

Renesas Synergy™ Platform

DK-S3A7 Ambient Light Sensor Example

This application note describes the Ambient Light Sensor (ALS) Example Project that is pre-loaded on the DK-S3A7 Synergy™ MCU Development Kit. It includes the procedure to import the Example project, so that you can recreate or modify the program within Renesas Synergy™ e² studio Integrated Solutions Development Environment (ISDE).

The DK-S3A7 ALS Example uses the Renesas Synergy™ Software Package (SSP) and the DK-S3A7 Synergy MCU Group Development Kit. The example application drives the Segment LCD (SLCD) panel while monitoring an on-board Ambient Light Sensor (ALS). The SLCD includes several screens to show the status of both the RTC data and the ALS data items. The Example also includes the use of the LED I/O expansion and the Realtime Clock (RTC) features.

The example is fully integrated with ThreadX® RTOS and SSP Application Framework modules through the e² studio ISDE. The example includes source code for the following peripherals available on the DK-S3A7 Synergy MCU Kit:

- I²C communication
- SLCD control
- RTC time

The example also includes code that uses a subset of the ThreadX RTOS features:

- Multiple threads
- Message queues
- Mutex

Note: This application note does not provide details on the operation of the example code or guidelines on using the code in another design. This application note describes how to use the example to prove the installation of the tools, programming the device and some of the features of the DK-S3A7 board. Guidelines on how to leverage example code are found in this application note explaining specific functions and capabilities.

This application note describes the process for importing and building the Ambient Light Sensor demonstration for the DK-S3A7 Development Kit. It is a useful demonstration for showing the Synergy Tool flow and illustrating some of the features of the DK-S3A7 Synergy MCU. The demonstration also illustrates some of the key advantages provided by the integration of the ThreadX- RTOS with the SSP when implementing threaded designs.

Target Device

DK-S3A7 Synergy MCU Group Development Kit

Minimum PC Recommendation

- Microsoft® Windows® 7 or Windows 10
- Intel® Core™ family processor running at 2.0 GHz or higher processor
- 8 GB memory
- 250 GB hard disk or SSD
- USB 2.0
- Connection to the Internet

Installed Software

- Synergy e² studio ISDE v7.3.0 or later
- Synergy Software Package (SSP) v1.6.0 or later
- IAR Embedded Workbench® for Renesas Synergy™ v8.23.3 or later
- Synergy Software Configurator (SSC) v7.3.0 or later

Note: If you do not have one of these software applications you should install it before continuing.

Intended Audience

The intended audience is a user who wants to use the SLCD, RTC, I2C, mutexes and message queues within their Renesas Synergy™ Platform development.

Contents

1. ALS Program Description	3
2. DK-S3A7 Development Kit Setup	3
3. Import the Project into e ² studio	4
4. Open the IAR EW for Synergy Project	5
5. Ambient Light Sensor Example.....	5
5.1 Boot Up Initialization.....	5
5.2 System Thread operation	6
5.2.1 Run Mode description	6

1. ALS Program Description

The ALS example program consists of four threads. The System Thread, SLCD Thread, LED Bar Thread and the ALS Thread. Each is designed to work at a type of task, shown in the following figure. Each of the threads use an instance of the required SSP Module, that are highlighted in beige boxes.

