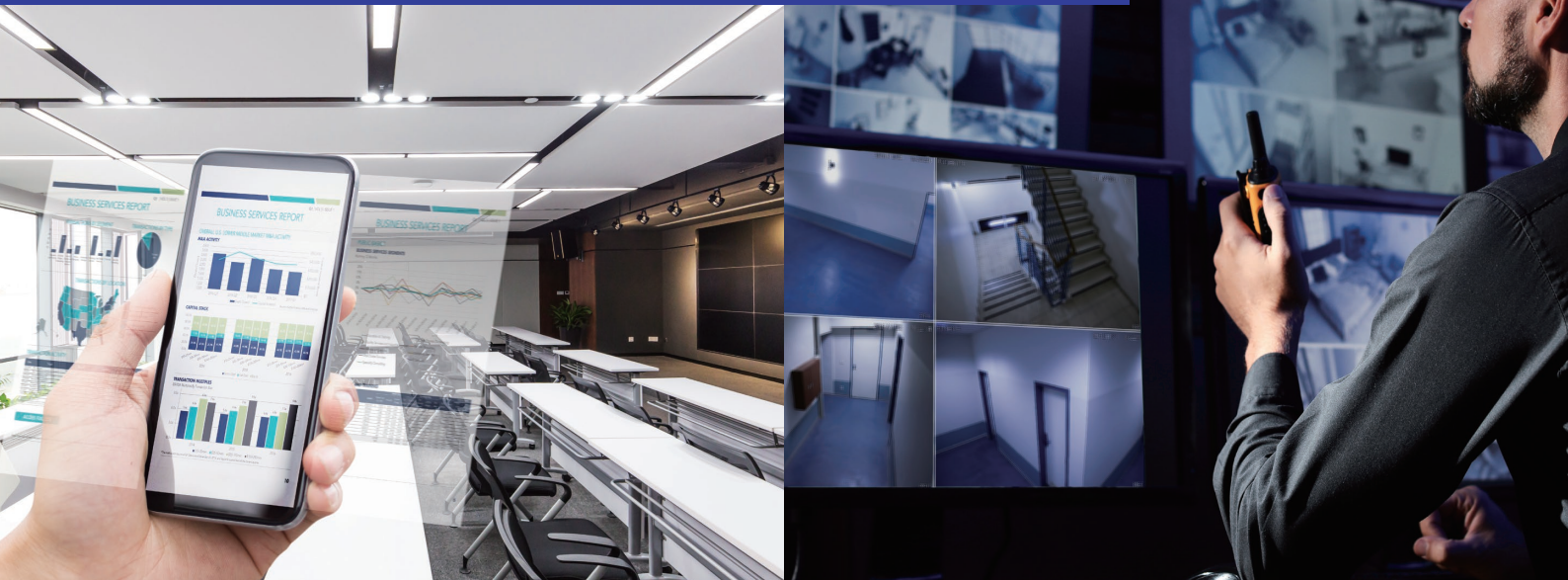


# BUILDING AUTOMATION

Leading-edge IoT solutions for HVAC, fire/safety, building security, and lighting





# BUILDING AUTOMATION

## BRINGING COMFORT, SAFETY, AND ENERGY SAVINGS TO PEOPLE, BUILDINGS, AND COMMUNITIES WITH SOLUTIONS TO CONNECT, PROTECT, AND CONSERVE

By connecting air conditioning, disaster prevention, crime prevention, and lighting equipment via networks, buildings can be made more convenient, secure, and energy efficient. Renesas leverages advanced technologies in connectivity, sensing, user interface, and low-power to enable the next generation of advancements in building automation.

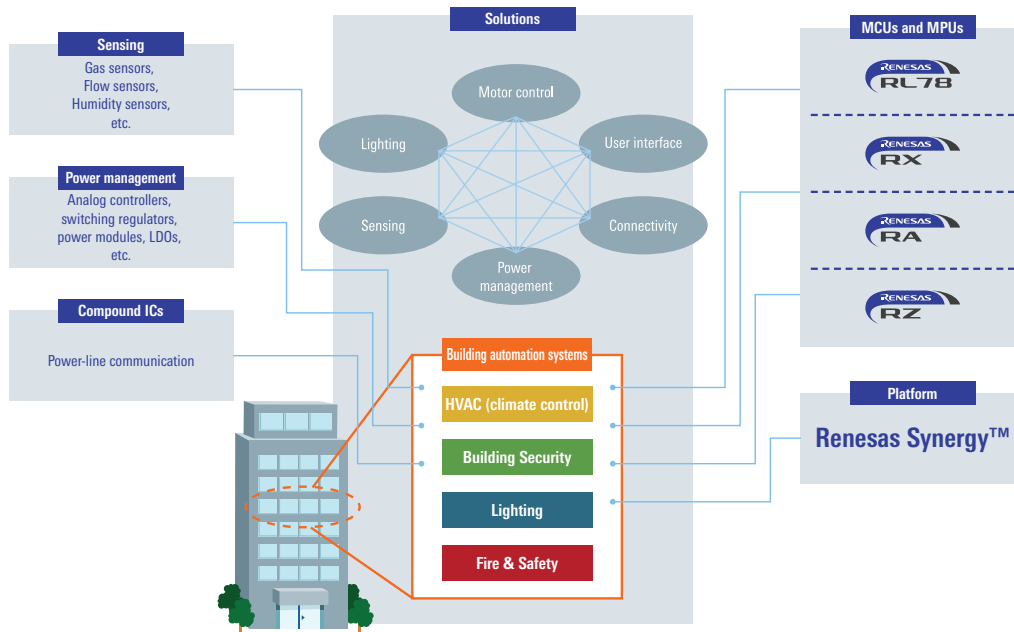


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# RENESAS TECHNOLOGY FOR BUILDING AUTOMATION

## Building Automation System Configuration

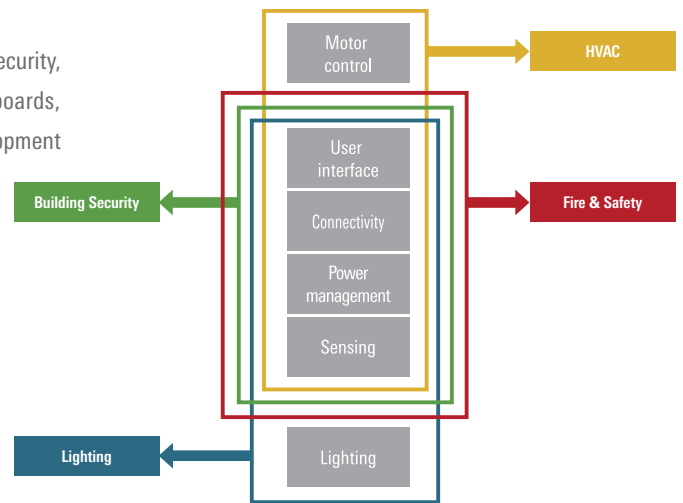


## Building Automation Solution Devices and Platform

Renesas provides solutions for building systems (HVAC\*, fire and safety, building security, and lighting). Each solution includes components such as devices, evaluation boards, development tools, and documentation to provide total support for customers' development efforts.

The Renesas Synergy™ platform provides three types of value to developers of complex embedded systems in fields such as building automation: shorter development time, reduced total cost of ownership, and elimination of barriers to starting development.

\* HVAC: Heating, Ventilation, and Air Conditioning



## Web

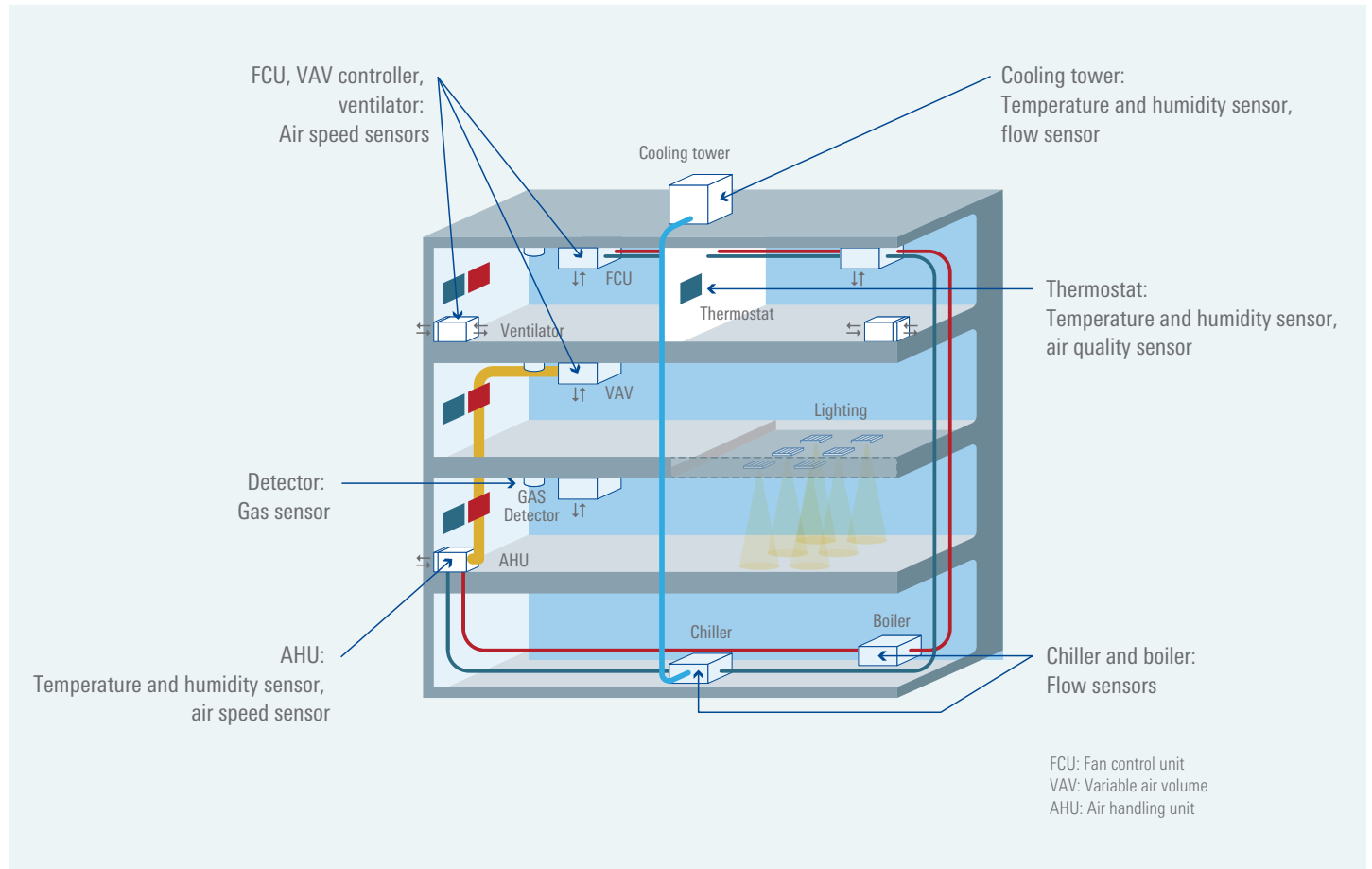
<https://www.renesas.com/application/industrial/building-home-automation>

Solutions		HVAC	Fire & Safety	Building Security	Lighting
Motor control	Induction motor control solutions	●			
	Brushless DC motor control solutions	●			
User interface	Capacitive touch panel solutions	●	●	●	●
	HMI solutions	●	●	●	●
Connectivity	PLC (power line communication)	●	●	●	●
	Bluetooth® low energy	●	●	●	●
	Wi-SUN/Sub-GHz	●	●	●	●
Power management	RS-485 communication solutions	●	●	●	●
	Analog controllers	●	●	●	●
	Switching regulators	●	●	●	●
Sensing	Power modules	●	●	●	●
	Motion sensor solutions	●	●	●	●
	Glass break detector solutions			●	
	Smoke detector solutions		●		
Lighting	Carbon monoxide detector solutions		●		
	LED lighting power supply solutions				●
	DALI communication solutions				●

# Key Building Automation Technologies: Sensors

## Sensors in the Building Environment

Nowadays there are a variety of sensors at various locations throughout the interior of a typical building, and demand for such sensors is expected to increase. Here we highlight some of the locations and specific applications in which sensors from Renesas are used.



## Features of Renesas Sensors

Renesas sensors include compact products offering superior sensitivity and accuracy. Evaluation boards are also available, making it easy to assess the performance of these products.

### Temperature and Humidity Sensors

#### Representative Product

HS300x, HS310x

#### Features

- Wide measurement range (0% to 100% RH)
- High measurement accuracy ( $\pm 1.5\%$  RH,  $\pm 0.2^\circ\text{C}$ )
- Compact package (3.0 × 2.4 × 0.8 mm)
- I<sup>2</sup>C interface for easy connections
- Available in a waterproof package with an IP67 rating



#### Evaluation Board Product Name

SDAH01, SDAH02

#### Application Example

Temperature and humidity measurement in HVAC systems and thermostats

### Air Quality (Gas) Sensors

#### Representative Products

ZMOD4410, ZMOD4510

#### Features

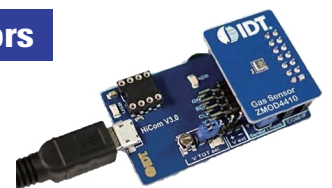
- Detects total volatile organic compounds (TVOC). (Supports estimated carbon dioxide (eCO<sub>2</sub>) calculation.)
- Extensible via firmware updates.
- Supports IAQ-grade detection conforming to German Environment Agency (UBA) standards.
- Detects emissions of ozone and NO<sub>x</sub> (ZMOD4510 only).
- Available in a waterproof package with an IP67 rating

#### Evaluation Board Product Name

ZMOD4410-EVK

#### Application Example

Air quality measurement in thermostats





## Flow Sensors (Liquid, Gas) and Airflow Sensors

### Representative Products

FS2012, FS102x

### Features

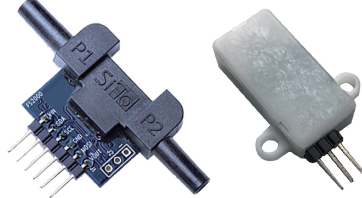
- Mass flow sensor module measures the flow
- Superior acid and alkali tolerance
- Vibration resistant
- High sensitivity

### Evaluation Board Product Names

SDAF0x

### Application Example

Liquid and air(gas) flow and airflow measurement in HVAC systems



## Time of Flight (ToF) Signal Processing IC

Low cost, Low Power, and Long Range Optical Distance Sensing

### Representative Products

ISL29501IRZ-T7, ISL29501RZ-T7A

### Application Level Integrated

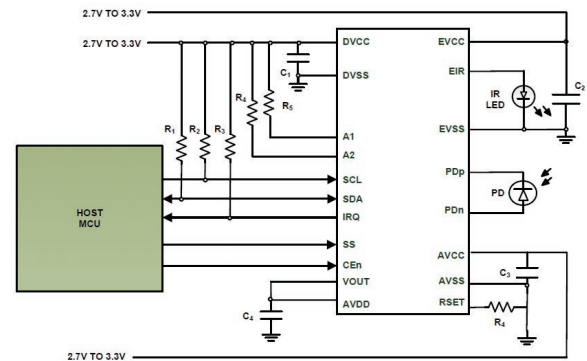
- On-chip Digital Signal Processor calculates the time of flight
- Built-in current DAC circuit that drives LED or laser
- On-chip active ambient light rejection

### Easy Control

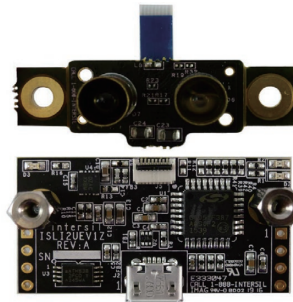
- I<sup>2</sup>C interface for configuration and control.
- Operates in Continuous and Single Shot mode
- Auto gain control mechanism
- Interrupt controller
- Modulation frequency of 4.5MHz

### Suitable for Different Design

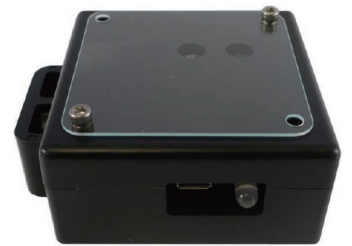
- Enables proximity detection and distance measurement
- Allows to optimize for performance/ power/ distance etc.
- Wavelength agnostic
- Emitter DAC with programmable current up to 255mA
- I<sup>2</sup>C interface supporting 1.8V and 3.3V bus
- Low profile 24 Ld 4 × 5 QFN package



Typical Application Circuit



ISL29501-CS-EVKIT1Z Cat Shark



ISL29501-ST-EV1Z Sand Tiger

### Use in Conjunction with an MCU

Renesas offers MCU products that are the perfect match for sensors. By choosing an MCU with support for various communication interfaces, it is possible to transfer sensor data over a network. Example uses of sensors in conjunction with MCUs to implement building automation applications are presented here.

Example	Sensors	Recommended MCUs
Thermostat with wireless functionality	ZMOD4410 air quality sensor and HS3001 temperature and humidity sensor	RL78/G1H (sub-GHz RF), RA4W1, RX23W, RL78/G1D (Bluetooth LE), and RX100 or RX200 Series (HMI)
HVAC refrigerant sensor	FS1012 flow sensor	RL78/G Series (system control)
Gas alarm	SGAS711 gas sensor	RL78/G12 (system control)

For the latest information on using sensors in conjunction with MCUs, visit the Winning Combinations webpage

(<https://www.renesas.com/us/en/solutions/idt.html>).

