

# RX600/RX700 MICROCONTROLLERS

For superior performance



**BIG IDEAS  
FOR EVERY SPACE**

# RX600/RX700 SERIES MCUs

# PERFORMANCE WITHOUT SACRIFICE

The RX architecture is future oriented and feature rich. It's driven by a Renesas technology roadmap that focuses on the global environment and anticipates the enormous gains in sophistication that microcontroller-based products are expected to achieve in the next 10 to 20 years. Thus, the RX family of microcontrollers (MCUs) delivers superior performance in terms of core processing performance, code efficiency, and power consumption.

An extensive portfolio of on-chip mixed-signal peripherals is available, and fast 90nm and 40nm Flash memory is embedded. The embedded Flash unleashes full CPU performance, feeding instructions to the 32-bit RX CPU with no delays – no waits, no stalls – maintaining the MCU's peak performance. Memory acceleration isn't required, and the result is just pure, predictable performance.





## Superior Architecture

2.00 DMIPS/MHz  
with FPU and DSP



## Fast Flash

Industry's only  
40 nm 120 MHz  
Embedded Flash



## Code Efficiency

Up to 28%<sup>1</sup>  
Code Size Savings



## Power Efficiency

133  $\mu$ A/MHz<sup>2</sup>,  
1.6  $\mu$ A RTC Standby

# THE RX71M GROUP – HIGH PERFORMANCE AND SUPERIOR CONNECTIVITY

## HIGH PERFORMANCE

- New RXv2 CPU Core offering 2.00 DMIPS per MHz and 4.25 CoreMark™ per MHz with enhancements for floating point and digital signal processing operations
- Industry's only 40nm embedded flash process with zero wait states up to 120 MHz, integrating up to 4 MB Flash and 512 KB SRAM
- With RXv2 CPU Core and 40 nm, RX71M consumes only 133  $\mu$ A per MHz with all peripherals off

## SUPERIOR CONNECTIVITY

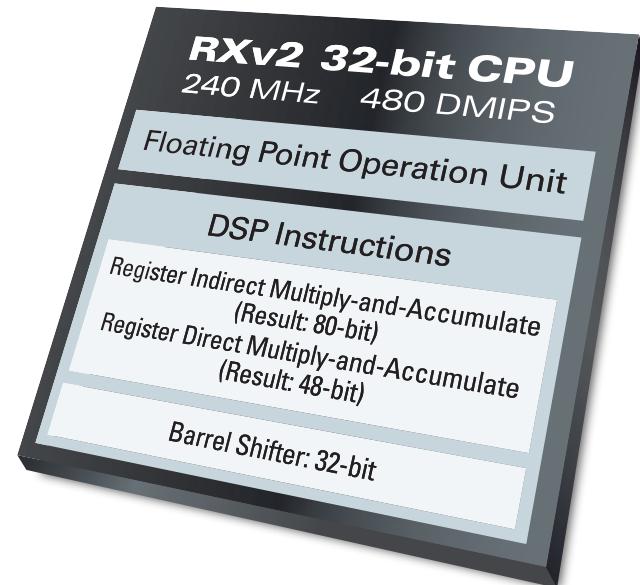
- Dual Ethernet with IEEE 1588 Version 2 support
- Dual USB including one channel high speed
- Three CAN channels
- SD Host Interface transfer speed up to 15 Mbytes/sec
- MMC Interface transfer speed up to 30 Mbytes/sec
- QSPI transfer speed up to 120 Mbits/sec
- SPI transfer speed up to 30 Mbits/sec
- SCI with FIFO transfer speed up to 15 Mbits/sec
- Camera Interface with 8-bit parallel data interface
- Two channels I2S compliant Serial Sound Interface

MEMORY
Flash up to 4 MB
SRAM 512 KB ECC RAM: 32 KB Standby RAM: 8 KB
Data Flash 64 KB

SYSTEM
Data Transfer Controller ExDMA Controller x 2 ch DMA Controller x 8 ch
Interrupt Controller 16 levels, 16 pins
Clock Generation Circuit PLL High-speed On-chip Oscillator
Power-on Reset Voltage Detection Circuit
Event Link Controller

ANALOG
12-bit ADC: 29 ch
12-bit DAC: 2 ch
Temp Sensor

IMAGE CAPTURE
Parallel Data Capture Unit



TIMERS
Multifunction Timer Pulse Unit (MTU3) 16-bit 8 ch 32-bit 1 ch
General PWM Timer (GPT) 16-bit 4 ch
Timer Pulse Unit (TPU) 16-bit 6 ch
Programmable Pulse Generator (PPG)
8-bit Timer (TMR) 8-bit 4 ch
16-bit Timer (CMT) x 4 ch
32-bit Timer (CMTW) x 2 ch
Real-time Clock Calendar Function

IMAGE CAPTURE
Parallel Data Capture Unit

COMMUNICATION
Ethernet Controller 2 ch
IEEE 1588 Clock Synchronization Control
USB High-Speed: 1 ch USB Full-Speed: 1 ch
I2C Bus Interface x 2 ch
Serial Communications Interface x 13 ch (incl. 4 ch with FIFO)
Serial Peripheral Interface
Quad Serial Peripheral Interface
SD Host Interface
MMC Host Interface
Serial Sound Interface 2 ch
CAN: 2 ch
External Bus 8-, 16-, or 32-bit

ENCRYPTION/SAFETY
Encryption Modules AES/DES/SHA/RNG
Memory Protection Unit
Register Write Protection Unit
Clock Frequency Accuracy Measurement Circuit
CRC Calculator
Data Operation Circuit
Watchdog Timer 14-bit 1 ch
Independent Watchdog Timer 14-bit 1 ch
Trusted Memory Function

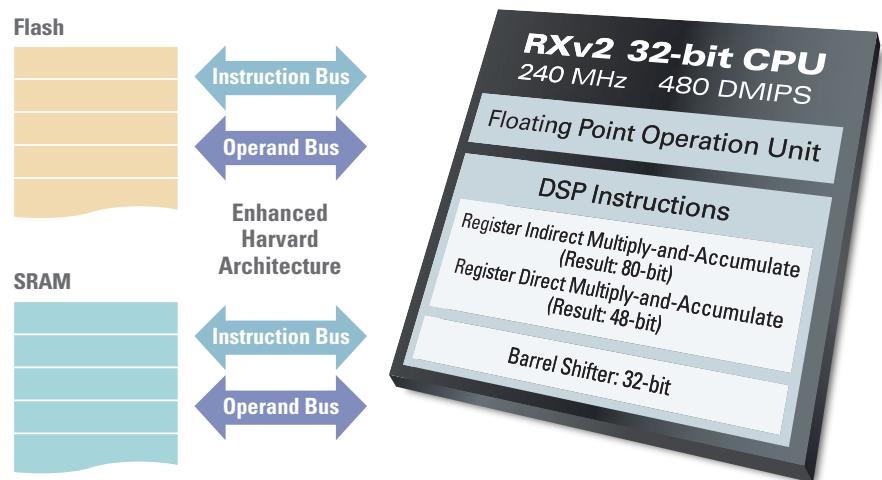
# ADVANCED DESIGN AND INTEGRATION

## RX600/RX700 KEY BENEFITS

CPU cores in the RX family (RXv1 and RXv2) marry 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.

