

Renesas Synergy™ Platform

USB™ CDC ACM (Device) Application for S1/S3/S5 Target Board Kits

Introduction

This application note describes the use of USB communication device class on Synergy Microcontrollers as a serial communications device connected through a serial port (COM port) on a host PC and provides implementation details of the USBX CDC ACM Device application project provided for the Synergy Target Board Kits.

This application note also provides step-by-step instructions to:

1. Import and build the application project using the Synergy Software Package and e² studio Integrated Solutions Development Environment (ISDE) or IAR Embedded Workbench® for Renesas Synergy™ (IAR EW for Synergy).
2. Download and execute the application on Synergy Target Board Kits.
3. Recreate, generate, and build the application with any modifications that you intend to make in the application provided.

Required Resources

To build and run the application, you need the following:

	Hardware	Software and Development Tools
System	Host PC <ul style="list-style-type: none"> • At least 8 GB of RAM • At least 2 GB of free hard disk space • One USB 2.0 (or later) port 	Operating system <ul style="list-style-type: none"> • Windows® 7 (or later) Drivers <ul style="list-style-type: none"> • Synergy Signed USB CDC Driver Applications <ul style="list-style-type: none"> • Tera Term or similar terminal emulation program
	One of the following Target Board Kits	
Embedded	TB-S3A6, TB-S5D5, TB-S3A3	<ul style="list-style-type: none"> • e² studio ISDE v5.4.0.023 or later • IAR EW for Synergy v7.71.3 or later • Synergy Software Package (SSP) v1.3.0 or later • Synergy Standalone Configurator (SSC) v5.4.0.023 or later
	TB-S3A1	<ul style="list-style-type: none"> • e² studio ISDE v6.2 or later • IAR EW for Synergy v8.2 or later • Synergy Software Package (SSP) v1.4.0 or later • Synergy Standalone Configurator (SSC) v6_2_0_R20180102 or later
	TB-S1JA, TB-S5D3	<ul style="list-style-type: none"> • e² studio ISDE v6.2.1 or later • IAR EW for Synergy v8.23.1 or later • Synergy Software Package (SSP) v1.5.0 or later • Synergy Standalone Configurator (SSC) v6_2_1_R20180629 or later

Estimated time required is 60 minutes (assuming all the necessary hardware is available, software is installed and ready to use).

Prerequisites and Assumptions

Software and Tool readiness: It is assumed that the Synergy Software Package, J-Link drivers, and development tools are installed on the Windows® PC. The software and tools are bundled and can be downloaded using one of the two platform installers:

- A. **e² studio Platform Installer** installs Synergy Software Package and e² studio for Synergy IDE with IAR compiler and J-Link USB drivers.
Download from www.renesas.com/synergy/e2studio.
- B. **IAR Platform Installer** installs Synergy Software Package and IAR Embedded Workbench® for Renesas Synergy™ IDE with IAR compiler and J-Link USB drivers.
Download from www.renesas.com/synergy/ewsynergy.

Synergy Standalone Configurator (SSC) (Optional)

SSC can be used with IAR Embedded Workbench® for Renesas Synergy™ IDE and can be downloaded from www.renesas.com/synergy/ssc.

To download the Synergy Signed USB Driver, visit www.renesas.com/synergy/addons or www.renesas.com/synergy/add-ons/usb-cdc-drivers.

Tool experience: It is assumed that the user has prior experience working with embedded development environments such as the e² studio Integrated Solutions Development Environment (ISDE), and familiarity working with a common terminal emulation program such as Tera Term.

Subject knowledge: It is assumed that the user has basic knowledge about the Synergy Software Package and USB device stack and its communication protocols.

Note: It is recommended that you first refer to the Quick Start Guide for your Target Board Kit to become familiar with the hardware. It is also recommended that you refer to the *Out-of-Box (OoB) Demonstration (Blinky) Application for S1/S3/S5 Target Board Kits* application note to familiarize yourself with Synergy Software Package and using the development tools. Both documents can be downloaded from the Target Board Kit webpage (www.renesas.com/synergy/tb-sXXX).

For example, TB-S5D5 Target Board Kit webpage is at www.renesas.com/synergy/tb-s5d5.

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1. Application Project Overview

This application project shows the use of a USB communication device class as a serial communications device connected through a serial port (COM port) on a PC. This application also demonstrates how key elements work together in a typical design. These elements include the ThreadX® RTOS, the USBX device class, the USBX device driver for the Renesas Synergy Platform, and a sample USBX CDC ACM device application.

1.1 USBX Subsystem

The Renesas Synergy Platform uses the Express Logic USBX USB stack (UX) integrated in the SSP. USBX supports USB specifications 1.1 and 2.0. The USB Device CDC-ACM class allows a USB host system to communicate as a serial device with the Target Board. This class is based on the USB standard and is a subset of the CDC standard.

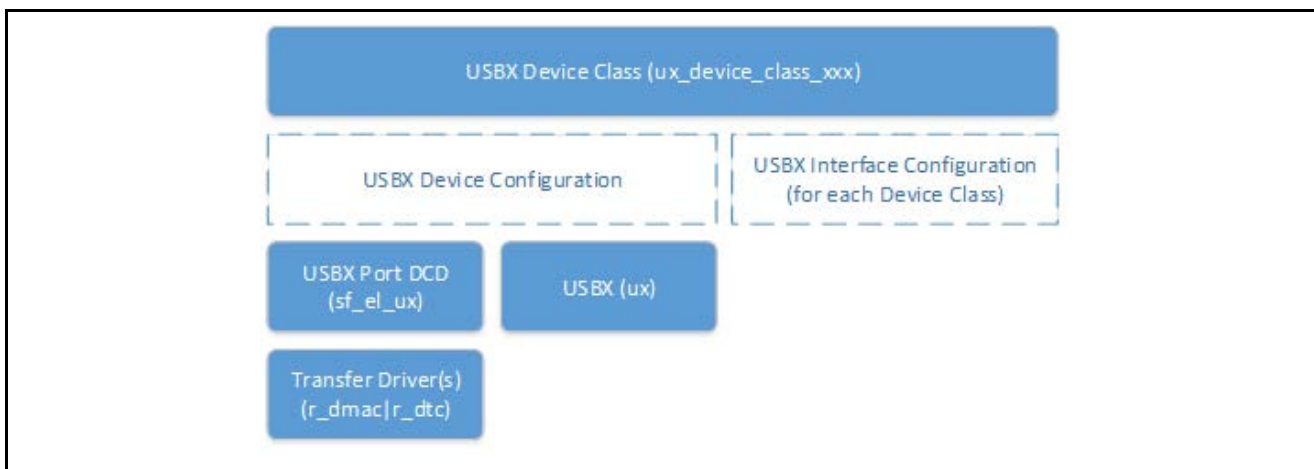


Figure 1. USBX Device Class Stack Configuration

The USBX device class stack configuration shows one USBX Device class component (`ux_device_class_xxx`) on top with its components, the USBX (`ux`) in the middle, and the USBX Port driver (`sf_el_ux`) Device Controller Driver (DCD) located at the bottom of the stack.

As the recommended option, the SSP Transfer module (`r_dmac` or `r_dtc`) supports data transfer between the memory and hardware FIFO in the Synergy USB peripherals (USBHS or USBFS). To support the USB device stack configuration, there are some components named USBX Device Configuration and USBX Interface Configuration. These components do not represent actual software modules in the SSP, but are virtual modules used to handle the code generation.

1.2 USBX Device CDC-ACM Configuration

The USBX Device Class CDC-ACM component has configurations to setup USB Device Class CDC-ACM. The component can be configured through the SSC.

Table 1. USB Device Class CDC-ACM Configurations

Configuration	Settings	Description
Name	Arbitrary symbol name Default: "g_ux_device_class_cdc_acm0"	Specify the name of USBX Device CDC-ACM class module instance.
USBX CDC-ACM instance_activate Function Callback	Arbitrary symbol name Default: "ux_cdc_device_instance_activate"	Specify the name of instance_activate user callback function for the USBX Device CDC-ACM Class module.
USBX CDC-ACM instance_deactivate Function callback	Arbitrary symbol name Default: "ux_cdc_device_instance_deactivate"	Specify the name of instance_deactivate user callback function for the USBX Device CDC-ACM Class module.

1.3 Application Software Architecture

The USB thread and the button thread are the main software components in the application.

