Quick Start Guide

Application Example for Capacitive Touch (AE-CAP1)

Quick Start Guide

Renesas Synergy™ Platform

Synergy Solutions

Kits: AE-CAP1

All information contained in these materials, including products and product specifications, represents information on the product at the time of publication and is subject to change by Renesas Electronics Corp. without notice. Please review the latest information published by Renesas Electronics Corp. through various means, including the Renesas Electronics Corp. website (http://www.renesas.com).

Renesas Electronics
www.renesas.com

Rev.1.01 Apr 2018

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.

(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.

(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.4.0-1 November 2017)

General Precautions

1. Precaution against Electrostatic Discharge (ESD)

A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.

2. Processing at power-on

The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.

3. Input of signal during power-off state

Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.

4. Handling of unused pins

Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.

5. Clock signals

After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.

6. Voltage application waveform at input pin

Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).

7. Prohibition of access to reserved addresses

Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.

8. Differences between products

Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

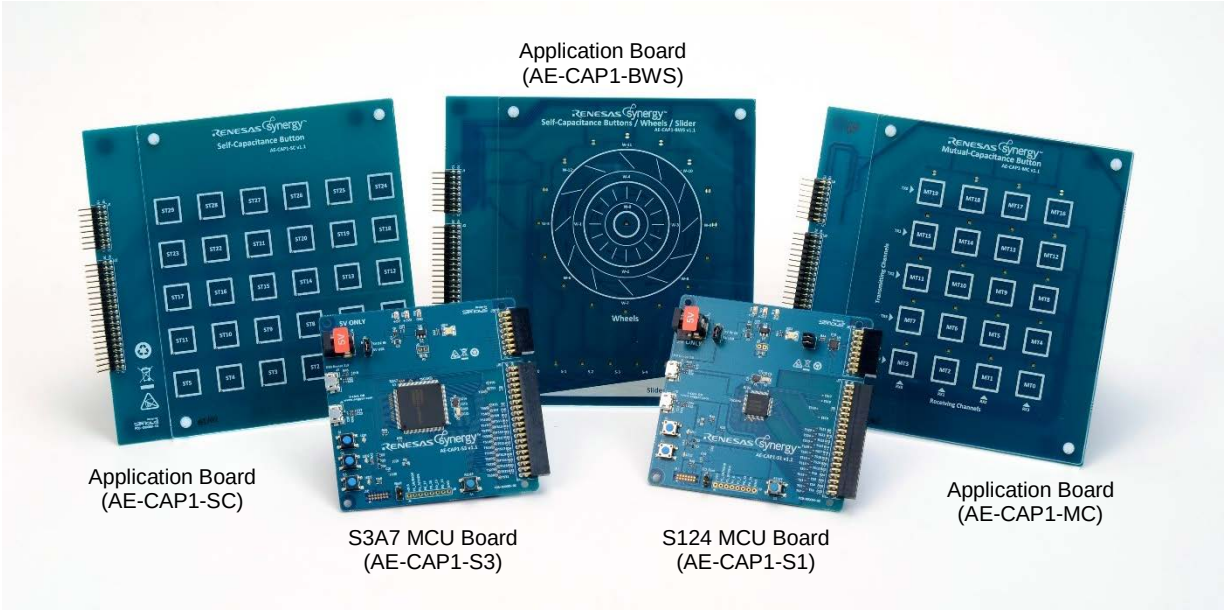
Renesas Synergy™ Platform

Application Example for Capacitive Touch (AE-CAP1)

R12QS0016EU0101
Rev.1.01
Apr 9, 2018

1. In the box

The Renesas Synergy™ Application Example for Capactive Touch (AE-CAP1) kit includes five PCBs:



Not pictured are two USB A to Micro B Cables and a 5V output 2A 12w power adapter, as well as this Quick Start Guide (QSG).

