RENESAS

AUTOMOTIVE WINNING COMBINATIONS

Analog & Power & Embedded Processing & Connectivity work together to deliver comprehensive solutions.

2022.12

WINNING COMBINATIONS
INTRODUCTION.

System Level Designs Utilizing Complementary Products

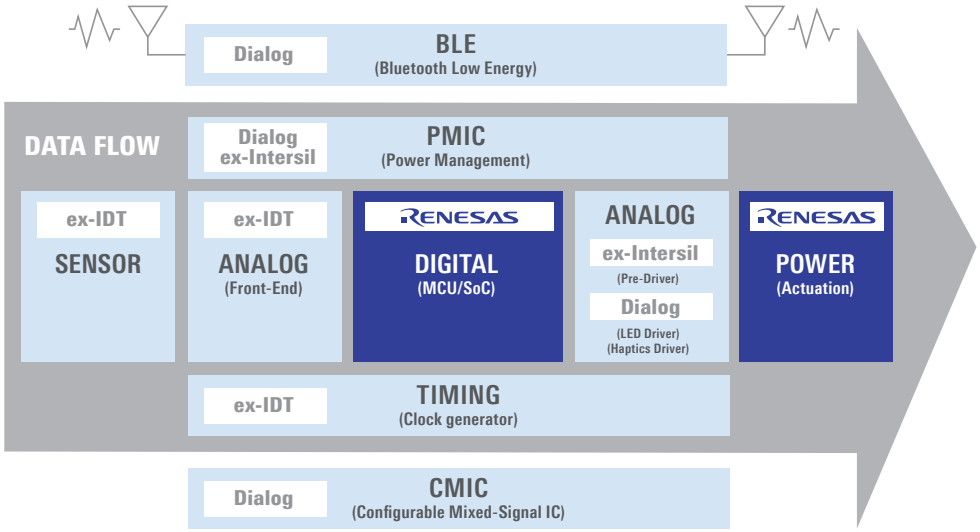
Renesas' complementary product portfolios of Analog + Power + Embedded Processing + Connectivity work together to deliver comprehensive solutions. Our product experts have developed "Winning Combinations," compelling product combinations that include matching products from the entire Renesas product portfolio. Our reference designs and turnkey solutions are built to reduce your R&D time, cost and effort.
Who wouldn't want to save themselves the trouble of searching for and evaluating components? Renesas Winning Combinations save you this effort and offer excellent service & safety and last but not least cost benefits.

For more details please see also our website:
Winning Combinations for Automotive | Renesas

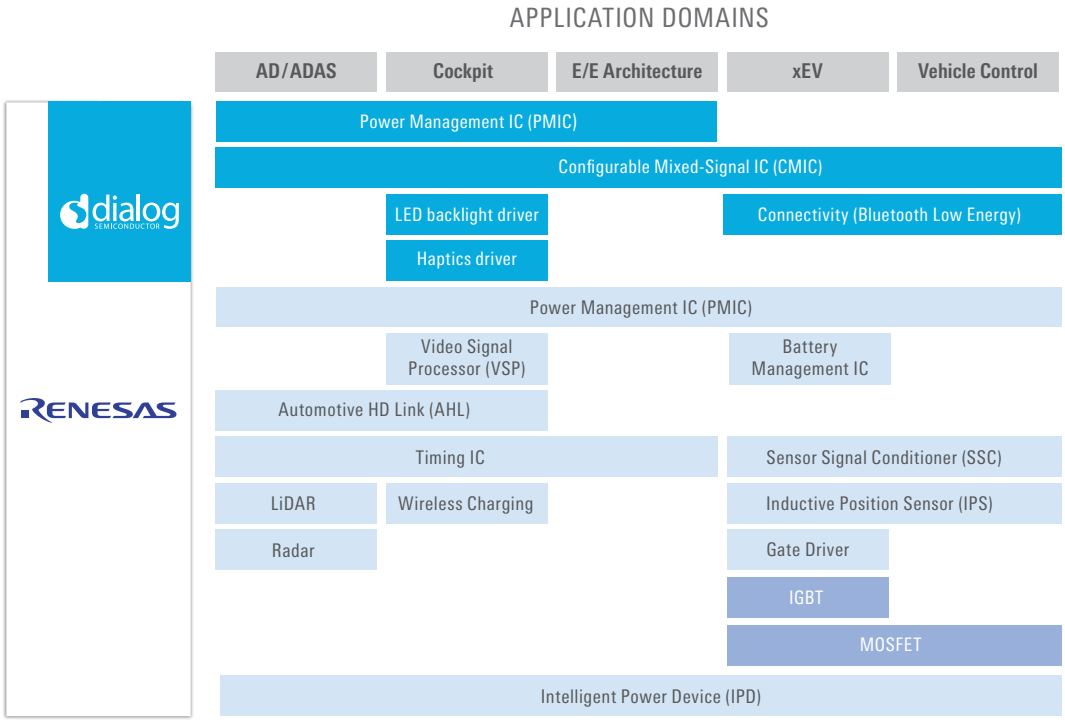
CONTENTS

ANALOG & POWER STRATEGY

After Intersil, IDT and Dialog integrations, Renesas further strengthen automotive Analog products.
Our product portfolio complements signal chain and support to establish end-to-end solution.



EXPANDING AUTOMOTIVE PRODUCT PORTFOLIO



IGBT: Insulated-Gate Bipolar Tansistor

ANALOG & POWER PRODUCTS

Clocks and Timing Solutions

Renesas offers the broadest and deepest silicon timing portfolio in the industry. In addition to our wide selection of buffers and clock synthesyzer products, we deliver leading-edge system timing solutions to resolve timing challenges in virtually any application.

Features

- Lowest phase noise and highest performance
- Industrie's broadest and deepest portfolio
- Proven expertise in both analog and digital timing
- Advanced timing technology

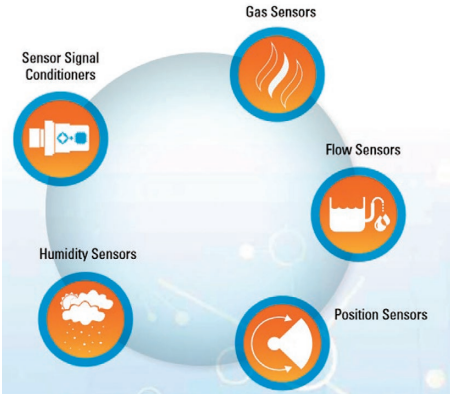
Benefits

- Extensive online tools library
- Deep knowledge base / FAQ
- Complimentary clock tree design and review services
- Expert engineering support

Applications

- Automotive infotainment and navigation
- Dashboard
- Driver Assistant Systems

Sensor Solutions



With more than 20 years of industry experience, Renesas is an expert in providing sensor technologies that enable our customers to design and build best-in-class sensor solutions. As we expand the breadth of our sensor technologies, Renesas will create unique and differentiated sensor solutions

Automotive Solutions with „Single-pass" Calibration

Renesas' automotive sensor signal conditioning ICs are all-in-one, energy efficient products that are easy-to use. Our single-pass operation calibration lowers costs by reducing test time without compromising precision, enabling design of cost-effective, accurate sensing systems. These SSCs also offer best-in-class performance with highly integrated operations and support for ISO26262, Automotive EMC, and reliability

Inductive Position Sensor (IPS)

Inductive Position Sensor is a product, which has a broad customer base with various applications. This system does not use a magnet. Inductive sensor is robust against environmental contaminants and provides excellent stray field immunity.

Features

- Contactless position sensor with Sin/cos output differential output signals
- Automotive qualified AECQ100 grade 0 with temperature range from -40 °C up to +160 °C
- ISO26262 supports up to ASIL-C requirements
- Maximum rotational speed up to 600,000 rpm
- Totally stray field immune

Benefits

- Superior accuracy and resolution by thinner, lighter and much more cost effective than resolvers
- Allows through- and side-shaft sensor design
- Superior accuracy by matching the sensor sectors to the number of pole pair of the motor

Application Examples

- Electric Power Steering (EPS) - BLDC
- Traction Motors
- xSG - Belt or Integrated Starter Generator
- Electric Park Brake
- Oil Pump Motors

Sensor Signal Conditioner (SSC)

Renesas' best-in-class automotive sensor signal conditioning (SSC) ICs are optimized to withstand harsh automotive environments, requiring low supply current to reduce power consumption (critical for PHEV, BEV and FCEV vehicles), offering excellent EMC and ESD protection to ensure safety and reliability.

Features

- Capable of measuring resistive bridge sensor signal
- Temperature measurement using external diode/PTC/TCR or internal (PTAT) sensor
- Ability to cover large sensor span & high accuracy over the entire temp. range (-40°C to 150°C)
- Over-voltage and reverse polarity protection, robust EMC performance, and multiple diagnostic features
- Output signal as ratio-metric analog or digital SENT or LIN.

Benefits

- Flexible adoption of the bridge sensor technology offering offset compensation and high analog gain
- Best-in-class signal processing technology delivering highly accurate and enhanced output signal
- Minimal EOL (end-of-line) production costs during mass production using digital calibration
- Minimum amount of external components to design of sensor modules with best-in-class form factor

Renesas' Highly Accurate, Cost-Effective Pressure Sensing Solution for Automotive

Power Management IC (PMIC)

Renesas power management IC is a product designed for Renesas MCU and SoC. The optimized specifications help to reduce system BOM cost, PCB area and development period of system design.

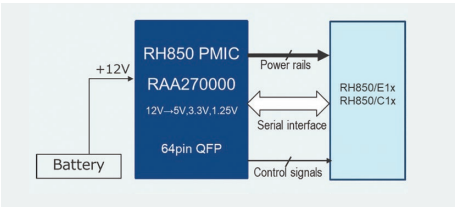
Features

- Ideal power solution for Renesas MCU and SoC. (e.g. RH850/E1x/C1x/P1x, R-Car Gen3, Gen4)
- Integrated fault diagnosis and monitor functions for ASIL applications

Benefits

- Optimized specifications help reduce system BOM cost and PCB area
- On-time support by advantage both MCU/SoC and PMIC in-house development
- Highly configurable for multi platforms

Application Example Connected to RH850/E1x/C1x



Battery Management IC

Battery management IC has the best voltage measurement accuracy (<±2.5 mV on board) and Long-Term Drift (<±6 mV@6σ after 15 years on board). Battery Management System (BMS) Solution is available in combination with RH850/P1M.

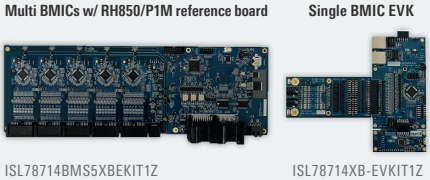
Features

- Best voltage measurement accuracy (<±2.5 mV) and Long-Term Drift
- Lowest BOM cost and best FuSa/EMC/ Hot-Plug solution
- BMS Solution is available with BMICs, RH850/P1M and SW which can realize ASIL-D system.

Benefits

- Alleviates R&D effort and easy-to-use with RH850 MCU family with dedicated drivers and Software for BMS
- Full system deliverables committed to automotive quality and support, which is optimized to be used high voltage battery management applications

Evaluation Environment



ANALOG & POWER PRODUCTS

Video Signal Processing (VSP)

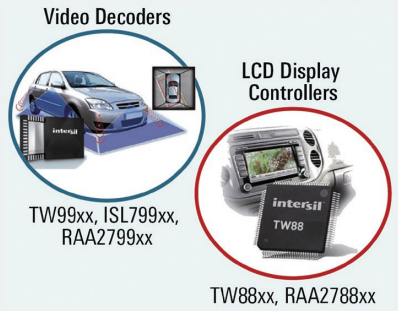
Renesas VSP products include basic Analog Video Decoders and Advanced LCD Controllers. Optimized for Automotive video & display applications, providing best-in-class video quality, system robustness & flexibility.

Features

- 1 & 4 Channel Analog Video Decoders
  - ✓Supports BT.656 or MIPI-CSI2 output
  - ✓Built-in diagnostics (short detection)
- Highly Integrated LCD Controllers
  - ✓Supports Digital & Analog inputs up to 1080p/60
  - ✓Integrated Image Diagnostics with Frozen & Corrupt Image Detection
  - ✓Drives most automotive LCD panels
  - ✓H/W based Fast Boot (< 500 ms)

Benefits

- Video Decoders provide superior video quality with low power consumption
- LCD Controllers add versatility and realiability to Automotive Display Systems
  - ✓Arbitrary horizontal & vertical video scaling for any resolution up to Full HD 1080p
  - ✓Flexible I/O's: MIPI-CSI2, LVDS, TTL, Analog



Wireless Charging IC

Qi compatible wireless charging ICs for Automotive deliver charging speeds that rival traditional plug-in charging

Features

- Industry first, flexible ARM® Cortex®-M0-based SoC architecture
- Industry-leading efficiency
  - ✓ >75 % end-to-end
  - ✓As fast as wired
  - ✓Cool operation temperature
- Very low EMI
  Unique and proven hardware /algorithm implementation

Benefits

- Significant reduction of charging time by up to 20 W wireless solutions
- Design support:
  - ✓ reference design kits enable fast prototyping and time to market
  - ✓ Extensive documentation library

Automotive HD Link (AHL)

Automotive High-Definition Link (AHL) is a new video transmission technology designed to reduce the cost of transporting high resolution video from the camera to the ECU. Optimized for parking assistance applications.

Features

- HD Video Transmission Link
  - ✓ RAA279971 AHL video encoder
  - ✓ RAA279972 AHL 1ch video decoder
- No Latency
- Independent Control Channel
  - ✓ Works without active video
- Robust against interference
- Supports non-standard resolutions
- Up to 30 m transmission distance

Benefits

- Reduce HD camera system costs by utilizing lower cost cables (UTP) and connectors.
- Re-use existing NTSC camera cable infrastructure with HD camera resolutions
- Initialize camera from the ECU with built-in bi-directional control channel

Renesas Automotive HD Link (AHL) Allows Low-Cost Cables and Connectors to Transmit HD Video

Gate Driver Unit (GDU)

Renesas GDU is a product designed for xEV inverter. The performance has been proven by Renesas reference board and it contributes the reduction of BOM cost and engineering development workload.

Features

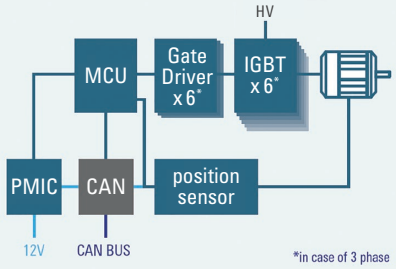
- Low Ron (1 ohm max.), IGBT gate driver with 2.5 k Vrms isolation
- Support IGBT parallel connection
- Built-in analog I/F can help to know operation condition of secondary side (IGBT side)

Benefits

- Provides cost-effective solution (20% BOM Cost reduction expected)
- Contributes to reduced engineering development workload

Solution Example

Inverter reference design with HV-GDU



Power MOSFETs

Focusing performance driven application to contribute to system innovation. (high efficiency, down-sizing, robust design)

Features

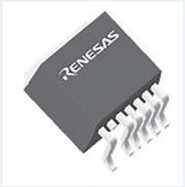
- Top class Low Ron with Super junction structure
- Extensive lineup for 12 V / 48 V battery application
- Excellent quality
- Customized Bare Die support for pad layout & shipment form

Benefits

- High efficiency based on excellent Ron and switching performance
- Down-sizing by selecting optimized package from product line-up and bare die support options
- Robust design with high withstanding capability and sensing option

Low Ron package

TO-263 7pin SHL



Tape & Reel

for Bare Die

IGBT

Renesas supplies bare-die IGBT products that enable customers to achieve an ideal matching with the system and modules they design.

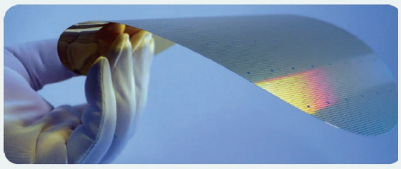
Features

- High performance & high quality IGBT bare die for HEV/PHV/EV
- WW Top level performance achieved with low Vce (sat) and faster switching
- Voltage rating variations from 650 V to 1200 V
- Current and Temp sensing (optional)

Benefits

- High efficiency and low heat generation based on low power comsuption
- Enable to adopt vairous mounting method with top metal options
- High quality based on various testing options and qualification test

Thin Wafer Technology



IGBT

FRD

IGBT & FRD
Pair products

Inteligent Power Device (IPD)

Replaces mechanical relays for longer lifetime, smaller size, lighter weight, and extended functionality.

