RENESAS

BIG IDEAS FOR EVERY SPACE

RENESAS SYNERGY™ PLATFORM

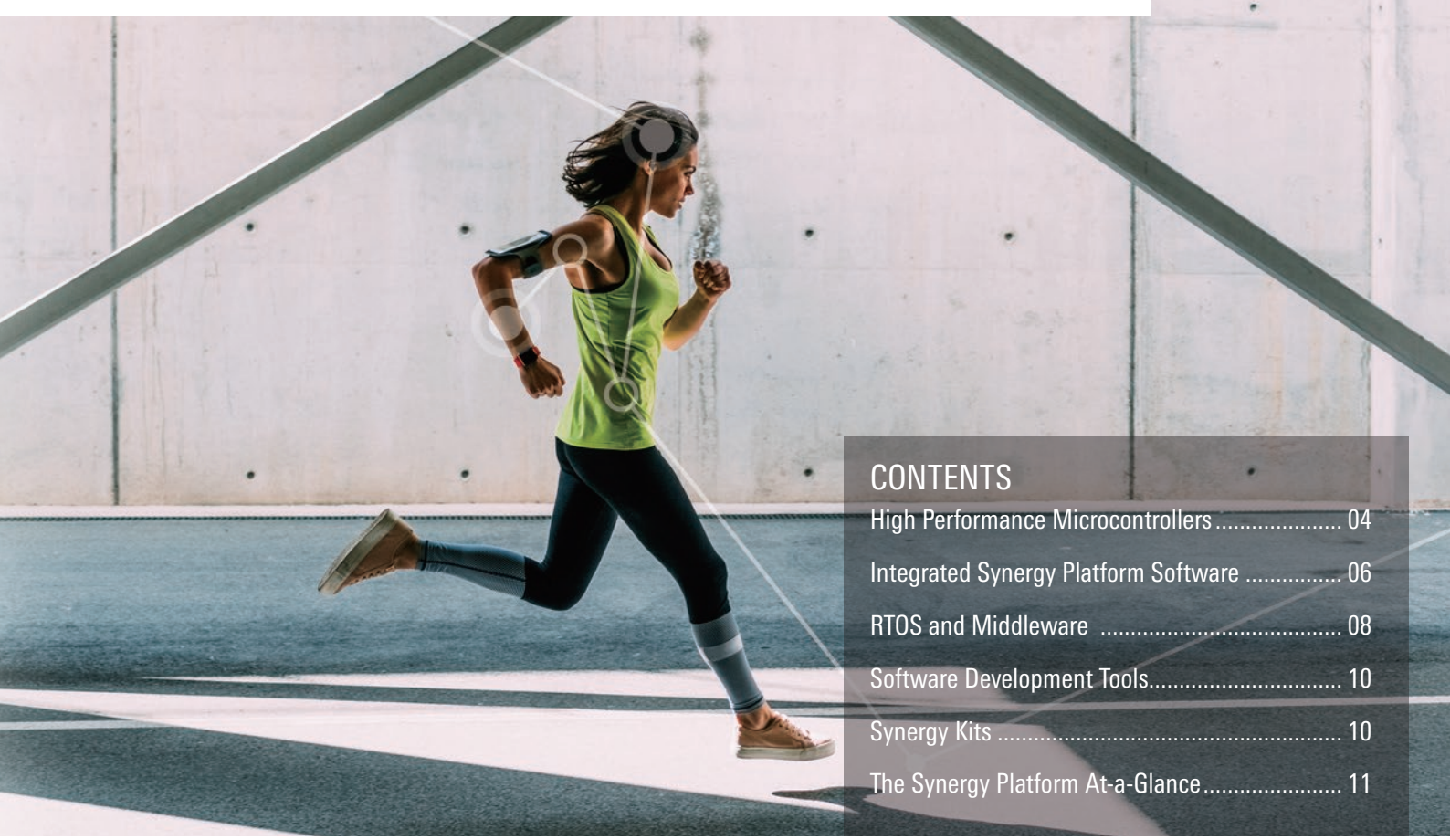
Integrated software, scalable MCUs, and comprehensive tools that make development faster and easier

2020.02

Renesas Synergy™

START AHEAD

**Get to market faster and easier with Renesas Synergy™.
As the first fully qualified MCU software and hardware platform,
we help you reach more people, sooner.**



CONTENTS

Accelerate Development

Let us take care of everything below the API so you can focus on differentiating your product.

Reduce Total Cost of Ownership

Lower your costs from start to finish – technology, development, and maintenance are all included.

Eliminate Barriers to Entry

Innovate without facing obstacles of upfront costs, complicated licensing, or starting from square one.

renesas.com/synergy

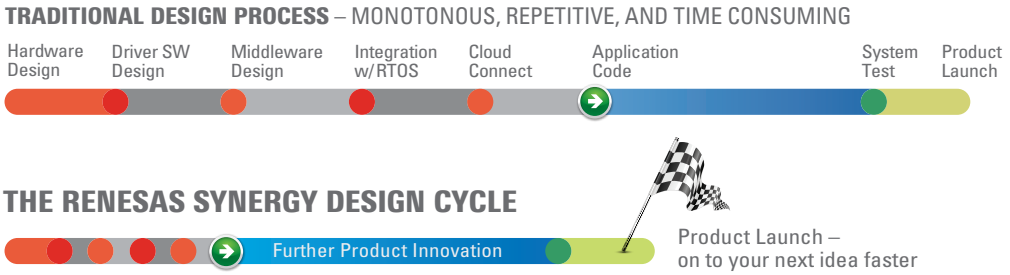
What is the Renesas Synergy Platform?

