RENESAS
BIG IDEAS FOR EVERY SPACE

MOTOR SOLUTIONS

User-Friendly Motor Control Development Environment
to Shorten Time to Market

2022.07

RENESAS MOTOR SOLUTIONS FOR A GREENER SOCIETY

Renesas offers semiconductor products with low environmental impact throughout their life cycle in the interest of coexistence with the planet and harmony between humankind and the environment.
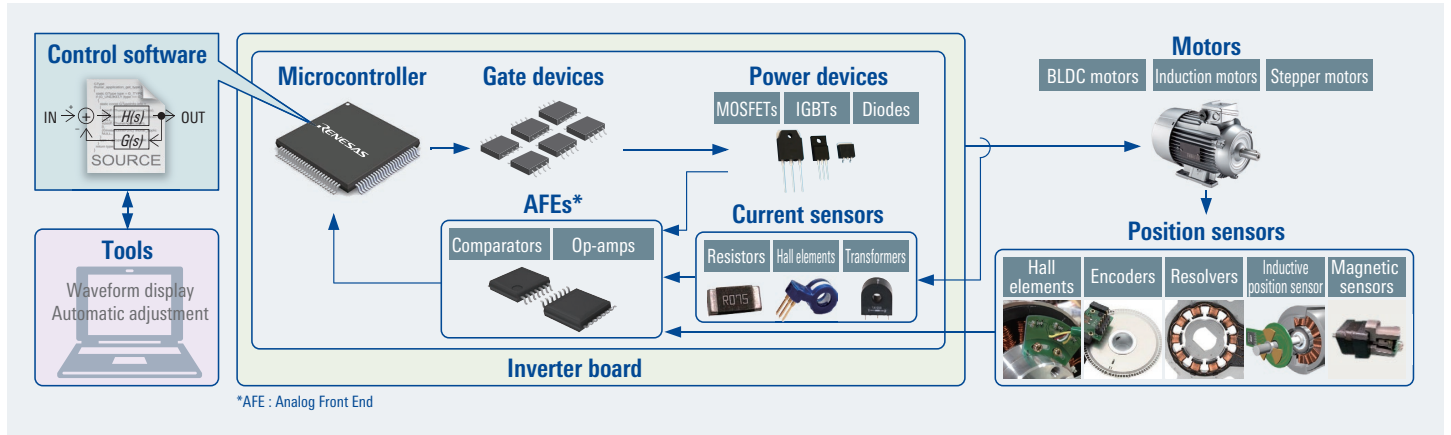
As the scope of motor applications has broadened in recent years, Renesas semiconductor devices for motors have come to be used in a wide variety of fields. Renesas provides customers with optimal motor solutions to help realize a greener society.
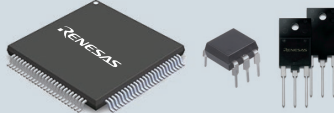
CONTENT

Powerful Support for Customers' Development Efforts
Motor Solutions

Basic Motor Control Configuration

Control software

IN → ⊕ → H(s) → OUT
G(s)
SOURCE

Tools
Waveform display
Automatic adjustment

Microcontroller **Gate devices** **Power devices**
MOSFETs | IGBTs | Diodes

AFEs*
Comparators | Op-amps

Current sensors
Resistors | Hall elements | Transformers

Inverter board

*AFE : Analog Front End

Motors
BLDC motors | Induction motors | Stepper motors

Position sensors
Hall elements | Encoders | Resolvers | Inductive position sensor | Magnetic sensors

Motor Solution Classification

Renesas motor solutions are comprised of devices, hardware, software, and tools.

Devices
- Microcontrollers
- Position sensor
- MOSFETs
- Op-amps, etc.

Hardware
- Solution kit
- Starter kit
- Evaluation kit

Software
- Vector control
  - Speed control, position control
- 120-degree continuity control

Tools
- Integrated development environments
- Motor control development support tools

CS+
e² studio

High Availability and Easy Operation

▶ Tools and software can be downloaded free of charge from the web, and anyone can feel free to use them.

▶ The solution kit can be purchased from an online shop, and you can easily control the motor by using the support tool downloaded from the web.

Motor Control

User-Friendly Motor Control Development Environment to Shorten Time to Market

Solutions | Kits | App Notes | Principles | Recommended Products for Motor Control | Virtual Exhibition | Partners | Contact

https://www.renesas.com/solutions/proposal/motor-control.html

Motor Types and Features

There are various types of motors and the applications used differ according to their features. Renesas offers solutions for permanent magnet synchronous motors (brushless DC motors), stepping motors and induction motors.

Motor Types

The classification of motors is an example, and various other motors exist.

DC Motor
- Brushed motor
- Brushless DC motor (BLDC)

Stepper Motor (Stepping motor)
- Permanent magnet stepper (PM type)
- Variable reactance stepper (VR type)
- Hybrid synchronous stepper (HB type)

AC Motor
- Induction motor (Single phase/Three phases)
- Synchronous motor (SPM, IPM, SynRM)
- Commutator motor

Other Motor
- Ultrasonic motor
- Switched reluctance motor

Motor Features

Brushless DC Motor (BLDC)

A motor that can rotate without using mechanical contacts (brushes) by using an inverter circuit. A permanent magnet is used for the rotor, and the position of the rotor is detected by a position sensor or sensorless position estimation to control the motor drive. Thanks to its features of small size, high output, high rotation speed and long life, it is used in various applications such as home appliances, OA equipment, automobiles and medical equipment.
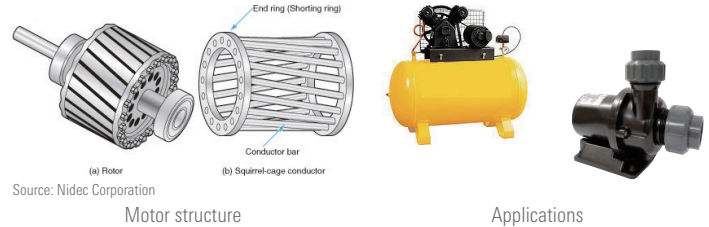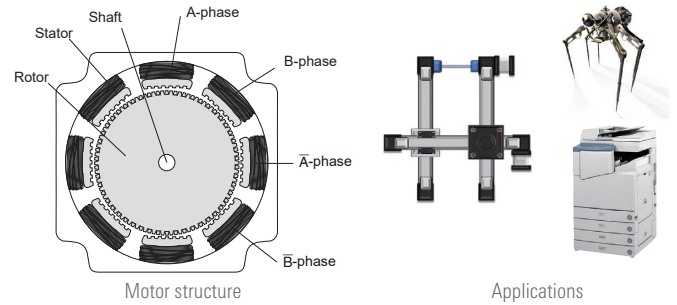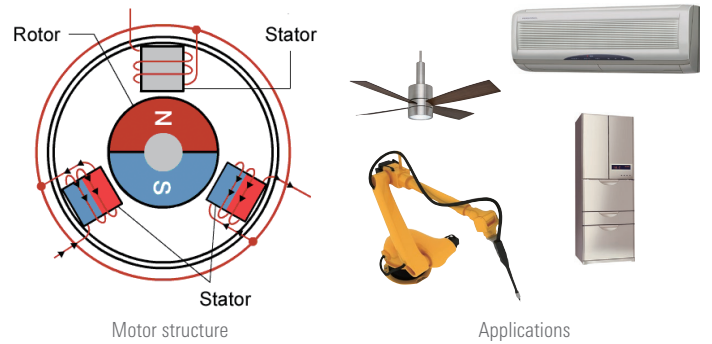
⇒ Renesas offers a variety of brushless DC motor solutions.

Motor structure

Applications

Stepper Motor

A motor that rotates based on the pulse signal input to the drive circuit and is mainly used in industrial robots and printers that require position control. There are PM type that uses a permanent magnet for the rotor, VR type that uses a gear-shaped iron core for the rotor, and HB type that has the characteristics of both PM type and VR type. Generally, open loop control which does not require feedback is used, but an increasing number of more advanced applications use sensor output as feedback.

⇒ Renesas offers solutions for stepping motors employing resolver sensors.

Motor structure

Applications

Induction Motor

It is a motor that rotates by magnetic induction. By directly inputting AC power to the motor, it can rotate without a special drive unit. Vector control using a drive unit such as an inverter enables variable speed operation and high-efficiency operation according to the load. Mainly used in industrial machines such as fans, pumps, conveyors and trains.

Source: Nidec Corporation

Motor structure

Applications

⇒ Renesas offers induction motor solutions for applications such as fans and pumps.
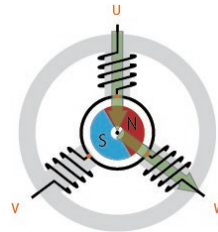
Motor Control Method

Methods for driving motors are introduced below. Renesas provides sample code for 120-degree conducting control (trapezoidal control) and vector control applications. Each sample provides specific features and utilizes a control method suited to a particular application. They can be downloaded from the Renesas website and used as reference when developing your own programs.

120-Degree Conducting Control (Square Wave Control)

Features
- Simple control method with low software load
- It is susceptible to load fluctuation due to the control method that does not detect current
- Precision and efficiency are inferior to vector control

In this control, two of the three coils of the BLDC motor are energized, and six energizing patterns are switched.

Image of energization pattern for 120-degree conducting control

Vector Control

Features
- Advanced control method that detects current and performs fine control
- Highly accurate and efficient control can be realized
- Complex processing is required, and software load is high

In this control, by energizing all three coils and finely controlling the rotating magnetic field, smoother driving is possible compared to 120-degree conducting control. A feature of vector control is that the three-phase AC values are coordinate-converted into two-phase DC values to facilitate control.
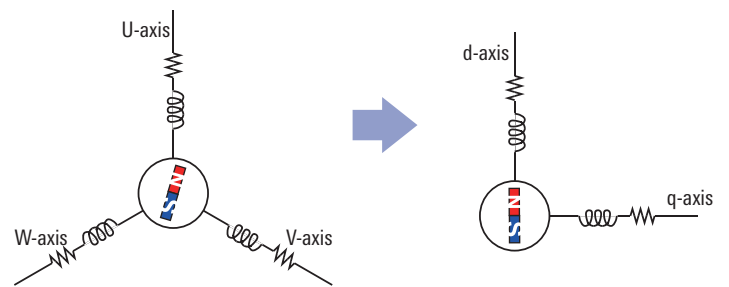
Image of coordinate conversion by vector control (3-phase motor)

Position Sensor of Motor

The required sensor is different between when controlling the "motor speed" like a fan and when controlling the "motor position" like a robot. Each sensor has its own features, and the appropriate sensor is used according to the application. Renesas offers sample code that uses typical types of motor control position sensors, such as Hall sensors, encoders, resolvers, inductive sensors, and magnetic sensors. We also provide sample code for "position sensor-less" control that does not use position sensors.

Hall Sensor

- It is mainly used as an output for switching of energization of 120-degree conducting control with three hall sensors.
- It is also possible to control the motor speed based on the output of hall sensor.
- Because of its low cost, the output may be used for purposes such as functional safety.
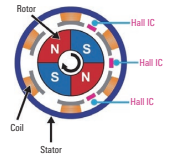
Motor with hall sensor

Encoders and Magnetic Sensors

- There are optical encoders that use light emitting and receiving elements and slits, and magnetic sensors that use a custom IC and a magnet for sensing. Among magnetic sensors, the type of angular information output, such as analog output, digital output, or SPI output, differs depending on the product.
- Wide lineup from inexpensive low resolution to expensive high resolution.
- High resolution encoders are used in robots and AC servos.
- There is also an absolute type that can detect the absolute position.

Encoder   Magnetic sensor

Resolver

- A sensor that detects the position based on the magnetic fluctuation between the rotor and stator.
- It is highly resistant to external factors such as dust, heat, and vibration, and is mainly used in the automotive and industrial fields.
- A resolver digital converter is used to obtain the analog signal at the output of the resolver and use it for control.
- High accuracy is possible by correcting/removing resolver winding error and output signal noise.
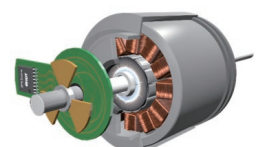
Motor with resolver

Inductive Position Sensors

- The position is detected by means of electromagnetic induction by using a position sensor employing a coil.
- Resistant to external factors such as dust, heat and vibration.
- There are products that do not use magnets for detection, and products that are made smaller by supplementing the coil with a board pattern.

Induction sensor image

Renesas Solutions for Motor Types and Control Methods

Renesas provides kits and motor control sample code for different types of motors and MCUs. Since the sample code available for each kit differs, refer to the appropriate solution in the correspondence table below.

