MOTOR SOLUTIONS

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

2025.10

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

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

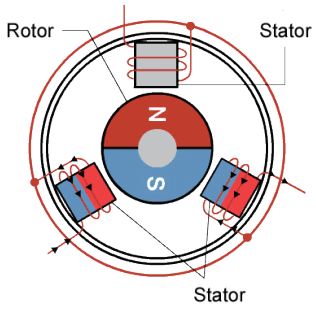
Other Motor
- Ultrasonic motor
- Switched reluctance motor

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.



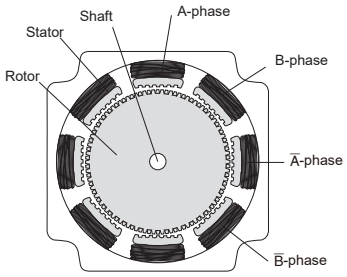
Motor structure


Applications

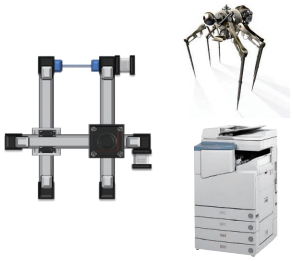
Stepper Motor

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.



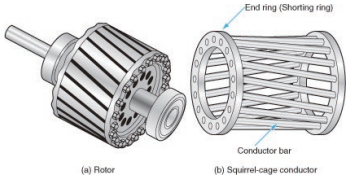
Motor structure


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.

⇒ Renesas offers induction motor solutions for applications.



Source: Nidec Corporation
Motor structure


Applications

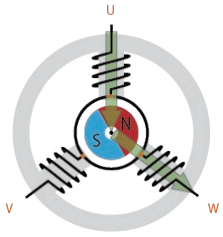
Motor Control Method

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.



Energizing Mode	Energized Phase	Resultant Flux
1	U → W	
2	U → V	
3	W → V	
4	W → U	
5	V → U	
6	V → W	

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.

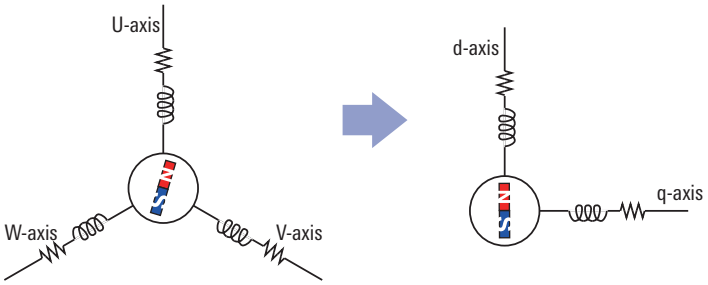


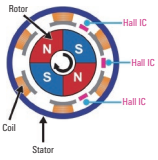
Image of coordinate conversion by vector control (3-phase motor)

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 sensorless” 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.

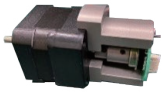


Motor with hall sensor

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

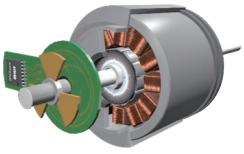
Resolver

- 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.

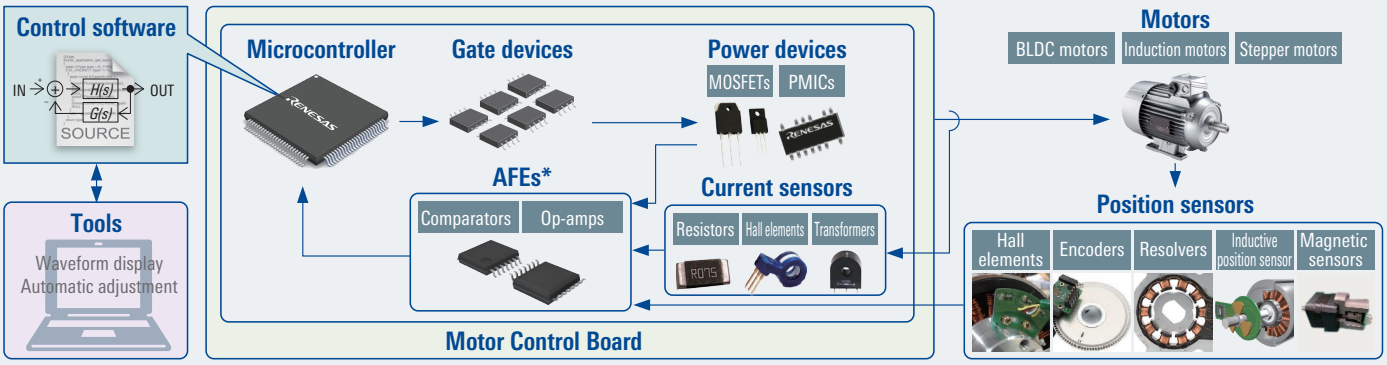


Induction sensor image

Powerful Support for Customers' Development Efforts

Motor Solutions

Basic Motor Control Configuration



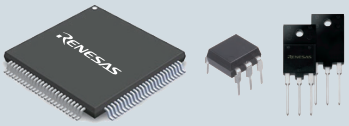
*AFE : Analog Front End

Motor Solution Classification

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

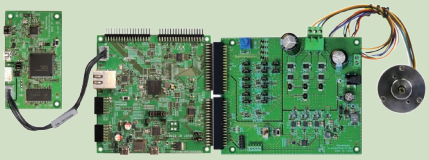
Devices

- Microcontrollers
- Position sensor
- MOSFETs
- Configurable Logic (GreenPAK, HVPAK, etc.)



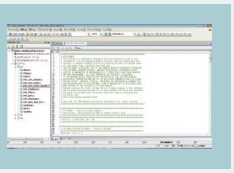
Hardware

- Motor Control Kit
- Reference Design



Software

- Vector control
  - Speed control, Position control
- 120-degree conduct control
- V/f control

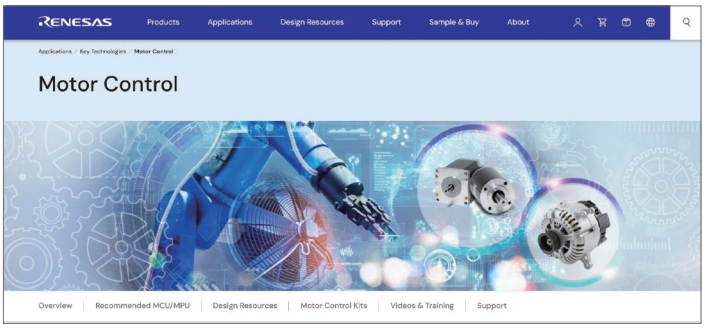


Tools

- Renesas Motor Workbench
- QE for Motor

High Availability and Easy Operation

- Software and Tools can be download for free.
- Evaluation kits are purchasable on renesas.com for easy evaluate/control motors with use of support tool.



https://www.renesas.com/key-technologies/motor-control

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.

Renesas Motor Control Kit Lineup

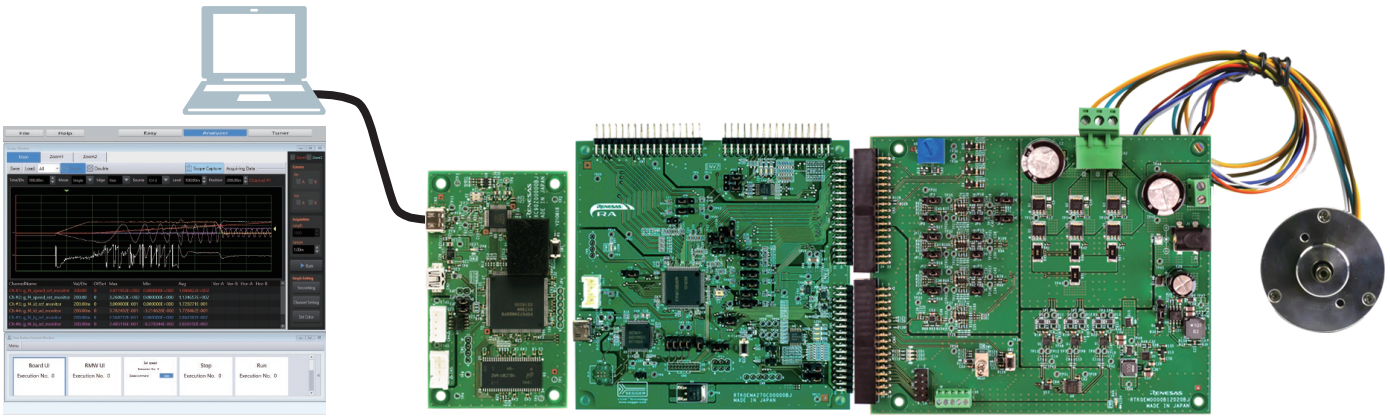
Motor Type	Product ID	Reference Page	Vector Control				120-Degree Conducting Control		Open-Loop Mode
			Sensorless	Encoder	Magnetic Sensor Inductive Sensor	Resolver	Sensorless	Hall	
			Speed Control	Speed Control/ Position Control	Speed Control/ Position Control	Speed Control/ Position Control	Speed Control	Speed Control	
BLDC motor	MCK-RA8T2	7	✓	✓*	✓*	–	✓	✓	–
	MCK-RA8T1	7	✓	✓*	✓*	–	✓	✓	–
	MCK-RA6T3	7	✓	✓*	✓*	–	✓	✓	–
	MCK-RA6T2	7	✓	✓*	✓*	–	✓	✓	–
	MCK-RA4T1	7	✓	✓*	✓*	–	✓	✓	–
	MCK-RA2T1	7	✓	–	–	–	–	–	–
	MCK-RX26T	7	✓	✓*	–	–	✓	✓	–
	MCI-HV-1	10	✓	–	–	–	–	–	–
	MOTOR-RSSK-BLDC	11	✓	✓*	✓*	–	✓	✓	–
	MOTOR-RSSK-RA6T1	–	✓	✓*	–	–	✓	✓	–
	MCEK-RL78G24	12	✓	–	–	–	✓	✓	–
	INVB-LV-RZT-I	13	–	✓	–	–	–	–	–
AC synchronous motor	CN032-ACSERVO	14	–	✓	–	–	–	–	–
AC induction motor	MCI-HV-2-3PH	15	–	–	–	–	–	–	✓
	MCI-HV-2-1PH	16	–	–	–	–	–	–	✓
Stepping motor	MOTOR-RSSK-STEPPER	18	–	–	–	✓	–	–	–
	SLG47105V-DMO	37	–	–	–	–	–	–	✓
	SLG47105V-EVB	37	–	–	–	–	–	–	✓

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

Solutions for Permanent Magnet Synchronous Motor (BLDC Motor)

MCK-XXXXX Renesas Flexible Motor Control Kit

Note: XXXXX designates MCU group name mounted on the CPU board.



Motor Control Development Support Tool
Renesas Motor Workbench

Communication Board

CPU Board

Inverter Board

Evaluation Environment

MCK-XXXXX is a development kit for BLDC/PMSM motors consisted of CPU board, inverter board, BLDC motor and communication board. Sample code and a development support tool are provided so you can get started with motor control development right after purchase.

Features

- Equipped with onboard debugger for MCU flash programming.
- Supports 1-shunt and 3-shunt current sensing.
- 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.

* Some products do not include a communication board.
In order to safely implement motor control evaluation, either obtain a communication board separately or use a commercially available USB isolator.

Specifications

Product ID		MCK-RA8T2	MCK-RA8T1	MCK-RA6T3	MCK-RA6T2*	MCK-RA4T1	MCK-RA2T1	MCK-RX26T*
Part No.		RTK0EMA6L0S00020BJ	RTK0EMA5K0S00020BJ	RTK0EMA330S00020BJ	RTK0EMA270S00020BJ RTK0EMA270S00021BJ	RTK0EMA430S00020BJ	RTK0EMA810S00020BJ	RTK0EMXE70S00020BJ RTK0EMXE70S00021BJ
Bundled items	Inverter board	MCI-LV-1 (RTK0EM0000S04020BJ)	←	←	←	←	←	←
	CPU board	MCB-RA8T2 (RTK0EMA6L0C00000BJ)	MCB-RA8T1 (RTK0EMA5K0C00000BJ)	MCB-RA6T3 (RTK0EMA330C00000BJ)	MCB-RA6T2 (RTK0EMA270C00000BJ or RTK0EMA270C00002BJ)	MCB-RA4T1 (RTK0EMA430C00000BJ)	MCB-RA2T1 (RTK0EMA810C00000BJ)	MCB-RX26T Type A (RTK0EMXE70C00000BJ or RTK0EMXE70C00001BJ)
	Communication board	MC-COM (RTK0EMXC90S00000BJ)	←	–	MC-COM (RTK0EMXC90S00000BJ)	–	MC-COM (RTK0EMXC90S00000BJ)	←
	BLDC motor	R42BLD30L3 (MOONS’ Industries)	←	←	←	←	←	←
Inverter specification		■ Rated voltage: 48V ■ Rated current: 10A (continuous) ■ Protect functions: Overcurrent detection, etc.	←	←	←	←	←	←
Resources		■ MCK-RA8T2 User’s Manual ■ Design Package ■ MCK-RA8T2 Quick Start Guide	■ MCK-RA8T1 User’s Manual ■ Design Package ■ MCK-RA8T1 Quick Start Guide	■ MCK-RA6T3 User’s Manual ■ Design Package ■ MCK-RA6T3 Quick Start Guide	■ MCK-RA6T2 User’s Manual ■ Design Package ■ MCK-RA6T2 Quick Start Guide	■ MCK-RA4T1 User’s Manual ■ Design Package ■ MCK-RA4T1 Quick Start Guide	■ MCK-RA2T1 User’s Manual ■ Design Package ■ MCK-RA2T1 Quick Start Guide	■ MCK-RX26T User’s Manual ■ Design Package ■ MCK-RX26T Quick Start Guide

* MCK-RA6T2 and MCK-RX26T have 2 version depending on MCB version.

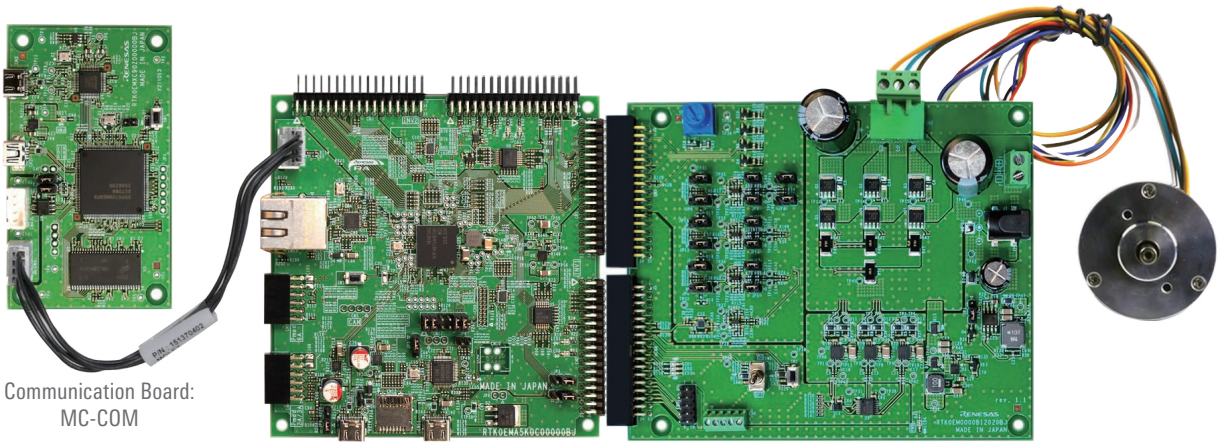
Solutions for Permanent Magnet Synchronous Motor (BLDC Motor)

Available Sample Code for MCK-XXXXX

Sample Code		MCK-RA8T2	MCK-RA8T1	MCK-RA6T3	MCK-RA6T2*	MCK-RA4T1	MCK-RA2T1	MCK-RX26T*
120-degree conducting control + speed control (Hall sensor, sensorless)		✓	✓	✓	✓	✓	–	–
Vector control + speed control	Sensorless	✓	✓	✓	✓	✓	✓	✓
	Encoder (A/B)	✓	✓	✓	✓	✓	–	✓
	Inductive sensor	✓	✓	✓	✓	✓	–	–
	Hall	✓	✓	–	✓	–	–	–
Vector control + position control	Encoder (A/B)	✓	✓	✓	✓	✓	–	✓
	Inductive sensor	✓	✓	✓	✓	✓	–	–
Dual motor control	Sensorless	✓	✓	–	✓	–	–	–

* MCK-RA6T2 and MCK-RX26T have 2 version depending on MCB version. For supported sample code, please check MCK web page.

Renesas provides a scalable solution to support rapid development needs. Renesas Flexible Motor Control Kit allows for a variety of CPU and inverter combination from Low to High voltage targeting wide range of applications.



Communication Board: MC-COM

CPU Board: MCB-RA8T1

Inverter Board: MCI-LV-1

eg. Motor Control Kit Configuration (MCK-RA8T1)

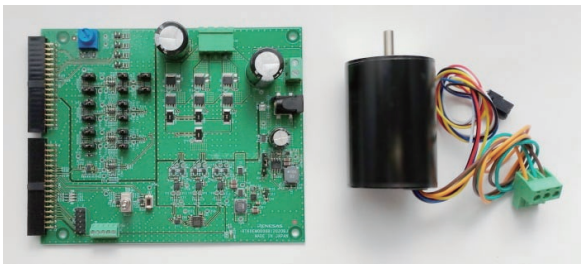
MCI-LV-1

Renesas Flexible Motor Control Inverter Board – Low Voltage 48V/10A for Three-Phase BLDC/PMSM Motor

MCI-LV-1 is a low voltage inverter board kit for 3-phase BLDC/PMSM motor, which is used with CPU board and Communication Board.
MCI-LV-1 and CPU board are included in MCK(Motor Control Kit) as all-in-one kit, simplify the preparation and contribute to quick start of evaluation and shorten time to market.

Features

- Supports 1-shunt and 3-shunt current sensing.
- Overcurrent detection function.
- Supports Hall sensors, Encoders and Inductive position sensors.



Motor Control Inverter Board Configuration (MCI-LV-1)

Specifications

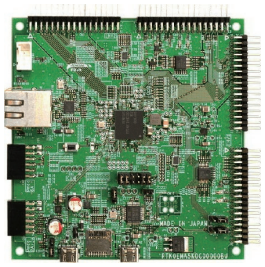
Item	Specification		
Product ID	MCI-LV-1		
Part No.	RTK0EM0000S04020BJ		
Bundled items	48V 10A BLDC motor inverter board (RTK0EM0000B12020BJ)		
	BLDC motor (R42BLD30L3 manufactured by MOONS' Industries)		
Inverter specification	■ Rated voltage: 48V ■ Rated current: 10A (continuous) ■ Safety functions: Overcurrent detection, etc.		
Supported CPU board	MCB-RA8T2, RA8T1, RA6T3, RA6T2, RA4T1, RA2T1, RX26T		
Resources	■ MCI-LV-1 User's Manual ■ MCI-LV-1 Design Package		
Related Products	Analog	ISL28191	Single Supply Ultra-Low Noise, Low Distortion Rail-to-Rail Output, Op Amp

Solutions for Permanent Magnet Synchronous Motor (BLDC Motor)

MCB-XXXXX

Renesas Flexible Motor Control CPU Board

Note: XXXXX designates MCU group name mounted on the CPU board.



Motor Control CPU Board (MCB-RA8T1)

MCB-xxxxx is a CPU board for evaluation of BLDC Motor which is used in combination with Motor Control Inverter board (MCI). MCB-xxxxx and MCI-LV-1 are included in MCK (Motor Control Kit.)

Features

- Equipped with onboard debugger for MCU flash programming.
- Supports signal input from Hall sensors, encoders, and inductive position sensors.

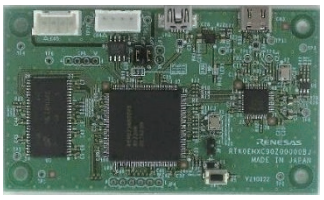
Specifications

Product ID	MCB-RA8T2	MCB-RA8T1	MCB-RA6T3	MCB-RA6T2	MCB-RA4T1	MCB-RA2T1
Part No.	RTK0EMA6L0C00000BJ	RTK0EMA5K0C00000BJ	RTK0EMA330C00000BJ	RTK0EMA270C00000BJ RTK0EMA270C00002BJ	RTK0EMA430C00000BJ	RTK0EMA810C00000BJ
MCU (ROM/RAM)	R7KA8T2LFLCAC	R7FA8T1AHECBD (2MB / 1MB)	R7FA6T3BB3CFM (256KB / 40KB)	R7FA6T2BD3CFP	R7FA4T1BB3CFM (256KB / 64KB)	R7FA2T1074CFL (64KB / 8KB)
2-motor control*1	✓	✓	–	✓	–	–
Supported inverter board	MCI-LV-1	←	←	MCI-LV-1 MCI-HV-1 MCI-HV-2-3PH MCI-HV-2-1PH	MCI-LV-1	←
Resources	MCB-RA8T2 User's Manual	MCB-RA8T1 User's Manual	MCB-RA6T3 User's Manual	MCB-RA6T2 User's Manual	MCB-RA4T1 User's Manual	MCB-RA2T1 User's Manual

Product ID	MCB-RX26T-TYPE-A	MCB-RX26T-TYPE-B	MCB-RX26T-TYPE-C
Part No.	RTK0EMXE70C00000BJ RTK0EMXE70C00001BJ	RTK0EMXE70C01000BJ RTK0EMXE70C01001BJ	RTK0EMXE30C00000BJ
MCU (ROM/RAM)	R5F526TFCDFP (512KB / 64KB)	R5F526TFDDFP (512KB / 64KB)	R5F526TACDFM (256KB / 48KB)
2-motor control	✓	✓	–
Supported inverter board	MCI-LV-1 MCI-HV-1	MCI-LV-1	←
Resources	MCB-RX26T Type A User's Manual	MCB-RX26T Type B User's Manual	MCB-RX26T Type C User's Manual

MC-COM

Renesas Flexible Motor Control Communication Board



MC-COM is a communication board for serial communication with Renesas MCU. It provides an electrically isolated environment for safe evaluation preventing from electric shock and burns enabling 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.

Specifications

Item	Specification		
Product ID	MC-COM		
Part No.	RTK0EMXC90S00000BJ		
Isolation	Between SCI connector and MCU 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, RL78/G1F CPU Card MCB-RA6T2/RA6T3/RA4T1/RA2T1/RA8T1/RA8T2 MCB-RX26T Type A/Type B/Type C		
Resources	MC-COM User’s Manual		
Related Products	Analog	ISL80505	Linear Regulators (LDO)

Solutions for Permanent Magnet Synchronous Motor (BLDC Motor)

High-voltage motor control evaluation and development must be conducted in a safe environment to reduce the risk of electric shock and burns faced during development and create a safe evaluation environment. Renesas provides scalable high-voltage solutions to support rapid development needs. Renesas' high-voltage motor control evaluation kits include two products—MCI-HV-1 for BLDC Motor for home appliances application and MCI-HV-2-3PH/1PH for Induction Motor for industrial applications with three-phase/single-phase input.

MCI-HV-1

Renesas Flexible Motor Control Inverter Board for 100V/200V Three-Phase BLDC/Induction Motor

MCI-HV-1 is an inverter board for 100V/200V Three-Phase BLDC/Induction Motor which allows easy evaluation of motor control using high-voltage motors by combining with a compatible CPU board.

Features

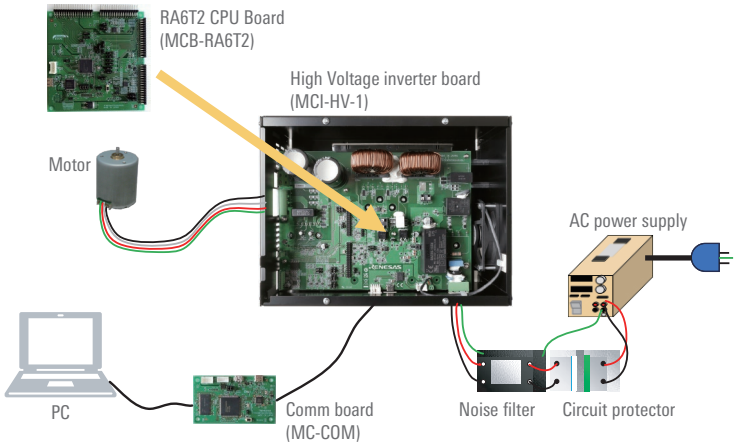
- Input supply voltage range (AC100-240V 50/60Hz or DC141-390V).
- Equipped with PFC control circuit.
- Supports 1-shunt and 3-shunt current sensing.
- Overcurrent detection, overvoltage protection and overtemperature detection.
- Compatible with MCB Type CPU Board.

