

RENESAS SOTB™ RE MCU FAMILY INTRODUCTION

[RE FAMILY]



RENESAS ELECTRONICS CORPORATION

A W A R D S

Electronic PRODUCTS
Product of the year 2019
Finalist



ELECTRONS D'OR
2019
Best Digital Product



IOT WORLD 2019
Best In Show



Produkte des Jahres 2020
Finalist



Design & Elektronik
Innovator of the year 2019
Chip Production



2019 WEAA
Microcontroller
/Interface of the year

World Electronics
Achievement Awards

AGENDA

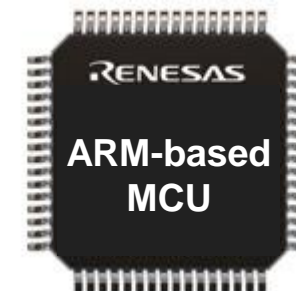
- RE MCU Powered by SOTB™ Technology
- SOTB™ RE Family Demos
- Target Applications
- RE01 MCU Feature Highlight
- SOTB™ RE Family Ecosystem
- SOTB™ RE Family Product Offering
- Summary



RE MCU POWERED BY SOTB™ TECHNOLOGY



RENESAS ARM CORE BASED MCU SOLUTIONS



New



- **Ultra-Low Power Solution**
- SOTB™ Process

- **Energy Harvesting controller**
- **Ultra low power ARM Cortex M0+**
- **ULPMark-CP 705**
- **Run 25uA/MHz (12uA/MHz w/ extDCDC)**
Standby 400nA
- **ADC 4uA & Flash Programming 600uA**
- **Wake up timer 30nA**
- **RTC in Deep Standby 250nA**



- **MCU Solution**
- Open Ecosystem

- Efficient Software HAL driver
- **ARM Cortex® M4, M33, M23**
- Enhanced Security & Trustzone Technology
- Most robust Capacitive Touch

Renesas Synergy™

- **Fully Qualified Platform**
- Fast time to market

- Guaranteed & maintained Software
- **ARM Cortex® M0+, M4, M23**
- Integrated & tested Middleware
- Partnered with Microsoft (Express Logic)



- **MPU Platform Solution**
- Leading MPUs for Industrial Network & Real-time Control

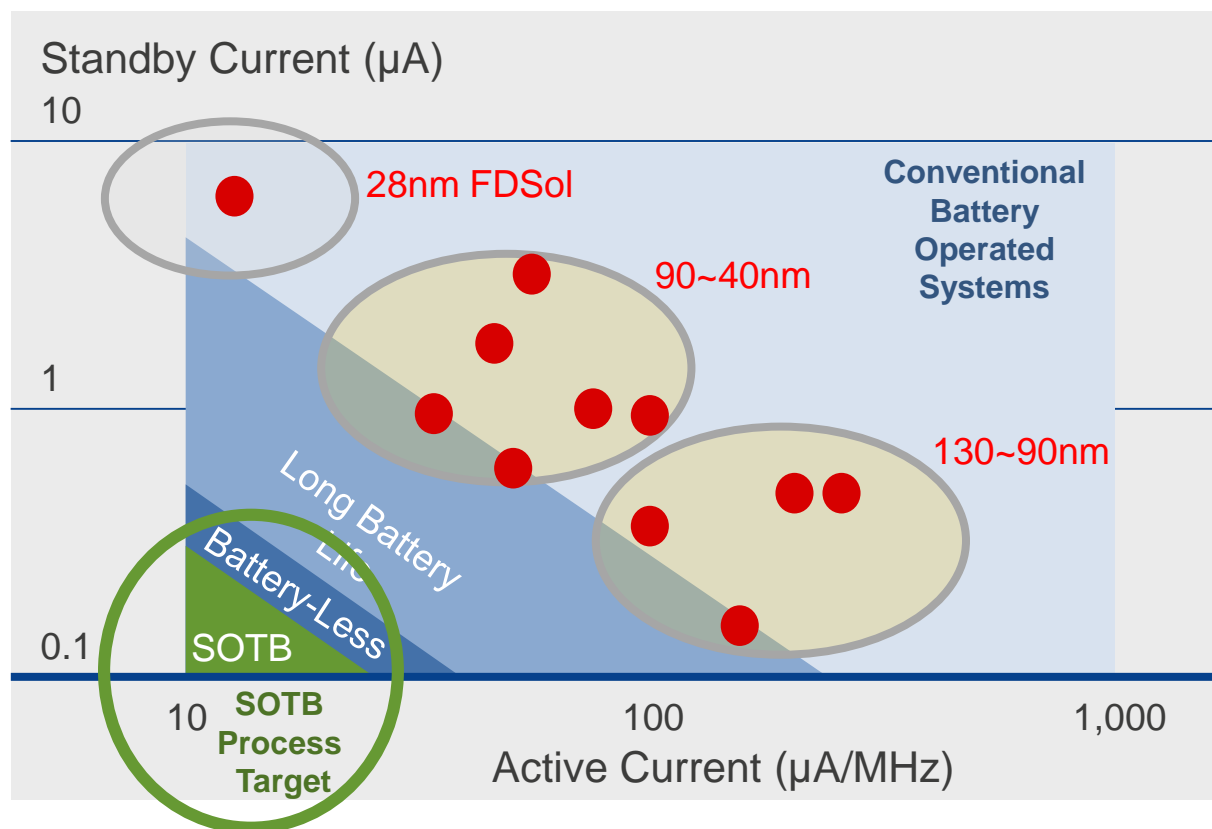
- Scalable Software Platform Solution
- **ARM Cortex , A7, A9, A15, A53, A57 and R4**
- High-resolution HMI, Embedded artificial intelligence, multiprotocol industrial communication, Motor Control & PLC

SOTB™ PROCESS TECHNOLOGY

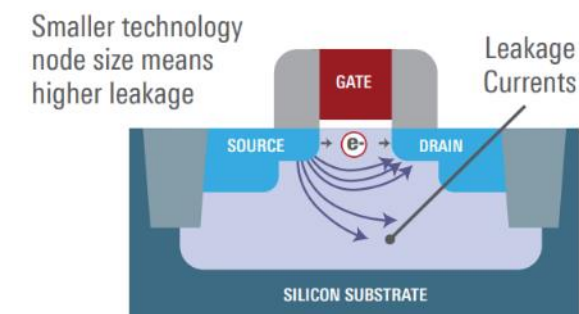
SILICON ON THIN BURIED OXIDE



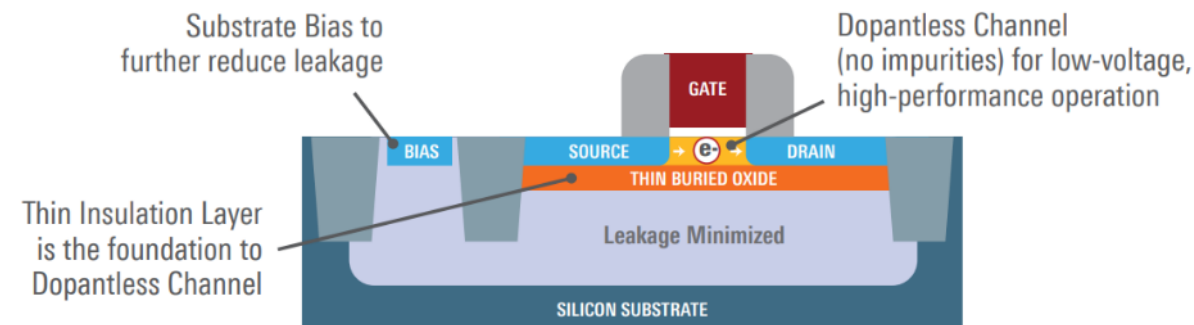
Ultra low operating current × Ultra low standby current
 Low voltage 1.62V × High speed operation up to 64MHz



