True Low Power™ Platform for 8-/16-bit Applications

RL78 Microcontrollers

Renesas Electronics America
www.renesas.com
The expanding family of RL78 microcontrollers consists of both general-purpose devices and application-specific chips. These increasingly popular MCUs make possible ultra-low-power applications by giving system designers advanced power-saving features and high-performance operation. Because the devices offer important capabilities such as an innovative Snooze mode that allows serial communication and ADC operation while the CPU is inactive, Renesas’ RL78 MCUs are demonstrably superior solutions for a vast span of battery-powered applications.

Why RL78?
- Best-in-class performance for superior designs and low power
- Scalability of package, memory and peripheral features
- System cost saving features
- Wide voltage and temperature operation
- On-chip safety features
Microcontroller Platform

Introducing the RL78/I1D Group – Analog Integration with New Low Power Capabilities and Fast Wake-up

RL78/I1D – Unrivaled Power Savings

<table>
<thead>
<tr>
<th>Operating current – µA at 1 MHz</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
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<tbody>
<tr>
<td>RL78/I1D</td>
<td>124µA</td>
<td>220µA</td>
<td>260µA</td>
<td>400µA</td>
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</tbody>
</table>

*)1: CPU operation (Execute instruction from flash memory), Normal operation, Stop peripherals

RL78/I1D Block Diagram

VDD = 1.6 to 3.6V
Ta = -40 to 105°C

Memory
- Program Flash: 8 to 32 KB
- SRAM: 0.7 to 3 KB
- Data Flash: 2 KB

System
- DTC: 23 sources, 24 sets
- Data Operation Circuit: 4 Levels
- Interrupt Controller: Internal, External
- Clock Generation: Internal, External
- POR, LVD
- Event Link Controller
- Debug w/trace: Single-wire

Safety
- RAM, SFR: Parity, Protection, Invalid
- ADC: Self-diagnostic
- Clock Monitoring
- Memory CRC
- I/O Port Read back

Analog
- ADC: 12-bit, 17 ch
- Internal Vref.: 1.8V, all modes
- Temperature Sensor: 1.8V, all modes
- Comparator: 2 ch
- Op-Amp: 4 ch

Timers
- 16b TAU: 16-bit, 4 ch
- PPM: 3 ch
- Interval Timer: 12-bit, 1 ch
- Interval Timer: 8-bit, 4 ch (16-bit, 2 ch)
- WDT: 17-bit, 1 ch
- RTC: Calendar

Power Management
- HALT: RTC, DTC Enabled
- SNOOZE: Serial, ADC Enabled
- STOP: SRAM On
- Fast Wake-up: 4 µsec

Communications
- 2 x I2C Master
- 2 x CSI/SPI: 7-, 8-bit
- 1 x UART: 7-, 8-, 9-bit

RL78/I1D – Unrivaled Power Savings

The RL78/I1D group is ideal for applications that require analog functions and low power usage, such as smoke and CO detectors, as well as motion and glass break detectors.

True Low Power Enhancement

- New LP mode and mid-speed on-chip oscillator (MOCO) combine to enable extremely low power operation (124 µA at 1 MHz) with a fast wake-up capability: 4 µs (max.)
- Using the DTC, ELC, and DOC in Snooze mode implements a low-power configuration that handles tasks without CPU intervention
- New timer generates intervals up to 9 minutes long using the 15 kHz low-speed on-chip oscillator (LOCO) and consumes just 0.52 µA; up to 5 channels are available

Analog Integrations

- 12-bit ADC has up to 17 channels; it completes a conversion in 3.375 µs
- OpAmp (4 channels) has two modes: High Speed (1.7 MHz GBW, 140 µA) and Low Power (0.04 MHz GBW, 2.5 µA)
- Comparator (2 channels) offers a Window mode
- Internal voltage reference and temperature sensor operate down to 1.8V
- ADC and OpAmp can be started up by an ELC trigger from a timer, comparator or external interrupt
RL78’s Low Power Modes Maximize Battery Life

Three low-power modes maximize battery life either by putting on-chip functions such as the CPU, clock and peripherals in standby or by turning them off when they aren’t being used.

**Snooze mode**
- Some peripherals (ADC, UART and SPI) remain operational in Standby modes.
- MCU transits from STOP mode by timer trigger or serial data reception.
- MCU wakes up only when acquired data matches the condition. If not, go back to Stop mode without CPU intervention.
- Power savings up to 76% can be obtained; e.g., the ADC consumes 1.2 mA in Snooze mode vs. 5.1 mA in the 32 MHz Run mode.

