The Renesas RL78 contributes to greatly improve power efficiency, BOM cost reduction, and equipment miniaturization with industry-leading low power consumption and various built-in high-performance peripheral functions.

**RL78 FAMILY LINEUP**

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

**Low Power Consumption**
- 37.5 µA/MHz operation*¹
- 0.355 µA (RTC + LVD)  
  (SN00ZE mode)

**Broad Scalability**
- 8 to 144 pins/1 to 768 KB
  Extensive product lineup to meet a broad range of requirements
- Pin compatibility
- Ability to reassigned peripheral function pins

**Reduced System Cost**
- 32 MHz ±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

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**Comprehensive Development Tools**
- Integrated development tools for more efficient development
- Support for powerful tools from Renesas partners
- Open source (compiler/IDE) environment are available
- Immediately realize Rapid Prototyping in Arduino compatible environment

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

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

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**RL78 FAMILY LINEUP**

<table>
<thead>
<tr>
<th>General Purpose</th>
<th>ASSP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard</strong></td>
<td></td>
</tr>
<tr>
<td>RL78/G12</td>
<td></td>
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<tr>
<td>RL78/G13</td>
<td></td>
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<tr>
<td>RL78/G14</td>
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<tr>
<td>RL78/G15</td>
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<tr>
<td><strong>Communication</strong></td>
<td></td>
</tr>
<tr>
<td>RL78/G10</td>
<td></td>
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<tr>
<td>RL78/G11</td>
<td></td>
</tr>
<tr>
<td>RL78/G12</td>
<td></td>
</tr>
<tr>
<td><strong>Motor</strong></td>
<td></td>
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<tr>
<td>RL78/G14</td>
<td></td>
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<tr>
<td>RL78/G15</td>
<td></td>
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<tr>
<td>RL78/G16</td>
<td></td>
</tr>
<tr>
<td><strong>LCD</strong></td>
<td></td>
</tr>
<tr>
<td>RL78/L12</td>
<td></td>
</tr>
<tr>
<td>RL78/L13</td>
<td></td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td></td>
</tr>
<tr>
<td>RL78/L14</td>
<td></td>
</tr>
</tbody>
</table>

**Lighting, Power Source**
- RL78/G1A
- RL78/G11A
- RL78/I1A

**Electricity Meter**
- RL78/I1B
- RL78/I1C

**Automotive**
- RL78/F12
- RL78/F13
- RL78/F14
- RL78/F15

**RL78/F16**
For Small Systems

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**RL78**
Renesas Low power

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*¹ Power supply current value during basic RL78/G22 SNOOZE mode

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**RL: Renesas Low power**
RL78 FAMILY APPLICATIONS

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

### Industrial Automation
- **Lineup** of microcontrollers for industrial applications requiring high reliability
- **Broad array** of compact packages
- **Operating temperature range** of −40°C to +105°C, and support available for higher temperatures

### Automotive
- **Lineup** of highly reliable microcontrollers for automotive applications
- **Support** for high operating temperatures (up to +150°C)
- **CAN communication**, safety functions, etc., for automotive applications

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

### White Goods
- **Hardware support** for European safety standard for household appliances (IEC60730)
- **Standard temperature range** of −40°C to +85°C, and support available for higher temperatures (−40°C to +105°C or +125°C)
- **On-chip high-speed on-chip oscillator**, power-on reset, etc., ideal for cost-sensitive electric household appliances

### Lighting, Power Supply
- **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
- **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
- **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
- **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
- **Lineup** of compact packages
- **Proven track record** supplying major medical equipment manufacturers
- **Active member** of Continua Health Alliance

### Metering
- **Standby function** that is ideal for low-power applications such as meters and measuring devices
- **On-chip analog functions** for smartmeters

### Motor Control
- **On-chip advanced-functionality timers** for motor control
- **High-speed on-chip oscillator** with accuracy of ±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.

SNOOZE mode sequencer

- RL78 is the first MCU family equipped with this function.
- RL78/G23 and RL78/G22 have this function. (as of 2023/Mar.)
- By this function, even lower power consumption than the conventional SNOOZE mode is possible.
- Details are described on page 09.

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 37.5 μA/MHz (while operating at 32 MHz) and a clock operation current of 0.355 μA. Also, a 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.

<table>
<thead>
<tr>
<th>Operating current (μA/MHz)</th>
<th>Clock operation current (32kHz, LVD)</th>
<th>STOP mode current (standby, WDT + LVD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company A: 223μA</td>
<td>Company A: 2.06μA</td>
<td>Company A: 2.05μA</td>
</tr>
<tr>
<td>Company B: 129μA</td>
<td>Company B: 10.4μA</td>
<td>Company B: 9.51μA</td>
</tr>
<tr>
<td>Renesas</td>
<td>Renesas</td>
<td>Renesas</td>
</tr>
<tr>
<td>1/2 to 1/5</td>
<td>1/4 to 1/18</td>
<td>1/4 to 1/18</td>
</tr>
</tbody>
</table>

Source: Product data sheets and actual measurement
BROAD SCALABILITY

Extensive memory size and package options

- The extensive lineup includes more than 1000 product versions, with memory sizes from 1 KB to 768 KB and package pin counts from 8 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.

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.

Example of I/O port assignments on RL78/G1x

Flash(KB)
768
512
256
128
64
32
16
8
4
2
1
Pin Count

8 10 12 14 16 20 24 25 30 32 36 38 40 44 48 52 64 80 85 100 128 144
**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.

- 16-bit CPU Core with Pipelining
- Efficient Instruction Execution -> 86% in 1-2 Cycles
- Single Cycle Multiplication (HW Math Assist)
- DMA Engine (up to 4 channels)

**RL78 Instruction Execution Cycles:**
- 1 cycle: 56%
- 2 cycles: 30%
- 3 cycles: 9%
- 4+ cycles: 5%

<table>
<thead>
<tr>
<th>HW Assist for Math</th>
<th>Operation</th>
<th>Clock Cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>16bit Barrel Shifter for Shift and Rotate</td>
<td>16bit n Shift/Rotate (n = 1 to 15)</td>
<td>1</td>
</tr>
<tr>
<td>Multiply Signed &amp; Unsigned</td>
<td>16 × 16 = 32 Bit Result</td>
<td>1</td>
</tr>
<tr>
<td>Multiply/Accumulate Signed &amp; Unsigned</td>
<td>16 × 16 + 32 = 32 Bit Result</td>
<td>2</td>
</tr>
</tbody>
</table>

**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 that enables customers to achieve reduced system cost and smaller overall system size.

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

- Data access unit: 1 byte
- Data flash size: 4 KB (eraser 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*1
  - CPU stack pointer monitoring function*1
  - Illegal memory access detection function*1

- **Memory guard**
  This function disables writing to selected addresses in the RAM and SFRs*2. 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*1

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.

- **Security function**
  RL78/G23 and RL78/G22 can prevent spoofing by the AES library. This function is installed in RL78/G23 and RL78/G22. Details are described on page 09.