Specifications

Item	Specification		
Product ID	MCI-HV-1		
Part No.	RTK0EM0000B14030BJ		
Bundled items	100-240V 50/60Hz 10A BLDC motor inverter board		
	Connectors and cables		
Support CPU board	MCB-RA6T2, MCB-RX26T		
Inverter specification	■ Rated Input: AC100-200V, 50/60Hz 10A DC141-390V, 10A ■ Rated Output: 500W (AC100V) 1kW (AC200-240V) 2kW (DC390V) ■ Detection Function: Phase voltage, Phase current, Bus voltage, Input voltage, PFC current, temperature ■ PFC: Max output 1kW, Single/Interleaved control ■ Current detection: 1-/3-shunt ■ Protection function: Overcurrent detection, Short circuit prevention, Overtemperature detection, Over voltage prevention, Inrush current prevention ■ Support sensor: Hall sensor, Encoder ■ Isolation: Sensor I/F, Comm I/F (Both are reinforced isolated.)		
Sample code *	■ RA6T2 Sensorless Vector Control of PM Motor by High-Voltage Inverter ■ RA6T2 Sensorless Vector Control for IPMSM over the Speed Range by High-Voltage Inverter ■ Renesas RA and RX Families Sensorless Vector Control of PM Motor by High-Voltage Inverter		
Resources	■ MCI-HV-1 User's Manual ■ MCI-HV-1 Design Package		
Related Products	Analog	ISL32173EIVZ	QUAD, ±16.5kV ESD Protected, 3.0V to 5.5V, RS-485/RS-422 Receivers
		ISL85003AFRZ	Highly Efficient 3A Synchronous Buck Regulator
	Power	ISL85003AFRZ	4.5V to 42V, 5A, DC/DC Synchronous Step-Down Regulator

Note: Supported Sample Code differs depend on CPU board version.
Please confirm the P/N of CPU board on web page.

Evaluation System Configuration



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.

MOTOR-RSSK-BLDC

Evaluation System for BLDC Motor

With Compatible CPU cards, free download sample code and a development support tool, you can get started with motor control evaluation immediately after purchase.

Evaluation System for BLDC Motor

Features

- Motor control kit that supports up to DC48V input.
- Supports 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.

Specifications

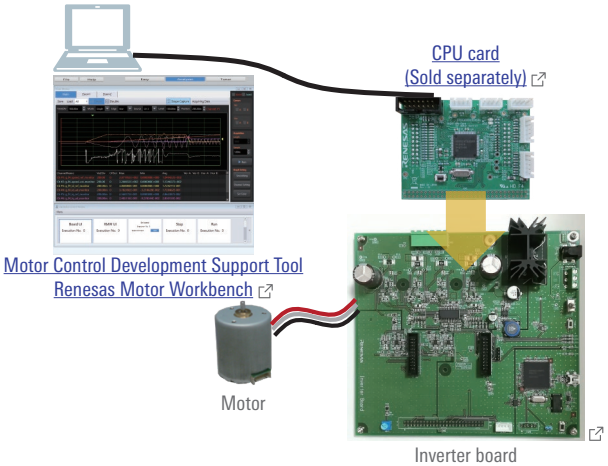
Item	Specification
Product ID	Evaluation System for BLDC Motor
Part No.	RTK0EMX270S00020BJ
Bundled items	48V 5A Inverter board for BLDC motor
	BLDC motor (TG-55L-KA)
Inverter specification	■ Rated voltage: 48V ■ Rated current: 5A (continuous) ■ Protect function: Overcurrent detection, others
Resources	Evaluation System for BLDC Motor User's Manual Schematic, BOM List
Related Products	Gate driver: HIP4086ABZT Regulator: ISL9001AIRNZ

Available Sample Code for Evaluation

Item		Supported MCUs								
		RL78 Family	RX Family							RA Family
		RL78/G1F*	RX13T	RX23T	RX24T	RX24U	RX66T	RX72T	RX72M	RA6T1
120-degree conducting control + speed control (Hall sensor, sensorless)		–	✓	✓	✓	–	–	–	–	✓
Vector control + speed control	Sensorless	–	✓	✓	✓	✓	✓	✓	✓	✓
	Encoder (A/B)	–	✓	✓	✓	✓	✓	✓	✓	✓
	Magnetic sensor	–	✓	✓	✓	✓	✓	✓	✓	–
	Inductive sensor	–	✓	✓	✓	✓	✓	✓	✓	–
	Resolver	–	–	✓	✓	–	✓	✓	✓	–
Vector control + position control	Encoder (A/B)	–	✓	✓	✓	✓	✓	✓	✓	✓
	Magnetic sensor	–	✓	✓	✓	✓	✓	✓	✓	–
	Inductive sensor	–	✓	✓	✓	✓	✓	✓	✓	–
	Resolver	–	–	✓	✓	–	✓	✓	✓	–
Multiple motor control		–	–	–	–	–	✓ (2 motors: sensorless)	✓ (3 motors: encoder) (4 motors: sensorless)	–	✓ (2 motors: sensorless)

* RL78/G1F CPU Card is compatible with MOTOR-RSSK-BLDC.

Evaluation System Configuration

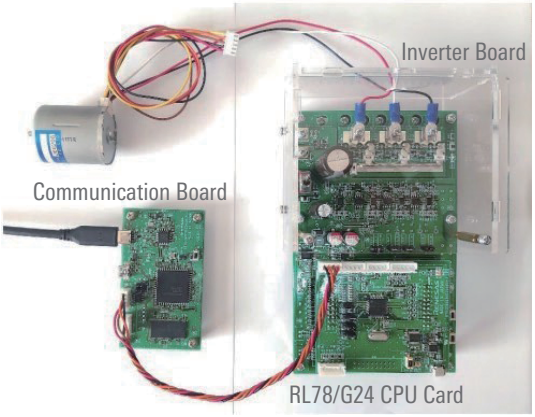


Solutions for Permanent Magnet Synchronous Motor (BLDC Motor)

MCEK-RL78G24

RL78/G24 Motor Control Evaluation Kit

The RL78/G24 Motor Control Evaluation Kit is a permanent magnet synchronous motor (brushless DC motor) control evaluation kit that is equipped with an RL78/G24 microcontroller, which allows easy evaluation of motor control.



Features

- Equipped with 16-bit RL78/G24 microcontroller.
- Controlled by Hall sensor and Encoder with BLDC motor, or Sensorless control by phase voltage or sensing current.
- Supports 1-shunt 2-shunt and 3-shunt current sensing.
- Zero-crossing detection with built-in compilator.
- Supports the motor control development support tool “Renesas Motor Workbench” for easy debugging.
- Compatible with RL78/G1F CPU card.

Specifications

Item	Specification	
Product ID	RL78/G24 Motor Control Evaluation Kit	
Part No.	RTK0EMG24SS00000BJ	
Bundled items	■ Inverter Board (RTK0EMGPLVB00000BJ) ■ RL78/G24 CPU Card (RTK0EMG240C00000BJ) ■ Communication Board (RTK0EMXC90Z00000BJ) ■ Permanent Magnet Synchronous Motor (TG-55L-KA) ■ Various cables, screws, spacers	
Inverter specifications	Operating input voltage: 50V	
	Rated output current: 30A (peak current for each phase)	
	Protect functions	Overcurrent detection, etc.
Sample code	■ RL78/G24 120-degree conducting control of permanent magnetic synchronous motor ■ RL78/G24 Sensorless vector control for permanent magnetic synchronous motor ■ RL78/G24 Sensorless vector control for permanent magnetic synchronous motor FAA Library	
Resources	■ RL78/G24 Motor Control Evaluation Kit User's Manual ■ Schematics, BOM	
Related Products	■ MCU: R7F101GLG2DFB ■ Gate Driver: HIP2101IBZ ■ Regulator: ISL85003FRZ	

Solutions for Permanent Magnet Synchronous Motor (BLDC Motor)

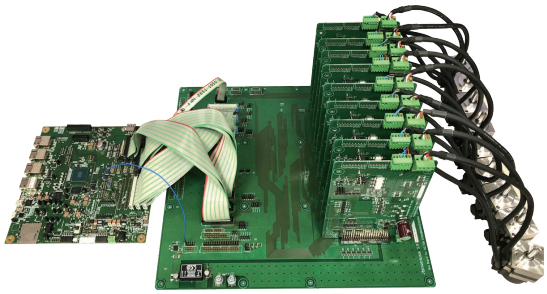
RZT2H-9-AXIS-MOTOR

RZ/T2H 9-Axis Motor Control Reference Design

If you want to control up to 9motors simultaneously, this is the best solution.

Features

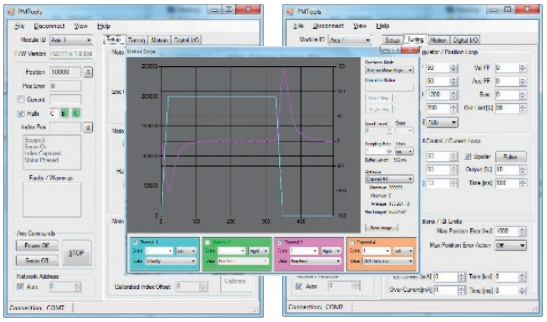
- Up to 9 axis motor control by RZ/T2H.
- Enable to control each axis as speed/position control.
- Support FA-CODER as encoder I/F.
- Inverter board supports absolute/incremental type encoder.
- Enable to operate each axis individually using Motion Control Utility that is motor control development support tool by Renesas.
- Offering 9 axis motor control sample code and app note from Renesas website.



From left: Evaluation Board Kit for RZ/T2H,
Bus Board for RZ/T2H and RZ/T Series Inverter Board
set up

Specifications

Item	Specification
Product ID	RZT2H-9-AXIS-MOTOR
Part No.	■ RZ/T2H Evaluation Board Kit (RTK9RZT2H0S00000BJ) ■ Bus Board for RZ/T2H (RTK0EM0000Z03000BJ) ■ RZ/T Series Inverter Board (RTK0EM0000B15010BJ)
Structure	■ RZ/T2H Evaluation Board Kit ■ Bus Board for RZ/T2H ■ RZ/T Series Inverter Board ■ BLDC Motor with Encoder (FA-CODER®)
Inverter specifications	■ Rated voltage: 24V DC ■ Rated current: 4A (effective value) ■ Current detection: 3-shunt delta-sigma modulator ■ Safety functions: Overcurrent detection ■ Position detection: Incremental encoder x1, Absolute encoder x2
Sample code	RZ/T2H 9-axis Motor Control Program
Resources	■ RZ/T2H Startup Manual (RZ/T2H Motion Control Utility) ■ RZ/T2H Program Writing Guide ■ RZ/T2H Evaluation Board Kit Design Files ■ BUSB-RZT2H-B Design Files ■ INVB-LV-RZT-I Design Files



Motion Control Utility

Related Products

Category	Part No.	Key Features
MPU/MCU	RZ/T2H	1200MHz Arm® Quad Cortex®-A55 and Arm® Dual Cortex®-R52, Real-time control + Industrial Ethernet
Analog	RV1S9061A	15Mbps IPM Drive Photocouplers
	RV1S9355A	Optically Isolated ΔΣ Modulator
	ISL3172EIBZ	RS-485/RS-422 Transceivers
	ISL32179EFRZ	RS-422 Transmitters
	ISL32177EFRZ	RS-485/RS-422 Receivers
	RV1S9213ACCSP-10YV#	OPTO COUPLER IN 5PIN SSOP
	PS2733-1-A	OPTOISOLATOR 2.5KV DARL 4SMD
	PS2561DL-1	OPTOISOLATOR 5KV TRANS 4SMD
	PS8101-AX	OPTOISO 3.75KV PUSH PULL 6SO
	PS2761B-1	OPTOISOLATOR 3.75KV TRANS 4SOP
Power	DA9061-16AM1	PMIC for Applications Requiring up to 6 A
	RAA211450GSP#HA0	4.5V to 42V, 5A, DC/DC Synchronous Step-Down Regulator
Memory	AT25SF128A-SHB-T	IC FLASH 128MBIT SPI/QUAD 8SOIC
	R1EX24016ASAS	IC EEPROM 16KBIT I2C 400KHZ 8SOP

Solutions for AC Synchronous Motors

CN032-ACSERVO

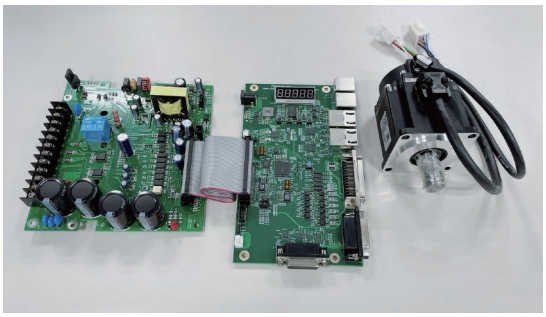
RZ/T2M, RZ/T2L, RZ/N2L Motor Solution Kit (AC 220V Version)

These solution kits simplify the initial and ongoing development of servo systems and motion controllers employing the RZ/T2M, RZ/T2L, and RZ/N2L. Each comprises a control board populated with the RZ/T2M, RZ/T2L, or RZ/N2L, an inverter board capable of driving a 220V AC synchronous motor, a motor for use in evaluation, a utility tool for adjusting motor parameters and motion control operation, control software, and more. The utility tool runs on a PC and allows operation of the motor with position and speed control by means of control commands sent via UART or RS-485. Alternatively, the motor can be operated via EtherCAT using CiA 402 profiles.

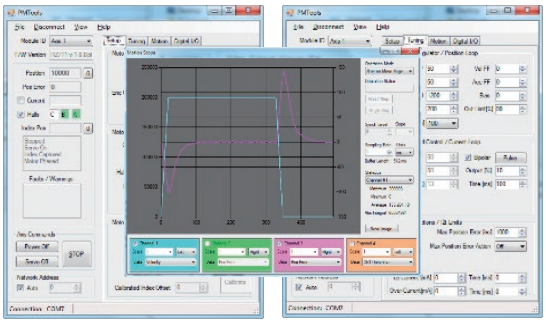
Features

- Compatible with power supplies from 100 to 250V AC.
- Compatible with absolute encoders from Tamagawa Seiki.
- A Renesas delta-sigma (ΔΣ) modulator can be connected to the delta-sigma (ΔΣ) interface for highly precise current sensing.
- Either UART or RS-485 can be used for data transfer with the utility tool.
- A sample program is provided for servo control via industrial Ethernet (EtherCAT or CiA 402).*1
- Motor control using CiA 402 profiles (pp, csp, and csv*2) is supported.

*1: An EtherCAT master such as TwinCAT® 3 must be provided by the customer.
*2: pp: position profile, csp: cyclic synchronous position, csv: cyclic synchronous velocity



Available for loan free of charge. Please contact a Renesas Electronics distributor or sales office for details.



Motion Control Utility

Specifications

Item	Specification
Product ID	CN032-ACSERVO
Part No.	CN032-ACSERVOT2LPOCZ, CN032-ACSERVOT2MPOCZ
Bundled items	■ Controller board (populated with RZ/T2M, RZ/N2L, or RZ/T2L) ■ Single-axis drive inverter board
	AC synchronous motor (BM0602B1PD-A02) (with Tamagawa Seiki absolute encoder)
Supported CPU Board	RZ/T2M, RZ/T2L, RZ/N2L
Inverter specifications	■ Rated voltage: 100 to 250V AC ■ Rated current: 1.5A (effective value) ■ Current detection: ∑ΔModulator (RV1S9353A) ■ Safety functions: Overcurrent detection, bus voltage detection ■ Position detection: Absolute encoder ■ Communication functions: EtherCAT ports x2, CAN, UART, USB, RS485
Sample code	AC Servo Solution Package
Resources	■ AC Servo Solution Controller Board Manual (for RZ/T2M, RZ/N2L) ■ AC Servo Inverter Board Manual ■ AC Servo Solution Firmware Manual ■ AC Servo Solution Startup Guide (for Motion Control Utility) ■ AC Servo Solution Design Package

Related Products

Category	Part No.	Key Features
MPU/MCU	RZ/T2M	800MHz dual core Arm®-based High-end 32-bit MPU, Real-time control + Industrial Ethernet
	RZ/T2L	800MHz single core Arm®-based High-end 32-bit MPU, Real-time control + Industrial Ethernet
	RZ/N2L	400MHz single core Arm®-based High-end 32-bit MPU, Real-time control + Industrial Ethernet
Analog	RV1S9061A	15Mbps IPM Drive Photocouplers
	RV1S9353A	Optically Isolated ΔΣ Modulator
	ISL3172EIBZ	RS-485/RS-422 Transceivers
	ISL32179EFRZ	RS-422 Transmitters
	ISL32177EFRZ	RS-485/RS-422 Receivers
	RV1S9213ACCSP-10YV#	OPTO COUPLER IN 5PIN SSOP
	PS2733-1-A	OPTOISOLATOR 2.5KV DARL 4SMD
	PS2561DL-1	OPTOISOLATOR 5KV TRANS 4SMD
	PS8101-AX	OPTOISO 3.75KV PUSH PULL 6SO
	PS2761B-1	OPTOISOLATOR 3.75KV TRANS 4SOP
Power	DA9061-16AM1	PMIC for Applications Requiring up to 6 A
	RAA211450GSP#HA0	4.5V to 42V, 5A, DC/DC Synchronous Step-Down Regulator
Memory	AT25SF128A-SHB-T	IC FLASH 128MBIT SPI/QUAD 8SOIC
	R1EX24016ASAS	IC EEPROM 16KBIT I2C 400KHZ 8SOP

Solutions for AC Induction Motor

MCI-HV-2-3PH

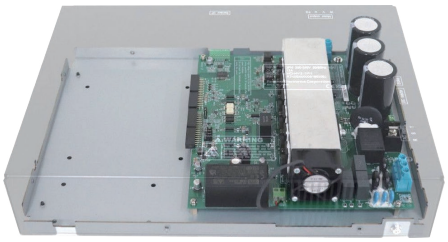
Flexible Motor Control Inverter Board for Three-Phase BLDC/Induction Motor for Industrial Application, 200-240VAC 3PH Input

The inverter board allows users to evaluate motor control using a 3-phase AC200V industrial High-voltage BLDC/Induction motor. The board has built-in protection functions and has an enclosure that can install CPU board and Comm board for safety evaluation.

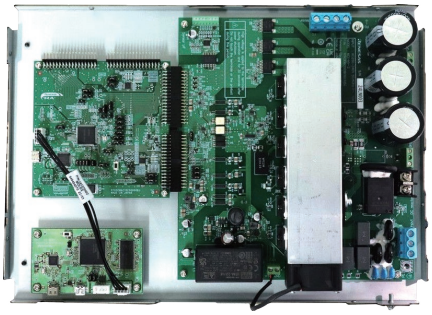
Features

- Supports over current detection, over voltage protection, over temperature detection.
- Supports AC input power supply (3-phase AC200-240V 50/60Hz).
- Reinforced isolation between high voltage domain and user interface domain.
- Supports 3-phase in-line current sensing.
- Supports HALL sensor and Encoder signal input with reinforced isolation.
- Compatible with MCB type CPU board.

Exterior with Enclosure



Board exterior



Exterior with CPU board, Comm board attached.

Specifications

Item	Specification
Product ID	MCI-HV-2-3PH
Part No.	RTK0EM0000B16030BJ
Bundled items	Inverter board
	Accessories (Screws, Spacers)
Supported CPU Board	MCB-RA6T2
Inverter specifications	■ Rated input: AC:200-240V 50/60Hz 10A (3-Phase) 3.5kVA ■ Rated output: 12A, 2.2kW ■ Detection function: Phase current, Bus voltage, Temperature ■ Current detection: 3 phase in-line sensing with HALL CT ■ Protection function: Over current, Over voltage, Low voltage, Over speed, Over temperature ■ Support sensor: HALL sensor, Encoder (A/B/Z-phase) ■ Isolation: Sensor I/F, Comm I/F (Both are reinforced isolation)
Sample code	IMV/f Control by High-Voltage Inverter
Resources	■ MCI-HV-2-3PH User's Manual ■ MCI-HV-2-3PH_DesignPackage

Related Products

Category	Part No.	Key Features
Analog	RV1S9207ACCSP-10YC	0.6 A Output Current, High CMR, IGBT Gate Drive, 5-PIN SSOP (LSSO5 WITH 8.2mm Creepage Distance) Photocoupler
	PS9013-Y-F3-AX	1 Mbps, Open Collector Output, High CMR, IPM DRIVER, 5-PIN SSOP (LSO5) Photocoupler
	PS8352AL2-E3-AX	Analog Output Type Optical Coupled Isolation Amplifier
	ISL32173EIVZ	QUAD, ±16.5kV ESD Protected, 3.0V to 5.5V, RS-485/RS-422 Receivers
	ISL28191FRUZ-T7	Single Supply Ultra-Low Noise, Low Distortion Rail-to-Rail Output, Op Amp
	RV1S9231ACCSP-10YC	2.5 A Output Current, High CMR, IGBT Gate Drive, 5-PIN SSOP (LSSO5 WITH 8.2mm Creepage Distance) Photocoupler
Power	RAA2230214GSP	700V AC/DC Regulator with Ultra-Low Standby Power and up to 12W Output Power
	ISL85003AFRZ	Highly Efficient 3A Synchronous Buck Regulator
	ISL80103IRAJZ-TK	High Performance 3A Linear Regulator
Programmable Mixed-signal	SLG46826V	GreenPAK Programmable Mixed-Signal Matrix with In-System Programmability

Solutions for AC Induction Motor

MCI-HV-2-1PH

Flexible Motor Control Inverter Board for Three-Phase BLDC/Induction Motor for Industrial Application, 200-240VAC 1PH Input

The inverter board allows users to evaluate motor control using a 1-phase AC200V industrial High-voltage BLDC/Induction motor. The board has built-in protection functions and has an enclosure that can install CPU board and Comm board for safety evaluation.

Features

- Supports over current detection, over voltage protection, over temperature detection.
- Supports AC input power supply (1-phase AC200-240V 50/60Hz).
- Reinforced isolation between high voltage domain and user interface domain.
- Supports 1-phase in-line current sensing.
- Supports HALL sensor and Encoder signal input with reinforced isolation.
- Compatible with MCB type CPU board.

