

QE for Capacitive Touch V4.0.0

Release Note

Thank you very much for using the QE for Capacitive Touch V4.0.0.

This release note covers product installation, restrictions, and so on. Please read this document before using the product.

Contents

1.	About QE for Capacitive Touch	3
1.1	Summary	3
1.2	Functions	3
1.3	New Functions	3
1.3.1	RX260, RX261 support	3
1.3.2	Added a Function to Select the Touch Judgement Type (CTSU2)	3
1.3.3	Improved Calculation Accuracy of Capacitance Value	3
1.3.4	Low Voltage Operation Mode Support (CTSU2)	3
1.3.5	Bug Fixes	3
1.4	Supported Environments	4
1.4.1	For Plugin Version	4
1.4.2	For Standalone Version	4
1.5	Confirmed Debugging Tools	4
1.6	Supported Microcontrollers	5
1.7	Supported Software	5
2.	Installation and Uninstallation	6
2.1	Installing This Product	6
2.1.1	Install from the "Renesas Software Installer" menu of e ² studio	6
2.1.2	Install using QE (zip file) downloaded from the Renesas website	6
2.1.2.1	Install Plugin Version	6
2.1.2.2	Install Standalone Version	7
2.2	Updating This Product (for Plugin Version)	7
2.3	Uninstalling This Product	7
2.3.1	Uninstall Plugin Version	7
2.3.2	Uninstall Standalone Version	7
3.	Notes / Restrictions	8
3.1	Usage Considerations	8
3.1.1	Notes on the clock supplied to the CTSU	8
3.1.2	Notes on View Operation	8
3.1.3	Notes on Tuning	8

3.1.4	Notes on Monitoring	8
3.1.5	Notes on Serial Connection.....	9
3.1.6	Notes on creating touch interface configuration.....	9
3.1.7	Notes on Standalone Version.....	9
3.1.8	Notes on TrustZone.....	9
3.1.9	Notes on Auto Judgement Function (Auto Sensing by Hardware)	9
3.1.10	Notes on CapTouch Workflow (QE) View	9
3.1.11	Notes on Using e ² studio 2023-01 to 2024-07	10
3.1.12	Notes on Installation.....	10
3.2	Functional Restrictions	10
3.2.1	Restrictions on Standalone Version	10
3.2.2	Restrictions on RL78/G16 Monitoring Function	10
3.2.3	Restrictions on Tuning.....	10
3.2.4	Restrictions on Auto Judgement Function	11
3.3	Improved Functional Restrictions	11
3.3.1	Restrictions on Monitoring Function of Auto Judgement	11
4.	Related Videos	12
	Revision History	13

1. About QE for Capacitive Touch

1.1 Summary

QE for Capacitive Touch is an assistance tool for applications and operates under the e² studio integrated development environment. In the development of an embedded system based on an RX family, RA family, RL78 family or Renesas Synergy MCU that incorporates the capacitive touch sensing unit (hereafter the CTSU), this product facilitates the easy initialization of touch interfaces and tuning of their sensitivity, thus reducing development times.

To use this product, you will first need to add a project for the RX family, RA family, RL78 family or Renesas Synergy MCU and the capacitive touch sensor-related CTSU driver and Touch middleware.

1.2 Functions

The three functions below make it easy to develop applications that involve capacitive touch sensors.

1. Creating touch interface configurations
2. Tuning
3. Monitoring and parameter adjustment

Also, it is easy to develop gesture applications using e-AI. QE's three functions, "recording function", "AI generation function", and "monitoring and tuning function", support AI application development, which is a difficult process with many steps. Anyone can develop AI applications without the need for specialized AI skills

For more information, please refer to here. <https://www.renesas.com/qe-eai-gesture>

1.3 New Functions

1.3.1 RX260, RX261 support

This product can now be used in a project for RX260 and RX261 devices.

1.3.2 Added a Function to Select the Touch Judgement Type (CTS2).

For CTS2 devices, you can now select the touch judgement type. The touch judgement type can be chosen between the "Value Majority Mode" and the "Judgment Majority Mode."

