

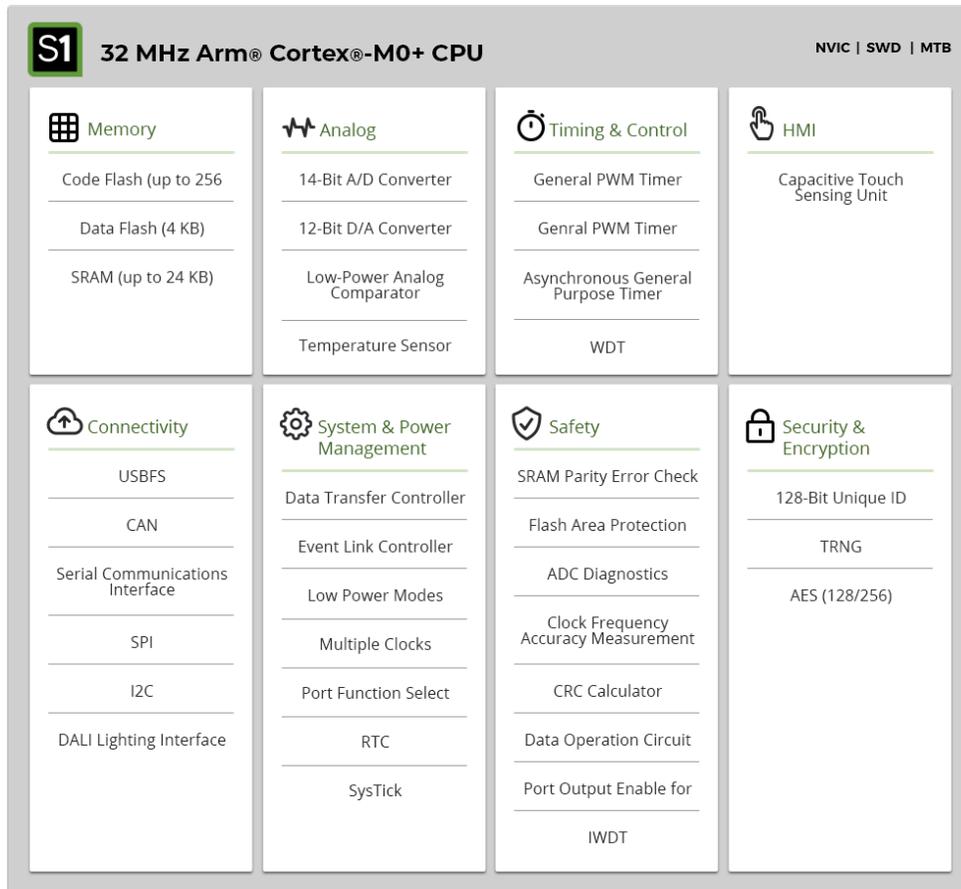
## **Renesas Synergy™ MCUs Build a Foundation for Groundbreaking Integrated Embedded Platform Development**

*New Family of Microcontrollers Combine Scalability and Power Efficiency with Extensive Peripheral Capabilities*

Designers eyeing new applications in the embedded and rapidly emerging IoT markets need a highly scalable, upwards compatible family of microcontrollers (MCUs) that combines high efficiency and scalability with excellent price/performance characteristics. The Synergy Family of MCUs was designed from the ground up to serve that purpose and provide a firm foundation on which developers can build new innovative products. Based on the Arm® Cortex®-M cores, these new controllers combine extremely low power consumption with excellent deterministic behavior in a small package.

### **Low Power, High Performance MCUs**

Synergy MCUs consists of four Series: S1, S3, S5 and S7. At the low power end of the market, where many embedded and IoT solutions are expected to emerge, Renesas provides the S1 Series based on the Cortex M0+ CPU core. The S1 Series is optimized for battery-powered applications, offering an exceptional level of power efficiency with a highly optimized two-stage instruction pipeline that allows developers to deliver 32-bit performance at price points typically seen in 8-bit MCUs.



**Figure 1:** Block Diagram representing the Synergy S1 Series MCUs

The S1 Series is designed for very low power, cost-sensitive embedded and IoT applications where developers may be considering migrating from an 8-bit or 16-bit solution. With these new devices, developers now have access to the processing resources of a 32-bit MCU while still maintaining exceptionally low power consumption in both standby and operating mode. The S1 MCU's also provide on-chip memory ranges from 64 KB to 128 KB of code flash, 4 KB of data flash and up to 24 KB of SRAM.

