RENESAS

RENESAS CAPACITIVE TOUCH SOLUTION

Brochure

2025.12

CONTENTS

The capacitive touch solutions for the advanced capacitive touch HMIs 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
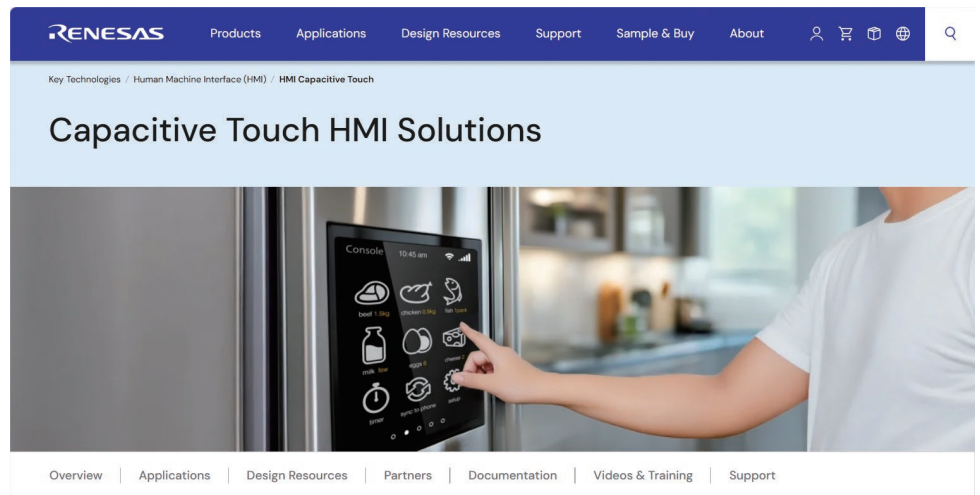
About Capacitive Touch Interfaces

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
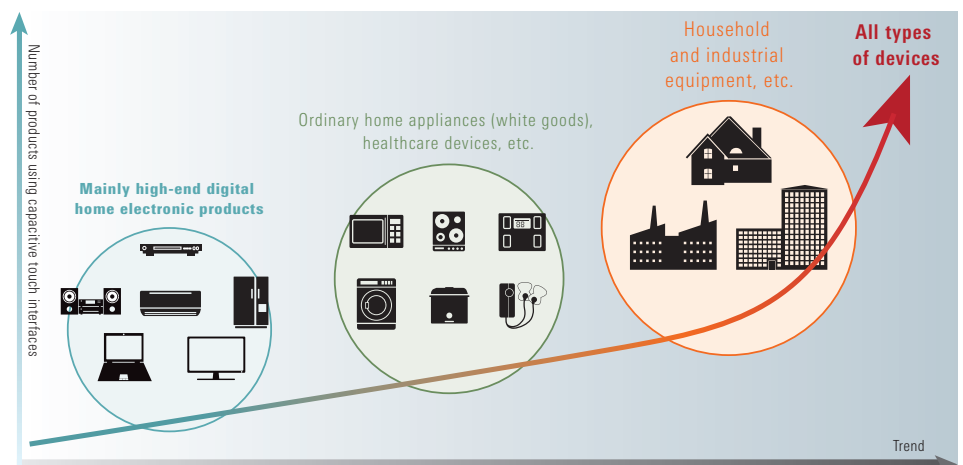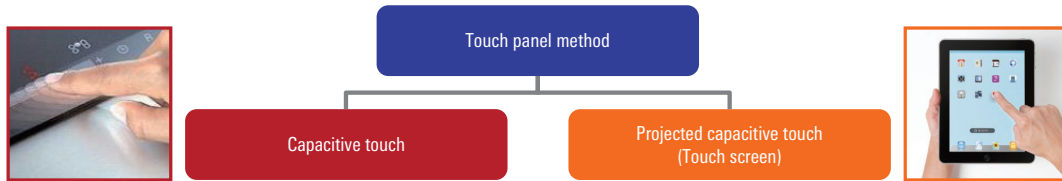

As replacements for mechanical keys, touch keypads enable a variety of interface types
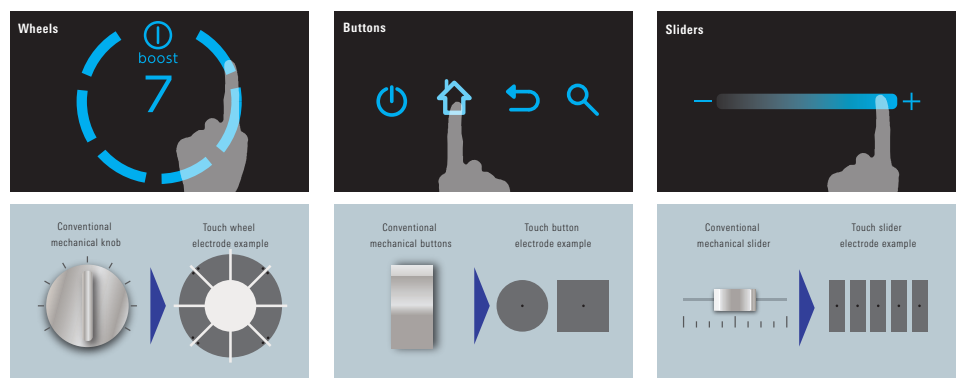
Renesas' Basic Capacitive Touch Technology

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	• Low degree of freedom in operation (one-dimensional) • Fewer parts	• 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	• White goods (refrigerators, microwaves, rice cookers) • Healthcare equipment (blood pressure monitors, body composition monitors) etc.	• 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.
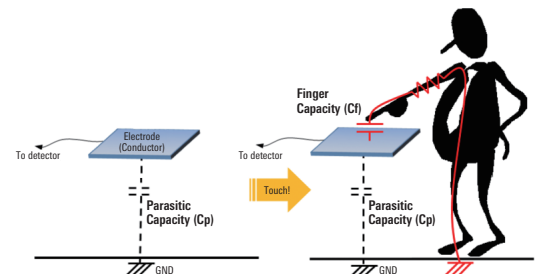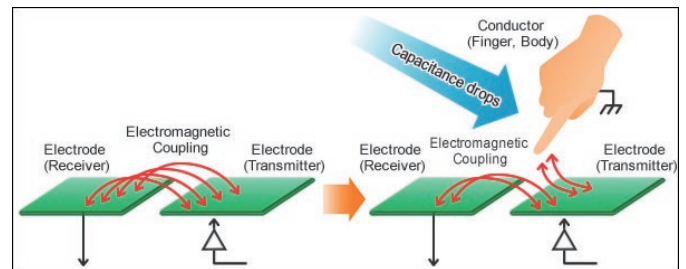

"Self Capacitance" and "Mutual Capacitance" Detection Methods

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
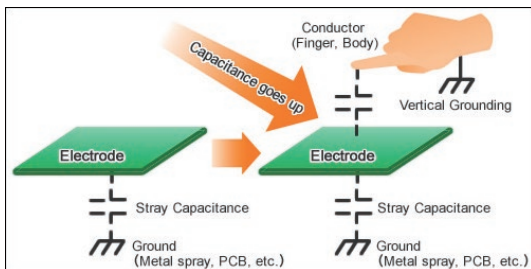
Mutual-capacitance methods

Comparison of self-capacitance and mutual-capacitance methods

Items	Self-capacitance method	Mutual-capacitance method
Ease of electrode design	Simple	Complex
Board cost	Low	High
Water resistance	Weak	Robust
Key Matrix	Single touch	Multi touch

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

Plastic	Cloth	Ceramics	Stone

| Mirror	Tile	Japanese paper	Cloth	Wood	Metal
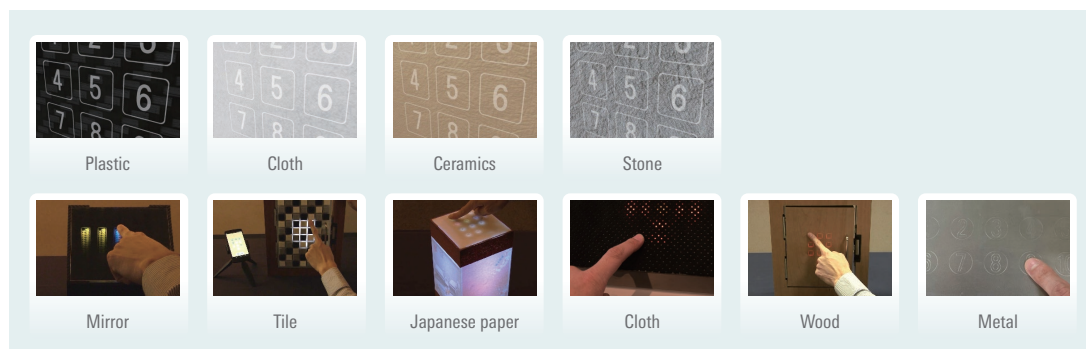
Advantages of Capacitive Touch Technology: Freedom to Use a Variety of Interfaces

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.