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+, e2 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.
## RL78/G22 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: 32KB–64KB
- SRAM: 4KB
- Data Flash: 2KB

#### System
- High-speed on-chip oscillator: 32 MHz ±1%
- Middle-speed on-chip oscillator: 4MHz ±12%
- Library support for multiply/divide and multiply-accumulate operation unit
- SNOOZE mode sequencer(SMS)
- Logic & Event link controller

#### Power management
- Operating current 37.5μA/MHz *2
- HALT current 0.33μA (RTC+LVD) *2
- STOP current 200nA (only 4KB SRAM data retained) *2
- Snooze current 600μA (UART), 0.9mA (ADC)

#### Safety
- Compliant with European safety standard for household appliances (IEC/UL 60730)
- Illegal memory access detection

#### Security
- Unique ID
- Customer ID
- Random number generator

#### Timers
- Advanced-functionality timer array unit (TAU)
- 32-bit interval timer
- Watchdog timer, real-time clock

#### Analog
- 1.6 V (VDD) operation
- On-chip ADC, 10-bit × 10 channels,
- 1.6 V (VDD) operation
- Watchdog timer, real-time clock

#### Human Machine Interface
- Capacitive sensing unit × 29 channels
- Controlled current drive output × 8 channels

#### Communication
- CSI, UART, I2C, Simple I2C
- Remote control receiver

#### Package
- 30-pin–128-pin

### Memory/Pin lineup: RL78/G22

<table>
<thead>
<tr>
<th>Pin Count</th>
<th>16</th>
<th>20</th>
<th>24</th>
<th>25</th>
<th>30</th>
<th>32</th>
<th>36</th>
<th>40</th>
<th>44</th>
<th>48</th>
<th>52</th>
<th>64</th>
<th>80</th>
<th>100</th>
<th>128</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAM (KB)</td>
<td>768</td>
<td>512</td>
<td>384</td>
<td>256</td>
<td>2048</td>
<td>2048</td>
<td>256</td>
<td>256</td>
<td>256</td>
<td>256</td>
<td>256</td>
<td>256</td>
<td>256</td>
<td>256</td>
<td>256</td>
</tr>
<tr>
<td>Data Flash (KB)</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>48</td>
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<td>48</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>48</td>
</tr>
</tbody>
</table>

Note: The block diagram of G23
**SNOOZE mode sequencer**
The RL78/G23 and RL78/G22 have the new sequencer which can operate most of peripheral functions while in SNOOZE mode.
The SNOOZE mode sequencer realizes even lower power consumption for applications.

**Operation in RL78/G13 SNOOZE mode**
- CPU stops while in SNOOZE mode for low power consumption
- Operation in RL78/G23 SNOOZE mode

**Capacitive touch sensing unit**
- 2 to 32 touch sensor channels are available.
- Compatible with self-capacitance and mutual capacitance methods.
- Up to 64 keys are supported when using mutual capacitance.
- Supports keys such as switches, wheels, and sliders. Can also be used as a proximity sensor.
- Supports SNOOZE mode for low-power sensing.

**Secure update and secure boot**
The RL78/G23 and RL78/G22 can prevent spoofing by using an AES library.

Furthermore, the RL78/G23 and RL78/G22 enable safe flash programming using a boot swap and flash shield window function, as well as program startup from a secured area using a boot cluster 0 rewrite prohibition function.

This provides support for secure update and secure boot to prevent spoofing.

In addition, using the AES-GCM library also prevents eavesdropping on communications between the RL78/G23, RL78/G22 and the main MCU.

**Logic and event link controller (Only RL78/G23)**
- Directly link event signals from up to 94 types of peripheral functions to a specified peripheral function
- Link 8 outputs to peripheral functions, ports, interrupts, or the DTC
- Change the conditions for linking event signals from peripheral functions by passing the signals through logic cells (AND, OR, or EX-OR circuits)
- Start a specified peripheral function by inputting event signals from other peripheral functions to a selector
- Connect event signals from peripheral functions to a specified peripheral function in synchronization with a clock by inputting the signals to a flip-flop

**Secure update and secure boot**
The RL78/G23 and RL78/G22 can prevent spoofing by using an AES library.

Furthermore, the RL78/G23 and RL78/G22 enable safe flash programming using a boot swap and flash shield window function, as well as program startup from a secured area using a boot cluster 0 rewrite prohibition function.

This provides support for secure update and secure boot to prevent spoofing.

In addition, using the AES-GCM library also prevents eavesdropping on communications between the RL78/G23, RL78/G22 and the main MCU.
# GENERAL-PURPOSE, LOW-PIN-COUNT

**RL78/G10**

**RL78/G10 features**

- **Ultra-low power consumption**
  - CPU operation: 45.5 μA /MHz
  - STOP mode: 560 nA

- **High-speed on-chip oscillator**
  - Max. 20 MHz, oscillation accuracy ±2%

- **Lineup of low-pin-count products**
  - 10 pin: LSSOP (4.4 × 3.6 mm)
  - 16 pin: SSOP (4.4 × 5 mm)

- **Other on-chip functions**
  - ADC
  - Comparator
  - Timer
  - Serial communication
  - Selectable power-on reset

**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 ±2%
  - Selectable POR

- **Power management**
  - Operating current: 45.5 μA/MHz
  - HALT current: 290 μA
  - STOP current: 560 nA (SRAM data retained)

(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.


**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 SPOR detection voltage (VSPOR) must be between 2.25 V and 5.5 V.

(Reference) RL78: Block diagram of G10 Group 16-pin product.

### Table: ROM Pins

<table>
<thead>
<tr>
<th>ROM size</th>
<th>10</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 KB</td>
<td>512</td>
<td>512</td>
</tr>
<tr>
<td>2 KB</td>
<td>256</td>
<td>256</td>
</tr>
<tr>
<td>1 KB</td>
<td>128</td>
<td>128</td>
</tr>
</tbody>
</table>
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 (VDD = 1.8 V and above) and with no analog wiring**
  - ADC + internal constant voltage (1.45 V)

- **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 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 = 1.8 V and above)

**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 ±1%
  - Medium-speed on-chip oscillator: 4 MHz ±12%
  - DTC, ELC, DOC, INTFO
  - Support for POR, LVD, different-potential communication

- **Power management**
  - Normal operation: 58.3 μA/MHz
  - Halt mode: 0.65 μA (LVD)

- **Analog**
  -鉴 定

- **Power Management**
  - Normal power supply voltage range
  - ADC: 1.6V - 5.5V
  - Internal constant voltage V BGR: 1.8V - 5.5V

- **Analog**
  - A/D conversion results
  - (10-bit) 10
  - A/D conversion results
  - (10-bit) 10

- **Communication**
  - CSI, UART, I'C, Simple I'C

- **Package**
  - 10-pin/16-pin/20-pin/24-pin/25-pin

- **Operating temperature range**
  - -40°C to +85°C / +105°C

---

**Reference** RL78 Block diagram of G11 Group 25-pin product.
**GENERAL-PURPOSE, STANDARD**

**RL78/G12, G13, G13A**

**RL78/G12, G13, G13A 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**
  - 1.8 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

**Extensive lineup: RL78/G12, G13, G13A**

Choose with confidence. Extensive lineup of 284 products.

**New Product: RL78/G13A lineup**

<table>
<thead>
<tr>
<th>ROM (KB)</th>
<th>Pins</th>
<th>20</th>
<th>24</th>
<th>25</th>
<th>30</th>
<th>32</th>
<th>36</th>
<th>40</th>
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<th>52</th>
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<th>100</th>
<th>128</th>
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<tbody>
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<td>512</td>
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<tr>
<td>384</td>
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<td>32</td>
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<td>256</td>
</tr>
</tbody>
</table>

**RL78/G12, G13, G13A**

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 84-pin (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

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.