The Renesas Synergy Platform is a complete, qualified system solution. It includes software, a scalable family of microcontrollers, and development tools.

With this comprehensive, proven platform, engineering teams can begin IoT application software development at the API level, saving them months of time and effort. It also ensures that their product innovations rest on a solid, robust technology foundation optimized for MCU-based product designs.

Accelerate time to market.

Because the Synergy Platform's standardized API eliminates the need to wrestle with low-level middleware and network stacks, engineers can now focus on developing and implementing innovative, differentiated products and solutions.



RENESAS SYNERGY™ PLATFORM

Solutions Gallery

Software

- Development Tools
- Synergy Software Package
- Software Add Ons

Hardware

- Kits
- Microcontrollers

Performance and capabilities for the highest quality embedded system products

HIGH-PERFORMANCE MICROCONTROLLERS

The Renesas Synergy Platform includes four different series of upward software-, architecture-, and pin-compatible Synergy MCUs. The advanced S7 Series (High Performance), S5 Series (High Integration), S3 Series (High Efficiency), and S1 Series (Ultra Low Power) MCUs utilize the popular ARM® Cortex®-M CPU architecture. The devices implement easy connectivity, rock-solid security, dependable safety, and facilitate the creation of easy-to-use human-machine interfaces.

The high-performance 240 MHz S7 Series MCUs feature high-speed connectivity and industry-leading flash memory density.

KEY FEATURES

- Cortex-M4, 240 MHz, 2.7 V to 3.6 V, 75 µA/MHz
- 40-nm high-performance process
- Operating temperature range -40° C to 105° C
- USBHS, IEEE 1588 PTP Ethernet MAC, QSPI External Memory Bus
- 4 MB and 3 MB Flash, 640 KB SRAM, Memory Mirror Function, Memory Protection Unit
- 12-bit A/D, Programmable Gain Amplifier
- JPEG Codec, 2D Drawing Engine, WVGA (800x480) with 32-bit color
- Features to address functional safety requirements
- Industry-leading, NIST-validated security features: hardware acceleration for cryptography and HASH algorithms, true random number generator, secure key generation and storage, 128-bit unique ID, and more

The highly integrated 120 MHz S5 Series MCUs balance processing performance with large memory and an extensive array of built-in features.

KEY FEATURES

- Cortex-M4, 120 MHz, 2.7 V to 3.6 V, 117 µA/MHz
- 40-nm high-performance process
- Operating temperature range -40°C to 105°C
- Comprehensive and flexible connectivity including USBHS, Ethernet PTP, QSPI External Memory Bus, and more
- 2 MB Flash, 640 KB SRAM, Memory Mirror Function, Memory Protection Unit
- 12-bit A/D, Programmable Gain Amplifier
- JPEG Codec, 2D Drawing Engine, WVGA (800x480) with 32-bit color
- Features to address functional safety requirements
- Industry-leading, NIST-validated security features: hardware acceleration for cryptography and HASH algorithms, true random number generator, secure key generation and storage, 128-bit unique ID, and more

High-efficiency 48 MHz S3 Series MCUs are low-power chips that integrate up to 1 MB of Flash and 192 KB of SRAM.

KEY FEATURES

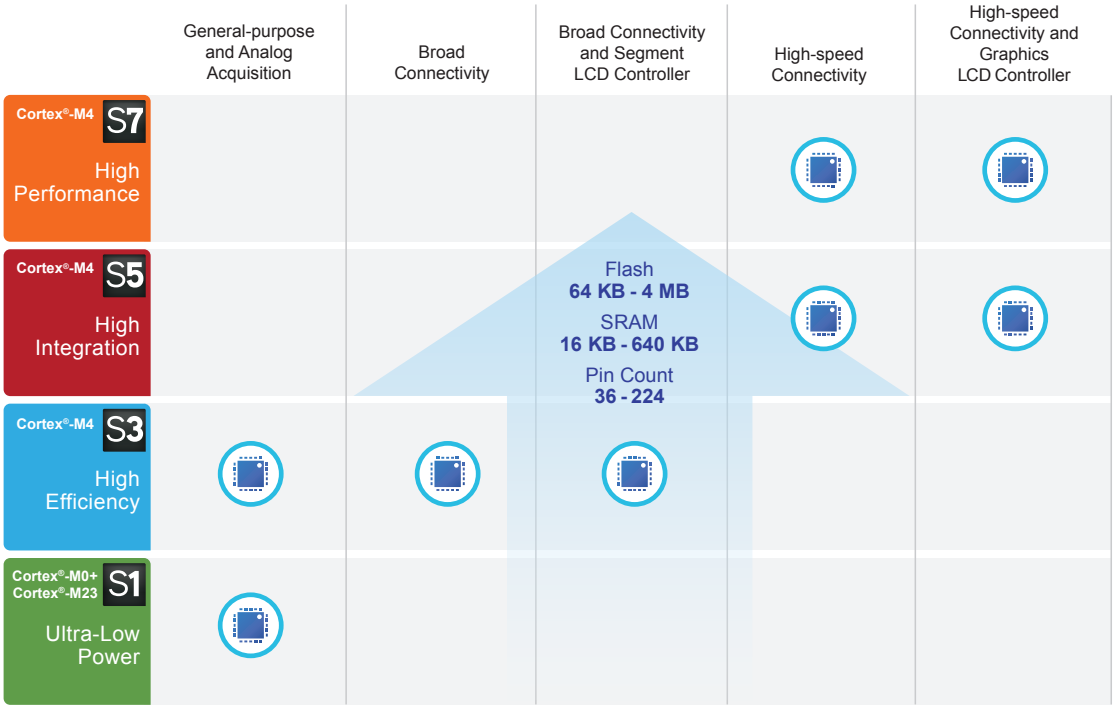
- Cortex-M4, 48 MHz, 1.6 V to 5.5 V
- 130-nm low power process
- Operating temperature range -40°C to 105°C
- External Memory Bus
- Features to address functional safety requirements
- Memory Mirror Function, Memory Protection Unit
- 12-bit A/D, Programmable Gain Amplifier
- 28-channel 14-bit A/D
- Capacitive Touch Sensing Unit with Segment LCD Controller
- ECC and Parity Error Check in SRAM, ADC Diagnostics, CRC Calculator
- NIST-compliant security features: hardware acceleration for cryptography and HASH algorithms, true random number generator, secure key generation and storage, unique ID, and more

