

# RENESAS RL78 FAMILY MICROCONTROLLERS

The True Low Power Microcontroller Platform



# RL78 – TRUE LOW POWER MICROCONTROLLER FAMILY

It enables customers to build compact and energy-efficient systems at lower cost.

The Renesas RL78 is a new generation of power-efficient microcontrollers that combine the excellent CPU performance of the 78K0R with the superior on-chip functions of the R8C and 78K. It delivers higher performance and lower power consumption than previous microcontrollers while enabling customers to utilize software resources developed for the R8C and 78K.

## Comprehensive Development Tools

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

## Low Power Consumption

- 45.5  $\mu\text{A}/\text{MHz}$  operation\*1
  - 0.57  $\mu\text{A}$  (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

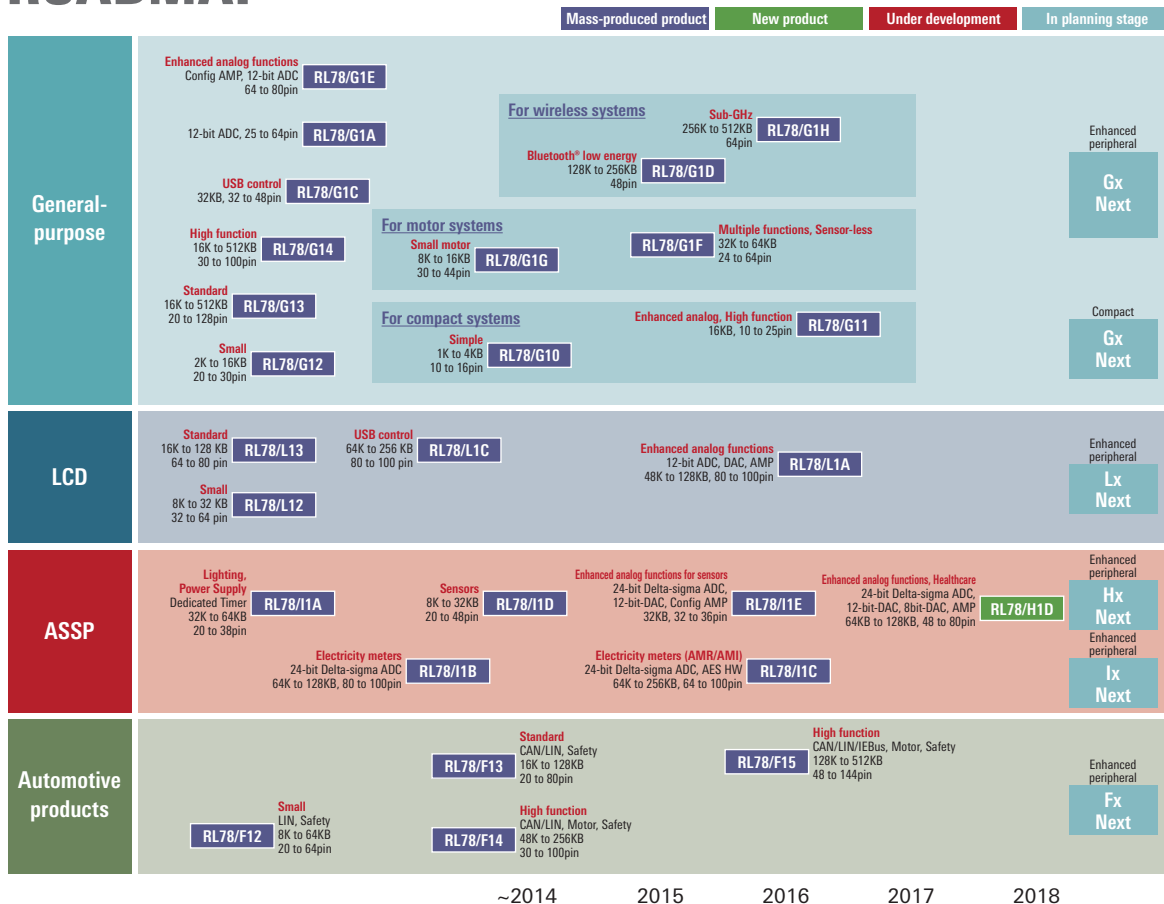
- High processing performance of 1.6 DMIPS/MHz
- Support for power supply voltages from 1.6 to 5.5 V
- Max. 32 MHz operation

RL: Renesas Low power

RL products deliver reduced power consumption.

\* Specifications vary depending on the application. Please refer to each product page for details.

## RL78 ROADMAP



# RL78 FAMILY APPLICATIONS

The RL78 Family is utilized in a wide variety of applications.



## Industrial Automation

**G14** **G11** **I1A** **I1E**

- Lineup of microcontrollers for industrial applications requiring high reliability
- Broad array of compact packages
- Operating temperature range of  $-40^{\circ}\text{C}$  to  $+105^{\circ}\text{C}$ , and support available for higher temperatures



## Automotive

**F13** **F14** **F15**

- Lineup of highly reliable microcontrollers for automotive applications
- Support for high operating temperatures (up to  $+150^{\circ}\text{C}$ )
- CAN communication, safety functions, etc., for automotive applications



## Consumer Electronics

**G13** **G12** **G10**

- Calendar function (RTC) as standard feature
- Serial communication, timers, and on-chip high-speed oscillator as standard features



## White Goods

**G13** **G12** **L13**

- Hardware support for European safety standard for household appliances (IEC60730)
- Standard temperature range of  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ , and support available for higher temperatures
- On-chip high-speed on-chip oscillator, power-on reset, etc., ideal for cost-sensitive electric household appliances



## Lighting, Power Supply

**I1A** **G11**

- High-resolution PWM output for lighting and power supply control applications
- Easy-to-use Applilet software (free of charge) supporting program development for lighting applications
- Support for DALI, DMX512, PMBus, and SMBus communication



## Detector

**I1D** **G11**

- Improved analog functions necessary for detecting very small sensor signals
- Support for power-efficient detection when returning to high-speed operation from STOP mode



## Home Automation

**G13** **G1D** **G1H**

- Power efficiency among the best in the industry for extended battery life
- Support for low-voltage operation (1.6 V to (G1H: 1.8 V and above))
- Standby function with newly added SNOOZE mode for low power consumption during intermittent operation



## Power Tools

**G1F** **G14** **G11**

- Proven track record supplying consistently high-quality microcontrollers over the long term
- Ideal microcontroller platform for system development with lineup covering wide range of memory capacities, pin counts, and package options



## Medical/Healthcare

**L1A** **L13** **I1E** **G1D** **H1D**

- Lineup of compact packages
- Proven track record supplying major medical equipment manufacturers
- Active member of Continua Health Alliance



## Metering

**I1B** **I1C** **L13** **L1C** **G11** **G1H** **H1D**

- Standby function that is ideal for low-power applications such as meters and measuring devices
- On-chip analog functions for smartmeters
- Proven track record supplying the meter field for over 30 years



## Motor Control

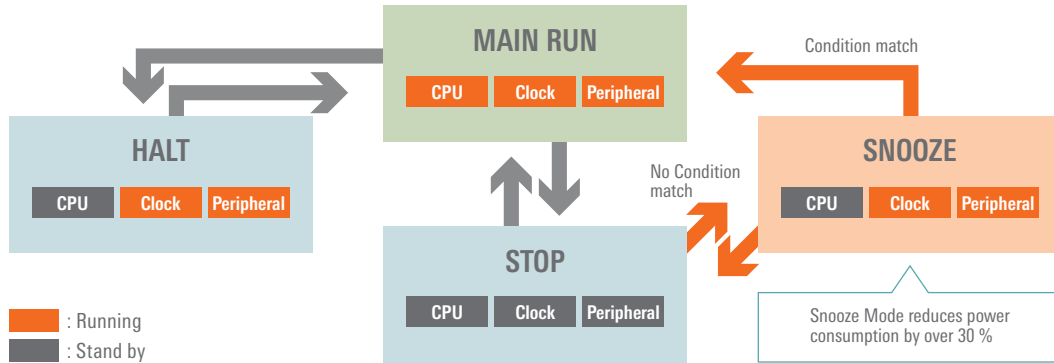
**G14** **G1F** **G1G**

- On-chip advanced-functionality timers for motor control
- High-speed on-chip oscillator with accuracy of  $\pm 1\%$ , ideal for low-cost, high-precision solutions

# LOW POWER CONSUMPTION

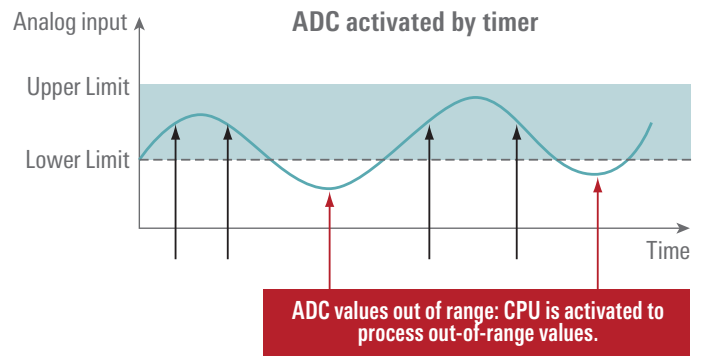
## SNOOZE mode for more power savings

In SNOOZE mode the CPU is halted while A/D conversion and data reception are enabled. By transitioning from STOP mode (clock stopped) to SNOOZE mode, it is possible to start the on-chip oscillator and operate peripheral functions while the CPU remains inactive.



## SNOOZE mode

- It is not necessary to activate the CPU for data reception.
- Using the exclusive SNOOZE mode, peripheral functions such as the ADC, UART or CSI can operate when CPU is in standby mode.
- Power consumption is one-tenth of normal operation.  
SNOOZE mode: 0.5 mA, RUN mode (ADC): 5 mA

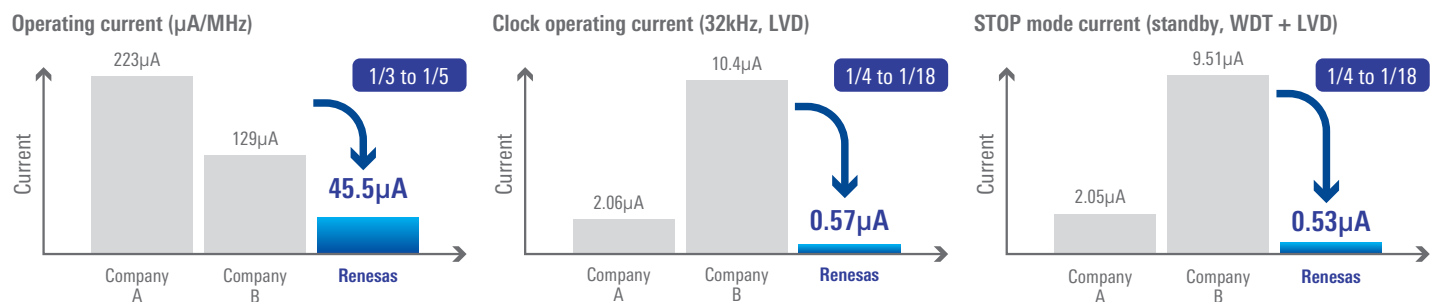


## HALT and STOP modes

- The standby function stops CPU operation, reducing overall microcontroller current consumption by 80%.
- The STOP mode disables the microcontroller's on-chip functions, reducing power consumption to the lowest level possible.

## Low-power, high-performance products for lower system power consumption overall

In the most common operating modes, the RL78 Family delivers an operating current of 45.5  $\mu\text{A}/\text{MHz}$  (while operating at 32 MHz) and a standby current of 0.57  $\mu\text{A}$  (in SUB-HALT mode, with the RTC and LVD operating). Also, a newly developed SNOOZE mode has been added to the previously implemented HALT and STOP low-power operation modes. In SNOOZE mode the CPU is in the standby state while A/D conversion and serial communication are enabled, and the CPU is activated only when required. This mode is excellent for battery-powered systems as it greatly increases battery life.

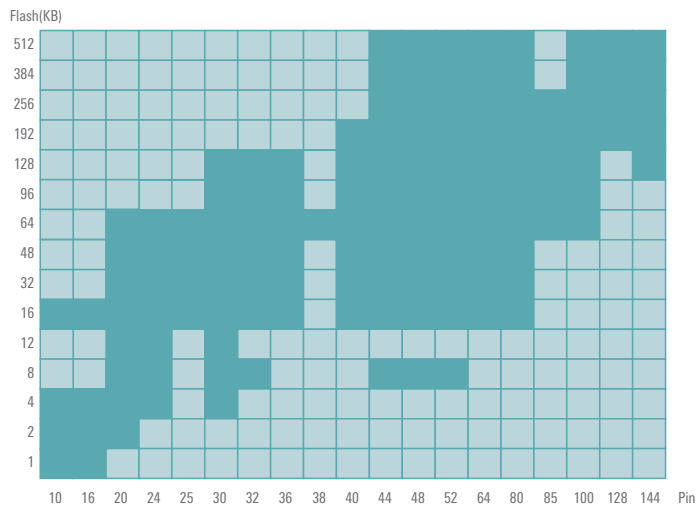


Source: Product data sheets and actual measurement

# BROAD SCALABILITY

## Extensive memory size and package options

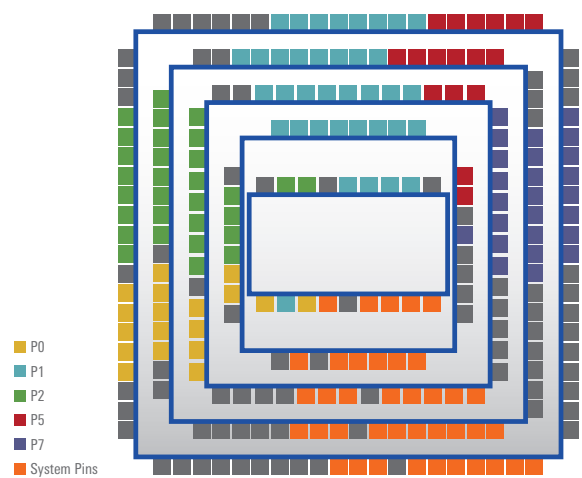
- The extensive lineup includes more than 500 product versions, with memory sizes from 1 KB to 512 KB and package pin counts from 10 pins to 144 pins. This extensive selection provides support for a broad range of application fields, including consumer, automotive, industrial, and communications.
- The wide range of options means a lot to developers if there are changes made to the specifications or more ROM capacity becomes necessary than originally estimated in the middle of the development process.
- Customers can rely on the same microcontroller series when developing product models ranging from the low-end to the high-end. Total development man-hours are reduced.



## Excellent pin compatibility

- Scalability is maintained because the general location of peripheral function pins and input/output pins remains the same even when the pin count changes. Customers can continue to use the RL78 Family of microcontrollers with confidence in the future.
- Customers can use standardized boards for product models ranging from the low-end to the high-end and boost the efficiency of the verification process.

Example of I/O port assignments on RL78/G1x

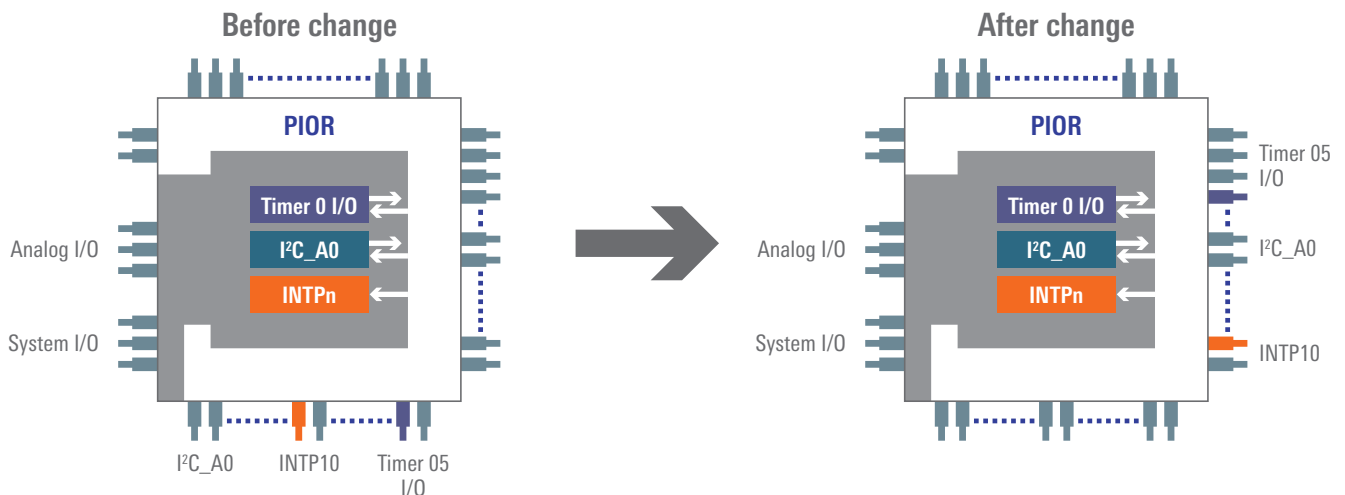


## Ability to reassign pin functions with PIOR\* register settings

Pin assignments can be changed for added board layout flexibility. The locations of peripheral function pins can be optimized.

Note: \* PIOR: Peripheral I/O Redirection

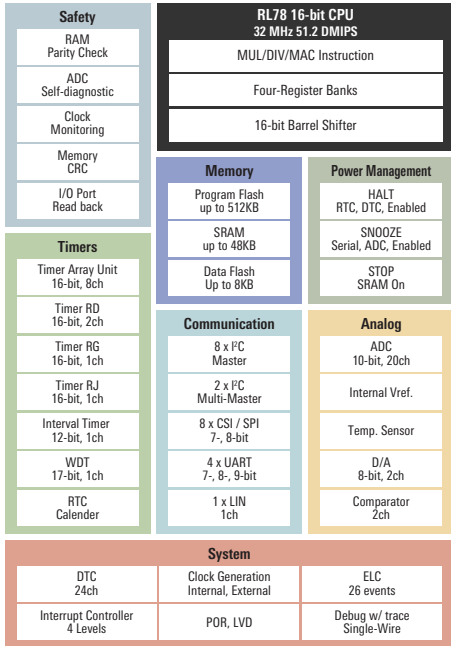
Not all pins can be reassigned.



# HIGH PERFORMANCE

## RL78 microcontrollers with CPU core employing three-stage pipeline and Harvard architecture

RL78 CPU processing performance is overwhelming other MCU vendors' CPU cores.

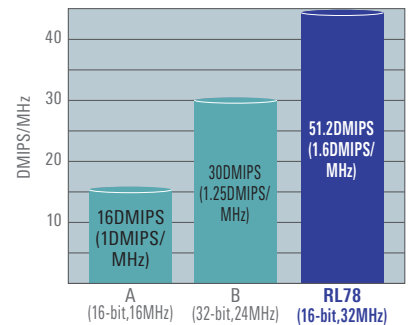


(Reference) RL78: Block diagram of G14 Group 100-pin product.

- **RL78 CPU Core**
  - Three-stage pipeline CISC architecture
  - Max. operating frequency: 32 MHz
  - Support for multiply, divide, and multiply-accumulate instructions
- **Memory**
  - Support for 1.8 V flash programming and boot swap
  - Program flash: 1 KB–512 KB
  - SRAM: 2.5 KB–48 KB
  - Data flash: 4 KB/8 KB
- **System**
  - High-speed on-chip oscillator: 32 MHz ±1% (operation supported on timer RD only, 64/48 MHz)
- **Power management**
  - Operating current: 66 μA/MHz\*1
  - HALT current: 0.57 μA (RTC + LVD)\*1
  - STOP current: 240 nA (SRAM data retained)\*1
  - SNOOZE current: 700 μA (UART), 1.2 mA (ADC)
- **Safety**
  - Compliant with European safety standard for household appliances (IEC/UL 60730)

- **Timers**
  - Advanced-functionality timer array unit (TAU)
  - Timer RD for three-phase motor control
  - Timer RG with two-phase encoder PWM function
  - Watchdog timer, real-time clock
- **Analog**
  - On-chip ADC: 10-bit × 20 channels, conversion time: 2.1 μs
  - On-chip DAC: 8-bit × 2 channels, comparator × 2 channels
- **Communication**
  - CSI, UART, I<sup>2</sup>C, Simple I<sup>2</sup>C
- **Package**
  - 10-pin–144-pin

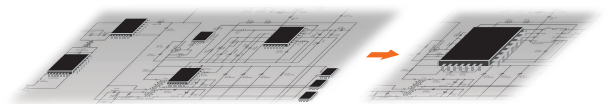
Note: 1. Power supply current for RL78/G14 Group, 64-pin, ROM = 64 KB product.



# REDUCED SYSTEM COST

## Helping customers reduce system size and cost

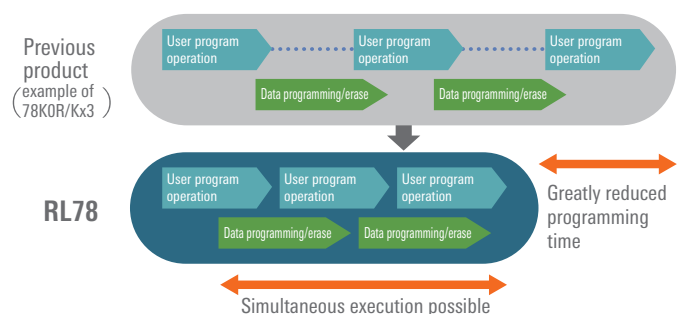
On-chip peripheral functions include a high precision (±1%) high-speed on-chip oscillator, background operation data flash supporting 1 million erase/program cycles, a temperature sensor, and multiple power supply interface ports. The RL78 Family is fabricated using a newly developed 130 nm process that enables customers to achieve reduced system cost and smaller overall system size.



Neat and compact design

## Data flash with advanced functionality (background operation) for substantially reduced programming time

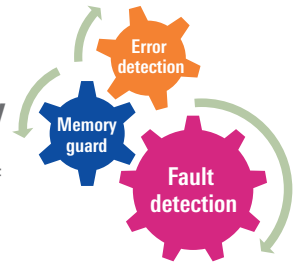
- Data access unit: 1 byte
- Data flash size: 4 KB (erasure unit: 1 KB)
- Number of overwrites: 1 million (typ.)
- Dedicated library: Simplifies operations



# RELIABLE SAFETY FUNCTIONS

## Safety functions built into the microcontroller that enhance system reliability

Generally speaking a microcontroller is expected to operate normally even when exposed to noise. The RL78 Family of microcontrollers have a number of safety functions that allow confirmation of normal operation. Customers can use these functions to easily perform self-diagnostics on microcontrollers.



The self-diagnostic functions of the RL78 Family contribute to enhanced system reliability.

### ■ Error detection

These functions check to make sure that the microcontroller's internal CPU and memory are operating properly. When an error is detected, measures such as an internal reset of the microcontroller can help to prevent the system from malfunctioning.

- Watchdog timer (WDT) as standard feature
- Flash memory CRC calculation
- RAM ECC function\*<sup>1</sup>
- Illegal memory access detection function\*<sup>1</sup>
- RAM parity error detection
- CPU stack pointer monitoring function\*<sup>1</sup>

### ■ Memory guard

This function disables writing to selected addresses in the RAM and SFRs\*<sup>2</sup>. It makes it possible to protect settings in RAM and the SFRs, contributing to improved reliability for the customer's system.

- RAM write protection
- SFR write protection

### ■ Fault detection

This function is for checking the operation of the microcontroller's clock generator circuit, A/D converter, and I/O pins. It simplifies the task of verifying microcontroller operation and makes it easier for customers to ensure safe and reliable operation of their systems.

- Frequency detection
- I/O port output level detection
- A/D self-check test
- Clock monitoring function\*<sup>1</sup>

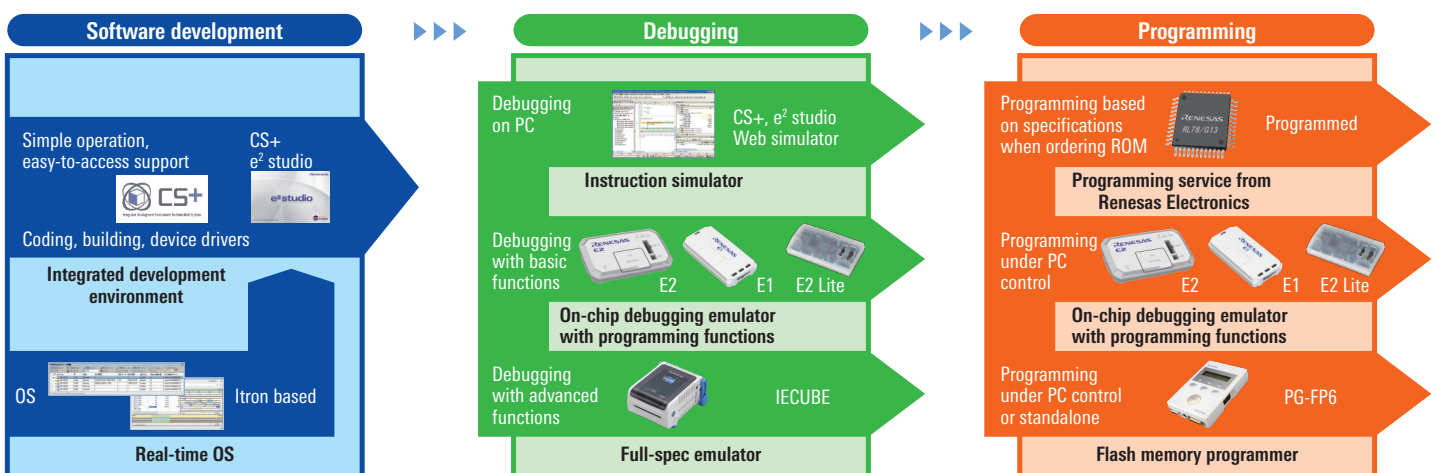
Notes:

1. Available on the RL78/F13, RL78/F14 and RL78/F15.
2. SFR (special function register): Registers that store settings related to special functions such as clock control, the low-voltage detection circuit, port control, and interrupts.

# COMPREHENSIVE DEVELOPMENT TOOLS

## A full lineup of tools that provides powerful support for efficient development

Renesas provides support for all stages of RL78 application development. The Renesas (CS+, e<sup>2</sup> studio) and IAR integrated development environments are easy to use and learn, helping shorten development cycles. A variety of debugging and programming environments are available to meet specific customer needs. Finally, Renesas partner vendors offer a rich array of tools and services covering a broad range of requirements.



