RX200
MICROCONTROLLERS

More performance with less energy.

RENESAS

BIG IDEAS
FOR EVERY SPACE

RX200 MCUs FOR HIGH-PERFORMANCE, POWER-EFFICIENT APPLICATIONS

The RX200 series of Flash MCUs brings new levels of capability and performance to ultra-low-power, low-voltage embedded applications. Based on the fast, efficient 32-bit RX core, the RX231 MCUs are the latest members of the RX200 series. RX231 devices feature the new RXv2 CPU core with FPU/MPU and enhanced DSP capabilities, while operating over a wide voltage range with the lowest possible standby current. A wide set of peripherals are available, including communication channels like USB, CAN and SDHI, capacitive touch support, 12-bit ADC and 12-bit DAC, and state-of-the-art HW-based security and safety functions.

Products in the RX210 group include many of the same features and extend on-chip memory density to 1 MB of Flash and 96 KB of RAM, while RX21A devices offer a high-precision 24-bit delta sigma ADC. RX23T and RX24T MCUs are optimized for motor control applications and include a 40 MHz PWM with two channels of a three-phase complementary output.

RX FOR PORTABLE MEDICAL

- High performance
- Low power consumption
- FPU/MPU
- Low voltage
- Digital signal processing
- USB/SDHI

RX FOR SENSORS

- Low power
- Low voltage
- Enhanced DSP capability
- Communication peripherals
- Data flash programmable while code is executed (BGO)

RX FOR BUILDING AUTOMATION

- Capacitive touch
- Security
- Safety
- Low pin count

RX FOR INDUSTRIAL AUTOMATION

- EMC performance with true 5V operation
- Motor control
- Security
- Communication peripherals
- Integrated ADC & DAC, temp. sensor
- CAN/SDHI

RX FOR APPLIANCES

- 3-phase motor control timer
- Safety functions (IEC60730)
- Integrated analog comparator
- Temperature sensor
- Capacitive touch

RENESAS
RX
RX200

RXv2 32-bit CPU
54 MHz   88 DMIPS

Floating Point Operation Unit

Digital Signal Processing

| MAC 72-bit | RMPA 80-bit |

Barrel Shifter 32-bit

Memory

| Zero-wait Flash |
| up to 1 MB |
| SRAM |
| up to 96 KB |
| Data Flash |
| 8 KB |

System

| Event Link Controller |
| Multifunction Pin Controller |
| Data Mgmt. DTC/DMA |
| Interrupt Cont. 16 levels 9 pins |
| Clocks OSC PLL IRC |
| POR/LVD |
| Safety CAC DOC CRC |
| Security TSIP AES RNG |

Communication

| I2C 7 x Simple I2C |
| SCI/UART 7 ch |
| SPI |
| External Bus |
| GPIO |
| USB 2.0 |
| SD Host Inteface |
| IrDA/I2S/CAN |

Analog

| Comparator 4ch |
| ADC 12-bit 24 ch |
| DAC 12-bit 2ch |
| 24-bit ΔΣ ADC |
| Temp. Sensor |

User Interface

| Capacitive Touch up to 24 touch keys |

Timers

| MTU2 16-bit 6 ch | RTC Calendar | WDT 14-bit 1 ch |
| TMR 8-bit 4 ch | CMT 16-bit 4 ch | I-WDT |

LOW POWER, FAST WAKE-UP

- 120 µA/MHz
- 0.8 µA standby, 5 µs wake-up

HIGH PERFORMANCE

- 1.64 DMIPS/MHz
- 88.6 DMIPS @ 50 MHz, 2.7V to 5.5V
- RXv2 Core with FPU/MPU
- Enhanced DSP

SAFETY AND SECURITY FEATURES

- Built-in safety features (CAC, DOC, I-WDT, GPIO)
- TSIP-Lite: AES, RNG, Unique ID

MOTOR CONTROL

- Single and dual inverter
- With FPU

ULTRA-LOW VOLTAGE OPERATION

- 1.62V operation @ up to 20 MHz, 32.8 DMIPS

ADVANCED PERIPHERALS & INTERFACES

- USB 2.0
- Capacitive Touch
- SD Host Interface
- CAN (ISO 11898-1 Compliant)

