RL78 – TRUE LOW POWER MICROCONTROLLER FAMILY

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

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

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

- Low Power Consumption
  - 45.5 µA/MHz operation*1
  - 0.57 µA (RTC + LVD)
  - New SNOOZE mode
  - Note: 1. Power supply current value during basic RL78/G10 operation

- Broad Scalability
  - 10 to 144 pins/1 to 512 KB
  - Extensive product lineup to meet a broad range of requirements

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

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

- High Performance
  - 45.5 µA/MHz operation*1
  - 0.57 µA (RTC + LVD)
  - New SNOOZE mode
  - Note: 1. Power supply current value during basic RL78/G10 operation

- Low Power Consumption Broad Scalability
- High Performance

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

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

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

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

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

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

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
- 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

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

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

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.

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

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

Operating current (μA/MHz)

<table>
<thead>
<tr>
<th>Company</th>
<th>Current (μA)</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company A</td>
<td>223μA</td>
<td>1/3 to 1/5</td>
</tr>
<tr>
<td>Company B</td>
<td>129μA</td>
<td></td>
</tr>
<tr>
<td>Renesas</td>
<td>45.5μA</td>
<td></td>
</tr>
</tbody>
</table>

Clock operating current (32kHz, LVD)

<table>
<thead>
<tr>
<th>Company</th>
<th>Current (μA)</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company A</td>
<td>2.06μA</td>
<td>1/4 to 1/18</td>
</tr>
<tr>
<td>Company B</td>
<td>0.57μA</td>
<td></td>
</tr>
</tbody>
</table>

STOP mode current (standby, WDT + LVD)

<table>
<thead>
<tr>
<th>Company</th>
<th>Current (μA)</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company A</td>
<td>2.05μA</td>
<td>1/4 to 1/18</td>
</tr>
<tr>
<td>Company B</td>
<td>0.53μA</td>
<td></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 500 product versions, with memory sizes from 1 KB to 512 KB and package pin counts from 10 pins to 144 pins. This extensive selection provides support for a broad range of application fields, including consumer, automotive, industrial, and communications.
- The wide range of options means a lot to developers if there are changes made to the specifications or more ROM capacity becomes necessary than originally estimated in the middle of the development process.
- Customers can rely on the same microcontroller series when developing product models ranging from the low-end to the high-end. Total development man-hours are reduced.

**Excellent pin compatibility**

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

**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.

* PIOR: Peripheral I/O Redirection

Not all pins can be reassigned.

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**Example of I/O port assignments on RL78/G1x**

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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.

REDUCED SYSTEM COST

Helping customers reduce system size and cost

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

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
- RAM parity error detection
- CPU stack pointer monitoring function
- Illegal memory access detection function

Memory guard
This function disables writing to selected addresses in the RAM and SFRs. 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

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

COMPREHENSIVE DEVELOPMENT TOOLS

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

Renesas provides support for all stages of RL78 application development. The Renesas (CS+, 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/G10 features

- Ultra-low power consumption
  - CPU operation: 45.5 μA /MHz
  - STOP mode: 560 nA
- Lineup of low-pin-count products
  - 10 pin: LSSOP (4.4 × 3.6 mm)
  - 16 pin: SSOP (4.4 × 5 mm)

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

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)

Lower system cost: Replacement for general-purpose logic ICs

Using general-purpose logic components complicates the design, manufacturing, and testing processes and can lead to malfunctions. Reducing the number of components is a key issue when developing new products.

RL78 microcontrollers help simplify the design, manufacturing, and testing processes; reduce malfunctions; and provide numerous other advantages.
- More compact circuit board
- Reduced system cost

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

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

Note: The RL78/G10 includes a SPOR circuit detection voltage (VSPOR), so it should be used within a voltage range of 2.25 V to 5.5 V.
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 voltage monitoring at 1.8 V and above (ADC = 1.6 V and above, VBGR = 1.8 V and above, CMP1 = 1.6 V and above, DAC = 1.6 V and above)

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

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

RL78/G11 specifications

RL78 CPU Core
- Three-stage pipeline CISC architecture
- Support for multiply, divide, and multiply-and-accumulate instructions

Memory
- Support for 18 V flash programming and boot swapping
- Code Flash: 16KB
- SRAM: 1.5KB
- Data Flash: 2KB
- For support 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)
GENERAL-PURPOSE, STANDARD

RL78/G12, G13 specifications

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

**Memory**
- Support for 1.8 V flash programming and boot swap
- Program flash: 2 KB–512 KB
- SRAM: 256 B–32 KB
- Data flash: 2 KB/4 KB/8 KB/None

**System**
- High-speed on-chip oscillator: 32 MHz ±1%
- Library support for multiply/divide and multiply-accumulate operation unit

**Power management**
- Operating current: 66 μA/MHz*1
- HALT current: 0.57 μA (RTC + LVD)*1
- STOP current: 230 nA (SRAM data retained)*1
- SNOOZE current: 700 μA (UART), 1.2 mA (ADC)

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

**Timers**
- Advanced-functionality timer array unit (TAU)
- Watchdog timer, real-time clock

**Analog**
- 1.6 V (VDD) operation
- On-chip ADC, 10-bit × 26 channels, conversion time: 2.1 μs
- Internal reference voltage (1.45 V)

**Communication**
- CSI, UART, I2C, Simple I2C

**Package**
- 20-pin–128-pin

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

Extensive lineup: RL78/G12, G13

Choose with confidence. Extensive lineup of 284 products.
Extensive lineup: Compact packages
Available compact package options are ideal for miniaturized products.