**Run mode**
- In Run mode, RL78 devices offer substantial savings in current consumed as compared to competitors.

**Halt mode**
- Halt mode disables CPU operation, saving as much as 80% of total MCU current, while allowing a fast CPU wake-up time.

**Stop mode**
- Stop mode achieves the lowest RL78 power consumption; it disables the CPU and on-chip functions that run on the CPU clock.

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Notes: 1: At 32 MHz (NOP instructions) 2: 0.49 µA (32.786 kHz and RTC only) 3: 0.23 µA (all stopped, RAM retained)
Low average power

Multiple features of the RL78 MCUs hold average system power consumption to extremely low levels.

- Low-voltage operation (1.6V)
- Low active current (4.6 mA @ 32 MHz)
- High efficiency (44 DMIPS @ 32 MHz)
- Low standby current with peripherals operating (0.45 μA in Stop mode with 15 kHz clock and 12-bit interval timer running)
- CPU intervention minimization using Snooze mode (1.2mA@32MHz with ADC on)

### Peripheral selection

RL78 MCUs have versatile power-down modes and main and subsystem (32kHz) clock options.

- Peripheral functions available in Standby mode consume miniscule current
  - 12-bit interval timer (0.02 μA)
  - RTC (0.02 μA)
  - WDT (0.02 μA)
  - 15 kHz on-chip oscillator (0.20 μA)
  - 32 kHz oscillator (0.24 μA)
  - LVD (0.08 μA)
- RAM data is retained in all MCU modes
- ADC, UART and SPI can be active in Snooze mode
- In Halt mode, system can wait for ADC end or serial transfer end, followed by a quick (0.3 μs) wake-up

### Clock configuration

System power consumption is readily minimized by individually switching off or on oscillators, clock lines, functions, etc., as application requirements change.

- High-speed on-chip oscillator (HOCO) clock can be divided from the original source clock; its frequency can be as low as 1 MHz
- 32 kHz external clock can be used to run the CPU and peripherals
- RTC and Interval Timer can operate from 32 kHz or 15 kHz clocks
High Efficiency

The RL78 family provides up to 44 DMIPS performance at 32 MHz

- Ratio of power consumption to performance the devices achieve is unrivaled – 1/3 that of other devices – enabling major power savings
- RL78 devices have a higher DMIPS rating and consume less power than a popular 32-bit technology – big design advantages

Optimized CPU architecture

- 16-bit CPU core incorporates a 3-stage pipeline
- 86% of instructions execute in one or two clock cycles
- Single-cycle multiplication (HW Math Assist) boosts application performance
- DMA Engine has up to 4 channels for design flexibility

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

Event Link Controller (ELC)

- ELC reduces interrupt processing, saving CPU cycles
- Reductions in interrupts improve real-time performance and reduce program size

Wide operating range without sacrificing efficiency

- RL78 MCUs have widest operating voltage in their class: 1.6V to 5.5V
- Built-in voltage regulator allows RL78-based systems to operate from a 5.0V with the same power consumption over the voltage range
Built-in Features Help Reduce System Cost

High integration of external component features

- With many added features built in, the RL78 family can help you lower system cost and get you to market faster.

High-accuracy on-chip oscillator

- ±1% accuracy over temperature and voltage (-20 to 85°C)*
- ±1.5% accuracy over temperature and voltage (-40 to 85°C)*
- Two pre-set frequencies: 24 MHz and 32 MHz
  - 16/12/8/4/3/2/1 MHz clocks are available using a divider
- Correction register improves clock accuracy
- UART communication is implemented without factory trimming

* RL78/G10: 2% (-20 to 85°C), 3% (-40 to 85°C)
** On-chip Oscillator
The growing RL78 family now contains 18 product groups and over 500 MCUs. Devices provide 1 KB to 512 KB of on-chip flash memory and are produced in 29 package options with from 10 to 128 pins. These low-power MCUs are excellent solutions for a wide range of low-power and battery-operated products and systems used in global consumer, industrial and automotive markets.

**Broad Scalability**

**RL78 MCU Series Portfolio**

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<table>
<thead>
<tr>
<th>Pin/Package</th>
<th>Body Size</th>
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<tbody>
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<td>40QFN</td>
<td>6x6mm</td>
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<td>44QFP</td>
<td>10x10mm</td>
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<td>48QFP</td>
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<td>128QFP</td>
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</table>

Note 1: Some package options are not shown.

