Renesas Synergy™ Platform

QE for Capacitive Touch for e² studio Quick Start Guide

Introduction

This document will create an application example that integrates QE for capacitive touch using e² studio, this also provides instructions for building and debugging.

Target Device

S5D9 Microcontroller Group (R7FS5D97E3A01CFC)

Operating Environment

Target Board	PK-S5D9
IDE	e² studio version 2021-10 and SSP v2.2.0
Toolchains	GNU Arm Embedded Toolchain: 9-2019-q4-update (GNU ARM Embedded 9.2.1.20191025)
QE	QE for Capacitive Touch V3.0.2

Note: Please download and install tools from the following URL in advance.

- QE for Capacitive Touch V3.0.2 Release Note download site :
  https://www.renesas.com/software-tool/qe-capacitive-touch-development-assistance-tool-capacitive-touch-sensors
- Renesas QE download site:
  https://www.renesas.com/software-tool/qe-tools-particular-applications
- Renesas Synergy™ e2 studio v2021-10 or higher Quick Start Guide download site:
  https://www.renesas.com/software-tool/e-studio
- Renesas Synergy™ Software Package (SSP) download site:
  https://www.renesas.com/products/microcontrollers-microprocessors/renesas-synergy-platform-mcus/renesas-synergy-software-package
- Promotion Kit S5D9 (PK-S5D9) User's Manual:
  https://www.renesas.com/document/mat/promotion-kit-s5d9-pk-s5d9-users-manual
- S5D9 Microcontroller Group User's Manual:
  https://www.renesas.com/document/mah/s5d9-microcontroller-group-users-manual

Contents

1. Installation

1.1 Install SSP with e² studio

Refer to section 2.2, Installing e² studio and SSP Independently of Renesas Synergy™ e2 studio v2021-10 or higher Quick Start Guide.

1.2 Install QE for Capacitive Touch

Refer to section 2.1.1, Install from the Renesas Software Installer menu of e² studio of QE for Capacitive Touch V3.0.2 Release Note.

2. Creating a project

e² studio has a simple wizard for creating projects. You can create a new Synergy™ project by specifying the project name, corresponding devices and boards, project type, output object type, and project template.

Start the e² studio application and choose a workspace folder in the Workspace Launcher. To create a new Synergy™ project, follow these steps:

2.1 Creating a Bare Metal – Minimal Project

1. Select **File** menu **> New > Synergy C/C++ Project**.

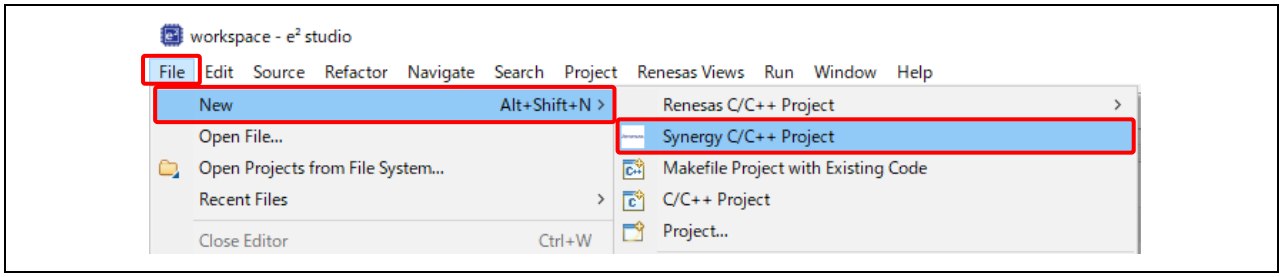

Figure 2-1. Synergy C/C++ Project

2. Select the **Renesas Synergy C Executable Project** template. Click **Next** to continue.

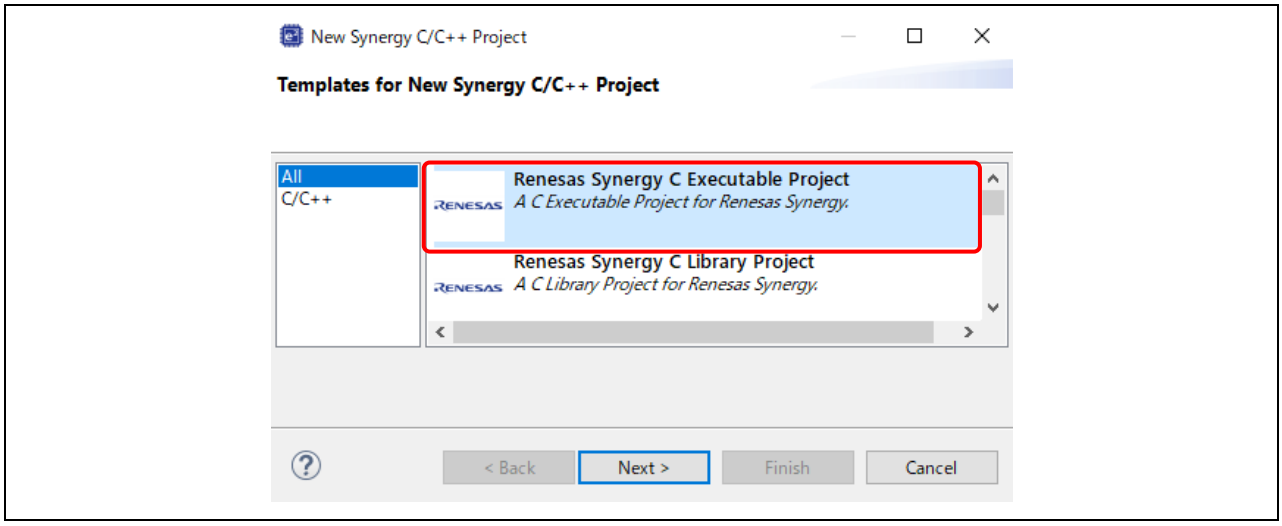

Figure 2-2. Renesas Synergy C Executable Project

3. In the next dialog box, enter a project name and click **Next**.

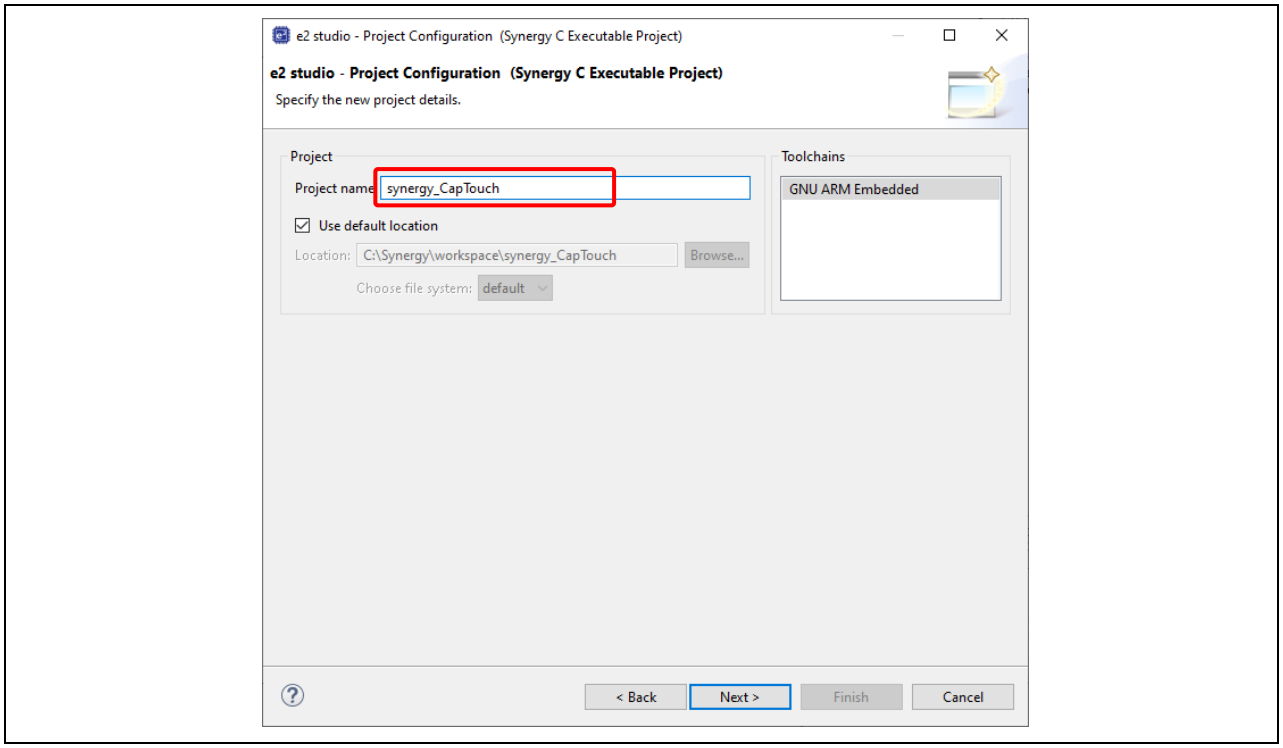

Figure 2-3. Project Name and Location

4. In the device selection dialog, enter device and tool information:
   - SSP version: **2.2.0**
   - Board: **S5D9 PK**
   - Device: Auto selected
   - Toolchain version: GNU ARM Embedded **9.2.1.20191025**
   - Debugger: **J-Link ARM**

   Click **Next** to continue.

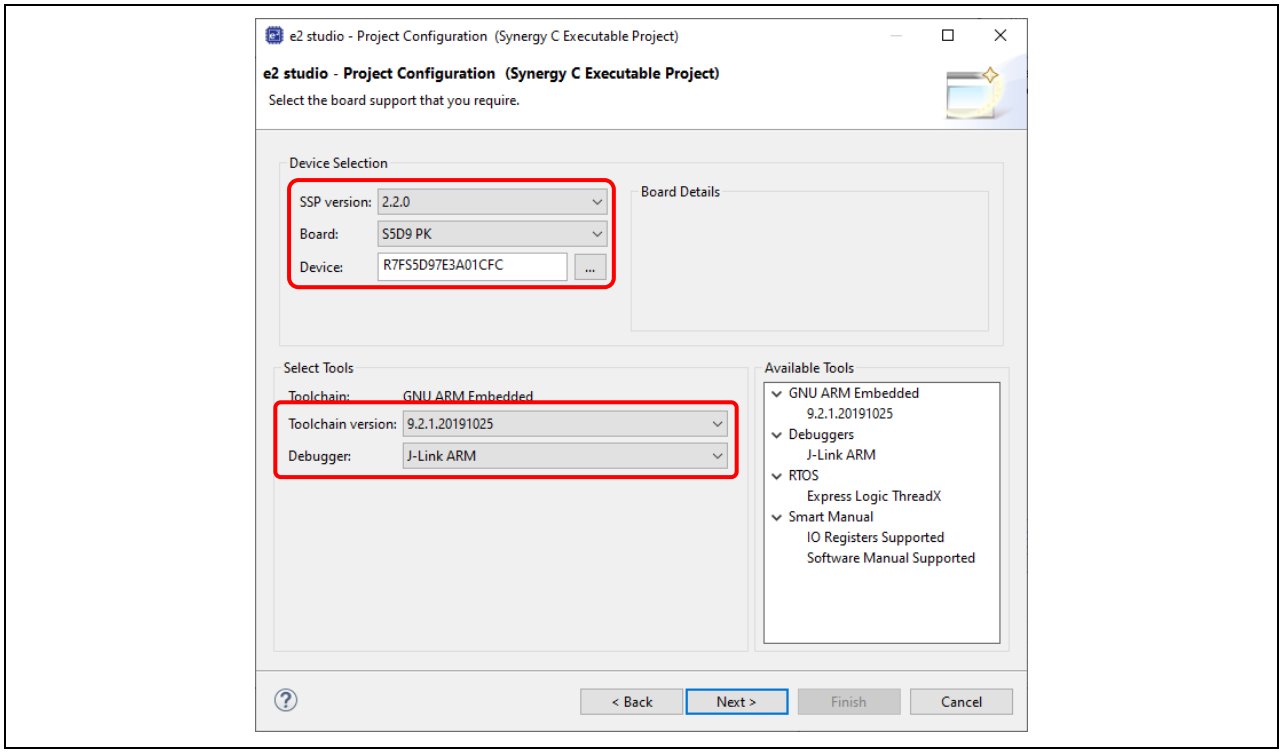

Figure 2-4. Create New Project for S5D9 PK

5. In the project template dialog, select **BSP** and click **Finish**.

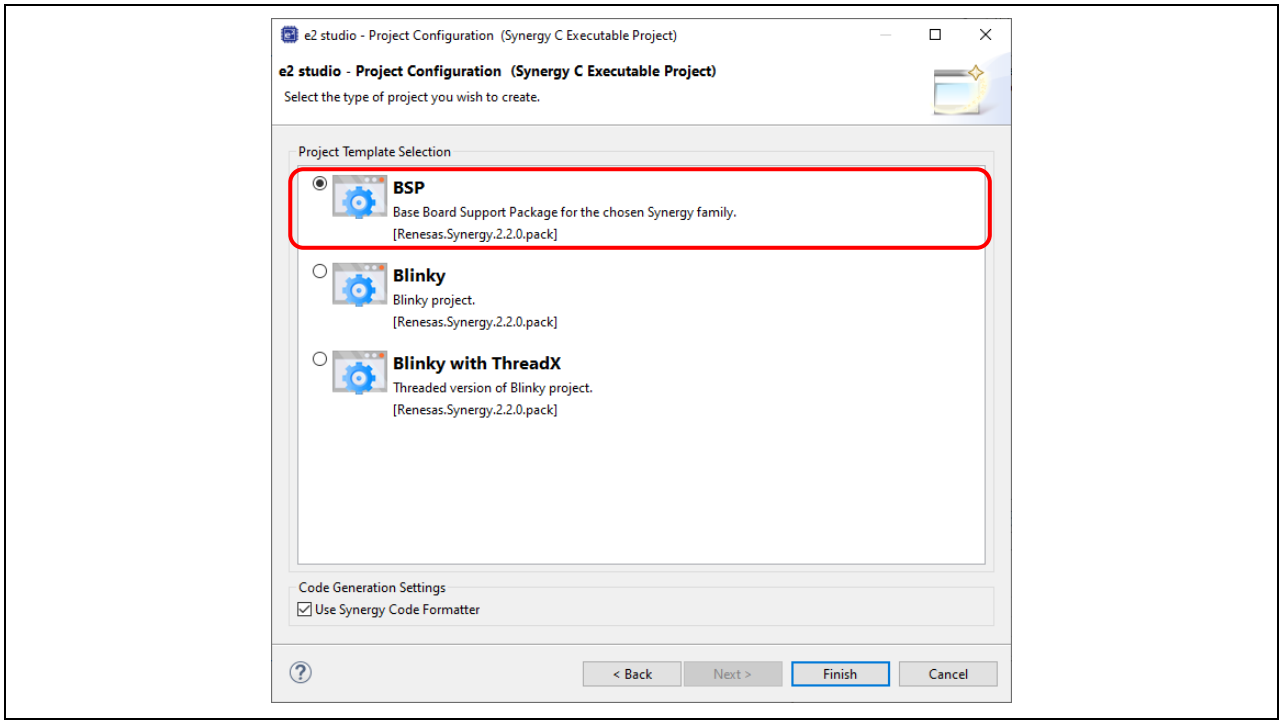

Figure 2-5. Select the type of project

6. Once complete, e² studio creates a new project with the **Synergy Configuration** perspective open and ready for project configuration.

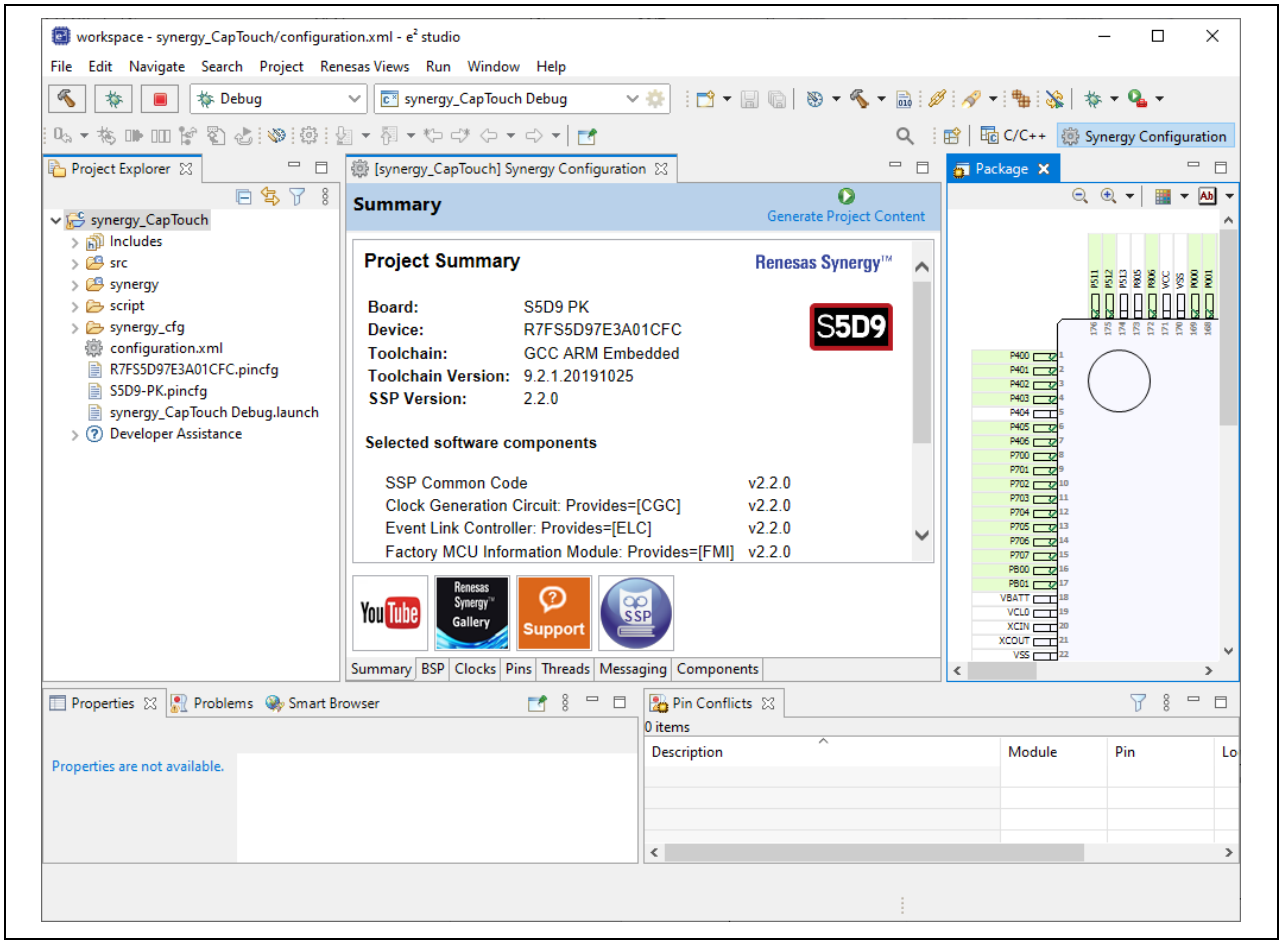

Figure 2-6. New project for S5D9 PK

2.2 Adding TOUCH Driver

1. In Synergy Configuration, select the **Pins** tab at the bottom of the pane. Type **ctsu** in the search box and select the **CTSU0** pin in the search result.

