RX Family

Sample Program Using On-Chip Memory to Display Images on a WVGA Display

Summary

This application note describes a sample program that uses emWin middleware from Segger, the graphic LCD controller (GLCDC), and FIT modules to display images on an WVGA display. The frame rate (FPS) is displayed on the screen, allowing the user to confirm the update status of the screen by referring to a numeric value.

Note that the description of the sample program in this application note is not intended as a detailed explanation of the program. For the processing details, refer to the source code.

Note:

1. The target evaluation boards are the Renesas Starter Kit+ for RX72N (RSK RX72N) and Renesas Starter Kit+ for RX65N (RSK RX65N), which have WQVGA support as a standard feature. However, a separate WVGA display is required in order to run the sample program.
2. It is recommended allocating a frame buffer to the on-chip memory, because it would not display properly due to not enough access speeds to the external memory(SDRAM) in RX MCU in case of allocating a frame buffer to the external memory.

Target Devices

RX65N and RX651 Group with ROM capacity of 1.5 MB to 2 MB

RX72N Group

When using this application note with other Renesas MCUs, careful evaluation is recommended after making modifications to comply with the alternate MCU.

Contents

1. Specifications

The sample code described in this application note uses the GLCDC and emWin middleware in order to operate. The sample code assumes operation on an WVGA display (800 × 480) and does not make use of the TFT-LCD (480 × 272) mounted on the RSK.

The sample code supports the six screen display modes listed below, each of which includes an on-screen FPS indication except for Mandelbrot.

- Start menu: This screen is displayed immediately after startup. From here you can switch to any of the following four screen display modes.
- 2D Drawing: An icon moves around on the screen.
- Bounding balls: 25 large and small balls move around within a frame and bounce off the walls.
- Mandelbrot: A Mandelbrot set is displayed, and it can be enlarged or reduced in size.
- Stopwatch: Measures a duration of time.
- Help dialog: Displays explanations of the various screen display modes.

In addition, the LCD panel supports touch input, so the sample program can be controlled by touching the screen.

The versions of the sample program for the RX65N and RX72N both operate in the same way, but there are some settings that differ between the devices, such as system clock (ICLK) and the color format specified to GLCDC and emWin. Refer to 6.3, Differences between Devices, for the main points of difference.

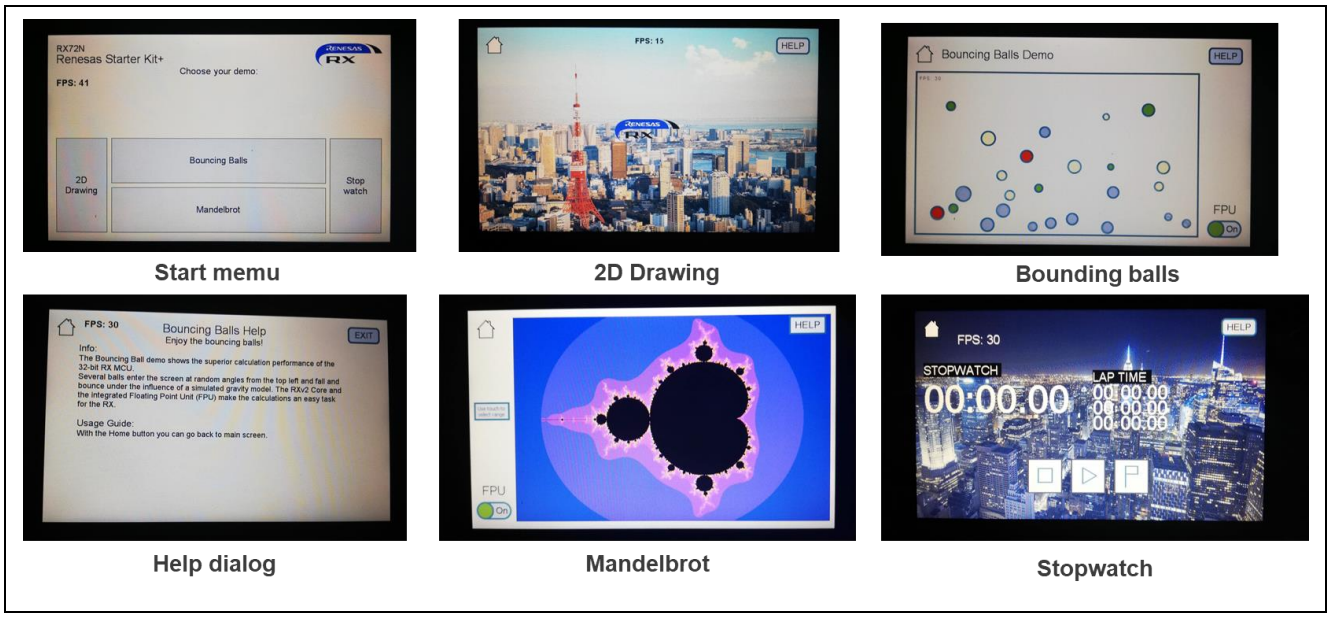


Figure 1.1 Sample Program Screen Display Modes

2. Operation Confirmation Conditions

The operation of the sample code referenced in this application note has been confirmed under the following conditions.

