RX Family

RX DSP Library Version 5.0

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Rev.1.00
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Introduction

This document provides an overview of the RX DSP Library Version 5.0 and the sample project using RX DSP Library Version 5.0 on e^{2}studio and CS+.

Target Device

RX Family

Contents

1. Overview of RX DSP Library

The RX DSP library Version 5.0 contains the following 5 APIs:

1. Statistical Operation API
2. Filter Operation API
3. Linear Transform API
4. Complex Number Operation API
5. Matrix Operation API

The APIs provide efficient operations using the RX CPU's floating-point and DSP instructions.

1.1 Structure of the Application Note

As shown in Table 1-1, the RX DSP Library Version 5.0 consists of several documents, library files and sample projects. The library files are optimized for each RXv1, RXv2 and RXv3 CPU and the sample projects are configured for each CPU.

Table 1-1 Structure of DSP Library

Folder	File	Descriptions
an-r01an4359ej0100-rx-dsplib	r01an4359ej0100-rx-dsplib.pdf	This application note
reference_document	r01tu0012ej0100-rx-dsplib.pdf	Release note
	r01uw0200ej0100-rx-dsplib.pdf	User's Manual of RX DSP Library APIs
	r01an4360ej0100-rx-dsplib.pdf	Information of RXv1 DSP library such as execution cycle count
	r01an4361ej0100-rxv2-dsplib.pdf	Information of RXv2 DSP library such as execution cycle count
	r01an4362ej0100-rxv3-dsplib.pdf	Information of RXv3 DSP library such as execution cycle count
dsplib-rxv1	RX_DSP_*.lib r_dsp_*.h	Library and header files for RXv1 DSP library
dsplib-rxv2	RX_DSP_*.lib r_dsp_*.h	Library and header files for RXv2 DSP library
dsplib-rxv3	RX_DSP_*.lib r_dsp_*.h	Library and header files for RXv3 DSP library
RXv1_DSP_Sample_CCRX	Sample project files for RXv1	Sample project (MCU: RX631)
RXv2_DSP_Sample_CCRX	Sample project files for RXv2	Sample project (MCU: RX64M)
RXv3_DSP_Sample_CCRX	Sample project files for RXv3	Sample project (MCU: RX66T)

There are eight types of library files and eight header files in each CPU's "dsplib-rxv*" folder.
As shown in Table 1-2, the library files are classified according to the supported FPU, endian modes, and error checking. As shown in Table 1-3, the header files are categorized into definitions for API exclusive and common. All common definitions are described in r_dsp_types.h, which is included in each API header file. Refer to "RX DSP Library APIs Version 5.0 User's Manual: Software (R01UW0200)" for detailed information.

Table 1-2 List of DSP Library files

FPU	Endian	Error checking	Library file name
available	Little-endian	unavailable	RX_DSP_NOFPU_LE.lib
		available	RX_DSP_NOFPU_LE_Check.lib
	Big-endian	unavailable	RX_DSP_NOFPU_BE.lib
		available	RX_DSP_NOFPU_BE_Check.lib
unavailable	Little-endian	unavailable	RX_DSP_FPU_LE.lib
		available	RX_DSP_FPU_LE_Check.lib
	Big-endian	unavailable	RX_DSP_FPU_BE.lib
		available	RX_DSP_FPU_BE_Check.lib

NOTE: In case of using the floating-point Linear Transform API and/or Complex Number Operation API in the DSP Library supporting the FPU, “mathf.h” of the standard library is necessary.

Table 1-3 List of DSP Library’s header files

Header file	Category	Description
r_dsp_statistical.h	API exclusive	Definitions for Statistical Function API
r_dsp_filters.h		Definitions for Filter Function API
r_dsp_transform.h		Definitions for Linear Transform Function API
r_dsp_complex.h		Definitions for Complex Function API
r_dsp_matrix.h		Definitions for Matrix Function API
r_dsp_types.h	Common	Definitions for structures, error codes and options
r_dsp_ver_info.h		Common definitions for all APIs
r_dsp_typedefs.h		Data type definitions for DSP Library

2. Sample Project

The sample projects provide examples of usage of the RX DSP Library.
The RX DSP Library contains sample projects for the RXv1, RXv2 and RXv3 CPUs. This section explains the sample project for RXv3 as an example.