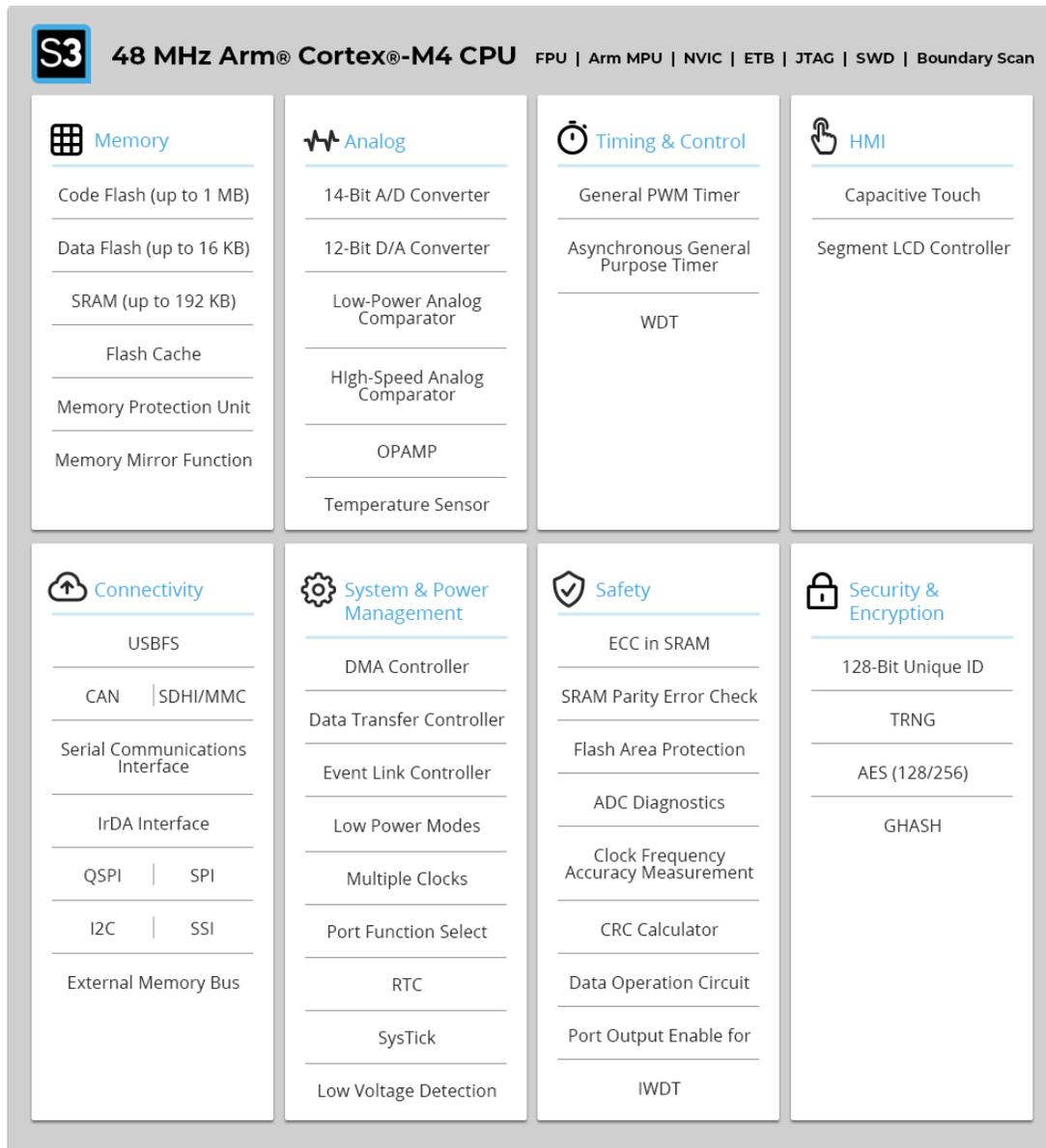
When performance outweighs the need for ultra-low power operation, developers can look to the S3, S5 and S7 Series to cover mid-to-high performance embedded applications. All three MCU series are based on Arm's Cortex-M4 processor core and are specifically designed with HMI, motor control, industrial automation and similar embedded applications in mind. The Cortex-M4 features:

- extended single cycle multiply accumulate (MAC) instructions
- optimized SIMD arithmetic
- saturating arithmetic instructions
- a single precision Floating Point Unit (FPU)
- an ETM for advanced debugging and application tracing

- Memory Protection Unit (MPU)