Conventional Bulk Transistor



SOTB Transistor and Back Bias Control



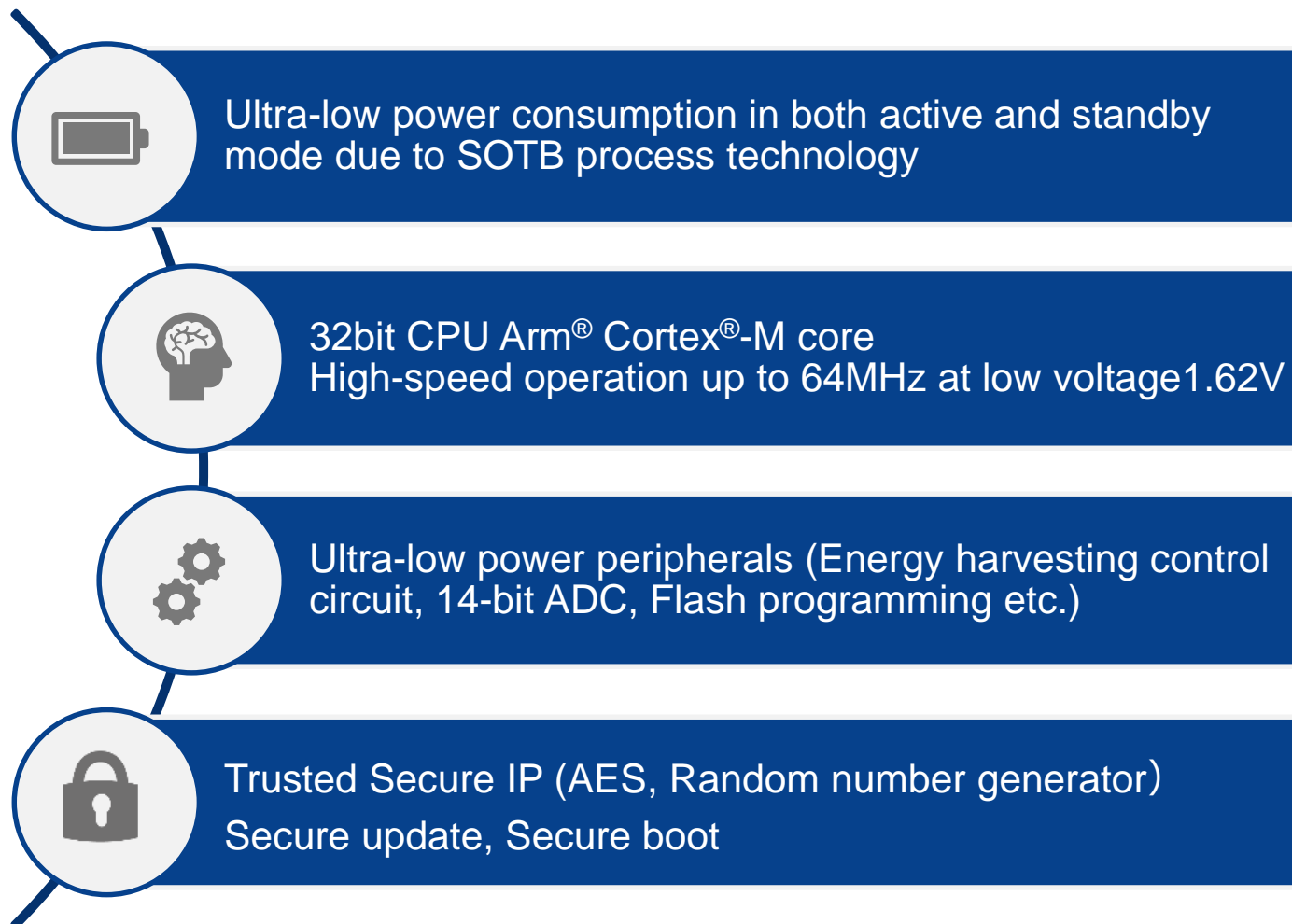
RE FAMILY

POWERED BY WORLD'S BEST LOW POWER SOTB™ PROCESS TECHNOLOGY



SOTB™ Process Technology

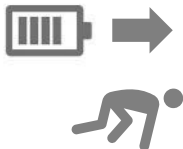
***The World's Most
Energy Efficient MCU***



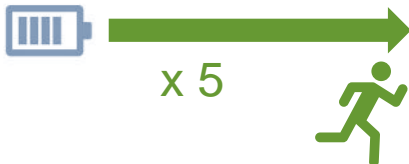
VALUE OF RE FAMILY

Wearable, Portable devices Free from battery replacement

Today :



with RE:
5 times longer battery life



(note) Cortex-M base 10 : 990 intermitted operation ULP score proves this.

Home automation, Wearable Small size and light weight

Today :
Big size and
heavy weight

600mAh
6264mm³
12.5g



1/5

with RE:
Very small and
light weight
5 times smaller



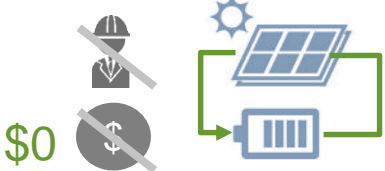
120mAh
1749mm³
2g

Agri, Structural Health Monitor Tracker 0 cost to replace battery by Energy harvesting

Today :
High cost to
replace battery

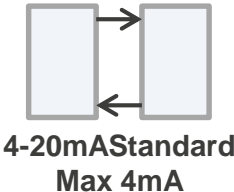


with RE:
Energy harvesting
Zero cost



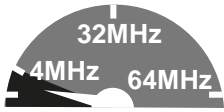
Industry 4-20mA, Healthcare coin battery High speed CPU at only 4mA

Coin Cell
Max.4mA



Today :
4MHz

2mA



with RE:
64MHz

2mA



x16

(note) Budget for MCU is 2mA of total 4mA.

SOTB™ PROCESS TECHNOLOGY

THE WORLD'S TOP-CLASS ENERGY EFFICIENCY



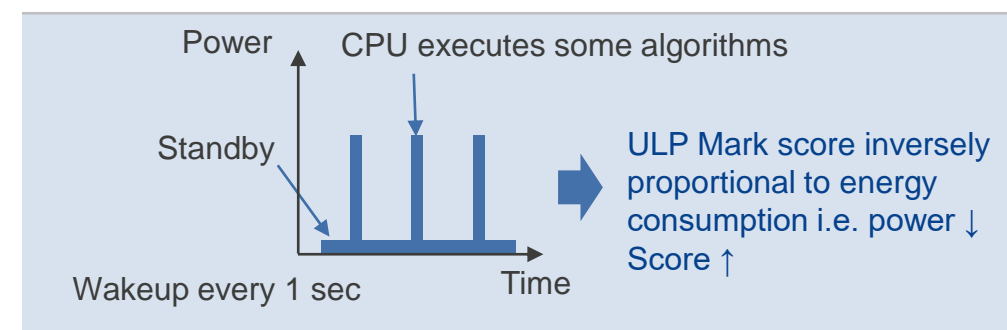
- RE01 achieves one of the highest ULP Mark-CP score 705 at 1.8V



<https://www.eembc.org/ulpmark/scores.php>

| Clear | Hardware | Vendor Score | Cert. | Core Profile (3.0 V) | Core Profile (User) | Periph. Profile (3.0 V) | Periph. Profile (User) | Date ↓ |
|--------------------------|---|--------------|-------|----------------------|---------------------|-------------------------|------------------------|------------|
| <input type="checkbox"/> | Renesas Electronics R7F0E01182CFP | ✓ | ✓ | 366 | 705 1.8V | | | 2020-04-04 |
| <input type="checkbox"/> | Renesas Electronics R5F117GC | ✓ | ✓ | | | 122 | 219 1.8V | 2019-11-13 |
| <input type="checkbox"/> | STMicroelectronics STM32WB3x/5x Rev Y | ✓ | ✓ | 158 | 303 1.8V | | | 2019-04-10 |
| <input type="checkbox"/> | Microchip Technology ATSAML10E16A rev B | ✓ | ✓ | 277 | 396 1.8V | 120 | 166 1.8V | 2019-03-01 |
| <input type="checkbox"/> | Microchip Technology ATSAML11E16A rev B | ✓ | ✓ | 280 | 410 1.8V | 118 | 167 1.8V | 2019-03-01 |
| <input type="checkbox"/> | STMicroelectronics STM32L412 Rev A | ✓ | ✓ | 247 | 447 1.8V | 94.0 | 167 1.8V | 2018-10-17 |
| <input type="checkbox"/> | STMicroelectronics STM32L552 Rev1 | ✓ | | 267 | 402 1.8V | 33.5 | 59.5 1.8V | 2018-10-15 |
| <input type="checkbox"/> | Analog Devices ADuCM4050 Rev 0.1 | ✓ | ✓ | 189 | | 24.3 | | 2018-07-04 |
| <input type="checkbox"/> | Analog Devices ADuCM302x Rev1.0 | | | | | 3.43 | 3.47 1.8V | 2018-03-12 |
| <input type="checkbox"/> | Silicon Labs EFM32PG1B200F256 + 32KB SRAM retention | | | | 135 1.8V | | | 2018-02-11 |
| <input type="checkbox"/> | Silicon Labs EFM32PG1B200F256 | | | 106 | 144 1.8V | | | 2018-02-11 |
| <input type="checkbox"/> | Silicon Labs EFM32HG322F64 | | | 101 | 157 2.0V | 4.84 | 8.03 2.0V | 2018-02-09 |
| <input type="checkbox"/> | Silicon Labs EFM32LG990F256 | | | 74.2 | 114 2.0V | 35.9 | 57.2 2.0V | 2018-02-09 |
| <input type="checkbox"/> | Texas Instruments MSP432P401R Rev. C + BOD/SVS + 64K SRAM | | | 150 | 208 1.8V | 7.08 | 12.4 1.8V | 2018-02-09 |
| <input type="checkbox"/> | Silicon Labs EFM32TG840F32 | | | 97.6 | 150 2.0V | 40.4 | 64.9 2.0V | 2018-02-09 |
| <input type="checkbox"/> | Silicon Labs EFM32GG995 | | | 72.1 | 111 2.0V | 33.3 | 51.7 2.0V | 2018-02-09 |
| <input type="checkbox"/> | Silicon Labs EFM32WG380 | | | 77.7 | 115 2.1V | 37.1 | 58.3 2.0V | 2018-02-08 |
| <input type="checkbox"/> | Silicon Labs EFM32GG995 + 128K SRAM retention | | | 67.8 | 102 2.0V | 32.0 | 50.0 2.0V | 2018-02-08 |

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



SOTB™ RE FAMILY DEMOS



VOICE RECOGNITION DEMO (ULTRA-LOW POWER 1.0mA)

Contact sales for demo availability

RE01 Customer Benefits

1. Operates with a Small Battery

Ultra-low power consumption enables voice recognition feature for energy conscious battery-operated devices while keeping the battery size small

