RENESAS

BIG IDEAS FOR EVERY SPACE

RE FAMILY

Low Power and Energy Efficiency MCU

2020.12

RENESAS RE

RE FAMILY

The World's Most Energy Efficient MCUs with Arm® Cortex® M Core Implemented on Silicon on Thin Buried Oxide (SOTB)

CONTENT

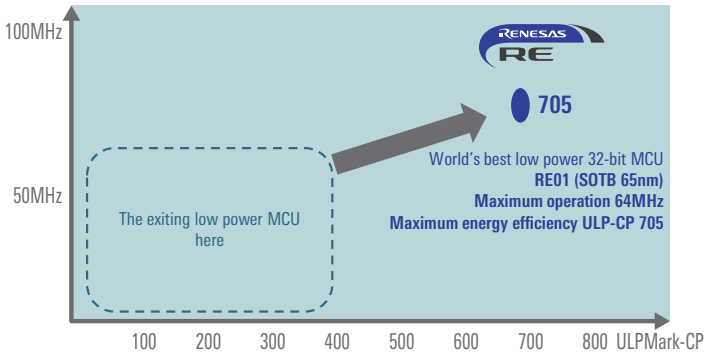
Please visit the web site for details.

https://www.renesas.com/products/microcontrollers-microprocessors/re.html

RE Family Positioning in MCU Portfolio

WW top level ULP-CP score 705 certified by EEBC

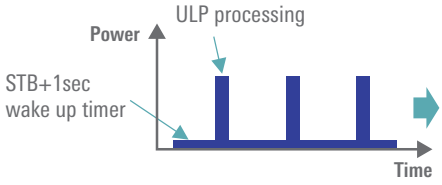
The RE Family based on the Silicon on Thin Buried Oxide (SOTB™) process technology realizes both ultra-low current consumption in both active and standby mode and high speed CPU operation (64MHz) at low voltage (1.62V), which is impossible to achieve with conventional bulk silicon processes. The RE01 has been certified by EEMBC to have the highest score of 705 for the ULPMark-CP by the EEMBC ULPMark™ benchmark, which has been developed to provide a standard method to compare the energy efficiency of ultra-low power MCUs.



EEMBC ULPMark™

A benchmark for low energy consumption.
Energy consumption in the case of from standby to processing every second

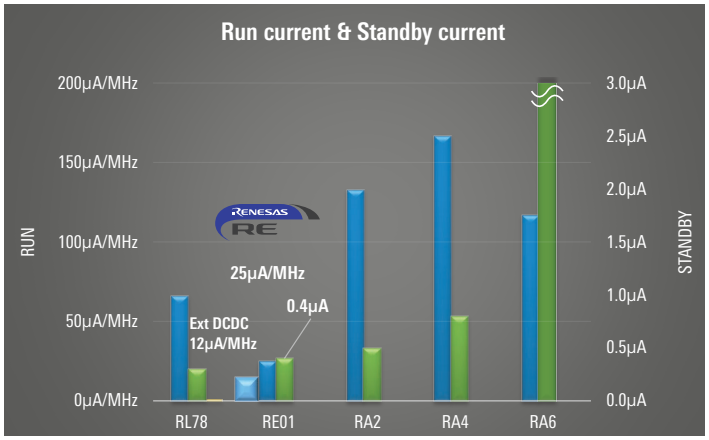
EEMBC CERTIFIED
https://www.eembc.org/ulpmark/scores.php

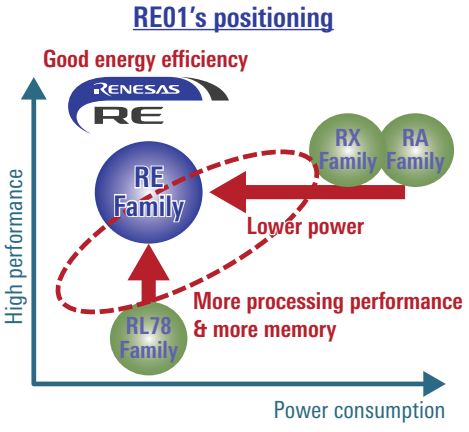


The smaller the total area, the higher the score.

