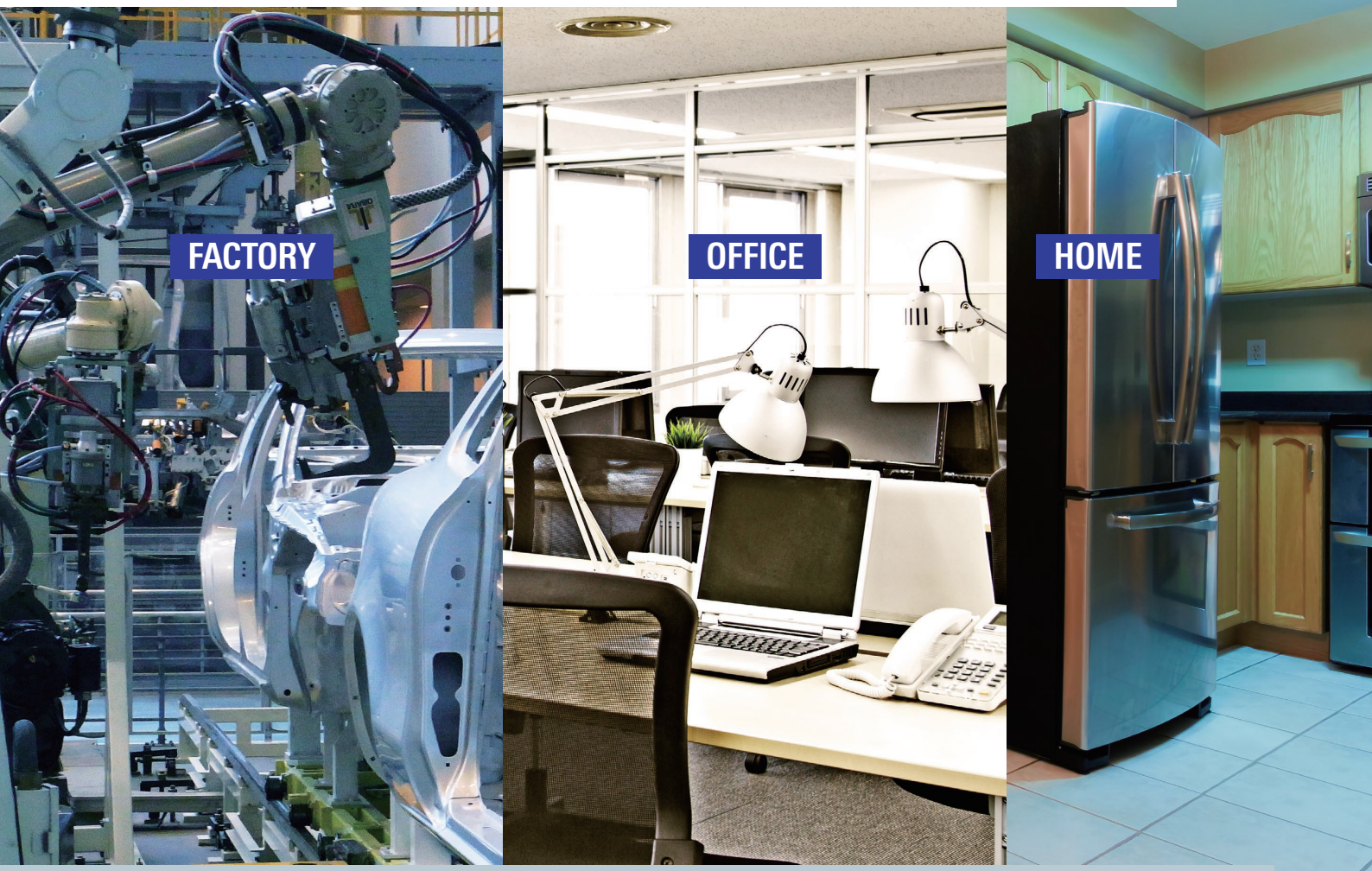
RX FAMILY

Renesas 32-Bit Microcontrollers

2023.12

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

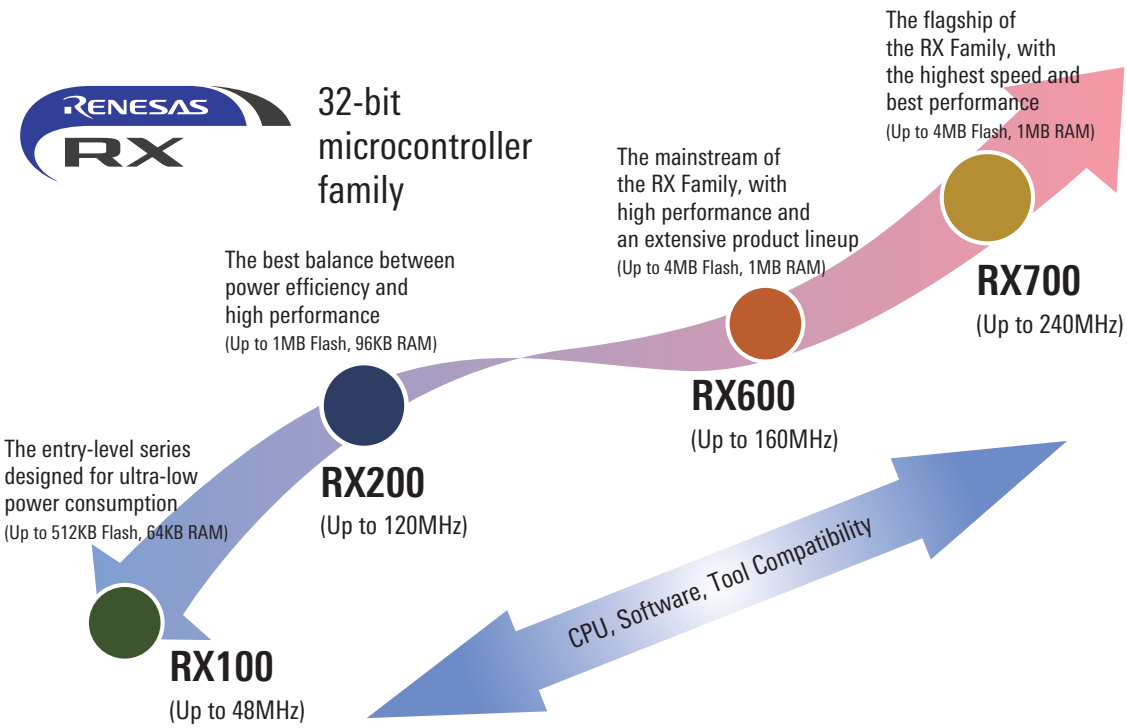
Maintaining and Advancing the Renesas Tradition



CONTENT

- The following new products have been added:
  RX600 Series: RX660, RX65W-A
  RX200 Series: RX23E-B, RX26T
- The following pages have been added.
  RX-E (for Sensor Measurement)
  Winning Combinations (Reference Designs)
  Renesas Ready Partner Network

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 fields.



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.

Renesas Core	**32-bit MCU** RENESAS RX **Power Efficiency** **Max operating frequency:** 32MHz~240MHz **Features:** Superior power efficiency High-capacity flash memories Broad lineup	**8/16-bit MCU** RENESAS RL78 **Low Power** **Max operating frequency:** 16MHz~32MHz **Features:** Ultra-low energy Low pin count lineup available
Arm® Core	**32/64-bit MPU** RENESAS RZ **High Performance** **Max operating frequency:** 125MHz~1.5GHz **Features:** Multi-core up to 8 cores Linux or RTOS available High-capacity on-chip RAM DRP*1 image processing acceleration DRP-AI DNN acceleration *1 DRP: Dynamically Reconfigurable Processor	**32-bit MCU** **Renesas Synergy™** **Qualified Platform** **Max operating frequency:** 32MHz~240MHz **Features:** Qualified software and tools
	32-bit MCU RENESAS RA **Arm® Ecosystem** **Max operating frequency:** 48MHz~200MHz **Features:** High efficiency Advanced security Flexible Software Package	

Features of the RX Family

The RX Family mainly comprises four series. The RX700 Series and RX600 Series are designed to deliver high speed and excellent performance. The RX200 Series and RX100 Series are optimized for low power consumption.

RX700 Series Up to 240MHz — The flagship of the RX Family, with the highest speed and best performance

4MB Flash Max Dual Bank	2.7V to 5.5V 1441CoreMark @240MHz	Ethernet USB,CAN SDHI	Security Safety	EtherCAT TFT LCD Motor

RX600 Series Up to 160MHz — The mainstream of the RX Family, with high performance and an extensive product lineup

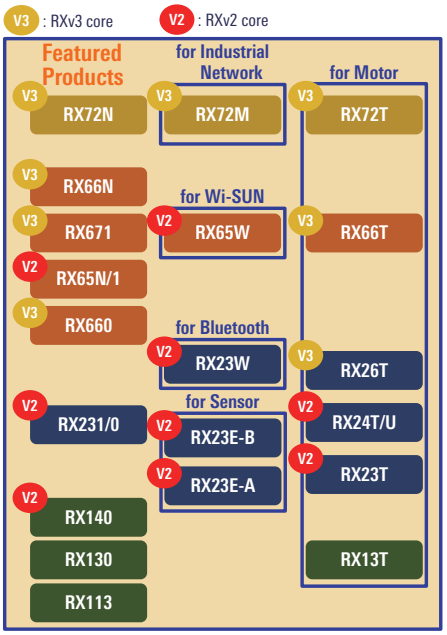
4MB Flash Max Dual Bank	2.7V to 5.5V 721CoreMark @120MHz	Ethernet USB,CAN SDHI	Security Safety	TFT LCD Wi-SUN Motor Capacitive Touch

RX200 Series Up to 120MHz — 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	Security Safety	Bluetooth Motor Capacitive Touch IA Sensor

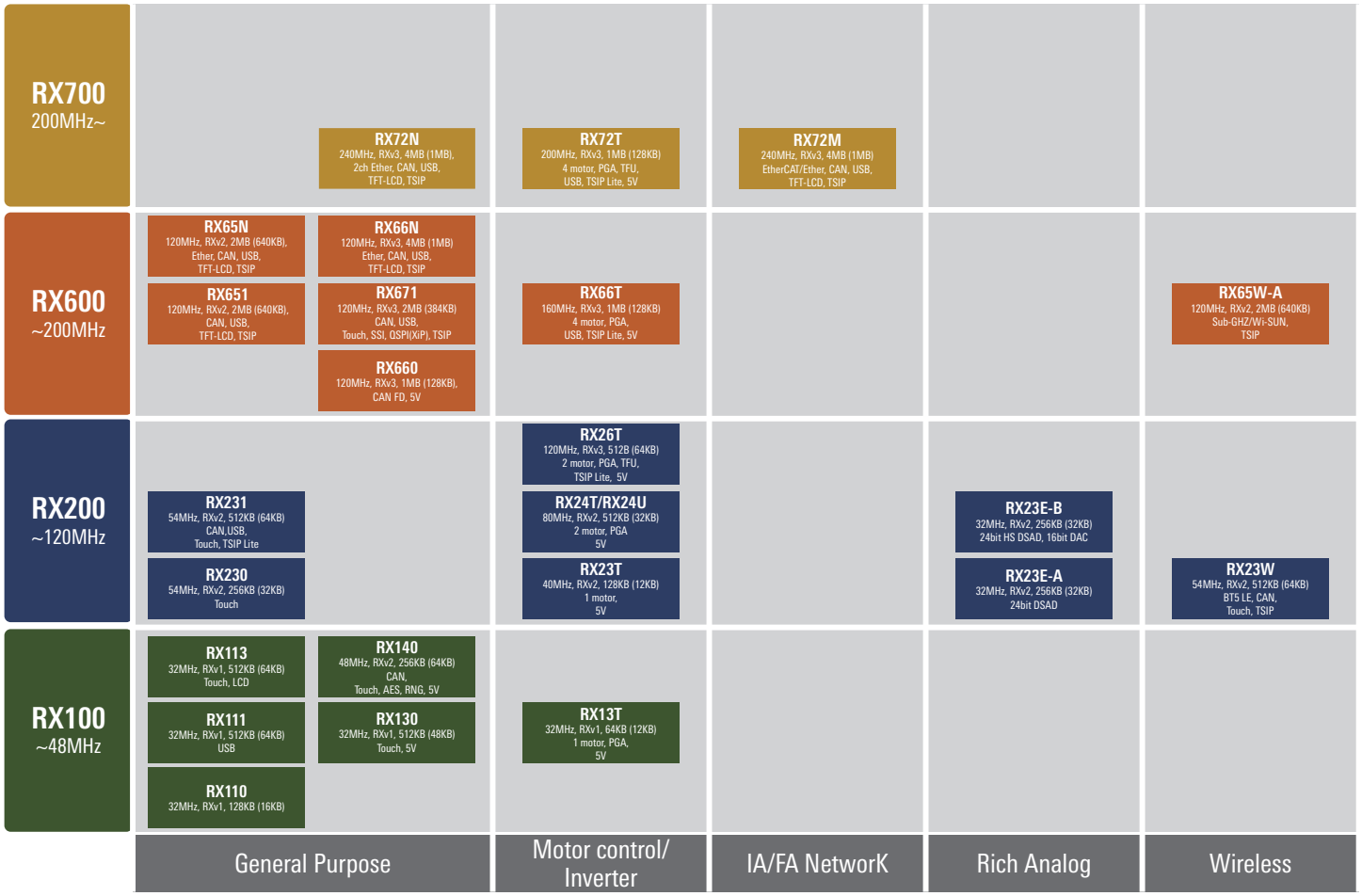
RX100 Series Up to 48MHz — The entry-level series designed for ultra-low power consumption

512KB Flash Max	1.8 to 5.5V 0.1mA/MHz 0.25µA(stby)	USB,CAN	Security Safety	Segment LCD Motor Capacitive Touch



RX Family Portfolio

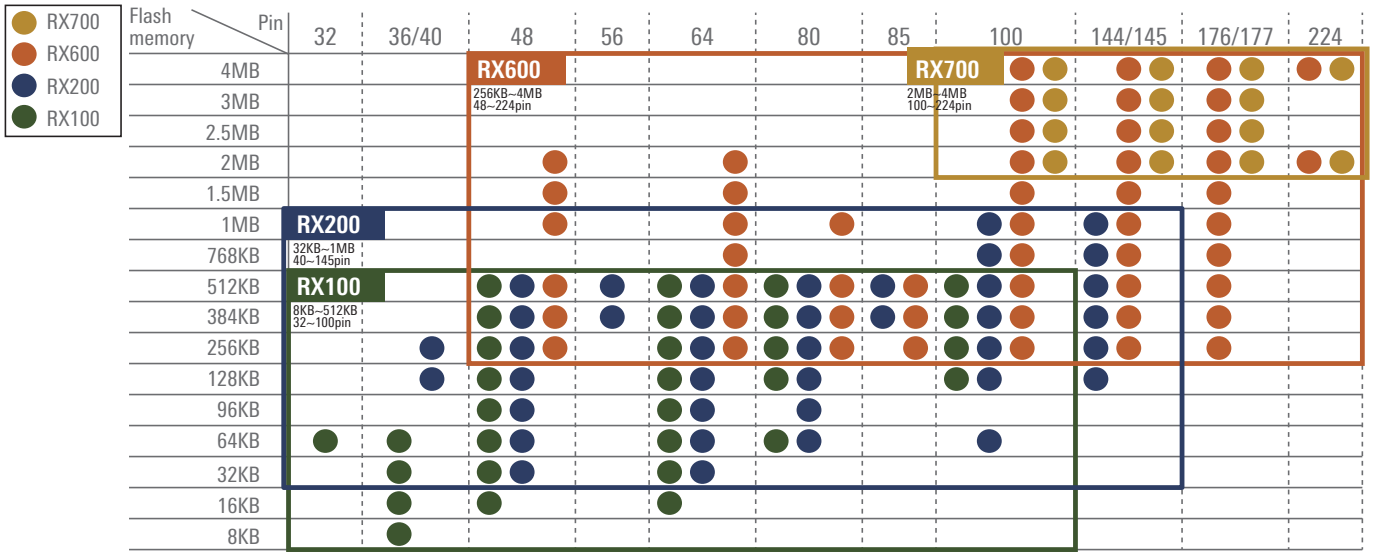
The RX Family has products suitable for a variety of different applications.



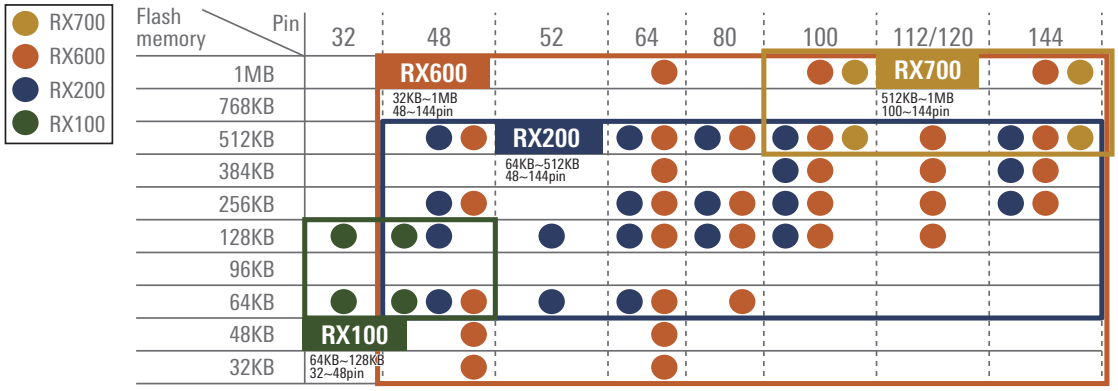
RX Family Memory/Pin Lineup

RX Family MCUs are available in packages with pin counts from 32 to 177 pins and flash memory capacities from 4MB to 8KB. Customers can choose the product that best meets their needs from this extensive lineup.

