RA4L1 Group

RA4L1 Group Capacitive Touch Evaluation System Example Project

Introduction

This document describes the sample code for the RA4L1 Capacitive Touch Evaluation System.

Target Device

RA4L1 (R7FA4L1BD4CFP)

Contents

1. Overview

This sample code is software that operates with capacitive touch in the RA4L1 Capacitive Touch Evaluation system. The following is added to the project created by e²studio.

- Components generated by the FSP Configuration
- Capacitive touch configuration files and applications generated by QE for Capacitive Touch (QE)
- LED control application

1.1 Function

The functions of this software are shown below.

1. When the power is turned on and started, the LED test is performed. First, turn on LEDs 2 and 3 on the CPU board. After that, the LEDs on the electrode board are turned on and off in the order of buttons, sliders, and wheels. (See Figure 1-1.)
2. The LEDs are controlled in conjunction with the operation of the two buttons (TS-B1, TS-B3), wheel, and slider (three TS configurations: TS-S1, TS-S2, TS-S3) on the touch electrode board. (See Figure 1-2).
3. LED control is performed in conjunction with the push button on CPU board. Pressing SW2, LED 2 lights up. Pressing SW3, LED3 lights up. (See Figure 1-2)

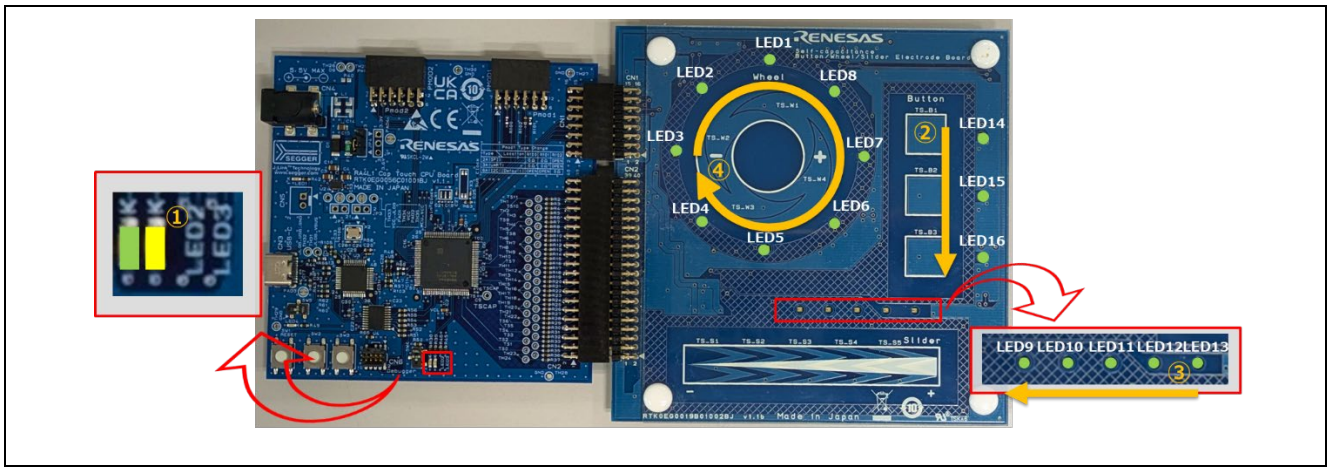

Figure 1-1 LED Testing During Software Startup

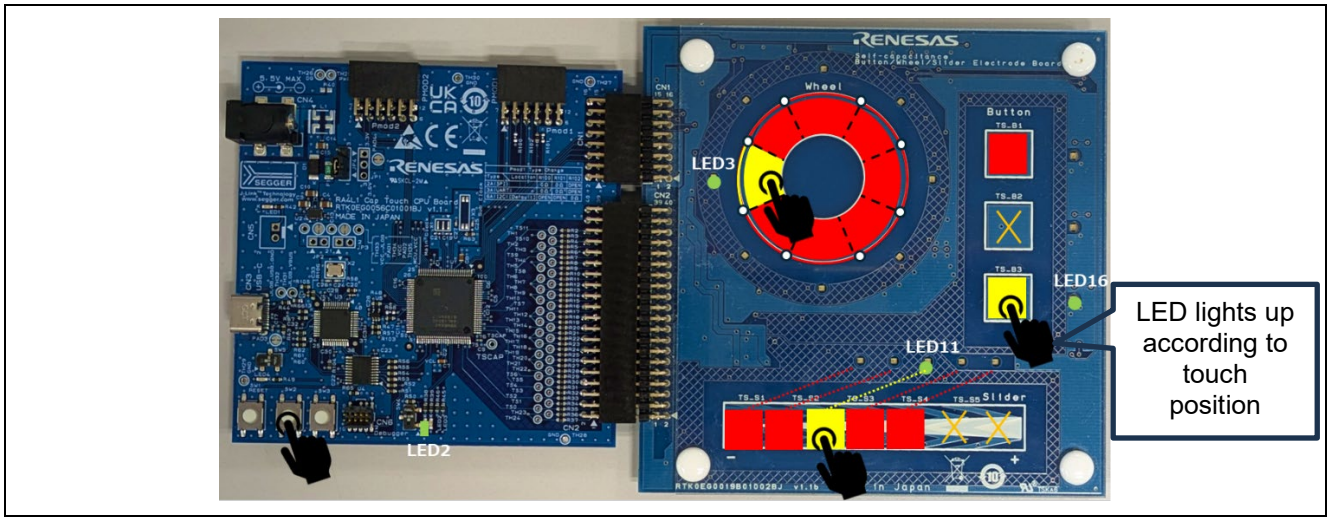

Figure 1-2 LED Control in Conjunction with Capacitive Touch Buttons, Sliders, and Wheel Movements