Ultra-low-power 32/48 MHz S1 Series MCUs operate down to 1.6 V and feature low-power operating modes and fast wake-up times.

KEY FEATURES

- Cortex-M0+, 32 MHz, 1.6 V to 5.5 V, 500 nA (Software Standby Mode), 130 µA/MHz
- Cortex-M23, 48 MHz, 1.6 V to 5.5 V
- Operating temperature range -40°C to 105°C
- Features to address functional safety requirements
- 256 MB Flash, 32 KB SRAM, Memory Protection Unit
- Up to 16-bit SAR ADC
- 24-bit delta-sigma ADC
- 31-channel Capacitive Touch Sensing Unit
- USBFS, CAN
- Real-Time Clock
- SRAM Parity Error Check, ADC Diagnostics, CRC Calculator, Flash Area Protection
- NIST-compliant security features: hardware acceleration for cryptography, unique ID, and more

Pin-Compatible and Scalable MCUs



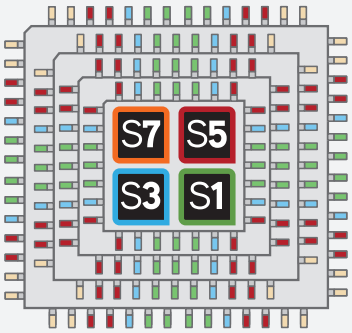
The capabilities provided by S7, S5, S3, and S1 Series MCUs readily handle a wide range of applications, from ultra-small mobile devices to calculation-intensive industrial systems, medical equipment, and more. The rigorously enforced compatibilities expand system design flexibility and help conserve development resources.

No matter the requirements of an IoT application, there is a Synergy MCU that can meet them.

Learn more at renesas.com/synergy/hardware

Scalable MCUs Designed with Software in Mind.

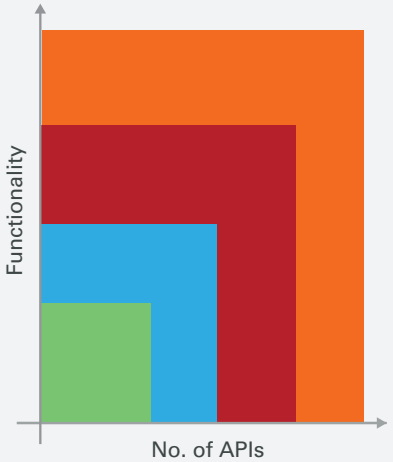
Package Footprint



Register Set & Features

Rn	31	30	...	...	2	1	0
...	31	30	...	...	2	1	0
...	31	30	...	...	2	1	0
...	31	30	...	...	2	1	0
...	31	30	...	...	2	1	0
...	31	30	...	...	2	1	0
R3	31	30	...	...	2	1	0
R2	31	30	...	...	2	1	0
R1	31	30	...	...	2	1	0
R0	31	30	...	...	2	1	0

