

RENESAS CAPACITIVE TOUCH SOLUTION

Brochure





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The capacitive touch solutions for the advanced capacitive touch HMI's that are becoming an essential part of our daily lives

The Internet of Things (IoT) is expanding rapidly as network capabilities find their way into every aspect of our daily lives, including household equipment such as electric home appliances. At the same time rapid advances are occurring in the human machine interfaces (HMIs) that link people and machines, and the use of capacitive touch panels is expanding quickly. By replacing the fixed functions of mechanical switches with capacitive touch panels it is possible to achieve more intuitive interfaces incorporating complex and sophisticated operations to match a variety of applications. For example, users can touch an overlay with their fingers or slide their fingers to specify the volume. Nevertheless, the time and cost of development can raise high hurdles to the realization of advanced usability due to the need to achieve greater sensitivity and noise tolerance, assure error-free operation even when the user's hands are wet, and so on. We at Renesas Electronics are developing solutions that lower the capacitive touch development hurdles for customers. We provide total support for the development of products with high added value.

INTRODUCING THE CAPACITIVE TOUCH WEB SITE

Here you will find timely, up-to-date information that you will find useful when selecting capacitive touch solutions.

renesas.com/touch



ABOUT CAPACITIVE TOUCH INTERFACES

Utilization of capacitive touch interfaces in an ever wider range of fields

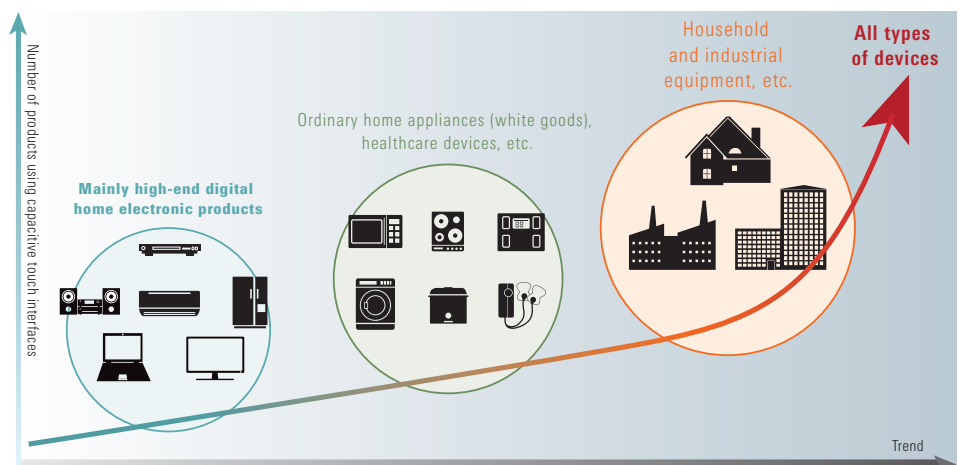
We rely on the functionality of a variety of electrical appliances and household equipment in our everyday lives. Most such products are becoming ever more advanced as they acquire added value and enhanced functionality. As a result, a superior HMI is necessary in order to make full use of this functionality. This is why much attention has come to be focused on capacitive touch interfaces. They enable the user to accomplish a variety of tasks in an intuitive way, bringing out the full potential of today's highly functional products.

High Hopes for Capacitive Touch Interfaces to Expand Markets by Pioneering New Applications

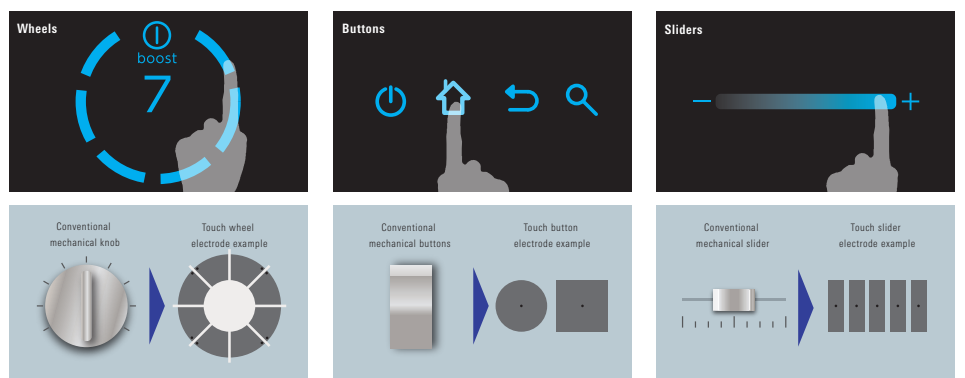
Applications for capacitive touch keypads have grown rapidly in recent years. Previously used mainly in high-end digital home electronic products requiring a high functionality and aesthetically appealing design, the use of touch keypads has expanded over the past few years to include ordinary home appliances known as "white goods" as well as healthcare-related devices.

The advantages of capacitive touch interfaces, such as durability and resistance to dust and moisture, make them attractive for use both in household and industrial equipment, and they are expected to achieve adoption in all types of devices moving forward.

Market trend toward rapid adoption of capacitive touch interfaces in embedded devices

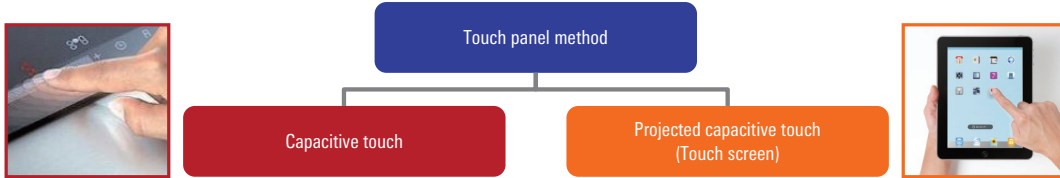


As replacements for mechanical keys, touch keypads enable a variety of interface types



RENESAS' BASIC CAPACITIVE TOUCH TECHNOLOGY

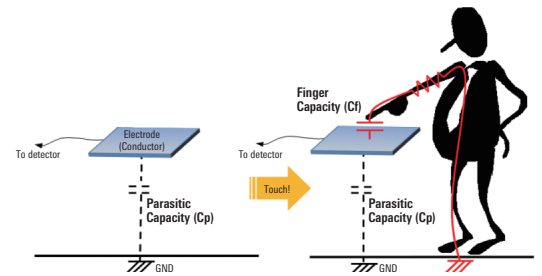
Touch panels can be broadly divided into two types: "capacitive touch" and "projected capacitive touch." Renesas' capacitive touch solutions employ capacitive touch technology. Since they provide excellent design flexibility and require fewer components, capacitive touch panels are widely used in a variety of applications, particularly ordinary home appliances known as white goods.



Items	Capacitive Touch	Projected capacitive touch
Features	<ul style="list-style-type: none"> • Low degree of freedom in operation (one-dimensional) • Fewer parts 	<ul style="list-style-type: none"> • High degree of freedom in operation (two-dimensional) • Uses expensive parts such as LCDs
Main parts	Cover panel	LCD, ITO electrode, cover panel
Cost	Low	High
Main applications	<ul style="list-style-type: none"> • White goods (refrigerators, microwaves, rice cookers) • Healthcare equipment (blood pressure monitors, body composition monitors) etc. 	<ul style="list-style-type: none"> • Smartphones, tablets • Gaming devices etc.

Detection Mechanism of Capacitive Touch Panels

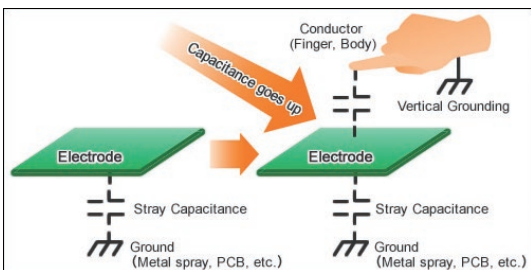
Capacitive touch technology works by detecting changes in capacitance that occur when the user's finger or hand comes in contact with a touch panel. Electrodes are arranged on the touch panel in such a way that a weak capacitance is generated between the panel and a finger that is brought into contact with it. The touch position is determined by detecting changes in capacitance between specific electrodes.



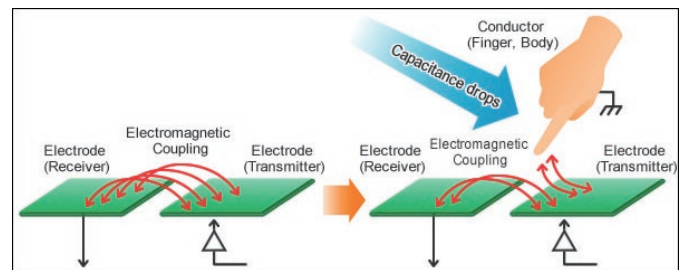
"Self Capacitance" and "Mutual Capacitance" Detection Methods

Touch panels typically use one of two capacitance detection methods: "self-capacitance" and "mutual-capacitance." Self-capacitance detects changes in the electromagnetic field formed between the electrodes and the user's finger. Specifically, when the user's finger comes near an electrode, a pseudocapacitor is created between the electrode and finger, and this causes the capacitance to increase. The touch action is recognized by detecting this change. Mutual-capacitance uses pairs of electrodes, one for transmitting (the transmission node) and one for receiving (the reception node). The transmission node generates an electromagnetic field, and the reception node absorbs it. The electromagnetic field changes when the user's finger approaches, and the capacitance decreases. The touch action is recognized by detecting this change.

Self-capacitance methods



Mutual-capacitance methods



Comparison of self-capacitance and mutual-capacitance methods

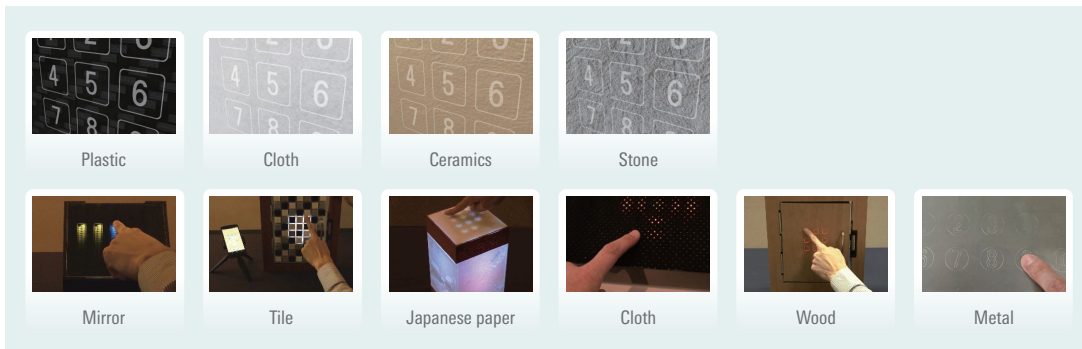
Items	Comparison
Water proof	Both self-capacitance and mutual capacitance are water proof However, active shielding is required when using self-capacitance
Matrix electrode configuration	Only mutual-capacitance is possible
Electrode design	Self-capacitance is easier

DESIGN FLEXIBILITY

Advantages of Capacitive Touch Technology: Freedom to Use a Variety of Materials

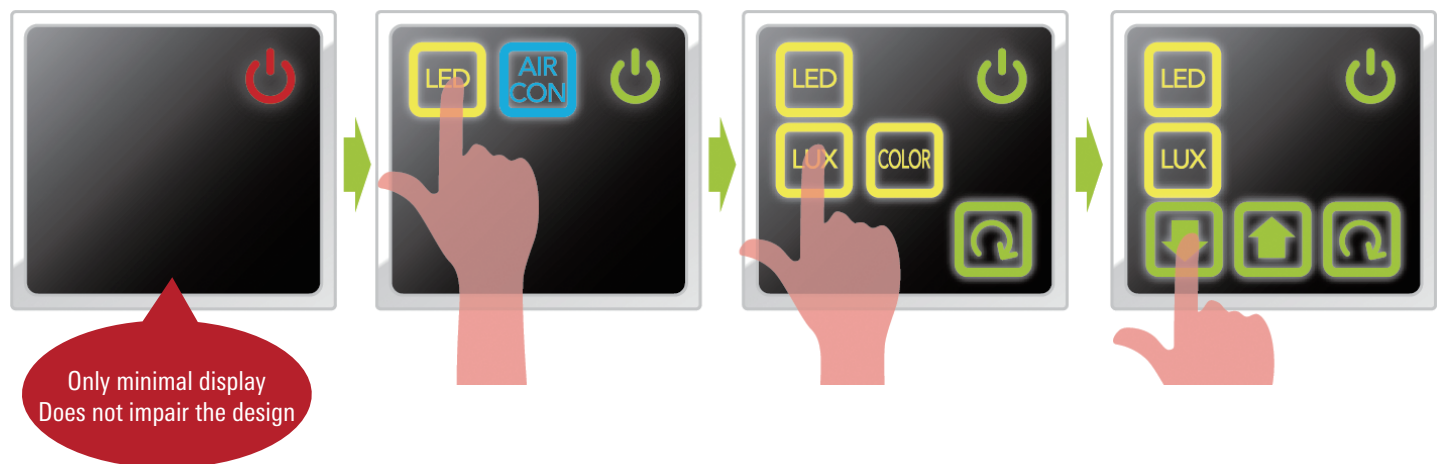
Renesas' capacitive touch technology supports the use of a variety of panel materials. It allows development of many types of switches with attractive designs.