Note 2: F12, F13, F14, D1A series are not shown.
# RL78 Family Overview

<table>
<thead>
<tr>
<th>Key Feature, Application</th>
<th>G10</th>
<th>G12</th>
<th>G13</th>
<th>G14</th>
<th>G1A</th>
<th>G1C</th>
<th>G1E</th>
<th>G1G</th>
<th>L12</th>
<th>L13</th>
<th>L1C</th>
<th>I1A</th>
<th>I1B</th>
<th>I1D</th>
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<td>1.6-5.5</td>
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<td>RAM (KB)</td>
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## RL78 Package Options

### Pin-Type: 10-LSSOP
- Size: 4.4 x 3.6 mm
- Pitch: 0.65 mm
- Thickness: 1.45 mm
- Group: G10

### Pin-Type: 16-LSSOP
- Size: 4.4 x 5 mm
- Pitch: 0.65 mm
- Thickness: 1.25 mm
- Group: G10

### Pin-Type: 20-LSSOP
- Size: 6.1 x 6.65 mm
- Pitch: 0.65 mm
- Thickness: 1.40 mm
- Group: G13, F12, F13

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

### Pin-Type: 24-HWQFN
- Size: 4 x 4 mm
- Pitch: 0.65 mm
- Thickness: 0.80 mm
- Group: G12, G13, I1D

### Pin-Type: 25-WFLGA
- Size: 3 x 3 mm
- Pitch: 0.50 mm
- Thickness: 0.76 mm
- Group: G13, G1A

### Pin-Type: 30-LSSOP
- Size: 6.1 x 9.85 mm
- Pitch: 1.40 mm
- Thickness: 1.60 mm
- Group: G12, G13, G14, G1G, I1A, I1D, F12, F13, F14

### Pin-Type: 32-LQFP
- Size: 7 x 7 mm
- Pitch: 0.80 mm
- Thickness: 1.60 mm
- Group: G13, G14, G1A, G1C, F12

### Pin-Type: 32-HWQFN/HVQFN
- Size: 5 x 5 mm
- Pitch: 0.80 mm
- Thickness: 1.60 mm
- Group: G13, G14, G1A, G1C, F12

### Pin-Type: 36-WFLGA
- Size: 4 x 4 mm
- Pitch: 0.65 mm
- Thickness: 1.00 mm
- Group: G13, G14

### Pin-Type: 40-HWQFN
- Size: 6 x 6 mm
- Pitch: 0.80 mm
- Thickness: 1.60 mm
- Group: G13, G14

### Pin-Type: 44-LQFP
- Size: 10 x 10 mm
- Pitch: 0.80 mm
- Thickness: 1.60 mm
- Group: G13, G14, G1A, G1C, L12, F12, F13, F14

### Pin-Type: 48-LFQFP
- Size: 7 x 7 mm
- Pitch: 1.00 mm
- Thickness: 1.60 mm
- Group: G13, G14, G1A, G1C, F12

### Pin-Type: 48-HWQFN/HVQFN
- Size: 7 x 7 mm
- Pitch: 0.80 mm
- Thickness: 1.60 mm
- Group: G13, G14, G1A, G1C, F12

### Pin-Type: 52-LQFP
- Size: 10 x 10 mm
- Pitch: 0.80 mm
- Thickness: 1.60 mm
- Group: G13, G14, L12

### Pin-Type: 64-LQFP
- Size: 14 x 14 mm
- Pitch: 0.80 mm
- Thickness: 1.60 mm
- Group: G13, G14, L12

### Pin-Type: 64-LQFP
- Size: 12 x 12 mm
- Pitch: 0.80 mm
- Thickness: 1.60 mm
- Group: G13, G14, G1A

### Pin-Type: 64-VFBGA
- Size: 4 x 4 mm
- Pitch: 0.40 mm
- Thickness: 0.76 mm
- Group: G13, G1A

### Pin-Type: 64-FLGA
- Size: 5 x 5 mm
- Pitch: 0.65 mm
- Thickness: 1.60 mm
- Group: G13, G14

### Pin-Type: 64-LQFP
- Size: 10 x 10 mm
- Pitch: 0.80 mm
- Thickness: 1.60 mm
- Group: G13, G14, G1A, G1C, L12, F12, F13, F14

