

BUILDING AUTOMATION

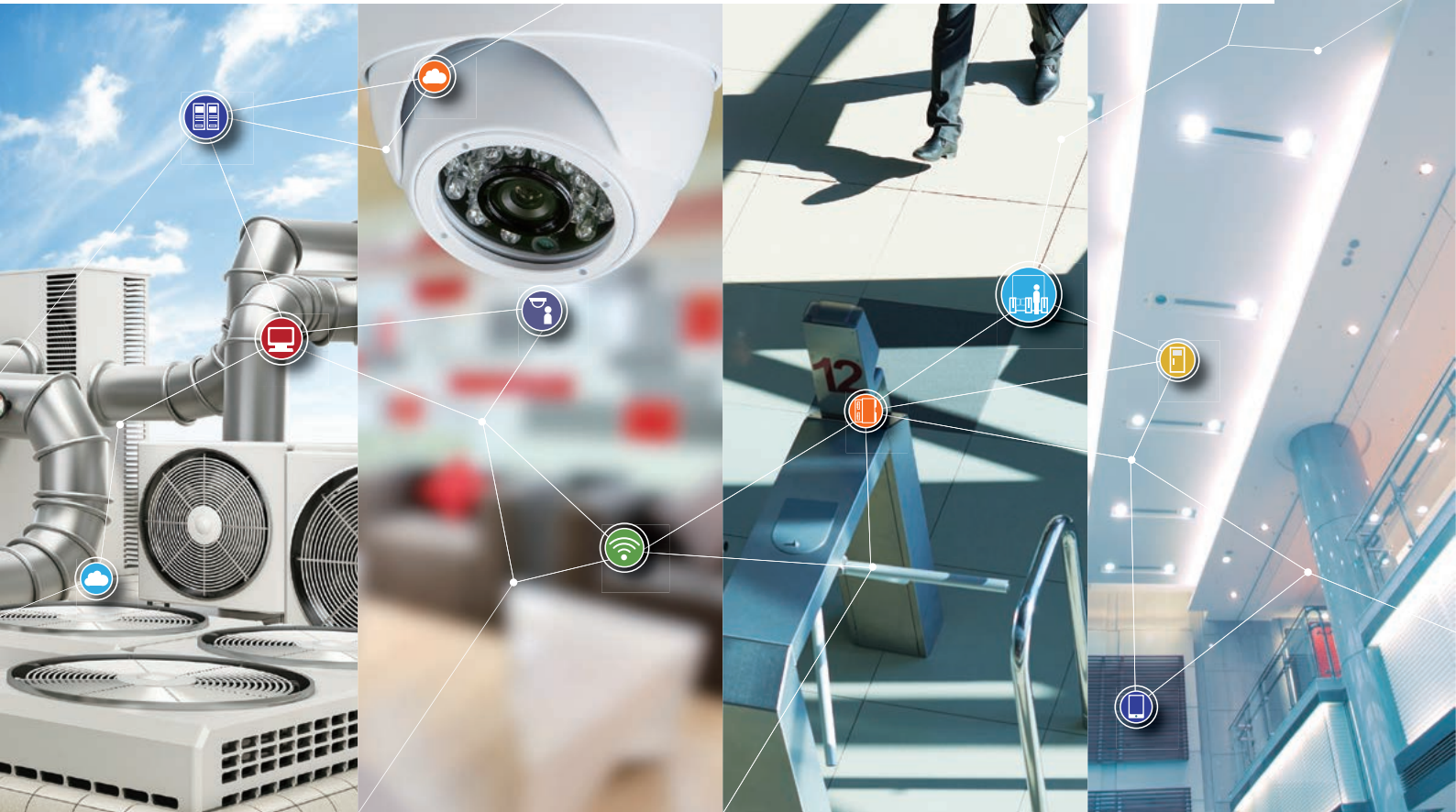
Leading-edge IoT solutions for HVAC, fire/safety, building security, and lighting



BUILDING AUTOMATION

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

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

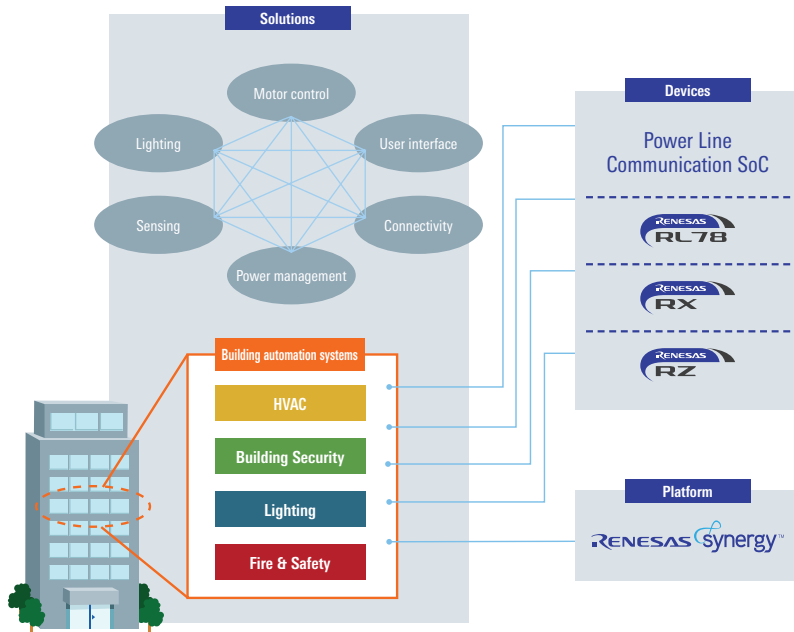


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RENESAS TECHNOLOGY FOR BUILDING AUTOMATION

Building Automation System Configuration

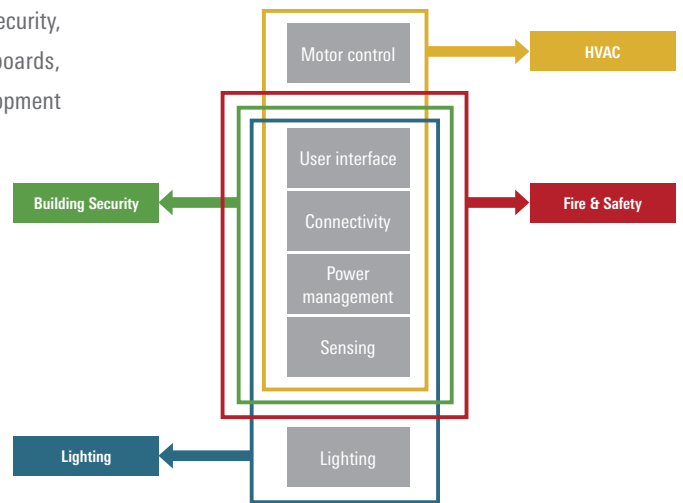


Building Automation Solution Devices and Platform

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

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

* HVAC: Heating, Ventilation, and Air Conditioning



Web

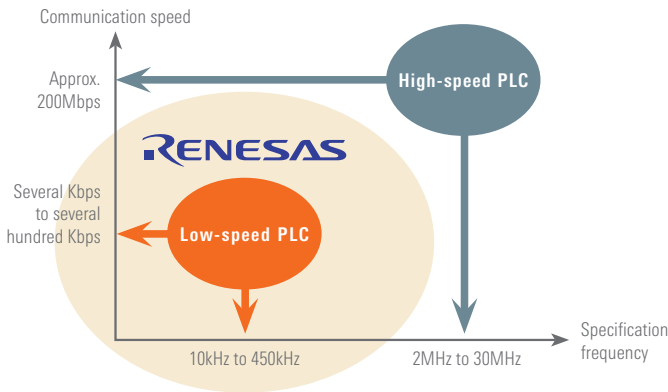
<https://www.renesas.com/solutions/building-automation.html>

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

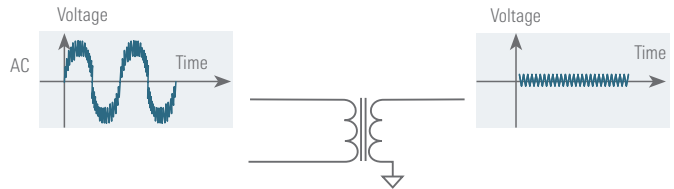
KEY BUILDING AUTOMATION COMMUNICATION TECHNOLOGIES

Power Line Communication (PLC)

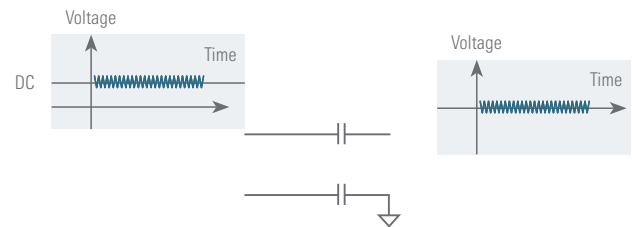
Power Line Communication, abbreviated PLC, is a technology that allows power lines to be used for data communication by transferring data over existing power lines. There are “low-speed” and “high-speed” versions of PLC, each of which uses a different communication protocol. The frequencies used for each are stipulated in Japan by the Radio Law and in other countries by local communication regulations. In addition, it is possible to make the same device compatible with both AC and DC power supplies by changing the peripheral circuits. Placing the focus on the ability to **connect**, Renesas offers products that support low-speed PLC for building automation applications.



[AC power supply] Uses a transformer to remove AC components.



[DC power supply] Uses a coupling capacitor to remove AC components.



Strengthening Internal Building Communication Networks and Related Issues

A variety of communication networks are used in a typical building for applications such as HVAC, fire and safety, building security, and lighting. Also in use are information gathering (sensing) functions to provide safety, security, and comfort, and this further increases the volume of data to be handled. Renesas PLC technology provides the means to solve issues such as the following.

Issues When Constructing Building Communication Systems

Maintaining connectivity

Obstacles such as walls and ceilings, long distances

Adding more communication terminals

Increasing communication speeds, adding contact points

Increased costs from installing cables

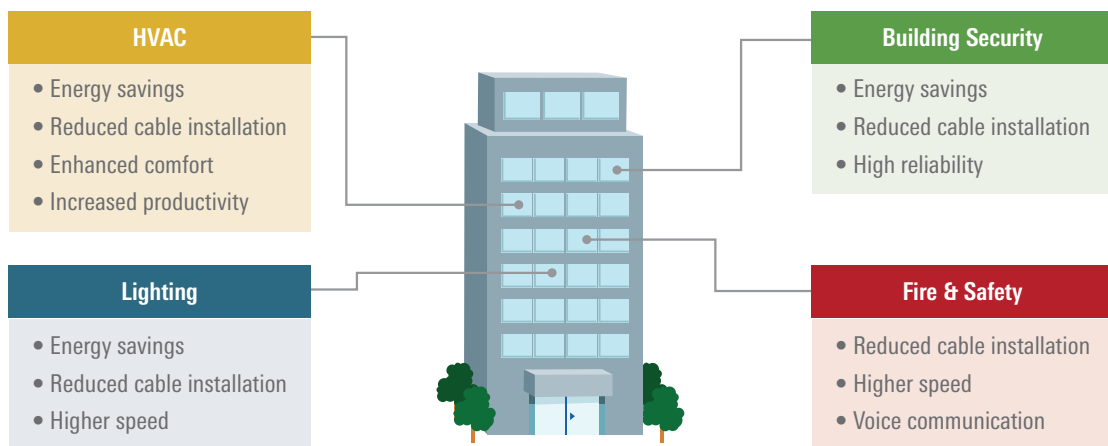
Reducing wiring and labor costs

Using Renesas PLC Technology to **Connect**

Renesas devices, developed based on knowhow gleaned from the utilization of smart meters in many countries, allow advances through software updates.

Examples

- Algorithms and parameters can be updated flexibly to match the installation environment.
- Software can be updated to match local regulations.
- Processing can be modified to increase noise tolerance.

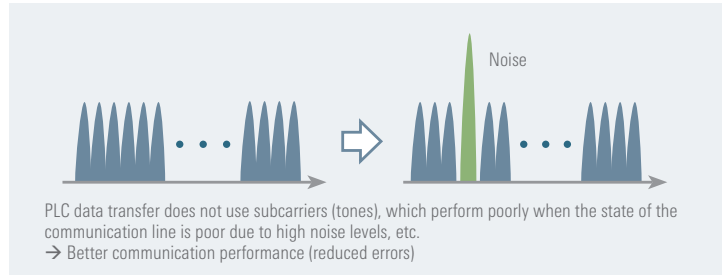
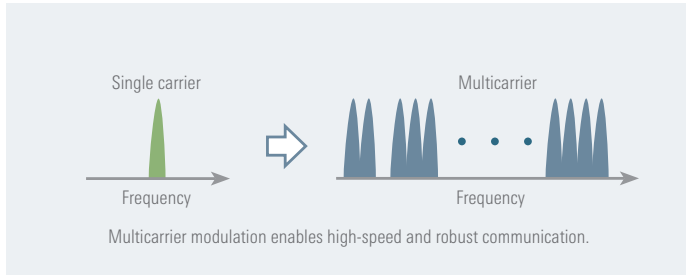


Connectivity Technology That Solves a Variety of Problems

Renesas PLC devices eliminate a variety of issues by reducing cable installation while providing high speed and high reliability. This technology allows power lines to be used as communication lines for transmitting sensor data, audio data, images, and more.