# GENERAL-PURPOSE, LOW-PIN-COUNT

## RL78/G10

### RL78/G10 features

#### Ultra-low power consumption

- CPU operation: 45.5  $\mu$ A /MHz
- STOP mode: 560 nA

#### Lineup of low-pin-count products

- 10 pin: LSSOP (4.4  $\times$  3.6 mm)
- 16 pin: SSOP (4.4  $\times$  5 mm)

#### High-speed on-chip oscillator

- Max. 20 MHz, oscillation accuracy  $\pm$ 2%

#### Other on-chip functions

- ADC
- Comparator
- Timer
- Serial communication
- Selectable power-on reset

| ROM  | Pins |     |
|------|------|-----|
|      | 10   | 16  |
| 4 KB | 512  | 512 |
| 2 KB | 256  | 256 |
| 1 KB | 128  | 128 |

■ RAM size (B)

### RL78/G10 specifications

#### ■ RL78 CPU Core

- Three-stage pipeline CISC architecture
- Max. operating frequency: 20 MHz

#### ■ Memory

- Program flash: 1 KB–4 KB
- SRAM: 128 B–512 B

#### ■ System

- High-speed on-chip oscillator: 20 MHz  $\pm$ 2%
- Selectable POR

#### ■ Power management

- Operating current: 45.5  $\mu$ A/MHz
- HALT current: 290  $\mu$ A
- STOP current: 560 nA (SRAM data retained)

#### ■ Safety

- Internal reset at illegal instruction execution

#### ■ Timers

- Advanced-functionality timer array unit (TAU)
- Watchdog timer

#### ■ Analog

- On-chip ADC, 10-bit  $\times$  7 channels, conversion time: 3.4  $\mu$ s
- On-chip comparator

#### ■ Communication

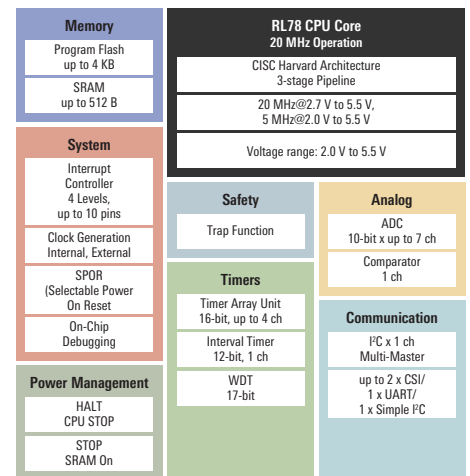
- CSI, UART, I<sup>2</sup>C, Simple I<sup>2</sup>C

#### ■ Package

- 10-pin/16-pin

(Reference) The power supply voltage range during flash memory programming is 4.5 V to 5.5 V. A low-voltage OCD board is required for debugging at less than 4.5 V.

[https://www.renesas.com/en-us/doc/products/tool/doc/003/r20ut2451ej0100\\_e510y16lvb.pdf](https://www.renesas.com/en-us/doc/products/tool/doc/003/r20ut2451ej0100_e510y16lvb.pdf)

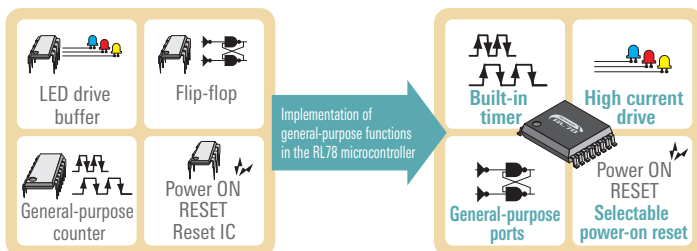


Note: The SPOR detection voltage (VSPOR) must be between 2.25 V and 5.5 V. (Reference) RL78: Block diagram of G10 Group 16-pin product.

### Lower system cost: Replacement for general-purpose logic ICs

Using general-purpose logic components complicates the design, manufacturing, and testing processes and can lead to malfunctions.

Reducing the number of components is a key issue when developing new products.

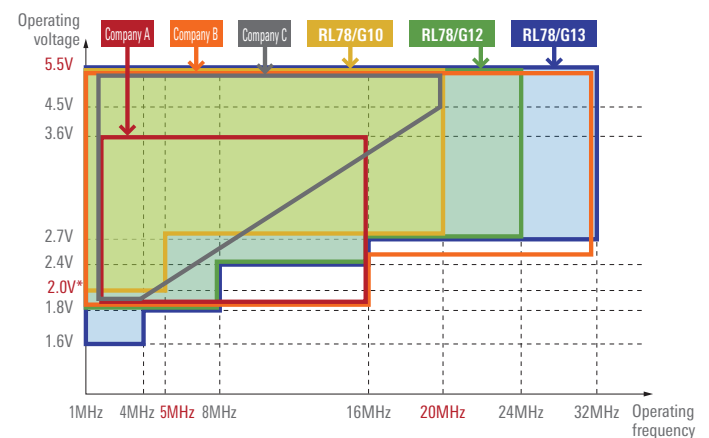


RL78 microcontrollers help simplify the design, manufacturing, and testing processes; reduce malfunctions; and provide numerous other advantages.

- More compact circuit board
- Reduced system cost

### RL78/G10 vs. competing products: Operating voltage/frequency range

Covers the voltage range required by compact electric household appliance applications.



Note: The RL78/G10 includes a SPOR circuit detection voltage (VSPOR), so it should be used within a voltage range of 2.25 V to 5.5 V.



# GENERAL-PURPOSE, ADVANCED FUNCTIONALITY

## RL78/G11

### RL78/G11 features

#### Ultralow power consumption for extended battery life

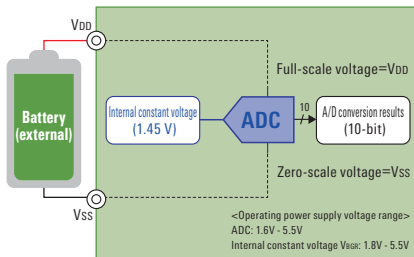
- Continues the low power consumption of the RL78 Family.
- Current consumption can be minimized by using the appropriate operating mode setting (HS, LS, LV, or LP).
- Fast wakeup makes intermittent operation more efficient.
- Reduced current consumption contributes to extended battery life.

#### Advanced-functionality timers supporting PWM forced shutoff

- Advanced-functionality timers (timer KB, TAU)
- Support for forced shutoff of PWM output (timer KB + external interrupts/ CMP)
- Interval timer (8-/12-/16-bit) supporting intermittent operation with long periods

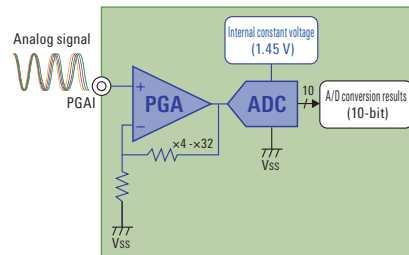
#### Ability to check battery voltage at low power supply voltages ( $V_{DD} = 1.8\text{ V}$ and above) and with no analog wiring

ADC + internal constant voltage (1.45 V)



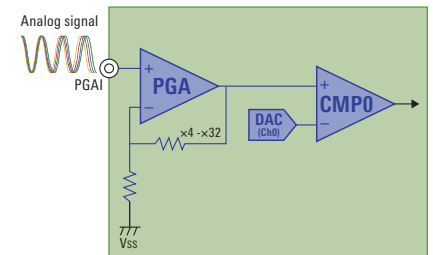
#### Quantitative measurement of minute analog signals using only a single pin (PGAI)

PGA + ADC (+ internal constant voltage)



#### Detection of minute voltages using a single pin and setting of detection threshold using microcontroller's on-chip DAC

PGA + CMPO + DAC



### RL78/G11 specifications

- **RL78 CPU Core**
  - Three-stage pipeline CISC architecture
  - Support for multiply, divide, and multiply-and-accumulate instructions
- **Memory**
  - Support for 1.8 V flash programming and boot swapping
  - Code Flash: 16KB
  - SRAM: 1.5KB
  - Data Flash: 2KB
  - Support for shipment of pre-programmed microcontrollers
- **System**
  - Operating voltage range: 1.6 V to 5.5 V
  - Operation state control (flash operating mode transition)
  - High-speed on-chip oscillator: 24 MHz  $\pm 1\%$
  - Medium-speed on-chip oscillator: 4 MHz  $\pm 12\%$
  - DTC, ELC, DOC, INTFO
  - Support for POR, LVD, different-potential communication
- **Power management**
  - Normal operation: 58.3  $\mu\text{A}/\text{MHz}$
  - Halt mode: 0.65  $\mu\text{A}$  (LVD)
- Stop mode: 0.25  $\mu\text{A}$  (data retained)
- SNOOZE mode: 0.7mA (UART), 0.67mA (ADC)
- **Safety**
  - Support for household safety standards (IEC/UL 60730 and IEC 61508)
- **Timers**
  - Timer array unit (TAU)  $\times 4$  channels
  - Timer KB  $\times 1$  channel (max. 48 MHz operation), support for PWM forced stop
  - Interval timer (8-bit, 12-bit, or 16-bit)
  - Watchdog timer (WDT)
- **Analog**
  - ADC 10-bit  $\times 11$  channels, conversion time: 2.1  $\mu\text{s}$
  - DAC 8-bit  $\times 2$  channels
  - Comparator  $\times 2$  channels
  - PGA  $\times 1$  channel
  - Internal reference voltage  $V_{BGR}$  (operation at  $1.8\text{V} \leq V_{DD} \leq 5.5\text{V}$ )
- **Communication**
  - CSI, UART, I<sup>2</sup>C, Simple I<sup>2</sup>C
- **Package**
  - 10-pin/16-pin/20-pin/24-pin/25-pin
- **Operating temperature range**
  - $-40^\circ\text{C}$  to  $+85^\circ\text{C}$  /  $+105^\circ\text{C}$

#### Analog functions connected to the microcontroller internally

- Organic internal connections eliminate the need for external analog wiring (PGA + ADC + VBGR, PGA + CMP + DAC/VBGR, etc.).
- Analog functions operate at low voltages, supporting voltage monitoring at 1.8 V and above (ADC = 1.6 V and above, VBGR = 1.8 V and above, CMP1 = 1.6 V and above, DAC = 1.6 V and above)

| Pins                | 10  |       | 16    |     | 20    |     | 24    |     | 25    |     |
|---------------------|-----|-------|-------|-----|-------|-----|-------|-----|-------|-----|
|                     | ROM | 16 KB | 1.5 K | 2 K | 1.5 K | 2 K | 1.5 K | 2 K | 1.5 K | 2 K |
| RAM size (B)        |     |       |       |     |       |     |       |     |       |     |
| DATA flash size (B) |     |       |       |     |       |     |       |     |       |     |

RAM size (B) DATA flash size (B)

| Memory                                 | RL78 16-bit CPU<br>24 MHz 38.4 DMIPS                                     |                      |  |
|--|--|----------------------|--|
| Program Flash<br>16 KB                 | MUL/DIV/MAC Instruction  |                      |  |
| SRAM<br>1.5 KB                         | Four Register Banks  |                      |  |
| Data Flash<br>2 KB                     | 16-bit Barrel Shifter  |                      |  |
| System                                 | Safety   | Analog               |  |
| DTC<br>24 sources                      | RAM<br>Parity Check  | ADC<br>10-bit, 11 ch |  |
| ELC<br>18 Events                       | ADC<br>Self-diagnostic   | DAC<br>8-bit, 2 ch   |  |
| Interrupt Controller<br>4 Levels       | Clock<br>Monitoring  | Comparator<br>2 ch   |  |
| Clock Generation<br>Internal, External | Memory<br>CRC  | PGA                  |  |
| POR, LVD                               |  | Internal Vref.       |  |
| Debug<br>Single-Wire                   | Timers   | Temp. Sensor         |  |
|  | Timer Array Unit<br>16-bit, 4 ch   |                      |  |
|  | Timer KB<br>16-bit, 1 ch   |                      |  |
|  | Interval Timer<br>8-bit, 2 ch  |                      |  |
|  | Interval Timer<br>12-bit, 1 ch   |                      |  |
|  | WDT<br>17-bit, 1 ch  |                      |  |
| Power Management                       | Communication  |                      |  |
| HALT<br>DTC Enabled                    | 2 x I <sup>2</sup> C<br>Multi-Master                                     |                      |  |
| SNOOZE<br>Serial, ADC Enabled          | CSI $\times 2$ / UART $\times 1$<br>/ Simple I <sup>2</sup> C $\times 2$ |                      |  |
| STOP<br>SRAM On                        | CSI $\times 2$ / UART $\times 1$<br>/ Simple I <sup>2</sup> C $\times 2$ |                      |  |

(Reference) RL78: Block diagram of G11 Group 25-pin product.

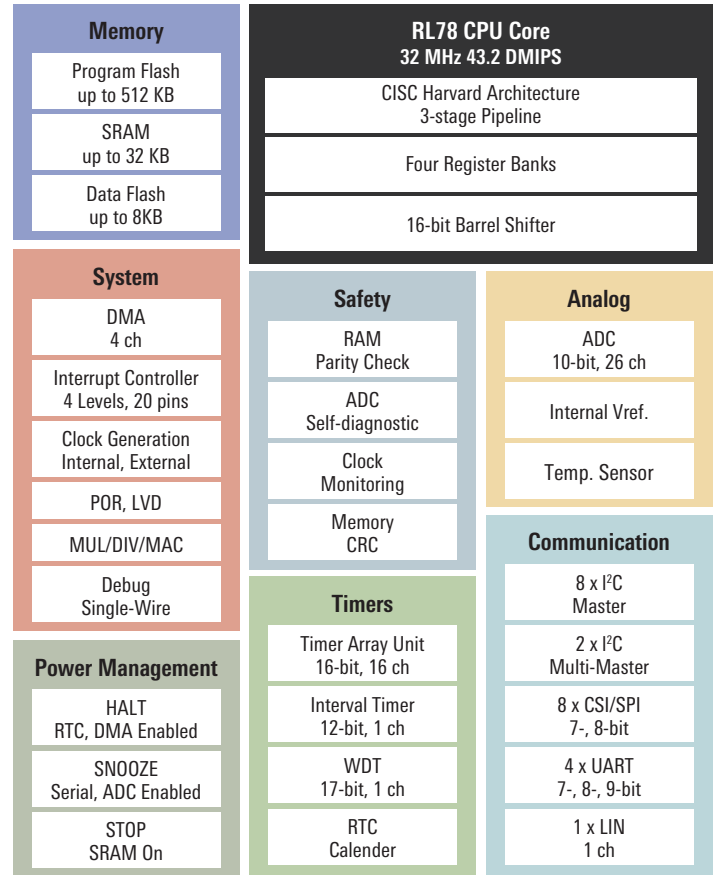
# GENERAL-PURPOSE, STANDARD

## RL78/G12, G13

### RL78/G12, G13 specifications

- **RL78 CPU Core**
  - Three-stage pipeline CISC architecture
  - Max. operating frequency: 32 MHz
- **Memory**
  - Support for 1.8 V flash programming and boot swap
  - Program flash: 2 KB–512 KB
  - SRAM: 256 B–32 KB
  - Data flash: 2 KB/4 KB/8 KB/None
- **System**
  - High-speed on-chip oscillator: 32 MHz ±1%
  - Library support for multiply/divide and multiply-accumulate operation unit
- **Power management**
  - Operating current: 66 µA/MHz\*1
  - HALT current: 0.57 µA (RTC + LVD)\*1
  - STOP current: 230 nA (SRAM data retained)\*1
  - SNOOZE current: 700 µA (UART), 1.2 mA (ADC)
- **Safety**
  - Compliant with European safety standard for household appliances (IEC/UL 60730)
  - Illegal memory access detection
- **Timers**
  - Advanced-functionality timer array unit (TAU)
  - Watchdog timer, real-time clock
- **Analog**
  - 1.6 V (VDD) operation
  - On-chip ADC, 10-bit × 26 channels, conversion time: 2.1 µs
  - Internal reference voltage (1.45 V)
- **Communication**
  - CSI, UART, I2C, Simple I2C
- **Package**
  - 20-pin–128-pin

Note: 1. Power supply current RL78/G13 Group product with 64 pins and 64 KB of ROM.



### Extensive lineup: RL78/G12, G13

Choose with confidence. Extensive lineup of 284 products.

| ROM    | Pins  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|        | 20    |       | 24    |       | 25    |       | 30    |       | 32    |       | 36    |       | 40    |       | 44    |       | 48    |       | 52    |       | 64    |       | 80    |       | 100   |       | 128   |       |       |       |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 512 KB |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 32 K  | 32 K  | 32 K  | 32 K  | 32 K  | 32 K  | 32 K  | 32 K  | 32 K  | 32 K  | 32 K  | 32 K  | 32 K  | 32 K  | 32 K | 32 K | 32 K | 32 K | 32 K | 32 K | 32 K | 32 K | 32 K | 32 K | 32 K | 32 K | 32 K | 32 K | 32 K |      |
| 384 KB |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 24 K  | 24 K  | 24 K  | 24 K  | 24 K  | 24 K  | 24 K  | 24 K  | 24 K  | 24 K  | 24 K  | 24 K  | 24 K  | 24 K  | 24 K | 24 K | 24 K | 24 K | 24 K | 24 K | 24 K | 24 K | 24 K | 24 K | 24 K | 24 K | 24 K | 24 K | 24 K |      |
| 256 KB |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 20 K  | 20 K  | 20 K  | 20 K  | 20 K  | 20 K  | 20 K  | 20 K  | 20 K  | 20 K  | 20 K  | 20 K  | 20 K  | 20 K  | 20 K | 20 K | 20 K | 20 K | 20 K | 20 K | 20 K | 20 K | 20 K | 20 K | 20 K | 20 K | 20 K | 20 K |      |      |
| 192 KB |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 16 K  | 16 K  | 16 K  | 16 K  | 16 K  | 16 K  | 16 K  | 16 K  | 16 K  | 16 K  | 16 K  | 16 K  | 16 K  | 16 K  | 16 K | 16 K | 16 K | 16 K | 16 K | 16 K | 16 K | 16 K | 16 K | 16 K | 16 K | 16 K | 16 K | 16 K | 16 K | 16 K |
| 128 KB |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 12 K  | 12 K  | 12 K  | 12 K  | 12 K  | 12 K  | 12 K  | 12 K  | 12 K  | 12 K  | 12 K  | 12 K  | 12 K  | 12 K  | 12 K | 12 K | 12 K | 12 K | 12 K | 12 K | 12 K | 12 K | 12 K | 12 K | 12 K | 12 K | 12 K | 12 K | 12 K | 12 K |
| 96 KB  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 8 K   | 8 K   | 8 K   | 8 K   | 8 K   | 8 K   | 8 K   | 8 K   | 8 K   | 8 K   | 8 K   | 8 K   | 8 K   | 8 K   | 8 K  | 8 K  | 8 K  | 8 K  | 8 K  | 8 K  | 8 K  | 8 K  | 8 K  | 8 K  | 8 K  | 8 K  | 8 K  | 8 K  | 8 K  | 8 K  |
| 64 KB  | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K   | 4 K  |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 48 KB  | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K   | 3 K  |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 32 KB  | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K  |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 16 KB  | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K   | 2 K  |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 12 KB  | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 8 KB   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768   | 768  |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 4 KB   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512   | 512  |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 2 KB   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256   | 256  |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |

RL78/G13

RL78/G12

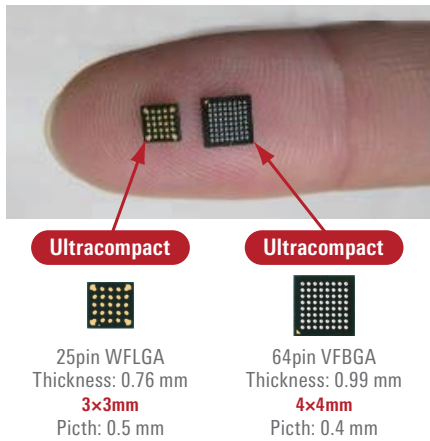
RAM No data flash      RAM Equipped with data flash

1. For 20-pin packages, the pin spacing of the RL78/G12 is 225 mil and that of the RL78/G13 is 300 mil.

2. For the 64-pin BGA (4 × 4) package products, the ROM capacity ranges from 32 KB to 256 KB.

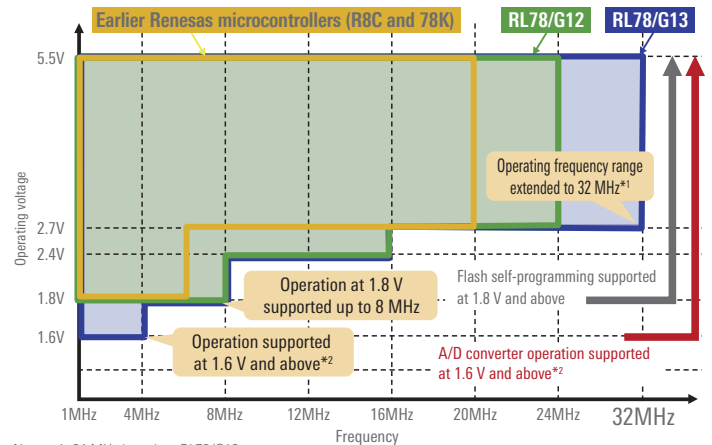
### Extensive lineup: Compact packages

Available compact package options are ideal for miniaturized products.



### High performance: Low-voltage operation

Expanded operating range compared with previous products and support for A/D conversion at voltages from 1.6 V



Notes: 1. 24 MHz (max.) on RL78/G12  
2. Operation supported at 1.8 V and above on RL78/G12

### High performance: Multiply and divide/multiply-accumulate operation unit

On-chip multiply-accumulate operation unit for reduced operation load on CPU

- Completion interrupt generated for divide operations only.
- Multiply-accumulate operation overflow/underflow interrupt generated when the cumulative result of multiply-accumulate operations causes an overflow or underflow.
- Combined-use divide completion interrupt and multiply-accumulate operation overflow/underflow interrupt.
- Whether an overflow or underflow occurred can be determined by referencing a status flag.
- Since the C lacks multiply-accumulate operation instructions, library functions are provided.

Multiply and divide circuit with support for multiply-accumulate operations

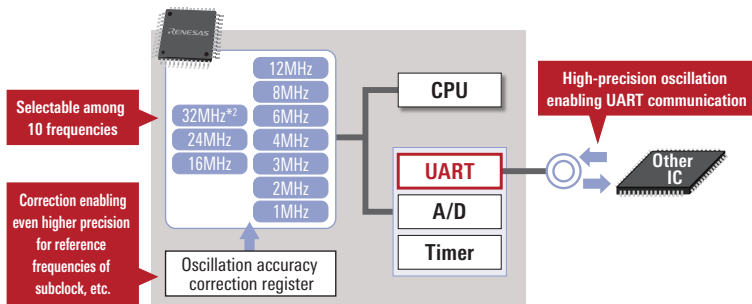
| operation                    | exec cycle                                      |
|------------------------------|---|
| Signed multiply              | 16 bits×16 bits=32 bits<br>1 clock              |
| Unsigned multiply            | 16 bits×16 bits=32 bits<br>1 clock              |
| Unsigned divide              | 32 bits/32 bits=32 bits ... 32 bits<br>16 clock |
| Signed multiply-accumulate   | 16 bits×16 bits+32 bits=32 bits<br>2 clock      |
| Unsigned multiply-accumulate | 16 bits×16 bits+32 bits=32 bits<br>2 clock      |

### Reduced system cost: On-chip high-precision, high-speed oscillator

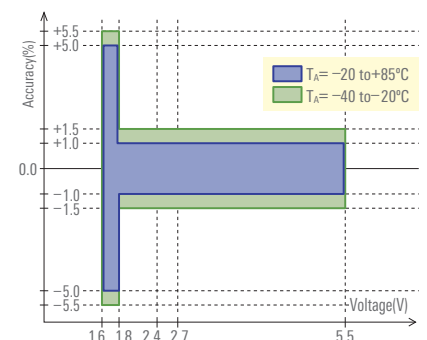
On-chip high-precision, high-speed oscillator to support UART communication

- On-chip high-speed clock generator circuit with precision of  $\pm 1\%^{*1}$
- Selectable frequencies: 32 MHz<sup>\*2</sup>, 24 MHz, 16 MHz, 12 MHz, 8 MHz, 6 MHz, 4 MHz, 3 MHz, 2 MHz, and 1 MHz
- Oscillation accuracy correction register for even higher precision

Notes: 1.  $\pm 5\%$  on R5F103x 2. RL78/G13 only



### HOCO oscillation frequency accuracy



# GENERAL-PURPOSE, ADVANCED FUNCTIONALITY

## RL78/G14

### CPU core supporting multiply and divide/multiply-accumulate instructions

Added multiply, divide, and multiply-accumulate instructions that enable high-speed operation by direct execution without needing to utilize library functions

Overview of multiply, divide, and multiply-accumulate instructions

| operation           |                                       | exec cycle |
|---------------------|---------------------------------------|------------|
| Multiply            | 8 bits×8 bits=16 bits                 | 1 clock    |
|                     | 16 bits×16 bits=32 bits               | 2 clock    |
| Divide              | 16 bits / 16 bits=16 bits ... 16 bits | 9 clock    |
|                     | 32 bits / 32 bits=32 bits ... 32 bits | 17 clock   |
| Multiply-accumulate | 16 bits×16 bits+32 bits=32 bits       | 3 clock    |

Points of difference from multiply and divide/multiply-accumulate operation unit on RL78/G12 and RL78/G13

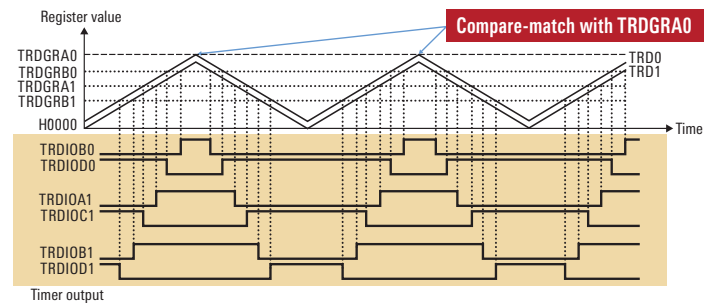
- No interrupts are generated.
- A carry flag is set when the cumulative result of multiply-accumulate operations causes an overflow or underflow.