Provided as a Kit by Renesas

Motor Type	Name of Kit Used	Reference Page	Vector Control				120-Degree Conducting Control	
			Sensorless	Encoder	Magnetic Sensor Inductive Sensor	Resolver	Sensorless	Hall
			Speed Control	Speed Control/ Position Control	Speed Control/ Position Control	Speed Control/ Position Control	Speed Control	Speed Control
BLDC	Evaluation System for BLDC Motor + CPU card (P/N: RTK0EMX270S00020BJ)	7	✓	–	–	–	✓	✓
	24V Motor Control Evaluation System for RX23T (P/N: RTK0EM0006S01212BJ)	7	✓	–	–	–	✓	✓
	MCK-RA6T2 (P/N: RTK0EMA270S00020BJ)	8	✓	–	–	–	✓	✓
	Motor Control Evaluation System for RAJ306010 (P/N: RTK0EML2C0S01020BJ)	9	–	–	–	–	✓	✓
	RZ/T2M Motor Solution Kit	10	–	✓	–	–	–	–
Stepping motor	Evaluation System for Stepping Motor with Resolver (P/N: RTK0EMX270S01020BJ)	13	–	–	–	✓	–	–

Renesas Kit + Motor with Sensor

It is necessary for the customer to prepare a motor with sensor.

Motor Type	Name of Kit Used	Reference Page	Vector Control				120-Degree Conducting Control	
			Sensorless	Encoder	Magnetic Sensor Inductive Sensor	Resolver	Sensorless	Hall
			Speed Control	Speed Control/ Position Control	Speed Control/ Position Control	Speed Control/ Position Control	Speed Control	Speed Control
BLDC	Evaluation System for BLDC Motor + CPU card (P/N: RTK0EMX270S00020BJ)	7, 14	–	✓	✓	–	–	–
	24V Motor Control Evaluation System for RX23T (P/N: RTK0EM0006S01212BJ)	7	–	✓	✓	–	–	–
	MCK-RA6T2 (P/N: RTK0EMA270S00020BJ)	8	–	✓	–	–	–	–
	Motor Control Evaluation System for RAJ306010 (P/N: RTK0EML2C0S01020BJ)	8	–	✓	✓	–	–	–

Sample Software/Application Note Provided by Renesas

It is necessary for the customer to prepare a motor and an inverter board.

Motor Type	Name of Kit Used	Reference Page	Vector Control				120-Degree Conducting Control	
			Sensorless	Encoder	Magnetic Sensor Inductive Sensor	Resolver	Sensorless	Hall
			Speed Control	Speed Control/ Position Control	Speed Control/ Position Control	Speed Control/ Position Control	Speed Control	Speed Control
Induction motor	Evaluation System for ACIM	14	✓	–	–	–	–	–

Solutions for Permanent Magnet Synchronous Motor (BLDC Motor)

Renesas offers permanent magnet synchronous motor solutions to support customers' evaluation and development. Supported devices differ, so please select a solution that uses the product you are considering.

Evaluation System for BLDC Motor

A compatible CPU card, sample code, and a development support tool are provided so you can get started with motor control immediately after purchase.

Features
- Motor control kit that supports up to DC48V input.
- Compatible with Renesas Motor Workbench for easy debugging.
- Equipped with overcurrent protection function.
- Various motor control MCUs can be evaluated in combination with an optional CPU card.

Evaluation System for BLDC Motor + CPU card

Kit specifications

Item	Specification
Kit name	Evaluation System for BLDC Motor
Kit model No.	RTK0EMX270S00020BJ
Structure	48V 5A Inverter board for BLDC motor
	BLDC motor (TG-55L-KA)
Inverter specification	■ Rated voltage: 48V ■ Rated current: 5A (continuous) ■ Protect function: Overcurrent detection, others

Available Sample Code for Evaluation		Supported MCUs
120-degree conducting control + speed control (Hall sensor, sensorless)		RX13T, RX23T, RX24T
Vector control + speed control	Encoder, sensorless, magnetic sensor, inductive sensor	RX13T, RX23T, RX24T, RX24U, RX66T, RX72T, RX72M, RA6T1*¹
	Resolver	RX23T, RX24T, RX66T, RX72T, RX72M
Vector control + position control	Encoder, magnetic sensor, inductive sensor	RX13T, RX23T, RX24T, RX24U, RX66T, RX72T, RX72M, RA6T1*¹
	Resolver	RX23T, RX24T, RX66T, RX72T, RX72M

*1: Magnetic sensors and inductive sensors not supported.

Supported Devices

MCU: RX13T, RX23T, RX24T, RX24U, RX66T, RX72T, RX72M, RA6T1
Gate Driver: HIP4086ABZT
MOSFET: RJK1054DPB, RJK0854DPB
Regulator: ISL9001AIRNZ

Overall Structure

Emulator
(Sold separately)
CPU card
(Sold separately)
Renesas Motor Workbench
Motor
Inverter board

* A kit that includes the RA6T1 CPU card in this inverter board is also available. "Motor Control Evaluation System for RA Family - RA6T1 Group"

24V Motor Control Evaluation System for RX23T

Production discontinued.

Motor solution that includes CPU card. A learning kit which is the basis of the Evaluation System for BLDC Motor allows you to try various control methods.

Features
- Many CPU cards are made available, enabling motor control in various MCUs.
- Compatible with Renesas Motor Workbench for easy debugging. Various sample software are available.
- A variety of sample code is available.
  - Compatible with sample code for RL78/G1F 1-shunt vector control and sensorless 120-degree conducting control with initial position detection function.
  - Supports vector control sample code and application note using RX24T magnetic sensor.
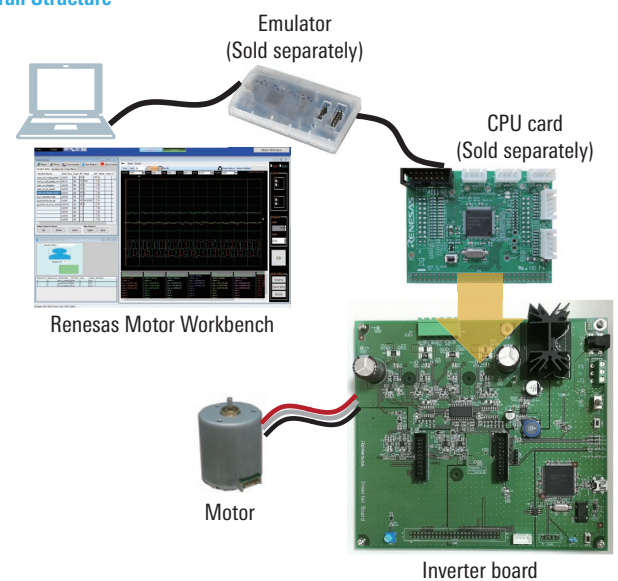
Supported Devices

MCU: RL78/G1G, RL78/G1F, RL78/G14, RL78/G1M, RX13T, RX23T, RX24T, RX24U, RX66T, RX72T
MOSFET: N0602N-S19-AY

24V Motor Control Evaluation System for RX23T

Kit specifications

Item	Specification
Kit name	24V Motor Control Evaluation System for RX23T
Kit model No.	RTK0EM0006S01212BJ
Structure	24V 2A Inverter board for BLDC motor
	RX23T CPU card
	BLDC motor (TG-55L-KA)
Inverter specification	■ Rated voltage: 24V ■ Rated current: 2A (continuous) ■ Protect function: Overcurrent detection, others

Sample Software	Supported MCUs
120-degree conducting control + Speed control (Hall, Sensorless)	RL78/G1M, RL78/G1G, RL78/G14, RL78/G1F, RX23T, RX24T
Vector control + Speed control (Encoder, Sensorless, Magnetic sensor*²)	RL78/G1F*¹, RX13T*¹, RX23T, RX24T, RX24U, RX66T, RX72T, RA6T1
Vector control + Position control (Encoder, Magnetic sensor*²)	RX23T, RX24T, RX24U, RX66T, RX72T, RA6T1

*1: Sensorless only.
*2: Compatible with RX24T only.

Solutions for Permanent Magnet Synchronous Motor (BLDC Motor)

MCK-RA6T2

This motor solution includes a CPU board, inverter board, and communication board. Sample code and a development support tool are provided so you can get started with motor control immediately after purchase.

Features
- Equipped with onboard debugger for RA6T2 flash programming.
- Supports 1-shunt and 3-shunt current detection.
- Overcurrent detection function.
- Supports the motor control development support tool "Renesas Motor Workbench" for easy debugging.
- Use of a communication board provides electrical isolation from the PC for safe evaluation and debugging of motor control applications.


MCK-RA6T2

Kit specifications

Item	Specification
Kit name	MCK-RA6T2
Kit model No.	RTK0EMA270S00020BJ
Structure	48V 10A inverter board for BLDC motor (MCI-LV-1)
	RA6T2 CPU board (MCB-RA6T2)
	Communication board (MC-COM)
	BLDC motor (R42BLD30L3 manufactured by Moons' Industries)
Inverter specification	■ Rated voltage: 48V ■ Rated current: 10A (continuous) ■ Protect functions: Overcurrent detection, etc.

Supported Devices
MCU: RA6T2
Gate Driver: ISL89401AR3Z
MOSFET: RJK1054DPB

Regulator: ISL9001AIRNZ,
ISL97656IRTZ,
ISL80505IRAJZ
Opamp: ISL28191FHZ

Overall Structure
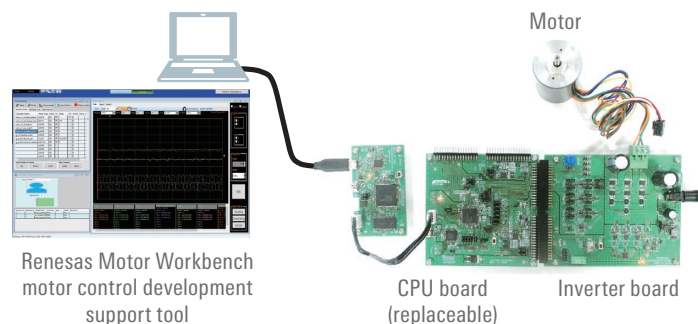
Renesas Motor Workbench motor control development support tool

CPU board (replaceable)

Inverter board

Motor

MCI-LV-1

When combined with separately available CPU boards, this BLDC motor drive inverter board kit can be used to evaluate a variety of motor control MCUs.

Features
- Supports 1-shunt and 3-shunt current detection.
- Overcurrent detection function.
- Includes BLDC motor.

Kit specifications

Item	Specification
Kit name	MCI-LV-1
Kit model No.	RTK0EM0000S04020BJ
Structure	48V 10A BLDC motor inverter board
	BLDC motor (R42BLD30L3 manufactured by Moons' Industries)
Inverter specification	■ Rated voltage: 48V ■ Rated current: 10A (continuous) ■ Safety functions: Overcurrent detection, etc.

Supported Devices
Gate Driver: ISL89401AR3Z
MOSFET: RJK1054DPB

Regulator: ISL97656IRTZ
Opamp: ISL28191FHZ

MCB-RA6T2

When combined with a separately available inverter board, this CPU board enables evaluation of BLDC motor control applications utilizing the RA6T2.

Features
- Equipped with onboard debugger for RA6T2 flash programming.
- Supports 2-motor control.
- Supports signal input from Hall sensors, encoders, and inductive position sensors.

Kit specifications

Item	Specification
Kit name	MCB-RA6T2
Kit model No.	RTK0EMA270C00000BJ
Compatible inverter board	MCI-LV-1 (RTK0EM0000S04020BJ)

Supported Devices
MCU: RA6T2
Regulator: ISL9001AIRNZ

MC-COM

The communication board for serial communication with a Renesas MCU. It provides an electrically isolated environment to enable safe evaluation and debugging of motor control applications.

Features
- Supports the motor control development support tool "Renesas Motor Workbench".
- CPU board by manufacturers other than Renesas can be used by embedding code from libraries supported by Renesas Motor Workbench in the user's motor control software.