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 ±1% \(^*1\)
- Selectable frequencies: 32 MHz, 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. ±5% on R5F103x  
   2. RL78/G13 only

Multiply and divide circuit with support for multiply-accumulate operations

<table>
<thead>
<tr>
<th>operation</th>
<th>exec cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signed multiply</td>
<td>16 bits×16 bits=32 bits</td>
</tr>
<tr>
<td>Unsigned multiply</td>
<td></td>
</tr>
<tr>
<td>Unsigned divide</td>
<td>32 bits/32 bits=32 bits ... 32 bits</td>
</tr>
<tr>
<td>Signed multiply-accumulate</td>
<td>16 bits×16 bits+32 bits=32 bits</td>
</tr>
<tr>
<td>Unsigned multiply-accumulate</td>
<td></td>
</tr>
</tbody>
</table>

HOCO oscillation frequency accuracy

<table>
<thead>
<tr>
<th>Accuracy(%)</th>
<th>Voltage(V)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>5.5</td>
</tr>
<tr>
<td>±1.0%</td>
<td>±1.5%</td>
</tr>
<tr>
<td>±5.0%</td>
<td>±5.5%</td>
</tr>
</tbody>
</table>

Notes: 1. ±5.0% at TA= –40 to+85ºC  
   2. ±5.0% at TA= –20 to+85ºC
GENERAL-PURPOSE, ADVANCED FUNCTIONALITY

RL78/G14

RL78/G14 specifications

- RL78/G14 CPU Core
  - Three-stage pipeline CISC architecture
  - Max. operating frequency: 32 MHz

- Memory
  - Code Flash: 16KB-512KB
  - SRAM: 2.5KB-48KB
  - Data Flash: 4KB, 8KB
  - 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: 64 MHz ±1%
  - Low-speed on-chip oscillator: 15 kHz±15%
  - DTC, ELC, POR, LVD, different-potential Communication

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

<table>
<thead>
<tr>
<th>Operation</th>
<th>exec cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiply 4 bits×8 bits=16 bits</td>
<td>1 clock</td>
</tr>
<tr>
<td>Divide 16 bits / 16 bits=16 bits ... 16 bits</td>
<td>9 clock</td>
</tr>
<tr>
<td>Multiply-accumulate 16 bits×16 bits=32 bits</td>
<td>2 clock</td>
</tr>
<tr>
<td>32 bits / 32 bits=32 bits ... 32 bits</td>
<td>17 clock</td>
</tr>
<tr>
<td>16 bits×16 bits=32 bits</td>
<td>3 clock</td>
</tr>
</tbody>
</table>

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 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.

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*

*Note: 1. The DTC can only read data from flash memory.

Comparison of DMA and DTC

<table>
<thead>
<tr>
<th>DMA(G13 100pin)</th>
<th>DTC(G14 100pin)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of channels</td>
<td>4 channels</td>
</tr>
<tr>
<td>Transfer address space</td>
<td>4 KB</td>
</tr>
<tr>
<td>Max. transfer count/block size</td>
<td>1024/1024 bytes</td>
</tr>
<tr>
<td>Transfer target</td>
<td>SRAM</td>
</tr>
<tr>
<td>Number of activation sources</td>
<td>21</td>
</tr>
<tr>
<td>Other</td>
<td>Repeated chain transfers supported</td>
</tr>
</tbody>
</table>

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: Event link controller (ELC)**

Direct links between hardware modules

Direct and immediate activation

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

No CPU operation needed

Activation occurs even with CPU in sleep state.

---

**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

1. Normal mode
   - D/A conversion is started by a write operation to the DACSn ($n = 0$ or $1$) register.

2. 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, STANDARD

RL78/G15 specifications

- RL78 CPU Core
  - Three-stage pipeline CISC architecture
  - Max. operating frequency: 16 MHz

- Memory
  - Program flash: 4 KB / 8 KB
  - SRAM: 1 KB
  - Data flash: 1 KB

- System
  - High-speed on-chip oscillator: 16 MHz ±1%
  - Selectable POR

- Power management
  - Operating current: 54.4 μA/MHz
  - HALT current: 371 μA
  - STOP current: 620 nA (SRAM data retained)

- Timers
  - Timer array unit (TAU) × 8 channels
  - Interval Timer (12-bit)
  - Watchdog timer

- Analog
  - ADC 10-bit × 11 channels
  - Comparator x2 channels
  - Internal Reference Voltage(0.815V)

- Communication
  - CSI, UART, I2C, Simple I2C

- Package
  - 8-pin/10-pin/16-pin/20-pin

- Operating temperature range
  - -40 to 125 degree C

Memory/Pin lineup:

Enhancing Low-Pin-Count/Small package with 8-pin.-Compatible pin functions with the existing products.

<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>8 KB</td>
<td>1 / 1</td>
<td>1 / 1</td>
</tr>
<tr>
<td>10 / 11 / 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 / 11 / 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 / 11 / 1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

High-speed on-chip oscillator with high accuracy

The accuracy of ±1% over a wide temperature range *

*Note: 1. G-version, M-version

<table>
<thead>
<tr>
<th>Accuracy [%]</th>
<th>VDD [V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>+2.0%</td>
<td>±20%</td>
</tr>
<tr>
<td>+1.5%</td>
<td>±15%</td>
</tr>
<tr>
<td>+1.0%</td>
<td>±10%</td>
</tr>
<tr>
<td>0.0%</td>
<td>±5.5%</td>
</tr>
<tr>
<td>-1.0%</td>
<td>±2.4%</td>
</tr>
<tr>
<td>-1.5%</td>
<td>±1.1%</td>
</tr>
<tr>
<td>-2.0%</td>
<td>±0.0%</td>
</tr>
</tbody>
</table>

![High-speed on-chip oscillator with high accuracy graph]
**RL78/G1A**

**RL78/G1A features**

**High-precision A/D converter**
- 12-bit A/D converter
  - Total error: ±1.7 LSB (typ.)
  - Conversion time: 3.375 μs
- Multi-channel analog input
  - 28 analog input channels (max.) to support input from multiple sensors

**Low power consumption/standby mode**
- 1.6 V (VDD) operation
- On-chip ADC, 12-bit × 28 channels, conversion time: 3.375 μs
- Internal reference voltage (1.45 V)

**Compact package/extensive peripheral functions**
- Compact package
  - 3 x 3 mm square : 25-pin LGA package
  - 4 x 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, I2C, 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 ±1%
- Library support for multiply/divide and multiply-accumulate operation unit

**Power management**
- Operating current: 66 μA/MHz
- HALT current: 0.57 μA (SUB + RTC + LVD)
- STOP current: 0.23 μA (SRAM data retained)
- SNOOZE current: 700 μA (UART), 1020 μA (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**
- On-chip ADC, 12-bit × 28 channels
- Control: 1.45 V

**Communication**
- CSI, UART/LIN I/F, Simple I/F

**Power Management**
- HALT
- RTC, DMA Enabled
- SNOOZE
- SRAM On

**Memory lineup**
- Compact packages and extensive memory capacity options

**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 μA/MHz when running 0.57 μA/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: ±1%
  - Support for background operation
- Multiply and divide/multiply-accumulate operation unit
  - Reduced CPU load

**Support for multiple sensors of various types**
- Multi-channel analog input support
  - Among the best in the industry with 12-bit A/D converter
  - Infrared sensors, ultrasonic sensors, acceleration sensors, gyro sensors, pressure sensors, thermistors, etc.
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 current: 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.

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 × 6 channels
- Communication
- On-chip ADC, 10-bit × 6 channels
- Communication
- CSI×3, UART×2, F/C×2
- Package
- HVOFN 9×9mm 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 on 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.

