Renonias Automotive

RL78 Brushless DC Motor Solution

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Brushless DC motors are achieving ever wider adoption in automobiles.

From mechanical systems to brushed DC motors

Motors are used for a variety of applications in automobiles. They help to make possible a safe, secure, and convenient driving experience while taking environmental considerations into account. Advantages of brushed DC motors include high efficiency and compactness. They can be driven using only a power supply, and they are cheap to manufacture. Many mechanical systems in automobiles have been replaced by systems employing brushed DC motors in order to boost fuel efficiency. However, there are problems associated with brushed DC motors. These include noise caused by brush friction, the generation of sparks and electrical noise, and limited service life due to frictional wear on the brushes.

And then, to brushless DC motors

Brushless DC motor eliminate the above deficiencies of brushed motors. In a brushless DC motor the magnetic force generated by a stator winding circuit drives a permanent magnet attached to the rotor. Current switching, which is performed by the brushes and commutator in a brushed DC motor, is accomplished by means of sensors and electronic circuits. Brushless DC motors only became practical due to advances in peripheral technologies such as semiconductors. In terms of the proportional relationship between current and torque, and between voltage and rotation speed, brushless DC motors are like other DC motors, but their structure is like that of AC motors. They combine the advantages of both. Brushless DC motors are energy efficient, deliver long service life, produce little noise, are compact and lightweight, and do not generate sparks or electric noise. They are gaining widespread adoption in many automotive applications where easy maintenance, quiet operation, compactness, and safety are important.

Accelerating adoption of brushless DC motors with vehicle motor control solutions —— RL78 Family

The RL78/F13 and RL78/F14 microcontrollers are built around the RL78 core, which combines power consumption among the lowest in the world with high processing performance, and they incorporate enhanced calculation capabilities and peripheral functions designed specifically for motor control. They are ideal for brushless DC motor vector control. Intended specifically for automotive use, these microcontrollers enable safe operation of brushless DC motors in applications where reliability is essential. They can operate in environments as hot as Ta = 150°C, allowing them to be combined with the motor as a single unit. Renesas offers simple kit solution products that make it possible for customers new to brushless DC motor control to get started quickly. This contributes to increased development efficiency for customers.
Motors are used extensively in today’s automobiles. The typical automobile contains more than 50 small motors. Nowadays more and more of them are brushless DC motors, especially in units where saving energy, long service life, compactness, and low noise are essential.

RL78 Brushless DC Motor Application Examples
The microcontrollers of the RL78 Family support a variety of body control system applications. They are ideal solutions for customers seeking to reduce power consumption, cut software development man-hours, and reduce system cost. They retain the advanced functionality of the peripheral circuits featured on the earlier 78K0R and R8C Families, allowing customers to make maximum use of existing resources.

The RL78/F13 and RL78/F14 Groups deliver low power consumption while offering support for a variety of motor control and Functional Safety requirements.

- Ultra-low power consumption, improving the environmental friendliness of the system overall.
- An extensive range of product versions sharing the same CPU core and peripheral functions simplifies the task of building a development platform.
- Ability to withstand high temperatures (Ta = 150°C), allowing use in hot environments such as the engine compartment or headlights.
- The ability to reuse software in successive product iterations helps reduce development costs and shorten development time.

**Roadmap**

**Lineup [RL78/F13, F14 Group]**

<table>
<thead>
<tr>
<th>ROM</th>
<th>20 pin</th>
<th>30 pin</th>
<th>32 pin</th>
<th>48 pin</th>
<th>64 pin</th>
<th>80 pin</th>
<th>100 pin</th>
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<tbody>
<tr>
<td>256KB</td>
<td></td>
<td></td>
<td></td>
<td>20</td>
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<td>20</td>
<td>20</td>
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<tr>
<td>192KB</td>
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<td>16</td>
<td>16</td>
</tr>
<tr>
<td>128KB</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>10</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>96KB</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
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<td>6</td>
<td>8</td>
</tr>
<tr>
<td>64KB</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>48KB</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>32KB</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>16KB</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Package**