2.1 Operation Confirmation Conditions

Table 2-1 shows the operation confirmation conditions of the sample project.

Table 2-1 Operation Confirmation Conditions

Item	Description
IDE	Renesas Electronics e^2 studio V7.2.0 Renesas Electronics CS+ for CC V8.00.00
C/C++ Compiler	Renesas Electronics RX Compiler CC-RX V3.00.00

2.2 Sample Source Files

Table 2-2 shows the sample source files in the sample project.

Table 2-2 List of sample source files

Source file	Description
sample_dsp_main.c	main program of the sample project
sample_dsp_realFFT.c	example to use the floating-point real FFT API
sample_dsp_complexFFT.c	example to use the complex FFT API
sample_dsp_fir.c	example to use the Generic FIR Filter API
sample_dsp_iirbiquad.c	example to use the IIR Biquad Filter API
sample_dsp_iirsinglepole.c	example to use the single-pole IIR Filter API
sample_dsp_iir.c	example to use the Generic IIR Filter API
rFFT_in256_f32.h	input data for floating-point real FFT
windowCoefficient_f32.h	window function coefficients for real FFT
cFFT_in64_i16.h	input data for complex FFT

NOTE: “sample_dsp_realFFT.c” is effective only when the build configuration supports an FPU.

2.3 Build Configuration

As shown in Table 2-3,the sample project has eight build configurations. The build configurations consist of with/without FPU, endian and with/without error checking according to each library file.

Table 2-3 List of Debug Configuration corresponding to Library File

Build Configuration	FPU	Endian	Error Checking	Library File
RXV3_DSP_NOFPU_LE	unavailable	Little-endian	unavailable	RX_DSP_NOFPU_LE.lib
RXV3_DSP_NOFPU_LE_Check			available	RX_DSP_NOFPU_LE_Check.lib
RXV3_DSP_NOFPU_BE		Big-endian	unavailable	RX_DSP_NOFPU_BE.lib
RXV3_DSP_NOFPU_BE_Check			available	RX_DSP_NOFPU_BE_Check.lib
RXV3_DSP_FPU_LE	available	Little-endian	unavailable	RX_DSP_FPU_LE.lib
RXV3_DSP_FPU_LE_Check			available	RX_DSP_FPU_LE_Check.lib
RXV3_DSP_FPU_BE		Big-endian	unavailable	RX_DSP_FPU_BE.lib
RXV3_DSP_FPU_BE_Check			available	RX_DSP_FPU_BE_Check.lib

3. Procedure to Execute the Sample Project

The following describes the steps to build and execute the sample project on each IDE.

3.1 e² studio

This section describes how to use the sample project with e² studio V7.2.0.

3.1.1 Import

Figure 3-1 shows the procedure to import the sample project into e² studio workspace.