Exterior with Case

Board exterior

Specifications

Item	Specification
Product ID	MCI-HV-2-1PH
Part No.	RTK0EM0000B18030BJ
Bundled items	Inverter board
	Accessories (Screws, Spacers)
Supported CPU Board	MCB-RA6T2
Inverter specifications	■ Rated input: AC:200-240V 50/60Hz 20A (1-Phase) 2.3kW ■ Rated output: 12A, 2.2kW ■ Detection function: Phase current, Bus voltage, Temperature ■ Current detection: 1 phase in-line sensing with HALL CT ■ Protection function: Over current, Over voltage, Low voltage, Over speed, Over temperature ■ Support sensor: HALL sensor, Encoder (A/B/Z-phase) ■ Isolation: Sensor I/F, Comm I/F (Both are reinforced isolated.)
Sample code	IM V/f Control by High-Voltage Inverter
Resources	■ MCI-HV-2-1PH User's Manual ■ MCI-HV-2-1PH Design Package

Related Products

Category	Part No.	Key Features
Analog	RV1S9207ACCSP-10YC	0.6 A Output Current, High CMR, IGBT Gate Drive, 5-PIN SSOP (LSSO5 WITH 8.2mm Creepage Distance) Photocoupler
	PS9013-Y-F3-AX	1 Mbps, Open Collector Output, High CMR, IPM DRIVER, 5-PIN SSOP (LSO5) Photocoupler
	PS8352AL2-E3-AX	Analog Output Type Optical Coupled Isolation Amplifier
	ISL32173EIVZ	QUAD, ±16.5kV ESD Protected, 3.0V to 5.5V, RS-485/RS-422 Receivers
	ISL28191FRUZ-T7	Single Supply Ultra-Low Noise, Low Distortion Rail-to-Rail Output, Op Amp
	RV1S9231ACCSP-10YC	2.5 A Output Current, High CMR, IGBT Gate Drive, 5-PIN SSOP (LSSO5 WITH 8.2mm Creepage Distance) Photocoupler
Power	RAA2230214GSP	700V AC/DC Regulator with Ultra-Low Standby Power and up to 12W Output Power
	ISL85003AFRZ	Highly Efficient 3A Synchronous Buck Regulator
	ISL80103IRAJZ-TK	High Performance 3A Linear Regulator
Programmable Mixed-signal	SLG46826V	GreenPAK Programmable Mixed-Signal Matrix with In-System Programmability

Solutions for Stepping Motor

Resolver motor control solutions featuring superlative cost performance

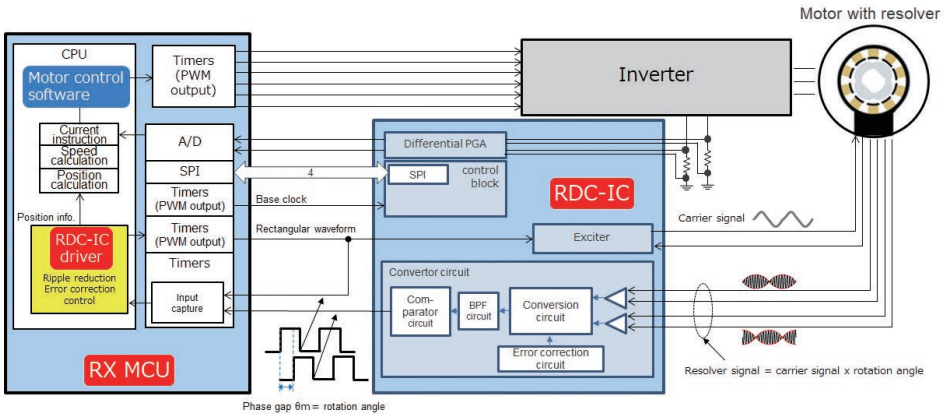
Resolver Motor Control Solutions

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

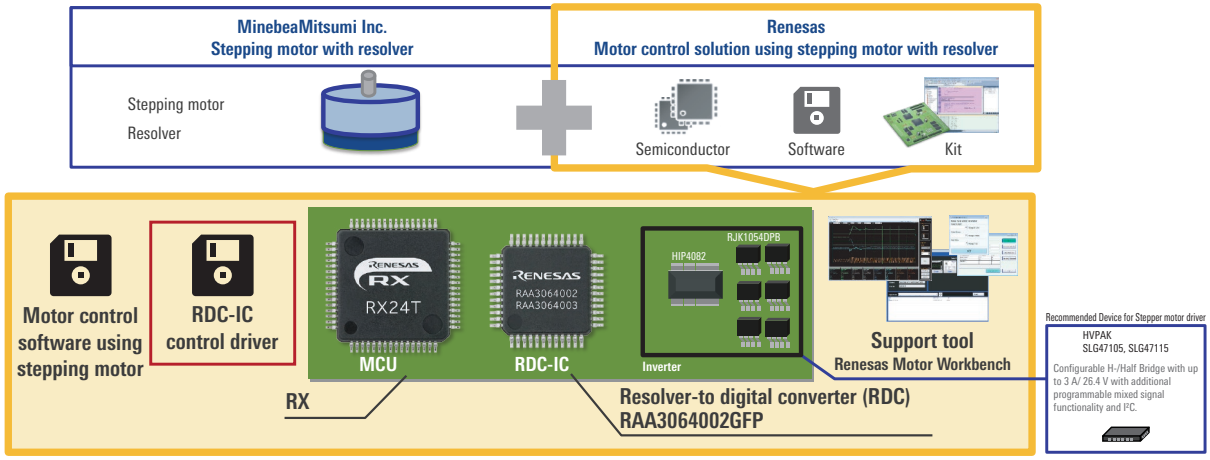
- High-precision motor control is possible even in the harsh environments with heat, dust, or vibration.
- Realize high-precision control at low cost using a new type of resolver control with higher cost performance.
- Resolver signal gain, phase, and angle error are automatically corrected through the 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

For simple, highly integrated open-loop stepper motors- info can be found at pages 36-37.

Solutions for Stepping Motor

MOTOR-RSSK-STEPPER

Evaluation System for Stepping Motor with Resolver

A solution kit that enables easy evaluation/consideration of the RX MCU and RDC-IC. Includes a stepping motor with resolver, allowing users to start the evaluation just after purchase by using the software that is downloadable from the web.

Evaluation System for Stepping Motor with Resolver

Features

- A kit for servo control with a stepping motor, enabling servo control of the stepping motor with the FB information of current and position through the inverter circuit.
- Includes a stepping motor with resolver sensor 'R17PMK440CNVA4438' (manufactured by Minebea Mitsumi Inc.) and a board with RDC-IC 'RAA3064002GFP' (manufactured by Renesas), enabling the high-resolution position control.
- Includes a CPU Card with a MCU for motor control 'RX24T' mounted, realizing the control of motor with resolver by using RX24T.
- Renesas provides a sample code with resolver driver that supports this kit. Also provides an Application Note that describes the control methods and how to implement them into MCUs.
- Supports motor control development support tool 'Renesas Motor Workbench'. It enables intuitive setting and tuning of motor control parameters and real-time analysis, improving customers' development efficiency.

Specifications

Item	Specification
Product ID	MOTOR-RSSK-STEPPER
Part No.	RTK0EMX270S01020BJ
Bundled items	Inverter board for stepping motor
	RX24T CPU Card with RDC *
	Stepping motor with resolver (R17PMK440CNVA4438) (MinebeaMitsumi Inc.)
Supported CPU Board	RX24T CPU Card with RDC-IC *, RX72M CPU Card with RDC-IC
Inverter specifications	■ Rated voltage: 48V ■ Input voltage range: 24 - 48V ■ Rated current: 2A (continuous) ■ Detection function: Phase current, Bus voltage ■ Protection function: Overcurrent detection
Sample code	■ Vector Control of Two-Phase Stepping Motor with Resolver Rev.1.01 ■ Using the Driver (Rev. 2.10) for Resolver-to-Digital Converter Control
Resources	■ Evaluation System for Stepping Motor with Resolver User's Manual ■ rtk0emx270s01020bj-design-package

* RX24T CPU Card with RDC is not purchasable by itself.

Related Products

Category	Part No.	Key Features
MPU/MCU	RX24T	32-bit MCU, FPU*1, 5V operation, PGA*2, 2 motor control
	RX66T	32-bit MCU, FPU*1, 5V operation, PGA*2,3, 4 motor control, Security module
	RX72T	32bit MCU, FPU*1, 5V operation, PGA*2,3, Built-in TFU*4, 4 motor control, Security module
	RX72M	32-bit MCU, Double precision FPU*1, Built-in TFU*4, Security module, EtherCAT® compatible
RDC-IC	RAA3064002GFP (85°C) RAA3064003GFP (105°C)	Single-phase induced/Two phase output Excitation frequency: 5/10/20kHz, 2.5Vp-p
Analog	HIP4082IBZT	80V/1.25A Peak Current Full Bridge FET Driver
	ISL3156EIUZ	16kV ESD Protected, RS-485/RS-422 Differential Transceiver with Full Fail-safe Rx
Power	ISL9001AIRNZ	LDO with Low ISUPPLY, High PSRR

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

Air Conditioner Outdoor Unit Reference Design

AIR-CON-ODU-REF

Dual Motor Control with Interleaved PFC for Air Conditioner Outdoor Unit Reference Design

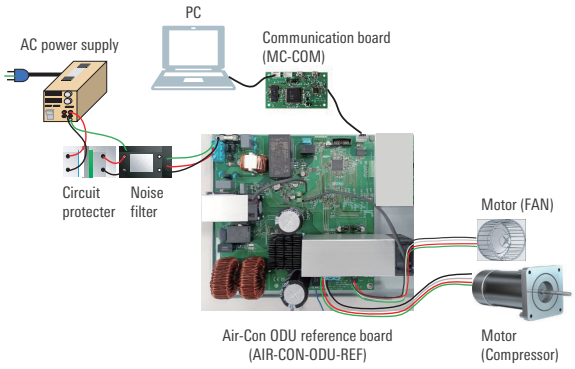
Designing Air Conditioner ODU requires higher power efficiency. This reference design for air conditioner outdoor units using Renesas MCU enables efficient control of the compressor motor, fan motor, and PFC with a single microcontroller.

Features

- Dual motor control (compressor and fan).
- Open-loop control from standstill or/and low-speed.
- PM sensorless vector control using induced voltage observer during medium to high-speed operation (1-shunt and 3-shunt).
- Flux weakening control for high-speed operation and maximum torque per ampere (MTPA) control for IPMSM.
- Torque vibration suppression function, step-out detection, and flying start.
- Single-phase and interleaved PFC control (power factor correction and boost function).

Specifications

Item	Specification
Product ID	AIR-CON-ODU-REF
Bundled items	■ AIR-CON-ODU-REF ■ MC-COM
Supported CPU	RX26T
Inverter specifications	■ Rated input: 100~240Vac,2.4kVA,50/60Hz(input from CN1) ■ Rated output: 10Arms (for compressor), 1Arms (for fan) ■ Switching frequency: PFC : 32 kHz (typical), Inverter : 8kHz (typical) ■ Current sensing: 1-/3-shunt sensing ■ Voltage sensing: AC input voltage, Bus voltage ■ Protection function: Over current, Over voltage, Over-temperature ■ Supporting peripheral function: Electronic expansion valve(EEV) , 4way valve ■ Communication: Motor Control Development Support Tool "Renesas Motor Workbench", JTAG, Communication with indoor unit
Sample code	Dual Motor Control with Interleaved PFC for Air Conditioner Outdoor Unit Reference Design
Resources	■ Air Con ODU Ref User's Manual ■ Air Conditioner Outdoor Unit Design Files

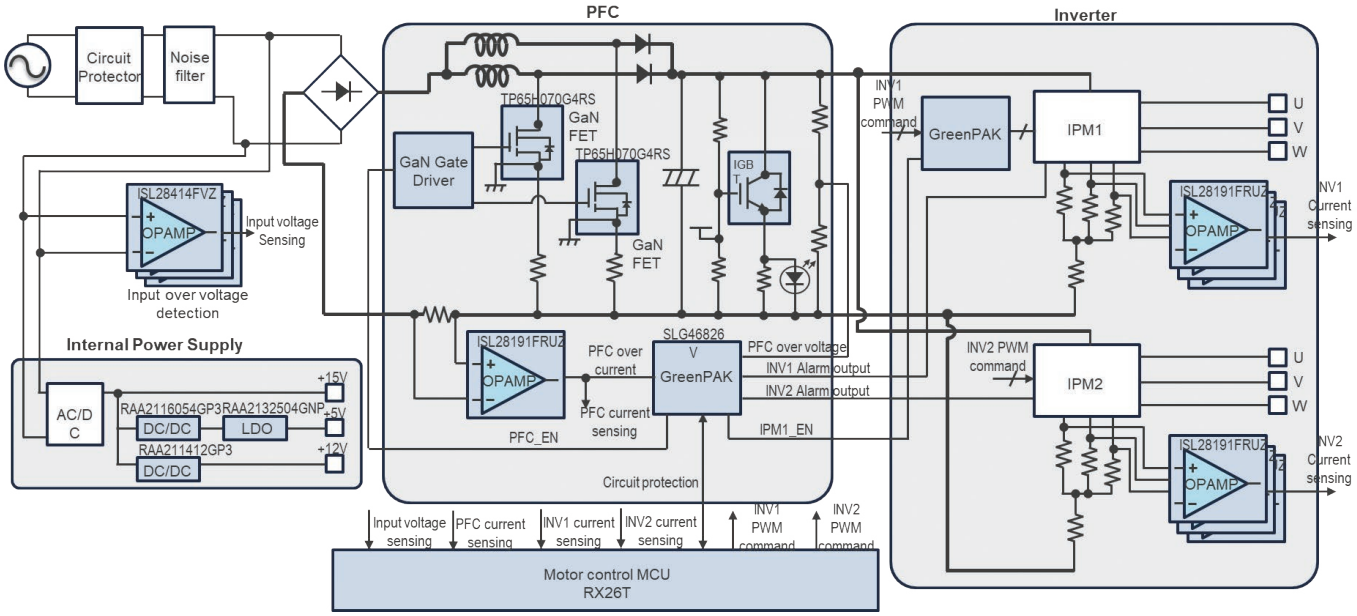


System Configuration

Related Products

Category	Part No.	Key Features
MPU/MCU	RX26T	120 MHz CPU RXv3 core (721 CoreMark)
Analog	SLG46826V	GreenPAK Programmable Mixed-Signal IC, VDD Range: 2.3-5.5V
	ISL28191FRUZ	OPAMP Single Supply Ultra-Low Noise, Low Distortion Rail-to-Rail Output
	ISL28414FVZ	OPAMP Quad General Purpose Micropower
Power	TP65H070G4RS	650V 72mΩ Super GaN FET

Block Diagram



2-Axis Arm Robot Reference Design

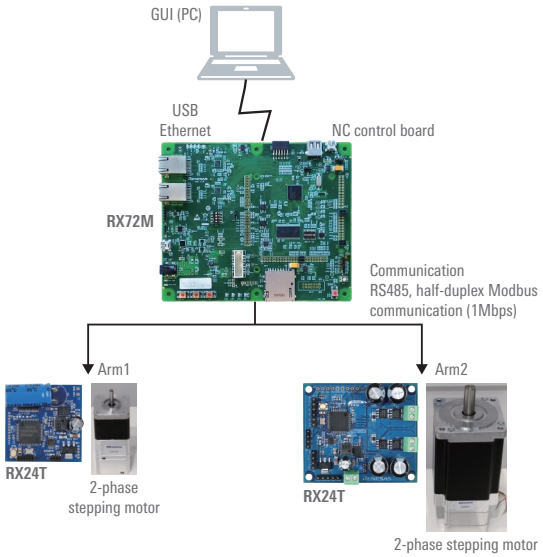
2-AXIS-ROBOT-ARM-REF

2-Axis Robot Arm Reference Design

This demonstration kit for a 2-axis robot arm utilizes Renesas' motor control solution for position control using the RX24T and RX72M 32-bit microcontrollers (MCUs) for 2-phase stepping motor control with resolvers. The RX72M handles the numerical control and dual RX24T handle each axis of the 2-phase stepping motor. The system enables movement of the arm at speeds of up to 250mm per second within the movable range of 150mm x 153mm.

Features

- Numerical control (NC) is achieved with the RX72M and motor control of each axis with the RX24T.
- Arm trajectory control (controlled path control or CP) enables continuous operation of any path at speeds up to 250mm/s in a 150mm x 153mm range of motion.
- The high position resolution (200,000P/R) of the resolver enables ±0.2mm positioning accuracy.



System Configuration

Specifications

Item	Specification
Product ID	2-AXIS-ROBOT-ARM-REF
Bundled items	■ System control board (Renesas Starter Kit+ for RX72M) ■ Motor control board (42-mm square motor control board, 85-mm square motor control board) ■ Stepping motor with a resolver (42-mm square, 85-mm square)
Supported CPU	RX72M, RX24T
System specifications	■ Input power supply: 24VDC ■ Sensor: Resolver (RDC IC is installed, part number: RAA3064002GFP), origin sensor (DOG, FLS, or RLS) ■ Protection function: Over current, Hardware reset ■ Communication: Motor Control Development Support Tool "Renesas Motor Workbench", pulse string, RS485
Sample code	RX24T, RX72M, RAA3064002GFP/RAA3064003GFP Reference Guide for a 2-Axis Robot Arm with 2-Phase Stepping Motors Incorporating Resolvers
Resources	■ Reference Guide for a 2-Axis Robot Arm with 2-Phase Stepping ■ 2-Axis Robot Arm with 2-Phase Stepping Motors Incorporating Resolvers Design Files

Related Products

Category	Part No.	Key Features
MPU/MCU	RX72M	High-Performance 32-bit Microcontroller for Industrial Network Solutions
	RX24T	32-Bit Microcontroller with On-Chip FPU Enable to Drive Two Motors Simultaneously
Analog	RAA3064002GFP	Resolver-to-Digital Converters
	RAA3064003GFP	Resolver-to-Digital Converters

Whole Speed Range Sensorless Vector Control Solution for IPM Motors

This solution implements sensorless vector control of a salient IPM motor (IPMSM) from zero speed at the rated torque.

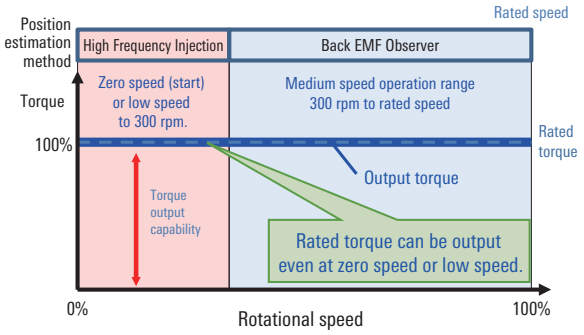
This solution includes Inverter board, CPU cards, sample code, application notes as well as development support tool. This solution is ideal for applications involving load torque at zero speed (start) or low speed and applications requiring energy efficiency in the low-speed range, such as Home appliance, E-bike, Electric Wheelchair, or Power tools.

Features

- Supports IPM motors. (Ordinary SPM motors and non-salient motors are not supported.)
- Eliminates need for magnetic pole position sensor for reduced BOM cost and better reliability.
- The sensorless algorithm enables output of the rated torque from zero speed or low speed.
- Compatible with Motor Control Development Support Tool Renesas Motor Workbench.
- Overcurrent, overvoltage, and overheating protection functions enable safety evaluation.
- Three inverter board options for High Voltage and Low Voltage motor control as below table.
- Sample Code available: implementing high-voltage motor control (PFC control, Vibration suppression function, etc.) and control method (vector control, etc.) along with application note that describe control method explanation and how to implement to MCU *.
- Can be used for IPM motor control when used in combination with the DC 311V input high-voltage inverter board (which must be purchased separately from Desk Top Laboratories Inc.).

* Please make sure to confirm sample program and application note are targeting MCI-HV-1 (RTK0EM0000B14030BJ) and MCB-RA6T2 before use.

Operation Overview

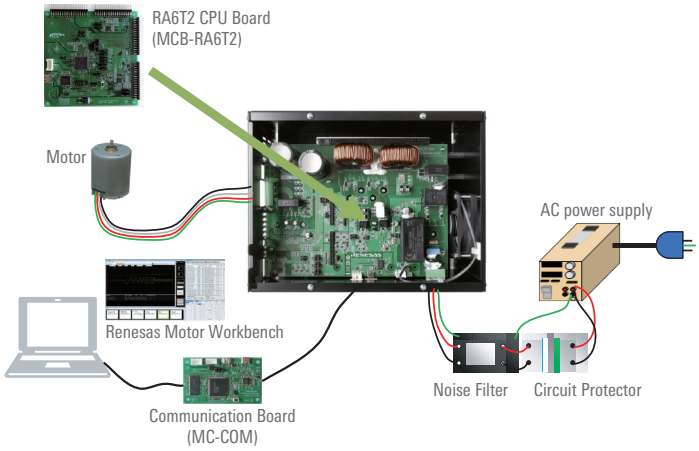


Evaluation Environment Specifications

Item		Specification	
Bundled items	Inverter Board	MCI-LV-1*	MCI-HV-1
	CPU Board	MCB-RX26T TypeA*	MCB-RA6T2
	Communication Board	MC-COM*	MC-COM
Inverter specification	Rated Voltage	DC24V	AC240V, DC390V
	Rated Current	AC10A	AC10A
	Protect Function	Overcurrent detection	Overcurrent detection, Overheat detection, Overvoltage protection, Short-circuit prevention, Inrush current prevention
Sample code		Sensorless Vector Control for IPMSM over the Whole Speed Range for MCK	RA6T2 Sensorless Vector Control for IPMSM over the Whole Speed Range by High-Voltage Inverter

* MCI-LV-1, MCB-RX26T TypeA and MC-COM are included in MCK-RX26T.

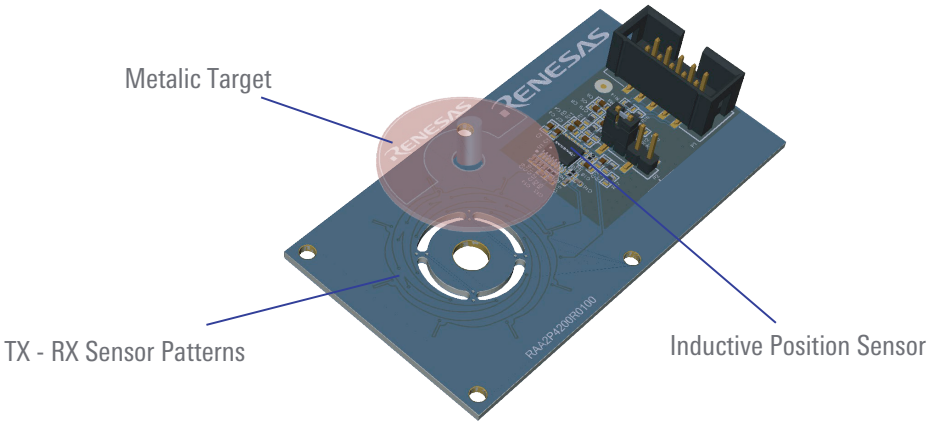
System Configuration



Motor Control Solutions with Inductive Position Sensors

Inductive Position Sensors provide an optimal solution for motor control, offering a thin, lightweight, and cost-effective fit.
Their immunity to stray magnetic fields makes them especially suitable for industrial and medical motor commutation, as well as robotics applications.

- Inductive Position Sensors detect the position of the target metal based on the electromagnetic induction of the coil and the principle of Eddy Currents.
- The sensing element can be tailored around the motor: by matching the number of target sectors to pole pairs of the motor the solution maximizes the sensing 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.
- Renesas offers a wide portfolio including Analog Sin/Cos Interfaces and Digital interfaces such as SPI, UART, I2C, UVW and Incremental interfaces like ABI / Step-Dir.



Inductive Position Sensor System

- Cost Effective Lowest BOM
- Magnet-Free Technology
- Total Stray-Field Immune
- High Accuracy and Resolution
- Tolerant to Misalignments
- Durable in Harsh-Environment

Inductive Position Sensor Portfolio for Motor Commutation

Off-Chip Calculation

IPS2550
High Speed Analog

SIN/COS

On-Chip Calculation

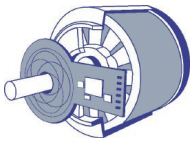
RAA2P3200
Single Coil High Speed

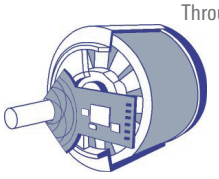
SPI UART ABI STEP-DIR UVW

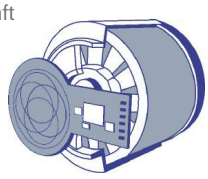
RAA2P3226
Dual Coil High Accuracy

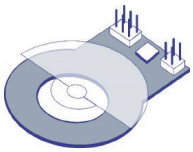
UART ABI STEP-DIR I2C

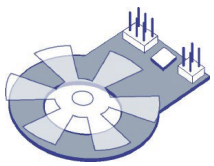
Tailored around the Motor


Through Shaft


Side Shaft


End of Shaft


1-pole


Multi-pole

Motor Control Solutions with Inductive Position Sensors

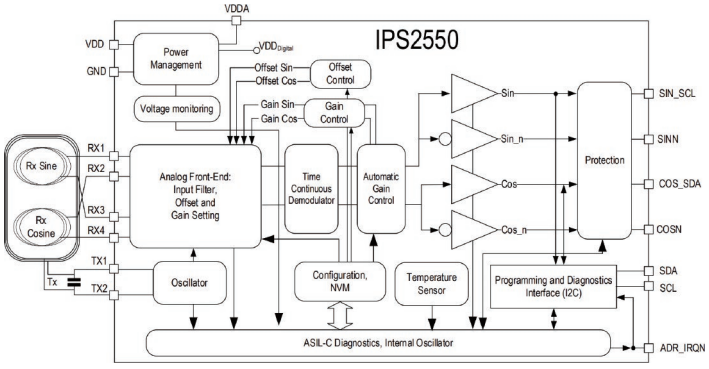
IPS2550

High-Speed Motor Control with Analog Sin/Cos Outputs

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 robotics application.