- **25pin WFLGA**
  - Thickness: 0.76 mm
  - Size: 3x3mm
  - Pitch: 0.5 mm

- **64pin VF BGA**
  - Thickness: 0.99 mm
  - Size: 4x4mm
  - Pitch: 0.4 mm

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.

Multiply and divide circuit with support for multiply-accumulate operations

<table>
<thead>
<tr>
<th>Operation Type</th>
<th>exec cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signed multiply</td>
<td>16 bits x 16 bits = 32 bits</td>
</tr>
<tr>
<td>Unsigned multiply</td>
<td>16 bits x 16 bits = 32 bits</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 x 16 bits + 32 bits = 32 bits</td>
</tr>
<tr>
<td>Unsigned multiply-accumulate</td>
<td>16 bits x 32 bits = 32 bits</td>
</tr>
</tbody>
</table>

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

HOCO oscillation frequency accuracy

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**Notes:**
1. 24 MHz (max.) on RL78/G12
2. Operation supported at 1.8 V and above on RL78/G12
3. A/D converter operation supported at 1.6 V and above
4. Flash self-programming supported at 1.8 V and above
5. Operation supported at 1.6 V and above**2
6. ±5% on R5F103x
7. RL78/G13 only
GENERAL-PURPOSE, ADVANCED FUNCTIONALITY

RL78/G14

CPU core supporting multiply and divide/multiply-accumulate instructions

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

Overview of multiply, divide, and multiply-accumulate instructions

<table>
<thead>
<tr>
<th>Operation</th>
<th>Exec Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiply</td>
<td>1 clock</td>
</tr>
<tr>
<td>8 bits × 8 bits = 16 bits</td>
<td></td>
</tr>
<tr>
<td>16 bits × 16 bits = 32 bits</td>
<td></td>
</tr>
<tr>
<td>Divide</td>
<td>2 clock</td>
</tr>
<tr>
<td>16 bits / 16 bits = 16 bits ... 16 bits</td>
<td></td>
</tr>
<tr>
<td>32 bits / 32 bits = 32 bits ... 32 bits</td>
<td></td>
</tr>
<tr>
<td>Multiply-accumulate</td>
<td>3 clock</td>
</tr>
<tr>
<td>16 bits × 16 bits + 32 bits = 32 bits</td>
<td></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 RD (complementary PWM mode)

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

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

Complementary PWM mode operation example

<table>
<thead>
<tr>
<th>TRGCLKB pin</th>
<th>TRGCLKA pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRDGRA0</td>
<td>TRDGRA1</td>
</tr>
<tr>
<td>TRDGRA2</td>
<td>TRDGRA3</td>
</tr>
<tr>
<td>TRDGRB0</td>
<td>TRDGRB1</td>
</tr>
<tr>
<td>TRD0</td>
<td>TRD1</td>
</tr>
<tr>
<td>TRDGRB0</td>
<td>TRDGRB1</td>
</tr>
<tr>
<td>TRDIOD0</td>
<td>TRDIOD1</td>
</tr>
</tbody>
</table>

Timer output

Setting value of TRGCNT register

<table>
<thead>
<tr>
<th>CNTEN7 to CNTEN0 in TRGCNT register</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1 1 1 1 1 1 1</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: 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.

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 24 channels</td>
</tr>
<tr>
<td>Transfer address space</td>
<td>4 KB 64 KB</td>
</tr>
<tr>
<td>Max. transfer count/block size</td>
<td>1024/1024 bytes 256/512 bytes</td>
</tr>
<tr>
<td>Transfer target</td>
<td>SFR ↔ RAM SFR ↔ RAM Flash memory ↔ SFR, RAM</td>
</tr>
<tr>
<td>Number of activation sources</td>
<td>39</td>
</tr>
<tr>
<td>Other</td>
<td>Repeat and chain transfers supported</td>
</tr>
</tbody>
</table>

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.

DTC disabled

<table>
<thead>
<tr>
<th>CPU</th>
<th>Peripheral function memory</th>
<th>Data bus</th>
</tr>
</thead>
</table>

DTC enabled

<table>
<thead>
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</tbody>
</table>
Featured function: Event link controller (ELC)

Direct links between hardware modules

No CPU operation needed

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

High-speed module activation

Lower power consumption

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

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

D/A converter operation
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

Analog input voltage
Reference input voltage (Vref 1:0)

Interrupt generation

Interrupt A: Inside window
Interrupt B: Outside window
GENERAL-PURPOSE, ANALOG

RL78/G1A

RL78/G1A features

High-performance peripheral functions
- High-performance 16-bit CPU
- High-speed 16-bit CPU

Low-power consumption/standby mode
- Low power consumption
- Carries on the low power consumption of the RL78 family

Standby mode
- Three modes: HALT, SNOOZE, and STOP
- Reduced average current during intermittent operation

Compact package/extensive peripheral functions
- Compact package
- 3 x 3 mm: 25-pin LGA package
- 4 x 4 mm: 64-pin BGA package

Extensive peripheral functions
- Timer (16-bit x 8 channels)
- Data flash (nonvolatile memory for data)
- Serial communication (CSI, UART, I²C, etc.)
- Fault detection (safety functions)

Multi-channel analog input
- 12-channel A/D converter
- High-precision A/D converter

General-purpose, analog
- RL78/G1A overview
- Lineup of RL78 Family products with enhanced analog functions
- Features
- 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

