RENESAS

Solutions for a Myriad of Applications
R8C Microcontrollers

RENESAS R8C

Industrial Control

Automotive

Motor Control

Building Automation

R8C

Medical

Consumer

Home Appliances

Networking Systems

Renesas Electronics America
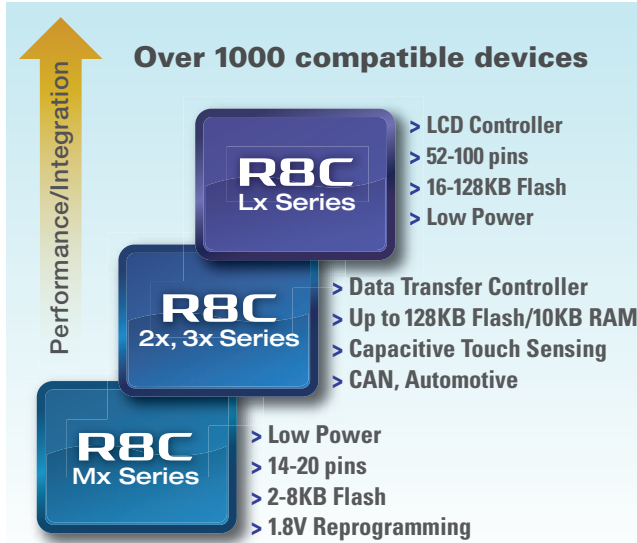www.am.renesas.com

R8C Family System Solutions

By combining advanced design methodologies, proven manufacturing processes and efficient testing techniques, R8C MCUs deliver great performance, innovative features and superior quality.

The wide range of features simplifies the task of finding robust, economical solutions for 8-bit embedded-system applications. The R8C/Mx series is the entry lineup, offering devices with as few as 14 pins and 2KB of Flash memory.

The MCUs in the R8C/2x and R8C/3x series cover virtually an unlimited number of applications. The expanded feature sets of the R8C/Lx series include an LCD controller for enhanced user interface capability. Full peripheral compatibility is maintained through the family to allow system variations to be designed with minimum effort.

am.renesas.com/r8c

Over 1000 compatible devices

Performance/Integration

R8C Lx Series
> LCD Controller
> 52-100 pins
> 16-128KB Flash
> Low Power

R8C 2x, 3x Series
> Data Transfer Controller
> Up to 128KB Flash/10KB RAM
> Capacitive Touch Sensing
> CAN, Automotive

R8C Mx Series
> Low Power
> 14-20 pins
> 2-8KB Flash
> 1.8V Reprogramming

Key Features

> 16-bit CPU with multiplier
> Data transfer controller
> Background operation flash
> Hardware-assisted touch sensing
> On-board LCD controller
> Accurate 40MHz oscillator
> Advanced debugging unit
> Dedicated safety controls
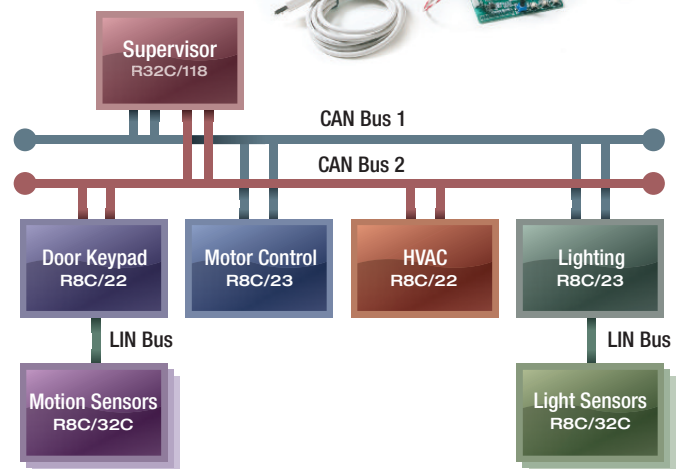> Settable input level threshold
> Direct LED drive

Adding Reliability to Connected Systems

R8C products incorporate Local Interconnect Network (LIN) hardware, providing a low-cost and reliable communication channel. This dedicated LIN hardware supports advanced functions such as synchronization field measurement and bus collision detection. For systems requiring higher transfer speeds and advanced error detection, R8C devices are available with Control Area Network (CAN 2.0B) hardware.