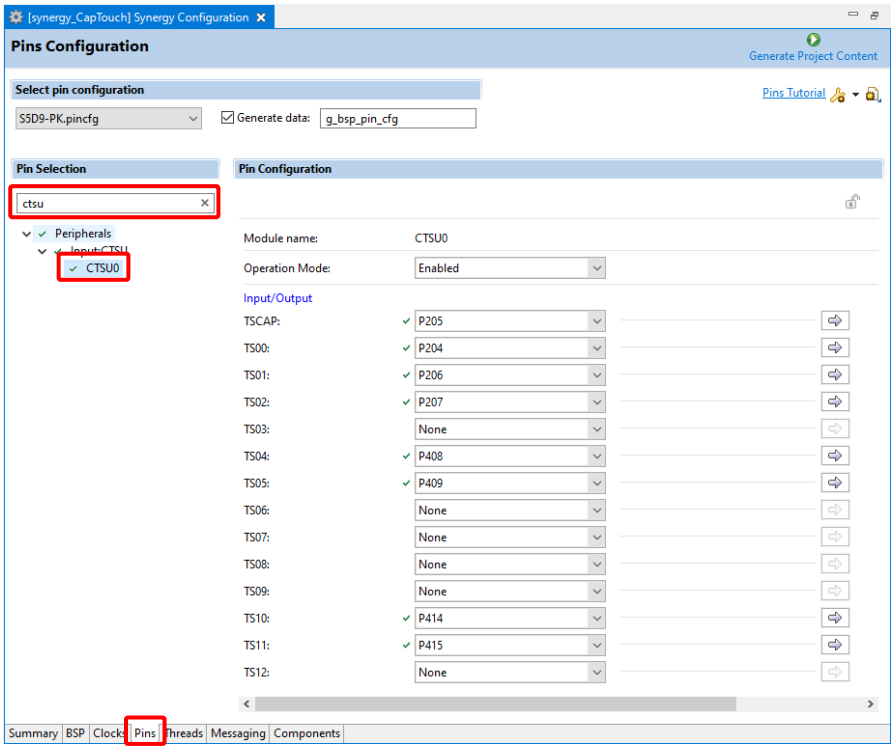

Figure 2-7. Select Pin CTSU0

2. Ensure that the **Operation Mode** and the **TS pins** below are enabled:
   TSCAP, TS00, TS01, TS02, TS04, TS05, TS10, TS11.
   Note: Refer to section 4.8, Capacitive Touch Interface of *Promotion Kit S5D9 (PK-S5D9) User's Manual*.

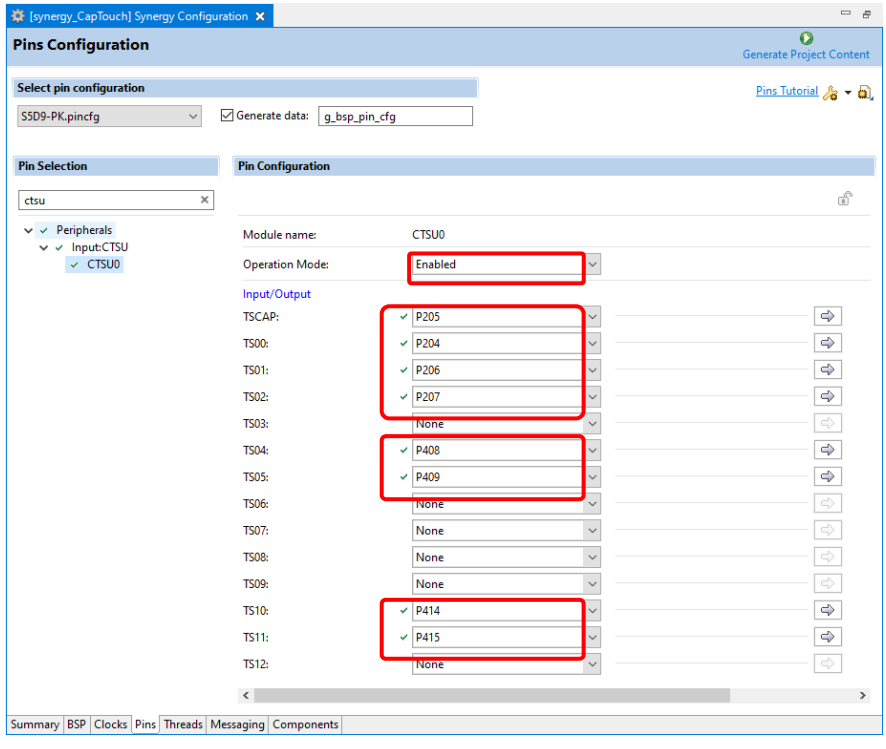

Figure 2-8. Enable TS Pins for S5D9 PK

3. Move to the **Threads** tab. Add the Capacitive Touch Driver by clicking **New Stack > Framework > Input > Cap Touch Framework on sf_touch_ctsuv2**.

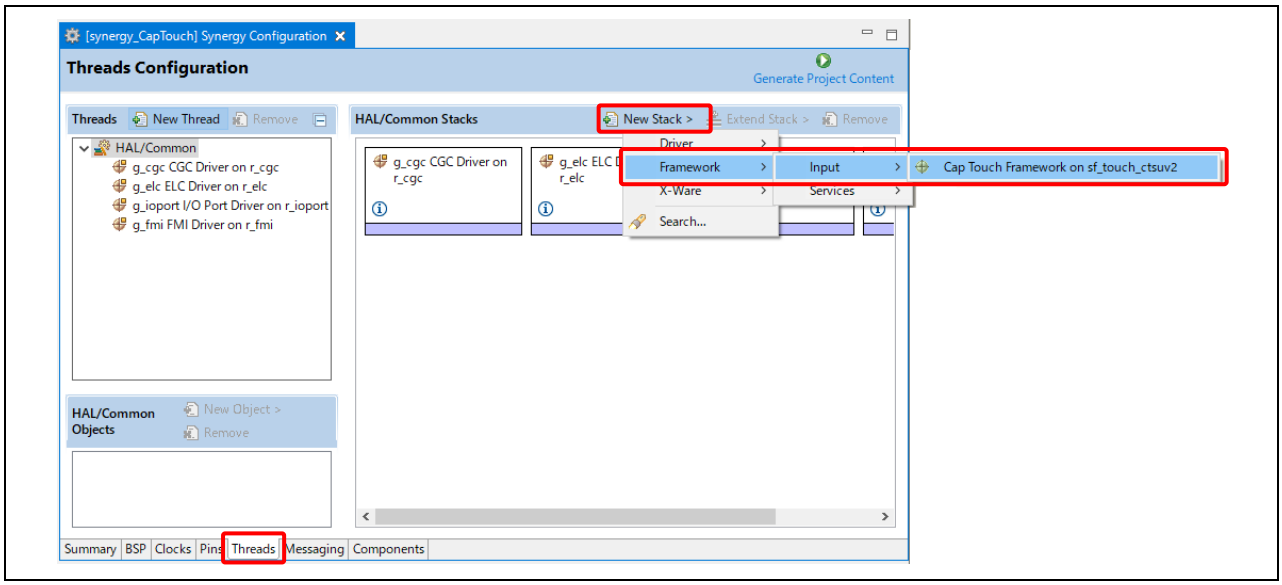

Figure 2-9. Add Cap Touch Driver

4. Click on **CTSU Driver on r_ctsuv2** to display properties.
Change **Support for using DTC** to Enabled.

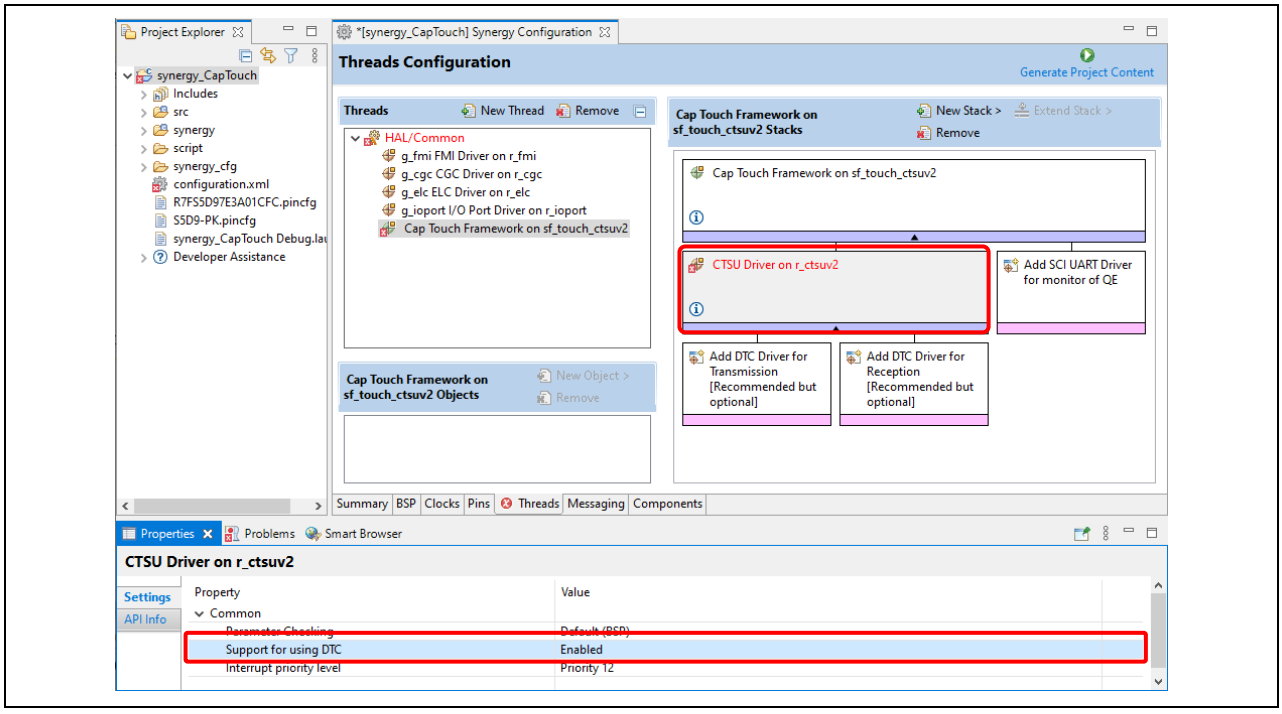

Figure 2-10. Properties in CTSU Driver on r_ctsuv2

5. Click on **Add DTC Driver for Transmission** to select the **New** > **Transfer Driver on r_dtc** to add the DTC driver for Transmission.

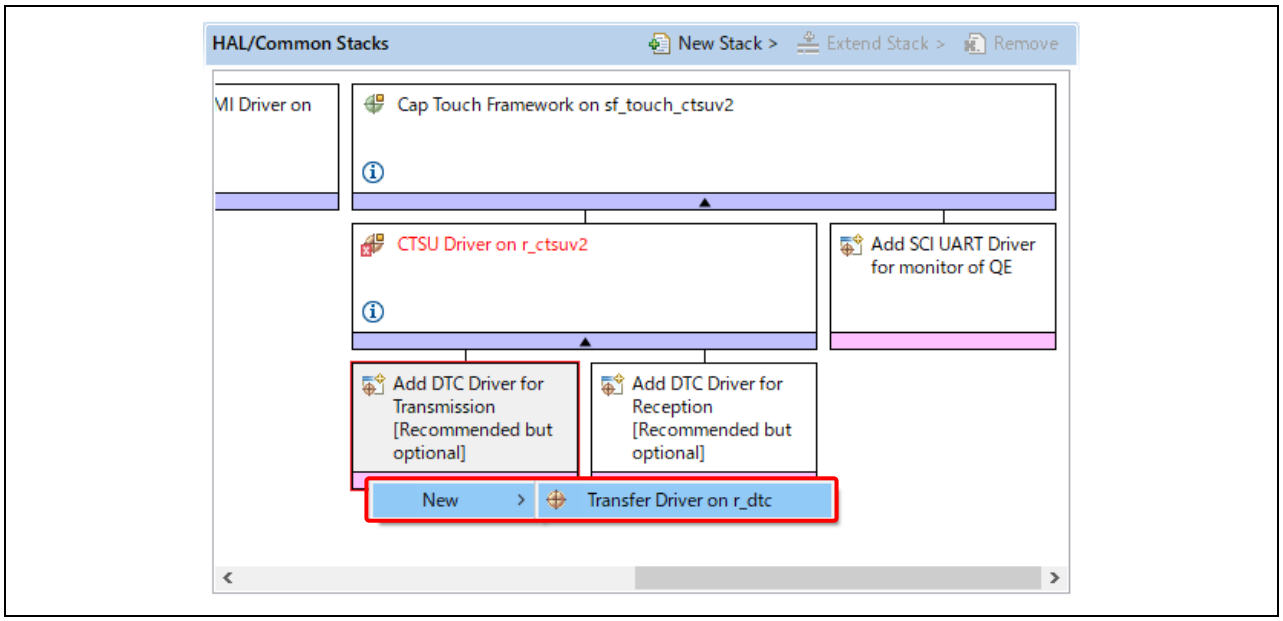

Figure 2-11. Add DTC Driver for Transmission

6. Click on **Add DTC Driver for Reception** to select the **New** > **Transfer Driver on r_dtc** to add the DTC driver for Reception.

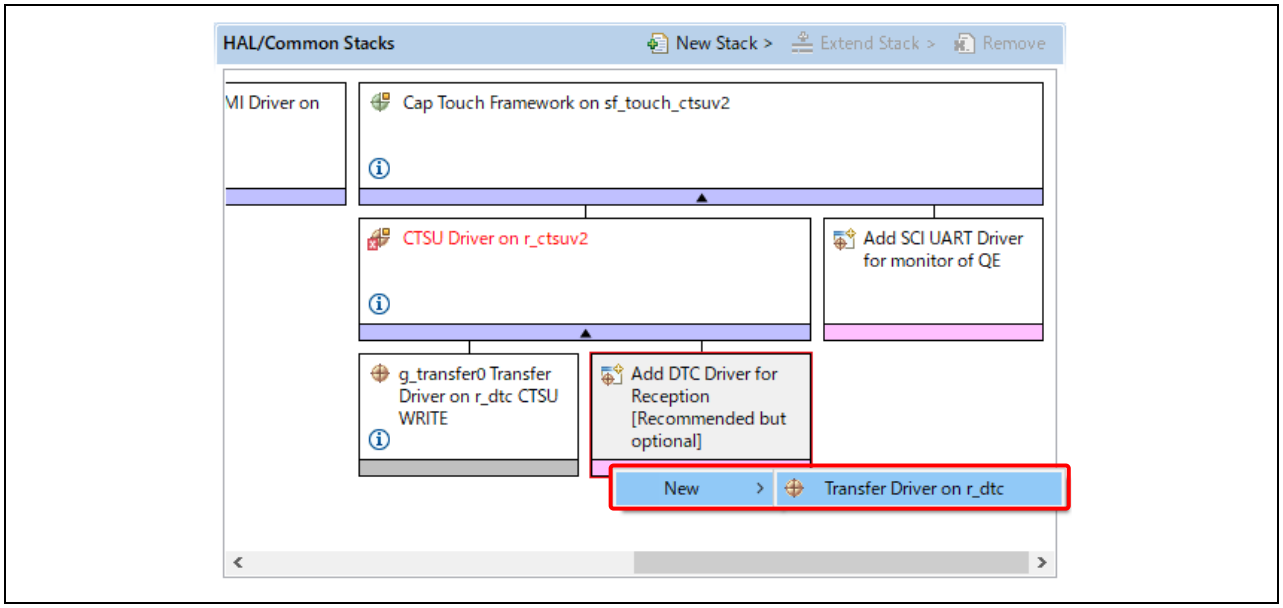

Figure 2-12. Add DTC Driver for Reception

7. Click on the 

button to generate the source files.

3. Configuration for CapTouch Main

3.1 Executing the "Select a Project"

1. From the menu of e² studio, select **Renesas Views > Renesas QE > CapTouch Main (QE)** to open the main perspective for configuring capacitive touch to the project.

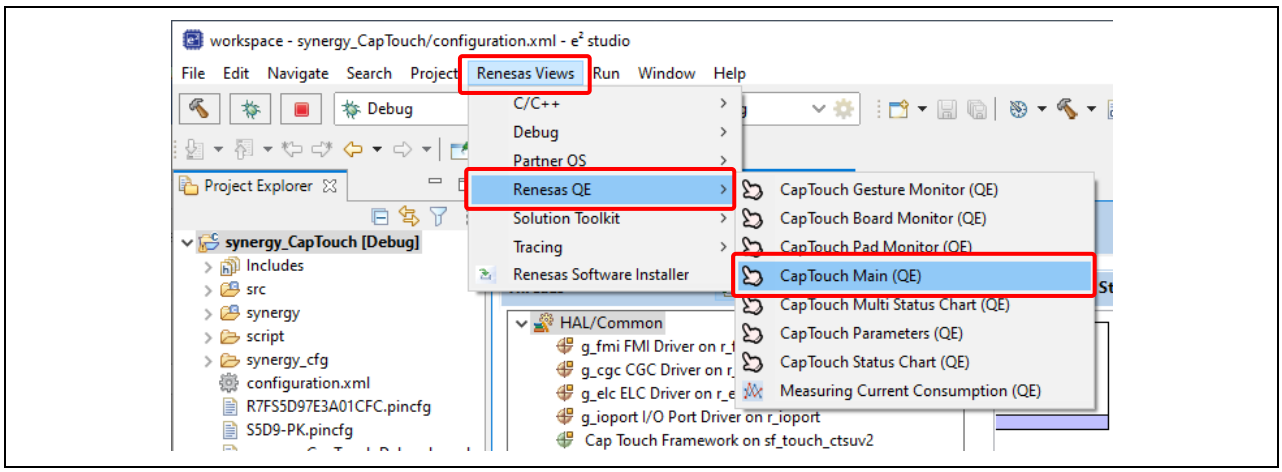

Figure 3-1. Open CapTouch Main (QE)

2. In the **CapTouch Main (QE)** pane, select the project to configure the Touch interface for by using the pull-down tab and selecting the **Synergy_CapTouch** project as shown below.

