RENESAS SOTB™ RE MCU FAMILY INTRODUCTION

RENESAS ELECTRONICS AMERICA

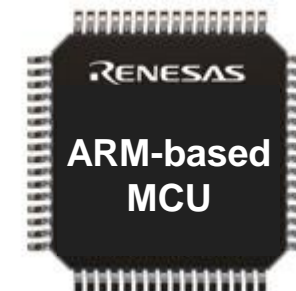BIG IDEAS FOR EVERY SPACE

AGENDA

- **RE MCU powered by SOTB^{TM} Technology**

- **RE01 Family Product Offering**

- **RE01 MCU Feature Highlight**

- **Target Applications & Winning Combo Solution**

- **RE MCU Ecosystem**

- **RE MCU Demos**

- **Summary**

BIG IDEAS FOR EVERY SPACE

RE MCU POWERED BY SOTB™ TECHNOLOGY

BIG IDEAS FOR EVERY SPACE

RENESAS ARM CORE BASED MCU SOLUTIONS

RENESAS BIG IDEAS FOR EVERY SPACE — **ARM**® POWERED

ARM-based MCU

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

- **Energy Harvesting controller**
- **Ultra low power ARM Cortex M0+**
- ULP Mark-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

RENESAS RA
- **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 (Expess Logic)

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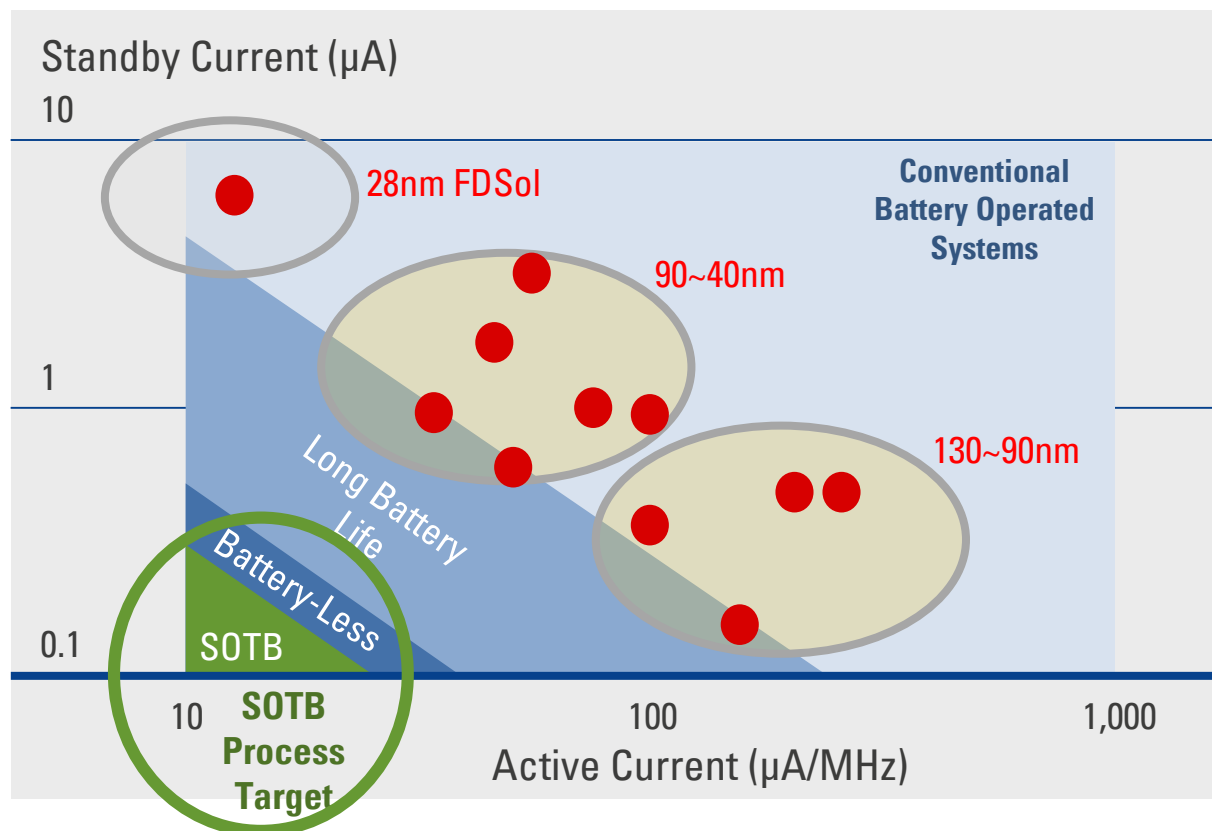- Leading MPUs for Industrial Network & Real-time Control

- 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
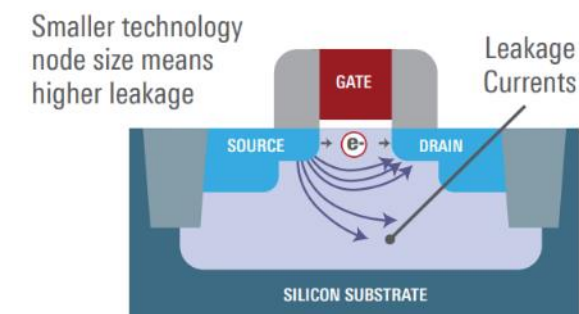
BIG IDEAS FOR EVERY SPACE **RENESAS**

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**

Standby Current (µA)

10

28nm FDSoI

90~40nm

Conventional Battery Operated Systems

1

Long Battery Life

130~90nm

0.1

Battery-Less

SOTB

10

SOTB Process Target

100   1,000

Active Current (µA/MHz)

Conventional Bulk Transistor

Smaller technology node size means higher leakage

Leakage Currents

GATE
SOURCE   e→   DRAIN
SILICON SUBSTRATE

SOTB Transistor and Back Bias Control

Substrate Bias to further reduce leakage

Dopantless Channel (no impurities) for low-voltage, high-performance operation

GATE
BIAS   SOURCE →e→ DRAIN
THIN BURIED OXIDE

Thin Insulation Layer is the foundation to Dopantless Channel

Leakage Minimized

SILICON SUBSTRATE

BIG IDEAS FOR EVERY SPACE
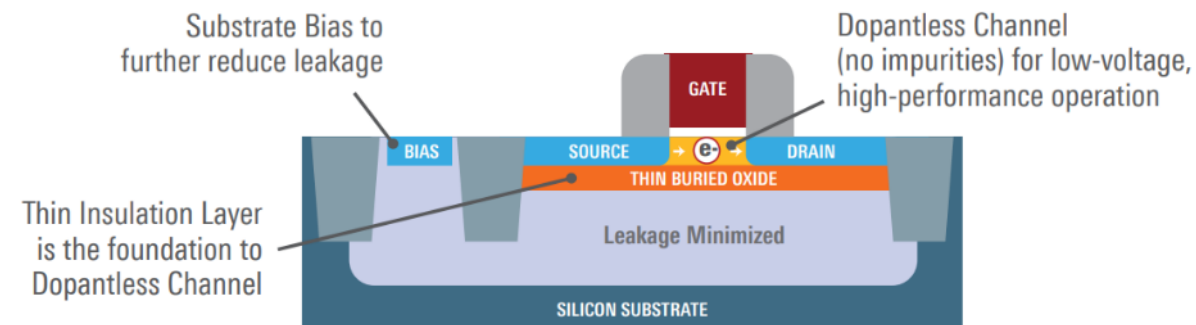
RENESAS RE MICROCONTROLLER FAMILY
POWERED BY WORLD'S BEST LOW POWER SOTB™ PROCESS TECHNOLOGY

ARM POWERED®

RENESAS RE

SOTB™ Process Technology

The World's Most Energy Efficient MCU

- Ultra-low power consumption in both active and standby mode due to SOTB process technology

- 32bit CPU Arm® Cortex®-M core
High-speed operation up to 64MHz at low voltage1.62V

- Ultra-low power peripherals (Energy harvesting control circuit, 14-bit ADC, Flash programming etc.)

- Trusted Secure IP (AES, Random number generator)
Secure update, Secure boot

BIG IDEAS FOR EVERY SPACE **RENESAS**

VALUE OF RE FAMILY

Wearables, Portable devices
Free from battery replacement

Today :

with RE:
5 times longer battery life

x 5

Wearable, Home automation
Small size and light weight

Today :
Large and heavy

with RE:
Very small and light weight

600mAh
6264mm³
12.5g

1/5

120mAh
1749mm³
2g
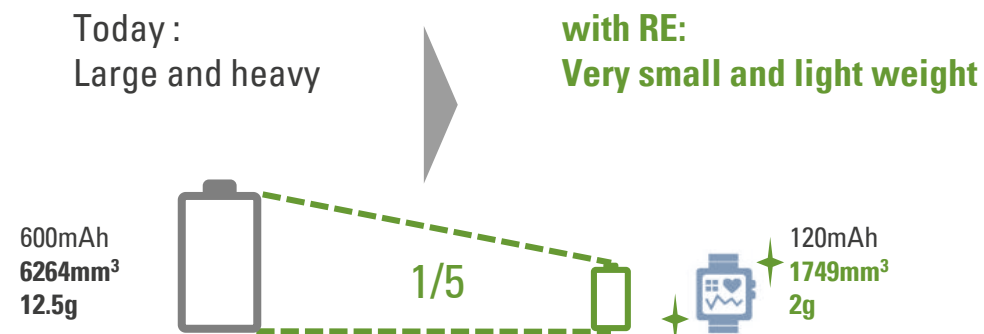
Agriculture, Structural Health Monitor, Tracker
0 cost to replace battery by Energy harvesting

Today :
High OPEX for battery
replacement

with RE:
Little OPEX by energy harvesting

$0
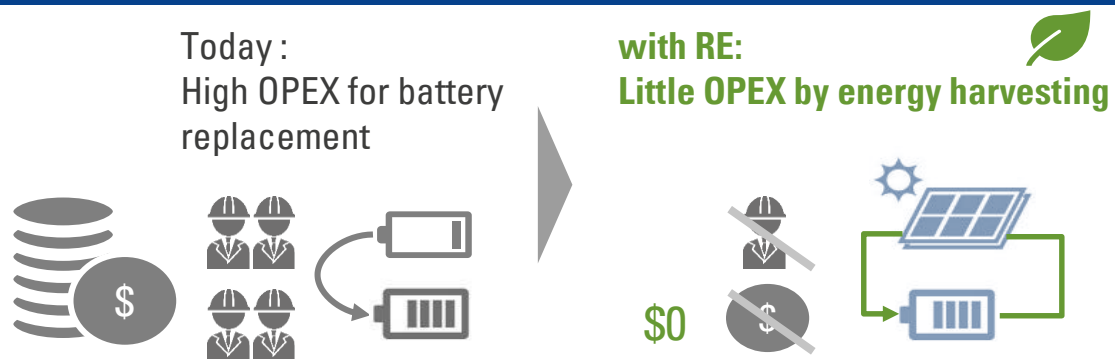
Wearables, Healthcare, Coin cell powered devices
High-speed CPU operation at low current

Today :
4MHz

with RE:
64MHz

2mA

2mA

Coin cell
Max.4mA

32MHz
4MHz   64MHz

32MHz
4MHz   64MHz

x16

BIG IDEAS FOR EVERY SPACE
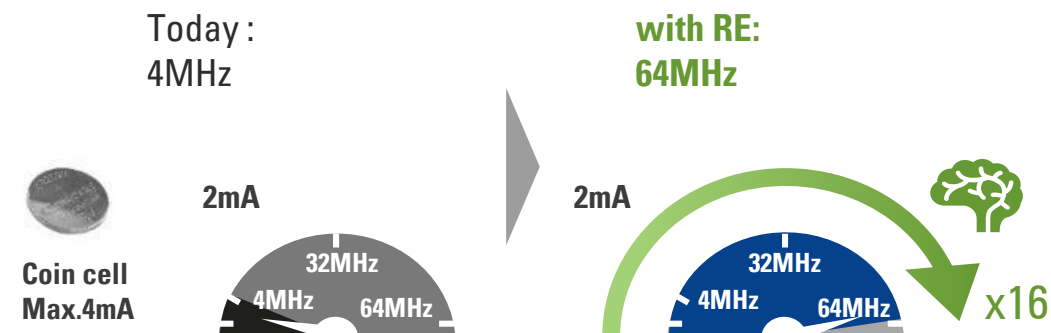
SOTB™ PROCESS TECHNOLOGY
THE WORLD'S TOP-CLASS ENERGY EFFICIENCY

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

ULP Mark-CP : A benchmark for low energy consumption
The benchmark score inversely proportional to energy consumption i.e. power ↓ score ↑

BIG IDEAS FOR EVERY SPACE
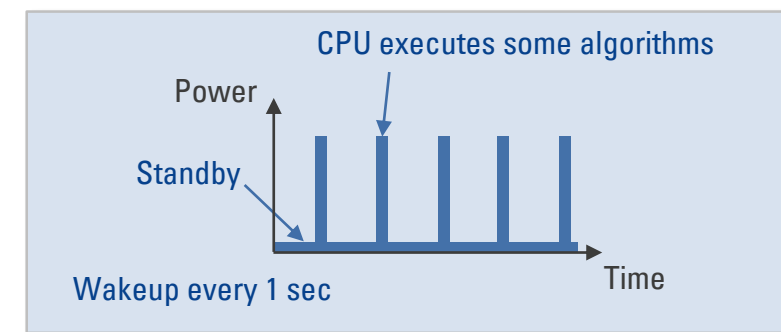
SOTB™ RE FAMILY PRODUCT OFFERING

BIG IDEAS FOR EVERY SPACE

WORLD'S BEST ENERGY EFFICIENCY

- RE01 using SOTB process achieves market leading energy efficiency
- RE01 enables long battery life, increased processing speed at low voltage and with low current, and allows the use of energy harvesting, which was not possible with conventional MCUs

BIG IDEAS FOR EVERY SPACE
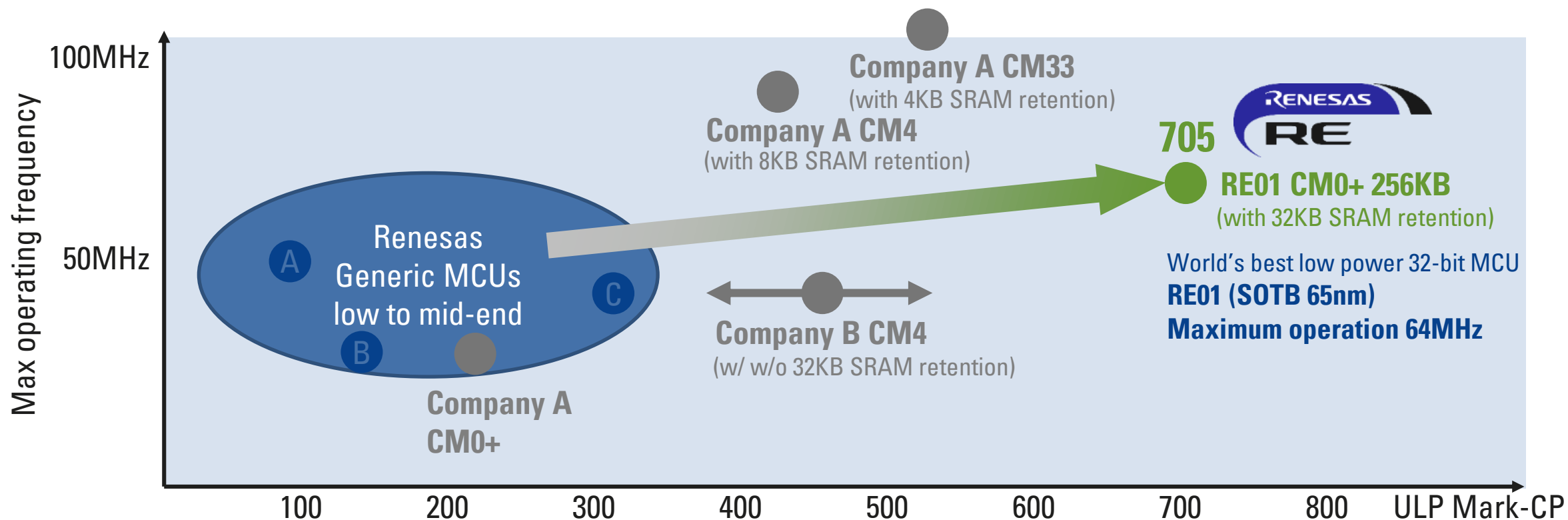
SOTB RE01 256KB MCU DEVICE

Features

- Operating Voltage : 1.62V to 3.6V
- Operating temperature : -40°C to 85°C
- GPIO pins: up to 74
- 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
  - 25uA/MHz Active (internal LDO mode)
  - 12uA/MHz Active (ext. DCDC mode)
  - 400nA Standby with 32KB RAM retention
  - 100nA Deep standby
- Energy Harvesting Controller (5uA bootup)
- Ultra-low power HMI (2DG + 8-bit MIP)
- Ultra-low power ADC (at 4uA)
- Crypto engine for security with Root of Trust
- Packages : WLBGA72, LQFP100, QFN56

64-MHz ARM® Cortex®-M0+ CPU   R7F0E011   DIV / NVIC / SWD / MTB

Memory
- Code Flash (256KB)
- SRAM (128 KB)

Analog
- 14-Bit A/D Converter (18 ch.)
- Vref out
- Temperature Sensor

Timing & Control
- PWM Timer 32-Bit x 2, 16Bit x 4
- Wake Up Timer 32-Bit x 1
- LP Timer 16-Bits x 2, 32-Bits x 2
- CCC (1sec Event Timer) x 1
- 8-bit Timer x 4
- RTC

HMI
- Memory In Pixel Display parallel Interface
- 2D Graphics Data Conversion Circuit
- Key Interrupt

Connectivity
- USART w/o FIFO x 5 w/ FIFO x2
- SPI x2
- IIC x2
- QSPI x 1
- ~~USB x 1~~

System & Power Management
- DMA Controller x 4
- Data Transfer Controller
- Event Link Controller
- Low Power Modes
- Multiple Clocks
- CCC
- SysTick
- Energy Harvesting Controller

Safety
- Flash Access Window
- ADC Diagnostics
- ADC Disconnection Detection
- Clock Accuracy Circuit
- CRC Calculator
- Data Operation Circuit
- Port Output Enable for GPT
- Independent WDT

Security & Encryption
- TSIP - Lite
- 128-Bit Unique ID
- TRNG
- AES (128/256)
- Hidden Root Key
- Flash Access Window
- Flash ID Code Protection
- MPU x 4

BIG IDEAS FOR EVERY SPACE

SOTB RE01 1.5MB MCU DEVICE

Features

- Operating Voltage : 1.62V to 3.6V
- Operating temperature : -40°C to 85°C
- GPIO pins: up to 110 pins
- External clock oscillators
  - 8 to 32 MHz, 32.768 kHz
- PLL : 32, 48, 64 MHz
- On-chip clock oscillators
  - LOCO 32.768 kHz
  - MOCO 2 MHz
  - HOCO 24/32/48/64 MHz
- Ultra-low power by SOTB
  - 35uA/MHz Active (internal LDO mode)
  - 15uA/MHz Active (ext. DCDC mode)
  - 500nA Standby with 32KB RAM retention
  - 120nA Deep standby
- Energy Harvesting Controller (5uA bootup)
- Ultra-low power ADC (at 4uA)
- Ultra-low power HMI (2DG + 8-bit MIP)
- Crypto engine for security with Root of Trust
- Packages : WLBGA156, LQFP144/100

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

Memory
- Code Flash (1.5 MB)
- SRAM (256 KB)