Kit specifications

Item	Specification
Kit name	MC-COM
Kit model No.	RTK0EMXC90S00000BJ
Isolation device used	Si8622BC-B-IS (Skyworks Solutions Inc.) or ISO7421FED (Texas Instruments)
Compatible CPU boards	RX13T/23T/24T/24U/66T/72T/72M CPU Card RA6T1 CPU Card MCB-RA6T2

Supported Devices
MCU: RX72N
Regulator: ISL80505IRAJZ

Solutions for Permanent Magnet Synchronous Motor (BLDC Motor)

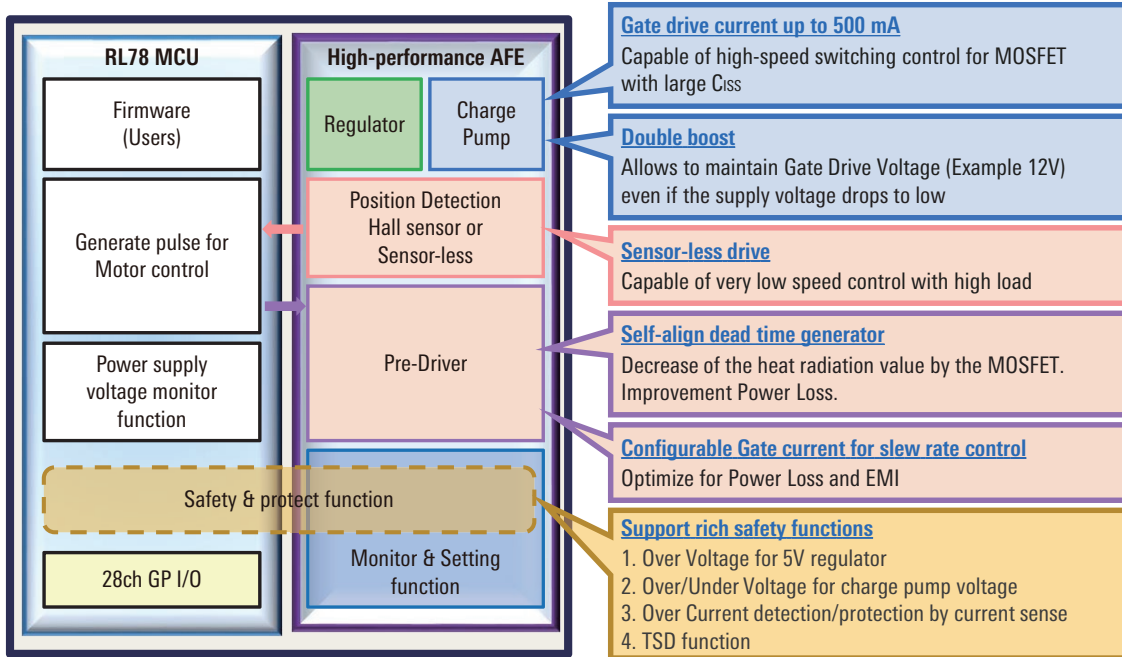## Motor Control Evaluation System for RAJ306010

Easy to start motor evaluation with Renesas evaluation motor and sample code.

Features
- System miniaturization [Board size reduction by 50%]
- Motor control evaluation kit supports DC: 24V
- Easy development environment for BLDC motor

Motor Control Evaluation System
for RAJ306010

RL78 MCU
- Firmware (Users)
- Generate pulse for Motor control
- Power supply voltage monitor function
- Safety & protect function
- 28ch GP I/O

High-performance AFE
- Regulator
- Charge Pump
- Position Detection Hall sensor or Sensor-less
- Pre-Driver
- Monitor & Setting function

Gate drive current up to 500 mA
Capable of high-speed switching control for MOSFET with large C_{ISS}

Double boost
Allows to maintain Gate Drive Voltage (Example 12V) even if the supply voltage drops to low

Sensor-less drive
Capable of very low speed control with high load

Self-align dead time generator
Decrease of the heat radiation value by the MOSFET. Improvement Power Loss.

Configurable Gate current for slew rate control
Optimize for Power Loss and EMI

Support rich safety functions
1. Over Voltage for 5V regulator
2. Over/Under Voltage for charge pump voltage
3. Over Current detection/protection by current sense
4. TSD function

Kit specifications

Item	Specification
Kit name	Motor Control Evaluation System for RAJ306010
Kit model No.	RTK0EML2C0S01020BJ
Structure	24V Inverter board for BLDC motor
	BLDC motor (TG-55L-KA)
Inverter specification	■ Rated voltage: 24V ■ Rated current: 420mA (RMS) Use included motor

Sample Software	Supported Products
120-degree conducting control (Hall)	RAJ306010
120-degree conducting control + Speed control (Hall)	RAJ306010
120-degree conducting control + Speed control (Sensorless)	RAJ306010
180-degree conducting control + Speed/position control (Encoder)*1	RAJ306010

*1: Please prepare a motor with an encoder separately.

Please contact us via the web for kits that can be used with RAJ306001.

Supported Devices

Part No.	Package	Operating Voltage (V)	Applications
RAJ306010GNP *2	P-HTQFN64 (8mm × 8mm) [terminal compatible]	6 to 42V (LiB: 2 to 10 Cell)	Power tool (36V), Gardening tool, Cord-less vacuum cleaner (8 to 10 cell), Cooling-fan (36V), etc.

*2: Ta: −40 to +85°C RAJ306001GNP, RAJ306010GNP   Ta: −40 to +105°C RAJ306001ZGNP, RAJ306010ZGNP

Solutions for Permanent Magnet Synchronous Motor (BLDC Motor)

RZ/T2M Motor Solution Kit

✓ Motor position and speed control software is available to enable initial evaluation when developing equipment incorporating industrial motors.
✓ Circuit diagrams are available in addition to software that runs on-board and PC software to help reduce the time required for development.

Features
- Ability to combine RZ/T2M $\Delta\Sigma$ interface and Renesas $\Delta\Sigma$ modulator for high-precision current sensing.
- A current sensing reference circuit for the motor's U-, V-, and W-phase lines and a sample program are available.
- Supports incremental and absolute encoders (A-format only). Support is planned for a variety of absolute encoders (BiSS-C, HIPAER FACE DSL, Endat2.2, and FA-CODER).
- A servo control sample program that operates via an industrial Ethernet link (EtherCAT, CiA402) is available.
- The board is populated with the RX72N and a monitoring IC, and a reference circuit is provided for a functional safety system implementing redundant monitoring functionality using the RZ/T2M and RX72N.
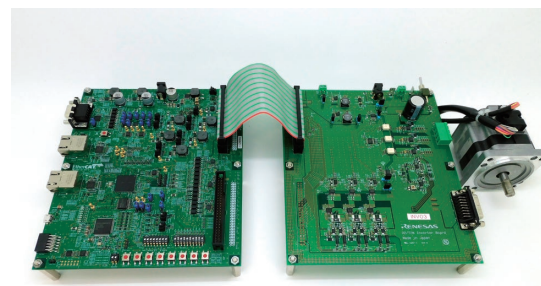
Available for free rental starting in June 2022. Please contact a Renesas Electronics distributor or sales office for details.

Kit specifications

Item	Specification	
Kit name	RZ/T2M Motor Solution Kit	
Structure	RZ/T2M motor solution board	
	• RZ/T2M controller board	
	• Low-voltage single-shaft drive inverter board	
	Brushless DC motor (FH6S20E-X81) (with incremental encoder)	
Board specifications	Rated voltage	24V DC
	Rated current	2A (effective value)
	Current detection	Current transducer, $\Sigma\Delta$ modulator (RV1S9353A)
	Safety functions	Overcurrent detection, bus voltage detection
	Position detection	Incremental/absolute encoder
	Communication functions	2 Ethernet ports, CAN, UART, USB
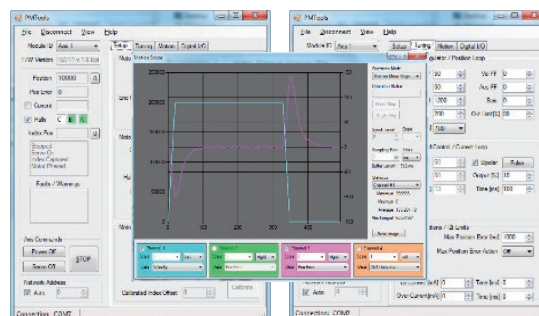
Motion Control Utility

General Configuration

Hardware	Controller board
	Inverter board
	BLDC motor (with incremental encoder)
Software	Sinusoidal Vector Control w/ encoder and Delta Sigma Modulator*
	PC software (Motion Control Utility)
Documentation	Startup Manual
	Motor Solution Board Hardware Manual
	Circuit diagrams, Gerber data, BOM list

* Supports incremental and absolute encoders (presently A-format only).

Supported Devices

Category	Part No.	Key Features
MPU/MCU	RZ/T2M	Arm®-based High-end 32-bit MPU, Real-time control + Industrial Ethernet, FuSa
	RX72N	32-bit MCU with Enhanced DSP, FPU and CTSU
Analog	RV1S9207A	0.6A Output Current, High CMR, IGBT Gate Drive, Photocoupler
	RV1S9353A	Optically Isolated $\Delta\Sigma$ Modulator
	ISL3178	High ESD Protected RS-485/RS-422 Transceivers
Power	ISL80030	2.7V to 5Vin, 3A Sync Buck
	ISL8117	Synchronous Step-Down PWM Controller

Solutions for Permanent Magnet Synchronous Motor (BLDC Motor)

Recommended Products

MCUs and MPUs

Part No.	Operating Frequency	Key Features
RL78/G1M	20MHz	8-bit MCU, 5V Operation, Less pin package, Specialized for 120-degree conduction control
RL78/G1G	24MHz	16-bit MCU, 5V operation, Less pin package
RL78/G14	32MHz	16-bit MCU, 5V operation, Less pin package, Various line up
RL78/G1F	32MHz	16-bit MCU, 5V operation, Less pin package, Built-in comparator and PGA[*2]
RX13T	32MHz	32-bit MCU, FPU[*1], 5V operation, Built-in PGA[*2]
RX23T	40MHz	32-bit MCU, FPU[*1], 5V operation
RX24T	80MHz	32-bit MCU, FPU[*1], 5V operation, Built-in PGA[*2], 2 motor control
RX24U	80MHz	32-bit MCU, FPU[*1], 5V operation, Built-in PGA[*2], 2 motor control
RX66T	160MHz	32-bit MCU, FPU[*1], 5V operation, Built-in PGA[*2,3], 4 motor control, Security module
RX72T	200MHz	32-bit MCU, FPU[*1], 5V operation, Built-in PGA[*2,3], Built-in TFU[*4], 4 motor control, Security module
RX72M	240MHz	32-bit MCU, Double-precision FPU support,[*1] Built-in TFU,[*4] Security function, EtherCAT support
RA6T1	120MHz	32-bit MCU, Arm Cortex-M4 Processor, FPU[*1], Built-in PGA[*2,3], 2 motor control, Security module
RA6T2	240MHz	32-bit MCU, Arm Cortex-M33 Processor, FPU[*1], Built-in PGA[*2,3], 2-motor control, Built-in TFU[*4], Security module
RZ/T2M	800MHz	32-bit MCU, Arm Cortex-R52 Processor, Built-in FPU, Absolute encoder interface support, Built-in TFU[*4]

*1: Floating Point Unit
*2: Programmable Gain Amplifier
*3: Pseudo-Differential PGA
*4: Arithmetic Unit for Trigonometric Functions

Motor control IC (Integrated product of MCU and gate driver)

Part No.	Operating Frequency	Key Features
RAJ306010	32MHz	Built-in RL78/G1F, gate driver (6 to 42V)

Analog, Power devices

Category	Part No.	Key Features
MOSFET	N0602N-S19-AY	Nch Power MOSFET, 60V/100A, $R_{DS(on)}$ = 4.6 m
	RJK0854DPB	Nch Power MOSFET, 80V/25A, $R_{DS(on)}$ = 13 mΩ max, surface-mount device (LFPAK)
	RJK1054DPB	Nch Power MOSFET, 100V/20A, $R_{DS(on)}$ = 22 mΩ max, surface-mount device (LFPAK)
	RJK1003DPN-A0	Nch Power MOSFET, 100V/50A, $R_{DS(on)}$ = 11 mΩ max, lead-insertion device (TO-220)
	UPA3753GR	Nch Dual Power MOSFET, 60V/5A, $R_{DS(on)}$ = 56 mΩ max
Gate Driver	HIP4086	80V, 500mA, 3-Phase MOSFET Driver
	HIP2211	100V, 3A Source, 4A Sink, High Frequency Half-Bridge Drivers with HI/LI Input
	ISL89401	100V, 1.25A Peak, High Frequency Half-Bridge Drivers *Production discontinued.
Regulator	ISL9001AIRNZ	2.3 to 6.5V operation, high PSRR: 90dB@1kHz, low current consumption
	ISL9005AIRNZ	2.3 to 6.5V operation, high PSRR: 75dB@1kHz, low current consumption
	ISL80505IRAJZ	High Performance 500mA LDO
	ISL97656IRTZ	2.3 to 6.5V operation, high PSRR: 75dB@1kHz, low current consumption
Opamp	ISL28191FHZ	Single Supply Ultra-Low Noise, Low Distortion Rail-to-Rail Output, Op Amp
RS-485/RS-422	ISL32173EFVZ	RS-485/RS-422 receiver, 3.0 to 5.5V operation
	ISL32177EFRZ	RS-485/232 receiver, 3.0 to 5.5V operation, ±16.5kV ESD
	ISL3159E	RS-485/RS-422 transceiver, 3.0 to 5.5V operation, fail-safe
	ISL8485E	RS-485/RS-422 transceiver, 3.0 to 5.5V operation
RS-422	ISL32179EFRZ	RS-422 transmitter, 3.0 to 5.5V operation, low current consumption
RS-485/RS-232	ISL41387IRZ	RS-485/232 transceiver, ±15kV ESD