Features

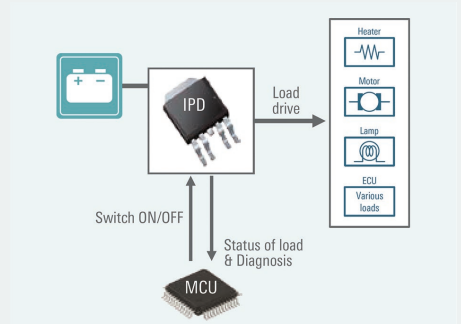
- Proven MOSFET and Control-Chip Technology in a single package
- Low ON-Resistance and wide SOA
- Self-protection against short circuit, overcurrent and overtemperature
- Self-diagnostic and monitoring functions
- High max operating temperature
- AEC-Q100 qualified and RoHS compliant

Benefits

- Mechanical relay replacement offering better lifetime, size, weight and functionality
- Switching of high currents of more than 30 A
- Easy control by MCU with reduced power consumption
- Contributing to high system reliability by integrated smart protections
- Efficient drive of resistive, inductive or capacitive loads

Solutions Example

IPD outputs power supply and protects itself & loads



Radar Transceiver

Highly integrated 76-81GHz radar transceiver for automotive applications with the best noise figure and low power consumption, which enable high resolution MIMO Radar. Renesas offers Radar total system solution.

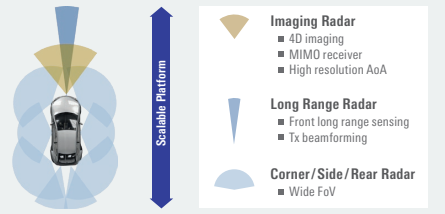
Features

- 76GHz-81GHz mmWave Radar transceiver
- 4Rx/4Tx channels MIMO
- Low Noise transceiver
- Low Power Consumption
- Automotive Grade

Benefits

- Radar total system solution for ADAS/AD application to reduce R&D efforts; R-Car, Radar Transceiver, PMIC, Timing
- Scalable combination of Radar transceiver and R-Car SoC, which is applicable from Hi-end imaging to Mid-/Short range corner

Application



GreenPAK™ Configurable Mixed-signal ICs (CMICs)

Configurable solutions enable flexible electronic designs while reducing BoM count, cost, and sourcing issues.

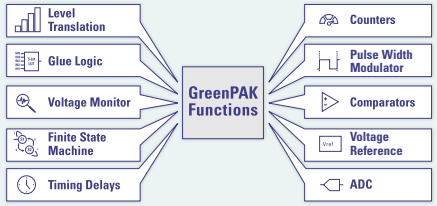
Features

- Cost effective NVM programmable IC containing digital and analog resources which can be implemented into 100s of different functions
- With GreenPAK designer software/ development kit, quickly respond to changing design requirements and increase productivity at the design and prototype verification stages

Benefits

- Reduce Solution Size, Cost & Power Consumption
- Dramatically Reduce Reliability Issues
- Configurability Allows Fast Cost Effective Differentiation

Functions



Bluetooth Low Energy (BLE)

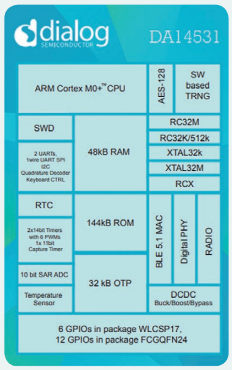
Cost-optimized, ultra-low power BLE SoC solution. *AEC-Q100 qualification is under planning

Features

- Compact, highly integrated BLE 5.1 connectivity solution
- ARM Cortex processor to efficiently handle secure, encrypted communication.
- Integrated DCDC enables 1.1 – 3.3 V operation

Benefits

- Smallest device footprint & Lowest BoM
- Ultra-low power consumption (240nA Hibernation mode)
- BLE solution space optimized PCB trace antenna reference designs available
- Production Line Tool for accelerated production ramp up



*DA14531 is Industrial grade.

Haptics Driver

Low-power, wide-bandwidth haptic driver for vibrations and clicks using ERM (eccentric rotating mass) motor and LRA (linear resonant actuator) applications.

Features

- Dynamic display control panels in the cabin that utilize haptics to provide immediate feedback to the driver – gives tactile feedback
- Provides multiple feedback states – not just a simple click
- Applications : Button replacement, Rotary Encoding, Steering wheel fingertip feedback, etc.

Benefits

- Wideband support for sharper effects
- Low latency: fastest response from 3x GPI that triggers waveform memory
- 80% lower idle current consumption than the nearest competitor
- AEC-Q100 Grade 2, 3x3 mm WFQFN package

LED Backlight Driver

Advanced technology solutions enable local dimming, HDR (High Dynamic Range) for high-contrast, high-image quality, large displays

Features

- 32 channels
- Integrated current sink MOSFETs and current sense resistors achieve small PCB occupied area
- Comprehensive protection features

Benefits

- Patented BroadLED™ adaptive switch technology
  - ✓ Reduces power dissipation in the driver
  - ✓ Maintains operation during LED short with minimal temperature increase
  - ✓ Enables use of less costly, loosely binned LED arrays for lower BOM cost
- AnyMode™ technology reduces video motion blur
- 13-bit PWM dimming and 11-bit analog dimming improve dynamic range

DIGITAL PRODUCTS

MICROCONTROLLER

In response to user requirements that are rapidly expanding in scope, Renesas offers microcontroller products that provide excellent expandability while allowing customers to make full use of existing resources.
Available in a wide array of memory and package options, Renesas MCUs are fast, highly reliable, low in cost and deliver eco-friendly performance. Incorporating the latest process technology, which enables integration of large-capacity flash memory, Renesas MCUs are used in a wide array of appliations – meeting the high quality and high reliability standards of the automotive industry.

RENESAS RH850

32-bit high-performance MCUs

- Hypervisor / Virtualization HW implemented
- QoS (Quality of Service) support
- Incorporates dedicated HW accelerators
- Multi-core technology
- Scalability of hardware and software
- High performance and low power consumption
- Embedded security features
- Guaranteed high-temperature operation
- AUTOSAR support
- Functional safety support

RENESAS RL78

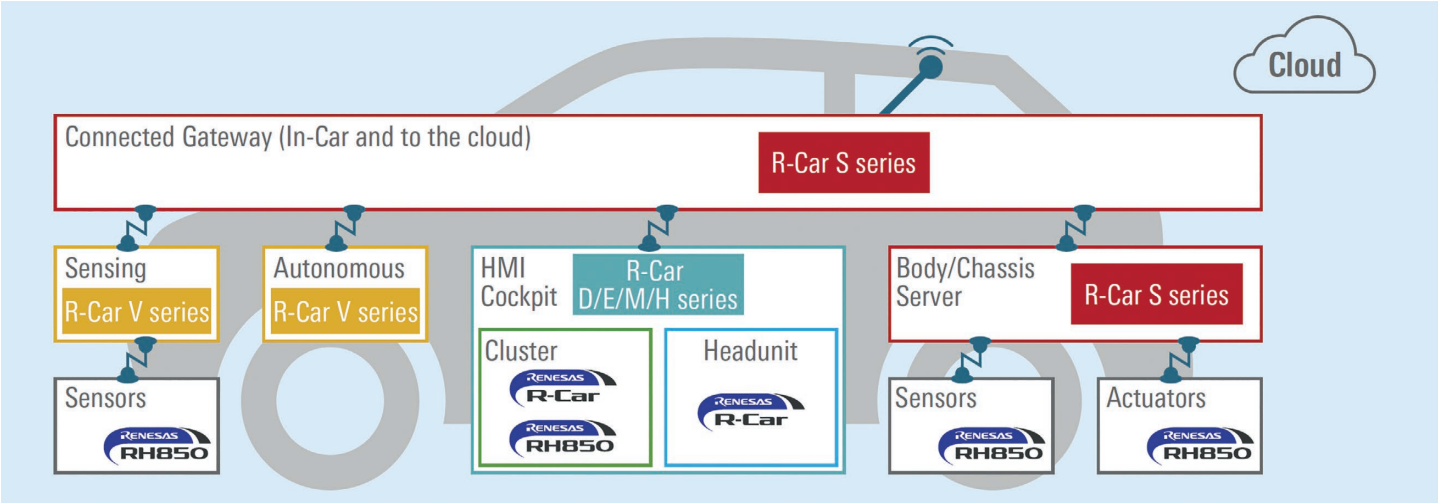
16-bit ultra-low power MCUs

- All Actuator/Sensor applicaiton covered at Automotive
- Wide package and memory scalability
- Industry's lowest level of consumption current
- Guaranteed high-temperature operation
- Hardware safety features
- Built-in a variety of functions for system cost and size reduction

R-CAR SYSTEM-ON-CHIP SOLUTIONS

Rensas' system-on-chip (SoC) family, R-Car, is designed for advanced driver assistance systems (ADAS), autonomous drive (AD), car information systems, and connected gateways. Renesas offers end-to-end total solutions from cloud services to sensing and vehicle control that contribute to an autonomous driving society.

R-Car in The Future Car Architecture



R-Car Key Features

- ✓ Scalable line-up up from Gen3 to Gen4
- ✓ Common HW architecture on major in-vehicle functions
- ✓ Functional Safety support (ISO26262)
- ✓ Integration of in-vehicle peripheral functions (e.g. CAN-FD, FlexRay) and real-time core
- ✓ Advanced function support with dedicated HW engine and scalable performance

Benefits

- ✓ Enable high coverage of ADAS/AD, GW, Cockpit/IVI, and Cluster applications
- ✓ High re-usability of customer assets within R-Car line-up and between generations
- ✓ Contribution to ASIL-B to ASIL-D support in customer systems
- ✓ Contribution to BOM cost reduction
- ✓ Combination of CNN and image recognition engines realizes advanced computer vision processing

COMPLETE SOLUTIONS AT YOUR FINGERTIPS
WINNING COMBINATIONS

With Renesas' scalable MCU and SoC platforms, supplemented by efficient power and MSIG product and ever-growing software offers, we deliver all ingredients to cover groundbreaking applications shaping the future of mobility. Being at the edge of technological innovation Renesas offers it's solutions to support the mega trends that drive the industry: Connected, Automated, Shared, and Electrified with enabling E/E architecture changes.

To showcase how our complementary products work together to deliver comprehensive solutions, we've developed many "Winning Combinations", compelling product combinations that capture and highlight the technological advantages Renesas, ISL, IDT and Dialog can provide as a combined company. With verified designs, you can take advantage of an elevated platform for your design ideas accelerating your product development cycle and lowering your overall effort to bring your design to market.

To learn more about our Winning Combinations, visit
https://www.renesas.com/application/winning-combinations-automotive

WINNING COMBINATIONS
OVERVIEW

AD/ADAS

- ADAS Front Camera Solution
- AD/ADAS Solution w/V3H
- AD/ADAS Solution w/V4H
- Parking Assistance with AHL Camera
- Intelligent Camera Solution
- Satellite Radar for AD/ADAS
- Imaging Radar for AD/ADAS
- R-Car V3H Video Output Expansion
- Fewer Components System for R-Car Solution

Cockpit

- Wireless Charger
- Hi-End Cockpit & Infotainment
- Full Graphics Cluster & Cockpit
- Low-Cost TFT Cluster with Telematics
- Low-Cost Digital Instrument Cluster
- In-Cabin Air Qualitiy
- Full Digital Cluster Solution with AHL
- Haptic Touch Key Solution
- Cockpit Solution with Haptics

E/E Architecture

- Domain Control Unit
- E-Fuse Box
- Communication Gateway Platform
- Vehicle Computer
- Zone-ECU Virtualization Platform
- CoGW & Integrated DVR/DMS
- Remote Sensing w/IPS and CAN/LIN

xEV

- xEV Inverter Reference Solution
- xEV Inverter Model & SW
- BMS Model & SW
- Battery Management
- FuSa for xEV Inverter
- Motor Generator System
- 12/48V DCDC Converter
- 12/48V DCDC Converter w / GaN HEMT
- Inverter for 2/3 Wheeler Traction Motor
- xEV Inverter Reference Solution w/IPS
- 48V Auxiliary Inverter
- Wireless BMS
- Monitoring Function Extension(motor)

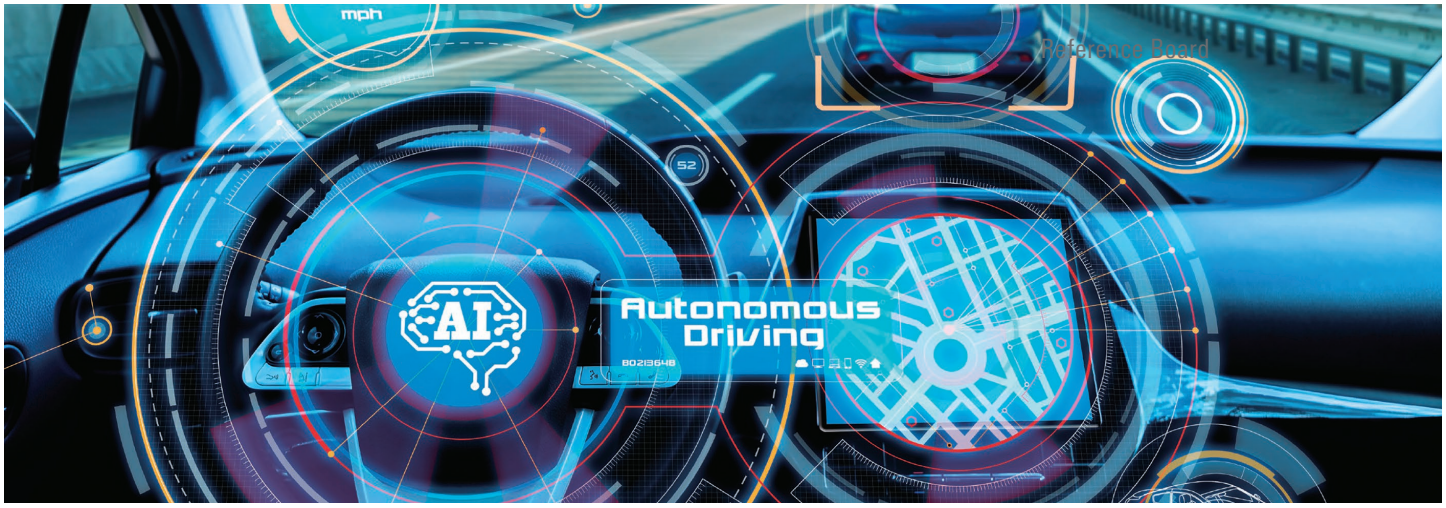
Vehicle Control

- 12V Small Motor Solution
- Sensor Reference Solution
- Electric Power Steering System
- Tire Pressure Monitoring System
- Monitoring Function Extension (5V power supply)

LEGEND

- Turnkey Board HW & SW
- Reference Design
- Demonstration Proof of Concept
- Concept paper
  Verified by lab or study

AD/ADAS



Reference Board

ADAS Front Camera Solution

https://www.renesas.com/application/automotive/adas-autonomous/adas-front-camera-solution

System Benefits

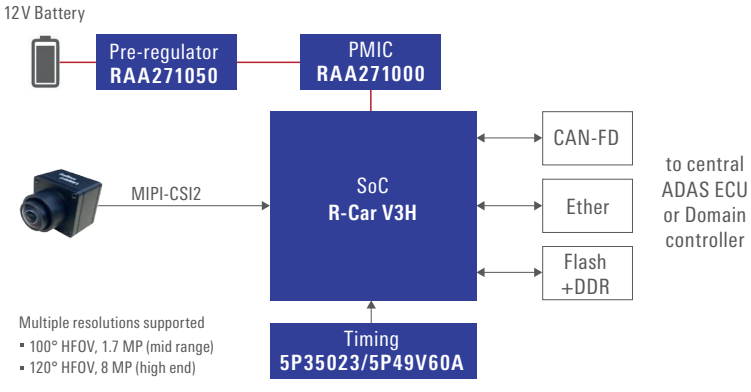
- Turnkey end-to-end solution for NCAP*1 on front camera application (ASIL B)
- Optimized solution with low system BoM while reducing customer's R&D effort
- Variety of perception SW available from partners, which greatly reduces R&D TAT and efforts.
- Extensions possible: Surround view, driver monitoring, augmented reality video, radar fusion to enhance supported driving functions
- R-Car V3H: Highest TOPS/Watt performance with deep learning engine for object detection, classification algorithms, real-time AUTOSAR*2 support. Scalability with R-Car V3M
- PMIC: Optimized design for R-Car V3x with high power-efficiency and FuSa features.