Supported materials: plastic, glass, wood, rubber, cloth, stone, ceramics, mirror, metal

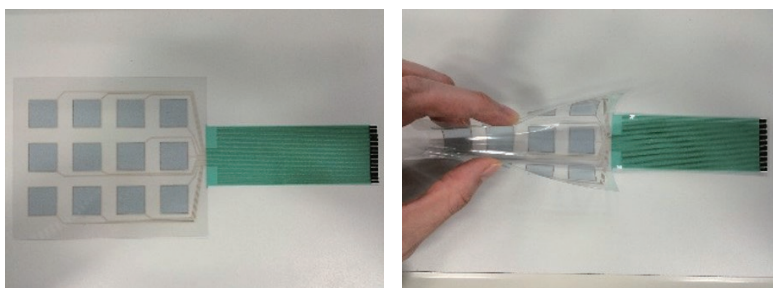


Advantages of Capacitive Touch Technology: Freedom to Use a Variety of Interfaces

It is possible to show only the buttons needed at a particular time and hide the others. This makes it easy to build guidance features into the design and enables the creation of interfaces that are easier to navigate for elderly users, for example.



Application examples of film electrodes



Features

- (1) Switches can be placed even on curved surfaces
- (2) Transparent

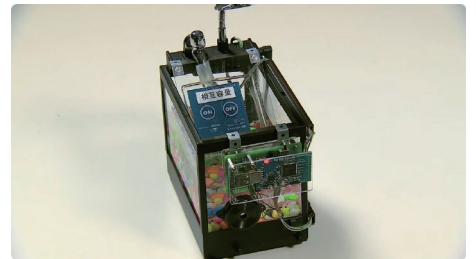
Cooperation: TOYO LABEL CO.,LTD.

<https://toyolabel.co.jp/product/capacitance-switch.html>

WATERPROOF

Renesas' capacitive touch solutions can be used in demanding environments such as outdoor settings or places exposed to water. This is because even when the control panel is wet it can distinguish between the approach of a user's finger and water droplets.

Mutual capacitance provides reliable waterproof. This can also be achieved with self capacitance through the use of active shielding.



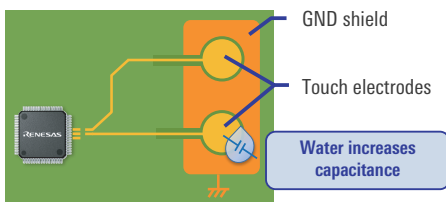
Renesas capacitive touch waterproof demonstration
<https://www.youtube.com/watch?v=gwJ-RFjMM2w>
https://v.youku.com/v_show/id_XNDUwMjQxNjgwOA==.html?spm=a2hcb.profile.app.5~5!2~5~5!3~5!2~5~5!2~5!10~A

Active Shielding

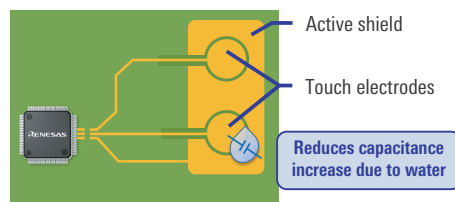
Active shielding is an output function that employs shield electrodes driven in the same phase and potential as the sensor drive pulses of the measurement electrodes. A high degree of waterproof can be achieved even with self capacitance when active shielding is used.

Waterproof

GND shielded: Mis-reacting with water

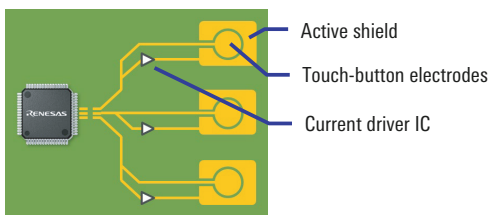


Active shield: no false response in water

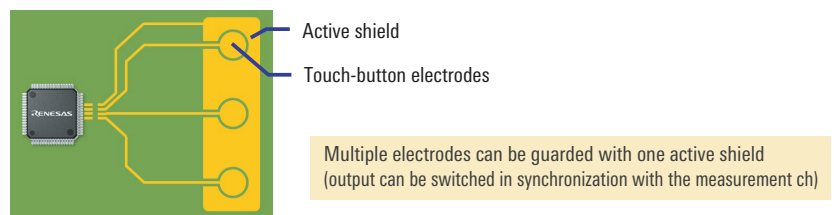


Implementation method

CTSU1: Current-driver IC required for each electrode



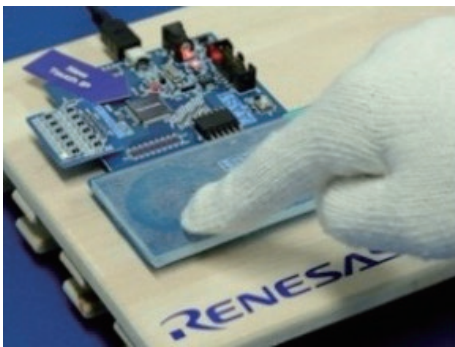
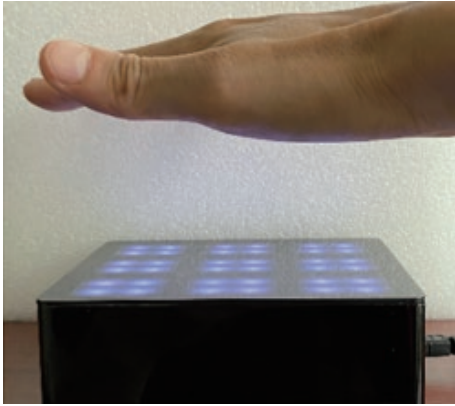
CTSU2: Direct drive via MCU touch pins



Note: For the differences in functions between CTSU1 and CTST2, please refer to the Functions of Each MCU table on page 10 and after.

HIGH SENSITIVITY

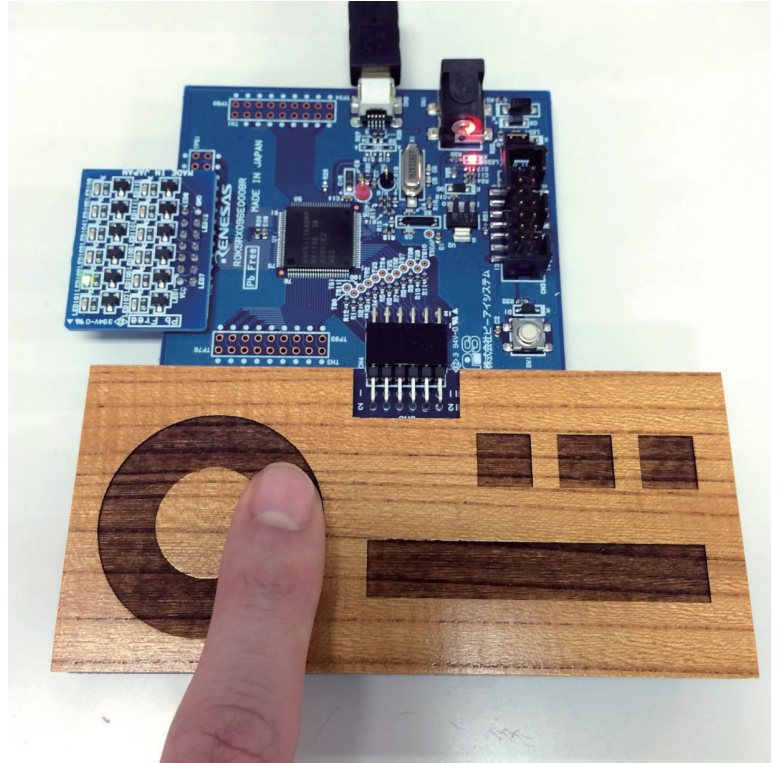
Implements proximity sensing (hovering) distance of approximately 30 cm, and supports sensing through overlay materials with a low dielectric constant. Operation is possible while wearing gloves, and there is no need for special gloves.



Renesas capacitive touch high sensitivity demonstration

<https://www.youtube.com/watch?v=NaeUkn3vufw>

https://v.youku.com/v_show/id_XMTUyNTA0MTM2NA==.html?spm=a2hcb.profile.app.5~5!2~5~5!3~5!2~5~5!2~5!2~A



HIGH NOISE TOLERANCE

Noise tolerance meets the requirements of IEC 61000 4-3 level 4 for consistently stable operation. This high tolerance for external noise allows use in a wide range of environments.

Radiation immunity test (IEC61000 4-3)

Items	Description	Test environment
Overview	Testing for immunity to relatively high frequency RF noises	
Frequency range	80MHz-1GHz ~ 2.7GHz or ~ 6.0GHz are used depending on the test version [Test level] Lv1: 1 V/m Lv2: 3V/m Lv3: 10V/m Lv4: 30V/m X: Individually stipulated	

LOW POWER CONSUMPTION

This Renesas capacitive touch solution incorporates a smart wake-up function that makes touch on/off judgments without the need to activate the CPU. Also, the multiple electrode connection function converts the measurement values of multiple electrodes into the equivalent of a single electrode, shortening the time required for measurement and reducing overall system power consumption.

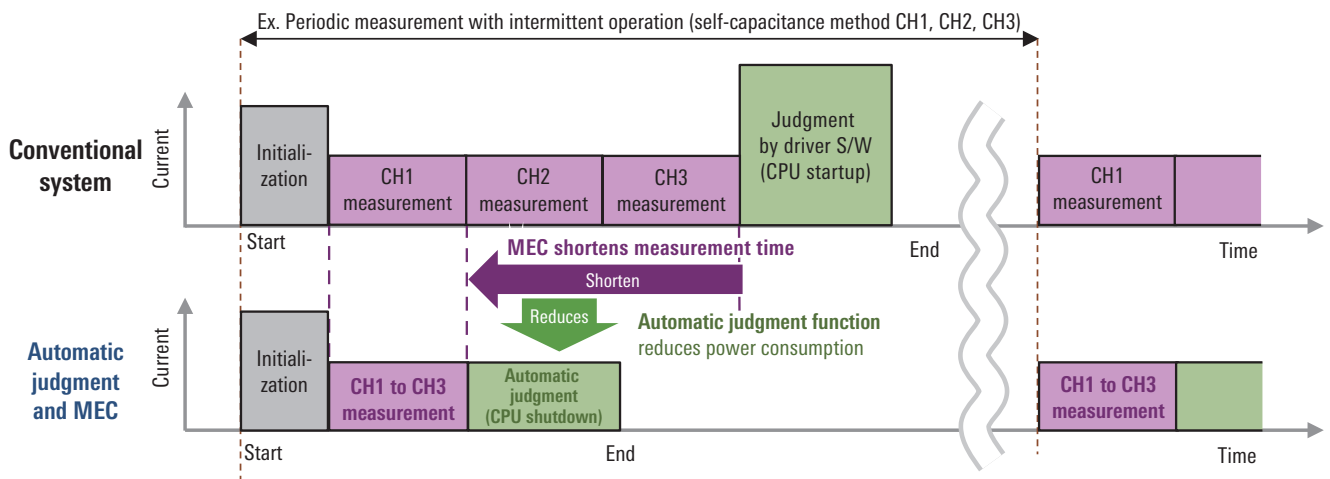
Multiple electrode connection (MEC)

Multiple self-capacitance electrodes are connected inside the MCU to function as a single electrode. It can shorten the measurement time and reduce the power consumption.