2. High-resolution Voice Recognition

14-bit high-resolution ADC at Ultra-low power

3. Interactive Processing Possible

64MHz high-speed CPU operation for real-time voice recognition processing

4. Ultra-low Power LCD Support

8-bit parallel MIP LCD (MLCD) for ultra-low power display applications

Photo

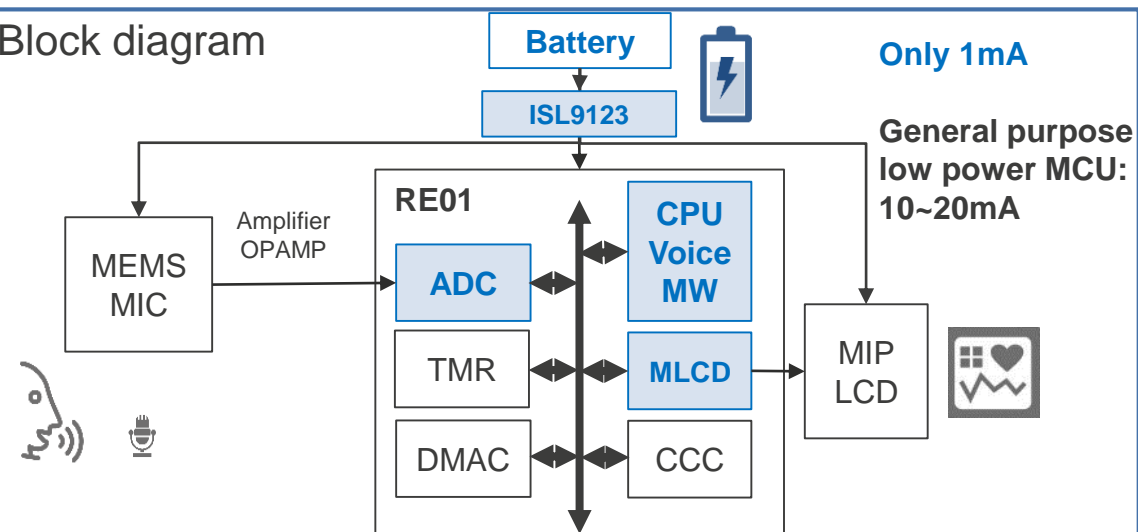
MIC module*
(MEMS MIC + OPAMP)

*ADMP401 MEMS MIC module

Parallel MIP
(Low power LCD)



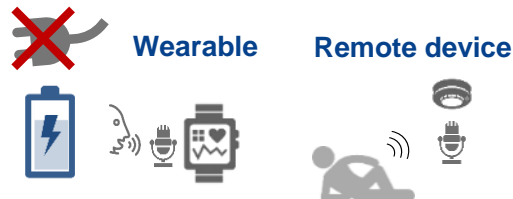
Block diagram



Previous (AC power)
Installation restrictions



RE (Small battery)
No restrictions, small

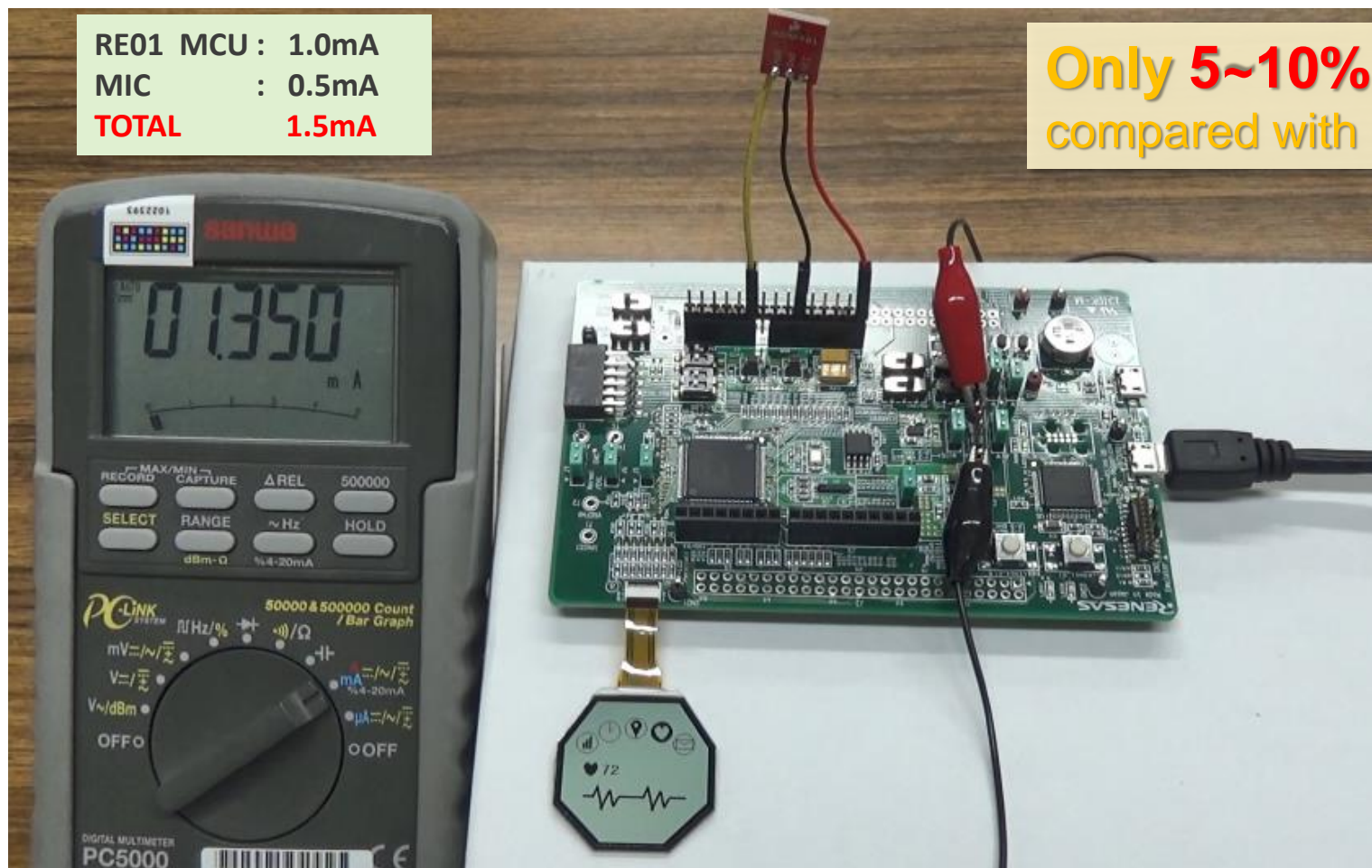


VOICE RECOGNITION DEMO (ULTRA-LOW POWER 1.0mA) AMI MIDDLEWARE



Contact sales for demo availability

- For wearable and codeless HA (Faucet, Dispenser, Bathroom etc..)



RE01 MCU : 1.0mA
MIC : 0.5mA
TOTAL 1.5mA

Only 5~10% of energy is required
compared with general purpose low power MCUs

External DCDC mode is used to lower the power

“Power on”

“Watch”

“Heart rate”



“GPS”

“Power off”

ENERGY HARVESTING QUICK STARTUP DEMO

RE01 Customer Benefits

1. Very Quick Energy Harvesting Startup

Operable CPU by EHC quick startup during charging

2. Ultra-low Power Consumption

can run on only 1 small solar panel, or small thermoelectric power generator harvester with DCDC converter.

3. Huge Maintenance Cost Reduction

Human-maintenance free: Automatic program recovery without human intervention after the program shuts down due to lack of power source, then restart when power source is available.

Target Applications

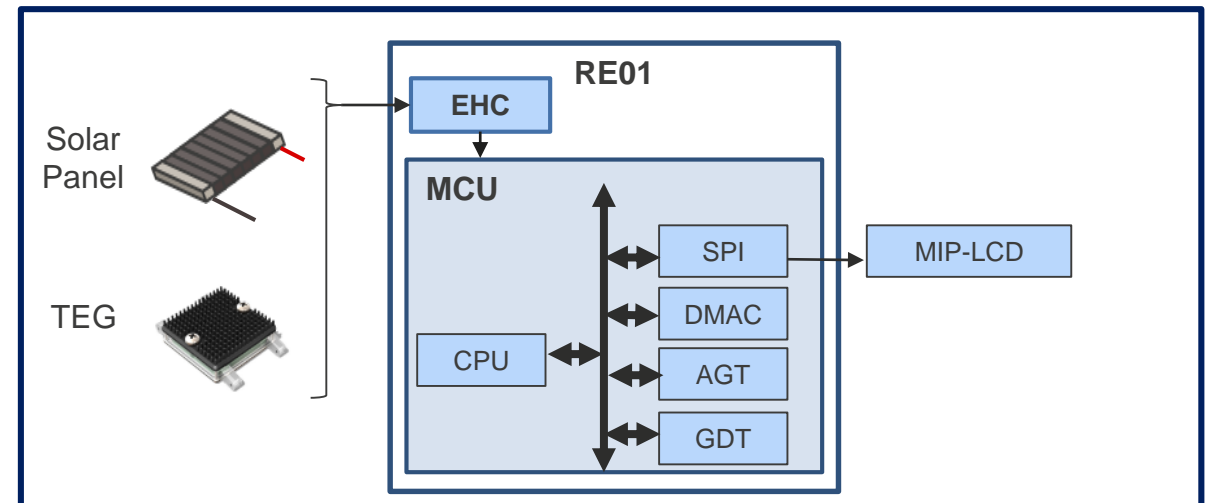
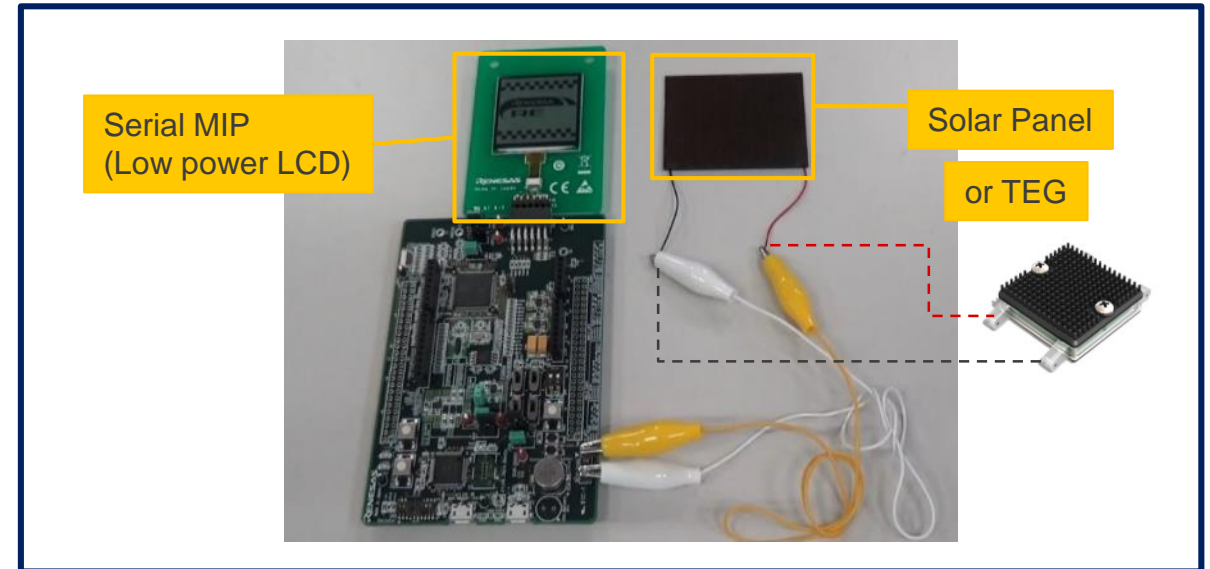


Wearables: the device can start immediately without having to wait for the charging to complete.