# HVAC SYSTEMS

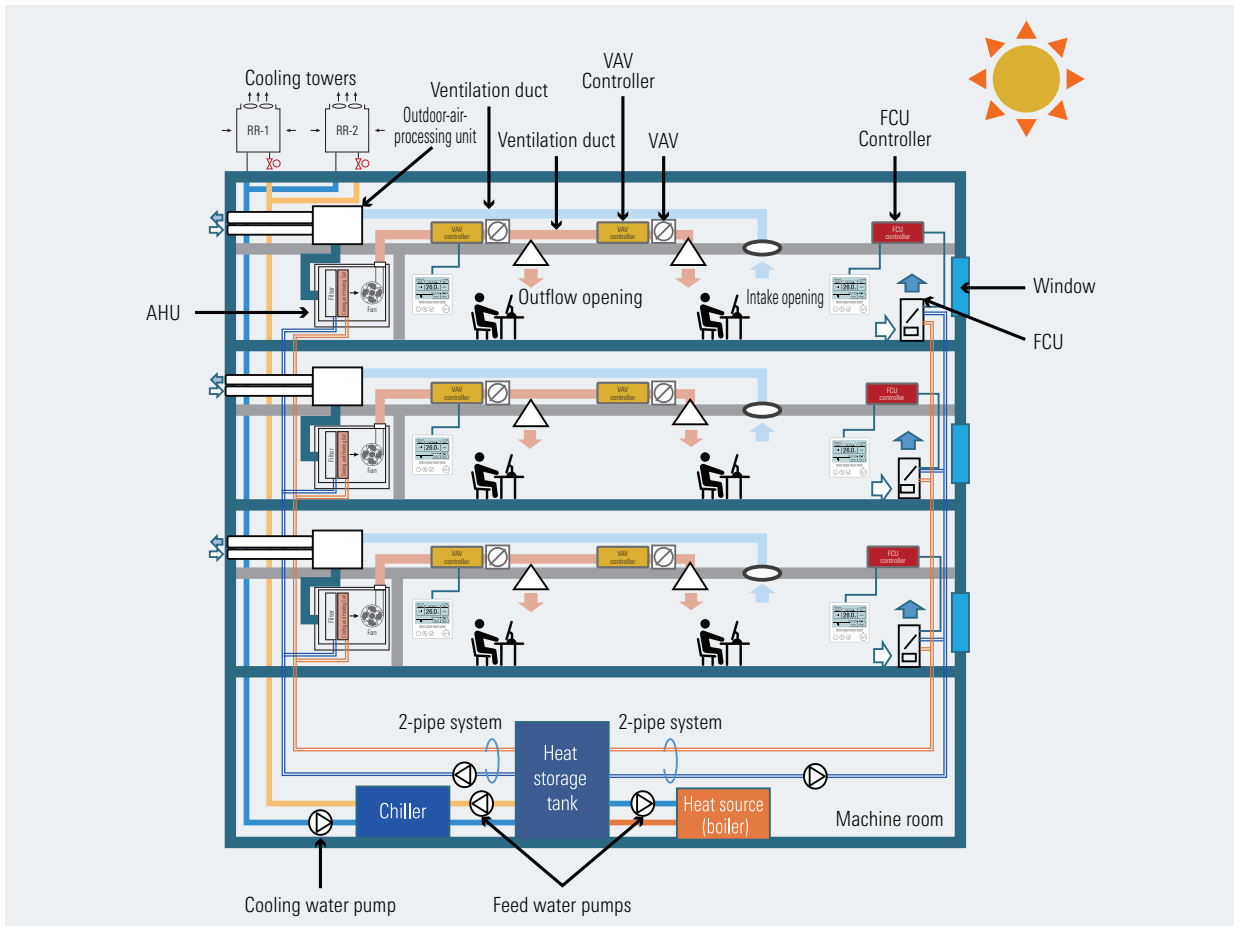
HVAC building automation system can be divided into two types: central air conditioning and individual air conditioning.

## Central Air Conditioning System

As illustrated in Figure 1, in a central air conditioning system a heat source in a single location is used to circulate air, water, or steam to the various rooms, and exchange heat, in order to cool or heat each room to the specified temperature. Water refrigerated by the chiller is pumped to the air handling units (AHUs) where heat exchange with the air takes place, producing cold air that passes through the ducts to cool the rooms. The cooling water gradually becomes warmer and is returned to the chiller, where it is refrigerated again. During this process the CFC refrigerant, etc., that acts as the heat medium evaporates and is sent to a compressor, where it is turned into a high-temperature, high-pressure gas. Cooling water is used to convert this gas into liquid form. After the cooling water undergoes heat exchange in a condenser, it is sent to the cooling towers on the roof, where it is cooled through contact with the air. Then it is returned to the chiller and the cycle is repeated. The heat source (boiler) is powered by gas, oil, or electricity. It heats water in a vessel to produce hot water or steam. To heat the rooms, this hot water or steam is circulated through the rooms, and heat exchange takes place. Either a pair of two pipes or a set of four pipes can be used to circulate the cold or hot water. There are outgoing and incoming hot-water and cold-water pipes used to distribute the hot and cold water to air handling units (AHUs), fan coil units (FCUs), etc. In a two-pipe system the same pipes are used

for both hot and cold water, switching from one to the other depending on the season and whether heating or cooling is required. This means heating and cooling operation cannot take place at the same time. On the other hand, if the cooling and heating coils built into the AHUs, FCUs, etc., are each equipped with their own outgoing and incoming pipes, simultaneous heating and cooling operation is possible within the same building. Such an arrangement is called a four-pipe system from the total number of pipes used. An outdoor-air processing unit (or total heat exchanger) extracts the heat or cold from indoor air that expelled to the outside (exhaust) and transfers it to fresh air from outside, thereby minimizing the difference in temperature between the indoor air and the fresh air from outside. ACU or air handling unit uses cold water, hot water, or steam supplied by the heat source unit to adjust the temperature and humidity of the air, which is then supplied to the rooms. HVAC systems use air, water, or refrigerant as the medium for heat exchange. Some central air conditioning systems use a method called variable air volume (VAV), in which valves connected to the AHU are used to adjust the volume of cool (or warm) air passing through the ducts. In a water-cooled system cold or hot water is circulated via pipes, and FCUs perform heat exchange to adjust the temperature of each room.

■ Figure 1 Central Air Conditioning System





## Individual Air Conditioning System

In an individual air conditioning system refrigerant gas is circulated and exchanges heat. One typical example (Figure 2) is a building multiple air conditioner system. The temperature can be set for each room, and simultaneous heating and cooling operation are possible.

Sometimes central air conditioning and individual air conditioning are used in combination, depending on the size of the building and its purpose.

## HVAC Motor Control

Table 1 and Table 2 list the units requiring motor control that are used in the two types of air conditioning system. The use of inverters and brushless DC motors is increasing in variable speed motor control applications requiring energy efficiency.

In addition, an individual indoor unit or outdoor unit may contain multiple motors requiring control. Renesas offers development kits for the control systems most appropriate for three motor types: induction motors, brushless DC motors, and stepping motors.

Figure 2 Individual Air Conditioning System

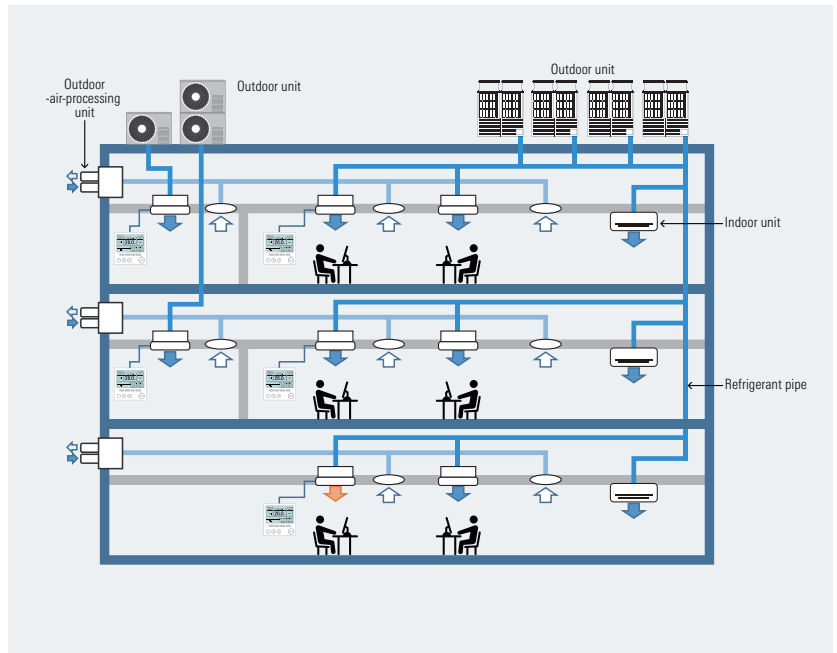


Figure 3 Overview of Building Air Conditioning Communication Network

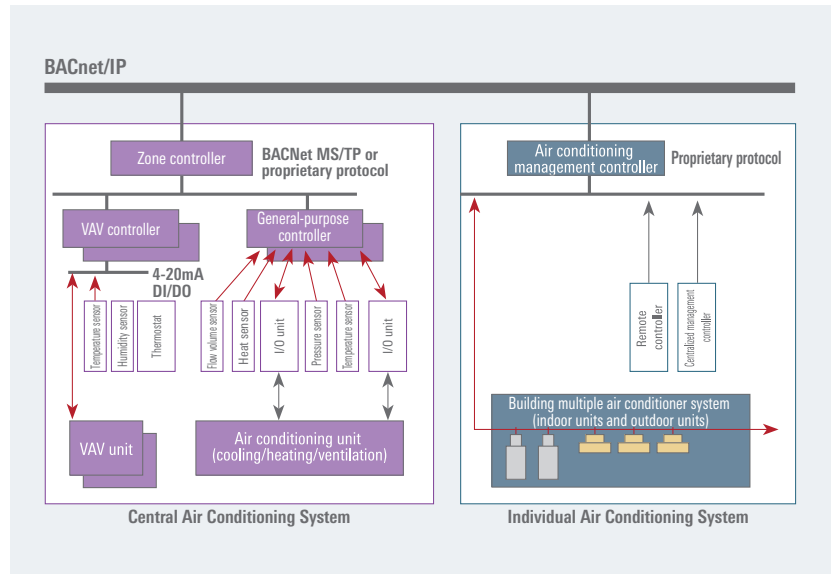


Table 1 Motor Control Units in Central Air Conditioning Systems

Unit	Motor Control Application
AHU	Fan
FCU	Fan
VAV	Damper
Outdoor-air processing unit	Fan
Chiller	Compressor
Heat source	Fan
Cooling tower	Fan
Feed water pump	Pump
Cooling water pumps	Pump

Table 2 Motor Control Units in Individual Air Conditioning Systems

Unit	Motor Control Application
Indoor unit	Fan, damper
Outdoor unit	Fan, compressor
Outdoor-air processing unit	Fan

## HVAC Communication Network

Regardless of the type of air conditioning system, generally speaking the various units are connected to a wired or wireless network to facilitate control and state management. In the context of building automation in particular, BACnet\* is used to connect HVAC devices from different manufacturers and configure the building management system.

Figure 3 shows conceptual diagrams of HVAC system communication in a central air conditioning system and an individual air conditioning system, respectively.

In the central air conditioning system, digital signals (DI and DO) and analog signals (4-20mA) are used for communication between sensors, VAV units, and general-purpose controllers. Due to the long distances involved and need for noise tolerance, Renesas offers communication solutions that employ power line communication (PLC).

## HVAC User Interface

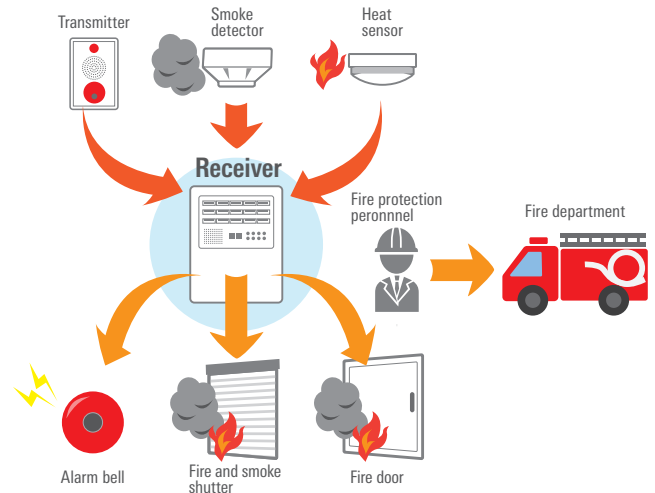
Some remote controllers for indoor unit temperature setting utilize screen-based interfaces. The recent trend is away from using conventional mechanical keys (mechanical switches) and toward the use of touch panels. These touch panels must be able to withstand demanding environmental conditions, including high noise levels, water, dirt, and temperature variations. Renesas offers HMI solutions that meet these challenges.

\* BACnet (Building Automation and Control Networking protocol) is an open protocol established in 1995 by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). In 2003 it was adopted as the international standard ISO 16484-5.

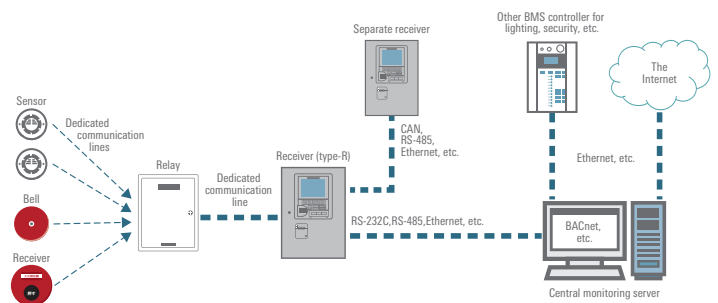
# FIRE AND SAFETY SYSTEMS

In the context of building automation, fire and safety systems are designed to detect the outbreak of fires and provide warning, for example by sounding alarm bells throughout the building. An automatic fire alarm system for buildings has a receiver that detects when one of the sensors connected by wires is triggered by a fire. The system then alerts the building occupants by sounding alarm bells or voice alarms throughout the building. Fire alarms used in buildings and in homes employ the same sensing methods, but they differ in that building systems are connected to networks while home systems are independent and sound the alarm individually. Figure 1 illustrates examples of sensing and notification types.

■ Figure 1 Fire Detection and Notification



■ Figure 2 Example Type-R Receiver and Peripheral System



## Automatic Fire Alarm Systems

An automatic fire alarm system comprises a receiver, automatic sensors, manual transmitters, sound devices, fire doors, fire shutters, smoke shutters, and network devices to which they are connected.

The receiver is installed in a fire protection center or management office within the building. It receives signals from the sensors if a fire breaks out, and controls such things as the display of indications of where the outbreak occurred and the sounding of audible alarms such as bells or voice messages. The receiver also supplies power to the system as a whole. It normally operates on the AC 100V power supply, but it is equipped with a backup power supply in case of a power failure. Figure 2 shows an example type-R receiver and peripheral system. The receiver is connected to automatic sensors, alarms, etc., via a relay, or it may be connected to the building's central monitoring system.

The automatic sensors are installed in the various alarm zones throughout the building. They automatically detect the outbreak of fire from the heat, smoke, or flame, and send a signal to the receiver. Figure 3 shows a photoelectric spot sensor for detecting smoke. When smoke enters the sensor, the light emitted by the emitter (LED) is diffused by the smoke particles, and this is detected by the receiver.

The sound devices are installed in various locations throughout the building. These emergency alarm units sound a bell or a voice warning when they receive a signal from the receiver. Each of these devices is connected to the network via a wired or wireless communication system. Wired networks use the RS-485 data transfer standard over dedicated wires, and wireless networks use the 426MHz band, BLE, or Sub-GHz band, among others.

Renesas offers the following solutions for fire and safety systems.

### Controllers for Detection and Communication

#### Recommended devices

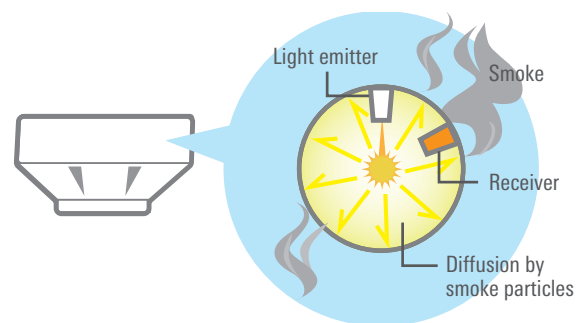
RL78/I1D and RL78/G11: analog function (amp, CMP), low power consumption

RL78/G10, RL78/G12, and RL78/G13: general-purpose MCUs with low power consumption

RL78/G1H and RL78/G1D: RF communication

R9A06G037 and R9A06G061: NB-PLC communication

■ Figure 3 Photoelectric Spot Sensor



### Analog Products

#### Recommended devices

SGAS7xx Series gas sensors

RAA211605 or ISL85415 step-down regulator

ISL9123 ultra-Low Iq buck regulator

ISL9122A ultra-Low Iq buck-boost regulator



# BUILDING SECURITY SYSTEMS

In the context of building automation, a security systems is composed of two constituent elements. Figure 4 is a conceptual diagram. The first is a monitoring systems that oversees what is going on in and around the building by means of cameras and sensors of various types. The second is a crime prevention systems that performs ingress and egress management and control based on the information from the monitoring systems.

## Monitoring Systems

Monitoring systems may include motion sensors for ingress monitoring and fire detectors, carbon monoxide detectors, and the like to monitor for emergencies within the building (Figure 5). The monitored information is sent via the network to a supervisor in the form of emergency signals and images. This information can also be stored and managed on a security data server, if needed.

## Crime Prevention Systems

Crime prevention systems may incorporate sensors such as door open-close detectors and glass break detectors to detect emergencies as well as ingress and egress management functions to enforce entrance and exit regulations and keep logs of those entering and leaving. They control the entrance and exit of persons to and from the building in conjunction with the information from the monitoring systems (Figure 5).

## Communication Networks of Security Systems

Via the network, the large volumes of data making up the security logs, operation logs, and entrance and exit logs from the monitoring and crime prevention systems are tracked on security monitoring PCs and stored and managed on security data servers. This information may also be linked via a network to other building automation systems (air conditioning systems, lighting systems, etc.) to enable more efficient building security management.

Renesas offers the following solutions for building security applications and provides support to developers as well.

