RENESAS

BIG IDEAS FOR EVERY SPACE

RX FAMILY

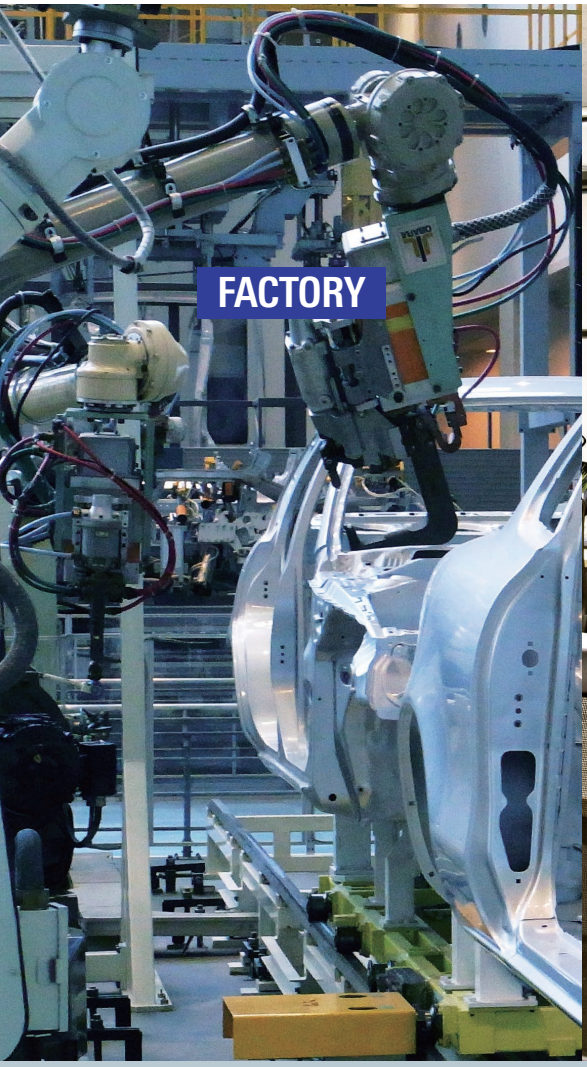
Renesas 32-Bit Microcontrollers

2020.04

RENESAS RX

Mid-range 32-bit microcontrollers built around an exclusive CPU core developed by Renesas

Maintaining and Advancing the Renesas Tradition

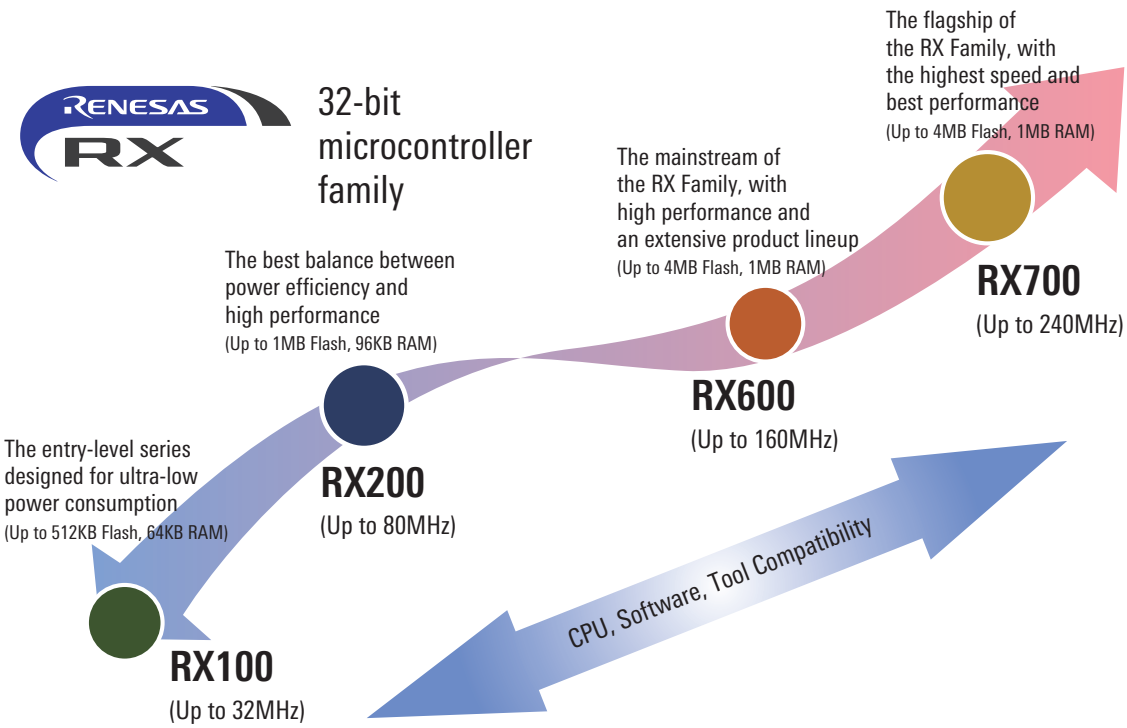


CONTENT

- The following new products have been added:
  RX700 Series: RX72M, RX72N, RX72T
  RX600 Series: RX66N, RX66T
  RX200 Series: RX23W, RX23E-A
  RX100 Series: RX13T
- Information on the following solutions has been added:
  Resolver position control solution
  Cloud solutions
- Information on the RXv3 core has been added.

RX Family MCUs are built around advanced CPU cores packed with innovations unique to Renesas. Based on proprietary technology amassed over many years, they are designed to deliver improved responsiveness and power efficiency in all aspects while combining excellent operation performance and low power consumption. The RX Family brings together a variety of technical innovations from Renesas and aims to define the ultimate in 32-bit MCUs with on-chip flash memory for the industrial, home electronics, office automation, and ICT*1 fields.

Note: 1. ICT: Information and Communication Technology



Power and functionality poised to dominate the market: The four powerful product series that compose the RX Family

The RX Family of 32-bit microcontrollers are built around Renesas' exclusive RX CPU core and combine excellent operation performance with superior power efficiency.

The family consists of four product series: the flagship RX700 Series, with the fastest performance and most advanced functions; the mainstream RX600 Series; the RX200 Series, which delivers an optimal balance of power efficiency and high performance; and the entry-level RX100 Series, with extremely low power consumption. These four series encompass a range of products that provide seamless scalability from small-scale to large-scale applications.

POSITIONING OF THE RX FAMILY

Positioning of the RX Family

With a proven track record and superior reliability, the RX family of 32-bit microcontrollers is suitable for a wide range of applications in the industrial and home electronics fields and supports the full lineup of customer products with a seamless range of operating frequencies from 32MHz to 240MHz.

8/16bit MCU	32bit MCU			32/64bit MPU
Renesas Core		Arm® Core		
RENESAS RL78	RENESAS RX	RENESAS RA	Renesas Synergy™	RENESAS RZ
Low Power	Power Efficiency	Arm® Ecosystem	Qualified Platform	High Performance
Features: Ultra-low energy Low pin count lineup available	**Features:** Superior power efficiency High-capacity flash memories Broad lineup	**Features:** High efficiency Security	**Features:** Qualified software and tools	**Features:** Multi-core up to 8 cores Linux or RTOS available High-capacity on-chip RAM DRP*1 image processing acceleration
Operating frequency: 20~32MHz	**Operating frequency:** 32~240MHz	**Operating frequency:** 48~200MHz	**Operating frequency:** 32~240MHz	**Operating frequency:** 125MHz~1.5GHz
Applications: General-purpose Sensor Motor Control LCD Display Bluetooth® Low Energy Sub-GHz Wireless Communication Security	**Applications:** General-purpose Motor Control Security Capacitive Touch Battery Powered LCD Control Industrial Network Cloud Connectivity	**Applications:** Motor Control LCD Control Network Capacitive Touch Security	**Applications:** Motor Control LCD Control Network IoT Devices Security	**Applications:** HMI HD Graphics AI Inferencing Machine Vision Industrial Network Real-time Control
				*1 DRP: Dynamically Reconfigurable Processor

Features of the Four Series Composing the RX Family

RX700 Series Up to 240MHz

The flagship of the RX Family, with the highest speed and best performance

4MB Flash Max Dual Bank	EtherCAT IEEE1588 Ethernet	USB,CAN SDHI, LCDC	Security Safety	Motor

RX600 Series Up to 160MHz

The mainstream of the RX Family, with high performance and an extensive product lineup

4MB Flash Max Dual Bank	IEEE1588 Ethernet	USB,CAN SDHI, LCDC	Security Safety	Motor

RX200 Series Up to 80MHz

The best balance between power efficiency and high performance

1MB Flash Max	1.8 to 5.5V 0.12mA/MHz 0.8μA(stby)	USB,CAN SDHI, Bluetooth	Security Safety	Motor Capacitive Touch IA Sensor

RX100 Series Up to 32MHz

The entry-level series designed for ultra-low power consumption

512KB Flash Max	1.8 to 5.5V 0.1mA/MHz 0.35μA(stby)	USB Segment LCD	Safety	Motor Capacitive Touch

Featured Products

- RX72M/N (RXv3)
- RX66N (RXv3)
- RX65N/1
- RX231/0
- RX23W
- RX130

for Motor

- RX72T (RXv3)
- RX66T (RXv3)
- RX24U/T
- RX23T
- RX13T

for Sensor

- RX23E-A

RX Family Lineup

Recommended Product | In Planning

Flagship RX700

RXv2 RX71M	240MHz	RXv3 Double Precision FPU RX72M	240MHz Up to 4MB Flash Register Bank Save EtherCAT	Common - Dual Bank flash memory - Ethernet - USB/CAN - LCD - Security (Trusted Secure IP)
		RXv3 Double Precision FPU RX72N	240MHz Up to 4MB Flash Register Bank Save	

Next-Generation RX7xx

Mainstream RX600

RXv2 RX64M	120MHz	RXv3 Double Precision FPU RX66N	120MHz Up to 4MB Flash Register Bank Save	Common - Dual Bank flash memory - Ethernet - USB/CAN - LCD - Security (Trusted Secure IP)
RXv1 RX63N, RX631 RX62N, RX621 RX630, RX610	100MHz	RXv2 RX65N, RX651	120MHz Up to 2MB Flash	

Next-Generation RX6xx

Best Mix RX200

		RXv2 For Bluetooth RX23W	54MHz Up to 512KB Flash Bluetooth, Capacitive Touch Security (Trusted Secure IP Lite)	Common - USB/CAN
RXv1 RX210 RXv1 RX220	50MHz 32MHz	RXv2 RX231, RX230	54MHz Up to 512KB Flash Touch Key Security (Trusted Secure IP Lite)	
RXv1 RX21A	50MHz	RXv2 For Sensor RX23E-A	32MHz Up to 256KB Flash High Precision AFE	

Next-Generation RX2xx

Entry RX100

		RXv1 RX130	32MHz Up to 512KB Flash 5V Support, Capacitive Touch
		RXv1 RX113	32MHz Up to 512KB Flash USB, LCD, Capacitive Touch
		RXv1 RX110, RX111	32MHz RX110 : Up to 128KB Flash RX111 : Up to 512KB Flash USB

Next-Generation RX1xx

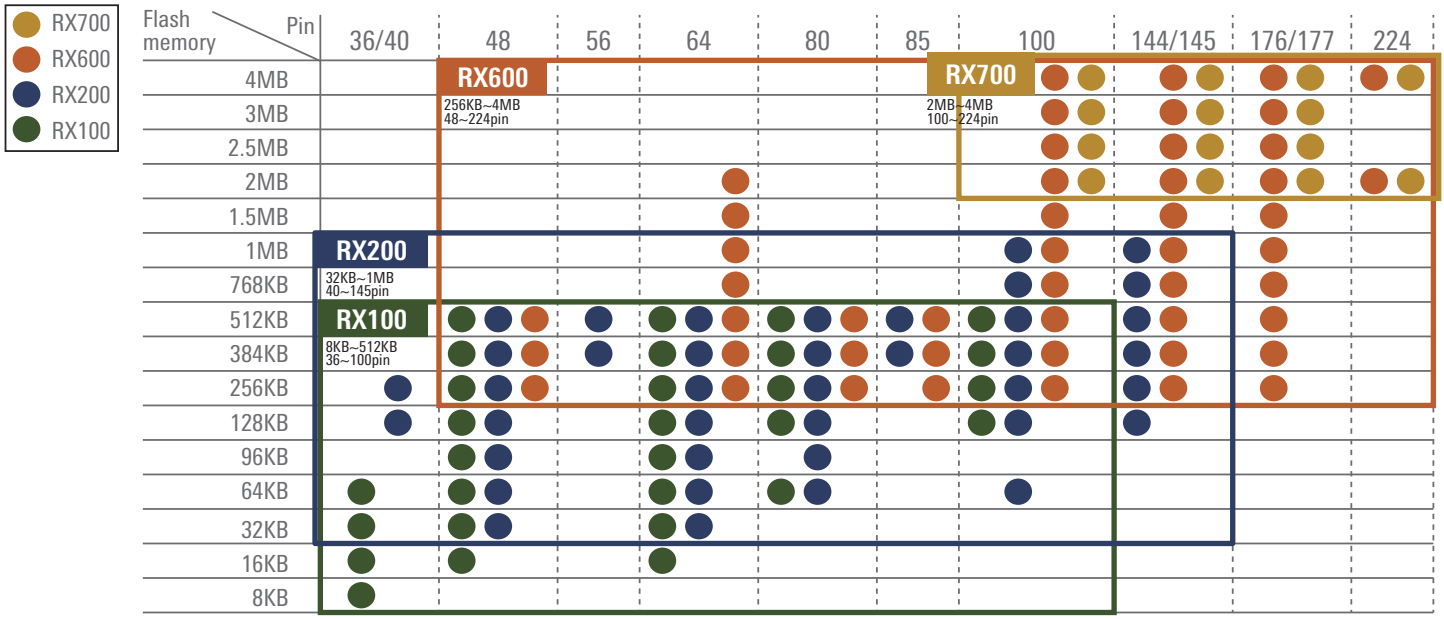
For Motor RX-T

RXv1 RX63T, RX62T, RX62G	100MHz	RXv3 3-4 Motors RX72T	200MHz Up to 1MB Flash Register Bank Save, TFU USB/CAN, PGA Security (Trusted Secure IP Lite)	Common - 5V Support - Comparator
		RXv3 3-4 Motors RX66T	160MHz Up to 1MB Flash USB/CAN, PGA Security (Trusted Secure IP Lite)	
		RXv2 2-3 Motors RX24T/RX24U	80MHz Up to 512KB Flash CAN, PGA	
		RXv2 1 Motor RX23T	40MHz Up to 128KB Flash	
		RXv1 1 Motor RX13T	32MHz Up to 128KB Flash PGA	