APIs & Functionality

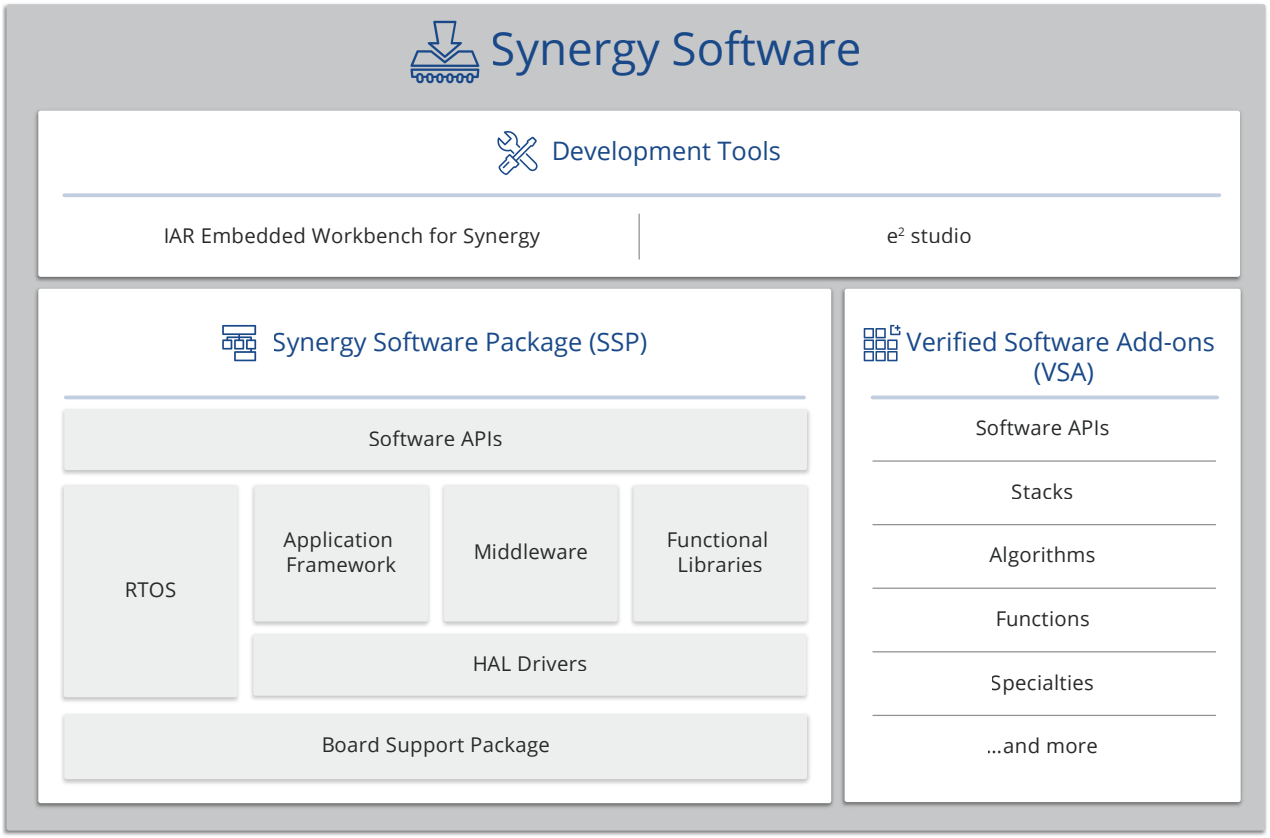


Compatibilities are rigorously enforced for Synergy MCUs. This configuration discipline ensures the design flexibility needed to leverage engineering investments for diverse opportunities in local and global IoT markets.

Tested and Production Ready

INTEGRATED SYNERGY PLATFORM SOFTWARE

Connected devices, especially for IoT, elevate the requirements for embedded systems software. Real-time operating systems (RTOS), network protocols, security, and power management are just a few examples. Synergy Software delivers solutions in three ways – your choice of professional Development Tools, the Synergy Software Package (SSP), and Verified Software Add-ons. Full licensing, maintenance, support, and an unlimited number of seats of development tools and products that use the SSP are included. No royalties, no fees.