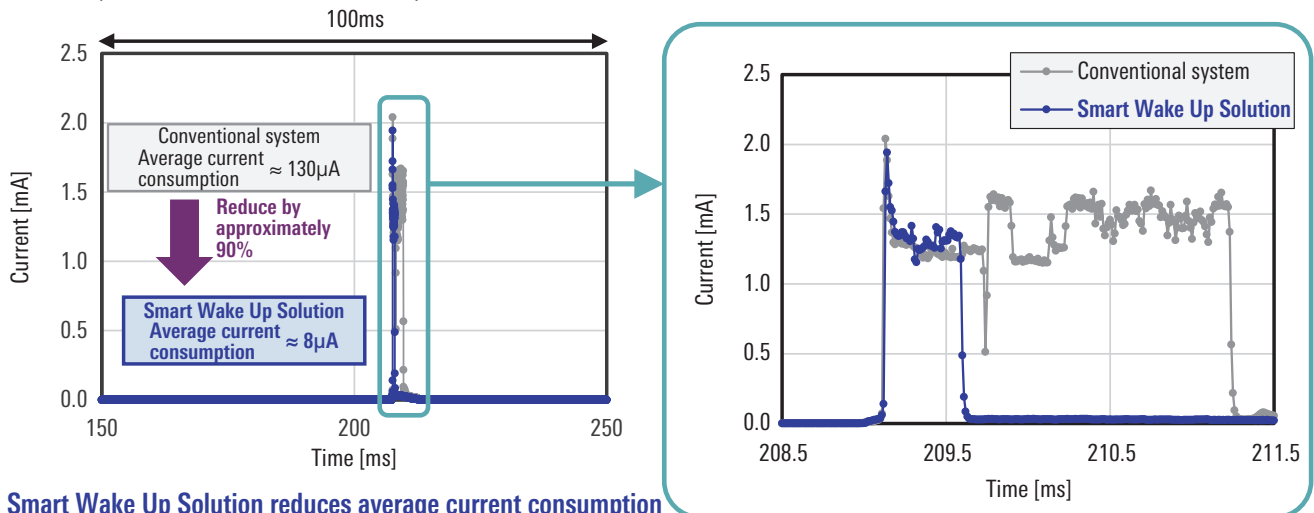
Automatic judgment function

Enables touch ON/OFF detection without CPU activation, reducing power consumption.

Image of Current Reduction Effect by Automatic Judgment and MEC Use



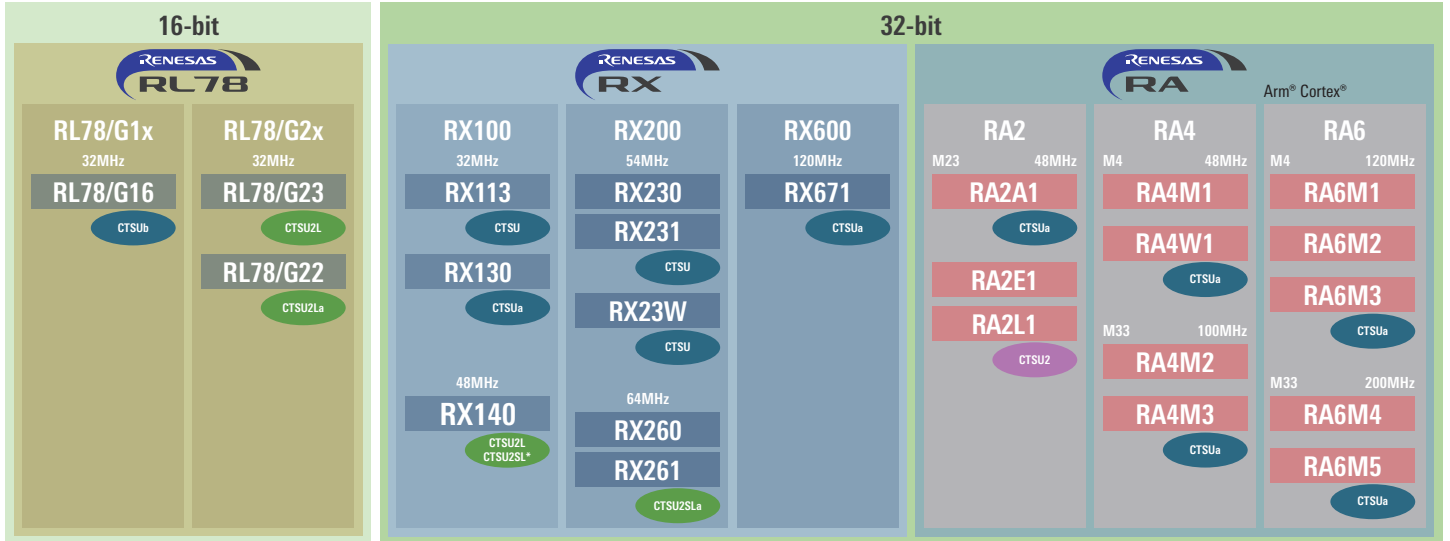
Average current consumption at 100ms touch measurement cycle (in standby mode with 12 channels of self-capacitance buttons)



Smart Wake Up Solution reduces average current consumption by approximately 90% compared to conventional system.

MCU LINEUP

Renesas offers an extensive lineup of MCUs with capacitive touch functionality.



* CTSU2SL: Products with 128-Kbyte or larger ROM

MCU Family with Capacitive Touch Functions

MCU Family with CTSU2

Product Group Name	RA2E1	RA2L1	RX140		RX260	RX261	RL78/G23	RL78/G22
CPU core	Cortex®-M23	Cortex®-M23	RXv2		RXv3	RXv3	RL78-S3	RL78-S3
Max. operating frequency (MHz)	48	48	48		64	64	32	32
Operating voltage (V) *1	1.6 - 5.5	1.6 - 5.5	1.8 - 5.5		1.6 - 5.5	1.6 - 5.5	1.6 - 5.5	1.6 - 5.5
Program Memory (KB)	32, 64, 128	128, 256	64	128, 256	256, 384, 512	256, 384, 512	96, 128, 192, 256, 384, 512, 768	32, 64
Data Flash (KB)	4	8	4	8	8	8	8	2
RAM (KB)	16	32	16	32, 64	128	128	16, 12, 48, 32, 24, 20	4
Capacitive sensor type	CTSU2	CTSU2	CTSU2L	CTSU2SL	CTSU2SLa	CTSU2SLa	CTSU2L	CTSU2La
Number of Touch pins	30	32	12	36	36	36	32	29
Self-capacitance method	✓	✓	✓	✓	✓	✓	✓	✓
Mutual-capacitance method	✓	✓	✓	✓	✓	✓	✓	✓
Multi-frequency measurement	✓	✓	✓	✓	✓	✓	✓	✓
Active shield	✓	✓	✓	✓	✓	✓	✓	✓
Auto judgment				✓	✓	✓	✓*2	✓*2
Auto correction				✓	✓	✓	✓*2	✓*2
Multiple electrode connection: MEC				✓	✓	✓		✓
Mutual simultaneous scan: CFC	18	20						
Temperature correction	✓	✓	✓	✓	✓	✓	✓	✓

*1: This is the operating voltage of the MCU. It may differ from the operating voltage of the capacitive touch.
The operating voltage condition for CTSU2L and CTSU2La is VDD = 1.8 to 5.5 V. When using CTSU2L and CTSU2La, use them in the range of VDD = 1.8 to 5.5 V.

*2: Realized by combining with Snooze mode sequencer (SMS).

RA Family with CTSU1 (CTSU/CTSUA/CTSUB)

Product Group Name	RA2A1	RA4M1	RA4M2	RA4M3	RA4W1	RA6M1	RA6M2	RA6M3	RA6M4	RA6M5
CPU core	Cortex®-M23	Cortex®-M4	Cortex®-M33	Cortex®-M33	Cortex®-M4	Cortex®-M4	Cortex®-M4	Cortex®-M4	Cortex®-M33	Cortex®-M33
Max. operating frequency (MHz)	48	48	100	100	48	120	120	120	200	200
Operating voltage (V) *1	1.6 - 5.5	1.6 - 5.5	2.7 - 3.6	2.7 - 3.6	1.8 - 3.6	2.7 - 3.6	2.7 - 3.6	2.7 - 3.6	2.7 - 3.6	2.7 - 3.6
Program Memory (KB)	256	256	256, 384, 512	512, 768, 1024	512	512	512, 1024	1024, 2048	512, 768, 1024	1024, 1536, 2048
Data Flash (KB)	8	8	8	8	8	8	32	64	8	8
RAM (KB)	32	32	128	128	96	256	384	640, 384	256	512
Capacitive sensor type	CTSU	CTSU	CTSU	CTSU	CTSU	CTSU	CTSU	CTSU	CTSU	CTSU
Number of Touch pins	26	27	12	20	11	19	18	18	20	12
Self-capacitance method	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mutual-capacitance method	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Random pulse frequency measurement	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

*1: This is the operating voltage of the MCU. It may differ from the operating voltage of the capacitive touch.

RX Family with CTSU1 (CTSU/CTSUA/CTSUB)

Product Group Name	RX113	RX130	RX230	RX231	RX23W	RX671
CPU core	RXv1	RXv1	RXv2	RXv2	RXv2	RXv3
Max. operating frequency (MHz)	32	32	54	54	54	120
Operating voltage (V) *1	1.8 - 3.6	1.8 - 5.5	1.8 - 5.5	1.8 - 5.5	1.8 - 3.6	2.7 - 3.6
Program Memory (KB)	128, 256, 384, 512	64, 128, 256, 384, 512	128, 256	128, 256, 384, 512	384, 512	1024, 1536, 2048
Data Flash (KB)	8	8	8	8	8	8
RAM (KB)	64, 32	10, 16, 48, 32	32	32, 64	64	384
Capacitive sensor type	CTSU	CTSUA	CTSU	CTSU	CTSU	CTSUA
Number of Touch pins	12	36	24	24	12	17
Self-capacitance method	✓	✓	✓	✓	✓	✓
Mutual-capacitance method	✓	✓	✓	✓	✓	✓
Random pulse frequency measurement	✓	✓	✓	✓	✓	✓

*1: This is the operating voltage of the MCU. It may differ from the operating voltage of the capacitive touch.

RL78 Family with CTSU1 (CTSU/CTSUA/CTSUB)



Product Group Name	RL78/G16
CPU core	RL78-S2
Max. operating frequency (MHz)	16
Operating voltage (V) *1	2.4 - 5.5
Program Memory (KB)	16, 32
Data Flash (KB)	1
RAM (KB)	2
Capacitive sensor type	CTSUB
Number of Touch pins	15
Self-capacitance method	✓
Mutual-capacitance method	✓
Random pulse frequency measurement	✓
Multiple electrode connection: MEC	✓


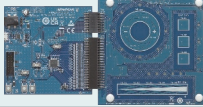

*1: This is the operating voltage of the MCU. It may differ from the operating voltage of the capacitive touch.