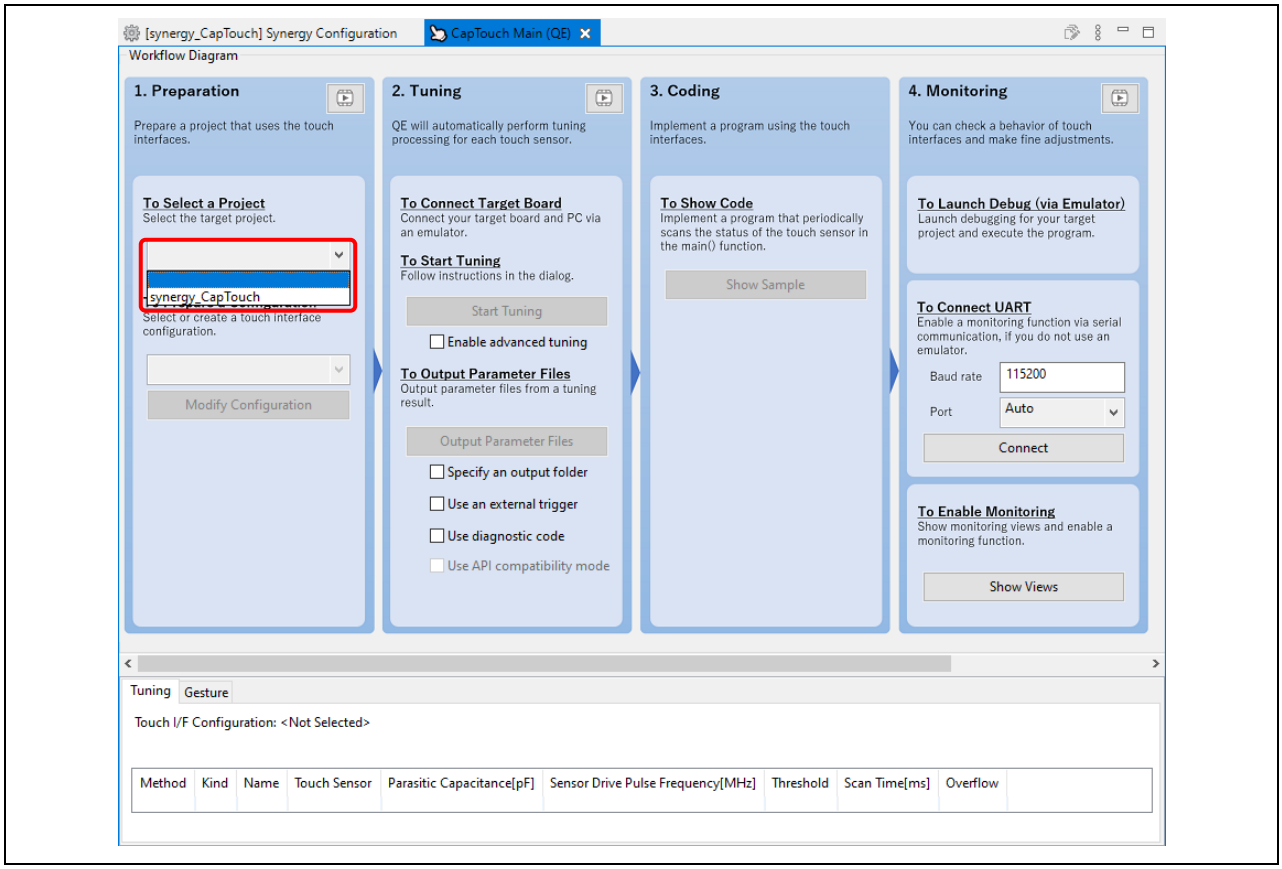

Figure 3-2. Select Project

3.2 Executing the "Preparing a Configuration"

1. Create a new Touch configuration by using the lower pull-down and selecting **Create a new configuration.**

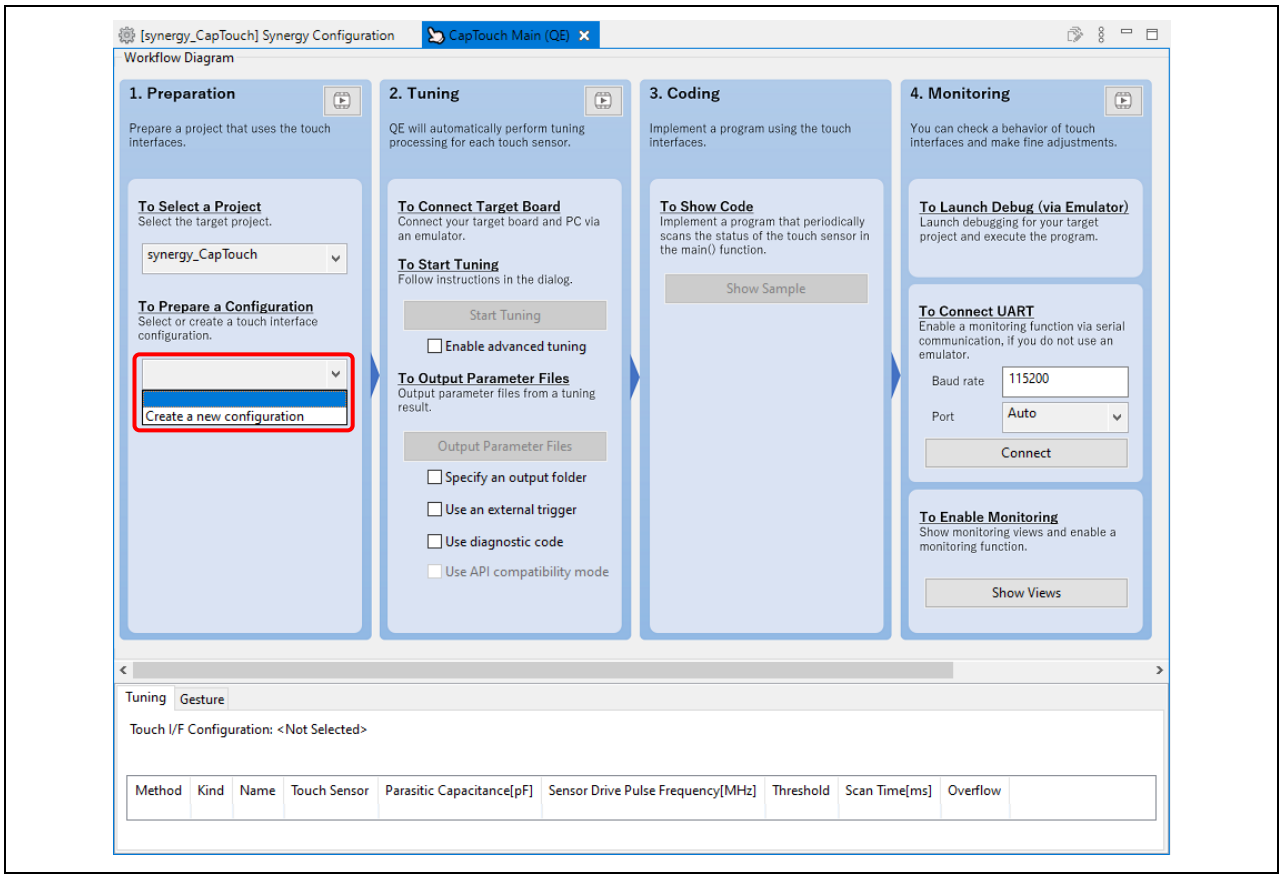

Figure 3-3. Create a new configuration

2. Add **Slider (vertical)** to the canvas:
   A. Selecting the **Slider (vertical)** menu item from the right-hand side and moving the mouse onto the canvas.
   B. Click the left-hand mouse button to drop the **Slider** icon. Do this once to add one slider.
   C. Press the **ESC** key to exit once the slider are added.

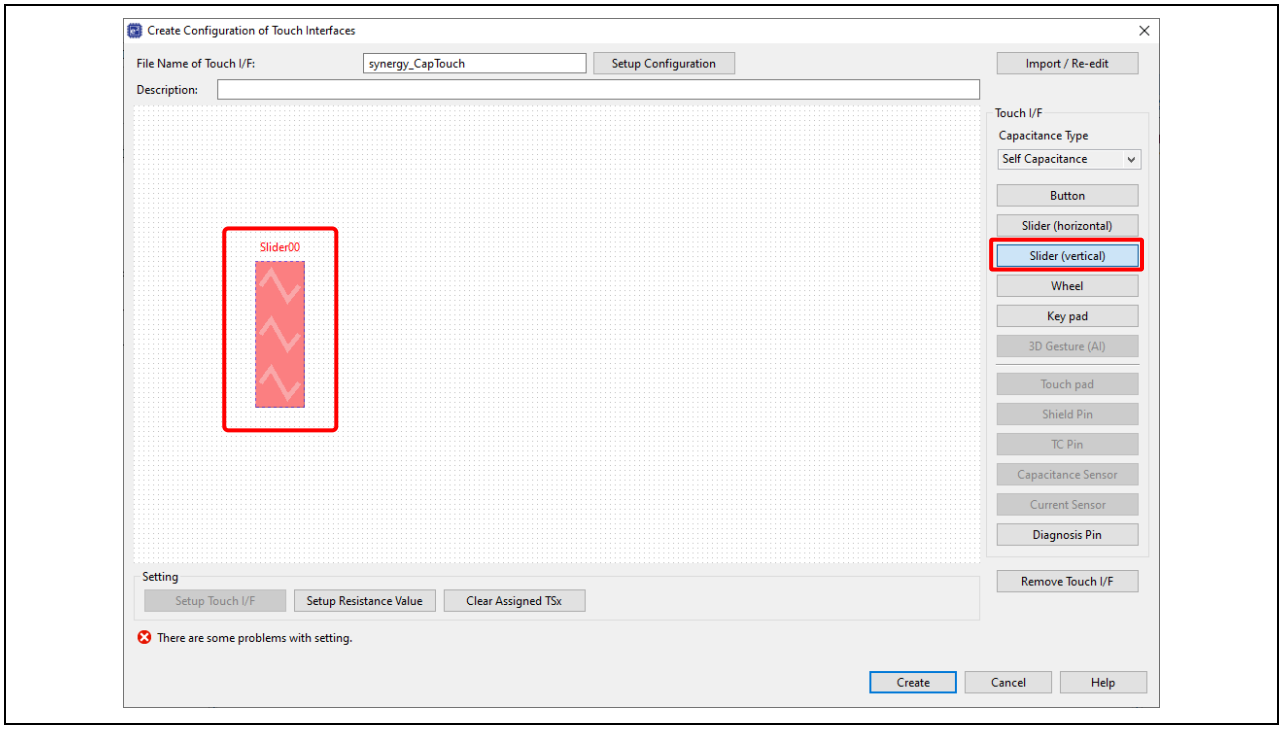

Figure 3-4. Create New Touch Slider

3. Add 2 **capacitive touch buttons** (capacitive button) to the canvas by:
   A. Selecting the **Button** menu item from the right-hand side and moving the mouse onto the canvas.
   B. Click the left-hand mouse button to drop the button icon. Do this two times to add two buttons.
   C. Press the **ESC** key to exit once the two buttons are added.

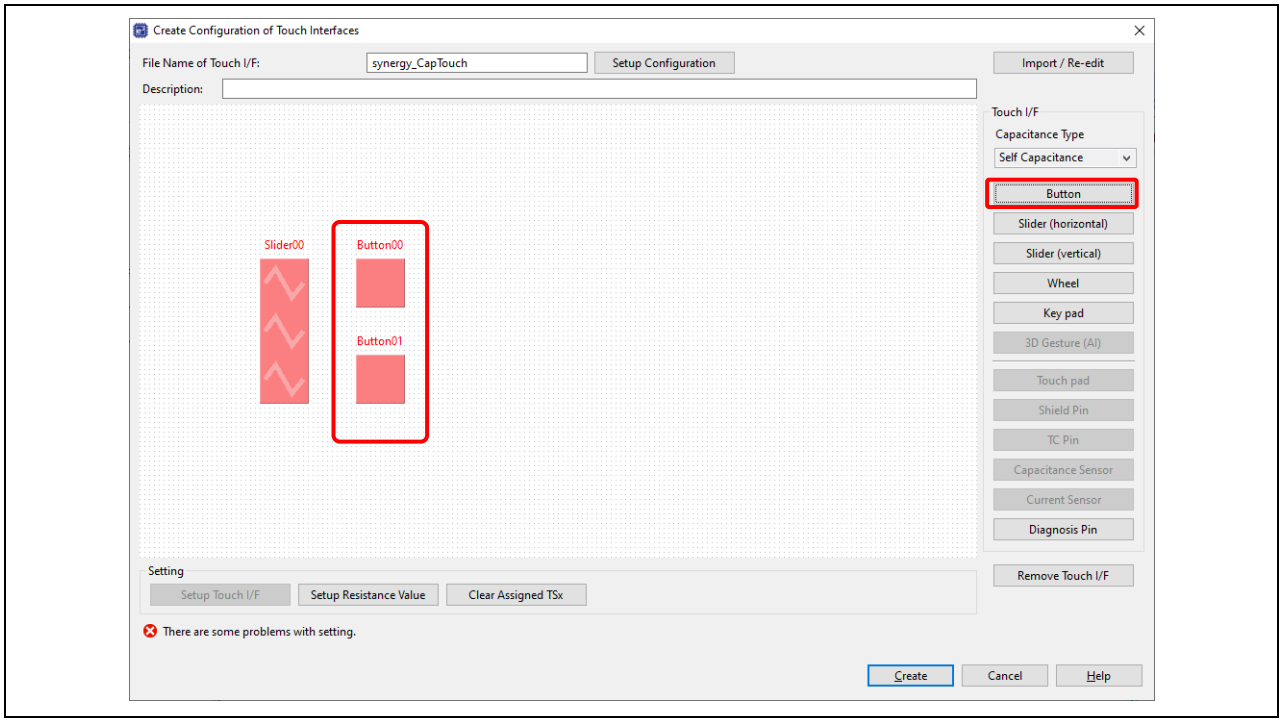

Figure 3-5. Create New Touch Button

4. Hardware port assignments.

Note: Table 1 is created based on the following reference materials. For settings for step 5 and later, see *Table 1*.

Reference material :

— section 1.7, Pin Lists of *S5D9 Microcontroller Group User's Manual*.
— section 4.8, Capacitive Touch Interface of *Promotion Kit S5D9 (PK-S5D9) User's Manual*.

Table 1. Hardware port assignments

CTSU0	PORT	CAPACITIVE TOUCH
TSCAP	P205	-
TS00	P204	S1-1
TS01	P206	S3-1
TS02	P207	S2-5
TS04	P408	S2-4
TS05	P409	S2-3
TS10	P414	S2-2
TS11	P415	S2-1

5. Setup capacitive button:

A. Double click on **Button00** icon.
B. Rename **Button00** to **S3** for using S3 Touch Switch on PK-S5D9**.**
C. Using the pull-down and select **TS01** as the MCU sensor to assign to this button.

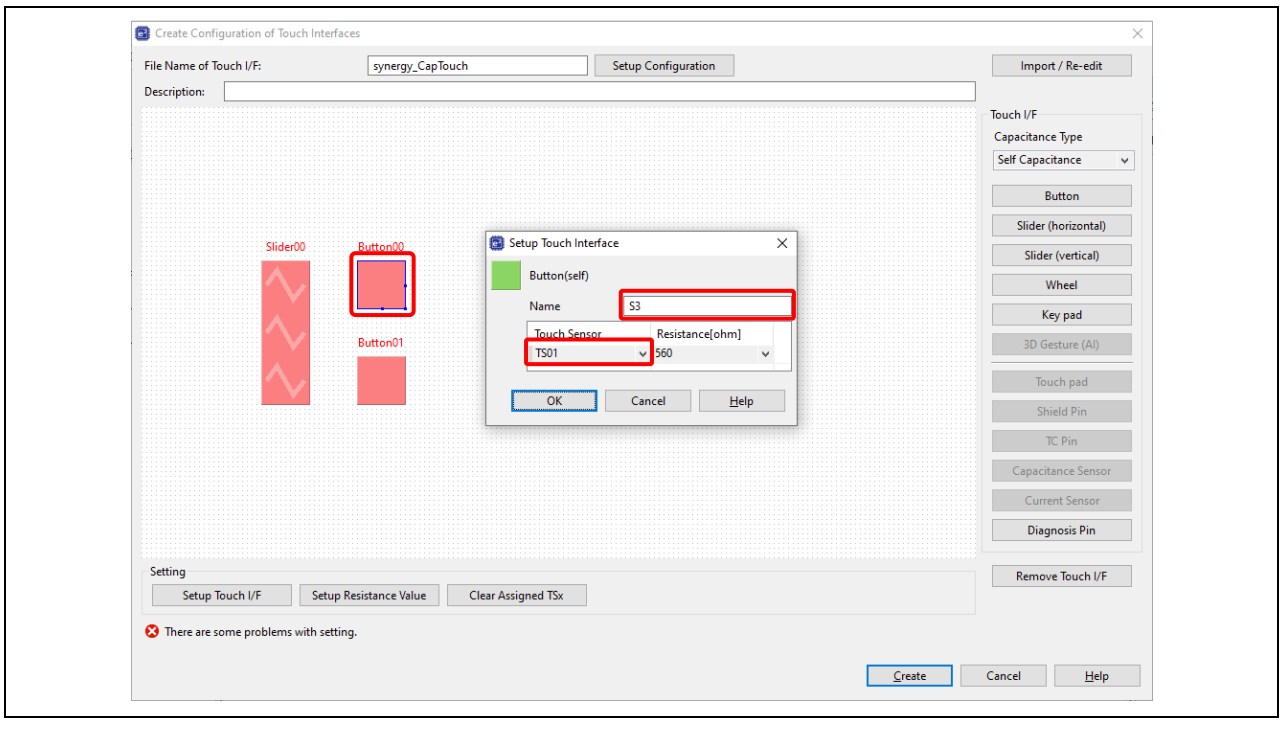

Figure 3-6. Setup Touch Sensor to Button00

D. Double click on **Button01** icon.
E. Rename **Button01** to **S1** for using S1 Touch Switch on PK-S5D9.
F. Using the pull-down and select **TS00** as the MCU sensor to assign to this button.