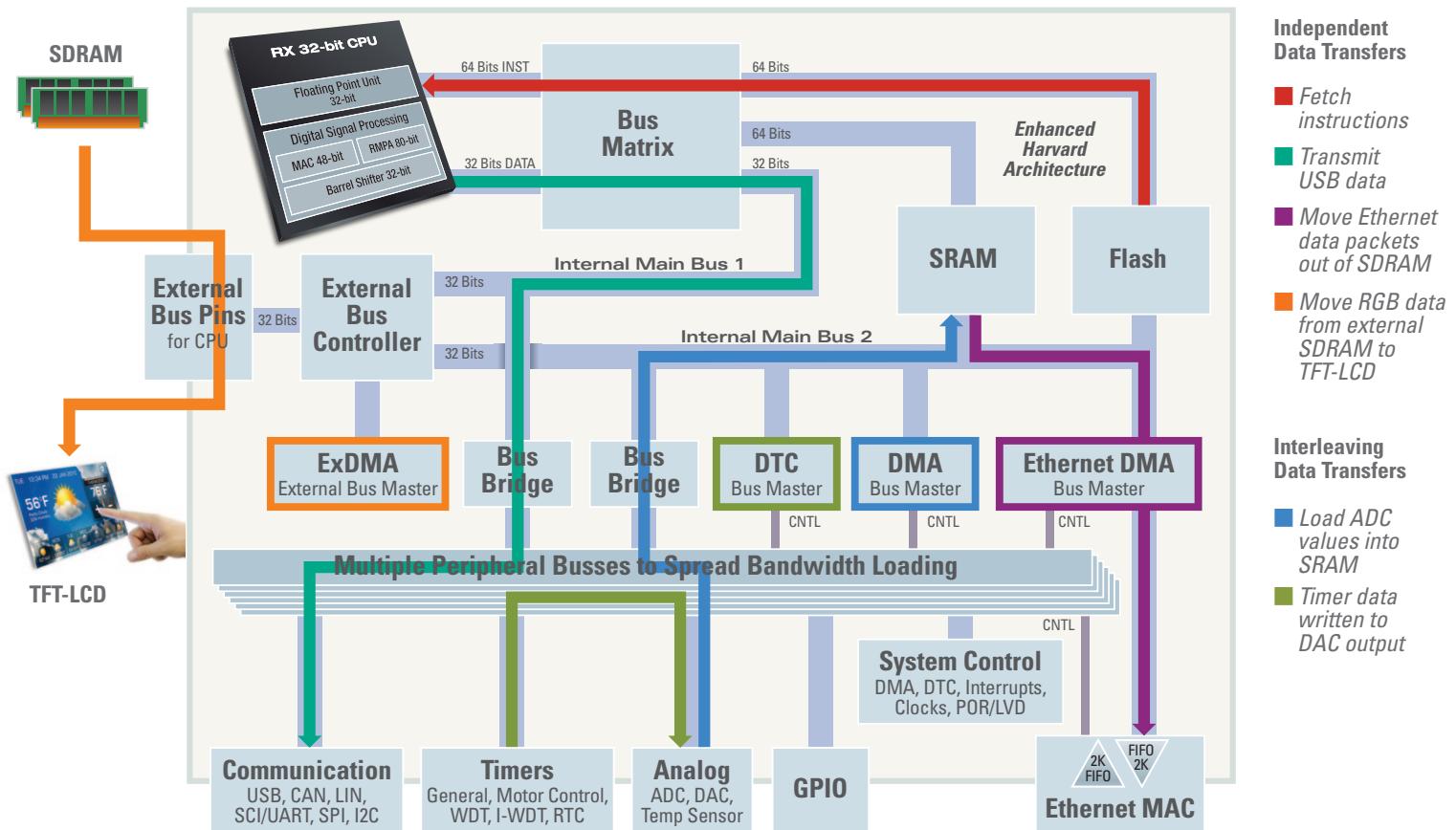
Both cores leverage the industry's fastest Flash memory, delivering performance as high as 2.0 DMIPS/MHz without wait states.

The cores are tightly coupled to FPU, MAC, and RMPA (Repeat Multiply Accumulate) functions driven by DSP and floating-point instructions to meet the processing requirements of DSC (Digital Signal Controller) type applications.



## SIMULTANEOUS DATA TRANSFERS

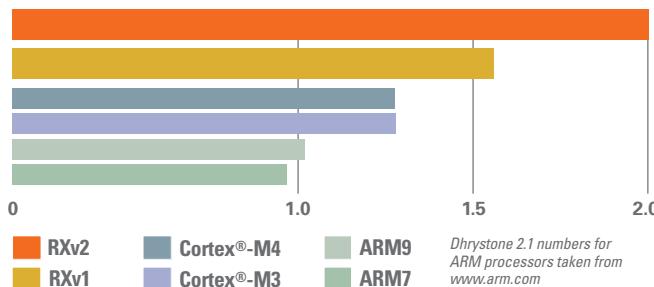
RX MCUs use parallel busses that allow simultaneous movements of data between the CPU core, flash, SRAM, and peripherals; thereby, spreading the bandwidth loading. Six peripheral busses enable a flexible distribution of slow and fast peripherals for optimized throughput. An external bus with an independent DMA moves data directly from one external device to another, such as from a graphic frame buffer to a TFT-LCD panel.



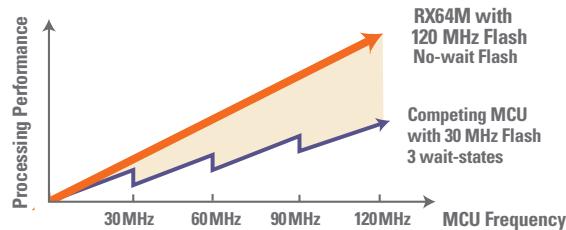
## PERFORMANCE

The RX Core delivers 2.00 DMIPS per MHz, achieving 480 DMIPS when running at 240 MHz.