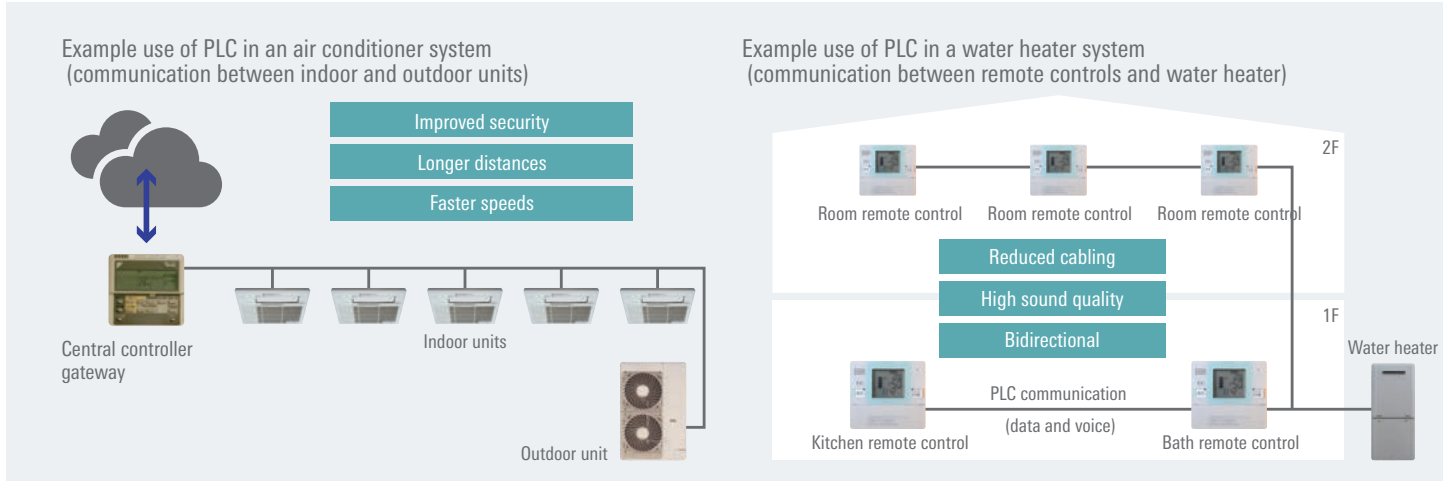
Features of Renesas PLC include:

- Ability to use power lines as communication lines, reducing cable installation.
- Use of multicarrier technology such as orthogonal frequency division multiplexing (OFDM) for high-speed and robust communication over long distances
- DSP-based software modem easily accommodates updates to support different standards or boost performance.

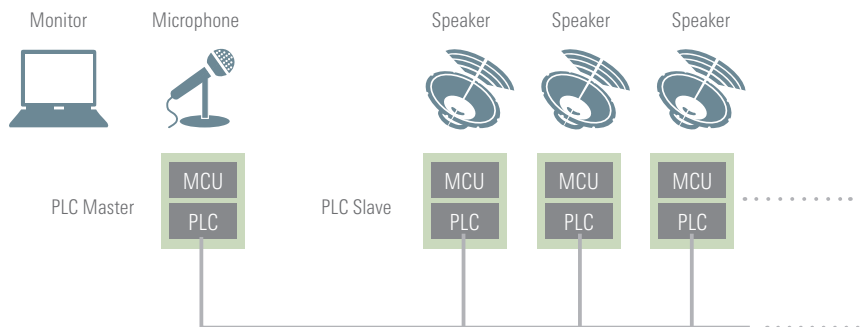


No expensive wiring, such as shielded or twisted-pair cables, is needed, and this contributes to more compact housings and reduced cost. There is no need to worry about issues such as increased complexity and the need for additional wiring to accommodate the increase in various types of information collection and use of sensors, and it is not necessary to install cables when building a new communication network. Some building automation application examples are shown below.

PLC Use Case for Data and Voice Communications



Example of Use of Power Cables as Transfer Routes for Audio Data



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.

The chiller refrigerates water for use as a refrigerant, circulates it to the various rooms, and exchanges heat. The cooling water gradually becomes warmer, and in the cooling tower on the roof it is chilled through contact with air and then reused. Pumps are used to recirculate the water.

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.

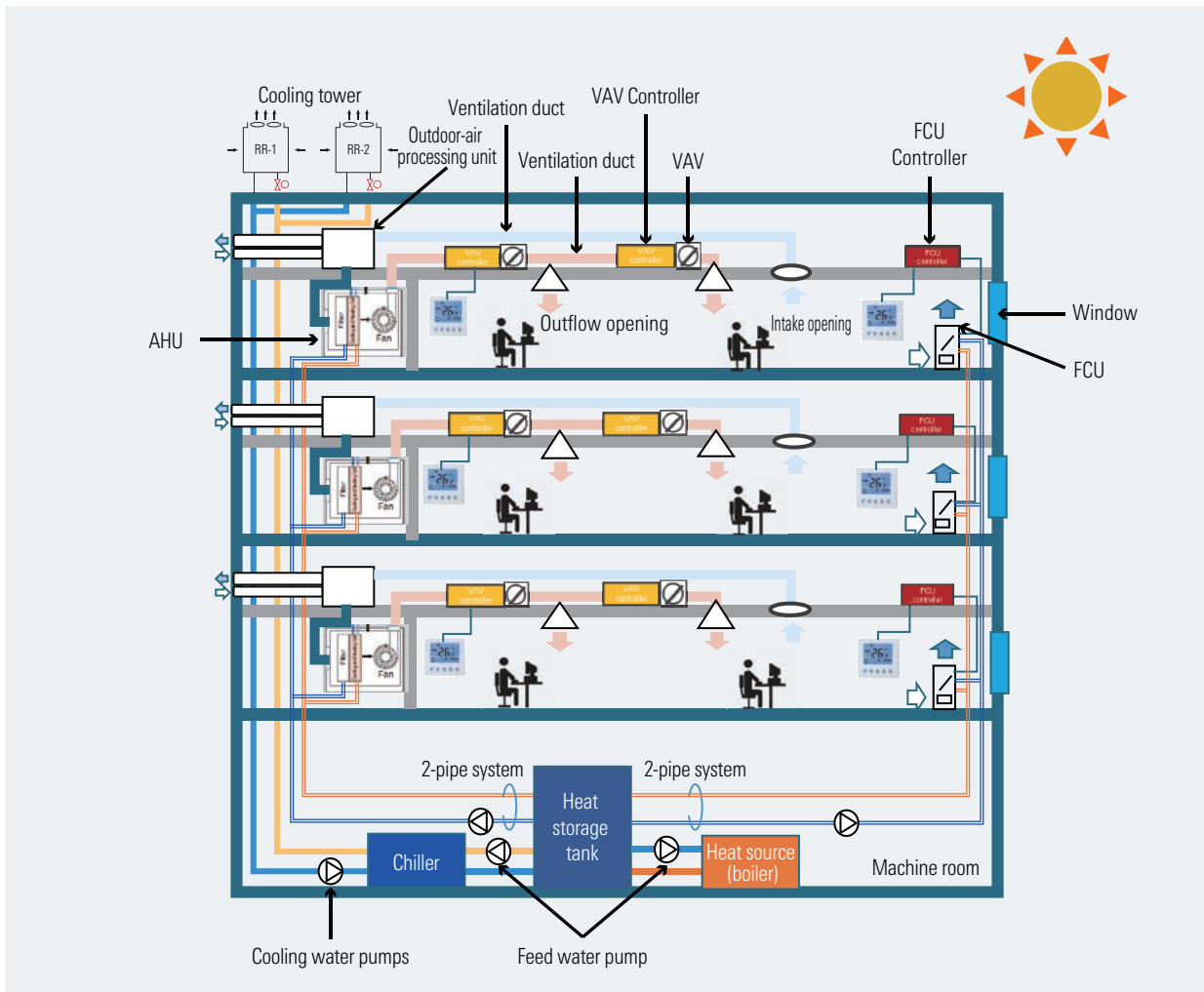
Either a pair of two pipes or a set of four pipes can be used to circulate the cold or hot water. There are outgoing and incoming hot-water and cold-water pipes used to distribute the hot and cold water to air handling units (ACUs), fan coil units (FCUs), etc. In a two-pipe system the same pipes are 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 ACUs, 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. An 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 or 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 independently 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).

Figure 2 Individual Air Conditioning System

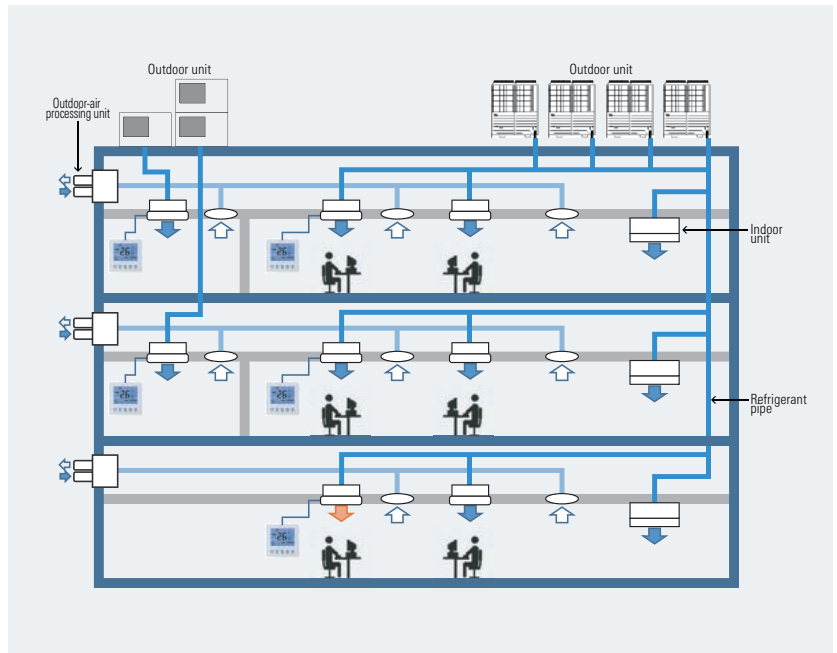
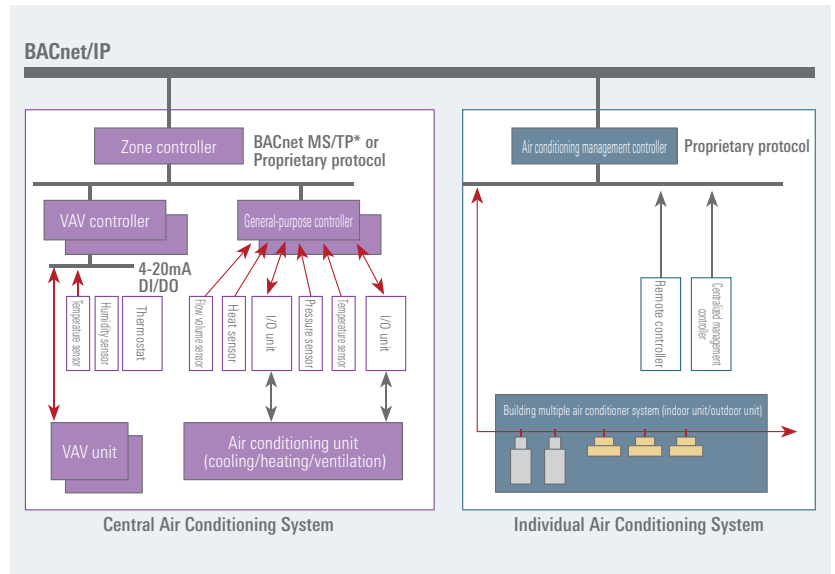


Figure 3 Overview of Building Air Conditioning Communication Network



HVAC User Interface

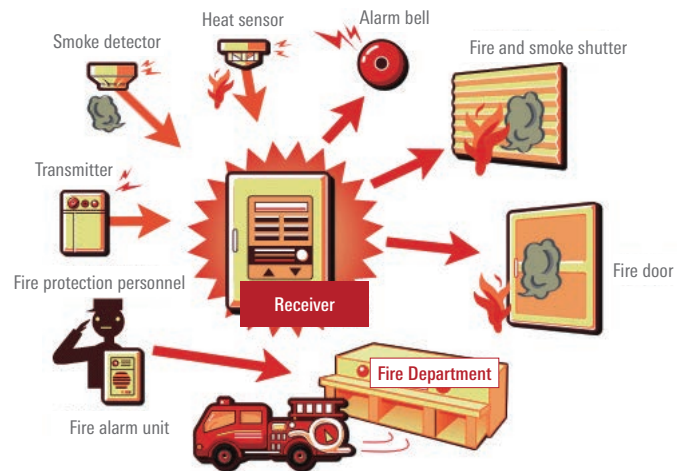
Some remote controllers for indoor unit temperature setting utilize screen-based interfaces. The recent trend is away from using conventional mechanical keys (mechanical switches) and toward the use of touch panels. These touch panels must be able to withstand demanding environmental conditions, including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

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

FIRE AND SAFETY SYSTEMS

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

■ Figure 1 Fire Detection and Notification



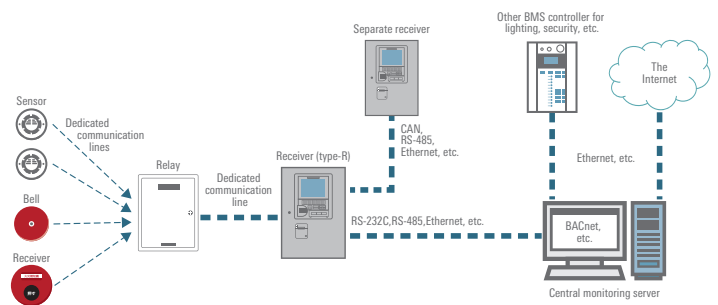
Source: Japan Fire Alarms Manufacturer's Association

Automatic Fire Alarm Systems

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

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

■ Figure 2 Example Type-R Receiver and Peripheral System



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

■ Figure 3 Photoelectric Spot Sensor



Source: Japan Fire Alarms Manufacturer's Association

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 radio band (in the case of Japan).