Low Power and Energy Efficiency

The low power consumption and high energy efficiency MCU allows you to add CPU processing capabilities that were previously impossible to battery-powered applications. This feature makes it possible to add new functional value to conventional application.



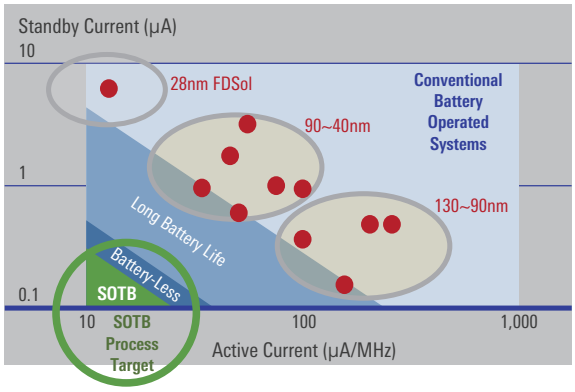


RE family's contribution
1) Existing applications with good balance between low consumption and high-speed processing needed
2) Utilizing energy harvesting with a limited electric power source

The Benefit of SOTB™ Process Technology

Exclusive SOTB technology from Renesas breaks the previous trade-off between getting either low active current or low standby current consumption – previously you could only choose one. With SOTB, you get both without compromise. Additionally, SOTB supports high operating frequency for high performance and small silicon node geometry for high-density memory.

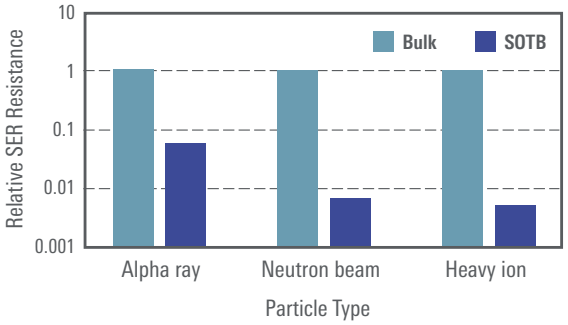
- One of the best energy efficiency in WW
- Active: 25µA/MHz, 12µA/MHz (external DCDC ISL9123)
- Software Standby: 400nA with SRAM 128KB retention



Another benefit of SOTB:
SOTB's soft error immunity is more than 10 times better than bulk-Si.

Soft Error Rate (SER) approaches zero

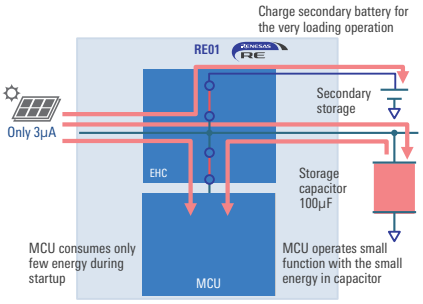
Immunity to code/data corruption by radiation



Supporting Energy Harvesting Power

The power circuit system for supporting the energy harvesting power supply is carried. In addition, it supports rechargeable batteries. This makes it possible to build a hybrid power supply system that does not require battery replacement.

1. Quick start
   - Quick start is supported with small energy stored in storage capacitor. Small start up current 3µA by active management of MCU blocks.
2. Charge secondary battery
   - Overcharge prevention, reverse current protection



Product Outline

Common features

- **Operating Voltage: 1.62V to 3.6V**
- Operating temperature: -40°C to 85°C
- External clock oscillators
  - 8 to 32 MHz, 32.768 kHz
- On-chip clock oscillators
  - LOCO 32.768 kHz
  - MOCO 2 MHz
  - HOCO 24/32/48/64 MHz
- **Ultra-low power by SOTB**
- **Energy Harvesting Controller (3µA bootup)**
- **Ultra-low power HMI (2DG + 8-bit MIP)**
- **Ultra-low power ADC (at 4µA)**
- **Crypto engine for security with Root of Trust**