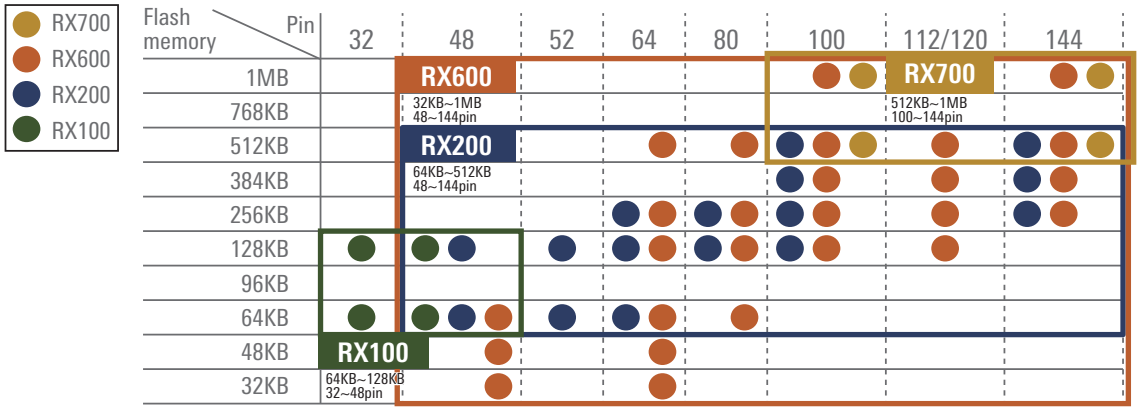
Next-Generation RXxxT

RX Family Memory/Pin Lineup

Industrial, Home Appliances, and OA/ICT

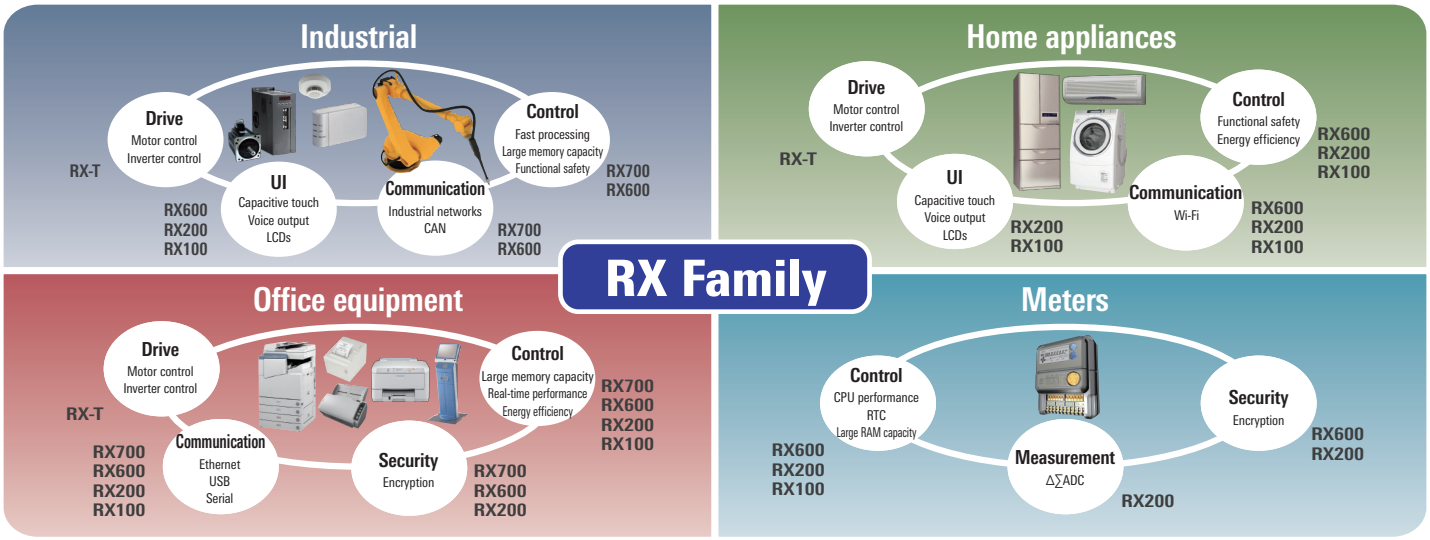


Motor



Contributing to the Development of Platforms in a Variety of Fields

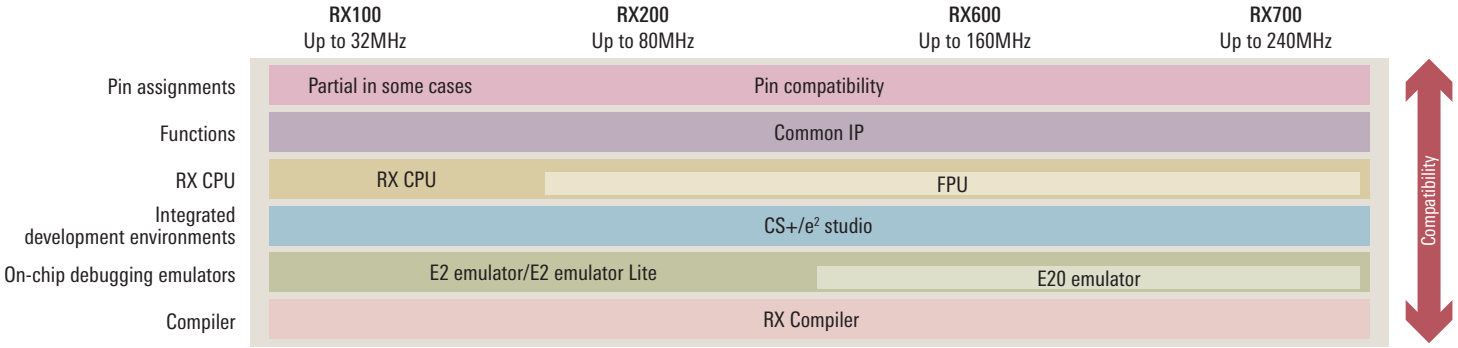
Wide performance range from 32MHz to 240MHz, abundant peripheral functions for many applications, and excellent compatibility



RX Family Compatibility

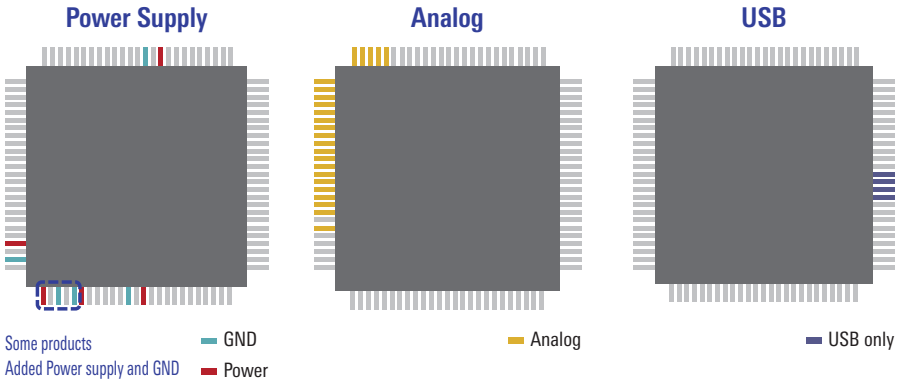
The RX Family is designed for compatibility across products in terms of CPU instructions, pin assignments, and functions.

- The instruction sets of the RXv1, RXv2, and RXv3 cores are intercompatible.
- The functions of RX Family MCUs are based on common IP cores, allowing for easy migration between RX products.
- The pin assignments of RX Family MCUs are fundamentally consistent with those of earlier Renesas products.
- Pin positions for digital peripheral functions can be selected from among multiple locations, simplifying the development of printed circuit boards.
- Compatibility among development environments has been enhanced, reducing the development burden and cost of tools while simplifying program management.



Pin Compatibility between Series for Power Supply, Analog, and USB

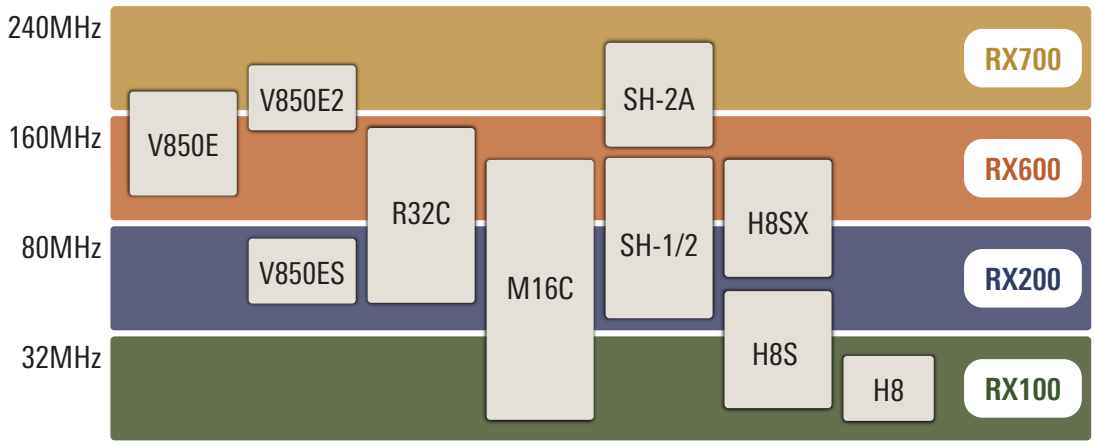
Analog and USB pins are pin compatible. Power supply pins are compatible except in some devices which require additional pins.



*100-pin version terminal layout example

Existing Products and RX Extensibility

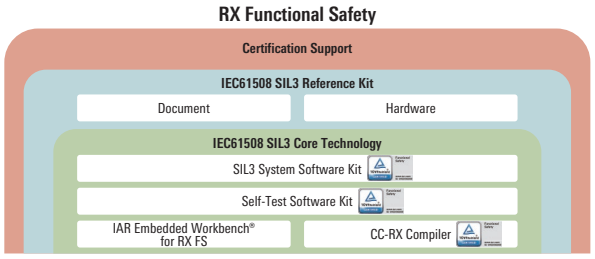
- The RX Family covers the performance range of a variety of CPU cores utilized in earlier Renesas products.
- Improved software reusability and unification of development environments allow the RX Family to provide seamless scalability when developing products over the entire model range from low- to high-end.



RX FAMILY SOLUTIONS

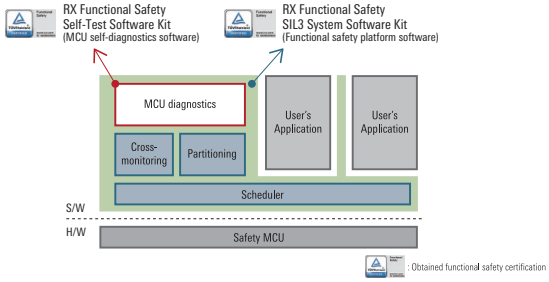
Functional Safety Solution for Industrial Automation

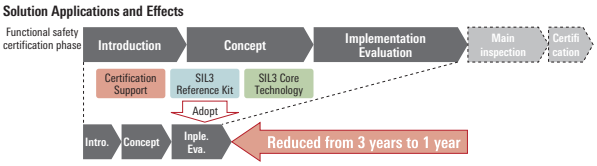
In the industrial equipment field the importance of "functional safety," which aims to maintain safety even when malfunctions occur, is increasing as a way to prevent the adverse effect of breakdowns and accidents on plant operation, the adverse effect of injuries to personnel on society, and the associated economic losses.
The European Union's Machinery Directive also requires that equipment meet functional safety standards.
In response to the need for functional safety certification in a range of industrial fields, Renesas provides RX Functional Safety as a one-stop solution designed to reduce the burden on customers at the development and functional safety certification stages.



RX Functional Safety

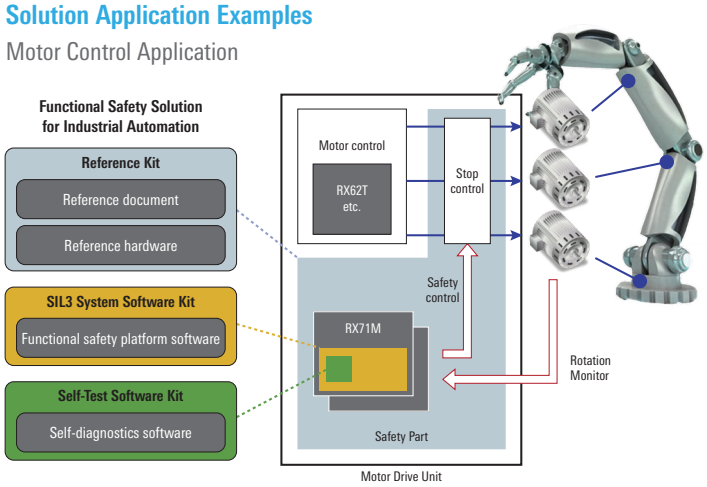
IEC 61508 SIL 3 core technology comprises three components: self-test software kits, SIL3 system software kits, and functional safety certified compilers. A self-test software kit is an MCU self-diagnostic software product package for examining the CPU, ROM, and RAM internal to the MCU. An SIL3 system software kit is a functional safety platform software product package for mutual diagnostics in MCUs with redundant configurations or controlling the behavior of user applications.
IEC 61508 SIL 3 reference kits include the results of cases where Renesas has drawn up the safety specifications and implementation specifications, and then implemented a detailed design, failure analysis, and diagnostics for an MCU redundant configuration system based on these cases. Both reference documents and reference hardware are available. To assist customers' efforts to obtain certification, Renesas provides a wide range of support to match every development stage and situation, from individual seminars to design consulting and contracted software development.



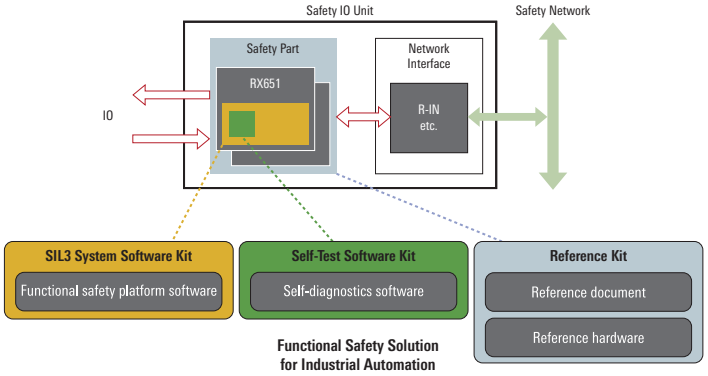


Solution Application Examples

Motor Control Application



Remote IO Application



Functional Safety Solution Products for Industrial Automation

Self-Test Software Kit

for CC-RX compiler
for RX700 series product version RTK0EF0054F27001SJ
free version RTK0EF0054F37001SJ
for RX600 series product version RTK0EF0054F26001SJ
free version RTK0EF0054F36001SJ
for RX200 series product version RTK0EF0054F22001SJ
free version RTK0EF0054F32001SJ
for RX100 series product version RTK0EF0059F21001SJ
free version RTK0EF0059F31001SJ
for IAR tool
for RX700 series product version RTK0EF0055F27001SJ
free version RTK0EF0055F37001SJ
for RX600 series product version RTK0EF0055F26001SJ
free version RTK0EF0055F36001SJ
for RX200 series product version RTK0EF0055F22001SJ
free version RTK0EF0055F32001SJ
for RX100 series product version RTK0EF0060F21001SJ
free version RTK0EF0060F31001SJ

(The product and free versions of these kits have the same content, however the free versions do not offer support.)

SIL3 System Software Kit

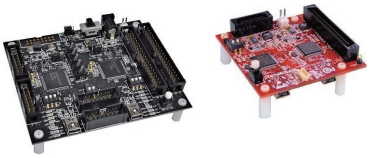
for CC-RX compiler
for RXv2 core product version RTK0EF0061F22001SJ
for RXv2 core evaluation version RTK0EF0061F32001SJ
(The functions of the product version and evaluation version are identical, but the evaluation version software is not subject to functional safety certification.)

Reference Document

Full document set (total 19 volumes)
common to all RX RTK0EF0005Z11001ZJ
Set for concept phase (excerpts in 4 volumes)
common to all RX RTK0EF0031Z11001ZJ

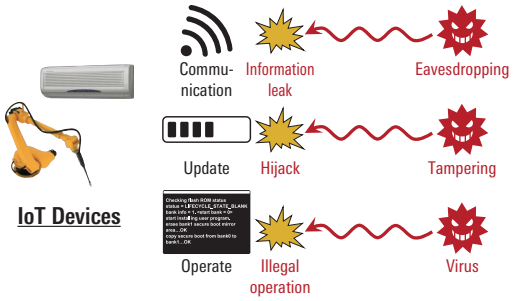
Reference Hardware

for RX71M-RX651 RTK0EF0058D01001BJ
for RX111-RX111 RTK0EF0011D01001BJ



Security Solutions

In recent years, the creation of new added value for the Internet of Things (IoT) has been gaining attention. On the other hand, since IoT devices connect to the Internet, they are exposed to risks such as eavesdropping, tampering, and viruses, and such harmful incidents are also seeing an increase in number. Consequently, the demand for security features is increasing for devices that previously didn't need them.



Robust Security with Trusted Secure IP

RX security solutions implement Root of Trust for IoT devices using encryption by key data that is protected by a strong Trusted Secure IP and an authentication program using a memory-protection function. By implementing security functions using an RX microcontroller (MCU), you can easily and strongly protect IoT devices against threats.

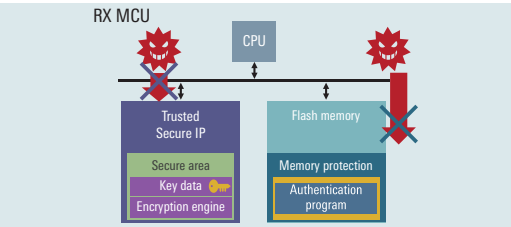
The RX65N and RX231 with Trusted Secure IP are CAVP certified under the FIPS 140-2 standard of the National Institute of Standards and Technology (NIST) of the United States, so the encryption algorithm employed can be used with confidence.

Threats	Security
Eavesdropping	Encrypted communication
Tampering	Secure updating
Virus	Secure boot

Secure updating: Authentication for program updating detects and prevents tampering

Secure boot: Authentication for program execution detects and prevents tampering

Security Hardware Implementing Root of Trust



Hardware-Based Security Features of RX

Function / MCU Group	Encryption					Memory Protection				
	Trusted Secure IP	AES	RSA	ECC	SHA	TRNG	Code Protect	Trusted memory	Area Protection	Memory Protection Unit
RX23W/RX231	✓	✓	–	–	–	✓	✓	–	✓	✓
RX66T/RX72T	✓	✓	–	–	–	✓	✓	–	–	✓
RX651/RX65N/RX66N/ RX72M/RX72N	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Code protect: A function that prohibits connection with a debugger or programmer
Trusted memory: A function that prohibits reading and copying of code that is located in certain areas within a microcontroller
Area protection: A function that prohibits rewriting of a specified area of the flash memory
Memory protection unit: A function that monitors whether access to an address that is in violation of the settings is performed

Components of Communication Security Evaluation Kit

Reference solutions for communication and security are available.

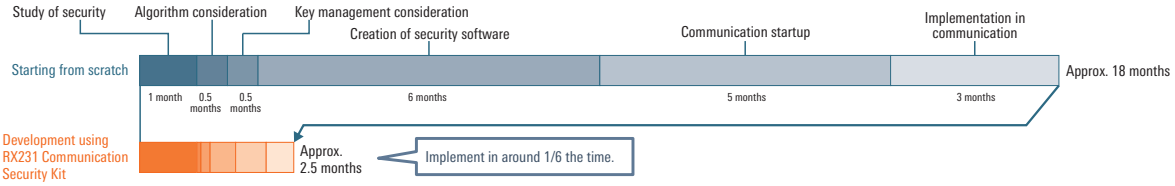
Start implementing security features in your project immediately using one of these one-stop solutions.

	Necessary Components			RX65N and RX231 Wireless LAN Support	
	Board/Kit	Software		Board/Kit	Software
	Renesas Starter Kit with Security Functions (Including Evaluation Version of Development Tools)	RX Driver Package	Trusted Secure IP Driver*1	Renesas Starter Kit Expansion Board with SDIO Wireless LAN Support	SDIO Wireless LAN Protocol Stack
Security Solution Evaluation Kits	TSIP-Lite support: RX23W, RX231, RX66T, RX72T TSIP support: RX65N, RX72M, RX72N	Renesas standard device drivers for peripheral functions such as USB, Ethernet, LCD, SCI, A/D, timers, IIC, and SPI	Coding & decoding, secure boot/ updating	d-broad wireless LAN module 	FreeRTOS or ITRON Renesas TCP/IP SDIO driver d-broad wireless LAN driver
Seller	Renesas (See web site: https://www.renesas.com/rx-security-solution)				

Notes: 1. Root of trust implemented in security hardware.
2. xxx represents the version number.
3. Please contact a sales company or agent.