Note : The electrodes marked with 'X' do not work because the TS pin of the RA4L1 is not assigned

2. Operation confirmation conditions

The operation of this sample code has been confirmed the following environment.

Table 2-1 Operation confirmation conditions

Item	Description
MCU	RA4L1 (R7FA4L1BD4CFP)
Operating frequency	80MHz
Operating voltage	5V
Evaluation board	RA4L1 Capacitive Touch Evaluation System (Product No : RTK0EG0057S01001BJ) RA4L1 CPU Board (Product No : RTK0EG0056C01001BJ V1.1) Capacitive Touch Evaluation Application Board (Product No : RTK0EG0019B01002BJ V1.1)
Integrated development environment	e^2 studio Version 2025-01 (25.1.0)
C Compiler	Arm GNU Toolchain: 13.2
Development Assistance Tool for Capacitive Touch Sensors	QE for Capacitive Touch V4.1.0
Emulator	J-Link OB
Software Package	FSP V5.8.0

Figure 2-1 shows device connection diagram

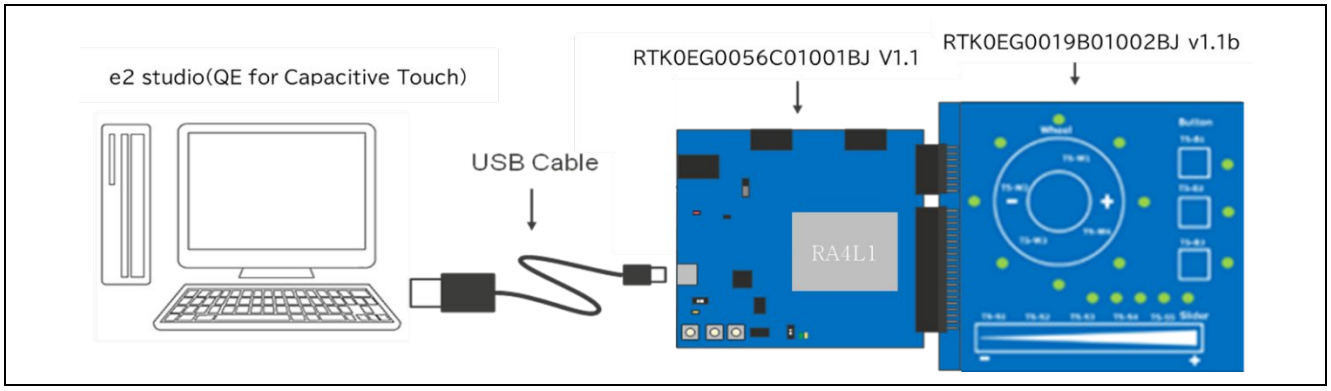

Figure 2-1 Device Connection Diagram

3. Software specification

3.1 Software structure diagram

Figure 3-1 shows the software structure diagram of this sample code. This software uses components generated by the FSP Configuration.