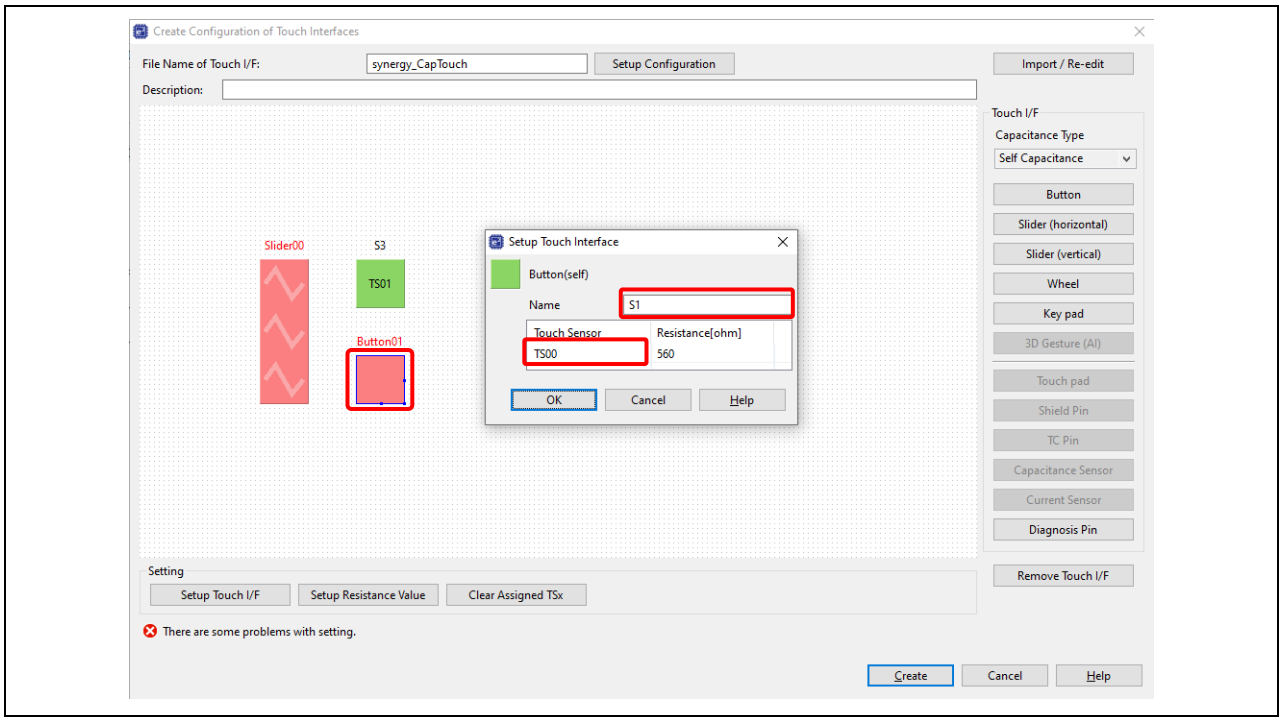

Figure 3-7. Setup Touch Sensor to Button01

6. Setup capacitive touch slider:
A. Double click on **Slider00** icon.
B. Rename **Slider00** to **S2**.
C. Select Number of Touch Sensor **5**.
D. Using the pull-down and select **TS02**, **TS04**, **TS05**, **TS10**, and **TS11** as the MCU sensors to assign to this slider.

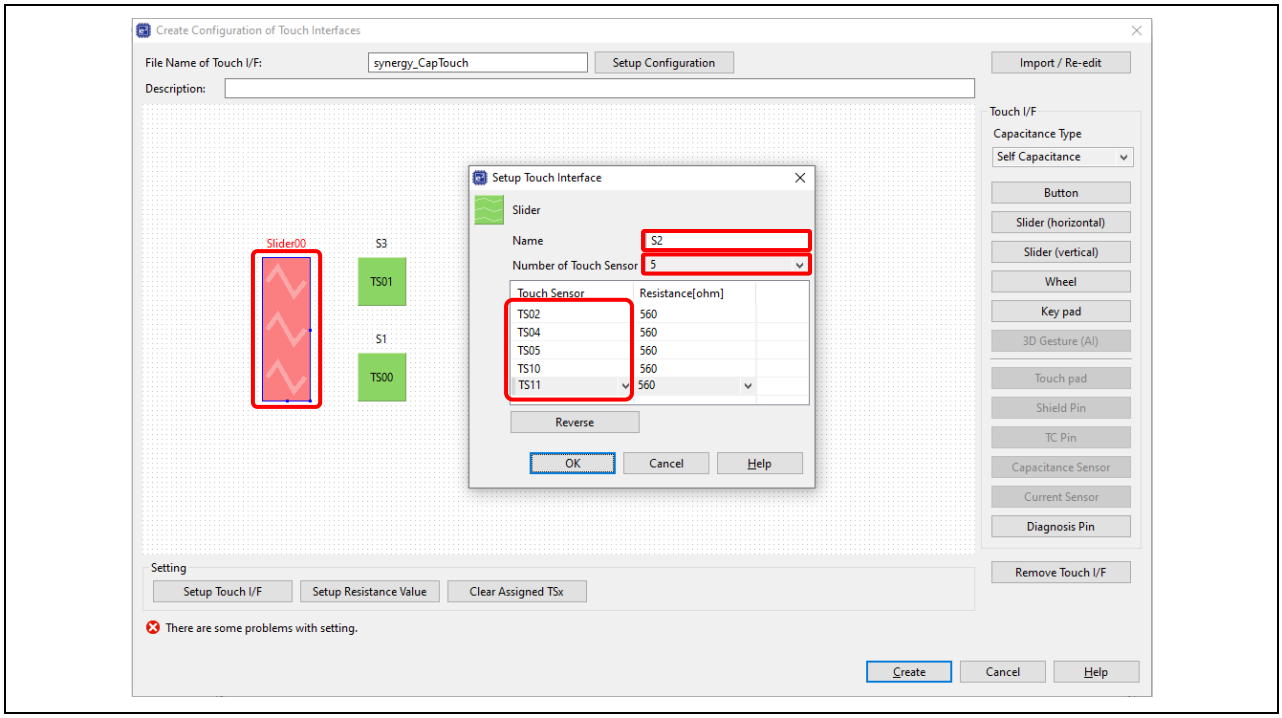

Figure 3-8. Setup Touch Sensor to Slider00

7. All sensor settings change icon to green, the warning "**There are some problems with setting.**" disappears.
   Click **Create** button to set up the Touch Interface.

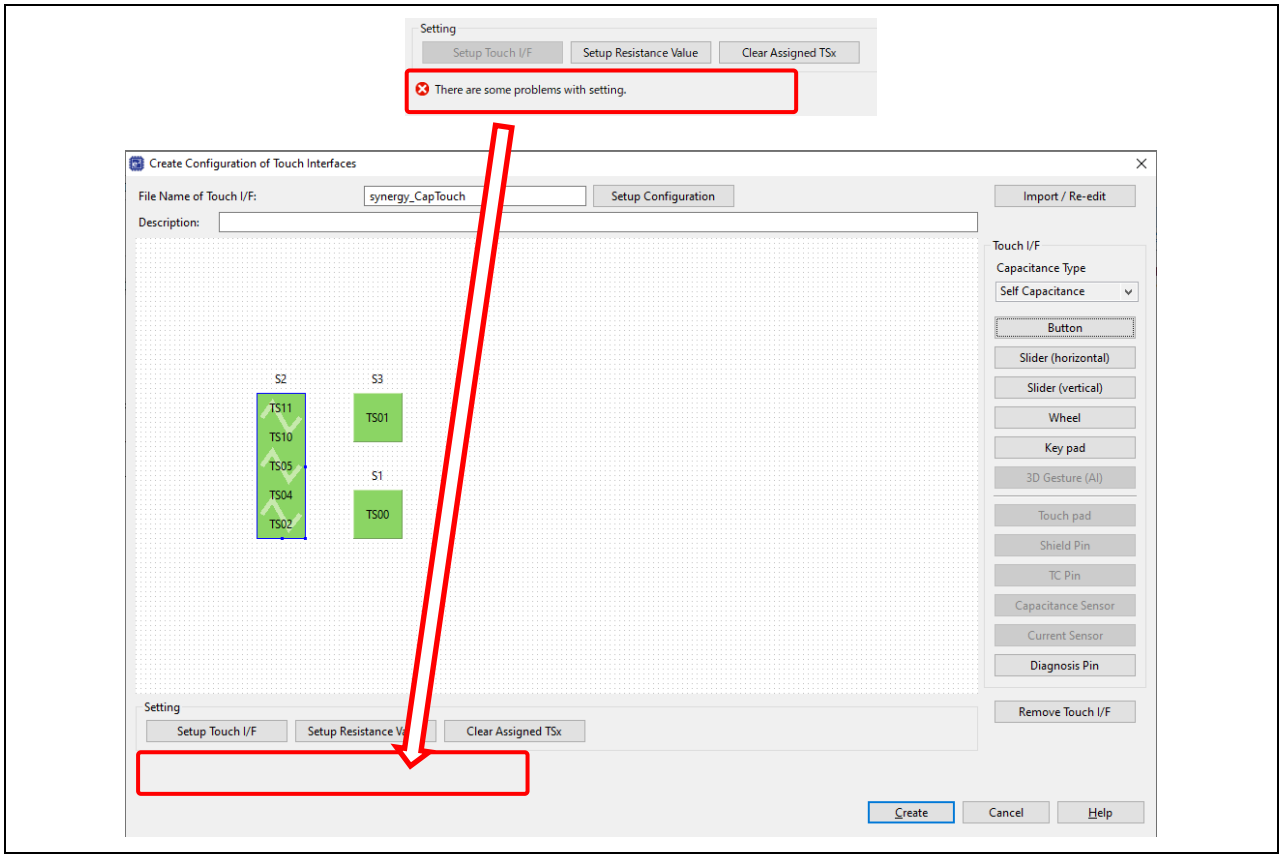

Figure 3-9. Create New Touch Interface

8. The CapTouch Main (QE) window will now display the configuration of the touch interface in the main view pane.

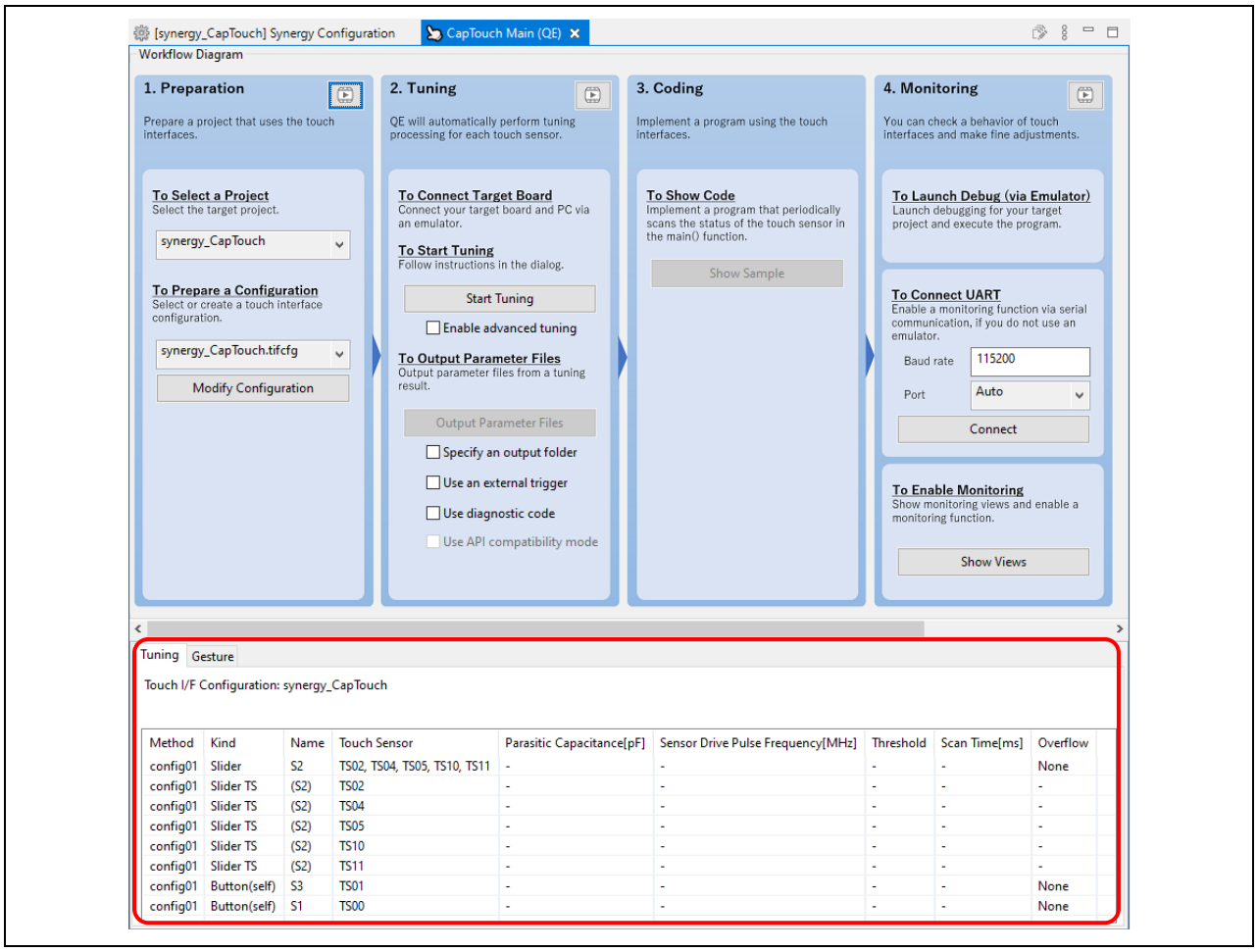

Figure 3-10. Main View Pane Displays the Touch Configuration

4. Connecting PC and PK-S5D9 Board

The picture below shows the connection between the host PC and the PK-S5D9 board.
Setting to jumper J1 is in position 1-2 (default), the MCU boots in normal mode (from its ROM).
Connecting the USB cable, USB port J19 for power supply and J-Link OB.

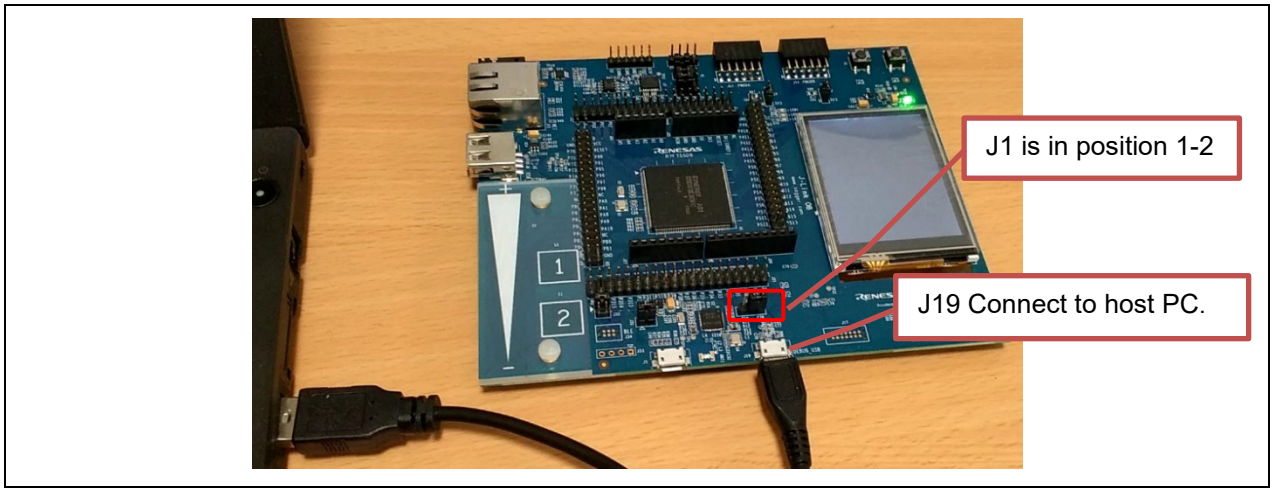

Figure 4-1. PK-S5D9 Board Connection

5. Tuning on CapTouch Main

5.1 Executing the "Start Tuning"

1. To start the automatic tuning process, click the button **Start Tuning** in the **CapTouch Main (QE)**.

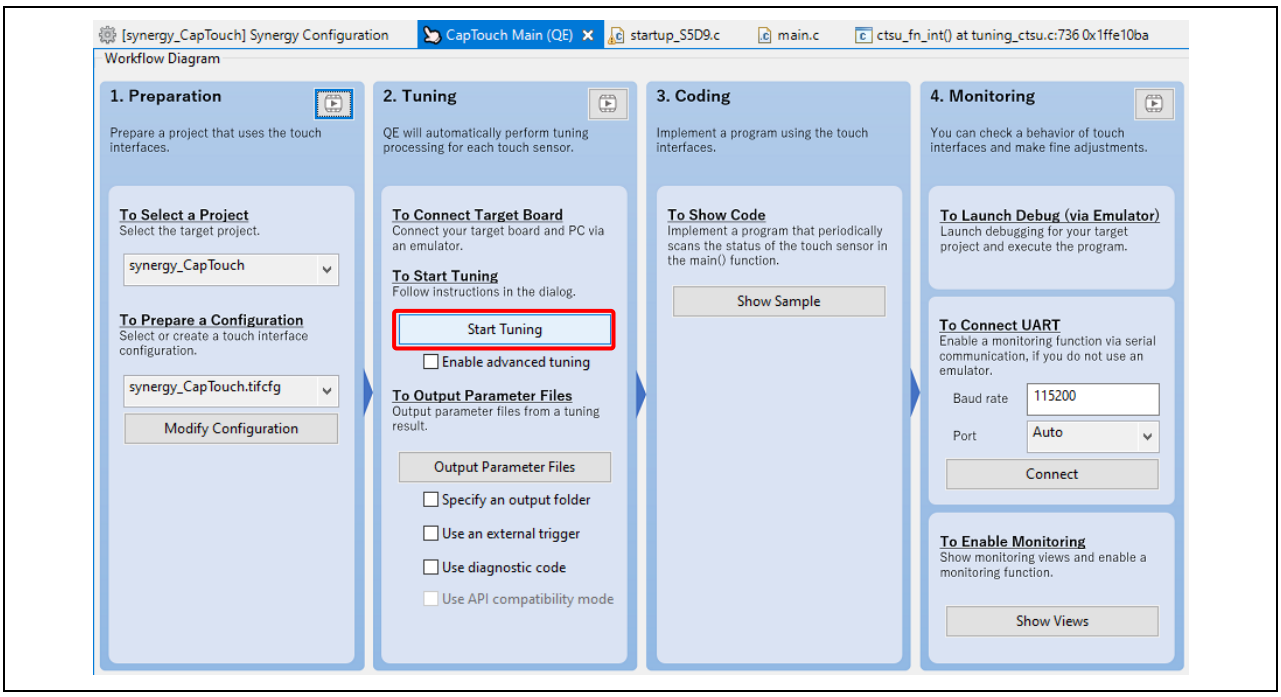

Figure 5-1. Select a "Start Tuning"

2. At the start of the first debug session, e² studio may display a message indicating that is will switch to the Debug perspective. Click the **Remember my decision** check box and **Switch** to continue the Debug process and the QE for Capacitive Touch automatic tuning.

