

## Easy-to-Start (ETS) 32-bit MCU RH850/C1M-A for Traction Motor Control

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### Abstract

The RH850/C1M-Ax microcontroller (MCU) paves the next generation inverter for e-drive and is ideal for highly cost-optimized ASIL-C automotive traction motor control systems. It can strongly contribute to overall system cost reduction because of its embedded key features. These key features comprise an embedded motor-control IP (EMU3) to unload the CPU for additional function integration, and an embedded Resolver to Digital Converter (RDC) to reduce the number of components and PCB space. Several types of position sensors can be interfaced, e.g., resolvers and inductive concepts.

Renesas' Easy-to-Start Program for RH850/C1M-A2, includes sample provisioning, a hardware (HW) - starter kit, necessary documents, MCAL and other application-relevant software, enabling users to evaluate this product solution on-the-fly.

### Introduction

The independent control of motors and synchronization efforts become more complex as the automotive electrification trend accelerates Hybrid Electric Vehicles (HEV) development due to tighter environmental regulations in global regions. High communication load and increased diagnostics efforts to maintain the targeted ASIL-level are needed to fulfill the requirement.

An obvious solution to optimize these efforts is to integrate both inverter control systems into one ECU, operated by a single and highly specialized MCU. By using such a concept, the synchronization between both inverter control loops can be implemented within one controller, resulting in high communication bandwidth and low latency. Furthermore, the diagnostics & Functional Safety concepts will become more straightforward with the selection of an ASIL-compliant target device. Another benefit of an integrated solution is certainly a strongly optimized Bill-of-Materials (BOM) which goes along with reduced component space requirements, both highly welcomed for the overall system concept.

### Easy-to-Use by Controlling Dual Motor Controls with a Single MCU

The RH850/C1M-Ax provides the ideal traction motor control system for E-drive to control traction / generator motors with a single MCU. The single MCU can create the next-generation inverter for E-drive by driving 2 motor controls by itself, and implement high motor control performance using a CPU + HW accelerator (EMU3). The ECU BOM cost is reduced with an embedded Resolver to Digital Converter (RDC3A). Seamless upgrade to a successor is possible by using the same architecture for motor control and re-using SW.

#### Key Features of RH850/C1M-Ax

- 320MHz speed for 2+1 (LS) CPUs (C1M-A2)
- Top-level ratio of performance (3.44 DMIPS / MHz) vs. power consumption
- High temperature support: Tj = 150°C, AEC-Q100
- Embedded RDC, EMU3 / TSG3 for FOC motor control
- 3 x ADC (12-bit), max. 48 ch, 6+6+4 T/H
- State-of-the-Art Interfaces

- Interfaces: CAN-FD, SPI, SENT, LIN, UART
- Support for Functional Safety and Security
  - EVITA Light
  - ISO26262 ASIL-C Capable
- RV40F 40nm manufacturing technology

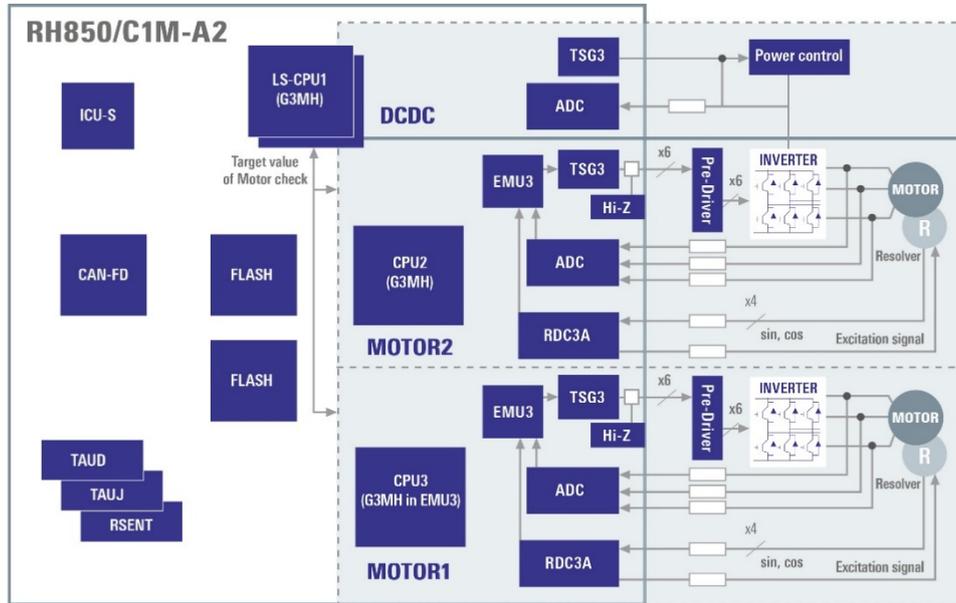


Figure 1: System Example to Control Dual E-Motor/Generator

## Easy to Develop with Extensive Ecosystem Supporting the Latest Standards

The extensive ecosystem supports our customer during their development and can reduce development time on the customer side. Renesas provides technical support through a Q&A structure. Also, there are standard business models and contracts to shorten negotiations and allow users to jumpstart the development.