Smart Agri & Structure monitor: Semi-permanent autonomous operation suitable for places that are difficult to reach. During installation, the device can also send visuals to inform the users that the installation is successful.

Application Note: ([Link](#))



ENERGY HARVESTING GPS DEMO FOR GNSS TRACKING APPLICATIONS



Contact sales for demo availability

RE01 Customer Benefits

1. GNSS System Without a Battery

RE01 can accumulate energy from a small solar panel to operate a GNSS system. No external PMIC part is required.

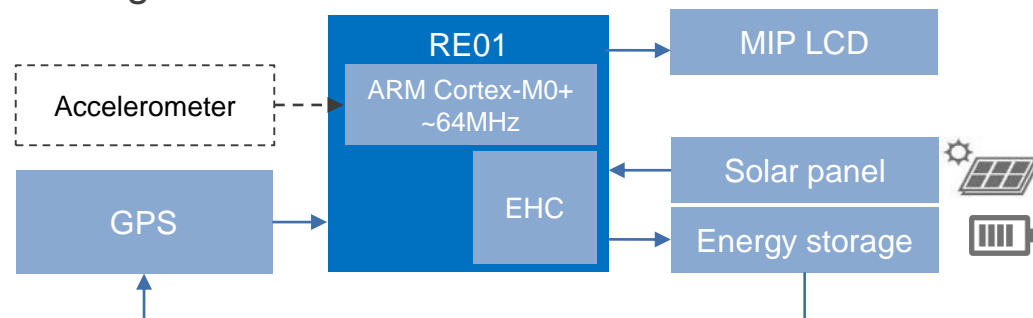
2. Energy Harvesting Power Management System

Energy harvesting power management is available to download from here Application Note R01AN4837 ([Link](#))

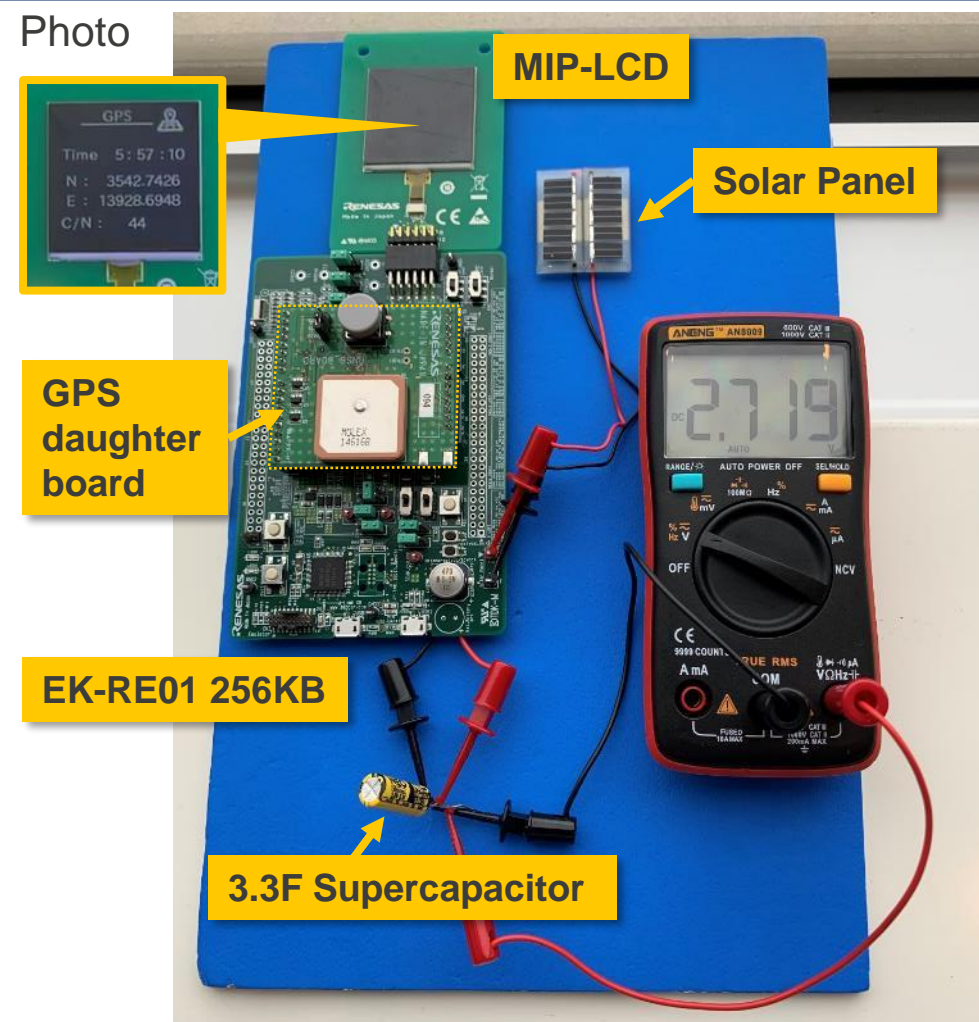
3. Compact and Stylish Product Design

Simple circuitry and no need of large battery reduces BOM cost and make a customer product design compact and stylish.

Block diagram for location tracker



Photo



TARGET APPLICATIONS



TARGET MARKETS AND APPLICATIONS

Wearable/Watch



- Solar drive
- High-speed CPU for accelerometer/heart rate sensor processing
- Low power graphic MIP-LCD

Smart Home



- Improved design with smaller battery
- Water consumption detection, human sensor

Smart Lock



- Eliminates battery maintenance
- Prevention of battery exhaustion

Structural Health Monitor



- Battery replacement cost reduction by energy harvesting

Healthcare



- High-speed processing with coin battery up to 4mA
- Ultra low power ADC 4uA FW update 600uA

Smart Meter



- Low consumption RTC
- OTA with large capacity memory
- Strong security

Smart Agriculture



- Easy installation and battery replacement by energy harvesting
- Cost reduction

Tracker



- Prevents missing by eliminating battery replacement

WEARABLE / HYBRID WATCH EXAMPLE

CASIO G-SHOCK



Renesas' RE Family Adopted as Main Controller of G-SHOCK Watch with Heart Rate Monitor and GPS Functionality



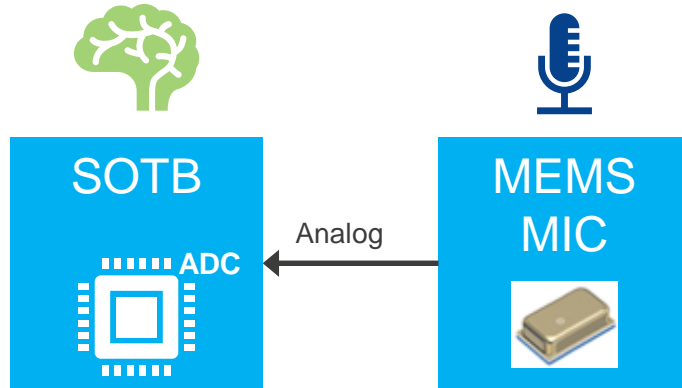
RE01-1.5MB was adopted by Casio for its new G-Shock product. Casio's first product equips smartphone features that have become common these days, such as EKG (heart rate monitor) and GPS.

RE01-1.5MB's value for Wearables:

1. Ultra-low power 32bit CPU sensor processing
2. Ultra-low power clock operation
3. Ultra-low power 2D graphic MIP-LCD display
4. Large Flash ROM to store display data

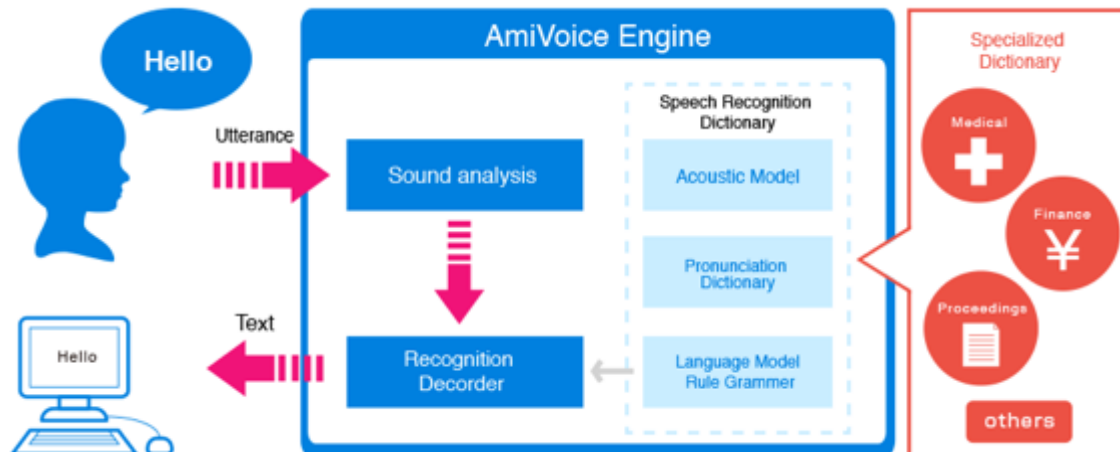
WEARABLE / HYBRID WATCH EXAMPLE

ULTRA-LOW POWER VOICE RECOGNITION



Ultra-low Power Voice Recognition Solution

- RE01 Cortex-M0+ 64MHz enables ultra-low power voice recognition
- Only 0.8mA overhead current for voice recognition
- Enables the addition of voice-recognition to a watch or remote-control which has small storage of battery.