INTEGRATED ANALOG

- Comparators
- 24-bit delta sigma
- Temperature sensor

DSP READY

- Single-cycle multiply
- Hardware-based divide
- Extensive DSP library
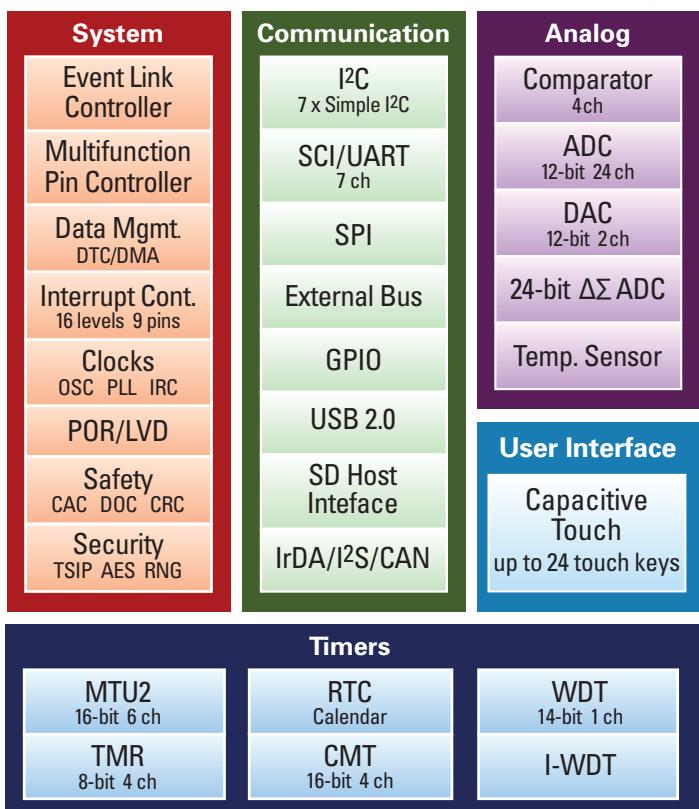
ADVANCED DESIGN AND INTEGRATION

CPU cores in the RX200 series (RXv1 and RXv2) combine the speed of a RISC architecture with the flexibility and code efficiency of a CISC architecture. They interact with the flash and SRAM through an enhanced Harvard design. Both cores leverage the industry's fastest Flash memory, delivering performance as high as 1.64 DMIPS/MHz without wait states. The enhanced DSP capability with built-in FPU (IEEE754 compliant) and support for 32-bit multiply accumulate and 16-bit multiply subtract instructions and RMPA make the RX200 ideal for near-sensor processing and IoT node applications.

Flash

Instruction Bus
Operand Bus

Enhanced Harvard Architecture

SRAM

Instruction Bus
Operand Bus

RXv2 32-bit CPU
54 MHz   88 DMIPS

Floating Point Operation Unit

DSP Instructions

32-bit Multiply/Accumulate

16-bit Multiply/Subtract

Barrel Shifter: 32-bit
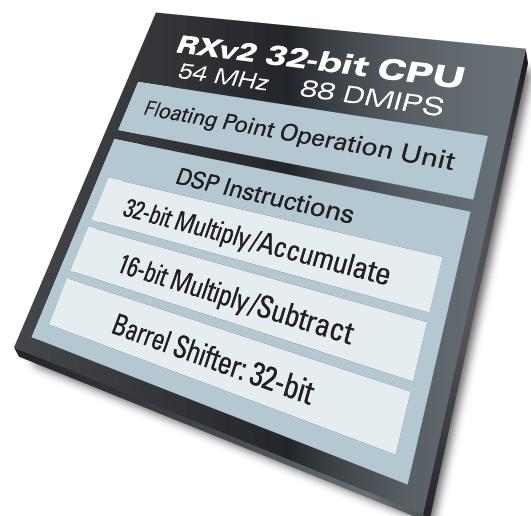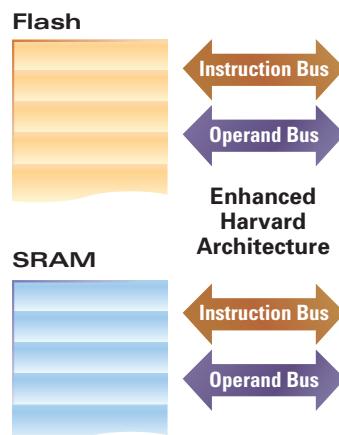
SAFETY FUNCTIONS