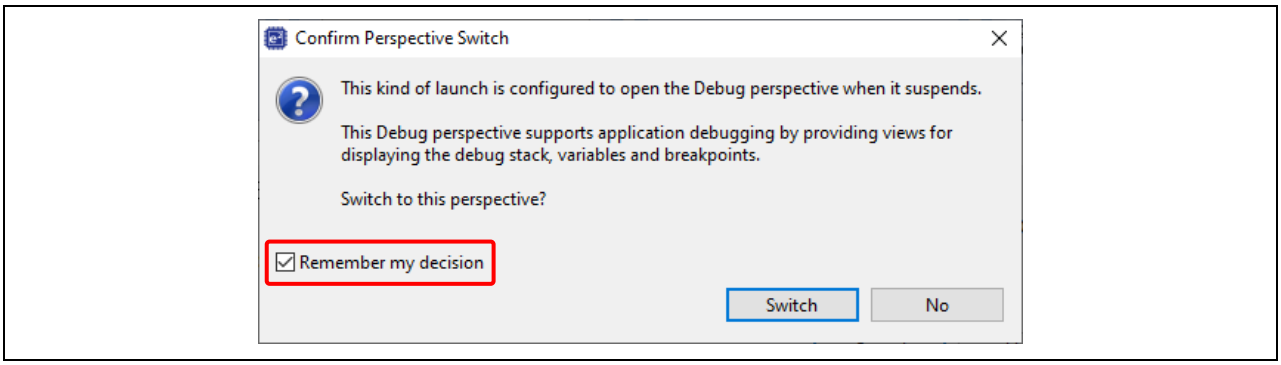

Figure 5-2. Switch Perspective

3. The QE for Capacitive Touch automatic tuning will now begin. Please read the tuning dialog windows carefully as they will guide you through the tuning process. An example screen is shown below. Typically, no interaction is required during the initial tuning process steps.

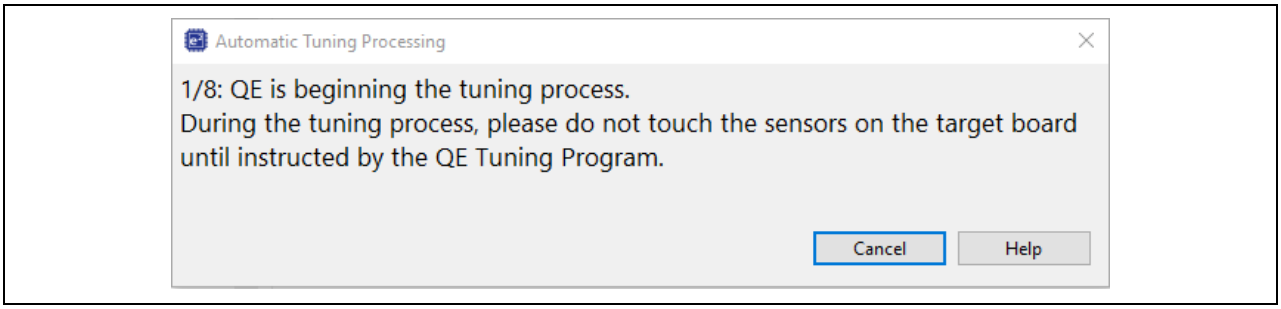

Figure 5-3. Tuning Dialog Window

4. After several automated steps, you will arrive at the dialog box with information like what is shown below. This is the Touch sensitivity measurement step of the tuning process. Press using normal Touch pressure on the sensor being indicated in the dialog box (S1, TS00). When you press, the bar graph will increase to the right and the Touch counts go numerically up. While holding that pressure, press any key on the PC keyboard to accept the measurement.

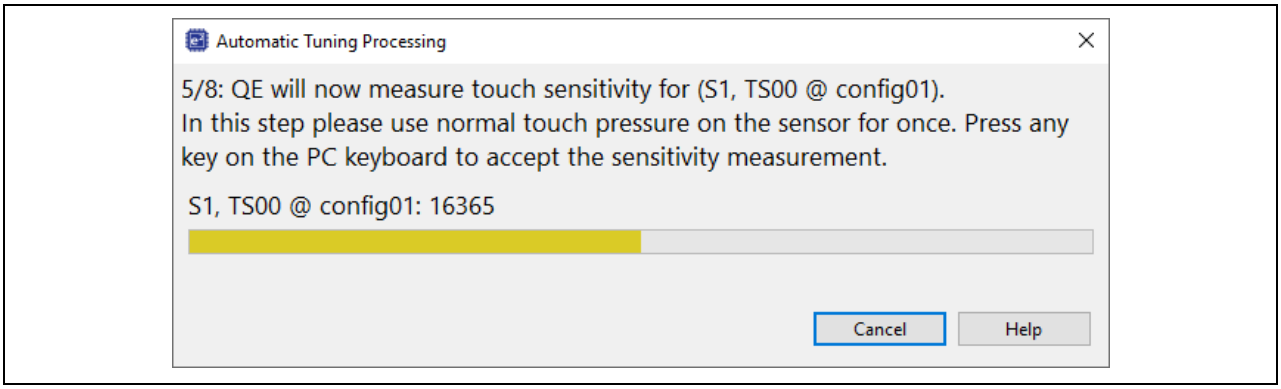

Figure 5-4. Measure Touch Button S1

5. Repeat the process for capacitive button S3 and TS01.

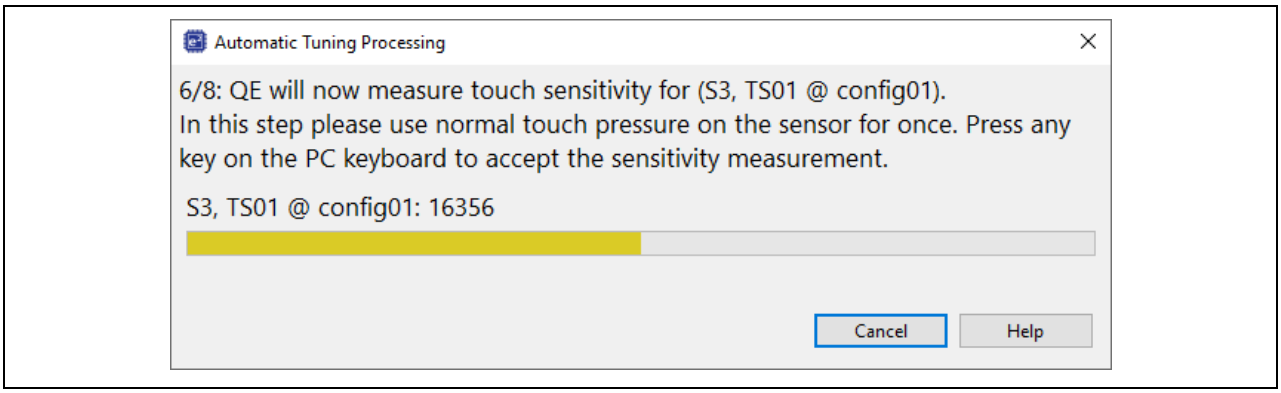

Figure 5-5. Measure Touch Button S3

6. Next, we will adjust the slider. Move your finger across the slider 3-4 times. After that, press any key on the PC keyboard to accept the measurement.

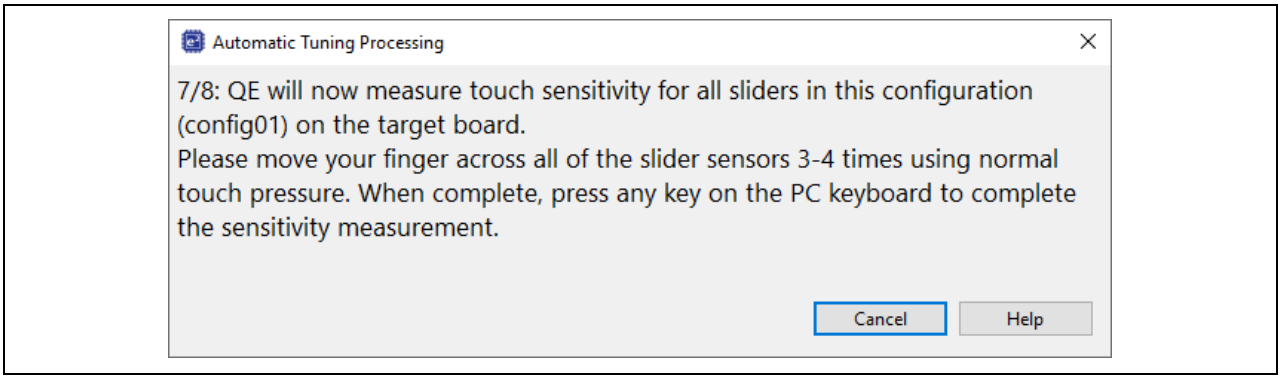

Figure 5-6. Repeat Measurement 3 Times

7. Once complete, you will see a screen like what is shown below. This is the detection threshold that is used by the middleware to determine if a Touch event has occurred.

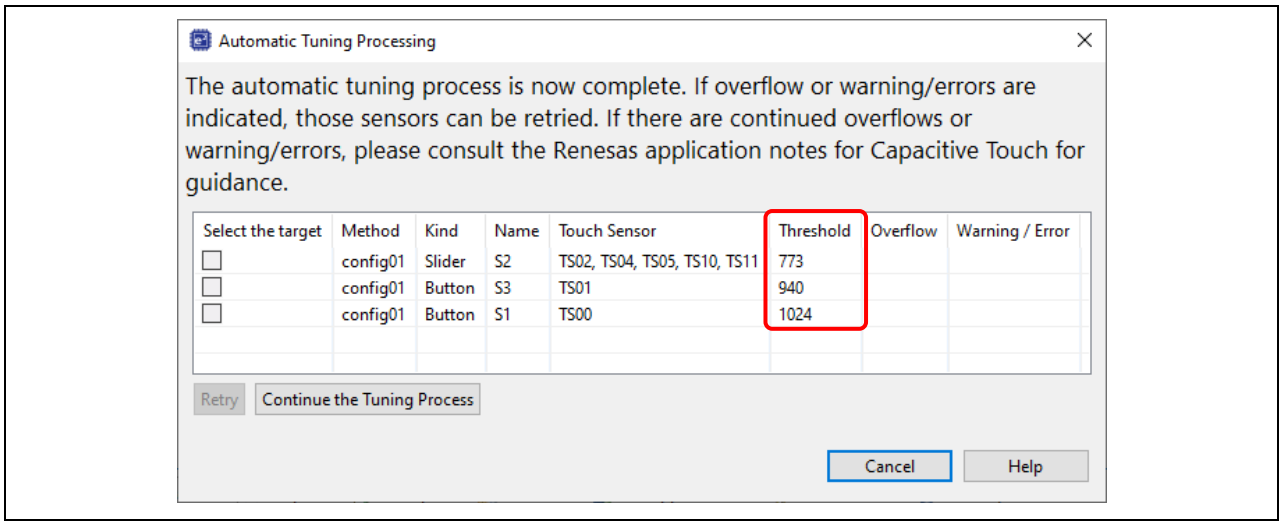

Figure 5-7. Threshold for Touch Event

8. Click the **Continue the Tuning Process** button in the dialog box shown. This will exit the tuning process and disconnect from the Debug session on the target. You should return to the default **CapTouch Main (QE)** screen in the e² studio IDE.

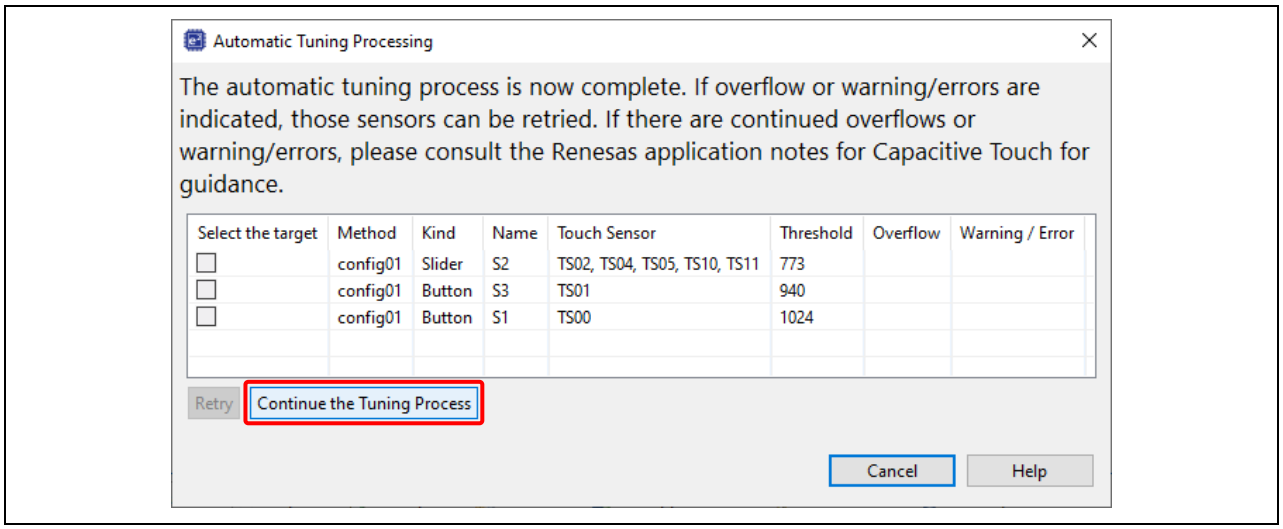

Figure 5-8. Select a "Continue the Tuning Process"

9. After the tuning process is completed, the default view of **the CapTouch Main (QE)** presented here will be the results of the tuning process for the sensors in the configuration. This gives the user a quick way to examine the tuning results.