The USB thread includes the USBX device CDC ACM class stack framework, the USBX port driver, and the SSP transfer module `r_dmac` that supports data transfer between memory and hardware FIFO in the Synergy USB peripherals. The USB thread handles all USB related communication with the underlying USB controller, such as enumeration of the USB CDC communication protocol. The USB thread receives any button push event from the button processing thread and sends out a **Welcome to the Synergy Platform** text string to serial console.

The button thread processes button events using an interrupt mechanism. Whenever you press a button, the interrupt is generated and the `pb_switch_event_callback` is invoked. The button event is processed, and the button trigger event is sent to USB thread through ThreadX message queue API.

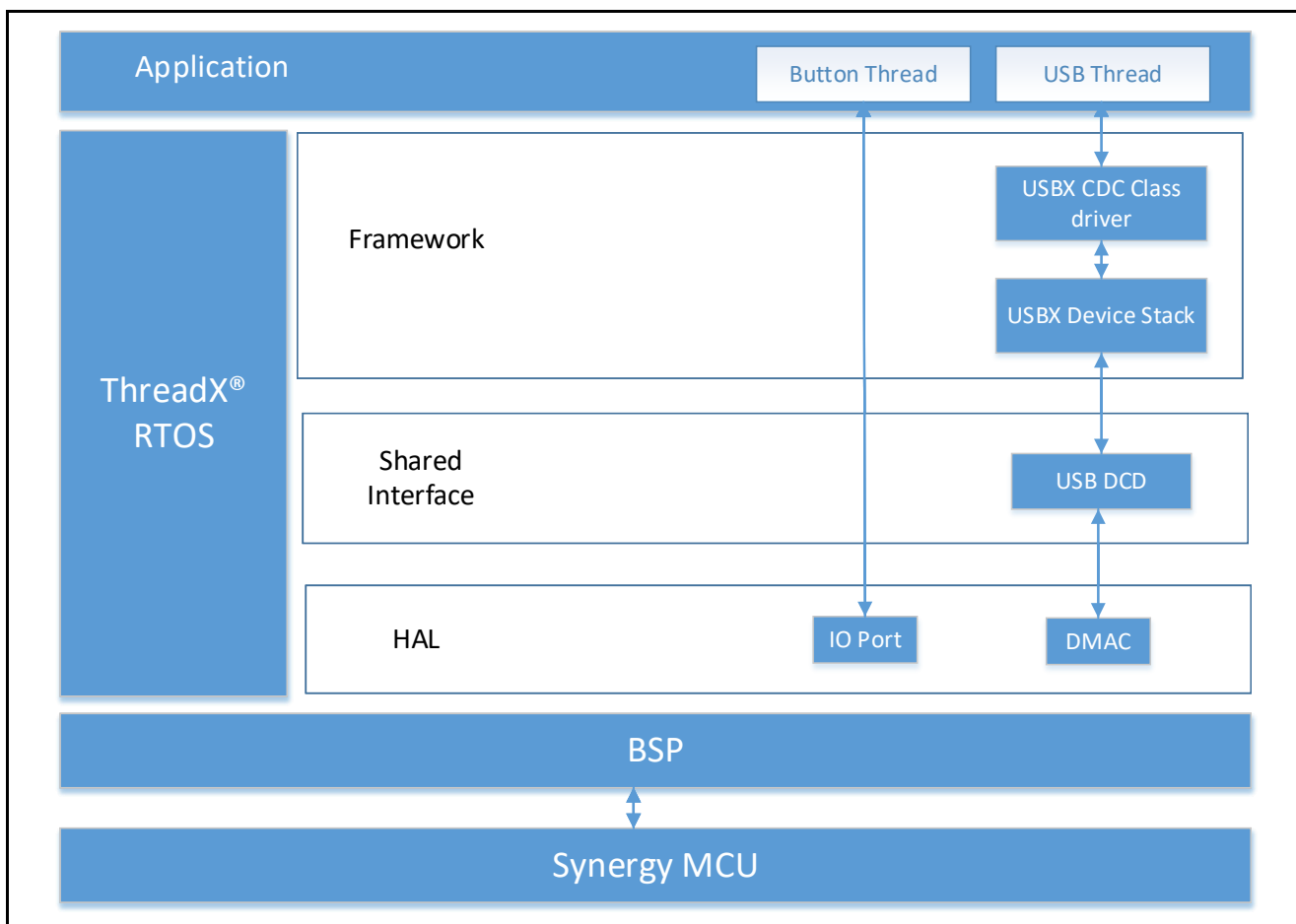


Figure 2. USBX CDC ACM Device Application Software Architecture

2. Powering up the Board

Power up the Target Board by connecting it to the USB port on the PC using the USB Type-A to USB Micro-B cable. Connect the Micro USB end of the cable to connector J11 (DEBUG USB located in the DEBUG area) on the Target Board . Connect the other end of the cable to the USB port of a host PC. LED2 (PWR) on the Target Board lights up solid green indicating that the Target Board is powered on.

Note: The Target Board uses SEGGER J-Link® On-board (OB) as the debug interface. Make sure that the J-Link drivers are installed on your computer by checking for them in the Windows Device Manager. If J-Link drivers are not installed on the PC, LED2 (DEBUG) blinks orange. If J-Link drivers are installed on the PC and detected by the Target Board, the LED2 (DEBUG) blinks orange with a very small duty cycle that is barely noticeable.

3. Importing, Building, and Downloading the Application Project

Refer to the *SSP Import Guide* (r11an0023eu0121-synergy-ssp-import-guide.pdf) for instructions on importing the bundled application project into e² studio ISDE or IAR EW, to build and run the project. The SSP Import Guide is included in the zipped folder along with this application note.

Note: You need to select the **USBX_CDC_Device_TBxxx Debug GDB Hardware Debugging** configuration based on the kit for debugging.

4. Running the Application Project

4.1 Installing the Synergy Signed USB CDC Drivers

1. Download and install the Synergy Signed USB CDC Driver from www.renesas.com/products/synergy/software/add-ons/usb-cdc-drivers. Installation instructions are provided in the *Installing Synergy signed USB CDC Drivers* Application Note.
2. Connect a micro USB cable to the Renesas Synergy™ Target Board J9 connector (USB DEVICE). Connect the other end of the USB cable to the USB port on your workstation.
3. Open the device manager window on your PC. The Target Board should be detected, as **USB Serial Device** under **Ports (COM & LPT)**.