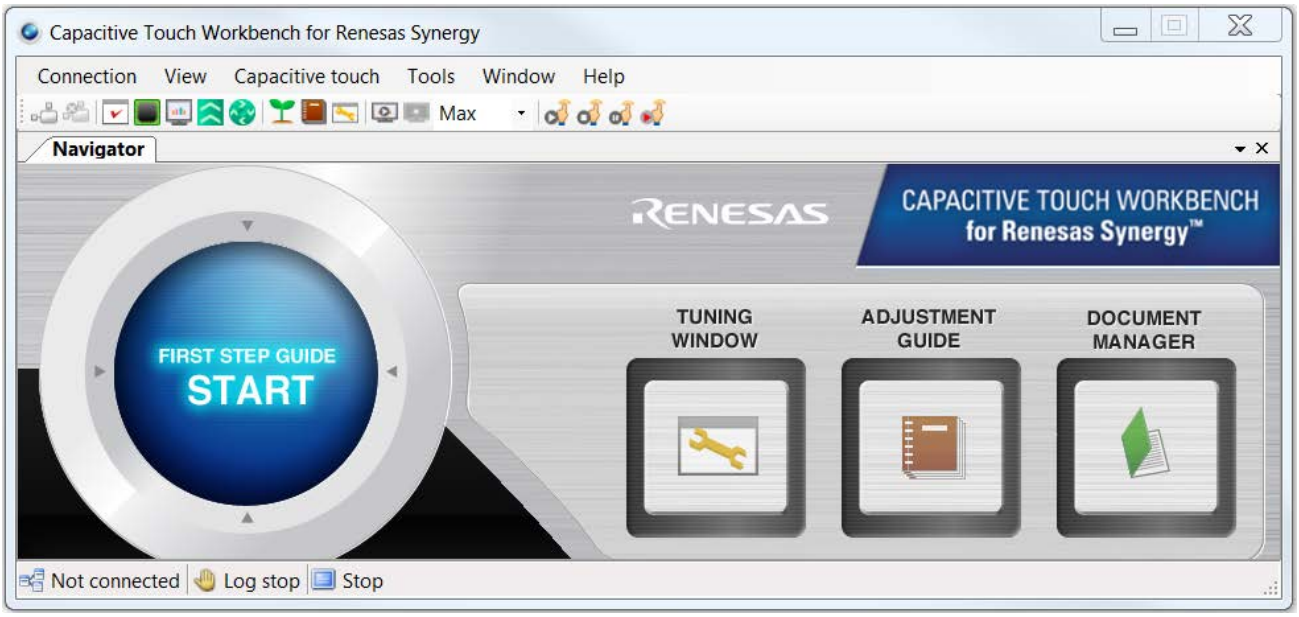
If any components from the box are missing or damaged, contact your local sales representative or the Renesas Electronics office for assistance.

2. Overview

The Renesas Synergy AE-CAP1 kit enables rapid evaluation, prototyping, development, and testing of the Renesas world-class capacitive touch technology with Synergy Platform Microcontrollers (MCUs) from the S3A7 or S124 group.

This QSG walks you through the setup and operation of the AE-CAP1 hardware, and the monitoring of the MCU's capacitive touch performance using the Capacitive Touch Workbench for Renesas Synergy™.

3. Capacitive Touch Workbench for Renesas Synergy™



The Capacitive Touch Workbench for Renesas Synergy™ (CTW for Synergy) is a PC-based tool that aids tuning and optimization of touch-sensing parameters, and defines touch areas and buttons using your touch-enabled application on Synergy Kits.

To use CTW for Synergy to peform sensor tuning and sensor data monitoring, you first need to download the workbench and its accompanying user manual from 'SSP Utilities' section of the Synergy Software Package (SSP) on the Synergy Gallery website: https://synergygallery.renesas.com.