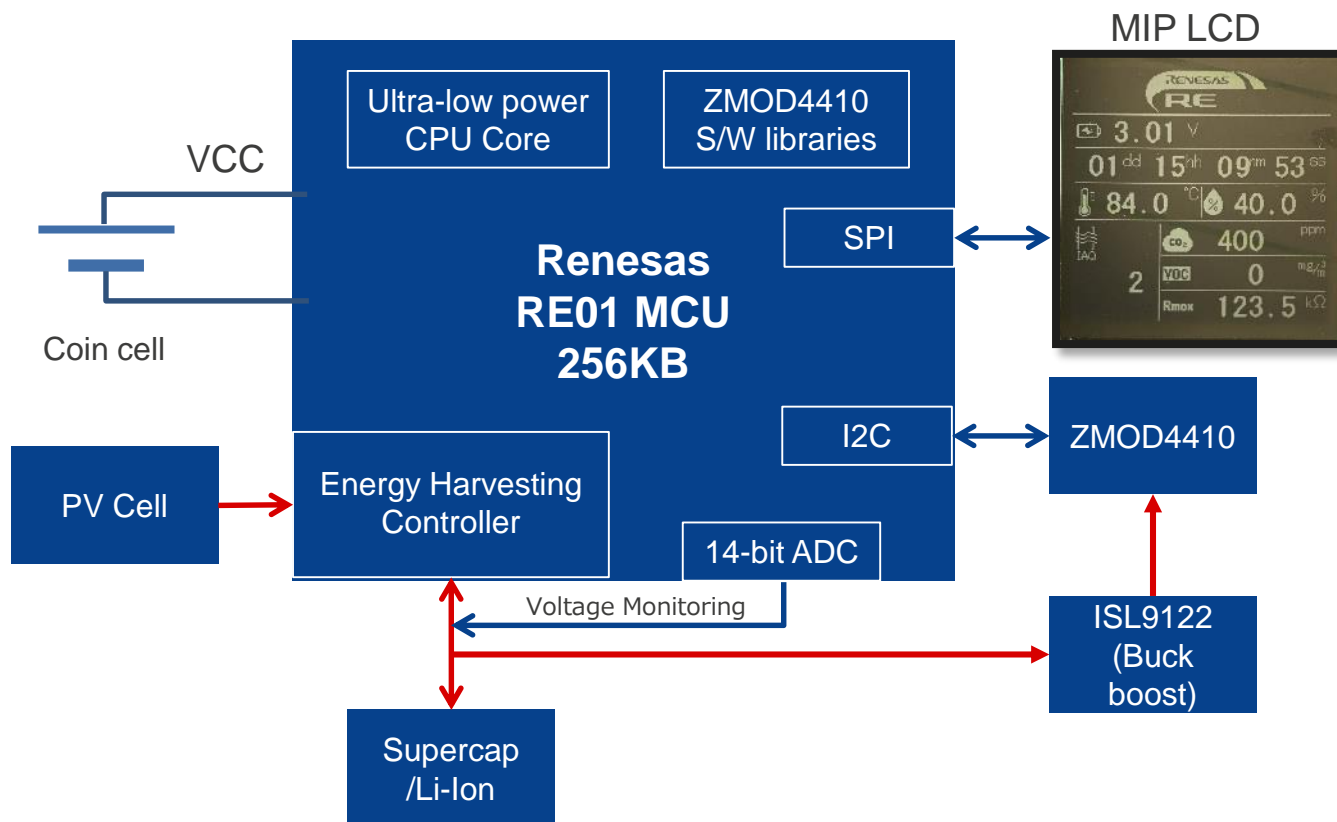


SMART HOME EXAMPLE

ULTRA-LOW POWER AIR QUALITY MONITOR (AQM)



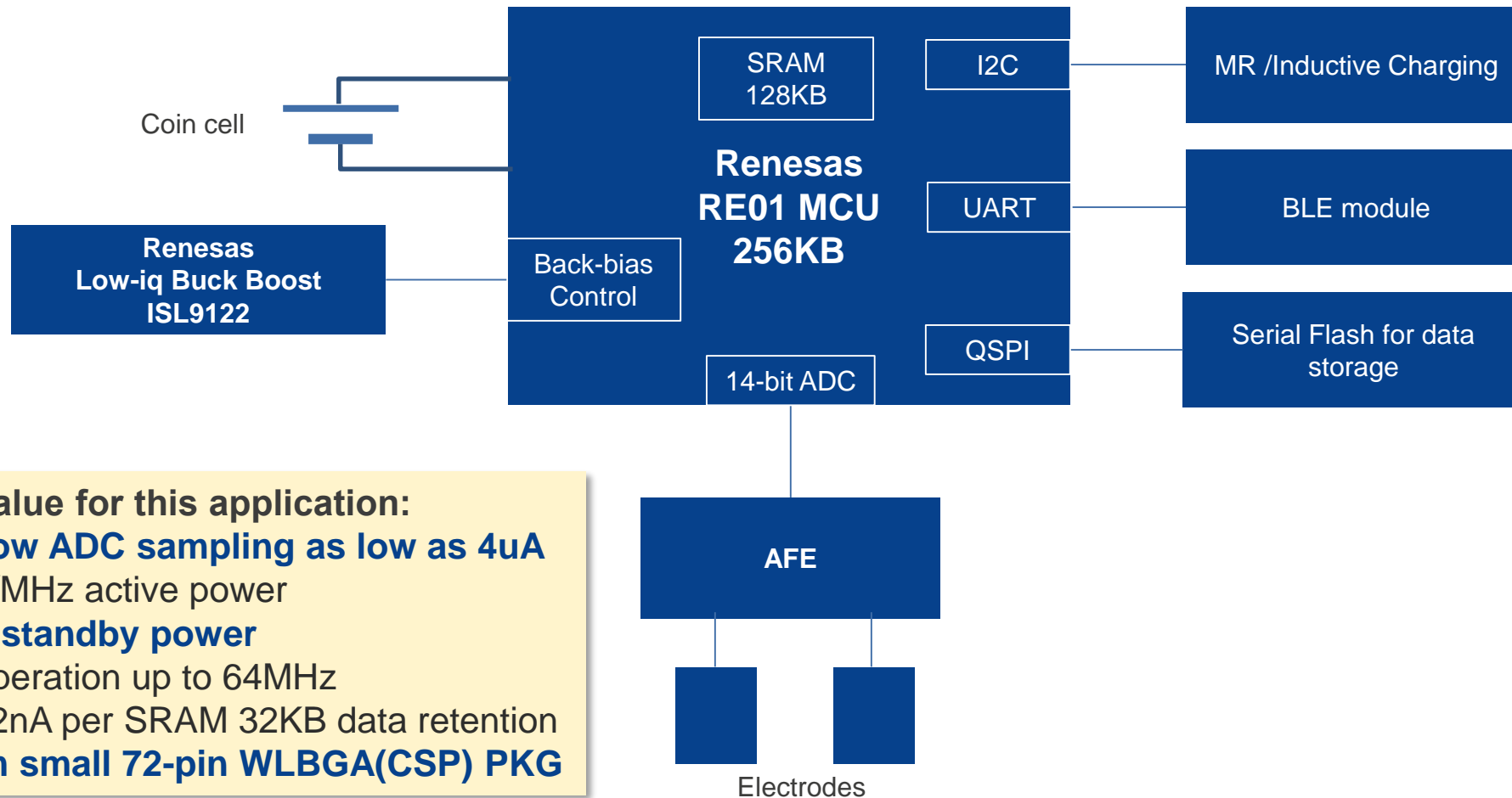
- Ultra-low power AQM application using RENESAS ZMOD4410 gas sensor
- A gas sensor is power consuming in general but RE MCU can double the battery life by enabling a hybrid power system using a solar panel and a primary battery



RE01B's value for this application:

- **Ultra-low power at both active and standby**
- Combo solution with the ZMOD4410 for its ultra-low power firmware support (the release is planned)
- **Cost effective PV cell energy harvesting can extend the battery life significantly**