Analog
- 14-Bit A/D Converter (18 ch.)
- 12-Bit D/A Converter x 1
- Vref out
- Analog Comparator x1
- Temperature Sensor
- Motor Driver for Watches

Timing & Control
- PWM Timer 32-Bit x 2, 16Bit x 4
- Wake Up Timer 32-Bit x 1
- LP Timer 16-Bit x 2
- CCC (1sec Event Timer) x 1
- 8-bit Timer x 4
- RTC

HMI
- Memory In Pixel Display parallel Interface
- 2D Graphics Data Conversion Circuit
- LED driver

Connectivity
- USART w/o FIFO x 5 w/ FIFO x2
- SPI x2
- IIC x2
- QSPI x 1
- USB x 1

System & Power Management
- DMA Controller x 4
- Data Transfer Controller
- Event Link Controller
- Low Power Modes
- Multiple Clocks
- CCC
- SysTick
- Energy Harvesting Controller

Safety
- Flash Access Window
- ADC Diagnostics
- ADC Disconnection Detection
- Clock Accuracy Circuit
- CRC Calculator
- Data Operation Circuit
- Port Output Enable for GPT
- Independent WDT

Security & Encryption
- TSIP - Lite
- 128-Bit Unique ID
- TRNG
- AES (128/256)
- Hidden Root Key
- Flash Access Window
- Flash ID Code Protection
- MPU x 4

BIG IDEAS FOR EVERY SPACE

SOTB RE01B BLE5.0 MCU DEVICE

P/N : R7F0E01BD2DNB

Features

- Operating Voltage : 1.62V to 3.6V
- Operating temperature : -40°C to 85°C
- GPIO pins: up to 110 pins
- External clock oscillators
  - 8 to 32 MHz, 32.768 kHz
- PLL : 32, 48, 64 MHz
- On-chip clock oscillators
  - LOCO 32.768 kHz
  - MOCO 2 MHz
  - HOCO 24/32/48/64 MHz
- Ultra-low power by SOTB
  - 35uA/MHz Active (LDO mode)
  - 15uA/MHz Active (ext. DCDC mode)
  - 600nA Standby with 32KB RAM retention
  - 220nA Deep standby
- BLE5 Connectivity
- Flash ROM 1.5MB
- Ultra-low power ADC (at 4uA)
- Crypto engine for security
- Energy Harvesting Controller (5uA bootup)
- Packages : QFN64

64-MHz ARM® Cortex®-M0+ CPU | **RE01B** | *DIV / NVIC / SWD / MTB*

Memory
- Code Flash (1.5 MB)
- SRAM (256 KB)

Analog
- 14-Bit A/D Converter (4 ch.)
- Temperature Sensor

Timing & Control
- General PWM Timer 32-Bit x 2
- General PWM Timer 16-Bit x 1
- Ultra-low-power 16-bit Timer x 2
- 8-bit Timer x 2
- Low Speed Clock Timer
- RTC

HMI
- 2D Graphics Data Conversion Circuit

Connectivity
- USART w/o FIFO x 2
- SPI x1
- IIC x1
- BLE5

System & Power Management
- DMA Controller
- Data Transfer Controller
- Event Link Controller
- Low Power Modes
- Multiple Clocks
- CCC
- SysTick
- Energy Harvesting Controller

Safety
- Flash Area Protection
- ADC Diagnostics
- Clock Correction Circuit
- Clock Accuracy Circuit
- CRC Calculator
- Data Operation Circuit
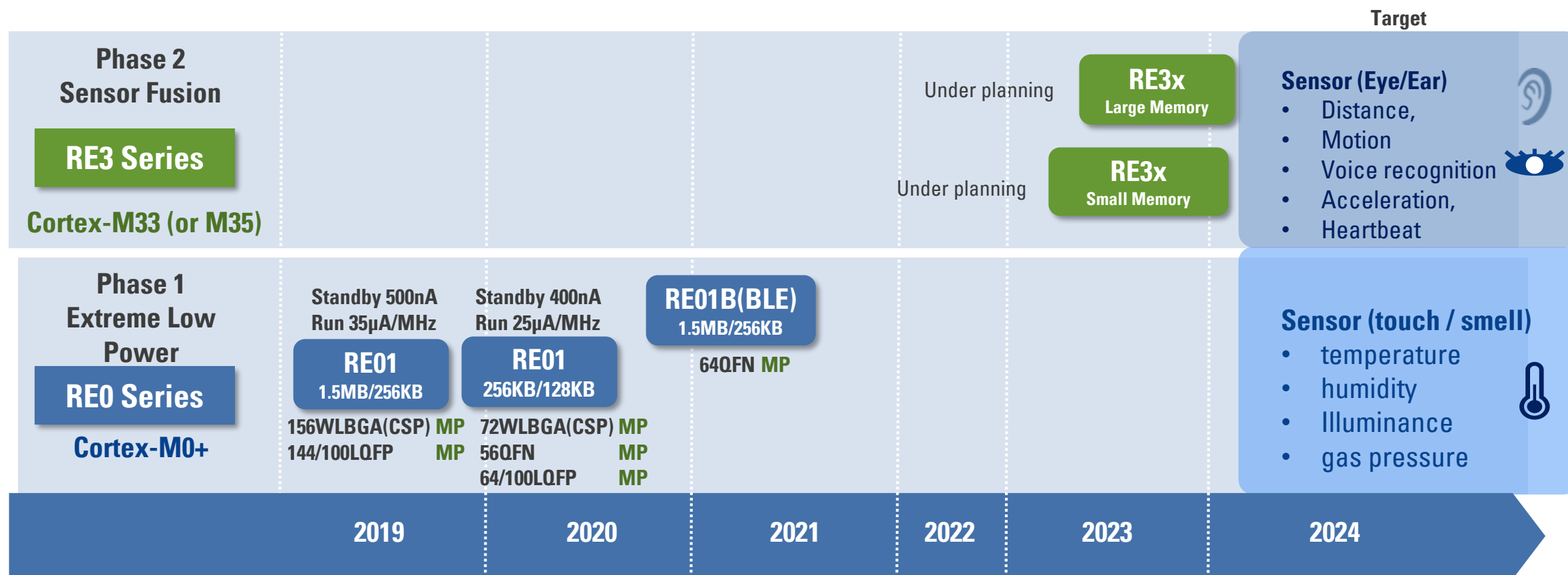- IWDT & WDT

Security & Encryption
- TSIP - Lite
- 128-Bit Unique ID
- TRNG
- AES (128/256)
- MPU x 4

BIG IDEAS FOR EVERY SPACE

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**

Target

Phase 2
Sensor Fusion

RE3 Series

Cortex-M33 (or M35)

Under planning — **RE3x** Large Memory

Under planning — **RE3x** Small Memory

Sensor (Eye/Ear)
- Distance,
- Motion
- Voice recognition
- Acceleration,
- Heartbeat

Phase 1
Extreme Low Power

RE0 Series

Cortex-M0+

Standby 500nA
Run 35µA/MHz

RE01
1.5MB/256KB

156WLBGA(CSP) **MP**
144/100LQFP **MP**

Standby 400nA
Run 25µA/MHz

RE01
256KB/128KB

72WLBGA(CSP) **MP**
56QFN **MP**
64/100LQFP **MP**

RE01B(BLE)
1.5MB/256KB

64QFN **MP**

Sensor (touch / smell)
- temperature
- humidity
- Illuminance
- gas pressure

| 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |

BIG IDEAS FOR EVERY SPACE **RENESAS**

RE01 MCU FEATURE HIGHLIGHT

BIG IDEAS FOR EVERY SPACE
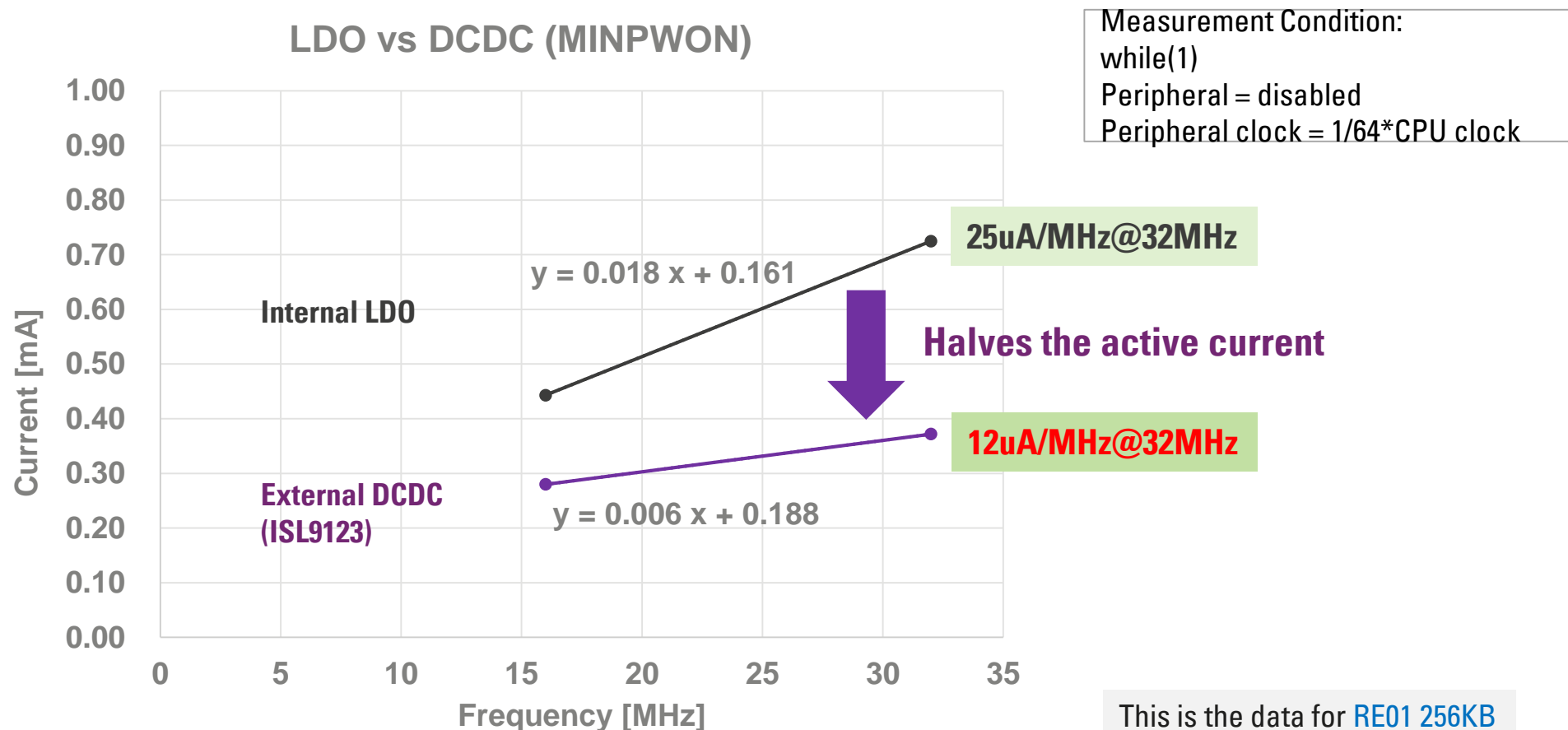
RE01 KEY FEATURES : ACTIVE CURRENT REDUCTION

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

LDO vs DCDC (MINPWON)

Measurement Condition:
while(1)
Peripheral = disabled
Peripheral clock = 1/64*CPU clock

$y = 0.018 x + 0.161$

25uA/MHz@32MHz

Internal LDO

Halves the active current

12uA/MHz@32MHz

External DCDC (ISL9123)

$y = 0.006 x + 0.188$

This is the data for RE01 256KB
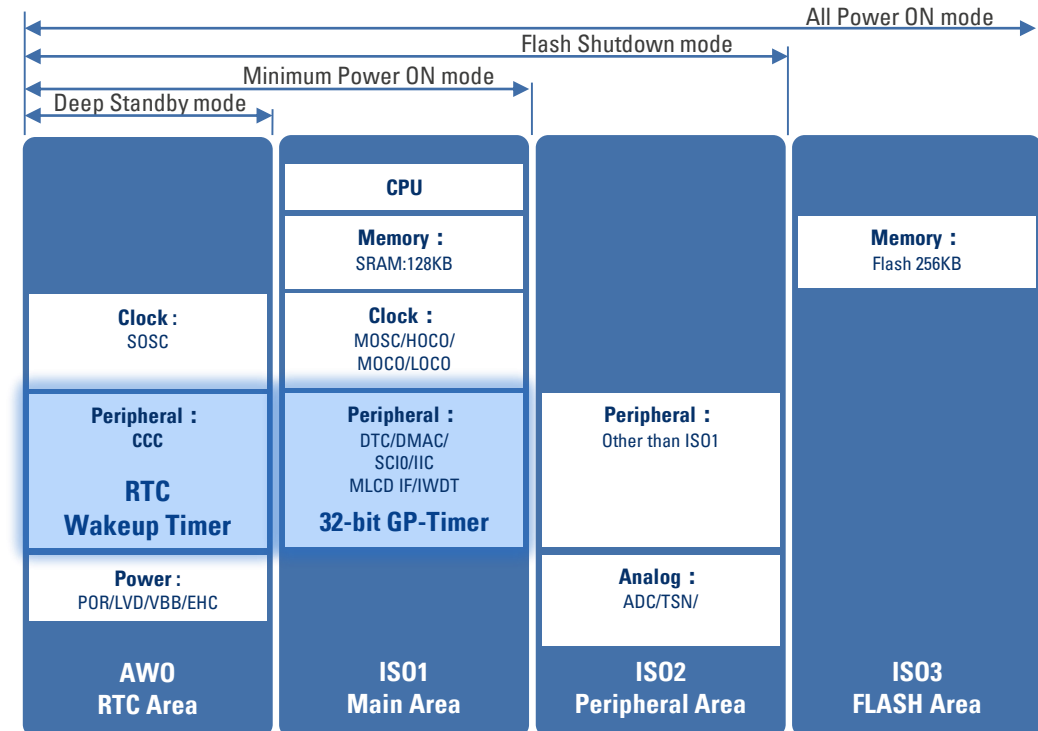
BIG IDEAS FOR EVERY SPACE

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**

All Power ON mode
Flash Shutdown mode
Minimum Power ON mode
Deep Standby mode

	CPU		
	Memory : SRAM:128KB		Memory : Flash 256KB
Clock : SOSC	Clock : MOSC/HOCO/ MOCO/LOCO		
Peripheral : CCC	Peripheral : DTC/DMAC/ SCI0/IIC MLCD IF/IWDT	Peripheral : Other than ISO1	
RTC Wakeup Timer	32-bit GP-Timer		
Power : POR/LVD/VBB/EHC		Analog : ADC/TSN/	
AWO RTC Area	ISO1 Main Area	ISO2 Peripheral Area	ISO3 FLASH Area

BIG IDEAS FOR EVERY SPACE

RE01 KEY FEATURE : ULTRA-LOW POWER 14-BIT ADC

- **RE01 equips ultra-low power 14-bit ADC (SAR)**
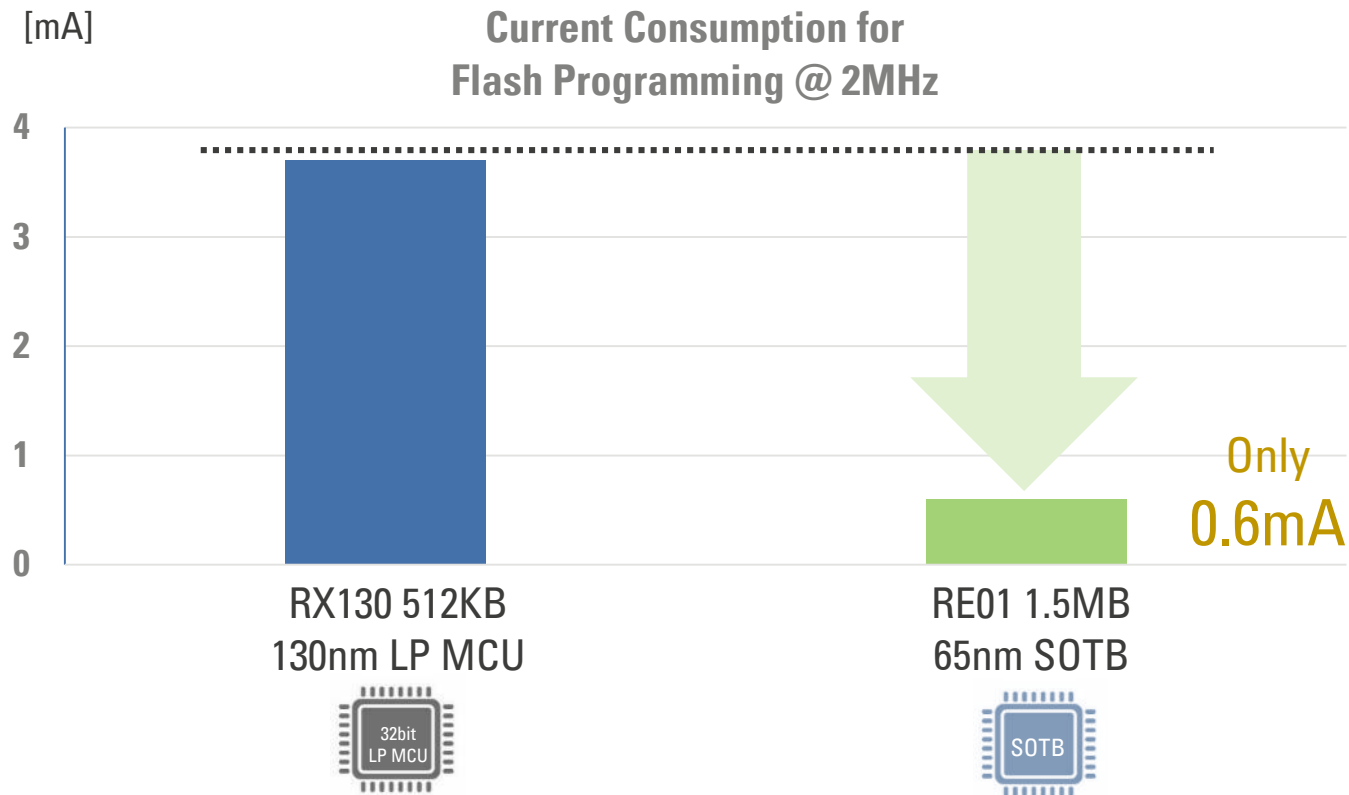