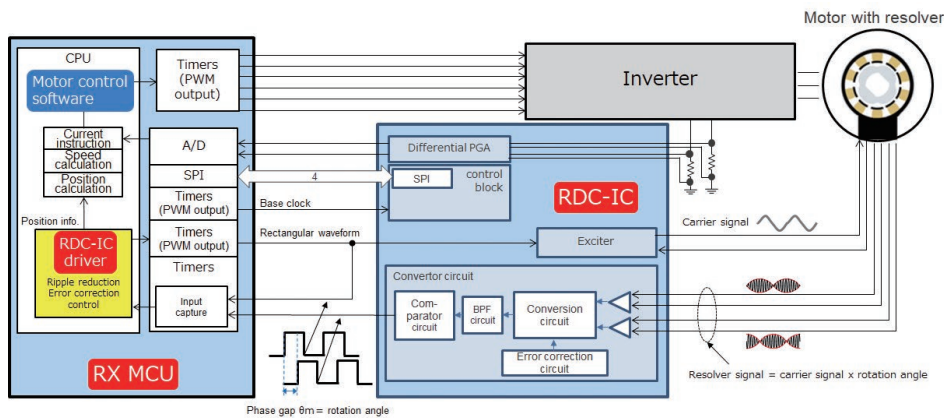# Solutions for Stepping Motor

Resolver motor control solutions featuring superlative cost performance

Resolver Motor Control Solutions

These resolver-based motor control solutions are motor control systems for industrial and consumer applications realized by combining resolver-to-digital converter (RDC) ICs and RX Family microcontrollers (MCUs).It is possible to easily control a resolver-based stepping motor or brushless DC motor using the driver software of the microcontroller. Solution kits, sample code, development support tools, and application notes for motors with resolvers are provided, so motor control using resolvers can be started immediately.

Features
- High-precision motor control is possible even in the harsh environments with heat, dust, or vibration.
- Realize high-precision control at low cost using a new type of resolver control with higher cost performance.
- Resolver signal gain, phase, and angle error are automatically corrected through the driver API that can be used in combination with an RX MCU to achieve high precision.

System configuration

- In resolver-based motor control solutions, the RDC IC and RX MCU process signals from the resolver as angle information, and the RX MCU controls the motor. A dedicated driver for the RDC IC is provided on the RX MCU, and resolver processing can be easily performed using the API.
- Using a portion of the MCU functions makes it possible to simplify the RDC IC and thereby lower its cost.

Motor Control Solutions for Stepping Motors with Resolvers
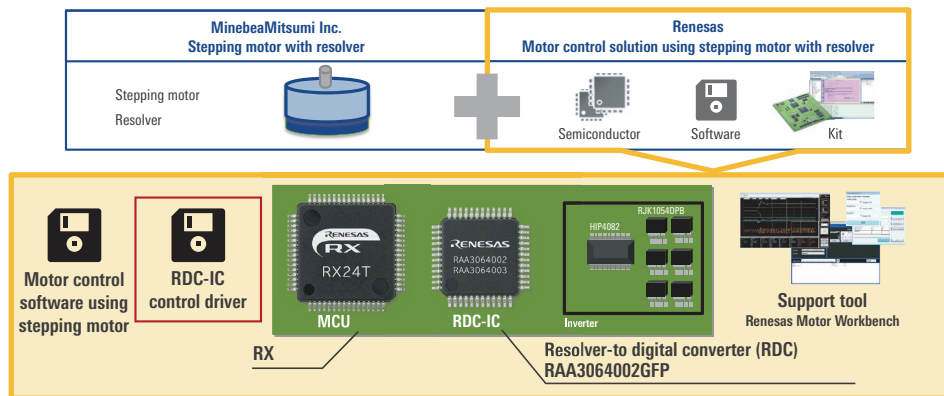
- Stepping motors with resolvers and resolver motor control solutions developed by collaboration between MinebeaMitsumi Inc. and Renesas make it possible to servo control the stepping motor which is normally controlled by the open loop.
- This solution realizes many advantages such as low noise, low vibration, low power consumption and maximization of motor torque.
- ICs, software, development kits, and development support tools for resolver control and motor control are available.

Solution Contents

Stepping motor with resolver: New motor manufactured by MinebeaMitsumi Inc.
RX24T/RX66T/RX72T/RX72M: MCU for motor control
Resolver-to-digital converter: IC that converts resolver output into digital signal
Solution kit: All items necessary for controlling a stepping motor with resolver are provided
Support tool: Development support tool essential for motor control debugging

Solutions for Stepping Motor

Evaluation System for Stepping Motor with Resolver

Evaluation System for Stepping Motor with Resolver

Kit specifications

Item	Specification
Kit name	Evaluation System for Stepping Motor with Resolver
Kit model No.	RTK0EMX270S01020BJ
Structure	48V 2A Inverter board for stepping motor
	RX24T with RDC IC CPU card
	Stepping motor with Resolver (Minebea Mitsumi)
Inverter specification	■ Rated voltage: 48V ■ Rated current: 2A (RMS) ■ Detect function: Phase current, Bus voltage ■ Protect function: Overcurrent protection

Sample Code	Supported MCUs
Vector control + Speed control (Resolver)	RX24T, RX66T, RX72T, RX72M
Vector control + Position control (Resolver)	RX24T, RX66T, RX72T, RX72M

■ Supports RS485, CAN, pulse train command, general-purpose input/output for external device communication as the I/F specification of the kit.

■ Equipped with on-board emulator circuit (flash programming circuit).

Recommended Products

MCUs

Part No.	Operating Frequency	Key Features
RX24T	80MHz	32-bit MCU, FPU[*1], 5V operation, PGA[*2], 2 motor control
RX66T	160MHz	32-bit MCU, FPU[*1], 5V operation, PGA[*2,3], 4 motor control, Security module
RX72T	200MHz	32bit MCU, FPU[*1], 5V operation, PGA[*2,3], Built-in TFU[*4], 4 motor control, Security module
RX72M	240MHz	32-bit MCU, Double precision FPU[*1], Built-in TFU[*4], Security module, EtherCAT® compatible

*1: Floating Point Unit
*2: Programmable Gain Amplifier
*3: Pseudo-Differential PGA
*4: Arithmetic Unit for Trigonometric Functions

Analog, Power devices

Category	Part No.	Key Features
RDC-IC	RAA3064002GFP (85°C) RAA3064003GFP (105°C)	Single-phase induced/Two phase output Rectangle waveform 5/10/20kHz, 2.5Vp-p
Motor Driver	HIP4082IBZT	80V, 1.25A Peak Driver
MOSFET	RJK0854DPB	Nch Power MOSFET, 80V/25A, $R_{DS(on)}$ = 13 mΩ max, surface-mount device (LFPAK)
	RJK1054DPB	Nch Power MOSFET, 100V/20A, $R_{DS(on)}$ = 22 mΩ max, surface-mount device (LFPAK)
RS-485/RS-422	ISL3156E	RS-485/RS-422 transceiver, 4.5 to 5.5V operation, fail-safe

Solutions for AC Induction Motor

Three-phase induction motor solution provides inverter control software to be embedded in a motor control MCU. By providing an inverter control software with a high level of development difficulty, you can easily and reasonably develop a customer-specific inverter.
* This solution uses an inverter board made by a partner and does not provide a kit from Renesas.

Evaluation System for ACIM

Renesas can provide CPU cards, sample code, application notes, development support tools, and can control induction motors in combination with partner-made inverter boads.

Features
- Equipped with speed sensorless vector control function can remove speed sensor to reduce BOM cost and improve reliability.
- Compatible with Renesas Motor Workbench (motor control development support tool), for easy debugging.
- Built-in over current/over voltage/over temperature protection function, enables safe evaluation.
- Various motor control MCUs can be evaluated in combination with an optional CPU card.
- High voltage inverter board is compatible with AC85 to 265Vrms input(Need to be purchased separately from Desk Top Lab Co.,Ltd).

Evaluation Environment Specifications

Item	Specification
Structure	T1102 (Inverter board made by Desk Top Laboratories Inc.)
	RX13T CPU card, RX66T CPU card
Inverter specification	■ Rated voltage: AC 85 to 265V ■ Rated current: 15A (RMS) ■ Protect function: Overcurrent protection, others

Sample Software	Supported MCUs
Vector control + Speed control (Sensorless)	RX13T, RX66T

Supported Devices
MCU: RX13T, RX66T

Overall Structure

Renesas Motor Workbench

Emulator (Sold separately)

CPU card

ACIM

Inverter board made by Desk Top Laboratories Inc. (T1102)
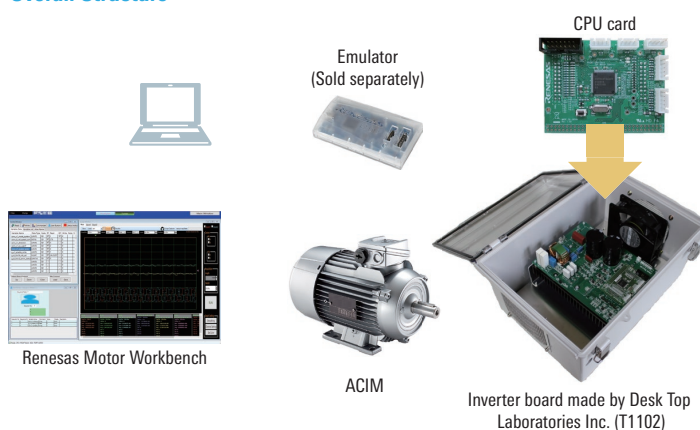
Solutions Using Magnetic Sensors

Motor Control with Magnetic Sensor

A motor control solution for applications using a BLDC motor with a magnetic sensor.
Renesas have released sample software and application notes that can correct the sensor output, which can be used as a reference for motor control using magnetic sensors.
Renesas does not supply the BLDC motor with magnetic sensor used in this solution.

Features
- Sample code and application notes supporting magnetic sensors with analog output, digital output, and SPI output are provided.
- The sample code implements an error correction function for analog output signals.
- Compatible with Renesas Motor Workbench, a motor control development support tool, for easy debugging.
- Equipped with protection functions such as overcurrent and overvoltage detection for safe evaluation.
* The TAD2141 and TAS2143 magnetic sensors manufactured by TDK Corporation were used to confirm the operation of the sample code.

Overall Structure

Emulator (Sold separately)

CPU card

Renesas Motor Workbench

BLDC motor with magnetic sensor

Inverter board (included with Evaluation System for BLDC Motor)
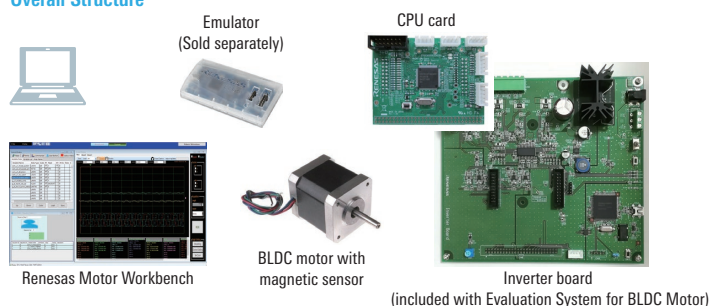
Evaluation Environment Specifications

Item	Specification
Structure	Evaluation System for BLDC Motor
	RX13T/23T/24T/24U/66T/72T/72M CPU card
	BLDC motor with magnetic sensor
Inverter specification	■ Rated voltage: 48V ■ Rated current: 5A (RMS) ■ Protect function: Overcurrent detection, others

Sample Software	Supported MCUs
Vector control + Speed control (Magnetic sensor)	RX13T*[1], RX23T*[2], RX24T, RX24U, RX66T, RX72T, RX72M
Vector control + Position control (Magnetic sensor)	RX13T*[1], RX23T*[2], RX24T, RX24U, RX66T, RX72T, RX72M

*1: Digital output only
*2: Digital or SPI output only

Supported Devices
MCU: RX13T, RX23T, RX24T, RX24U, RX66T, RX72T, RX72M
Gate Driver: HIP4086ABZT
MOSFET: RJK1054DPB, RJK0854DPB
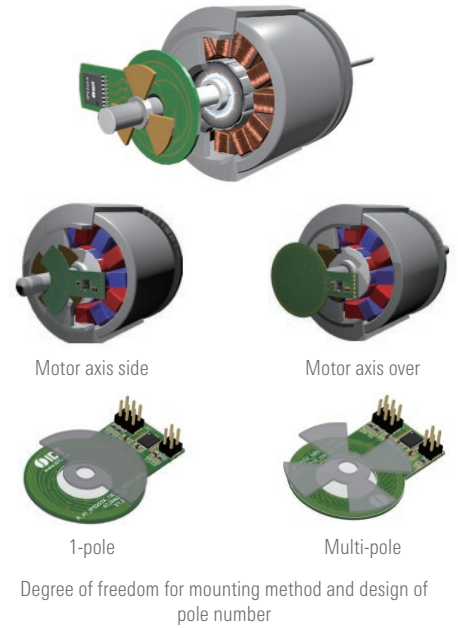Regulator: ISL9001AIRNZ

Solutions Using Inductive Position Sensors

■ IPS2200 (Inductive Position Sensor)

This is thin, lightweight and cost effective with stray magnetic field immunity and contributes to the design for industrial motor. This is ideal for industrial and medical motor commutation and robot application.