➤ Value Majority Mode (Traditional Mode)

In this mode, measurement results are taken at three different frequencies, and the two results with the least noise influence are summed up to determine touch judgement based on a threshold.

➤ Judgment Majority Mode

In this mode, measurements are taken at three different frequencies, and each result undergoes a touch ON/OFF judgement based on its respective threshold. The final touch judgement is determined by a majority vote among the three touch ON/OFF results.

1.3.3 Improved Calculation Accuracy of Capacitance Value

The calculation method has been revised to improve the accuracy of capacitance value.

1.3.4 Low Voltage Operation Mode Support (CTS2)

Tuning and monitoring in low voltage operation mode are now supported for CTS2 devices.

1.3.5 Bug Fixes

The following issues have been fixed:

1. Fixed an issue where the "Positive Noise Filter Judgement Count" and "Negative Noise Filter Judgement Count" could not be disabled in the CapTouch Parameters (QE) view. (Tool News: R20TS1059EJ0100)
2. Fixed an issue where the threshold display for software judgement in the CapTouch Tuning Result (QE) view was incorrect when there are auto and software judgement configuration in touch I/F configuration. (Usage Considerations in QE for Capacitive Touch V3.5.0: Release Note Section 3.1.11)
3. Fixed an issue where the parameter file generation function in the CapTouch Parameters (QE) view could not be used when monitoring a touch I/F configuration with auto judgement. (Functional Restrictions in QE for Capacitive Touch V3.5.0: Release Note Section 3.2.3)
4. Fixed an issue where a build error occurred in files output by this product when using TrustZone in projects with FSP V3.0.0 or later, where the touch driver/middleware was on the Secure side.
5. Fixed an issue where the tuning results were incorrect when performing emulator tuning using J-Link on RA2E1.

1.4 Supported Environments

1.4.1 For Plugin Version

Windows 10 (64-bit version), Windows 11

Renesas e² studio 2022-10 (or later)

* If you are using a version of the e² studio earlier than 2022-10, please update it to 2022-10 or later.

1.4.2 For Standalone Version

Windows 10 (64-bit version) , Windows 11

1.5 Confirmed Debugging Tools

- RX Family
 - E2 emulator
 - E2 emulator Lite
 - J-Link
- RA Family
 - E2 emulator
 - E2 emulator Lite
 - J-Link
- RL78 Family
 - E2 emulator
 - E2 emulator Lite
- Renesas Synergy
 - J-Link

1.6 Supported Microcontrollers

- RX Family (only MCUs that incorporate the CTSU)
 - RX100 Series: RX113, RX130, RX140
 - RX200 Series: RX230, RX231, RX23W, RX260, RX261
 - RX600 Series: RX671
- RA Family (only MCUs that incorporate the CTSU)
 - RA2A Series: RA2A1
 - RA2E Series: RA2E1
 - RA2L Series: RA2L1
 - RA4M Series: RA4M1, RA4M2, RA4M3
 - RA4W Series: RA4W1
 - RA6M Series: RA6M1, RA6M2, RA6M3, RA6M4, RA6M5
- RL78 Family (only MCUs that incorporate the CTSU)
 - RL78/G16
 - RL78/G22
 - RL78/G23
- Renesas Synergy (only MCUs that incorporate the CTSU)
 - S1 Series: S124, S128, S1JA
 - S3 Series: S3A1, S3A3, S3A6, S3A7
 - S5 Series: S5D3, S5D5, S5D9
 - S7 Series: S7G2

1.7 Supported Software

- Driver and middleware for capacitive touch sensor
 - RX Firmware Integration Technology (FIT)
 - CTSU driver: r_ctsu_qe V3.00 (or later)
 - Touch middleware: rm_touch_qe V3.00 (or later)
 - RA Flexible Software Package (FSP)
 - CTSU driver: r_ctsu V5.6.0 (or later)
 - Touch middleware: rm_touch V5.6.0 (or later)
 - RL78 Software Integration System (SIS)
 - CTSU driver: r_ctsu V2.00 (or later)
 - Touch middleware: rm_touch V2.00 (or later)
 - Renesas Synergy Software Package (SSP)
 - CTSU driver: r_ctsuv2 V2.6.0 (or later)
 - Touch framework: sf_touch_ctsuv2 V2.6.0 (or later)

2. Installation and Uninstallation

2.1 Installing This Product

Use either of the following procedure to install this product.