BIO-SENSING WEARABLES EXAMPLE

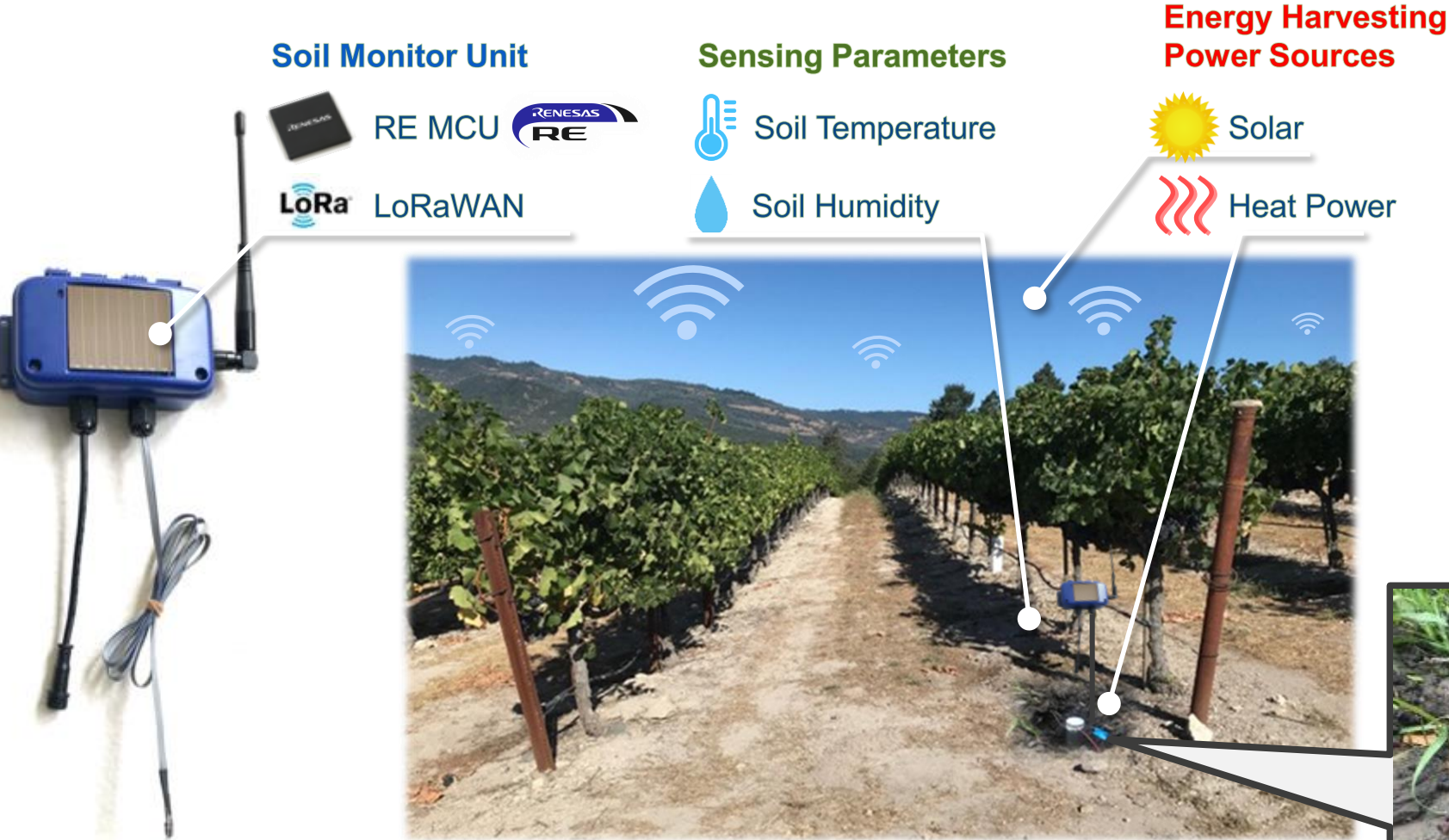


RE01's value for this application:

- **Ultra-low ADC sampling as low as 4uA**
- **<15uA/MHz active power**
- **400nA standby power**
- CPU operation up to 64MHz
- Only 12nA per SRAM 32KB data retention
- **3x3mm small 72-pin WLBGA(CSP) PKG**

SMART AGRICULTURE EXAMPLE

BATTERY-LESS SOIL MONITOR



Issues of the smart farming in the farm field

- No Power
- Poor Connectivity

RE01's value

Our solution

- Energy Harvesting – No battery needed
- Long-range radio enablement



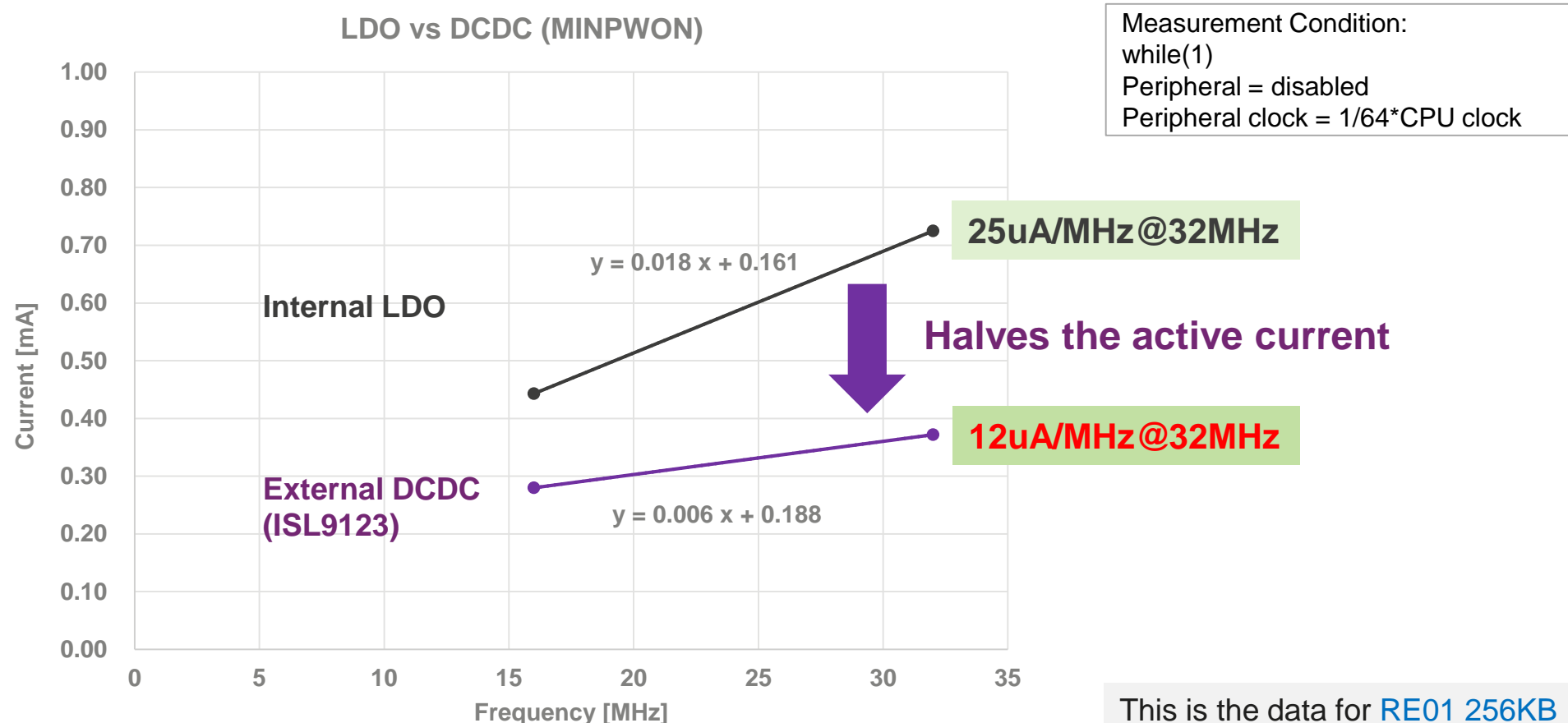
Proof-of-concept sensor

RE01 MCU FEATURE HIGHLIGHT



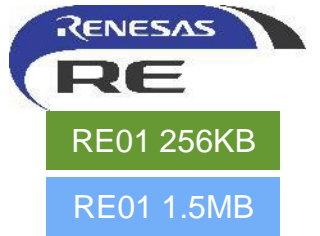
RE01 KEY FEATURES : ACTIVE CURRENT REDUCTION

- Active current of the RE01 can be **halved** by using an external DCDC such as RENESAS ISL9123