Renesas offers a huge amount of supporting documentation and software examples, which can be easily downloaded from the Renesas website: [RH850/C1M-Ax Design Support Resources](#).

- Manuals
- Application Notes
- SW-Drivers
- Functional Safety analysis
- MCAL

<b>RH850/C1M-A</b>	
<b>HW</b>	RH850/C1M-A2 Starter Kit Target Board
	E1 On-Chip Debugging Emulator
<b>SW</b>	3 development environments to choose from: - Green Hills MULTI IDE (90 days evaluation version) - IAR Embedded Workbench EWRH850 for Renesas RH850 (128KB kickstart version or 30 days evaluation version) - CS+ integrated development environment with compiler CC-RH (compiler is 60 days evaluation version, afterwards it can be used as 256KB code size limited version)
	Renesas Flash Programming GUI (RFP)
	Renesas SmartConfigurator/Code Generator
	Renesas MCAL
	Sample SW to start-up
	Model-based Development (MBD) solution: Renesas IP Model for MILS and Motor SW Driver Model
	Vector MICROSAR evaluation package

**Figure 2:** Hardware and Software Available on RH850/C1M-A Website

Also, Renesas releases a starter kit based on an engineer-vetted solution that can optimize inverter control systems for hybrid vehicles. Development can start directly by using the starter kit optimized for motor control applications.

## Reference Solution (Winning Combination) Available on Web to Easily Develop the Motor Generator System, a Key Technology for Vehicle Electrification

Renesas' solution features a comprehensive lineup of MCUs that incorporate high-performance CPUs, timers and ADC functions ideal for motor and recuperation control, and position-sensor interface (RDCs) for a further reduction in system cost, and also to supply analog and power devices suitable for motor-generator systems.

- This motor control solution is available in the form of a starter kit for evaluation purposes ([Y-ASK-RH850C1M-A2](#)).
- Motor Control IP (EMU3):
  - Perform feedback control of a motor using dedicated hardware, and motor control without a CPU (software)
  - Vastly reduce CPU processing load and realize high-speed rotation
  - Highly flexible usage of EMU3 functional blocks to either unload SW-based motor control algorithms partly or realize full stand-alone control of the traction inverter
  - Enable fine-granular configuration of the gain-control based on variable parameter setting
- Resolver/Digital Converter (RDC)
  - Dedicated IP that processes analog signals from a motor rotational angle sensor (resolver)
  - Integration proven external RDC into Renesas' state-of-the-art process
  - More compact system size

- Improved noise tolerance, reliability, and precision
- Recommended complementary products:
  - Power Management IC: [RAA270000](#)
  - Power MOSFET: [NP15P04SLG-E1-AY](#)
  - OpAmp: [UPC842AMP](#)
  - Induction Position Sensor: [IPS2550](#)

In addition to motor generator system, users can also easily develop the xEV with 100kW class motors or 48V inverter applications by referring to Renesas' [xEV Inverter Reference Solution](#) and [48V Auxiliary Inverter](#).

## Conclusion

Hybrid vehicles that operate based on e-drive/ ICE combinations are especially in need of cost-efficient and size-optimized propulsion systems due to the increased system complexity. Traction motor specific high-performance MCUs included with a dedicated HW accelerator function for vector math calculations can help to achieve an overall optimized electronic and electro-mechanic system design.

Generation of well-proven concepts for HEV-control exist within the 40nm microcontroller - RH850/C1M-Ax. This device and its soon to be released 28nm successors, focus on inverter control functions for traction motors. The suitable PMICs, gate drivers and IGBT devices, as well as inverter turnkey solutions can significantly reduce customers' R&D efforts.

In addition to the white paper, more technical information can be found from the blog titled: "[RH850/C1M-Ax MCU Solves Complex Control Challenge in Integrated Dual Traction Inverter](#)".

## Related Information

- [RH850/C1M-A](#) (R7F701275EABG-C#AC6) – 252-pin BGA / 4MB Flash Automotive MCU with G3MH CPU Core, ideal for HEV/ EV Motor Control
- [RH850/C1M-A2 Starter Kit](#) (Y-ASK-RH850C1M-A2) – Simple and easy-to-use platform for evaluating the features and performance of Renesas' 32-bit RH850/C1M-A2 MCUs.
- [RAA270000](#) – Power Management IC (PMIC) for Automotive RH850 MCUs
- [NP15P04SLG-E1-AY](#) – P-channel MOS Field Effect Transistor designed for high current switching applications.
- [UPC842AMP](#) – Single Power Supply, High-Speed, Wide Band, Dual Bipolar Operational Amplifier
- [IPS2550](#) – Inductive Position Sensor for High-Speed Motor Commutation (Automotive)

## Revision History

Revision	Date	Description
1.0	November 2, 2021	Initial release
2.0	November 25, 2021	Updated software information

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