### Pin-Type: 64-LQFP
- Size: 8 x 8 mm
- Pitch: 0.80 mm
- Thickness: 1.60 mm
- Group: G13, G14

### Pin-Type: 64-HWQFN
- Size: 9 x 9 mm
- Pitch: 0.80 mm
- Thickness: 1.60 mm
- Group: G13, G14, G1E

### Pin-Type: 80-LQFP
- Size: 14 x 14 mm
- Pitch: 0.80 mm
- Thickness: 1.60 mm
- Group: G13, G14, L13

### Pin-Type: 80-LQFP
- Size: 12 x 12 mm
- Pitch: 0.80 mm
- Thickness: 1.60 mm
- Group: G13, G14, G1E, F13, F14

### Pin-Type: 85-VFLGA
- Size: 7 x 7 mm
- Pitch: 0.80 mm
- Thickness: 1.60 mm
- Group: G13, G14

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

### Pin-Type: 100-LQFP
- Size: 14 x 14 mm
- Pitch: 0.80 mm
- Thickness: 1.60 mm
- Group: G13, G14, G1E, F13, F14

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

---

Note 1: G14 (384, 512KB): Thickness is 1.70mm
Compatibility

RL78 MCUs offer full pin compatibility
- I/O and peripheral pins scale up to provide design flexibility
- Additional I/O capabilities and increased functionality are easily achieved by migrating to larger pin counts
- Peripheral-pin PCB layouts can maintain the same order/position as pin counts increase
- Software code can be reused across the full RL78 family, from 10-pin to 128-pin devices

Flexibility

Peripheral I/O Redirection (PIOR) capability remaps functions to alternate ports
- The RL78 PIOR capability solves conflicts for peripheral I/O pin assignments caused by layout or peripheral pin-sharing constraints
- Peripheral pin functionality is readily optimized by easing function bottlenecks on contested pins
- PIOR capability can help ease a bottleneck, as shown in this example, by remapping to alternate pins

TAU, SAU flexibility for entire RL78 family

The RL78 architecture is a configurable design that delivers flexible timer and serial communication capabilities.

- The TAU has 7 independent operation modes, as well as 3 multiple-channel configurations for making PWM and one-shot pulse outputs
- For example, TAU 4 ch can be configured as follows
  - 2 PWMs with different cycle times
  - 3 PWMs with the same cycle time

<table>
<thead>
<tr>
<th>Independent channel operation</th>
<th>Simultaneous channel operation function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interval timer</td>
<td>One-shot pulse output</td>
</tr>
<tr>
<td>Square wave output</td>
<td>PWM output</td>
</tr>
<tr>
<td>External event counter</td>
<td>Multiple PWM output</td>
</tr>
<tr>
<td>Divider</td>
<td></td>
</tr>
<tr>
<td>Input pulse interval measurement</td>
<td></td>
</tr>
<tr>
<td>Measurement of high-/low-level width of input signal</td>
<td></td>
</tr>
<tr>
<td>Delay counter</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit</th>
<th>Channel</th>
<th>Used as CSI</th>
<th>Used as UART</th>
<th>Used as Simplified I2C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>CSI00</td>
<td>UART0</td>
<td>IIC00</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>CSI01</td>
<td>UART1</td>
<td>IIC01</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>CSI10</td>
<td>UART1</td>
<td>IIC01</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>CSI11</td>
<td>UART1</td>
<td>IIC01</td>
</tr>
</tbody>
</table>
# Safety

## Safety features – built-in hardware for IEC/UL 60730 compliance

<table>
<thead>
<tr>
<th>CRC</th>
<th>RAM</th>
<th>SFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory verification</td>
<td>Parity/write protection</td>
<td>Write protection</td>
</tr>
<tr>
<td>■ High-speed CRC: Entire Flash memory (64 KB/512 μs @ 32 MHz)</td>
<td>■ Parity: Internal reset when parity error generated on Read or Write</td>
<td>■ Write Protection for: Port setting, interrupt setting, clock setting, LVI setting, RAM parity setting</td>
</tr>
<tr>
<td>■ General CRC: Various data (1B/1clock)</td>
<td>■ Write Protection: Select from: 128 B/256 B/512 B</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CPU</th>
<th>CLOCK</th>
<th>ADC</th>
<th>PORT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illegal memory access detection</td>
<td>Stop detection/frequency check</td>
<td>AD function check</td>
<td>I/O function check</td>
</tr>
<tr>
<td>■ Illegal memory access: generates “internal reset”</td>
<td>■ Stop detection: possible to detect by WWDT</td>
<td>■ Self AD function check: possible by changing the inputs between external ADC input pins and external/internal AVref sources, and internal Vref and temperature sensor</td>
<td>■ Read digital output level as input and verify</td>
</tr>
<tr>
<td>■ Trap instruction: generates “internal reset”</td>
<td>■ Frequency check: possible to check by timer function</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Security

### Flash security

RL78 MCUs provide robust protection for code and data stored in flash memory in all three communication modes.

