

Renesas Automotive

RL78 Brushless DC Motor Solution



RL78

BRUSHLESS DC MOTOR

SOLUTION

KEEP MOVING

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Many mechanical systems in automobiles have been replaced by systems employing brushed DC motors in order to boost fuel efficiency.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 $T_a = 150^{\circ}\text{C}$, allowing them to be combined with the motor as a single unit.

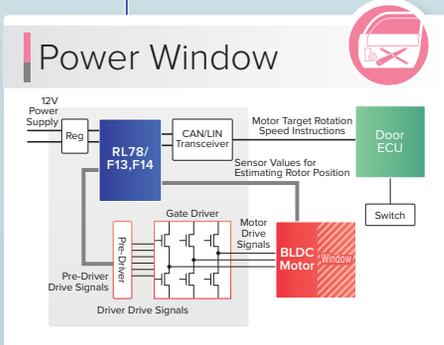
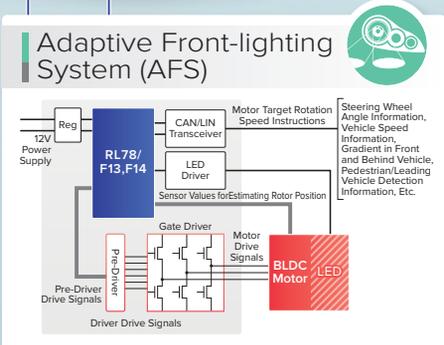
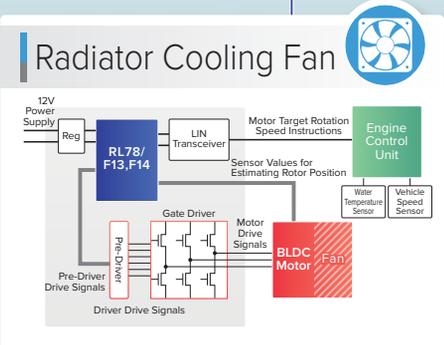
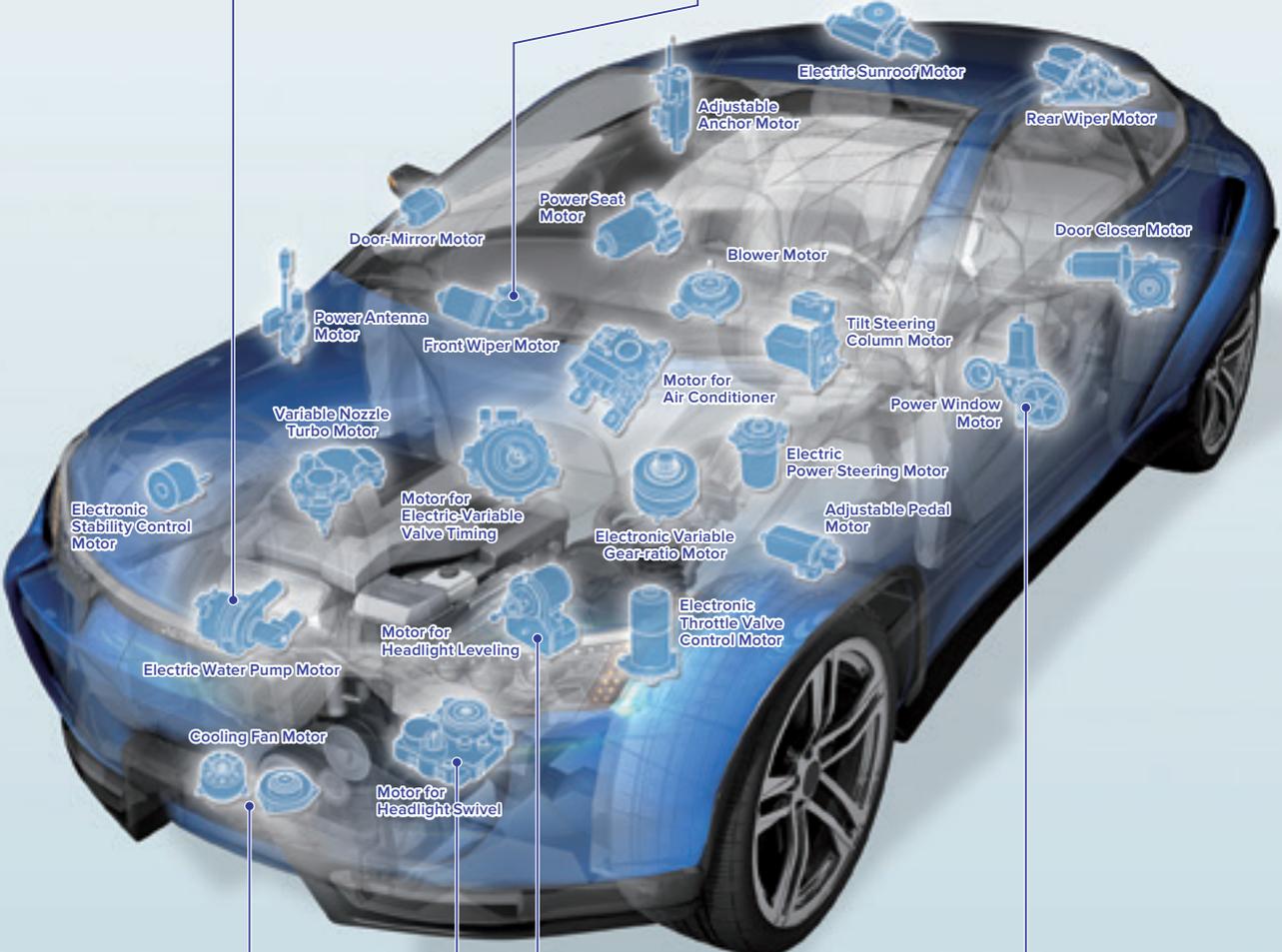
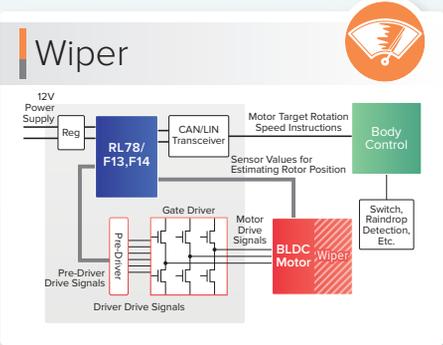
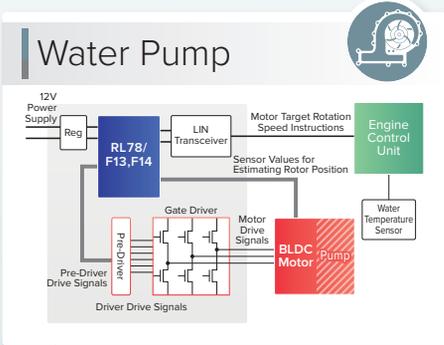
Renesas offers simple kit solution products that make it possible for customers new to brushless DC motor control to get started quickly.