Table 2.1 Operation Confirmation Conditions (RX65N)

Item	Description
MCU used	R5F565NEDDFC (RX65N Group)
Operating frequency	Main clock: 24 MHz PLL: 240 MHz (main clock ×1/1 ×10) System clock (ICLK): 120 MHz (PLL ×1/2) Peripheral module clock A (PCLKA): 120 MHz (PLL ×1/2) Peripheral module clock B (PCLKB): 60 MHz (PLL ×1/4) LCD panel clock (LCD_CLK): 30 MHz (PLL × 1/8)
Operating voltage	3.3 V
Integrated development environment	Renesas Electronics e² studio 2020-07
C compiler	Renesas Electronics C/C++ Compiler for RX Family V3.02.00 Compiler option: The following option is added to the default settings of the integrated development environment -lang = c99
iodefine.h version	V2.30
Endian order	Little endian
Operating mode	Single-chip mode
Sample program version	Rev.1.00
Board used	Renesas Starter Kit for RX65N-2MB (product No.: RTK500565Nxxxxxxxxx)
WVGA display	Manufacturer: Newhaven Display NHD-5.0-800480TF-ATXL#-CTP

Table 2.2 Operation Confirmation Conditions (RX72N)

Item	Description
MCU used	R5F572NNDDBD (RX72N Group)
Operating frequency	Main clock: 24 MHz PLL: 240 MHz (main clock ×1/1 ×10) System clock (ICLK): 240 MHz (PLL ×1/1) Peripheral module clock A (PCLKA): 120 MHz (PLL ×1/2) Peripheral module clock B (PCLKB): 60 MHz (PLL ×1/4) LCD panel clock (LCD_CLK): 30 MHz (PLL × 1/8)
Operating voltage	3.3 V
Integrated development environment	Renesas Electronics e² studio 2020-07
C compiler	Renesas Electronics C/C++ Compiler for RX Family V3.02.00 Compiler option: The following option is added to the default settings of the integrated development environment -lang = c99
iodefine.h version	V1.00C
Endian order	Little endian
Operating mode	Single-chip mode
Sample program version	Rev.1.00
Board used	Renesas Starter Kit for RX72N (product No.: RTK5572NNxxxxxxxx)
WVGA display	Manufacturer: Newhaven Display NHD-5.0-800480TF-ATXL#-CTP

3. FIT Modules and Tool Used

The FIT modules and tool used by the sample program described in this application note are listed below. Refer to the documentation below in conjunction with this document.

FIT modules

- RX Family Board Support Package Module Using Firmware Integration Technology (R01AN1685)
- RX Family Graphic LCD Controller Module Using Firmware Integration Technology (R01AN3609)
- RX Family DMAC Module Using Firmware Integration Technology (R01AN2063)
- RX Family GPIO Module Using Firmware Integration Technology (R01AN1721)
- RX Family Simple I2C Module Using Firmware Integration Technology (R01AN1691)
- RX Family CMT Module Using Firmware Integration Technology (R01AN1856)
- RX Family emWin v.6.14 module Using Firmware Integration Technology (R01AN5533)
- RX Family RX DRW2D Driver (R01AN5373) Attention : This driver is installed in the sample program, but the application do not use it.

Tool

- QE for Display [RX]V2.0.0: Development Assistance Tool for Display (R20TS0606)
- RX Family QE for Display [RX] Application Note (R20AN0582)

If a newer version is available, use the newer version. You can confirm the latest versions of FIT modules and tools, and download newer versions if available, on the Renesas Electronics website.

4. Running the Project

How to run the sample program is described below. A separate version of the sample program is available for each device.

- wvga_sample_rx65n (project version for RSK RX65N)
- wvga_sample_rx72n (project version for RSK RX72N)

