

Renesas RA Family

# QE for Capacitive Touch usage for IAR EWARM

# Introduction

This document will demonstrate how to generate QE code for Capacitive Touch in e<sup>2</sup> studio and copy the QE code to IAR EW for ARM using Renesas RA Microcontrollers.

# Target Device

Capacitive Touch Evaluation System for RA2L1 (RSSK RA2L1)

#### **Operating Environment**

IDE	IAR Embedded Workbench for Arm version 9.20.2 or later e <sup>2</sup> studio version 2021-10 is used for Capacitive Touch tuning and code generation
Configuration Tool	RA Smart Configurator (RA SC) v2021-10 and FSP v3.5.0
Toolchains	GNU Arm Embedded Toolchain: 10.3-2021.10
	(GNU ARM Embedded 10.3.1.20210824)
QE	Renesas QE for Capacitive Touch v3.0.1

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

- Renesas QE download site: <u>https://www.renesas.com/software-tool/qe-tools-particular-applications</u>
- FSP with e<sup>2</sup> studio installer download site: <u>https://github.com/renesas/fsp/releases</u>
- IAR EW for ARM download site: https://www.iar.com/products/architectures/arm/iar-embedded-workbench-for-arm



Figure 1. Configuration diagram when using QE for Capacitive Touch with IAR EWARM



# Contents

1.	Creating a project in e <sup>2</sup> studio	3
2.	Create Capacitive Touch Configuration in e <sup>2</sup> studio	6
3.	Capacitive Touch Tuning in e <sup>2</sup> studio	.12
4.	Creating a project in IAR EWARM	.16
5.	Adding TOUCH Driver in IAR EWARM	.21
6.	Copying QE files to IAR EWARM	.24
7.	Run Capacitive Touch Project in IAR EWARM	.27
Rev	/ision History	.31



# 1. Creating a project in e<sup>2</sup> studio

A project generation wizard is available in e<sup>2</sup> studio to generate an RA project with a project name and the associated device and board, including board-level drivers.

Start the e<sup>2</sup> studio application and choose a workspace folder in the Workspace Launcher. To create a new RA project, follow these steps:

- 1. Select File > New > C/C++ Project.
- 2. Select the Renesas RA: Renesas RA C/C++ Project template. Click Next to continue.

New C/C++ Pro	oject			$\times$
Templates for N	Templates for New C/C++ Project			
				_
All CMake Make	Renesas RA C/C++ Project	C++ project for Renesa	ıs RA.	
Renesas Debug Renesas RA				
?	< <u>B</u> ack <u>N</u> ext >	Einish	Cancel	

#### Figure 2. Template Selection

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

📴 Renesas RA C/C++ Project		×
Renesas RA C/C++ Project Project Name and Location		Ď
Project name RACapTouchExample		
Use default location Location: C:\Users\Renesas\e2_studio\RA_workspace\RACapTouchExample Choose file system: default	B <u>r</u> o	WSe
You can download more Renesas packs here		

Figure 3. Project Name and Location



- 4. In the device selection dialog, enter device and tool information:
  - FSP version: **3.5.0**
  - Board: RSSK-RA2L1
  - Device: Auto selected
  - Language: C
  - Toolchain version: Latest GNU Arm Embedded Toolchain approved for use with Renesas RA. (for example, GCC ARM Embedded 10.3.1.20210824)
  - Debugger: J-Link ARM
  - Click Next to continue.

<ul> <li>Renesas RA C/C++ Project</li> <li>Renesas RA C/C++ Project</li> <li>Device and Tools Selection</li> </ul>	×
Device Selection FSP Version: 3.5.0 Board: RSSK-RA2L1 Device: R7FA2L1AB2DFP	-Board Description
Language: OC ++	Device Details TrustZone No Pins 100 Processor Cortex-M23
Toolchains	Debugger
GNU ARM Embedded ARM Compiler 6.17 10.3.1.20210824 ~	J-Link ARM ~
0	< Back Next > Finish Cancel

Figure 4. Create New Project for RSSK-RA2L1

5. Build Artifact Selection: Executable RTOS Selection: No RTOS

<ul> <li>Renesas RA C/C++ Project</li> <li>Renesas RA C/C++ Project</li> <li>Build Artifact and RTOS Selection</li> </ul>		_	
Build Artifact Selection    Executable	RTOS Selection No RTOS		~
<ul> <li>Static Library         <ul> <li>Project builds to a static library file</li> <li>Executable Using an RA Static Library</li> <li>Project builds to an executable file</li> <li>Project uses an existing RA static library project</li> </ul> </li> </ul>			
0	< <u>B</u> ack <u>N</u> ext >	Einish	Cancel

Figure 5. Build Artifact and RTOS Selection



6. In the project template dialog, select **Bare Metal - Minimal** and click **Finish.** 

🖪 Renesas RA C/C++ Project - 🗆 🗙
Renesas RA C/C++ Project Project Template Selection
Project Template Selection
Bare Metal - Blinky Bare metal FSP project that includes BSP and will blink LEDs if available. This project will initialize clocks, pins, stacks, and the C runtime environment. [Renesas.RA:3.5.0.pack]
Bare Metal - Minimal Bare metal FSP project that includes BSP. This project will initialize clocks, pins, stacks, and the C runtime environment. [Renesas.RA.3.5.0.pack]
Code Generation Settings
Use Renesas Code Formatter
(?) < Back Next > Finish Cancel



7. Once complete, e<sup>2</sup> studio creates a new project with the "FSP Configuration" perspective open and ready for project configuration.