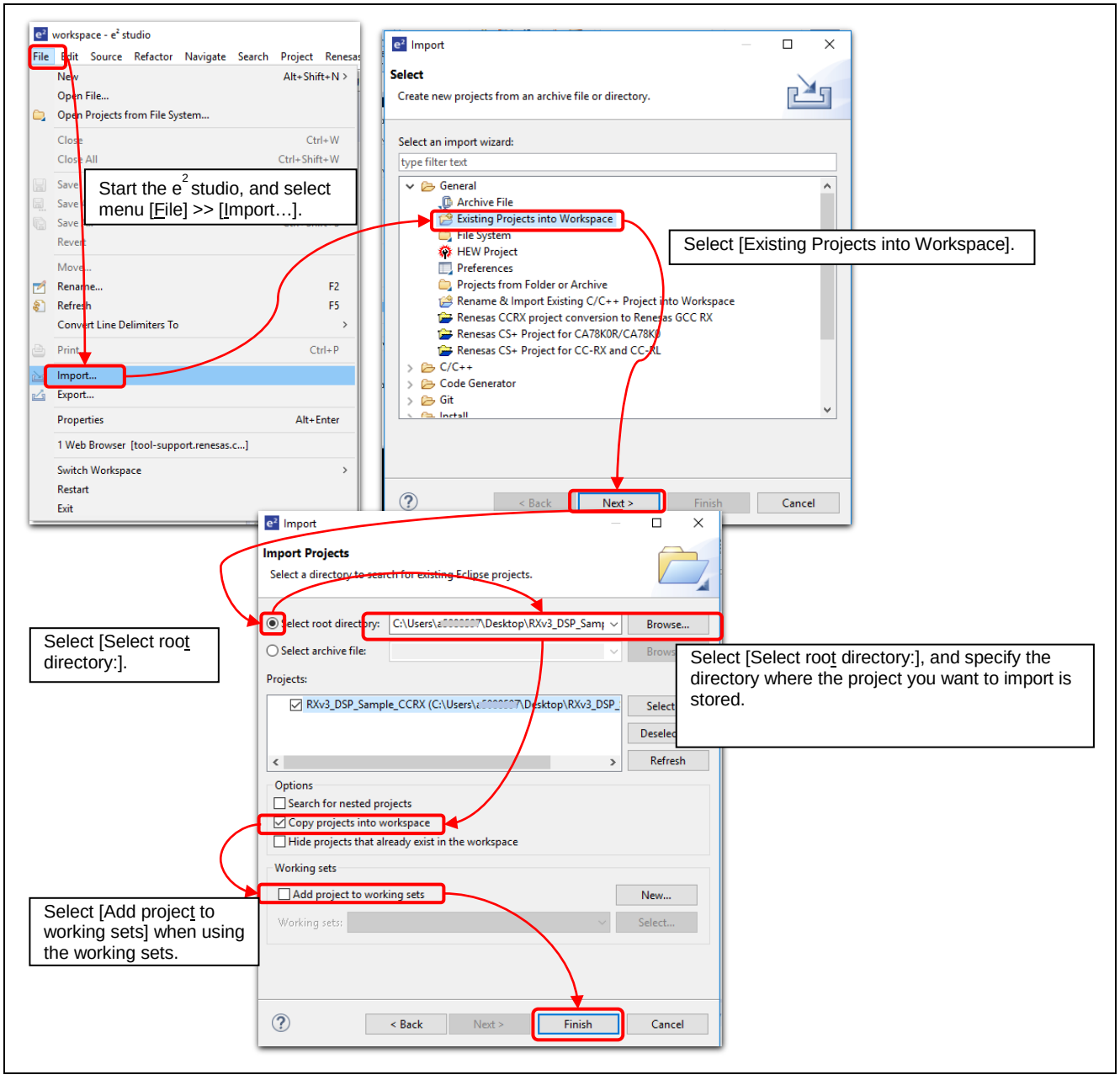

Figure 3-1 Importing a Project into e² studio

3.1.2 Build

1. As shown in Figure 3-2, click the “RXv3_DSP_Sample_CCRX” project in Project Explorer, then from the menu select “Project” > “Build Configuration” > “Set Active” to select the desired build configuration.
   As shown in Table 2-3, there are eight build configurations.
   (Example: “RXV3_DSP_FPU_LE_Check” is selected.)
2. Build the sample project. Click the “RXv3_DSP_Sample_CCRX” project in Project Explorer and then from the menu select “Project” > “Build Project”.