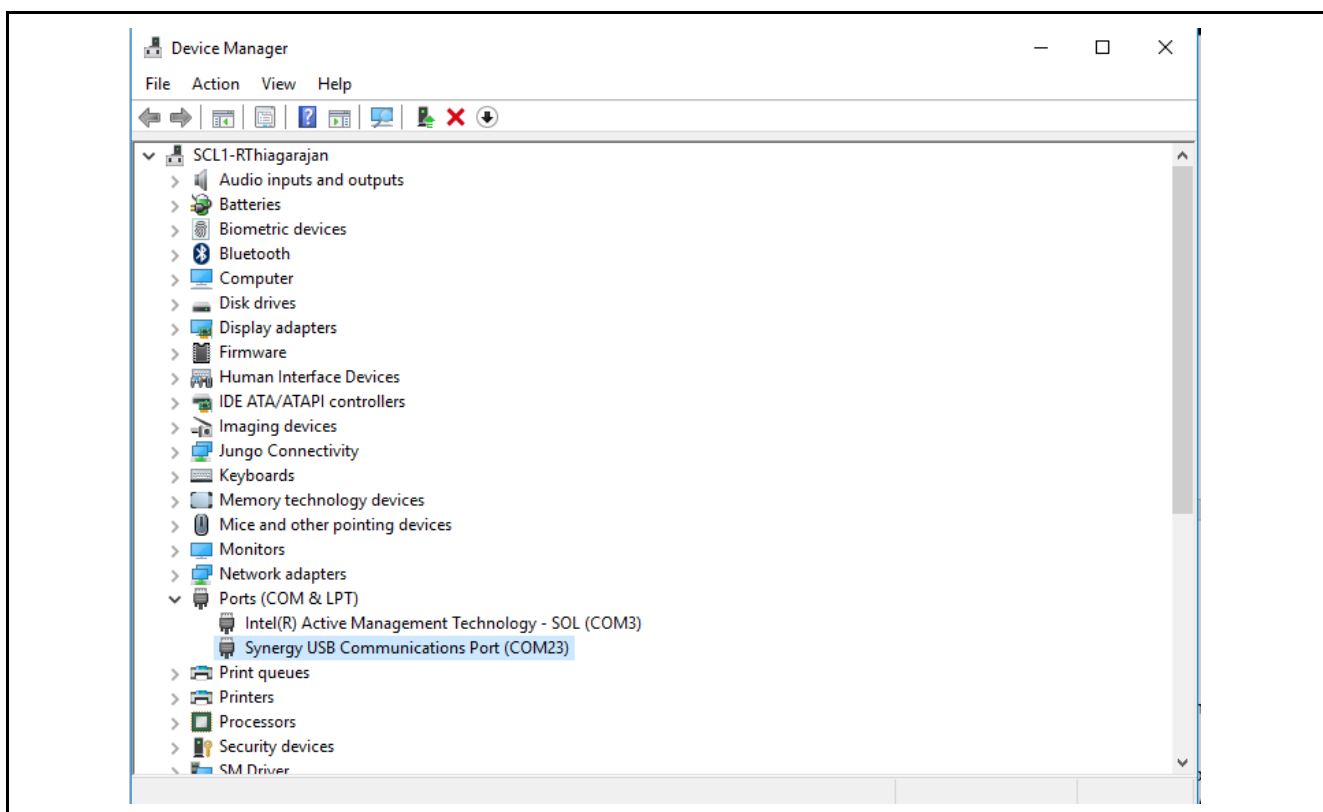


Figure 3. Device Manager in Windows

4.1.1 Verifying the Expected Results

1. Launch the **Tera Term** and open a new connection by selecting the **USB Serial** device.
2. Press the S1 user button on the Renesas Synergy Target Board. Every time the S1 button is pressed, the following message is printed on the Tera Term terminal.

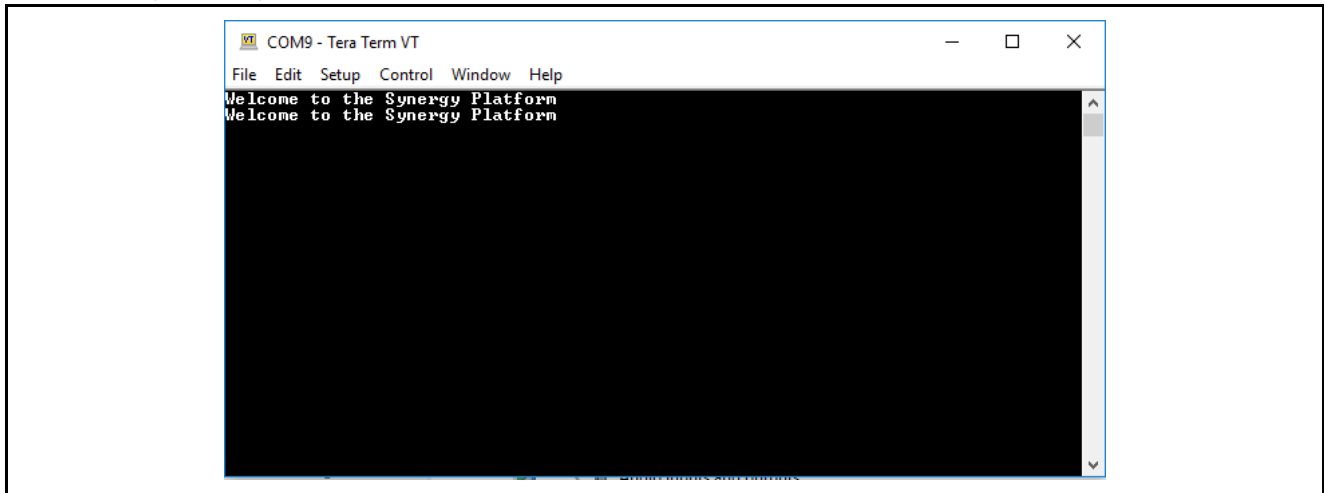


Figure 4. Welcome to the Synergy Platform Screen

5. Recreating, Generating, and Building the Application Project

You can make modifications to the source code of the provided application project if needed. The procedures for recreating, generating, and building the project using the e² studio ISDE or Synergy SSC for IAR EW are explained in the following sections.

5.1 Creating a New Project with RTOS

1. Create a new Synergy project by clicking **File > New > Synergy C/C++ Project**.
2. For IAR EW for Synergy, click **Renesas Synergy > New Synergy Project**. Select the name as described in the figure that follows and select the license file and SSC version.
3. Choose **Renesas Synergy C Executable Project** and click **Next** (see Figure 5).

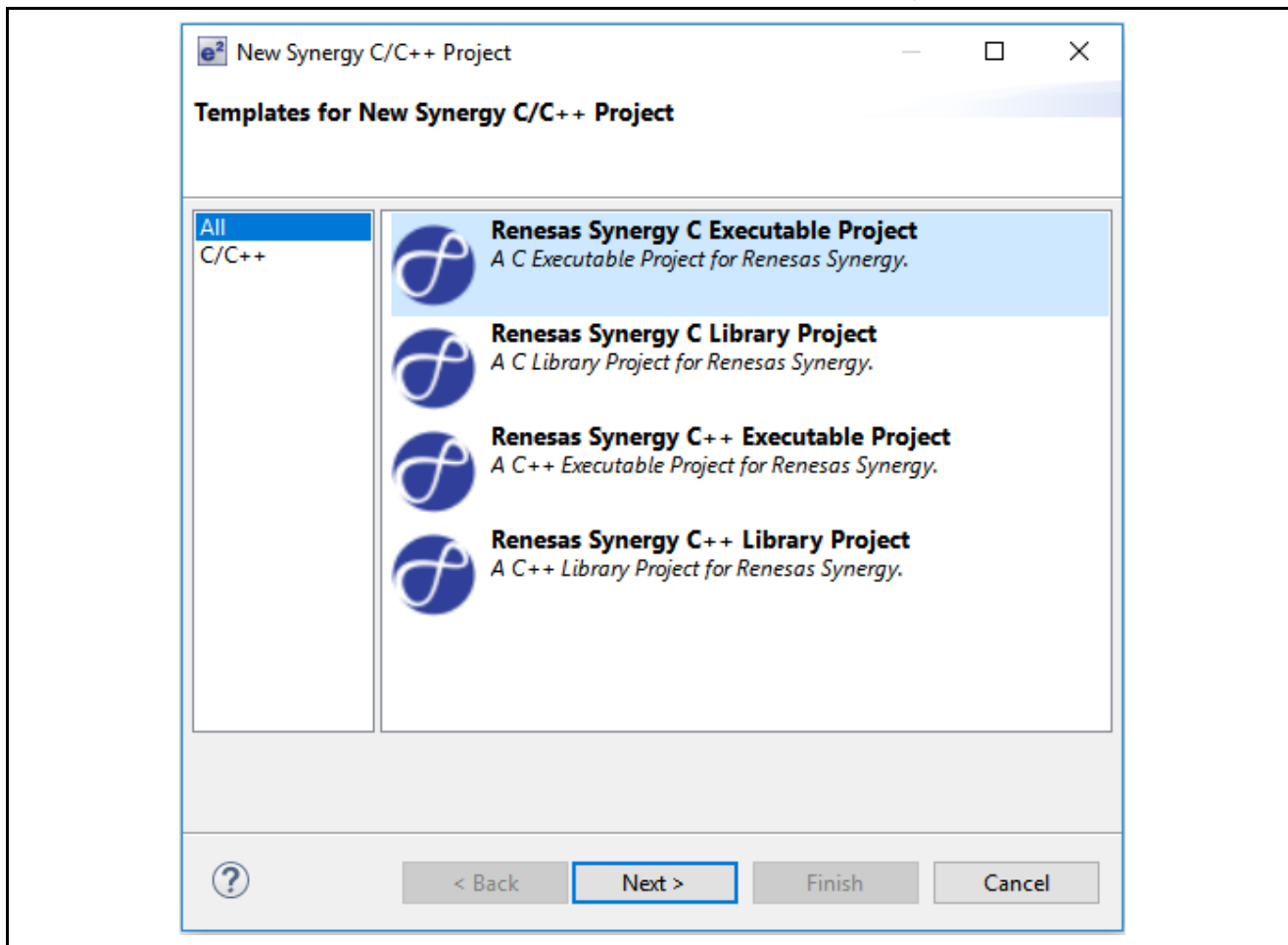


Figure 5. Choose “Renesas Synergy C Executable Project”

For TB-S1JA Boards using e² studio, in order to build the project, you need to install the IAR compiler. You can install this as a plugin as referenced by the document, “Installing IAR Compiler into e² studio,” available at www.renesas.com. Follow the instructions and select the IAR Toolchain for ARM –(8.x), as shown in the following graphic.

