RZ/G2L & RZ/G2LC 64-bit MPUs Enable Entry-Level HMI with AI Inference Processing Features

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Abstract

64-bit MPUs equipped with Linux, or other high-performance OS in human-machine interface (HMI) products for industrial and building automation, are increasingly adopted in entry-level HMI devices, starting with high/middle-end products. Cloud integration, AI inference execution and other advanced functions are also being required for HMI devices. RZ/G2L and RZ/G2LC offer all the features necessary for resolving the challenges presented by the deployment and functional enhancement of entry-level HMI products.

Equipped with all the necessary HMI features

RZ/G2L and RZ/G2LC are equipped with all the functions required for entry-level HMI applications used in industrial and building automation.

- **Enhanced CPU performance in entry-level products**
  First use of the Cortex-A55 core in the RZ/G Series. Improved processing performance by 20% compared to conventional Cortex-A53 at the same frequency. Select a dual or single core device.
- **Image processing without heavy CPU load**
  Dedicated image processing hardware (video codec, graphics engine). Compresses/decompresses videos and handles graphics without imposing a load on the software.
- **Image input/output selectable per task**
  Supports MIPI-CSI and parallel interface for camera connections, MIPI-DSI and parallel interface for LCD panel connections. Enables user to select interface based on the task at hand: MIPI (generally used for high-resolution) or parallel interface (for low-res camera or LCD panel use).
- **Compatible with communication buses in industrial equipment**
  Industrial HMI is expected to provide both display functions and communication functions, ensuring connectivity with industrial equipment. The RZ/G2L and RZ/G2LC CAN (Controller Area Network), used as the industrial equipment communication bus, is equipped with two channels of CAN-FD (Flexible Data rate) that enable faster communications.
- **Scalable as an IoT device**
  Equipped with two channels of Gigabit Ethernet for use as a gateway to handle two networks in addition to HMI functions. The RZ/G Series is the first of its kind to provide two channels of Giga Ethernet.
- **Enhanced security functions**
  Protecting customer system with secure boot, trust zone, and secure debugging.

	RZ/G2L	RZ/G2LC
CPU	2x Cortex-A55@1.2GHz 1x Cortex-M33@200MHz L1$, L3$ parity/ECC	2x Cortex-A55@1.2GHz 1x Cortex-M33@200MHz L1$, L3$ parity/ECC
DRAM I/F	DDR3L/DDR4 x 16-bit (ECC)	DDR3L/DDR4 x 16-bit (ECC)
Video codec	Full HD resolution: H.254 codec	–
Graphics engine	Arm Mali-G31 GPU	Arm Mali-G31 GPU
Video input	1x MIPI CSI-2 or 1x Digital Parallel input	1x MIPI CSI-2

Video output	1x MIPI DSI or 1x Digital Parallel output	1x MIPI DSI
Security	Secure boot, TrustZone, Secure debugging	Secure boot, TrustZone, Secure debugging
Ethernet	2x GbE	1x GbE
Other peripheral functions	USB 2.0, SDHI, CAN-FD, ADC, etc	USB 2.0, SDHI, CAN-FD, etc
Package	• 456pin 15x15mm LFBGA(0.5mm pitch) • 551pin 21x21mm LFBGA(0.8mm pitch)	• 361pin 13x13mm LFBGA(0.5mm pitch)

Table 1. Functional Outline of RZ/G2L & RZ/G2LC Microprocessors

Accelerated AI Inference Execution Processing

In addition to HMI functions, RZ/G2L and RZ/G2LC offer the added value of advanced AI inference execution processing. Compared with the previous Cortex-A53, the Cortex-A55 core supports Int8 dot-product arithmetic operations which accelerate CNN (Convolutional Neural Network) processing, essential to edge-AI and other applications. The benchmark of more than 70 pre-built models tested confirms a three-fold improvement in AI processing performance compared to products using Cortex-A53. Use of RZ/G2L or RZ/G2LC enables the evaluation of AI inference execution that was once nearly impossible without a dedicated AI accelerator.

Table 2 summarizes the inference execution time for each AI model. The smaller the number, the faster the processing was completed.