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

RL78/G1D lineup

<table>
<thead>
<tr>
<th>ROM</th>
<th>Pins</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>256 KB</td>
<td>20 K</td>
<td>8 K</td>
</tr>
<tr>
<td>192 KB</td>
<td>16 K</td>
<td>8 K</td>
</tr>
<tr>
<td>128 KB</td>
<td>12 K</td>
<td>8 K</td>
</tr>
</tbody>
</table>

RL78/G1D 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: 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, I2C × 1, Simple I2C × 2

- **Package**
  - WQFN 6 × 6 mm 48-pin, 0.4 mm pitch

- **Memory**
  - Program Flash: 128 KB to 256 KB
  - SRAM: 12 KB to 20 KB
  - Data Flash: 8 KB

- **Power Management**
  - HALT
  - RTC, DMA Enabled
  - STOP
  - SRAM On

- **Safety**
  - RAM Parity Check
  - ADC Self-diagnostics
  - Clock Monitoring
  - Memory CRC

- **System**
  - DMA 4 ch
  - Interrupt Controller 4 Levels
  - Clock (Internal, External)
  - PLL, LVDS
  - MUL/O/V/MAC
  - Debug: Single-Wire

- **Communication**
  - CSI/VAST
  - UART x 1 ch

- **Timers**
  - Timer Array (8-bit, 8-ch)
  - Internal Timer
  - 12-bit, 1-ch
  - WDT 16-bit, 1-ch
  - RTC Calendar

- **Antilog**
  - ADC 16-bit, 8-ch
  - Internal/External
  - Temp. Sensor

- **RF**
  - Bluetooth 4.2 Single-mode
  - Master/Slave
  - AES engine
  - RF unit power management
  - Reference clock: 32 kHz
  - 5 kHz clock: 32.768 kHz

RF transmit and receive currents among the world’s smallest

G O O D

TRANSMIT: 4.3 mA
RECEIVE: 3.5 mA

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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 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.

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
  - Glucose
  - 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**

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)
  - 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/μs (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.
  - Very small signals (less than 0.1 mV) are detected only when the internal noise level is specified, and the signal can be amplified as much as possible with the PGA amplification. However, if the input is larger than the noise level, the actual amplification factor is set by the comparator and the CPU. The PGA amplification is not affected by noise.

**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.

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/μs (min.) (VDD ≥ 4.0 V). The dedicated GND input (PGAGND pin) ensures that amplification is not affected by internal noise.

**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.

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/G1F features**

- **Debug functions including real-time trace**
- **IrDA communication function**
- **D/A converter (1 or 2 channels)**
- **2-channel comparator (CMP0 and CMP1)**
- **Programmable-gain amplifier (PGA)**
- **Rotor position detection for high torque**
- **On-chip 4-input-selectable high-speed comparator (CMP1) and timer RX**
- **Fast response time of 70 ns (typ.) (1/8 that of RL78/G14)**
- **High slew rate of 3.0 V/μs (min.) (VDD ≥ 4.0 V)**
- **Selector**
  - ×4, ×8, ×16, and ×32
  - Processed by CPU
  - Comparator
  - Specified voltage
- **Amplification**
  - Selector
  - ×4, ×8, ×16, and ×32
  - Processed by CPU
  - Comparator
  - Specified voltage
- **Internal Vref**
- **DAC**
- **ADC**
- **PGA**
- **Selectables amplification factor**
- **Input capture**
- **PWM control**
- **Timer RX (max. 64 MHz)**
- **Inverter**
**RL78/G1G** Consumer applications only

Ideal for DC brushless motor applications

Support for power-efficient maintenance-free motor operation

<table>
<thead>
<tr>
<th>Motor control timer</th>
<th>Overcurrent detection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three-phase complementary PWM</td>
<td>Forced shutoff</td>
</tr>
<tr>
<td>Supported (Hi-Z, H/L output settings supported)</td>
<td></td>
</tr>
<tr>
<td>Programmable-gain amplifier</td>
<td>1 channel (on-chip amplifying resistor)</td>
</tr>
<tr>
<td>Comparator</td>
<td>2 channels (response time: 0.15 μs [max.])</td>
</tr>
<tr>
<td>Comparator reference voltage</td>
<td>8-bit DAC or internal reference voltage of 1.45 V</td>
</tr>
</tbody>
</table>

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

**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)**

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

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

<table>
<thead>
<tr>
<th>Pins</th>
<th>30</th>
<th>32</th>
<th>44</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 K</td>
<td>1.5 KB</td>
<td>1.5 KB</td>
<td>1.5 KB</td>
</tr>
<tr>
<td>8 K</td>
<td>1.5 KB</td>
<td>1.5 KB</td>
<td>1.5 KB</td>
</tr>
</tbody>
</table>

**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)
GENERAL-PURPOSE, USB

Common to RL78/G1C and RL78/L1C

Low-end USB microcontroller roadmap

RL78 Series next-generation low-end USB microcontrollers

USB features (low power consumption)
Operating current among world’s lowest

Comparison of current consumption (mA) during USB operation

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

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 I2C × 4
    I2C (Multi-Master) × 1
    USB Peripheral × 1

Product lineup

<table>
<thead>
<tr>
<th>Function</th>
<th>Pins</th>
<th>32</th>
<th>48</th>
<th>80</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash 32KB</td>
<td>32/48pin QFN/LQFP</td>
<td>16 K</td>
<td>16 K</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Host x 2 or Function x 1 BC1.2 support</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flash 64-256KB</td>
<td>80/100pin LOFP</td>
<td>16 K</td>
<td>16 K</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Function x 1 LCD Driver</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flash 33KB</td>
<td>32/48pin QFN/LQFP</td>
<td>12 K</td>
<td>12 K</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Host</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flash 256KB</td>
<td>80/100pin LOFP</td>
<td>10 K</td>
<td>10 K</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Function</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flash 64KB</td>
<td>80/100pin LOFP</td>
<td>8 K</td>
<td>8 K</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RL78/G1C : 1 x only Function 2 x Host or 1 x Function
RL78/L1C : 1 x only Function

Company A Company B RL78/G1C

USB battery charging, USB Host support

Comparison of current consumption (mA) during USB operation

4mA*1
Overview of USB controller specifications
USB Host and USB BC1.2 support

<table>
<thead>
<tr>
<th>Transfer speed</th>
<th>Function</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS(1.5Mbps)</td>
<td>1 channel</td>
<td>RL78/G1C</td>
</tr>
<tr>
<td>FS(12Mbps)</td>
<td>2 channels</td>
<td>Host version only</td>
</tr>
<tr>
<td>HS(480Mbps)</td>
<td>Not supported</td>
<td></td>
</tr>
</tbody>
</table>

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

All application notes are available for download on the Renesas website
USB sample firmware

Overview of USB battery charging standards
Standards designed to enable rapid battery charging

Current max. value

<table>
<thead>
<tr>
<th>Standard</th>
<th>Max. Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB 2.0</td>
<td>500mA</td>
</tr>
<tr>
<td>BC1.2 standard</td>
<td>1500mA</td>
</tr>
</tbody>
</table>

USB battery charging application example

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

All application notes are available for download on the Renesas website
USB sample firmware

Notes:
1. ROM and RAM sizes for CC-RL (V2.0) environment, and ROM and RAM sizes for all Device Classes include size of Basic driver.
2. EEPROM devices used as media.
GENERAL-PURPOSE, 8-bit

**RL78/G1M**

**RL78/G1M features**
- 8-bit Core
- Max. Operating Freq. 5 MHz@2.0~5.5 V/ 20 MHz@2.7~5.5 V
- Small Pin Count (20pin TSSOP), Small ROM (4 KB or 8 KB)
- Realtime Output for Motor Control
- 120-degree energization control (can drive BLDC Motor)

**RL78/G1M lineup**

<table>
<thead>
<tr>
<th>Pins</th>
<th>ROM</th>
<th>RAM size</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>8 K</td>
<td>1 KB</td>
</tr>
<tr>
<td></td>
<td>4 K</td>
<td>512 B</td>
</tr>
</tbody>
</table>

**GENERAL-PURPOSE, 8-bit**

**RL78/G1N**

**RL78/G1N features**
- 8-bit Core
- Max. Operating Freq. 5 MHz@2.0~5.5 V/ 20 MHz@2.7~5.5 V
- Small Pin Count (20pin TSSOP), Small ROM (4 KB or 8 KB)
- High Current Output for LED Display
  (COM 6 ch; 120 mA (duty; 45%), SEG 8 ch; 15 mA)
  (can directly drive super luminosity LED, 8-seg x 6-digit)