Speed up Time-To-Market

You can greatly speed up the time-to-market of your security and communication project using these ready-to-use security evaluation kits.



Device Lifecycle Management (DLM) to Ensure Security from Manufacture to Decommissioning of IoT Devices

In recent years it has become necessary to ensure security over the entire lifecycle of a product. This process is called Device Lifecycle Management (DLM). By making use of RX security functionality to implement a root of trust, customers can implement robust and sophisticated security management that extends over the entire lifecycle of a device.

For details, visit the following webpage:

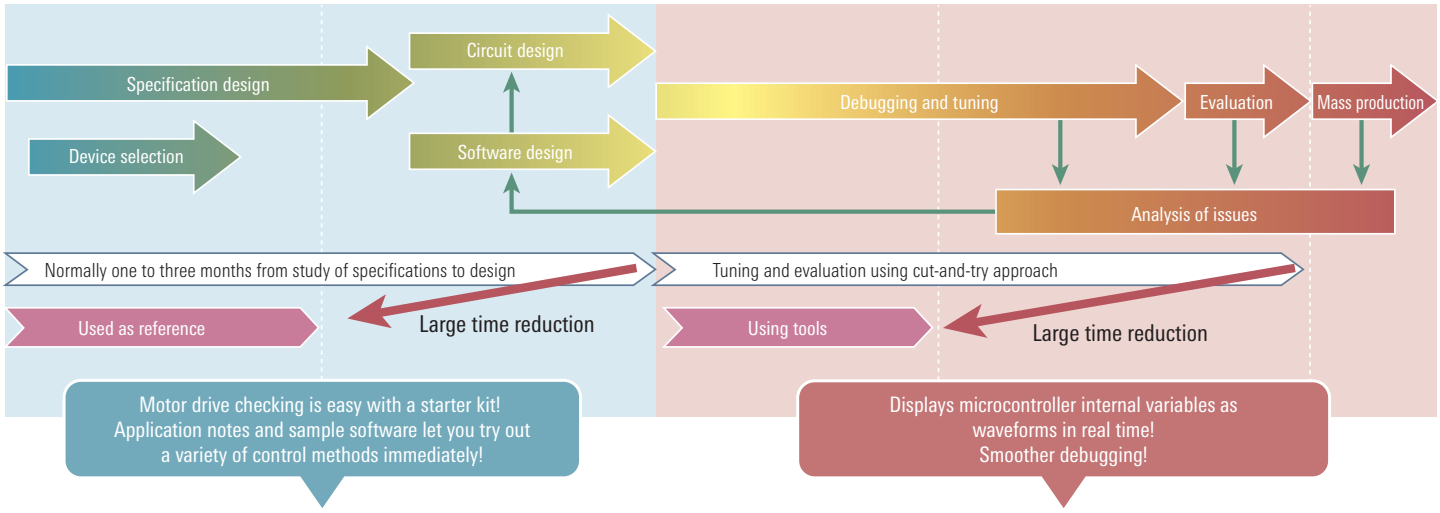
https://www.renesas.com/rx-security-solution

RX FAMILY SOLUTIONS

Motor Control Solutions

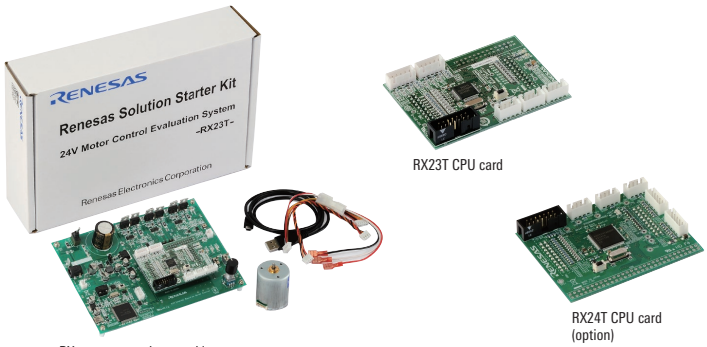
Renesas offers motor control solutions incorporating microcontrollers and analog products that are designed to enable reduced power consumption and quieter operation when driving brushless DC motors (permanent magnet synchronous motor) and stepping motors. Development tools optimized for each stage in the customer's development workflow are available. They help shorten the time needed for development.

Development Workflow



Motor Control Starter Kit (Renesas Solution Starter Kit)

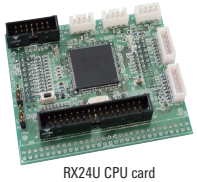
Just connect a power supply to get started checking your motor drive application.
This kit consists of a motor and an inverter board.*1
The provided "sample programs" are ideal for leaning about different control methods.



RX motor control starter kit
(24V Motor Control Evaluation System for RX)

RX23T CPU card

RX24T CPU card
(option)



RX24U CPU card
(option)

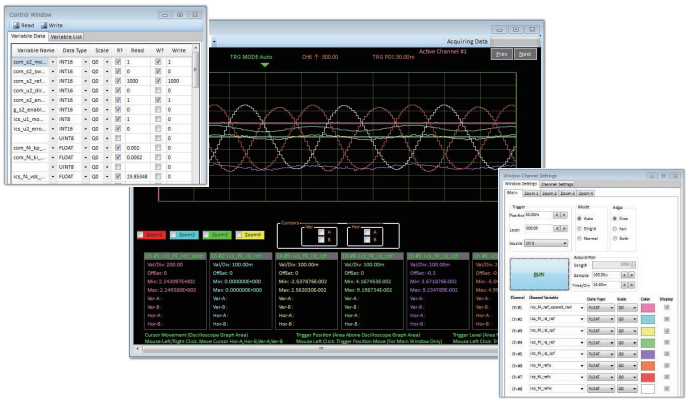
RX66T CPU card
(option)

RX72T CPU card
(option)

- Motor control board (populated with MCU, power elements, etc.)
  Target MCUs: RX23T, RX24T, RX24U, RX66T, RX72T, RX13T
- Brushless DC motor (permanent-magnet synchronous motor, 24V)*2
- Kit user's manual and sample software are available on the website.
  Available on website: Kit user's manual, circuit diagrams, parts lists, application notes, sample software

Motor Control Development Support Tool Renesas Motor Workbench

Analyzer function reduces the debugging workload. Tuner function enables simple vector control, even if you have no specialized knowledge.



Analyzer Function
- Realtime debugging tool that does not require halting the CPU
- Provides oscilloscope-like display for monitoring internal microcontroller information.

Tuner Function
- Automated measurement of motor-specific parameters
- Allows manual fine adjustment of PI gain after parameter identification

Related URL

Renesas motor control solutions: https://www.renesas.com/solutions/motor

Notes: 1. The RX23T kit does not include the E1 or a power supply. These must be provided by the customer. The RX62T kit includes the E1.
2. The specifications of the supplied motor differ depending on the kit. For details, refer to the product specifications of specific kit.

Resolver Position Control Solution

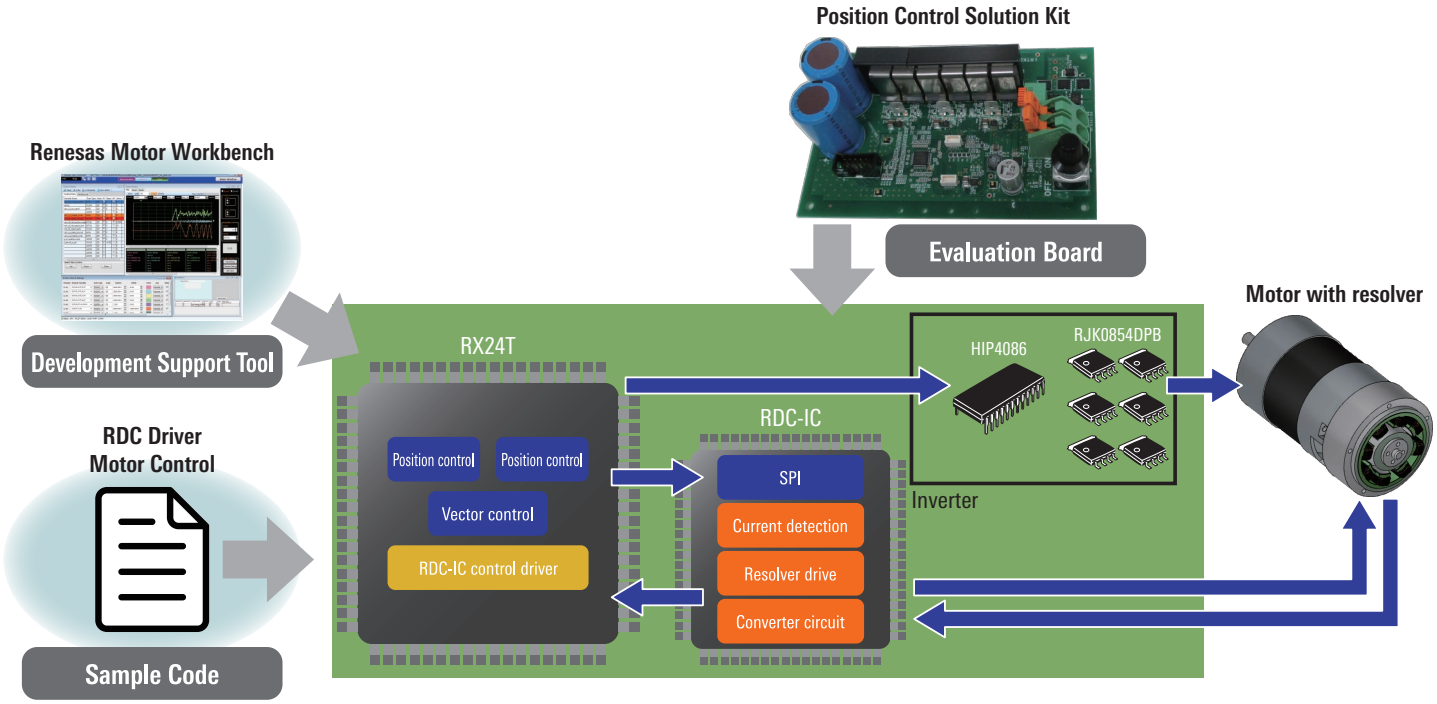
Resolver Solution Features

- Low current consumption and low heat generation: Uses the minimum current necessary for torque control, and cuts current consumption in standby mode.
  - Reduced energy consumption, allowing for simplified cooling
- Low noise and low vibration: Server control reduces torque ripple, for reduced noise and vibration.
  - Ability to reduce cost of mechanical elements such as dampers
- Reduced motor size: Server control eliminates the need for a step-out margin and increases the usable torque.
  - Ability to achieve the same torque with a smaller motor

Position Sensor Comparison

Comparison Item	Magnetic Encoder	Optical Encoder	Resolver + RDC IC
Position resolution (P/R)	Average	Good	Good
Environmental resistance (dust, vibration, impacts, magnetism, moisture/oil)	Average Affected by magnetism from motor	Bad Susceptible to vibration, impacts, and dust	Good Environmental resistance
Cost	Good Magnet + magnetic sensor + magnetic shielding and housing	Bad	Good Resolver + RDC IC
Overall evaluation	Average Suitable only for certain applications	Average Cost and environmental resistance	Good Performance, cost, environmental resistance

Kit Information



Selected Products		Detail
MCU	RX24T	80/100-pin
RDC-IC	RAA3064002GFP	LQFP48
S/W	- RDC Driver - Motor Control	Certified Sample
H/W	Solution Board	For evaluation Includes MCU, RDC, Inverter
Doc	Application Note	

RX FAMILY SOLUTIONS

Capacitive Touch Solutions

RX Capacitive Touch Functionality

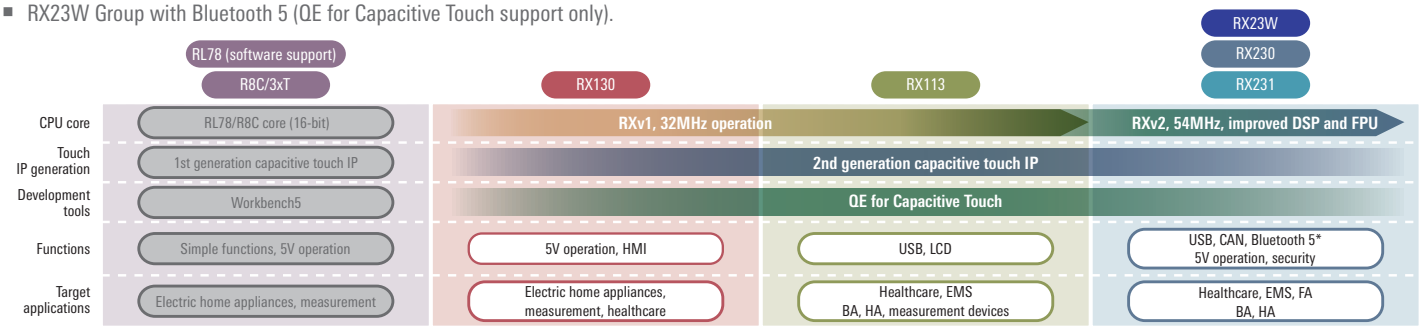
- Support for two capacitive touch technologies on a single chip:
  Self-capacitance, which provides high sensitivity and proximity sensing, and mutual-capacitance, which provides superior water resistance.
- Accurate touch input even in harsh environments and excellent design flexibility.
- QE for Capacitive Touch program simplifies development by letting you easily adjust the sensitivity of touch sensors, previously a complex task, and control system operation.

Features	Advantages for the User
High sensitivity/improved noise tolerance	Support for thick overlay panels or wood panels, operation when wearing gloves, and air gaps.
Improved water resistance	Enables capacitive touch operation in wet environments or outdoors.
Simple development	The development tool can generate detection programs automatically, provides self-calibration functions to shorten development time, and reduces resource requirements.

	Self-capacitance	Mutual-capacitance
Noise tolerance	✓	✓
High sensitivity	✓	–
Water resistance	–	✓

Roadmap

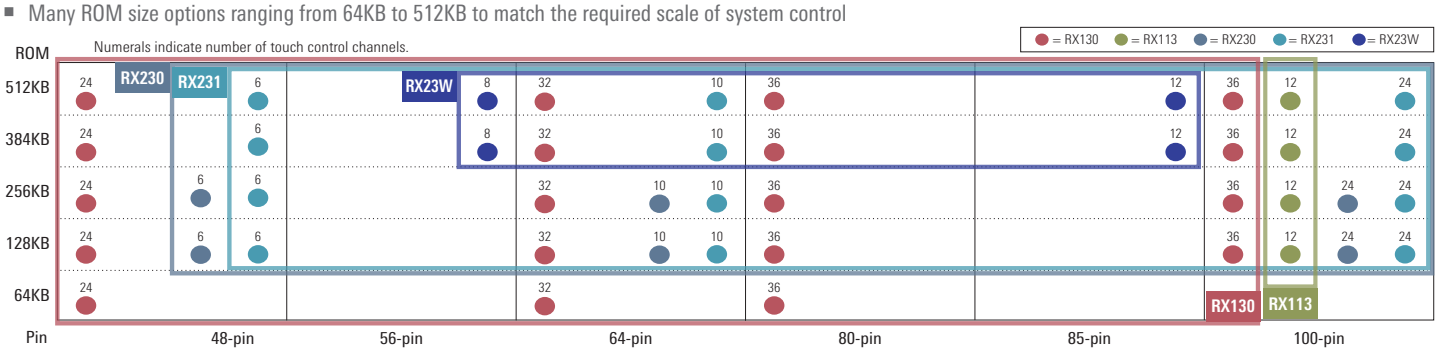
- More products with capacitive touch functions will be added to the RX Family moving forward.
- The RX130 group with small ROM capacity and low pin count can handle input from multiple touch controls.
- The RX113 Group has integrated LCD functions that can be combined with a touch panel to create an HMI.
- The RX231 and RX230 Groups combine the RXv2 core with enhanced DSP and FPU with low-power-consumption technology for superior power efficiency.
- RX23W Group with Bluetooth 5 (QE for Capacitive Touch support only).



*: Bluetooth 5 is RX23W only

Product Lineup

- Lineup of packages with pin counts from 48 to 100 pins to accommodate the number of touch controls required by the system and the mounting area
- Many ROM size options ranging from 64KB to 512KB to match the required scale of system control

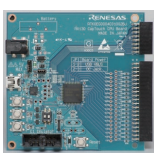


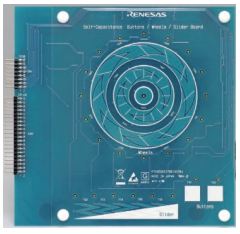
Capacitive Touch Evaluation System with RX130 (RTK0EG0003S02001BJ)

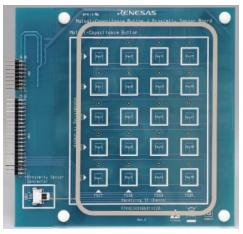
Start evaluating your capacitive touch system right away. Evaluation of custom electrodes can be accomplished easily through development on the application board side. For details, refer to www.renesas.com/RTK0EG0003S02001BJ.