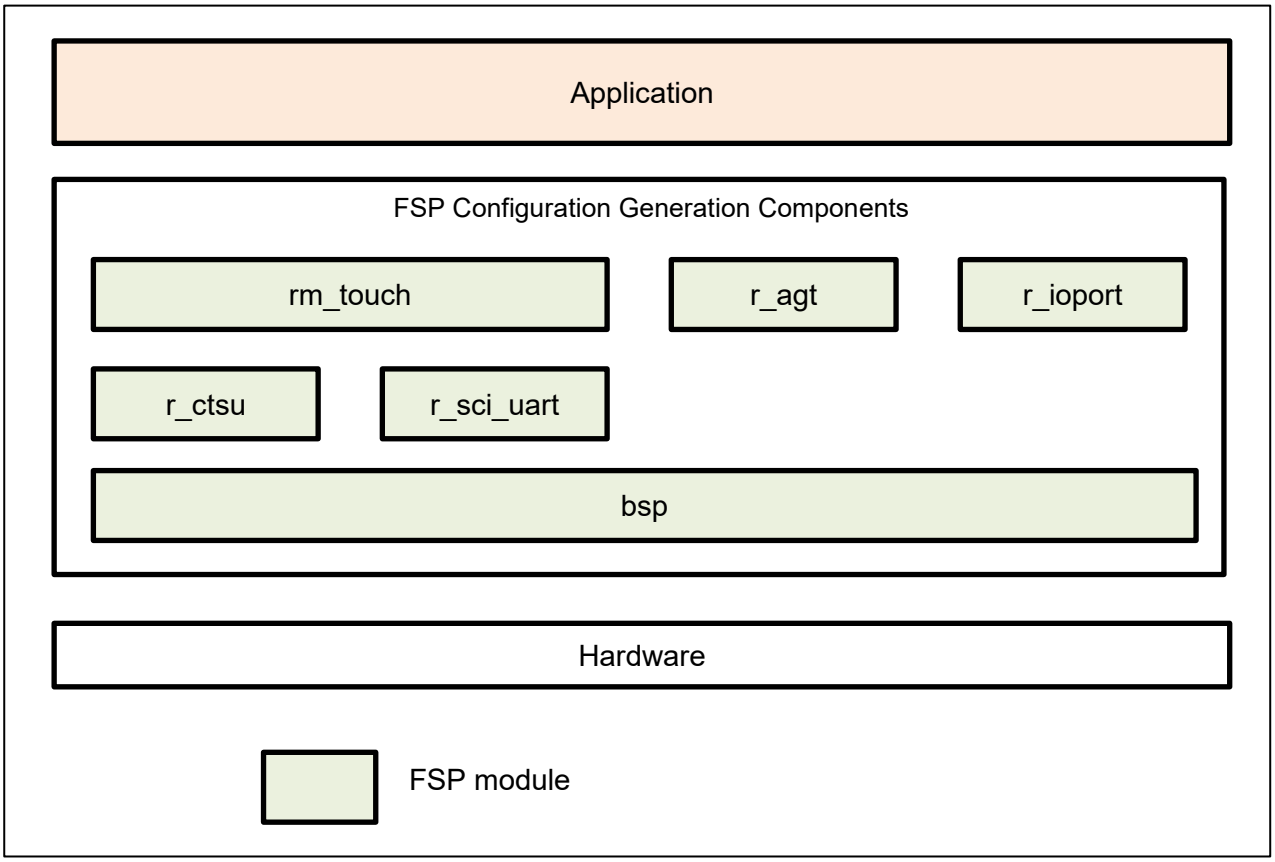

Figure 3-1 Software structure diagram

Table 3-1 shows a list of components and versions. Refer to the FSP configuration for component settings

Table 3-1 Components and versions list

Selected software components	
Board Support Package Common Files	v5.8.0
I/O Port	v5.8.0
Arm CMSIS Version 6 - Core (M)	v6.1.0+fsp.5.8.0
RSSK-RA4L1 Board Support Files	v5.8.0
Board support package for R7FA4L1BD4CFP	v5.8.0
Board support package for RA4L1	v5.8.0
Board support package for RA4L1 - FSP Data	v5.8.0
Board support package for RA4L1 - Events	v5.8.0
Asynchronous General Purpose Timer	v5.8.0
Capacitive Touch Sensing Unit	v5.8.0
SCI UART	v5.8.0
Touch	v5.8.0

3.2 List of Peripheral Functions Used and Pins Used

Table 3-2 shows a list of peripheral functions used, Table 3 7 shows a list of used pins and Table 3 8 shows a list of handling of unused pins in this sample software.

Table 3-2 List of Peripheral Functions Used

Peripheral Function	Usage
TOUCH	Touch control
CTSU	CTSU measurement
SCI	QE serial monitoring and serial tuning
AGT	LED control trigger
IOPORT	LED control, Unused pin control

- Touch

Use rm_touch for touch control. Table 3-3 shows the rm_touch settings. This setting enables serial monitoring and serial tuning.

Table 3-3 rm_touch Setting

Item	Setting
Support for QE monitoring using UART	Enabled
Support for QE Tuning using UART	Enabled

- CTSU

Use CTSU to run touch measurement. The CTSU setting is the default setting.

- SCI

Use SCI for serial monitoring of QE for Capacitive Touch. Table 3-4 shows the SCI settings.

Table 3-4 SCI Setting

Item	Setting
Usable mode	Asynchronous UART
Usable channel	9

- AGT

Use AGT for LED control. Table 3-5 shows the AGT settings.

Table 3-5 AGT Setting

Item	Setting
Interval	5ms
Usable channel	0

- IOPORT

Use IOPORT for LED control. The IOPORT setting is the default setting.

