select it and click on the “Finish” button.



8. If you selected a board when creating the project, pins for use by the GLCDC are also set in response to adding the component for the GLCDC. You can confirm the settings of pins by selecting “Graphic - LCD controller” on the “Pins” tabbed page. If you are using a custom board, make the settings of pins on this tabbed page.



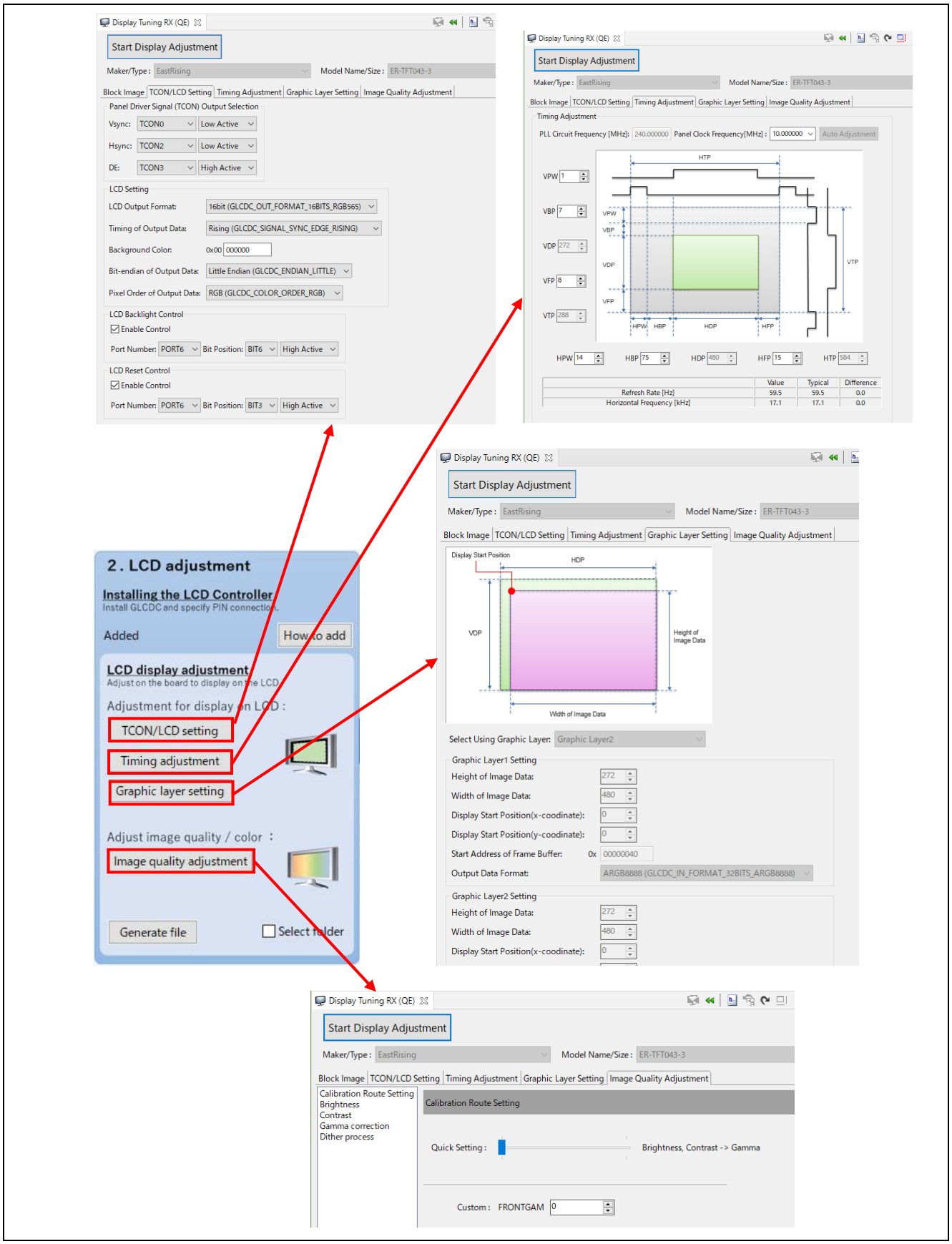
9. Click on the “Generate Code” button in the upper-right corner of the Smart Configurator window. The code is generated according to the settings.
After code generation is finished, “Added” is displayed immediately below “Installing the LCD controller”.



After that, adjust the LCD.

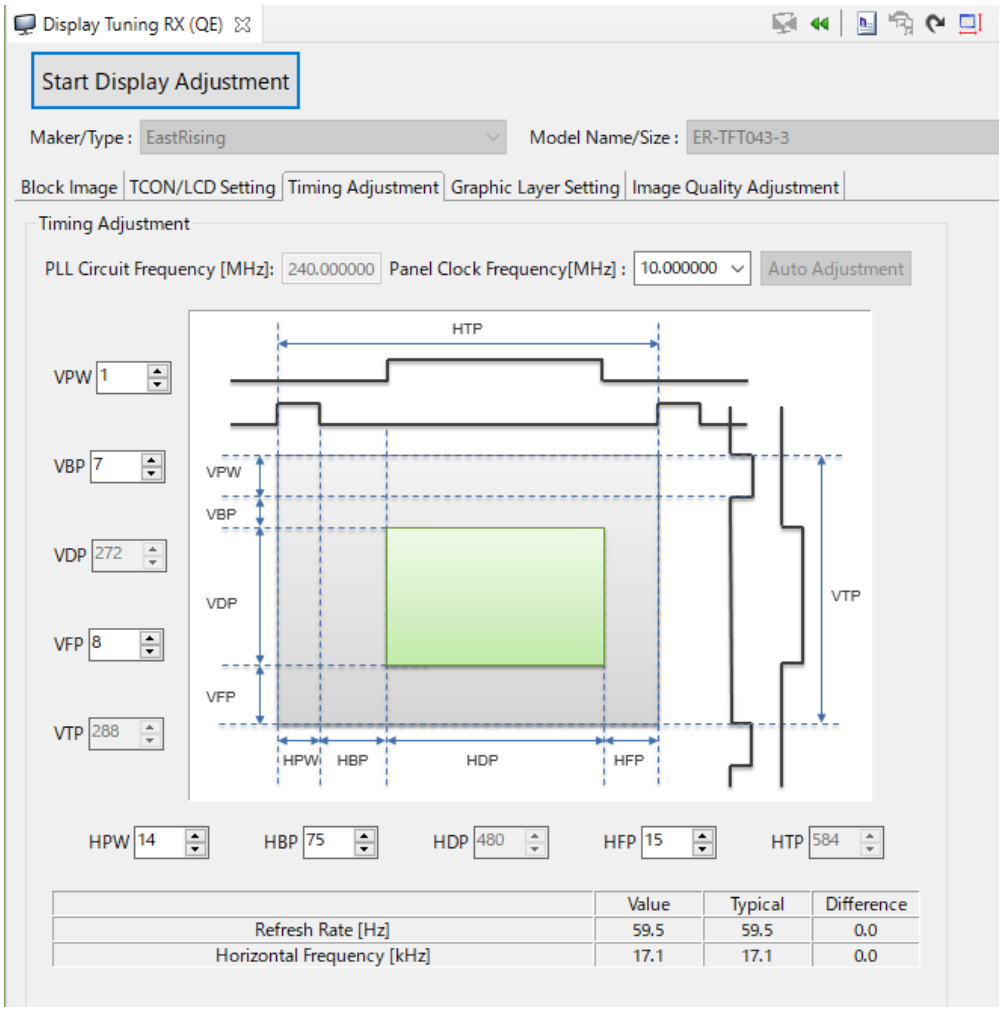
Clicking on the “TCON/LCD setting”, “Timing adjustment”, “Graphic layer setting”, and “Image quality adjustment” buttons opens the “Display Tuning RX (QE)” views of QE for Display [RX] which correspond to each button and allows changing of the settings. In addition, clicking on the “Start Display Adjustment” button in each “Display Tuning RX (QE)” view allows adjustment of the display with real-time confirmation on the actual display.

For details, refer to the help system entries for the “Display Tuning RX (QE)” views.


Display Tuning RX (QE)
Start Display Adjustment
Maker/Type : EastRising
Model Name/Size : ER-TFT043-3
Block Image
TCON/LCD Setting
Timing Adjustment
Graphic Layer Setting
Image Quality Adjustment
Panel Driver Signal (TCON) Output Selection
Vsync: TCON0 Low Active
Hsync: TCON2 Low Active
DE: TCON3 High Active
LCD Setting
LCD Output Format: 16bit (GLCDC_OUT_FORMAT_16BITS_RGB565)
Timing of Output Data: Rising (GLCDC_SIGNAL_SYNC_EDGE_RISING)
Background Color: 0x00 000000
Bit-endian of Output Data: Little Endian (GLCDC_ENDIAN_LITTLE)
Pixel Order of Output Data: RGB (GLCDC_COLOR_ORDER_RGB)
LCD Backlight Control
Enable Control
Port Number: PORT6 Bit Position: BIT6 High Active
LCD Reset Control
Enable Control
Port Number: PORT6 Bit Position: BIT3 High Active
Timing Adjustment
PLL Circuit Frequency [MHz]: 240.000000
Panel Clock Frequency[MHz]: 10.000000
Auto Adjustment
HTP
VPW
VBP
VDP
VFP
VTP
HPW
HBP
HDP
HFP
Value
Typical
Difference
Refresh Rate [Hz] 59.5 59.5 0.0
Horizontal Frequency [kHz] 17.1 17.1 0.0
2 . LCD adjustment
Installing the LCD Controller
Install GLCDC and specify PIN connection
Added
How to add
LCD display adjustment
Adjust on the board to display on the LCD
Adjustment for display on LCD :
TCON/LCD setting
Timing adjustment
Graphic layer setting
Adjust image quality / color :
Image quality adjustment
Generate file
Select folder
Display Start Position
Height of Image Data
Width of Image Data
Select Using Graphic Layer: Graphic Layer2
Graphic Layer1 Setting
Height of Image Data: 272
Width of Image Data: 480
Display Start Position(x-coodinate): 0
Display Start Position(y-coodinate): 0
Start Address of Frame Buffer: 0x 00000040
Output Data Format: ARGB8888 (GLCDC_IN_FORMAT_32BITS_ARGB8888)
Graphic Layer2 Setting
Height of Image Data: 272
Width of Image Data: 480
Display Start Position(x-coodinate): 0
Calibration Route Setting
Brightness
Contrast
Gamma correction
Dither process
Quick Setting :
Brightness, Contrast -> Gamma
Custom : FRONTGAM 0

If you are using any of the following boards, default values are set on the “Timing Adjustment” tabbed page according to the specifications of the LCD panel incorporated in the given board. Since the values are set when the “Display Tuning RX (QE)” view is opened, be sure to open this view even if changes to the default settings are not required.

- RX72N RSK
- RX65N RSK
- RX72N Envision Kit
- RX65N Envision Kit



The following values are automatically set when the panel clock frequency is 10 MHz in the RSK RX72N, RSK RX65N, Envision RX72N, or Envision RX65N.

Table 4-4 Example of Timing Settings when the Panel Clock Frequency is 10 MHz (for RSK RX72N and RSK RX65N)

Connected Device	Item	Value
NHD-4.3-480272EF-ATXL#-CTP	VPW	10
	VBP	2
	VDP	272
	VFP	2
	VTP	286
	HPW	41
	HBP	29
	HDP	480
	HFP	34
	HTP	584

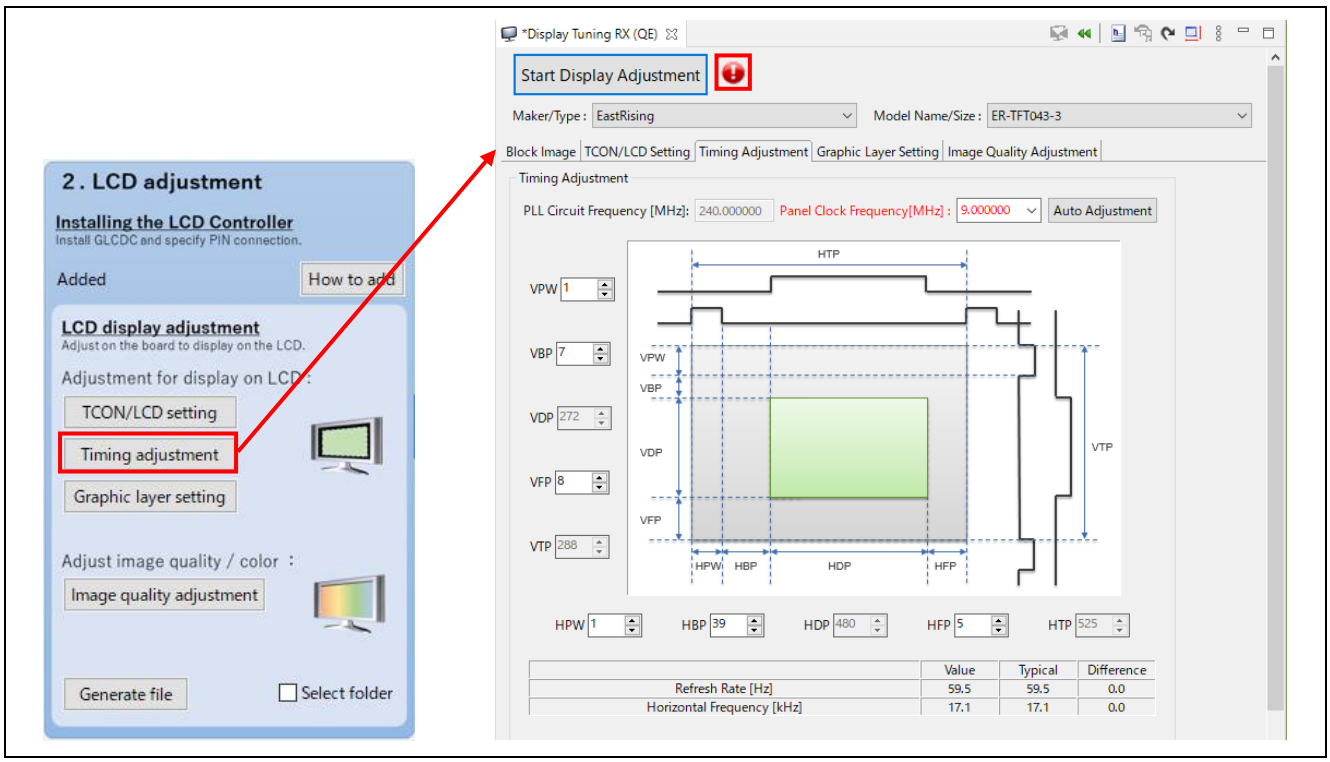
Table 4-5 Example of Timing Settings when the Panel Clock Frequency is 10 MHz (for Envision RX72N and Envision RX65N)

Connected Device	Item	Value
ER-TFT043-3	VPW	1
	VBP	7
	VDP	272
	VFP	8
	VTP	288
	HPW	14
	HBP	75
	HDP	480
	HFP	15
	HTP	584

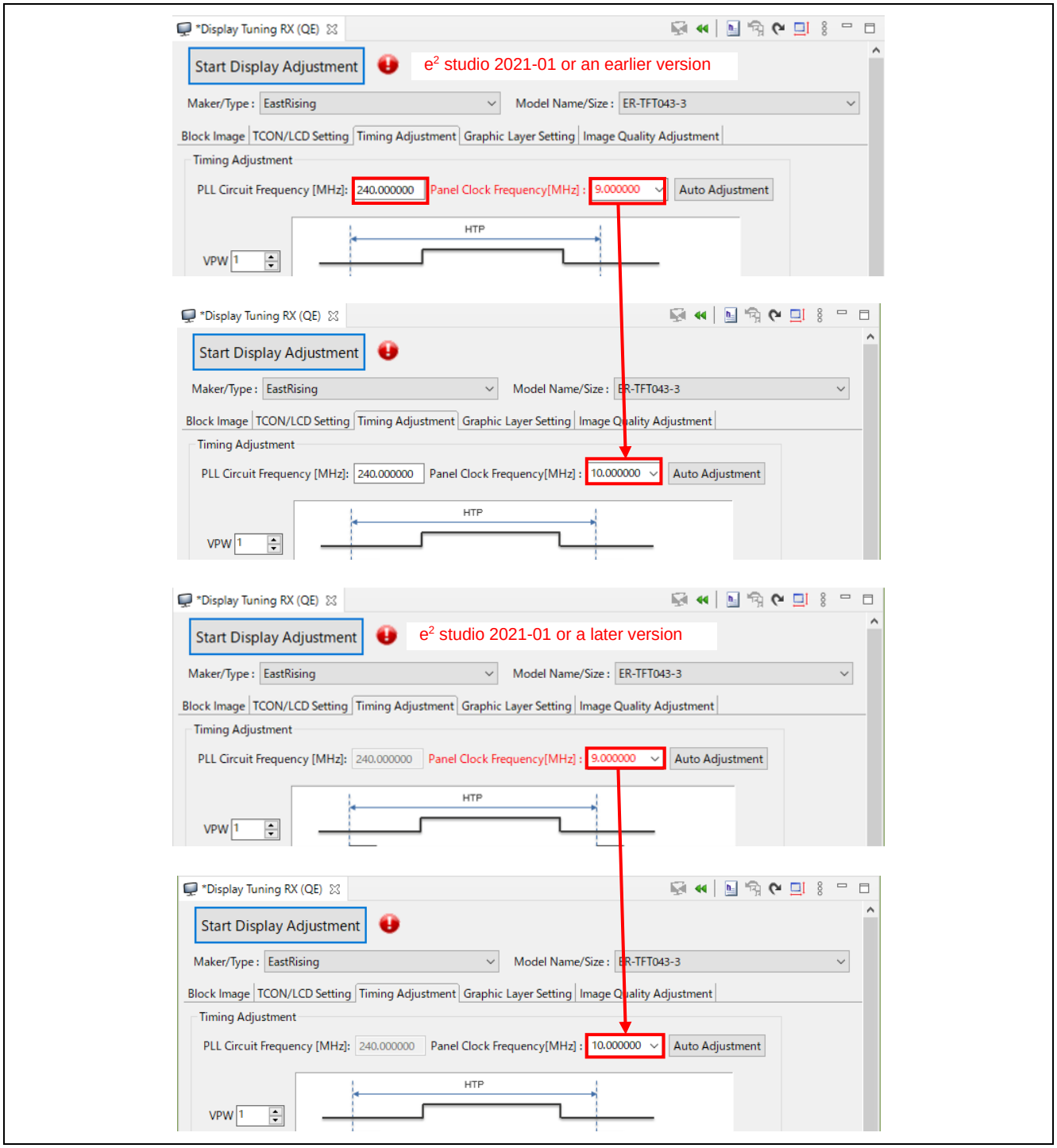
If you are using a custom board, set the values on the “Timing Adjustment” tabbed page such that no errors appear in the display.

Here, modify the values so that values for the horizontal frequency that are in error produce normal results after having modifying the value for the panel clock frequency.

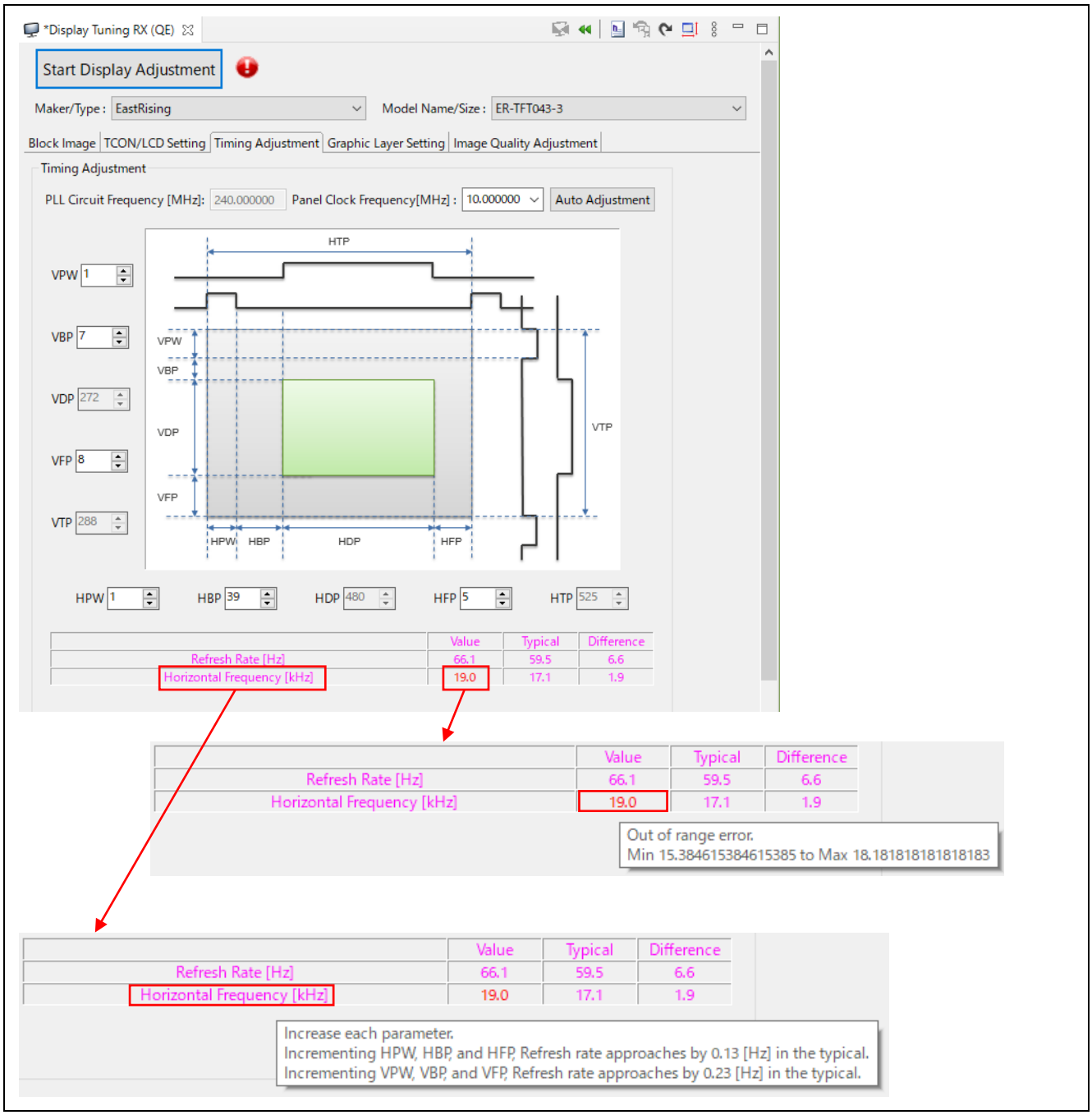
10. Click on “Timing adjustment”.
11. The “Display Tuning RX (QE)” view of QE for Display [RX] opens. If a value has an error, an error mark is displayed. Modify the value so this error mark disappears.



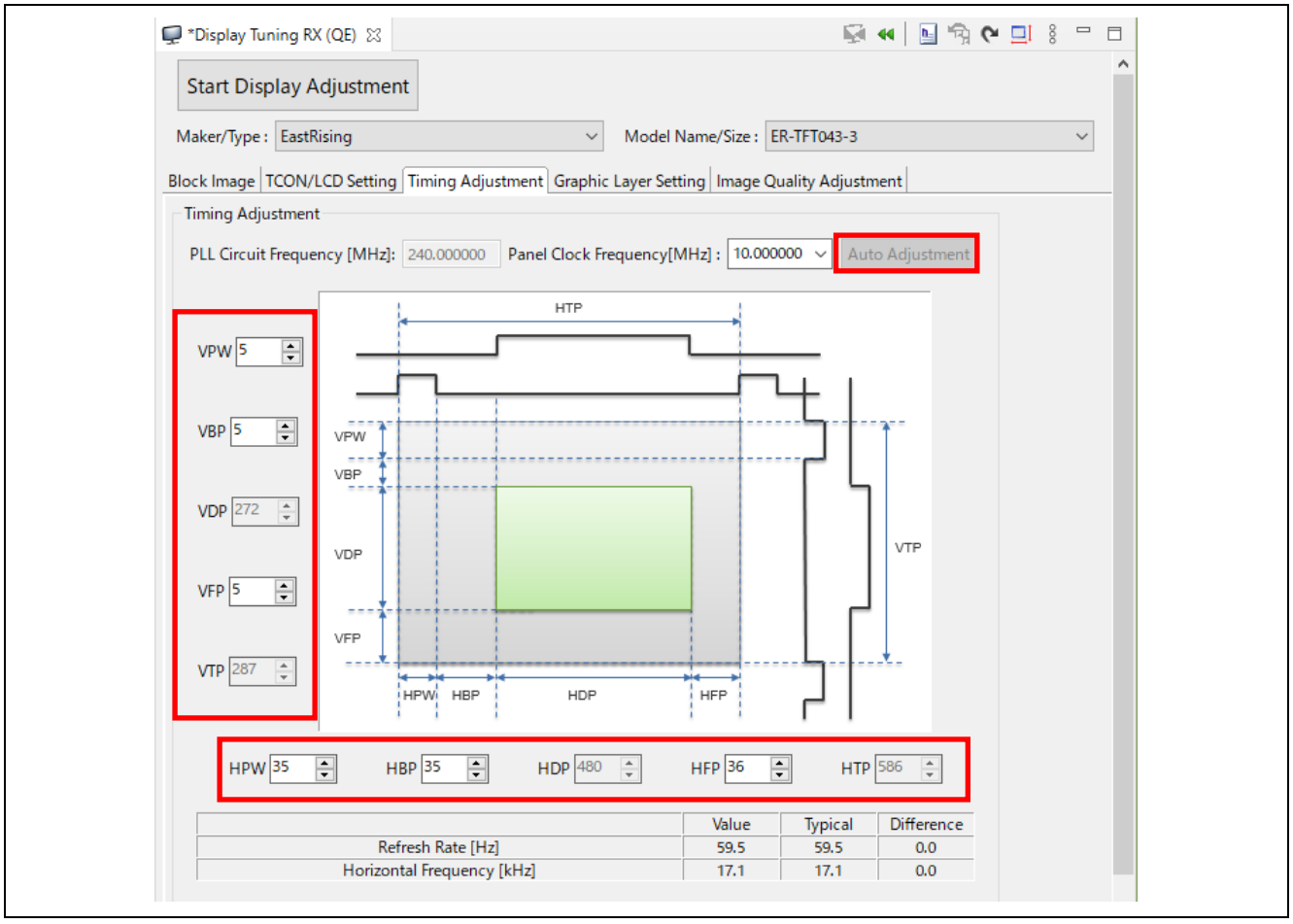
12. If you are using e² studio 2021-01 or an earlier version for the development environment, confirm that the value of “PLL Circuit Frequency [MHz]” matches the setting for the clock in the Smart Configurator.
    If you are using e² studio 2021-01 or a later version, you need not confirm the value of “PLL Circuit Frequency [MHz]” since that value is automatically obtained by the Smart Configurator.
    After that, adjust the value of “Panel Clock Frequency [MHz]”, which is displayed in red to indicate that it is in error.
    Here, select “10.000000”, which is the nearest available value to the 9.0 MHz panel clock frequency for the LCD, from the combo box.



13. Setting the value of the panel clock frequency to 10.0 MHz makes the value of “Horizontal Frequency [kHz]” incorrect, so it is displayed in red.
    Hovering the mouse cursor over the erroneous value (the value of “Horizontal Frequency [kHz]”) displayed in red produces a display of the range of specifiable values.
    Hovering the mouse cursor over the label (“Horizontal Frequency [kHz]”) for the erroneous value produces a display of a description of how to eliminate the error.

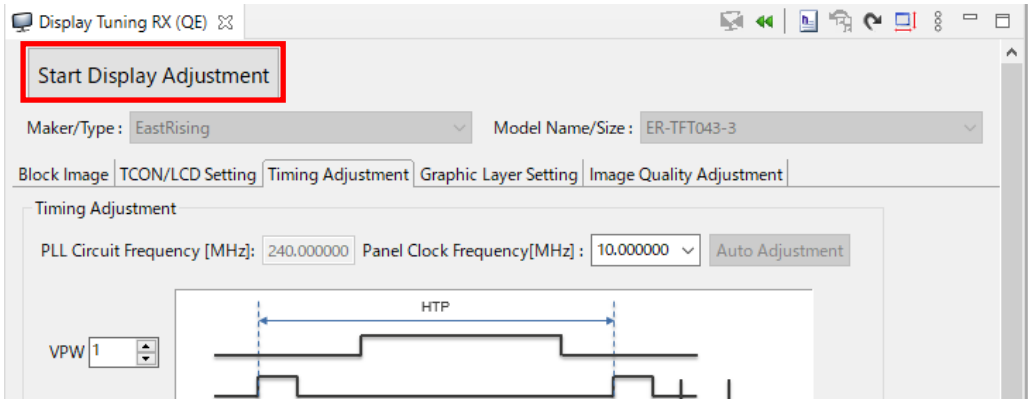


14. Clicking on the “Auto Adjustment” button to the right of “Panel Clock Frequency [MHz]” automatically sets each value so that the refresh rate and the horizontal frequency are within the range of specifiable values at the specified panel clock frequency.
Once there are no errors, the “Auto Adjustment” button becomes inactive.



The settings of the LCD can be adjusted by the GUIs for the display adjustment facilities while confirming the results on the actual display. The following shows an example of the adjustment of brightness from the “Image Quality Adjustment” tabbed page.

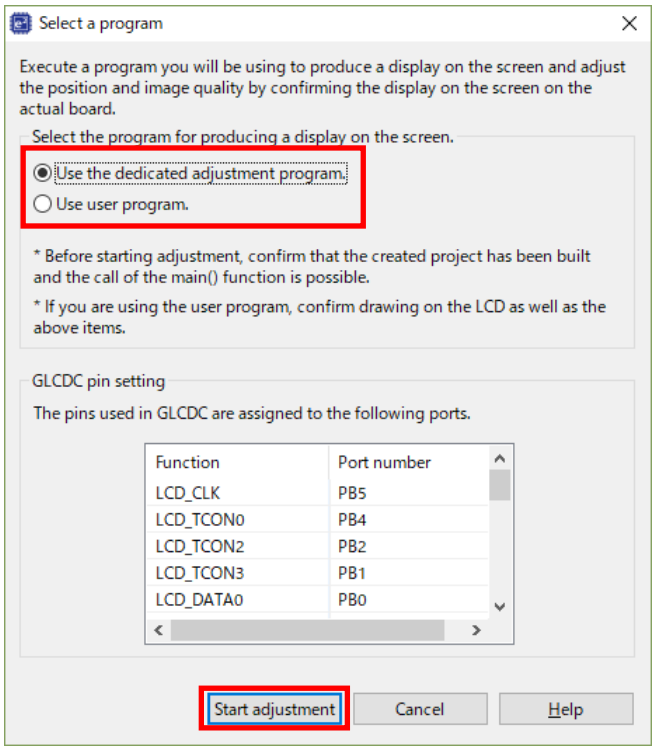
15. Build a project with reference to section 4.5, Building the Project.
16. Make the settings for the debugger and connect the board with reference to section 4.6, Connecting a Debugger and Executing the Program.
17. Click on the “Start Display Adjustment” button.



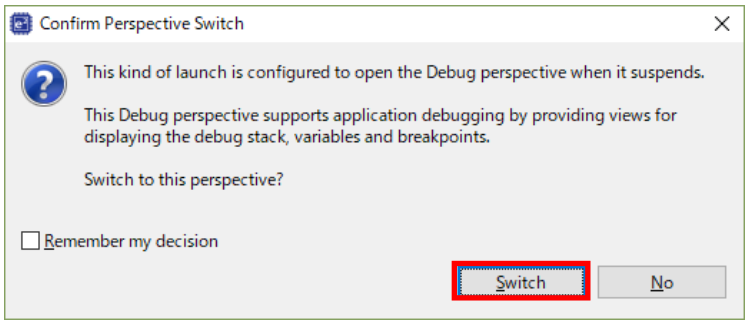
18. In the “Select a Program” dialog box, click on the “Start adjustment” button after selecting either of the following:

- “Use the dedicated adjustment program.”: when setting up the state of the GLCDC for the LCD panel has not been completed
- “Use user program.”: when setting up the state of the GLCDC for the LCD panel has been completed

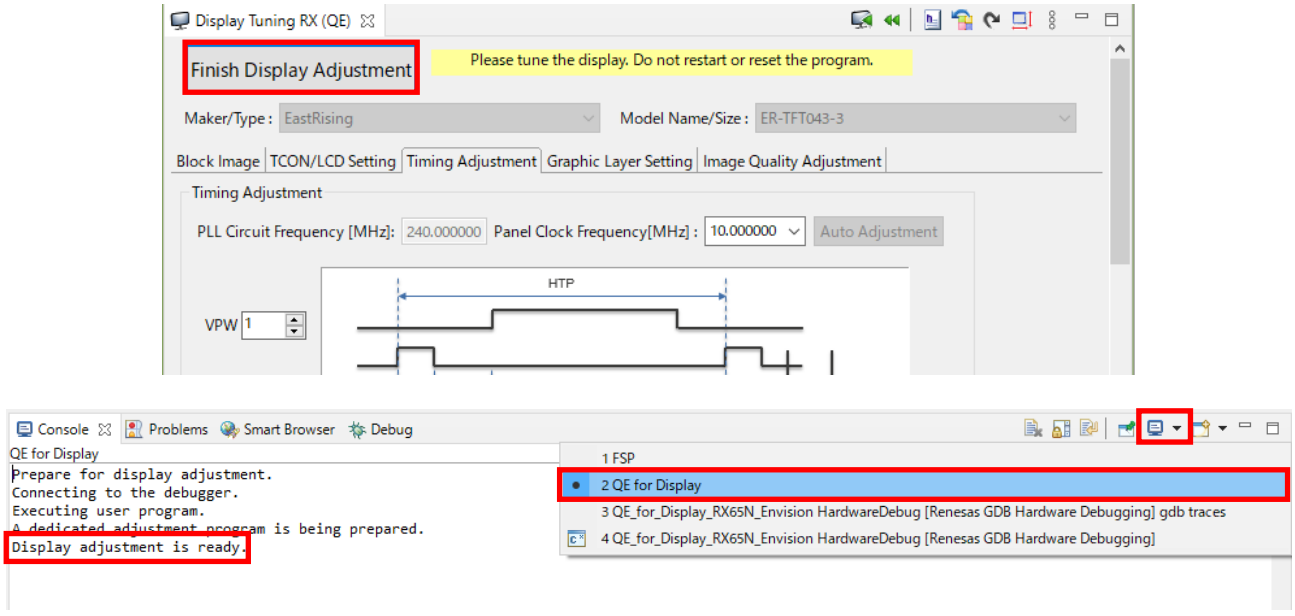
If the board has not been connected to the debugger, clicking on “Start adjustment” starts the connection.



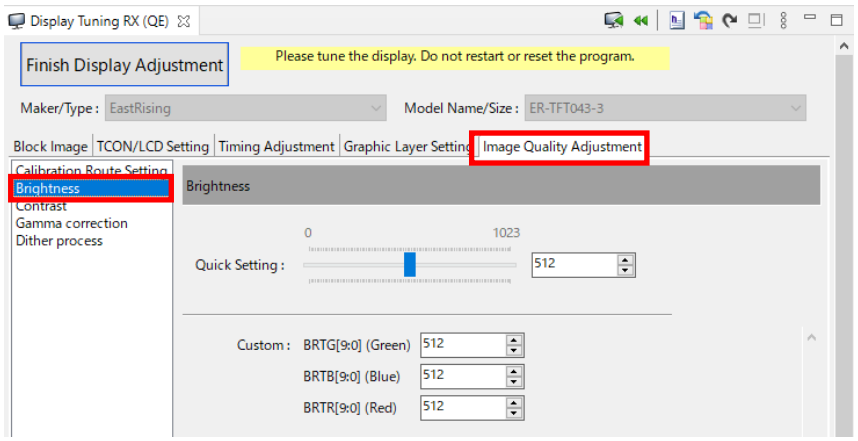
19. When the following message is displayed, click on “Switch”.



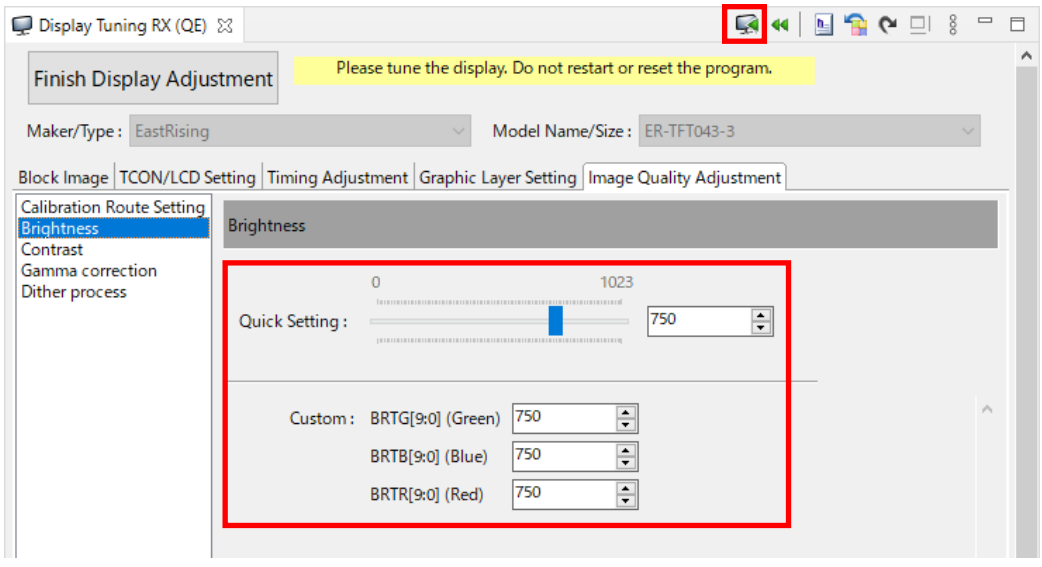
20. When the board is connected to the debugger and adjustment of the display is started, the “Start Display Adjustment” button is replaced by the “Finish Display Adjustment” button and the message “Display adjustment is ready.” appears in the console of QE for Display. When the console of QE for Display is not displayed, click on the “Display Selected Console” icon ( ) and select “QE for Display”.



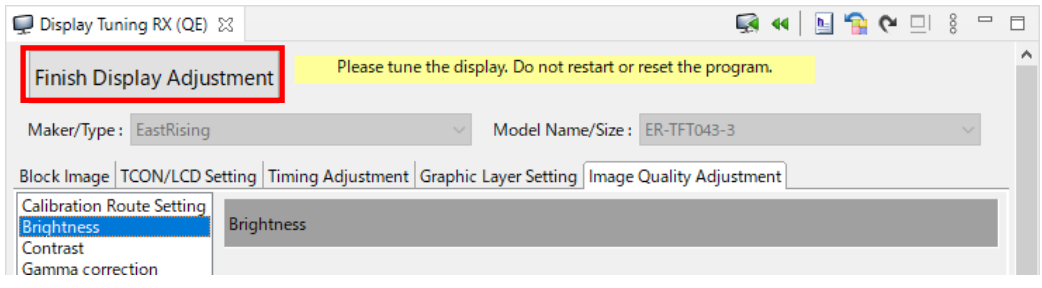
21. Select the “Image Quality Adjustment” tabbed page in the “Display Tuning RX (QE)” view, then select “Brightness” from the menu to the left.



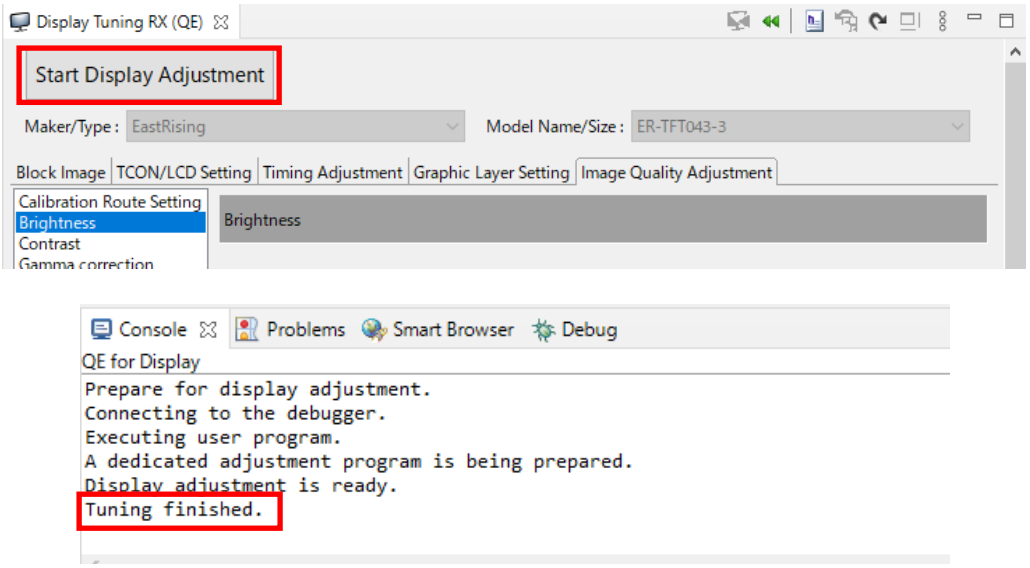
22. Modify the value for the gauge of “Quick Setting:” or the values of “Custom:” and click on the “Set the Register” icon ( ).
The values are set in the registers and can be confirmed on the display of the connected board.
Repeat modification of the values and settings of the registers until the display is as expected.
The display can be confirmed by showing an image. For details on displaying an image, refer to section 6.7, Image-Downloading Facility.



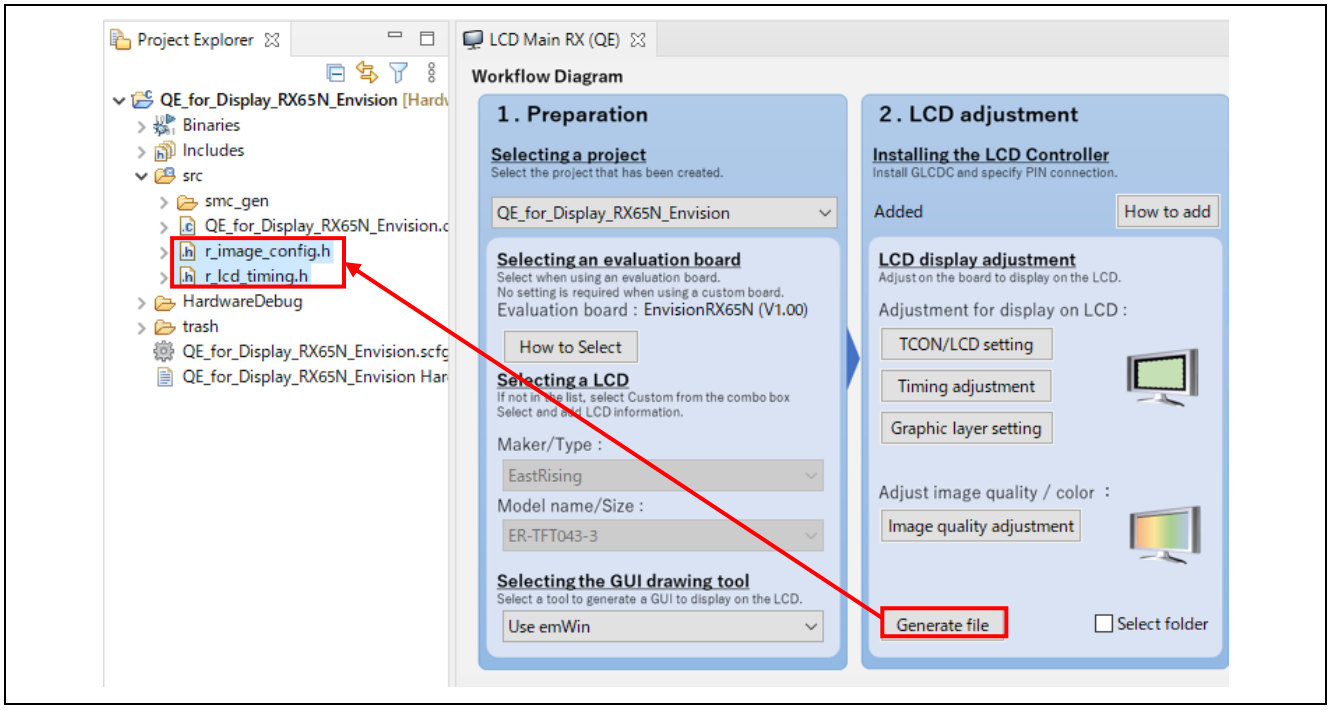
23. After you have finished adjusting the values, click on the “Finish Display Adjustment” button.



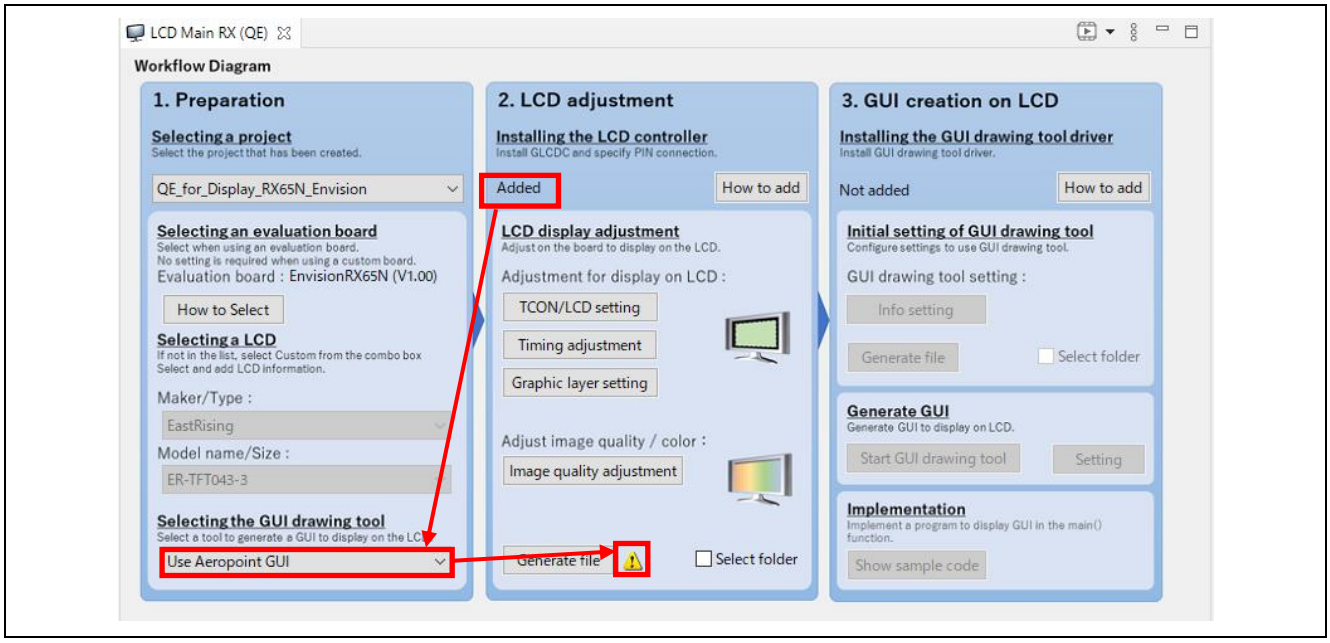
24. The board is disconnected from the debugger and the “Start Display Adjustment” button is restored to replace the “Finish Display Adjustment”.
    The message “Tuning finished.” appears in the console of QE for Display.



25. Header files reflecting the results of adjusting the display are then output.
Click on the “Generate file” button to output r_image_config.h and r_lcd_timing.h. They are output to src immediately under the project folder by default. The output destination folder can be changed by selecting the “Select folder” checkbox.
The path for including the output header files is also automatically added.

