BUILDING AUTOMATION

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

2024.12

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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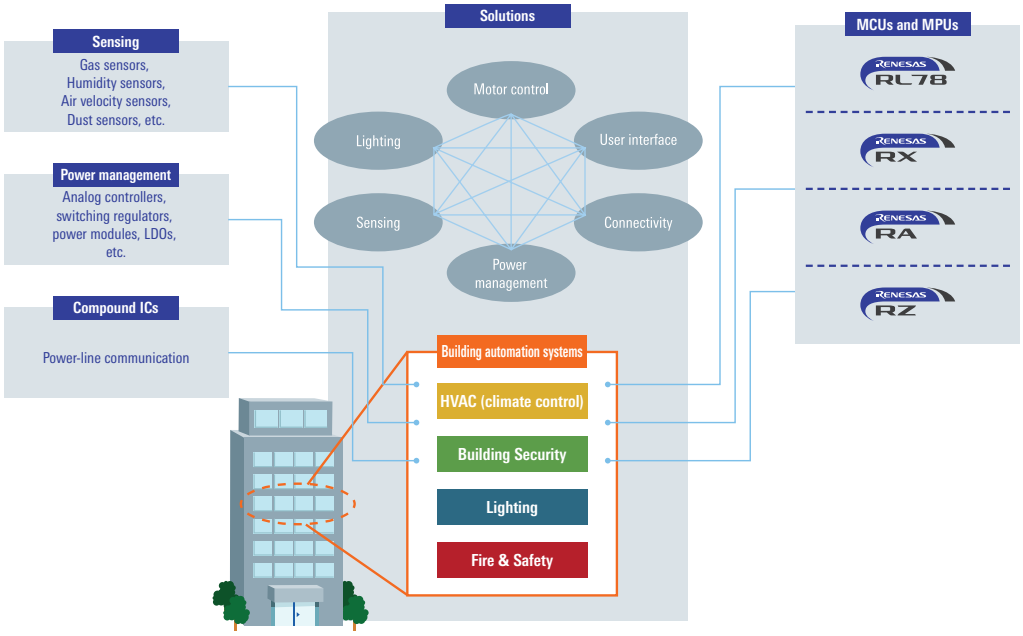
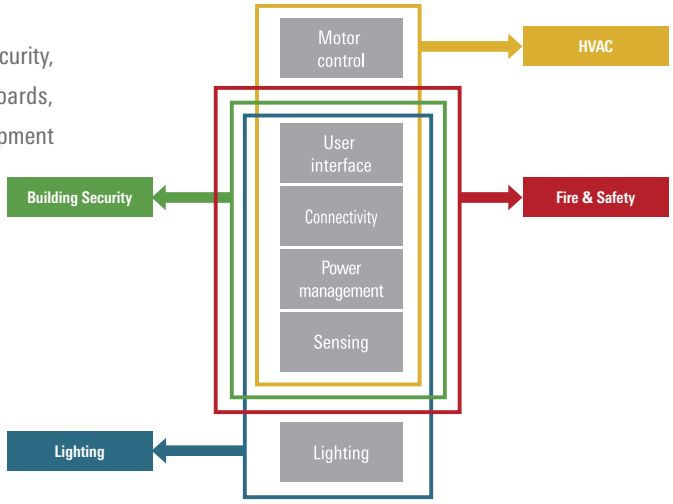


Building Automation Solution Devices

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.

* HVAC: Heating, Ventilation, and Air Conditioning



Web

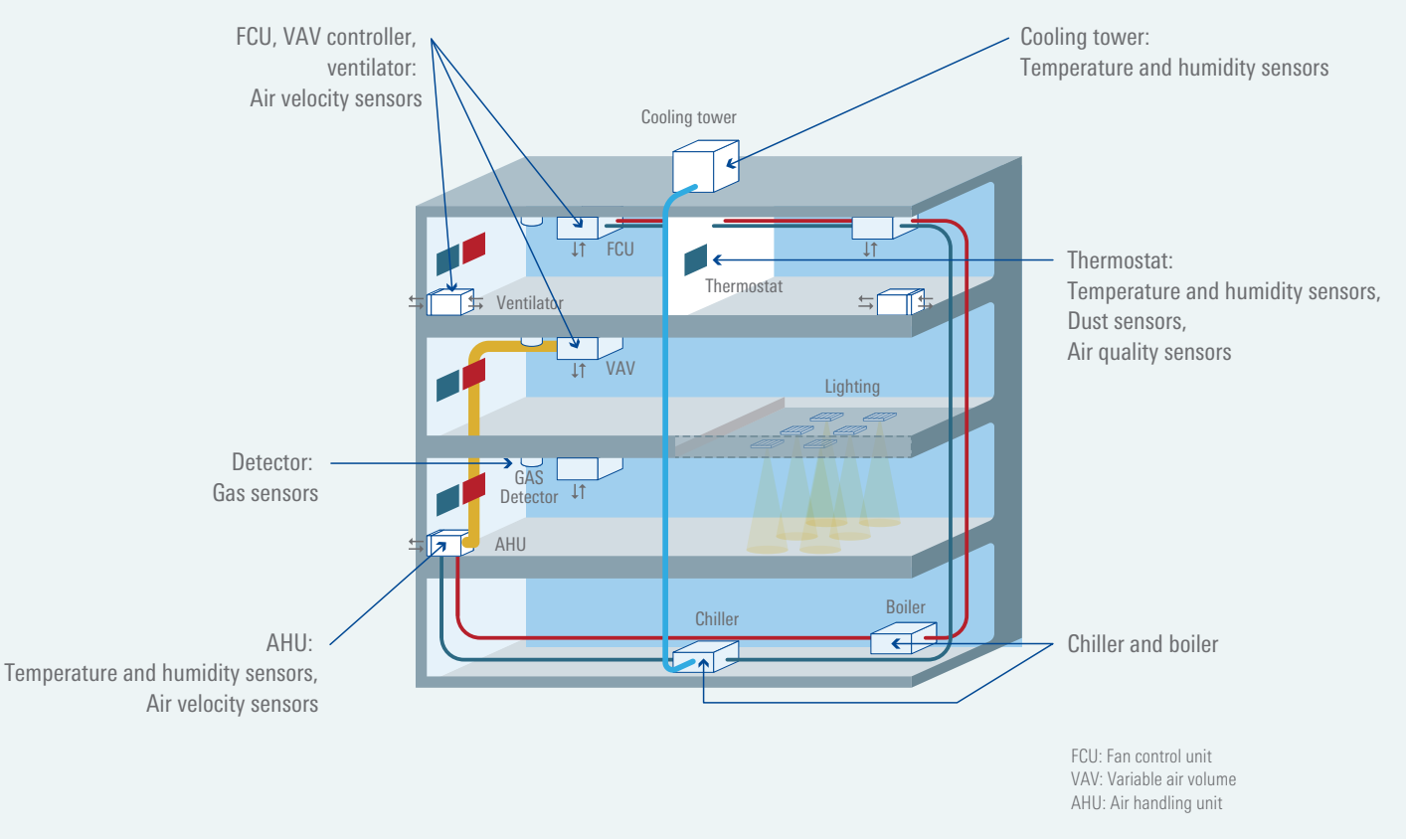
https://www.renesas.com/applications/industrial/building-automation

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	●	●	●	●
	RS-485 communication solutions	●	●	●	●
Power management	Analog controllers	●	●	●	●
	Switching regulators	●	●	●	●
	Power modules	●	●	●	●
	LDO	●	●	●	●
Sensing	Motion sensor solutions	●	●	●	●
	Smoke detector solutions		●		
Lighting	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.

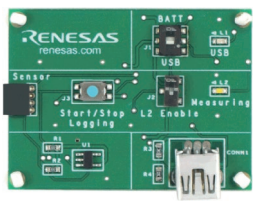
Temperature and Humidity Sensors

Representative Product

HS300x, HS310x, HS40xx, HS41xx

Features

- Wide measurement range (0% to 100% RH)
- High measurement accuracy (±1.5% RH, ±0.2°C)
- Compact package (3.0 × 2.4 × 0.8 mm)
- I²C interface for easy connections
- Available in a waterproof package with an IP67 rating



Evaluation Board Product Name

HS4000-EVK

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_2) calculation.)
- Extensible via firmware updates.
- Supports IAQ-grade detection conforming to German Environment Agency (UBA) standards.
- Detects emissions of ozone and NOx (ZMOD4510 only).
- Available in a waterproof package with an IP67 rating
- Firmware released to support air quality standards for buildings

Evaluation Board Product Name

ZMOD4410-EVK

Application Example

Air quality measurement in thermostats

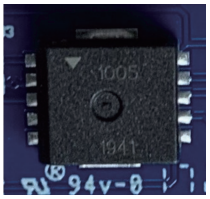
Air Velocity Sensors

Representative Products

FS3000

Features

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



Evaluation Board Product Names

FS3000-EVK

Application Example

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

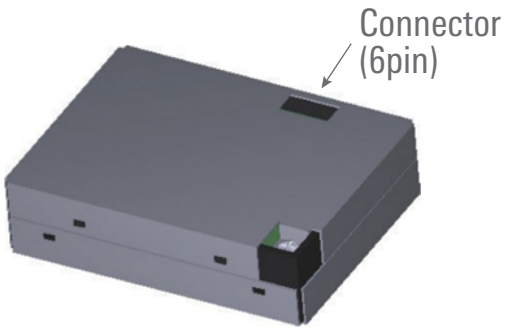
Integrated Sensor Module

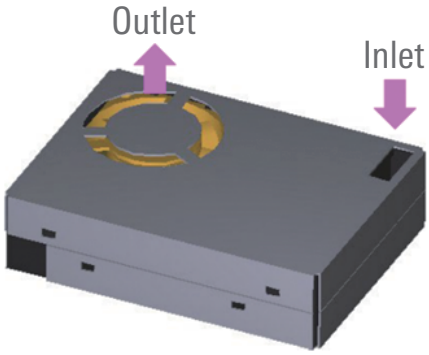
Representative Products

RRH62000

Multiple sensing in one module

- Dust sensors
  - Laser-based PM1, PM2.5, PM10 detection
- Temperature and humidity sensors
  - Accuracy: ±2.5%RH, ±0.25°C
  - High-speed response
- TVOC/indoor air quality sensor
  - German UBA compliant air quality level display
  - Estimated CO_2 (eCO_2) concentration display





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), RL78/G2x, RL78/G16, RX100, RX200, and RA2 (HMI)

For the latest information on using sensors in conjunction with MCUs, visit the Winning Combinations webpage (https://www.renesas.com/winning-combinations).

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.

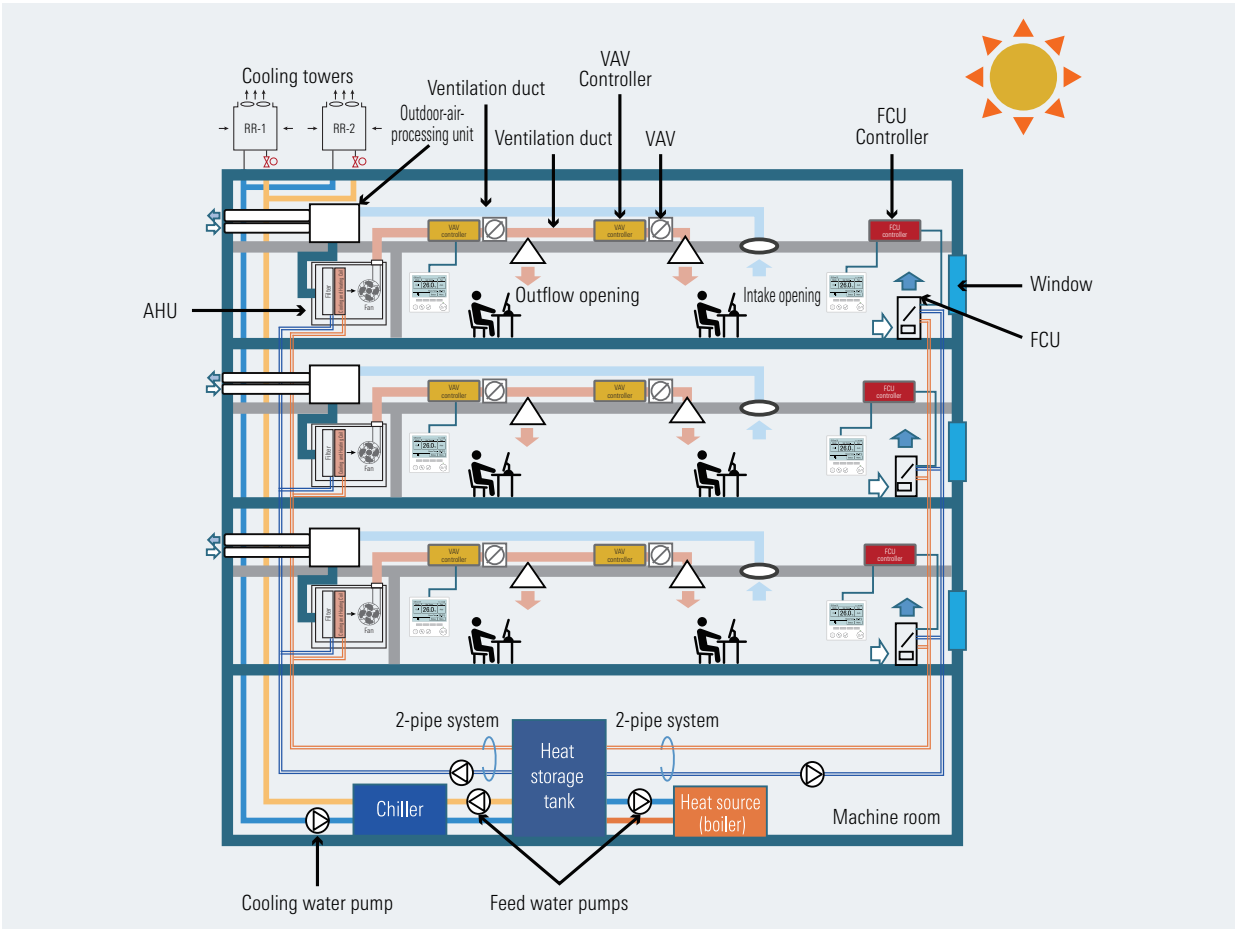
The heat source (boiler) is powered by gas, oil, or electricity. It heats water in a vessel to produce hot water or steam. To heat the rooms, this hot water or steam is circulated through the rooms, and heat exchange takes place.

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.

