

Renesas RA Family

RA Arm® TrustZone® Example Project QSG

Introduction

This Quick Start Guide (QSG) provides basic steps to import and run example projects for RA Arm® TrustZone® (TZ) for the RA Family of microcontrollers with e2studio. It also highlights methods to handle MCU pins and guard functions in a TZ project. A background knowledge of e² studio, RA device hardware, and Arm® TrustZone® Tooling Primer is expected.

Target Device

RA Arm® Cortex®-M33 devices with TrustZone security extension.

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1. Where To Find TZ Example Projects

You can find TZ example projects in the “/example_projects/board_name/trustzone” folder, in the ra-fsp-examples-master.zip file.

This ra-fsp-examples-master.zip can be downloaded from <https://github.com/renesas/ra-fsp-examples>.

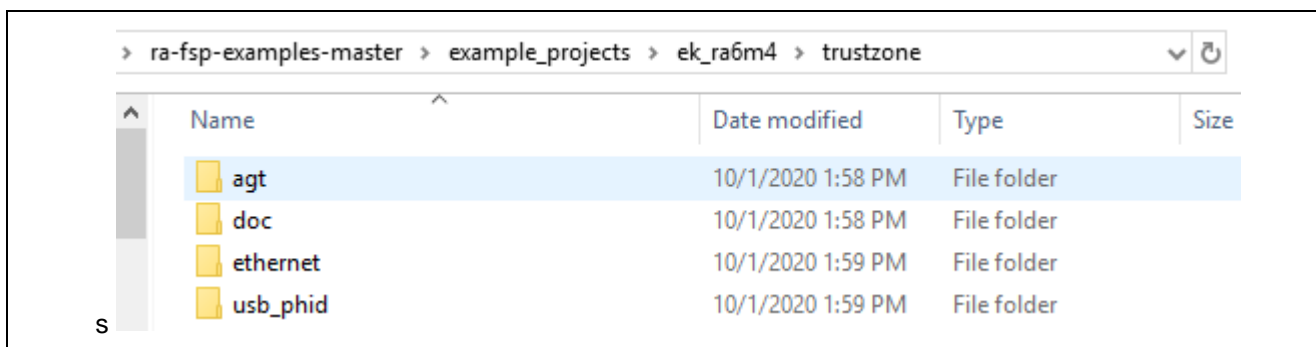


Figure 1. TZ Example Projects for EK-RA6M4 Kit in ra-fsp-examples-master.zip

Refer to Renesas Arm® TrustZone® Tooling Primer (r20an0577eg0101) and Security Design with Arm TrustZone - IP Protection App Note (r11an0467eu0100) for background knowledge of TZ project development.

2. Import and Build a TZ Project

A TZ example project consists of two projects within a workspace, a Secure project that is named with a prefix _s_ before the board name, and a Non-Secure project that is named with a prefix _ns_ before the board name. Follow the section “Importing an Existing Project into e2 studio” in FSP User’s Manual to import a TZ example project. Browse to project folder, then import both import both secure and Non-Secure projects to your workspace at once, as shown in Figure 2.