*1 NCAP (New Car Assessment Program)
*2 AUTOSAR (AUTomotive Open System ARchitecture)

Recommended Devices

R-Car V3H	SoC
RAA271000	Power management IC
RAA271050	Pre-regulator
5P35023/5P49V60A	Timing IC

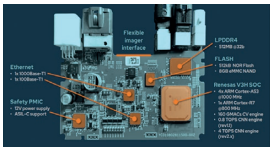
Block Diagram



Multiple resolutions supported
- 100° HFOV, 1.7 MP (mid range)
- 120° HFOV, 8 MP (high end)

LUPA's EagleCAM*3

*3 Renesas and LUPA collaborate on turnkey open platform solutions for smart cameras URL: https://lupa-electronics.com/



ADAS and Automated Driving Solution w/ R-Car V3H

https://www.renesas.com/application/automotive/adas-autonomous/solution-adas-and-automated-driving-applications

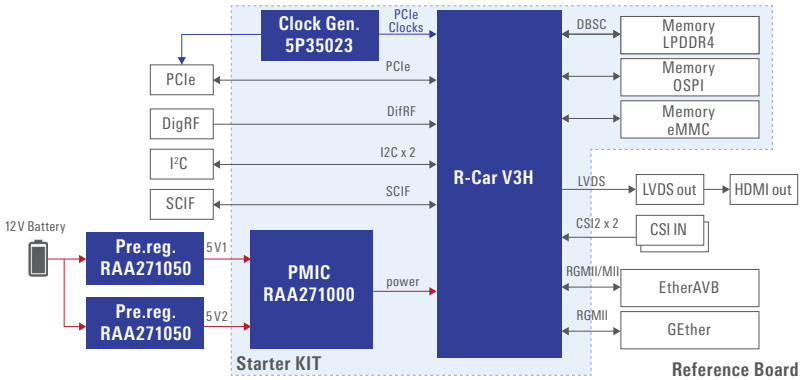
System Benefits

- Complete hardware and software development kit for ADAS and automated driving applications like front camera, surround view and lidar
- R-Car V3H has image recognition engine with an optimized performance-to-power balance and the Quad ArmR Cortex R-A53 and Cortex-R7, enabling advanced video processing and image recognition.
- Pre-regulator and PMIC optimized for ISO-26262 compliant R-Car V3H SoC, enabling high efficiency and reduced peripheral components.
- Flexible clock generator capable of generating any clock frequency from 1 to 500 MHz, allows a single device to replace several crystal oscillators.
- Supporting RGMII (2 channels) as the Ether IF and CSI2 (2 channels) as the camera IF to support various inputs and outputs.

Recommended Devices

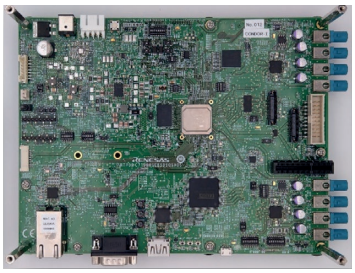
R-Car V3H	SoC
5P35023	Programmable Clock Generator
RAA271000	Safe 7ch output PMIC
RAA271050	Safe Synchronous Pre-regulator

Block Diagram

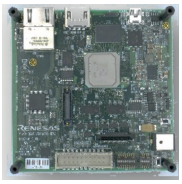


Reference Boards

R-Car V3H Reference Board (Condor-I)



R-Car V3H Starter Kit



Next-Generation AD/ADAS Solution w/ R-Car V4H

https://www.renesas.com/application/automotive/adas-autonomous/next-generation-ad-adas-solution-with-r-car-v4h

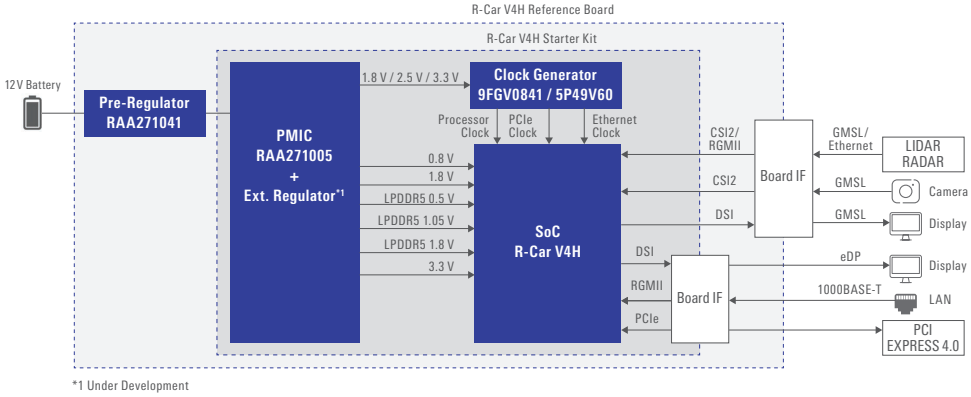
System Benefits

- Complete environment for the development of AD/ADAS applications equivalent to automated driving level 2–3, including adaptive cruise control, lane keeping, parking support systems, and more
- Supports multi-camera inputs including high resolution 4K, 4K display output, audio output, network communications interfaces and PCIeGen4 for parallel operation of multiple ECUs by using the R-Car V4H reference board
- Shorten time to market by using a reference board that enables immediate platform development
- Provides an easy-to-start system development environment by using an R-Car V4H starter kit, R-Car compatible power management ICs, LPDDR5-6400 memory, Flash memory, display output, and Ethernet 1000BASE-T in a compact, separate core system
- Delivers 34 TOPS from the R-Car V4H for deep learning, enabling high-speed object recognition through camera, radar and lidar sensor data fusion
- Provides 4 RGMII for Ethernet channels, 2 CSI2 channels, 2 DSI channels, 2 PCIeGen4 channels, and 8 CAN channels
- Supports remote power control via CAN and Ethernet, enabling system evaluation in a remote environment
- R-Car V4H and PMIC's support functional safety up to ISO 26262 ASIL D
- Reduces BOM cost and mounting size by replacing multiple crystal oscillators with a programmable clock generator

Recommended Devices

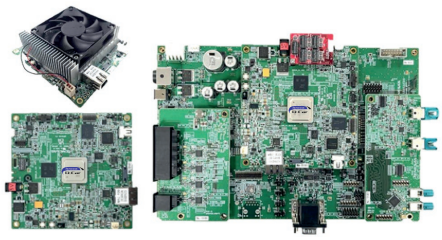
R-Car V4H	SoC
RAA271005	PMIC for V4H
RAA271041	Pre-regulator (buck/boost controller)
9FGV0841	Programmable clock generator for PCIe
5P49V60	Programmable clock generator

Block Diagram



*1 Under Development

Reference Boards



R-Car V4H Starter Kit

R-Car V4H Reference Board (White Hawk)

Parking Assistance System with AHL Camera

https://www.renesas.com/application/automotive/adas-autonomous/parking-assistance-system-ahl-camera

System Benefits

- Reduces the cost of an HD camera system by using low-cost connectors and cables (UTP*1 or STP*2). Ideal solution for parking assistance and mirror replacement camera system applications.
- No latency with excellent picture quality compared to digital transmission. Proven to work with object recognition software demo
- Bi-directional I²C control channel works independent of the video data, allowing the ECU to initialize, monitor, and program the camera using the same wires as the video transmission.
- The AHL*5 camera reference design with OmniVision OX01F 1.3MP*3 SoC (Sensor + ISP*4) and Renesas camera PMIC, offers a working design with lower power consumption in a small module size for automotive camera systems
- Validated functionality of AHL with the OmniVision OX01F reduces customer implementation time

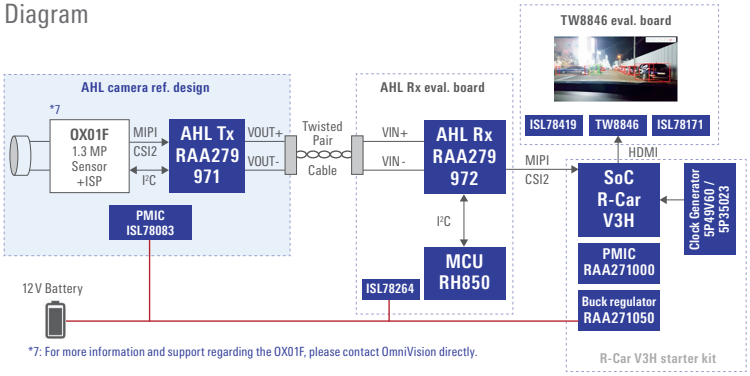
*1 UTP: Unshielded Twisted Pair
*2 STP: Shielded Twisted Pair
*3 MP: Mega Pixel
*4 ISP: Image Signal Processor
*5 AHL: Automotive HD Link

Recommended Devices

RAA279971	AHL video encoder
RAA279972	AHL video decoder
RH850/F1L	32bit MCU
ISL78264	Buck regulator
R-Car V3H	SoC
RAA271000	Power management IC
RAA271050	Buck regulator
TW8846 / RAA278842*6	VSP LCD controller
ISL78171	LED backlight controller
ISL78083 / RAA271082*6	Camera PMIC
ISL78419	TFT PMIC
5P49V60 / 5P35023	Programmable clock generator

*6 Not contained in the reference board

Block Diagram



*7: For more information and support regarding the OX01F, please contact OmniVision directly.

Reference Boards

Intelligent Camera Solution w/ R-Car V3M

https://www.renesas.com/application/automotive/intelligent-camera-solution-r-car-v3m

System Benefits

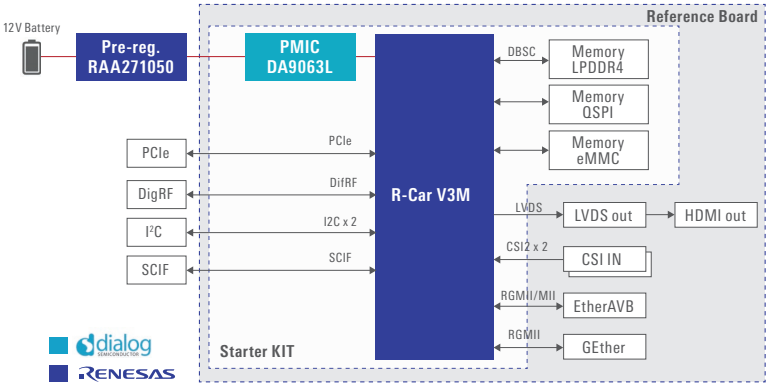
- Provides a high-efficiency image recognition engine, functional safety features and a high level of integration to implement front camera applications, surround view, and LiDAR systems meeting NCAP (New Car Assessment Program) evaluation criteria.
- Enables advanced video processing and image recognition using the R-Car V3M with an image recognition engine optimized performance-to-power balance and dual Arm® Cortex®-A53 and Cortex-R7
- A flexible system PMIC can supply a wide range of multicore SoCs and integrates full power rail management with multiple sleep modes for an optimized system solution
- Reduces R&D cost and development time using PMICs verified for R-Car SoCs

Recommended Devices

R-Car V3M	SoC
DA9063L	11 outputs PMIC up to 12A Bucks Continuous Current
RAA271050*1	Safe Synchronous Pre-regulator

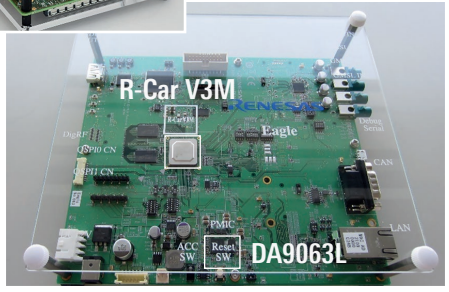
*1 Not on the reference board

Block Diagram



Reference Boards (Eagle)

R-Car V3M Starter Kit



Satellite Radar System for AD/ADAS

https://www.renesas.com/application/automotive/adas-autonomous/satellite-radar-system-ad-adas

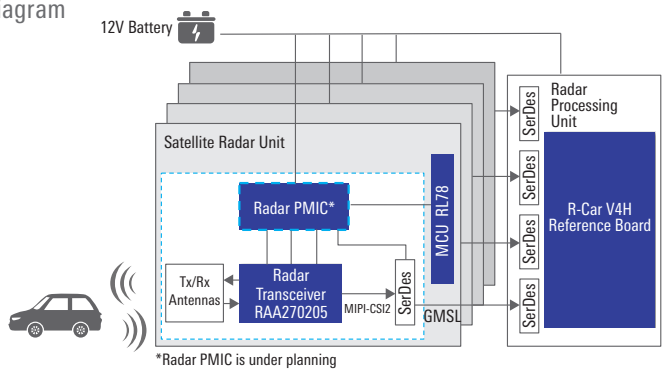
System Overview

Radar system with centralized processing, which consist of several satellite units with their respective radar transceivers connected to a central processing unit based on the R-Car V4H SoC.

System Benefits

- 360° radar coverage by combining the detections from the different radar units.
- Improved performance and reduced cost by limiting data processing on the edge (Range FFT) and processing radar data in the central unit
- Satellite modules with RAA270205 radar transceiver
  - High resolution with 4TX/4RX 16 MIMO channels, 5GHz modulation bandwidth
  - Optimized RF performance (high power, low noise figure), low phase noise, low power consumption and high-speed ADCs
  - High capacity MIPI-CSI2 interface to the R-Car V4H processing unit

Block Diagram

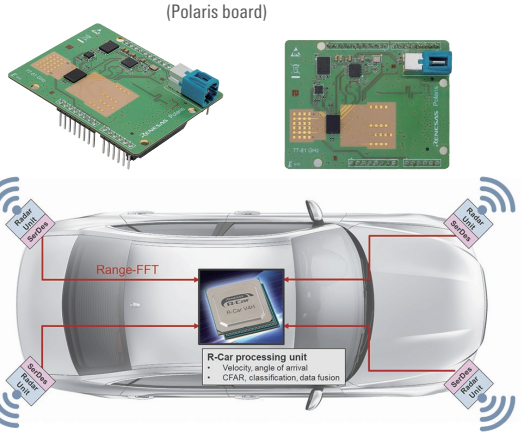


Recommended Devices

RAA270205	4Rx/4Tx channels automotive-grade mmWave radar transceiver
RTK7RLG230CLG000BJ	RL78/G23-64p microcontroller Fast Prototyping Board
R-Car V4H Reference board (White Hawk)	SoC board for autonomous driving

Proof of Concept

Satellite radar board (Polaris board)



Imaging Radar for AD/ADAS

https://www.renesas.com/application/automotive/imaging-radar-adas-ad

System Benefits

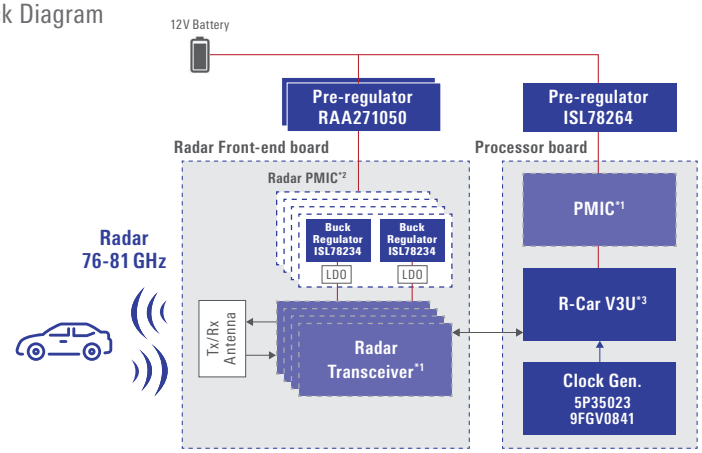
- 4D imaging radar system consists of a radar transceiver and R-Car SoC to provide high object recognition and redundancy when fusing with camera data, which is an essential combination for higher-level autonomous driving.
- Provides an automotive radar total solution for AD/ADAS applications including adaptive cruise control (ACC), autonomous emergency braking (AEB), lane change assistance (LCA), blind spot detection (BSD), and cross traffic alerts(CTA) to reduce customers' R&D efforts.
- Equipped with a highly integrated 76GHz to 81GHz RFCMOS radar transceiver chip for automotive applications with the best noise figure and low power consumption. MIMO radar with a 4-channel Tx and 4-channel Rx creates a 16-channel virtual receiver providing high special resolution.
- The radar front-end board and R-Car processor board is proved to be able to detect surrounding traveling vehicles and accurate position measurement of range and direction.