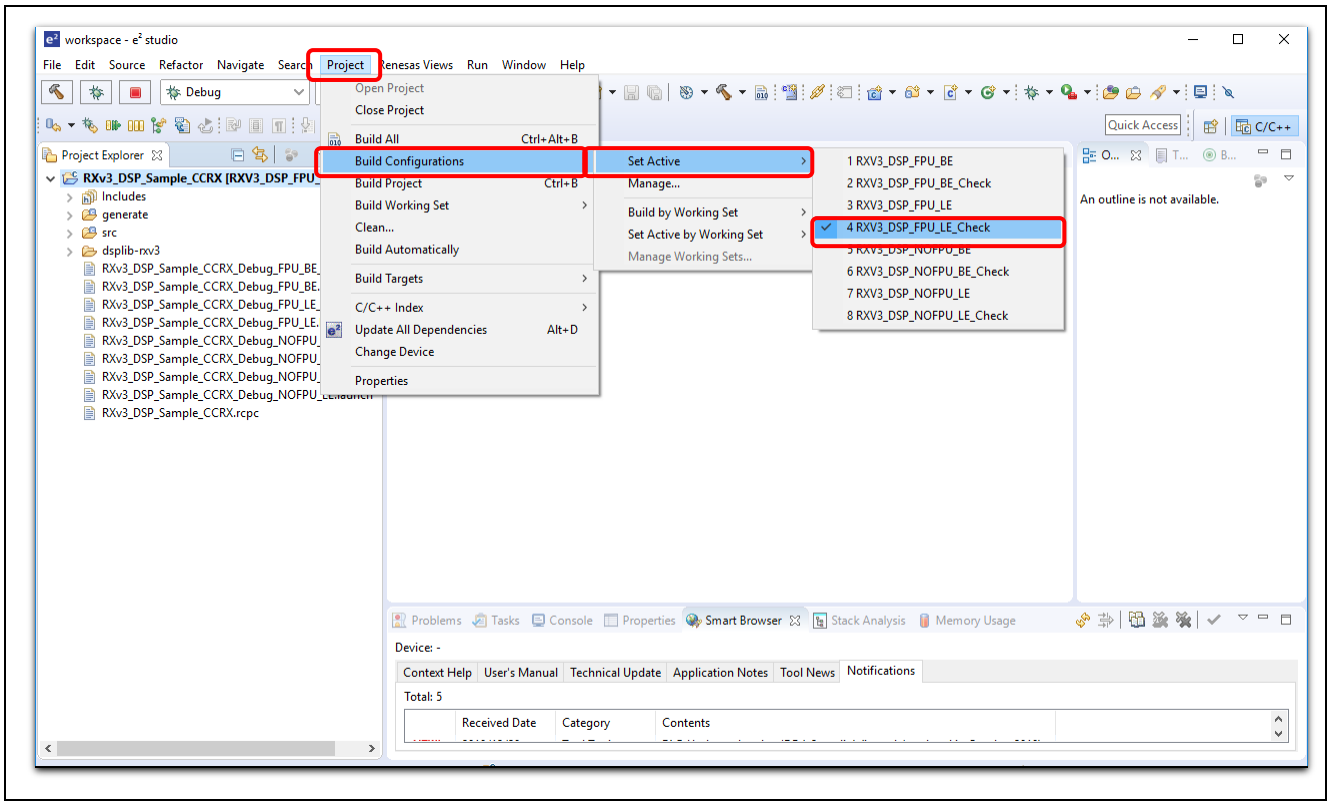

Figure 3-2 Selecting the build configuration in e² studio

3.1.3 Execute

As shown in Table 3-1, the sample project has eight debug launchers. Execute the sample program in RX simulator with the debug launcher that corresponds to the build configuration.

1. Right click the debug launcher that corresponds to the selected build configuration and then select the desired debug launcher from the “Debug As” pop-up menu.
   (Example: “RXv3_DSP_Sample_CCRX_FPU_LE_Check” is selected.)
   In the “Confirm Perspective Switch” dialog box, click “Yes”.
   e² studio switches to Debug Perspective.
2. Select “Run” > “Resume” from the menu to execute the program.
   For details of Debug Perspective, refer to the e² studio help at “e² studio Users Guide” > “General” > “Tutorial” > “Renesas CC-RX Tutorial”.

Table 3-1 List of Debug Launcher corresponding to Build Configuration

Build Configuration	Debug Launcher
RXV3_DSP_FPU_LE	RXv3_DSP_Sample_CCRX_Debug_FPU_LE.launch
RXV3_DSP_FPU_LE_Check	RXv3_DSP_Sample_CCRX_Debug_FPU_LE_Check.launch
RXV3_DSP_FPU_BE	RXv3_DSP_Sample_CCRX_Debug_FPU_BE.launch
RXV3_DSP_FPU_BE_Check	RXv3_DSP_Sample_CCRX_Debug_FPU_BE_Check.launch
RXV3_DSP_NOFPU_LE	RXv3_DSP_Sample_CCRX_Debug_NOFPU_LE.launch
RXV3_DSP_NOFPU_LE_Check	RXv3_DSP_Sample_CCRX_Debug_NOFPU_LE_Check.launch
RXV3_DSP_NOFPU_BE	RXv3_DSP_Sample_CCRX_Debug_NOFPU_BE.launch
RXV3_DSP_NOFPU_BE_Check	RXv3_DSP_Sample_CCRX_Debug_NOFPU_BE_Check.launch