[Product configuration]

- CPU board populated with RX130
- Touch application board
  Self-capacitance evaluation board
  Allows evaluation of controls such as wheels, sliders, and buttons employing self-capacitance.
  Mutual-capacitance matrix key + self-capacitance proximity sensor evaluation board
  Self-capacitance and mutual-capacitance controls can operate at the same time, opening up possibilities for a wide range of applications.
- USB cable
- Quick start guide


RX130 CPU board


Self-capacitance evaluation board


Mutual-capacitance matrix key + self-capacitance proximity sensor evaluation board

The following items are available on the Renesas website:
QE for Capacitive Touch, sample software, application notes, user's manual, circuit diagrams, pattern diagrams

Cloud Solutions

Alongside the rapid pace of technical innovations in networking, the emergence of IoT devices is accelerating in an array of fields and applications. By making use of a variety of sensor technologies data can be managed device by device, and it is now possible to obtain more types of device data than ever before. On the other hand, cloud-based services have become essential in order to efficiently process the enormous volumes of data involved.
Many manufacturers are deploying new technology to implement communications with the cloud, but the barriers to development are considered high. Renesas offers solutions that enable customers to easily build and evaluate cloud-based communication environments, allowing even customers with little experience in the development of IoT devices to get started with development work without delay.

Renesas RX65N Cloud Kit

powered by aws

This all-in-one evaluation kit is intended for use in the development and evaluation of devices that communicate with Amazon Web Services (AWS). It includes a board mounted with three types of sensors and Wi-Fi communication functions as well as a standard software program for transmitting sensor data to the AWS cloud at regular intervals.
www.renesas.com/rx65n-cloud

1. Certified for FreeRTOS.
2. Available from Renesas sales agents.
3. Wireless communication using Silex Wi-Fi module.
4. Send three types of sensor data (temperature/humidity, brightness, and three-axis accelerometer) to the AWS cloud and view a graphical display on Renesas Dashboard.*

*Renesas Dashboard: A Renesas system that allows users to view data sent to the cloud in graphical format on a web browser.

Renesas RX65N Cloud Kit

Renesas Starter Kit+ for RX65N-2MB

powered by aws

Enables customers to evaluate the AWS cloud by programming FreeRTOS, an embedded OS provided by AWS for IoT devices, to the RSK.*

1. Certified for FreeRTOS.
2. Free download from GitHUB.
3. Ethernet communication via wireless LAN.
4. Ability to use RX65N functions on RSK.*

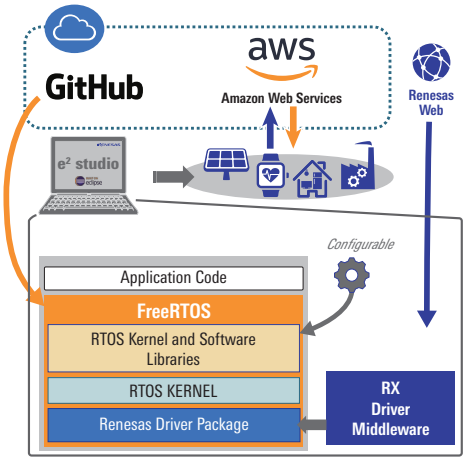
*RSK: Renesas Starter Kit+ for RX65N-2MB

Renesas Starter Kit+ for RX65N-2MB

e² studio with FreeRTOS Support

Use e² studio, the integrated development environment from Renesas, to download the latest verified FreeRTOS projects from GitHub and get started with development work right away.
www.renesas.com/e2studio

1. Generate and build the latest FreeRTOS sample projects from GitHub.
2. Provides assistance with network stack component library settings.
3. Easily add drivers and middleware to support USB, file systems, etc.



Integrated development environment e² studio

RX FAMILY SOLUTIONS

Human-Machine Interface (HMI) Solutions

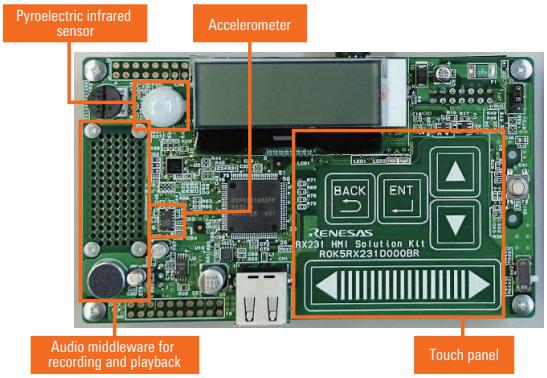
RX231 HMI Evaluation Kit (R0K5RX231D000BR)

www.renesas.com/rx231hmi

This reference solution simplifies the process of developing user interfaces for home appliances, industrial equipment, healthcare equipment, or office equipment. It enables you to create attractive designs and user-friendly interfaces.

- Highly power efficient 32-bit RX231 microcontroller with integrated capacitive touch and USB functionality
- SAIC101 Smart Analog IC for controlling 16-bit A/D converter, amplifier gain, etc., allowing evaluation of the following functions:
  - Capacitive touch functions
  - Audio recording and playback functions (audio middleware)
  - LCD panel (character)
  - Pyroelectric infrared sensor, accelerometer

Release notes (User's manual, circuit diagrams, parts lists, etc., are available for download on the Renesas website.)



RX65N/RX72N HMI Evaluation Kit (Envision kit)

www.renesas.com/envision

An all-in-one kit equipped with a WQVGA TFT-LCD makes it easy for customers to get started with GUI development.

- A debugger is provided, so a USB cable is all you need to perform debugging.
- Just launch the preinstalled demo to experience the capabilities of the 2D drawing engine.
- Segger emWin GUI tools are available for use free of charge.
- The RX72N version provides even higher performance and a larger memory capacity. Standard functions include onboard Wi-Fi, audio DSP, MEMS microphone, Ethernet, SD slot, and more.
- Includes sample code and video on GUI creation. Visit the Renesas website for details.

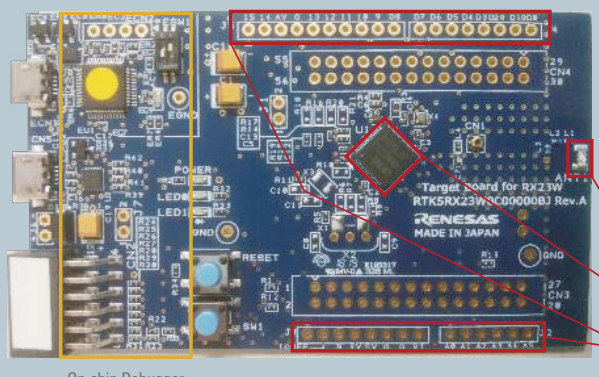
Topics (Target Board for RX)

RX Evaluation Kit Entry Model (Target Board for RX130, RX231, RX23W, and RX65N)

www.renesas.com/rxtb

Two types of RX evaluation board are available to match the needs of different users: a Renesas Starter Kit board or an RX Family target board. The RX Family target board is an entry model intended for new users of RX products and is mounted with an MCU and an on-chip debugger only. It can be used for inexpensive and simple RX MCU evaluation using free sample code such as FIT modules available on the Renesas website. In addition to the previously available RX130, RX231, and RX65N versions, a new RX23W version with Bluetooth® Low Energy has now been added to the lineup.

[RX23W Target Board]



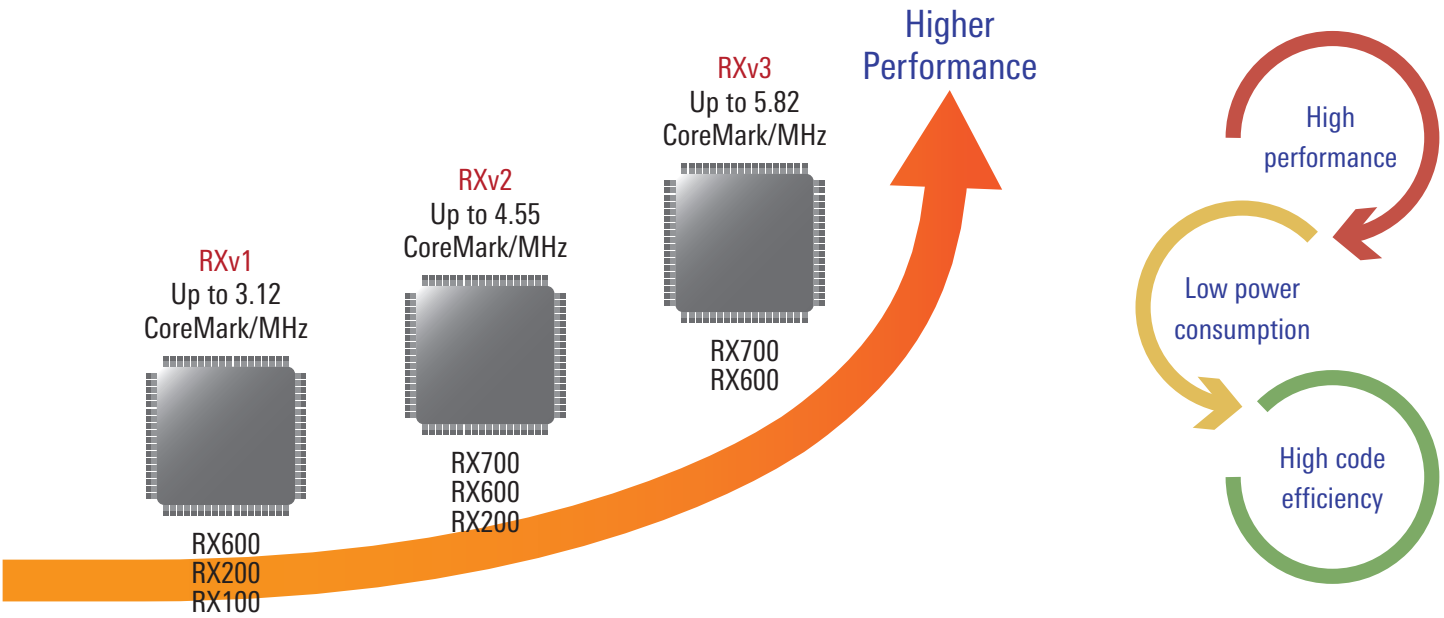
- **Built-in emulator circuit:**
  There is no need for the E2 Emulator or E2 Emulator Lite to perform application development.
- **Ability to access all MCU signal pins:**
  Pin header through holes are provided, allowing access to all MCU signal pins.
- **Arduino interface:**
  Arduino interface pin headers are provided to ensure expandability.

MEMO

RX CORE FEATURES

RX Core Roadmap

The need for increasing added value and system complexity demands higher microcontroller performance. At the same time, energy saving and longer battery life is also needed, so lower power consumption is also demanded. The RX core continues to evolve even further to meet these demands.



RX Family Features:
https://www.renesas.com/products/microcontrollers-microprocessors/rx/rx-features.html

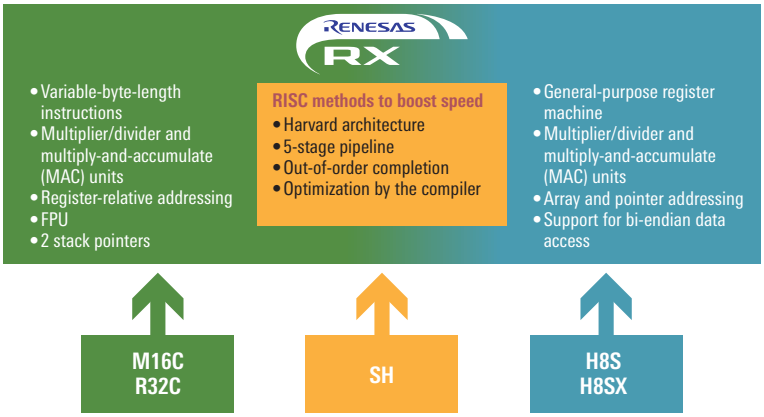
Comparison of RX Cores

Item	RXv1	RXv2	RXv3
Architecture	32-bit CISC, Harvard architecture		
General purpose registers	32bit × 16ch		
Compatibility	RXv1	Downward compatible with RXv1	Downward compatible with RXv1/RXv2
Instruction set	90 instructions	109 instructions (90 RXv1 instructions + 19 instructions)	113 instructions (109 RXv2 instructions + 4 instructions)
Pipeline	5-stage	Improved 5-stage pipeline Improved IPC through enhanced pipeline (enhanced performance through parallel execution of memory access and operations)	Improved 5-stage pipeline Improved IPC through enhanced pipeline (enhanced performance through improved combination of simultaneously executable instructions)
DSP function instructions	Single-cycle MAC instructions(16-bit), Accumulator × 1	Single-cycle MAC instructions (16-bit, 32-bit), Accumulator × 2	Single-cycle MAC instructions (16-bit, 32-bit), Accumulator × 2
FPU	Single-precision floating-point operation instruction	Single-precision floating-point operation instruction	Single precision / double precision floating-point operation instruction (double precision is optional)
Performance	Up to 3.12 CoreMark/MHz	Up to 4.55 CoreMark/MHz	Up to 5.82 CoreMark/MHz
Others	-	-	Register bank save function (optional) *Availability of optional functions depends on product specifications

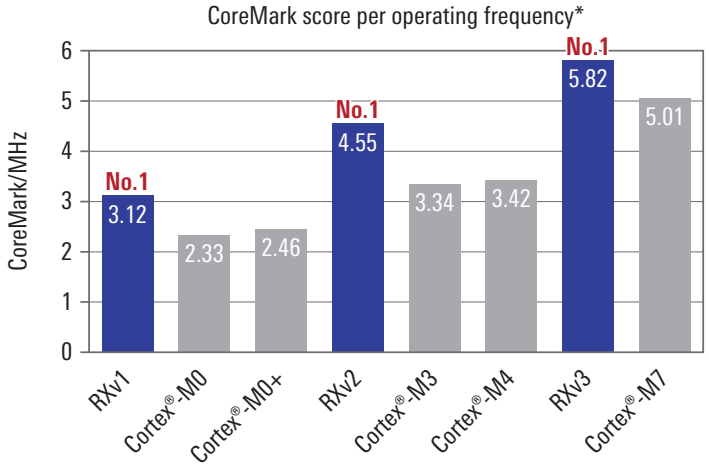
Feature 1: Original CPU That Inherits the Strengths of Its Predecessors

RX core combining advantages of CISC and RISC

- Combines the variable byte-length instructions of CISC with the general-purpose register machine, architecture, and pipelines of RISC. The RX CPU core brings together Renesas technology accumulated over many years.



Feature 2: RX CPU Core with Industry-Top-Class Performance



CoreMark/MHz value = 5.82

Superior embedded performance and power efficiency

RX core features

- CPU developed in-house for high operational efficiency.
- Five-stage superscalar architecture.
- Optimized for power efficiency and high performance.
- Processing capability and code efficiency on par with RISC.
- Improved interrupt responsiveness and FPU/DSP instructions.

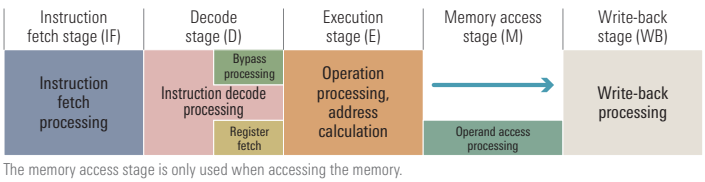
* Cortex®-M is the nominal value of Arm

Feature 3: Pipeline Stage Configuration

- Harvard architecture enabling parallel execution of instruction fetches and data accesses.
- Five-stage pipeline configuration and out-of-order completion for even faster execution. (Allows no-wait execution of later instructions when there is no dependency between later and earlier instructions.)

Pipeline Stage Configuration

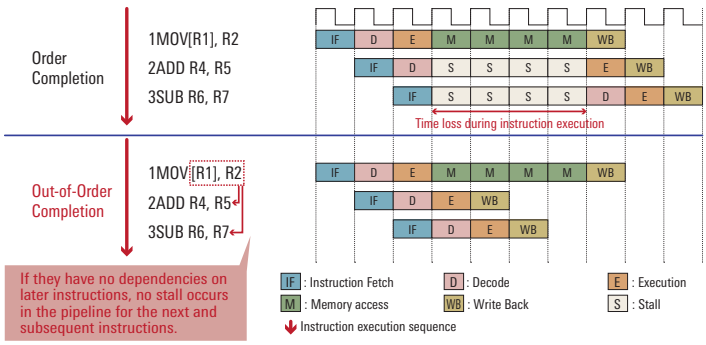
- 5-stage pipeline for faster processing
- Through benchmark testing of various types of application software, processing performance was more than doubled compared with earlier products.



The memory access stage is only used when accessing the memory.

Out-of-Order Completion

- Out-of-order completion boots the efficiency and speed of instruction execution.



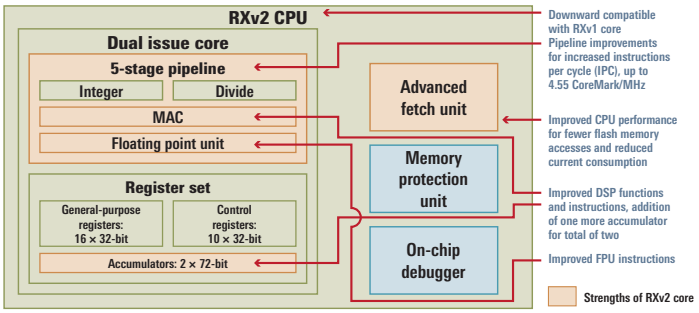
RXv2 CORE FEATURES

RXv2 Core: CPU Block Diagram

Further enhancements while maintaining compatibility with the RXv1 core

- Improved pipeline for substantial increase in the number of instructions per cycle (IPC)
- Advanced fetch unit with improved interface to on-chip flash memory. Reduces re-fetching of instructions due to penalty imposed by branch instructions and reduces the number of flash memory accesses. Achieves improved CPU performance alongside reduced power consumption.
- Improved instructions for DSP and FPU functions.

