MCUs with on-chip CAN CC and CAN FD protocol controllers

Figure 1: The RA8M1 family is suitable for different AI-based applications (Source: Renesas)

Renesas is a Japanese chipmaker providing micro-controller units (MCUs) for automotive and non-automotive applications. Many of the offered MCUs come with on-chip CAN CC and CAN FD protocol controllers. The company also supplies SoC (system-on-chip) solutions with CAN connectivity. According to the chipmaker, the company ships 3,5 billion units per year.

Renesas was founded in 2010, when the Japanese semiconductor industry merged into one enterprise. There are roots to the semiconductor business units of Hitachi, NEC, and Mitsubishi. Nowadays, Renesas is the most important chipmaker headquartered in Japan. From the beginning, the company was a CiA member.

End of 2023, the enterprise has announced the RA8 micro-controller family based on the 480-MHz Cortex-M85 processor by Arm. It delivers a performance of over 3000 Coremark points. Coremark is a benchmark measuring the performance of embedded controllers and it is replacing the Dhrystone benchmark. The MCUs deploy the Helium technology by Arm featuring a four-times performance boost for digital signal processor (DSP) and machine learning (ML) implementations versus MCUs based on the Cortex-M7 processor. Some family members provide on-chip CAN FD (flexible data-rate) controllers.

The RA8 family is designed for AI (artificial intelligence) applications. "The advent of AI is increasing demand for intelligence at the edge and endpoints to serve new applications across diverse markets including industrial automation, smart home, and medical," said Paul Williamson from Renesas, "our new MCUs, built on Arm's highest-performing and most secure Cortex-M processor to date, are specifically optimized for signal processing and ML

workloads, and will be game-changing for innovators looking to address the growing AI opportunities in the embedded and IoT space, without compromising on security."

The Cortex-M85 core includes the Trustzone technology, which enables isolation and secure/non-secure partitioning of memory, peripherals, and code. It features the Security-IP by Renesas with cryptographic accelerators and supports a true secure boot procedure. Besides the CAN FD ports, the MCU family comes with Ethernet, USB, and 16-bit camera interfaces.

A number of customers are already designing with the RA8M1 MCUs. For example, Mantra Softech, a provider of biometric solutions, has employed the products in a fingerprint scanner. Hiren Bhandari, Technical Director at Mantra, said, "We are delighted with the functionality and efficacy of the RA8M1 MCUs. The combination of high performance and Helium technology enables us to integrate AI features into this solution." This MCU comes with the FSP software. An evaluation is also available.

MCUs and SoCs for automotive applications

The R-Car micro-controllers and systems-on-chips are Arm-based. They target the automotive industry. The recently introduced fifth generation is designed for high-end ECUs ▷

(electronic control units) including those running AI applications. The company also shared its plans for two forthcoming MCU product advancements in the next-generation R-Car family. One is a cross-over MCU series designed to deliver the performance required for domain and zone ECUs. These MCUs are expected to close the performance gap between traditional MCUs and the advanced R-Car SoCs. Secondly, the company announced plans to introduce a separate MCU platform tailored for the vehicle control market. Both of these MCUs will be powered by Arm architectures and are set to become an integral part of the R-Car family, offering scalable options and software reusability for automotive engineers. These products feature CAN CC (classic) and optionally CAN FD connectivity. They will be released from 2024 onward, following the company's roadmap.

Until the fourth generation, the R-Car SoCs were designed for specific use cases, such as ADAS (advanced driver assistance system), AD (autonomous driving) that requires high AI performance, and gateway solutions with enhanced communication capabilities. Renesas' fifth-generation R-Car SoC incorporates the Chiplet technology to create a flexible platform that can be customized to meet various requirements for each use case. The platform offers multiple processor-sets from entry-level to higher-end models, and can integrate a variety of IP (intellectual property) modules such as AI accelerators and IP modules by partners and customers into a single package. This gives users the option to customize designs according to their needs.
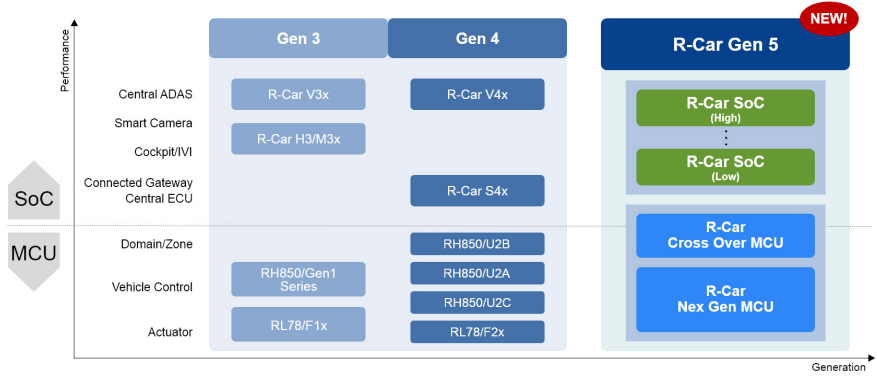
Figure 2: The fifth generation of R-Car family is designed for cross-over ECU designs overcoming MCUs dedicated for specific applications (Source: Renesas)