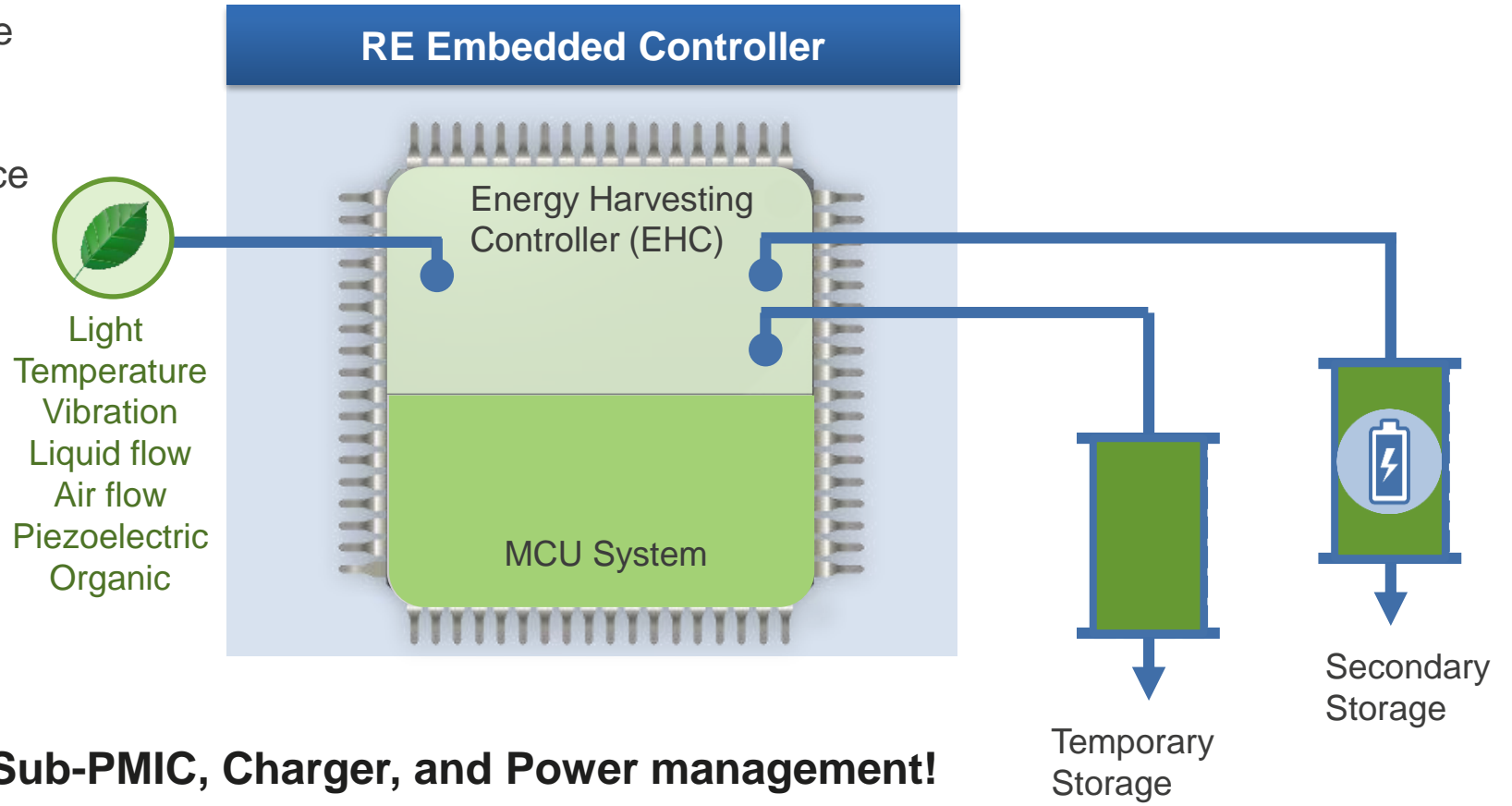


RE01 KEY FEATURES : ENERGY HARVESTING CONTROLLER

VERY UNIQUE FEATURE ON MICROCONTROLLER



- Small start-up current **5uA** at minimum
- Multiple power source & charge storage management
- Autonomous & reliable startup sequence
- Overcharge prevention
- Charge detection
- Reverse current protection
- Quick start function
- Simultaneous charge mode for battery and capacitor

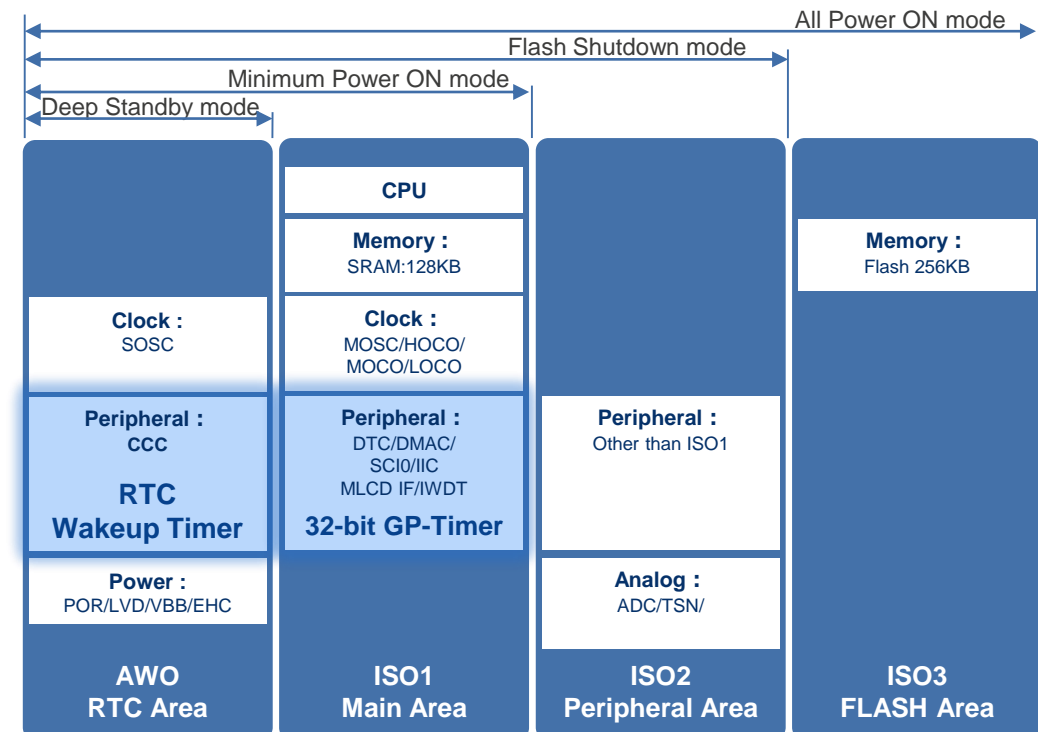


RE01 256KB KEY FEATURES : ULTRA-LOW TIMERS

- 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**

These 32-bit timers can create **36.4hours** at 32kHz resolution

These ultra-low power timers are suitable for ultra-low power applications such as metering that requires **very long duty cycle** and **high resolution**

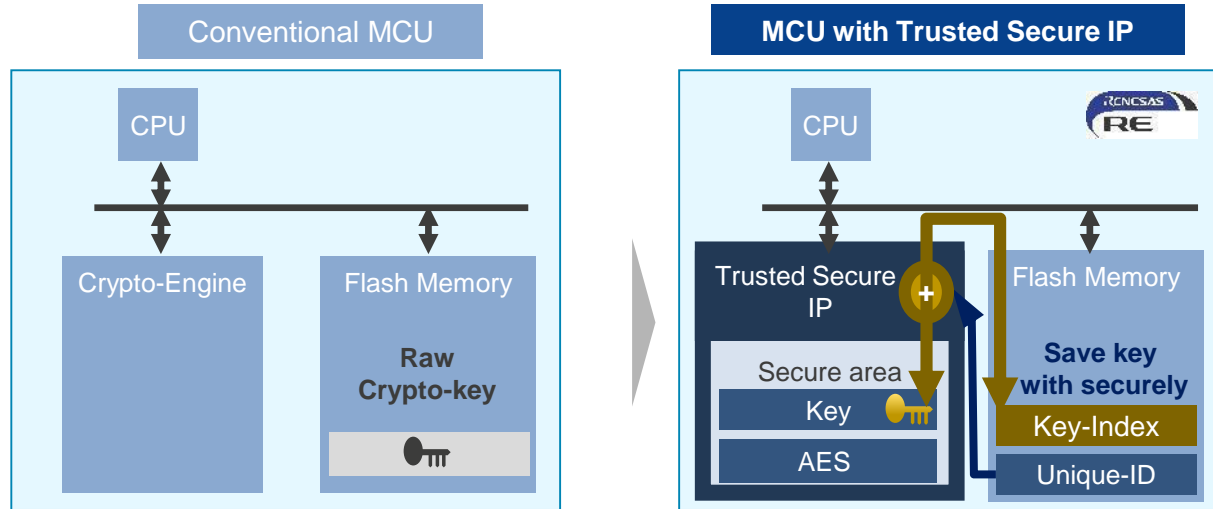




RE01 256KB

RE01 1.5MB

MCU FEATURE : STRONG SECURITY (TRUSTED SECURE IP)



- 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, the key is scrambled by the unique ID and becomes an unreadable key index which is a strong key security

Security features on RE01

| IP | function | | details |
|-------|--------------------------|-----------------|---|
| TSIP | AES | Key length | 128bit/256bit |
| | | Hidden Root Key | Supported |
| | | Modes | ECB, CBC, CTR, CMAC, CCM, GCM, XTS |
| | TRNG | | 128bit/256bit |
| | Unique-ID | | Used to generate key index |
| Flash | Access management | | Prevent unauthorized access |
| | 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 |

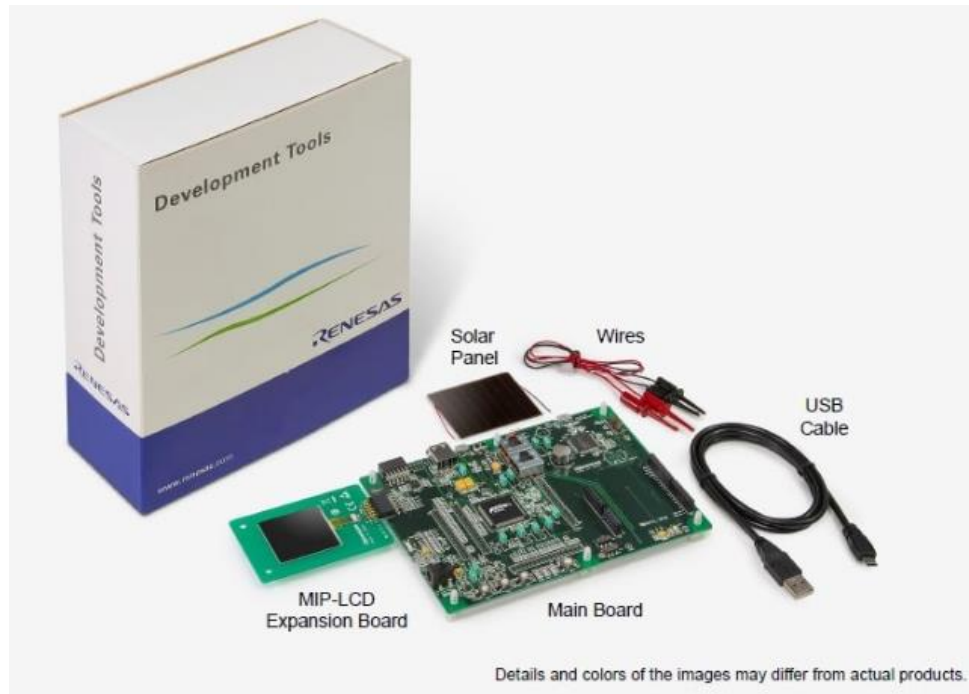
SOTB™ RE FAMILY ECOSYSTEM



RE01 EVALUATION KITS FOR RE01 PARTS

RTK70E015DS00000BE

RE01 EK-1.5MB for RE01 1.5MB part



RTK70E0118S00000BJ

RE01 EK-256KB for RE01 256KB part




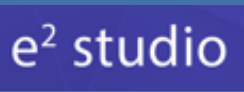




Support Documents

<https://www.renesas.com/us/en/products/microcontrollers-microprocessors/re-cortex-m0-ultra-low-power-sotb-mcus/rtk70e015ds00000be-re01-1500kb-mcu-evaluation-kit>