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



KEEP INNOVATING

MCU

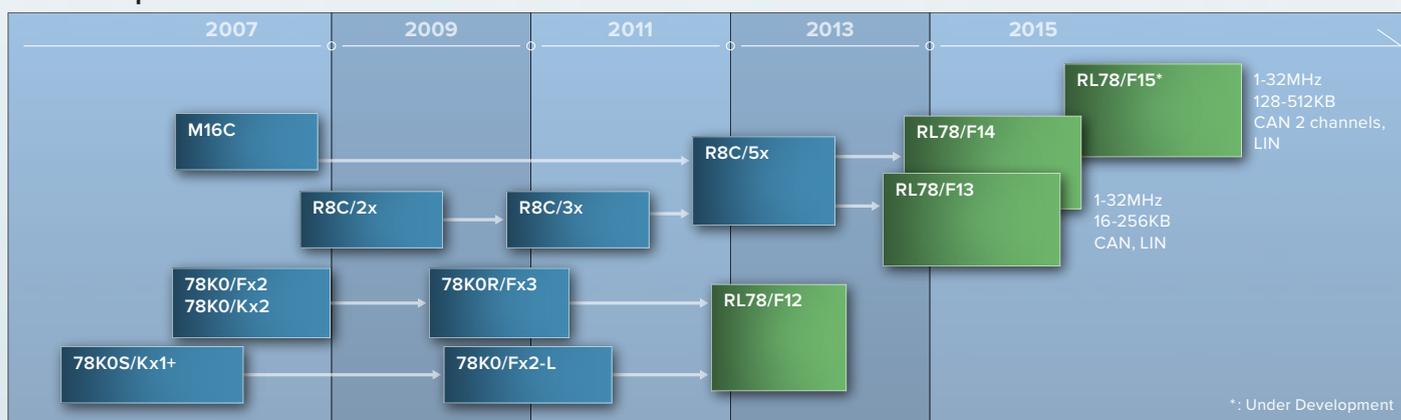
RL78 Family 

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 ($T_a = 150^\circ\text{C}$), 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]