Renesas offers the following solutions for fire and safety systems.

Sensing (Sensors for Detectors)

Smoke detectors

Carbon monoxide detectors

Recommended devices: RL78/11D, analog circuits, low power
(ideal for op-amp and battery powered applications)
RL78/11E, advanced functionality analog circuits
(24-bit $\Delta\Sigma$ ADC, configurable amplifier, etc.)

HMI (ingress and egress management)

Human-machine interface (HMI)

Capacitive touch panel

Recommended devices: RX130, powerful touch functions
RX231, high-performance 32-bit RXv2 core

BUILDING SECURITY SYSTEMS

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

Monitoring Systems

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

Crime Prevention Systems

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

Communication Networks of Security Systems

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

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

Sensing (Sensors for Monitoring and Crime Prevention)

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

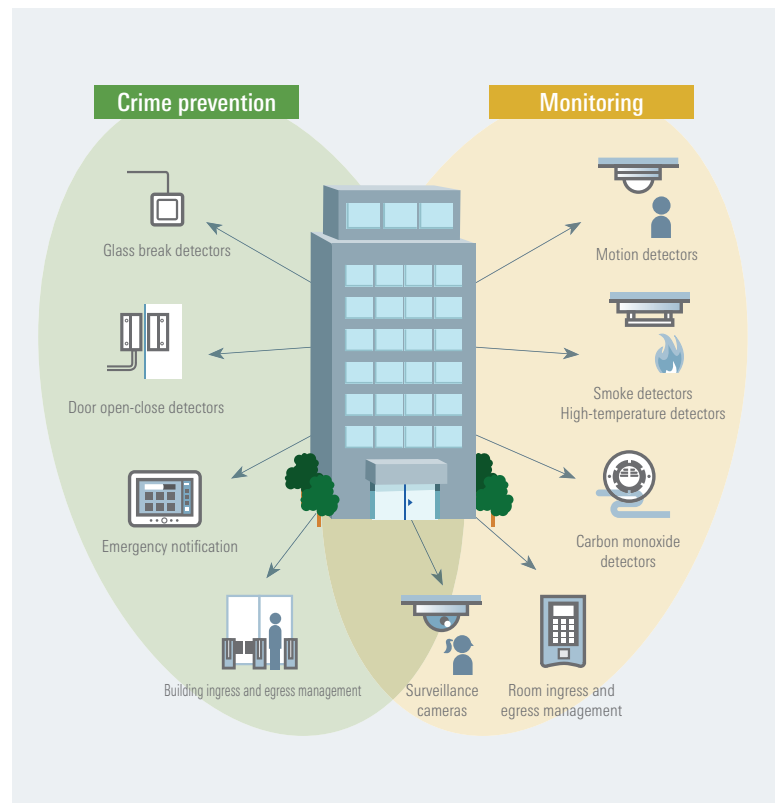
Connectivity (Networks Linking Units and Systems)

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

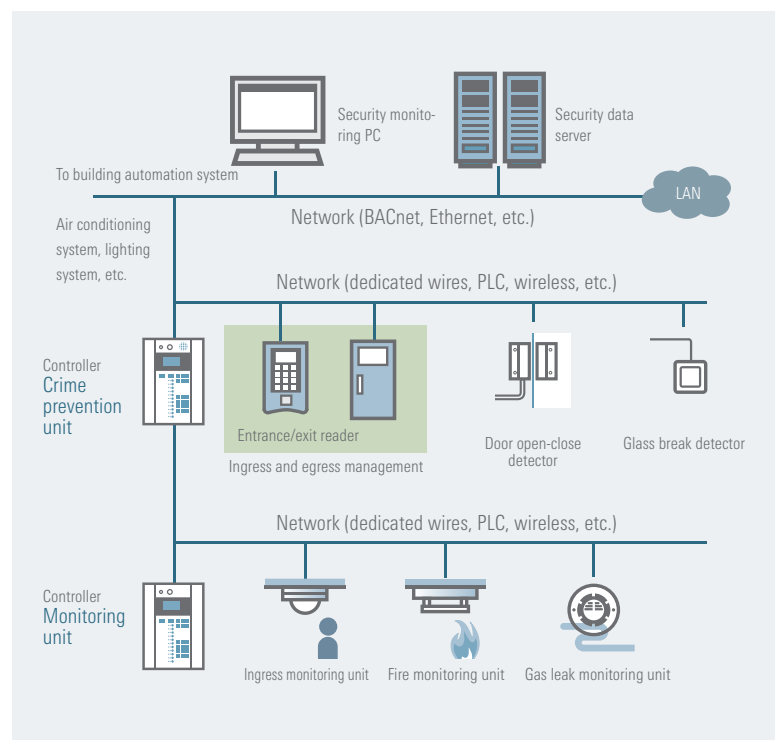
HMI (Ingress and Egress Management)

Human-machine interface (HMI) / Capacitive touch panels

■ Figure 4 Building Security Systems



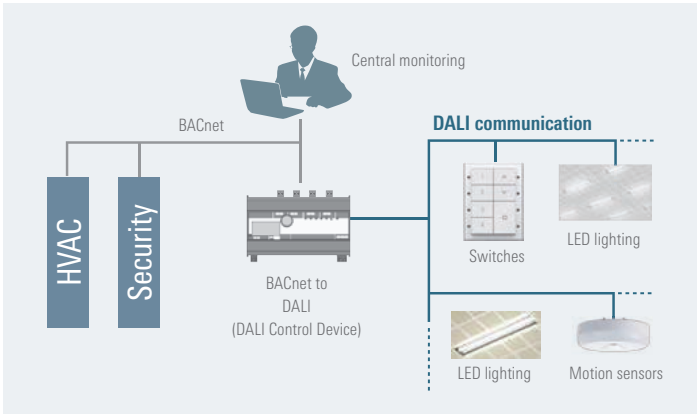
■ Figure 5 Building Security Network



LIGHTING SYSTEMS

LED Lighting Networks

Figure 1 BACnet



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

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

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 normal DALI standard supports a single control device, which can control up to 64 items of control gear.

Figure 2 DALI Standard Listing

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

Source: DALI - a working party of ZVEI

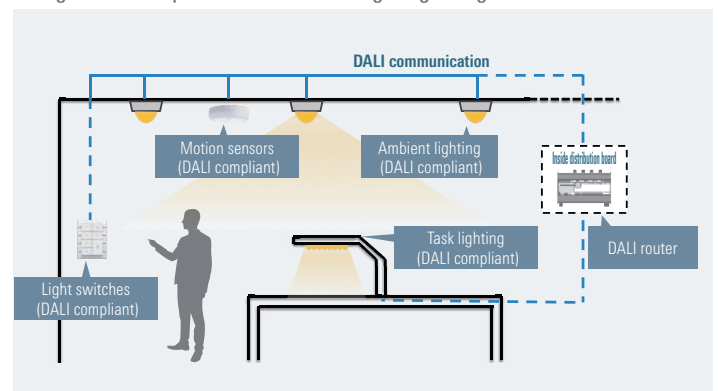
DALI Communication Features

One feature of DALI is that the entire setup is standardized systematically. Figure 2 is a listing of the DALI standard numbers. 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 sensors. Control gear includes lighting fixtures. Upper-level extended standard numbers (2xx) cover characteristics specific to various devices. This means that a variety of lighting products can be developed on a shared foundation. DALI is an open standard, so all products that conform to it can interconnect with each other and the overall system can be controlled in order to reduce energy use. In the past products from one manufacturer could only interoperate with other products from the same manufacturer. With DALI, products from different manufacturers can be controlled in the same manner, to adjust the brightness and color for example. By adopting the international DALI standard it is possible to maximize the energy efficiency of the building's lighting system. Renesas was the first semiconductor device manufacturer to join the DALI standardization organization. This enables up to deliver latest solutions that is included DALI ed.2.0.

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. Task lighting should provide the brightness desired by those in the task area in order to improve work efficiency, while ambient lighting can be energy efficient because it is not necessary to brightly light all parts of the room. In addition, motion sensors can be used to detect when people are around, and the lights can be turned off on floors where no one is present, further saving energy. 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 customer needs (such as communication functions and advances in LED chips). In particular, development of the power supply block, where several functions are concentrated, is a key point. One way to make development more efficient and require less time is to digitize the power supply. Digital power supplies provide three major features.

- **Shorter development time**

It is possible to modify the operation of a digital power supply simply by making changes to the software (parameters). 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 products that match market needs in a short period of time. Figure 4 provides conceptual illustrations of the development processes for a digital power supply and for a conventional analog power supply.

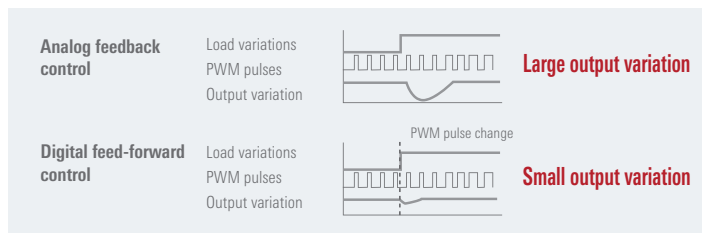
- **Fewer components**

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, microcontrollers designed for digital power supplies integrate essential peripheral functions on-chip, so the cost of external IC devices is greatly reduced. Figure 5 provides an example of the cost reduction made possible by the RL78/I1A.

- **Improved power supply performance**

When a sudden change in load occurs, the output variation is 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 shows contrasting examples of feedback control using analog and digital means.

■ Figure 6 Digitizing the Power Supply for Improved Performance

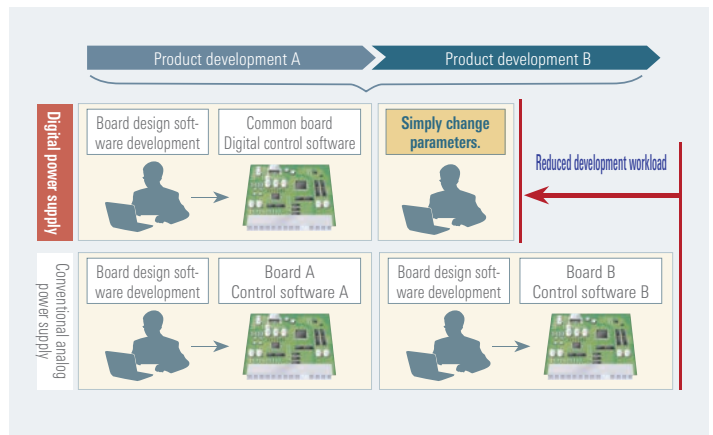


Renesas Lighting Solutions

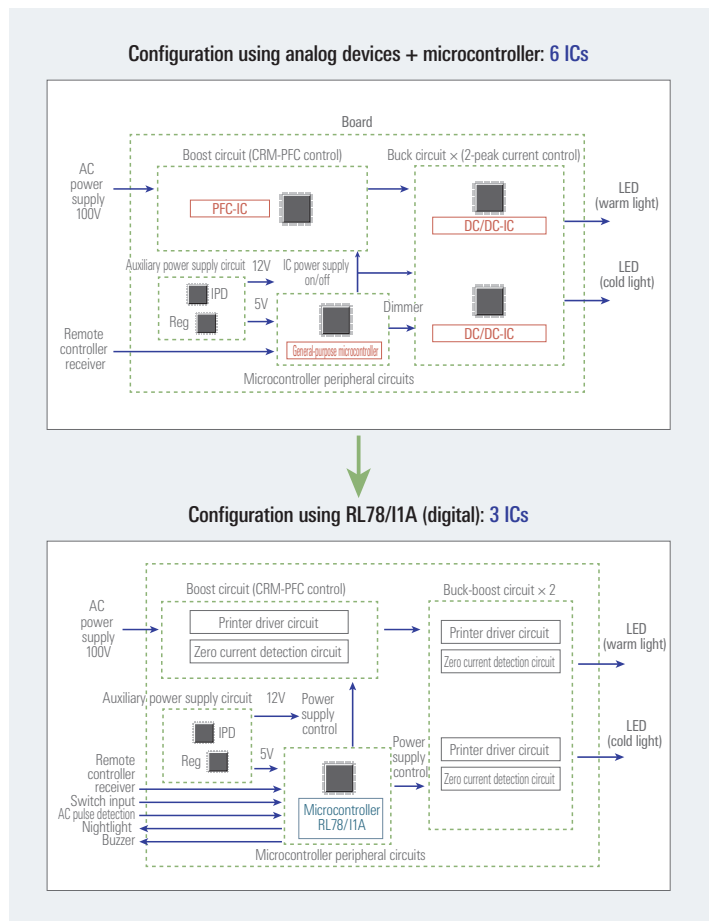
Renesas offers solutions that provide powerful support for customers' product development efforts in areas such as networking and lighting systems employing digital power supplies (Figure 7). These solutions allow customers to focus their development work on giving added value to their products. For details, refer to the lighting solutions on page 18. Also make sure to look into the following types of solutions, which can be applied to lighting applications as well.

