Renesas Synergy™ Platform

DK-S128 v1.1 Out-of-Box Demonstration Programming Guidelines

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Introduction

The DK-S128 Out-Of-Box (OOB) Demonstration Kit shows a multithreaded application that reads the analog values present on the potentiometer, light sensor, and temperature sensor, and displays these values on the kit's Pmod™ LCD. This guide covers the application and its DK-S128 development kit implementation using the Renesas Synergy™ Software Package (SSP).

This document also describes how to import the project, so that you can recreate the application using the e^2 studio Integrated Solutions Development Environment (ISDE) or IAR Embedded Workbench® for Renesas Synergy™.

Minimum PC Requirements

- Microsoft® Windows® 7 or 10
- 8 GB memory RAM
- 2 GB free space on hard disk or SSD
- USB 2.0

Required Resources

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

- Synergy DK-S128 Development Kit
- e^2 studio ISDE v6.2.0 or greater or IAR EW for Synergy v8.21.1 or greater
- SSP v1.4.0 or greater and Synergy Standalone Configurator (SSC) v6.2.0 or greater
- SEGGER J-Link® USB driver
- Okaya Pmod™ LCD display (included with the DK-S128 kit)
- Micro USB cables

You can download the required Synergy software and development tools from the Synergy Solutions Gallery: renesassynergy.com/solutionsgallery.

Prerequisites and Intended Audience

This OOB demonstration assumes you have some experience with the Renesas e^2 studio ISDE, or the IAR EW for Synergy, and the SSP. For example, before you perform the procedure in this application note, you should follow the procedure to build and run the **Blinky** 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

The intended audience are users who want to evaluate features of the S128 Synergy MCU using SSP.

Contents

1. Application Overview

The DK-S128 kit contains several analog sensors along with a 3-axis accelerometer connected to the I2C bus. The analog sensors include a potentiometer, a temperature sensor, and a light sensor. This OOB application continuously reads the analog values provided by these sensors and displays them on the Pmod LCD screen. It also flashes the three on-board LEDs in proportion to the analog voltage being produced by the potentiometer or the light sensor. The LEDs may be programmed to flash in unison or chase each other. The selection of which sensor drives the flashing rate and whether the LEDs flash or chase is controlled by push button switches S1 and S2 (found in the lower right corner of the DK-S128 kit).

The application illustrates the use of Synergy peripheral drivers to read the sensor values along with demonstrating how easy it is to setup a multithreaded application. The application has separate threads to read the sensors, display the values to the LCD and flash the LEDs based on pushbutton and sensor inputs.

1.1 Application software architecture

The following table shows the main software components of the applications.

Table 1 Main Components

Thread Name	Thread Function
LED Thread	Controls flashing/chasing of the 3 onboard LEDs
LCD Thread	Updates the LCD as new data arrives from 3 analog sensors
Inputs Thread	Periodically polls the switch inputs and reads the analog sensor voltages

The input thread periodically samples the state of the pushbuttons and the voltage values present on the analog sensors. It makes this data available to the other threads through two access functions, eliminating the need for global variables.

While both pushbuttons are connected to hardware pins with interrupt capability, this application uses a thread to periodically poll the switch states by reading the I/O port pins connected to the switches. This simple technique provides basic switch debouncing by reading the state of the switch at an interval longer than the typical mechanical switch bounce time (50 ms).