Industrial, Home Appliances, and OA/ICT

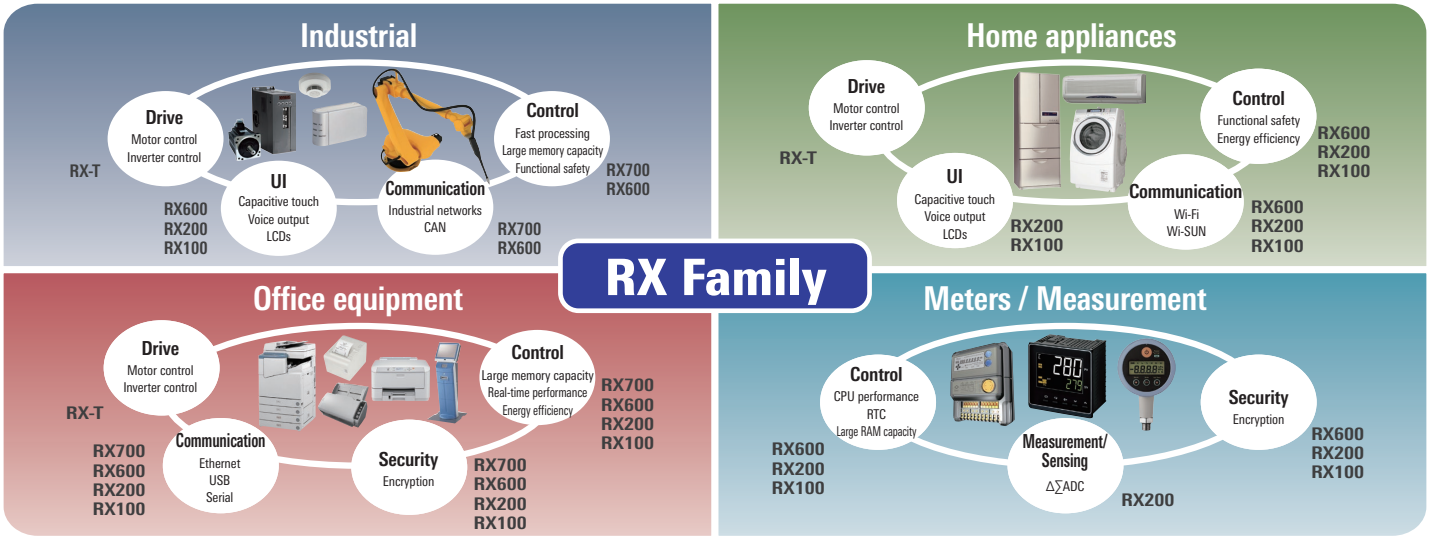


Motor



Contributing to the Development of Platforms in a Variety of Fields

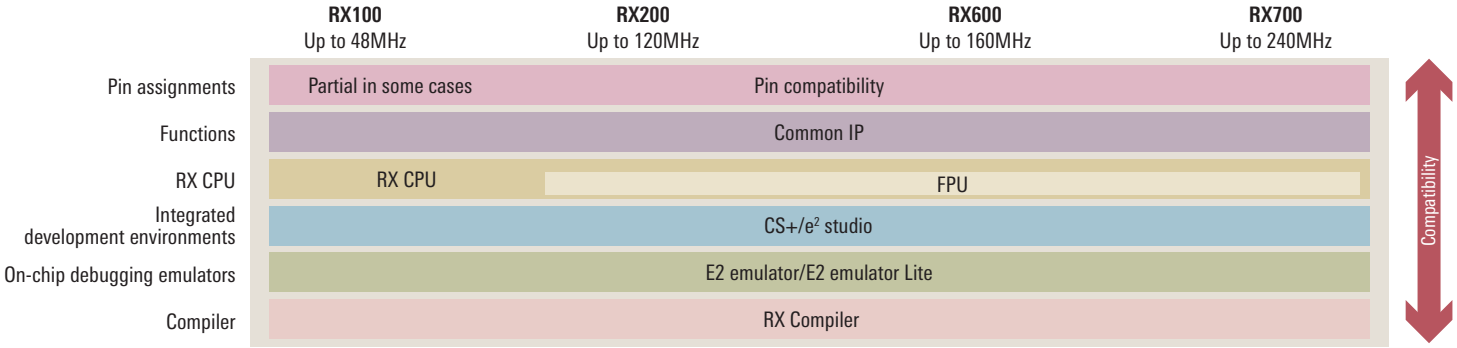
RX Family MCUs cover a wide performance range from 32MHz to 240MHz while providing abundant peripheral functions for many applications and excellent compatibility.



RX Family Compatibility

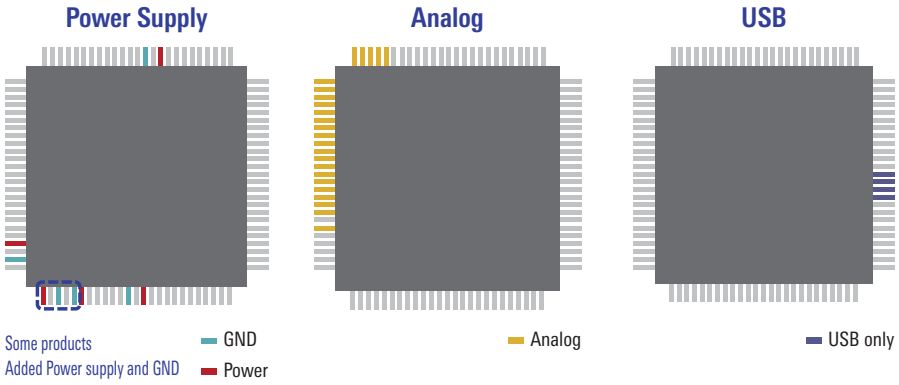
The RX Family is designed for compatibility across products in terms of CPU instructions, pin assignments, and functions.

- 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

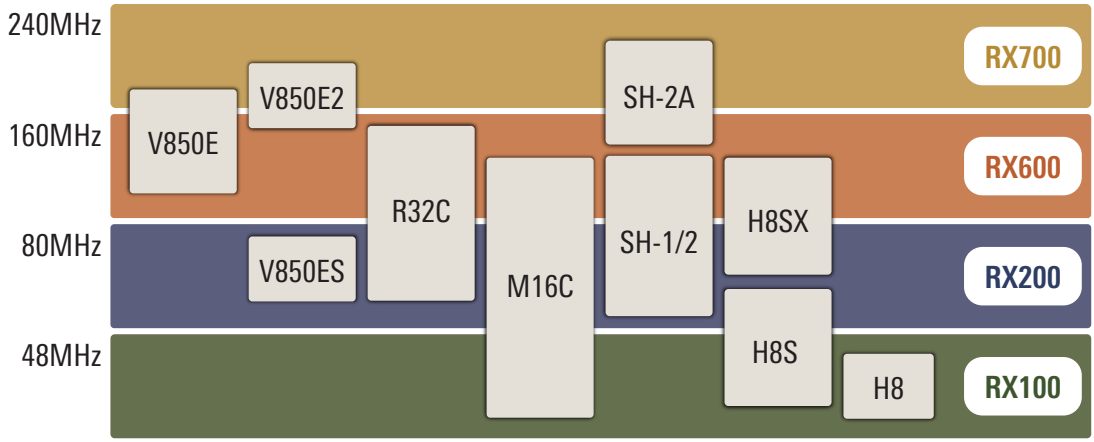
Analog and USB pins are pin compatible. Power supply pins are compatible except in some devices which require additional pins.



*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.



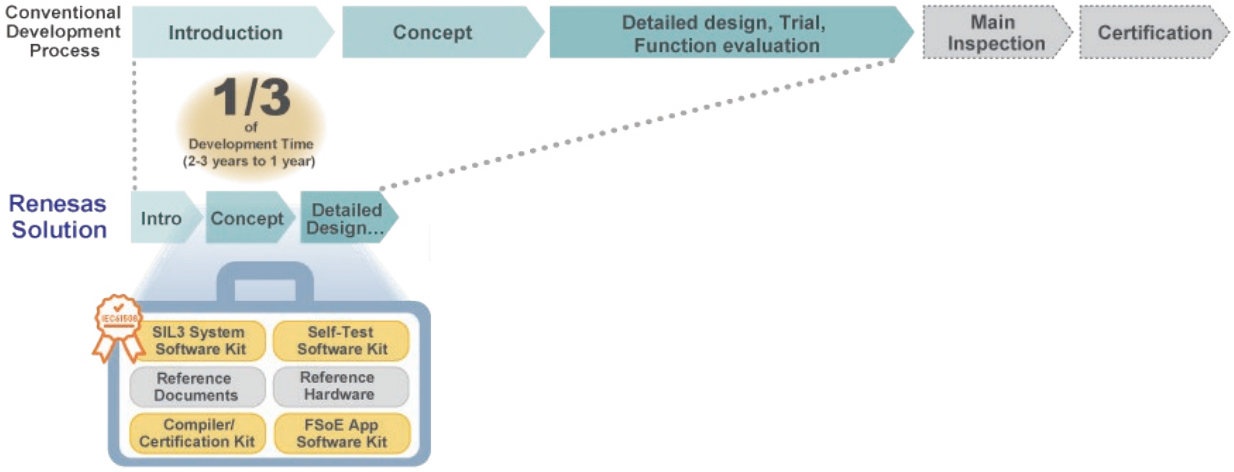
RX FAMILY SOLUTIONS

IEC61508 Functional Safety Solutions

The crucial importance of functional safety is rising in the industrial field, aiming to maintain safety when malfunctions occur in order to prevent breakdowns and accidents during planned operation, adverse impacts from operator injuries, and associated economic losses. However, while equipment is required to meet functional safety standards and the scope of application to apply functional safety standard is expanding in many industrial fields, the development burden on customers is also increasing.
As a solution towards this problem, Renesas released a functional safety solution certified by the certification body.

Functional Safety Solution Overview

As Renesas been the 1st MCU supplier to complete the verification of the core self test, Renesas provides functional safety solutions that reduce the development burden on customer and contributes to realize safe and reliable factories.
IEC61508 SIL3 certified products provide MCU self-test software, platform software to build dual MCU systems, safety network software, and safety compilers. In addition, we also provide evaluation boards of dual MCU configuration and technical document for acquiring IEC61508 certification and development, as a reference solution.

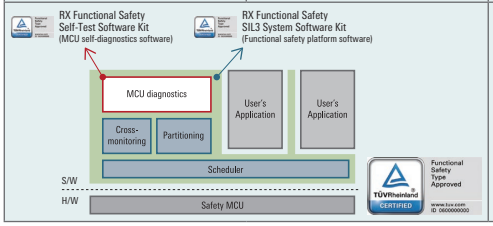
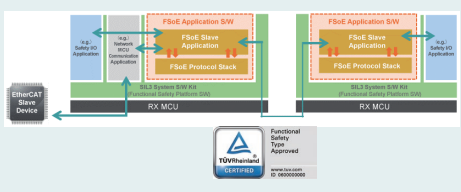
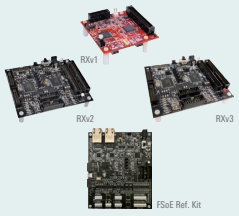


Functional Safety Solution List

The key features and our aim of our solution are;

- One-stop functional safety solution for general purpose MCU
- Reduces time for constructing functional safety systems
- Easy implementation of safety system for various safety applications such as motor, safety controllers, programmable logic controls, and sensors.

Free evaluation version available for download via our web.

Self-test Software Kit	SIL3 System Software Kit	Safety Network Application Software Kit	Reference Documents	Reference Hardware Boards
Free package of MCU Self-diagnostics SW for diagnosing CPU, ROM, and RAM in MCU.	Package of Functional Safety Platform SW for cross-monitoring dual MCU and controlling user's application behavior.	Renesas offers this safety network protocol solution that can be used with the SIL3 System Software Kit. (Both FSoE slave and PROFIsafe slave functions are supported.)	Technical document explaining the method to comply with IEC61508 standard. The document consists with documents and excel data with easy explanation of the requirements to meet the IEC61508 standard.	These kits combine software and hardware, including evaluation boards for dual configurations and software for implementing the FSoE slave function. They can be used to evaluate Renesas safety software.
				

Also, because to prove that compiler generates a valid code when constructing SW, Renesas original certified compiler and certification kit is available. Certified IAR compiler also available from IAR.

~Coffee Break~ Functional Safety Standards for Home Appliances

IEC60730 Functional Safety Solutions

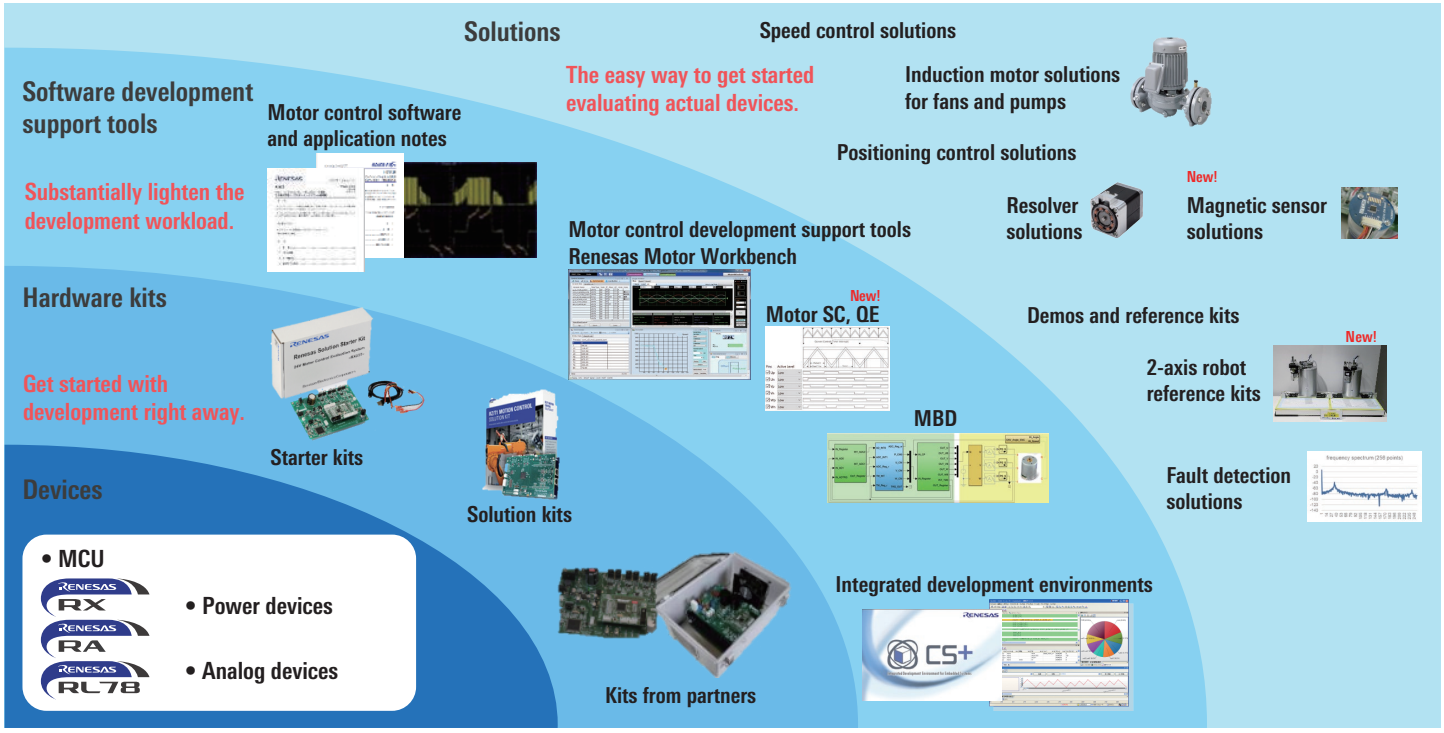
The IEC/UL60730 is the harmonized safety standard for household appliances.
The standard describes control requirements for household appliances such as air conditioners, washing machines, dishwashers, dryers and refrigerators to guarantee safe and reliable operation.
Renesas offers a package for the RX family that includes self-test libraries and application notes that meet the IEC60730 Class B/C requirements. The self-test library is certified by a leading technical-scientific association and a copy of the test certificate is included in the download package.
By using this package, you can reduce the burden of certification when acquiring IEC60730 certification for your application.

MEMO

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.



Renesas Solutions for Different Motor Types and Control Methods

Renesas offers kits and motor control software to match various motor types and control MCUs. Each kit comes with different sample software, so refer to the table below to select the appropriate solution to meet your requirements.

Distribution Format	Motor Type	Name of Kit	Vector Control			120-Degree Conducting Control	
			Sensorless	Optical Encoder	Resolver	Sensorless	Hall Effect
			Speed Control	Speed Control/ Positioning Control	Speed Control/ Positioning Control	Speed Control	Speed Control
Supplied as complete kit by Renesas	BLDC	Evaluation system for BLDC Motor + CPU Card (P/N: RTK0EMX270S00020BJ)	✓	–	–	✓	✓
	BLDC	MCK-RX26T (P/N: RTK0EMXE70S00020BJ)	✓	–	–	✓	✓
	Stepping	Evaluation System for Stepping Motor with Resolver (P/N: RTK0EMX270S01020BJ)	–	–	✓	–	–
Renesas kit + motor with encoder*1	BLDC	Evaluation system for BLDC Motor + CPU Card (P/N: RTK0EMX270S00020BJ)	–	✓*1*2	–	–	–
	BLDC	MCK-RX26T (P/N: RTK0EMXE70S00020BJ)	–	✓	–	–	–
Supplied as sample software and application note by Renesas	Induction motor	Evaluation system for ACIM	✓*3	–	–	–	–

*1. The customer must supply a motor with an optical encoder.
*2. Magnetic encoder also supported. (The customer must supply a motor with a magnetic encoder.)
*3. The customer must supply an induction motor and inverter board.

Motor Control Solutions

Motor Control Development Kits

Evaluation System for BLDC Motor

CPU cards, sample software, and development support tools are available separately, allowing you to get started with motor control without delay.

Item	Specification
Kit name	Evaluation System for BLDC Motor
Kit model No.	RTK0EMX270S00020BJ
Structure	48V 5A Inverter board for BLDC motor
	BLDC motor (TG-55L-KA)
Inverter specification	■ Rated voltage: 48V ■ Rated current: 5A (RMS) ■ Protect function: Overcurrent detection, others

Sample Software	Supported MCUs
120-degree conducting control + Speed control (Hall, Sensorless)	RX23T, RX24T
Vector control + Speed control (Encoder, Sensorless)	RX13T*1,RX23T, RX24T, RX24U, RX66T, RX72T, RA6T1
Vector control + Position control (Encoder)	RX23T, RX24T, RX24U, RX66T, RX72T, RA6T1

*1: Sensorless only.

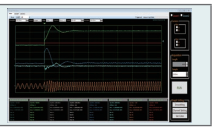
Motor Control Development Support Tool

Renesas Motor Workbench

- Dynamic reading/writing of variables and waveform display while operating the motor.
- Automatic identification of motor parameters and control gains required for vector control.
- Analyzer waveform display data is in csv format. Tuner identification results can be outputted as PDF file or header file.

Analyzer

Extensive functions include trigger, zoom, and commander transmission etc., useful for debugging and evaluation.
Also usable as user I/F.

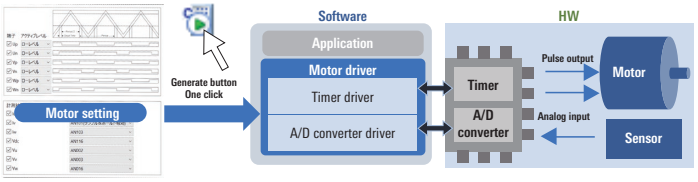


Tuner

Vector control at ease without know-how.
Fine adjustment at ease with manual adjustment function, as well as quick result check.

Motor Driver Generation Function of RX Smart Configurator

This function generates driver code for MCU peripheral functions suitable for motor control. Simply enter motor-related settings via the GUI, click a button, and RX Smart Configurator generates drivers for the timer and A/D converter based on your settings.



Motor driver generation function

MCK-XXXXX

Note: XXXXX designates the group name of the MCU mounted on the CPU board.

This motor solution includes a CPU board, inverter board, and communication board. Sample code and a development support tool are provided so you can get started with motor control immediately after purchase.