### Encryption/Hash library

Renesas offers AES and SHA libraries for RL78 MCUs to facilitate the development of system security features.

### Noise Immunity

RL78 offers 5V system operation

The 5.0V operation and internal regulator system of RL78 MCUs give the devices inherently high levels of noise immunity, allowing savings in overall system costs.

- Noise Immunity for
  - Analog inputs, Digital I/O
  - CPU, Peripherals
- System designs can eliminate or minimize external noise-reduction filters

---

**Note:** The diagrams and tables are not re-rendered as text. They are intended for visual reference and are not transcribed into a natural text format.
Value Propositions for Various Applications

Motor Control

RL78/G14 and G1G Group

- RL78/G14 and G1G MCUs integrate the Timer RD motor-control timer, as well as ADC, TAU, SAU, ELC functions
- The devices can drive 5V parts without level shifters
- Full pin compatibility is maintained for common peripherals on RL78/G14 and G1G MCUs

Power Tools

- Renesas is renowned for high-quality long-life MCUs
- RL78 is available in multiple packages and scalable for the platform design approach

White Goods

- Integrated safety compliance for white goods (IEC 60730)
- High temperature support
- RL78’s integrated peripherals make it the ideal choice for cost-sensitive white goods

On-chip motor control features

- Three-phase (6ch) synchronous PWM output timer (Timer RD)
- Over-current protection with PGA and comparator
- Functions for controlling BEMF Brushless DC Motors

Motor Control

RL78/G14 and G1G feature integrated motor control timers
- On-chip oscillators with 1% accuracy provide an integrated low-cost solution for timing critical applications

RL78/G14 motor control kit

- The kit allows evaluations of motor control techniques
- Renesas offers royalty-free motor control software
- The MCUs enable field-oriented sensorless vector control
- These kits implement the 3-shunt detection approach
- RL78/G1x can greatly reduce design time and effort to meet IEC60730 compliance requirements

P/N: YRMCKITRL78G14

<table>
<thead>
<tr>
<th>CPU Frequency (max)</th>
<th>G1G</th>
<th>G14</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 MHz</td>
<td></td>
<td>32 MHz</td>
</tr>
<tr>
<td>HOCO</td>
<td>+/-2%</td>
<td>+/-1%</td>
</tr>
<tr>
<td>VDD</td>
<td>2.7V-5.5V</td>
<td>1.6V-5.5V</td>
</tr>
<tr>
<td>Motor timer</td>
<td>Timer RD (48 MHz)</td>
<td>Timer RD (64 MHz)</td>
</tr>
<tr>
<td>2-phase encoder timer</td>
<td>–</td>
<td>Timer RG</td>
</tr>
<tr>
<td>DTC</td>
<td>–</td>
<td>Yes</td>
</tr>
<tr>
<td>Comparator</td>
<td>Yes 0.15 µs max. 8-bit reference</td>
<td>Yes1 1.2 µs max. 3 references (0.76VDD, 0.24VDD, 1.49V)</td>
</tr>
<tr>
<td>PGA</td>
<td>Yes</td>
<td>–</td>
</tr>
<tr>
<td>DAC</td>
<td>–</td>
<td>Yes1 (8-bit)</td>
</tr>
<tr>
<td>Pin count</td>
<td>30-44-pin</td>
<td>30-100-pin</td>
</tr>
<tr>
<td>Data Flash</td>
<td>–</td>
<td>Yes</td>
</tr>
<tr>
<td>Application examples</td>
<td>– Fans</td>
<td>Power tools – DC Motor</td>
</tr>
<tr>
<td></td>
<td>– Power tools</td>
<td>– White goods – RC motor</td>
</tr>
</tbody>
</table>

Note 1: 96KB or higher flash memory size devices only

On-chip motor control features

- Three-phase (6ch) synchronous PWM output timer (Timer RD)
- Over-current protection with PGA and comparator
- Functions for controlling BEMF Brushless DC Motors