Recommended Devices

Radar Transceiver[*1]	4Rx/4Tx channels mmWave Radar transceiver
ISL78234	Synchronous Buck Regulator used in the board instead of Radar PMIC[*2]
RAA271050	Pre-regulator
R-Car V3U[*3]	SoC for autonomous driving
5P35023/9FGV0841	Programmable clock generator
ISL78264[*4]	Pre-regulator

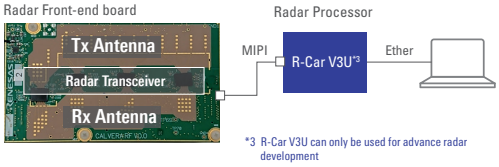
*1 Under development
*2 Radar PMIC is under planning
*3 R-Car V3U can only be used for advance radar development
*4 Not on processor board

Block Diagram



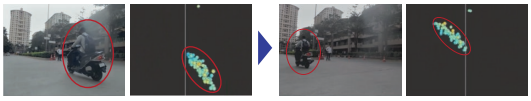
*1 Under development, *2 Radar PMIC is under planning
*3 R-Car V3U can only be used for advance radar development

Proof of Concept



*3 R-Car V3U can only be used for advance radar development

Outdoor measurement: the motorcycle is running



R-Car V3H Video Output Expansion Solution for Surround View & AR-HUD

https://www.renesas.com/application/automotive/adas-autonomous/r-car-v3h-video-output-expansion-solution-surround-view-ar-hud

System Benefits

- For surround view and AR-HUD*1 applications, the combination of R-Car V3H and TW8846/8847 enables these two applications' video outputs and AI processing in one system at the same time, reducing the system BOM cost.
- Easily expandable from existing R-Car V3H systems
- High accuracy AI image recognition is possible by using R-Car V3H with CNN*2 IP
- R-Car V3H and PMIC support functional safety up to ISO 26262 ASIL B
- AHL*3 reduces the cost of an HD camera system by using low-cost connectors and cables
- Integrates many components in several Renesas R-Car systems into a tiny CMIC*4, allowing product differentiation at a lower cost and PCB space

*1 AR-HUD: Augmented Reality Head-Up Display *2 CNN: Convolutional neural network *3 AHL: Automotive HD Link *4 CMIC: Configurable Mixed-signal IC

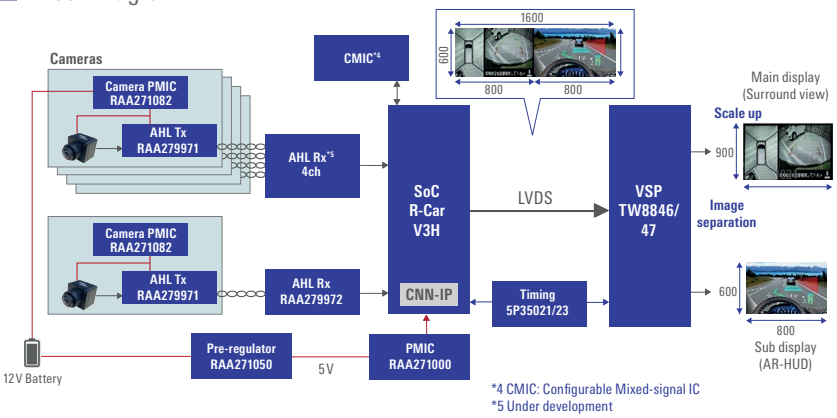
Recommended Devices

R-Car V3H	SoC
TW8846/47	VSP for image separation and display
5P35021/23	Clock generator
RAA271050	Pre-regulator
RAA271000	PMIC for R-Car
RAA271082	Camera PMIC
RAA279971	AHL video encoder
RAA279972	AHL video decoder
SLG46827-A	CMIC Dual supply support w/ Level Shifter
SLG46855-A	CMIC Single supply

Optional Devices

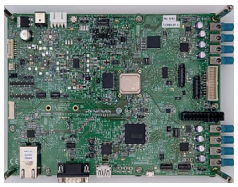
RAA2778840/42/43	VSP for image separation and display

Block Diagram



Reference Boards

R-Car V3H Reference Board (Condor-I)



TW884x Evaluation Board

Infotainment and Automated Driving Systems with Fewer Components

https://www.renesas.com/application/automotive/infotainment-and-automated-driving-systems-fewer-components

System Benefits

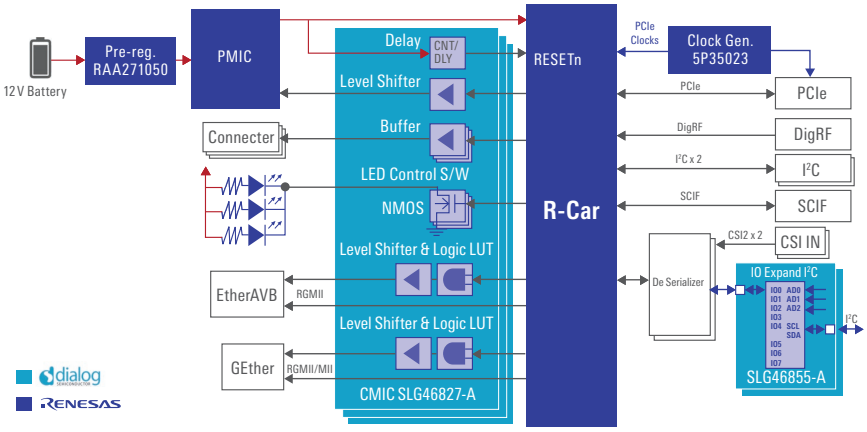
- Renesas offers a variety of infotainment and automated driving solutions using R-Car SoCs, which can be combined with CMICs to further reduce costs.
- Dialog CMIC GreenPAK™ is a cost-effective NVM programmable device that allows automotive designers to integrate many system functions, into a single AEC-Q100 qualified IC
- Integrates many components in several Renesas R-Car systems into a tiny CMIC, allowing product differentiation at a lower cost and PCB space
- With GreenPAK designer software/development kit, quickly respond to changing design requirements and increase productivity at the design and prototype verification stages

*1 CMIC: Configurable Mixed-signal IC

Recommended Devices

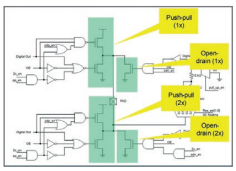
R-Car V3H/V3M/H3/M3/E3	SoC
5P35023	Programmable Clock Generator
RAA271000	Safe 7ch output PMIC
RAA271050	Safe Synchronous Pre-regulator
DA9063-A	Power management IC
DA9213-A	Multiphase 20A Sub-PMIC
DA9214-A	Multiphase 2x 10A Sub-PMIC
SLG46827-A	CMIC Dual supply support w/ Level Shifter
SLG46855-A	CMIC Single supply

Block Diagram



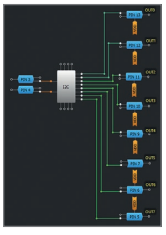
Used CMIC Components

IO Structure (NMOS)

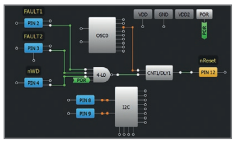


LOGIC LUT

IO EXPANDER



SYSTEM RESET (CNT/DLY)



COCKPIT

Automotive In-Cabin Wireless Power Solution

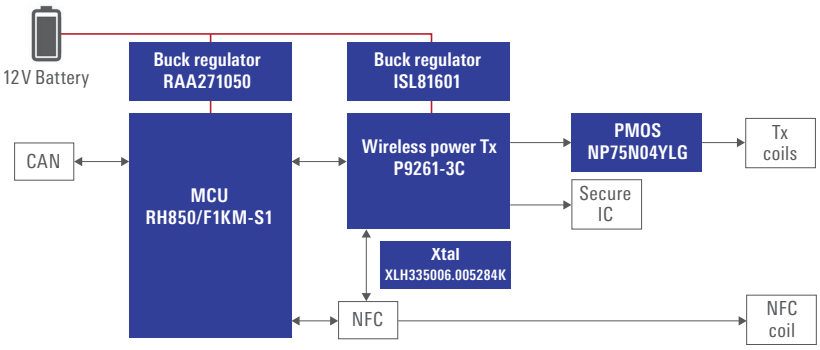
https://www.renesas.com/application/automotive/automotive-cabin-wireless-power-solution

System Benefits

- Complies to WPC*1 Qi 1.3 EPP*2 (@15W) specification and is capable of providing 30 W fast charging (PPDE*3)
- Supports WPC Qi 1.3 Rx-to-Tx authentication with safe power transfer
- Supports functional safety up to ASIL B with RH850 and Renesas buck regulator
- Realizes wide charging area and highly efficient (up to 75%) wireless power transfer with support for up to 3-coil application using P9261-3C
- Meets CISPR25 Class 4 for superior EMI performance

*1 WPC: Wireless Power Consortium
*2 EPP: Extended Power Profile
*3 Proprietary Power Delivery Extension

Block Diagram



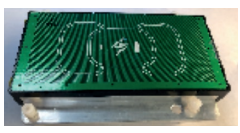
Recommended Devices

P9261-3C	Wireless power transmitter
RH850/F1KM	Host micro controller
RAA271050	Buck regulator for RH850/F1KM
ISL81601*5	Buck-boost controller for P9261-3C
NP75N04YLG	N-channel power MOSFET
XLH335006.005284K	Precision clock

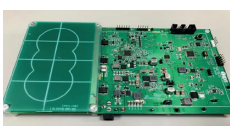
Reference Board

In-cabin

Module



Reference board



High-End Cockpit & Infotainment Solution w/ R-Car H3, M3, M3N

https://www.renesas.com/application/automotive/high-end-cockpit-infotainment-solution-r-car-h3-m3-m3n

System Benefits

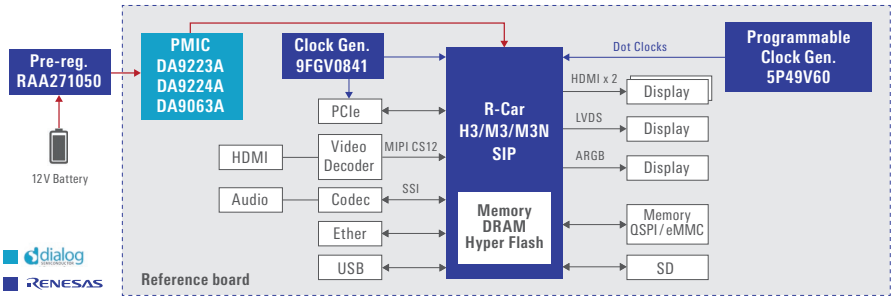
- The combination of the R-Car (H3/M3/M3N) SoC, power management IC (PMIC), and programmable clock generator enables a scalable cockpit and infotainment solution that supports high image quality, multiple video display outputs, and a wide variety of memory interfaces.
- R-Car SoC with LPDDR4-3200 and HyperFlash™ memories, the reference board including peripheral circuits, and board-to-board connectors for customization provide an efficient and complete development environment for application development.
- Flexible clock generators are capable of generating any clock frequency from 1MHz to 350MHz and allow a single device to replace several discrete clock circuits, saving BOM cost and reducing PCB area
- A flexible system PMIC can supply a wide range of multicore SoCs and integrates full power rail management with multiple sleep modes for an optimized system solution
- Reduces R&D cost and development time using PMICs verified for R-Car SoCs

Recommended Devices

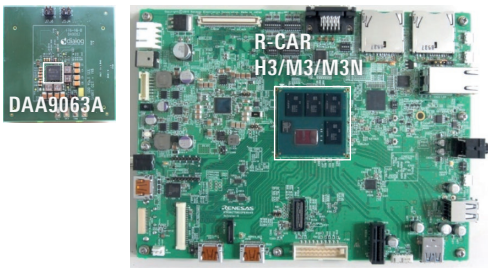
R-Car H3	SoC
R-Car M3	SoC
R-Car M3N	SoC
5P49V60	Programmable Clock Generator
9FGV0841	Clock Generator
DA9063-A	6 Bucks + 11 LDOs Output PMIC
DA9223-A	Multiphase 16A Sub-PMIC
DA9224-A	Multiphase 2x8A Sub-PMIC
RAA271050[*1]	Safe Synchronous Pre-regulator

*1 Not on the reference board

Block Diagram



Reference Board (Salvator-X PEB)



Full Graphics Cluster & Cockpit Solution w/ R-Car E3

https://www.renesas.com/application/automotive/connected-infotainment/full-graphics-cluster-cockpit-solution-r-car-e3

System Benefits

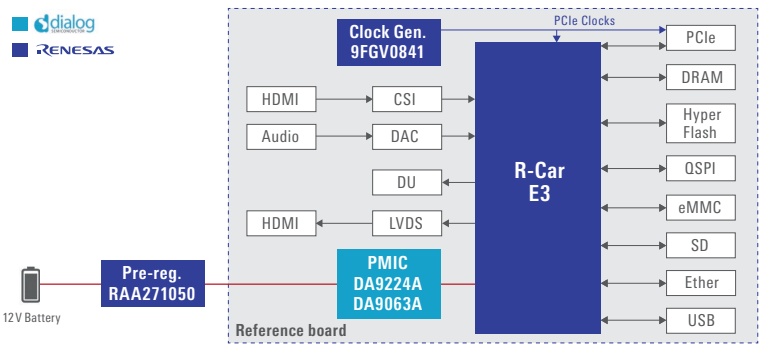
- The combination of an R-Car E3, PMIC and a configurable PCIe clock generator provides high efficiency and supports a variety of display outputs and high-quality outputs for scalable cockpit and infotainment solutions.
- Reference board allows developers to efficiently conduct required tasks such as evaluating the performance of an R-Car E3-based solution and thereby reduce the turn-around time for product development
- R-Car E3 enables smooth 3D cluster on the largest class, 12.3-inch display at 1920 x 720 pixels
- A flexible system PMIC can supply a wide range of multicore SoCs and integrates full power rail management with multiple sleep modes for an optimized system solution
- Reduces R&D cost and development time using PMICs verified for R-Car SoCs

Recommended Devices

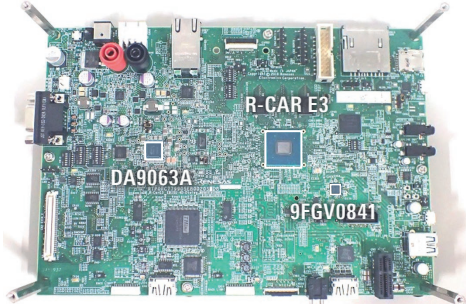
R-Car E3	SoC
9FGV0841	Clock Generator
DA9224-A	Multiphase 2x8A Sub-PMIC
DA9063-A	6 Bucks + 11 LDOs Output PMIC
RAA271050[*1]	Safe Synchronous Pre-regulator

*1 Not on the reference board

Block Diagram



Reference Board (Ebisu-4DD)



Low-Cost TFT Instrument Cluster with Telematics

https://www.renesas.com/application/automotive/connected-infotainment/low-cost-tft-instrument-cluster-telematics

System Overview

This reference design provides rich connectivity, including Wi-Fi mirroring of mobile screens and Bluetooth® Low Energy (LE) connectivity, and low-cost solutions required for instrument clusters, such as camera image display, tell-tale and TFT brightness control.

System Benefits

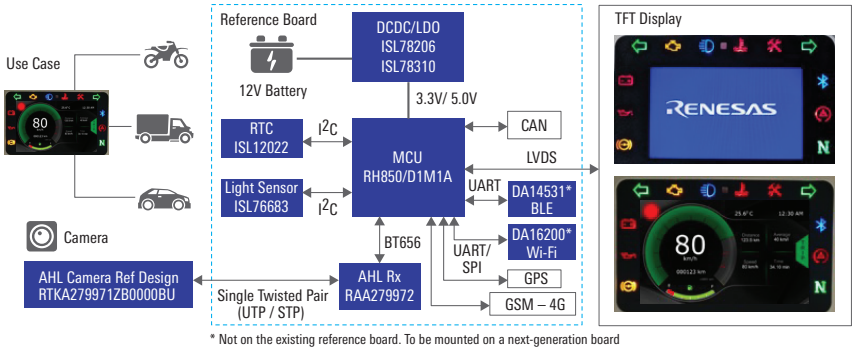
- Cost-effective, compact and simple real-world vehicle instrument cluster implemented on RH850/D1M1-A microcontroller to achieve graphics and connectivity.
- Sample application software to jumpstart the application development. Sample Firmware is BareMetal C code and does not require any Linux / Android OS know-how to start development.
- Ready Connectivity options available on the reference board - Wi-Fi, BLE, Ethernet, GPS, GSM-4G.
- Independent Dual Port CAN enables connection with other ECUs on vehicle bus & also provides a separate interface for a diagnostic port.
- Eliminates expensive SerDes camera interface, replacing it with Automotive HD Link that interfaces to a low-cost analog camera via Single Twisted Pair [UTP/STP] connection without loosing video quality.
- Support for Cell phone like UI using popular tools such as Qt, Candera, etc is available.

Recommended Devices

RH850/D1M1A	32bit MCU
ISL78206	40V 2.5A Buck Controller
ISL78310	High Performance 1A LDO
RAA279972	AHL Decoder
RAA279971	AHL Encoder (use in Camera)
ISL76683	Light-to-Digital Output Sensor
ISL12022[*1]	Real Time Clock
DA14531[*1 *2]	Low Power BLE SoC
DA16200[*1 *2]	Low Power Wi-Fi SoC
DA16600MOD[*1 *2 *3]	Wi-Fi+BLE Module

*1 Industrial grade
*2 Not on the existing reference board.
*3 DA16600MOD deploys DA14531 + DA16200 SoC in module. To be mounted on a next-generation board (available in Q1 2023)

Block Diagram



* Not on the existing reference board. To be mounted on a next-generation board

Reference Board

Low-Cost Digital Instrument Cluster

https://www.renesas.com/application/automotive/low-cost-digital-instrument-cluster

System Benefits

- Low-cost digital instrument cluster reference design using MCU + VSP scaler.This system can also be applied to HVAC display.
- Less software work to support multiple display resolutions with a single design
  - Generate Cluster graphics in 1 resolution in the RH850, then easily scale to different resolutions using the RAA278840
  - Use RAA278840 to upscale 1280x480 resolution primary cluster graphics made for 8" LCD panel to 1920x720 to support an upgrade option to 12.3" panel for premium trim vehicle model
- Use RAA278840 for "fast boot" to display Tell Tale Lamps at ignition (<500ms to display OSD through RAA278840), allowing the MCU software time to boot up properly
- Optimized power management IC's for the ECU

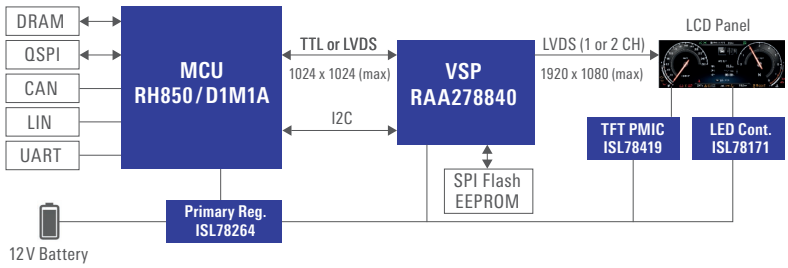
Recommended Devices

RH850/D1M1A	32bit MCU with 2D GPU
RAA278840	VSP LCD Controller
ISL78264	Primary Regulator
ISL78171	LED Backlight Controller
ISL78419	TFT PMIC

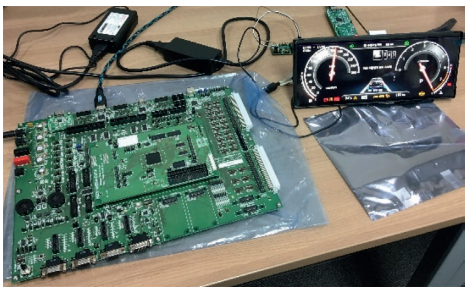
Optional Devices

ISL78206	Primary Regulator
ISL76683	Light-to-Digital Output Sensor

Block Diagram



Reference Board



In-Cabin Air Quality Sensor Solution

https://www.renesas.com/application/automotive/connected-infotainment/in-cabin-air-quality-sensor-solution

System Benefits

- Reference design for smart and energy-efficient automotive HVAC*1 systems using air quality sensors.
- Improves passenger comfort and health by detecting a wide range of organic pollutants (VOC*2), oxidizing pollutants (Ozone), humidity and temperature
- Renesas MEMS based sensor solution providing measurements with stable characteristics and high accuracy using neural network-trained firmware (AI).
- Easy integration and reduced R&D effort with user-friendly GUI and firmware support.

