Renesas Synergy™ Platform

Simple PMOD Display Application Example for DK-S128

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Introduction

This application note describes a Pmod™-based display application on the DK-S128 kit using the Renesas e^2 studio ISDE and Renesas Synergy Software Package (SSP).

Also included in this document are how-to steps on importing the project, so that you can recreate the application with the e^2 studio Integrated Solutions Development Environment (ISDE/IAR SSC).

Minimum PC Requirements

- Microsoft® Windows® 7 or 10
- Intel® Core™ family processor running at 2.0 GHz or higher (or equivalent processor)
- 8 GB memory
- 2 GB of free space hard disk or SSD
- USB 2.0.

Required Resources

The example application targets Renesas Synergy S128 MCU group. To build and run the application, you will need:

- Renesas DK-S128 kit
- e^2 studio ISDE v6.2.0 or greater or IAR EW for Synergy v8.21.1 or later
- Synergy Software Package (SSP) 1.4.0 or greater, Synergy Standalone configurator (SSC) 6.2.0 or later
- Segger J-link® USB driver
- Micro USB cables
- An Okaya Pmod™-based LED display (included with the DK-S128 kit)

You can download the required Renesas Synergy™ software from the Renesas Synergy Gallery (https://synergygallery.renesas.com).

Prerequisites and Intended Audience

As the user of this application note, you are assumed to have some experience with the Renesas e^2 studio ISDE and SSP. For example, before you perform the procedure in this application note, you should follow the procedure in your board's Quick Start Guide to build and run the OOB application project. By doing so, you will become familiar with e^2 studio and the SSP, and ensure that the debug connection to your board is functioning properly.

Contents

1. Application Overview

This document shows how to create a simple graphics-enabled application using the Okaya Pmod™-based LCD display and drivers within the SSP. When the application is running, you can control the content displayed using two on-board pushbuttons and a potentiometer. The example can be adapted to add visual effects to more complex applications.

1.1 Application Software Architecture

The main components of this application are:

- Control Thread
- LCD Thread.

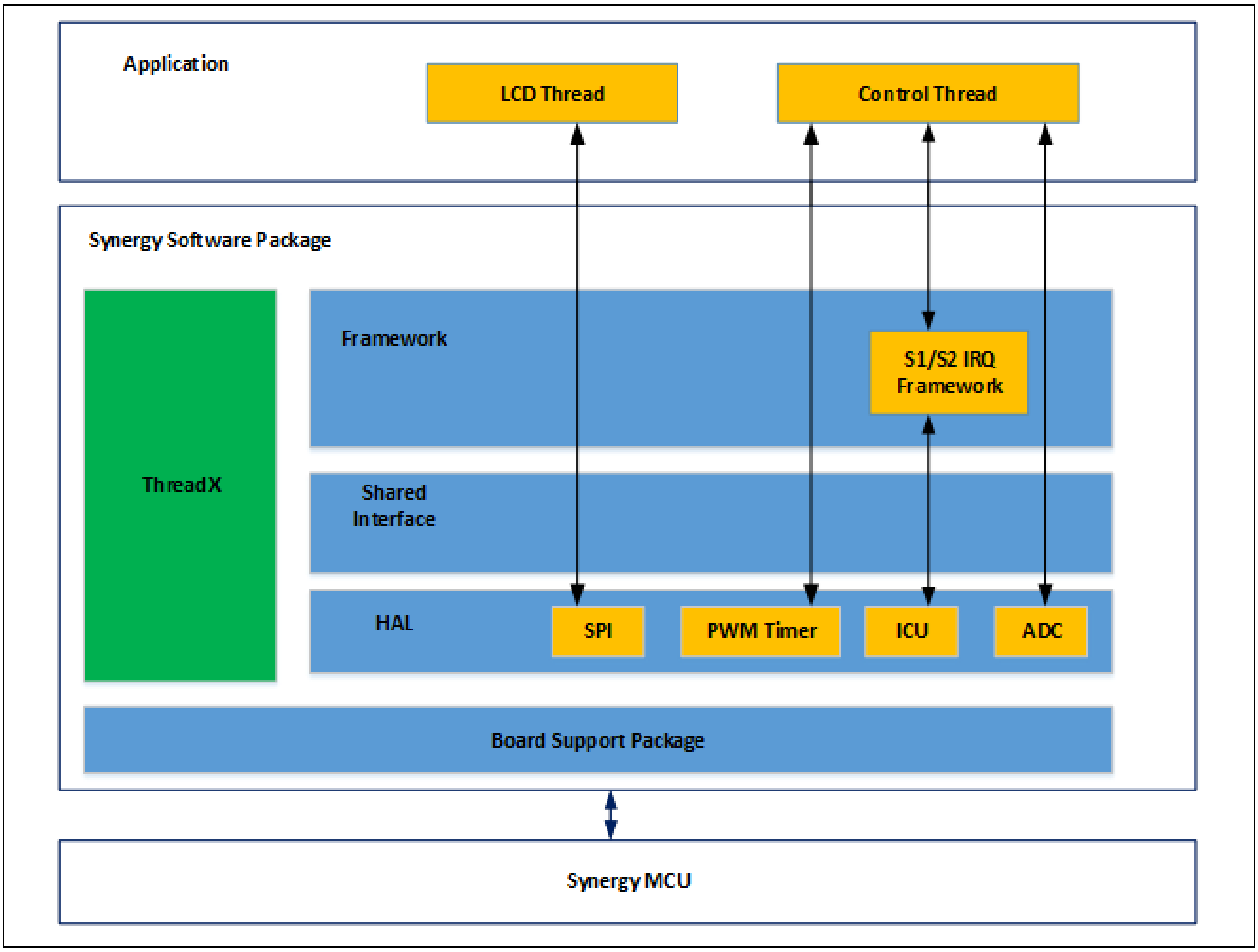

Figure 1 DK-S128 Simple Pmod™ Display Application Architecture

1.1.1 LCD Thread

The Simple Pmod™ display application is controlled by pushbutton switches S1 and S2 (found in the lower right corner of the DK-S128 board) and a potentiometer POT (located to the right of the two buttons).

Both pushbuttons are connected to hardware interrupt pins, which are controlled by the external IRQ framework. The framework allows you to control thread execution using hardware IRQs. In most cases, the application uses `sf_irq. p_api->wait` with the `TX_WAIT_FOREVER` timeout argument, to block processing in the thread until the given interrupt request is received. In the simple display example, however, the lcd thread scans through both button interrupts with a timeout value of zero, and, if neither button is pressed, it waits for 20 ms before repeating the process (IRQs are buffered by the framework before the next `sf_irq. p_api->wait call`). This gives enough processor ticks to lower-priority threads while still providing a responsive interface.

The simple display example uses an Okaya Pmod™ LCD driver running on the SCI peripheral in Simple SPI mode. All driver files are contained inside the `src/lcd_setup` folder and can be easily copied into another application to enable the use of the PMOD display. The `SPILCD_Init` function accepts two arguments: a pointer to the SPI instance and an initial value for screen rotation. The SPI module needs to be configured for the right channel and bit rate (9 and

2.5 Mbps, respectively). However, the callback function input in the configurator is discarded as the display driver overrides it automatically with its own implementation, allowing for better data flow control when outputting data through the PMOD. The Okaya Pmod™ LCD driver works with Simple SPI on SCI as well as RSPI, though you must be careful to remove the transfer drivers for the RSPI interface to allow 8-bit data width.