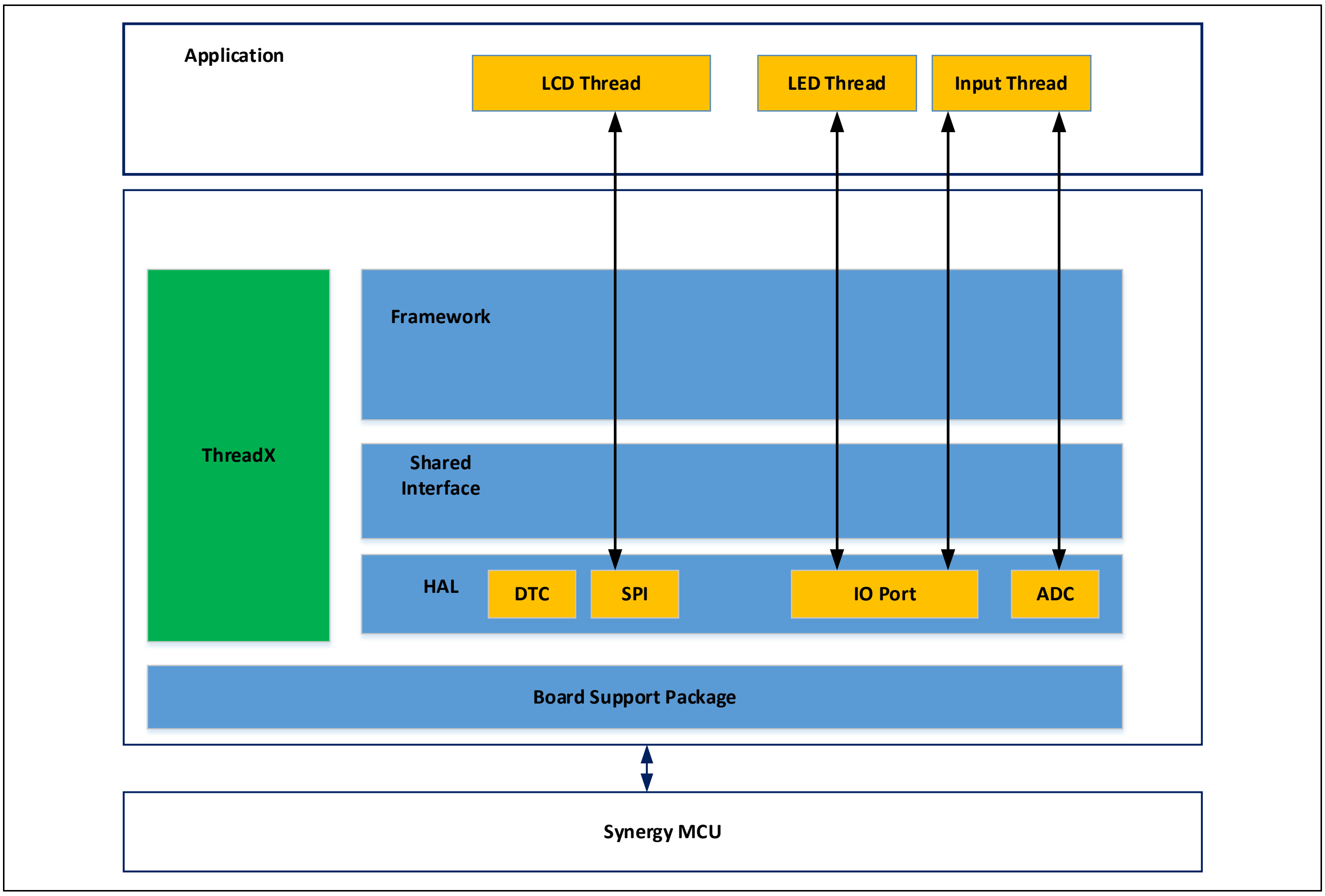

Figure 1 DK-S128 OOB Application Architecture

1.1.1 Input Thread

The following figure shows the logic implemented in the inputs thread. To be responsive, the inputs thread samples the sensors and switch inputs every 50 ms. The LCD thread periodically updates the Pmod LCD screen with the current mode, selected by the pushbuttons, and the latest sensor values.

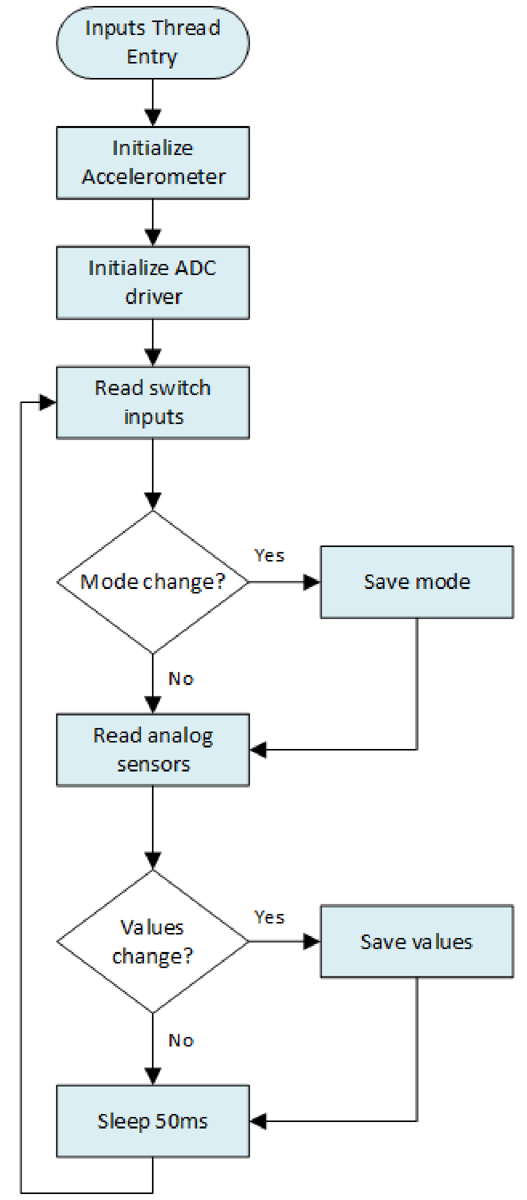

Figure 2 Simplified flowchart of Input Thread

1.1.2 LCD Thread

The LCD thread periodically wakes up, reads the current mode and sensor values, and displays these values to the Pmod LCD screen. The following figure shows the logic implemented in the LCD thread. The mode and sensor values are obtained by calling the two access functions provided by the inputs thread.

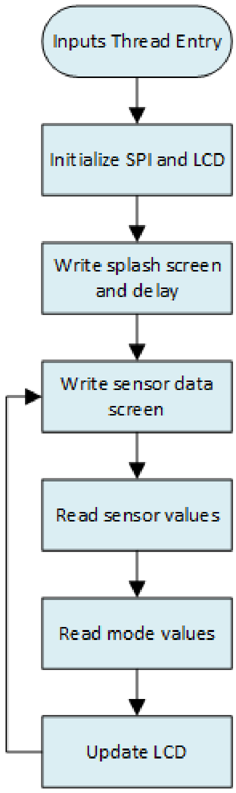

Figure 3 Simplified flowchart of LCD Thread

1.1.3 LED Thread

The LED thread must refresh the LEDs at a periodic rate driven by the voltage value present on either the light sensor or the potentiometer depending on the current mode selected by the operator. The standard `tx_thread_sleep()` call is used as the periodic delay.