workspace - RACapTouchExample/configuration.	.xml - e² studio			- 0	×
File Edit Navigate Search Project Renesas V	ïews Run Window Help				
🍝 🔅 🔳 🔅 Debug 🗸	💽 RACapTouchExample Debug_Flat 🛛 🗸 🔅	📩 🕶 🗐 🕲 🕶 🔦 🕶 🗟 🥖 🛷 🕶	🖷 i 😳 i 🗞 i 🏘 🗸	Q	
□ 🗸 ▾ 袮 🗰 💷 😭 🖏 🕹 : 🍩 : 🎽 ▾ 🗿 ▾	*5 + -		Q 🛛 😰 🛛 🖬 C/C+-	+ 🔅 FSP Conf	iguration
陷 Project Explorer 🔀 📄 🔄 🖓 🖇 🖳 🗖	🔅 [RACapTouchExample] FSP Configuration 🕽	< C C C C C C C C C C C C C C C C C C C	🌮 FSP Visualizati 🛛	🗿 👩 Package	
✓ C RACapTouchExample > M Includes > A ra	Summary	Generate Project Content			L >>
> 😝 ra > 🔑 ra_gen > 🔑 src	Project Summary				
<ul> <li>&gt;&gt; cacfg</li> <li>&gt;&gt; cript</li> <li>&gt;&gt; configuration.xml</li> <li>&gt;&gt; R7A2L1AB2DFRpincfg</li> <li>&gt;&gt; RACapTouchExample Debug_Flat.launch</li> <li>&gt; ? Developer Assistance</li> </ul>	Board:       RSSK-RA2L1         Device:       R7FA2L1AB2DF4         Toolchain:       GCC ARM Embe         Toolchain Version:       10.3.1.20210824         FSP Version:       3.5.0         Project Type:       Flat         Selected software components         Board Support Package Common File         I/O Port         Arm CMSIS Version 5 - Core (M)         Board support package for R7FA2L1,         Board support package for RA2L1         Board Support package for RA2L1	dded s v3.5.0 v3.5.0 v5.8.0+renesas.0.fsp.3.5.0 kB2DFP v3.5.0 v3.5.0	V3.5.0 V3.5.0 V3.5.0 V3.5.0 v3		
	Summary BSP Clocks Pins Interrupts Event	Links Stacks Components	▶ Legend		
Properties 🛛 💦 Problems 🏟 Smart Browser		Pin Conflicts 🛛		78	- 0
Properties are not available.		Ditems	Module	Pin	Location
					,

Figure 7. New Project for RSSK RA2L1



# 2. Create Capacitive Touch Configuration in e<sup>2</sup> studio

- If you have not installed the QE for Capacitive Touch, select Renesas Views > Renesas Software Installer from the menu of e<sup>2</sup> studio to install it.
- 2. In the Renesas Software Installer dialog box, select Renesas QE, then click Next.
- 3. Select **QE for Capacitive Touch** and click **Finish** to install it.

📓 Renesas Software Installer — 🗆 🗙	,
Install Extensions	
Select extensions to install. Press Finish to proceed with installation. Press the information button to see a detailed overview and a link to more Find:	
QE for BLE[RA,RE] (v1.3.0)         Tools to assist in development work involving Bluetooth 73 Low Energy.	^
QE for BLE[RX] (v1.1.0)         Tools to assist in development work involving Bluetooth73 Low Energy.	
QE for Capacitive Touch (v3.0.1) Tools to assist in the configuration, tuning, and monitoring of touch interfaces. (supports all touch MCUs: RX, RA, RL78, and Renesas Synergy)	
QE for Capacitive Touch[RX] (v1.1.0) Tools to assist in the configuration, tuning, and monitoring of touch interfaces. (only supports use with FIT modules V1.1 or before in RX family)	
QE for Display[RX] (v2.1.0) Tools to assist with timing settings or the image quality of displays. (for use with display controllers from Renesas)	
QE for Motor (v1.0.0)	~
? < Back Next > Finish Cancel	

#### Figure 8. Install QE for Capacitive Touch

4. From the menu of e<sup>2</sup> studio, select **Renesas Views > Renesas QE > CapTouch Main (QE)** to open the main perspective for configuring capacitive touch to the project.



Figure 9. Open CapTouch Main (QE)



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

4. Monitoring	3. Coding	2. Tuning	1. Preparation
You can check a behavior of touch interfaces and make fine adjustments.	Implement a program using the touch interfaces.	QE will automatically perform tuning processing for each touch sensor.	Prepare a project that uses the touch interfaces.
To Launch Debug (via Emulate Launch debugging for your target project and execute the program. To Connect UART Enable a monitoring (unction via seri emulator. Baud rate 115200 Port Auto Connect To Enable Monitoring Show monitoring views and enable a monitoring function. Show Views	To Show Code Inplement a program that periodically scans the status of the touch sensor in the main() function. Show Sample	Decennect Target Board and PC via an emulator.     Decennect your target board and PC via an emulator.     Decennect Transmer Provide the structures in the dialog.     Decennect Provide the structures of the structure of t	Te Select a Project Select the target project.

Figure 10. Select Project

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

Figure 11. Create New Touch Configuration



#### 7. A new menu window will open with the default blank canvas for creating the Touch Interface.

File Name of Touch I/F:	RACapTouchExample	Setup Configuration	Import / Re-edit
Description:			
			Touch I/F Capacitance Type
			Self Capacitance 💗
			Button
			Slider (horizontal)
			Slider (vertical)
			Wheel
			Key pad
			3D Gesture (A)
-			Touch pad
			Shield Pin
			TC Pin
			Capacitance Sensor
			Current Sensor
			Diagnosis Pin
Setting Setup Touch I/F	Setup Resistance Value Clear Assigned	I TSx	Remove Touch I/F

Figure 12. Blank Canvas

- 8. Add 3 buttons 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 three times to add three buttons.
  - c. Press the **ESC** key to exit once the three buttons are added.

File Name of Touch I/F:	RACapTouchExample Setup Configuration	Import / Re-edit
Description:		
		Touch I/F
		Capacitance Type
	Button00	Self Capacitance 🗸 🗸
		Button
		Slider (horizontal)
	Button01	Slider (vertical)
		Wheel
	Button02	Key pad
		3D Gesture (AI)
		Touch pad
		Shield Pin
		TC Pin
		Capacitance Sensor
		Current Sensor
		Diagnosis Pin
		Dignoss in
Setting		Remove Touch I/F
Setup Touch I/F	Setup Resistance Value Clear Assigned TSx	
O These are a set to be a set	at weather	
😢 There are some problems wit	th setting.	