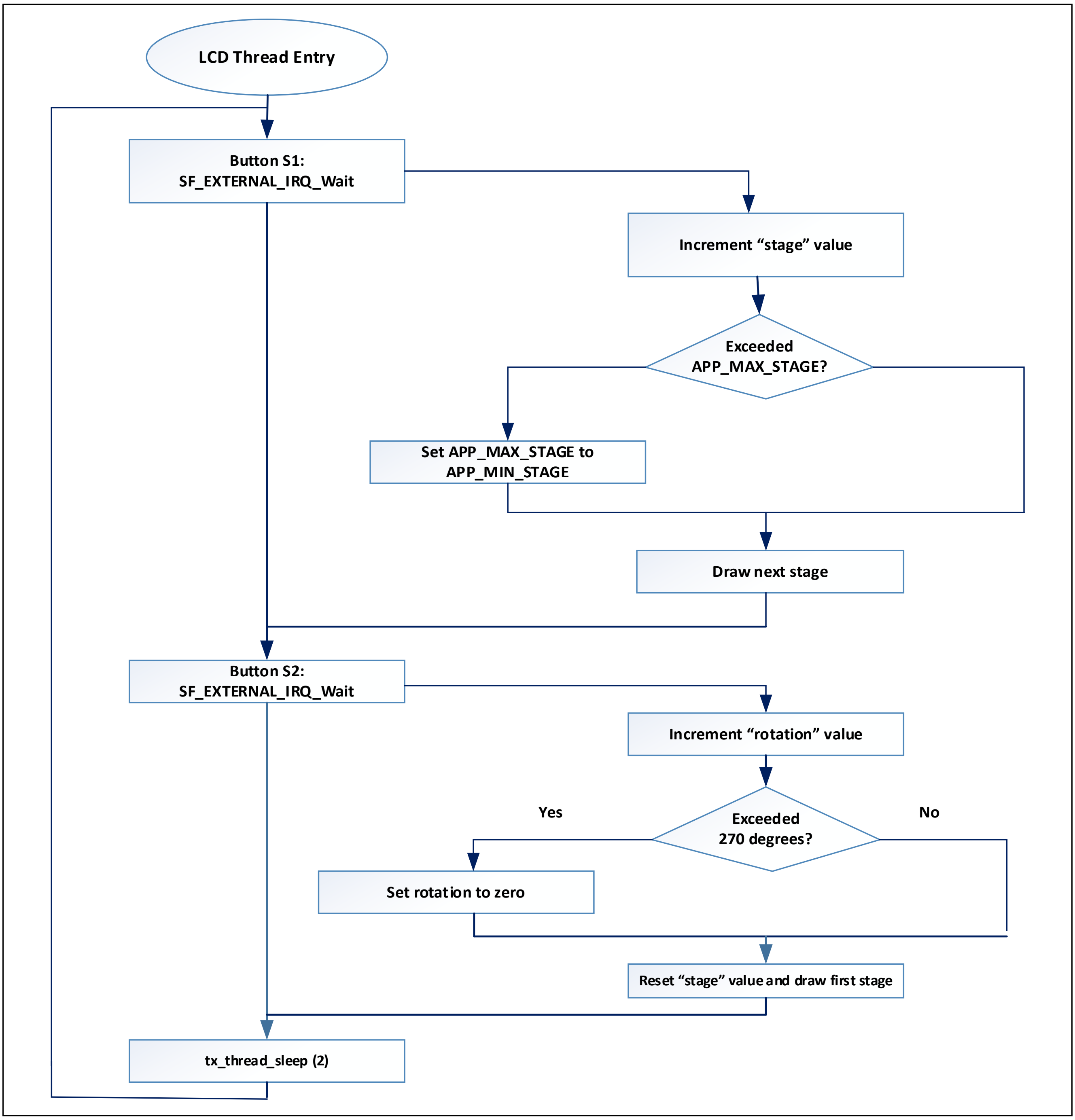

Figure 2 Simplified view of LCD Thread processing

1.1.2 Control Thread

The Simple Pmod™ display application uses Okaya LCD driver to draw 15 different screens, each implementing different features of the driver.

In addition to the displayed content, control of backlight intensity is provided through an ADC peripheral running inside the control thread. This task is launched before the LCD thread is initialized, to ensure that all setup is complete before displaying any data on the screen. The ADC peripheral running in continuous scan mode takes periodic readings of the channel 7 potential difference, through a connection to the on-board potentiometer, POT1. Despite the module being configured to read data with 12-bit resolution, software manipulates the data so that readings become an integer value contained within the 0-100 range. While the level of precision required for smooth backlight control is still sufficient, reducing the effective resolution acts as a jitter-filter to prevent unnecessary PWM duty cycle updates when the ADC readings are rapidly oscillating. If the reading (post-processing) is different from the previous one, the duty cycle of the GPT (connected to the PMOD display backlight-enable pin) is updated using `R_GPT_DutyCycleSet`. ADC sampling frequency is limited to 33 Hz by suspending the thread for 30 ms using `tx_thread_sleep` (3) after each reading.