CAN/LIN KIT (P/N: RCDK8C)
> Two R8C target boards
> E8/E8a emulator and HEW
> CAN analyzer
> CAN and LIN drivers/API

Supervisor
R32C/118

CAN Bus 1

CAN Bus 2

Door Keypad
R8C/22

Motor Control
R8C/23

HVAC
R8C/22

Lighting
R8C/23

LIN Bus

LIN Bus

Motion Sensors
R8C/32C

Light Sensors
R8C/32C

Increasing Motor System Efficiency

Some R8C MCUs have advanced features for implementing different algorithms for controlling electric motors. Timers operate at up to 40MHz and support up to 6-ch complementary PWMs with independent registers, programmable dead-time control, selectable buffer operation and PWM signal shut-off.
A 2.15µs A/D conversion time and optimized CPU operation allow precise motor control.
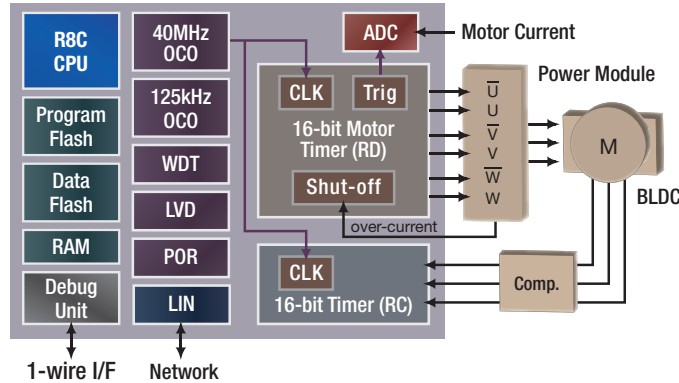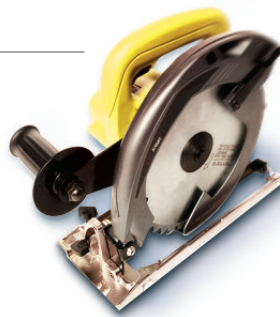
> R8C-based BLDC board
> 24V BLDC motor
> PC-based BLDC GUI
> Various BLDC control algorithms
> E8/E8a emulator and HEW

Enhanced Human-Machine Interfaces

R8C/3xT microcontrollers combine a low-noise capacitive touch key sensing capability with the processing power and peripheral integration to deliver rich user interfaces and system control functionality in a single chip.

> Keys, wheel and slider interfaces
> MCU power consumption measurement
> Workbench touch tuning tool
> Touch API source code and application notes
> E8a debug emulator and
> Full-featured 64KB C compiler

Specialized Touch Hardware (SCU)

> Full scanning and processing with less than 15% CPU utilization
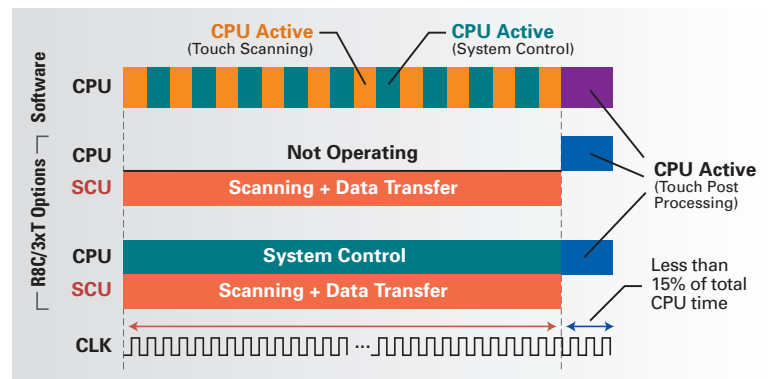
Low Power Consumption

> Sub 16µA (average) during touch detection

Low System Cost

> Only two capacitors and one resistor for touch sensing

Flexible and Easy

> Optimized API in source code, advanced touch tuning tool

> **SCU vs non-SCU**

R8C Family Features & Benefits

R8C MCUs have been widely adopted worldwide over the last five years for countless applications. Today, Renesas ships over five million R8C devices worldwide each month and is forecasting to double that in the next two years. The key reasons for this strong market position is the high level of reliability, performance, integration and competitive prices.
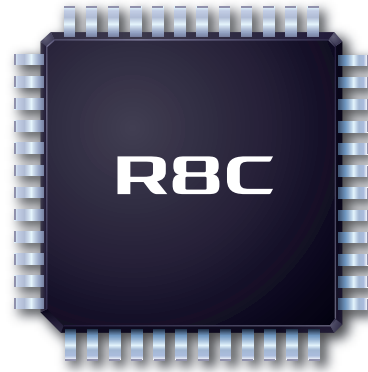
Scalable platform
– 14 to 100 pins
– 2 to 128 KB Flash

