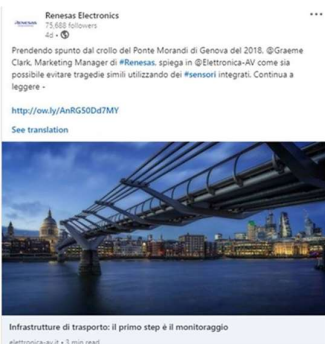# RE Newsletter

The newsletter for the RE embedded controller family

Hello everyone

Welcome to the Winter Edition of the RE Newsletter, we hope that you and your families are all safe and well in this strange time.

In this month's newsletter we look at one of the application areas where we are seeing a demand for Memory In Pixel displays, with the sudden rise in demand for QR codes, we also have an introduction to Dracula Technology, one of our partners for organic solar cells, check out their great logo inside

We have also had quite a lot of promotion activity underway, preparing for Embedded World in March. We have several technical articles published in the next few weeks, the first of which was just published on the web in the last few days. We have also done quite a bit of social media activity, where we have been promoting an article covering the use of the RE family in smart cities and structural health monitoring applications) in the Italian technical magazine, Elettronica AV. We also show a real structural health monitoring application that uses RE family by Force Technology, this is a really interesting use of the RE and energy harvesting.

We also have an article from Segger introducing emWin support for the RE and we also look at some of our winning combos that use the RE and some the latest technical articles based around the RE that have been published in Europe.

We also look at some of the latest videos we have of the various RE demos that are available, and we have all the latest status and reference information. Please contact your Renesas sales contact for access to these.

If you are interested in more information about the Renesas RE family or have any questions or requests, you can visit our dedicated website at www.renesas.com/RE or contact your Renesas sales contact.

In this month's newsletter, we want to start to introduce some of the partners that we have been working with. To start we'd like to introduce you to Dracula Technologies, who will tell you something about themselves in their own words. In the next months you will see some really neat energy harvesting demo's from Renesas using their LAYER® Organic Photovoltaic cells, so over to Dracula.

Dracula Technologies

We are Dracula Technologies, a Deeptech startup that created LAYER® (Light As Your Energetic Response), an innovative Organic Photovoltaic technology to power low consumption devices.

Why « Dracula » ?

Many companies active in the photovoltaic have names including Sun, Solar, Helia,.. As we are not related to the sun but to the ambient light, we chose Dracula with the meaning that even Dracula can use our technology. We could generate energy from his candles, and he would not be affected by direct light. It was initially a joke, but we kept it with a nice logo!

Energy Harvesting

With growing numbers of IoT devices in activity, IoT electronics manufacturers must find ways to replace batteries or extend battery life. In fact, depending on the application, batteries used for IoT devices have an estimated lifespan of 1 to 3 years. Replacing all those dead batteries causes higher maintenance costs and raises controversial debates regarding battery production and the end of life. There is different way to harvest energy, but we chose the one which is the most tangible, light. We know where and when we have light even low luminosity. So, it is quite obvious/simple to use it.
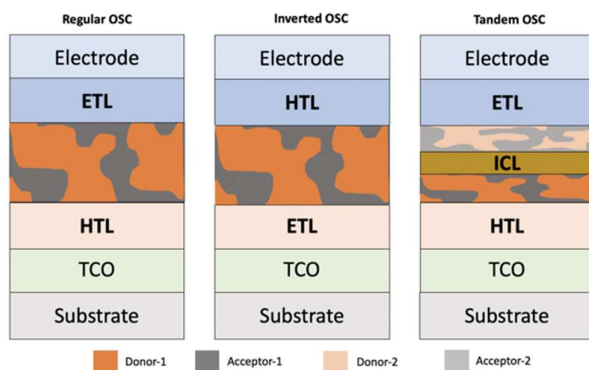
We rely on OPV (Organic Photovoltaic)

Figure 1 : Schematic diagram of typical BHJ-OSC (Regular OSC, inverted OSC and tandem OSC)

Third-generation cells are less commercially advanced 'emerging' technologies. This includes organic photovoltaics (OPVs), copper zinc tin sulfide (CZTS), perovskite solar cells, dye-sensitized solar cells (DSSCs), and quantum dot solar cells. The two last generations are unlikely to challenge silicon's dominance for large-scale electricity generation but offer promise in applications where lower cost, weight, low energy requirement, and durability can be traded-off against efficiency. The

third generation of photovoltaic cells, so-called thin film, is revolutionizing the energy harvesting market by offering a technology efficient in low light conditions, lightweight, and greener than the previous generation.

9 years of R&D into OPV's

Dracula Technologies has spent over 9 years of research into OPV's, with 18 team members among whom 80% with technical education and background including 4 with PhD's who have contributed to more than 60 publications on organic photovoltaics and 6 patents about LAYER® structure and composition.

We created LAYER®

Thanks to unique properties :

1. The best Indoor performances
2. Lightweight, Flexibility & Design opportunity
3. Low environmental impact
4. Cost

Our modules have high efficiency in low-light conditions. LAYER$^{®}$ generates energy from ambient light because we use specific materials that harvest both natural and artificial light. And thanks to inkjet printing, we can realize the on-demand module to meet customers' specifications in terms of performance and design.