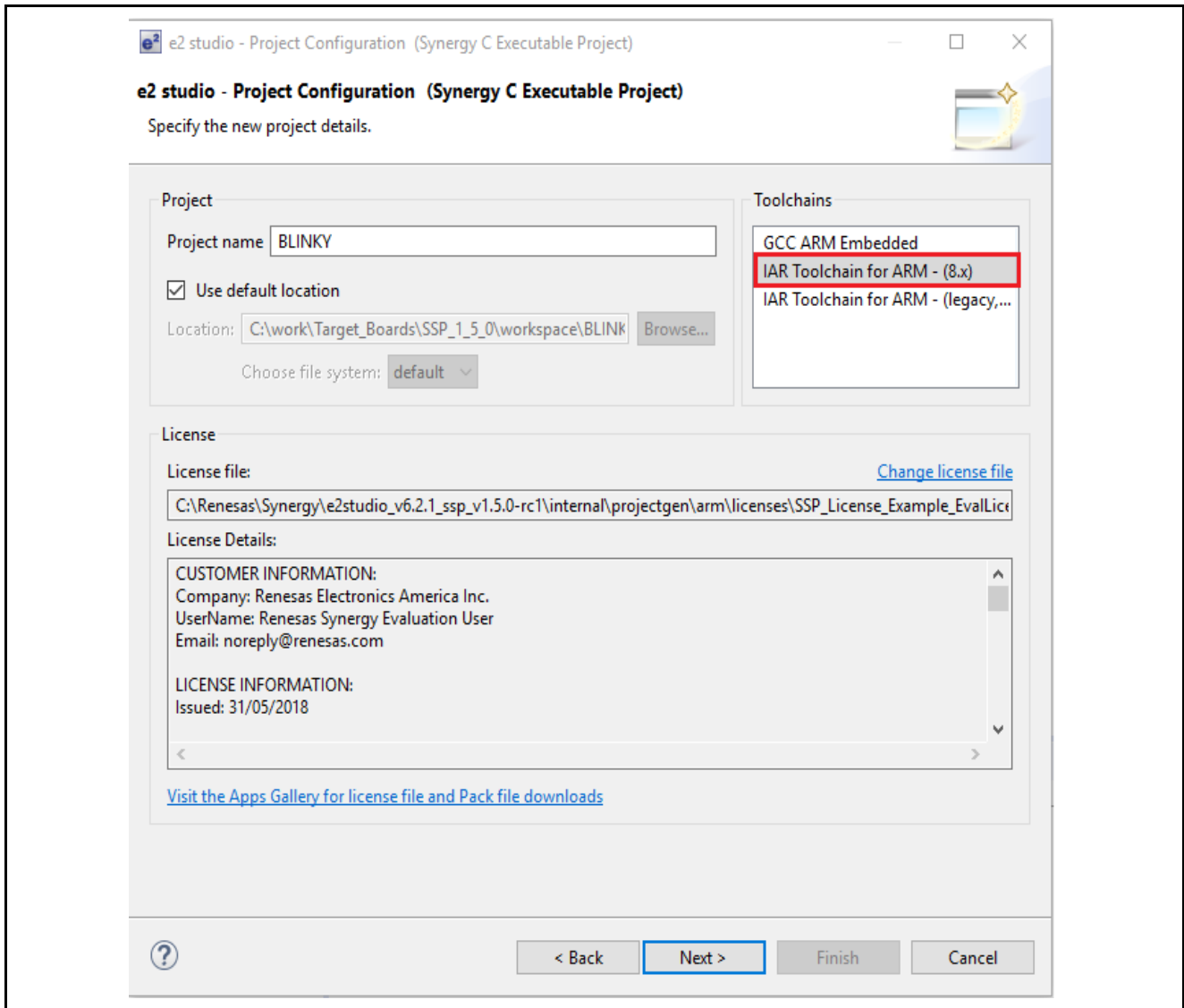


Figure 6. e² studio IAR Compiler Selection Window

4. Enter the project name and then set up the **Synergy license** file.
5. Toolchain: GCC ARM Embedded (for TB-S3A1, TB-S3A3, TB-S3A6, TB-S5D3, TB-S5D5 kits).
6. Toolchain: IAR Toolchain for ARM (8.x) (for TB-S1JA kit).
7. Enter the project name and set up the Synergy license file.
8. Choose the target board (for example, in case of TB-S3A6, choose **S3A6 TB** (see Figure 7)).
9. Choose **SSP version** (in case of SSP 1.3.0, choose **1.3.0** (see Figure 7)).

10. Choose the **BSP** option in the project template selection window.

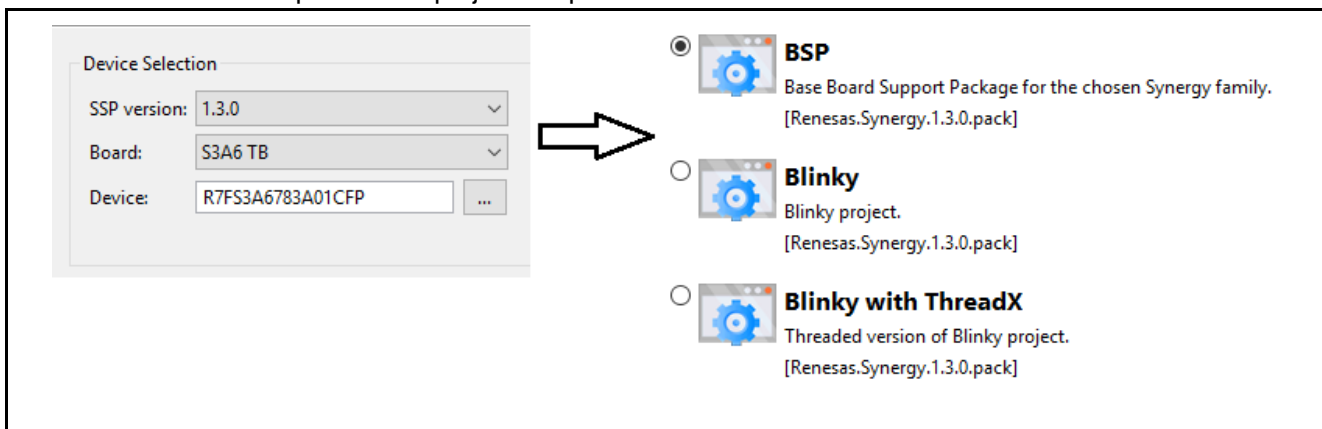


Figure 7. Synergy Project Creation

5.2 Creating the USB Thread

1. Under the **Thread** tab, click the **New Thread** button to create a new thread.
2. Set the property of this new thread (see Figure 8).

5.3 Adding the USBX CDC Device Framework

1. Click **USB Thread**, the newly created thread. In the **USB Thread Stacks** window, click the **New Stack** button to add the **USBX CDC ACM Device** framework.
2. Choose **X-Ware > USBX > Device > Classes > CDC-ACM > USBX Device Class CDC-ACM**.