Short time-to-market
– Complete tool chain

Efficient
– Low power
– Flexible clocking

Powerful
– 16-bit CPU
– Single-cycle memory access

Quiet
– Low EMI and EMS

Versatile
– High integration
– Rich peripheral set

Robust Flash
– Secured
– Multiple programming modes

Reliable
– Numerous fail-safe features

Optimized CPU Core

The heart of all R8C MCUs is a powerful 16-bit CISC core with an instruction set engineered for optimum operation. Frequently-used instructions such as MOV, ADD and JMP are only one byte long to reduce code size, and powerful bit-, nibble- and string-based manipulation/transfer instructions are included to increase performance.

Direct clock-cycle operation: Allows the CPU to operate at a 1:1 ratio and at speeds up to 20MHz for high throughput.

On-chip hardware multiplier: Accelerates mathematical computations. For example, a 16x16-bit multiplication operation takes just five clock cycles.
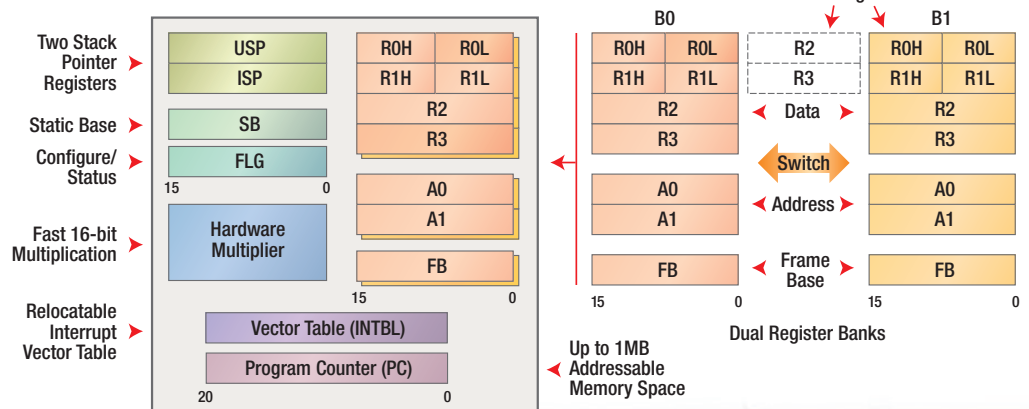
Dual register banks: Allows context switching for fast interrupt servicing. They consist of four 16-bit general-registers (also configurable in 8-bit and 32-bit lengths), Address registers and Base registers.

> *CPU Core*

Two Stack Pointer Registers — USP / ISP

Static Base — SB

Configure/Status — FLG

Fast 16-bit Multiplication — Hardware Multiplier

Relocatable Interrupt Vector Table — Vector Table (INTBL)

Program Counter (PC)

R0H R0L / R1H R1L / R2 / R3 / A0 / A1 / FB

32-bit Configuration

B0: R0H R0L / R1H R1L / R2 / R3 / A0 / A1 / FB

R2 / R3 — Data

B1: R0H R0L / R1H R1L / R2 / R3 / A0 / A1 / FB

Switch

Address / Frame Base

Dual Register Banks

Up to 1MB Addressable Memory Space

Quiet and Reliable

Excellent EMI and EMS Performance: Optimized chip layout design, I/O protection circuits and built-in filters to reduce noise.

Safety-Guard Features: Numerous safety features such as window watchdog timer with dedicated on-chip oscillator, external oscillator fail detection circuit and reset-source detection mechanism which are essential for UL1998 and IEC/UL 60730 compliance are available.

Full Compatibility

Compatibility is maintained throughout the R8C product line for easy design scalability. The same CPU and peripherals are used. Also, pin assignments and package options are carefully selected to aid in the design of versatile circuit board layouts.