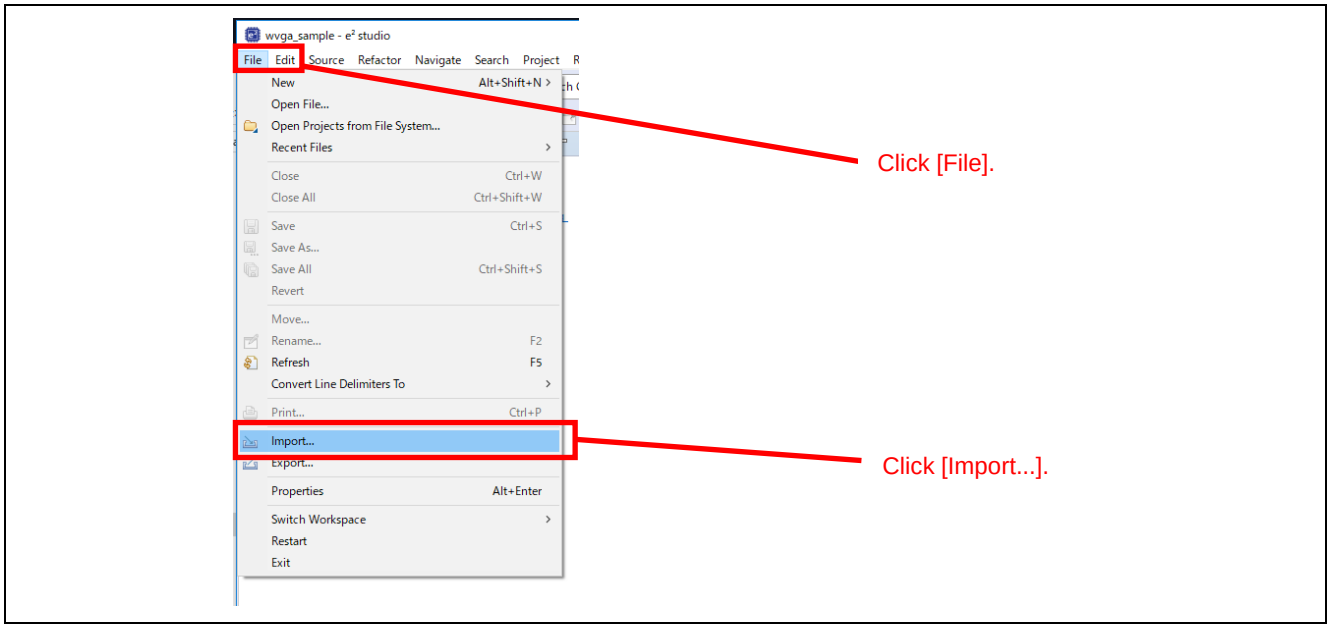
4.1 Installing the WVGA Display

The sample code utilizes the WVGA display listed in section 2, Operation Confirmation Conditions. This is different from the WQVGA (480 × 272) display mounted on the RSK board. The connector of the WVGA display used by the sample program is completely compatible with the connector of the WQVGA display on the RSK board. This means no special operations are needed in order to connect the WVGA display.

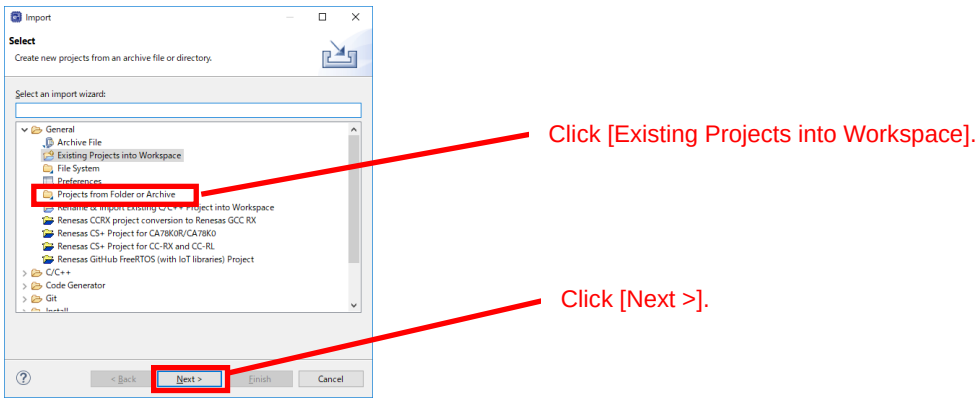
4.2 Importing the Project

Although there is a different project for each device, the method used to import and run them is the same. Therefore, the method used to run the project on RSK RX72N is described below as a representative example.

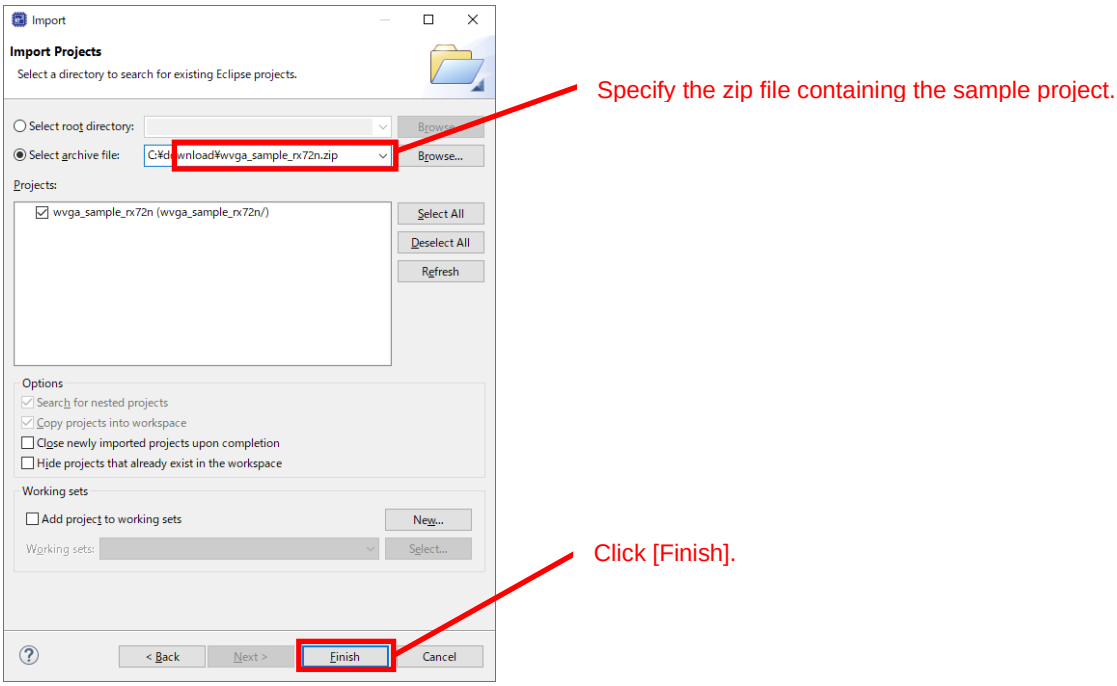
1. Click [File].
2. Click [Import...].