### Featured function: Timer RD (complementary PWM mode)

High-resolution three-phase complementary PWM output ideal for driving DC brushless motors

- Ability to output three sets of PWM waveforms with no overlap between the forward and reverse phases
  - Use of on-chip high-speed oscillator (64 MHz or 48 MHz) as count source supported
- Ability to operate using multiples of the CPU clock frequency for reduced power consumption

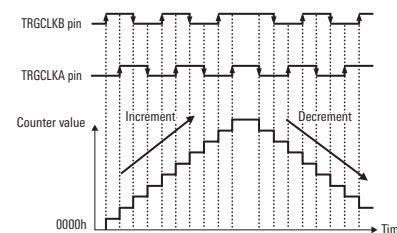
### Complementary PWM mode operation example



### Featured function: Timer RG (phase counting mode)

This function counts (increments or decrements a counter) at both edges when two pulse signals with different phases are input to pins TRGCLKA and TRGCLKB. It is ideal for counting in a two-phase encoder.

|   |         |         |         |         |         |         |         |         |
|---|---------|---------|---------|---------|---------|---------|---------|---------|
| TRGCLKB pin                               |         | "H"     |         | "L"     | "H"     |         | "L"     |         |
| TRGCLKA pin                               | "L"     |         | "H"     |         |         | "L"     |         | "H"     |
| Bits CNTEN7 to CNTEN0 in TRGCNTC register | CNTEN 7 | CNTEN 6 | CNTEN 5 | CNTEN 4 | CNTEN 3 | CNTEN 2 | CNTEN 1 | CNTEN 0 |
| Setting value of TRGCNT register          | 1       | 1       | 1       | 1       | 1       | 1       | 1       | 1       |
| Increment/decrement counter               | +1      | +1      | +1      | +1      | -1      | -1      | -1      | -1      |

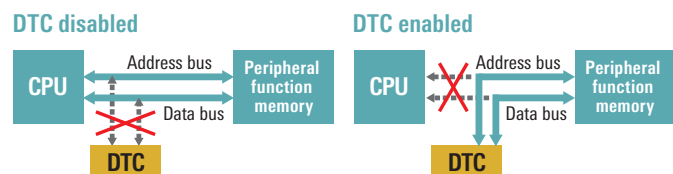


In combination with the TRGCNTC register value, this function performs phase counting by incrementing or decrementing a counter when a user-defined input state occurs.

### Featured function: Data transfer controller (DTC)

The DTC provides functionality to transfer data from one memory location to another, bypassing the CPU.

- Increased number of transfer channels and activation sources for improved flexibility
  - Support for data transfers among SFRs, on-chip RAM, and flash memory\*1
- Note: 1. The DTC can only read data from flash memory.

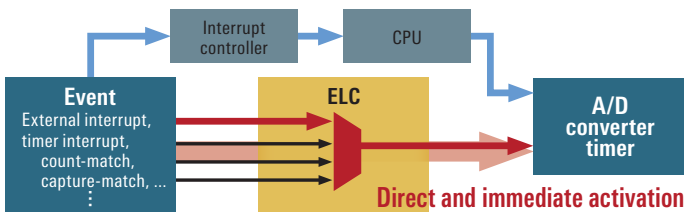


### Comparison of DMA and DTC

|                                | DMA(G13 100pin) | DTC(G14 100pin)                      |
|--------------------------------|-----------------|--------------------------------------|
| Number of channels             | 4 channels      | 24 channels                          |
| Transfer address space         | 4 KB            | 64 KB                                |
| Max. transfer count/block size | 1024/1024 bytes | 256/512 bytes                        |
| Transfer target                | SFR ⇄ RAM       | SFR ⇄ RAM<br>Flash memory ⇒ SFR, RAM |
| Number of activation sources   | 21              | 39                                   |
| Other                          | —               | Repeat and chain transfers supported |

### Featured function: Event link controller (ELC)

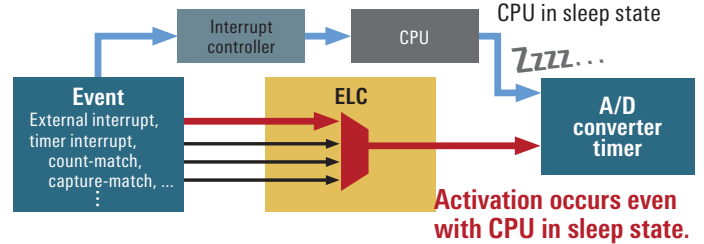
Direct links between hardware modules



The ELC function bypasses the interrupt controller, allowing direct activation of modules by events.

High-speed module activation

No CPU operation needed



The ELC function enables activation of modules by events even when the CPU is in the sleep (halted) state.

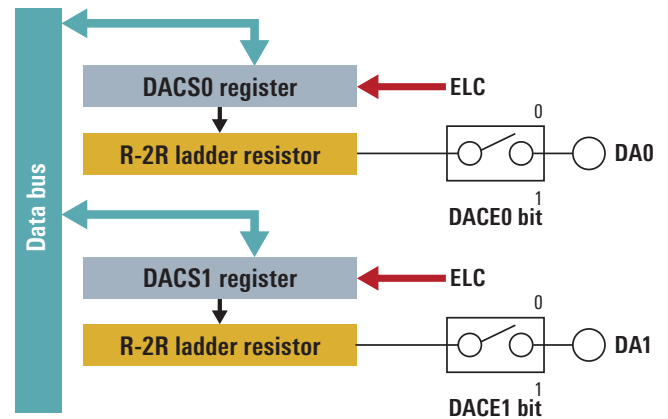
Lower power consumption

### Featured function: D/A converter (products with ROM capacity of 96 KB or more only)

On-chip 8-bit D/A converter (2 channels) that simplifies control of analog output for applications such as audio playback or power supply control

D/A converter operation

- Normal mode  
D/A conversion is started by a write operation to the DACSn (n = 0 or 1) register.
- Real-time output mode  
D/A conversion is started using the real-time output signal input by the ELC as the activation trigger.

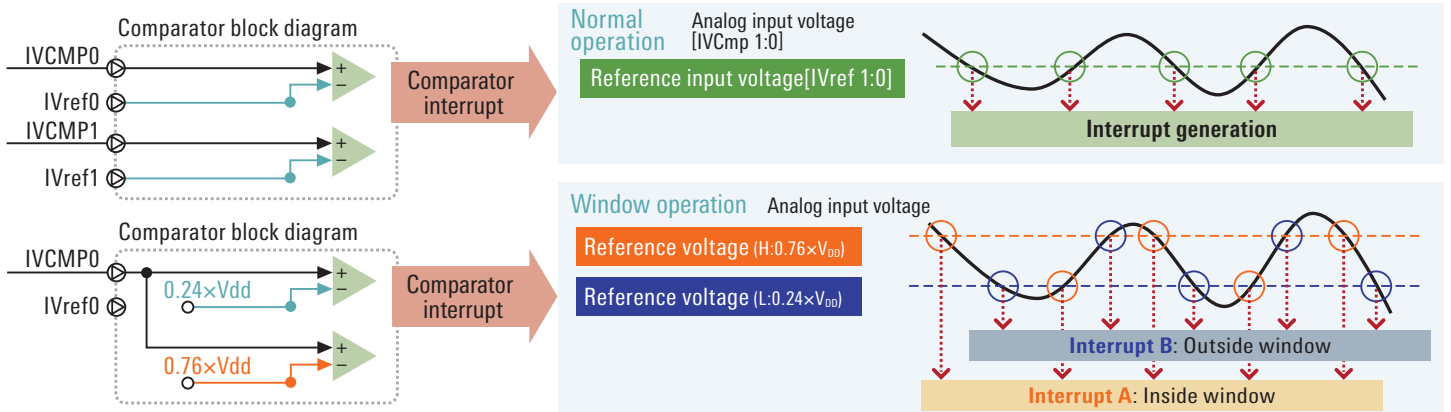


### Featured function: Comparator (products with ROM capacity of 96 KB or more only)

Comparator with two channels and support for switching between high-speed and low-speed modes (one channel on 30-pin SOP products)

- High-speed mode: Support for high-speed operation for motor control feedback, etc.
- Low-speed mode: Support for low power consumption during battery monitoring, etc.

Ability to use as a window function by combining channels



# GENERAL-PURPOSE, ANALOG

## RL78/G1A

### RL78/G1A features

#### High-precision A/D converter

- 12-bit A/D converter
  - Total error:  $\pm 1.7$  LSB (typ.)
  - Conversion time: 3.375  $\mu$ s
- Multi-channel analog input
  - 28 analog input channels (max.) to support input from multiple sensors

#### Low power consumption/standby mode

- Low power consumption
  - Carries on the low power consumption of the RL78 Family
  - Operating current: 66  $\mu$ A/MHz
  - STOP current: 0.23  $\mu$ A
- Standby mode
  - Three modes: HALT, SNOOZE, and STOP
  - Reduced average current during intermittent operation

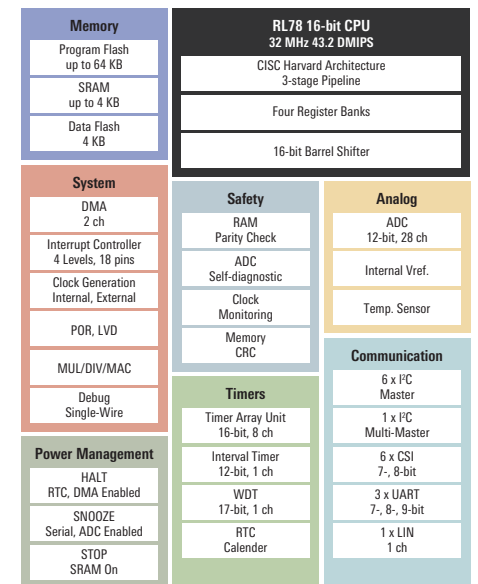
#### Compact package/extensive peripheral functions

- Compact package
  - 3 × 3 mm square : 25-pin LGA package
  - 4 × 4 mm square : 64-pin BGA package
- Extensive peripheral functions
  - Timer (16-bit × 8 channels)
  - Data flash (nonvolatile memory for data)
  - Serial communication (CSI, UART, I<sup>2</sup>C, etc.)
  - Fault detection (safety functions)

### RL78/G1A specifications

- **RL78 CPU Core**
  - Three-stage pipeline CISC architecture
  - Max. operating frequency: 32 MHz
- **Memory**
  - Support for 1.8 V flash programming and boot swap
  - Program flash: 16 KB–64 KB
  - SRAM: 2 KB–4 KB
  - Data flash: 4 KB
- **System**
  - High-speed on-chip oscillator: 32 MHz  $\pm 1\%$
  - Library support for multiply/divide and multiply-accumulate operation unit
- **Power management**
  - Operating current: 66  $\mu$ A/MHz
  - HALT current: 0.57  $\mu$ A (SUB + RTC + LVD)
  - STOP current: 0.23  $\mu$ A (SRAM data retained)
  - SNOOZE current: 700  $\mu$ A (UART), 1020  $\mu$ A (ADC)

- **Safety**
  - Compliant with European safety standard for household appliances (IEC/UL 60730)
  - Illegal memory access detection
- **Timers**
  - Advanced-functionality timer array unit (TAU)
  - Watchdog timer, real-time clock
- **Analog**
  - 1.6 V (VDD) operation
  - On-chip ADC, 12-bit × 28 channels, conversion time: 3.375  $\mu$ s
  - Internal reference voltage (1.45 V)
- **Communication**
  - CSI, UART(LIN) I<sup>2</sup>C, Simple I<sup>2</sup>C
- **Package**
  - 25-pin LGA (3 × 3 mm square)
  - 32-pin QFN (5 × 5 mm square)
  - 48-pin QFP (7 × 7 mm square)
  - 64-pin QFP (7 × 7 mm square)
  - 64-pin QFP (10 × 10 mm square)
  - 64-pin BGA (4 × 4 mm square)



(Reference) RL78: Block diagram of G1A Group 64-pin product.

### RL78/G1A overview

Lineup of RL78 Family products with enhanced analog functions

#### Features

- **RL78 CPU core**
  - High-performance 16-bit CPU High-speed 32 MHz operation
  - Low power consumption 66  $\mu$ A/MHz when running 0.57  $\mu$ A/MHz during standby (SUB + RTC + LVD)
- **High performance peripheral functions**
  - High-resolution 12-bit A/D converter Improved sensing precision, max. 28 channels
  - On-chip high-precision high-speed clock generator circuit Precision:  $\pm 1\%$
  - Data flash: 4 KB Support for background operation
  - Multiply and divide/multiply-accumulate operation unit Reduced CPU load

### Memory lineup

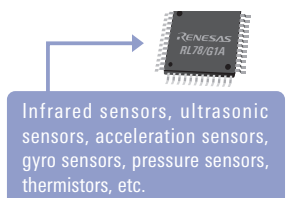
Compact packages and extensive memory capacity options

| ROM | Pins | 25  |      | 32  |      | 48  |      | 64  |      |
|-----|------|-----|------|-----|------|-----|------|-----|------|
|     |      | RAM | DATA | RAM | DATA | RAM | DATA | RAM | DATA |
| 64K |      | 4K  | 4K   | 4K  | 4K   | 4K  | 4K   | 4K  | 4K   |
| 48K |      | 3K  | 4K   | 3K  | 4K   | 3K  | 4K   | 3K  | 4K   |
| 32K |      | 2K  | 4K   | 2K  | 4K   | 2K  | 4K   | 2K  | 4K   |
| 16K |      | 2K  | 4K   | 2K  | 4K   | 2K  | 4K   |     |      |

■ RAM size (B) ■ DATA flash size (B)

### Support for multiple sensors of various types

Multi-channel analog input support among the best in the industry with 12-bit A/D converter



# GENERAL-PURPOSE, WIRELESS

## RL78/G1H

### RL78/G1H features

Power-efficient microcontroller with sub-GHz band transceiver compliant with IEEE 802.15.4g standard

#### Integration of RF peripheral circuits

- RF peripheral balun and filter functions are integrated into the chip. This contributes to a substantial reduction in the design workload and system cost.

#### Ultralow current consumption during reception, among the lowest in the industry

- RF reception: 6.3 mA\*1, RF reception standby: 5.8 mA\*1
- Reception sensitivity: -105 dBm\*2

Notes: 1. Typ., VDD = 3.3 V 2. 2GFSK, 100 kbps, BER < 0.1%

#### IEEE 802.15.4e/g-compliant hardware for reduced CPU load

- Generates in hardware wireless frames compliant with IEEE 802.15.4g.
- Provides integrated functionality to automatically distinguish two systems of communication addresses. This reduces the development load, since software it not needed for this processing.
- Supports ACK reply/receive functionality, including the enhanced format required under the Wi-SUN specification, and CSMA-CA functionality in hardware. This reduces the need to implement complicated timing control processing in software.

| ROM    | Pins  |      |
|--------|-------|------|
|        | 64    |      |
| 512 KB | 48 KB | 8 KB |
| 384 KB | 32 KB | 8 KB |
| 256 KB | 24 KB | 8 KB |

RAM size DATA flash size

### RL78/G1H specifications

#### RL78 CPU Core

- Three-stage pipeline CISC architecture
- Max. operating frequency: 32MHz
- Support for multiply, divide, and multiply-and-accumulate instructions

#### Memory

- Support for 1.8 V flash programming and boot swapping
- Program Flash: 256 KB, 384 KB, 512 KB
- SRAM: 24 KB, 32 KB, 48 KB
- Data Flash: 8 KB

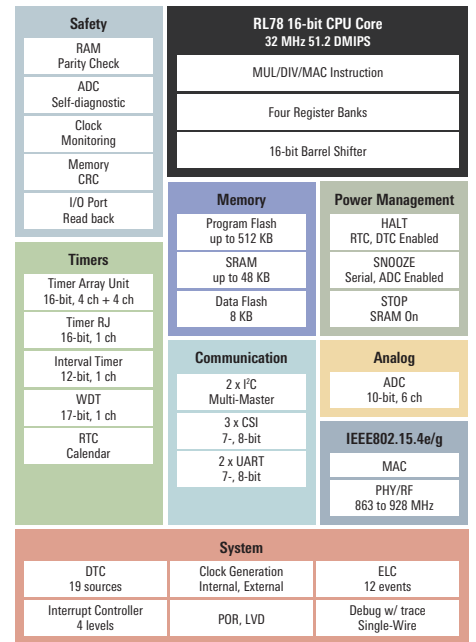
#### IEEE802.15.4e/g

- IEEE 802.15.4g compliant sub-GHz band transceiver

#### System

- High-speed on-chip oscillator: 32 MHz/24 MHz/16 MHz/12 MHz/8 MHz/6 MHz/4 MHz/3 MHz/2 MHz/1 MHz

- Data transfer controller
- Event link controller
- Power management
  - Power-on reset
  - Voltage detection circuit
- Safety
  - Compliant with European household safety standard (IEC/UL 60730)
- Timers
  - Advanced-functionality timer array unit (TAU)
  - Interval timer
  - Watchdog timer, real-time clock
- Analog
  - On-chip ADC, 10-bit x 6 channels
- Communication
  - CSIx3, UARTx2, I<sup>2</sup>Cx2
- Package
  - HVQFN 9x9mm 64pin, 0.5mm pitch



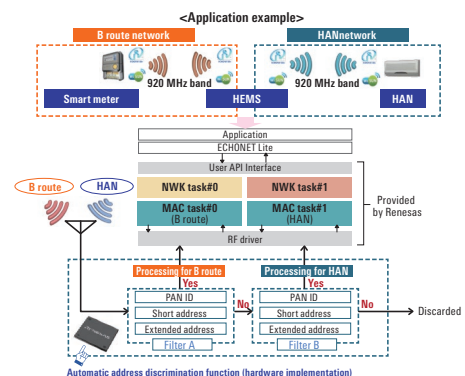
### Sub-GHz band transceiver

- Compliant with IEEE 802.15.4g specification
- RF frequency range: 863 to 928 MHz
- Modulation method: 2FSK/GFSK, 4FSK/GFSK
- Data rate: 10 to 300 kbps for 2FSK/GFSK, 200/400 kbps for 4FSK/GFSK
- Forward error correction (FEC) function
- RF reception current: 6.9 mA (typ.) at 3.0 V, 100 Kbps, 2FSK/MCU block stop mode
- RF transmission current: 21 mA (typ.) at 3.0 V, 100 Kbps, 2FSK, +10 dBm/MCU block stop mode; 36 mA (typ.) at 3.0 V, 100 Kbps, 2FSK, +13 dBm/MCU block stop mode

### 2-system address filtering

- Provides integrated hardware functionality to automatically distinguish two systems of communication addresses. This makes it simple to use a single chip to process communications for two networks. It also reduces the development load, since software it not needed for this processing.

- Pass-through data can be selected conditionally based of the following information in receive frames: transmission destination PAN identifier (PAN ID), transmission destination short address, or transmission extended address.



# GENERAL-PURPOSE, WIRELESS

## RL78/G1D

### RL78/G1D features

Power-efficient low-end microcontrollers with Bluetooth® low energy

- RF with ultra-low current consumption
  - 4.3 mA during RF transmission, 3.5 mA during RF reception (using on-chip DC-DC converter, 3 V operation)
  - Average current: 9.1 µA (1-second intervals, connection maintained CC-RL compiler)
- Contributes to reduced system cost and more compact mounting board
  - Integrates circuit components necessary for antenna connection.
  - Simplifies circuit design and reduces number of external components required. Contributes to smaller mounting area and reduced product cost.
- Adaptable RF technology
  - Automatic adjustment of transmission output (transmission operating current) to match the communication distance
  - Optimization that prioritizes low current consumption at short distances and prioritizes the communication distance at long distances

### Applications employing Bluetooth® low energy

Applications utilizing Bluetooth® low energy to connect wirelessly with devices such as smartphones while using little power are proliferating rapidly, and include products incorporating wireless tags, such as healthcare and fitness devices, home appliances, and beacons. Renesas provides solutions that support Bluetooth® low energy and enable reliable connections with current consumption levels among the lowest in the industry.

### RL78/G1D lineup

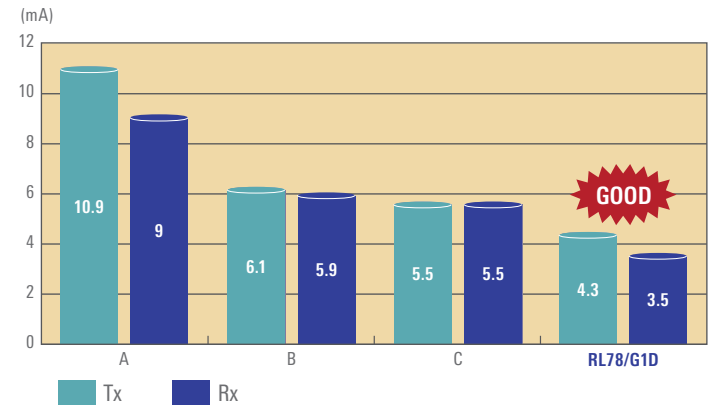
| ROM    | Pins | 48  |  |
|--------|------|-----|--|
| 256 KB | 20 K | 8 K |  |
| 192 KB | 16 K | 8 K |  |
| 128 KB | 12 K | 8 K |  |

■ RAM size ■ DATA flash size

### 2.4 GHz RF transceiver

- Compliant with Bluetooth® v4.2 low energy (Master/Slave) specification
- Reception sensitivity: -90 dBm
- Max. transmission output power: 0 dBm
- Support for wireless updates
- Software protocol stack provided at no charge

### RF transmit and receive currents among the world's smallest



### RL78/G1D specifications

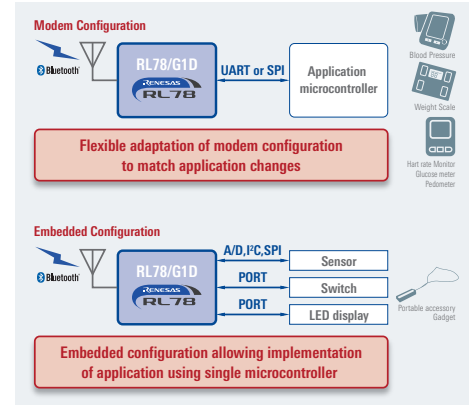
- **RL78 CPU Core**
  - Three-stage pipeline CISC architecture
  - Max. operating frequency: 32MHz
- **Memory**
  - Support for 1.8 V flash programming and boot swap
  - Program Flash: 128 KB, 192 KB, 256 KB
  - SRAM: 2 KB, 6 KB, 20 KB
  - Data Flash: 8 KB
- **System**
  - High-speed on-chip oscillator: 32 MHz
  - Library support for multiply/divide and multiply-accumulate operation unit
- **RF**
  - Bluetooth® v4.2 low energy Master/Slave
  - RF unit power management
  - On-chip oscillator circuit for RF: 32.768 kHz
- **Power management**
  - Transmission current (MCU: STOP): 4.3 mA at 3 V
  - Reception current (MCU: STOP): 3.5 mA at 3 V
  - Sleep current (MCU: STOP, RF: DEEP\_SLEEP): 1.4 µA
  - Stop current (MCU: STOP, RF: POWER\_DOWN): 0.3 µA
- **Safety**
  - Compliant with European safety standard for household appliances (IEC/UL 60730)
  - Illegal memory access detection
- **Timers**
  - Advanced-functionality timer array unit (TAU)
  - Watchdog timer, real-time clock
- **Analog**
  - On-chip ADC, 10-bit × 8 channels, conversion time: 2.1 µs
  - Internal reference voltage (1.45 V)
- **Communication**
  - CSI × 2, UART × 2, I<sup>2</sup>C × 1, Simple I<sup>2</sup>C × 2
- **Package**
  - WQFN 6 × 6 mm 48-pin, 0.4 mm pitch

|   |  |
|---|--|
| <b>Memory</b><br>Program Flash<br>128 KB to 256 KB<br>SRAM<br>12 KB to 20 KB<br>Data Flash<br>8 KB  | <b>RL78 16-bit CPU</b><br>32 MHz 43.2 DMIPS<br>CISC Harvard Architecture<br>3-stage Pipeline<br>Four Register Banks<br>16-bit Barrel Shifter                         |
| <b>System</b><br>DMA<br>4 ch<br>Interrupt Controller<br>4 Levels<br>Clock Generation<br>OCO, External<br>POR, LVD<br>MUL/DIV/MAC<br>Debug<br>Single-Wire                      | <b>Safety</b><br>RAM<br>Parity Check<br>ADC<br>Self-diagnostic<br>Clock Monitoring<br>Memory CRC   |
| <b>Power Management</b><br>HALT<br>RTC, DMA Enabled<br>SNOOZE<br>Serial, ADC Enabled<br>STOP<br>SRAM On   | <b>Timers</b><br>Timer Array Unit<br>16-bit, 8 ch<br>Interval Timer<br>12-bit, 1 ch<br>WDT 17-bit<br>RTC Calendar  |
| <b>Communication</b><br>CSI/UART<br>/Simplified I <sup>2</sup> C x 1 ch<br>CSI/<br>/Simplified I <sup>2</sup> C x 1 ch<br>UART x 1 ch<br>1 x I <sup>2</sup> C<br>Multi-Master | <b>RF</b><br>Bluetooth 4.2<br>Single mode<br>Master/Slave<br>AES Engine<br>RF unit Power<br>Management<br>Resonator clock:<br>32 MHz<br>Sub clock OCO:<br>32.768 kHz |
| <b>Analog</b><br>ADC 10-bit, 8 ch<br>Internal Vref.<br>Temp. Sensor   |  |



### RL78/G1D usage configuration examples

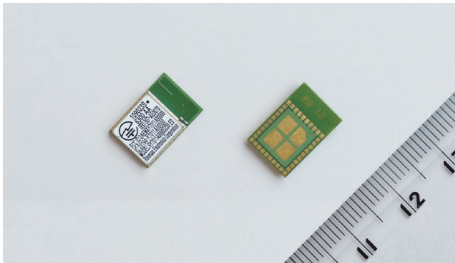
- It is possible to develop a modem configuration in which the RL78/G1D is controlled by the host microcontroller via a serial connection. This provides flexible support for adding wireless capabilities to applications.
- Renesas microcontroller host samples are available. By making use of a host sample, the customer can reduce the development workload.
- It is possible to develop a combined configuration that makes use of the many peripheral functions of the RL78/G1D. Power-efficient applications can be realized using the RL78/G1D alone.



### RL78/G1D module

#### RL78/G1D module features

Retains the many function pins of the RL78/G1D. Module is compliant with radio laws and Bluetooth® SIG.



- RL78/G1D (ROM: 256 KB, RAM: 20 KB)
- Convenient compact size (8.95 × 13.35 × 1.7)
- 24 GPIO output pins can be used as microcontroller peripheral function pins.
- Current consumption among the lowest in the industry
- Certified compliant with radio laws of Japan (MIC), Europe (CE), and North America (FCC/IC)
- Bluetooth® SIG certified\*1 QD ID: 82194
- Operating voltage: 1.6 to 3.6 V\*2
- Operating temperature: -25 to +75°C
- Pin count: 42 pins

Notes:

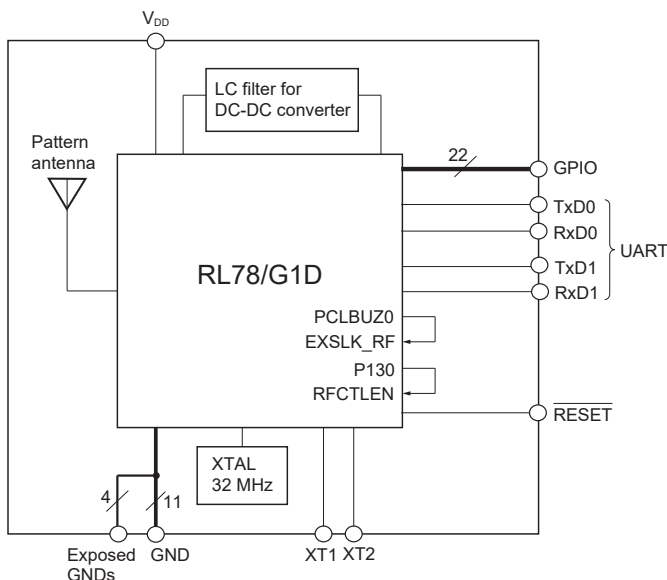
- It is only necessary to register the final product.
- 1.8 to 3.6 V when using on-chip DC/DC converter.