Table 3-6 List of used pins

Pin No	Pin Name	I/O	Usage
72	TS00	I/O	CTSU measurement
73	TS01	I/O	
74	TS02	I/O	
75	TS03	I/O	
77	TS04	I/O	
78	TS05	I/O	
79	TS06	I/O	
80	TS07	I/O	
84	TS08	I/O	
85	TS09	I/O	
86	TS10	I/O	
87	TS11	I/O	
76	TSCAP	I	
52	P109/TXD9	O	QE serial communication
53	P110/RXD9	I	
69	P106	I	LED control
68	P107	I	
22	P410	O	
23	P409	O	
24	P408	O	
25	P407	O	
66	P601	O	
67	P600	O	
91	P513	O	
96	P004	O	
97	P003	O	
98	P002	O	
Pins other than above		O	Low Output

3.3 File structure

This is the file structure of this sample code. The project configuration file and FSP configuration generation file of the development environment are omitted.

```
quickstart_rssk_ra4l1_ep
•  │
•  ├──QE-Touch
•  │    quickstart_rssk_ra4l1_ep_log_tuning20250213134730.log ・・・QE Tuning log
•  │    quickstart_rssk_ra4l1_ep.tifcfg                       ・・・Touch interface configuration file
•  │
•  ├──qe_gen
•  │    qe_touch_config.c          ・・・Touch configuration source
•  │    qe_touch_config.h          ・・・Touch configuration header
•  │    qe_touch_define.h          ・・・Touch define header
•  │    qe_touch_sample.c          ・・・Touch sample application
•  │
•  └──src
•       │ hal_entry.c                ・・・Main file
•       │ r_rssk_switch_led.c        ・・・Switch & LED function source
•       │ r_rssk_switch_led.h        ・・・Switch & LED function header
•       │ r_rssk_touch_led.c         ・・・Touch electrode LED function source
•       └ r_rssk_touch_led.h         ・・・Touch electrode LED function header
```

3.4 Constants

Table 3-7 lists the constants.

Table 3-7 List of Constant

Constant Name	Setting Value	Description
File Name : qe_touch_sample.c		
TOUCH_SCAN_INTERVAL_EXAMPLE	(20)	Software delay value [Unit : msec]
File Name : r_rssk_switch_led.c		
RSSK_SW2_PORT	(BSP_IO_PORT_01_PIN_07)	SW2 control port definition
RSSK_SW3_PORT	(BSP_IO_PORT_01_PIN_06)	SW3 control port definition
RSSK_LED2_PORT	(BSP_IO_PORT_06_PIN_01)	LED2 control port definition
RSSK_LED3_PORT	(BSP_IO_PORT_06_PIN_00)	LED3 control port definition
SW_EDGE_RIZE	(0x07U)	Switch rising judgment
SW_EDGE_FALL	(0x08U)	Switch falling judgment
SW_EDGE_BIT_MASK	(0x0FU)	Switch state judgement mask
RSSK_LED_ON	(0x00U)	Turn on the LED
RSSK_LED_OFF	(0x01U)	Turn off the LED
File Name : r_rssk_touch_led.c		
LED_COL0	(BSP_IO_PORT_05_PIN_13)	COL0 control port definition
LED_COL1	(BSP_IO_PORT_00_PIN_04)	COL1 control port definition
LED_COL2	(BSP_IO_PORT_00_PIN_03)	COL2 control port definition
LED_COL3	(BSP_IO_PORT_00_PIN_02)	COL3 control port definition
LED_ROW0	(BSP_IO_PORT_04_PIN_08)	ROW0 control port definition
LED_ROW1	(BSP_IO_PORT_04_PIN_07)	ROW1 control port definition
LED_ROW2	(BSP_IO_PORT_04_PIN_10)	ROW2 control port definition
LED_ROW3	(BSP_IO_PORT_04_PIN_09)	ROW3 control port definition
LED_COL_MAX	(4)	Number of COL signals
LED_ROW_MAX	(4)	Number of ROW signals
LED_COL_OFF	(BSP_IO_LEVEL_LOW)	COL signal OFF
LED_COL_ON	(BSP_IO_LEVEL_HIGH)	COL signal ON
LED_ROW_OFF	(BSP_IO_LEVEL_HIGH)	ROW signal OFF
LED_ROW_ON	(BSP_IO_LEVEL_LOW)	ROW signal ON
SLIDER_LED_NUM	(5U)	Number of slider LED
SLIDER_RESOLUTION	(100)	Maximum slider touch result
WHEEL_LED_NUM	(8U)	Number of wheel LED
WHEEL_LED_MSB	(1U << (WHEEL_LED_NUM - 1))	Wheel LED control bit MSB
WHEEL_RESOLUTION_DEGREE	(360)	Maximum wheel touch result [unit : degree]
WHEEL_POSITION_OFFSET_DEGREE	(112)	Wheel touch position offset [unit : degree]
ALL_LED_NUM	(16U)	Number of touch electorode board LEDs
LED_TEST_INTERVAL	(100U)	LED lighting interval time
DUMMY_BUTTON02	(2)	Dummy judgment button for LED 15 lighting

3.5 Enumerations

Table 3-8 lists the rssk_sw_status_t enum.

Table 3-8 rssk_sw_status_t

Member	Value	Description
RSSK_SW_OFF	0x00	Switch OFF state
RSSK_SW_ON	0x01	Switch ON state

3.6 Global Variables

Table 3-9 lists the global variables

Table 3-9 List of Global Variable

Variable Name	Types	Description
File Name : r_rssk_touch_led.c		
g_led_column[]	bsp_io_port_pin_t	Touch electrode board LED column control port array
g_led_row[]	bsp_io_port_pin_t	Touch electrode board LED row control port array
g_led_drive_colmun	uint8_t	Touch electrode board LED drive information
g_button_idx[]	uint8_t	Button index array

3.7 Functions

Table 3-10 lists the functions.