Features

- For control of electrical motor (especially BLDC motor)
- Power-supply voltage: 3.3V or 5V
- Support up to 600,000 rpm, low latency (<4µs)
- Magnet-free, thin, lightweight and low-cost solution
- Sin/Cos amplitude mismatch and offset compensation
- AGC (Automatic Gain Control) increasing airgap performances
- High stray magnetic field immunity
- Sine/cosine (analog) output
- Support multiple pole pairs
- Operating temperature: –40°C to +160°C
- TSSOP-16 with exposed pad

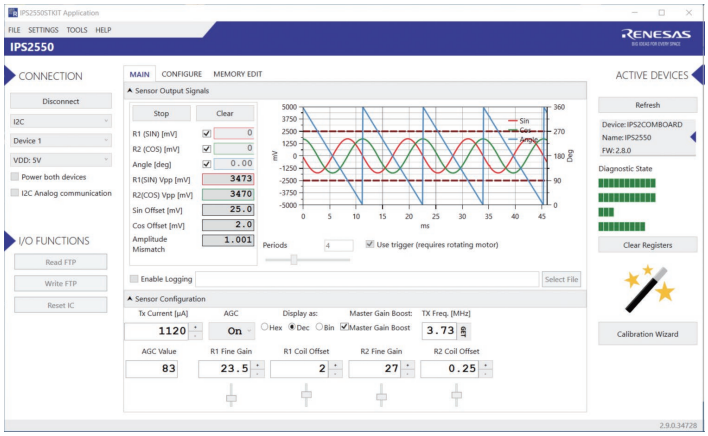


IPS2550 Block Diagram

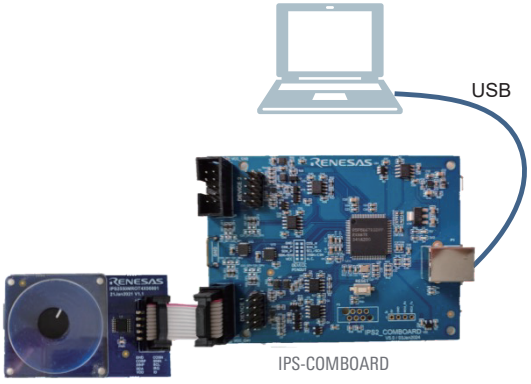
IPS2550STKIT

This is the kit for IPS2550, 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.

Note: 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.



IPS2550 Dedicated GUI



IPS2550 Evaluation Kit: IPS2550STKIT

Ordering Information

Part No.	Operation Voltage	Operation Temperature	Rated Speed	Output Type	Safety Function	Package	Provide
IPS2550DE1R	3.3V or 5.0V	Ta = –40°C to +160°C	Max. 600.000 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 parts/reel

Motor Control Solutions with Inductive Position Sensors

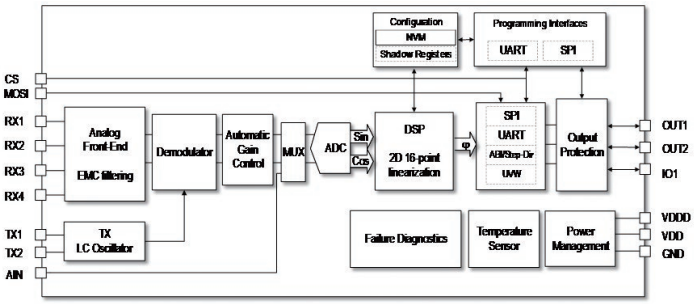
RAA2P3200

High-Speed, Low-latency Inductive Position Sensor with On-chip Calculation and Digital Interfaces

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 robotics application.

Features

- For digital control of electrical motor (especially BLDC motor)
- Power-supply voltage: 3.3V or 5.0 V
- Support up to 600,000 rpm, low propagation delay (< 100 ns)
- Digital Interfaces: SPI, High-Speed UART, ABI, Step/Dir, UVW, AB+PWM
- Automatic Gain Control (AGC) to compensate for air-gap variations
- Autocalibration and 16-point Linearization
- High Accuracy Sensor Solution: 11-bit Accuracy / 14-bit Resolution
- Magnet-free, thin, lightweight and low-cost solution
- High stray magnetic field immunity
- Supports Rotary, multi-pole, arc and linear sensing
- Operating temperature: –40°C to +125°C
- On-Chip Failure Diagnostics
- TSSOP-16

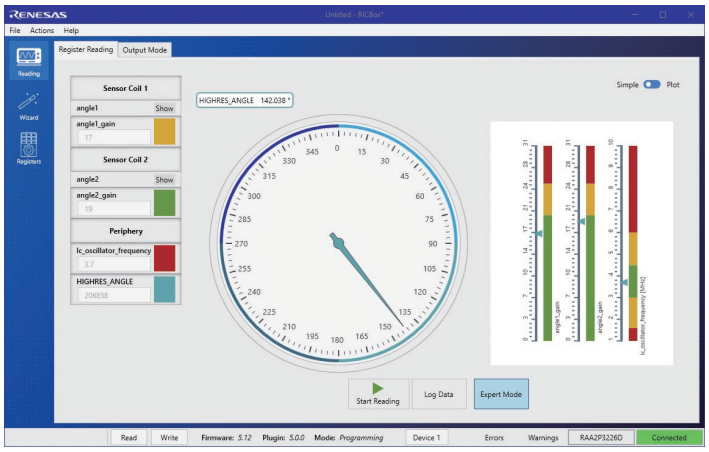


RAA2P3200 Block Diagram

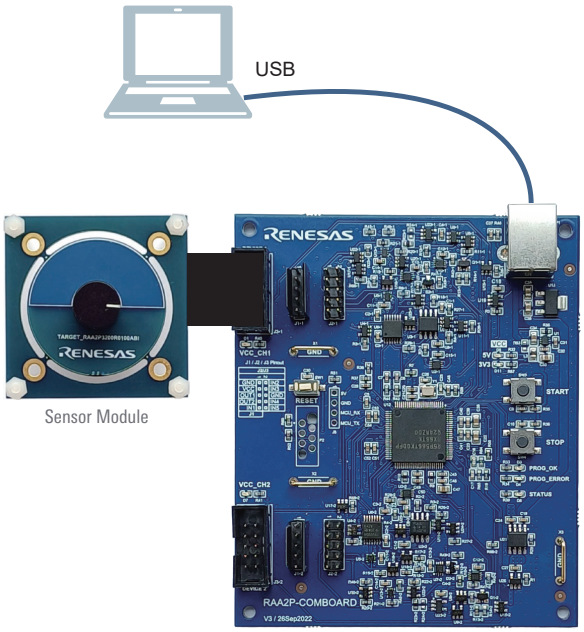
RTKA2P3200S00000BE

This is the kit for RAA2P3200, 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.

Note: 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.



RAA2P3200 Dedicated GUI



Sensor Module

IPS-COMBOARD

RAA2P3200 Evaluation Kit: RTKA2P3200S00000BE

Ordering Information

Part No.	Operation Voltage	Operation Temperature	Rated Speed	Output Type	Safety Function	Package	Provide
RAA2P3200E4GSP#HA0	3.3V or 5.0V	Ta = –40°C to +125°C	Max. 600.000 rpm (Electric angle)	SPI High Speed UART ABI Step/Dir UVW AB+PWM	Overvoltage detection, reverse polarity detection, short circuit protection	TSSOP-16 Pin (4.4mm × 5.0mm)	13" Reel, 4000 parts/reel

Motor Control Solutions with Inductive Position Sensors

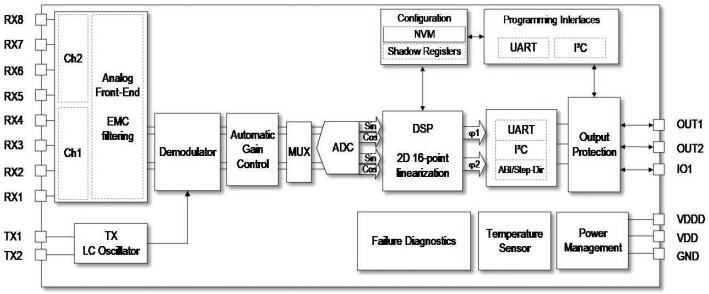
RAA2P3226

High-Speed, High-Accuracy, Dual Channel Position Sensor with On-chip Calculation and Digital Interfaces

This is a high-end dual coil sensor for digital motor control. Thin, lightweight and cost effective with stray magnetic field immunity is ideal for motor commutation in robotics application.

Features

- For High-end, High-Accuracy motor and gear box control
- Power-supply voltage: 3.3V or 5.0 V
- Support up to 600,000 rpm, low propagation delay (< 100 ns)
- Dual Channel On-Chip Angle Calculation with Integrated Vernier
- Digital Interfaces: High-Speed UART, ABI, Step/Dir, I²C
- Automatic Gain Control (AGC) to compensate for air-gap variations
- Autocalibration and 16-point Linearization
- High Accuracy Sensor Solution: up to 15-bit Accuracy / 19-bit Resolution
- True Power On position information with Incremental Interfaces
- Supports Rotary, multi-pole, arc and linear sensing
- Magnet-free, thin, lightweight and low-cost solution
- High stray magnetic field immunity
- Operating temperature: –40°C to +125°C
- On-Chip Failure Diagnostics
- TSSOP-16



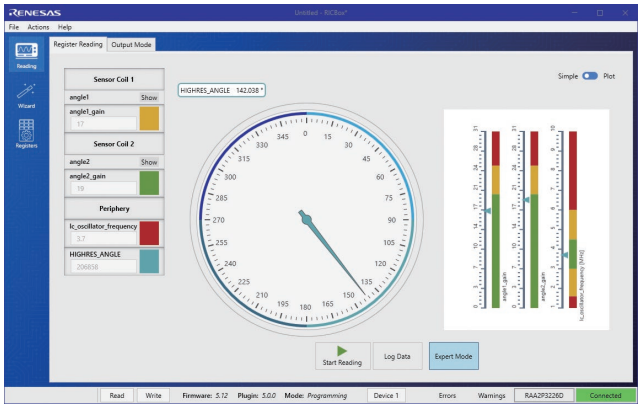
RAA2P3226 Block Diagram

RTKA2P3226S00000BE: Rotary Evaluation Kit

This is the kit for RAA2P3226, 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 high-resolution angle.

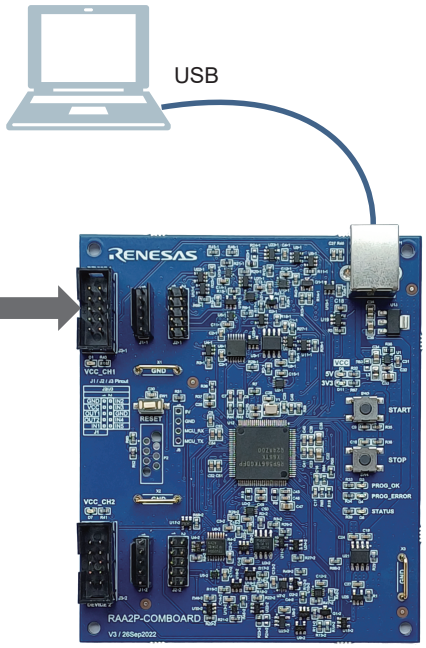
Note: This kit does not include a motor.

This kit is not designed to perform motor control but to check the output information from the position sensor.



RAA2P3226 Dedicated GUI

Sensor Module



IPS-COMBOARD

RAA2P3226 Rotary Evaluation Kit: RTKA2P3226S00000BE

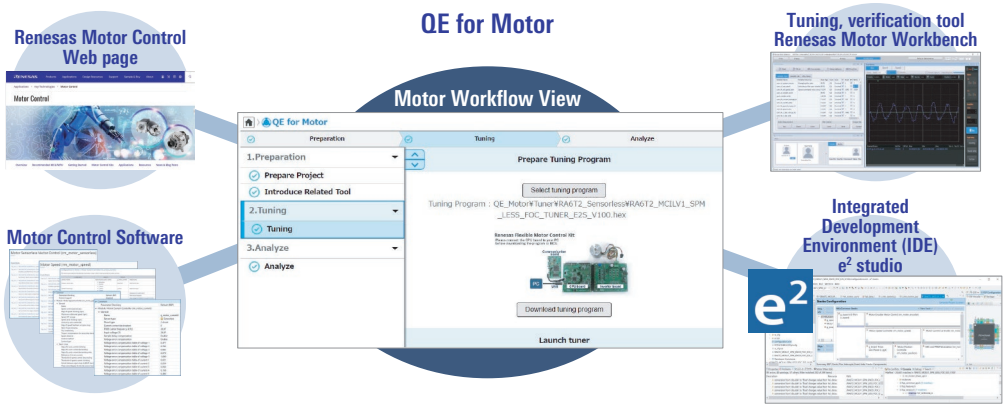
Ordering Information

Part No.	Operation Voltage	Operation Temperature	Rated Speed	Output Type	Safety Function	Package	Provide
RAA2P3226E4GSP#HA0	3.3V or 5.0V	Ta = –40°C to +125°C	Max. 600.000 rpm (Electric angle)	High Speed UART ABI Step/Dir I2C	Overvoltage detection, reverse polarity detection, short circuit protection	TSSOP-16 Pin (4.4mm × 5.0mm)	7" Reel, 1300 parts/reel

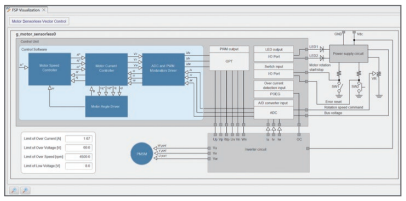
Motor Control Development Support Tool

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.



Motor Control Software Configuration GUI



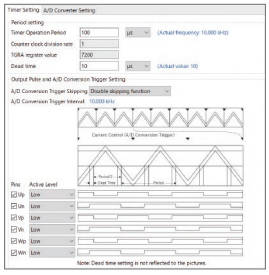
Features

- Simply follow a workflow in QE for Motor to seamlessly implement the steps required to evaluate motor control software.
- Information on motor control solutions is available on the Renesas website.
- You can configure settings of sample code middleware and drivers used for motor control via a GUI displaying a motor control block diagram.
- You can launch the Tuner and Analyzer modules of Renesas Motor Workbench from QE for Motor with a single click to easily generate parameter files and evaluate software.
- Supported MCUs RA Family: RA2T1, RA4T1, RA6T1, RA6T2, RA6T3, RA8T2
  RX Family: RX26T
  RL78 Family: RL78/G1F, RL78/G24

Motor Driver Generator Function of Smart Configurator for RX

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).

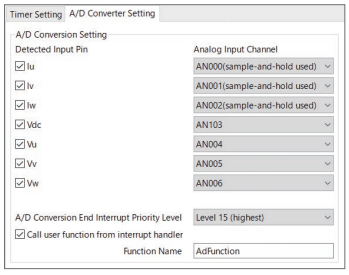
Timer (MTU/GPT) Settings



Configurable Settings

- Complementary PWM mode (MTU3 or GPT) or triangle-wave PWM mode (GPT)
- Switching frequency
- Dead time duration
- A/D conversion start trigger settings
- PWM signal output polarity
- Motor connection pin selection

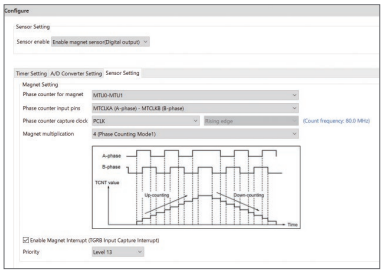
12-Bit A/D Converter (S12AD) Settings



Configurable Settings

- A/D converter pin selection for motor control
- Interrupt priority level selection

Sensor Settings



Configurable Settings

- Motor component setting support Encoder and Hall sensor
- Motor component setting support Magnetic sensor (digital output) for RX24T

Features

- By configuring settings in a simple GUI, you can generate driver source code for the timer (multi-function timer pulse unit (MTU) or general PWM timer (GPT)) 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.

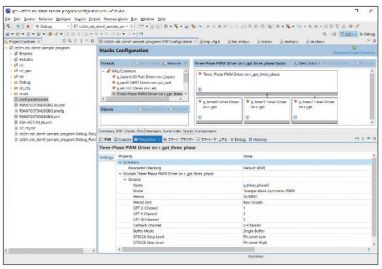
Supported MCUs: RX13T, RX23T, RX24T, RX24U, RX26T, RX66T, RX72T, and RX72M
Supported motors: 3-phase brushless DC motors and 2-phase stepping motors

Motor Control Development Support Tool

Motor Driver Generation Function of RZ Flexible Software Package (FSP)

Using the FSP versions available for the RZ/T2M, RZ/T2L, RZ/N2L, and RZ/T2H, you can generate drivers suitable for motor control for peripheral functions such as timers, A/D converters, and the delta-sigma (ΔΣ) interface, all without needing to think about detailed peripheral settings. This function is available in the e2 studio integrated development environment and in the version of Smart Configurator (standalone product) with support for software from IAR Systems.

The FSP can generate the following types of motor drivers.
- 3-phase PWM output timer for GPT
- 3-phase PWM output timer for MTU3
- A/D converter
- Delta-sigma (ΔΣ) interface
- Phase counting mode using GPT
- Phase counting mode using MTU3



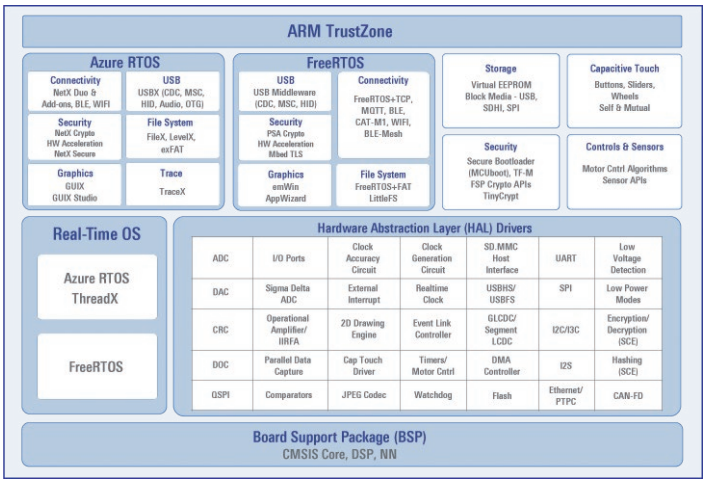
Settings
- Left-right symmetric/asymmetric triangle-wave PWM settings
- Carrier period
- Dead time
- A/D conversion start trigger settings
- PWM signal output polarity
- Motor connection pin selection
- Single- or double-buffer selection

Features
- By configuring settings in a simple GUI, you can generate driver source code for the multi-function timer pulse unit 3 (MTU3) and general PWM timer (GPT) that generate PWM output, and for the 12-bit A/D converter (ADC12) and delta-sigma (ΔΣ) interface (DSMIF) that perform current measurement, both of which are necessary for motor control.
- Smart Configurator lets you easily change settings to configure items such as the peripheral function channels and pins used for motor control.

Supported MPUs: RZ/T2M, RZ/T2L, RZ/N2L, and RZ/T2H

Flexible Software Package (RA Family)

The Renesas Flexible Software Package (FSP) is an enhanced software package designed to provide easy-to-use, scalable, high-quality software for embedded system designs using Renesas RA Family Microcontrollers. With the support of Arm® TrustZone® and other advanced security features, FSP provides a quick and versatile way to build secure, connected IoT devices using production-ready drivers, Azure® RTOS, FreeRTOS™, and other middleware stacks.
FSP uses an open software ecosystem and provides flexibility in using bare-metal programming, included Azure RTOS or FreeRTOS, your preferred RTOS, legacy code, and third-party ecosystem solutions.
The combination of the flexible open architecture of the FSP plus the wide choice of 3rd party solutions as part of the Arm ecosystem increases the range of choice for application development. This means that developers can choose the software model that best suits their needs while utilizing Renesas's excellent Arm-based silicon solutions as well as speed up the implementation time of complex areas like connectivity and security.



Benefits

- Provides an easy-to-use, scalable, high-quality software for embedded system designs using the Renesas RA Family of Arm microcontrollers
- Includes best-in-class HAL drivers with high performance and low memory footprint
- Middleware stacks with Azure RTOS and FreeRTOS integration are included to ease the implementation of complex modules like communication and security
- The e² studio IDE provides support with intuitive configurators and intelligent code generation to make programming and debugging easier and faster
- Uses an open software ecosystem and provides flexibility in using bare-metal programming, included Azure RTOS and FreeRTOS, your preferred RTOS, legacy code, and third-party ecosystem solutions
- Integrated package with all required components for easy setup and starting development (single installer with e² studio, CMSIS packs, tool chain and SEGGER J-Link drivers)
- Complete source code available through GitHub

Motor Control Development Support Tool

Renesas Motor Workbench –Overview–

When developing motor control software, if operation of the program is halted for debugging while the MCU is connected, control of the inverter circuit stops. This poses the danger of a large current flow occurring. Renesas provides a development support tool to deal with such situations.

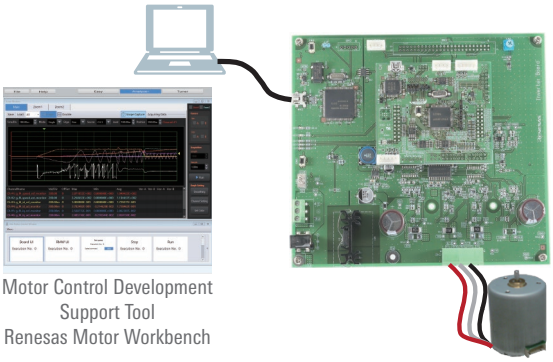
Product Summary

- 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.
- Easy GUI function: Makes it quick and easy for anyone to implement motor speed and position control by means of intuitive operations.
- Servo function: Implements an adjustment function for the motor's embedded position control system. (Supports adjustment of position control parameters, inertia estimation, origin return operation, and point-to-point control.)
- RMW-DLL: Functions needed for debugging are provided as APIs, allowing connection to a GUI developed to the user's specifications.
- Built-in communication library: In addition to the standard library, a communication library for simple debugging using a commercially available serial-USB conversion cable or the like is provided.

Renesas Motor Workbench provides powerful support for developers of motor control applications, allowing operation of motor control programs from a PC and extraction of data within programs.

Example usage scenario

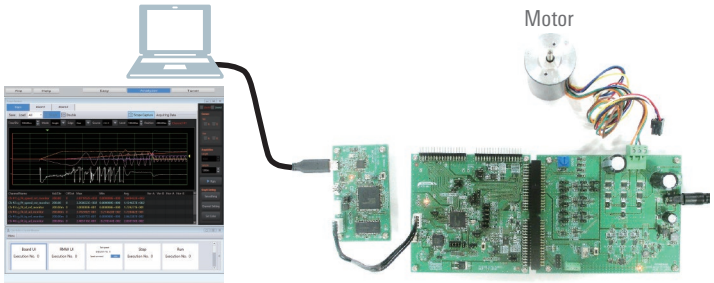
Evaluation System for BLDC Motor / for Stepping Motor with Resolver



Motor Control Development Support Tool
Renesas Motor Workbench

Motor

MCK-XXXXX



Motor Control Development Support Tool
Renesas Motor Workbench

CPU board (replaceable)

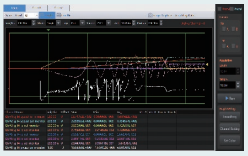
Inverter board

Motor

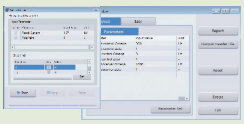
Renesas Motor Workbench Functions

Analyzer

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



Tuner



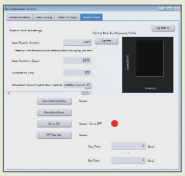
Vector control at ease without know-how. Fine adjustment at ease with manual adjustment function, as well as quick result check.

Easy GUI

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

Servo

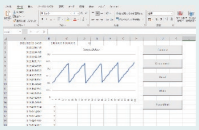
Provides a custom GUI for adjusting position control parameters, inertia estimation, and operation of the actual system.



DLL

Makes it possible to use the functions of Renesas Motor Workbench via a GUI matching the user's specifications.

Excel VBA



Net applications

Motor Control Development Support Tool

Renesas Motor Workbench –Features–

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
- The commander function allows creation and transmission of sequences for changing variables of your choice.
- The user button function lets you change a user-defined group of variables with a single click.

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.

Easy analysis with trigger/zoom functions

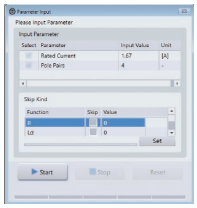
Step response evaluation at ease with commander (command value creation & transmission)

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

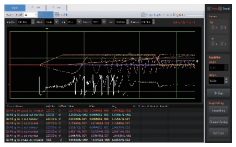
Tuner

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

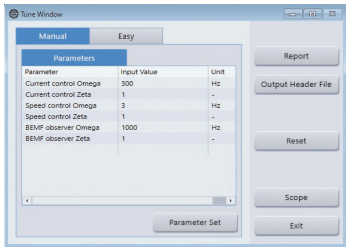


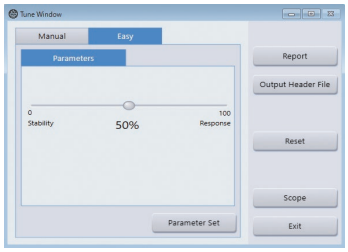
Input information are only rated current and pole pairs.