LIN **CAN/LIN** RL78/F13 RAM size (KB)
CAN/LIN RL78/F14 RAM size (KB)

ROM	20 pin	30 pin	32 pin	48 pin	64 pin	80 pin	100 pin
256KB				20	20	20	20
192KB				16	16	16	16
128KB		8	8	8 8 10	8 8 10	8 8 10	10
96KB		6	6	6 6 8	6 6 8	6 6 8	8
64KB	4	4 4 6	4 4 6	4 4 6	4 4 6	4 4 6	6
48KB	3	3 3 4	3 3 4	3 3 4	3 3		
32KB	2	2 2	2 2	2 2	2 2		
16KB	1	1	1	1			
Package	SSOP (300mil)	SSOP (300mil)	QFN (5x5)	QFP (7x7) / QFN (7x7)	QFP (10x10)	QFP (12x12)	QFP (14x14)

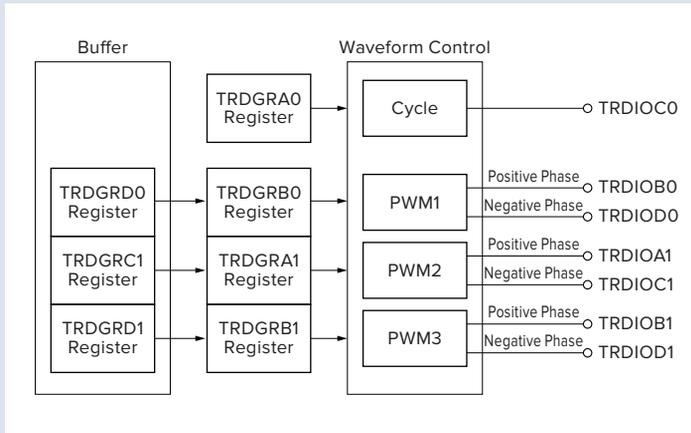
Specifications [RL78/F14 Group]

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

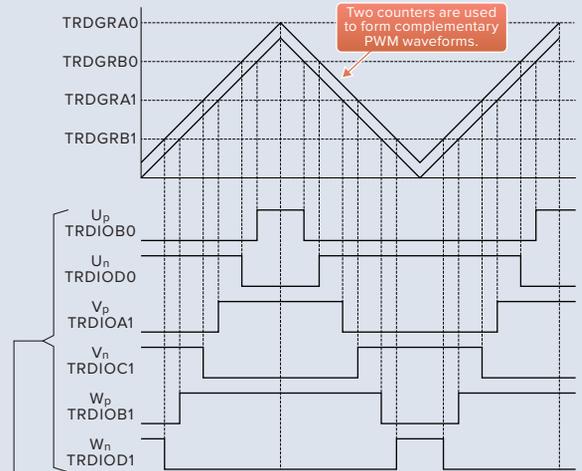
Key Features

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.



TRD0 Register Count Value



Complementary output waveforms with dead time can be generated easily by specifying separate compare registers for U, V, and W.

Note: The timing of duty reloading is selectable between counter peak and trough.

KEEP SUPPORTING

TOOLS FROM PARTNERS

Desk Top Laboratories Inc.

<http://www.desktoplab.co.jp/>

Contact: a Renesas distributor or the sales representative in your area.

The RL78/F13 and RL78/F14 Groups are optimal solutions for customers considering or implementing brushless DC motor control. Sample software is available from Renesas.

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

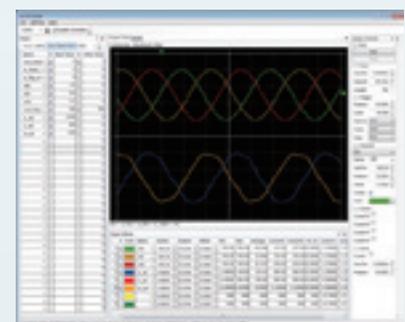


CPU Board Mounted with R5F10PMFL (RL78/F14)

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 this 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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Renesas Electronics Corporation

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