- Wireless network solutions
- PLC solutions
- HMI solutions
- Sensing solutions

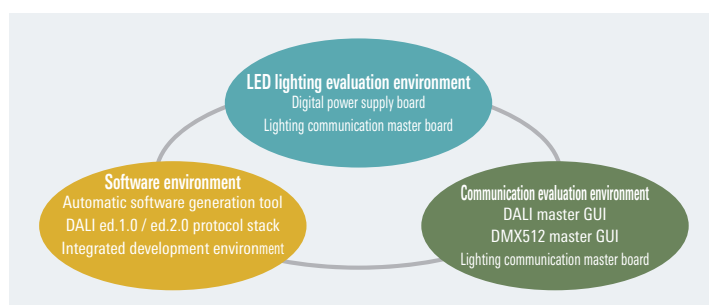
■ Figure 4 Differences Between Development Times for Digital Power Supply and Conventional Analog Power Supply



■ Figure 5 Example of Cost Reduction by Using RL78/I1A



■ Figure 7 Renesas Lighting Solutions



MOTOR CONTROL SOLUTIONS

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

Induction Motor Control Solution

Outline

This solution enables single-phase or three-phase induction motor inverter control (V/F control) using a microcontroller.

Configuration

- Motor control evaluation system for use with RL78/G14.
- Induction motor control software for the target microcontroller is available for download on the Renesas website and can be used in conjunction with inverter boards from our partner vendors.

Applications

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

RL78/G14 CPU Card



Brushless DC Motor Control Solution

Outline

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

Configuration

- The motor control evaluation board (RX23T) includes a board and a motor for evaluating motor control.
- Motor control software for the target microcontroller is available for download on the Renesas website.
- It is possible to perform evaluation using different microcontrollers for motor control use simply by swapping CPU cards.
- Supports the Renesas Motor Workbench development support tool.
 - Automatic tuning function for vector control (Tuner)
 - Debugging functions optimized for motor control (Analyzer)

Available Software (Devices, Control Methods)

| Control Method | Rotor Detection | RX 23T | RX 24T | RX 24U | RL78 G1F | RL78 G1G | RL78 G14 |
|-------------------------------|-----------------|--------|--------|--------|----------|----------|----------|
| Vector control | Sensorless | ○ | ○ | ○ | ○ | | |
| | Encoder | ○ | ○ | ○ | | | |
| 120-degree conduction control | Sensorless | ○ | ○ | | ○ | ○ | ○ |
| | Hall sensor | ○ | ○ | | ○ | ○ | ○ |

Applications

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

Motor Control Evaluation Board (RX23T)



- Brushless DC motor × 1
- Inverter board × 1
- RX23T CPU card × 1

Renesas Motor Workbench



USER INTERFACE SOLUTIONS

Renesas HMI solutions comprise microcontrollers incorporating exclusive touch panel sensing technology and a custom development environment that facilitates quick development of high-grade products. There are also solutions that can be used to boost legibility and ease of use with interfaces supporting video and 3D-graphics. These solutions support the efforts of customers to develop systems providing high affinity between human and machine and allow users to make the most of the functions they offer. AE-CAP1, with support for capacitive touch, and PE-HMI1, with support for HMI, are available as solutions through the Renesas Synergy™ Platform. For details, refer to Renesas Synergy™ Platform Solutions on page 22.

Capacitive Touch Panel Solution

Outline

With the capacitive touch panel solution customers can use the RX130 or RX231 to develop product interfaces employing touch panels instead of conventional mechanical switches. This solution supports customer's efforts to develop products that can withstand water, dirt, and temperature variations while providing an attractive and sophisticated design.

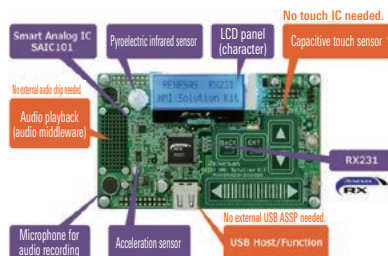
Configuration

- Comprises RX130 or RX231 evaluation system and Workbench6 GUI-based development tool.
- Using the board and software included in the RX130 evaluation system you can get started with evaluation right away.
- The RX231 evaluation system integrates segment LCD display, audio playback, and touch panel circuits, allowing development and evaluation of HMIs and application products.

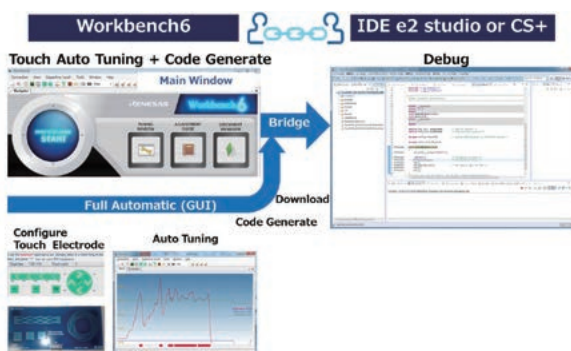
RX130 Evaluation System



RX231 HMI Solution Kit



Workbench6



Applications

For use in the HMI block of HVAC, fire and safety, building security, or lighting systems.

HMI Solution

Outline

This human-machine interface solution (Armadillo-EVA 1500) incorporates an RZ/G Series microcontroller and enables customers to create new value through enhanced expressiveness and video sensing. Intended as an evaluation board for testing and demos, it supports multi-plane video processing, 3D graphics, and a variety of high-speed interfaces.

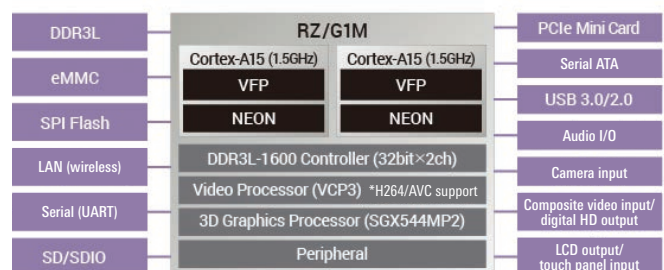
Configuration

- The RZ/G1M evaluation board (Armadillo-EVA 1500) supports the following functions and has Linux installed as standard.
- Related software, documentation, parts lists, circuit diagrams, and additional data sheets are available for download from the Renesas website.
- Touch panel LCD and wireless LAN modules are available as options.

Armadillo-EVA1500 Board



Armadillo-EVA 1500 Function Blocks



Applications

For use in the HMI block of 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

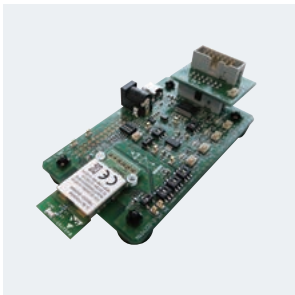
Bluetooth® low energy (BLE) enables low-power data links with devices including smartphones. Customers can use the evaluation board to develop new BLE applications with a BLE system employing the RL78/G1D. The evaluation board is FCC, IC, CE, KC, SRRC, and MIC (Japan) certified.

Configuration

- RL78/G1D evaluation board and BLE control (GUI) tool
 - BLE protocol stack
 - Bluetooth Developer Studio (BDS) plugin
 - GATTBrowser smartphone app for BLE operation confirmation

■ RL78/G1D Evaluation Board

■ BLE Control Tool



Sub-GHz Solution

Outline

Provides support for the Wi-SUN for ECHONET Lite Profile, an international wireless communication standard established by the Wi-SUN Alliance, to enable home energy management applications such as smart meters or home energy management systems (HEMS) to use the ECHONET Lite communication standard wirelessly on the 920MHz frequency band.

Configuration

- RL78/G1H evaluation board as low-power solution
- RX63N + RAA604S00 evaluation board as advanced functionality solution
- Both products include RF driver/MAC stack, IP stack, and RF characteristics evaluation program.

■ RL78/G1H Evaluation Board

■ RX63N+RAA604S00 Evaluation Board



Applications

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

RS-485 Communication Solution

Outline

RS-485 uses differential signaling to enable long-distance data transfer, even under noisy conditions. It also aims to improve and extend the functionality of the earlier RS-422 standard. With RS-485 up to 32 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

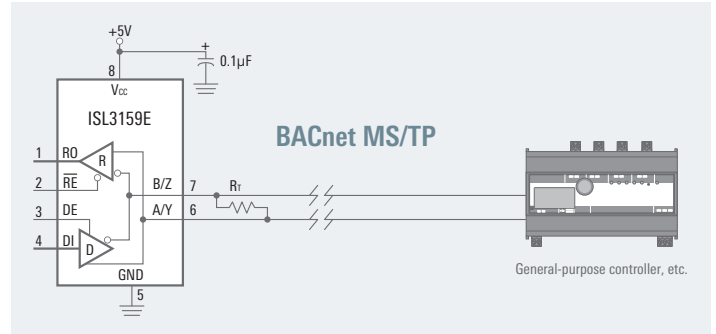
- Extensive product lineup to meet an array of system requirements
- High-speed communication support (up to 100Mbps)
 - PROFIBUS® support
 - Isolated products
 - Operation at 125°C
- Highest level of noise tolerance and ESD protection

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

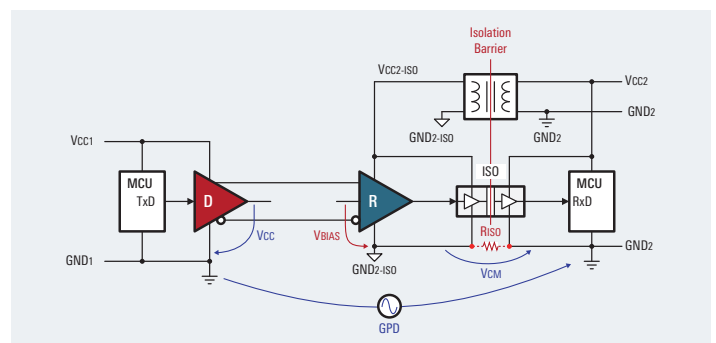
- High output voltage/high noise tolerance (RS485)

ISL315XE: Output voltage of 2.4V (min.), 3.1V (typ.)

- Isolation (RS-485)

ISL32741E/5E: High isolation voltage (6kVrms), High-speed (40Mbps)

ISL32740E: Small QSOP package, High-speed (40Mbps), 125°C operation

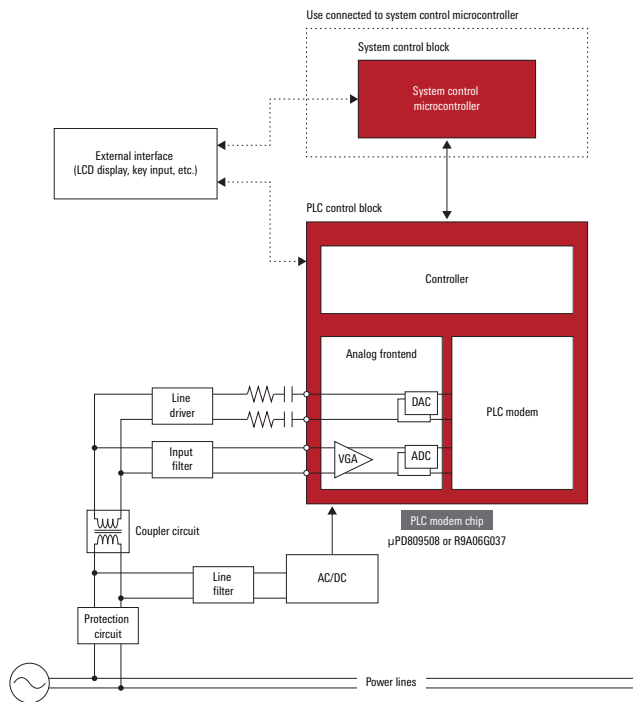


Power Line Communication (PLC) Solutions

Outline

The R9A06G037 PLC modem chip supports the G3-PLC and PRIME powerline communication standards, and the Renesas protocol stack is certified by both alliances. Under G3-PLC support can be added for different regional modem standards (Japan, Europe, and North America) by changing to the appropriate software library (supplied). Available development tools include evaluation boards, protocol stacks, and sample application software.

System Block Diagram



Evaluation Kits

These evaluation kits can be used to develop software for the R9A06G037 PLC modem chip and to evaluate systems using it. Separate kits are available for AC and DC.

• High-Voltage Version: AC 100 to 230V

This kit is certified as special carrier system digital transmission equipment (technically compatible), allowing it to be used as a power line communication device under Article 44, Paragraph 1 of the Japanese Radio Law Enforcement Regulation.