Figure 13. Create New Touch Button



- 9. Assign Touch Sensor to buttons:
  - a. Double click on **Button00** and a dialog box will appear. Rename it to TS\_B1. Using the pull-down and select **TS11** as the MCU sensor to assign to this button.
  - b. Double click on **Button01** and a dialog box will appear. Rename it to TS\_B2. Using the pull-down and select **TS10** as the MCU sensor to assign to this button.
  - c. Double click on **Button02** and a dialog box will appear. Rename it to TS\_B3. Using the pull-down and select **TS09** as the MCU sensor to assign to this button.

9	Setup Touch Interface X
	Button(self)
	Name TS_B1
	Touch Sensor Resistance[ohm] TS11 v 560 v
	OK Cancel Help

Figure 14. Assign Touch Sensor to Button

- 10. Select the **Wheel** menu item from the right-hand side and add it onto the canvas. Press **ESC** once completed.
- 11. Double click on **Wheel00** and a dialog box will appear. Using the pull-down and select **TS21**, **TS18**, **TS32**, **TS23** as the MCU sensors to assign to this wheel.

0	Setu	up Touch Interface				×
		Wheel				
		Name		Wheel00		
		Number of Touch Senso	or	4		~
		Touch Sensor	1	Resistance[ohm]		
	ſ	TS21		560		
		TS18		560		
		TS32		560		
	l	TS23	5	560	¥	
	[	Reverse				
		ОК		Cancel	Help	

Figure 15. Assign Touch Sensor to Wheel

- 12. Selecting the **Slider (horizontal)** menu item from the right-hand side and add it onto the canvas. Press **ESC** once completed.
- 13. Double click on **Slider00** and a dialog box will appear.
  - a. Select Number of Touch Sensor: 5.
  - b. Use the pull-down and select **TS06**, **TS07**, **TS05**, **TS02**, and **TS04** as the MCU sensors to assign to this slider.

🐻 Set	tup Touch Interface			×
$\langle \rangle \rangle$	Slider			
	Name	Slider00		
	Number of Touch Sensor	5		۷
	Touch Sensor	Resistance[ohm]		
		560		
	TS07	560		
	TS05	560		
		560		
	TS04 ♥ 5	560	× .	
	Reverse OK	Cancel	Help	

Figure 16. Assign Touch Sensor to Slider



14. Select the Shield Pin menu item from the right-hand side.

- a. Add the 1st shield to the canvas to cover the three buttons.
- b. Add the 2nd shield to the canvas to cover the wheel.
- c. Add the 3rd shield to the canvas to cover the slider.
- d. Press **ESC** once completed.
- 15. Assign Touch Sensor to shields.
  - a. Double click on Shield00 and a dialog box will appear. Assign TS00 to this shield.
  - b. Double click on Shield01 and a dialog box will appear. Assign TS14 to this shield.
  - c. Double click on Shield02 and a dialog box will appear. Assign TS08 to this shield.
- 16. This completes the addition of the Touch interface like shown below Figure 17.

File Name of Touch I/F:	RACapTouchExample	Setup Configuration	Import / Re-edit
Description:			
		Shieldoo, TSoo	Touch I/F Capacitance Type
	Shield01, TS14	TS_B1	Self Capacitance v
	Wheeloo	TSII	Button
			Slider (horizontal)
	T\$21 T\$18	T\$_82	
		7510	Slider (vertical)
	TS23 TS32	610	Wheel
		T5_83	Key pad
	Val The	7509	3D Gesture (Al)
			Teach pod
	Shield02, TS	06	Shield Pin
	Siderto		TCPin
	TS06 TS07 TS05 TS03	2 TSM	Capacitance Sensor
	1000		Current Sensor
			Diagnocis Pin
Setting			Remove Touch UF
Setup Touch VF	Setup Resistance Value Clear Assigned T	15x	

Figure 17. Complete New Touch Interface

17. Next, set the touch interface configuration. Press **Setup Configuration** button to open the **Setup Configuration** (methods) dialog and set the three active shields.

File Name of Touch I/F: RACapTouchExample Setup Configuration Add Configuration Remove Configu Description: Add Configuration Remove Configu Config01 TS_B1(self) ✓ Available TS_B2(self) ✓ Available TS_B3(self) ✓ Available	ration
Config01 TS_B1(self) ✓ Available TS_B2(self) ✓ Available TS_B3(self) ✓ Available TS_B3(self) ✓ Available	
TS_B2(self) ✓ Available TS_B3(self) ✓ Available	
TS_B3(self) 🗸 Available	
Wheel00(self) 🗸 Available	
Slider00(self) 🗸 Available	
Shield00(self) 🗸 Available	
Shield01(self)	
Shield02(self)	
OK Cancel	Help

Figure 18. Setup Configuration



- 18. The following steps to configure like Figure 19.
  - a. Uncheck Wheel00(self) and Slider00(self) to compose Shield00(self) with TS\_B1(self), TS\_B2(self) and TS\_B3(self) as config01.
  - b. Press Add Configuration, config02 is added.
  - c. Uncheck TS\_B1(self), TS\_B2(self), TS\_B3(self), Slider00(self), Shield00(self) and Shield02(self) to compose Shield01(self) with Wheel00(self) and Shield01(self) as config02.
  - d. Press Add Configuration, config03 is added.
  - e. Uncheck TS\_B1(self), TS\_B2(self), TS\_B3(self), Wheel00(self), Shield00(self) and Shield01(self) to compose Shield02(self) with Slider00(self) and Shield02(self) as config03.
  - f. Click **OK** to close the dialog box.