Memory lineup
- Compact packages and extensive memory capacity options

<table>
<thead>
<tr>
<th>ROM</th>
<th>Pins</th>
<th>25</th>
<th>32</th>
<th>48</th>
<th>64</th>
</tr>
</thead>
<tbody>
<tr>
<td>64K</td>
<td></td>
<td>4K</td>
<td>4K</td>
<td>4K</td>
<td>4K</td>
</tr>
<tr>
<td>48K</td>
<td></td>
<td>3K</td>
<td>4K</td>
<td>3K</td>
<td>4K</td>
</tr>
<tr>
<td>32K</td>
<td></td>
<td>2K</td>
<td>4K</td>
<td>2K</td>
<td>4K</td>
</tr>
<tr>
<td>16K</td>
<td></td>
<td>2K</td>
<td>4K</td>
<td>2K</td>
<td>4K</td>
</tr>
</tbody>
</table>

Support for multiple sensors of various types
- Multi-channel analog input support among the best in the industry with 12-bit A/D converter

System
- Support for I²C, UART, I²C, etc.
- Advanced-functionality timer array unit (TAU)
- Watchdog timer, real-time clock

Analog
- High-speed on-chip oscillator: 32 MHz ±1%
- Library support for multiply/divide and multiply-accumulate operation unit

Memory
- SRAM: 2 KB–4 KB
- Program flash: 16 KB–64 KB
- Data flash: 4 KB

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)

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

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)

Memory lineup
- Compact packages and extensive memory capacity options

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.
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.

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 makes it simple to use a single chip to process communications for two networks. It also reduces the development load, since software is not needed for this processing.

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 is not needed for this processing.

Ultralow current consumption during reception, among the lowest in the industry
- RF reception: 6.3 mA**, RF reception standby: 5.8 mA***
- Reception sensitivity: −105 dBm*

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

**Typical values
**Typical values
**Device-specific measurement

### 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**
- CSI×3, UART×2, F/C×2
- Package
- HVQFN 9×9mm 64pin, 0.5mm pitch

**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

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 is not needed for this processing.

*Notes: 1. Typ., VDD = 3.3 V 2. 2GFSK, 100 kbps, BER < 0.1%
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)
  - Integrates circuit components necessary for antenna connection.
  - Simplifies circuit design and reduces number of external components required. Contributes to smaller mounting area and reduced product cost.
  - Adaptable RF technology
    - Automatic adjustment of transmission output (transmission operating current) to match the communication distance
    - Optimization that prioritizes low current consumption at short distances and prioritizes the communication distance at long distances

Applications employing Bluetooth® low energy

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

RL78/G1D 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

RL78/G1D lineup

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

2.4 GHz RF transceiver

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

RF transmit and receive currents among the world’s smallest

![Graph showing RF currents for RL78/G1D](image)
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 features**

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

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

Notes:
1. It is only necessary to register the final product.
2. 1.8 to 3.6 V when using on-chip DC/DC converter.

**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
  - Blood Pressure
  - Phone Alert Status
- Custom profiles
  - General-purpose bidirectional communication
  - Firmware Update

**Connections to the host microcontroller**

Connections to the host microcontroller use UART 2-wire branch connection.
**GENERAL-PURPOSE, MOTOR**

**RL78/G1F**

**RL78/G1F features**

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

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

**Motor control functions of the RL78/G1F**

- **120-degree conducting control for sensor-less brushless DC motors**
  - On-chip 4-input-selectable high-speed comparator (CMP1) and timer RX for rotor position detection without the use of sensors
  - Enables detection of the rotor position when stopped and during high-speed rotation.

- **Overcurrent detection and forced cutoff of PWM output**
  - On-chip high-speed PGA for overcurrent detection + high-speed comparator (CMP0) and control output signal forced cutoff function (PWMOPA)
  - Supports quick detection of overcurrent conditions and immediate cutoff of PWM output.

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

The amplification factor for boosting very small signals is selectable among ×4, ×8, ×16, and ×32. The slew rate ranges from a minimum of 3.0 V/μs (VDD ≥ 4.0 V). The dedicated GND input (PGAGND pin) ensures that amplification is unaffected by internal noise.

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

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

---

**RL78/G1F block diagram**

[Diagram showing the block diagram of RL78/G1F with PWM control, Timer BD (max. 64 MHz), I/O Port, Timer RX (max. 64 MHz), and other components relevant to motor control.]
Ideal for DC brushless motor applications

Support for power-efficient maintenance-free motor operation

<table>
<thead>
<tr>
<th>Motor control timer</th>
<th>Three-phase complementary PWM</th>
<th>RL78/G1G</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6 channels (48 MHz operation supported)</td>
<td>Supported (Hi-Z, H/L output settings supported)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Overcurrent detection</th>
<th>Programmable-gain amplifier</th>
<th>Comparator</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 channel (on-chip amplifying resistor)</td>
<td>2 channels (response time: 0.15 μs (max.))</td>
</tr>
</tbody>
</table>

| Comparator reference voltage | 8-bit DAC or internal reference voltage of 1.45 V |

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

Lineup of products with low pin count and small ROM capacity

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

<table>
<thead>
<tr>
<th>ROM</th>
<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>
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<td>8 K</td>
<td>1.5 KB</td>
<td>1.5 KB</td>
<td>1.5 KB</td>
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</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

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

<table>
<thead>
<tr>
<th>Product lineup</th>
<th>Pins</th>
<th>32</th>
<th>48</th>
<th>80</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>256 KB</td>
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<td>16 K</td>
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<tr>
<td>192 KB</td>
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<tr>
<td>32 KB</td>
<td>5.5 K</td>
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</tr>
</tbody>
</table>