RX200 MCUs provide six modular hardware subsystems that help products meet safety standards. Clock Accuracy Control checks that the clock frequency is within a predefined range. Oscillation Stop Detection switches the chip's main clock to an alternative source if the primary one fails. Data Operation Circuit continuously performs a SRAM failure test independently of the CPU. The Independent Watchdog Timer (I-WDT) uses a reliable internal clock source. ADC has disconnect-detection and self-diagnostic functions. I/O pins can read back output values.

Clock	RAM	Serial Communication	OCO Dedicated for WDT	ADC
CAC Detects abnormal frequency	**Data Operation Circuit** Assists RAM failure check test	**Cyclic Redundancy Check** Detects serial communication data error	**I-WDT** Independent watchdog timer clock source from system clock	**Disconnect Detection** Detects disconnection of analog input
Oscillation Stop Detection Detects OSC stop Switch clock source to OCO			**GPIO** With read-back ability	**ADC Self-Diagnosis** Detects ADC circuit failure

CAC: Clock frequency accuracy measurement circuit   OCO: On-chip oscillator

RX231 – BEST-IN-CLASS SECURITY FEATURES

TSIP-Lite (Trusted-Secure-IP)
- Prevent illegal access to encryption module with access management circuit
- Offers secure key management

AES
- Built-in encryption/decryption engine in hardware with GCM support

RNG (True Random Number Generator)
- Generate true random number which can be used for encryption key

Chip-unique ID
- Chip-unique ID can be connected to key information to prevent a key from being copied illegally

MPU (Memory Protection Unit)
- Prevent illegal access to important area from user application

Flash ID Code Protection
- Prevent illegal E/W of Flash and spoofing

TSIP-Lite Advantage vs. Conventional AES Encryption Engine – Safe Operation of Key

- TSIP-Lite offers the safest key management, since it is handled only inside TSIP-Lite
- Key output outside TSIP-Lite is not "as is." Instead it's output as key generation information

- Key generation info is linked to chip's unique ID and cannot be regenerated in another device to prevent key from being copied illegally.

Conventional

Emulator — Debug IF — CPU

Access not limited — AES Engine

Access not limited — ROM

Key stored in ROM or hidden by additional processing. Key management not secure.

TSIP-Lite

Debugger illegal access

Emulator — Debug IF — CPU

Proper Access

Access of illegal program

Access Management Circuit
AES Engine
True Random Number Generator
Key Register

Chip-Unique ID
Key Generation Information
ROM
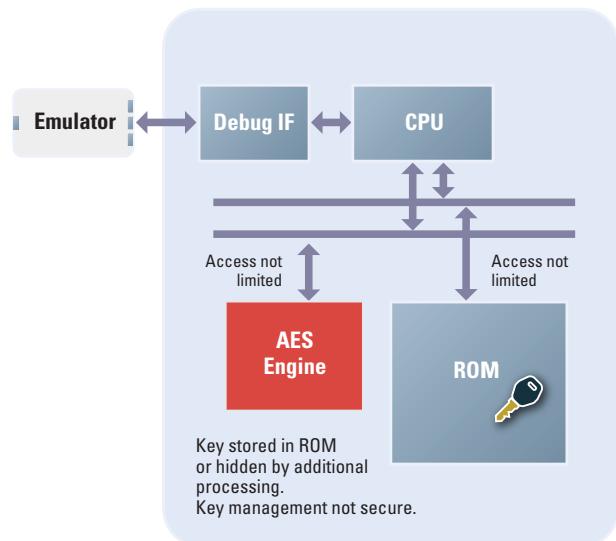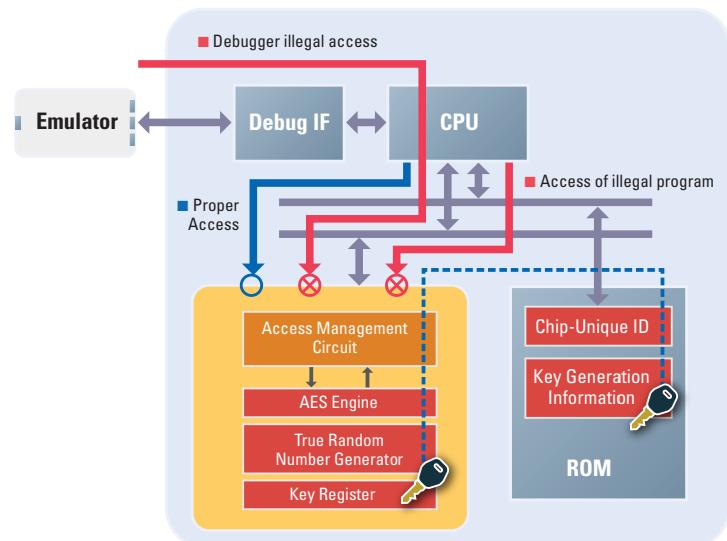
○ Proper Access Accepted   ⊗ Illegal Access Denied