3. Click [General] > [Existing Projects into Workspace].
4. Click [Next >].



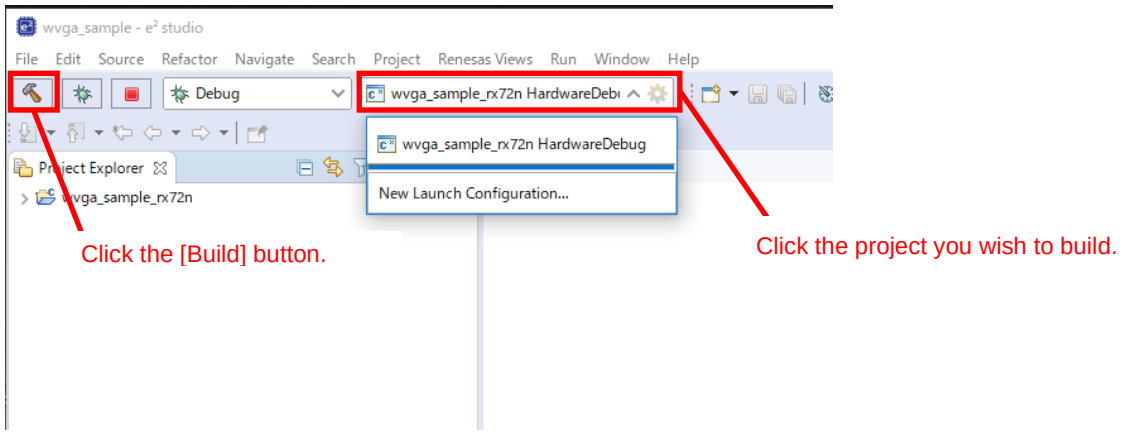
5. Specify the zip file containing the sample project in the combo box next to [Select archive file:].
6. Click [Finish].



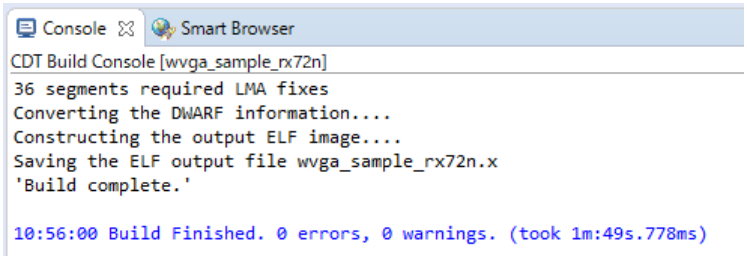
4.3 Building the Project

Follow the steps below to build the project and create a load module.