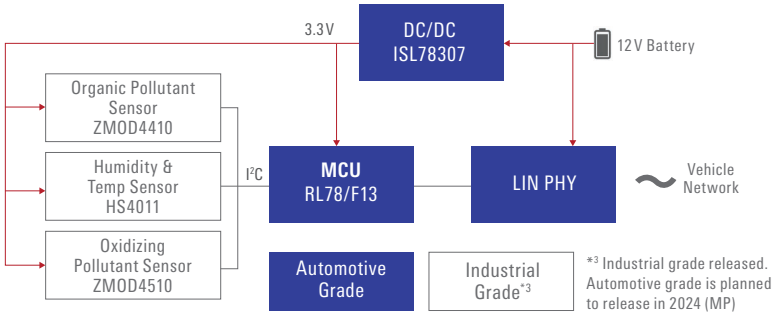
*1 HVAC (Heating, Ventilation, and Air Conditioning)
*2 VOC (Volatile Organic Compounds)

Recommended Devices

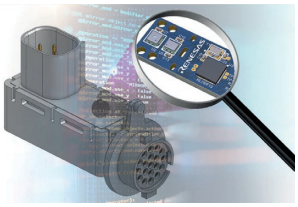
RL78/F13	16-bit Microcontroller with LIN/CAN
ZMOD4410*3	Air quality sensor for Organic Pollutants
ZMOD4510*3	Air quality sensor for Oxidizing Pollutants
ISL78307	Automotive DC/DC Converter
HS4011*3	Humidity & Temperature sensor

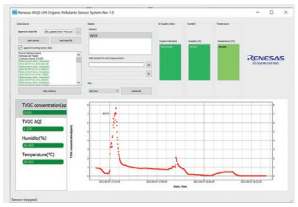
*3 Industrial grade released. Automotive grade is planned to release in 2024 (MP)

Block Diagram



Reference Board





Full Digital Cluster Solution with AHL

https://www.renesas.com/application/automotive/connected-infotainment/full-digital-cluster-solution-ahl

System Overview

Realizes a full HD cluster solution with a four-channel Automotive High-definition Link (AHL) using SVM (Surround View Monitor)

System Benefits

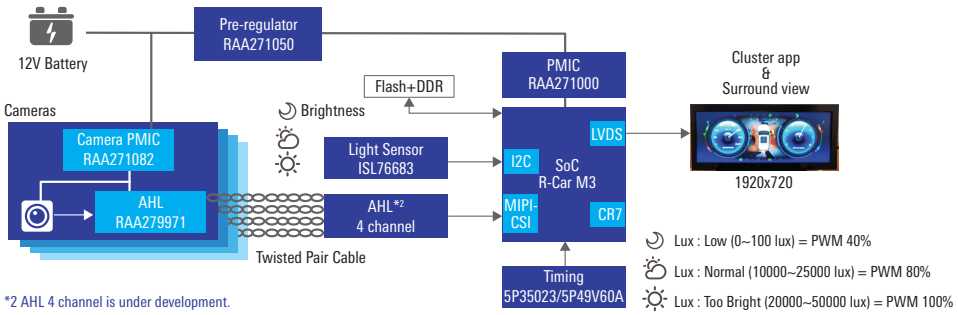
- Utilizes inexpensive analog cables and connectors, specifically the twisted-pair connector ($0.50/pc), which reduces costs by up to 30% compared to a coaxial connector
- No latency with excellent picture quality compared to digital transmission
- Realizes dimming control of displays using a light sensor
- Provides a power management solution that is proven compatible with the R-Car M3
- R-Car M3 and PMIC's support functional safety up to ISO 26262 ASIL B

Recommended Devices

R-Car M3	SoC
RAA271050*1	Pre-regulator
RAA271000*1	Power management IC
RAA271082	Power management IC
RAA279971	Automotive High-definition Link (AHL)
5P35023/5P49V60A*1	Timing IC
ISL76683	Light sensor

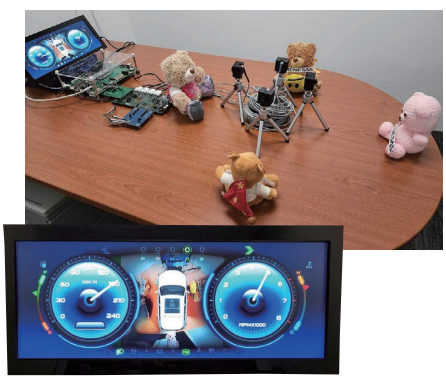
*1 Not contained in the reference board

Block Diagram



*2 AHL 4 channel is under development.

Demonstration



Haptic Touch Key Solution for Automotive Switches

System Overview

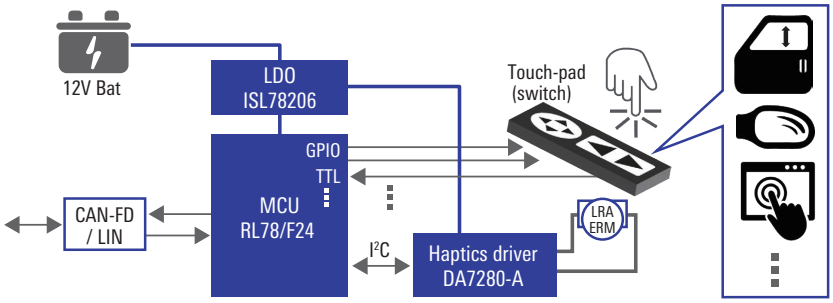
Automotive touch key solution with ‚Haptics' at minimal cost.

System Benefits

- Entry-class RL78/F24 can control touch sensing and haptic drivers, and the rest of the system including support for high-speed communication protocol CAN FD and in-vehicle security EVITA-Light. All this can be offered at the lowest possible cost.
- DA7280-A can input up to 6 different triggers from 3 GPIO pins, so it is possible to assign different signal patterns to multiple touch keys. Vibration delay is minimized (0.75ms) and it achieves a low current consumption of 0.36uA when idle.
- The touch key demo board works together with the touch sensitivity tuning tool, which works in conjunction with the DA728x-EVAL-KIT and a haptic sequence design tool. Software for interoperation of both boards is also available.
- Consider creating a PoC equipped with a touch dedicated hard IP (CTSU) that achieves improved noise immunity and sensor accuracy using consumer MCU RL78/G23.

CTSU: Capacitive Touch Sensor Unit

Block Diagram



LRA: Linear Resonant Actuator
ERM: Eccentric Rotating Mass motor

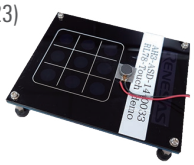
Recommended Devices

DA7280-A	Haptics driver
ISL78206[*1]	LDO
RL78/F24, F1x[*2]	16bit MCU

*1 Not contained in the reference board.
*2 If CANFD / AES-256 is not required, the cost minimum RL78 / F1x series can be used.

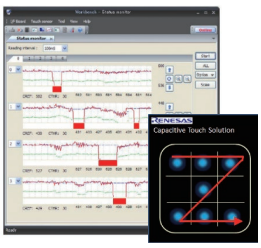
Reference Board / GUI

Touch key demo board
(Samples to be provided from 2023)

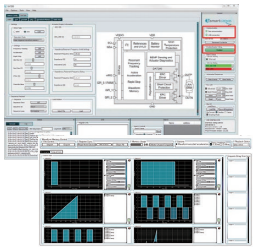


DA728x-EVAL-KIT

Touch sensitivity tuning tool
(Workbench5)



Haptic sequence design tool
(SmartCanvas™ GUI)



Automotive Cockpit Solution with Haptics

https://www.renesas.com/application/automotive/automotive-cockpit-solution-haptics

System Benefits

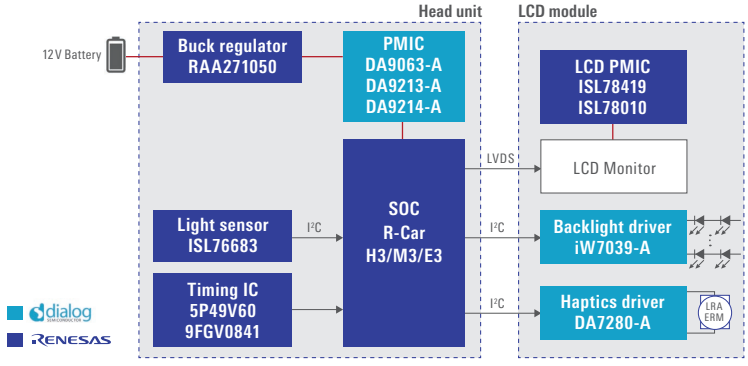
- Offers a total cockpit solution using next generation haptic human machine interface
- Low-latency direct drives for haptics drive distinct haptic effects triggered by multiple inputs without need to wake the apps processor
- BroadLED™ backlight driver technology in iW7039 provides best-in-class LED current matching with highest possible efficiency
- A flexible system PMIC can supply a wide range of multicore SoCs and integrates full power rail management with multiple sleep modes for an optimized system solution
- Reduces R&D cost and development time using PMICs verified for R-Car SoCs
- Reference boards provide a quick and easy start to development

Recommended Devices

R-Car H3/M3/E3	SoC
RAA271050	Buck regulator
DA9063-A	Power management IC
DA9213-A	Multiphase 20A Sub-PMIC
DA9214-A	Multiphase 2x 10A Sub-PMIC
DA7280-A	Haptics driver
iW7039-A[*1]	LCD backlight driver
ISL78419/ISL78010	LCD PMIC
5P49V60/9FGV0841	Clock generator
ISL76683	Light sensor

*1 AEC-Q100 qualification is under planning

Block Diagram

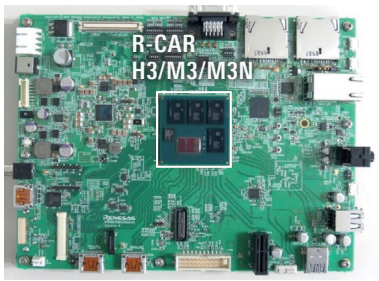


LRA: Linear Resonant Actuator, ERM: Eccentric Rotating Mass motor

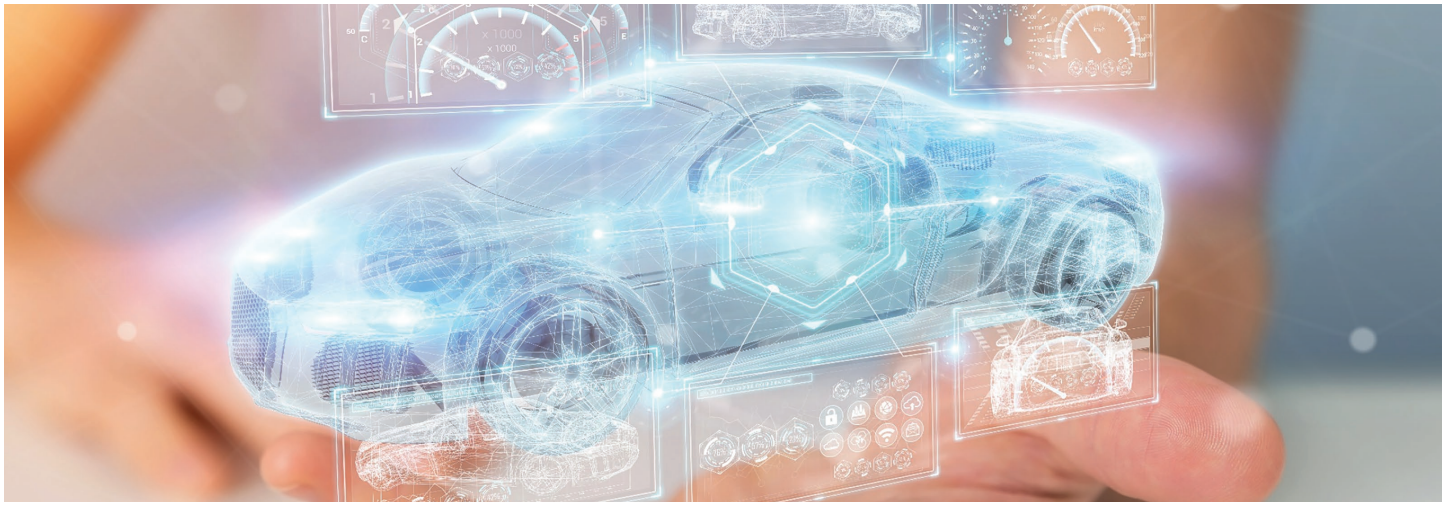
Reference Boards

DA7280 performance evaluation board

R-Car reference board
Salvatore-XS



E/E Architecture



Domain Control Unit

https://www.renesas.com/application/automotive/domain-control-unit

System Benefits

- RH850 U2A is used to realize a domain control unit application to support the evolving E/E architecture. The U2A includes hypervisor mode to address cybersecurity, functional safety requirements and numerous network interfaces(FlexRay 2ch,CAN-FD 16ch,LIN 24ch,1Gbps Ethernet 1ch etc.)
- RH850/U2A starter kit includes network interfaces, including 1Gbps Ethernet and 100Mbps Ethernet, CAN-FD, LIN, UART and SENT protocols.
- Includes software for using the peripheral modules (CAN, LIN, Ethernet, etc.) to enable a fast and easy implementation.

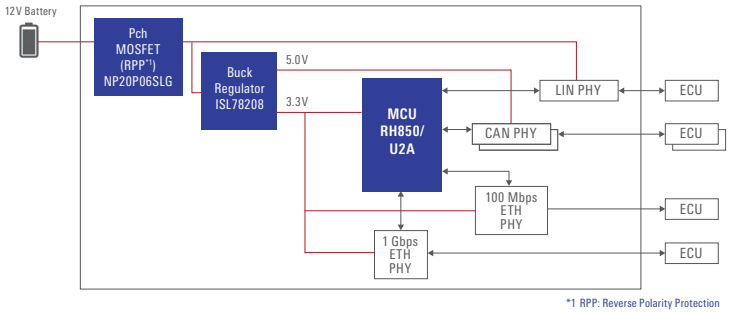
Recommended Devices

RH850/U2A16	32bit MCU
ISL78208	Dual buck regulator 3A/3A
NP20P06SLG	P-channel MOSFET

Optional Devices

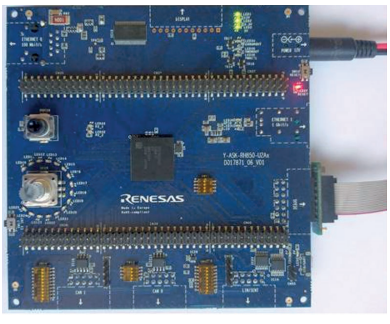
ISL78206	Buck regulator 2.5A
ISL78233/4	Buck regulator 3A/4A

Block Diagram



Evaluation Board

RH850/U2A Starter Kit



Power Distribution Box with E-Fuse*

*Electronic Fuse

https://www.renesas.com/application/automotive/gateway-domain-control/power-distribution-box-e-fuse

System Benefits

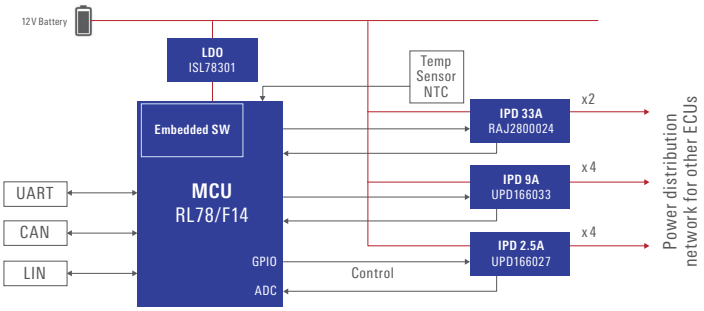
- This reference board demonstrates an efficient wire harness protection concept by smart electronic fusing for use in future automotive power distribution networks. Demo software is available together with the reference board
- E-Fuses offer maintenance-free load and wire protection. Due to significantly higher accuracy, smaller cables can be used, reducing the weight of the wire harness. The e-fuse characteristics can be configured and adapted to a variety of cables.
- 10 output channels are integrated on a just 30 cm^2 sized board which underlines the potential of the smart e-fuse concept to reduce size and weight of a fuse box by replacing conventional melting fuses.
- The software-based e-fuse is based on the current-sense feedback of the IPD to the MCU. The MCU is programmed to implement the fuse function.
- A safe Parking Mode* can be emulated by switching on the IPD and setting the MCU into a low power mode. The MCU can continue to monitor the load current and wakeup on a detected current threshold.