Only minimal display
Does not impair the design
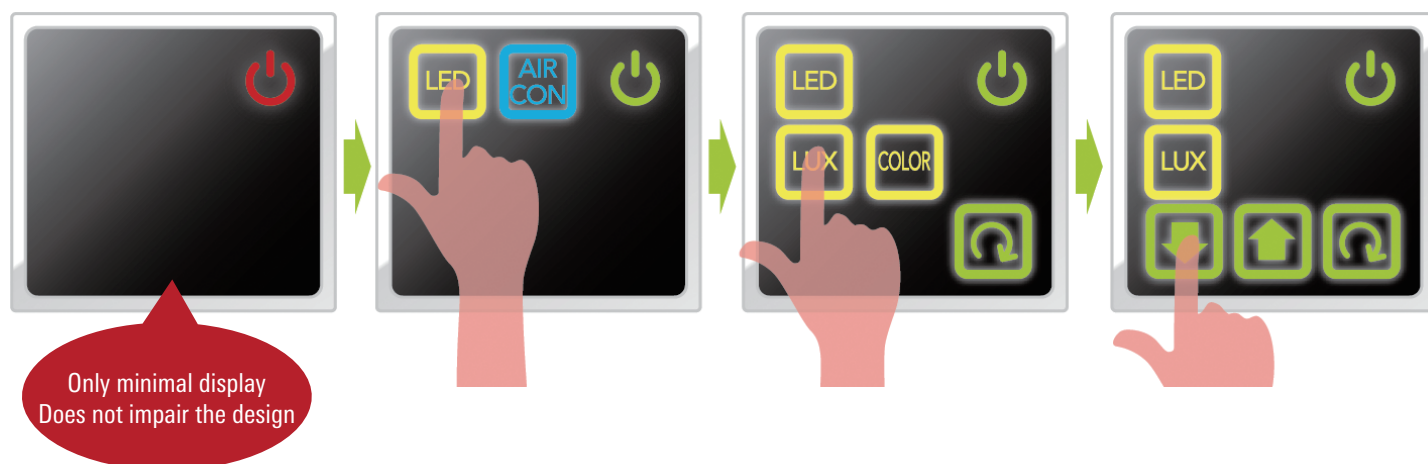
Application examples of film electrodes
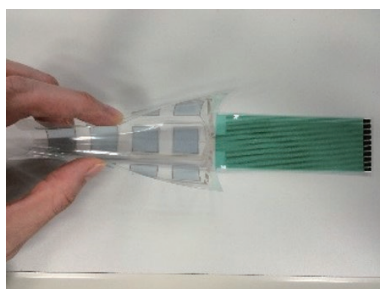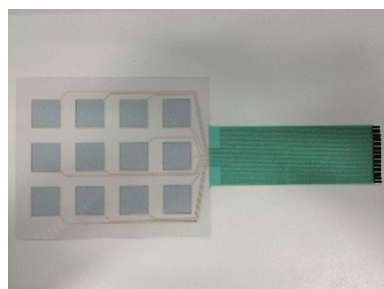
Features

(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

The metal overlay panel, which detects pressing force by measuring deflection, is also immune to false activation caused by water droplets.

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.
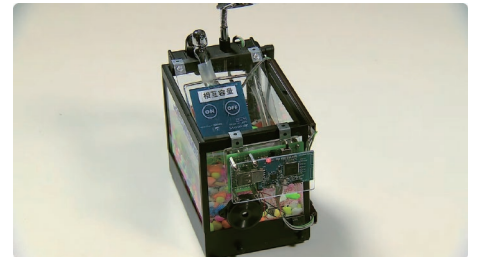

Renesas capacitive touch waterproof demonstration
https://www.youtube.com/watch?v=gwJ-RFjMM2w

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
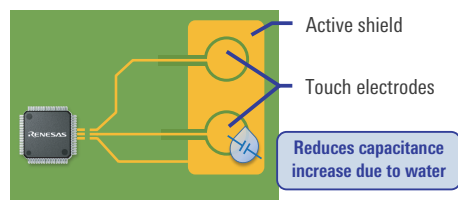
Active Shielding

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.
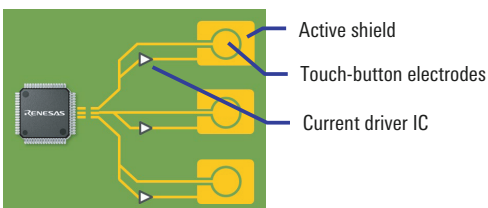
■ Waterproof

GND shielded: Mis-reacting with water

- GND shield
- Touch electrodes
- Water increases capacitance
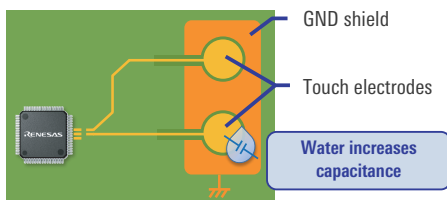
Active shield: no false response in water

- Active shield
- Touch electrodes
- Reduces capacitance increase due to water

■ Implementation method

CTSU1: Current-driver IC required for each electrode

- Active shield
- Touch-button electrodes
- Current driver IC

CTSU2: Direct drive via MCU touch pins

- Active shield
- Touch-button electrodes

Multiple electrodes can be guarded with one active shield (output can be switched in synchronization with the measurement ch)
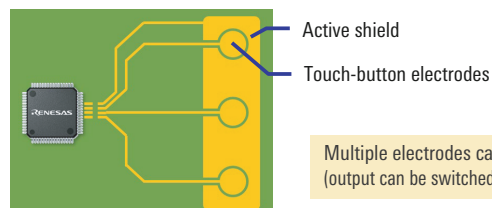
Note: For the differences in functions between CTSU1 and CTST2, please refer to the Functions of Each MCU table on page 10 and after.

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.
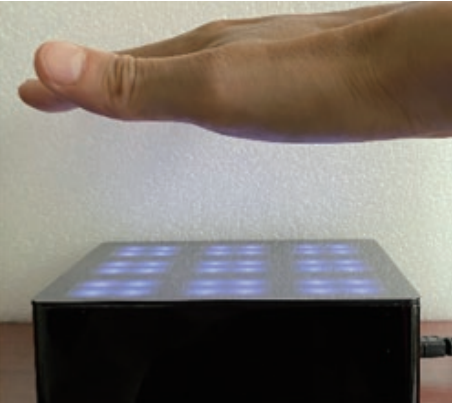
Renesas capacitive touch high sensitivity demonstration
https://www.youtube.com/watch?v=NaeUKn3vufw

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
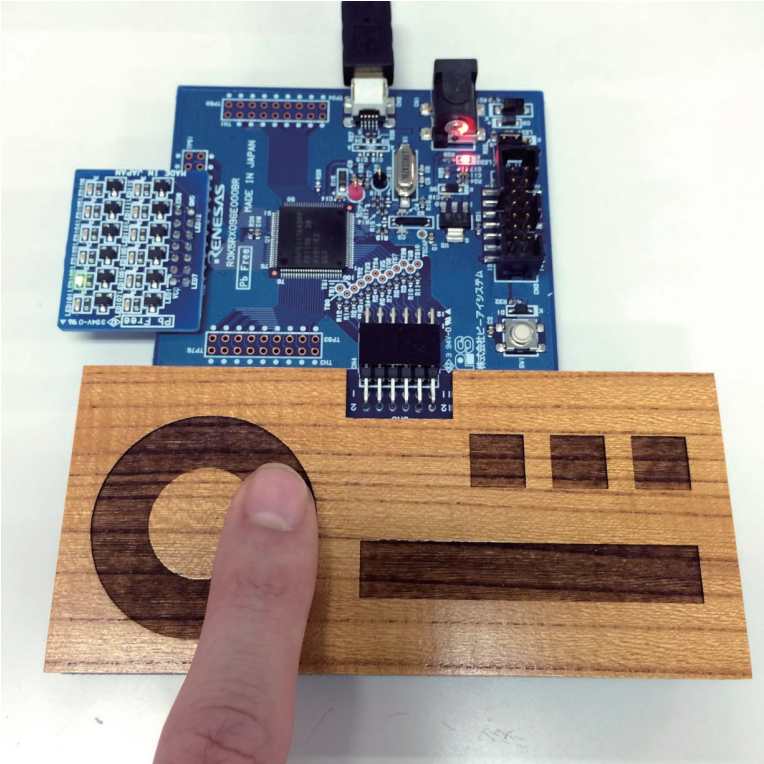
High Noise Tolerance

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

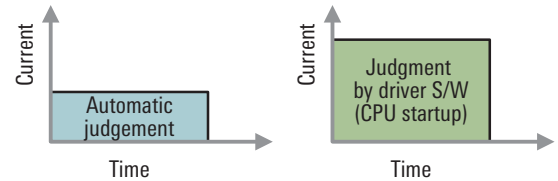**Enables touch ON/OFF detection without CPU activation, reducing power consumption.**
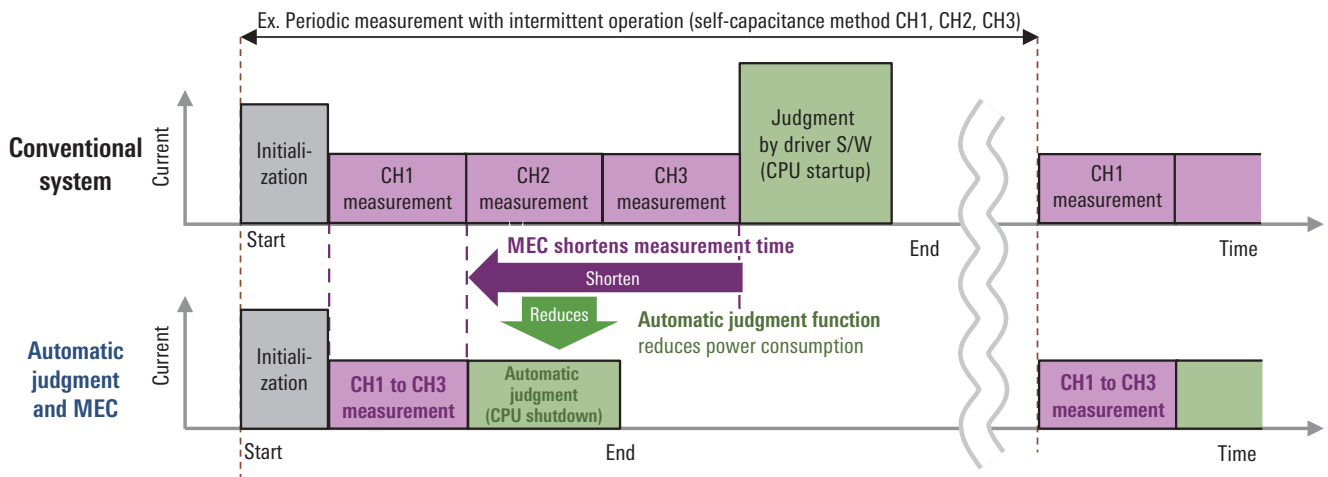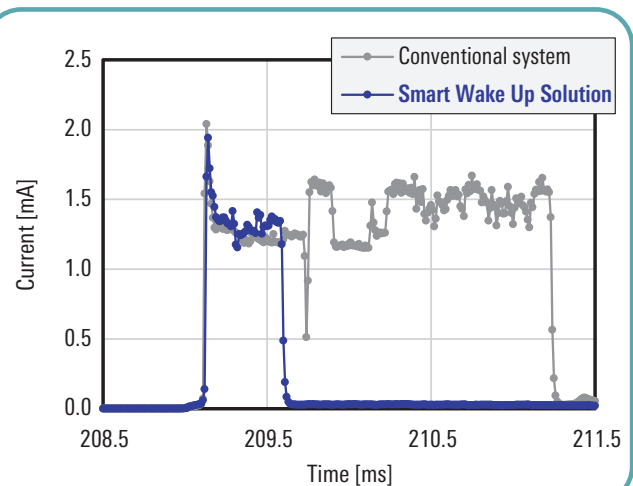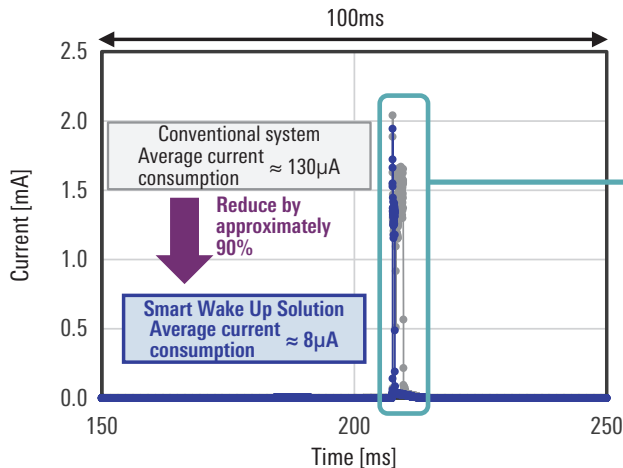
Image of Current Reduction Effect by Automatic Judgment and MEC Use