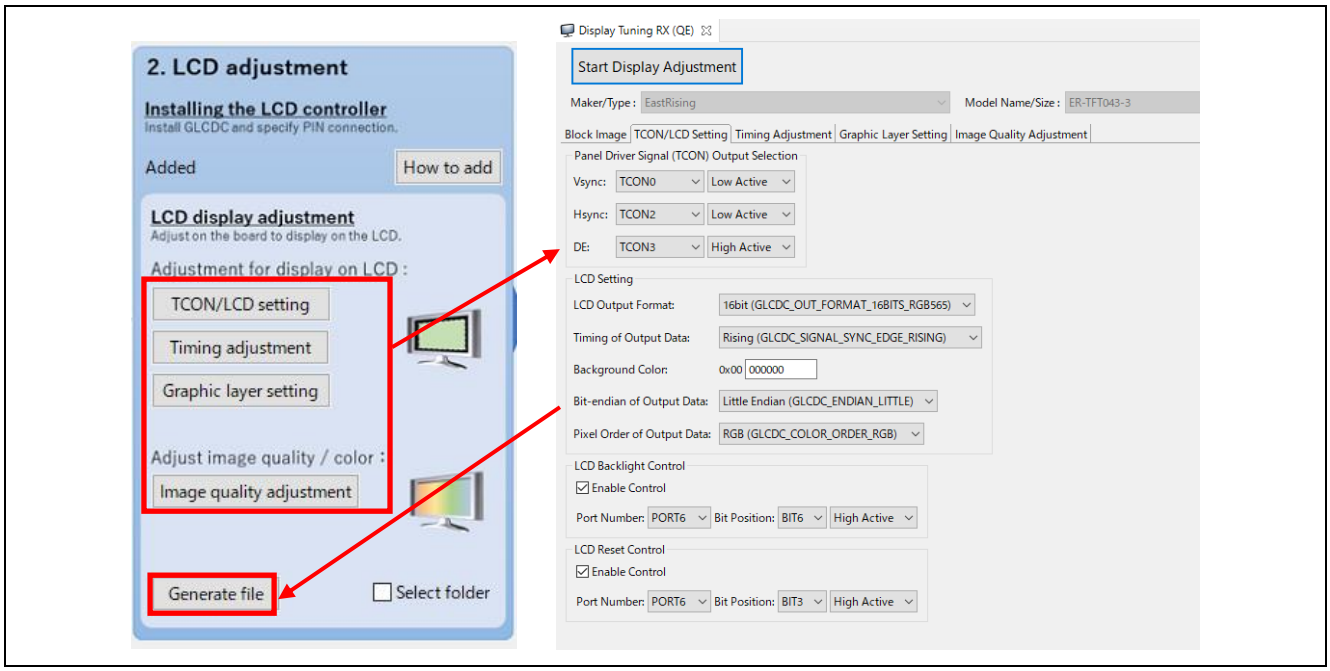


Note: If the GUI drawing tool is changed from emWin to Aeropoint GUI or vice versa after the LCD controller (GLCDC FIT module) has been installed as described in section 4.4.2, LCD Adjustment, a warning message will be displayed to prompt output of the file again since the settings of the GLCDC FIT module differ between emWin and Aeropoint GUI.
In such cases, reflect the changes of the settings of the GLCDC FIT module as shown below.



The settings of the GLCDC FIT module for emWin or Aeropoint GUI are reflected when the “Display Tuning RX (QE)” view is opened. Open this view by clicking on a button such as “TCON/LCD setting”.

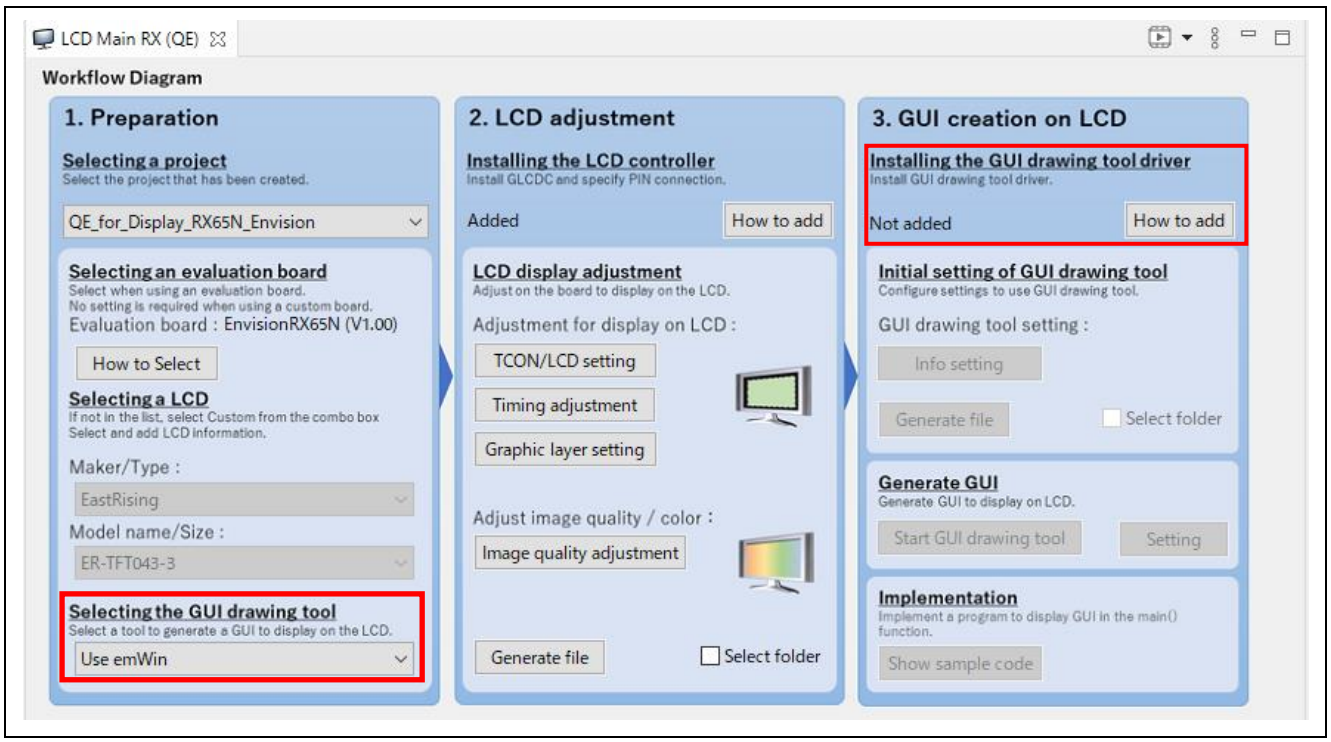
After that, click on the “Generate file” button to output the file again. After the file has been output, the changed settings are reflected and the warning message disappears.



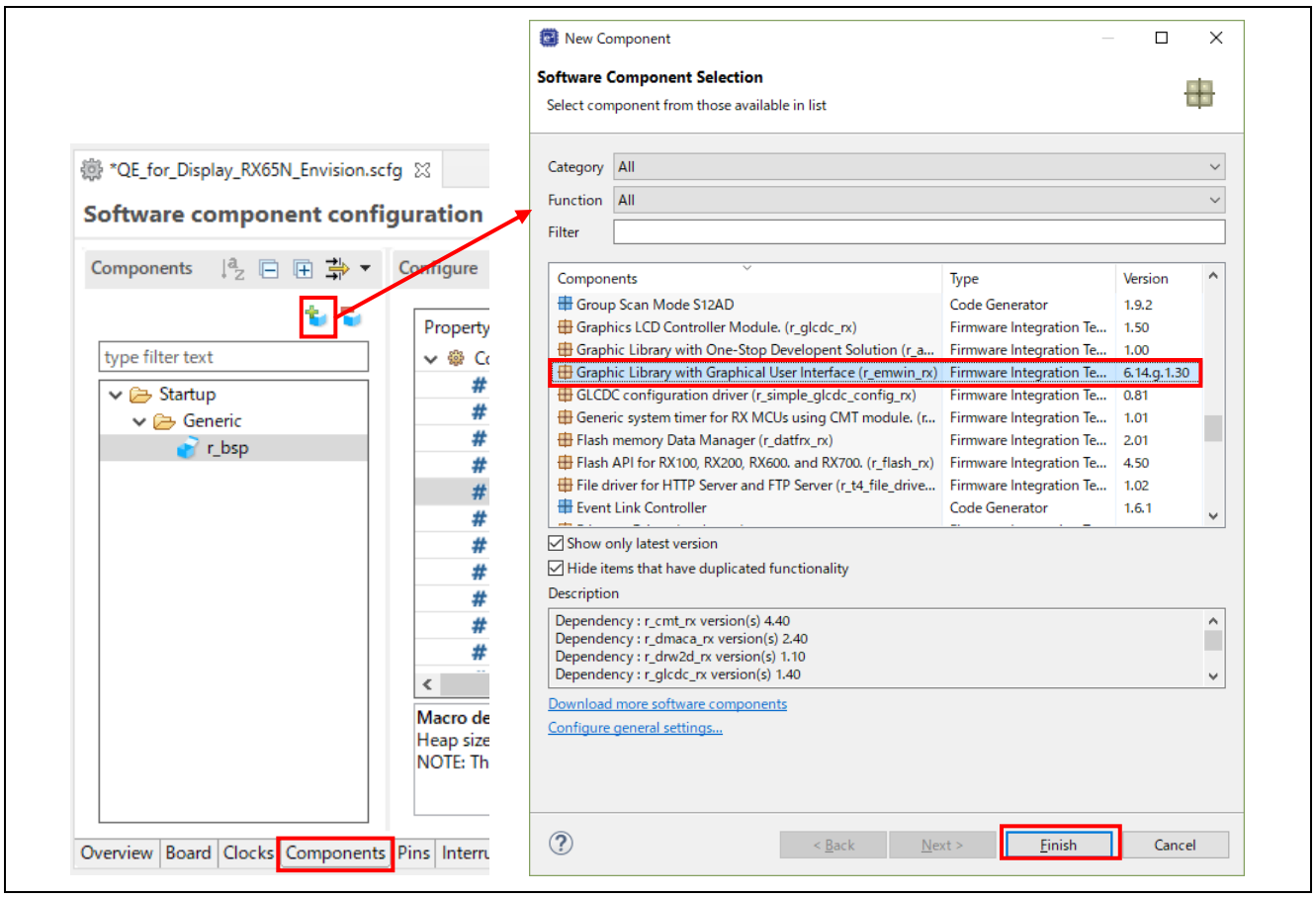
4.4.3 Using emWin to Create a GUI for an LCD

This section describes how to install the GUI drawing tool when “Use emWin” is selected for “Selecting the GUI drawing tool”.

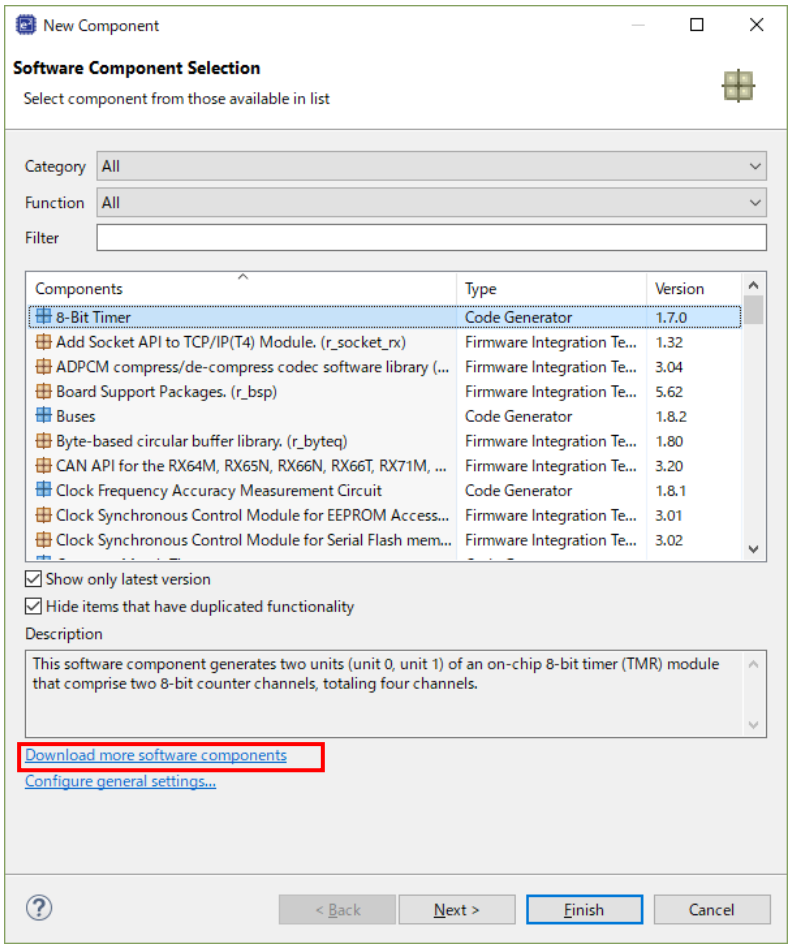
For the method when “Use Aeropoint GUI” is selected, refer to section 4.4.4, Using Aeropoint GUI to Create a GUI for an LCD.



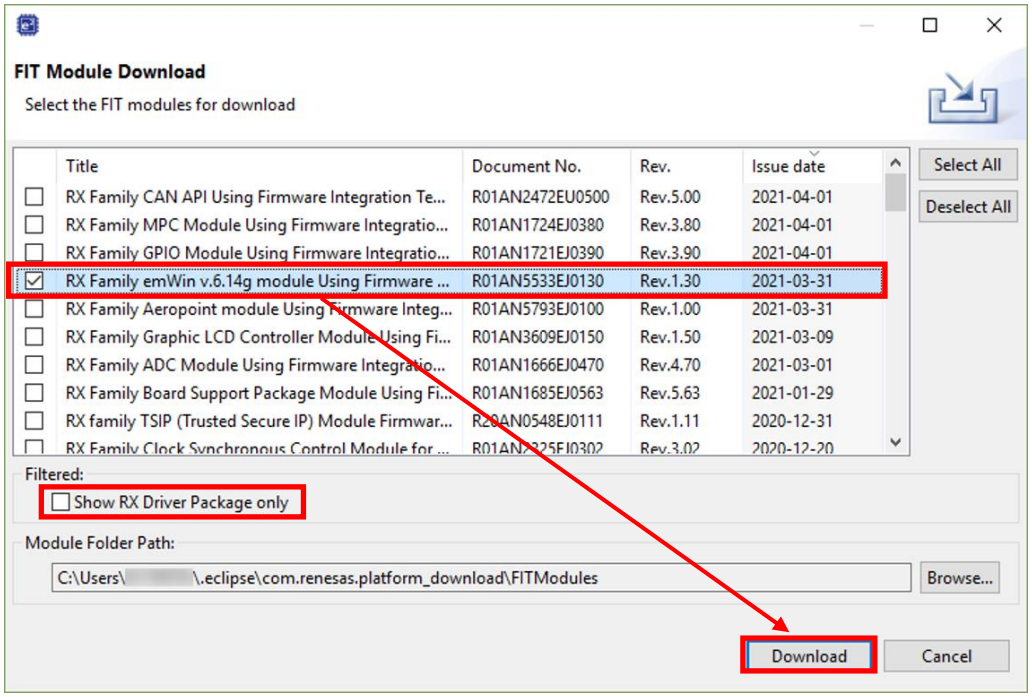
1. Select the “Components” tab of the Smart Configurator and click on the “Add component” icon.
2. In the “New Component” dialog box, select “Graphic Library with Graphical User Interface (r_emwin_rx)” (version 6.14.g.1.30 or a later version) and click on the “Finish” button.



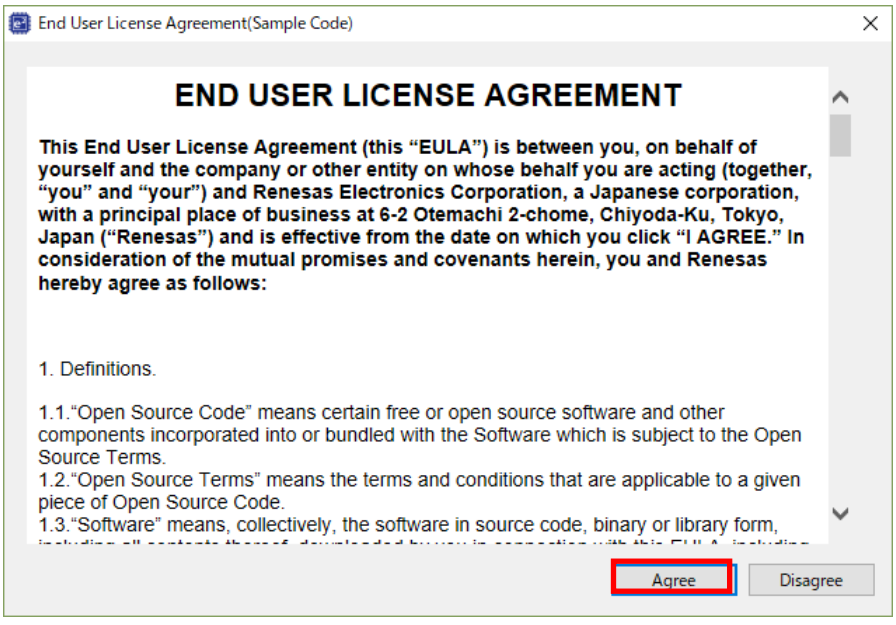
3. If the graphic library is not displayed in the list of components in the “New Component” dialog box, click on “Download more software components”.



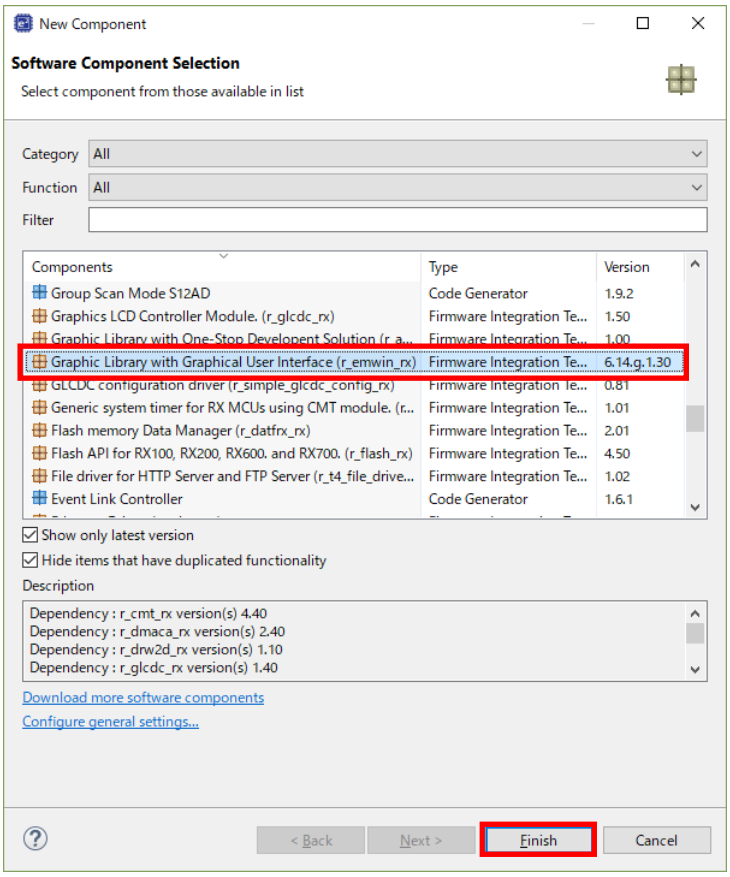
4. In the “FIT Module Download” dialog box, remove the check against “Show RX Driver Package only” and select “RX Family emWin v6.14 module” (Rev.1.30 or a later version).
5. Click on “Download”.



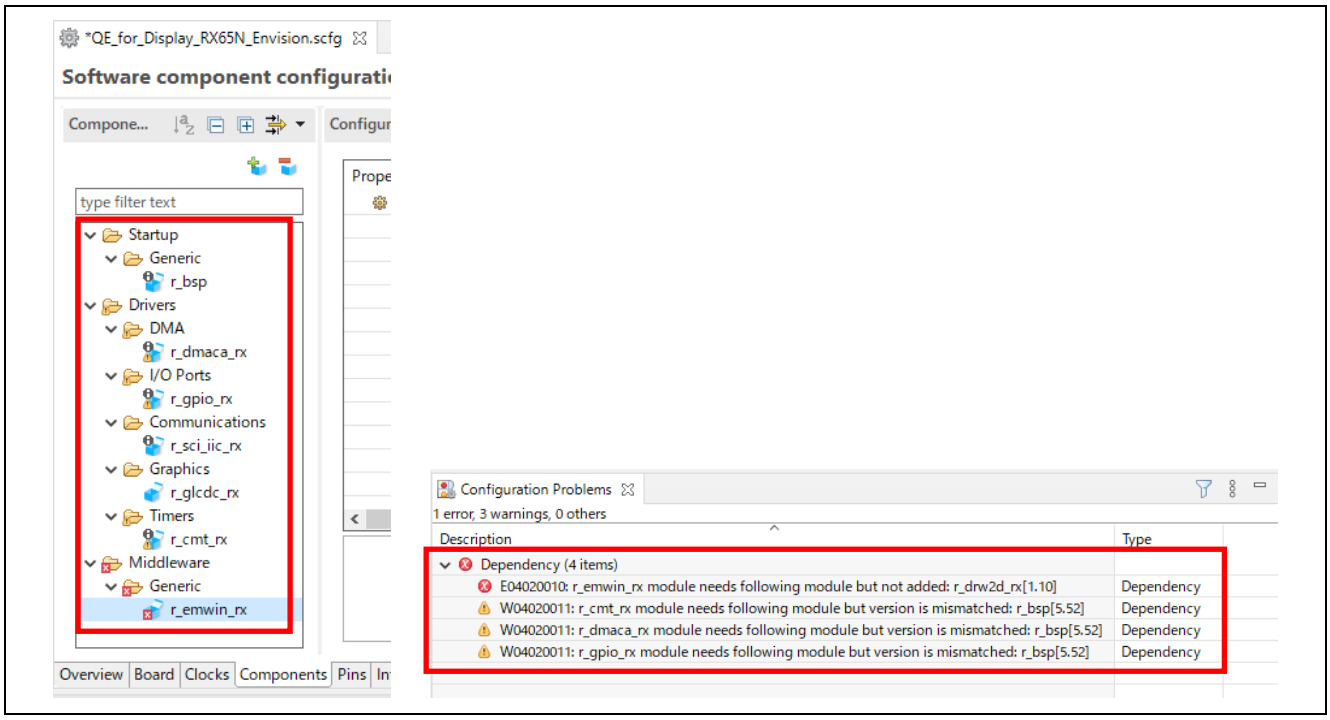
6. Read the description in the “End User License Agreement (Sample Code)” dialog box. If you agree, click on “Agree”.



7. When “Graphic Library with Graphical User Interface (r_emwin_rx)” is displayed in the list of components, select it and click on the “Finish” button.

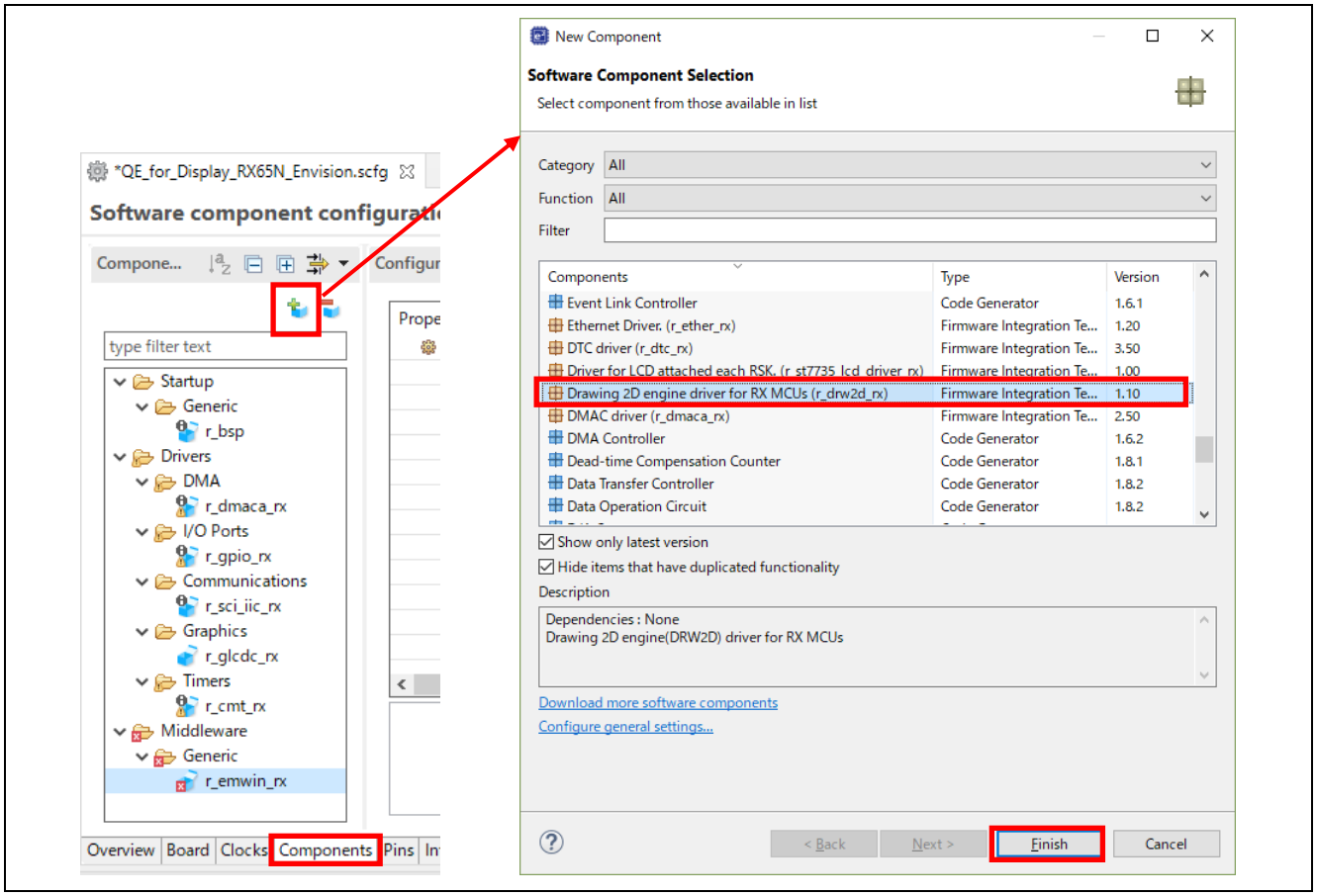


8. Components the added component having dependencies with is automatically added. However, a component that has not been added or a component with a version that differs from the required one will lead to an error message or a warning.
   In such cases, add the required component or update the version.
   The following shows the error message for a component that has not been added (r_drw2d_rx) and warning messages regarding the version of a component (r_bsp).



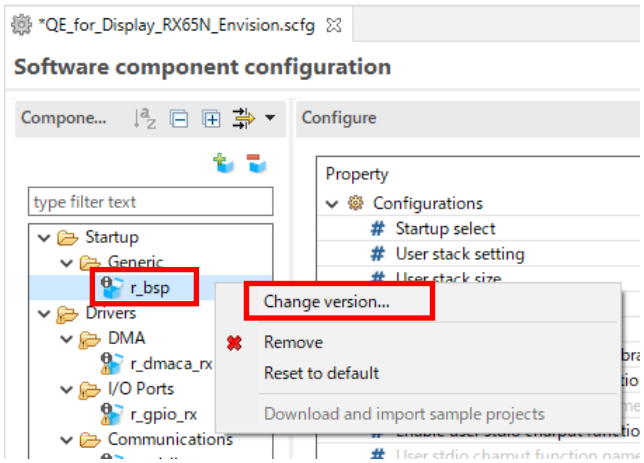
Add the required component (r_drw2d_rx).

9. Select the “Components” tab and click on the “Add component” icon.
10. In the “New Component” dialog box, select “Drawing 2D engine driver for RX MCUs (r_drw2d_rx)” and click on the “Finish” button.
    If the component is not in the list of components in the “New Component” dialog box, click on “Download more software components”.

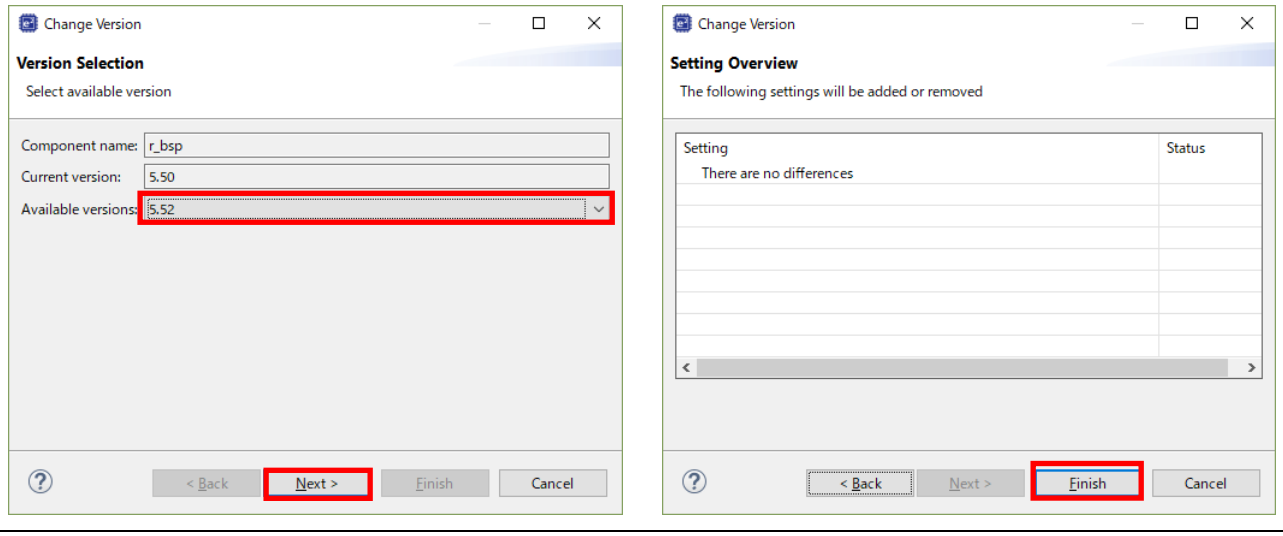


Update the component to the required version (r_bsp_rx).

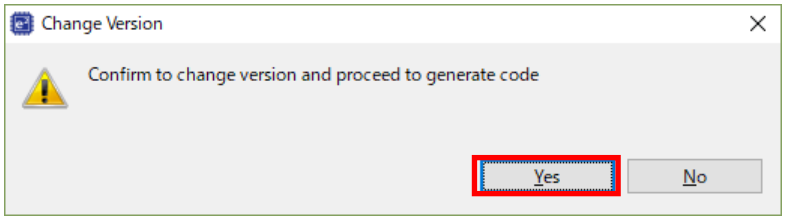
11. Right-click on the component for r_bsp and select “Change version”.



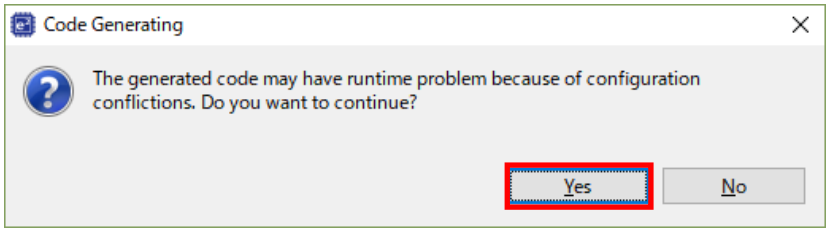
12. Confirm “Available versions” in the “Change Version” dialog box and click on “Next”.
13. Confirm “Setting Overview” and click on “Finish”.



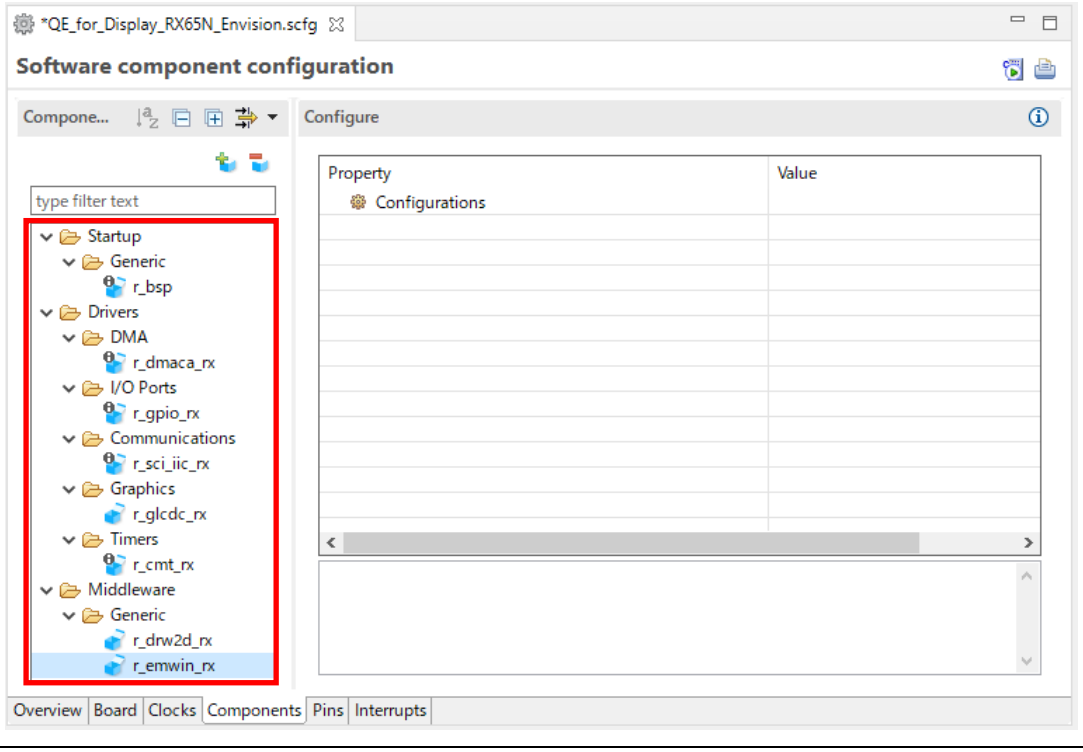
14. When the confirmation message is displayed in the “Change Version” dialog box, click on “Yes”.



15. When the confirmation message is displayed in the “Code Generation” dialog box, click on “Yes”.



16. The error and warnings regarding the dependencies of components have now been resolved.

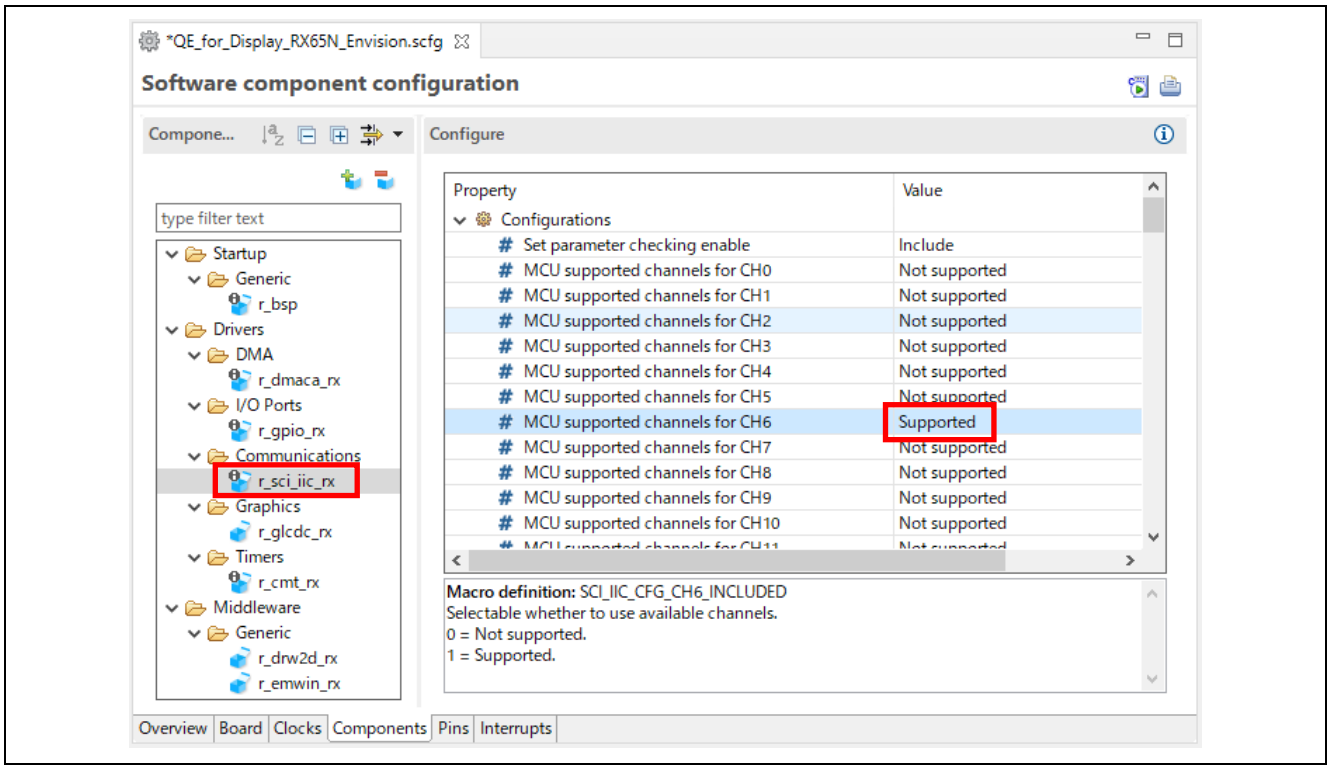


Set the IIC channel which is to be used with emWin.

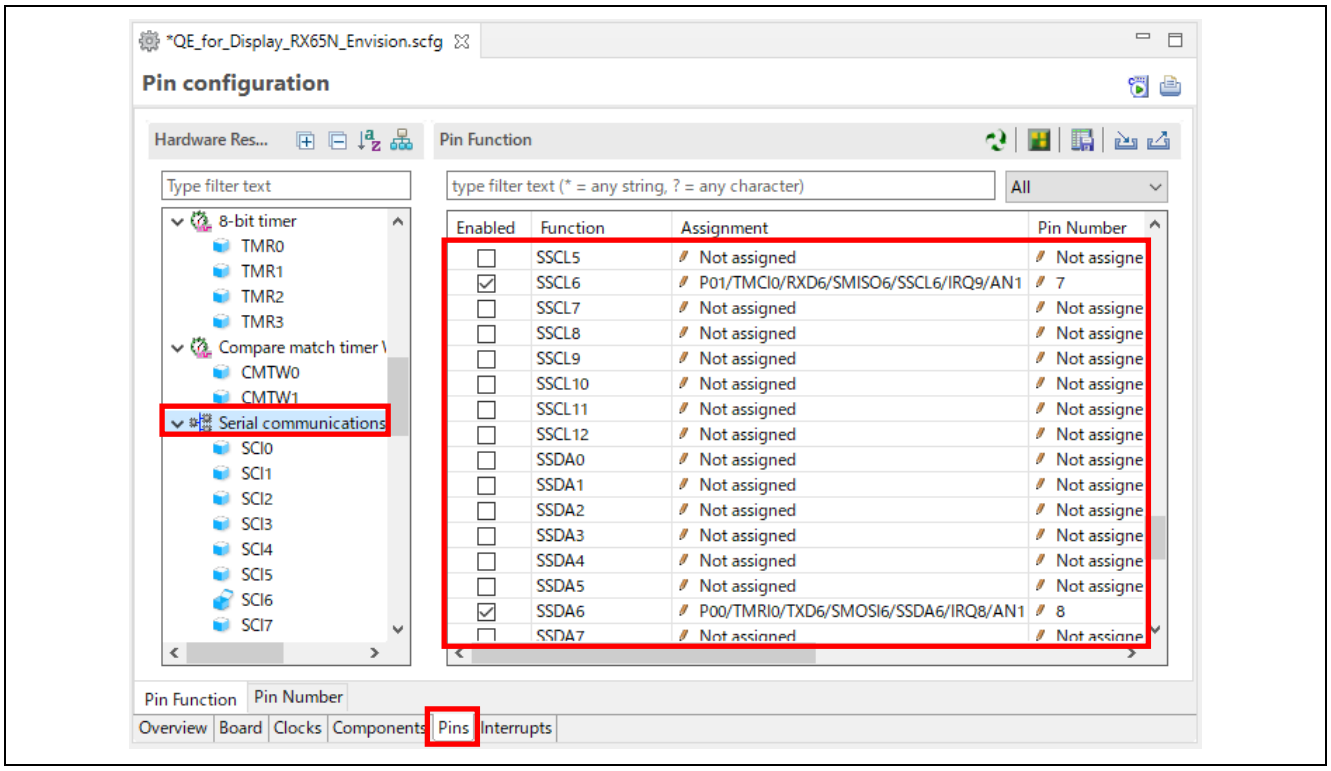
17. Select “r_sci_iic_rx” from the components.
18. Change the setting for the IIC channel which is to be used with emWin. Specify the value of “MCU supported channels for CHn” of the channel to be used as “Supported”.

Table 4-6 IIC Channel Numbers to be Used (Initial Values)

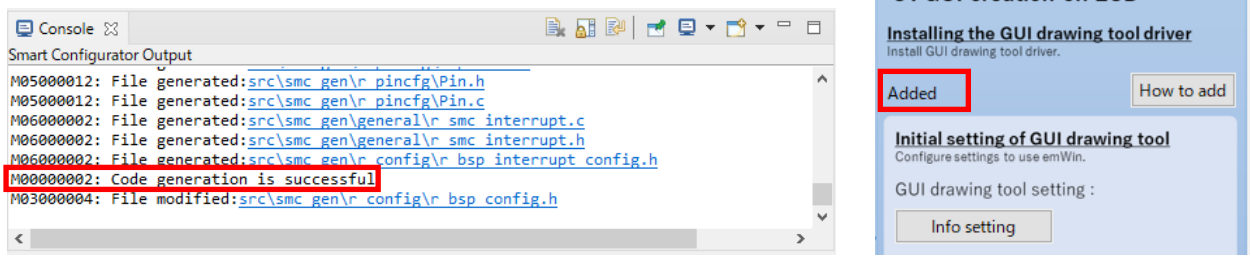
Evaluation Board	IIC Channel Number
RSK RX72N	11
Envision RX72N	6
RSK RX65N	7
Envision RX65N	6



19. When a board is selected in the creation of a project, setting the IIC channel to be used with emWin also sets the pins for use with the channel. Select “Serial communications interface” on the “Pins” tabbed page to confirm the settings of the pins. Set the pins here if you are using a custom board.

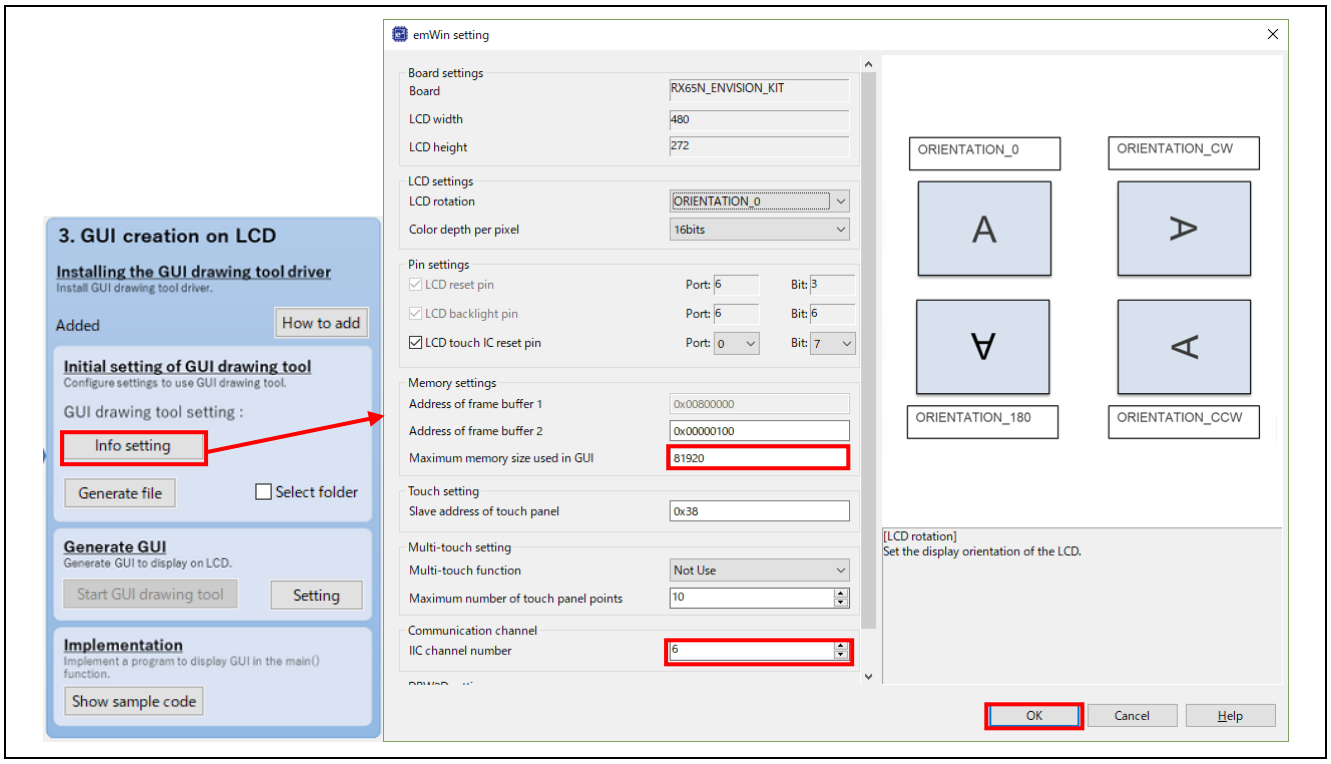


20. When the pins have been set, click on the “Generate Code” button in the upper-right corner of the window. The code is generated according to the settings.
21. After code generation is finished, “Added” is displayed immediately below “Installing the GUI drawing tool driver”.

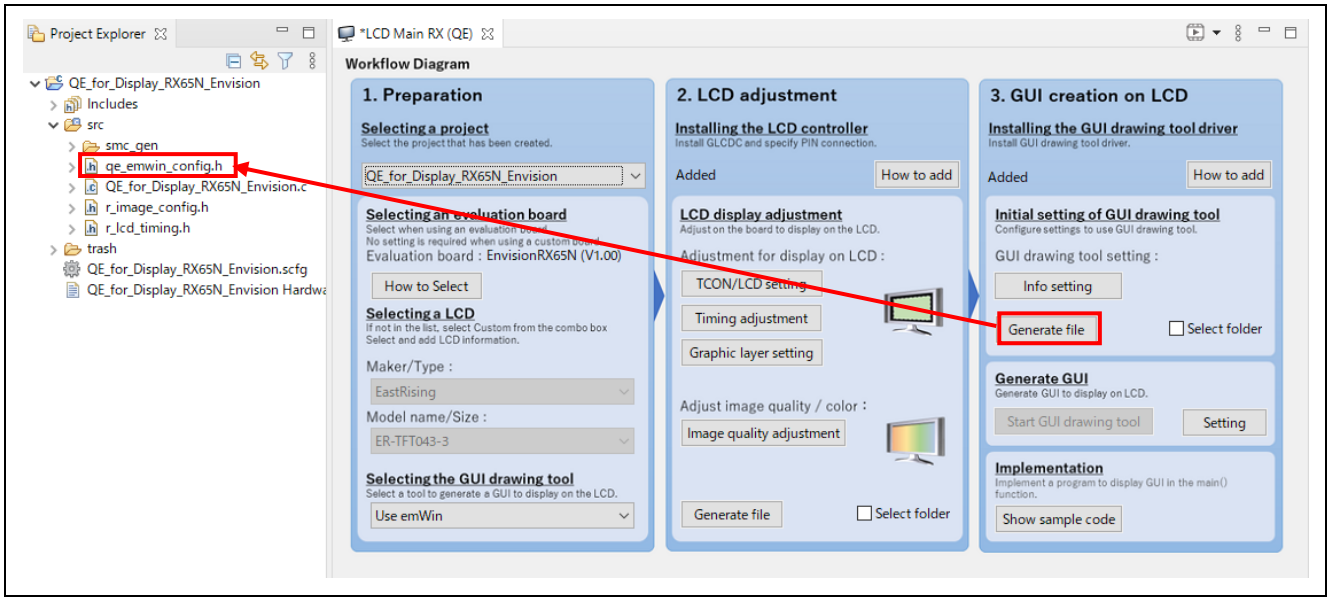


Make the initial settings for the GUI drawing tool.

22. Clicking on the “Info setting” button displays the “emWin setting” dialog box.
23. Values are set according to the information on the board selected in the project.
    For “Maximum memory size used in GUI”, “81920 bytes” (80 * 1024) is set by default. However, if you create a graphical GUI, 102400 bytes (100 * 1024) or more are usually required.
    For “IIC channel number”, the channel number must match that specified as “Supported” by the “r_sci_iic_rx” component in the Smart Configurator.
    For details, refer to the explanation produced by clicking on the “Help” button.
    Confirm the settings and click on the “OK” button to close the dialog box.