Several International Awards

Our award at Hello Tomorrow (Energy Transition track) in 2017 marked the transition from laboratory stage to our drive to bring the technology to market. In 2020, LAYER® has also been selected to be a part of Solar Impulse #1000 solutions that are both clean and profitable and have a positive impact on the quality of life. And recently our LAYER® powered sensor received "honoree" award at the Innovation Awards at CES2021 in Las Vegas.

Lead your IoT to the next level
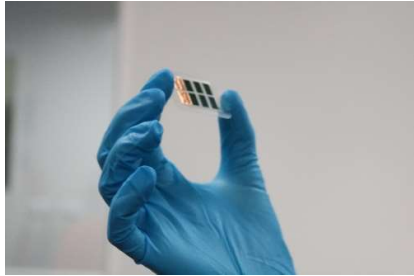
Our mission is to make indoor devices sustainable by harvesting the available energy directly inside the house, the building, the facilities, that's why LAYER® is the technology for next-generation IoT. With LAYER® Labs, we design tailored OPV solutions to tackle your problematics linked to the power supply (Sizing, Prototyping, Designing) and with LAYER® Factory, we produce OPV modules at a large scale (Scaling, Industrializing, Producing).

You can find more about Dracula Technology and their LAYER® OPV solutions on their website here www.dracula-technologies.com and you can contact them here contact@dracula-technologies.com

PS: You can subscribe to our newsletter "The Harvesting Revolution" to get the latest Energy Harvesting's news.
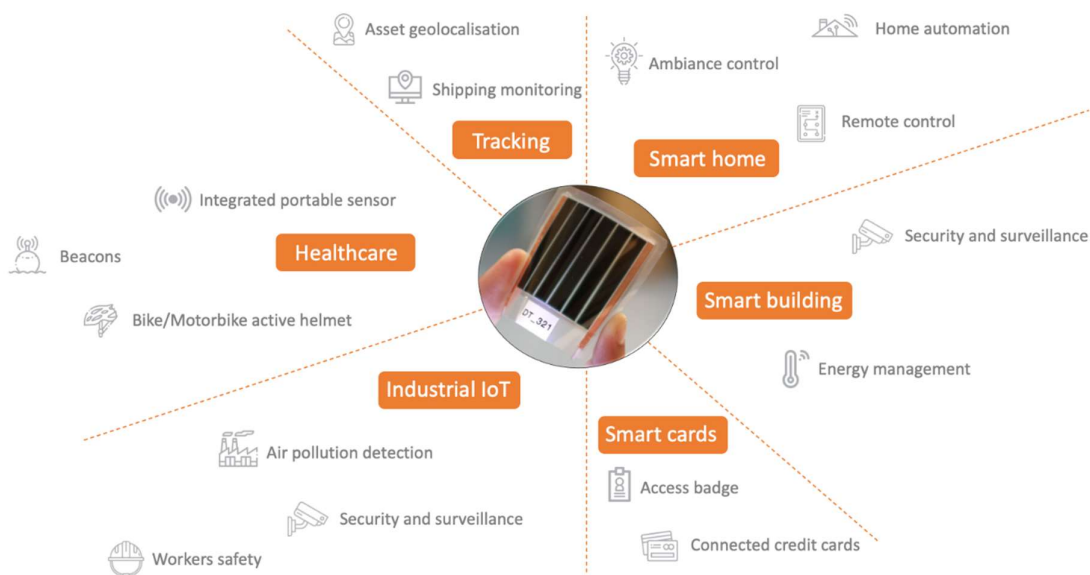
Renesas plan to release the first demo of an energy harvesting environmental sensor, that can monitor the environment and share information via a BLE radio to a mobile phone or tablet, all without a battery. This demo uses Dracula Technology's LAYER® module as the only power source. This is planned to be released sometime in March, please watch out for these demos.

emWin and embOS Running on Renesas EK-RE01 256KB Evaluation Kit

Renesas, along with SEGGER, make a significant contribution to the development of low power devices. Discover more with the following demo.
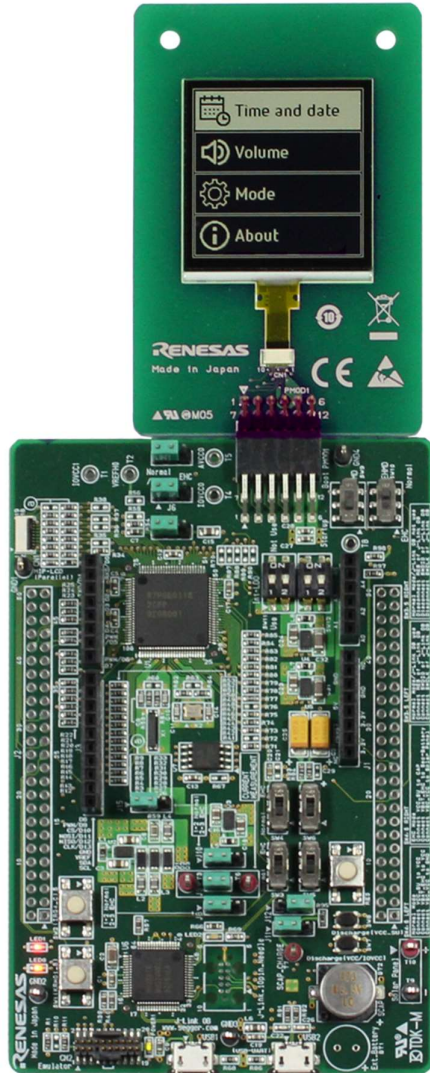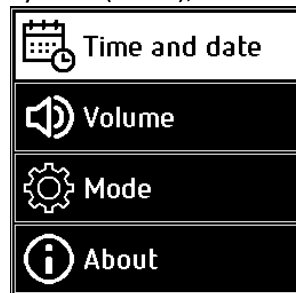
Renesas's RE01 256KB specifically targets the low power market. This includes small electronic devices which demand low power consumption and host a small display screen. RE01 focuses on ultra-low power consumption in both active and standby modes, while pushing for high-speed operation at a low voltage. Even then, managing display screens will always have side effects on consumption, memory requirements and performance.