When the LED thread wakes up it calls two different access functions, `inputs_get_sensor_values ()` and `inputs_get_mode ()`, to obtain the current sensor values. This is one of the benefits of threads, shared memory space. It allows the inputs thread to maintain a local copy of these variables while still providing access to those variables to the LED thread. The access functions eliminate the use of global variables and allow the sensor variables to have local scope inside the inputs thread.

2. Procedure to Create DK-S128 OOB Project

The following steps are used to recreate the DK-S128 OOB application project from scratch using the e^2 studio ISDE or IAR EW for Synergy.

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 '**Renesas Synergy C Executable Project**'.
3. Enter the project name and setup the Synergy license file.
4. Choose **Board S128 DK.**
5. Choose **BSP** option in the project template selection window.

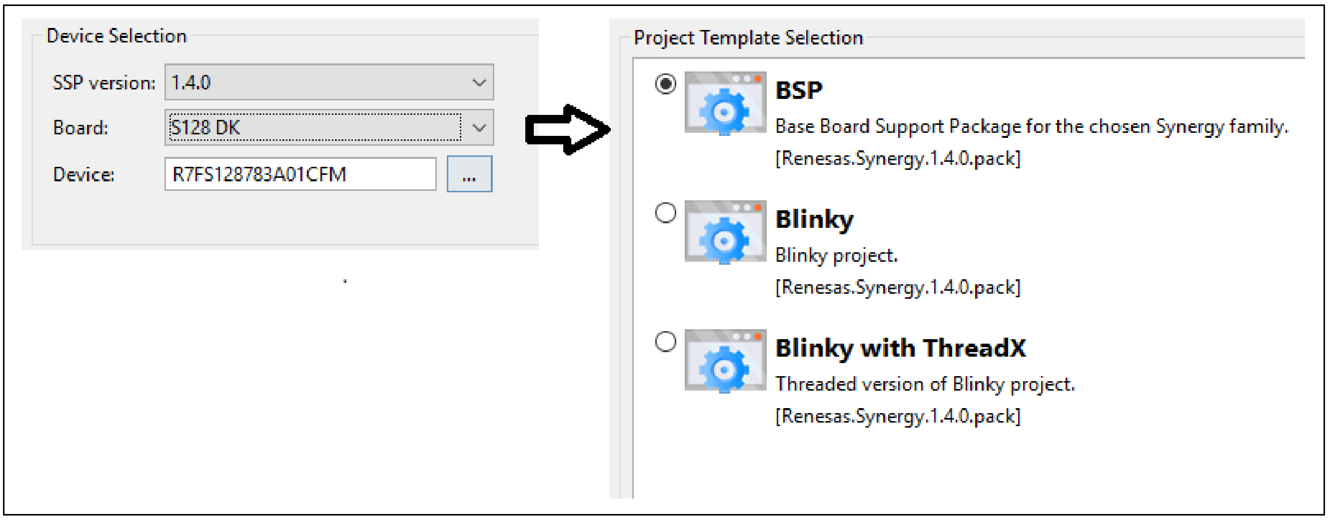

Figure 4 New Synergy project creation

Step 2: Create Input thread

1. Under the **Thread** tab, click the **'New Thread'** to create a new thread.
2. Set the property of this new thread as shown in the following figure.
3. In the **Inputs Thread Stacks** window, click the '**New Stack'** to add the ADC driver module **ADC Driver on r_adc** as shown in the following figure.