Parser	Model	Format	RZ/G2L, RZ/G2LC 2x Cortex-A55(1.2GHz)	Conventional Product 2x Cortex-A53(1.0GHz)
TensorFlow Lite	inception_v4	float32	1867.36	2810.54
TensorFlow Lite	inception_v4_299_quant	uint8	593.99	1755.83
TensorFlow Lite	mobilenet_v1_1.0_224_quant	uint8	44.27	106.05
TensorFlow Lite	mobilenet_v1_1.0_224	float32	134.71	185.79

Table 2. ArmNN v21.02 Inference Execution Performance (ms)

Mechanisms for reducing system costs

RZ/G2L and RZ/G2LC are also equipped with various mechanisms that help achieve the low system costs normally expected of entry-level products. The MPUs feature integrated peripheral components, power supply for peripheral optimization, and a 4-layer board.

- **Embedded analog input components**
  The RZ/G Series is the first to incorporate a 12-bit ADC, while allowing direct connection of sensors with analog output to reduce costs for external components.
- **Built-in MCU**
  The RZ/G2L series MPUs are equipped with the Cortex-M33 core that runs at 200MHz. Cortex-M33 handles real-time processing that was previously carried out with an external MCU. This core also supports RTOS, allowing the user to build an RZ/G2L Linux platform with a multi-OS environment.
- **Optimized power source with dedicated PMIC**
  RAA215300, the dedicated PMIC (Power Management IC) for RZ/G2L and RZ/G2LC, optimizes the

layout design around the power supply, reduces the number of components and helps simplify the design. It also improves time-to-market.

- **Supports 4-layer PCB board**
  A 4-layer board platform for RZ/G2L can be realized using a DDR4-SDRAM and standard interfaces. The DDR signal wire in the 4-layer PCB design meets JEDEC standards, and board design time is greatly shortened by using the Renesas 4-layer PCB board reference design.

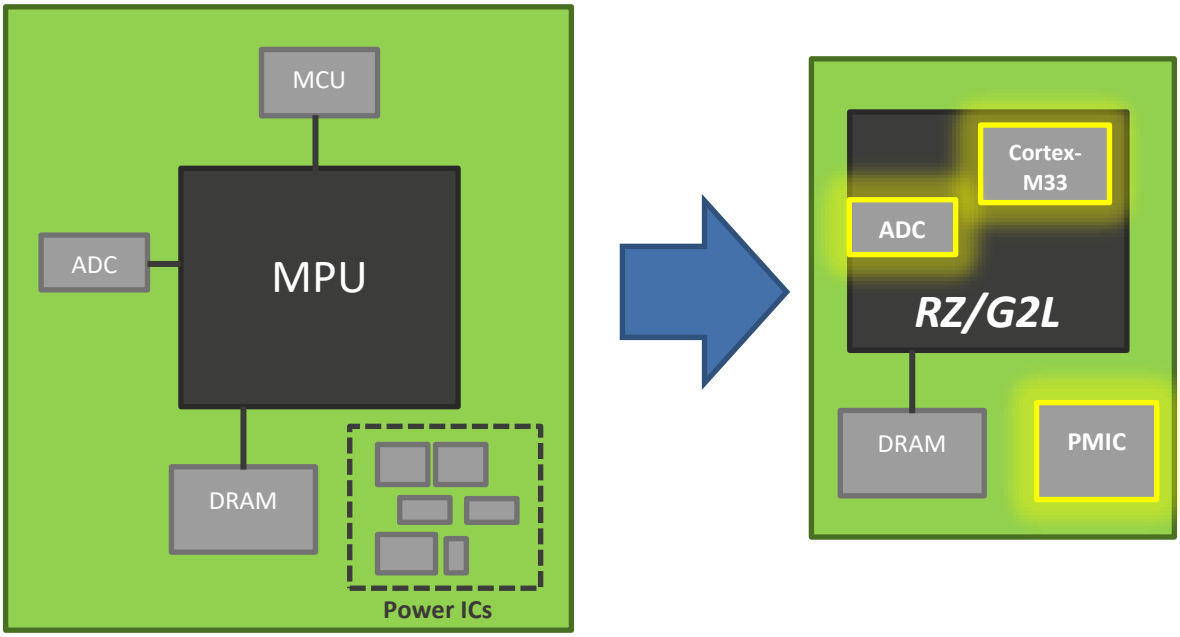

Figure 1. Peripheral Circuitry

Scalability enhances development efficiency

Compared to high/middle-end products, entry-level products boast a shorter development span and higher development efficiency. RZ/G2L and RZ/G2LC guarantee software and evaluation environment scalability, enabling faster customer product development.

