Maintaining and Advancing the Renesas Tradition

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

**CONTENT**

- Positioning of the RX Family .............................................................. 04
- RX Family Solutions ......................................................................... 08
- RX Core Features ............................................................................... 18
  - RXv2 Core Features ............................................................................ 20
  - RXv3 Core Features ............................................................................ 21
- RX700/RX600 Series (Industrial/Appliances/Office Equipment/ICT) .......... 22
- RX200 Series (Industrial/Appliances/Office Equipment/ICT) ................. 26
- RX100 Series (Industrial/Appliances/Office Equipment/ICT) ................. 28
- RX-T (for Motor Control) ................................................................... 30
- RX-E (for Sensor Measurement) .......................................................... 32
- RX Family Motor Control .................................................................. 34
- RX Family Development Tools ............................................................. 36
- Winning Combinations (Reference Designs) .......................................... 40
- RX Evaluation Boards ......................................................................... 42
- Renesas Ready Partner Network .......................................................... 42
- RX Family Web Page ........................................................................... 43
- RX Family Package Lineup .................................................................. 44
- Explanation of Orderable Part Numbers ............................................... 45

- 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.
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.

<table>
<thead>
<tr>
<th>Positioning of the RX Family</th>
</tr>
</thead>
</table>

### 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.

#### Power Efficiency

<table>
<thead>
<tr>
<th>Series</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>RX700</td>
<td>Max operating frequency: 32MHz~240MHz</td>
</tr>
<tr>
<td>RX600</td>
<td>Max operating frequency: 125MHz~1.5GHz</td>
</tr>
<tr>
<td>RX200</td>
<td>Max operating frequency: 48MHz~200MHz</td>
</tr>
<tr>
<td>RX100</td>
<td>Max operating frequency: 16MHz~32MHz</td>
</tr>
</tbody>
</table>

#### Arm® Core

<table>
<thead>
<tr>
<th>Series</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>RX700</td>
<td>Multi-core up to 8 cores</td>
</tr>
<tr>
<td>RX600</td>
<td>Linux or RTOS available</td>
</tr>
<tr>
<td>RX200</td>
<td>High-capacity on-chip RAM</td>
</tr>
<tr>
<td>RX100</td>
<td>DRP*: image processing acceleration</td>
</tr>
</tbody>
</table>

#### Arm® Ecosystem

<table>
<thead>
<tr>
<th>Series</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>RX700</td>
<td>V3: RXv3 core</td>
</tr>
<tr>
<td>RX600</td>
<td>V2: RXv2 core</td>
</tr>
<tr>
<td>RX200</td>
<td>V2: RXv2 core</td>
</tr>
<tr>
<td>RX100</td>
<td>V2: RXv2 core</td>
</tr>
</tbody>
</table>

---

[Diagram showing various products and features]

### Positioning of the RX Family

<table>
<thead>
<tr>
<th>32-bit MCU</th>
<th>8/16-bit MCU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Efficiency</td>
<td>Low Power</td>
</tr>
<tr>
<td>Renesas Synergy™</td>
<td>Qualified Platform</td>
</tr>
</tbody>
</table>

### Renesas Core

- **Renesas Core**
  - 32-bit MCU
  - Max operating frequency: 32MHz~240MHz
  - Features:
    - Superior power efficiency
    - High-capacity flash memories
    - Broad lineup

### 32/64-bit MPU

- **32/64-bit MPU**
  - Max operating frequency: 125MHz~1.5GHz
  - Features:
    - Multi-core up to 8 cores
    - Linux or RTOS available
    - High-capacity on-chip RAM
    - DRP*: image processing acceleration

---

### 32-bit MCUs

#### 32-bit MCU

- **32-bit MCU**
  - Max operating frequency: 48MHz~200MHz
  - Features:
    - High efficiency
    - Advanced security
    - Flexible Software Package

---

### Featured Products

<table>
<thead>
<tr>
<th>Product</th>
<th>Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>RX72N</td>
<td>RX700</td>
</tr>
<tr>
<td>RX72M</td>
<td>RX700</td>
</tr>
<tr>
<td>RX66N</td>
<td>RX600</td>
</tr>
<tr>
<td>RX671</td>
<td>RX600</td>
</tr>
<tr>
<td>RX65N/1</td>
<td>RX600</td>
</tr>
<tr>
<td>RX660</td>
<td>RX600</td>
</tr>
<tr>
<td>RX231/B</td>
<td>RX200</td>
</tr>
<tr>
<td>RX23E-A</td>
<td>RX200</td>
</tr>
<tr>
<td>RX140</td>
<td>RX100</td>
</tr>
<tr>
<td>RX130</td>
<td>RX100</td>
</tr>
<tr>
<td>RX13T</td>
<td>RX100</td>
</tr>
</tbody>
</table>
## RX Family Portfolio

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

### RX700
- **RX700**
  - 200MHz–

### RX600
- **RX600**
  - 200MHz–

### RX200
- **RX200**
  - 120MHz–

### RX100
- **RX100**
  - 48MHz–

<table>
<thead>
<tr>
<th>Model</th>
<th>Frequency</th>
<th>CPU Speed</th>
<th>Flash Memory</th>
<th>RAM</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>RX700</td>
<td>200MHz</td>
<td>200MHz</td>
<td>512KB (64KB)</td>
<td>64KB</td>
<td>General Purpose, Motor control/Inverter, IA/FA Network, Rich Analog, Wireless</td>
</tr>
<tr>
<td>RX600</td>
<td>120MHz</td>
<td>120MHz</td>
<td>512KB (64KB)</td>
<td>64KB</td>
<td>General Purpose, Motor control/Inverter, IA/FA Network, Rich Analog, Wireless</td>
</tr>
<tr>
<td>RX200</td>
<td>120MHz</td>
<td>120MHz</td>
<td>512KB (64KB)</td>
<td>64KB</td>
<td>General Purpose, Motor control/Inverter, IA/FA Network, Rich Analog, Wireless</td>
</tr>
<tr>
<td>RX100</td>
<td>48MHz</td>
<td>48MHz</td>
<td>512KB (64KB)</td>
<td>64KB</td>
<td>General Purpose, Motor control/Inverter, IA/FA Network, Rich Analog, Wireless</td>
</tr>
</tbody>
</table>