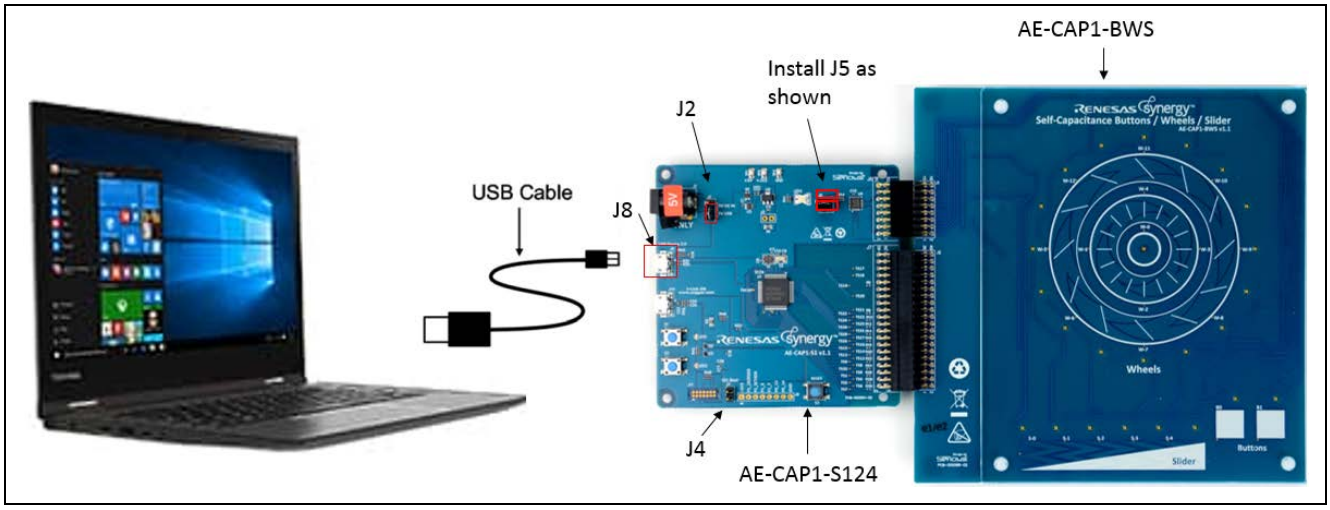
Windows versions supported: The CTW for Synergy supports Windows 7 and Windows 10. See the latest version of the *Capacitive Touch Workbench for Renesas Synergy™ User's Manual* for system requirements, installation instructions, and supported Synergy MCU Groups and Kits.

4. Running the Out-of-Box Demo

The Out-of-Box Demo pre-programmed on MCU boards supports only the Buttons/Wheels/Slider (BWS) application board (AE-CAP1-BWS). You can find sample programs for the other MCU and application board combinations from http://www.renesassynergy.com/kits/ae-cap1.

4.1 AE-CAP-S1 and AE-CAP1-BWS Out-of-Box Demo

4.1.1 Connecting the AE-CAP1-S1 and BWS board components



S124 Buttons/Wheels/Slider application board connections

1. Connect the AE-CAP1-S1 and AE-CAP1-BWS boards together.
   - J5 is the LED control on the application board.
   - J4 is for booting from on-chip flash memory programming routine. Keep it open.
   - J2 is for power selection and by default J2 is set for 5V USB. Use the default setting.
2. Connect J8 to your Windows PC using the included USB cable.

Confirm your board settings, and then connect the system to your Windows PC.

4.1.2 Running the AE-CAP1-S1 and BW Out-of-Box Demo

To observe and operate the system:

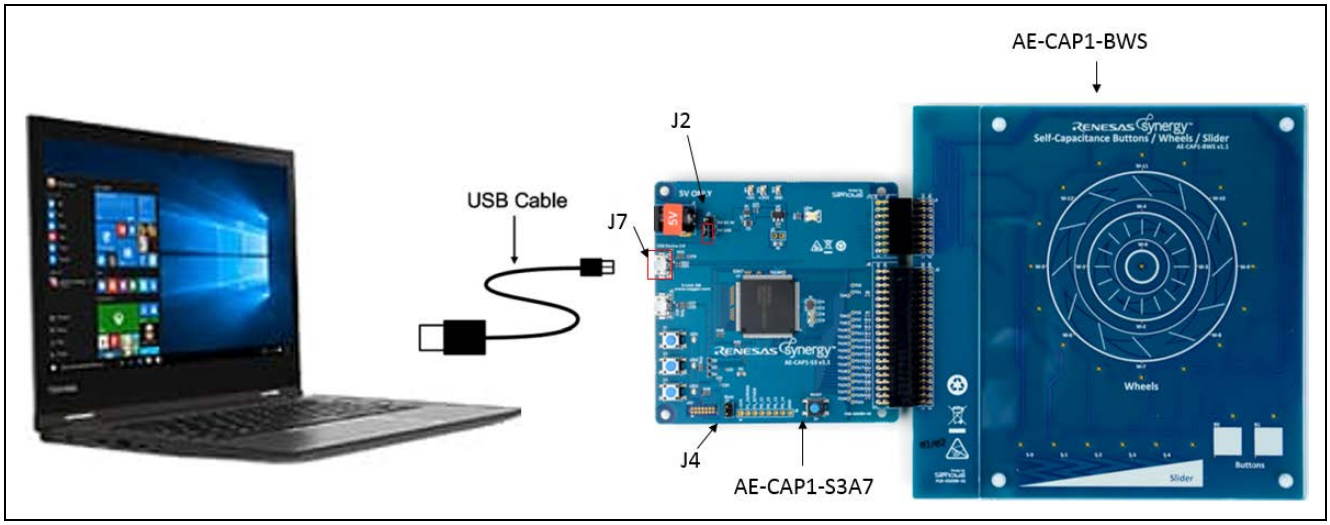
1. At power on, the system performs an auto-tuning test on the BWS board (about 2 seconds).
2. Once auto tuning is done, the AE-CAP1-S1 board LED1 (Red) and LED2 (Green) blinks five (5) times.

Note: Do not touch the boards before LED1 and LED2 start to blink.

3. If auto-tuning is successful, LED2 (Green) continues to blink.
   A. Touch buttons B0, B1, and W-0.
      Observe that the corresponding LEDs light up.
   B. Using your finger, slide the slider.
      Observe the corresponding LEDs light up with your finger movement.
   C. Move your finger along the inner and outer wheel.
      Observe the LEDs lighting up with your finger movement.
4. If auto-tuning fails, LED1 (Red) alone blinks to indicate a hardware failure.
   If you get a hardware failure:
   A. Make sure you are using the correct application board, AE-CAP1-BWS.
   B. Make sure the boards you are using are placed on a non-conductive surface.

4.2 AE-CAP-S3 and AE-CAP1-BWS Out-of-Box Demo

4.2.1 Connecting the AE-CAP1-S3 and BWS board components



S3A7 Buttons/Wheels/Slider application board connections

1. Connect the AE-CAP1-S3 and the AE-CAP1-BWS boards together.
   - J4 is used to boot from on-chip flash memory programming routine. Keep it open.
   - J2 is used to select power. J2 is set by default to 5V USB. Use the default setting.
2. Connect J7 to your Windows PC using the included USB cable.

4.2.2 Install USB CDC Driver for Windows 7 PC

The AE-CAP1-S3 communicates with CTW for Synergy via the USB port.

1. For Windows 7, install the USB CDC Device driver.
   See *AE-CAP1 Out-of-Box Demo Programming Guidelines*. See the References section for a link.
2. Install the USB CDC driver before proceeding.
   There is no need to install the USB driver for Windows 10 PC.

4.2.3 Running the AE-CAP1-S3 and BWS Out-of-Box Demo

To observe and operate the system:

1. At power on, the system performs an auto-tuning test on the BWS board (approximately 2 seconds).
2. When the auto-tuning is done, AE-CAP1-S3 board LED1 (Red), LED2 (Yellow) and LED3 (Green) blinks five (5) times.

Note: Do not touch the boards before LED1, LED2 and LED3 start to blink.

3. If auto-tuning is successful, LED3 (Green) continues to blink.
   A. Touch buttons B0 and B1 and W-0. Observe the corresponding LEDs light up
   B. Using your finger, slide the slider.
      Observe the corresponding LEDs light up with your finger movement.
   C. Move your finger along the inner and outer wheel.
      Observe the LEDs lighting up with your finger movement.
4. If auto-tuning fails, LED1 (Red) alone blinks to indicate a hardware failure.
   If you get a hardware failure:
   A. Make sure you are using the correct application board, AE-CAP1-BWS.
   B. Make sure the boards you are using are placed on a non-conductive surface.