### Sensing (Sensors for Monitoring and Crime Prevention)

Motion detectors / Smoke detectors / Carbon monoxide detectors / Glass break detectors

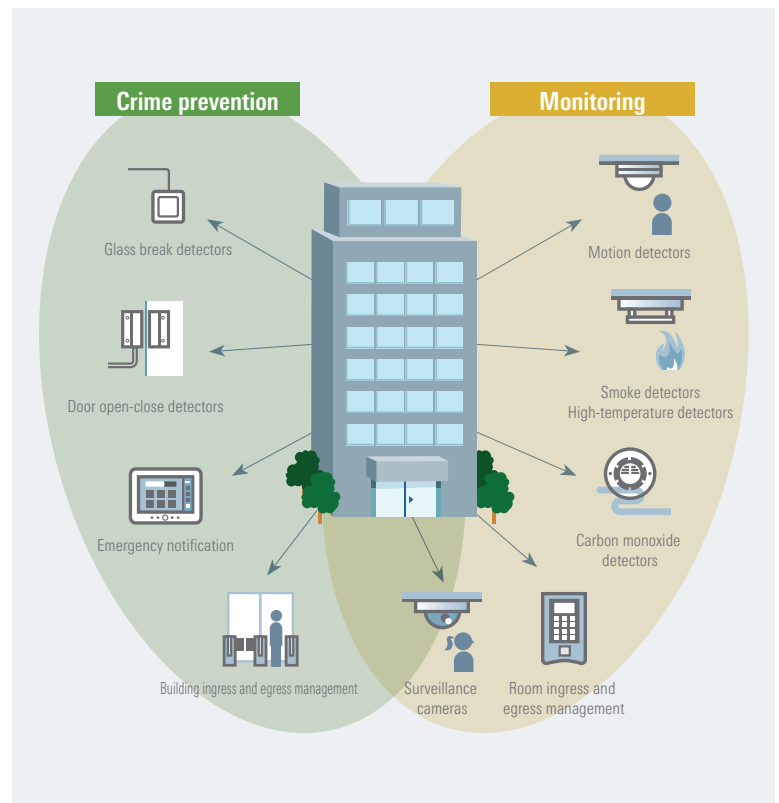
### Connectivity (Networks Linking Units and Systems)

Power line communication (PLC) / Bluetooth low energy (BLE) / Sub-GHz

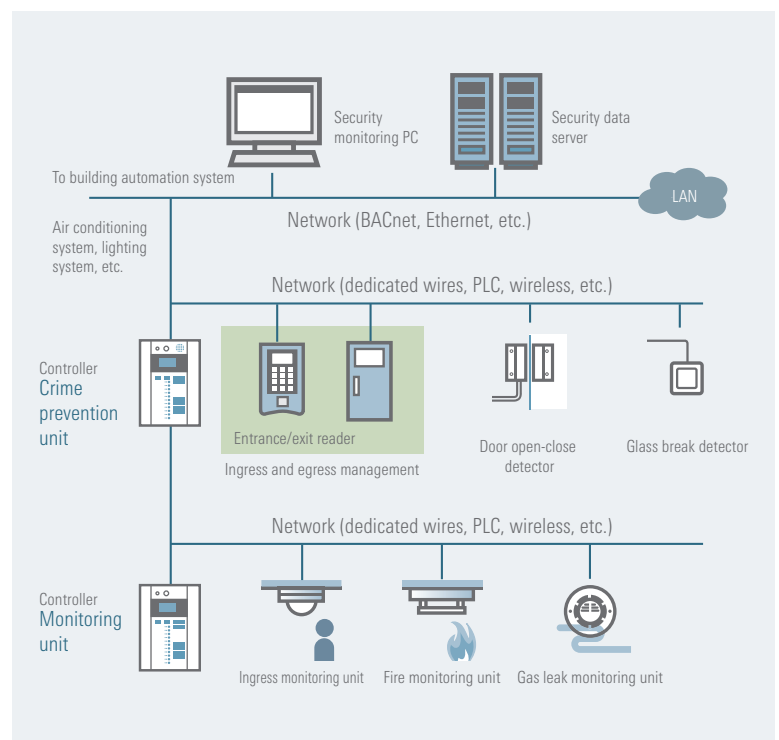
### HMI (Ingress and Egress Management)

Human-machine interface (HMI) / Capacitive touch keys

■ Figure 4 Building Security Systems



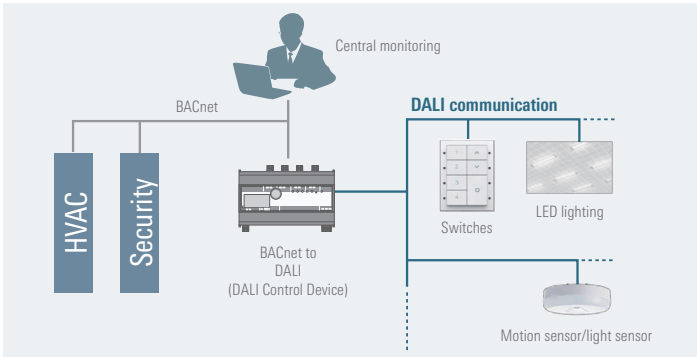
■ Figure 5 Building Security Network



# LIGHTING SYSTEMS

## LED Lighting Networks

Figure 1 BACnet



In recent years there is increased demand in building lighting for reduced installation and operating costs as well as energy efficiency, low maintenance, and attractiveness (the ability to adjust the brightness and color of the light) in order to attract tenants and users. The keys to achieving these things are network support, task/ambient lighting, brightness and color adjustment, and digitization.

One building management network standard that is gaining worldwide adoption is the BACnet communication protocol. BACnet supports integrated management of building automation systems for air conditioning, lighting, crime prevention, disaster prevention, and more. In addition, it makes it possible to reduce the energy consumption of the building overall.

A variety of connected communication devices support the subsystems that run under BACnet. Among these communication standards, Digital Addressable Lighting Interface (DALI) is an open standard that supports lighting systems.

## DALI Communication

DALI is an international communication standard for lighting specified in IEC 62386. Communication takes place between a master (control device) and slaves (control gear). The DALI standard supports a single control device, which can control up to 64 items of control gear.

One feature of DALI is that the entire setup is standardized systematically. Data transfer route basics are covered by 101, control gear by 102, control devices by 103, and so on. Control devices include routers, switches, and motion or light sensors. Control gear includes lighting fixtures. There are also upper-level standard numbers (2xx and 3xx) that cover characteristics specific to individual

Figure 2 DALI Standard Listing

<Slave: Control Gear>				<Master: Control Device>				
210 Sequencer								
209 Color control								
202 Emergency								
206 0-10V dimmer	207 LED	208 Switching		301 Push - buttons	302 Rotaries & sliders	304 Presence detector	305 Light Sensor	3xx Other devices
201 FL	203 HID	204 LV Halogen	205 incandescent lamp dimmer					
102 (Ed.2) Control gear				103 Control devices				
101 (Ed.2) basic system								

Source: Digital Illumination Interface Alliance

devices. This means that a variety of lighting products can be developed on a shared foundation. A second feature is that DALI is an open standard. Products from different manufacturers can connect to each other, to adjust the brightness and color for example. Thus, it is possible to centrally manage the entire lighting system and implement control in a way that saves energy. DALI lets users maximize the energy efficiency of the building's lighting system.

## Advancing to DALI-2

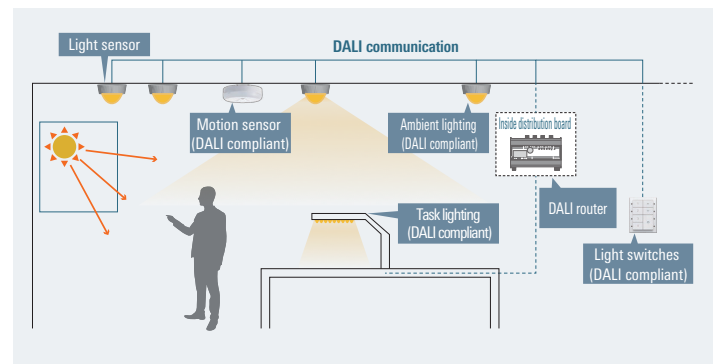
A new DALI standard, DALI-2, is currently coming into use. DALI-2 defines new applications, adds new functions, and improves compatibility to better meet the lighting requirements of customers. Also, a device must pass an official test to receive certification of compliance with the standard. Renesas was the first semiconductor device manufacturer to join the DALI standardization organization. This enables us to deliver solutions that track the latest trends in the standard and include a tested protocol stack by official DALI tester.

## Implementing Task/Ambient Lighting with DALI

"Task/ambient lighting" means that different types of lighting are used for "tasks" such as desks and for "ambient" areas such as floors and corridors. Some features of task/ambient lighting are that it can boost work efficiency by allowing adjustment of the brightness and hue to match individual preferences, and that it can boost energy efficiency by providing only the amount of light needed in each location.

Further energy savings can be achieved by, for example, using motion sensors to detect when people are around, allowing the lights to be extinguished automatically when not needed, or using light sensors to detect light from outside, which can be taken into account when controlling brightness. Figure 3 shows an example of task/ambient lighting using DALI.

Figure 3 Example of Task/Ambient Lighting Using DALI



This task/ambient lighting configuration allows individual control of the lighting of task areas such as desks and of ambient areas such as floors and corridors. The lighting fixtures, sensors, and switches are all connected via DALI, and alternatively a unit such as a lighting controller can be used to provide centralized management. In this way DALI can be used to link and control all essential devices, making it easy to implement task/ambient lighting.



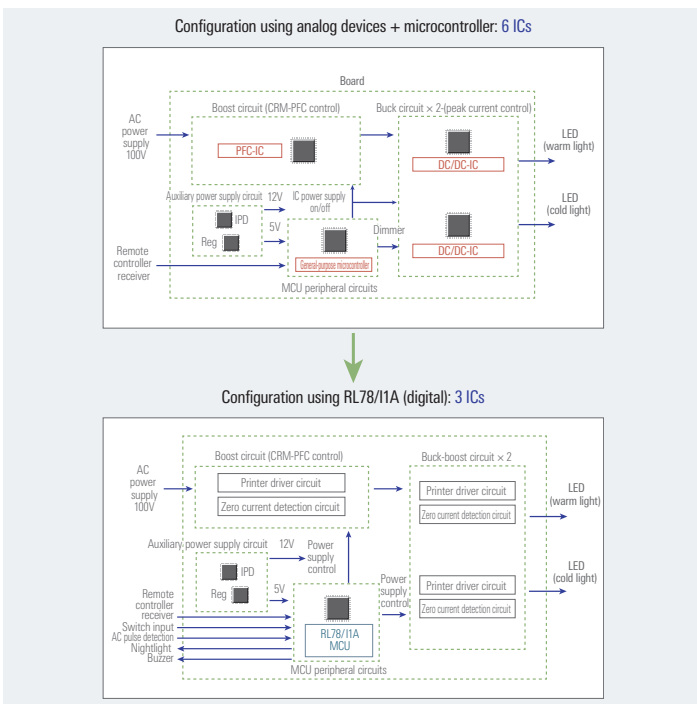
## Digital Power Supplies for Lighting Fixtures

LED lighting product development cycles are growing shorter due to efforts to respond to new market needs. In particular, development of the power supply block, where several functions are concentrated, is a key point. One way to make development more efficient is to digitize the power supply. Digital power supplies provide three major features.

- **Fewer Components**

Since software can be used to tune the performance of a digital power supply, there is no need for the hardware tuning components previously required. In addition, MCUs designed for digital power supplies integrate essential peripheral functions on-chip, greatly reducing the system cost.

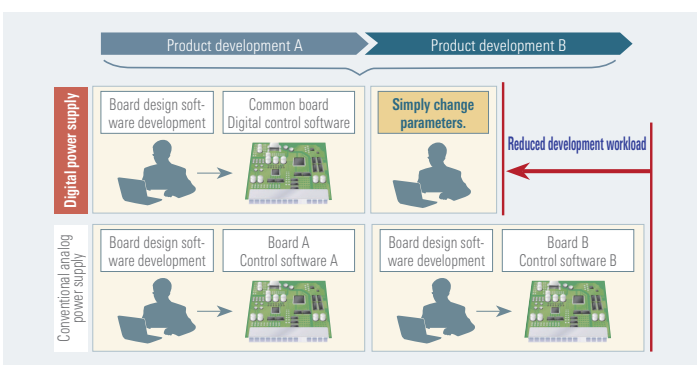
■ Figure 4 MCU for Digital Power Supplies (RL78/11A)



- **Shorter Development Time**

It is possible to modify the operation of a digital power supply simply by making changes to the software (parameters). This means that creating a platform based on a common board and software makes it easy to derive new products from existing ones. In addition, there is a high affinity with communication functions, making it possible to develop DALI-conformant products that match market needs in a short period of time.

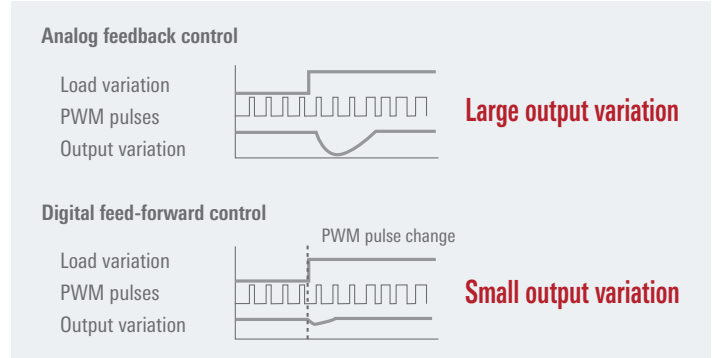
■ Figure 5 Reduction in Development Time with Digital Power Supply



- **Improved Power Supply Performance**

When a sudden change in load occurs, it is possible to keep the output variation smaller with a digital configuration than with an analog one. This means that there is no longer any need for capacitors to suppress LED flicker when dimming the brightness or as a countermeasure for ripple currents. In addition, digital power supply technologies such as variable gain and auto-tuning can be used to increase responsiveness, maintain stability, and suppress variability in ways that are not possible using analog devices.

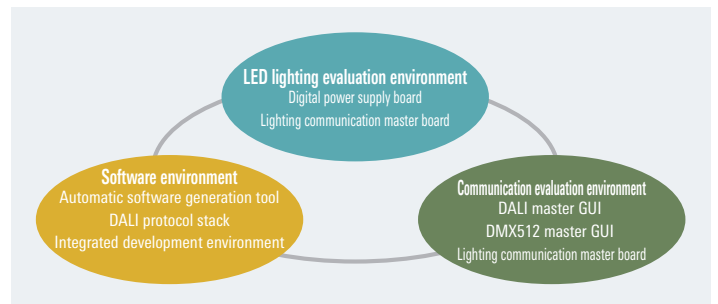
■ Figure 6 Example of Performance Boost by Digitizing the Power Supply



## Renesas Solutions

Renesas offers many solutions that provide powerful support for customers' product development efforts in areas such as networking and digital power supplies.

■ Figure 7 Renesas Lighting Solutions



In particular, the DALI protocol stack consists of elements that have already been tested by official DALI tester. These solutions allow customers to focus their development work on functions and products that provide added value. For details, refer to the lighting solutions on page 18. Also make sure to look into the following types of solutions, which can be applied to lighting applications as well.

- User interface solutions (page 13)
- Connectivity solutions (page 14)
- Sensing solutions (page 16)

# MOTOR CONTROL SOLUTIONS

Renesas motor control solutions aim to make buildings more efficient by reducing the power consumption of motors. A number of motor control methods are used to accommodate various product applications, and each poses its own difficulties during development. Renesas offers motor control solutions for brushless DC motors. They include environments for experimenting with 120-degree conduction control and vector control with brushless DC motors. A wide variety of sample programs, documentation, and development support tools are available, providing total support for customers' development efforts.

## Brushless DC Motor Control Solution

### Outline

This solution supports multiple control methods for driving brushless DC motors and includes hardware, control software, and development support tools. It provides an easier way to evaluate sensorless vector control, which enables motor drive with high efficiency and at low cost.

### Configuration

- Permanent magnet synchronous motor (brushless DC motor)
- Three-shunt current detection function
- Overcurrent protection function
- With optional CPU cards (sold separately), various motor control MCUs can be evaluated.
- Compatible with higher voltage and current than conventional kits (48V / 5A)
- Compatible with existing CPU cards
- Supports the Renesas Motor Workbench development support tool.
  - Automatic tuning function for vector control (Tuner)
  - Debugging functions optimized for motor control (Analyzer)

### Available Software

Sample Software	Supported MCUs
120-degree conducting control + Speed control (Hall, Sensorless)	RX23T, RX24T
Vector control + Speed control (Encoder, Sensorless)	RX13T*1, RX23T, RX24T, RX24U, RX66T, RX72T, RA6T1
Vector control + Position control (Encoder)	RX23T, RX24T, RX24U, RX66T, RX72T, RA6T1

\*1: Sensorless only.

### Applications

- Brushless DC motor control for fans, pumps, compressors, etc., in HVAC units.

### Renesas Solutions for Different Motor Types and Control Methods

Renesas offers kits and motor control software to match various motor types and control MCUs. Each kit comes with different sample software, so refer to the table below to select the appropriate solution to meet your requirements.

Distribution Format	Motor Type	Name of Kit	Vector Control			120-Degree Conducting Control	
			Speed Control	Speed Control/ Positioning Control	Speed Control/ Positioning Control	Speed Control	Speed Control
			Speed Control	Speed Control/ Positioning Control	Speed Control/ Positioning Control	Speed Control	Hall Effect Speed Control
Supplied as complete kit by Renesas	BLDC	Evaluation system for BLDC Motor + CPU Card RTK0EMX270S00020BJ	✓	—	—	✓	✓
	Stepping	Evaluation System for Stepping Motor with Resolver RTK0EMX270S01020BJ	—	—	✓	—	—
Renesas kit + motor with encoder*1	BLDC	Evaluation system for BLDC Motor + CPU Card RTK0EMX270S00020BJ	—	✓*1, *2	—	—	—
Supplied as sample software and application note by Renesas	Induction motor	Evaluation system for ACIM	✓*3	—	—	—	—

\*1. The customer must supply a motor with an optical encoder.

\*2. Magnetic encoder also supported. (The customer must supply a motor with a magnetic encoder.)

\*3. The customer must supply an induction motor and inverter board.

### Evaluation System for BLDC Motor



- 48V inverter board
- Permanent magnet synchronous motor
- Cables
- This solution kit does not include a CPU card. Please purchase the desired CPU card before use.

### Renesas Motor Workbench





# USER INTERFACE SOLUTIONS

Renesas user interface solutions comprise microcontrollers incorporating exclusive touch panel sensing technology and a custom development environment that facilitates quick development of high-grade products. There are also solutions that can be used to boost legibility and ease of use with interfaces supporting video and 3D-graphics. These solutions support the efforts of customers to develop systems providing high affinity between human and machine and allow users to make the most of the functions they offer. AE-CAP1, with support for capacitive touch, and PE-HMI1, with support for HMI, are available as solutions through the Renesas Synergy™ Platform. For details, refer to Renesas Synergy™ Platform Solutions on page 26.

## Capacitive Touch Sensor Solutions

### Outline

Capacitive Touch Sensor solution can develop product interfaces operated by touching the panels with a finger instead of conventional mechanical switches. With the capacitive touch sensor can realize intuitive user interface and excellent design.

### Configuration

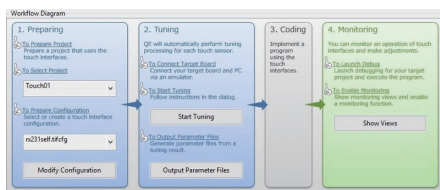
- **Capacitive Touch Evaluation System:**  
Using the board, software and development tool included in the evaluation system, you can get started with evaluation right away.
- **Capacitive Touch Development Tool QE for Capacitive Touch:**  
QE for Capacitive Touch makes it easy to adjust the sensitivity of the touch buttons, shortening time to market.