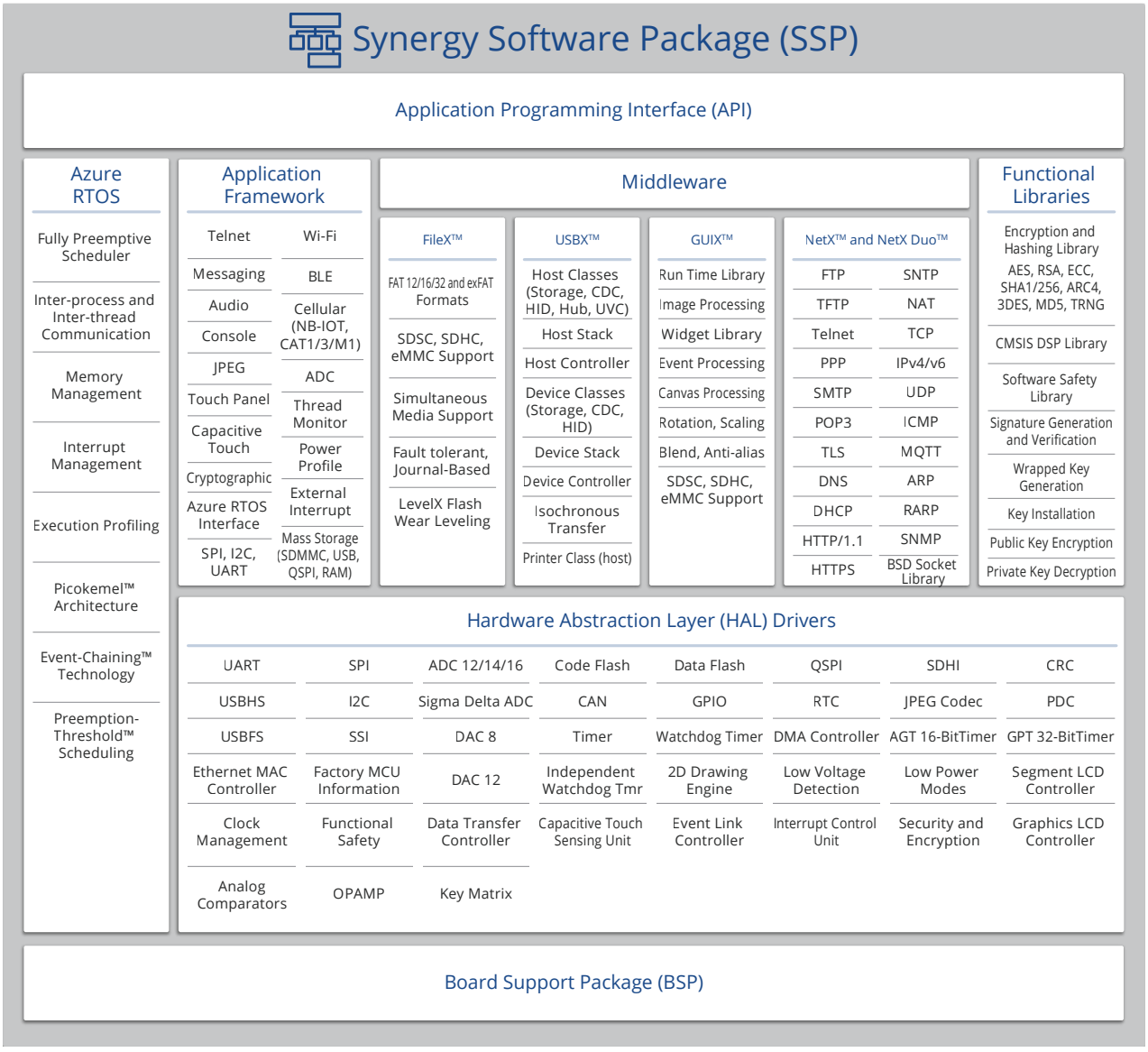


Learn more about Synergy Software, visit: renesas.com/synergy/software

Synergy Software Package

Synergy Software Package (SSP) is a proven series of frameworks and standard APIs that tightly integrate a premium commercial RTOS, a suite of middleware, a variety of libraries, and low-level drivers to simplify complex functions you encounter while developing connected embedded systems.

A layered architecture enables you to write your application with the Application Frameworks using common APIs or by directly connecting to the MCU device driver level as needed. Renesas qualifies the SSP to operate per SSP datasheet specifications, and Renesas provides all SSP maintenance and support.



Software Quality Assurance

To ensure production readiness, Renesas developed the SSP according to the international standard ISO/IEC/IEEE 12207 that covers the entire Software Development Life Cycle. Every element of the SSP is defined by and tested to meet these requirements.

SSP quality is tracked and measured using combinations of unit, functional, integration, performance, regression, dynamic, and static analysis tests.

Developed and Optimized for the Synergy Platform

RTOS AND MIDDLEWARE

Optimized for size, performance, and ease of use on Synergy MCUs

The Synergy Platform integrates Microsoft's popular Azure real-time operating system (formerly Express Logic ThreadX RTOS).

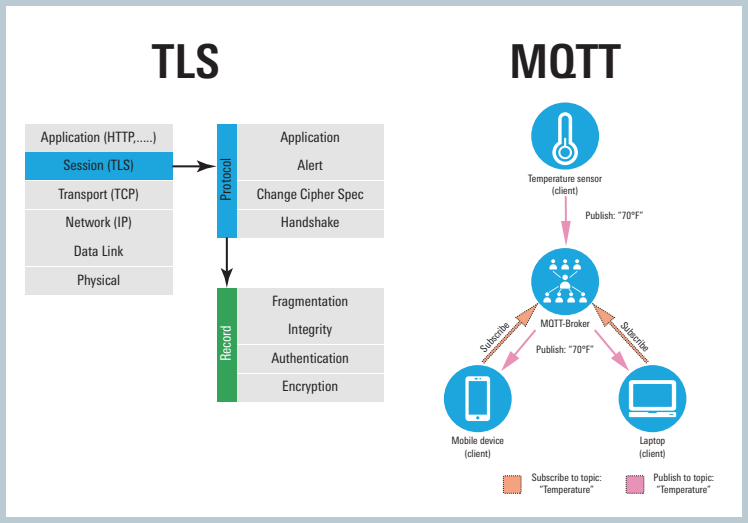
This RTOS ensures reliable system operation, supports an API that allows portability across Synergy MCUs, and minimizes the length of system development cycles. Azure RTOS features an extremely fast, commercial multitasking real-time kernel with preemptive scheduling and a small memory footprint.

Microsoft's Azure RTOS Features

- Small FLASH footprint
  - Less than 2 KB on Synergy processor families
- Small RAM requirements
  - Minimum of <1 KB for kernel RAM
- Fast Context Switch
  - 0.7 ms on Synergy S7G2 MCU Group
- Optimized for Synergy MCUs with stack bounds checking and Cortex®-M optimizations
- Intuitive API
- Multiple scheduling algorithms (Fully Preemptive, Round-Robin, Preemption-Threshold™)
- Real-time event trace
- Fully deterministic
- Certified by SGS-TUV Saar for use in safety-critical systems according to IEC-61508 SIL 4, IEC-62304 SW Safety Class C, ISO 26262 ASIL D and EN 50128