24. A header file reflecting the initial settings for the GUI drawing tool is output.
    Click on the “Generate file” button to output qe_emwin_config.h. It is output to src immediately under the project folder by default. The output destination folder can be changed by selecting the “Select folder” checkbox.
    The path for including the output header files is also automatically added.



25. If the address of the frame buffer which has been set in the “emWin setting” dialog box overlaps with section addresses, the section address must be changed.
    If the default value has been set, since the address of frame buffer 2 (0x00000100) means that the buffer overlaps with addresses of the SU and subsequent sections (from 0x00000004) in the RX65N RSK and RX65N Envision, the section address must be changed. However, it does not require changing in the RX72N RSK and RX72N Envision.

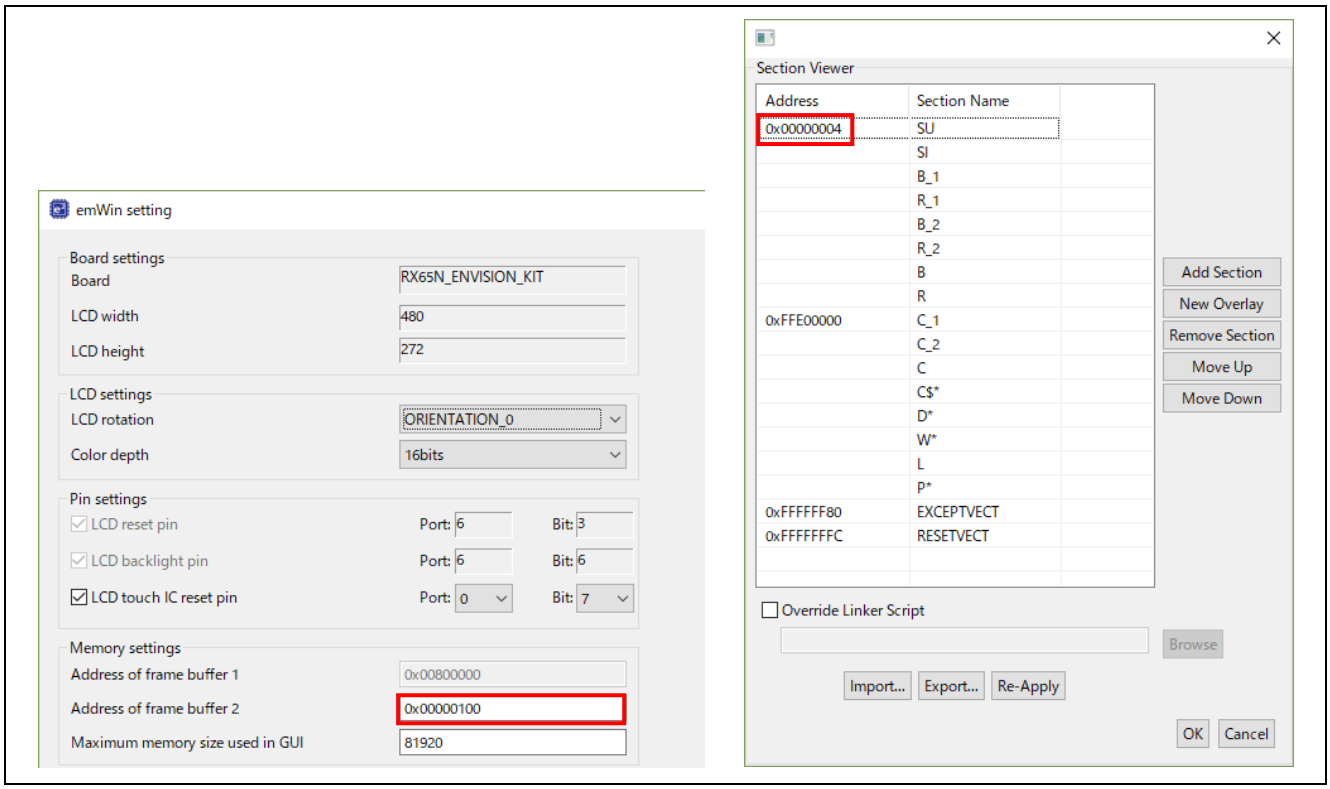


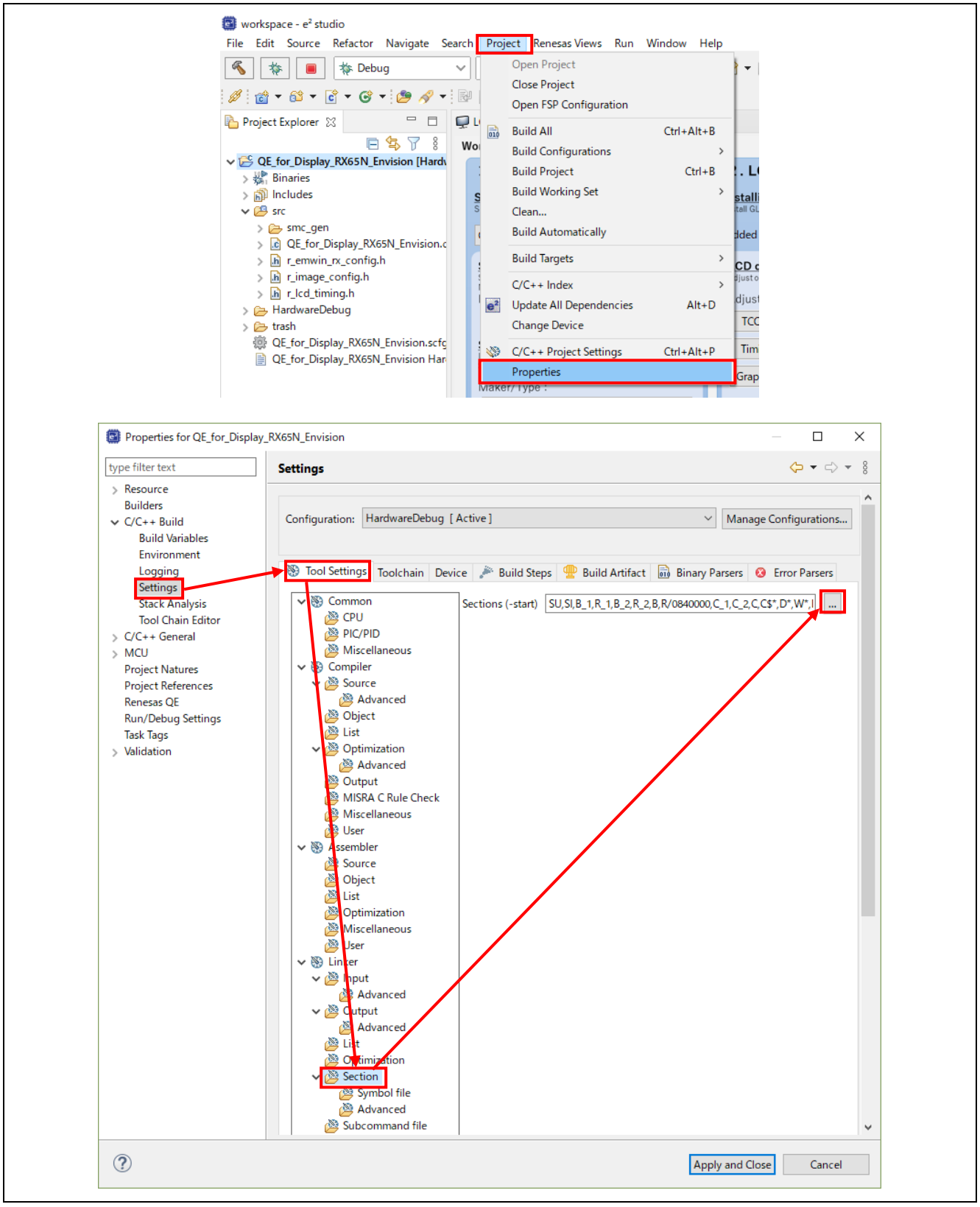
Table 4-7 Addresses of Frame Buffers (Initial Values)

Evaluation Board	Address of Frame Buffer 1	Address of Frame Buffer 2
RSK RX72N Envision RX72N	0x00800000	0x00840000
RSK RX65N Envision RX65N	0x00800000	0x00000100

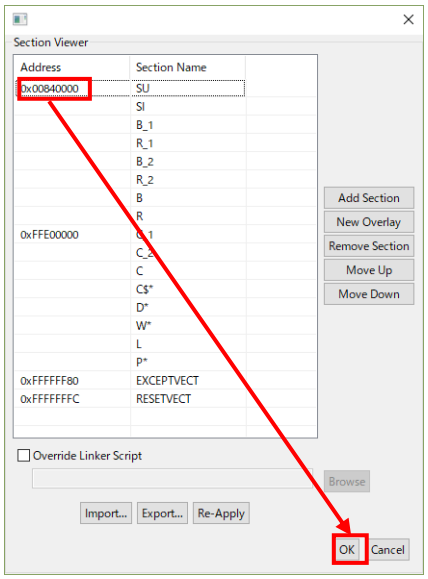
Table 4-8 Examples of the Change of Addresses of the SU and Subsequent Sections

Evaluation Board	Address of Section
RSK RX72N Envision RX72N	0x00000004 (initial value)
RSK RX65N Envision RX65N	0x00840000

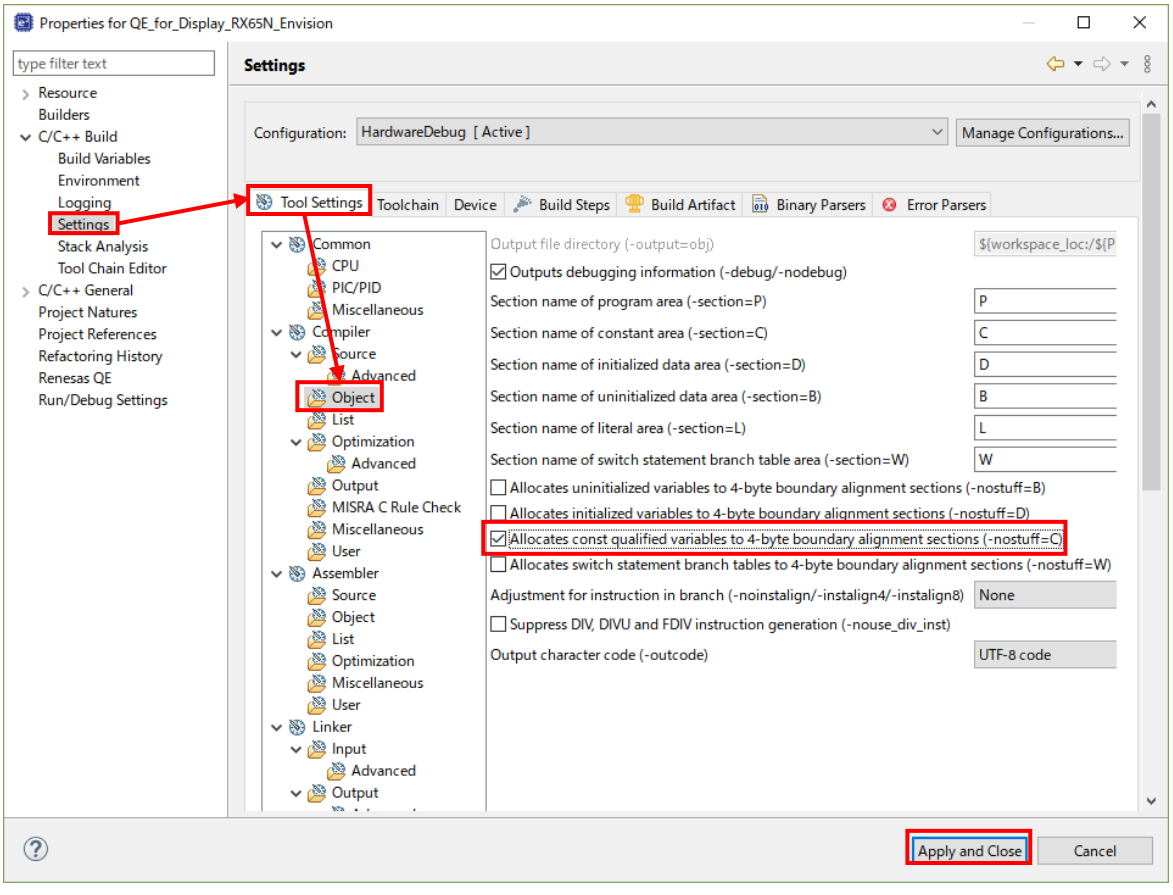
26. Select “Properties” under the “Project” menu to open the “Properties” window.
Select “Settings” in the “Properties” window then “Section” in the “Tool Settings” tabbed page. Click on the “Browse” button for “Section (-start)”.



27. Change the section address so that the addresses do not overlap with those of the frame buffer. Here, it is changed from “0x00000004” to “0x00840000”. Click on the “OK” button.

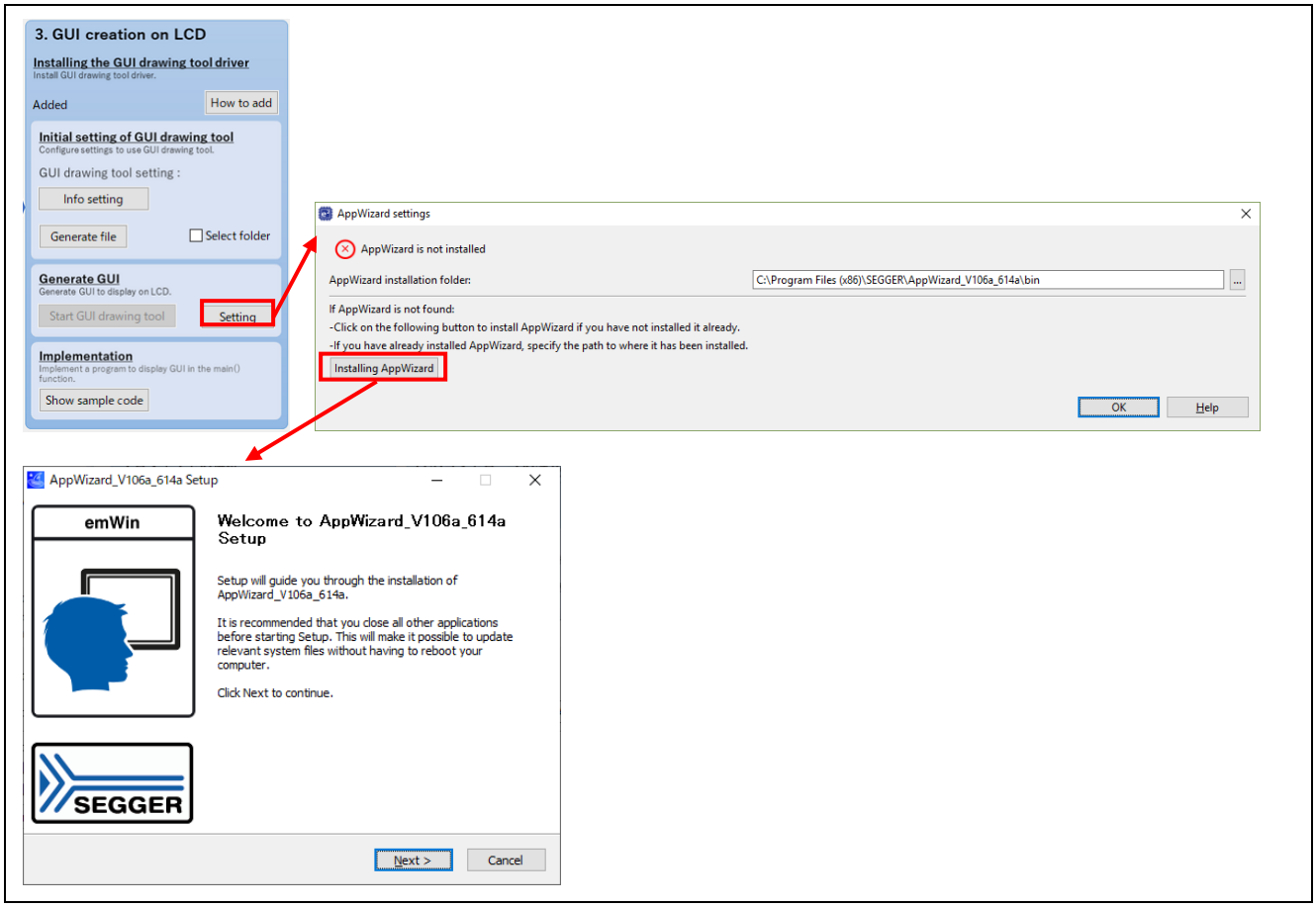


28. Change the compiler options to make the drawing engine work properly.
Select “Settings” in the “Properties” window then “Object” on the “Tool Settings” tabbed page. Select the “Allocates const qualified variables to 4-byte boundary alignment sections (-nostuff=C)” checkbox.
Click on the “Apply and Close” button for “Settings” in the “Properties” window.

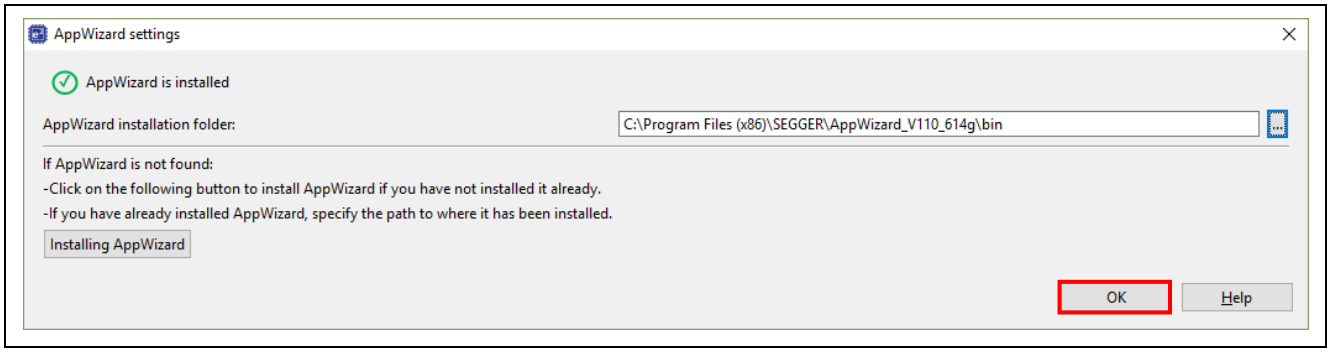


Install AppWizard, which is to be used to create the GUI.

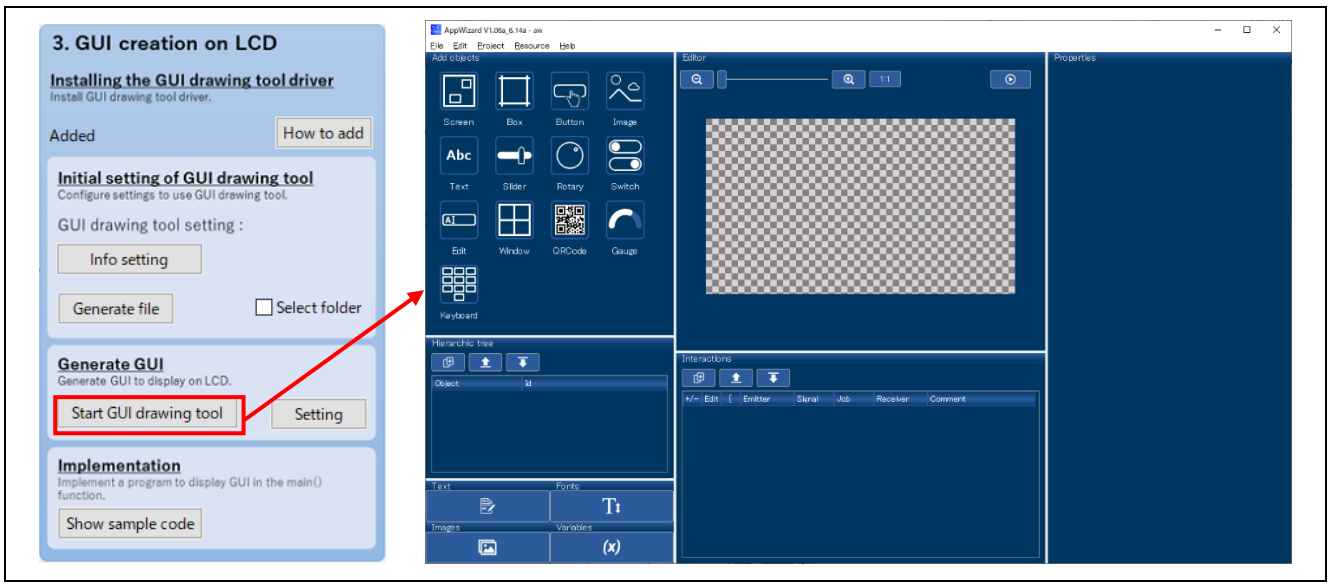
29. Click on the “Setting” button under “Generate GUI” to open the “AppWizard settings” dialog box.
30. Click on the “Installing AppWizard” button to install AppWizard by following the instructions of the AppWizard setup wizard that is displayed.



31. After having installed AppWizard, the state indicator of the “AppWizard settings” dialog box is changed to “AppWizard is installed”. Click on the “OK” button to close the “AppWizard settings” dialog box.

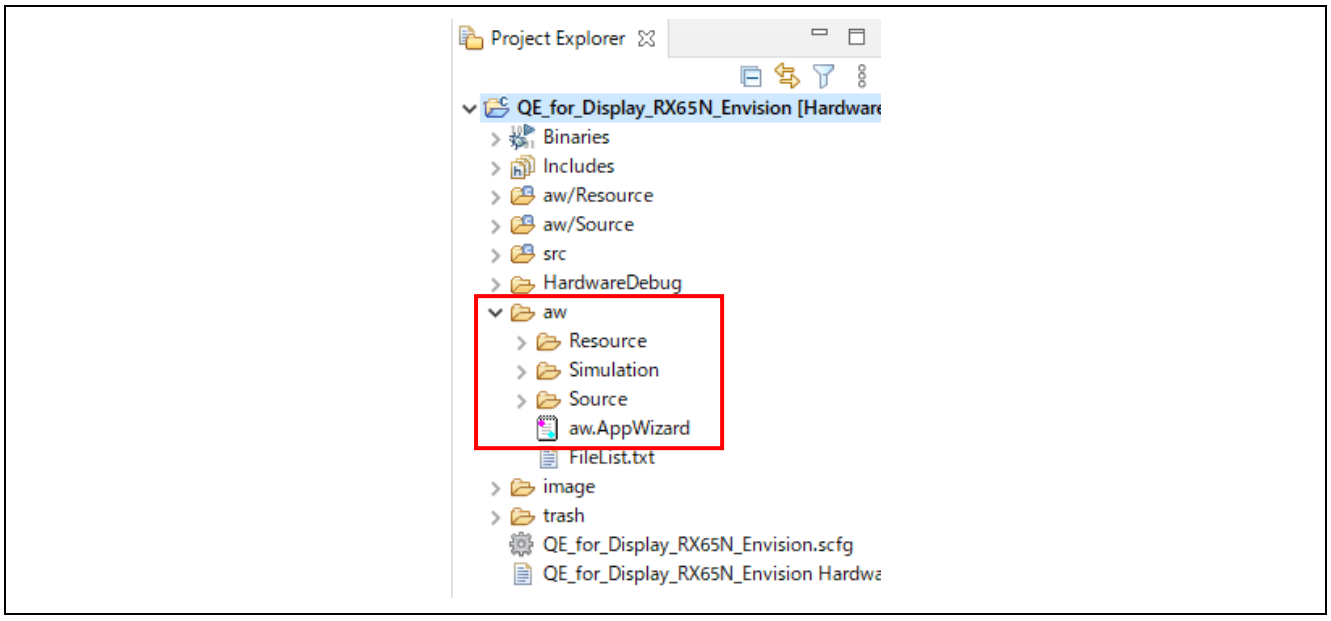


32. The “Start GUI drawing tool” button is now active.
Click on this button to start AppWizard.

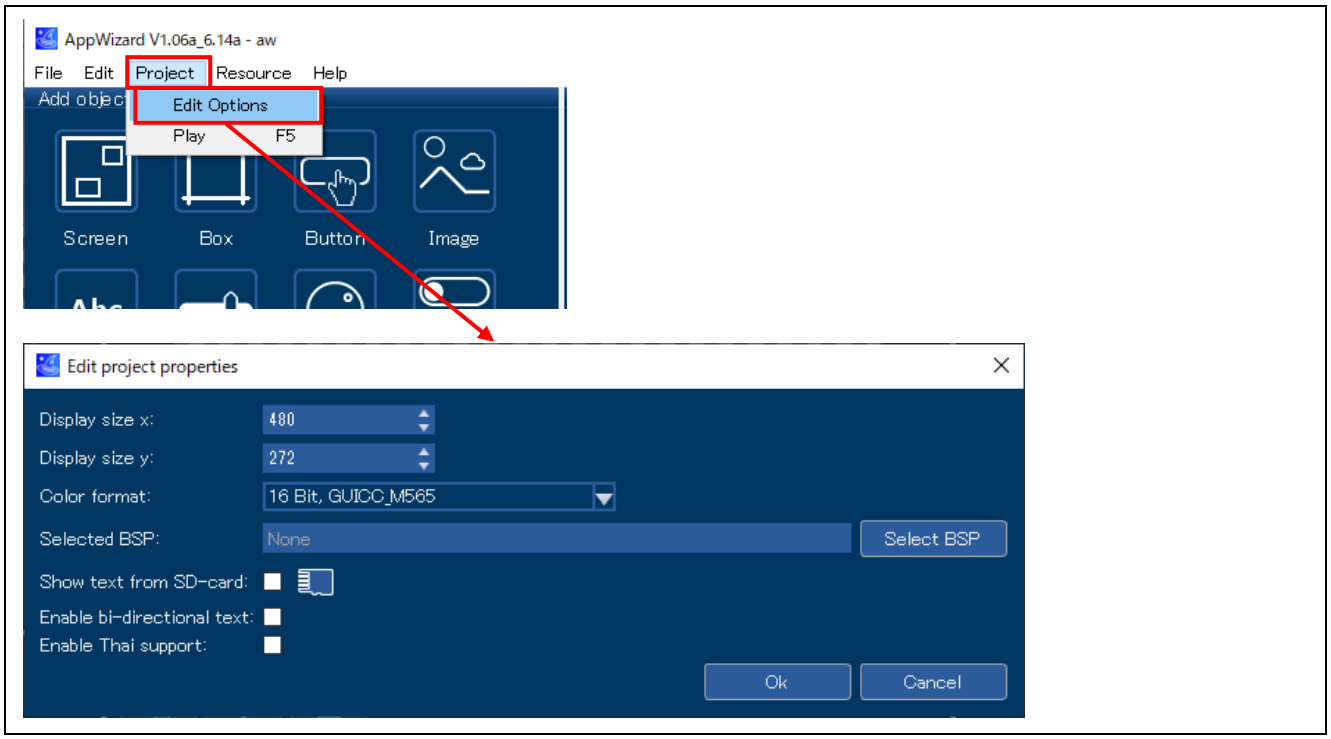


Note: The usage of AppWizard may differ from the way which is described in this application note due to changes to the specifications. For the usage of AppWizard, refer to its help system.

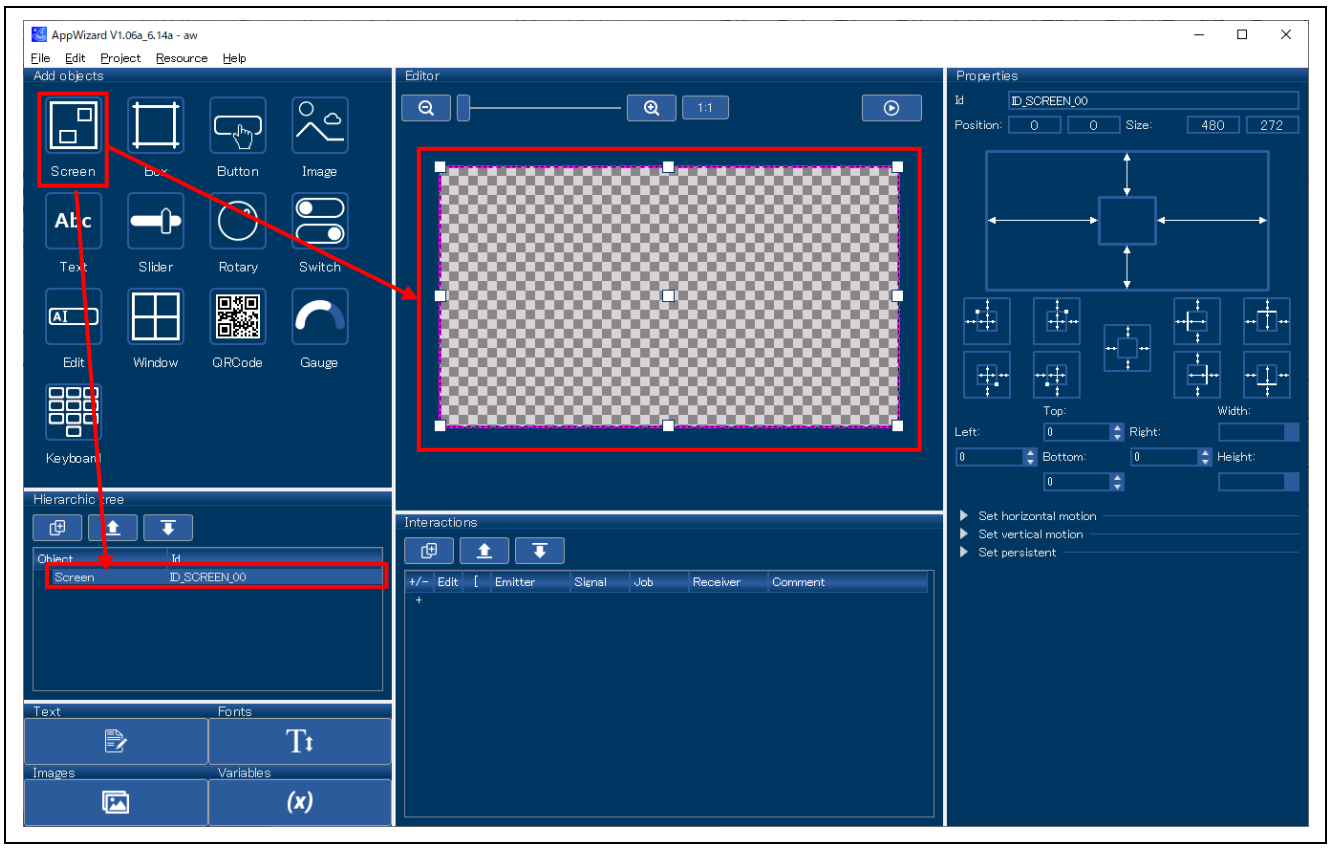
33. When AppWizard is started, the “aw” project folder of AppWizard is automatically created immediately under the project. This folder contains Resource, Simulation, and Source folders and the project file for AppWizard (aw.AppWizard).



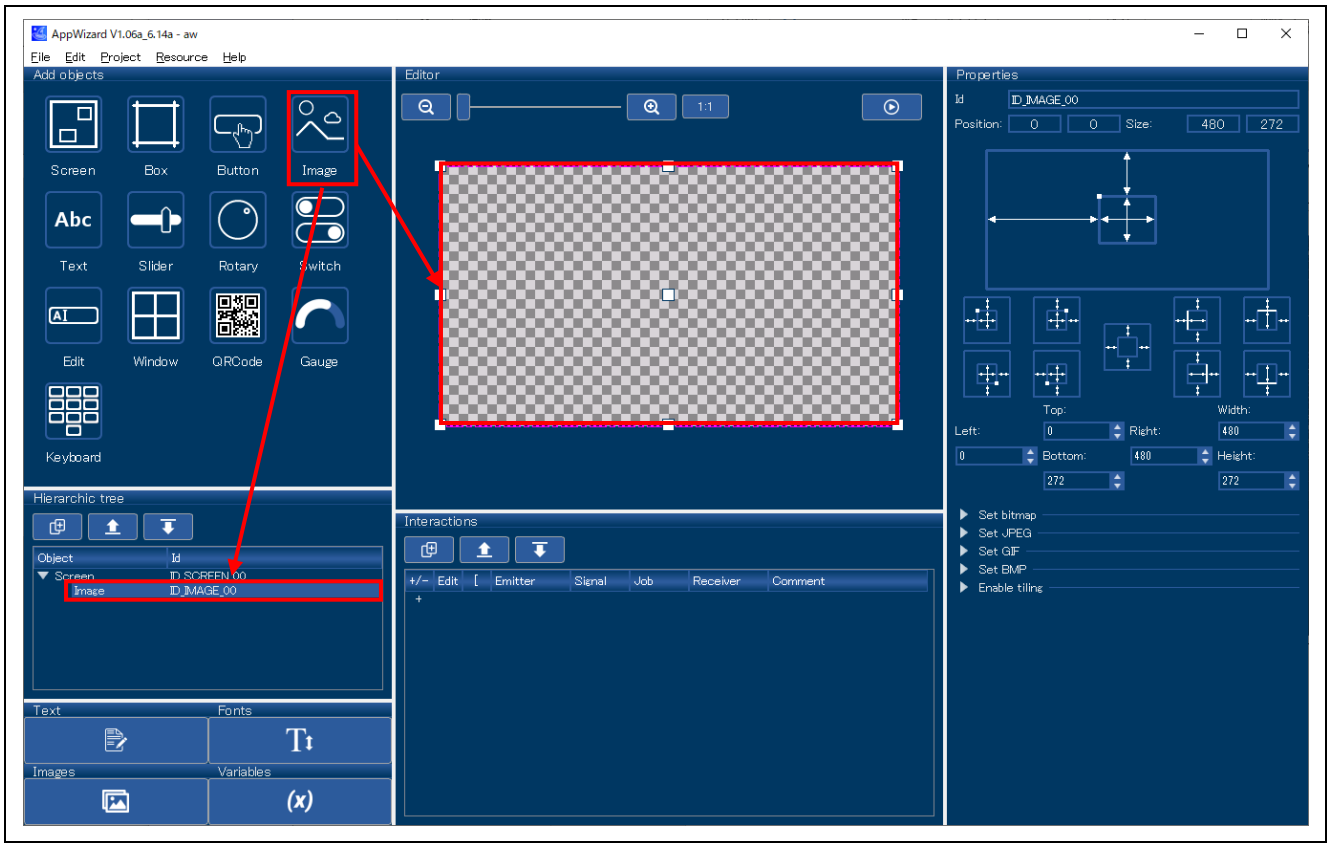
34. In the AppWizard project, the board to be used, display size, and color depth per pixel have automatically been specified.
The setting values can be confirmed in the “Edit project properties” dialog box which is opened from the “Edit Options” item of the “Project” menu.



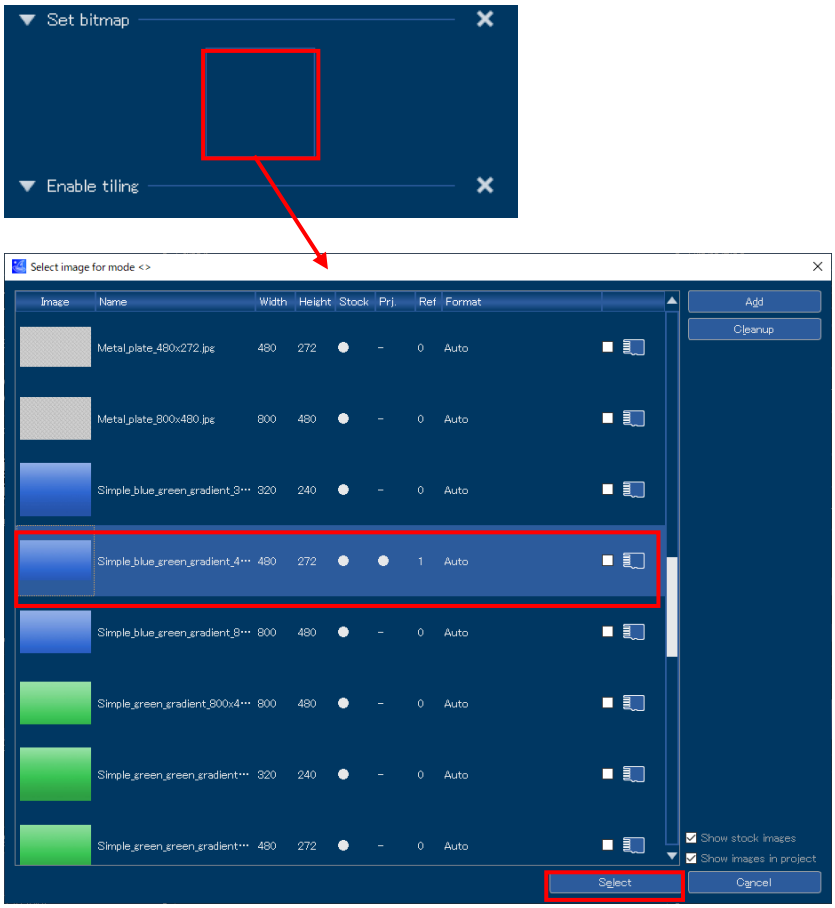
35. Create a GUI with AppWizard.
    Start by adding a screen. Clicking on the “Screen” button adds “Screen ID_SCREEN_00”. Multiple screens can be set and this allows switching between their displays.



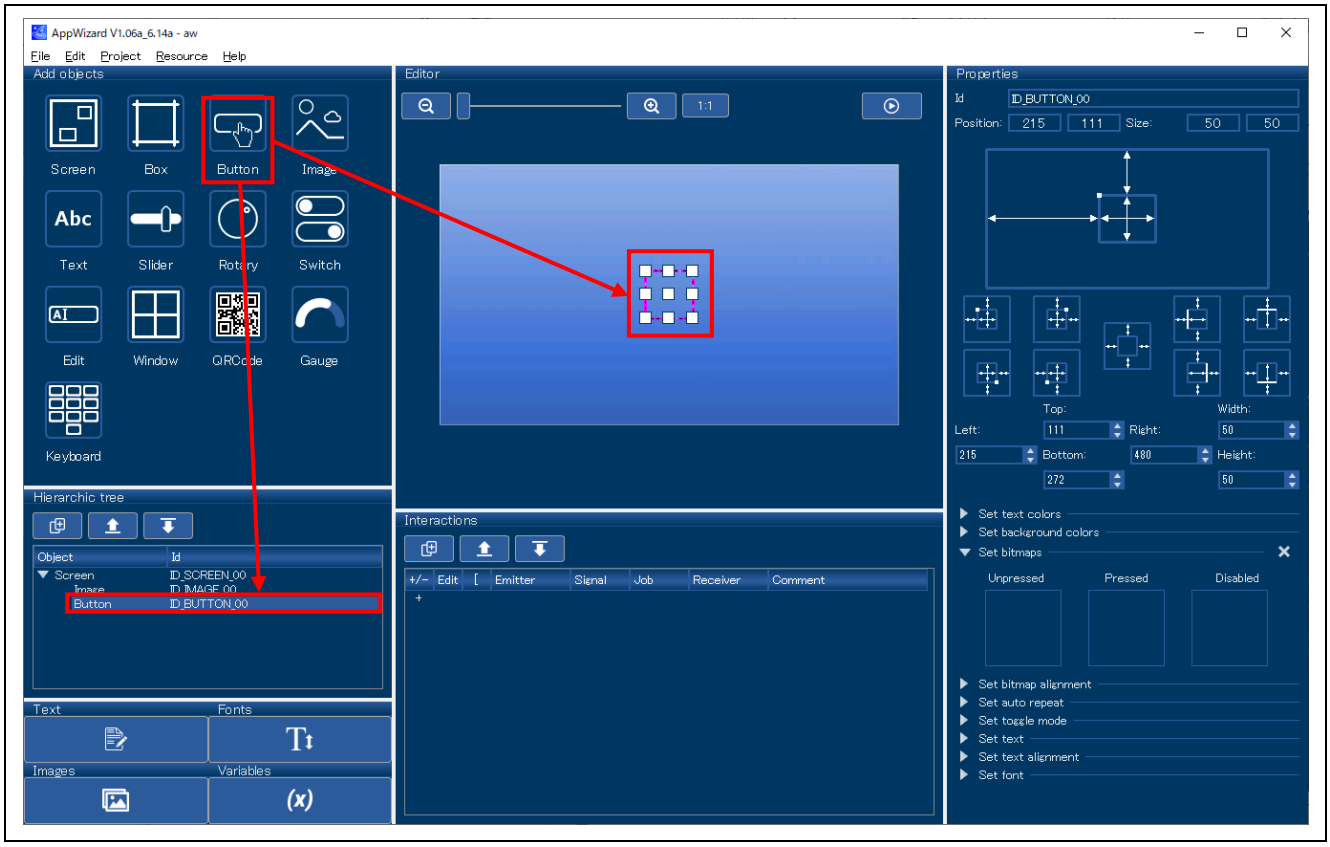
36. After that, add an image. Clicking on the “Image” button adds “Image ID_IMAGE_00”. The position and size are adjusted in “Editor” or “Properties”. In this case, use “Editor” to expand the image to fill the LCD screen.



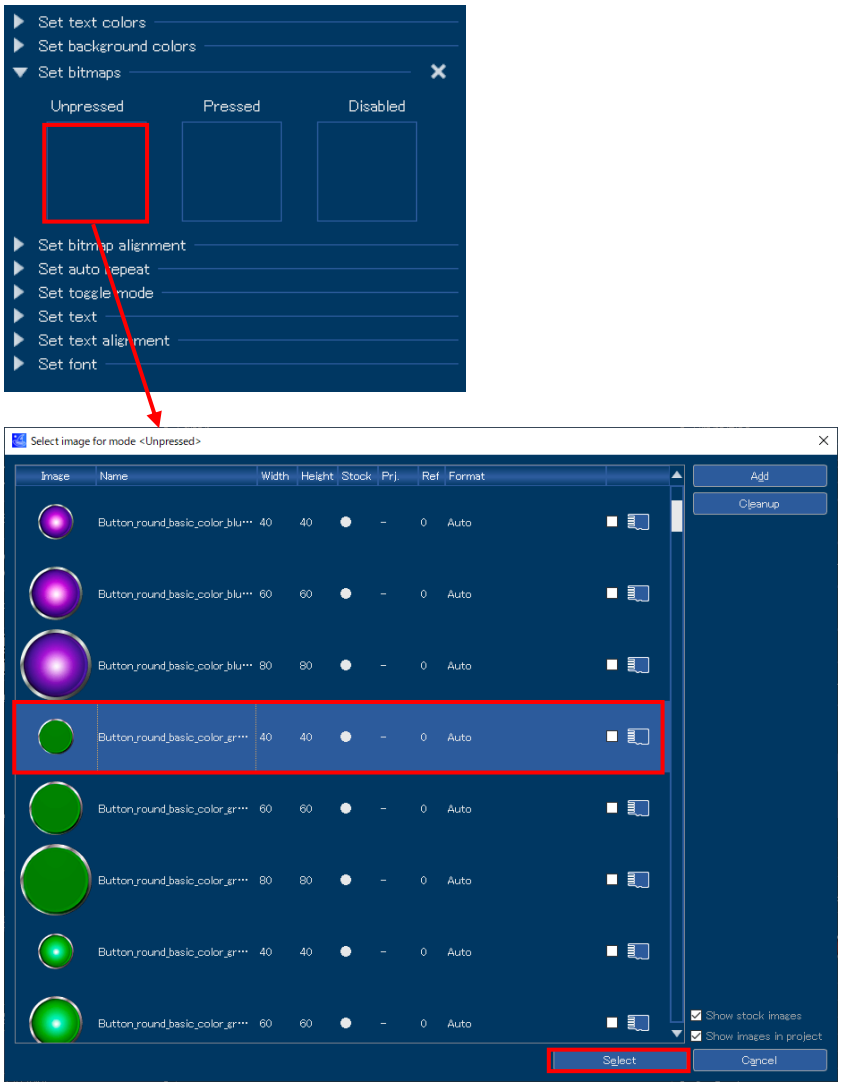
37. Set an image. Open “Set bitmap” in “Properties” and click on the rectangle below the label. Select a desired image from “Select image for mode <>” and click on “Select”. For the image format to be specified, also refer to section 8.4, Points for Caution on the Image Drawing Speed.



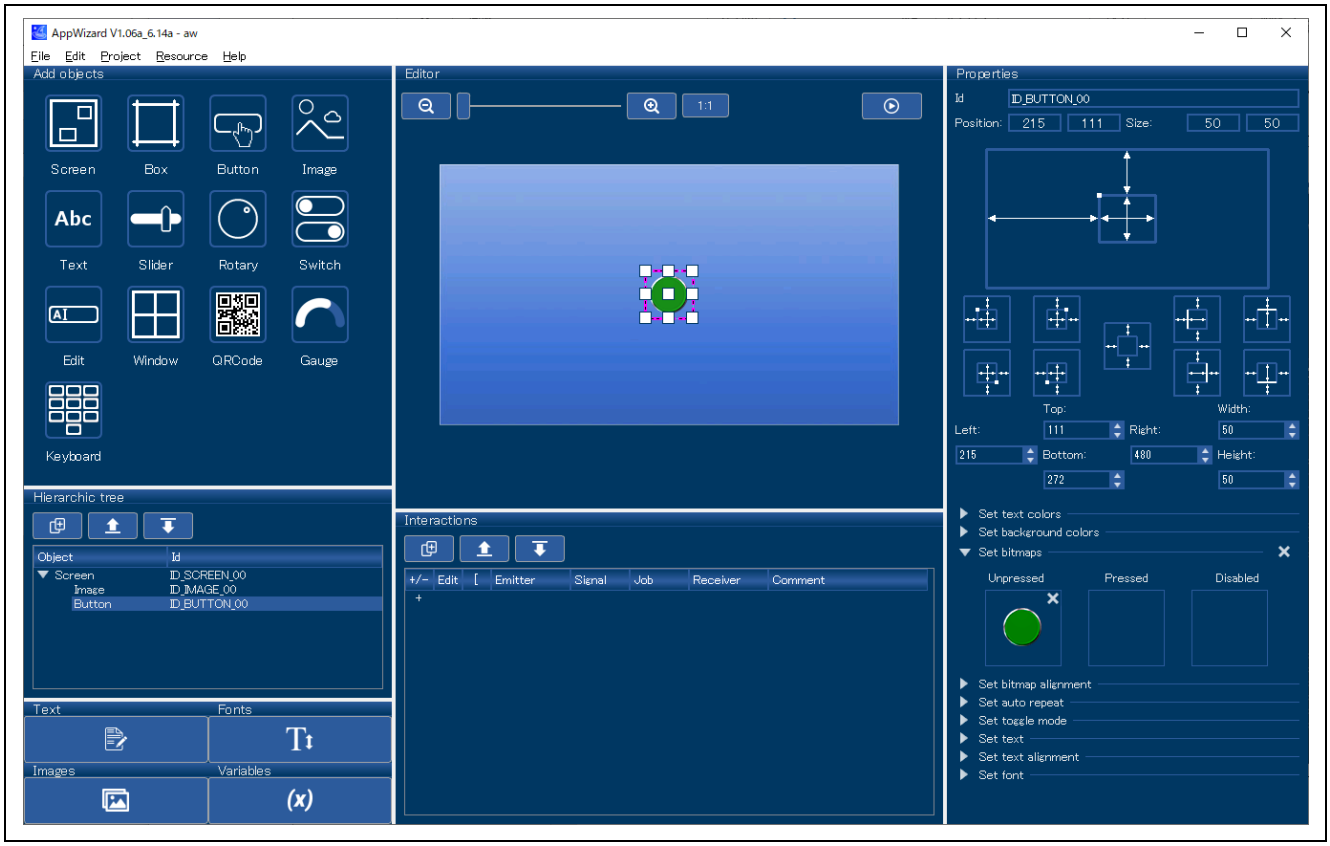
38. Add a button. Clicking on the “Button” button adds “Button ID_BUTTON_00”. The position and size are adjusted in “Editor” or “Properties”.