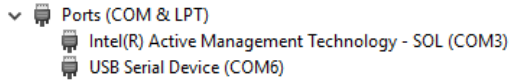
5. Running touch sensor monitoring using the Capacitive Touch Workbench for Renesas Synergy

5.1 Configuring the PC for touch sensor monitoring

Note: Only the Out-of-Box Demo for the S3A7 MCU Board is able to communicate with the CTW for Synergy. Sample applications for the S124 MCU Board that can be used CTW for Synergy can be downloaded from http://www.renesassynergy.com/kits/ae-cap1.

1. When the S3A7 device green LED continues to blink (successful auto-tuning), open the Device Manager on your PC. Double check the enumeration exists.

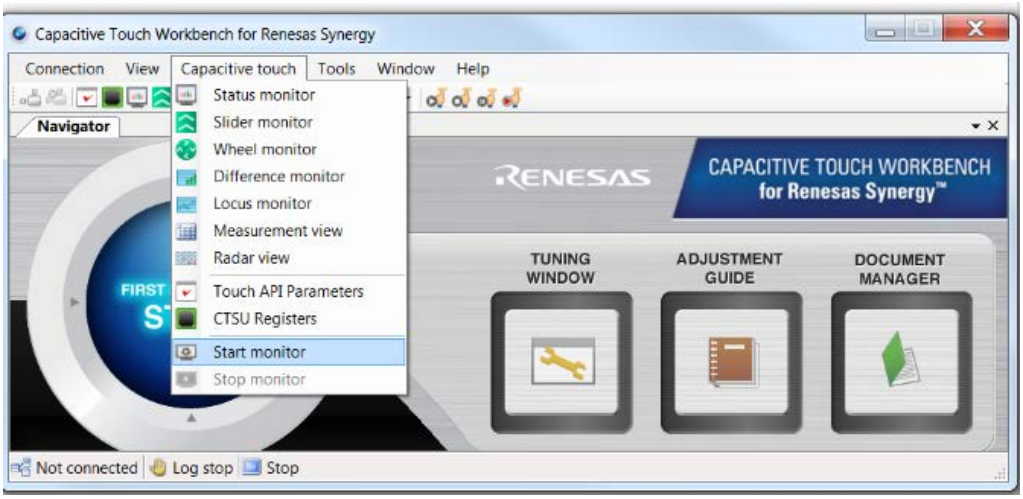
   On a Windows 10 PC, the USB connection enumerates as a COM Port named **USB Serial Device**. Your COM number may be different from the one shown.



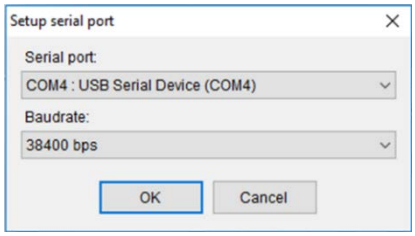
2. For Windows 7 system, install the USB CDC Device driver according to *AE-CAP1 Out-of-Box Demo Programming Guidelines*. See the References section for a link.

5.2 Launching touch sensor monitoring

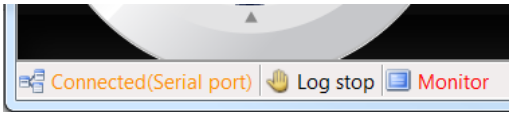
1. From the Windows Start menu, launch the Renesas CTW for Synergy (CTW for Synergy) icon.



2. Click **Start monitor** from the menu.
   The Start monitor menu is under the **Capacitive touch** tab on top of CTW for Synergy application window.



3. On the pop-up window, select the COM port corresponding to the enumerated COM port you identified earlier. Windows 10 is shown in the example. The system supports the baudrates available in the dropdown menu.



4. Click OK and wait momentarily.
   Notice that the connection status (at the bottom of the window) changes. The black status **Not connected** changes to the orange status **Connected (Serial port)**.