■ 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

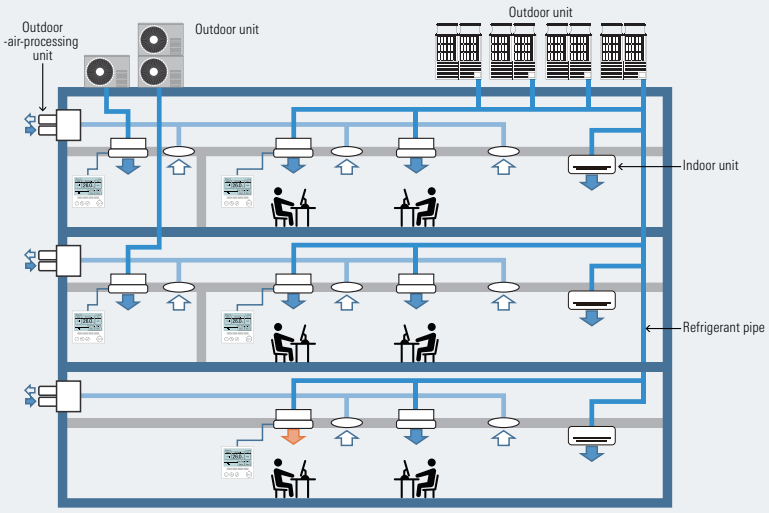
Regardless of the type of air conditioning system, generally speaking the various units are connected to a wired or wireless network to facilitate control and state management. In the context of building automation in particular, BACnet* is used to connect HVAC devices from different manufacturers and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

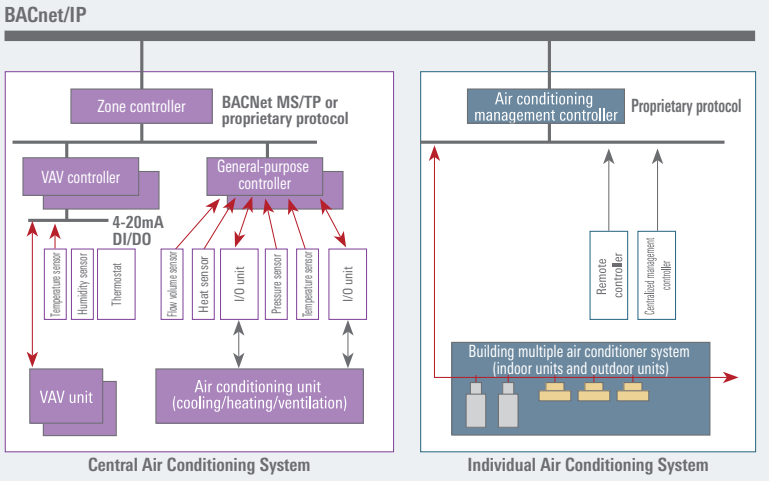
In the central air conditioning system, digital signals (DI and DO) and analog signals (4-20mA) are used for communication between sensors, VAV units, and general-purpose controllers. Due to the long distances involved and need for noise tolerance, Renesas offers communication solutions that employ power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

* 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.

■ Figure 2 Individual Air Conditioning System



■ Figure 3 Overview of Building Air Conditioning Communication Network



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.

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.

Automatic Fire Alarm Systems

An automatic fire alarm system comprises a receiver, smoke detectors, 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 addressable 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 smoke detectors 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.

Figure 1 Fire Detection and Notification

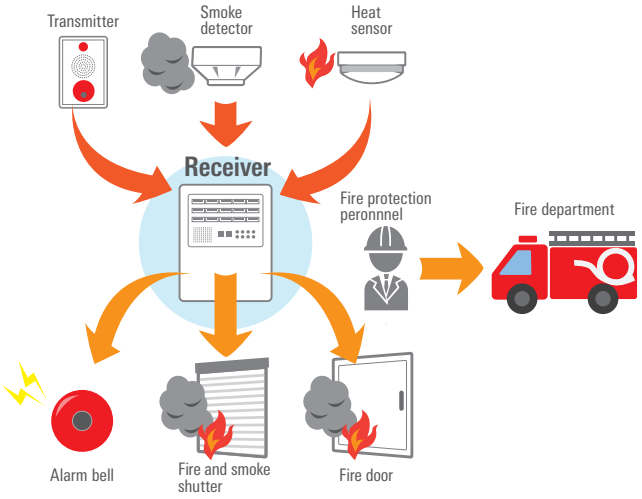


Figure 2 Example Type-R Receiver and Peripheral System

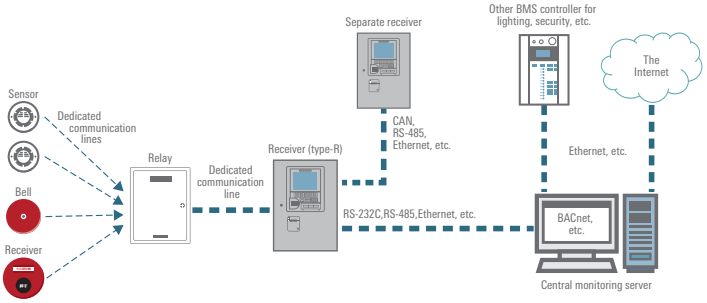
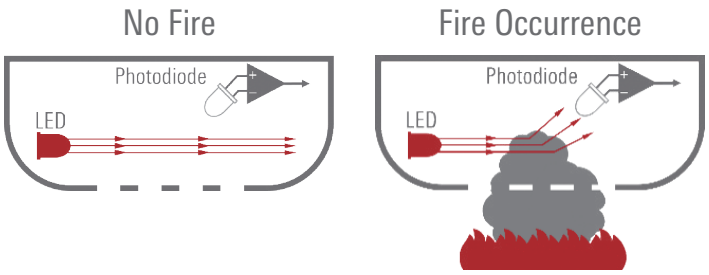


Figure 3 Photoelectric Spot Sensor



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, RL78/G13, RL78/G22, and RL78/G23: general-purpose MCUs with low power consumption

RL78/G1H and RL78/G1D: RF communication

R9A06G037 and R9A06G061: NB-PLC communication

Analog Products

Recommended devices

SGAS7xx Series gas sensors

RAA211605 or ISL85415 step-down regulator

ISL9123 ultra-Low Iq buck regulator

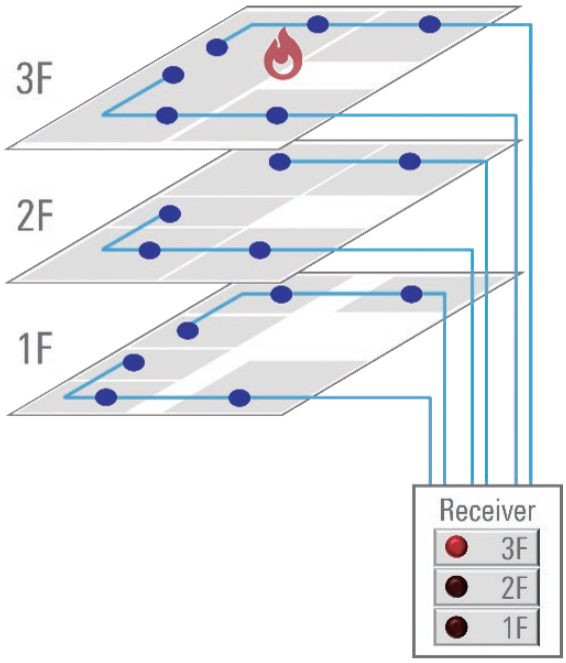
RAA23610x ultra-Low Iq buck-boost regulator

Smoke Detector & Standard

Smoke detectors are classified according to the location of use and the type of system. In particular, for commercial facilities, conventional smoke detectors are a cost-effective option.

Conventional systems connect multiple detectors to a single zone, allowing for quick identification of the zone in the event of a fire, making them effective for large commercial facilities. Additionally, installation and maintenance are relatively easy, enabling reliable fire protection while keeping initial investment costs low.

■ Figure 4 Conventional System



Smoke detector standards vary by country and region. The standards for major regions, including the United States, Europe, Japan, and China, are shown in Table 1.

■ Table 1 Regional Standards

Region	Residential	Commercial
The United States	UL217	UL268
Europe	EN 14604	EN 54-7
Japan	JIS C 7924-1	JIS C 7920, JIS C 7923
China	GB 20517	GB 4715

UL Standard Revision

UL standards for fire detectors are periodically revised to improve performance, and recent revisions have added new tests aimed at early fire detection and reducing false alarms. Specifically, two new tests were introduced in the 2020 revisions of UL217 and UL268:

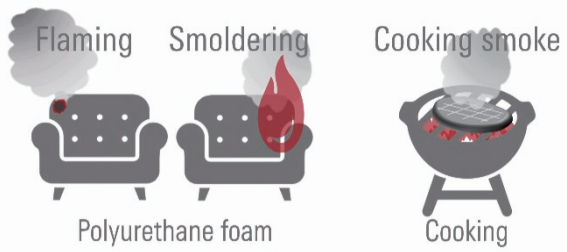
1. Polyurethane Foam Smoldering Test:

This test evaluates the detector's ability to detect smoke from smoldering polyurethane foam, a highly combustible material commonly used in modern homes. This test enables early detection of fires.

2. Hamburger Test:

This test was added to address the issue of smoke detectors triggering false alarms due to cooking smoke and steam. The test simulates actual cooking conditions and evaluates the detector's response to smoke, with a focus on reducing false alarms in kitchens.

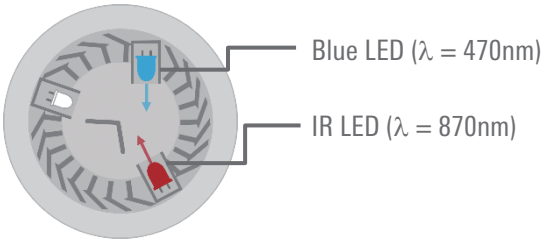
■ Figure 5 New Tests Added to UL Revisions



To address these tests, it is recommended to use multiple LEDs. Conventional smoke detectors used a single wavelength to detect smoke, but with the revised standards, multiple wavelengths are used to more accurately analyze smoke particles and distinguish between fire smoke and cooking smoke. This technology solves two major challenges: reducing false alarms and detecting fires early.

Figure 6 shows an example of using multiple LEDs.

■ Figure 6 Multi-LED Smoke Detector



Fire and Safety Systems

Renesas Solution

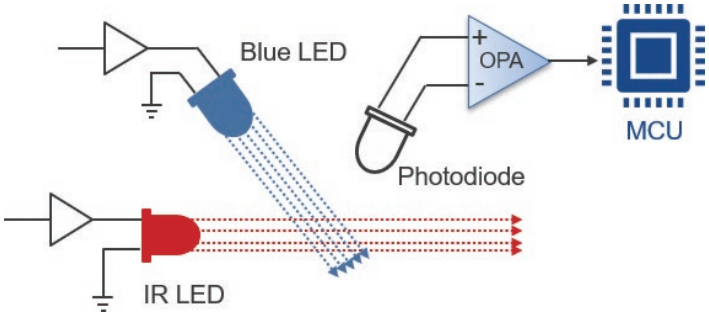
Currently, the market is demanding high-accuracy smoke detector solutions that meet the revised UL standards. In particular, high accuracy is required for early fire detection and false alarm prevention. Additionally, many commercial facilities using traditional systems prioritize ultra-low power consumption. Furthermore, simple configuration and BOM cost reduction are also important. The demand for solutions that meet these requirements is increasing across the market.

Renesas provides high-accuracy, ultra-low power consumption, and BOM cost-reducing smoke detectors.

High Accuracy

Utilizing the principle that different wavelengths of light have different scattering efficiencies for different sizes of smoke particles, we use blue LED and IR LED to detect smoke.

■ Figure 7 Configurated by Multi-LED

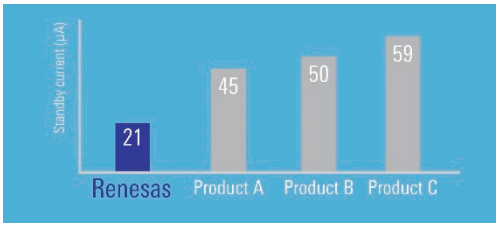


Low Power Consumption

In conventional systems, the lower the current of the sensor, the more sensors can be connected to a single detection zone, resulting in cost reduction for the entire system. By using the RL78 microcontroller, which achieves the industry's lowest power consumption, and further utilizing the SNOOZE mode sequencer, we provide an ultra-low power smoke detector solution.

Figure 8 shows a comparison of standby current with existing products in a smoke detector system.

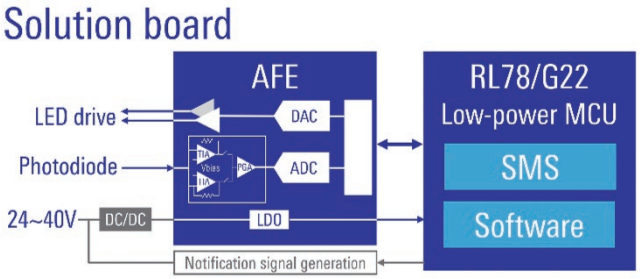
■ Figure 8 Standby Current Comparison



Reduce BOM Cost

The MCU and optical smoke detector AFE IC configuration can be simplified, minimizing external components and reducing PCB size.

■ Figure 9 Solution Configuration



Building Security Systems

In the context of building automation, a security systems is composed of two constituent elements. Figure 1 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 2). 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 2).