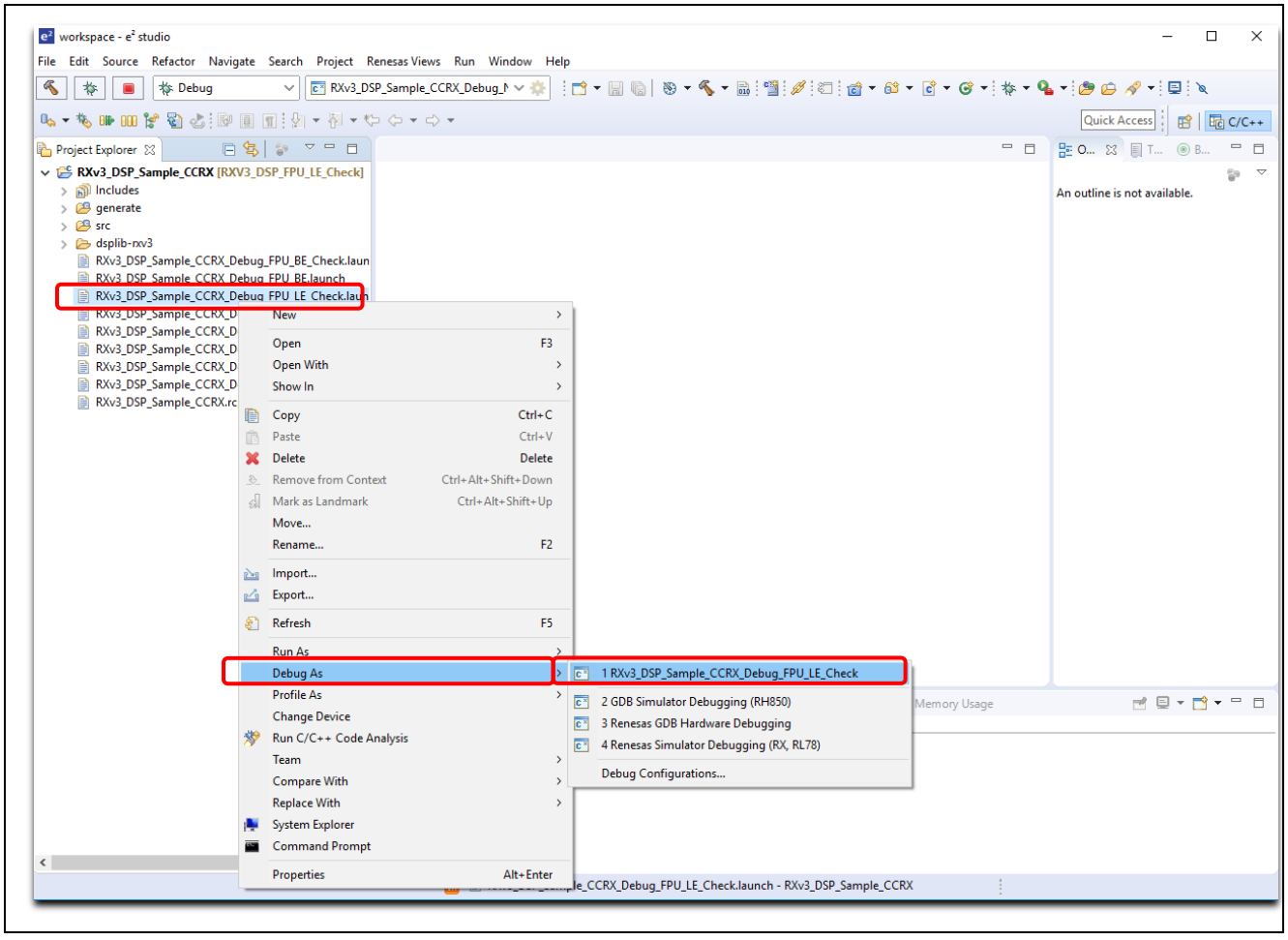

Figure 3-3 Launching a Debug Perspective

3.2 CS+

This section describes how to use CS+ V8.00.00.