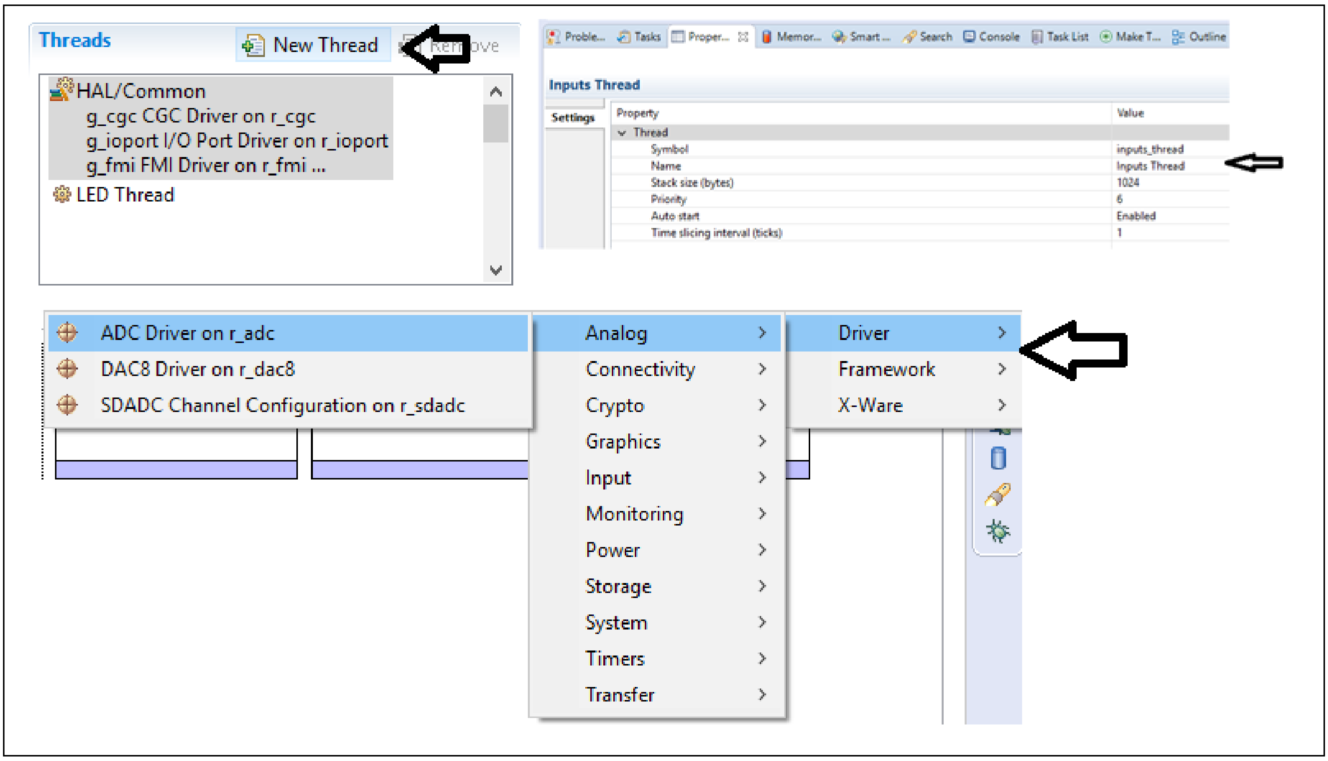

Figure 5 Adding ADC driver module

4. Go to the **Properties** tab for the ADC driver and select the resolution and channels as shown in the following figure. 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.