#### ■ Capacitive Touch Evaluation System

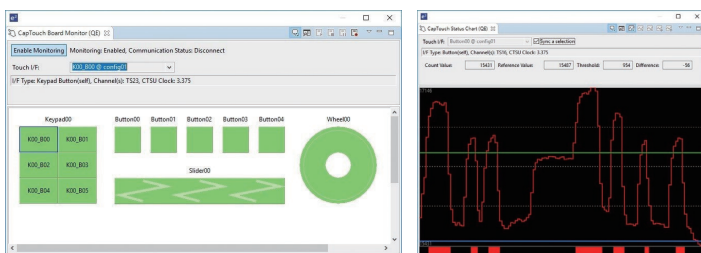


Supported MCU:  
RL78/G23, RA2L1, RA6M2, RX130, RX140, RX671, Renesas Synergy™ S124, Renesas Synergy™ S3A7

#### ■ Capacitive Touch Development Tool QE for Capacitive Touch



Main/Sensor Tuner View



Board Monitor View

Status Chart View

### Applications

Suitable for use as user interface solutions for HVAC, fire and safety, building security, or lighting systems.

## HMI Solutions

### Outline

These human-machine interface solutions incorporate RZ/G2 microcontrollers and enable customers to create new value through sensing. Designed for use in system evaluation and development, they support multi-plane video processing, 3D graphics, and a variety of high-speed interfaces.

### Configuration

- The RZ/G2 evaluation boards each support a Verified Linux Package (VLP).
- The VLP utilizes an industrial grade Linux Civil Infrastructure Platform (CIP) providing 10 years or more of long-term support.
- The product package includes middleware that has been verified on the evaluation board. This enables customers to develop applications in a stable operating environment.

#### ■ RZ/G2E Development Kit (96Boards format compatible)



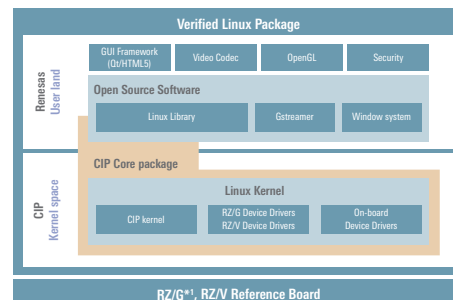
#### ■ RZ/G2H,G2M,G2N Development Kit (96Boards format compatible)



#### ■ RZ/G2L SMARC v2.1 Module Board + Carrier Board



#### ■ Verified Linux Package (VLP)



\*1. RZ/G Reference Board is used for Kernel development as a software development platform for CIP projects.

- GUI Framework
- Qt application framework
  - HTML5 application framework
- Multimedia
- H.264 Codec
  - H.265 Decoder
  - 3D graphics
- Secure Middle Ware
- Encrypted kernel boot
  - Security communication
  - Secure storage
- CIP SLTS Kernel
- Civil Infrastructure Platform project
  - 10+ years super long term support
  - Reliability/Security/Real-time

### Applications

Suitable for use as user interface solutions for HVAC, fire and safety, building security, or lighting systems.

# CONNECTIVITY SOLUTIONS

Renesas connectivity solutions are available for wireless communication (BLE and Sub-GHz) and wired communication (PLC) applications. They enable customers to build networks linking devices and systems without the need to install new wiring.

Evaluation boards, sample software, evaluation tools, and documentation are provided to provide total support for customers' development efforts.

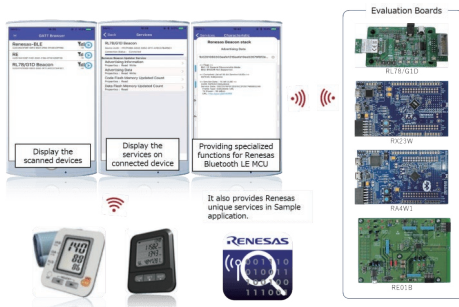
## Bluetooth Low Energy Solution

### Outline

Bluetooth® Low Energy enables low-power data link with devices including smartphones. Bluetooth LE is supported in a wide range of Renesas MCUs such as RA4W1, RX23W and RL78/G1D. Customers can use the evaluation board to develop new Bluetooth LE applications.

### Configuration

- Evaluation board and Bluetooth LE control (GUI) Tool
  - Bluetooth LE protocol stack
  - QE for BLE — Development Assistance Tool
  - GATTBrower — iOS/Android Application for operation confirmation



Added Dialog SmartBond™ products. For more details, please visit:  
<https://www.renesas.com/solutions/bluetooth>

## Sub-GHz (920MHz) Wireless Solution

### Outline

Provides support for the Wi-SUN for FAN Profile, an international wireless communication standard established by the Wi-SUN Alliance. Wi-SUN FAN enables us to control various infrastructures such as sensing, lighting and building automation remotely by building a large-scale mesh network.

### Configuration

- RL78/G1H evaluation board as low-power solution
- RX651 + RAA604S00 evaluation board as advanced functionality solution
- Both products include RF driver/MAC stack, IP stack, and RF characteristics evaluation program.

■ RL78/G1H Evaluation Board

■ RX651+RAA604S00 Evaluation Board



### Applications

Used for induction motor control for fans, pumps, compressors, etc., in HVAC units.

## RS-485 Communication Solution

### Outline

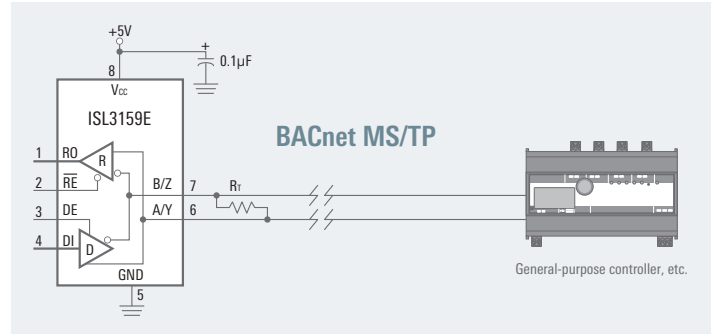
RS-485 uses differential signaling to enable long-distance data transfer, even under noisy conditions. It also aims to improve and extend the functionality of the earlier RS-422 standard. With RS-485 up to 31 devices can share a single data line. Any slave device on the RS-485 bus can communicate with the other 31 devices without the need to connect via a master device.

### Features of Renesas Products

- Extensive product lineup to meet an array of system requirements
- High-speed communication support (up to 100Mbps)
  - PROFIBUS® support
  - Isolated products
  - Operation at 125°C
- Highest level of noise tolerance and ESD protection

### Product Examples

- High speed (RS-485)
  - ISL3159E: PROFIBUS support, high-speed (40Mbps), operation at 125°C
  - ISL3259E: Ultra-high speed (100Mbps)



- Overvoltage protection (RS-485)
  - ISL3245XE: ±60V overvoltage protection, among the best in the industry
- High output voltage/high noise tolerance (RS485)
  - RAA78815X: Output voltage of 3.1V (typ.) and ±5kV EFT immunity

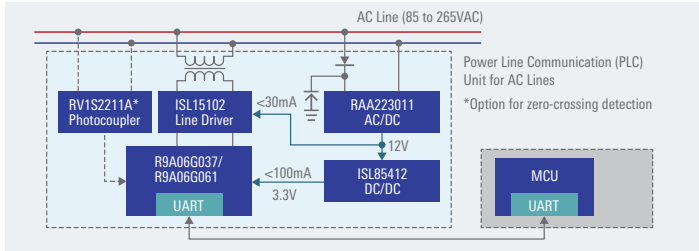
# Power Line Communication (PLC) Solutions

## PLC Solutions

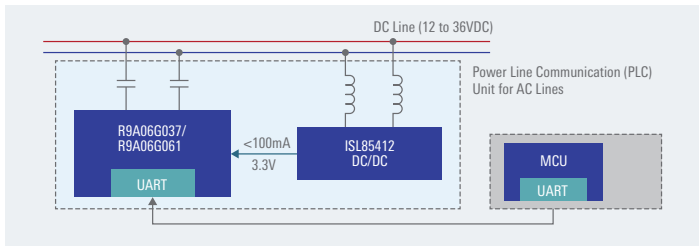
PLC is a technology that uses existing power lines as the communication medium. Using the power grid as a communication network makes it possible to build out systems cheaply and quickly. Either AC power lines or DC power lines can be employed as the communication medium.

Renesas offers narrowband PLC modem IC products with integrated CPUs that implement high-performance DSP and support a variety of power line communication protocols. They employ orthogonal frequency-division multiplexing (OFDM) to deliver highly reliable, robust communication. Renesas PLC modem ICs support high data transfer speeds up to 1Mbps over long distances of a kilometer or more.

### Example of PLC Communication Module Configuration for AC Power Lines



### Example of PLC Communication Module Configuration for DC Power Lines



## Evaluation Environment

Multiple types of evaluation kits optimized for AC power lines or DC power lines are available for R9A06G061/R9A06G037 evaluation and development work. Circuit diagrams, parts lists, and Gerber data are available for each evaluation kit.

### R9A06G061 Evaluation Kit

Evaluation Kit	Product No.	Description
CPX4 Evaluation Kit M01D01	RTK0EE009D01001BJ	DC power line communication evaluation kit
CPX4 Evaluation Kit M02D02	RTK0EE009D02001BJ	AC power line communication evaluation kit

Evaluation Kit	M01D01	M02D02
Type	For DC power lines	For AC power lines
Supported voltage range	16V to 48V DC	100V to 230V AC
Mounted MCU	RX651	RX651
Exterior view		

### R9A06G037 Evaluation Kit

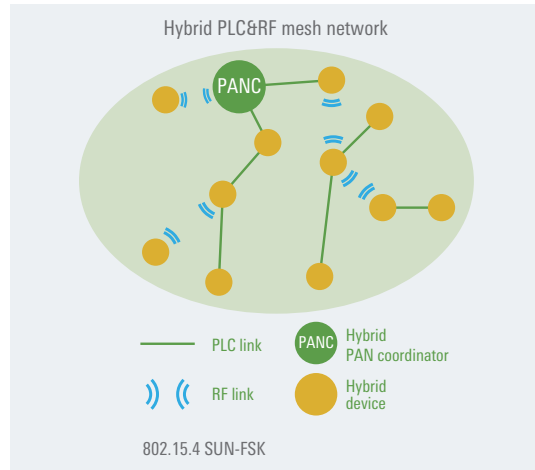
Evaluation Kit	Product No.	Description
CPX3 Evaluation Kit J70D1	RTK0EE0003D01002BJ	AC power line communication evaluation kit
CPX3 Evaluation Kit J80D1	RTK0EE0007D01001BJ	DC power line communication evaluation kit
CPX3 Evaluation Kit J80D2	RTK0EE0007D02001BJ	DC power line communication evaluation kit

Evaluation Kit	J70D1	J80D1	J80D2
Type	For AC power lines	For DC power lines	
Supported voltage range	100V to 230V AC	16V to 48V DC	
Mounted MCU	RX631	RX651	RL78/G13
Note	—	Audio board for voice communication included	—
Exterior view			

## PLC-RF Hybrid Solution

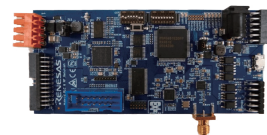
Renesas offers a PLC-RF hybrid solution that combines a PLC solution and a Sub-GHz wireless communication solution. The PLC-RF hybrid solution provides Sub-GHz wireless communication coverage in areas where communication cannot be implemented using PLC alone, thereby enhancing network reliability and expandability.

The PLC-RF hybrid solution brings together two different communication technologies in a way that makes it easy for users to make use of them as a single network.



## PLC-RF Hybrid Evaluation Board

This evaluation board implements the Renesas PLC-RF hybrid solution. It is populated with the R9A06G037 as the PLC modem IC and the RAA604S00 as the wireless communication IC. The evaluation board supports two major communication protocols, G3-PLC Hybrid and PRIME Hybrid, making it suitable for a broad range of applications.

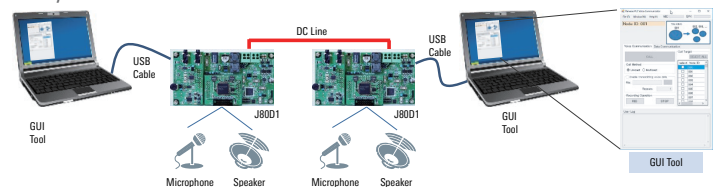


Devices Mounted on PLC-RF Hybrid Evaluation Board

PLC modem IC	R9A06G037
Sub-GHz wireless communication IC	RAA604S00
Host MCU	RX651

## Voice Communication Solution

A RX651 library is provided to enable use of the R9A06G037 PLC modem chip to realize a voice communication solution. Voice data can be encoded and decoded, and sent and received over power lines via the R9A06G037. The J80D1 evaluation kit is supported. In addition, a GUI tool can be used to easily control and check the status of voice communications.



# SENSING SOLUTIONS

These solutions are suitable for building security systems and deliver low cost and power efficiency alongside highly accurate measurement. Using these reference boards contributes to significantly shorter development time. The core devices of these solutions are RL78/I1x microcontrollers. They combine the exclusive architecture and superior power performance of the RL78 Family of microcontrollers with analog functions ideal for sensing applications. For details, visit the RL78/I1x Series page on the Renesas website.

## Glass Break Detector Solution

### RL78/I1D Detect it!

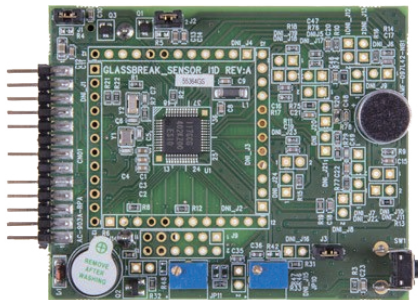
#### Outline/Features

This solution uses a microphone to detect when the glass is broken. Active filtering for the microphone is implemented using the microcontroller's on-chip low-power op-amp. Reduces costs while achieving extended operation on battery power.

#### Configuration

- Microcontroller: RL78/I1D low-power analog microcontroller
  - Solution board: RL78/I1D Detect it! glass break detector board
- Circuit diagrams, parts lists, and sample programs are available.

■ Glass Break Detector Board



#### Applications

Crime prevention products

## Smoke Detector Solution

### RL78/I1D Detect it!

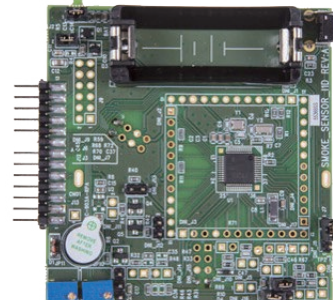
#### Outline/Features

This solution uses an infrared LED and an optical receiver to detect the presence of smoke. The low-power RL78/I1D with on-chip sensor amplifier helps reduce system cost while achieving extended operation on battery power.

#### Configuration

- Microcontroller: RL78/I1D low-power microcontroller
  - Solution board: RL78/I1D Detect it! smoke detector board
- Circuit diagrams, parts lists, and sample programs are available.

■ Smoke Detector Board



#### Applications

Sensors, alarms

## Carbon Monoxide Detector Solutions

### 1) RL78/I1D Detect it!

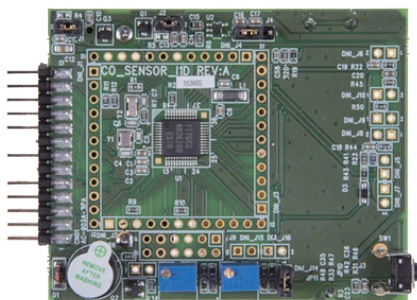
#### Outline/Features

This sensing solution uses a carbon monoxide canister. It enables detection of carbon monoxide at concentrations of  $100\text{ppm} \pm 10\text{ppm}$ .

#### Configuration

- Microcontroller: RL78/I1D low-power analog microcontroller
  - Solution board: RL78/I1D Detect it! carbon monoxide detector board
- Circuit diagrams, parts lists, and sample programs are available.

■ Carbon Monoxide Detector Board



#### Applications

Carbon monoxide warning systems, carbon monoxide detectors

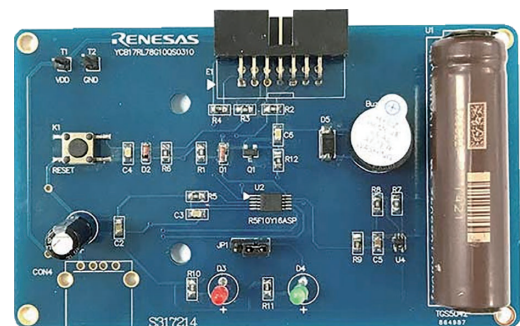
### 2) RL78 Quick Solution

#### Outline/Features

This is a reference design for a carbon monoxide alarm for home use. The output of a carbon monoxide canister is amplified by the ISL28113 op-amp, and A/D conversion is performed on the compact, low-pin-count RL78/G10 MCU to determine the concentration of carbon monoxide.

#### Configuration

- Microcontroller: Compact, low-pin-count RL78/G10 MCU
- Op-amp: ISL28113



#### Applications

Carbon monoxide alarm for home use



## Motion Sensor Solutions

### 1) RL78/I1D Detect it!

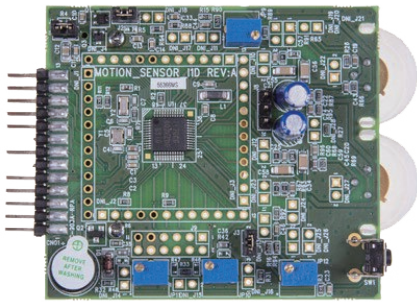
#### Outline/Features

This solution uses pyroelectric motion sensors to detect the movement of persons. Two sensors are used to allow detection of the direction of movement. The microcontroller's on-chip low-power op-amp reduces the system cost.

#### Configuration

- Microcontroller: RL78/I1D low-power analog microcontroller
- Solution board: RL78/I1D Detect it! motion detector board  
Circuit diagrams, parts lists, and sample programs are available.

#### ■ Motion Detector Board

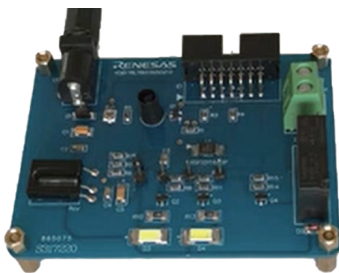


### 2) RL78 Quick Solution

This Infrared Human Sensor reference design detects human presence/absence using an infrared sensor, and turns on/off a high brightness LED automatically. It can be applied to a wide range of applications including office lights and automatic doors.

#### Configuration

- User's manual, source code, circuit diagram, PCB, and BOM are available.



#### Applications

Crime prevention units, lighting systems

## Portable PM2.5 Measuring Device Solution

### RL78 Quick Solution

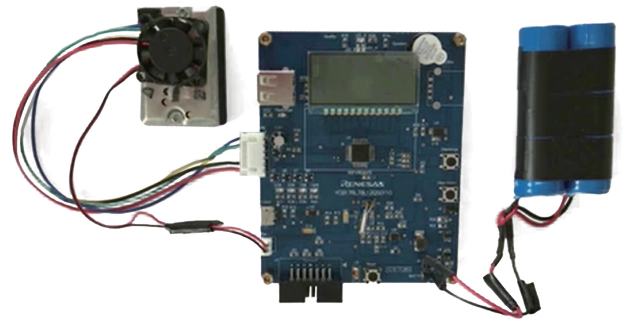
#### Outline/Features

This portable measuring device detects and measures the concentration of PM2.5 in the air in real time. The air quality is indicated by the color of an LED (read, green, or blue) and an LCD panel. The system also provides charging and power supply functionality as a mobile battery, and displays the battery capacity using LEDs. If the PM2.5 concentration exceeds a preset threshold or the battery voltage drops below 2.8V, a buzzer sounds.