64-MHz Arm®Cortex®-M0+ CPU — R7F0E017 — DIV | NVIC | SWD | MTB

Memory	Analog	Timing & Control	HMI
Code Flash (1.5 MB)	***14-Bit A/D Converter (18 ch.)***	*PWM Timer 32-Bit x 2, 16-Bit x 4*	***Memory In Pixel Display parallel Interface***
SRAM (256 KB)	*12-Bit D/A Converter x 1*	*Wake Up Timer 32-Bit x 1*	***2D Graphics Data Conversion Circuit***
	Vref out	*LP Timer 16-Bit x 2*	*Key Interrupt*
	Analog Comparator x 1	*CCC (1sec Event Timer) x 1*	*LED driver*
	Temperature Sensor	*8-bit Timer x 4*	
	Motor Driver for Watches	*RTC*	

Connectivity	System & Power Management	Safety	Security & Encryption
USART w/o FIFO x 5	*DMA Controller x 4*	*Flash Access Window*	*TSIP-Lite*
w/ FIFO x 2	*Data Transfer Controller*	*ADC Diagnostics*	*128-Bit Unique ID*
SPI x 2	*Event Link Controller*	*ADC Disconnection Detection*	*TRNG*
IIC x 2	*Low Power Modes*	*Clock Accuracy Circuit*	***AES (128/256)***
QSPI x 1	*Multiple Clocks*	*CRC Calculator*	*Hidden Root Key*
USB x 1	*CCC*	*Data Operation Circuit*	*Flash Access Window*
	SysTick	*Port Output Enable for GPT*	*Flash ID Code Protection*
	Energy Harvesting Controller	*Independent WDT*	*MPU x 4*

64-MHz Arm®Cortex®-M0+ CPU — R7F0E011

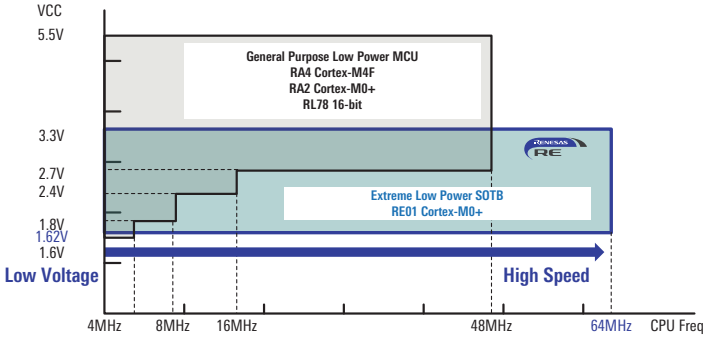
Memory	Analog	Timing & Control	HMI
Code Flash (256KB)	*14-Bit A/D Converter (12 ch.)*	*PWM Timer 32-Bit x 2, 16-Bit x 4*	*Memory In Pixel Display parallel Interface*
SRAM (128 KB)	*Vref out*	*Wake Up Timer 32-Bit x 1*	*2D Graphics Data Conversion Circuit*
	Temperature Sensor	*LP Timer 16-Bits x 2, **32-Bits x 2***	*Key Interrupt*
		CCC (1sec Event Timer) x 1	
		8-bit Timer x 4	
		RTC	

Connectivity	System & Power Management	Safety	Security & Encryption
USART w/o FIFO x 5	*DMA Controller x 4*	*Flash Access Window*	*TSIP-Lite*
w/ FIFO x2	*Data Transfer Controller*	*ADC Diagnostics*	*128-Bit Unique ID*
SPI x2	*Event Link Controller*	*ADC Disconnection Detection*	*TRNG*
IIC x2	*Low Power Modes*	*Clock Accuracy Circuit*	*AES (128/256)*
QSPI x 1	*Multiple Clocks*	*CRC Calculator*	*Hidden Root Key*
	CCC	*Data Operation Circuit*	*Flash Access Window*
	SysTick	*Port Output Enable for GPT*	*Flash ID Code Protection*
	Energy Harvesting Controller	*Independent WDT*	*MPU x 4*