RL78/G1C 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

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

RL78/G1C
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
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)
  - Suitable for a broad range of applications
Overview of USB controller specifications

USB Host and USB BC1.2 support

<table>
<thead>
<tr>
<th>RS78/G1C</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB2.0</td>
<td>Function</td>
</tr>
<tr>
<td>Host</td>
<td>2 channels</td>
</tr>
<tr>
<td>Transfer speed</td>
<td>LS (1.5 Mbps)</td>
</tr>
<tr>
<td>FS (12 Mbps)</td>
<td>○</td>
</tr>
<tr>
<td>HS (480 Mbps)</td>
<td>—</td>
</tr>
<tr>
<td>Transfer mode</td>
<td>Control</td>
</tr>
<tr>
<td>Bulk</td>
<td>○</td>
</tr>
<tr>
<td>Interrupt</td>
<td>○</td>
</tr>
<tr>
<td>Isochronous</td>
<td>—</td>
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</tbody>
</table>

On-chip resistors: ○: D+ and D– lines, pull-up and pull-down resistors

Supported battery charging classes: ○: Support for Host and Function

On-chip PLL: ○: External resonator → 48 MHz generation

USB sample firmware

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

All application notes are available for download on the Renesas website

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
**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

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**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>
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<tbody>
<tr>
<td>256 KB</td>
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<td>12 K</td>
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</tbody>
</table>
### LCD display seg × com lineup

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

<table>
<thead>
<tr>
<th>Pin Count</th>
<th>32</th>
<th>48</th>
<th>52</th>
<th>64</th>
<th>80</th>
<th>100</th>
<th>128</th>
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</thead>
<tbody>
<tr>
<td>50 or more</td>
<td>51</td>
<td>56</td>
<td>56</td>
<td>54</td>
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<tr>
<td>45 - 49</td>
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<tr>
<td>25 - 29</td>
<td>26</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 - 24</td>
<td>22</td>
<td>24</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 - 19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 - 14</td>
<td></td>
<td></td>
<td>13</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Resistance division method*2</th>
<th>Company A</th>
<th>Company B</th>
<th>Company C</th>
<th>Company D</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.6 μA (typ.)</td>
<td>11.7 μA (0/2.2 V)</td>
<td>Not implemented</td>
<td>12.0 μA (0/1.8 V)</td>
<td>Not implemented</td>
</tr>
<tr>
<td>Capacitor split method</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>23.7 μA</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Features/anticipated applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>For heavy-duty LCD/AC power supply applications</td>
</tr>
<tr>
<td>Using resistance division to generate the drive voltage achieves high LCD drive capacity at low cost. External resistors are used for voltage division to generate the LCD drive voltage. The ability to input an external voltage means that external resistors and capacitors can be used to adjust the operating current and drive capacity.</td>
</tr>
<tr>
<td>Resistance division method</td>
</tr>
<tr>
<td>High Good Standard Dependent on VDD</td>
</tr>
<tr>
<td>Suitable for large LCD panels 10.4 μA (typ.)*3</td>
</tr>
<tr>
<td>Display dims as power supply voltage drops.</td>
</tr>
<tr>
<td>Microwave ovens</td>
</tr>
<tr>
<td>Washing machines</td>
</tr>
<tr>
<td>Rice cookers</td>
</tr>
<tr>
<td>Kitchen tools</td>
</tr>
<tr>
<td>LCD remote controls</td>
</tr>
<tr>
<td>Composition meters</td>
</tr>
<tr>
<td>Activity meters</td>
</tr>
<tr>
<td>Thermometers</td>
</tr>
</tbody>
</table>

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

**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: 24MHz
- **Memory**
  - Support for 1.8 V flash programming and boot swap
  - Program Flash: 48 KB–128 KB
  - SRAM: 5.5 KB
  - Data Flash: 8 KB
- **System**
  - High-speed on-chip oscillator: 24 MHz
  - Low-speed on-chip oscillator: 15 kHz
- **Power management**
  - Power-on reset (POR)
  - Low-voltage detection circuit (LVD)
  - RTC output (1 Hz) × 1
- **Safety**
  - Compliant with European safety standard for household appliances (IEC/UL 60730)

**Analog frontend function configuration**

In blood glucose meter use case

- RAM parity error detection function
- Illegal memory access detection
- ADC test function
- **Timers**
  - Advanced-functionality timer array unit (TAU)
  - Watchdog timer, real-time clock
- **Analog**
  - 12-bit ADC × 14 channels
  - 12-bit DAC × 2 channels
- **Communication**
  - 3 × SCI: Simple SPI/simple I2C/UART
- **LCD**
  - 32 seg × 4 com (80-pin)
  - 45 seg × 4 com (100-pin)

**Package**

- LFQFP 12 × 12 mm 80-pin, 0.5 mm pitch
- LFQFP 14 × 14 mm 100-pin, 0.5 mm pitch

**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

**Advantages of RL78/I1A**

**Dithering function**

Delivers min. average resolution of 0.98 ns.