---

The RX Family has products suitable for a variety of different applications, including general purpose, motor control/inverter, IA/FA network, rich analog, and wireless. Each model is equipped with specific features to cater to diverse 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**

<table>
<thead>
<tr>
<th>RX700</th>
<th>RX600</th>
<th>RX200</th>
<th>RX100</th>
</tr>
</thead>
<tbody>
<tr>
<td>4MB</td>
<td>36/40</td>
<td>48</td>
<td>56</td>
</tr>
<tr>
<td>3MB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5MB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2MB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5MB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1MB</td>
<td>768KB</td>
<td>512KB</td>
<td>384KB</td>
</tr>
<tr>
<td>512KB</td>
<td>384KB</td>
<td>256KB</td>
<td>128KB</td>
</tr>
<tr>
<td>384KB</td>
<td>256KB</td>
<td>128KB</td>
<td>96KB</td>
</tr>
<tr>
<td>256KB</td>
<td>128KB</td>
<td>96KB</td>
<td>64KB</td>
</tr>
<tr>
<td>128KB</td>
<td>64KB</td>
<td>32KB</td>
<td>16KB</td>
</tr>
</tbody>
</table>

**Motor**

<table>
<thead>
<tr>
<th>RX700</th>
<th>RX600</th>
<th>RX200</th>
<th>RX100</th>
</tr>
</thead>
<tbody>
<tr>
<td>1MB</td>
<td>768KB</td>
<td>512KB</td>
<td>384KB</td>
</tr>
<tr>
<td>512KB</td>
<td>384KB</td>
<td>256KB</td>
<td>128KB</td>
</tr>
<tr>
<td>384KB</td>
<td>256KB</td>
<td>128KB</td>
<td>96KB</td>
</tr>
<tr>
<td>256KB</td>
<td>128KB</td>
<td>96KB</td>
<td>64KB</td>
</tr>
<tr>
<td>128KB</td>
<td>64KB</td>
<td>32KB</td>
<td>16KB</td>
</tr>
<tr>
<td>64KB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32KB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8KB</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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.
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.

### RX Family Compatibility

<table>
<thead>
<tr>
<th>Pin assignments</th>
<th>RX100</th>
<th>RX200</th>
<th>RX600</th>
<th>RX700</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functions</td>
<td>Partial in some cases</td>
<td>Common IP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RX CPU</td>
<td>RX CPU</td>
<td></td>
<td>FPU</td>
<td></td>
</tr>
<tr>
<td>Integrated development environments</td>
<td></td>
<td>CS+e2 studio</td>
<td>E2 emulator/E2 emulator Lite</td>
<td>RX Compiler</td>
</tr>
<tr>
<td>On-chip debugging emulators</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 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.

### 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.
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.

<table>
<thead>
<tr>
<th>Self-test Software Kit</th>
<th>SIL3 System Software Kit</th>
<th>Safety Network Application Software Kit</th>
<th>Reference Documents</th>
<th>Reference Hardware Boards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free package of MCU Self-diagnostics SW for diagnosing CPU, ROM, and RAM in MCU.</td>
<td>Package of Functional Safety Platform SW for cross-monitoring dual MCU and controlling user’s application behavior.</td>
<td>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.)</td>
<td>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.</td>
<td>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.</td>
</tr>
</tbody>
</table>

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.
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.
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.

### Motor Control Solutions

**Software development support tools**

- Motor control software and application notes

**Hardware kits**

- Starter kits
- Solution kits

**Devices**

- MCU
- Power devices
- Analog devices

**Integrated development environments**

### 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.

<table>
<thead>
<tr>
<th>Distribution Format</th>
<th>Motor Type</th>
<th>Name of Kit</th>
<th>Vector Control</th>
<th>120-Degree Conducting Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sensornless</td>
<td>Optical Encoder</td>
</tr>
<tr>
<td>Supplied as complete kit by Renesas</td>
<td>BLDC</td>
<td>Evaluation system for BLDC Motor + CPU Card (P/N: RTX10EMX27000020BLJ)</td>
<td>✓</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>BLDC</td>
<td>MCK-RCX07 (P/N: RTX10EMX270500020BLJ)</td>
<td>✓</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Stepping</td>
<td>Evaluation system for Stepping Motor with Resolver (P/N: RTX10EMX2705001020BLJ)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Renesas kit + motor with encoder*</td>
<td>BLDC</td>
<td>Evaluation system for BLDC Motor + CPU Card (P/N: RTX10EMX27050020BLJ)</td>
<td>—</td>
<td>✓*</td>
</tr>
<tr>
<td></td>
<td>BLDC</td>
<td>MCK-RCX07 (P/N: RTX10EMX27050020BLJ)</td>
<td>—</td>
<td>✓</td>
</tr>
<tr>
<td>Supplied as sample software and application note by Renesas</td>
<td>Induction motor</td>
<td>Evaluation system for ACIM</td>
<td>✓*</td>
<td>—</td>
</tr>
</tbody>
</table>

*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.