RXv2 CPU Block Configuration Diagram



Feature 1: Pipeline Enhancements

RXv2 Pipeline Processing Stage Configuration

Instruction fetch stage (IF)	Decode stage (D)	Execution stage (E)	Memory access stage (M)	Write-back stage (WB)
Instruction fetch processing	Bypass processing	Operation processing, address calculation		Write-back processing
	Instruction decode processing			
	Register fetch	FPU instruction	FPU instruction	
		Load/store	Memory access	

The memory access stage is only used when accessing the memory.

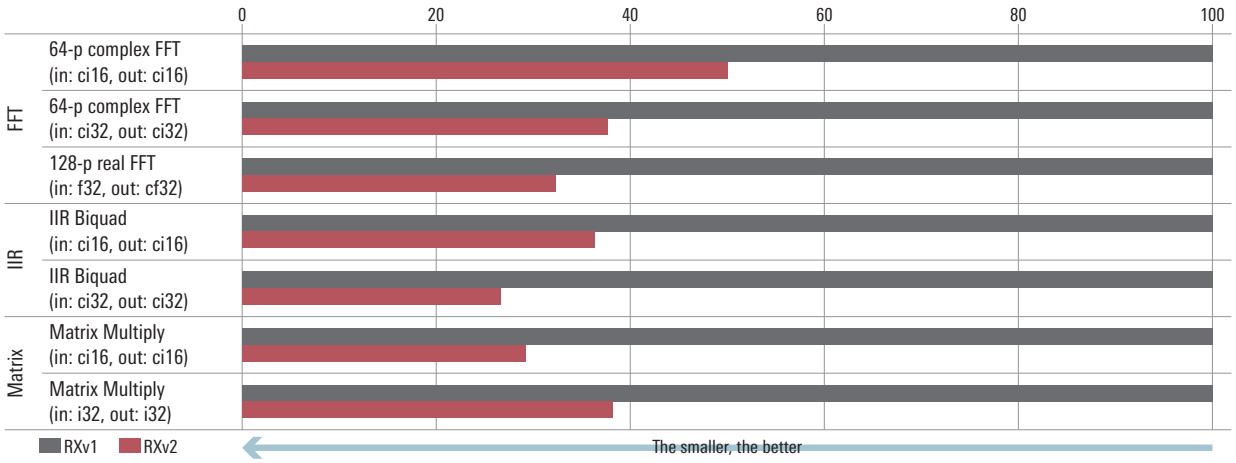
Improved pipeline processing and parallel execution of floating-point operations

- Floating-point operations take place in parallel during execution stages and memory access stages.
- Integer operation instructions and memory access or FPU instructions can execute at the same time.
- Contributes to improved FPU execution speed and CPU performance.

Feature 2: FPU and DSP Enhancements

Enhanced FPU and DSP functions

- Reduced execution cycle count for existing instructions and addition of new instructions.
- The number of accumulators with dedicated buffers has been increased from one to two for more efficient DSP operations.
- Performance in filter operations has been boosted fourfold.



FPU functions (new instructions added, existing instructions speeded up)	
New instructions	FSQRT (√), FTOU, UTOF
	Three-operand format
Speed [cycles]	FADD/FSUB: 4 cycles → 2 cycles FMUL: 3 cycles → 2 cycles
Single-cycle throughput	Pipelined FPU

Improvements are shown in red.

DSP functions (new instructions added, accumulator for operations added)	
32×32=acc, acc ±32×32=acc	EMULA, EMACA, EMSBA
16×16=acc, acc ±16×16=acc	HULLH, MACLH, MSB (LH, HI, LO)
Accumulator rounding instructions (16-/32-bit, round off/down)	RDACW, RDACL, RACL
Accumulator added	1 → 2

RXv3 CORE FEATURES

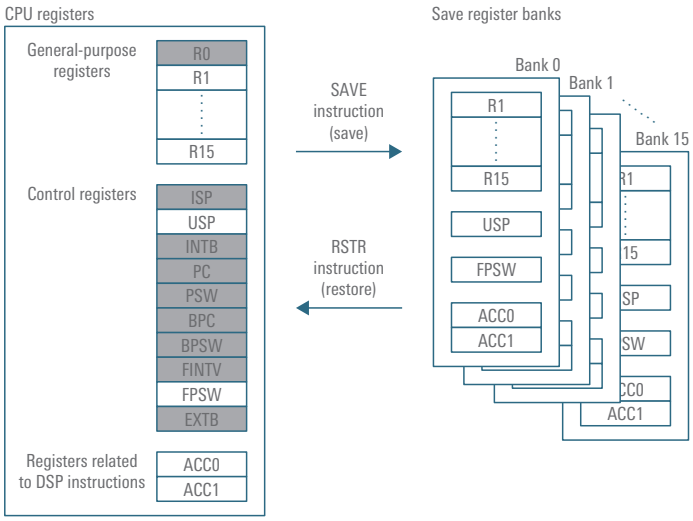
The successor to the RXv2 core, the RXv3 core boosts performance with new functions while adding a double-precision FPU and a register bank save function. These improvements enable it to achieve a score of 5.82 CoreMark/MHz on the EEMBC CoreMark® benchmark test, among the best CPU performance levels in the industry. The RXv3 core contributes to extremely fast and efficient operations in a wide array of applications requiring realtime processing.

Feature 1: Register Bank Save Function

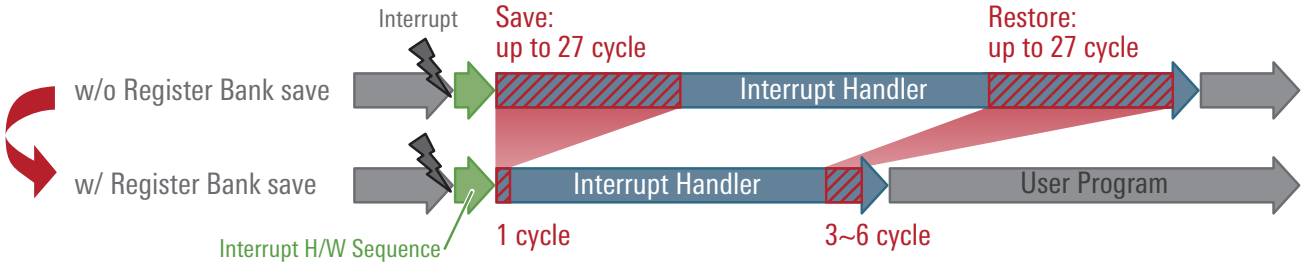
Dedicated memory for improved interrupt responsiveness

- Faster saving/restoring data to/from CPU registers and improved interrupt responsiveness.
- "Register save banks" provided as dedicated memory for register saves.
- Dedicated instructions (SAVE and RSTR) for accessing the register save banks.
- Number of register save bank areas: 16 (RX72T)*1

Note: 1. Number of banks differs among products.

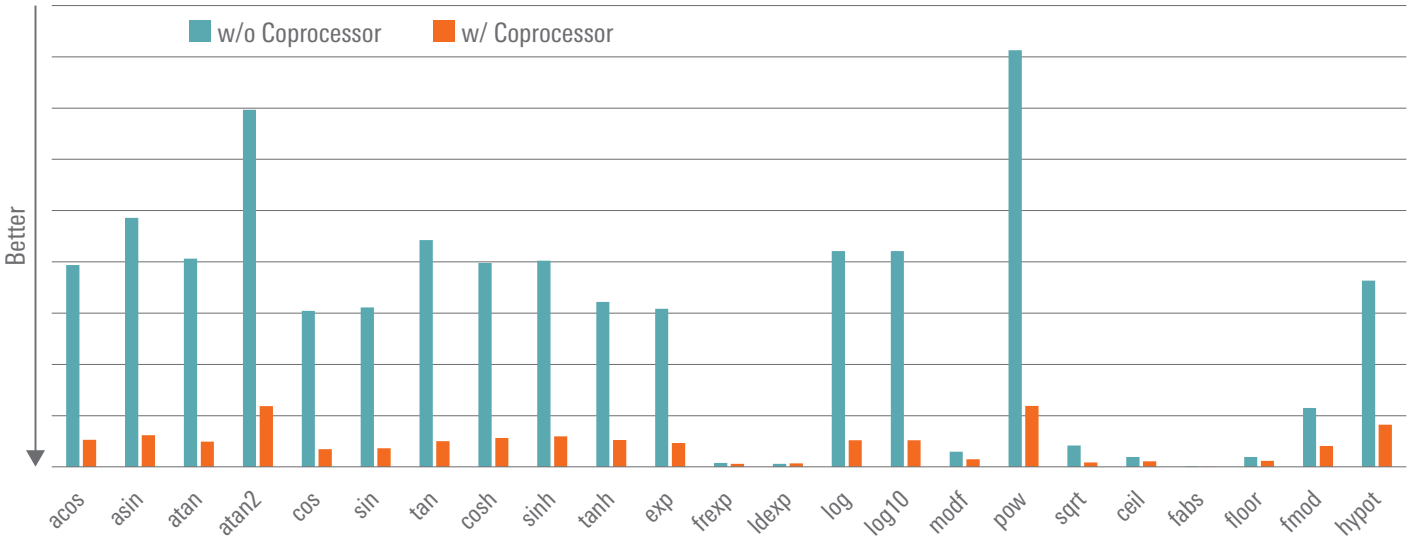


Comparison with conventional product (saving data to all registers)



Feature 2: Double-Precision FPU Support

- First RX Family CPU core with a double-precision floating-point processor.
- Greatly improved processing performance in double-precision floating-point operations (up to eight times better).



RX700/RX600 SERIES

Features of RX700/RX600 Series

High-performance, High-speed response

1396CoreMark @240MHz
Double precision FPU coprocessor
Trigonometric functions arithmetic unit
Register bank save function

Large-capacity

4MB Flash
(Dual bank function)
1MB SRAM

Numerous peripheral functions

Various communication interfaces
3-phase complementary PWM timer
12-bit A/D converter
TFT LCD controller
2D rendering engine
Trusted Secure IP

Various solutions

HMI
Cloud
Security
Functional safety

Main Applications of RX700 and RX600 Series

Industrial

Robots, Machine tools

General-purpose inverters

PLC

Smart meter

Power conditioner

HVAC controller

Security controller

Office Automation

Copiers
Printers

Projector

Consumer

Camera body
Lens

Audiovisual equipment

Air conditioner (outdoor unit, indoor unit)

Lineup of RX700 and RX600 Series

RX72M

240MHz, 4MB Flash, 1MB SRAM
176/224-pin

RXv3 | Double precision FPU | Register bank save | Trigonometric functions arithmetic unit | IEEE1588 | EtherCAT slave

RX72N

240MHz, 4MB Flash, 1MB SRAM
100/144/145/176/224-pin

RXv3 | Double precision FPU | Register bank save | Trigonometric functions arithmetic unit | IEEE1588

RX66N

120MHz, 4MB Flash, 1MB SRAM
100/144/145/176/224-pin

RXv3 | Double precision FPU | Register bank save

RX65N/ RX651

120MHz, 2MB Flash, 640KB SRAM
64/100/144/145/176/177-pin

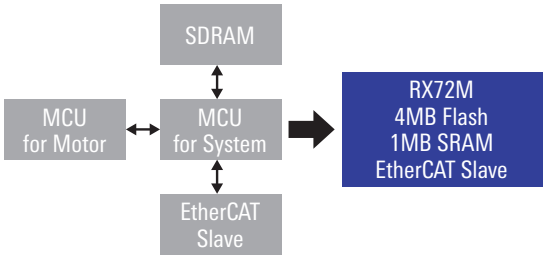
RXv2 | Single precision FPU

Common functions

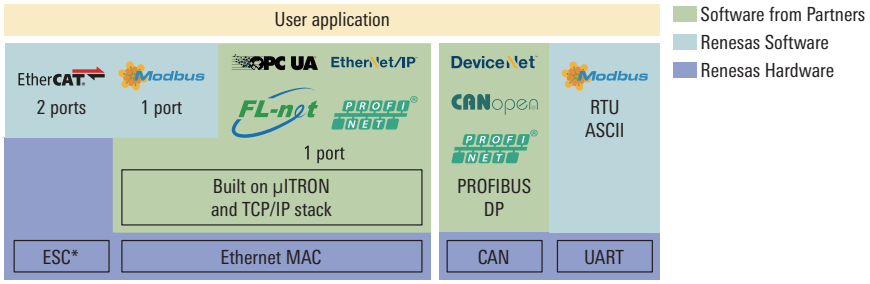
- Dual bank
- Quad SPI
- Ethernet
- GLCDC
- USB
- Trusted Secure IP
- CAN
- 12-bit ADC
- SD host I/F

RX72M and RX72N: Flagship Models with Support for a Variety of Industrial Networking Standards

- EtherCAT slave control* and high-precision time synchronization control for multiple industrial motors implemented on a single chip, enabling more compact product design.
- Full 1MB of on-chip SRAM. Enables high speed execution of middleware for TCP/IP, web server, file system, etc., without need for external memory.
- Supports a variety of industrial network protocol stacks in addition to EtherCAT. Flexible support for diversifying protocol requirements.



4MB flash memory, 1MB SRAM, and EtherCAT slave controller* on-chip.

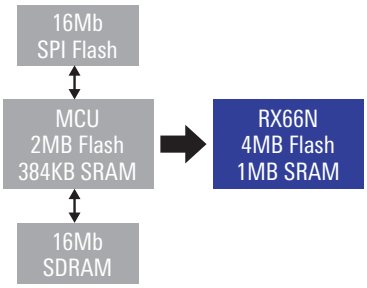


Protocol stacks from Renesas and from partner vendors provide coverage for major industrial network standards.

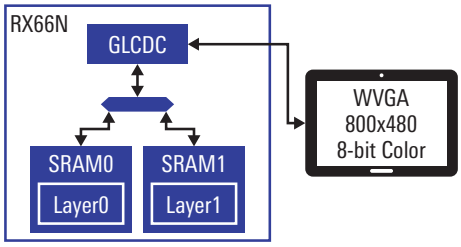
* EtherCAT slave controller (ESC) available on RX72M only.

RX66N: Successor to RX65N and RX651 with Enhanced CPU and On-Chip Memory

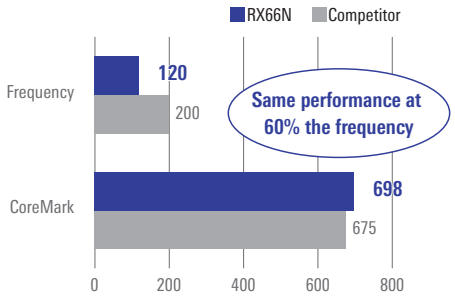
- The industry's only MCU to combine 4MB of flash memory and 1MB of SRAM. Ability to implement a broad range of functions without external memory.
- Dual-plane SRAM (512KB + 512KB) configuration, allowing smooth display performance on WVGA (800 × 480, 8bpp) displays.
- The RXv3 core delivers excellent performance per unit of operating frequency, achieving performance when operating at 120MHz equivalent to that of competing MCUs operating at 200MHz.



Large-capacity code area and work area on a single chip



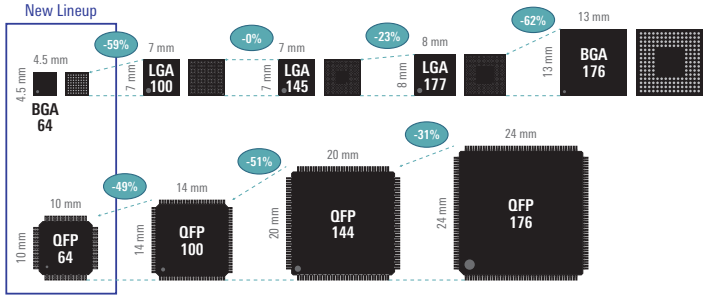
Ability to control a WVGA display without external memory



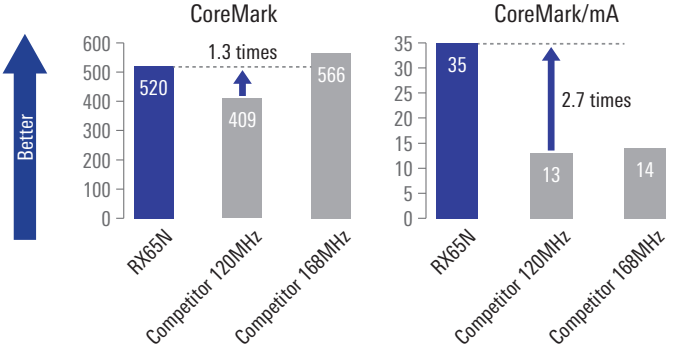
High-performance (5.82 CoreMark/MHz) RXv3 core

RX65N and RX651: A Broad Lineup of Mainstream Models

- Broad lineup with 512KB, 768KB, 1MB, 1.5MB, or 2MB of flash memory and pin counts of 64, 100, 144, 145, 176, or 177 pins.
- Large memory capacity in a 4.5mm-square, 64-pin ultracompact package. Reduces the number of components required in compact IoT devices with limited mounting area.
- High-performance RXv2 core and state-of-the-art 40nm process deliver excellent performance and overwhelmingly superior power efficiency compared with competing MCUs.



All packages (other than 176-pin) are available in flash memory capacities ranging from 512KB to 2MB.
(176-pin model is available in 1.5MB and 2MB versions only.)



Ideal for IoT devices, with CPU performance exceeding that of competing MCUs and overwhelmingly superior power efficiency.