2.1.1 Install from the "Renesas Software Installer" menu of e² studio

1. Start e² studio.
2. Select the "Renesas Views" – "Renesas Software Installer" menu of e² studio to open the "Renesas Software Installer" dialog box.
3. Select the "Renesas QE" and click the "Next>" button
4. Select the "QE for Capacitive Touch (v4.0.0)" check box, and click the "Finish" button.
5. Check that the "Renesas QE for Capacitive Touch" check box is selected in the "Install" dialog box, and click the "Next>" button.
6. Check that the "Renesas QE for Capacitive Touch" check box is selected as the target of installation, and click the "Next>" button.
7. After confirming the license agreements, if you agree to the license, select the "I accept the terms of the license agreements" radio button, and click the "Finish" button.
8. If the dialog of the trust certificate is displayed, check that certificate, and click the "OK" button to continue installation.
9. When prompted to restart e² studio, restart it.
10. Start this product from the "Renesas Views" - "Renesas QE" menu of e² studio. For details about how to use this product, see the "Help" menu of e² studio.

2.1.2 Install using QE (zip file) downloaded from the Renesas website

A downloaded zip file has both a plugin version and a standalone version.

2.1.2.1 Install Plugin Version

1. Extract the downloaded zip file.
2. Start the e² studio.
3. Click on "Help", and then click on the "Install New Software..." menu item to open the "Install" dialog box.
4. Click on the "Add..." button to open the "Add Repository" dialog box.
5. Click on the "Archive..." button, select the installation file (zip file under the QE-CapTouch folder) in the opened file selection dialog box, and then click on the "Open" button.
6. Click on the "OK" button in the "Add Repository" dialog box.
7. Expand the "Renesas QE" item shown in the "Install" dialog box, select the "Renesas QE for Capacitive Touch" check box, and then click on the "Next>" button.
* If you check off the "Contact all update sites during install to find required software" checkbox, you can shorten the installation time.
8. Confirm that the installation target is "Renesas QE for Capacitive Touch", and then click on the "Next>" button.
9. After checking the license, select the "I accept the terms of the license agreements" radio button if you agree it, and then click on the "Finish" button.
10. When the dialog box for selecting a trusted certificate appears, check the displayed certificate, and then click on the "OK" button to continue installation.
11. Restart the e² studio by following the instructions on the screen.
12. Start this product from the "Renesas Views" - "Renesas QE" menu of the e² studio.

2.1.2.2 Install Standalone Version

1. Extract the downloaded zip file.
2. Move the QE-CapTouch folder to any folder.
* Avoid moving to the Windows folder or Program Files folder or folders whose name contain spaces.
3. Start this product from the "QE-CapTouch\eclipse\qe-captouch.exe" file.

2.2 Updating This Product (for Plugin Version)

If you have already installed this product, you can update it in the same way as the procedure for installation 2.1.2.1.

2.3 Uninstalling This Product

Follow the procedure below to uninstall this product.

2.3.1 Uninstall Plugin Version

1. Start the e² studio.
2. Select "Help -> About e² studio" to open the "About e² studio" dialog box.
3. Click the "Installation Details" button to open the "e² studio Installation Details" dialog box.
4. Select "Renesas QE for Capacitive Touch" displayed on the "Installed Software" tabbed page and click on the "Uninstall..." button to open the "Uninstall" dialog box.
5. Check the displayed information and click on the "Finish" button.
6. When you are prompted to restart the e² studio, restart it.