CAPACITIVE TOUCH SENSING (CTSU) PERIPHERAL

The RX231 group of MCUs incorporates a patented hardware peripheral block designed to measure small variations in electrical capacitance independent of the main CPU operation. The CTSU can be configured for self- or mutual-capacitance detection for maximum flexibility. This feature has been optimized to detect the presence of human touch typically used in many interface applications.

CTSU Block Diagram
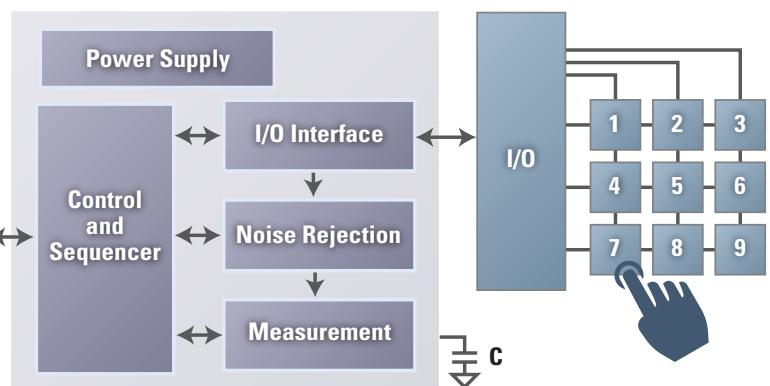
Key Features and Benefits

- Hardware-assisted rejection of electrical noise and adaptation to environmental changes
- Touch detection through 10 mm of acrylic in user interface panels
- Automatic tuning mechanism for optimal touch performance
- Autonomous operation to enable ultra-low-power touch detection for portable devices
- Twelve touch channels supporting up to 36 touch electrodes
- PC-based GUI tool for system configuration and development

RX Capacitive Touch Starter Kit

- CPU board
- Four sensor boards
- Evaluation software
- USB cable
- Quick-start guide

For RX231 Device and Cap Touch Evaluation
YR0K505231S000BE
am.renesas.com/RSKRX231

For RX Cap Touch Development
PN: RTK0EG0003S02001BJ
www.renesas.com/en-us/RX130CAPT01

USB CONNECTIVITY OF RX200 MCUS

Devices in the RX231 group incorporate a USB 2.0 Host/Function controller and an OTG communication peripheral. Operating as a host, the controller provides full-speed and low-speed data transfers. It also supports battery charging and complies with the battery charging application specification, rev 1.2.