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

**RL78/I1A lineup**

<table>
<thead>
<tr>
<th>ROM</th>
<th>Pins</th>
<th>20</th>
<th>30</th>
<th>38</th>
</tr>
</thead>
<tbody>
<tr>
<td>64 KB</td>
<td>4 K</td>
<td>4 K</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32 KB</td>
<td>2 K</td>
<td>2 K</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- 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

**Main applications**

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

**DALI master/slave communication functions**

Manchester coding

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

RL78/I1B

Target electricity meter markets of RL78/I1B

Electricity meter types

<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)
- Newly developed 24-bit ΔΣ ADC
  - Current during ADC operation: 0.53 mA/channel

25% lower power consumption than competing products*1

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

Lower power consumption at all operating frequencies

<table>
<thead>
<tr>
<th>CPU Frequency (MHz)</th>
<th>0</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2.8</td>
<td>4.35</td>
<td>5.1</td>
<td>3.525</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>3.3</td>
<td>5.55</td>
<td>6.6</td>
<td>4.595</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>4.2</td>
<td>—</td>
<td>9.6</td>
<td>6.695</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>6</td>
<td>—</td>
<td>—</td>
<td>10.725</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: 1. Based on research by Renesas

ΔΣ ADC with improved functionality for electricity meters

Implementation in hardware of functions essential for power measurement

- Phase correction circuit, high-pass filter

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

High-speed on-chip oscillator with accuracy of ±0.05%

Subclock resonator single-crystal system

Exclusive Renesas system is more robust than conventional PLL designs.

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

**RL78/I1C**

**Target electricity meter markets of RL78/I1C**

<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>
<tr>
<td>Three-phase, four-wire</td>
<td>Commercial/industrial, Agriculture/urban housing</td>
<td>Worldwide</td>
</tr>
</tbody>
</table>

**RL78/I1C lineup and concept**

<table>
<thead>
<tr>
<th>ROM</th>
<th>Pins</th>
<th>64</th>
<th>80</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>256 KB</td>
<td>16 K</td>
<td>16 K</td>
<td></td>
<td></td>
</tr>
<tr>
<td>128 KB</td>
<td>8 K</td>
<td>8 K</td>
<td>8 K</td>
<td></td>
</tr>
<tr>
<td>64 KB</td>
<td>6 K</td>
<td>6 K</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Improved security functions and arithmetic performance**

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

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

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

**Target markets**

- Ideal for smart meters, including those using DLMS communication.
- Suitable for a wide variety of power platforms, from single-phase two-wire to three-phase four-wire.
- Available flash memory configurations are 256 KB for DLMS or three-phase meters, 128 KB for single-phase meters or low-end three-phase meters, and 64 KB for low-end single-phase meters.
- Available package pin counts are 100 for three-phase meters or single-phase meters for advanced economies, 80 for single-phase meters for emerging economies, and 64 for applications where space is restricted.
- A total of seven product versions are available.
- Power measurement processing and DLMS processing on a single chip.
- Ability to handle DLMS communication while power measurement processing is taking place.
- Approx. 30% reduction in power consumption compared with two-chip solutions combining an earlier meter microcontroller and a dedicated microcontroller for DLMS processing.
- Contributes to reduced system cost.

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

### RL78/I1D lineup

<table>
<thead>
<tr>
<th>ROM</th>
<th>Pins</th>
</tr>
</thead>
<tbody>
<tr>
<td>32 KB</td>
<td>20</td>
</tr>
<tr>
<td>16 KB</td>
<td>24, 30, 32</td>
</tr>
<tr>
<td>8 KB</td>
<td>32, 48</td>
</tr>
</tbody>
</table>

### SNOOZE mode operation example

1. **Sensor signal**
2. **Op-amp activation**
3. **ADC activation**
4. **DTC activation**
5. **8-bit timer**

**Operation procedure**
- Sensor activation
- ADC activation
- Obtaining A/D conversion results
- Storing A/D conversion results in RAM
- 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 × 4 channels
  - 10-bit SAR A/D converter × 10 channels
  - Configurable amplifier × 3 channels
  - 12-bit D/A converter × 1 channel
  - Sensor power supply × 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>
<th>32</th>
<th>36</th>
</tr>
</thead>
<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

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

Configurable amplifier settings
ASSP, HEALTHCARE/ELECTRICITY METER

**RL78/H1D**

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

**RL78/H1D features**
- Rich analog functions
  - 24-bit 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>
<th>Pins</th>
<th>48</th>
<th>64</th>
<th>80</th>
</tr>
</thead>
<tbody>
<tr>
<td>128 KB</td>
<td></td>
<td>5.5 KB</td>
<td>4 KB</td>
<td>5.5 KB/8 KB</td>
</tr>
<tr>
<td>96 KB</td>
<td></td>
<td>5.5 KB</td>
<td>4 KB</td>
<td>5.5 KB</td>
</tr>
<tr>
<td>64 KB</td>
<td></td>
<td></td>
<td>5.5 KB</td>
<td>4 KB</td>
</tr>
</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.
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>ROM</th>
<th>Pins</th>
<th>20</th>
<th>30</th>
<th>32</th>
<th>48</th>
<th>64</th>
<th>80</th>
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</thead>
<tbody>
<tr>
<td>128 KB</td>
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<td>8 K</td>
<td>8 K</td>
<td>8 K</td>
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<tr>
<td>16 KB</td>
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<td>1 K</td>
<td>1 K</td>
<td>1 K</td>
<td>1 K</td>
<td>1 K</td>
<td>1 K</td>
</tr>
</tbody>
</table>