Dhrystone MIPS per MHz with no wait-state memory access



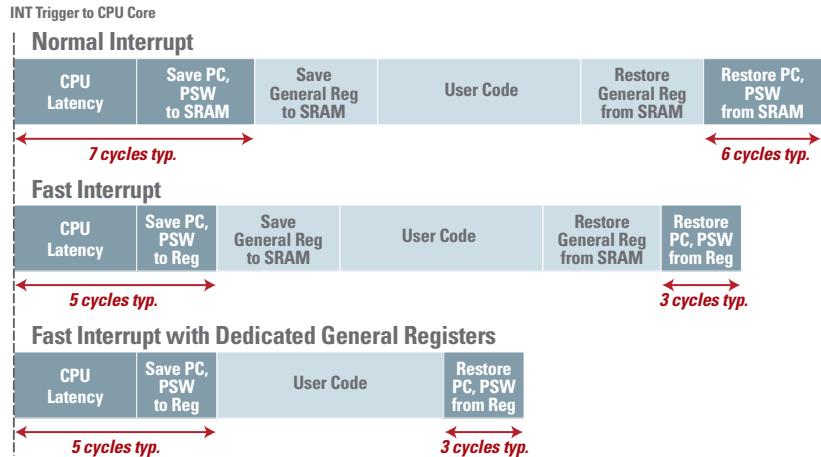
## INDUSTRY'S ONLY 120 MHZ ON-CHIP FLASH



## EFFICIENT INTERRUPT HANDLING

There are flexible options to achieve minimum latency for various scenarios:

- Normal interrupt responds in as few as seven CPU clock cycles from the event until the firmware serves the interrupt.
- Fast interrupt mode can be assigned dynamically to any interrupt source, responding in just five CPU clocks using dedicated registers to save and restore the CPU state.
- All interrupt service routines can be shortened by dedicating up to four RX CPU general registers for use only by interrupts, eliminating the need to push and pop the registers to and from the stack.



## SUBSTANTIAL CODE SIZE REDUCTION

The RX CISC CPU architecture has inherent advantages over RISC CPUs in terms of code size, with RX's variable length instructions ranging from 8 bits to 64 bits, allowing the compiler to select just the right instruction to do the job.

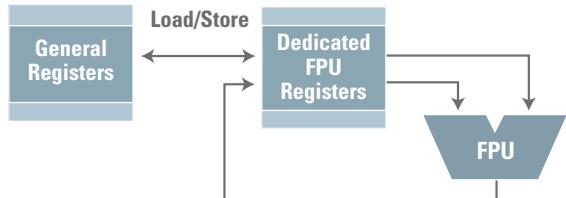
- Many RISC MCUs have only two instruction lengths – 16 bits and 32 bits – so the compiler must make compromises.
- RX CPU supports 10 addressing modes, which optimize manipulation and movement of data.
- Compiled RX code has been measured as much as 28% smaller than the same code compiled on a popular RISC MCU.

## SUPERIOR FPU IMPLEMENTATION

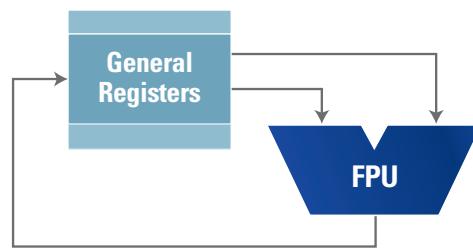
The RX FPU implementation allows direct access to general registers, resulting in faster execution and smaller code size.

- RX eliminates the overhead of load/store operations
- Results in higher performance and smaller code size

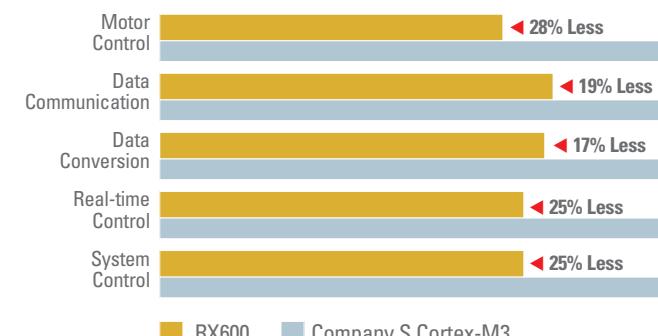
### Traditional FPU Implementation



### RX FPU Implementation



### Code Size (relative)\*



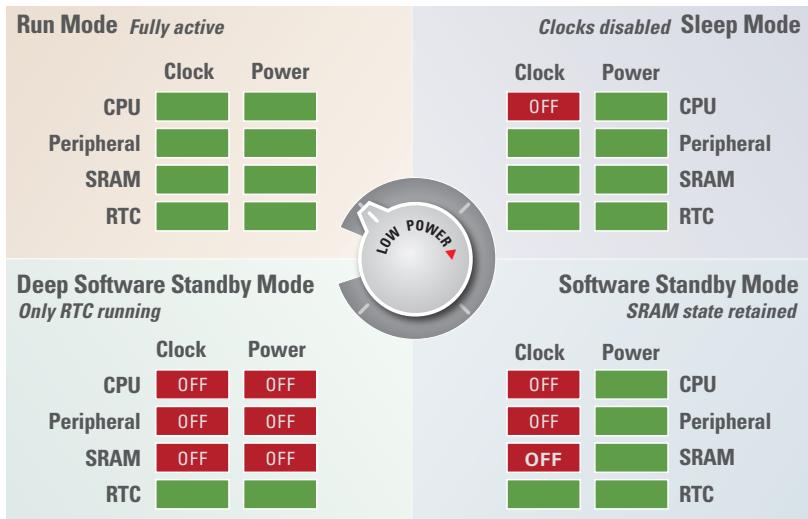
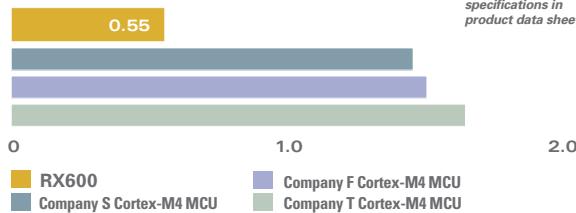
\*Renesas internal testing

## HIGHLY EFFECTIVE POWER MANAGEMENT

Strike an optimized balance of performance and power consumption with many low-power modes of operation enabled by these design techniques:

- Flexible system clocking and gating for each peripheral
- Selective power domain gating for unused sections of the device
- Low-power, high-voltage threshold transistors minimize leakage

### Milliwatts per DMIPS\*



The RX Series has four power modes to manage precious battery energy consumption without compromising performance

## EMC ADVANTAGES – BUILT-IN TO ELIMINATE ADD-ONS

Outstanding EMC performance of RX600 MCUs reduces system-integration problems, lowers development costs, and shortens design cycles. BOM costs also drop because external components can be eliminated.

- Strong electromagnetic immunity boosts system reliability
- Careful VCC and VSS layout
- Noise filters on input signals
- Advanced chip layout techniques

**LANGER**  
EMV-Technik

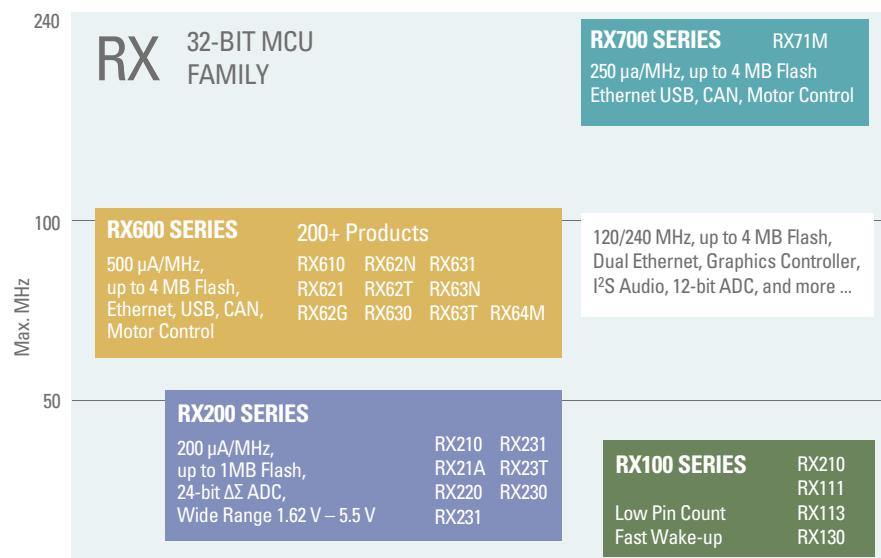
"Langer EMV and Renesas Electronics today announced that the RX600 microcontroller (MCU) family is the most robust MCU Langer EMV has ever tested against environmental noise."