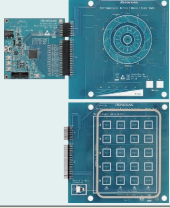

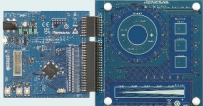

CAPACITIVE TOUCH EVALUATION SYSTEMS

Renesas offers kits that allow you to easily evaluate capacitive touch solutions. Using the boards and software included in the kit, you can begin evaluation immediately after purchasing the kit. For details on each kit, see below.

[renesas.com/touch](https://www.renesas.com/touch)

Mounted MCU	RA2L1	RA6M2
Board Image		
Package	100-pin LFQFP	144-pin QFP
ROM/RAM	256kB/32kB	1MB/384KB
Part No.	RTK0EG0022S01001BJ	RTK0EG0021S01001BJ
Capacitive sensor type	CTS2	CTS2La
Number of Touch pins	32	18
Included items	<ul style="list-style-type: none"> • Evaluation board <ul style="list-style-type: none"> – RA2L1 CPU board – Self-capacitance electrode board (buttons, sliders, wheels) • First Step Guide 	<ul style="list-style-type: none"> • Evaluation board <ul style="list-style-type: none"> – RA6M2 CPU board – Self-capacitance electrode board (buttons, sliders, wheels) • First Step Guide

Mounted MCU	RL78/G23	RL78/G22	RL78/G16
Board Image			
Package	128-pin LFQFP	48-pin LFQFP	32-pin LQFP
ROM/RAM	768KB/48KB	64KB/4KB	32KB/2KBFP
Part No.	RTK0EG0030S01001BJ	RTK0EG0042S01001BJ	RTK0EG0047S01001BJ
Capacitive sensor type	CTS2L	CTS2La	CTSUb
Number of Touch pins	32	29	15
Included items	<ul style="list-style-type: none"> • Evaluation board <ul style="list-style-type: none"> – RL78/G23 CPU board – Self-capacitance electrode board (buttons, sliders, wheels) • First Step Guide 	<ul style="list-style-type: none"> • Evaluation board <ul style="list-style-type: none"> – RL78/G22 CPU board – Self-capacitance electrode board (buttons, sliders, wheels) • First Step Guide 	<ul style="list-style-type: none"> • Evaluation board <ul style="list-style-type: none"> – RL78/G16 CPU board – Self-capacitance electrode board (buttons, sliders, wheels) • First Step Guide

Mounted MCU	RX130	RX671	RX140	RX261
Board Image				
Package	80-pin LFQFP	100-pin LFQFP	80-pin LFQFP	100-pin LFQFP
ROM/RAM	128KB/16KB	2MB/384KB	256KB/64KB	512kB/128kB
Part No.	RTK0EG0003S02001BJ	RTK0EG0044S01001BJ	RTK0EG0039S01001BJ	RTK0EG0055S01001BJ
Capacitive sensor type	CTS2La	CTS2La	CTS2SL	CTS2SLa
Number of Touch pins	36	17	36	34
Included items	<ul style="list-style-type: none"> • Evaluation board <ul style="list-style-type: none"> – RX671 CPU board – Self-capacitance electrode board (buttons, sliders, wheels) – Mutual-capacitance electrode board (buttons, proximity sensors) • USB cable • First Step Guide 	<ul style="list-style-type: none"> • Evaluation board <ul style="list-style-type: none"> – RX671 CPU board – Self-capacitance electrode board (buttons, sliders, wheels) • First Step Guide 	<ul style="list-style-type: none"> • Evaluation board <ul style="list-style-type: none"> – RX140 CPU board – Self-capacitance electrode board (buttons, sliders, wheels) • First Step Guide 	<ul style="list-style-type: none"> • Evaluation board <ul style="list-style-type: none"> – RX261 CPU board – Self-capacitance electrode board (buttons, sliders, wheels) • First Step Guide

TOUCHLESS USER INTERFACE SOLUTION

This touchless user interface solution includes a 3D gesture solution, which allows the user to control the product touchlessly by detecting gestures in three-dimensional space, and a 2D gesture solution, which detects movement using two-dimensional coordinates. Both are intended for situations where the user needs to control the product without touching it, perhaps because their hands are wet, or because they can't reach the product, or because they don't want to touch the product. For example, in the kitchen, you can adjust the water temperature and flow with hand movements, and simply waving your hand over the range hood allows you to control the fan and turn on the lights.

Features

Based on Renesas' high-sensitivity, noise-tolerant capacitive touch solutions.

- Recognition of hand position up to a height of 200mm above the sensor
- Maximum accuracy: 1mm

High tolerance for noise and obstructions.

- Capable of sensing through non-conductive barriers (such as wall materials, wood, resin, glass, fabric, paper, etc.)
- Support for IEC 61000 4-3 and IEC 61000 4-6 Level 3 Class B noise immunity standards*

* Class B: No false detection in a noisy environment when there are no objects nearby.

Suitable for use in a variety of products.

- High-performance and power-efficient 32-bit MCU and capacitive touch IP enable product system control and operation using 3D gestures.
- Can be combined with existing capacitive touch functions (gestures and capacitive touch buttons).

For more information, visit <https://www.renesas.com/products/software-tools/boards-and-kits/eval-kits/3d-gesture-reference-design.html>

3D Gesture Reference Design

Hand positions are converted into coordinates up to a maximum height of 200mm above the sensor. Conversion is accurate and fast, making it possible to control devices by means of dynamic gestures or simple figure recognition.

2D Gesture Reference Design

By combining multiple capacitive proximity sensors, it is possible to detect when the user's hand is held over or near an electrode for a certain period of time as well as hand movements spanning multiple electrodes. This makes it a simple matter to implement gesture-based controls.



Resource information	Title
Hardware	RX231 Group CTSU Application Example: 3D Gesture Demo Set (Hardware)
	RX130 Group CTSU Application Example: 3D Gesture Demo Set Small version (Hardware)
	RA2L1 Group CTSU Application Example: 3D Gesture Electrode Board (Hardware)
Software	RX Family CTSU 3D Gesture Demo Set Sample Software
	RA2L1 Group CTSU 3D Gesture Electrode Board Sample Software
Development Tools	CTSU 3D Gesture Demo Set Evaluation Tool
	QE for Capacitive Touch
	3D Gesture AI Solution
Sample codes	CTSU 3D Gesture Demo Set Sample Software (Standard version)
	CTSU 3D Gesture Demo Set Sample Software (Small version)
	RA2L1 Group CTSU 3D Gesture Electrode Board Sample Software
	RX140 Group CTSU 3D Gesture Electrode Board Sample Software
Others	Usage example of e-AI x 3D gesture recognition feature - QE for Capacitive Touch

SELF-CAPACITANCE WATERPROOF BUTTON SOLUTION

The demonstration of self-capacitance waterproof button compares the waterproof capabilities of GND shields and Active shields used in a self-capacitance button.

The Renesas capacitive sensor, CTSU2 can utilize an active shield without any external components. Active shielding is effective in improving water resistance and noise immunity of self-capacitance buttons. The Self-Capacitance Waterproof Button Solution reference design compares water resistance of traditional GND shields to active shield for the self-capacitance buttons.

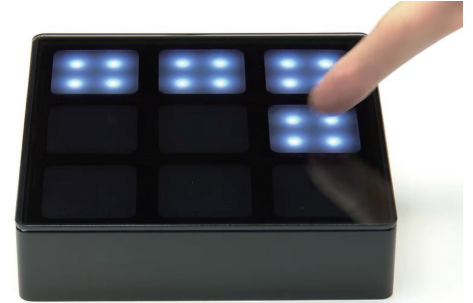


For more information, visit <https://www.renesas.com/application/home-building/capacitive-touch-solutions/self-capacitance-waterproof-button-solution>

Resource information	Title
Hardware	RX140 Group Capacitive Touch Evaluation System User's Manual
	RL78/G23 Capacitive Touch Evaluation System User's Manual
	RA2L1 Group Capacitive Touch Evaluation System User's Manual
Development Tool	QE for Capacitive Touch
Sample codes	RX140 Self-capacitance Waterproof Touch Button Demo Software
	RL78/G23 Self-capacitance Waterproof Touch Button Demo Sample Software
	RA2L1 Group Self-capacitance Waterproof Touch Button Demo Sample Software
Document	RA2L1 Group Self-Capacitance Waterproof Demo Hardware Manual

TOUCHLESS-BUTTON REFERENCE DESIGN

The touchless button reference design can detect the approach of fingers and hands without physical contact using Renesas' capacitive touch solution. The electrode detects the proximity of the finger via self-capacitance and turns on the LED. The demo solution is compatible with all types of Renesas capacitive touch CPU boards.



For more information, visit <https://www.renesas.com/application/home-building/capacitive-touch-solutions/capacitive-sensor-application-reference-design-touchless-button-solution-reference-design>

Resource information	Title
Hardware	RX140 Group Capacitive Touch Evaluation System User's Manual
	RL78/G23 Capacitive Touch Evaluation System User's Manual
	RA6M2 Group Capacitive Touch Evaluation System User's Manual
	RX130 Group RX Capacitive Touch Evaluation System CPU Board User's Manual
	RA2L1 Group Capacitive Touch Evaluation System User's Manual
Development Tool	QE for Capacitive Touch
Sample codes	RX140 Group Touchless Button Demo Solution Sample Software
	RL78/G23 Group Touchless Button Demo Solution Sample Software
	RA6M2 Group Touchless Button Demo Solution Sample Software
	RX130 Group Touchless Button Demo Solution Sample Software
Document	RA2L1 Group Touchless Button Demo Solution (Hardware)

SMART WAKEUP SOLUTION

The CTSU2SL's automatic detection function and multiple electrode connection function enable low power consumption standby.

Automatic Judgment Function

Previously, button touch judgements were performed by the driver or middleware based on calculations performed by the CTSU. This meant that touch judgements required activation of the CPU. The automatic judgment function enables touch judgements to be performed by the CTSU, without the need to activate the CPU. As a result, it is not necessary to periodically wake the CPU, allowing for reduced power consumption.

Multiple Electrode Connection Function

It used to be necessary to use a particular button, such as the power button, to wake the MCU from the low-power mode, but the multiple electrode connection function enables wakeup from low-power mode by touching any button.

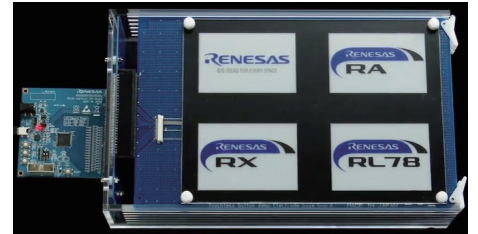
For more information, visit <https://www.renesas.com/products/microcontrollers-microprocessors/rx-32-bit-performance-efficiency-mcus/smart-wake-solution-smart-wake-solution>



Resource information	Title
Hardware	RX140 Group Capacitive Touch Evaluation System User's Manual
Development Tool	QE for Capacitive Touch
Sample code	RX140 Group Smart Wakeup Solution
Documents	RX140 Group Smart Wakeup Solution Application Note
	RX140 Group Smart Wakeup Solution (Touchless Demo) Application Note

TOUCHLESS BUTTON ELECTRODE BOARD

The touchless button electrode board uses a Renesas capacitive touch solution to sense the approach of the user's finger or hand without the need for physical contact. Self capacitance electrodes detect when the user's finger is nearby, and an LED turns on. A variety of Renesas capacitive touch CPU boards are supported. The buttons are designed to evoke devices used in public places, such as ticket vending machines.