**RL78/F13 features**

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

**RL78/F14 features**

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

**RL78/F15 features**

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

**RL78/F14 block diagram**

**RL78/F13, F14, F15 lineup**

<table>
<thead>
<tr>
<th>ROM</th>
<th>Pins</th>
<th>48</th>
<th>64</th>
<th>80</th>
<th>100</th>
<th>144</th>
</tr>
</thead>
<tbody>
<tr>
<td>512 KB</td>
<td></td>
<td>32 K</td>
<td>32 K</td>
<td>32 K</td>
<td>32 K</td>
<td>32 K</td>
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<td>384 KB</td>
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<td>26 K</td>
<td>26 K</td>
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</tr>
<tr>
<td>256 KB</td>
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<td>20 K</td>
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<td>152 KB</td>
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<td>16 K</td>
<td>16 K</td>
<td>16 K</td>
<td>16 K</td>
<td>16 K</td>
</tr>
<tr>
<td>128 KB</td>
<td></td>
<td>10 K</td>
<td>10 K</td>
<td>10 K</td>
<td>10 K</td>
<td>10 K</td>
</tr>
</tbody>
</table>

**RL78/F14 features**

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

**RL78/F15 features**

- Compatible with RL78/F13 and RL78/F14 for easy migration
- Expanded number of CAN and LIN channels, on-chip IEBus 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 (timer RD)
  - Advanced on-chip debugging functionality
    - Hot plugin
    - DTC real-time RAM monitor (RRM) and dynamic memory modification (DMM)
  - On-chip trace
  - Functional safety support
- Compact package
  - QFN Package lineup:
    - Ex. 32-pin SSOP 32-pin QFN
- High temperature support
  - Operation at Ta = 150°C (RL78/F13, F14)
CAN module
- Architecture enabling continued utilization of legacy communication software specifications
  - Retains functionality of previous CAN module
- Reduced load for interrupt handling
  - Implementation in hardware of typical interrupt-related functions
  - Reduction of overhead from interrupts at CAN transmit/receive completion
  - Suppression of interrupts at completion of CAN reception of unneeded messages
- Improved self-diagnostic functions
  - Support for read/write testing of RAM used by CAN
- Implementation in hardware of communication control software processing for reduced CPU load
  - Partial implementation in hardware of AUTOSAR-compliant CAN MCAL block and Pdu_Router
  - Implementation in hardware of ECU self-diagnostic functions (OBD II support functions)

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

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

- Various types of motor control
- Various types of body control
- Car audio
  - Powertrain (sub-microcontroller)
  - Airbags (sub-microcontroller)

The high reliability required by automotive applications makes these microcontrollers suitable for industrial applications as well.
### RL78 FAMILY OVERVIEW

| Key Feature, Application | G10  | G11  | G12  | G13  | G14  | G1A  | G1C  | G1D  | G1F  | G1G  | G1H  | LT2  | LT3  | L1A  | L1C  | H1D  | I1A  | I1B  | I1C  | I1D  | I1E  | F12  | F13  | F14  | F15  |
|--------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Key Feature, Application |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Low Pin |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Low Power Analog |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Standard |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Enhanced |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 12-bit ADC |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| USB |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Bluetooth |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Sub-Gig |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| LCD Basic |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Standard |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Enhanced |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| LCD Enhanced |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| LCD Control |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Low Power |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Standard |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Enhanced |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 3-4 ch |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Pre-Amp |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Inst. |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| CAN |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 1 ch option |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| USB |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| CAN |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 1 ch, 2 ch |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |

**Notes:**
- *1. No Vref and 12-bit interval timer in 10-pin, no temp sensor.
- *2. Except R5F11R
- *3. Except 480FP and 64BG A
### RL78 FAMILY PACKAGE LINEUP

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

#### Pin-type: 16-SSOP
- **Size:** 4.4 x 5 mm
- **Pitch:** 0.65 mm
- **Thickness:** 1.275 mm
- **Group:** G10, G11

#### Pin-type: 20-LSSOP
- **Size:** 4.4 x 6.5 mm
- **Pitch:** 0.65 mm
- **Thickness:** 1.45 mm
- **Group:** G10, G11, G12, I1A, I1D

#### Pin-type: 20-LSSOP
- **Size:** 4.4 x 6.5 mm
- **Pitch:** 0.65 mm
- **Thickness:** 1.40 mm
- **Group:** G13, F13

#### Pin-type: 24-HWQFN
- **Size:** 4 x 4 mm
- **Pitch:** 0.50 mm
- **Thickness:** 0.80 mm
- **Group:** G13, G14, G1A, G1C, G1F, I1D

#### Pin-type: 25-WFLGA
- **Size:** 3 x 3 mm
- **Pitch:** 0.50 mm
- **Thickness:** 0.80 mm
- **Group:** G11, G13, G1A

#### Pin-type: 30-LSSOP
- **Size:** 6.1 x 9.85 mm
- **Pitch:** 1.40 mm
- **Group:** G12, G13, G14, G1G, I1A, I1D, F13, F14

#### Pin-type: 32-HVQFN
- **Size:** 5 x 5 mm
- **Pitch:** 0.80 mm
- **Thickness:** 1.00 mm
- **Group:** G13, G14, G1A

#### Pin-type: 32-LQFP
- **Size:** 7 x 7 mm
- **Pitch:** 0.80 mm
- **Thickness:** 1.60 mm
- **Group:** F13, F14

#### Pin-type: 36-WFLGA
- **Size:** 4 x 4 mm
- **Pitch:** 0.50 mm
- **Thickness:** 0.80 mm
- **Group:** I1A

#### Pin-type: 36-SSOP
- **Size:** 6.1 x 12.3 mm
- **Pitch:** 2.00 mm
- **Group:** I1D

#### Pin-type: 44-LQFP
- **Size:** 10 x 10 mm
- **Pitch:** 0.80 mm
- **Thickness:** 1.60 mm
- **Group:** G13, G14, L12

#### Pin-type: 48-LFQFP
- **Size:** 10 x 10 mm
- **Pitch:** 0.80 mm
- **Thickness:** 1.60 mm
- **Group:** G13, G14, G1A, G1C