<table>
<thead>
<tr>
<th>Kit name</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation System for BLDC Motor</td>
<td>Kit model No. RTK0EMXZ705000020BJ</td>
</tr>
<tr>
<td>Inverter structure</td>
<td>48V 5A Inverter board for BLDC motor</td>
</tr>
<tr>
<td>Motor</td>
<td>BLDC motor (TG-55L-KA)</td>
</tr>
</tbody>
</table>

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.

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 Control Development Support Tool
Renesas Motor Workbench
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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.

Kit specifications

<table>
<thead>
<tr>
<th>Kit name</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kit name</td>
<td>MCK-RX26T</td>
</tr>
<tr>
<td>Kit model No.</td>
<td>RTK0EMXZ705000020BJ</td>
</tr>
<tr>
<td>Structure</td>
<td>48V 10A Inverter board for BLDC motor (MCI-LV-1)</td>
</tr>
<tr>
<td>Motor</td>
<td>RX26T CPU board (MCB-RX26T Type A)</td>
</tr>
<tr>
<td>Communication board (MC-CDM)</td>
<td>BLDC motor (R42BLD30L3 manufactured by Moons’ Industries)</td>
</tr>
<tr>
<td>Inverter specification</td>
<td>Rated voltage: 48V</td>
</tr>
<tr>
<td></td>
<td>Rated current: 10A (continuous)</td>
</tr>
<tr>
<td></td>
<td>Protect functions: Overcurrent detection, etc.</td>
</tr>
</tbody>
</table>

Overall Structure

MC-XXXX
- 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.

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.

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.

**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.
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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.

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 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.

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 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.

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 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.

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.

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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** FIPS 140-2 (RX65N)* and encryption technology safety certified as CAVP conformant*3

Notes: 1. National Institute of Standards and Technology
3. Certification obtained for RX231, RX65N, and RX651.

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.

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 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.

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

---

<table>
<thead>
<tr>
<th>Company</th>
<th>Products Supplied</th>
<th>Summary</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>wolfSSL</td>
<td>SSL/TLS library with TSIP support</td>
<td>TLS, MQTT, and crypto libraries and middleware</td>
<td>Worldwide</td>
</tr>
<tr>
<td>IAR Systems / Secure Things</td>
<td>IAR Embedded Workbench for RX Embedded Trust, C-Trust, Secure Desktop Provisioner Compliance Suite</td>
<td>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.</td>
<td>Worldwide</td>
</tr>
<tr>
<td>EPS GLOBAL</td>
<td>Secure Provisioning &amp; IC Programming</td>
<td>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</td>
<td>Worldwide</td>
</tr>
<tr>
<td>Ubiquitous AI Corporation</td>
<td>Edge Trust Secure IoT device development kits SSL/TLS library with TSIP support</td>
<td>Solutions for implementing secure IoT services, TLS, HTTP, MQTT, and TCP/IP/middleware, SSL/TLS library with TSIP support, Implementation of device lifecycle management</td>
<td>Worldwide</td>
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<tr>
<td>Veridify</td>
<td>Veridify Security</td>
<td>Security solutions for implementing software, Suitable with products such as the RX100 that lack TSIP functionality</td>
<td>Worldwide</td>
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<tr>
<td>Trusted Objects</td>
<td>Tops Plug6Go</td>
<td>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</td>
<td>Worldwide</td>
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</table>
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.

<table>
<thead>
<tr>
<th>MCU</th>
<th>Part Number</th>
<th>CPU</th>
<th>Frequency</th>
<th>ROM</th>
<th>RAM</th>
<th>Trusted Secure IP</th>
<th>Dual Bank ROM</th>
<th>Driver support</th>
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</thead>
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<tr>
<td></td>
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</tr>
<tr>
<td>RX72M/RX72N</td>
<td>RXv3</td>
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<td>1MB</td>
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<tr>
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<tr>
<td>RX671</td>
<td>RXv3</td>
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<tr>
<td>RX65N/RX651</td>
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</table>

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.

<table>
<thead>
<tr>
<th>Kit</th>
<th>Communication method</th>
<th>RX Evaluation Kit</th>
<th>RX65N Cloud Kit</th>
<th>RX72N Envision Kit</th>
<th>Renesas Starter Kit+ for RX671</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK-RX65N</td>
<td>LTE Cat-M1 / Ethernet / Wi-Fi</td>
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<td>✓</td>
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</table>

*: 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.

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

<table>
<thead>
<tr>
<th>Features</th>
<th>Self-capacitance</th>
<th>Mutual-capacitance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise tolerance</td>
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<tr>
<td>High sensitivity</td>
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<tr>
<td>Water resistance</td>
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</table>

* When using active shield

RX Capacitive Touch MCU Lineup

Capacitive touch sensor IP

- 2nd generation
  - RX113 (RXv1 32MHz)
  - RX130 (RXv2 54MHz)
  - RX231/0
  - RX23V
  - RX671

- 3rd generation
  - RX140 (RXv2 48MHz)
  - RX671

Touch key ch

- Max 12ch
- Max 24ch
- Max 12ch
- Max 17ch
- Max 36ch

Features

- 5V, Segment LCDC
- 5V
- 5V, Security
- Cloud, Connectivity
- Security

Application

- Electric home appliances, measurement, healthcare, OA, portable device, industrial equipment

<table>
<thead>
<tr>
<th>Flash memory</th>
<th>Pin</th>
<th>32</th>
<th>48</th>
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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

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*1. Version for RX130 only

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Capacitive touch sensor IP

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- 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

RX 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
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.