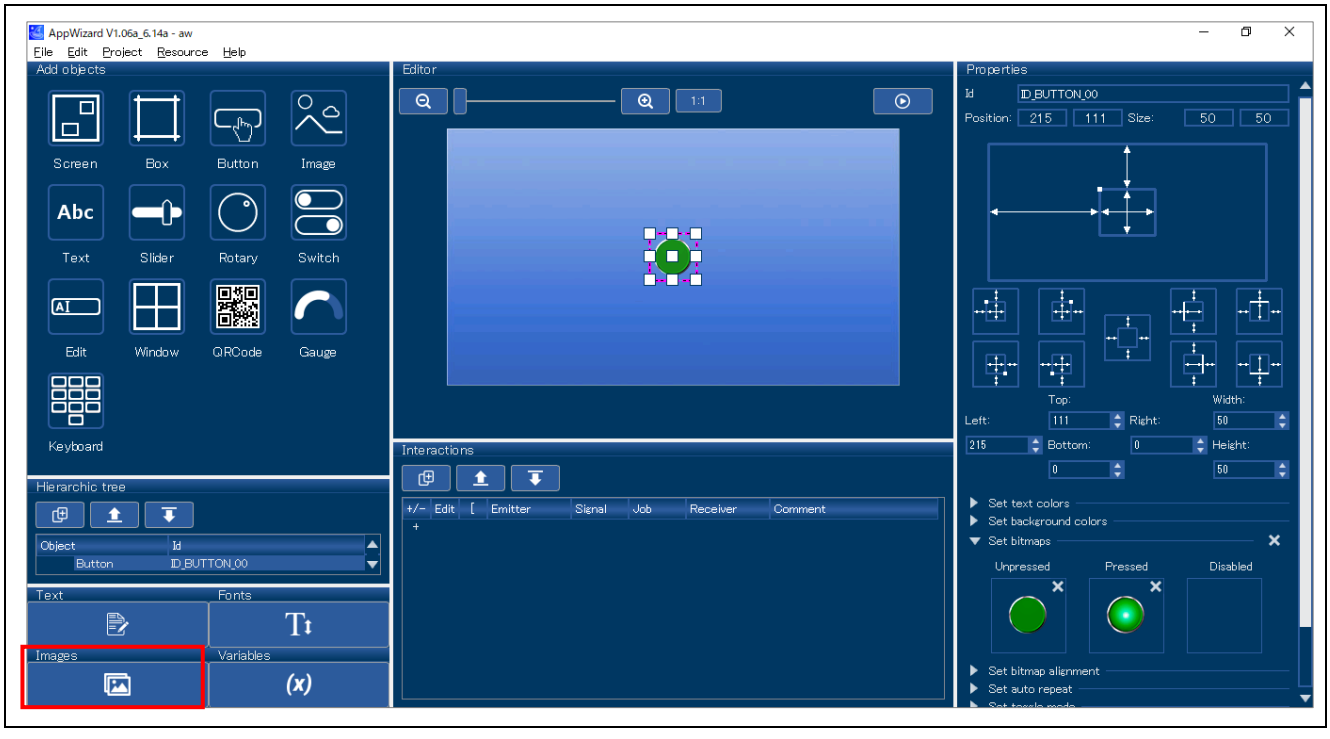
39. Set images to indicate when the button is and is not being pressed. Expand “Set bitmaps” in “Properties” and click on the square under “Unpressed”. Select a desired image from “Select image for mode <Unpressed>” and click on “Select”.



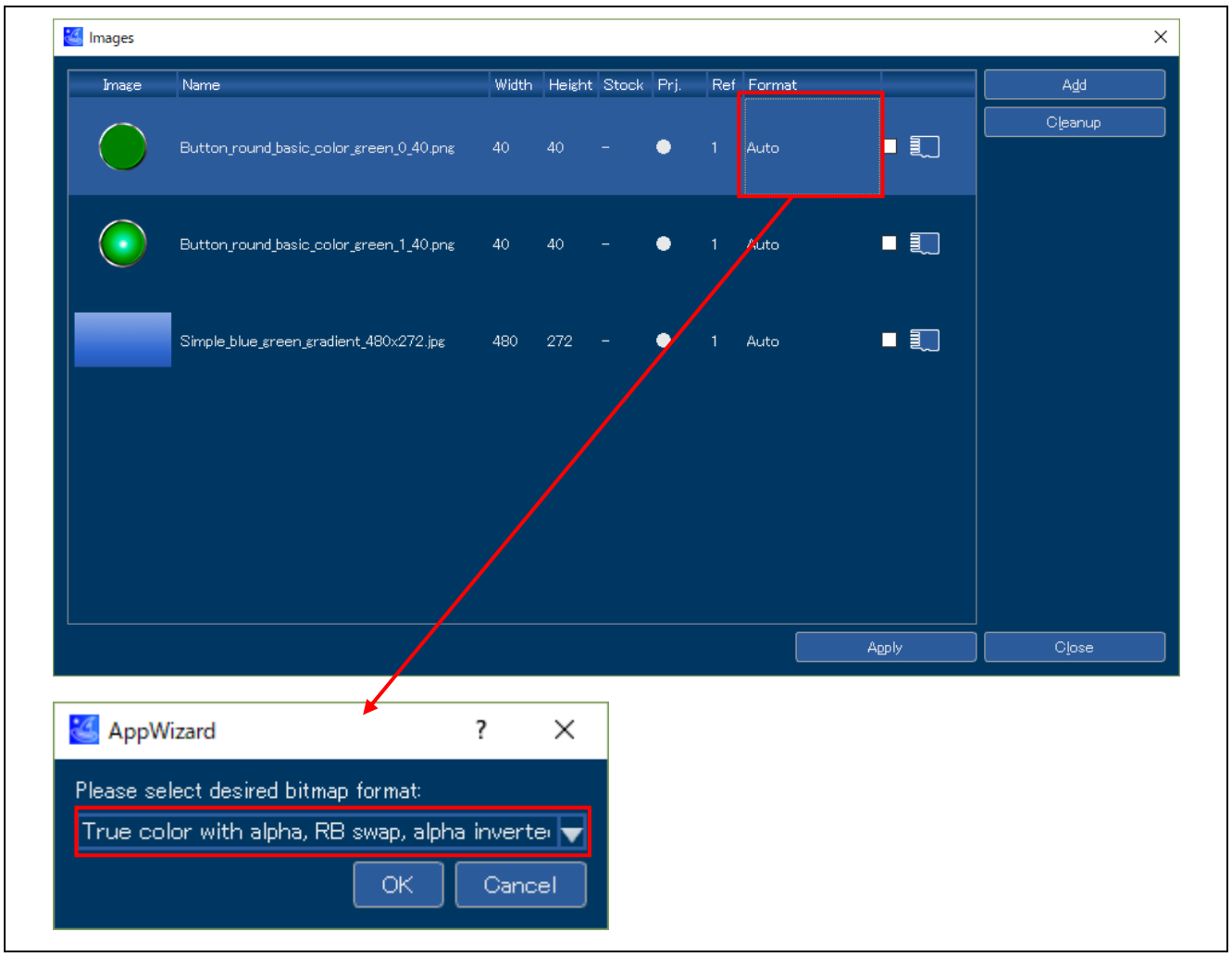
40. The selected image is set as “Unpressed”. Set the image for “Pressed” in the similar way.



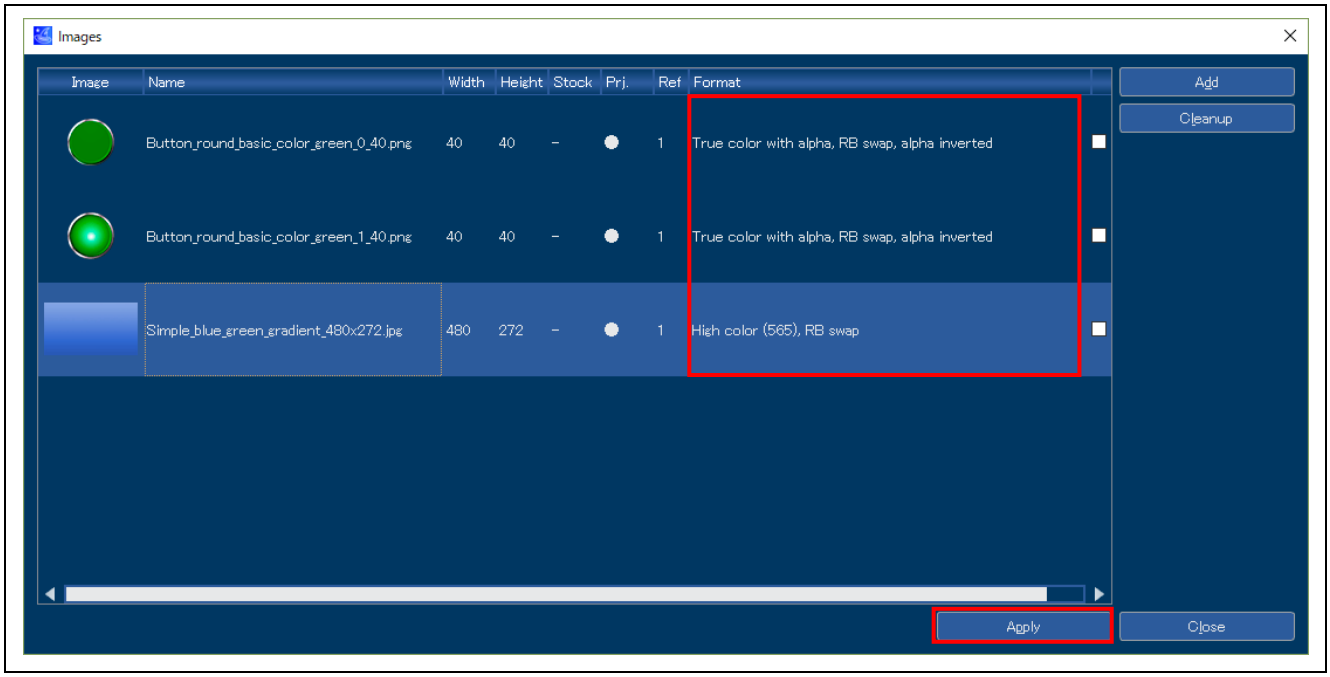
41. After having set images for both the “Unpressed” and “Pressed” states, set the bitmap format applied to the image. Click on “Images”.
Steps 41 to 43 are not necessary if you are using AppWizard V1.08_6.14d or a later version. If this is the case, go to step 44. For details, refer to 8.4.2, Setting the Bitmap Format in AppWizard.



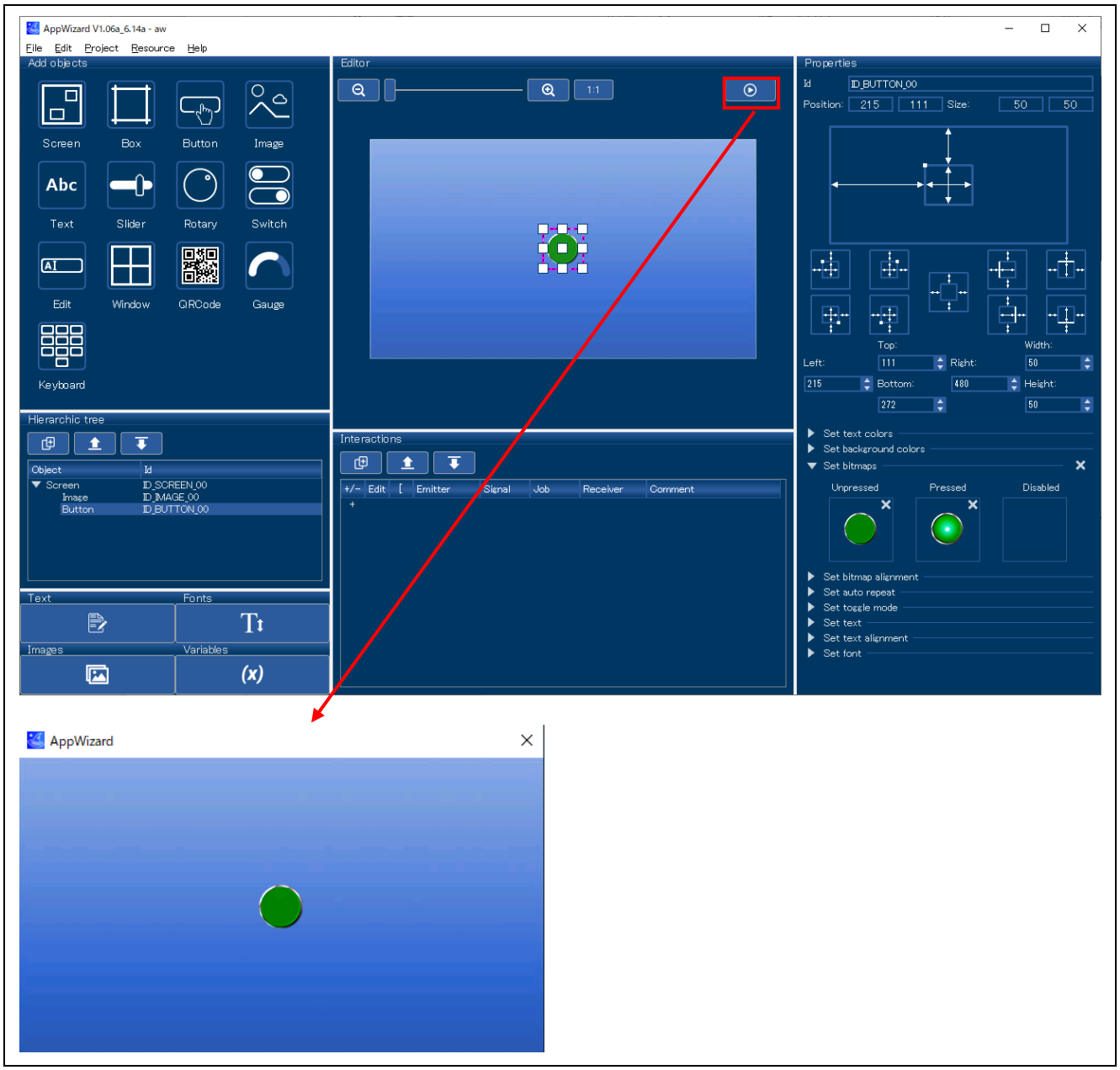
42. Click on the item in the “Format” column of an image entry and select the bitmap format.
    Select “True color with alpha, RB swap, alpha inverted” for the bitmap format of the button and “High color (565), RB swap” for that of the image.



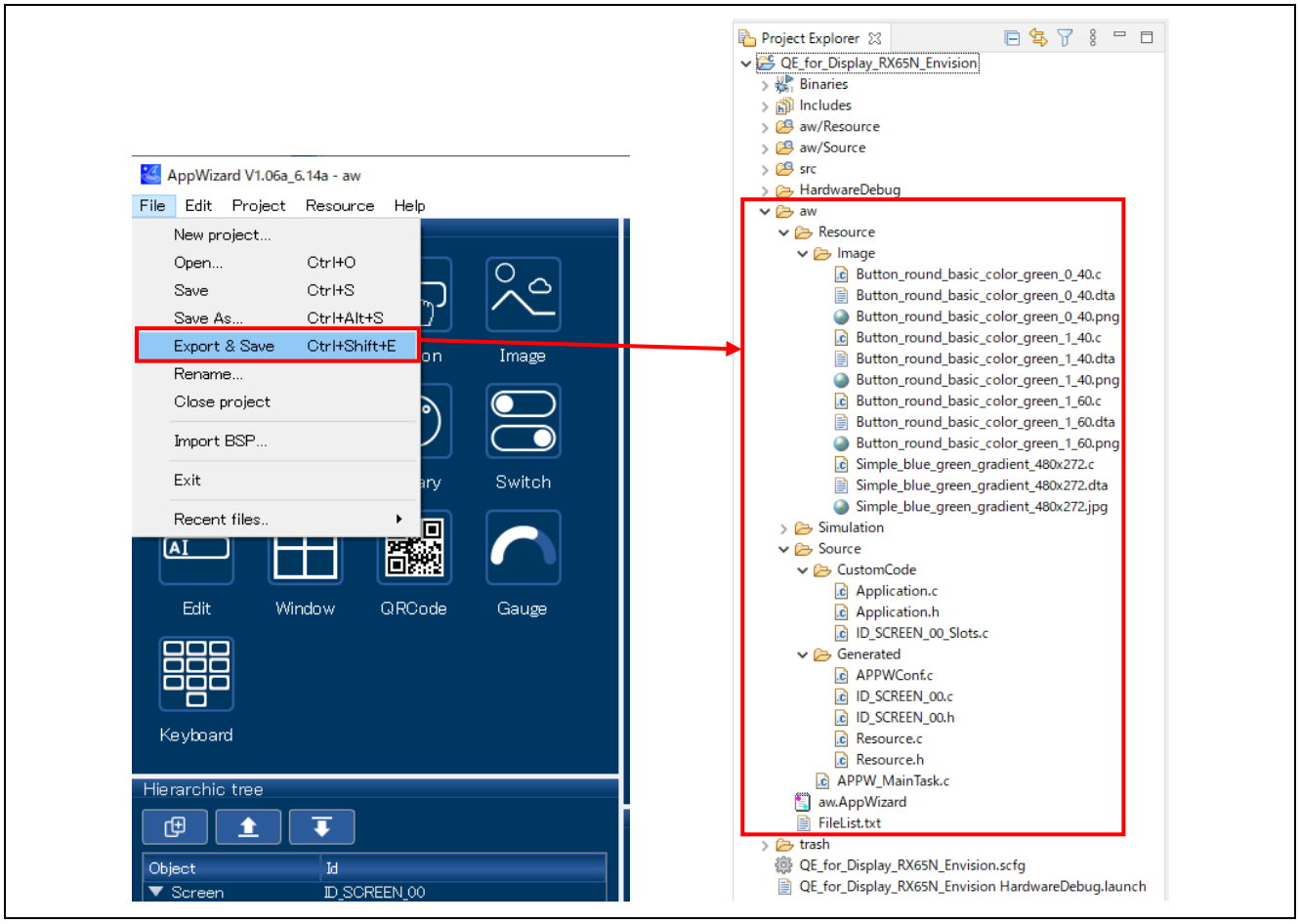
43. After having set the bitmap formats for all images, click on “Apply”.



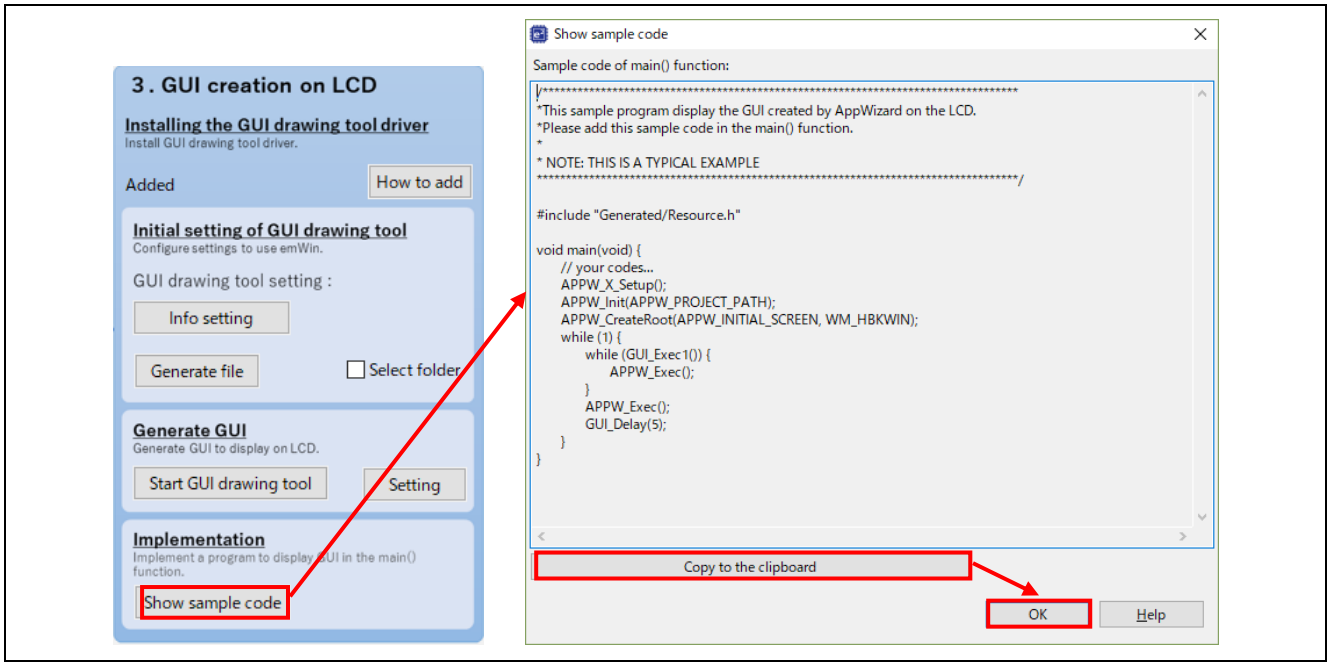
44. Clicking on the “Start play mode” button located at the upper right confirms the operation of the created GUI in the preview. By clicking on the button in the preview, you can confirm that the image changes according to the settings made for “Unpressed” and “Pressed”. Clicking on the “Esc” button closes the preview.



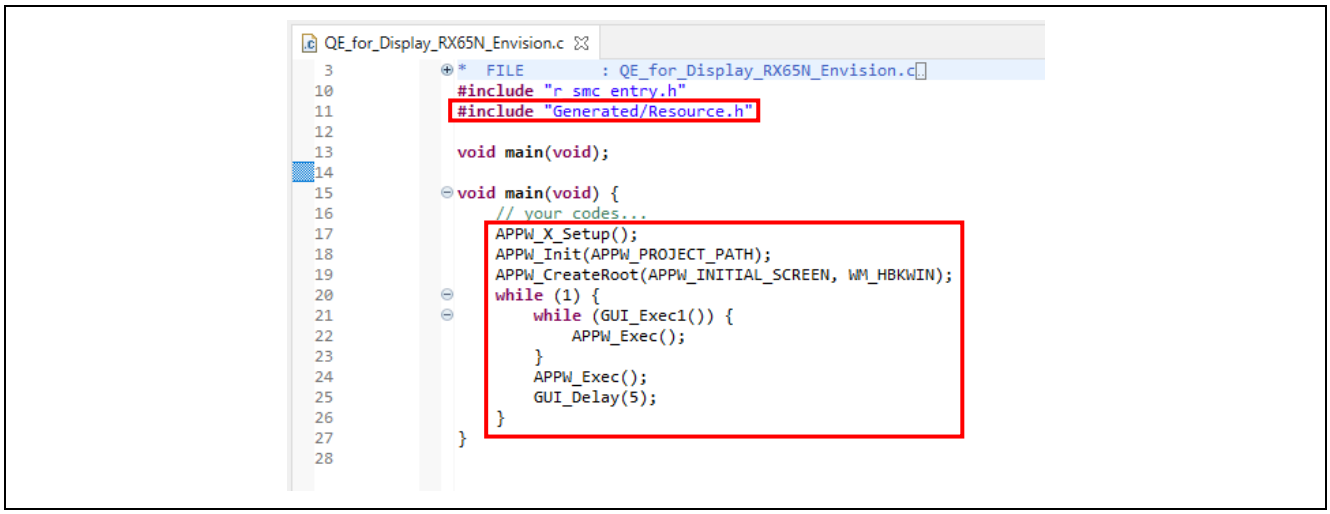
45. Output code from AppWizard.
    Select the “Export & Save” item from the “File” menu of AppWizard.
    Code is output in the “Source” and “Resource” folders under the “aw” project folder of AppWizard. The “Source” and “Resource” folders are automatically specified as the target folders for building.



46. Include code for displaying the created GUI in the main() function.
    Click on the “Show sample code” button in the lower part of “3. GUI Creation on LCD” of QE for Display [RX].
    After clicking on the “Copy to the clipboard” button in the “Show sample code” dialog box, click on the “OK” button to close it.



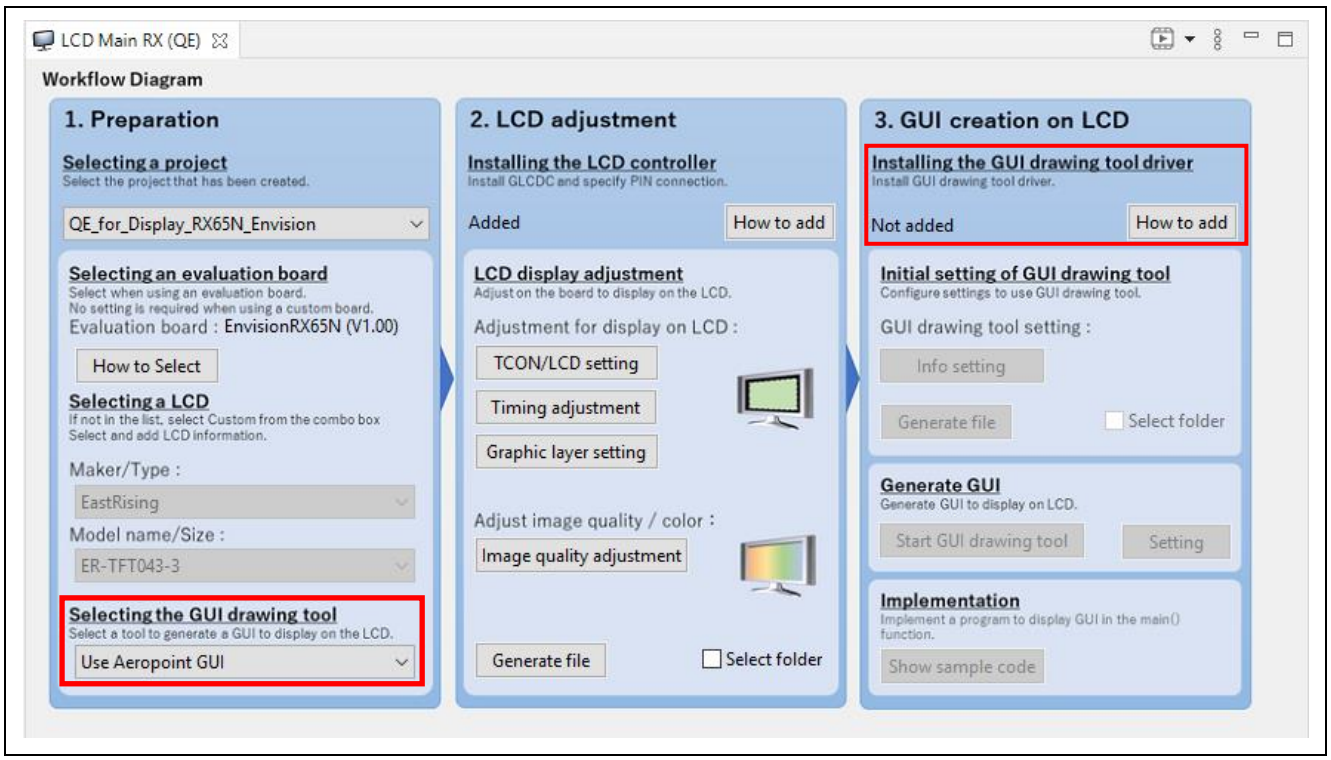
47. Paste the copied code under the user code within the main() function.



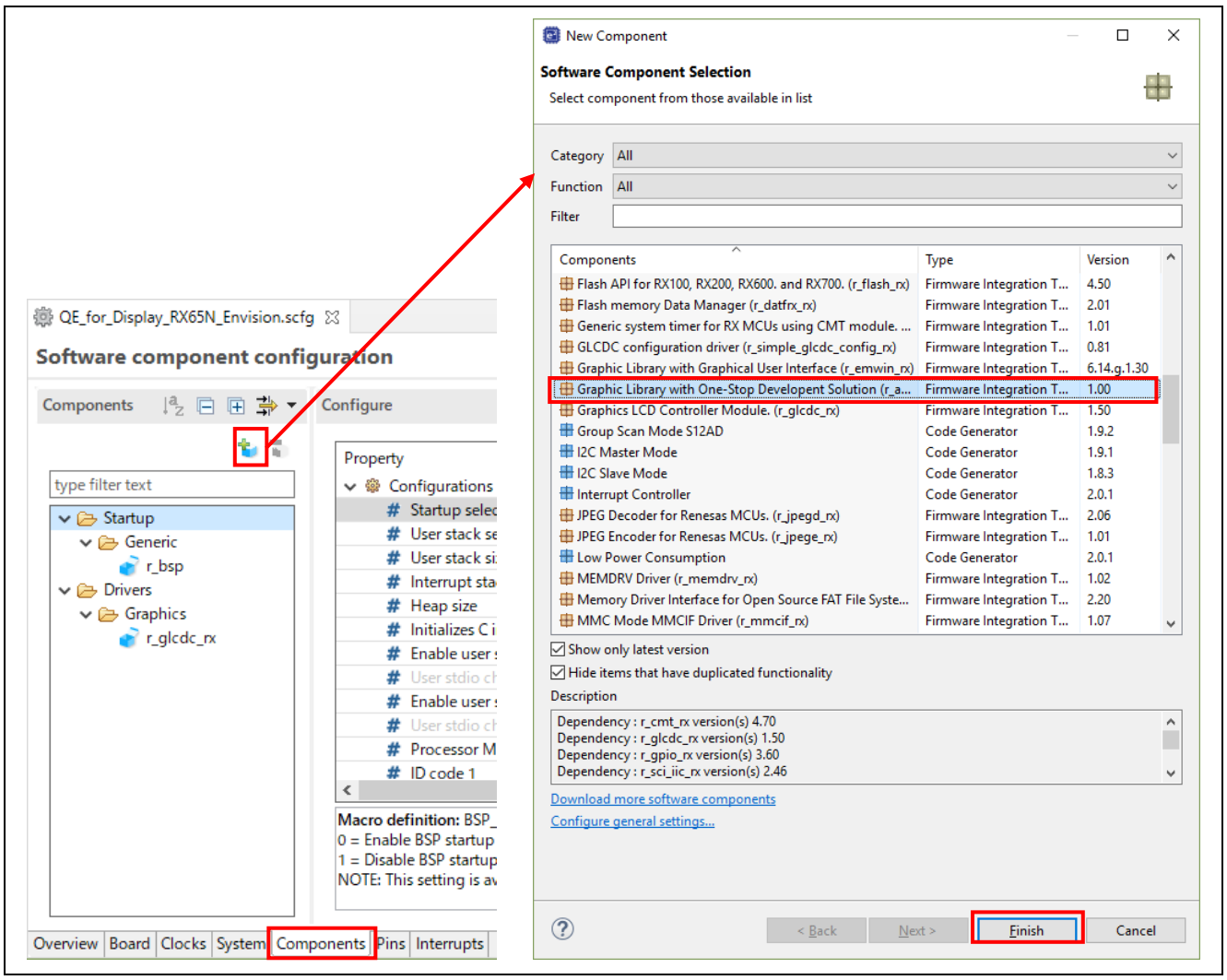
4.4.4 Using Aeropoint GUI to Create a GUI for an LCD

This section describes how to install the GUI drawing tool when “Use Aeropoint GUI” is selected for “Selecting the GUI drawing tool”.

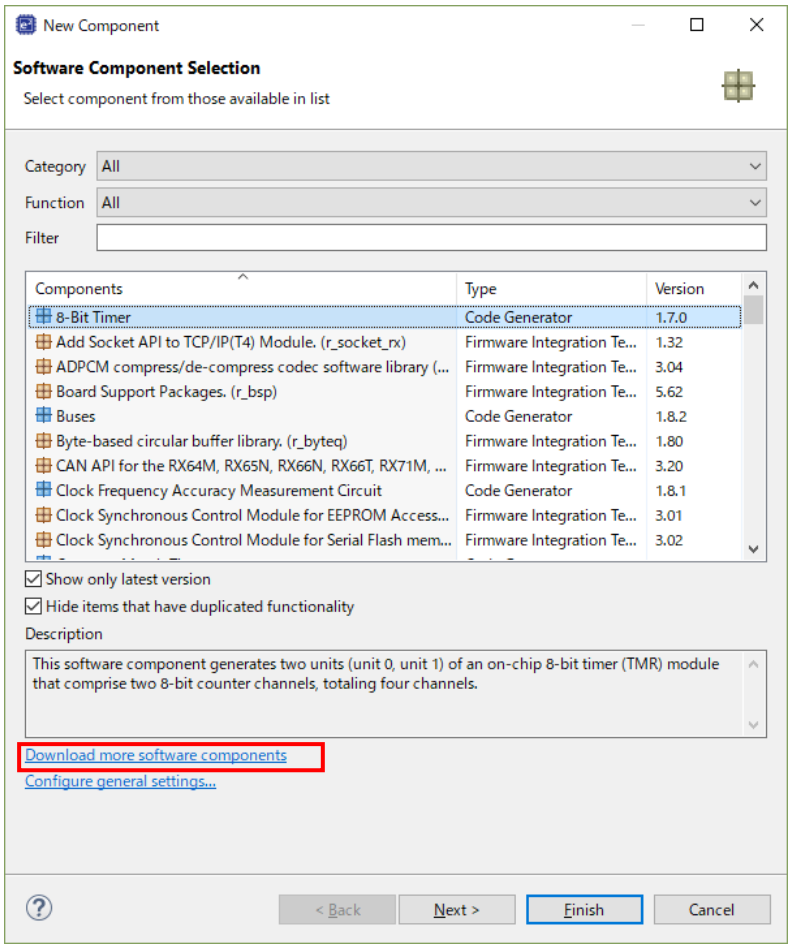
For the method when “Use emWin” is selected, refer to section 4.4.3, Using emWin to Create a GUI for an LCD.



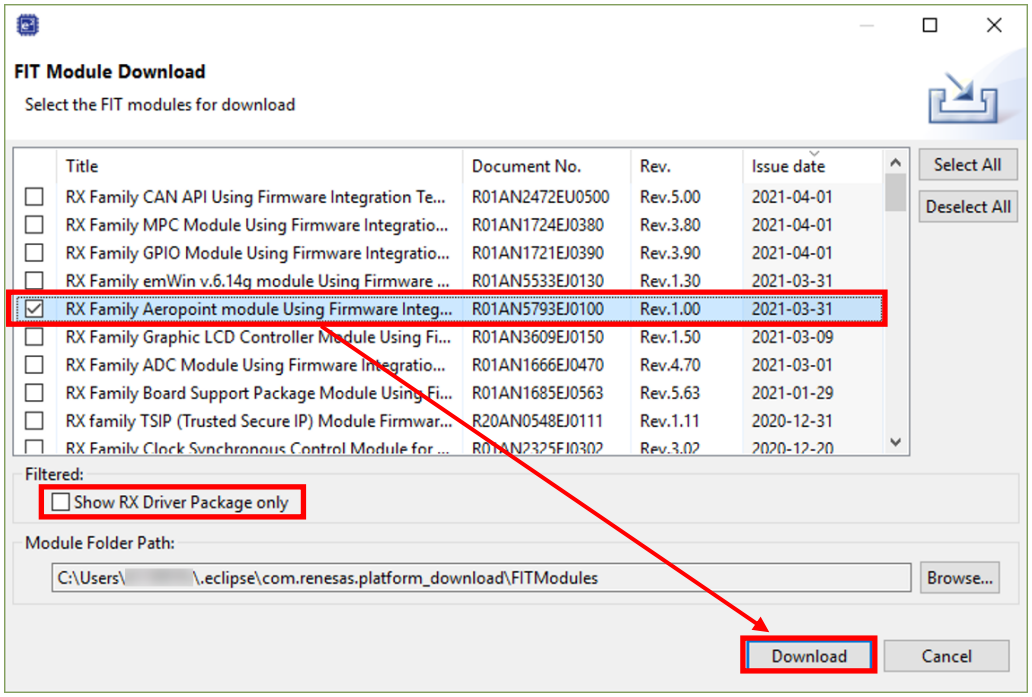
1. Select the “Components” tab of the Smart Configurator and click on the “Add component” icon.
2. In the “New Component” dialog box, select “Graphic Library with One-Stop Development Solution (r_aeropoint_rx)” (version 1.00 or a later version) and click on the “Finish” button.



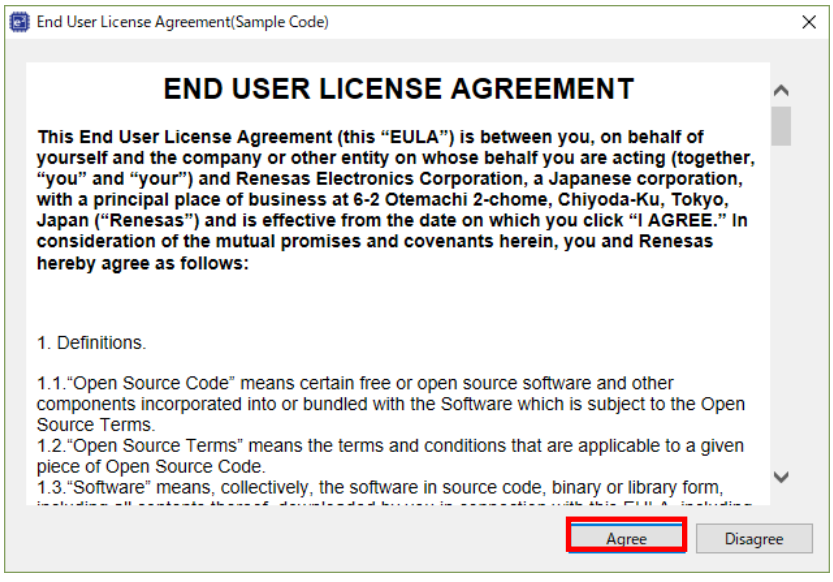
3. If the graphic library is not displayed in the list of components in the “New Component” dialog box, click on “Download more software components”.



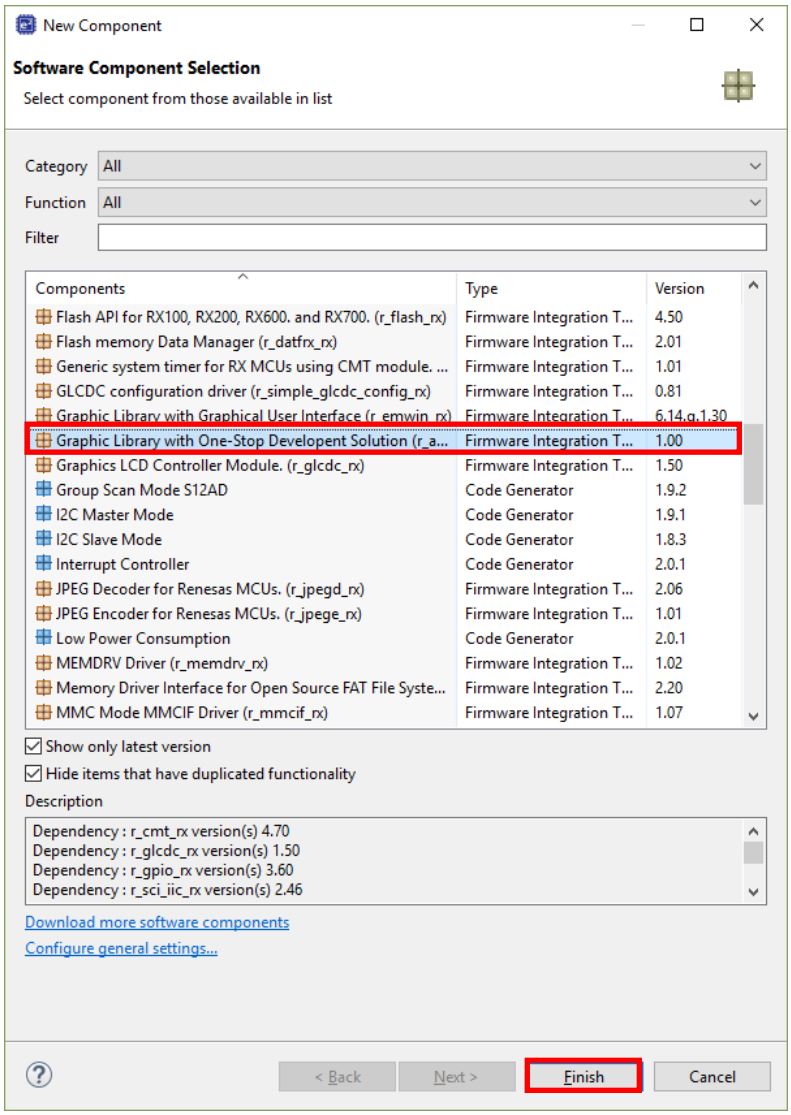
4. In the “FIT Module Download” dialog box, remove the check against “Show RX Driver Package only” and select “RX Family Aeropoint module” (Rev.1.00 or a later version).
5. Click on “Download”.



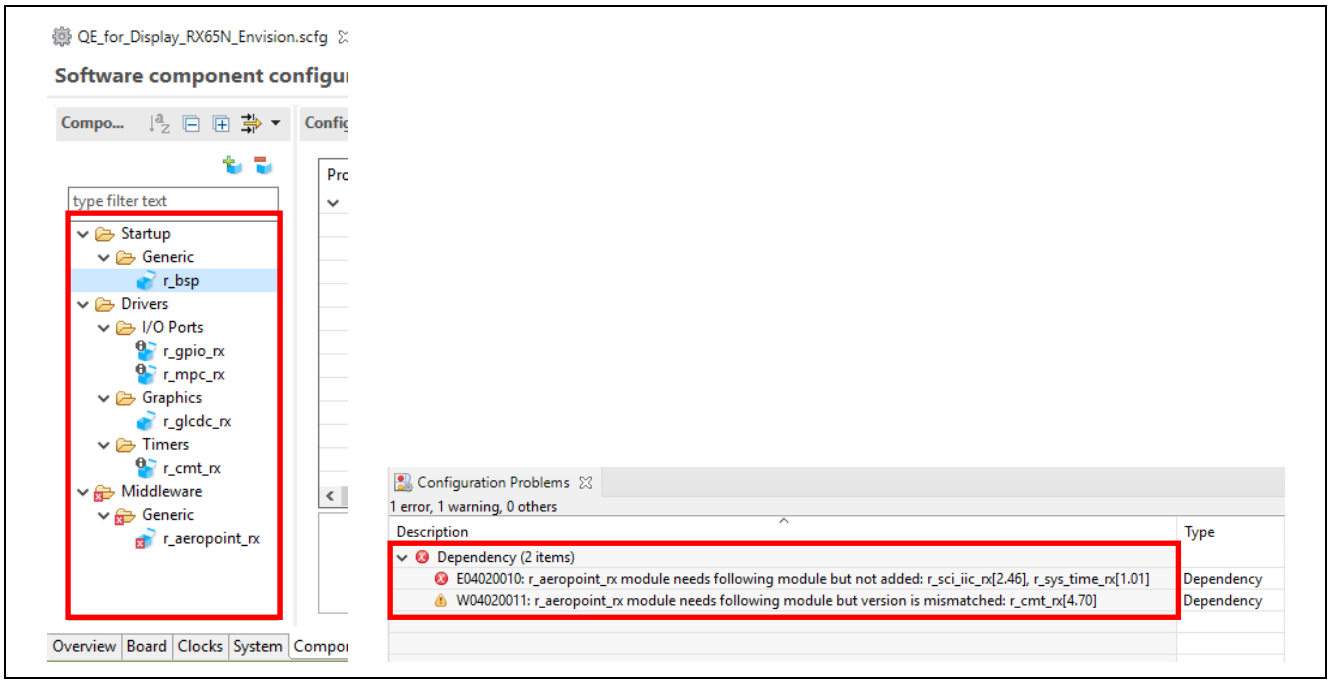
6. Read the description in the “End User License Agreement (Sample Code)” dialog box. If you agree, click on “Agree”.



7. When “Graphic Library with One-Stop Development Solution (r_aeropoint_rx)” is displayed in the list of components, select it and click on the “Finish” button.

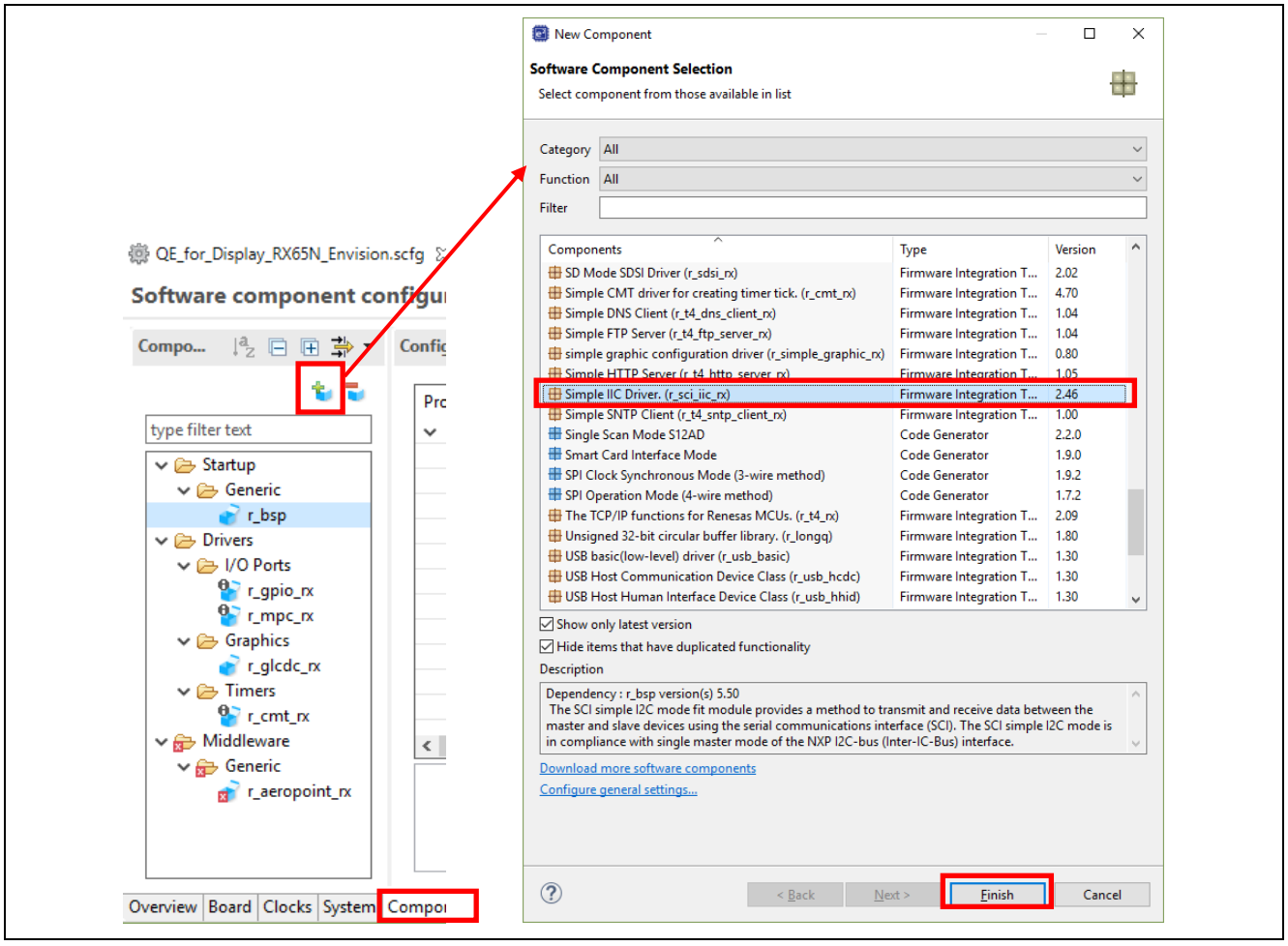


8. Components the added component having dependencies with is automatically added. However, a component that has not been added or a component with a version that differs from the required one will lead to an error message or a warning.
   In such cases, add the required component or update the version.
   The following shows the error message for a component that has not been added (r_sci_iic_rx and r_sys_time_rx) and warning messages regarding the version of a component (r_cmt_rx).