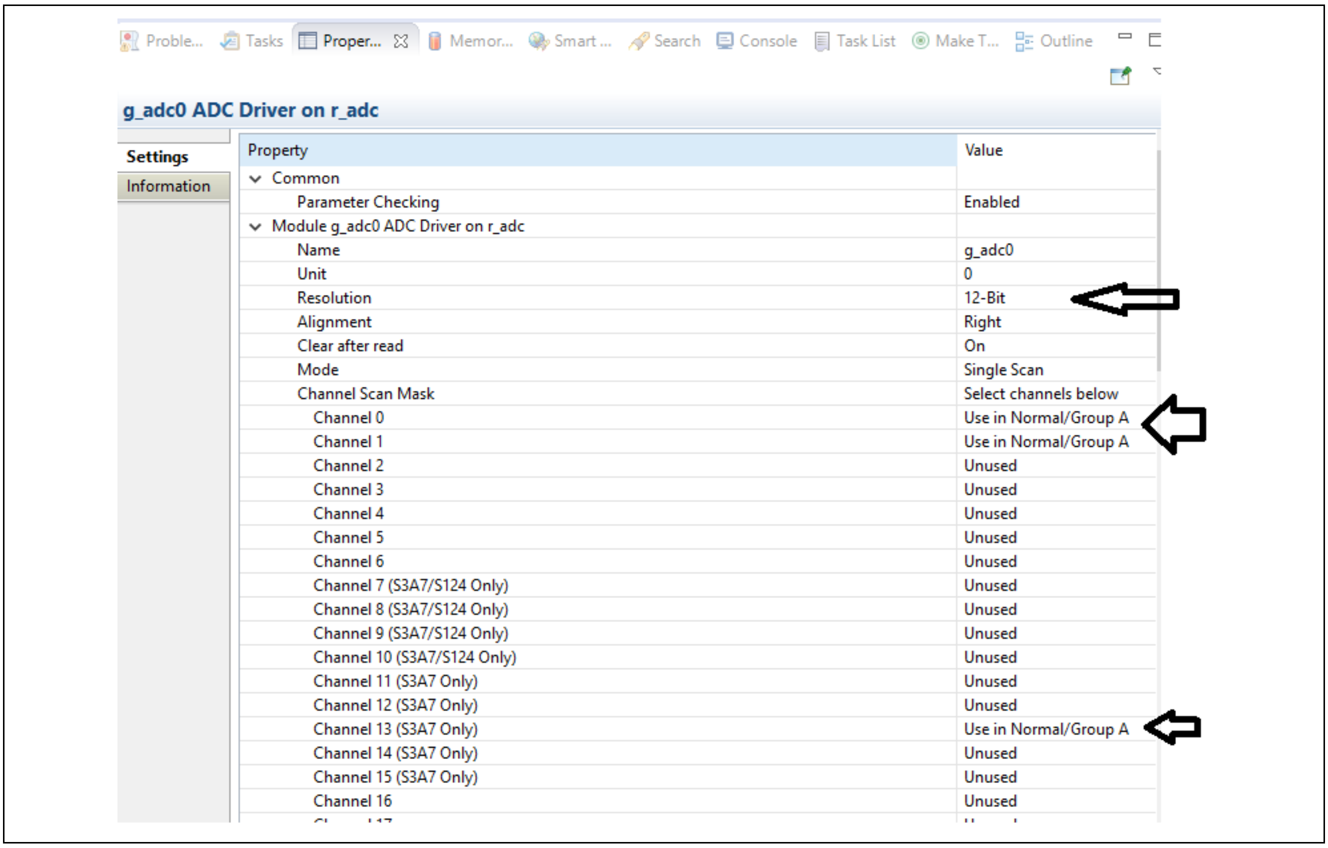

Figure 6 ADC Driver module properties

Step 3: Create LCD Thread

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

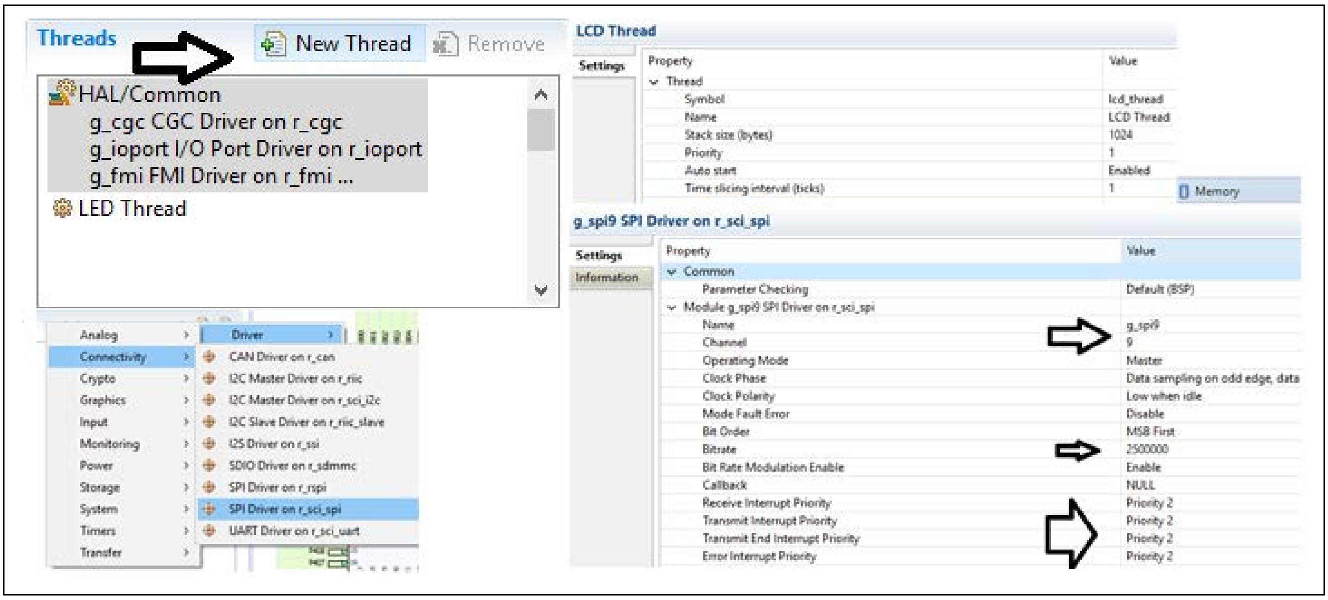

Figure 7 Adding SPI driver modules and its properties

Step 4: Create LED Thread

1. Go to the **Thread** tab, click the **+** sign to create a new thread.
2. Go to the **Properties** tab of LED thread and set the property of this new thread shown in the following figure.

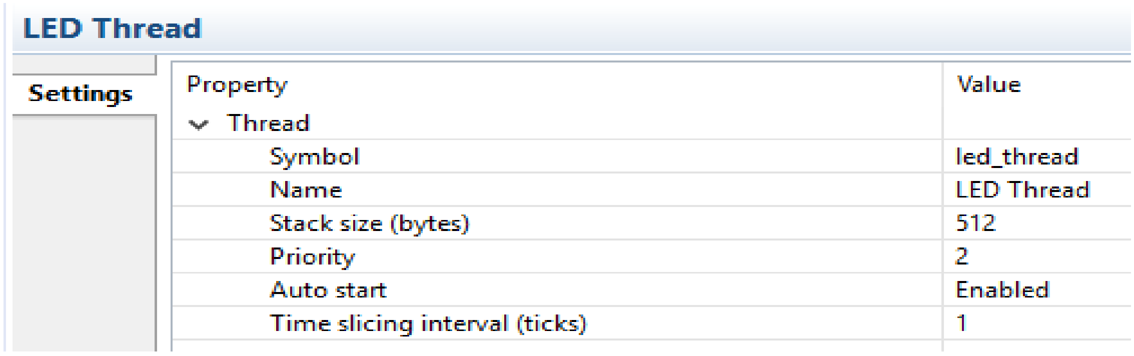

Figure 8 Led Thread properties tab

Step 5: Update Pin Configurations

Go to the **Pins** tab and change the pin configurations for the following ports shown in the following figure.