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

Finely adjust the PI gain of current/speed/position



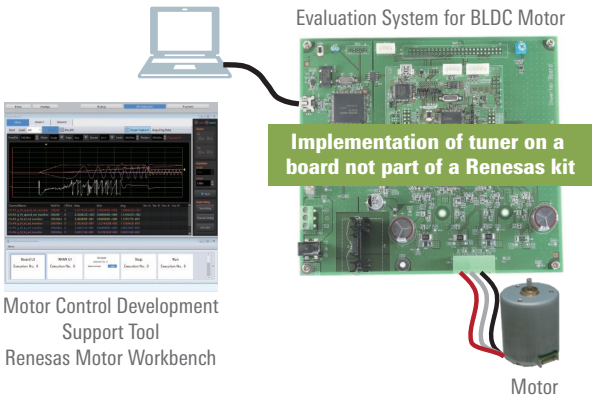


User's voice

- 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.

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.



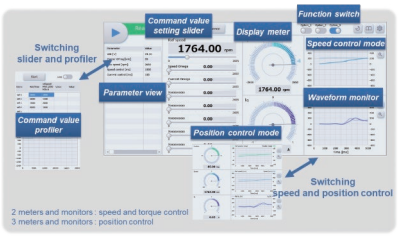
Motor Control Development Support Tool

Renesas Motor Workbench –Features–

Easy GUI

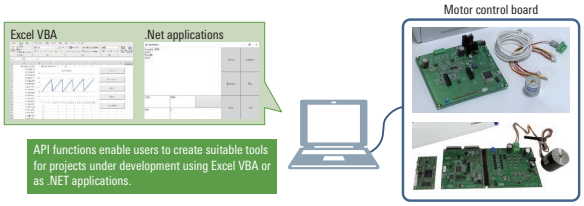
Implements a GUI that allows more intuitive operation of the motor.

- 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.



DLL

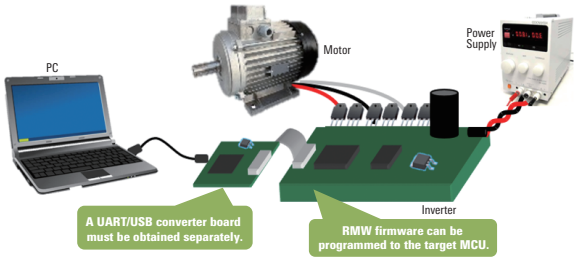
Variable read and write functions executed by the RMW (GUI) are provided in a DLL, making it possible to create tools using Excel VBA or as .NET applications.



Built-In Communication Library

The download package contains both a standard communication library and a built-in communication library. Embedding the built-in communication library in the motor control program allows you to perform simple debugging using a USB-serial conversion board instead of a communication board compatible with Renesas Motor Workbench. Supported MCUs are the RA6T2, RA6T3, and RA4T1 (with support for additional MCUs planned for future release.).

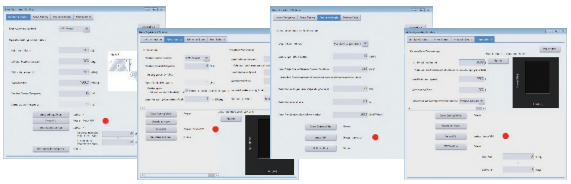
Note: The number of points of waveform display data that can be displayed using the Analyzer module is limited.
Using MC-COM communication board: 100,000 data points
Using built-in communication library: 1,000 data points (RA6T2),
500 data points (RA6T3 and RA4T1)



Servo

GUI for servo control

- Motor axis connected load inertia estimation function.
- Servo setting configuration function covering position control type, fixed frequencies, etc.
- Function for configuring the origin return method, return speed, etc.
- Function for point-to-point (PTP) single-axis operation.



Other

- Function for displaying variable uses.
- Function for outputting variables adjusted using the Analyzer module to a folder of your choice in sample code header file format.
- Navigation function with GUI support.
- Improved variable search function.

New Functions of Renesas Motor Workbench 3.2

Tuner for RL78

Tuner support RL78 device (Target is BLDC motor).
All tuner functions are available with RL78/G24 Motor Control Evaluation Kit.

RL78/G24 Motor Control Evaluation Kit

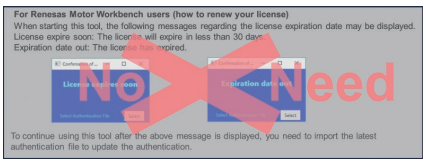
Tuner support MCI-HV-1

Tuner support Renesas Flexible Motor Control Inverter Board for 100V/200V Three-Phase BLDC/ Induction Motor.
All tuner functions are available with MCI-HV-1.

MCI-HV-1

Remove authentication function

Authentication function was removed from Renesas Motor workbench 3.2.
You don't need to import the latest authentication file.



Motor Control Development Support Tool

Renesas Motor Workbench –Specifications–

Specification

Item		Specification
All	Supported MCU	RX13T, RX23T, RX24T, RX24U,RX26T, RX66T, RX72T, RX72M, RA2T1, RA4T1, RA6T1, RA6T2,RA6T3, RA8T1, RA8T2, RL78/G24. RL78/G1F, RL78/G14 supports the analyzer function only.
	Usage environment (OS)	Windows 10 or Windows 11
Communication	Peripherals, port	UART 1 ch, DMA (DTC)　Port: TXD, RXD
	Communication I/F	USB2.0 (Communication Device Class)
	Communication board	The following kits have communication circuits. • Evaluation System for BLDC Motor • Evaluation System for Stepping Motor with Resolver For MCK-XXXXX or user 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)
	Number of waveform display data points	100,000 data points (using standard library)
Tuner	Input information	Rated voltage and number of pole pairs of motor to be measured
	Output information	Motor-unique parameter (Resistance, Inductance, Magnet flux, Rotor inertia) and Control gain output Output file format: pdf file, header file*1
Servo	Supported functions	Inertia estimation function (rotor + load), servo adjustment function, origin return processing, PTP control

*1: Corresponds to sample files for motor control sample code released by Renesas. Refer to the user's manual of Renesas Motor Workbench for details..

Item		Specification
DLL	Usage environment	Windows 10 only, .NET Framework 4.6.1 or later
	Development environment	Visual Studio 2015 or later, Excel
	Supported functions	Serial data connection, reading and writing variables, scope function

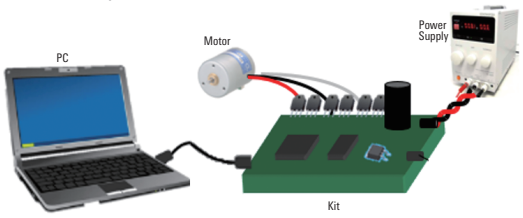
Item		Specification
Built-in communication library	Supported MCUs	RA6T2, RA6T3, RA4T1
	Communication board	Commercially available USB-serial conversion cable or board
	Number of analyzer waveform display data points	RA6T2: 1,000 data points RA6T3/RA4T1: 500 data points

Environment Used

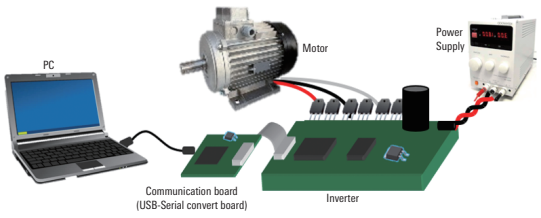
- Evaluation System for BLDC Motor
- Evaluation System for Stepping Motor with Resolver
- MCK-XXXXX (Bundled MC-COM is used.)
- MCI-HV-1 + MCB-RA6T2

Simply connect the kit with the sample code programmed to it to a PC using a USB cable, then launch Renesas Motor Workbench to get started.

• Evaluation system for XXXXX



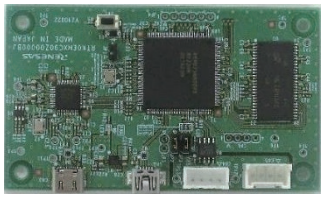
• MCK-XXXXX, MCH-HV-1 or user environment



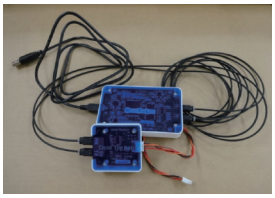
Note: A communication board is required when using a user environment.

Communication boards

Renesas Electronics
MC-COM



Desk Top Laboratories
W2002

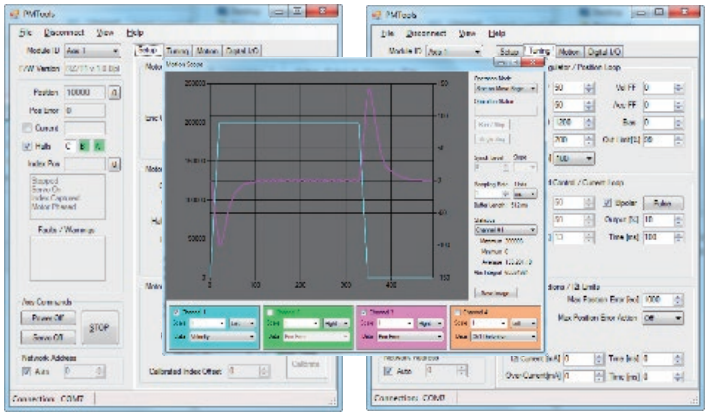


Desk Top Lab
http://www.desktoplab.co.jp/

Motor Control Development Support Tool

Motion Control Utility

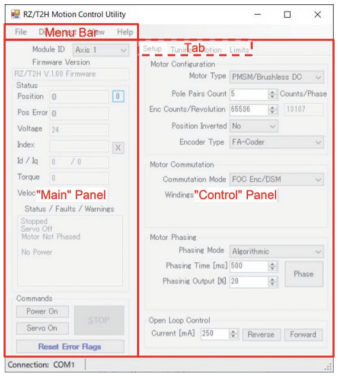
RZ Motion Control Utility is a tool to support development for debugging, tuning and analyzing motor control programs using RZ Family MPU.



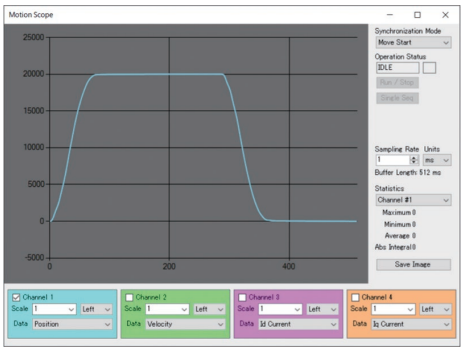
Motion Control Utility

Function

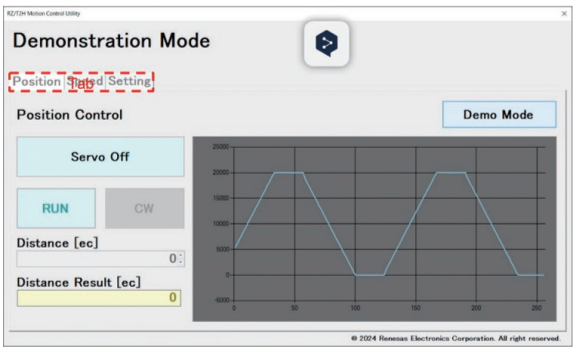
- Tuner / Analyzer Mode: Users can tune and analyze various parameters.
- Motion Scope: Users can check waveform graphs of up to four channels in real time.
- Demonstrations Mode: Users can execute position control and speed control with simple operations.



Tuner / Analyzer Mode" Window



"Motion Scope" Window



"Demonstrations Mode" Window

Benefit

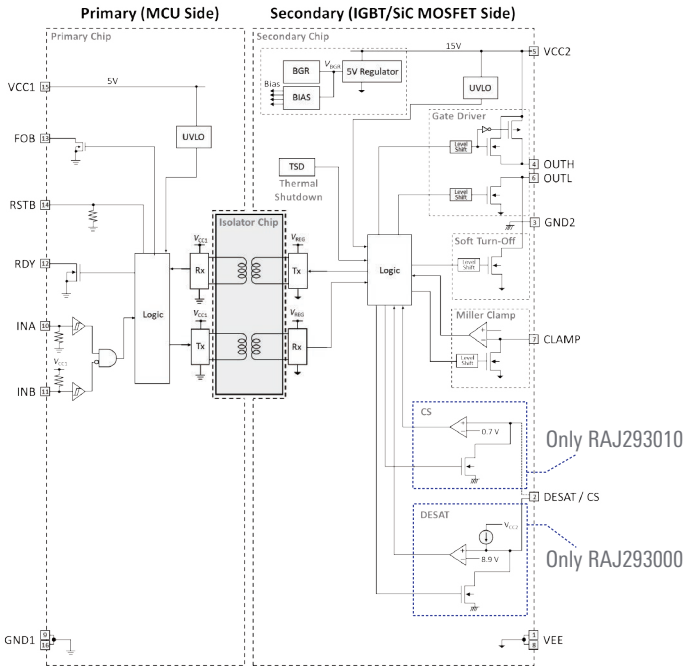
- By using this tool, users can rotate the motor with simple operations.

RAJ293000 / RAJ293010 Gate Driver IC for IGBT and SiC MOSFETs

RAJ293000 / RAJ293010 Gate Driver IC

System Integration

The inverter converts the DC power provided by the battery into 3-phase AC power to drive the motor. The high voltage side consists of a motor, a high voltage battery that drives the motor and an IGBT or SiC MOSFET. And the low voltage side consists of an MCU, PMIC and a low voltage battery that provides power to the control circuit. In addition, the Gate Driver IC is installed between the high and low voltage sides. The Gate Driver IC not only drives the IGBT or SiC MOSFET, but also performs the functions of information communication and isolation between the high and low voltage sides.



Features

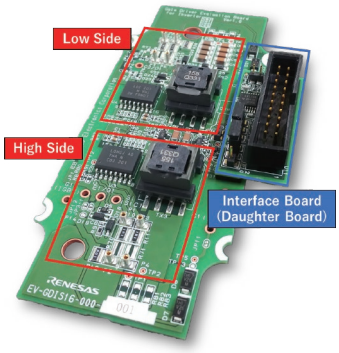
- On-chip Micro Isolator (isolated circuit)
  - High voltage isolation: 3750Vrms, 1min
  - High CMTI (Common Mode Transient Immunity): over 150V/ns
- High output gate drive circuit
  - Gate drive output peak current (Source / Sink): 10A typ. / 10A typ.
  - On-chip active miller clamp
  - Soft turn-off function
- Various on-chip protection circuits
  - Over current detection by DESAT (Desaturation Protection): 8.9V typ. (RAJ293000)
  - Over current detection by Current Sense: 0.7V typ. (RAJ293010)
  - On-chip under voltage lockout circuit (UVLO)
    VCC1 (5 V system): 4.1V typ.
    VCC2 (15 V system): 10V typ.
  - Fault Alarm outputs on FOB pin and the latched fault status can be reset by RSTB pin
- Operating temperature: - 40 to 125 °C (Junction temperature: 150 °C max)
- AEC-Q100 Qualified (Grade 1)

Development Tool

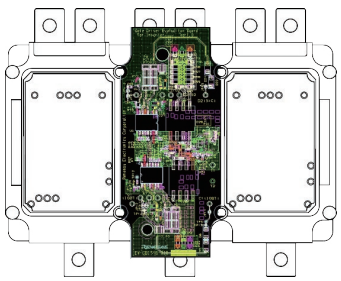
The EV-GDIS16 evaluation board is designed can easy to combine with a 6-in-1 IGBT/SiC MOSFET modules and other modules with the same pin compatibility as the 6-in-1 IGBT/SiC MOSFET modules to evaluate the on-board Renesas Gate Driver IC. The EV-GDIS16 is designed to allow 3 boards to be mounted side-by-side on these target modules.

Features

- PCB size: 104.5mm x 47.0mm
- Using flyback external control
- Convenient Test pins are set up
- Both IGBT and SiC MOSFET can be connected and switched easily
- Singal input: External pulse generator or MCU control
- Convenient evaluate Double Pulse Test(DPT) for evaluating switching efficiency



EVB for RAJ293000/RAJ293010
(EV-GDIS16)



EV-GDIS16 combine with
IGBT/SiC MOSFET power module

Specifications

Part No.	Package	Operating Voltage (V)	Applications
RAJ293000 / RAJ293010	P-SOP16 (7.5mm × 10.3mm)	Primary side: 4.5 to 5.5V (VCC1) Secondary side: 12.5 to 33V (VCC2) -16.5 to 0V (VEE)	Traction inverters for EV/HEV in automotive applications, DC-DC converters for EV/HEV in automotive applications, On-board charger for EV in automotive applications, Inverters and converters for industrial instruments, etc.

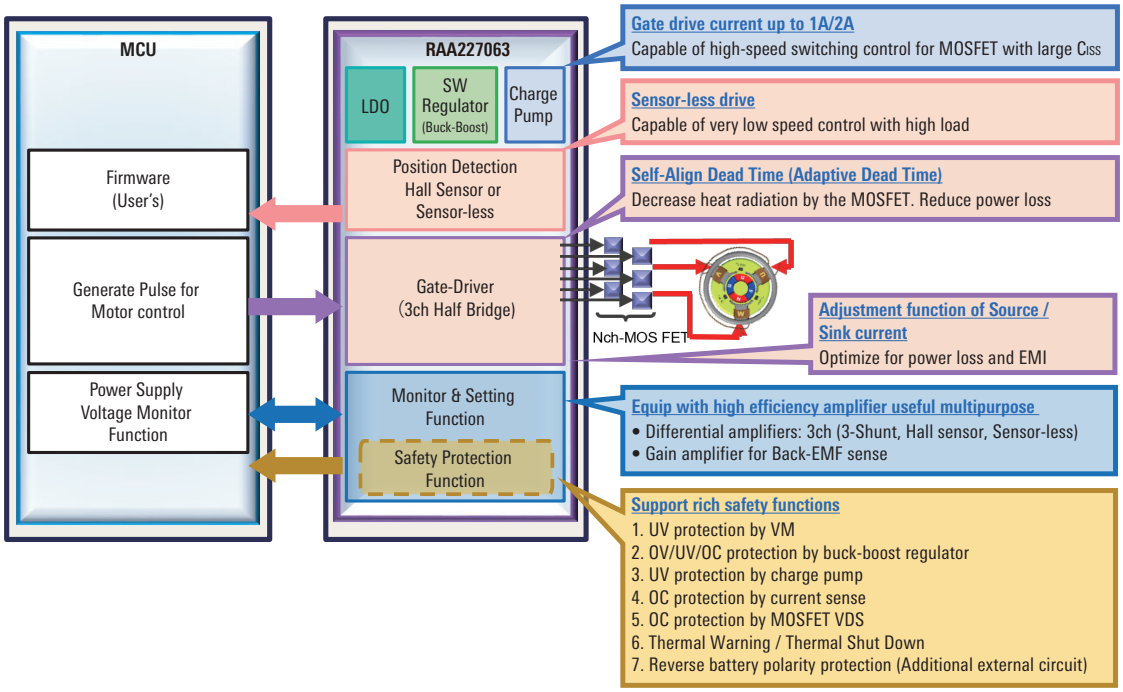
Inquiry window

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

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)

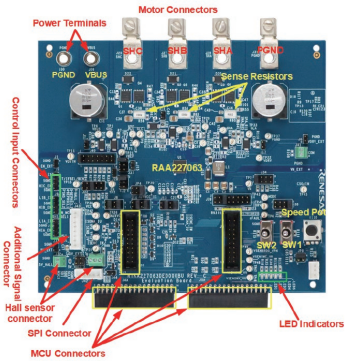


Development Tool

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)

Specifications

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

RAA306012 3-Phase Smart Gate Drivers

RAA306012 3-Phase Smart Gate Driver

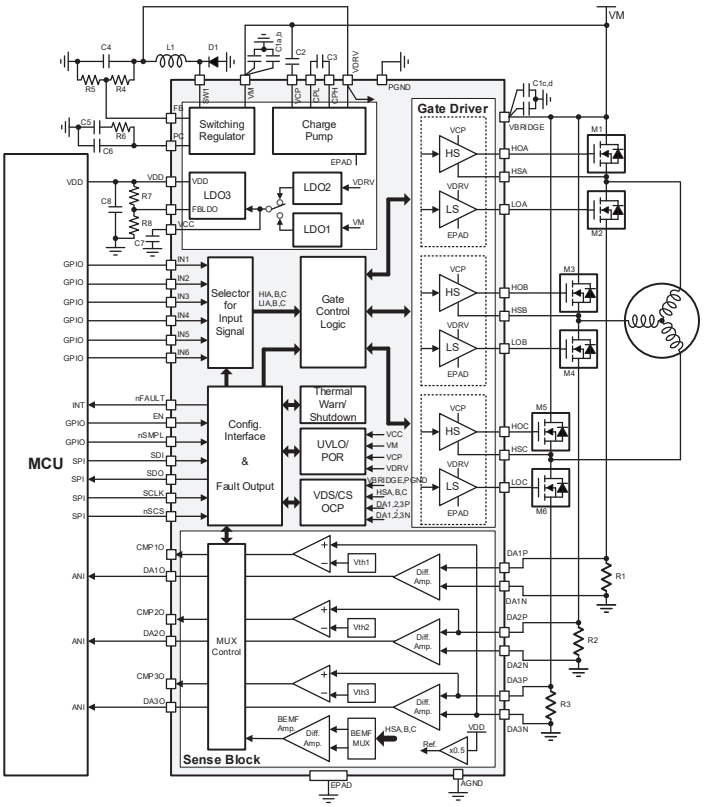
System Integration (Smart Gate Driver with Built-in Power Supply for System and High Accuracy Amp for 3-Shunt)

Features

- Wide VIN range: 4.5V to 65V (78V abs max)
- Switching frequency range up to 200kHz
- 3-Phase drive for BLDC application
  - Peak current 0.64A/1.28A (source/sink) with adjustable drive strength
  - Supports up to 16 adjustable levels of drive strength through SPI
- Adjustable and adaptive dead-time control
- Low power consumption sleep mode with less than 28uA quiescent current to maximize battery life in portable applications.
- Includes complete system power supply with efficient architecture
- Support back-EMF sensing to support BLDC motor sensorless operation
- Extensive fault protection: UV/OV, VDS OCP, Current sense OCP, etc.
- Package: 48 Ld QFN (7mm x 7mm, 0.5mm pitch)

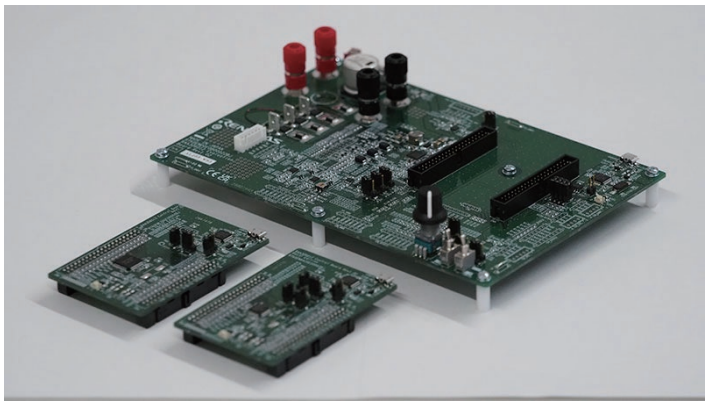
Benefits

- Allows to Scale the MCU to Address the Application Specifications
  - Renesas MCU: RL78, RX32T, RA6T1,RA2L1, etc.
- Integration of Analog Power Components Saves Board Space and Allows for Easy Tuning



Development Tool

- Starter Kit is used to evaluate a BLDC motor system using the RAA306012 and RX13T&RL78/G1F(MCUs).
- Easy to start motor control evaluation with the RAA306012
- The reference firmware is written to the control board of the set. By connecting the attached small motor to the board and supplying power, evaluation can be started immediately.
- Board with high expandability and operability (size: 160mm × 210mm)
- The board is easy to operate, and switches, potentiometers, LEDs, and thermistors are mounted, their functions can be used by using the user program.



Specifications

Part No.	Package	Operating Voltage (V)	Applications
RAA306012	48Ld QFN (7mm × 7mm)	4.5 to 65V	Power tool, Gardening tool, Cord-less vacuum cleaner, Cooling-fan, Water pump, Air pump, AGV, Robotics, etc.