■ J70D2 (RTK0EE0003D02002BJ)



Board Configuration

This product comprises the following three boards:

- 1) PLC board: PLC modem chip and AFE device
- 2) Base board: Power supply circuit and control microcontroller (RX631)
- 3) Filter board: Filter circuit compliant with G3-ARIB standard

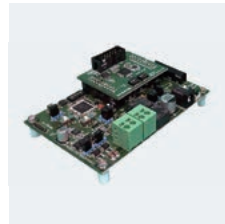
Applications

For communication among units in a building and use in communication blocks of BEMS/FEMS products and smart meters.

• Low-Voltage Version: AC 24V or DC 48V

This kit is a PLC evaluation kit for use with DC power lines. There is also a kit with support for audio communication solutions.

■ J80D2 (RTK0EE0007D02001BJ)

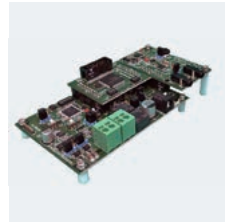


Board Configuration

This product comprises the following three boards:

- 1) PLC board: PLC modem chip and AFE device
- 2) RL78/G13 MCU board: Control microcontroller board (RL78/G13)
- 3) Power supply filter board: Impedance booster and PLC signal elimination filter for DC power supply source

■ J80D1 (RTK0EE0007D01001BJ) Note: Audio support



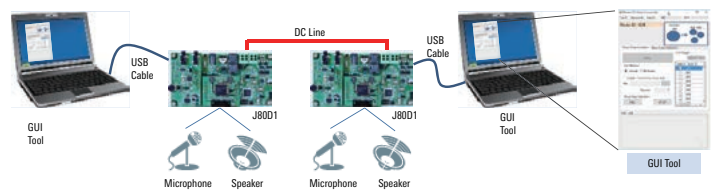
Board Configuration

This product comprises the following four boards:

- 1) PLC board: PLC modem chip and AFE device
- 2) RX651 board: Control microcontroller board (RX651)
- 3) Audio board: Audio input board
- 4) Power supply filter board: Impedance booster and PLC signal elimination filter for DC power supply source

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.



Applications

For communication functions in air conditioner systems, LED lighting systems, solar panel monitoring systems; voice communication functions in alarms, water heaters, etc.; communication between boards in multifunction office machines; etc.

SENSING SOLUTIONS

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

Glass Break Detector Solution

RL78/I1D Detect it!

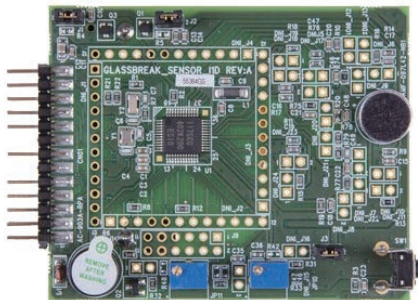
Outline/Features

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

Configuration

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

■ Glass Break Detector Board



Applications

Crime prevention products

Smoke Detector Solution

RL78/I1D Detect it!

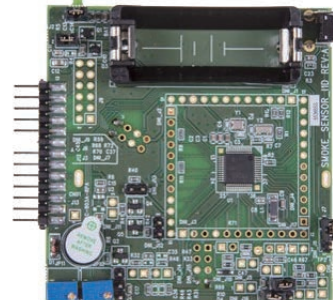
Outline/Features

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

Configuration

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

■ Smoke Detector Board



Applications

Sensors, alarms

Carbon Monoxide Detector Solutions

RL78/I1D Detect it!

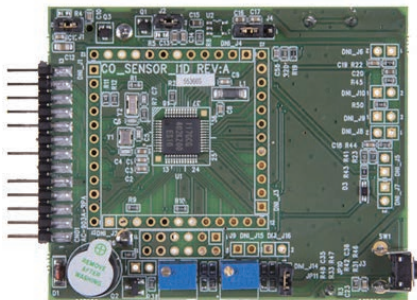
Outline/Features

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

Configuration

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

■ Carbon Monoxide Detector Board



Applications

Carbon monoxide warning systems, carbon monoxide detectors

Motion Sensor Solutions

1) RL78/I1D Detect it!

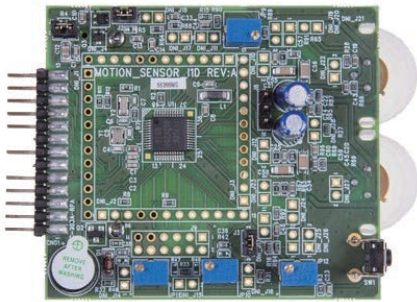
Outline/Features

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

Configuration

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

■ Motion Detector Board



2) RL78 Quick Solution

This is a convenient solution you can use right away for product development. Items available for download:

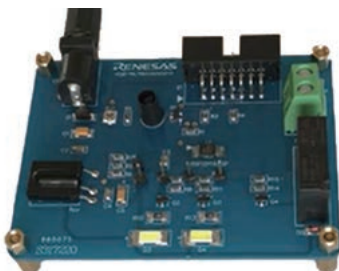
- User's manual
- Sample software source code
- Circuit diagram
- PCB layout data, BOM

Outline/Features

This solution uses an infrared sensor to detect the presence or absence of persons, and turns a high-luminosity LED on and off automatically. It can be utilized as the basis for a wide range of applications, such as controlling lighting in an office or automatic doors. A timer array unit (TAU01) of the RL78/G10 controls transmission of signals by the infrared LED, and a timer array unit (TAU00) and external interrupt pin (INTP0) are used for infrared LED reception control. When the presence of a person is detected, the high-luminosity LED turns on. Ten seconds after the person leaves, the LED turns off and the system transitions the infrared signal to the receive-standby state. Current consumption is among the lowest in the industry, which is ideal for human sensor applications.

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

This is a convenient solution you can use right away for product development. Items available for download:

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

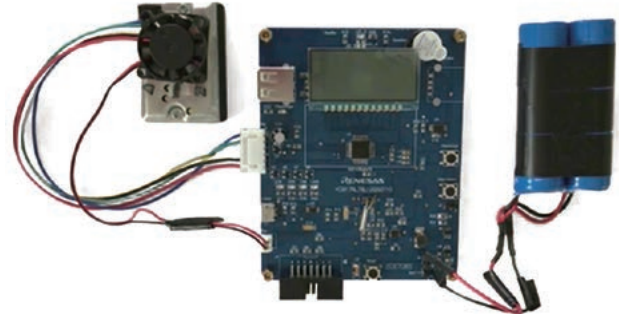
Outline/Features

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, the ISL97656 (DC-DC converter chip) controls battery discharge and the ISL6294 (battery charger chip) 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.



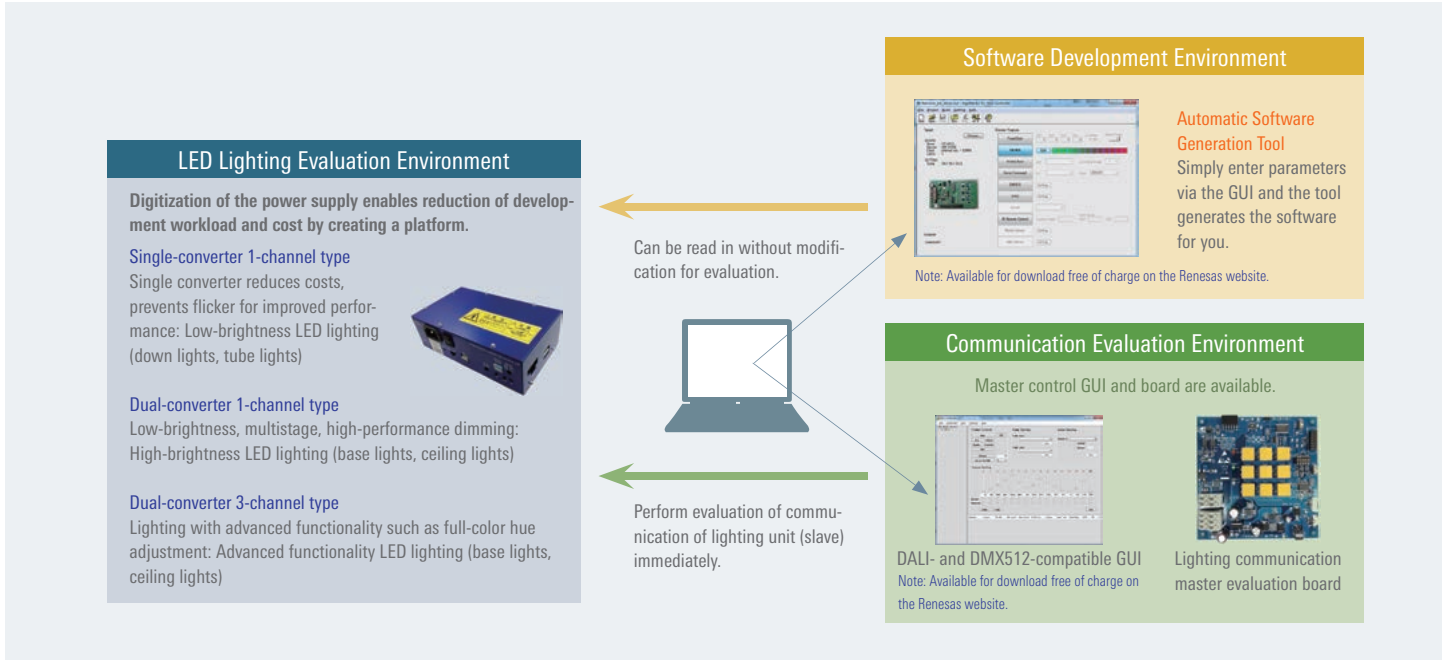
Applications

Air conditioner systems

LIGHTING SOLUTIONS (DALI ED2.0)

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

These solutions consist of an LED lighting evaluation environment, software development environment, and communication evaluation environment.



LED Lighting Evaluation Environment and Communication Evaluation Environment



Several evaluation boards with different topologies and dimmer interfaces are available as LED lighting evaluation environments for a variety of customer applications. Most boards support DALI interface. There is also a lighting communication master board for use as a communication evaluation environment. It can be used for evaluation of communication functions and to support development of lighting controllers (such as switches). Visit the Renesas website for details of each board.

| | AC/DC Single-Converter 1-Channel Output | AC/DC Dual-Converter 1-Channel Output | AC/DC Dual -Converter 3-Channel Output | Lighting communication master evaluation board | Renesas Synergy™ DK-S128 | S128 DALI2.0 Solution Board |
|-------------------------------------------|---------------------------------------------------------|----------------------------------------------------------|-------------------------------------------------------------|------------------------------------------------|--------------------------|-----------------------------|
| Power supply voltage | AC100-240V | AC100-240V | AC100-240V | DC5V | DC5V or USB | DC12V-DC24V |
| Topology | Single-converter (non-isolated) | Dual-converters (non-isolated) | Dual converters (isolated) | — | — | — |
| AC/DC | Flyback(DCM-PFC) | Boost(CRM-PFC) | Flyback(CRM-PFC) | — | — | — |
| DC/DC | — | Buck (low-side drive) | Buck (high-side drive) | — | — | PWM chopper |
| Output (max.) | 60V, 200mA 1 channel (LED single-color applications) | 200V, 250mA 1 channel (LED single-color applications) | 90V/ch, 350mA/ch 3-channel (LED full-color applications) | — | — | 20V 2A |
| Dimmer type (min. dimmer value) | Current dimmer (5%) | Current + burst dimmer (0.4%) | Current dimmer (1%) | — | — | PWM dimming |
| Dimmer interface | Volume SW | DALI2.0*/IR | DALI1.0/DMX512/IR | DALI2.0*/DMX512/IR | DALI2.0 | DALI2.0 |
| Automatic software generation tool | Supported (available free of charge) | Supported (available free of charge) | Supported (available free of charge) | Supported (available free of charge) | — | — |
| Unit size (W × D × H) | 160.4 × 107.6 × 63.8mm | 190.4 × 110.6 × 63.8mm | 240 × 195 × 70mm | 120 × 120mm | 140 × 160mm | 55 × 86mm |

* Supports IEC 62386-102 ed. 2.0 transmission and reception commands.

Software Development Environment (Applilet EZ for HCD)



This tool can be used to create LED lighting software and to write programs to hardware. Simply specify dimmer operations or communication modes in the GUI to generate digital power control (PFC, DC/DC) or DALI/DMX512 communication software. The software created in this way can then be written automatically to the microcontroller's flash memory via a USB cable so that you can check its operation on the evaluation board.

Features

- Dramatically reduces the time required to develop LED control and communication software.
- Allows evaluation of LED lighting or illumination systems without requiring an extensive knowledge of microcontrollers.
- The generated programs can be edited in an integrated development environment (IDE).
- Applilet EZ for HCD is available for download free of charge.

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

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

Automatic software generation tool

Applilet EZ for HCD

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

(1) Generate software by operating a mouse.



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



Single-converter board



Dual-converter boards

Applications

For routers and switches supporting LED lighting and DALI communication.

Library with DALI ed. 2.0 Support



The Renesas LED lighting solution supports the DALI ed. 2.0 international lighting communication standard. Compatible RL78 libraries and Renesas Synergy™ VSAs are available.