> **Pin compatibility from 20- to 80-pin devices within the R8C/3x Series.**

> **Devices fit inside each other to allow multiple package footprints while maintaining non-crossing wiring connections.**

System Pins
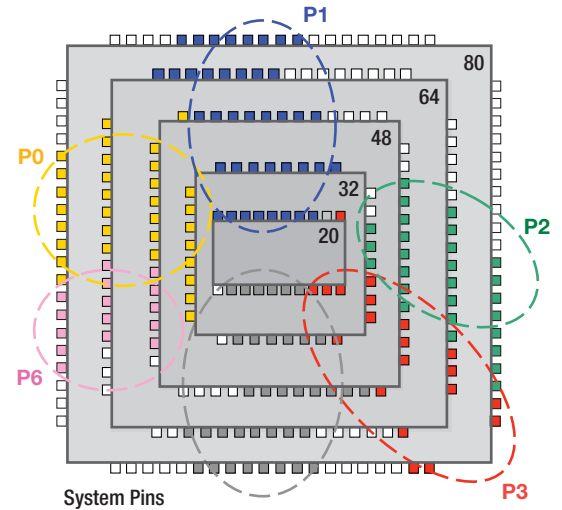
High Integration

Besides offering many Flash sizes (2KB to 128KB) and a broad selection of peripheral functions, R8C MCUs integrate key components that facilitate system optimization and reduce total BOM cost. Examples include the data flash, OCO, POR and LVD features highlighted below.

> **Data Flash with BGO**
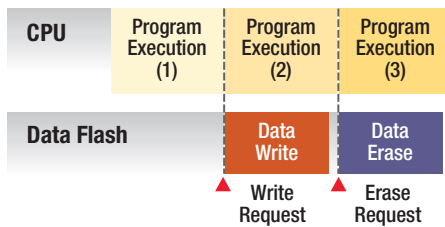
Data Flash: Special flash memory sectors are guaranteed to support a high number of erase cycles, thus eliminating the need for external EEPROM chips. The latest R8C devices also incorporate Background Operation (BGO) that allows erasing/writing of data flash while executing application code.
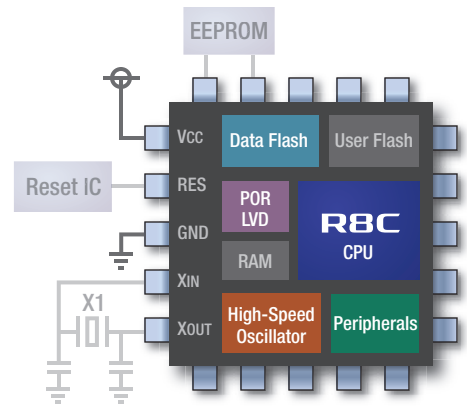
High-speed On-chip Oscillator (OCO): Factory-calibrated clock source guarantees high accuracy over operating temperature and voltage range. The R8C/3x and R8C/Lx Series include a 40MHz OCO with ±1.5% accuracy between -40°C to +85°C and 1.8V to 5.5V operation*. A 36.864MHz setting is also available for accurate baud-rate generation during asynchronous serial communication.
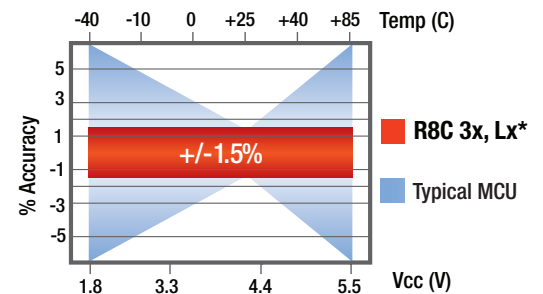
* Available in R8C/3xM and R8C/L3xM versions.

> **High Accuracy OCO**
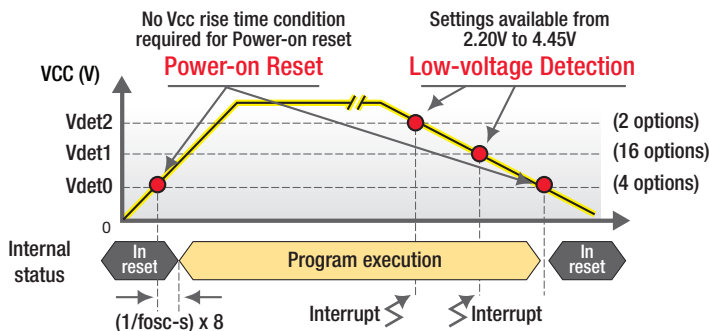
Power-on reset (POR) and Low-voltage detect (LVD): Specialized hardware helps to ensure optimal MCU operating conditions during power-up and undesired voltage supply fluctuations. The POR circuit in the latest R8C products does not require a specific Vcc rise time condition; thereby, reducing the complexity and cost of the power supply designs.