Accommodating low power consumption for small devices means recognizing screen displays as a key component of that device. Modern screen displays often provide their own illumination, which means more power is being consumed. Memory in Pixel displays and ePapers present more opportunity for saving on power consumption because they do not have their own illumination. If you want to go low power, use low power devices.

For many years, SEGGER's emWin has been a driving force behind electronic displays which require little computing power and next to zero memory beyond display memory. It is this trait that comes in useful when creating a visual interface for applications running on RE01. SEGGER also provides evaluation software which includes graphics software like emWin and the real-time operating system (RTOS), embOS. The RE01 evaluation board also has an extension with an MiP display. This can be downloaded with the following link: https://www.segger.com/evaluate-our-software/renesas/#renesas-ek-re01-256kb

The demo allows us to see and scroll through several different menu items shows the capability of emWin to easily create a wide range of different menu and display items that could typically be used in a MiP display application. You can see some of these in this article. The included demo has a few control features. One of these control features can change the orientation of the

display at runtime. The whole application requires 138kB of ROM and 21kB of RAM, so it leaves plenty of memory space to fill with a more complex application.

When it comes to ROM memory consumption, it is divided as follows:

- • 90 kB for emWin
- • 11 kB for resources (fonts and bitmaps) used in the sample
- • 2 kB for the RTOS
- • 35 kB for Renesas drivers

RAM memory usage is divided as follows:

- • 4 kB used by the Renesas drivers
- • 8 kB used as a display cache
- • 6 kB used by emWin
- • 3 kB used as task stack

The above values were achieved by using the libraries as delivered by Renesas. Even with these numbers, there is still room for size optimization. And when speaking of resource handling, it is worth mentioning that using emWin's BitmapConverter enables the use of the smallest bitmap binaries using 1bpp without palette and RLE compression.

New RE applications and demos on the way

Ultra-Low-Power LoRaWAN® Sensor Class A Application

Hopefully everyone is familiar with some of our existing demos, such as the smart agriculture demo using a LoRA radio that we promoted last year (if not you can find out more in the following pages)

There was a lot of interest in many of our demos, especially the LoRA demo. Some companies have used our demo as the basis of a real product development. Taking our schematics and application code and using this as the basis for the development of a real product, making their development   quicker and easier.

To make this even easier, we have decided to create full application notes and applications that can be downloaded from our website, along with instructions on how to build complete prototype systems, and a Class A LoRA sensor node is the first of these applications notes that will be released.

This application note will come with a complete project, with all the code required for the application, including the code to drive the Semtech Lora module. You can see in the picture below that we use a Semtech Arduino shield which easily fits onto the RE01 evaluation board to create this demo. The demo collects data from the ubiquitous HS3001 humidity and temperature sensor and sends it via the Lora radio to a gateway, and from there onto the cloud. We will also explain how to register a gateway create an application on The Things Network to see your data. The demo itself can be powered by the small Panasonic solar cell that comes with the evaluation board, and we provide all the software needed to manage the board and to run the complete sensor application to achieve this. It's possible with this application note to make the sensor completely batteryless.
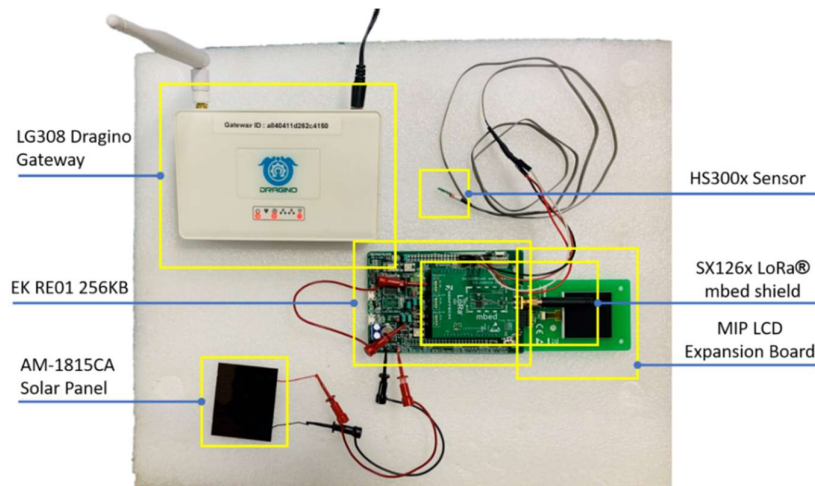
The RE01 LoRA application note and associated project will be available for download in March from our website, www.renesas.com/RE