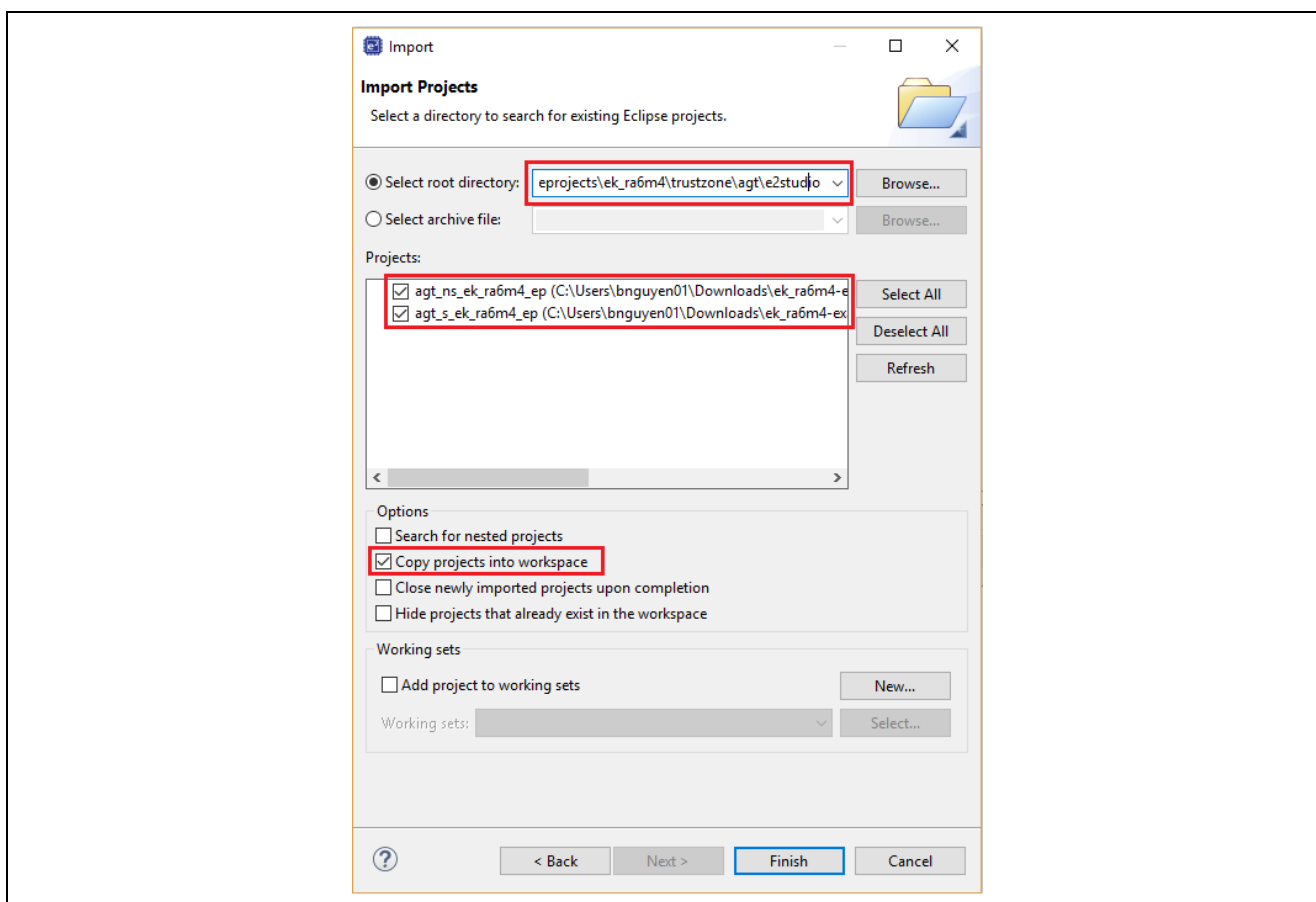


Figure 2. Import a TZ Example Project into e2studio Workspace

After the TZ project is imported, follow the below steps to build a TZ project:

1. Double-click the Configuration.xml in the Secure project, then click “Generate Project Content” and build the Secure project. It is important to build the secure project every time the source code of the secure project is updated.
2. Double-click the Configuration.xml in the Non-Secure project, then click “Generate Project Content” and build the Non-Secure project.