**RL78/G1N lineup**

<table>
<thead>
<tr>
<th>Pins</th>
<th>ROM</th>
<th>RAM size</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>8 K</td>
<td>1 KB</td>
</tr>
<tr>
<td></td>
<td>4 K</td>
<td>512 B</td>
</tr>
</tbody>
</table>

**LOW-PIN-COUNT, ANALOG**

**RL78/G1P**

**RL78/G1P features**
- Max. Operation Freq. 32 MHz@2.7~3.6 V
- Small Pin Count (24pin QFN, 32pin QFP)
- Small ROM (16 KB)
- High-Function Analog (12-bit A/D, 10-bit D/A*)
* Only among General RL78

**RL78/G1P lineup**

<table>
<thead>
<tr>
<th>Pins</th>
<th>ROM</th>
<th>RAM size</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>16 K</td>
<td>1.5 K</td>
</tr>
<tr>
<td></td>
<td>512 B</td>
<td>2 KB</td>
</tr>
<tr>
<td>32</td>
<td>1.5 K</td>
<td>2 KB</td>
</tr>
</tbody>
</table>
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

RL78/L12, L13, L1C Product lineup

<table>
<thead>
<tr>
<th>ROM</th>
<th>Pins</th>
<th>32</th>
<th>44</th>
<th>48</th>
<th>52</th>
<th>64</th>
<th>80</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>256 KB</td>
<td></td>
<td>16 K</td>
<td>16 K</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>192 KB</td>
<td></td>
<td>16 K</td>
<td>16 K</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>128 KB</td>
<td></td>
<td>12 K</td>
<td>12 K</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>96 KB</td>
<td></td>
<td>10 K</td>
<td>10 K</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>64 KB</td>
<td></td>
<td>8 K</td>
<td>8 K</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>48 KB</td>
<td>RL78/L12</td>
<td>8 K</td>
<td>8 K</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32 KB</td>
<td>RL78/L12</td>
<td>4 K</td>
<td>4 K</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 KB</td>
<td>RL78/L12</td>
<td>2 K</td>
<td>2 K</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 KB</td>
<td>RL78/L12</td>
<td>1 K</td>
<td>1 K</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RAM: RL78/L12: 32-pin - 64-pin  RL78/L13: 64-pin - 80-pin  RL78/L1C: 80-pin - 100-pin
**LCD display seg x com lineup**

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

<table>
<thead>
<tr>
<th>Pin Count</th>
<th>50 or more</th>
<th>45 - 49</th>
<th>40 - 44</th>
<th>35 - 39</th>
<th>30 - 34</th>
<th>25 - 29</th>
<th>20 - 24</th>
<th>15 - 19</th>
<th>9 - 14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segs</td>
<td>32 48 52 64 80 100 128</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Method</th>
<th>RL78/L1x</th>
<th>78K0R/Lx3</th>
<th>78K0/Lx3</th>
<th>R8C/L3xx</th>
<th>R8C/LAxx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance division method*2</td>
<td>11.6 μA (typ.)</td>
<td>Not implemented</td>
<td>12.0 μA (VDD 1.8 V)</td>
<td>Not implemented</td>
<td>Not implemented</td>
</tr>
<tr>
<td>Capacitor split method</td>
<td>7.35 μA (typ.)</td>
<td>Not implemented</td>
<td>Not implemented</td>
<td>Not implemented</td>
<td>Not implemented</td>
</tr>
<tr>
<td>Voltage boost method</td>
<td>21.19 μA (typ.)</td>
<td>24.5 μA</td>
<td>22.9 μA</td>
<td>Not implemented</td>
<td>23.7 μA</td>
</tr>
</tbody>
</table>

Notes: 1. Current value including sub-oscillator, RTC operation, LCD operation and current flow to LCD panel.
2. Calculated using an external resistance value of 1,000 kΩ for the external resistance division method.

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

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

### Features/anticipated applications

<table>
<thead>
<tr>
<th>Method</th>
<th>Microwave ovens</th>
<th>Washing machines</th>
<th>Rice cookers</th>
<th>Kitchen tools</th>
<th>Composition meters</th>
<th>LCD remote controls</th>
<th>Thermometers</th>
<th>Activity meters</th>
</tr>
</thead>
</table>
**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 μA/MHz
- In RTC mode: 1 μA 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: 24 MHz
- **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) × 1
- **Safety**
  - Compliant with European safety standard for household appliances (IEC/UL 60730)

**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 helps 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 μs 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 μA (STOP current)
- Full complement of connectivity functions
  - Communication functions (DALI, PMBus, SMBus, DMX512, UART, I2C, 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

**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
  - Boost converter
  - Flyback converter
- DC/DC control circuit
  - Buck converter
  - Boost converter
  - Flyback converter
  - Half-bridge
  - Full-bridge

**DALI master/slave communication functions**
Manchester coding
Transmit/receive data: 8-, 16-, 17-, or 24-bit

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

**RL78/I1A lineup**

<table>
<thead>
<tr>
<th>ROM size</th>
<th>Pins</th>
<th>20</th>
<th>30</th>
<th>38</th>
</tr>
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<tr>
<td>32 KB</td>
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</table>

Operating temperature ranges up to 105°C or 125°C supported.
ASSP, ELECTRICITY METER

RL78/I1B

Target electricity meter markets of RL78/I1B

<table>
<thead>
<tr>
<th>Wiring Type</th>
<th>Main Applications</th>
<th>Main Regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-phase, two-wire</td>
<td>Home</td>
<td>Europe, China, India</td>
</tr>
<tr>
<td>Single-phase, three-wire</td>
<td>Home</td>
<td>Japan, U.S.A</td>
</tr>
<tr>
<td>Three-phase, three-wire</td>
<td>Commercial/Industrial</td>
<td>Worldwide</td>
</tr>
</tbody>
</table>

RL78/I1B lineup and concept

- Product lineup to accommodate various meter types
- Four products

Aiming for low power consumption

- Low power consumption
  - Operating current: 96 μA/MHz
  - Standby current: 0.69 μA (during RTC or LVD operation)
- 24-bit ΔΣ ADC
  - Current during ADC operation: 0.53 mA/channel

25% lower power consumption than competing products*1

ΔΣ ADC with improved functionality for electricity meters

Implementation in hardware of functions essential for power measurement
- Phase correction circuit, high-pass filter

- 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 ±0.05%

Subclock resonator single-crystal system

Exclusive Renesas system is more robust than conventional PLL designs.

Lowest power consumption at all operating frequencies

A high-speed on-chip oscillator with accuracy of ±0.05%

Integrated circuits and functions

- Phase correction circuit
- High-pass filter
- ΔΣ ADC

CPU Frequency (MHz) | MCU | 64/128 KB | A | B | C
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<td>24</td>
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<td>6</td>
<td>—</td>
<td>—</td>
<td>10.725</td>
</tr>
</tbody>
</table>

Note: 1. Based on research by Renesas
ASSP, ELECTRICITY METER

RL78/I1C

RL78/I1C 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.

RL78/I1C lineup
■ Available flash memory configurations are 512 KB or 256 KB for high-end single-phase and three-phase meters, and 128 KB or 64 KB for low-end single-phase meters.
■ Available package pin counts are 64, 80, and 100 pins to accommodate a variety of requirements regarding peripheral functions and mounting space.

RL78/I1C features
■ World’s first Continuous Metrology FOTA* solution that solves the problem of power meter operation stopping during firmware updates.
  • The RL78/I1C’s bank programming and bank swapping functions and improved 32-bit multiply-accumulator enable continuous power meter operation during firmware updates.
  *: Firmware update Over The Air

■ 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.

■ 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 the system cost reduction.

■ 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 multiply-and-accumulate unit dramatically reduce the software burden when performing calculations on 24-bit data converted by the 24-bit ΔΣ A/D converter.