RE Mode Transition Power consumption

The big benefit of the RE and on the SOTB™ process is the ultra-low power consumption in active mode and in standby mode. The SOTB process that we use to manufacture the RE has many unique features, and one of these is the way our designers have designed the power stages of the RE and the hardware sequencer that controls the changes of state to minimise the current consumed during any mode transition.

In a typical microcontroller, for instance an RX, when we make a mode transition between standby and active mode, the device can power up quite quickly but typically takes a lot of power during this time. A RX100 can start up in around 4.8 µS, typically during this time we take something like 60 – 70 % of the active mode power consumption during the transition, this is due to the power supply activity and the switching on and stabilisation of the various oscillators and other circuitry. This type of value is typical of many microcontrollers, the device will consume a lot of power during start up or during the transition between modes.

The RE is designed very carefully to manage this issue, our mode transition time can be slower, however we don't have a big increase in the current consumption until the very end of the mode transition, you can see a typical example of the mode transition power consumption below.

Below is a real trace from a device transiting between software standby mode (MINIPON)   and normal high speed mode, you can see the initial power consumption is almost zero (in fact around 0.5 µA) , the same as in software standby mode, then it increase slightly to around 25 µA until almost the last µS where it increases to the full active mode value

This saves a significant amount of power and means that we stay in the lowest power possible during the whole mode transition, this, combined with the low power performance of the RE in active and standy modes means we save a considerable amount of power compared to a typical microcontroller.

Memory in Pixel Displays on the RE family

The RE is the first microcontroller family from Renesas that support Memory in Pixel (MiP) displays, these displays are ultra-low power and are often used in many applications where they need the lowest power consumption possible while still providing complex displays, applications today include wearables and smart watches, our design win for the RE01 in Casio is an example of this, the Casio G-Shock uses a MiPs display. Other applications include bike computers, hand-held navigation systems, portable medical applications and a wide range of consumer applications. Renesas have been working with several MiP suppliers and our drivers for the RE01 support MiPs displays from Kyocera, JDI and Sharp.
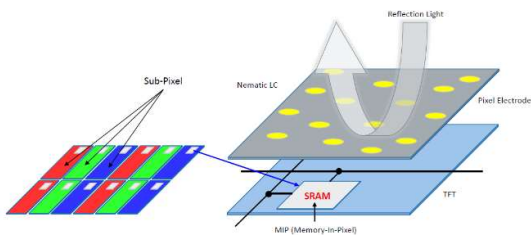
Memory in Pixel displays offer the use a number of advantages, first and most importantly each pixel in the display has its own memory, so you only need to write to the display when the image changes, when there is no change there is no need for any write access unlike most other display technologies. The RE01 supports a dedicated 8-bit parallel MiP interface (see picture on the left) which supports displays from Kyocera, this consumes as little as 0.5µA when only displaying and around 3.5µA when u[dating the display, compare that to standard TFT graphics technology.
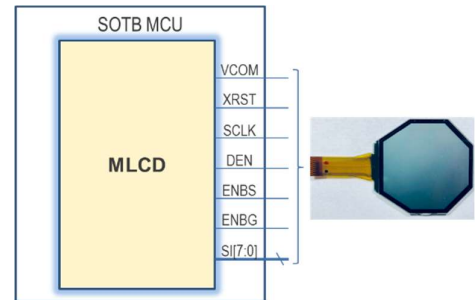
Until recently most MiPs displays were monochrome, but today colour displays are available from companies such as JDI supporting up to 262,000 colours.
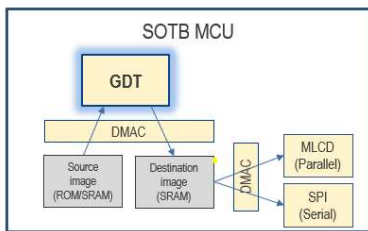
The RE01 not only has the MiPs direct interface but we also have a small graphics controller, the GDT, that allows us to use a number of graphics primitives to scale, scroll, rotate, mirror or blend images, this is both significantly faster than using the CPU to do this but also takes significantly less power. The GDT is supported by the RE driver software and we have application notes describing how to support both mono and colour displays from Kyocera, JDI and Sharp. The drivers could also be modified to support other displays and suppliers as required.
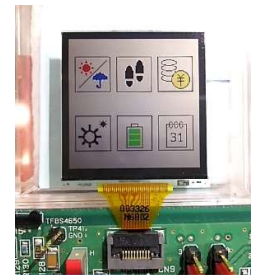
To find out more about how to use MiPs displays with members of the RE01 microcontroller family please download the relevant application notes from our website. r01an4810ej0103 & r01an4755ej0105.