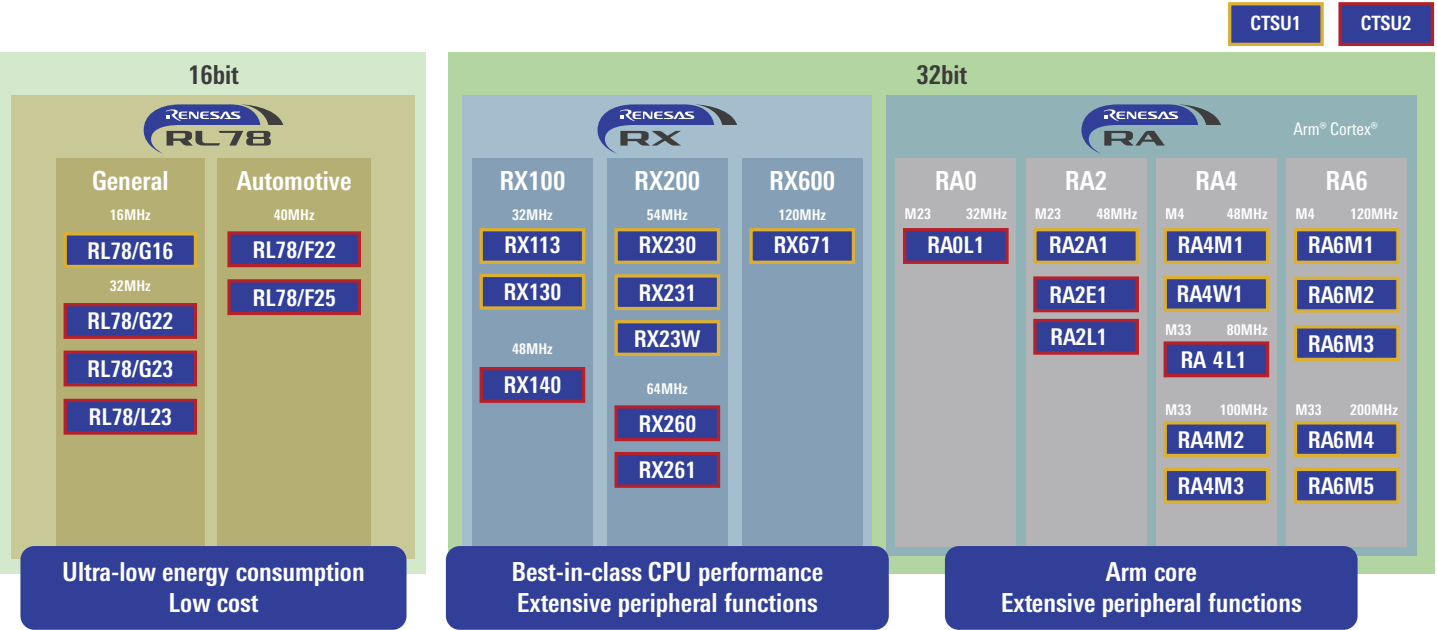Ex. Periodic measurement with intermittent operation (self-capacitance method CH1, CH2, CH3)

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

Conventional system Average current consumption ≈ 130µA

Reduce by approximately 90%

Smart Wake Up Solution Average current consumption ≈ 8µA

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.

Legend: CTSU1 | CTSU2

16bit

RL78

General	Automotive
16MHz	40MHz
RL78/G16	RL78/F22
32MHz	RL78/F25
RL78/G22	
RL78/G23	
RL78/L23	

Ultra-low energy consumption / Low cost

32bit

RX

RX100 32MHz	RX200 54MHz	RX600 120MHz
RX113	RX230	RX671
RX130	RX231	
48MHz RX140	RX23W	
	64MHz RX260	
	RX261	

Best-in-class CPU performance / Extensive peripheral functions

RA — Arm® Cortex®

RA0 M23 32MHz	RA2 M23 48MHz	RA4 M4 48MHz	RA6 M4 120MHz
RA0L1	RA2A1	RA4M1	RA6M1
	RA2E1	RA4W1	RA6M2
	RA2L1	M33 80MHz RA 4L1	RA6M3
		M33 100MHz RA4M2	M33 200MHz RA6M4
		RA4M3	RA6M5

Arm core / Extensive peripheral functions

MCU Family with Capacitive Touch Functions

MCUs with CTSU2 (CTSU2/CTSU2L/CTSU2La/CTSU2SL/CTSU2SLa) (All Family)

Product Group Name	RA0L1	RA2E1	RA2L1	RA4L1	RX140	RX260	RX261	RL78/G22	RL78/G23	RL78/F22	RL78/F25	RL78/L23
CPU core	Cortex®-M23	Cortex®-M23	Cortex®-M23	Cortex®-M33	RXv2	RXv3	RXv3	RL78-S3	RL78-S3	RL78-S3	RL78-S3	RL78-S3
Max. operating frequency (MHz)	32	48	48	80	48	64	64	32	32	40	40	32
Operating voltage (V) *1	1.6 - 5.5	1.6 - 5.5	1.6 - 5.5	1.6 - 3.6	1.8 - 5.5	1.6 - 5.5	1.6 - 5.5	1.6 - 5.5	1.6 - 5.5	1.8 - 5.5	2.7 - 5.5	1.6 - 5.5
Program Memory (KB)	32, 64	32, 64, 128	128, 256	256, 512	64	128, 256	256, 384, 512	32, 64	96, 128, 192, 256, 384, 512, 768	128	512	64, 128, 256, 512
Data Flash (KB)	1	4	8	8	4	8	8	2	8	8	16	8
RAM (KB)	16	16	32	64	16	32, 64	128	4	16, 12, 48, 32, 24, 20	12	40	16, 32
Capacitive sensor type	CTSU2SLa	CTSU2	CTSU2	CTSU2SLa	CTSU2L	CTSU2SL	CTSU2SLa	CTSU2La	CTSU2L	CTSU2SLa	CTSU2SLa	CTSU2SLa
Number of Touch pins	24	30	32	12	12	36	36	29	32	12	31	36
Self-capacitance method	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mutual-capacitance method	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Multi-clock measurement	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Active shield	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Automatic judgment	✓		✓			✓	✓	✓ *2	✓ *2	✓	✓	✓ *2
Automatic correction	✓		✓			✓	✓	✓ *2	✓ *2	✓	✓	✓ *2
Multi-clock automatic correction	✓		✓			✓	✓			✓	✓	
Multiple electrode connection: MEC	✓			✓		✓	✓	✓		✓		✓
Mutual capacitance parallel measurement		✓	✓									
Measurement voltage setting	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓

*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.
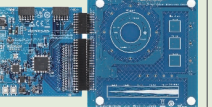
RX Family with CTSU1 (CTSU/CTSUa/CTSUb)

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)

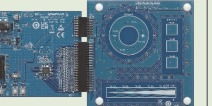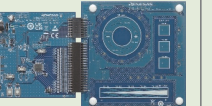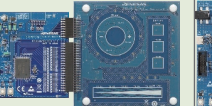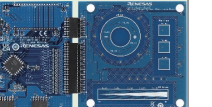| Product Group Name		RL78/G16
CPU core		RL78-S2
Max. operating frequency (MHz)		16
Operating voltage (V) [1]		2.4 - 5.5
Program Memory (KB)		16, 32
Data Flash (KB)		1
RAM (KB)		2
Capacitive sensor type		CTSUb
	Number of Touch pins	15
	Self-capacitance method	✓
	Mutual-capacitance method	✓
	Random pulse 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.
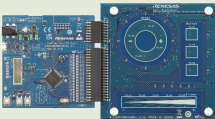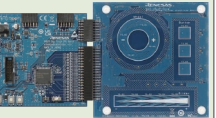
Capacitive Touch Evaluation Systems