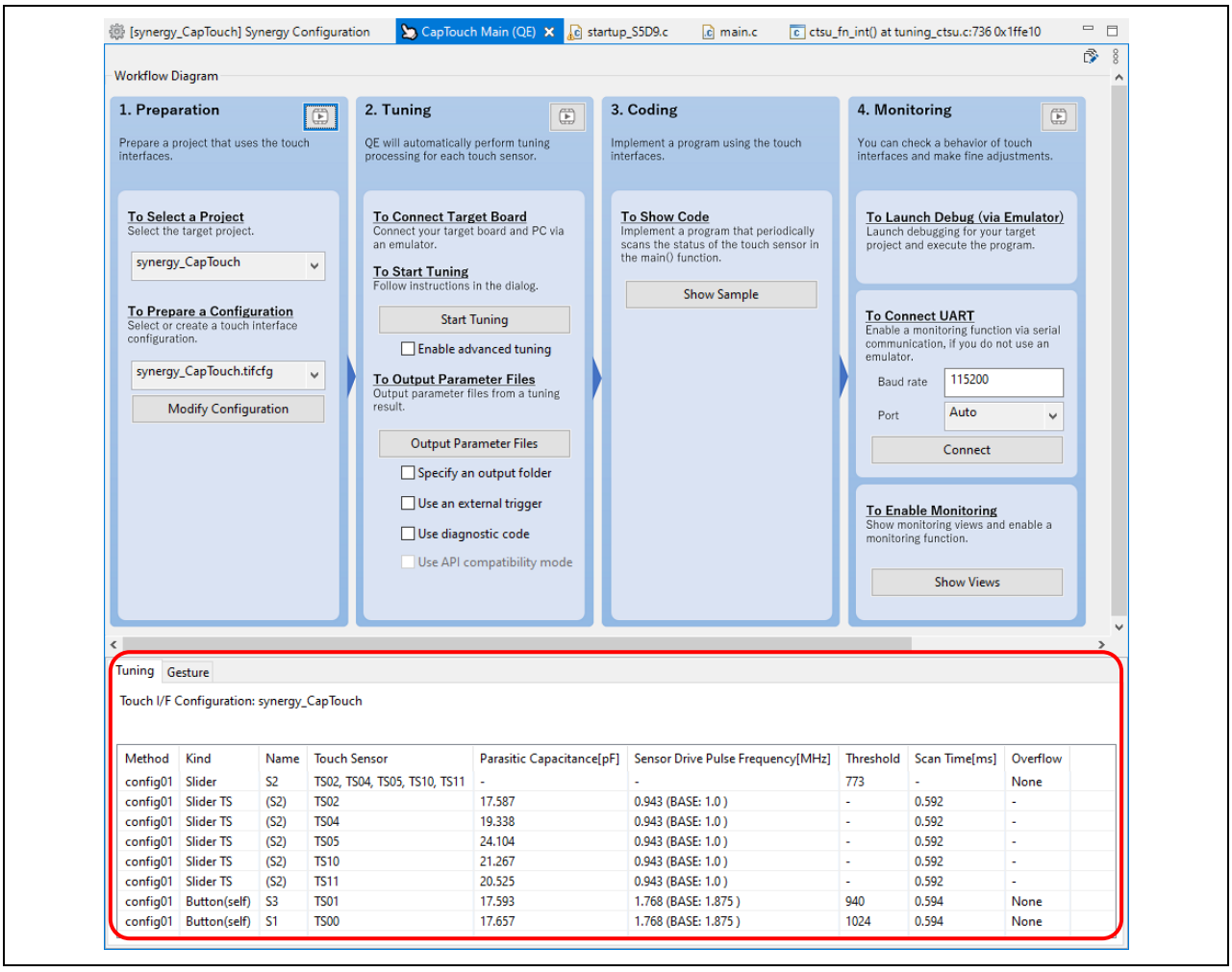

Figure 5-9. Tuning Result

5.2 Executing the "Output Parameter Files"

1. Output the tuning parameter files. Click the button **Output Parameter Files**.

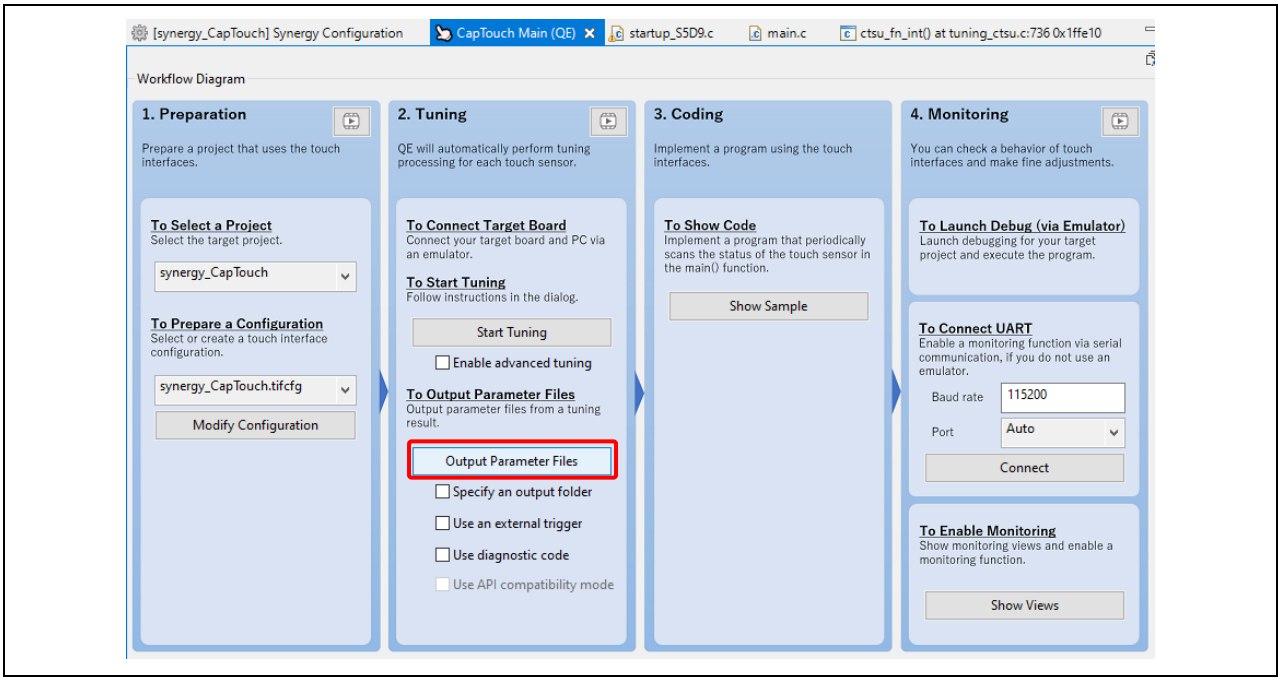

Figure 5-10. Output Parameter Files

2. Look at the **Project Explorer** window and you will see that files have been added. These contain the needed tuning information to enable Touch detection using.

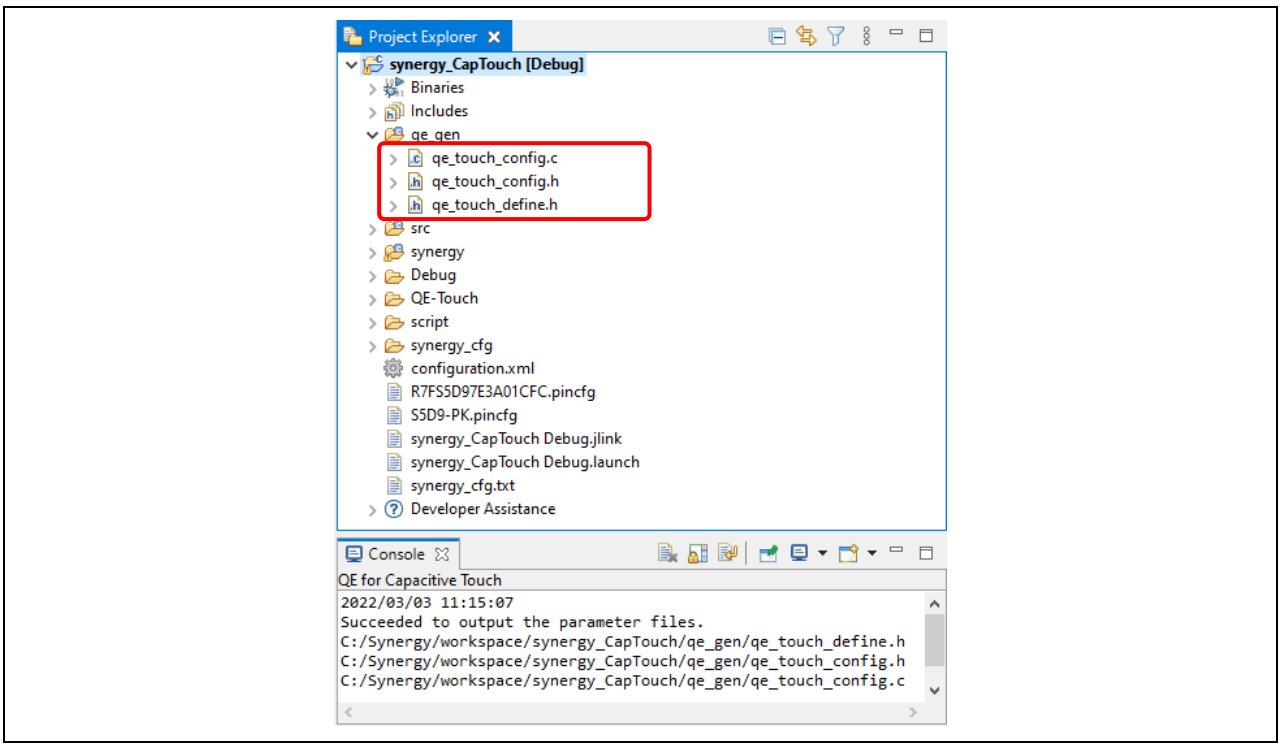

Figure 5-11. Created Output Parameter Files

6. Coding on CapTouch Main

1. To implement application code to scan and report the state of the touch sensor, click the button **Show Sample** in the CapTouch Main (QE) e² studio IDE

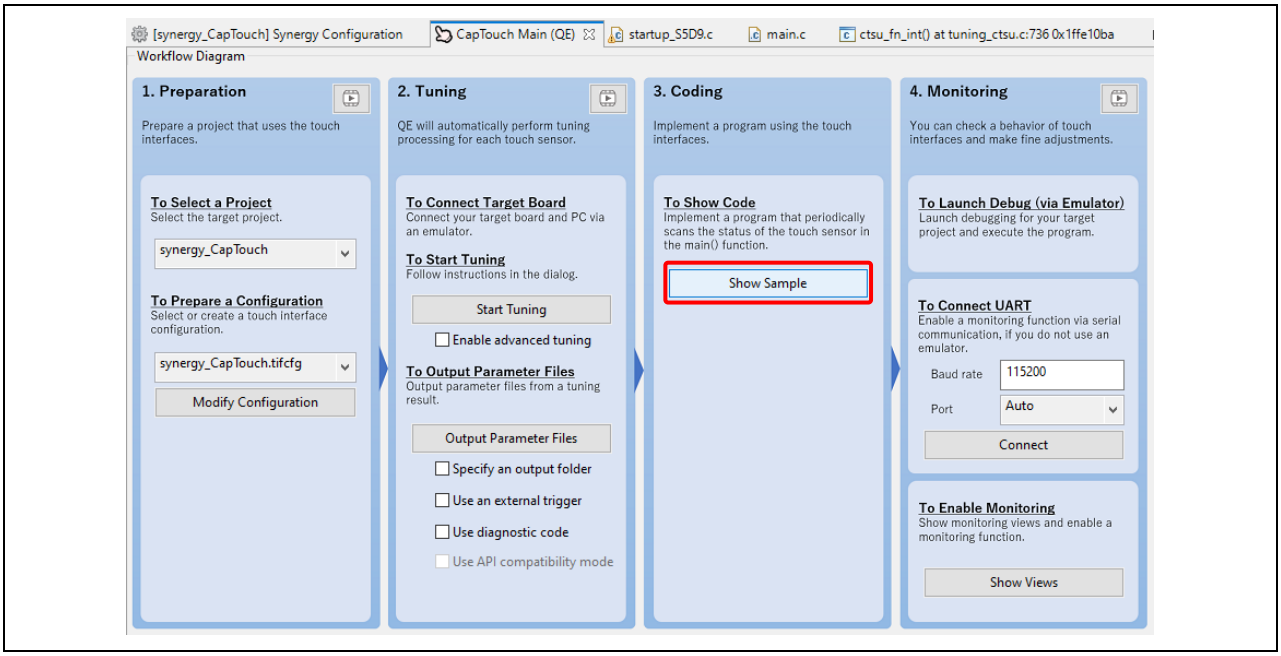

Figure 6-1. Select a "Show Sample"

2. A new menu window will open with shows the sample code in text. Click the button **Output to a File**.

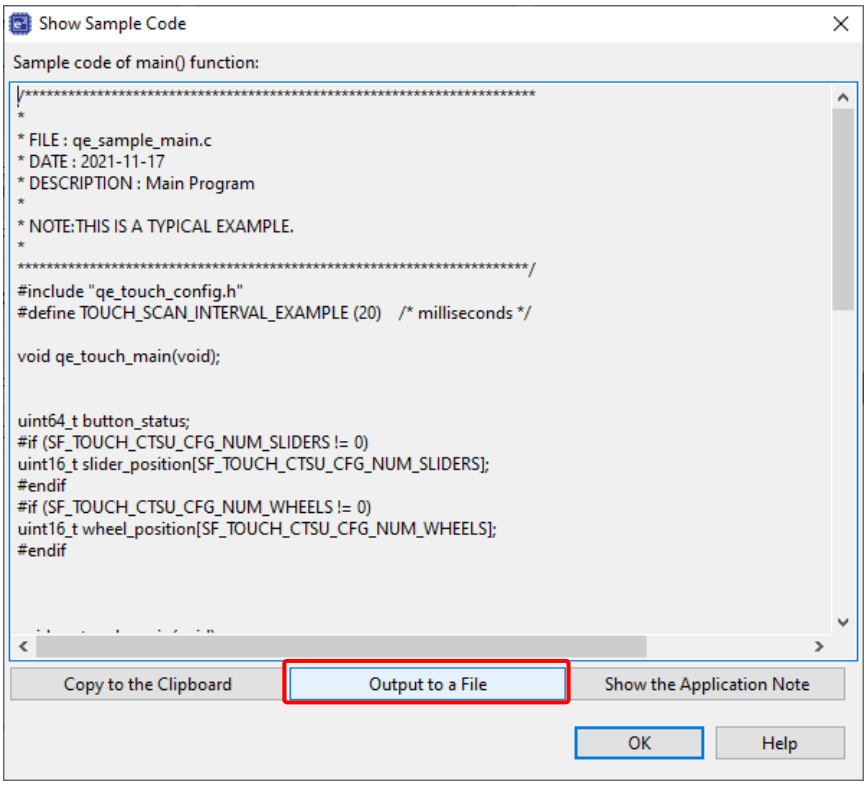

Figure 6-2. Output to a sample code

3. Created a new project file that describes the sample code. In the Project Explorer window and you will see that **qe_touch_sample.c** files have been added.

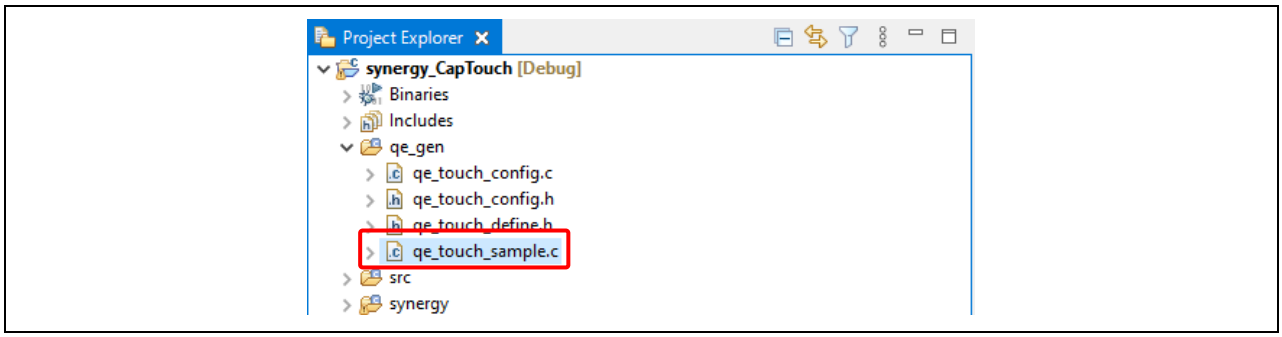

Figure 6-3. Created a qe_touch_sample.c

4. Open the **hal_entry.c**, add the **qe_touch_main()** of the sample main program.

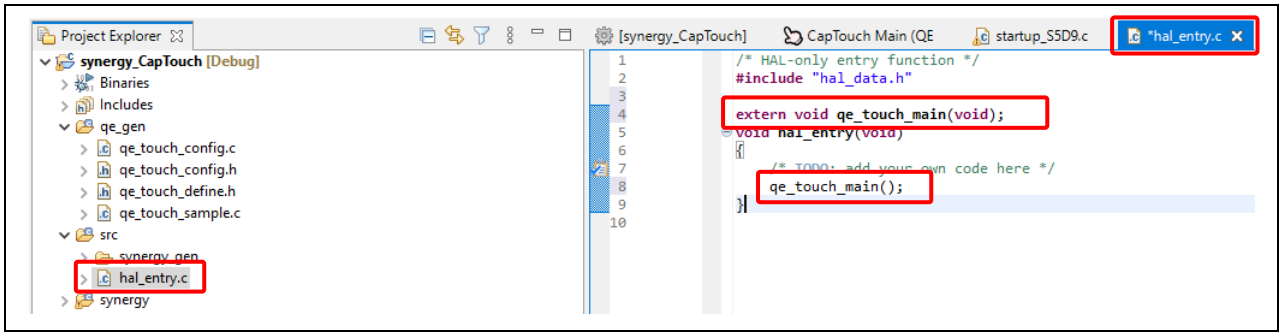

Figure 6-4. Adding a code

5. Building the code should result in no errors or warnings for this simplified application example.

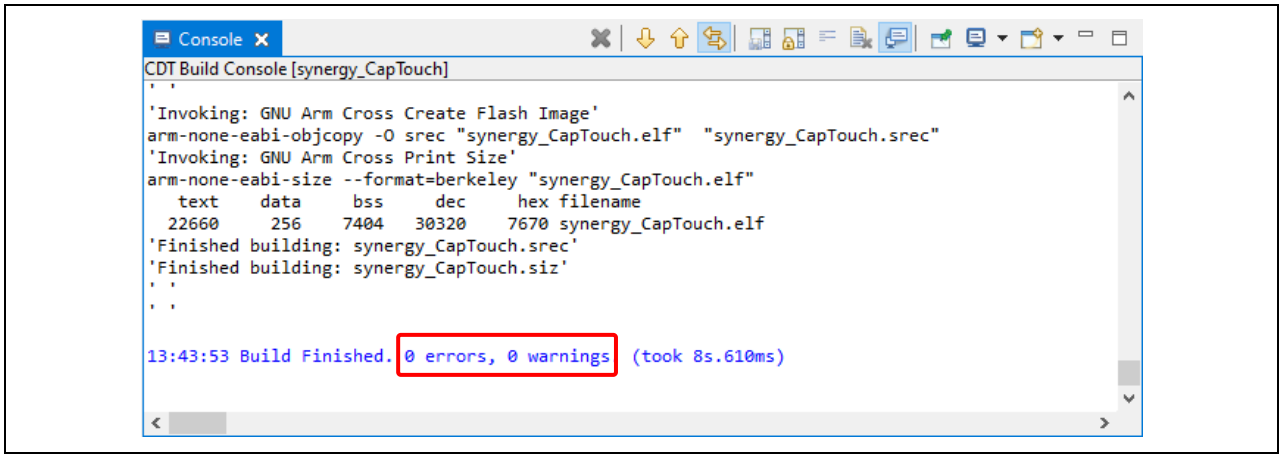

Figure 6-5. Result in no errors

7. Debugging

This chapter is debugging on detects the S3 Capacitive Touch Button.
Add a **button_status** to the watch expression, verify that the detected value is correct.
Step 2-7 to set up Watch Expression, resume in step 8, and detect in step 9.

1. Start a Debug session by clicking the Bug icon in the upper left-hand corner of e² studio. A Debug session will commence.
2. Open the **qe_touch_sample.c** file.
   Find the **button_status** on **g_qe_touch_instance_config01.p_api->dataGet()** function.
   Right-click the **button_status**, and click the **Add Watch Expression…**.