*Renesas press release, October 21, 2010*

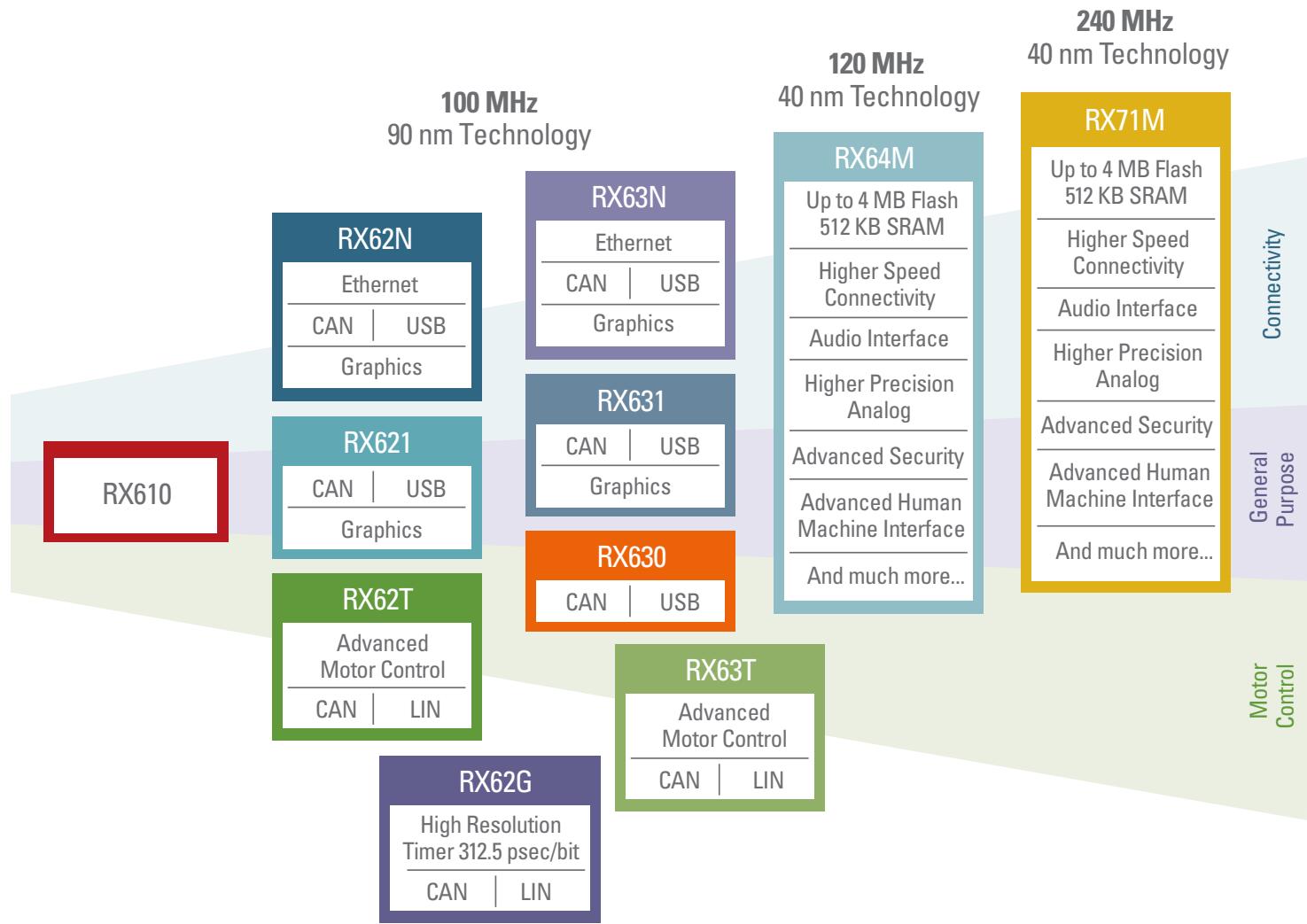
## RX FAMILY PRODUCT PORTFOLIO

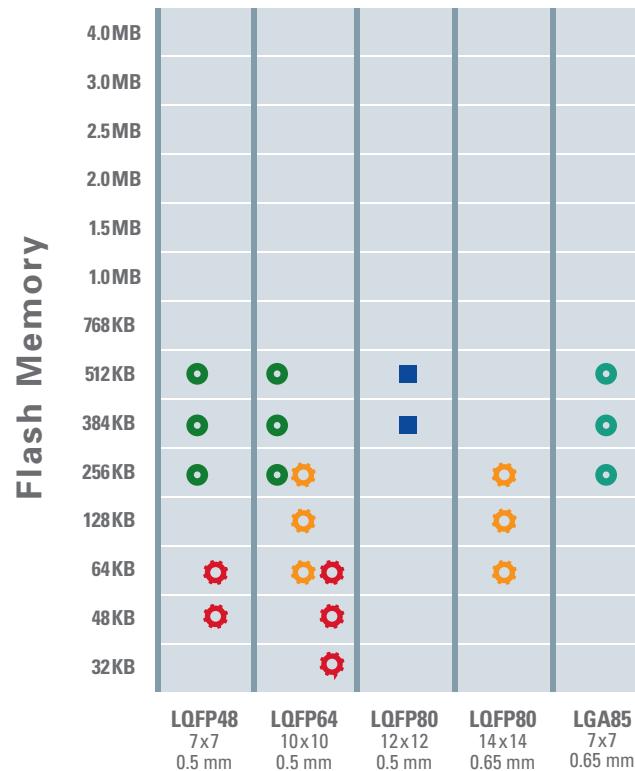
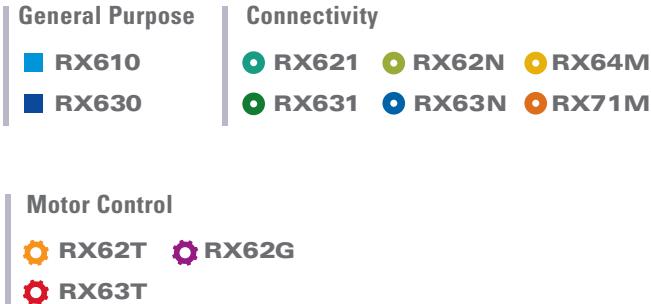
The RX family consists of multiple product series containing over 900 different devices. MCUs in the RX600/RX700 series are ideal for applications requiring high-performance, high-efficient processors. Devices in the RX200 and RX100 series expand the range of compatible system design choices, adding smaller, lower power devices with fewer pins.