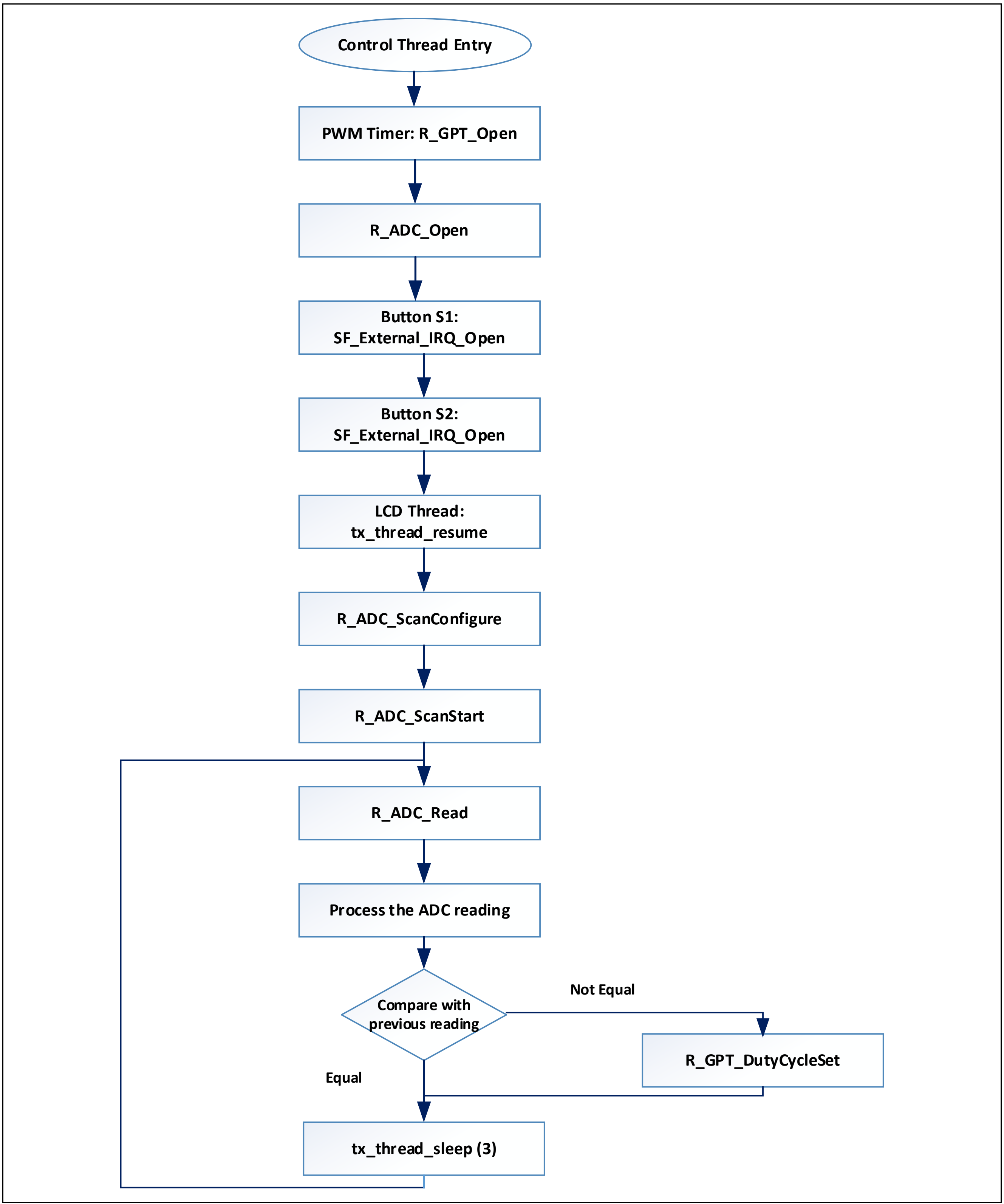

Figure 3 Control Thread Processing

2. Procedure to Create Simple Pmod Display Example Project

The following steps are used to recreate the DK-S128 Pmod™ display example application project from scratch using the e² studio ISDE.

Step 1: Create a new project with RTOS included:

1. Create a new Synergy project by clicking **File->New->Synergy C\C++ Project**.
2. Select the '**Renesas Synergy C Executable Project**'.
3. Enter the project name and setup the Synergy license file.
4. Choose the DK-S128 board by selecting **S128 DK** in the **Board** window.
5. Choose BSP option in the **Project Template Selection** window.

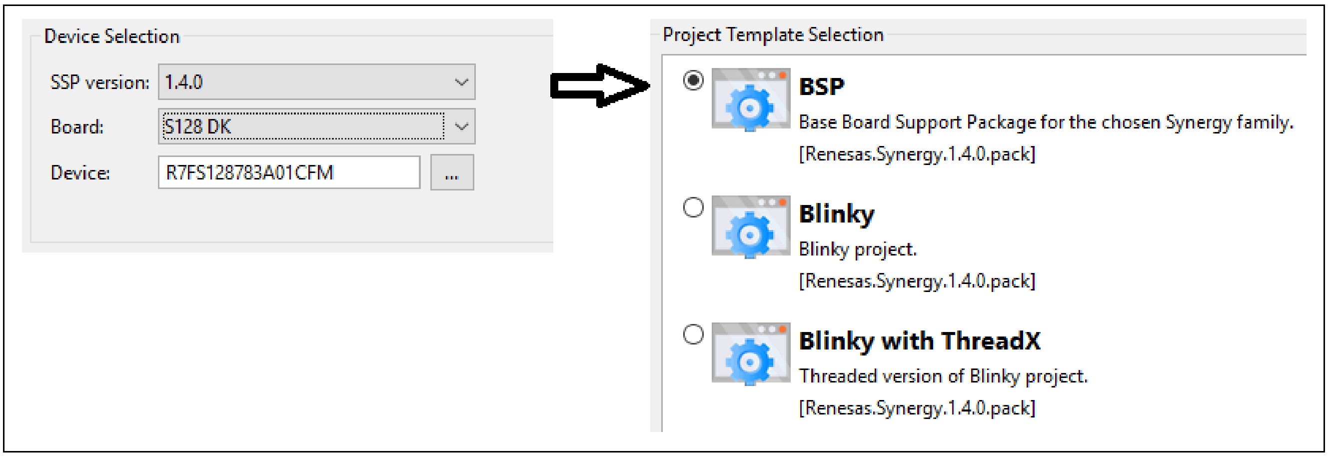

Figure 4 Synergy Project Creation window

Step 2: Create Control thread

1. Under the **Thread** tab, click '**New Thread**' to create a new thread.
2. Set the property of this new thread, as shown in Figure 5.
3. In the **Control Thread Stacks** window, click '**New Stack**'to add the ADC driver (ADC Driver on r_adc), GPT driver (Timer driver on r_gpt) modules, as shown in Figure 5.

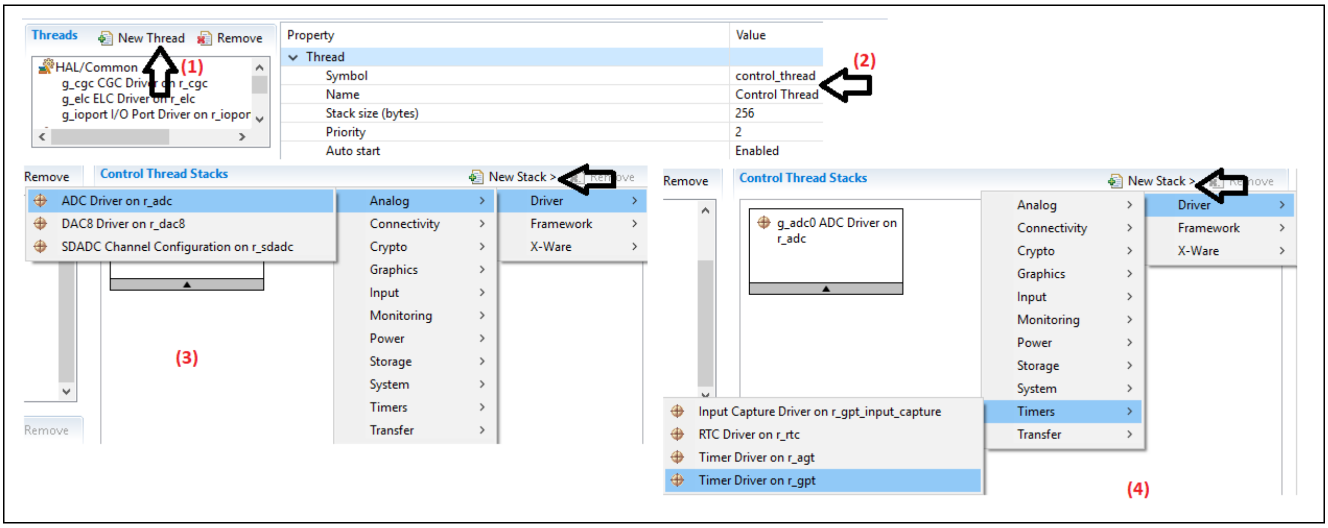

Figure 5 Adding ADC and r_gpt driver module

4. Go to the **Properties** tab for the ADC driver and select the resolution and channels, as shown in Figure 6. For details on the ADC driver properties, see the ADC module guide. Use the keyword "`r_adc`" in this link to download the ADC module guide document.