Setup Configuration	ns (Methods)			×
Add Configuration	Remove Configurat	ion		
	config01	config02	config03	
TS_B1(self)	✓ Available			
TS_B2(self)	✓ Available			
TS_B3(self)	✓ Available			
Wheel00(self)		✓ Available		
Slider00(self)			✓ Available	
Shield00(self)	✓ Available			
Shield01(self)		✓ Available		
Shield02(self)			✓ Available	
	<u> </u>			
		ОК	Cancel <u>H</u> elp	

Figure 19. Setting Setup Configurations (Methods)

- 19. This is the final Touch Interface. Click **Create** button bottom right of the **Configuration of Touch Interfaces** window to set up the Touch Interface.
- 20. The CapTouch Main (QE) will now display the configuration of the touch interface in the main view pane.

Method	Kind	Name	Touch Sensor	Parasitic Capacitance[pF]	Sensor Drive Pulse Frequency[MHz]	Threshold	Scan Time[ms]	Overflow 🔺
config01	Button(self)	TS_B1	TS11	-	-	-	-	None
config01	Button(self)	TS_B2	TS10	-	-	-	-	None
config01	Button(self)	TS_B3	TS09	-	-	-	-	None
config01	Shield Electrode Pin	Shield00	TS00	-	-	-	-	-
config02	Wheel	Wheel00	TS21, TS18, TS32, TS23	-	-	-	-	None
config02	Wheel TS	(Wheel00)	TS21	-	-	-	-	-
config02	Wheel TS	(Wheel00)	TS18	-	-	-	-	-
config02	Wheel TS	(Wheel00)	TS32	-	-	-	-	-
config02	Wheel TS	(Wheel00)	TS23	-	-	-	-	-
config02	Shield Electrode Pin	Shield01	TS14	-	-	-	-	-
config03	Slider	Slider00	TS06, TS07, TS05, TS02, TS04	-	-	-	-	None
config03	Slider TS	(Slider00)	TS06	-	-	-	-	-
config03	Slider TS	(Slider00)	TS07	-	-	-	-	-
config03	Slider TS	(Slider00)	TS05	-	-	-	-	-
config03	Slider TS	(Slider00)	TS02	-	-	-	-	-
config03	Slider TS	(Slider00)	TS04	-	-	-	-	-

Figure 20. Main View Pane Displays the Touch Configuration



21. Build the project by clicking the hammer icon. The project should build without any errors or warnings.

workspace - e² studio	
File Edit Navigate Search Project Renesas Views Run Window I	
🔦 🔅 🔳 🎄 Debug 🗸 💽 RACapTouchExample	
🎦 Pin Conflicts 📃 Console 🗙	
TTP : : : : : : : : : : : : : : : : : :	📃 🕶 📑 🔻
CDT Build Console [RACapTouchExample]	
• •	^
14:14:58 Build Finished. 0 errors, 0 warnings. (took 8s.294ms)	- 1
	×
<	>

Figure 21. Build Project

# 3. Capacitive Touch Tuning in e<sup>2</sup> studio

- 1. Connect the board with a PC. Refer to the Figure 53 for how to connect.
- 2. To start the automatic tuning process, click the button Start Tuning in the CapTouch Main (QE).

L. Preparation	2. Tuning	3. Coding	4. Monitoring
Prepare a project that uses the touch nterfaces.	QE will automatically perform tuning processing for each touch sensor.	Implement a program using the touch interfaces.	You can check a behavior of touch interfaces and make fine adjustments.
To Select a Project Select the target project. RACapTouchExample	<b>Lo Connect Target Board</b> Connect your target board and PC via         an emulator. <b>Dollaw instructions in the dialog. Start Tuning Chable advanced tuning Doutput Parameter Files</b> Output Parameter Files         Specify an output folder         Use an external trigger         Use diagnostic code         Use API compatibility mode	To Show Code Implement a program that periodically scans the status of the to buch sensor in the main() function. Show Sample	To Launch Debug (via Emulator)         Launch debugging for your target project and execute the program.         To Connect UART         Enable a monitoring function via serial communication, if you do not use an emulator.         Baud rate       115200         Port       Auto         Port       Auto         To Enable Monitoring         Show wonitoring function.         Show Views

Figure 22. Start Tuning



3. At the start of the first debug session, e<sup>2</sup> 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.

圆 Conf	irm Perspective Switch		Х
?	This kind of launch is configured to open the Debug	perspective when it suspends.	
	This Debug perspective supports application debug the debug stack, variables and breakpoints.	ging by providing views for displa	aying
	Switch to this perspective?		
🗹 Ren	nember my decision		
		Switch No	

Figure 23. Switch Perspective

4. The QE for Capacitive Touch RA 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.

Automatic Tuning Processing		Х
1/14: QE is beginning the tuning process. During the tuning process, please do not touch the sensors of until instructed by the QE Tuning Program.	on the target boar	d
	Cancel Help	

Figure 24. Tuning Dialog Window

5. 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 (TS\_B3, TS09). 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.

Automatic Tuning Processing	×
7/14: QE will now measure touch sensitivity In this step please use normal touch pressu key on the PC keyboard to accept the sensi	are on the sensor for once. Press any
TS_B3, TS09 @ config01: 6139	
	Cancel Help

Figure 25. Measure Touch Button TS\_B3



#### 6. Repeat the process for buttons TS\_B2 and TS\_B1.

Automatic Tuning Processing	×
3/14: QE will now measure touch sensitivity for (TS_B2, TS10 @ config01). In this step please use normal touch pressure on the sensor for once. Press a key on the PC keyboard to accept the sensitivity measurement.	ny
TS_B2, TS10 @ config01: 6074	
Cancel Help	·

Figure 26. Measure Touch Button TS\_B2

7. Next, we will measure the sensitivity of the wheel. Move your finger across the wheel sensors 3-4 times. After that, **press any key on the PC keyboard** to accept the measurement.

Automatic Tuning Processing	×
11/14: QE will now measure touch sensitivity for all wheels (config02) on the target board. Please move your finger across all of the wheel sensors 3-4 touch pressure. When complete, press any key on the PC the sensitivity measurement.	4 times using normal
C	Cancel Help

Figure 27. Repeat Measurement 3 Times

8. 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 28. Repeat Measurement 3 Times



9. 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 29. Threshold for Touch Event

 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 e<sup>2</sup> studio IDE.