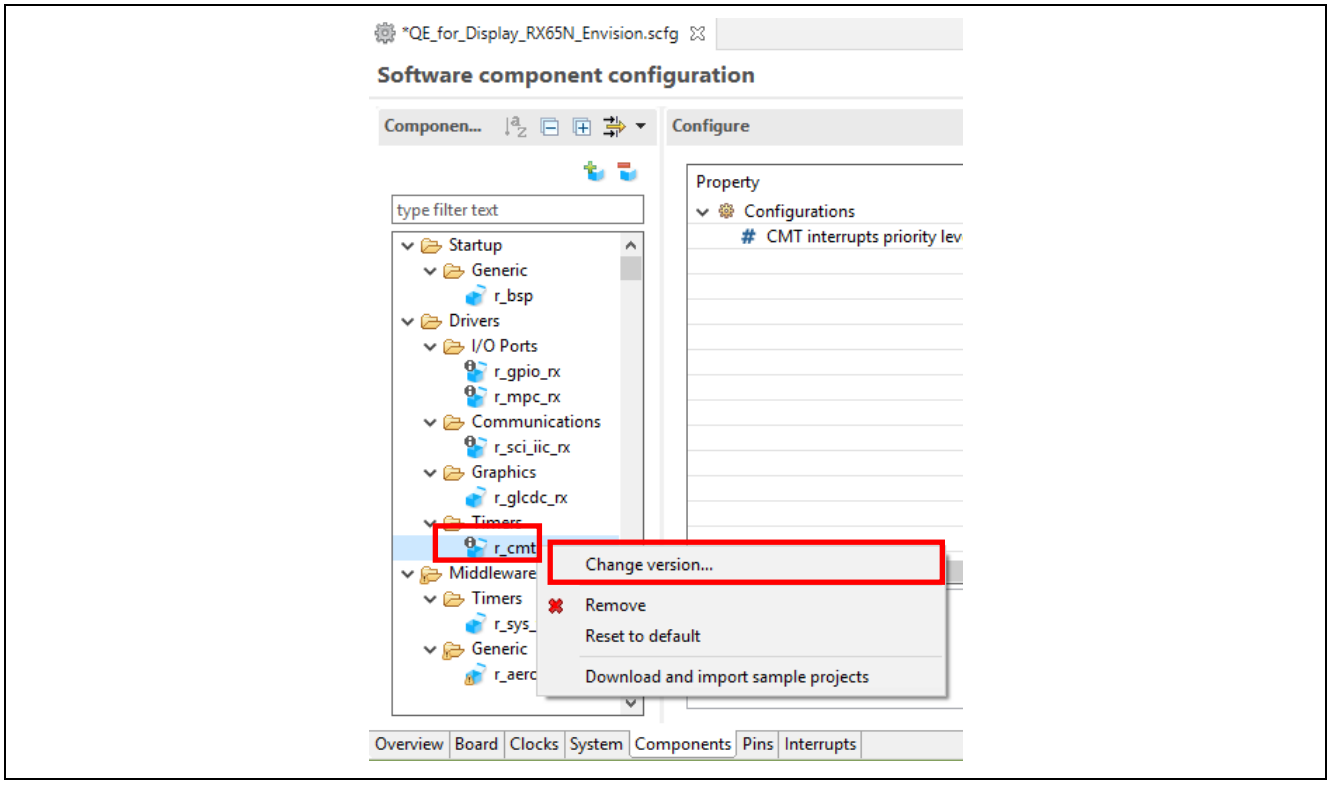
Add the required component.

9. Select the “Components” tab and click on the “Add component” icon.
10. In the “New Component” dialog box, select “Simple IIC Driver (r_sci_iic_rx)” and click on the “Finish” button. Also add the “r_sys_time_rx” component in the same way.
    If the component is not in the list of components in the “New Component” dialog box, click on “Download more software components”.

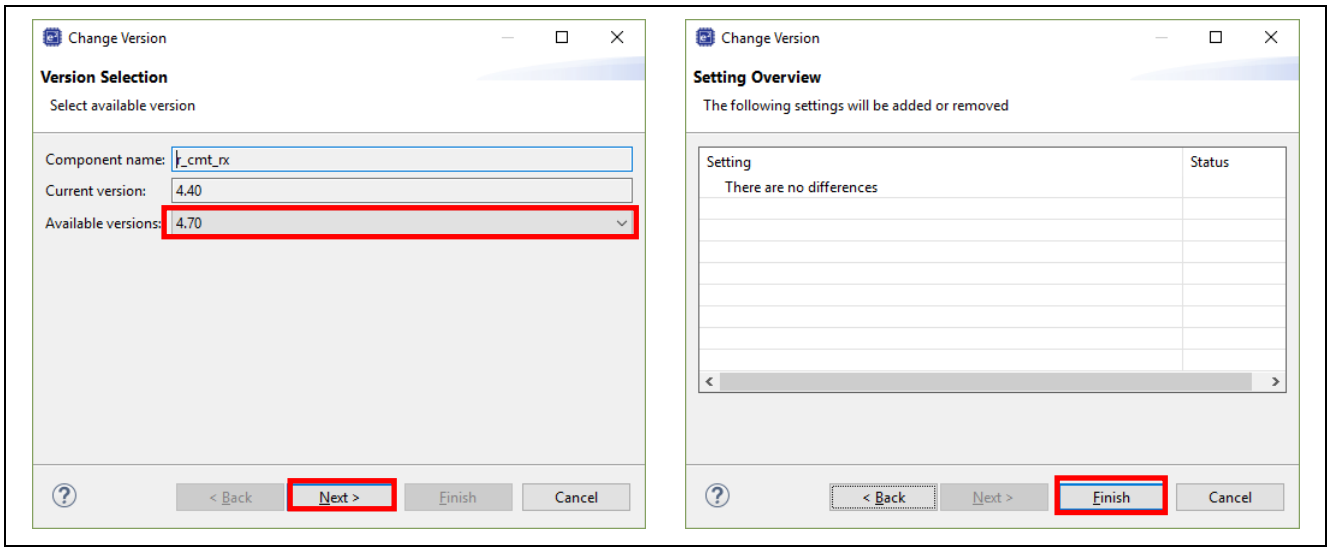


Update the component to the required version (r_cmt_rx).

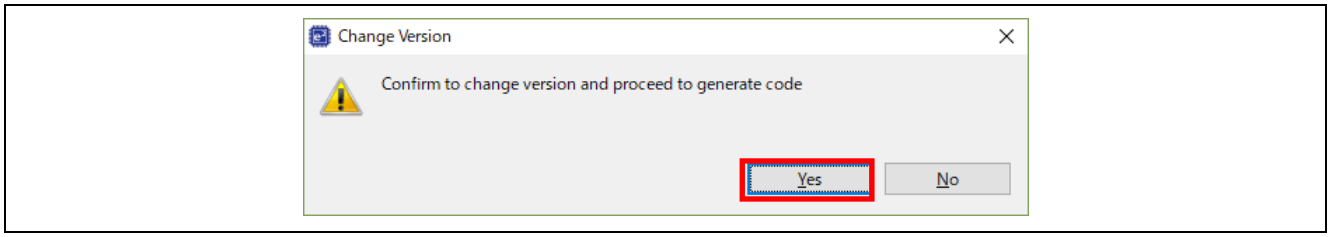
11. Right-click on the component for r_cmt_rx and select “Change version”.



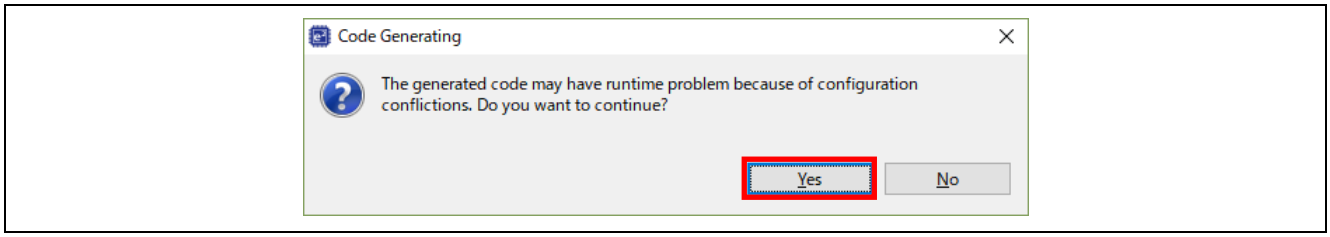
12. Confirm “Available versions” in the “Change Version” dialog box and click on “Next”.
13. Confirm “Setting Overview” and click on “Finish”.



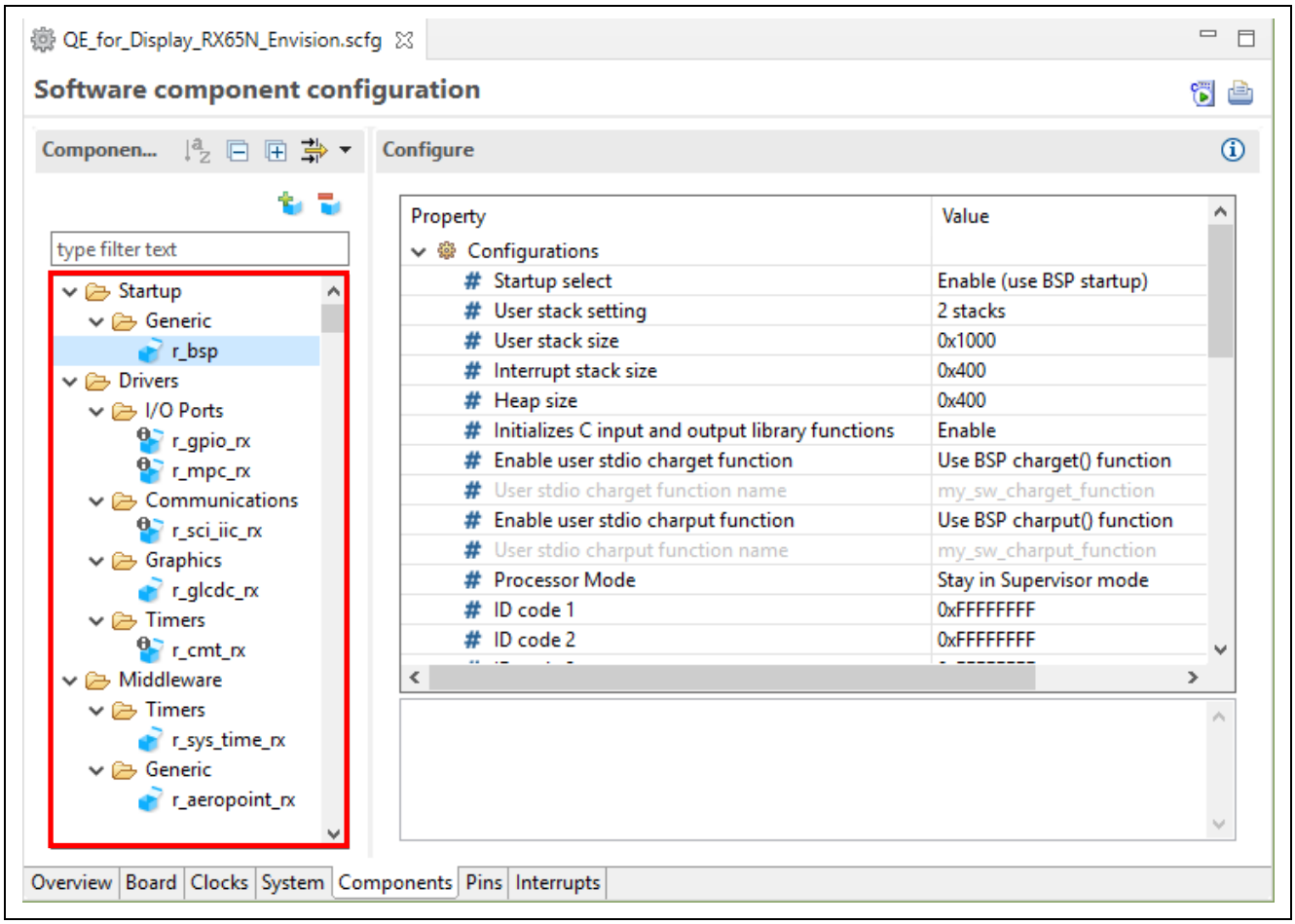
14. When the confirmation message is displayed in the “Change Version” dialog box, click on “Yes”.



15. When the confirmation message is displayed in the “Code Generating” dialog box, click on “Yes”.



16. The error and warnings regarding the dependencies of components have now been resolved.

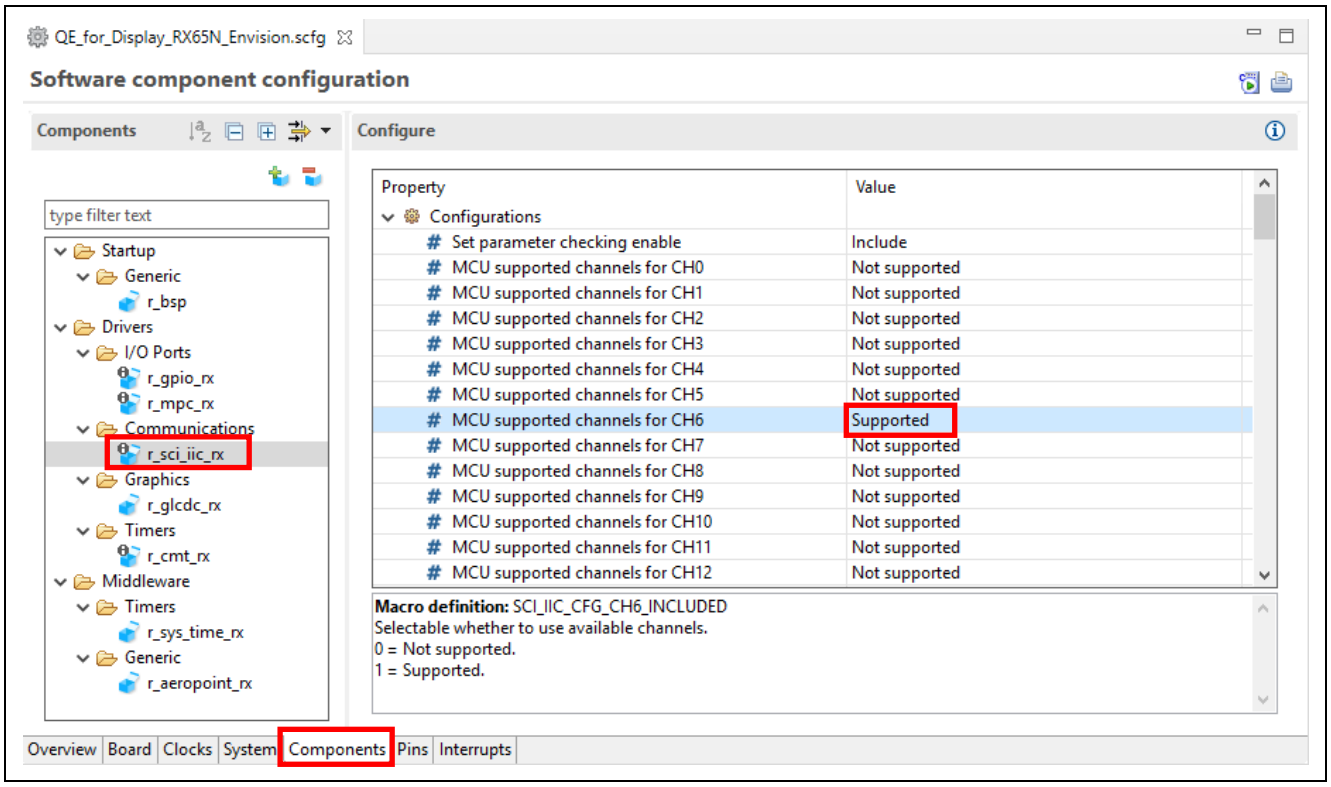


Set the SCI channel for touch facilities to be used with Aeropoint GUI.

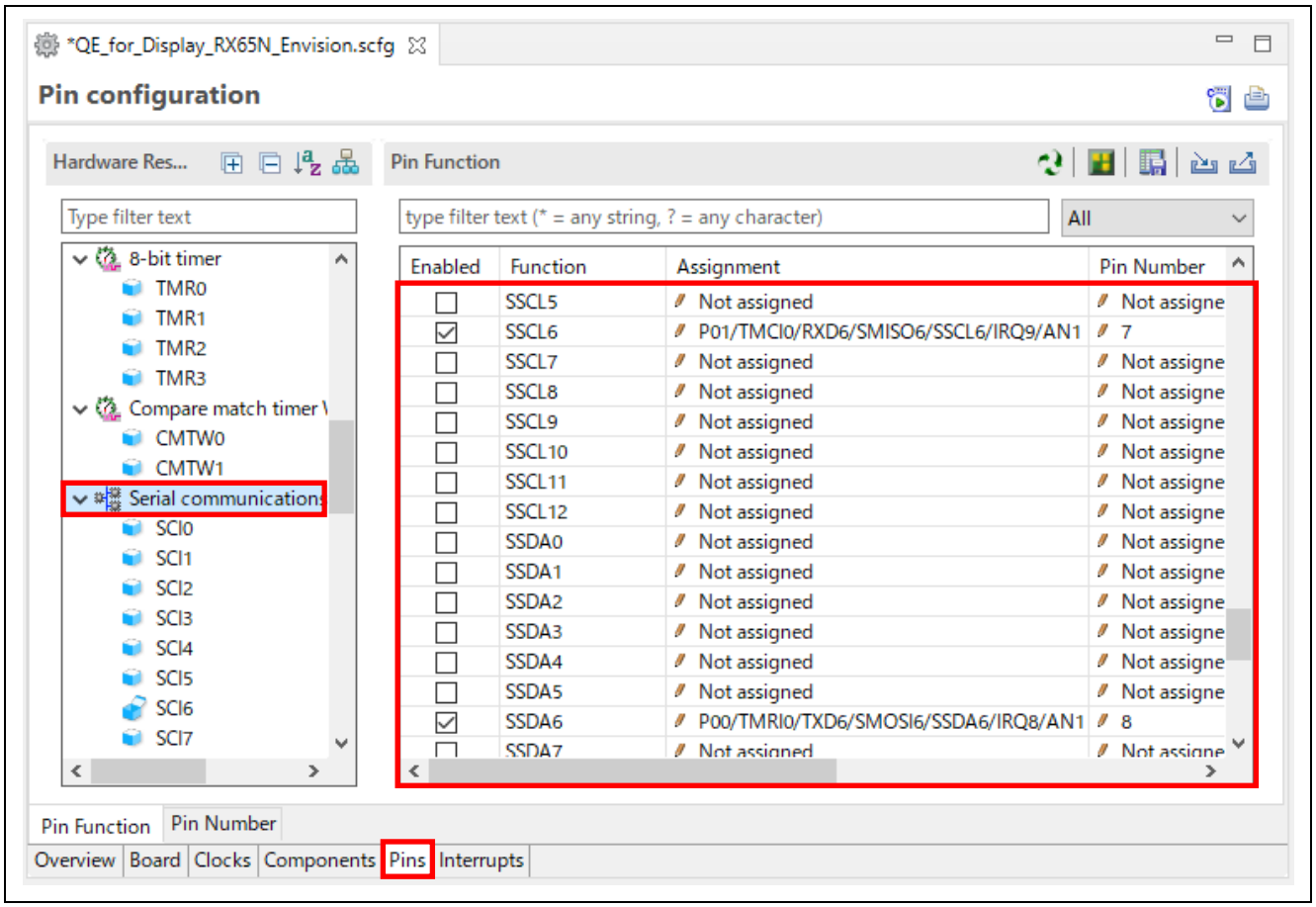
17. Select “r_sci_iic_rx” from the components.
18. Change the setting for the SCI channel for touch facilities to be used with Aeropoint GUI. Specify the value of “MCU supported channels for CHn” of the channel to be used as “Supported”.

Table 4-9 SCI Channel Numbers to be Used for Touch Facilities (Initial Values)

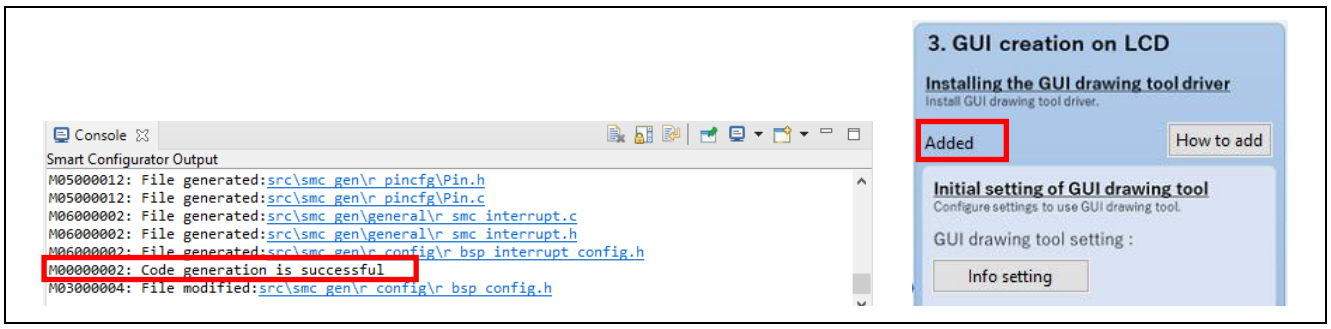
Evaluation Board	IIC Channel Number
RSK RX72N	11
Envision RX72N	6
RSK RX65N	7
Envision RX65N	6



19. When a board is selected in the creation of a project, setting the SCI channel for touch facilities to be used with Aeropoint GUI also sets the pins for use with the channel. Select “Serial communications interface” on the “Pins” tabbed page to confirm the settings of the pins. Set the pins here if you are using a custom board.

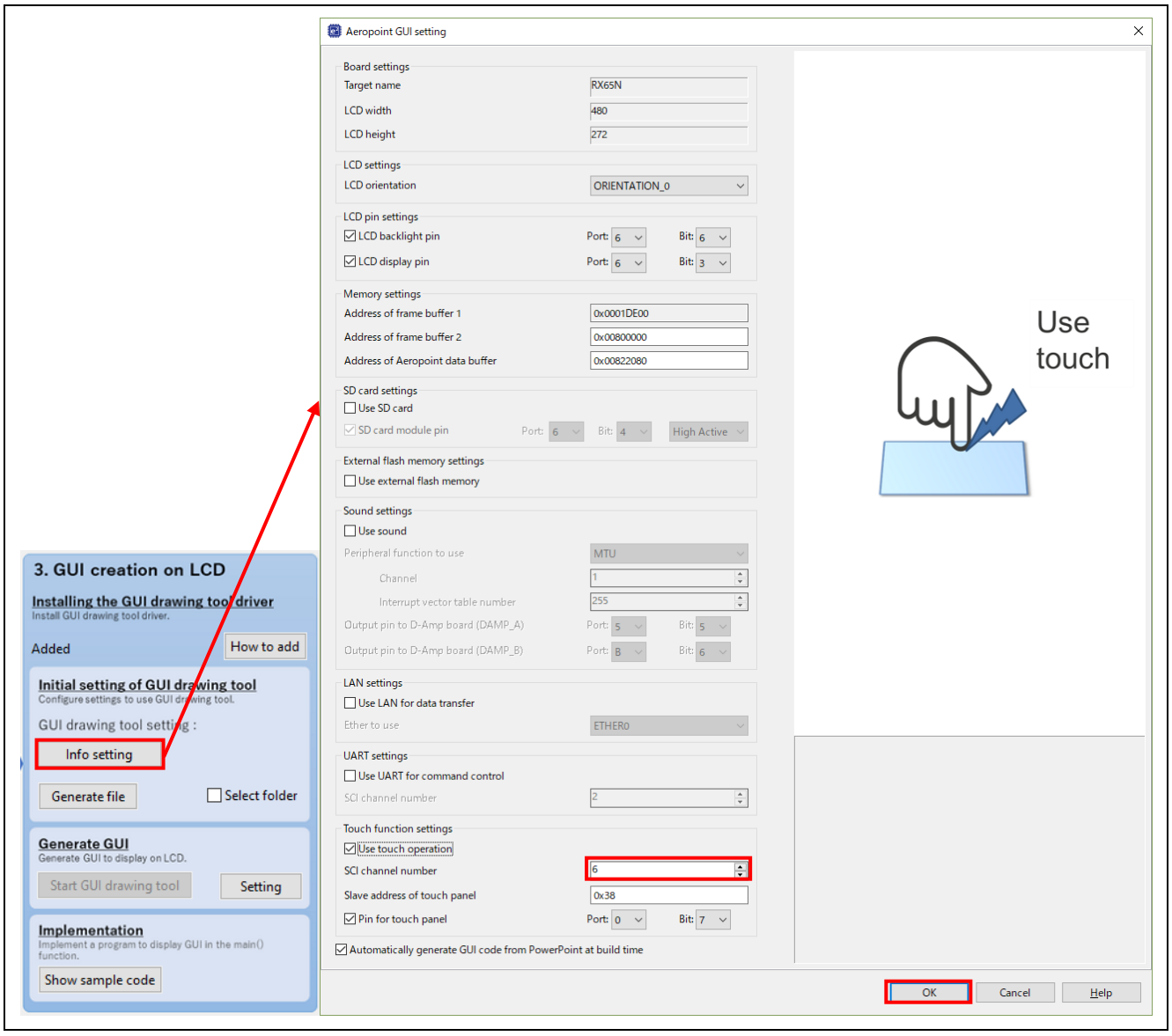


20. When the pins have been set, click on the “Generate Code” button in the upper-right corner of the window. The code is generated according to the settings.
21. After code generation is finished, “Added” is displayed immediately below “Installing the GUI drawing tool driver”.

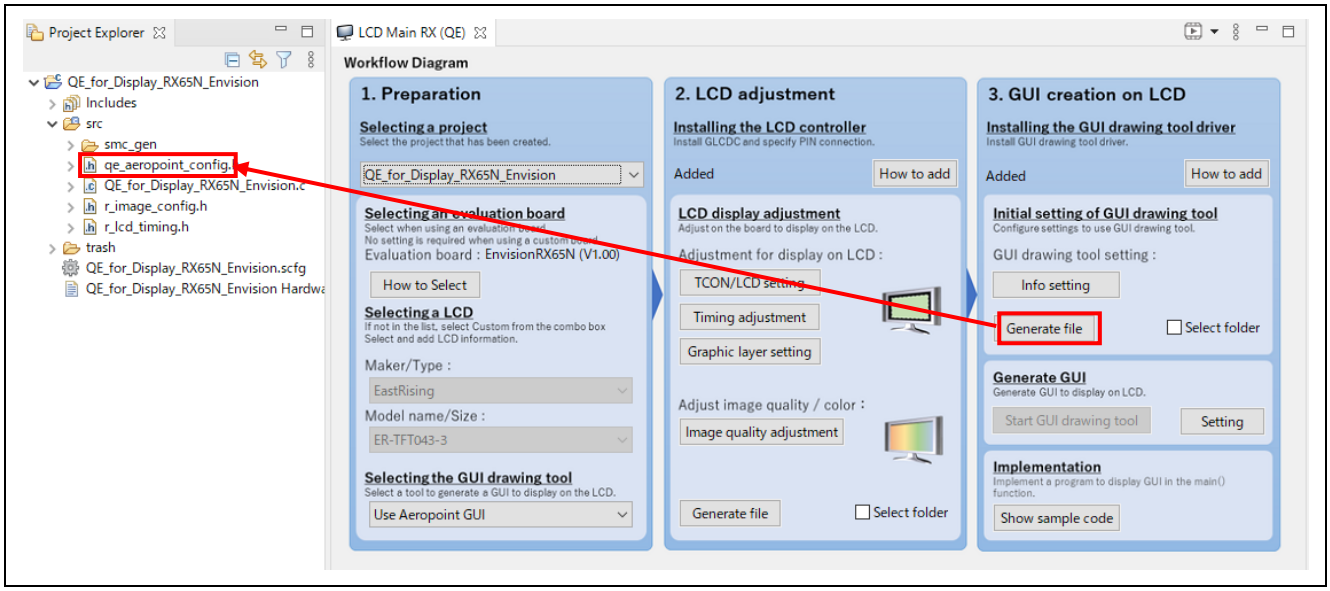


Make the initial settings for the GUI drawing tool.

22. Clicking on the “Info setting” button displays the “Aeropoint GUI setting” dialog box.
23. Values are set according to the information on the board selected in the project.
    The setting for “SCI channel number” in the “Touch function settings” group must match the channel number specified to be “Supported” as the “r_sci_iic_rx” component in the Smart Configurator.
    For details, refer to the explanation produced by clicking on the “Help” button.
    Confirm the settings and click on the “OK” button to close the dialog box.



24. A header file reflecting the initial settings for the GUI drawing tool is output.
    Click on the “Generate file” button to output qe_aeropoint_config.h. It is output to src immediately under the project folder by default. The output destination folder can be changed by selecting the “Select folder” checkbox.
    The path for including the output header files is also automatically added.



25. If the addresses of the frame buffers and Aeropoint data buffer which have been set in the “Aeropoint GUI setting” dialog box overlap with the section address, the given addresses must be adjusted to eliminate the overlap.
Leaving the default values as they are will not require any changes in the case of the RX65N RSK, RX65N Envision, RX72N RSK, or RX72N Envision.

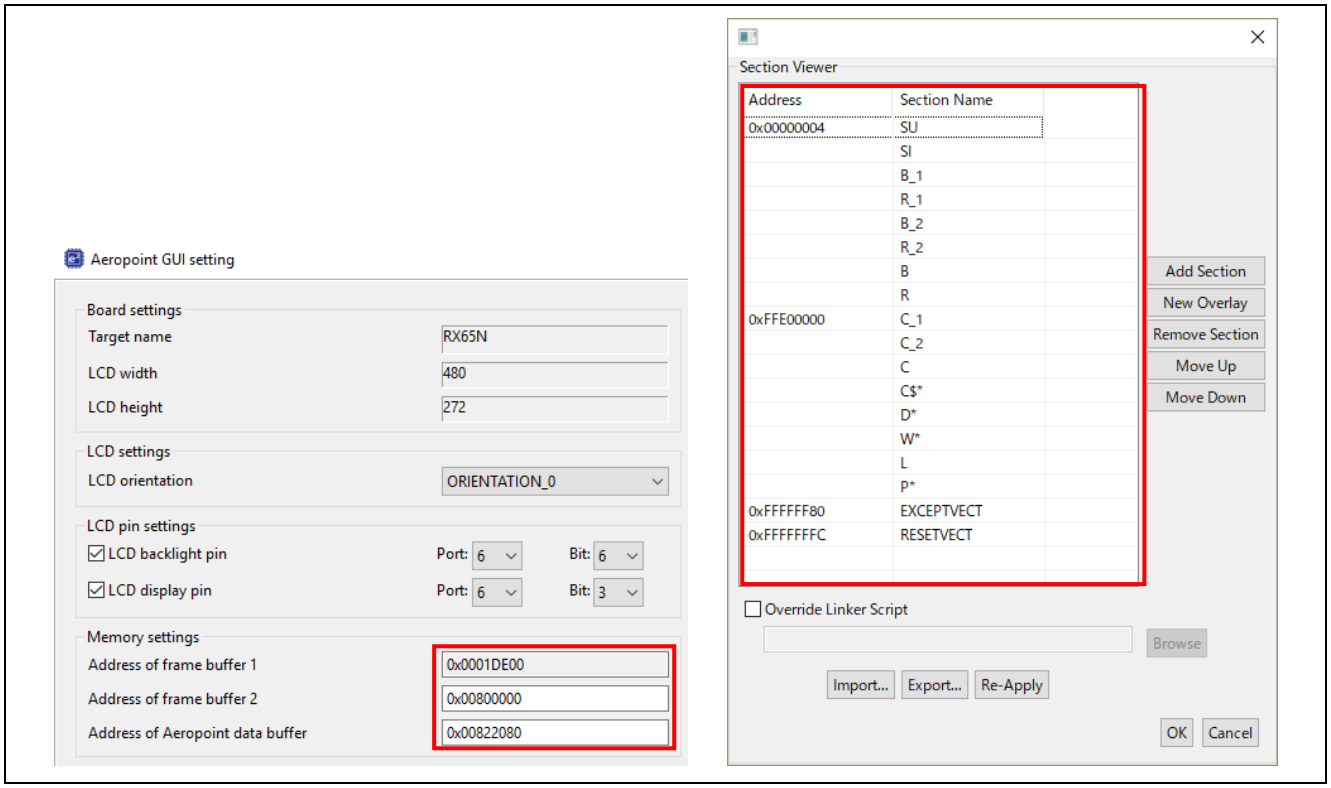
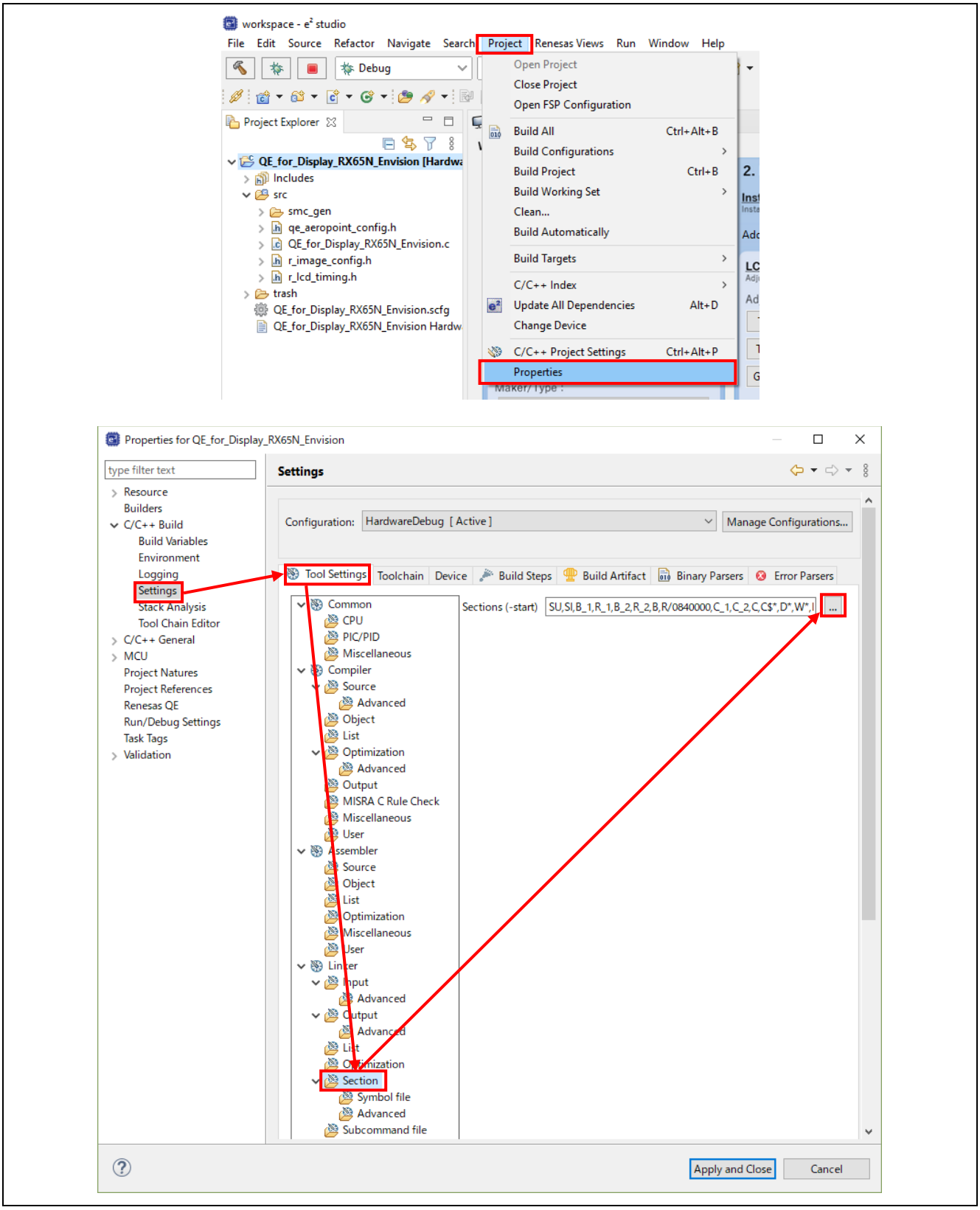


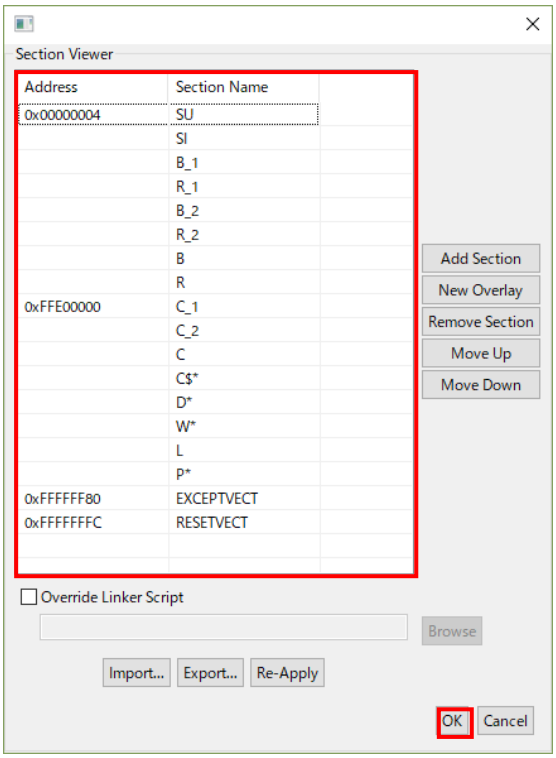
Table 4-10 Addresses of Frame Buffers and Aeropoint Data Buffer (Initial Values)

Evaluation Board	Address of Frame Buffer 1	Address of Frame Buffer 2	Address of Aeropoint Data Buffer
RSK RX72N Envision RX72N	0x0003C000	0x0005E000	0x00800000
RSK RX65N Envision RX65N	0x0001DE00	0x00800000	0x00822080

26. Select “Properties” under the “Project” menu to open the “Properties” window.
    Select “Settings” in the “Properties” window then “Section” in the “Tool Settings” tabbed page. Click on the “Browse” button for “Section (-start)”.



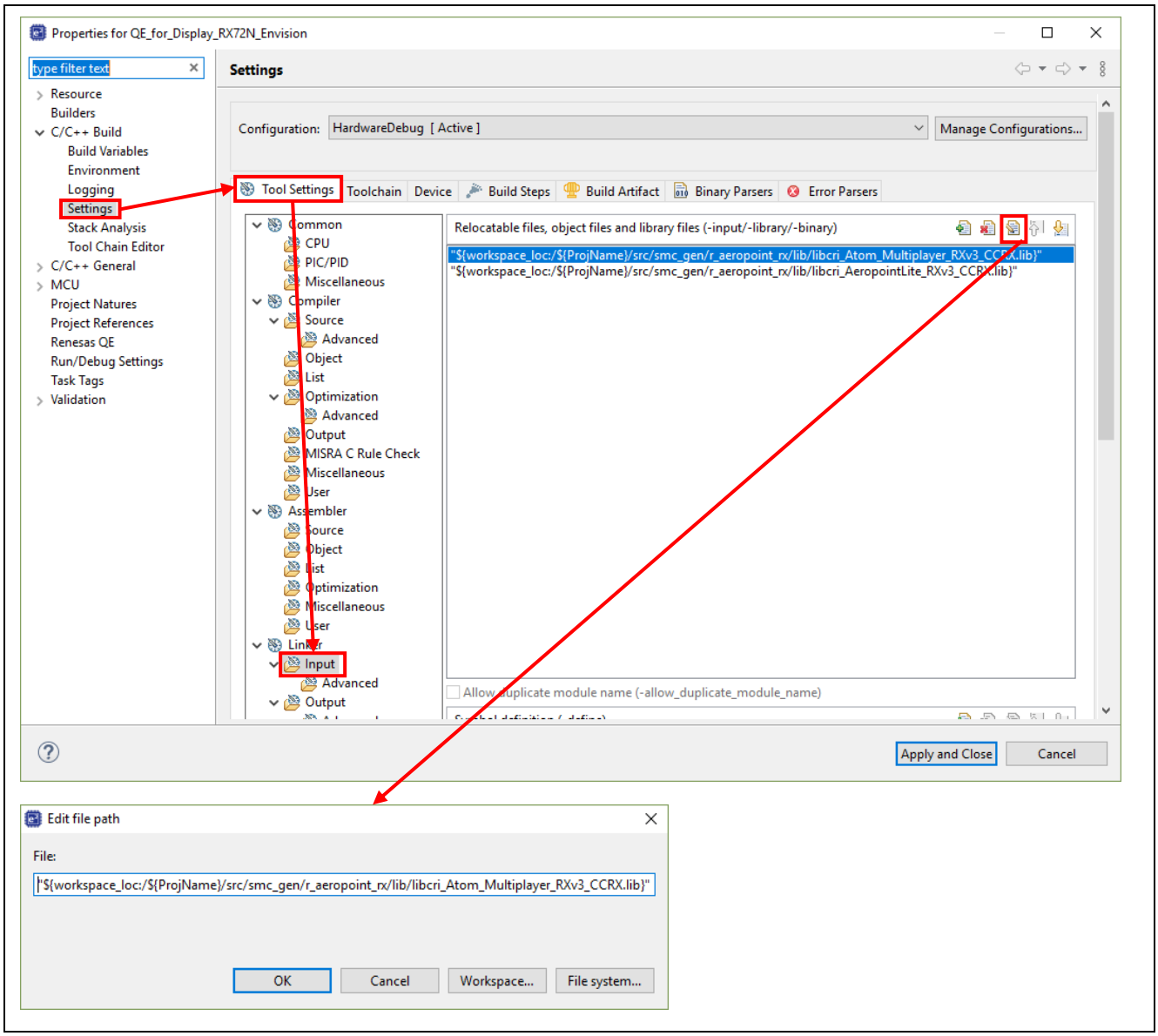
27. Change the section address so that the addresses do not overlap with those of the frame buffer. Click on the “OK” button.



28. Confirm the settings of libraries. The libraries for the RXv3 instruction set and the RXv2 instruction set are automatically set as inputs for RX72x and RX65x devices, respectively, by default.
Manually set the library of the RXv2 instruction set for an RX72x device.

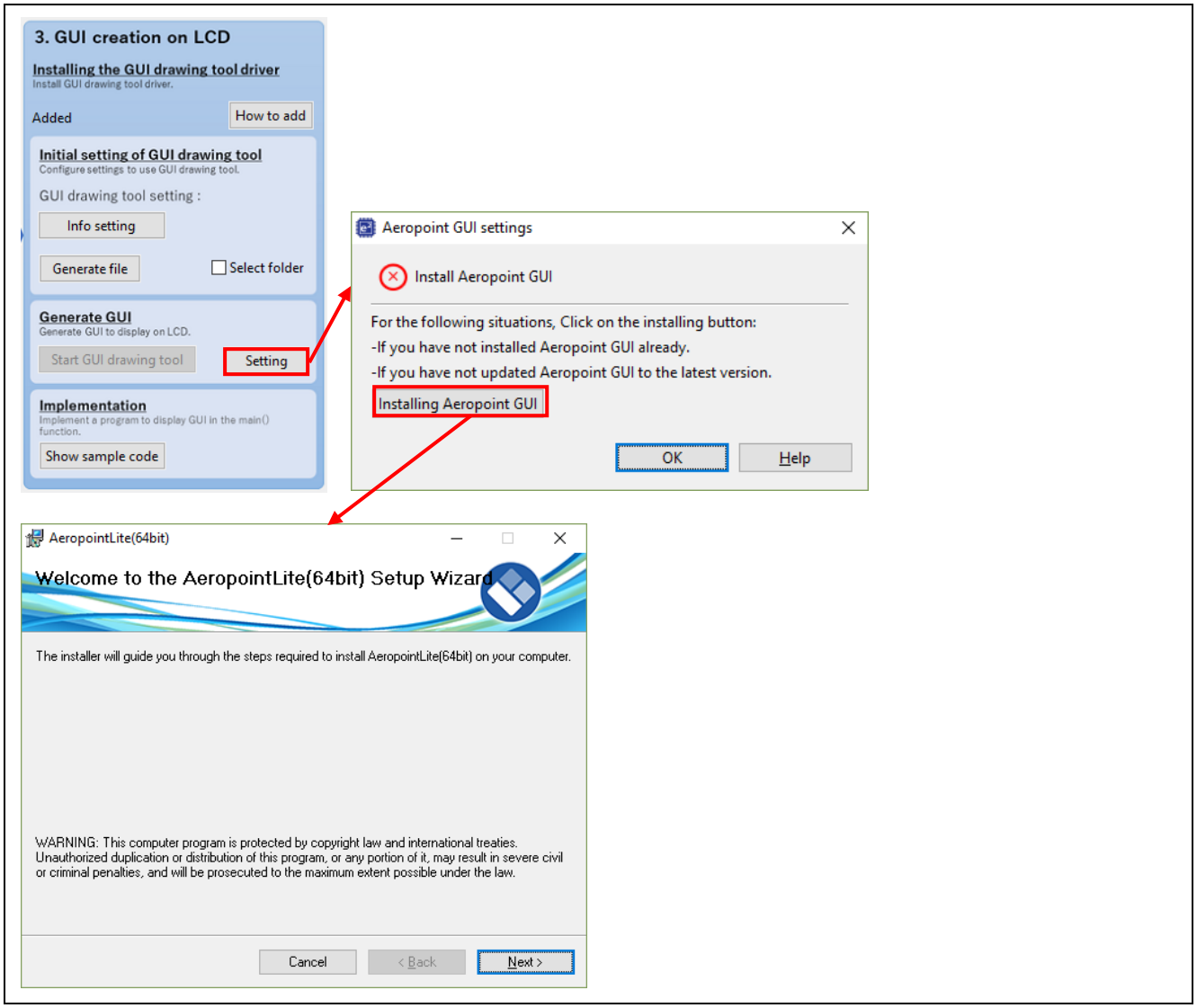
Table 4-11 Settings of the Aeropoint Libraries

Device	Instruction Set	Aeropoint Library	Setting
RX72x	RXv3	libcri_Atom_Multiplayer_RXv3_CCRX.lib libcri_AeropointLite_RXv3_CCRX.lib	Automatic
	RXv2	libcri_Atom_Multiplayer_RXv3_CCRX.lib libcri_AeropointLite_RXv2_CCRX.lib	Manual
RX65x	RXv2	libcri_Atom_Multiplayer_RXv2_CCRX.lib libcri_AeropointLite_RXv2_CCRX.lib	Automatic

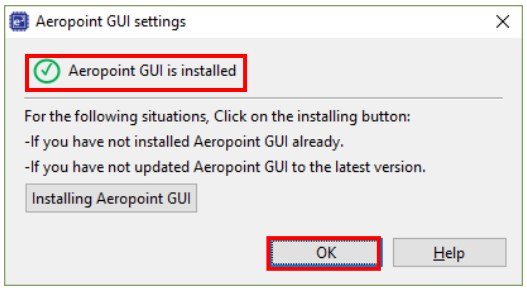

Properties for QE_for_Display_RX72N_Envision
type filter text
Resource
Builders
C/C++ Build
Build Variables
Environment
Logging
Settings
Stack Analysis
Tool Chain Editor
C/C++ General
MCU
Project Natures
Project References
Renesas QE
Run/Debug Settings
Task Tags
Validation
Settings
Configuration: HardwareDebug [Active]
Manage Configurations...
Tool Settings
Toolchain
Device
Build Steps
Build Artifact
Binary Parsers
Error Parsers
Common
CPU
PIC/PID
Miscellaneous
Compiler
Source
Advanced
Object
List
Optimization
Advanced
Output
MISRA C Rule Check
Miscellaneous
User
Assembler
Source
Object
List
Optimization
Miscellaneous
User
Linker
Input
Advanced
Output
Relocatable files, object files and library files (-input/-library/-binary)
"${workspace_loc:/${ProjName}/src/smc_gen/r_aeropoint_rx/lib/libcri_Atom_Multiplayer_RXv3_CCRX.lib}"
"${workspace_loc:/${ProjName}/src/smc_gen/r_aeropoint_rx/lib/libcri_AeropointLite_RXv3_CCRX.lib}"
Allow duplicate module name (-allow_duplicate_module_name)
Apply and Close
Cancel
Edit file path
File:
"${workspace_loc:/${ProjName}/src/smc_gen/r_aeropoint_rx/lib/libcri_Atom_Multiplayer_RXv3_CCRX.lib}"
OK
Cancel
Workspace...
File system...

Install Aeropoint GUI, which is to be used to create the GUI.

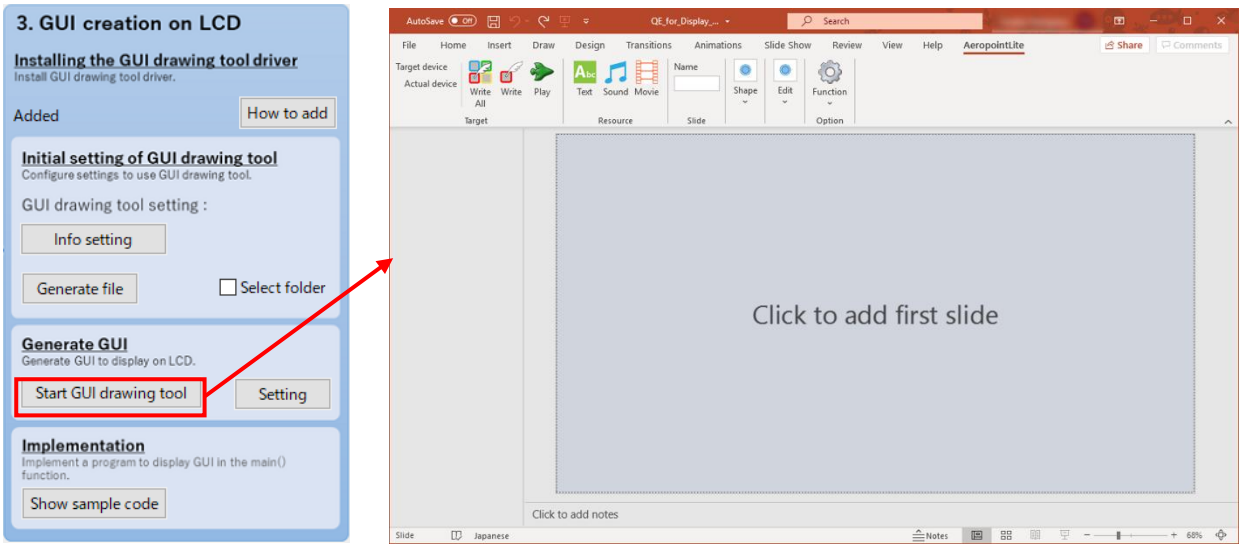
29. Click on the “Setting” button under “Generate GUI” to open the “Aeropoint GUI settings” dialog box.
30. Click on the “Installing Aeropoint GUI” button to install Aeropoint GUI by following the instructions of the AeropointLite setup wizard that is displayed.