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

MCU	RA0L1	RA2L1	RA4L1	RA6M2
Product ID	RSSK-RA0L1	RSSK-RA2L1	RSSK-RA4L1	RSSK-RA6M2
Kit Name	Capacitive Touch Evaluation System for RA0L1	Capacitive Touch Evaluation System for RA2L1	Capacitive Touch Evaluation System for RA4L1	Capacitive Touch Evaluation System for RA6M2
Part No.	RTK0EG0065S01001BJ	RTK0EG0022S01001BJ	RTK0EG0057S01001BJ	RTK0EG0021S01001BJ
Board Image				
MCU P/N	R7FA0L1074CFL	R7FA2L1AB2DFP	R7FA4L1BD4CFP	R7FA6M2AF3CFB
Package	48-pin LQFP	100-pin LQFP	100-pin LQFP	144-pin LQFP
ROM/RAM	64KB/16KB	256KB/32KB	512KB/64KB	1MB/384KB
Number of Touch pins	24	32	12	18
Bundled items	• Evaluation board – RA0L1 Cap Touch CPU board – Self-capacitance electrode board (buttons, sliders, wheels) • First Step Guide	• Evaluation board – RA2L1 Cap Touch CPU board – Self-capacitance electrode board (buttons, sliders, wheels) • First Step Guide	• Evaluation board – RA4L1 Cap Touch CPU board – Self-capacitance electrode board (buttons, sliders, wheels) • First Step Guide	• Evaluation board – RA6M2 Cap Touch CPU board – Self-capacitance electrode board (buttons, sliders, wheels) • First Step Guide

MCU	RL78/F22	RL78/F25	RL78/G16	RL78/G22	RL78/G23	RL78/L23
Product ID	RSSK-RL78F22	RSSK-RL78F25	RSSK-RL78G16	RSSK-RL78G22	RSSK-RL78G23	RSSK-RL78L23
Kit Name	Capacitive Touch Evaluation System for RL78/F22	Capacitive Touch Evaluation System for RL78/F25	Capacitive Touch Evaluation System for RL78/G16	Capacitive Touch Evaluation System for RL78/G22	Capacitive Touch Evaluation System for RL78/G23	Capacitive Touch Evaluation System for RL78/L23
Part No.	RTK7F122FGST0000BJ	RTK7F125FPST0000BJ	RTK0EG0047S01001BJ	RTK0EG0042S01001BJ	RTK0EG0030S01001BJ	RTK0EG0063S01001BJ
Board Image						
MCU P/N	R7F122FGG3AFB	R7F125FPL3AFB-C	R5F121BCAFP	R7F102GGE2DFB	R7F100GSN2DFB	R7F100LPL3CFB
Package	48-pin LFQFP	100-pin LFQFP	32-pin LQFP	48-pin LFQFP	128-pin LFQFP	100-pin LFQFP
ROM/RAM	128KB/12KB	512KB/40KB	32KB/2KBFP	64KB/4KB	768KB/48KB	512KB/32KB
Number of Touch pins	12	31	15	29	32	36
Bundled items	• Evaluation board – RL78/F22 CPU board – Self-capacitance electrode board (buttons, sliders) • First Step Guide	• Evaluation board – RL78/F25 CPU board – Self-capacitance electrode board (buttons, sliders, wheels) • First Step Guide	• Evaluation board – RL78/G16 CPU board – Self-capacitance electrode board (buttons, sliders, wheels) • First Step Guide	• Evaluation board – RL78/G22 CPU board – Self-capacitance electrode board (buttons, sliders, wheels) • First Step Guide	• Evaluation board – RL78/G23 CPU board – Self-capacitance electrode board (buttons, sliders, wheels) • First Step Guide	• Evaluation board – RL78/L23 CPU board – Self-capacitance electrode board (buttons, sliders, wheels) • First Step Guide

MCU	RX130	RX140	RX261	RX671
Product ID	RSSK-RX130	RSSK-RX140	RSSK-RX261	RSSK-RX671
Kit Name	Capacitive Touch Evaluation System for RX130	Capacitive Touch Evaluation System for RX140	Capacitive Touch Evaluation System for RX261	Capacitive Touch Evaluation System for RX671
Part No.	RTK0EG0003S02001BJ	RTK0EG0039S01001BJ	RTK0EG0055S01001BJ	RTK0EG0044S01001BJ
Board Image				
Package	80-pin LFQFP	80-pin LFQFP	100-pin LFQFP	100-pin LFQFP
ROM/RAM	128KB/16KB	256KB/64KB	512KB/128KB	2MB/384KB
Capacitive sensor type	CTSUa	CTSU2SL	CTSU2SLa	CTSUa
Number of Touch pins	36	36	34	17
Bundled items	• Evaluation board – RX130 CPU board – Self-capacitance electrode board (buttons, sliders, wheels) – Mutual-capacitance electrode board (buttons, proximity sensors) • USB cable • First Step Guide	• Evaluation board – RX140 CPU board – Self-capacitance electrode board (buttons, sliders, wheels) • First Step Guide	• Evaluation board – RX261 CPU board – Self-capacitance electrode board (buttons, sliders, wheels) • First Step Guide	• Evaluation board – RX671 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 touchless 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

Renesas' High-sensitivity and noise-tolerant capacitive touch solution
- Recognition of hand position up to a height of 200mm above the sensor
- Maximum accuracy: 1mm

High tolerance for noise and obstructions
- Sensing through non-conductive barriers (such as wall materials, wood, resin, glass, fabric, paper, etc.)
- Comply with 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/en/design-resources/reference-designs/3d-gesture-ct-ref
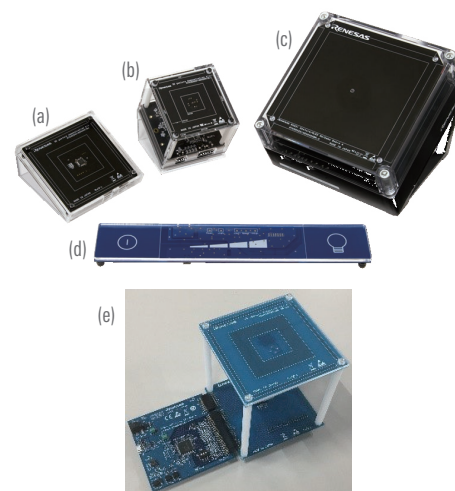
(a) 3D Gesture Slim Version (100*100mm) RX130
(b) 3D Gesture Small Version (80*80mm) RX130
(c) 3D Standard Version (160*160mm) RX231
(d) 2D Gesture (300*50mm) RX130
(e) 3D Gesture Electrode Board

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.

Demo Title	3D Gesture Slim Version (100*100mm) RX130
MCU	RX130 (RTK0EG0016D00001BJ)
Software	–
Document	3D Gesture Demo Set Slim version (Hardware) Application note, Design file (Gerber, Layout, BOM, Schematic)
Development Tool	–

Demo Title	3D Standard Version (160*160mm) RX231
MCU	RX231 (RTK5RX2310D00000BR)
Software	–
Document	3D Gesture Demo Set (Standard Version) Hardware Guide Application note, Design file (Gerber, Layout, BOM, Schematic)
Development Tool	–

Demo Title	3D Gesture Small Version (80*80mm) RX130
MCU	RX130 (RTK0EG0014D00001BJ)
Software	–
Document	3D Gesture Demo Set (Small Version) Hardware Guide Application note, Design file (Gerber, Layout, BOM, Schematic)
Development Tool	–

Demo Title	3D Gesture Electrode Board
MCU	RA2L1 Cap Touch CPU board
Software	RA2L1 Group 3D Gesture Electrode Board Sample Software CTSU 3D Gesture Demo Set Evaluation Tool 3D Monitor v.100
Document	Application note, Design file (Gerber, Layout, BOM, Schematic)
Development Tool	QE for Capacitive Touch 3D Monitor Tool

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.

Demo Title	2D Gesture (300*50mm) RX130
MCU	RX130
Software	–
Document	Application note, Design file (Gerber, Layout, BOM, Schematic)
Development Tool	–

Self-Capacitance Waterproof Button Solution

Capacitive Touch Waterproof Button with Self-Capacitance Reference Design 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/design-resources/reference-designs/waterproof-self-ct-ref

Demo Title	Capacitive Touch Waterproof Button with Self-Capacitance Reference Design
MCU	RA2L1 RX140 RL78/G23
Software	RA2L1 Group Self-capacitance Waterproof Touch Button Demo Sample Software RX140 Self-capacitance Waterproof Touch Button Demo Software Rev.1.00 RL78/G23 Self-capacitance Waterproof Touch Button Demo Sample Software Rev.1.00
Document	Self-Capacitance Waterproof Demo Hardware Manual Application note, Design file (Gerber, Layout, BOM, Schematic)
Development Tool	QE for Capacitive Touch
Video	Self-capacitance Waterproof Touch Button Solution

Metal Overlay Reference Design

Renesas' Metal Touch Overlay reference design applies capacitive touch technology using a Capacitive Touch Sensor Unit (CTSU) and a corresponding metal material overlay panel.

It is possible to assign multiple functions to a single button by determining the pressure applied from the amount of panel deflection as an added value.