Figure 30. Continue the Tuning Process

11. 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.

purch I/E (	Configuration: RACapT	ouchEvappel							
ouchiyre	configuration: NACapit	ouchexample	-						
Method	Kind	Name	Touch Sensor	Parasitic Capacitance[pF]	Sensor Drive Pulse Frequency[M	Threshold	Scan Time[ms]	Overflow	1
config01	Button(self)	TS_B1	TS11	6.59	1.0	397	0.576	None	
config01	Button(self)	TS_B2	TS10	7.528	1.0	379	0.576	None	
config01	Button(self)	TS_B3	TS09	5.75	1.0	288	0.576	None	
config01	Shield Electrode Pin	Shield00	TS00	25.972	-	-	-	-	
config02	Wheel	Wheel00	TS21, TS18, TS32, TS23	-	-	389	-	None	
config02	Wheel TS	(Wheel00)	TS21	6.424	1.0	-	0.576	-	
config02	Wheel TS	(Wheel00)	TS18	6.431	1.0	-	0.576	-	
config02	Wheel TS	(Wheel00)	TS32	6.09	1.0	-	0.576	-	
config02	Wheel TS	(Wheel00)	TS23	6.562	1.0	-	0.576	-	
config02	Shield Electrode Pin	Shield01	TS14	23.979	-	-	-	-	
config03	Slider	Slider00	TS06, TS07, TS05, TS02, TS04	-	-	1312	-	None	
config03	Slider TS	(Slider00)	TS06	5.75	1.0	-	0.576	-	
config03	Slider TS	(Slider00)	TS07	5.792	1.0	-	0.576	-	
config03	Slider TS	(Slider00)	TS05	5.382	1.0	-	0.576	-	
config03	Slider TS	(Slider00)	TS02	4.764	1.0	-	0.576	-	
config03	Slider TS	(Slider00)	TS04	5.806	1.0	-	0.576	-	
config03	Shield Electrode Pin	Shield02	TS08	25.326	-	-	-	-	•

Figure 31. Tuning Result



#### 12. Finally, output the tuning parameter files. Click the button **Output Parameter Files**.



Figure 32. Continue The Tuning Process

**13.** 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 the **r\_ctsu** and **rm\_touch** FSP modules.



Figure 33. Output Parameter Files

## 4. Creating a project in IAR EWARM

- 1. Install the IAR Embedded Workbench for ARM version 9.20.2 from https://www.iar.com/products/architectures/arm/iar-embedded-workbench-for-arm.
- Install the RA Smart Configurator (RA SC) from <a href="https://www.renesas.com/smart-configurator">https://www.renesas.com/smart-configurator</a>. Note: Please check the version of the RA Smart Configurator installer. If the FSP is not v3.5.0, download and install the latest version from <a href="https://github.com/renesas/fsp/releases">https://github.com/renesas/fsp/releases</a>.
- 3. To create a third-party IDE project with the RA Smart Configurator, run the "rasc.exe" application. In the "New Renesas RA FSP Project" wizard, enter the **Project name** and **Location**.

🕼 New Renesas RA FSP Project	×
New Renesas RA FSP Project	
Project Name and Location	
Project name	
IAR_QECapTouchExample	
Location: C:\Users\Renesas\IAR\workspace	Browse
You can download more Renesas packs here	

Figure 34. Project Name And Location



### 4. Board: RSSK-RA2L1

Kew Renesas RA FSP Project New Renesas RA FSP Project Device and Tools Selection	- [	X נ
Device Selection FSP Version: 3.5.0 Board: RSSK-RA2L1 Device: R7FA2L1AB2DFP	Board Description	
Language:	Device Details           TrustZone         No           Pins         100           Processor         Cortex-M23	
IDE Project Type IAR EWARM Version 8   Toolchains IAR Toolchain for ARM		
	< Back Next > Finish C	ancel

Figure 35. Board Selection for RSSK RA2L1

#### 5. RTOS Selection: No RTOS

🕼 New Renesas RA FSP Project				$\times$
New Renesas RA FSP Project				
RTOS Selection				
RTOS Selection				
No RTOS	~			
	< <u>B</u> ack <u>N</u> ex	d > Einish	Cance	

Figure 36. RTOS Selection



#### 6. Project Template Selection: **Bare Metal – Minimum**. Click **Finish** to create project.

\_\_\_\_

Figure 37. Template Selection

7. After the project is created, the DDSC Smart Configurator window will pop-up.

Help Run	nfigurator					-	x c
	:hExample] FSP Configuration 🔀		- 0	FSP Visualization	Package		
Summary	nexample) for comgutation 23		Generate Project Content			] 端子機能名	
Project Sum	mary		RENESAS				
Board:	RSSK-RA2L1		(CIVES/15				
Device:	R7FA2L1AB2DFP						
FSP Version:					Hull	1	
Project Type:							
Froject Type.	T lat						
Selected softw	are components						-
Board Suppo	rt Package Common Files	v3.5.0					
I/O Port	<u>-</u>	v3.5.0					
	Version 5 - Core (M)	v5.8.0+renesas.0.fsp.3.5.0				: 2	
	rt package for R7FA2L1AB2DFP						
Board suppo	rt package for RA2L1	v3.5.0			RENES	AS 🚦	•
	rt package for RA2L1 - FSP Data	v3.5.0			RAZL1 R7FAZL1AB2DF		·····
Supp							
	Doort Office State	ks Components		▶ 凡例			
	cks Pins Interrupts Event Links Stat	rks Components		▶ 凡例		<b>ए</b>	8 <sup>–</sup> E
Summary BSP Cloc	cks Pins Interrupts Event Links Stat		0 items	▶ 凡例			
Summary BSP Cloc	roblems		0 items	▶ 凡例	Module		8 🗆 🗖
Summary BSP Cloc	roblems		0 items	▶ 凡例	Module		
Summary BSP Cloc	roblems		0 items	▶ 凡例	Module		
Summary BSP Cloc	roblems		0 items	▶ 凡例	Module		
Summary BSP Cloc	roblems		0 items	▶ 凡例	Module		
Summary BSP Cloc	roblems		0 items	▶ 凡例	Module		

Figure 38. Smart Configurator Window



8. Navigate to the project location in Windows Explorer and double-click on the main workspace (IAR EWARM \*.eww file) to open the project.