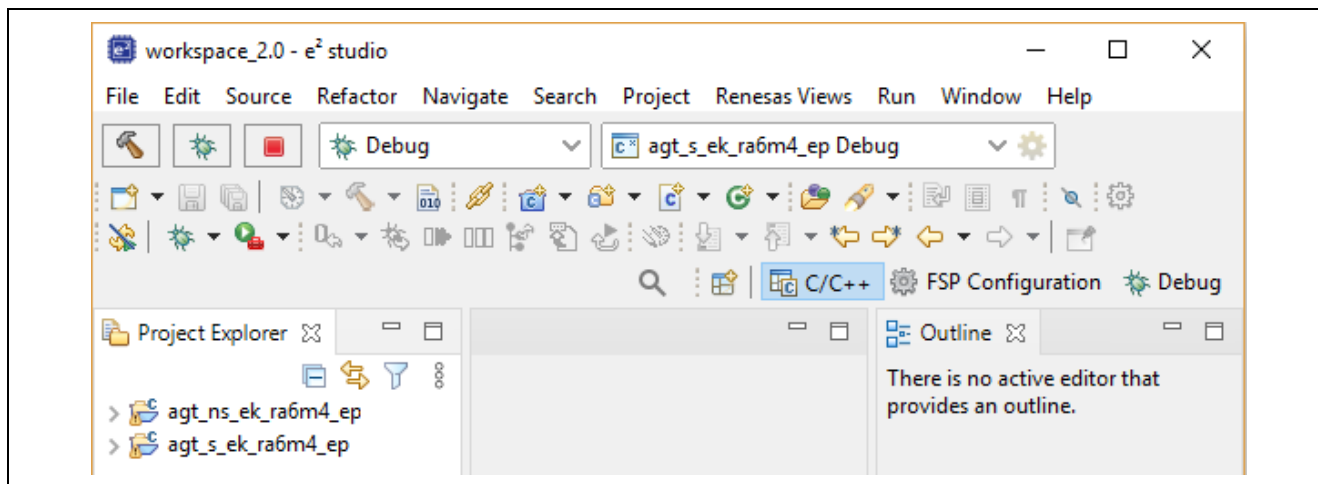


Figure 3. The TZ Example Project in e2Studio Workspace

Tip: You can use Project References setting in your Non-Secure project to ensure the Secure project is built every time the NS project is built, as shown in Figure 4. Note that this is not a default setting in the TZ example projects.

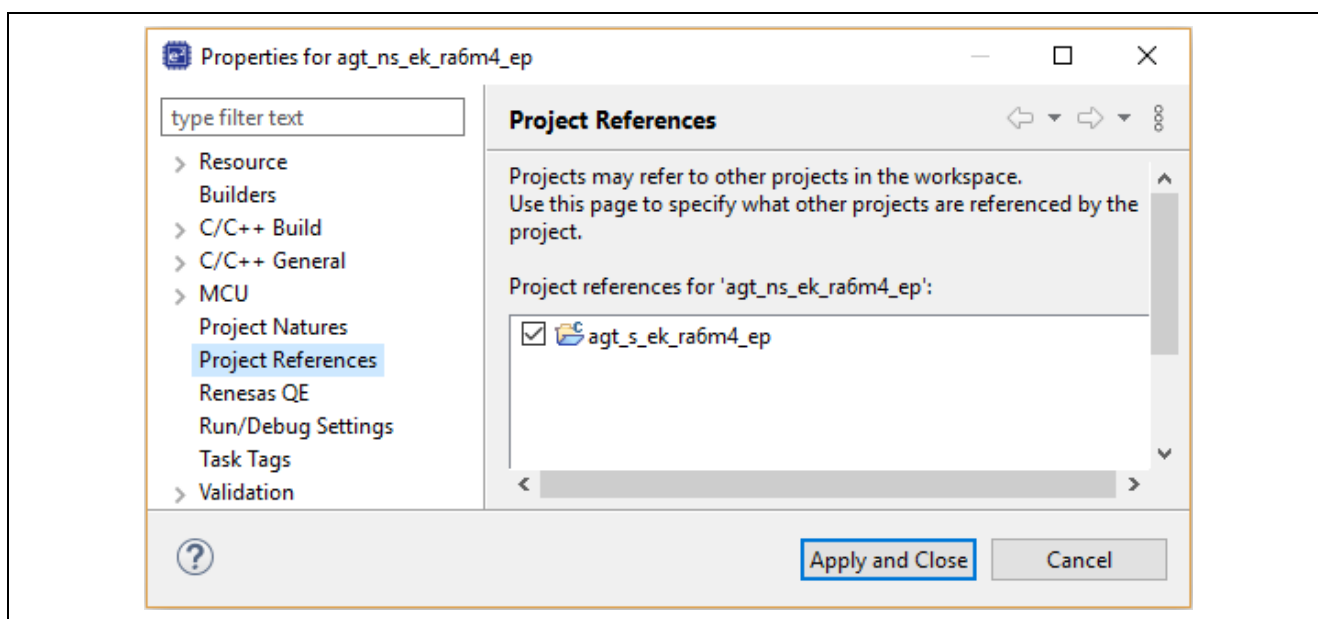


Figure 4. Project References in The Non-Secure Project

3. Debug a TZ Project

Right-click on the Non-Secure project, select “Debug As” then “Renesas GDB Hardware Debugging” to run the TZ example project.