3.2.1 Import

Figure 3-1 shows the procedure to import a sample project into CS+.

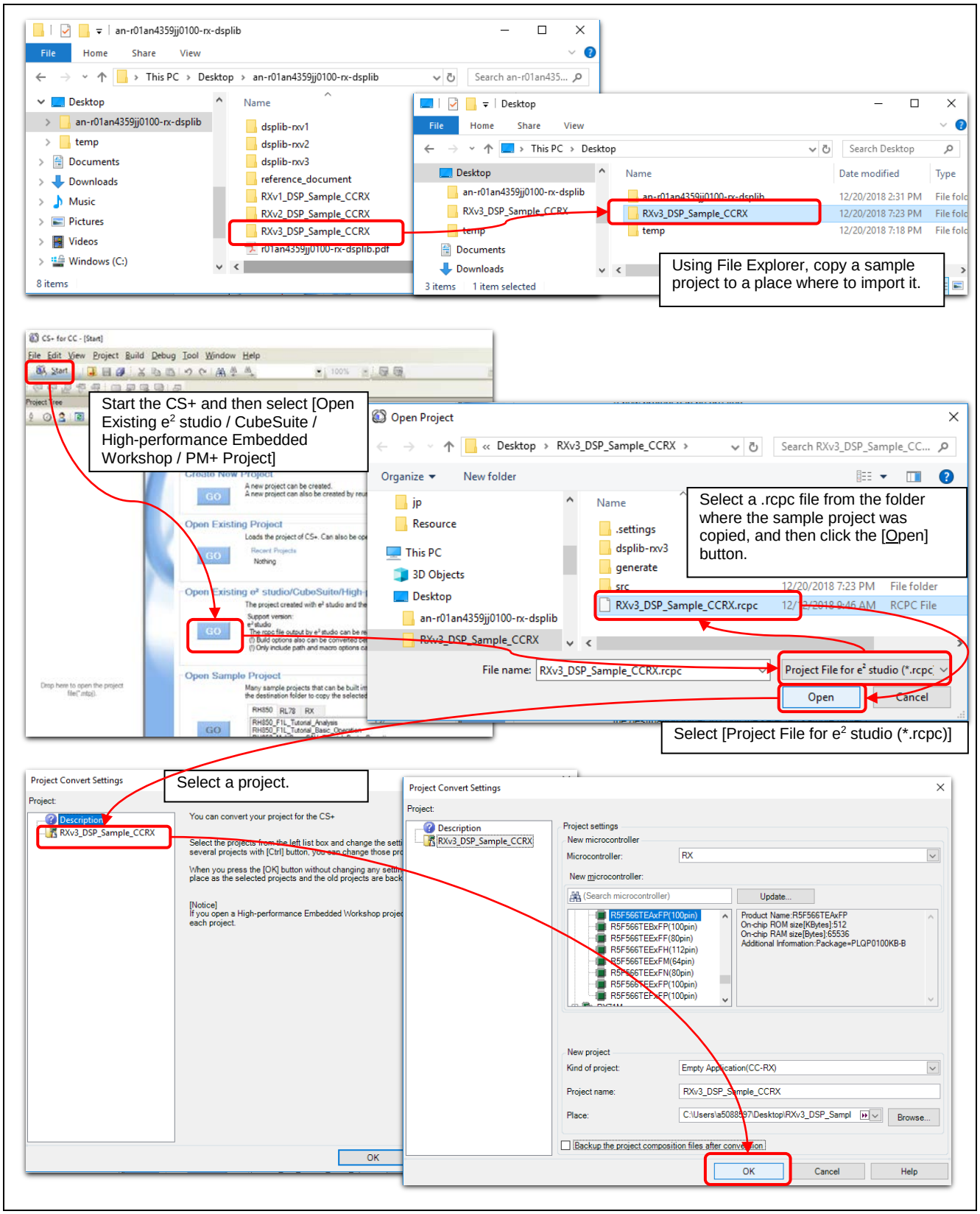

Figure 3-4 Importing a project into CS+

3.2.2 Build

1. In the Project Tree, click “CC-RX (Build Tool)”, then using the Common Options tab select Build Mode under CC-RX Property.
   As shown in Table 2-3, there are eight build configurations.