<https://www.renesas.com/us/en/products/microcontrollers-microprocessors/re-cortex-m0-ultra-low-power-sotb-mcus/rtk70e0118s00000bj-re01-256kb-mcu-evaluation-kit>

INTEGRATED DEVELOPMENT ENVIRONMENT

- Development Tools

| IDE | | IAR EWARM  | Renesas e2 studio  |
|----------|---------------|---|---|
| Compiler | | IAR C/C++ | GCC GNU ARM |
| Emulator | IAR I-Jet | ✓  | NA |
| | SEGGER J-Link | ✓  | ✓  |
| | Renesas E2 | NA | ✓  |

- Flash programmer

| | Renesas | | SEGGER |
|-----------------|---|---|--|
| Writer software | PG-FP6  | RFP  | J-Flash  |
| Writer | PG-FP6  | Serial-USB USB  | J-Link  |
| Communication | UART | UART/USB | SWD |

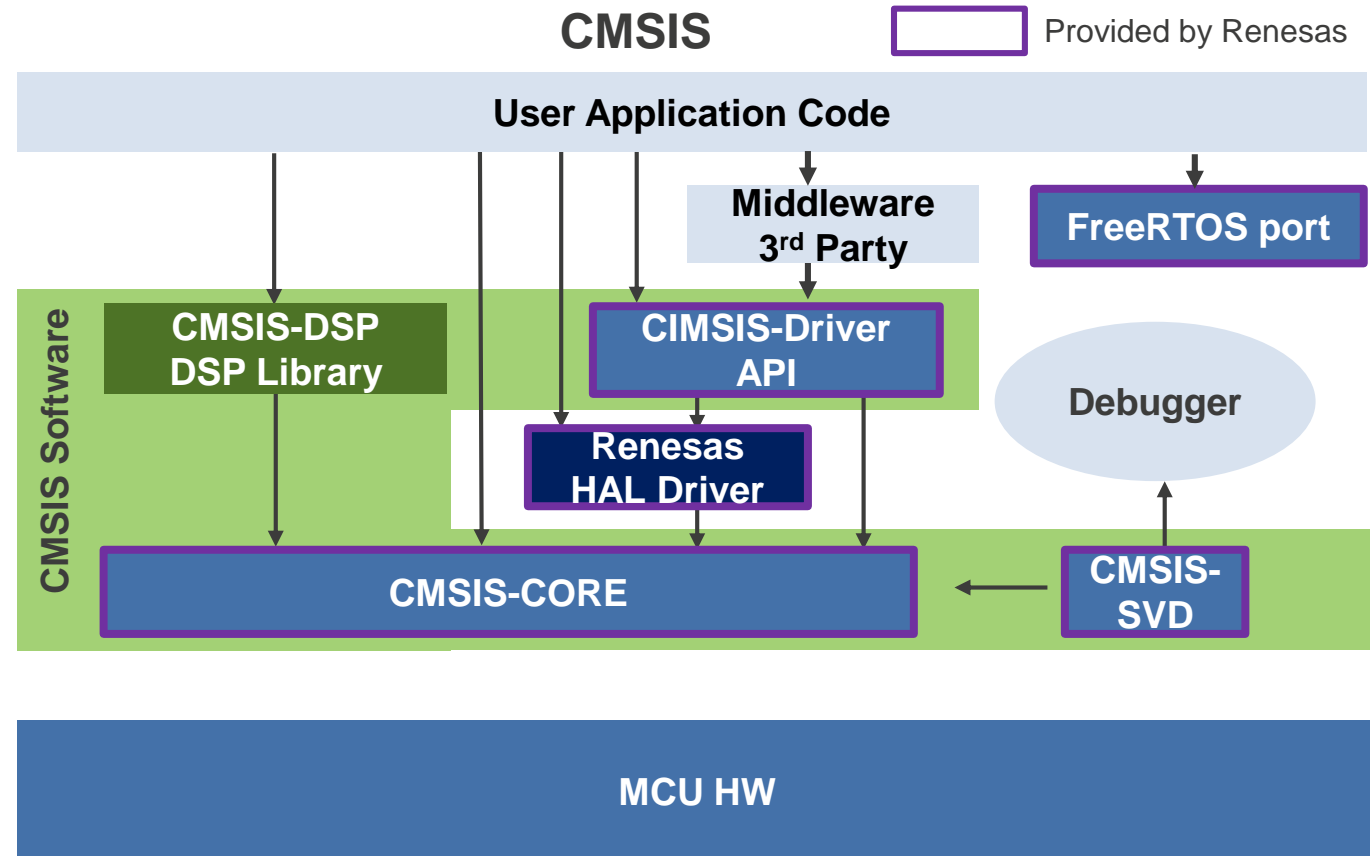
RE01 CMSIS DRIVER SOFTWARE

- ARM CMSIS compliant software package is provided for RE01 MCU group



- CMSIS-SVD
- CMSIS-CORE
- CMSIS-DSP (Provided by ARM)
- CMSIS-DRIVER
 - I2C
 - SPI
 - USART

- Renesas HAL Driver
 - ADC
 - LPM
 - System
 - TSIP
 - 2D-Graphic
 - DMAC/DTC
 - Pin
 - Flash API

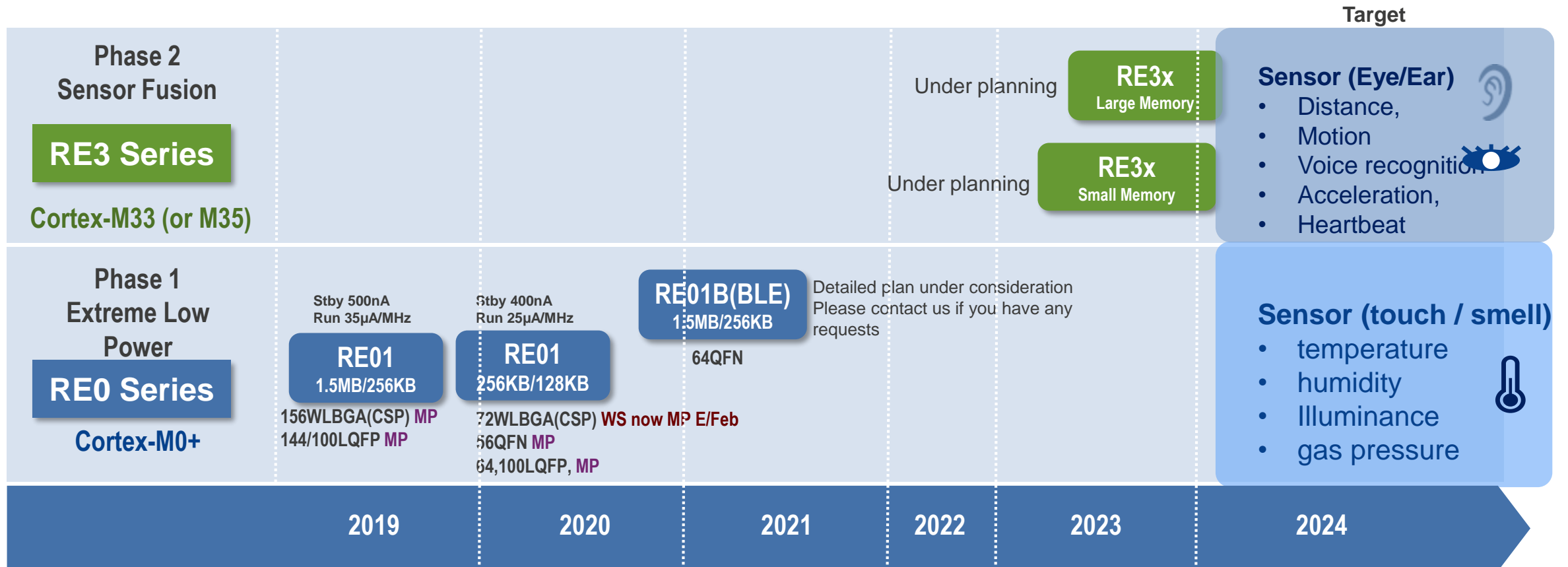


SOTB™ RE FAMILY PRODUCT OFFERING



RE FAMILY ROADMAP

- Cortex-M0+ RE01 for applications that **always requires ultra-low power.**
- Cortex-M33 planning for applications that **requires enhanced real-time signal processing with DSP and FPU.**



IN SUMMARY

- RE01 got world's top level ULP-CP score 705 for its 256KB product – World's best energy efficiency is proven
- RE01's positioning is unique – Best energy efficiency AND Fast CPU speed up to 64MHz
- RE01 implements ultra-low power peripherals (14-bit ADC, 32-bit low power timers, low power Flash for FOTA, etc..) that are beneficial for many ultra-low power applications
- RE is suitable for wearable, smart home, smart agriculture, structural health monitor and tracker
- RE01 extends battery life under limited power supply while it can perform high
- RE01 enables energy harvesting by its built-in Energy Harvesting Controller
- Download RE01 development tools & sample firmware from Renesas web site

THANK YOU!

For more information, visit www.renesas.com/re