#### Pin-type: 52-LQFP
- **Size:** 10 x 10 mm
- **Pitch:** 0.80 mm
- **Thickness:** 1.70 mm
- **Group:** G13, G14, L12

#### Pin-type: 64-HVQFN
- **Size:** 9 x 9 mm
- **Pitch:** 0.80 mm
- **Thickness:** 1.60 mm
- **Group:** G13, G14, G1A, G1C

#### Pin-type: 64-LQFP
- **Size:** 12 x 12 mm
- **Pitch:** 0.80 mm
- **Thickness:** 1.70 mm
- **Group:** G13, G14, L12, L13

#### Pin-type: 64-LQFP
- **Size:** 14 x 14 mm
- **Pitch:** 0.80 mm
- **Thickness:** 1.70 mm
- **Group:** G13, G14, L13

#### Pin-type: 64-TFBGA
- **Size:** 4 x 4 mm
- **Pitch:** 0.40 mm
- **Thickness:** 1.10 mm
- **Group:** G13, G14

#### Pin-type: 64-VFBGA
- **Size:** 4 x 4 mm
- **Pitch:** 0.50 mm
- **Thickness:** 0.90 mm
- **Group:** G13, G1A

#### Pin-type: 64-WFLGA
- **Size:** 5 x 5 mm
- **Pitch:** 0.50 mm
- **Thickness:** 0.76 mm
- **Group:** G13, G14

#### Pin-type: 80-LQFP
- **Size:** 16 x 14 mm
- **Pitch:** 0.80 mm
- **Thickness:** 1.70 mm
- **Group:** G13, G14, L13

#### Pin-type: 80-LQFP
- **Size:** 14 x 14 mm
- **Pitch:** 0.80 mm
- **Thickness:** 1.70 mm
- **Group:** G13, G14

#### Pin-type: 85-VFLGA
- **Size:** 7 x 7 mm
- **Pitch:** 0.80 mm
- **Thickness:** 1.00 mm
- **Group:** L1C

#### Pin-type: 100-LQFP
- **Size:** 14 x 20 mm
- **Pitch:** 0.80 mm
- **Thickness:** 1.60 mm
- **Group:** G13, G14

#### Pin-type: 128-LQFP
- **Size:** 14 x 20 mm
- **Pitch:** 0.80 mm
- **Thickness:** 1.60 mm
- **Group:** G13

#### Pin-type: 144-LQFP
- **Size:** 20 x 20 mm
- **Pitch:** 0.80 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**

<table>
<thead>
<tr>
<th>RL78 web simulator</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU board</td>
</tr>
<tr>
<td>Software tool free evaluation version</td>
</tr>
<tr>
<td>Sample code</td>
</tr>
</tbody>
</table>

**Development**

- Integrated development environment CS+
- Build
  - Code generation function
- Coding
  - Software
- Debug
  - e2 studio
  - E2 Emulator on-chip debugging emulator
  - E2 Emulator Lite on-chip debugging emulator
  - E1 on-chip debugging emulator

**Mass production**

- Renesas Flash Programmer
  - flash programming software

**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**

- 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.

**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)

**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.

**RL78 web simulator**

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

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

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

RL78 Family self-programming libraries
These custom software libraries for flash programming can be used to write programs or data to microcontrollers that require programming in the field following shipment.

Code flash library
https://www.renesas.com/flash_libraries/self_prg

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*1

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.

Emulators
Renesas offers IECUBE, E2 Emulator, E1 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>Run/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>2*</td>
<td>Yes</td>
<td>No</td>
<td>Yes</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>No</td>
</tr>
<tr>
<td>E1 Emulator</td>
<td>Basic debugging functions</td>
<td>Yes*</td>
<td>1*</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes*</td>
<td>No</td>
</tr>
<tr>
<td>E2 Emulator Lite</td>
<td>Convenience for study or hobby use</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

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)

Application notes and sample code

Renesas provides sample programs with documentation describing how to use microcontroller peripheral functions as well as system examples.
- Sample code for RL78, constantly expanding lineup
- Extensive sample code including register definition files
- Substantial reduction in time to completion for products incorporating RL78 Family microcontrollers

Visit the following URL to download sample code based on the philosophy of “simpler and faster”.
http://www.renesas.com/software

Three types of debugging environment to match your development style

Debugging on a PC (CS+ simulator for RL78 Family, 78K0R, and 78K0)
Simulator enabling source-level debugging of applications in the CS+ integrated development environment before the target system exists
- Rich break functions and coverage measurement functions
- Ability to evaluate software modules in a manner very similar to evaluation on the actual device

Debugging with basic functions [E1, E2, E2 Lite on-chip debugging emulator]
Basic debugging capabilities at an inexpensive price. This emulator also supports on-chip trace functionality. *1
- Simple to connect. Allows debugging via a connection to an RL78 microcontroller mounted in the system under development.
- Also functions as a flash programmer.
- Environmentally friendly. All materials from the components to the packaging are RoHS compliant.

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

Debugging with high-level functions [IECUBE full-spec emulator]
A high-performance full-spec emulator with more advanced functions
- Trace with time-tag function
- Provides access via a GUI to more powerful debugging capabilities, including a duration measurement function and coverage function.