Ultra-Low Power ADC
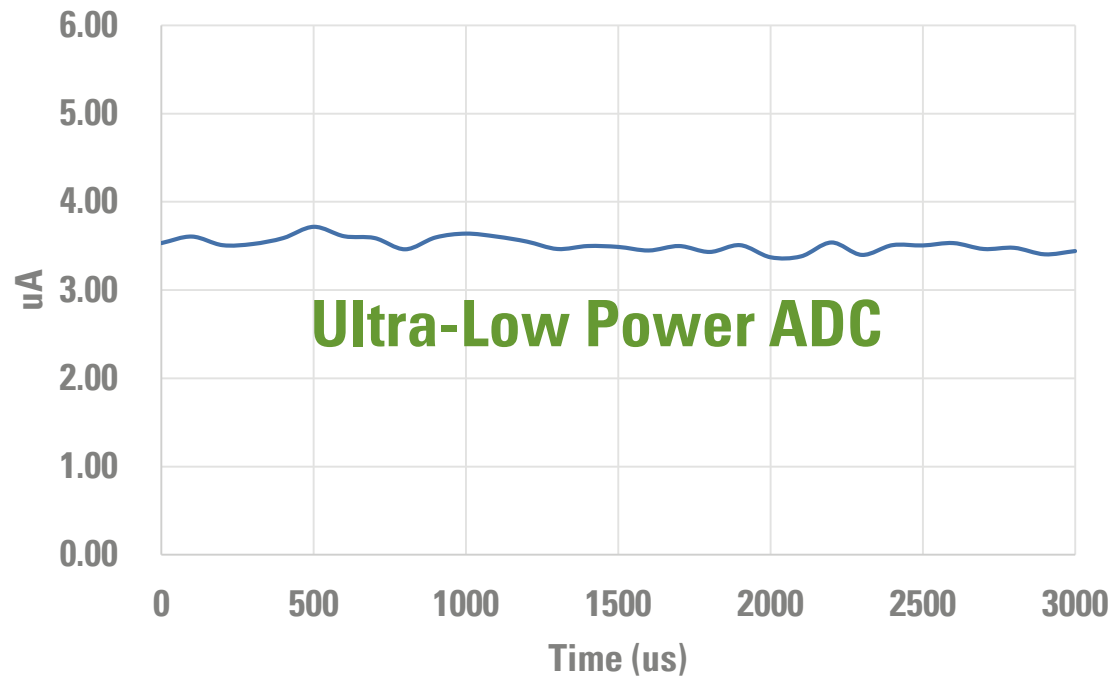
- AD conversion at **4uA** current (32kHz low-CL)

- Enables always-on data sensing on power-constraint IoT edge devices

* Current consumption when operating continuously at 32 kHz (low CL sub clock), the other peripherals are all OFF

BIG IDEAS FOR EVERY SPACE   RENESAS

RE01 KEY FEATURE : ULTRA LOW POWER FLASH
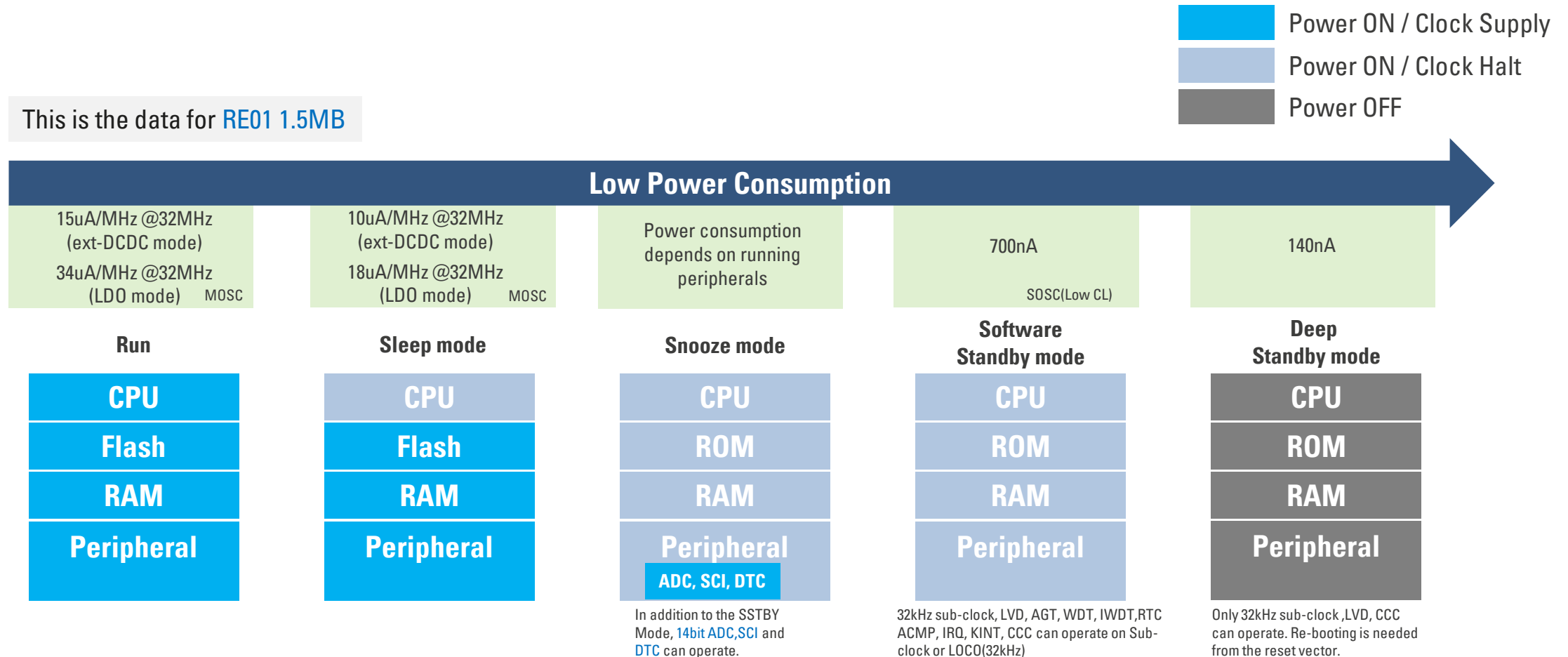
- **Flash programming at only 0.6mA**

- **The ultra-low power flash programming is suitable for Over-The-Air FW update on IoT edges**

[mA]

Current Consumption for Flash Programming @ 2MHz

4

3

2

1

0

RX130 512KB
130nm LP MCU

32bit
LP MCU

RE01 1.5MB
65nm SOTB

SOTB

Only
0.6mA

101
010

RE01 KEY FEATURE: CLOCK GATING AND STANDBY MODE

- **RE01 can halt the clock for each hardware blocks when not used to reduce power consumption**

Power ON / Clock Supply

Power ON / Clock Halt

Power OFF

This is the data for RE01 1.5MB

Low Power Consumption

15uA/MHz @32MHz (ext-DCDC mode)	10uA/MHz @32MHz (ext-DCDC mode)	Power consumption depends on running peripherals	700nA	140nA
34uA/MHz @32MHz (LDO mode) MOSC	18uA/MHz @32MHz (LDO mode) MOSC		SOSC(Low CL)	
Run	**Sleep mode**	**Snooze mode**	**Software Standby mode**	**Deep Standby mode**
CPU	**CPU**	**CPU**	**CPU**	**CPU**
Flash	**Flash**	**ROM**	**ROM**	**ROM**
RAM	**RAM**	**RAM**	**RAM**	**RAM**
Peripheral	**Peripheral**	**Peripheral**	**Peripheral**	**Peripheral**
		ADC, SCI, DTC		
		In addition to the SSTBY Mode, 14bit ADC,SCI and DTC can operate.	32kHz sub-clock, LVD, AGT, WDT, IWDT,RTC ACMP, IRQ, KINT, CCC can operate on Sub-clock or LOCO(32kHz)	Only 32kHz sub-clock ,LVD, CCC can operate. Re-booting is needed from the reset vector.

BIG IDEAS FOR EVERY SPACE   RENESAS

RE01 KEY FEATURE : SUPPLY VOLTAGE FLEXIBILITY

- Supports **independent digital and analog IO power domains** to connect external devices with different voltages

- **No external level shifters** are needed

Example:
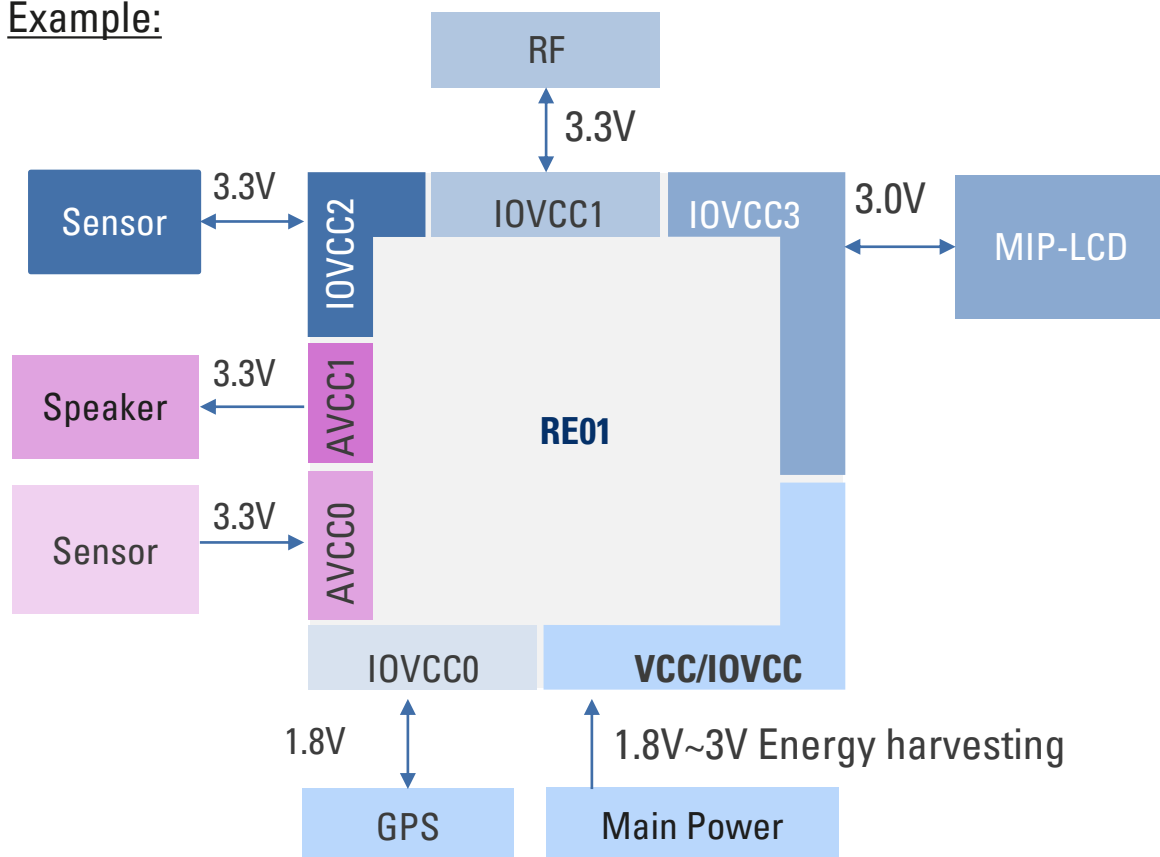
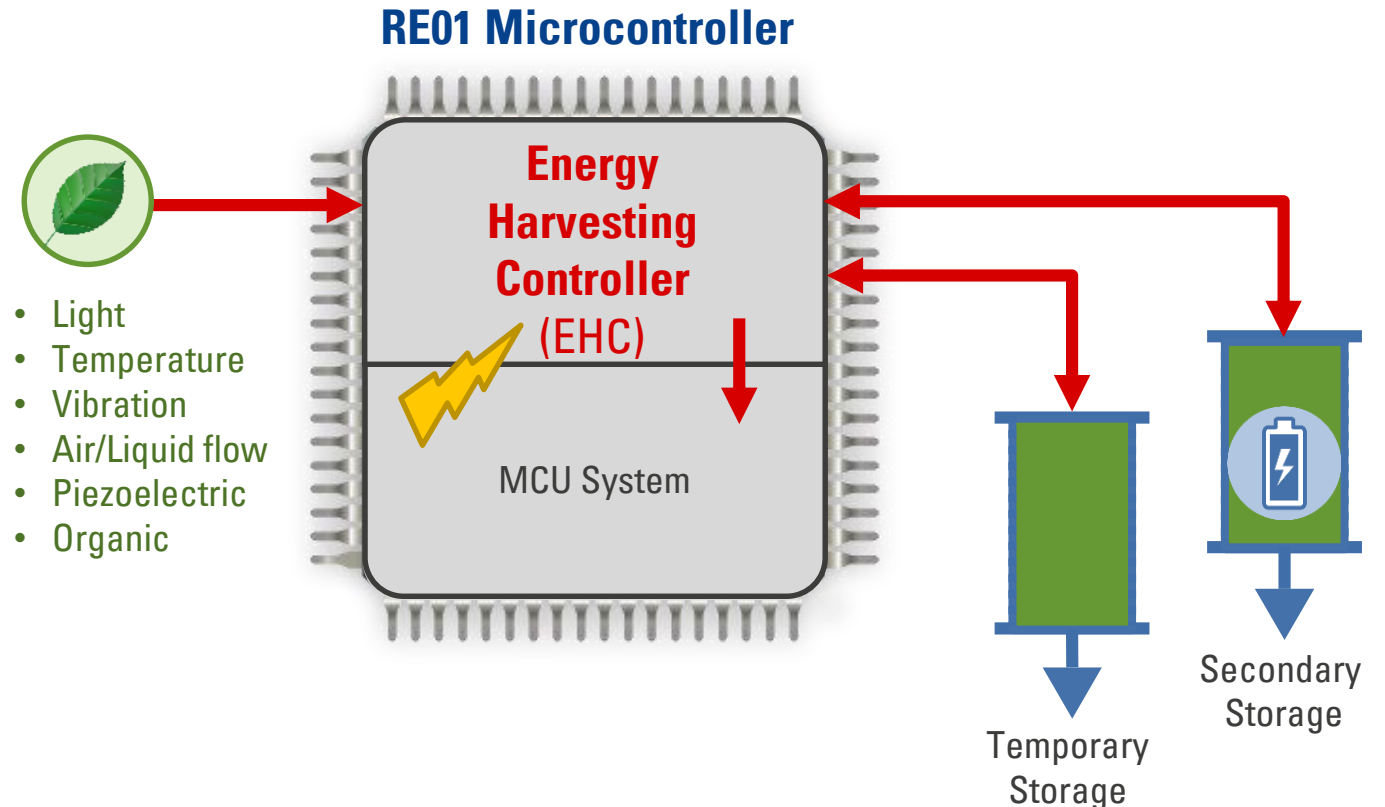| IO Power Domain	Value	Unit
Power Supply voltage for System (VCC/IOVCC)	1.62 to 3.6V	System
Power Supply voltage for IO0 (IOVCC0)	1.62 to 3.6V	General I/O and SPI etc…
Power Supply voltage for IO1 (IOVCC1)	1.62 to 3.6V	General I/O and MIP etc…
Power Supply voltage for IO2 (IOVCC2)	1.62 to 3.6V	General I/O
Power Supply voltage for Analog-IP (AVCC0)	1.62 to 3.6V	14bADC,TSN,VREF
Power Supply voltage for Analog-IP (AVCC1)	1.62 to 3.6V	DAC, ACMP
Power Supply voltage for USB (USBVCC)	3.0 to 3.6V	USB transceiver

This is the case for RE01 256KB

BIG IDEAS FOR EVERY SPACE

RE01 KEY FEATURE : ENERGY HARVESTING CONTROLLER
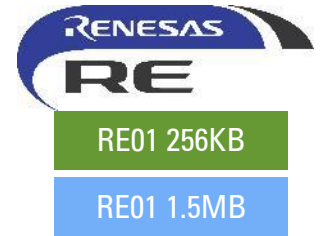
Energy Harvesting Controller Features:

- Direct energy harvester connection

- Voltage Regulation

- Quick start function

- Autonomous & reliable startup sequence

- Small start-up current 5uA at minimum

- Charge management

- Charge detection

- Reverse current protection

RE01 Microcontroller

Energy Harvesting Controller (EHC)

MCU System

- Light
- Temperature
- Vibration
- Air/Liquid flow
- Piezoelectric
- Organic

Temporary Storage

Secondary Storage

EHC = Sub-PMIC, Charger, and Power management!

RE01 KEY FEATURE : ULTRA LOW POWER MIP-LCD I/F

MIP-LCD I/F that enables a display with ultra-low power consumption.

Dot rewriting is supported and rewriting is also extremely low power.
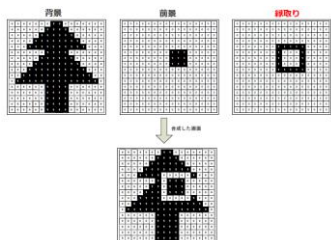
MIP : Memory In Pixel

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

GBD-H1000-1A7

Kyocera MIP-LCD
Display about 0.5uA
Rewrite about 3.5uA

8-bit parallel I/F

RE01 MIP-LCD IF

- Internal peripheral bus
- DATA0
- DATA1
- DATA2
- DATA3
- DATA30
- DATA31
- Drawing data setting registers
- MLCDCR
- MLCDSR
- MLCDADDR
- MLCDWRCR
- MLCDSEND
- MLCDBKCR
- MLCDVCOMCTL
- MLCDENBCR
- Control registers
- Interrupt circuit
  - Transmit end interrupt
  - Data register empty interrupt
  - Event output to the ELC
- CCC_2K
- PCLKA
- Communication circuit
  - MLCD_VCOM
  - MLCD_XRST
  - MLCD_SCLK
  - MLCD_DEN
  - MLCD_ENBS
  - MLCD_ENBG
  - MLCD_SI[7:0]
- MIP-LCD

RE01 KEY FEATURE : 2D GRAPHIC ENGINE
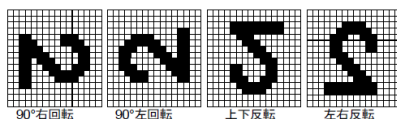
Supported hardware graphic accelerations

- 90deg Rotation

- Scaling down

- Color Inversion

- Color Composite (Mono/8-bit Color)

- Scrolling

- Glyph to Raster Conversion
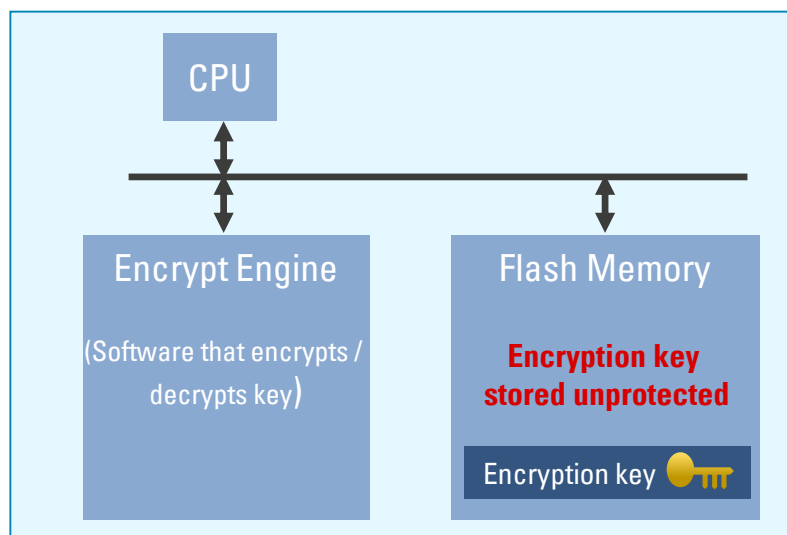
- Colorization

- Endian Conversion

MLCD or SPI

RE

MIP LCD

A **A**

Composite

Inversion

Rotation

For ultra-low power wearable applications with a MIP LCD display
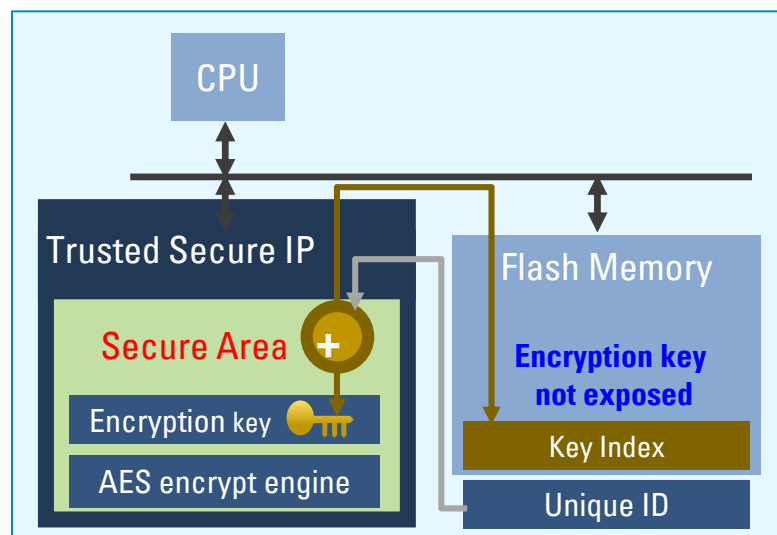
MCU KEY FEATURE : STRONG SECURITY 🔒