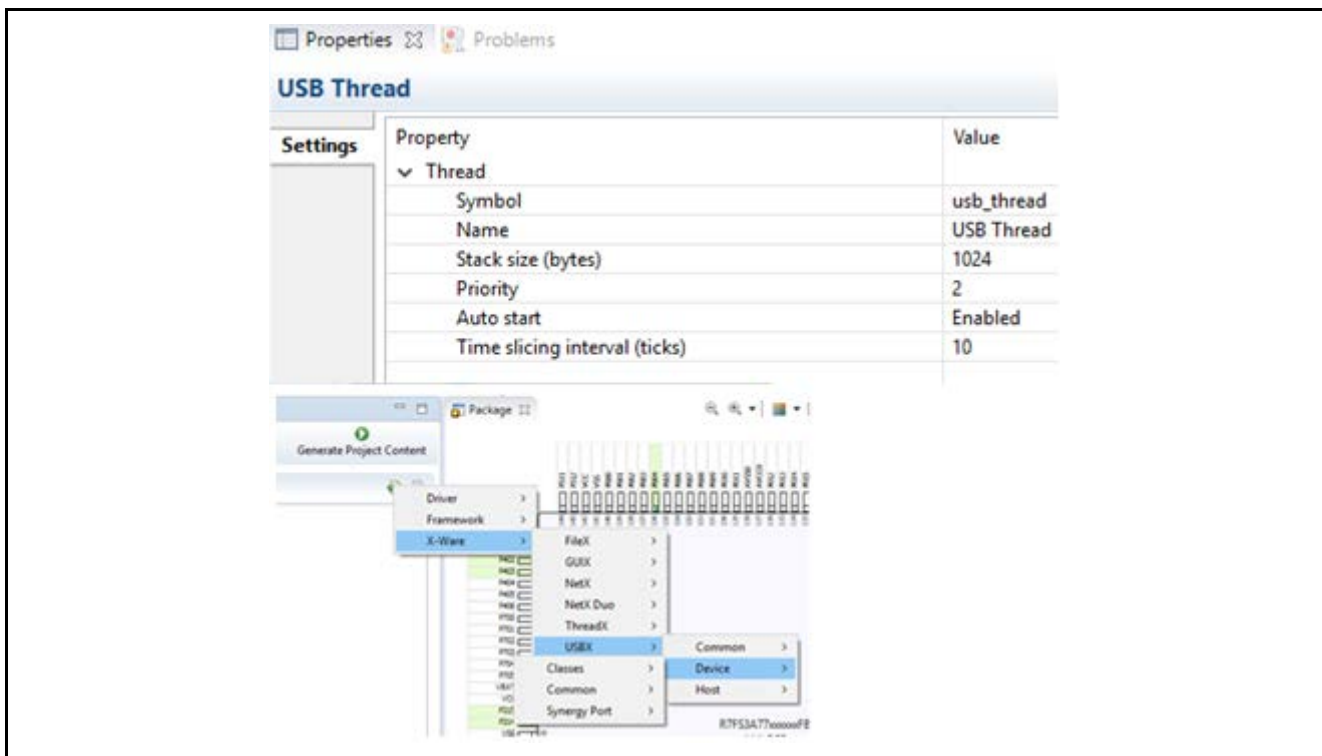


Figure 8. Adding USBX CDC ACM Device Framework Module

3. Click **Add USBX Port DCD** block in the **USB thread Stacks** window.
4. Select **USBX Port DCD on sf_el_ux** for **USBFS**.

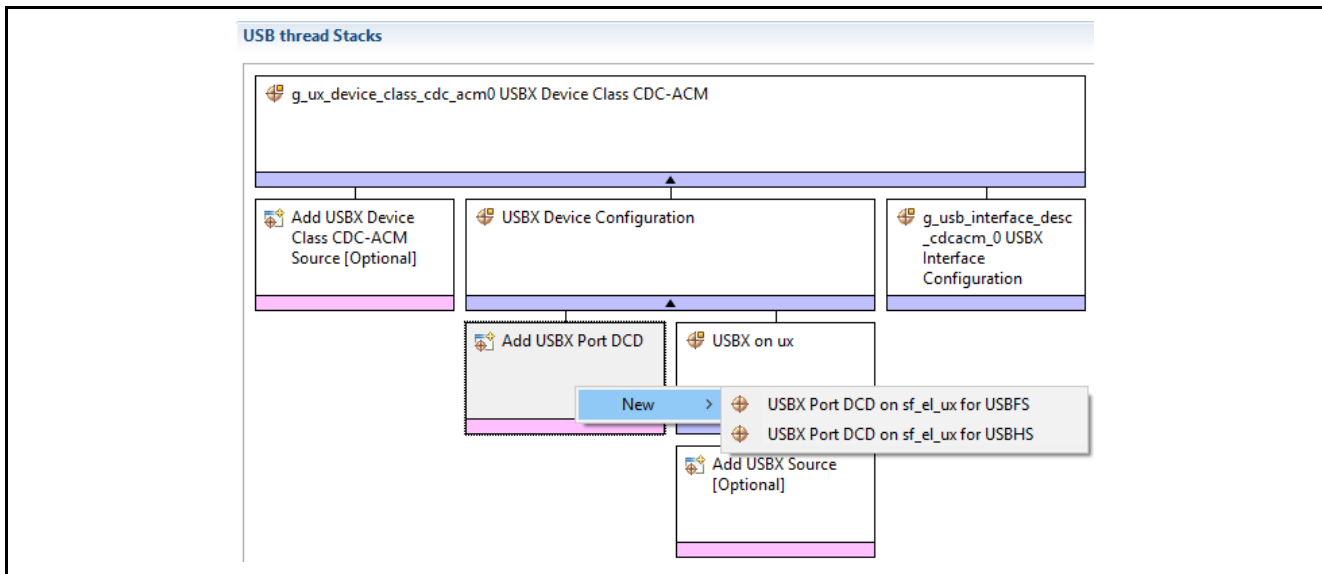


Figure 9. Adding USBX Port DCD Module

5. Click **Add Transfer Module for TX** and **Add Transfer Module for Rx** on the **USB thread Stacks** window.
6. Select **Transfer Driver** on **r_dmac**.

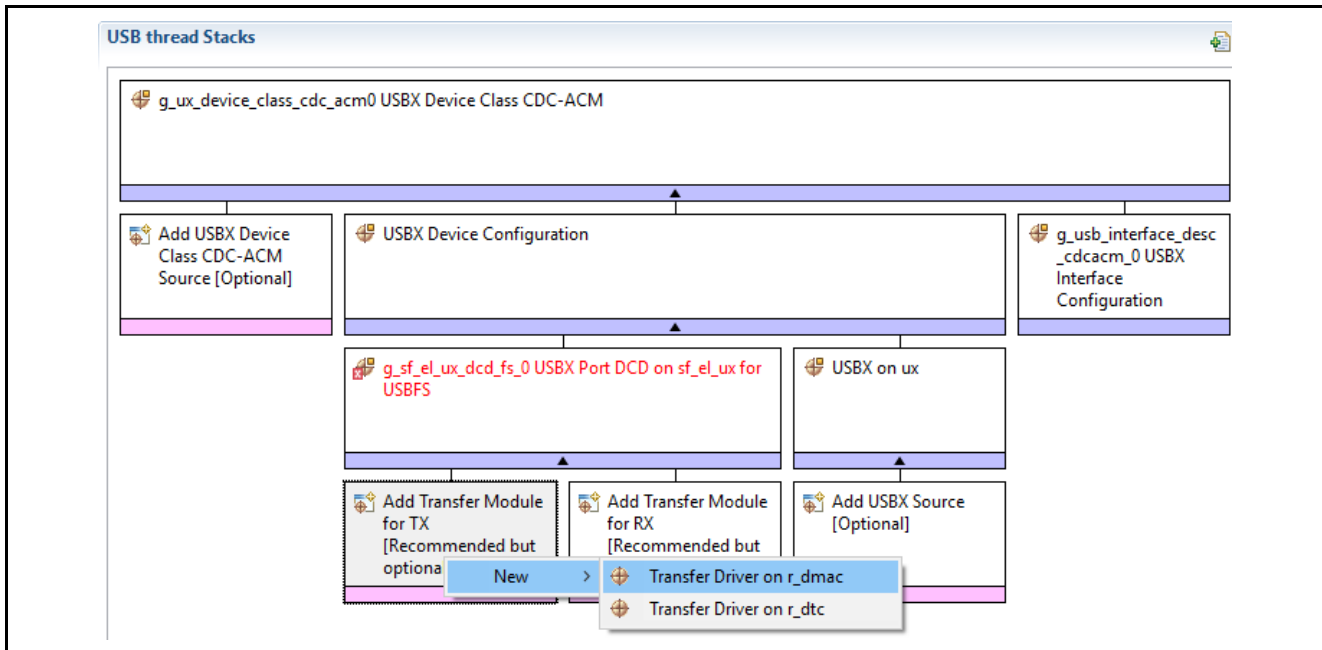


Figure 10. Adding r_dmac Module

7. Refer to **Figure 11** as you select the following USBX module properties:
 - A. Select **g_sf_el_ux_dcd_fs_0 USBX Port DCD on sf_el_ux for USBFS** and set the **Full Speed interrupt priority** in its **Properties** tab.
 - B. Select **g_transfer0 Transfer Driver on r_dmac Software Activation** box and set the **Interrupt priority** in its **Properties** tab.
 - C. Select **g_transfer1 Transfer Driver on r_dmac Software Activation** box and set the **Interrupt priority** in its **Properties** tab.