Migration from existing Renesas architectures to RX solutions is easy. And, of course, moving designs among RX family members is very easy, since RX700, RX600, RX200 and RX100 MCUs share the same basic CPU architecture and peripherals and provide upward code compatibility. This maximizes design flexibility and facilitates software reuse.



# RX600/RX700 MCU SERIES ROADMAP



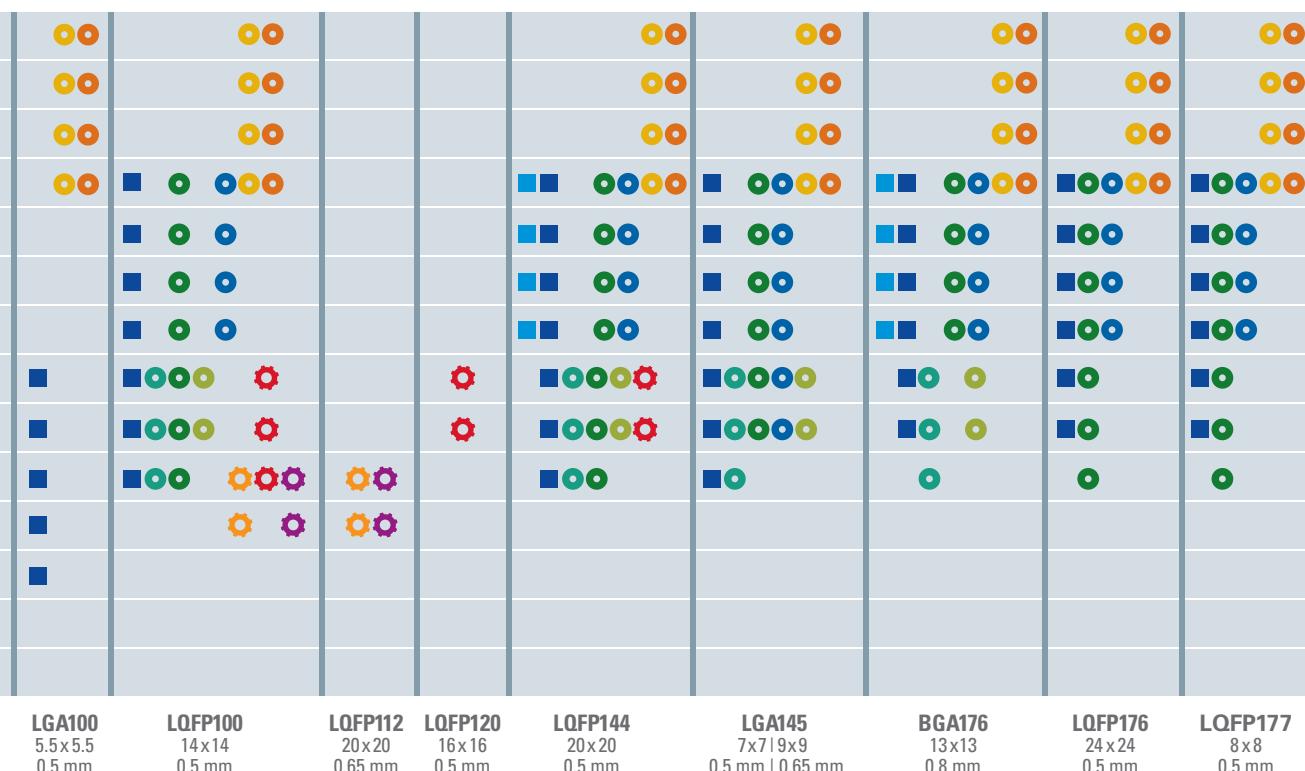


## COMPREHENSIVE ON-CHIP PERIPHERALS

To lower costs, simplify system designs, reduce total system power consumption, and enable the implementation of value-added features, a wide range of on-chip peripheral functions is clustered around the powerful CPU cores of RX MCUs. Broadly categorized into analog, timer, communication and system functions, these numerous peripherals are proven designs delivering impressive performance. The many different types of RX MCUs offer diverse sets of functions, so chip capabilities and cost can be matched to application needs.

- RX631/63N MCUs (100 MHz RXv1 core) offer up to 2 MB Flash and 256 KB RAM and provide extensive connectivity features: Ethernet, CAN, and up to two USB-FS 2.0 channels, each operating in Host, Device, or OTG (On the Go) modes. They also provide up to 13 SCI; three SPI, and four I2C serial channels; analog interfaces; timers; RTC and POR/LVD functions; and more.
- RX63T MCUs (100 MHz RXv1 core) have improved motor/inverter control timers, enhanced analog peripherals and up to 512 KB flash for designing precision motor control and positioning equipment. MTU3 and GPT timers enable one chip to control three motors simultaneously. The FPU and improved analog functions handle three-shunt or single-shunt vector-type motor control methods.
- RX64M/RX71M MCUs (120 MHz / 240 MHz RXv2 core) have more memory (up to 4 MB flash/552 KB RAM) and deliver greater functionality, especially in connectivity features. Noteworthy peripheral additions include IEEE1588 Ethernet, SD card, USB high speed (RX71M), MMC and QSPI interfaces; DES/SHA/RNG + AES encryption; improved 12-bit A/D; faster DSP; sophisticated timers; and a parallel data-capture unit (PDC) for connecting to image sensors.

Group	Advanced Peripherals							
	Connectivity							
	Ethernet 10/100 MAC	USB 2.0 Host/ Device/OTG	CAN 2.0B	Graphics ExDMA	PDC (Camera I/F)	SDHI	MMC	QSPI
<b>RX621</b>	—	1	1	1	—	—	—	—
<b>RX631</b>	—	2	3	1	1	—	—	—
<b>RX62N</b>	1	2	1	1	—	—	—	—
<b>RX63N</b>	1	2	3	1	1	—	—	—
<b>RX610</b>	—	—	—	—	—	—	—	—
<b>RX630</b>	—	1 <sup>(1)</sup>	3	—	—	—	—	—
<b>RX62T</b>	—	—	1	—	—	—	—	—
<b>RX62G</b>	—	—	1	—	—	—	—	—
<b>RX63T</b>	—	1 <sup>(1)</sup>	1	—	—	—	—	—
<b>RX64M</b>	2	2	3	1	1	1	1	1
<b>RX71M</b>	2	2 <sup>(3)</sup>	3	1	1	1	1	1