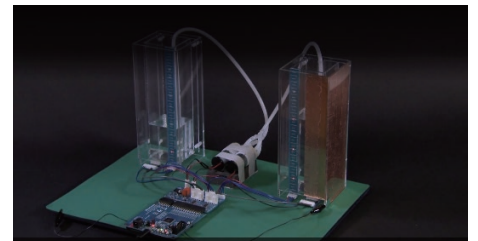


For more information, visit <https://www.renesas.com/video/touchless-button-electrode-board>

Resource information	Title
Hardware	RA6M2 Group Capacitive Touch Evaluation System User's Manual
	RL78/G23 Capacitive Touch Evaluation System User's Manual
	RX130 Group RX Capacitive Touch Evaluation System CPU Board User's Manual
	RA2L1 Group Capacitive Touch Evaluation System User's Manual
Development Tool	QE for Capacitive Touch
Sample codes	RA6M2 Group Touchless Button Electrode Board Sample Software
	RL78/G23 Group Touchless Button Electrode Board Sample Software
	RX130 Group Touchless Button Electrode Board Sample Software
	RA2L1 Group Touchless Button Electrode Board Sample Software
Document	Capacitive Sensor Microcontrollers Touchless Button Electrode Board Application Note

WATER LEVEL MEASUREMENT DEMO

This is a demo of the use of a capacitive touch to measure water levels.



For more information, visit <https://www.renesas.com/video/water-level-measurement-demo>

Resource information	Title
Hardware	RX130 Group RX Capacitive Touch Evaluation System CPU Board User's Manual
Development Tool	QE for Capacitive Touch
Software	RX Family Capacitive Water Level Measurement Demo Level Monitor
Sample code	RX Family Capacitive Liquid Level Indicator Demo System Sample Software
Documents	RX130 Group Capacitive Water Level Measurement Demo Set Application Note
	RX Family Capacitive Liquid Level Indicator Demo System Sample Software Application Note
	RX Family Capacitive Water Level Measurement Demo Level Monitor User's Manual

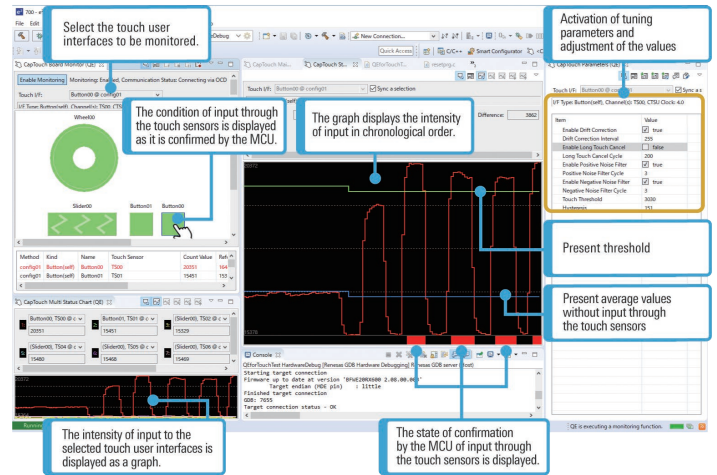
QE for Capacitive Touch: Development Assistance Tool for Capacitive Touch Sensors

QE for Capacitive Touch is a solution toolkit that runs in the e2 studio integrated development environment. It speeds up the development of integrated systems utilizing capacitive touch sensors by simplifying tasks such as configuring initial settings or tuning the sensitivity of the touch interface.

For more information, visit <https://www.renesas.com/qe-capacitive-touch>

Monitoring Function

The monitoring function displays waveforms of measurement values as capacitance changes over time. You can adjust a variety of tuning parameters while monitoring the capacitance waveforms. Saving displayed waveforms to a log is also supported.



Tuning Functions

The supported tuning functions are automatic tuning, manual tuning, and advanced mode tuning. Automatic tuning performs configuration of parameter settings to match the board under development. Simply connect a board populated with an MCU to QE, and you can complete basic adjustments by making selections on the GUI interface. Manual tuning and advanced mode tuning allow fine-grained customization tailored to individual customer requirements. For details, refer to the following application note.

<https://www.renesas.com/document/apn/capacitive-sensor-mcu-qe-capacitive-touch-advanced-mode-parameter-guide>

Preparing for adjustment

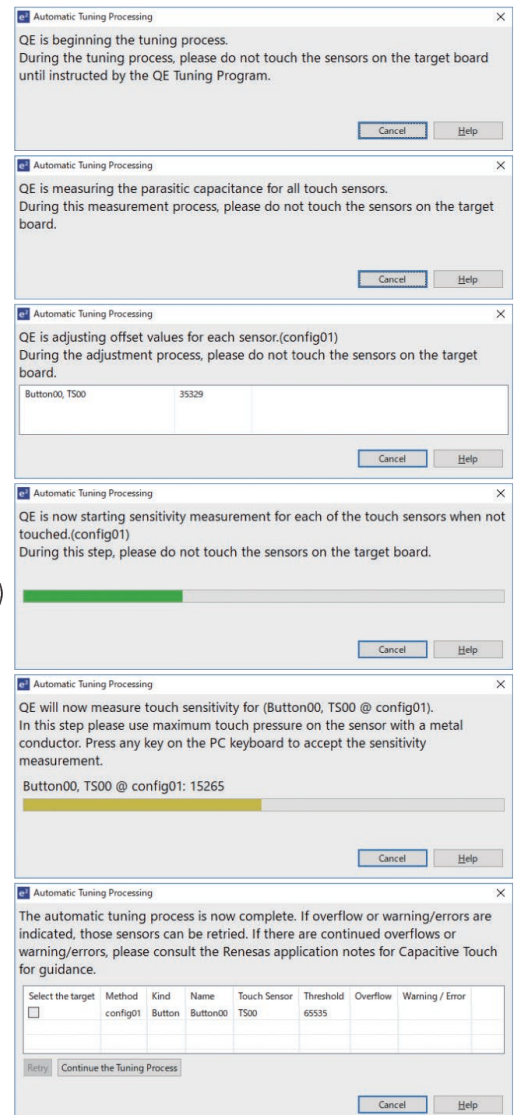
Measuring parasitic capacitance

Adjusting the offset

Measuring sensitivity (while not touched)

Measuring sensitivity (while touched)

Result of the tuning



Tutorial videos for each supported microcontroller

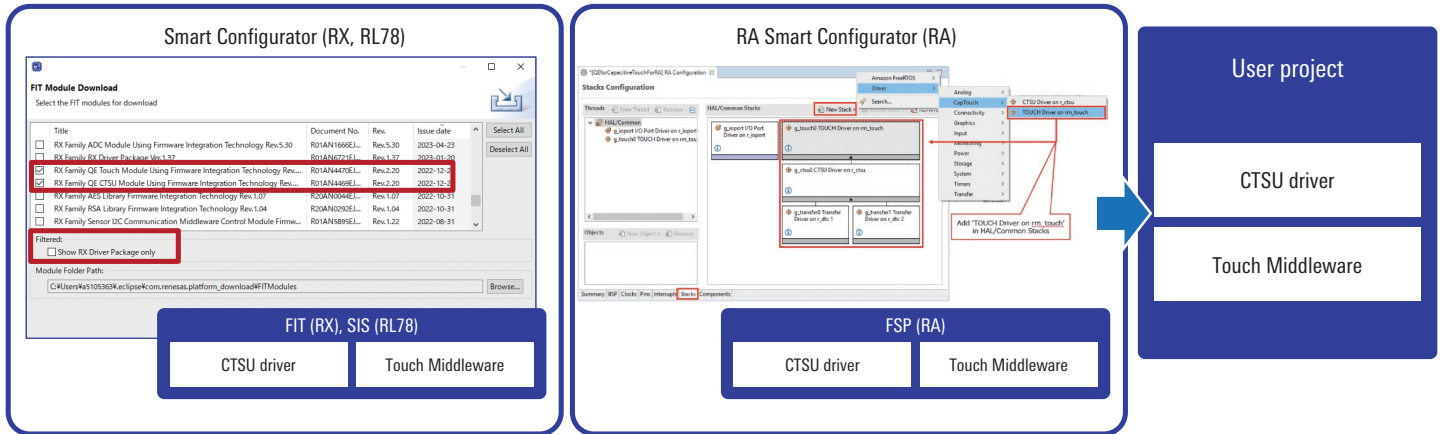
For RA family: <https://www.renesas.com/ra-how-to-video>

For RX family: <https://www.renesas.com/rx-how-to-video>

For RL78 family: <https://www.renesas.com/rl78-how-to-video>

EASILY GENERATE DRIVERS WITH SMART CONFIGURATOR

Smart Configurator is a tool that automatically generates initial configuration programs for specific MCUs. It lets you configure MCU peripheral pin settings and combine software resources such as middleware and drivers to match the project under development in a speedy and smart manner. Drivers and middleware for capacitive touch applications are supplied as modules that can be integrated into existing projects.



RELATED DEVICES

RA2E1

48MHz Arm® Cortex®-M23 Entry Line General Purpose Microcontroller

RA2E1		48MHz 32-bit Arm® Cortex®-M23 Core		NVIC SWD MTB	
Memory	Analog	Timer	HMI		
Code Flash (128kB, 64kB, 32kB) SRAM (16kB) Parity Data Flash (4kB)	12-bit ADC (13ch) Low Power Analog Comparator (2ch) Temperature Sensor	GPT 32-bit (1ch) GPT 16-bit (6ch) AGT 16-bit (2ch) WDT	Capacitive Touch Sensing Unit (30ch)		
Communication	System	Safety	Security		
I2C x1 SCI x4 SPI x1	Sys Tick DTC Multiple Clocks On-Chip Oscillator HOCC (24.32, 48, 64MHz), LOCO (32kHz), ILOCO (15kHz) Low Power Modes ELC Port Function Select RTC	Memory Protection Unit SRAM Parity Check POE Clock Frequency Accuracy Measurement CRC Calculator IWDT Data Operation Circuit Flash Area Protection ADC Self Test	AES (128/256) TRNG 128 bit Unique ID Package LQFP 32, 48, 64; LGA 36 BGA 64; QFN 32, 48; WLCSP 25		

RA2L1

48MHz Arm® Cortex®-M23 Ultra-Low power General Purpose Microcontroller

RA2L1		48MHz 32-bit Arm® Cortex®-M23 Core		NVIC SWD MTB	
Memory	Analog	Timer	HMI		
Code Flash (256kB, 128kB) SRAM (16kB) Parity SRAM (16kB) ECC Data Flash (8kB)	12-bit ADC (19ch) 12-bit DAC (1ch) Low Power Analog Comparator (2ch) Temperature Sensor	GPT 32-bit (4ch) GPT 16-bit (6ch) AGT 16-bit (2ch) WDT	Capacitive Touch Sensing Unit (32ch) High Current IO (~20mA)		
Communication	System	Safety	Security		
CAN x1 I2C x2 SCI x5 SPI x2	Sys Tick DTC Multiple Clocks On-Chip Oscillator HOCC (24.32, 48, 64MHz), LOCO (32kHz), ILOCO (15kHz) Low Power Modes ELC Port Function Select RTC	Memory Protection Unit SRAM Parity Check ECC in SRAM POE Clock Frequency Accuracy Measurement CRC Calculator IWDT Data Operation Circuit Flash Area Protection ADC Self Test	AES (128/256) TRNG 128 bit Unique ID Package LQFP 48, 64, 80, 100 QFN 48		

RA4M1

32-bit Microcontrollers with 48MHz Arm® Cortex®-M4 and LCD Controller and Capacitive Touch for HMI