For more information, visit https://www.renesas.com/design-resources/reference-designs/metal-touch-ct-ref
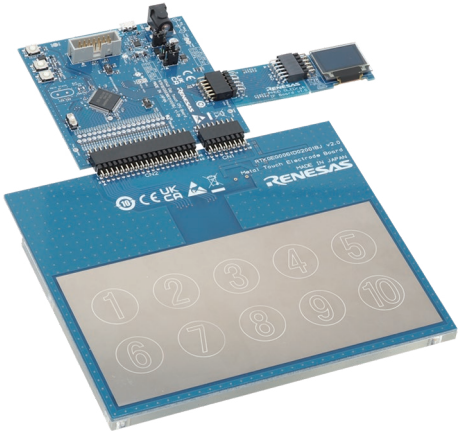
| Demo Title	METAL-TOUCH-CT-REF
MCU	RX140
Software	RX140 Group Metal Touch Solution Sample Software
Document	Application note, Design file (Gerber, Layout, BOM, Schematic)
Development Tool	QE for Capacitive Touch
Video	Metal Touch Solution Introduction

Proximity Touch 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/design-resources/reference-designs/proximity-touch-ct-ref

Demo Title	Touchless Button Demo
MCU	RA2L1 RA6M2 RX140 RL78/G23
Software	RA2L1 Group Touchless Button Demo Solution Sample Software RX140 Group Touchless Button Demo Solution Sample Software RA6M2 Group Touchless Button Demo Solution Sample Software RL78/G23 Group Touchless Button Demo Solution Sample Software
Document	RA2L1 Group Touchless Button Demo Solution (Hardware) Application note, Design Files
Development Tool	QE for Capacitive Touch
Video	Touchless Button Demo

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 video, visit https://www.renesas.com/video/touchless-button-electrode-board
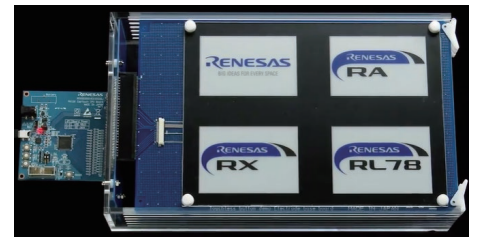
Demo Title	Touchless Button Electrode Board
MCU	RA2L1 RA6M2 RX130 RL78/G23
Software	RA2L1 Group Touchless Button Electrode Board Sample Software RA6M2 Group Touchless Button Electrode Board Sample Software RX130 Group Touchless Button Electrode Board Sample Software RL78/G23 Group Touchless Button Electrode Board Sample Software
Document	Capacitive Sensor Microcontrollers Touchless Button Electrode Board Application note, Design file (Gerber, Layout, BOM, Schematic)
Development Tool	QE for Capacitive Touch
Video	Touchless Button Electrode Board

Low Power Consumption 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/design-resources/reference-designs/smart-wakeup-ct-ref

Demo Title	Capacitive Touch Smart Wake Up Reference Design
MCU	RA4L1 RX140 RX261 RL78/G22 RL78/L23 RL78/F25
Software	RA4L1 Group Smart Wakeup Solution RX140 Group Smart Wakeup Solution RX261 Group Smart Wakeup Solution RL78/G22 Capacitive Touch Low Power Guide (SMS / MEC function) RL78/L23 Low power consumption Smart Wakeup Solution RL78/F25 Group Low power consumption Smart Wakeup Solution
Document	RX140 Group Capacitive Touch Evaluation System User's Manual Application note, Design file (Gerber, Layout, BOM, Schematic)
Development Tool	QE for Capacitive Touch
Video	RX140 Smart Wake Up Solution

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/design-resources/reference-designs/liquid-level-ct-ref
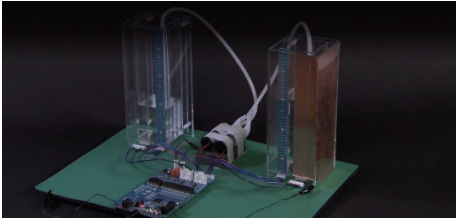
Demo Title	Capacitive Touch Liquid Level Indicator Reference Design
MCU	RX130, RX113, RX230, RX231, RX23W
Software	RX Family Capacitive Water Level Measurement Demo Level Monitor RX Family Capacitive Liquid Level Indicator Demo System Sample Software
Document	Application note, Design file (Gerber, Layout, BOM, Schematic)
Development Tool	QE for Capacitive Touch
Video	Water level measur4ement demo

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.
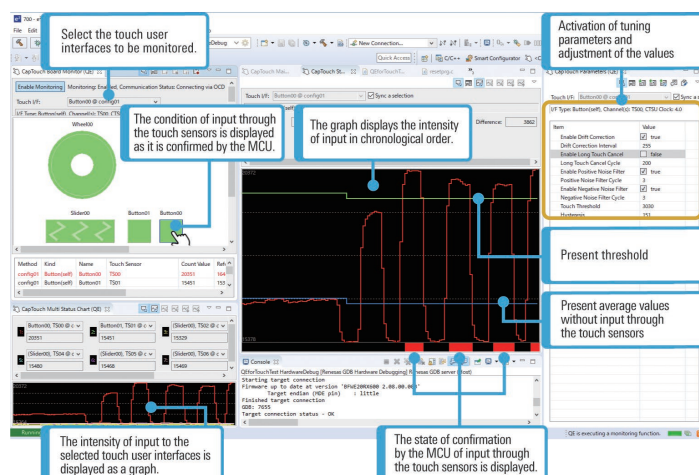
Tuning Functions

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
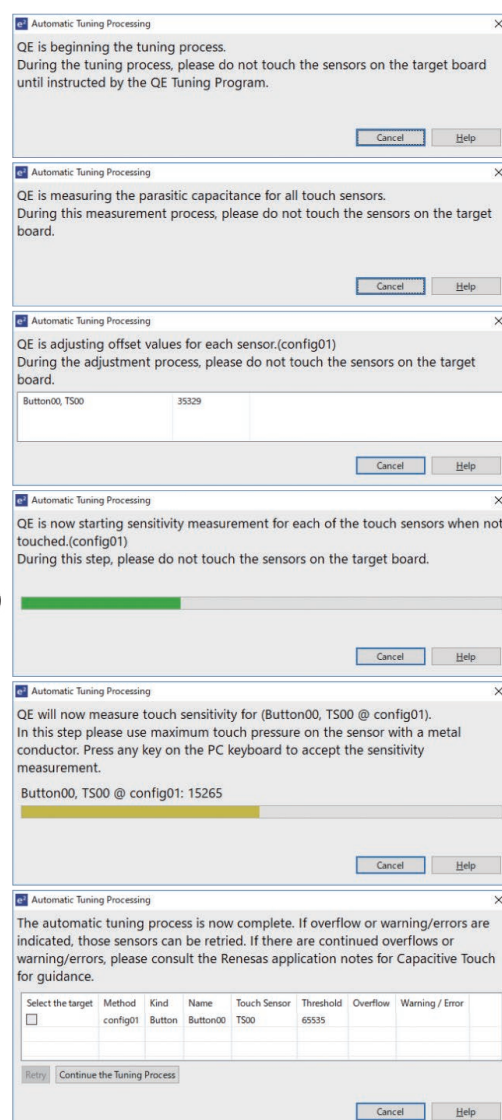
Tutorial videos for each supported microcontroller

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.
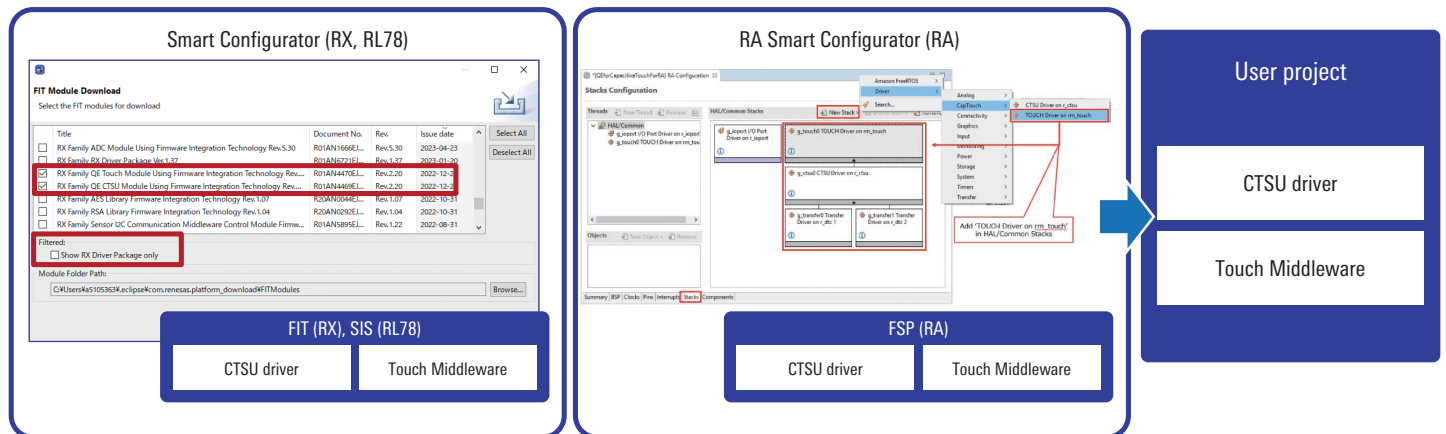
Related Devices

RA0L1

32MHz Arm® Cortex®-M23 Entry Line General Purpose Microcontroller

RA0L1 — 32MHz 32-bit Arm® Cortex®-M23

NVIC | SWD | MTB

Memory
- Code Flash 64KB
- SRAM 16KB Parity
- Data Flash 1KB (256B x 4)
- Startup Program Protection 8KB

Analog
- 12-bit A/D (13ch, 2µs)
- Temperature Sensor
- Internal Reference Voltage

Timers
- Timer Array Unit (16-bit x 8ch)
- 32-bit Interval Timer (8-bit x 4ch)
- RTC

HMI
- IRQ (8ch)
- Capacitive Touch (24ch)
- Controlled Current Drive Port (8pin)

Communication
- Simple SPI x2 / UART x1 / Simple I²C x2
- Simple SPI x2 / UART x1 / Simple I²C x2
- Simple SPI x1 / UART x1 / Simple I²C x2
- UARTA x 2
- I²C x 2

System
- High-speed OCO 32MHz
- Middle-speed OCO 4MHz
- Low-speed OCO 32kHz
- External clock controller
- Clock output
- Power on reset
- Voltage detection
- Data Transfer controller
- Event link controller
- Interrupt controller

Safety
- SRAM Parity Check
- Invalid Memory Access Detection
- A/D test
- Frequency detection
- CRC Calculator
- Register write protection
- Output level detection
- UART loop back
- IWDT

Security
- Unique ID
- TRNG
- Flash read protection
- Flash access window

Package
- QFN 24, 32, 48
- LSSOP 20
- LQFP 32, 48

RA2E1

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

RA2E1 — 48MHz 32-bit Arm® Cortex®-M23 Core

NVIC | SWD | MTB

Memory
- Code Flash (128kB, 64kB, 32kB)
- SRAM (16kB) Parity
- Data Flash (4kB)

Analog
- 12-bit ADC (13ch)
- Low Power Analog Comparator (2ch)
- Temperature Sensor