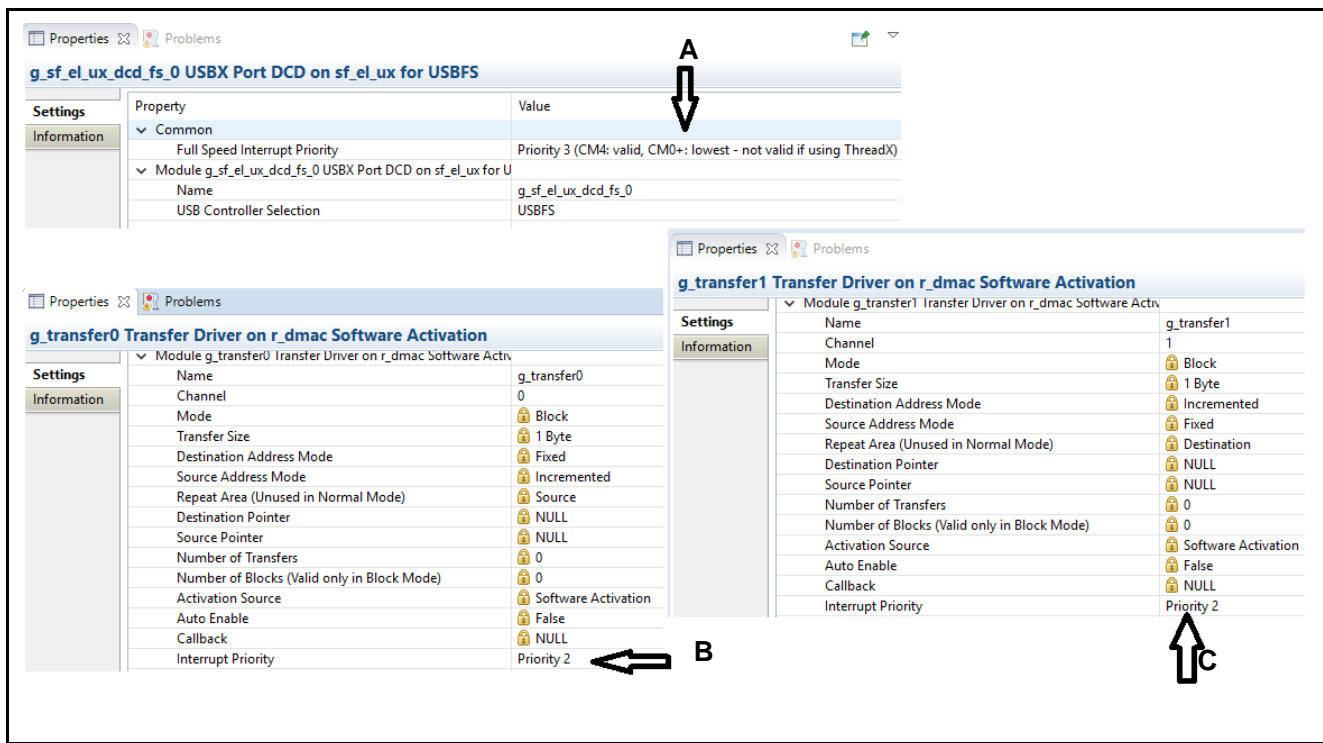


Figure 11. USBX Module Properties

8. Select the **USBX Device Configuration** block. In the **Properties** tab, configure the **Product ID** and **Class Code**.