As E/E architecture in vehicles continues to evolve, it becomes increasingly important for domain control units (DCUs) and zone control units (ZCUs) to handle both high computing performance and real-time processing. Renesas addresses this challenge by developing an Arm-based 32-bit cross-over R-Car MCU platform with built-in NVM (non-volatile memory) that can deliver higher performance than traditional MCUs. Moreover, to build upon the success achieved by the RH850 family, Renesas is also extending its vehicle control portfolio with the recent R-Car MCU series, which is also powered by Arm cores. This means for the first time, automotive system developers are able to take advantage of the Arm software and eco-system to build powertrain, body control, chassis, and instrument cluster systems.

In order to start software developments without having MCU hardware available, Renesas has launched a cloud-based environment for automotive AI software. This AI Workbench environment can also be used for AI software evaluation purposes. With this environment, engineers can begin designing automotive software by leveraging
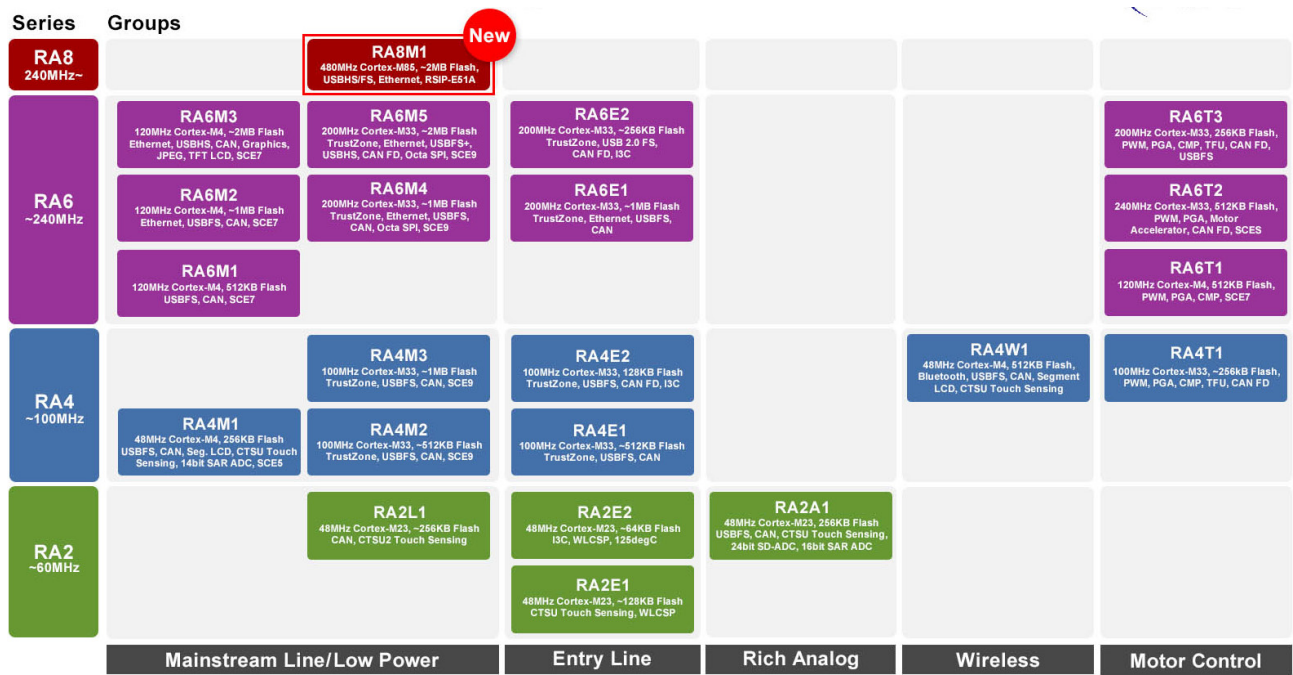
Figure 3: The RA family of MCUs provides on-chip CAN CC and CAN FD protocol controllers, which are based on the Bosch IP core (Source: Renesas)
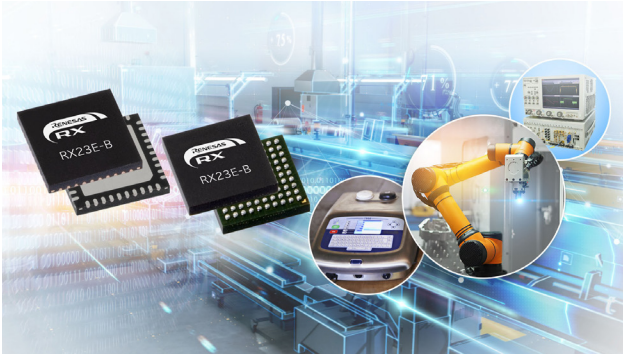
Semiconductors

