Introduction

The purpose of this application note is to demonstrate USB mass storage connectivity. This document describes how to use the Renesas Synergy™ Platform including importing an example application in the Renesas Synergy e² studio ISDE and running the application on the target board. The application example illustrates the use of a board as a USB mass storage device to store data. This example application also includes the key elements to demonstrate how they work together in a typical design with ThreadX® RTOS, USBX™ mass storage class (device), and USBX™ device driver for the Renesas Synergy Platform.

Target Device or Required Hardware

Any one of the following Renesas Synergy™ Kits is required:

- DK-S124 Development Kit
- SK-S7G2 Starter Kit
- DK-S3A7 Development Kit
- DK-S7G2 Development Kit
- PE-HMI1 Product Example
- PK-S5D9 Promotion Kit
- DK-S128 Development Kit

Minimum PC Recommendation

- Microsoft® Windows® 7
- Intel® Core™ family processor running at 2.0 GHz or higher
- 8-GB memory
- At least 2 GB of free hard disk or SSD space
- USB 2.0
- Internet connection.

Installed Software

- Synergy e² studio v5.4.0.023 or later
- Synergy Software Platform (SSP) v1.2.0 or later
- IAR Embedded Workbench® for Renesas Synergy™ v7.71.3-13746 or later
- Synergy Standalone Configurator v5.4.0.023
- SEGGER J-Link® USB driver
- Micro USB cables

You can download the required Renesas software from the Renesas Synergy™ Gallery at https://synergygallery.renesas.com. If you do not have one of the required software applications, you should install it before continuing.

Target Audience

As the user of this application note, it is assumed that you have some experience with the Renesas e² studio ISDE and SSP. For example, before you perform the procedure in this application note, you should follow the procedure in the Quick Start Guide for your board to build and run the Out-of-Box (OoB) application project. By doing so, you will become familiar with e² studio and SSP to ensure that the debug connection to your board is functioning properly.

The intended audience are developers who want to develop an application that uses USBX Mass Storage Class (Device) to enable quick and easy file transfer between devices using Synergy MCUs.
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1. Application Overview

This application illustrates the use of a Synergy kit as a USB mass storage device to store data. Additionally, you can use other kits as USB mass storage devices to store data. This example application also includes the key elements to demonstrate how they work together in a typical design with ThreadX® RTOS, USBX™ Mass Storage Class (device), and USBX™ device driver for the Renesas Synergy Platform.

1.1 USBX Subsystem Overview

The Renesas Synergy Platform uses Express Logic USBX USB stack (ux) which is integrated into the SSP. USBX supports USB specifications v1.1 and v2.0. The USB mass storage class device allows for board to be used as mass storage device for storing data. This class is based on the USB standard and is a subset of the USB Mass Storage Class (MSC) standard.

The Figure below shows the interface diagram of the USBX device class stack. The stack consists of one USBX device class components (ux_device_class_xxx) on top, a USBX (ux) in the middle, and a USBX Port driver (sf_el_ux Device Controller Driver (DCD)) on the bottom of the device class stack. As a recommended option, the SSP Transfer module (r_dmac or r_dtc) supports data transfer between memory and the hardware buffer in 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 two components do not represent the actual software modules in SSP but virtual modules to handle the code generation.

![USBX Device Class Stack Configuration](image)

**Figure 1  USBX Device Class Stack Configuration**

**USBX Device Mass Storage Class Configuration**

The USBX Device Class Mass Storage component has configurations to set up the USB Device Mass Storage Class as shown in Table 1. The settings can be configured with the Synergy Configuration tool.
<table>
<thead>
<tr>
<th>Configuration</th>
<th>Settings</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Arbitrary symbol name (Default: g_ux_device_class_storage)</td>
<td>Specify the name of USBX Interface Descriptor for Mass Storage Class.</td>
</tr>
<tr>
<td>Mass Storage Class Parameter Setup</td>
<td>Auto (Default), Manual</td>
<td>Manual (User Manual setup if LUN is greater than 1), Auto (Simple setup if LUN is 1).</td>
</tr>
<tr>
<td>User Setup Callback (Only valid if Parameter Setup is Auto)</td>
<td>Arbitrary C symbol name (Default: ux_device_class_storage_user_setup)</td>
<td>Specify the name of user callback function to set up the storage parameter. This parameter is only valid when the configuration Mass Storage Class Parameter Setup is Auto.</td>
</tr>
<tr>
<td>Last LBA of Storage Media</td>
<td>Arbitrary integer value (Default: 0)</td>
<td>Specify the last LBA of storage media device (the number of sectors available in the media). This parameter is only valid when the configuration Mass Storage Class Parameter Setup is Auto.</td>
</tr>
<tr>
<td>Bytes Per Sector of Storage Media</td>
<td>Arbitrary integer value, which is multiple of 512 (Default: 512)</td>
<td>Specify the sector size of storage media. It can take multiple of 512 such as 512 bytes, 4 KB. This parameter is only valid when the configuration Mass Storage Class Parameter Setup is Auto.</td>
</tr>
<tr>
<td>Type of Storage Media</td>
<td>Arbitrary integer value (Default: 0)</td>
<td>Specify the type of storage media device. Typically, the parameter takes following values: Flash Drive (0), CD-ROM device (5). This parameter is only valid when the configuration Mass Storage Class Parameter Setup is Auto.</td>
</tr>
<tr>
<td>Removable Flag of Storage Media</td>
<td>Arbitrary integer value (Default: 0x80)</td>
<td>Specify the Removable Flag value of Storage Media. This parameter is only valid when the configuration Mass Storage Class Parameter Setup is Auto.</td>
</tr>
<tr>
<td>Media Read Function Callback</td>
<td>Arbitrary C symbol name (Default: ux_device_msc_media_read)</td>
<td>Specify the C symbol name of Media Read callback for the USBX Device Mass Storage Class. The function is to be called back from the Class library when read access to the USB storage device is requested from user application.</td>
</tr>
<tr>
<td>Media Write Function Callback</td>
<td>Arbitrary C symbol name (Default: ux_device_msc_media_write)</td>
<td>Specify the C symbol name of Media Write callback for the USBX Device Mass Storage Class. The function is to be called back from the Class library when write access to the USB storage device is requested from user application.</td>
</tr>
<tr>
<td>Media Status</td>
<td>Arbitrary C symbol name (Default: )</td>
<td>Specify the C symbol name of</td>
</tr>
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</table>
### 1.2 Application Software Architecture