#### RL78/G1D module lineup

| Pins   |          | 48              |  |
|--------|----------|-----------------|--|
| ROM    | RAM size | DATA flash size |  |
| 256 KB | 20 K     | 8 K             |  |

#### Block diagram of RL78/G1D module functions

- On-chip antenna, LC for DC/DC converter, and 32 MHz crystal oscillator are ready for immediate use.
- 32.768 kHz supplied as default by on-chip oscillator.
- Lower power consumption can be achieved by using an external 32.768 kHz clock.
  - Supplied by host microcontroller
  - Supplied by an external crystal resonator (XT1 or XT2)

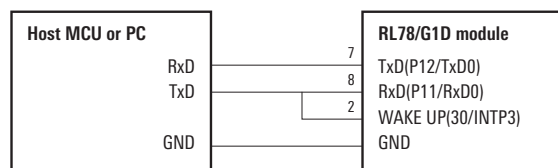


#### Software for checking operation

- Software is provided to check the operation of the modem configuration used for control by the host microcontroller via the UART. Multiple profiles are supported. Customers can also use Renesas custom profiles.
- The RL78/G1D module can be used in a combined configuration that makes use of the many peripheral functions of the RL78/G1D. The module provides a good balance between size and the number of function pins, making it easy to use in a combined configuration.

#### Supported profiles

- ◆ Bluetooth® SIG standard profiles
  - Proximity
  - Heart Rate
  - Alert Notification
  - Health Thermometer
  - Glucose
  - Find Me
  - Time
  - Running Speed and Cadence
  - Blood Pressure
  - Phone Alert Status
- ◆ Custom profiles
  - General-purpose bidirectional communication
  - Firmware Update



Connections to the host microcontroller use UART 2-wire branch connection.

# GENERAL-PURPOSE, MOTOR

## RL78/G1F

### RL78/G1F features

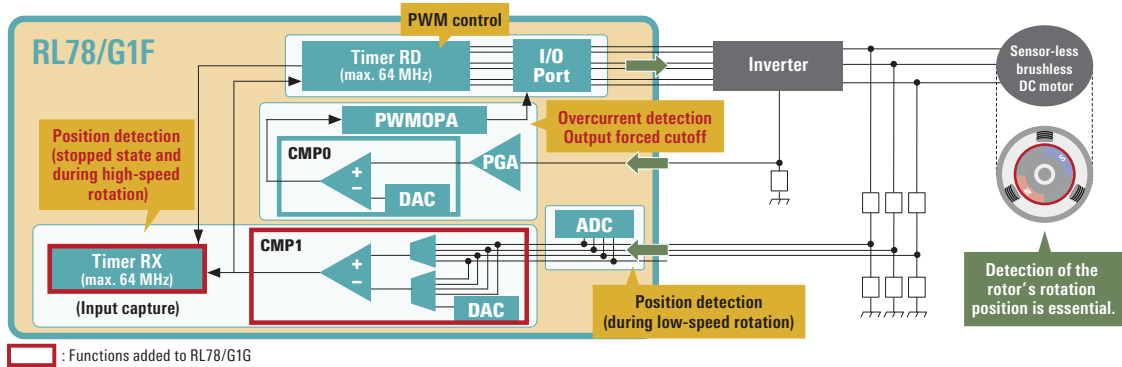
Peripheral functions and flexibility have been improved while retaining the same ROM sizes as the RL78/G14. In particular, analog functions have been strengthened, and the on-chip functions are ideal for motor control.

- Main improvements to peripheral functions compared with RL78/G14
  - Rotor position detection for high torque
  - Programmable-gain amplifier (PGA)
    - High slew rate of 3.0 V/μs (min.) (VDD ≥ 4.0 V)
  - 2-channel comparator (CMP0 and CMP1)
    - Fast response time of 70 ns (typ.) (1/8 that of RL78/G14)
  - D/A converter (1 or 2 channels)
  - IrDA communication function
  - Debug functions including real-time trace

| Safety                        |                                   | RL78 16-bit CPU Core<br>32 MHz 51.2 DMIPS     |                               |
|-------------------------------|-----------------------------------|---|-------------------------------|
| RAM Parity Check              | ADC Self-diagnostic               | MUL/DIV/MAC Instruction                       |                               |
| Clock Monitoring              | Memory CRC                        | Four Register Banks                           |                               |
| I/O Port Read back            |                                   | 16-bit Barrel Shifter                         |                               |
| Timers                        |                                   | Memory  | Power Management              |
| Timer Array Unit 16-bit, 4 ch | Timer RD 16-bit, 2 ch             | Program Flash up to 64 KB                     | HALT<br>RTC, DTC Enabled      |
| Timer RG 16-bit, 1 ch         | Timer RJ 16-bit, 1 ch             | SRAM 5.5 KB                                   | SNOOZE<br>Serial, ADC Enabled |
| Interval Timer 12-bit, 1 ch   | WDT 17-bit, 1 ch                  | Data Flash 4 KB                               | STOP<br>SRAM On               |
| RTC Calendar                  | Timer RX 16-bit, 1 ch             |   |                               |
| Communication                 |                                   | Analog  |                               |
| 6 x I <sup>2</sup> C Master   | 1 x I <sup>2</sup> C Multi-Master | ADC 10-bit, 17 ch                             | Internal Vref                 |
| 6 x CSI/SPI 7-, 8-bit         | 3 x UART 7-, 8-, 9-bit            | Temp. Sensor                                  | DAC 8-bit, 2 ch               |
| 1 x LIN 1 ch                  | IrDA                              | Comparator                                    | Input Selectable Comparator   |
|                               |                                   |   | PGA                           |
| System                        |                                   |   |                               |
| DTC 33 sources                | Interrupt Controller 4 levels     | Clock Generation Internal, External Sub-clock | ELC 22 events                 |
|                               |                                   | POR, LVD                                      | Debug w/ trace Single-Wire    |

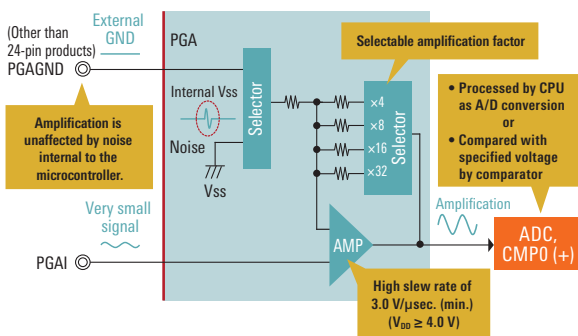
### Motor control functions of the RL78/G1F

- 120-degree conducting control for sensor-less brushless DC motors
  - On-chip 4-input-selectable high-speed comparator (CMP1) and timer RX for rotor position detection without the use of sensors
    - Enables detection of the rotor position when stopped and during high-speed rotation.
- Overcurrent detection and forced cutoff of PWM output
  - On-chip high-speed PGA for overcurrent detection + high-speed comparator (CMP0) and control output signal forced cutoff function (PWMOPA)
    - Supports quick detection of overcurrent conditions and immediate cutoff of PWM output.



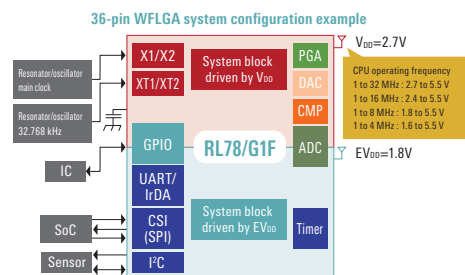
### Programmable-gain amplifier (PGA) for boosting sensor signals

The amplification factor for boosting very small signals is selectable among ×4, ×8, ×16, and ×32. The slew rate ranges from a minimum of 3.0 V/μsec. (3.5 V/μsec. (min.) at other than ×32 V (VDD ≥ 4.0 V)). The dedicated GND input (PGAGND pin) ensures that amplification is not affected by internal noise.



### 36-pin LGA package (4 × 4 mm) suitable for mobile devices

- Some functions support separate power supplies on 36-pin and 64-pin products. By providing separate power supplies (VDD and EVDD) it is possible to perform communication with an SoC, etc., at low voltage with running the CPU at high speed.
- The 36-pin products allow use of a 32.768 kHz subsystem clock oscillator (XT1) despite low pin count.



**RL78/G1G Consumer applications only**

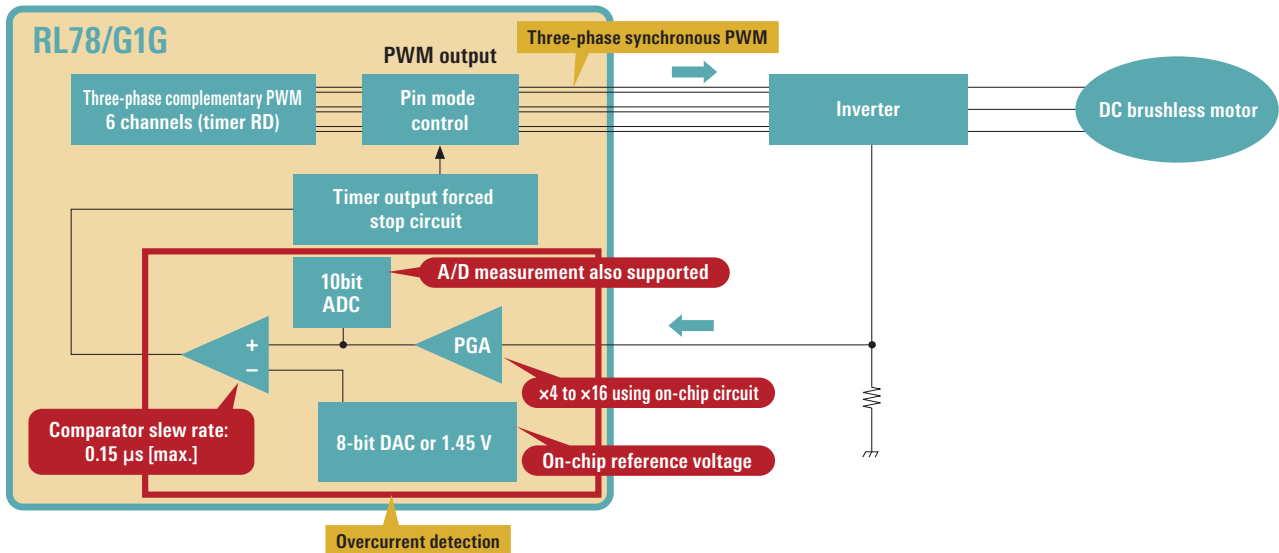
**Ideal for DC brushless motor applications**

Support for power-efficient maintenance-free motor operation



|                       |                               | RL78/G1G  |
|-----------------------|-------------------------------|---|
| Motor control timer   | Three-phase complementary PWM | 6 channels (48 MHz operation supported)           |
|                       | Forced shutoff                | Supported (Hi-Z, H/L output settings supported)   |
| Overcurrent detection | Programmable-gain amplifier   | 1 channel (on-chip amplifying resistor)           |
|                       | Comparator                    | 2 channels (response time: 0.15 μs [max.])        |
|                       | Comparator reference voltage  | 8-bit DAC or internal reference voltage of 1.45 V |

**Application example: Three-phase synchronous PWM support and overcurrent detection circuit for reduced system cost**



**Lineup of products with low pin count and small ROM capacity**

LQFP with 0.8 mm pin pitch for easy mounting using flow soldering

| ROM \ Pins | 30     | 32     | 44     |
|------------|--------|--------|--------|
| 16 K       | 1.5 KB | 1.5 KB | 1.5 KB |
| 8 K        | 1.5 KB | 1.5 KB | 1.5 KB |

RAM size Note: The RL/G1G is not equipped with data flash.

**Other functions**

- Operating current : 75 μA/MHz
- STOP current : 240 nA (SRAM contents retained)
- On-chip oscillator : 24 MHz ±2% (Ta = -40 to +85°C) (48 MHz supply by timer RD for motor control supported)
- Compliant with European safety standard for household appliances (IEC/UL 60730)

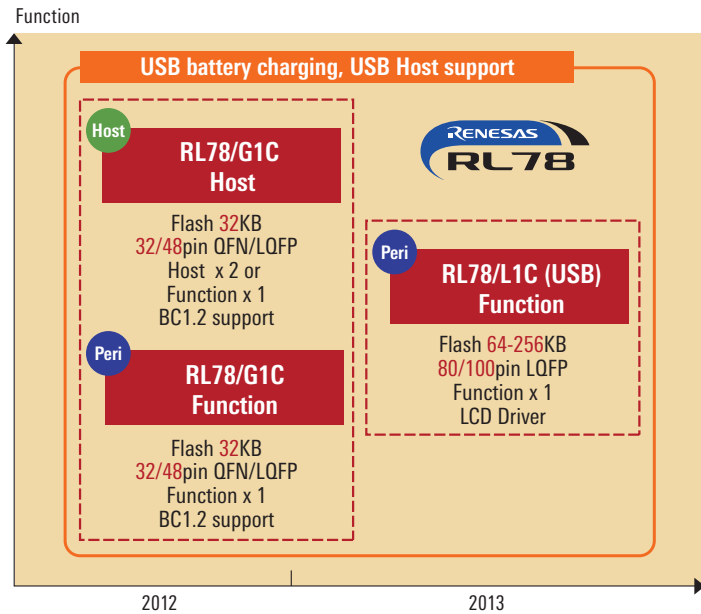
|  |   |  |
|--|---|--|
| <b>Memory</b><br>Program Flash<br>8 KB / 16 KB<br>SRAM<br>1.5 KB   | <b>RL78 16-bit CPU</b><br>24 MHz 38.4 DMIPS<br>CISC Harvard Architecture<br>3-stage Pipeline<br>Four Register Banks<br>16-bit Barrel Shifter        |  |
| <b>System</b><br>Event Link Controller<br>Interrupt Controller<br>4 Levels<br>Clock Generation<br>Internal, External<br>POR, LVD<br>Debug<br>Single-Wire | <b>Safety</b><br>RAM Parity Check<br>ADC Self-diagnostic<br>Clock Monitoring<br>Memory CRC  | <b>Analog</b><br>ADC 10-bit, 8 ch/12 ch<br>Internal Vref.<br>Comparator 2 ch<br>PGA 1 ch |
| <b>Power Management</b><br>HALT<br>SNOOZE<br>Serial, ADC Enabled<br>STOP<br>SRAM On  | <b>Timers</b><br>Timer Array Unit 16-bit, 4 ch<br>Timer RD 16-bit, 2 ch<br>Timer RJ 16-bit, 1 ch<br>Interval Timer 12-bit, 1 ch<br>WDT 17-bit, 1 ch | <b>Communication</b><br>2 x UART<br>1 x CSI (slave select)<br>1 x Simple PC              |

# GENERAL-PURPOSE, USB

## Common to RL78/G1C and RL78/L1C

### Low-end USB microcontroller roadmap

RL78 Series next-generation low-end USB microcontrollers



### Product lineup

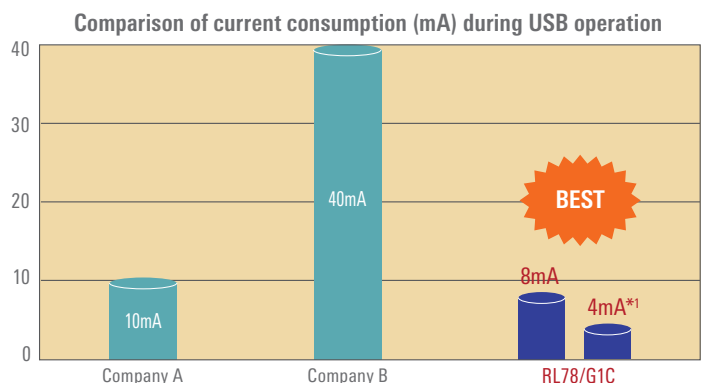
| ROM    | Pins  |       |       |       |
|--------|-------|-------|-------|-------|
|        | 32    | 48    | 80    | 100   |
| 256 KB |       |       | 16 K  | 16 K  |
| 192 KB |       |       | 16 K  | 16 K  |
| 128 KB |       |       | 12 K  | 12 K  |
| 96 KB  |       |       | 10 K  | 10 K  |
| 64 KB  |       |       | 8 K   | 8 K   |
| 32 KB  | 5.5 K | 5.5 K | 5.5 K | 5.5 K |

RL78/G1C : ■ 1 x only Function ■ 2 x Host or 1 x Function

RL78/L1C : ■ 1 x only Function

### USB features (low power consumption)

Operating current among world's lowest



## RL78/G1C

### RL78/G1C (USB)

World's first low-end microcontroller with support for USB Battery Charging Specification, Revision 1.2 (BC1.2)

- Support for fast charging and power supply control in addition to USB communication  
Ability to charge up to 1.5 A using BC1.2 (0.5 A for USB 2.0)
- Low power consumption during USB operation  
Approx. 65% reduction compared with 78K0R, approx. 20% reduction compared with R8C
- Host × 2 channels, Function × 1 channel  
Suitable for a broad range of applications

| Necessary Functions    | Target Applications   |
|------------------------|---|
| BC function            | Mobile batteries<br>USB chargers  |
| Host functionality     | Vending machines<br>Printer<br>DVD player<br>Smartphone peripheral accessories  |
| Function functionality | Health devices<br>Measuring devices<br>USB memory<br>Mouse / keyboard<br>Handheld terminals<br>Barcode readers<br>UPS |



## RL78/L1C

### RL78/L1C features

- 100-pin LCD microcontroller with large-capacity ROM
  - ROM: 256 KB, RAM: 16 KB (max.)  
→ Suitable for applications with advanced functionality
- Low-power LCD microcontroller retaining the features of the RL78 microcontroller family  
High-performance 16-bit CPU  
Low power consumption (particularly low LCD drive current due to divided allocation of LCD capacity)  
Safety functions (compliant with European safety standard for household appliances)
- High-resolution ADC
  - 12-bit ADC to support high-precision sensing  
→ Suitable for sensor measuring devices for consumer and industrial applications
- Full complement of communication functions
  - Compliant with Battery Charging Specification, Revision 1.2 (BC1.2) for USB peripherals  
→ Ability to rapidly charge secondary batteries
  - Variety of serial interface functions  
CSI/UART/Simple I<sup>2</sup>C × 4  
I<sup>2</sup>C(Multi-Master) × 1  
USB Peripheral × 1

**RL78/G1C**

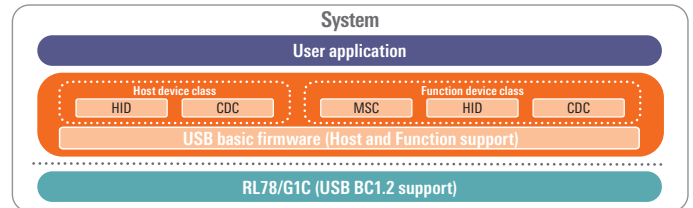
**Overview of USB controller specifications**

USB Host and USB BC1.2 support

|                                    |             | RL78/G1C   | Reference  |
|------------------------------------|-------------|------------|--|
| USB2.0                             | Function    | 1 channel  |  |
|                                    | Host        | 2 channels | Host version only                                |
| Transfer speed                     | LS(1.5Mbps) | ○          | Host/Function                                    |
|                                    | FS(12Mbps)  | ○          | Host/Function                                    |
|                                    | HS(480Mbps) | —          | Not supported                                    |
| Transfer mode                      | Control     | ○          | FIFO 64 bytes                                    |
|                                    | Bulk        | ○          | FIFO 64 × 2 bytes, double buffering              |
|                                    | Interrupt   | ○          | FIFO 64 bytes                                    |
|                                    | Isochronous | —          |  |
| On-chip resistors                  |             | ○          | D+ and D– lines, pull-up and pull-down resistors |
| Supported battery charging classes |             | ○          | Support for Host and Function                    |
| On-chip PLL                        |             | ○          | External resonator → 48 MHz generation           |

**USB sample firmware**

USB sample firmware is available free of charge. This simplifies system development and reduces the amount of time required.



Free sample software (firmware)

Note: BC1.2 detection control functionality is implemented for all device classes.

All application notes are available for download on the Renesas website

USB sample firmware

| USB function | Title                              | Rev  | Memory size[kByte] |        |
|--------------|------------------------------------|------|--------------------|--------|
|              |                                    |      | ROM*1              | RAM*2  |
| Host         | Basic firmware                     | 2.15 | 15.0 KB            | 2.7 KB |
|              | HID (Human Interface Device Class) |      | 14.7 KB            | 1.9 KB |
|              | CDC (Communication Device Class)   |      | 16.1 KB            | 1.8 KB |
| Peripheral   | Basic firmware                     |      | 10.9 KB            | 1.4 KB |
|              | HID (Human Interface Device Class) |      | 10.5 KB            | 0.8 KB |
|              | CDC (Communication Device Class)   |      | 10.5 KB            | 1.0 KB |
| AOA          | MSC (Mass Storage Class)*2         |      | 13.7 KB            | 2.4 KB |
|              | USB Host Android Open Accessory    |      | 15.7 KB            | 1.6 KB |
| Downloader   | USB Peripheral Firmware Update     |      | 5.8 KB             | 0.5 KB |

Notes: 1. ROM and RAM sizes for CC-RL (V2.05) environment, and ROM and RAM sizes for all Device Classes include size of Basic driver. 2. EEPROM devices used as media.

**RL78/L1C**

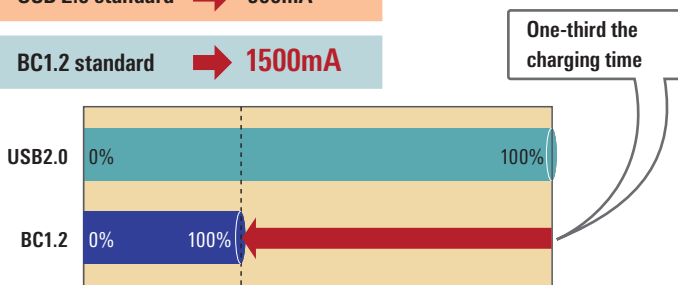
**Overview of USB battery charging standards**

Standards designed to enable rapid battery charging

Current max. value

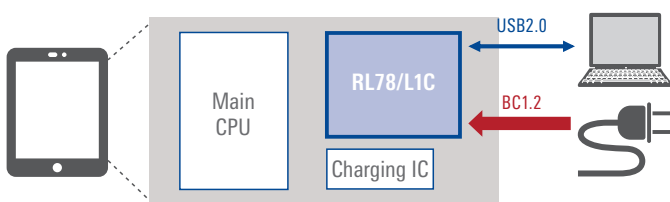
USB 2.0 standard → 500mA

BC1.2 standard → 1500mA



Note: Calculated value

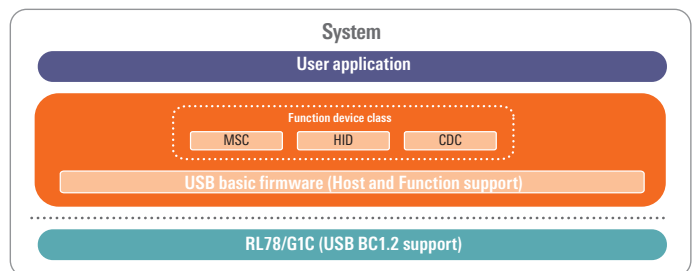
USB battery charging application example



Data communication possible during USB battery charging

**USB sample firmware**

USB sample firmware is available free of charge. This simplifies system development and reduces the amount of time required.



Free sample software (firmware)

Note: BC1.2 detection control functionality is implemented for all device classes.

All application notes are available for download on the Renesas website

USB sample firmware

| USB function | Title                              | Rev    | Memory size[kByte] |        |
|--------------|------------------------------------|--------|--------------------|--------|
|              |                                    |        | ROM*1              | RAM*2  |
| Peripheral   | Basic firmware                     | 2.15   | 10.9 KB            | 1.4 KB |
|              | HID (Human Interface Device Class) |        | 10.5 KB            | 0.8 KB |
|              | CDC (Communication Device Class)   |        | 10.5 KB            | 1.0 KB |
|              | MSC (Mass Storage Class)*2         |        | 13.7 KB            | 2.4 KB |
| Downloader   | USB Peripheral Firmware Update     | 5.8 KB | 0.5 KB             |        |

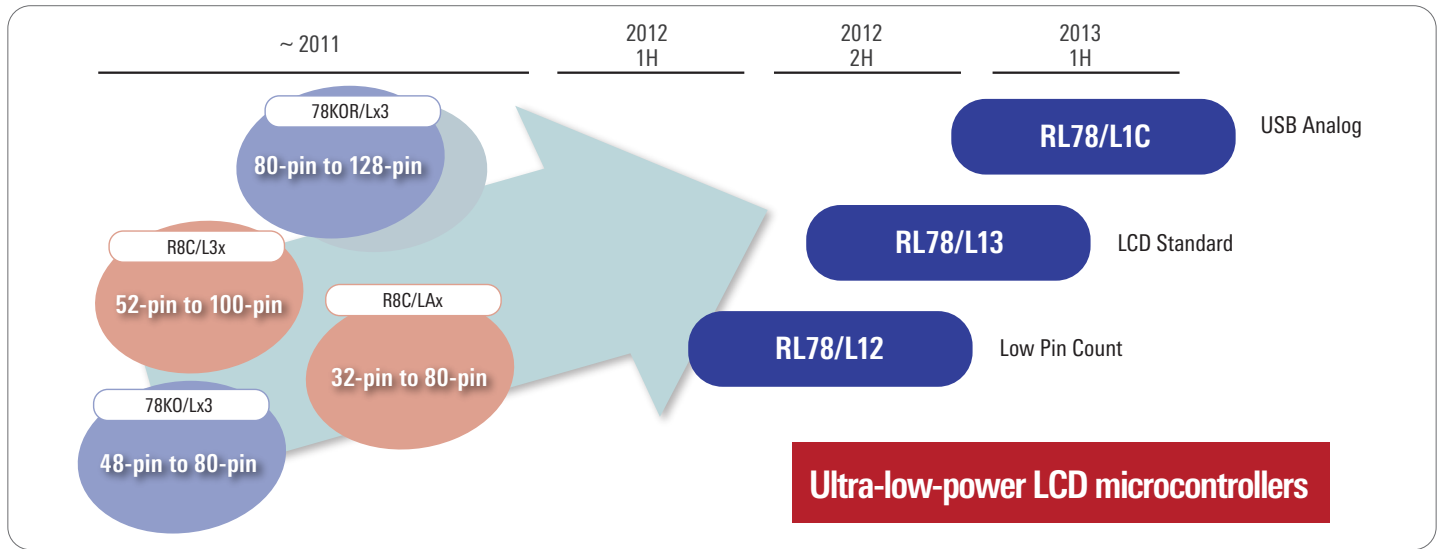
Notes: 1. ROM and RAM sizes for CC-RL (V2.05) environment, and ROM and RAM sizes for all Device Classes include size of Basic driver. 2. EEPROM devices used as media.

