RZ/A1 Embedded ARM® Microprocessors
The Right Choice for HMI Designs
The RZ Family of ARM-based High-Performance MPUs
Innovative Architecture & Advanced Integration

Renesas RZ/A1 series microprocessors (MPUs) offer an innovative architecture based on the ARM Cortex®-A9 processor and up to an industry-leading 10MB of on-chip memory. RZ/A1 MPUs can execute code at 1000 DMIPS from the abundant on-chip memory or in-place from inexpensive QSPI memory, while using on-chip memory for graphics buffering up to WXGA (1280x800) resolution. The 128-bit wide internal memory bus with x4 parallel access enables higher-throughput memory access as compared to systems with external DDR memory. The RZ/A1 series offers enormous advantages in terms of BOM cost, performance, power consumption, and system design time, making it the right choice for HMI (Human Machine Interface) and other system-on-chip applications.

- Remove the need for external DRAM
- Execute code from on-chip RAM or in-place from inexpensive serial flash memory
- Choose from three sizes of on-chip RAM: 3MB (RZ/A1L), 5MB (RZ/A1M), and 10MB (RZ/A1H)

Renesas RZ/A1 solution streamlines board design and reduces BOM cost

**Conventional Solution**
- Complicated power-management and PCB layout
- Memory bandwidth split between code and graphics

**Renesas RZ/A1 HMI Solution**
- Easy system design and testing

<table>
<thead>
<tr>
<th>BOM Component</th>
<th>Conventional Solution</th>
<th>RZ/A1 Solution</th>
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<tbody>
<tr>
<td>Flash</td>
<td>$$$ (NOR Flash)</td>
<td>$ (SPI Flash)</td>
</tr>
<tr>
<td>RAM</td>
<td>$$$ (DDR2)</td>
<td>n/a (internal)</td>
</tr>
<tr>
<td>Regulators</td>
<td>$$$ (5-7 PMIC channels)</td>
<td>$ (3.3V, 1.2V regulator)</td>
</tr>
<tr>
<td>PCB layers</td>
<td>$$$ (DDR2 supplies, routing)</td>
<td>$ (as few as two)</td>
</tr>
<tr>
<td>Total BOM cost</td>
<td>$$$</td>
<td>$</td>
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</tbody>
</table>
Create Superior HMI Designs with Fewer Components

On-chip functions provided by RZ/A1 MPUs reduce BOM cost, save board space and minimize integration tasks. Typical applications like the one shown below take advantage of a rich portfolio of intellectual property from Renesas and can utilize a range of built-in peripherals, including: CMOS camera interface, JPEG Codec Unit, 12-bit ADC, and OpenVG 2D graphics engine, among others.

RZ/A1 Series System Diagram

**Features**

- **Up to 10MB on-chip RAM**
  - For code execution/data buffering
- **128-bit memory bus**
  - With parallel (x4) access to deliver superior memory throughput
- **Execute-In-Place (XIP) from inexpensive QSPI memory**
  - With three layers of cache
- **LCD controller to drive up to two independent WXGA displays**
  - For vivid displays

**Benefits**

- **Lower BOM Cost**
  - No external SDRAM or LCD controller
  - Simpler voltage regulators
  - Reduced PCB layers
- **Increased Performance**
  - 1000 DMIPS at 400MHz
  - 6x throughput of 333MHz 16-bit DDR2
- **Decreased Power Consumption**
  - Fewer board components
  - No copying of code from flash to RAM
- **Accelerate Time to Market**
  - Simpler PCB design
  - Decreased EMI via reduced switching
  - No DDR procurement issues

One RZ/A1 MPU can accommodate entire software stack (libraries, operating system and application code) plus graphics frame buffer.
RZ/A1L MPUs

Ideal Solutions for Cost-Sensitive Designs (up to WSVGA Resolution)

- Buffer up to WSVGA (1024x600) images in internal memory
- Accelerate multimedia processing with ARM NEON™ SIMD (Single Instruction, Multiple Data) engine
- Connect to single LCD display

Highly Efficient 32-bit CPU Core (ARM Cortex-A9)

- 1000 DMIPS performance at 400MHz
- ARM NEON multimedia engine
- Boots from parallel or serial flash

3MB Internal RAM

- Use as large data buffer or to run system from internal memory
- Employs parallel bus structure dedicated to SRAM to speed processing