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).

<table>
<thead>
<tr>
<th>Middleware</th>
<th>Vendor</th>
<th>Type</th>
<th>Applicable Demo</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMI Voice</td>
<td>Advanced Media, Inc.</td>
<td>Voice recognition library</td>
<td>RX72N Envision Kit, RSK+ for RX671</td>
</tr>
<tr>
<td>RECAUS</td>
<td>Toshiba</td>
<td>Voice recognition library</td>
<td>RSK+ for RX671</td>
</tr>
<tr>
<td>Zoom Voice</td>
<td>Techno Mathematical Co., Ltd.</td>
<td>Noise suppressor and beam focusing functions</td>
<td>RX72N Envision Kit, RSK+ for RX671</td>
</tr>
</tbody>
</table>
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 (RTX0EMXDEI000008J)
- Supports BLDC motor and stepping motor control when combined with a compatible inverter board.
- A variety of sample code is provided.

RX72M COM* (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.

Performance Evaluation

Protocol stack / Profiles

Product Development

Smartphone Apps

Evaluation Boards

<table>
<thead>
<tr>
<th>Item</th>
<th>Renesas Solution Starter Kit</th>
<th>Target Board for RX23W</th>
<th>Target Board for RX23W module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device</td>
<td>85-pin RX23W (R5F523W8ADB: without encryption functions) / (R5F523W8BBDB: with encryption functions)</td>
<td>56-pin RX23W (R5F523W8ADNG: without encryption functions)</td>
<td>RX23W module (R5F523W8CDLN: without encryption functions) (certified under Radio Law)</td>
</tr>
<tr>
<td>Accessories</td>
<td>LCD panel, E2 Emulator Lite</td>
<td>None (However, an emulator is mounted on the board.)</td>
<td></td>
</tr>
</tbody>
</table>

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.

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.

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.

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 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

<table>
<thead>
<tr>
<th>Item</th>
<th>RXv1</th>
<th>RXv2</th>
<th>RXv3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture</td>
<td>32-bit CISC, Harvard architecture</td>
<td>Downward compatible with RXv1</td>
<td>Downward compatible with RXv1/RXv2</td>
</tr>
<tr>
<td>General purpose registers</td>
<td>32bit × 16ch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compatibility</td>
<td>RXv1</td>
<td>Downward compatible with RXv1</td>
<td>Downward compatible with RXv1/RXv2</td>
</tr>
<tr>
<td>Instruction set</td>
<td>90 instructions</td>
<td>109 instructions (90 RXv1 instructions + 19 instructions)</td>
<td>113 instructions (109 RXv2 instructions + 4 instructions)</td>
</tr>
<tr>
<td>Pipeline</td>
<td>5-stage</td>
<td>Improved 5-stage pipeline</td>
<td>Improved 5-stage pipeline</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improved IPC through enhanced pipeline</td>
<td>Improved IPC through enhanced pipeline</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(enhanced performance through parallel execution of memory access and operations)</td>
<td>(enhanced performance through improved combination of simultaneously executable instructions)</td>
</tr>
<tr>
<td>DSP function instructions</td>
<td>Single-cycle MAC instructions(16-bit), Accumulator × 1</td>
<td>Single-cycle MAC instructions (16-bit, 32-bit), Accumulator × 2</td>
<td>Single-cycle MAC instructions (16-bit, 32-bit), Accumulator × 2</td>
</tr>
<tr>
<td>FPU</td>
<td>Single-precision floating-point operation instruction</td>
<td>Single-precision floating-point operation instruction</td>
<td>Single precision / double precision floating-point operation instruction (double precision is optional)</td>
</tr>
<tr>
<td>Performance</td>
<td>Up to 3.42 CoreMark/MHz</td>
<td>Up to 5.05 CoreMark/MHz</td>
<td>Up to 6.01 CoreMark/MHz</td>
</tr>
<tr>
<td>Others</td>
<td>-</td>
<td>-</td>
<td>Register bank save function (optional)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>*Availability of optional functions depends on product specifications</td>
</tr>
</tbody>
</table>
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.

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.

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.

Feature 1: Pipeline Enhancements

RXv2 Pipeline Processing Stage Configuration

<table>
<thead>
<tr>
<th>Instruction fetch stage (IF)</th>
<th>Decode stage (D)</th>
<th>Execution stage (E)</th>
<th>Memory access stage (M)</th>
<th>Write-back stage (WB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instruction fetch processing</td>
<td>Instruction decode processing</td>
<td>Operation processing, address calculation</td>
<td>FPU instruction</td>
<td>Write-back processing</td>
</tr>
<tr>
<td>Register fetch</td>
<td></td>
<td></td>
<td>FPU instruction</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Memory access</td>
<td></td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>FFT</th>
<th>IIR</th>
<th>Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>128-p real FFT (in: f32, out: f32)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Improved FPU and DSP functions defined in red.

<table>
<thead>
<tr>
<th>FPU functions (new instructions added, existing instructions speeded up)</th>
<th>DSP functions (new instructions added, accumulator for operations added)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New instructions: FSQRT ((\sqrt{\cdot})), FTOU, UTOF</td>
<td>32x32=acc, acc</td>
</tr>
<tr>
<td>Speed [cycles]: FADD/FSUB: 4 cycles (\rightarrow) 2 cycles FMUL: 3 cycles (\rightarrow) 2 cycles</td>
<td>16x16=acc, acc, acc (\rightarrow) acc</td>
</tr>
<tr>
<td>Single-cycle throughput: Pipelined FPU</td>
<td>Accumulator rounding instructions (16-/32-bit, round off/down)</td>
</tr>
<tr>
<td></td>
<td>RDACW, RDACL, RACL</td>
</tr>
</tbody>
</table>

Improvements are shown in red.