- **RE01 equips Trusted Secure IP (TSIP-Lite)**

- **No unauthorized access allowed to the crypto engine and an encryption key** : TSIP has a secure area

- **Strong key management** : An encryption key can be stored outside the TSIP as **unreadable 'key index'**

Conventional encryption engine installed
General-purpose MCU

CPU

Encrypt Engine

(Software that encrypts / decrypts key)

Flash Memory

Encryption key stored unprotected

Encryption key 🔑

Equipped with trusted secure IP
SOTB

CPU

Trusted Secure IP

Secure Area ⊕

Encryption key 🔑

AES encrypt engine

Flash Memory

Encryption key not exposed

Key Index

Unique ID

Trusted Secure IP

AES* Encryption engine functions
- Key length: 128 bits / 256 bits
- Cryptographic mode :
  Encryption / decryption : ECB, CBC, GCM
  Tamper detection : CMAC

*AES: Advanced Encryption Standard
US standard encryption method established by the
National Institute of Standards and Technology (NIST)

TARGET APPLICATIONS

BIG IDEAS FOR EVERY SPACE

TARGET MARKETS AND APPLICATIONS

Wearable/Watch

- Solar drive
- High-speed CPU to run algorithms for accelerometer/heart rate sensors
- Ultra-low power graphics

Smart Home

- Security Sensors
- Water leakage detection
- Motion sensor
- Smaller battery, Better product designs

Smart Lock

- Battery maintenance-free lock
- Preventing locked out by battery runout

Structural Health Monitor

- Battery maintenance-free by energy harvesting
- OPEX cost reduction

Healthcare

- High-speed processing with small battery
- Ultra-low power ADC 4uA
- Low power firmware update 600uA

Smart Meter

- Low consumption RTC
- Large memory for FUOTA
- Strong security

Smart Agriculture

- Battery maintenance free by energy harvesting
- OPEX cost reduction

Tracker

- Prevent missing tracking by battery runout

BIG IDEAS FOR EVERY SPACE

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

GBD-H1000-1A7

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 CASIO G-SHOCK:

1. Ultra-low power 32bit CPU sensor processing

2. Ultra-low power clock operation

3. Ultra-low power 2D graphic MIP-LCD display
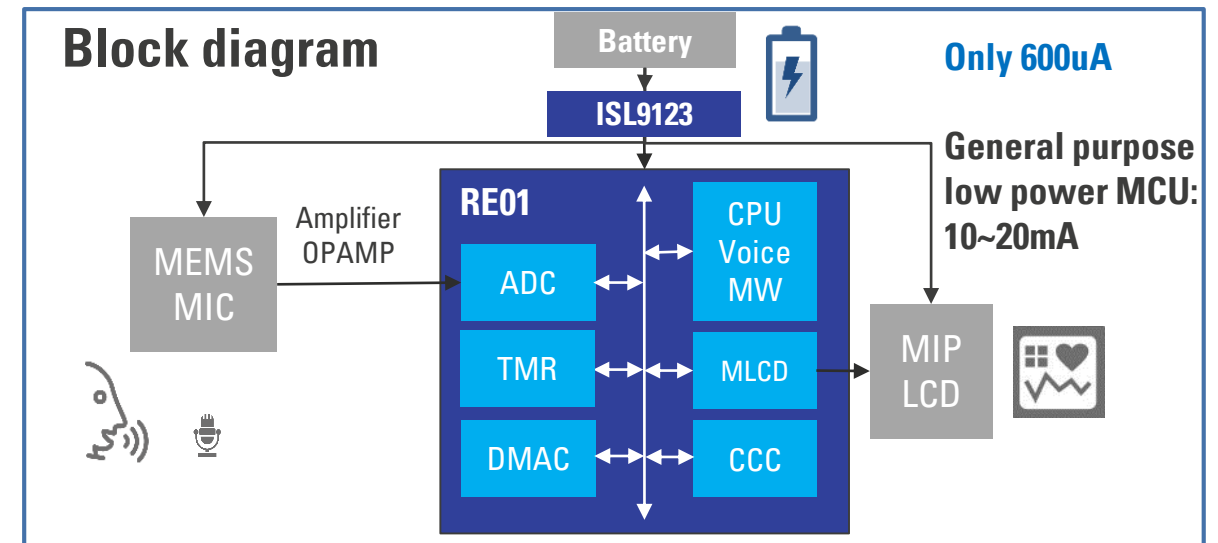
4. Large Flash ROM to store display data

BIG IDEAS FOR EVERY SPACE

WEARABLE / HYBRID WATCH EXAMPLE
VOICE RECOGNITION (ULTRA-LOW POWER 600UA)
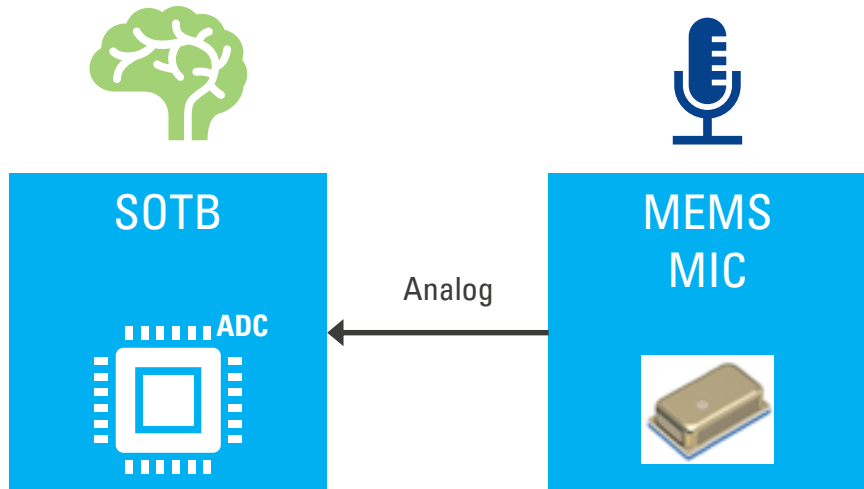
Ultra-low Power Voice Recognition Solution:

- SOTB Cortex-M0+ 32/64MHz enables ultra-low power voice recognition

- Only 600uA for voice recognition (when using ext-DCDC mode)

- Enables the addition of voice recognition to a watch or remote-control which has small storage of battery.

Block diagram

Only 600uA

Battery

ISL9123

General purpose low power MCU: 10~20mA

RE01

Amplifier OPAMP

ADC	CPU Voice MW
TMR	MLCD
DMAC	CCC

MEMS MIC

MIP LCD

SOTB

MEMS MIC

Analog

ADC

See the demo section on the later slides
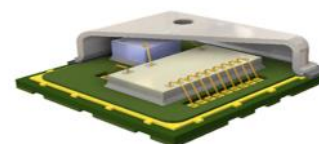
BIG IDEAS FOR EVERY SPACE

SMART HOME EXAMPLE
ULTRA-LOW POWER AIR QUALITY MONITOR SOLUTION

RE01 SOTB MCU + ZMOD4x10 sensor for Ultra-long battery-life Air Quality Sensors 🍃

EHC

RE01 : Ultra-low Power "SOTB" MCU
Active current down to 12uA/MHz, Standby 400nA

EPA Standard

- **ZMOD4510 :** Outdoor Air Quality Sensor
  Average power 150uW@1sample per 2sec
- **ZMOD4410 :** Indoor Air Quality Sensor
  New low-power firmware is coming out in Q3'21

Level of Concern and Air Quality Condition
Good
Moderate
Unhealthy for Sensitive Groups
Unhealthy
Very unhealthy
Hazardous

- **BENEFITS**
  - Ultra-long battery life
  - Extending battery life by energy harvesting

- **APPLICATIONS**

  Indoor Air Quality Monitoring Applications:
  - Kitchen fans, Cooking odors
  - Bedroom odors (eCO2)
  - Bathroom fans, Foul odors
  - HVAC systems (eCO2, TVOC)

  Outdoor Air Quality Monitoring Applications:
  - Weather Stations
  - Smart Cities
  - Home, Building automation, HVAC smart dampers
  - Personal monitors including Wearables

BIG IDEAS FOR EVERY SPACE

SMART HOME EXAMPLE
RENESAS RE01 ULTRA-LOW POWER AIR QUALITY MONITOR SOLUTION

- **Block Diagram**   👉 **See the demo section on the later slides**

Battery-less AQM system powered by a solar panel 🌿

*12uA/MHz w/ external DCDC mode

PV Cell

100uF

Supercapacitor/
Rechargeable
Battery

~+3V

Energy
Harvesting
Controller

RE01 MCU
- ARM CM0+ 25uA/MHz*
- SRAM ULP retention
- DMA Engine
- ULP RTC 350nA
- ULP Timer 30nA
- SPI
- SPI
- I2C-BUS

VCC ~+3V

LPWA Radio Module

Ultra-low power MIP Display

RH & Temp Sensor HS3001 — Average current 25uA@1sps

Gas Sensor ZMOD4510-ULP — ZMOD4510 (Outdoor Air Quality) Average power 150uW@1sample/2sec

BIG IDEAS FOR EVERY SPACE

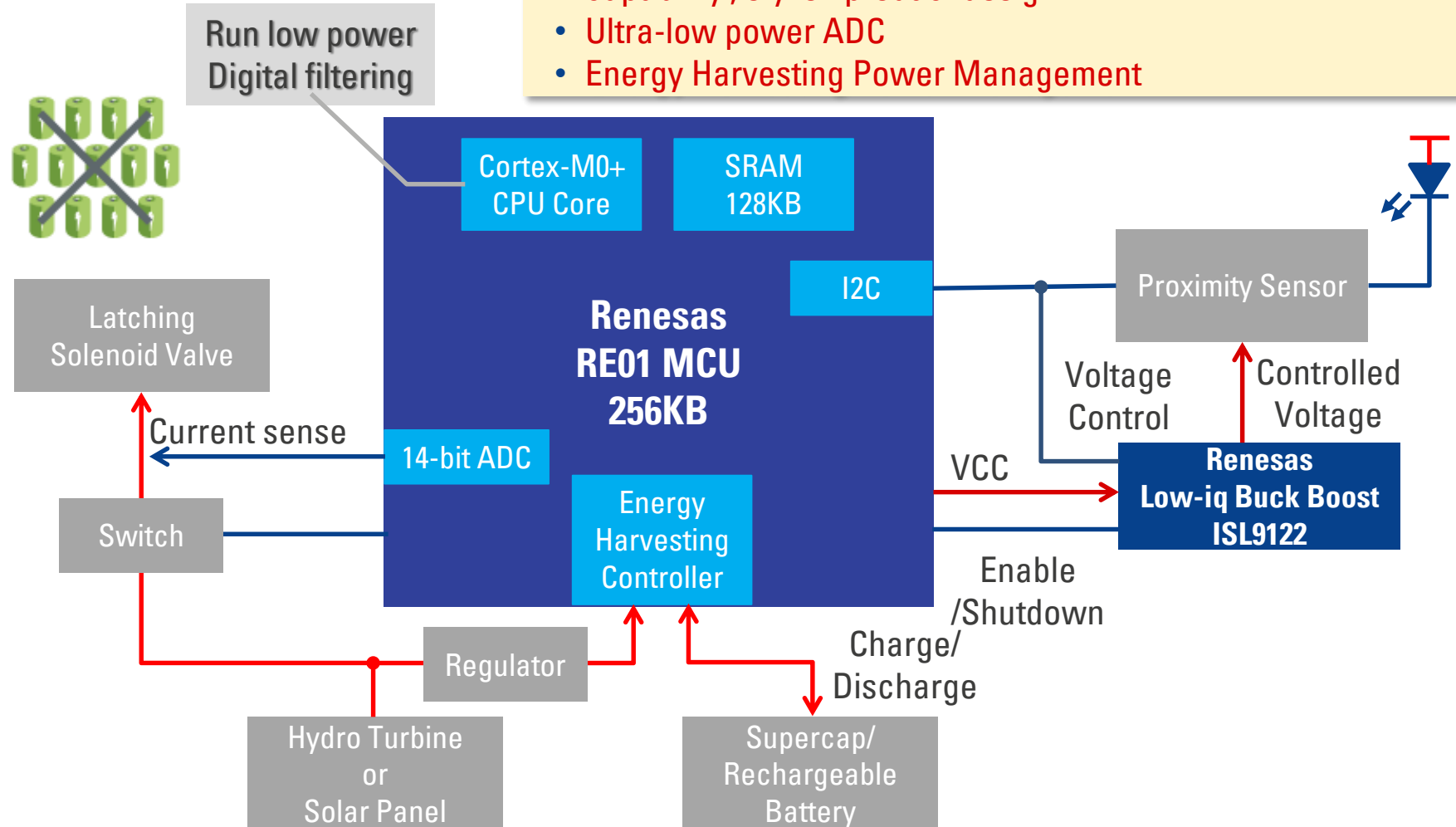# SMART HOME EXAMPLE
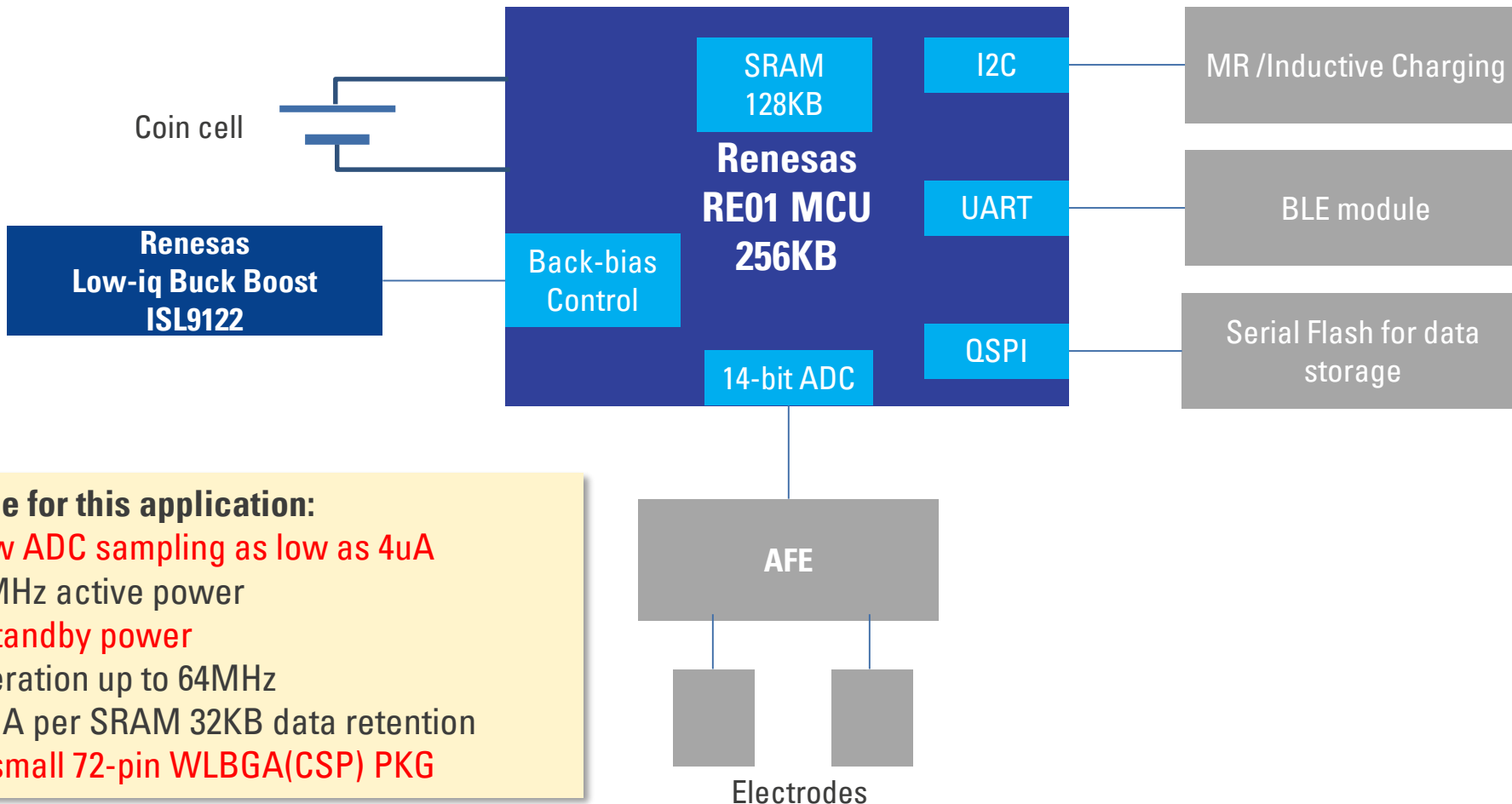## SMART FAUCET

RE01's value for this application:

- Make the battery size smaller by the low-power Digital Filtering capability ; stylish product design
- Ultra-low power ADC
- Energy Harvesting Power Management

Run low power Digital filtering

Reference:
https://www.bu.edu/sustainability/what-were-doing/water/self-charging-hands-free/

Renesas RE01 MCU 256KB

- Cortex-M0+ CPU Core
- SRAM 128KB
- I2C
- 14-bit ADC
- Energy Harvesting Controller