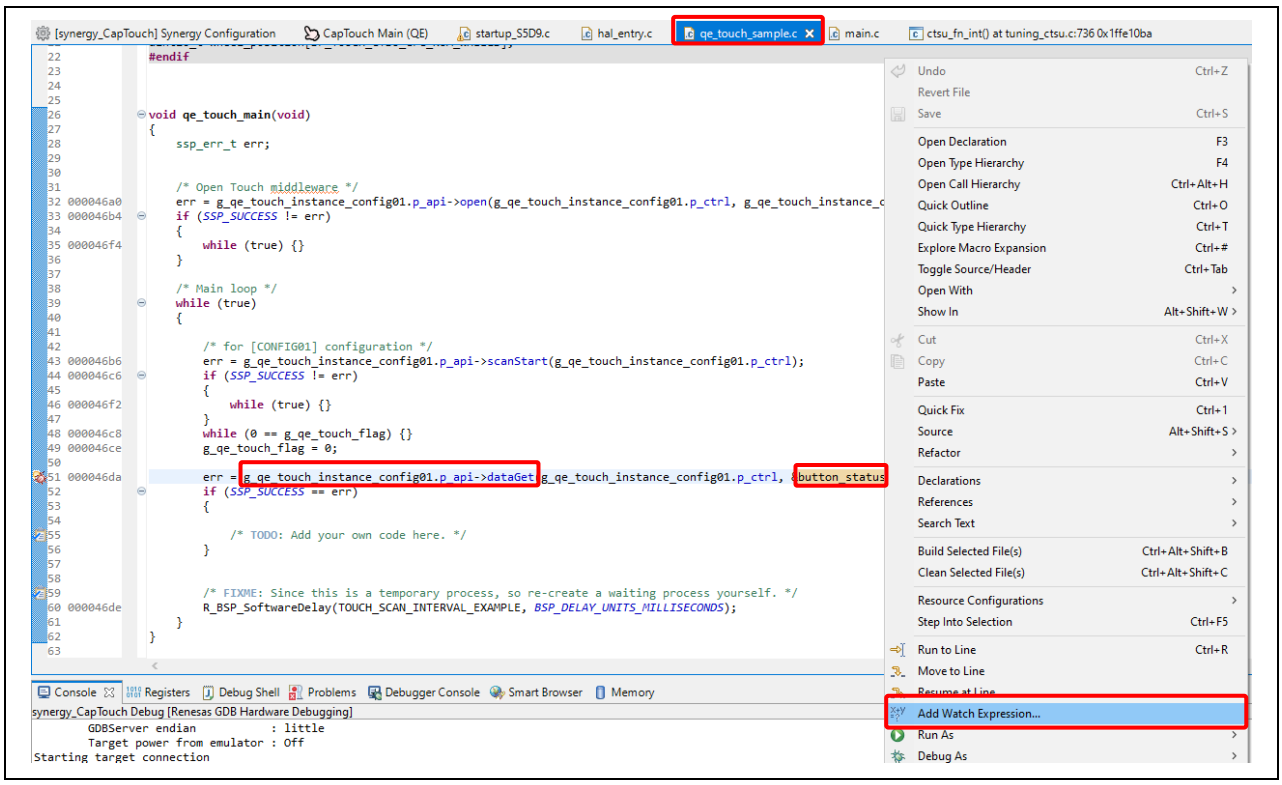

Figure 7-1. Add Watch Expression

3. Click **OK**.

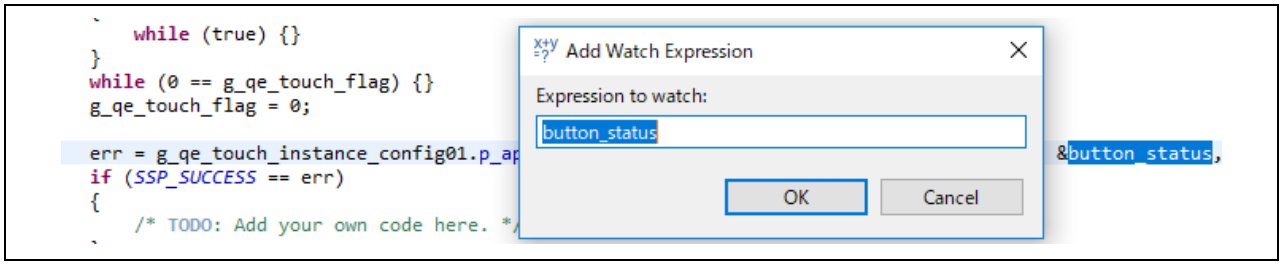

Figure 7-2. Add expression to watch

4. **button_status** in the **Expression window list** is added.

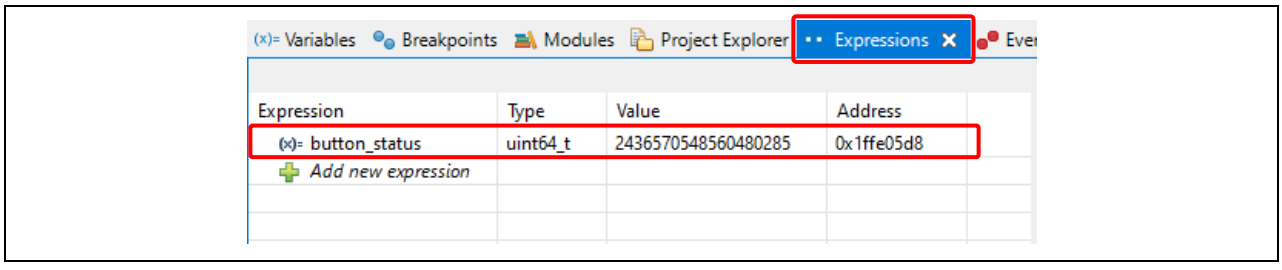

Figure 7-3. Added in the "Expression window list"

5. Right-click the **button_status**, Select to the **Real-time Refresh** > **Real-time Refresh Interval**.

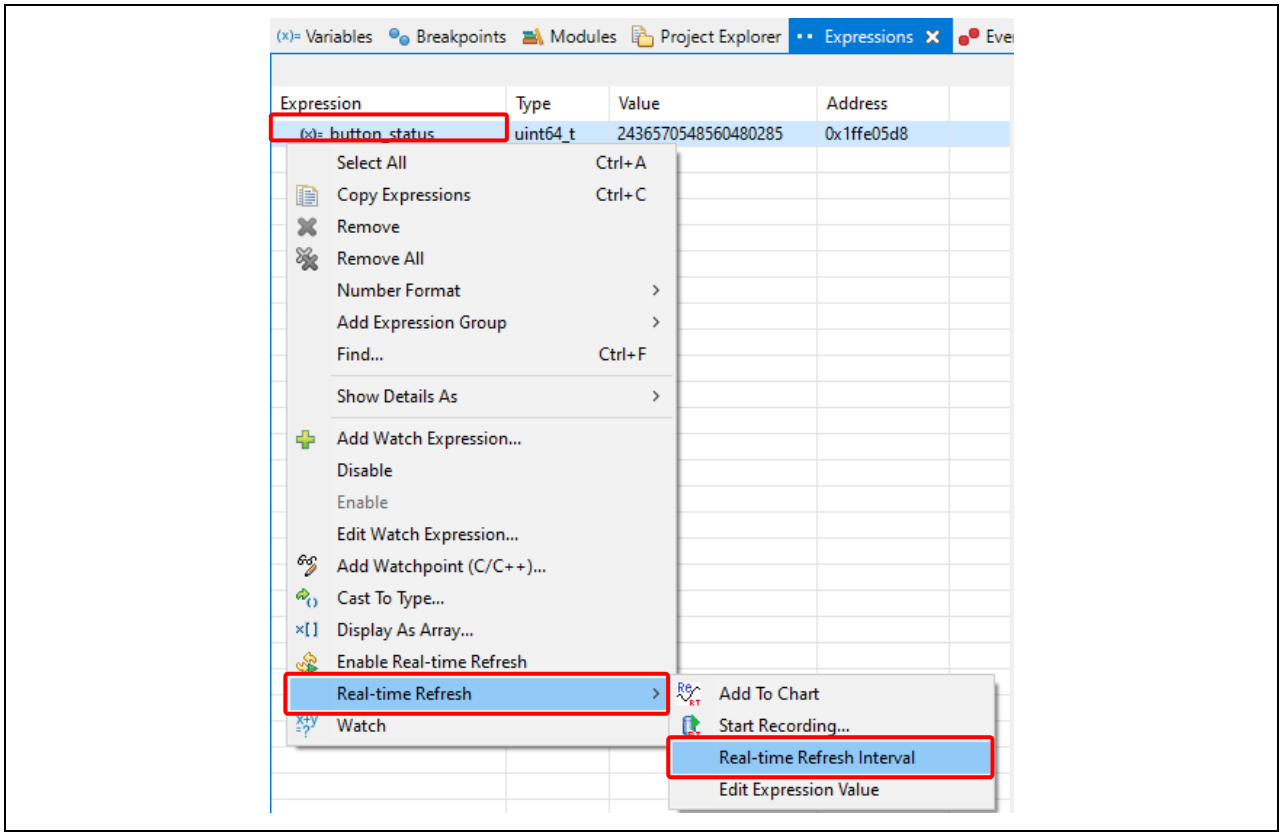

Figure 7-4. Select "Real-time Refresh Interval"

6. Set is the Interval-time 100milliseconds. click **OK**.

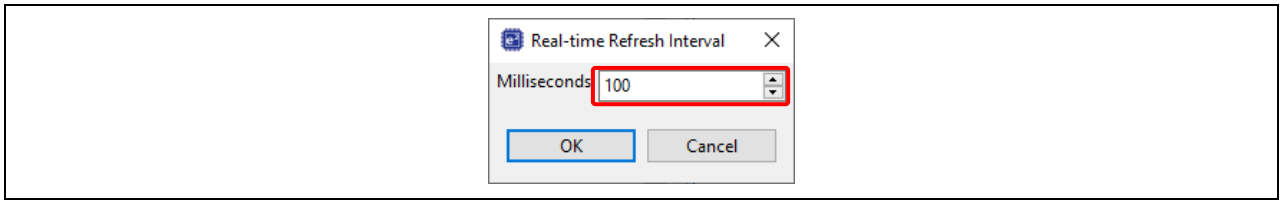

Figure 7-5. Set "Real-time Refresh Interval"

7. Right-click the **button_status**. Select **Enable Real-time Refresh**.

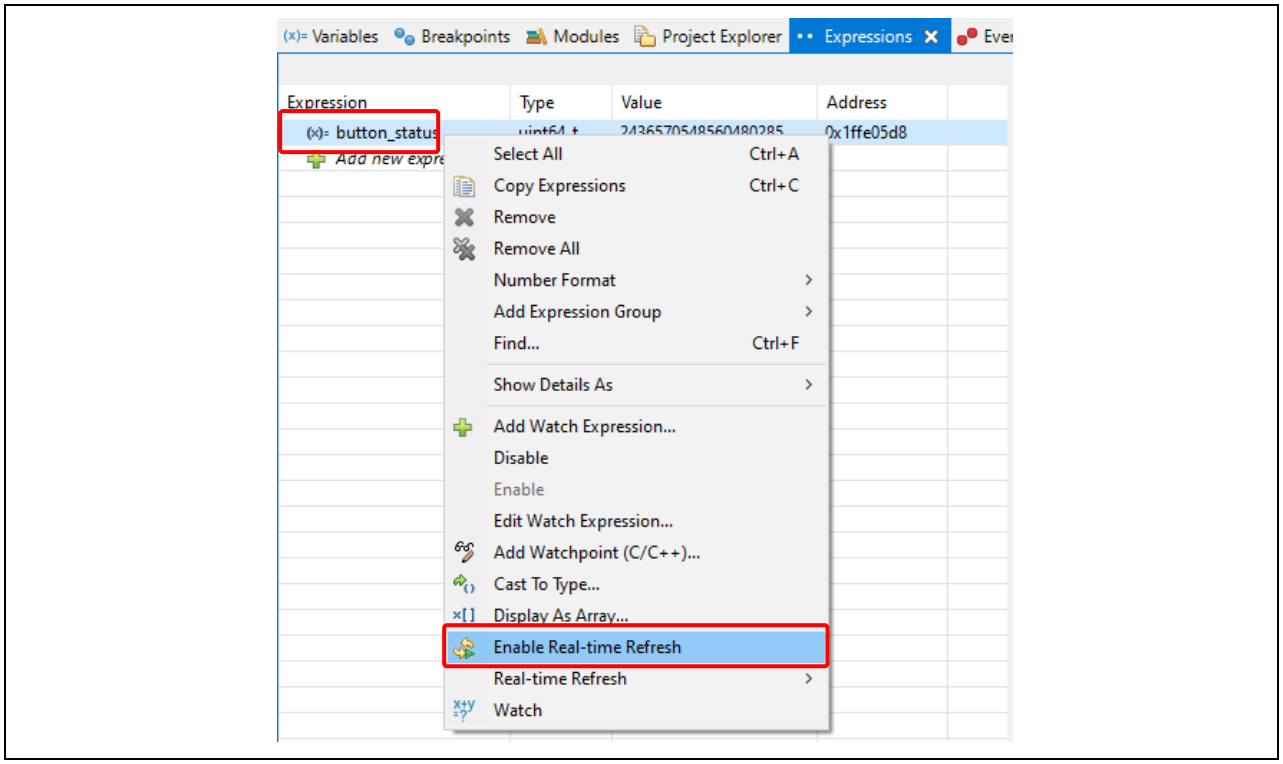

Figure 7-6. Enable Real-time Refresh

8. Click the **Resume** button located approximately in the middle of the e² studio menu bar to continue code execution.

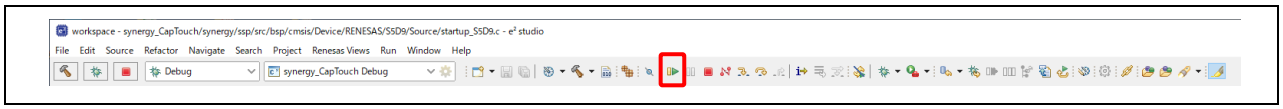

Figure 7-7. **Click the "Resume"**

9. Press S3 on the board, which was configured as S3 in section 3.2. When pressed, a "2" will appear for the capacitive button in the Expressions window, indicating a binary indication of touch.

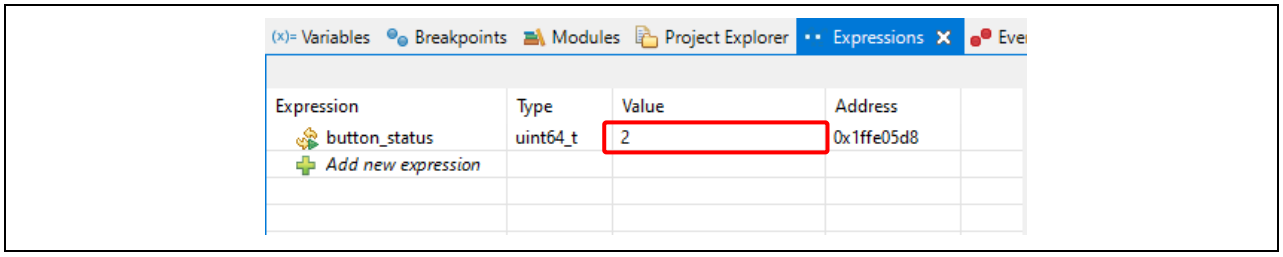

Figure 7-8. See S3 values

8. Monitoring on CapTouch Main

This chapter is monitoring on detects capacitive button S3.
Monitor detailed values for The Capacitive Touch Interface using the Monitoring feature.

8.1 Monitoring on detects capacitive button S3

Monitors the detection status of the Capacitive Touch Interface.

1. Open the Monitoring view from **Show Views** of CapTouch Main (QE).

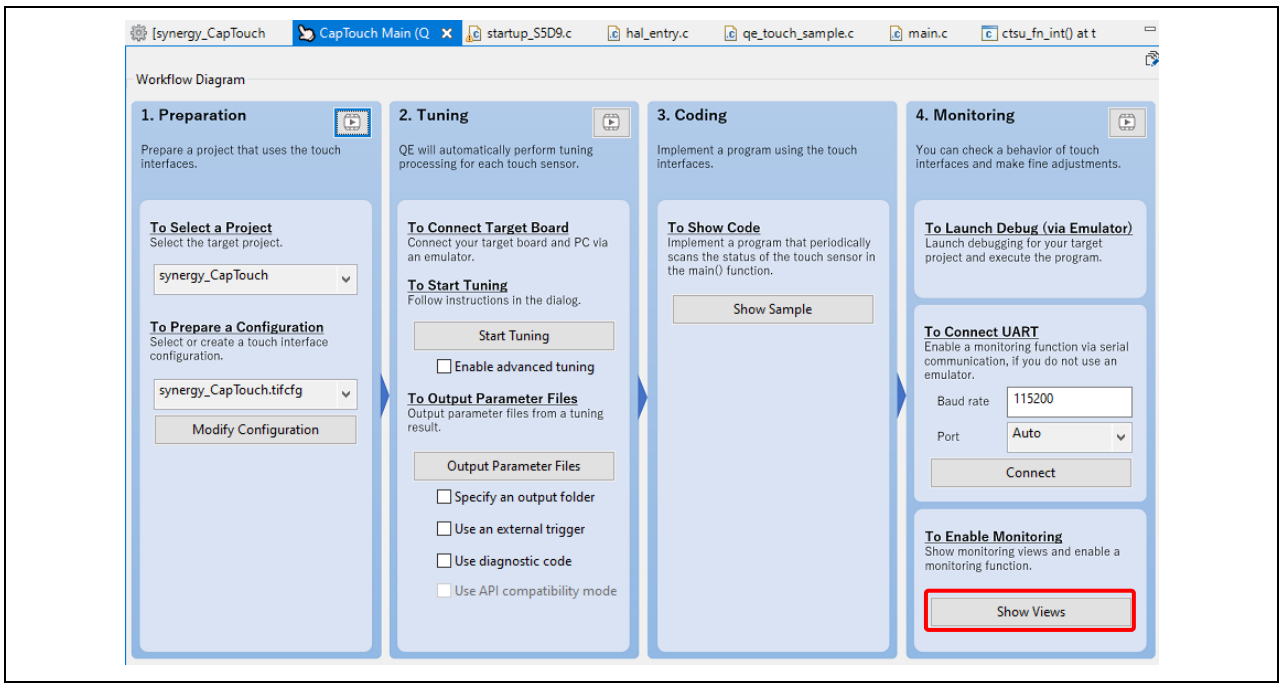

Figure 8-1. Select “Show Views”

2. It may be necessary to drag the pane up for better viewing, however you should see the **CapTouch Board Monitor (QE)** pane appear like the image below.