RXv1            RXv2
The smaller, the better

FPU functions (new instructions added, existing instructions speeded up)

<table>
<thead>
<tr>
<th>New instructions</th>
<th>Speed [cycles]</th>
<th>Single-cycle throughput</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSQRT ((\sqrt{\cdot})), FTOU, UTOF</td>
<td>FADD/FSUB: 4 cycles (\rightarrow) 2 cycles FMUL: 3 cycles (\rightarrow) 2 cycles</td>
<td>Pipelined FPU</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>High-performance, High-speed response</th>
<th>Large-capacity</th>
<th>Numerous peripheral functions</th>
<th>Various solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1416CoreMark @240MHz Double precision FPU coprocessor Trigonometric functions arithmetic unit Register bank save function</td>
<td>4MB Flash (Dual bank function) 1MB SRAM</td>
<td>Various communication interfaces 3-phase complementary PWM timer 12-bit A/D converter TFT LCD controller 2D rendering engine Trusted Secure IP Capacitive touch</td>
<td>HMI Cloud Security Functional safety</td>
</tr>
</tbody>
</table>

### Main Applications of RX700 and RX600 Series

<table>
<thead>
<tr>
<th>Industrial</th>
<th>Office Automation</th>
<th>Consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robots, Machine tools</td>
<td>General-purpose inverters</td>
<td>Printers</td>
</tr>
<tr>
<td>PLC</td>
<td>Security controller</td>
<td>Camera body Lens</td>
</tr>
<tr>
<td>Power conditioner</td>
<td>HVAC controller</td>
<td>Air conditioner (outdoor unit, indoor unit)</td>
</tr>
</tbody>
</table>

### Lineup of RX700 and RX600 Series

#### RX72M
- **RXv3**: Double precision FPU
- **RX72M**: 240MHz, 4MB Flash, 1MB SRAM
- **RX72M**: 100/144/176/224-pin

#### RX72N
- **RXv3**: Double precision FPU
- **RX72N**: 240MHz, 4MB Flash, 1MB SRAM
- **RX72N**: 100/144/176/224-pin

#### RX66N
- **RXv3**: Double precision FPU
- **RX66N**: 120MHz, 4MB Flash, 1MB SRAM
- **RX66N**: 100/144/176/224-pin

#### RX671
- **RXv3**: Double precision FPU
- **RX671**: 120MHz, 2MB Flash, 384KB SRAM
- **RX671**: 48/64/100/144/145-pin

#### RX65W-A
- **RXv2**: Single precision FPU
- **RX65W-A**: 120MHz, 2MB Flash, 640KB SRAM
- **RX65W-A**: 145-pin

#### RX65W-A
- **RXv2**: Single precision FPU
- **RX65W-A**: 120MHz, 2MB Flash, 640KB SRAM
- **RX65W-A**: 145-pin

#### RX660
- **RXv3**: Single precision FPU
- **RX660**: 120MHz, 1MB Flash, 128KB SRAM
- **RX660**: 48/64/100/144-pin

### Common functions

- **Dual bank**
- **USB**
- **CAN**
- **SD host I/F**
- **Quad SPI**
- **Trusted Secure IP**
- **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).

Input signal voltage range

```
<table>
<thead>
<tr>
<th>Voltage</th>
<th>0V</th>
<th>3V</th>
<th>5V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vcc</td>
<td>0</td>
<td>3V</td>
<td>5V</td>
</tr>
</tbody>
</table>
```

About 1.7 times

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

Large Memory: ROM 2MB, RAM 640KB

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

Visualization of Target Applications

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

Features of RX200 Series

- Both low power consumption and high performance
- Wide voltage range and external bus
- Robust security and networking/sensors
- Various solutions

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

<table>
<thead>
<tr>
<th>RXv2</th>
<th>Single precision FPU</th>
<th>CAN</th>
<th>USB</th>
<th>SDHI</th>
<th>Capacitive touch</th>
<th>Security</th>
<th>Bluetooth</th>
</tr>
</thead>
</table>

RX231 54MHz, 512KB Flash

<table>
<thead>
<tr>
<th>RXv2</th>
<th>Single precision FPU</th>
<th>CAN</th>
<th>USB</th>
<th>SDHI</th>
<th>Capacitive touch</th>
<th>Security</th>
</tr>
</thead>
</table>

RX230 54MHz, 256KB Flash

<table>
<thead>
<tr>
<th>RXv2</th>
<th>Single precision FPU</th>
<th>CAN</th>
<th>USB</th>
<th>SDHI</th>
<th>Capacitive touch</th>
</tr>
</thead>
</table>

RX200 Series Memory/Pin Lineup

<table>
<thead>
<tr>
<th>RX23W</th>
<th>RX231</th>
<th>RX23W</th>
<th>RX231</th>
</tr>
</thead>
<tbody>
<tr>
<td>56-pin</td>
<td>83-pin</td>
<td>85-pin</td>
<td>95-pin</td>
</tr>
<tr>
<td>512KB</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>384KB</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>256KB</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>128KB</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>
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 (Trasted 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.

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

Software Development Environment
Evaluation Board
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.