Latching Solenoid Valve

Current sense

Switch

Proximity Sensor

Voltage Control

Controlled Voltage

Renesas Low-iq Buck Boost ISL9122

VCC

Enable /Shutdown

Charge/ Discharge

Regulator

Hydro Turbine or Solar Panel

Supercap/ Rechargeable Battery

BIO-SENSING WEARABLES EXAMPLE

Coin cell

**Renesas
Low-iq Buck Boost
ISL9122**

Back-bias
Control

SRAM
128KB

**Renesas
RE01 MCU
256KB**

14-bit ADC

I2C

UART

QSPI

MR /Inductive Charging

BLE module

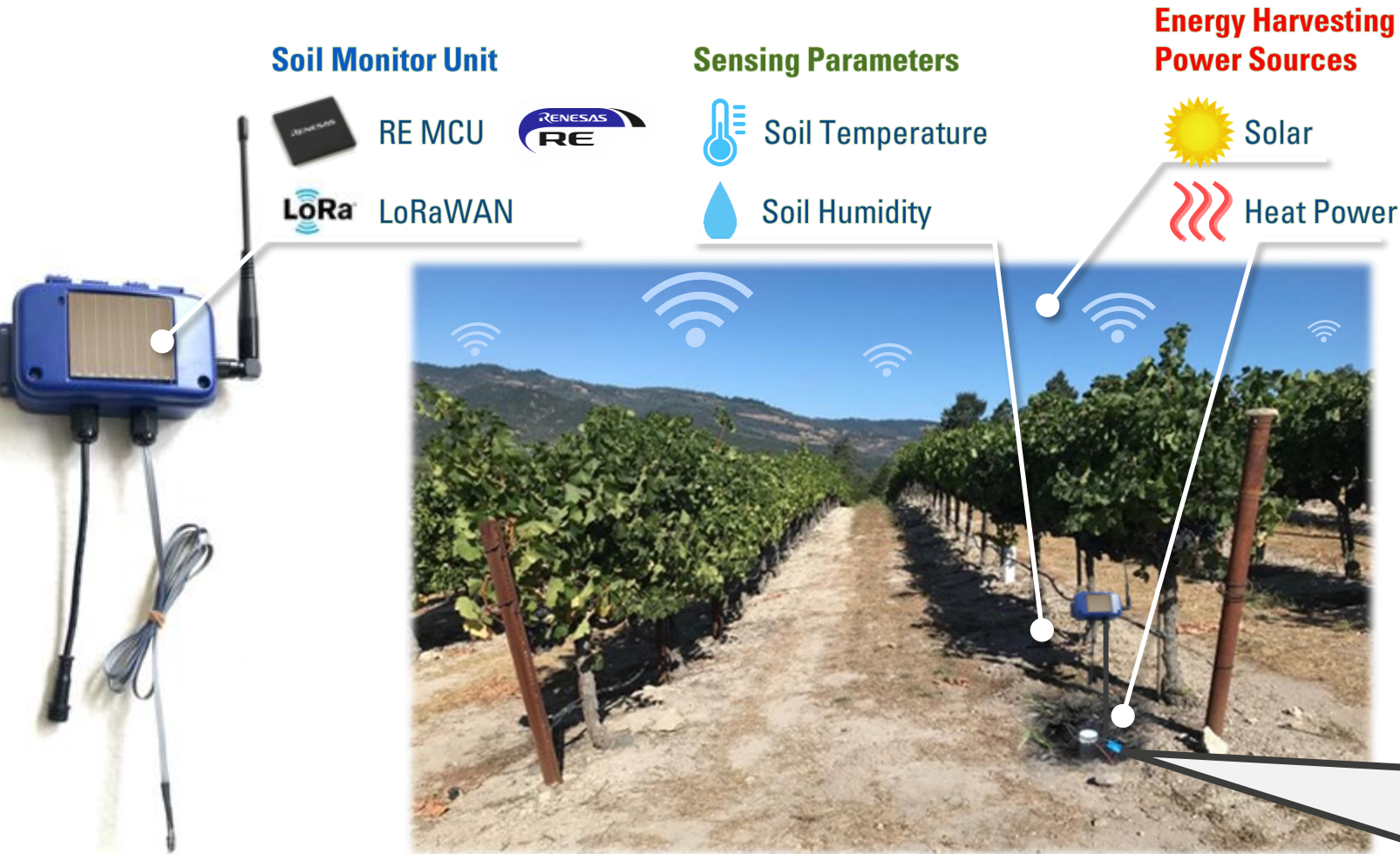Serial Flash for data storage

AFE

Electrodes

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

BIG IDEAS FOR EVERY SPACE **RENESAS**

SMART AGRICULTURE EXAMPLE
BATTERY-LESS SOIL MONITOR

Winning Combos
Analog + Power + Embedded Processing

Soil Monitor Unit
- RE MCU — RENESAS RE
- LoRa — LoRaWAN

Sensing Parameters
- Soil Temperature
- Soil Humidity

Energy Harvesting Power Sources
- Solar
- Heat Power

Issues of the smart farming in the farm field
- No Power
- Poor Connectivity

RE01's value

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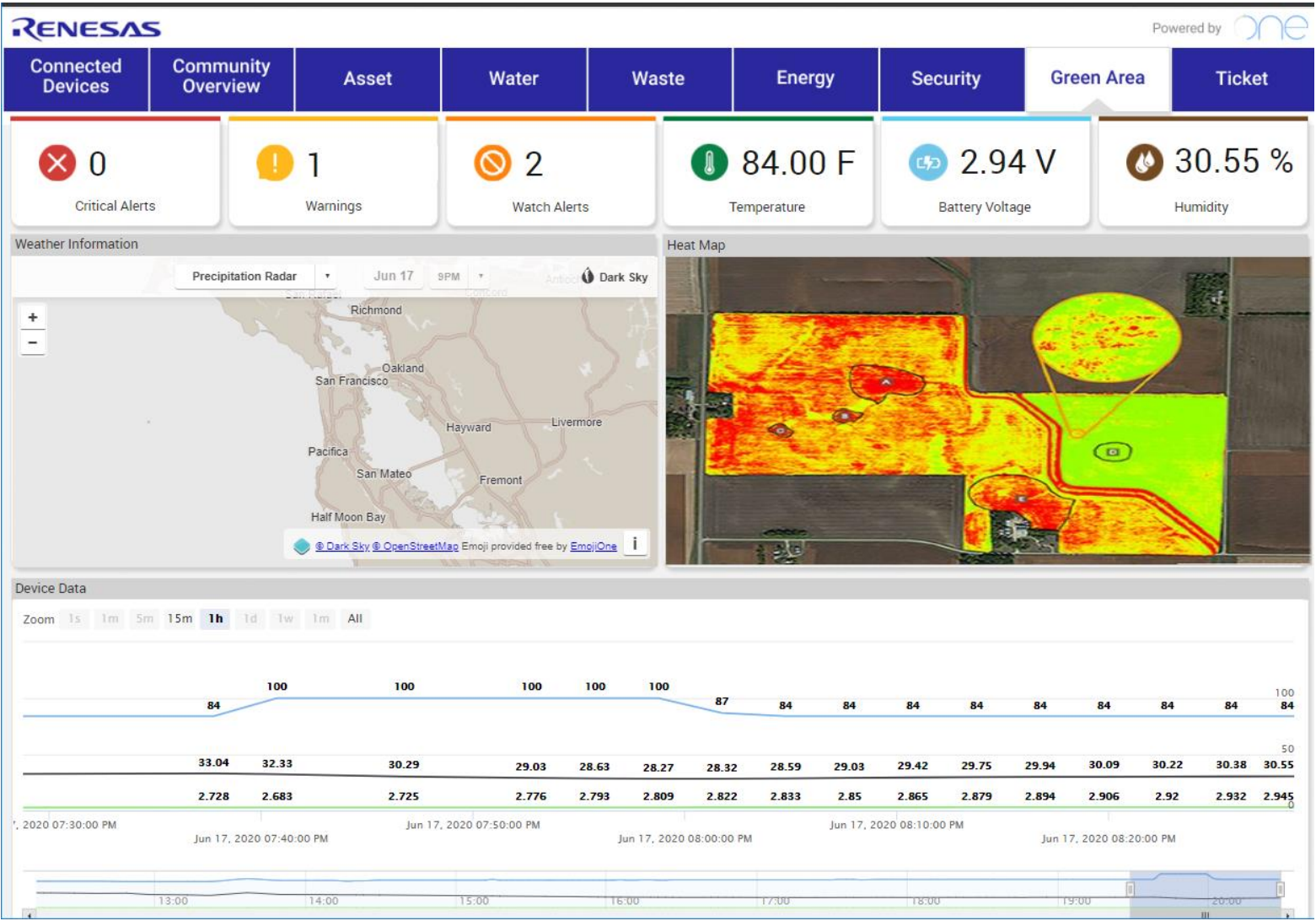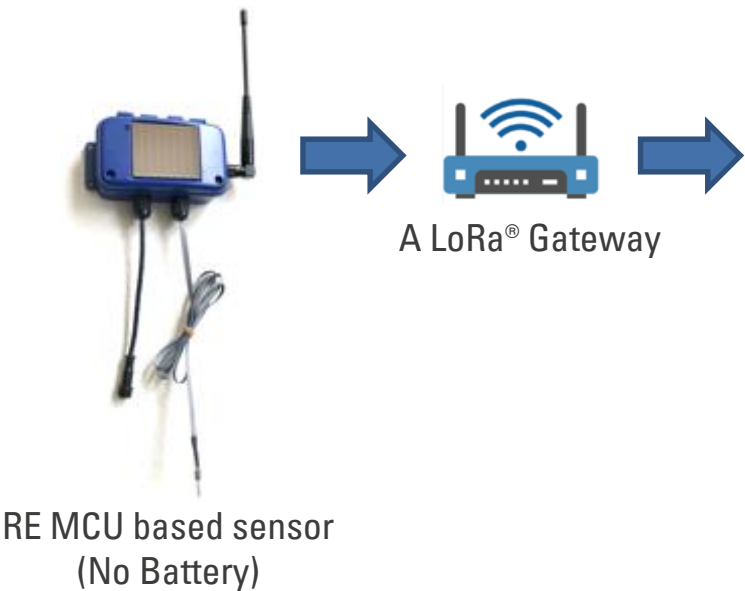- Long-range radio enablement

Proof-of-concept sensor

MATRIX POWERED

BIG IDEAS FOR EVERY SPACE — RENESAS

SMART AGRICULTURE EXAMPLE
BATTERY-LESS SOIL MONITOR

Winning Combos
Analog + Power + Embedded Processing

- Dashboard (from a cloud partner ONE Tech)

A LoRa® Gateway

RE MCU based sensor
(No Battery)

TRACKER EXAMPLE
BATTERY-LESS GNSS LOCATION TRACKER

Target Applications :
Personal & Asset Tracking
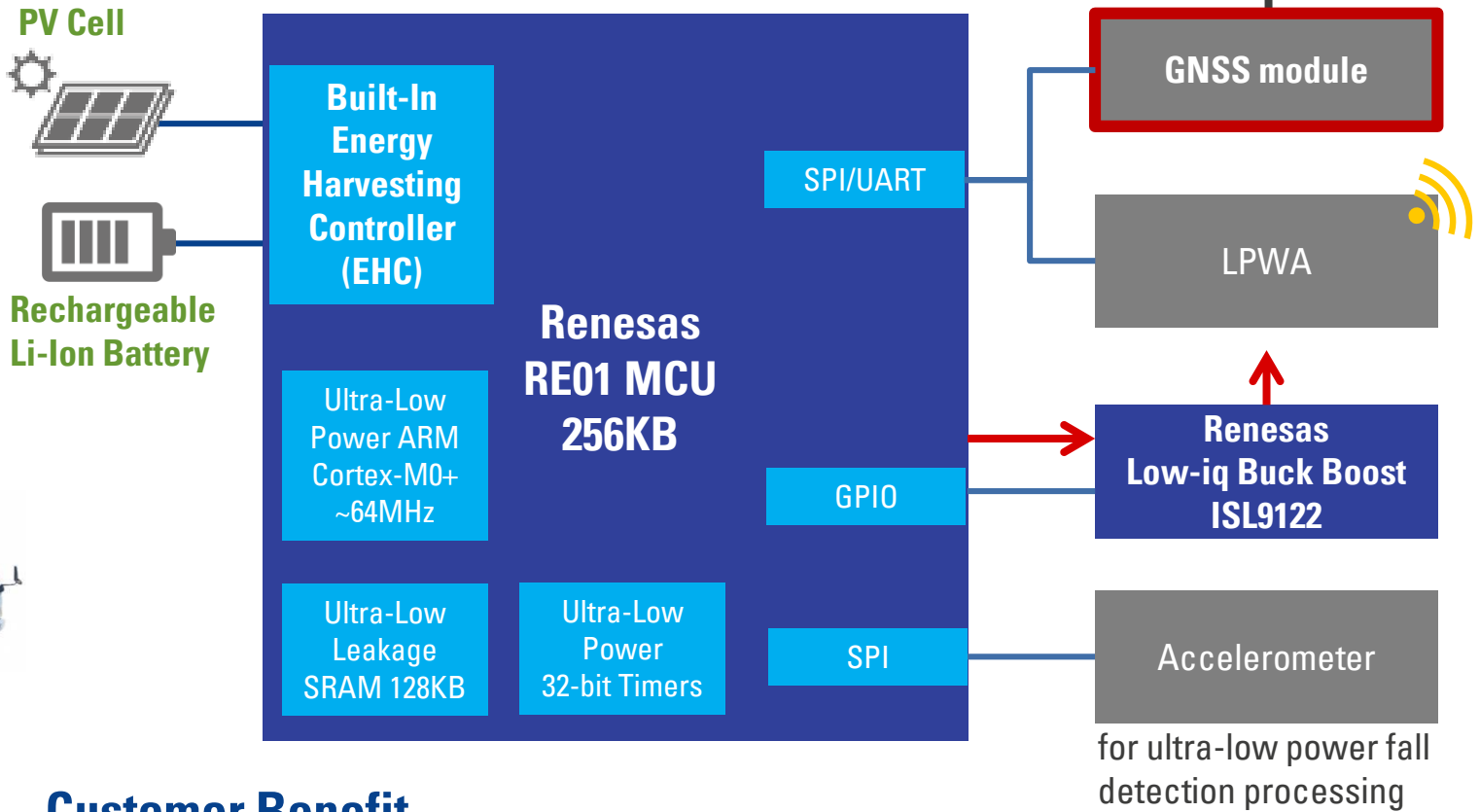
Kids and Elderly

Bikes, Motorcycles

Pet, Animal

Truck

Expensive tools

Block Diagram

PV Cell

Rechargeable
Li-Ion Battery

Built-In Energy Harvesting Controller (EHC)

Renesas RE01 MCU 256KB

Ultra-Low Power ARM Cortex-M0+ ~64MHz

Ultra-Low Leakage SRAM 128KB

Ultra-Low Power 32-bit Timers

SPI/UART

GPIO

SPI

GNSS module

LPWA

Renesas Low-iq Buck Boost ISL9122

Accelerometer

for ultra-low power fall detection processing

Customer Benefit
Significant long battery life by SOTB ultra-low power and energy harvesting

BIG IDEAS FOR EVERY SPACE

WEARABLES
WINNING COMBO DESIGN

Li-Ion Battery Power Supply

Li-ion Battery Charger ISL9205

Buck Regulator ISL9123

3.3V

To Sensors, LCD, BLE, etc.

Voltage Supervisor ISL88002

EN

Protected Li-ion Pack

VCC 3.3V

EN

EN

Buck Regulator ISL9123

Buck Regulator ISL9123

LDO

LDO

VCL=0.85V

VCLH=1.25V

0.79V Logic

1.25V Logic

Humidty & Temp. Sensor HS3001

I²C

Light Sensor ISL29125

I²C

Accelerometer Sensor

SPI

Bluetooth

UART

MCU RL78/G1D

Op Amp READ2302GSP

14bit ADC

SPI

MIP LCD

MCU RE01

JP151

This design reduces RE01's active power down to 12uA/MHz

25uA/MHz

12uA/MHz

LDO

Ext-DCDC (ISL9123)

BIG IDEAS FOR EVERY SPACE
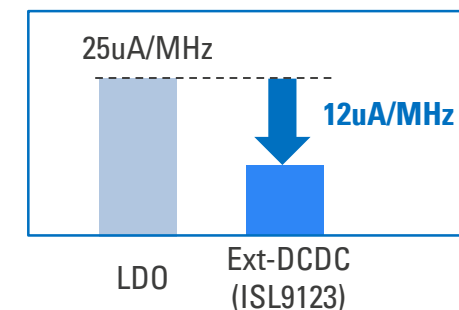
STRUCTURAL HEALTH MONITOR
WINNING COMBO DESIGN

Energy harvesting with a solar panel

ISL9122
Buck/Boost Regulator

3.3V → To Sensors, LCD, LoRa etc.

VCC 1.62~3.0V (When Energy Harvest is used)

Solar Cells

EHC*

LDO   LDO

VCL
VCLH

Storage Capacitance

Secondary Battery

0.79V logic   1.25V logic

RE01
Extreme Low Power MCU

ISL29035
Lighting sensor

I2C

ZMOD4510
Outdoor Air Quality Sensor

I2C

HS3001
Humi. &Temp. Sensor

Accelerometer

SPI

UART → LoRA® Transceiver

10km to 20km

SPI → MIP LCD

226 lux

* EHC: Energy harvest controller

| | MCU / MPU | | Analog | | Power |

ENERGY-SAVING ELECTRONIC LOCK SYSTEM
WINNING COMBO DESIGN

ISL9122
Buck/Boost Regulator

4.0V → To Motor driver, RF transceiver etc.

Primary Battery 3.6V

VCC

RE01B
Extreme Low Power MCU

EHC**

TSIP

I2C

LDO LDO

VCL
VCLH

0.79V logic   1.25V logic

Bluetooth Low Energy

Bluetooth

PWM → Motor driver → M

Pyroelectric IR sensor

Magnetic Sensor

Inductive Position Sensor IPS2200

MCU / MPU   Analog   Power

BIG IDEAS FOR EVERY SPACE **RENESAS**

ENERGY-SAVING GNSS TRACKING SYSTEM
WINNING COMBO DESIGN

RENESAS RE

*GNSS: Global Navigation Satellite System

ISL9122
Buck/Boost Regulator

3.3V → 3.3V To Sensors.