TLS and MQTT for Secure, Efficient IoT Communication

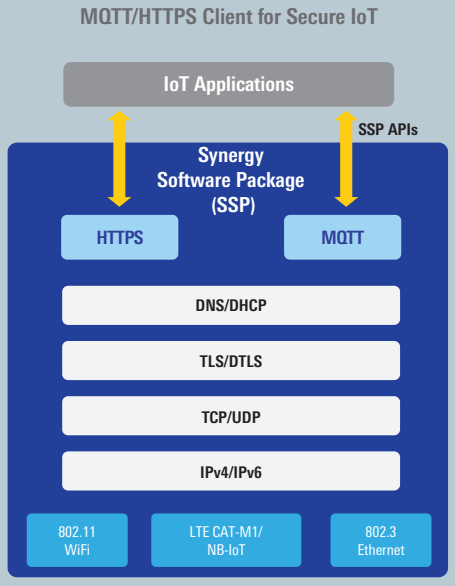
SSP v1.3 and higher includes Transport Layer Security (TLS) that delivers security three ways: by establishing secret keys between the client and server, applying hashing algorithms to detect alteration or forgery of packet content, and authorizing remote host identity using digital certificates. TLS is used for sending confidential data such as personal and credit card information in a secure fashion.



Complete, Integrated IoT Connectivity Client

Quickly add secure device to cloud connectivity using SSP APIs

Supports secure connectivity with AWS, Azure, and Google Cloud platforms



Advanced Commercial-Grade Middleware and Network Stack Included

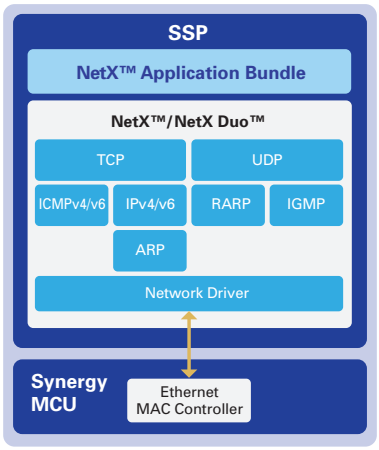
Synergy Software includes Azure RTOS, a complete set of commercial-grade middleware products. The easy-to-use NetX™, NetX Secure, FileX®, USBX™, GUIX®, and TraceX® software products are all fully licensed, with no runtime royalties, and fully supported.

FileX®	FAT compatible file system. Supports FAT12, FAT16, FAT32 and exFAT
NetX™	Embedded TCP/IP Network Stack
NetX Secure	Secure cloud connectivity protocols TLS, HTTPS, MQTT
USBX™	USB Host/Device Protocol Stack
GUIX®	Embedded GUI Development Framework
TraceX®	Real-Time, Graphical Event Trace/Analysis
LevelX®	Flash wear leveling support for internal and external memory

NetX Duo™, a streamlined TCP/IP stack, provides both IPv4 and IPv6 capabilities. Its unique Piconet™ architecture links into the final image only those services and protocols actually used by the application. NetX Duo achieves "Near Wire Speed" performance on the independent Iperf benchmark suite and has obtained IPv6 Ready Logo certification.

NetX Duo IPv4/IPv6 TCP/IP Networking

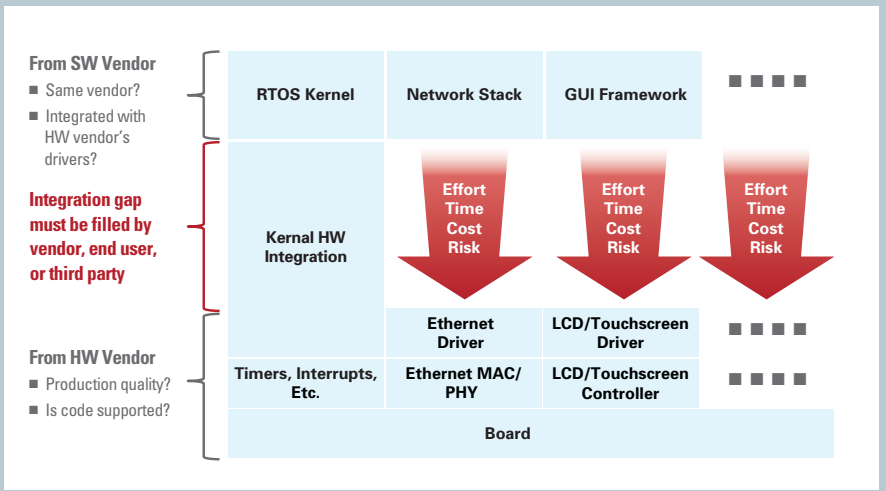
- Optimized IPv4/IPv6 Dual TCP/IP stack for embedded systems
- Small footprint, Azure RTOS-optimized performance
- "Near Wire Speed" on Iperf network throughput benchmark
- TCP, UDP, IP, ARP, RARP, IGMP, and ICMP core support
- TLS, HTTP/1.1, HTTPS, MQTT
- Network configuration protocols
- DHCP client/server (dynamic address allocation)
  - DHCPv6 (client only)
  - SNTP (network time protocol)
- Domain name services
  - DNS, mDNS, DNS-SD
  - DNSv6
  - NAT (private network extension)



Streamlined TCP/IP stack in NetX Duo provides both IPv4 and IPv6 capabilities, easing the design of IoT products that utilize TCP/IP network communication.

Conquer the Integration Gap with the Synergy Platform

A major benefit of the Synergy Software Package is that it eliminates the laborious R&D work associated with bridging the integration gap. This thoroughly engineered solution makes it unnecessary to write the critical code that unites stacks with I/O drivers, handles GUI frameworks with touch-screen drivers, and manages other system peripherals so IoT applications work predictably and reliably.