■ Independent power supply real-time clock
  • Current consumption of 0.7 μA (typ.) during operation

■ 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.

<table>
<thead>
<tr>
<th>Wiring Type</th>
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<tbody>
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</tr>
<tr>
<td>Three-phase, three-wire</td>
<td>Commercial/industrial</td>
<td>Worldwide</td>
</tr>
<tr>
<td>Three-phase, four-wire</td>
<td>Commercial/industrial Agriculture/urban housing</td>
<td>Worldwide</td>
</tr>
</tbody>
</table>

![ROM and RAM size diagram]

**ROM**
- 512 KB (256KB × 2 bank)
- 256 KB
- 128 KB
- 64 KB

**RAM size**
- 64 K
- 8 K
- 6 K

**Pins**
- 64
- 80
- 100

**Evolution of firmware download & programming**

![Evolution of firmware download & programming diagram]
## ASSP, DETECTOR/SENSOR

### RL78/I1D

#### RL78/I1D features
- **Low power consumption for extended battery life**
  - High-speed recovery from STOP mode in just 3.4 μs, and supply of operating current in 124 μA when operating at 1 MHz.
  - Ability to operate peripheral circuits (sensor activation, signal amplification, obtaining A/D conversion results) without CPU intervention. Ability to determine whether it is necessary to activate the CPU based on A/D conversion results.
- **On-chip analog functions needed for security and emergency applications**
  - On-chip general-purpose op-amp, 12-bit A/D converter, and comparator

#### RL78/I1D specifications

- **RL78 CPU Core**
  - Three-stage pipeline CISC architecture
  - Max. operating frequency: 24 MHz
  - Support for multiply, divide, and multiply-accumulate instructions
- **Memory**
  - Support for 1.8 V flash programming and boot swap
  - Program flash: 8 KB~32 KB
  - SRAM: 0.7 KB~3 KB
  - Data flash: 2 KB
- **System**
  - High-speed on-chip oscillator: 24 MHz ±1%
  - Middle-speed on-chip oscillator: 4 MHz ±12%
  - Support for high-speed wakeup in 3.4 μs
- **Power management**
  - Operating current: 58.3 μA/MHz
  - HALT current: 0.64 μA (RTC + LVD)
  - STOP current: 220 nA (SRAM data retained)
  - SNOOZE current: 700 μA (UART), 500 μA (ADC)
- **Safety**
  - Compliant with European safety standard for household appliances (IEC/UL 60730)
- **Timers**
  - Advanced-functionality timer array unit (TAU)
  - 8-bit interval timer (can be used as 16-bit interval timer)
  - Watchdog timer, real-time clock
- **Analog**
  - 1.6 V (VDD) operation
  - On-chip ADC, 12-bit × 17 channels, conversion time: 3.375 μs
  - Internal reference voltage (1.8 V)
  - Op-amp × 4 channels (high-speed and low-power modes)
  - Comparator × 2 channels (window mode support)
- **Communication**
  - CSI, UART, Simple I2C
- **Package**
  - 20-pin, 24-pin, 30-pin, 32-pin, 48-pin

#### RL78/I1D lineup

<table>
<thead>
<tr>
<th>ROM</th>
<th>Pins</th>
<th>20</th>
<th>24</th>
<th>30</th>
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<td>0.7 K</td>
<td>0.7 K</td>
<td>0.7 K</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### SNOOZE mode operation example

**Operation procedure**
1. Sensor activation
2. ADC activation
3. Obtaining A/D conversion results
4. Storing A/D conversion results in RAM
5. Transmission of A/D conversion results to DOC (determination of need for CPU activation)
ASSP, ANALOG

RL78/I1E

RL78/I1E features
- High-precision analog functions
  - 24-bit ΔΣ A/D converter x 4 channels
  - 10-bit SAR A/D converter x 10 channels
  - Configurable amplifier x 3 channels
  - 12-bit D/A converter x 1 channel
  - Sensor power supply x 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

<table>
<thead>
<tr>
<th>ROM</th>
<th>Pins</th>
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<th>36 KB</th>
</tr>
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<tbody>
<tr>
<td>32 KB</td>
<td>8 KB</td>
<td>8 KB</td>
<td></td>
</tr>
</tbody>
</table>

On-chip 24-bit ΔΣ 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

Configuration examples

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 + ΔΣ A/D converter settings

* Uses external resistors.
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 ΔΣ 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

<table>
<thead>
<tr>
<th>ROM</th>
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<tr>
<td>64 KB</td>
<td></td>
<td>5.5 KB</td>
<td>4 KB</td>
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</tbody>
</table>

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.
RL78 FAMILY FAST PROTOTYPING BOARD

Overview
The Fast Prototyping Board for RL78 Family comes equipped with an RL78 Family microcontroller and is an evaluation board specialized for prototype development for a variety of applications. It has a built-in emulator circuit that is equivalent to an E2 emulator Lite so you can write/debug programs without additional tools. In addition, with Arduino and Pmod™ interfaces included as standard and through-hole access to all pins of the microcontroller, and so on, it has high expandability.

Features
- Equipped with an RL78 family 8/16-bit microcontroller
- No additional tools are required for program debugging/writing with the built-in emulator circuit equivalent to an E2 emulator Lite or the built-in for COM port debug circuit
- Through-holes with access to the pins of the microcontroller
- Arduino and Pmod™ interfaces come standard (some products have Arduino interface only)
- Support for various RL78 software and tools

Product lineup

<table>
<thead>
<tr>
<th>Description</th>
<th>Orderable Part ID</th>
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<tbody>
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<td>RL78/G14 Fast Prototyping Board</td>
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<td>RL78/G15 Fast Prototyping Board</td>
<td>RTK5RLG150C00000BJ</td>
</tr>
<tr>
<td>RL78/G1P Fast Prototyping Board</td>
<td>RTK5RLG1P0C00000BJ</td>
</tr>
<tr>
<td>RL78/G1M Fast Prototyping Board</td>
<td>RTK5RLG1M0C00000BJ</td>
</tr>
<tr>
<td>RL78/G1N Fast Prototyping Board</td>
<td>RTK5RLG1N0C00000BJ</td>
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<tr>
<td>RL78/G22 Fast Prototyping Board</td>
<td>RTK7RLG220C00000BJ</td>
</tr>
<tr>
<td>RL78/G23-64p Fast Prototyping Board</td>
<td>RTK7RLG230CLG000BJ</td>
</tr>
<tr>
<td>RL78/G23-128p Fast Prototyping Board</td>
<td>RTK7RLG230CSN000BJ</td>
</tr>
<tr>
<td>RL78/I1C(512KB) Fast Prototyping Board</td>
<td>RTK5RL10N0CPL000BJ</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>RL78/F13</th>
<th>RL78/F14</th>
<th>RL78/F15</th>
</tr>
</thead>
<tbody>
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<td>ROM</td>
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<tr>
<td>128 KB</td>
<td>10 K</td>
<td>10 K</td>
</tr>
</tbody>
</table>

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
- 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 I2Ebus controller. Enhanced functions suitable for use in automotive gateway products.