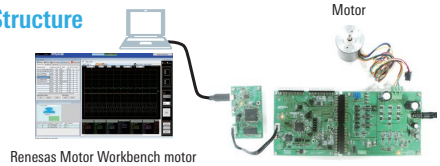
Features

- Equipped with onboard debugger for MCU flash programming.
- Supports 1-shunt and 3-shunt current detection.
- Overcurrent detection function.
- Supports the motor control development support tool “Renesas Motor Workbench” for easy debugging.
- Use of a communication board provides electrical isolation from the PC for safe evaluation and debugging of motor control applications.

Kit specifications

Kit name	MCK-RX26T
Kit model No.	RTK0EMXE70S00020BJ
Structure	48V 10A inverter board for BLDC motor (MCI-LV-1)
	RX26T CPU board (MCB-RX26T Type A)
	Communication board (MC-COM)
	BLDC motor (R42BLD30L3 manufactured by Moons’ Industries)
Inverter specification	■ Rated voltage: 48V ■ Rated current: 10A (continuous) ■ Protect functions: Overcurrent detection, etc.

Overall Structure



Renesas Motor Workbench motor control development support tool

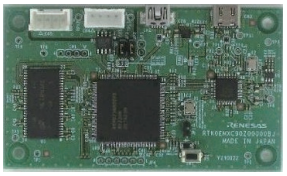
CPU board (replaceable) Inverter board

MC-COM

The communication board for serial communication with a Renesas MCU. It provides an electrically isolated environment to enable safe evaluation and debugging of motor control applications.

Features

- Supports the motor control development support tool “Renesas Motor Workbench”.
- CPU board by manufacturers other than Renesas can be used by embedding code from libraries supported by Renesas Motor Workbench in the user’s motor control software.



Kit specifications

Item	Specification
Kit name	MC-COM
Kit model No.	RTK0EMXC90S00000BJ
Isolation device used	Si8622BC-B-IS (Skyworks Solutions Inc.) or ISO7421FED (Texas Instruments)
Compatible CPU boards	RX13T/23T/24T/24U/66T/72T/72M CPU Card RA6T1 CPU Card MCB-RA6T2/RA6T3/RA4T1 MCB-RX26T Type A/Type B/Type C

RX FAMILY SOLUTIONS

Security Solutions

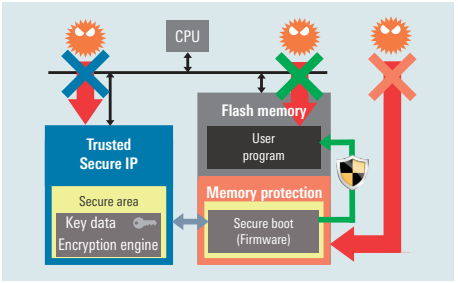
Interest has been growing in recent years in IoT as a means of creating new added value. But connecting IoT devices to the internet exposes them to risks such as eavesdropping, tampering, and execution of unauthorized software or viruses. This has caused demand for security to expand even to devices which previously did not require security functions.

Security Features Provided by RX Security Solutions

- Key protection: Hardware secure IP module (Trusted Secure IP (TSIP)) prevents leaks of key data.
- Simple implementation: One-stop solutions for building robust protection mechanisms for IoT devices.
- Operation management: Support for life-cycle management from product shipment, market operation, and OTA updates to EOL.
- Safe and secure: First general-purpose MCU certified CMVP Level 3 under NIST*[1] FIPS 140-2 (RX65N)*[2] and encryption technology safety certified as CAVP conformant*[3]

Notes: 1. National Institute of Standards and Technology
2. Press release dated April 22, 2021.
3. Certification obtained for RX231, RX65N, and RX651.

Root of Trust implementation in security hardware



RX Security Solutions

RX Hardware-Based Security Functions

The Root of Trust is implemented by the Trusted Secure IP module that protects key data from compromise and an authentication program that provides memory protection functionality against tampering. In addition, performing encryption processing in hardware boosts speed.

Function / MCU Group	Encryption					Memory Protection				
	Trusted Secure IP	AES	RSA	ECC	SHA	TRNG	Code Protect	Trusted memory	Area Protection	Memory Protection Unit
RX231/RX23W	✓	✓	–	–	–	✓	✓	–	✓	✓
RX26T	✓	✓	–	–	–	✓	✓	✓	✓	✓
RX66T/RX72T	✓	✓	–	–	–	✓	✓	✓	–	✓
RX651/RX65N/RX66N/RX671/ 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

Driver Software: Trusted Secure IP Custom Driver

- Simple API reduces barriers to implementation.
- Optimized driver for high-speed encryption processing.
- No nondisclosure agreement (NDA) required, free of charge.
- Availability of sample programs for applications such as such as secure boot and secure update simplify development.

Tool Service: Key Wrap Service

This service securely encrypts customers' encryption keys.

- PGP* is used for transfer of keys to ensure security. * PGP (Pretty Good Privacy) is public key encryption–based software that is widely used to encrypt data such as files and emails.
- The service is automated, so encrypted keys can be generated and supplied immediately.
- Support is provided for secure key installation.

RX Family Security Evaluation Kits

Start evaluating robust security applications using the Trusted Secure IP right away.

Part No.	Supported MCU Group	Availability	How to Purchase
RSK (Renesas Starter Kit)	RX231, RX23W, RX66T, RX72T, RX65N, RX72M, RX72N, RX671	Worldwide	Contact your local agent or sales representative.
Envision Kit	RX72N	Worldwide	Chip One Stop, Inc., Marutsuelec Co., Ltd.
GR-ROSE	RX65N	Worldwide	Akizuki Denshi Tsusho Co., Ltd., Chip One Stop, Inc., Marutsuelec Co., Ltd.
MCB-RX26T Type B / CPU Board for RX26T MCU Group with Trusted Secure IP (TSIP-Lite)	RX26T	Worldwide	Contact your local agent or sales representative.
CK-RX65N	RX65N	Worldwide	Chip One Stop, Inc.

RSK (Renesas Starter Kit)


Envision kit


Renesas Flexible Motor Control CPU Board

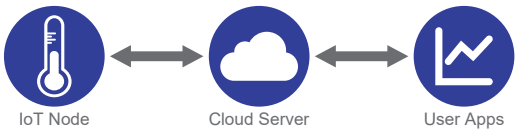
Ecosystem Partners

Renesas works with partner vendors to deliver sample and robust security solutions.

Company	Products Supplied	Summary	Availability
wolfSSL https://www.wolfssl.com/	Security Layer Library SSL/TLS library with TSIP support	■ TLS, MQTT, and crypto libraries and middleware ■ SSL/TLS library with TSIP support	Worldwide
IAR Systems / Secure Thingz https://www.iar.com/ https://www.securethingz.com/	IAR Embedded Workbench for RX Embedded Trust, C-Trust, Secure Desktop Provisioner Compliance Suite	■ Security development tools ■ Support for integration with IAR Embedded Workbench for RX ■ Coverage of entire product lifecycle from the development stage to market rollout with secure updates, etc.	Worldwide
EPS GLOBAL https://www.epsprogramming.com/	Secure Provisioning & IC Programming	■ Secure provisioning services at a very competitive price point ■ Supports Renesas Synergy, RE, RA, RL78 and RX families ■ Seamless transition from prototype to high volume	Worldwide
Ubiquitous AI Corporation https://www.ubiquitous-ai.com/en/	Edge Trust Secure IoT device development kits SSL/TLS library with TSIP support	■ Solutions for implementing secure IoT services ■ TLS, HTTP, MQTT, and TCP/IP middleware ■ SSL/TLS library with TSIP support ■ Implementation of device lifecycle management	Worldwide
Veridify https://www.veridify.com/	Veridify Security	■ Security solutions for implementing software ■ Usable with products such as the RX100 that lack TSIP functionality	Worldwide
Trusted Objects https://www.trusted-objects.com/	Tops Plug&Go	■ Secure and automated programming solution for production facilities. ■ Simplify the OEM process for secure programming on RX MCUs ■ Improve the security level of the programming operations	Worldwide

Cloud Connectivity Solutions

RX Family cloud connectivity solutions make it possible to develop devices that connect to the cloud "simply, safely, and securely." On evaluation kits certified by leading cloud vendors, developers can run sample projects integrating realtime operating systems (FreeRTOS and Azure RTOS) and libraries (MQTT, TLS, OTA, etc.) from Amazon Web Services (AWS) and Microsoft Azure. Support is provided for tools such as QE for OTA, which simplifies complex OTA protocols, as well as functions essential for connecting to the cloud that utilize the security functionality built into Renesas products, such as "safe and secure firmware updating," "fast encryption and decryption," and "robust key concealment."



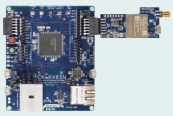
RX MCUs Recommended for Cloud Applications (IoT Devices)

From the extensive lineup of RX MCUs, we've selected the products ideally suited to cloud connectivity.

	Part Number	CPU	Frequency	ROM	RAM	Trusted Secure IP	Dual Bank ROM	Driver support		
								Ether	Wi-Fi	Cellular
MCU	RX72M/RX72N	RXv3	240MHz	4MB	1MB	✓	✓	✓	✓	✓
	RX66N	RXv3	120MHz	4MB	1MB	✓	✓	✓	✓	✓
	RX671	RXv3	120MHz	2MB	384KB	✓	✓	—	✓	✓
	RX65N/RX651	RXv2	120MHz	2MB	640KB	✓	✓	✓	✓	✓

Evaluation Kits for Cloud Applications (IoT Devices)

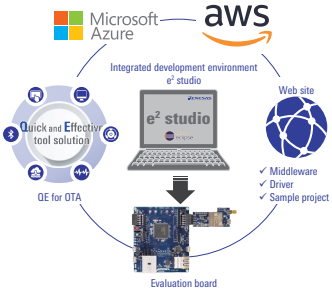
These kits provide a board mounted with an RX MCU and make it easy to try out applications employing cloud communication.
A variety of sample programs for the various boards are also available to download free of charge.

	CK-RX65N	RX65N Cloud Kit	RX72N Envision Kit	Renesas Starter Kit+ for RX671
RX Evaluation Kit				
Communication method	LTE Cat-M1 / Ethernet / Wi-Fi	Ethernet	Ethernet / Wi-Fi*	Wi-Fi*
aws	✓	✓	✓	✓
Microsoft Azure	✓	✓	✓	✓

*: The customer need to purchase Wi-Fi-Pmod-Expansion-Board separately.

Simply Selecting a Project in e² studio to Start Development

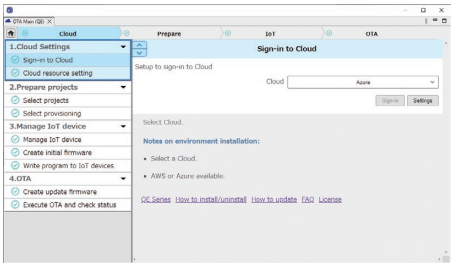
In Renesas' e² studio integrated development environment, you can select sample programs (MQTT communication, OTA functions, fleet provisioning, etc.) for AWS and Azure. Simply use Smart Configurator, which is integrated into e² studio, to configure clock and peripheral function settings to match the evaluation kit you are using, and you can get started with development and evaluation right away. The firmware update FIT module also supports secondary OTA for updating the firmware on MCUs that cannot connect to the cloud directly. This enables use of OTA in a wide variety of cases.



Quick and Easy Implementation of Complex OTA Functions Using QE for OTA

Implementing OTA functions involves following a complex series of steps. What's more, the time required increases dramatically as the number of OTA target devices increases.

QE for OTA, which runs in e² studio, allows visualization of these complex steps using a GUI. Once the settings have been configured, processing of OTA functions can be performed automatically. You can execute OTA functions on multiple IoT devices simply by clicking a few buttons. QE for OTA also lets you check the status of devices after OTA functions are run, making it suitable for managing products that utilize OTA.



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	–/✓*	✓

*: When using active shield

RX Capacitive Touch MCU Lineup

Capacitive touch sensor IP	2nd generation					3rd generation
MCU	RX113	RX130	RX231/0	RX23W	RX671	RX140
	RXv1 32MHz		RXv2 54MHz		RXv3 120MHz	RXv2 48Mz
Touch key ch	Max 12ch	Max 36ch	Max 24ch	Max 12ch	Max 17ch	Max 36ch
Features	5V, Segment LCDC	5V	5V, Security	5V, Security Bluetooth	Cloud, Connectivity, Security	5V, Security
Application	Electric home appliances, measurement, healthcare, OA, portable device, industrial equipment					

Numerals indicate number of touch control channels.

RX113
RX130
RX140
RX230
RX231
RX23W
RX671

Flash memory \ Pin	32	48	56	64	80	83	85	100	144	145
2MB		6		8				17	17	17
1.5MB		6		8				17	17	17
1MB		6		8				17	17	17
512KB		24 6	8	32 10	36	12	12	12 36 24		
384KB		24 6	8	32 10	36	12	12	12 36 24		
256KB		24 36 6		32 36 10	36			12 36 24		
128KB		24 36 6		32 36 10	36			12 36 24		
64KB	12	24 12		32 12	36					

Capacitive Touch Evaluation System

Using the board and software that come with the kit, you can get started with evaluation right away.

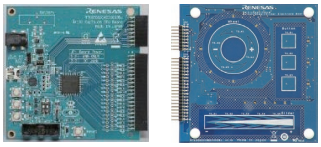
- Version for RX130 (RTK0EG0003S02001BJ)
- Version for RX140 (RTK0EG0039S01001BJ)
- Version for RX671 (RTK0EG0044S01001BJ)

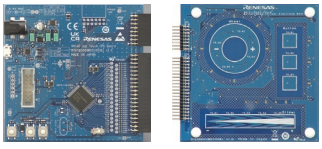
[Product Contents]

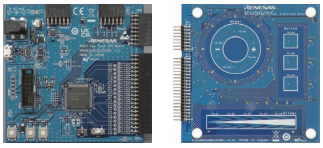
- CPU board populated with RX140, RX671, or RX130
- Touch application board
  - Self-capacitance evaluation board
    Supports basic capacitive touch controls, such as switches, sliders, and wheels.
  - Mutual-capacitance evaluation board*1
    Mutual-capacitance matrix keys and self-capacitance proximity sensor
    *1. Version for RX130 only

[Related Information]

- The following items are available on the websites linked to above.
  User's manuals, application notes, sample code, circuit diagrams, pattern diagrams


Version for RX130 (RTK0EG0003S02001BJ)


Version for RX140 (RTK0EG0039S01001NJ)


Version for RX671 (RTK0EG0044S01001BJ)

LCD Solutions

These LCD solutions feature a graphic LCD controller (GLCDC) and large on-chip memory capacity (maximum 4MB ROM and 1MB RAM). Display resolutions up to WVGA (8-bit) are supported without requiring external memory. An integrated 2D rendering engine (DRW2D) ensures smooth graphics rendering with a reduced CPU processing load.
What's more, new LCD display solutions are now available with an RX device as the standard MCU and employing an SPI interface. They are ideal for applications where cost efficiency is a priority or cases where a small, high-resolution display is required.

GUI Evaluation Kit

The Envision Kit (RX72N/RX65N) for GLCDC or DRW2D evaluation includes a WQVGA LCD and makes it easy to get started with GUI development.

- A debugger is included. Simply connect the board to a PC with a USB cable to start debugging.
- A preinstalled demo lets you experience the rendering performance of the 2D rendering engine.
- Compatible with the emWin for RX GUI tool from Segger. (Available free of charge to RX users.)
- Ample sample code and demos are available for download on the web.

The available sample LCD display applications using the SPI interface are quite similar to actual applications. Alongside QVGA LCD display applications, capacitive touch sensor operations can be evaluated at the same time.

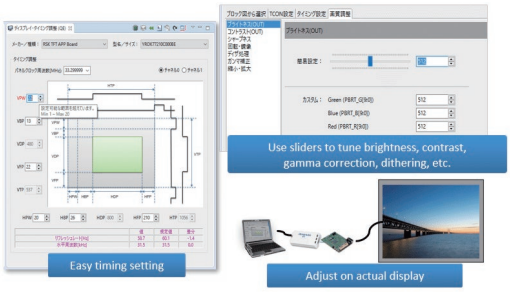
RX72N Envision Kit

Display sample using SPI

QE for Display (e² studio Plugin)

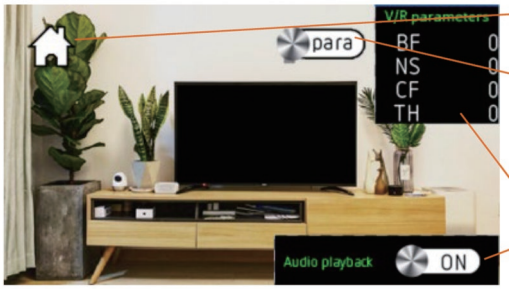
This tool assists in GUI development by simplifying configuration of LCD panel settings and enabling links with GUI tools from Renesas partner vendors.

1. Simple LCD adjustment
   - Simplifies timing adjustments and picture quality adjustments.
   - Just click a button to update parameter values in registers. You can see the results on the LCD as you make adjustments.
2. Linkage with GUI tools from partner vendors
   - Download, install, and call tools from partner vendors.
   - Update projects with image data edited in tools.
   - Supports emWin for RX from Segger and Aeropoint GUI from CRI middleware.



Voice Recognition Solutions

By making use of voice recognition middleware from Renesas partner vendors developers can facilitate operation triggered by voice commands. With fast response not requiring access to a network and small memory requirements, these solutions make it possible to implement voice recognition even on MCUs with comparatively little on-chip memory, such as the RX200 Series. Support for directional sound collection functionality using a stereo microphone makes possible use even in noisy environments.



RX72N Envision Kit/Renesas Starter Kit+ for RX671 Voice Recognition Demo

- This demo lets the user experience screen transitions triggered by voice commands, noise tolerance, CPU load factors, and more.
- Perform evaluation while making changes to parameters such as threshold and directional strength.
- Demo firmware available on the web can be installed on the kit.
- An (optional) cloud connection function is available that enables synchronizing the operation results of voice commands with a cloud service (RX671 only).

Middleware	Vendor	Type	Applicable Demo
AMI Voice	Advanced Media, Inc.	Voice recognition library	RX72N Envision Kit, RSK+ for RX671
RECAIUS	Toshiba	Voice recognition library	RSK+ for RX671
Zoom Voice	Techno Mathematical Co., Ltd.	Noise suppressor and beam focusing functions	RX72N Envision Kit, RSK+ for RX671

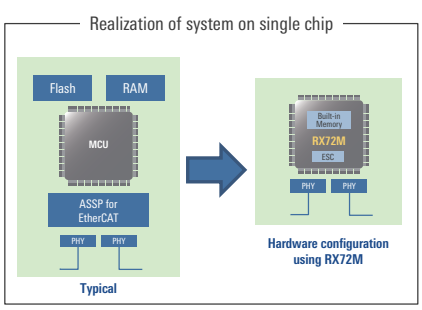
RX FAMILY SOLUTIONS

Industrial Network Solutions

Industrial networks are characterized by a variety of protocols coexisting side by side, each utilized for its own particular strongpoints. Renesas offers solutions that are compatible with multiple protocols to provide support for customers' development efforts.