Inquiry window

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

HVPAK™

Programmable Mixed-Signal Matrix with High Voltage Features (up to 26.4 V and up to 3 A per output)

The HVPAK (SLG47105, SLG47105-E, SLG47115, SLG47115-E, and SLG47104) combine GreenPAK™ mixed-signal logic and H-/Half-bridge functionality. The HVPAK advanced PWM macrocells allow driving multiple motors or inductive loads with different PWM frequencies and duty cycles. Low (70 nA) current consumption in the standby mode together with a compact 2 mm x 3 mm size provide even more benefits. This highly versatile device allows a wide variety of mixed-signal functions to be designed alongside high-voltage capabilities.

HVPAK Capabilities

Brushed DC

- Programmable Current Limiting
- PWM frequency up to 200 kHz

Stepper Motor

- Full step mode
- Microstep mode
- Changing motor rotation direction

Solenoid/Relay/Valve

- Rising current curve control
- Multi-drivers
- No need an external diode for relay coil
- Zero-Crossing Detection

Multiple Functions

- Programmed constant motor speed
- Programmable undervoltage and overcurrent protection
- LEDs indicator

Buck / Boost / Buck-Boost

- No external switches or diodes
- Minimum external components
- Internal selectable Vref
- Overcurrent/short circuit protection
- Highly customizable design

HVPAK Value

Integrate

Reduce

- ✓ Solution price
- ✓ BOM
- ✓ PCB size
- ✓ Power consumption

Differentiate

Add

- ✓ New features
- ✓ More custom protections
- ✓ Unique control signals

Create a custom motor driver solution

Protect the design from being copied by competitor

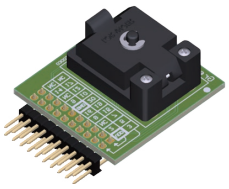
Offload MCU

Offload MCU with motor driving control moved to HVPAK

Monitor sensor signals and make a decision based on these signals

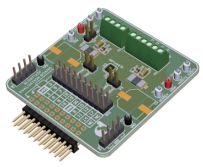
Get standalone solution without MCU in simple applications

Development and Evaluation Tools



HVPAK Socket Adapters
(SLG47105V-SKT, SLG47115V-SKT, SLG47105EV-SKT, SLG47115EV-SKT, and SLG47104V-SKT)

* works together with SLG4DVKADV and SLG4DVKLITE



HVPAK Evaluation Board
(SLG47105V-EVB and SLG47115V-EVB)

* works together with SLG4DVKADV and SLG4DVKLITE

Download Go Configure™ Software Hub | Renesas to create your HVPAK designs. This is free GUI-based software.
Useful Resources: Documentation & Downloads Search | Renesas

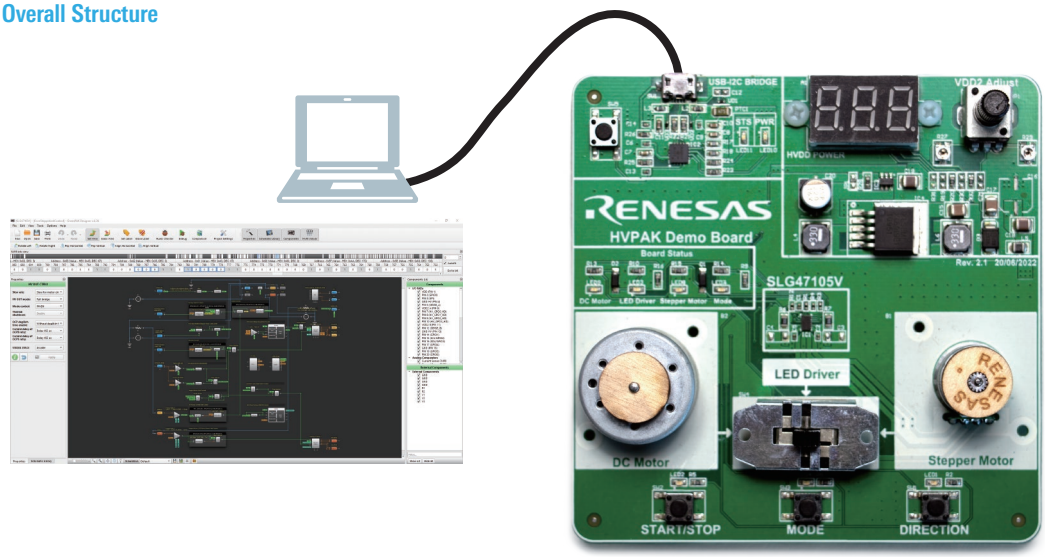
Solutions for DC / Stepper Motors, Solenoid, LED, and DC-DC

HVPAK SLG47105 Demo Board

The HVPAK Demo Board allows to get acquainted with SLG47105's functionality, especially the H-Bridge and Half-Bridge functions, and demonstrates the power part of the chip. This board is designed for hands-on and visually shows the SLG47105 chip's capability to handle both DC and Stepper Motors, as well as LEDs. The chip on the Board is already programmed with a versatile project, allowing to control different loads and switch between modes.

To launch the board, it is necessary just to connect it to any power source using a USB cable. Additionally, it is possible to emulate any custom project on this board using Go Configure™ Software Hub.

Overall Structure



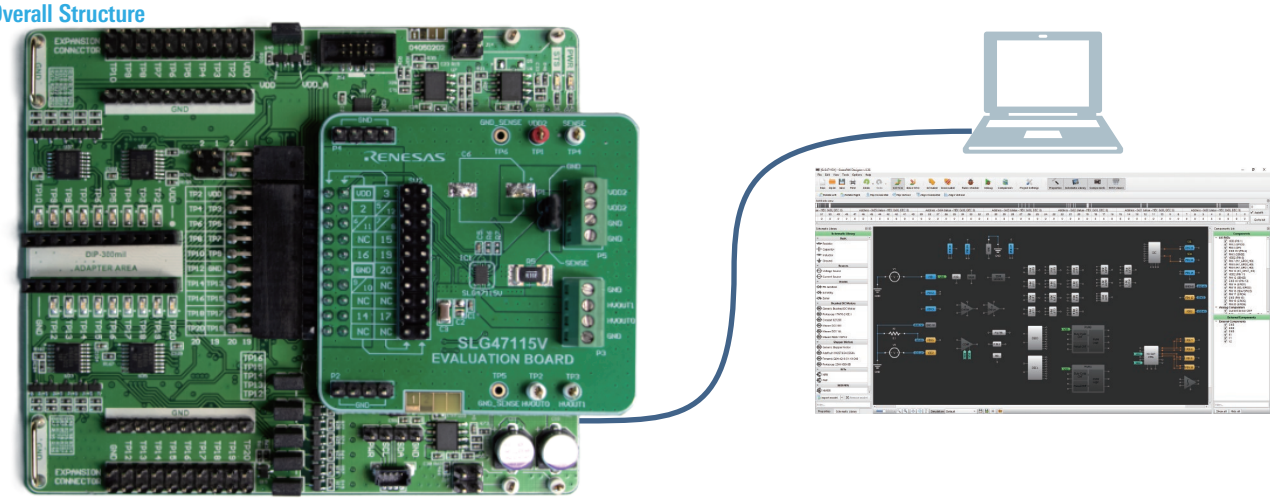
HVPAK Evaluation Boards

SLG47105V-EVB and SLG47115V-EVB

The HVPAK evaluation boards have been developed for testing designs with all features and high current loads. You can emulate/program the HVPAK chip using this evaluation board with the GreenPAK Advanced Development Board. Just connect the evaluation board to the Advanced Development Board and use a USB cable to power them.

The Go Configure™ Software Hub will identify the boards and let you emulate/program the part. To start the evaluation, you need to separately power the HV part. Then, you can test your design using the measuring equipment.

Overall Structure



Recommended Products: MCUs and MPUs

RL78 Family

Part No.	Pin Number	ROM (KB)	RAM (KB)	Operating Frequency	Power-supply Voltage
RL78/G1F	24 to 64	32/64	5.5	32MHz	1.6 to 5.5V
RL78/G24	20 to 64	64/128	12	48MHz	1.6 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
RX26T	48 to 100	128 to 512	48 to 64	120MHz	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/T2L	196	0	1600	800MHz	3.0 to 3.6V
RZ/T2M	128/176/225/320	0	576 to 2624	800MHz	3.0 to 3.6V
RZ/T2H	729	0	2048	1200MHz	3.135 to 3.465V

RA Family

Part No.	Pin Number	ROM (KB)	RAM (KB)	Operating Frequency	Power-supply Voltage
RA2T1	24/32/48	64	8	Arm Cortex-M23:64MHz	1.6 to 5.5V
RA4T1	32/48/64	128/256	40	Arm Cortex-M33:100MHz	2.7 to 3.6V
RA6T1	64/100	256/512	64	Arm Cortex-M4:120MHz	2.7 to 3.6V
RA6T2	48/64/100	256/512	64	Arm Cortex-M33:240MHz	2.7 to 3.6V
RA6T3	32/48/64	256	40	Arm Cortex-M33:200MHz	2.7 to 3.6V
RA8T1	100/144/176/224	1024/2048	1024	Arm Cortex-M85:480MHz	1.68 to 3.6V
RA8T2	176/224/289/303	512/1024 MRAM 4096/8192 SIP	2048	Arm Cortex-M85:1GHz Arm Cortex-M33:250MHz	1.62 to 3.63V

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 to +85°C	LQFP-48pin (7mm × 7mm)
RAA3064003GFP													–40°C +105°C	

Inductive Sensor Processing IC (IPS2550 Series)

Part No.	Operation Voltage	Operation Temperature	Rated Speed	Output Type	Safety Function	Package	Provide
IPS2550DE1R	3.0V to 3.6V or 4.5V to 5.5V	Ta = –40°C to +160°C	Max. 600.000 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

HVPAK™

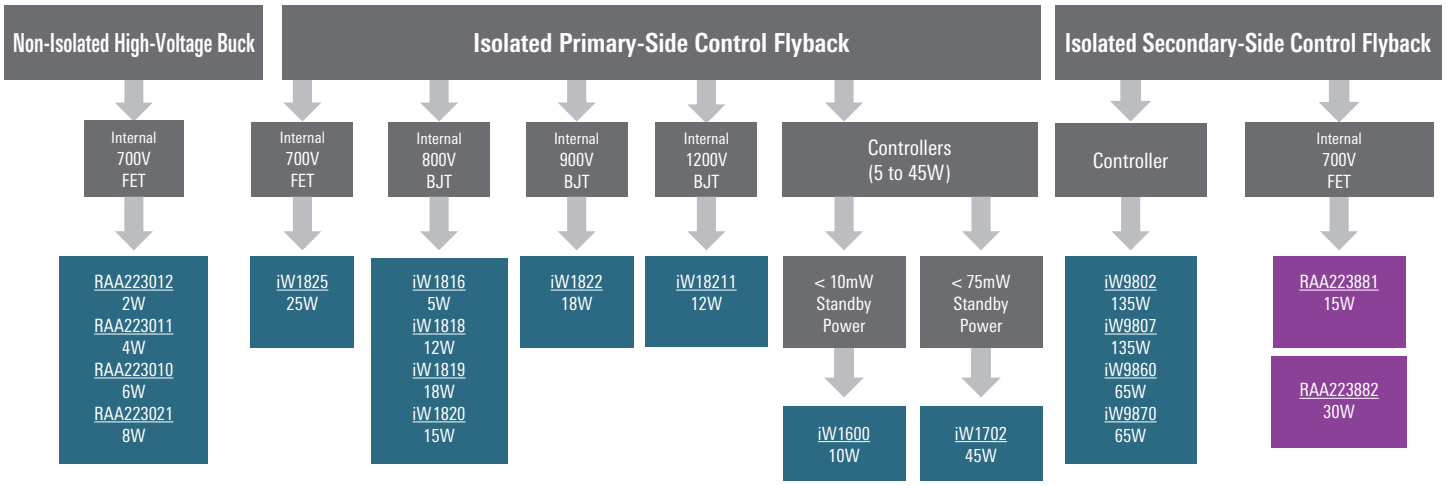
Programmable Mixed-Signal Matrix with High Voltage Features - DC/Stepper Motor, Solenoid, Valve, LED Control, DC-DC

Part No.	SLG47105V	SLG47115V	SLG47105-EV	SLG47115-EV	SLG47104V
# of Pins / # of GPIO	20/8 + 4 x HD	20/8 + 2 x HD	20/8 + 4 x HD	20/8 + 2 x HD	20/8 + 2 x HD
Operating Voltage, VDD (V)	2.3 to 5.5	2.3 to 5.5	2.3 to 5.5	2.3 to 5.5	2.3 to 5.5
Dual Supply, VDD2 (V)	3.0 to 13.2	4.5 to 26.4	3.0 to 13.2	4.5 to 26.4	3.0 to 13.2
ACMPs	4	3	4	3	2
Voltage Reference	Trimmed	Trimmed	Trimmed	Trimmed	Trimmed
Combo Function Macro-cells	12 Total	12 Total	12 Total	12 Total	9
Multi-Function Macro-cells	5 Total	5 Total	5 Total	5 Total	3
PWMs	2	2	2	2	1
Counters/Delays	5	5	5	5	3
DFF / Latch	15	15	15	15	10
3-Output Pipe Delay	16-stage	16-stage	16-stage	16-stage	16-stage
Programmable Delay	Yes	Yes	Yes	Yes	No
Internal Oscillator (Hz)	2k/25M	2k/25M	2k/25M	2k/25M	2k/25M
Temp Sensor	Yes	Yes	Yes	Yes	No
Communication Interface	I²C	I²C	I²C	I²C	I²C
STQFN Package Size (mm)	2.0×3.0	2.0×3.0	2.0×3.0	2.0×3.0	2.0×3.0
Temperature range	–40°C to +85°C	–40°C to +85°C	–40°C to +105°C	–40°C to +105°C	–40°C to +85°C

Recommended Products: Power Management

ISOLATED non-ISOLATED

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



PWM Controller

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
ISL85009	3.8 to 18V	0.8 to Vin*92%	9	300k/600k	Yes	Max. 95	High: 17 Low: 8.5	–40 to 125°C	15-TQFN
ISL85014	3.8 to 18V	0.8 to Vin*92%	14	300k/600k	Yes	Max. 95	High: 15 Low: 6.5	–55 to 150°C	15-TQFN
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	12-DFN
ISL85418	3 to 40V	0.6 to 34	0.8	300k to 2M	Yes	Max. 96	High: 250 Low: 90	–40 to 125°C	12-DFN
ISL85410	3 to 40V	0.6 to 34	1.0	300k to 2M	Yes	Max. 96	High: 250 Low: 90	–40 to 125°C	12-DFN
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
RAA211412	5.8 to 45V	0.8 and up	1.0	630k	–	Max. 90	High: 600	–40 to 125°C	6-TSOT23
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

Recommended Products: Power Management

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
RAA214220	150mA, 20V, low Iq	2.5 to 20	ADJ	+2.0/–2.0	220	225@150mA	92@100Hz	38	150@10mA	3-SOT23
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

Recommended Products: Gate Driver, MOSFET, Peripheral IC

GreenPAK™

Programmable Mixes-Signal Matrix (fully customizable solution, low power, compact size, cost-optimized, programmed at factory)

GreenPAK™ with Low Drop Out Regulators (LDO)

Item		SLG51000	SLG51001	SLG51002	SLG51003	SLG46580	SLG46582	SLG46583	SLG46585
General Parameters									
	Memory Type	OTP	OTP	OTP	OTP	OTP	OTP	OTP	OTP
	# of Pins / # of GPIOs	20 / 6	16 / 4	25 / 6	14 / 5	20 / 9	20 / 9	20 / 9	29 / 7
	Operating Voltage (V)	2.8 - 5.0	2.8 - 5.0	2.8 - 5.0	2.8 - 5.0	2.3 - 5.5	2.3 - 5.5	2.3 - 5.5	2.5 - 5.5
	Communication Interface Type	I²C	I²C	I²C	I²C	I²C	I²C	I²C	I²C
	Communication Interface Voltage	1.2V - 1.8V	1.2V - 1.8V	1.2V - 1.8V	1.2V - 5.0V	1.2V - 5.5V	1.2V - 5.5V	1.2V - 5.5V	1.2V - 5.5V
	GPIO Voltage	1.2V - 1.8V	1.2V - 1.8V	1.2V - 5.0V	1.2V - 5.0V	1.2V - 5.5V	1.2V - 5.5V	1.2V - 5.5V	1.2V - 5.5V
	Package Type	WLCSP	WLCSP	WLCSP	TQFN	TQFN	TQFN	TQFN	TQFN
	Package Size (mm)	1.675 x 2.075 x 0.465, 0.4 pitch	1.675 x 1.675 x 0.465, 0.4 pitch	1.992 x 1.992 x 0.44, 0.35 pitch	2.0 x 2.2 x 0.55, 0.4 pitch	2 x 3 x 0.55, 0.4 pitch	2 x 3 x 0.55, 0.4 pitch	2 x 3 x 0.55, 0.4 pitch	3 x 3 x 0.55, 0.4 pitch
	Operating temperature (°C)	-40 to +85	-40 to +85	-40 to +85	-40 to +85	-40 to +85	-40 to +85	-40 to +85	-40 to +85
Combinatorial Logic									
	Analog Comparators	–	–	–	–	4	4	4	4
	Max. Look Up Tables (LUTs) / DFF	12 / –	12 / –	8 / 8	8 / 8	15 / 9	15 / 9	15 / 9	16 / 9
	Pipe Delay	–	–	–	–	16 - stage	16 - stage	16 - stage	16 - stage
	Internal Oscillator (Hz)	8M	8M	8M	8M	1.73k / 25k / 2M	25k / 2M	25k / 2M	25k / 2M
	Max. Counters/Delays	–	–	1 / 4	1 / 4	5	5	5	5
	Combination Function Macro-cells	–	–	8	7	4	15	15	15
	State Machine	Power Sequencer	Power Sequencer	Power Sequencer	–	8-state ASM	8-state ASM	8-state ASM	8-state ASM
	Flexible Timing & Event-Triggered Sequencer	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Power Parameters									
	# LDOs	7	6	8	3	4	2	2	4
	VIN total range	0.8V - 5.0V	0.8V - 5.0V	0.8V - 5.0V	0.8V - 5.0V	2.3V - 5.5V	2.3V - 5.5V	2.3V - 5.5V	2.5V - 5.5V
	VOUT total range	0.5V - 3.75V	0.5V - 3.75V	0.5V - 3.75V	0.5V - 3.75V	0.9V to 4.35V	0.9V to 4.35V	0.9V to 4.35V	0.9V to 4.2V
	Output Current Max (A)	0.8	1	1.3	0.8	0.15	0.3	0.6	0.15
	Max Iout_LDO1 (mA)	475 (High PSRR)	475 (High PSRR)	500	475 (High PSRR)	150	300	600	150
	Max Iout_LDO2 (mA)	475 (High PSRR)	500	500	500	150	300	–	150
	Max Iout_LDO3 (mA)	500	500	500	800	150	–	–	150
	Max Iout_LDO4 (mA)	500	500	500	–	150	–	–	150
	Max Iout_LDO5 (mA)	800	500	500	–	–	–	–	–
	Max Iout_LDO6 (mA)	800	1000	1 A	–	–	–	–	–
	Max Iout_LDO7 (mA)	500	–	1 A	–	–	–	–	–
	Max Iout_LDO8 (mA)	–	–	1.3 A	–	–	–	–	–
	# of Load Switches	2	1	5	1	R	2	1	1
	Vdropout	80mV @ 0.8A (LV LDO)	100mV @1A (LV LDO)	130mV @ 1.3A (LV LDO)	100mV @ 0.8A (LV LDO)	250mV	250mV	250mV	250mV
	PSRR	87dB @ 100kHz (HP LDO)	87dB @ 100kHz (HP LDO)	65dB @ 100kHz (HV LDO)	87dB @ 100kHz (HP LDO)	50dB @ 100Hz to 100kHz	50dB @ 100Hz to 100kHz	50dB @ 100Hz to 100kHz	50dB @ 100Hz to 100kHz
	Output Noise	13µV @ 10Hz to 100kHz (HP LDO)	13µV @ 10Hz to 100kHz (HP LDO)	152µV @ 10Hz to 100kHz (HV LDO)	18µV @ 10Hz to 100kHz (HP LDO)	75µV @ 10Hz to 100kHz	75µV @ 10Hz to 100kHz	75µV @ 10Hz to 100kHz	75µV @ 10Hz to 100kHz
	Current limit	Startup & Functional (Programmable)	Startup & Functional (Programmable)	Startup & Functional (Programmable)	Startup & Functional (Programmable)	Over-current & Short-Circuit Detection Current Limit	Over-current & Short-Circuit Detection Current Limit	Over-current & Short-Circuit Detection Current Limit	Over-current & Short-Circuit Detection Current Limit
	Protection Features	ESD, OCL, OTP, UVLO	ESD, OCL, OTP, UVLO	ESD, OCL, OTP, UVLO	ESD, OCL, OTP, UVLO	ESD, OCL, SCD, OTP, Read Lock	ESD, OCL, SCD, OTP, Read Lock	ESD, OCL, SCD, OTP, Read Lock	ESD, OCL, SCD, OTP, Read Lock

Recommended Products: Gate Driver, MOSFET, Peripheral IC

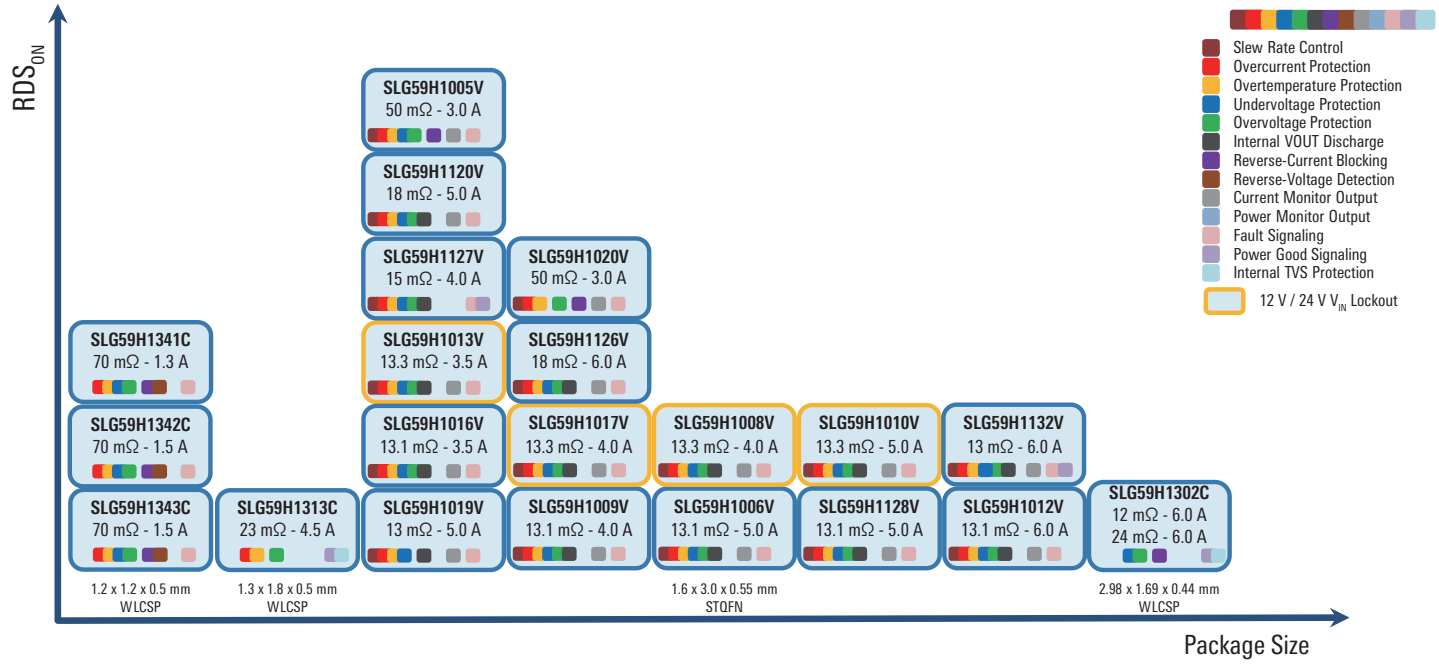
Power GreenPAK™

User-programmable ASICs (Also available programmed at the factory.)