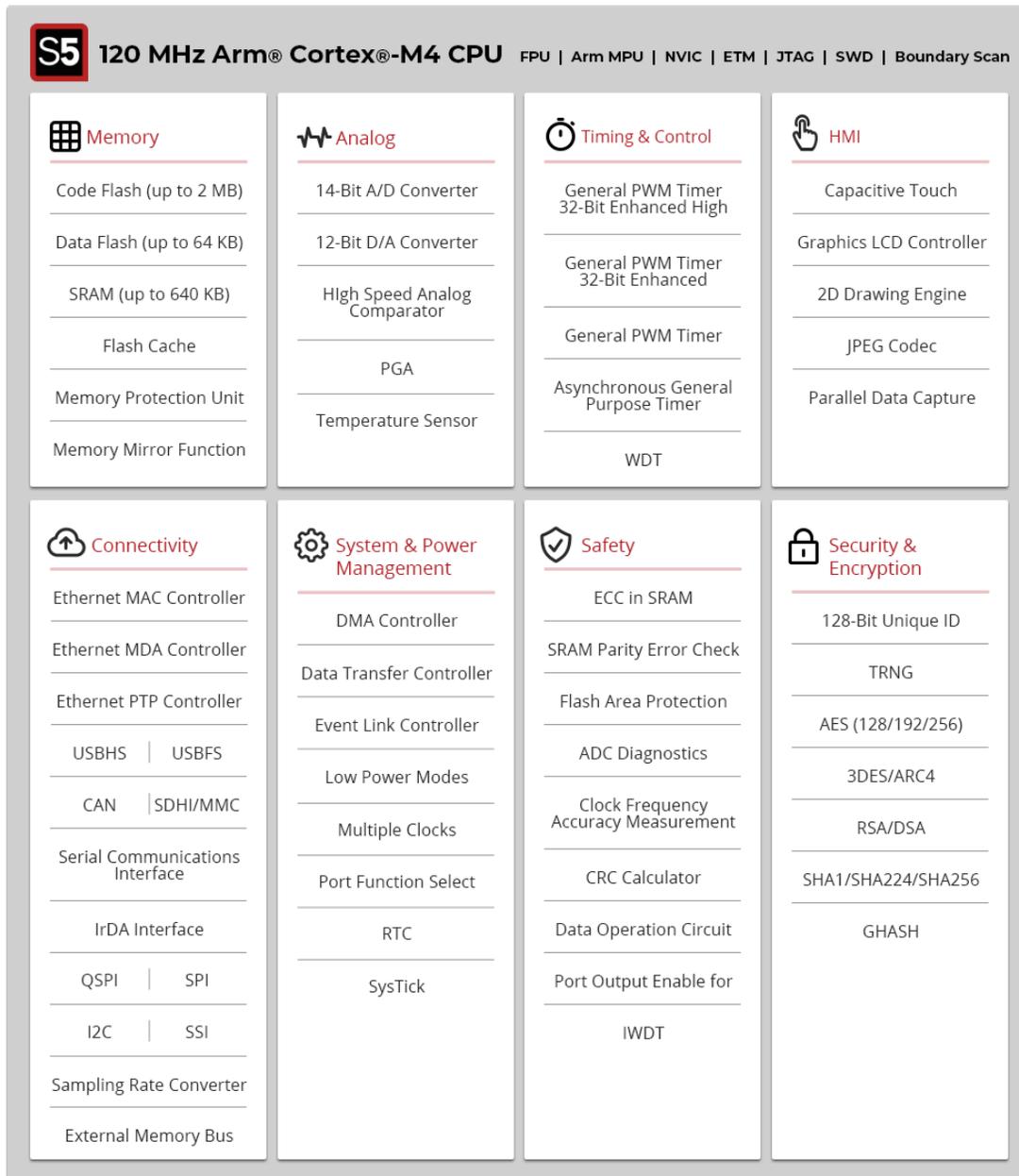
These architectural attributes, along with integrated sleep modes and state retention capability, allow the Cortex-M4 to deliver excellent performance at very low power levels.

The S3 Series MCUs serve applications that demand higher levels of integration than the Cortex M0+-based Series S1. The S3 Series adds up to 130 GPIOs and larger memory resources with up to 1 MB of code flash, 16 KB of data flash and up to 192 KB of SRAM, and built-in segment LCD controller.