Supported standards

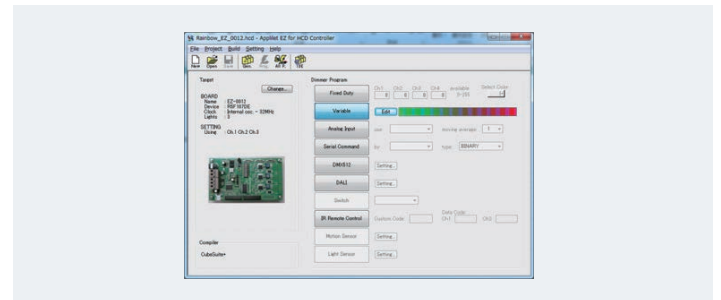
- IEC 62386-102 ed. 1.0, IEC 62386-207 ed. 1.0, IEC 62386-102 ed. 2.0, and IEC 62386-103 ed. 1.0

Features

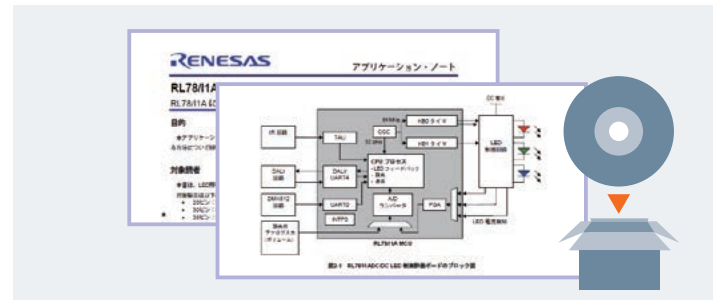
- Automatic software generation tool is simple to try out and use.
- Libraries and VSAs substantially reduce the development workload and time required.
- DALI master control GUI can be used for evaluation.

* The compatible libraries, VSAs, and GUIs differ depending on the product.

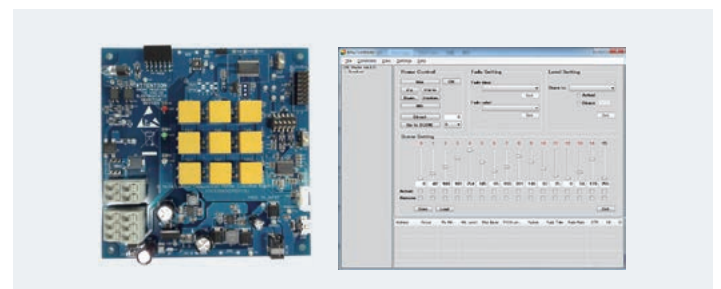
Automatic Software Generation Tool



DALI Library



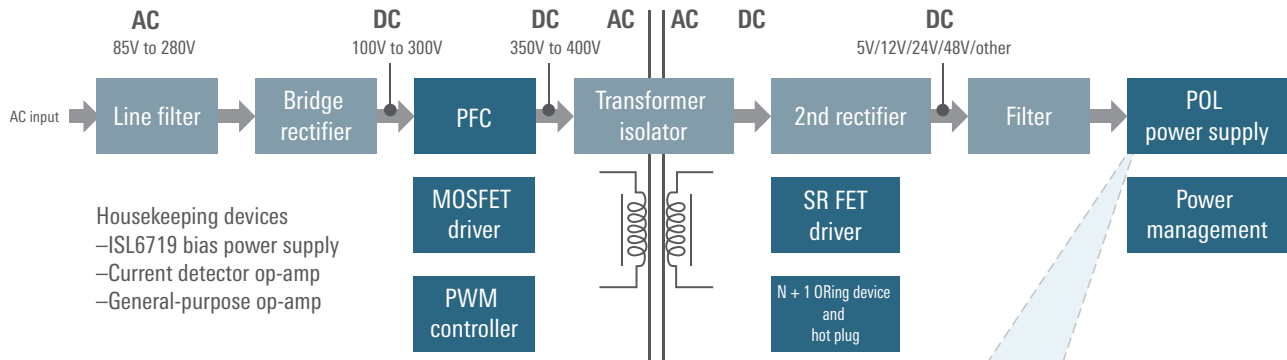
DALI Master Control GUI



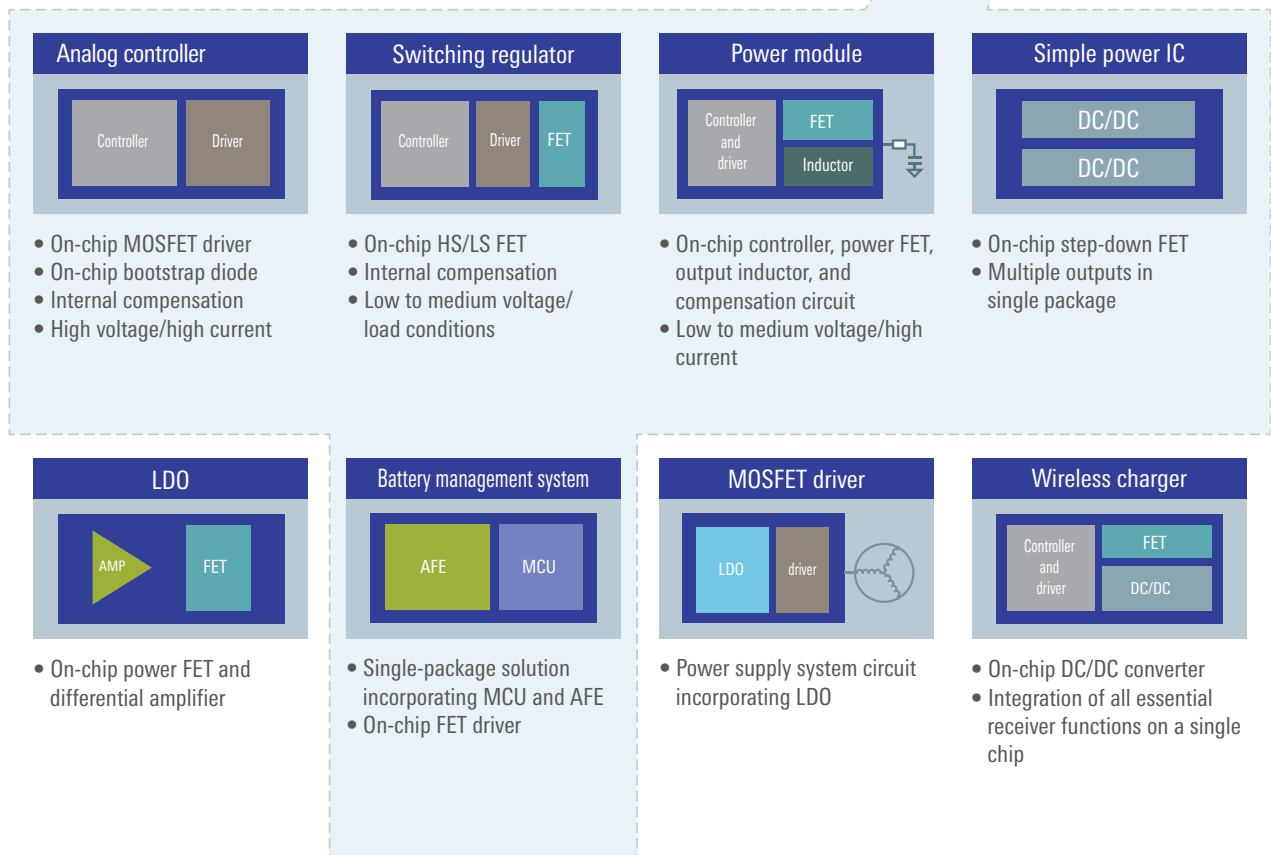
POWER MANAGEMENT SOLUTIONS

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.



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



Analog Controllers

High voltage and high current support to meet current demand for power supplies

Advantages and Main Features

Stability and high performance

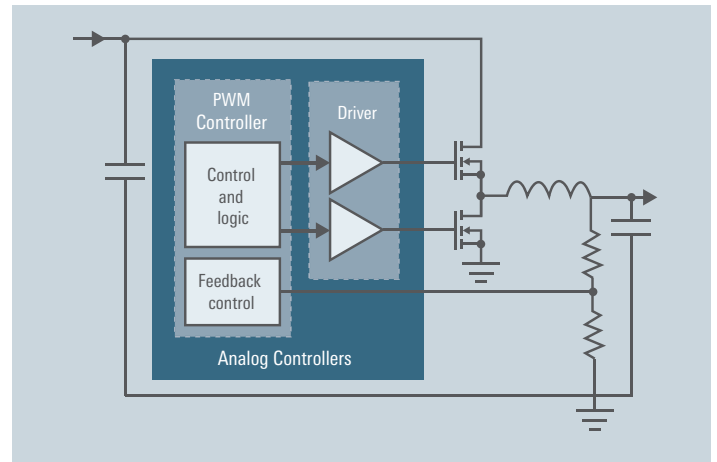
- Wide range of protection functions (OCP, OVP, OTP, SCP)
- Pre-bias startup, external compensation

Extensive product lineup

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

High degree of integration

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



Switching Regulators

Support for wide range of input voltages

Advantages and Main Features

Stability and high performance

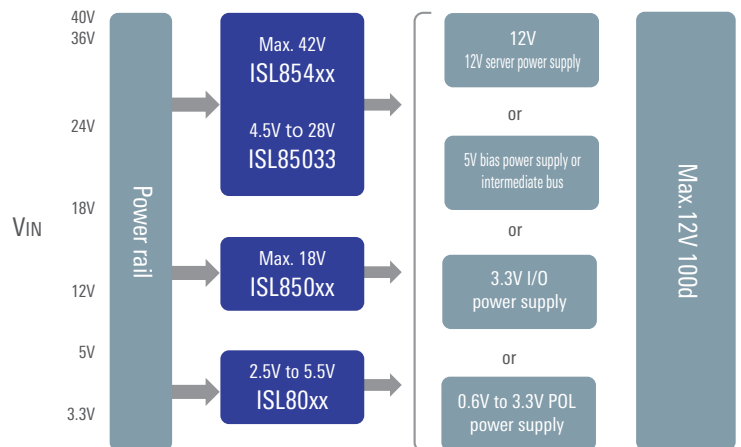
- Power-good, enable, variable software start
- Wide range of protection functions (OCP, OVP, OTP, SCP)
- External frequency synchronization

High degree of integration

- On-chip HS/LS FET
- Internal compensation

Target applications

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



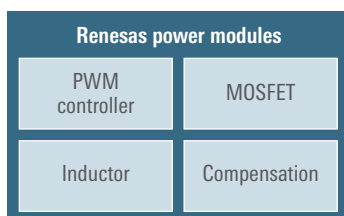
Power Modules

Complete power supply systems composed of capsule-like modules

Advantages and Main Features

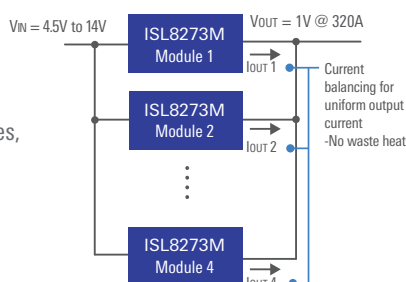
Superior ease of use

- Completely integrated design that reduces complexity and simplifies design



Full functionality

- Numerous functions such as software start, fault protection, parallel modules, and multi-phasing

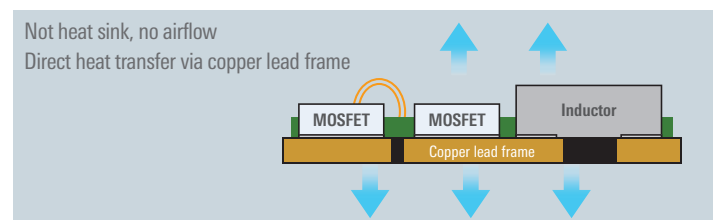


High power density

- Ability to realize up to 250W POL output in a single package

Heat-resistant package technology

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



RENESAS SYNERGY™ PLATFORM SOLUTIONS

Renesas Synergy™ Platform Solutions for the Building Automation Market

Renesas Synergy™ Platform comprises software packages whose operation is warranted by Renesas, scalable microcontrollers, and integrated development tools. The platform is certified for quality, and also includes extensive eco-friendly systems. Renesas Synergy™ Platform provides developers of highly sophisticated embedded applications such as building automation an effective means to bring innovative new products to market quickly.

Reasons to Choose the Renesas Synergy™ Platform



Faster Development

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



Lower Overall Costs

Software whose operation is warranted by Renesas lets developers minimize risks and reduce overall costs, including maintenance.