- 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 ±2% at −40 to +105°C
  - CPU: 32 MHz, peripheral:64 MHz (timerRD)
  - 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)
- Electric Power Steering Motor
- Motor for Headlight Swivel
- Door-Mirror Motor
- Adjustable Pedal Motor
- Electronic Variable Gear-ratio Motor
- Electric Throttle Valve Control Motor
- Motor for Headlight Leveling
- Cooling Fan Motor
- Electronic Stability Control Motor
- Variable Nozzle Turbo Motor
- Motor for Headlight Swivel

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

Easy to Start
Online development support infrastructure has been set up as Easy to Start. This makes it easy for you to start developing the RL78/F1x.
https://www.renesas.com/products/automotive-products

Renesas Partner Compiler Toolchain
IAR Embedded Workbench provides extensive support for RL78 devices. IAR Embedded Workbench is a complete set of development tools with leading optimization technology for creating powerful automotive applications.
https://www.iar.com/iar-embedded-workbench/#!?architecture=RL78
## RL78 FAMILY OVERVIEW

| Feature/Connector | G10 | G11 | G12 | G13 | G13A | G14 | G15 | G1A | G1C | G1D | G1F | G1G | G1H | G1M | G1N | G1P | G22 | L12 | L13 | L1A | L1B | L1C | L1D | L1E | F12 | F13 | F14 | F15 |
|------------------|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Key Features/Applications | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth | 16-bit ADC 2-ch SPI 4-ch USB 2-ch I²C 1-ch CAN 1-ch Blue-tooth |

| Notes: | *1. No Vref and 12-bit interval timer in 10-pin; no temp sensor. | *2. Except R5F11R | *3. Except 480F and 64BG | *4. Only 1IC (512KB) |
## RL78 FAMILY PACKAGE LINEUP

### Pin-type: 8-WDFN
- **Size:** 3 x 3 mm
- **Pitch:** 0.65 mm
- **Thickness:** 0.80 mm
- **Group:** G15

### Pin-type: 10-LSSOP
- **Size:** 4.4 x 3.6 mm
- **Pitch:** 0.65 mm
- **Thickness:** 1.45 mm
- **Group:** G10, G11, G15

### Pin-type: 16-SSOP
- **Size:** 4.4 x 5 mm
- **Pitch:** 0.65 mm
- **Thickness:** 1.725 mm
- **Group:** G10, G11, G15

### Pin-type: 16-HWQFN
- **Size:** 4.4 x 6.5 mm
- **Pitch:** 0.65 mm
- **Thickness:** 1.45 mm
- **Group:** G11, G12, G15, G22, H1A, H1D

### Pin-type: 20-LSSOP
- **Size:** 1.0 x 1.05 mm
- **Pitch:** 1.45 mm
- **Thickness:** 1.40 mm
- **Group:** G12, G13, G15, G1M, G1N

### Pin-type: 20-TSSOP
- **Size:** 4 x 4 mm
- **Pitch:** 0.65 mm
- **Thickness:** 1.20 mm
- **Group:** G13, G12, G13, G22, G1F, G1P, H1D

### Pin-type: 25-WFLGA
- **Size:** 3 x 3 mm
- **Pitch:** 0.76 mm
- **Thickness:** 2.00 mm
- **Group:** G11, G13, G22, G1A

### Pin-type: 30-LSSOP
- **Size:** 4.4 x 5 mm
- **Pitch:** 0.65 mm
- **Thickness:** 1.725 mm
- **Group:** G11, G12, G13, G1M, G1N

### Pin-type: 32-SSOP
- **Size:** 6.1 x 6.65 mm
- **Pitch:** 0.65 mm
- **Thickness:** 1.45 mm
- **Group:** G13, F13

### Pin-type: 32-HWQFN
- **Size:** 5 x 5 mm
- **Pitch:** 0.50 mm
- **Thickness:** 0.90 mm
- **Group:** G11, G12, G13, G1M, G1F, G1P, H1D

### Pin-type: 32-LOFP
- **Size:** 6 x 6 mm
- **Pitch:** 0.65 mm
- **Thickness:** 1.70 mm
- **Group:** G14, G22, G23, G1C, G1F, G1G, G1P, H1D

### Pin-type: 36-TFBGA
- **Size:** 4 x 4 mm
- **Pitch:** 0.50 mm
- **Thickness:** 1.10 mm
- **Group:** G13, G14, G22, G23, G1F

### Pin-type: 36-WFLGA
- **Size:** 4 x 4 mm
- **Pitch:** 0.76 mm
- **Thickness:** 1.70 mm
- **Group:** G13, G14, G22, G23, G1F

### Pin-type: 38-SSOP
- **Size:** 6.1 x 12.3 mm
- **Pitch:** 0.65 mm
- **Thickness:** 2.00 mm
- **Group:** G11, G13, G22, G1A

### Pin-type: 40-HWQFN
- **Size:** 10 x 10 mm
- **Pitch:** 0.80 mm
- **Thickness:** 1.60 mm
- **Group:** G13, G14, G23, L12

### Pin-type: 44-LOFP
- **Size:** 9 x 9 mm
- **Pitch:** 0.50 mm
- **Thickness:** 1.00 mm
- **Group:** G1H

### Pin-type: 48-HVQFN
- **Size:** 7 x 7 mm
- **Pitch:** 0.65 mm
- **Thickness:** 1.00 mm
- **Group:** G13, G14, G23, G1A, G1C, G1F, G1G, G1P, H1D, L12

### Pin-type: 48-HWQFN
- **Size:** 7 x 7 mm
- **Pitch:** 0.65 mm
- **Thickness:** 1.00 mm
- **Group:** G13, G14, G23, G1A, G1C

### Pin-type: 48-LOFP
- **Size:** 12 x 12 mm
- **Pitch:** 0.80 mm
- **Thickness:** 1.60 mm
- **Group:** G13, G14, F13, F14, F15

### Pin-type: 64-LQFP
- **Size:** 10 x 10 mm
- **Pitch:** 0.65 mm
- **Thickness:** 1.60 mm
- **Group:** G13, G14, G23, L12, L13

### Pin-type: 64-LOFP
- **Size:** 12 x 12 mm
- **Pitch:** 0.80 mm
- **Thickness:** 1.60 mm
- **Group:** G13, G14, G23, H1D, I1C, L13

### Pin-type: 64-LOQF
- **Size:** 14 x 14 mm
- **Pitch:** 0.80 mm
- **Thickness:** 1.70 mm
- **Group:** G13, G14, G23

### Pin-type: 64-LQFP
- **Size:** 14 x 14 mm
- **Pitch:** 0.80 mm
- **Thickness:** 1.60 mm
- **Group:** G13, G14, F13, F14, F15

### Pin-type: 80-LOFP
- **Size:** 14 x 14 mm
- **Pitch:** 0.85 mm
- **Thickness:** 1.70 mm
- **Group:** G13, G14, G23, L13

### Pin-type: 80-LOQF
- **Size:** 14 x 14 mm
- **Pitch:** 0.85 mm
- **Thickness:** 1.70 mm
- **Group:** G13, G14, G23

### Pin-type: 85-VFLGA
- **Size:** 7 x 7 mm
- **Pitch:** 0.65 mm
- **Thickness:** 1.00 mm
- **Group:** L1C

### Pin-type: 100-LOFP
- **Size:** 14 x 20 mm
- **Pitch:** 0.85 mm
- **Thickness:** 1.60 mm
- **Group:** G13, G14, G23

### Pin-type: 100-LOQF
- **Size:** 14 x 20 mm
- **Pitch:** 0.85 mm
- **Thickness:** 1.70 mm
- **Group:** G13, G14, G23

### Pin-type: 128-LOQF
- **Size:** 14 x 20 mm
- **Pitch:** 0.85 mm
- **Thickness:** 1.70 mm
- **Group:** G13, G14, G23

### Pin-type: 144-LOQF
- **Size:** 20 x 20 mm
- **Pitch:** 0.85 mm
- **Thickness:** 1.60 mm
- **Group:** 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.