2.3.2 Uninstall Standalone Version

1. Delete the QE-CapTouch folder.

3. Notes / Restrictions

3.1 Usage Considerations

Please pay attention to the following items.

3.1.1 Notes on the clock supplied to the CTSU

1. Ensure that the clock supplied to CTSU (PCLKB or fCLK) is set to the following frequencies or higher. Lower frequencies are not supported.
 - CTSU: 8MHz
 - CTSU2: 1MHz

3.1.2 Notes on View Operation

1. When floating (detaching from e² studio) each view in QE for Capacitive Touch, it may not function correctly.
Please use each view without floating.

3.1.3 Notes on Tuning

1. If there are multiple debugging configurations in the target project, automatic tuning may fail. Please check whether it is possible to debug the target board using the IDE's function. If there are multiple debugging configurations in the target project, the configurations used for debugging in the last time is chosen to automatic tuning. If the debug configuration used in last time is different from the project for automatic tuning, QE cannot start debugging. Before starting automatic tuning, please debug target project once.
2. When the "Automatic Tuning Processing" dialog box is waiting for key input, pressing the "Cancel" / "Help" button is not possible.
3. When using a board without a sub-clock (e.g. Capacitive Touch Evaluation System for RA2L1), the project is not executed up to the main() function and the tuning function cannot be used. Change the FSP's "BSP" property – "Subclock Populated" setting to "Not Populated".
4. When using RL78/G22, the tuning function cannot be used for touch I/F configuration that include current sensor.

3.1.4 Notes on Monitoring

1. When monitoring using serial communication on the RX family, set the TX buffer size of the SCI FIT module (r_sci_rx) to the same size as the QE monitoring buffer (g_touch_monitor_buf). The QE monitoring buffer size is the value defined by the TOUCH_MONITOR_BUFFER_SIZE macro.
2. For RL78 Family, the emulator has a low data rate, and as the number of buttons increases, monitoring using the emulator becomes impossible. In such cases, please use serial communication for monitoring.
3. If you need to perform memory access while monitoring using serial communication on RL78/G16, the following settings are required.
 - Set "Pseudo-RRM/DMM function setting" to "Used" in Smart Configurator.
 - In the C/C++ build settings of the project, set the address in "Tool Settings" – "Linker" – "Device" – "Reserve working memory for RRM/DMM function (-rrm)" so that the first 4 bytes of RAM are not used.
 - In the debug configuration, set "Debugger" - "Debug Tool Settings" - "Allow to access by stopping execution while running" to "Yes".
4. The SNRSUM in the Standard Deviation Measurement Result is for reference only.

5. In the CapTouch Parameters (QE) view, the contents may not be displayed after selecting a Touch I/F.
Please close the CapTouch Parameters (QE) view once and then reopen it.

3.1.5 Notes on Serial Connection

1. Before connecting to the Fast Prototyping Board (FPB), an evaluation board for the RL78 family (RL78/G23, RL78/G22, RL78/G16) using a serial port, please see the documentation that came with the FPB and the user's manual of the FPB.

3.1.6 Notes on creating touch interface configuration

1. The RAM size of the MCU may be exceeded depending on the number of touch interfaces (buttons, sliders, wheels, etc.). Please create the touch interface configuration considering the amount of memory used by the touch function and the user program. Pay particular attention to MCU, which has a maximum RAM size of 2 KB.

3.1.7 Notes on Standalone Version

1. It may be slow to enable / disable the internal toolbar buttons of each view. Please move the focus to another view once.
2. The 3D gesture recognition is not available in the standalone version. Please use the plugin version.

3.1.8 Notes on TrustZone

1. When using TrustZone with RA6M4 etc., the tuning processing using an emulator cannot be performed on the non-secure side. Please perform the tuning process on the secure side and use results on the non-secure side, or perform the tuning using serial communication.