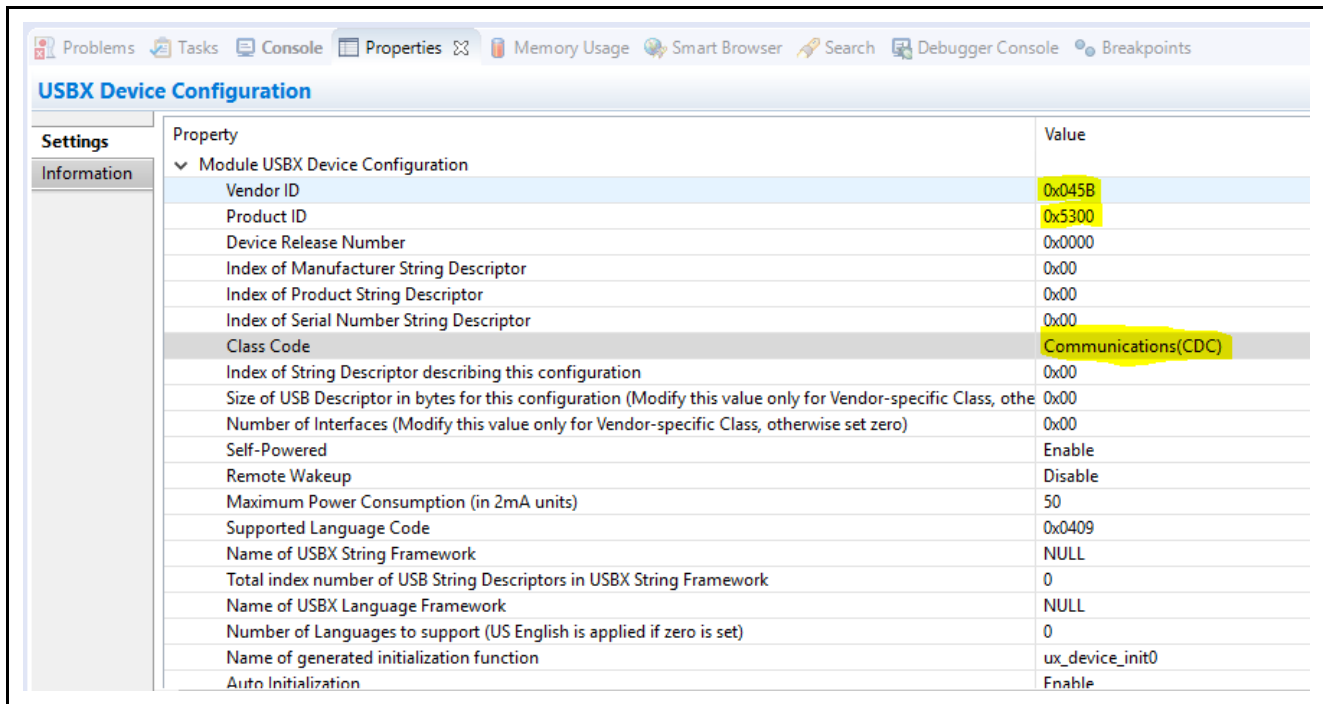


Figure 12. USBX Device Configuration Properties

9. Click the **New Object** button in the **USB Thread Objects** window and create the following thread objects.

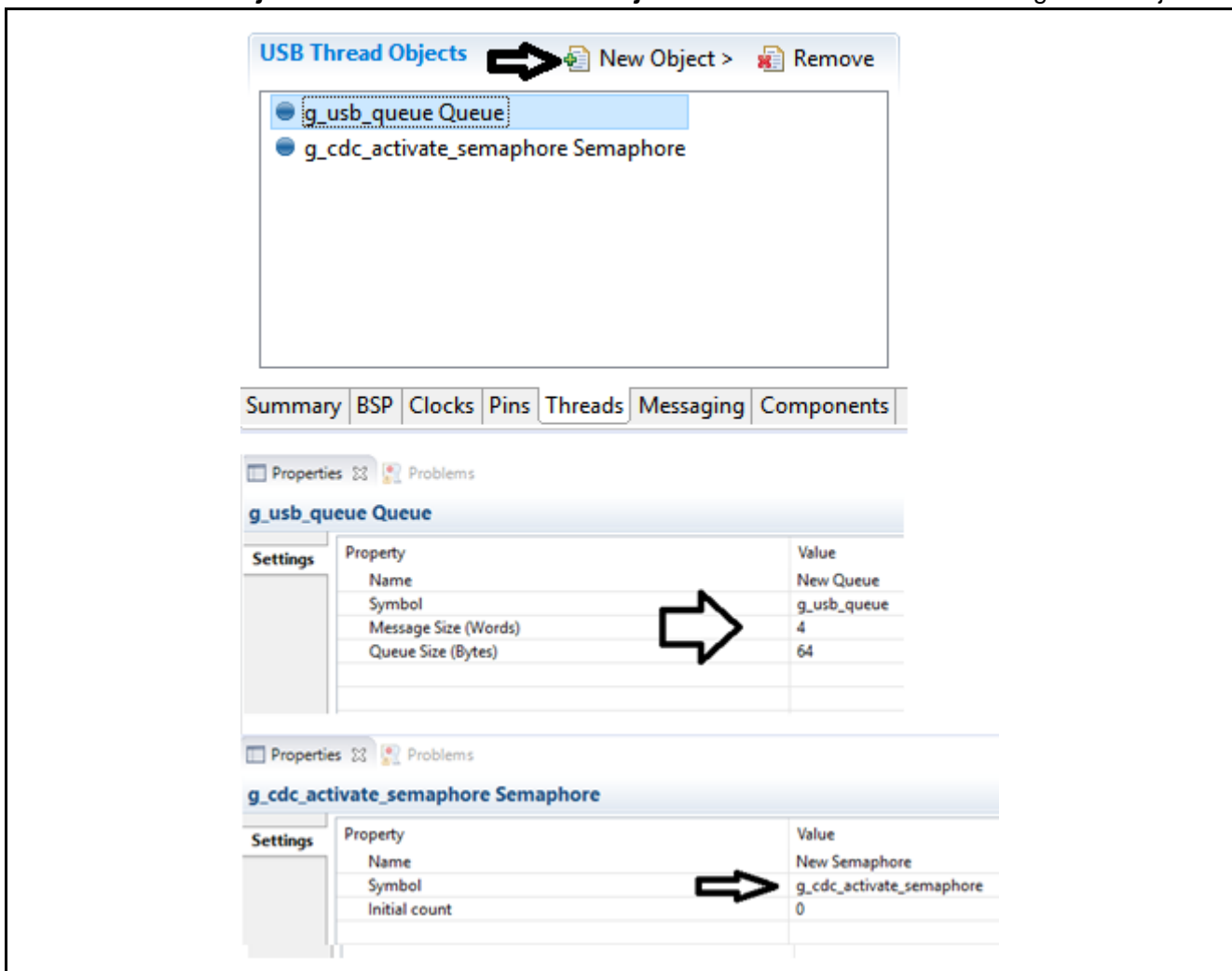


Figure 13. USB Thread Objects Properties

5.4 Creating the Button Processing Thread

1. Go to the new **Thread** tab and click the **New Thread** button plus (+) sign to create the `button_processing_thread`.
2. In the **Property** of this new thread, update the **Symbol Name** to `button_processing_thread` (see Figure 14).
3. Include the **External IRQ Driver on r_icu** module by clicking the **New Stack** button (+) sign in the **HAL/Common Stacks** window and go to **Driver > Input > External IRQ Driver on r_icu** (see Figure 14).

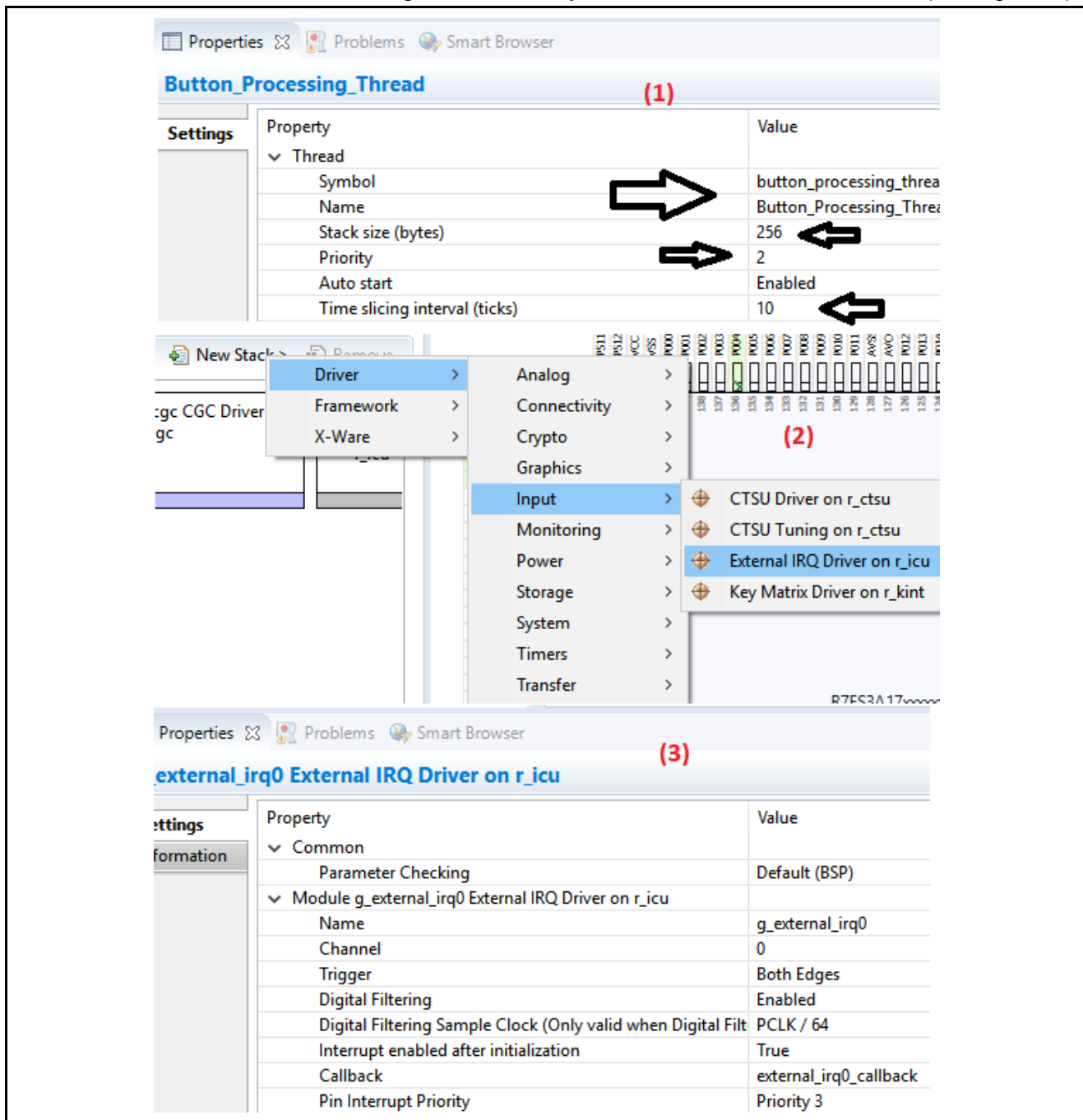


Figure 14. Adding IRQ Driver Module

- Click the **New Object** button in the **Button_Processing_Thread Objects** window. Create the thread object (see Figure 15).