USBm_DP
USBm_DM

USB Clock (48 MHz)
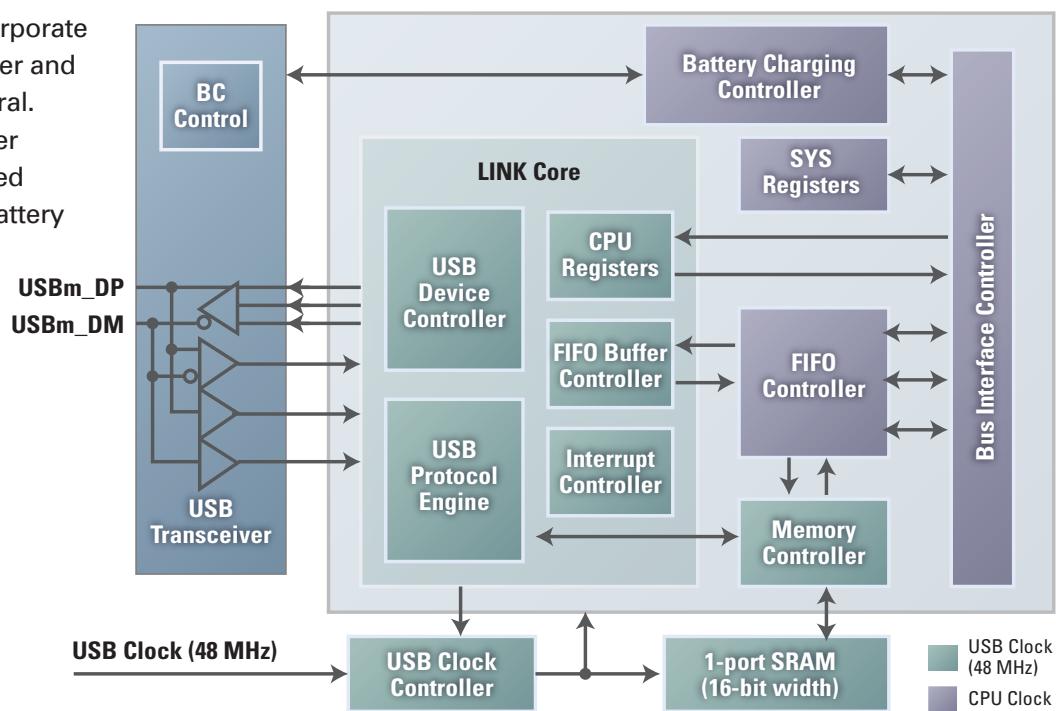
RX200 OFFERS LOW POWER WITHOUT COMPROMISING PERFORMANCE

- RX200 MCUs are great design choices for embedded systems that must minimize power consumption by running in sleep mode whenever possible, yet must wake up quickly whenever there is a need to perform computing or control tasks. Renesas' True Low-Power capability offers designers the lowest possible power consumption across the entire temperature and voltage range, including all peripherals and Flash memory, while also providing maximum flexibility with multiple operational and sleep modes. Four different power-saving modes are available: Run, Sleep, Deep Sleep, and Software Standby. Wake-up time in low-power mode ranges from less than 1 μs to 5.0 μs.

Run Mode	ICLK Frequency	Internal Voltage Regulator Mode
High Speed	4 MHz - 54 MHz	High Power
Middle Speed	1 MHz - 12 MHz	Middle Power
Low Speed	32 kHz - 1 MHz	Low Power

- Peripherals that aren't required can be completely shut down in every mode. A flexible clock system allows peripherals to use a clock frequency from the one driving the CPU to achieve the lowest possible level of power consumption.

- In run modes, the RX200 MCUs' three different operating modes can be applied according to the demands of the application at any point in time: high speed, middle speed and low speed.

Low Power Consumption, Fast Wake-up

- Software standby achieves a power consumption of only 800 nA, with a 5.0 μs wake-up time. Applications requiring a shorter wake-up time can utilize the Sleep- and Deep-Sleep modes that reduce the delay to just 1 μs.
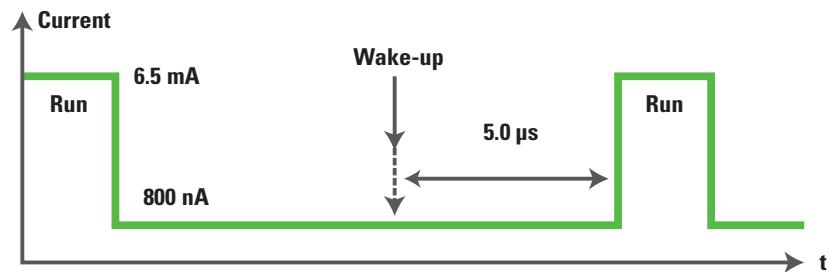
INTRODUCING THE RX23T AND RX24T: SOLUTIONS FOR SINGLE AND DUAL MOTOR CONTROL