   (Example: “RXV3_DSP_FPU_LE_Check” is selected.)
2. To build the sample project, select “Build” > “Build Project” from the menu.

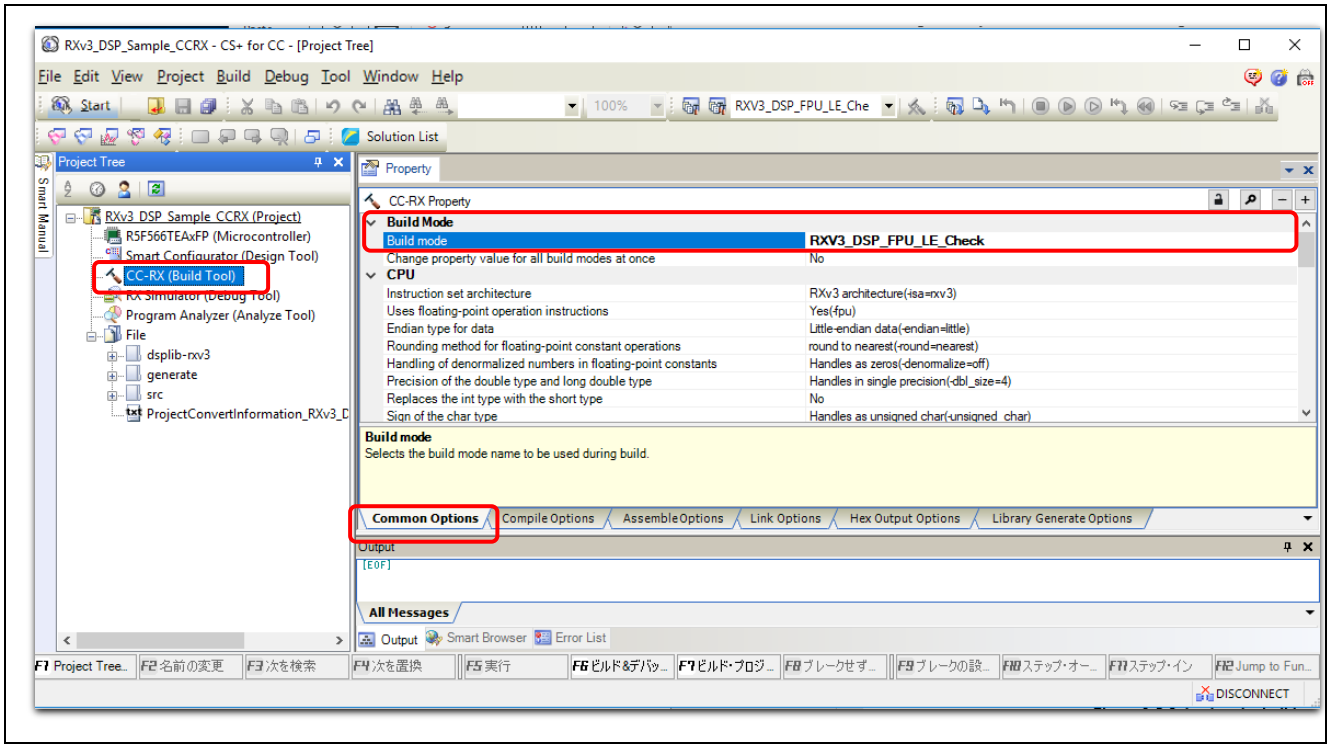

Figure 3-5 Selecting the build mode in CS+

3.2.3 Execute

Execute the sample program in RX Simulator. Before executing the program, set endian depending on the selected build configuration.