P205 to Output mode (PMOD_SS)
P302 to Output mode (PMOD_EN)
P111 to Output mode (PMOD_RST)
P303 to Output mode (PMOD_DC)
P201 to Output mode (LED2)

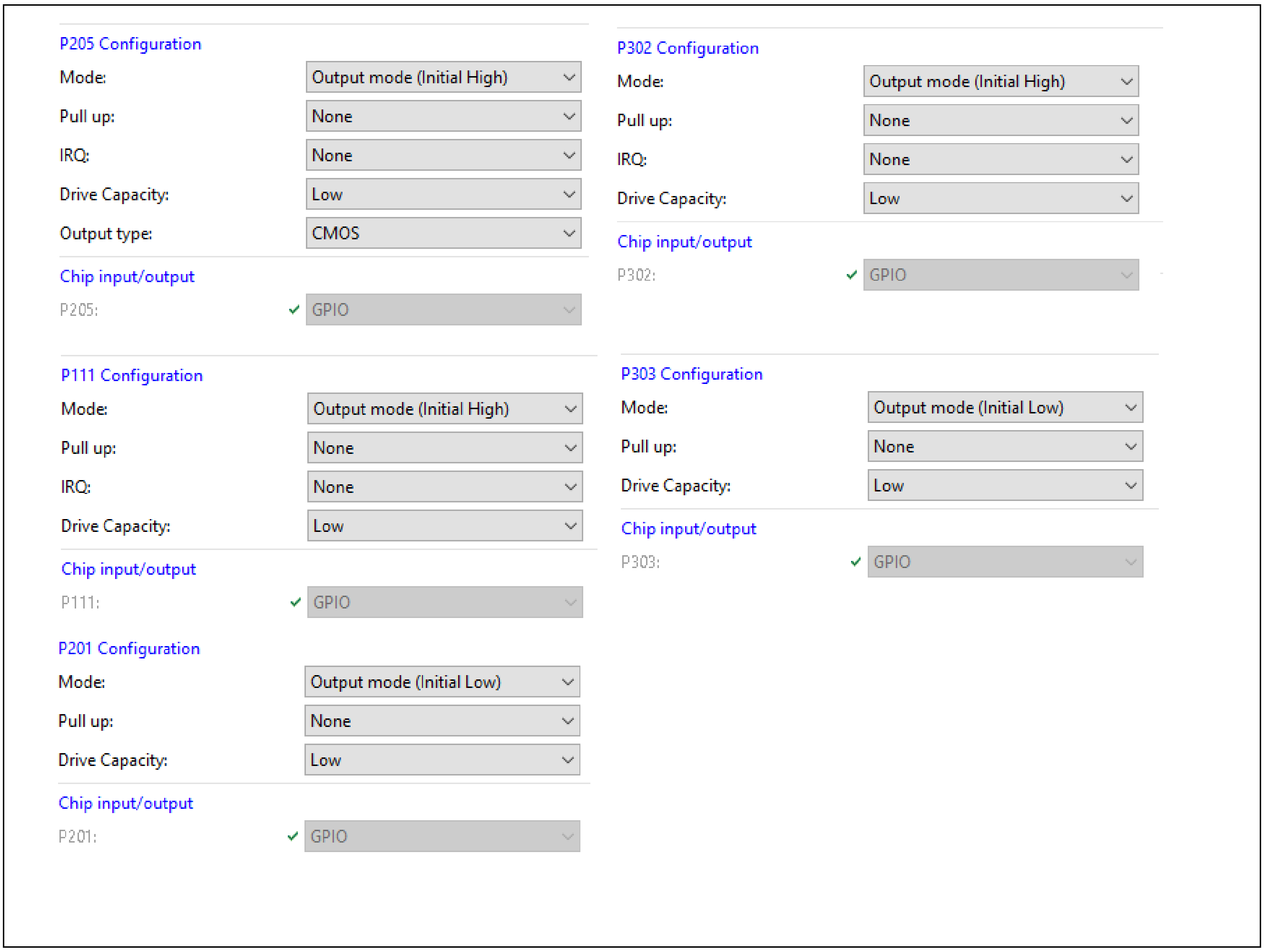

Figure 9 Pin Configuration

Step 6: Generate Project Content

Click the **Generate Project Content** button to generate the project files using the configuration options you selected.

Step 7: Application Project files

1. After Step 7, the e[2] studio ISDE generates the application project files with the configuration chosen.
2. Go to the **Project Explorer** window, under your project, open the **src** folder. The following figure shows the files generated for this application project.

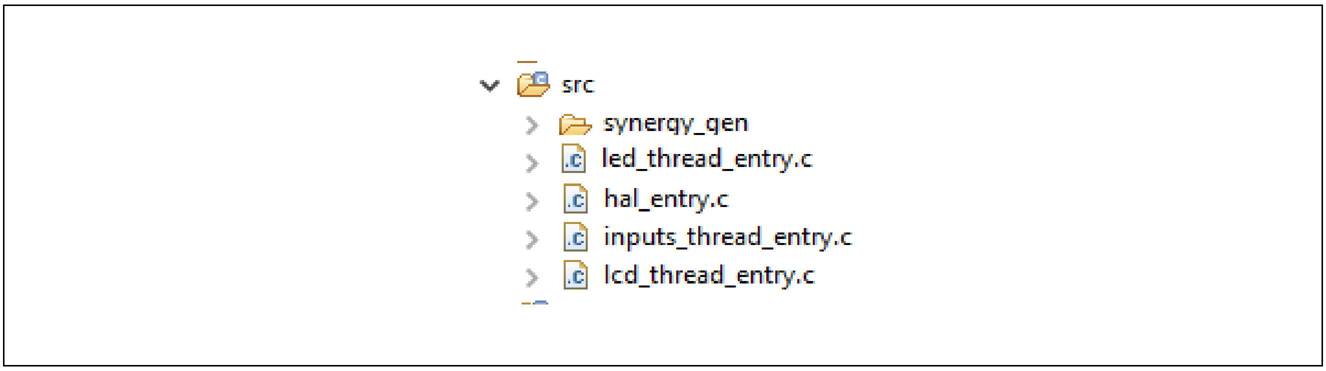

Figure 10 Generated Files

3. The files are placeholders for adding your application code. You can either write your own application functions for these threads or copy the existing `dk_s128_oob` demo application project source files to recreate this OOB demonstration.
4. If you are recreating this OOB demonstration, go to the existing `dk_s128_oob` project `src` folder and copy the following files/folders contents to your newly created project.
   `lcd_setup` (folder)
   `led_thread_entry.c`
   `inputs_thread_entry.c`
   `inputs.h`
   `lcd_thread_entry.c`
   `system_cfg.h`