- SSOP (300mil) 20 pin, 32 pin, 48 pin, 64 pin, 80 pin, 100 pin
- QFN (5x5) 20 pin, 32 pin, 48 pin, 64 pin, 80 pin, 100 pin
- QFP (10x10) 20 pin, 32 pin, 48 pin, 64 pin, 80 pin, 100 pin
- QFP (14x14)

**Specifications [RL78/F14 Group]**

<table>
<thead>
<tr>
<th>Pin count</th>
<th>30</th>
<th>32</th>
<th>48</th>
<th>64</th>
<th>80</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>System clocks</td>
<td>Main clock: 32MHz (Ta = −40 to 105°C), 24MHz (Ta = −40 to 125°C/150°C), High-speed on-chip oscillator: 32MHz (timer RD only: 64MHz), Low-speed on-chip oscillator: 15KHz</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power-on reset, voltage detection circuit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External interrupts</td>
<td>Code flash more than 96KB</td>
<td>9 channels</td>
<td>14 channels</td>
<td>15 channels</td>
<td>16 channels</td>
<td></td>
</tr>
<tr>
<td>Code flash up to 96KB</td>
<td>13 channels</td>
<td>14 channels</td>
<td>16 channels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Key input interrupts</td>
<td>8 channels</td>
<td>6 channels</td>
<td>8 channels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DTC</td>
<td>37 sources</td>
<td>38/44 sources</td>
<td>44 sources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16-bit timer</td>
<td>16-bit (8 channels+4 channels)</td>
<td>16-bit (8 channels+2/8 channels+4 channels)</td>
<td>16-bit (8 channels+2/8 channels+4 channels)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timer RD (sawtooth wave modulation and triangular wave modulation supported)</td>
<td>2 units (6 outputs)</td>
<td>16-bit (8 channels+2/8 channels+4 channels)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial interfaces</td>
<td>CSI/simplified I2C/UART</td>
<td>3 channels / 3 channels / 2 channels</td>
<td>4 channels / 4 channels / 2 channels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multi-master I2C</td>
<td>-</td>
<td>1 channel</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIN/UART</td>
<td>1 channel</td>
<td>2 channels (code flash more than 96KB), 1 channel (code flash up to 96KB)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAN</td>
<td>1 channel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A/D converter (10-bit)</td>
<td>12 channels</td>
<td>10 channels</td>
<td>15/18 channels</td>
<td>19/20 channels</td>
<td>20/25 channels</td>
<td>31 channels</td>
</tr>
<tr>
<td>D/A converter (8-bit)</td>
<td>1 channel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comparator</td>
<td>1 channel (4 inputs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Key Features

- **Conduction Pattern Setting Using Timer RD**
  - Two triangular waves are used to form 3-phase conduction patterns with dead time.
  - The dead time can be specified easily using the offset of the triangular waves.

![Diagram of conduction pattern settings using Timer RD]

- **TRD0 Register Count Value**

  - The image shows a diagram of the TRD0 register count value with various counters and registers.

Tools from Partners

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  ![Diagram of conduction pattern settings using Timer RD]

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Starter Kit

- **Low-Voltage Inverter**
  - T2002B
  - Allows testing using an inverter equivalent to circuits used in actual products.
  - DC12-24V 50VA@24V

- **CPU Board**
  - T5102
  - CPU Board Mounted with R5F10PMFL (RL78/F14)

Waveform Display Tool

- **ICS Series**
  - W1004 ICS++
  - Displays variables of the software used internally by the CPU as temporal waveforms, similar to an oscilloscope, and allows simultaneous changing of variable values. Isolation from the actual device means that the tool can be used while the control software is running. This allows debugging to be performed safely and in far less time, and does not impose a large burden on the user software.
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