31. After having installed Aeropoint GUI, the state indicator of the “Aeropoint GUI settings” dialog box is changed as “Aeropoint GUI is installed”. Click on the “OK” button to close the “Aeropoint GUI settings” dialog box.

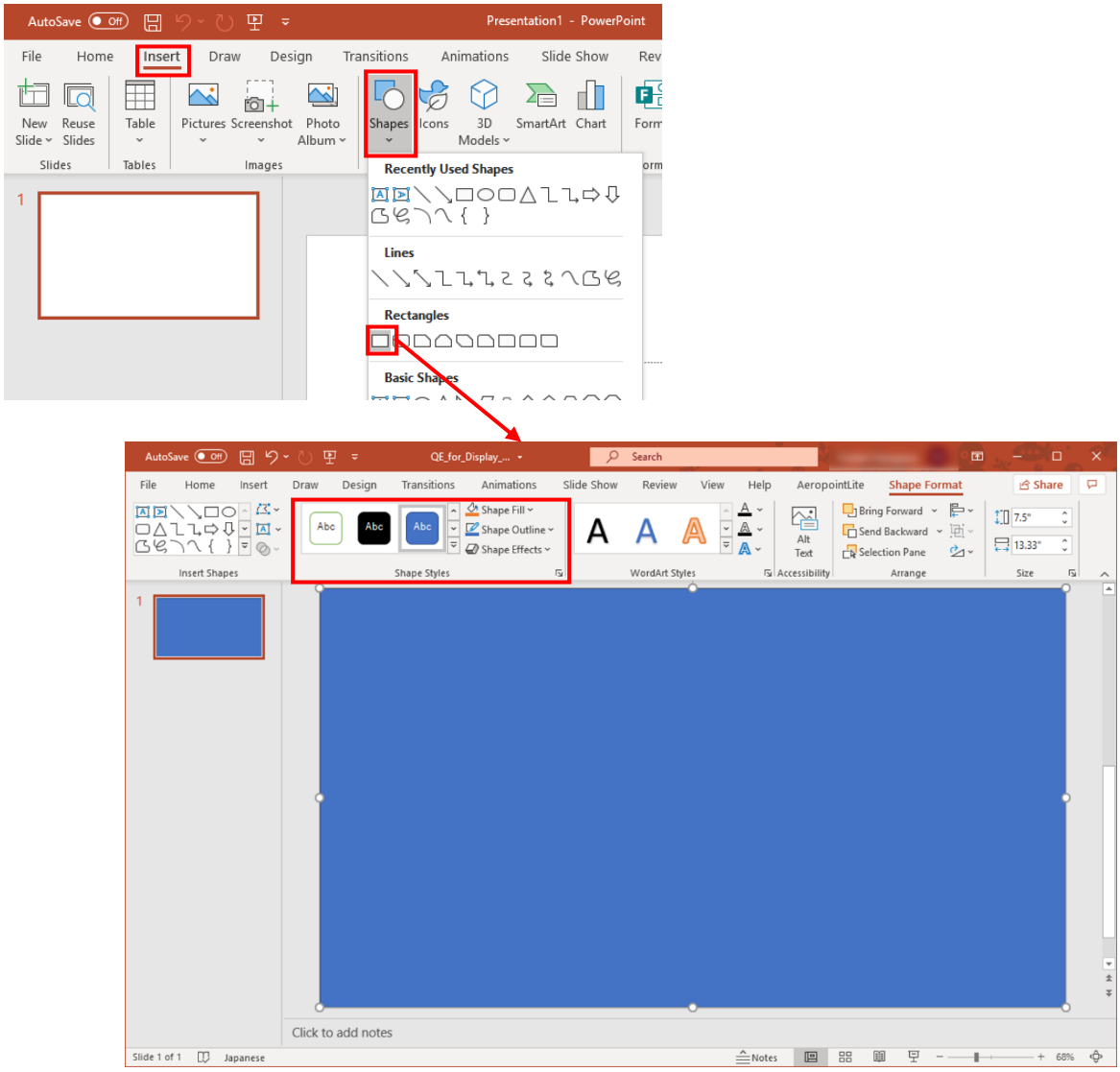


32. The “Start GUI drawing tool” button is now active.
Click on this button to start the PowerPoint file in which Aeropoint GUI add-ins have been included.

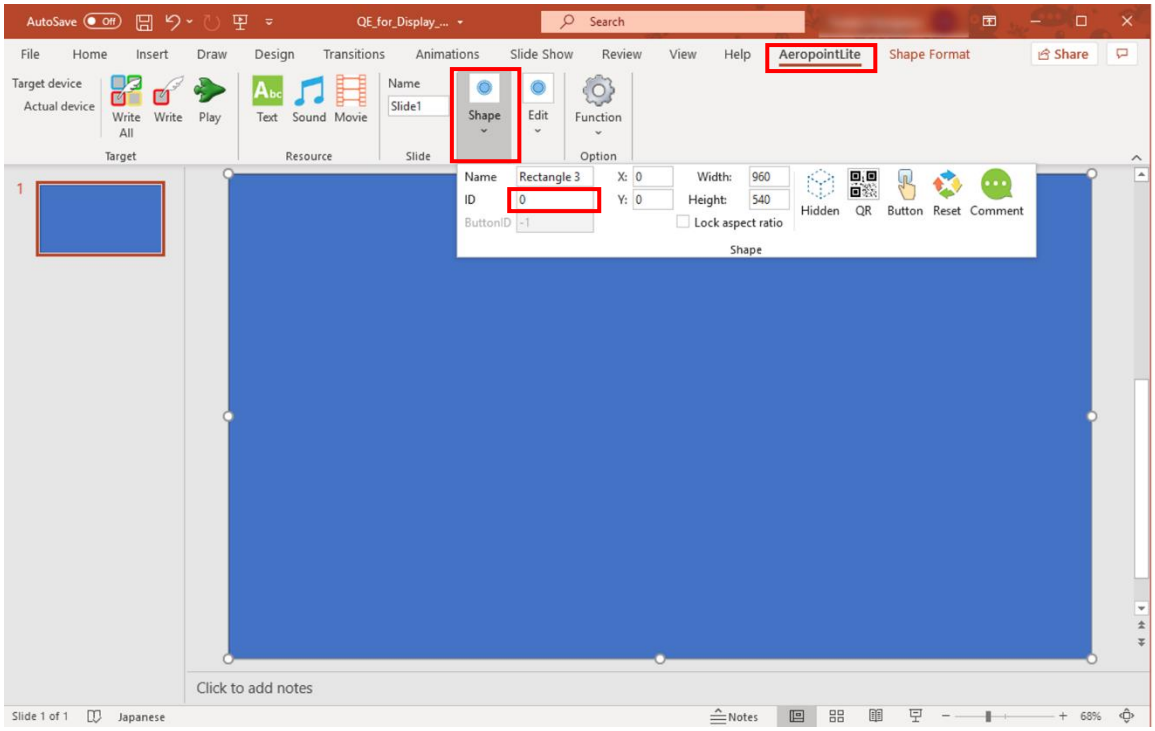


Note: The usage of Aeropoint GUI add-ins in PowerPoint may differ from the method described in this application note due to changes to the specifications. Refer to the respective help systems regarding the usage of Aeropoint GUI add-ins in PowerPoint.

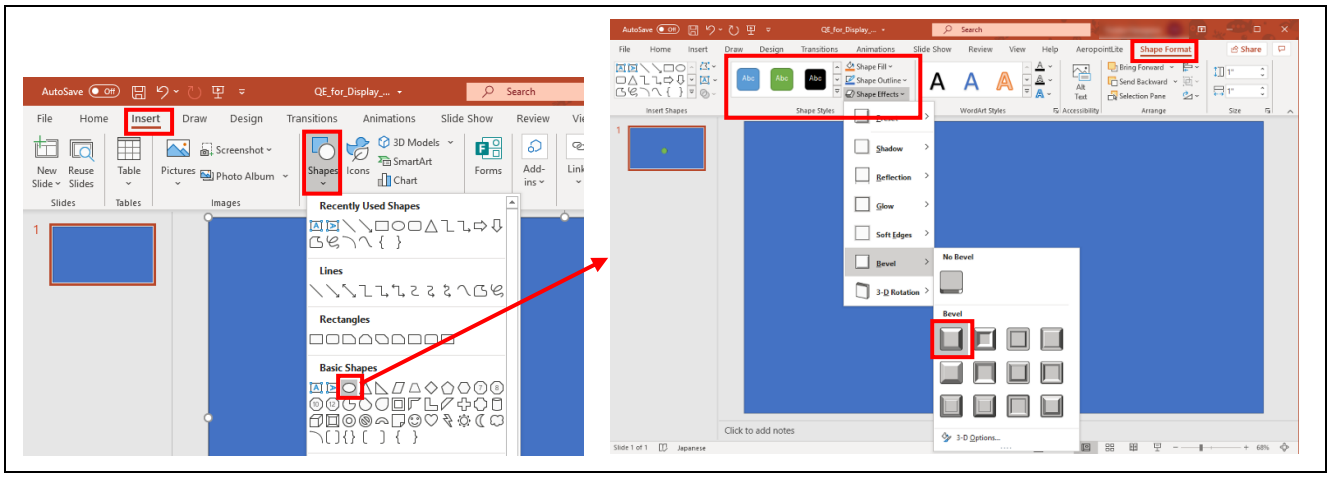
33. Create a GUI in PowerPoint.
    Click on “Click to add first slide” to add a slide.
    Select “Rectangles” from “Shapes” in the “Insert” menu to add a rectangle as the background of the screen.
    Set a desired format from “Shape Styles” on the “Shape Format” menu. Adjust the size by expanding the image to fill the screen.



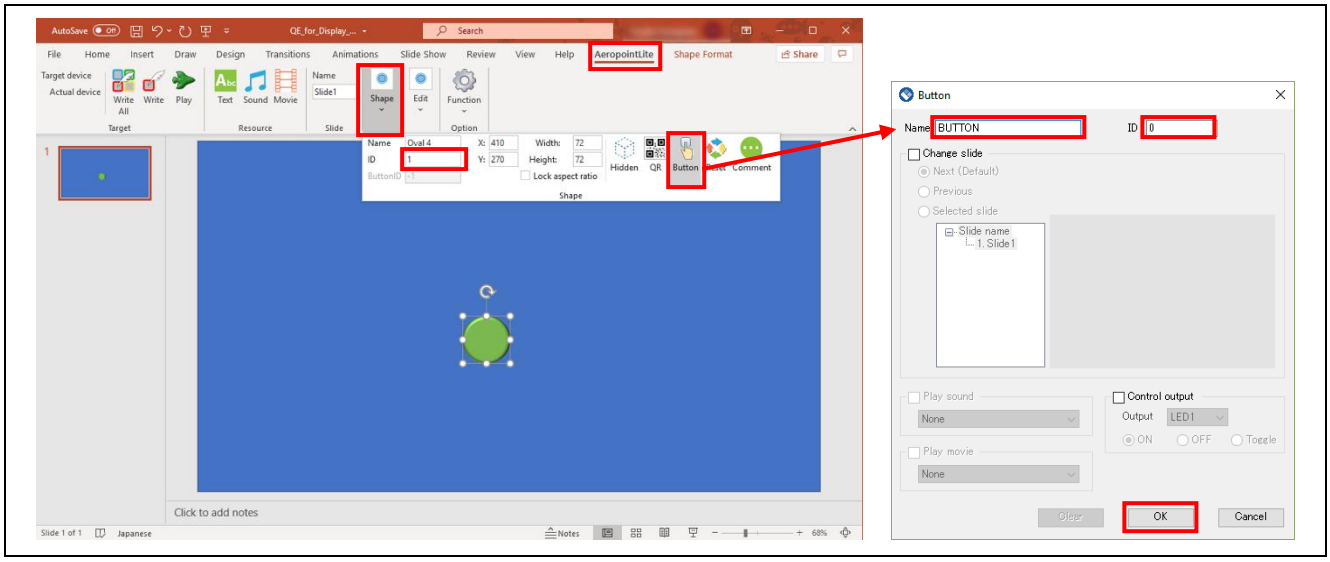
34. Open “Shape” in the “AeropointLite” menu to set the ID to 0 or a greater value. Here, specify the ID as 0.



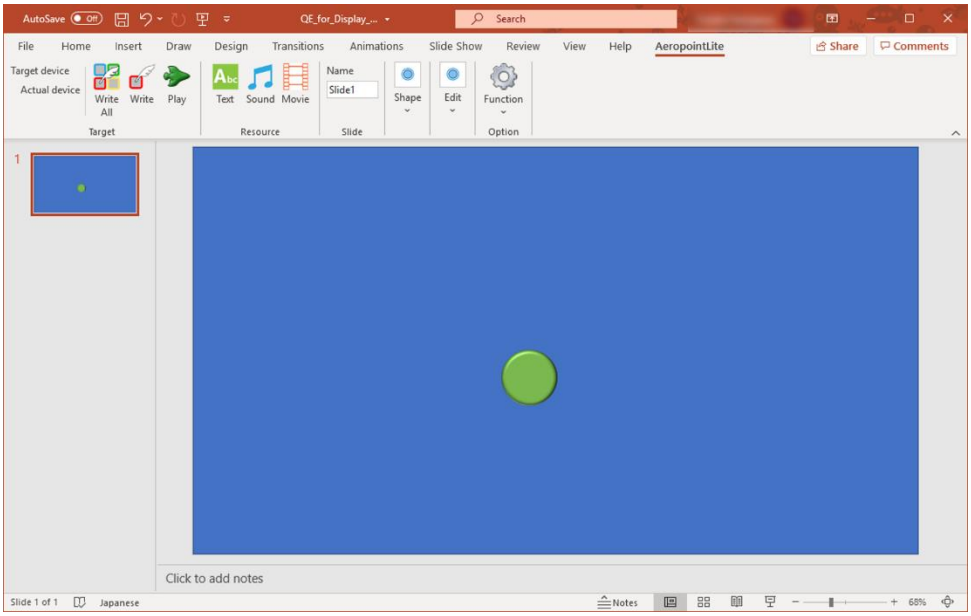
35. Select an oval shape from “Shapes” on the “Insert” menu to add a circle as the shape of a button.
    Set a desired format from “Shape Styles” on the “Shape Format” menu.

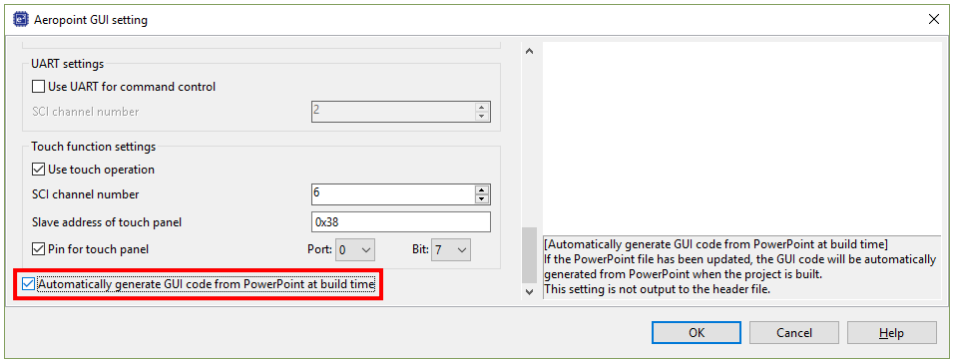


36. Open “Shape” in the “AeropointLite” menu to set the ID to 0 or a greater value. Here, specify the ID as 1. Select “Button” to open the “Button” dialog box. Set “Name” and “ID”, then click on the “OK” button.

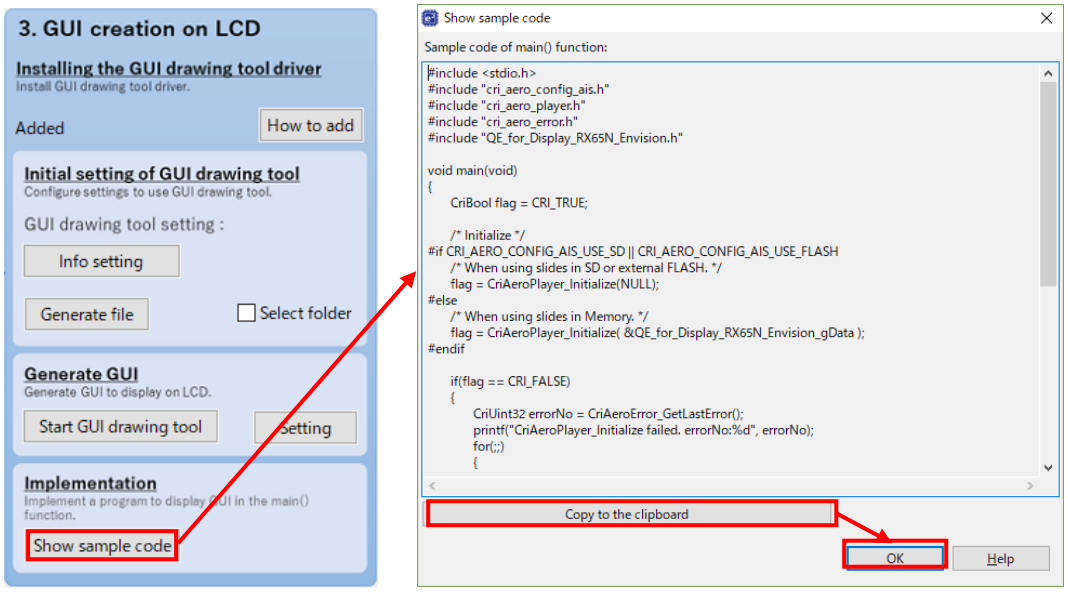


37. After having created the GUI, save the PowerPoint file.
    If the “Automatically generate GUI code from PowerPoint at build time” checkbox in “Aeropoint GUI setting” is selected, the GUI code is automatically generated from the PowerPoint file during building of a project; so the GUI code need not be manually output.



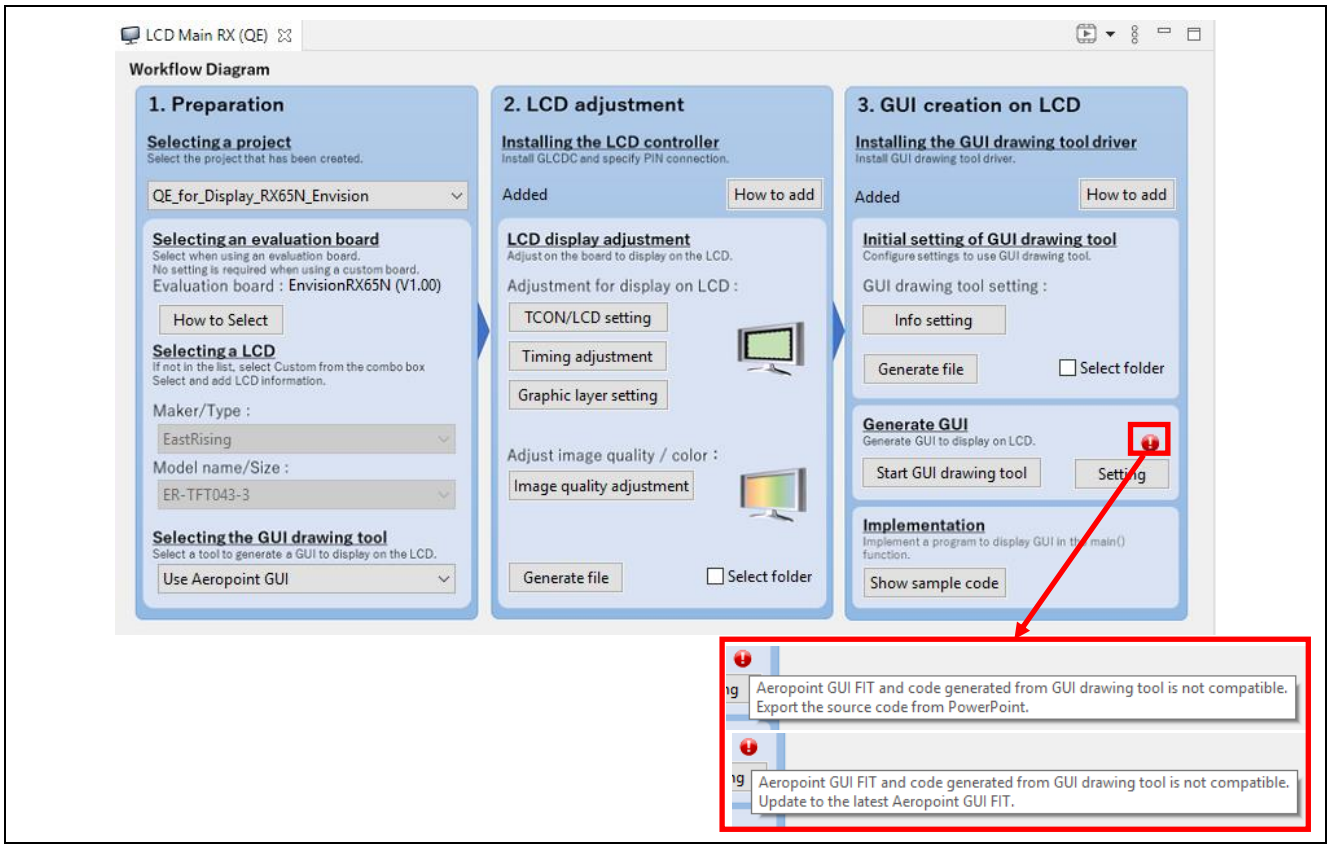


38. Include code for displaying the created GUI in the main() function.
    Click on the “Show sample code” button in the lower part of “3. GUI Creation on LCD” of QE for Display [RX].
    After clicking on the “Copy to the clipboard” button in the “Show sample code” dialog box, click on the “OK” button to close it.



39. Paste the copied code under the user code within the main() function.

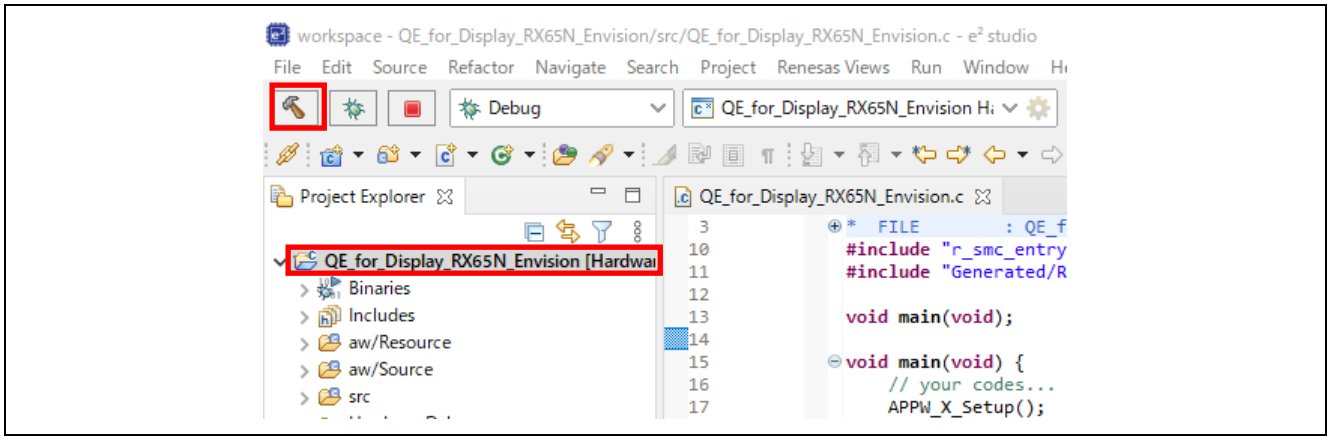
Note: If the runtime of the Aeropoint GUI FIT module does not match the version of the data output from PowerPoint, an error icon ( ) is displayed. See the tooltip shown by hovering the mouse cursor over the icon and update the Aeropoint GUI FIT module or output the PowerPoint code again.



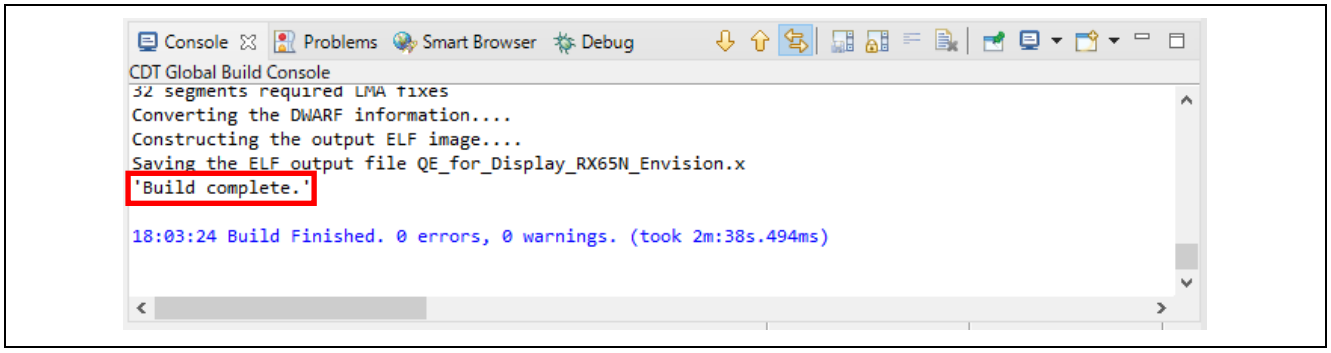
4.5 Building the Project

Build the project and make the load module according to the following procedure.

1. Click on the project you want to build (e.g. QE_for_Display_RX65N_Envision HardwareDebug).
2. Click on “Build”.



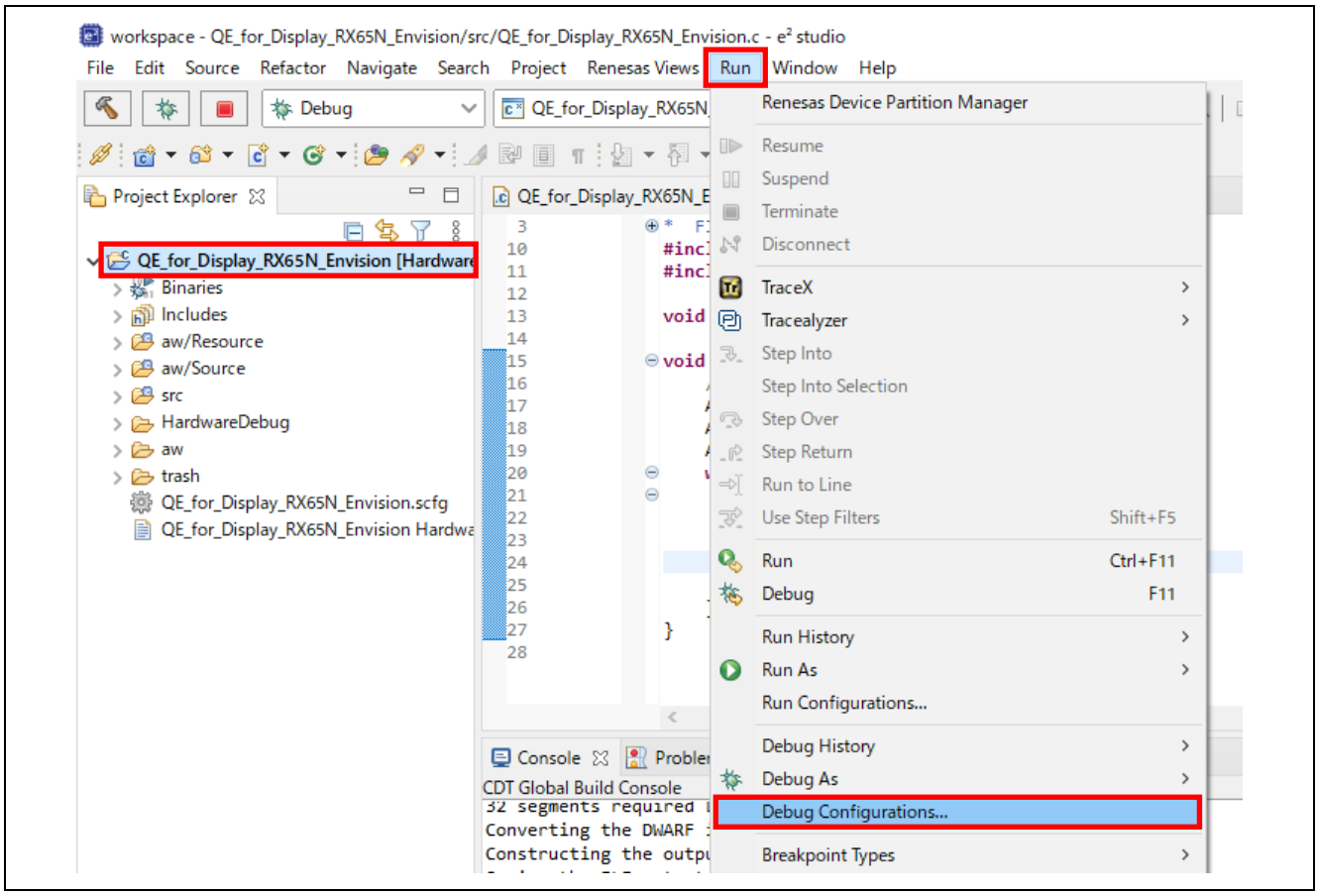
3. When the “Console” panel displays 'Build complete.', the build operation is complete.



Note: If the “Automatically generate GUI code from PowerPoint at build time” checkbox in “Aeropoint GUI setting” is selected, a build error will occur since all of the required configuration files will not be created in the first build. Build the project again.

4.6 Connecting a Debugger and Executing the Program

1. Click on the project you want to debug (e.g. QE_for_Display_RX65N_Envision HardwareDebug).
2. Click on “Debug Configurations” from the “Run” menu item.

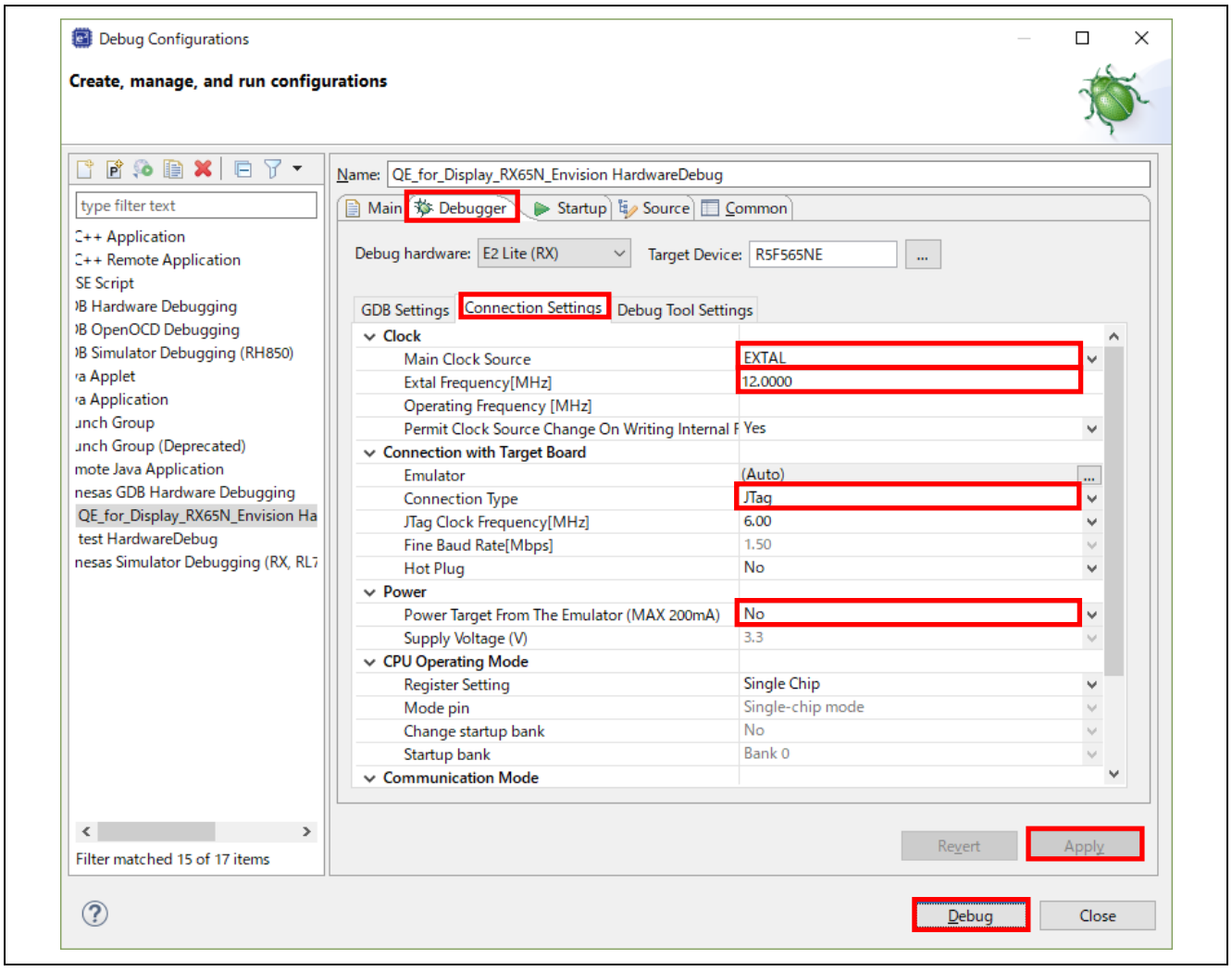


3. Select the “Connection Settings” tab on the “Debugger” tabbed page of the “Debug Configurations” dialog box.
4. Change the value for “Main Clock Source” to “EXTAL”.
5. Change the values for “Extal Frequency [MHz]” and “Connection Type” to suit the board. For setting the board, refer to chapter 2, Operating Environment.
6. Change the value for “Power Target From The Emulator (MAX 200mA)” according to the board and click on the “Apply” button. Clicking on the “Debug” button starts the connection to the target.

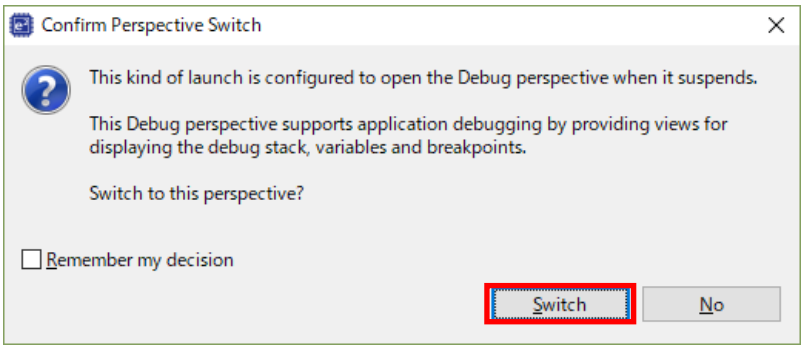
Table 4-12 Power Supplied from the Emulator

Evaluation Board	Power Supplied from the Emulator
RSK RX72N RSK RX65N	No
Envision RX72N Envision RX65N	No

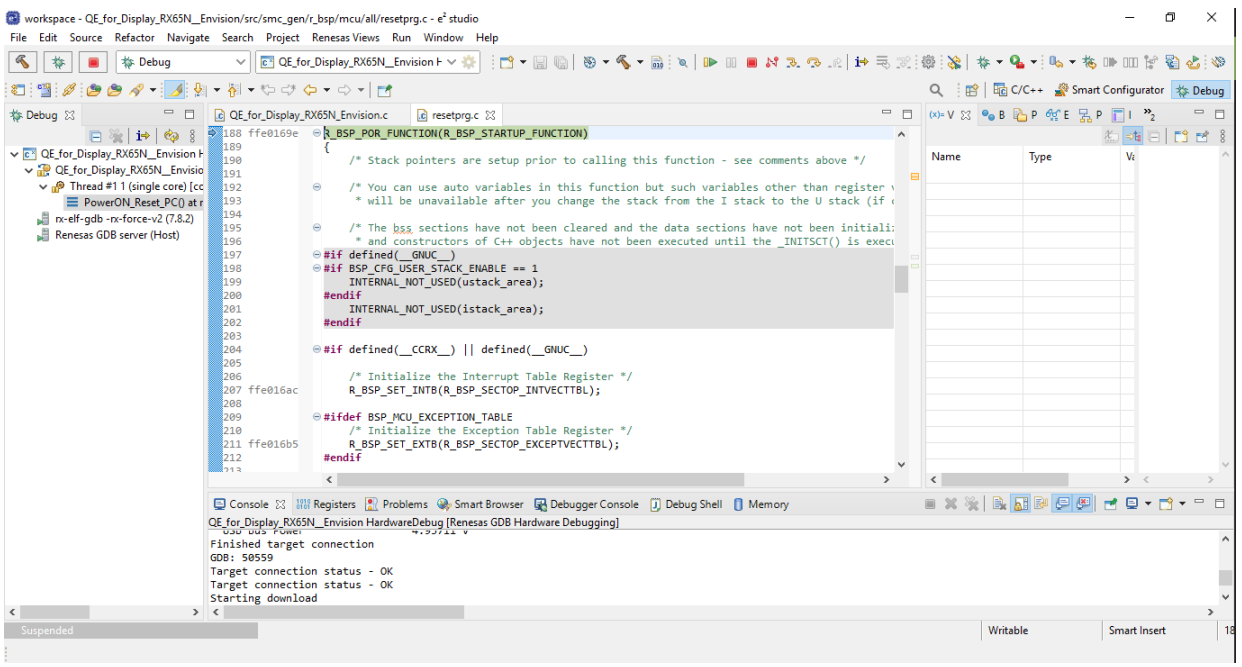
Note: To supply power to the RSK RX72N and RSK RX65N, use an external power source having a stable DC output (min. 10 W) and center-positive connector.



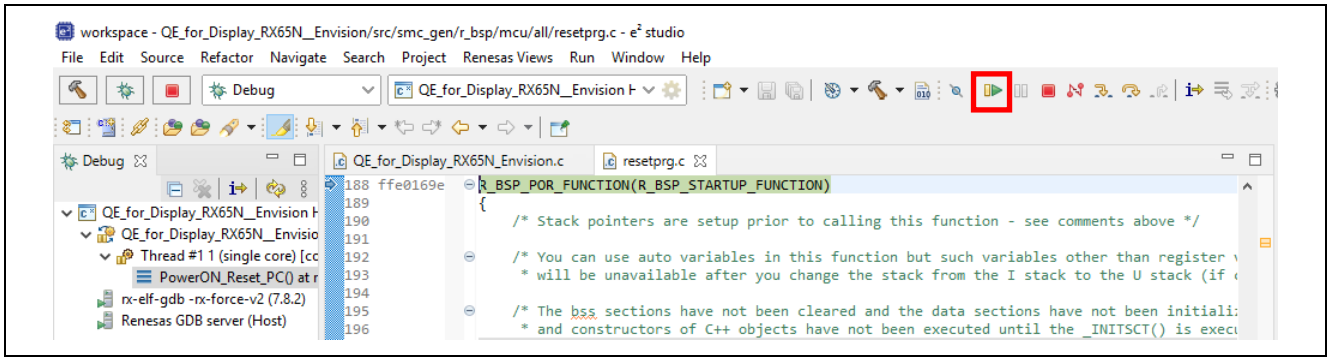
7. When the following message is displayed, click on “Switch”.



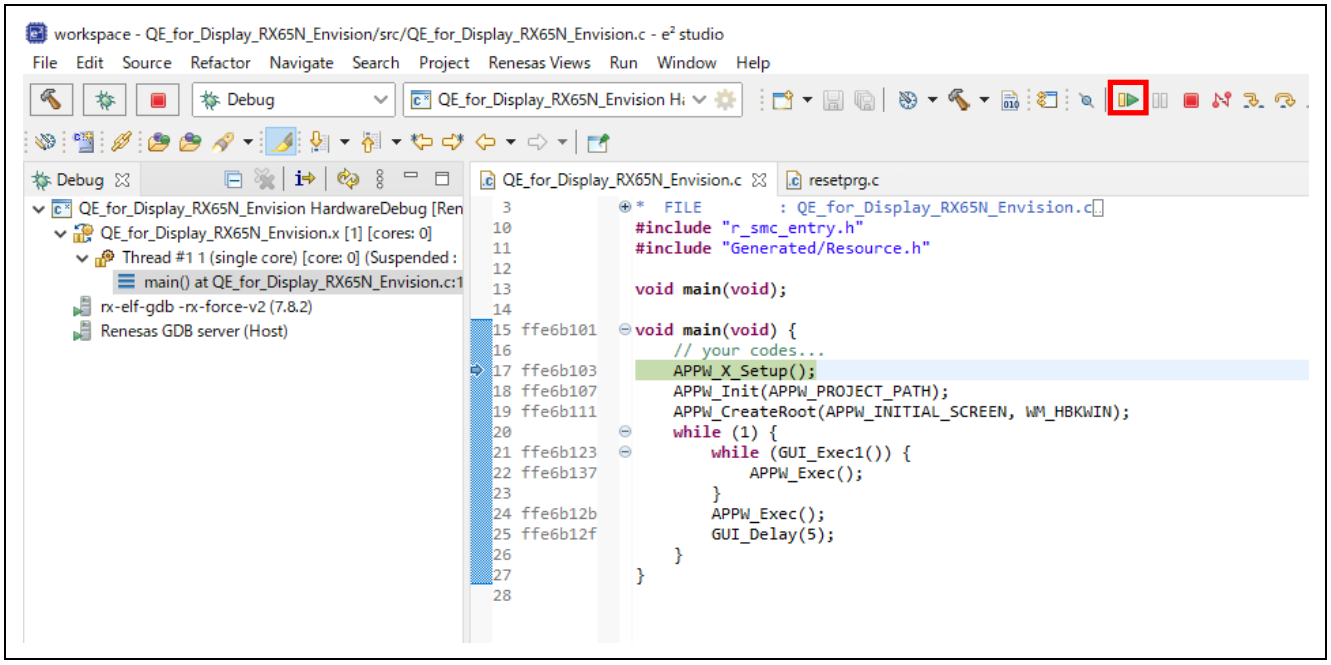
8. When downloading of the load module is completed, the “Debug” perspective opens.



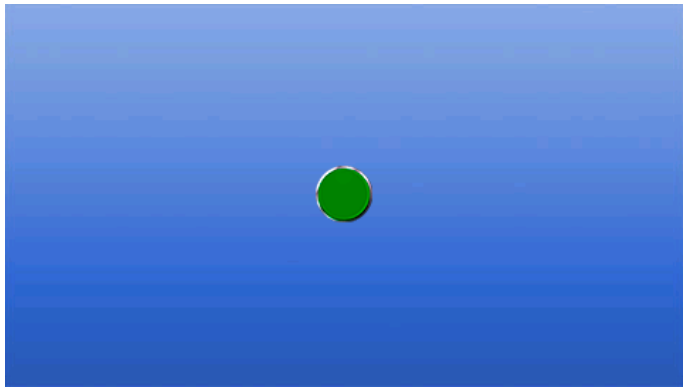
9. Click on “Resume” on the tool bar. The program is executed and breaks at the beginning of the main function.



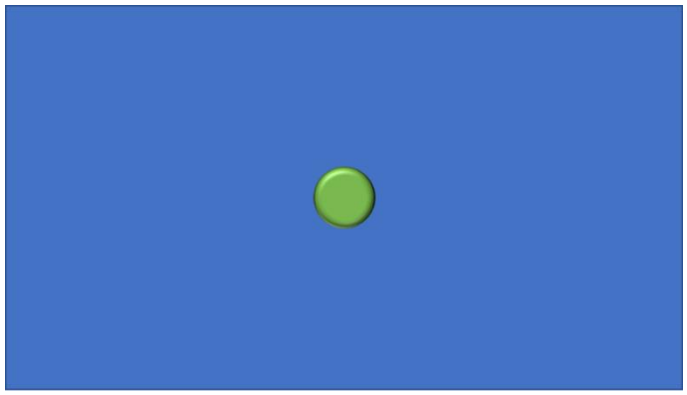
10. After a break occurs at the beginning of the main function, click on “Resume” again on the toolbar.



11. When the setting of the display device is done correctly, the following screen will be displayed on the LCD panel. Touch the button and confirm that the color changes according to your settings.
If Aeropoint GUI was used as the drawing tool, the “Aeropoint” logo will be displayed.



Display in emWin



Display in Aeropoint GUI

5. Hardware

5.1 Configuration of Hardware

Table 5-1 shows the LCD panel used in this application note.

Table 5-1 LCD Panel Used in the Sample

Board	Information on the LCD Panel Product
RSK RX72N RSK RX65N	Manufacturer: Newhaven Display Co. Part number: NHD-4.3-480272EF-ATXL#-CTP Display size:480 x 272 Synchronization signal: VS, HS, DE (three signals) Built-in touch controller
Envision RX72N Envision RX65N	Manufacturer: EastRising Co. Part number: ER-TFT043-3 Display size:480 x 272 Synchronization signal: VS, HS, DE (three signals) Built-in touch controller

5.2 Pin Functions

The following shows pins used on each RSK and Envision and describes the pin functions used. Select the pins according to the product you are using. Pin functions are automatically set by using the Smart Configurator and QE for Display [RX].

Table 5-2 Pins and Functions to be Used (RSK RX72N)

Connected Device	Pin Name	Input/Output	Description
NHD-4.3-480272EF-ATXL#-CTP	P14/LCD_CLK-B	Output	Outputs the panel clock.
	P13/LCD_TCON 0-B	Output	Outputs the synchronization signal (VSYNC).
	PJ2/LCD_TCON 2-B	Output	Outputs the synchronization signal (HSYNC).
	PB1/LCD_TCON 3-B	Output	Outputs the synchronization signal (DE).
	PC5/LCD_DATA 0-B	Output	Outputs the LCD signal R[3].
	P82/LCD_DATA 1-B	Output	Outputs the LCD signal R[4].
	P81/LCD_DATA 2-B	Output	Outputs the LCD signal R[5].
	P80/LCD_DATA 3-B	Output	Outputs the LCD signal R[6].
	PC4/LCD_DATA 4-B	Output	Outputs the LCD signal R[7].
	P55/LCD_DATA 5-B	Output	Outputs the LCD signal G[2].
	P54/LCD_DATA 6-B	Output	Outputs the LCD signal G[3].
	P11/LCD_DATA 7-B	Output	Outputs the LCD signal G[4].
	P83/LCD_DATA 8-B	Output	Outputs the LCD signal G[5].
	PC7/LCD_DATA 9-B	Output	Outputs the LCD signal G[6].
	PC6/LCD_DATA 10-B	Output	Outputs the LCD signal G[7].
	PJ0/LCD_DATA 11-B	Output	Outputs the LCD signal B[3].
	P85/LCD_DATA 12-B	Output	Outputs the LCD signal B[4].
	P84/LCD_DATA 13-B	Output	Outputs the LCD signal B[5].
	P57/LCD_DATA 14-B	Output	Outputs the LCD signal B[6].
	P56/LCD_DATA 15-B	Output	Outputs the LCD signal B[7].
	PQ1/SSCL11	Input/output	Inputs or outputs for the clock of the I^2C interface connected to the touch controller.
	PQ2/SSDA11	Input/output	Inputs or outputs for the data of the I^2C interface connected to the touch controller.
	P27/general-purpose input/output port	Output	Backlight
	PK4/general-purpose input/output port	Output	Panel reset
	PL3/general-purpose input/output port*	Output	Touch controller reset

Note: When PL3 is to be used, a resistor must be changed. For details, refer to the user's manual of the evaluation board.