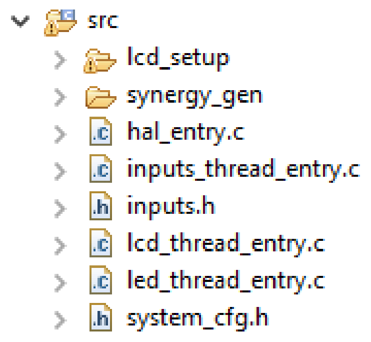

Figure 11 DK-S128 OOB Files

Step 8: Compiling the project

Build the application project by clicking the **hammer** icon as seen in the menu bar in the following figure.

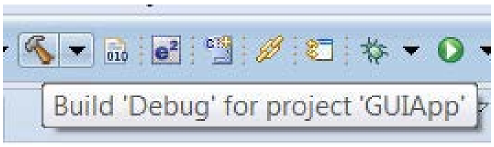

Figure 12 Build button

3. Running the Pre-existing DK-S128 Application Demonstration

3.1 Powering up the Board

This section describes how to connect the board to power, the J-Link debugger to the PC, and 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® OB (On-board). 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 *Importing a Renesas Synergy Project* (r11an0023eu0119-synergy-ssp-import-guide.pdf) for instructions on importing the project into e^2 studio ISDE, or IAR EW for Synergy, and building and running the project. It is also included in this package.

Note: You need to select the **dk_s128_oob Debug** GDB Hardware Debugging configuration for debugging.

3.3 Verifying the demonstration

1. Connect the Pmod LCD display (included as part of DK-S128 kit) to the Pmod connector J4.
2. Verify that the J3 header near the battery has two jumpers to make the connections, see the following figure.

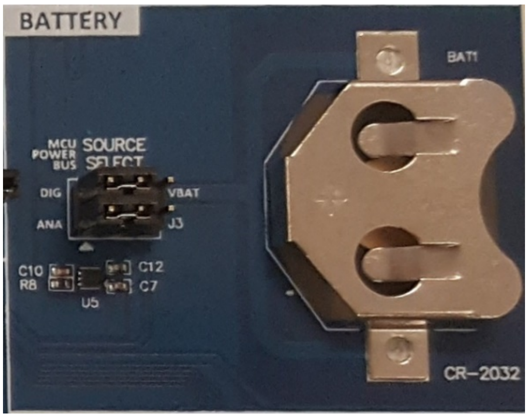

Figure 13 J3 Jumper setting

Refer to the following figure for the software settings needed to run this OOB demonstration.