More videos showing the king of performance customers can achieve with MiPs displays can be downloaded from the SOTB Sharepoint site.

QR Codes have their Day – and Memory in Pixel displays bring low power programmability to your menu

In the previous article we looked at the Memory in Pixel (MiPs) display and the small graphics controller we have implemented on the RE01 family to support small graphics displays. Let's look at one of the application areas that's now booming for these displays, where power consumption is

also a big issue. The current coronavirus pandemic has suddenly caused an old technology to suddenly become ubiquitous, appearing all around us. QR codes (quick response codes), a technology that has been with us since the 1990s, have suddenly appeared all around us, in restaurants, bars and shops, allowing us to scan them with our mobile phones. The QR code can generate menus and bills and even allowing us to pay and leave without interacting with anyone, or touching anything, this is really important in these pandemic times, to keep us all safe.

QR codes were developed in Japan in the mid-90s to track components in car production lines, their main advantage is that they can hold a massive amount of data compared to standard barcodes – a QR code can contain up to 2,500 numeric characters compared to a standard barcode which typically can only hold 43. This, when combined with the smart phones that almost everyone carries around with them in their pockets make the QR code an ideal solution to provide menu's prices and other information direct to the consumer without any contact or printed material which potentially could carry the virus.

The RE01 with its Memory in Pixel (MiPs) display can easily display a QR code, which you can then scan with your mobile, allowing restaurants and bars to dynamically change what items they are offering electronically, rather than relying on paper copies with the need to make physical changes.

Renesas has prepared a demo using the RE01 evaluation board which shows how the memory in pixel display on the RE can be used to create a QR code easily.

You can download the complete project including source code for this application from our website and it will work on the evaluation board without any additional equipment as the evaluation board also comes with the MiPs display extension board that connects to one of the PMoD interfaces.

This makes the MiP QR code solution easy to demonstrate to customers. For more information visit our dedicated RE microsite at www.renesas.com/RE

Force Technology – A Structural Health Monitor Design

Where possible, I'd like to share information about some of the design that use the RE microcontroller , this month I'd like to tell you a bit about the structural health monitor design at Force Technology in Denmark that uses the RE01.

The customer makes structural health monitoring equipment, in this case their first target is monitoring the Oresund bridge between Denmark and Sweden.

The problem is one we have discussed before, as soon as you build structures of concrete and steel, they start to corrode and are on their way to failure. According to the customer this can start to be a problem as early as 10 years into its service life, especially in a marine environment, and typically these structures are required to last 50 – 100 years as the cost or early replacement is prohibitive, the Forth crossing in in Scotland, near my university town of Edinburgh,

recently had to be replaced at a cost of over 1.5 Billion Euros. Once the corrosion start to impact on these structures we must replace them as otherwise the costs, as the people of Genoa sadly found when the Ponte Morandi (the Morandi bridge) collapsed in 2018 with a significant loss of life ,are even higher.

This is where structural health monitoring comes into play, if we can monitor the health of these structures, then we have a chance to manage and repair them as required, before the damage becomes significant. In Europe along, we have over 700,00o structures that are part of our highways system that were built in the 50's and 60's that are now towards the end of their expected lifetime, and the cost of replacement or worse of failure is literally trillions of Euros. A good example of these problems can be seen today on the A1 bridge between Leverkusen and Cologne, which has had to ban all vehicles with a weight > 3.5 tonnes. This is a huge problem, not only in Europe but in the US and Asia as well.
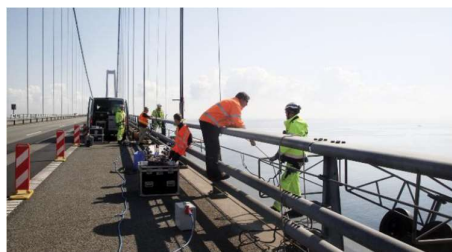
The problem with monitoring structures today is that the inspections required to assure the structures safety are that access is often quite difficult and often dangerous and costly to as well. It's not easy to look inside the structure so we must use a variety of sensors, looking for chemical changes in the material or listening for strange sounds that may indicate failure. Corrosion is an electrochemical process, which typically leads to rust-formation so it can be detected within a
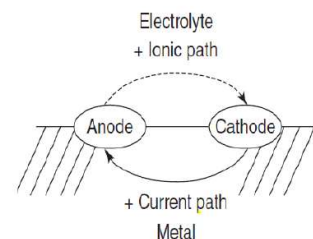
structure by the right types of sensor. Then the question is how to access these sensors, how to get them power, how to extract data and how do we access them if we need to change something. The cost of shutting a road or railway bridge for a significant length of time to do this can be extremely high.

Force Technology decided the solution was to use energy harvesting to provide the power and a radio to transmit the data. This was to address multiple challenges; the use of radio facilitates easier access to data. Currently the need for physical access to corrosion monitoring probes means the collection of data is expensive and time consuming, so currently this data is only measured once or twice per year. The use of a radio enables more frequent measurements of corrosion status, where data can be collected in real time twice per day. This required the use of energy harvesting, to allow long lifetimes for the sensors, which was driven by the long lifetimes of the structures that the sensors are monitoring.