> **Advanced POR & LVD (R8C/3x and R8C/Lx)**

Advanced Features

The newest members of the R8C family have advanced features
that boost MCU functionality and performance.

Data Transfer Controller (DTC)

R8C/3x and R8C/Lx series devices
incorporate a DMA-like engine that
allows data transfers between memory
and peripherals without CPU interven-
tion, increasing overall performance
significantly. Data can be transferred
automatically within the first 64KB
of memory. The DTC is activated by
software control or by a peripheral
interrupt, allowing fast response.
A transfer is defined in a "Control File"
(i.e., a channel) located in RAM.
A maximum of 24 channels can be set
up in the MCU. Each transfer can
consist of up to 256 bytes and can occur
up to 256 times in normal or repeat mode.
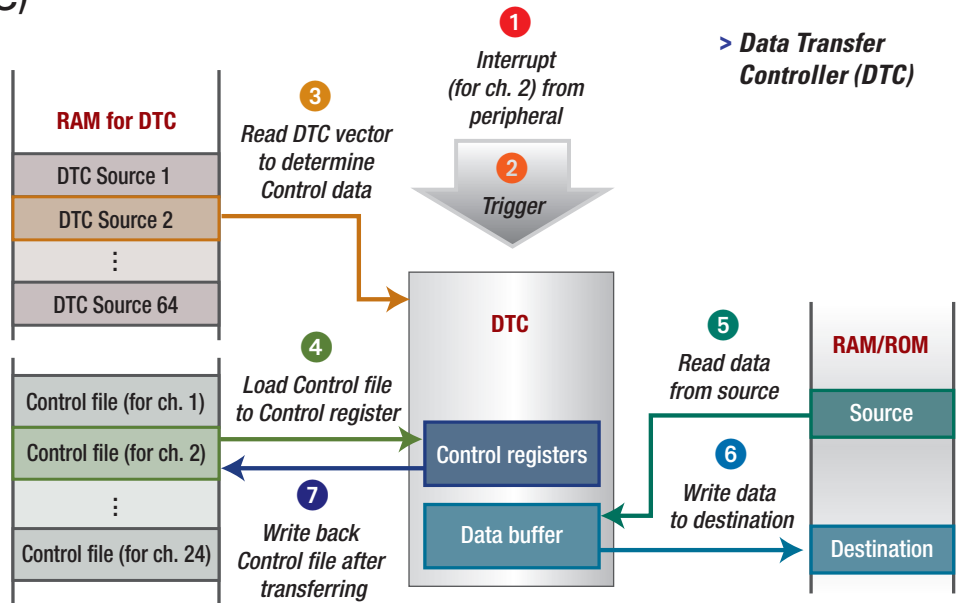
> *Data Transfer Controller (DTC)*

LCD Controller

MCUs in the R8C/Lx series support a maximum of 56 segment and
8 common lines, for a total of up to 416 LCD pixels. Segment- and dot-
matrix type LCDs can be connected directly to the MCU. These devices
can be used to drive 3V and 5V LCD glass in 1/2, 1/3 and 1/4 bias
configurations and generate the drive voltage internally.
A hardware-based blink function is available for
each pixel independently, a capability that
greatly reduces software overhead.
Contents to be displayed are stored in a
dedicated LCD RAM area, allowing fast display updates and
enabling maximum use of the general-purpose RAM for other
application tasks. All SEG and COM lines are multiplexed
with GPIO functions to optimize pin usage.
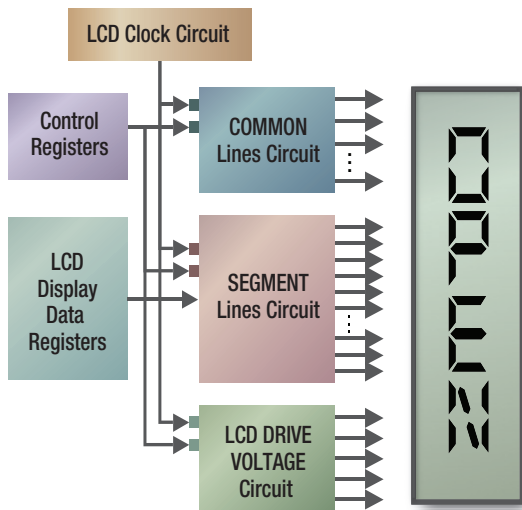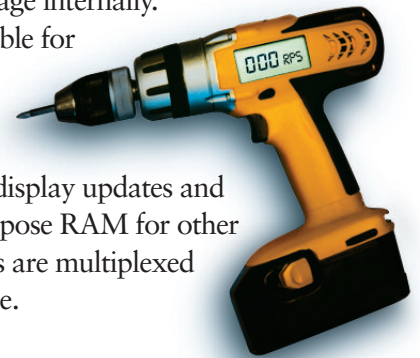
> *Advanced LCD Controller*

Innovative I/O Structure

Drive Capability Option: Any GPIO pin can be configured for
high-current drive.