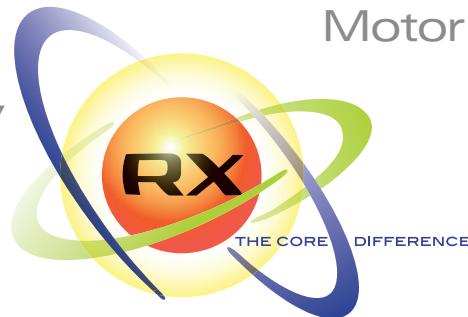
Motor				Basic Peripheral Set																Communication						
				Memory		Analog				Timers																
ADC 12-bit	MTU3	GPT	Hardware Security	Flash (max)	SRAM (max)	Data Flash	ADC 10-bit	DAC 10-bit	ADC 12-bit	DAC 12-bit	Temp Sensor	MTU2	TPU	PPG	TMR	CMT	WDT	I-WDT	RTC	CMTW	I2C	SSI (I <sup>2</sup> S)	SCI	ExBus	SPI	LIN
-	-	-	-	512KB	96KB	32KB	-	2	8	-	-	12	-	8	4	4	1	1	1	-	2	-	6	8/16/32	2	-
-	-	-	Yes	2MB	256KB	32KB	8	2	21	-	1	6	12	8	4	4	1	1	1	-	4	-	13	8/16/32	3	-
-	-	-	-	512KB	96KB	32KB	-	2	8	-	-	12	-	8	4	4	1	1	1	-	2	-	6	8/16/32	2	-
-	-	-	Yes	2MB	256KB	32KB	8	2	21	-	1	6	12	8	4	4	1	1	1	-	4	-	13	8/16/32	3	-
-	-	-	-	2MB	128KB	32KB	16	2	-	-	-	-	12	8	4	4	1	-	-	2	-	7	8/16	-	-	
-	-	-	-	2MB	128KB	32KB	8	2	21	-	1	6	12	8	4	4	1	1	1	-	4	-	13	8/16/32	3	-
8	8	4	-	256KB	16KB	32KB	12	-	-	-	-	-	-	-	-	4	1	1	-	-	1	-	3	-	1	1
8	8	4 <sup>(2)</sup>	-	256KB	16KB	32KB	12	-	-	-	-	-	-	-	-	4	1	1	-	-	1	-	3	-	1	1
8	8	8	-	512KB	48KB	32KB	20	2	-	-	-	-	-	-	-	4	1	1	-	-	2	-	5	8/16	2	-
-	9	4	Yes	4MB	512KB	64KB	-	-	29	2	1	-	6	8	4	4	1	1	1	2	2	2	13	8/16/32	1	-
-	9	4	Yes	4MB	512KB	64KB	-	-	29	2	1	-	6	8	4	4	1	1	1	2	2	2	13	8/16/32	2	-

Note 1: USB device only   Note 2: High Resolution   Note 3: Includes High-speed USB

# DESIGN VERSATILITY OF THE RX

System design versatility, application capability, and economic sensibility are built into the many microcontrollers in the RX family. Driven by a technology roadmap that anticipates more sophisticated applications in the next decade that demand cost effectiveness, RX devices offer abundant core performance and extensive peripheral functions enabling a variety of solutions.

Connectivity



Motor Control

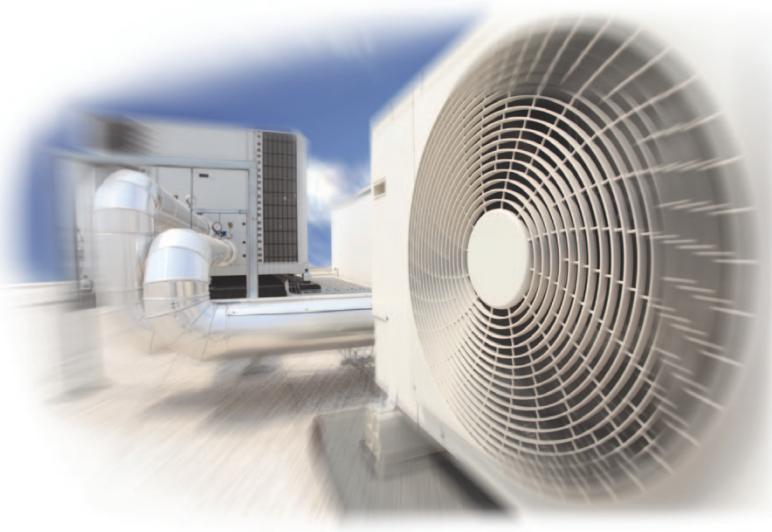
Graphics

## RX FOR MOTOR CONTROL

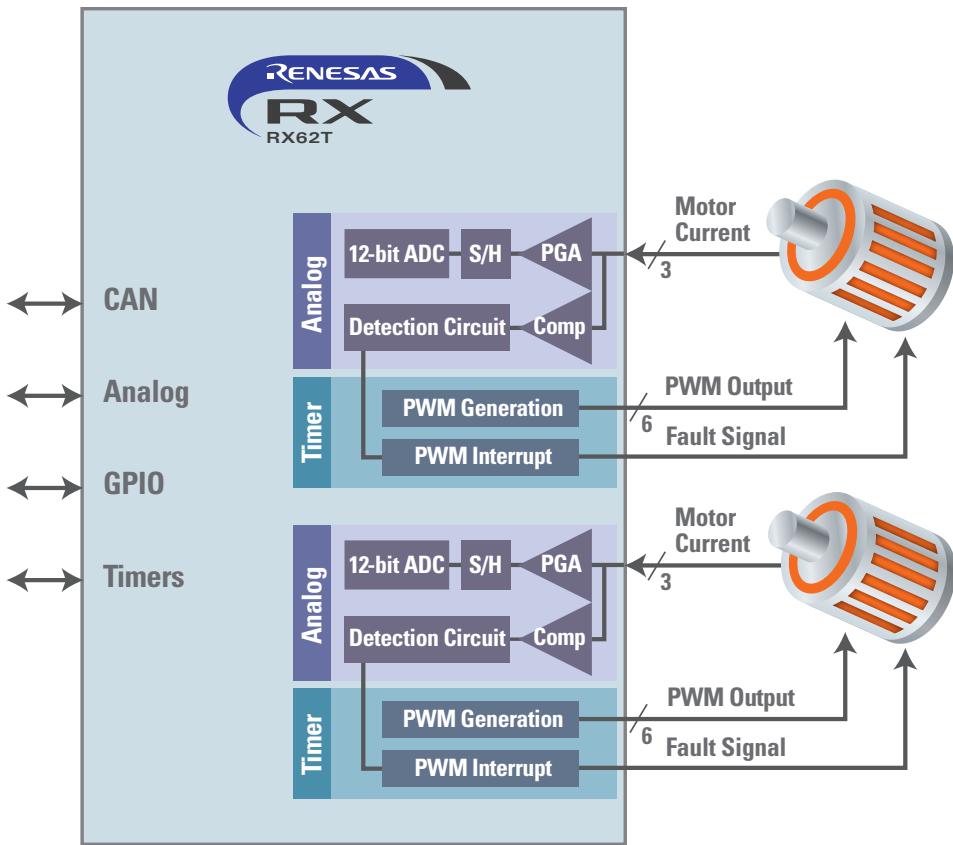
High-performance CPU and FPU capability, and advanced analog and timer peripherals, make the RX62T/62G and RX63T ideal solutions for inverter and motor control applications. Renesas can help you develop your motor control solution with kits and firmware that support many kinds of motor control, including ultra-quiet, energy-efficient, and high-precision three-phase sensorless vector control.