Table 5-3 Pins and Functions to be Used (Envision RX72N)

Connected Device	Pin Name	Input/Output	Description
ER-TFT043-3	PB5/LCD_CLK-B	Output	Outputs the panel clock.
	PB4/LCD_TCON 0-B	Output	Outputs the synchronization signal (VSYNC).
	PB2/LCD_TCON 2-B	Output	Outputs the synchronization signal (HSYNC).
	PB1/LCD_TCON 3-B	Output	Outputs the synchronization signal (DE).
	PB0/LCD_DATA 0-B	Output	Outputs the LCD signal B[3].
	PA7/LCD_DATA 1-B	Output	Outputs the LCD signal B[4].
	PA6/LCD_DATA 2-B	Output	Outputs the LCD signal B[5].
	PA5/LCD_DATA 3-B	Output	Outputs the LCD signal B[6].
	PA4/LCD_DATA 4-B	Output	Outputs the LCD signal B[7].
	PA3/LCD_DATA 5-B	Output	Outputs the LCD signal G[2].
	PA2/LCD_DATA 6-B	Output	Outputs the LCD signal G[3].
	PA1/LCD_DATA 7-B	Output	Outputs the LCD signal G[4].
	PA0/LCD_DATA 8-B	Output	Outputs the LCD signal G[5].
	PE7/LCD_DATA 9-B	Output	Outputs the LCD signal G[6].
	PE6/LCD_DATA 10-B	Output	Outputs the LCD signal G[7].
	PE5/LCD_DATA 11-B	Output	Outputs the LCD signal R[3].
	PE4/LCD_DATA 12-B	Output	Outputs the LCD signal R[4].
	PE3/LCD_DATA 13-B	Output	Outputs the LCD signal R[5].
	PE2/LCD_DATA 14-B	Output	Outputs the LCD signal R[6].
	PE1/LCD_DATA 15-B	Output	Outputs the LCD signal R[7].
	P33/SSCL6	Input/output	Inputs or outputs for the clock of the I^2C interface connected to the touch controller.
	P32/SSDA6	Input/output	Inputs or outputs for the data of the I^2C interface connected to the touch controller.
	P67/general-purpose input/output port	Output	Backlight
	PB3/general-purpose input/output port	Output	Panel reset
	P66/general-purpose input/output port	Output	Touch controller reset

Table 5-4 Pins and Functions to be Used (RSK RX65N)

Connected Device	Pin Name	Input/Output	Description
NHD-4.3-480272EF-ATXL#-CTP	PB5/LCD_CLK-B	Output	Outputs the panel clock.
	PB4/LCD_TCON 0-B	Output	Outputs the synchronization signal (VSYNC).
	PB2/LCD_TCON 2-B	Output	Outputs the synchronization signal (HSYNC).
	PB1/LCD_TCON 3-B	Output	Outputs the synchronization signal (DE).
	PB0/LCD_DATA 0-B	Output	Outputs the LCD signal R[3].
	PA7/LCD_DATA 1-B	Output	Outputs the LCD signal R[4].
	PA6/LCD_DATA 2-B	Output	Outputs the LCD signal R[5].
	PA5/LCD_DATA 3-B	Output	Outputs the LCD signal R[6].
	PA4/LCD_DATA 4-B	Output	Outputs the LCD signal R[7].
	PA3/LCD_DATA 5-B	Output	Outputs the LCD signal G[2].
	PA2/LCD_DATA 6-B	Output	Outputs the LCD signal G[3].
	PA1/LCD_DATA 7-B	Output	Outputs the LCD signal G[4].
	PA0/LCD_DATA 8-B	Output	Outputs the LCD signal G[5].
	PE7/LCD_DATA 9-B	Output	Outputs the LCD signal G[6].
	PE6/LCD_DATA 10-B	Output	Outputs the LCD signal G[7].
	PE5/LCD_DATA 11-B	Output	Outputs the LCD signal B[3].
	PE4/LCD_DATA 12-B	Output	Outputs the LCD signal B[4].
	PE3/LCD_DATA 13-B	Output	Outputs the LCD signal B[5].
	PE2/LCD_DATA 14-B	Output	Outputs the LCD signal B[6].
	PE1/LCD_DATA 15-B	Output	Outputs the LCD signal B[7].
	P01/SSCL6	Input/output	Inputs or outputs for the clock of the I^2C interface connected to the touch controller.
	P00/SSDA6	Input/output	Inputs or outputs for the data of the I^2C interface connected to the touch controller.
	PB7/general-purpose input/output port	Output	Backlight
	P97/general-purpose input/output port	Output	Panel reset

Table 5-5 Pins and Functions to be Used (Envision RX65N)

Connected Device	Pin Name	Input/Output	Description
ER-TFT043-3	PB5/LCD_CLK-B	Output	Outputs the panel clock.
	PB4/LCD_TCON 0-B	Output	Outputs the synchronization signal (VSYNC).
	PB2/LCD_TCON 2-B	Output	Outputs the synchronization signal (HSYNC).
	PB1/LCD_TCON 3-B	Output	Outputs the synchronization signal (DE).
	PB0/LCD_DATA 0-B	Output	Outputs the LCD signal B[3].
	PA7/LCD_DATA 1-B	Output	Outputs the LCD signal B[4].
	PA6/LCD_DATA 2-B	Output	Outputs the LCD signal B[5].
	PA5/LCD_DATA 3-B	Output	Outputs the LCD signal B[6].
	PA4/LCD_DATA 4-B	Output	Outputs the LCD signal B[7].
	PA3/LCD_DATA 5-B	Output	Outputs the LCD signal G[2].
	PA2/LCD_DATA 6-B	Output	Outputs the LCD signal G[3].
	PA1/LCD_DATA 7-B	Output	Outputs the LCD signal G[4].
	PA0/LCD_DATA 8-B	Output	Outputs the LCD signal G[5].
	PE7/LCD_DATA 9-B	Output	Outputs the LCD signal G[6].
	PE6/LCD_DATA 10-B	Output	Outputs the LCD signal G[7].
	PE5/LCD_DATA 11-B	Output	Outputs the LCD signal R[3].
	PE4/LCD_DATA 12-B	Output	Outputs the LCD signal R[4].
	PE3/LCD_DATA 13-B	Output	Outputs the LCD signal R[5].
	PE2/LCD_DATA 14-B	Output	Outputs the LCD signal R[6].
	PE1/LCD_DATA 15-B	Output	Outputs the LCD signal R[7].
	P01/SSCL6	Input/output	Inputs or outputs for the clock of the I^2C interface connected to the touch controller.
	P00/SSDA6	Input/output	Inputs or outputs for the data of the I^2C interface connected to the touch controller.
	P66/general-purpose input/output port	Output	Backlight
	P63/general-purpose input/output port	Output	Panel reset
	P07/general-purpose input/output port	Output	Touch controller reset

6. Using QE for Display [RX]

This chapter describes the usage of QE for Display [RX] according to the actual flow of display adjustment. For details on the facilities of QE for Display [RX], refer to the help file which comes with QE for Display [RX].

6.1 Starting QE for Display [RX]

Selecting “Renesas Views” -> “Renesas QE” -> “LCD Main RX (QE)” from the menu of the e² studio starts QE for Display [RX] (Figure 6-1).

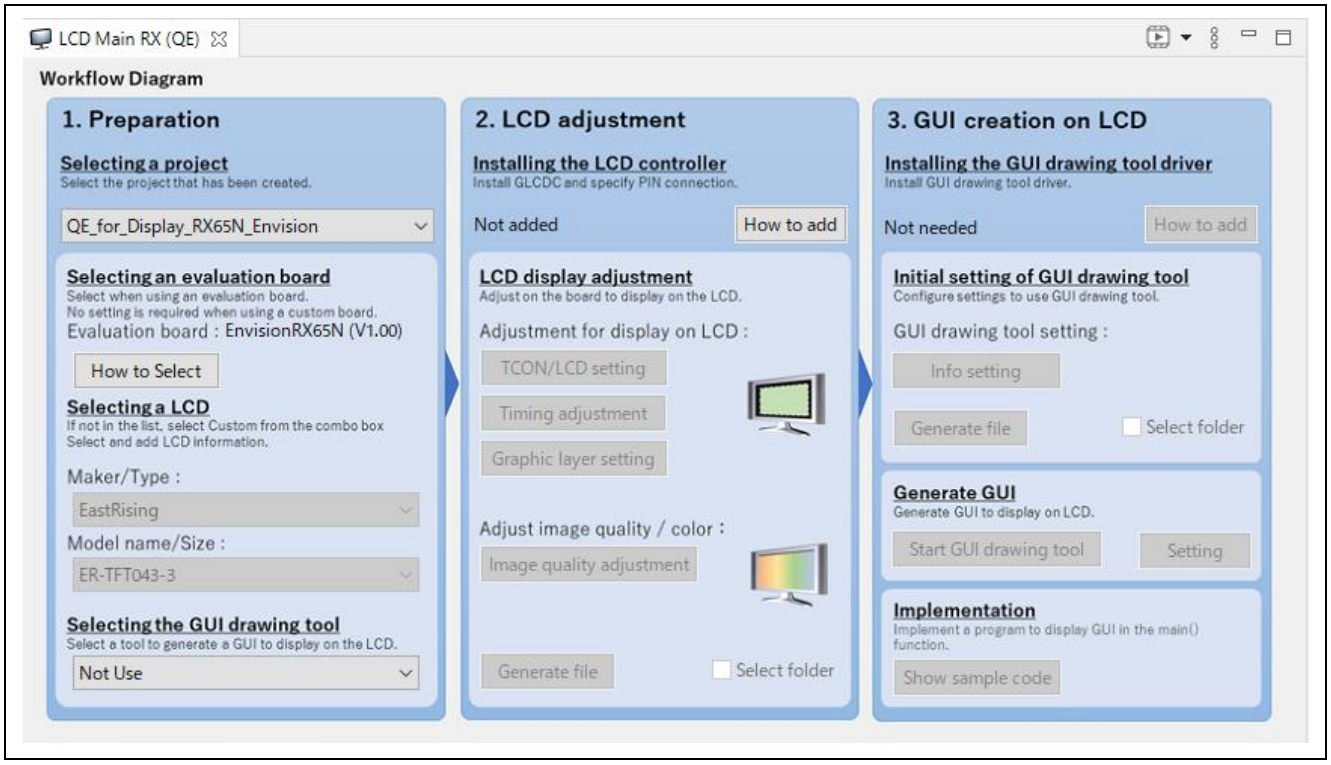


Figure 6-1 Initial State of QE for Display [RX]

After a project has been selected in “1. Selecting a project” in the workflow diagram of QE for Display [RX], selecting “Renesas Views” -> “Renesas QE” -> “Display Tuning RX (QE)” from the menu of the e² studio opens the “Display Tuning RX (QE)” view of QE for Display [RX] (Figure 6-2).

Figure 6-2 is the display of a block diagram of the hardware of the GLCDC, showing the path for the output of image data and the relationships between the positions where images are to be corrected. Clicking on “Brightness” or “Contrast” for the adjustment of image quality produces the “Image Quality Adjustment” tabbed page, which allows various adjustments.

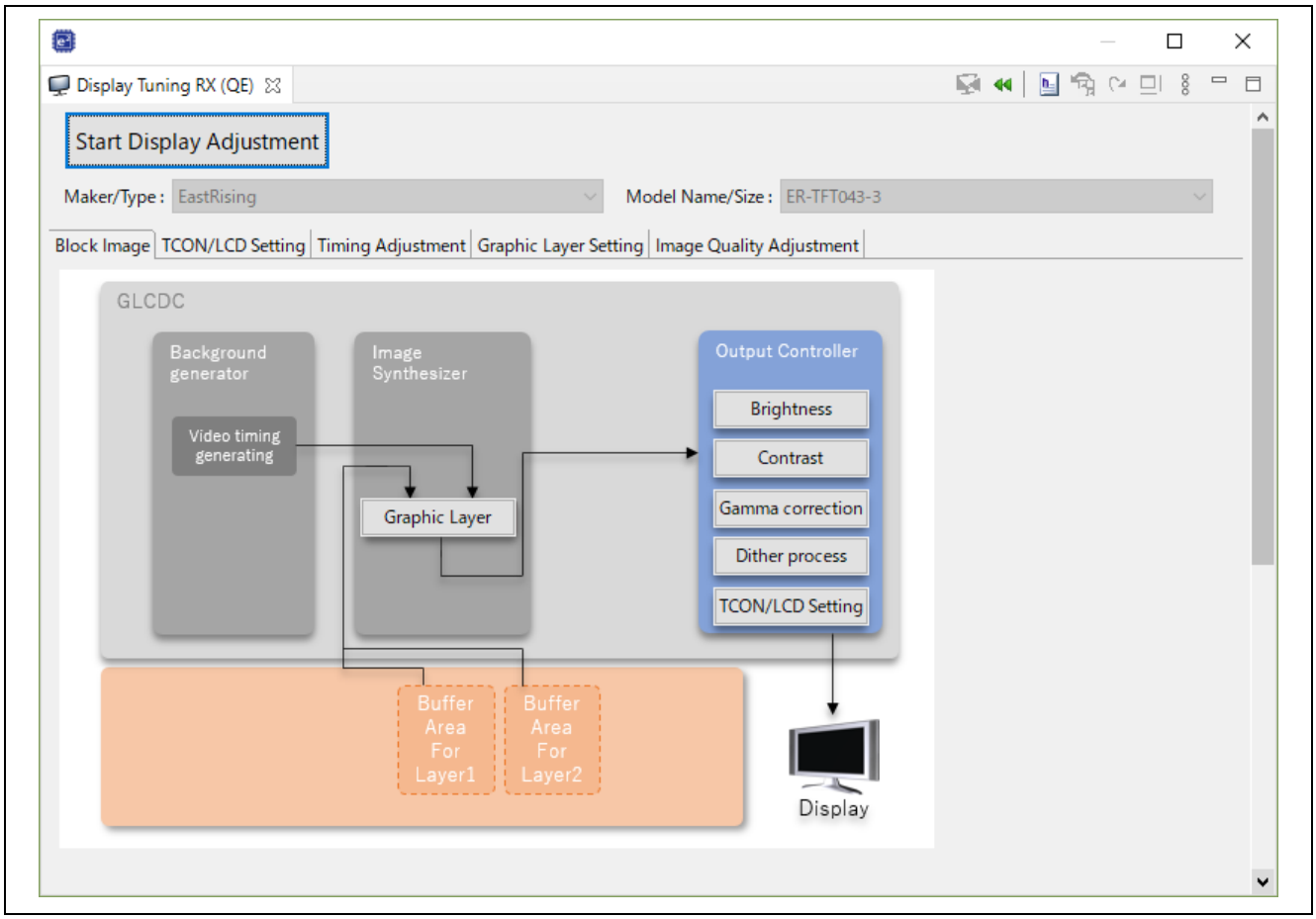


Figure 6-2 “Display Tuning RX (QE)” View

6.2 Setting Data on the LCD Panel

Information on the LCD panel which is connected to the user system is specified. When the display is connected to a system under development, you need to compare and adjust the specifications of the LCD panel and the display controller and find specifiable and appropriate settings. Information that has been specified is used in comparison.

The LCD mounted on the RSK is an NHD-4.3-480272EF-ATXL#-CTP manufactured by Newhaven Display International. The LCD mounted on the Envision is an ER-TFT043-3 manufactured by EastRising Technology Co., Ltd.

For the package of QE for Display [RX] V2.0.0 or later versions, selecting a project for which the board to be used has been specified in the “LCD Main RX (QE)” view displays information on the LCD panel.

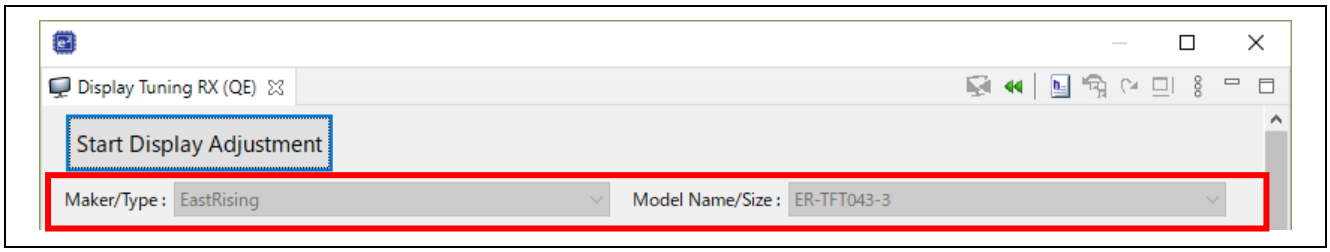


Figure 6-3 Selecting the LCD Panel

When information on the LCD panel is set, the display type can be specified by selecting from among three patterns. The display type adopted is 3 (the method of using Vsync, Hsync, and DE signals) for the LCD panel mounted on the RSK and Envision.

For details on setting information on the LCD panel, refer to chapter 7, Setting Detailed Data on the LCD Panel.

6.3 Setting the Output of Control Signals

Select the “TCON/LCD Setting” tabbed page in the “Display Tuning RX (QE)” view and specify the settings for the output of control signals (Figure 6-4).

The following settings for the output of control signals are available on this page.

[Panel Driver Signal (TCON) Output Selection]
- Selection of output pins:
  - Output to the LCD_TCON0 to LCD_TCON3 pins (TCON0 to TCON3)
- Active sense of control signals:
  - Positive sense: [High Active]
  - Negative sense: [Low Active]

[LCD Setting]
- [LCD Output Format]
  - 24-bit RGB888 output: [24bit (GLCDC_OUT_FORMAT_24BITS_RGB888)]
  - 18-bit RGB666 output: [18bit (GLCDC_OUT_FORMAT_18BITS_RGB666)]
  - 16-bit RGB565 output: [16bit (GLCDC_OUT_FORMAT_16BITS_RGB565)]
- [Timing of Output Data]
  - Output on rising edges of the panel clock: [Rising (GLCDC_SIGNAL_SYNC_EDGE_RISING)]
  - Output on falling edge of the panel clock: [Falling (GLCDC_SIGNAL_SYNC_EDGE_FALLING)]
- [Background Color]
  - 0x00000000 to 0x00FFFFFF
- [Bit-endian of Output Data]
  - Little Endian (GLCDC_ENDIAN_LITTLE)
  - Big Endian (GLCDC_ENDIAN_BIG)
- [Pixel Order of Output Data]
  - RGB (GLCDC_COLOR_ORDER_RGB)
  - BGR (GLCDC_COLOR_ORDER_BGR)

[LCD Backlight Control]
- Selection of control
- Selection of port number:
  - PORT0 to PORTJ
- Selection of bit position:
  - BIT0 to BIT7
- Active sense of control signals:
  - Negative sense: [Low Active]
  - Positive sense: [High Active]

[LCD Reset Control]
- Selection of control
- Selection of port number:
  - PORT0 to PORTJ
- Selection of bit position:
  - BIT0 to BIT7
- Active sense of control signals:
  - Negative sense: [Low Active]
  - Positive sense: [High Active]

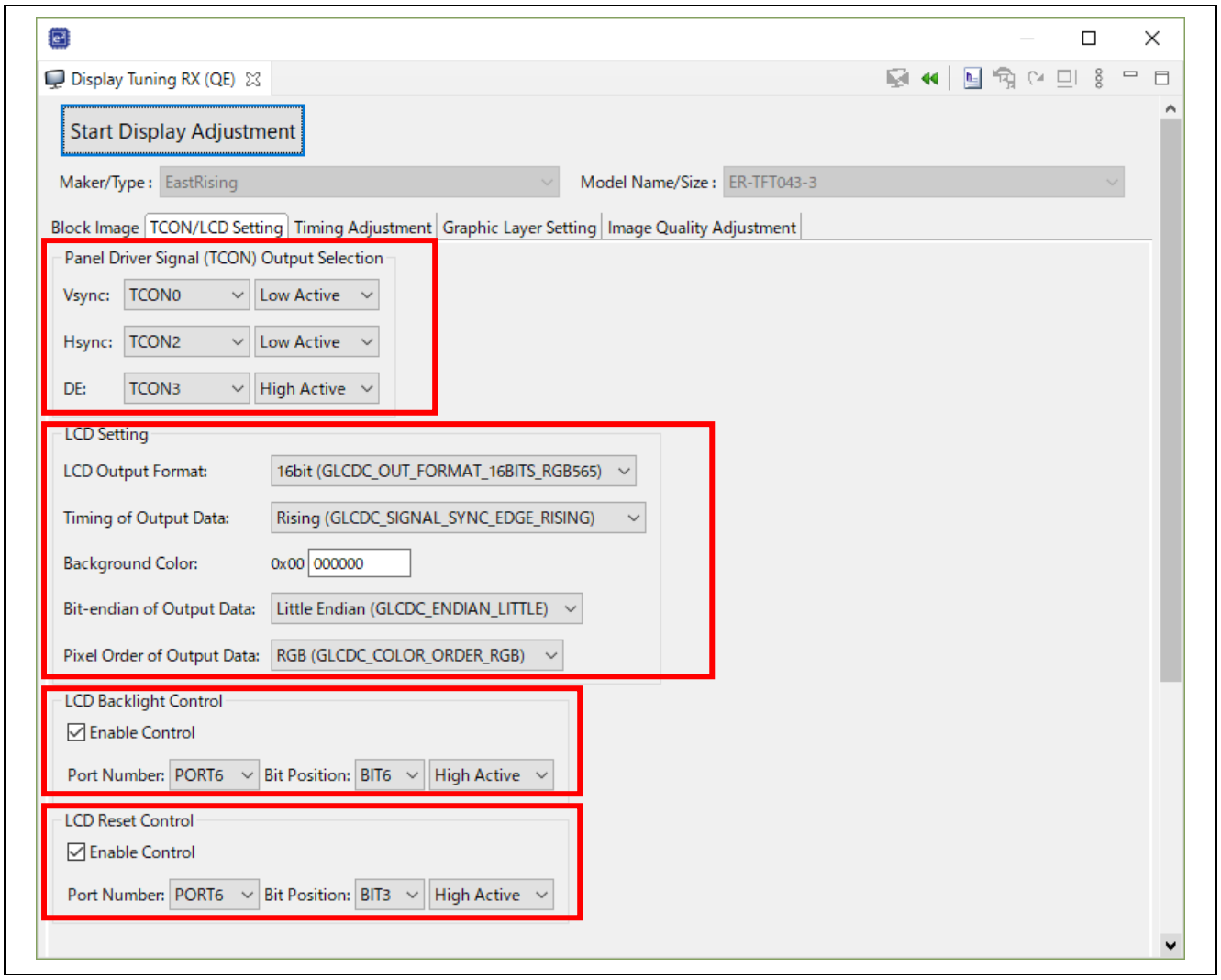


Figure 6-4 “TCON/LCD Setting” Tabbed Page

The following lists the settings that match the specifications of the each RSK and Envision board.

Table 6-1 Settings of TCON and the LCD Panel Used for the Application

	RSK RX72N	RSK RX65N	Envision RX72N	Envision RX65N
Selection of output pins				
Vsync	TCON0		TCON0	
Hsync	TCON2		TCON2	
DE	TCON3		TCON3	
Active sense of control signals				
Vsync	Negative sense: [Low Active]		Negative sense: [Low Active]	
Hsync	Negative sense: [Low Active]		Negative sense: [Low Active]	
DE	Positive sense: [High Active]		Positive sense: [High Active]	
[LCD Output Format]	16-bit RGB565 output [16bit (GLCDC_OUT_FORMAT_16 BITS_RGB565)]		16-bit RGB565 output [16bit (GLCDC_OUT_FORMAT_16 BITS_RGB565)]	
[Timing of Output Data]	Output on rising edges of the panel clock [Rising (GLCDC_SIGNAL_SYNC_ EDGE_RISING)]		Output on rising edges of the panel clock [Rising (GLCDC_SIGNAL_SYNC_ EDGE_RISING)]	
[Background Color]	0x00000000		0x00000000	
[Bit-endian of Output Data]	Little Endian (GLCDC_ENDIAN_LITTLE)		Little Endian (GLCDC_ENDIAN_LITTLE)	
[Pixel Order of Output Data]	BGR (GLCDC_COLOR_ORDER_BGR)		RGB (GLCDC_COLOR_ORDER_RGB)	
[LCD Backlight Control]				
Selection of control	Enabled		Enabled	
[Port Number]	PORT2	PORTB	PORT6	PORT6
[Bit Position]	BIT7	BIT7	BIT7	BIT6
Active sense of control signals	Positive sense: [High Active]		Positive sense: [High Active]	
[LCD Reset Control]				
Selection of control	Enabled		Enabled	
[Port Number]	PORTK	PORT9	PORTB	PORT6
[Bit Position]	BIT4	BIT7	BIT3	BIT3
Active sense of control signals	Positive sense: [High Active]		Positive sense: [High Active]	

6.4 Setting the Graphics Layers

Select the “Graphic Layer Setting” tabbed page in the “Display Tuning RX (QE)” view and specify the settings for the graphics.

The following settings for graphics are available on this page.

[Select Using Graphic Layer]
- Graphic layer 1
- Graphic layer 2
- Graphic layers 1 and 2

[Graphic Layer 1 Setting]
- [Height of Image Data]
  - 16 to the value of VDP on the [Timing Adjustment] tabbed page
- [Width of Image Data]
  - 16 to the value of HDP on the [Timing Adjustment] tabbed page
- [Display Start Position (x-coordinate)]
  - 0 to the value of “VDP – 16” on the [Timing Adjustment] tabbed page
- [Display Start Position (y-coordinate)]
  - 0 to the value of “HDP – 16” on the [Timing Adjustment] tabbed page
- [Start Address of Frame Buffer]
  - 0x00000040 to 0xFFFFFFC0
- [Output Data Format]
  - ARGB8888 (GLCDC_IN_FORMAT_32BITS_ARGB8888)
  - RGB888 (GLCDC_IN_FORMAT_32BITS_RGB888)
  - RGB565 (GLCDC_IN_FORMAT_16BITS_RGB565)
  - ARGB1555 (GLCDC_IN_FORMAT_16BITS_ARGB1555)
  - ARGB4444 (GLCDC_IN_FORMAT_16BITS_ARGB4444)
  - CLUT8 (GLCDC_IN_FORMAT_CLUT8)
  - CLUT4 (GLCDC_IN_FORMAT_CLUT4)
  - CLUT1 (GLCDC_IN_FORMAT_CLUT1)

[Graphic Layer 2 Setting]
- The same settings as those for [Graphic Layer 1 Setting]

[Interrupts Setting]
- Selection of enabling VPOS detection
- Selection of enabling VPOS interrupts
- Selection of the use of a callback function
- [Callback Function Name]
  - Desired character string

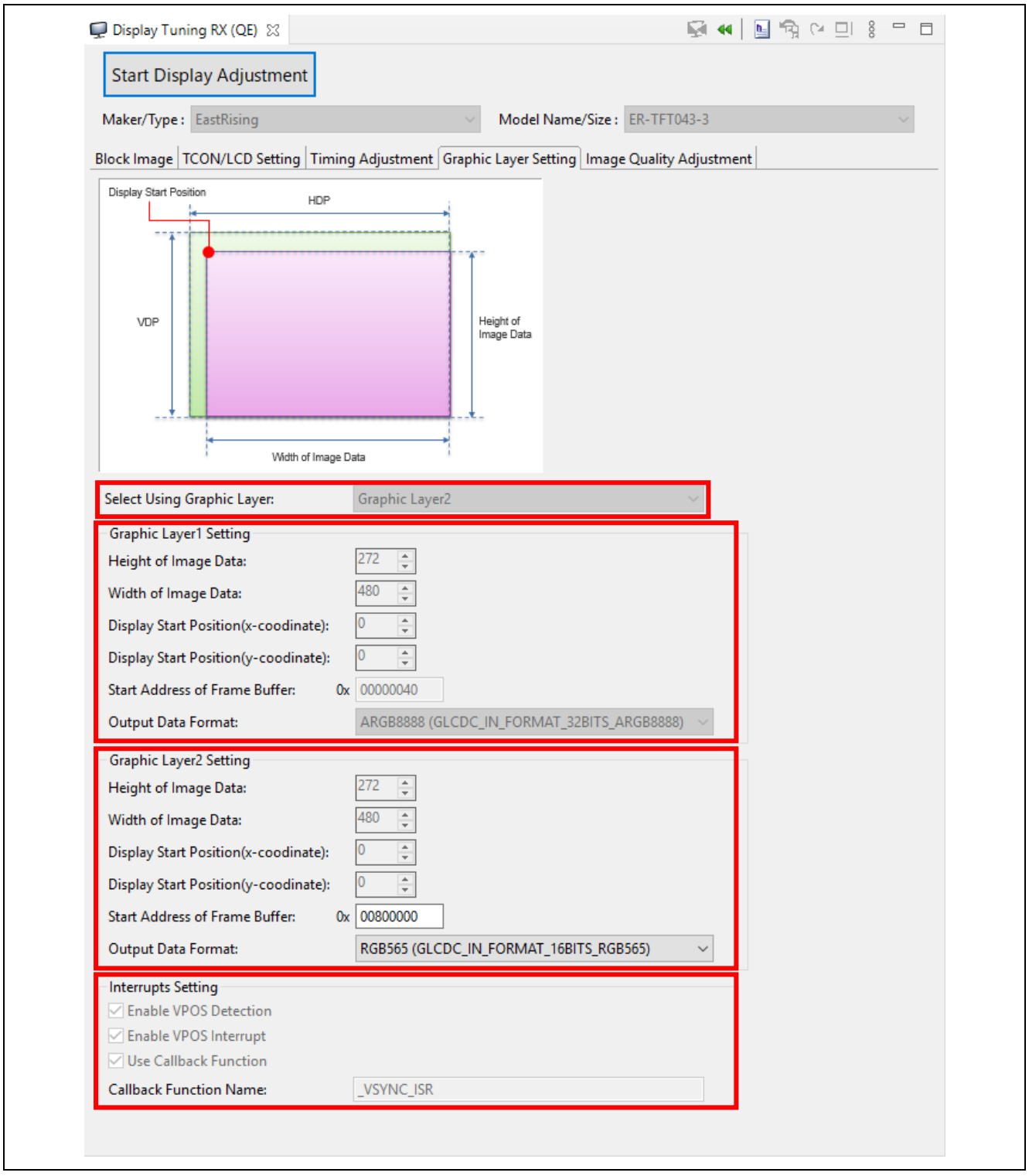


Figure 6-5 “Graphic Layer Setting” Tabbed Page

The following lists the settings that match the specifications of the each RSK and Envision board.

Table 6-2 Settings of Graphics Layers Used for the Application (RSK RX72N/RX65N)

	RSK RX72N		RSK RX65N	
	emWin	**Aeropoint GUI**	**emWin**	**Aeropoint GUI**
[Select Using Graphic Layer]	Graphic layer 2	Graphic layer 2	Graphic layer 2	Graphic layer 2
[Graphic Layer 1 Setting]				
All items	Disabled	Disabled	Disabled	Disabled
[Graphic Layer 2 Setting]				
[Height of Image Data]	272	272	272	272
[Width of Image Data]	480	480	480	480
[Display Start Position (x-coordinate)]	0	0	0	0
[Display Start Position (y-coordinate)]	0	0	0	0
[Start Address of Frame Buffer]	0x00800000	0x0003C000	0x00800000	0x0001DE00
[Output Data Format]	RGB565 (GLCDC_IN_FORMAT_16BITS_RGB565)	CLUT8 (GLCDC_IN_FORMAT_CLUT8)	RGB565 (GLCDC_IN_FORMAT_16BITS_RGB565)	CLUT8 (GLCDC_IN_FORMAT_CLUT8)
[Interrupts Setting]				
[Enable VPOS Detection]	Enabled	Enabled	Enabled	Enabled
[Enable VPOS Interrupt]	Enabled	Enabled	Enabled	Enabled
[Use Callback Function]	Used	Used	Used	Used
[Callback Function Name]	_VSYNC_ISR	criAeroGraphics_VSyncCallback_AIS	_VSYNC_ISR	criAeroGraphics_VSyncCallback_AIS

Table 6-3 Settings of Graphics Layers Used for the Application (Envision RX72N/RX65N)

	Envision RX72N		Envision RX65N	
	emWin	**Aeropoint GUI**	**emWin**	**Aeropoint GUI**
[Select Using Graphic Layer]	Graphic layer 2	Graphic layer 2	Graphic layer 2	Graphic layer 2
[Graphic Layer 1 Setting]				
All items	Disabled	Disabled	Disabled	Disabled
[Graphic Layer 2 Setting]				
[Height of Image Data]	272	272	272	272
[Width of Image Data]	480	480	480	480
[Display Start Position (x-coordinate)]	0	0	0	0
[Display Start Position (y-coordinate)]	0	0	0	0
[Start Address of Frame Buffer]	0x00800000	0x0003C000	0x00800000	0x0001DE00
[Output Data Format]	RGB565 (GLCDC_IN_FORMAT_16BITS_RGB565)	CLUT8 (GLCDC_IN_FORMAT_CLUT8)	RGB565 (GLCDC_IN_FORMAT_16BITS_RGB565)	CLUT8 (GLCDC_IN_FORMAT_CLUT8)
[Interrupts Setting]				
[Enable VPOS Detection]	Enabled	Enabled	Enabled	Enabled
[Enable VPOS Interrupt]	Enabled	Enabled	Enabled	Enabled
[Use Callback Function]	Used	Used	Used	Used
[Callback Function Name]	_VSYNC_ISR	criAeroGraphics_VSyncCallback_AIS	_VSYNC_ISR	criAeroGraphics_VSyncCallback_AIS

6.5 Adjusting the Timing of Control Signals for the LCD Panel

Clicking on the “Start Display Adjustment” button after the debugger is connected opens the “Select a program” dialog box. Selecting the program and clicking on the “Start adjustment” button starts adjustment of the display.

Figure 6-6 “Start Display Adjustment” Button

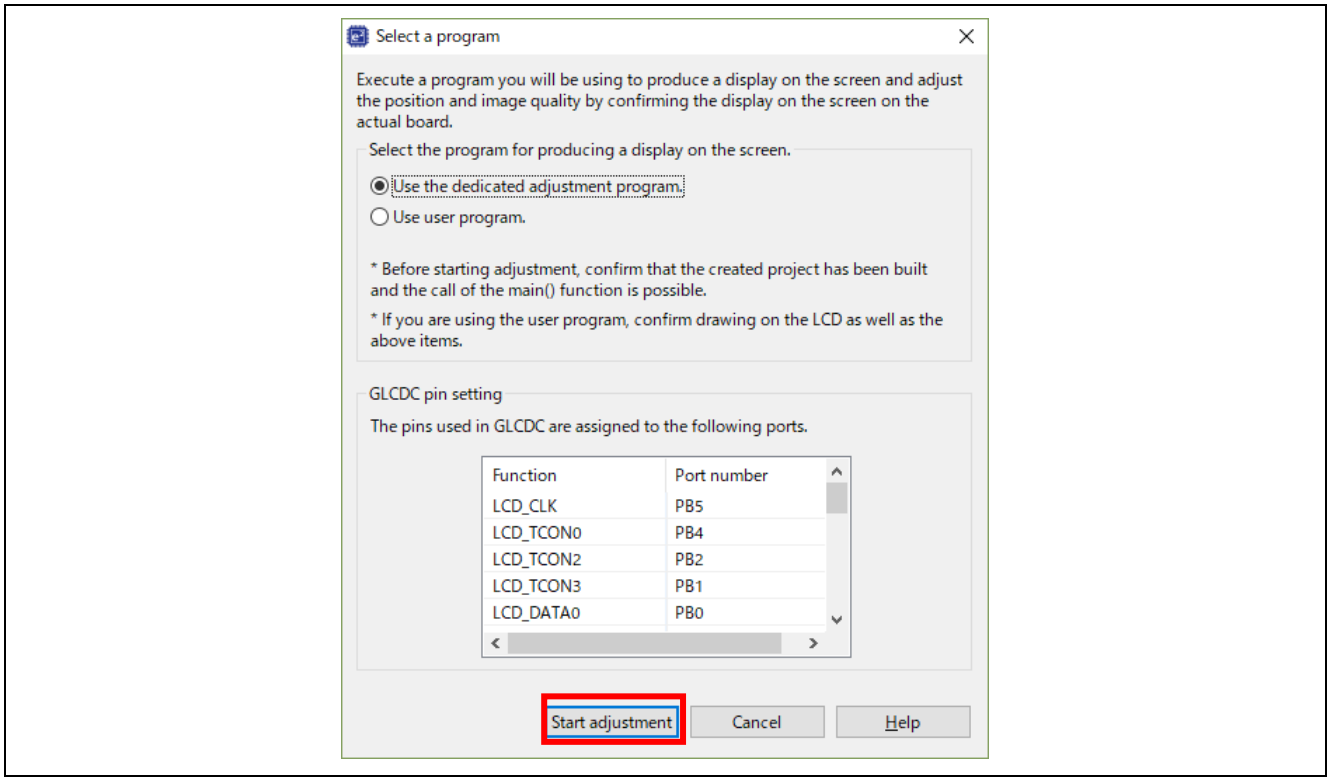
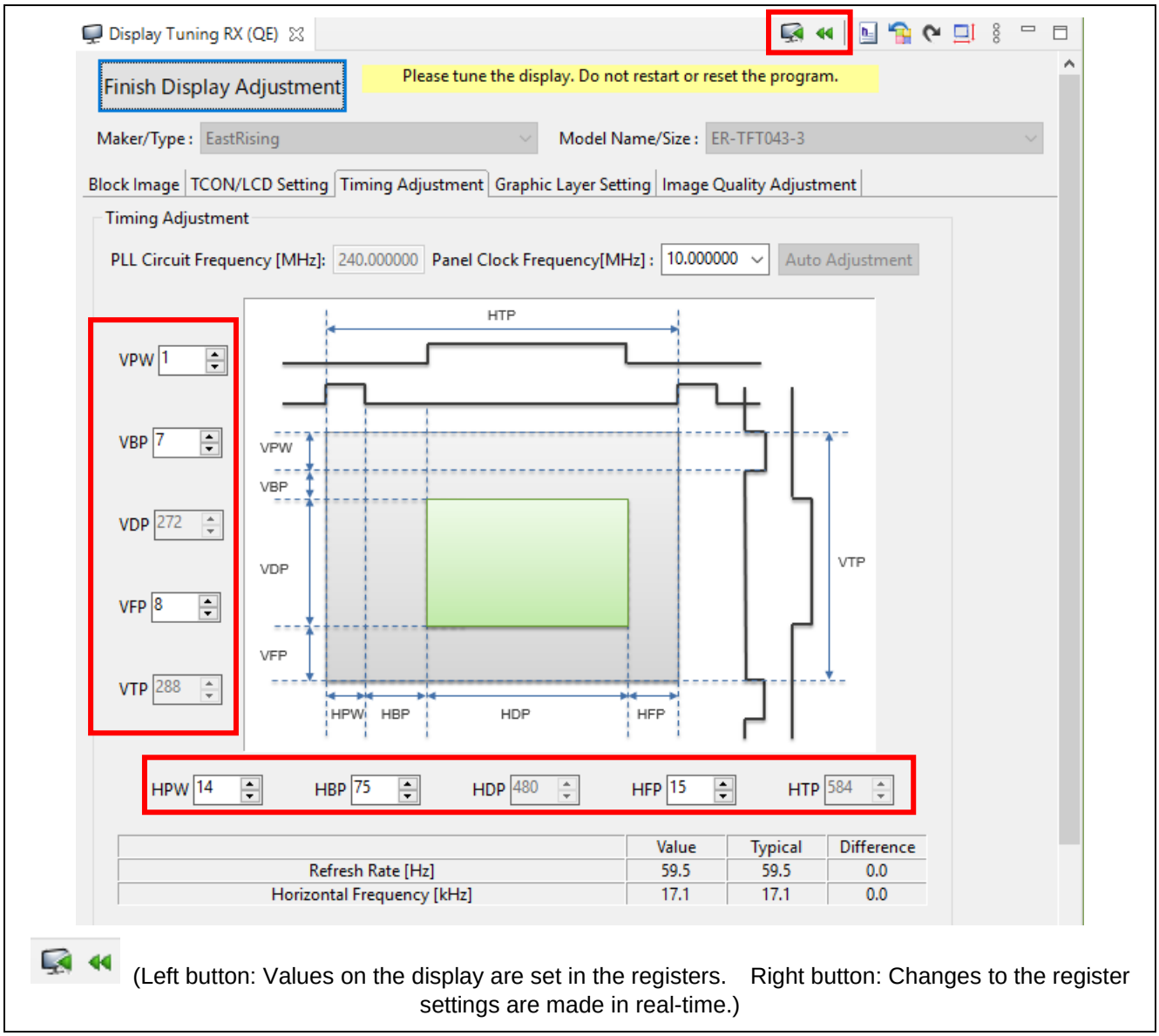


Figure 6-7 “Select a program” Dialog Box

During adjustment of the display, the message “Please tune the display. Do not restart or reset the program.” is displayed and the “Start Display Adjustment” button is replaced by the “Finish Display Adjustment” button. Changing the values shown in Figure 6-8 changes the timing of the control signals. This tool directly writes the changed values to registers of the GLCDC so that they are reflected in the operation of the LCD panel on the board.



(Left button: Values on the display are set in the registers. Right button: Changes to the register settings are made in real-time.)

Figure 6-8 Adjusting the Timing of Control Signals

Select the frequency of the panel clock from the combo box. The selected frequency is used to calculate the refresh rate, which is indicated at the bottom of the page, along with a value for any difference from the recommended value for the LCD panel. The value recommended for the LCD panel will have been specified as the initial value.

Adjust the individual parameters in the spin boxes. The result of adjustment being shown in red numerals means that the value is out of the range of the specifications of the GLCDC or of the LCD panel. In such cases, adjust the value so that it is within the range of the specifications of the GLCDC and of the LCD panel. Check the range of values which are allowable in the specifications of the GLCDC by hovering the mouse over the value for adjustment that is being shown in red.

In an RSK, if a value being adjusted is restored to its default (the specifications of the LCD panel mounted on the RSK) with the “Restore the Displayed Settings to the Default” button, the recommended value for the horizontal front porch (HFP) of the LCD panel will be two, and this must be modified since it is out of the range of the specifications of the GLCDC. Modify the value to three or greater to satisfy the specifications of both the LCD panel and GLCDC. After that, the display of the adjusted value is changed from red to black.

After you have determined the adjusted values, you can write the values from this tool to the registers of the GLCDC and check the results.

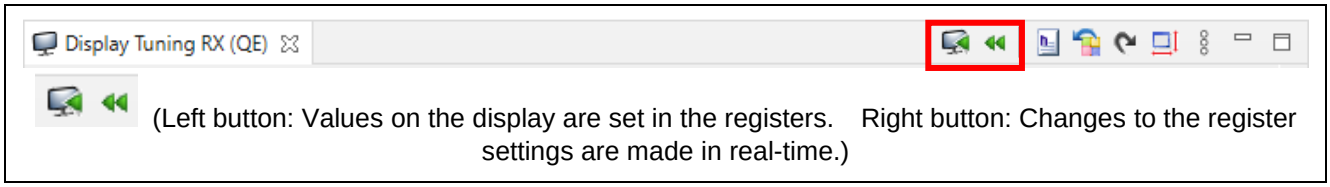


Figure 6-9 Buttons for Setting Registers

The following two methods are used to set or make changes to values in the registers.

Table 6-4 Facilities for Setting or Making Changes to Values in Registers

Button	Name	Description
	Set the Register	The settings are written to the registers. This button is only effective during adjustment of the display.
	Set the Registers in Real-time when the Parameters are Changed	When this button is active, changes are automatically written to registers every time the setting is changed. This button is not active by default. Writing to the registers only proceeds when the display is being adjusted; no operation proceeds if the display is not being adjusted.

If “Use the dedicated adjustment program.” is selected in the “Select a program” dialog box for use in adjusting the display and the display is correctly set, a one-pixel-wide red line is drawn around the outer periphery of a blue-colored image as shown in Figure 6-10.

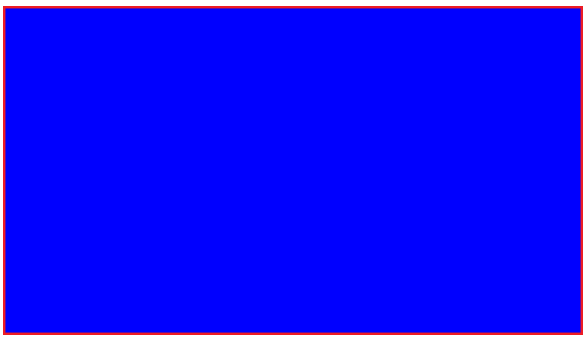


Figure 6-10 Display on the LCD Panel

Note:

For the facility to write the adjusted values to registers in QE for Display [RX], the graphics screen is adjusted to be aligned with the upper left of the background screen when the timing is adjusted.

For definitions of the graphics and background screens, refer to the RX65N Group, RX651 Group User's Manual: Hardware (R01UH0590) or RX72N Group User’s Manual: Hardware (R01UH0824).

Due to the display type and specifications of the LCD panel, fine changes to setting values (e.g. moving by several pixels) or changes to particular settings may not appear on the LCD panel. For example, the LCD panels mounted on the RSK and Envision are of display type 3, which does not allow the movement of positions in response to changes to the settings for the back porches and so on.

6.6 Reflecting the Output of Control Signals, Setting of Graphic Layers, and the Results of Timing Adjustment

The output of control signals, setting of graphic layers, and the results of timing adjustment can be reflected in a program through the output of a header file. Clicking on the “Generating Header File” button of QE for Display [RX] (Figure 6-11) generates a header file that reflects the specified items.

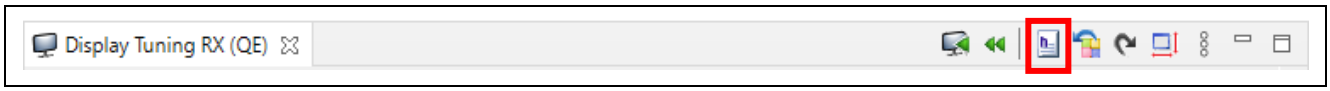


Figure 6-11 “Generating Header File” Button

When you select “For Display Settings” only and click on “Generate”, a header file is generated at the specified destination for output. The name of the header file and the output destination can be specified as desired.

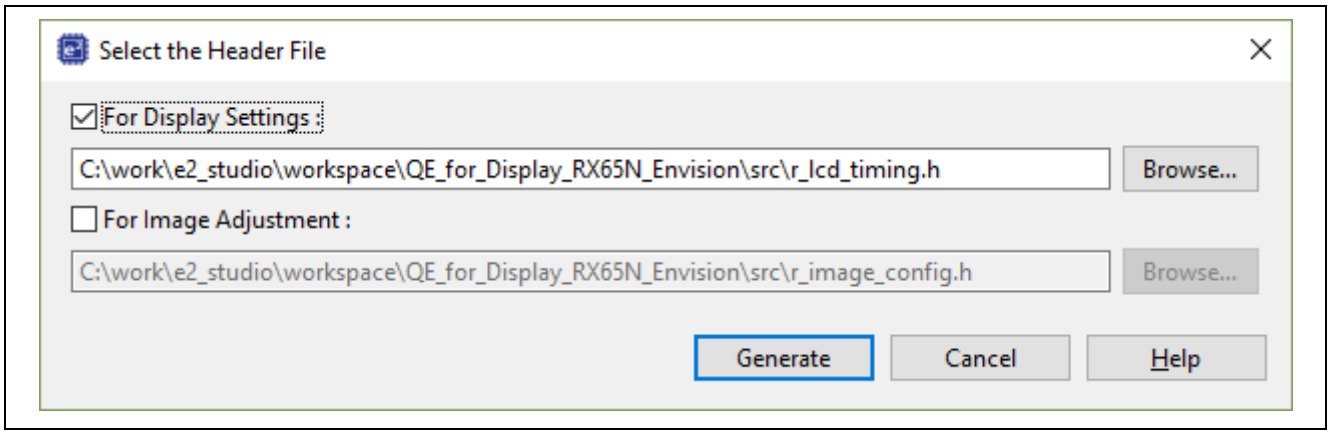


Figure 6-12 Selecting “For Display Settings”

To reflect the timing of the project, output the header file with the name 'r_lcd_timing.h' in the following directory, and clean and build the project.

Directory:

<*workspace folder*>¥<*project folder*>¥src

6.7 Image-Downloading Facility

In QE for Display [RX], image quality is adjusted by checking the LCD according to the characteristics of the LCD. The image that is displayed on the LCD can be changed without changing the program.

Using the image-downloading facility downloads image data (binary file) from the personal computer to be displayed on the LCD.

Figure 6-13 “Send the Image File” Button

Click on the “Send the Image File” button on the toolbar.