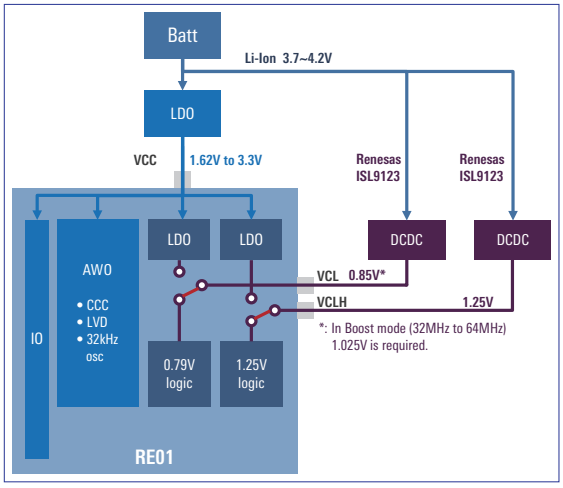
Key Features

1. High-Speed Operation at Low Voltage

With utilizing the characteristics of the SOTB process, it realizes high-speed operation at low voltage. This achieves both reduction of power consumption and maximization of CPU performance.

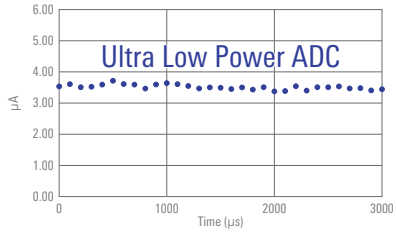


The optional configuration for power supply



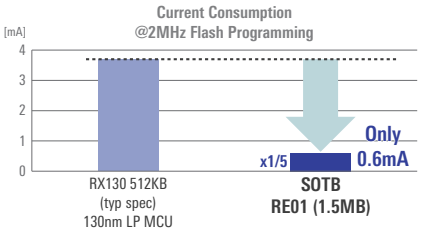
2. Ultra-Low Power Peripherals

14-bit AD converter



- AD conversion at about 4µA (1.68ksps with 32kHz low CL)
- Enables data sensing with ultra low power consumption in IoT edge devices

Integrated Flash memory



- Flash programing with only 0.6mA
- Reducing battery depletion concerns for Over-The-Air IoT FW updates

Ultra low power MIP-LCD interface

MIP-LCD IF that enables a display with ultra-low power consumption. Dot rewriting is supported and rewriting is also extremely low power.

MIP: Memory In Pixel

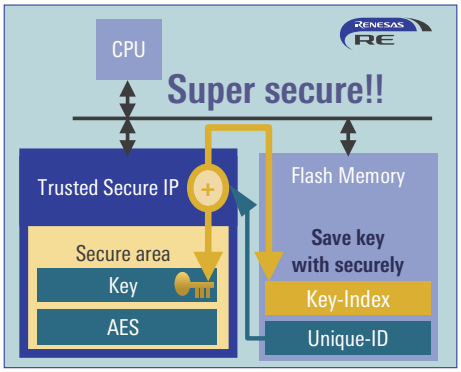
Ultra-low power timer peripherals for ultra-low power applications

- RTC: 350nA @ 1.8V
- 32-bit Wakeup Timer: 30nA @1.8V
- 32-bit General Purpose Timer: 38nA @1.8V-3.3V, 32.768kHz

3. Strong Security

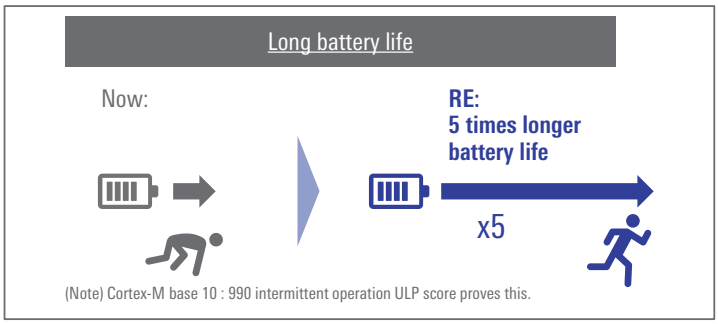
- Trusted Secure IP builds a secure area inside the hardware block by monitoring and controlling unauthorized access. It enables safe operation of the encryption engine and encryption key.
- When storing the encryption key outside the TSIP, it is scrambled by the unique ID and becomes an unreadable key index which enables strong key security.