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 1 Building Security Systems

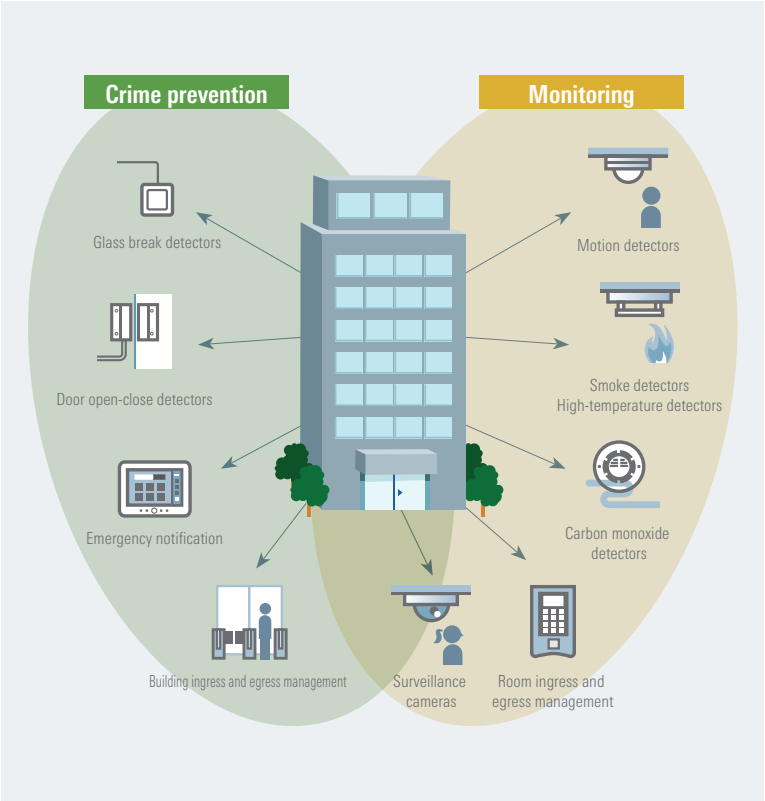
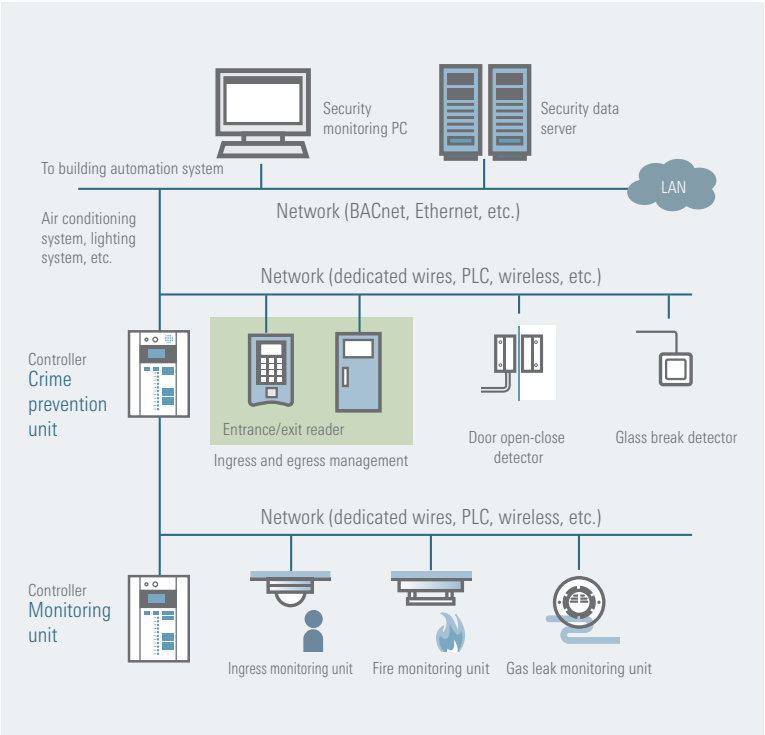


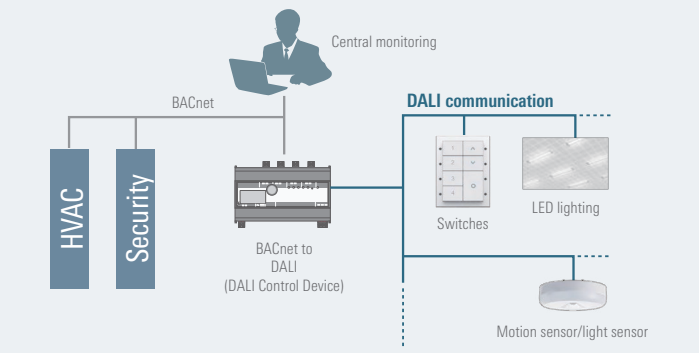
Figure 2 Building Security Network



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.

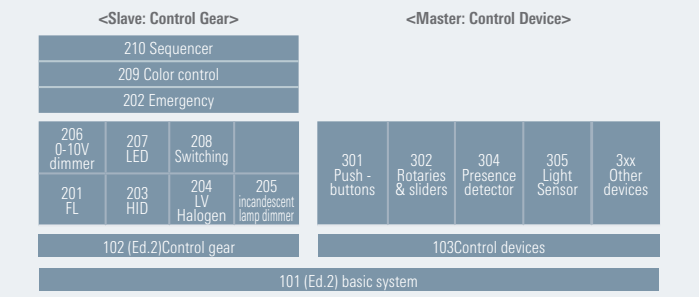
A variety of connected communication devices support the subsystems that run under BACnet. Among these communication standards, Digital Addressable Lighting Interface (DALI) is an open standard that supports lighting systems.

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 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.

Figure 2 DALI Standard Listing



Source: Digital Illumination Interface Alliance

Advancing to DALI-2

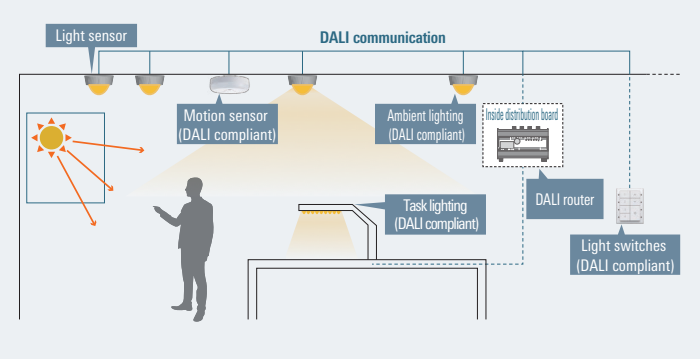
A new DALI standard, DALI-2, is currently coming into use. DALI-2 defines new applications, adds new functions, and improves compatibility to better meet the lighting requirements of customers. Also, a device must pass an official test to receive certification of compliance with the standard. Renesas 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 night 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.

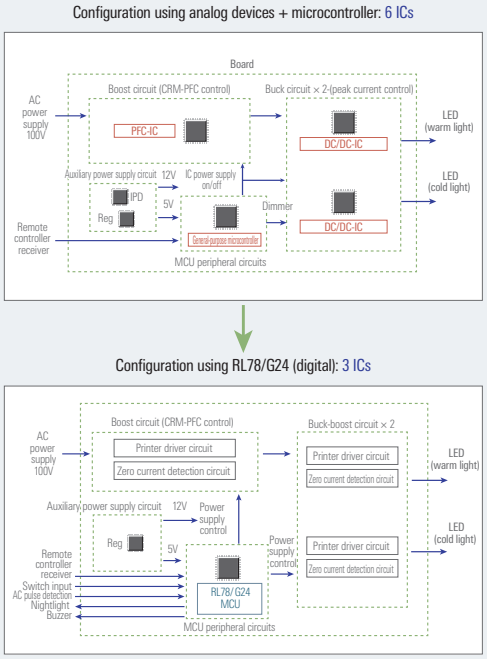
Digital Power Supplies for Lighting Fixtures

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, since the Renesas RL78/G24 is the microcontroller for digital power supplies with ultra-low power consumption, system costs can also be significantly reduced by incorporating IPD and other peripheral functions.

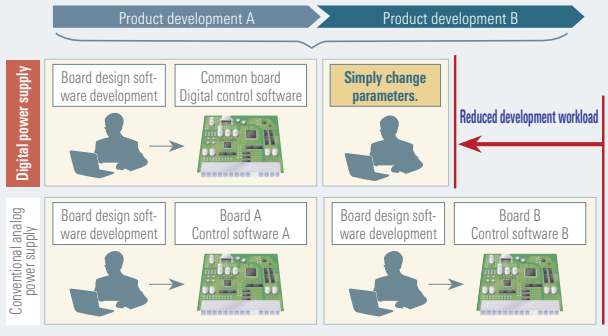
■ Figure 4 MCU for Digital Power Supplies (RL78/G24)



- 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.

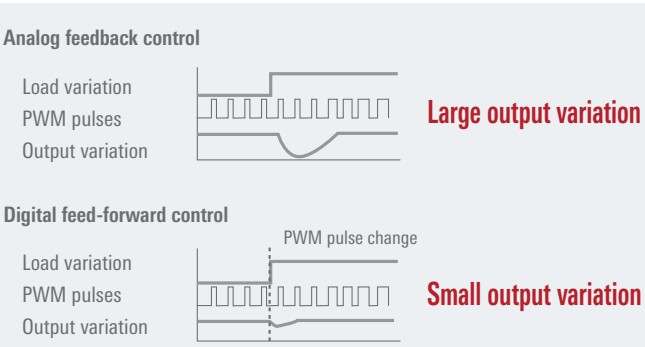
■ Figure 5 Reduction in Development Time with Digital Power Supply



- 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.

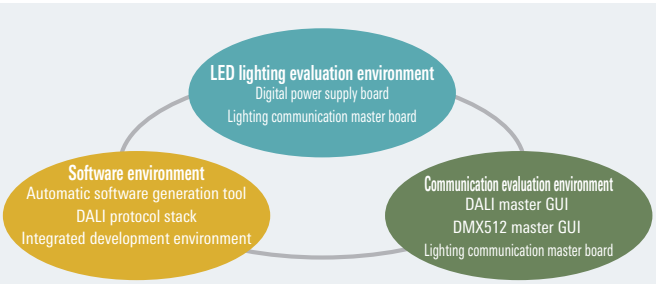
■ Figure 6 Example of Performance Boost by Digitizing the Power Supply



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 24. Also make sure to look into the following types of solutions, which can be applied to lighting applications as well.

- User interface solutions (page 15)
- Connectivity solutions (page 16)
- Sensing solutions (page 18)

Motor Control Solutions

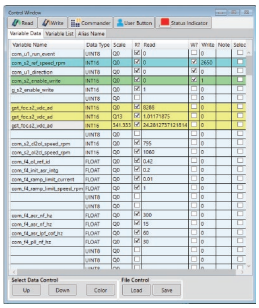
Overview

This solution enables brushless DC motors to be driven using a variety of control methods, and we provide a set of hardware, control software, and development support tools. Evaluation can be easily performed using sample software for standard motor control such as vector control and square wave control.

Motor Control Development Support Tool Renesas Motor Workbench available.

- Functions for measuring motor parameters required for vector control and calculating control parameters
- Extensive debugging functions suitable for motor control software development

Renesas Motor Workbench



Product Name	Hardware Configuration			INV-board Specification		Compatible CPU
	INV board	CPU board	Isolated Circuit for Debugging	Rated Voltage/Current (Input Voltage Range)	Current Detection	
Evaluation System for BLDC Motor (RTK0EMX270S00020BJ)	✓	–	Mounted on INV-board	48V/5Arms (24~48V)	3-shunt	RX13T/24T/24U/66T/72T RX72M with RDC-IC RA6T1
Motor Control Evaluation System for RA Family - RA6T1 Group (RTK0EMA170S00020BJ)	✓	✓	Mounted on INV-board	48V/5Arms (24~48V)	3-shunt	RX13T/24T/24U/66T/72T/ RX72M with RDC-IC RA6T1
MCI-LV-1 (RTK0EM0000S04020BJ)	✓	–	None*1	48V/10Arms (12~48V)	1-shunt 3-shunt	RX26T RA6T2/RA6T3/RA4T1/RA8T1
MCI-HV-1 (RTK0EM0000B14030BJ)	✓	–	None*1	AC240V/10Arms DC390V/10A (AC100~240V, DC141~390V)	1-shunt 3-shunt	RA6T2
MCK-RX26T (RTK0EMXE70S00020BJ) MCK-RA6T2 (RTK0EMA270S00020BJ) MCK-RA8T1 (RTK0EMA5K0S00020BJ)	✓	✓	Mounted on MC-COM Kit includes	48V/10Arms (12~48V)	1-shunt 3-shunt	RX26T RA6T2/RA6T3/RA4T1/RA8T1
MCK-RA6T3 (RTK0EMA330S00020BJ) MCK-RA4T1 (RTK0EMA430S00020BJ)	✓	✓	None*1	48V/10Arms (12~48V)	1-shunt 3-shunt	RX26T RA6T2/RA6T3/RA4T1/RA8T1
RL78/G24 Motor Control Evaluation Kit (RTK0EMG24SS00000BJ)	✓	–	Mounted on MC-COM Kit includes	48V/30A (12~50V)	1-shunt 3-shunt	RL78/G1F, RL78/G24

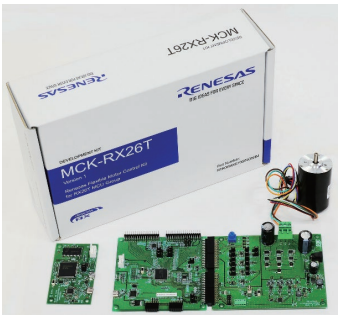
*1. Please use MC-COM sold separately or USB isolator in the market.

A development kit that allows users to evaluate BLDC motor control at ease. By using this kit, the sample code that is downloadable from the web, and QE for Motor, users can immediately start the evaluation of motor control using Renesas motor control microcontrollers.

MCK-RA4T1
(P/N: RTK0EMA430S00020BJ)

Please access below Renesas web and download kit related documents.
https://www.renesas.com/RTK0EMA430S00020BJ

MCK-RX26T
(P/N: RTK0EMXE70S00020BJ)



Please access below Renesas web and download kit related documents.
https://www.renesas.com/RTK0EMXE70S00020BJ

RL78/G24 Motor Control Evaluation Kit
(P/N: RTK0EMG24SS00000BJ)

Please access below Renesas web and download kit related documents.
https://www.renesas.com/RTK0EMG24SS00000BJ

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.

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 Sensing Unit can realize intuitive user interface and excellent design.

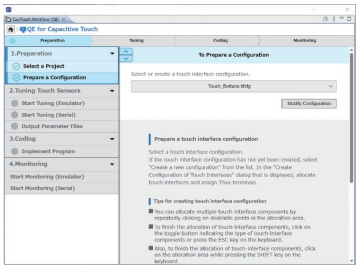
Configuration

- 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 button via GUI, shortening time to market.

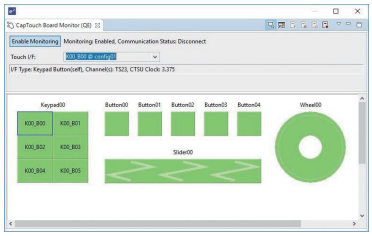
■ Capacitive Touch Evaluation System

Supported MCU:
RL78/G16, RL78/G22, RL78/G23, RA2L1, RA6M2, RX130, RX140, RX261, RX671

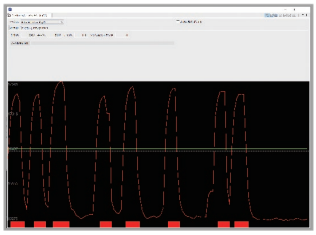
■ Capacitive Touch Development Tool QE for Capacitive Touch



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

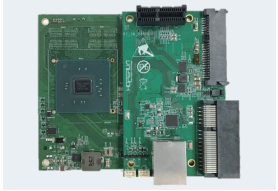
These human-machine interface solutions incorporate RZ/G2 microcontrollers and enable customers to create new value through sensing. Designed for use in system evaluation and development, they support multi-plane video processing, 3D graphics, and a variety of high-speed interfaces.