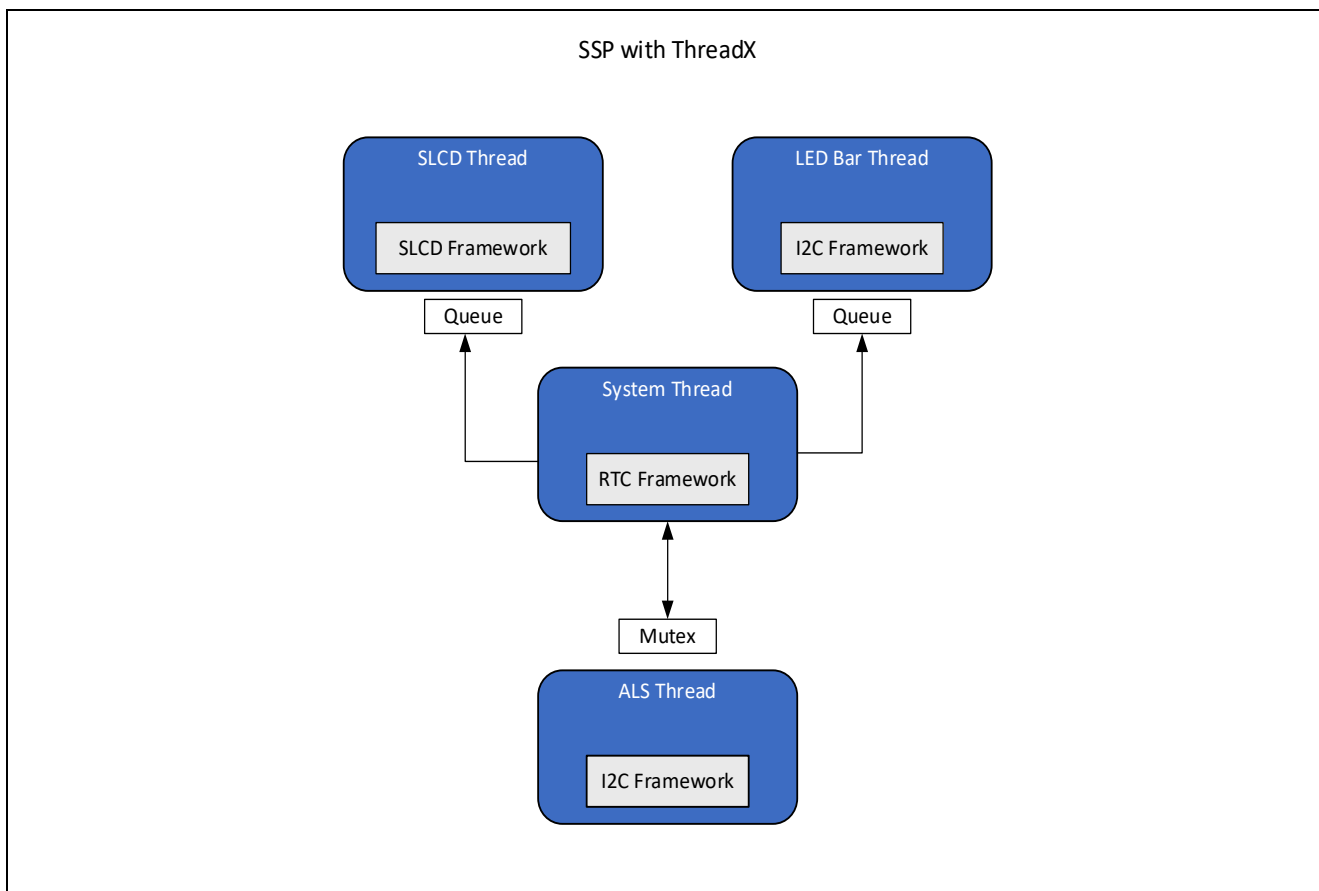


Figure 1. Ambient Light Sensor Program Architecture

The System Thread acts as a central manager to control the general operation of the example. It collects time data from the RTC Framework SSP Module instance through its SSP API. Using ThreadX message queues, the System Thread sends simple unidirectional messages to communicate with the SLCD and LED Bar Threads which controls their behavior. Message queues are a powerful feature of the ThreadX RTOS. Their use in these threads can serve as a simple illustration of how they are usually implemented.

The ALS data is retrieved from the ALS Thread task, through a data get function that uses the ThreadX RTOS mutex (mutual exclusion) feature for bidirectional communication between two threads. The use of a mutex is required to guarantee only one thread accesses the data at a time. This avoids time dependent access mistakes that can occur without such an exclusion capability. The example mutex implementation illustrates this important capability, one that ThreadX integration within SSP dramatically simplifies.

2. DK-S3A7 Development Kit Setup

Shown in the following figure is the DK-S3A7 board and associated components used by the ALS example. Note the location of the light sensor, the light scale and the SLCD panel that are the primary user interface elements of the demonstration.

Connect a Type A male to Micro-B male cable between your computer and connector J15 of the DK-S3A7 board. When connected correctly, LED13 will light green.