Timer
- GPT 32-bit (1ch)
- GPT 16-bit (6ch)
- AGT 16-bit (2ch)
- WDT

HMI
- Capacitive Touch Sensing Unit (30ch)

Communication
- I2C x1
- SCI x4
- SPI x1

System
- Sys Tick
- DTC
- Multiple Clocks
- On-Chip Oscillator HOCO (24,32,48,64MHz), LOCO (32kHz), ILOCO (15kHz)
- Low Power Modes
- ELC
- Port Function Select
- RTC

Safety
- Memory Protection Unit
- SRAM Parity Check
- POE
- Clock Frequency Accuracy Measurement
- CRC Calculator
- IWDT
- Data Operation Circuit
- Flash Area Protection
- ADC Self Test

Security
- 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
- Code Flash (256kB, 128kB)
- SRAM (16kB) Parity
- SRAM (16kB) ECC
- Data Flash (8kB)

Analog
- 12-bit ADC (19ch)
- 12-bit DAC (1ch)
- Low Power Analog Comparator (2ch)
- Temperature Sensor

Timer
- GPT 32-bit (4ch)
- GPT 16-bit (6ch)
- AGT 16-bit (2ch)
- WDT

HMI
- Capacitive Touch Sensing Unit (32ch)
- High Current IO (-20mA)

Communication
- CAN x1
- I2C x2
- SCI x5
- SPI x2

System
- Sys Tick
- DTC
- Multiple Clocks
- On-Chip Oscillator HOCO (24,32,48,64MHz), LOCO (32kHz), ILOCO (15kHz)
- Low Power Modes
- ELC
- Port Function Select
- RTC

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 (128/256)
- TRNG
- 128 bit Unique ID

Package
- LQFP 48, 64, 80, 100
- QFN 48

RA4L1

80MHz Arm® Cortex®-M33 Based Low Power MCU with TrustZone, Segment LCD Controller and Advanced Security

RA4L1 — 80MHz 32-bit Arm® Cortex®-M33

NVIC | SWD | ETB

Memory
- Code Flash (256KB x 2 Banks)
- SRAM 32KB Parity
- SRAM 32KB ECC
- DataFlash 8KB

Analog
- 12-bit A/D
- 12-bit D/A
- Temperature Sensor
- Comparator x 2

Timer
- GPT 32-bit (2ch)
- GPT 16-bit (4ch)
- Low-power AGT 32-bit (2ch)
- WDT
- RTC, Calendar

HMI
- Segment LCD Controller
- 8 com x 48 seg with Charge Pump
- Cap Touch (12 ch)

Communication
- I3C x 1
- I2C x 1
- SCI x 6
- LPUART x 2
- SPI x 1
- QSPI x 1
- CANFD x 1
- USBFS w/o crystal
- SSI x 1

System
- TrustZone
- DMA (8ch), DTC, ELC
- Interrupt Controller
- Clock Generation
- On-Chip Oscillator
- HOCO (24/32/40/48/64/80MHz)
- LOCO (32KHz)
- ILOCO (15KHz)
- Low-power Modes

Safety
- Memory Protection Unit
- SRAM Parity Check
- ECC SRAM
- Clock Frequency Accuracy Measurement
- CRC Calculation
- IWDT
- Data Operation Circuit
- Flash Area Protection
- ADC Self Test
- LVDs for 3V to 1.6V

Security
- Unique ID
- TRNG
- AES 128//256
- Key Management
- ECC (256)
- SHA-2 (256)
- Tamper Detection
- SPA/DPA Resistance

Package
- LQFP 48, 64, 100
- BGA 64, 100
- QFN 48, CSP72

Related Devices

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
- Code Flash (256kB)
- SRAM (16kB) Parity
- SRAM (16kB) ECC
- Data Flash (8kB)

Analog
- 14-bit A/D (25ch) 1S/H
- 12-bit DAC (1ch)
- OPAMP (4ch)
- Low Power Comparator (2ch)
- Temperature Sensor

Timer
- GPT 32-bit (2ch)
- GPT 16-bit (6ch)
- Low Power GPT (2ch)
- WDT
- RTC, Calendar, Vbat

HMI
- Capacitive Touch Sensing Unit (27ch)
- Segment LCD Controller 38 Seg/8 Com

Communication
- USB2.0 FS x1
- CAN x1
- I2C x2
- SCI x4
- SPI x2
- SSI x1

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
- 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
- Code Flash (256kB, 384kB, 512kB)
- SRAM (64kB) Parity
- SRAM (64kB) ECC
- Data Flash (8kB)
- Standby SRAM (1kB)

Analog
- 12-bit A/D (13ch) 1S/H
- 12-bit DAC (2ch)
- Temperature Sensor

Timer
- GPT 32-bit (4ch)
- GPT 16-bit (4ch)
- Low Power GPT (6ch)
- WDT
- RTC, Calendar, Vbat, 128Byte SRAM

HMI
- Capacitive Touch Sensing Unit (12ch)

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 48, 64, 100
- QFN 48

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 4com x 9seg

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

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

Security
- Unique ID
- TRNG

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 | ETM |

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

Related Devices

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

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

RX113

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

RX113	32MHz 32-bit RXv1 core		

▦ **Memory**	⩘ **Analog**	⏱ **Timer**	☝ **HMI**
Code Flash (512KB)	12-bit A/D converter (17ch)	Multi-function timer pulse unit 2 16-bit (6ch)	Capacitive touch sensing unit (36ch)
SRAM (64KB)	8-bit D/A converter (2ch)	8-bit timer (2ch+2ch)	Serial sound I/F
Data Flash (8KB)	Temperature Sensor	Compare match timer 16-bit (4ch)	LCDC
	Comparator (2ch)	Realtime clock	
		Low power timer	

⇄ **Connectivity**	⚙ **System**	✓ **Safety**	🔒 **Security**
SCI (8ch)	DTC	Clock frequency accuracy measurement circuit	ID code protection
I2C (1ch)	Interrupt (8-pin+NMI)	Register write protection	Unique ID
SPI (1ch)	High/low-speed on-chip oscillators	Oscillation stop detection	
USB2.0 Full Speed Host/Function (1ch)	Power-on reset (POR)	CRC calculator	🖿 **Package**
IrDA (1ch)	Voltage detection circuit (LVD)	Data operation circuit (RAM test assist)	LFQFP 64/100
	Event link controller	14-bit independent watchdog timer	TFLGA 100
		Port output enable	

RX130

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

RX130	32MHz 32-bit RXv1 core		

▦ **Memory**	⩘ **Analog**	⏱ **Timer**	☝ **HMI**
Code Flash (512KB)	12-bit A/D converter (24ch)	Multi-function timer pulse unit 2 16-bit (6ch)	Capacitive touch sensing unit (36ch)
SRAM (48KB)	8-bit D/A converter (2ch)	8-bit timer (2ch+2ch)	
Data Flash (8KB)	Temperature Sensor	Compare match timer 16-bit (2ch)	
	Comparator (2ch)	Realtime clock	
		Low power timer	

⇄ **Connectivity**	⚙ **System**	✓ **Safety**	🔒 **Security**
SCI (7ch)	DTC	Clock frequency accuracy measurement circuit	ID code protection
I2C (1ch)	Interrupt (8-pin+NMI)	Register write protection	Unique ID
SPI (1ch)	High/low-speed on-chip oscillators	Oscillation stop detection	
Remote control signal receiver (1ch)	Power-on reset (POR)	CRC calculator	
	Voltage detection circuit (LVD)	Data operation circuit (RAM test assist)	🖿 **Package**
	Event link controller	A/D self-diagnostic (Fault detection)	LFQFP 48/64/80/100
		A/D disconnection detection	LQFP 64
		14-bit independent watchdog timer	HWQFN 48
		Port output enable	

RX140

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

RX140	**48MHz 32-bit RXv2 core**		
Memory	**Analog**	**Timer**	**HMI**
Code Flash (256KB)	12-bit A/D converter (18ch)	Multi-function timer pulse unit 2 16-bit (6ch)	Capacitive touch sensing unit (36ch)
SRAM (64KB)	8-bit D/A converter (2ch)	8-bit timer (2ch+2ch)	
Data Flash (8KB)	Temperature Sensor	Compare match timer 16-bit (2ch)	
	Comparator (2ch)	Realtime clock	
		Low power timer	
Connectivity	**System**	**Safety**	**Security**
CAN (1ch)	DTC	Clock frequency accuracy measurement circuit	AES hardware accelerator
SCI (6ch)	Interrupt (8-pin+NMI)	Register write protection	True random number generator
I2C (1ch)	High/low-speed on-chip oscillators	Oscillation stop detection	ID code protection
SPI (1ch)		CRC calculator	Unique ID
	Power-on reset (POR)	Data operation circuit (RAM test assist)	
	Voltage detection circuit (LVD)	A/D self-diagnostic (Fault detection)	**Package**
	Event link controller	A/D disconnection detection	LFQFP 48/64/80
		14-bit independent watchdog timer	LQFP 32/64
		Port output enable	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	**Analog**	**Timer**	**HMI**
Code Flash (2MB)	12-bit A/D converter (18ch)	Multi-function timer pulse unit 3 16-bit (8ch), 32-bit (1ch)	Capacitive touch sensing unit (17ch)
SRAM (384KB)	8-bit D/A converter (2ch)	8-bit timer (4ch)	Serial sound I/F
Data Flash (8KB)	Temperature Sensor	Compare match timer 16-bit (4ch), 32-bit (2ch)	
		16-bit timer pulse unit (6ch)	
		Realtime clock	
Connectivity	**System**	**Safety**	**Security**
USB 2.0 FS (1ch)	DTC, DMAC (8ch), EXDMAC (2ch)	Clock frequency accuracy measurement circuit	Cryptographic engine (AES, RSA, ECC, SHA, TRNG)
CAN (2ch)	Interrupt (16-pin+NMI)	Register write protection	Key management
SCI (15ch)	High/low-speed on-chip oscillators	Oscillation stop detection	ID code protection
I2C (3ch)		CRC calculator	Unique ID
SPI (4ch)	Power-on reset (POR)	Data operation circuit (RAM test assist)	Tamper detection
QSPI with XIP (1ch)	Voltage detection circuit (LVD)	A/D self-diagnostic (Fault detection)	Trusted Memory function
SDHI (1ch)	Event link controller	A/D disconnection detection	**Package**
		14-bit independent watchdog timer	LFQFP 64/100/144
		Port output enable	LFBGA 64
		Memory protection unit	HWQFN 48
			TFLGA 100/145