Execute-In-Place Operation from QSPI Flash

- Take full advantage of cost-effective external serial flash
- Simplifies program execution

Single- and Double-Precision Floating Point Unit, IEEE754 Compliant

- Accelerates trigonometric operations such as scaling and rotation

LCD Controller with 24-bit RGB Interface

- Handles 3-layer overlays
- Provides 1-ch video input, 1-ch display output
- Implements alpha blending
- Supports chroma keying

Bus Interface Controller

- Directly connects to SRAM, SDRAM, and flash (NOR, NAND, eMMC), as well as 128KB L2 cache

Display Resolutions Supported by RZ/A1 MPUs

<table>
<thead>
<tr>
<th>Display Resolutions Supported by RZ/A1 MPUs</th>
</tr>
</thead>
<tbody>
<tr>
<td>QVGA 320x240 16bpp</td>
</tr>
<tr>
<td>WQVGA 480x272 16bpp</td>
</tr>
<tr>
<td>VGA 640x480 32bpp</td>
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<tr>
<td>WVGA 800x480 32bpp</td>
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<tr>
<td>SVGA 800x600 32bpp</td>
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<tr>
<td>WSVGA 1024x600 32bpp</td>
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<tr>
<td>XGA 1024x768 32bpp</td>
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<tr>
<td>WXGA 1280x800 32bpp</td>
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</table>

<table>
<thead>
<tr>
<th>Number of Images in Frame Buffer</th>
<th>RZ/A1L</th>
<th>RZ/A1M</th>
<th>RZ/A1H</th>
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<tr>
<td>1</td>
<td>0.1 MB</td>
<td>0.2 MB</td>
<td>1.2 MB</td>
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<tr>
<td>2</td>
<td>0.3 MB</td>
<td>0.5 MB</td>
<td>2.3 MB</td>
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<tr>
<td>3</td>
<td>0.4 MB</td>
<td>0.7 MB</td>
<td>3.5 MB</td>
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<tr>
<td>4</td>
<td>0.6 MB</td>
<td>1.0 MB</td>
<td>4.7 MB</td>
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| Number of Images in Frame Buffer | 5.9 MB | 7.3 MB | 9.4 MB |

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<tr>
<th>Multiple Network Connectivity Interfaces</th>
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<tbody>
<tr>
<td>Integrates 10/100 EtherMAC controller (1 ch.)</td>
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<tr>
<td>Includes USB 2.0 host and function controller with integrated USB transceiver (2 ch.)</td>
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<tr>
<td>Offers up to 2 CAN channels</td>
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</tbody>
</table>

Three Package Options

- 208-pin QFP (0.5mm)
- 176-pin QFP (0.5mm)
- 176-pin BGA (0.5mm)
### RZ/A1H and RZ/A1M MPUs

**Best Choices for Higher-End HMI Designs**
(up to WXGA Resolution)

- Buffer up to two independent WXGA (1280x800) images with a single RZ/A1H MPU chip
- Buffer up to two WSVGA (1024x600) images or a single WXGA (1280x800) image with one RZ/A1M chip
- Utilize the on-chip OpenVG graphics engine for impressive 2D graphics acceleration
- Connect to one or two independent LCD displays
- Exploit additional peripherals, including: NAND Flash interface, JPEG Codec Unit, IMR engine, sound generator, NTSC/PAL decoder for video, and PWM timer

**Highly Efficient 32-bit CPU Core (ARM Cortex-A9)**
- 1000 DMIPS performance at 400MHz
- ARM NEON multimedia engine
- Boots from parallel or serial flash

**10MB (RZ/A1H) and 5MB (RZ/A1M) Internal RAM**
- Use as large data buffer or to run system from internal memory
- Employs parallel bus structure dedicated to SRAM to speed processing

**Execute-In-Place Operation from QSPI Flash**
- Take full advantage of cost-effective external serial flash
- Simplifies program execution

**Single- and Double-Precision Floating Point Unit, IEEE754 Compliant**
- Accelerates trigonometric operations such as scaling and rotation

**2D-Graphics Engine with OpenVG 1.1 Capability**
- Fully supports the Khronos™ OpenVG 1.1 API
- Offloads CPU for rendering, animation and video acceleration operations