5.3 Experimenting with sensor monitoring options

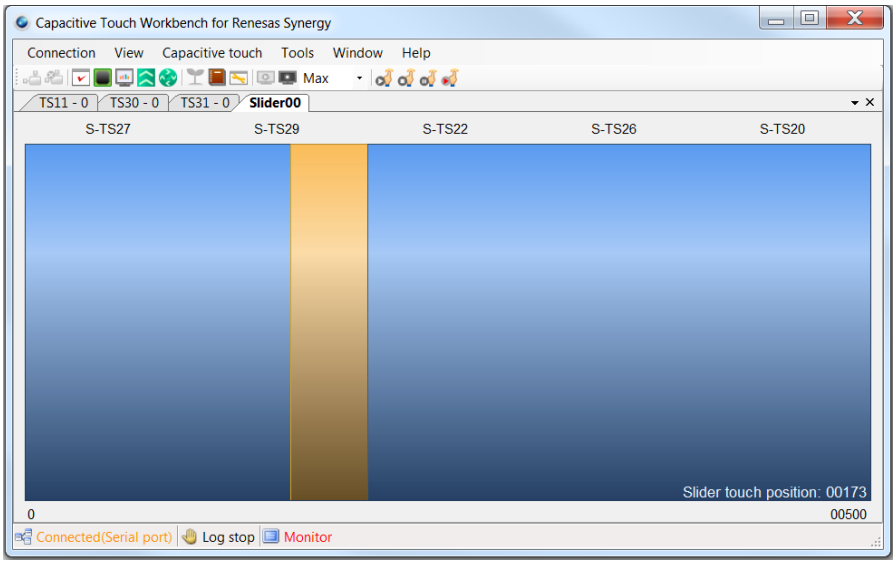
Several windows are available to monitor status and fine-tune existing capacitive touch thresholds. For details on window options and usage, see *Capacitive Touch Workbench for Renesas Synergy User's Manual* on the Synergy Software Package 'SSP Utilities' section at the Synergy Gallery website: https://synergygallery.renesas.com.

5.3.1 Monitoring status

Status Monitor

Click **Capacitive Touch** > **Status Monitor** to bring up the configured channel one at a time.
In the example shown, observe the blue sensor baseline, the green threshold, and the red sensor count value. A bump on the red line that passes the threshold value represents a sensed touch event. TS11 correlates to the center button W-0 on the wheel and TS30/31 correlate to the buttons B0 and B1 on the lower right.

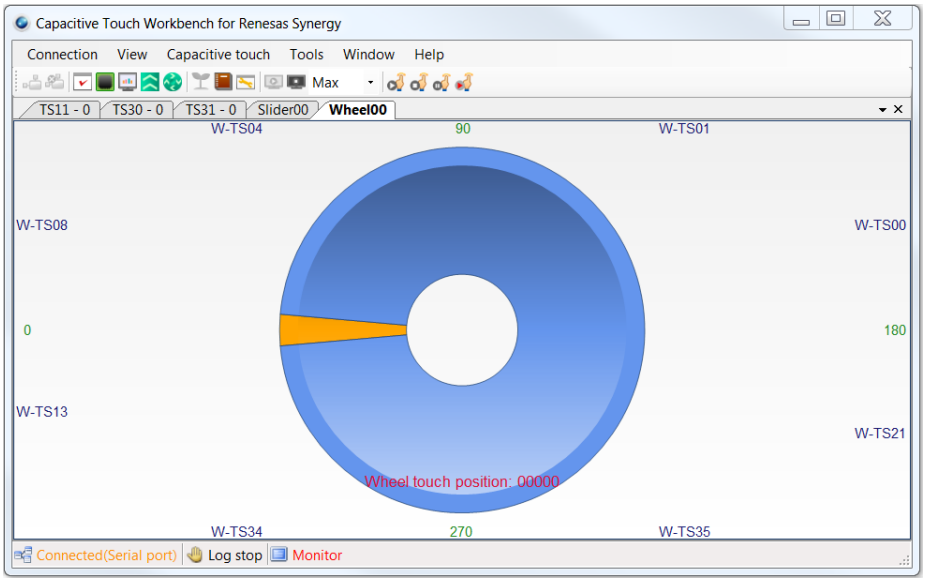
5.3.2 Monitoring the slider



Slider Monitor

1. Click **Capacitive Touch** > **Slider Monitor** to bring up below slider view.
2. Run your finger across the Slider on the BWS board.
   Observe the yellow band going left and right following the finger movement.