Application Notes for motor control

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Document No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor</td>
<td>V/f Control of Induction Motor (RL78/G14)</td>
<td>R01AN2196EJ0100</td>
</tr>
<tr>
<td></td>
<td>Vector control of permanent magnetic synchronous motor using encoder</td>
<td>R01AN1664EJ0100</td>
</tr>
<tr>
<td></td>
<td>Sensorless vector control of permanent magnetic synchronous motor</td>
<td>R01AN1661EJ0100</td>
</tr>
<tr>
<td></td>
<td>120 degrees conducting control of permanent magnetic synchronous motor with hall sensor</td>
<td>R01AN1659EJ0100</td>
</tr>
<tr>
<td></td>
<td>Sensorless 120 degrees conducting control of permanent magnetic synchronous motor</td>
<td>R01AN1660EJ0100</td>
</tr>
<tr>
<td></td>
<td>Inverter control of the single phase induction motor</td>
<td>R01AN1658EJ0100</td>
</tr>
<tr>
<td></td>
<td>120 degrees conducting control of brushless DC motor with hall sensor</td>
<td>R01AN1387EJ0100</td>
</tr>
<tr>
<td>DSP</td>
<td>RL78 Digital Signal Controller Library – Fixed Point and Motor</td>
<td>R01AN1216ES0101</td>
</tr>
<tr>
<td></td>
<td>RL78 Digital Signal Controller Library – Filter</td>
<td>R01AN1665ES0100</td>
</tr>
</tbody>
</table>
Segment Display Applications

RL78/L12, L13 and L1C group

The RL78/L1x series offer an on-chip LCD drive enabling system low power and flexibility.
- Low power LCD drive: As low as 0.68 μA, including 32 kHz and RTC currents
- More segment drive for a smaller package:
  - RL78/L12 up to 39 segments x 4 com
  - RL78/L13 up to 51 segments x 4 com
  - RL78/L1C up to 56 segments x 4 com
- More segments using 8 com mode
- LCD booster voltage is configurable from 3.0V to 5.25V, with 0.15V resolution
- Three control methods can be used: Booster, capacitor split and resistance division
- Drive is generated for both A and B waveform panels
- Segment or I/O functions are selectable for every segment pin

Metering
- RL78 MCUs are ideal for smart metering applications with their lower power active mode and standby mode, including LCD and RTC current

Medical
- RL78 MCUs offer true low-power consumption and their rich features are ideal for portable health and fitness devices.
- Renesas is an active member of the Continua Alliance

Home Automation
- For long battery life and operation down to 1.6V, the RL78 is the top choice

RL78/L1C Human Machine Interface (HMI) solution kit

Built-in segmented LCD display, software touch key, and audio playback functionality make it easy to develop and evaluate HMI for home appliances, healthcare equipment, and other products.

P/N: R0K578L1CD000BR

Low power display solution kit

The RL78 MCU and E Ink’s electronic paper technology provide an extremely low-power, thin, flexible segmented display solution.

P/N: YDBRL78EINK
RL78 for Lighting Applications

Devices in the RL78/I1A product group offer dedicated lighting-communication features and power-stage control capabilities. They can communicate with a host controller for altering lighting intensity and/or color.

- High-resolution PWM timers enable excellent lighting control performance
- Support for the DALI/DMX512 communication standard aids system integration
- Features of the power stage control include the 64 MHz Timer KB, which provides dithering (0.98 nsec quasi resolution), soft-start turn-on, comparator triggered stop, zero-current detection and timer restart options
- Free Windows® based Applilet software facilitates designs for remotely controllable lighting installations
- High temperature support (105°C and 125°C)

RL78 for Metering

RL78/I1B Group

RL78/I1B group offers on-chip 24-bit ∆Σ-type ADC and an LCD drive capability. Their very low power architecture and advanced analog I/O functions are optimized for high precision sensing application with LCD display.