Features
- For control of electrical motor (especially BLDC motor)
- Power-supply voltage: 3.3V or 5V
- Support up to 250,000 rpm, low latency (<10µs)
- Magnet-free, thin, lightweight and low-cost solution
- High stray magnetic field immunity
- Sine/cosine (analog) output
- Support multiple pole pairs
- Operating temperature: −40°C to +125°C
- TSSOP-16

- This is a sensor detecting the position of the target metal based on the electromagnetic induction of the coil.
- The sensing element of IPS2200 enables to match the number of target sectors to pole pairs of the motor to maximize accuracy. Sectors can be mounted both to shaft axis (on-axis) and shaft side (off-axis) of the motor, which increases the degree of freedom of the design.
- This is thin and lightweight with one-tenth thickness and one-hundredth weight of the existing resolvers at maximum.

Motor axis side   Motor axis over

1-pole   Multi-pole

Degree of freedom for mounting method and design of pole number

IPS2200STKIT

This is the kit for IPS2200, which includes the detection part of the position sensor and the interface board with PC. By combining with the dedicated GUI, you can easily visualize the angle.
* This kit does not include a motor.
  This kit is not designed to perform motor control but to check the output information from the position sensor.

Dedicated GUI

USB

Inductive Sensor Processing IC (IPS2200 Series)

Part No.	Operation Voltage	Operation Temperature	Rated Speed	Output Type	Safety Function	Package	Provide
IPS2200BI1R	3.0V to 3.6V or 4.5V to 5.5V	Ta = −40°C to +125°C	Max. 250.000 rpm (Electric angle)	sin/cos (Differential or single ended)	Overvoltage detection, reverse polarity detection, short circuit protection	TSSOP-16 Pin (4.4mm × 5.0mm)	13" reel - 4000 IC/reel
IPS2200BI1W							7" reel - 500 IC/reel

Motor Control Development Support Tool

Renesas Motor Workbench

When developing motor control software, it is dangerous to stop a program for debugging while the MCU is connected because this halts output of signals from the MCU to the inverter circuit and can result in a large current flow. Renesas provides a dedicated development support tool to get around this problem.

Product Summary

- Analyzer function: Dynamic reading/writing of variables and waveform display while operating the motor.
- Tuner function: Automatic identification of motor parameters and control gains required for vector control.
- Output of results is possible: Analyzer waveform display data is in csv format. Tuner identification results can be outputted as PDF file or header file.
- Easy GUI function: Makes it quick and easy for anyone to implement motor speed and position control by means of intuitive operations.

Renesas Motor Workbench runs on a PC connected to the target inverter
Strong support for motor control development

Renesas Motor Workbench

Evaluation System for BLDC Motor

Motor
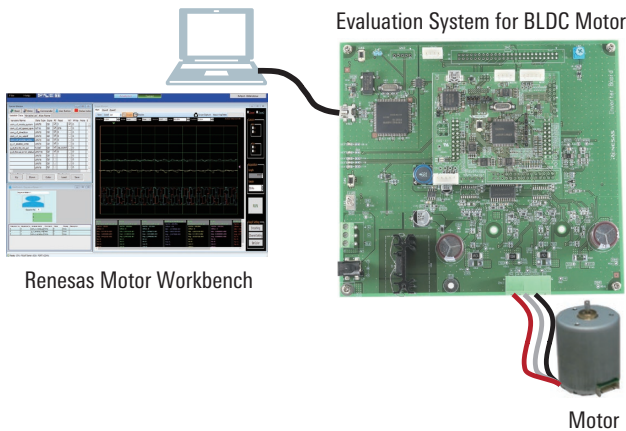
Analyzer

Extensive functions include trigger, zoom, and commander transmission etc., useful for debugging and evaluation. Also usable as user I/F.
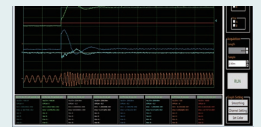
Tuner

Vector control at ease without know-how.
Fine adjustment at ease with manual adjustment function, as well as quick result check.

Easy GUI

Meters and waveform displays allow you to confirm the motor's operating status at a glance, greatly simplifying the debugging process.

Analyzer

Functions

- Dynamically write/read variables while driving a motor
- Dynamically display waveform while driving a motor
- Specify trigger and each display settings with the waveform display
- Create and send operating sequence to any variable in advance
- Batch process buttons by user definition

User's voice
- Very useful, you can observe variables inside MCU.
- Amazed at the debugging function without the need to stop CPU. The tool to enable safe analysis operation.

trigger/zoom functions

Zoom function

Step response evaluation at ease with commander (command value creation & transmission)

Display variables for 8 channels (can specify scale and off-set settings etc. per channel)

Motor Control Development Support Tool

Tuner

Functions
- Automatically measure motor-unique parameters (resistance, inductance, induced voltage constant variable, and inertia)
- Automatically adjust the PI control gain of current/speed/position
- Automatically adjust the expected gain for sensorless vector control
- Manual tuning to finely adjust each PI control
- Output results in pdf and motor-driver header files

Finely adjust the PI gain of current/speed/position

Input information are only rated current and pole pairs.

User's voice
- Great help, as I had much trouble in adjusting parameters.
- I could start motor right away after purchase.
- Convenient enough just to be able to use motor parameter.

Check adjustment results right away with the analyzer
Output adjustment results in pdf and motor header files available on the Web

New Functions of Renesas Motor Workbench 3.0

Easy GUI

Implements a GUI that allows more intuitive operation of the motor.
- Ability to set instruction values by manipulating sliders.
- Ability to configure instruction value profiles.
- Display of rotation speed, current values, etc., on meters.
- Switches for function switching.
- Waveform display of changes in values of variables.
- Ability to display a variety of parameters.

2 meters and monitors : speed and torque control
3 meters and monitors : position control
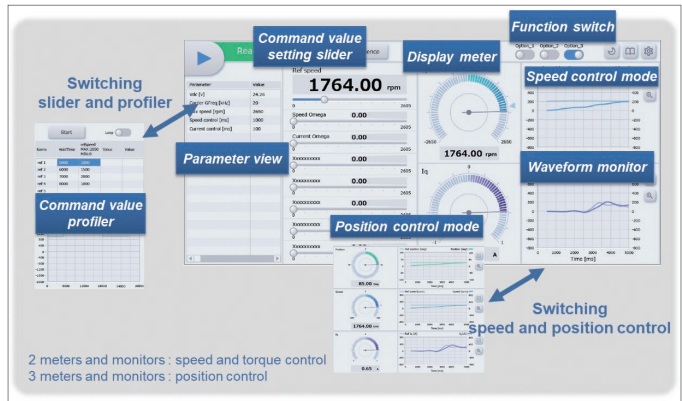
Tuner Implementation Using Non-Renesas Kit

Using the tuner project included with the sample code, you can implement a tuner using a kit from a manufacturer other than Renesas.

Evaluation System for BLDC Motor

Implementation of tuner on a board not part of a Renesas kit

Renesas Motor Workbench
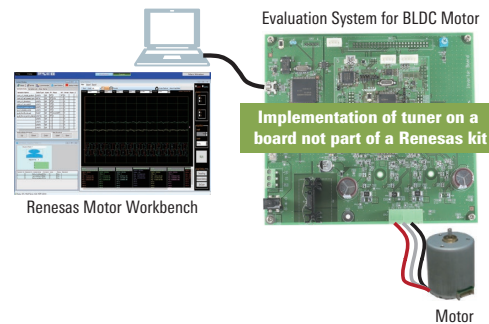
Motor

Built-in Firmware

If you do not have a communication board compatible with Renesas Motor Workbench, you can simply use a USB-serial converter board.
Target MCU: RA6T2 (sequential rollout planned)

Note: The number of data points that can be shown in the analyzer using waveform
display is limited.
Using communication board: 100,000 points
Using built-in firmware: 1,000 points

PC
Motor
Power Supply
Inverter
A UART/USB converter board must be obtained separately.
Programming of RMW firmware to target MCU
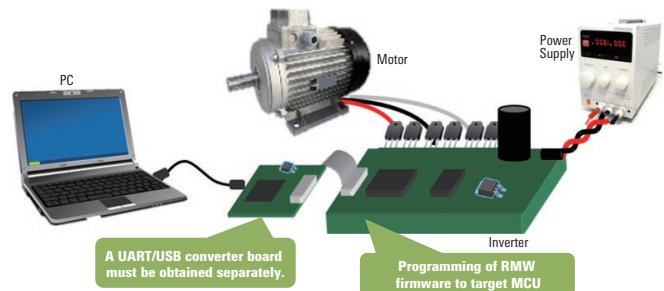
Motor Control Development Support Tool

Specification

Item		Specification
All	Supported MCU	RX13T, RX23T, RX24T, RX24U,RX66T, RX72T, RX72M, RA6T1, RA6T2, RL78/G1F, RL78/G14 (RL78 family supports the analyzer function only)
	Usage environment (OS)	Windows 10
Communication	Peripherals, port	UART 1 ch, DMA (DTC)　Port: TXD, RXD
	Communication I/F	USB2.0 (Communication Device Class)
	Communication board	A tool communication board is required when using an environment other than Evaluation System for BLDC Motor. Tool communication board: MC-COM, W2002 (Desk Top Laboratories Inc.*)
Analyzer	Waveform display	8 channels (scale and off-set setting per channel), zoom function (2 windows), Trigger mode selectable from Single/Auto/Normal, save waveform data in a csv format
	Write/ Read variable	Ability to select up to 255 variables simultaneously, useful functions that simplify debugging (user buttons, commander function, rename function)
Tuner	Input information	Automatic adjustment of motor rated current and number of pole pairs
	Output information	Motor-unique parameter (Resistance, Inductance, Magnet flux, Rotor inertia) and control gain Output file format: pdf file, header file*1

*1: Support motor control SW header file released by Renesas. See Renesas Motor Workbench User's Manual for details.

Environment Used
- Evaluation System for BLDC Motor
- 24V Motor Control Evaluation System for RX23T
- Evaluation System for Stepping Motor with Resolver
- MCK-RA6T2 (Bundled MC-COM is used.)

Simply connect the kit pre-programmed with the sample code to a PC with a USB cable and launch the tool to get started.

Using your own user environment requires a communication board for the tool.