This solution utilizes the I/O port, A/D converter, buzzer, LCD controller, and STOP mode functions of the RL78/L12, a microcontroller ideally suited for small home appliances. In addition, ISL97656 (DC-DC converter) or ISL9122A (ultra-low Iq buck-boost regulator) controls battery discharge and the ISL6294 (battery charger) controls charging. The threshold value and PM2.5 concentration data are saved in EEPROM. (If there is less than 2KB of data, it can be stored in the on-chip data flash of the RL78/L12.)

#### Configuration

- User's manual, source code, circuit diagram, PCB, and BOM are available.



#### Applications

Air conditioner systems

#### About RL78 Quick Solution

RL78 Quick Solution is a convenient solution you can use right away for product development.

#### Items available for download

- User's manual
- Sample software source code
- Circuit diagram
- PCB layout data, BOM

# WINNING COMBINATIONS

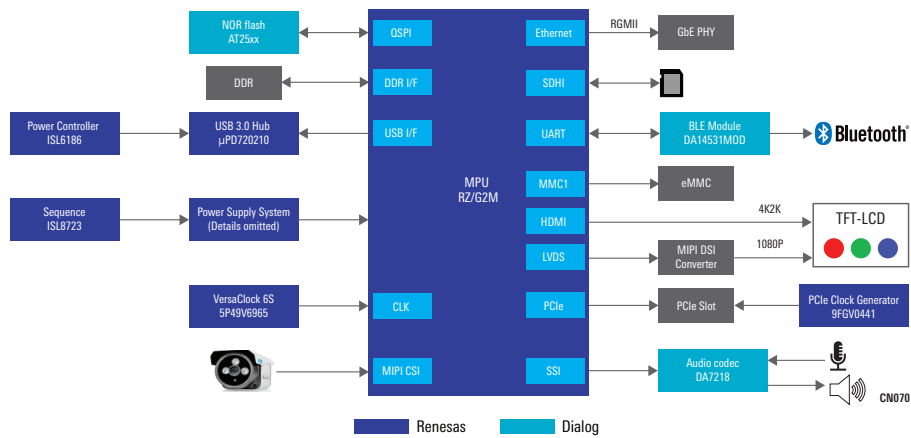
Creating integrated solutions by combining analog devices, power devices, embedded processing, and connection functionality from Renesas and a portfolio of complementary products from Dialog.

## Voice/Face Recognition for Security Systems

Security systems continue to evolve to provide secure access to individuals based on biometric feedback. This solution utilizes a combination of voice and facial recognition to provide authorized entry.

### System Benefits

- Soft error-free MCU with ECC function for all memory interfaces
- Turnkey solution on hardware with power and timing devices
- Embedded 3D graphic acceleration for high-speed processing



## Voice Activated DALI Lighting Controls

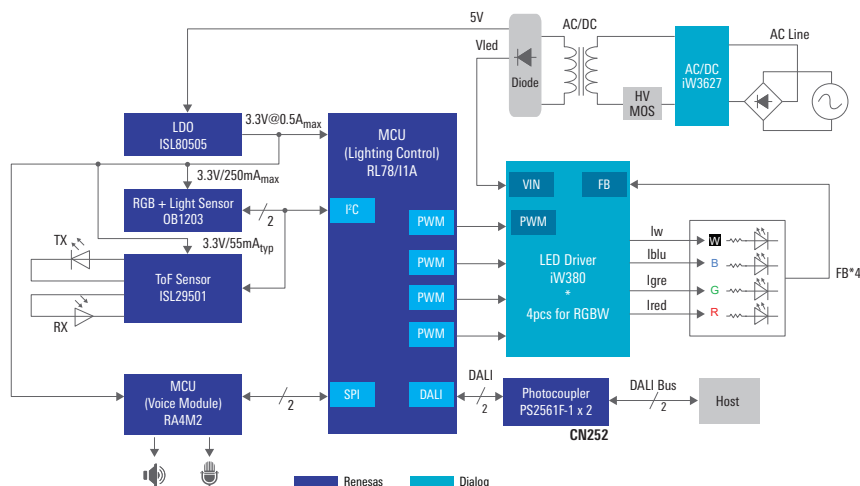
Digital addressable lighting interface (DALI) is a dedicated lighting control protocol for intelligent lighting systems that is widely used in commercial lighting control and building lighting control.

### System Benefits

- The RL78/11A is a one-chip solution for DALI/DMX512 and PWM dimming controls
- Voice module supports multi-national offline voice control
- Supports Time of Flight (ToF) distance detection
- Includes an OB1203 fully integrated optical sensing module to support RGB sensor function and biosense
- High-performance AC/DC and DC/DC for lighting

### Target Applications

- Commercial lighting
- DALI-2 systems
- Building automation



## Air Quality Control for IoT Building Automation

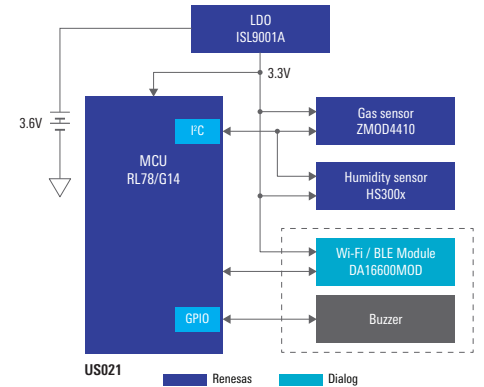
The ZMOD4410 gas sensor and HS300x humidity sensor family along with the RL78/G14 microcontroller enable users to sense the environment for gases, measure and improve air quality, and provide observations of goods during transport. The solution meets strict air quality regulations, saves energy, and helps maintain the user's health and wellness.

### Key Features

- Easy and fast integration into existing systems
- Fast productization
- Gas sensor with highest sensitivity to gases in the market
- Firmware upgradeable solution to meet specific customer needs and requirements

### Target Applications

- Factory automation
- Building automation



## Household Smoke Detector

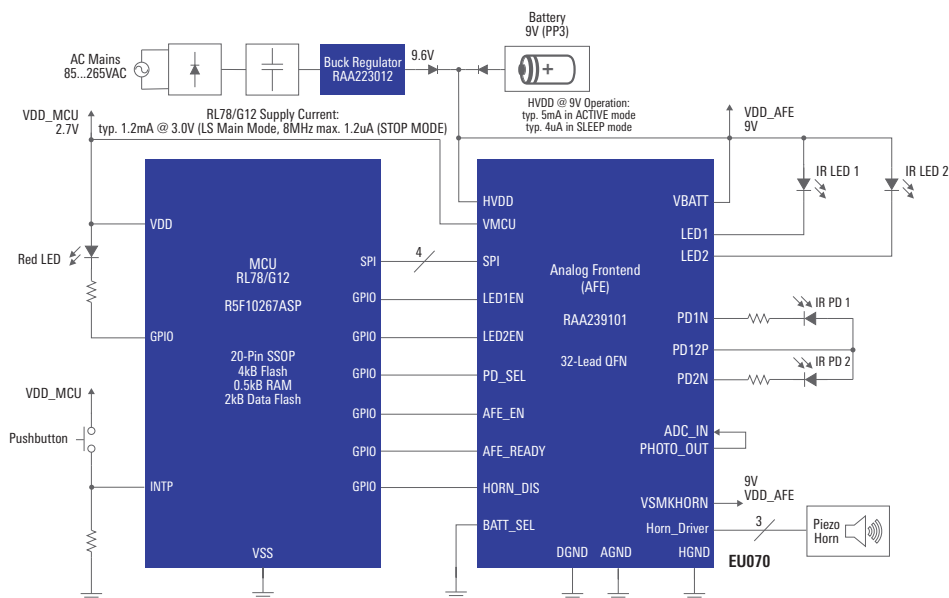
The highly integrated RAA239101 low-power analog front-end IC includes all necessary peripherals and features required for a complete smoke detector system based on photoelectric detection principle. It enables a very flexible implementation with parametrization capabilities (LED-current selection, PGA gain setting, integrated battery test feature).

### System Benefits

- Low-power analog front-end includes all necessary peripherals for a photoelectric smoke detector
- Ultra-low current consumption enables 10y+ battery lifetime
- Very few external components needed with a cost-optimized bill-of-materials (BOM) and small solution size vs. a discrete design
- Highly integrated analog front-end (AFE) allows the use of two different IR wavelength diodes/photodetectors (enhanced accuracy, UL217 compliant)
- Utilizes the small pin-count and low cost RL78/G12 MCU with DataFlash, enabling non-volatile data storage for alarm counter, operating hours, etc.
- AC mains power supply with small-sized and low quiescent current (IQ) AC/DC buck regulator (optional)

### Target Applications

- Residential smoke detectors based on photoelectric principle



# Smart Lock with Super-Low Power Wi-Fi and Bluetooth Low Energy

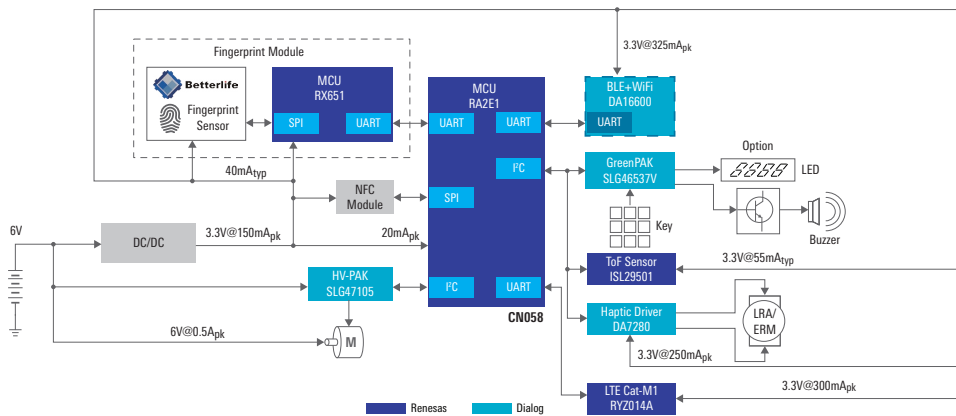
The demand for smart locks is a rapidly growing segment for the home and building automation industries. These locks need to be able to communicate with a smart home or building via fingerprint recognition and/or with a mobile phone using a common wireless communication protocol such as Bluetooth® or Wi-Fi. This smart lock solution features fingerprint control, low power Bluetooth and low power Wi-Fi options. The DA16600 low power Wi-Fi plus low power Bluetooth Low Energy (LE) module, DA16200 low power Wi-Fi networking system-on-chip (SoC) and DA14531 SmartBond TINY™ Bluetooth LE module provide the smallest and lowest Bluetooth 5.1, ultra-low power Wi-Fi SoC for battery-powered Internet of Things (IoT) devices. Additionally, the GreenPAK™ family of cost-effective NVM programmable devices provides features such as motor driver and LED control. And, the RX651 high-performance, low pin count, 32-bit microcontroller (MCU) is available to design in a fingerprint module for the algorithm design. A wide input range ultra-low quiescent current LDO and Time of Flight (ToF) sensor are also used for a complete compact design.

## System Benefits

- Includes the world's smallest and lowest power Bluetooth 5.1 system-on-chip
- Ultra-low power Wi-Fi SoC for battery-powered IoT devices
- High-performance 120MHz low pin count MCU for adding a fingerprint module
- Programmable mixed-signal matrix enables innovators to integrate many system functions into a single custom circuit

## Target Applications

- Smart homes
- Smart buildings



# Bluetooth Low Energy (BLE) Sensor Network Solution

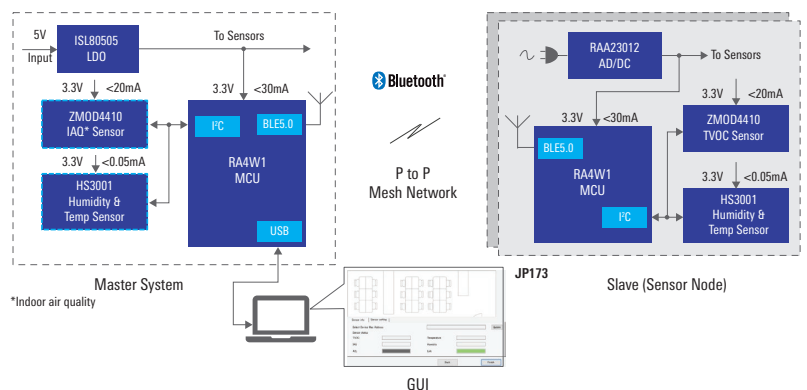
This reference design provides the wireless sensor network solution to make indoor environments comfortable and healthy when using an HVAC system. It monitors temperature/humidity/indoor air quality (IAQ) data from each sensor using Bluetooth® 5.0 Low Energy.

## System Benefits

- Bluetooth 5.0 Low Energy networking with the power efficient RA4W1 microcontroller.
- HS3001/HS3101 (with hydrophobic membrane to protect from dust and water) measures humidity and temperature.
- ZMOD4410 measures IAQ.
- The slave side monitors autonomously and sends out an alert, if necessary, eliminating the need for frequent inquiries to the master side.
- Customer can develop HVAC control algorithms based on alerts from the slave side.
- Wireless sensors are used to reduce the initiate set-up cost.
- Free GUI is provided that is suitable for demo, design, manufacturing, installation, and operation.

## Target Applications

- HVAC for buildings, industry or homes





## Touchless Button Solution

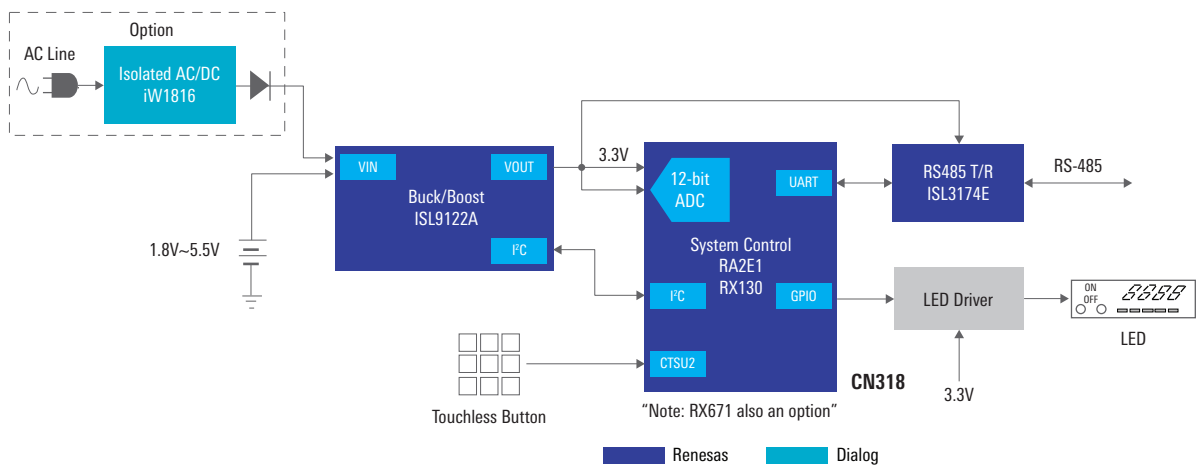
A touchless button solution can be widely used in homes (lighting switches, bathroom switches, etc.) and public locations (vending machines, electric door openers, etc.). A touch can be detected without directly touching the button; therefore, the adhesion of bacteria and dirt to the fingers is reduced. The touchless button solution lessens concerns over contaminated surfaces.

### System Benefits

- Entry-level RA 32-bit MCU with a Capacitive Touch Sensor Unit 2 (CTS2) provides touchless control with high sensitivity and high noise immunity. All Renesas MCUs that contain a CTSU are also compatible.
- Ultra-low Iq buck-boost can fully extract the power of a battery as low as 1.8V.
- Output voltage can be adjusted by the I<sup>2</sup>C bus.

### Target Applications

- Elevators, vending machines, ticket selling machines
- Toilet flushing, water faucets
- Automatic door buttons
- Kitchen appliances: Refrigerators, microwave ovens, range hoods, etc.



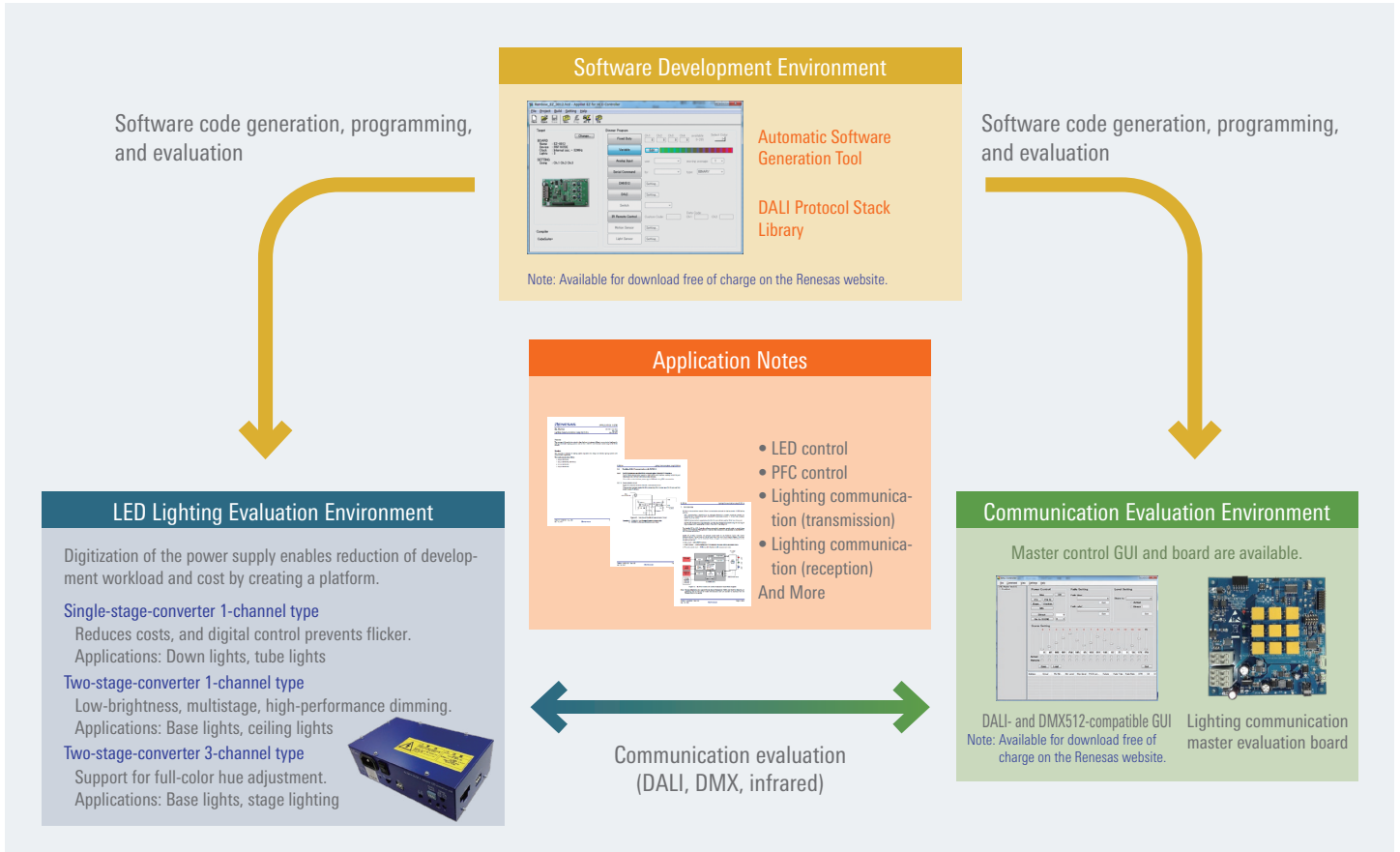
For more Winning Combinations, please visit:

<https://www.renesas.com/application/winning-combinations>

# LIGHTING SOLUTIONS (DALI-2)

Renesas lighting solutions provide powerful support for your development efforts. They make it possible to develop lighting applications in a short period of time in response to market demand for functionality such as network connectivity, digital power supply, and brightness or color adjustment.