One of the big benefits of structural health monitoring is that everything happens slowly, so you only need to monitor occasionally perhaps once a day or a week, or even a month. This means the total mounts of energy used are very small, so this energy is more than enough to power the sensors electronics.
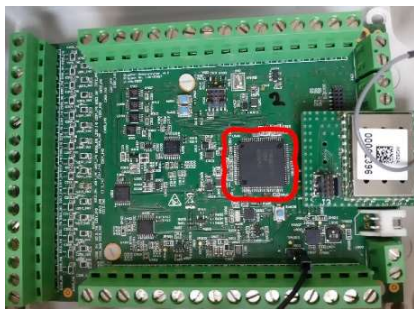
You can see Force technologies PCB in the photo on the left, with the RE01-256K shown highlighted. The RE01 was an ideal solution for this application, because of its very low active and standby currents and the low power timers which allow very long programmable timeouts, the ultra-low power ADC operation, 4 µA or less, which is far lower than any of our competitor can offer

was also ideal for providing a method of reading the sensors. You can see a photograph of the Lora module which they use for the radio communications on picture on the right.

This is a unique application and shows the real benefits that the combination of the RE and energy harvesting can provide to some types of sensor application. The customer used our set of driver software, and after sorting out a few initial issues they had with understanding how to use the drivers, they finished their design in less than 6 months. Already the first units of the structural health monitoring sensors using this technology has been tested in the Oresund Bridge Tunnel and shows a really interesting use of the RE in a unique energy harvesting application.

Winning Combos with RE

RE based Winning combos showcasing the RE and many of our sensor and low power products, enhancing our cross selling opportunities

WC No.	Application
JP151	Wearable Devices with the RE01 32-Bit MCU
JP152	Structural Health Monitor
JP153	Low Power Global Navigation Satellite System (GNSS) Tracking Solution
JP087	Smart Agriculture Sensing with Energy Harvesting
EU077	Indoor Sensor for Automatic Home or Building HVAC System
EU078	Outdoor Sensor for Automatic Home or Building HVAC System

You can find all our winning combos on the internet here

www.renesas.com/eu/en/application/winning-combinations
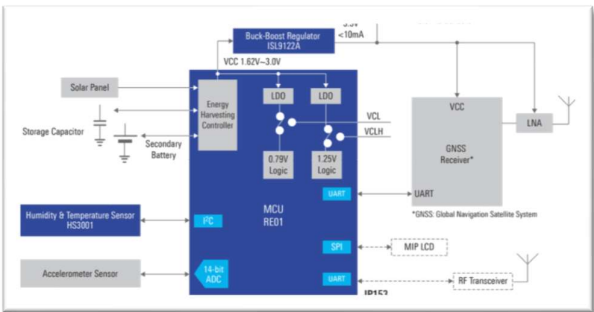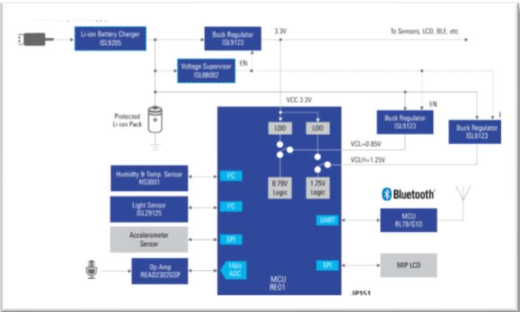
RE Technical articles

I wanted to share with you all some of the recent technical articles we have had published in the last 3-4 months around Europe, we are still getting good coverage for the RE in the European technical press.

The articles below were recently published in Actuel Elektronik in Denmark, Electronics Weekly in the UK, Elecktronik Informationen & Elektro Automation website in Germany and Elettronica AV in Italy

RE on the Internet

We wanted to remind everyone of all the resources that are available for you on both the internet and our intranet to support you in your promotion of the RE. If you don't have any access to the REE RE SharePoint please let us know or click on the link in the accompanying email and request access and we can let you in.
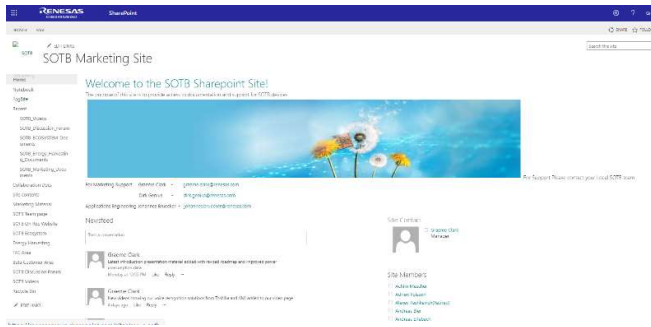
The REE SOTB SharePoint site