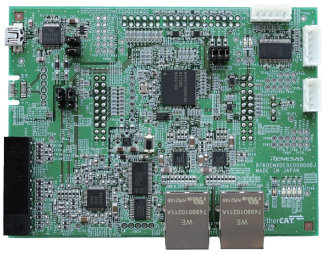
RX72M Network Solutions

The sample software supports EtherCAT® and other leading industrial network communication protocols that cover 70% of the market. Benefiting from collaboration with Renesas partner vendors, these sample program packages help reduce the development time required for implementation of protocols. The RX72M delivers superior performance with a 1461 CoreMark® score when operating at 240MHz together with large memory capacity, making it possible to realize a system on a single chip, reducing the BOM cost associated with development, and contributing to reduced device size.



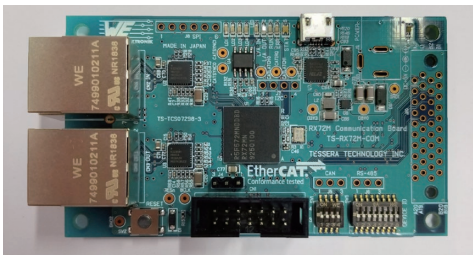
RX72M Network Solution Boards

These solutions consist of an evaluation board mounted with an RX72M MCU ideal for initial evaluation of networked devices, OS, middleware, and sample code.



RX72M CPU Card with RDC-IC (RTK0EMXDE0C00000BJ)

- Supports BLDC motor and stepping motor control when combined with a compatible inverter board.
- A variety of sample code is provided.

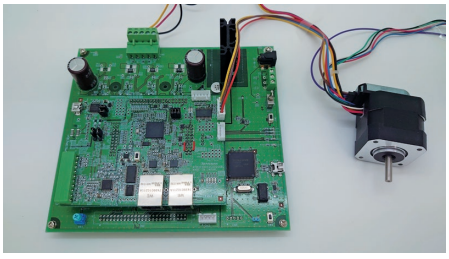


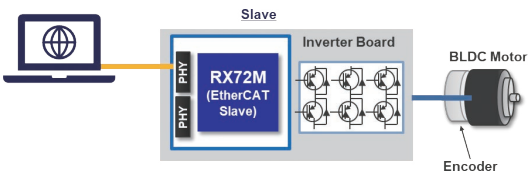
EtherCAT Conformance tested | CERTIFIED PI PROFIBUS • PROFINET | ODVA CONFORMANT

TS-RX72M-COM*

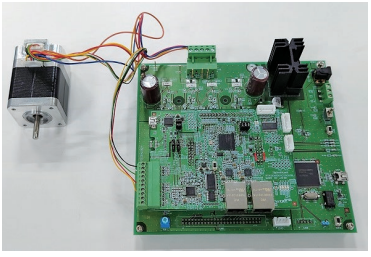
- EtherCAT and 2-channel Ethernet ports (MII)
- RS-485 and CAN transceiver (field network support)
- Conformance tested on three major protocols (EtherCAT®, PROFINET RT, and EtherNet/IP).

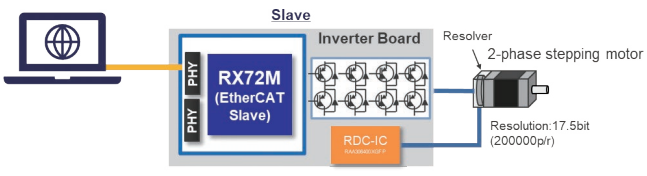
* The TS-RX72M-COM board is available for purchase from Tessera Technology, Inc. For details, please contact your Renesas sales agent.





- Encoder vector control for permanent magnet synchronous motors
  By installing encoder vector control software on an RX72M MCU, EtherCAT® communication and encoder brushless motor control can be implemented on a single chip.

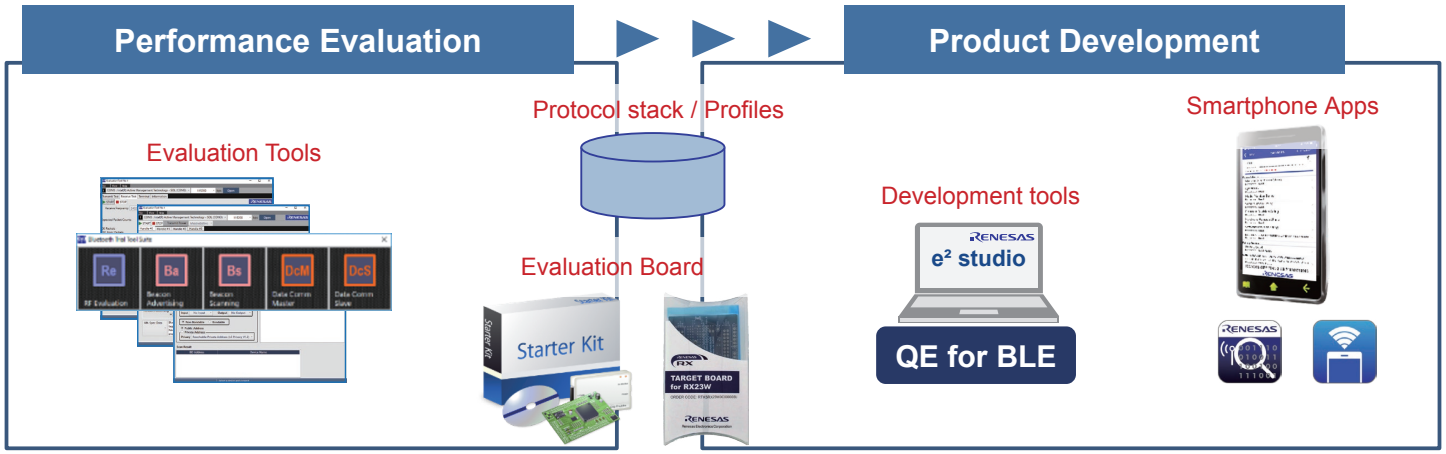




- Vector control for resolver-equipped stepping motors
  By installing resolver vector control software on an RX72M MCU, EtherCAT® communication and resolver-equipped stepping motor control and can be implemented on a single chip.

Bluetooth® Low Energy Solutions

RX Bluetooth solutions deliver industry-top-class power efficiency and smart connections, making them ideal for applications such as healthcare and fitness devices, consumer electronics, and RFID tags. Tools suitable for evaluating functions and performance as well as application development support are available.



Evaluation Boards

Item	Renesas Solution Starter Kit	Target Board for RX23W	Target Board for RX23W module
Device	85-pin RX23W (R5F523W8ADBL: without encryption functions)/ (R5F523W8BDBL: with encryption functions)	56-pin RX23W (R5F523W8ADNG: without encryption functions)	RX23W module (R5F523W8CDLN: without encryption functions) [certified under Radio Law]
Accessories	LCD panel, E2 Emulator Lite	None (However, an emulator is mounted on the board.)	
URL	https://www.renesas.com/RX23W-Starter-Kit/	https://www.renesas.com/RTK5RX23W0C00000BJ/	https://www.renesas.com/RTK5RX23W0C01000BJ/

Protocol Stacks

Bluetooth Low Energy Protocol Stack (FIT)

This FIT module consists of a Bluetooth LE–conformant protocol stack and application development support software. It can be combined with Bluetooth profiles generated by QE for BLE to reduce the development time required for a wide range of applications. Additional support for application development is available in the form of sample programs using the protocol stack and a development guide.

Bluetooth Mesh Stack for RX Family

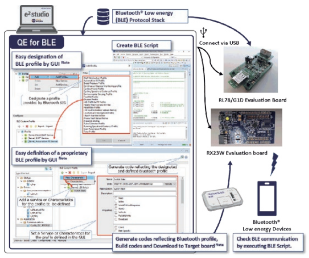
The Bluetooth Mesh Stack can be used to create a secure mesh network conforming to the Bluetooth Mesh networking standard. All mesh models are supported, so a variety of applications can be accommodated. In addition to sample programs compatible with the evaluation board for RX23W, there is also a sample smartphone application for network configuration.

Development Support Tools

Bluetooth Low Energy Development Support Tool: QE for BLE

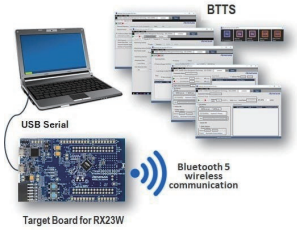
This tool runs on the e2 studio integrated development environment and provides support for system development using the Bluetooth Low Energy protocol stack.

- Create custom profiles.
- Check Bluetooth LE communication.



Bluetooth Test Tool Suite (BTTS)

This Windows application provides a GUI for controlling the RX23W. It can help users evaluate Bluetooth functions and better understand the APIs provided with the protocol stack. BTTS also can be used as a tool for controlling devices undergoing certification testing under the Radio Law.

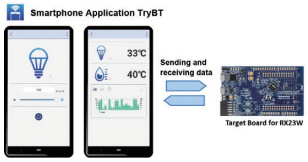


iOS/Android Application: GATTBrowser

GATTBrowser is a smartphone app for verifying the operation of Bluetooth LE applications developed using the RX23W. It can also connect to and transfer data with commercially available products that support Bluetooth LE.

Smartphone Sample Application: TryBT

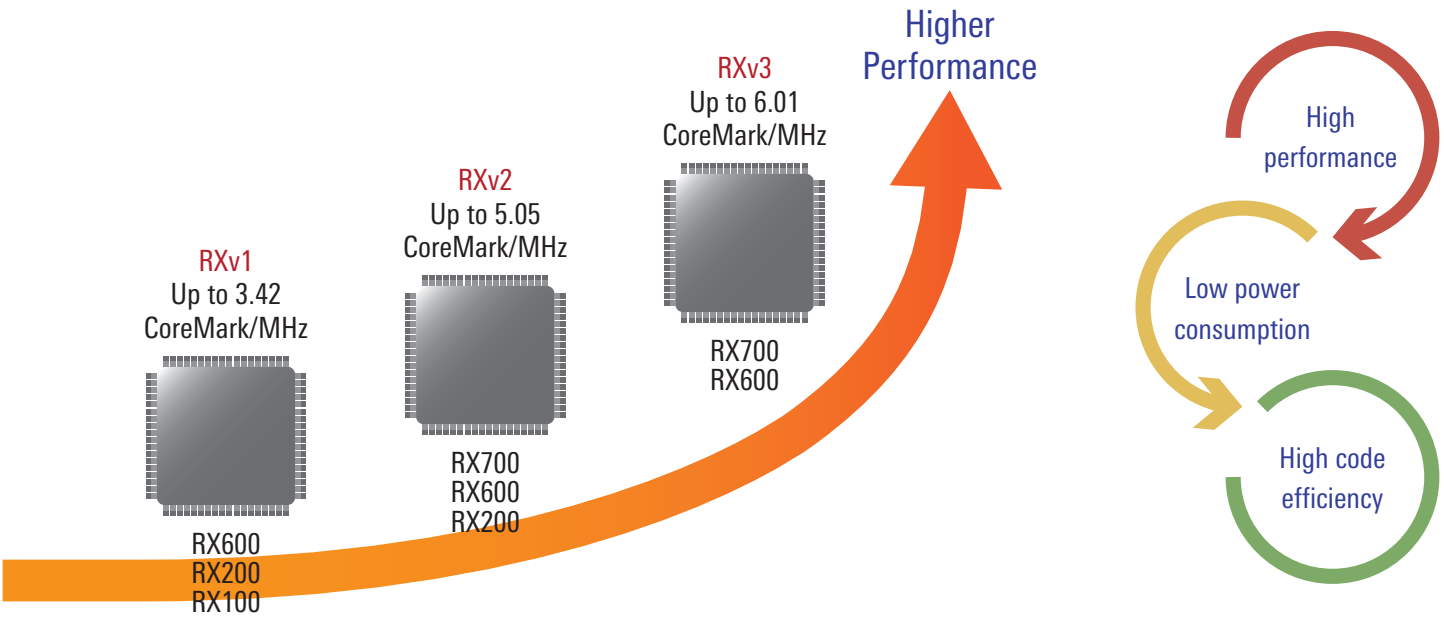
TryBT is supplied as a project that can be used as a basis for developing smartphone applications by modifying its operation and design elements. In its initial form TryBT can be used to test communication with the software preinstalled on the target board.



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.



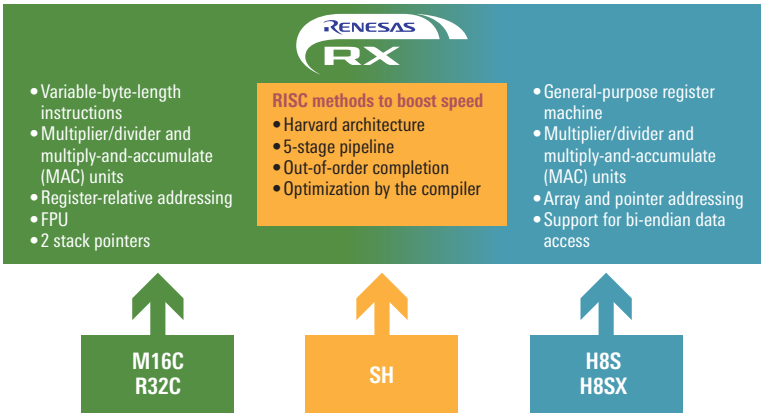
Comparison of RX Cores

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 3.42 CoreMark/MHz	Up to 5.05 CoreMark/MHz	Up to 6.01 CoreMark/MHz
Others	-	-	Register bank save function (optional) *Availability of optional functions depends on product specifications

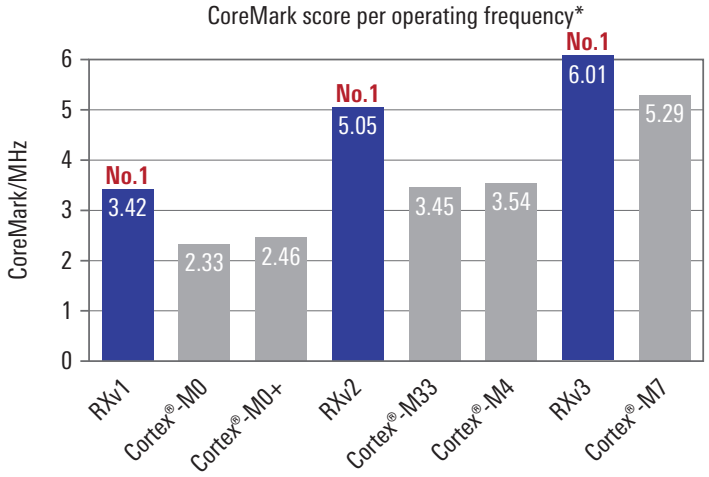
Feature 1: Original CPU That Inherits the Strengths of Its Predecessors

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 = 6.01

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.

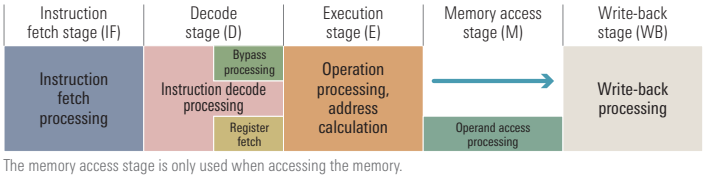
* Cortex®-M is the nominal value of Arm

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

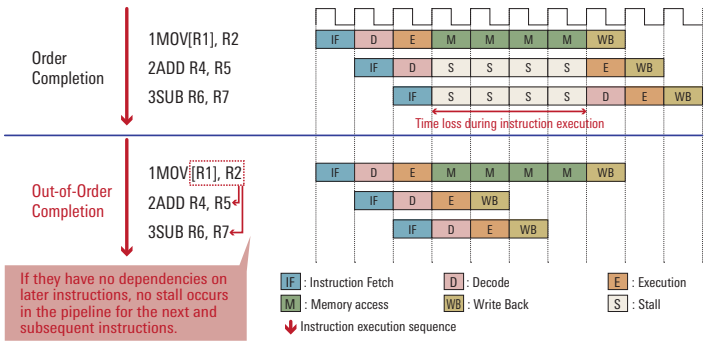
- 5-stage pipeline for faster processing
- Through benchmark testing of various types of application software, processing performance was more than doubled compared with earlier products.



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.



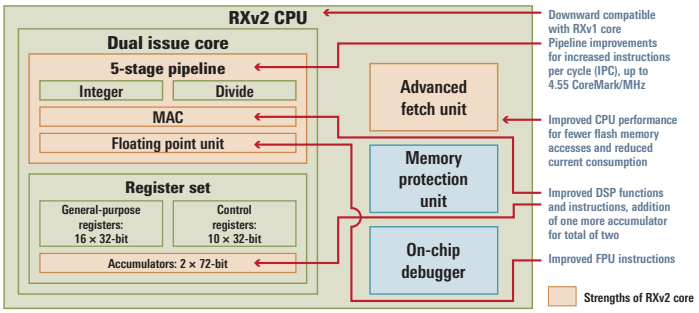
RXv2 CORE FEATURES

RXv2 Core: CPU Block Diagram

Further enhancements while maintaining compatibility with the RXv1 core

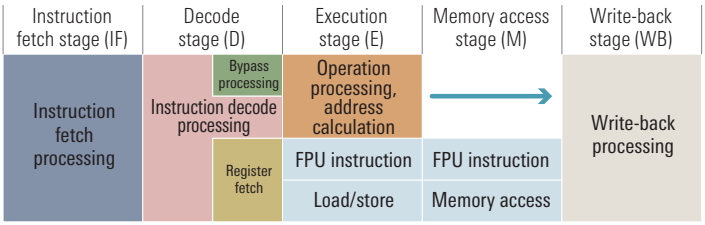
- Improved pipeline for substantial increase in the number of instructions per cycle (IPC)
- Advanced fetch unit with improved interface to on-chip flash memory. Reduces re-fetching of instructions due to penalty imposed by branch instructions and reduces the number of flash memory accesses. Achieves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



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

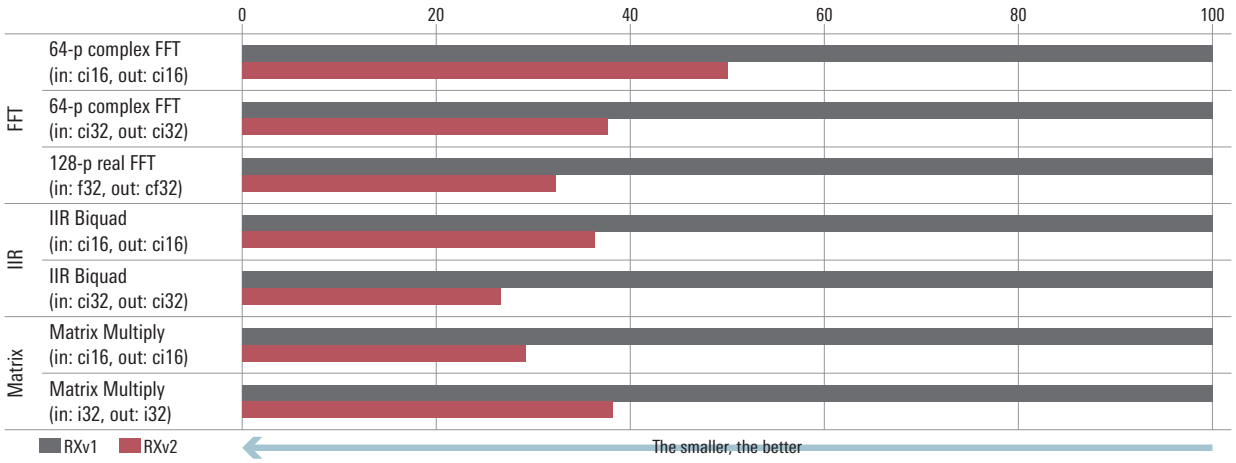
Improved pipeline processing and parallel execution of floating-point operations