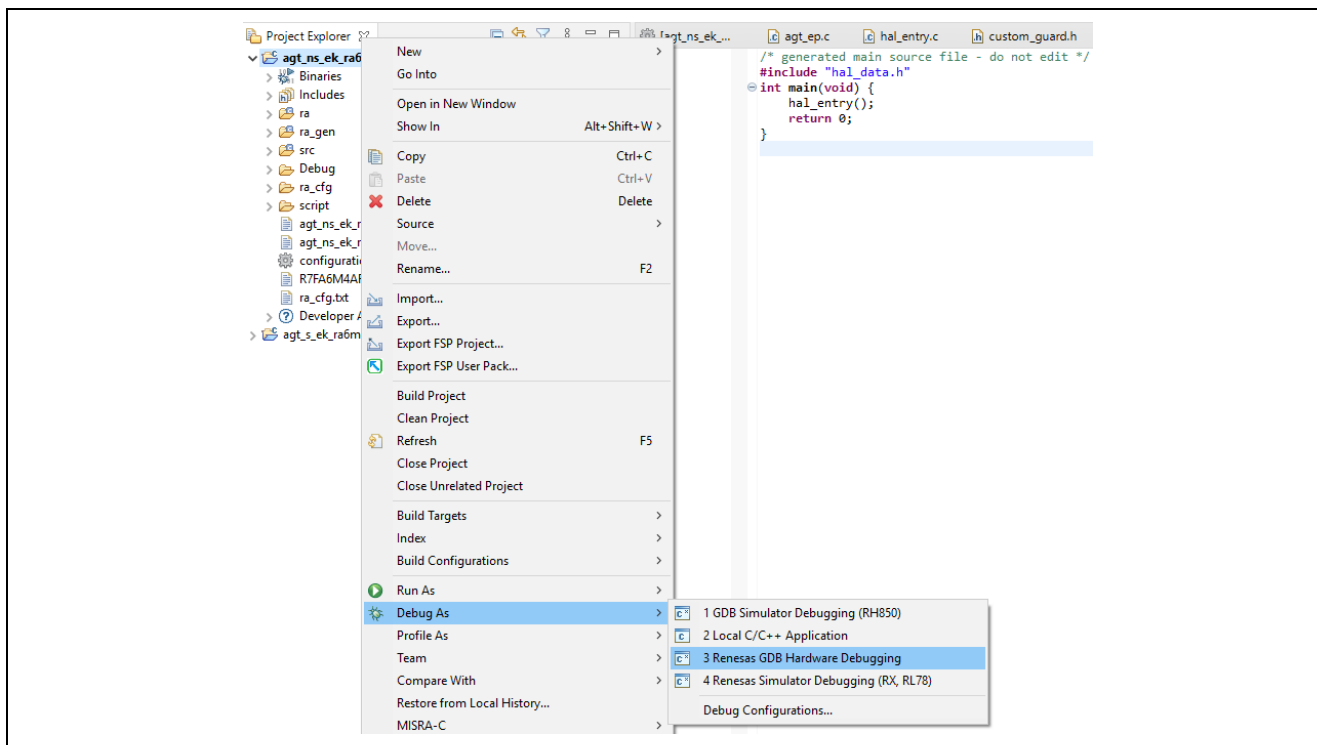


Figure 5. Debug a TZ Project

The Debug Configuration in the Non-Secure project is configured to allow downloading of both Secure and Non-Secure project at once, as shown in Figure 6.

Follow **readme.txt** in the example project folder to verify its functionalities.