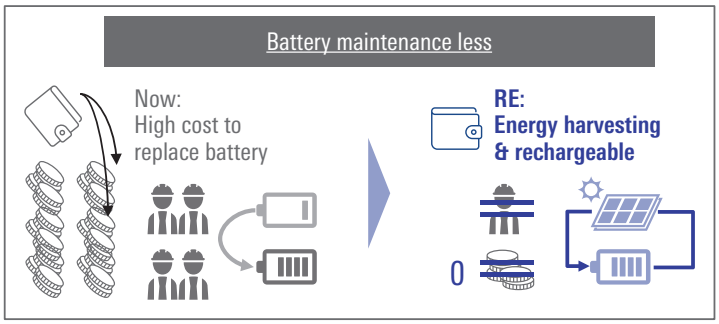
IP	Function		Details
TSIP	AES	Key length	128-bit/256-bit
		Hidden Root Key	Supported
		Modes	ECB, CBC, CTR, CMAC, CCM, GCM, XTS
	TRNG		128-bit/256-bit
	Unique-ID		Used to generate key index
	Access management		Prevent unauthorized access
Flash	Flash area protection		Used for secure-boot and secure-OTA to protect authentication program.
	Flash ID code protection		ID code protection for the flash programming from a host device

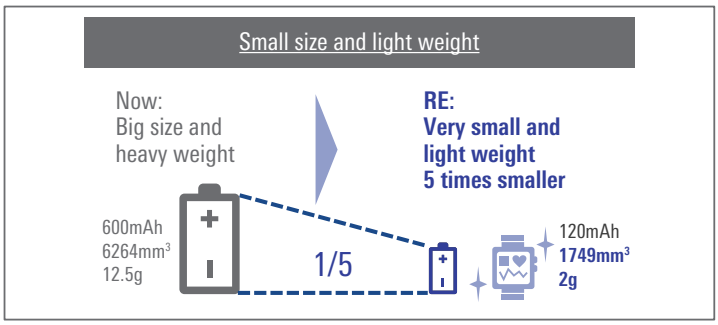


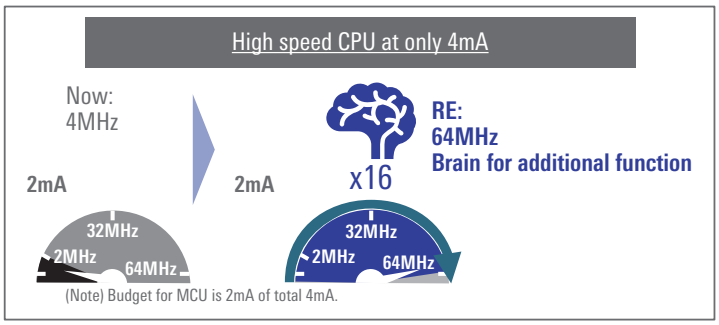
RE's Benefits and Target Applications

The RE Family can significantly extend battery life and deliver high performance even for small batteries and energy harvesting power supplies that can supply only a small amount of current. The RE Family is suitable for many IoT applications such as hybrid watch, smart home/building, healthcare, smart agriculture, structure monitoring, and trackers.









Sports Watch/Wearable Device

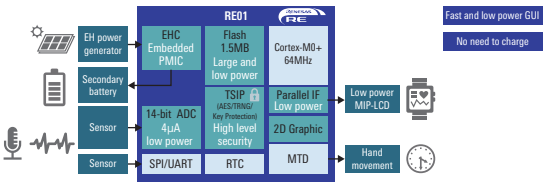
Features

- Energy Harvesting Controller
- Exclusive Low Power of SOTB
  - Active: 35µA/MHz@3.3V
  - Standby: 700nA@3.3V
  - Flash Programming: 0.6mA
- High speed 64MHz 32bit CPU with low power consumption
- Ultra-low-power MIP-LCD I/F
- 2D Graphic engine
- Trusted secure IP (AES TRNG)
- 1.5MB Large size Flash memory and 256KB large SRAM
- Small CSP package

Benefits

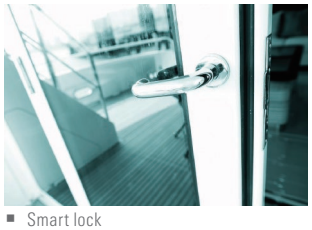
- Solar charging assist
- Ultra low consumption clock operation
- Sensor function
- Graphic display function
- Voice recognition user IF
- Personal data protection
- Virus infection prevention