- 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

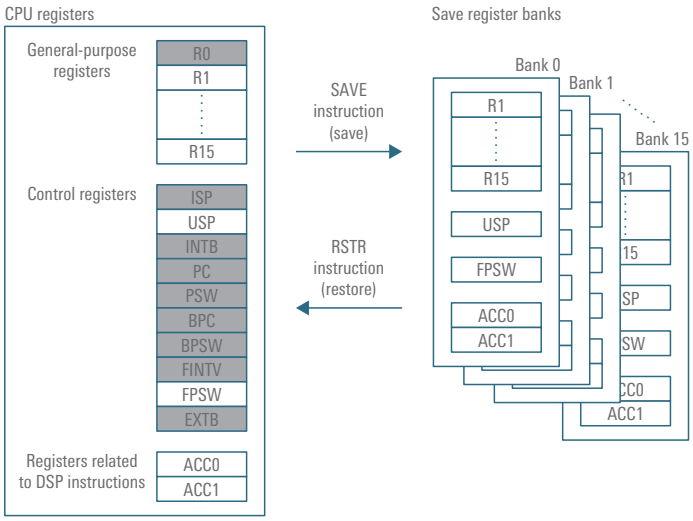
The successor to the RXv2 core, the RXv3 core boosts performance with new functions while adding a double-precision FPU and a register bank save function. These improvements enable it to achieve a score of 5.82 CoreMark/MHz on the EEMBC CoreMark® benchmark test, among the best CPU performance levels 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

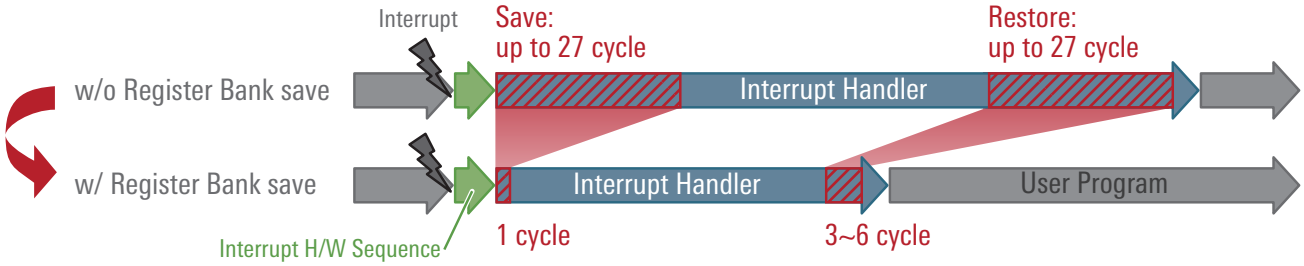
Dedicated memory for improved interrupt responsiveness

- 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.

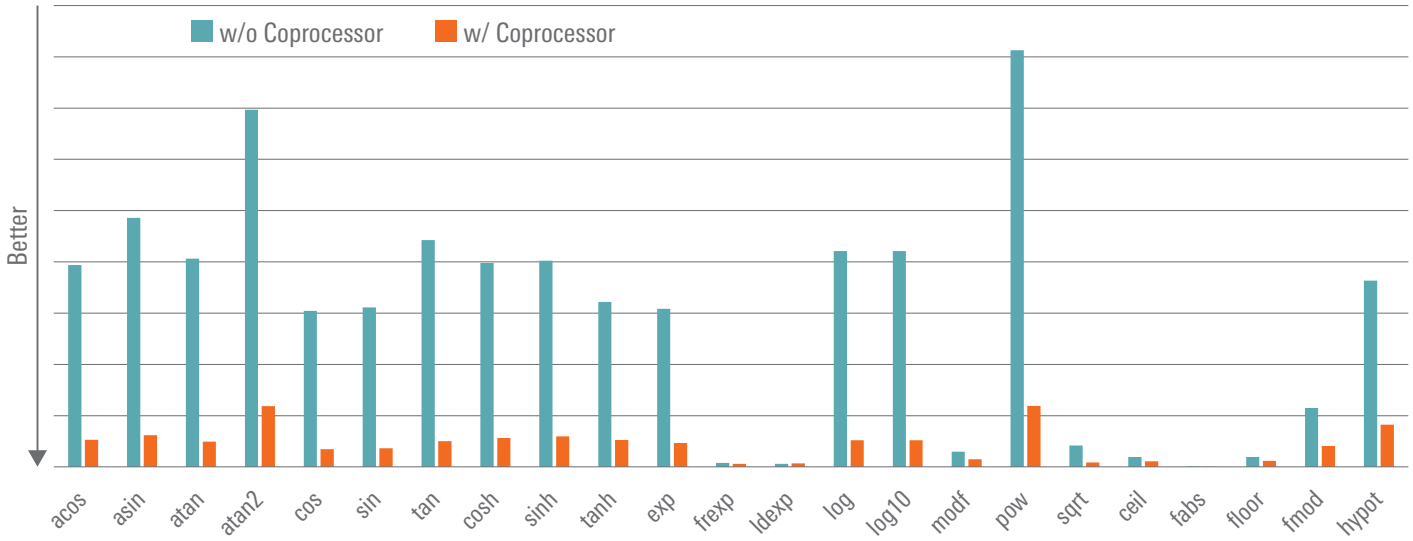


Comparison with conventional product (saving data to all registers)



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 (Industrial/Appliances/Office Equipment/ICT)

Features of RX700/RX600 Series

High-performance, High-speed response

1416CoreMark @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
Capacitive touch

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, 100/144/176/224-pin

RXv3 | Double precision FPU | Trigonometric functions arithmetic unit | Ethernet IEEE1588 | I²S | TFT LCD | EtherCAT slave

RX72N — 240MHz, 4MB Flash, 1MB SRAM, 100/144/145/176/224-pin

RXv3 | Double precision FPU | Trigonometric functions arithmetic unit | Ethernet IEEE1588 | I²S | TFT LCD

RX66N — 120MHz, 4MB Flash, 1MB SRAM, 100/144/145/176/224-pin

RXv3 | Double precision FPU | Ethernet | I²S | TFT LCD

RX671 — 120MHz, 2MB Flash, 384KB SRAM, 48/64/100/144/145-pin

RXv3 | Double precision FPU | I²S | Capacitive touch

RX65N/RX651 — 120MHz, 2MB Flash, 640KB SRAM, 64/100/144/145/176/177-pin

RXv2 | Single precision FPU | Ethernet | TFT LCD

RX65W-A — 120MHz, 2MB Flash, 640KB SRAM, 145-pin

RXv2 | Single precision FPU | Ethernet | Wi-SUN

RX660 — 120MHz, 1MB Flash, 128KB SRAM, 48/64/100/144-pin

RXv3 | Single precision FPU | CAN-FD | 5V

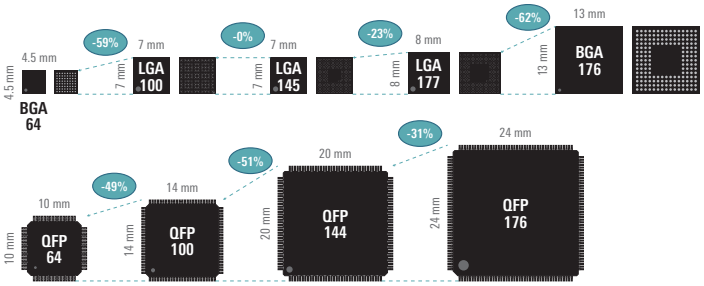
Common functions

- Dual bank*1
- USB*1
- CAN*2
- SD host I/F*1
- Quad SPI*1
- Trusted Secure IP*1
- 12-bit ADC

*1: Not implemented on RX660.
*2: Not implemented on RX65W.

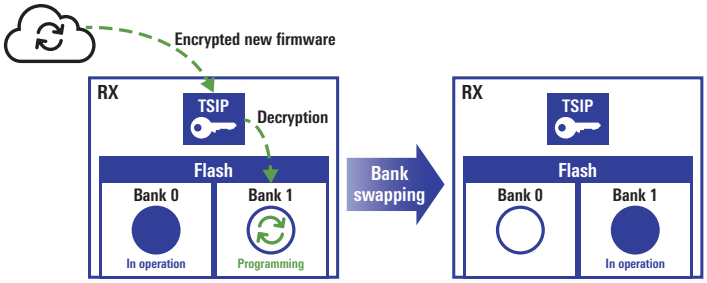
RX65N/RX651: Mainstream MCUs that Integrate Functions Essential for IoT Devices on a Single Chip

- Broad lineup ideal for a range of products, with flash memory capacity from 512KB to 2MB and package pin counts from 64 to 177 pins
- Easy implementation of secure firmware over-the-air (FOTA) updates essential for IoT devices



Broad Package Lineup

With the exception of 176- and 177-pin products, all packages are available with flash memory capacities from 512KB to 2MB (1.5MB or 2MB only for 176- and 177-pin products).

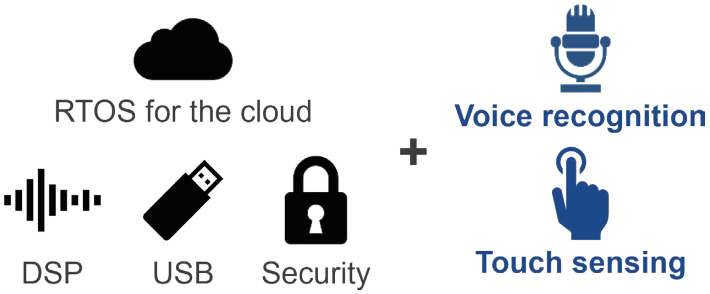


FOTA Solutions Bringing New Added Value

Firmware can be updated while the system continues to operate.
Select wired or wireless connectivity to match the application.
Authentication enables tampering detection and prevents unauthorized updates.

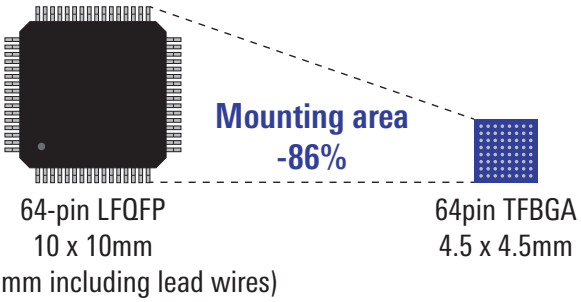
RX671: Support for Superior Power Efficiency, Hygienic User Interfaces, and Cloud-Connected IoT Applications

- Functionality for implementing a contactless UI using voice recognition or touch sensing and sophisticated system control on a single chip
- 4.5 × 4.5mm 64-pin BGA standard package enabling compact applications with more advanced functions



Contributing to Simpler System Configurations

A single-chip solution that supports larger memory requirements of communication protocol stack processing and accommodating an RTOS to enable operation processing on contactless UI devices.

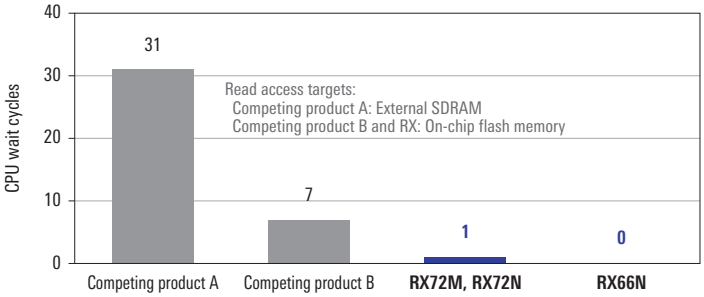


High-Performance CPU and Large Memory Capacity in an Ultracompact 4.5 × 4.5mm Standard Package

Helps realize more advanced functionality in applications with limited available mounting area..

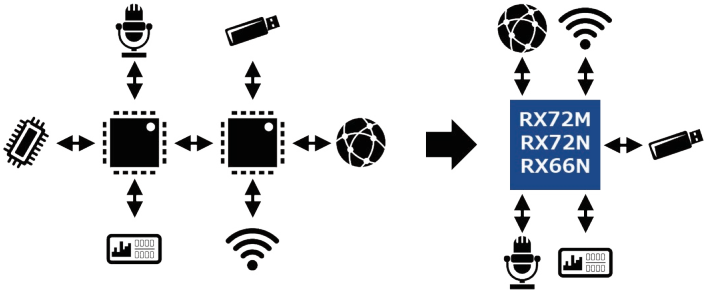
RX72M, RX72N, and RX66N: Device Control and Network Functions on a Single Chip

- The flash memory supports the industry's fastest read times when operating at 120MHz. This permits consistent peak CPU performance and is ideal for applications demanding excellent real-time performance.
- The on-chip memory capacity and number of general-purpose I/O ports are also the highest in the industry. This allows concentration of multiple functions on single chip, enabling more compact finished products and reduced development time.



Outstanding Realtime Performance

On the RX72M and RX72N there is only one wait cycle when a cache miss occurs.
On the RX66N there generally are no wait cycles.



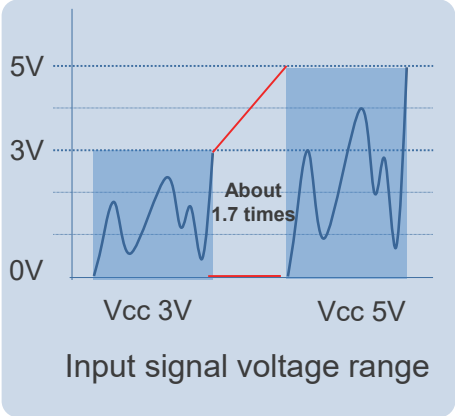
Multifunctionality and Compact Size

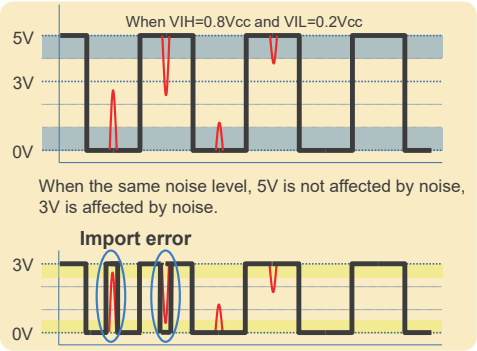
4MB flash memory, 1MB SRAM, and 182 general-purpose I/O ports on a single chip.

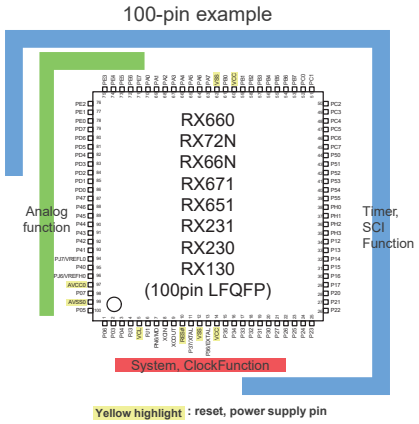
RX700/RX600 SERIES (Industrial/Appliances/Office Equipment/ICT)

RX660: 5V Power Supply Compatibility Combined with High-Performance CPU Core

- Support for 5V power supply with noise tolerance superior to that of 3V power supply reduces the need for external components to suppress noise.
- Features the latest RXv3 CPU core while retaining pin compatibility with other 5V products (such as the RX210).







Helping to Improve System Noise Tolerance

Using a 5V power supply increases the dynamic range to 1.7 times that possible with a 3V power supply, which is valuable in scenarios requiring high-precision sensing. It also makes it possible to reduce the relative noise level.

Easy Migration from Other 5V MCUs

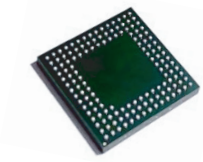
Pin compatibility with previous-generation products such as the RX210 makes it possible to switch to the latest high-performance CPU core while minimizing the system configuration burden.

RX65W-A: Wi-SUN FAN 1.1 Conformant Sub-GHz Communication MCU

- Conforms to the latest Wi-SUN FAN Profile: Wi-SUN FAN 1.1
- Support for two modulation methods: OFDM and FSK (max. 2.4Mbps)
- Support for main sub-GHz bands: US, EU, JP, and BR bands*
- Industry-top-class RF reception sensitivity: -109dBm in 50kbps SUN FSK
  -119dBm in 12.5kbps SUN OFDM

* Supported frequency bands
European band: 863-876MHz
American band: 902-928MHz
Japanese band: 920-928MHz
Brazilian band: 902.0-907.5, 915.0-928.0MHz

RENESAS RX + Wi SUN + compact package =



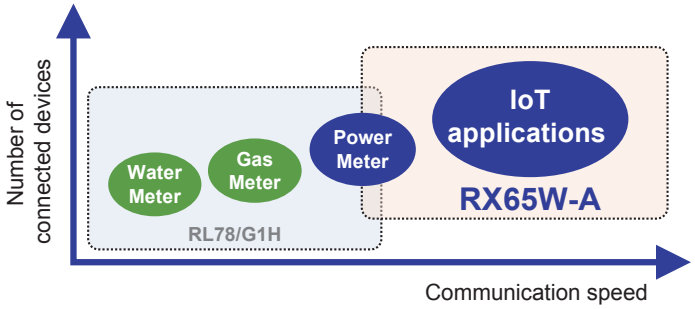
Large Memory:
ROM 2MB, RAM 640KB

Renesas is a board member of the Wi-SUN Alliance.

145pin TFBGA
8 x 8mm

The Wi-SUN FAN sub-GHz wireless communication standard provides *high signal reachability, long-distance communication over a multi-hop mesh network*, and a *network automatic rebuild function yielding stable communications*. Its use is growing in smart meters for electricity, gas, and water systems. Wi-SUN FAN is expected to be adopted and its market to expand as a means of linking IoT devices of all kinds as our smart society develops.
The RF firmware and Wi-SUN FAN 1.1 protocol software stack for the RX65W-A, as well as development tools and reference designs, provide support for customers developing IoT systems and making the smart society a reality.