1. Select endian depending on the selected build configuration. As shown in Figure 3-6, click “RX Simulator (Debug Tool)”, then under RX Simulator Property select the Connect Settings tab and under Endian select “Endian of CPU”.
   For example, since the build configuration is “RXV3_FPU_**LE**_Check”, select endian “**L**ittle-**e**ndian data”.
2. Select “Debug” > “Download” from the menu to execute the program.
   For details of the debug screen, refer to CS+ Help “RX [with CC-RX]” > “Debug Tool” >.

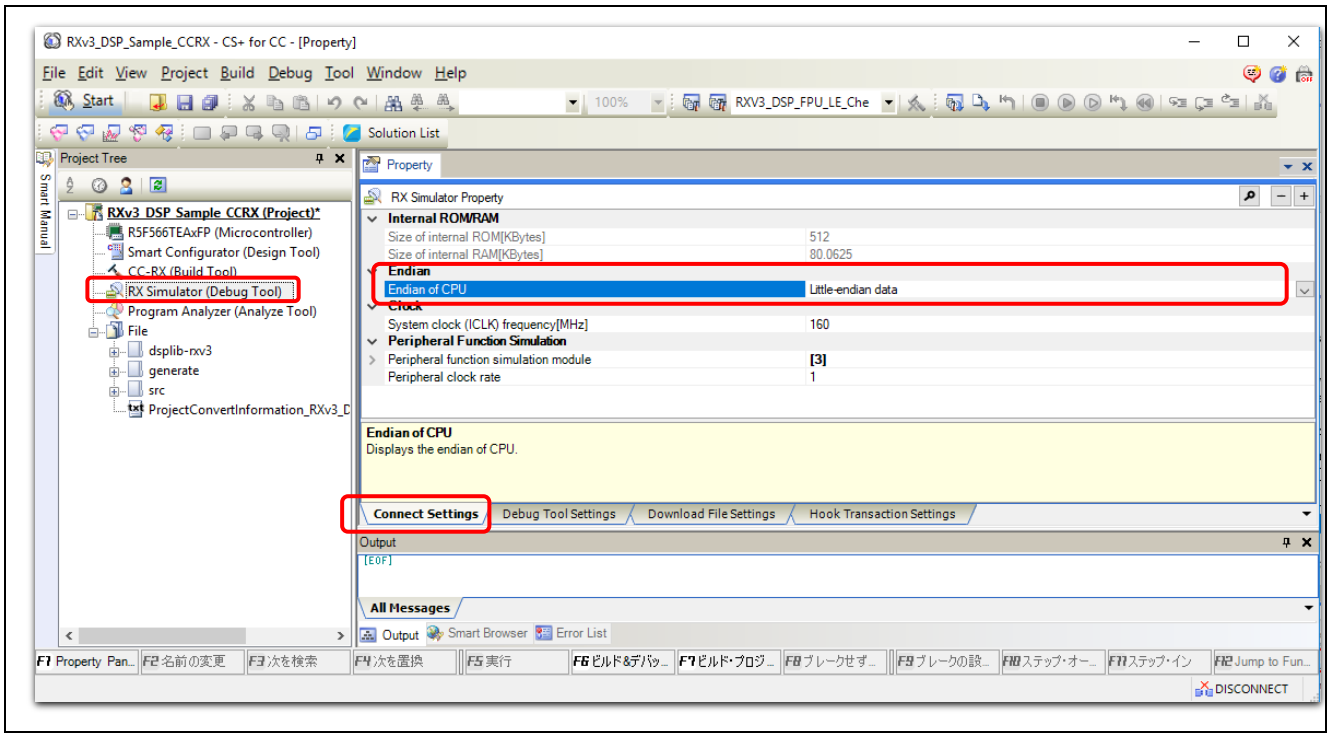

Figure 3-6 Setting of RX Simulator in CS+

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Revision Record

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Jan 21, 2019	—	First edition issued

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2. Processing at Power-on

   The state of the product is undefined at the moment when power is supplied.

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

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   Access to reserved addresses is prohibited.

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

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

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