RA4M1		48MHz 32-bit Arm® Cortex®-M4 Core		FPU ARM MPU NVIC JTAG SWD ETB Boundary Scan	
Memory	Analog	Timer	HMI		
Code Flash (256kB) SRAM (16kB) Parity SRAM (16kB) ECC Data Flash (8kB)	14-bit A/D (25ch) 1S/H 12-bit DAC (1ch) OPAMP (4ch) Low Power Comparator (2ch) Temperature Sensor	GPT 32-bit (2ch) GPT 16-bit (6ch) Low Power GPT (2ch) WDT RTC, Calendar, Vbat	Capacitive Touch Sensing Unit (27ch) Segment LCD Controller 38 Seg/8 Com		
Communication	System	Safety	Security		
USB2.0 FS x1 CAN x1 I2C x2 SCI x4 SPI x2 SSI x1	DMA (4ch) DTC Clock Generation On-Chip Oscillator HOCC (24, 32, 48, 64MHz), MOCO (8MHz), LOCO (32kHz), ILOCO (15kHz) Low Power Modes ELC Interrupt Controller	Memory Protection Unit SRAM Parity Check ECC in SRAM POE Clock Frequency Accuracy Measurement CRC Calculator IWDT Data Operation Circuit Flash Area Protection ADC Self Test	AES (128/256) TRNG Key Management GHASH Package LQFP 48, 64, 100 QFN 48, 64, 40, LGA 100		

RA4M2

100MHz Arm® Cortex®-M33 TrustZone®, High Integration with Lowest Active Power Consumption

RA4M2		100MHz 32-bit Arm® Cortex®-M33 Core		NVIC JTAG SWD ETB	
Memory	Analog	Timer	HMI		
Code Flash (256kB, 384kB, 512kB) SRAM (64kB) Parity SRAM (64kB) ECC Data Flash (8kB) Standby SRAM (1kB)	12-bit A/D (13ch) 1S/H 12-bit DAC (2ch) Temperature Sensor	GPT 32-bit (4ch) GPT 16-bit (4ch) Low Power GPT (6ch) WDT RTC, Calendar, Vbat, 128Byte SRAM	Capacitive Touch Sensing Unit (12ch)		
Communication	System	Safety	Security		
USB2.0 FS x1 CAN x1 I2C x2 SCI x6 SPI x1 QSPI x1 SDHI / MMC SSI x1	DMA (8ch) DTC Clock Generation On-Chip Oscillator HOCC (16, 18, 20MHz), LOCO (32kHz), ILOCO (15kHz) Low Power Modes ELC Interrupt Controller TrustZone	Memory Protection Unit SRAM Parity Check ECC in SRAM POE Clock Frequency Accuracy Measurement CRC Calculator IWDT Data Operation Circuit Flash Area Protection ADC Self Test	Unique ID AES (128/192/256) TRNG Key Management RSA / ECC / DSA SHA256 / SHA224 Tamper Resistance SPA/DPA Enhanced Resistance Package LQFP 48, 64, 100 QFN 48		

RELATED DEVICES

RA4M3

100MHz Arm® Cortex®-M33 TrustZone®, High Integration with Rich Connectivity

RA4M3 100MHz 32-bit Arm® Cortex®-M33 Core NVIC JTAG SWD ETB			
Memory Code Flash (512kB, 768kB, 1MB) Block SWAP Function SRAM (64kB) Parity SRAM (64kB) ECC Data Flash (8kB) Standby SRAM (1kB)	Analog 12-bit A/D (9ch) 1S/H 12-bit A/D (10ch) 1S/H 12-bit DAC (2ch) Temperature Sensor	Timer GPT 32-bit (2ch) GPT 16-bit (6ch) Low Power GPT (6ch) WDT RTC, Calendar, Vbat, 128Byte SRAM	HMI Capacitive Touch Sensing Unit (20ch)
Communication USB2.0 FS x1 CAN x1 I2C x2 SCI x6 SPI x1 QSPI x1 SDHI / MMC SSI x1	System DMA (8ch) DTC Clock Generation On-Chip Oscillator HOCO (16, 18, 20MHz), LOCO (32kHz), ILOCO (15kHz) Low Power Modes ELC Interrupt Controller TrustZone	Safety Memory Protection Unit SRAM Parity Check ECC in SRAM Clock Frequency Accuracy Measurement CRC Calculator IWDT Data Operation Circuit Flash Area Protection ADC Self Test	Security Unique ID AES (128/192/256) TRNG Key Management RSA / ECC / DSA SHA256 / SHA224 Tamper Resistance SPA/DPA Enhanced Resistance
			Package LQFP 64, 100, 144

RA4W1

48MHz Arm® Cortex®-M4 Core + Low Energy, Single Chip 32-bit Microcontrollers with Bluetooth® 5.0

RA4W1 48MHz 32-bit Arm® Cortex®-M4 Core FPU ARM MPU NVIC JTAG SWD ETB Boundary Scan			
Memory Code Flash (512 KB) Data Flash (8 KB) SRAM (96 KB) Flash Cache Memory Mirror Function	Analog 14-bit A/D Converter (8 ch.) 12-bit D/A Converter x1 Low-Power Analog Comparator x2 OPAMP x1 Temperature Sensor	Timer General PWM Timer 32-bit x4 General PWM Timer 16-bit x3 Asynchronous General Purpose Timer x2 WDT RTC	HMI Capacitive Touch Sensing Unit (11 ch.) Segment LCD Controller 4cm x 9mm
Communication USBFS x1 CAN x1 Serial Communications Interface x4 SPI x2 I2C x2 SCI x4 2.4 GHz RF (Bluetooth 5, Master/Slave AES Engine for BT5)	System DMA (4ch) DTC Clock Generation On-Chip Oscillator HOCO (24, 32, 48, 64MHz), MOCO (8MHz), LOCO (32kHz), ILOCO (15kHz) Low Power Modes ELC Interrupt Controller	Safety Memory Protection Unit SRAM Parity Check ECC in SRAM POE Clock Frequency Accuracy Measurement CRC Calculator IWDT Data Operation Circuit Flash Area Protection ADC Self Test	Security 128-bit Unique ID TRNG Key Management AES (128/256) GHASH
			Package QFN 56

RA4E1

100MHz Arm® Cortex®-M33, Entry-Line with Balanced Low Power Consumption & Optimized Feature Integration

RA4E1 100MHz 32-bit Arm® Cortex®-M33 Core NVIC JTAG SWD ETB			
Memory Code Flash (256kB, 512kB) SRAM (128kB) Data Flash (8kB) Standby SRAM (1kB)	Analog 12-bit A/D (9ch) 1S/H 12-bit DAC (1ch)	Timer GPT 32-bit (2ch) GPT 16-bit (2ch) Low Power GPT (6ch) WDT RTC, Calendar, Vbat, 128Byte SRAM	Security Unique ID TRNG
Communication USB2.0 FS x1 CAN x1 I2C x1 SCI x4 SPI x1 QSPI x1 SDHI x1 SSI x1	System DMA (8ch) DTC Clock Generation On-Chip Oscillator HOCO (16, 18, 20MHz), LOCO (32kHz), ILOCO (15kHz) Low Power Modes ELC Interrupt Controller TrustZone	Safety Memory Protection Unit SRAM Parity Check Clock Frequency Accuracy Measurement CRC Calculator IWDT Data Operation Circuit Flash Area Protection ADC Self Test	Package LQFP 64 QFN 48

RA6M1

120MHz Arm® Cortex®-M4 Core, 32-bit Microcontrollers with Optimized Entry Point to the RA6 Series

RA6M1 120MHz 32-bit Arm® Cortex®-M4 Core NVIC JTAG SWD ETB			
Memory Code Flash (512kB) SRAM (96kB) Parity SRAMHS (128kB) Parity SRAM (32kB) ECC Data Flash (8kB) Standby SRAM (8kB)	Analog 12-bit A/D (11ch) 3S/H 12-bit A/D (8ch) 3S/H 12-bit DAC (2ch) 3ch PGA for each ADC High Speed Comparator (6ch) Temperature Sensor	Timer GPT HighRes 32-bit (4ch) GPT Enh. 32-bit (4ch) GPT 32-bit (5ch) Low Power GPT (2ch) WDT RTC, Calendar, Vbat	HMI Capacitive Touch Sensing Unit (12ch)
Communication USB2.0 FS x1 CAN x2 I2C x2 SCI x7 SPI x2 QSPI x1 SDHI x2 SSI x1 and SRC External Memory Bus	System DMA (8ch) DTC Clock Generation On-Chip Oscillator HOCO (16, 18, 20MHz), MOCO (8MHz), LOCO (32kHz), ILOCO (15kHz) Low Power Modes ELC Interrupt Controller	Safety Memory Protection Unit SRAM Parity Check ECC in SRAM POE Clock Frequency Accuracy Measurement CRC Calculator IWDT Data Operation Circuit Flash Area Protection ADC Self Test	Security AES (128/192/256) TRNG Key Management GHASH SHA1/SHA224/SHA256 ECC/RSA/DSA 3DES/ARC4
			Package LQFP 64, 100 LGA 100, QFN 64

RA6M2

120MHz Arm® Cortex®-M4 Core, 32-bit Microcontrollers with Medium Size Memory Integration and Ethernet

RA6M2 120MHz 32-bit Arm® Cortex®-M4 Core NVIC JTAG SWD ETM			
Memory Code Flash (512KB, 1MB) SRAM (224KB) Parity SRAMHS (128KB) Parity SRAM (32KB) ECC Data Flash (32KB) Standby SRAM (8KB)	Analog 12-bit A/D (13ch) 3S/H 12-bit A/D (9ch) 3S/H 12-bit DAC (2ch) High Speed Comparator (6ch) Temperature Sensor	Timer GPT HighRes 32-bit (4ch) GPT Enh. 32-bit (4ch) GPT 32-bit (6ch) Low Power GPT (2ch) WDT RTC, Calendar, Vbat	HMI Capacitive Touch Sensing Unit (18ch) Parallel Capture Unit
Communication Ethernet MAC with DMA USB2.0 FS x1 CAN x2 I2C x3 SCI x10 SPI x2 QSPI x1 SDHI x2 SSI x1 and SRC External Memory Bus	System DMA (8ch) DTC Clock Generation On-Chip Oscillator HOCO (16, 18, 20MHz), MOCO (8MHz), LOCO (32kHz), ILOCO (15kHz) Low Power Modes ELC Interrupt Controller	Safety Memory Protection Unit SRAM Parity Check ECC in SRAM POE Clock Frequency Accuracy Measurement CRC Calculator IWDT Data Operation Circuit Flash Area Protection ADC Self Test	Security AES (128/192/256) TRNG Key Management GHASH SHA1/SHA224/SHA256 ECC/RSA/DSA 3DES/ARC4 Package LQFP 100, 144 LGA 145

RA6M3

120MHz Arm® Cortex®-M4 Core, 32-bit Microcontrollers with USB High-Speed, Ethernet and TFT controller

RA6M3 120MHz 32-bit Arm® Cortex®-M4 Core NVIC JTAG SWD ETM			
Memory Code Flash (1MB, 2MB) SRAM (480KB) Parity SRAMHS (128KB) Parity SRAM (32KB) ECC Data Flash (64KB) Standby SRAM (8KB)	Analog 12-bit A/D (13ch) 3S/H 12-bit A/D (11ch) 3S/H 12-bit DAC (2ch) 3ch PGA for each ADC High Speed Comparator (6ch) Temperature Sensor	Timer GPT HighRes 32-bit (4ch) GPT Enh. 32-bit (4ch) GPT 32-bit (6ch) Low Power GPT (2ch) WDT RTC, Calendar, Vbat	HMI Graphic LCD Controller for TFT 2D Drawing Engine JPEG Codec Capacitive Touch Sensing Unit (18ch) Parallel Capture Unit
Communication Ethernet MAC with DMA USB2.0 FS x1 USB2.0 HS x1 CAN x2 I2C x3 SCI x10 SPI x2 QSPI x1 SDHI x2 SSI x2 and SRC External Memory Bus	System DMA (8ch) DTC Clock Generation On-Chip Oscillator HOCO (16, 18, 20MHz), MOCO (8MHz), LOCO (32kHz), ILOCO (15kHz) Low Power Modes ELC Interrupt Controller	Safety Memory Protection Unit SRAM Parity Check ECC in SRAM POE Clock Frequency Accuracy Measurement CRC Calculator IWDT Data Operation Circuit Flash Area Protection ADC Self Test	Security AES (128/192/256) TRNG Key Management GHASH SHA1/SHA224/SHA256 ECC/RSA/DSA 3DES/ARC4 Package LQFP 100, 144, 176 LGA 145, BGA 176