Configuration

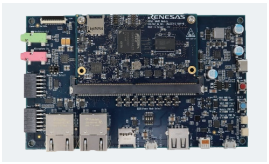
- The RZ/G2 evaluation boards each support a Verified Linux Package (VLP).
- The VLP utilizes an industrial grade Linux Civil Infrastructure Platform (CIP) providing 10 years or more of long-term support.
- The product package includes middleware that has been verified on the evaluation board. This enables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

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

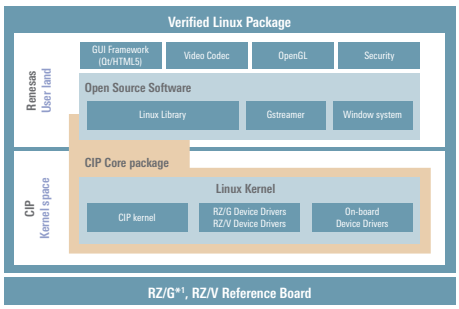
■ RZ/G2H,G2M,G2N Development Kit
(96Boards format compatible)



■ 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.

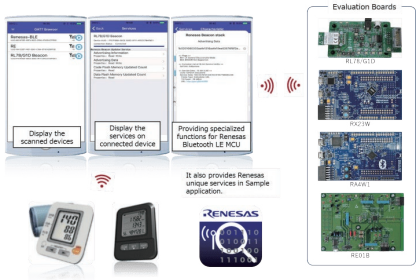
Bluetooth Low Energy Solution

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
  - – GATTBrowser — iOS/Android Application for operation confirmation



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

Sub-GHz 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 remote monitoring and control of various sensors and lighting devices for building automation using its large-scale mesh network.

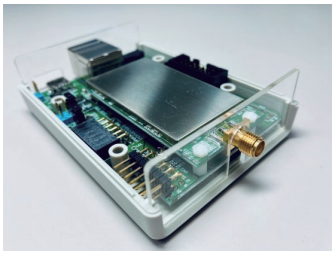
Evaluation Kit

- "RL78/G1H" evaluation board with FSK modulation as low-power solution.
- "RX65N + R9A06G062" evaluation board with FSK and OFDM modulation as high-speed communication solution.
- RF driver and FAN stack software packages available.

■ "RL78/G1H" evaluation board

Product No.: TK-RLG1H+SB2
manufactured by Tessera Technology Inc.

■ "RX65N + R9A06G062" evaluation board



Product No.: RTK0EE0013D10001BJ
(FCC certified)
RTK0EE0013D10002BJ
(CE certified)
RTK0EE0013D10003BJ
(Construction design certified in Japan)

For the latest information, please visit:
https://www.renesas.com/products/wireless-connectivity/sub-ghz-wi-sun-transceivers

RS-485 Communication Solution

Outline

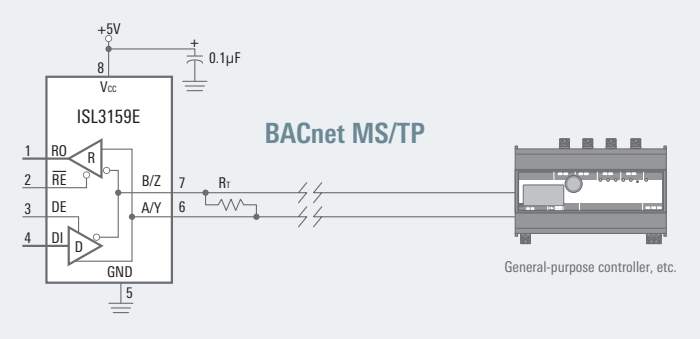
RS-485 uses differential signaling to enable long-distance data transfer, even under noisy conditions. It also aims to improve and extend the functionality of the earlier RS-422 standard. With RS-485 up to 31 devices can share a single data line. Any slave device on the RS-485 bus can communicate with 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)



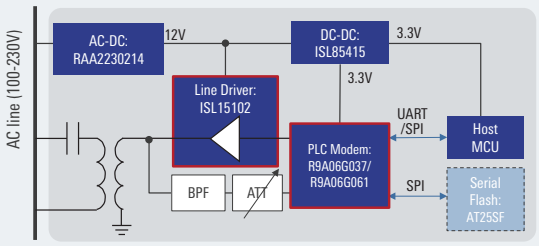
- Overvoltage protection (RS-485)
  ISL3245XE: ±60V overvoltage protection, among the best in the industry
- High output voltage/high noise tolerance (RS485)
  RAA78815X: Output voltage of 3.1V (typ.) and ±5kV EFT immunity

Power Line Communication (PLC) Solutions

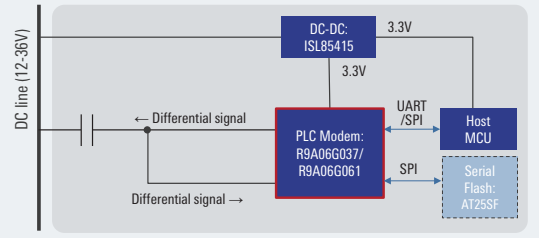
Outline/Features

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

For evaluation and development of the PLC communication modem IC: R9A06G061/R9A06G037, evaluation kits, sample applications, test tools, circuit diagrams, and design guides are available.

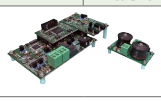
R9A06G061 Evaluation Kit

PLC Modem IC	Feature
R9A06G061	Compact and powerful PLC modem IC designed specifically for peer-to-peer (P2P) networks and archive high speed communication up to 1Mbps

Evaluation Kit	CPX4 Evaluation Kit M01D1	CPX4 Evaluation Kit M02D2
Part No.	RTK0EE0009D01001BJ	RTK0EE0009D02001BJ
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

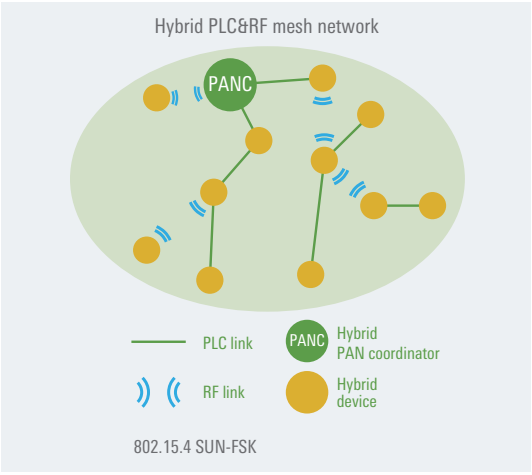
PLC Modem IC	Feature
R9A06G037	Complies with international power line communication standards (G3-PLC, PRIME, and Meters and More), and supports multi-hop networks

Evaluation Kit	CPX3 Evaluation Kit J70D1	CPX3 Evaluation Kit J80D1	CPX3 Evaluation Kit J80D2
Part No.	RTK0EE0003D01002BJ	RTK0EE0007D01001BJ	RTK0EE0007D02001BJ
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
Exterior view			

For the latest information, please visit:
https://www.renesas.com/products/interface/power-line-communications-plc

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.



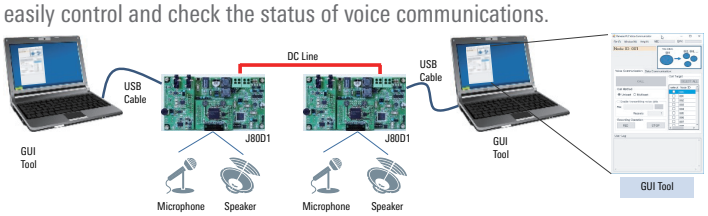
PLC-RF Hybrid Evaluation Board

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.

Evaluation Kit	PLC&RF Hybrid Evaluation Kit
Part No.	Y-G-HYBRID-PLC-RF
Supported voltage range	100V to 230V AC
Mounted device	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. Renesas provides schematics, PCB design files, and sample code, significantly shortening your 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.

Smoke Detector Solution

RL78/G22+AFE Multiwavelength Smoke Detector

Outline/Features

A high-accuracy smoke detection solution using multiple LEDs (infrared LED, blue LED) and photodiode. By adopting the ultra-low power RL78/G22 with built-in SNOOZE mode sequencer (SMS) and combining it with an AFE IC that integrates the necessary AFE functions for 2-wavelength systems, the solution achieves reduced system costs and long-term operation.

Configuration

- Microcontroller: RL78/G22 low-power microcontroller built-in SMS mode
- Solution board: RL78/G22+AFE Multiwavelength Smoke Detector board
  Circuit diagrams, parts lists, and sample programs are available.

■ Multiwavelength Smoke Detector Board

Applications

Detectors, alarms

Carbon Monoxide Detector Solutions

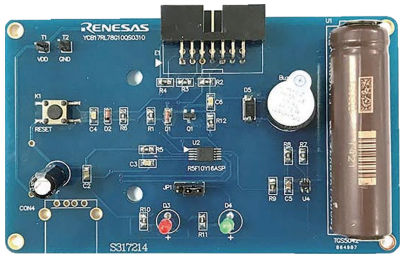
RL78 Quick Solution

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

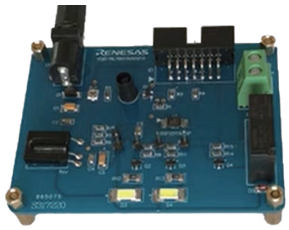
Motion Sensor Solutions

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

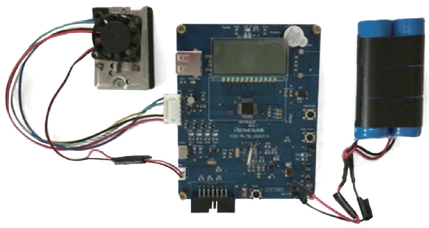
Outline/Features

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

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 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.

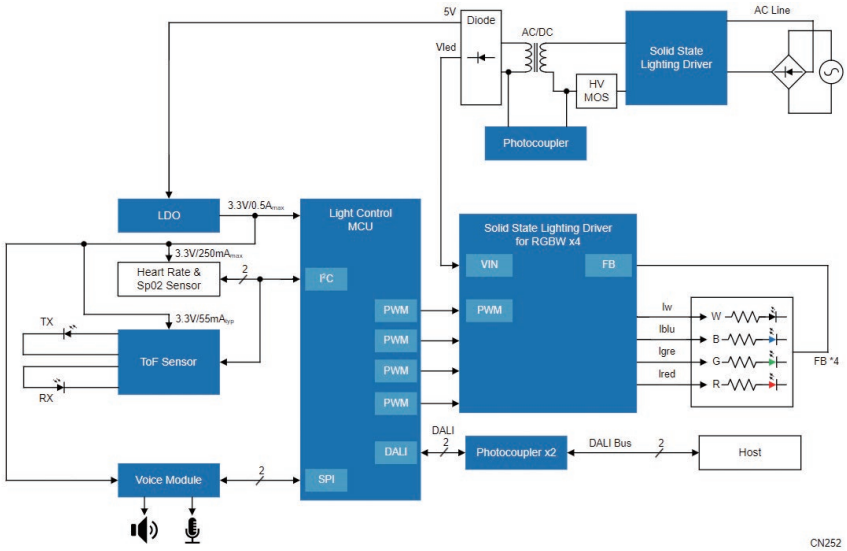
System Benefits

- The RL78/I1A 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

Block	Product
LDO	ISL80505
ToF Sensor	ISL29501
Voice Module	RA4M2
Light Control MCU	RL78/I1A
Photocoupler	PS2911-1
Solid State Lighting Driver for RGBW x4	iW380
Photocoupler x2	PS2561F-1
Solid State Lighting Driver	iW3627



HVAC Air Quality Sensor

This HVAC air quality sensor features a gas sensor and humidity sensor in conjunction with an MCU for HVAC systems, making it ideal for smart appliances and smart home and office applications. It helps meet compliance with stringent air quality regulations, supports energy conservation, and promotes health and well-being.

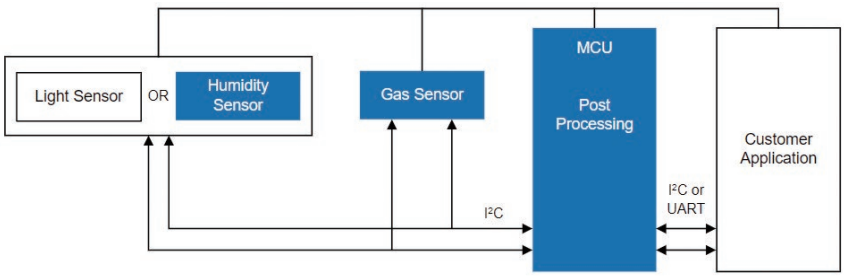
System Benefits

- Easy and fast integration into HVAC systems reduces installation time with minimal disruptions.
- Gas sensor with the highest sensitivity to gases in the market enhances accuracy and improves safety by enabling HVAC systems to respond quickly to the presence of dangerous gases.
- Upgradeable firmware allows customization to meet specific customer needs and requirements.

Target Applications

- Smart appliances
- Smart home/office
- HVAC

Block	Product
Humidity Sensor	HS3001
Gas Sensor	ZMOD4410
	RRH47000
MCU Post Processing	RL78/G14



Winning Combinations

Smoke Detector for Commercial Buildings

This smoke detection system for fire alarms in buildings is compliant with the UL 268 standard, 8th Edition. There are two types of fire alarms: P-type and R-type. The P-type requires low power consumption, allowing the connection of more than 100 detectors to a single line. This system combines an MCU (RL78/G22) and a photoelectric smoke detector AFE to create a fire alarm with ultra-low power consumption and a simple configuration. Optionally, high-performance R-type and intelligent-type fire alarms that utilize power line communication (PLC) are available.

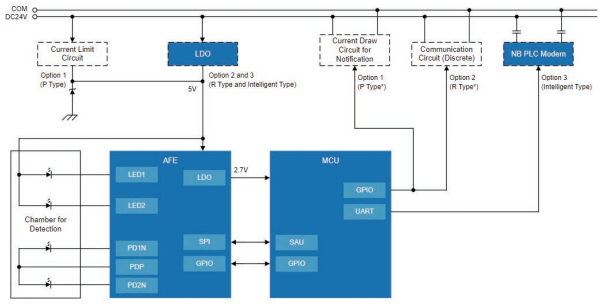
System Benefits

- Achieves ultra-low power consumption by applying SNOOZE mode sequencer (SMS) operation on the MCU.
- Simplifies the configuration of MCU and photoelectric smoke detector AFE IC, minimizing the need for external parts and reducing PCB size.
- Reduces power consumption and allows for an increased number of sensors, resulting in fewer sub-systems in a building. This helps to reduce deployment costs.

Target Applications

- Smoke detector for commercial buildings

Block	Product
LDO	ISL80410
AFE	RAA239101
MCU	RL78/G22
NB PLC Modem	R9A06G061



Option	Type	Power Supply	Notification
1	P Type*	Zener diode •Current limit circuit	Current draw circuit
2	R Type*	LDO	Communication circuit (Discrete)
3	Intelligent	LDO	PLC

*Complies with UL268, Edition 8

JP252

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.