VCC 1.62~3.0V

Solar Panel

EHC**

LDO   LDO

VCL
VCLH

0.79V logic   1.25V logic

Storage Capacitor

Secondary Battery

HS3001
Humi. &Temp. Sensor

I2C

Accelerometer Sensor

14bit ADC

RE01
Extreme Low Power MCU

UART

SPI

UART

GNSS Receiver

VCC

LNA

UART

MIP LCD

RF transceiver

NB-IoT
ELTRES
LoRa
sigfox
Bluetooth®

JP153

** EHC: Energy harvest controller

	MCU / MPU		Analog		Power

BIG IDEAS FOR EVERY SPACE   RENESAS

SOTB™ RE FAMILY ECOSYSTEM STATUS

BIG IDEAS FOR EVERY SPACE

RE SOLUTION OVERVIEW

- **Basic Solution** : **Development tools, Eval Boards, Driver software, Application notes, RTOS support**
- **Advanced Solution** : **3rd party middleware, Radio connectivity, Cloud integration, Demos**

Basic solutions			Advanced solutions			
Tools	**Board**	**SW**	**S/W M/W**	**Radio**	**Cloud**	**Demos**
IDE, Complier e² studio — GNU ARM GCC Configurator IAR SYSTEMS — IAR CC	**EK-RE01 256KB**	**Driver** CMSIS COMPLIANT ARM Cortex Microcontroller Software Interface Standard • CMSIS-BSP • CMSIS-Driver • FOTA • Sample code	**Voice recognition** TOSHIBA LINGUWERK signals · technology · media Advanced Media, Inc. 株式会社アドバンスト・メディア	**LoRaWAN** SEMTECH LoRaWAN stack and RE01 port	**Cloud service** one One tech One tech cloud	
Debugger SEGGER J-Link IAR I-jet Renesas E2/E2-Lite	**EK-RE01 1.5MB**	**RTOS** FreeRTOS AMAZON FreeRTOS (21/Q2/E)	**Security** Trusted Secure IP — Veridify Security TSIP Driver Secure OTA — WalnutDSA IronWood KAP DOME	**NBIoT** QUECTEL Build a Smarter World Quectel AT cmd driver (2Q '21)	aws (21/Q2/E)	
Flash Writer Renesas PG-FP6 SEGGER J-Flash Renesas RFP	**RE01B Eval Kit**	**APN** • Peripheral usages • Energy Harvesting • Low power mode • LoRaWAN integration • Voice Trigger example • GNSS example • etc…	**Graphic** SEGGER — emWin Segger emWin	**BLE** RE01B BLE stack RE01B Beacon stack	Microsoft Azure (TBD)	

BIG IDEAS FOR EVERY SPACE — RENESAS

RENESAS RE01 MCU EVALUATION KITS

Ready-To-Go Solution for Ultra-Low Power and Energy Harvesting app development

- RE01 256KB Evaluation Kit : RTK70E0118S00000BJ
- RE01 1.5MB Evaluation Kit : RTK70E015DS00000BE

Orderable at Digi-Key, Mouser, Avnet, Future Electronics

RE01 EVALUATION KIT WEB
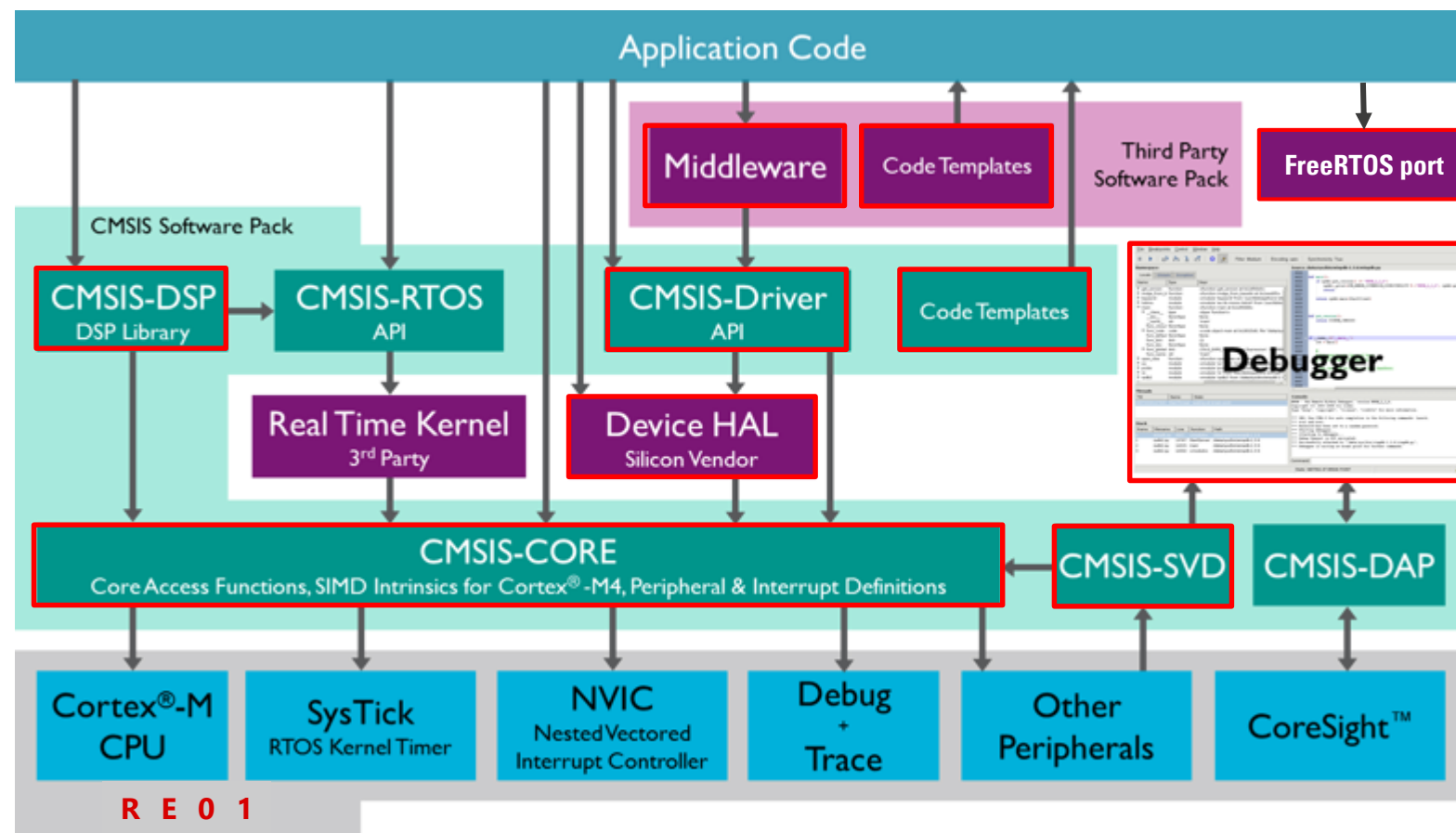- Manual, Schematics, Design Files
- Various Application Notes

EK-RE01 256KB : RTK70E0118S00000BJ

RE01 MCU(R7F0E01182CFP)

MIP LCD Board

Arduino I/F for radio/sensor expansion

Solar Panel Panasonic AM-1815CA

Debugger I/F

USB Serial

PMOD I/F

Supercapacitor 47uF

Low-iq buck regulators ISL9123

BIG IDEAS FOR EVERY SPACE
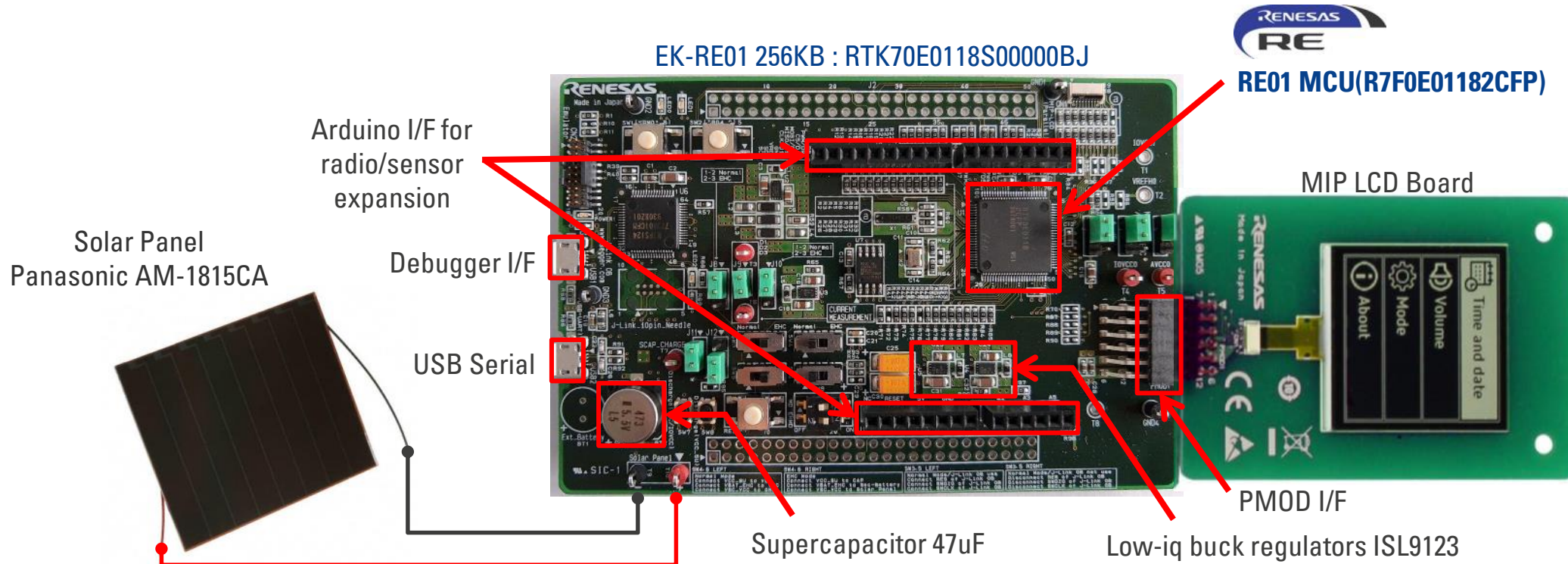
RE01B SOFTWARE SUPPORT

CMSIS

Renesas provides the following ARM CMSIS* compatible software for RE01

*CMSIS : Cortex Microcontroller Software Interface Standard

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

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

Application Code

Middleware | Code Templates | Third Party Software Pack | **FreeRTOS port**

CMSIS Software Pack

CMSIS-DSP — DSP Library
CMSIS-RTOS — API
CMSIS-Driver — API
Code Templates

Real Time Kernel — 3rd Party
Device HAL — Silicon Vendor

Debugger

CMSIS-CORE
Core Access Functions, SIMD Intrinsics for Cortex®-M4, Peripheral & Interrupt Definitions

CMSIS-SVD | CMSIS-DAP

Cortex®-M CPU | SysTick — RTOS Kernel Timer | NVIC — Nested Vectored Interrupt Controller | Debug + Trace | Other Peripherals | CoreSight™

R E 0 1

BIG IDEAS FOR EVERY SPACE

SMART CONFIGURATOR SUPPORT FOR RE MCU

- **GUI-based Smart Configurator Support on e2 studio for RE01 MCU**

- **Common Tool Support for Renesas ARM MCUs**
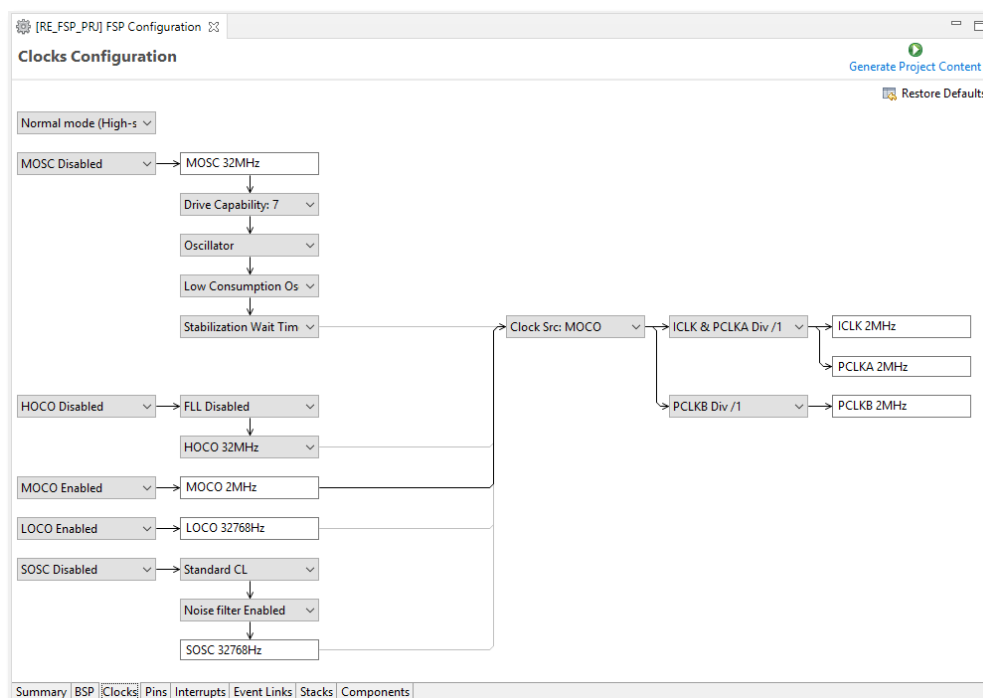
Clock Configuration
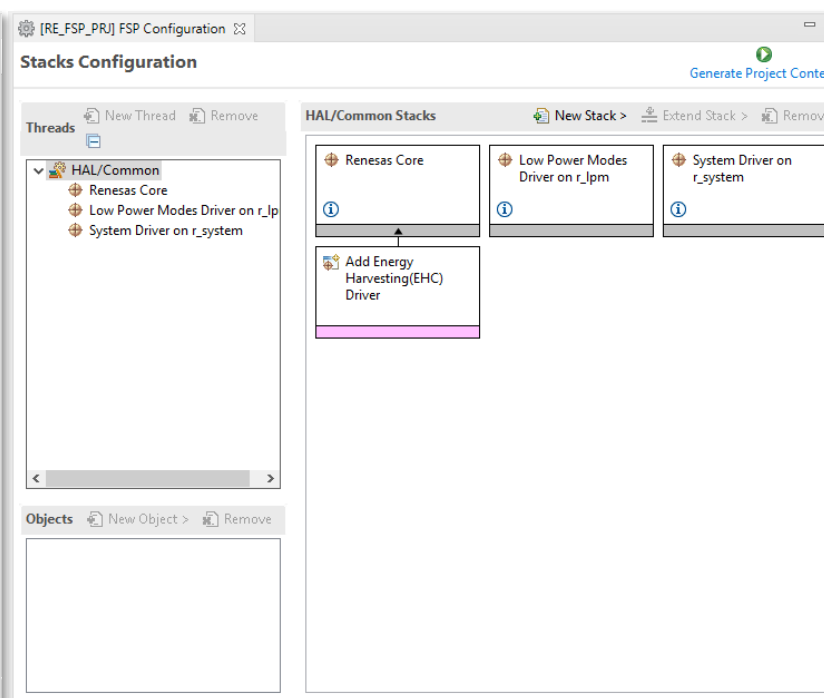
Stacks Configuration
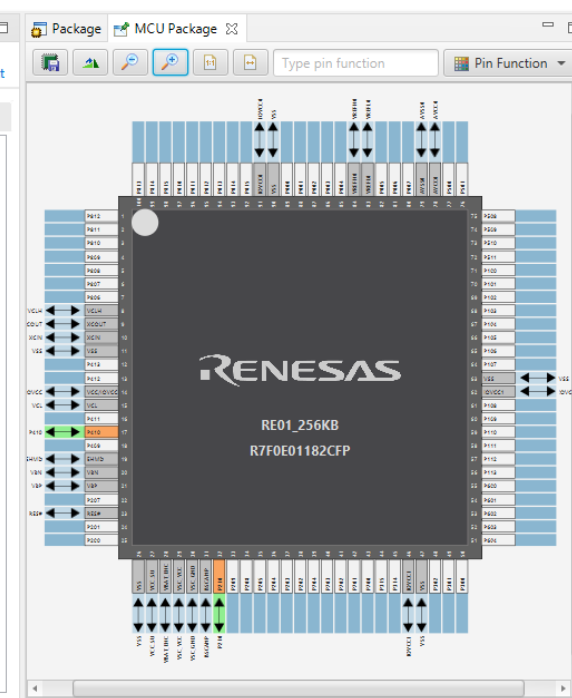
Pin Configuration

SOTB™ RE FAMILY DEMOS

BIG IDEAS FOR EVERY SPACE
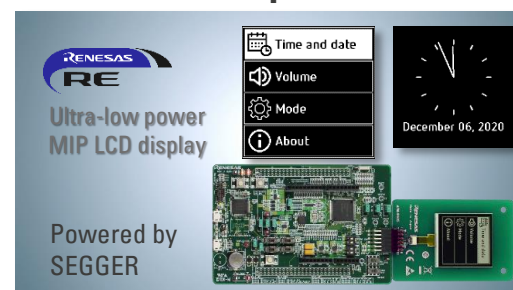
RE MCU ULTRA-LOW POWER SOLUTIONS

*BMF : Battery Maintenance-Free

Extremely-low power Voice Recognition

https://www.renesas.com/video/re-solution-low-power-voice-recognition

- Wearables
- Smart home

BMF* Air Quality Sensor

https://www.renesas.com/jp/en/video/long-lasting-battery-driven-air-quality-monitoring
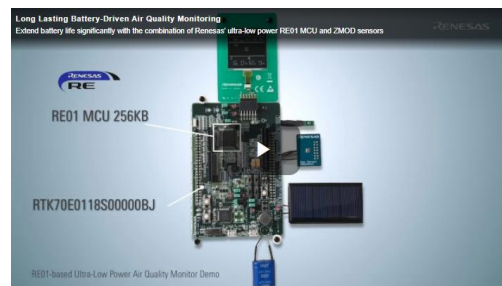
- Smart home
- Weather Station
- HVAC system
- Personal monitors

BMF* GPS Tracker

https://www.renesas.com/video/re-solution-battery-maintenance-free-gps-receiver

- Asset Management
- Livestock, Pet
- Medical Alert

BMF* LoRaWAN® Sensor

https://www.renesas.com/video/re-solution-battery-maintenance-free-lorawan-sensor

- Industrial Health Monitor
- Weather Station

Battery-less QR Code Display

https://www.renesas.com/video/re-solution-battery-less-qr-code-display
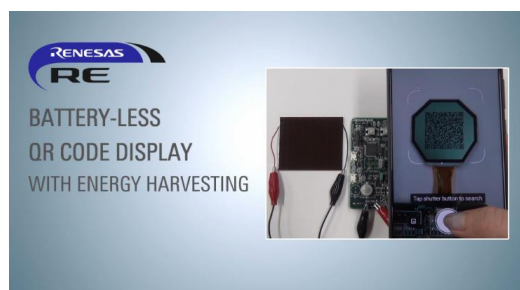
- Wearables
- Smart home

Extremely Low-Power Voice Recognition Wearable UI and Remote Control

https://www.renesas.com/video/re-solution-low-power-voice-recognition-wearable-ui-and-remote-control

- Wearables
- Smart home

emWin ultra low-power Graphics

https://www.renesas.com/us/ja/document/prb/segger-emwin-gui-embos-rtos-renesas-re-partner-solution?r=1492201

- Wearables
- Smart home

LAB on the Cloud Ultra-Low Power

https://www.renesas.com/jp/en/video/lab-cloud-ultra-low-power-mcu-re-family

BIG IDEAS FOR EVERY SPACE RENESAS

RE01 ENERGY HARVESTING QUICK STARTUP DEMO

* Vibration transducer needs additional rectifier circuit and a capacitor

▪ 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 small solar panel, small thermoelectric power generator, or vibration transducer.

3. **Huge maintenance cost reduction**

   Battery-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.