Table 3-10 ist of Function

Function Name	Description
File Name :qe_touch_sample.c	
qe_touch_main	Main function
r_rssk_initialize	Initialization processing of Capacitive Touch Evaluation System
r_rssk_led_test	LED test processing for Capacitive Touch Evaluation System
timer0_callback	AGT interrupt callback
File Name :r_rssk_switch_led.c	
r_rssk_switch_led_control	r_rssk_switch_led_control
r_rssk_led2_on	r_rssk_led2_on
r_rssk_led2_off	r_rssk_led2_off
r_rssk_led3_on	r_rssk_led3_on
r_rssk_led3_off	r_rssk_led3_off
rssk_get_sw2_status	rssk_get_sw2_status
rssk_get_sw3_status	rssk_get_sw3_status
File Name :r_rssk_touch_led.c	
r_rssk_touch_led_test	Touch electrode board LED test pattern processing
r_rssk_touch_led_control	Touch electrode board LED control processing

3.8 Processing Flowchart

Figure 3-2 shows processing flowchart of this software.

- Initialization

① 1.Initial setting of switches / touch electrodes / LEDs, performing LED tests
2. Touch measurement initial setting, open touch middleware
3. Timer activation for touch measurement loops

- Touch measurement loop (main loop)

② 1. Touch measurement of buttons, sliders, wheels → Waiting for measurement results
→ Acquisition of measurement results
2. Software wait (wait 20ms after processing 1.)

- Timer interrupt processing

③ LED control of the touch electrode board (The LEDs are configured in a 4x4 matrix, so they are controlled by a dynamic lighting method, with four interrupts per row.)

④ LED control corresponding to the switch on the CPU board (To prevent chattering, the LED will light up if the switch input is judged to be ON three times in a row.)