Communication board for tool
MC-COM (P/N: RTK0EMXC90S00000BJ) manufactured by Renesas Electronics

* Manufactured by Desk Top Laboratories

Desk Top Lab
http://www.desktoplab.co.jp/
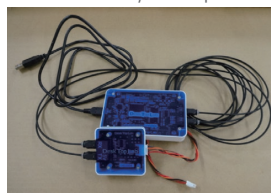
• Using board implementing communication circuit for Renesas Motor Workbench

PC | Motor | Power Supply | Kit

• Using your own user environment

PC | Motor | Power Supply | Communication board (USB-Serial convert board) | Inverter
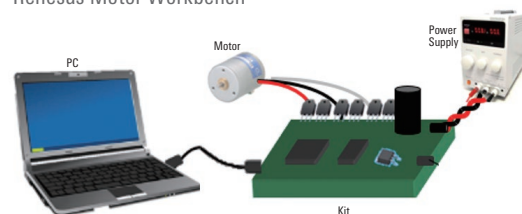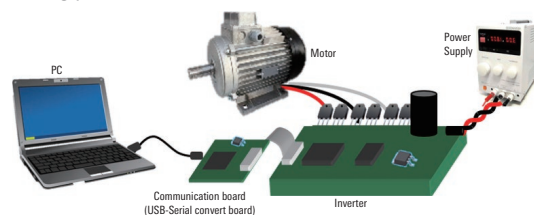
Motor Control Development Support Tool

QE for Motor

QE for Motor is a motor control software development support tool that enables users to develop motor control software by performing operations arranged into a workflow. It is an extension to the e² studio integrated development environment e² studio that can be downloaded at no charge.
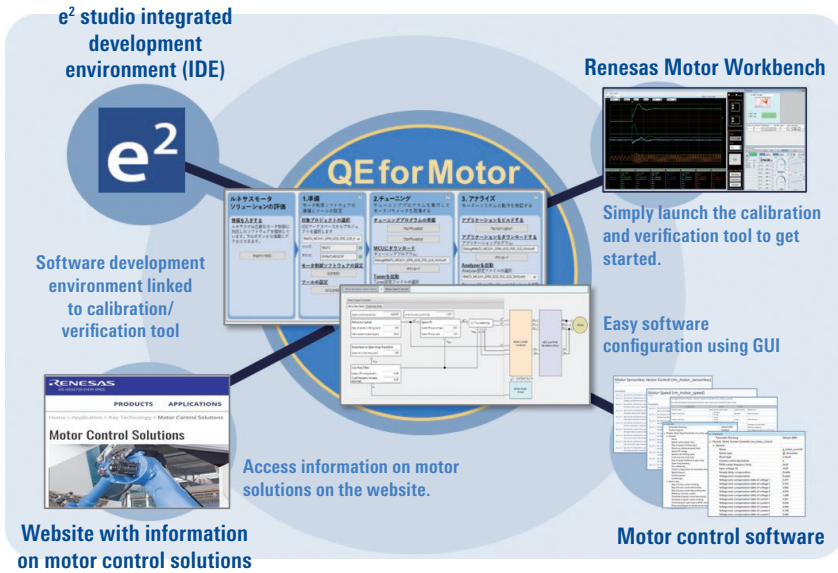
QE for Motor Workflow View
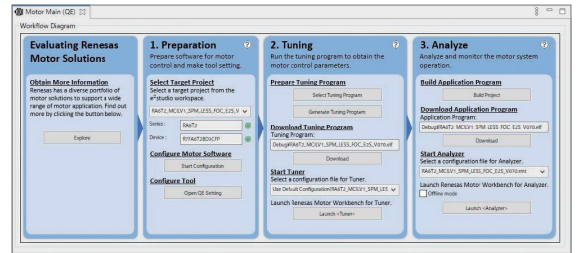
Motor Control Software Configuration GUI
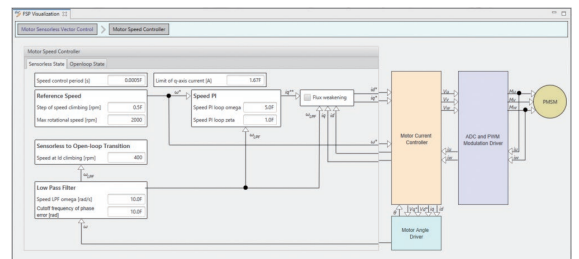
Features
- By following a workflow in QE for Motor you can seamlessly implement the steps required to develop motor control software, including obtaining information about motor control solutions from the Renesas website, configuring the motor control software parameters using a GUI, linking to the Tuner module of Renesas Motor Workbench to generate parameter files, and linking to the Analyzer module of Renesas Motor Workbench to evaluate your motor control program.
- You can configure settings of middleware and drivers used for motor control via a GUI displaying a motor control block diagram.
- You can launch the Tuner or Analyzer module of Renesas Motor Workbench from QE for Motor with a single click.

Compatible MCU: RA6T2

Motor Driver Generator Function

The Motor component of Smart Configurator for the RX Family can generate drivers suitable for motor control for peripheral functions such as the multi-function timer pulse unit and A/D converter module, and you can use it without needing to be aware of the minute details of peripheral settings. This function is available in the e² studio integrated development environment and in RX Smart Configurator (standalone version).

Multi-Function Timer Pulse Unit (MTU) Settings
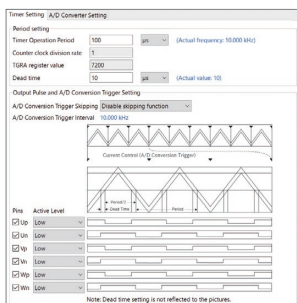
Configurable Settings
- Complementary PWM mode (MTU3) (fixed)
- Switching frequency
- Dead time duration
- A/D conversion start trigger settings
- PWM signal output polarity
- Motor connection pin selection

12-Bit A/D Converter (S12AD) Settings
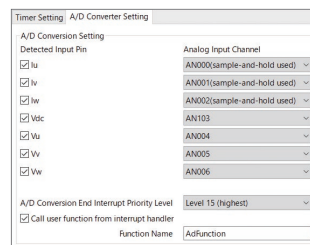
Configurable Settings
- A/D converter pin selection for motor control
- Interrupt priority level selection

Features
- By configuring settings in a simple GUI, you can generate driver source code for the multi-function timer pulse unit (MTU) and 12-bit A/D converter (S12AD) peripheral modules that perform pulse output and current measurement essential for motor control. Complex settings such as timer pulse output settings (complementary PWM mode settings) and settings to trigger A/D conversion by timer events are configured automatically by the generated drivers.
- It is easy to change settings for the peripheral function channels or pins used for motor control from within Smart Configurator.

Compatible MCUs: RX13T, RX23T, RX24T, RX24U, RX66T, RX72T, and RX72M
Compatible motors: 3-phase brushless DC motors and 2-phase stepping motors

RAA227063 3-Phase Smart Gate Drivers

RAA227063 Smart 3-Phase

System Integration (Smart Gate Driver with Built-in Power Supply for System and High Accuracy Amp for 3-Shunt)

Gate drive current up to 1A/2A
Capable of high-speed switching control for MOSFET with large C_{iss}

Sensor-less drive
Capable of very low speed control with high load

Self-Align Dead Time (Adaptive Dead Time)
Decrease heat radiation by the MOSFET. Reduce power loss

Adjustment function of Source / Sink current
Optimize for power loss and EMI

Equip with high efficiency amplifier useful multipurpose
• Differential amplifiers: 3ch (3-Shunt, Hall sensor, Sensor-less)
• Gain amplifier for Back-EMF sense

Support rich safety functions
1. UV protection by VM
2. OV/UV/OC protection by buck-boost regulator
3. UV protection by charge pump
4. OC protection by current sense
5. OC protection by MOSFET VDS
6. Thermal Warning / Thermal Shut Down
7. Reverse battery polarity protection (Additional external circuit)

Development Tool

Easy to Connect with Renesas CPU Card, Start to Evaluate by Sample Firmware of Renesas MCU
- PCB size: 14.1cm x 16.0cm
- Power input: 4.5V to 60V, motor driving MOSFETs are rated at 80V 132A.
- MCU connectors are compatible to Renesas RL78/G1F, RX23T, and RA6T1 CPU card interface. (Has interface to MCU for motor current & voltage sensing, PWM signals, fault condition, enable IC, SPI connection, etc.)
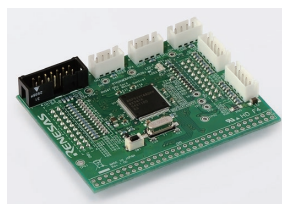
CPU Card
(RL78/G1F, RX23T, RA6T1)
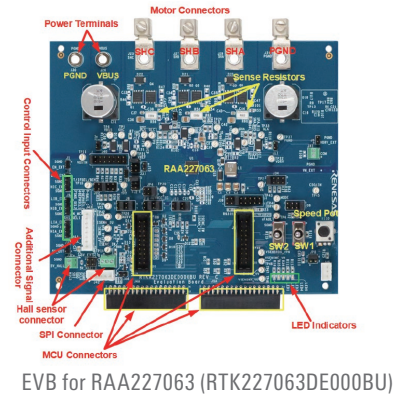
EVB for RAA227063 (RTK227063DE000BU)

Product	PKG	Operating Voltage (V)	Applications
RAA227063*[1]	48 Ld QFN (7mm × 7mm)	4.5 to 60V	Power tool, Gardening tool, Cord-less vacuum cleaner, Cooling-fan, Water pump, Air pump, AGV, Robotics, etc.

*1: RAA2270634GNP#MA0: Reel 250pcs Ta= -40 to 125 °C
    RAA2270634GNP#HA0: Reel 4k pcs Ta= -40 to 125 °C

Inquiry window

Please contact customer support via the website for further information. https://www.renesas.com

Recommended Products: MCUs and MPUs

RL78 Family

Part No.	Pin Number	ROM (KB)	RAM (KB)	Operating Frequency	Power-supply Voltage
RL78/G14	30 to 64	16 to 64	2.5 to 5.5	32MHz	1.6 to 5.5V
	80 to 100	96 to 512	12 to 48		
RL78/G1F	24 to 64	32/64	5.5	32MHz	1.6 to 5.5V
RL78/G1G	30 to 44	8/16	1.5	24MHz	2.7 to 5.5V
RL78/G1M	20	4/8	0.512/1	20MHz	2.0 to 5.5V

RX Family

Part No.	Pin Number	ROM (KB)	RAM (KB)	Operating Frequency	Power-supply Voltage
RX13T	32 to 48	64 to 128	12	32MHz	2.7 to 5.5V
RX23T	48 to 64	64 to 128	12	40MHz	2.7 to 5.5V
RX24T	64 to 100	128 to 512	16 to 32	80MHz	2.7 to 5.5V
RX24U	100 to 144	256 to 512	32	80MHz	2.7 to 5.5V
RX66T	48 to 144	256 to 1024	64 to 128	160MHz	2.7 to 5.5V
RX72T	100 to 144	512 to 1024	128	200MHz	2.7 to 5.5V
RX72M	176/224	2048 to 4096	1024	240MHz	2.7 to 3.6V

RZ Family

Part No.	Pin Number	ROM (KB)	RAM (KB)	Operating Frequency	Power-supply Voltage
RZ/T2M	128/176/225/320	0	576 to 2624	800MHz	3.0 to 3.6V
RZ/T1	176/320	0	544 to 1568	600MHz	3.0 to 3.6V
RZ/T1-M	112	0	544 to 1568	450MHz	3.0 to 3.6V

RA Family

Part No.	Pin Number	ROM (KB)	RAM (KB)	Operating Frequency	Power-supply Voltage
RA6T1	64/100	256/512	64	120MHz	2.7 to 3.6V
RA6T2	48/64/100	256/512	64	240MHz	2.7 to 3.6V

Recommended Products: Motor Sensor Processing IC, Motor Control IC

RDC IC (Resolver to Digital Converter)

Part No.	Resolver Driving Block			Converter Block			Amplifier Circuit Block	Control Block		Conversion Error	Power-supply Voltage	Power-supply Current	Operating Ambient Temperature	Package
	Input	Excitation Signal Output	Over Temperature Detection Circuit	Differential Amplifier Circuit	Signal Conversion Circuit	Disconnection Detection Circuit	Differential Amplifier Circuit	Communication Function	Operating Frequency					
RAA3064002GFP	Square wave: 5/10/20 kHz	Alternating current: 35mAp-p (Max.)	Built-in	Gain Variable: 2, 4, 8, 16.5 times	Angle error correction function, Internal circuit error correction function	Detect disconnection from signal amplitude	2 ch (Support differential input), Gain variable: 10, 25 times	SPI interface (Max. 1MHz)	4MHz	±0.2°	VDD = 4.5-5.5V, IOVDD = AVDD	Maximum operating current: 20 mA (Typ.)	−40°C to +85°C	LQFP-48pin (7mm × 7mm)
RAA3064003GFP													−40°C to +105°C	

3 Phase BLDC Motor Control (RAJ306000 Series)

Part No.	Motor Drive Voltage	MCU	Communication I/F	Timer	Guaranteed Operating Temperature Range	5V Regulator Accuracy	A/D Converter	Pre-Driver Block		Safety Function	Package
								Gate Drive Peak Current	Boosting Function		
RAJ306010GNP/ZGNP	VM = 6V to 42V	RL78G1F (Flash ROM: 64KB, RAM: 5.5KB)	3 units (SPI: 2ch, IIC: 2ch, UART: 1ch)	16-bit timer: 8ch	GNP: Ta = −40°C to +85°C, ZGNP: Ta = −40°C to +105°C	5V ± 5% (Ta = 25°C)	9ch (Resolution: 10-bit)	500mA Drive peak current supporting up to 500mA, Dead time adjustment function, Gate current adjustment function	Double boost / Single boost switch	Over temperature protection, Over Voltage for 5V regulator detection/ protection, Over/ Under Voltage for charge pump voltage detection/ protection, Over Current detection/ protection by current sense	P-HTQFN-64 Pin (8mm × 8mm)

Inductive Sensor Processing IC (IPS2200 Series)

Part No.	Operation Voltage	Operation Temperature	Rated Speed	Output Type	Safety Function	Package	Provide
IPS2200BI1R	3.0V to 3.6V or 4.5V to 5.5V	Ta = −40°C to +125°C	Max. 250.000 rpm (Electric angle)	sin/cos (Differential or single ended)	Overvoltage detection, reverse polarity detection output, short circuit protection	TSSOP-16 Pin (4.4mm × 5.0mm)	13" reel - 4000 IC/reel
IPS2200BI1W							7" reel - 500 IC/reel

Recommended Products: Power Management

ISOLATED PWM   Pout < 200W

* Used for Step-down from 200V to 24V and so on.