- Low-power features are tailored for meter requirements:
  - 3.3 mA @ 6 MHz CPU and ADC 3 ch operation
  - 0.61 μA standby with 32 kHz and RTC
  - RTC backup mode with BVAT pin
- The 24-bit ADC facilitates data adjustment, as does phase control and high-pass filtering by hardware
- High-accuracy clocks provide better analog accuracy and precise time data
  - 0.05% HOCO calibration by 32 kHz RTC clock
  - 0.975ppm RTC clock compensation

RL78 for USB applications

RL78/G1C Group

RL78/G1C MCUs have USB capabilities that support battery-charging specification standards. They are excellent choices for products such as intelligent USB battery/wall chargers. Their features include the following:

- USB version 2.0, host/function controller
- Full-speed (12 Mbps) and low-speed (1.5 Mbps) support
- Compliant with Battery Charging Specification Revision 1.2 enabling 1.5A charging mode
- Compliant with the 2.1A/1.0A charging mode specified in Apple MFi
- Small packages with 32 to 48 pins

Support for this product group includes the RL78/G1C USB Charger Solution Kit

P/N: R0K578L1CD000BR
**RL78 for CAN Applications**

**RL78/F1x Group**

MCUs in the RL78/F1x group primarily meet the needs of networked products used in automotive markets, including aftermarket accessories. Their CAN functions and high-temperature operation also make them top choices for industrial equipment.

- RL78/F13 and RL78/F14 MCUs have CAN functions
- Operation is supported at temperatures up to 150°C
- Devices have from 8KB to 256KB flash and from 20 to 100 pins
- High reliability is provided by Renesas’ automotive grade quality

---

**RL78 for Sensor Applications**

**RL78/G1A Group**

The RL78/G1A MCU is a G13 base device for industrial sensor applications. It offers enhanced (12-bit) ADC resolution and small package options, including a 25-pin LGA. In the 64-pin package, it provides 28 ADC input channels.

Its other features include the following:

- 12-bit ADC, 3.375 μs, up to 28 channels
- 16 KB to 64 KB Flash memory
- 25LGA, 32QFN, 48QFN, and 64BGA packages

---

**RL78/G1E Group**

High-accuracy sensor systems require more than just an ADC in the front end; many need an amplifier, multiplexer, filters and LDO. The MCUs in the RL78/G1E product group meet those needs. Their OpAmp buffered input channel, signal amplifier and DAC reference are software configurable. These devices accommodate different types of sensors without sacrificing dynamic range and offset-trimming accuracy. Configurable settings for on-chip functions provide long-term calibration flexibility that can be used to compensate for degradations of sensor sensitivity over time.

- SAIC500 and RL78/G1A functions
  - SAIC500 features include a 4 ch MUX, 3 configurable OpAmps, gain adjustment OpAmp, DAC, LDO (variable regulator), and low- and high-pass filters
- Amplitude and offset adjustments that accommodate different types of sensors
- Compensation adjustments for sensor variations
- Long-term drift correction

---

**Table 1: Key features/Application**

<table>
<thead>
<tr>
<th></th>
<th>F12</th>
<th>F13</th>
<th>F14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key feature/Application</td>
<td>Auto</td>
<td>CAN Auto</td>
<td>CAN Auto</td>
</tr>
<tr>
<td>Max speed (MHz)</td>
<td>32</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>Voltage (V)</td>
<td>2.7-5.5</td>
<td>2.7-5.5</td>
<td>2.7-5.5</td>
</tr>
<tr>
<td>Pin</td>
<td>20-64</td>
<td>20-80</td>
<td>30-100</td>
</tr>
<tr>
<td>Flash (KB)</td>
<td>8-64</td>
<td>16-128</td>
<td>48-256</td>
</tr>
<tr>
<td>RAM (KB)</td>
<td>0.5-4</td>
<td>1-8</td>
<td>4-20</td>
</tr>
<tr>
<td>Max temperature option (°C)</td>
<td>85 125</td>
<td>105 125 150</td>
<td>105 125 150</td>
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<td>DMA/DTC (DMA unless otherwise noted)</td>
<td>DTC</td>
<td>DTC</td>
<td>DTC</td>
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<tr>
<td>ELC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comparator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAC (8-bit)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timer RD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAN</td>
<td>1 ch option</td>
<td>1 ch</td>
<td>1 ch</td>
</tr>
</tbody>
</table>

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**Diagram 1: Smart Analog MCU**

- Optimize AFE configuration and SPI characteristics according to environment or situation.
Extensive Renesas Development Ecosystem

**Hardware Tools**

- **Explore**
  - Renesas Promotion Board
  - RL78/G14 RPB Board
    - P/N: YRPBRL78G14
    - RL78 high-performance demo
    - Evaluate and measure the low-power modes
    - PC software included (GUI, drivers)
    - IAR KickStart included
      - (16 KB code limited)
    - Applilet device code generator
  - RL78/G14 Starter Kit
    - P/N: YR0K5104PS000BE
    - Allows full system development
    - LCD Panel for diagnostic connection
    - Program using E1 on-chip debugger
    - C/C++ compiler included
    - Trial e² studio IDE included
    - Applilet device code generator
    - Sample peripheral code