- **Software Compatibility**
  RZ/G2LC is a replica of RZ/GL2 without the video codec or parallel IF, which makes its on-board IP common among all series products, with fully compatible software. RZ/V2L, a spinoff of RZ/G2L, comes with a built-in AI accelerator (DRP-AI) and is compatible with most software. In addition, pins are fully compatible, and products developed with RZ/G2L can be easily expanded to models with enhanced AI inference execution processing. Finally, the Renesas RZ/G2UL, a truly entry-level model MPU, also boasts software compatibility.

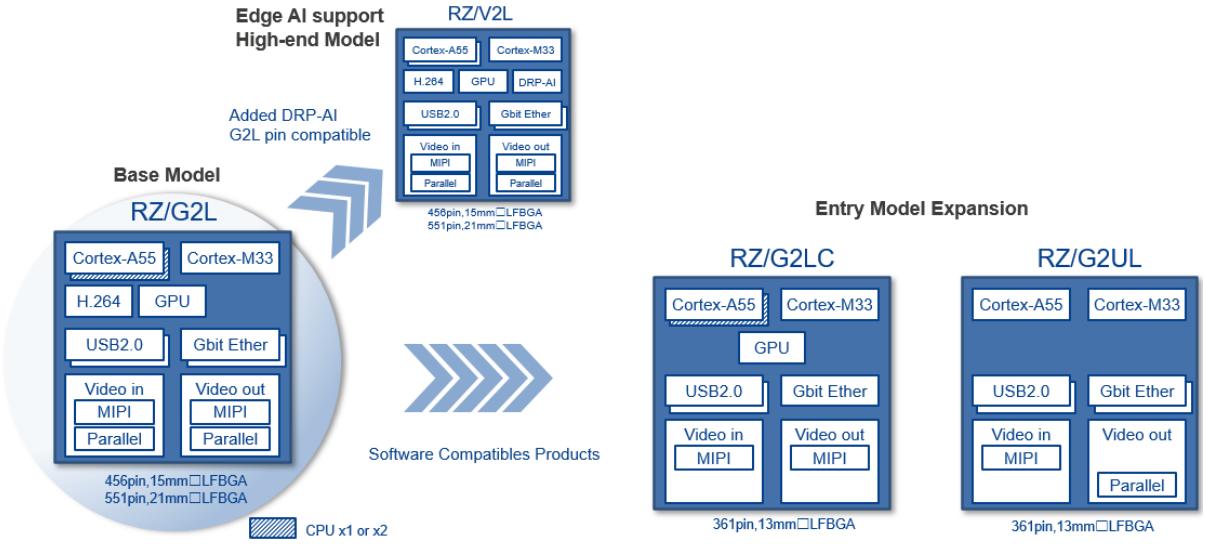

Figure 2. Software Compatibility

- **Evaluation board compatibility**
  RZ evaluation boards are built according to SMARC standards and comprise a SMARC board equipped with the target MPU and a Carrier Board. The same Carrier Board can be used for RZ/G2L, RZ/G2LC, RZ/G2UL, and RZ/V2L. This enables evaluation of any MPU by simply switching SMARC boards. In addition, POC (Proof of Concept) can be developed in shorter time by customizing the Carrier Board.