1. Click the project you wish to build (example: wvga_sample_rx72n HardwareDebug).
2. Click the [Build] button.

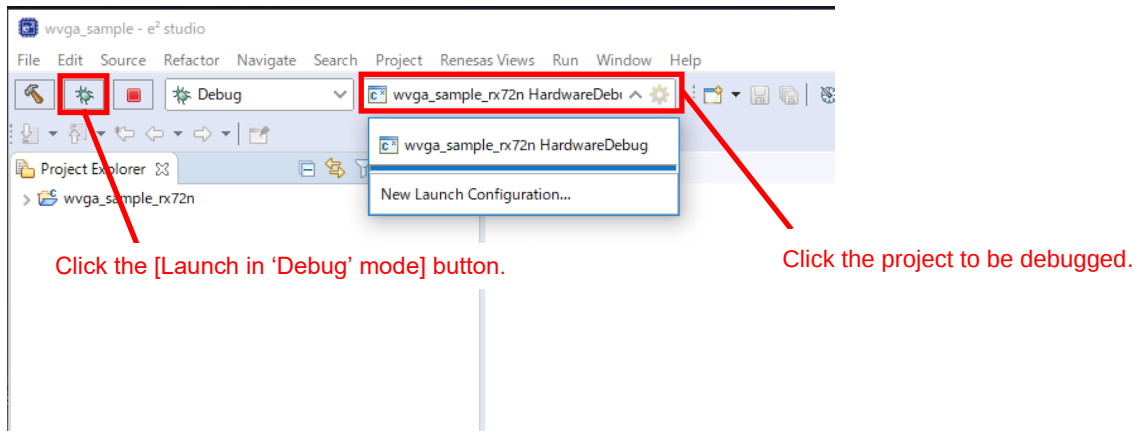


3. When the message ‘Build complete.’ appears on the [Console] panel, the build operation is complete.

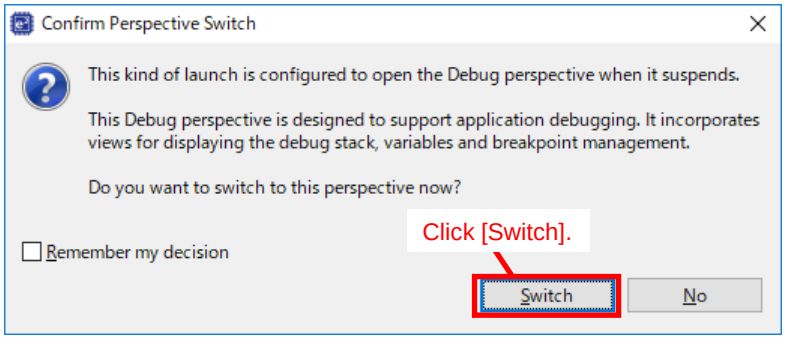


4.4 Connecting a Debugger and Running the Program

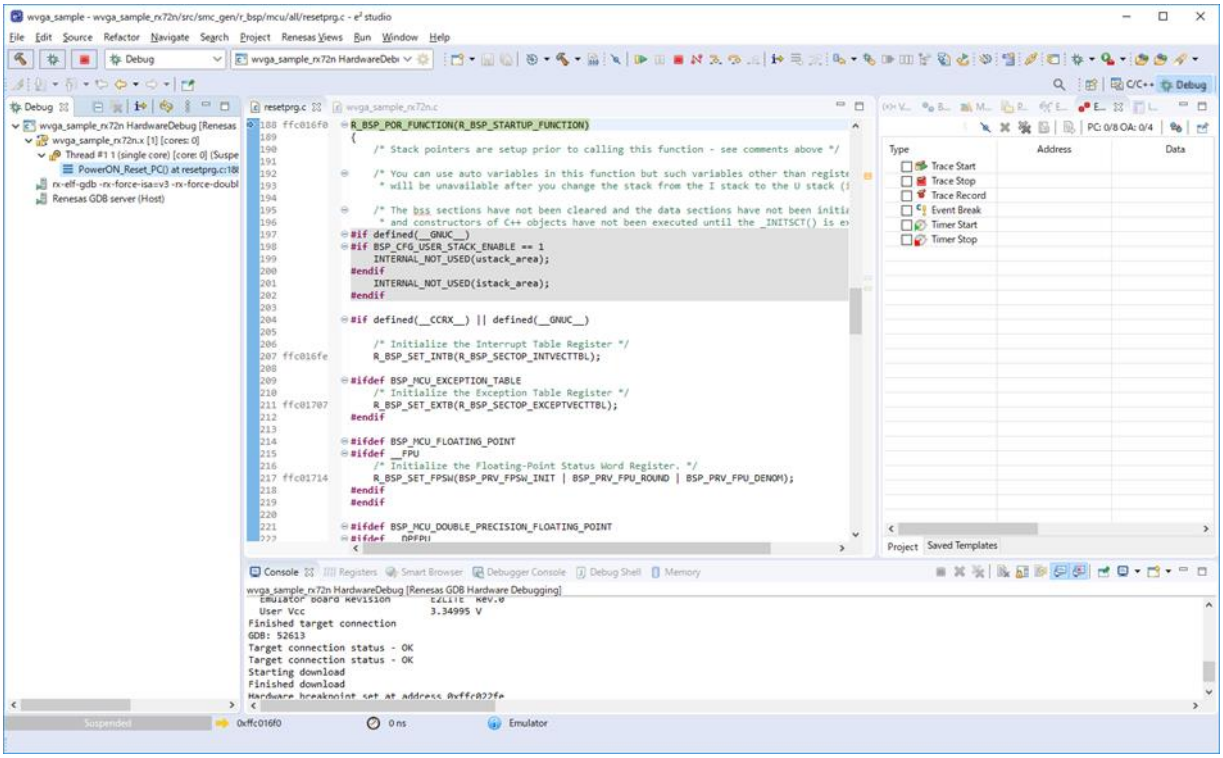
1. Click the project to be debugged (example: wvga_sample_rx72n HardwareDebug).
2. Click the [Launch in ‘Debug’ mode] button.