Power GreenPAK™ with Load Switches

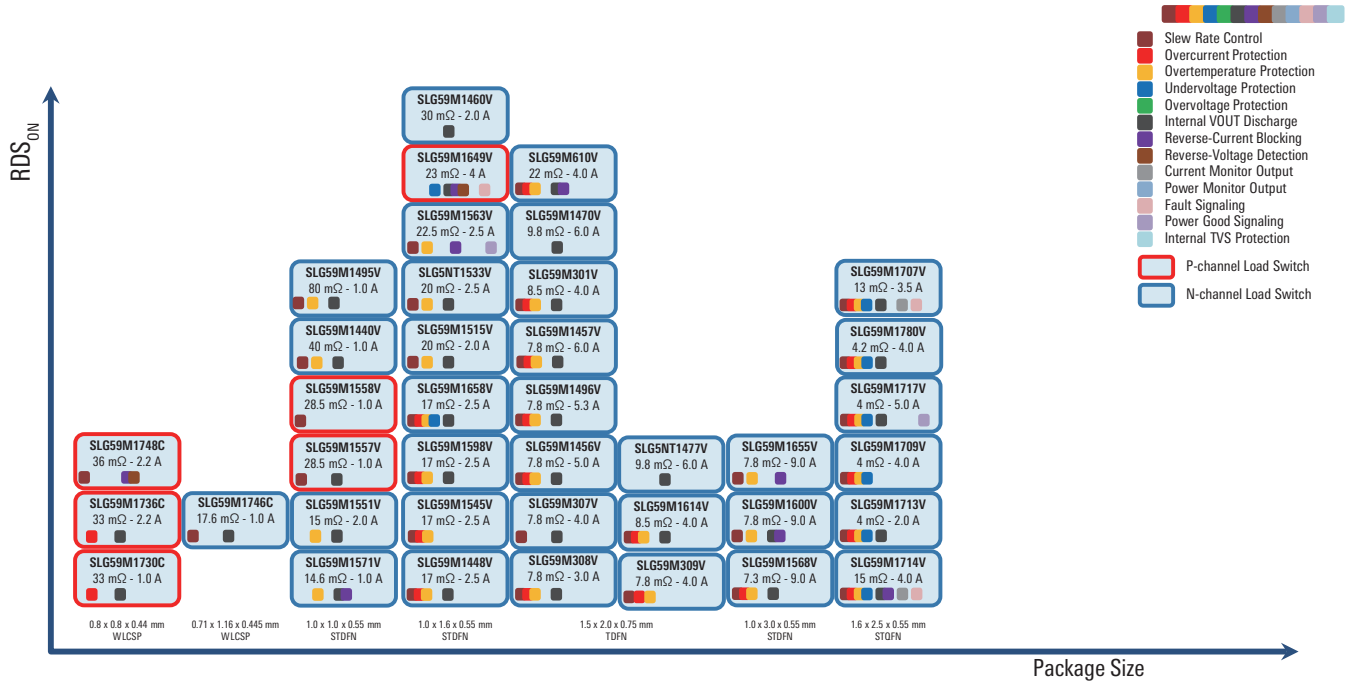
Item	SLG51000	SLG51001	SLG51002	SLG51003	SLG46116/7	SLG46127	SLG46517	SLG46867
General Parameters								
Memory Type	OTP	OTP	OTP	OTP	OTP	OTP	OTP	OTP
# of Pins / # of GPIOs	20 / 6	16 / 4	25 / 6	14 / 5	14 / 7	16 / 6	28 / 16	20 /12
Operating Voltage (V)	2.8 - 5.0	2.8 - 5.0	2.8 - 5.0	2.8 - 5.0	1.71 - 5.5	1.71 - 5.5	1.71 - 5.5	2.3 - 5.5
Communication Interface Type	I²C	I²C	I²C	I²C	–	–	I²C	I²C
Communication Interface Voltage	1.2V - 1.8V	1.2V - 1.8V	1.2V - 1.8V	1.2V - 5.0V	–	–	1.2V - 5.0V	1.2V - 5.0V
GPIO Voltage	1.2V - 1.8V	1.2V - 1.8V	1.2V - 5.0V	1.2V - 5.0V	1.71 - 5.5 V	1.2V - 5.0V	1.2V - 5.0V	1.2V - 5.0V
Package Type	WLCSP	WLCSP	WLCSP	TQFN	TQFN	TQFN	TQFN	TQFN
Package Size (mm)	1.675 x 2.075 x 0.465, 0.4 pitch	1.675 x 1.675 x 0.465, 0.4 pitch	1.992 x 1.992 x 0.44, 0.35 pitch	2.0 x 2.2 x 0.55, 0.4 pitch	1.6 x 2.5 x 0.55, 0.4 pitch	1.6 x 2.0 x 0.55, 0.4 pitch	2.0 x 3.0 x 0.55, 0.4 pitch	1.6 x 3.0 x 0.4, 0.4 pitch
Operating temperature (°C)	-40 to +85	-40 to +85	-40 to +85	-40 to +85	-40 to +85	-40 to +85	-40 to +85	-40 to +85
Combinatorial Logic								
Analog Comparators	–	–	–	–	2	2	4	4
Max. Look Up Tables (LUTs) / DFF	12 / –	12 / –	8 / 8	8 / 8	10 / 4	10 / 4	17 / 8	23 / 21
Pipe Delay	–	–	–	–	8-stage	8-stage	16-stage	16-stage
Internal Oscillator (Hz)	8M	8M	8M	8M	25k / 2M	25k / 2M	25k / 2M / 25M	25k / 2M / 25M
Max. Counters/Delays	–	–	1 / 4	1 / 4	4	4	7	8
Combination Function Macro-cells	–	–	7	7	6	6	17	15
State Machine	Power Sequencer	Power Sequencer	Power Sequencer	–	–	–	8-state ASM	–
Power Parameters								
# of Load Switches	2	1	5	1	1 Total	2 Total	2 Total	2 x PFET
Load Switch Type (PMOS / NMOS)	2 x NMOS	1 x NMOS	3 x NMOS, 2 x PMOS	1 x NMOS	1 x PMOS	2 x PMOS	2 x PMOS	2 x PMOS
Max Iout	0.8A	1A	1.3A	0.8A	1.25A	2A	2A	2A
RON	40mΩ	40mΩ	40mΩ	40mΩ	28.5mΩ	44mΩ	44mΩ	44mΩ
Programmable Current Limit	Yes	Yes	Yes	Yes	–	–	–	–
Slew Rate	Yes	Yes	Yes	Yes	Fixed	–	–	–
# of LDOs	7	6	8	3	–	–	–	–
Protection Features	ESD, OCP, OTP, UVLO	ESD, OCP, OTP, UVLO	ESD, OCP, OTP, UVLO	ESD, OCP, OTP, UVLO	ESD, Read Lock	ESD, Read Lock	ESD, Read Lock	ESD, Read Lock
Discharge Resistance	Fixed	Fixed	Programmable	Programmable	W/O Fixed	–	–	–

High-Voltage GreenFET Load Switch

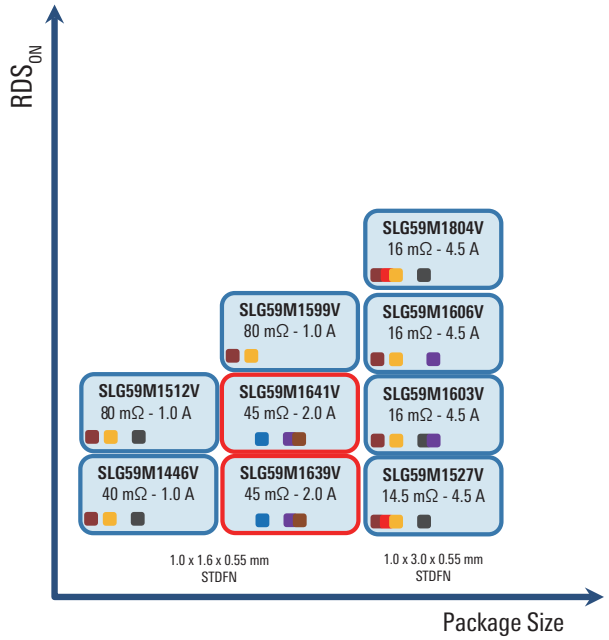


Recommended Products: Gate Driver, MOSFET, Peripheral IC

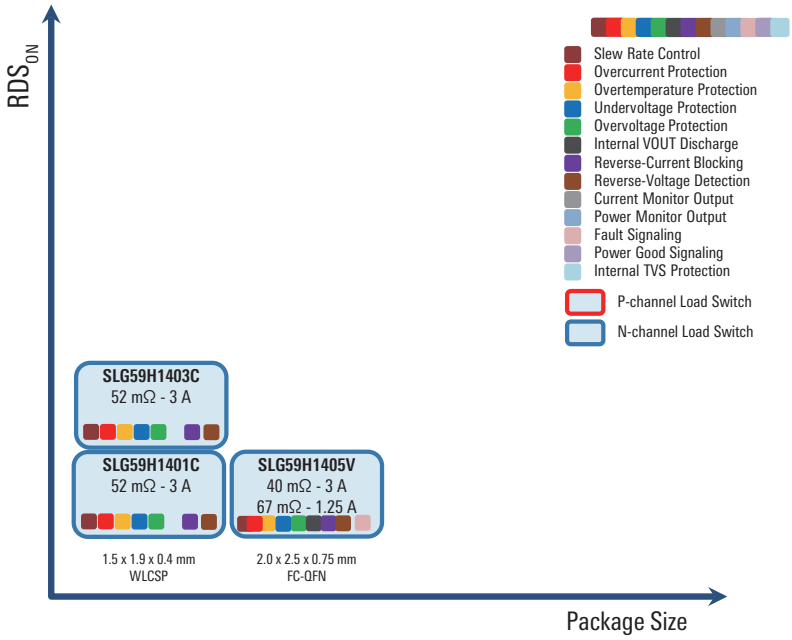
Single-Channel GreenFET Load Switch



Dual-Channel GreenFET Load Switch



High Voltage GreenFET for Powermux Applications



Recommended Products: Gate Driver, MOSFET, Peripheral IC

Gate Driver: for IGBTs and SiC MOSFETs

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
RAJ293000	DESAT OCP, On-chip Micro Isolator gate driver	36	33	1/1	10/10	70/70	33/27	CMOS	SOP16	3750Vrms Isolation, Over 150V/ns CMTI, Soft turn-off function
RAJ293010	CS OCP, On-chip Micro Isolator gate driver	36	33	1/1	10/10	70/70	33/27	CMOS	SOP16	3750Vrms Isolation, Over 150V/ns CMTI, Soft turn-off function

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
RAA227063	60V smart 3-phase gate driver	74	14	6/6	1/2	40/40	Programmable drive control	TTL (VIL / VIH 1.21 / 1.57)	QFN-48	Buck Boost 500mA LDO (5V or 3.3V) 200mA
RAA306012	65V smart 3-phase gate driver	78	17	6/6	0.64/1.28	40/40	Programmable drive control	TTL (VIL / VIH 1.21 / 1.57)	QFN-48	Buck Boost 500mA LDO (5V or 3.3V) 100mA
HIP4083	80V, 300mA peak, for 3-phase	95	15	3/3	0.24/0.3	60/65	35/30	TTL/CMOS	SOC-16P DIP-16	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	SOC-24 PDIP-24	Part No. without A: Integrated charge pump.

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

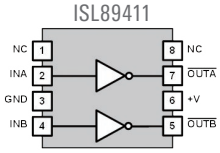
Gate Driver: Half-Bridge Product Family

Part No.	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
HIP2210	115	18	1/2	3/4	30/30	20/20	Tri state	10-TDFN	Tri-state, adjustable input threshold, adjustable dead time
HIP2211	115	18	2/2	3/4	15/15	20/20	CMOS	8-SOIC, 10-TDFN, 8-DFN	–
HIP2100	114	14	2/2	2/2	20/20	10/10	CMOS	8-EPSOIC, 8-SOIC, 16-QFN	–
HIP2101	114	14	2/2	2/2	25/25	10/10	TTL/CMOS	8-EPSOIC, 8-SOIC 16-QFN, 12-DFN	–
ISL2100A	114	14	2/2	2/2	39/31	10/10	CMOS	8-SOIC, 9-DFN	Equivalent to HIP2100 with input hysteresis added.
ISL2101A	114	14	2/2	2/2	39/31	10/10	TTL	8-SOIC, 9-DFN	Equivalent to HIP2101, but with ability to swing input up to the bias voltage
ISL2110A	114	14	2/2	3/4	38/32	9/7.5	CMOS	8-SOIC, 12-DFN	–
ISL2111A/B	114	14	2/2	3/4	38/32	9/7.5	TTL	8-SOIC, 10-TDFN 12-DFN, 8-DFN	–
HIP2103	66	16	2/2	1/2	28/30	20/17	CMOS	8-DFN	–
HIP2104	66	–	2/2	1/2	23/27	21/17	CMOS	12-DFN	VBAT = 60V, 75mA, built-in LDO

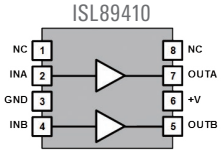
Other Drivers and Detectors

MOSFET Driver

ISL89411



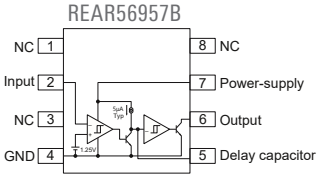
ISL89410



V+ = 18V (max)
Ipk = 2A (max)
VIH/VIL=2.4V/0.8V
8Ld PDIP, SOIC

Voltage Detector (Reset-IC)

REAR56957B



Vcc = 18V (max)
Vref=1.25V
SOP

Recommended Products: Gate Driver, MOSFET, Peripheral IC

Gate Driver: Low-Side Product Family

Part No.	Vin (max) (V)	Input Lines/ Output Lines	Peak Current (A)	Turn On/Off Propagation Delay (nS)	Rise/Fall Time (nS)	Input Logic	Package	Remarks
ISL89163	16	2/2	6	25/25	25/25	TTL/CMOS	8-EPSOIC, 8-TDFN	Non-inverting/non-inverting driver
ISL89164	16	2/2	6	25/25	25/25	TTL/CMOS	8-EPSOIC, 8-TDFN	Inverting/inverting driver
ISL89165	16	2/2	6	25/25	25/25	TTL/CMOS	8-EPSOIC, 8-TDFN	Inverting/non-inverting driver
ISL89410	18	2/2	4	18/20	10/13	CMOS	8-PDIP, 8-SOIC	Non-inverting/non-inverting driver High-voltage-tolerance version of EL7202
ISL89411	18	2/2	4	18/20	10/13	CMOS	8-PDIP, 8-SOIC	Inverting/inverting driver High-voltage-tolerance version of EL7212
ISL89412	18	2/2	4	18/20	10/13	CMOS	8-PDIP, 8-SOIC	Inverting/non-inverting driver High-voltage-tolerance version of EL7222
RAA226110	18	1/1	0.3/0.75/2	20/20	2/2	–	16-QFN	For GaN FETs

Peripheral IC: RS-485 Transceiver

Device	Duplex	VCC (V)	Data Rate (Mbps)	Fail-Safe	Fractional Unit Load	Tx V_{OD} (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		Y	–40 to 85 –40 to 125	8L SOIC/MSOP 10L DFN
ISL3179E		3.0 to 3.6				Min. 1.5	±16.5kV	±9kV				
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
RAA788172 / 75 / 78		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
RAA788170 / 72 / 76		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 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

Recommended Products: Gate Driver, MOSFET, Peripheral IC

Power MOSFETs

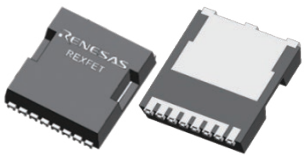
Features

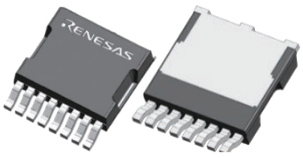
- Industrial and automotive application with AEC-Q101 Qualified products & PPAP support
- Small 5x6 SO8-Flat Lead package with copper clip
- High current capability with TOLL/TOLG/TOLT packages
- Low Rds(on) to minimizing conduction loss
- Low input capacitance & Stable switching capability
- Standard Level gate threshold (VGS(th) = 2V - 4V)
- Lower surge and ringing voltage

Benefits

- Standard package and pin out, allow for drop-in replacement
- Small footprint, high current capability enables higher power density
- TOLL with wettable flank for optical inspection
- TOLT for superior thermal performance with top-side cooling
- Outstanding package reliability

Part No.	VDSS	Ron (max.)	ID	Qg (typ.)	Package
RBE020N04R0SZN6	40V	2mΩ	100A	83nC	5x6 SO8-FL
RBE023N04R0SZN6	40V	2.3mΩ	100A	60nC	5x6 SO8-FL
RBE030N04R0SZN6	40V	3mΩ	80A	56nC	5x6 SO8-FL
RBE035N04R0SZN6	40V	3.5mΩ	80A	40nC	5x6 SO8-FL
RBE050N04R0SZN6	40V	5mΩ	50A	34nC	5x6 SO8-FL
RBE058N04R0SZN6	40V	5.8mΩ	50A	24nC	5x6 SO8-FL
RBE100N04R0SZN6	40V	10mΩ	30A	19nC	5x6 SO8-FL
RBE011N08R1SZQ4	80V	1.06mΩ	360A	230nC	TOLL
RBE020N04R0SZN6	80V	1.06mΩ	360A	230nC	TOLT
RBE020N04R0SZN6	80V	1.3mΩ	340A	170nC	TOLL
RBE020N04R0SZN6	80V	1.3mΩ	340A	170nC	TOLT
RBE020N04R0SZN6	80V	2.4mΩ	175A	99nC	5x6 SO8-FL
RBE020N04R0SZN6	80V	3.1mΩ	140A	88nC	5x6 SO8-FL
RBE020N04R0SZN6	80V	5.6mΩ	90A	47nC	5x6 SO8-FL
RBE020N04R0SZN6	80V	9.3mΩ	50A	31nC	3x3 µSO8-FL
RBE020N04R0SZN6	80V	17.2mΩ	30A	20nC	3x3 µSO8-FL
RBE012N10R1SZQ4	100V	1.2mΩ	360A	230nC	TOLL
RBE012N10R1SZPW	100V	1.2mΩ	360A	230nC	TOLT
RBE015N10R1SZQ4	100V	1.5mΩ	340A	170nC	TOLL
RBE015N10R1SZPV	100V	1.5mΩ	340A	170nC	TOLG
RBE015N10R1SZPW	100V	1.5mΩ	340A	170nC	TOLT
RBE019N10R1SZQ4	100V	1.9mΩ	230A	150nC	TOLL
RBE019N10R1SZPW	100V	1.9mΩ	230A	150nC	TOLT
RBE029N10R1SZN6	100V	2.9mΩ	160A	90nC	5x6 SO8-FL
RBE037N10R1SZN6	100V	3.7mΩ	130A	80nC	5x6 SO8-FL
RBE067N10R1SZN6	100V	6.7mΩ	80A	43nC	5x6 SO8-FL
RBE111N10R1SZN2	100V	11.1mΩ	40A	28nC	3x3 µSO8-FL
RBE210N10R1SZN2	100V	21mΩ	20A	18nC	3x3 µSO8-FL
RBE034N15R1SZQ4	150V	3.4mΩ	200A	96nC	TOLL
RBE034N15R1SZPW	150V	3.4mΩ	200A	96nC	TOLT
RBE039N15R1SZQ4	150V	3.9mΩ	190A	76nC	TOLL
RBE039N15R1SZPW	150V	3.9mΩ	190A	76nC	TOLT


TOLL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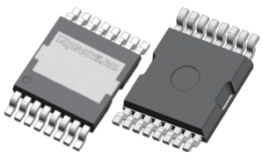
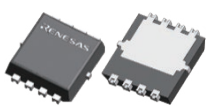

TOLT


5x6 SO8-FL


3x3 SO8-FL

Recommended Products: Photocoupler

IGBT Drive

Part No.	Output Peak Current [A]	Power Supply Voltage [V]	Package		Isolation Voltage [Vr.m.s.]	Ta max. [°C]	Electrical Characteristics					Protection Functions		
							DC	SW				Protection		
			Configuration	Creepage Distance [mm]			IFLH max. [mA]	tpHL,LH max. [ns]	PWD max. [ns]	PDD [ns]	CMTI min. [kV/µs]	UVLO	Clamp	Desat
PS9307A	0.6	10 to 30	SDIP6	L:7 L2:8	5000	125	5.0	150	50	-80 to 80	50	○	–	–
RV1S9207A			LSSO5	8.2	5000	125	5.0	150	50	-80 to 80	50	○	–	–
PS9506			DIP8	-/L3:7 L1/L2:8	5000	110	7.0	400	250	-300 to 300	25	–	–	–
PS9031	2.5	15 to 30	LSO5	8	5000	125	4.0	175	75	-90 to 90	50	○	–	–
RV1S9231A			LSSO5	8.2	5000	125	5.2	175	75	-90 to 90	50	○	–	–
PS9331			SDIP6	L:7 L2:8	5000	125	4.0	175	75	-90 to 90	50	○	–	–
PS9531			DIP8	-/L3:7 L1/L2:8	5000	125	4.0	175	75	-90 to 90	50	○	–	–
PS9905			LSDIP8	15	7500	110	6.0	150	75	-100 to 100	25	○	–	–
PS9332	2	15 to 30	SDIP8	L:7 L2:8	5000	125	4.0	200	75	-90 to 90	50	○	○	–
PS9402	2.5	15 to 30	SO16	8	5000	110	5.0	200	100	-100 to 100	25	○	○	○
RV1S9091A	4	10 to 30	LSO5	8	5000	125	6.0	95	35	-35 to 35	100	○	–	–
RV1S9092A		13 to 30	LSO5	8	5000	125	6.0	95	35	-35 to 35	100	○	–	–
RV1S9291A		10 to 30	LSSO5	8.2	5000	125	6.0	95	35	-35 to 35	100	○	–	–
RV1S9292A		15 to 30	LSSO5	8.2	5000	125	6.0	95	35	-35 to 35	100	○	–	–
RV1S9991A		10 to 30	LSDIP8	15	7500	125	8.0	95	35	-35 to 35	100	○	–	–
RV1S9992A		15 to 30	LSDIP8	15	7500	125	8.0	95	35	-35 to 35	100	○	–	–
RV1S9993A	10	10 to 30	LSDIP8	15	7500	125	8.0	95	35	-35 to 35	100	○	–	–
RV1S9994A		15 to 30	LSDIP8	15	7500	125	8.0	95	35	-35 to 35	100	○	–	–

IPM Drive

Part No.	Output Type	Logic	Package		Recommended Operating Conditions	Absolute Maximum Ratings		Electrical Characteristics				
								DC	SW			
			Configuration	Creepage Distance [mm]	Power Supply Voltage [V]	Isolation Voltage [Vr.m.s.]	Ta max. [°C]	IFHL/LH max. [mA]	tpHL/LH max. [ns]	PWD max. [ns]	PDD max. [ns]	CMR min. [kV/µs]
RV1S9161A	Totem Pole	Active High	SO5	4.2	4.5 to 30	3750	125	3.0	60	20	25	100
PS9009			LSO5	8	4.5 to 20	5000	125	3.0	200	80	100	50
RV1S9061A					4.5 to 30	5000	125	4.5	60	20	25	100
RV1S9209A			LSSO5	8.2	4.5 to 20	5000	125	3.8	200	80	100	50
RV1S9261A					4.5 to 30	5000	125	4.0	60	20	25	100
PS9309			SDIP6	L:7 L2:8	4.5 to 20	5000	110	3.0	200	80	80	15
PS9303			SDIP6	L:7 L2:8	4.5 to 20	5000	100	5.0	500	350	–	15
RV1S9162A		Active Low	SO5	4.2	4.5 to 30	3750	125	3.0	60	20	25	100
RV1S9062A			LSO5	8	4.5 to 30	5000	125	4.1	60	20	25	100
RV1S9262A			LSSO5	8.2	4.5 to 30	5000	125	4.0	60	20	25	100
PS9513	Open Collector		DIP8	-/L3:7 L1/L2:8	4.5 to 20	5000	100	5.0	500 750	650	650	15
PS9013			LSO5	8	4.5 to 25	5000	125	5.0	500 750	650	650	50
RV1S9213A			LSSO5	8.2	4.5 to 25	5000	125	5.0	500/750	650	650	50
PS9313			SDIP6	L:7 L2:8	4.5 to 20	5000	110	5.0	500 750	650	650	15
PS9113			SO5	4.2	4.5 to 20	3750	100	5.0	500 750	650	650	15