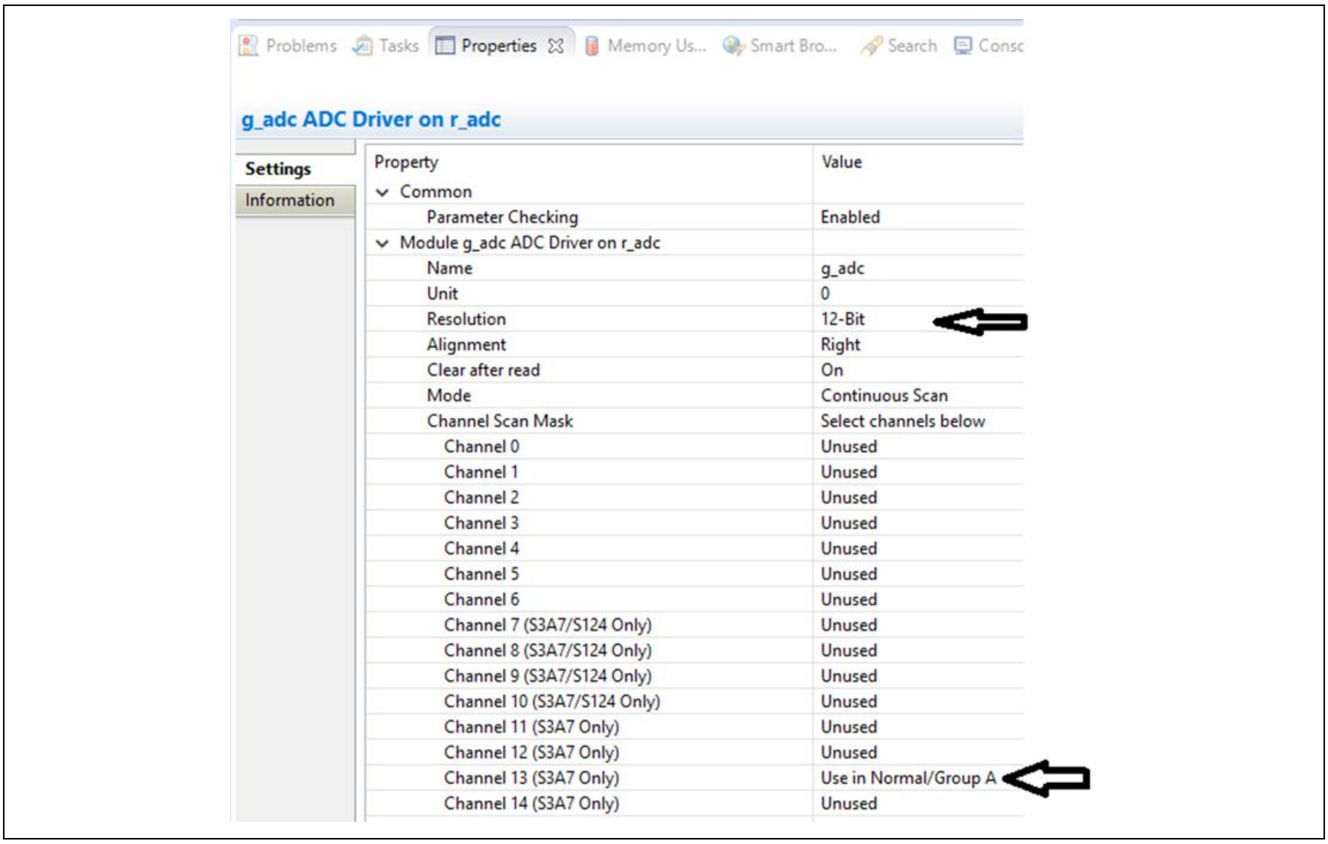

Figure 6 ADC Module properties window

5. Go to the **Properties** tab for the `r_gpt` driver and set the properties, as shown in Figure 7. For details on GPT driver properties, see the GPT module guide. Use the keyword "`r_gpt`" in this link to download the GPT module guide document.

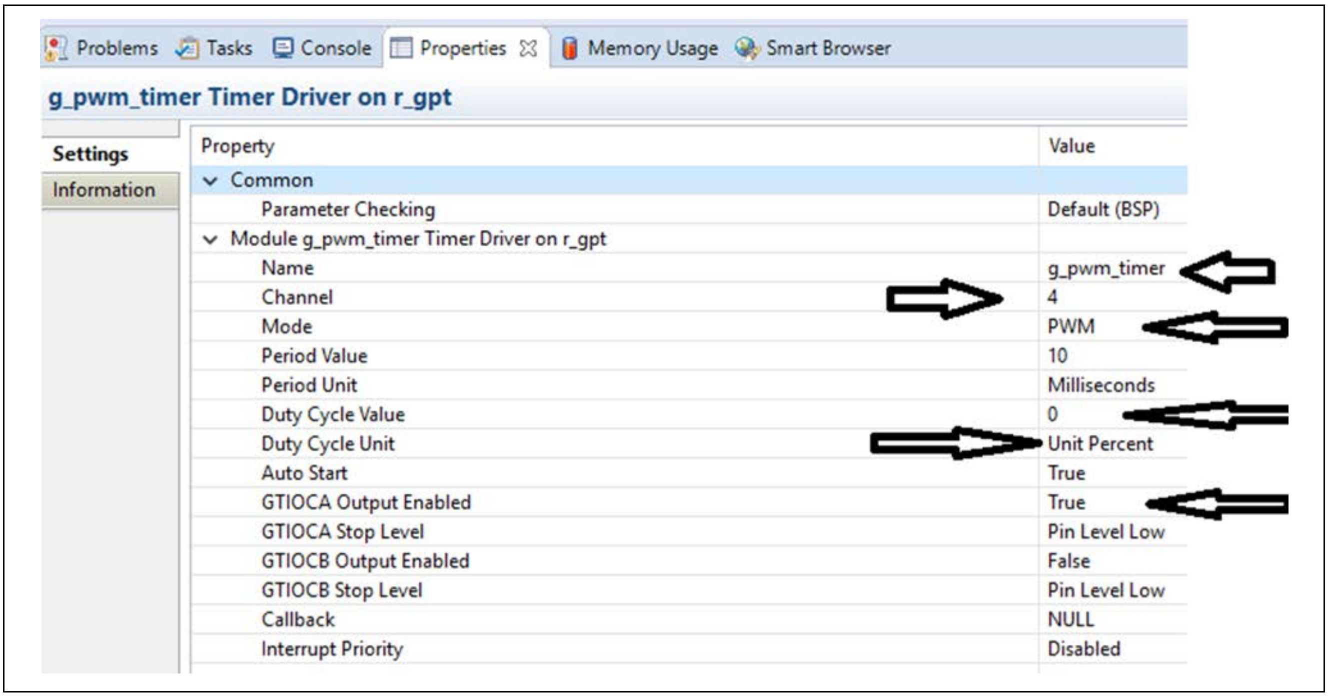

Figure 7 gpt module properties window

6. In the **Control Thread Stacks** window, click **New Stack** to add the **External IRQ framework on sf_external_irq** for user button S1 and S2, as shown in Figure 8.