**Figure 2:** Block Diagram representing the Synergy S3 Series MCUs

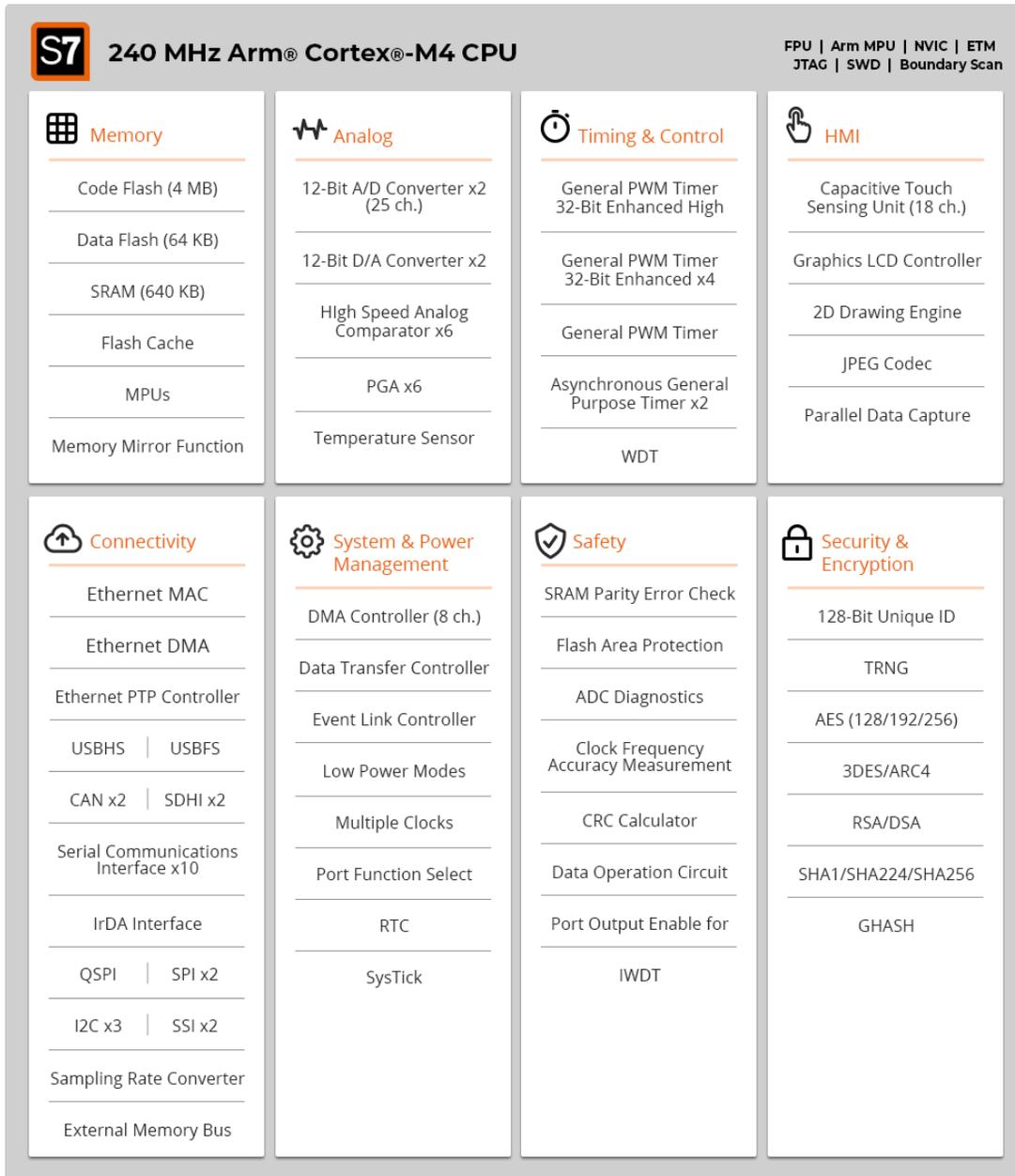
For higher performance applications, the S5 Series MCUs target more complex embedded applications such as HMI, gateway, and analog capture applications. The S5 Series offers more memory on-chip including up to 2 MB of code flash, and 640 KB of SRAM. This large SRAM can eliminate the need for external frame buffer memory when driving a color TFTLCD panel.



**Figure 3:** Block Diagram representing the Synergy S5 Series MCUs

At the top end of the performance spectrum, SynergyS7 Series MCUs deliver highest performance in the Synergy MCU Family, operating at 240 MHz. The S7 Series features

a wide array of peripherals and significantly more memory on-chip including 4 MB of code flash and 640 KB of SRAM. These additional resources give embedded developers substantial new design options particularly when their solutions require memory resources to buffer large high-speed messages, perform calculations in background, or run multiple software applications concurrently.



**Figure 4:** Block Diagram representing the Synergy S7 Series MCUs

## Peripheral and Connectivity Options

The range of potential embedded applications for the Synergy MCUs run the gamut from simple sensor tags to complex connected devices with user interfaces and TFTLCD displays. Given the wide variety of application requirements, crafting the right MCU feature set is no small task. Connectivity is one of those essential functions.