- **Evaluate**
  - Renesas Starter Kit
  - E1 On-chip Debugging Emulator
    - P/N: R0E000010KCE00
    - Universal Renesas on-chip debugger
    - Debugger or Flash programmer interface
    - Single-wire connection to RL78 device
    - Assembler and C source stepping
    - Software and hardware breakpoints
  - IECUBE Full In-circuit Emulator
    - P/N: QB-RL78xxx
    - Trace and break functions
    - Time measurement
    - Real-time RAM monitor function

- **Develop**
  - Emulators: E1 (OCD), IECUBE (Full ICE)
  - Renesas software tool generates device driver code to initialize and use on-chip peripherals
  - Full code generation for IAR EWRL78, GNU GCCRL78, Renesas CS+
  - Integrated project wizard guides user to create a new project
  - Download free at: www.renesas.com/applilet

- **Manufacture**
  - Programmer PG-FP5-EA, Renesas Factory

**IDE/Compiler**

- **IAR Embedded Workbench (EWRL78)**
  - Integrated development environment and optimized C++ compiler for RL78
  - Full C and C++ support, MISRA C compliance checker
  - Project management tools and editor
  - Configuration files for all RL78 devices

- **Renesas e² studio**
  - Based on the popular Eclipse open-source environment
  - Complete IDE supports free GNU and IAR compilers
  - IAR & GNU build phase plug-in support, E1/IECUBE debug phase plug-in support
  - Powerful project management
  - Download free at: am.renesas.com/e²studio

**Code Generator**

- **Applilet**®
  - Royalty-free Windows®-based code generator

- **Micrium**
  - μC/OS-II and μC/OS-III
    - μC/OS-II™ & μC/OS-III™ RTOS
    - Highly efficient and ideal for safety-critical designs

- **CMX SYSTEMS**
  - RTX
    - Fast contest switching time
    - Nested interrupts

- **Free RTOS**
  - Free of charge RTOS for download to deploy RL78 designs
  - Commercial version available as OpenRTOS

- **embOS**
  - Priority controlled RTOS based on zero interrupt latency
  - Optimized for minimum memory consumption in both RAM and ROM

[1: For complete part number, refer to Renesas web site.]

**Real Time OS**

- [Micrium](#)
- [CMX SYSTEMS](#)
- [Free RTOS](#)
- [embOS](#)
**RL78 Development Hardware & Solution Kits**

**CPU Board**
- All the pins available in 2.54 mm pitch for quick implementation to the prototype
- Easy MCU-only power evaluation by simplicity of the board
- Basic components like 32 kHz crystal; reset circuit ready
- Debugging and programming through the connector for E1 and PG-FP5

![CPU Board Image](image)

**Renesas Demo Kit (RDK)**
- RL78 MCU board with integrated debugger (USB powered)
- Sample projects exercising peripherals using sensors, display, audio speaker and on-board Wi-Fi module
- IAR Embedded Workbench for RL78 (16 KB KickStart edition), including compiler and powerful debugger

<table>
<thead>
<tr>
<th>RL78/xxx</th>
<th>CPU Board</th>
<th>Renesas Promotion Boards</th>
<th>Renesas Starter Kits</th>
<th>Renesas Development Kits</th>
<th>Solutions Kit</th>
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</thead>
<tbody>
<tr>
<td>G10</td>
<td>QB-RSF10Y16-TB</td>
<td>YRBPRL78G13</td>
<td>YR0K5010LS000BE</td>
<td>YRDKRL78G13</td>
<td></td>
</tr>
<tr>
<td>G12</td>
<td>QB-RSF1026-A-TB</td>
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<td>–</td>
<td>–</td>
<td>–</td>
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<tr>
<td>G13</td>
<td>QB-RSF100LE-TB</td>
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<td>YR0K5010APS000BE</td>
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<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>G1A</td>
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**Middleware & Software Solutions**

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Getting Started with RL78 MCUs is Easy!

Renesas Electronics has made embedded design with the RL78 microcontroller family as easy as possible.

An extensive ecosystem for RL78, including training, free evaluation boards (Renesas Promotion Boards), low-cost starter kits and multiple application notes, aid the embedded system designer to develop the world’s lowest power designs.

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