Settable Input Level Threshold: Voltage levels (VIH and VIL) of
input ports can be software configured independently as $0.35V_{cc}$,
$0.50V_{cc}$ or $0.70V_{cc}$ for easy IC interface or noise filtering.

Output Level Read: The actual output state (High or Low) of any
output port can be read internally to the MCU.
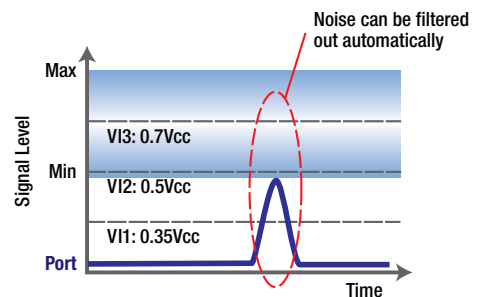
> *Selectable VIH/VIL Levels*

Middleware Library Protection

Each flash memory block (Data or Program area) can be locked independently under software control, allowing safe storage of middleware and preventing undesired reprogramming. In addition, contents of flash memory can be protected from intentional read-out when connected to programming equipment via serial or parallel interface.
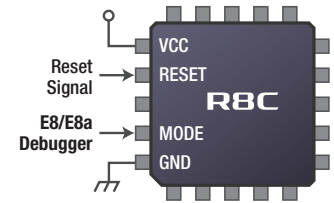
Advanced On-chip Debug Function

A one-wire interface implemented with specialized hardware provides trace, hardware breakpoint and real-time memory-modification capabilities.

R8C Family Selection Chart

am.renesas.com/r8c

RENESAS R8C

R8C MCUs recommended for new designs (shortened list)

Visit our website and search for R8C – Find a complete list of available products and detailed MCU specifications; download documentation and tool information; and access many other free resources for device evaluation and system design.