Serial MIP (Low power LCD)

PV cell

or

TEG module

or

Vibration*

Solar Panel

TEG

Vibration Transducer*

RE01

EHC

MCU

CPU

SPI → MIP-LCD

DMAC

AGT

GDT

BIG IDEAS FOR EVERY SPACE
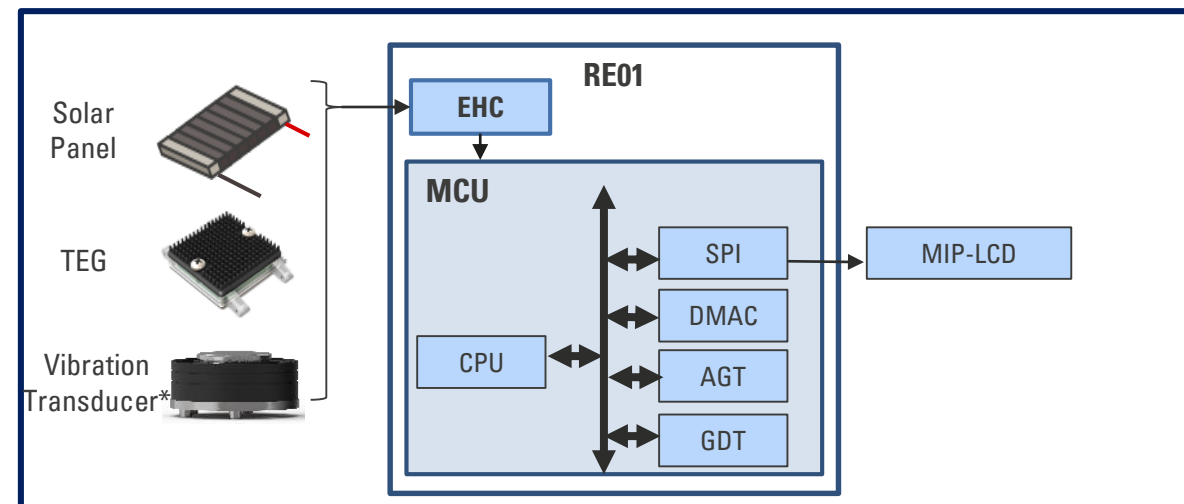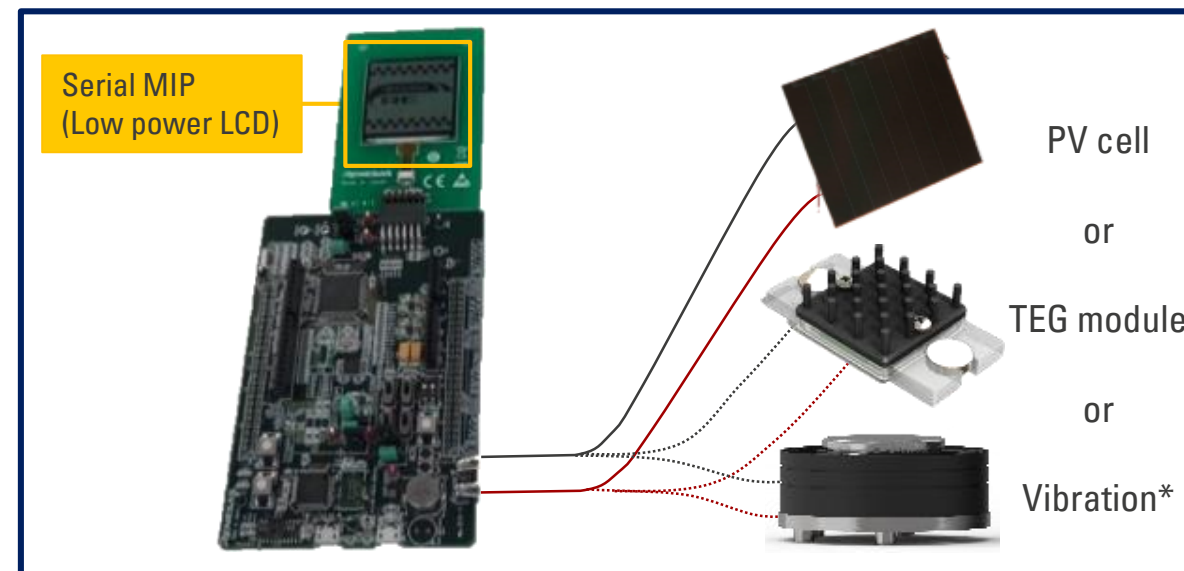
RE01 BATTERY-LESS LORAWAN® SENSOR
FOR SMART AGRICULTURE, STRUCTURAL HEALTH MONITOR

■ **RE01 Customer Benefits**
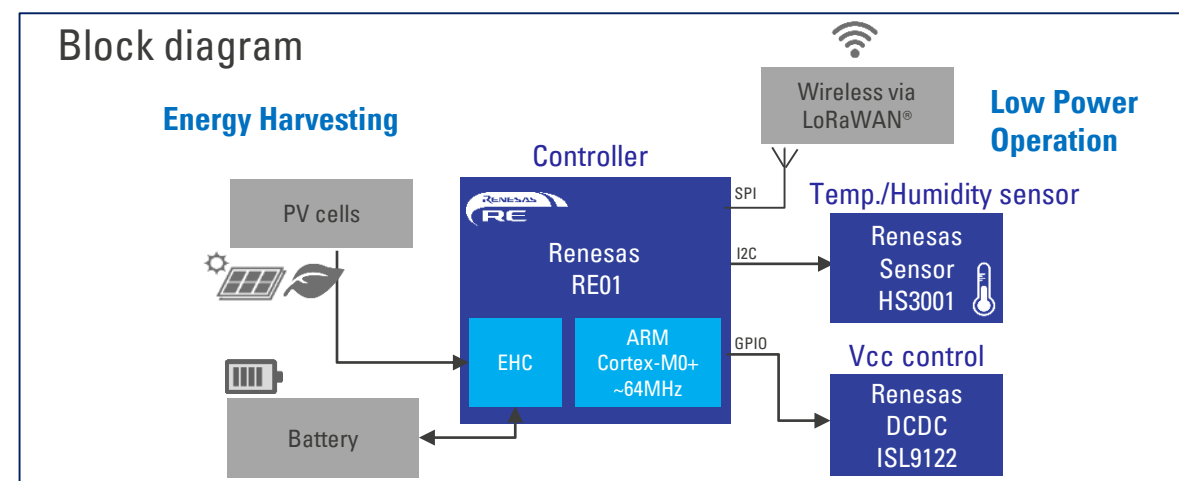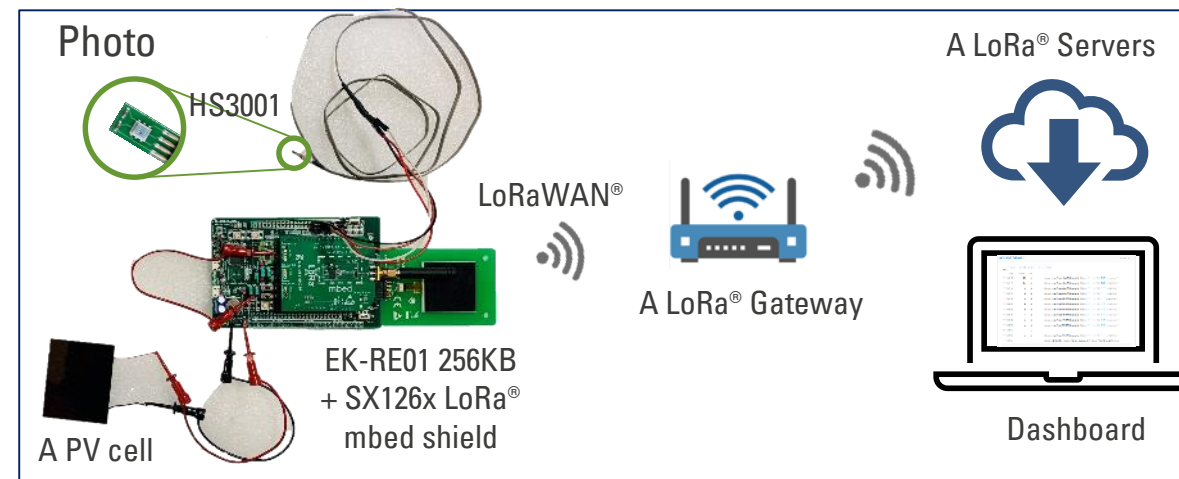
1. **Ultra-low power consumption** 🌿

   Low power consumption of LoRa® data transmission and sensor data acquisition for smart agriculture by applying ultra low power RE01.

2. **Huge maintenance cost reduction**

   Energy harvesting control circuit (EHC) enables operation with only small amount of environmental energy. Semi-permanent autonomous operation is possible without human intervention. No maintenance required.

3. **BOM cost reduction**

   External PMIC for energy harvesting is not required, reducing BOM cost. No power wiring required. Can apply LoRa® without network carrier.

   Vast area   Backcountry   Uneasy access

Photo

HS3001

LoRaWAN®

A LoRa® Servers

A LoRa® Gateway

Dashboard

EK-RE01 256KB + SX126x LoRa® mbed shield

A PV cell

Block diagram

Energy Harvesting

Controller

Wireless via LoRaWAN®

Low Power Operation

PV cells

Renesas RE01

SPI

I2C

Temp./Humidity sensor

Renesas Sensor HS3001

EHC   ARM Cortex-M0+ ~64MHz

GPIO

Vcc control

Renesas DCDC ISL9122

Battery

BIG IDEAS FOR EVERY SPACE

RE01 BATTERY-LESS OUTDOOR AIR QUALITY MONITOR

- **Ultra-low power Outdoor Air Quality monitor demo with RE01MCU and ZMOD4510**

RE01 256KB

HS3001

ZMOD4510

A PV Cell

A Li-Ion Rechargeable Battery
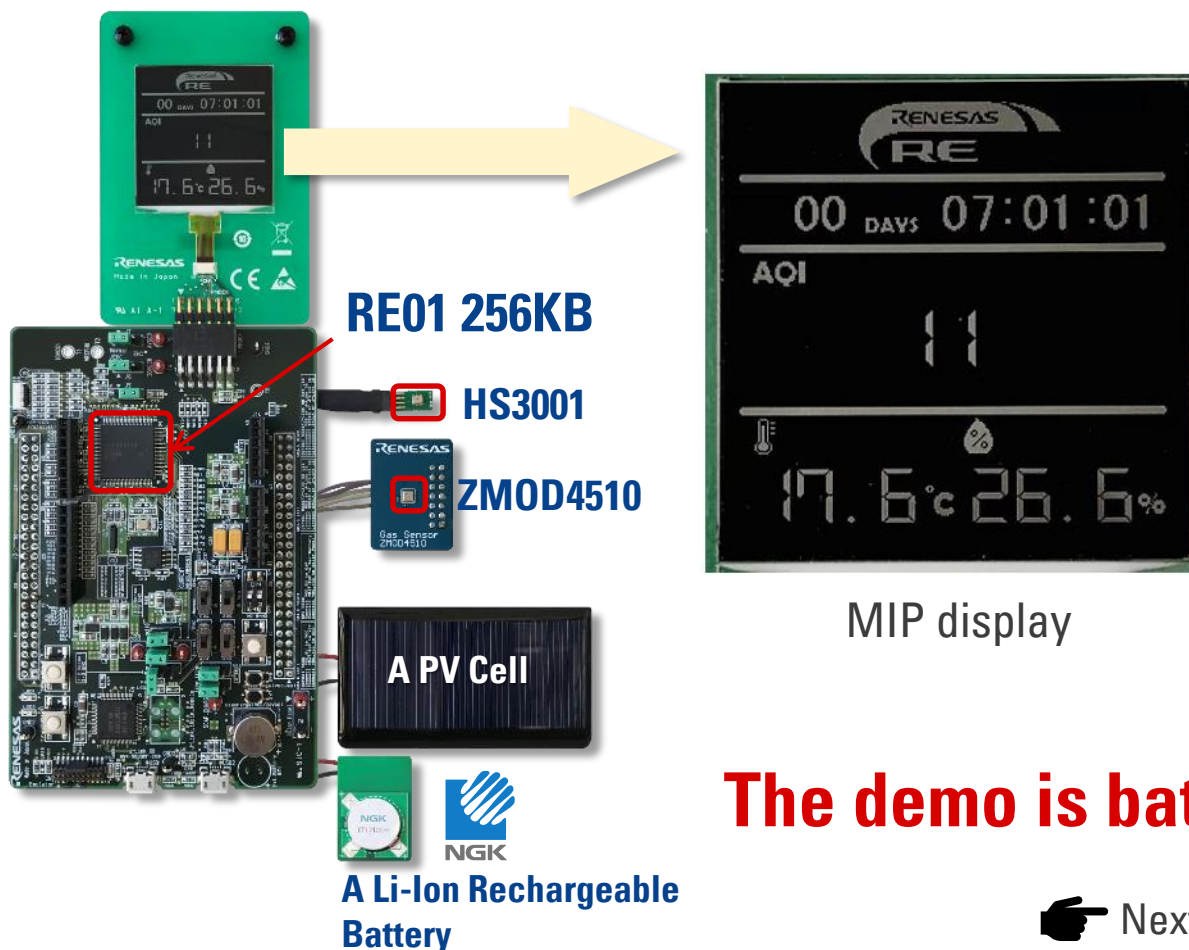
MIP display

RE01 MCU :
- CPU CM0+ :
  - Active current 25uA/MHz
  - Standby current 500nA@3.0V
  - Runs AI algorithm for AQI calc. at low power
- RTC runs in standby mode : 350nA@3.0V
- MIP display : 3uA@3.0V to keep a static image
- EHC : min. 5uA to start energy harvesting

ZMOD4510 :
- Ultra-low power AQI reading
  - 150uW@1sample per 2sec

The demo is battery-less, it's a solar-powered 🍃

👉 Next coming : Ultra-low power Indoor Air Quality using ZMOD4410

RE01 EXTREME-LOW POWER VOICE RECOGNITION
LINGUWERK VOICE RECOGNITION

Extreme-low power speech recognition solution from Linguwerk(www.linguwerk.de) **to provide touchless interfaces for wearable and touchless user interface applications**

- **Memory usage :**
  - 50 Kbytes Flash
  - 17 Kbytes SRAM
- **Power consumption** (during recognition) :
  - **1.5 mA** with internal LDO
  - **600 µA** with external DC-DC
- Operates with a 32 MHz system clock

Less than 1/10 power consumption of competitors solutions

BIG IDEAS FOR EVERY SPACE
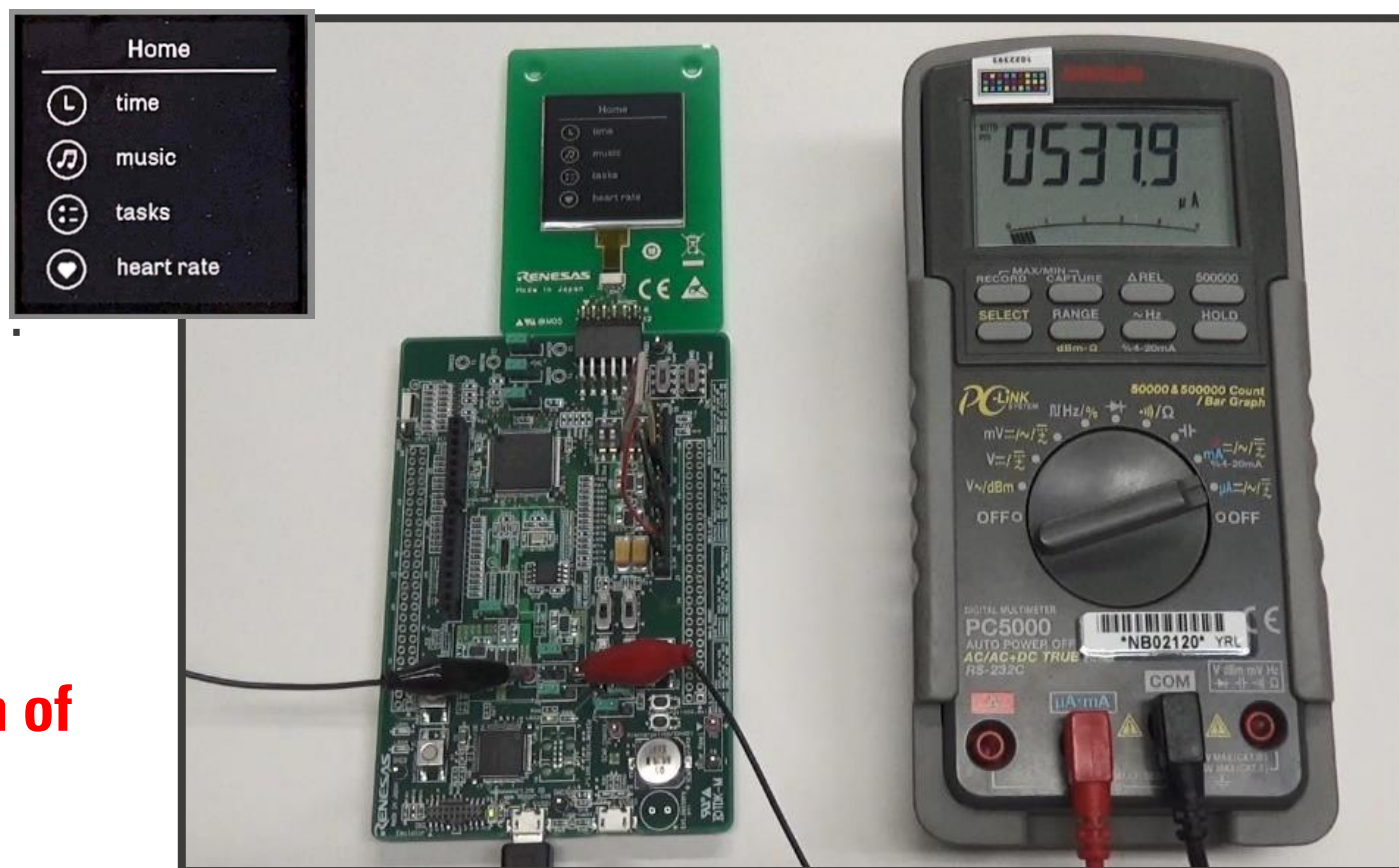
RE01 ENERGY HARVESTING GPS DEMO
FOR GNSS TRACKING APPLICATIONS

Application Note Available. Ask your sales contact 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.
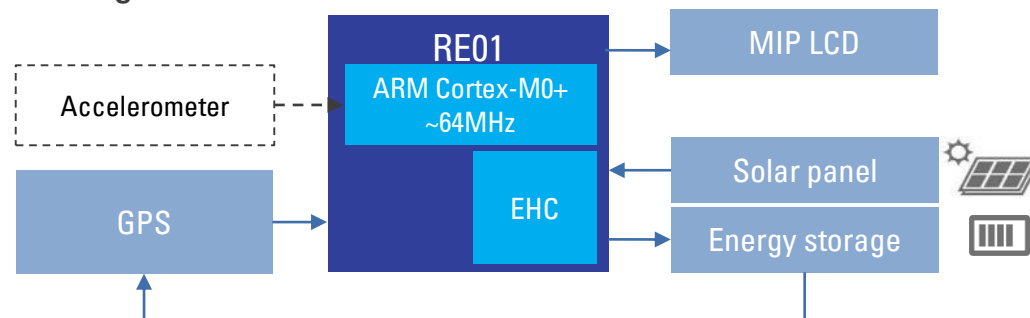
2. **Energy Harvesting Power management system** 🍃

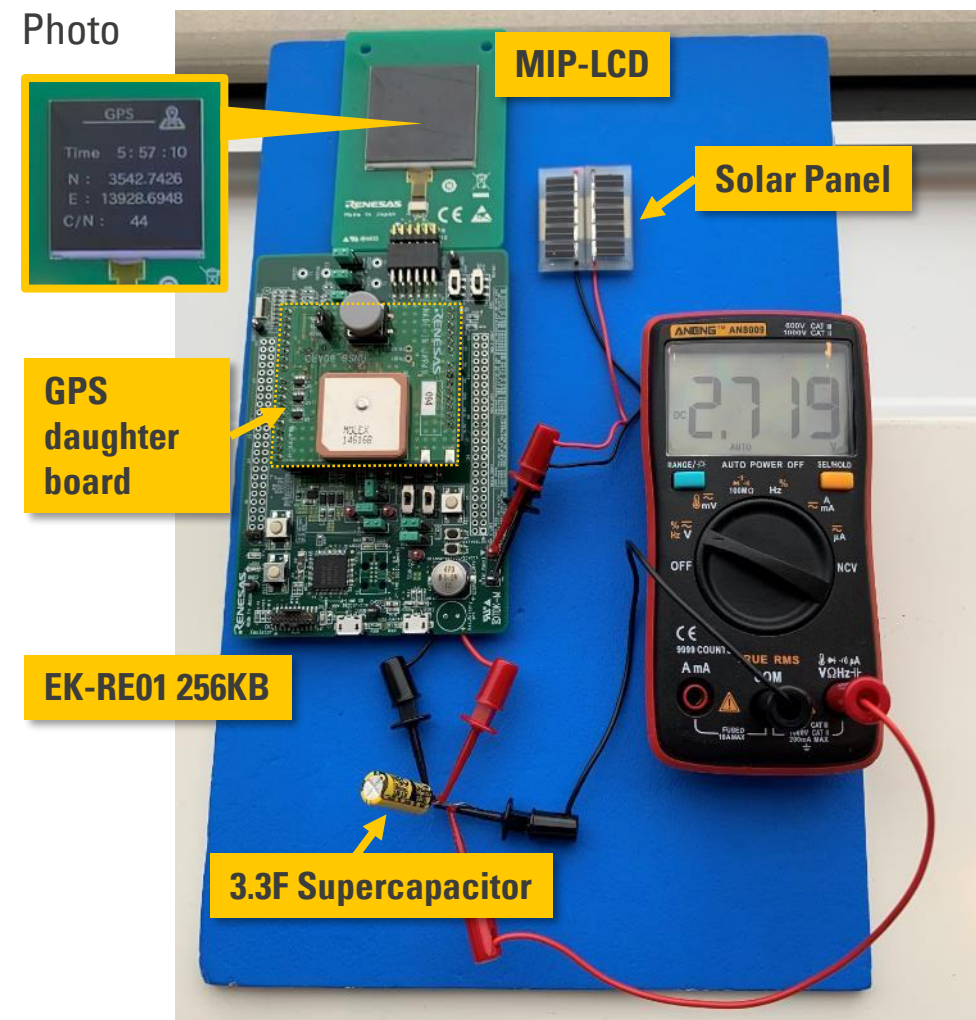   Energy harvesting power management is available to download from here Application Note R01AN4837 (Link)

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.