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.
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

- **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

<table>
<thead>
<tr>
<th>Flash size</th>
<th>RXv1</th>
<th>RX100 Series Memory/Pin Lineup</th>
</tr>
</thead>
<tbody>
<tr>
<td>512KB</td>
<td></td>
<td><img src="chart.png" alt="Flash size chart" /></td>
</tr>
<tr>
<td>384KB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>256KB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>128KB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>64KB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32KB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16KB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8KB</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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

Advanced Capacitive Touch

<table>
<thead>
<tr>
<th>Capacitive Touch IP</th>
<th>ADVANTAGES</th>
<th>RX130</th>
<th>RX140</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiated noise tolerance</td>
<td>Reduction in malfunctions due to radiated noise</td>
<td>Level 3</td>
<td>Level 4</td>
</tr>
<tr>
<td>Conductive noise tolerance</td>
<td>Reduction in malfunctions due to conductive noise</td>
<td>Level 3</td>
<td>Level 3</td>
</tr>
<tr>
<td>Pins for shielded electrode drive</td>
<td>Improved water resistance</td>
<td>Not supported</td>
<td>Supported</td>
</tr>
<tr>
<td>Smart wakeup (auto-sensing and multi-scan)</td>
<td>Reduced power consumption</td>
<td>Not supported</td>
<td>Supported</td>
</tr>
</tbody>
</table>

*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

Capacitive touch (CTSU)
Remote control
5V operation

Capacitive touch
Capacitive touch + system control
Large memory capacity enabling multilingual display support
Remote control

100 pins/512KB
80 pins/256KB
64 pins/128KB
48 pins/64KB
### 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

- **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)

<table>
<thead>
<tr>
<th>Robots, Machine tools</th>
<th>General-purpose inverters</th>
<th>Meters</th>
<th>Building automation</th>
<th>Office Automation</th>
<th>Copiers</th>
<th>Printers</th>
<th>Home appliances</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Industrial</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>Office Automation</strong></td>
<td></td>
<td></td>
<td><strong>Home appliances</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Air conditioners</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Refrigerators</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Washing machines</td>
</tr>
<tr>
<td><strong>Home appliances</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Product Lineup of RX-T (for Motor Control)

<table>
<thead>
<tr>
<th>Model</th>
<th>Frequency</th>
<th>Flash Memory</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RX72T</strong></td>
<td>200MHz, 1MB Flash</td>
<td></td>
</tr>
<tr>
<td>RXv3</td>
<td>Single precision FPU</td>
<td>Motors 3 to 4</td>
</tr>
<tr>
<td><strong>RX66T</strong></td>
<td>160MHz, 1MB Flash</td>
<td></td>
</tr>
<tr>
<td>RXv3</td>
<td>Single precision FPU</td>
<td>Motors 3 to 4</td>
</tr>
<tr>
<td><strong>RX26T</strong></td>
<td>120MHz, 512KB Flash</td>
<td></td>
</tr>
<tr>
<td>RXv3</td>
<td>Single precision FPU</td>
<td>Motors 2</td>
</tr>
<tr>
<td><strong>RX24U</strong></td>
<td>80MHz, 512KB Flash</td>
<td></td>
</tr>
<tr>
<td>RXv2</td>
<td>Single precision FPU</td>
<td>Motors 2 to 3</td>
</tr>
<tr>
<td><strong>RX24T</strong></td>
<td>80MHz, 512KB Flash</td>
<td></td>
</tr>
<tr>
<td>RXv2</td>
<td>Single precision FPU</td>
<td>Motors 2 to 3</td>
</tr>
<tr>
<td><strong>RX23T</strong></td>
<td>40MHz, 128KB Flash</td>
<td></td>
</tr>
<tr>
<td>RXv2</td>
<td>Single precision FPU</td>
<td>Motors 1</td>
</tr>
<tr>
<td><strong>RX13T</strong></td>
<td>32MHz, 128KB Flash</td>
<td></td>
</tr>
<tr>
<td>RXv1</td>
<td>Single precision FPU</td>
<td>Motors 1</td>
</tr>
</tbody>
</table>
Product Lineup of RX-T (for Motor Control)

Allocation of Resources Specially for Motor Control

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 real-time 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
  - I2C

**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
- RX2: 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
- RX2: 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

**24-bit ∆∑ Pin Unit**

<table>
<thead>
<tr>
<th>Max. Date rate</th>
<th>Unit</th>
<th>40-pin</th>
<th>48-pin</th>
<th>40-pin</th>
<th>48-pin</th>
<th>64-pin</th>
<th>80-pin</th>
<th>100-pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>125ksps</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>1</td>
</tr>
<tr>
<td>31.25ksps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.6ksps</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: The symbols represent the availability of each feature.*
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

### 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.

#### 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.

#### Peltier Cooler

This reference design employs the RX23E-A MCU with on-chip high-precision AFE to implement a Peltier cooler. Peltier coolers utilize 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.