RA6M4

200MHz Arm® Cortex®-M33 TrustZone®, High Integration with Ethernet and OctaSPI

RA6M4 200MHz 32-bit Arm® Cortex®-M33 Core NVIC JTAG SWD ETB			
Memory Code Flash (512KB, 768KB, 1MB) BGO/SWAP Function SRAM (192KB) Parity SRAM (64KB) ECC Data Flash (8KB) Standby SRAM (1KB)	Analog 12-bit A/D (10ch) 1S/H 12-bit A/D (12ch) 1S/H 12-bit DAC (2ch) Temperature Sensor	Timer GPT 32-bit (4ch) GPT 16-bit (6ch) Low Power GPT (6ch) WDT RTC, Calendar, Vbat, 128Byte SRAM	HMI Capacitive Touch Sensing Unit (20ch) Security Unique ID AES (128/192/256) TRNG Key Management RSA / ECC / DSA SHA256 / SHA224 Tamper Detection SPA/DPA Enhanced Resistance Package LQFP 64, 100, 144
Communication Ethernet MAC with DMA USB2.0 FS x1 CAN x2 I2C x2 SCI x10 SPI x2 QSPI x1 + OctaSPI SDHI / MMC SSI x1 External Memory Bus	System DMA (8ch) DTC Clock Generation On-Chip Oscillator HOCO (16, 18, 20MHz), LOCO (32kHz), ILOCO (15kHz) Low Power Modes ELC Interrupt Controller TrustZone	Safety Memory Protection Unit SRAM Parity Check ECC in SRAM Clock Frequency Accuracy Measurement CRC Calculator IWDT Data Operation Circuit Flash Area Protection ADC Self Test	Security Unique ID AES (128/192/256) TRNG Key Management RSA / ECC / DSA SHA256 / SHA224 Tamper Resistance SPA/DPA Enhanced Resistance Package LQFP 100, 144, 176 BGA 176

RA6M5

200MHz Arm® Cortex®-M33 TrustZone®, Highest Integration with Ethernet and CAN FD

RA6M5 200MHz 32-bit Arm® Cortex®-M33 Core NVIC JTAG SWD ETB			
Memory Code Flash (1MB, 1.5MB, 2MB) BGO/SWAP Function SRAM (448KB) Parity SRAM (64KB) ECC Data Flash (8KB) Standby SRAM (1KB)	Analog 12-bit A/D (10ch) 1S/H 12-bit A/D (16ch) 1S/H 12-bit DAC (2ch) Temperature Sensor	Timer GPT 32-bit (4ch) GPT 16-bit (6ch) Low Power GPT (6ch) WDT RTC, Calendar, Vbat, 128Byte SRAM	HMI Capacitive Touch Sensing Unit (20ch) Security Unique ID AES (128/192/256) TRNG Key Management RSA / ECC / DSA SHA256 / SHA224 Tamper Resistance SPA/DPA Enhanced Resistance Package LQFP 100, 144, 176 BGA 176
Communication Ethernet MAC with DMA USB2.0 FS x1 USB2.0 HS x1 CAN FD x2 I2C x2 SCI x10 SPI x2 QSPI x1 + OctaSPI x 1 SDHI / MMC / HDMI-CEC SSI x1 External Memory Bus	System DMA (8ch) DTC Clock Generation On-Chip Oscillator HOCO (16, 18, 20MHz), LOCO (32kHz), ILOCO (15kHz) Low Power Modes ELC Interrupt Controller TrustZone	Safety Memory Protection Unit SRAM Parity Check ECC in SRAM Clock Frequency Accuracy Measurement CRC Calculator IWDT Data Operation Circuit Flash Area Protection ADC Self Test	Security Unique ID AES (128/192/256) TRNG Key Management RSA / ECC / DSA SHA256 / SHA224 Tamper Resistance SPA/DPA Enhanced Resistance Package LQFP 100, 144, 176 BGA 176

RELATED DEVICES

RX140

48MHz RXv2 Core, 32-bit Microcontrollers with Third-Generation Touch IP

RX140 48MHz 32-bit RXv2 core			
Memory Code Flash (256KB) SRAM (64KB) Data Flash (8KB)	Analog 12-bit A/D converter (18ch) 8-bit D/A converter (2ch) Temperature Sensor Comparator (2ch)	Timer Multi-function timer pulse unit 2 16-bit (6ch) 8-bit timer (2ch+2ch) Compare match timer 16-bit (2ch) Realtime clock Low power timer	HMI Capacitive touch sensing unit (36ch)
Connectivity CAN (1ch) SCI (6ch) I2C (1ch) SPI (1ch)	System DTC Interrupt (8-pin+NMI) High/low-speed on-chip oscillators Power-on reset (POR) Voltage detection circuit (LVD) Event link controller	Safety Clock frequency accuracy measurement circuit Register write protection Oscillation stop detection CRC calculator Data operation circuit (RAM test assist) A/D self-diagnostic (Fault detection) A/D disconnection detection 14-bit independent watchdog timer Port output enable	Security AES hardware accelerator True random number generator ID code protection Unique ID Package LFOFP 48/64/80 LOFP 32/64 HWQFN 32/48

RX671

120MHz RXv3 Core, 32-bit Microcontrollers for Fast Real-Time Control and Contactless HMI

RX671 120MHz 32-bit RXv3 core			
Memory Code Flash (2MB) SRAM (384KB) Data Flash (8KB)	Analog 12-bit A/D converter (18ch) 8-bit D/A converter (2ch) Temperature Sensor	Timer Multi-function timer pulse unit 3 16-bit (8ch), 32-bit (1ch) 8-bit timer (4ch) Compare match timer 16-bit (4ch), 32-bit (2ch) 16-bit timer pulse unit (6ch) Realtime clock	HMI Capacitive touch sensing unit (17ch) Serial sound I/F
Connectivity USB 2.0 FS (1ch) CAN (2ch) SCI (15ch) I2C (3ch) SPI (4ch) QSPI with XIP (1ch) SDHI (1ch)	System DTC, DMAC (8ch), EXDMAC (2ch) Interrupt (16-pin+NMI) High/low-speed on-chip oscillators Power-on reset (POR) Voltage detection circuit (LVD) Event link controller	Safety Clock frequency accuracy measurement circuit Register write protection Oscillation stop detection CRC calculator Data operation circuit (RAM test assist) A/D self-diagnostic (Fault detection) A/D disconnection detection 14-bit independent watchdog timer Port output enable Memory protection unit	Security Cryptographic engine (AES, RSA, ECC, SHA, TRNG) Key management ID code protection Unique ID Tamper detection Trusted Memory function Package LFOFP 64/100/144 LFBGA 64 HWQFN 48 TFLGA 100/145

RX113

32MHz RXv1 Core, 32-bit Microcontroller with Segment LCD and USB

RX113 32MHz 32-bit RXv1 core			
Memory Code Flash (512KB) SRAM (64KB) Data Flash (8KB)	Analog 12-bit A/D converter (17ch) 8-bit D/A converter (2ch) Temperature Sensor Comparator (2ch)	Timer Multi-function timer pulse unit 2 16-bit (6ch) 8-bit timer (2ch+2ch) Compare match timer 16-bit (4ch) Realtime clock Low power timer	HMI Capacitive touch sensing unit (36ch) Serial sound I/F LCD
Connectivity SCI (8ch) I2C (1ch) SPI (1ch) USB2.0 Full Speed Host/Function (1ch) IrDA (1ch)	System DTC Interrupt (8-pin+NMI) High/low-speed on-chip oscillators Power-on reset (POR) Voltage detection circuit (LVD) Event link controller	Safety Clock frequency accuracy measurement circuit Register write protection Oscillation stop detection CRC calculator Data operation circuit (RAM test assist) 14-bit independent watchdog timer Port output enable	Security ID code protection Unique ID Package LFOFP 64/100 TFLGA 100

RX130

32MHz RXv1 Core, 32-bit MCUs with a Wide Range of Memory Lineup

RX130 32MHz 32-bit RXv1 core			
Memory Code Flash (512KB) SRAM (48KB) Data Flash (8KB)	Analog 12-bit A/D converter (24ch) 8-bit D/A converter (2ch) Temperature Sensor Comparator (2ch)	Timer Multi-function timer pulse unit 2 16-bit (6ch) 8-bit timer (2ch+2ch) Compare match timer 16-bit (2ch) Realtime clock Low power timer	HMI Capacitive touch sensing unit (36ch)
Connectivity SCI (7ch) I2C (1ch) SPI (1ch) Remote control signal receiver (1ch)	System DTC Interrupt (8-pin+NMI) High/low-speed on-chip oscillators Power-on reset (POR) Voltage detection circuit (LVD) Event link controller	Safety Clock frequency accuracy measurement circuit Register write protection Oscillation stop detection CRC calculator Data operation circuit (RAM test assist) A/D self-diagnostic (Fault detection) A/D disconnection detection 14-bit independent watchdog timer Port output enable	Security ID code protection Unique ID Package LFOFP 48/64/80/100 LOFP 64 HWQFN 48

RX231/RX230

54MHz Rxv2 Core, 32-bit Microcontrollers with Enhanced Communication and Security Functions

RX231 54MHz 32-bit RXv2 core			
Memory Code Flash (512KB) SRAM (64KB) Data Flash (8KB)	Analog 12-bit A/D converter (24ch) 12-bit D/A converter (2ch) Temperature Sensor Comparator (4ch)	Timer Multi-function timer pulse unit 2 16-bit (6ch) 8-bit timer (2ch+2ch) Compare match timer 16-bit (4ch) Realtime clock Low power timer 16-bit timer pulse unit (6ch)	HMI Capacitive touch sensing unit (24ch) Serial sound I/F
Connectivity CAN (1ch) ** SCI (6ch) I2C (1ch) SPI (1ch) USB2.0 Full Speed Host/Function (1ch) ** SDHI (1ch) ** IrDA (1ch)	System DMAC (4ch) DTC Interrupt (8-pin+NMI) High/low-speed on-chip oscillators Power-on reset (POR) Voltage detection circuit (LVD) Event link controller 8/16-bit External bus	Safety Clock frequency accuracy measurement circuit Register write protection Oscillation stop detection CRC calculator Data operation circuit (RAM test assist) A/D self-diagnostic (Fault detection) A/D disconnection detection 14-bit watchdog timer 14-bit independent watchdog timer Port output enable Memory protection unit	Security AES hardware accelerator ** True random number generator *1 ID code protection Unique ID Key management ** Access management ** Package LFQFP 48/64/100 HWQFN 48/64 WFLGA 64 TFLGA 100

*1: Only RX231

RX23W

54MHz Rxv2 Core, 32-bit Microcontrollers Supporting Bluetooth® 5.0 Wireless Communication

RX23W 54MHz 32-bit RXv2 core			
Memory Code Flash (512KB) SRAM (64KB) Data Flash (8KB)	Analog 12-bit A/D converter (14ch) 12-bit D/A converter (2ch) Temperature Sensor Comparator (2ch)	Timer Multi-function timer pulse unit 2 16-bit (5ch) 8-bit timer (2ch+2ch) Compare match timer 16-bit (4ch) Realtime clock Low power timer 16-bit timer pulse unit (6ch)	HMI Capacitive touch sensing unit (12ch) Serial sound I/F
Connectivity CAN (1ch) SCI (4ch) I2C (1ch) SPI (1ch) USB2.0 Full Speed Host/Function (1ch) SDHI (1ch) IrDA (1ch) RF (BLE5.0)	System DMAC (4ch) DTC Interrupt (8-pin+NMI) High/low-speed on-chip oscillators Power-on reset (POR) Voltage detection circuit (LVD) Event link controller	Safety Clock frequency accuracy measurement circuit Register write protection Oscillation stop detection CRC calculator Data operation circuit (RAM test assist) A/D self-diagnostic (Fault detection) A/D disconnection detection 14-bit watchdog timer 14-bit independent watchdog timer Port output enable Memory protection unit	Security AES hardware accelerator True random number generator ID code protection Unique ID Key management Access management Package BGA 85 QFN 56