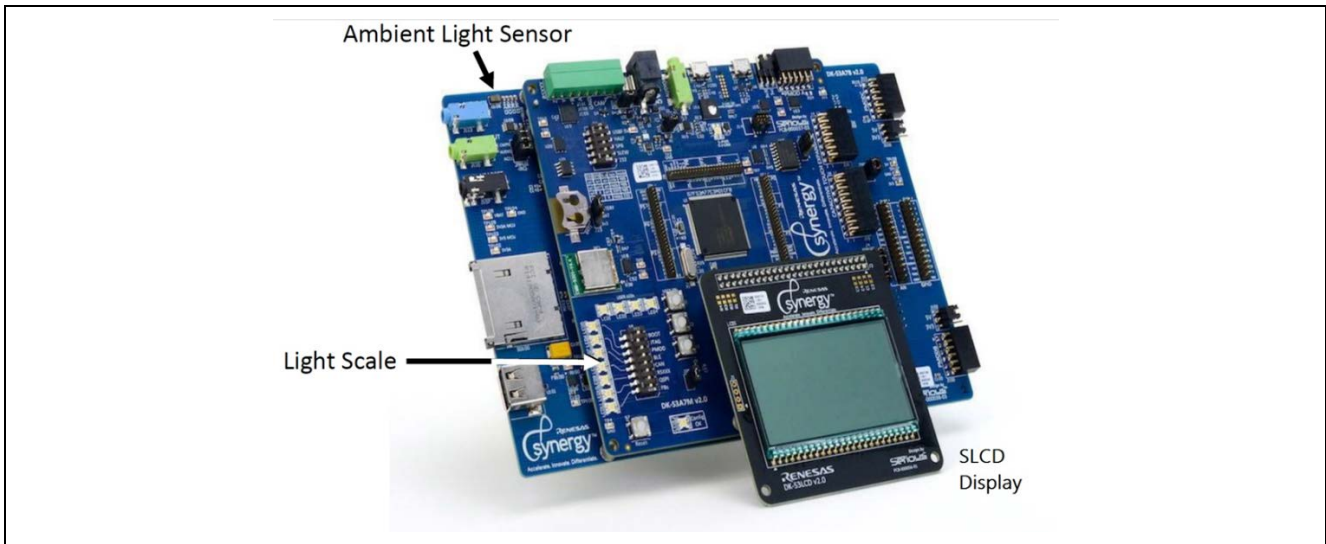


Figure 2. Key Features for Ambient Light Sensor example for DK-S3A7 Development Kit

3. Import the Project into e² studio

1. Refer to the *Synergy Software Package Import Guide (r11an0023eu0121-synergy-ssp-import-guide.pdf)* included in this package, for instructions on importing the completed project into the e² studio ISDE and building the project. The included **DKS3-A7-ALS_OOB_image_source.zip** file contains the complete project.
2. When asked to select the Debug configuration, select the **DKS3OoBoxV120 Debug** configuration under **Renesas GDB Hardware Debugging**, as shown in the following figure.