These solutions consist of an LED lighting evaluation environment, software development environment, communication evaluation environment, and application notes containing detailed information on how to use them.



## LED Lighting Evaluation Environments and Communication Evaluation Environments



LED lighting evaluation environments consist mainly of reference solutions for developers of LED lighting fixtures. Several evaluation boards with different topologies and dimmer interfaces including DALI are available for a variety of customer applications. All boards support digital power supplies. Communication evaluation environments provide reference solutions for developers of products such as dimmers with communication capabilities (communication masters, DALI switches, sensors). They can be used to evaluate communication with lighting fixtures. Visit the Renesas website for details of each board.

	RL78/I1A DC/DC LED Control Evaluation Board (EZ-0012)	AC/DC Single-Stage-Converter 1-Channel Output (TPW-RL78I1A-1C)	AC/DC Two-Stage-Converter 1-Channel Output (TPW-RL78I1A-2C)	AC/DC Two-Stage-Converter 3-Channel Output (TPW-RL78I1A)	Lighting Communication Master Evaluation Board (RTK7RL23LMP00000BJ) <b>NEW</b>
Power supply voltage	DC 5V	AC100-240V	AC100-240V	AC100-240V	DC5V
Topology	Single-converter (non-isolated)	Single-stage-converter (non-isolated)	Two-stage-converter (non-isolated)	Two-stage-converter (isolated)	—
AC/DC	—	Flyback (DCM-PFC)	Boost (CRM-PFC)	Flyback (CRM-PFC)	—
DC/DC	Buck (high-side drive)	—	Buck (low-side drive)	Buck (high-side drive)	—
Output (max.)	5V 350mA	60V, 200mA 1-channel (LED single-color applications)	200V, 250mA 1-channel (LED single-color applications)	90V/channel, 350mA/channel 3-channel (LED full-color applications)	—
Dimmer type (min. dimmer value)	Current dimmer	Current dimmer (5%)	Current + burst dimmer (0.4%)	Current dimmer (1%)	—
Dimmer interface	DALI/DMX512/IR/Volume	Volume SW	DALI/IR	DALI/DMX512/IR	DALI/DMX512/IR
Automatic Software Generation Tool	Supported	Supported	Supported	Supported	—
Unit size (W × D × H)	65 × 115mm	160.4 × 107.6 × 63.8mm	190.4 × 110.6 × 63.8mm	240 × 195 × 70mm	120 × 120mm

## Software Development Environment



### Applilet EZ for HCD

This tool can be used to create sample code for LED lighting and communication software and to program this software to hardware. Simply specify dimmer operations or communication modes in the GUI to generate digital power control (PFC, DC/DC) or DALI/DMX512 communication software code. The software created in this way can then be programmed automatically to the MCU's flash memory via a USB cable so that you can check its operation on the evaluation board. This tool is available for download free of charge on the Renesas website.

### Features

- Dramatically reduces the workload required to develop and evaluate LED control and communication software.
- Allows evaluation of LED lighting or illumination systems without requiring an extensive knowledge of MCUs and MCU environments.
- Generated program code can be edited in an integrated development environment (IDE).

Easily generate DALI communication or digital power control software using a GUI. Reduces the development workload and costs.

I'm new to programming....  
I'm not confident about developing new software....  
I'd like to refer to sample programs....

### Automatic Software Generation tool

Applilet EZ for HCD

Note: Available for download free of charge on the Renesas website.

(1) Generate software automatically by operating a mouse.



(2) Program the unmodified result to the board for evaluation.



Single-converter board



Dual-converter boards

### DALI Protocol Stack Library



Renesas is the first semiconductor device manufacturer to become a member of the Digital Illumination Interface Alliance (DiiA), the standardization body behind DALI. We have offered MCU products, evaluation boards, and protocol stacks supporting the DALI interface for over a decade, and a large number of customers in many countries have adopted these products. DALI protocol stack components from Renesas have been tested\*1 by official DALI tester, who must all be members of the DiiA, so customers can use them with confidence. A number of library versions have also been developed by partner vendors working closely with Renesas. Moving forward, Renesas is committed to fostering the widespread adoption of DALI by supporting the development work of customers in collaboration with our partner vendors.

### Features

- Tested by official testers.
- Versions are available to match specific MCU products.
- Substantially reduces the workload and time associated with development.
- Application notes providing a basic understanding of DALI are available.



### Protocol Stack Library Versions (As of December 2022)

IEC62386 Standard	Application	Details	RL78*1	RX65N*1	RA*2
102	Lighting fixtures, PWM converters etc.	Control gear (General requirements)	✓	—	✓
207		LED modules (Particular requirements)	✓	—	✓
209		Color modules (Particular requirements)	✓*3	—	✓
103	Switches, sensors, routers etc.	Control devices (General requirements)	✓*4	✓*5	✓
301		Pushbuttons (Particular requirements)	Under development	—	✓

\*1. Official testers and test sequences are used to confirm the operation of the communication components of DALI products.

\*2. MBS/CS-Lab GMBH

\*3. As Tc protocol. XY and RGBWAF are under development.

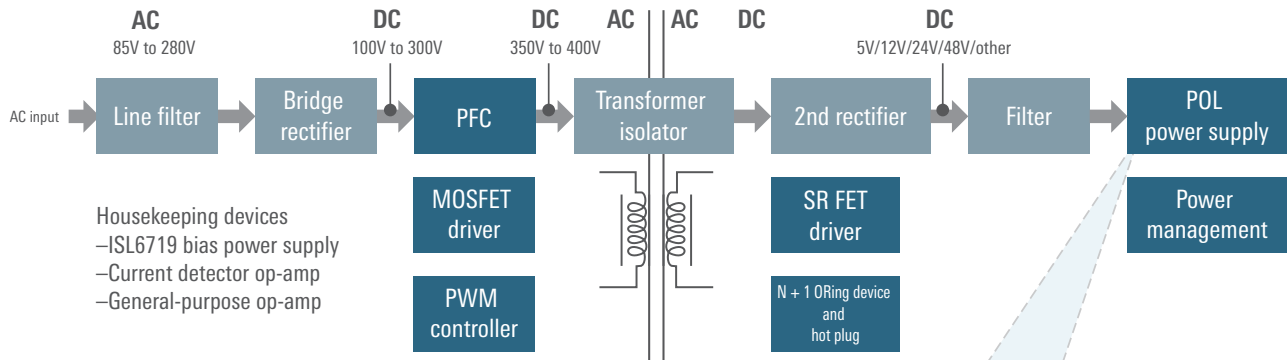
\*4. The stack for input device.

\*5. The stack for application controller.

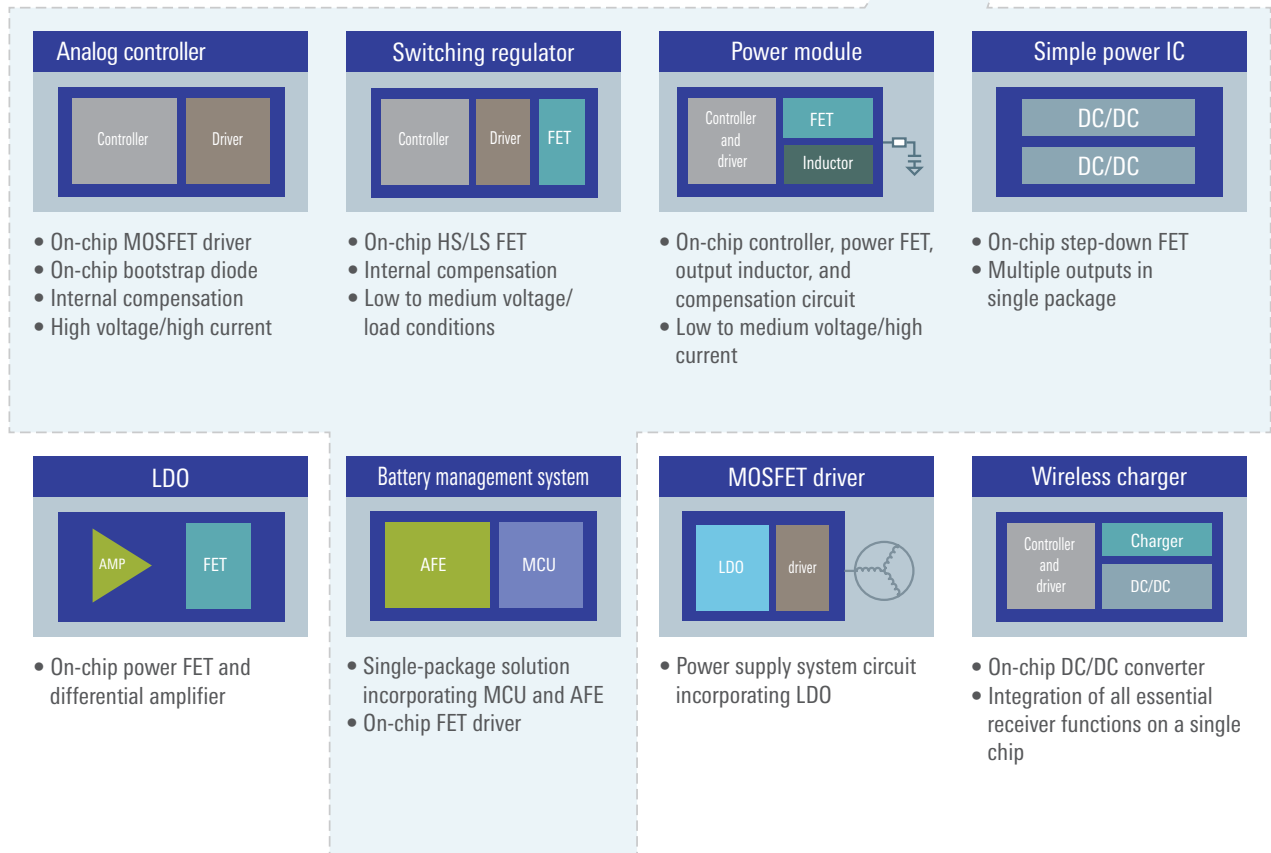
# POWER MANAGEMENT SOLUTIONS

An array of power management solutions suitable for various systems and devices.

Renesas offers an extensive product lineup as high-performance power supply solutions for system processors, controllers, DSPs, FPGAs, CPLDs, DDR memory, and other loads. Such Renesas products include general-purpose linear regulators, highly flexible PWM controllers and regulators, and fully integrated power modules, each of which is designed to meet a particular need that arises during power supply development.



Power management solutions for an array of applications, voltages, and currents.





## Analog Controllers

Products with high-voltage and large-current support to meet current demand for power supplies

### Advantages and Main Features

#### Stability and high performance

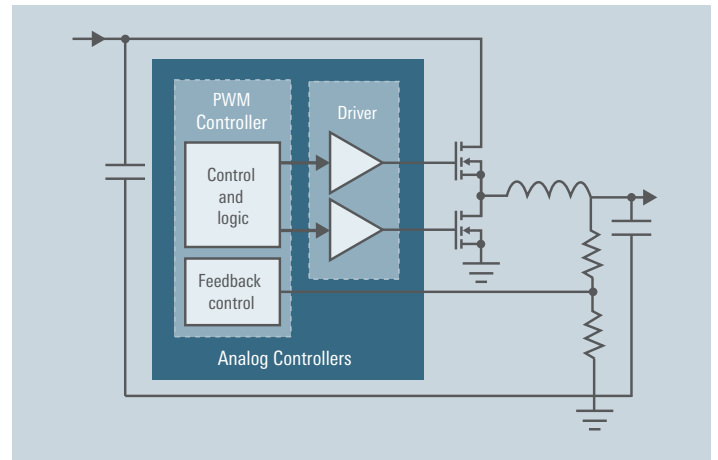
- Wide range of protection functions (OCP, OVP, OTP, SCP)
- Pre-bias startup, external compensation

#### Extensive product lineup

- Wide input voltage range up to 72V
- Multiple settings possible (single-output, multi-output, multi-phase)
- Wide frequency range: 100kHz to 2.5MHz
- Many package options (DFN, QFN, HTSSOP, QSOP, etc.)

#### High degree of integration

- On-chip MOSFET driver
- On-chip bootstrap diode
- Internal compensation



## Switching Regulators

Support for wide range of input voltages

### Advantages and Main Features

#### Stability and high performance

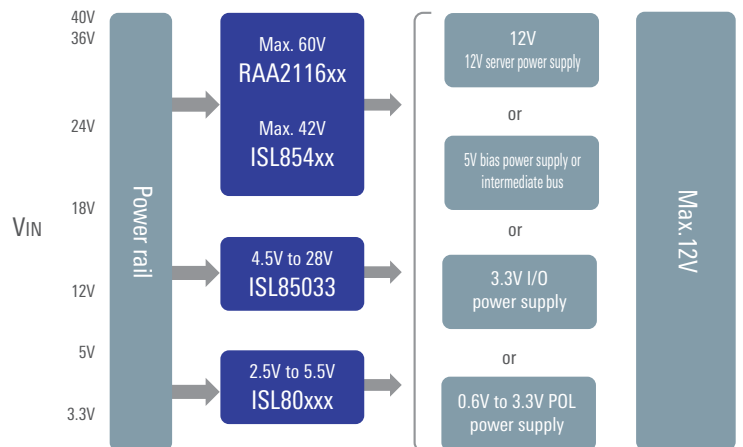
- Power-good, enable, variable software start
- Wide range of protection functions (OCP, OVP, OTP, SCP)
- External frequency synchronization

#### High degree of integration

- On-chip HS/LS FET
- Internal compensation

#### Target applications

- POL converters for servers and infrastructure
- Industrial PCs, factory automation, PLC
- General-purpose POL converters
- Communication and networking systems



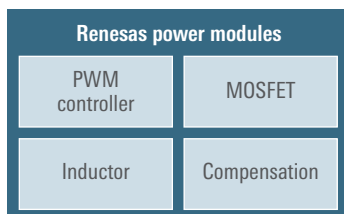
## Power Modules

Complete power supply systems composed of capsule-like modules

### Advantages and Main Features

#### Superior ease of use

- Completely integrated design that reduces complexity and simplifies design

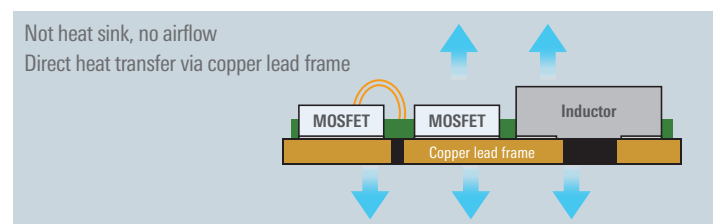


#### High power density

- Ability to realize up to 40A output in a single package

### Heat-resistant package technology

- Use of thermoplastic compounds for more efficient heat dispersion
- Large copper pads to improve thermal efficiency
- Full-load operation over wide temperature range
- Pin access via lead package



# RENESAS SYNERGY™ PLATFORM SOLUTIONS

## Renesas Synergy™ Platform Solutions for the Building Automation Market

Renesas Synergy™ Platform comprises software packages, scalable microcontrollers, integrated development tools, and extensive eco-friendly systems. Renesas Synergy™ Platform provides developers of highly sophisticated embedded applications such as building automation an effective means to bring innovative new products to market quickly.

### Reasons to Choose the Renesas Synergy™ Platform



#### Faster Development

Renesas takes care of the development of low level code up to the API. Customers can focus on innovating and differentiating their own end-products.



#### Lower Overall Costs

Renesas Synergy Software Package lets developers minimize risks and reduce overall costs, including maintenance.

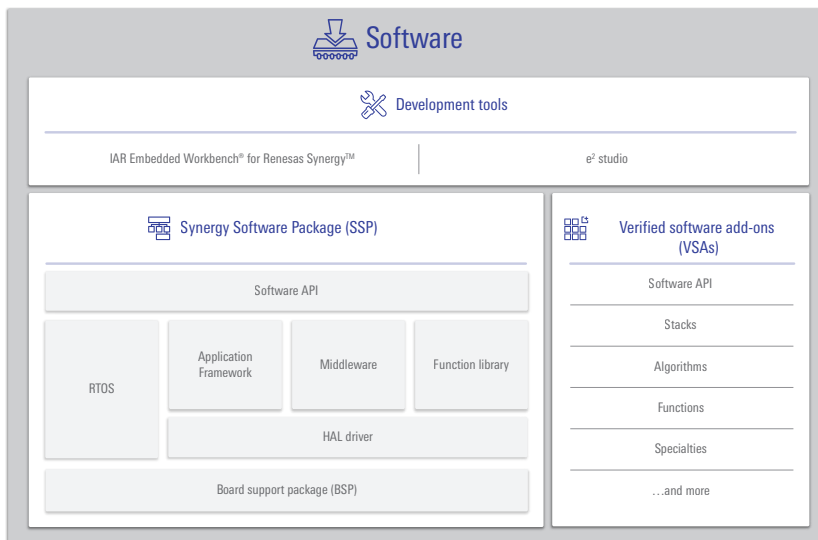


#### Lower Barriers to Entry

Since there is no need to start from zero with initial costs and complex licensing fees, developers can focus on innovation.