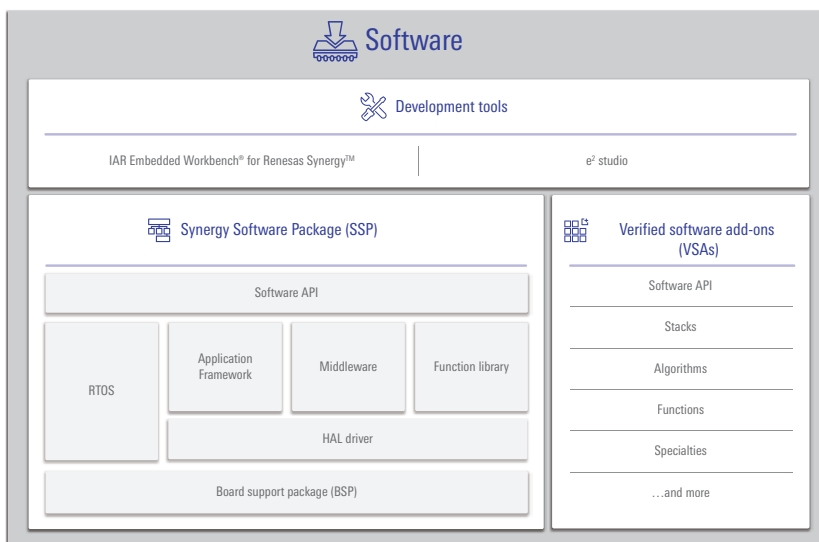


Lower Barriers to Entry

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

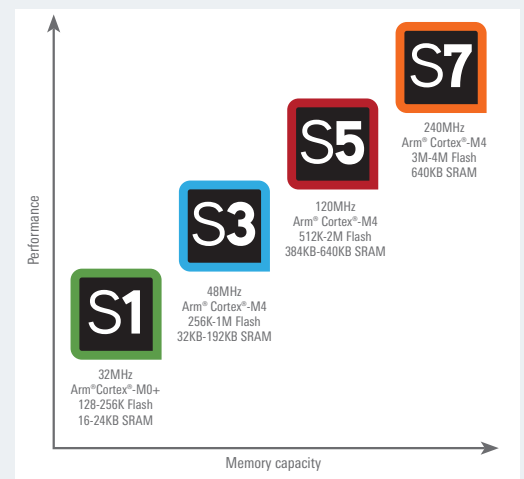
General Structure of Renesas Synergy™ Platform

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



Scalable and Compatible Microcontrollers

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



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

Application Frameworks

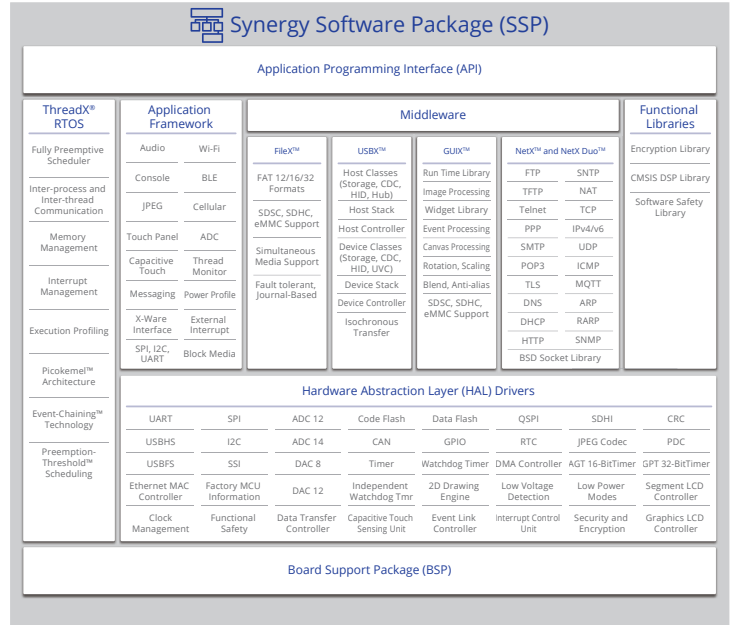
SSP has a rich set of Application Frameworks that provide a set of uniform Application Program Interfaces (APIs) that are useful for the development of target system. These APIs will free developers from worrying about the low-level software such as drivers, middleware or network stacks.

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

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

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

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



VSAs (Verified Software Add-Ons)

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

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

Skkynt ETK: Stack to connect device and cloud. Available from Skkynt.

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

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

* VSA: Verified Software Add-ons

Product Example (PE), Application Example (AE)

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

PE-HMI1

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



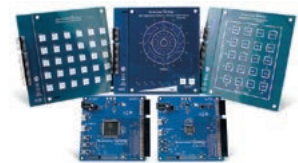
AE-CLOUD1

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



AE-CAP1

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



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

RENESAS SYNERGY™ PLATFORM SOLUTIONS

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

Synergy Platform Technology Matrix for the Building Automation Market

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

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

1. User Interface Solutions

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

2. Connectivity Solutions

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

3. Sensing Solutions

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

4. Motor Control Solutions

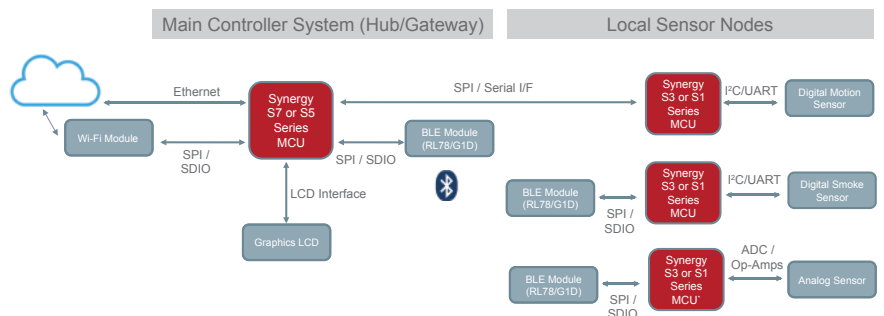
- High-precision timer, PGA, A/D converter, and D/A converter for motor control [MCU]
- Direct access to MCU control registers for real-time control

5. Embedded Security (Common Technology Across Subsegments)

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

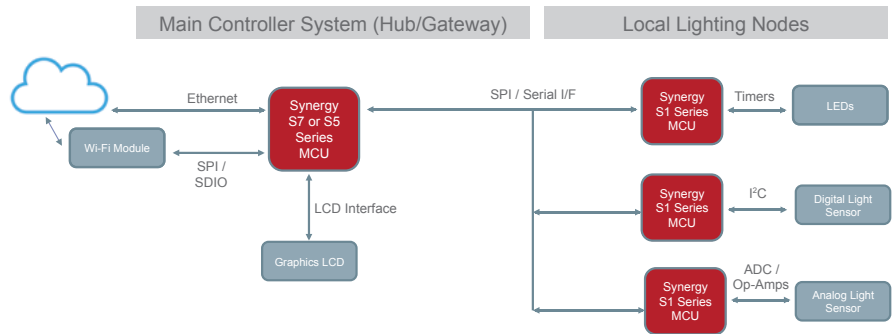
Building Security System Solution Block Diagram

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



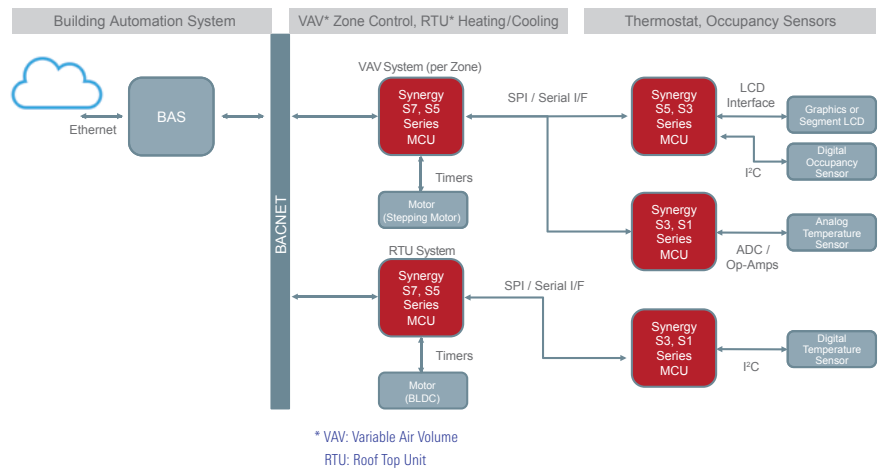
Lighting System Solution Block Diagram

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



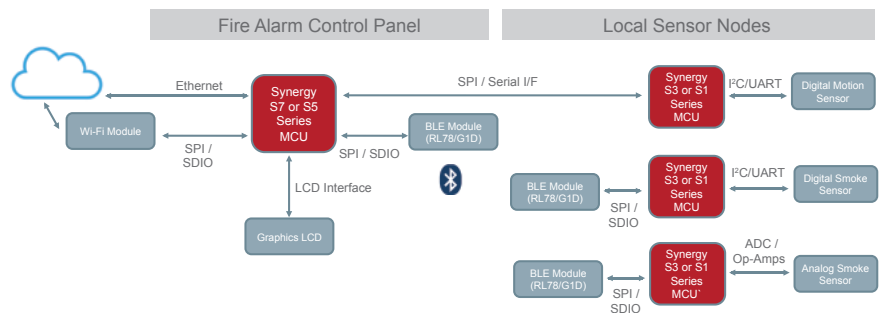
HVAC System Solution Block Diagram

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



Fire and Safety System Solution Block Diagram

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



RECOMMENDED DEVICES FOR BUILDING AUTOMATION

RL78

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

Comprehensive Development Tools

- Integrated development tools for more efficient development
- Support for powerful tools from Renesas partners

Low Power Consumption

- 45.5 μ A/MHz operation*1
- 0.57 μ A (RTC + LVD)
- New SNOOZE mode

Note: 1. Power supply current value during basic RL78/G10 operation

Broad Scalability

- 10 to 144 pins/1 to 512 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

Reduced System Cost

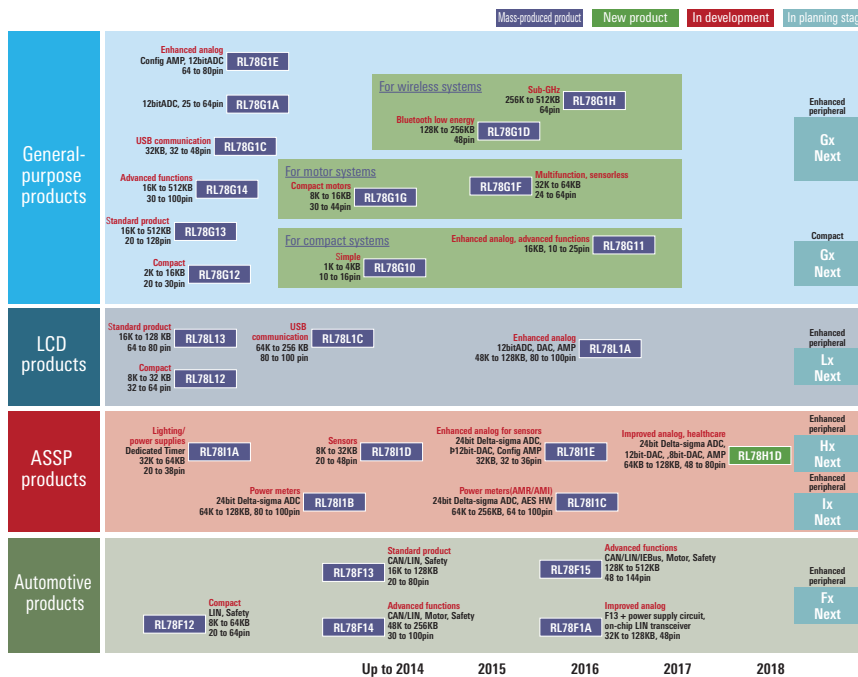
- 32 MHz \pm 1% high-precision on-chip oscillator
- On-chip power-on reset, low-voltage detection circuit, temperature sensor, data flash memory, etc.

High Performance

- High processing performance of 1.39 DMIPS/ MHz
- Support for power supply voltages from 1.6 to 5.5 V
- Max. 32 MHz operation

RL: Renesas Low power
RL products deliver reduced power consumption.

Roadmap of RL 78



RL78/I1x Series

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

Main Features

Feature 1: Powerful analog functions

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

Feature 2: Reduced power consumption

The most advanced low-power functionality in the RL78 Family

Feature 3: High-temperature tolerance

Operation at up to 125°C

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

Note: Functions differ depending on the product.

ASSP for LED Lighting Power Supplies

RL78/I1A

Features

Basic peripheral functions for lighting power supplies

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

Robust connectivity functions

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

Peripheral functions specifically for intelligent and highly efficient operation

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

Main Applications

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



ASSP for Power Meters

RL78/I1B, I1C

Features

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

- Implementation in hardware of functionality essential for measurement

Low power consumption

- Low power consumption during both metering operation and backup operation

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

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

Enhanced security functions and antithetic operation performance

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

Main Applications

- Smart meters
- Eco-friendly meters



ASSP for Sensors and Detectors

RL78/I1D

Features

Low power consumption for extended operation on battery power

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

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

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

Main Applications

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



ASSP for High-Precision Sensing

RL78/I1E

Features

Analog functions for high-precision sensors

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

Compact package, contributing to more compact sensor products

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

High-temperature tolerance

- -40 to 125°C

Main Applications

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

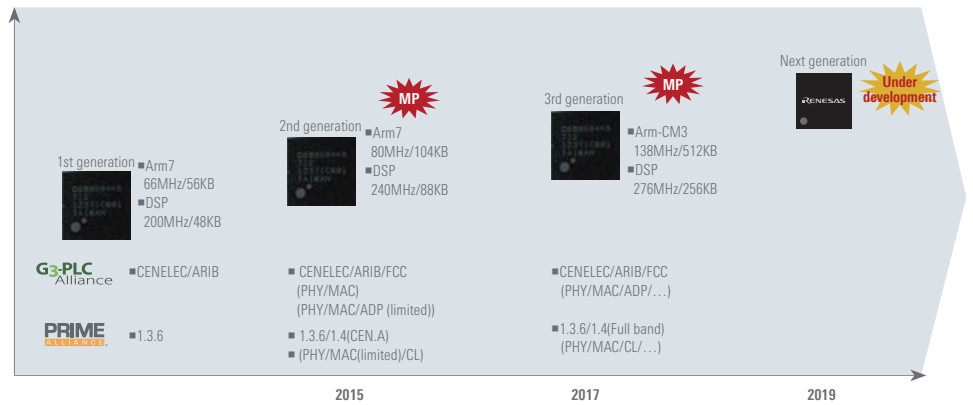


RECOMMENDED DEVICES FOR BUILDING AUTOMATION

PLC Modem IC

PLC transfers communication signals by overlaying them on power lines, turning them into communication lines. No new wiring is required, and the use of power lines enables communication through barriers, such as walls and ceilings, that can block wireless signals. This is why PLC is gaining attention as a key communication tool for use with smart meters (Advanced Metering Infrastructure), HEMS, BEMS, and solar panel monitoring systems that will play key roles in realizing the “smart society” of the future. Both AC and DC power supply lines can be used for data transfer. This provides an effective way to reduce cable installation costs associated with building automation.