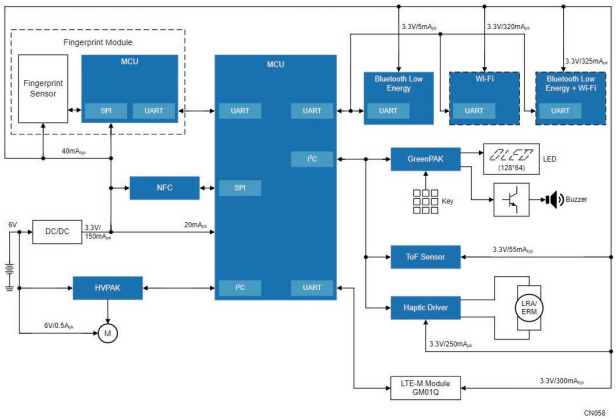
System Benefits

- 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

Block	Product
MCU	RX651
NFC	PTX105R
HVPAK	SLG47105
MCU	RA2E1
Bluetooth Low Energy	DA14531
GreenPAK	SLG46537
ToF Sensor	ISL29501
Haptic Driver	DA7280
Wi-Fi	DA16200
Bluetooth Low Energy + Wi-Fi	DA16600MOD



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.

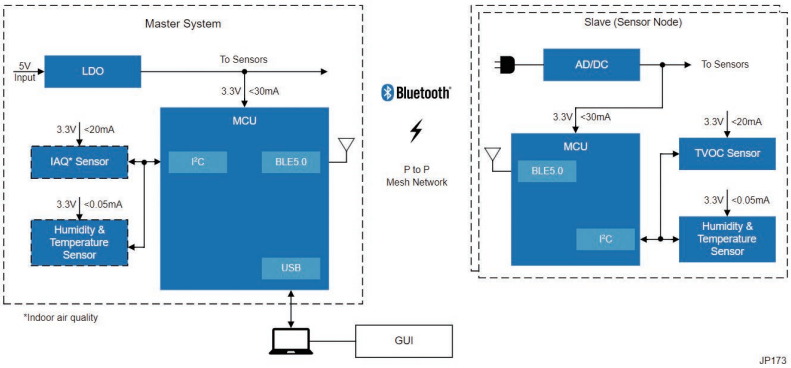
System Benefits

- 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

Block	Product
LDO	ISL80505
IAQ Sensor	ZMOD4410
Humidity & Temperature Sensor	HS3001
	HS3101
MCU	RA4W1
AD/DC	RAA223012
MCU	RA4W1
TVOC Sensor	ZMOD4410
Humidity & Temperature Sensor	HS3001
	HS3101



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.

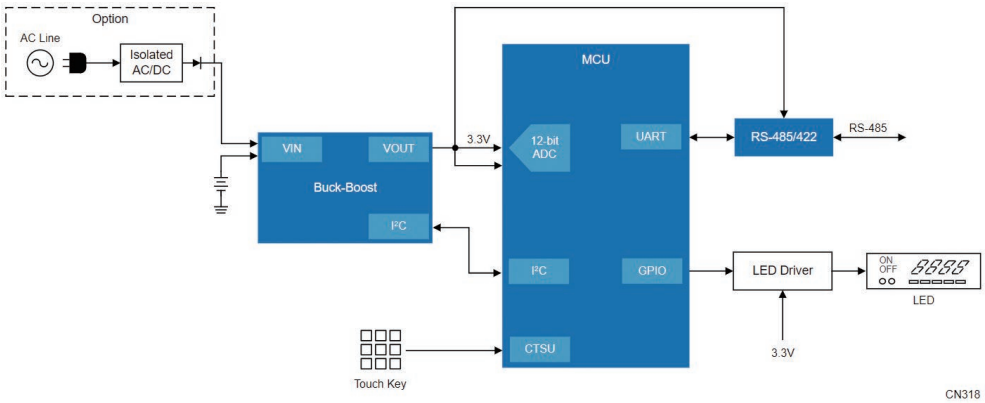
System Benefits

- Entry-level RA 32-bit MCU with a Capacitive Touch Sensor Unit 2 (CTSU2) 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 I²C bus.

Target Applications

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

Block	Product
Buck-Boost	ISL9122A
MCU	RA2E1
	RX130
	RX671
RS-485/422	ISL3174E



Winning Combinations

Network System for Building Automation

This network system collects data from various building automation (BA) systems, including HVAC, lighting, smoke and fire detection, etc. It utilizes the industrial communication companion chip RZ/N2L MPU and various devices to support communication protocols like Ethernet-based OPC UA and BACnet. Additionally, it supports communications via RS-485 and power line communication (PLC), commonly used in BA networks.

System Benefits

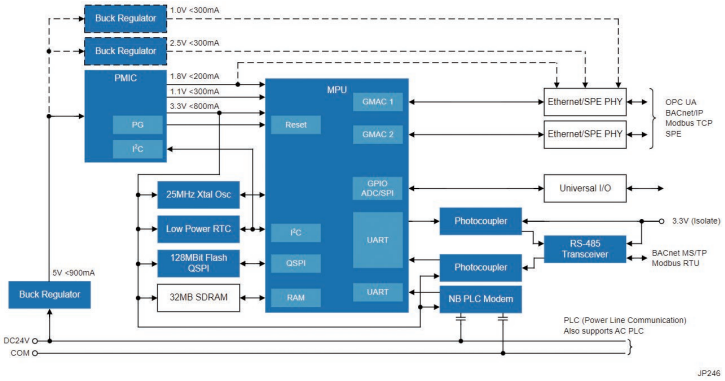
- Supports gateway systems covering various network hierarchies:
  - BA Ethernet functions such as OPC UA, BACnet
  - Industrial Ethernet protocols such as Modbus TCP, EtherNet/IP, EtherCAT, etc.
  - RS-485 transceiver with BA serial communication such as BACnet MS/TP, Modbus RTU, etc.
  - NB-PLC modem that supports PLC communication in the BA system.
- MPU has a built-in TSN-compliant 3-port Gigabit Ethernet switch and can support Time-Sensitive Networking (TSN) compatible devices.
- MPU HOST I/F allows for easy and high-speed connectivity to the existing system.

Target Applications

- Building automation
- HVAC
- Network gateway

Block	Product
Buck Regulator	ISL80015
Buck Regulator	ISL80015
PMIC	DA9080
Buck Regulator	ISL85410
25MHz Xtal Osc	XL
Low Power RTC	ISL1219

Block	Product
128MBit Flash QSPI	AT25SF128A
MPU	RZ/N2L
Photocoupler	RV1S9160A
Photocoupler	RV1S9160A
NB PLC Modem	R9A06G061
RS-485 Transceiver	ISL3155E



Smart Wireless Door Lock

Smart electronic door locks are gaining popularity in government, commercial, enterprise, and residential buildings as part of smart city initiatives. These locks feature Bluetooth® Low Energy (LE) connection to smartphones for convenient lock/unlock operations and Near Field Communication (NFC) based credential exchange. They also establish an IoT connection to a central PC for centralized access control and monitoring. Another notable innovation is the hassle-free and contactless charging of the integrated battery through NFC-WLC wireless charging technology.

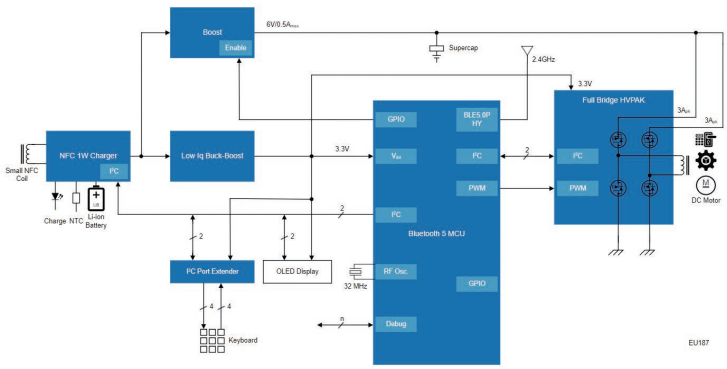
System Benefits

- Wire-free and effortless installation, powered by an integrated battery charged via NFC-WLC technology
  - Can be paired with our Universal NFC Charger solution
- Exceptional security features include:
  - Secure Bluetooth pairing facilitated by NFC
  - Utilizes Bluetooth 5 and NFC communication
- Boasts ultra-low power design with a minimal bill of materials (BOM)
- Offers centralized control and tracking capabilities, such as approval of Bluetooth keys, through an optional IoT backbone (requires an additional router)
- Optionally designed to meet IP67 dust and waterproof standards

Target Applications

- Commercial, residential, educational, government, and industrial buildings requiring access control and monitoring

Block	Product
NFC 1W Charger	PTX30W
Boost	ISL97519A
Low Iq Buck-Boost	ISL9122A
I²C Port Extender	SLG46537
Bluetooth 5 MCU	DA14531
Full Bridge HVPAK	SLG47105



Heat Pump Control System

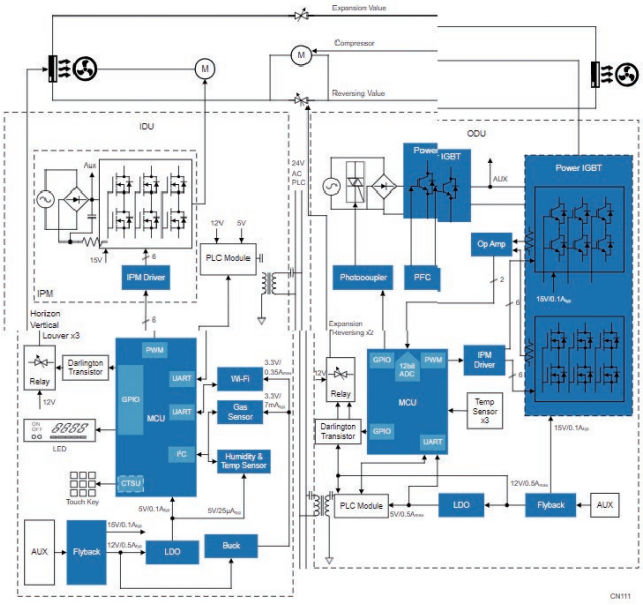
Heat pumps can play a key role in climate change mitigation. They have a reversing valve that can move the heat from inside the house to the outdoors (cooling mode) or reverse the cycle and move the heat from outside the house to indoors (heating mode). The coefficient of performance (COP) is high for heat pumps. Renesas provides comprehensive solutions for heat pump control systems.

System Benefits

- High-performance and dedicated motor control MCU
- Power line communication (PLC) and Wi-Fi modules provide stable wire or wireless communication
- Multiple integrated sensors to monitor the system and optimize the operation

Target Applications

- Heat pump
- HVAC



Block	Product
Flyback	Iw1825
IPM Driver	RV1S9061A
MCU	RL78/G13
	RL78/G23
LDO	RAA214250
Wi-Fi	DA16200MOD
Gas Sensor	ZMOD4410
Humidity & Temp Sensor	HS3003
Buck	RAA211250

Block	Product
Photocoupler	PS2711-1
Power IGBT	RBN75H65TT1FPQ-A0
PFC	R2A20114BFP
MCU	RX24T
Op Amp	READ2304G
IPM Driver	RV1S9061A
LDO	RAA214250
Power IGBT	RBN75H65T1FPQ-A0
Flyback	RAA223181

HVAC Environment Monitor Module for Public Buildings

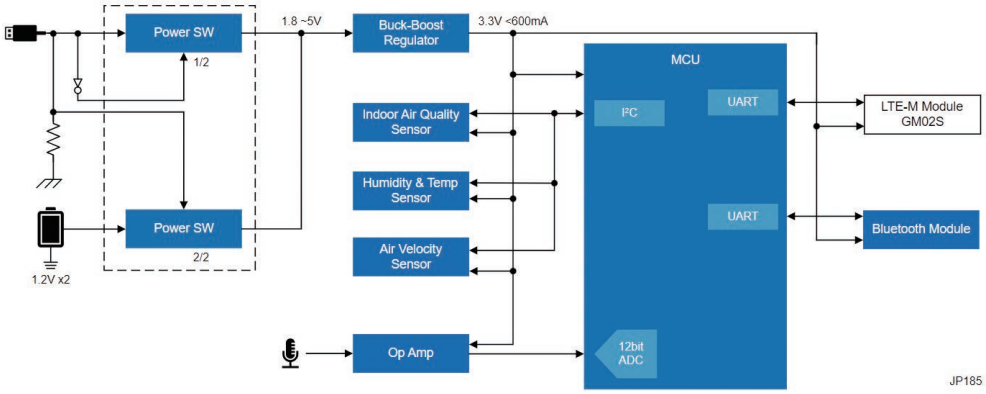
The Renesas HVAC Environment Monitor Module is designed specifically for assessing the air quality in public buildings (PBAQ) to prioritize people's health and well-being. It measures the air and sound conditions and efficiently transmits the gathered information through multiple communication devices, including LTE, Wi-Fi, and Bluetooth® Low Energy.

System Benefits

- High-precision measurement of air conditions with high-performance sensors:
  - Indoor air quality sensor
  - Humidity & temperature sensor
  - Air velocity sensor
- High-precision sound and noise measurement function.
- Battery life can be maximized with the combination of low-power devices (sensors, MCU, communication, and power supply system).