The RX23T and RX24T product groups are ideally suited for single and dual inverter control with a built-in FPU (floating-point processing unit) that makes it easy to program complex inverter control algorithms. Thanks to the efficient v2 RX200 CPU core, current consumption in software standby mode (with RAM retention) is a mere 0.45 μA. RX23T and RX24T microcontrollers operate in a broad voltage range from 2.7 V to 5.5 V, which is useful for inverter control, and are highly compatible with the RX62T group at the pin arrangement and software level.

RX200 SERIES DEVICES[1]

231 220 210 21A 23T 24T

Memory							
1 MB							
512 KB							
384 KB							
256 KB							
128 KB							
64 KB							

| 48LQFP 0.5mm 7x7mm | 64LQFP 0.5mm 10x10mm | 80LQFP 0.5mm 12x12mm | 100LQFP 0.5mm 14x14mm | 48HQFN 0.5mm 7x7mm | 64HQFN 0.5mm 9x9mm | 64WFLGA 0.5mm 5x5mm | 100TFLGA 0.5mm 5.5x5.5mm |
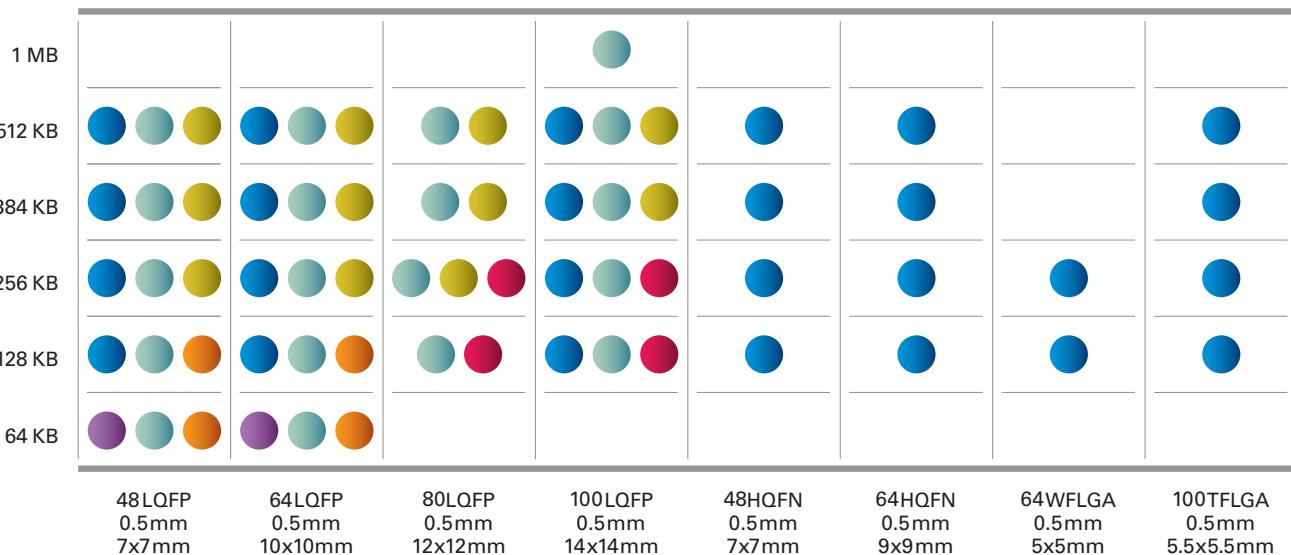
RX200 PRODUCT TABLE[1]