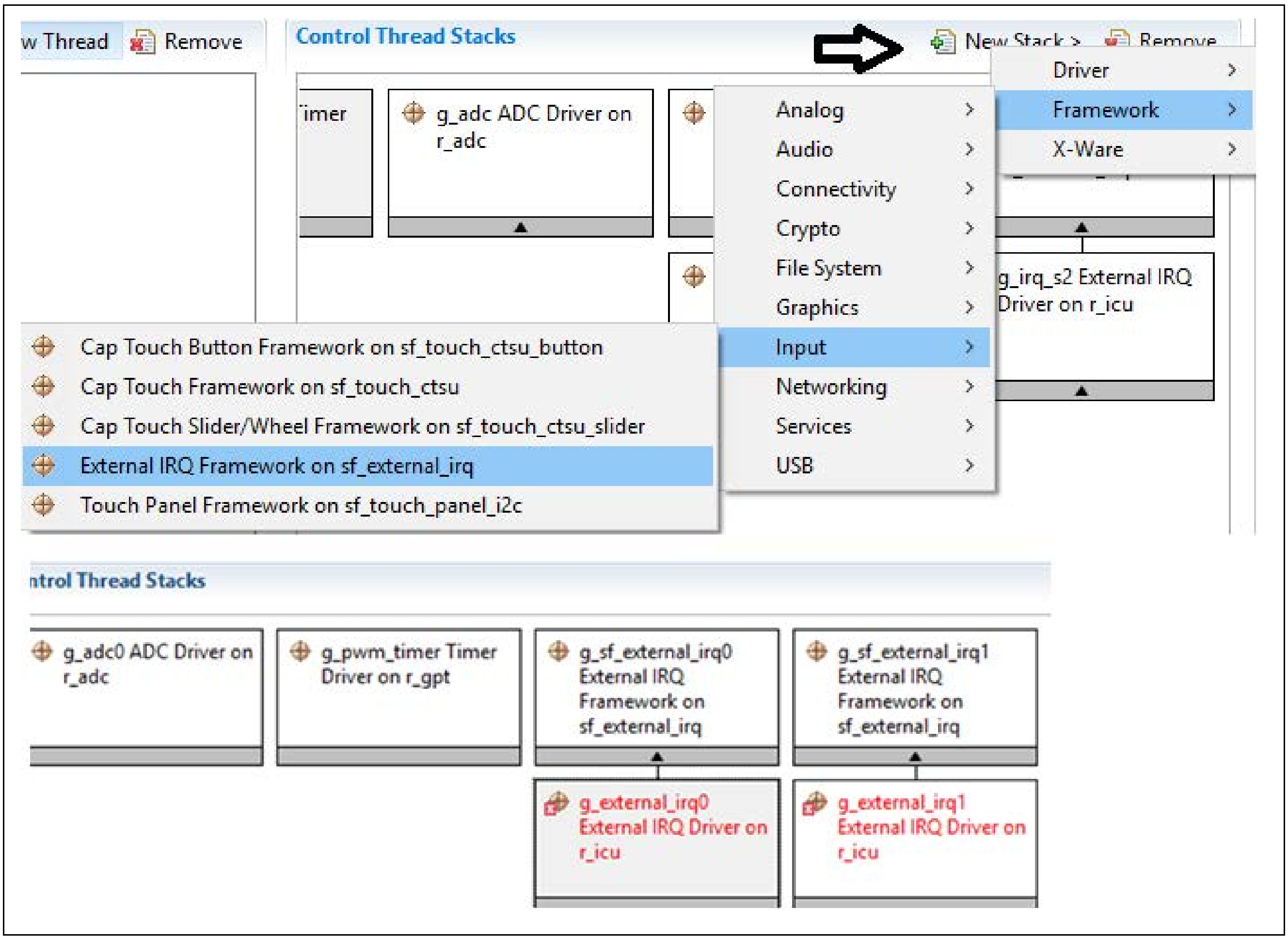

Figure 8 Adding IRQ Framework

7. Go to **Properties** window for `r_icu` driver and set their properties, as shown in Figure 9.

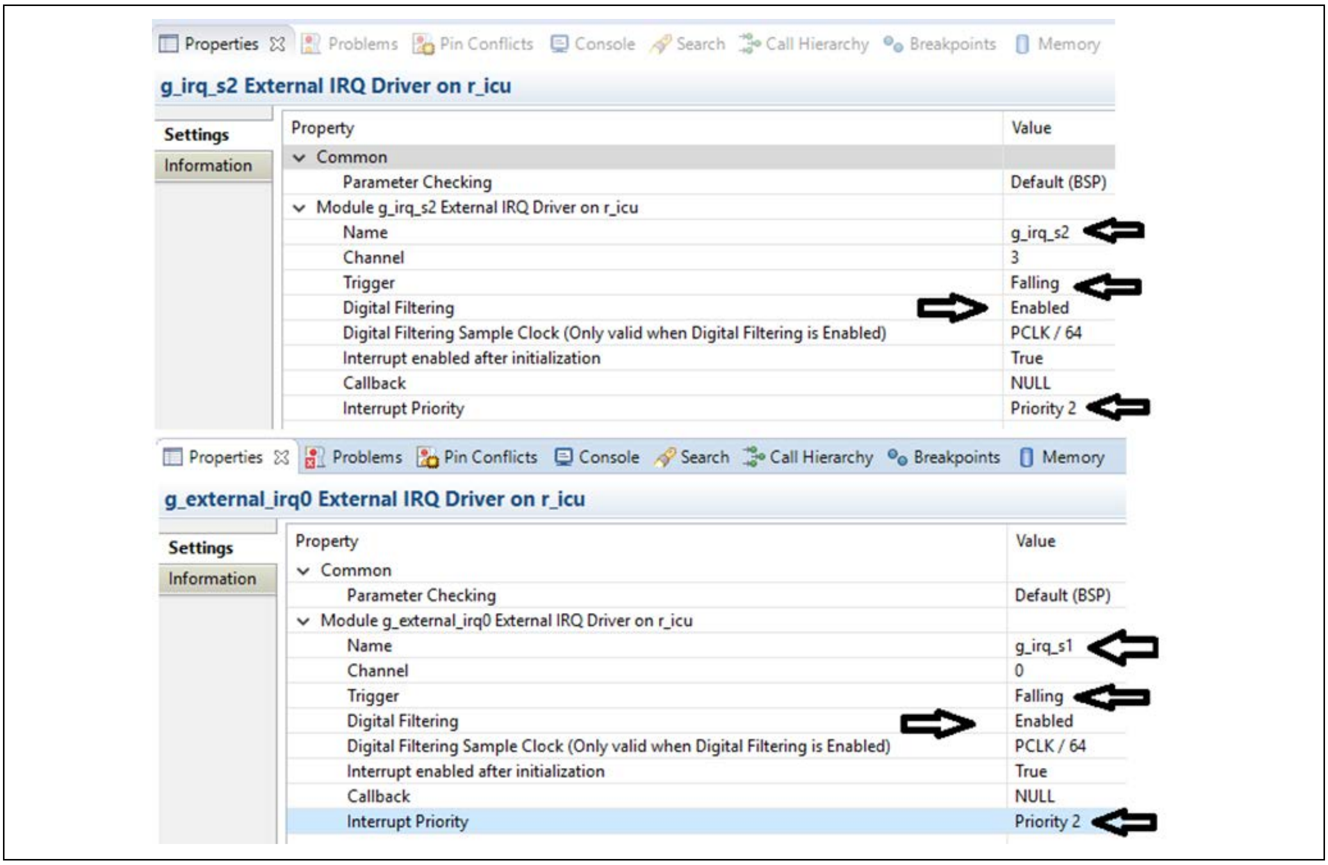

Figure 9 r_icu driver properties window

8. Go to **Properties** window for sf_external_irq framework and set the properties, as shown in Figure 10.

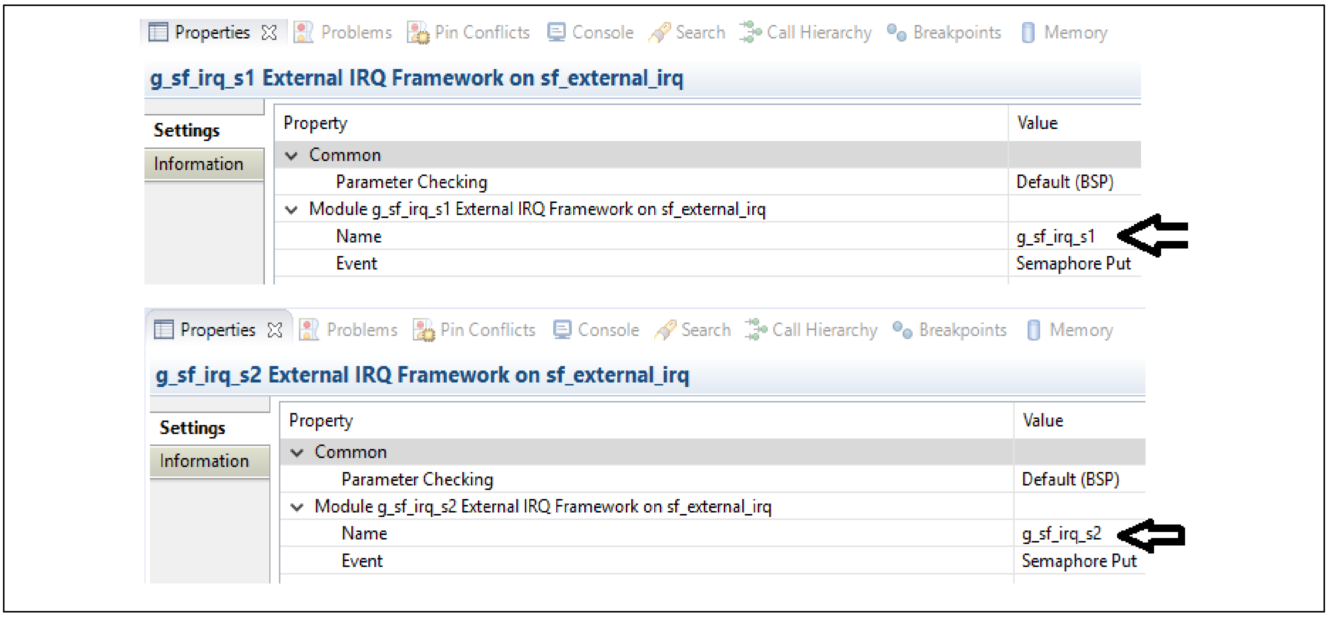

Figure 10 sf_external_irq properties window

Step 3: Create LCD Thread

1. Under the **Thread** tab, click '**New Thread**' to create a new thread.