Most of the MCUs in the embedded market today supply a base set of peripherals including a wide array of connectivity options. Synergy MCUs take this one step further. The top-of-the-line S7 Series, for example, offers dual Ethernet with IEEE-1588 synchronization, high-speed USB, plus many serial interfaces including UART, I<sup>2</sup>C, SPI, IrDA, QSPI, I<sup>2</sup>S, SDHC/MMC and CAN interfaces. As embedded and IoT applications move toward the edge, where systems are often measuring the environment, analog interfaces play an increasingly crucial role. To meet this need, the Synergy MCUs add a full array of analog-to-digital and digital-to-analog converters, analog comparators and temperature sensors. In addition, the S5 and S7 Series MCUs add a variety of timing functions that are typically used in motor and industrial control applications.

The S5 and S7 devices can drive a WVGA TFTLCD panel with 24-bits of color and offers integrated capacitive touch capability which is required for human-machine interfaces (HMI) and markets where Renesas plays a leading role such as in industrial and home automation. For cost-conscious display designs, the S7 (and S5 Series) MCUs have enough internal SRAM to implement a dual graphic frame buffer when driving a WQVGA TFT LCD, eliminating the cost of external RAM graphic frame buffer. With Ethernet and High-Speed USB capability and a 32-bit MCU running at 240 MHz to process graphics, developers have all the functions they need to build a HMI solution.

While the high and mid-range S7 and S5 Series MCUs naturally offer a more extensive peripheral lineup, many of these same functions can be found on the lower power S1 and S3 Series MCUs. Both the S1 and S3 Series feature a complete array of analog interfaces and timing functions as well as multiple SCI including I<sup>2</sup>C, SPI, USB and CAN interfaces.

Safety functions are becoming increasingly important in embedded designs as well. A growing number of regulatory agencies now require a MCU in an appliance, for example, to run self-tests to ensure clocks are running at the correct frequency and Synergy MCUs offer a variety of integrated safety peripherals including ADC diagnostics, Clock Accuracy Circuit, CRC, Data Operation Circuit, ECC in RAM, Flash Area Protection, Port Output Enable, RAM parity error check and 14-bit independent WDT.

## Security Focused

Given the fundamental role connectivity plays in every IoT design, solutions at every level of the network are vulnerable to malicious attacks. The threats can occur at every stage of the product lifecycle. During manufacturing a less-than-honest employee could clone firmware or the security configuration of a product. Once the product goes into the field, hackers could replace firmware with malware or exploit a software update session to inject malware into a system. If system parameters are lost, firmware could be susceptible to an eavesdropping attack. Clearly product designers must address a wide array of potential security concerns, not only to ensure the integrity of their product, but also to reassure prospective consumers before they buy into this new market.

Threat	S7	S5	S3	S1
Product cloning	Best	Best	Better	Good
Product disruption with malware injection during update	Best	Best	Better	Good
Eaves-dropping during update	Best	Best	Better	Good
Privacy threat by firmware/date exposure	Best	Best	Best	Good
Add-on program to damage or steal	Best	Best	Best	Limited

**Figure 5: Synergy MCU Security Features**

To protect embedded systems from these threats, Synergy MCUs add significant security capabilities in hardware where they are less susceptible to attack. For example, when each Synergy MCU is manufactured, it is assigned a unique 128-bit number which can be used to generate keys to protect applications and assist provisioning. Offering a significant improvement over pseudo random number generators, the True Random Number Generator in the Synergy Microcontrollers meets NIST SP 800-90 specifications. The S3, S5 and S7 Series MCUs also include security features that can be used to read- and write-protect an area within SRAM, code flash or data flash. Developers can use this feature to create a secure region that is protected from access by a rogue program. The S5 and S7 Series MCUs also feature hardware accelerators for symmetric cryptography and asymmetric cryptography as well as hash generation. The S3 Series MCUs offer many of the same security capabilities, while at the low power end of the product line the S1 Series MCUs combines a true random number generator with some basic encryption functions.

## Conclusion

The Synergy Platform promises to transform the embedded design process by eliminating many of the traditional hardware/software integration functions and freeing the designer to spend more time innovating. To achieve that goal, however, embedded designers need a line of MCUs that can offer a highly attractive tradeoff between low power and performance while delivering key peripheral functions that developers need. By building upon the low power advances in the Arm Cortex-M4 line and developing an extensive portfolio of connectivity, safety and security functions, the Synergy MCU family offers a comprehensive platform for building next generation embedded solutions.

(Remarks) Contents of this article are subject to change.

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