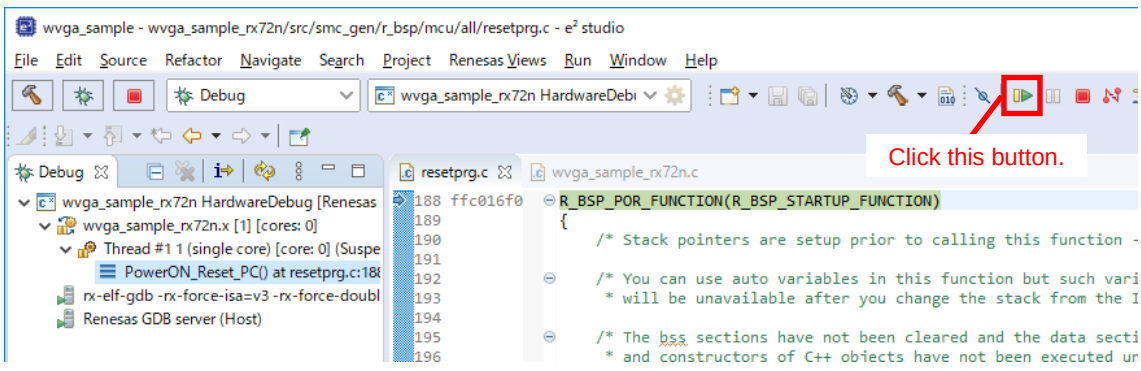
3. When the following message is displayed, click [Switch].



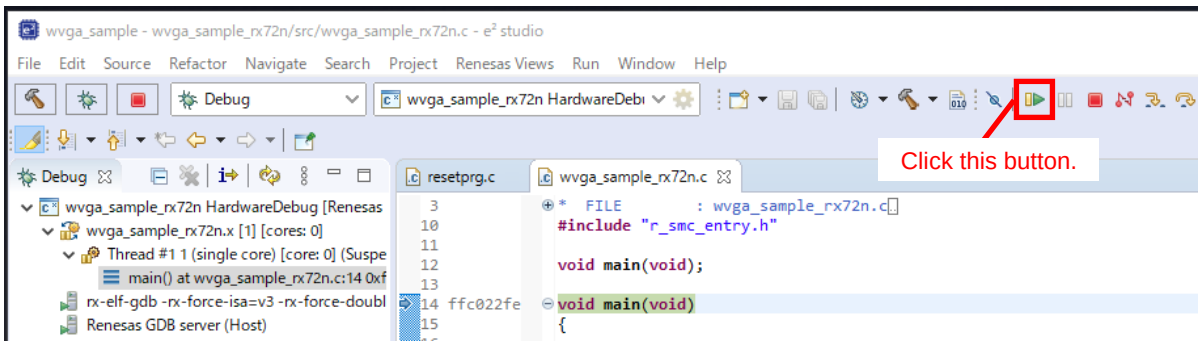
4. When the load module finishes downloading, the [Debug] perspective opens.



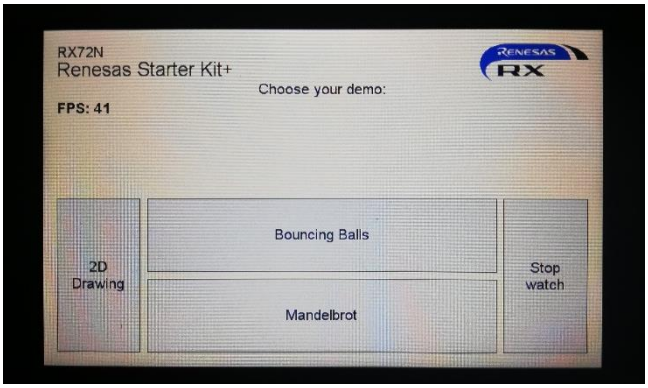
5. Click the [Resume] button on the tool bar. The program is run and breaks at the beginning of the main function.



6. After a break occurs at the beginning of the main function, click the [Resume] button on the toolbar again.



7. The screen shown below is displayed on the LCD panel.



5. Hardware

5.1 Hardware Configuration and Jumper Settings

Table 5.1 lists details of the display device used by the sample program described in this application note.

Jumper settings are only necessary when using the LCD panel with the RSK RX65N board. Apply the jumper settings listed in Table 5.1 as shown in Figure 5.1 before running the sample program. Note that no jumper settings are needed on the RSK RX72N board.

Table 5.1 Display Device Used and Jumper Settings

Device	Product Information (All Project Versions)	Jumper Settings (RSK RX65N Only)
LCD panel	Manufacturer: Newhaven Display Model No.: NHD-5.0-800480TF-ATXL#-CTP Screen size: 800 × 480 Equipped with touch controller	<SW4> Pin 3: Off Pin 4: On (OnBoard_TFT Available)

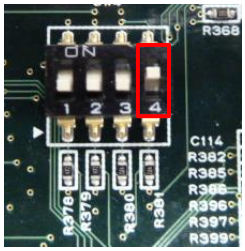


Figure 5.1 RSK RX65N Jumper Settings

Table 5.2 and Table 5.3 list the pins used and their functions.