RX200 SERIES

Features of RX200 Series

Both low power consumption and high performance

54MHz
0.12mA/MHz operation

Wide voltage range and external bus

1.8-5.5V
8/16-bit external bus

Robust security and networking/sensors

Trusted secure IP
Bluetooth
Industrial sensor

Various solutions

Functional safety
HMI
Capacitive touch
Security

Main Applications of RX200 Series

Consumer (battery drive)

Digital cameras
Gadgets

Healthcare

Wearable devices
Blood glucose meter

Industrial

Power meters
Pressure, temperature,
and flow volume meters Inverters

Home appliances

Air conditioners
Refrigerators
Washing machines

Lineup of RX200 Series

RX23W 54MHz, 512KB Flash

RXv2 | Single precision FPU | CAN | USB | SDHI | Capacitive touch | Security | Bluetooth

RX23E-A 32MHz, 256KB Flash

RXv2 | Single precision FPU | CAN | USB | SDHI | High-precision AFE

RX231 54MHz, 512KB Flash

RXv2 | Single precision FPU | CAN | USB | SDHI | Capacitive touch | Security

RX230 54MHz, 256KB Flash

RXv2 | Single precision FPU | Capacitive touch

Excellent Balance of Low Power Consumption and High Performance

Excellent Balance of Low Power Consumption (0.12 mA/MHz) and High Performance (4.33 CoreMark/MHz)

Power consumption

- During operation
  0.12mA/MHz*
- During standby with RAM contents retained 0.8µA
- Fast recovery
  Min. 5µs*

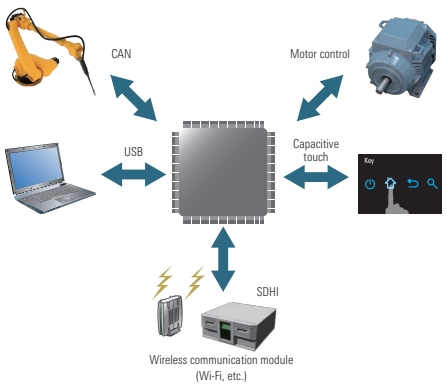
Processing performance

- RXv2 core
  4.33 CoreMark/MHz
- DSP/FPU instruction extension*

* Example of RX231, details of other products differ.

Peripheral Functions for Home Electronics, Industrial, and IoT Applications

Equipped with functions suitable for capacitive touch, communication, and motor control applications. In addition to support for control and manipulation, implementation of IoT capabilities is simplified.



RX23W Concept and Platform

High Performance CPU, Security, and Wireless Communications on a Single Chip

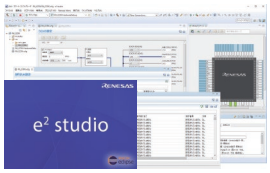
www.renesas.com/rxble

High performance RXv2 core capable of controlling multiple systems, Trusted Secure IP implementing robust security functions, and Bluetooth 5.0 Low Energy with enhanced connectivity functions, all on a single chip.

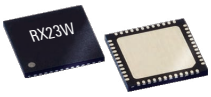
High Performance RXv2 Core | Trusted Secure IP | Bluetooth 5.0 Low Energy Full Function | Implemented on a single chip

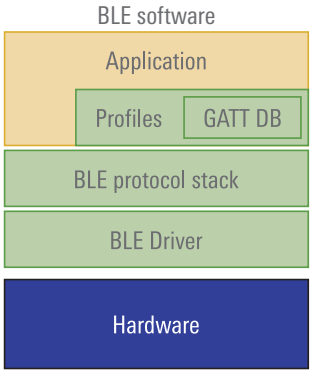
Application development platform

Performance evaluation and certification platform

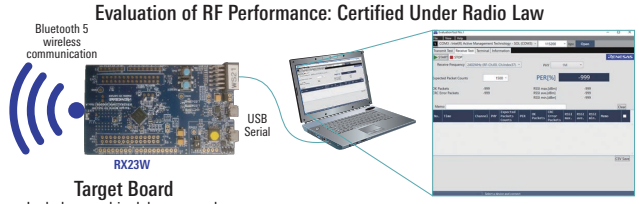


Generates custom profile driver and protocol stack.





Evaluation of RF Performance: Certified Under Radio Law



Target Board
Includes on-chip debugger and provides access to all MCU signal pins.

Bluetooth Trial Tool Suite
Evaluation tool to control RX23W

BLE communication evaluation

GATTBrowser
Smartphone app to communicate with RX23W

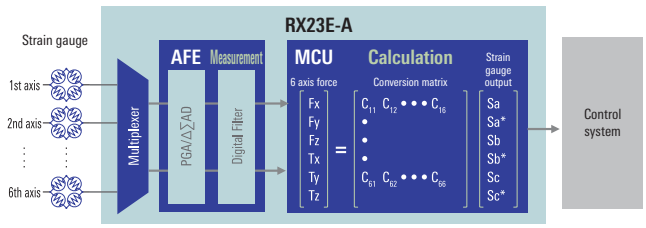
Also displays definition information exclusive to Renesas.

RX23E-A Concept and Target

High-Precision AFE and High-Performance MCU on a Single Chip

- High-precision AFE ideal for industrial applications such as temperature and distortion measurement.
- High-performance MCU suitable for digital signal processing.
- Rich communication interface provides more freedom in system and board design.

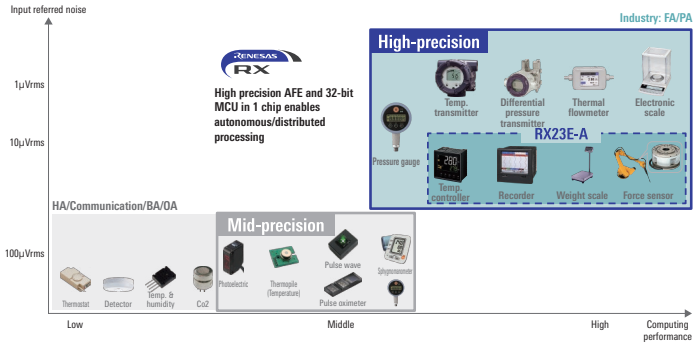
Application Example (Force Sensor)



The amount and direction of force are calculated from data input from a distortion gauge and sent to the control system.

For Sensor Devices Demanding High-Precision Analog Characteristics

Sensor devices requiring an ADC with low noise, low drift, and high effective resolution are the target.



RX100 SERIES

Features of RX100 Series

Power consumption among the lowest in the industry

32MHz
0.35μA standby

5V power supply support
Segment LCD support

5V power supply support
Segment LCD support

Superior cost/performance ratio

Low-pin-count/
small-ROM-capacity versions
Integration of peripheral ICs

Various solutions

Functional safety
Capacitive touch

Main Applications of RX100 Series

Consumer (battery drive)

Sensor hubs
(smartphones, game consoles, PCs, tablets),
digital cameras, digital camcorders

Healthcare

Healthcare devices,
wearable devices

Home appliances

Cooking appliances,
water heaters

Industrial

Power meters,
detectors (smoke detectors, etc.),
pressure gauges, thermostats

Lineup of RX100 Series

RX130 32MHz, 512KB Flash

RXv1 | 12-bit A/D | Capacitive touch | 5V

RX113 32MHz, 512KB Flash

RXv1 | 12-bit A/D | USB | Segment LCD | Capacitive touch

RX111 32MHz, 512KB Flash

RXv1 | 12-bit A/D | USB

RX110 32MHz, 128KB Flash

RXv1 | 12-bit A/D

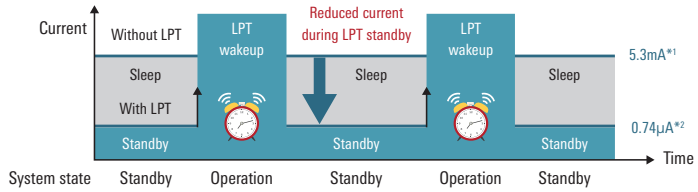
Power Consumption Among the Lowest in the Industry

Ultralow current consumption during standby and during operation

Standby current : 0.35µA
Normal operation current: 0.1mA/MHz
Recovery time : 4.8µs

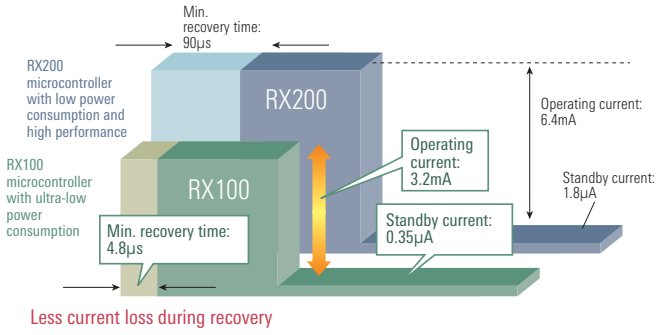
Low-Power Timer (LPT) for Reduced Standby Current During Intermittent Operation

- LPT generates wakeup events to recover from standby mode.
- Current can be transitioned to standby state in standby periods during intermittent operation.

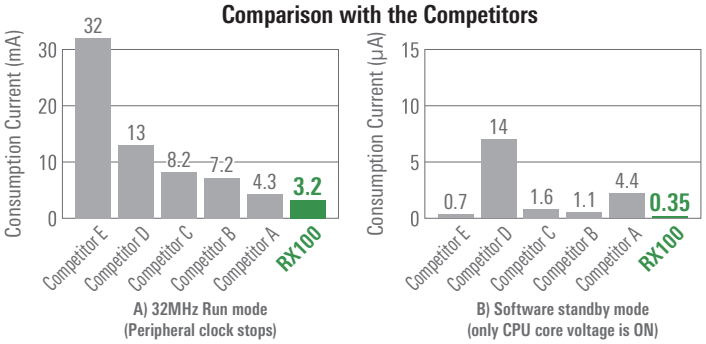


Notes: 1. Current value during all-peripheral operation at 32MHz on the RX130.
2. Current value including LPT operating current (0.37µA) on the RX130.

Comparison of Current Consumption in RX Family

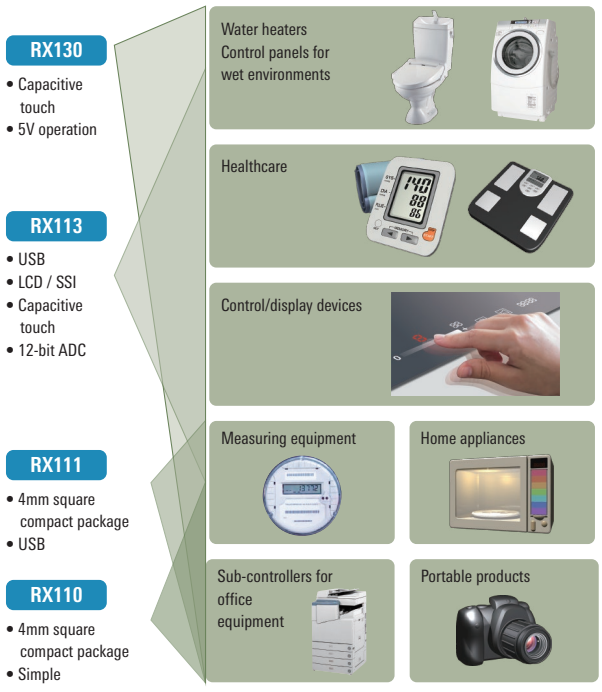


Comparison with the Competitors



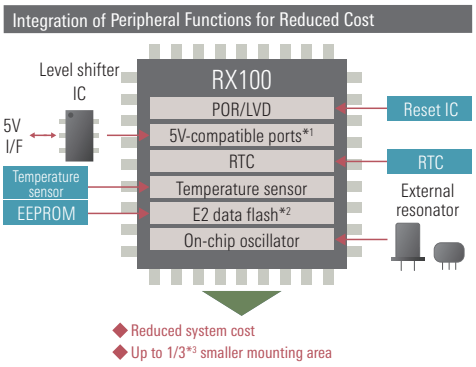
Essential Peripheral Functions for Measuring Equipment and Household Appliances

- Integrates peripheral functions suitable for measuring equipment and household appliances, such as capacitive touch/LCD, communication, and 12-bit ADC.
- Support for applications ranging from system control in household appliances or industrial equipment to user interfaces for wet environments.



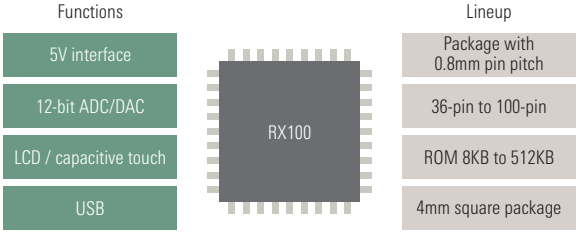
Superior Cost/Performance Ratio

- Performance reduced to cut power consumption and lower costs.
- Lineup includes low-cost products with low pin count and small ROM capacity.
- Integration of peripheral functions reduces BOM cost.



Notes: 1. The 5V-tolerant ports of the RX110, RX111, and RX113 are compatible. The RX130 has a maximum power supply voltage of 5.5V, so all its ports are compatible.
2. The RX110 has no E2 data flash.
3. Comparison with Renesas system product.

Functions and Lineup Selected for Enhanced Flexibility



RX FOR MOTOR CONTROL (RX-T)

Features of RX for Motor Control (RX-T)

Broad lineup

32MHz to 200MHz
1 motor to 4 motors
Highly compatible pin assignments

5V power supply support External bus

5V power supply support
External bus

Analog circuit to extract full performance potential

Three-channel simultaneous sample-and-hold circuit
PGA
Comparator

Specialized motor control functions

Three-phase complementary PWM output
Timer output emergency stop
Trigonometric function unit

Main Applications of RX for Motor Control (RX-T)

Industrial

Robots, Machine tools

General-purpose inverters

Meters

Building automation

Office Automation

Copiers
Printers

Home appliances

Air conditioners
Refrigerators
Washing machines

Lineup of RX for Motor Control (RX-T)

RX72T 200MHz, 1MB Flash

RXv3	Single precision FPU	Motors 3 to 4	Pseudo-differential PGA	Register bank save	Trigonometric functions arithmetic unit	CAN	USB	Security

RX66T 160MHz, 1MB Flash

RXv3	Single precision FPU	Motors 3 to 4	Pseudo-differential PGA			CAN	USB	Security

RX24U 80MHz, 512KB Flash

RXv2	Single precision FPU	Motors 2 to 3	Pseudo-differential PGA			CAN		

RX24T 80MHz, 512KB Flash

RXv2	Single precision FPU	Motors 2 to 3	PGA			CAN		

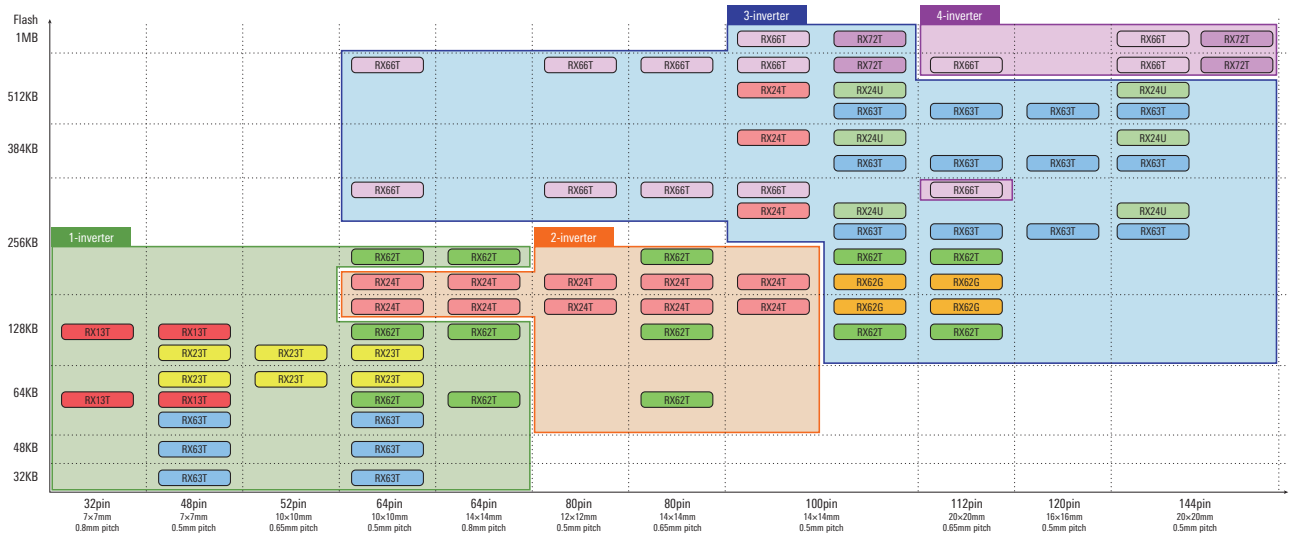
RX23T 40MHz, 128KB Flash

RXv2	Single precision FPU	Motors 1						

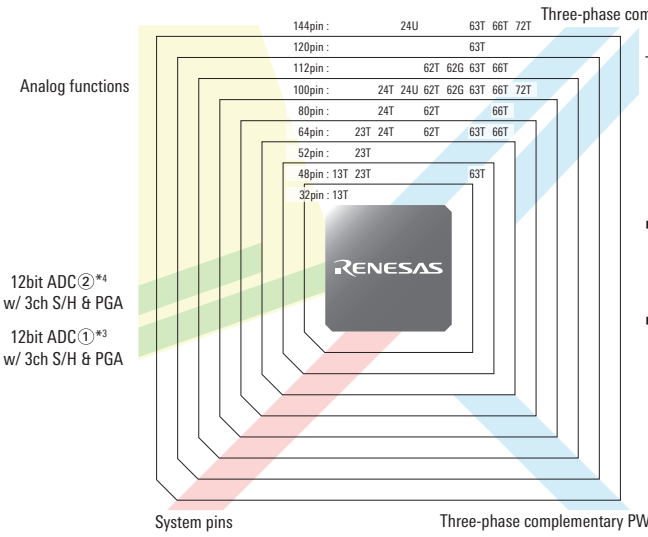
RX13T 32MHz, 128KB Flash

RXv1	Single precision FPU	Motors 1	PGA					

RX for Motor Control (RX-T) Product Lineup



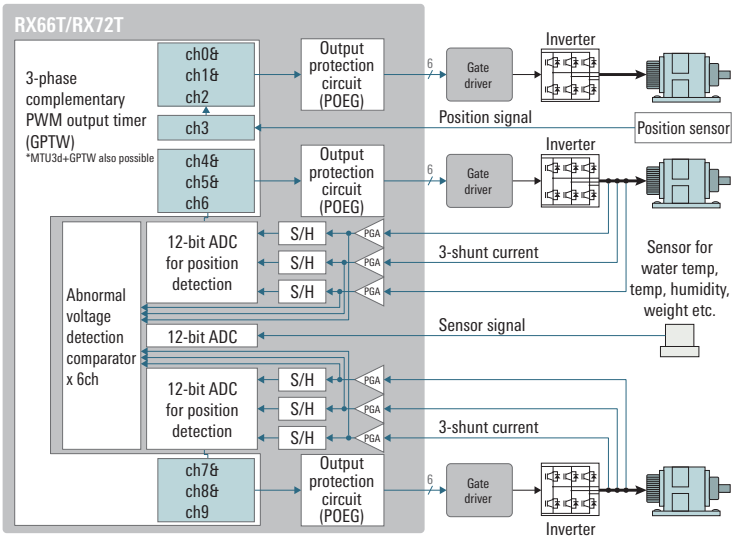
Allocation of Resources Specially for Motor Control



- Pin assignments that simplify design and layout
  - Six pins for three-phase complementary PWM output arranged side-by-side.
  - A/D converter input pins (with simultaneous three-channel sample-and-hold support) arranged side-by-side by unit.
- Consistent approach to motor control–related pin assignments across all RX devices designed for motor control

Notes: 1. Pin assignments provided on RX24T/U, RX62T/G, RX63T (some product versions), RX66T, and RX72T.
2. Pin assignments provided on products with GPT, except RX62T 64-pin products.
3. PGA function provided on all products, except RX23T and RX63T (some product versions).
4. Pin assignments provided on RX62T/G, RX63T (some product versions), RX66T, and RX72T.