Group	Part Number	Memory			Operating Voltage	Processor		Communications						I/O			Packaging			
		ROM (KB)	RAM (KB)	Data Flash (KB)	Min.-Max (V)	CPU	FPU	CSI (ch)	SPI (ch)	UART (ch)	I2C (ch)	CAN	USB	External Bus	I/O Ports	External Interrupts	Package Type	Size	Pin Count	Pitch
RX210	R5F52105BDFM	128	20	8	1.62-5.5	RX	–	6	7	6	7	–	–	–	49	8	LQFP	10 x 10	64	0.5
	R5F52106BDFP	256	32	8			–	7	8	7	8	–	–	Y	85	9	LQFP	14 x 14	100	0.5
	R5F52107CDFP	384	64	8			–	7	8	7	8	–	–	Y	85	9	LQFP	14 x 14	100	0.5
	R5F52108CDFN	512	64	8			–	7	8	7	8	–	–	–	65	9	LQFP	12 x 12	80	0.5
	R5F52108CDFP	512	64	8			–	7	8	7	8	–	–	Y	85	9	LQFP	14 x 14	100	0.5
	R5F52108CDLJ	512	64	8			–	7	8	7	8	–	–	Y	85	9	TFLGA	7 x 7	100	0.65
RX21A	R5F521A6BDFM	256	32	8	1.8-3.6	RX	–	5	7	5	6	–	–	–	38	8	LQFP	10 x 10	64	0.5
	R5F521A8BDLJ	512	64	8			–	5	7	5	7	–	–	–	66	9	TFLGA	7 x 7	100	0.65
RX231	R5F52315CDLF	128	32	8	1.8-5.5	RXv2	Y	6	7	6	7	–	Y	–	44	8	WFLGA	5 x 5	64	0.5
	R5F52315ADFL	128	32	8			Y	5	6	5	6	1	Y	–	31	7	LQFP	7 x 7	48	0.5
	R5F52315ADFM	128	32	8			Y	6	7	6	7	1	Y	–	44	8	LQFP	10 x 10	64	0.5
	R5F52315ADNE	128	32	8			Y	5	6	5	6	1	Y	–	31	7	HWQFN	7 x 7	48	0.5
	R5F52316CDLF	256	32	8			Y	6	7	6	7	–	Y	–	44	8	WFLGA	5 x 5	64	0.5
	R5F52316ADFL	256	32	8			Y	5	6	5	6	1	Y	–	31	7	LQFP	7 x 7	48	0.5
	R5F52316ADFM	256	32	8			Y	6	7	6	7	1	Y	–	44	8	LQFP	10 x 10	64	0.5
	R5F52316ADFP	256	32	8			Y	7	8	7	8	1	Y	Y	80	9	LQFP	14 x 14	100	0.5
	R5F52316ADNE	256	32	8			Y	5	6	5	6	1	Y	–	31	7	HWQFN	7 x 7	48	0.5
	R5F52317ADFM	384	64	8			Y	6	7	6	7	1	Y	–	44	8	LQFP	10 x 10	64	0.5
	R5F52317ADFP	384	64	8			Y	7	8	7	8	1	Y	Y	80	9	LQFP	14 x 14	100	0.5
	R5F52317ADLA	384	64	8			Y	7	8	7	8	1	Y	Y	80	9	TFLGA	5.5 x 5.5	100	0.5
	R5F52317ADND	384	64	8			Y	6	7	6	7	1	Y	–	44	8	HWQFN	9 x 9	64	0.5
	R5F52318ADFM	512	64	8			Y	6	7	6	7	1	Y	–	44	8	LQFP	10 x 10	64	0.5
	R5F52318ADFP	512	64	8			Y	7	8	7	8	1	Y	Y	80	9	LQFP	14 x 14	100	0.5
	R5F52318ADLA	512	64	8			Y	7	8	7	8	1	Y	Y	80	9	TFLGA	5.5 x 5.5	100	0.5
	R5F52318ADND	512	64	8			Y	6	7	6	7	1	Y	–	44	8	HWQFN	9 x 9	64	0.5
RX23T	R5F523T3ADFL	64	10	–	2.7-5.5	RX	Y	2	3	2	3	–	–	–	35	7	LQFP	7 x 7	48	0.5
	R5F523T5ADFL	128	10	–			Y	2	3	2	3	–	–	–	35	7	LQFP	7 x 7	48	0.5
	R5F523T5ADFM	128	10	–			Y	2	3	2	3	–	–	–	48	7	LQFP	10 x 10	64	0.5
RX24T	R5F524T8ADFN	128	16	8	2.7-5.5	RX	Y	3	3	2	3	–	–	–	58	9	LQFP	12x12	80	0.5
	R5F524T8ADFP	128	16	8			Y	3	3	2	3	–	–	–	78	9	LQFP	14x14	100	0.5
	R5F524TAADFN	256	16	8			Y	3	3	2	3	–	–	–	58	9	LQFP	12x12	80	0.5
	R5F524TAADFP	256	16	8			Y	3	3	2	3	–	–	–	78	9	LQFP	14x14	100	0.5