All included with the Synergy Platform

SOFTWARE DEVELOPMENT TOOLS

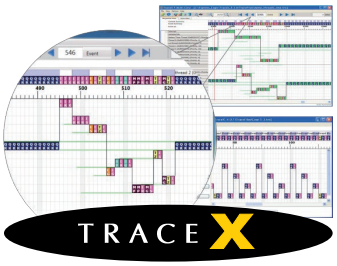
Designed to accelerate time to market through rapid code development, Synergy Tools facilitate file management, software and MCU configuration, code generation, compilation, debugging, and intuitive graphic interface design.

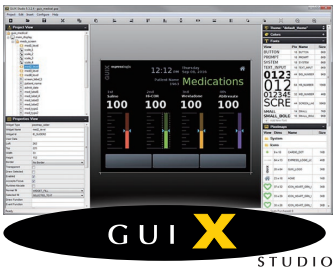
All Synergy Tools, support, unlimited seats of development tools, and maintenance are included with the Synergy Platform in the price of a single Synergy MCU.

You can use any of these professional tools to develop software for your end-product.

- e² studio Integrated Development Environment (IDE) with choice of GCC or fully licensed IAR C/C++ compilers and automatic code generation
- IAR Embedded Workbench® for Renesas Synergy™ IDE to generate fast performing, highly compact code
- TraceX® to visually monitor run-time performance
- GUIX Studio™ to enable drag-and-drop design of graphical user interfaces (GUI)

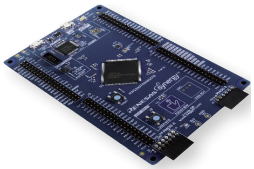
Learn more about Synergy Tools, visit: renesas.com/synergy/tools

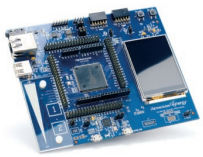




SYNERGY KITS

Select a Synergy Kit to evaluate the full Synergy Platform, access functionality of Synergy MCUs, and prototype rapidly.


Target Board Kits

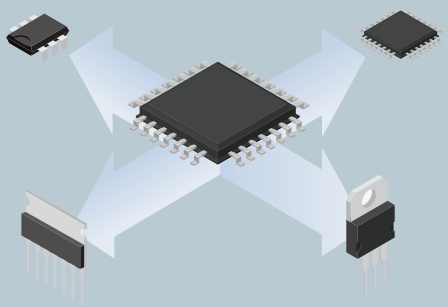

Starter Kit


Development Kits

Learn more about Synergy Kits, visit: renesas.com/synergy/kits

Powering an MCU

Renesas' digital and analog controllers, power modules and switching regulators provide a comprehensive set of solutions to power an MCU.



Learn more about Renesas power management ICs: renesas.com/products/power-management

Buck-Boost Converter

ISL9120, ISL91107, ISL91128
- Current Range: 400mA – 2.4A
- Low Iq ~ 20µA
- Input Voltage: 0.6V – 5.5V
- Output Voltage: 2.5V – 5.25V

Buck Converters

ISL9103/A, ISL9107/A, ISL9307
- Current Range: 500mA – 1.5A
- Low Iq ~ 17µA
- Input Voltage: 2.7V – 6V
- Output Voltage: 0.8V - V_{IN}

Boost Converters

ISL9111, ISL9113, ISL91133
- Current Range: 400mA – 2.3A
- Low Iq ~ 20µA
- Input Voltage: 0.6V – 5.4V
- Output Voltage: 2.5V – 5.25V

Linear Regulators

ISL9007, ISL9021A, ISL9016
- Current Range: 150mA – 400mA
- Low Iq ~ 25µA
- Input Voltage: 1.5V – 6.5V
- Output Voltage: 0.9V – 3.3V

Bi-Directional Buck-Boost Converter

ISL95338
- Current Range: <10A
- V_{IN}: 3.2V – 23.5V; V_{OUT}: 2.4V – 20V

Battery Chargers

ISL6294, ISL9230, ISL9220
- Dual power source (USB & Wireless Charging + Power Path)
- Current Range: 300mA – 1.5A
- 30V Input Compliant

THE SYNERGY PLATFORM AT-A-GLANCE

Synergy Software Package (SSP)

- Azure Real Time Operating System (RTOS)
- NetX™ and NetX Duo™ IPv4/IPv6 TCP/IP networking stack with protocols: DNS, AutoIP, DHCP, FTP HTTP/1.1, HTTPS, TLS, MQTT, SMTP, POP3, PPP, UDP, and more
- Phase-2 IPv6 Ready Logo certification
- USBX™ USB host/device/OTG stack
- GUIX™ graphical user interface framework with WYSIWYG GUIX™ Design Studio
- FileX® 12/16/32 FAT. exFAT-compatible file system
- LevelX® Flash Wear Leveling
- Standardized multi-layer API:
  - Azure RTOS, NetX™, NetX Duo™, USBX™, GUIX™, FileX®
  - Functional Libraries including Security & Encryption, CMSIS DSP, and Captouch
  - Application Framework, Hardware Abstraction Layer (HAL), and Board Support Package (BSP)
- Rich Application Framework to encapsulate many common functions such as security services, audio playback, power management, network messaging, JPEG conversion, and more
- Security & Encryption Library for Symmetric and Asymmetric crypto functions, HASH algorithms, secure key generation, storage, and more