Table 5.2 Pins Used and Their Functions (RSK RX65N)

Connected Device	Pin Name	I/O	Description
LCD panel	PB5/LCD_CLK-B	Output	Panel clock output
	PB4/LCD_TCON 0-B	Output	Sync signal (VSYNC) output
	PB2/LCD_TCON 2-B	Output	Sync signal (HSYNC) output
	PB1/LCD_TCON 3-B	Output	Sync signal (DE) output
	PB0/LCD_DATA 0-B	Output	LCD signal output R[3]
	PA7/LCD_DATA 1-B	Output	LCD signal output R[4]
	PA6/LCD_DATA 2-B	Output	LCD signal output R[5]
	PA5/LCD_DATA 3-B	Output	LCD signal output R[6]
	PA4/LCD_DATA 4-B	Output	LCD signal output R[7]
	PA3/LCD_DATA 5-B	Output	LCD signal output G[2]
	PA2/LCD_DATA 6-B	Output	LCD signal output G[3]
	PA1/LCD_DATA 7-B	Output	LCD signal output G[4]
	PA0/LCD_DATA 8-B	Output	LCD signal output G[5]
	PE7/LCD_DATA 9-B	Output	LCD signal output G[6]
	PE6/LCD_DATA 10-B	Output	LCD signal output G[7]
	PE5/LCD_DATA 11-B	Output	LCD signal output B[3]
	PE4/LCD_DATA 12-B	Output	LCD signal output B[4]
	PE3/LCD_DATA 13-B	Output	LCD signal output B[5]
	PE2/LCD_DATA 14-B	Output	LCD signal output B[6]
	PE1/LCD_DATA 15-B	Output	LCD signal output B[7]
	PB7/general I/O port	Output	Backlight (controlled by program)
	P97/general I/O port	Output	Panel reset (controlled by program)
LCD panel touch controller (Simple I^2C)	P92/SSCL7	Input/output	Clock I/O
	P90/SSDA7	Input/output	Data I/O
	P42	Input	Trigger input

Table 5.3 Pins Used and Their Functions (RSK RX72N)

Connected Device	Pin Name	I/O	Description
LCD panel	P14/LCD_CLK-B	Output	Panel clock output
	P13/LCD_TCON 0-B	Output	Sync signal (VSYNC) output
	PJ2/LCD_TCON 2-B	Output	Sync signal (HSYNC) output
	PB1/LCD_TCON 3-B	Output	Sync signal (DE) output
	PC5/LCD_DATA 0-B	Output	LCD signal output R[3]
	P82/LCD_DATA 1-B	Output	LCD signal output R[4]
	P81/LCD_DATA 2-B	Output	LCD signal output R[5]
	P80/LCD_DATA 3-B	Output	LCD signal output R[6]
	PC4/LCD_DATA 4-B	Output	LCD signal output R[7]
	P55/LCD_DATA 5-B	Output	LCD signal output G[2]
	P54/LCD_DATA 6-B	Output	LCD signal output G[3]
	P11/LCD_DATA 7-B	Output	LCD signal output G[4]
	P83/LCD_DATA 8-B	Output	LCD signal output G[5]
	PC7/LCD_DATA 9-B	Output	LCD signal output G[6]
	PC6/LCD_DATA 10-B	Output	LCD signal output G[7]
	PJ0/LCD_DATA 11-B	Output	LCD signal output B[3]
	P85/LCD_DATA 12-B	Output	LCD signal output B[4]
	P84/LCD_DATA 13-B	Output	LCD signal output B[5]
	P57/LCD_DATA 14-B	Output	LCD signal output B[6]
	P56/LCD_DATA 15-B	Output	LCD signal output B[7]
	P27/general I/O port	Output	Backlight (controlled by program)
	PK4/general I/O port	Output	Panel reset (controlled by program)
LCD panel touch controller (Simple I^2C)	PQ1/SSCL11	Input/output	Clock I/O
	PQ2/SSDA11	Input/output	Data I/O
	P10	Input	Trigger input

6. Description of Sample Program

6.1 Overall Configuration

Figure 6.1 illustrates the overall software configuration of the sample program. The emWin middleware and peripheral function drivers are used to implement the operation of the application. For details of the individual software components, refer to the associated application notes.