3.1.9 Notes on Auto Judgement Function (Auto Sensing by Hardware)

1. If you are using only the auto judgement function and not using software judgement, please do not add the touch middleware in the smart configurator. For usage examples, please refer to the sample code provided by QE for Capacitive Touch.
2. When using the auto judgement function, tuning and monitoring using serial communication are not available.
3. Even when you start monitoring, there may be cases where the monitoring data is not updated. After pausing and resuming the program, please start monitoring again.
4. When the touch threshold or hysteresis value is changed in the CapTouch Parameters view and then written to the target board, the value may not change to the specified value or may change to a value different from the specified value.
In the case of touch threshold, change the hysteresis value to a sufficiently small value before writing.
In case of hysteresis, please change the value of touch threshold to a sufficiently large value before writing.
5. When using the auto judgement function with QE for Capacitive Touch V4.0.0, please use RX FIT V3.00 or later and RL78 SIS V2.0.0 or later.

3.1.10 Notes on CapTouch Workflow (QE) View

1. The workflow view has been changed from CapTouch Main (QE) view to CapTouch Workflow (QE) view starting from QE for Capacitive Touch V3.2.0. When QE for Capacitive Touch is updated to V3.2.0 with the CapTouch Main (QE) view displayed, an error message "Could not create the view" appears in the CapTouch Main (QE) view.

[Workaround]

Close the CapTouch Main (QE) view and use the CapTouch Workflow (QE) view.

2. If you press the "Maximize"/"Restore" button in the e² studio window while playing a tutorial video with the video window maximized, you will not be able to maximize the video window again.

[Workaround]

Close and re-open the CapTouch Workflow (QE) view.

3. The workflow cannot be opened if WebView2 Runtime is not installed on your PC.

[Workaround]

Download and install WebView2 (x64 version) from the Microsoft web page. (FAQ:[3000670](#))

3.1.11 Notes on Using e² studio 2023-01 to 2024-07

1. Renesas Synergy projects are not available.
Use e² studio 2022-10.

3.1.12 Notes on Installation

1. When installing QE for Capacitive Touch V3.5.0 or V4.0.0 plugin version, the "Trust Artifacts" dialog box displays the QE for Capacitive Touch plugin as unsigned.
Check "Unsigned" and click the "Trust Selected" button to continue the installation.

3.2 Functional Restrictions

There are restrictions in QE for Capacitive Touch V4.0.0.

3.2.1 Restrictions on Standalone Version

1. Help files are not existed.

3.2.2 Restrictions on RL78/G16 Monitoring Function

1. When using RL78/G16, monitoring using an emulator is not available. Please use serial communication for monitoring.
When debugging by memory access during monitoring, refer to 3.1.4 Notes on Monitoring.

3.2.3 Restrictions on Tuning

1. When performing tuning using an emulator on the RL78 family, please ensure that the debug stack area does not overlap with the tuning RAM program area. If these areas overlap, tuning will not be performed correctly.
For more details about the debug stack area, refer to the " On-chip Debugging" section in the RL78 microcontroller's User Manual: Hardware.

The tuning RAM program area is allocated as follows: (QE for Capacitive Touch writes and executes the tuning program in the RAM area).

- RL78/G22: 0xFE00 – 0xFFE0
- RL78/G23: 0xFCF0 – 0xFEB0

3.2.4 Restrictions on Auto Judgement Function

1. For RX260 and RX261, the " Value Majority Mode " can be selected for auto judgement, but it is not available in RX FIT V3.00.
Please set the touch judgement type to "Judgment Majority Mode" in advanced mode for methods where auto judgement is enabled in the touch I/F configuration.

3.3 Improved Functional Restrictions

There is an improved restriction in QE for Capacitive Touch V4.0.0

3.3.1 Restrictions on Monitoring Function of Auto Judgement

1. When monitoring a touch I/F configuration with auto judgement, the output parameter file function in the CapTouch Parameters (QE) view is not available.

4. Related Videos

Many videos about this product are published in the Renesas website.