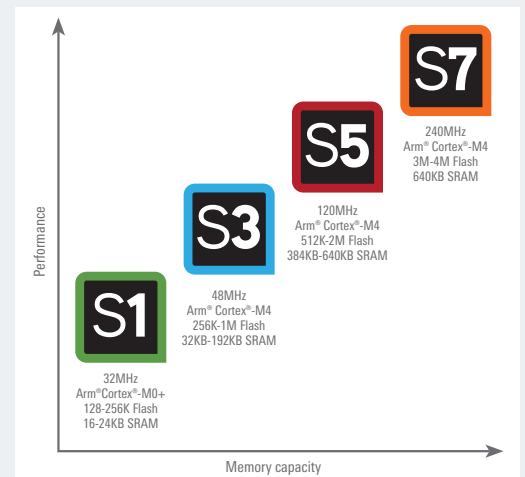
### General Structure of Renesas Synergy™ Platform

Renesas Synergy™ Platform is composed of a solution gallery, software, and hardware. The solution gallery features software, tools, kits, application projects, and services from Renesas and partner vendors that are compatible with Renesas Synergy™ Platform. At the core of the platform is the Synergy Software Package (SSP) and development environment (tools). Both are available at no additional charge to purchasers of Renesas Synergy™ microcontrollers.



### Scalable and Compatible Microcontrollers

Renesas Synergy™ Family microcontrollers are based on Arm® Cortex®-M CPU cores and designed for scalability and the ability to reuse code between series. They offer connectivity functions and human-machine interface features facilitating easy implementation, alongside robust security and safety functions as well as numerous peripheral functions suitable for a variety of embedded systems.



## Features of SSP: Application Frameworks and VSAs (Verified Software Add-ons)

### Application Frameworks

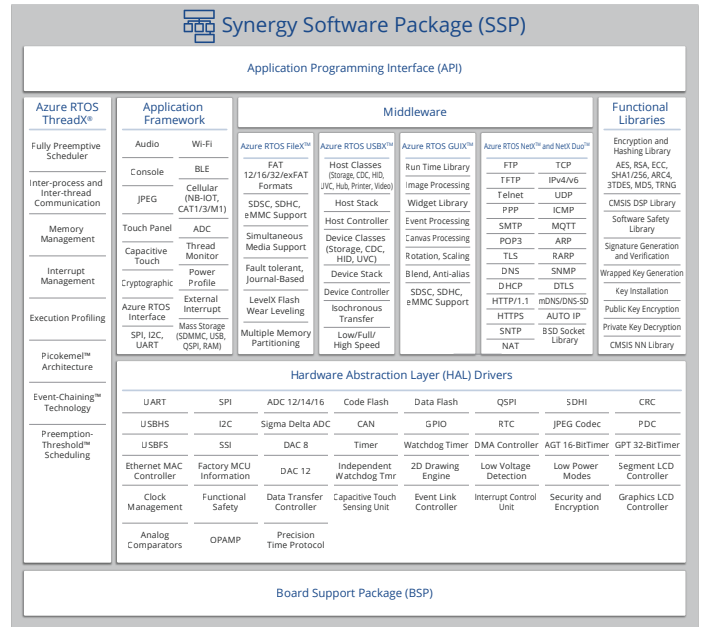
SSP has a rich set of Application Frameworks that provide a set of uniform Application Program Interfaces (APIs) that are useful for the development of target system. These APIs will free developers from worrying about the low-level software such as drivers, middleware or network stacks.

**Messaging framework:** High-level APIs for inter-thread communication and synchronization that give superior usability than traditional message queuing supported by real-time OS.

**GUIX™ interface framework:** APIs to leverage the performance advantage of Synergy Microcontroller graphic accelerators while using the GUIX runtime library.

**Wi-Fi framework:** APIs to easily integrate Wi-Fi connectivity solutions from various module and chipset providers into the user application.

**Capacitive touch sensing framework:** APIs to easily access the Capacitive touch sensing unit (CTSU). Also available is a Capacitive Touch Workbench for Renesas Synergy™ software tool to tune sensitivity of the touch sensors.



### VSAs (Verified Software Add-Ons)

Developers who adopt SSP for building automation applications can also utilize verified software add-ons (VSAs) from third-party partners to implement a variety of functions. VSAs are pre-tested by Renesas to be compatible with SSP.

**BACnet Stack:** BACnet stack compliant to CiA specifications. Available from CS Lab.

**Skynet ETK:** Stack to connect device and cloud. Available from Skynet.

**DALI 2.0 lighting control:** Stack compatible with the Digital Addressable Lighting Interface 2 (DALI-2) standard. Supplied by CS Lab.

**Medium One Cloud Agent:** Easily connect to cloud and access services. Available from Medium One.

\* VSA: Verified Software Add-ons

### Product Example (PE), Application Example (AE)

Synergy Solutions are examples of actual products that adopt the platform (PE) or demonstrate a group of technologies that are implemented with the platform (AE). Following are solutions useful for BA.

#### PE-HMI1

- Connected Human Machine Interface
- Based on S7G2 Group MCU
- WVGA LCD display
- Wi-Fi, Bluetooth®(BT), & wired connectivity



#### AE-CLOUD2

- Hardware kit for evaluating cloud connectivity
- Support for two cloud solutions (Synergy Enterprise Cloud Toolbox (SECT) and Renesas IoT Sandbox), enabling quick implementation of cloud connectivity
- Based on S5D9 Group MCU
- Many analog input functions suitable for a variety of sensor input types



#### AE-CAP1

- Capacitive Touch Evaluation and Tuning
- Based on S124 or S3A7 Group MCU
- Buttons, sliders, wheels



Other Available Synergy Kits: SK-S7G2, PK-S5D9, TB-S5D5, TB-S3A1, TB-S3A6, TB-S3A3, DK-S7G2, DK-S3A7, DK-S128, DK-S124

The Synergy Platform provides technologies that support the applications demanded by the building automation segment. It makes it possible to quickly deliver optimized solutions to meet constantly changing technology needs such as performance, power efficiency, and design flexibility.

## Synergy Platform Technology Matrix for the Building Automation Market

Building Automation Subsegment	Motor Control Solutions	User Interface Solutions	Connectivity Solutions	Sensing Solutions	Synergy MCU Series*			
					S1	S3	S5	S7
HVAC systems	<ul style="list-style-type: none"> <li>&lt; PWM timer</li> <li>&lt; HAL direct access to timer functions [SSP]</li> <li>&lt; Safety functions</li> <li>&lt; A/D converter, D/A converter, comparator</li> </ul>	<ul style="list-style-type: none"> <li>&lt; Graphic LCD controller</li> <li>&lt; Capacitive touch sensing unit</li> <li>&lt; Capacitive touch solution</li> </ul>	<ul style="list-style-type: none"> <li>&lt; Wired connection interface</li> <li>&lt; Wi-Fi framework</li> <li>&lt; BACNet stack VSA</li> <li>&lt; Renesas RL78/G1D BLE chipset</li> </ul>	<ul style="list-style-type: none"> <li>&lt; Temperature sensor</li> <li>&lt; Analog data collection framework</li> <li>&lt; A/D converter, D/A converter, PGA, comparator</li> <li>&lt; Digital sensor interface</li> </ul>	●	●	●	●
Fire and safety systems		<ul style="list-style-type: none"> <li>&lt; Graphic LCD controller</li> <li>&lt; Segment LCD controller</li> <li>&lt; Graphic LCD interface</li> <li>&lt; Capacitive touch sensing unit</li> <li>&lt; Capacitive touch solution</li> </ul>	<ul style="list-style-type: none"> <li>&lt; Wired connection interface</li> <li>&lt; Wi-Fi framework</li> <li>&lt; BACNet stack VSA</li> <li>&lt; Renesas RL78/G1D BLE chipset</li> </ul>	<ul style="list-style-type: none"> <li>&lt; Temperature sensor</li> <li>&lt; Analog data collection framework</li> <li>&lt; A/D converter, D/A converter, PGA, comparator</li> <li>&lt; Digital sensor interface</li> </ul>	●	●	●	●
Building security systems		<ul style="list-style-type: none"> <li>&lt; Graphic LCD controller</li> <li>&lt; Segment LCD controller</li> <li>&lt; Capacitive touch sensing unit</li> <li>&lt; Capacitive touch solution</li> </ul>	<ul style="list-style-type: none"> <li>&lt; Wi-Fi framework</li> <li>&lt; BACNet stack VSA</li> <li>&lt; Renesas RL78/G1D BLE chipset</li> </ul>	<ul style="list-style-type: none"> <li>&lt; Temperature sensor</li> <li>&lt; Analog data collection framework</li> <li>&lt; A/D converter, D/A converter, PGA, comparator</li> <li>&lt; Digital sensor interface</li> </ul>	●	●	●	●
Lighting systems		<ul style="list-style-type: none"> <li>&lt; General-purpose I/O ports</li> <li>&lt; Capacitive touch sensing unit</li> <li>&lt; Capacitive touch solution</li> </ul>	<ul style="list-style-type: none"> <li>&lt; General-purpose I/O ports</li> <li>&lt; Serial interfaces (SPI, QSPI, I2C, UART)</li> <li>&lt; DALI communication interface</li> <li>&lt; DALI 2.0 lighting control VSA</li> </ul>	<ul style="list-style-type: none"> <li>&lt; Temperature sensor</li> <li>&lt; Analog data collection framework</li> <li>&lt; A/D converter, D/A converter, PGA, comparator</li> <li>&lt; Digital sensor interface</li> </ul>	●	●	●	●

\* Refer to the block diagrams below for the recommended Synergy MCU Series for each subsegment.

### 1. User Interface Solutions

- Graphic LCD, segment LCD control [MCU]
- GUIX™ runtime library [SSP]
- PE-HMI1 [PE]
- Capacitive touch sensing unit [MCU]
- Capacitive touch sensing framework [SSP]
- Touch sensing workbench [SSP]

### 2. Connectivity Solutions

- Wired connection: Single/dual Ethernet
- USB, serial interfaces (SPI, QSPI, I2C, UART), SDIO
- Wireless connection: Wi-Fi framework [SSP] for connection to various Wi-Fi devices and chipsets
- BACnet protocol [VSA]
- DALI 2.0 lighting control [VSA]
- TLS/MQTT[SSP]

### 3. Sensing Solutions

- Interfaces for data collection from analog sensors or digital sensors [MCU]
- Op-amp, PGA, A/D converter, D/A converter, comparator [MCU]
- Low-power operating mode for intermittent operation

### 4. Motor Control Solutions

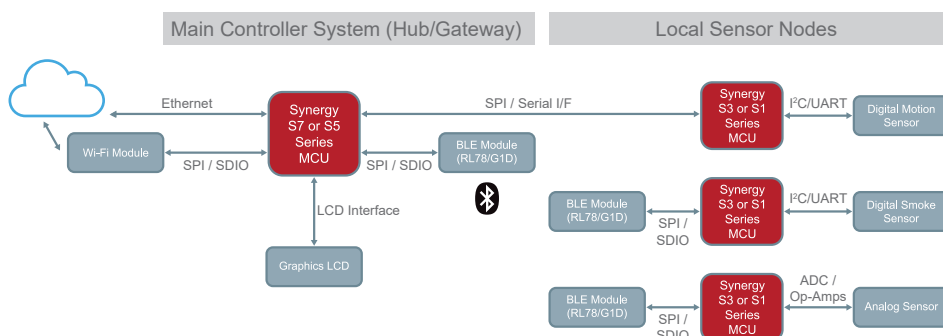
- High-precision timer, PGA, A/D converter, and D/A converter for motor control [MCU]
- Direct access to MCU control registers for real-time control

### 5. Embedded Security (Common Technology Across Subsegments)

- Encryption, security key generation and storage [MCU]
- Security function library [SSP/MCU]

## Building Security System Solution Block Diagram

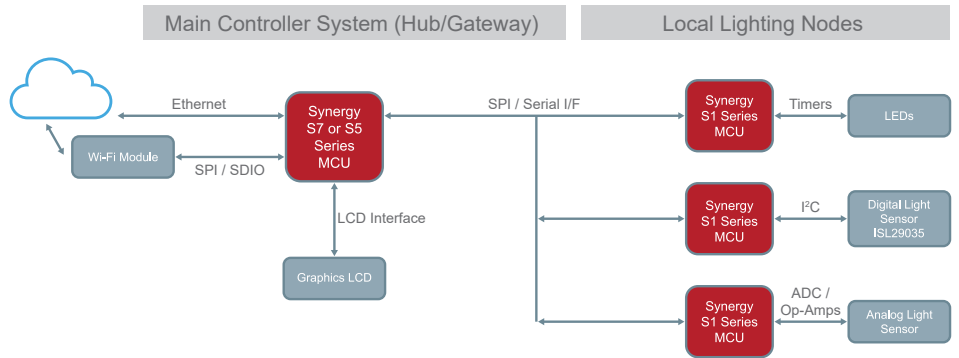
- Synergy S7 or S5 MCU Series acts as the primary controller for the hub (main controller).
- Synergy S3 or S1 MCU Series acts as the controller for the nodes.
- Connectivity to the cloud via Ethernet or Wi-Fi.
- BLE connectivity between nodes and the hub.





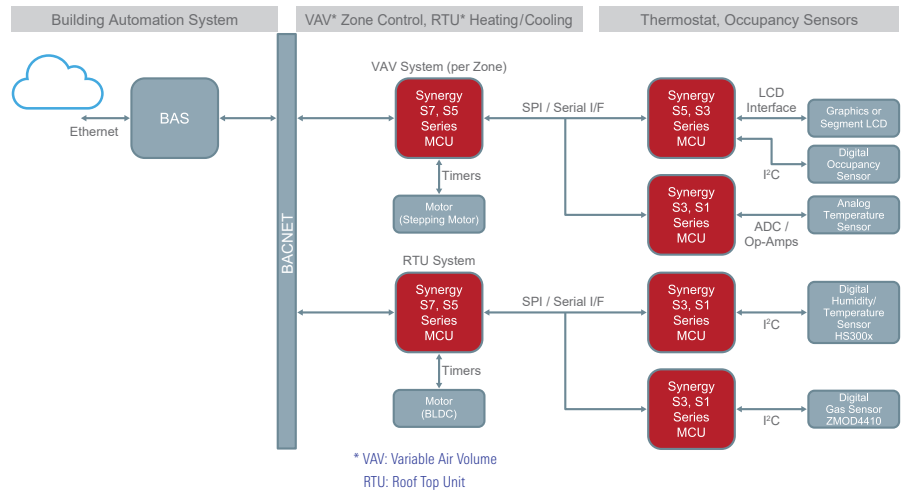
## Lighting System Solution Block Diagram

- Synergy S7 or S5 MCU Series acts as the primary controller for the hub (main controller).
- Synergy S3 or S1 MCU Series acts as the controller for the nodes.
- Connectivity to the cloud via Ethernet or Wi-Fi.



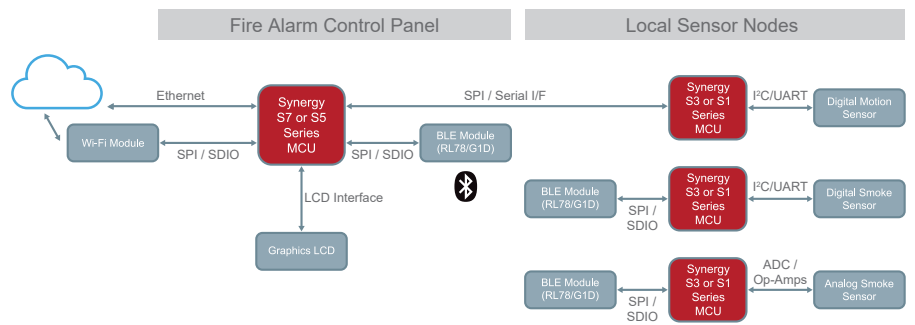
## HVAC System Solution Block Diagram

- Synergy S7 or S5 MCU Series acts as primary controller for Zone Control.
- Synergy S5 or S3 MCU Series for the Thermostat.
- Synergy S1 MCU Series acts as the controller for the nodes.
- Connectivity to the supervisory BAS system using BACnet.



## Fire and Safety System Solution Block Diagram

- Synergy S7 or S5 MCU Series acts as the primary controller for the control panel.
- Synergy S3 or S1 MCU Series acts as the controller for the local sensing nodes.
- Connectivity to the cloud via Ethernet or Wi-Fi.
- BLE connectivity between nodes and the hub.



# RECOMMENDED DEVICES FOR BUILDING AUTOMATION

## RL78

The RL78 family is the new generation of power-efficient microcontrollers from Renesas. It enables customers to build compact and energy-efficient systems at lower cost.

### Comprehensive Development Tools

- Improve development efficiency with code generation tool/integrated development environment
- Support for powerful tools from Renesas partners
- Open source (compiler/IDE) environment are available
- Immediately realize Rapid Prototyping in Arduino compatible environment

### Low Power Consumption

- 41  $\mu$ A/MHz operation (Power supply current value during basic RL78/G23 operation)
- 0.355  $\mu$ A (RTC + LVD)
- SNOOZE mode

### Broad Scalability

- 10 to 144 pins/1 to 768 KB Extensive product lineup to meet a broad range of requirements
- Pin compatibility
- Ability to reassign peripheral function pins

### Reliable Safety Functions

- Memory with ECC
- Compliant with Safety Standard for Household Appliances (IEC 60730)
- Support for high operating temperatures (up to 150°C)
- Abnormal operation detection/avoidance function
- True Random Number Generator (TRNG)

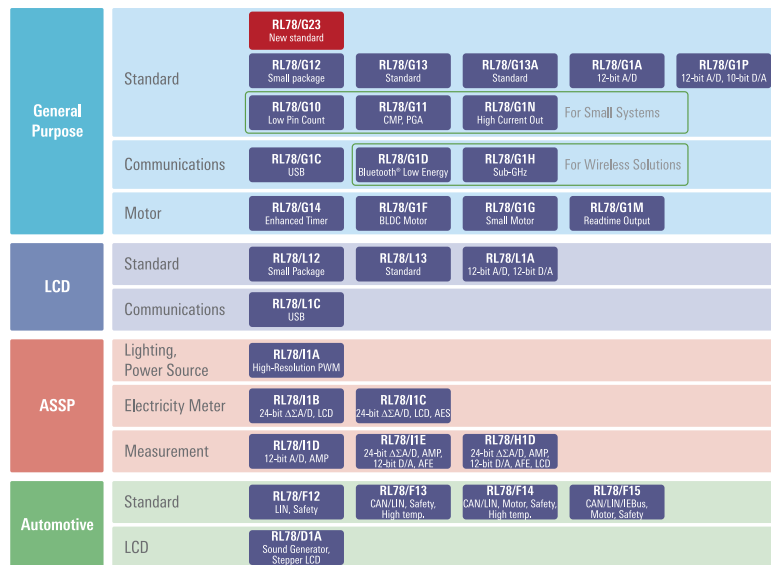
### Reduced System Cost

- 32 MHz  $\pm$ 1% high-precision on-chip oscillator
- On-chip power-on reset, low-voltage detection circuit, temperature sensor, data flash memory, etc.
- Built-in logic function (ELCL), AMP, DAC, comparator (some products)

### High Performance

- High processing performance of 1.6 DMIPS/MHz
- Support for power supply voltages from 1.6 to 5.5 V
- Max. 32 MHz operation

## RL78 Family Portfolio



## RL78/I1x Series

This series of microcontrollers provides functionality ideal for use in products for building systems and industrial applications. It is particularly well suited for applications involving sensing, energy control, measurement, and detection.