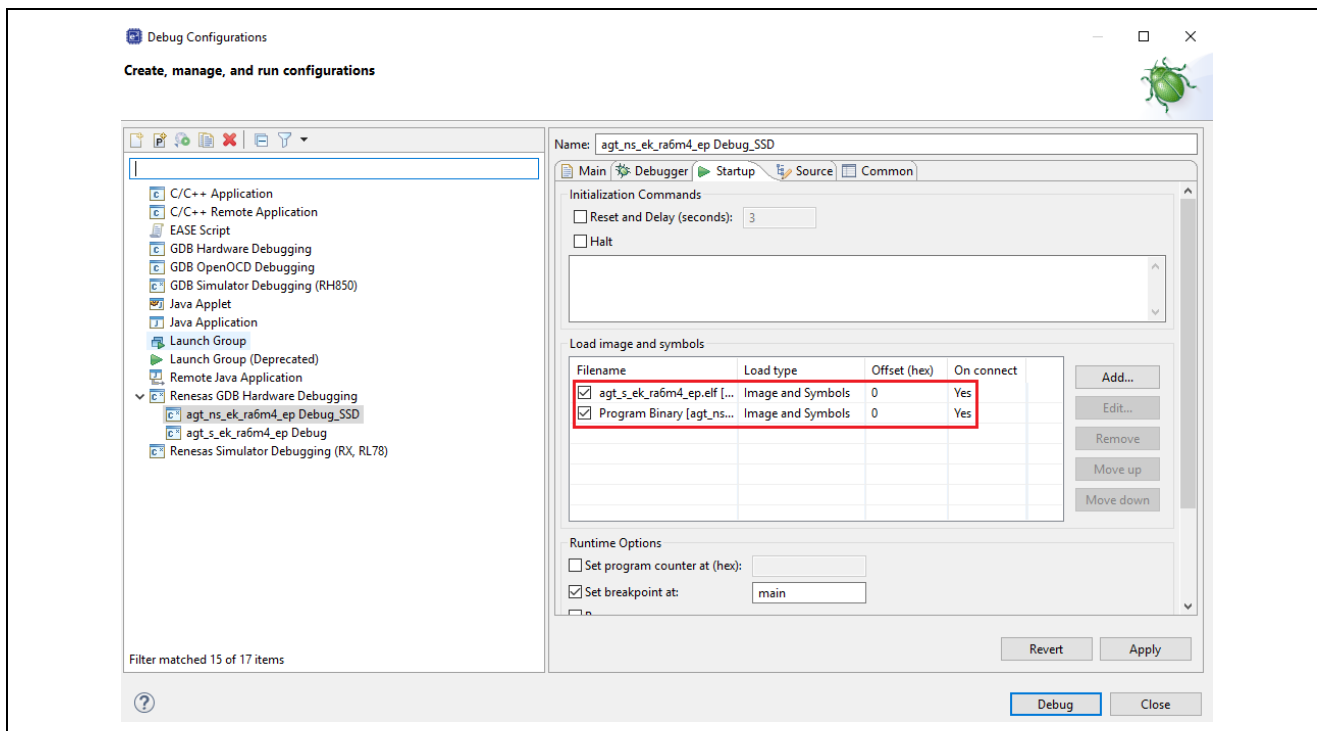


Figure 6. Startup Settings in the Non-Secure Project

4. Control Non-Secure Pin in The Non-Secure Project

A MCU pin is in Non-Secure mode when it is disabled in the Pin Configuration of the Secure project and is enabled in the Non-Secure project, as shown in Figure 7 and Figure 8.