R8C Group*	Flash (Kbytes)	RAM (Kbytes)	Data Flash Option	BGO and DTC	Vcc	Max MHz	32 kHz Sub Clock	SCU ch	8-bit timers	16-bit timers	A/D ch	Comparators ch	D/A ch	Serial (sync/async)	Hardware LIN ch	CAN	LCD SEG/COM Lines (Max.)	Pin Count (GPIO)	Starter Kit	Example Application
R8C/Mx Series																				
R8C/M11A	2-8	0.25-.05	Y	–	1.8-5.5	20	–	–	1	2	5	1	–	1	–	–	–	14 (11)	R0K502M12S000BE	GP, IN, AP
R8C/M12A	2-8	0.25-.05	Y	–	1.8-5.5	20	–	–	1	2	6	2	–	1	–	–	–	20 (17)	R0K502M12S000BE	GP, IN, AP
R8C/2x Series																				
R8C/22-23	32-128	2-6	Y	–	2.7-5.5	20	–	–	3	2	12	–	–	3	1	Y	–	48 (44)	R0K521237S001BE	IN, AU
R8C/26-27	16-32	1-1.5	Y	–	2.7-5.5	16	–	–	3	1	12	–	–	3	1	–	–	32 (28)	R0K521276S001BE	AU
R8C/3x Series																				
R8C/33T	16-32	1.5-2.5	Y	Y	1.8-5.5	20	–	18	2	1	12	–	–	3	1	–	–	32 (28)	YR8C33TKIT01	GP, IN, AP
R8C/3JT	16-32	1.5-2.5	Y	Y	1.8-5.5	20	–	22	2	1	12	–	–	2	1	–	–	40 (32)	YR8C33TKIT01	GP, IN, AP
R8C/32C	4-16	0.5-1.5	Y	Y	1.8-5.5	20	Y	–	3	1	4	2	–	3	1	–	–	20 (16)	R0K521350S000BE	GP, IN, AP
R8C/3GC	8-32	1-2.5	Y	Y	1.8-5.5	20	Y	–	3	1	8	2	2	3	1	–	–	24 (20)	R0K521350S000BE	CP
R8C/33C	4-32	0.5-2.5	Y	Y	1.8-5.5	20	Y	–	3	1	12	2	2	4	1	–	–	32 (28)	R0K521350S000BE	GP, IN, AP
R8C/3JC	8-32	1-2.5	Y	Y	1.8-5.5	20	Y	–	3	3	10	2	2	4	1	–	–	36 (32)	R0K521350S000BE	MC, IN, AP
R8C/34C	16-32	1.5-2.5	Y	Y	1.8-5.5	20	Y	–	3	3	12	2	2	4	1	–	–	48 (44)	R0K521350S000BE	MC, IN, AP
R8C/34Y-Z	32-128	2.5-10	Y	Y	2.7-5.5	20	–	–	3	3	12	–	–	4	1	–	–	48 (44)	Contact Renesas	AU
R8C/34W-X	32-128	2.5-10	Y	Y	2.7-5.5	20	–	–	3	3	12	–	–	4	1	Y	–	48 (44)	Contact Renesas	AU
R8C/35C	16-128	1.5-10	Y	Y	1.8-5.5	20	Y	–	3	3	12	2	2	4	1	–	–	52 (48)	R0K521350S000BE	MC, IN, AP
R8C/36C	16-128	1.5-10	Y	Y	1.8-5.5	20	Y	–	3	4	12	2	2	4	1	–	–	64 (60)	R0K521380S000BE	MC, IN, AP
R8C/36Y-Z	32-128	2.5-10	Y	Y	2.7-5.5	20	–	–	4	4	16	–	–	4	2	–	–	64 (60)	Contact Renesas	AU
R8C/36W-X	32-128	2.5-10	Y	Y	2.7-5.5	20	–	–	4	4	16	–	–	4	2	Y	–	64 (60)	Contact Renesas	AU
R8C/38C	32-128	2.5-10	Y	Y	1.8-5.5	20	Y	–	3	5	20	2	2	4	1	–	–	80 (76)	R0K521380S000BE	MC, IN, AP
R8C/38Y-Z	64-128	6-10	Y	Y	2.7-5.5	20	–	–	4	5	20	–	–	4	2	–	–	80 (76)	Contact Renesas	AU
R8C/38W-X	64-128	6-10	Y	Y	2.7-5.5	20	–	–	4	5	20	–	–	4	2	Y	–	80 (76)	Contact Renesas	AU
R8C/Lx Series																				
R8C/LA6A	16-64	2-3.5	Y	–	1.8-5.5	20	Y	–	3	3	8	2	–	1	–	–	32/4	64 (56)	R0K502LA8S000BE	CP, IN, AP
R8C/LA8A	16-64	2-3.5	Y	–	1.8-5.5	20	Y	–	3	4	12	2	–	2	–	–	40/4	80 (72)	R0K502LA8S000BE	CP, IN, AP
R8C/L35C	48-128	6-10	Y	Y	1.8-5.5	20	Y	–	3	4	12	2	2	4	1	–	24/4	52 (41)	R0K52L3A0S000BE	CP, IN, AP
R8C/L36C	48-128	6-10	Y	Y	1.8-5.5	20	Y	–	3	4	12	2	2	4	1	–	32/8	64 (52)	R0K52L3A0S000BE	CP, IN, AP
R8C/L38C	48-128	6-10	Y	Y	1.8-5.5	20	Y	–	3	4	16	2	2	4	1	–	48/8	80 (68)	R0K52L3A0S000BE	CP, IN, AP
R8C/L3AC	48-128	6-10	Y	Y	1.8-5.5	20	Y	–	3	4	20	2	2	4	1	–	56/8	100 (88)	R0K52L3A0S000BE	CP, IN, AP

Contact Renesas for details and availability

APPLICATION SECTOR:
AP: Appliance
AU: Automotive
CP: Consumer
GP: General Purpose
IN: Industrial
LC: Lighting Control
MC: Motor Control

FUNCTION:
BGO: Background Operation
DTC: Data Transfer Controller
OCO: On-chip Oscillator
CAN: Control Area Network
LIN: Local Interconnect Network
LVD: Low Voltage Detect
EMI: Electromagnetic Interference
EMS: Electromagnetic Susceptibility
POR: Power-On Reset
THD: Total Harmonic Distortion
WDT: Watchdog Timer
SCU: Sensor Control Unit