# LCD

## RL78/L12, L13, L1C

### LCD microcontroller product roadmap

New successor products combining the features of earlier LCD microcontrollers



### RL78/L12, RL78/L13, and RL78/L1C product concept

#### Low-power LCD driver

- Capacitor split type for generating LCD drive voltage
- **89% reduction** in current consumption compared with previous product  
Particularly large reduction in LCD drive current

#### Support for many segment LCD panel types

- **Resistance division type** suitable for large panels
- **Voltage boost type** suitable for battery powered systems
- **Capacitor split type** suitable for very small currents

#### Return of panels with very large segment counts

- Max. display segment count: 416

|                                       |                         | L12 | L13 | L1C |
|---------------------------------------|-------------------------|-----|-----|-----|
| Healthcare                            | Blood pressure meters   | ✓   | ✓   | ✓   |
|                                       | Composition meters      |     | ✓   | ✓   |
|                                       | Blood glucose meter     |     |     | ✓   |
|                                       | Pedometers              | ✓   | ✓   | ✓   |
|                                       | Thermometers            | ✓   |     |     |
| Electric household appliances         | Rice cookers            |     | ✓   |     |
|                                       | Microwave ovens         | ✓   | ✓   | ✓   |
|                                       | Hot water pots          |     | ✓   |     |
| Compact electric household appliances | LCD remote controls     | ✓   | ✓   |     |
|                                       | Hot water heaters       |     | ✓   |     |
|                                       | Telephones              | ✓   | ✓   |     |
| Measuring devices                     | Kitchen tools           |     | ✓   |     |
|                                       | Temperature controllers |     | ✓   | ✓   |
|                                       | Sensor modules          |     |     | ✓   |
|                                       | Flow meter              |     |     | ✓   |



### RL78/L12, L13, L1C Product lineup

| ROM    | Pins | 32    | 44    | 48    | 52    | 64    | 80    | 100  |
|--------|------|-------|-------|-------|-------|-------|-------|------|
| 256 KB |      |       |       |       |       |       | 16 K  | 16 K |
| 192 KB |      |       |       |       |       |       | 16 K  | 16 K |
| 128 KB |      |       |       |       |       | 8 K   | 12 K  | 12 K |
| 96 KB  |      |       |       |       |       | 6 K   | 10 K  | 10 K |
| 64 KB  |      |       |       |       |       | 4 K   | 8 K   | 8 K  |
| 48 KB  |      |       |       |       |       | 2 K   |       |      |
| 32 KB  |      | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K | 1.5 K |      |
| 16 KB  |      | 1 K   | 1 K   | 1 K   | 1 K   | 1 K   | 1 K   |      |
| 8 K    |      | 1 K   | 1 K   | 1 K   | 1 K   |       |       |      |

RAM RL78/L12 : 32-pin - 64-pin

RAM RL78/L13 : 64-pin - 80-pin

RAM RL78/L1C : 80-pin - 100-pin

### LCD display seg × com lineup

At each pin count the new products support higher segment counts than earlier products.

| Seg count (K com) | Pins |    | 32 | 48 | 52 | 64 | 80 | 100 | 128 |    |
|-------------------|------|----|----|----|----|----|----|-----|-----|----|
| 50 or more        |      |    |    |    |    |    | 51 | 56  | 56  | 54 |
| 45 - 49           |      |    |    |    |    |    | 48 |     |     |    |
| 40 - 44           |      |    |    |    |    |    | 40 | 40  |     |    |
| 35 - 39           |      |    |    |    |    | 39 |    | 40  |     |    |
| 30 - 34           |      |    |    | 30 | 32 | 32 | 32 | 31  | 32  |    |
| 25 - 29           |      | 26 |    | 24 |    |    |    |     |     |    |
| 20 - 24           |      | 22 | 24 | 24 |    |    |    |     |     |    |
| 15 - 19           |      |    |    |    |    |    |    |     |     |    |
| 9 - 14            | 13   | 9  |    |    |    |    |    |     |     |    |

■ RL78/L1x ■ 78K0R/Lx3 ■ 78K0/Lx3 ■ R8C/L3xx ■ R8C/LAxx







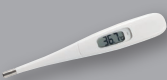

### Ultra-low standby current consumption (clock counter + LCD display)

Capacitor split provides extremely low current consumption when driving LCD panels.

|                           |                              | Renesas RL78/L1x | Company A        | Company B       | Company C        | Company D       |
|---------------------------|------------------------------|------------------|------------------|-----------------|------------------|-----------------|
| Current during LCD drive* | Resistance division method*2 | 11.6 μA (typ.)   | 11.7 μA (@2.2 V) | Not implemented | 12.0 μA (@1.8 V) | Not implemented |
|                           | Capacitor split method       | 7.35 μA (typ.)   | Not implemented  | Not implemented | Not implemented  | Not implemented |
|                           | Voltage boost method         | 21.19 μA (typ.)  | 24.5 μA          | 22.9 μA         | Not implemented  | 23.7 μA         |

Notes: 1. Current value including sub-oscillator, RTC operation, LCD operation and current flow to LCD panel. The calculation assumes an LCD panel drive current of 10 μA when using the resistance division method. (The value differs depending on the drive method.)  
 2. Calculated using an external resistance value of 1,000 kΩ for the external resistance division method.

### Supports the three typically used LCD drive methods. Enables LCD circuits with ultra-low power consumption.

|                            |  | Features/anticipated applications                            |  |   |   |  |
|----------------------------|--|--|--|---|---|--|
| Resistance division method | <p><b>For heavy-duty LCD/AC power supply applications</b></p> <p>Using resistance division to generate the drive voltage achieves high LCD drive capacity at low cost. External resistors are used for voltage division to generate the LCD drive voltage. The ability to input an external voltage means that external resistors and capacitors can be used to adjust the operating current and drive capacity.</p>   | <p>High <b>Good</b></p> <p>Suitable for large LCD panels</p> | <p>Standard</p> <p>10.4 μA[typ.]*1</p>                           | <p>Dependent on VDD</p> <p>Display dims as power supply voltage drops.</p>  |  <p>Microwave ovens</p>  <p>Washing machines</p>  <p>Rice cookers</p>        |  |
|                            | <p><b>For battery-powered applications</b></p> <p>The operating current is small and the drive voltage remains constant even when the battery voltage drops, so there is no dimming of the LCD display. The reference voltage is generated internally, and external capacitors are used to boost the voltage. The reference voltage can be adjusted by software in order to modify the LCD contrast. (On the RL78/L12, 18 setting steps are supported.)</p>  | <p>Standard</p>  | <p>Small current <b>Good</b></p> <p>0.63μA[typ.]*</p>            | <p>Constant <b>Good</b></p> <p>No change when power supply voltage from battery, etc., drops, so no dimming of display.</p> |  <p>Kitchen tools</p>  <p>Composition meters</p>  <p>LCD remote controls</p> |  |
| Capacitor split method     | <p><b>For battery-powered applications</b></p> <p>This method uses the smallest operating current. The LCD display dims when the battery voltage drops. It can be used without modification in cases where the aim is to dim the display according to the remaining battery capacity. To prevent the display from dimming as the battery voltage drops, the system can switch to the internal voltage boost method when the battery voltage is low. It is also possible to use the internal voltage boost method with the capacitor split method implemented in an external circuit.</p> | <p>High <b>Good</b></p>                                      | <p>Very small current <b>Very Good</b></p> <p>0.12μA[typ.]*1</p> | <p>Dependent on VDD</p> <p>Display dims as power supply voltage drops.</p>  |  <p>Thermometers</p>  <p>Activity meters</p>  |  |

Note: 1. Drive voltage: 3 V, 1/3 bias, external resistance value: 1,000 kΩ, no LCD panel connected

# LCD, ANALOG

## RL78/L1A

### RL78/L1A features

On-chip analog functions, low current consumption, low-voltage analog, on-chip LCD driver

This power-efficient 16-bit LCD microcontroller is ideal for use in portable healthcare devices such as blood glucose meter.

#### World-top-class power efficiency

- Current consumption during operation: 66  $\mu$ A/MHz
- In RTC mode: 1  $\mu$ A or less

#### Notable analog functions

- On-chip 12-bit ADC and 12-bit DAC that maintain consistent accuracy up to 2.0 V
- Rail-to-rail op-amp with analog switch

### RL78/L1A specifications

- **RL78 CPU Core**
  - Three-stage pipeline CISC architecture
  - Max. operating frequency: 24MHz
- **Memory**
  - Support for 1.8 V flash programming and boot swap
  - Program Flash: 48 KB–128 KB
  - SRAM: 5.5 KB
  - Data Flash: 8 KB
- **System**
  - High-speed on-chip oscillator: 24 MHz
  - Low-speed on-chip oscillator: 15 kHz
- **Power management**
  - Power-on reset (POR)
  - Low-voltage detection circuit (LVD)
  - RTC output (1 Hz)  $\times$  1
- **Safety**
  - Compliant with European safety standard for household appliances (IEC/UL 60730)
- **Timers**
  - Advanced-functionality timer array unit (TAU)
  - Watchdog timer, real-time clock
- **Analog**
  - 12-bit ADC  $\times$  14 channels
  - 12-bit DAC  $\times$  2 channels
- **Communication**
  - 3  $\times$  SCI: Simple SPI/simple I<sup>2</sup>C/UART
- **LCD**
  - 32 seg  $\times$  4 com (80-pin)
  - 45 seg  $\times$  4 com (100-pin)
- **Package**
  - LQFP 12  $\times$  12 mm 80-pin, 0.5 mm pitch
  - LQFP 14  $\times$  14 mm 100-pin, 0.5 mm pitch
- **RAM parity error detection function**
- **Illegal memory access detection**
- **ADC test function**

### RL78/L1A lineup

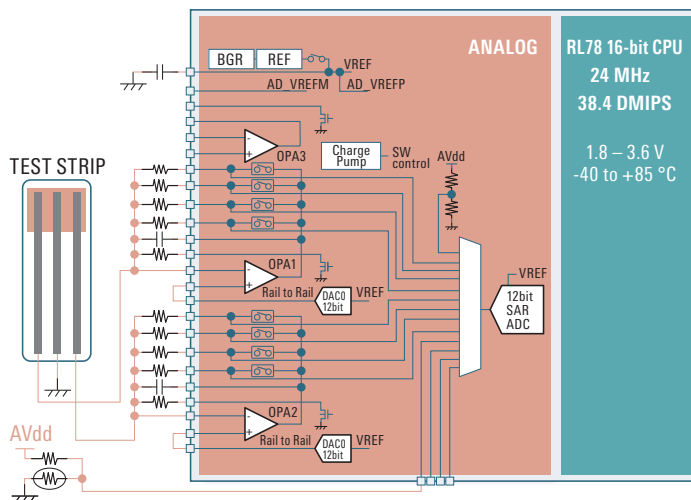
| ROM   | Pins  |                 | 80    |                 | 100   |                 |
|-------|-------|-----------------|-------|-----------------|-------|-----------------|
|       | RAM   | DATA flash size | RAM   | DATA flash size | RAM   | DATA flash size |
| 128 K |       |                 | 5.5 K | 8 KB            | 5.5 K | 8 KB            |
| 96 K  | 5.5 K | 8 KB            | 5.5 K | 8 KB            | 5.5 K | 8 KB            |
| 64 K  | 5.5 K | 8 KB            | 5.5 K | 8 KB            | 5.5 K | 8 KB            |
| 48 K  | 5.5 K | 8 KB            |       |                 |       |                 |

■ RAM size ■ DATA flash size

| Memory                                 | RL78 16-bit CPU<br>24 MHz 38.4 DMIPS           |                      |  |
|--|--|----------------------|--|
| Program Flash<br>up to 128 KB          | CISC Harvard Architecture<br>3-stage Pipeline  |                      |  |
| SRAM<br>5.5 KB                         | MUL/DIV/MAC instruction                        |                      |  |
| Data Flash<br>8 KB                     | Four Register Banks                            |                      |  |
|  | 16-bit Barrel Shifter                          |                      |  |
| System                                 | Safety   | Analog               | Communication  |
| DTC/ELC                                | RAM Parity Check                               | ADC<br>12-bit, 14 ch | I <sup>2</sup> C<br>Multi-Master<br>CSI/UART/<br>Simplified I <sup>2</sup> C<br>4 ch |
| Interrupt Controller<br>4 Levels       | ADC Self-diagnostic                            | DAC<br>12-bit, 2 ch  |  |
| Clock Generation<br>Internal, External | Clock Monitoring                               | Op-Amp<br>3 ch       | Internal Vref.<br>Temp. Sensor   |
| POR, LVD                               | Memory CRC                                     | Comparator<br>1 ch   |  |
| Debug<br>Single-Wire                   |  |                      |  |
| Power Management                       | Timers   |                      |  |
| HALT<br>RTC, DTC Enabled               | Timer Array Unit<br>16-bit, 8 ch               |                      |  |
| SNOOZE<br>Serial Enabled               | Interval Timer<br>16-bit/8-bit, 1 ch/2 ch      |                      |  |
| STOP<br>SRAM On                        | Interval Timer<br>12-bit, 1 ch                 |                      |  |
|  | RTC<br>Calendar                                |                      |  |
| LCD                                    | 45 seg $\times$ 4 com<br>41 seg $\times$ 8 com | Internal Boost       | Split Cap.   |

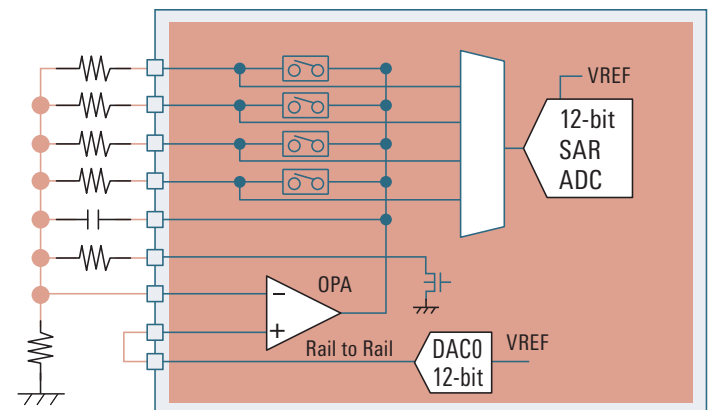
### Analog frontend function configuration

In blood glucose meter use case



### Features of analog functions

I/V conversion with transimpedance amplifier

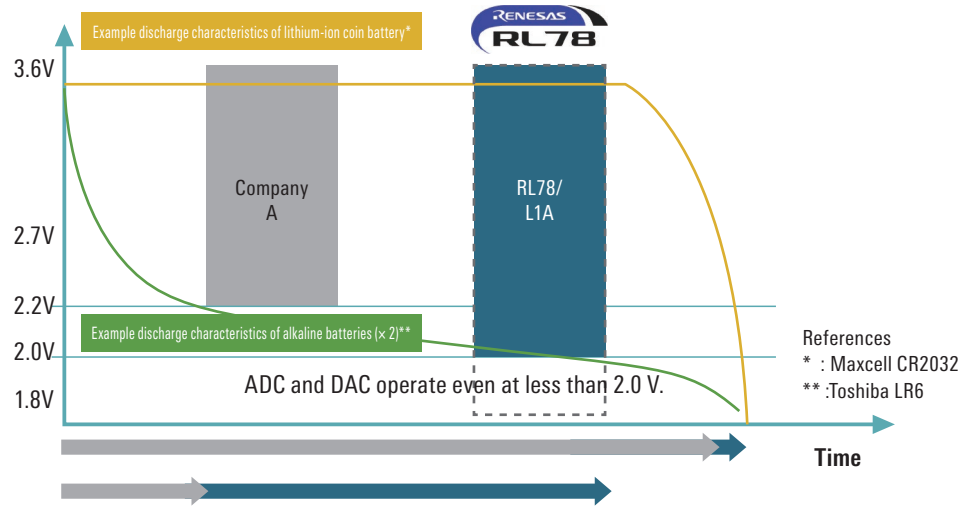


Using analog switches, you can switch among the external feedback resistors. It can be accomplished by means of software. So they help you to create a common board design for use with multiple product types.



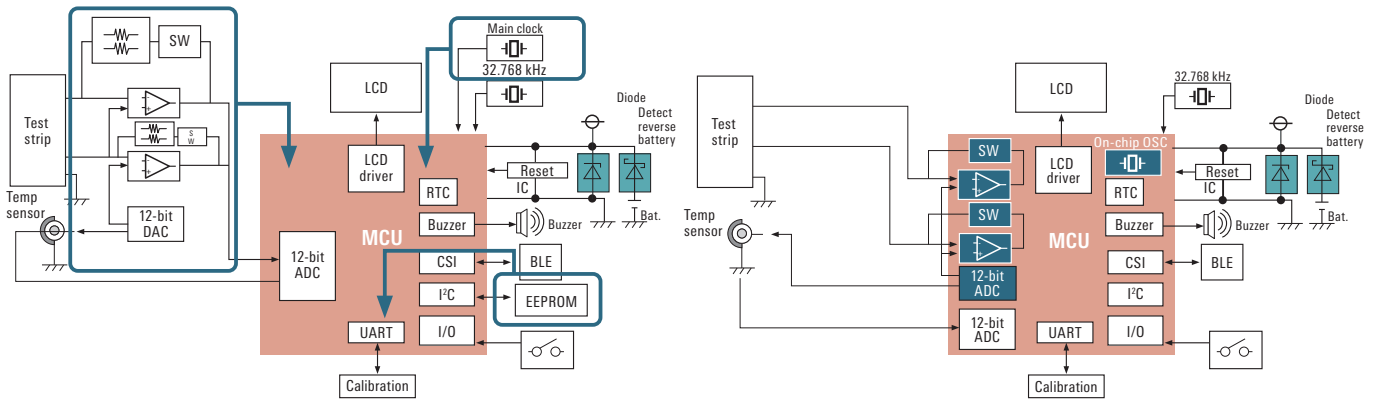
### Low-voltage operation of analog functions

Analog functions maintain accuracy while operating at 2.0 V. Low-voltage operation contributes to extended battery life.



### Enhanced on-chip microcontroller functions to reduce the number of system components

Peripheral functions such as AFE, main clock, and EEPROM are incorporated into the microcontroller. This reduces the number of additional components required.

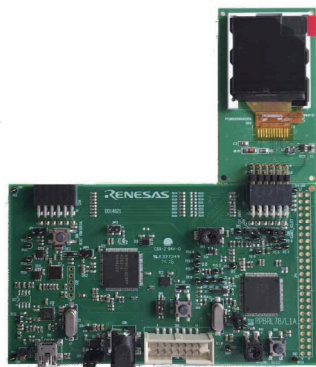


### RL78/L1A RPB (Renesas promotion board)

RL78/L1A RPB is available to evaluate an RL78/L1A for your products.

#### Features

- Operates on USB power supply.
- Outputs trace data via USB.
- Supports connection of an LCD display.
- Includes a 128 × 128 color dot matrix PMOD display.



### Blood glucose meter reference solution is coming soon

We plan to expand its range of reference solutions and application notes for blood glucose meter. It utilizes analog functions of RL78/L1A, such as 12-bit A/D and 12-bit D/A converters and op-amps.

# ASSP, LIGHTING/POWER SUPPLY

## RL78/I1A

### RL78/I1A features

- Basic peripheral functions for lighting and power supply applications
  - Timers for LED control and PFC control
  - 64 MHz source clock, zero current detection, forced output stop function
  - Analog functions for feedback
  - 10-bit A/D converter (2.125  $\mu$ s. conversion), PGA, comparator
  - Support for high temperatures up to 105°C or 125°C
- Current consumption
  - LED power supply control: 3.3 mA (main operation), CPU clock: 16 MHz, timer KB clock: 64 MHz, PLL: on
  - UART (DALI) receive standby: 0.23  $\mu$ A (STOP current)
- Full complement of connectivity functions
  - Communication functions (DALI, PMBus, SMBus, DMX512, UART, I<sup>2</sup>C, CSI)
- Special peripheral functions for "intelligent" operation and improved efficiency
  - Dithering function (0.98 ns pseudo-resolution), software start function, max. frequency limit function, interleaved PFC, standby communication wait

### RL78/I1A lineup

| ROM   | Pins | 20  | 30  | 38  |
|-------|------|-----|-----|-----|
| 64 KB |      |     | 4 K | 4 K |
| 32 KB |      | 2 K | 2 K |     |

RAM size

Operating temperature ranges up to 105°C or 125°C supported

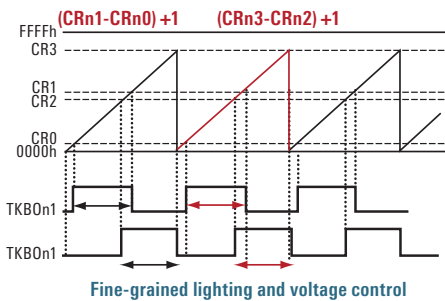
### Main applications

- LED Lighting, Lighting switches
- Digital power supplies
- Illumination fixtures
- Laser printers
- Microwave ovens
- Vacuum cleaners
- Communication devices

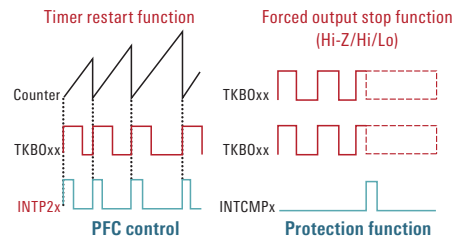
### Advantages of RL78/I1A

#### Dithering function

Delivers min. average resolution of 0.98 ns.



#### Linked operation of 16-bit timer KB and INTP comparator



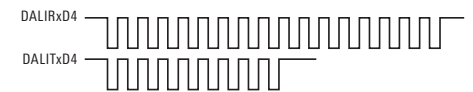
#### Support for multiple power supply control methods

| AC/DC (PFC) control circuit | PFC control mode                            |
|-----------------------------|---|
| Boost converter             | CRM-PFC control (DCM or CCM also supported) |
| Flyback converter           |   |
| DC/DC control circuit       | Constant-current control mode               |
| Buck converter              | Average-current control                     |
| Boost converter             | Peak-current control                        |
| Flyback converter           |   |
| Half-bridge                 |   |
| Full-bridge                 |   |

#### DALI master/slave communication functions

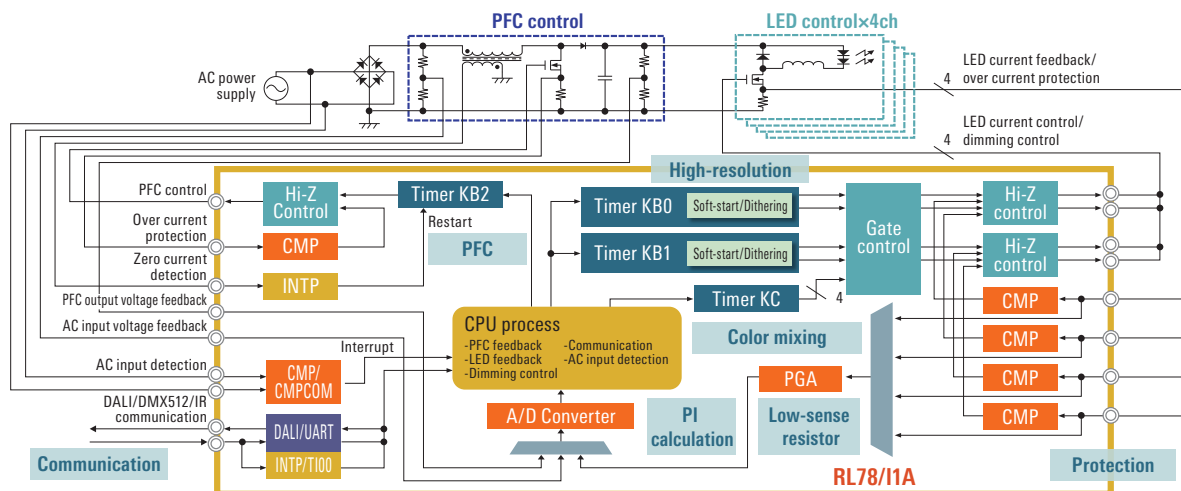
Manchester coding

Transmit/receive data: 8-, 16-, 17-, or 24-bit



Implementation in hardware of communication functions for lighting

### System configuration example: PFC control + LED constant current control



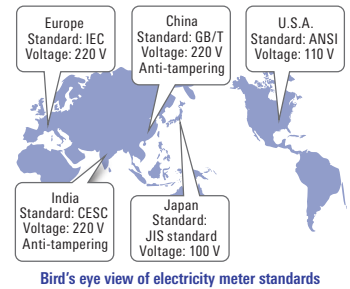
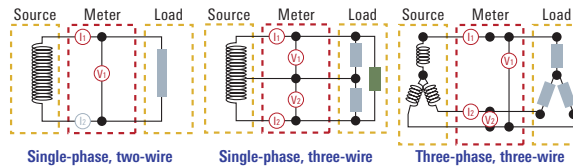
# ASSP, ELECTRICITY METER

## RL78/I1B

### Target electricity meter markets of RL78/I1B

#### Electricity meter types

| Wiring Type              | Main Applications     | Main Regions         |
|--------------------------|-----------------------|----------------------|
| Single-phase, two-wire   | Home                  | Europe, China, India |
| Single-phase, three-wire | Home                  | Japan, U.S.A         |
| Three-phase, three-wire  | Commercial/industrial | Worldwide            |



### RL78/I1B lineup and concept

| ROM    | Pins | 80  | 100 |
|--------|------|-----|-----|
| 128 KB |      | 8 K | 8 K |
| 64 KB  |      | 6 K | 6 K |

RAM size

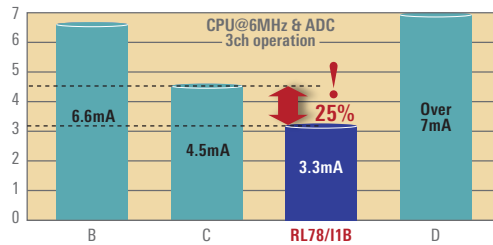
- Product lineup to accommodate various meter types
- Four products

### Aiming for low power consumption

Low power consumption among the best in its class: Power efficient during both calculations and backup operation

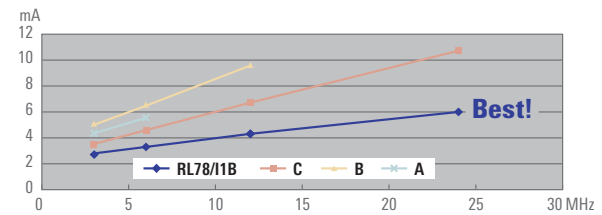
- Low power consumption
  - Operating current: 96  $\mu$ A/MHz
  - Standby current: 0.69  $\mu$ A (during RTC or LVD operation)
- Newly developed 24-bit  $\Delta\Sigma$  ADC
  - Current during ADC operation: 0.53 mA/channel

### 25% lower power consumption than competing products\*1



Note: 1. Based on research by Renesas

### Lowest power consumption at all operating frequencies

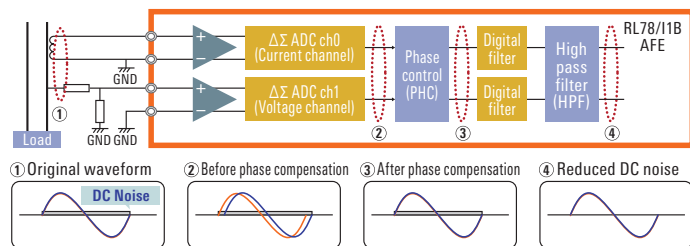


| CPU Frequency (MHz)   | MCU | RL78/I1B  | A           | B            | C            |
|---|-----|-----------|-------------|--------------|--------------|
|   |     | 64/128 KB | Up to 32 KB | Up to 120 KB | Up to 128 KB |
| ADC 3-channel operation at each CPU operating frequency (MHz) | 3   | 2.8       | 4.35        | 5.1          | 3.525        |
|   | 6   | 3.3       | 5.55        | 6.6          | 4.595        |
|   | 12  | 4.2       | —           | 9.6          | 6.695        |
|   | 24  | 6         | —           | —            | 10.725       |

### $\Delta\Sigma$ ADC with improved functionality for electricity meters

#### Implementation in hardware of functions essential for power measurement

#### Phase correction circuit, high-pass filter

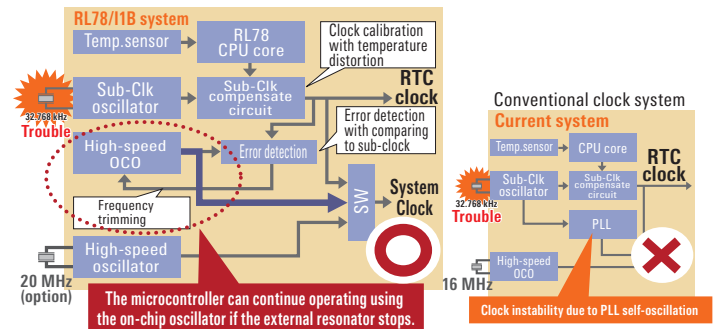


- Newly developed 24-bit ADC
  - Designed for low power consumption
  - Reduced CPU operating frequency that contributes to lower power consumption (on-chip PHC and HPF)
- To further cut power consumption ...
  - Support for multiple sampling frequencies (3.906 kHz and 1.953 kHz)

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

#### Subclock resonator single-crystal system

Exclusive Renesas system is more robust than conventional PLL designs.