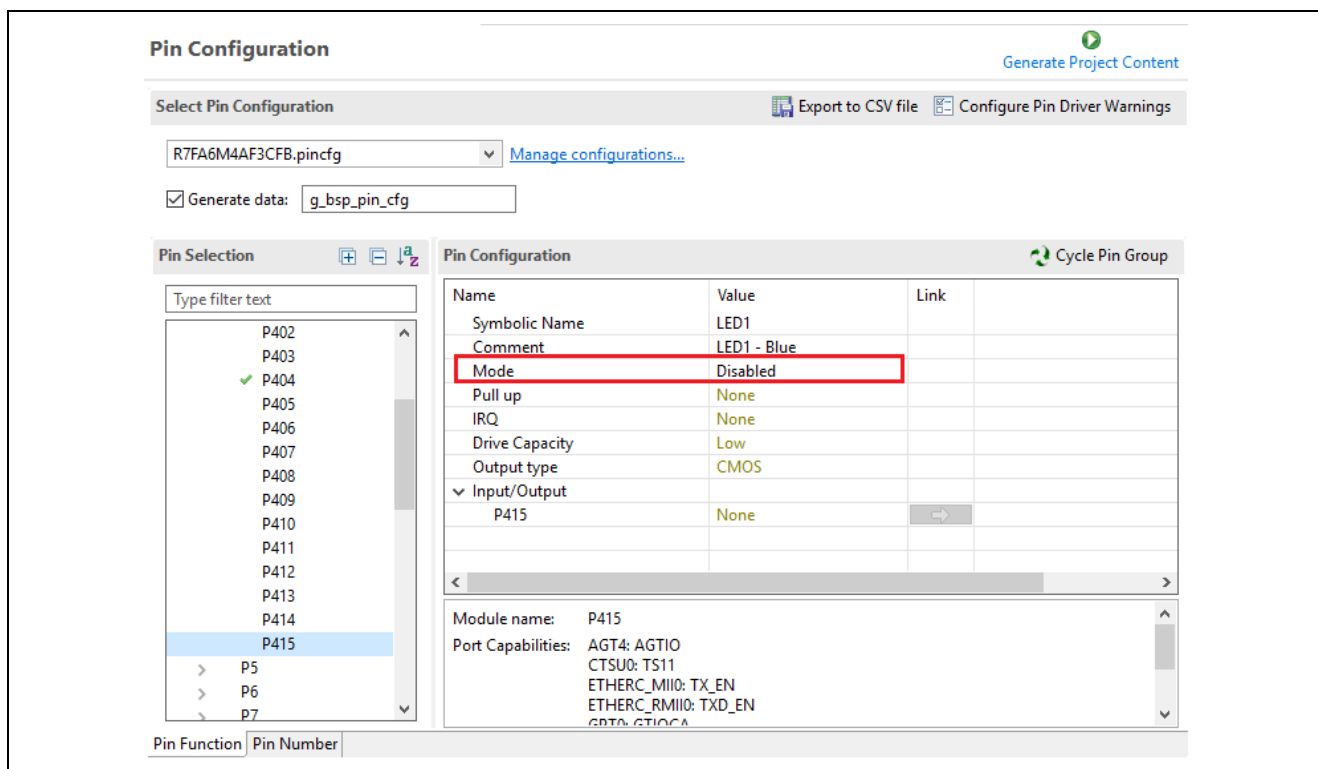


Figure 7. Disable Pin P415 (LED1) in The Secure Project

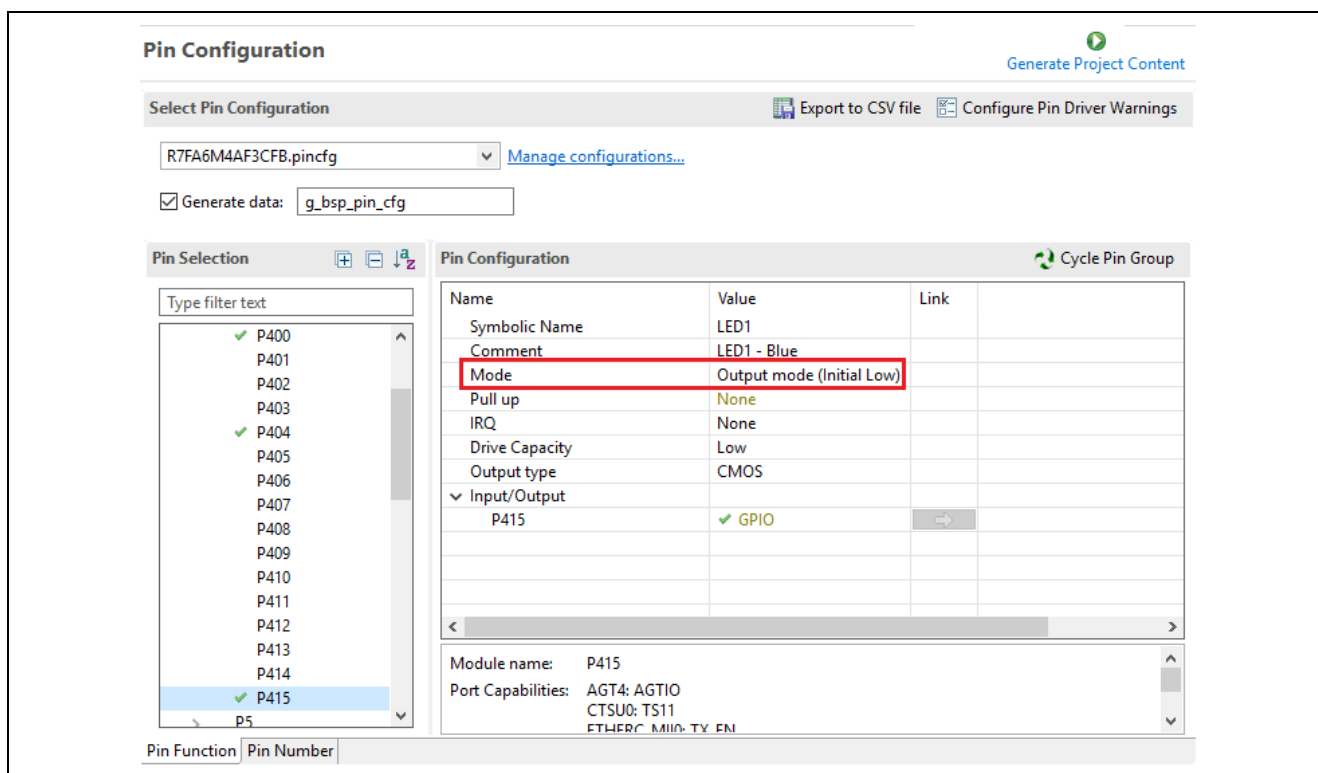


Figure 8. Enable Pin P415 (LED1) in The Non-Secure Project

You can control this Non-Secure pin by using driver APIs directly in the Non-Secure project.

```
/* Change LED state */
fsp_err_t err = R_IOPORT_PinWrite(&g_ioport_ctrl, (bsp_io_port_pin_t) g_bsp_leds.p_leds[RESET_FLAG], led_level);
```

Figure 9. Toggle LED1 in The Non-Secure Project

5. Control Secure Pin in The Non-Secure Project

A MCU pin is in Secure mode when it is enabled in the Pin Configuration in the Secure project, as shown in Figure 10.