Recommended Products: Photocoupler

Isolation Amplifiers

Part No.	Output	Package		Absolute Maximum Ratings		Electrical Characteristics							
		Configuration	Creepage Distance [mm]	Isolation Voltage [Vr.m.s.]	Ta max. [°C]	Input Voltage Linearity Range [mV]	Gain typ. [V/V]	Gain Error Max.[%]	NL typ. [%]	VDD2 [V]	CMR min. [kV/µs]	fc typ. [kHz]	Output Type
PS8551A	Analog	DIP8	8	5000	105	-200 to 200	8	1	0.014	5	10	100	Differential
PS8352A		SDIP8	8	5000	110	-200 to 200	8	1	0.014	5	10	100	Differential

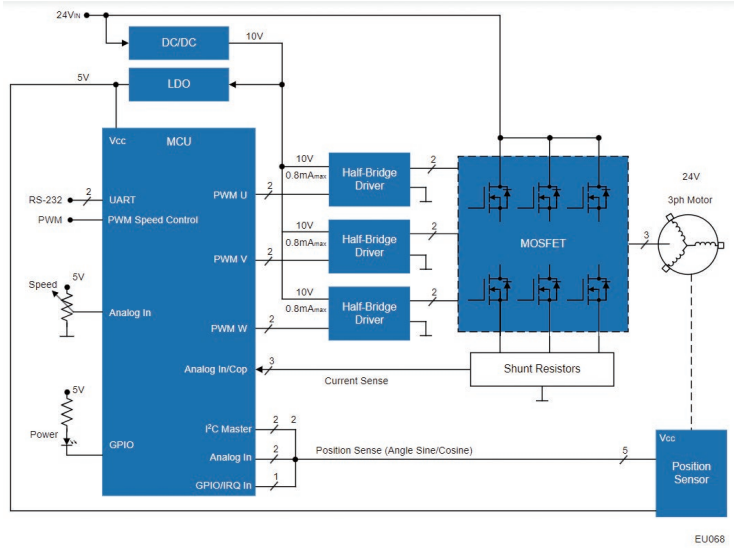
Δ-∑ Modulators

Part No.	Output	Package		Absolute Maximum Ratings		Electrical Characteristics						
		Configuration	Creepage Distance [mm]	Isolation Voltage [Vr.m.s.]	Ta max. [°C]	Input Voltage Linearity Range [mV]	Gain Error Max.[%]	INL typ. [LSB]	VDD2 [V]	ENOB typ. [bits]	CMTI min. [kV/µs]	fCLK typ. [MHz]
PS9551A	Digital	DIP8	8	5000	105	-200 to 200	1	3	5	12	15	10
RV1S9353A		SDIP8	8	5000	110	-200 to 200	0.5	3	3.3/5	13.8	15	10
RV1S9355A		SDIP8	8	5000	125	-250 to 250	0.5	3	3.3/5	14	50	20
RV1S9356A		SDIP8	8	5000	125	-250 to 250	0.5	3	3.3/5	14	50	20

Winning Combinations

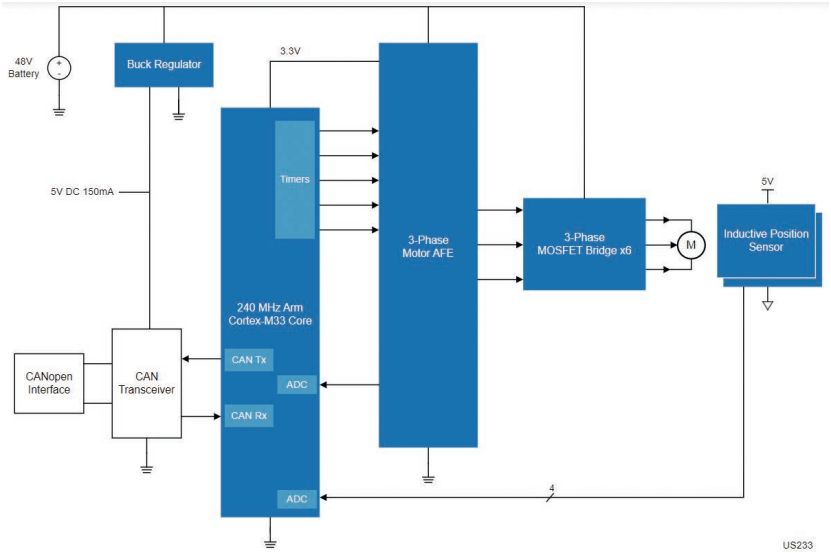
36V/144W BLDC Motor Controller

This design features a 32-bit MCU optimized for field-oriented control (FOC) of a single BLDC motor. The MCU includes a best-in-class floating point unit (FPU) and built-in peripherals for motor control, allowing for a compact and cost-effective motor controller. The system is powered off a standard 24VDC input and receives precise position feedback from an inductive position sensor.



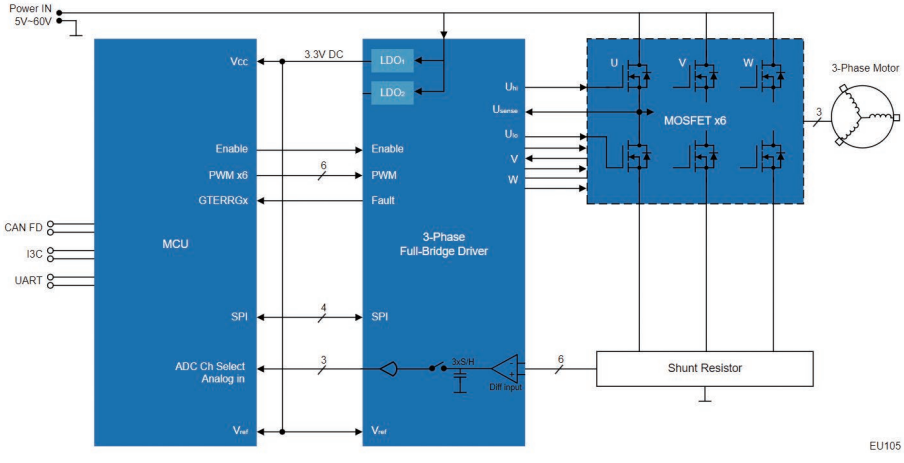
BLDC Traction Motor Drive

The combination of a high-performance MCU and a 3-phase smart driver delivers optimal processing speed and power efficiency, catering to traction motors with small form factor limitations and varied power requirements. The integrated power management allows the driver and MCU to be powered directly from the battery, reducing overall circuitry. Programmability enables customers to optimize the inverter power stage for different power levels by adjusting MOSFETs and tuning slew rate, dead time, and gate drive via software. By using two inductive position sensors, customers can replace large, costly optical encoders. These sensors provide absolute position information and incremental position sensing with up to 17 bits of resolution, utilizing the MCU's advanced ADC capabilities.



High Power, Compact BLDC Motor Control

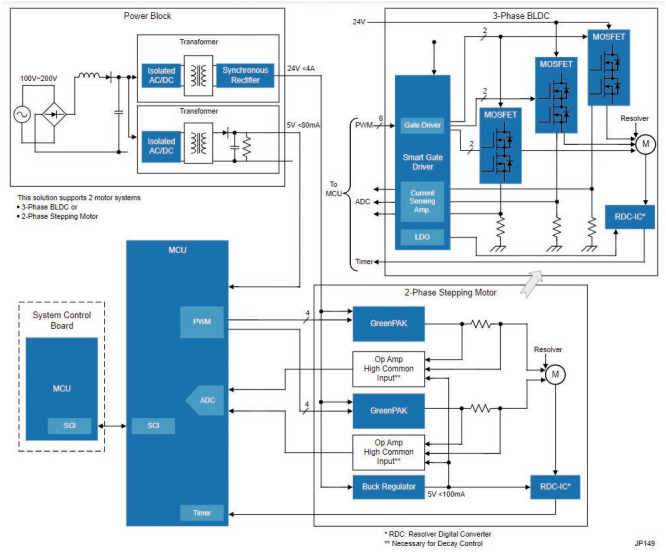
The smart gate driver IC is designed for 3-phase sensorless Brushless DC (BLDC) motor applications. It integrates three half-bridge smart gate drivers capable of powering N-channel MOSFET bridges with voltages ranging from 4.5V to a maximum of 60V, featuring 1A drive and 2A sinking current capability. This setup enables control of high-current GaN MOSFETs. The IC includes a buck-boost converter to supply power to the MCU and incorporates three differential amplifiers with adjustable gain for precise ground-side shunt current sensing, feeding data to the MCU's ADC input. The MCU enhances data communication through CAN FD and I3C protocols and features a specialized ADC for motor control, supporting calculation-intensive algorithms for smoother motor tuning. The use of GaN high voltage MOSFETs allows for high current switching without bulky heatsinks, optimizing the system for compact, high-efficiency applications.



Winning Combinations

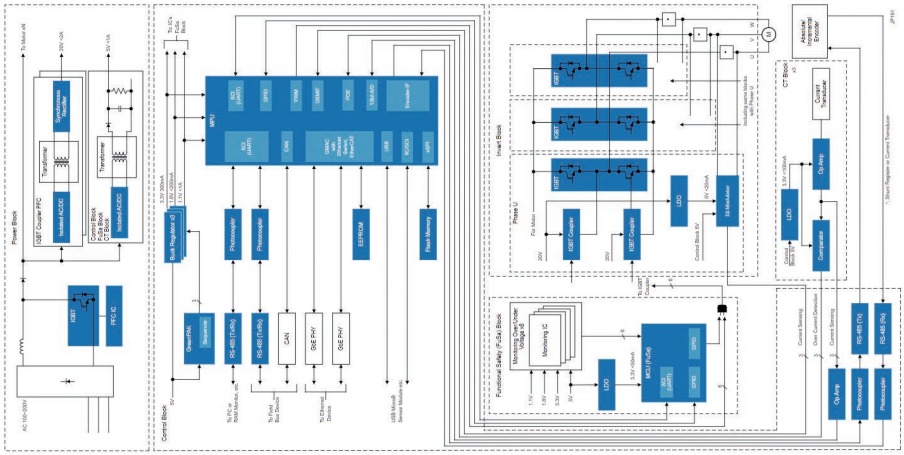
Motor Control with Resolver

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.



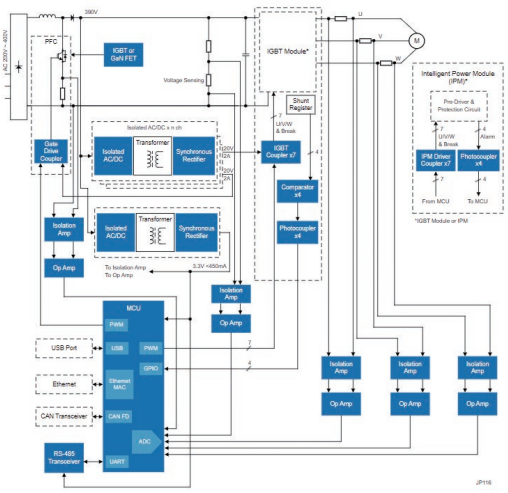
Motor Control System with Industrial Network and Functional Safety

Renesas provides a comprehensive system for industrial motor control, integrating an MPU and MCU for mutual monitoring, along with power supply ICs, delta-sigma ($\Delta\sum$) modulators, and other essential devices. This combination of components enables a streamlined and high-performance approach to motor control, industrial networking, and functional safety, ensuring efficient and reliable operations in industrial environments.



AC Drive & General Purpose Inverter System

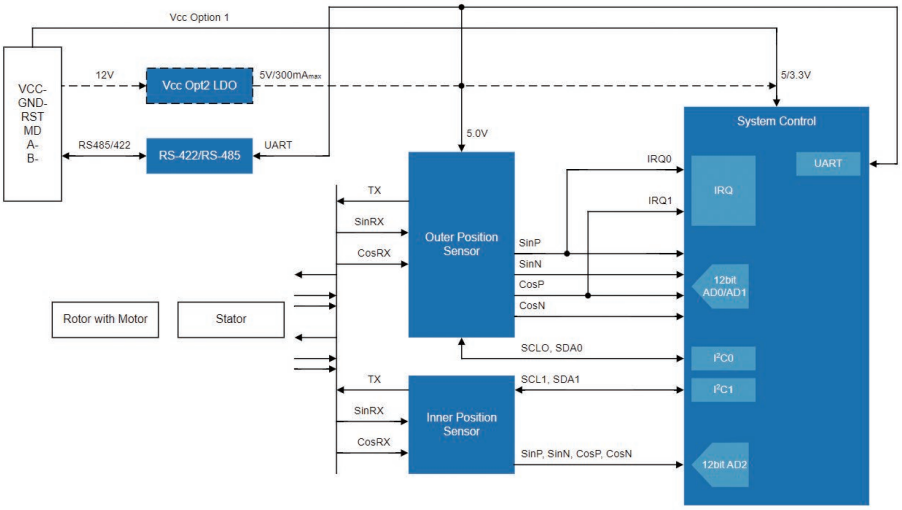
This system provides a basic configuration and essential components for AC drives and general purpose (GP) inverters, serving as a variable-speed controller to precisely regulate shaft rotation speed in induction and synchronous motors. It is widely used in industrial machinery such as conveyors, cranes, elevators, fans, pumps, and compressors. Due to its versatile application scenarios, the system supports multiple optional functions to meet diverse industrial requirements, ensuring adaptability and efficiency in various settings.



Winning Combinations

Absolute Inductive Position Sensor

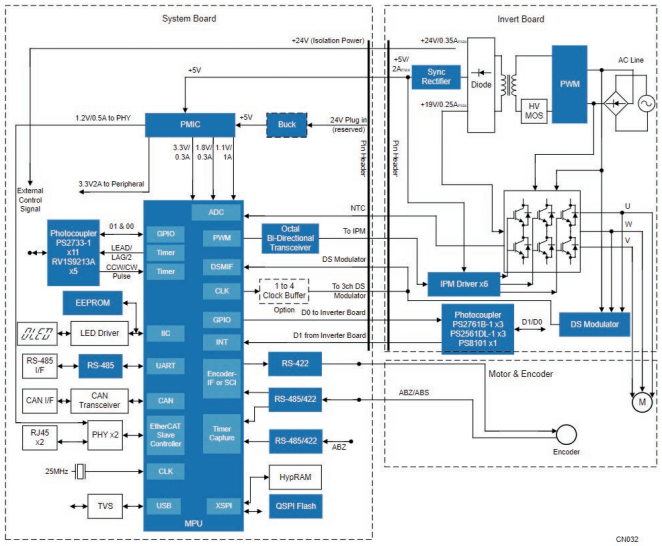
This simple and cost-effective design utilizes off-the-shelf components like a standard PCB, a Renesas' position sensor, passive components, and a metal piece as a target. The sensing element consists of a set of coils on the PCB rather than inside the Renesas IC, allowing the sensor system to be tailored to specific customer applications. This flexibility enables the sensor system to be customized to the customer's needs. It uses dual inductive position sensors (IPS) for absolute position detection, optimizes coil size, and aligns with market trends such as 35mm motors.



CN317

AC Servo

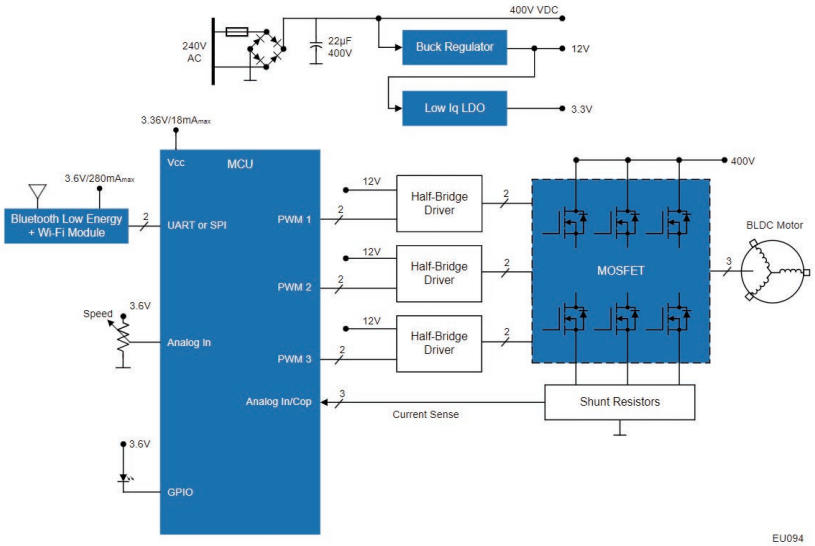
This Renesas AC servo solution integrates motor control and EtherCAT design to support high-speed and high-precision motor control through synchronizing time-sensitive industrial Ethernet communications. This solution is composed of three blocks: system control, power drive and motor encoder, which are physically isolated while maintaining a high degree of interconnect. By utilizing the high-performance RZ/T2L, RZ/T2M or RZ/N2L microprocessor, this monolithic solution design outperforms traditional two-chip platforms on performance and cost.



CN032

240V AC-Input BLDC Motor Controller

This design features an MCU optimized for single motor field-oriented control (FOC) of a BLDC motor. The MCU has a best-in-class built-in floating point unit (FPU) and various peripheral functions, allowing for a compact, low BOM cost motor controller board. This design is intended for an un-isolated environment where the user cannot make direct contact with the controller. The system offers remote control via an ultra-low power Wi-Fi + Bluetooth® Low Energy (LE) module, providing flexibility and advanced connectivity for modern industrial applications.

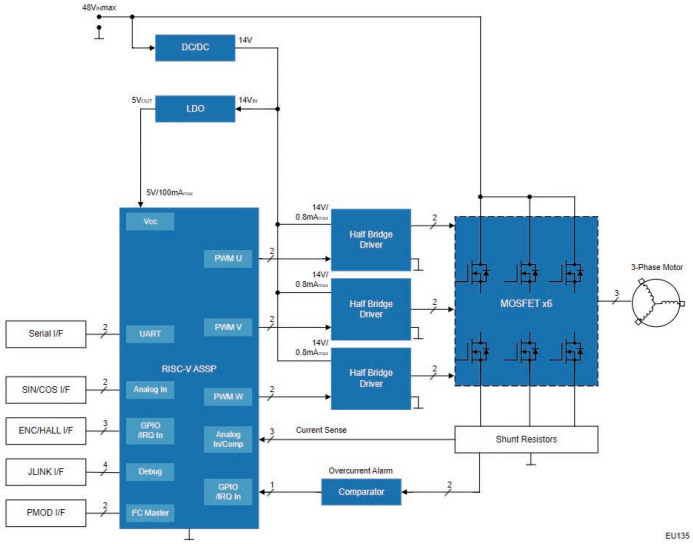


EU094

Winning Combinations

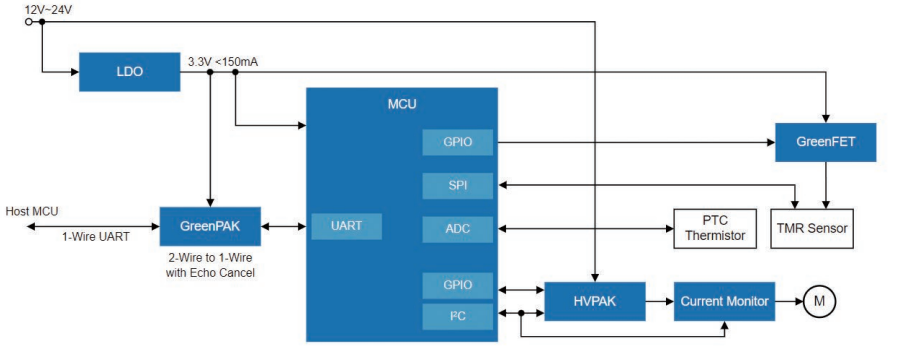
3-Phase RISC-V Motor Controller

This simplified 3-phase motor control system features a cost-optimized RISC-V 32MHz 32-bit ASSP, with rich analog IP and support for temperatures up to 125°C. The ASSP is a pre-programmed motor control solution, allowing users to store specific motor characteristics in device flash via a GUI interface. Additional input channels accommodate signals from a motor position encoder and Hall sensors. A Pmod™ interface with I^2C and serial ports enables connection to external environmental sensors or wireless connectivity modules.



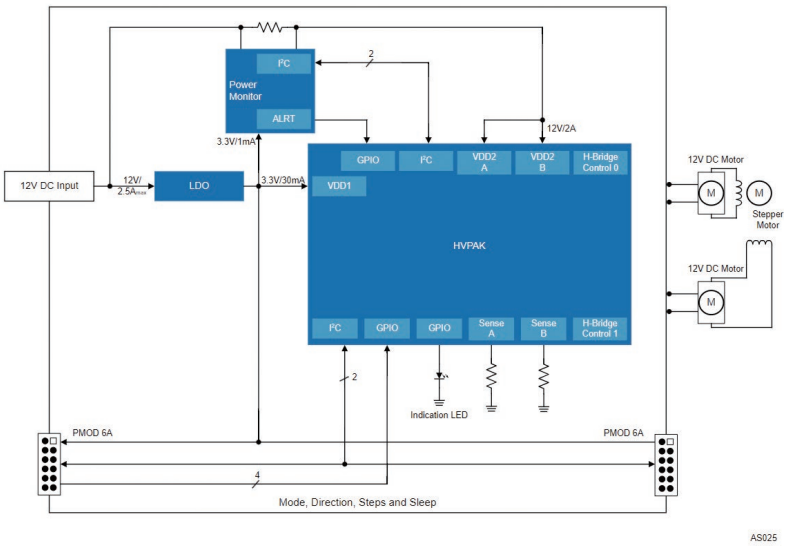
Servo Motor Control for Robot Limbs

This system enables motor control for angular motion with adequate torque and speed. It also monitors the status of multiple motors via 1-wire through UART from the host MCU, which allows users to reduce the harness in a system and to control robot limbs such as for service robots, manipulators and Automatic Guided Vehicles (AGV). The SLG47115 HVPAK™ programmable mixed-signal matrix has high-voltage H-bridge functionality in a tiny 2mm x 3mm QFN package which contributes to minimizing the size of the servo motor.



DC Motor Driver Pmod

This implementation of the HVPAK™ programmable mixed-signal matrix over Pmod™ provides flexibility for users to control and configure the HVPAK motor drive using any MCU/MPU. There are multiple protection sections implemented to use it as a standalone motor drive as well. The motors, the DC motor with direction and speed control as well as the stepper motor with micro-steps are easily configurable. This will reduce the development and turnaround time of any customer.



Partner's Solution

Following partners support motor control solutions with Renesas MCUs. Visit Renesas Ready Partner Network for more information.

Partner Name	Solution Overview	Target Application	Supported Region
BFG ENGINEERING	The BFG motor control reference design and software solution address a wide range of embedded motor-driven applications. The motor control reference design for Renesas RA or RX MCUs is integrated with the motor control development kits for a total project-ready solution.	■ Smart appliances ■ Smart homes ■ Smart buildings ■ Industrial control	EMEA
Desk Top Lab	The Desk Top Lab supports the development of custom motor drivers based on customer requirements using Renesas' RA, RX, and RL78 families, and provide motor control software, evaluation tools, and hardware for zero-level prototyping.	■ Air conditioner compressor ■ Refrigerator compressor ■ Fan ■ Oil pump ■ Water pump ■ Various motor control applications	APAC Japan
CT eMOTOR	The CT Green Tech. provides references with motor evaluation and development environment to increase time-to-market design based on RX MCUs, such as the 3kW Power Stage and the FLYING START CONTROL.	■ Compressors, Air conditioning, Fans, Air extractors, Pumps ■ Home appliances, Inverters, Industrial drives ■ Electric vehicles, Electric bikes, Electric assist bikes	APAC
DTDS	The DTDS provides references based on RX MCUs that are production-ready, cost-optimized solutions reduce time-to-market for motor control applications. Motor control and system tuning software are provided to help customers optimize their systems. Smart failure prediction with AI can be implemented upon request.	■ Inverter air conditioner, Inverter cooling system, HVACs ■ Consumer refrigerators, Inverter fridges, Industrial freezers	Americas APAC EMEA Japan
ETOUCH	The Etouch high-resolution position motor control solution is based on Renesas' RX24T and RDC (Resolver-to-Digital Converter) IC. The solution provides high resolution, environmental resistance, low sound noise and vibration, low power, low heat, and high acceleration/deceleration response.	■ Power assistant bicycle ■ Automatic guided vehicle (AGV) ■ Robot ■ 3D printer ■ General-purpose (GP) inverter ■ Stepping motor ■ Other motor applications	China

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