Target Applications

- Indoor air quality sensor
- HVAC
- Air conditioner



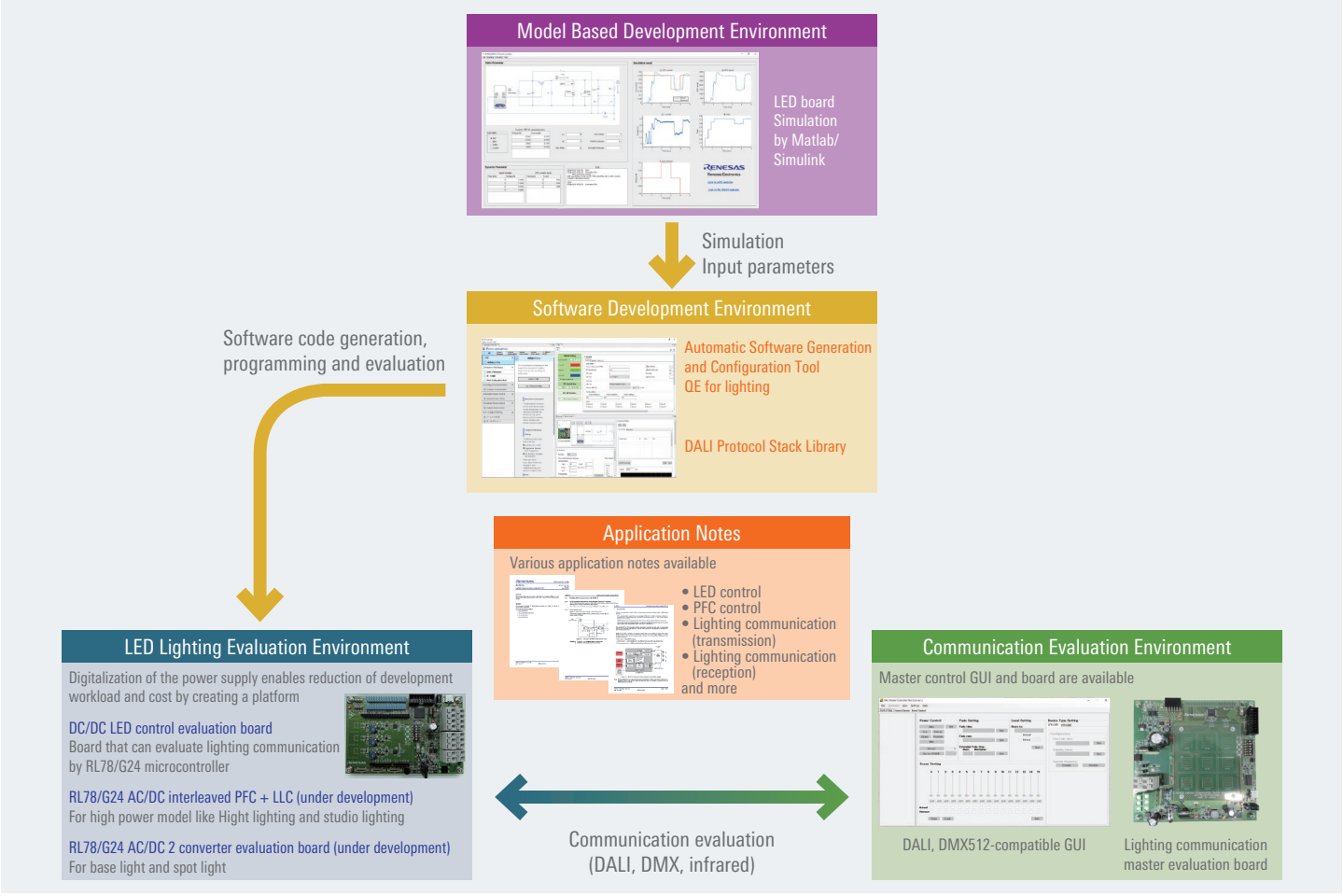
Block	Product
Power SW	SLG59M1641V
Power SW	SLG59M1641V
Buck-Boost Regulator	ISL9120
Indoor Air Quality Sensor	ZMOD4410
Humidity & Temp Sensor	HS3001

Block	Product
Air Velocity Sensor	FS3000
Op Amp	SLG88103
MCU	RA0E1
	RL78/G13
Bluetooth Module	DA14531MOD

For more Winning Combinations, please visit:
https://www.renesas.com/winning-combinations

Lighting Solutions

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 a model based development environment, 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

The LED Lighting Evaluation Environment is a reference solution for those developing LED lighting fixtures. Various types of topologies and evaluation boards with dimming interfaces, including DALI, are available for customers to choose according to their applications. All are compatible with digital power supply. The communication evaluation environment is a reference solution for those developing communication-enabled dimmers (wall switches, control routers, sensors). It can also be used as a communication evaluation with luminaires. For more information about each board, please visit the Renesas Web site.

Item	LED lighting Evaluation Environment			Communication Evaluation Environment	
	RL78/G24 DC/DC LED Control evaluation board	RL78/G24 AC/DC 2 Converter Evaluation board	RL78/G24 AC/DC interleaved PFC + LLC	RL78/G23 Lighting communication master evaluation board	RX65N DALI2 Application controller
Part No.	RTK7RLG240P00000BJ	Under development	Under development	RTK7RL23LMP00000BJ	TCM-RX65N-OP1 RTK5RX65N0S00000BE
Input	DC5V	AC90-260V	AC90-260V	DC5V or USB	DC5V or USB
Topology	Buck (High side)	Boost (CRM-PFC), Buck (High side)	Interleaved PFC (CRM-PFC), LLC	–	–
Output	350mA, 3ch	200V, 250mA, 50W	13V 6A, 50V 6A, 400W	–	–
Dimming	DC dimming	DC dimming (0.1%)	Constant Voltage	–	–
Interface	DALI2/IR/DMX512/PMBus/SMBus	DALI2/IR	Switch, IR	DALI2/DMX512/IR/Switch	DALI2/Switch
Use case	Basic evaluation, Development for Lighting and power supply	Evaluation development for Lighting fixture	Evaluation for Power supply	Development for Lighting switches and master	Development for Application controller with Cloud connection

Model Based & Software Development Environment

Model based development environment

LED board simulation

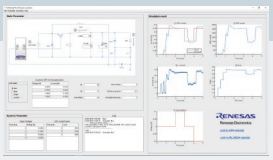
This tool integrates and simulates microcontroller peripheral functions, software, and circuits external to the microcontroller. Transient characteristics can be checked by changing external circuit parameters and software controller gains.

Automatic software generation & configuration

QE for lighting

A tool for sample software generation, configuration, and program writing for LED lighting evaluation environments. Software for digital power control and DALI communication can be generated simply by specifying the dimming operation and communication mode on the GUI. The generated software can be automatically written to the flash memory of the microcontroller via USB cable. The generated software can be automatically written to the flash memory of the microcontroller via a USB cable, and operation checks can be performed on the evaluation board.

Simulation of digital power supply control without actual equipment. Code generation including communication reduces development man-hours and costs.



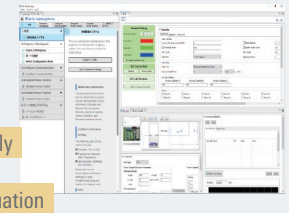
Model based development

LED board simulation

(1) Simulate circuit and software by operating a mouse

Automatic software generation & configuration

QE or Lighting



(2) Input parameters from simulation

(3) Configure & Generate software automatically

(4) Program the software to the board for evaluation

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.

■ List of Protocol stack library (As of December. 2024)

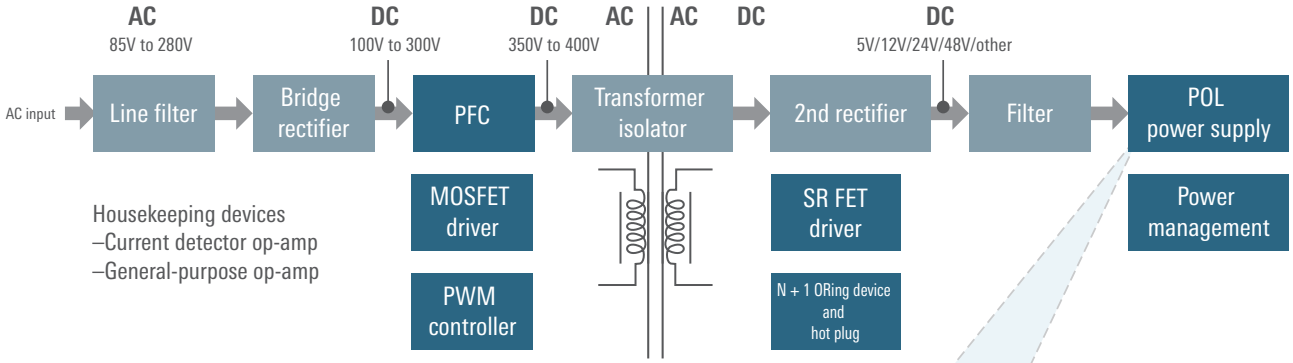
IEC62386 standard	Application	Contents	RL78	RX65N	RA*2
102	Control Gear (Lighting fixture)	General Requirements	✓		✓
207		Particular requirements LED modules	✓		✓
209		Particular requirements Colour Control	✓		✓
103	Control Devices (Router Switch, sensor)	General Requirements	✓*3	✓*4	✓
301		Particular requirements Push buttons	✓		✓
302		Particular requirements Absolute input devices	✓		
303		Particular requirements Occupancy sensors	✓		✓
304		Particular requirements Light sensors	✓		✓

*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. The stack for input device
*4. The stack for application controller

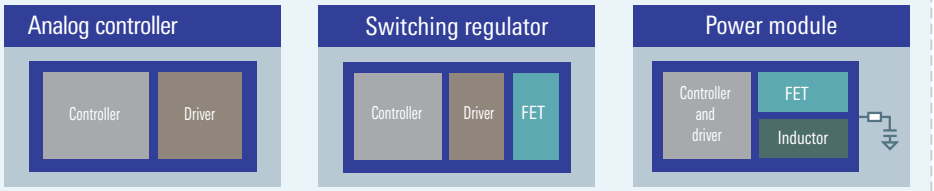
Power Management Solutions

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.



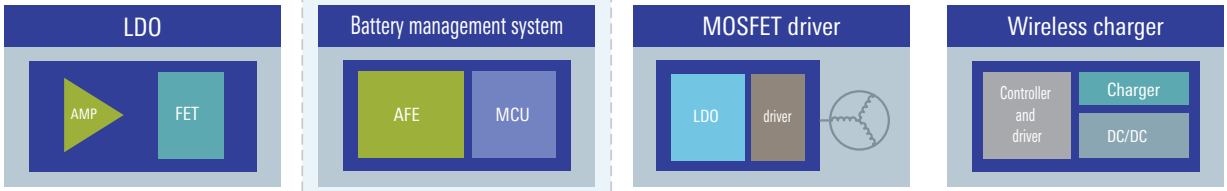
Power management solutions for an array of applications, voltages, and currents.



- On-chip MOSFET driver
- On-chip bootstrap diode
- Internal compensation
- High voltage/high current

- On-chip HS/LS FET
- Internal compensation
- Low to medium voltage/ load conditions

- On-chip controller, power FET, output inductor, and compensation circuit
- Low to medium voltage/high current



- On-chip power FET and differential amplifier

- Single-package solution incorporating MCU and AFE
- On-chip FET driver

- Power supply system circuit incorporating LDO

- On-chip DC/DC converter
- Integration of all essential receiver functions on a single chip

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

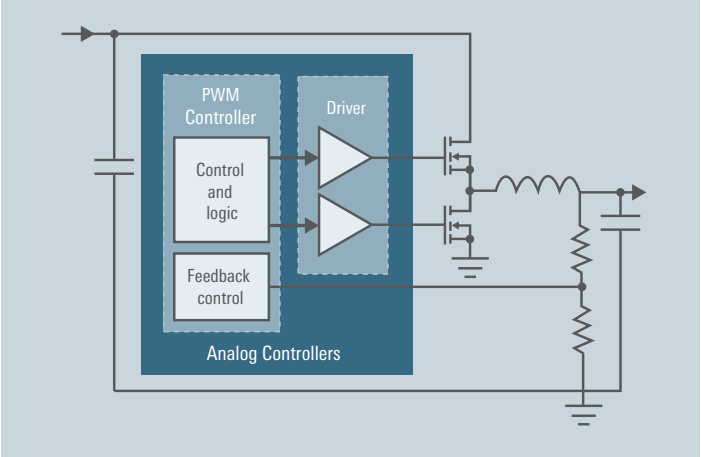
- Wide range of protection functions (OCP, OVP, OTP, SCP)
- Pre-bias startup, external compensation

Extensive product lineup

- Wide input voltage range up to 80V
- 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

Wide input voltage range up to 80V

Stability and high performance

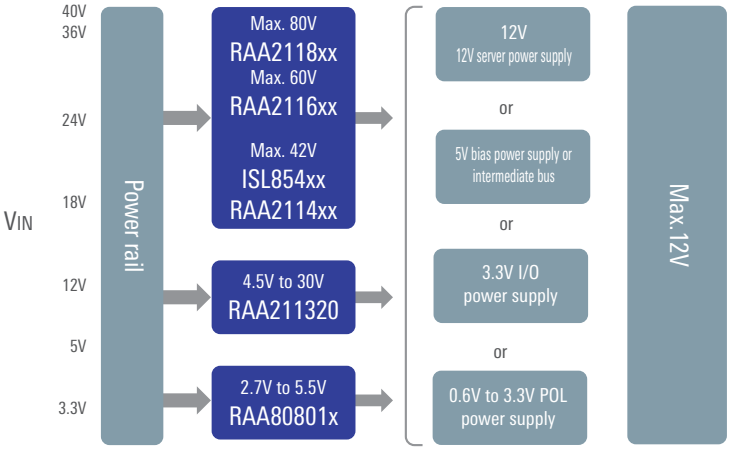
- Power-good, enable, variable software start
- Wide range of protection functions (OCP, OVP, OTP, SCP)
- External frequency synchronization

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



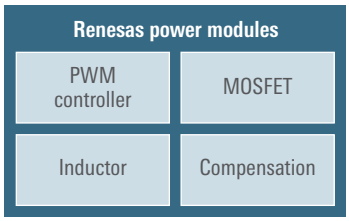
Power Modules

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

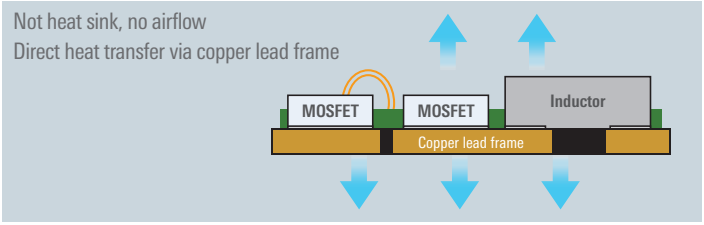


High power density

- Ability to realize up to 30A output in a single package

Heat-resistant package technology

- Use of thermoplastic compounds for more efficient heat dispersion
- Full-load operation over wide temperature range
- Pin access via lead package



Recommended Devices For Building Automation

RL78 Family

The RL78 family is the low-power 8-bit & 16-bit microcontrollers. It enables customers to build compact and energy-efficient systems at lower cost. The Renesas RL78 contributes to greatly improve power efficiency, BOM cost reduction, and equipment miniaturization with industry-leading low power consumption and various built-in high-performance peripheral functions.