Application Example Controlling Multiple Motors with a Single Chip



1. Control 3 inverters in a single chip
   GPTW timer for multiple 3-phase complementary PWM outputs
   (3-inverter drive, compatible register setting)
   *MTU3d can also drive 2 inverters
   *MTU3d+GPTW can drive up to 4 inverters
   (only 112/144-pin)
2. Enable 3-shunt x 2 current detection at the same time
   - Can control 3-shunt inverter×2 with PGA & S/H x 6 at the same time.
     PGA (pseudo differential input mode) reduces common noise substantially.
   - ADC 3 unit
3. Less external parts required
   Including reset circuit, E2PROM, op-amp, comparator
4. Designed to improve safety
   - Comparator x 6ch for PWM forced cutoff
   - Output protection circuit dedicated to GPTW
5. Support function safety
   Functions to support IEC60730 Safety Standard for Household Appliances class B (Fail-safe).
   System fail-safe with less software load

Target Application:
High-end air conditioner / washing machine, general-purpose inverter, robot etc.

PGA: Programmable gain amp, S/H: sample & hold circuit
* The left figure only shows an image, not the actual layout.

RX FAMILY MOTOR CONTROL

Motor Types and Recommended Microcontrollers

	Consumer/office equipment				Industrial					
	 Air conditioners	 Washing machines	 Refrigerators	 Printers/ multifunction units	 Pumps	 Fans	 Surveillance cameras	 General-purpose inverters	 Robots/ machine tools/ industrial motors	 AC servos
Motors	BLDC IM	BLDC IM	BLDC IM	BLDC STM	BLDC IM	BLDC IM	BLDC STM	BLDC IM	BLDC STM	BLDC
Recommended microcontrollers	RX200	RX100 RX200	RL78 RX100 RX200	RL78 RX100 RX200	RL78 RX100 RX200	RL78 RX100 RX200	RL78 RX100 RX200	RX200 RX600 RX700	RX100 RX200 RX600 RX700 RZ/T1	RX600 RX700 RZ/T1

BLDC: Brushless DC motor, IM: AC induction motor, STM: Stepping motor

Motor Types, Control Methods, and Recommended RX Series

Motor type	Control method	Necessary functions	Performance required by application and recommended RX microcontroller			
			Up to 20MHz	Up to 50MHz	Up to 100MHz	Over 100MHz
			RX100	RX200	RX200 (RX24T/U) RX600	RX700 RX600
Brushless DC motor	Vector control (180-degree conducting control)	PWM × 6, dead time generation, POE, A/D converter (PWM link)	Compact industrial motors	Compact robots, surveillance cameras, general-purpose inverters, printers/multifunction units		General-purpose inverters, machine tools, industrial robots, AC servos
				Washing machines (1-motor), refrigerators (1-motor), pumps, compressors	Air conditioner outdoor units (2-motor), washing machines (2-motor)	
			Fans, drone			
	Square wave control (120-degree conducting control)	PWM × 6, A/D converter	Refrigerators, fans, compact robots	Refrigerators, pumps, compressors		
AC induction motor	Vector control	PWM × 6, dead time generation, POE, A/D converter (PWM link)		Industrial pumps	General-purpose inverters (fans, pumps)	
	V/f control		Fans, refrigerators, washing machines pumps	Air conditioner outdoor units, pumps	General-purpose inverters (fans, pumps)	
Stepping motor	Pulse output	Port control or PWM control	Printers/multifunction units, surveillance cameras		Industrial motors	
	Vector control (resolver)	PWM × 4, dead time generation, POE, A/D converter		Compact robots, carrier machine, textile machine, printers/multifunction units		Industrial robots and AC servos for low-end

Motor Control by RX

RX delivers high-speed arithmetic performance alongside MTU2 or MTU3, GPT timer, 12-bit A/D converter, and POE functions to simplify the process of implementing motor control.

High-speed arithmetic operations (RX core)

High-speed vector calculations
- High-speed processing at 240MHz
- FPU for high-speed floating point operations
- TFU for high-speed trigonometric functions
  - single-precision floating point
  - sin, cos, arctan, sqrt (x2+y2)
  - Fast/fixed cycle operation

*Only RX72T/RX72M/RX72N supports TFU

Waveform control/feedback control (MTU2 and MTU3, GPT, etc.)

PWM waveform output
- PWM output with 0 to 100% duty
- 3-phase complementary PWM waveform output
- Automatic insertion of dead time
- A/D activation at user-defined timing for 1-shunt current detection

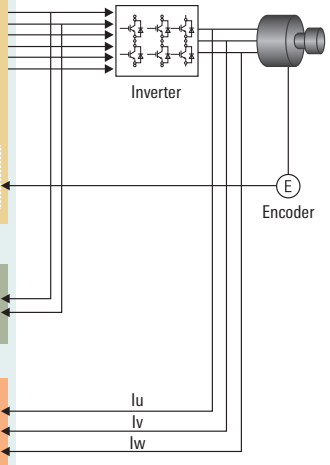
Feedback control
- Acquisition of feedback information (position/rotation rate) from encoder

Disable control output signals (POE)

Disable output signals for the MTU and the GPT without using software.
- Forcibly disable complementary PWM output and realize fail-safe

Feedback control (high-speed 12-bit A/D converter)

Acquisition of feedback information using motor current
- High-speed (1.0µs) 12-bit A/D converter
- Simultaneous sampling of three tracks for 3-shunt current detection
- Reduce BOM by using built-in comparator and PGA (some products)



Examples of Motor Control Functions Provided by RX

Description		For motor control				For General-Purpose, Sensor, and Network Applications						
		RX23T/RX24T/RX24U	RX13T	RX66T	RX72T	RX111/RX113	RX130/RX220	RX230/RX231/RX23E-A	RX23W	RX651/RX65N	RX64M/RX66N/RX71M	RX72N/RX72M
Waveform output control	PWM output with 0 to 100% duty	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Synchronous output on multiple channels	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Chopping or level waveform output in AC synchronous motor drive mode	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	3-phase complementary PWM output with dead time (left-right symmetric dead time amplitude)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	3-phase complementary PWM output with dead time (left-right asymmetric dead time amplitude)	✓	✓	✓	✓						✓	✓
	High-resolution PWM output			✓	✓							
Feedback detection	Phase counting mode	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	High-speed 12-bit A/D converter using sequential conversion	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	A/D converter activation requests at user-defined timing (for 1-shunt current detection)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	12-bit A/D converter double-trigger function (storage of data from two conversions in separate registers)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	12-bit A/D converter with simultaneous sampling of three tracks	✓	✓	✓	✓					✓	✓	✓
Acceleration	Compare match and A/D conversion start request skipping function	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	FPU for high-speed arithmetic operations	✓	✓	✓	✓			✓	✓	✓	✓	✓
	Double buffering function (provision of two register buffer stages for compare match operation)	✓	✓	✓	✓					✓	✓	✓
Safety functions	Error detection and PWM output auto-cutoff using port output enable	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Other	Compare match/input capture	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	5V power supply	✓	✓	✓	✓		✓	✓				
	32-bit counter support	✓	✓	✓	✓					✓	✓	✓
	Trigonometric functions arithmetic unit				✓							✓

RX FAMILY DEVELOPMENT TOOLS

Development Tools Designed to Maximize the Features of the RX Family

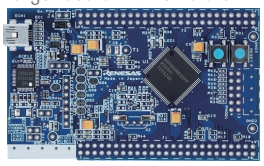
Renesas supports all stages of the development of RX applications by supplying integrated development environments, real-time OSes, middleware, and programming tools that dramatically enhance the development process. Renesas integrated development environments enable you to accomplish coding, building, and debugging tasks quickly and easily, helping to reduce system development time.

Introduction

Free evaluation versions

Free evaluation versions of tools, sample software, application notes

Low price.
Target board with emulator



Low price.
Evaluation board kit with LCD

Renesas Cloud Kit for testing AWS

A growing selection of starter kits you can start using immediately

Development

Renesas offers two integrated development environments to match the customer's system.

Integrated development environment e² studio

Provides a large number of functions. Development environment based on Eclipse. Supports compilers from IAR Systems and the GNU Project in addition to Renesas. Now supports FreeRTOS.

Integrated development environment CS+

A stable, proprietary Renesas development environment initially developed nearly a decade ago. Supports Renesas compiler. Will continue to support Renesas devices in the years ahead.

Build

RENESAS — Renesas C/C++ Compiler Package for RX Family (CC-RX) (node locked and floating license versions)

IAR SYSTEMS — Compiler from IAR Systems

GNU Tools — GNU compiler

Coding (OS)

RENESAS — Embedded OS with the best established track record in Japan and conformant with µITORN standard (RI600V4 and RI600PX)

powered by aws — FreeRTOS, which supports connecting to AWS

Free Evaluation Versions
URL https://www.renesas.com/tool_evaluation

e² studio
URL https://www.renesas.com/e2studio

CC-RX Compiler
URL https://www.renesas.com/rx_c

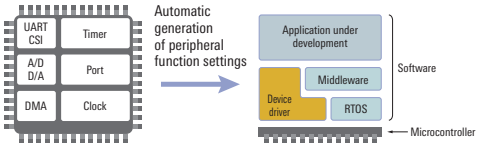
Boards and Kits
URL https://www.renesas.com/products/software-tools/boards-and-kits.html

CS+
URL https://www.renesas.com/cs+

Real-time OS/Middleware
URL https://www.renesas.com/mw

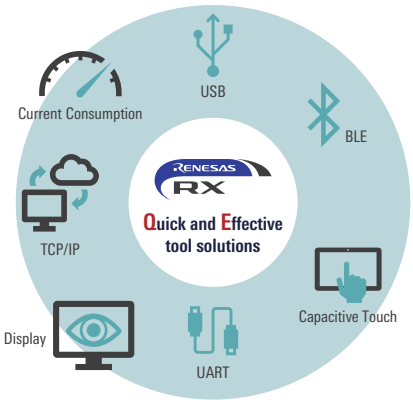
Development

Software tools that make development even faster



[Smart configurator]
Tool that automatically generates device drivers

[On-chip debugging emulators]
Choose from the low-cost E2 Emulator Lite; the E2 Emulator, which lets you measure current consumption right on the emulator; and the E20 Emulator, with advanced functions.

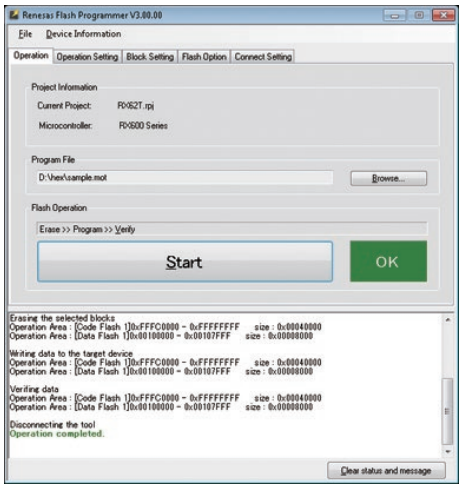


[QE (Quick and Effective tool)]
Tools suitable for a variety of applications

[Middleware]
Support for communication environments, security, image processing, and signal processing

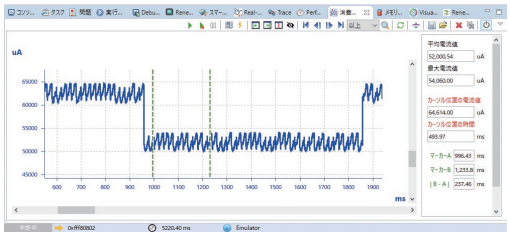
Mass production

Renesas Flash Programmer
flash memory programming software

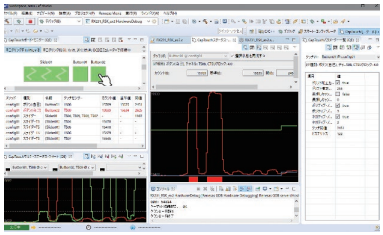


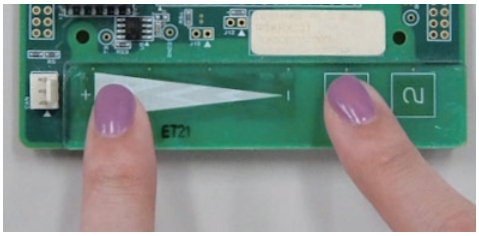
PG-FP6
standalone flash programmer

Debug



[QE for Current Consumption]
Using just the E2 Emulator you can measure current consumption and detect abnormal current flows.





[QE for Capacitive Touch]
Supports embedded systems employing capacitive touch sensors. Easily implement touch and slider operations in applications.

Smart Configurator
URL https://www.renesas.com/smart-configurator

QE
URL https://www.renesas.com/qe

Renesas Flash Programmer
URL https://www.renesas.com/rfp

RX Driver Package
URL https://www.renesas.com/rdp

OCD Emulator
URL https://www.renesas.com/ocd

PG-FP6
URL https://www.renesas.com/pg-fp6

RX FAMILY DEVELOPMENT TOOLS

Software and Support Tools You Can Use Immediately with the RX Family

Available software packages include board-specific programs, peripheral function drivers, middleware, and documents and application examples illustrating usage procedures. Users can also use Smart Configurator to easily incorporate the above Renesas software components into their own projects, automatically generate I/O drivers for MCU peripheral functions, and more. This makes it possible to boost the efficiency of the development process overall.

Searching for Information in Sample Code or Manuals

From within the integrated development environment you can search for and display sample code, middleware, and Renesas product information on the web, as well as downloading and installing sample code.

Making Complex Pin Settings and Embedding Drivers

You can add and verify middleware and drivers for USB, file system, and other functions from within the integrated development environment.

You can also make complex and time-consuming pin settings from the built-in GUI, and when conflicts are detected you can resolve them with a single click.

Assistance for Coding and Debugging

From within the integrated development environment you can reference register information and perform coding and debugging.

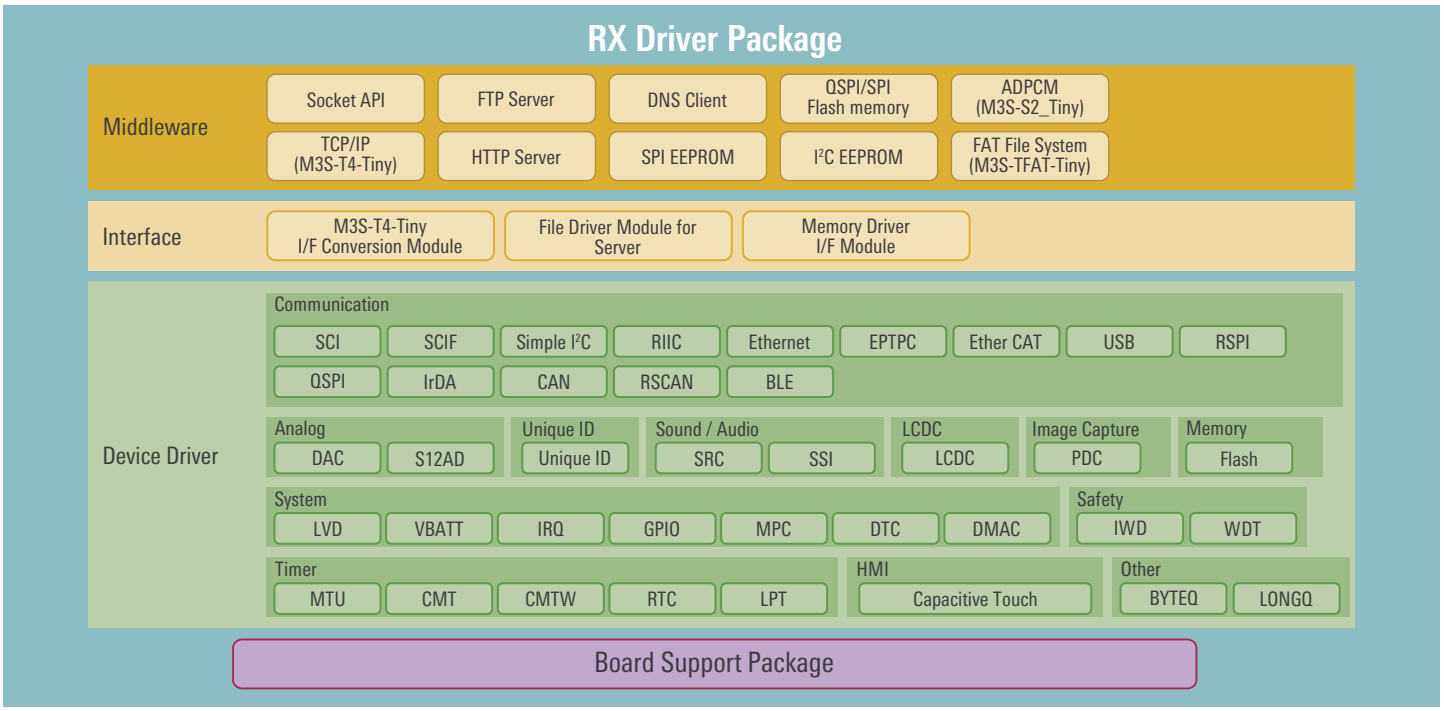
The development knowhow that allows you to begin development of a variety of applications with a few simple settings can significantly reduce overall development time.