In the home appliance example shown here, the RX62T is driving two three-phase motors simultaneously using its advanced PWM timers. These timers are well suited for Brushless DC three-phase motors by having complementary PWM outputs with automatic dead-time insertion, an emergency "Shut-down" (stop) input, and quadrature encoder inputs for speed and direction feedback.

The RX62T's advanced analog subsystem with multiple sample-hold circuits enables sampling of three simultaneous current measurements. It also offers programmable operational amplifiers and integrated window comparators to eliminate external components. The 12-bit ADCs have a fast 1  $\mu$ sec conversion time, can be triggered by the PWM timers, and provide self-diagnostic capability.



The RX62G has a high-resolution (312.5ps) timer, making it ideal for motor control with power factor correction (PFC).



### Advanced Analog

- Two 12-bit ADC units, each with 4 input channels, 1  $\mu$ sec conversion time and self-diagnostic capability
- Each 12-bit ADC unit has:
  - 3 x independent sample-hold circuits
  - 3 x programmable op amps
  - 3 x analog window comparators
  - 3 trigger sources (PWM timers, external and software)

### Advanced Timers

- 100 MHz, 16-bit Multifunction Timer unit (MTU3)
- 100 MHz, 16-bit General-Purpose Timer unit (GPT)
- Complementary PWM and Reset-Synchronous outputs
- Dead-time insertion
- Quadrature encoder inputs
- Emergency motor “Shut-down” (stop) input

## Motor Control Solutions using the RX MCU

A solid evaluation and development platform for motor control

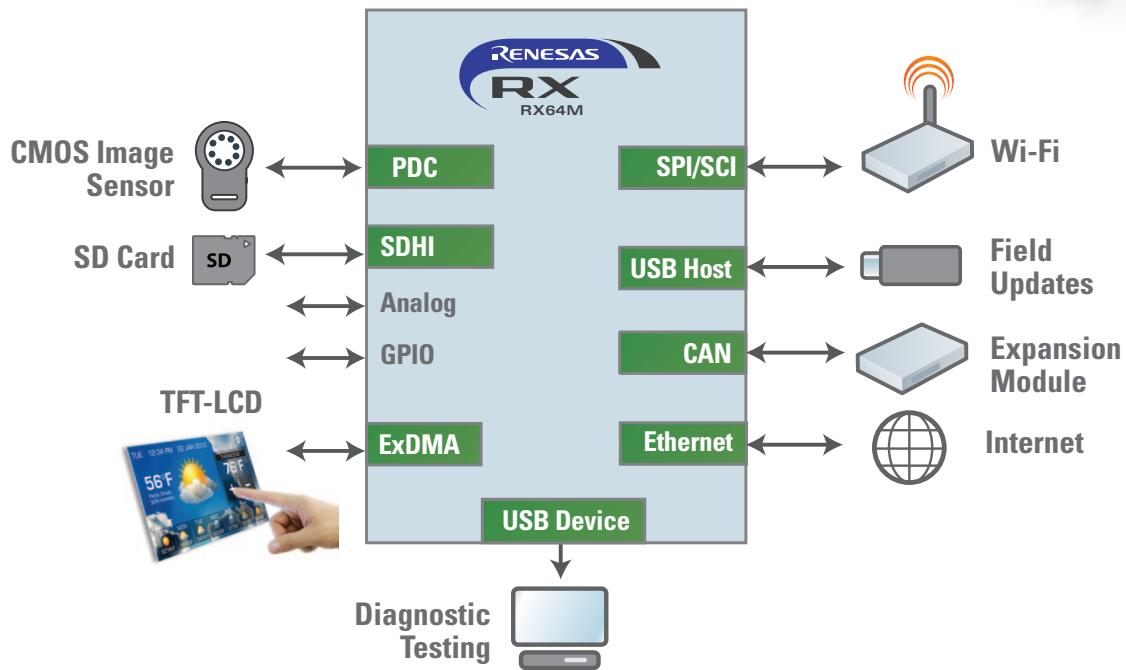
- Vector control of BLDC motors
- Four sensorless vector speed-control algorithms
- One position-control algorithm
- Easy parameter tracking using GUI
- 24V/4-pole BLDC motor
- Connector for user-supplied boards
- E1; Renesas Integrated Device Environment (IDE):  
Renesas compiler unlimited for 60 days;  
128 KB code size limit after 60 days



PN: YMCRPRX62T

# RX FOR CONNECTIVITY

RX MCUs provide built-in hardware for implementing efficient communications with external peripherals, systems, test equipment and networks such as the Internet. In particular, devices in two product groups excel for such applications: RX63N MCUs (100-MHz RXv1 core) and RX64M MCUs (120-MHz RXv2 core). RX63N chips serve mainstream systems, while RX64M MCUs provide the additional connectivity features, more memory and extra functions essential for top-end products.



## RX63N Amazon Web Services (AWS) Kit

For designs that require 802.11n connectivity, ultra-low power and high performance

- RX63N MCU board with integrated debugger
- Ethernet port
- LCD display
- 3-Axis accelerometer, temperature sensor
- MEMS microphone and class-D audio amplifier



**Micrium**<sup>®</sup>  
Embedded Software

PN: YRDKRX63N-AWS

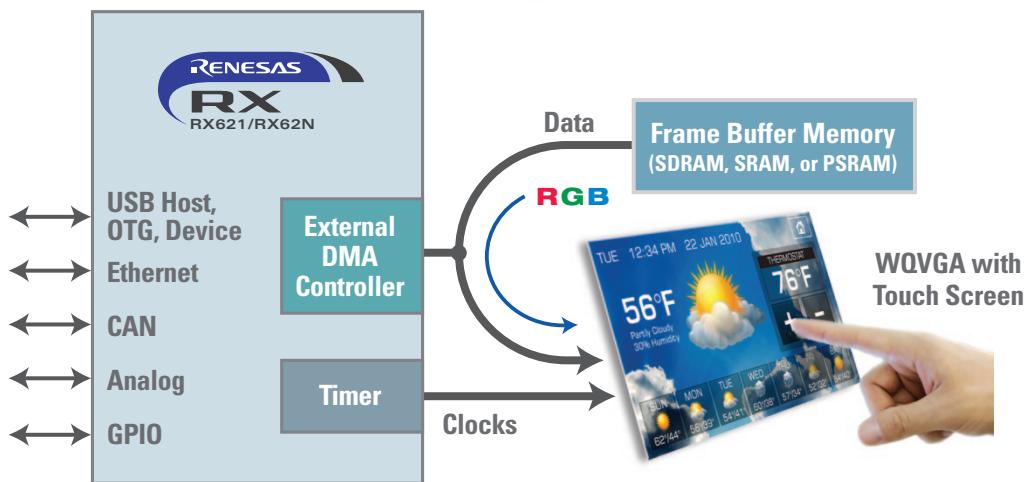
# RX FOR GRAPHICS

The external DMA controller integrated into RX devices can drive a TFT-LCD panel directly, greatly reducing the load on the MCU's CPU; thus, maximizing the performance of application software.