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

- 37.5 µA/MHz operation*1
- 0.355 µA (RTC + LVD)
- SNOOZE mode

Note: 1. Power supply current value during basic RL78/G22 operation

Broad Scalability

- 8 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

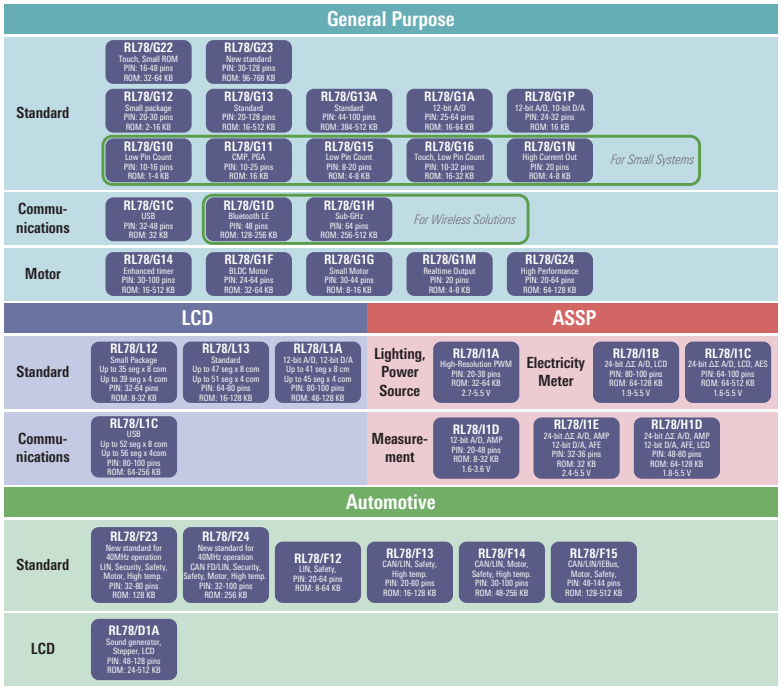
- High precision ±1% high-speed on-chip oscillator
- On-chip power-on reset, low-voltage detection circuit, temperature sensor, data flash memory, etc.
- Built-in logic function (ELCL), AMP, DAC, comparator (some products)

High Performance

- High processing performance of 1.6 DMIPS/MHz
- Support for power supply voltages from 1.6 to 5.5 V
- Max. 48 MHz operation

RL: Renesas Low power

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 ΔΣ 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 ΔΣADC	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 RL78/G24

Features

Basic peripheral functions for lighting power supplies

- Timers for LED control and PFC, DC/DC 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 (0.65ns pseudo-resolution: G24), soft start function, maximum frequency limit function, single/interleaved PFC function, multi-phase function, communication standby function

Main Applications

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

ASSP for Power Meters

RL78/I1B RL78/I1C

Features

ΔΣ 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 ±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 3.4µs, and low 124µA 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 ΔΣ A/D converter × 4 channels
- 10-bit SAR-A/D converter ×10 channels
- configurable amplifier ×3 channel
- 12-bit D/A converter ×1 channel
- Sensor power supply ×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

Recommended Devices For Building Automation

PLC Modem IC

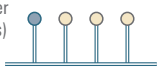
PLC is a technology that uses existing power lines as the communication medium. Using the power grid as a communication network makes it possible to build out systems cheaply and quickly. Either AC power lines or DC power lines can be employed as the communication medium.
Renesas offers narrowband PLC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

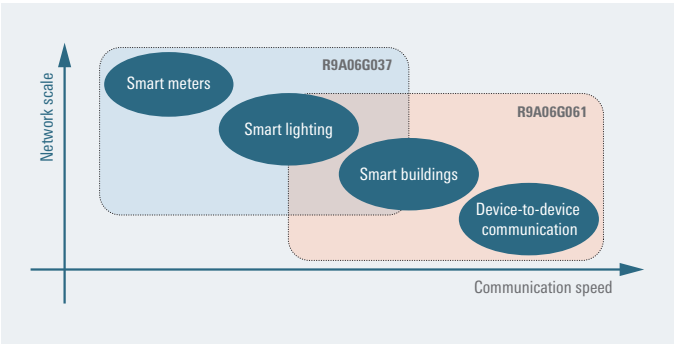
	R9A06G037	R9A06G061
Speed	Max. 280kbps	Max. 1Mbps
Communication distance	1km or more	1km or more
Network type	Multi-hop (mesh or tree) 	Peer-to-peer (star or bus) 

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

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.



RZ Family

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 1.8GHz
Low-power Embedded AI
for Vision-AI Application

RZ/N Series

64/32-bit Cortex®-A/R/M CPU, Up to 1.2GHz
Multi-protocol Industrial Network and TSN
for PLC, Remote IO, Gateway

RZ/T Series

64/32-bit Cortex®-A/R CPU, Up to 1.2GHz
Real-time Control
Multi-protocol Industrial Network and TSN
Multi-protocol Encoder I/F
for AC servo, Actuator, Inverter

RZ/G Series

32/64-bit Cortex®-A CPU, Up to 1.5Hz
64-bit RISC-V CPU, Up to 1.0GHz
for HMI and IoT Application

RZ/A Series

32/64-bit Cortex®-A CPU, Up to 1GHz
DDR3L/4 (RZ/A3UL)
Up to 10MB Embedded RAM
for HMI Application

RZ/V Series Application Fields

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


Surveillance cameras

RZ/N Series Application Fields

- HVAC system
- Network gateway
- PLC (Programmable Logic Controller)
- Remote I/O
- Sensor hub


PLC

RZ/T Series Application Fields

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


Industrial motors

RZ/G Series Application Fields

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


Entrance/exit gates

RZ/A Series Application Fields

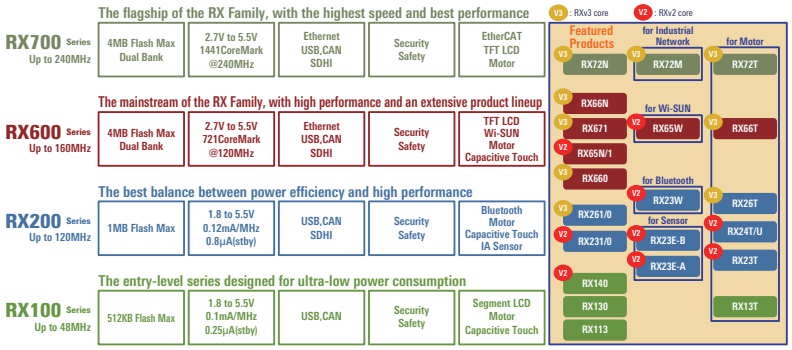
- White goods
- Barcode scanners
- Biometric authentication, face recognition
- Banknote detection
- Communication robots
- Intercoms
- Smart speakers


Intercoms

RX Family

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

RX72T RX66T RX26T

Features

- RXv3 Core + single-precision FPU
  RX66T: 160MHz operation, RX72T: 200MHz
  RX26T: 120MHz (6.01 CoreMark/MHz)
- 2.7V~5.5V single power supply
- High-capacity memories
  RX66T/RX72T: up to 1MB ROM, up to 128KB SRAM
  RX26T: up to 512KB ROM, up to 64KB SRAM

Main Applications

- Building automation
- Motor control

- Equipped with peripheral functions essential for high-speed motor control
- PWM output timer
  RX66T/RX72T: 160MHz/200MHz PWM, single-phase complementary switching x10ch, 3-phase complementary switching x4ch
  RX26T: 120MHz PWM, single-phase complementary switching x8ch, 3-phase complementary switching x2ch
- Analog functions
  – 12bit A/D converter x 3 unit, 12-bit D/A converter x 2ch
  – Comparator x 6ch
  – PGA x 6ch (RX66T/RX72T: pseudo-differential, RX26T: single-ended)
- Trigonometric Function Accelerator (RX72T/RX26T only)
- Encryption engine (AES, TRNG)

Capacitive Touch Key and System Control

RX671

Features

- RXv3 Core 120MHz operation + double-precision FPU (6.01 CoreMark/MHz)
  Register bank save function that speeds up interrupt response
- 2.7V~3.6V single power supply
- up to 2MB ROM (Dual bank function) up to 384KB SRAM

Main Applications

- System control panel (Elevator, HVAC, etc.)

- High-capacity memories, Equipped with a wide range of HMI functions
- Including ultra-compact 64-pin TFBGA (4.5mm × 4.5mm) 48-pin~176-pin package lineup
- Capacitive touch sensing unit (CTSUa)
- Serial sound interface
- SD host interface
- USB FS, CAN 2ch, QSPI (XIP mode support)
- Encryption engine (AES, RSA, ECC, SHA)
  Key management, access management circuit, flash memory protection

RX261 RX260

Features

- RXv3 Core 64MHz operation + single-precision FPU (5.55 CoreMark/MHz)
- 1.6V~5.5V single power supply
- up to 512KB ROM, 128KB SRAM

Main Applications

- System control panel (Elevator, HVAC, etc.)

- Equipped with next-generation touch IP, achieving both high performance and low power consumption
- Low power consumption (Active: 69μA/MHz, Standby: 1μA)
- 8KB data flash memory that can store data just like an EEPROM
- High-speed on-chip oscillator with ±1.0% accuracy
- Capacitive Touch Sensing Unit (CTSU2SLa)
- USB FS*, CAN FD*, UART, SPI, I2C
- Low power timer
- Encryption engine* (AES, ECC, SHA, TRNG)
- Diverse package lineup from 48 to 100 pins (including QFP and QFN)

* RX261 only

RX140

Features

- RXv2 Core 48MHz operation + single-precision FPU (4.25 CoreMark/MHz)
- 1.8V~5.5V single power supply
- up to 256KB ROM, up to 64KB SRAM

Main Applications

- System control panel (Elevator, HVAC, etc.)

- Low-power microcontroller with next-generation touch IP
- Low power consumption (Active: 52μA/MHz, Standby: 0.25μA)
- 8KB data flash memory that can store data just like an EEPROM
- High-speed on-chip oscillator with ±1.0% accuracy
- Capacitive Touch Sensing Unit (CTSU2SL*, CTSU2L)
- CAN, UART, SPI, I2C
- Low power timer
- Encryption engine (AES, TRNG)
- Diverse package lineup from 32 to 80 pins (including QFP and QFN)

* ROM 128 kB or more only

Recommended Devices For Building Automation

RA Family

The Renesas RA family of 32-bit MCUs are built on the Arm® Cortex®-M core architecture. Offering a wide range of performance and features, the Renesas RA family meets the scalability, power consumption and performance needs of nearly any embedded systems end-product.

Strong Security

- Leading-edge, integrated Renesas Security IP
- An extra layer of embedded hardware security providing tamper detection and resistance to side-channel attacks
- Integrated Arm v8-M TrustZone®

Arm Core

- Arm Cortex-M23 core for the most cost/power sensitive applications
- Arm Cortex-M4/M33 cores to deliver the best balance of performance and power
- Arm Cortex-M85 core with Helium™ technology for unprecedented performance

Flexible Software Solution

- Supported by an open and flexible ecosystem concept, the Flexible Software Package (FSP)
- Can be replaced and expanded by any other RTOS or middleware

Best-in-Class Peripheral IP

- Excellent HMI capacitive touch technology
- The industry's highest code flash memory capacity
- Wide range of connectivity solutions

Renesas RA Family Product Series

The five Renesas RA Family MCU series are based on 32-bit Arm Cortex-M cores. All five have been designed on common DNA, making these products feature- and pin-compatible. This allows easy scalability and code reuse from one device to another.

High Performance

	Performance Range	Feature	Series Memory Ranges	ASSP Extensions
RA8	Over 240 MHz 1.68-3.6V	Highest Performance, HMI, Connectivity, Security, Analog	Highest memory integration: up to 2MB Flash, 2MB SRAM	Motor/Inverter AI/ML, HMI
RA6	Up to 240 MHz 2.7-3.6V	Advanced Performance, Connectivity, Security	High memory integration: up to 2MB Flash, 640kB SRAM	Motor/Inverter AI/ML, HMI
RA4	Up to 100 MHz 1.6V-5.5V	Excellent Power, High Performance Mix Paired with Security	Medium memory integration: up to 1MB Flash,128kB SRAM	Motor/Inverter Sensor, Wireless
RA2	Up to 64 MHz 1.6V-5.5V	Low Power	Medium memory integration: up to 512kB Flash, 48kB SRAM	Rich Analog
RA0	32 MHz 1.6V-5.5V	Optimized functionalities Ultra Low power	Small memory integration: up to 64kB Flash, 12kB SRAM	Sensor

Power Savings

Renesas RA Family MCU Portfolio

Series	Groups					
RA8 Over 240MHz			RA8E2 480MHz Cortex-M85, 1MB Flash, USBFS, GLCDC, 2DRW, OSPI, CAN-FD, TrustZone			
	RA8D1 480MHz Cortex-M85, ~2MB Flash, GLCDC, MIPI-DSI, 2D, USBHS/FS, Ethernet, CAN-FD, OSPI, 32b SDRAM, RSIP-E51A, Camera i/f	RA8M1 480MHz Cortex-M85, 2MB Flash, USBHS/FS, Ethernet, OSPI, CAN-FD, RSIP-E51A	RA8E1 360MHz Cortex-M85, 1MB Flash, USBFS, Ethernet, OSPI, CAN-FD, Camera I/F, TrustZone			RA8T1 480MHz Cortex-M85, ~2MB Flash, PWM, Ethernet, USBFS, CAN-FD, RSIP-E51A
RA6 Up to 240MHz	RA6M3 120MHz Cortex-M4, ~2MB Flash, Ethernet, USBHS, CAN, Graphics, JPEG, TFT LCD, SCE7	RA6M5 200MHz Cortex-M33, ~2MB Flash, TrustZone, Ethernet, USBFS+, USBHS, CAN-FD, OSPI, SCE9	RA6E2 200MHz Cortex-M33, ~256KB Flash, USBFS, CAN FD, I3C			RA6T3 200MHz Cortex-M33, 256KB Flash, PWM, PGA, CMP, TFU, CAN FD, USBFS
	RA6M2 120MHz Cortex-M4, ~1MB Flash, Ethernet, USBFS, CAN, SCE7	RA6M4 200MHz Cortex-M33, ~1MB Flash, TrustZone, Ethernet, USBFS, CAN, OSPI, SCE9	RA6E1 200MHz Cortex-M33, ~1MB Flash, TrustZone, Ethernet, USBFS, CAN			RA6T2 240MHz Cortex-M33, 512KB Flash, PWM, PGA, Motor Accelerator, CAN-FD, SCE5
	RA6M1 120MHz Cortex-M4, 512KB Flash, USBFS, CAN, SCE7					RA6T1 120MHz Cortex-M4, 512KB Flash, PWM, PGA, CMP, SCE7
RA4 Up to 100MHz		RA4M3 100MHz Cortex-M33, ~1MB Flash, TrustZone, USBFS, CAN, SCE9	RA4E2 100MHz Cortex-M33, 128KB Flash, USBFS, CAN FD, I3C		RA4W1 48MHz Cortex-M4, 512KB Flash, Bluetooth, USBFS, CAN, Segment LCD, CTSU Touch Sensing	RA4T1 100MHz Cortex-M33, ~256KB Flash, PWM, PGA, CMP, TFU, CAN FD
	RA4M1 48MHz Cortex-M4, 256KB Flash, USBFS, CAN, Seg. LCD, CTSU Touch Sensing, 14bit SAR ADC, SCE5	RA4M2 100MHz Cortex-M33, ~512KB Flash, TrustZone, USBFS, CAN, SCE9	RA4E1 100MHz Cortex-M33, ~512KB Flash, TrustZone, USBFS, CAN			
RA2 Up to 60MHz			RA2E3 48MHz Cortex-M23, ~64KB Flash, 32-48pin, 5V	RA2A2 48MHz Cortex-M23, 512KB Flash, 24bit SD-ADC, 12bit SAR ADC, Segment LCD, 5V		
		RA2L1 48MHz Cortex-M23, ~256KB Flash, CAN, CTSU2 Touch Sensing	RA2E2 48MHz Cortex-M23, ~64KB Flash, I3C, WLCSP, 125°C	RA2A1 48MHz Cortex-M23, 256KB Flash, USBFS, CAN, CTSU Touch Sensing, 24bit SD-ADC, 16bit SAR ADC		
			RA2E1 48MHz Cortex-M23, ~128KB Flash, CTSU Touch Sensing, WLCSP			
RA0 Up to 32MHz			RA0E1 32MHz Cortex-M23, ~64KB Flash, 16-32pin, 5V			
	Mainstream Line / Low Power		Entry Line	Rich Analog	Wireless	Motor Control