RX231/RX230

54MHz RXv2 Core, 32-bit Microcontrollers with Enhanced Communication and Security Functions

RX231	**54MHz 32-bit RXv2 core**		
Memory	**Analog**	**Timer**	**HMI**
Code Flash (512KB)	12-bit A/D converter (24ch)	Multi-function timer pulse unit 2 16-bit (6ch)	Capacitive touch sensing unit (24ch)
SRAM (64KB)	12-bit D/A converter (2ch)	8-bit timer (2ch+2ch)	Serial sound I/F
Data Flash (8KB)	Temperature Sensor	Compare match timer 16-bit (4ch)	
	Comparator (4ch)	Realtime clock	
		Low power timer	
		16-bit timer pulse unit (6ch)	
Connectivity	**System**	**Safety**	**Security**
CAN (1ch) *1	DMAC (4ch) DTC	Clock frequency accuracy measurement circuit	AES hardware accelerator *1
SCI (6ch)	Interrupt (8-pin+NMI)	Register write protection	True random number generator *1
I2C (1ch)	High/low-speed on-chip oscillators	Oscillation stop detection	ID code protection
SPI (1ch)		CRC calculator	Unique ID
USB2.0 Full Speed Host/Function (1ch) *1	Power-on reset (POR)	Data operation circuit (RAM test assist)	Key management *1
	Voltage detection circuit (LVD)	A/D self-diagnostic (Fault detection)	Access management *1
SDHI (1ch) *1	Event link controller	A/D disconnection detection	**Package**
IrDA (1ch)	8/16-bit External bus	14-bit watchdog timer	LFQFP 48/64/100
		14-bit independent watchdog timer	HWQFN 48/64
		Port output enable	WFLGA 64
		Memory protection unit	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	**Analog**	**Timer**	**HMI**
Code Flash (512KB)	12-bit A/D converter (14ch)	Multi-function timer pulse unit 2 16-bit (5ch)	Capacitive touch sensing unit (12ch)
SRAM (64KB)	12-bit D/A converter (2ch)	8-bit timer (2ch+2ch)	Serial sound I/F
Data Flash (8KB)	Temperature Sensor	Compare match timer 16-bit (4ch)	
	Comparator (2ch)	Realtime clock	
		Low power timer	
		16-bit timer pulse unit (6ch)	
Connectivity	**System**	**Safety**	**Security**
CAN (1ch)	DMAC (4ch) DTC	Clock frequency accuracy measurement circuit	AES hardware accelerator
SCI (4ch)	Interrupt (6-pin+NMI)	Register write protection	True random number generator
I2C (1ch)	High/low-speed on-chip oscillators	Oscillation stop detection	ID code protection
SPI (1ch)		CRC calculator	Unique ID
USB2.0 Full Speed Host/Function (1ch)	Power-on reset (POR)	Data operation circuit (RAM test assist)	Key management
	Voltage detection circuit (LVD)	A/D self-diagnostic (Fault detection)	Access management
SDHI (1ch)	Event link controller	A/D disconnection detection	**Package**
IrDA (1ch)		14-bit watchdog timer	BGA 85
RF (BLE5.0)		14-bit independent watchdog timer	QFN 56
		Port output enable	
		Memory protection unit	

Related Devices

RX260

64MHz RXv3 Core, 32-bit Microcontrollers with Enhanced Communication and Security Functions

RX260 — 64MHz 32-bit RXv3 core

Memory	**Analog**	**Timer**	**HMI**
Code Flash (512KB)	12-bit ADC x 24ch	PWM timers - 32-bit x 2ch (GPTW) - 16-bit x 6ch (GPTW)	Capacitive touch sensor x 34ch
SRAM (128KB)	8-bit DAC x 2ch	General timers - 16-bit x 4ch (CMT) - 8-bit x 4ch (TMR)	
Data Flash (8KB) *1	Comparator x 2ch	Low power timer (LPT)	
	Temperature Sensor	Real-time clock (RTC)	

Connectivity	**System**	**Safety**	**Security**
Remote control signal receiver x 1ch	DMAC x 4ch, DTC	Watchdog timer x 2ch	Memory protect
Serial communication - UART x 7ch (w/ Simple SPI / I2C) - SPI x 1ch - I2C x 1ch	High-speed on-chip oscillators	CRC calculator	Unique ID
	Low-speed on-chip oscillators	PWM wave output shutdown	
	Event link controller	Failure detect assist (Clock, Memory, Analog)	

			Package
			LFQFP 48/64/80/100
			HWQFN 48

*1: Background operation

RX261

64MHz RXv3 Core, 32-bit Microcontrollers with Capacitive Touch and Enhanced Security

RX261 — 64MHz 32-bit RXv3 core

Memory	**Analog**	**Timer**	**HMI**
Code Flash (512KB)	12-bit ADC x 24ch	PWM timers - 32-bit x 2ch (GPTW) - 16-bit x 6ch (GPTW)	Capacitive touch sensor x 34ch
SRAM (128KB)	8-bit DAC x 2ch	General timers - 16-bit x 4ch (CMT) - 8-bit x 4ch (TMR)	
Data Flash (8KB) *1	Comparator x 2ch	Low power timer (LPT)	
	Temperature Sensor	Real-time clock (RTC)	

Connectivity	**System**	**Safety**	**Security**
USB2.0 x 1ch - Full speed host/function	DMAC x 4ch, DTC	Watchdog timer x 2ch	RSIP-E11A - AES/ECC/SHA engines - TRNG - Key management - Access management
CAN-FD x 1ch	High-speed on-chip oscillators	CRC calculator	
Remote control signal receiver x 1ch	Low-speed on-chip oscillators	PWM wave output shutdown	Memory protect
Serial communication - UART x 7ch (w/ Simple SPI / I2C) - SPI x 1ch - I2C x 1ch	Event link controller	Failure detect assist (Clock, Memory, Analog)	Unique ID

			Package
			LFQFP 48/64/80/100
			HWQFN 48

*1: Background operation

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

Memory	**Analog**	**Timer**	**HMI**
Code Flash (16KB / 32KB)	10-bit A/D Converter 11ch	Timer Array Unit (16-bit, 8ch)	Buzzer Output Controller
SRAM (Parity) (2KB)	Internal Reference Voltage (0.815V)	Interval Timer 12-bit, 1ch	Capacitive Touch Sensor (CTSUb)
2.4V to 5.5V Flash Writing	Temperature Sensor	Watchdog Timer (WDT)	
Memory Mirror Function	Comparator 2ch	Reset-less Realtime Clock (RTC) Calender Function	
Data Flash (1KB)			

Connectivity	**System**	**Safety**	**Package**
I²C (Multi-master) x1	Interrupt Controller (4 Levels)	A/D Test	LQFP: 32-pin
CSI x1 / UART / Simple I²C x1	High-Speed OCO 16MHz ±1%*1	CRC Calculator	SSOP: 10, 16, 20-pin
CSI x1 / UART / Simple I²C x1	Low-Speed OCO 15kHz	RAM Parity Error Detection	HWQFN: 16, 24, 32-pin
CSI x1 / UART / Simple I²C x1	External Clock Controller (12MHz/32.768kHz)	Frequency Detection	General Purpose I/O up to 30 I/Os
	Selectable Power-on Reset (SPOR)	Invalid Memory Access Detection	
	On-chip Debug (2.4V to 5.5V) (Single-wire, Double-wire)		

*1: A-ver: ±2.0% (-40 to +85°C)
G/M-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

Memory	**Analog**	**Timer**	**HMI**
Code Flash (64KB)	10-bit A/D Converter 10ch	Timer Array Unit (16-bit, 8ch)	Key Interrupt Function
SRAM (4KB)	Internal Reference Voltage	32-bit Interval Timer (8-bit x 4)	Buzzer Output Controller
Data Flash (2KB)	Temperature Sensor	Watchdog Timer (WDT)	Capacitive Sensing Unit 29ch + Multiple Electrode Connection
1.8V Flash Writing		Realtime Clock	
Boot Swap (8KB)			
Memory Mirror Function			

Connectivity	**System**	**Safety**	**Security**
I²C (Multi-master/Multi-slave) x1	High-Speed OCO 32MHz 1%	RAM Parity Error Check	Flash Writing Protection
CSI x2 / UART / Simple I²C x2	Middle-Speed OCO 4MHz	Invalid Memory Access Detection	Flash Shield Window Function
CSI x2 / UART / Simple I²C x2	Low-Speed OCO 32kHz	A/D Test	Unique ID
CSI x2 / UART / Simple I²C x2	External Clock Controller	Frequency Detection	Customer ID
UART	Power-on Reset (POR)	CRC Calculator	Ramdom Number Generator
	Voltage Detection	RAM Guard	
	Data Transfer Controller	SFR Guard	
	Event Link Controller	Trap Function	
	Snooze mode Sequencer	Output Level Detection	
	Interrupt Controller (4 Levels)		
	On-chip Debug (Single-wire, Double-wire)		

			Package
			SSOP: 20, 30-pin
			LQFP: 32, 44-pin
			HWQFN: 16, 24, 32, 40, 48-pin
			WFLGA: 25, 36-pin
			LFQFP: 48-pin
			General Purpose I/O max 44 pins

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

Memory
- Code Flash (768KB)
- SRAM (48KB)
- Data Flash (8KB)
- 1.6V Flash Writing
- Boot Swap (16KB)
- Memory Mirror Function

Analog
- 12-bit A/D Converter 26ch
- Internal Reference Voltage
- Comparator 2ch
- 8-bit D/A Converter 2ch
- Temperature Sensor

Timer
- Timer Array Unit (16-bit, 16ch)
- 32-bit Interval Timer (8-bit x 4)
- Watchdog Timer (WDT)
- Realtime Clock