## External DMA Controller

- Directly drive a TFT-LCD panel
- RGB pixel data moves directly from frame buffer to the TFT-LCD and never enters the RX MCU
- RX CPU is loaded only 5%, while refreshing at 60Hz
- Plenty of CPU bandwidth remains to run the application, communication channels, and create moderate animation on the TFT-LCD



## RX Embedded GUI Kit

**A quick and easy solution to add color TFT-LCD to your design**

- RX63N with DDLCD technology
- Color TFT-LCD with touchscreen
  - 4.3" WQVGA (480x272)
- Supports multiple GUI software platforms
  - Micrium µC/GUI
  - Serious Integrated SHIPtide
  - Renesas GAPI
- J-Link Lite RX debugger included
- Pre-loaded demo software



PN: YLCDRX63N

# GET UP AND RUNNING WITH THE RX ECOSYSTEM

## Renesas Starter Kit (RSK)

Renesas Starter Kits (RSK) facilitate in-depth MCU experimentation and allow system design development

- This complete RX600-based hardware/software platform for in-depth application design includes the E1 Debugger, a trial version of the Renesas IDE, and demonstration firmware.

MCU	RSK Part Number
RX610	R0K556100S000BE
RX62N	R0K5562N0S000BE
RX62T	R0K5562T0S000BE
RX630	R0K505630S000BE
RX63N	R0K50563NS000BE
RX64M	YR0K50564MS000BE
RX71M	YR0K50571MS000BE



## APPLICATION DEVELOPMENT TOOLS

RX MCUs are supported by a comprehensive set of popular Renesas hardware and software tools that have been widely praised for their capabilities and ease of use. Additional support is provided by a dedicated community of third-party experts offering many helpful, time-saving products and services, including the IAR EW RX development environment and optimized compilers from IAR and CyberTHOR Studios Ltd.



[www.iar.com/ewrx](http://www.iar.com/ewrx)



[www.gnu.org/software/gnutools/](http://www.gnu.org/software/gnutools/)

## COMPLETE DEBUGGING, EMULATION, AND PROGRAMMING

On-chip debugging of an RX-based application is performed via JTAG connection to the target and USB connection to the Windows-based IDE. E1 and J-Link offer thorough CPU control and visibility. E20 adds high-speed tracing.



Renesas E2 Lite  
RTE0T0002LKCE00000R



Renesas E1  
R0E000010KCE00



Renesas E20  
R0E000200KCT00

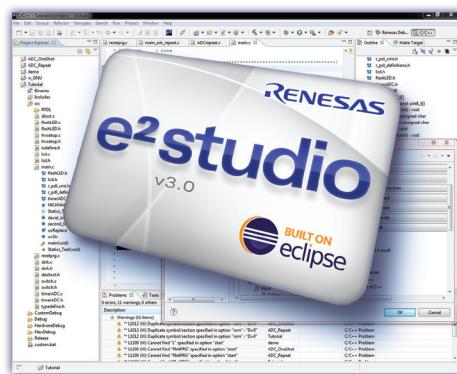
## E2 STUDIO: A COMPLETE INTEGRATED DEVELOPMENT ENVIRONMENT (IDE)

e<sup>2</sup> studio is a development and debug environment from Renesas based on the popular Eclipse platform. It can be combined with either the free KPI T GNURX toolchain or the RX toolchains from Renesas and IAR, which require a commercial license. Evaluation versions of the Renesas and IAR toolchains are available.

Full versions can be purchased from Renesas and IAR, respectively. The e<sup>2</sup> studio IDE itself is free of charge and includes free technical support from Renesas.

- Free Eclipse-based IDE with free support from Renesas
- Powerful code editing and code navigation features
- Project generation wizard
- Supports Renesas, IAR, and GNU compilers
- Advanced debug features like real-time memory view, IO Register view, complex breakpoints, and trace
- Complete installer or separate plug-ins

Renesas RX toolchain  
single-user license  
bundled with e<sup>2</sup> studio IDE:  
YRX2-E2STUDIO-1U

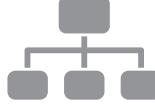


[am.renesas.com/e2studio](http://am.renesas.com/e2studio)

# SUPPORT SOFTWARE

## RENESAS SOFTWARE SOLUTIONS

Renesas offers a wide variety of free sample code and libraries supporting applications such as Ethernet, USB, CAN, DSP, motor control, audio and graphics. Renesas also provides the Renesas Peripheral Driver Library (RPDL) and the Peripheral Driver Generator (PDG) free of charge. Here is a sampling of our software solutions. For a complete list, visit: [am.renesas.com/softwarelibrary](http://am.renesas.com/softwarelibrary).

<b>Connectivity</b>	<b>Graphics</b>	<b>File System</b>	<b>Numerical</b>	<b>Sound/Audio</b>
<ul style="list-style-type: none"> <li>■ TCP/IP</li> <li>■ USB</li> <li>■ CAN API</li> </ul> 	<ul style="list-style-type: none"> <li>■ Graphics and GUI Libraries</li> <li>■ JPEG</li> </ul> 	<ul style="list-style-type: none"> <li>■ TFS</li> <li>■ FAT12</li> <li>■ SD Simplified</li> </ul> 	<ul style="list-style-type: none"> <li>■ FAT16</li> <li>■ MMS</li> </ul> 	<ul style="list-style-type: none"> <li>■ ADPCM</li> </ul> 
<b>Motor Control</b>	<b>Security</b>	<b>Safety</b>	<b>Peripherals</b>	<b>Programming</b>
<ul style="list-style-type: none"> <li>■ Sensorless Vector Control</li> <li>■ Position Control</li> <li>■ SPWM</li> </ul> 	<ul style="list-style-type: none"> <li>■ DES</li> <li>■ AES 128/256</li> </ul> 	<ul style="list-style-type: none"> <li>■ IEC 607030 Library</li> </ul> 	<ul style="list-style-type: none"> <li>■ Peripheral Driver Generator</li> <li>■ Peripheral Driver Library</li> </ul> 	<ul style="list-style-type: none"> <li>■ Flash API</li> <li>■ Flash over CAN</li> <li>■ Flash via UART</li> <li>■ Data Flash Drivers</li> </ul> 

## THIRD-PARTY RTOS AND MIDDLEWARE

RX600 devices are well suited for embedded real time tasks and high computation, as well as simultaneous data transfers on many high-speed communication channels. Because of this, communication middleware and Real-Time Operating Systems (RTOS) are commonly needed. Renesas has established technology partnerships with many leading independent suppliers to provide high-quality, cost-effective solutions.

Middleware	TCP/IP	■	■	■	■	■	■
RTOS	CMX-RTX	ThreadX	FreeRTOS	μEZ (based on FreeRTOS)	μC/OS-III (MPU support available)	Unison	embOS
Middleware							
TCP/IP	■	■	■	■	■	■	■
USB	■	■			■	■	■
CAN					■	■	
Graphics					■		■
File System	■	■		■	■	■	■

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