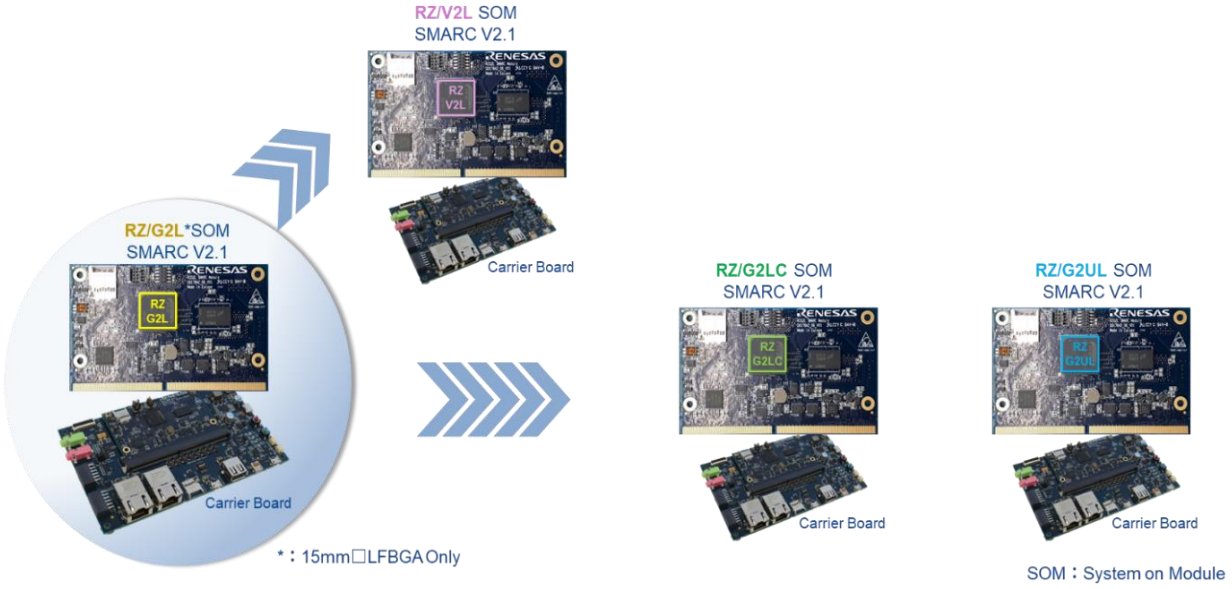

Figure 3. Evaluation Board Compatibility

CIP Linux kernel reduces long-term product maintenance burden

Industrial and building automation products required a lengthy period from development to release, remain in operation for a long time, and required maintenance during this product life cycle. Normally, the cost and time required to perform maintenance by the customer alone would be vast and would be a major issue in the development stage; however, RZ/G2L and RZ/G2LC greatly reduce these burdens with the following measures.

- Adopting the Linux kernel provided by the Civil Infrastructure Platform (CIP), which has been maintaining the industrial grade Linux for more than 10 years (Super Long-Term Support).

- Providing the Verified Linux Package (VLP) based on the CIP Linux kernel to greatly reduce Linux maintenance required by the customer.

What is the Civil Infrastructure Platform (CIP)?
The Civil Infrastructure Platform is a platform that aims to establish a base layer for building Linux-based embedded systems that satisfy the requirements of modern civil infrastructure. It is driven by The Linux Foundation and global leading infrastructure system manufacturers. For more details, click here.

Summary

RZ/G2L and RZ/G2LC are optimal MPUs for entry-level HMI products used for industrial and building automation. They come equipped with all the functions necessary for HMI devices, with the added value of enhanced AI inference execution processing performance. The MPUs boast features that help reduce system costs, an environment that boosts customer development efficiency, and components that reduce post-delivery maintenance costs. Integrating RZ/G2L or RZ/G2LC in products can resolve challenges faced by customers when deploying and/or enhancing functions of entry-level HMI products.

Related information

- RZ/G2L – General Purpose Microprocessors with Dual Core Arm® Cortex®-A55 CPUs (1.2GHz), 3D Graphics, and Video CODEC Engine for HMI applications
- RZ/G2LC – General Purpose Microprocessors with Dual Core Arm® Cortex®-A55 CPUs (1.2GHz), 3D Graphics Engine for HMI applications
- RZ/G2L, LC Board Support Package – Linux Super Long-Term Support (SLTS) for Linux
- RAA215300 – PMIC High Performance 9-Channel PMIC

Revision History

Revision	Date	Description
1.0	Oct. 20, 2021	Initial release.

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