HMI
- Key Interrupt Function
- Buzzer Output Controller
- Capacitive Touch Sensor 32ch
- Controlled Current Drive Port 8ch
- 40mA Output Port

Connectivity
- I²C (Multi-master/Multi-slave) x2
- CSI x2 / UART / Simple I²C x2
- CSI x2 / UART / Simple I²C x2
- CSI x2 / UART / Simple I²C x2
- CSI x2 / UART / Simple I²C x2
- UART
- UART
- Remote Control Receiver

System
- 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)

Safety
- RAM Parity Error Check
- Invalid Memory Access Detection
- A/D Test
- Frequency Detection
- CRC Calculator
- RAM Guard
- SFR Guard
- Trap Function
- Output Level Detection

Security
- Flash Writing Protection
- Flash Shield Window Function
- Unique ID
- Customer ID
- Ramdom Number Generator

Package
- LSSOP: 30-pin
- LQFP: 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

RL78/F22

Next-Generation Actuator and Sensor Microcontroller with Capacitive Touch IP

System
- Data Transfer Controller (DTC)
- Event Link Controller (ELC)
- Internal Oscillator 80MHz
- Internal Oscillator 15kHz
- Ext. Main Oscillator 20MHz
- Ext. Sub Oscillator 32.7kHz
- PLL 80MHz
- Clock Monitor
- Ext. Interrupt
- Key Return
- Power On Reset (POR)
- Low Voltage Detector (LVD)
- On Chip Debug (Hot plug-in, Live debug)

16-bit CPU
RL78 CPU Core
@40MHz
VDD = 1.8V to 5.5V
Ta = -40 ~ +105°C (Grade-3)
Ta = -40 ~ +125°C (Grade-4)
MUL/MAC/DIV instructions

Memory
| Code Flash 128KB | RAM 12KB | Data Flash 8KB |

Generic Timers
- Timer Array Unit 16-bit, 12ch
- Timer RJ 16-bit, 1ch
- Real Time Clock (RTC)
- Enhanced Timer RD (Timer RDe) 16-bit, 2ch PWM/ Motor control/ Input capture/ Output compare
- Dithering Function

Safety + Security
| ISO26262 (ASIL B) | ISO/SAE21434 Evita-Light (AES-256) |

Human Machine Interface
- Capacitive Sensing Unit (CTSU2SLa) up to 12ch

Interfaces
- LIN/UART module (RLIN3) 1ch
- Serial Array Unit CSI/SPI: up to 4ch, UART: up to 2ch, Simplified I²C: up to 4ch, Simplified I²S: 1ch
- Multi-master I²C (Serial I/F IICA) 1ch

Accelerator
- FOC Assist Function* SIN, COS, Clarke/Park Transformation, PI Control, 32-bit Multiplier

Analog
- 12-bit ADC (with dedicated S&H) up to 17ch

* FOC: Field Oriented Control (BLDC motor vector control method)

RL78/F25

Next-Generation Actuator and Sensor Microcontroller with Capacitive Touch Function

System
- Data Transfer Controller (DTC)
- Event Link Controller (ELC)
- Internal Oscillator 80MHz
- Internal Oscillator 15kHz
- Ext. Main Oscillator 20MHz
- Ext. Sub Oscillator 32.7kHz
- PLL 80MHz
- Clock Monitor
- Ext. Interrupt
- Key Return
- Power On Reset (POR)
- Low Voltage Detector (LVD)
- On Chip Debug (Hot plug-in, Live debug)

16-bit CPU
RL78 CPU Core
@40MHz
VDD = 2.7V to 5.5V
Ta = -40 ~ +105°C (Grade-3)
Ta = -40 ~ +125°C (Grade-4)
MUL/MAC/DIV instructions

Memory
| Code Flash 512KB | RAM 40KB | Data Flash 16KB |

Generic Timers
- Timer Array Unit 16-bit, 16ch
- Timer RJ 16-bit, 1ch
- Real Time Clock (RTC)
- Enhanced Timer RD (Timer RDe) 16-bit, 2ch PWM/ Motor control/ Input capture/ Output compare
- Dithering Function

Safety + Security
| ISO26262 (ASIL B) | ISO/SAE21434 Evita-Light (AES-256) |

Human Machine Interface
- Capacitive Sensing Unit (CTSU2SLa) up to 31ch

Interfaces
- CAN Interface (RS-CANFD lite) 2ch
- LIN/UART module (RLIN3) 3ch
- Serial Array Unit CSI/SPI: up to 4ch, UART: up to 2ch, Simplified I²C: up to 4ch, Simplified I²S: 1ch
- Multi-master I²C (Serial I/F IICA) 1ch

Accelerator
- FOC Assist Function* SIN, COS, Clarke/Park Transformation, PI Control, 32-bit Multiplier

Analog
- 12-bit ADC (with dedicated S&H) up to 29ch
- 8-bit DAC
- Comparator

* FOC: Field Oriented Control (BLDC motor vector control method)

RL78/L23

32MHz Ultra-Low Power LCD Microcontroller with Capacitive Touch Function

System
- Interrupt Controller 4 Levels
- POR, LVD
- Clock Generation (Internal, External)
- Data Transfer Controller
- Logic & Event link Controller
- Debug (Single Wire, Two Wires)

RL78 CPU Core
32 MHz 51.2 DMIPS
- CISC Harvard Architecture 3-stage Pipeline
- Four-Register Banks
- 16-bit Barrel Shifter

Memory
| Program Flash up to 512KB (512KB, 256KB in 2banks) | SRAM up to 32KB | Data Flash 8KB |

Power Management
- HALT (ADC, DAC, RTC Enabled)
- SNOOZE (DTC, ADC Enabled) SNOOZE Mode Sequencer
- STOP (RTC Enabled)

Human Machine Interface
- LCD Controller 56 seg x 4com 52 seg x 8 com
- Capacitive Sensing Unit (CTSU2La), 36ch
- 40-mA port, 4ch
- Output Current Control Port, 8ch

Timers
- Timer Array Unit 16-bit, 8ch
- Interval Timer 32-bit, 1ch (8-bit, 4ch) 16-bit, 8ch (8-bit, 16ch)
- Timer RJ 16-bit, 2ch
- Timer KB 16-bit, 3ch
- WDT, 1ch
- RTC Calendar
- External Signal Sampler

Security & Encryption
- Flash Read Protection
- Flash Shield Protection
- Unique ID
- Customer ID
- True Random Number Generator

Communication
- I²C Single-Master, 8ch
- I²C Multi-Master/Slave, 2ch
- CSI/SPI, 8ch
- UART, 4ch
- UART with sync clock, 4ch
- LIN, 1ch

Safety
- RAM Parity Check
- ADC Self-Diagnostic
- Clock Monitoring
- Memory CRC
- Output Level Detection

Analog
- ADC 12-bit, 13ch
- DAC 8-bit, 2ch
- Comparator, 2ch
- Internal Vref.
- Temp. Sensor

Application Notes

Renesas provide CTSU Capacitive Touch Introduction Guide for basic knowledge for developing capacitive touch sensor.

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	How to design electrode patters, with sample patterns for reference, for MCUs that Capacitive Touch Sensing Unit (CTSU) is embedded.

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.

Useful Videos

Resource information	Title	Link
Introduction	Capacitive Touch Solution	Link
	Getting Started with Renesas Capacitive Touch	Link
Demo	RL78/G22 Appliance UI Demo -Contributing to The Innovative UI of Kitchen Appliances	Link
	Hand On/Off Detection and Steering Switch Demo Using Capacitive Touch Function of RL78/F25	Link
	RL78/F25 Anti-Pinch Power Window Demo	Link
Tutorial	QE for Capacitive Touch Tutorial: Settings for RL78	Link
	QE for Capacitive Touch Tutorial: Tuning for RL78	Link
	QE for Capacitive Touch Tutorial: Serial Monitoring for RL78	Link
	QE for Capacitive Touch Tutorial: Settings	Link
	QE for Capacitive Touch Tutorial: Tuning	Link
	QE for Capacitive Touch Tutorial: Monitoring	Link
	QE for Capacitive Touch Tutorial: Step 1 Configuration for RA	Link
	QE for Capacitive Touch Tutorial: Step 2 Tuning for RA	Link
	QE for Capacitive Touch Tutorial: Step 3 Monitoring for RA	Link

Winning Combinations

Winning combinations are comprehensive solutions that combine complementary Renesas products from our portfolio, such as analog + power + embedded processing devices. These winning combinations bring together products that work together optimally, enabling customers to speed up the design process and bring their finished products to market more quickly. With the focus on the industrial, infrastructure, and automotive fields, Renesas is working to provide an optimal portfolio of products to customers and partners worldwide.

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

Visit the website below to see examples of a variety of solutions for industrial equipment.

https://www.renesas.com/winning-combinations

The easy way to discover Winning Combinations:

Type the ID number into the search bar on the Renesas website (www.renesas.com) to view the corresponding page.

Partner's Solutions

Title	Overview
CapExt	CapExt is a software package for simulating capacitive touch that was designed from the ground up to be as easy to use as possible while returning accurate results. With CapExt, you can ensure optimal touch performance before the first prototype. **Device**: RA8, RA6, RA4, RA2, RA0
WT Microelectronics 文曄科技 WT MICROELECTRONICS	The WT 7" (800 x 480) TFT-LCD HMI Solution supports large 7" TFT-LCD Cap-touch panels with up to 800x480 resolution with RA MCUs. With powerful SEGGER emWin graphics, users enable the creation of highly efficient, high-quality, interactive graphical user interfaces. This HMI solution provides an excellent demonstration for embedded GUI applications. **Device**: RA6
Commotec Commotech ELECTRONICS	Renesas Capacitive Touch Demo Kits from Commotech are developed using three Renesas MCUs RL78/G23, RX140, and RA2E1 integrating an on-chip cap touch controller. Evaluation of touch detection and haptic feedback (touch key, slider, touchpad) is available. This solution is designed for early development and functional evaluation. **Device**: RA2E1, RX140, RL78/G23

Notice

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