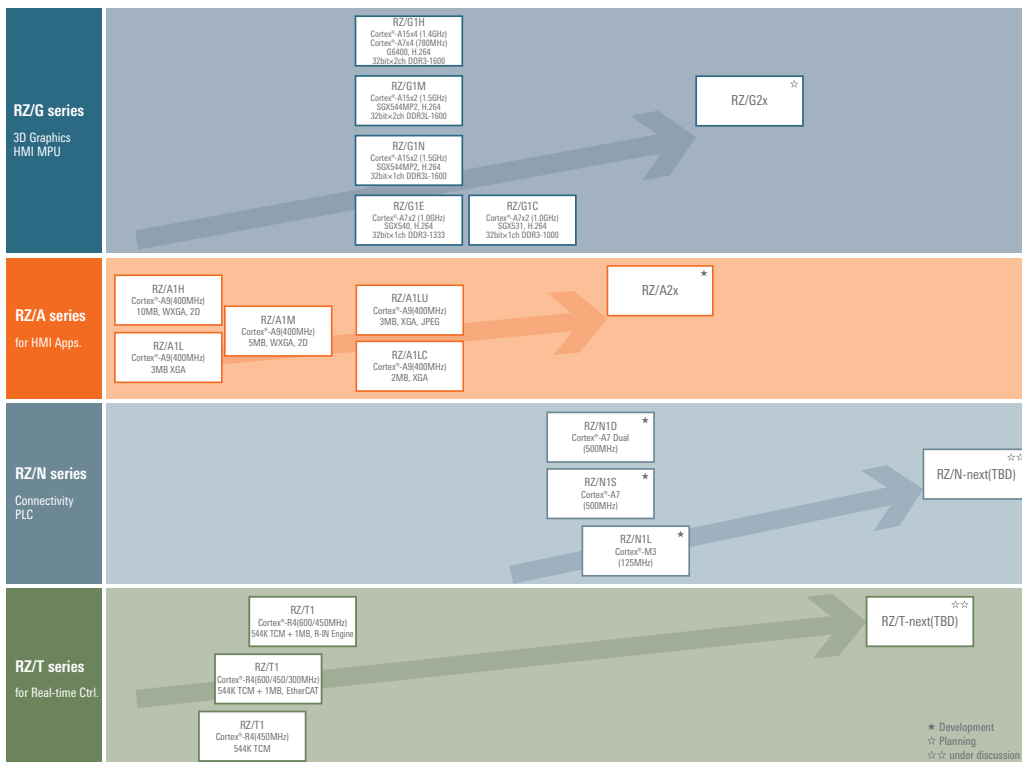
Renesas PLC modem IC support both the G3-PLC and PRIME specifications. The Renesas protocol stack is certified by the G3-PLC and PRIME alliances. With G3-PLC it is possible to make the modem compatible with a variety of regional standards (Japan, Europe, United States) by changing the software library.



RZ

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

RZ Family Roadmap



RZ/A Series application fields

- White goods
- Office equipment
- Surveillance cameras
- Intercoms
- Vending machines



Intercoms

RZ/G Series application fields

- Surveillance cameras
- Digital signage
- Intercoms
- POS



Surveillance cameras

RZ/T Series application fields

- Industrial motors
- Industrial controllers
- Robots
- AC servo drivers



Surveillance cameras

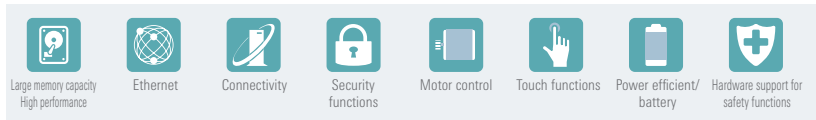
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RX

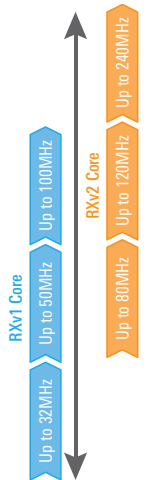
The RX Family is built around an advanced CPU core exclusive to Renesas. This 32-bit CPU core benefits from all the exclusive technology amassed by Renesas over the years and adds enhancements to boost responsiveness and improve power efficiency. It achieves small code size typical of 16-bit CPUs while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

RX Family: Lineup

Unified architecture covering the low end to the high end



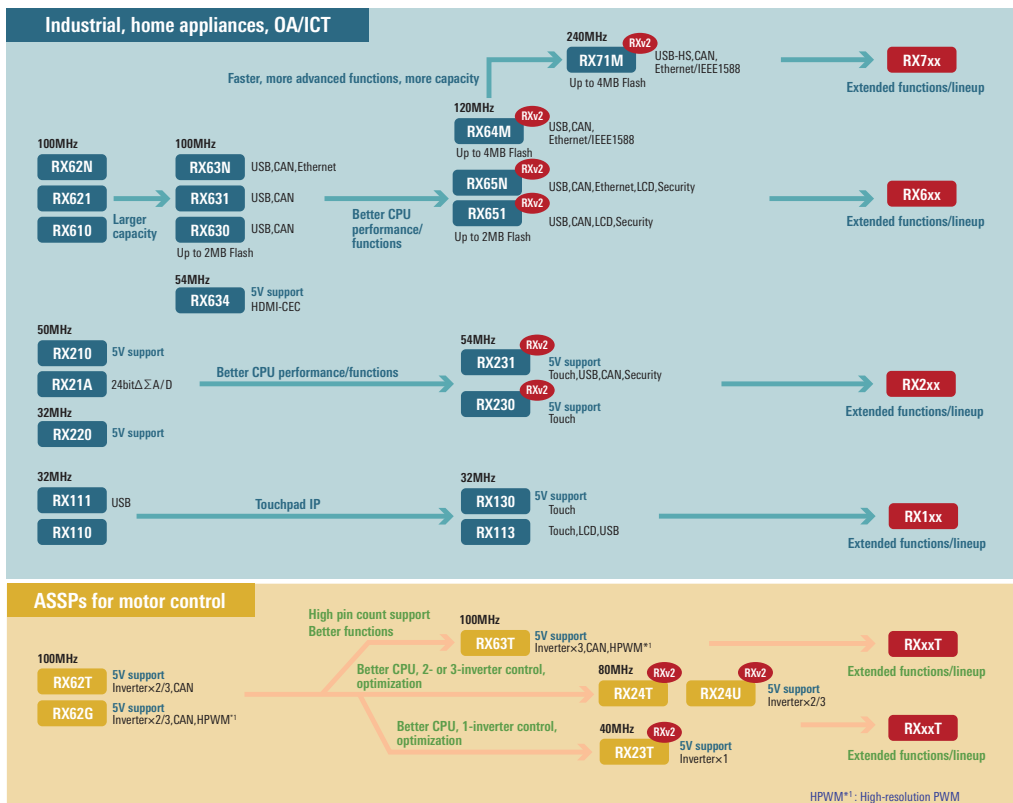
High Performance



| | |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RX700 SERIES | The flagship of the RX family, with the highest speed and best performance Max. 240MHz operation, 4MB flash memory IEEE 1588, Ethernet x 2, USB, CAN |
| RX600 SERIES | The mainstream of the RX family, with high performance and an extensive product lineup Max. 120MHz operation, 4MB flash memory IEEE 1588, Ethernet, USB, CAN, motor control, LCD |
| RX200 SERIES | The best balance between power efficiency and high performance Max. 80MHz operation, 1MB flash memory, 1.62 to 5.5V operation, capacitive touch, USB, CAN, 24-bit ΔΣA/D, motor control |
| RX100 SERIES | The entry-level series designed for ultra-low power consumption Max. 32MHz operation, 8 to 512KB flash memory, 1.8 to 5.5V operation capacitive touch, LCD, USB |



RX Family Roadmap



HPWM*: High-resolution PWM

ECO SYSTEM PARTNER



For more information, please contact
buildingautomation@renesas.com

Expanded horizons, expanded innovation

Effective January 1, 2018, Renesas and Intersil are operating as one unified enterprise, bringing about a significant expansion to the intrinsic capabilities of semiconductors.

This combination unites the widely acclaimed Renesas MCU and SoC technologies with Intersil's market-leading expertise in high performance power management and precision analog devices. In turn, this brings organic growth in the automotive, industrial and broadbased sectors, allowing the new enterprise to respond with greater speed to customers' systems needs.

The union of Renesas with Intersil began with the completion of the acquisition on February 24, 2017, and the unified "One Global Renesas" went into operation across all markets the following July—bringing together the strengths of both organizations in anticipation of customer requirements in a rapidly changing market environment. This truly global organization offers a vast synergistic effect.

Join Renesas as it strengthens its leading position in the global semiconductor market.

About Renesas

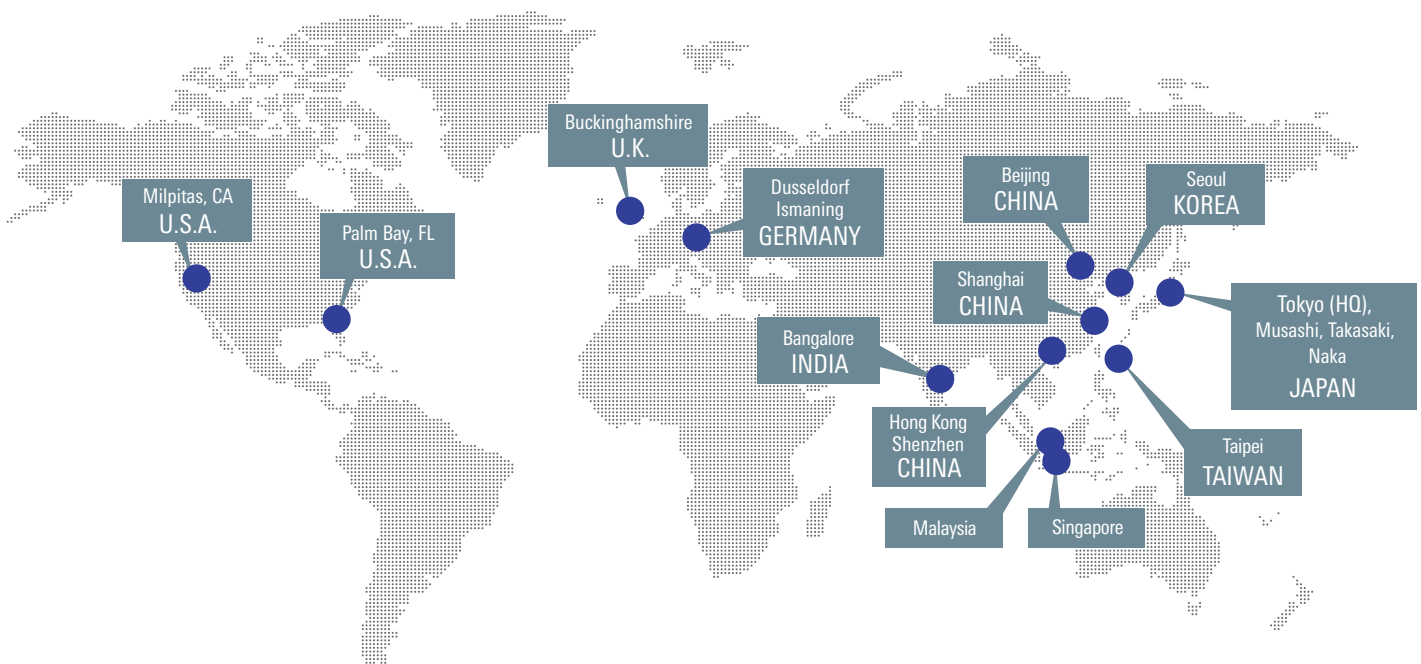
Renesas Electronics delivers trusted embedded design innovation with complete semiconductor solutions that enable billions of connected, intelligent devices to enhance the way people work and live—securely and safely.

The number one global supplier of microcontrollers, and a leader in Analog & Power and SoC products, Renesas provides the expertise, quality, and comprehensive solutions for a broad range of Automotive, Industrial, Home Electronics (HE), Office Automation (OA) and Information Communication Technology (ICT) applications to help shape a limitless future.

Global Network

Responding rapidly to customer needs through strong global operations.

Renesas Main Offices



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(Rev.4.0-1 November 2017)

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