#### 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.

<table>
<thead>
<tr>
<th>Item</th>
<th>RX23E-A 40pinQFP (R5F523E6ADFL)</th>
<th>RX23E-B 100pinQFP (R5F523E6DFP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device</td>
<td>RX23E-A 40pinQFP (R5F523E6ADFL)</td>
<td>RX23E-B 100pinQFP (R5F523E6DFP)</td>
</tr>
<tr>
<td>Related application notes</td>
<td>▪ 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)</td>
<td>▪ Example of 4-20mA transmitter using built-in D/A converter (R01AN6518) ▪ Example of weight measurement using AC excited load cell (R01AN6517)</td>
</tr>
</tbody>
</table>
## RX FAMILY MOTOR CONTROL

### Motor Types and Recommended Microcontrollers

<table>
<thead>
<tr>
<th>Motors</th>
<th>Recommended microcontrollers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air conditioners</td>
<td>BLDC IM</td>
</tr>
<tr>
<td>Washing machines</td>
<td>BLDC IM</td>
</tr>
<tr>
<td>Refrigerators</td>
<td>BLDC STM</td>
</tr>
<tr>
<td>Printers/multifunction units</td>
<td>BLDC IM</td>
</tr>
<tr>
<td>Pumps</td>
<td>BLDC IM</td>
</tr>
<tr>
<td>Fans</td>
<td>BLDC STM</td>
</tr>
<tr>
<td>Surveillance cameras</td>
<td>BLDC IM</td>
</tr>
<tr>
<td>General-purpose inverters</td>
<td>BLDC STM</td>
</tr>
<tr>
<td>Robots/machine tools/industrial motors</td>
<td>BLDC</td>
</tr>
<tr>
<td>AC servos</td>
<td></td>
</tr>
</tbody>
</table>

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

### Motor Types, Control Methods, and Recommended RX Series

<table>
<thead>
<tr>
<th>Motor type</th>
<th>Control method</th>
<th>Necessary functions</th>
<th>Performance required by application and recommended RX microcontroller</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brushless DC motor</td>
<td>Vector control (180-degree conducting control)</td>
<td>PWM × 6, dead time generation, POE, A/D converter (PWM link)</td>
<td>Compact industrial motors</td>
</tr>
<tr>
<td></td>
<td>Square wave control (120-degree conducting control)</td>
<td>PWM × 6, A/D converter</td>
<td>Refrigerators, fans, compact robots</td>
</tr>
<tr>
<td>AC induction motor</td>
<td>Vector control</td>
<td>PWM × 6, dead time generation, POE, A/D converter (PWM link)</td>
<td>Industrial pumps</td>
</tr>
<tr>
<td></td>
<td>V/F control</td>
<td></td>
<td>Fans, refrigerators, washing machines</td>
</tr>
<tr>
<td>Stepping motor</td>
<td>Pulse output</td>
<td>Port control or PWM control</td>
<td>Printers/multifunction units, surveillance cameras</td>
</tr>
<tr>
<td></td>
<td>Vector control (resolver)</td>
<td>PWM × 4, dead time generation, POE, A/D converter</td>
<td>Compact robots, carrier machine, textile machine, printers/multifunction units</td>
</tr>
</tbody>
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RX FAMILY MOTOR CONTROL

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<td>BLDC STM</td>
</tr>
<tr>
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<td>BLDC IM</td>
</tr>
<tr>
<td>Pumps</td>
<td>BLDC IM</td>
</tr>
<tr>
<td>Fans</td>
<td>BLDC STM</td>
</tr>
<tr>
<td>Surveillance cameras</td>
<td>BLDC IM</td>
</tr>
<tr>
<td>General-purpose inverters</td>
<td>BLDC STM</td>
</tr>
<tr>
<td>Robots/machine tools/industrial motors</td>
<td>BLDC</td>
</tr>
<tr>
<td>AC servos</td>
<td></td>
</tr>
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</table>

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<td></td>
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<td>Refrigerators, fans, compact robots</td>
</tr>
<tr>
<td>AC induction motor</td>
<td>Vector control</td>
<td>PWM × 6, dead time generation, POE, A/D converter (PWM link)</td>
<td>Industrial pumps</td>
</tr>
<tr>
<td></td>
<td>V/F control</td>
<td></td>
<td>Fans, refrigerators, washing machines</td>
</tr>
<tr>
<td>Stepping motor</td>
<td>Pulse output</td>
<td>Port control or PWM control</td>
<td>Printers/multifunction units, surveillance cameras</td>
</tr>
<tr>
<td></td>
<td>Vector control (resolver)</td>
<td>PWM × 4, dead time generation, POE, A/D converter</td>
<td>Compact robots, carrier machine, textile machine, printers/multifunction units</td>
</tr>
</tbody>
</table>
## 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.

### Examples of Motor Control Functions Provided by RX

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

**Development Tools Designed to Maximize the Features of the RX Family**

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.

### Evaluation

**Evaluation versions**

Evaluation versions of tools, sample software, application notes

Low price.

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

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.

#### 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 C/C++ Compiler Package for RX Family (CC-RX)**

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.

**Compiler from IAR Systems**

**GNU Tools**

**Embedded OS**

**powered by AWS**

FreeRTOS, which supports connecting to AWS

**Azure RTOS, which supports connecting to Azure**
**Development**

Software tools that make development even faster

On-chip debugging emulators

- **Smart configurator**
  Tool that automatically generates device drivers

- **[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

- **Software tools that make development even faster**

- **On-chip debugging emulators**

- **[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.

**Debug**

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

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

**PG-FP6**

standalone flash programmer
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.

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

<table>
<thead>
<tr>
<th>Connectivity</th>
<th>Sensor</th>
<th>Storage</th>
<th>Security</th>
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</thead>
<tbody>
<tr>
<td>Ethernet, BLE (RX23W)</td>
<td>HS300x, HS400x, FS2012, FS3000, FS1016, DB1203, ZMD44110, ZMD44510</td>
<td>EEPROM, USB, SDHI, SPI</td>
<td>TSIP, AES, DES, SHA, RNG, RSA, TLS</td>
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<table>
<thead>
<tr>
<th>File System</th>
<th>USB</th>
<th>Graphics</th>
<th>Capacitive Touch</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAT File System (M3S-TFAT-Tiny)</td>
<td>CDC, MSC, HID Host &amp; Peripheral</td>
<td>Segger emWin, CRI Airport</td>
<td>Button/Thumb/Wheel/Slider, self-capacitance, mutual-capacitance</td>
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Device Driver

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<tr>
<th>LVD</th>
<th>LPC</th>
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<th>ELC</th>
<th>GP0</th>
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<tr>
<td>POE</td>
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<td>IOVD</td>
<td>WDT</td>
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<td>RSGAN</td>
<td>SDHI</td>
<td>SDSD</td>
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<td>SRC</td>
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<td>REMC</td>
<td>BUS</td>
<td>DAC</td>
<td>AFE</td>
<td>TSP</td>
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Board Support Package (BSP)

RX Family

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.