Block Diagram



Smart Home (Water leakage detection, Smart lock)

- Water leakage detection
- Various sensor



- Smart lock

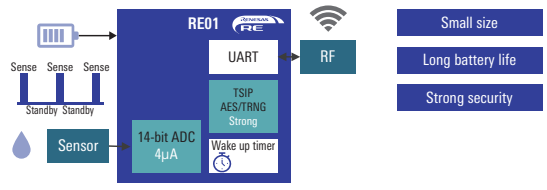
Features

- Energy Harvesting Controller
- Ultra Low Power Consumption
  - Active: 25µA/MHz@3.3V
  - Standby: 500nA@3.3V
  - Flash Programming: 0.6mA
- Ultra low power 14-bit ADC only 4µA
- Trusted secure IP (AES TRNG)
- Memory protection unit
- Flash Programming: 0.6mA
- Small Package (QFN/CSP)

Benefits

- Battery maintenance less
- Small size battery can allow the form factor flexibility
- Virus infection prevention

Block Diagram



Healthcare (Portable ECG)

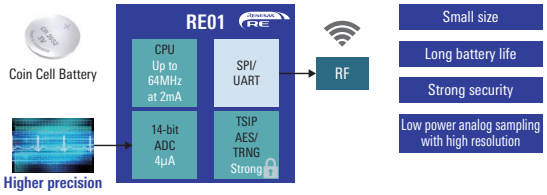
Features

- Energy Harvesting Controller
- Ultra Low Power Consumption
  - Active: 25µA/MHz@3.3V
  - Standby: 500nA@3.3V
  - Flash Programming: 0.6mA
- Ultra low power 14-bit ADC only 4µA
- Trusted secure IP (AES TRNG)
- Memory protection unit
- Small Package (QFN/CSP)

Benefits

- Provides 64MHz processing with 4mA coin battery
- Personal data protection
- Small size battery can allow the formfactor flexibility

Block Diagram



Smart Agriculture & Structure Health Monitoring

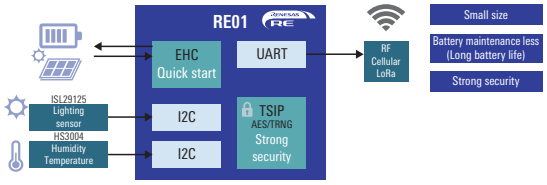
Features

- Energy Harvesting Controller
- Ultra Low Power Consumption
  - Active: 25µA/MHz@3.3V
  - Standby: 500nA@3.3V
  - Flash Programming: 0.6mA
- Ultra low power 14-bit ADC only 4µA
- Trusted secure IP (AES TRNG)
- Memory protection unit

Benefits

- Battery maintenance less
- Energy harvesting enables easier installation and longer product lifetime
- Prevents farm damage from virus infection

Block Diagram



Location (GPS) Tracker

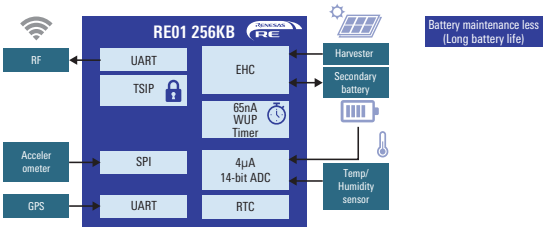
Features

- Energy Harvesting Controller
- Ultra Low Power Consumption
  - Active: 25µA/MHz@3.3V
  - Standby: 500nA@3.3V
  - Flash Programming: 0.6mA
- Ultra low power 14-bit ADC only 4µA
- Trusted secure IP (AES TRNG)
- Memory protection unit

Benefits

- Preventing missing tracking by maintenance less
- Battery maintenance less
- Prevents farm damage from virus infection