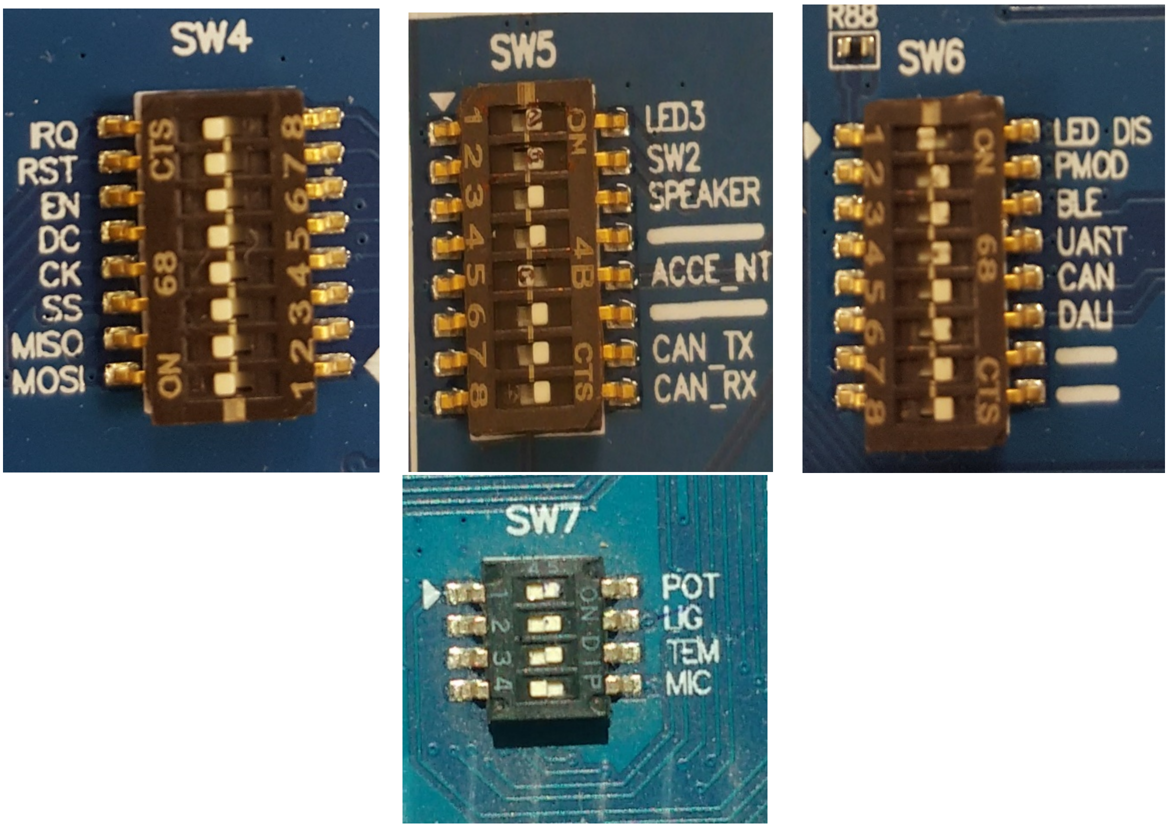

Figure 14 SW4/5/6/7 Settings for OOB Demonstration

Once the DK-S128 kit is plugged in, the board powers up and loads the OOB Demonstration. The three LEDS, LED1, LED2, and LED3 start flashing and the display shows a simple splash screen in the following figure on the Pmod™ LCD for 2 seconds.

This splash screen displays the board number and the version of the Out-of-Box software that shipped with this kit.

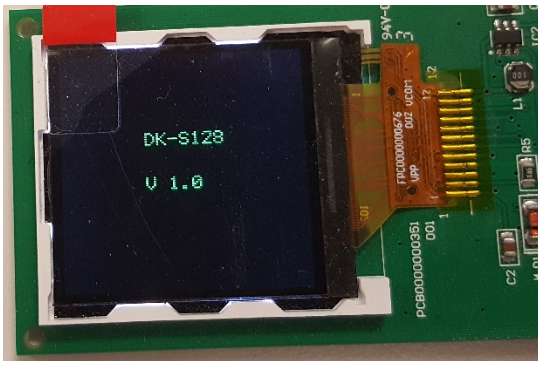

Figure 15 Initial LCD screen

After two seconds, the screen changes to the analog measurement screen shown in the following figure. The Out-of-Box application uses the A/D converter to read the voltage values present on the potentiometer (POT), the light sensor **U3** (APDS-9005) and the temperature sensor **U1** (TMP35). The program displays the raw hex values read from the light sensor and the potentiometer, and the program converts the analog value read from the temperature sensor to the equivalent Fahrenheit temperature.

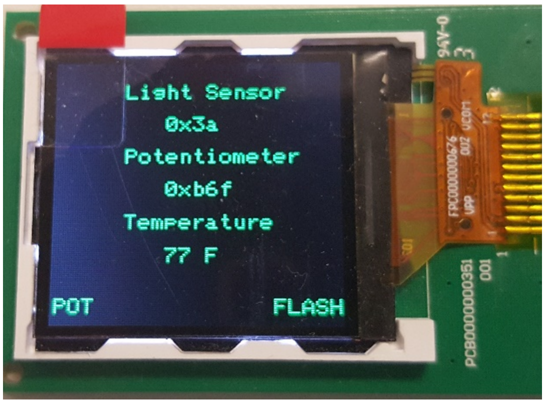

Figure 16 OOB Demonstration LCD Screen

You may interact with the Out-of-Box program in the following ways:

1. Toggle LEDs to alternate between flashing and chasing.

   The three LEDs, LED1, LED2, and LED3 all flash at once or chase each other. **Pushing the button S2** causes the LEDs to alternate between flashing and chasing. The bottom left corner of the screen indicates which mode the LEDS are operating in; FLASH/CHASE.

2. Toggle LED flash rate using either the light sensor or potentiometer.

   The flashing rate of the LEDs is determined by the value read from the light sensor or the potentiometer. You toggle between these two by **pushing the button S1**. The bottom right corner of the screen indicates which sensor is driving the LEDs flashing rate; POT/LIGHT.

3. Increase or decrease LED flashing using POT mode.

   With the POT mode selected **push S1**, rotate POT clockwise and counterclockwise.

   The flashing of the LEDS increases or decreases accordingly. The screen displays the raw value reported by the A/D converter.

4. Increase or decrease LED flashing using LIGHT mode.

   With the LIGHT mode selected **push S1**, move a light source (for example, a flashlight) closer and farther away from light sensor U3. Observe that the flashing rate of the LEDs changes. The raw hex value displayed to the screen also changes.

4. Next Steps

1. Visit http://renesassynergy.com/kits/dk-s128for more information about the DK-S128 development kit.
2. Visit renesassynergy.com/tools to learn more about development tools & utilities.
3. Visit http://www.renesassynergy.com/gallery to download development tools & utilities.
4. To learn more about:
   - Synergy kits at http://www.renesassynergy.com/kits
   - Synergy Microcontrollers at http://www.renesassynergy.com/microcontrollers
   - Synergy Software at http://www.renesassynergy.com/software
   - Synergy Solutions at http://www.renesassynergy.com/solution

5. Limitations and Assumptions

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

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 18, 2017	-	Initial version
1.01	Jan 19, 2018	-	Updated for the SSP v1.3.3
1.02	Mar 22, 2018	-	Updated to SSP v1.4.0

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