**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.

**Information Terminals**
Graphics, FAT file system, SD memory card driver, 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 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.

QE for OTA Development Support Tool for Cloud Applications

Using QE for OTA 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 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 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 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 tuning OTA functions.

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.
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 Home
- Smart Industry

Industry
- Factory Automation
- Safety, Surveillance & Security
- Lighting & Control

Retail, Automation & Payment
- Factory Automation
- Safety, Surveillance & Security
- Industrial Power Delivery

Lighting & Control
- Factory Automation
- Safety, Surveillance & Security
- Industrial Communication

Communication and Computing
- Data Center/Server
- Wireless Network

Medical and Healthcare
- Medical Instruments and Treatment
- Medical Diagnostic Equipment

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

Power and Energy
- Energy Generation & Distribution
- Power Line Communication (PLC)

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
### 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.

<table>
<thead>
<tr>
<th>Name of Kit</th>
<th>Renesas Stater Kit</th>
<th>RX Family EK Kit</th>
<th>Target Board for RX Family</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target MCUs</td>
<td>All RX MCUs (except the RX110, RX21A, RX634, and RX26T)</td>
<td>RX671</td>
<td>RX130, RX140, RX231, RX23W, RX23W module, RX65N, RX66N, RX660, and RX671</td>
</tr>
<tr>
<td>Photo</td>
<td><img src="image1.png" alt="StarterKit" /></td>
<td><img src="image2.png" alt="EK-RX671" /></td>
<td><img src="image3.png" alt="TargetBoard" /></td>
</tr>
<tr>
<td>Features</td>
<td>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.</td>
<td>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.</td>
<td>Easy to use, experiment with, and purchase. • Can be expanded to fit a variety of applications. • Provided with on-board debugging circuit. • Affordably priced.</td>
</tr>
</tbody>
</table>

### 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)

Ease of Using the Environment

Purchase the Renesas Starter Kit, a set which includes an IDE, debugger, evaluation board, and cables. Once you have the kit, you can quickly start evaluation including all the facilities of the given RX-family MCU.

Configuration
- Integrated Development environment
- On-chip debug
- Emulator
- Evaluation board
- Cables

Search for products to buy on the product list

**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.

**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

<table>
<thead>
<tr>
<th>Pin-type</th>
<th>Size</th>
<th>Pitch</th>
<th>Thickness</th>
<th>Group</th>
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<td>32-HQFN</td>
<td>5 x 5 mm</td>
<td>0.50 mm</td>
<td>0.80 mm</td>
<td>RX140, 13T</td>
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<td>32-LOFP</td>
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<td>36-WQFN</td>
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<tr>
<td>48-LQFP</td>
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<td>56-HQFN</td>
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<td>64-HQFN</td>
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### EXPLANATION OF ORDERABLE PART NUMBERS

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<th>R5</th>
<th>F</th>
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<th>72M</th>
<th>N</th>
<th>H</th>
<th>G</th>
<th>FC</th>
<th>#V</th>
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<tr>
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#### 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:** This information is different for each RX group.
Refer to the relevant user’s manual for details.
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Renesas Electronics Corporation
10100 Torrey Park, Suite 121-60, Torrey Pines, San Diego, CA 92121, U.S.A.
Tel: +1-858-232-8888, Fax: +1-858-237-7775

Renesas Electronics Americas Inc.
101 Murphy Ranch Road, Milpitas, CA 95035, U.S.A.
Tel: +1-408-432-8888, Fax: +1-408-434-0151

Renesas Electronics (Europe) Gmbh
Anladstrasse 10, 40472 Dusseldorf, Germany
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

Renesas Electronics Asia Pte. Ltd.
68 Rondel Road, #05-02, Singapore 359948
Tel: +65-6213-8288, Fax: +65-6213-8280

Renesas Electronics Malaysia Sdn. Bhd.
Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Kowloon, Hong Kong
Tel: +852-820-1880, Fax: +852-820-1888

Renesas Electronics Hong Kong Limited
Unit 801, 8/F., Tower 2, I. D. Century Plaza, 183 Prince Edward Road West, Tsimshatsui, Kowloon, Hong Kong
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Renesas Electronics Taiwan Co., Ltd.
1001 Murphy Ranch Road, Milpitas, CA 95035, U.S.A.
Tel: +1-408-432-8888, Fax: +1-408-434-5351

Renesas Electronics Korea Co., Ltd.
17F, KAMCO Yangjae Tower, 262, Gangnam-daero, Gangnam-gu, Seoul, 06265 Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5338

Renesas Electronics (China) Co., Ltd.
No.777C, 100 Feet Road, HAL 2nd Stage, Indiranagar, Bangalore 560 038, India
Tel: +91-80-67208700, Fax: +91-80-67208701

Renesas Electronics Singapore Pte. Ltd.
68 Rondel Road, #05-02, Singapore 359948
Tel: +65-6213-8288, Fax: +65-6213-8280

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