Note 1: See HW Manual for complete device list.

GET UP AND RUNNING WITH THE RX ECOSYSTEM

Renesas makes it easy to launch new system designs. Our comprehensive hardware and software tools – including very low cost and free products – help swiftly advance the product development process from concept stage to final RX-based design.

Renesas Customizable Software Library

Applilet is a support tool that makes it easy to generate code optimized for a RX200 MCU. It functions through a simple GUI Windows application or via a e²studio plug-in. This tool generates customizable device drivers that compile and work right out of the box.

Applilet®

am.renesas.com/applilet

e² studio – the new Eclipse-based Integrated Development Environment (IDE) from Renesas

Complete development and debug environment based on the popular Eclipse platform and the associated C/C++ Development Tooling (CDT) project.

Basic Features		Advanced Debug Features	

– Connect / Disconnect
– Run / Stop (Resume / Suspend)
– Software breakpoints
– Source step / disassembly step
	– Variable and
	  Expression views
	– Register view
	– Basic Memory view
	– Endian selection
		– Renesas Debug view
		  with Call Stack
		– I/O Registers view
		– Trace view
		– Eventpoints view
			– Real-time
			  Expression view
			– Real-time
			  Memory view
			– Real-time Chart view

am.renesas.com/e2studio			

RX23T Renesas Starter Kit (RSK)

The Renesas Starter Kit for RX23T is the perfect starter kit for developers who are new to the RX23T. The kit includes an LCD display module, on-chip debugging emulator, and integrated development environment so you can start evaluating the RX23T immediately.

RPB Part Number: YRTK500523TS00000BE
am.renesas.com/RSK23T

RX231 Renesas Starter Kit (RSK)

This complete RX231-based hardware/ software platform for in-depth application design includes the E1 Debugger, e² studio, demonstration firmware, and a trial version of the Renesas RX compiler.

RSK Part Number: YR0K505231S000BE
am.renesas.com/RSKRX231

Complete Debugging, Emulation, and Programming

On-chip debugging of an RX-based application is performed via a debug connection to the target and USB connection to the Windows-based IDE. The Renesas E1 and E20 debuggers offer thorough CPU control and visibility.

Renesas E1
R0E000010KCE00

Renesas E20
R0E000200KCT00

am.renesas.com/tools

THIRD-PARTY SOLUTIONS

Compilers

IAR SYSTEMS
www.iar.com/ewrx

The IAR Embedded Workbench for RX is now available in two editions – the EWRX Standard edition and the new EWRX-BL Baseline edition, which is targeted at developers working with Renesas RX MCUs with smaller memory like the RX100 series. The Baseline edition is limited to a code size of 256 KB, but otherwise provides a fully functional IDE, including project manager, editor, compiler, assembler, linker librarian and debugger tools.

NEW: Free 64 KB size-limited Kickstart version now also available!

KPIT Cummins Infosystems Limited
www.kpitgnutools.com

KPIT GNURX compiler

	Micriµm www.micrium.com	**CMX SYSTEMS** www.cmx.com	**RoweBots** www.rowebots.com	**expresslogic** www.expresslogic.com	**free RTOS** www.freertos.org	**SEGGER** www.segger.com
RTOS	µC/OS-III	CMX-RTX	Unison	ThreadX	FreeRTOS	embOS
USB	✓	✓	✓	✓		✓

RENESAS

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