Visualization of Target Applications



MEMO

RX200 SERIES (Industrial/Appliances/Office Equipment/ICT)

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

RX231 54MHz, 512KB Flash

RXv2	Single precision FPU	CAN	USB	SDHI	Capacitive touch	Security

RX230 54MHz, 256KB Flash

RXv2	Single precision FPU				Capacitive touch	

RX200 Series Memory/Pin Lineup

	RX23W			RX231 / RX230		
Flash size	56-pin	83-pin	85-pin	48-pin	64-pin	100-pin
512KB	●	●	●	●	●	●
384KB	●	●	●	●	●	●
256KB				● ●	● ●	● ●
128KB				● ●	● ●	● ●

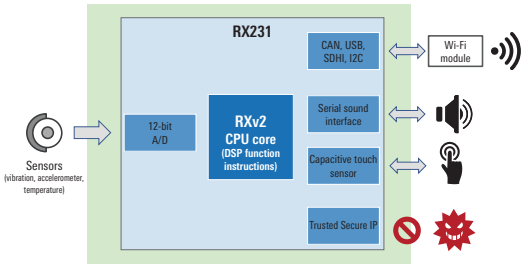
Pin

● RX23W
● RX231
● RX230

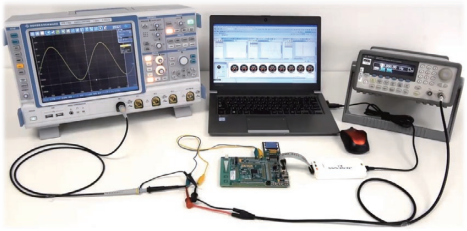
RX231 Concept

Power efficiency and performance	Operating current: 0.12mA/MHz, RAM maintenance standby current: 0.8μA DSP and FPU for improved power efficiency Ability to control digital filters and sophisticated applications
Communication and security	Hardware security engine (Trusted Secure IP Lite)
Ample peripheral functions	Timers, analog functions, UI support, and safety functions suitable for household appliances and industrial applications

Full array of functions needed for developing consumer electronics, industrial, and IoT applications



1) Collection of data from sensors of various types (A/D conversion of output signals)
2) Extraction and analysis of specific signals (IIR filter and FFT processing)
3) Control using analysis results (audio or LCD output)
What's more, capacitive touch and security functionality can be implemented using a single chip.



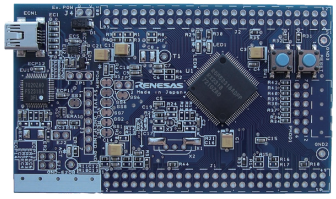
IIR Filter and FFT Demo System Utilizing DSP Library

A software development environment you can start using right away, backed by an array of development support tools

Software Development Environment

RX231 Starter Kit
(R0K505231S000BE)

Evaluation Board



RX231 Target Board
(RTK5RX2310C00000BR)

Software Libraries

- DSP library
- Touch reference designs
- Trusted Secure IP driver
- Functional safety software

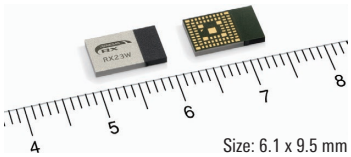
RX23W Concept and Platform

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

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.

RENESAS RX + Strong Security (Trasted secure IP) + Bluetooth® = RX23W

The lineup includes modular products with integrated antenna and oscillator. The module size is among the world's smallest, and the design enables use of a large number of MCU peripheral function pins. These modules are certified under the Radio Laws of Japan (technical standards compliance), North America (FCC/ISED), and Europe (CE), making it possible to bring products to market quickly.



Size: 6.1 x 9.5 mm

RX100 SERIES (Industrial/Appliances/Office Equipment/ICT)

Features of RX100 Series

Power consumption among the lowest in the industry

48MHz
0.25μA 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

RX140

48MHz, 256KB Flash

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

RX130

32MHz, 512KB Flash

RXv1 | 12-bit A/D | Remote control receiver circuit | 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

RX100 Series Memory/Pin Lineup

	3.3V + USB				RX113		5V + Touch					
Flash size	36	40	48	64	64	100	32	48	64	80	100	Pin
512KB			●	●	●	●		●	●	●	●	
384KB			●	●	●	●		●	●	●	●	
256KB			●	●	●	●		● ●	● ●	● ●	●	
128KB			● ●	● ●	●	●		● ●	● ●	● ●	●	
96KB			● ●	● ●								
64KB	● ●	● ●	● ●	● ●			●	● ●	● ●	●		
32KB	● ●	● ●	● ●	● ●								
16KB	● ●	● ●	● ●	● ●								
8KB	●	●										

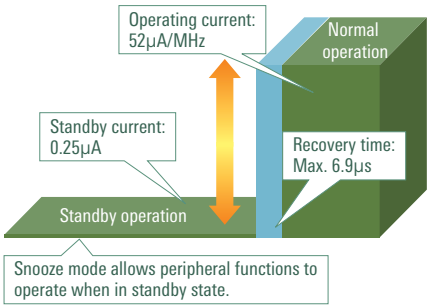
● RX140
● RX130
● RX113
● RX111
● RX110

RX140 Concept

Advanced ultralow power consumption	0.1mA/MHz when CPU operating, 0.25µA in standby mode 30% lower power consumption than preceding product (RX130) Addition of snooze mode, allowing peripheral functions to operate in standby mode while CPU is idle
Highest performance in the series	First RX100 Series MCU with RXv2 CPU core (max. operating frequency: 48MHz) 204 CoreMark score, double that of preceding product
Advanced capacitive touch	New-generation capacitive touch IP (CTSU2SL) combining high sensitivity with superior noise tolerance
Stronger security	Hardware security functions (AES and true random number generator)
High compatibility	5V operation, 12-bit A/D converter, RTC, etc., with functional- and pin-compatibility with earlier products

Advanced Ultralow Power Consumption

- Ideal for batteries and battery-driven applications



Ultralow current consumption during both standby and normal operation

Fast recovery from standby to normal operation

Snooze mode contributes to improved power efficiency for the entire system (touch measurement, reception of serial data, A/D conversion).

Advanced Capacitive Touch

Capacitive Touch IP	Advantages	RX130	RX140	
		CTSU	CTSU2L*1	CTSU2SL*2
Radiated noise tolerance (IEC/EN61000-4-3)*3	Reduction in malfunctions due to radiated noise	Level 3	Level 4	Level 4
Conductive noise tolerance (IEC/EN61000-4-6)*3	Reduction in malfunctions due to conductive noise	Level 3	Level 3	Level 3
Pins for shielded electrode drive	Improved water resistance	Not supported	Supported	Supported
Smart wakeup (auto-sensing and multi-scan)	Reduced power consumption	Not supported	Not supported	Supported

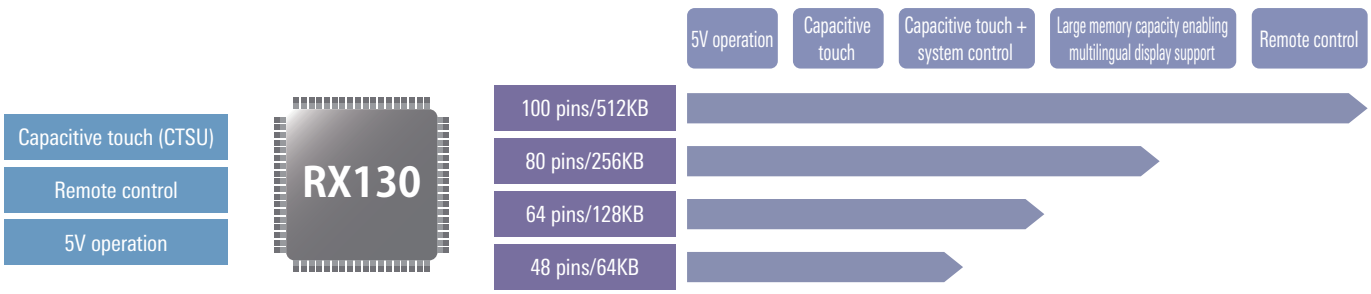
*1. Versions with 64KB of flash memory only
*2. Versions with at least 128KB of flash memory only
*3. Using capacitive touch evaluation system

Excellent Compatibility

- Low-pin-count/small ROM included in lineup of products
- Reduced BOM cost due to integration of peripheral IC functions
- Excellent compatibility across RX Family for reduced development cost with other RX products

RX130 Concept

Support for Development of Diverse Devices with Product Lineup Extending up to 512KB of Flash Memory and 100-pin LQFP Package



RX-T (for Motor Control)

Features of RX-T (for Motor Control)

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-T (for Motor Control)

Industrial

Robots, Machine tools

General-purpose inverters

Meters

Building automation

Office Automation

Copiers
Printers

Home appliances

Air conditioners
Refrigerators
Washing machines

Product Lineup of RX-T (for Motor Control)

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

RX26T

120MHz, 512KB Flash

RXv3	Single precision FPU	Motors 2	PGA	Register bank save	Trigonometric functions arithmetic unit	CAN FD	PGA	Security	Dual bank

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

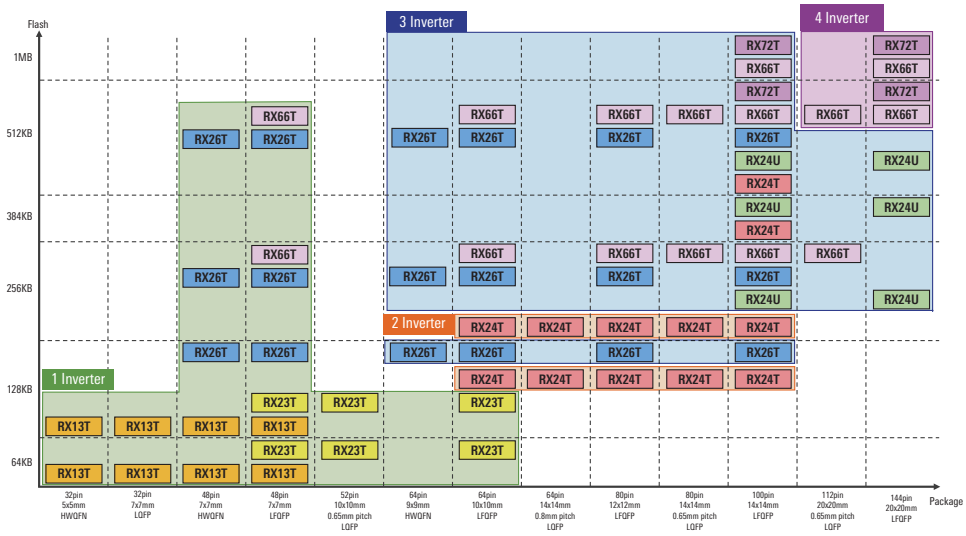
RXv2	Single precision FPU	Motors 1							

RX13T

32MHz, 128KB Flash

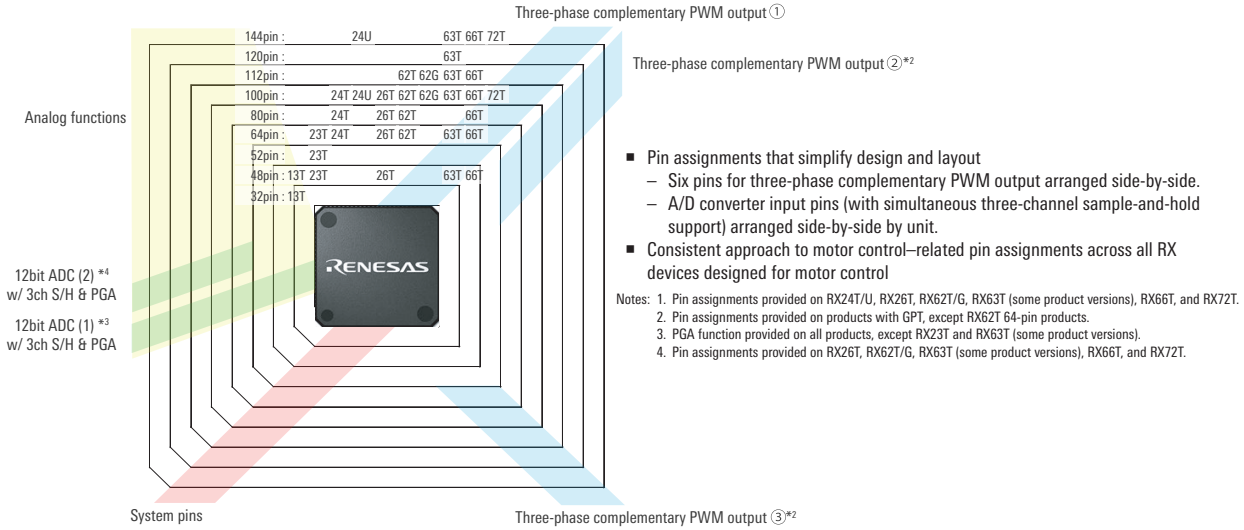
RXv1	Single precision FPU	Motors 1	PGA						

Product Lineup of RX-T (for Motor Control)



Note: The x in "x Inverter" represents the maximum number of units to which 3-phase complementary PWM output can be supplied.

Allocation of Resources Specially for Motor Control

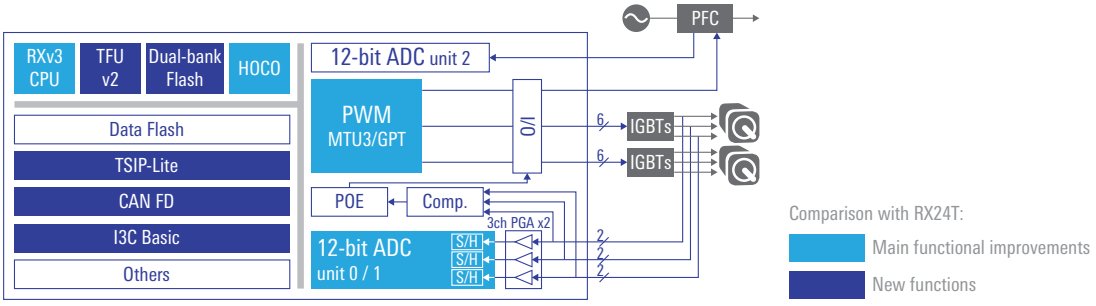


- Pin assignments that simplify design and layout
  - Six pins for three-phase complementary PWM output arranged side-by-side.
  - A/D converter input pins (with simultaneous three-channel sample-and-hold support) arranged side-by-side by unit.
- Consistent approach to motor control–related pin assignments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

Notes: 1. Pin assignments provided on RX24T/U, RX26T, 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 RX26T, RX62T/G, RX63T (some product versions), RX66T, and RX72T.

RX26T: Ideal for 2-Motor Control and PFC Control

- RXv3 CPU core operating at 120MHz (721 CoreMark score), flash memory with 120MHz read operation, and trigonometric function unit (TFU) for excellent computing performance and realtime performance enabling highly efficient motor or inverter control
- Retains the 5V power supply in high demand for motor applications for its high noise tolerance and ample analog input dynamic range.



Single-Chip Implementation of 2-Motor + PFC Control

120MHz PWM (2 channels for 3-phase complementary output + 2 channels for single-phase complementary output) timer, 12-bit ADC × 3 units, 3-channel simultaneous sample and hold circuit × 2 units

Latest Communication Standards and Improved Functions for IoT Technology

Latest Communication functions I3C BASIC and CAN FD, dual-bank flash memory, and security functions (TSIP-Lite)

RX-E (for Sensor Measurement)

Features of RX-E (for Sensor Measurement)

High-precision AFE and MCU on a single chip

24-bit delta-sigma ADC
Fully differential PGA
32MHz RXv2 CPU core

Ample peripheral functions

DAC
Excitation current source
Integrated voltage reference source
BIAS voltage generator circuit
On-chip temperature sensor

Variety of communication interfaces

CAN
SPI
UART
I^2C

Main Applications of RX-E (for Sensor Measurement)

Temperature

Resistance temperature detectors
Thermocouples
Temperature controllers
Peltier coolers

Strain

Load cells
Weight scales
Force sensors
Torque sensors

Pressure and flow

Pressure gauges
Pressure calibrators
Electropneumatic regulators
Flow meters
Mass flow controllers

Data acquisition

Data loggers
Recorders
Analog input modules
Digital multimeters

Product Lineup of RX-E (for Sensor Measurement)

RX23E-A 32MHz, 256KB Flash

RXv2 | Single precision FPU | 24 bit delta-sigma × 2 units | Fully-differential PGA | Excitation current source × 4 channels | Integrated voltage reference source | BIAS voltage generator circuit | On-chip temperature sensor

RX23E-B 32MHz, 256KB Flash

RXv2 | Single precision FPU | 24 bit delta-sigma | Fully-differential PGA | 16 bit DAC | Excitation current source × 2 channels | Integrated voltage reference source | BIAS voltage generator circuit | On-chip temperature sensor

Product Lineup of RX-E (for Sensor Measurement)

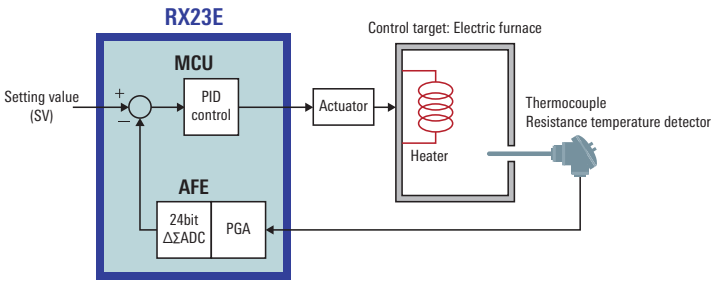
		RX23E-A		RX23E-B				
24bit ΔΣ		40-pin	48-pin	40-pin	48-pin	64-pin	80-pin	100-pin
Max. Date rate	Unit							
125ksps	1			●	●	●	●	●
31.25ksps				●	●	●	●	●
15.6ksps	2	●	●					
	1	●	●					

Pin

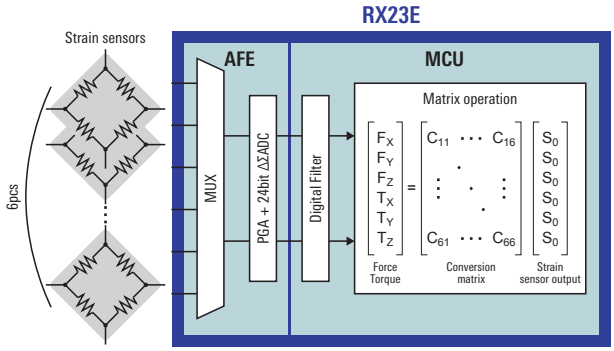
● RX23E-A
● RX23E-B

High-Precision AFE and MCU on a Single Chip

- High-precision AFE optimized for temperature and strain measurement in the industrial field
- High-performance MCU suitable for implementation of correction processing and digital signal processing
- Variety of communication interfaces enabling flexibility in system and board design



Application example: Temperature control

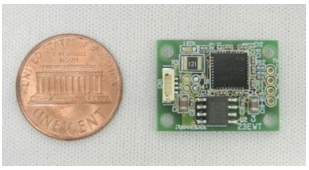


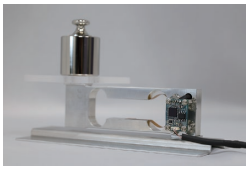
Application example: 6-axis force sensor

Sensor Measurement Reference Designs Using RX-E

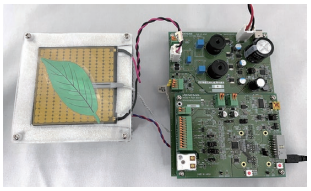
Tiny Board for Digital Load Cell

This reference design employs the RX23E-A or RX23E-B MCU with on-chip high-precision AFE to implement a digital load cell. Using the RX23E-A or RX23E-B eliminates the need for a dedicated AFE, allowing use of a smaller board. The reference design uses a compact board (22mm × 16mm) small enough to allow integration into the load cell.