**LCD Controller with 24-bit RGB and 16-bit LVDS Interfaces**
- Handles 4-layer overlays
- Provides 2-ch video input, 2-ch display output with 1-ch of LVDS
- Implements alpha blending
- Supports chroma keying

### Internal Memory

<table>
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<tr>
<th>SRAM</th>
<th>10MB, 5MB</th>
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<tbody>
<tr>
<td>L1 I-Cache</td>
<td>32KB</td>
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<tr>
<td>L1 D-Cache</td>
<td>32KB</td>
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<tr>
<td>L2 Cache</td>
<td>128KB</td>
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</table>

### External Memory Interface

- Bus State Controller
- SDRAM, NOR Flash
- NAND Flash I/F
- SPI Flash Interface
- SPI, Multi I/O, 2 ch
- MMC I/F
- SD Card Host Interface 3 channels
- CDROM Decoder

### System

- ADC 12-bit, 8 channels
- Encryption Engine (optional)
- Unique Customer ID (optional)
- Standby Modes Sleep/Software/Deep
- TAG
- Clock Generation with Spread Spectrum Clocking
- Interrupt Controller
- DMA 16 channels

### Communications

- USB 2.0 H/D 2 channels, High Speed
- SCI 10 channels
- I2C 4 channels
- SPI 5 channels
- QSPI 2 channels
- 10/100 Ethernet
- SSI (I2S) 6 channels
- SPDIF 1 channel
- IE Bus 1 channel
- CAN 5 channels
- LIN 2 channels

### Imaging

- CMOS Camera Imager Interface (Video In)
- LCD Controller Interface 2 channels RGB LVDS Video out
- OpenVG 1.1 2D Graphics Engine
- JPEG Codec Engine
- NTSC-LS
- IMR-LS
- NTSC/PAL Decoder

### Timers

- Motor Timer MTU2 16-bit x 5 channels
- OS Timer 32-bit 2 channels
- PWM Timer 10-bit 16 channels
- Real-Time Clock
- Watchdog Timer

### Miscellaneous

- Asynchronous Audio Sampling Rate Converter
- Sound Generator
- Display Output Compare
- IrDA

### Packages

- 324 BGA 19x19mm 0.8mm pitch
- 256 QFP 28x28mm 0.4mm pitch
- 256 BGA 11x11mm 0.5mm pitch
# Renesas RZ/A1 Device Selector

<table>
<thead>
<tr>
<th>Core Group</th>
<th>Part Number</th>
<th>Clock Speed</th>
<th>RAM</th>
<th>SPI / UARTs / I2C</th>
<th>CAN</th>
<th>USB</th>
<th>Ethernet</th>
<th>Timer Channels (8-bit / 16-bit / 24-bit)</th>
<th>PWM Outputs</th>
<th>I/O / A/D Converter</th>
<th>DMA</th>
<th>Supply Voltage</th>
<th>Packages / Pins</th>
<th>Other Features</th>
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<tbody>
<tr>
<td>RZ/A1H</td>
<td>R7S721000VLFP</td>
<td>400 MHz</td>
<td>10MB SRAM</td>
<td>5 ch / 8 ch / 4 ch</td>
<td>5 ch</td>
<td>2 ch</td>
<td>1 ch</td>
<td>1 ch / 5 ch / 2 ch</td>
<td>Yes</td>
<td>up to 2 ch WXGA (1280 x 800)</td>
<td>8 ch x 12-bit / –</td>
<td>16 ch</td>
<td>3.3V + 1.18V</td>
<td>QFP256</td>
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<td>ARM Cortex-A9</td>
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<td>RZ/A1L</td>
<td>R7S721020VLFP</td>
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<td>3MB SRAM</td>
<td>3 ch / 5 ch / 4 ch</td>
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<td>1 ch</td>
<td>1 ch / 5 ch / 2 ch</td>
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<td>up to 1 ch WSVGA (1024 x 600)</td>
<td>8 ch x 12-bit / –</td>
<td>16 ch</td>
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</table>

## Renesas RZ/A1 Packaging Options

<table>
<thead>
<tr>
<th></th>
<th>Part Number</th>
<th>TFT Display</th>
<th>Debugger</th>
</tr>
</thead>
<tbody>
<tr>
<td>RZ/A1H</td>
<td>YR0K77210S001BE</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>RZ/A1M</td>
<td>YR0K77210S003BE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>RZ/A1L</td>
<td>176-pin BGA 0.5 mm pitch 8 mm x 8 mm</td>
<td>176-pin QFP 0.5 mm pitch 24 mm x 24 mm</td>
<td>208-pin QFP 0.5 mm pitch 28 mm x 28 mm</td>
</tr>
</tbody>
</table>

## Renesas RZ/A1 Series Starter Kits

Shorten product development cycles with the Renesas Starter Kit (RSK). The RZ/A1 kit includes everything you need to jump-start your system development and ease the design and debug process.