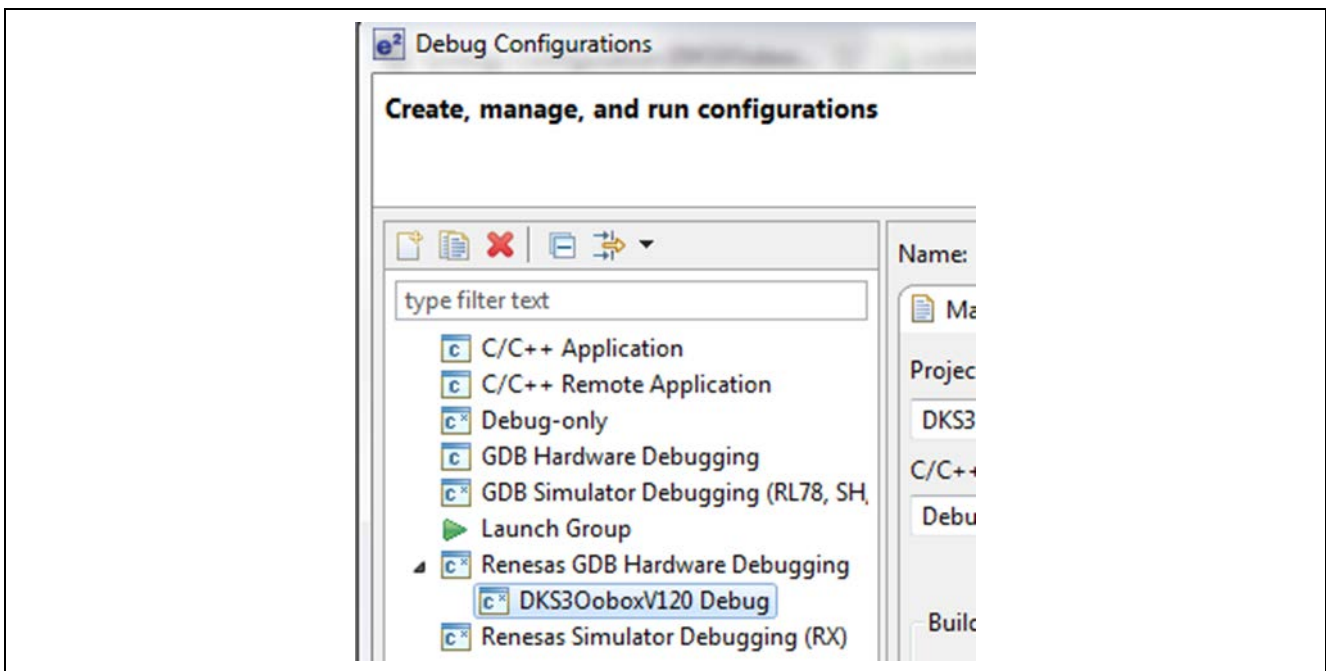


Figure 3. DKS3OoBoxV120 Debug Configuration

4. Open the IAR EW for Synergy Project

1. The SSP needs to be installed into the SSC before opening the IAR EW for Synergy workspace. After opening the IAR EW Workspace, go to **Renesas Synergy > Settings** and point IAR EW to the location where you installed SSC v6.2.0 and the associated SSP License file, shown in the following figure.