* Parking Mode represents a car parking situation where selected channels need to be active with min. power consumption.

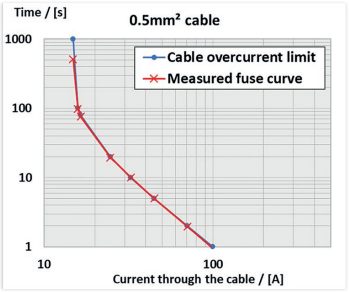
Recommended Devices

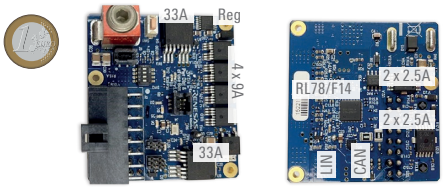
RL78/F14	16-bit MCU, 96KB Flash, 48 pins, CAN, LIN, 38x GP I/O, 18x 10bit ADC
RAJ2800024	IPD (1.6mΩ, 33A)
UPD166033T1U	IPD (6mΩ, 9A)
UPD166027T1J	IPD (35mΩ, 2.5A, dual Ch)
ISL78301	LDO

Block Diagram



Reference Board





Automotive Communication Gateway Platform

https://www.renesas.com/application/automotive/gateway-domain-control/automotive-communication-gateway-platform

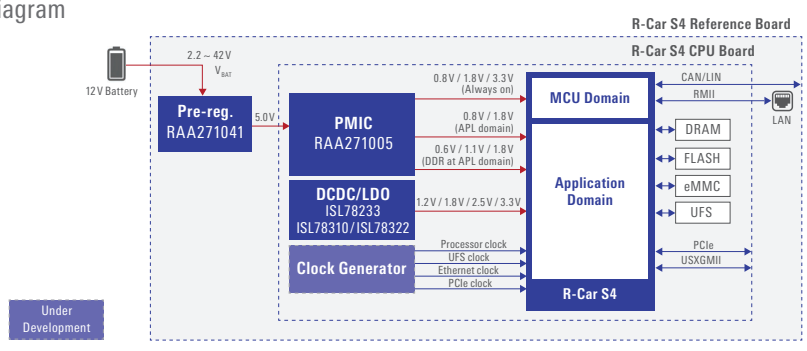
System Benefits

- Provides a complete development environment with hardware and software for automotive gateway applications to support the new E/E architecture.
- Reduces the board size and BoM costs through MCU core integration into R-Car SoC, and use a single board to control both MCU domain and application SoC domain, which previously required separately.
- The reference board consists of a CPU board with core SOC, PMIC, and memory, and an interface board, enabling support for a variety of networks. Supports 16 channels of CAN FD (can be used as 16 channels of LIN and 8 channels of SENT by multi-function), 2 channels of FlexRay, 2 channels of PCIe V4.0 x2 Lanes, and 3 channels of 5G-USXGMII for Ethernet.
- The core system is realized by installing R-Car S4, LPDDR4x-3200 memory and HyperFlash™ memory on the CPU board, which contributes to shorten the time to market by simplifying the design.
- PMIC support functional safety up to ISO 26262 ASIL D. R-Car S4 targets same level of functional safety
- Flexible clock generator capable of generating 12 outputs, PCIe Gen1-4 clocks for automotive applications, and UFS clocks to support multiple channels in a single device

Recommended Devices

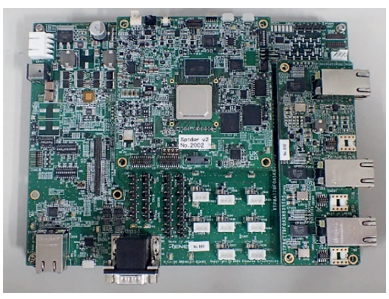
R-Car S4	SoC
RAA271005	PMIC for S4
RAA271041	Buck boost Controller
ISL78233	Buck regulator (3A)
ISL78310	LDO (1A)
ISL78322	Buck regulator (2A /1.7A)

Block Diagram



Reference Board

R-Car S4 reference board (Spider)



Vehicle Computer for Future E/E Architecture

https://www.renesas.com/application/automotive/gateway-domain-control/vehicle-computer-future-ee-architecture

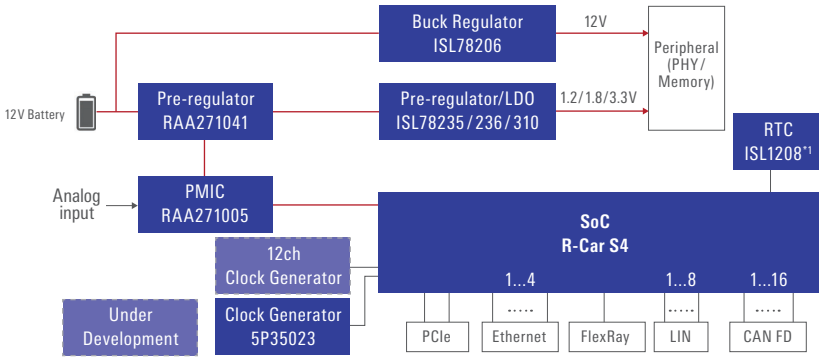
System Benefits

- The Vehicle Computer 4 is an ideal platform for the development of applications such as gateways, car servers, and zone control to realize the next generation E/E architecture
- Supports vehicle testing by consisting of a robust metal box, vehicle connectors, and components for automotive temperature (-40 to 85°C)
- Supports the newest automotive network technologies (TSN Ethernet Switch, 10BASE-T1S, 1000BASE-RH and 2.5GBASE-T1 etc.) plus legacy networks(CAN, LIN, FlexRay and SENTetc.) In addition, support for analog input, wake-up, and real-time clock increases development usability.
- Sufficient computing power(up to 27k DMIPS application performance plus greater than 5.3k DMIPS real-time performance) to host the ever-increasing amount of user applications.
- Allows designers to re-use up to 80 percent of software code developed for three generations of R-Car SoCs and RH850 MCU applications.
- The combination of pre-regulators and PMICs developed for R-Car S4 can provide various supply voltages to meet functional safety requirements up to ASIL D in accordance with ISO26262.functional safety.

Recommended Devices

R-CarS4	SoC
RAA271005	PMIC for S4
RAA271041	Buck boost Controller
ISL78235	Buck regulator(5A)
5P35023	Programmable clock generator
ISL1208[*1]	Realtime clock

Block Diagram



*1 Industrial grade.-40 to 85°C support

Reference Board

Vehicle Computer 4

RH850/U2x Zone-ECU Virtualization Solution Platform

https://www.renesas.com/application/automotive/gateway-domain-control/zone-ecu-virtualization-solution-platform

System Overview

The RH850/U2x Zone-ECU Virtualization Solution Platform is a development platform that provides a pre-integrated solution including relevant SW-products and tools to allow automotive customers a ready-to-use approach for their individual Zone-ECU project.

System Benefits

- Customers will benefit from significantly reduced development effort based on a prebuilt solution, resulting in less cost and reduced development risk.
- Based on a collaboration between ETAS and Renesas, the Zone-ECU Virtualization Solution Platform combines the MCU HW key-features for Zone, like hypervisor-support, safety, security, QoS and more with the outstanding SW-product portfolio and SW-competence of ETAS.
- Provide a SW-first solution to enable the integration of multiple applications into a single ECU that are safely and securely separated from each other to ensure the highest degree of freedom from interference.

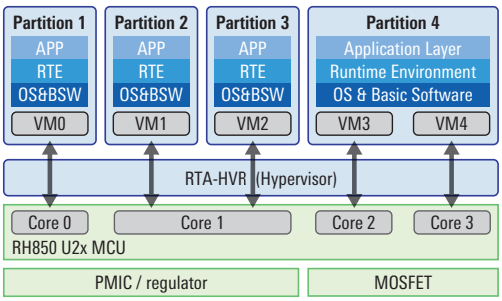
Recommended Devices

RH850/U2Bx	32bit MCU
RH850/U2A16	32bit MCU
ISL78208	Dual buck regulator 3A/3A
ISL78234	Compact 4A synchronous buck regulator
RAA271050[*2]	4A synchronous buck regulator
NP20P06SLG	P-channel MOSFET
RAA271082[*2]	PMIC

*2 Not contained in the reference board

System Concept

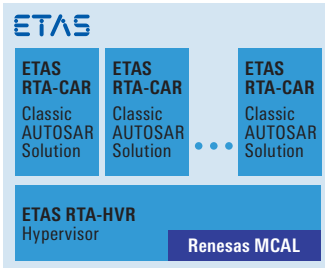
The Hypervisor allows a single microcontroller to run several Virtual Machines(VMs) independently and in parallel



Software[*1]

*1 Eval. licenses required

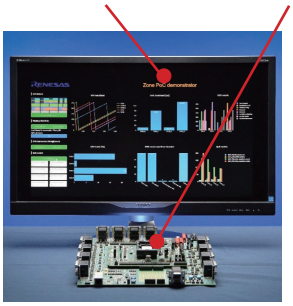
- RTA-HVR (Hypervisor) Prototype
- RTA-CAR (Classic AUTOSAR SW Stack)
- CycurHSM (Security stack for ICU-Mx)
- Renesas U2x MCAL



Virtualization Solution Platform

GUI

- Based on Python 2.7 32 bit
- Tkiner GUI interface



Evaluation Board options

1) RH850/U2A16 Starterkit

2) RH850/U2Bx Piggyback board

Communication Gateway and Integrated DVR/DMS System Solution

https://www.renesas.com/application/automotive/gateway-domain-control/communication-gateway-and-integrated-dvr-dms-system-solution

System Overview

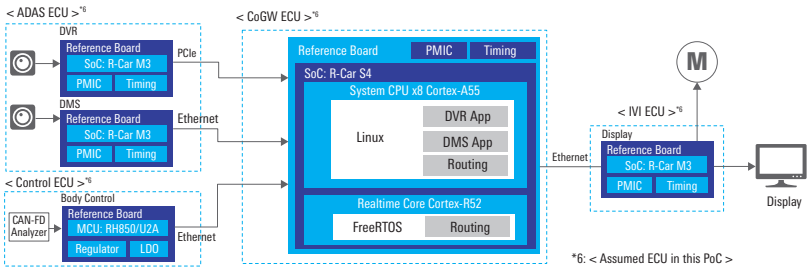
Today, E/E*1 architectures in the automotive CASE*2 era are evolving and in addition to the traditional key components of ADAS, IVI, and in-vehicle control; there is interest in the evolution and widespread use of CoGWs*3. This solution combines R-Car S4 for CoGW and R-Car M3 / RH850 to provide a reference environment that integrates a DVR*4 / DMS*5 for video processing applications into the central CoGW system.

System Benefits

- Provides a proven reference environment for evaluation of SoCs and MCU in a CoGW application
- Reduces time needed for the concept study phase, and allows user to leap forward to the feasibility study and system rationalization using the different reference boards
- Enables evaluation under high data rate conditions, communicating video data input / output via Gigabit Ethernet / PCIe
- Provides the foundational CoGW function and the R-Car S4 allows extended functionality to DVR / DMS applications

*1 E/E Architecture : Electronics and Electric Architecture, *2 CASE: Connected + Autonomous + Shared & Service + Electric, *3 CoGW: Communication Gateway, *4 DVR: Driving Video Recorder, *5 DMS: Driver Monitoring System, *4,*5: DVR and DMS middleware provided by partner

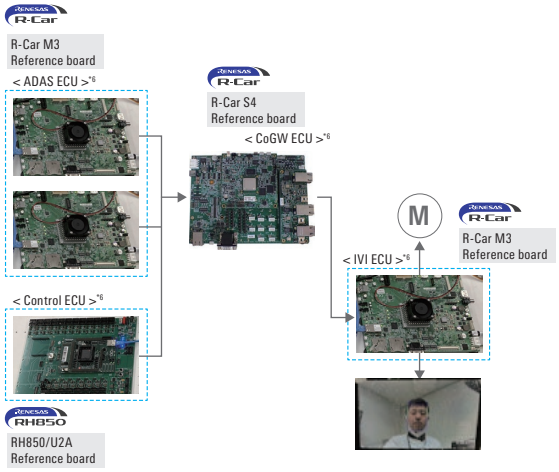
Block Diagram



Recommended Devices

R-Car S4 Reference board	
R-Car S4	SoC
RAA271005	PMIC for S4
RAA271041	Pre-regulator (buck/boost controller)
R-Car M3 Reference board	
R-Car M3	SoC
5P49V60	Programmable Clock Generator
9FGV0841	Clock Generator
RH850/U2A Reference board	
RH850/U2A16	MCU

PoC system configuration



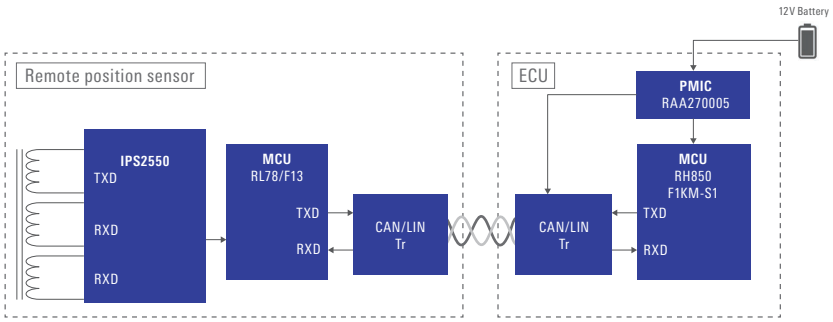
Remote Sensing with Inductive Position Sensor and CAN/LIN

https://www.renesas.com/application/automotive/gateway-domain-control/remote-sensing-inductive-position-sensor-and-canlin

System Benefits

- Solve influences of noise and parasitic component by longer distance on new car E/E architecture with centralized ECUs by supporting
- Remote sensing connection over longer distances using a communication interface sensing over CAN/LIN
  - Target application: Bridge between ECU and IPS for throttle, console and throttle pedal
- Support full bidirectional communication (sensor re-configuration over life-time, enhanced data security, OTA updates)
- Reduce wiring by supplying multiple sensors multiplexed on one interface
- Enable robust and secure communication from sensor to ECU
- MCU software is available

Block Diagram



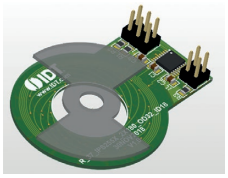
Recommended Devices

RH850/F1KM-S1	32bit Microcontroller
RL78/F13	16bit Microcontroller
RAA270005*1	Power Management IC
IPS2550	Inductive Position Sensor IC

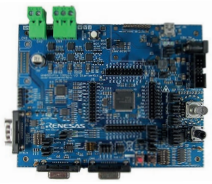
*1 Not in proof of concept

Proof of Concept

This concept has validated by using these boards



Remote position sensor



ECU

xEV

xEV Inverter Reference Solution

https://www.renesas.com/application/automotive/electrified-drivetrain-xev/xev-inverter-reference-solution

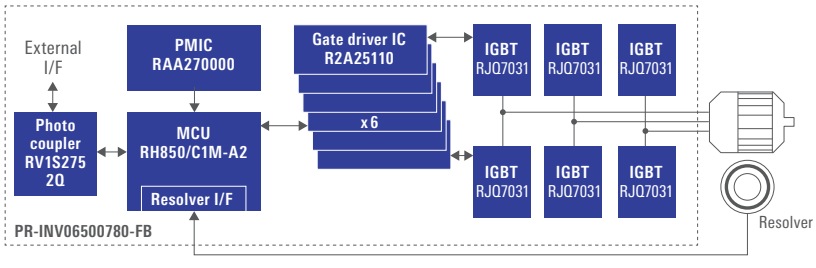
System Benefits

- Practical inverter specification for xEV 100kW class motor
- Jumpstart evaluation with reference solution kit, including inverter reference designs, software, model base designs, and calibration tools
- Provide early discovery and countermeasures for customers' issues, through Renesas' motor bench, dedicated engineering support
- 3.9L compact volume by highly integrate products and temperature management
- Superior power efficiency, Achieved 99% maximum inverter efficiency
- Function is already proven in real car demo

Recommended Devices

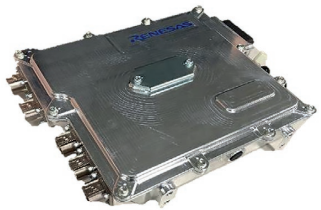
RH850/C1M-A2	32bit Microcontroller
RAA270000	Power management IC
R2A25110	Gate driver IC
RJQ7031/RJU7032	IGBT / FRD
RV1S2752Q	Photo Coupler

Block Diagram



Reference Board

xEV Inverter Solution with Inductive Position Sensor(IPS)



xEV Inverter Application Model and Software

https://www.renesas.com/software-tool/xev-inverter-application-model-software

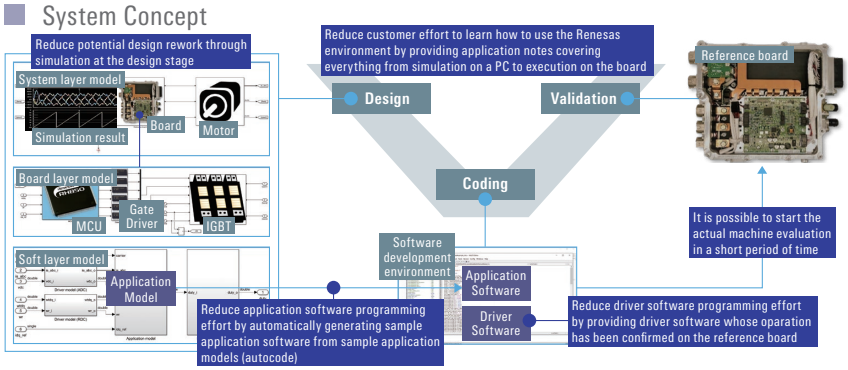
Overview

xEV Inverter Application Model and Software is a sample application model of motor control that can be simulated on a PC, and a sample application software of motor control that runs on an inverter kit for xEV (electric vehicle).