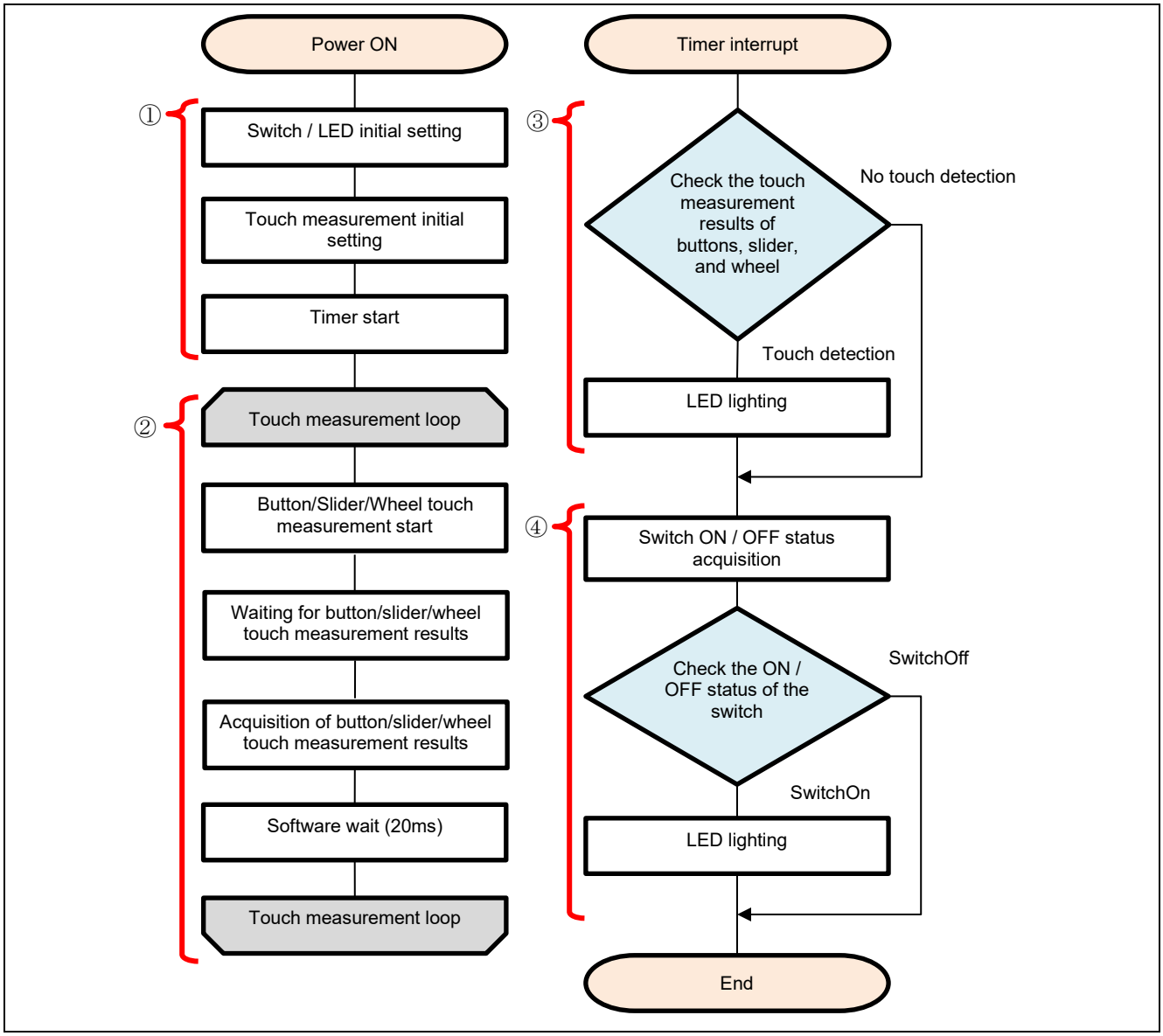

Figure 3-2 Processing Flowchart

4. Capacitive Touch Setting

These are the touch interface configuration, configuration (method) settings and tuning results of this sample code. These use the tuning function of QE.

4.1 Touch Interface Configuration

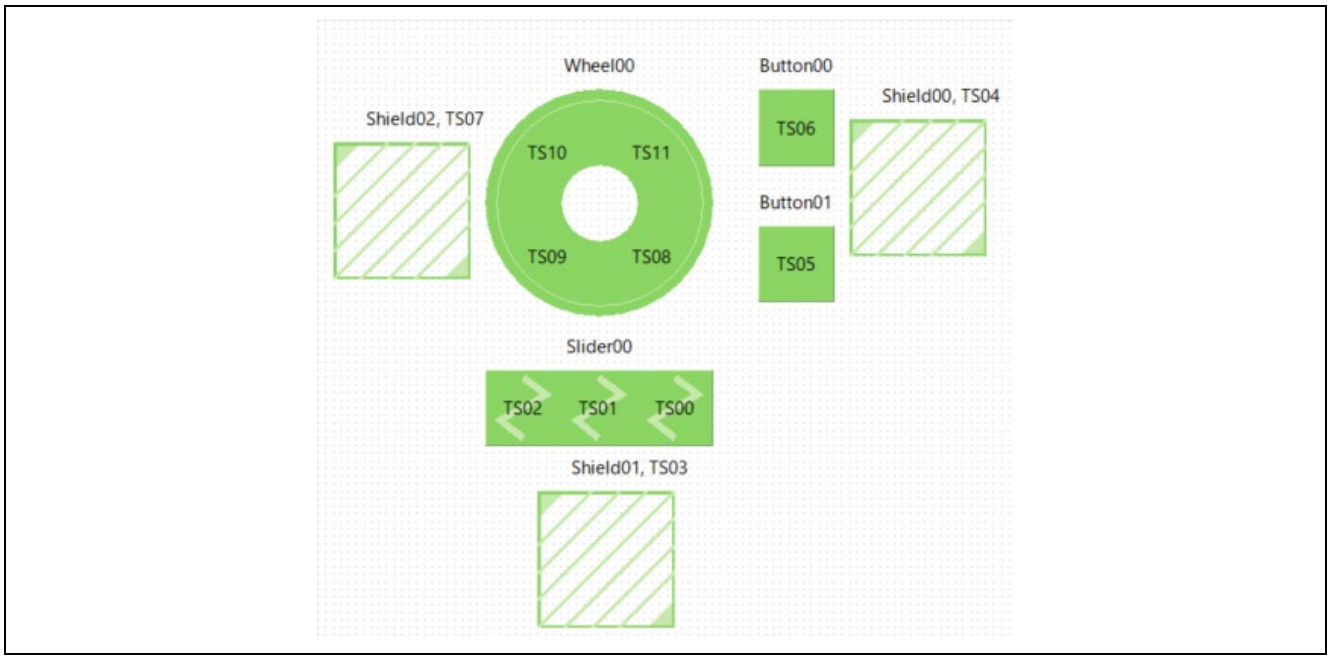

Figure 4-1 Touch interface configuration (Self-Capacitance Buttons / Wheel / Slider Board)