RX261

64MHz Rxv3 Core, 32-bit Microcontrollers with Capacitive Touch and Enhanced Security

RX261 64MHz 32-bit RXv3 core			
Memory Code Flash (512KB) SRAM (128KB) Data Flash (8KB) **	Analog 12-bit ADC x 24ch 8-bit DAC x 2ch Comparator x 2ch Temperature Sensor	Timer PWM timers - 32-bit x 2ch (GPTW) - 16-bit x 6ch (GPTW) General timers - 16-bit x 4ch (CMT) - 8-bit x 4ch (TMR) Low power timer (LPT) Real-time clock (RTC)	HMI Capacitive touch sensor x 34ch
Connectivity USB2.0 x 1ch - Full speed host/function CAN-FD x 1ch Remote control signal receiver x 1ch Serial communication - UART x 7ch (w/ Simple SPI / I2C) - SPI x 1ch - I2C x 1ch	System DMAC x 4ch, DTC High-speed on-chip oscillators Low-speed on-chip oscillators Event link controller	Safety Watchdog timer x 2ch CRC calculator PWM wave output shutdown Failure detect assist (Clock, Memory, Analog)	Security RSIP-E11A - AES/ECC/SHA engines - TRNG - Key management - Access management Memory protect Unique ID Package LFQFP 48/64/80/100 HWQFN 48

*1: Background operation

RX260

64MHz Rxv3 Core, 32-bit Microcontrollers with Enhanced Communication and Security Functions

RX260 64MHz 32-bit RXv3 core			
Memory Code Flash (512KB) SRAM (128KB) Data Flash (8KB) *1	Analog 12-bit ADC x 24ch 8-bit DAC x 2ch Comparator x 2ch Temperature Sensor	Timer PWM timers - 32-bit x 2ch (GPTW) - 16-bit x 6ch (GPTW) General timers - 16-bit x 4ch (CMT) - 8-bit x 4ch (TMR) Low power timer (LPT) Real-time clock (RTC)	HMI Capacitive touch sensor x 34ch
Connectivity Remote control signal receiver x 1ch Serial communication - UART x 7ch (w/ Simple SPI / I2C) - SPI x 1ch - I2C x 1ch	System DMAC x 4ch, DTC High-speed on-chip oscillators Low-speed on-chip oscillators Event link controller	Safety Watchdog timer x 2ch CRC calculator PWM wave output shutdown Failure detect assist (Clock, Memory, Analog)	Security Memory protect Unique ID Package LFQFP 48/64/80/100 HWQFN 48

*1: Background operation

RELATED DEVICES

RL78/G23

32MHz RL78-S3 Core, New Generation General-Purpose Microcontrollers with Further Refined Low-Power Performance and Expanded Peripheral Functions

RL78/G23
32MHz 16-bit RL78-S3 CPU core

<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> Memory</div> <ul style="list-style-type: none"> Code Flash (768KB) SRAM (48KB) Data Flash (8KB) 1.6V Flash Writing Boot Swap (16KB) Memory Mirror Function </div>	<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> Analog</div> <ul style="list-style-type: none"> 12-bit A/D Converter 26ch Internal Reference Voltage Comparator 2ch 8-bit D/A Converter 2ch Temperature Sensor </div>	<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> Timer</div> <ul style="list-style-type: none"> Timer Array Unit (16-bit, 16ch) 32-bit Interval Timer (8-bit x 4) Watchdog Timer (WDT) Realtime Clock </div>	<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> HMI</div> <ul style="list-style-type: none"> Key Interrupt Function Buzzer Output Controller Capacitive Touch Sensor 32ch Controlled Current Drive Port 8ch 40mA Output Port </div>
<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> Connectivity</div> <ul style="list-style-type: none"> FC (Multi-master/Multi-slave) x2 CSI x2 / UART / Simple FC x2 CSI x2 / UART / Simple FC x2 CSI x2 / UART / Simple FC x2 CSI x2 / UART / Simple FC x2 UART UART Remote Control Receiver </div>	<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> System</div> <ul style="list-style-type: none"> High-Speed OCO 32MHz Middle-Speed OCO 4MHz Low-Speed OCO 32kHz External Clock Controller Power-on Reset (POR) Voltage Detection Data Transfer Controller Logic & Event Link Controller Snooze mode Sequencer Interrupt Controller (4 Levels) On-chip Debug (Single-wire, Double-wire) </div>	<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> Safety</div> <ul style="list-style-type: none"> RAM Parity Error Check Invalid Memory Access Detection A/D Test Frequency Detection CRC Calculator RAM Guard SFR Guard Trap Function Output Level Detection </div>	<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> Security</div> <ul style="list-style-type: none"> Flash Writing Protection Flash Shield Window Function Unique ID Customer ID Random Number Generator </div> <div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> Package</div> <ul style="list-style-type: none"> LSSOP: 30-pin LOFP: 32, 44, 64, 80, 100-pin HWQFN: 32, 40, 48-pin WFLGA: 36, 64-pin LFQFP: 48, 64, 80, 100, 128-pin General Purpose I/O max 120 pins </div>

RL78/G16

16MHz RL78-S2 Core, Compact, Low Pin Count Microcontrollers with Capacitive Touch Sensor Unit, Ideal for Home Appliances and High-Temperature Environments

RL78/G16
32MHz 16-bit RL78-S2 CPU core

<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> Memory</div> <ul style="list-style-type: none"> Code Flash (16KB / 32KB) SRAM (Parity) (2KB) 2.4V to 5.5V Flash Writing Memory Mirror Function Data Flash (1KB) </div>	<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> Analog</div> <ul style="list-style-type: none"> 10-bit A/D Converter 11ch Internal Reference Voltage (0.815V) Temperature Sensor Comparator 2ch </div>	<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> Timer</div> <ul style="list-style-type: none"> Timer Array Unit (16-bit, 8ch) Interval Timer 12-bit, 1ch Watchdog Timer (WDT) Reset-less Realtime Clock (RTC) Calendar Function </div>	<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> HMI</div> <ul style="list-style-type: none"> Buzzer Output Controller Capacitive Touch Sensor (CTSUb) </div>
<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> Connectivity</div> <ul style="list-style-type: none"> FC (Multi-master) x1 CSI x1 / UART / Simple FC x1 CSI x1 / UART / Simple FC x1 CSI x1 / UART / Simple FC x1 </div>	<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> System</div> <ul style="list-style-type: none"> Interrupt Controller (4 Levels) High-Speed OCO 16MHz ±1%^{*1} Low-Speed OCO 15kHz External Clock Controller (12MHz/32.768kHz) Selectable Power-on Reset (SPOR) On-chip Debug (2.4V to 5.5V) (Single-wire, Double-wire) </div>	<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> Safety</div> <ul style="list-style-type: none"> A/D Test CRC Calculator RAM Parity Error Detection Frequency Detection Invalid Memory Access Detection </div>	<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> Package</div> <ul style="list-style-type: none"> LOFP: 32-pin SSOP: 10, 16, 20-pin HWQFN: 16, 24, 32-pin General Purpose I/O up to 30 I/Os </div>

*1: A-ver: ±2.0% (40 to +85°C)
 GM-ver: ±1.0% (-20 to +85°C)
 ±1.5% (-40 to -20°C)
 ±1.5% (+85 to +125°C)

RL78/G22

32MHz RL78-S3 Core, General-Purpose Microcontrollers with Excellent Low-Power Performance and Rich Capacitive Touch Channels



RL78/G22
32MHz 16-bit RL78-S3 CPU core

<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> Memory</div> <ul style="list-style-type: none"> Code Flash (64KB) SRAM (4KB) Data Flash (2KB) 1.8V Flash Writing Boot Swap (8KB) Memory Mirror Function </div>	<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> Analog</div> <ul style="list-style-type: none"> 10-bit A/D Converter 10ch Internal Reference Voltage Temperature Sensor </div>	<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> Timer</div> <ul style="list-style-type: none"> Timer Array Unit (16-bit, 8ch) 32-bit Interval Timer (8-bit x 4) Watchdog Timer (WDT) Realtime Clock </div>	<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> HMI</div> <ul style="list-style-type: none"> Key Interrupt Function Buzzer Output Controller Capacitive Sensing Unit 29ch + Multiple Electrode Connection </div>
<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> Connectivity</div> <ul style="list-style-type: none"> FC (Multi-master/Multi-slave) x1 CSI x2 / UART / Simple FC x2 CSI x2 / UART / Simple FC x2 CSI x2 / UART / Simple FC x2 UART </div>	<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> System</div> <ul style="list-style-type: none"> High-Speed OCO 32MHz 1% Middle-Speed OCO 4MHz Low-Speed OCO 32kHz External Clock Controller Power-on Reset (POR) Voltage Detection Data Transfer Controller Event Link Controller Snooze mode Sequencer Interrupt Controller (4 Levels) On-chip Debug (Single-wire, Double-wire) </div>	<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> Safety</div> <ul style="list-style-type: none"> RAM Parity Error Check Invalid Memory Access Detection A/D Test Frequency Detection CRC Calculator RAM Guard SFR Guard Trap Function Output Level Detection </div>	<div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> Security</div> <ul style="list-style-type: none"> Flash Writing Protection Flash Shield Window Function Unique ID Customer ID Random Number Generator </div> <div style="background-color: #f9f9f9; padding: 5px; border-bottom: 1px solid #ccc; margin-bottom: 5px;"> <div style="display: flex; align-items: center;"> Package</div> <ul style="list-style-type: none"> SSOP: 20, 30-pin LOFP: 32, 44-pin HWQFN: 16, 24, 32, 40, 48-pin WFLGA: 25, 36-pin LFQFP: 48-pin General Purpose I/O max 44 pins </div>






APPLICATION NOTES

Prepared basic and application notes for use when studying and designing touch.

For foundations

Title	Overview
CTSU Capacitive Touch Introduction Guide 	Introduction guide targeting customers who use capacitive touch sensors for the first time. The following are introduced: Detection principles and features of the capacitance touch, MCU lineup, hardware, software, development environment and evaluation kit (capacitance touch evaluation system).
CTSU Capacitive Touch Electrode Design Guide 	Electrode design and design examples of a microcomputer with a built-in capacitive touch detection circuit are described.

For applications

Title	Overview
Capacitive Touch Noise Immunity Guide 	This paper explains how to improve noise immunity of products using touch MCU for every immunity noise defined in the International Standard IEC61000-4.
Capacitive Touch Ripple Noise Prevention Guide 	Explains the sensing principle of capacitive touch and the effects of ripple noise on capacitive touch sensor measurement values. Describes the power supply configuration necessary to deal with ripple noise, power supply selection criteria, and power supply layout.
Capacitive Touch Software Filter Sample Program 	Describes software filters for capacitive touch systems.
QE for Capacitive Touch Advanced Mode Parameter Guide 	Describes the advanced modes (advanced settings) and adjustable CTSU parameters for QE for Capacitive Touch.
CTSU Self Test Software 	Describes the CTSU diagnosis software and provides to assist with compliance with IEC60730 class B safety standards.

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Winning Combinations

Analog + Power + Embedded Processing + Connectivity



Application	Title	ID
Appliances	Kitchen Range Hood with 2D Touch Sensor	CN158
Industrial Automation	Touchless Button	CN318
Building Automation	AC/DC Non-Isolated Capacitive Touch Wall Switch	AS107
Medical & Healthcare	Infusion Level Monitor Using Capacitive Touch Sensing	JP208
Infotainment Systems	Haptic Touch Key Module for Automotive Switches	AS253

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