### Introduction/Initial development

**RL78 web simulator**

Now you can easily develop prototypes using RL78 microcontrollers and run current consumption simulations without having to purchase developer tools. [https://www.renesas.com/websimulator-en](https://www.renesas.com/websimulator-en)

**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.

### Development

**Integrated development environment CS+**

**Build**

**Coding**

**Debug**

**Sample code**

**Middleware**

**Drivers**

**Smart Configuration/Code generation plugin**

**Software**

**Renesas Flash Driver/Self-programming library**

**Drivers**

**OS**

**Sample code**

**Starter kit**

**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**

**CPU board features and usage example**

- LED × 2 for operation confirmation
- Clock
- Universal area
- Switch (interrupt pin) for operation confirmation
- Through holes for signal monitoring (all microcontroller signals)
- Emulator connector
- CPU board
- Microcontroller testing before system development
- IC clips, etc.
- System developed previously using other microcontroller
- Target system
- Bundled emulator
- Starter board
- Mounted with components such as LCDs, potentiometers, etc.
- Tutorial sample code
- Development environment CS+/DVD
- Renesas Flash Driver/Self-programming library
- Sample code
- Start Kit
- Sample code
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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.

e² studio
Based on the “Eclipse” open-source integrated development environment, e² 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.

CC-RL
RL78 Family C compiler realized through Renesas’ latest compiler optimization techniques.
CC-RL assists device functions with C language specification conformed to ANSI-C, optimization function based on RL78 family architecture, interrupt servicing description.

Renesas Flash Driver, EEPROM Emulation Software for RL78/G2x
This custom driver software for flash programming can be used to write programs or data to microcontrollers that require programming in the field following shipment.
- Renesas Flash Driver RL78 Type01(RFD RL78 Type01): RFD RL78 Type01 is embedded in user program and user can re-program user program area or data flash area.*1
- EEPROM Emulation Software RL78 Type01(EES RL78 Type01): Software for EEPROM emulation.*2
Note: *1. Because the flash hardware interface for RL78/G2x is disclosed, RFD RL78 Type01 is distributed with a C language source program style. A customer refers to this source program and development of a customer’s own flash re-programming software is also possible.
Note: *2. Allows writing and reading of user data without consideration for the designated location for user data (data flash). EES can make the number of times of rewriting of the data for EES increase by decentralizing the writing of data with the system to add.

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/code_flash
Data flash library
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*3
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, and E2 Emulator Lite to meet the debugging requirements of customers.

<table>
<thead>
<tr>
<th>Lineup</th>
<th>Features</th>
<th>Trace Function</th>
<th>Time Measurement Function</th>
<th>Coverage Function</th>
<th>Rel. Programming Function</th>
<th>Device Equivalence</th>
<th>Extended Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>IECUBE</td>
<td>Support for powerful debugging functions</td>
<td>Yes</td>
<td>Yes**</td>
<td>No</td>
<td>Yes**</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>E2 Emulator</td>
<td>Correspondence to extended functions</td>
<td>Yes**</td>
<td>1**</td>
<td>No</td>
<td>Yes**</td>
<td>Yes**</td>
<td>Yes**</td>
</tr>
<tr>
<td>E2 Emulator Lite</td>
<td>Convenience for study or hobby use</td>
<td>Yes</td>
<td>No</td>
<td>Yes**</td>
<td>Yes**</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>


Evaluation software tools
Software tools for evaluating product functions and performance are available free of charge.
https://www.renesas.com/tool_evaluation

Smart Configurator/Code generation plugin
Included in CS+ and e² 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.
RI78V4 V2 real-time OS compliant with μITRON standard

A high-quality real-time multitasking environment for embedded systems
- Complies with worldwide standard μITRON 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

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 PIC serial EEPROM driver
  - I²C 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, e²studio simulator]
Simulator enabling source-level debugging of applications in the CS+ and e²studio 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

Debugging with basic functions [E2, E2 Lite on-chip debugging emulator]
Basic debugging capabilities at an inexpensive price. This emulator also supports on-chip trace functionality.
- 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 or serial
- Ability to embed unique code

Programming controlled by a PC or stand-alone programming [PC-FPP 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

<table>
<thead>
<tr>
<th>Group</th>
<th>CPU Boards</th>
<th>Promotion Boards</th>
<th>Starter Kits</th>
<th>Development Kits</th>
<th>Solutions Kits</th>
</tr>
</thead>
<tbody>
<tr>
<td>G10</td>
<td>QB-R5F10Y16-TB</td>
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<td>YRPBRL78G14</td>
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<td>YRDKRL78G14</td>
<td>YRMCKITRL78G14 (Motor control)</td>
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<td>G1D</td>
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<td>G1D Module</td>
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<td>YRDKRL78F14</td>
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<tr>
<td>F15</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

Notes: 1. Products of Naito Densei Machida Mfg.
2. Product of Tessera Technology Inc. (P/N: TK-RLG1H+SB2)
# EXPLANATION OF ORDERABLE PART NUMBERS

(For part numbers start with R5F)

## R5
Renesas MCU

## F
ROM Type
F: Flash

## 1
RL78 Family

## 00

## 6

## E

## C

## A

## SP

## #Vx

### Packaging, Material (Pb-free)

- **#H, #1**: Full Carton (LFQFP, LQFP, TSSOP, WDFN)
- **#H**: Full Carton (SSOP**)
- **#G, #0**: Full Carton (SSOP**, VQFN, HWQFN, WQFN)
- **#U, #2**: Tray (HWQFN, VQFN, VFBGA, WFLGA, VFBGA)
- **#V, #3**: Tray, Tube**1** (LFQFP, LQFP, TSSOP, SSOP, HWQFN)
- **#W, #4**: Embossed Tape (LFQFP, LQFP, TSSOP, SSOP, HWQFN)
- **#X, #5**: Embossed Tape (LFQFP, LQFP, TSSOP, SSOP, HWQFN)

### Package, Pin Pitch

- **SP**: SSOP 0.65 mm
- **LA**: WFLGA 0.5 mm
- **SM**: TSSOP 0.65 mm
- **BG**: VFBGA 0.4 mm
- **NA**: HWQFN 0.5 mm
- **FB**: LFQFP 0.5 mm
- **NB**: HWQFN 0.65 mm
- **FP**: LFQFP 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

### Bonding wire (Only part of RL78/F1x)**4

- **C**: Cu (Copper)

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**Notes:**
1. For 20-pin RL78/G11, RL78/G12 and RL78/I1A SSOP products only the package specification is tube.
2. Includes RL78/F12.
3. Does not include RL78/F12.
4. Please contact Renesas sales or agent for details.
# EXPLANATION OF ORDERABLE PART NUMBERS
(For part numbers start with R7F)

**R7 F 1 00G L J 3 C FB #AAx**

- **Renesas MCU**
- **RL78 Family**
- **ROM Type**
  - **F:** Flash
- **Packaging, Material (Pb-free)**
  - #BA0 Tray (LFQFP, LQFP, LSSOP, HWQFN)
  - #BC0 Tray (WFLGA)
  - #CA0 Tube* (LSSOP) * Also known as “magazine” (shipping form is the same)
  - #HA0 Embossed Tape (LFQFP, LQFP, LSSOP, HWQFN)
  - #HC0 Embossed Tape (WFLGA)

<table>
<thead>
<tr>
<th>ROM Size (KB)</th>
<th>C 32</th>
<th>E 64</th>
<th>F 96</th>
<th>G 128</th>
<th>H 192</th>
<th>J 256</th>
<th>K 384</th>
<th>L 512</th>
<th>N 768</th>
</tr>
</thead>
</table>

## Packaging, Pin Pitch
- **SP** LSSOP 0.65 mm
- **FP** LQFP 0.8 mm
- **FA** LFQFP 0.65 mm
- **FB** LFQFP 0.5 mm
- **NP** HWQFN 0.5 mm
- **LA** WFLGA 0.5 mm
- **BG** VFBGA 0.4 mm

## Temperature
- **2** -40°C to 85°C
- **3** -40°C to 105°C

## Quality Grade
- **C** Industrial
- **D** Consumer

## Product Group
- **00G G23**
- **02G G22**
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