2. Set the property of this new thread, as shown in Figure 11.
3. In the **LCD Thread Stacks** window, click '**New Stack'** to add the SPI driver module, `r_sci_spi`, as shown in Figure 11.
4. Go to the **Properties** tab for SPI driver, select the channel and set the interrupt priorities, as shown in Figure 11.

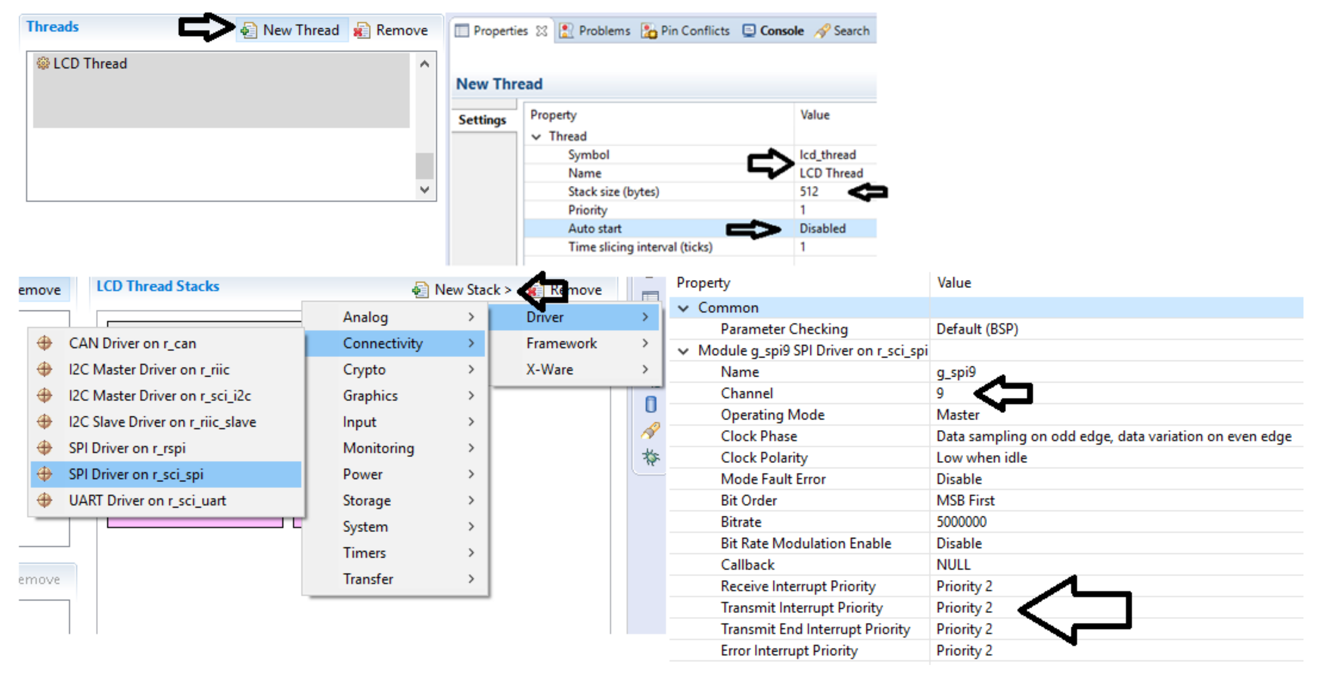

Figure 11 Adding SPI driver module

5. Under the newly added `r_sci_spi` driver, disable the DTC driver for the transfer and reception module in the configurator, as shown in Figure 12.