Part No.	Description	Control Mode	UVLO Rising (V)	UVLO Falling (V)	Vbias max (V)	No Load Operating Current (mA)	PWM Output Number	Error Amplifier	FET Driver Iout max (A)	Switching Frequency (Hz)	Maximum Duty Cycle (%)	Package
ISL6840	Industry standard single end	Peak current mode	7	6.6	20	3.3	1	Built-in	1	4k to 2M	96	8Ld MSOP, 8Ld DFN
ISL6726	Active clamp · forward	Current mode	7.65	6.23	22	10	1	–	2	10k to 1M	80	20Ld QSOP
ISL8840A to ISL8845A	High performance · Industry standard single end	Peak current mode	7, 8.4, 14.3	6.6 to 8.8	30	2.9	1	Built-in	1	2k to 2M	48, 96	8Ld SOIC, 8Ld MSOP

DC/DC

Part No.	Vin (V)	Vout (V)	Iout (A)	Fsw (Hz)	PWM/PFM	Efficiency (%)	On Resistance typ (mΩ)	Operating Temperature Range	Package
ISL85412	3.5 to 40V	0.6 to 34	0.15	700k	Yes	Max. 92	High: 900 Low: 500	−40 to 125°C	12-DFN
ISL85413	3.5 to 40V	0.6 to 34	0.3	700k	Yes	Max. 92	High: 900 Low: 500	−40 to 125°C	12-DFN
ISL85415	3 to 36V	0.6 to 34	0.5	300k to 2M	Yes	Max. 94	High: 450 Low: 250	−40 to 125°C	15-TQFN
ISL85418	3 to 40V	0.6 to 34	0.8	300k to 2M	Yes	Max. 96	High: 250 Low: 90	−40 to 125°C	15-TQFN
ISL85410	3 to 40V	0.6 to 34	1.0	300k to 2M	Yes	Max. 96	High: 250 Low: 90	−40 to 125°C	15-TQFN
ISL854102	3 to 40V	0.6 to 34	1.2	300k to 2M	Yes	Max. 93	High: 250 Low: 90	−40 to 125°C	12-DFN
RAA211605	4.5 to 60V	0.8 and up	0.5	450k	–	Max. 93	High: 600	−40 to 125°C	6-TSOT23
RAA211650	4.5 to 60V	0.8 and up	5.0	200k to 2.5M	–	Max. 90	High: 90 Low: 37	−40 to 125°C	28-QFN
RAA211651	4.5 to 60V	0.8 and up	5.0	565k	–	Max. 93	High: 90 Low: 37	−40 to 125°C	28-QFN

LDO

Part No.	Description	Vin (V)	Vout (V)	Reference Voltage Accuracy (%) Full Temperature Range	Current Limit Iout (typ) (mA)	Dropout Voltage typ (mV)	PSRR@ 1kHz (dB)	Iq (µA) typ	Output Noise (typ) (µV/rms)	Package	Remarks
RAA214220	150mA, 20V, low Iq	2.5 to 20	ADJ	+2.0/−2.0	220	225@150mA	92@100Hz	38	150@10mA	5-TSOT23	
ISL80136	50mA, 40V, low Iq	6 to 40	ADJ	1.223V +/−1.0	118	120@50mA	58@100Hz	18	26@10mA	8-EPSOIC	
ISL80138	150mA, 40V, low Iq	6 to 40	ADJ	1.223V +/−1.0	410	295@150mA	66@100Hz	18	26@10mA	14-HTSSOP	
ISL80410	150mA, 40V, low Iq	6 to 40	ADJ	1.223V +/−1.0	410	295@150mA	66@100Hz	90	26@10mA	8-EPSOIC	
RAA214401	150mA, 40V, low Iq	4.5 to 40	3.3	+2.7/−3.1	150min	1370@150mA	52	3.6	237@10mA	3-SOT23	
ISL6719	100V linear bias power supply	17 to 100	ADJ	1.5V +/−3.3	230	1800@100mA	–	1100	–	9-DFN	Vout = 1.55 to 20V

Recommended Products: Gate Driver, MOSFET, Peripheral IC

Gate Driver: Full-Bridge Product Family

Part No.	Description	Maximum Boot Strap Voltage (V)	Maximum Bias Voltage (V)	Input Lines/ Output Lines	Peak Pull-Up/ Pull-Down Current (A)	Turn On/Off Propagation Delay (nS)	Rise/Fall Time (nS)	Input Logic	Package	
									PDIP	SOIC
HIP4080A	80V, 2.5A peak, high-frequency dead time control, built-in input comparator	95	15	1/4	2.6/2.4	40/50	10/10	Logic Thresholds Compatible with 5V to 15V Logic level	20-pin	20-pin
HIP4081A	80V, 2.5A peak, high-frequency dead time control	95	15	4/4	2.6/2.4	35/45	10/10	Logic Thresholds Compatible with 5V to 15V Logic level	20-pin	20-pin
ISL83202	55V, 1A peak	70	15	4/4	1/1	75/55	9/9	Logic Thresholds Compatible with 5V to 15V Logic level	16-pin	16-pin

Gate Driver: 3-Phase Product Family

Part No.	Description	Maximum Boot Strap Voltage (V)	Maximum Bias Voltage (V)	Input Lines/ Output Lines	Peak Pull-Up/ Pull-Down Current (A)	Turn On/Off Propagation Delay (nS)	Rise/Fall Time (nS)	Input Logic	Package		Remarks
									PDIP	SOIC	
HIP4083	80V, 300mA peak, for 3-phase	95	15	3/3	0.24/0.3	60/65	35/30	TTL/CMOS	16-pin	16-pin	Integrated output level shift circuit
HIP4086/A	80V, 500mA peak, for 3-phase	95	15	6/6	0.5	45/30	20/10	TTL/CMOS	24-pin	24-pin	Part No. without A: Integrated charge pump.

MOSFET Driver

ISL89411

ISL89410
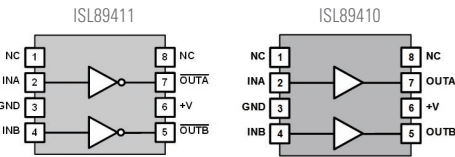
Vs = 18V (max)
Ipk = 2A (max)
8Ld PDIP, SOIC

IGBT Gate Driver Coupler

PS9031

SHIELD
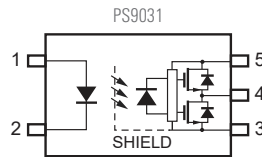
Vcc = 30V (max)
Ioh/Iol = 2.2A/2.4A
5Ld LSO5

Inverter Circuit: Power MOSFET

Part No.	Nch/Pch	Resisting Pressure	Current	ON Resistance (max)	Package
RJK1054DPB	Nch Single	100V	20A	22mΩ	LFPAK
RJK0854DPB	Nch Single	80V	25A	13mΩ	LFPAK
RJK0454DPB	Nch Single	40V	40A	4.9mΩ	LFPAK
RJK0455DPB	Nch Single	40V	45A	3.8mΩ	LFPAK
RJK0456DPB	Nch Single	40V	50A	3.2mΩ	LFPAK
NP75N04YUK	Nch Single	40V	75A	3.3mΩ	HSON-8
NP50N04YUK	Nch Single	40V	50A	4.8mΩ	HSON-8
NP30N04QUK	Nch Dual	40V	30A	8mΩ	HSON-8
NP29N04QUK	Nch Dual	40V	30A	10.1mΩ	HSON-8

Peripheral IC: RS-485 Transceiver

Device	Duplex	VCC (V)	Data Rate (Mbps)	Fail-Safe	Fractional Unit Load	Tx VOD (V)	Tx Out / Rx In			Hot Plug	Temp (°C)	Package
							HBM	IEC61000-4-2 ESD Contact	IEC61000-4-4 EFT			
ISL3159E	Half	4.5 to 5.5	40	Open, Short , Idle	160	Min. 2.1	±16.5kV	±8kV	±4.5kV	Y	−40 to 85	8L SOIC/MSOP 10L DFN
ISL3179E		3.0 to 3.6				Min. 1.5	±16.5kV	±9kV	±3kV		−40 to 125	
ISL3160E	Full	4.5 to 5.5				Min. 2.1	±10kV	±5kV			−40 to 125	14L SOIC
ISL3180E		3.0 to 3.6				Min. 1.5	±12kV	±5kV			−40 to 85	
RAA788152 / 55 / 58	Half	4.5 to 5.5	0.115 / 1 / 20	Open, Short , Idle	256	Min. 2.4	±16.5kV	±9kV	±5kV	Y	−40 to 85	8L SOIC/MSOP
ISL3172E / 75E / 78E		3.0 to 3.6	0.25 / 0.5 / 20			Min. 1.5	±15kV	±8kV	±3kV			
RAA788150 / 53 / 56	Full	4.5 to 5.5	0.115 / 1 / 20			Min. 2.4	±16.5kV	±9kV	±5kV			10L MSOP 14L SOIC
ISL3170E / 73E / 76E		3.0 to 3.6	0.25 / 0.5 / 20			Min. 1.5	±15kV	±8kV	±3kV			

Device	Duplex	VCC (V)	Data Rate (Mbps)	Fail-Safe	Devices on Bus	Wide VCM (V)	Protection Tx Out/Rx In	Hot Plug	Temp (°C)	Package
ISL32452E/55E/58E	Half	3.0 to 3.6 4.5 to 5.5	0.25 / 1 / 20	Open, Short, Idle	128	±20	±60V Fault Protected ±15k or 16.5kV HBM ESD	N	−40 to 85	8L SOIC / 8L MSOP
ISL32457E			0.25 / 20							8L SOIC
ISL32459E										
ISL32496E	Full	4.5 to 5.5	0.25 / 1 / 15			±25	±60V Fault Protected ±15k or 16.5kV HBM ESD	Y	−40 to 85	10L MSOP / 14L SOIC
ISL32492E/95E/98E	Half		0.25 / 1 / 15							8L SOIC / MSOP

Winning Combinations

High-Voltage Motor Driver

There are motors and motor control all around us. In this design, we highlight a high-voltage motor application suitable for appliances, HVAC compressors and fans, etc. We combine power factor correction (PFC), now required by many power providers, to produce a clean and stable 390VDC to the motor control sub-system. The heart of the motor control is a 32 bit high-performance RISC processor, the RX23T, containing a floating point unit (FPU) to simplify the algorithm implementation. Utilizing a 3-phase timer with complementary outputs, the RX23T supports a wide variety of algorithms that can be downloaded. In this particular block diagram, we are showing hardware to support sensor-less Field Oriented Control (FOC) utilizing multi-shunt phase-current sampling.
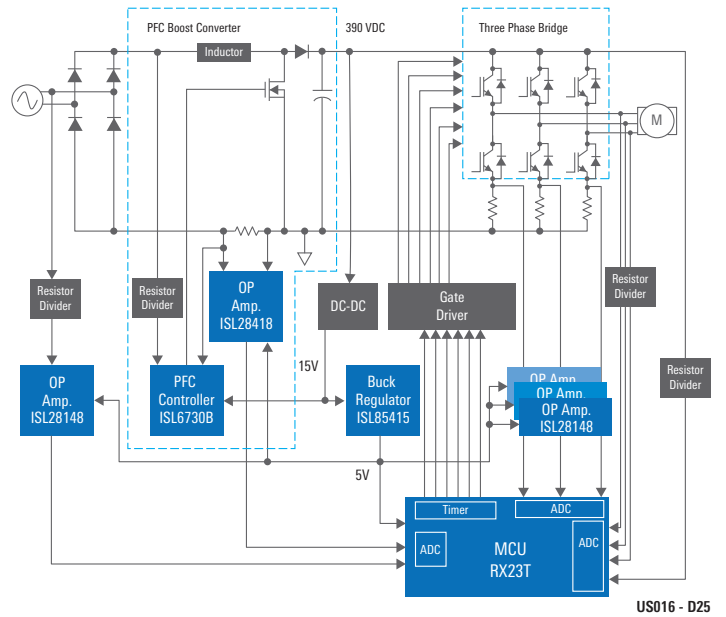
US016 - D25

Motor Control for Power Tools

This solution is showing a motor control reference design for power tools. The power source (battery or main power supply) is not part of this proposal and is represented here as a simple battery pack.

For this reference design, Renesas choose a high voltage solution (48V), which features the high-performance Arm®-M4 based RA6M3 MCU. It has specific PWM timers for 3-phase motor control and a floating point unit (FPU) to enhance algorithm performance.