Renesas Development Environment

I/O Wizard: Code builder for R8C MCUs. Get a quick start on peripheral evaluation with Renesas' free graphical initialization-code creator. Download the application and tutorials: **am.renesas.com/IOWizard**
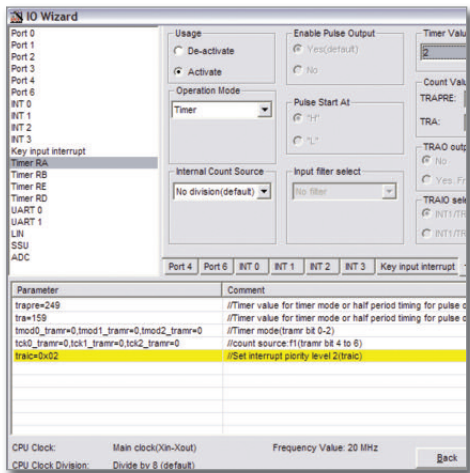
HEW 4: The Renesas High-performance Embedded Workshop integrates everything you need to build and debug your embedded applications in a single flexible easy-to-use environment.

Project Manager
– Graphical control of compiler/linker options
– Function browser
– Drag and drop code templates
– Built-in (or external) project make

Output Window
– Shows messages from build and find-in-files
– Linked to source in editor
– Version-control log

Built-in Editor
– Syntax sensitive coloring
– Multiple files open at once
– Source-level debugging

Full Bus Trace
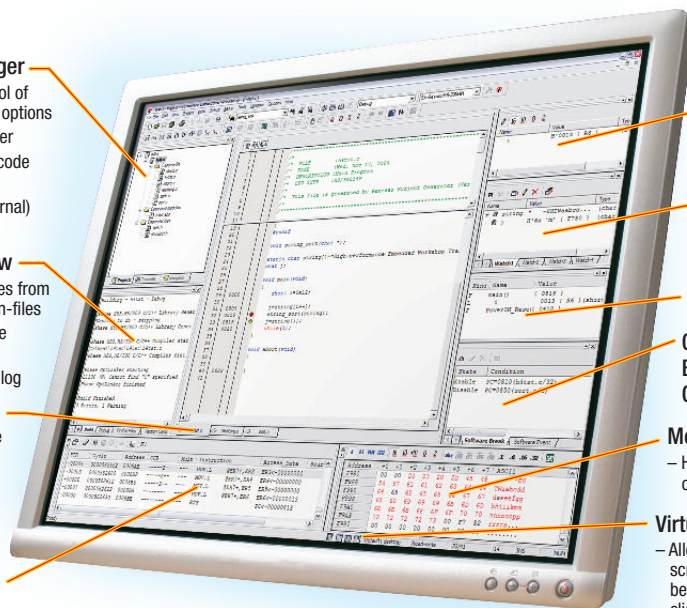
Local Variable Watch

C/C++ Variable Watch

Stack Trace

Complex Break Conditions

Memory View
– Highlights changed values

Virtual Desktop
– Allows multiple screen layouts to be recalled at the click of a button

Renesas Starter Kits (RSKs): These low-cost evaluation/ development bundles include:

> R8C target board for specific device group
> On-chip debug emulator that utilizes the R8C MCU's 1-wire interface for debugging and programming
> Free HEW and C compiler for ≤64KB code build (more capability can be purchased)
> Project generator with tutorials and peripheral sample code

Full-function In-circuit Emulator (ICE): The E100 next-generation emulation system provides flexible, advanced debugging capabilities such as complex hardware break events, extensive bus trace, performance measurement and code analysis.

> **E100 In-circuit Emulator**

The Renesas Ecosystem

ALLIANCE PARTNER RENESAS
> *Consultant and tool vendor network*
am.renesas.com/Alliance

RENESAS UNIVERSITY PROGRAM
> *University program*
RenesasUniversity.com

Renesas INTERACTIVE
> *Online training*
RenesasInteractive.com

RenesasRulz.com
Think it. Build it. Post it.

My Renesas
> *Customized updates*
am.renesas.com/MyRenesas

Software Library – *Free SW*
am.renesas.com/softwarelibrary

Free Samples
am.renesas.com/samples

Technical Support
am.renesas.com/tech_support

Renesas Electronics America Inc. | 2880 Scott Boulevard, Santa Clara, CA 95050-2554 | Phone: 1 (408) 588-6000, Literature/technical support: 1 (800) 366-9782 | **www.am.renesas.com**

RENESAS

Printed on Recycled Paper   1010/3K/VIP/BCD/SP   Document No.: 51162