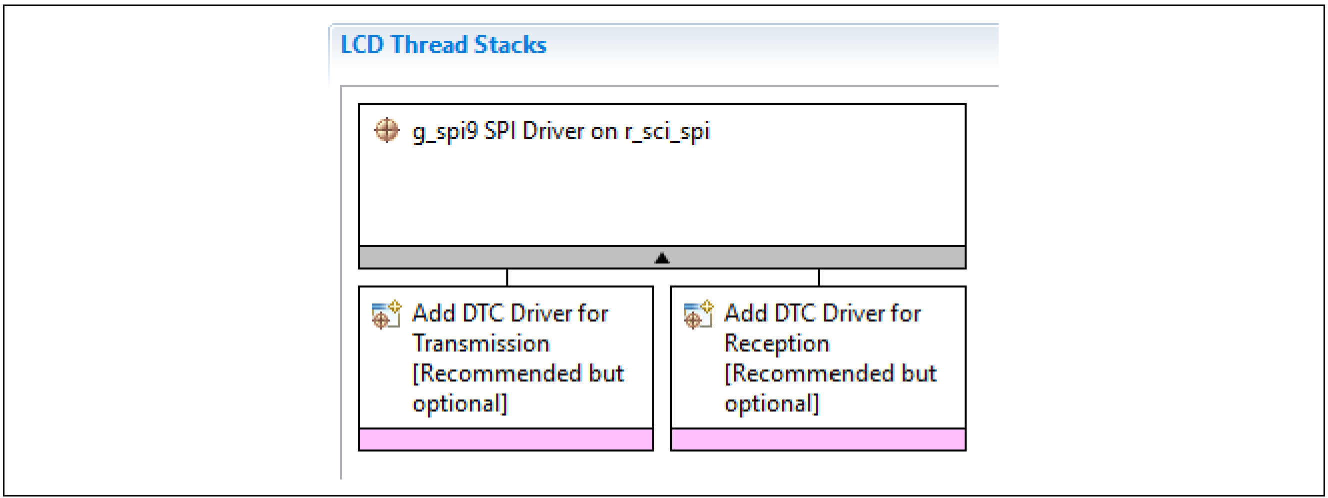

Figure 12 Disabling DTC driver

Step 4: Update Pin Configurations

Go to the **Pins** tab and change the pin configurations for the following ports, as shown in Figure 11:

1. P205 to Output mode (PMOD_SS)
2. P302 to Peripheral mode (PMOD_EN)
3. P111 to Output mode (PMOD_RST)
4. P303 to Output mode (PMOD_DC)

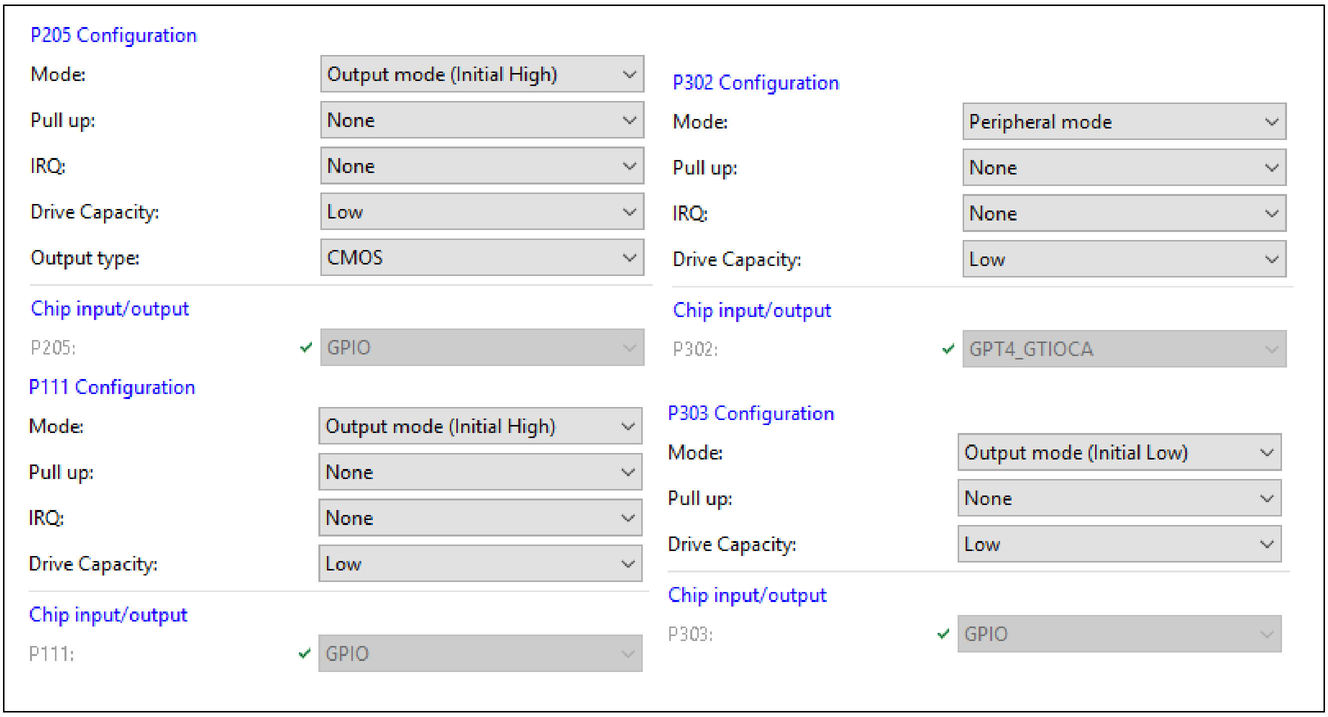

Figure 13 Pin Configuration

Step 5: Generate Project Content

Click the **Generate Project Content** button. It generates the project files using the configuration option you selected.

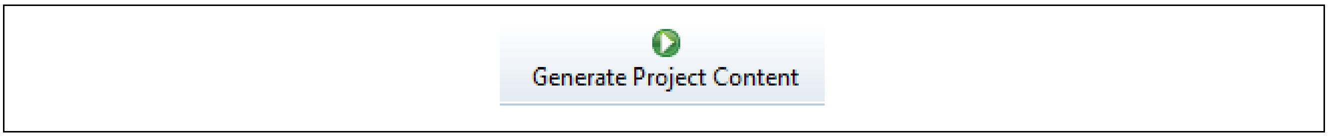

Figure 14 Generate Project Content button

Step 6: Application Project files

1. After step 5, the e^2 studio ISDE generates the application project files with the configuration chosen.
2. These files are a place holder for adding the user application code.
   You can either write your own application functions for these threads, or you can copy the existing DK_S128 Simple Pmod Display demonstration application project source files to recreate this example demonstration.
3. To recreate this example demonstration, go to the existing dk_s128_simplePmodDisplay project src folder and copy the following files/folders contents to your newly created project.
   A. `Lcd_setup` (folder)
   B. `control_thread_entry.c`
   C. `lcd_thread_entry.c`
   D. `util.h`.

Step 7: Compiling the project

Build the application project by clicking the hammer icon as seen in the menu bar in Figure 15.

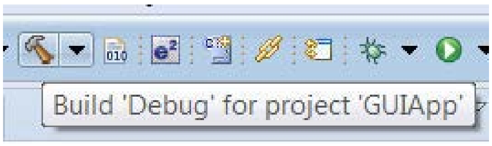

Figure 15 Build button

3. Running the Pre-existing DK-S128 Simple Pmod™ Display Demonstration

3.1 Powering up the Board

This section describes how to connect the board to power, the J-Link debugger to the PC, the board to the PC USB port, and how to run the debug application to see it in action.