This section describes the key features of the USB mass storage class (device) application and key components of the USBX device stack.

This application illustrates USB connectivity through the following functions:

- The host PC recognizes Synergy Kits as a 12-KB mass storage device
- The storage media used is the RAM inside the MCU
- The RAM storage area contains one text file, which can be read/write

![USB MSC Device Application Architecture](image-url)
2. Procedure to create USBX MSC Device project

The following steps are used to create a new Synergy project using the e² studio ISDE. For demo purpose, the DK-S128 Development Kit is used to demonstrate the development process.

Step 1: Create a new project with RTOS included
1. Create a new Synergy project by clicking File->New->Synergy C Project.
2. Enter the project name and set up the Synergy license file.
3. Choose the board such as S128 DK for DK-S128.
4. Choose the BSP option in the project template selection window.

![Figure 3 New Synergy Project Creation](image)

Step 2: Create USB thread
1. From the Thread tab, click the + sign to create a new thread.
2. Set the property of this new thread as shown in Figure below.
3. In the USB Thread Stacks window, click the + sign to add the USBX Device Class Mass Storage framework as shown in the Figure below.

![Figure 4 Adding USBX MSC Device Framework](image)

Step 2: Generate Project Content
1. Click the Generate Project Content button. This generates the project files using the configuration options you selected.

2. Copy the following files from the existing USBX MSC Application project to your project src folder:
   - Ramdisk_image.c
   - Ux_user_callback.c

3. After the files are copied, compile the application project. After successful compilation, the project is ready for testing.

3. Importing, Building and Running the Project

Refer to the SSP Import Guide (r11an0023eu0117-synergy-ssp-import-guide.pdf) for instructions on importing the project into e² studio and building/running the project.

Note: For debugging, you must select USBX_MSC_xxx Debug from GDB Hardware Debugging configuration.

4. Running the Demo

4.1 Powering up the Board

This section describes how to:
   - Connect the board to power up
   - Connect the J-Link debugger to the PC
   - Connect the board to the PC USB port
   - Run the debug application to see it in action

To set up the connections:

1. Refer to the Quick Start Guide for PE-HMI1, DK-S7G2, DK-S3A7, SK-S7G2, PK-S5D9, DK-S128 or DK-S124 for setting up the power connection and the J-Link debugger connection from your PC to the JTAG connector on the target board. See Section 5, Useful Links, for references to these documents.

2. Connect the board to your PC using a USB-to-Micro USB cable connected to USB Device Micro-B port on the target board. Figure 6 through Figure 10 show the USB connections for each board.

Figure 5 PE-HMI1 USB and Power Connections
Figure 6 DK-S7G2 USB, J-Tag, and Power Connections

Figure 7 DK-S3A7 USB, J-Tag, and Power Connections

Set USBF on the S6 switch block to ‘on’ to enable the USB on the DK-S3A7.

Figure 8 SK-S7G2/PK-S5D9 USB, J-Tag, and Power Connections
4.2 Verifying the Demo

After the kit is powered up and loaded with this USBX MSC application, perform the following steps:

1. Connect the board to your PC using a USB-to-Micro USB cable connected to USB Device Micro-B port on the target board.
2. Wait until the board is recognized as a mass storage driver on your PC as shown in Figure 11.
3. You can open, edit, delete, and write files as you would on a regular USB-connected flash disk or hard drive.
4. Click the **Terminate** button to close the debugger.

### 5. Next Steps

1. Refer to the appropriate *Quick Start Guides* for more information on the Synergy Kits:
   - PE-HM11
   - SK-S7G2
   - DK-S7G2
   - DK-S3A7
   - DK-S124
   - PK-S5D9

2. Visit renesassynergy.com/tools to learn more about development tools & utilities.
4. To learn more about:
   - Synergy Kits, go to [http://www.renesassynergy.com/kits](http://www.renesassynergy.com/kits)
   - Synergy Microcontrollers, go to [http://www.renesassynergy.com/microcontrollers](http://www.renesassynergy.com/microcontrollers)
   - Synergy Software, go to [http://www.renesassynergy.com/software](http://www.renesassynergy.com/software)
   - Synergy Solutions, go to [http://www.renesassynergy.com/solution](http://www.renesassynergy.com/solution)

### 6. Limitations and Assumptions

None.

### FCC Compliance

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
Website and Support
Support:  https://synergygallery.renesas.com/support

Technical Contact Details:
- America:  https://www.renesas.com/en-us/support/contact.html
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