4.2 Configuration (methods) Settings

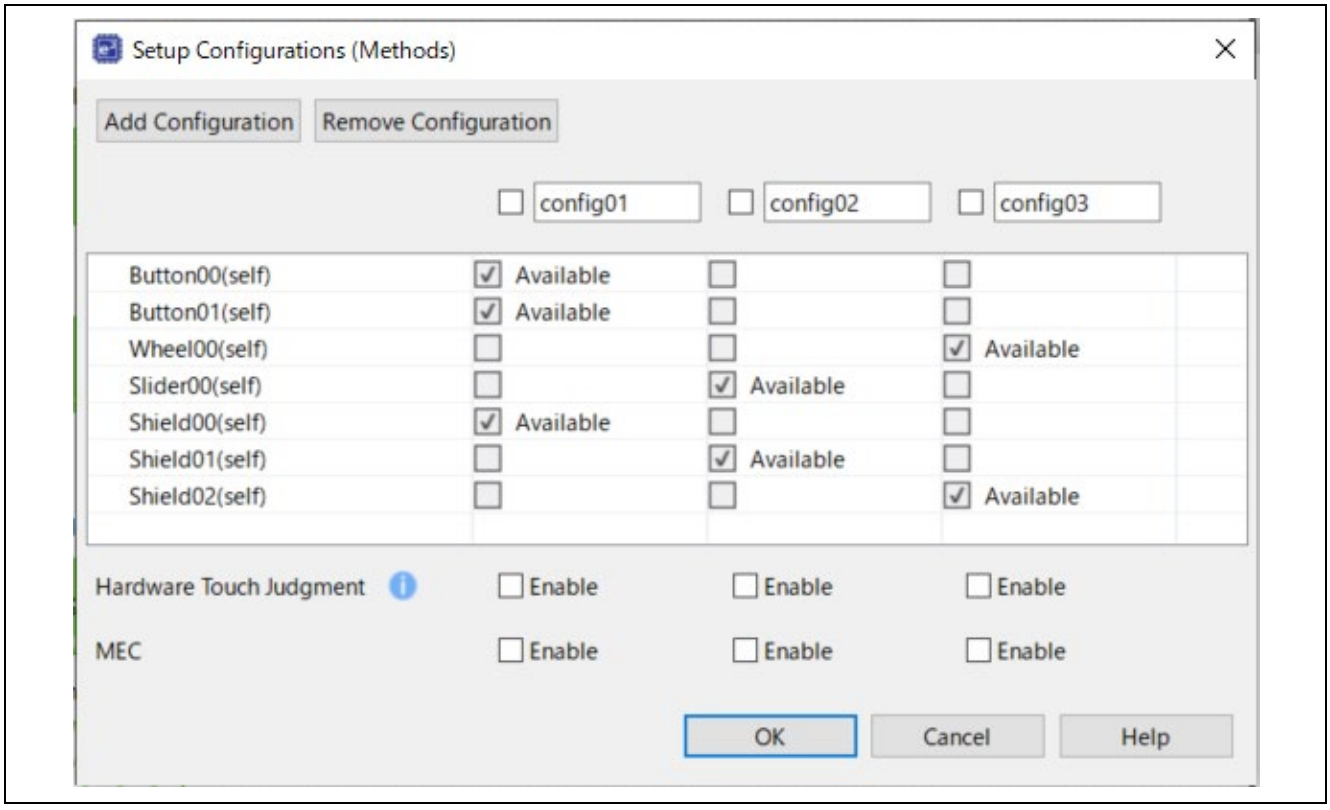

Figure 4-2 Configuration (methods) setting

4.3 Tuning results

Table 4-1 shows tuning results in QE tuning. Sample code operates with the setting values shown in the QE tuning result list.

Since the values in QE tuning result list depend on the operating environment at QE tuning, these values may change at QE tuning again.

Table 4-1 QE tuning result list (Self-Capacitance Buttons / Wheel / Slider Board)

methods	Button name	Touch senser	Parasitic capacitance [pF]	Drive pulse frequency [MHz]	Threshold	Scan time [ms]	so	snum	sdpa
config01	Button00	TS06	11.66	0.5 (BASE:0.5)	339	0.576	0x00F	0x07	0x1F
config01	Button01	TS05	10.91	0.5 (BASE:0.5)	310	0.576	0x013	0x07	0x1F
config01	Shield00	TS04	51.736						
config02	Slider00	TS02	9.972	0.5 (BASE:0.5)	268	0.576	0x014	0x07	0x1F
config02	Slider00	TS01	10.132	0.5 (BASE:0.5)	268	0.576	0x00B	0x07	0x1F
config02	Slider00	TS00	11.91	0.5 (BASE:0.5)	268	0.576	0x00A	0x07	0x1F
config02	Shield01	TS03	61.944						
config03	Wheel00	TS10	8.986	1 (BASE:1.0)	646	0.576	0x04E	0x07	0x0F
config03	Wheel00	TS11	10.285	1 (BASE:1.0)	646	0.576	0x038	0x07	0x0F
config03	Wheel00	TS08	11.646	1 (BASE:1.0)	646	0.576	0x033	0x07	0x0F
config03	Wheel00	TS09	9.472	1 (BASE:1.0)	646	0.576	0x041	0x07	0x0F
config03	Shield02	TS07	42.576						

so : Variables for sensor offset settings
snum : Variables for setting the measurement period
sdpa : Clock division setting variable

4.4 How to adjust the sensitivity

Button sensitivity adjustment uses QE for Capacitive Touch. The sensitivity adjustment method is as follows.

- The method using monitoring function of QE for Capacitive Touch

Follow the tutorial from the "CapTouch Workflow (QE)" of QE for Capacitive Touch.