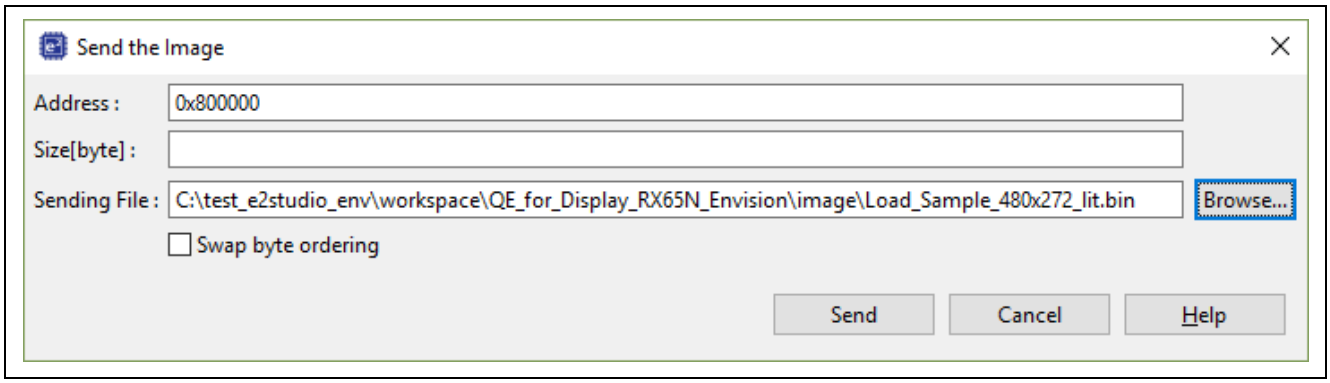


Figure 6-14 “Send the Image” Dialog Box

Specify the address of the destination and the file to be sent in the “Send the Image” dialog box. By default, the value that has been set in the graphics 2 frame buffer control register is specified as “Address”. When specification of “Size” is omitted, the entire file specified in the “Sending File” edit box is written to the range from the address specified in the “Address” edit box.

This application note includes sample image data. Send the following.

File:

Load_Sample_480x272_lit.bin

When sending is successfully completed, color bars are displayed as shown in Figure 6-15.

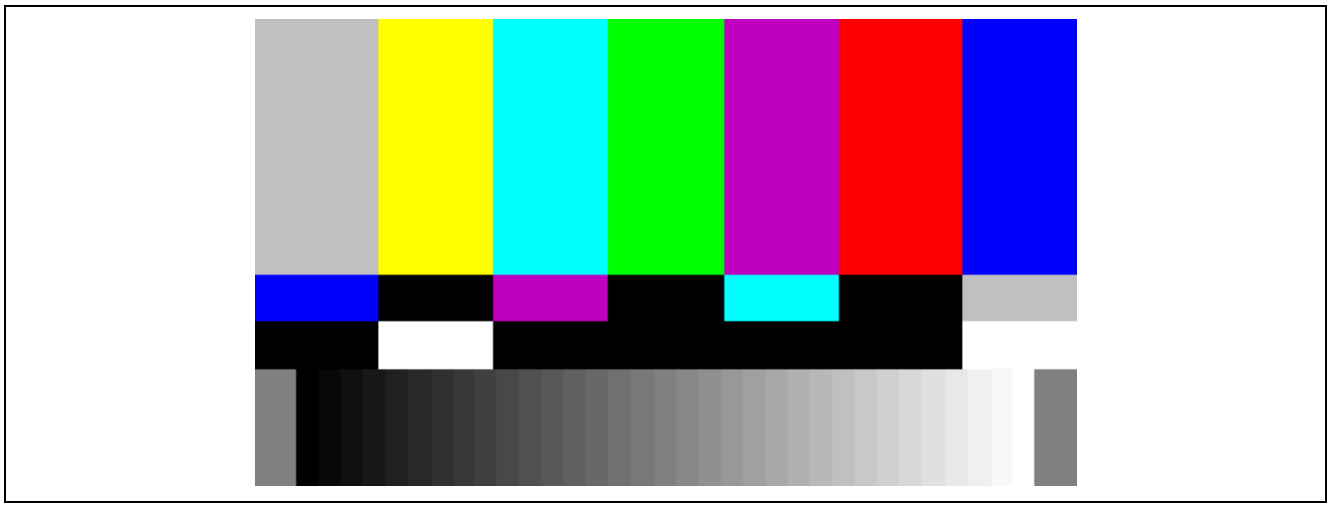


Figure 6-15 Image on Completion of Sending

6.8 Adjusting Image Quality

Clicking on the items for image quality adjustment enclosed by red frames in Figure 6-16 on the “Block Image” tabbed page makes the “Image Quality Adjustment” tabbed page appear, enabling the adjustment of image quality.

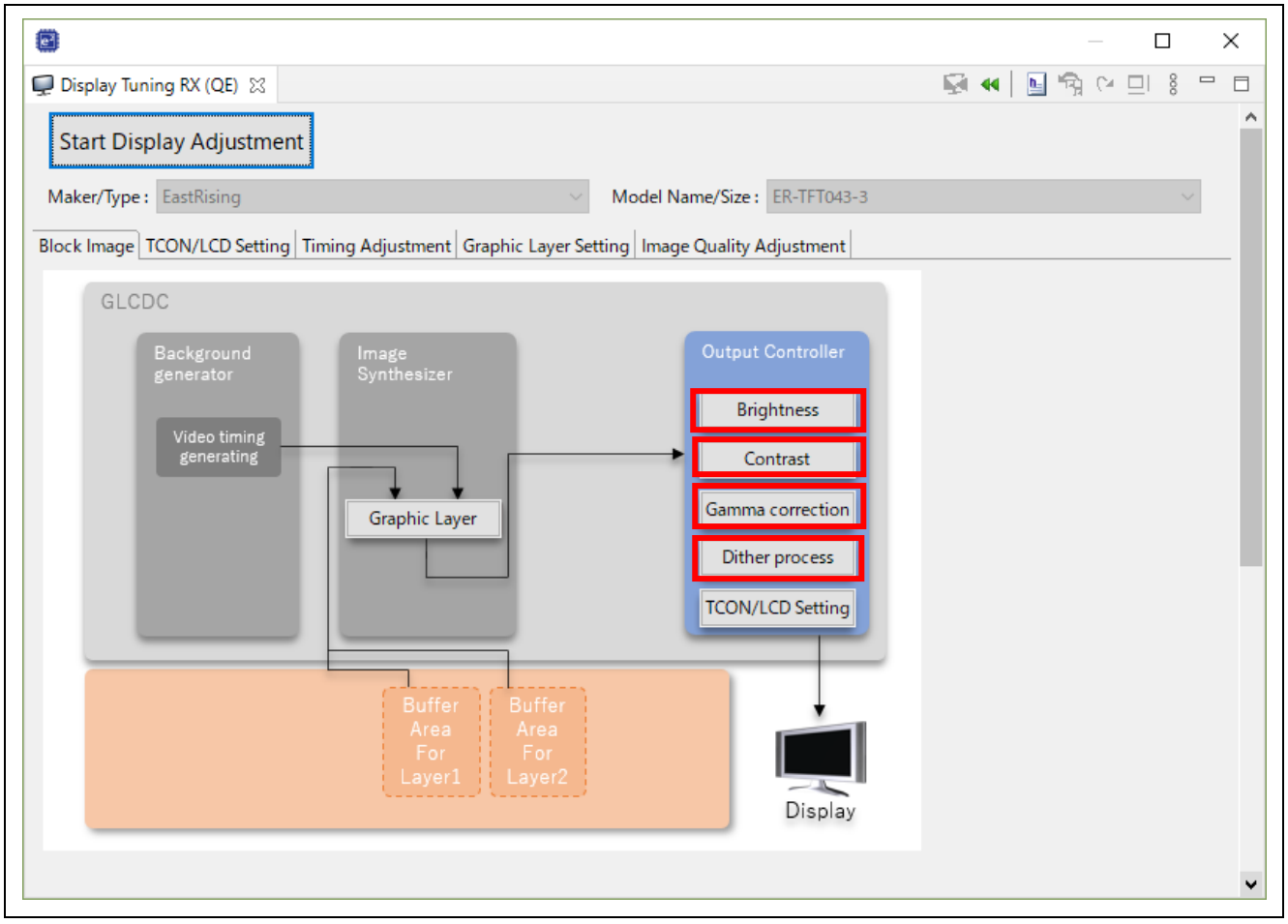


Figure 6-16 Buttons for Selecting the Adjustment of Image Quality

The “Image Quality Adjustment” tabbed page enables the adjustment of image quality. QE for Display [RX] supports “Calibration Route Setting” and four facilities for adjusting image quality: “Brightness”, “Contrast”, “Gamma correction”, and “Dither process”.

Changes to these settings are reflected in real-time, allowing the adjustment of image quality with reference to the display on the LCD panel.

Image quality is adjusted by using “Quick Setting” or “Custom”. If you select “Custom”, refer to the RX65N Group, RX651 Group User's Manual: Hardware (R01UH0590), RX72N Group User’s Manual: Hardware (R01UH0824) and the RX Family Graphic LCD Controller Module Using Firmware Integration Technology (R01AN3609), check the meanings of the settings made in each of the registers and the specifiable values, and adjust the image quality accordingly.

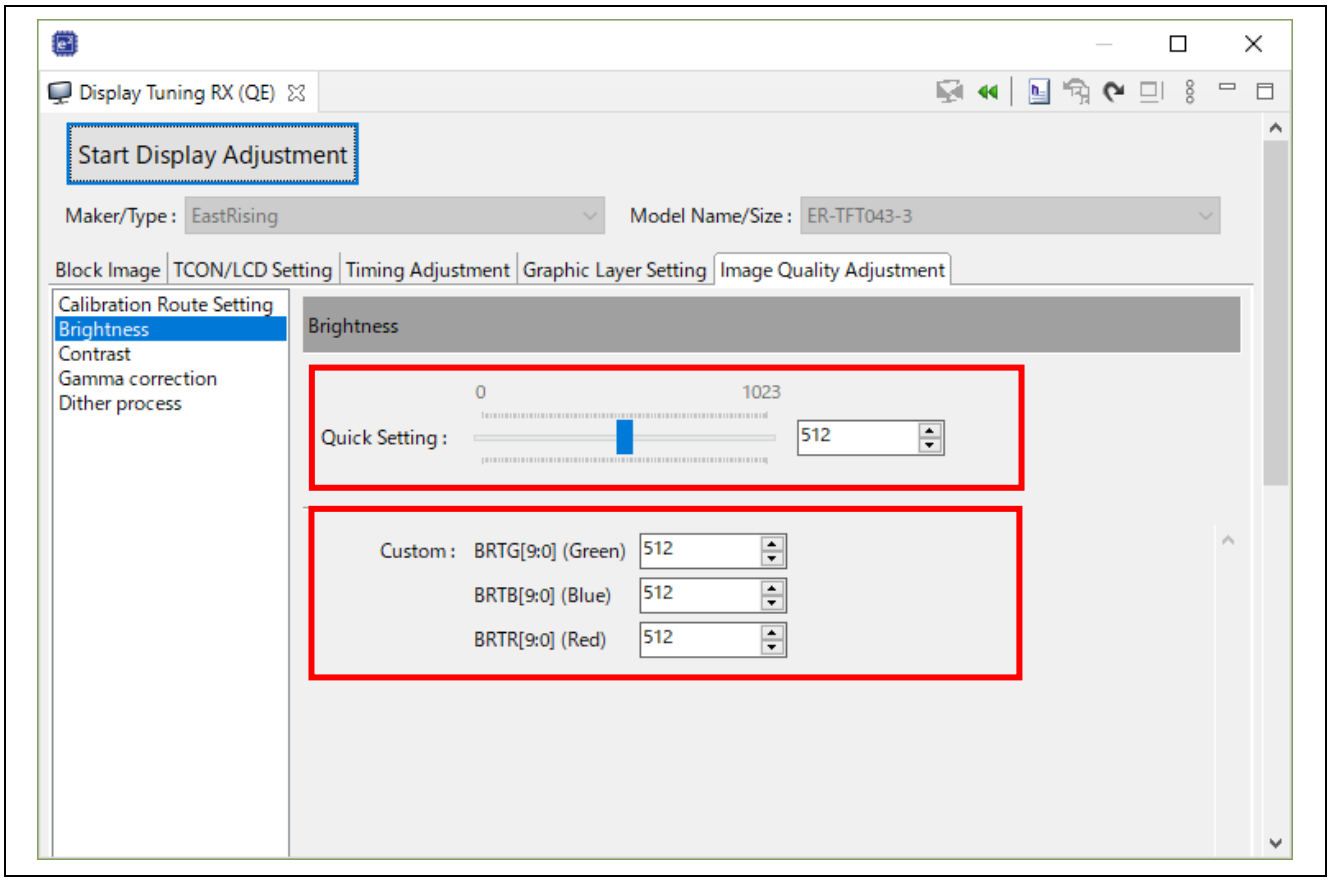


Figure 6-17 “Image Quality Adjustment” Tabbed Page

6.9 Generating a Header File with the Results of Adjusting Image Quality

Click on the “Generating Header File” icon of QE for Display [RX] to generate a header file that reflects the results of image quality adjustment which have been specified (see Figure 6-18).

When you select “For Image Adjustment” only and click on “Generate”, a header file is generated at the specified destination for output. The name of the header file and the output destination can be specified as desired.

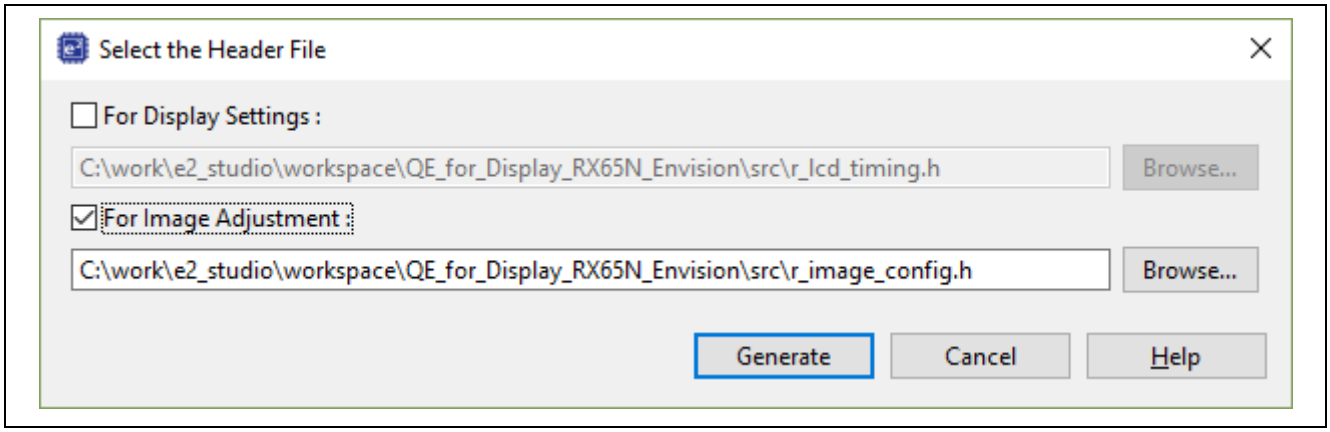


Figure 6-18 Selecting “For Image Adjustment”

To reflect the settings of image quality adjustment in the project, output the header file with the name 'r_image_config_.h' in the following directory, and clean and build the project.

Directory:

<*workspace folder*>¥<*project folder*>¥src

7. Setting Detailed Data on the LCD Panel

If you select “Custom” from the “Maker/Type” pull-down list in the upper section of the dialog box shown in Figure 6-2, the “Edit Custom Display Data” dialog box (Figure 7-1) appears. Enter information on the LCD panel in this dialog box.

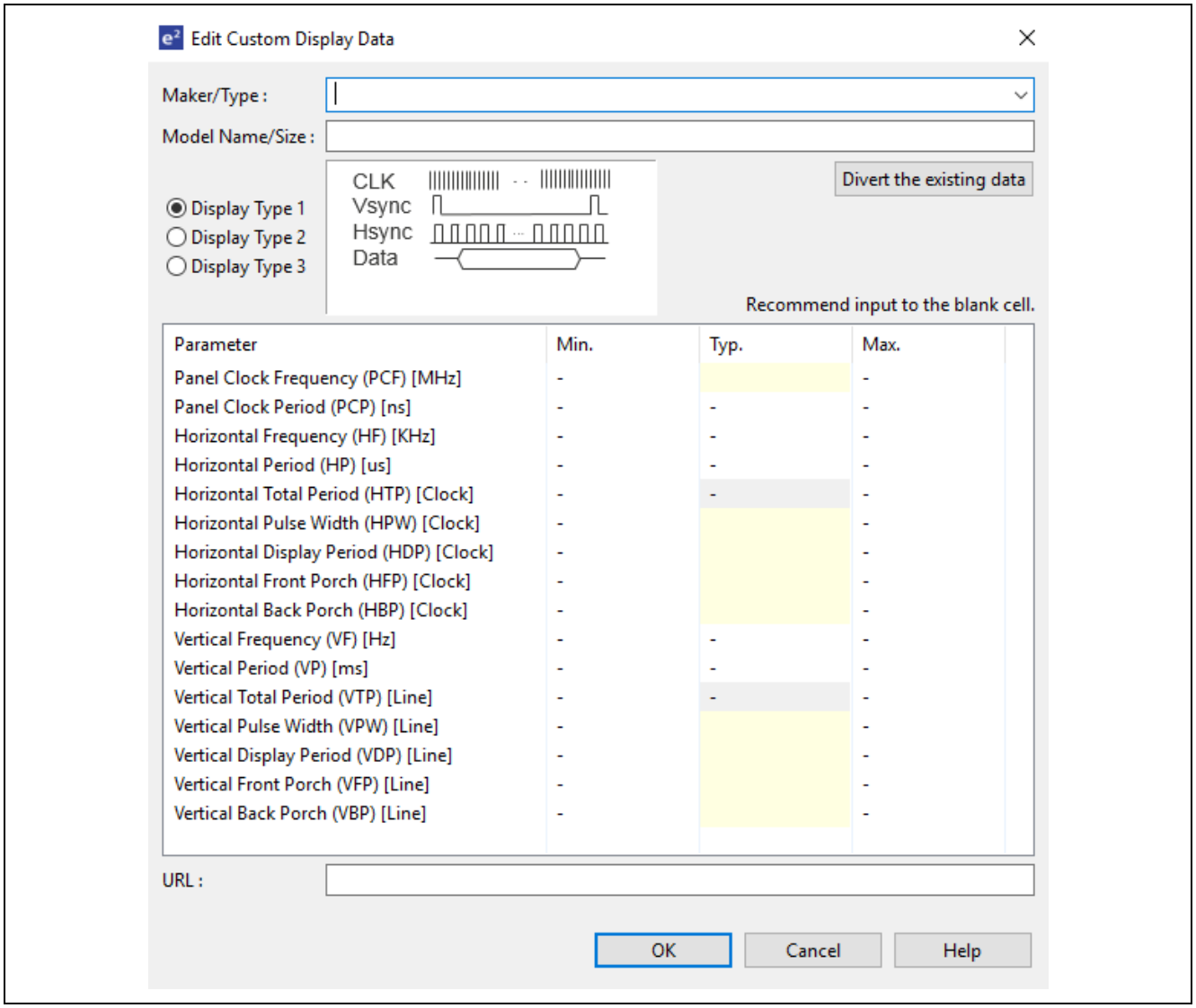


Figure 7-1 “Edit Custom Display Data” Dialog Box

7.1 Entering Names for Registration

Enter the desired names in “Maker/Type” and “Model Name/Size” in the “Edit Custom Display Data” dialog box (Figure 7-2). These names will be registered in the drop-down list for selection.

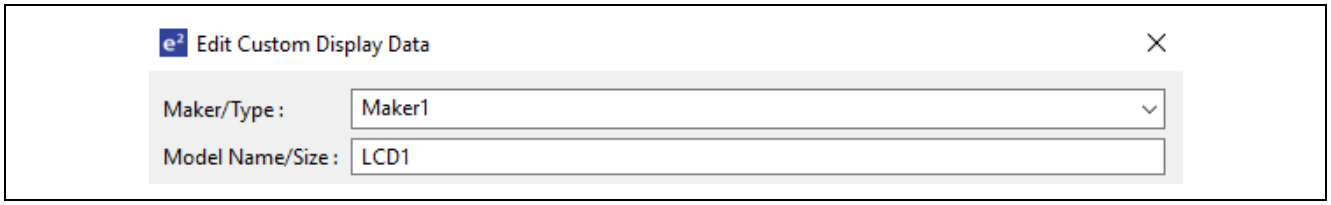


Figure 7-2 Registering a Name

7.2 Selecting the Display Type

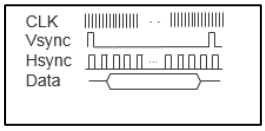
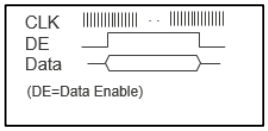
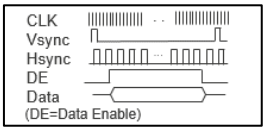
Table 7-1, Main Control Signals, lists the control signals required for connecting an LCD panel. QE for Display [RX] supports devices which have three display types with combination of those control signals.

Table 7-1 Main Control Signals

Name	Outline of Facility
Horizontal synchronization signal (Hsync)	The signal that generates the timing for one line to be displayed
Vertical synchronization signal (Vsync)	The signal that generates the timing for one screen to be displayed
Panel clock (CLK)	The signal that drives the sampling of pixels to be displayed
Display enable (DE)	The signal indicating that valid data are being output
Data (Data)	Data to be displayed

The user must check which control signals are required in the specifications of the LCD panel in use and select the appropriate one from among the three display types shown in Table 7-2, Display Types and Control Signals to be Used.

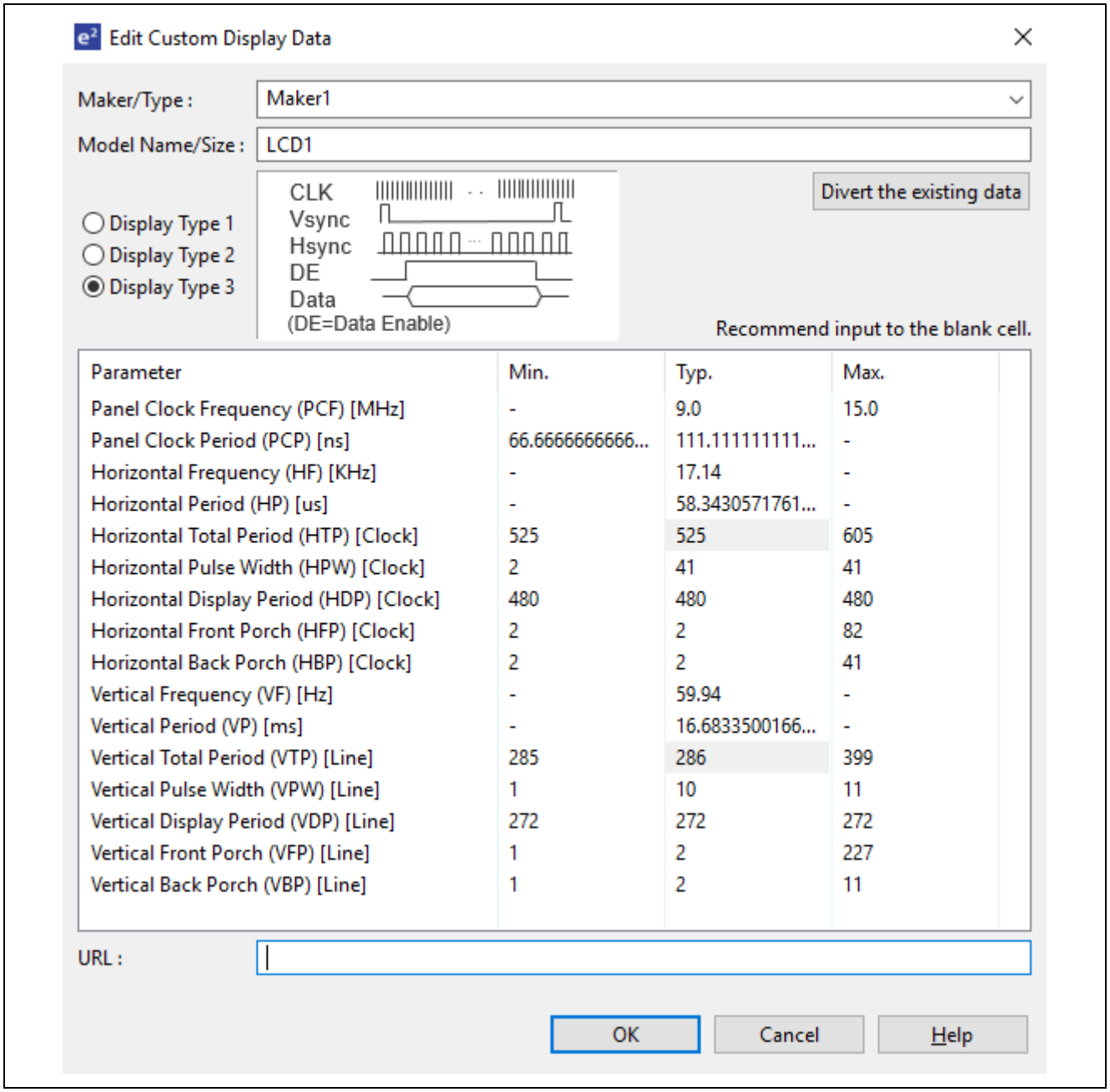
Table 7-2 Display Types and Control Signals to be Used

Name	Display type 1 	Display type 2 	Display type 3 
Horizontal synchronization signal (Hsync)	Used	Unused	Used
Vertical synchronization signal (Vsync)	Used	Unused	Used
Panel clock (CLK)	Used	Used	Used
Display enable (DE)	Unused	Used	Used
Data (Data)	Used	Used	Used

7.3 Entering Control Timing

Enter the control timing with reference to the datasheet for the LCD panel. Values entered under Typ. are used as the initial values for timing control. Values entered under Min. and Max. are used to check whether or not the timing as adjusted by using the QE for Display [RX] GUI is within the range.

Figure 7-3 shows the result of data input for the LCD panel mounted on the RSK. Enter values with reference to Table 7-3, Excerpt from the Datasheet for the LCD Panel on the RSK.



Parameter	Min.	Typ.	Max.
Panel Clock Frequency (PCF) [MHz]	-	9.0	15.0
Panel Clock Period (PCP) [ns]	66.6666666666...	111.111111111...	-
Horizontal Frequency (HF) [KHz]	-	17.14	-
Horizontal Period (HP) [us]	-	58.3430571761...	-
Horizontal Total Period (HTP) [Clock]	525	525	605
Horizontal Pulse Width (HPW) [Clock]	2	41	41
Horizontal Display Period (HDP) [Clock]	480	480	480
Horizontal Front Porch (HFP) [Clock]	2	2	82
Horizontal Back Porch (HBP) [Clock]	2	2	41
Vertical Frequency (VF) [Hz]	-	59.94	-
Vertical Period (VP) [ms]	-	16.6833500166...	-
Vertical Total Period (VTP) [Line]	285	286	399
Vertical Pulse Width (VPW) [Line]	1	10	11
Vertical Display Period (VDP) [Line]	272	272	272
Vertical Front Porch (VFP) [Line]	1	2	227
Vertical Back Porch (VBP) [Line]	1	2	11

Figure 7-3 Result of Control Timing Input

Table 7-3 Excerpt from the Datasheet for the LCD Panel on the RSK

Parameter	Symbol	Spec.			Unit
		Min.	Typ.	Max.	
Clock cycle	fclk	-	9	15	MHz
Hsync cycle	1/th	-	17.14	-	KHz
Vsync cycle	1/th	-	59.94	-	Hz
Horizontal Signal					
Horizontal cycle	th	525	525	605	CLK
Horizontal display period	thd	480	480	480	CLK
Horizontal front porch	Thf	2	2	82	CLK
Horizontal pulse width	thp	2	41	41	CLK
Horizontal back porch	thb	2	2	41	CLK
Vertical Signal					
Vertical cycle	tv	285	286	399	H
Vertical display period	tvd	272	272	272	H
Vertical front porch	tvf	1	2	227	H
Vertical pulse width	tvp	1	10	11	H
Vertical back porch	rvb	1	2	11	H

7.4 Editing Created Display Data

When the “Edit and Delete the Custom Display...” menu item is executed after clicking on the menu button on the toolbar, the created display data can be re-edited.

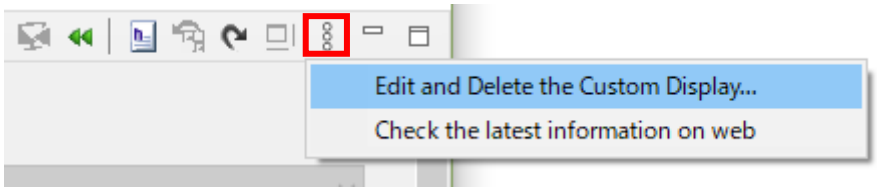


Figure 7-4 “Edit and Delete the Custom Display...” Menu Item

8. Details of Settings

This chapter gives supplementary explanations and notes for each of the procedures described in section 1.1, Flow of System Development with QE for Display [RX].

8.1 Setting the GLCDC FIT Module in Ways not Supported for QE for Display [RX]

The Smart Configurator can be used to change the settings of the GLCDC FIT module in ways that are not supported by QE for Display [RX]. However, changing the settings from the default values may lead to an error. Confirm the specifications of the GLCDC FIT module.

For the specifications of the GLCDC FIT module, refer to the RX Family Graphic LCD Controller Module Using Firmware Integration Technology Application Note.

8.2 From Execution to the End of Adjustment

After the program has been created, start the debugger and execute the program. If the initial screen is not correctly displayed, the settings are not correct. Check the values adjusted by QE for Display [RX] and the settings of parameters of the GLCDC FIT module.

Figure 8-1 shows the flow of troubleshooting.

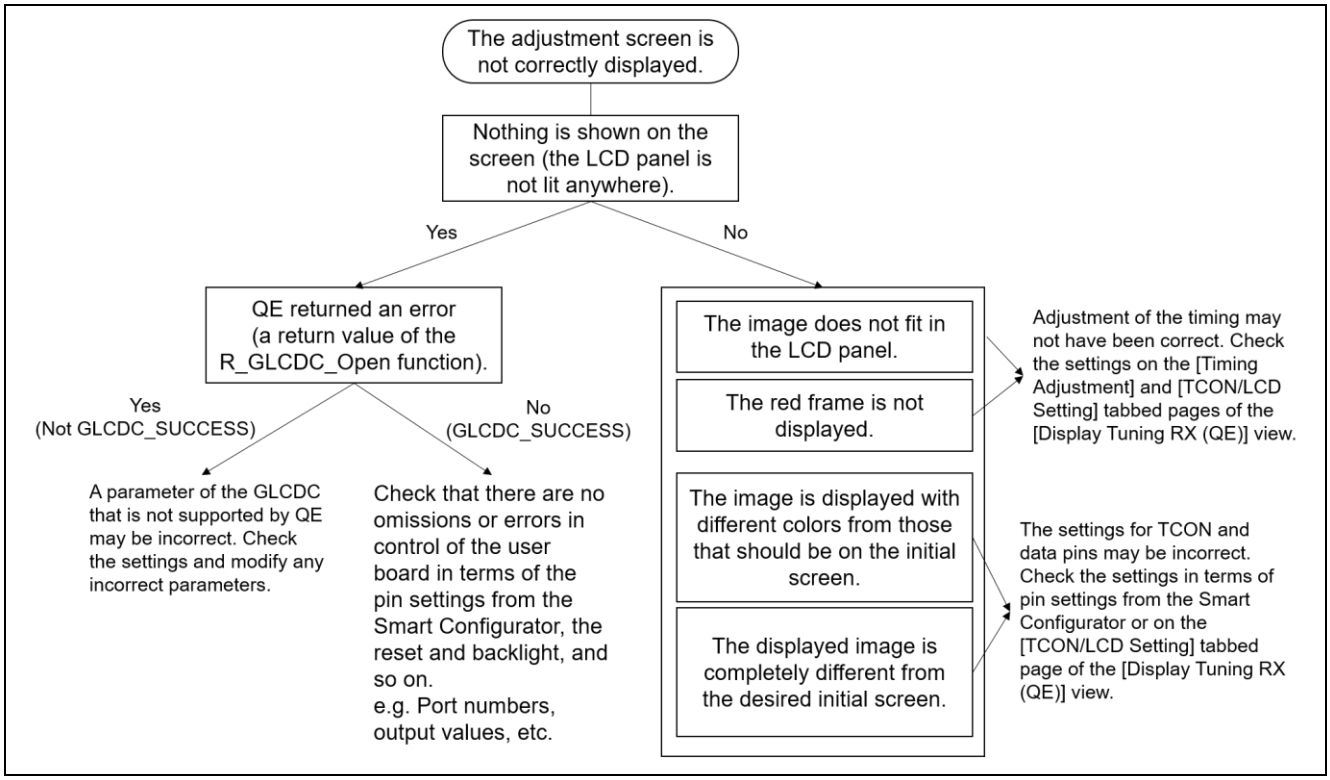


Figure 8-1 Troubleshooting

8.3 Setting the Maximum Memory Size for Use with the GUI

If a created GUI contains many widgets, the GUI may not work properly when they are displayed on the screen with the memory settings at the time. In this case, increase the value of “Maximum memory size used in GUI” in the “emWin setting” dialog box. The default setting is 80 KB (1024 * 80 = 81920). Set a value, such as 100 KB, that is suitable for the GUI you have created.

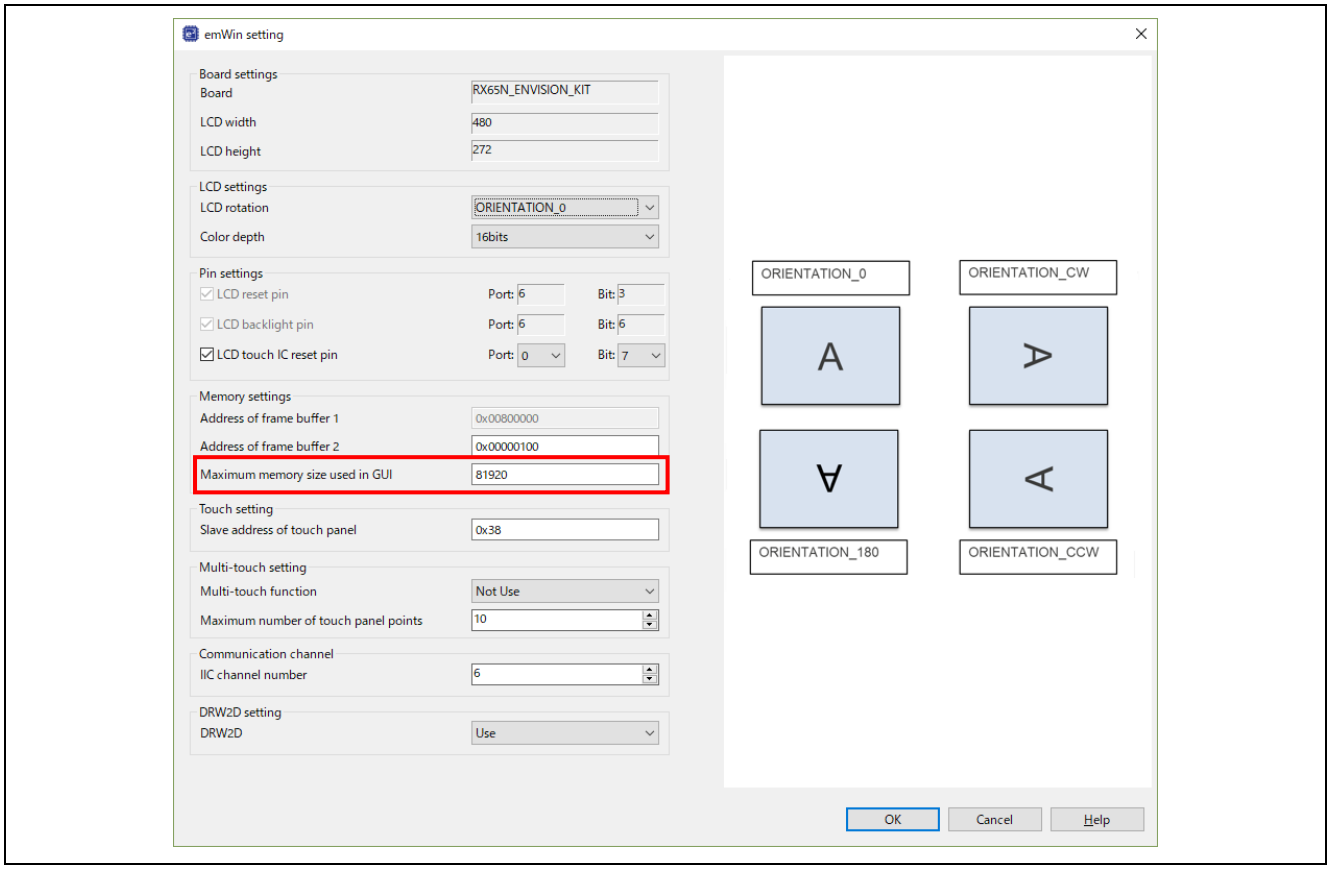


Figure 8-2 “emWin setting” Dialog Box

8.4 Points for Caution on the Image Drawing Speed

This chapter describes points for caution on the image drawing speed. In addition, since the GUI drawing process was improved in emWin FIT V6.14.g.1.20, download that or a later version and use it if you had been using an earlier version.

8.4.1 Point for Caution on Using JPEG Images with AppWizard

Since there is no JPEG decoder in hardware for the RX family, the drawing speed will be slow when JPEG images are used. Therefore, the use of JPEG images is not recommended. However, JPEG images can be converted to the bitmap format and used without slowing down the drawing speed. This can also be a way of saving memory.

To convert the JPEG format to the bitmap format, expand “Set bitmap” in “Properties” and select any image in a JPEG format. AppWizard will automatically convert the image from JPEG to the bitmap format.

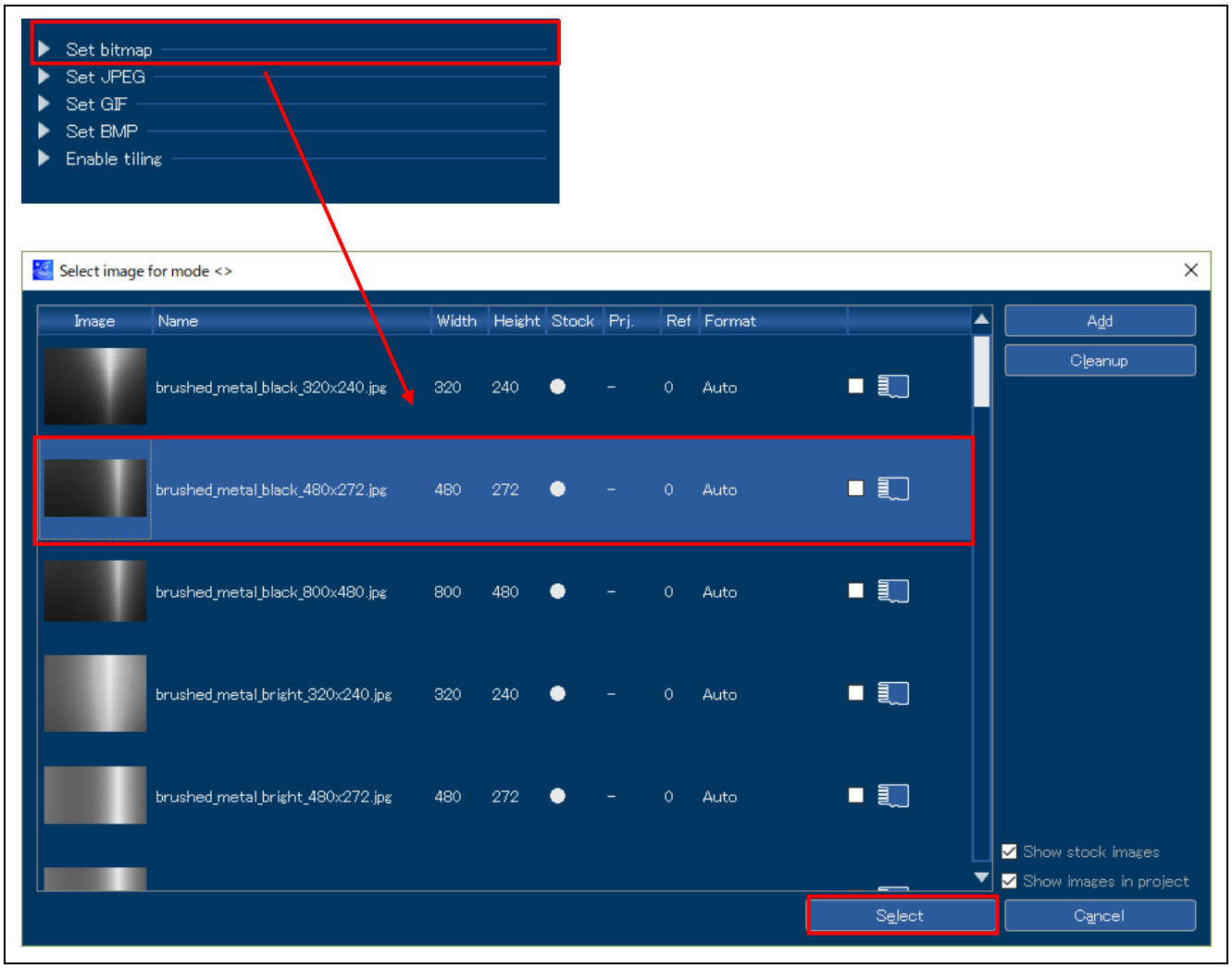


Figure 8-3 Expanding “Set bitmap” and Selecting a JPEG Image

8.4.2 Setting the Bitmap Format in AppWizard

Note: Since this problem has been resolved in AppWizard V1.08_6.14d or later version, download emWin FIT V6.14g.1.20 and use that or a later version.

In versions earlier than V1.08_6.14d, AppWizard would create an uncommon bitmap format when the color format was 16 bits. Thus, if the bitmap format applied to the image is “Auto”, the drawing engine would not draw it well. Follow the steps described below to change the bitmap format.

1. Click on the “Images” button at the lower left corner of AppWizard.

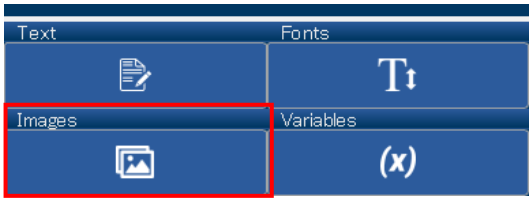


Figure 8-4 Clicking on “Images”

2. The “Images” dialog box will open. In this dialog box, you can select the format to be used for the generated bitmap image. Click in the “Format” column of an image entry and select the bitmap format.
   For images that require transparency, select “True color with alpha, RB swap, alpha inverted”. This is a 32-bpp format that the drawing engine can draw.
   For images that neither have nor require transparency, select “High color (565), RB swap”. This is a 16-bpp format that the drawing engine can also draw.

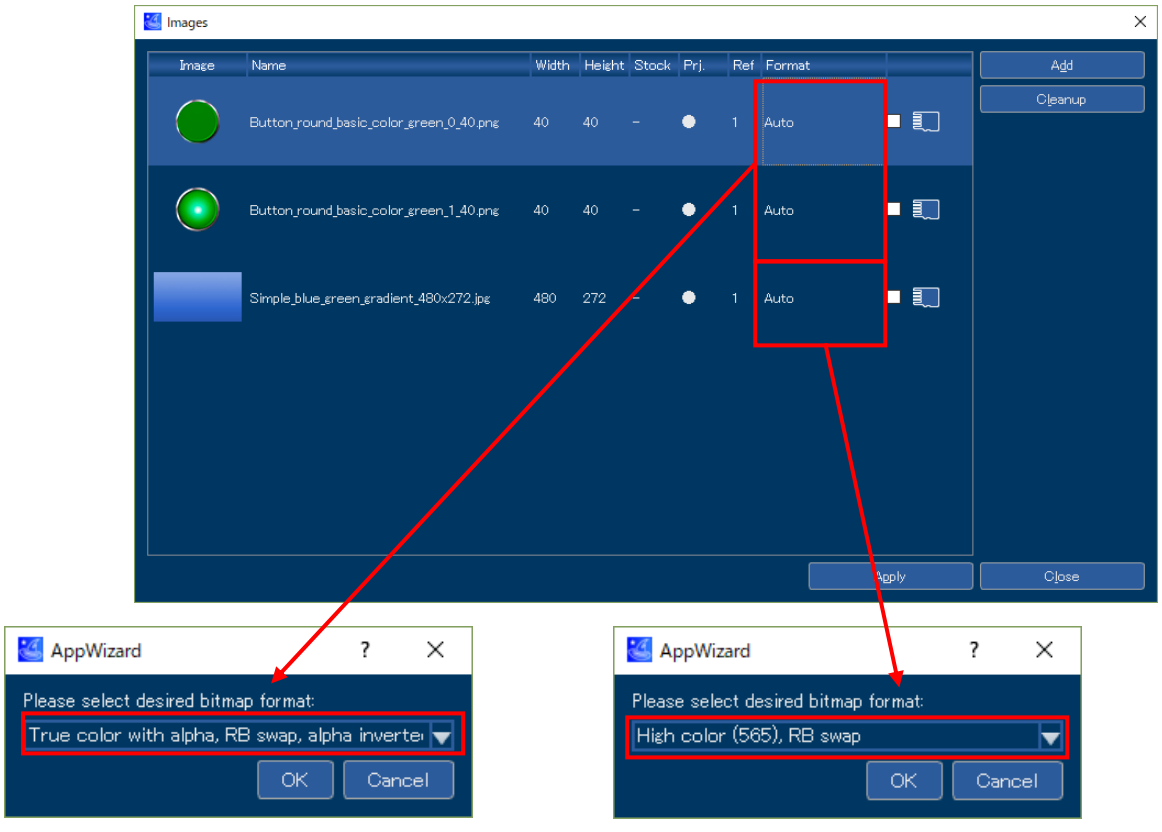


Figure 8-5 Selecting the Bitmap Format

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Sep.17.20	-	First edition issued.
1.10	Dec.25.20	12	Added notes on installing QE for Display [RX] by using the Renesas software installer for the e^2 studio.
		18	Added a step for opening the Smart Configurator perspective.
		21 to 26	Changed sources of examples of images from the Envision RX72N BDF to the Envision RX65N BDF.
		44	Added a step for opening the debug perspective. Added the display of the console of QE for Display.
		45	Added an image of the “Set the Register” icon.
		57	Added a step for confirming code generation.
		64	Added a step for setting the compiler.
		69	Added a step for adjusting the size of an image in the “Editor” panel.
		73 to 75	Added steps for setting the bitmap format.
		76	Added a step for confirming the operation of the button in the preview.
		107	Added “Main Clock Source”, “Extal Frequency [MHz]”, and “Connection Type” to the description of the “Debug Configuration” dialog box.
		110	Added a step for confirming the operation when the button is touched.
		141	Added the section “Setting the Maximum Memory Size Used in the GUI”.
		142 and 143	Added the section “Points for Caution on the Image Drawing Speed”.
1.21	May.26.21	1 and 4	Added statements on supporting the Aeropoint GUI.
		5	Modified statements on supporting the Aeropoint GUI.
		6	Modified the version of the e^2 studio IDE in table 2-1.
		9	Added a document related to the Aeropoint FIT module.
		11 to 13	Modified the descriptions due to updating of the versions of the e^2 studio and QE for Display [RX].
		27	Added a description of the size of the heap to be used by the Aeropoint GUI FIT module.
		29	Modified the description on supporting the Aeropoint GUI.
		31, 33, and 34	Updated the version of “Graphics LCD Controller Module (r_glcdc_rx)”.
		37 and 38	Added a statement that the values in the “Timing Adjustment” tabbed page are automatically set according to the board.
		40	Added a statement that the settings in “PLL Circuit Frequency [MHz]” differ with the version of the e^2 studio.
		47 and 48	Added a note on changing the GUI drawing tool after the GLCDC controller has been installed.
		37 to 47	Added a description of “Auto Adjustment” and updated the display of the screen.
		50 and 53	Updated the version of “Graphic Library with Graphical User Interface (r_emwin_rx)”.
		60	Added a statement on the setting of “Maximum memory size used in GUI”.

		61	Changed the name of the file to be generated.
		70	Added a reference to the image format to be specified.
		79 to 104	Added the section “Using Aeropoint GUI to Create a GUI for an LCD”.
		105	Added a note on generating code at the time of building when using Aeropoint GUI.
		110	Added images displayed when using Aeropoint GUI.
		124 and 125	Described values of “Graphic Layer Setting” dividing into tables for RSK and Envision.
		127 and 128	Corrected statements in descriptions.
		130	Modified the title of section 6.6.

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

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

1. Precaution against Electrostatic Discharge (ESD)

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

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

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

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

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

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

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

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

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Corporate Headquarters

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

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