### Main Features

#### Feature 1: Powerful analog functions

Integrated  $\Delta\Sigma$  ADC, CMP, PGA, etc., for reduced total cost

#### Feature 2: Reduced power consumption

The most advanced low-power functionality in the RL78 Family

#### Feature 3: High-temperature tolerance

Operation at up to 125°C

	10bit SAR ADC	12bit SAR ADC	24bit $\Delta\Sigma$ ADC	DAC	Comparator	Temperature Sensor	Op-Amp (PGA)
RL78/I1A	•			•	•	•	•
RL78/I1B	•		•		•	•	•
RL78/I1C	•		•			•	•
RL78/I1D		•			•	•	
RL78/I1E	•		•	•		•	•

Note: Functions differ depending on the product.

## ASSP for LED Lighting Power Supplies

### RL78/I1A

#### Features

##### Basic peripheral functions for lighting power supplies

- Timers for LED control and PFC control
- Analog feedback functions (PGA, comparator)
- Operation temperatures up to 105°C or 125°C

##### Robust connectivity functions

- Communication functions (DALI, PMBus, SMBus, DMX512, UART, I2C, CSI)

##### Peripheral functions specifically for intelligent and highly efficient operation

- Dithering function (0.98ns pseudo-resolution), soft start function, maximum frequency limit function, interleaved PFC, communication standby

#### Main Applications

- LED lighting
- Digital power supplies
- Illumination fixtures
- Laser printers
- Microwave ovens
- Vacuum cleaners
- Communication devices



## ASSP for Power Meters

### RL78/I1B, I1C

#### Features

##### $\Delta\Sigma$ ADC with enhanced functionality for power meters

- Implementation in hardware of functionality essential for measurement

##### Low power consumption

- Low power consumption during both metering operation and backup operation

##### High-speed on-chip oscillator with $\pm 0.05\%$ accuracy

- Implementation in a single-crystal system of precision needed for metering operation

##### Enhanced security functions and antithetic operation performance

- Industry's first hardware implementation of AES GCM mode for DLMS standard (I1C, I1C (512KB))

#### Main Applications

- Smart meters
- Eco-friendly meters



## ASSP for Sensors and Detectors

### RL78/I1D

#### Features

##### Low power consumption for extended operation on battery power

- Fast recovery from STOP mode in 3.4 $\mu$ s, and low 124 $\mu$ A operating current at 1MHz
- Support for peripheral circuit operation bypassing the CPU (sensor activation, amplification, acquisition of A/D conversion results), determination of whether or not the CPU needs to be activated based on A/D conversion results

##### On-chip integration of analog functions needed by sensors and detectors

- General-purpose op-amp, 12-bit A/D converter, comparator

#### Main Applications

- Sensors, detectors
- Other crime prevention devices
- Battery-powered devices
- Sensor applications



## ASSP for High-Precision Sensing

### RL78/I1E

#### Features

##### Analog functions for high-precision sensors

- 24-bit  $\Delta\Sigma$  A/D converter  $\times$  4 channels
- 10-bit SAR-A/D converter  $\times$  10 channels
- configurable amplifier  $\times$  3 channel
- 12-bit D/A converter  $\times$  1 channel
- Sensor power supply  $\times$  1 channel

##### Compact package, contributing to more compact sensor products

- 4mm-square: 36-pin FBGA
- 5mm-square: 32-pin VQFN

##### High-temperature tolerance

- -40 to 125°C

#### Main Applications

- Measuring devices
- Sensor applications
- Vacuum cleaners
- Communication devices



## PLC Modem IC

PLC is a technology that uses existing power lines as the communication medium. Using the power grid as a communication network makes it possible to build out systems cheaply and quickly. Either AC power lines or DC power lines can be employed as the communication medium.


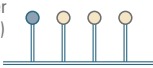
Renesas offers narrowband PLC modem IC products with integrated CPUs that implement high-performance DSP and support a variety of power line communication protocols. They employ orthogonal frequency-division multiplexing (OFDM) to deliver highly reliable, robust communication. Renesas PLC modem ICs support high data transfer speeds up to 1Mbps over long distances of a kilometer or more.

## Product Selection Guide

Renesas offers two PLC modem IC products. Select the one that best matches your application and the scale of your network.

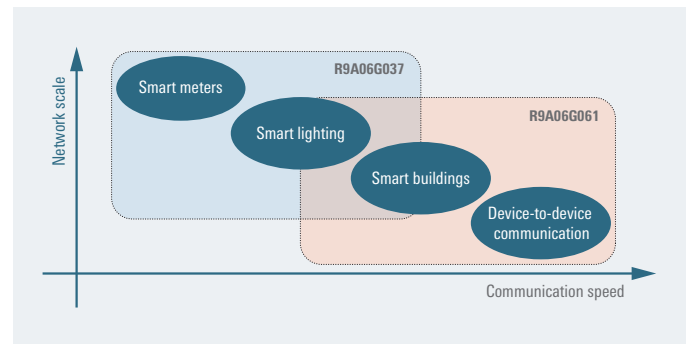
Product	Features
R9A06G037	This PLC modem IC complies with international power line communication standards (G3-PLC, PRIME, and Meters and More). Suitable for large-scale mesh networks with multi-hop support.
R9A06G061	This compact and powerful PLC modem IC is designed specifically for peer-to-peer (P2P) networks. It delivers high communication speeds up to 1Mbps.

### Comparison of Product Features

	R9A06G037	R9A06G061
Speed	Max. 280kbps	Max. 1Mbps
Communication distance	1km or more	1km or more
Network type	Multi-hop (mesh or tree) 	Peer-to-peer (star or bus) 

### Product Application Fields

The R9A06G037 is intended for large-scale networks, while the R9A06G061 is suitable for networks requiring high-speed communication and networks with a simple topology.



### Recommended Renesas Devices

Block	Product Category	Recommended Product
Control MCU	MCU	RX Family
Communication module	PLC modem IC	R9A06G037 R9A06G061
	Line driver	ISL15102
	AC/DC regulator	RAA223011
	DC/DC regulator	ISL85412
	Photocoupler	RV1S2211A

## RZ

All sorts of products that impact people's lives in areas such as household appliances, industrial equipment, building management, power networks, and transport are gaining intelligent functions, and the cloud-connected "smart society" is fast becoming a reality. In addition to high-performance and low-power control, today's microcontrollers are now expected to have sophisticated capabilities that would be difficult to implement with earlier microcontrollers, such as the ability to interoperate with IT networks and support human-machine interface functions. Embedded processors are making possible a new age we call "the Zenith of Renesas micro." The RZ Family delivers features not available elsewhere and brings new value to customer's applications.

### RZ/V Series



64-bit Cortex®-A CPU, up to 1GHz  
Low-power Embedded AI  
for Vision-AI Application

### RZ/V Series Application Fields

- IP camera
- Surveillance camera
- Entrance/exit gates
- Intercoms
- Video IP Phone
- POS terminal
- Barcode scanners

### RZ/G Series



32/64-bit Cortex®-A CPU, up to 1.5Hz  
3D Graphics  
for HMI Application

### RZ/G Series Application Fields

- Centralized building management (HVAC)
- Security panels, signage
- Entrance/exit gates
- Elevator monitoring
- Intercoms, VOIP, Videoconferencing

### RZ/A Series



32-bit Cortex®-A CPU, up to 528MHz  
10MB Embedded RAM  
for HMI Application

### RZ/A Series Application Fields

- White goods
- Barcode scanners
- Biometric authentication, face recognition
- Banknote detection
- Communication robots
- Intercoms
- Smart speakers



Intercoms

### RZ/T Series



32-bit Cortex®-R CPU, up to 600MHz  
Real-time Control  
Multi-protocol Encoder I/F  
for AC Servo, Actuator, Inverter

### RZ/T Series Application Fields

- Industrial motors
- Industrial controller
- Robots
- AC Servo drivers



Industrial motors

### RZ/N Series



32-bit Cortex®-A/M CPU, up to 500MHz  
Multi-protocol Industrial Network  
for PLC, Remote IO, Gateway



Entrance/exit gates



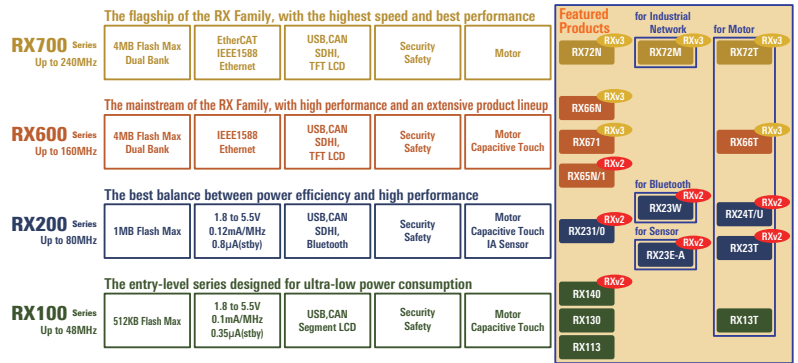
Surveillance cameras



## RX

The RX Family is built around an advanced CPU core exclusive to Renesas. This 32-bit CPU core benefits from all the exclusive technology amassed by Renesas over the years and adds enhancements to boost responsiveness and improve power efficiency. It achieves small code size typical of 16-bit CPUs while delivering top-class 32-bit arithmetic operation performance and low power consumption. Many technologies built by Renesas are integrated into the RX Family. It aims to be the ultimate family of 32-bit microcontrollers with on-chip flash for the industrial, home appliance, and OA/ICT fields.

### RX Family Features



### ASSP for Inverter Control

#### RX66T

##### Features

- RXv3 Core 160 MHz operation (5.8 CoreMark/MHz), single-precision FPU
- 2.7 to 5.5 V operation
- Operating Temperature -40 to 105 °C
- Program Flash up to 1 MB, SRAM up to 128 KB
- Enhanced Analog

- 12-bit A/D Converter  $\times$  3 units, 12-bit D/A Converter  $\times$  2 channels
- 6-channel Comparators
- 6-channel Pseudo-Differential PGA
- 160 MHz PWM
- 4 channels for 3-phase complementary switching, 2 channels for 5-phase complementary switching, 10 channels for single-phase complementary switching

- 4-channel high-resolution PWM enables minimum 195 ps timing adjustment
- Trusted Secure IP Lite (AES/TRNG)

##### Main Applications

- Industrial
- Office Automation
- Home appliances



### For Bluetooth & System Control

#### RX23W

##### Features

- RXv2 core 54MHz operation (4.33 CoreMark/MHz), single-precision FPU
- Operating voltage: 1.8V to 3.6V
- Operating temperature: -40°C to 85°C
- Program Flash up to 512KB, SRAM up to 64KB
- Communications
  - Bluetooth Low Energy (one channel)
    - Built-in Bluetooth 5.0-compliant RF transceiver and link layer
    - Supports LE 1M PHY, LE 2M PHY, LE Coded PHY (125kbps, 500kbps), LE Advertising Extensions

- Built-in Bluetooth dedicated AES-CCM (128-bit) encryption circuit
- USB 2.0 Host/Function/OTG (one channel)
  - Full speed (12Mbps), low speed (1.5Mbps), isochronous transfer
  - BC (battery charger) support
- CAN (one channel)
  - ISO11898-1 compliant CAN, up to 1Mbps transfer
- SD Host I/F (on channel)
  - SD memory/SDIO 1- or 4-bit SD bus support
- Capacitive Touch Sensing
  - Self-capacitive method: Up to 12 keys supported in a 1-terminal 1-key configuration

- Mutual capacitive method: Supports up to 36 keys in a 12-terminal matrix configuration
- Enhanced analog
  - Enhanced analog: 12-bit A/D converter (14 channels), 12-bit D/A converter (2 channels)
- Trusted Secure IP Lite (AES/TRNG)
- Module package size
  - 6.1  $\times$  9.5 mm, 0.5mm pitch (83-pin LGA)

##### Main Applications

- Bluetooth Low Energy Wireless
- Security



### For Touch Key

#### RX671

#### RX140

##### Features for RX671

- 120MHz RXv3 core (707 CoreMark, 48.8 CoreMark/mA), double-precision FPU, and register bank save function that speeds up interrupt response
- 2MB flash memory (60MHz read access, dual bank function), 384KB SRAM
- 48-pin to 176-pin package lineup including ultra-small 64-pin TFBGA (4.5mm  $\times$  4.5mm)
- Capacitive touch sensing unit and serial sound interface
- SD host interface, USB 2.0 full speed, CAN 2ch, and QSPI supporting XIP mode
- Encryption engine (AES, RSA, ECC, SHA, etc.), key management, access management circuit, flash memory protection

- 2.7V to 3.6V single supply operation
- Operating temperature: -40°C to 85°C or -40°C to 105°C

##### Features for RX140

- CPU RXv2 core (48MHz maximum operating frequency), single-precision FPU
- Low power consumption (56 $\mu$ A/MHz during CPU operation, 0.25 $\mu$ A in standby mode)
- Up to 256KB flash memory and 64KB SRAM
- 8KB data flash that can store data just like an EEPROM
- High-speed on-chip oscillator with +/- 1.0% accuracy
- 1.8V to 5.5V wide operating voltage range
- Updated Capacitive Touch Sensing Unit
- SCI (UART, Simple SPI, Simple I<sup>2</sup>C)
- SPI/I<sup>2</sup>C Multi-Master Interface
- CAN Interface

- 12-bit A/D converter, 8-bit D/A converter, temperature sensor
- 32-bit general-purpose PWM timer, 16-bit general-purpose PWM timer, low power asynchronous general-purpose timer
- Real-Time Clock
- Security (AES encryption, true random number generator)
- Enhanced Safety functionality
- Pin and peripheral compatibility with RX130
- Diverse package lineup from 32 to 80-pin, including QFP and QFN options

##### Main Applications











- Home appliances
- Industrial
- Building automation
- Home automation
- Consumer





## Target Applications and Markets

The Renesas RA family is targeted at a wide variety of application fields. Its superior scalability means that the RA family can meet the needs of a diverse range of applications and markets. The strengths of the Renesas RA family, including extended service life, long-term availability, and support for operating temperatures up to 105°C, make these MCUs highly suitable for industrial applications. The ability to combine specialized analog functions, such as A/D converters, programmable-gain amplifiers, and comparators, with highly functional high-performance timers make RA family MCUs ideal for the motor control field. Features such as peripheral functions supporting an array of connectivity options and hardware accelerated encryption make the RA family an excellent choice for not only the connectivity field but for the building automation field as well.

	Optimal Product Series	Usage Examples
<b>Industrial automation</b> 	Renesas RA2 Series, Renesas RA4 Series, Renesas RA6 Series	<ul style="list-style-type: none"> <li>Robotics</li> <li>Automatic door openers</li> <li>AC drives</li> <li>AC servos</li> <li>Uninterrupted power supplies</li> <li>Functional safety</li> </ul>
<b>Building automation</b> 	Renesas RA2 Series, Renesas RA4 Series, Renesas RA6 Series	<ul style="list-style-type: none"> <li>Emergency control panels</li> <li>HVAC (heating, ventilation, cooling)</li> <li>Boiler control</li> <li>Vending machines</li> <li>Motion sensors</li> <li>Monitoring systems</li> </ul>
<b>Measurement</b> 	Renesas RA4 Series, Renesas RA6 Series	<ul style="list-style-type: none"> <li>Power meters</li> <li>Automatic meter reading</li> <li>Network cards</li> <li>Flow meters</li> <li>Wattmeters</li> </ul>
<b>Consumer electronics</b> 	Renesas RA2 Series, Renesas RA4 Series	<ul style="list-style-type: none"> <li>HVAC (heating, ventilation, cooling)</li> <li>Air purifiers</li> <li>Coffeemakers</li> <li>Vacuum cleaners</li> <li>Robot vacuum cleaners</li> <li>Consumer electronics</li> </ul>
<b>Connectivity</b> 	Renesas RA4 Series, Renesas RA6 Series	<ul style="list-style-type: none"> <li>ASi5/I0-Link gateways</li> <li>Communication gateways</li> <li>Data concentrators</li> <li>Wired Ethernet</li> <li>Fleet tracking</li> </ul>
<b>Security</b> 	Renesas RA4 Series, Renesas RA6 Series	<ul style="list-style-type: none"> <li>Fire alarms</li> <li>Burglar alarms</li> <li>Panel control</li> <li>Automatic door openers</li> <li>Monitoring systems</li> <li>Access control</li> </ul>
<b>Motor control</b> 	Renesas RA6 Series	<ul style="list-style-type: none"> <li>Brushless DC motors</li> <li>Induction motors</li> <li>Stepping motors</li> <li>Magnetic encoders</li> <li>Optical encoders</li> <li>Hall sensors</li> </ul>
<b>Low power consumption</b> 	Renesas RA2 Series, Renesas RA4 Series	<ul style="list-style-type: none"> <li>I0-Link sensors</li> <li>Heat cost allocators</li> <li>Portable music players</li> <li>Smoke detectors</li> <li>IoT sensor nodes</li> <li>Wearable devices</li> </ul>
<b>HMI</b> 	Renesas RA2 Series, Renesas RA6 Series	<ul style="list-style-type: none"> <li>Speech recognition</li> <li>Capacitive touch panels</li> <li>Printers</li> <li>Vending machines</li> <li>Electrical appliances</li> <li>Medical equipment</li> </ul>
<b>Wireless</b> 	Renesas RA4 Series	<ul style="list-style-type: none"> <li>Wearable devices</li> <li>Healthcare</li> <li>Panel control</li> <li>Gateway units</li> <li>Automatic door openers</li> <li>Smart home devices</li> </ul>

## Overview of Partners

Renesas' network of partners changes constantly, so the overview presented here may be somewhat out of date. Please visit the Renesas website for the latest information.

<b>Security and Safety</b>	
<b>Connectivity and Cloud Collaboration</b>	
<b>Artificial Intelligence (AI)</b>	
<b>STREAM ANALYZE</b>	
<b>Human-Machine Interface (HMI)</b>	
<b>Sensing and Control</b>	
<b>Specific Applications/ New Applications</b>	
<b>Tools and User Experience</b>	

Visit the link below to learn more about RA MCUs.  
[RA Arm® Cortex®-M MCU | Renesas](#)

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