This block diagram shows a setup that includes an embedded power supply for the MCU (3.3V) and MOSFET half-bridge drivers (12V).
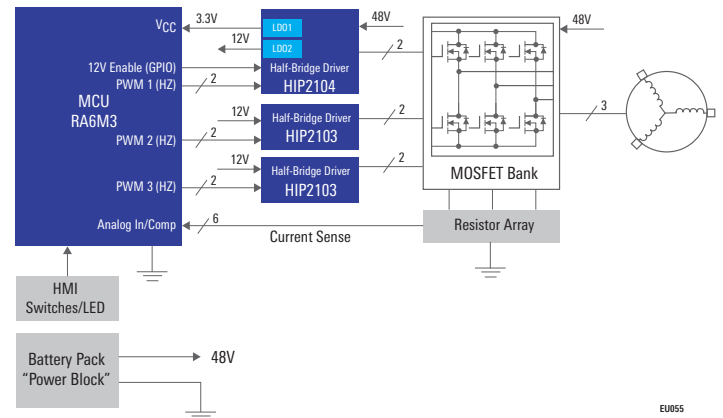
EU055

RX13T Motor Control

The RX13T 32-bit MCU is an optimized single motor control solution used to drive vector control/field-oriented control (FOC) of a permanent magnet synchronous motor (brushless DC motor). The RX13T also has a best-in-class built-in floating-point unit (FPU) at 32MHz and various built-in peripheral functions, making for a small and low BOM cost single motor control board. A standard DC input solution (24V) is shown with this RX13T solution. This application shows the use of the microcontroller together with the IPS22xx axial position sensor, allowing motor axle position feedback without HALL effect sensors.
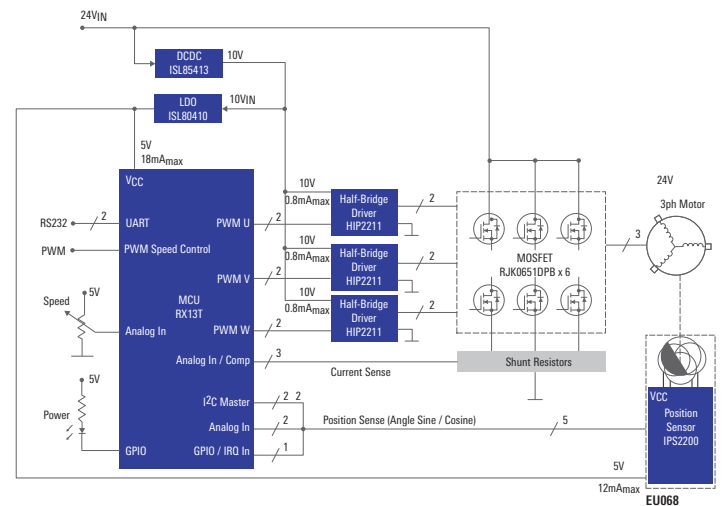
EU068

Winning Combinations

Triac-Based Motor Controller

Need for portable air conditioners has been growing for use in residential, RVs or mobile housing. This triac-based motor controller solution is a robust, compact air conditioning system that works well for small scale applications including vehicle systems. This system is based on triacs to simplify the design as compared to inverter-based designs.

Diagram labels:
- 115/230V L N
- AC Filter and Rectification
- Zero Cross Detection Circuit
- High Voltage Buck RAA223021
- -5V 21mA
- -5V 21mA
- Temp & Humidity HS300X
- 2 I²C
- PMOD
- MCU RX231*
- INT
- VSS
- VSS
- I2C
- GPIO
- PWM 4
- ADC
- UART 2
- -5V 180mA
- L
- Relay
- Triacs 4
- 4
- Current Sense ISL28005
- RS485 Isolated Transceiver ISL32704E
- -5V 62uA
- -5V 6mA
- 5V ISO (From PC)
- 2
- M
- Load (Compressor, Condenser, Fan, 4 way valve)
- US106
- *RA2E1 Alternative

BLDC Traction Motor Drive

The RA6T2 MCU and RAA227063 3-phase smart driver offer the perfect combination for processing speed and power efficiency to address traction motors that have very small form factor limitations and a wide breadth of power requirements. The RAA227063 integrates the power management to power the driver and the MCU directly from the battery reducing overall circuitry. Its programmability allows customers to optimize the inverter power stage and address different power levels by simply changing the MOSFETs and tuning slew rate, dead time and gate drive via software. Using two inductive position sensors, the customer can replace the large and costly optical encoder. The IPS2200 inductive position sensor can provide the absolute position information and it can provide the incremental position sensing up to 17 bits of resolution using the four of the 12-bit ADCs of the RA6T2 MCU.

Diagram labels:
- 48V Battery
- Buck Regulator RAA2112605
- 3.3V
- 5V DC 150mA
- Timers
- RA6T2 240 MHz Arm® Cortex®-M33 Core
- CAN Tx
- CAN Rx
- ADC
- ADC
- CANopen Interface
- CAN Transceiver
- 3 Phase Motor AFE RAA227063
- 3-Phase MOSFET Bridge
- RJK1002DPN-A0
- US233
- 5V
- Inductive Position Sensor IPS2200
- M
- 4
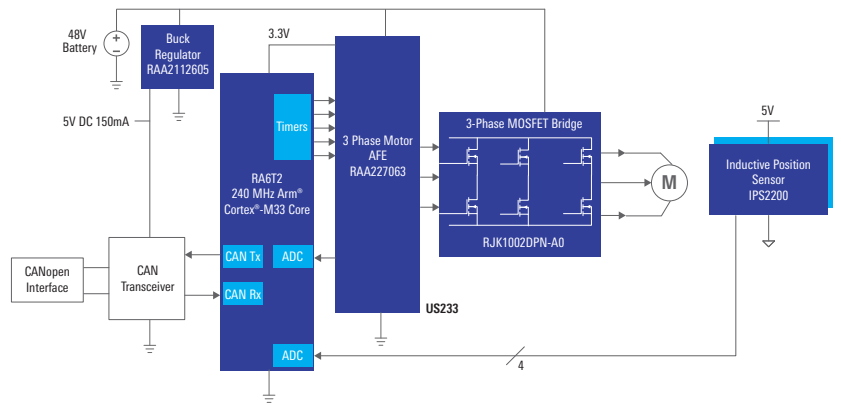
Smart Gate Driver BLDC Motor Control

The RAA227063 is a smart gate driver IC for 3-phase sensorless brushless DC (BLDC) motor applications. It integrates three half-bridge smart gate drivers that are capable of driving up to three N-Channel MOSFET bridges and supports bridge voltages from 4.5V to 60V, with 1A drive and 2A sinking current capability. It is equipped with an LDO that is fed directly from the input voltage, providing power to the MCU. Three accurate differential amplifiers with adjustable gain are integrated to support ground-side shunt current sensing with the S/H system, which provides results via one output channel to the MCU ADC input.

Diagram labels:
- 5V~60V DC
- MCU RA2E1
- V_{CC}
- enable
- PWM 3x
- GPIO / NMI
- SPI 4
- ADC Ch Select 2
- Analog in 1
- V_{ref}
- 5V/60mA$_{max}$
- 5V/200mA$_{max}$
- LDO₁
- LDO₂
- enable
- PWM
- fault
- SPI
- 3xS/H
- Diff input
- V_{ref}
- 3 Phase Full Bridge Driver RAA227063
- U_{hi}
- U_{sense}
- U_{lo}
- V
- W
- U V W
- 6x MOSFET RJK0659DPA
- 3-Phase Motor
- 3
- 6
- Shunt Resistors
- EU105
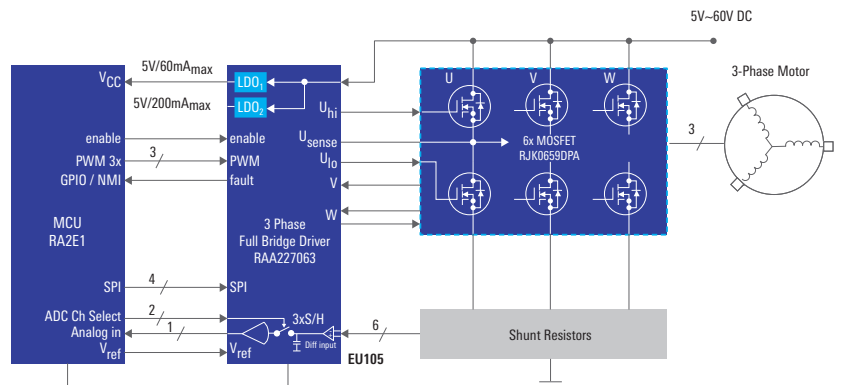
Winning Combinations

Motor Control with Resolver Solution

In this design, Renesas provides a stepping motor solution with resolver position control and an alternate BLDC motor solution. The stepping motor solution realizes a high-performance motor drive unit for office automation and industrial applications such as scanners, multi-function printers and automated cash deposit machines. While the BLDC motor solution realizes a high-performance motor drive unit for Automatic Guided Vehicle (AGV), small vehicle, service robot, and assisted bicycle applications. Both motor solutions consist of a motor with a built-in resolver, an MCU, a resolver digital converter, motor drivers, and power supply ICs for the motor and control circuit.
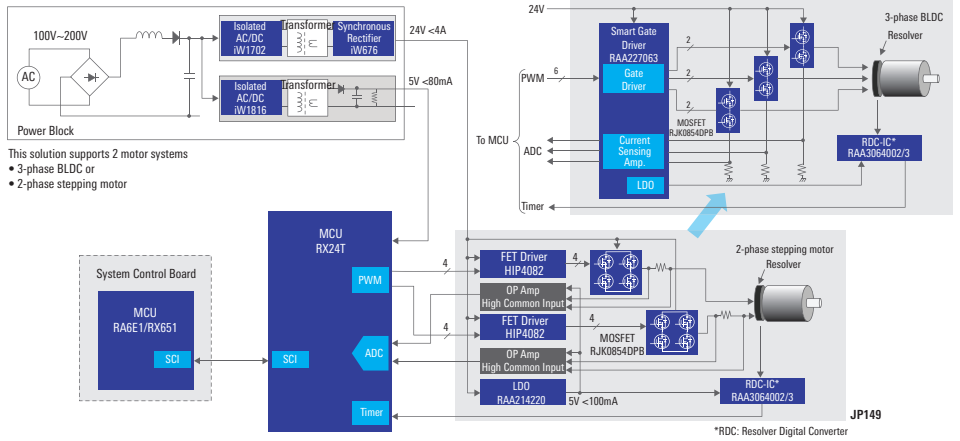
Motor Control System with Industrial Network and Functional Safety

Renesas provides the total solution required for industrial motor control systems with an MPU and MCU for mutual monitoring, power supply ICs, delta-sigma ($\Delta\Sigma$) modulator and other devices. The combination of these devices enables a simple and high-performance solution for motor control, industrial network and functional safety (FuSA).
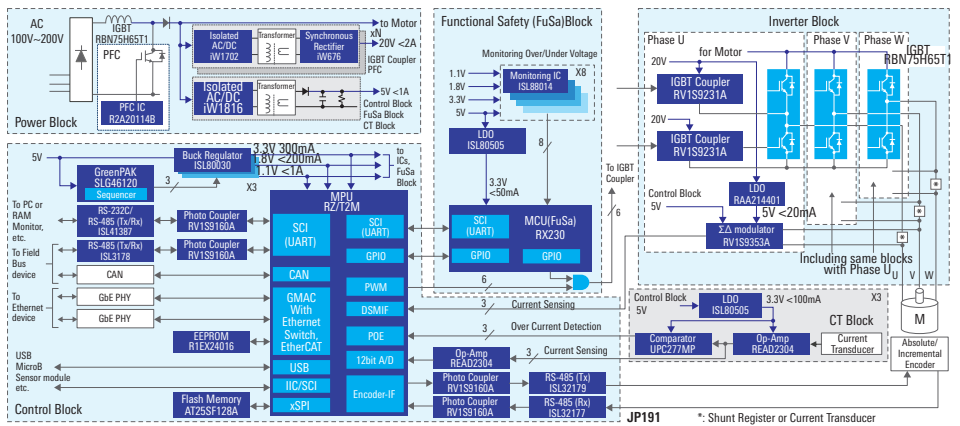
AC Drives/GP Inverters Solution

This solution provides basic system configuration and key devices for AC Drives and GP (General Purpose) Inverters. It is a variable-speed controller precisely controlling the shaft rotation speed, typically, an induction motor or synchronous motor. They are widely used in industrial machinery (e.g., conveyors, cranes, elevators, fans, pumps, and compressors). Due to its various use cases, multiple functions are required as an option for this type of solution.

SALES OFFICES

Refer to "http://www.renesas.com/" for the latest and detailed information.

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