Figure 4: The RX23E-B family addresses high-end industrial senor applications and provides CAN on-chip modules (Source: Renesas)

Figure 5: The RA8T1 micro-controllers are suitable for motion control applications featuring integrated CAN modules (Source: Renesas)

Microsoft Azure services including Azure Compute, IaaS services, Microsoft Entra ID, and Azure Security. Instead of installing tools on a PC or obtaining an evaluation board, they can perform tasks such as performance evaluation, debugging, and verification using simulation tools online. This approach aligns with the "Shift-Left" approach, which enables software creation and testing earlier in the design cycle, even before the actual hardware becomes available. This environment serves as a unified development platform for designing and testing Renesas' scalable automotive SoCs and MCUs, regardless of product type or application.

MCUs for industrial applications

Besides dedicated micro-controllers for the automotive industry, Renesas offers MCUs for high-end industrial sensor systems and MCUs for motion control devices. The 32-bit RX family integrates a 24-bit Delta-Sigma A/D converter as well as one CAN CC protocol controller. "With the addition of the RX23E-B, which comes with an AFE (analog front end) sensor interface, we can now serve a broad range of sensing applications from mid-end to high-end systems," said Sakae Ito from Renesas. "We will continue to extend our product options to meet the growing needs of battery-powered and wireless sensors that demand low-power consumption." Similar to the legacy RX23E-A, the RX23E-B incorporates a 32-MHz RXv2-based CPU (central processing unit), supporting DSP instructions and providing a floating-point unit (FPU). It offers peripheral functions such as a 16-bit D/A converter, which enables measurement adjustments, self-diagnosis, and analog signal output. The ±10-V analog input enables ±10-V measurement with a 5-V power supply without requiring external components or an additional power supply. An LCD controller and a real-time clock (RTC) function are also included. This MCU is already available, along with a starter kit.

The RA8DA1 family of MCUs based on the Cortex-M85 is targeting graphic display solutions as well as voice/vision multi-modal AI applications. Typical markets include building and smart home automation as well as consumer and medical devices. These products feature 6,39 Coremark/MHz. They include an LCD graphics controller support by the LVGL (Light and Versatile Graphics Library) open-source software. Of course, it features the above-mentioned Helium technology by Arm. The RA8DA1 family has CAN FD protocol controllers implemented as well as an Ethernet controller.

There is also the RA8TA1 family designed for motor control applications. It also features CAN FD connectivity. Also based on the Cortex-M85 processor, these MCUs include PWM (pulse-width modulation) timing features such as 3-phase complementary output, 0-percent and 100-percent duty-output capability, a double-buffer compare match register, and five phase counting modes. Analog capabilities of the MCUs include 12-bit ADCs, 12-bit DACs, and high-speed comparators used in voltage and current measurement as well as in over-current protection. The products also provide port output shutdown capability, when an anomaly is detected, an important safety feature in motion control. The Japanese chipmaker has shipped motor-control specific MCUs for over 10 years ago. The company has sold over 230 million motor-control embedded processors per year to thousands of customers worldwide. The RA8T1 family supports Arm's Trustzone technology and Renesas' Security IP. "The performance of these MCUs is critical in high-speed electric motor control that requires sophisticated algorithms and application software to run in a reliable, safe, and secure manner. The RA8T1 MCUs bring unprecedented CPU horsepower to the portfolio along with Helium technology that allows our customers the additional flexibility to deliver smart (AI/ML) solutions without the need for additional hardware," explained Daryl Khoo from Renesas.

64-bit MPU for IoT edge and gateway devices

The RZ/G3S family of general-purpose microprocessor units (MPUs) are intended for low-power devices. In stand-by modus they consume as less as 10 μW. They are designed for Linux applications providing a PCI Express interface that enables connectivity with 5G wireless modules. Additionally, the products boast security features such as tamper detection to ensure data security. These features make them suitable for IoT applications such as home gateways, smart meters, and tracking devices. The microprocessor family deploys one Cortex-A55 core as the main CPU with a maximum operating frequency of 1,1 GHz and two Cortex-M33 cores as sub-CPUs operating at 250 MHz. They feature an ECC (Error Correction Code) function in both internal memory and external DDR interface to maintain data integrity. The microprocessors provide CAN CC connectivity as well as other interfaces including EIA 485, I²C, UART, and USB. ◀

hz (based on information from [Renesas](#))