Synergy Microcontrollers

S7 Series High Performance

- 240 MHz ARM® Cortex®-M4 CPU w/FPU
- Up to 4 MB Code Flash
- Up to 640 KB SRAM
- Dual Ethernet MAC Controller w/PTP
- USBHS and USBFS
- CAN, SSI, QSPI, and SDHI
- Graphics LCD Controller w/2D Drawing Engine
- Capacitive Touch Sensing Unit
- TRNG, Symmetric and Asymmetric Crypto, HASH
- Functional Safety support

S5 Series High Integration

- 120 MHz ARM® Cortex®-M4 CPU w/FPU
- Up to 2 MB Code Flash
- Up to 640 KB SRAM
- Ethernet MAC Controller w/PTP
- USBHS and USBFS
- CAN, SSI, QSPI, and SDHI
- Graphics LCD Controller w/2D Drawing Engine
- Capacitive Touch Sensing Unit
- TRNG, Symmetric and Asymmetric Crypto, HASH
- Functional Safety support

S3 Series High Efficiency

- 48 MHz ARM® Cortex®-M4 CPU w/FPU
- Up to 1 MB Code Flash
- Up to 192 KB SRAM
- USBFS
- CAN, SSI, QSPI, and SDHI
- 14-bit A/D Converter and 12-bit D/A Converter
- OPAMP
- High-Speed and Low-Power Analog Comparators
- Capacitive Touch Sensing Unit
- TRNG, Crypto, HASH
- Functional Safety support

S1 Series Ultra Low Power

- 32 MHz ARM® Cortex®-M0+ CPU
- 48 MHz ARM® Cortex®-M23 CPU
- Up to 256 KB Code Flash
- Up to 32 KB SRAM
- USBFS
- CAN
- Up to 16-bit SAR A/D Converter, 24-bit SD A/D Converter, 12-bit D/A Converter
- Low-Power Analog Comparator
- Capacitive Touch Sensing Unit
- TRNG and AES
- Functional Safety support

Synergy Tools & Kits

IAR Embedded Workbench for Renesas Synergy

- IAR C/C++ compiler for ARM® C compiler
- C-SPY® debugger
- C-STAT® and C-RUN® code analytics tools
- Support for IAR I-jet™ with power consumption analysis

e² studio, an Integrated Solution Development Environment (ISDE)

- GNU ARM® C/C++ compiler
- Smart Manual — Context-aware embedded documentation

Common to IAR Embedded Workbench for Synergy and e² studio

- Project Generator to generate start-up code
- Pin, Clock, and Interrupt Configurator to generate start-up code
- GUIX™ Studio — Desktop graphical user interface design tool
- Segger J-Link debugger
- RTOS-aware debugging via J-Link® JTAG and Single Wire Debug (SWD)
- TraceX® real time task monitoring for Azure RTOS

Kits

- Starter Kits (SK) for low-cost introduction to using the entire Synergy Platform, with access to most Synergy MCU features and pins
- Development Kits (DK) for full project development. Modular access to all Synergy MCU features and pins
- Target Board Kits (TB) allow easy access to all MCU pins for prototyping

Synergy Solutions

Product Example Kits (PE)

- Human Machine Interface with brilliant color TFT-LCD and wired/wireless connectivity
- Industrial data logger with precision analog and wireless

Application Example Kits (AE)

- Capacitive touch evaluation modules
- Cloud connectivity reference using either Ethernet, Wi-Fi or cellular connectivity

Solution Gallery

- One stop hub to download tools, software, application projects, and more
- Get documentation, application notes, and working projects for all Synergy devices

renesas.com/synergy

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Notice

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   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.
   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.
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SALES OFFICES

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Renesas Electronics Corporation
TOYOSU FORESIA, 3-2-24 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Renesas Electronics America Inc. Milpitas Campus
1001 Murphy Ranch Road, Milpitas, CA 95035, U.S.A.
Tel: +1-408-432-8888, Fax: +1-408-434-5351

Renesas Electronics America Inc. San Jose Campus
6024 Silver Creek Valley Road, San Jose, CA 95138, USA
Tel: +1-408-284-8200, Fax: +1-408-284-2775

Renesas Electronics Canada Limited
9251 Yonge Street, Suite 8309 Richmond Hill, Ontario Canada L4C 9T3
Tel: +1-905-237-2004

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
Room 101-T01, Floor 1, Building 7, Yard No. 7, 8th Street, Shangdi, Haidian District, Beijing 100085, China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai 200333, China
Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

Renesas Electronics Hong Kong Limited
Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2265-6688, Fax: +852 2886-9022

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
80 Bendemeer Road, #06-02 Singapore 339949
Tel: +65-6213-0200, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.
Unit No 3A-1 Level 3A Tower 8 UOA Business Park, No 1 Jalan Pengaturcara U1/51A, Seksyen U1, 40150 Shah Alam, Selangor, Malaysia
Tel: +60-3-5022-1288, Fax: +60-3-5022-1290

Renesas Electronics India Pvt. Ltd.
No.777C, 100 Feet Road, HAL 2nd Stage, Indiranagar, Bangalore 560 038, India
Tel: +91-80-67208700

Renesas Electronics Korea Co., Ltd.
17F, KAMCO Yangjae Tower, 262, Gangnam-daero, Gangnam-gu, Seoul, 06265 Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5338

Renesas Electronics Corporation

www.renesas.com

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