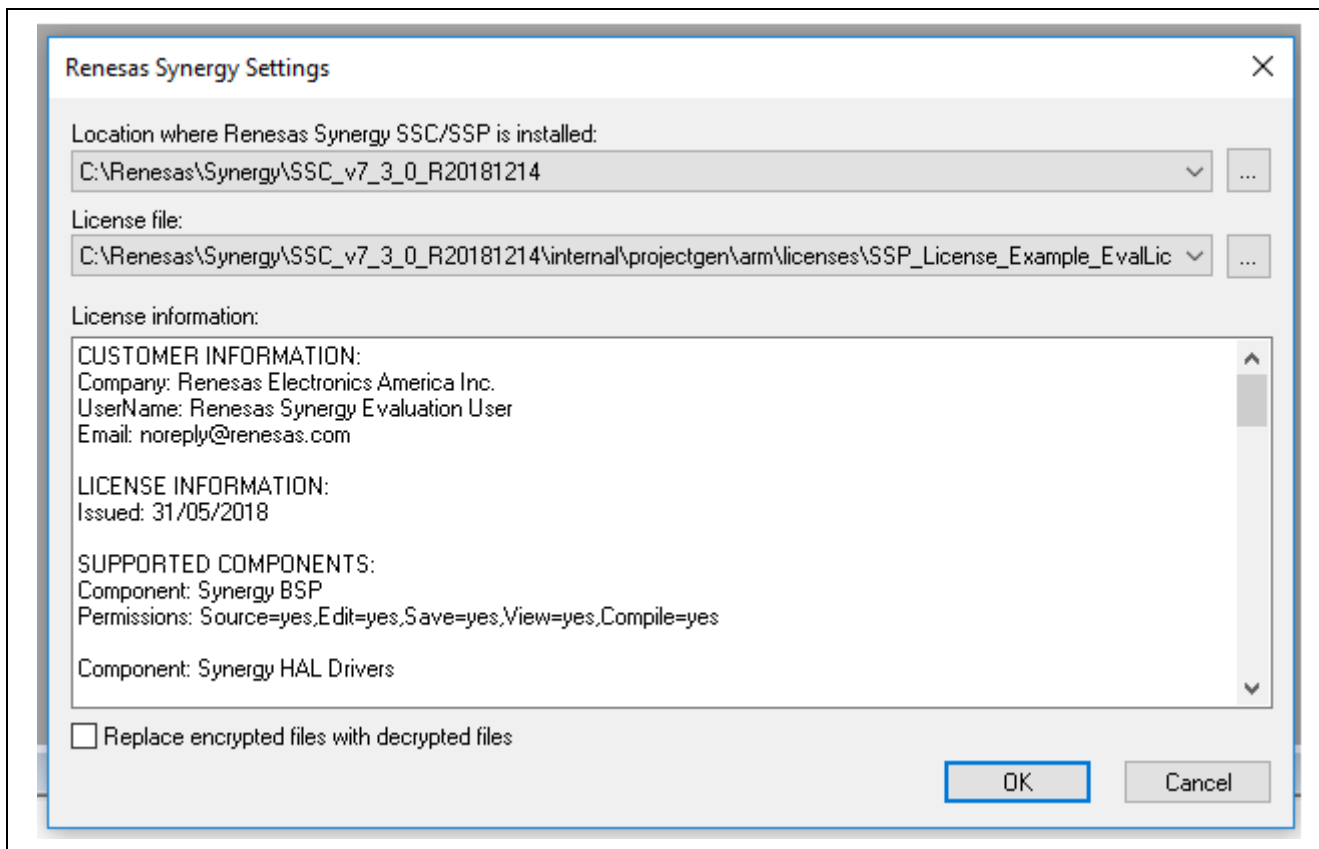


Figure 4. Location where the Renesas Synergy SSC/SSP is installed

2. Go to **Project->Rebuild All** in the IAR EW. Click the green arrow to download and debug the project.

5. Ambient Light Sensor Example

This section describes the various elements and features of the ALS example.

5.1 Boot Up Initialization

After the example program is started (on power-up or reset, for instance), the SLCD screen and the LED bar cycles ON and OFF, with all the LEDs and segment LEDs shown in the following screenshot. After several seconds, the screen changes to briefly show the firmware version number (1.2 for this release, as Figure 6 shows). After the version displays, the example program then enters the Run Mode state.



Figure 5. DK-S3A7 SLDC Panel Elements

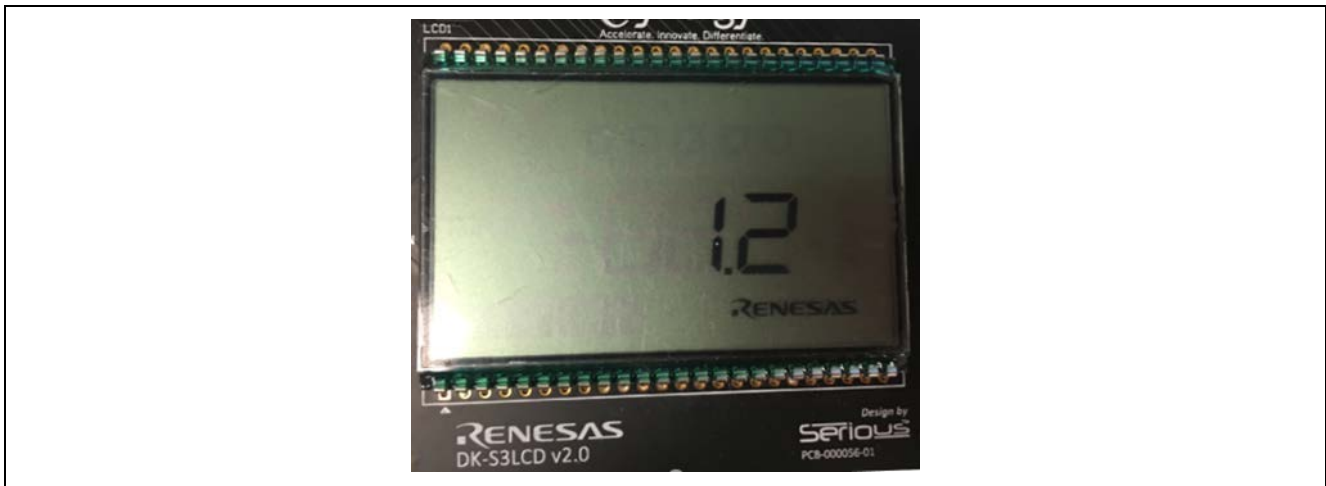


Figure 6. Example version number

5.2 System Thread operation

The System Thread uses a state machine to sequence its operation. The following figure shows the state transition diagram for the System Thread. The different system states are as follows:

- Initialize: Power up sequence flashes LEDs and SLCD image.
- Show Version: Shows the current Firmware version number for a few seconds.
- Run Mode: Collects ALS data and RTC time data and presents on LED bar graph and SLCD information.
- Over-Range: If ALS data is over 255, flashes SLCD ON and OFF. Stays in the Over Range state while ALS data is over 255. It returns to the Run Mode state when ALS data is back to normal, below 255.

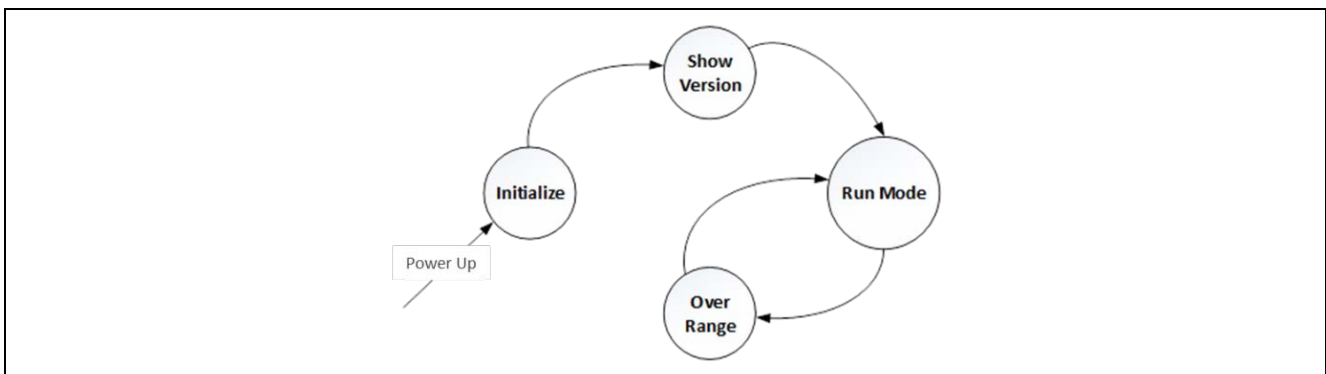


Figure 7. Example state transition diagram

5.2.1 Run Mode description

When the example program enters the Run Mode, the SLCD clears previously displayed data. The System Thread then begins to collect the ALS and RTC data. The ALS data is displayed on the SDLC and the LED Bar graph. The ALS data is displayed with a numerical value of 0-255, along with the Battery Bar Level indicator.

If the ALS data reaches the maximum value, the SLCD flashes ON and OFF. This indicates that it is in the Over-Range state.

The SLCD goes back to the normal Run Mode display when the ALS data goes below the maximum value.

The RTC seconds and minutes data is also displayed on the SLCD. Note that the PM indicator display is fixed and does not change. The same is true for the Renesas logo. As shown in example display in the following figure.



Figure 8. Run Mode display

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
Microcontrollers	www.renesas.com/synergy/mcus
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.17.17	-	Initial release
1.01	Sep.27.17	1	Required resources of SSP version changed
1.06	Jan.17.18	-	Updated for SSP v1.3.3
1.07	Feb.26.18	-	Updated for SSP v1.4.0
1.08	Mar.06.19	-	Updated for SSP v1.6.0

Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
 2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
 3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
 4. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
 5. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.
 - "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.
 - "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.
- Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user's manual or other Renesas Electronics document.
6. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
 7. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
 8. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
 9. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
 10. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
 11. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
 12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.

(Note2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.4.0-1 November 2017)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

Contact information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:
www.renesas.com/contact/.