REE has a dedicated SharePoint site where we hold all the local information including the latest marketing collateral, presentations and videos as well as dedicated material for the FAE team. If you don't have access to this SharePoint, please let us know and we can arrange access.
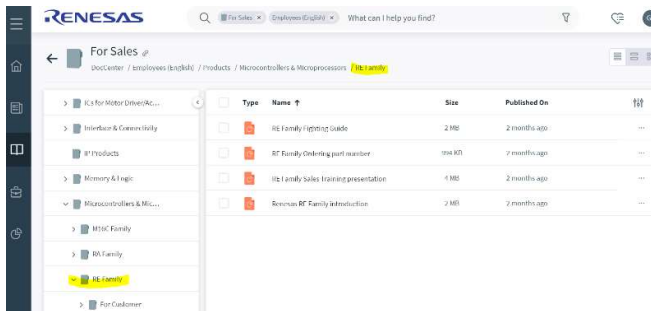
Seismic

The RE has its own support pages in Seismic where you can again find a lot of support material including training material, sales presentations videos and much more.
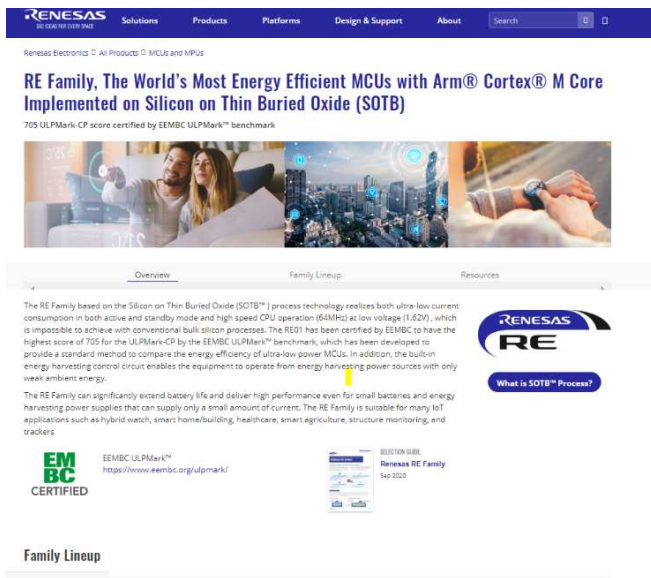
Renesas RE webpages

The RE family also has its own dedicated microsite on the Renesas webpages, you can find this using the short address www.renesas.com/RE

On the webpages our customers can access all the usual support material including datasheets and manuals, application notes and a lot of sample code and applications.

There are also many videos showing the advantages of the RE and showing the RE working with energy harvesting solutions.

We hope these resources are useful for you, and help in your promotion of the RE family, if you have any requests or ideas on how we can improve these resources, please let us know.

Available RE Demo's

We have several proofs of concept demo systems and some interesting demos showing the ability of the RE to improve the performance of a variety of different applications. Due to the current virus situation when it's not easy to visit customers to show these demos, we have created videos showing each of these demos and presentation material describing the features and benefits of each demo. You can find these on the REE SOTB SharePoint and on Seismic.

Air Quality Monitor

The air quality sensor shows how the RE powered only by a solar cell can measure air quality and air humidity and temperature using Renesas sensors and showing this information on a MiPs display

Batteryless Soil Monitor

The soil moisture sensor shows how the RE can be powered by the famous "power spike" which can generate enough power from the soil to both power the sensors and a Lora radio without a battery

Speech recognition demo

The speech recognition demo shows the power / performance capability of the RE, the demo can understand simple voice commands without any internet connection and using much lower power than a typical voice recognition application

Low Power Demo

This demo makes it easy to show all the low power modes of the RE and allows customers to see in real time the power consumed in each mode.
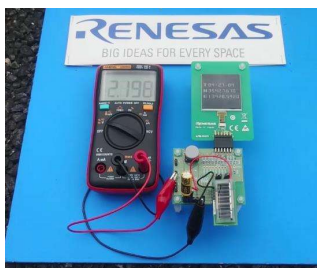
GNSS demo

This demo shows how the RE can be used in a GPS tracking application, consuming very little power and can control a GPS device, it also shows how this can be achieved using energy harvesting

QR code demo

This demo shows how we can use the MiPs display driven by the RE to display a QR code, which can then be used to point to a website or location on the internet using a smart phone. We've seen quite a few customers interested in this application for managing maintenance or support tasks.

RE01 Development Tools

The RE01 is supported by software tools from Renesas and IAR, which can be downloaded from the respective websites, and an evaluation kit for each specific member of the RE01 family. The RE01 Evaluation Kit allows the user to evaluate the use of the RE01 in their application. They can not only evaluate the RE01, but the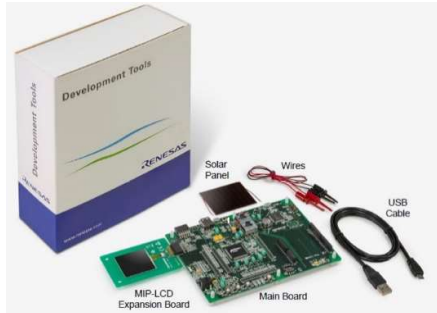y can also evaluate the use of the RE01 using a variety of energy harvesting power sources. The kit comes complete with a solar cell from Panasonic and provides a standard interface for the connection of other energy harvesting energy sources as well as the ability to connect and manage a super cap or rechargeable battery. This kit enables the easy evaluation of the use of the RE01 in a range of applications with and without energy harvesting. There are two evaluation kits available today, one supports the RE01-1.5 M device and one supports the RE01-256K.