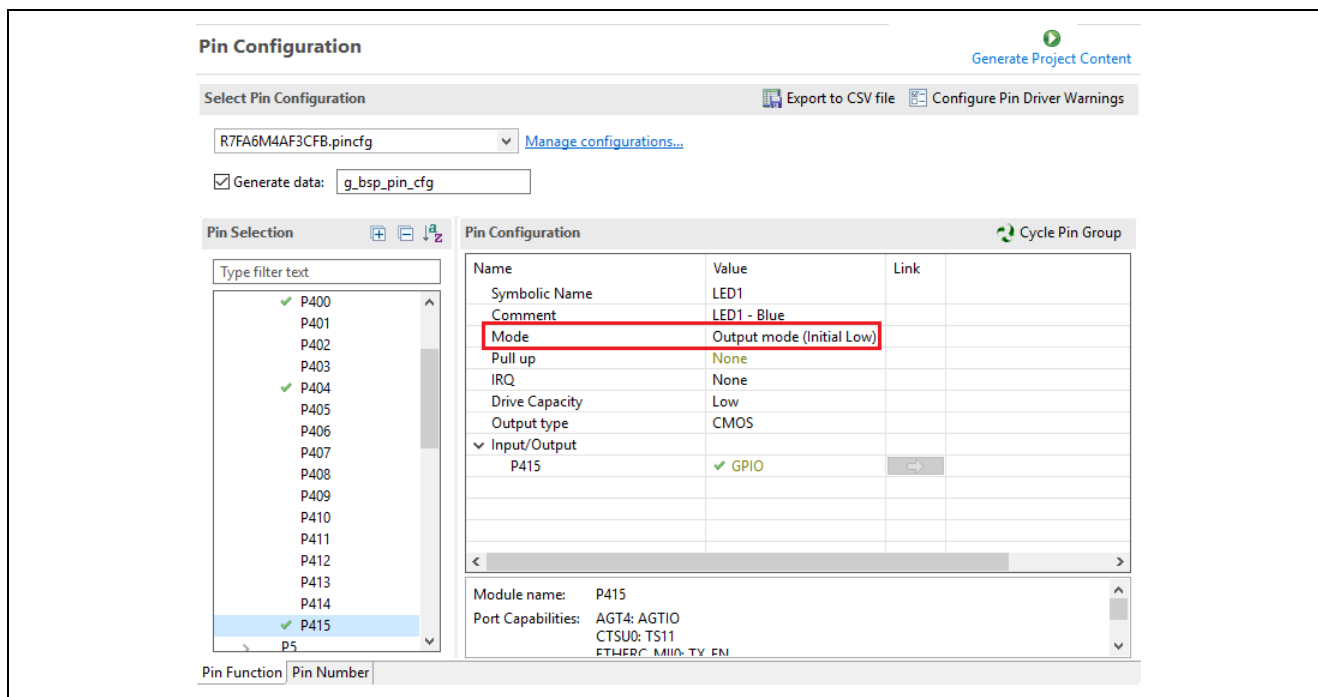


Figure 10. Enable Pin P415 in The Secure Project

If you want to control a secure pin, you need to create a guard function in the Secure project, as shown in Figure 11, then call this newly created guard function in the Non-Secure project.

```
/* Non secure callable function for LED1 */
BSP_CMSE_NONSECURE_ENTRY fsp_err_t led_set_guard (bsp_io_port_pin_t pin, bsp_io_level_t level)
{
    if(BSP_IO_PORT_04_PIN_15 == pin) //Only allowing access to LED1 (P415)
    {
        return R_IOPORT_PinWrite(&g_ioport_ctrl, pin, level);
    }
    else
    {
        return FSP_ERR_NOT_OPEN;
    }
}
```

Figure 11. Guard Function to Toggle LED1 in The Secure Project

Call the guard function to toggle LED1 in the Non-Secure project.

```
/* Turn ON LED to indicate callback triggered, along with output on RTT*/
led_set_guard(g_bsp_leds.p_leds[0], BSP_IO_LEVEL_HIGH);
```

Figure 12. Toggle LED1 in The Non-Secure Project

6. Remove Unused Guard Functions from TZ Project

FSP will automatically generate guard functions for stacks/drivers that are set as Non-Secure Callable in the “src” folder in the secure project. It is a good practice to remove guard functions when you don’t use them. In the TZ example projects, it is handled by adding a macro to disable or enable un-used guard functions.

```
#include "guard.h"
#include "custom_guard.h"

⊖ #if UNUSED_GUARD_ON //Enable/disable unused guard functions

⊖ BSP_CMSE_NONSECURE_ENTRY fsp_err_t g_doc_status_get_guard(doc_ctrl_t *const p_api_ctrl, doc_status_t *p_status)
{
    /* Verify all pointers are in non-secure memory. */
    doc_status_t *p_status_checked = cmse_check_pointed_object (p_status, CMSE_AU_NONSECURE);
    FSP_ASSERT (p_status == p_status_checked);

    /* TODO: add your own security checks here */

    FSP_PARAMETER_NOT_USED (p_api_ctrl);

    return R_DOC_StatusGet (&g_doc_ctrl, p_status_checked);
}

⊖ BSP_CMSE_NONSECURE_ENTRY fsp_err_t g_doc_version_get_guard(fsp_version_t *const p_version)
{
    /* Verify all pointers are in non-secure memory. */
    fsp_version_t *const p_version_checked = cmse_check_pointed_object (p_version, CMSE_AU_NONSECURE);
    FSP_ASSERT (p_version == p_version_checked);

    /* TODO: add your own security checks here */

    return R_DOC_VersionGet (p_version_checked);
}

⊖ #endif

⊖ BSP_CMSE_NONSECURE_ENTRY fsp_err_t g_doc_open_guard(doc_ctrl_t *const p_api_ctrl, doc_cfg_t const *const p_cfg)
{
    /* TODO: add your own security checks here */

    FSP_PARAMETER_NOT_USED (p_api_ctrl);
    FSP_PARAMETER_NOT_USED (p_cfg);

    return R_DOC_Open (&g_doc_ctrl, &g_doc_cfg);
}

⊖ BSP_CMSE_NONSECURE_ENTRY fsp_err_t g_doc_close_guard(doc_ctrl_t *const p_api_ctrl)
{
    /* TODO: add your own security checks here */

    FSP_PARAMETER_NOT_USED (p_api_ctrl);

    return R_DOC_Close (&g_doc_ctrl);
}

⊖ BSP_CMSE_NONSECURE_ENTRY fsp_err_t g_doc_write_guard(doc_ctrl_t *const p_api_ctrl, uint16_t data)
```

Figure 13. Adding a Macro to Disable/Enable Un-Used Guard Functions

Website and Support

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

RA Product Information	www.renesas.com/ra
RA Product Support Forum	www.renesas.com/ra/forum
RA Flexible Software Package	www.renesas.com/FSP
Renesas Support	www.renesas.com/support

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Oct.01.20	—	First release document

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