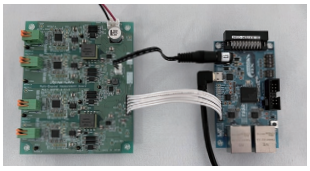


Peltier Cooler



This reference design employs the RX23E-A MCU with on-chip high-precision AFE to implement a Peltier cooler. Peltier coolers utilizes a phenomenon known as the Peltier effect to implement temperature controllers capable of both heating and cooling, and they are used in a wide range of temperature control applications. Using the RX23E-A makes it possible to use a single chip to implement the measurement, calculation, and control functions necessary for Peltier cooler temperature control.

CH-to-CH Isolated Analog Measurement System



This is a reference design of a system employing four RX23E-A MCUs on mutually isolated channels to simultaneously measure temperature and voltage. The reference design makes use of the RX23E-A MCUs with on-chip high-precision AFE to implement distributed processing. It is ideal for applications with multiple analog inputs such as analog input modules, temperature controllers, recorders, and data acquisition.

Force Sensor

This reference design employs the RX23E-B to implement a 6-axis force sensor. Such a 6-axis force sensor would typically be installed in a location such as the tip of a robotic arm. It is composed of six strain sensors that measure load and torque on the x-, y-, and z-axes, a total of six values. Using the RX23E-B makes it possible to use a single chip to implement the A/D conversion and matrix processing necessary for 6-axis force sensor measurement.

RX-E Evaluation Board (Renesas Solution Starter Kit)

This Renesas Solution Starter Kit (RSSK) is an evaluation kit that supports deployment of RX-E Series MCUs. The RSSK comprises an evaluation board populated with the RX-E and peripheral circuits for sensor measurement, a GUI tool, and related application notes. It enables evaluation of an AFE, including the sensors needed for deployment, without the need to develop software.

Item	Renesas Solution Starter Kit for RX23E-A	Renesas Solution Starter Kit for RX23E-B
Device	RX23E-A 40pinQFP (R5F523E6ADFL)	RX23E-B 100pinQFP (R5F523E6LDFP)
Related application notes	■ Temperature Measurement Example Using a Thermocouple (R01AN4747) ■ Temperature Measurement Examples Using Resistance Temperature Detectors (R01AN4788) ■ Weight Measurement Example Using a Load Cell (R01AN4789) ■ Force Sensor Measurement Example (R01AN5447)	■ Example of 4-20mA transmitter using built-in D/A converter (R01AN6518) ■ Example of weight measurement using AC excited load cell (R01AN6517)

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 RX600	RX100 RX200 RX600	RX100 RX200	RX100 RX200 RX600	RX100 RX200	RX100 RX200	RX100 RX200 RX600	RX200 RX600 RX700	RX100 RX200 RX600 RX700	RX600 RX700

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	RX600	RX700 RX600 RX200 (RX26T)
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 RX26T/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

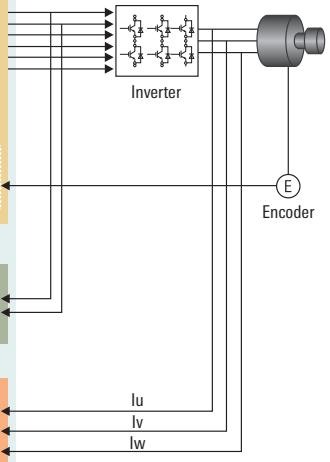
Feedback control
- Acquisition of feedback information (position/rotation rate) from encoder

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								
		RX13T/RX23T	RX24T/RX24U	RX66T	RX72T/RX26T	RX111/RX113	RX130	RX140	RX230/RX231	RX651/RX65N	RX660	RX671	RX66N	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

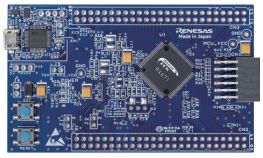
Renesas supports all stages of the development of RX applications by supplying integrated development environments, real-time OSes, middleware, and programming tools that dramatically enhance the development process. Renesas integrated development environments enable you to accomplish coding, building,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

Evaluation

Evaluation versions

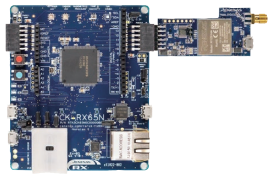
Evaluation versions of tools, sample software, application notes

Low price.
Target board with emulator



Low price.
Evaluation board kit with LCD

Renesas Cloud Kit for Trying Out AWS and Azure Cloud Services



A growing selection of starter kits you can start using immediately

Development

Renesas' integrated development environments provide powerful support for all aspects of embedded system development. Choose among applications based on open-source software, enabling use of a variety of extended functions, Renesas' proprietary development environments, and products from our partner vendors to meet your specific requirements.

e² studio Integrated Development Environment

Provides a large number of functions. Development environment based on Eclipse. Supports compilers from IAR Systems and the GNU Project in addition to Renesas. In addition, realtime OSs for IoT devices (FreeRTOS, Azure RTOS) are supported, and users can simply follow the instructions on the project creation screen to generate downloadable sample code that they can incorporate into projects they build and use.

CS+ Integrated Development Environment

With a single install, this package provides access to the basic software tools you will need to develop software for Renesas MCUs. Recommended for users looking for a convenient way to make use of basic functions.

IAR Embedded Workbench® for RX Integrated Development Environment

This is the C/C++ integrated development environment most broadly used internationally as a high-performance and highly reliable commercial tool for embedded software development. The proprietary compiler from IAR Systems is industry-top-level in terms of speed and object code compactness. All functions are integrated seamlessly to maximize development efficiency. The static response analysis and dynamic response analysis add-ons provide a low-cost way for developers to dramatically increase the quality of their code.

Build

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

Provides powerful optimized features that help you realize the full performance potential of Renesas' proprietary CPU cores and boost development efficiency. A selection of compiler licenses optimized for different development approaches as well as services and products related to long-term use of specific compiler versions, functional safety, etc., are available.

IAR SYSTEMS — Compiler from IAR Systems

GNU Tools — GNU compiler

Coding (OS)

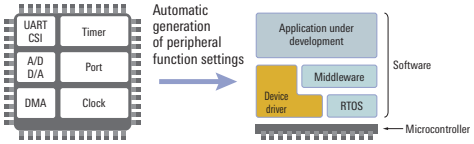
RENESAS — Embedded OS with the best established track record in Japan and conformant with µITORN standard (RI600V4 and RI600PX)

powered by aws — FreeRTOS, which supports connecting to AWS

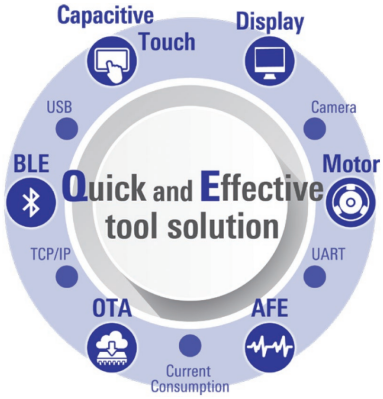
Microsoft Azure — Azure RTOS, which supports connecting to Azure

Development

Software tools that make development even faster



[Smart configurator]
Tool that automatically generates device drivers



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

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

On-chip debugging emulators

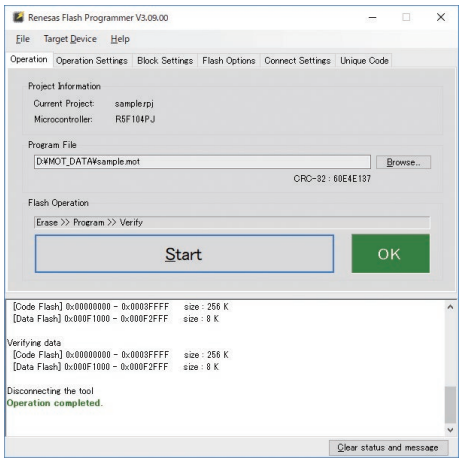
[E2 Emulator Lite]
This entry-level model is recommended for novice users looking for a low-priced option. It can be used for a wide range of purposes, from education and initial evaluation through actual development.

[E2 Emulator]
This model provides high functionality for enhanced development efficiency. It supports fast downloads, external trigger I/O, and the use of hot plugins without the need for a separately purchased adapter.

[E20 Emulator]
This model enables even faster debugging. It provides high-capacity trace functionality and RAM monitoring functionality suitable for use with the RX600 and RX700.

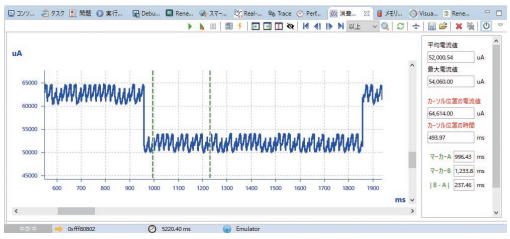
Mass production

Renesas Flash Programmer flash memory programming software

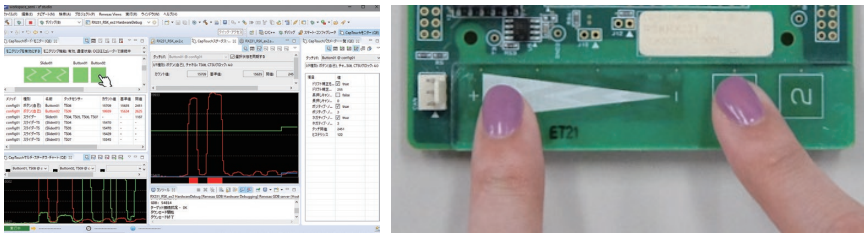


PG-FP6
standalone flash programmer

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.

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.

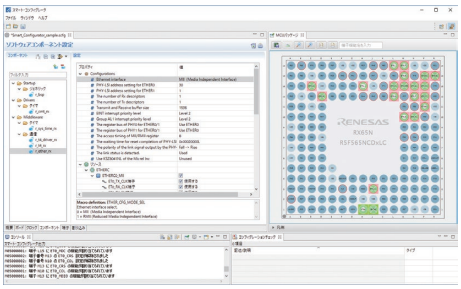
Searching for Information in Sample Code or Manuals

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.



Smart Configurator

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.

Software Package

Connectivity
Ethernet, BLE (RX23W)
Wi-Fi (SX-ULPGN)
Cat.M1 (RYZ014A)

Sensor
HS300x, HS400x,
FS2012, FS3000,
FS1015, OB1203,
ZMOD4410, ZMOD4510

Storage
EEPROM, USB,
SDHI, SPI

Security
TSIP
AES, DES, SHA, RNG
RSA, TLS

File System
FAT File System
(M3S-TFAT-Tiny)

USB
CDC, MSC, HID
Host & Peripheral

Graphics
Segger emWin
CRI Aeropoint

Capacitive Touch
Button/Wheel/Slider,
self-capacitance,
mutual-capacitance

Device Driver

LVD	LPC	VBATT	IRQ	DTC	DMAC	ELC	GPIO	MPC
CMT	CMTW	RTC	LPT	MTU	GPT	TPU	TMR	PPG
POE	POEG	IWDT	WDT	SCI	SCIF	RIIC	RIICHS	RI3C
RSPI	QSPI	QSPIX	USB	EPTPC	ETHERC	ETHERC Light	Ether CAT	IrDA
PDC	CAN	CANFD	RSCAN	SDHI	SDSI	MMCIF	SRC	SSI
S12AD	24-ΔΣAD	DAC	DSMIF	AFE	TSIP	SEG-LCDC	TFT-LCDC	DRW2D
CTSU	BLE	REMC	BUS	CAC	Flash	DOC	TFU	Unique ID

Board Support Package (BSP)

RX Family

AWS FreeRTOS

MQTT	Device Defender
Greengrass Discovery	Device Shadow
OTA Updates	PKCS #11
Secure Sockets	Wi-Fi
+TCP	TLS
FreeRTOS Kernels	
FreeRTOS Internal Libraries	

Microsoft AzureRTOS

NetX	NetXDuo
FileX	TraceX
USBX Device, CDC-ACM	GUIX/GUI Studio
ADU	Leaf Update
ThreadX	

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

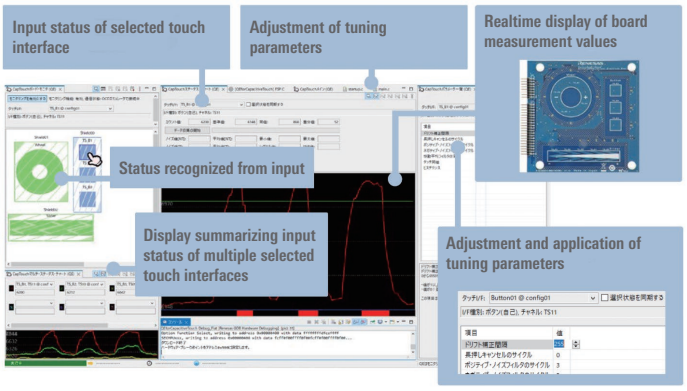
Plenty of Convenient Functions to Assist Application Development

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.

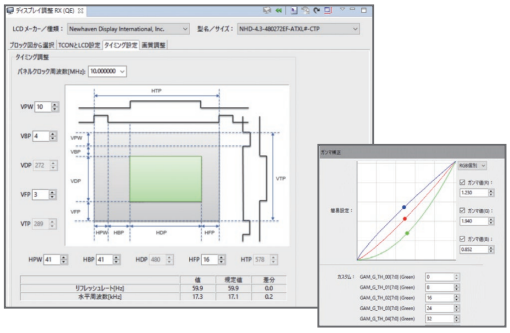
QE for Capacitive Touch Development Support Tool for Capacitive Touch Sensor Applications

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.



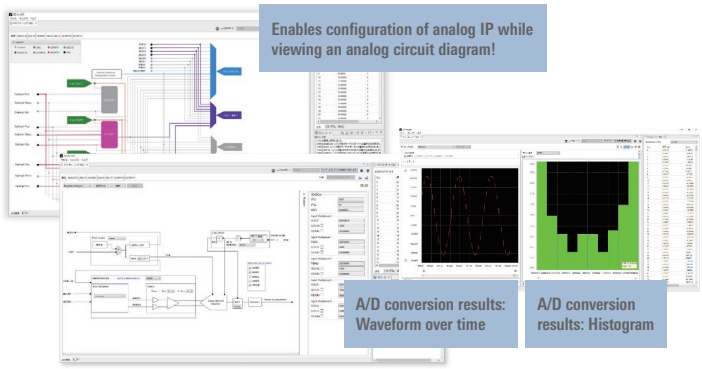
QE for Display Development Support Tool for Display Applications

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



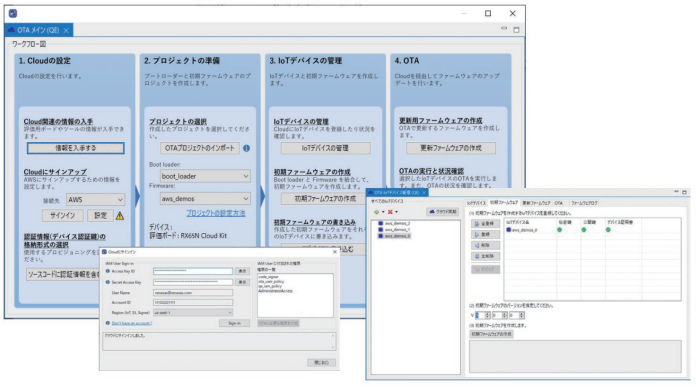
QE for AFE Development Support Tool with Analog Frontend Support

This development support tool supports development of embedded systems implementing high-precision sensing for MCUs with an on-chip analog frontend (AFE). The tool lets you design and modify circuit diagrams of the AFE configuration. You can check A/D conversion results (waveforms and histograms) in the monitoring window without the need for an oscilloscope and make adjustments to analog signals.



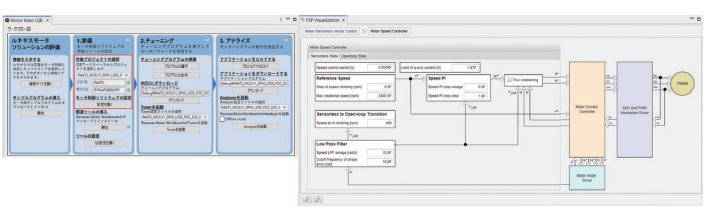
QE for OTA Development Support Tool for Cloud Applications

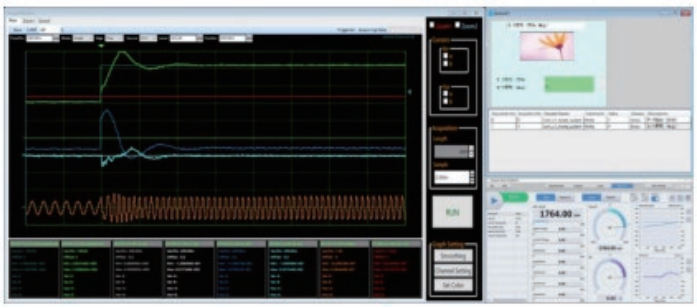
This development support tool lets you easily try out the over the air (OTA) functions of cloud services such as AWS and Azure. Simply follow the instructions in the workflow view to perform the steps from obtaining cloud-related information to OTA implementation, including cloud system registration, importing security information to the MCU, and tunning OTA functions.



QE for Motor Development Support Tool for Motor Applications

This development support tool assists with the development of embedded systems using motors by making it easy to configure motor-related middleware and driver settings and to perform motor tuning and analysis. It lets you efficiently configure motor-related middleware and driver settings while checking block diagrams representing hardware configurations. Also, Renesas Motor Workbench automates the process of configuring settings. Simply click a button to start motor tuning and analysis.





Renesas Motor Workbench

Winning Combinations (Reference Designs)

Speeding Up Application Design for Customers

More Than 600 Winning Combinations for a Variety of Applications

Renesas offers an array of total solutions combining microcontrollers with power ICs, analog ICs, and connectivity devices as “Winning Combinations.” By making use of these combinations you can speed up product development cycles and reduce the overall risk associated with bringing a new product to market. Renesas continues to make available new Winning Combinations, including many featuring RX Family MCUs, one after another.