Block Diagram

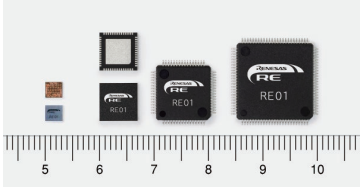


Product Functional Specification

Items		RE01_256KB				RE01_1.5MB		
CPU		Cortex-M0+ 64MHz						
Flash		256KB				1.5MB		
SRAM		128KB				256KB		
Package		LQFP		WLBGA	QFN	WLBGA	LQFP	LQFP
Pin count		100	64	72	56	156	144	100
Current consumption	Active current while(1) peripheral suspended	25µA/MHz@32MHz (w/ External DCDC 12µA/MHz)				35µA/MHz@32MHz (w/ External DCDC 15µA/MHz)		
	Standby current	400nA@1.8V (typ) 500nA@3.3V (typ)				500nA@1.8V (typ) 800nA@3.3V (typ)		
Code Flash Memory / SRAM		256KB / 128KB				1.5MB / 256KB		
CPU operation frequency		64MHz (Boost mode) 32MHz (Normal mode) 32kHz (Low leakage current mode)						
Clock		MainOSC, SubOSC, HOCO, MOCO, LOCO (PLL is not available)				PLL, MainOSC, SubOSC, HOCO, MOCO, LOCO		
Timer	GPT32/16	6ch						
	AGT 16-bit Timer (Return from Standby Timer)	2ch						
	AGTW 32-bit Timer (Return from Standby Timer)	2ch				NA		
	TMR, RTC, CCC, WDT, IWDT	2ch, 1ch, 1ch, 1ch, 1ch						
Communication function	SCI (UART/IIC/SPI)	5ch (w/o FIFO) + 2ch (w/ FIFO)						
	RIIC	2ch	1ch	2ch	1ch	2ch		
	SPI	1ch (128-bit buffer) + 1ch (32-bit buffer)						
	QSPI	1ch						
	USB	NA				1ch		
Analog	S14AD 14-bit ADC	12ch	8ch	12ch	7ch	18ch		12ch
	R12DA 12-bit DAC	NA				1ch		
	TEMP (Temperature sensor)	1ch						
	ACMP (Analog comparator)	NA				1ch		
	VREF	1ch						
	LED (for watch)	NA				3ch		NA
HMI	MIP-LCD Parallel IF	Available						
	Motor Driver (watch movement)	NA				3ch		NA
Graphic	GDT 2D Graphic	Available						
Security	TSIP-Lite AES/TRNG/Key Management)	With / Without (Option)						

Ordering References

Products			56 QFN	64 LQFP	72 WLBGA	100 LQFP	144 LQFP	156 WLBGA
Group	Flash/ RAM	TSIP (Security)	7 x 7mm 0.4mm pitch	10 x 10mm 0.5mm pitch	3.16x2.88mm 0.3mm pitch	14 x 14mm 0.5mm pitch	20 x 20mm 0.5m pitch	4.27 × 4.47mm 0.3mm pitch
RE01 1500KB	1.5MB/ 256KB	Yes	-	-	-	R7F0E015D2CFP	R7F0E015D2CFB	R7F0E017D2DBN
		No	-	-	-	R7F0E014D2CFP	R7F0E014D2CFB	R7F0E016D2DBN
RE01 256KB	256KB/ 128KB	Yes	R7F0E01182DNG	R7F0E01182CFM	R7F0E01182DBR	R7F0E01182CFP	-	-
		No	R7F0E01082DNG	R7F0E01082CFM	R7F0E01082DBR	R7F0E01082CFP	-	-



Evaluation Kit

Both EK-RE01 1500KB and EK-RE01 256KB support MCU current measurement, energy harvesting evacuation and sensor connectivity expansion through PMOD or /and Arduino interface.

EK-RE01 1500KB
RTK70E015DS00000BE

EK-RE01 256KB
RTK70E0118S00000BJ

Tools for Software Development

Items	IAR EWARM IAR C/C++	Renesas e² studio GCC ARM
IAR I-Jet	✓	NA
SEGGER J-Link	✓	✓
Renesas E2/E2-Lite	NA	✓

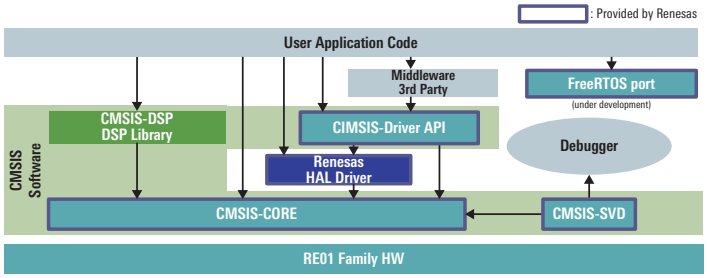
Items	Renesas		SEGGER
Writer Software	PG-FP6	RFP	J-Flash
Writer	PG-FP6	Serial-USB USB	J-Link
Communication	UART	UART USB	SWD