- High-precision clock:  $\pm 0.05\%$  (high-speed on-chip oscillator with correction circuit)
  - Correction of on-chip oscillator by subclock (exclusive Renesas circuit)
- Safety functions: Clock system
  - High-speed on-chip oscillator maintains oscillation at  $\pm 1\%$  accuracy even if external resonator stops operating.

# ASSP, ELECTRICITY METER

## RL78/I1C

### Target electricity meter markets of RL78/I1C

#### Electricity meter types

| Wiring Type              | Main Applications                                  | Main Regions         |
|--------------------------|--|----------------------|
| Single-phase, two-wire   | Home   | Europe, China, India |
| Single-phase, three-wire | Home   | Japan, U.S.A         |
| Three-phase, three-wire  | Commercial/industrial                              | Worldwide            |
| Three-phase, four-wire   | Commercial/industrial<br>Agriculture/urban housing | Worldwide            |

### RL78/I1C lineup and concept

| ROM    | Pins | 64  | 80   | 100  |
|--------|------|-----|------|------|
| 256 KB |      |     | 16 K | 16 K |
| 128 KB | 8 K  | 8 K | 8 K  | 8 K  |
| 64 KB  | 6 K  | 6 K |      |      |

RAM size

### Improved security functions and arithmetic performance

- First in the industry to implement AES GCM mode in hardware, as required by the DLMS standard.
  - Encryption and decryption are over 20 times faster than the software processing used on previous Renesas products.
- Approx. 30% improvement in arithmetic capacity required for power calculation.
  - On-chip PLL boosts the maximum operating frequency from 24 MHz to 32 MHz.
  - 32-bit multiplier/divider and multiply-and accumulate unit dramatically reduce the software burden when performing calculations on 24-bit data converted by the 24-bit  $\Delta\Sigma$  A/D converter.

### Retaining and improving the power efficiency of the RL78/I1C

- Independent power supply real-time clock
  - Current consumption of 0.7  $\mu\text{A}$  (typ.) during operation

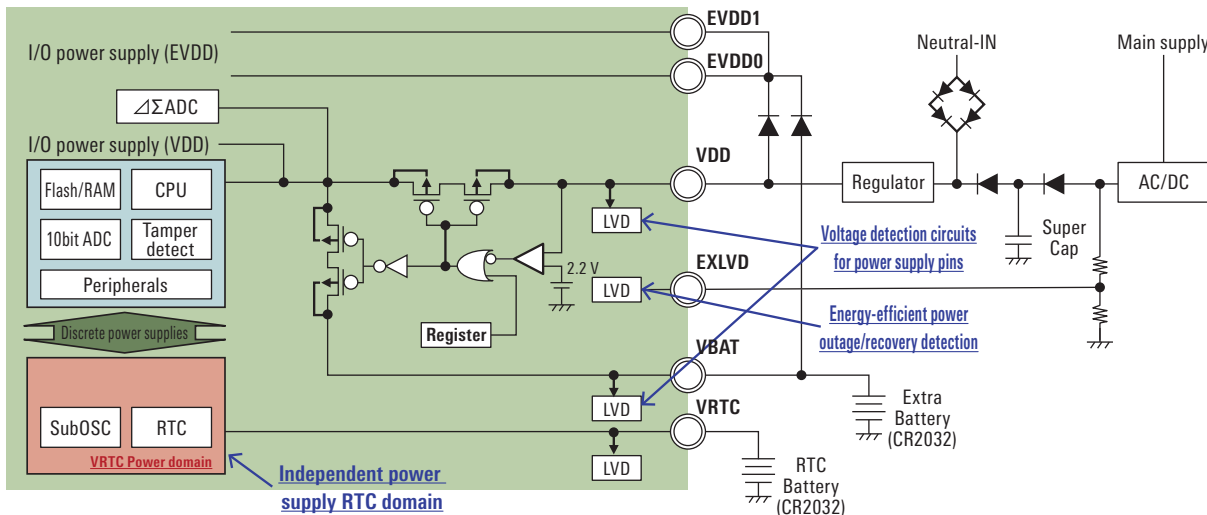
### Target markets

- Ideal for smart meters, including those using DLMS communication.
- Suitable for a wide variety of power platforms, from single-phase two-wire to three-phase four-wire.

- Available flash memory configurations are 256 KB for DLMS or three-phase meters, 128 KB for single-phase meters or low-end three-phase meters, and 64 KB for low-end single-phase meters.
- Available package pin counts are 100 for three-phase meters or single-phase meters for advanced economies, 80 for single-phase meters for emerging economies, and 64 for applications where space is restricted.
- A total of seven product versions are available.

- Power measurement processing and DLMS processing on a single chip.
  - Ability to handle DLMS communication while power measurement processing is taking place.
  - Approx. 30% reduction in power consumption compared with two-chip solutions combining an earlier meter microcontroller and a dedicated microcontroller for DLMS processing.
  - Contributes to reduced system cost.

- Enhanced power supply monitoring function
  - Low-voltage monitoring of power supply pins using LVD and improved battery backup function to deliver power to the CPU and peripheral functions when power is interrupted.





# ASSP, ANALOG

## RL78/I1E

### RL78/I1E features

- High-precision analog functions
  - 24-bit  $\Delta\Sigma$  A/D converter  $\times$  4 channels
  - 10-bit SAR A/D converter  $\times$  10 channels
  - Configurable amplifier  $\times$  3 channels
  - 12-bit D/A converter  $\times$  1 channel
  - Sensor power supply  $\times$  1 channel
- Compact package
  - 4 mm square: 36-pin FBGA
  - 5 mm square: 32-pin VQFN
- Support for high temperatures
  - 40 to 105°C
  - 40 to 125°C

### RL78/I1E lineup

| ROM   | Pins | 32   | 36   |
|-------|------|------|------|
| 32 KB |      | 8 KB | 8 KB |

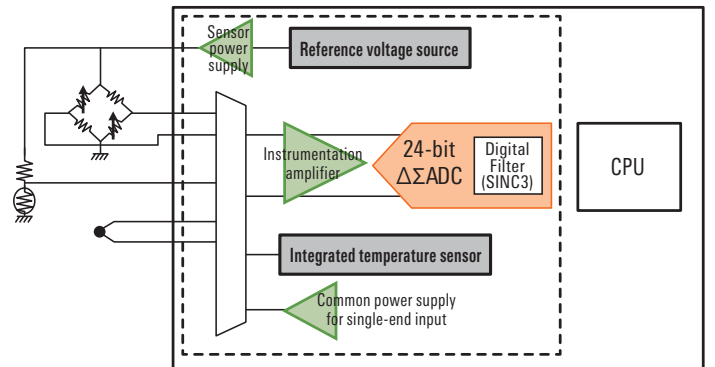
RAM Size

| Memory                 | System                           | Power Management      | Timers                           | Communication  | Analog   | Safety               |
|------------------------|----------------------------------|-----------------------|----------------------------------|--|--|----------------------|
| Program Flash<br>32 KB | DTC<br>23 sources                | Main OSC<br>1-20 MHz  | Timer Array Unit<br>16-bit, 6 ch | 2 x CSI<br>/2 x UART<br>/2 x Simplified I <sup>2</sup> C (exclusive) | Delta-Sigma ADC with Instrumentation AMP<br>24-bit, 4 ch | CMOS In/Dut<br>11 ch |
| SRAM<br>8 KB           | ELC<br>16 sources                | HOCO<br>32 MHz/24 MHz | Timer RG<br>16-bit, 1 ch         |  | SAR ADC<br>10-bit, 10 ch                                 | CMOS Input<br>3 ch   |
| Data Flash<br>4 KB     | Interrupt Controller<br>4 Levels | LOCO<br>15 kHz        | Timer RJ<br>16-bit, 1 ch         |  | Op-Amp<br>3 ch   |                      |
|                        | POR, LVD                         | PLL<br>32 MHz/24 MHz  | WDT                              |  | DAC<br>12-bit, 1 ch                                      |                      |
|                        | On-chip Debug<br>Single-Wire     |                       | RTC                              |  | Temperature sensor                                       |                      |
|                        |                                  |                       | Interval Timer<br>12-bit, 1 ch   |  | Sensor Bias  |                      |
|                        |                                  |                       |                                  |  |  |                      |

### On-chip 24-bit $\Delta\Sigma$ A/D converter

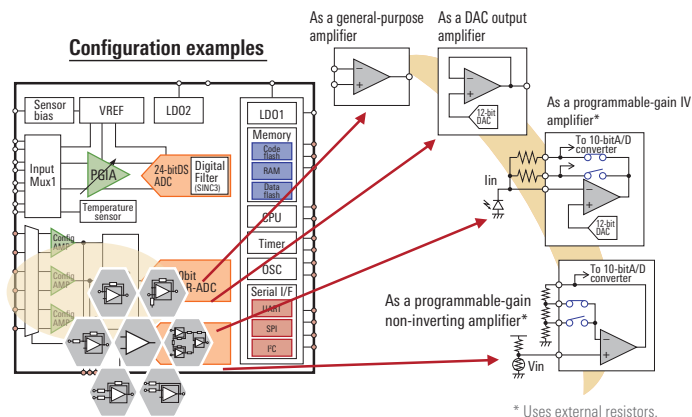
- AFE\* circuits for many types of sensor measurements, including using pressure sensors, load cells, and thermocouples, integrated on a single chip.
- Ability to use common sensor power supply and ADC reference voltage, minimizing ratiometric error.

\*AFE: Analog Front End



### On-chip configurable amplifier

- General-purpose analog I/O ports and configurable switches enable configuration of a variety of op-amp circuits.
- Integrated peripheral analog functions



\* Uses external resistors.

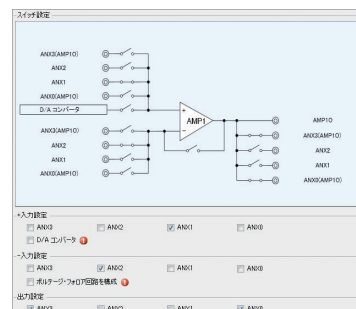
### Code generation tool for RL78/I1E

This GUI-based tool lets you specify a variety of information and automatically generates code for analog circuit control programs.

- PGA  $\Delta\Sigma$  A/D converter settings



- Configurable amplifier settings



# ASSP, HEALTHCARE/ELECTRICITY METER

## RL78/H1D

Optimized with rich analog functions and timers, the RL78/H1D microcontroller is ideal for healthcare and flow meter applications. The RL78/H1D microcontroller includes high precision analog functions such as Delta-Sigma A/D converter, SAR A/D converter, Programmable Gain amplifiers, Operational amplifier, and 8-bit/12-bit D/A converter. It also has a built-in LCD controller/driver which makes the RL78/H1D well suited for healthcare devices, especially blood pressure monitor.

### RL78/H1D features

- Rich analog functions
  - 24-bit  $\Delta\Sigma$  A/D converter
  - 10-bit SAR A/D converter
  - 12-bit D/A converter
  - 8-bit D/A converter
  - OpAMP
- Timers
  - External signal sampler
  - Sampling output timer detector
- Low power LCD
- Ideal for healthcare (blood pressure monitor, body composition monitor) and flow meter applications
- Rich package lineup
  - 48-/64-/80-pin LFQFP
  - 64-pin TFBGA

### RL78/H1D lineup

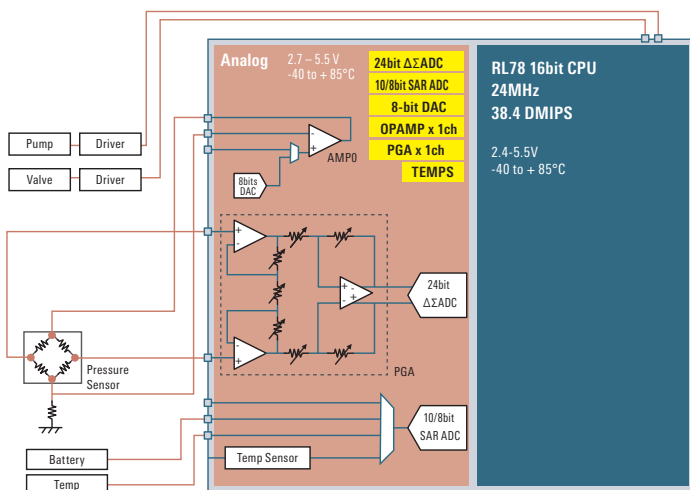
| ROM    | Pins | 48     |      | 64     |      | 80          |      |
|--------|------|--------|------|--------|------|-------------|------|
| 128 KB |      | 5.5 KB | 4 KB | 5.5 KB | 4 KB | 5.5 KB/8 KB | 4 KB |
| 96 KB  |      | 5.5 KB | 4 KB | 5.5 KB | 4 KB | 5.5 KB      | 4 KB |
| 64 KB  |      |        |      |        |      | 5.5 KB      | 4 KB |

■ RAM size ■ DATA flash size

|  |  |
|--|--|
| <b>Memory</b><br>Program Flash up to 128KB<br>SRAM 5.5KB<br>Data Flash 4KB   | <b>RL78 16-bit CPU</b><br>24 MHz 38.4 DMIPS<br>CISC Harvard Architecture<br>3-stage Pipeline<br>Four Register Banks<br>16-bit Barrel Shifter                             |
| <b>System</b><br>DTC/ELC 2ch<br>Interrupt Controller 4 Levels<br>Clock Generation Internal, External<br>POR, LVD<br>MUL/DIV/MAC<br>Debug Single-Wire | <b>Safety</b><br>RAM Parity Check<br>ADC Self-diagnostic<br>Clock Monitoring<br>Memory CRC   |
| <b>Power Management</b><br>HALT RTC, DTC Enabled<br>SNOOZE Serial, ADC Enabled<br>STOP SRAM On   | <b>Timers</b><br>Timer Array Unit 16-bit, 8ch<br>Interval Timer 16-bit/8-bit, 1ch/2ch<br>WDT 17-bit, 1ch<br>RTC Calendar   |
| <b>LCD</b> 32seg x 8com<br>Internal Boost<br>Capacitor Split   | <b>Analog</b><br>OpAMP 1ch<br>Internal Vref.<br>Temp. Sensor<br>Delta-Sigma ADC 24-bit x 2ch<br>SAR ADC 8/10-bit x 3ch<br>DAC 8-bit x 1ch<br>DAC 12-bit x 1ch<br>PGA 2ch |
|  | <b>Communication</b><br>1 x I <sup>2</sup> C Multi-Master<br>3 x CSI/UART / Simple I <sup>2</sup> C  |

### Analog front end function configuration

Blood pressure monitor use case (80-pin LFQFP)



### Blood Pressure Monitoring Evaluation Kit for RL78/H1D

Part Name: RTK0EH0003S02001BR

Blood Pressure Monitoring Evaluation Kit includes hardware and development tools needed to quickly and easily get started.



# AUTOMOTIVE

## RL78/F13, F14, F15

The RL78/F1x microcontrollers are the successors to the 78K0R and R8C families. They combine high performance with low power consumption, and features such as CAN/LIN communication functions, advanced-functionality timers, and safety functions make them ideal for both automotive and industrial applications.

### RL78/F13, F14, F15 lineup

#### RL78/F13

| ROM    | Pins |     | 20  | 30  | 32  | 48  | 64  | 80  |
|--------|------|-----|-----|-----|-----|-----|-----|-----|
| 128 KB |      |     |     | 8 K | 8 K | 8 K | 8 K | 8 K |
| 96 KB  |      |     |     | 6 K | 6 K | 6 K | 6 K | 6 K |
| 64 KB  | 4 K  | 4 K | 4 K | 4 K | 4 K | 4 K | 4 K | 4 K |
| 48 KB  | 3 K  | 3 K | 3 K | 3 K | 3 K | 3 K | 3 K |     |
| 32 KB  | 2 K  | 2 K | 2 K | 2 K | 2 K | 2 K | 2 K |     |
| 16 KB  | 1 K  | 1 K |     | 1 K |     | 1 K |     |     |

#### RL78/F14

| ROM    | Pins |     | 30  | 32  | 48   | 64   | 80   | 100  |
|--------|------|-----|-----|-----|------|------|------|------|
| 256 KB |      |     |     |     | 20 K | 20 K | 20 K | 20 K |
| 192 KB |      |     |     |     | 16 K | 16 K | 16 K | 16 K |
| 128 KB |      |     |     |     | 10 K | 10 K | 10 K | 10 K |
| 96 KB  |      |     |     |     | 8 K  | 8 K  | 8 K  | 8 K  |
| 64 KB  | 6 K  | 6 K | 6 K | 6 K | 6 K  | 6 K  | 6 K  | 6 K  |
| 48 KB  | 4 K  | 4 K | 4 K | 4 K |      |      |      |      |

#### RL78/F15

| ROM    | Pins |  | 48   | 64   | 80   | 100  | 144  |
|--------|------|--|------|------|------|------|------|
| 512 KB |      |  | 32 K | 32 K | 32 K | 32 K | 32 K |
| 384 KB |      |  | 26 K | 26 K | 26 K | 26 K | 26 K |
| 256 KB |      |  |      |      |      | 20 K | 20 K |
| 152 KB |      |  |      |      |      | 16 K | 16 K |
| 128 KB |      |  |      |      |      | 10 K | 10 K |

LIN CAN 1ch CAN 2ch White numbers indicate RAM Size (B)

### RL78/F13 features

- Lineup of pin counts from 20 to 80 pins and memory from 16 KB to 128 KB CAN products and non-CAN products are pin compatible.
- Compatible with RL78/F14 and RL78/F15 for easy migration

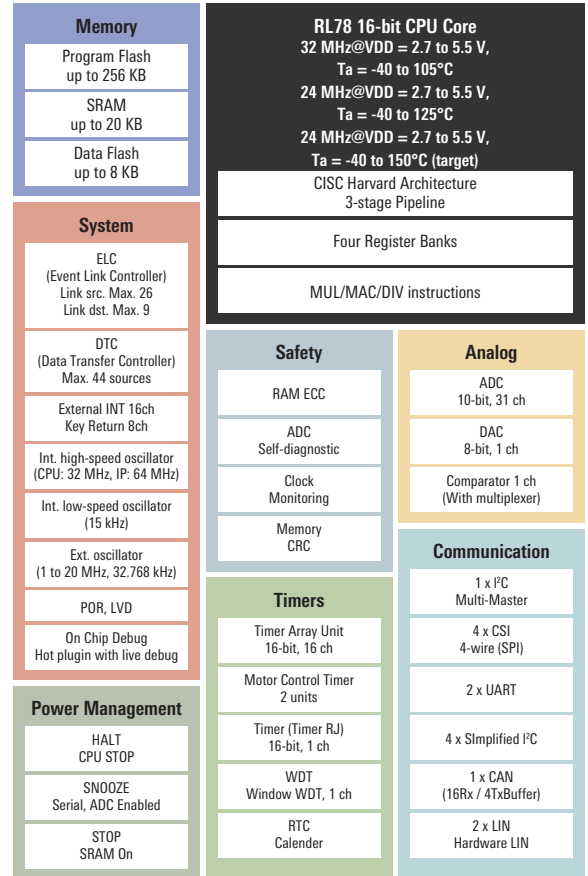
### RL78/F14 features

- AUTOSAR support  
Renesas is currently an AUTOSAR Alliance Partner.
- Expanded motor functionality  
Comparator and D/A converter can be combined with timer RD for applications such as brushless DC motor control.
- Compatible with RL78/F13 and RL78/F15 for easy migration

### RL78/F15 features

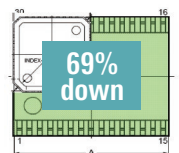
- Compatible with RL78/F13 and RL78/F14 for easy migration
- Expanded number of CAN and LIN channels, on-chip IEC bus controller.  
Enhanced functions suitable for use in automotive gateway products.

### RL78/F14 block diagram



100-pin product

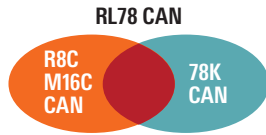
- More advanced functionality
  - 32 MHz operation (2.7 V to 5.5 V at 105°C)
  - Three-phase waveform output function (timer RD)
  - 4 KB BGO data flash (RL78/F13)
  - 8 KB BGO data flash (RL78/F14)
  - 16 KB BGO data flash (RL78/F15)
  - High-speed on-chip oscillator ( $\pm 2\%$  at  $-40$  to  $+105^\circ\text{C}$ )  
CPU: 32 MHz, peripheral: 64 MHz (timer RD)
  - Advanced on-chip debugging functionality  
Hot plugin  
DTC real-time RAM monitor (RRM) and dynamic memory modification (DMM)  
On-chip trace
  - Functional safety support
- Compact package
  - QFN Package lineup  
Ex. 32-pin SSOP 32-pin QFN
- High temperature support
  - Operation at Ta = 150°C (RL78/F13, F14)





### CAN module

- Architecture enabling continued utilization of legacy communication software specifications
  - Retains functionality of previous CAN module
- Reduced load for interrupt handling
  - Implementation in hardware of typical interrupt-related functions
  - Reduction of overhead from interrupts at CAN transmit/receive completion
  - Suppression of interrupts at completion of CAN reception of unneeded messages
- Improved self-diagnostic functions
  - Support for read/write testing of RAM used by CAN
- Implementation in hardware of communication control software processing for reduced CPU load
  - Partial implementation in hardware of AUTOSAR-compliant CAN MCAL block and Pdu\_Router
  - Implementation in hardware of ECU self-diagnostic functions (OBD II support functions)



### LIN module

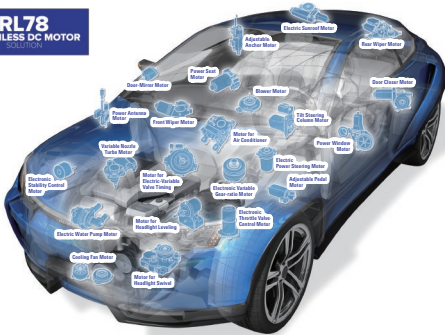
- Retains LIN protocol engine with proven track record on R32C and M16C.
- Full implementation in hardware of master and slave functionality
- Responses from header transmit/receive  
Handling of responses at transmit/receive completion and error detection are completely automated.
- Compliant with LIN revisions 1.3, 2.x, and SAEJ2602
- Functions designed for AUTOSAR (ability to issue frame headers and responses with separate commands, etc.)



### RL78/F1x applications

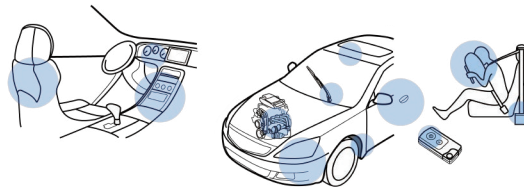
The RL78/F1x Group supports high operating temperatures and offers LIN/CAN communication functionality, making it suitable for a wide range of automotive applications. Some typical applications are listed below.

#### ■ Various types of motor control



#### ■ Various types of body control

#### ■ Car audio



- Powertrain (sub-microcontroller)
- Airbags (sub-microcontroller)

The high reliability required by automotive applications makes these microcontrollers suitable for industrial applications as well.