- Real-time change method using monitoring function of QE for Capacitive Touch

Display the Cap Touch parameter list of QE for Capacitive Touch and adjust it by the following steps。

1. Select the touch I/F corresponding to the button you want to adjust.
2. Click [Enable Monitoring] icon to start monitoring.
3. When monitoring is enabled, the CapTouch parameter item is displayed.
4. Click [Write Value to the Target Board] to enable.
5. Change the value of [Touch Threshold].
6. Repeat step 5 to adjust the sensitivity.
7. After completing the sensitivity adjustment, reflect the adjustment result in the source code by the following steps.
8. Click [Output Parameter Files] to generate the parameter file.
9. Build the project using the IDE (e² studio as an example).

Write the program to the MCU using the IDE (e² studio as an example).

Note : The above numbers 1, 2, 4, 5, and 8 will be changed with ①②④⑤⑧ below.

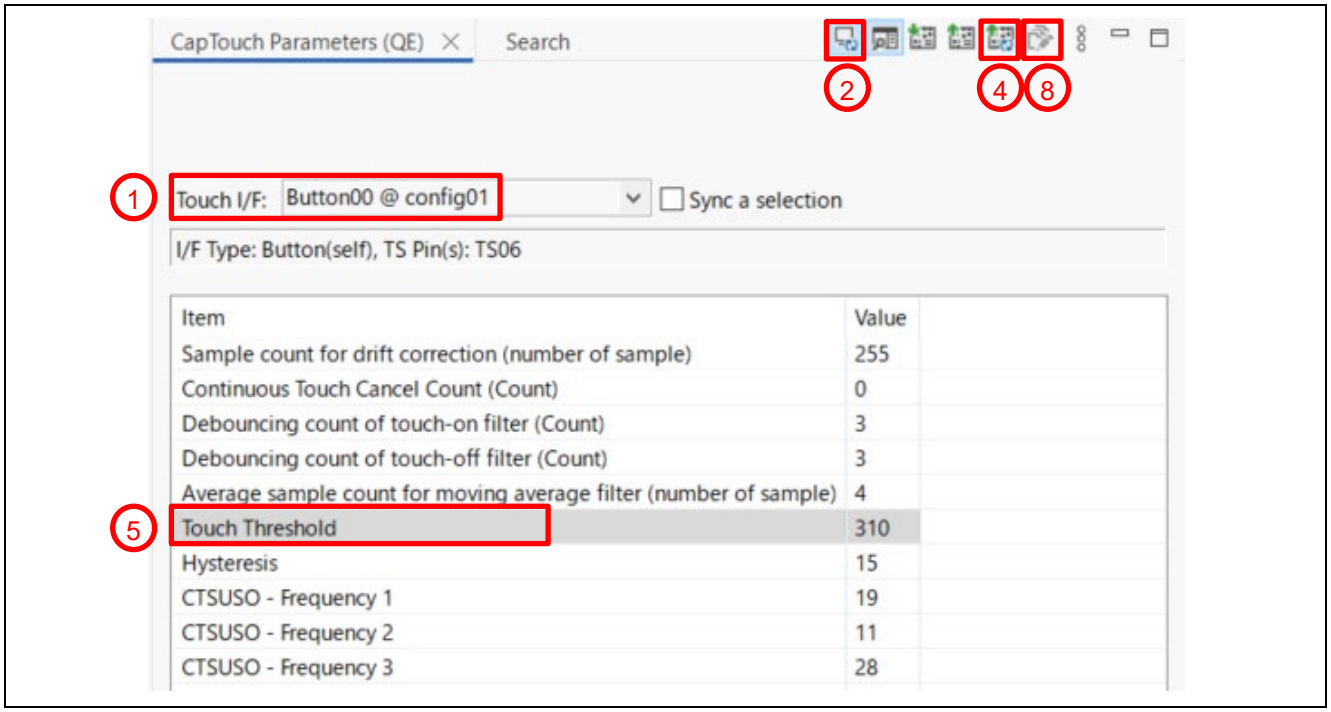

Figure 4-3 Touch Threshold Adjustment

- How to change the code manually

It can be adjusted by changing member variables of structure variable g_qe_touch_button_cfg_config01, g_qe_touch_slider_cfg_config02 or g_qe_touch_wheel_cfg_config03.

The variables to change are:

・ threshold : Touch detection threshold

It also supports QE serial monitoring and serial tuning. For more information on serial monitoring and serial tuning, refer to the QE help or ”6. Capacitance Touch Application Development Procedure” in “Using QE and FSP to Develop Capacitive Touch Applications”

5. Support

For information on capacitive touch, download tools and documentation, and technical support, please visit the website below.

RA4L1 Capacitive Touch Evaluation System

renesas.com/rssk-touch-ra4l1

RA Family Using QE and FSP to Develop Capacitive Touch Applications (R01AN4934)

renesas.com/jp/ja/document/apn/using-qe-and-fsp-develop-capacitive-touch-applications?r=1398061

QE for Capacitive Touch	renesas.com/qe-capacitive-touch
Renesas support	renesas.com/support

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Feb.19.25	-	First edition issued

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.

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 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.
13. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
14. 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:
www.renesas.com/contact/.