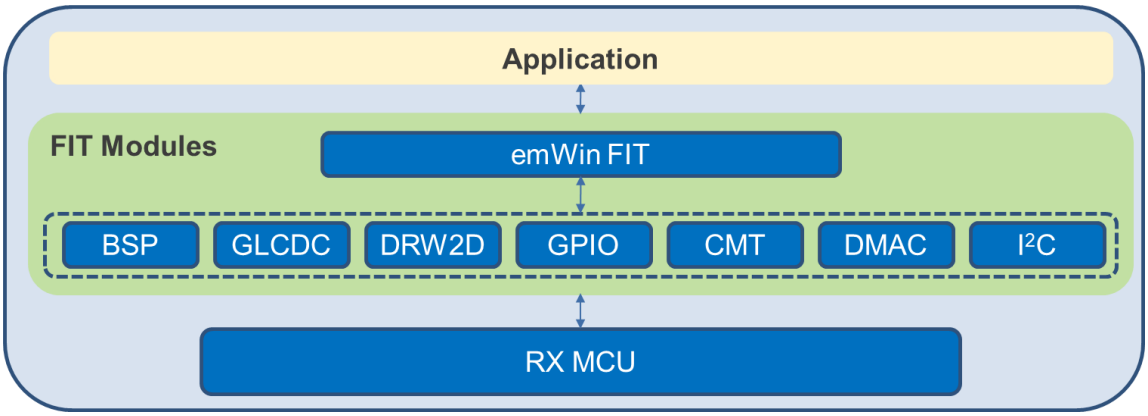


Figure 6.1 Configuration of Sample Program

6.2 Memory Configuration

The sample program reserves graphic frame buffers in the SRAM and extended SRAM. The amount of memory used by the frame buffers and the specified color format are listed below for each device.

Table 6.1 Frame Buffer Memory Usage and Color Format

Item	RSK RX72N	RSK RX65N
Frame buffer 1 (start address: 0x100)	390 KB	210 KB
Frame buffer 2 (start address: 0x800000)	390 KB	210 KB
Color format	CLUT8	CLUT4

6.3 Differences between Devices

The versions of the sample program for the RX65N and RX72N both operate in the same way. Nevertheless, there are some subtle differences between the two devices that result in differences in aspects such as the operating frequency and the color format (color depth), which is determined by the size of the frame buffer.

The main differences between the two devices are summarized below. For setting items other than those listed, refer to the sample code.

Table 6.2 Setting Differences between RX72N and RX65N

FIT	Item	RSK RX72N	RSK RX65N
BSP	System clock (ICLK)	240 MHz	120 MHz
GLCDC, emWin	Color format	CLUT8	CLUT4
GLCDC FIT	Macro line offset	832	448
	Output data pixel order	RGB	BGR
I^2C	Channels	11	7
GPIO	Display on/off signal pin	PK4	P97
	Backlight pin	P27	PB7
	Touch panel IC reset pin	PL3	P66

6.4 QE for Display [RX]

The sample program makes use of QE for Display [RX], a development assistance tool for display applications that supports display control via a graphical interface, when specifying settings such as the GLCD timing, graphic layers, and emWin parameters.

The files r_emwin_rx_config.h, r_image_config.h, and r_lcd_timing.h included in the project are output files containing settings specified using QE for Display [RX].

For details, refer to the documentation for QE for Display [RX] listed in section 3, FIT Modules and Tool Used.

6.5 Note on Usage of Free Version of C/C++ Compiler Package for RX Family

It is possible to continue to use the free version of C/C++ Compiler Package for RX Family after the trial period has expired, but the link size is limited to 128 KB. Be aware that since the link size of the sample project exceeds 128 KB, it is not possible to finish building it on the free version of the compiler.

For details, visit the free software development tools page on the Renesas website.

7. Reference

7.1 FPS Values under Operation Confirmation Conditions

Table 7.1,Table 7.2 lists FPS values under the conditions listed in section 2, Operation Confirmation Conditions.

Table 7.1 FPS Values under Operation Confirmation Conditions RSK RX65N (Reference Values)

Screen Display Mode	Start menu	2D Drawing	Bounding balls	Stopwatch	Help dialog
FPS Value	20	7	20	15	15

Table 7.2 FPS Values under Operation Confirmation Conditions RSK RX72N (Reference Values)

Screen Display Mode	Start menu	2D Drawing	Bounding balls	Stopwatch	Help dialog
FPS Value	41	15	30	30	30

The FPS value varies due to factors such as the characteristics of the image being displayed, the graphic processing, other processing that is occurring, and the operating frequency. For this reason you should evaluate the FPS of each application on your own system under actual usage conditions.

7.2 Code Size

Table 7.2 lists the ROM, RAM, and stack sizes of the sample program under the conditions listed in Table 2.1 and Table 2.2.

Table 7.3 ROM, RAM, and Stack Sizes

Code Sizes for ROM, RAM, and Stack		
Device	**Category**	**Memory Usage**
RX72N	ROM	1,394,198 bytes
	RAM	77,868bytes
	Stack	340 bytes
RX65N	ROM	1,393,503 bytes
	RAM	76,088bytes
	Stack*1	344 bytes

Note: 1. Includes maximum stack size used by interrupt handlers.

8. Reference Documents

User's Manual: Hardware

RX65N Group, RX651 Group User's Manual: Hardware (R01UH0590)
RX72N Group User's Manual: Hardware (R01UH0824)

The latest version can be downloaded from the Renesas Electronics website.

User's Manual: Evaluation board

Renesas Starter Kit+ for RX65N-2MB User's Manual (R20UT3888)
Renesas Starter Kit+ for RX72N User's Manual (R20UT4443)

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Oct. 16, 2020	—	First edition issued

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

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

1. 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.

Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
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5. Renesas Electronics products are classified according to the following two quality grades: “Standard” and “High Quality”. The intended applications for each Renesas Electronics product depends on the product’s quality grade, as indicated below.
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