- Getting Started with QE for Capacitive Touch for RX (old version)
— <https://www.renesas.com/video/getting-started-qe-capacitive-touch>
- Getting Started with QE for Capacitive Touch for RL78
— <https://www.renesas.com/video/getting-started-qe-capacitive-touch-rl78>
- Getting Started with QE for Capacitive Touch for RA
— <https://www.renesas.com/us/en/video/getting-started-qe-capacitive-touch-ra>
- QE for Capacitive Touch [Tutorial -Settings-] for RX (old version)
— <https://www.renesas.com/video/qe-capacitive-touch-tutorial-settings>
- QE for Capacitive Touch [Tutorial -Tuning-] for RX (old version)
— <https://www.renesas.com/video/qe-capacitive-touch-tutorial-tuning>
- QE for Capacitive Touch [Tutorial -Monitoring-] for RX (old version)
— <https://www.renesas.com/video/qe-capacitive-touch-tutorial-monitoring>
- QE for Capacitive Touch Tutorial: Settings for RL78
— <https://www.renesas.com/video/qe-capacitive-touch-tutorial-settings-rl78>
- QE for Capacitive Touch Tutorial: Tuning for RL78
— <https://www.renesas.com/video/qe-capacitive-touch-tutorial-tuning-rl78>
- QE for Capacitive Touch Tutorial: Serial Monitoring for RL78
— <https://www.renesas.com/video/qe-capacitive-touch-tutorial-serial-monitoring-rl78>
- QE for Capacitive Touch Tutorial: Step 1 Configuration for RA
— <https://www.renesas.com/us/en/video/qe-capacitive-touch-tutorial-step-1-configuration-ra>
- QE for Capacitive Touch Tutorial: Step 2 Tuning for RA
— <https://www.renesas.com/us/en/video/qe-capacitive-touch-tutorial-step-2-tuning-ra>
- QE for Capacitive Touch Tutorial: Step 3 Monitoring for RA
— <https://www.renesas.com/us/en/video/qe-capacitive-touch-tutorial-step-3-monitoring-ra>
- QE for Capacitive Touch Feature - Measuring Standard Deviation
— <https://www.renesas.com/video/qe-capacitive-touch-feature-measuring-standard-deviation>
- QE for Capacitive Touch Feature - Check Monitoring Values Using The Monitoring Log Feature
— <https://www.renesas.com/video/qe-capacitive-touch-feature-check-monitoring-values-using-monitoring-log-feature>
- QE for Capacitive Touch Feature – A New Workflow Diagram in QE V3.2.0.
— <https://www.renesas.com/us/en/video/qe-capacitive-touch-feature-new-workflow-diagram-qe-v320>
- QE for Capacitive Touch Tips - Warning Message Appeared During Tuning
— <https://www.renesas.com/video/qe-capacitive-touch-tips-warning-message-appeared-during-tuning>
- How to tune via serial communication using the standalone app of QE.
— <https://www.renesas.com/video/how-tune-serial-communication-using-standalone-app-qe>
- How to migrate the touch modules from version 1.1 to version 2.0 using the compatible APIs with QE tool.
— <https://www.renesas.com/video/how-migrate-touch-modules-version-11-version-20-using-compatible-apis-qe-tool>
- QE for Capacitive Touch Tutorial: How to Tune via Serial Communication Using the Plug-in
— <https://www.renesas.com/us/en/video/qe-capacitive-touch-tutorial-how-tune-serial-communication-using-plug>
- 3D Gesture AI Solution - QE for Capacitive Touch Makes It Easy To Develop a Contactless User Interface
— <https://www.renesas.com/video/3d-gesture-ai-solution-qe-capacitive-touch-makes-it-easy-develop-contactless-user-interface>
- QE for Capacitive Touch Tutorial: How to create the gesture data
— <https://www.renesas.com/video/qe-capacitive-touch-tutorial-how-create-gesture-data>
- QE for Capacitive Touch Tutorial: How to monitor gesture AI
— <https://www.renesas.com/video/qe-capacitive-touch-tutorial-how-monitor-gesture-ai>

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Oct.22.24	-	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/.