RE01 Evaluation board Features
• Energy harvesting system: can be evaluated with the power generation elements, the secondary battery connection interface, and the sample code provided by Renesas.
• Arduino Uno Header and PMOD interface supported: enable evaluation of energy harvesting system combined with the user's hardware system.
• On-board debug function supported: enable program debugging by simply connecting the included USB cable to a host PC.
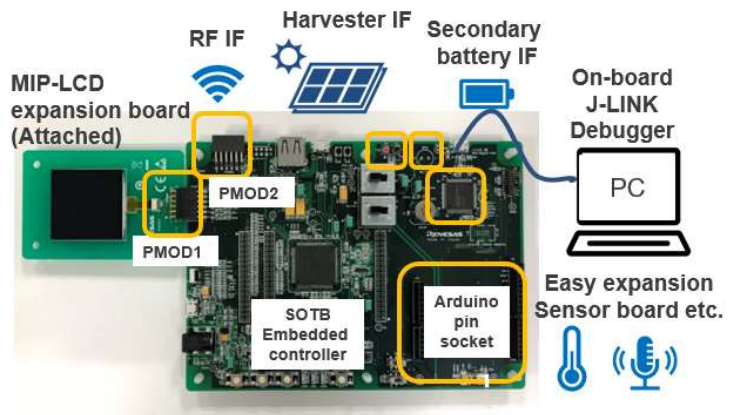
The sample code for the evaluation kit available on the Renesas website.

Kit Contents

1.Evaluation Board RE01 1500KB or RE 256K
2.PMOD-compatible low-power LCD (Memory-In-Pixel LCD) expansion board
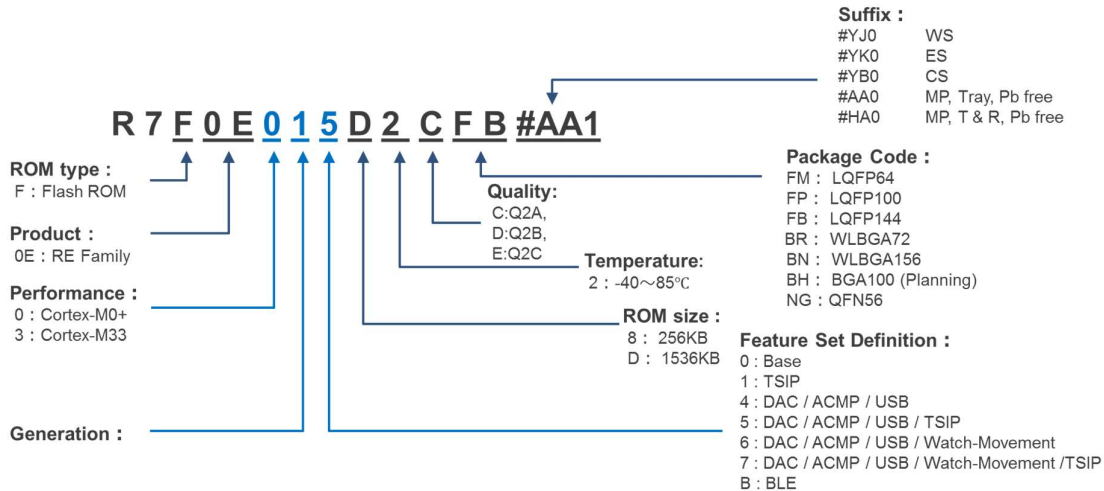3.Solar panel
4. USB cable (Micro-B)

Ordering Codes
RE01 -1.5M   : RTK70E015DS00000BE   available now
RE01 -256K   : RTK70E0118S00000BJ   available now

RE01 part Number & Status Information

RE01 Part Numbering explanation

You can find a complete explanation of the RE part numbering system in the diagram below.

RE01 Selector Guide

The table below shows a comparison of all the available versions of the first generation of the RE family, this should help you choose the correct part for every opportunity, if you need any help in selecting the right device, or if you have any questions regarding this, please let us know.

		RE01_256KB Flash/SRAM=256KB/128KB			RE01_1.5MB Flash/SRAM=1.5MB/256KB (MP)		
CPU		Cortex-M0+ 64MHz					
Package		LQFP	WLBGA	QFN	WLBGA	LQFP	LQFP
Pin count		100	64	72	56	156	144	100
Current consumption	Active current while(1) peripheral suspended	25uA/MHz@32MHz (w/ External DCDC 12uA/MHz)				35uA/MHz@32MHz (w/ External DCDC 12uA/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 (Norma 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 16bit Timer (Return from Standby Timer)	2ch						
	AGTW 32bit 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(128bit buffer) + 1ch (32bit buffer)						
	QSPI	1ch						
	USB	NA				1ch		
Analog	S14AD 14bit ADC	12ch	8ch	12ch	7ch	18ch	12ch	
	R12DA 12bit 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)						

For more information on the RE family of microcontrollers, please visit our website at
www.renesas.com/RE or contact your local renesas sales contact