The kit includes:
- 1024 x 800 touch panel for HMI development (optional)
- Segger JTAG-lite debugger
- Embedded IDE and compiler with evaluation license
- Sample code and peripheral drivers

![Renesas RZ/A1 Series Starter Kits](am.renesas.com/rskrza1)
Speed Up Your Development With the RZ/A1 Ecosystem

IAR Embedded Workbench®
- Integrated development environment and optimized C++ compiler for RZ MPUs
- Project management tools and editor
- Configuration files for all RZ devices
- Emulator debugger support
- Run-time libraries

ARM
- The ARM DS-5™ Development Studio, Renesas RZ Edition, is a complete software development environment for systems that use RZ/A1 MPUs.
- This IDE provides the DS-5’s code editor, compiler, debugger and performance analyzer. These tools seamlessly generate, debug and optimize code for the powerful ARM Cortex-A9 CPU built into RZ/A1 series chips.

Renesas e² studio
- Based on the popular Eclipse open-source environment
- Complete IDE supports IAR and free GNU compilers
- Powerful project management
- Download free at: am.renesas.com/e2studio

Green Hills Software
- Green Hills Software supports Renesas RZ/A1 MPUs with its MULTI® IDE, C/C++ optimizing compilers, Probe debugger, and many other development tools. These products let system engineers generate fast, compact code, quickly find and fix bugs, and make sense of complex systems.

RTOS

expresslogic
- ThreadX®
  www.expresslogic.com

Micrium
- μC/OS-III®
  www.micrium.com
  FreeRTOS
  www.freertos.com

KEIL
- Tools by ARM
  RTX
  www.keil.com

Linux
- Linux BSP
  oss.renesas.com
  embOS®
  www.segger.com

Graphical Packages

expresslogic
- GUIX™
  www.expresslogic.com

Crank software inc.
- Crank Storyboard™ Suite
  www.cranksoftware.com

Serious
- SHIPTide
  www.seriousintegrated.com

IS2T
- MicroEJ®
  www.is2t.com

altia
- DeepScreen®
  www.altia.com
Get on the RZ Express!

Fast track your next Renesas RZ/A1 design with Express Logic ThreadX® RTOS, middleware stack and more at no cost to you!

Renesas and Express Logic have teamed up to bring you the RZ Express promotion! This is a chance for qualified production customers of the Renesas RZ/A1 microprocessor (MPU) to apply for a single-product license of Express Logic ThreadX® real-time operating system (RTOS) and middleware stack at no cost. Customers who are chosen to receive this valuable single-product license free of charge will also enjoy free software support from Express Logic for 90 days. The RZ Express promotion is available for a limited time, so apply today!

See website for more details on this offer: renesas.com/rzexpress

RZ Express Benefits

- No royalties! No licensing fees!
- Speed your time to revenue with ThreadX by Express Logic
- Differentiate your product with RZ/A1 ARM® Cortex-A9 MPUs by Renesas
- Using the Express Logic RTOS and middleware, including GUIX™, enables designers to quickly and effectively build differentiated HMI solutions on top of the Renesas RZ/A1 hardware platform

Renesas Ecosystem

- The Alliance Partner Program allows you to connect instantly with hundreds of qualified design consulting and contracting professionals. am.renesas.com/Alliance
- A forum and community site to share technical information, questions and opinions with others who use Renesas MCUs and MPUs. www.RenesasRuiz.com
- Gain the technical knowledge you need. Evaluate, research and learn at your own pace, where you want, when you want, for free. www.RenesasInteractive.com
- For educators and students. Teach with professional grade tools. Learn MCUs with a modern architecture. www.RenesasUniversity.com
- Customize your data retrieval needs on the Renesas web site. You’ll receive updates on the products you’re interested in. 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

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