← → ~ ↑ <mark></mark> >	This PC $\rightarrow$ OS (C:) $\rightarrow$ Users $\rightarrow$ Renesas $\rightarrow$ IAR $\rightarrow$	workspace 🗸 🗸	$\mathcal{P}$ Search workspace	
📌 Quick access	Name	Date modified	Туре	Size
Desktop	.settings	12/3/2020 4:15 PM	File folder	
Desktop	📜 ra	12/3/2020 4:15 PM	File folder	
	📕 ra_cfg	12/3/2020 4:15 PM	File folder	
	📕 ra_gen	12/3/2020 4:15 PM	File folder	
	📕 script	12/3/2020 4:15 PM	File folder	
	📕 src	12/3/2020 4:15 PM	File folder	
	buildinfo.ipcf	12/3/2020 4:15 PM	IPCF File	
	configuration.xml	12/3/2020 4:15 PM	XML Document	
	IAR_QECapTouchExample.ewd	12/3/2020 4:15 PM	EWD File	
	IAR_QECapTouchExample.ewp	12/3/2020 4:15 PM	EWP File	
	IAR_QECapTouchExample.eww	12/3/2020 4:15 PM	IAR IDE Workspace	
	R7FA2L1AB2DFP.pincfg	10/30/2020 1:35 AM	PINCFG File	

Figure 39. Project Location

**9.** The project is opened by IAR EWARM. Right-click on the project and select Rebuild All. The project should be built without error.

Vorkspace	* a X		
	• • • •		
ebug			
iles IAR_OECapTouchExa Components Generated Data Program Entry Dulidinto.ipdf Output AR_OECapTouch BILAR_OECapTouch DIAR_OECapTouch			
IAR_QECapTouchExample			•
		File	₹ Line

Figure 40. Project is Built Successfully

10. After a project created with the RA Smart Configurator has been opened in IAR EWARM, its FSP configuration can be changed by relaunching the RA Smart Configurator from the IDE. Follow the instructions below to reopen the RA Smart Configurator.



11. In the menu of IAR EWARM, select **Tools > Configure Tools...** Then, select **New** and fill in the fields as follows.

Menu Text: **RA Smart Configurator** Command: Select "**Browse...**" and navigate to "**rasc.exe**" Argument: -compiler IAR configuration.xml Initial Directory: **\$PROJ\_DIR\$** 

Configure Tools	
Menu Content:	
RA Smart Configurator	OK
	Cancel
	New
	Delete
Menu Text:	
RA Smart Configurator	
Command:	
C:\Renesas\RA\sc_v2021-10_fsp_v3.5.0\eclipse\rasc.exe	Browse
Argument:	
-compiler IAR configuration.xml	
Initial Directory:	
\$PROJ_DIR\$	
Redirect to Output Window	
Prompt for Command Line	
Tool Available:	
Always ~	

Figure 41. How to Use RA Smart Configurator in IAR EWARM



**12.** Now, a FSP configuration of a created project can be reopened by select **Tool > RA Smart Configurator** in IAR EWARM.

File Edit View Project J	-Link	Tools Window Help
🗄 🗅 🔛 🕋 🔚 🕹 🕹	n D	🗘 🗘 Options 🔍 🔾 🔪
Workspace 👻	φ×	Filename Extensions
Debug	~	Configure Viewers
Files	¢	Configure Custom Argument Variables
🗆 🌒 IAR_QECapTouc	~	🍐 Configure Tools
├─── ■ Flex Software │		IAR Project Converter
└		RA Smart Configurator
AR_QECapTouchExample		

Figure 42. RA Smart Configurator Has Been Added

# 5. Adding TOUCH Driver in IAR EWARM

1. In Smart Configurator, 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 43. Select Pin CTSU0



 Ensure that the Operation Mode and the TS pins below are enabled: TSCAP, TS00, TS04, TS05, TS06, TS07, TS18, TS21, TS23, TS02-CFC, TS08-CFC, TS09-CFC, TS10-CFC, TS11-CFC, TS14-CFC, and TS32-CFC.

Pin Configuration			Gen	erate Project Conte
Select Pin Configuration		📑 Export to CSV file	🗄 Configure	Pin Driver Warning
RSSK-RA2L1	✓ Manage configu	irations		
Generate data: g_bsp_pin_c	fg			
Pin Selection $\equiv \oplus \downarrow_2^a$	Pin Configuration			😲 Cycle Pin Group
ctsu ×	Name	Value	Lock	Link
✓ ✓ Peripherals	Operation Mode	Enabled		
v v Input:CTSU	✓ Input/Output			$\langle \Box \rangle$
✓ CTSU0	TSCAP	✓ P112	l 💼	$\Rightarrow$
÷ C1500	TS00	✓ P204	i i i i i i i i i i i i i i i i i i i	$\Rightarrow$
	TS02-CFC	P303	i i i i i i i i i i i i i i i i i i i	$\Rightarrow$
	TS04	✓ P408		
	TS05	✓ P409		
	TS06	✓ P410		
	TS07	✓ P411		$\Rightarrow$
	TS08-CFC	✓ P302		$\Rightarrow$
	TS09-CFC	P301		$\Rightarrow$
	TS10-CFC	P109		
	TS11-CFC	✓ P110		
	TS12-CFC	✓ P111	l dî	$\Rightarrow$
	TS13-CEC	✓ P104		
	TS14-CFC	P103	l i i i	
	TS15-CFC	✓ P102		-
	TS16-CFC	✓ P101	- Č	
	T\$17	✓ P403	ē	
	TS18	✓ P402	- A	
	TS21	✓ P000		
	TS22	✓ P001		
	TS23	✓ P002		
	1524	✓ P002		
	TS25	✓ P004		
	TS26-CFC	✓ P100		
	TS27-CFC	✓ P113		
	TS28-CFC	✓ P015		
	TS29-CFC	✓ P114		
	TS30-CFC	✓ P114 ✓ P010		
	TS31-CEC	♥ P010		
	TS32-CFC	✓ P012		
	TS33-CFC	✓ P012		
	TS34-CFC TS35-CFC	✓ P105 ✓ P115		
	<	* FID		>
	Module name: CTSU0			
Pin Function Pin Number				