Photo

MIP-LCD

Solar Panel

GPS daughter board

EK-RE01 256KB

3.3F Supercapacitor

Block diagram for location tracker

Accelerometer → RE01 (ARM Cortex-M0+ ~64MHz) → MIP LCD

GPS → RE01 / EHC

Solar panel → EHC

Energy storage

BIG IDEAS FOR EVERY SPACE   **RENESAS**

Formfactor (37mm×19mm)

GPS satellite

GNSS chip
CXD5603GF
(SONY)

GPS Pattern
Antenna

- **Battery maintenance free location tracking** 🍃
- **GNSS data (time and coordinates) received every 10 min.**
- **Confirmed 24 / 7 energy harvesting operation**

DC/DC
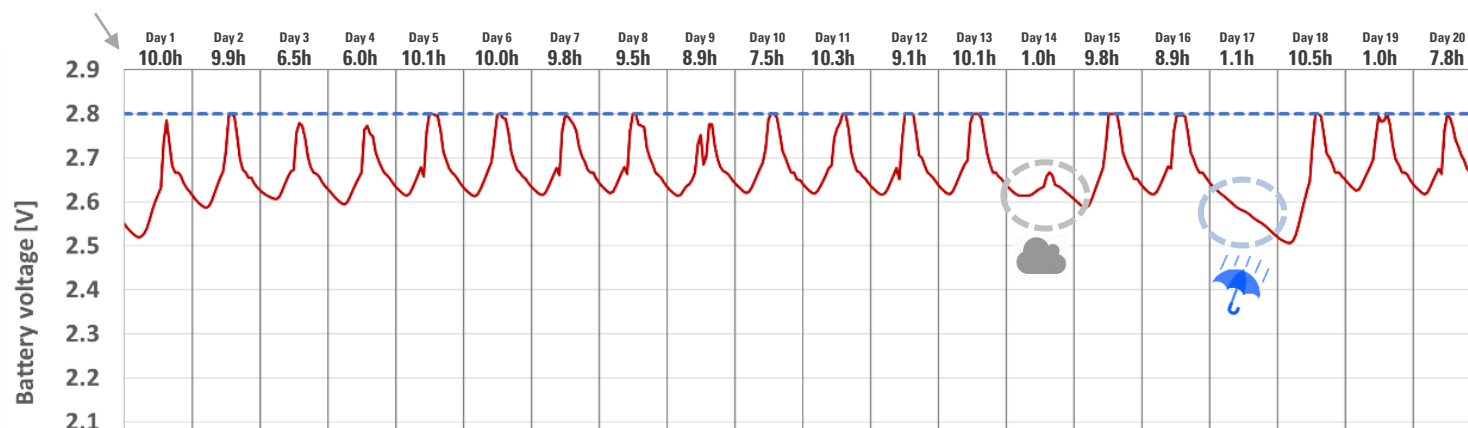Converter
ISL9123

RE01 256KB
R7F0E01182DNG

PV Cell

**Rechargeable
Li-Ion Battery**

Sunlight hours

Rechargeable battery example :
SLB08115L140 (nichicon)
- Voltage range 2.8V - 1.8V
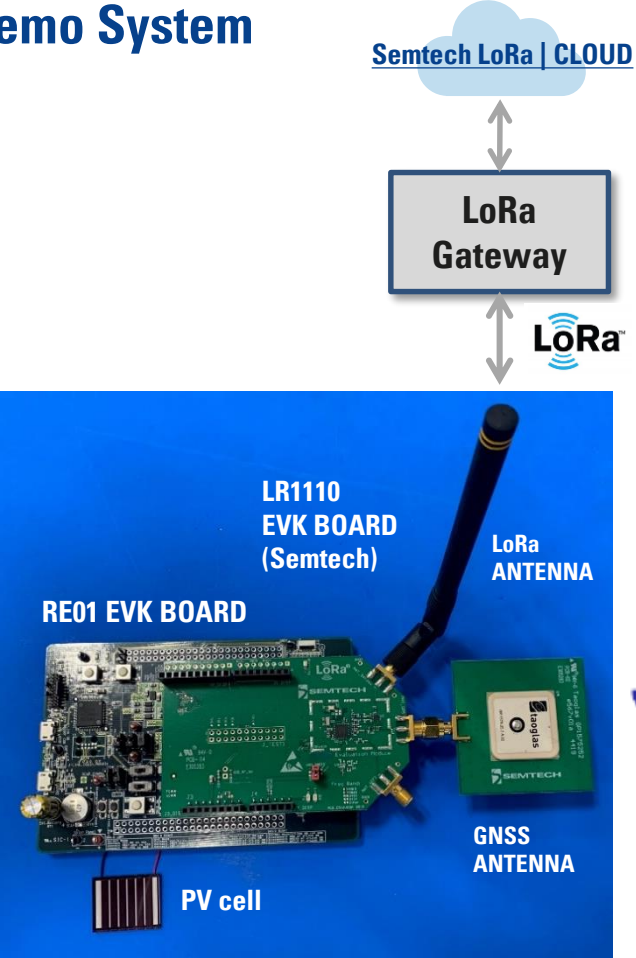- Nominal capacity: 14mAh

RE01 ULTRA-LOW POWER LOCATION TRACKING
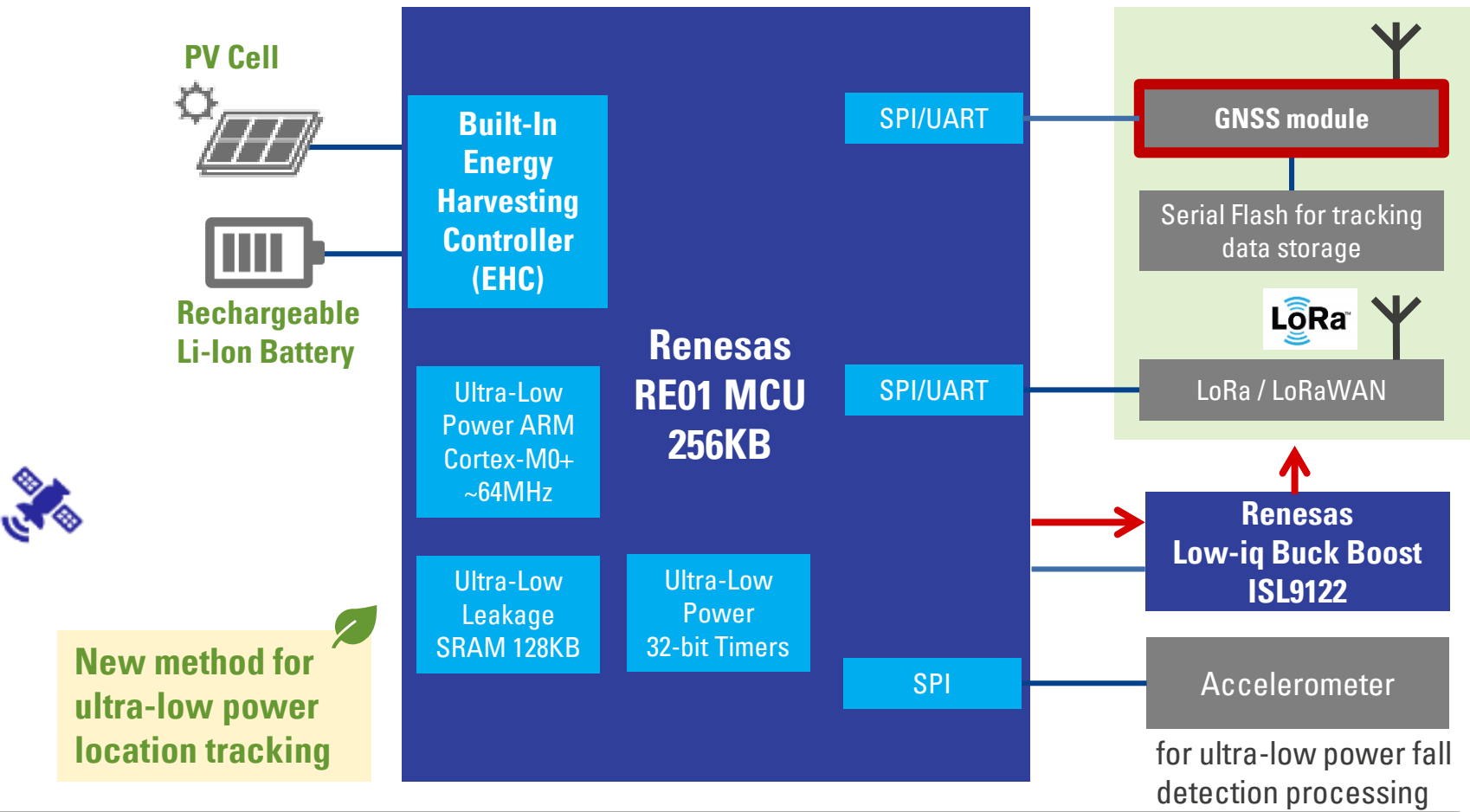## NEW ULTRA-LOW POWER LOCATION TRACKING + ENERGY HARVESTING

RENESAS RE

Under development

Demo System

Semtech LoRa | CLOUD

LoRa Gateway

LoRa

LR1110 EVK BOARD (Semtech)

LoRa ANTENNA

RE01 EVK BOARD

GNSS ANTENNA

PV cell

Demo available in Q2'21

Block Diagram

LR1110 (SEMTECH)

PV Cell

Rechargeable Li-Ion Battery

| Built-In Energy Harvesting Controller (EHC) |

Renesas RE01 MCU 256KB

| Ultra-Low Power ARM Cortex-M0+ ~64MHz |

| Ultra-Low Leakage SRAM 128KB | Ultra-Low Power 32-bit Timers |

SPI/UART

SPI/UART

SPI

GNSS module

Serial Flash for tracking data storage

LoRa

LoRa / LoRaWAN

Renesas Low-iq Buck Boost ISL9122

Accelerometer

for ultra-low power fall detection processing

New method for ultra-low power location tracking

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RENESAS

QR CODE DISPLAY DEMO (ULTRA-LOW POWER 1.9uA)
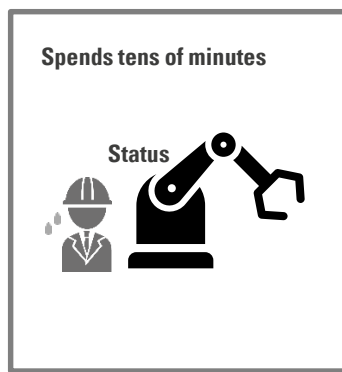
- **RE01 Customer Benefits**

1. **Ultra-low power QR code display** 🌿
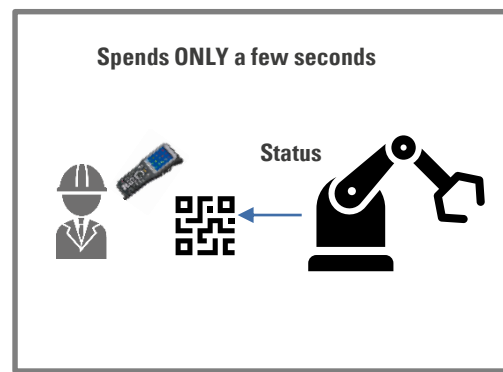   **Keeping image: 0.7uA, QR code rewrite 1.9uA**
   using the almost zero power MIP LCD display means that we can display a QR code with significantly lower power consumption than other technologies

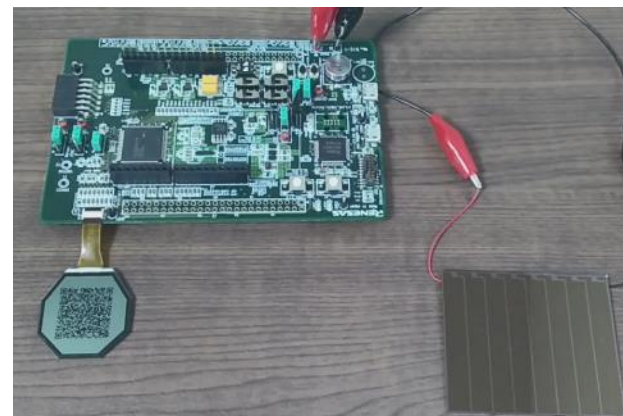2. **Significant reduction in operator cost**
   By displaying status of device with QR code, you do not need to open device to check status.

Spends tens of minutes

Status

Shorten to less than 1/100

Spends ONLY a few seconds

Status

Photo

Block diagram

RE01

DMAC

SRAM

Parallel MIP-LCD IF

32kHz
VBB(Low leakage current mode)
Sleep
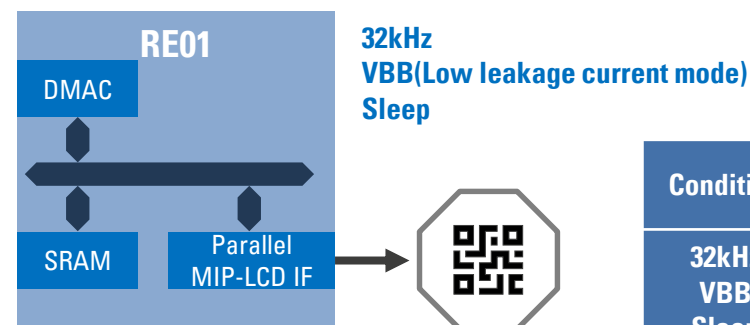
Condition	MIP rewrite	Keeping image
32kHz VBB Sleep	1.9uA	0.7uA

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SUMMARY

BIG IDEAS FOR EVERY SPACE

SUMMARY

- World's top level ultra-low power performance : ULP Mark-CP score 705

- SOTB™ is very unique – Best energy efficiency AND Fast CPU speed up to 64MHz

- Suitable for various ultra-low power applications :

- Built-in Energy Harvesting Controller enables battery maintenance free system (either extreme long battery-life or complete battery-less system)

- Ultra-low power MCU peripherals (14-bit ADC, 32-bit low power timers, low power Flash for FOTA, etc..) are beneficial for many ultra-low power applications

- RE01B is available for applications that need ultra-low power, large memory for FUOTA, RTOS or wireless stack, and BT5.0 capability

- RE01 development tools & sample firmware are downloadable from Renesas web site

- Renesas partners with various companies and provides the ecosystem for battery maintenance-free system designs (see next page).

Wearables

Smart home
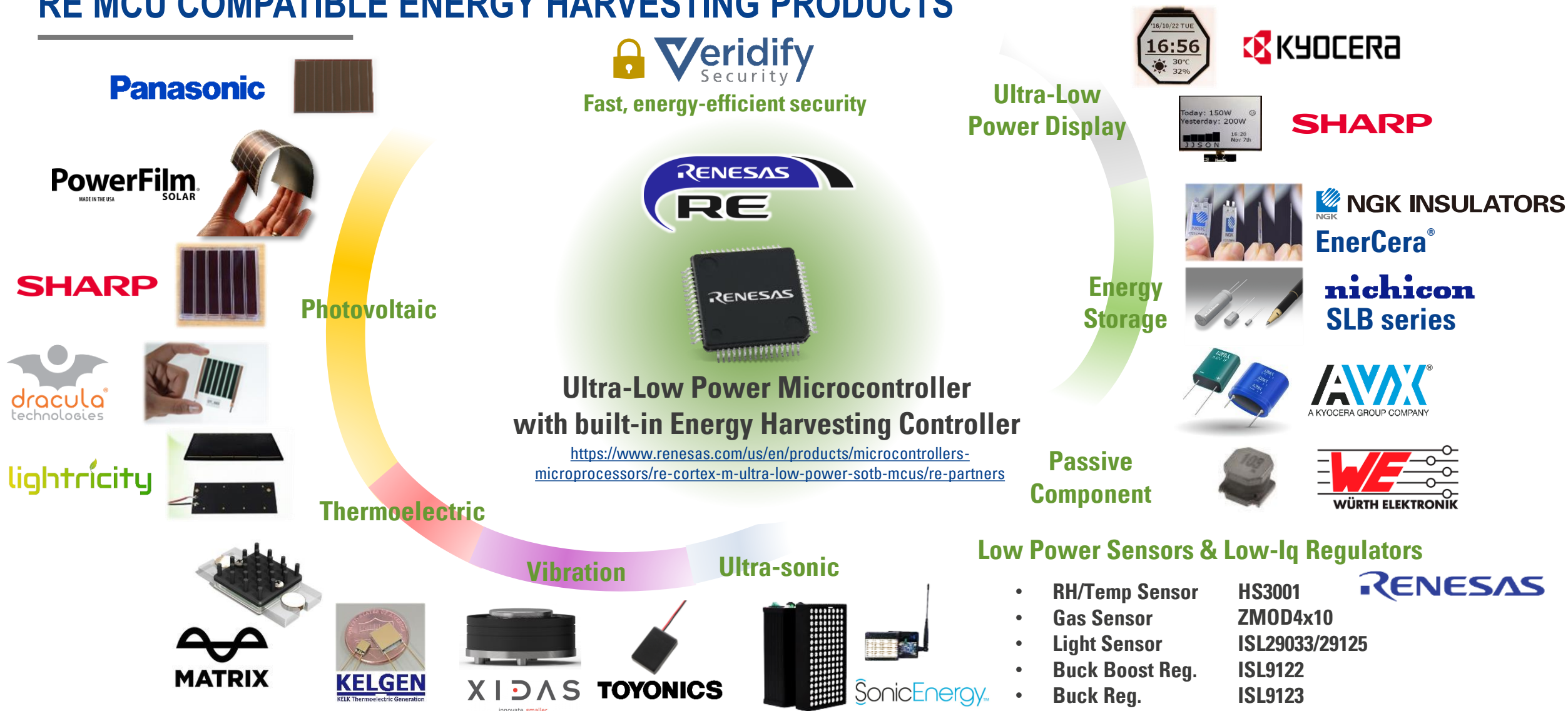
Smart locks

SHM

Healthcare

Smart meter

Agriculture

Trackers

BIG IDEAS FOR EVERY SPACE

RENESAS RE ENERGY HARVESTING PARTNER ECOSYSTEM
RE MCU COMPATIBLE ENERGY HARVESTING PRODUCTS

Fast, energy-efficient security

**Ultra-Low Power Microcontroller
with built-in Energy Harvesting Controller**

https://www.renesas.com/us/en/products/microcontrollers-microprocessors/re-cortex-m-ultra-low-power-sotb-mcus/re-partners

Photovoltaic

Thermoelectric

Vibration

Ultra-sonic

Ultra-Low Power Display

Energy Storage

Passive Component

Low Power Sensors & Low-Iq Regulators

- RH/Temp Sensor   HS3001
- Gas Sensor   ZMOD4x10
- Light Sensor   ISL29033/29125
- Buck Boost Reg.   ISL9122
- Buck Reg.   ISL9123

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THANK YOU!

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

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