5.3.3 Monitoring the wheel



Wheel Monitor

1. Click **Capacitive Touch** > **Wheel Monitor** to bring up below wheel view.
   Wheel00 corresponds to the outer wheel with the demo code.
2. Run your finger along the outer Wheel.
   Observe the yellow arrow spin around following the finger movement. Similarly, you can right click anywhere in the Wheel00 window to activate Wheel01 as the inner wheel and observe the behavior

6. References

1. To learn more about the Synergy Software Package, development tools, and utilities visit http://www.renesassynergy.com/ssp and http://www.renesassynergy.com/tools.
2. Download the application note, *AE-CAP1 Out-of-Box Programming Guide*, from http://www.renesassynergy.com/docs to learn more about hardware and software for this kit. This application includes S124 MCU Board projects to communicate with the CTW for Synergy via the UART port.
3. Download the application note, *Capacitive Touch Hardware Design and Layout Guide*, from http://www.renesassynergy.com/docs to learn about the hardware design guidelines for Renesas capacitive touch applications.
4. Download the application note, *Synergy Capacitive Touch Tuning*, from http://www.renesassynergy.com/docs to learn about the capacitive touch tuning with CTW for Synergy.

Next steps

Learn more about:

- Synergy kits at http://www.renesassynergy.com/kits
- Synergy Microcontrollers at http://www.renesassynergy.com/microcontrollers
- Synergy AE-CAP1 Application Projects at http://www.renesassynergy.com/kits/ae-cap1
- Synergy Software at http://www.renesassynergy.com/software
- Synergy Solutions at http://www.renesassynergy.com/solutions

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

All trademarks and registered trademarks are the property of their respective owners.

Revision History

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Apr 28, 2017	-	First release
1.01	Apr 9, 2018	-	Minor update

Application Example for Capacitive Touch (AE-CAP1) Quick Start Guide

Publication Date: Rev.1.01 Apr 9, 2018

Published by: Renesas Electronics Corporation

SALES OFFICES Renesas Electronics Corporation http://www.renesas.com

Refer to "http://www.renesas.com/" for the latest and detailed information.

Renesas Electronics America Inc.
1001 Murphy Ranch Road, Milpitas, CA 95035, U.S.A.
Tel: +1-408-432-8888, Fax: +1-408-434-5351

Renesas Electronics Canada Limited
9251 Yonge Street, Suite 8309 Richmond Hill, Ontario Canada L4C 9T3
Tel: +1-905-237-2004

Renesas Electronics Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-651-700, Fax: +44-1628-651-804

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
Room 1709 Quantum Plaza, No.27 ZhichunLu, Haidian District, Beijing, 100191 P. R. China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai, 200333 P. R. China
Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

Renesas Electronics Hong Kong Limited
Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2265-6688, Fax: +852 2886-9022

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre, Singapore 339949
Tel: +65-6213-0200, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.
Unit 1207, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

Renesas Electronics India Pvt. Ltd.
No.777C, 100 Feet Road, HAL 2nd Stage, Indiranagar, Bangalore 560 038, India
Tel: +91-80-67208700, Fax: +91-80-67208777

Renesas Electronics Korea Co., Ltd.
17F, KAMCO Yangjae Tower, 262, Gangnam-daero, Gangnam-gu, Seoul, 06265 Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5338

© 2018 Renesas Electronics Corporation. All rights reserved.

Colophon 5.0

Renesas Synergy™ Platform
Application Example for Capacitive Touch (AE-CAP1)

Renesas Electronics Corporation

R12QS0016EU0101