# RL78 FAMILY OVERVIEW

|   | G10                            | G11                  | G12     | G13         | G14                           | G1A         | G1C        | G1D                 | G1F                                 | G1G                                 | G1H              | L12         | L13                  | L1A                  | L1C  | H1D                                       | I1A                                   | I1B                        | I1C                        | I1D                  | I1E               | F12      | F13                 | F14                 | F15                 |
|---|--------------------------------|----------------------|---------|-------------|-------------------------------|-------------|------------|---------------------|-------------------------------------|-------------------------------------|------------------|-------------|----------------------|----------------------|--|---|---------------------------------------|----------------------------|----------------------------|----------------------|-------------------|----------|---------------------|---------------------|---------------------|
| Key Feature, Application                        | Low Pin                        | Low-Power Analog     | Basic   | Standard    | Enhanced                      | 12-bit ADC  | USB        | Bluetooth           | Enhanced Motor                      | Small Motor                         | Sub-GHz          | LCD Basic   | LCD Standard         | Blood Glucose        | LCD Enhanced                               | Blood Pressure                            | Lighting                              | Metering                   | Enhanced Metering          | Detector             | Incl. Sensor      | Auto     | CAN Auto            | CAN Auto            | CAN Auto            |
| Max speed (MHz)                                 | 20                             | 24                   | 24      | 32          | 32                            | 32          | 24         | 32                  | 32                                  | 24                                  | 32               | 24          | 24                   | 24                   | 24   | 24  | 32                                    | 24                         | 32                         | 24                   | 32                | 32       | 32                  | 32                  | 32                  |
| Voltage (V)                                     | 2.0-5.5                        | 1.6-5.5              | 1.8-5.5 | 1.6-5.5     | 1.6-5.5                       | 1.6-3.6     | 2.4-5.5    | 1.6-3.6             | 1.6-5.5                             | 2.7-5.5                             | 1.8-3.6          | 1.6-5.5     | 1.6-5.5              | 1.8-3.6              | 1.6-3.6                                    | 2.4-5.5                                   | 2.7-5.5                               | 1.9-5.5                    | 1.7-5.5                    | 1.6-3.6              | 2.4-5.5           | 1.8-5.5  | 2.7-5.5             | 2.7-5.5             | 2.7-5.5             |
| Pin   | 10-16                          | 20-25                | 20-30   | 20-128      | 30-100                        | 25-64       | 32-48      | 48                  | 24-64                               | 30-44                               | 64               | 32-64       | 64-80                | 80-100               | 80-100                                     | 48-80                                     | 20-38                                 | 80-100                     | 64-100                     | 20-48                | 32-36             | 20-64    | 20-80               | 30-100              | 48-144              |
| Flash (KB)                                      | 1-4                            | 16                   | 2-16    | 16-512      | 16-512                        | 16-64       | 32         | 128-256             | 32-64                               | 8-16                                | 256-512          | 8-32        | 16-128               | 48-128               | 64-256                                     | 64-128                                    | 32-64                                 | 64-128                     | 64-256                     | 8-32                 | 32                | 8-64     | 16-128              | 48-256              | 128-512             |
| Data Flash (KB)                                 | —                              | 2                    | -/2     | -/4-8       | 4-8                           | 4           | 2          | 8                   | 4                                   | —                                   | 8                | 2           | 4                    | 8                    | 8  | 4   | 4                                     | —                          | 4                          | 2                    | 4                 | 4        | 4                   | 4-8                 | 8-16                |
| RAM (KB)  | 0.1-0.5                        | 1.5                  | 0.2-2   | 2-32        | 2.5-48                        | 2-4         | 5.5        | 12-20               | 5.5                                 | 1.5                                 | 24-48            | 1-1.5       | 1-8                  | 5.5                  | 8-16                                       | 5.5/8                                     | 2-4                                   | 6-8                        | 6-16                       | 0.7-3                | 8                 | 0.5-4    | 1-8                 | 4-20                | 10-32               |
| Max temp. option (°C)                           | 85                             | 85, 105              | 85, 105 | 85, 105     | 85, 105                       | 85, 105     | 85, 105    | 85                  | 85, 105                             | 85                                  | 85               | 85, 105     | 85, 105              | 85                   | 85, 105                                    | 85  | 105, 125                              | 85                         | 85                         | 105                  | 105, 125          | 85, 125  | 105, 125, 150       | 105, 125, 150       | 105, 125            |
| ADC, TAU, 12-bit interval timer, SPI, UART, I2C | ■*1                            | ■                    | ■       | ■           | ■                             | ■           | ■          | ■                   | ■                                   | ■                                   | ■                | ■           | ■                    | ■                    | ■  | ■   | ■                                     | ■                          | ■                          | ■                    | ■                 | ■        | ■                   | ■                   | ■                   |
| Vref/temp. sensor                               | ■*1                            | ■<br>1.8V            | ■       | ■           | ■                             | ■           | ■          | ■                   | ■                                   | ■                                   | ■                | ■           | ■                    | ■                    | ■  | ■   | ■                                     | ■                          | ■                          | ■<br>1.8V            | ■                 | ■        | ■                   | ■                   | ■                   |
| Fast Wake-up 4µs max 8/16-bit interval timer    |                                | ■                    |         |             |                               |             |            |                     |                                     |                                     |                  |             |                      |                      |  |   |                                       |                            |                            | ■                    | ■                 |          |                     |                     |                     |
| RTC (32 kHz)                                    |                                |                      |         | ■<br>40pin+ | ■<br>40pin+                   | ■<br>48pin+ | ■<br>48pin |                     | ■<br>36pin+                         |                                     | ■                | ■<br>44pin+ | ■                    | ■                    | ■  | ■   | ■                                     | ■<br>38pin                 | ■                          | ■                    | ■<br>30pin+       |          | ■<br>48pin+         | ■<br>48pin+         | ■<br>48pin+         |
| MAC/DIV/MUL                                     |                                | ■<br>Inst.           | ■       | ■           | ■<br>Inst.                    | ■           | ■          | ■                   | ■<br>Inst.                          | ■<br>Inst.                          | ■<br>Inst.       | ■           | ■                    | ■<br>Inst.           | ■<br>Inst.                                 | ■<br>Inst.                                | ■                                     | ■<br>Inst.                 | ■<br>Inst.                 | ■<br>Inst.           | ■<br>Inst.        | ■        | ■<br>Inst.          | ■<br>Inst.          | ■<br>Inst.          |
| DMA/DTC (DMA unless otherwise noted)            |                                | ■<br>DTC             | ■       | ■           | ■<br>DTC                      | ■           | ■          | ■                   | ■<br>DTC                            |                                     | ■<br>DTC         | ■           | ■                    | ■<br>DTC             | ■<br>DTC                                   | ■<br>DTC                                  |                                       | ■                          | ■<br>DTC                   | ■<br>DTC             | ■<br>DTC          | ■<br>DTC | ■<br>DTC            | ■<br>DTC            | ■<br>DTC            |
| ELC   |                                |                      |         | ■           | ■                             |             |            |                     | ■                                   | ■                                   | ■                |             |                      | ■                    | ■  | ■   |                                       |                            | ■                          | ■                    | ■                 |          |                     | ■                   | ■                   |
| Comparator                                      | ■<br>16 pin<br>1 ch<br>(0.5µs) | ■<br>2 ch<br>(1.2µs) |         |             | ■<br>96KB+<br>2 ch<br>(1.2µs) |             |            |                     | ■<br>2 ch<br>(70ns)<br>8-bit<br>DAC | ■<br>2 ch<br>(70ns)<br>8-bit<br>DAC |                  |             | ■<br>2 ch<br>(1.2µs) | ■<br>1 ch<br>(1.2µs) | ■<br>1-2 ch<br>(1.2µs)                     |   | ■<br>4-6 ch<br>(70ns)<br>8-bit<br>DAC | ■<br>2 ch<br>(1.2µs)       |                            | ■<br>2 ch<br>(1.2µs) |                   |          |                     | ■<br>1 ch<br>(70ns) | ■<br>1 ch<br>(70ns) |
| DAC (8-bit) unless otherwise indicated          |                                | ■<br>1 ch            |         |             | ■<br>96KB+<br>1-2 ch          |             |            |                     | ■<br>1-2 ch                         |                                     |                  |             |                      | ■<br>12-bit<br>2 ch  | ■<br>2 ch                                  | ■<br>12-bit<br>0-1 ch,<br>8-bit<br>0-1 ch |                                       |                            |                            | ■<br>12-bit<br>1 ch  |                   |          | ■<br>1 ch           | ■<br>1 ch           |                     |
| PGA/AMP   |                                | ■<br>PGA<br>1 ch     |         |             |                               |             |            |                     | ■<br>PGA<br>1 ch                    | ■<br>PGA<br>1 ch                    |                  |             |                      | ■<br>AMP<br>3 ch     | ■<br>PGA<br>0-1 ch,<br>AMP<br>1-3 ch<br>*2 | ■<br>PGA<br>1 ch                          |                                       |                            |                            | ■<br>AMP<br>2-4 ch   | ■<br>AMP<br>3 ch  |          |                     |                     |                     |
| 12-bit ADC                                      |                                |                      |         |             | ■                             |             |            |                     |                                     |                                     |                  |             |                      | ■                    | ■  |   |                                       |                            |                            | ■                    |                   |          |                     |                     |                     |
| 24-bit ADC                                      |                                |                      |         |             |                               |             |            |                     |                                     |                                     |                  |             |                      |                      |  | ■<br>PGA<br>*2                            |                                       | ■<br>3-4 ch<br>Pre-<br>Amp | ■<br>3-4 ch<br>Pre-<br>Amp |                      | ■<br>Inst.<br>Amp |          |                     |                     |                     |
| Motor (RD), Power stage (KB) control timer      |                                | ■<br>KB              |         |             | ■<br>RD                       |             |            |                     | ■<br>RD                             | ■<br>RD                             | ■<br>RD          |             | ■<br>KB              |                      | ■<br>KB                                    |   | ■<br>KB                               |                            |                            |                      |                   |          | ■<br>RD             | ■<br>RD             | ■<br>RD             |
| LCD   |                                |                      |         |             |                               |             |            |                     |                                     |                                     |                  | ■           | ■                    | ■                    | ■  | ■<br>*3                                   |                                       | ■                          | ■                          |                      |                   |          |                     |                     |                     |
| USB   |                                |                      |         |             |                               |             | ■          |                     |                                     |                                     |                  |             |                      |                      | ■  |   |                                       |                            |                            |                      |                   |          |                     |                     |                     |
| CAN   |                                |                      |         |             |                               |             |            |                     |                                     |                                     |                  |             |                      |                      |  |   |                                       |                            |                            |                      |                   |          | ■<br>1 ch<br>option | ■<br>1 ch           | ■<br>2 ch           |
| 2x FC addresses                                 |                                | ■                    |         | ■<br>80pin+ | ■<br>80pin+                   |             |            |                     |                                     |                                     |                  |             |                      |                      |  |   |                                       |                            |                            |                      |                   |          |                     |                     |                     |
| Radio   |                                |                      |         |             |                               |             |            | ■<br>Blue-<br>tooth |                                     |                                     | ■<br>Sub-<br>GHz |             |                      |                      |  |   |                                       |                            |                            |                      |                   |          |                     |                     |                     |

Notes: \*1. No Vref and 12-bit interval timer in 10-pin; no temp sensor.  
\*2. Except R5F11R  
\*3. Except 48QFP and 64BGA

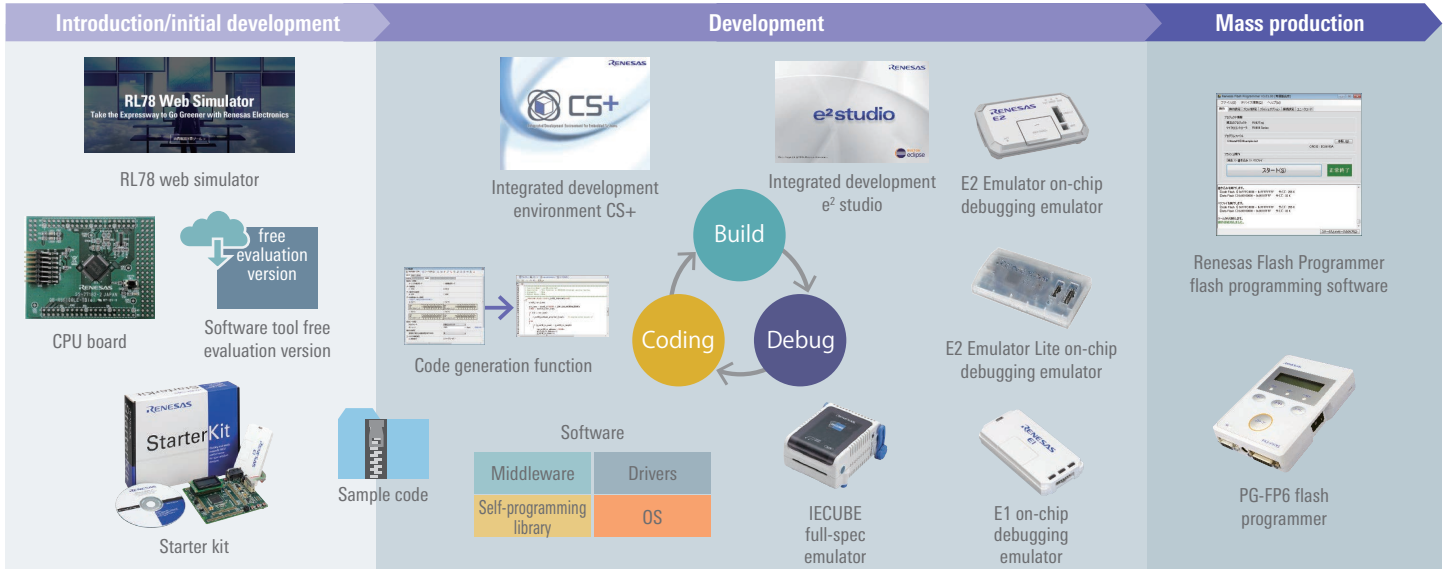
# RL78 FAMILY PACKAGE LINEUP

|  |  |  |   |   |   |   |
|--|--|--|---|---|---|---|
|   |   |   |    |   |    |    |
| <b>Pin-type:</b> 10-LSSOP<br><b>Size:</b> 4.4 x 3.6 mm<br><b>Pitch:</b> 0.65 mm<br><b>Thickness:</b> 1.45 mm<br><b>Group:</b> G10, G11       | <b>Pin-type:</b> 16-SSOP<br><b>Size:</b> 4.4 x 5 mm<br><b>Pitch:</b> 0.65 mm<br><b>Thickness:</b> 1.725 mm<br><b>Group:</b> G10, G11         | <b>Pin-type:</b> 20-LSSOP<br><b>Size:</b> 4.4 x 6.5 mm<br><b>Pitch:</b> 0.65 mm<br><b>Thickness:</b> 1.45 mm<br><b>Group:</b> G11, G12, I1A, I1D       | <b>Pin-type:</b> 20-LSSOP<br><b>Size:</b> 6.1 x 6.65 mm<br><b>Pitch:</b> 0.65 mm<br><b>Thickness:</b> 1.40 mm<br><b>Group:</b> G13, F13     | <b>Pin-type:</b> 24-HWQFN<br><b>Size:</b> 4 x 4 mm<br><b>Pitch:</b> 0.50 mm<br><b>Thickness:</b> 0.80 mm<br><b>Group:</b> G11, G12, G13, G1F, I1D         | <b>Pin-type:</b> 25-WFLGA<br><b>Size:</b> 3 x 3 mm<br><b>Pitch:</b> 0.50 mm<br><b>Thickness:</b> 0.76 mm<br><b>Group:</b> G11, G13, G1A | <b>Pin-type:</b> 30-LSSOP<br><b>Size:</b> 6.1 x 9.85 mm<br><b>Pitch:</b> 0.65 mm<br><b>Thickness:</b> 1.40 mm<br><b>Group:</b> G12, G13, G14, G1G, I1A, I1D, F13, F14 |
|   |   |   |    |   |    |    |
| <b>Pin-type:</b> 32-HVQFN<br><b>Size:</b> 5 x 5 mm<br><b>Pitch:</b> 0.50 mm<br><b>Thickness:</b> 0.90 mm<br><b>Group:</b> I1D, I1E, F13, F14 | <b>Pin-type:</b> 32-HWQFN<br><b>Size:</b> 5 x 5 mm<br><b>Pitch:</b> 0.50 mm<br><b>Thickness:</b> 0.80 mm<br><b>Group:</b> G13, G14, G1A, G1C | <b>Pin-type:</b> 32-LQFP<br><b>Size:</b> 7 x 7 mm<br><b>Pitch:</b> 0.80 mm<br><b>Thickness:</b> 1.70 mm<br><b>Group:</b> G14, G1C, G1F, G1G, I1D, L12  | <b>Pin-type:</b> 36-TFBGA<br><b>Size:</b> 4 x 4 mm<br><b>Pitch:</b> 0.50mm<br><b>Thickness:</b> 1.10mm<br><b>Group:</b> I1E                 | <b>Pin-type:</b> 36-WFLGA<br><b>Size:</b> 4 x 4 mm<br><b>Pitch:</b> 0.50mm<br><b>Thickness:</b> 0.76mm<br><b>Group:</b> G13, G14, G1F                     | <b>Pin-type:</b> 38-SSOP<br><b>Size:</b> 6.1 x 12.3 mm<br><b>Pitch:</b> 0.65mm<br><b>Thickness:</b> 2.00mm<br><b>Group:</b> I1A         | <b>Pin-type:</b> 40-HWQFN<br><b>Size:</b> 6 x 6 mm<br><b>Pitch:</b> 0.50mm<br><b>Thickness:</b> 0.80mm<br><b>Group:</b> G13, G14                                      |
|   |   |   |    |    |    |   |
| <b>Pin-type:</b> 44-LQFP<br><b>Size:</b> 10 x 10 mm<br><b>Pitch:</b> 0.80mm<br><b>Thickness:</b> 1.60mm<br><b>Group:</b> G13, G14, G1G, L12  | <b>Pin-type:</b> 48-HVQFN<br><b>Size:</b> 7 x 7 mm<br><b>Pitch:</b> 0.50mm<br><b>Thickness:</b> 0.90mm<br><b>Group:</b> F13, F14             | <b>Pin-type:</b> 48-HWQFN<br><b>Size:</b> 6 x 6 mm<br><b>Pitch:</b> 0.40mm<br><b>Thickness:</b> 0.80mm<br><b>Group:</b> G1D                            | <b>Pin-type:</b> 48-HWQFN<br><b>Size:</b> 7 x 7 mm<br><b>Pitch:</b> 0.50mm<br><b>Thickness:</b> 0.80mm<br><b>Group:</b> G13, G14, G1A, G1C  | <b>Pin-type:</b> 48-LFQFP<br><b>Size:</b> 7 x 7 mm<br><b>Pitch:</b> 0.50mm<br><b>Thickness:</b> 1.60mm<br><b>Group:</b> G13, G14, G1A, G1C, L12, F13, F14 | <b>Pin-type:</b> 52-LQFP<br><b>Size:</b> 10 x 10 mm<br><b>Pitch:</b> 0.65mm<br><b>Thickness:</b> 1.70mm<br><b>Group:</b> G13, G14, L12  |   |
|   |   |   |   |    |    |   |
| <b>Pin-type:</b> 64-HVQFN<br><b>Size:</b> 9 x 9 mm<br><b>Pitch:</b> 0.50mm<br><b>Thickness:</b> 1.00mm<br><b>Group:</b> G1H                  | <b>Pin-type:</b> 64-HWQFN<br><b>Size:</b> 8 x 8 mm<br><b>Pitch:</b> 0.40mm<br><b>Thickness:</b> 0.80mm<br><b>Group:</b> L12                  | <b>Pin-type:</b> 64-LFQFP<br><b>Size:</b> 10 x 10 mm<br><b>Pitch:</b> 0.50mm<br><b>Thickness:</b> 1.60mm<br><b>Group:</b> G13, G14, G1A, L12, F13, F14 | <b>Pin-type:</b> 64-LQFP<br><b>Size:</b> 12 x 12 mm<br><b>Pitch:</b> 0.65mm<br><b>Thickness:</b> 1.60mm<br><b>Group:</b> G13, G14, L12, L13 | <b>Pin-type:</b> 64-LQFP<br><b>Size:</b> 14 x 14 mm<br><b>Pitch:</b> 0.80mm<br><b>Thickness:</b> 1.70mm<br><b>Group:</b> G14                              | <b>Pin-type:</b> 64-TFBGA<br><b>Size:</b> 4 x 4 mm<br><b>Pitch:</b> 0.40mm<br><b>Thickness:</b> 1.10mm<br><b>Group:</b> H1D             |   |
|   |   |   |   |    |    |   |
| <b>Pin-type:</b> 64-VFBGA<br><b>Size:</b> 4 x 4 mm<br><b>Pitch:</b> 0.40mm<br><b>Thickness:</b> 0.99mm<br><b>Group:</b> G13, G1A             | <b>Pin-type:</b> 64-WFLGA<br><b>Size:</b> 5 x 5 mm<br><b>Pitch:</b> 0.50mm<br><b>Thickness:</b> 0.76mm<br><b>Group:</b> G14                  | <b>Pin-type:</b> 80-LFQFP<br><b>Size:</b> 12 x 12 mm<br><b>Pitch:</b> 0.50mm<br><b>Thickness:</b> 1.60mm<br><b>Group:</b> G13, G14, F13, F14           | <b>Pin-type:</b> 80-LQFP<br><b>Size:</b> 14 x 14 mm<br><b>Pitch:</b> 0.65mm<br><b>Thickness:</b> 1.70mm<br><b>Group:</b> G13, G14, L13      | <b>Pin-type:</b> 85-VFLGA<br><b>Size:</b> 7 x 7 mm<br><b>Pitch:</b> 0.65mm<br><b>Thickness:</b> 1.00mm<br><b>Group:</b> L1C                               | <b>Pin-type:</b> 100-LQFP<br><b>Size:</b> 14 x 20 mm<br><b>Pitch:</b> 0.65mm<br><b>Thickness:</b> 1.60mm<br><b>Group:</b> G13, G14      |   |
|   |   |    |   |   |   |   |
| <b>Pin-type:</b> 100-LFQFP<br><b>Size:</b> 14 x 14 mm<br><b>Pitch:</b> 0.50mm<br><b>Thickness:</b> 1.60mm<br><b>Group:</b> G13, G14, F14     | <b>Pin-type:</b> 128-LFQFP<br><b>Size:</b> 14 x 20 mm<br><b>Pitch:</b> 0.50mm<br><b>Thickness:</b> 1.60mm<br><b>Group:</b> G13               | <b>Pin-type:</b> 144-LFQFP<br><b>Size:</b> 20 x 20 mm<br><b>Pitch:</b> 0.50mm<br><b>Thickness:</b> 1.60mm<br><b>Group:</b> F15                         |   |   |   |   |

Note: \*1. G14 (384, 512 KB)

# RL78 FAMILY DEVELOPMENT ENVIRONMENT

Renesas Electronics supports all aspects of application development for the RL78 Family with products such as the integrated development environment CS+, real-time OSes, and programming tools.



## RL78 web simulator

Now you can easily develop prototypes using RL78 microcontrollers and run current consumption simulations without having to purchase developer tools.

<http://www.renesas.com/RL78-WebSimulator>

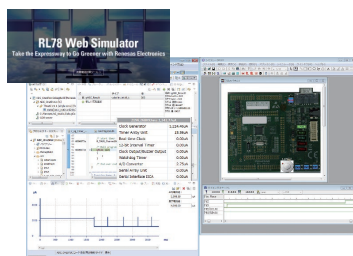
## Current consumption calculation tool

Just enter microcontroller operating settings and this tool instantly calculates the current consumption, including peripheral functions. There is no need to consult the hardware manual or write a program.



## Virtual board and current consumption simulator

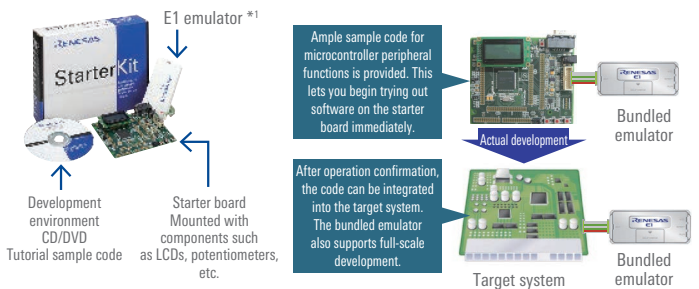
Use the virtual board to check the operation of microcontroller peripheral functions, external switches, LEDs, etc. It is also possible to monitor microcontroller I/O signals and get started with initial evaluation before actually purchasing a board or emulator. The virtual board is useful for everything from analyzing program operation to calculating current consumption with a high degree of accuracy.



## Evaluation boards: Enabling smooth introduction of new microcontrollers

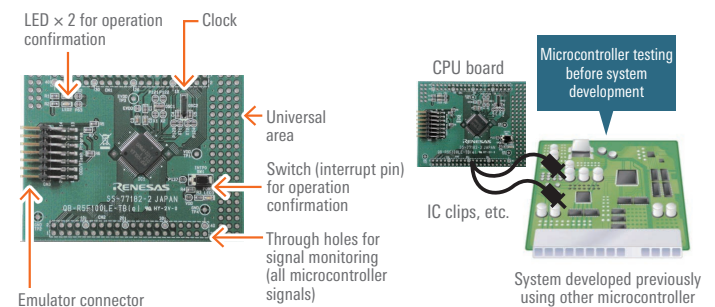
Renesas supplies evaluation boards for a variety of purposes, including microcontroller performance evaluation, initial operation confirmation, evaluation circuit creation, and prototyping of application products.

## Renesas starter kit features and usage example



Note: \*1. An even more affordable package without the E1 is also available.

## CPU board features and usage example



## Integrated development environments

### CS+

An integrated development environment for 8-bit to 32-bit microcontrollers from Renesas. Even novices will find CS+ simple, convenient, and safe to use. Highly recommended for developers making extensive use of Renesas microcontrollers.

### e<sup>2</sup> studio

Based on the "Eclipse" open-source integrated development environment, e<sup>2</sup> studio supports the Renesas RL78 Family of microcontrollers. Ideal for developers who are familiar with the Eclipse environment or who wish to utilize the many plugins available in the open-source ecosystem.

### Evaluation software tools

Software tools for evaluating product functions and performance are available free of charge.  
[https://www.renesas.com/tool\\_evaluation](https://www.renesas.com/tool_evaluation)

## RL78 Family self-programming libraries

These custom software libraries for flash programming can be used to write programs or data to microcontrollers that require programming in the field following shipment.

### Code flash library

[https://www.renesas.com/flash\\_libraries/self\\_prg](https://www.renesas.com/flash_libraries/self_prg)

### Data flash library





[https://www.renesas.com/flash\\_libraries/data\\_flash](https://www.renesas.com/flash_libraries/data_flash)

- FSL Type01: Library for writing user programs to flash memory
- FDL Type04: Library for writing data to data flash
- EEL Pack01/EEL Pack02: Library for EEPROM emulation\*1

Note: \*1. Allows writing and reading of user data without consideration for the designated location for user data (data flash). Also, since data is appended it is written to scattered locations, and this increases the number of write cycles for EEL target data.