IoT Applications

Smart City
Smart Health
Smart Home
Smart Appliances
Smart Industry
Smart Agriculture

Industry

Factory Automation
Safety, Surveillance & Security
Retail, Automation & Payment
Lighting & Control
Industrial Power Delivery
Industrial Communication

Key Technologies

HMI
Motor Control & Robotics
Artificial Intelligence (AI)
Functional Safety

Appliances and Consumer Products

Wearables (Non-medical)
Fitness & Health
Appliances
Portable Electronics

Medical and Healthcare

Medical Instruments and Treatment
Medical Diagnostic Equipment

Power and Energy

Battery Management Systems
Monitoring/Metering
Renewable Energy/Green Environment
Energy Generation & Distribution
Power Line Communication (PLC)

Communication and Computing

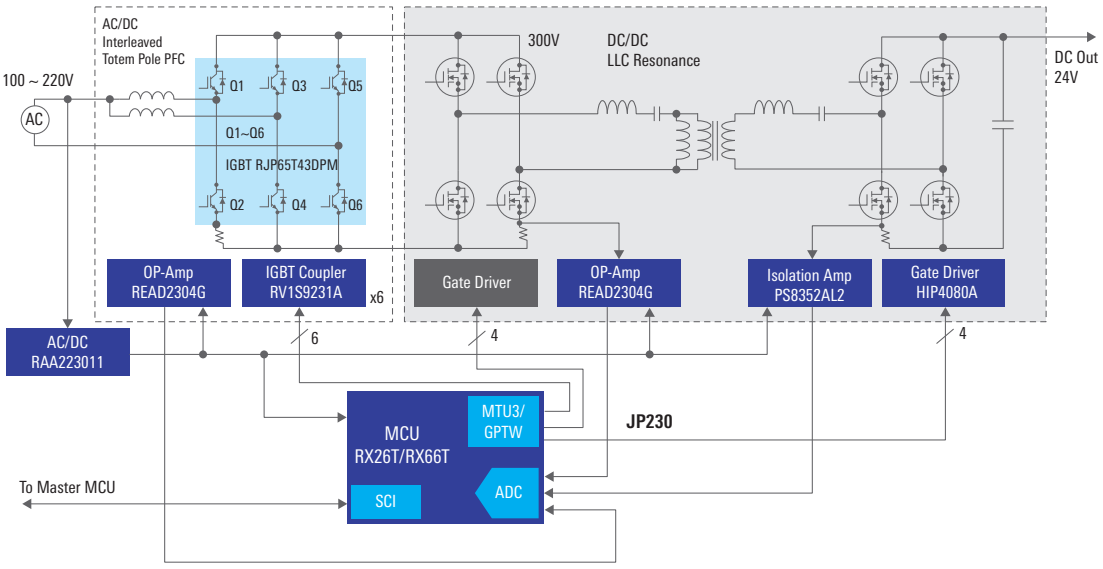
Data Center/Server
Wireless Network

Example Winning Combination: Digital Power Conversion with Totem Pole Interleaved PFC

Easy-to-understand explanation of benefits

Easy-to-read block diagram

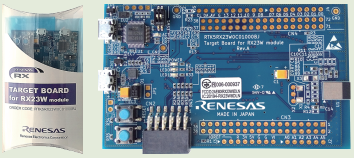
Easy access to related Renesas product pages



MEMO

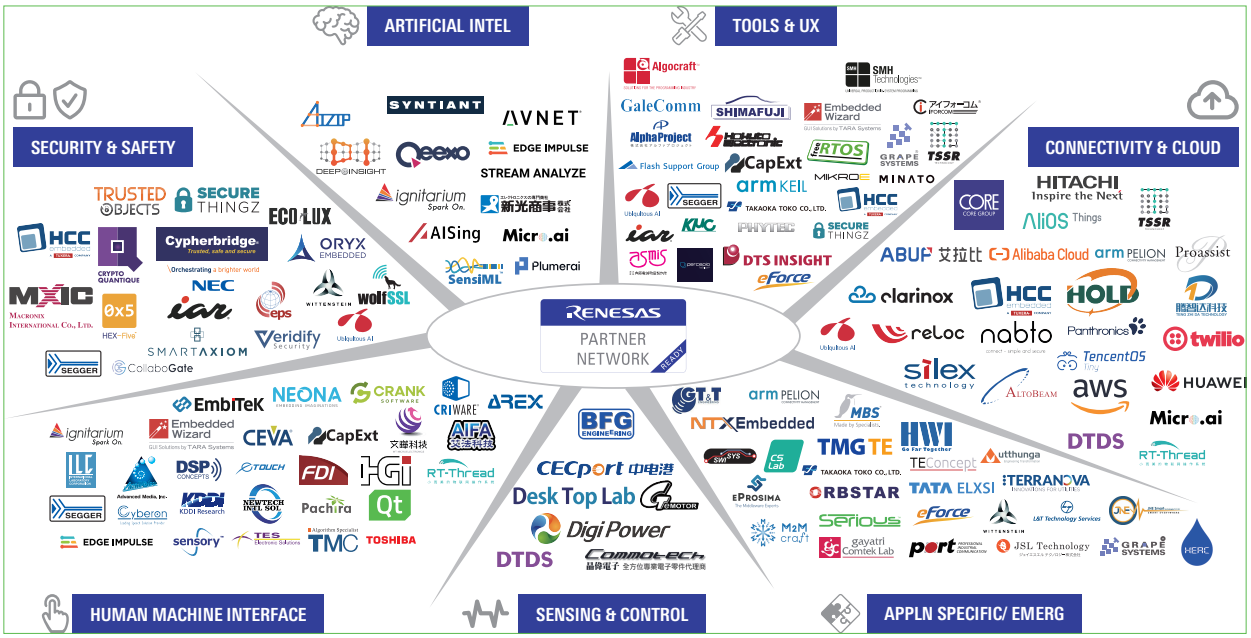
RX Evaluation Boards

In addition to RSSK and MCK board products offered as solutions for various applications, there are three categories of RX evaluation boards to meet different user requirements: Renesas starter kits, RX Family target boards, and EK kits. RX Family target boards are entry-level products intended for users getting started using RX MCUs. They are populated with an MCU and on-board debugging circuits only. Users can use sample code available free of charge on the Renesas website to evaluate RX MCUs easily and inexpensively. RX Family EK kits feature on-board standard connectors for ecosystems such as Arduino and Pmod. They can easily be combined with separately purchased expansion ecosystem boards to add functionality for sensors, wireless communication, LCD panels, and motors. This enables quick and wide-ranging prototyping for a wide variety of scenarios.

Name of Kit	Renesas Stater Kit	RX Family EK Kit	Target Board for RX Family
Target MCUs	All RX MCUs (except the RX110, RX21A, RX634, and RX26T)	RX671	RX130, RX140, RX231, RX23W, RX23W module, RX65N, RX66N, RX660, and RX671
Photo			
Features	No modifications needed to start evaluation • Provides the ability to evaluate all functions of the device. • Includes additional hardware such as standalone emulator or serial Pmod LCD panel.	Ability to easily extend the functions of the board • Provides the ability to evaluate standard RX functions. • Provided with on-board debugging circuit. • It is easy to connect expansion ecosystem boards for quick and wide-ranging prototyping of a wide variety of applications.	Easy to use, experiment with, and purchase. • Can be expanded to fit a variety of applications. • Provided with on-board debugging circuit. • Affordably priced.

Renesas Ready Partner Network

Renesas' extensive network of ecosystem of partner vendors offer software and hardware building blocks that you can start using with Renesas MCUs right away. The Renesas RX ecosystem makes it possible to accelerate development of IoT applications integrating core technologies related to security, safety, connectivity, HMI, and more. The network of partner vendors is growing constantly. Visit the Renesas website for detailed, up-to-date information.

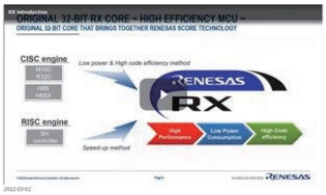


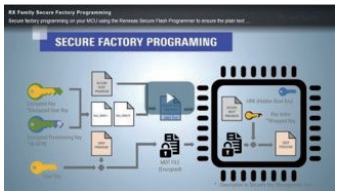
RX Family Web Page

Links to reach the ecosystem such as development support information, video libraries, solutions, etc. are posted on the RX TOP page.

Video library (Promotion videos and demos)

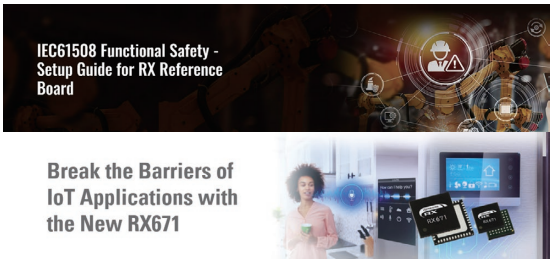
Introducing new product information and solution information of RX





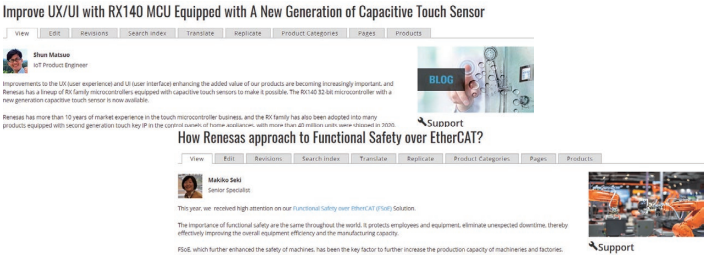
Webinar

Introducing customer's problem solution proposals in seminar format



Blog

RX latest information Blog



Getting Started with the RX Family Development Environment

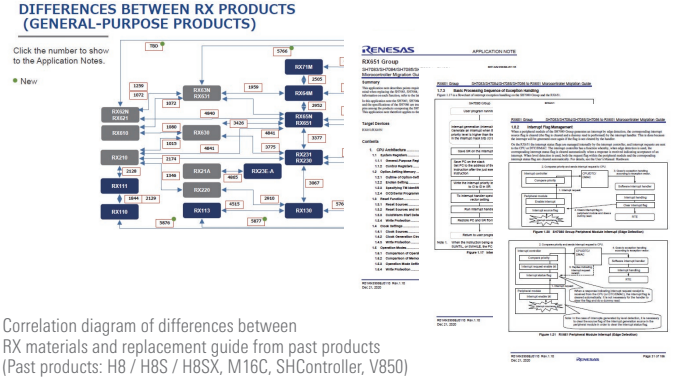
Full of information for those who are new to the RX family(Tools required for development / Recommended kits / Ready-to-use download information)

Software & tool course (how to videos)

Posted videos on how to install development tools, how to debug, how to use solution kits, etc.

RX replacement support information

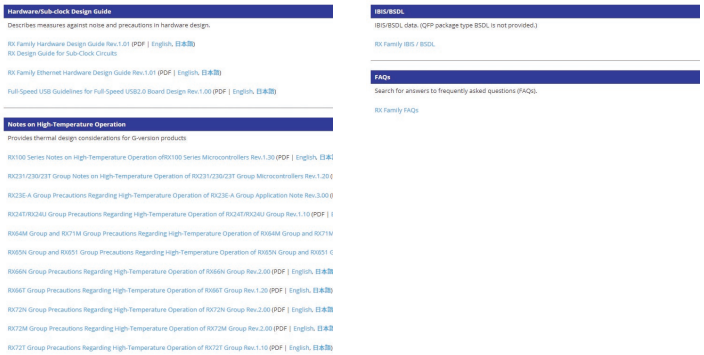
Differences between the RX series, or specification comparisons between past products such as SH and H8 and RX are posted together. Please use it when considering the replacement of the microcomputer.



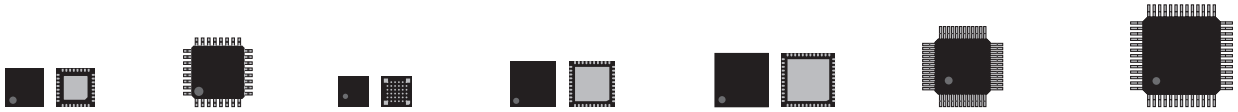
Correlation diagram of differences between RX materials and replacement guide from past products (Past products: H8 / H8S / H8SX, M16C, SHController, V850)

RX useful information

Full of useful information for development (hardware design guide, precautions for high temperature operation, IBIS / BSDL information, etc.)



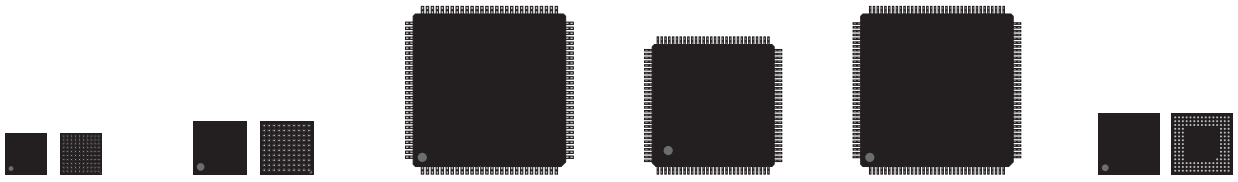
RX FAMILY PACKAGE LINEUP



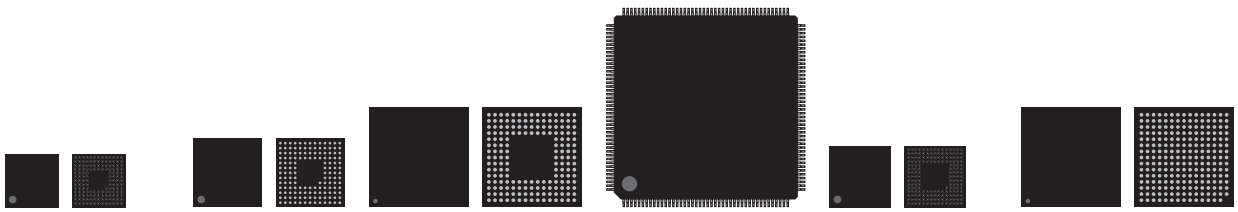
Pin-type:	32-HWQFN	32-LQFP	36-WFLGA	40-HWQFN	48-HWQFN	48-LFQFP	52-LQFP
Size:	5 x 5 mm	7 x 7 mm	4 x 4 mm	6 x 6 mm	7 x 7 mm	7 x 7 mm	10 x 10 mm
Pitch:	0.50 mm	0.80 mm	0.50 mm	0.50 mm	0.50mm	0.50 mm	0.65 mm
Thickness:	0.80 mm	1.70 mm	0.76 mm	0.80 mm	0.80mm	1.70 mm	1.70 mm
Group:	RX140, 13T	RX140, 13T	RX111, 110	RX23E-A, 111, 110	RX671, 26T, 231, 230, 140, 13T, 130, 111, 110	RX63T, 631, 26T, 23T, 23E-A, 231, 230, 220, 210, 140, 13T, 130, 111, 110	RX23T

Pin-type:	56-HVQFN	64-HWQFN	64-LFQFP	64-LQFP	64-TFBGA	64-TFLGA
Size:	7 x 7 mm	9 x 9 mm	10 x 10 mm	14 x 14 mm	4.5 x 4.5 mm	6 x 6 mm
Pitch:	0.40 mm	0.50 mm	0.50 mm	0.80 mm	0.50 mm	0.65 mm
Thickness:	0.90 mm	0.80 mm	1.70 mm	1.70 mm	1.20 mm	1.05 mm
Group:	RX23W	RX26T, 231, 230	RX671, 66T, 651, 63T, 631, 62T, 26T, 24T, 23T, 231, 230, 220, 21A, 210, 140, 130, 113, 111, 110	RX62T, 24T, 220, 140, 130, 111, 110	RX671, 651	RX631

Pin-type:	64-WFLGA	80-LFQFP	80-LQFP	83-TFLGA	85-TFBGA	85-TFLGA	100-LFQFP
Size:	5 x 5 mm	12 x 12 mm	14 x 14 mm	6.1 x 9.5 mm	5.5 x 5.5 mm	7 x 7 mm	14 x 14 mm
Pitch:	0.50 mm	0.50 mm	0.65 mm	0.50 mm	0.50 mm	0.65 mm	0.50 mm
Thickness:	0.76 mm	1.70 mm	1.70 mm	1.00 mm	1.20 mm	1.20 mm	1.70 mm
Group:	RX231, 230, 111, 110	RX66T, 630, 26T, 24T, 21A, 210, 140, 130	RX66T, 62T, 24T, 210	RX23W	RX23W	RX621	RX72T, 72M, 72N, 71M, 671, 66T, 66N, 65N, 651, 64M, 63T, 63N, 631, 630, 62T, 62N, 62G, 621, 26T, 24U, 24T, 231, 230, 220, 21A, 210, 130, 113



Pin-type:	100-TFLGA	100-TFLGA	112-LQFP	120-LFQFP	144-LFQFP	145-TFBGA
Size:	5.5 x 5.5 mm	7 x 7 mm	20 x 20 mm	16 x 16 mm	20 x 20 mm	8 x 8 mm
Pitch:	0.50 mm	0.65 mm	0.65 mm	0.50 mm	0.50 mm	0.50 mm
Thickness:	1.05 mm	1.05 mm	1.70 mm	1.70 mm	1.70 mm	1.19 mm
Group:	RX630, 231, 230, 210	RX71M, 671, 65N, 651, 64M, 63N, 631, 21A, 210, 113	RX66T, 63T, 62T, 62G	RX63T	RX72T, 72M, 72N, 71M, 671, 66T, 66N, 65N, 651, 64M, 63T, 63N, 634, 631, 630, 62N, 621, 610, 24U, 210	RX65W-A



Pin-type:	145-TFLGA	145-TFLGA	176-LFBGA	176-LFQFP	177-TFLGA	224-LFBGA
Size:	7 x 7 mm	9 x 9 mm	13 x 13 mm	24 x 24 mm	8 x 8 mm	13 x 13 mm
Pitch:	0.50 mm	0.65 mm	0.80 mm	0.50 mm	0.50 mm	0.80 mm
Thickness:	1.05 mm	1.20 mm	1.40 mm	1.70 mm	1.05 mm	1.40 mm
Group:	RX72N, 71M, 671, 66N, 65N, 651, 64M, 63N, 631, 630, 210	RX671, 62N, 621	RX72M, 72N, 71M, 66N, 65N, 651, 64M, 63N, 631, 630, 62N, 621, 610	RX72M, 72N, 71M, 66N, 65N, 651, 64M, 63N, 631, 630	RX71M, 65N, 651, 64M, 63N, 631, 630	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
72N	RX72N
71M	RX71M
66N	RX66N
660	RX660
671	RX671
65N	RX65N
65W	RX65W-A
651	RX651
64M	RX64M
63N	RX63N
631	RX631
62N	RX62N
621	RX621
634	RX634
630	RX630
610	RX610
72T	RX72T
66T	RX66T
63T	RX63T

62T	RX62T
62G	RX62G
26T	RX26T
24T	RX24T
24U	RX24U
23T	RX23T
23W	RX23W
231	RX231
230	RX230
23E	RX23E
220	RX220
210	RX210
21A	RX21A
13T	RX13T
140	RX140
130	RX130
113	RX113
111	RX111
110	RX110

Operating ambient temperature

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

Packing specification

U, V, 2, 3	Tray
0, 1	Tray (Full carton)
5	Tape and reel

Package type/pin count/pin pitch

BD	LFBGA	224	0.8
BG	LFBGA	176	0.8
BL	TFBGA	85	0.65
BP	TFBGA	64	0.5
FA	LFQFP	120	0.5
FB	LFQFP	144	0.5
FC	LFQFP	176	0.5
FD	LQFP	52	0.65
FF	LQFP	80	0.65
FH	LQFP	112	0.65
FJ	LQFP	32	0.8
FK	LQFP	64	0.8
FL	LFQFP	48	0.5
FM	LFQFP	64	0.5
FN	LFQFP	80	0.5
FP	LFQFP	100	0.5

LA	TFLGA	100	0.5
LC	TFLGA	177	0.5
LD	TFLGA	85	0.65
LE	TFLGA	145	0.65
LF	WFLGA	64	0.5
LH	TFLGA	64	0.65
LJ	TFLGA	100	0.65
LK	TFLGA	145	0.5
LM	WFLGA	36	0.5
LN	TFLGA	83	0.5
ND	HWQFN	64	0.5
NE	HWQFN	48	0.5
NF	HWQFN	40	0.5
NG	HVQFN	56	0.4
NH	HWQFN	32	0.5

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.

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(Rev.5.0-1 October 2020)

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