RX Family Middleware Driver Package (RX Driver Package)

The RX Driver Package is a software package that enables use of basic functions such as MCU visualization, flash self-programming, timer control, UART communication, and A/D conversion, as well as applied functions such as USB and Ethernet.

- Makes it possible to start using RX MCU peripheral functions right away, greatly reducing the time customers must spend considering prototypes.
- Applications that make use of Firmware Integration Technology (FIT) can be reused on MCUs across the RX Family. This significantly reduces the software development cost burden for customers extending their product lines.

URL https://www.renesas.com/rdp



Renesas Middleware Usage Examples

Medical and Healthcare Devices

TCP/IP, voice recording and playback, FAT file system, SPI serial EEPROM, I²C serial EEPROM, SD memory card driver, drivers for various memory types, etc.

Industrial Devices

TCP/IP, voice recording and playback, DSP, FAT file system, SPI serial EEPROM, I²C serial EEPROM, SD memory card driver, drivers for various memory types, etc.

Information Terminals

Graphics, FAT file system, SD memory card driver, etc.

Digital AV

AAC encoder/decoder, aacPlus decoder, MP3 encoder/decoder, FAT file system, SD memory card driver, encryption, etc.

Home Networks

TCP/IP, HTTP server, FTP server, SMTP/POP3, DHCP client, file system, encryption, security, etc.

Security Systems

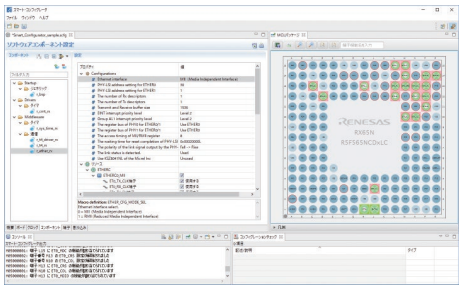
Encryption, security, graphics, audio, communication, file system, etc.

Convenient Development Support Tools

Smart Configurator

Smart Configurator provides functionality that makes it easy for users to incorporate Renesas drivers into their projects. The following functions support driver integration:

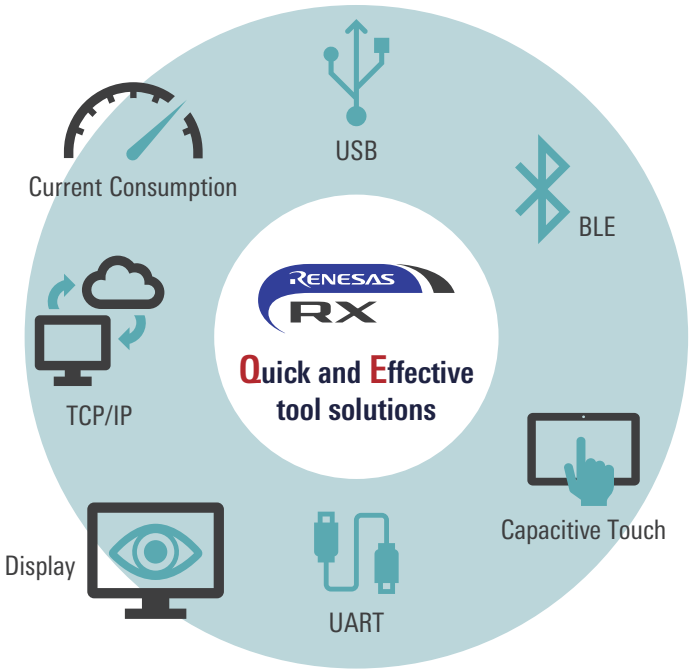
- Importing sample code (FIT)
  Download and import sample code, and use it in combination with generated driver code.
- Generating driver code
  Enter peripheral function settings via the GUI, and driver code is generated automatically according to the settings.
- Checking for pin conflicts
  Check in real time for conflicts among pins used by the driver code and FIT modules.



Plenty of Convenient Functions to Assist Application Development

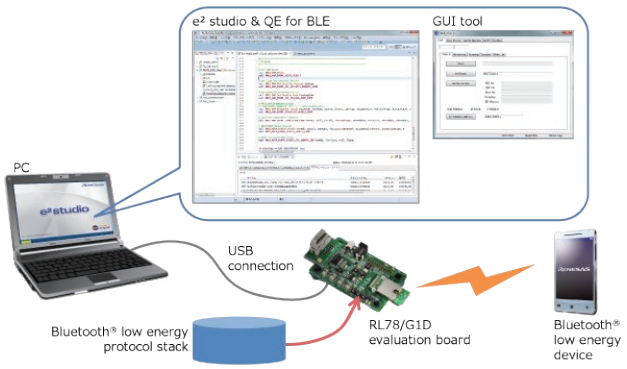
QE Development Support Tools for Many Application Types

"I've imported this application but it doesn't work! What should I do?" Has this ever happened to you? QE development support tools add development knowhow (functionality) to applications within the integrated development environment, helping to minimize the application development workload.



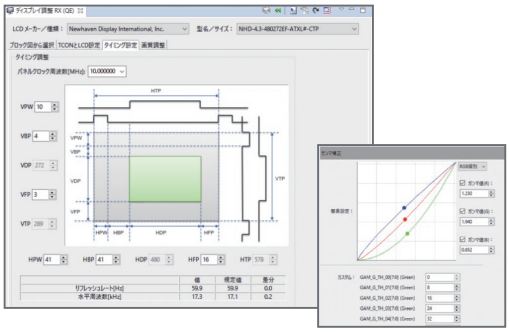
QE for BLE Development Support Tool for Bluetooth® Low Energy Applications

This development support tool is designed for embedded systems employing Bluetooth® Low Energy. It is compatible with the e² studio integrated development environment and allows users to try out communication functions based on the Bluetooth® specification without delay. Devices using BLE for communication must use the same profile, but QE for BLE makes it a simple matter to define the correct profile.



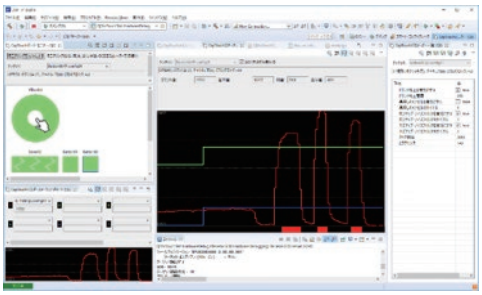
QE for Display Development Support Tool for Display Applications

Using QE for Display for embedded system development utilizing the image display functions of the RX Family's graphic LCD controller (GLCDC) greatly simplifies initial screen calibration of the display, reducing the time required for development.



QE for Capacitive Touch Development Support Tool for Capacitive Touch Sensor Applications

Using QE for Capacitive Touch in the development of embedded systems that utilize the capacitive touch sensor functions of RX Family MCUs simplifies making initial touch interface settings and tuning sensitivity, reducing the time required for development.



RX FAMILY PACKAGE LINEUP

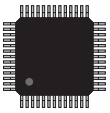
Pin-type:	32-LQFP
Size:	7 x 7 mm
Pitch:	0.80 mm
Thickness:	1.70 mm
Group:	RX13T

Pin-type:	36-WFLGA
Size:	4 x 4 mm
Pitch:	0.50 mm
Thickness:	0.76 mm
Group:	RX111, 110

Pin-type:	40-HWQFN
Size:	6 x 6 mm
Pitch:	0.50 mm
Thickness:	0.80 mm
Group:	RX23E-A, 111, 110

Pin-type:	48-HWQFN
Size:	7 x 7 mm
Pitch:	0.50mm
Thickness:	0.80mm
Group:	RX231, 230, 130, 111, 110

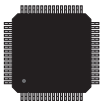
Pin-type:	48-LFQFP
Size:	7 x 7 mm
Pitch:	0.50 mm
Thickness:	1.70 mm
Group:	RX63T, 631, 23T, 23E-A, 231, 230, 220, 210, 13T, 130, 111, 110



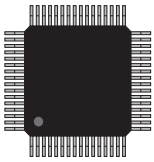
Pin-type:	52-LQFP
Size:	10 x 10 mm
Pitch:	0.65 mm
Thickness:	1.70 mm
Group:	RX23T

Pin-type:	56-HVQFN
Size:	7 x 7 mm
Pitch:	0.40 mm
Thickness:	0.90 mm
Group:	RX23W

Pin-type:	64-HWQFN
Size:	9 x 9 mm
Pitch:	0.50 mm
Thickness:	0.80 mm
Group:	RX231, 230



Pin-type:	64-LFQFP
Size:	10 x 10 mm
Pitch:	0.50 mm
Thickness:	1.70 mm
Group:	RX66T, 651, 63T, 631, 62T, 24T, 23T, 231, 230, 220, 21A, 210, 130, 113, 111, 110

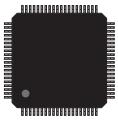


Pin-type:	64-LQFP
Size:	14 x 14 mm
Pitch:	0.80 mm
Thickness:	1.70 mm
Group:	RX62T, 220, 130, 111, 110

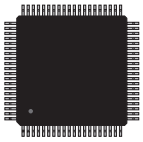
Pin-type:	64-TFBGA
Size:	4.5 x 4.5 mm
Pitch:	0.50 mm
Thickness:	1.20 mm
Group:	RX651

Pin-type:	64-TFLGA
Size:	6 x 6 mm
Pitch:	0.65 mm
Thickness:	1.05 mm
Group:	RX631

Pin-type:	64-WFLGA
Size:	5 x 5 mm
Pitch:	0.50 mm
Thickness:	0.76 mm
Group:	RX231, 230, 111, 110



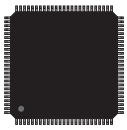
Pin-type:	80-LFQFP
Size:	12 x 12 mm
Pitch:	0.50 mm
Thickness:	1.70 mm
Group:	RX66T, 630, 24T, 21A, 210, 130



Pin-type:	80-LQFP
Size:	14 x 14 mm
Pitch:	0.65 mm
Thickness:	1.70 mm
Group:	RX66T, 62T, 24T, 210

Pin-type:	85-TFBGA
Size:	5.5 x 5.5 mm
Pitch:	0.50 mm
Thickness:	1.20 mm
Group:	RX23W

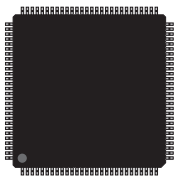
Pin-type:	85-TFLGA
Size:	7 x 7 mm
Pitch:	0.65 mm
Thickness:	1.20 mm
Group:	RX621



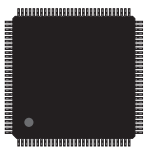
Pin-type:	100-LFQFP
Size:	14 x 14 mm
Pitch:	0.50 mm
Thickness:	1.70 mm
Group:	RX72T, 72N, 71M, 66T, 66N, 65N, 651, 64M, 63T, 63N, 631, 630, 62T, 62N, 62G, 621, 24U, 24T, 231, 230, 220, 21A, 210, 130, 113

Pin-type:	100-TFLGA
Size:	5.5 x 5.5 mm
Pitch:	0.50 mm
Thickness:	1.05 mm
Group:	RX630, 231, 230, 210

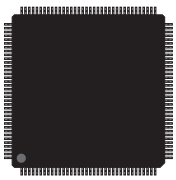
Pin-type:	100-TFLGA
Size:	7 x 7 mm
Pitch:	0.65 mm
Thickness:	1.05 mm
Group:	RX71M, 65N, 651, 64M, 63N, 631, 21A, 210, 113



Pin-type:	112-LQFP
Size:	20 x 20 mm
Pitch:	0.65 mm
Thickness:	1.70 mm
Group:	RX66T, 63T, 62T, 62G



Pin-type:	120-LFQFP
Size:	16 x 16 mm
Pitch:	0.50 mm
Thickness:	1.70 mm
Group:	RX63T

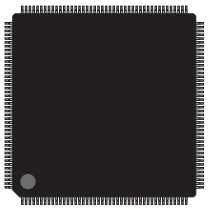


Pin-type:	144-LFQFP
Size:	20 x 20 mm
Pitch:	0.50 mm
Thickness:	1.70 mm
Group:	RX72T, 72N, 71M, 66T, 66N, 65N, 651, 64M, 63T, 63N, 634, 631, 630, 62N, 621, 610, 24U, 210

Pin-type:	145-TFLGA
Size:	7 x 7 mm
Pitch:	0.50 mm
Thickness:	1.05 mm
Group:	RX72N, 71M, 66N, 65N, 651, 64M, 63N, 631, 630, 210

Pin-type:	145-TFLGA
Size:	9 x 9 mm
Pitch:	0.65 mm
Thickness:	1.20 mm
Group:	RX62N, 621

Pin-type:	176-LFBGA
Size:	13 x 13 mm
Pitch:	0.80 mm
Thickness:	1.40 mm
Group:	RX72M, 72N, 71M, 66N, 65N, 651, 64M, 63N, 631, 630, 62N, 621, 610



Pin-type:	176-LFQFP
Size:	24 x 24 mm
Pitch:	0.50 mm
Thickness:	1.70 mm
Group:	RX72M, 72N, 71M, 66N, 65N, 651, 64M, 63N, 631, 630

Pin-type:	177-TFLGA
Size:	8 x 8 mm
Pitch:	0.50 mm
Thickness:	1.05 mm
Group:	RX71M, 65N, 651, 64M, 63N, 631, 630

Pin-type:	224-LFBGA
Size:	13 x 13 mm
Pitch:	0.80 mm
Thickness:	1.40 mm
Group:	RX72M, 72N, 66N

EXPLANATION OF ORDERABLE PART NUMBERS

R5	F	5	72M	N	H	G	FC	#V	0
Renesas MCU	ROM Type F: Flash S: ROM LESS	RX Family	Product Group	ROM/RAM/ data flash capacity (KB)*1	Chip Original info*1	Operating ambient temperature	Package type/pin count/pin pitch	Packing specification	Product identification code

Product Group

72M	RX72M	230	RX230
72N	RX72N	220	RX220
71M	RX71M	210	RX210
66N	RX66N	21A	RX21A
65N	RX65N	130	RX130
651	RX651	113	RX113
64M	RX64M	111	RX111
63N	RX63N	110	RX110
631	RX631	72T	RX72T
62N	RX62N	66T	RX66T
621	RX621	63T	RX63T
634	RX634	62T	RX62T
630	RX630	62G	RX62G
610	RX610	24T	RX24T
23W	RX23W	24U	RX24U
23E	RX23E-A	23T	RX23T
231	RX231	13T	RX13T

Operating ambient temperature

N	-20°C to 85°C
D	-40°C to 85°C
G	-40°C to 105°C

Package type/pin count/pin pitch

BD	LFBGA	224	0.8	FP	LQFP	100	0.5
BG	LFBGA	176	0.8	LA	TFLGA	100	0.5
BL	TFBGA	85	0.65	LC	TFLGA	177	0.5
BP	TFBGA	64	0.5	LD	TFLGA	85	0.65
FA	LFQFP	120	0.5	LE	TFLGA	145	0.65
FB	LFQFP	144	0.5	LF	WFLGA	64	0.5
FC	LFQFP	176	0.5	LH	TFLGA	64	0.65
FD	LQFP	52	0.65	LJ	TFLGA	100	0.65
FF	LQFP	80	0.65	LK	TFLGA	145	0.5
FH	LQFP	112	0.65	LM	WFLGA	36	0.5
FJ	LQFP	32	0.8	ND	HWQFN	64	0.5
FK	LQFP	64	0.8	NE	HWQFN	48	0.5
FL	LFQFP	48	0.5	NF	HWQFN	40	0.5
FM	LFQFP	64	0.5	NG	HVQFN	56	0.4
FN	LFQFP	80	0.5				

Packing specification

U, 2	Tray (HWQFN, WFLGA, TFLGA, LFBGA, WFBGA)
V, 3	Tray (LFQFP, LQFP)

Example of product information for RX72M (176-pin), product No. R5F572MNHGFC#V0

This guide lists the values for individual product numbers. For information on the actual product lineup, refer to the relevant user's manual.

Note: 1. This information is different for each RX group. Refer to the relevant user's manual for details.

RENESAS

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(Rev.4.0-1 November 2017)

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