## Emulators

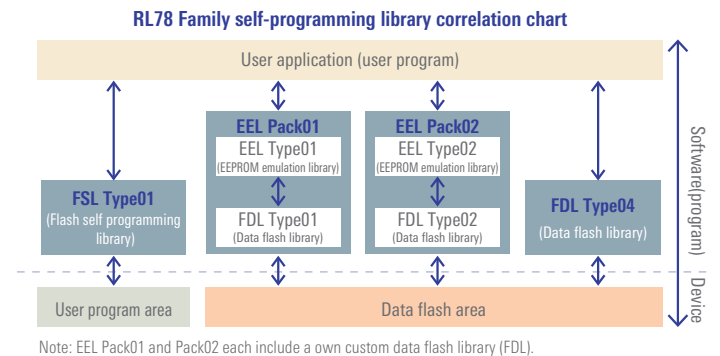
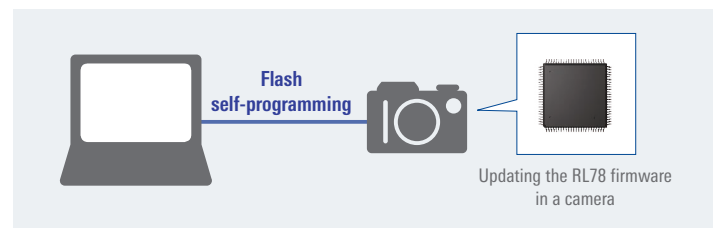
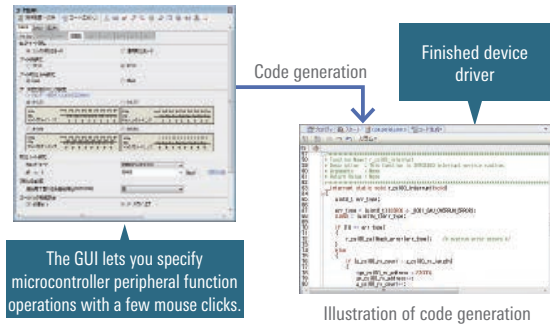
Renesas offers IECUBE, E2 Emulator, E1 Emulator, and E2 Emulator Lite to meet the debugging requirements of customers.

| Lineup  | Features   | Trace Function | Time Measurement Function | Coverage Function | Flash Programming Function | Device Equivalence | Extended Function |
|---|--|----------------|---------------------------|-------------------|----------------------------|--------------------|-------------------|
| <b>IECUBE</b><br>Support for powerful debugging functions      | Advanced debugging functions including tracing of all instructions, measurement of time between events, and coverage.                        | Yes            | 2*2                       | Yes               | No                         | ○*4                | No                |
| <b>E2 Emulator</b><br>Correspondence to extended functions     | An advanced on-chip debugging emulator and flash programmer developed based on a concept of "improvement of development efficiency".         | Yes*1          | 1*3                       | No                | Yes                        | ◎*5                | Yes*6             |
| <b>E1 Emulator</b><br>Basic debugging functions                | An on-chip debugging emulator and on-board programmer that supports a wide range of Renesas microcontrollers.                                |                |                           |                   |                            |                    | No                |
| <b>E2 Emulator Lite</b><br>Convenience for study or hobby use  | An affordably priced on-chip debugging emulator and on-board programmer that provides debugging functionality equivalent to the E1 Emulator. |                |                           |                   |                            |                    | No                |

Notes: \*1. Microcontrollers with on-chip trace support only \*2. Capable of measuring time between events \*3. Capable of measuring run-break duration  
 \*4. Emulation of device operation for FPGA, etc \*5. Actual device operating \*6. Current consumption tuning solution

## Code generation plugin

Included in CS+ and e<sup>2</sup> studio. It automatically generates code for device drivers, the software that controls microcontroller peripheral functions, based on settings entered via a GUI. A pin table can be displayed to check the settings of multiplexed pins.



## RL78V4 V2 real-time OS compliant with $\mu$ TRON standard

### A high-quality real-time multitasking environment for embedded systems

- Complies with worldwide standard  $\mu$ TRON 4.0 specification
- Compact design suitable for ROM storage
- Full complement of service calls
- Excellent real-time performance (interrupt response time, task switching time)
- Support for convenient functions when used in conjunction with the CS+ integrated development environment (automatic setting of options required to build the OS, display of the state of objects managed by the OS such as tasks and semaphores, graphical display of task operation history and service call issue history)
- Supports the RL78 family C compiler package (CC-RL)
- Provide a trial version

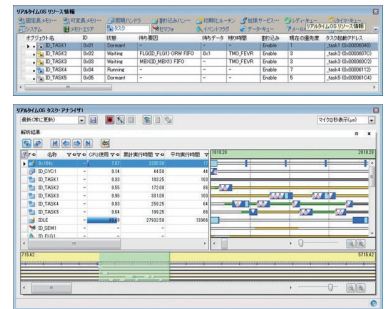


Illustration of function screens in conjunction with CS+

## Middleware

- Extensive lineup for RL78 applications, including audio, file system, and memory drivers
- Common interface design with flexible support for the entire RL78 Family
- Sample programs included. Highly efficient design process for less time to product completion

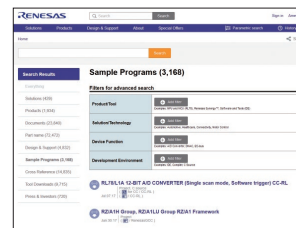
### RL78 Family middleware lineup

- Audio
  - ADPCM encoder/decoder
- Signal processing
  - Digital filters (FIR, IIR)
  - FFT library
- Security
  - AES library
  - SHA hash function library
  - RSA library
- File system
  - Open source FAT file system (TFAT)
- Memory drivers
  - SPI mode MultiMediaCard driver
  - SPI mode MMC/SD memory card driver
  - SPI serial flash driver
  - SPI single master driver
  - Renesas SPI serial EEPROM driver
  - Renesas I<sup>2</sup>C serial EEPROM driver
  - I<sup>2</sup>C single master driver

## Application notes and sample code

### Renesas provides sample programs with documentation describing how to use microcontroller peripheral functions as well as system examples.

- Sample code for RL78, constantly expanding lineup
- Extensive sample code including register definition files
- Substantial reduction in time to completion for products incorporating RL78 Family microcontrollers



Visit the following URL to download sample code based on the philosophy of "simpler and faster".

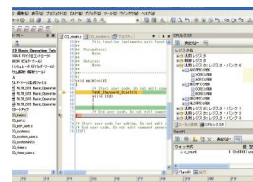
<http://www.renesas.com/software>

## Three types of debugging environment to match your development style

### Debugging on a PC [CS+ simulator for RL78 Family, 78K0R, and 78K0]

Simulator enabling source-level debugging of applications in the CS+ integrated development environment before the target system exists

- Rich break functions and coverage measurement functions
- Ability to evaluate software modules in a manner very similar to evaluation on the actual device



Simulator for CS+

### Debugging with basic functions [E1, E2, E2 Lite on-chip debugging emulator]

Basic debugging capabilities at an inexpensive price. This emulator also supports on-chip trace functionality.\*1

- Simple to connect. Allows debugging via a connection to an RL78 microcontroller mounted in the system under development.
- Also functions as a flash programmer.
- Environmentally friendly. All materials from the components to the packaging are RoHS compliant.



Note: 1. On microcontrollers with on-chip trace support only.

### Debugging with high-level functions [IECUBE full-spec emulator]

A high-performance full-spec emulator with more advanced functions

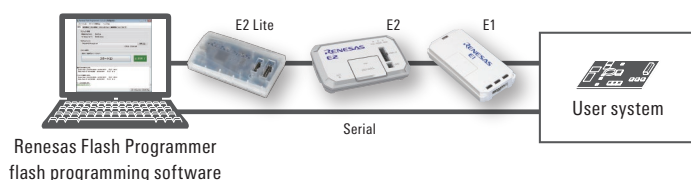
- Trace with time-tag function
- Provides access via a GUI to more powerful debugging capabilities, including a duration measurement function and coverage function.



## Three types of programming environment to match your development goals and circumstances

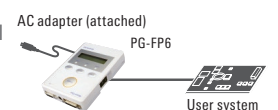
### Programming controlled by a PC [Renesas Flash Programmer flash programming software]

- Simple GUI specialized for programming
- Batch processing efficiently for programming large quantities at mass production
- PC-controlled programming using E2 emulator, E2 emulator Lite, E1 or serial
- Ability to embed unique code



### Programming controlled by a PC or stand-alone programming [PG-FP6 flash programmer]

- Stand-alone programming
- Programming controlled by a PC using a dedicated GUI
- Ability to store settings for up to eight environments
- Ideal for use on the production line (command control, remote control)
- Ability to embed unique code



### Ordering pre-programmed ROM (growing number of products supported)\*1

- Pre-programmed flash memory products from Renesas Electronics
- Note: 1. The support status differs depending on the product.  
Please contact a Renesas sales company or agent for details.



## Development tools for RL78 Family

| Group      | CPU Boards   | Promotion Boards | Starter Kits     | Development Kits | Solutions Kits                         |
|------------|--|------------------|------------------|------------------|--|
| G10        | QB-R5F10Y16-TB<br>RTE510Y470TGB00000R                            | –                | –                | –                | –                                      |
| G11        | YQB-R5F1057A-TB  | YRPBRL78G11      | –                | –                | –                                      |
| G12        | QB-R5F1026A-TB   | –                | –                | –                | –                                      |
| G13        | QB-R5F100LE-TB<br>QB-R5F100SL-TB                                 | YRPBRL78G13      | YR0K50100LS000BE | YRDKRL78G13      | –                                      |
| G14        | QB-R5F104LE-TB<br>QB-R5F104PJ-TB<br>FB-R5F104PL-TB* <sup>1</sup> | YRPBRL78G14      | YR0K50104PS000BE | YRDKRL78G14      | YRMCKITRL78G14<br>(Motor control)      |
| G1A        | QB-R5F10ELE-TB   | –                | –                | –                | –                                      |
| G1C        | QB-R5F10JGC-TB   | –                | YR0K5010JGS000BE | –                | R0K578G1CD010BR<br>(USB charger)       |
| G1D        | RTK0EN001D010001BZ<br>(Evaluation Kit)                           | –                | –                | –                | YRLI1D-BLE-SOL                         |
| G1D Module | RM-110-RFB-2* <sup>1</sup><br>(Evaluation Board)                 | –                | –                | –                | –                                      |
| G1F        | YQB-R5F11BLE-TB  | –                | –                | –                | RTK0EML240C03000BJ<br>(Motor CPU Card) |
| G1G        | YQB-R5F11EFA-TB  | –                | YR0K5011EFS000BE | –                | –                                      |
| G1H        | TK-RLG1H+SB2* <sup>2</sup><br>(Evaluation Kit)                   | –                | –                | –                | –                                      |
| L12        | QB-R5F10RLC-TB   | YRPBRL78L12      | YR0K5010RLS000BE | –                | –                                      |
| L13        | QB-R5F10WWMG-TB  | –                | YR0K5010WMS000BE | –                | –                                      |
| L1A        | –  | YRPBRL78L1A      | –                | –                | –                                      |
| L1C        | QB-R5F110PJ-TB   | –                | YR0K50110PS000BE | –                | R0K578L1CD000BR (HMI)                  |
| H1D        | –  | –                | –                | –                | RTK0EH0003S02001BR<br>(Blood Pressure) |
| I1A        | QB-R5F107DE-TB   | –                | –                | –                | Y-RL78-DCDC-LED (LED)                  |
| I1B        | RTE510MPG0TGB00000R  | –                | –                | –                | –                                      |
| I1C        | –  | –                | –                | –                | –                                      |
| I1D        | RTE5117GC0TGB00000R  | –                | –                | –                | YDETECT-IT-RL78 (Detector)             |
| I1E        | FB-R5F11CCC-TB* <sup>1</sup>                                     | –                | –                | –                | FB-R5F11CCC-LC* <sup>1</sup>           |
| F12        | QB-R5F109GE-TB   | –                | –                | –                | –                                      |
| F13        | QB-R5F10BMG-TB   | –                | –                | –                | –                                      |
| F14        | QB-R5F10PPJ-TB   | –                | –                | YRDKRL78F14      | –                                      |
| F15        | –  | –                | –                | –                | –                                      |

Notes: 1. Products of Naito Densai Machida Mfg.

2. Product of Tessera Technology Inc. (P/N: TK-RLG1H+SB2)

# EXPLANATION OF ORDERABLE PART NUMBERS

Product information for the RL78/G13 (20-pin) with product number R5F1006EASPV0 is shown as an example.

**R5 F 1 00 6 E A SP #V0**

**R5**  
 Renesas  
 MCU

**F**  
 ROM Type  
 F: Flash

**1**  
 RL78  
 Family

**Product group**

|    |     |                     |
|----|-----|---------------------|
| 00 | G13 | Data Flash          |
| 01 |     | No Data Flash       |
| 02 | G12 | Data Flash          |
| 03 |     | No Data Flash       |
| 04 | G14 |                     |
| 05 | G11 |                     |
| 07 | I1A |                     |
| 09 | F12 |                     |
| 0A | F13 | LIN                 |
| 0B |     | LIN & CAN           |
| 0E | G1A |                     |
| 0F | G1E |                     |
| 0J | G1C | USB Host & Function |
| 0K |     | USB Function        |
| 0M | I1B |                     |
| 0N | I1C |                     |
| 0P | F14 |                     |
| 0R | L12 |                     |
| 0W | L13 |                     |
| 0Y | G10 |                     |
| 10 | L1C | LCD & USB Function  |
| 11 |     | LCD                 |
| 13 | F15 |                     |
| 17 | I1D |                     |
| 1A | G1D |                     |
| 1B | G1F |                     |
| 1C | I1E |                     |
| 1E | G1G |                     |
| 1F | G1H |                     |
| 1M | L1A |                     |
| 1N | H1D | AFE, LQFP package   |
| 1P |     | AFE, TFBGA package  |
| 1R |     | Meter, Timer        |

**Pin count**

|   |     |
|---|-----|
| 1 | 10  |
| 4 | 16  |
| 6 | 20  |
| 7 | 24  |
| 8 | 25  |
| A | 30  |
| B | 32  |
| C | 36  |
| D | 38  |
| E | 40  |
| F | 44  |
| G | 48  |
| J | 52  |
| L | 64  |
| M | 80  |
| P | 100 |
| S | 128 |
| T | 144 |

**ROM Size (KB)**

|   |     |
|---|-----|
| 4 | 1   |
| 6 | 2   |
| 7 | 4   |
| 8 | 8   |
| 9 | 12  |
| A | 16  |
| C | 32  |
| D | 48  |
| E | 64  |
| F | 96  |
| G | 128 |
| H | 192 |
| J | 256 |
| K | 384 |
| L | 512 |

**Packaging, Material (Pb-free)**

|        |  |
|--------|--|
| #U, #2 | Tray<br>(HWQFN, HVQFN, VFBGA, WFLGA, VFBGA)          |
| #V, #3 | Tray, Tube*1<br>(LQFP, LQFP, LSSOP, SSOP)            |
| #W, #4 | Embossed Tape<br>(HWQFN, HVQFN, VFBGA, WFLGA, VFBGA) |
| #X, #5 | Embossed Tape<br>(LQFP, LQFP, LSSOP, SSOP)           |

**Package, Pin Pitch**

|    |               |    |               |
|----|---------------|----|---------------|
| SP | SSOP 0.65 mm  | LA | WFLGA 0.5 mm  |
|    | LSSOP 0.65 mm |    | VFLGA 0.65 mm |
| NA | HWQFN 0.5 mm  | BG | VFBGA 0.4 mm  |
|    | HVQFN 0.5 mm  |    | TFBGA 0.5mm   |
| NB | HWQFN 0.65 mm | FA | LQFP 0.65 mm  |
|    | HWQFN 0.4 mm  | FB | LQFP 0.5 mm   |
|    |               | FP | LQFP 0.8 mm   |

**Temperature & Quality Grade**

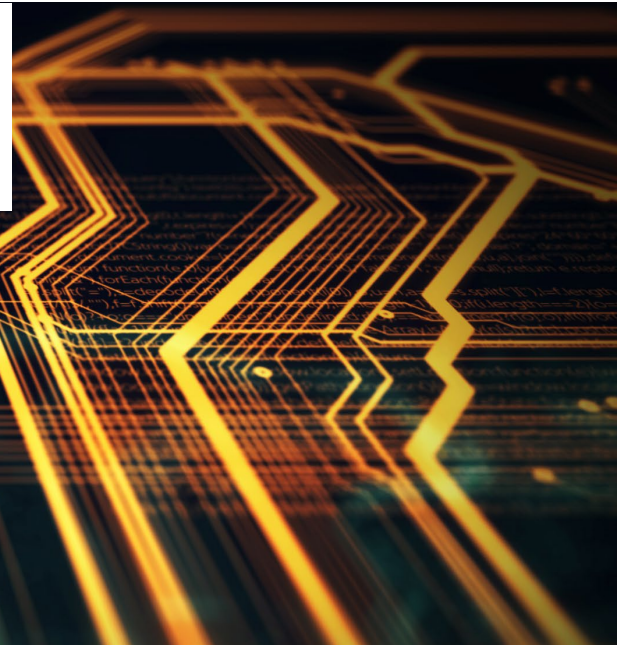
|   |                |            |
|---|----------------|------------|
| A | -40°C to 85°C  | Consumer   |
| D | -40°C to 85°C  | Industrial |
| G | -40°C to 105°C | Industrial |
| M | -40°C to 125°C | Industrial |
| J | -40°C to 85°C  | Automotive |
| L | -40°C to 105°C | Automotive |
| K | -40°C to 125°C | Automotive |
| Y | -40°C to 150°C | Automotive |

Note: 1. For 20-pin RL78/G11, RL78/G12 and RL78/I1A LSSOP products only the package specification is tube.



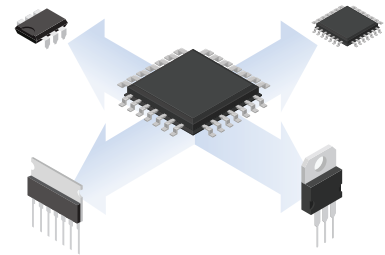


# PROCESSORS AND POWER/ANALOG



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| Power Management   | Amplifiers & Buffers  | Audio & Video  | Data Converters  | Switches & Multiplexers  | Optoelectronics  | Timing & Digital   |
|--|---|--|--|--|--|--|
| <ul style="list-style-type: none"> <li>• Discrete DC/DC Converters</li> <li>• Battery Management Systems (BMS)</li> <li>• Computing Power VRM/IMVP</li> <li>• Digital Power</li> <li>• Display Power and Backlighting</li> <li>• Hot Swap &amp; ORing</li> <li>• Isolated Power Supply</li> <li>• LED Drivers</li> <li>• LNB Regulators</li> <li>• Low Dropout Regulator ICs</li> <li>• MOSFET Drivers</li> <li>• PMIC</li> <li>• Power Modules</li> </ul> | <ul style="list-style-type: none"> <li>• Buffers</li> <li>• Comparators</li> <li>• Current Sense</li> <li>• Differential Amplifiers</li> <li>• Display Amplifiers and Buffers</li> <li>• Gain Blocks</li> <li>• High-Speed Op Amps</li> <li>• Instrumentation Amplifiers</li> <li>• Line Drivers</li> <li>• Precision Op Amps</li> <li>• Sample and Hold Amplifiers</li> <li>• Transistor Arrays</li> </ul> | <ul style="list-style-type: none"> <li>• Switches</li> <li>• Automotive Infotainment &amp; Security Surveillance</li> <li>• Buffered Video MUXs</li> <li>• Audio Processor</li> <li>• DVI/HDMI</li> <li>• Display ICs</li> <li>• HD Video Analog Front End (AFEs)</li> <li>• Surveillance ICs</li> <li>• Video Decoders/Encoders</li> <li>• Video ICs</li> </ul> | <ul style="list-style-type: none"> <li>• D/A Converters</li> <li>• Digital Potentiometers (DCPs)</li> <li>• High-Speed A/D Converters</li> <li>• Precision A/D Converters</li> <li>• Voltage References</li> </ul> | <ul style="list-style-type: none"> <li>• High Voltage</li> <li>• Low Voltage</li> <li>• Medium Voltage</li> <li>• USB                             <ul style="list-style-type: none"> <li>– High-Speed</li> <li>– High-Speed plus 2ch Stereo Audio</li> <li>– High-Speed UART Dual 3-1 MUX</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>• Ambient Light Sensors</li> <li>• Ambient Light and Proximity Sensors</li> <li>• Laser Diode Drivers (LDD)</li> <li>• Proximity Sensors</li> </ul> | <ul style="list-style-type: none"> <li>• Clock Generators</li> <li>• Counters/Time Base ICs</li> <li>• DSP</li> <li>• Memory</li> <li>• Microprocessors and Peripherals</li> <li>• Real Time Clocks</li> </ul> |
|  |   |  |  |  | <b>Interface</b> <ul style="list-style-type: none"> <li>• RS-485 &amp; RS-422</li> <li>• RS-232</li> <li>• 2-Wire Bus Buffers</li> <li>• Signal Integrity</li> </ul>                       | <b>Space &amp; Harsh Environment</b> <ul style="list-style-type: none"> <li>• Radiation Hardened</li> <li>• Defense &amp; Hi-Reliability</li> </ul>  |

## POWERING AN MCU

### Buck-Boost Converter

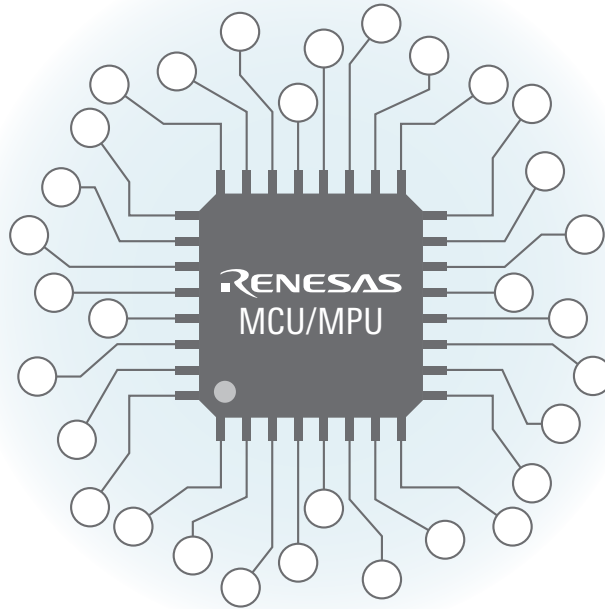
- ISL9120, ISL91107, ISL91128
- Current Range: 400mA – 2.4A
  - Low Iq ~ 20µA
  - Input Voltage: 0.6V – 5.5V
  - Output Voltage: 2.5V – 5.25V

### Buck Converters

- ISL9103/A, ISL9107/A, ISL9307
- Current Range: 500mA – 1.5A
  - Low Iq ~ 17µA
  - Input Voltage: 2.7V – 6V
  - Output Voltage: 0.8V - V<sub>IN</sub>

### Boost Converters

- ISL9111, ISL9113, ISL91133
- Current Range: 400mA – 2.3A
  - Low Iq ~ 20µA
  - Input Voltage: 0.6V – 5.4V
  - Output Voltage: 2.5V – 5.25V



### Linear Regulators

- ISL9007, ISL9021A, ISL9016
- Current Range: 150mA – 400mA
  - Low Iq ~ 25µA
  - Input Voltage: 1.5V – 6.5V
  - Output Voltage: 0.9V – 3.3V

### Bi-Directional Buck-Boost Conv

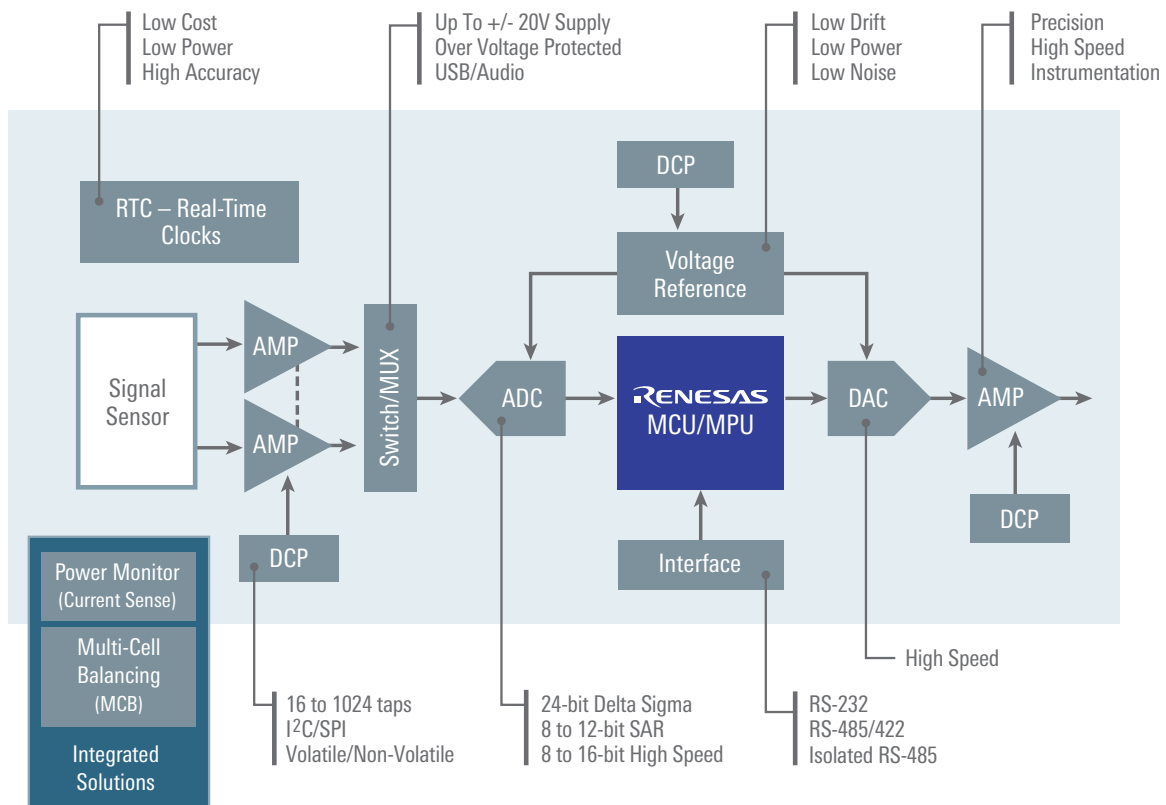
- ISL95338
- Current Range: <10A
  - V<sub>IN</sub>: 3.2V – 23.5V; V<sub>OUT</sub>: 2.4V – 20V

### Battery Chargers

- ISL6294, ISL9230, ISL9220
- Dual power source (USB & Wireless Charging + Power Path)
  - Current Range: 300mA – 1.5A
  - 30V Input Compliant

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Renesas' broad precision analog portfolio provides a wide range of next-gen precision instrumentation, medical, communication and industrial process control applications where innovation, reliability and dependability is central to the analog designs.



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