Figure 44. Enable TS Pins for RSSK-RA2L1



3. Move to the **Stacks** tab. Add the Capacitive Touch middleware by clicking **New Stack > CapTouch > Touch (rm\_touch)**.

Stacks Configuration			Generate	Project C	Content
Threads 🐔 New Thread 🔬 Remove 📄 H	AL/Common Stacks	🛃 New Stack	> 🐣 Extend Stack :	> 🔬 Re	
♥ MAL/Common         ♥ g_ioport I/O Port (r_ioport)         Øbjects       € New Object > € Remove	<pre>   g_ioport I/O Port   (r_ioport)</pre>	Auc Boc Cap Cor DSF Inp Mo Mo Net Pov	ficial Intelligence dio atloader Touch unectivity ut nitoring tor working ver urity	> > > > > > > > > > > > > > > > > > >	
		Stor Syst Tim		> > >	
Summary BSP Clocks Pins Interrupts Event Links	Stacks Components	Trar	nsfer	>	► Legend
Pin Conflicts 📃 Console		🔗 Sea	rch		₩ 8 -

Figure 45. Add TOUCH Driver

4. Click on the

Generate Project Content

button to generate the source files.

5. In IAR EWARM, right-click on the project and select **Rebuild All**. The project should be built without error.



Figure 46. Fix Errors



# 6. Copying QE files to IAR EWARM

1. Copy the  $qe_gen$  folder in  $e^2$  studio and paste it to the IAR EWARM project folder.



Figure 47. Copy qe\_gen Folder To IAR

2. In IAR EWARM, right-click on the project name and select **Add > Add Group...**. Enter the group name ge\_gen and click **OK**.



Figure 48. Create New Group



3. Right-click on qe\_gen group and select Add > Add Files.... Select all the source files inside the qe\_gen folder and click **Open** to add them to the project.

rile calt view Proj	ject J-Link Tools Window Help	)						
ני 🗈 🔛 🔤 🔚		- < Q						
rkspace	<b>→</b> ↓ ×							
ebug	~							
iles	•							
● IAR_QECapTo -⊞ ■ Flex Software	Juc V							
— 🗐 qe_gen 🚽								
— 🗋 buildinfo.ip	Options							
🕀 🛑 Output	Make							
	Compile							
	Rebuild All							
	Clean							
		-	Browse					
	C-STAT Static Analysis >		$\leftarrow \rightarrow \vee$	A Renesas	> IAR > workspace > qe_ge	u ∧ Ω	,○ Search of	ne gen
	Stop Build			New folder	, but , nonspoce , de_ge		j= bearente	8# • 🔟
	stop sana		Organize 👻	New folder				
	Add >	Add Files		^				Ree . IT
	Add		Name		Date modified	Type	Size	Rec 🖌 📊
C	Add >	Add Files Add Group	ge_touch_	_config.c	1/18/2022 3:45 PM	C File	18 KB	8:::
	Add		ge_touch_	.config.c .config.h	1/18/2022 3:45 PM 1/18/2022 3:45 PM	C File H File	18 KB 4 KB	8-1 •
	Add >	Add Group	ge_touch_	.config.c .config.h	1/18/2022 3:45 PM	C File	18 KB	822 • 11
	Add > Remove Rename Version Control System >	Add Group	ge_touch_	.config.c .config.h	1/18/2022 3:45 PM 1/18/2022 3:45 PM	C File H File	18 KB 4 KB	822 •
	Add > Remove Rename	Add Group	ge_touch_	.config.c .config.h .define.h	1/18/2022 3:45 PM 1/18/2022 3:45 PM	C File H File H File	18 KB 4 KB 5 KB	1.c; 1.cpp; 1.cc; 1.
C	Add     >       Remove	Add Group	ge_touch_	.config.c .config.h .define.h	1/18/2022 3:45 PM 1/18/2022 3:45 PM 1/18/2022 3:45 PM	C File H File H File	18 KB 4 KB 5 KB	

Figure 49. Add Source Files

4. Right-click on the project name and select **Options...** In the **Options** dialog, select **C/C++ Compiler > Preprocessor**. Click on the **[...]** button to add include directory.

	: J-Link Tools Window Help X 的ローンC	- < Q > Options for node "IAR	QECapTouchExample"
/orkspace Debug	<b>→ # ×</b>	Category:	Factory Settings
Files  IAR_QECapTouc  Filex Software	¢ • thExa ✓ Options_	General Options Static Analysis Runtime Checking C/C++ Compiler	Multi-file Compilation     Discard Unused Publics     MISRA-C:1998 Encodings Extra Options
	Make Compile Rebuild All Clean C-STAT Static Analysis Stop Build Add > Remove	Assembler Output Converter Custom Build Build Actions Linker Debugger Simulator CADI CADI CADI CASIS DAP GOB Server I-jet J-Link/J-Trace II. Stelaris	Language 1 Language 2 Code Optimizations Output List Preprocessor Diagnostics MISRA-C.2004 Ignore standard include directories Additional include directories (one per line) SPROJ. DIRS/ra/arm/CMSIS_5/CMSIS/Core/Include SPROJ. DIRS/ra/fsp/inc/api SPROJ. DIRS/ra/fsp/inc/api SP
IAR_QECapTouchExam	Rename Version Control System > Open Containing Folder File Properties	Nu-Link PE micro ST-LINK Third-Party Driver TI MSP-FET TI XDS	Defined symbols: (one per line)  Preprocessor output to file Preserve gomments Generate #line directives

Figure 50. Open Project Option



5. Click on the empty row and add the qe\_gen folder to the list of include directories. The triangle button can be used to change the absolute path to a relative path. Click **OK** to close the dialog.