Benefits

- Reduce customer effort of software development in product development using inverter kit for xEV (electric vehicle).
  - Reduce potential design rework through simulation at the design stage by using a sample application model and a sample IGBT model, motor model of MATLAB®/Simulink®.
  - Reduce application software programming effort by automatically generating sample application software from the sample application models using automatic code generation.
  - Reduce driver software programming effort by providing driver software whose operation has been confirmed on the reference board of the inverter kit for xEV (electric vehicle), it is possible to start the actual machine evaluation in a short period of time.
  - Reduce customer effort to learn how to use the Renesas environment from simulation on a PC to execution on the board by providing application notes covering everything from simulation on a PC to execution on the board.

System Concept



Recommended Devices

RH850/C1M-A2, U2B[*1]	32bit Microcontroller
RAA270000	Power management IC
R2A25110	Gate driver IC
AE3, AE4, AE5[*1]	IGBT/FRD
RV1S2752Q	Photo Coupler

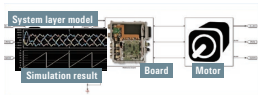
*1 Not contained in the reference board.

Reference Board[*2]

PR-INV06500780-FB	xEV Inverter Kit

*2 It is also possible for the customer to manufacture the board by purchasing only the design information (circuit diagram, Gerber data, BOM list) of the reference board.

Deliverables

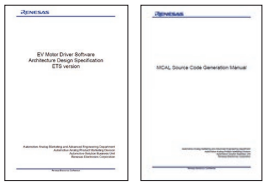


- Sample model[*3]
  - Sample application model
  - Sample IGBT model, motor model

*3 Sample model will be available in Q3 2022

- Sample software
  - Sample application software[*4]
  - Sample driver software

*4 Automatically generated from the sample application model



- Application note
  - How to use the Renesas environment

Automotive BMS Application Models and Software

https://www.renesas.com/software-tool/automotive-bms-application-model-software

System Benefits

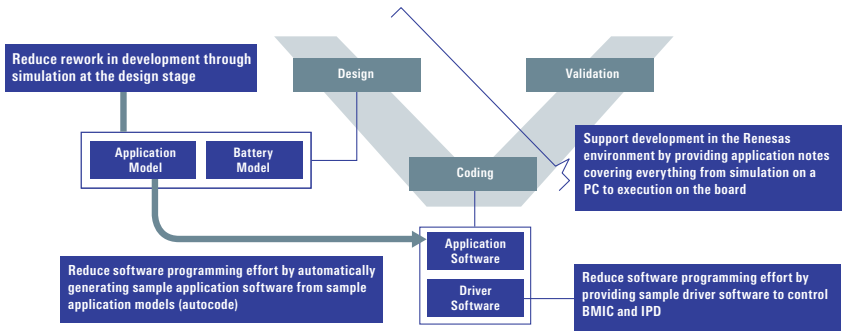
- Reduce customer development effort by providing sample application models that support State Of Charge (SOC) and State Of Health (SOH).
  - Reduce potential design rework through simulation at the design stage by using a sample application model and a sample battery model of Simulink®.
  - Reduce software programming effort by automatically generating sample application software from sample application models (autocode).
  - Reduce software programming effort by providing sample driver software to control BMIC and IPD.
  - Support development in the Renesas environment by providing application notes covering everything from simulation on a PC to execution on the board.
- Two selectable reference boards with ASIL-compatible MCUs
  - The sample application supports both a BMS board with a dual core RH850/P1M for functional safety and a single BMIC evaluation kit with a single core RH850/F1KM EVK for lower cost.

Recommended Devices

RH850-P1M	32bit Microcontroller (MCU)
RH850/F1KM-S1	32bit Microcontroller (MCU)
ISL78714	14ch Battery Management IC (BMIC)
RV1S2752Q[*1]	Photo Coupler for Isolation
RAA270005[*1]	Power Management IC(PMIC)
uPD166031A/32/33/34[*1]	Intelligent Power Device (IPD), 6-12mΩ
RAJ2800024/34/44[*1]	Intelligent Power Device (IPD), 1.6-3.8mΩ

*1 Not contained in the reference board

Block Diagram



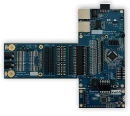
Reference Board

You can use sample application software on the board 1 or 2 .

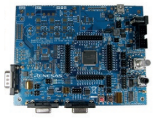
1 Multi BMICs w/ RH850/P1M reference board

ISL78714BMS5XBEKIT1Z

2 Single BMIC EVK + RH850/F1KM Starter Kit



ISL78714XB-EVKIT1Z



Y-ASKRH850F1KM-S1-V3

Automotive Battery Management System (BMS)

https://www.renesas.com/application/automotive/electrified-drivetrain-xev/automotive-battery-management-system-bms

System Benefits

- Best BMS accuracy and Long-Term Drift (LTD), which extend driving range and battery life performance, by superior accuracy of 2.5 mV and 6 sigma long term drift
- Lowest BOM cost and best FuSa/EMI/EMC/Hot-Plug solution, which alleviates R&D effort and easy-to-use with RH850 MCU family with dedicated drivers and Software for BMS.
- Immediate ASIL software development enabled by ISL78714 Complex Device Driver (CDD) managing BMS measurements and functional safety features.
- A wide range of MCU line-up with security features can support functional safety up to ASIL D.
- Intelligent Power Device for external load control.
- Full system deliverables committed to automotive quality and support, which is optimized to be used high voltage Battery Management applications

Recommended Devices

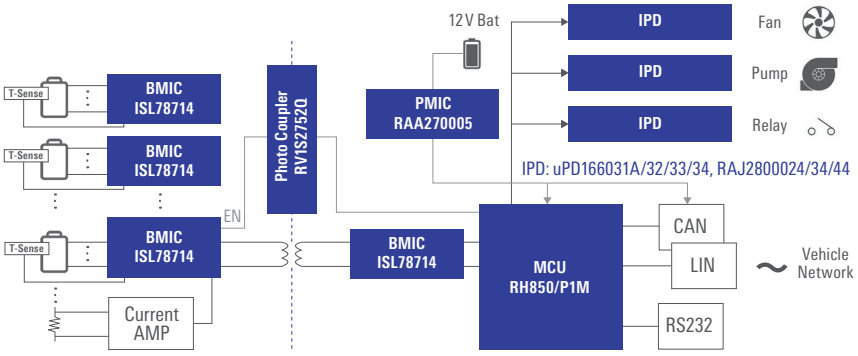
RH850/P1M	32bit Microcontroller (MCU)
ISL78714	14ch Battery Management IC (BMIC)
RV1S2752Q*1	Photo Coupler for Isolation
uPD166031A~34*1	Intelligent Power Device (IPD)
RAJ2800024/34/44*1	Intelligent Power Device (IPD)

*1 Not contained in the reference board

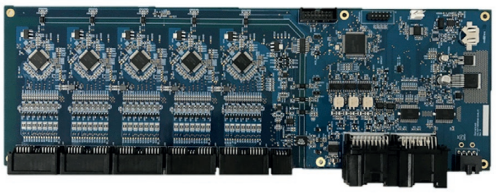
Optional Devices

RAA270005	Power Management IC(PMIC)

Block Diagram



Reference Board



Functional Safety Concept for xEV Inverter System

https://www.renesas.com/application/automotive/electrified-drivetrain-xev/functional-safety-system-concept-solution-xev

Benefits

- Reduce development time at customers to consider functional safety at the system level
  - Easy-to-start system development with functional safety by using the reference Work Products for development phases from concept to system design (Technical Safety Concept implementation)
  - xEV inverter system safety concept targeting ASIL C
  - Reference Work Products reviewed by a 3rd party organization, SGS Japan Inc.*1
  - Safety concept based on Renesas device's (MCU, PMIC) safety mechanisms
  - Enables development based on Renesas "xEV Inverter Reference Solution"
  - Flexible configuration for various inverter systems (Single motor, Dual motor, Boost/Buck)

*1 SGS Japan Inc.: Website https://www.sgsgroup.jp/en/

Recommended Devices

RH850/C1M-A2	Microcontroller (MCU)
RAA270000	Power Management IC(PMIC)
R2A25110	Isolated Gate Driver IC
RJQ7031/RJU7032	IGBT/FRD

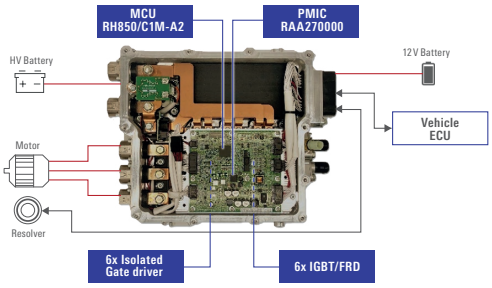
Deliverables

System level safety concept targeting ASIL C

- Technical report (Top page)
- Work Products

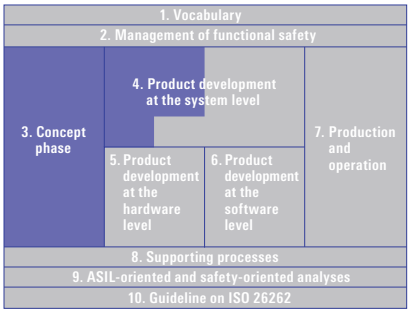
Configuration Diagram

System configuration using „xEV Inverter Reference Solution"



Target scope

ISO 26262 Scope



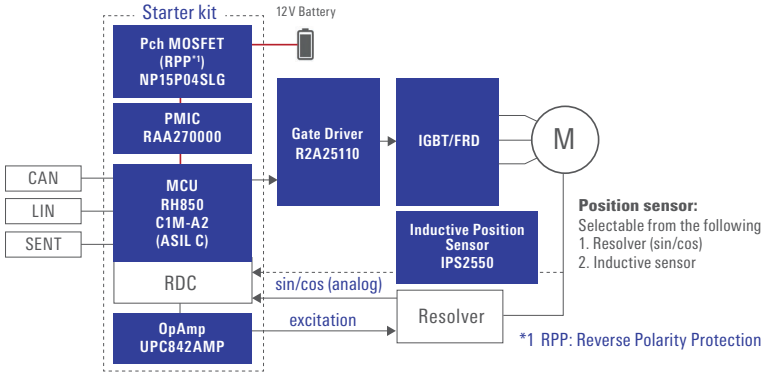
Motor Generator System

https://www.renesas.com/application/automotive/motor-generator-system

System Benefits

- Realizes high-performance xEV traction motor and regeneration control using RH850/C1M-Ax, supporting ASIL C and incorporating lock-step CPU cores & sophisticated motor-control IP (EMU3)
- Enhances diagnostic features and significantly reduces board area and BOM cost using an embedded resolver-to-digital (RDC) interface on RH850/C1M-Ax MCU
- Provides a proven system-design approach through a PMIC specifically designed for the RH850/C series, optimizing BOM cost & board space
- Provides models and software compatible with the RH850/C1M-A2 starter kit via the Renesas website to help customers get their motor-generator systems to market quickly

Block Diagram



Recommended Devices

RH850/C1M-A2	32bit microcontroller
RAA270000	Power management IC
UPC842AMP	Operational amplifier
NP15P04SLG	P-channel power MOSFET

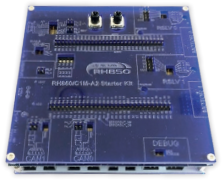
Optional Devices*2

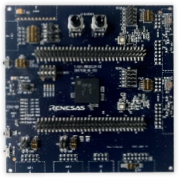
RH850/C1M-A1	32bit microcontroller
IPS2550	Inductive position sensor
R2A25110	Gate driver IC
RJQ7031/RJU7032	IGBT / FRD (power stage)

*2 Not contained in starter kit

Reference Board

RH850/C1M-A2 Starter kit





12V/48V Bidirectional DC/DC Converter

https://www.renesas.com/application/automotive/12v48v-bidirectional-dcdc-converter

System Benefits

- High efficiency 12/48V DC/DC converter + vehicle networking, perfect for 48V mild hybrid vehicles and electric motorcycle using LV148*1 board net
- Multi-phase DC/DC solution delivers beyond 3kW between 12V and 48V board nets at over 95% efficiency
- Bidirectional analog controller eliminates need for DSP with complicated firmware, separate buck/boost controllers and complex switching logic
- Supports functional safety up to ASIL B with RH850 and Renesas regulator
- Reduces user effort to determine modes and optimal settings for ISL78226, resulting in minimal setup time to begin useful evaluation

*1 Automotive 48 V power supply standards formulated mainly by German automakers
*2 Some reference work products can be provided for supporting customer's system functional safety activities

Recommended Devices

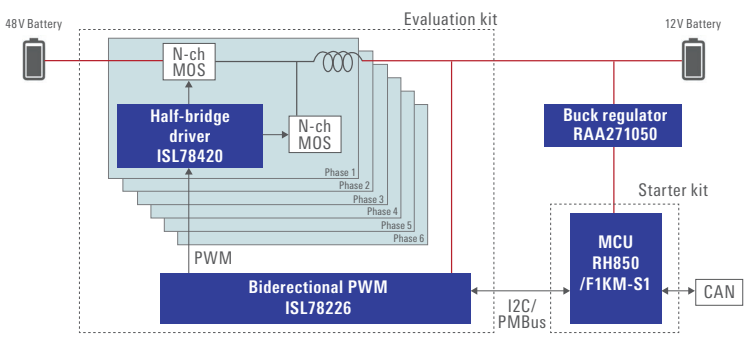
RH850/F1KM-S1	32-bit ASIL B MCU
ISL78226	6-phase bidirectional PWM controller
ISL78420	100 V, 2 A peak, half-bridge driver
RAA271050*3	Buck regulator for RH850

*3 Not contained in starter kit

Option Devices

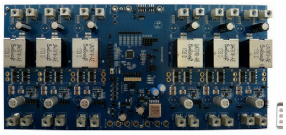
ISL78224	4-phase bidirectional PWM controller
ISL78424/444	100 V, 4 A peak, half-bridge driver
RBA250N10CHPF-4UA02	100 V N-channel power MOSFET
RL78/F1x	16-bit MCU RL78 series

Block Diagram

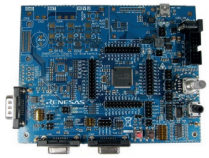


Reference Boards

ISL78226 / ISL78420 Evaluation kit



RH850 / F1KM-S1 Starter kit



12V/48V Bidirectional DC/DC Converter with GaN HEMT

https://www.renesas.com/application/automotive/electrified-drivetrain-xev/12v48v-bidirectional-dcdc-converter-gan-hemt

System Overview

Best system solution for 48V mild hybrid vehicles and electric motorcycles using high-efficiency 12/48V DC/DC converters

System Benefits

- Reducing the PCB area by 46%*1 is achieved using GaN HEMT with excellent switching characteristics, enabling a high-efficiency power conversion with a high switching frequency of 500kHz and a small 1.3uH inductors.
- Automatic Phase Drop function achieves highly efficient power conversion even at low loads, exceeding 94% power efficiency over a wide load range of 400W to 3kW.
- PWM Controller ISL78226 eliminates the need for complicated DC/DC converter control software development
- Half-bridge driver ISL78420/444 enables driving GaN HEMT devices
- Adaptive Dead Time function*2 automatically adjusts the dead time for optimal control
- MCU RL78/F24 supports mode setting and status monitoring of DC/DC converters through the CANFD

*1 Compared to 12V/48V Bidirectional DC/DC Converter with Si-MOSFET *2 Functions included in ISL78444

Recommended Devices

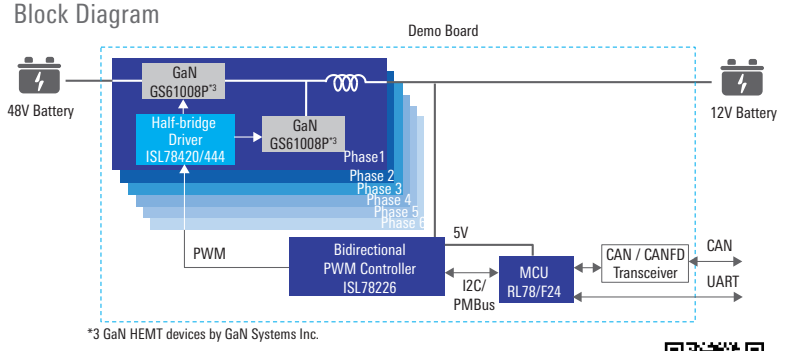
RL78/F24	32-bit MCU
ISL78226	6-phase bidirectional PWM controller
ISL78420/444	100V, 2A peak, half-bridge driver

Optional Devices*4

ISL78224	4-phase bidirectional PWM controller
ISL78424	100V, 4A peak, half-bridge driver
RL78/F1x	16-bit MCU RL78 series
RH850/F1KM-S1	32-bit MCU

*4 The device is not included in the demo board

Block Diagram

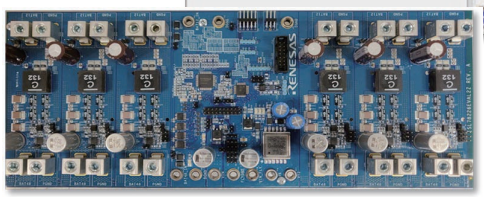


*3 GaN HEMT devices by GaN Systems Inc.