To connect to the board:

1. Connect the Micro USB end of the supplied USB cable to the DK-S128 board J12 connector (DEBUG_USB).

Note: The kit contains a SEGGER J-Link® On-board (OB). The J-Link provides full debug and programming capabilities for the DK-S128 kit.

2. Connect the other end of the USB cable to the USB port on your workstation. Wait for LED4 to turn solid green, indicating a good connection.

3.2 Importing, Building, and Running the Project

See the *Renesas Synergy Project Import Guide* (r11an0023eu0119-synergy-ssp-import-guide.pdf) for instructions on importing the project into e^2 studio to build and run the project.

Note: You need to select the "SimplePmodLCD_DKS128 Debug" GDB Hardware Debugging configuration for debugging.

3.3 Verifying the Demonstration

Connect the Pmod™ LCD display (included as part of the DK-S128 kit) to Pmod™ connector J4. Verify that the J3 header near the battery is configured with two jumpers to make connections, as shown in Figure 16.

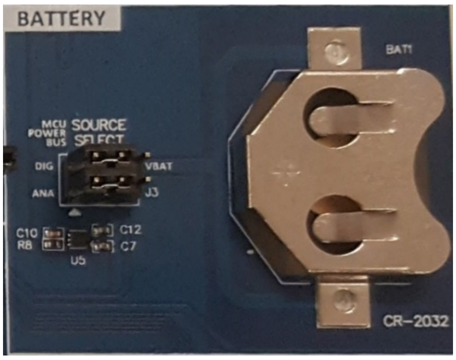

Figure 16 Jumper setting

Figure 17 shows the switch settings used to run this application project.

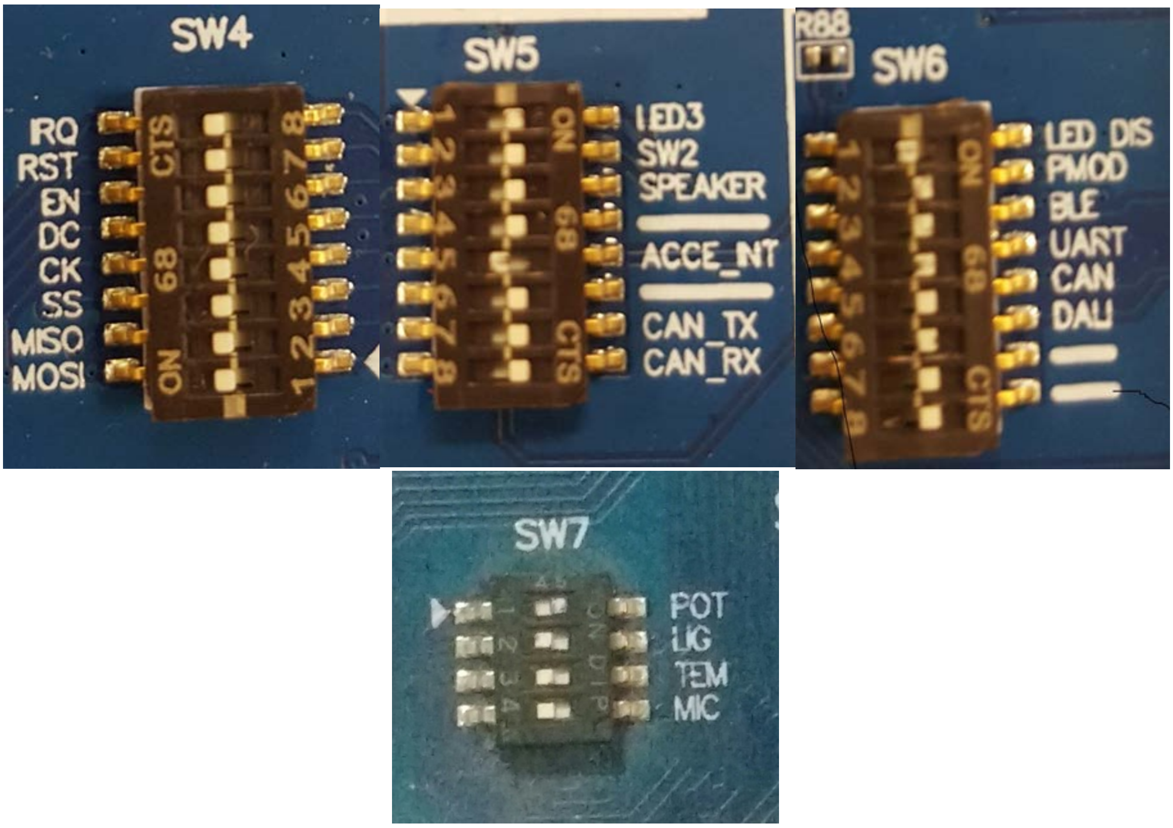

Figure 17 SW4/5/6/7 settings for Simple Pmod^{TM} Display demonstration

Once the DK-S128 kit is powered up and loaded with this application project, you should see a Welcome screen on the Pmod™ LCD display, as shown in Figure 18.

Figure 18 Splash Screen

After a few seconds (or once S1 is pressed), the program goes to the screen with instructions, as shown in Figure 19.

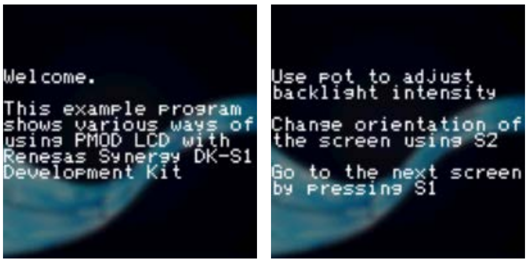

Figure 19 Welcome and Instruction screens

Then, you can use the S1 pushbutton to go to the next step (provided that the application has finished drawing the current screen) and the S2 pushbutton to change the screen orientation in the clockwise direction. Changing the screen orientation restarts the sequence of drawings, but the instruction screen is now skipped.

While the application is running, you can use the potentiometer to adjust the backlight intensity. If you cannot see any difference in the strength of the backlight, verify that the Pmod is outputting 3.3V on the Vcc pin.

4. Next Steps

1. Visit http://renesassynergy.com/kits/dk-s128 for more information about the DK-S128 kit.
2. Visit renesassynergy.com/tools to learn more about development tools and utilities.
3. Visit http://www.renesassynergy.com/gallery to download development tools and utilities.
4. To learn more about:
   A. Synergy kits, see http://www.renesassynergy.com/kits
   B. Synergy Microcontrollers, see http://www.renesassynergy.com/microcontrollers
   C. Synergy Software, see http://www.renesassynergy.com/software
   D. Synergy Solutions, see http://www.renesassynergy.com/solution

5. Limitations and Assumptions

In this application project, we set the DIP switch 1 (LED_DIS) in SW6 to OFF. You cannot use Reset button (SW3) to restart the kit if the DIP switch 1 (LED_DIS) in SW6 is set to OFF since the P2_1 is shared between LED2 and boot mode, in DK-S128 schematics.

Website and Support

Support: https://synergygallery.renesas.com/support

Technical Contact Details:

- America: https://www.renesas.com/en-us/support/contact.html
- Europe: https://www.renesas.com/en-eu/support/contact.html
- Japan: https://www.renesas.com/ja-jp/support/contact.html

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Aug 29, 2017		Initial version
1.01	Mar 16, 2018	—	Updated for 1.4.0

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