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

Programming controlled by a PC (Renesas Flash Programmer flash programming software)
- Simple GUI specialized for programming
- Batch processing efficiently for programming large quantities at mass production
- PC-controlled programming using E2 emulator, E2 emulator Lite, E1 or serial
- Ability to embed unique code

Programming controlled by a PC or stand-alone programming (PC-FP6 flash programmer)
- Stand-alone programming
- Programming controlled by a PC using a dedicated GUI
- Ability to store settings for up to eight environments
- Ideal for use on the production line (command control, remote control)
- Ability to embed unique code

Ordering pre-programmed ROM (growing number of products supported)*1
- Pre-programmed flash memory products from Renesas Electronics

Note: 1. The support status differs depending on the product. Please contact a Renesas sales company or agent for details.
## Development tools for RL78 Family

<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>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>RTE510Y470TGB00000R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G11</td>
<td>YQB-R5F1057A-TB</td>
<td>YRPBRL78G11</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>G12</td>
<td>QB-R5F1026A-TB</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>G13</td>
<td>QB-R5F100LE-TB</td>
<td>YRPBRL78G13</td>
<td>YR0K50100LS000BE</td>
<td>YRDKRL78G13</td>
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</tr>
<tr>
<td>G14</td>
<td>QB-R5F104LE-TB</td>
<td>YRPBRL78G14</td>
<td>YR0K50104PS000BE</td>
<td>YRDKRL78G14</td>
<td>YRMCKITRL78G14 (Motor control)</td>
</tr>
<tr>
<td></td>
<td>QB-R5F104PJ-TB</td>
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<tr>
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<td>FB-R5F104PL-TB*</td>
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<tr>
<td>G1A</td>
<td>QB-R5F10ELE-TB</td>
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<td>–</td>
<td>–</td>
<td>–</td>
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<td>G1C</td>
<td>QB-R5F10JGC-TB</td>
<td>–</td>
<td>YR0K5010JGS000BE</td>
<td>–</td>
<td>R0K578G1CD010BR (USB charger)</td>
</tr>
<tr>
<td>G1D</td>
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<td>–</td>
<td>–</td>
<td>YRLI1D-BLE-SOL</td>
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<td>RM-110-RFB-2*</td>
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<td>G1D Module</td>
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<tr>
<td>G1F</td>
<td>YQB-R5F11BLE-TB</td>
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<td>–</td>
<td>RTK0EML240C03000BJ (Motor CPU Card)</td>
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<tr>
<td>G1G</td>
<td>YQB-R5F11EFA-TB</td>
<td>–</td>
<td>YR0K5011EFS000BE</td>
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<tr>
<td>G1H</td>
<td>TK-RLG1H+SB2*</td>
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Notes:
1. Products of Naito Densei Machida Mfg.
2. Product of Tessera Technology Inc. (P/N: TK-RLG1H+SB2)
EXPLANATION OF ORDERABLE PART NUMBERS

Product information for the RL78/G13 (20-pin) with product number R5F1006EASP#V0 is shown as an example.

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**Note:** 1. For 20-pin RL78/G11, RL78/G12 and RL78/I1A LSSOP products only the package specification is tube.
Complete System Solutions at Your Fingertips

In today’s fast paced technology environment, designers need to be innovative without compromising time to market. Thinking at the system level is crucial to being able to address design challenges upfront. By offering quality solutions for the two most critical parts of your design, processors and power, Renesas accelerates your development and enables differentiation, while bringing predictability to your application. Whatever your product field – automotive, industrial, home electronics, office automation or information communication technology – Renesas is the partner you can rely on from design to production.

Power Management and Precision Analog Products

<table>
<thead>
<tr>
<th>Power Management</th>
<th>Amplifiers &amp; Buffers</th>
<th>Audio &amp; Video</th>
<th>Data Converters</th>
<th>Switches &amp; Multiplexers</th>
<th>Optoelectronics</th>
<th>Timing &amp; Digital</th>
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<td><em>Automotive Infotainment &amp; Security</em></td>
<td><em>Digital Potentiometers (DCPs)</em></td>
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<td><em>Ambient Light and Proximity Sensors</em></td>
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</table>

A top-to-bottom, front-to-back product offering will help speed design and bring quality, compatibility, and predictability to your applications.
POWERING AN MCU

COMPLETE SIGNAL CHAIN SOLUTIONS

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

Buck-Boost Converter

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

Buck Converters

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

Boost Converters

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

Linear Regulators

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

Bi-Directional Buck-Boost Conv

- ISL9533B
  - Current Range: <10A
  - VIN: 3.2V – 23.5V; VOUT: 2.4V – 20V

Battery Chargers

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

**RTC – Real-Time Clocks**
- Low Cost
- Low Power
- High Accuracy

**Signal Sensor**
- AMP
- Switch/MUX

**ADC**
- Up To +/- 20V Supply
- Over Voltage Protected
- USB/Audio
- DCP

**DAC**
- Voltage Reference
- Low Drift
- Low Power
- Low Noise

**AMP**
- Interface
- High Speed
- DCP

**Power Monitor (Current Sense)**

**Multi-Cell Balancing (MCB)**

**Integrated Solutions**
- 16 to 1024 taps
- 16C/8 SPI
- Volatile/Non-Volatile

**24-bit Delta Sigma**
- 8 to 12-bit SAR
- 8 to 16-bit High Speed

**RS-232**
- RS-485/422
- Isolated RS-485