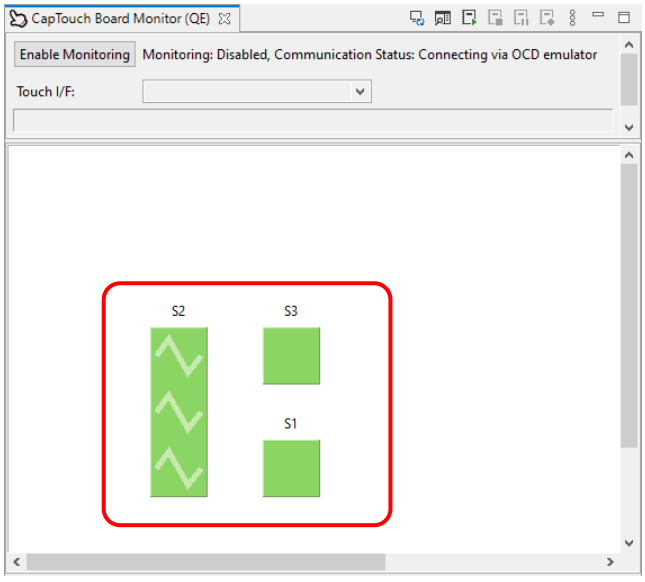

Figure 8-2. CapTouch Board Monitor (QE) window

3. Click the **Enable Monitoring** button. The dialog text will change to Monitoring: Enabled.

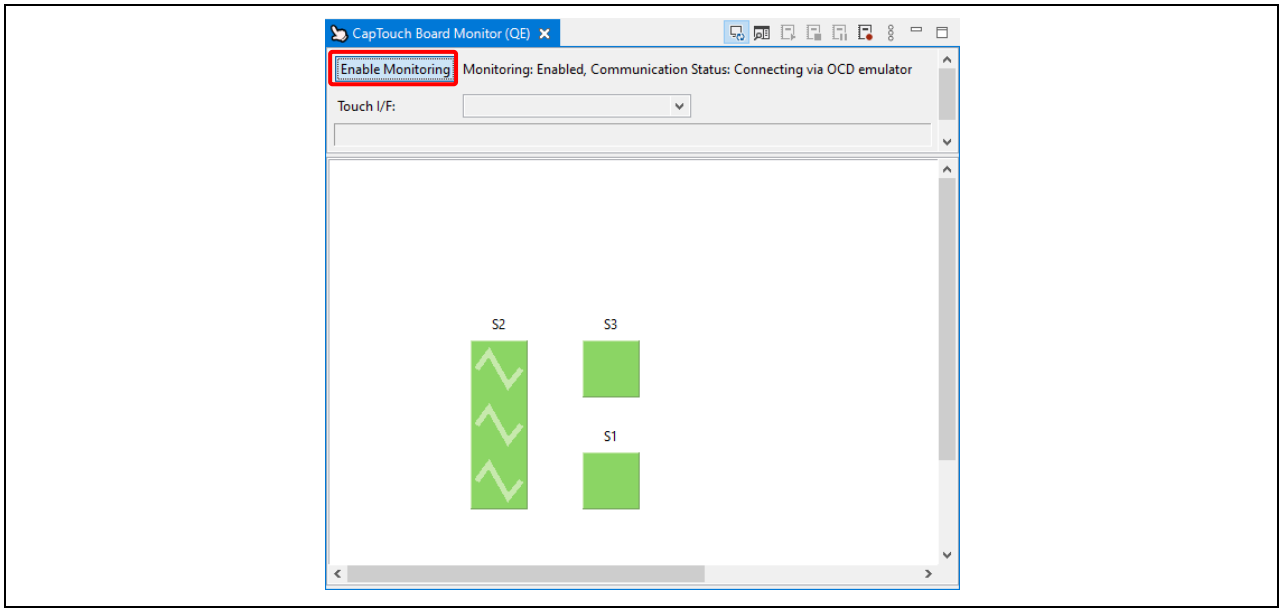

Figure 8-3. Enable Monitoring

4. Touch the capacitive button S3 on the PK-S5D9 board. The **CapTouch Board Monitor (QE)** will show a touch with a finger image on the button like the below image.

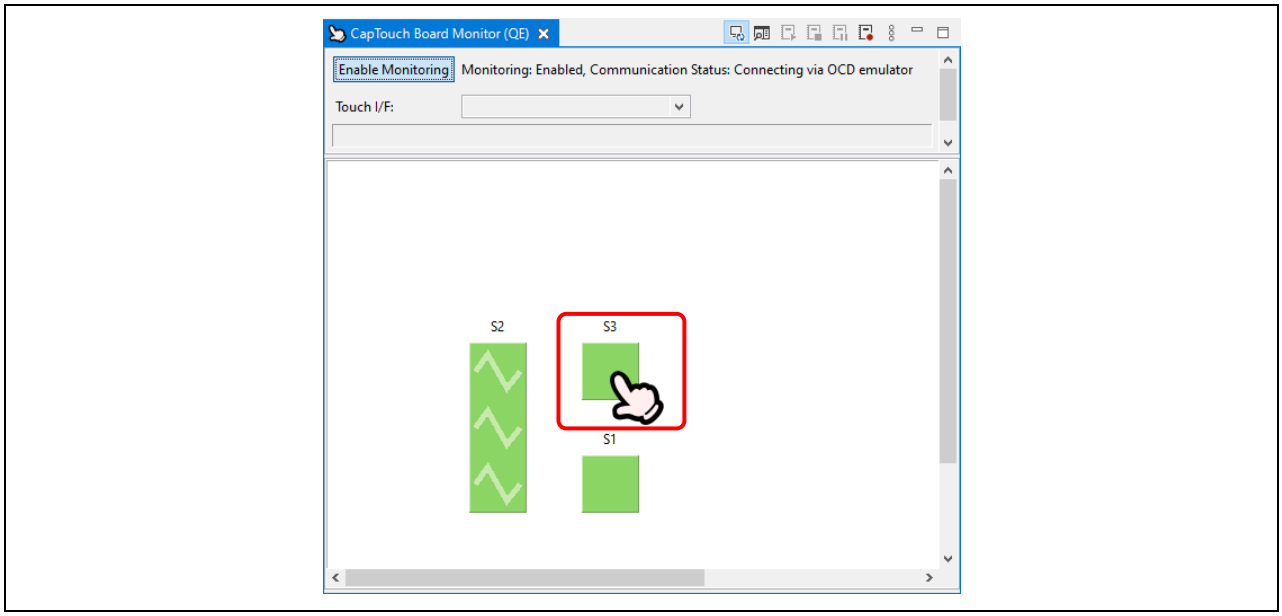

Figure 8-4. Show a touch with a finger image

5. To see a graphical representation of the 'touch counts' from the board, use the CapTouch Status Chart (QE). Using the pulldown, select "**S3 @ config01**".

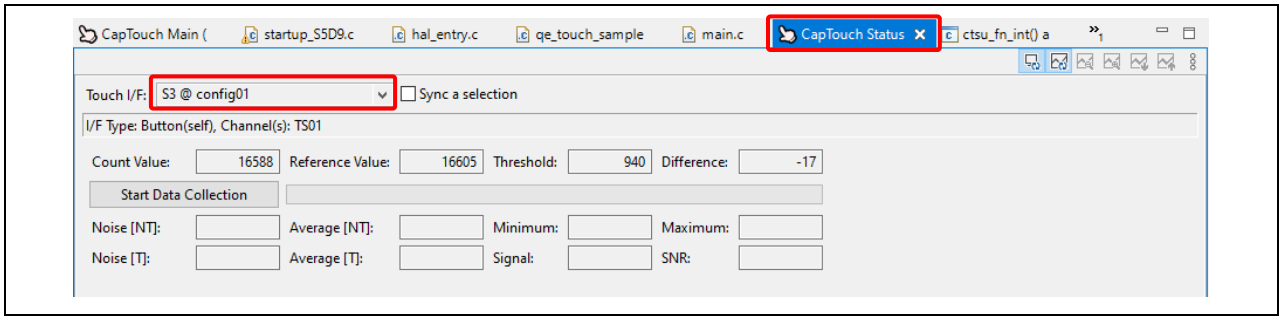

Figure 8-5. Select "S3 @ config01"

6. The graph will begin to display running values. Capacitive button S3 on the board and you should see the "touch counts" show as a step change on the running graph. The GREEN line is the touch "Threshold", which the middleware uses to determine whether a button is actuated/touched. The RED BELT at the bottom of the graph is a visual indication to the user that the "touch counts" have crossed above the threshold and a touch is detected.

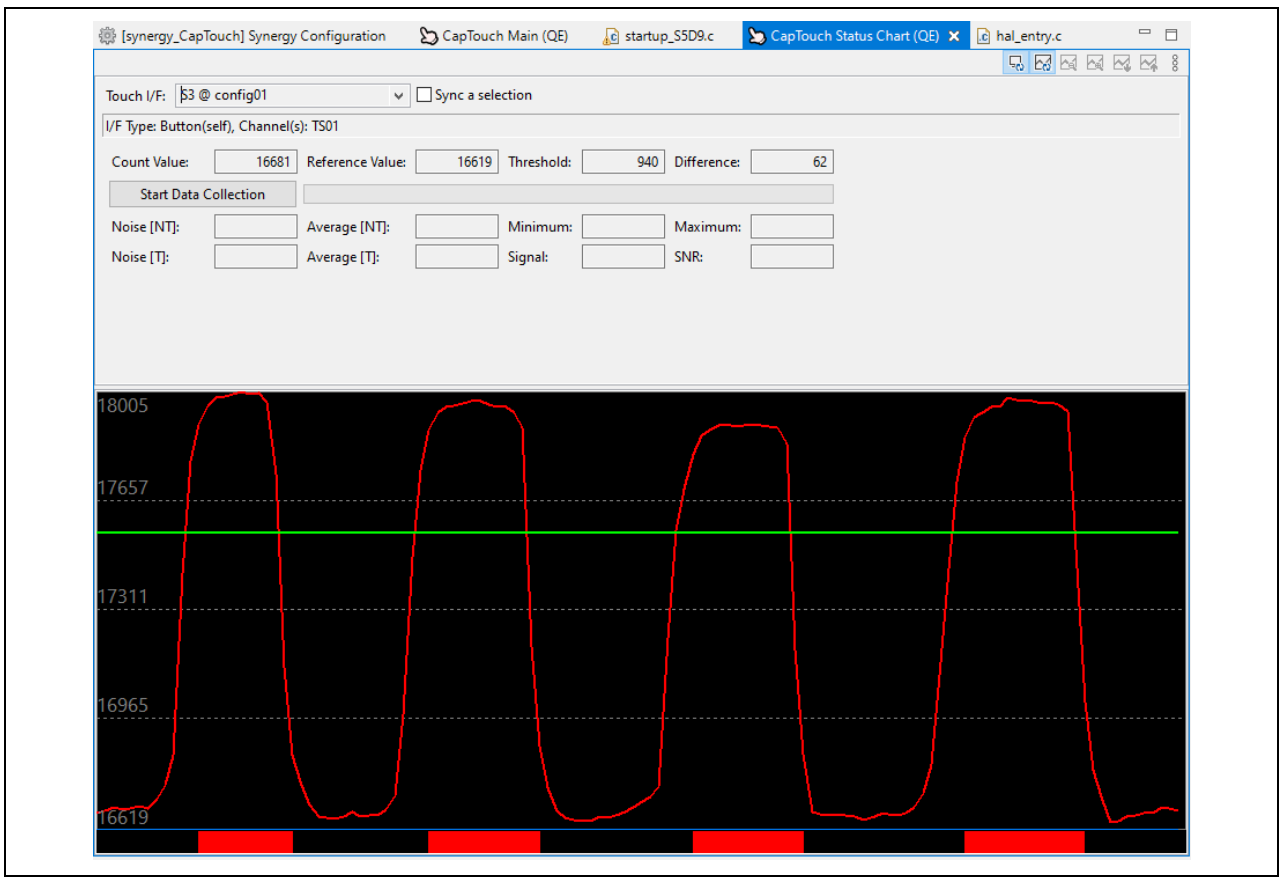

Figure 8-6. Display Running Values for Capacitive Button S3 on the Board

8.2 Displaying and measuring standard deviation

This setting should only be set when displaying and measuring standard deviation.
Also, if the measured standard deviation is unexpected value, re-tune from Chapter 5.1.

1. Next, measure standard deviation. Click the **Start Data Collection** button. Don't touch the electrode as this will collect data of touch-off state. The green bar is the data collection rate. When the green bar goes all the way to the right, the data collection of touch-off state is complete.

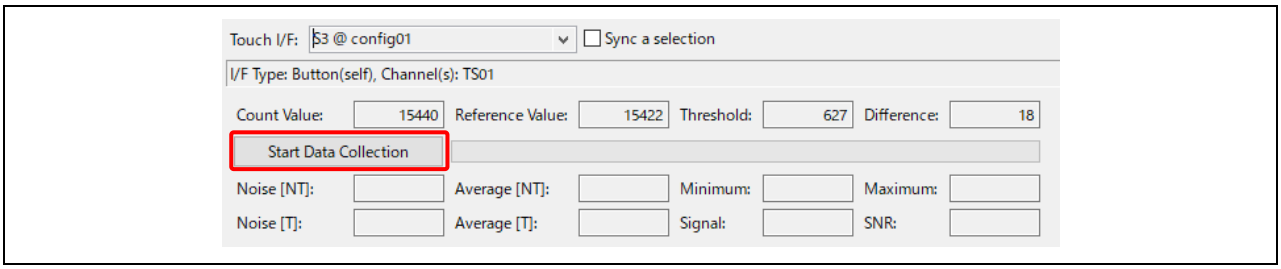

Figure 8-7. Touch-off Start Data Collection

2. Click the **Stop Data Collection** button, when the green bar goes all the way to the right.

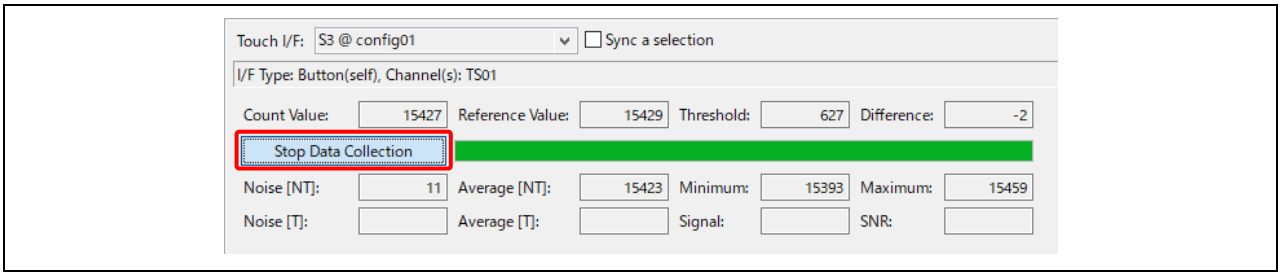

Figure 8-8. Touch-off Stop Data Collection

3. Next, Touch the electrode as this will collect data of touch-on state. Click the **Start Data Collection** button while touching the electrode.

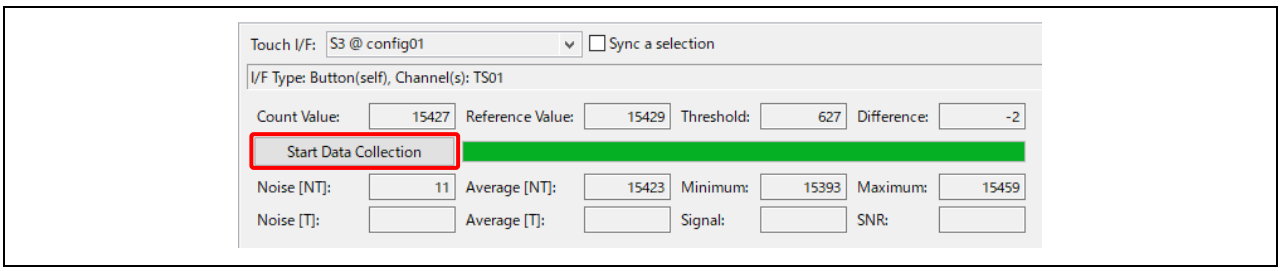

Figure 8-9. Touch-on Start Data Collection

4. Click the **Stop Data Collection** button, when the green bar goes all the way to the right. The SNR is displayed when data collection is complete.

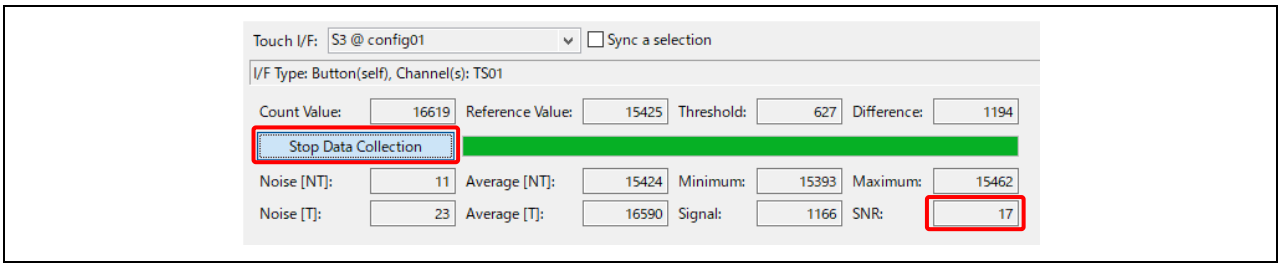

Figure 8-10. Touch-on Stop Data Collection

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Synergy Platform MCUs	www.renesas.com/renesas-synergy-platform-mcus
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SSP Components	www.renesas.com/synergy/ssp-components
MCU Components	www.renesas.com/synergy/renesas-synergy-platform-mcus
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Synergy Solutions Gallery:	
Partner projects	www.renesas.com/synergy/partnerprojects
Application projects	www.renesas.com/synergy/applicationprojects
Self-service support resources:	
Knowledgebase	www.renesas.com/synergy/knowledgebase
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Training	www.renesas.com/synergy/training
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Chat and web ticket	www.renesas.com/synergy/resourcelibrary

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Aug.16.21	—	First release document
1.10	Mar.14.22	1	Update to Operating Environment
		—	Changed version SSP to v2.2.0
		—	Changed version QE for Capacitive Touch to v3.0.2

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

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.

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