C\Users\Renesas\JAR\workspace\ae gen	Untra Generated Data	OK \$PROJ_DIR\$\qe_gen	\.\Users\Renesas\IAR\workspace\ge_gen
			{\workspace\ge_gen
	C:\Users\Renesas\IAR\workspace\qe_gen	· · · · · · · · · · · · · · · · · · ·	///< Correction stat
	\$PB0.LDIB\$/wc		
	\$PROJ_DIR\$/ra_gen		
	\$PROJ_DIR\$/ra_cfg/fsp_cfg/bsp		
	\$PR0J_DIR\$/ra_cfg/fsp_cfg		
	Include directory	^ 🖉 🚛 🖬 💼	
	Include directory	^	1

Figure 51. Add qe\_gen To List Of Include Directories

6. Right-click on the project and select **Rebuild All**. The project should be built without error.

File Edit View Project J-Link Tools Window Help				
5 C 🖸 🖆 🖌 🔓 🖆	Ŧ	< Q > ⇆ 🖻 < 🍕	> < > 🛯	〕 ≔ 〔 ● 〕 = ■ 〕
Workspace 🔻 🕈 🗙				
Debug				
Files 💠				
🗆 🌒 IAR_QECapTouchExample 🔽				
⊢⊞ ≡ Flex Software ⊢⊞ ≡ qe_gen				
🛛 🛏 🗋 buildinfo.ipcf				
La Output				
IAR_QECapTouchExample				
Build				<b>→</b> ‡ X
Messages	File	Line		^
Total number of errors: 0				
Total number of warnings. 8				
Build succeeded				
				¥
Build Debug Log				
Ready		Errors 0, Warnings 6	Ln 8, Col 1	System CAP NUM OVR

Figure 52. Build Successfully



## 7. Run Capacitive Touch Project in IAR EWARM

#### 1. USB connection for power:

Connect CN5 on RSSK-RA2L1 board to the USB port of the host PC using the USB cable.

#### 2. Debugger connection:

Connect the debugger cable from the Debugger port (J1) of RSSK-RA2L1 board to the J-Link. Connect the other side of J-Link to the host PC using a USB cable.

The picture below shows the connection between the host PC and the RSSK-RA2L1 board.



Figure 53. Connection Between PC & RSSK-RA2L1 Board

3. Right-click on the project and select **Options...**.

Workspace	↓      ↓
Debug	~
Files	typedef struc
IAR_QECapTouchExe	Options
Flex Software	Options
	Make
de_touch_config.c	Compile
📙 🖵 🖻 qe_touch_define.h	Rebuild All
buildinfo.ipcf	Clean
🛛 🖵 🖬 Output	

Figure 54. Open Project Option



# 4. In the **Options** dialog, select **Debugger > Setup**. Click on the **Driver** menu to select **J-Link/J-Trace**. Click **OK** to save the settings.



Figure 55. Setting Project Option

### 5. Click **Project**, select **Download and Debug**.



Figure 56. Download & Debug Project



6. The **Disassembly** window will pop up and the project should run smoothly.



Figure 57. Run Project



## Website and Support

Visit the following vanity URLs to learn about key elements of the RA family, download components and related documentation, and get support.

RA Product Information RA Product Support Forum RA Flexible Software Package www.renesas.com/ra/forum www.renesas.com/ra/forum www.renesas.com/FSP

Renesas Support

www.renesas.com/support



# **Revision History**

		Descriptio	n
Rev.	Date	Page	Summary
1.00	Feb.25.21	—	First release document
		1	Update to Operating Environment
	1.10 Jan.25.22	—	Changed version FSP to v3.5.0
1.10			Changed version QE for Capacitive Touch to v3.0.1
			Changed debugger to J-Link
		10	Added Setup Configuration



# 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 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.

#### Notice

- 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 be responsible for determining what licenses are required from any third parties, and obtaining such licenses for the lawful import, export, manufacture, sales, utilization, distribution or other disposal of any products incorporating Renesas Electronics products, if required.
- 5. 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.
- 6. 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.

- 7. No semiconductor product is absolutely secure. Notwithstanding any security measures or features that may be implemented in Renesas Electronics hardware or software products, Renesas Electronics shall have absolutely no liability arising out of any vulnerability or security breach, including but not limited to any unauthorized access to or use of a Renesas Electronics product or a system that uses a Renesas Electronics product. RENESAS ELECTRONICS DOES NOT WARRANT OR GUARANTEE THAT RENESAS ELECTRONICS PRODUCTS, OR ANY SYSTEMS CREATED USING RENESAS ELECTRONICS PRODUCTS WILL BE INVULNERABLE OR FREE FROM CORRUPTION, ATTACK, VIRUSES, INTERFERENCE, HACKING, DATA LOSS OR THEFT, OR OTHER SECURITY INTRUSION ("Vulnerability Issues"). RENESAS ELECTRONICS DISCLAIMS ANY AND ALL RESPONSIBILITY OR LIABILITY ARISING FROM OR RELATED TO ANY VULNERABILITY ISSUES. FURTHERMORE, TO THE EXTENT PERMITTED BY APPLICABLE LAW, RENESAS ELECTRONICS DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO THIS DOCUMENT AND ANY RELATED OR ACCOMPANYING SOFTWARE OR HARDWARE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE.
- 8. 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.
- 9. 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.
- 10. 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.
- 11. 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.
- 12. 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.
- This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
   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.5.0-1 October 2020)

# **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: <u>www.renesas.com/contact/</u>.