Software Solution

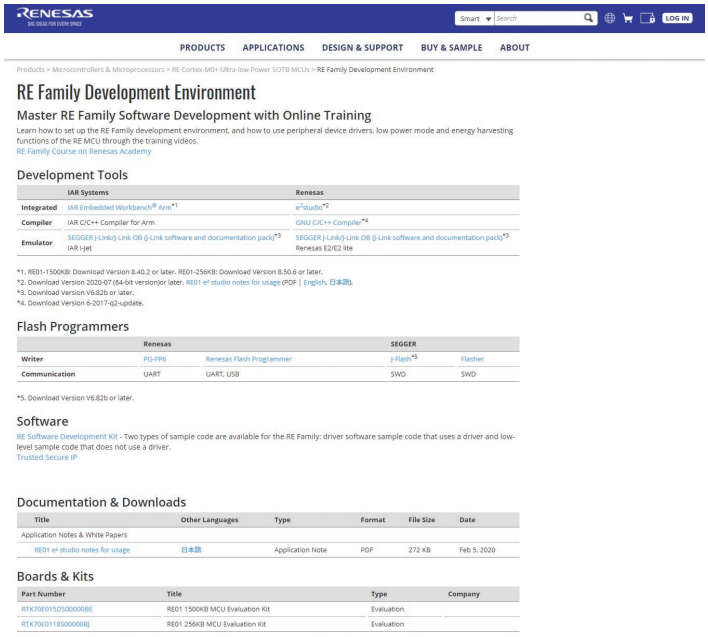
Getting Started Guide, RE01 Getting Started Guide to Development Using CMSIS Package, is available.

The Getting Started is a document that contains the following essential information for development. We recommend that you refer to it when starting development.

- Procedure/method of using driver (initial clock, pin setting, interrupt setting, program allocation method into RAM, etc.)
- How to set up the debugger in the development environment
- Trouble shooting



Technical Information Provided in Web


RENESAS

PRODUCTS APPLICATIONS DESIGN & SUPPORT BUY & SAMPLE ABOUT

RE Family Development Environment

Master RE Family Software Development with Online Training

Development Tools

	IAR Systems	Renesas
Integrated	IAR Embedded Workbench® Arm*1	e²studio*2
Compiler	IAR C/C++ Compiler for Arm	GNU C/C++ Compiler*4
Emulator	SEGGER J-Link/J-Link OB (J-Link software and documentation pack)*3 IAR I-jet	SEGGER J-Link/J-Link OB (J-Link software and documentation pack)*3 Renesas E2/E2 lite

*1. RE01-1500KB: Download Version 8.40.2 or later. RE01-256KB: Download Version 8.50.6 or later.
*2. Download Version 2020-07 (64-bit version)or later. RE01 e² studio notes for usage (PDF | English, 日本語).
*3. Download Version V6.82b or later.
*4. Download Version 6-2017-q2-update.

Flash Programmers

	Renesas		SEGGER	
Writer	PG-FP6	Renesas Flash Programmer	J-Flash*5	Flasher
Communication	UART	UART, USB	SWD	SWD

*5. Download Version V6.82b or later.

Software

RE Software Development Kit - Two types of sample code are available for the RE Family: driver software sample code that uses a driver and low-level sample code that does not use a driver.
Trusted Secure IP

Documentation & Downloads

Title	Other Languages	Type	Format	File Size	Date
Application Notes & White Papers					
RE01 e² studio notes for usage	日本語	Application Note	PDF	272 KB	Feb 5, 2020

Boards & Kits

Part Number	Title	Type	Company
RTK70E015DS00000BE	RE01 1500KB MCU Evaluation Kit	Evaluation	
RTK70E0118S00000BJ	RE01 256KB MCU Evaluation Kit	Evaluation	

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