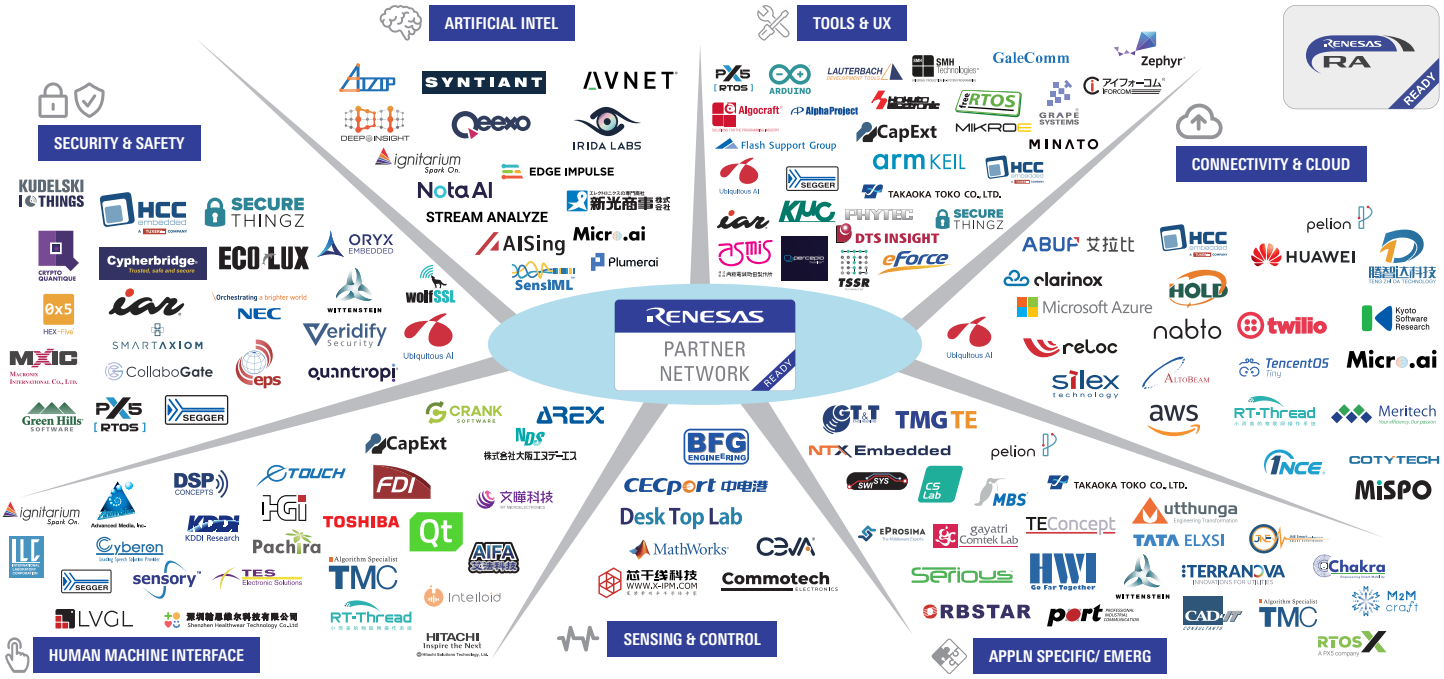
Target Applications and Markets

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.

	Best Suitable Product Series	Application Examples	
Industrial Automation	RA0 RA2 RA4 RA6 RA8	▪ Robotics ▪ Door Openers ▪ AC Drive	▪ AC Servo ▪ UPS ▪ Functional Safety
Building Automation	RA0 RA2 RA4 RA6 RA8	▪ Fire Panels ▪ HVAC ▪ Boiler Control	▪ Vending Machines ▪ Motion Detection ▪ Monitoring Systems
Metering	RA2 RA4 RA6 RA8	▪ Electricity Meters ▪ Automated Meter Reading ▪ Network Cards	▪ Flow Meters ▪ Power Meters
Home Appliance	RA0 RA2 RA4 RA6 RA8	▪ HVAC ▪ Air Cleaners ▪ Coffee Machines	▪ Vacuum Cleaners ▪ Cleaning Robots ▪ White Goods
Connectivity	RA0 RA2 RA4 RA6 RA8	▪ ASi5 / IO-Link Gateways ▪ Communication Gateways ▪ Data Concentrators	▪ Wired Ethernet ▪ Fleet Tracking
Security	RA4 RA6 RA8	▪ Fire Detectors ▪ Burglar Detection ▪ Panel Control	▪ Door Openers ▪ Monitoring Systems ▪ Access Control
Motor Control	RA4 RA6 RA8	▪ Brushless DC Motors ▪ Induction Motors ▪ Stepper Motors	▪ Magetic Encoders ▪ Optical Encoders ▪ Hall Sensors
Low Power	RA0 RA2 RA4	▪ IO-Link Sensors ▪ Heat Cost Allocators ▪ Portable Audio Devices	▪ Smoke Detectors ▪ IoT Sensing Nodes ▪ Wearable Devices
HMI	RA2 RA4 RA6 RA8	▪ Voice Recognition ▪ Capacitive Touch Panels ▪ Printers	▪ Vending Machines ▪ Home Appliances ▪ Medical Equipment
Wireless	RA4	▪ Wearable Devices ▪ Healthcare ▪ Panel Control	▪ Gateway Units ▪ Door Openers ▪ Smart Home

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.



Visit the link below to learn more about RA MCUs.

RA Arm® Cortex®-M MCU | Renesas

Recommended Devices For Building Automation

ASSP for Inverter Control

RA4T1 RA6T3 RA6T2

Features for RA4T1/RA6T3/RA6T2

- 100MHz(RA4T1)/200MHz(RA6T3)/240MHz(RA6T2) Arm® Cortex®-M33 core
- RA4T1/RA6T3:256KB Flash Memory, 40KB SRAM (8KB:ECC, 32KB:Parity), and 8KB Data Flash & RA6T2:512KB Flash Memory, 64KB ECC SRAM, and 16KB Data Flash
- RA4T1/RA6T3:Scalable from 32pin to 64pin & RA6T2:Scalable from 48pin to 100pin, with variety of LQFP, LFQFP & HWQFN Package options
- Enhanced Analog functions : 12/16*1-bit A/D Converters with 3ch S/H, D/A Converter, Programable Gain Amp, and Comparators
- PWM timer (GPT) for various control algorithms
- Hardware accelerator : Trigonometric Function Unit(TFU), IIR Filter*1
- Security: Arm® TrustZone®, TRNG, AES/Key management/GHASH by Secure Engine*1
- Multiple communication interface : USB2.0 FS*2, CAN FD, I2C/I3C*3, SCI, SPI
- 2.7V to 3.6V single supply operation
- Operating temperature(Ta): -40°C to 105°C

*1: RA6T2 only, *2: RA6T3 only, *3: RA4T1/RA6T3 only

Main Applications

- Building automation
- Motor control
- Industrial automation
- Home appliances
- Medical & healthcare
- Consumer electronics

ASSP for High-Precision Sensing

RA2A2

Features for RA2A2

- 48MHz Arm® Cortex®-M23 core
- 512KB Flash Memory (in 2 banks), 48KB SRAM (16kB: ECC, 32kB:Parity), and 8KB Data Flash (100,000 Program/Erase cycles)
- from 64pin to 100pin options with LFQFP
- Up to 7ch 24-bit Sigma Delta A/D, Digital Filter, 12-bit SAR A/D
- 16-bit GPT, 16-bit & 32-bit LPAGT, Independent RTC
- Multiple serial communication interface (5ch of SCI, 1ch of SPI, 2ch of I2C)
- Segment LCD (8com x 38 Seg)
- 32-bit Multiply Accumulator
- Security functions including AES, Secure MPU,Flash Access Window and TRNG
- 1.6V to 5.5V single supply operation
- Operating temperature(Ta): -40°C to 105°C

Main Applications

- Building automation
- Energy management
- Industrial automation
- Home appliances
- Medical & healthcare
- Consumer electrics

ASSP for Bluetooth & System Control

RA4W1

Features for RA4W1

- 48MHz Arm® Cortex®-M4 with 512KB Flash Memory and 96KB SRAM
- 8KB Data Flash to store data as in EEPROM
- Available in 56pin QFN package
- USB2.0 Full Speed, CAN 2.0B
- SCI (UART, Simple SPI, Simple I2C), SPI and I2C
- Segment LCD Controller and Capacitive Touch
- Integrated ADC and DAC, Comparator and Operational Amplifier
- TRNG, AES, GHASH and Unique ID
- Full Bluetooth 5.0 LE Feature Set
- 1.8V to 3.6V single supply operation
- Operating temperature(Ta): -40°C to 85°C

Main Applications

- Building automation
- Smart home and building
- Appliances
- Healthcare and wearable

For Display control

RA6M3

Features for RA6M3

- 120MHz Arm® Cortex®-M4F with 1MB~2MB Flash Memory, 640KB SRAM and 64KB Data Flash to store data as in EEPROM
- Scalable from 100pin to 176pin, with variety of LQFP, BGA & LGA Package options
- TFT Controller with JPEG and 2DG Accelerators & Capacitive Touch Sensing Unit
- Ethernet Controller with DMA, USB2.0 High Speed & Full Speed, CAN 2.0B
- 12-bit A/D Converters & D/A Converter, Programable Gain Amp, and Comparators
- SCI (UART, Simple SPI, Simple I2C), SPI/I2C Multi-master interface/SSI
- QSPI, SD/MMC interface, as well as External Memory Bus
- Sync/Async Cryptographic, Hash, TRNG, and Key management by Secure Engine
- 2.7V to 3.6V single supply operation
- Operating temperature(Ta): -40°C to 85°C/105°C

Main Applications

- Home and building automations
- Home appliances
- Renewable energy & grid

RA8D1

Features for RA8D1

- 480MHz Arm® Cortex®-M85 core with Helium (Arm M-Profile Vector Extension for AI/ML), 6.39 CM/MHz
- Up to 2MB Flash, 1MB SRAM incl. TCM, 32KB I/D caches, 12KB Data Flash
- Graphics LCD controller w/ MIPI-DSI and RGB Interfaces, 2D GPU, 16bit Camera & 32bit SDRAM interface
- Advanced security with TrustZone, Renesas Security IP, Secure Boot, immutable storage, tamper protection
- Rich peripheral set with ADC, DAC, Comparators, Timers and Functional Safety
- Several connectivity options such as xSPI compliant Octal SPI interface with XIP and decryption-on-the-fly, Ethernet MAC with DMA, CAN-FD, USB HS/FS, I2C/I3C, SPI, SDHI etc.
- Operating temperature(Tj): -40°C to 125°C; Operating Voltage: 1.68 to 3.6V; 100-224 pin LQFP and BGA packages

Main Applications

- Industrial HMI
- Machine vision
- Home/Building/Office automation
- Consumer/IoT
- Voice and vision AI
- Medical/Healthcare

For Touch Key control

RA2L1

Features for RA2L1

- 48MHz Arm® Cortex®-M23
- 128kB/ 256kB Flash Memory and 32kB SRAM(ECC support), 8kB Data Flash
- Scalable from 48pin to 100pin packages
- Internal DCDC converter
- Capacitive Touch Sensing Unit (CTSU2)
- 32-bit general PWM timer, 16-bit general PWM timer, low power AGT, RTC
- 12-bit ADC, 12-bit DAC, LPACMP
- CAN
- SCI (UART, Simple SPI, Simple I2C), SPI/I2C Multi-master interface
- 1.6V to 5.5V single supply operation
- Operating temperature(Ta): -40°C to 85°C and -40°C to 105°C

Main Applications

- Building automation
- Consumer applications
- Home appliances
- Industrial automation
- Medical & healthcare
- General purpose

RA4M3

Features for RA4M3

- 100MHz Arm® Cortex®-M33 with 1 MB Flash Memory and 128kB SRAM (64kB wECC)
- 8KB Data Flash to store data as in EEPROM
- 1kB Stand-by SRAM
- Scalable from 64pin to 144pin packages
- Capacitive Touch Sensing Unit (CTSU)
- USB2.0 Full Speed, CAN 2.0B
- SCI (UART, Simple SPI, Simple I2C)
- SPI/I2C Multi-master interface, SDHI/QSPI/SSI/ Serial Sound Interface
- Secure Crypto Engine SCE9
- 2.7V to 3.6V single supply operation
- Operating temperature(Ta): -40°C to 85°C/105°C

Main Applications

- Industrial automation
- Building automation
- Security

RA6M5

Features for RA6M5

- 200MHz Arm® Cortex®-M33 with Trustzone,1MB~2MB Flash Memory and 512KB SRAM
- 8KB Data Flash to store data as in EEPROM
- Scalable from 100pin to 176pin, with variety of LQFP, BGA Package options
- Capacitive Touch Sensing Unit (CTSU)
- Ethernet Controller with DMA, USB2.0 High Speed & Full Speed, CAN FD
- SCI (UART, Simple SPI, Simple I2C) and SPI/I2C Multi-master interface, SSI
- Quad/Octa SPI, SD/MMC interface, as well as External Memory Bus
- Sync/Async Cryptographic, Hash, TRNG, and Key management by Secure Engine
- 2.7V to 3.6V single supply operation
- Operating temperature(Ta): -40°C to 85°C and -40°C to 105°C

Main Applications

- Industrial automation
- Building automation
- AI voice recognition
- Security

Renesas Electronics Corporation TOYOSU FORESIA, 3-2-24 Toyosu, Koto-ku, Tokyo 135-0061, Japan

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