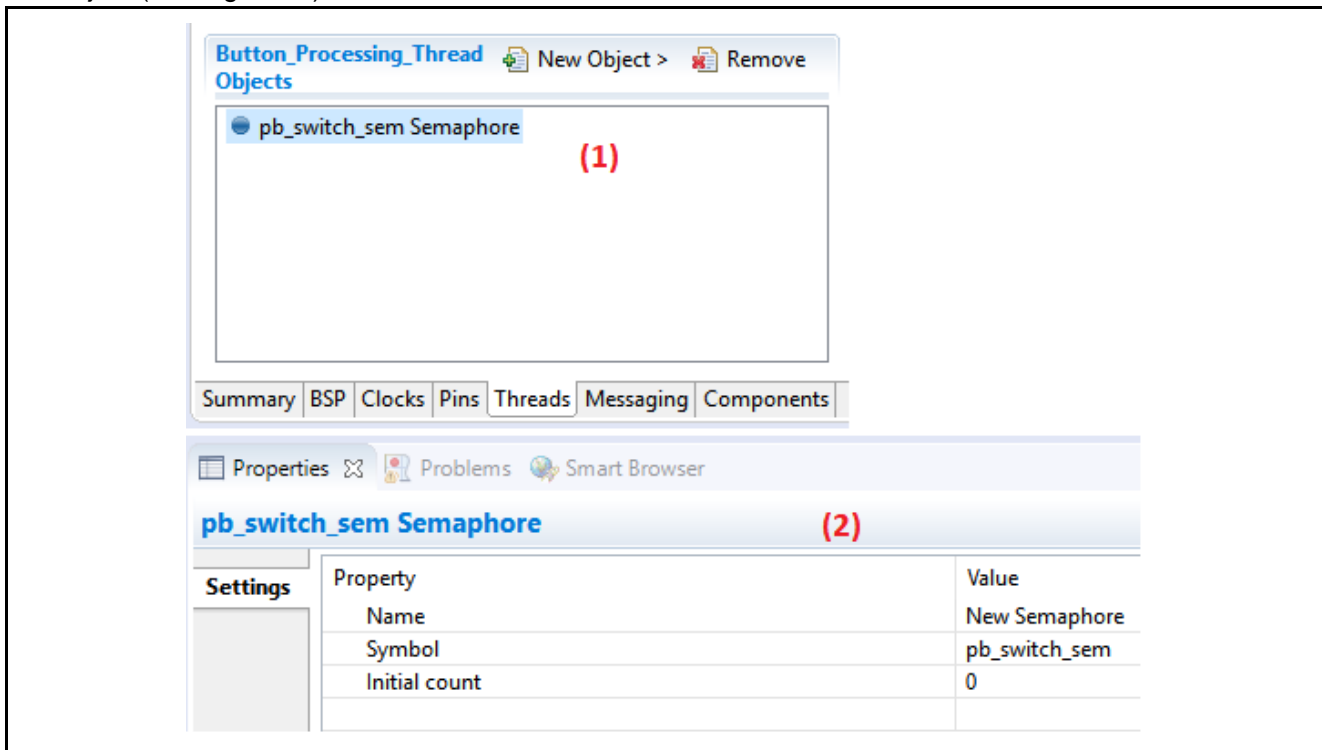


Figure 15. Button Thread Object Properties

5.5 Generating the Project Content

Click the **Generate Project Content** button. The project files are generated with the configuration options you selected. Your new project is now created, configured, and ready to build.

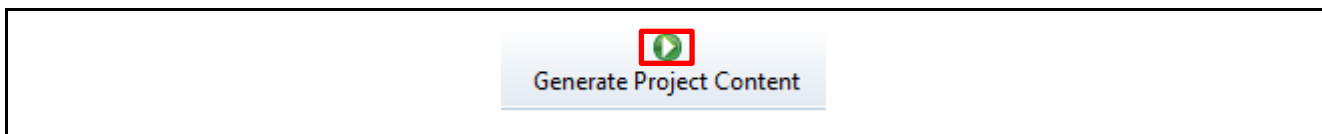


Figure 16. Generate Project Content Button

5.6 Setting up the Application Project Files

- After the e² studio ISDE generates the application project files for the configuration chosen, go to the **Project Explorer** window under your project, open the `src` folder to view the files generated for this application project.

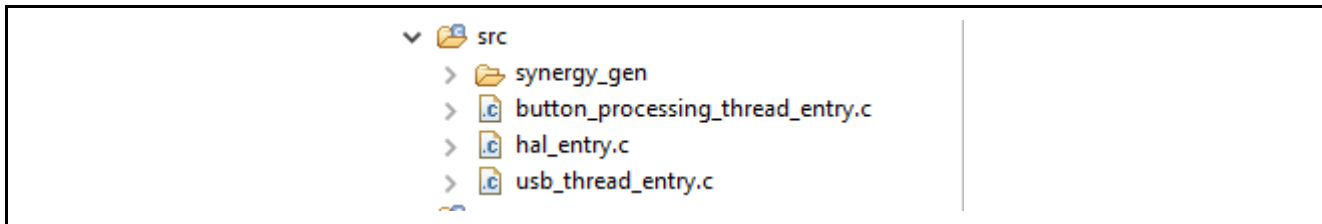


Figure 17. Generated Files

These files are place holders for adding your application code.

2. You can either write your own application functions for these threads or copy the existing USBX CDC ACM device demonstration application project source file to recreate this demonstration.
 - Button_processing_thread_entry.c
 - Common.h
 - Board configuration file (for example, Config_s3a6.h)
 - Push_button_switch.h
 - Usb_thread_entry.c
 - Util.h

5.7 Building the Project

Build the application project by clicking the hammer  icon as shown in the following graphic.

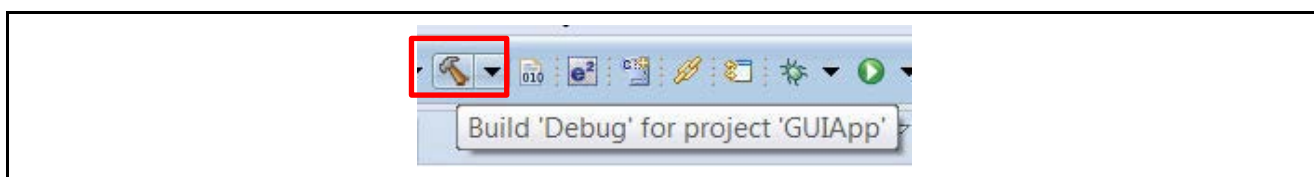


Figure 18. Build Button

5.8 Running the Application

Run the project and verify the functionality as per the modifications performed in the source code of the provided application project.

6. Next Steps

1. Learn more about the Target Board Kit.

Visit the Target Board Kit webpage (www.renesas.com/synergy/tb-sXXX) to learn more about the kit and download documentation, schematics, design files, and so forth.

For example, the TB-S5D5 Target Board Kit webpage is at www.renesas.com/synergy/tb-s5d5.

2. Explore existing application projects for the Target Board Kit.

Renesas provides several application projects to demonstrate different capabilities of the S1/S3/S5 MCU Series. These application projects can also serve as a good starting point for you to develop your custom application. Application projects available for the Target Board Kit are listed on the Target Board Kit webpage (www.renesas.com/synergy/tb-sXXX).

For example, TB-S5D5 Target Board Kit webpage is at www.renesas.com/synergy/tb-s5d5.

3. Learn more about the Synergy Platform.

Visit the following URLs to learn about the following elements of the Synergy Platform and download different components:

- Synergy Software: www.renesas.com/synergy/software
- Synergy Hardware: www.renesas.com/synergy/hardware
- Synergy Solutions Gallery: www.renesas.com/synergy/solutionsgallery

7. Limitations and Assumptions

None

Website and Support

Visit the following vanity URLs to learn about key elements of the Synergy Platform, download components and related documentation, and get support.

Synergy Software	www.renesas.com/synergy/software
Synergy Software Package	www.renesas.com/synergy/ssp
Software add-ons	www.renesas.com/synergy/addons
Software glossary	www.renesas.com/synergy/softwareglossary
Development tools	www.renesas.com/synergy/tools
Synergy Hardware	www.renesas.com/synergy/hardware
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MCU glossary	www.renesas.com/synergy/mcuglossary
Parametric search	www.renesas.com/synergy/parametric
Kits	www.renesas.com/synergy/kits
Synergy Solutions Gallery	www.renesas.com/synergy/solutionsgallery
Partner projects	www.renesas.com/synergy/partnerprojects
Application projects	www.renesas.com/synergy/applicationprojects
Self-service support resources:	
Documentation	www.renesas.com/synergy/docs
Knowledgebase	www.renesas.com/synergy/knowledgebase
Forums	www.renesas.com/synergy/forum
Training	www.renesas.com/synergy/training
Videos	www.renesas.com/synergy/videos
Chat and web ticket	www.renesas.com/synergy/resourcelibrary

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Aug.25.17	-	Initial release
1.01	Oct.16.17	1, 4, &13	Modified required resources version information, updated the software architecture diagram, and added module guide collateral link.
1.02	Oct.27.17	-	Updated to SSP v1.3.2
1.03	Feb.28.18	-	Added support for TB-S3A1
1.04	Sep.17.18	-	Added support for TB-S1JA and TB-S5D3
1.05	Oct.16.18	-	Minor update
1.06	Feb.27.19	-	Updated Website and Support URLs
1.07	Feb.27.19	-	The sample code packages attached to this document have been updated. The document itself has not been changed.

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