Demonstration

GUI for control

Demo board



Low Voltage Inverter for 2/3 Wheeler Traction Motor

https://www.renesas.com/application/automotive/low-voltage-inverter-23-wheeler-traction-motor-control

System Benefits

- The reference design provides the complete inverter evaluation for motor control application using RH850/C1M-A1 MCU
- Includes inverter hardware design files (schematics and Gerber) and peripheral sample code (for "motor control unit" and "resolver-to-digital converter"), allowing fast evaluation and development based on real-life use cases.
- The Power stage can drive up to 10kW Motor. Proper heat sinks and temperature monitors are provided for a complete system level validation for the OEM/Tier1.
- Supports to scale the 48V power stage of the inverter as per customer requirement.
- Supports connection with vehicle I/O, Brake sensor, Accelerator, Gear and Drive modes along with PWM output for the Digital cluster.

Recommended Devices

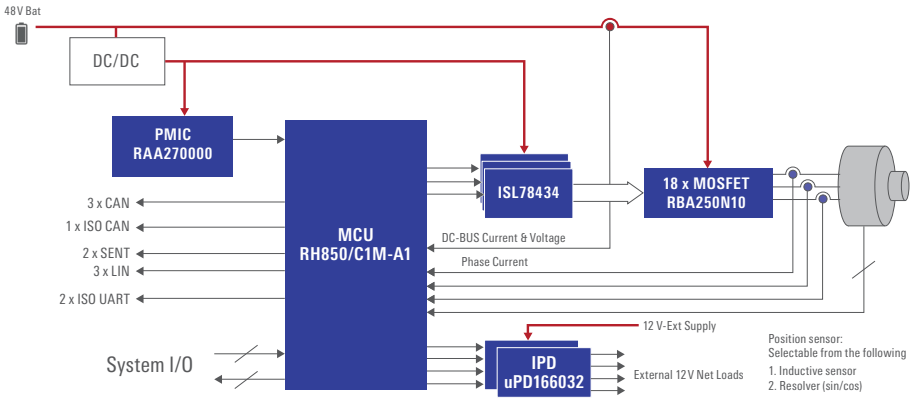
RH850/C1M-A1	32-Bit Microcontroller
ISL78434	Half-Bridge Driver
uPD166029	Intelligent Power Device (IPD)
RAA270000KFT	PMIC for RH850/C1M-A1
RBA250N10	N-Channel Power MOSFET
IPS2550*1	Inductive position sensor

Optional Devices

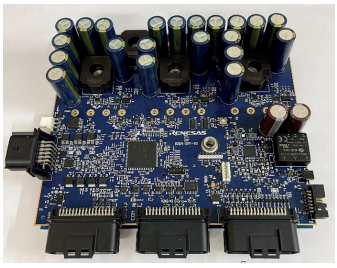
uPD166031A~34*1	Intelligent Power Device (IPD)
RAJ2800024/34/44*1	Intelligent Power Device (IPD)

*1 Not on the reference board

Block Diagram



Reference Board



xEV Inverter Solution with Inductive Position Sensor (IPS)

https://www.renesas.com/application/automotive/electrified-drivetrain-xev/xev-inverter-solution-inductive-position-sensor-ips

System Benefits

- IPS contributes to high accuracy angle ≤ 0.1% full scale (with ideal coil), high-speed rotation up to 600,000rpm (electric angle), small size, light weight and thin size
- Verified noise immunity in high voltage inverter environments (400V, 100kW, 500Arms)
- Lower Bill-of-Material: > 30%*1 less expensive than resolvers. Contributes to the reduction of BOM components
- Easy to design and optimize your own IPS Tx/Rx coil pattern.
- Sample software (RDC/ADC) can be provided for quick evaluation.

*1 Based on Renesas research

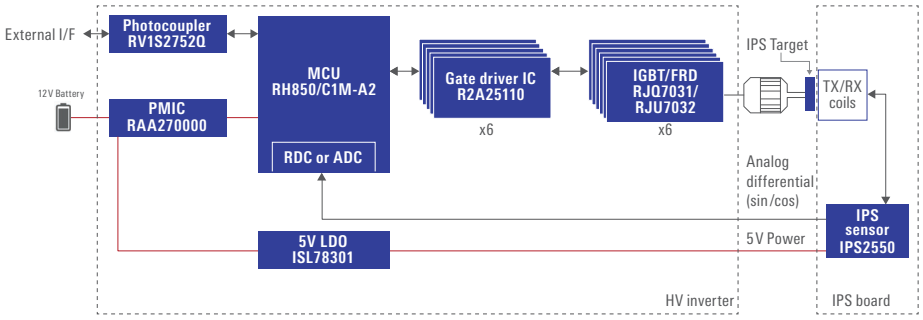
Recommended Devices

IPS2550	Inductive Position Sensor IC
ISL78301	LDO for IPS 5V Power
RH850/C1M-A2	Microcontroller
RAA270000	Power Management IC
R2A25110	Gate Driver IC
RJQ7031/RJU7032	IGBT/FRD
RV1S2752Q	Photocoupler

Optional Device

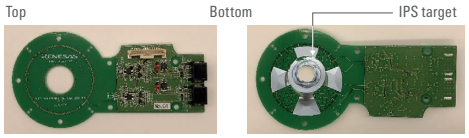
µPC842A	OP-AMP for IPS Analog Line

Block Diagram



Reference Board

IPS board



IPS board attached to the motor

48V Auxiliary Inverter Solution

https://www.renesas.com/application/automotive/electrified-drivetrain-xev/48v-auxiliary-inverter

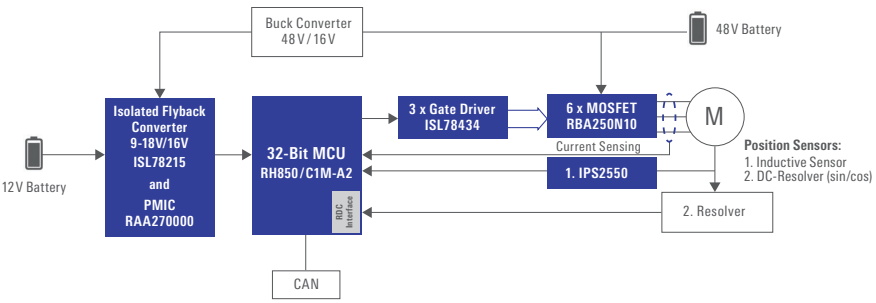
System Benefits

- 12V/48V dual supply concept with domain isolation
- Controls 48V 3-phase BLDC motor
- Supports shunt based and hall sensor based current sensing
- Supports cos/sin resolver, inductive sensor for rotor position
- DC-link voltage measurement
- Diagnostic and monitoring functions
- Functional & performance verification proven

Recommended Devices

RH850/C1M-A2	32-bit MCU with resolver/digital converter
ISL78215	Isolated PWM controller for power conversion
RAA270000	Power Management IC for RH850 MCU
IPS2550	Inductive sin/cos high-speed rotary position sensor
RBA250N10	100V ANM2 Power MOSFET
ISL78434	Half-bridge driver

Block Diagram

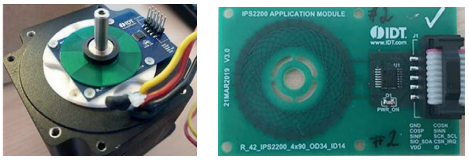


Proof of Concept

This concept has validated by using these boards

Motor Control Module

IPS Module



Wireless Battery Management System

https://www.renesas.com/application/automotive/electrified-drivetrain-xev/wireless-battery-management-system

System Overview

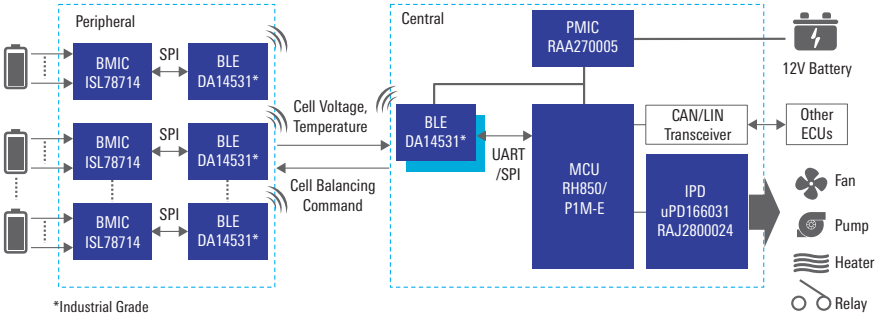
The automotive wireless BMS*1 eliminates wire harnesses allowing flexible battery placement, simplifying the development of scalable electric vehicles

System Benefits

- Eliminates the traditional wire harnesses required in BMS, saving weight and area while improving flexibility
- Easier battery replacement and recycling throughout the life cycle
- Renesas' low-power BLE*2 5.1 device*3 for wireless BMS is ideal for battery life cycle standardization based on the open BLE standard, instead of a proprietary wireless protocol unique to a single supplier
- A system-level functional safety concept for the wireless BMS is being developed*4

*1 Battery Management System *2 Bluetooth Low Energy *4 The concept is available in 2023
*3 The device for automotive grade is under development, not included in the demo. The sample is available in 2023

Block Diagram

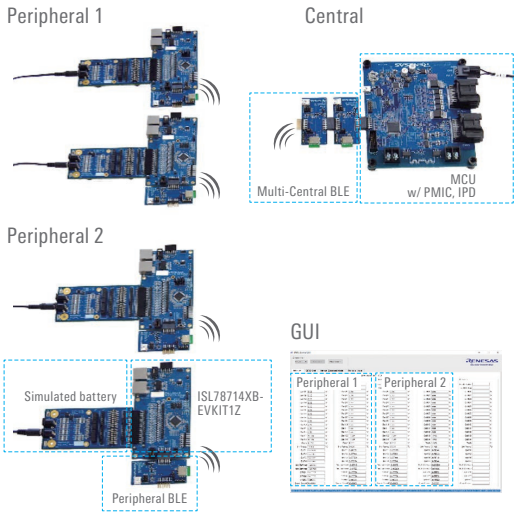


Recommended Devices

RH850/P1M, P1M-E, U2Ax	32bit Microcontroller
RAA270005	Power Management IC
ISL78714,	Battery Management IC
DA14531*5	Bluetooth Low Energy
uPD166031/33*6/34*6	IPD (10mΩ/6mΩ/8mΩ)
RAJ2800024/34*6/44*6	IPD (1.6mΩ/2.5mΩ/3.8mΩ)

*5 Industrial grade *6 The device is not included in the demo

Demonstration



Automotive Monitoring Function Extension for Motor Control System

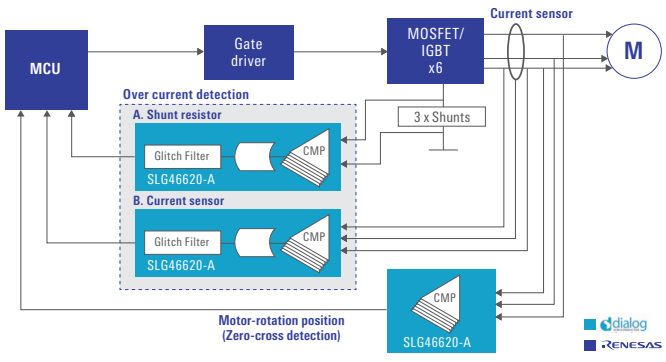
https://www.renesas.com/application/automotive/automotive-monitoring-function-extension-motor-control-system

System Benefits

- Renesas offers monitoring functions using a tiny CMIC*1 in variety of motor control solution
- CMIC GreenPAK™ is a cost-effective NVM programmable device that allows automotive designers to integrate many system functions while minimizing component count, board space, into a single AEC-Q100 qualified IC
- Provides over current detection system using shunt resistor for 12V motor systems and current sensor for xEV motor systems
- Providing motor rotation position detection by zero-cross comparator in square-wave motor controller system
- Enables retrofitting CMIC to existing designs
- With GreenPAK designer software/development kit, quickly respond to changing design requirements and increase productivity at the design and prototype verification stages

*1 CMIC: Configurable Mixed-signal IC

Block Diagram

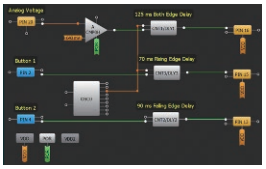


Recommended Devices

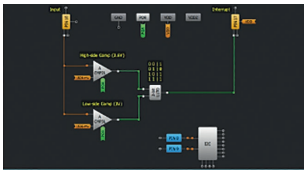
RL78/F14,15	16 Bit MCU
RH850/C1x,F1KM,F1L	32 Bit MCU
NP50N04YUK	40V Power MOSFET
RBA250N10	100V Power MOSFET
RJQ7031/RJU7032	IGBT / FRD
R2A25110	Gate driver IC(On-chip Micro Isolator)
ISL78434	Gate driver IC
SLG46620-A	CMIC Window comparator, Glitch filter

Used CMIC Components

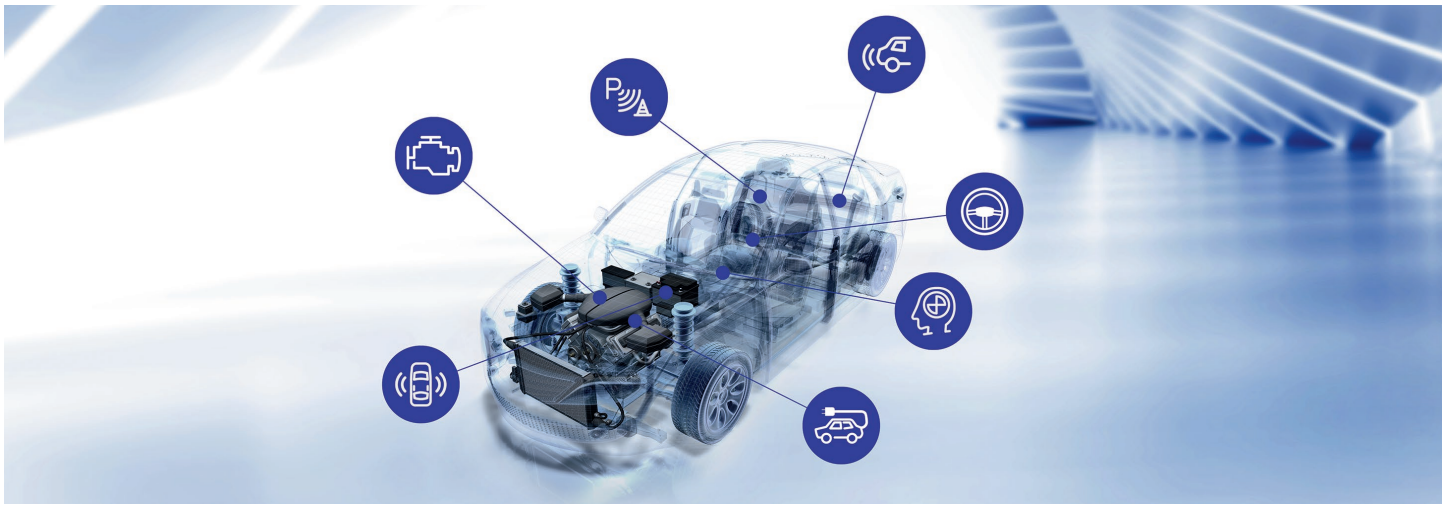
Glitch filter



Window comparator



Vehicle Control



12V Small Motor Solution (RL78/F24 RSSK)

https://www.renesas.com/application/automotive/powertrain-ice/12v-small-motor-solution

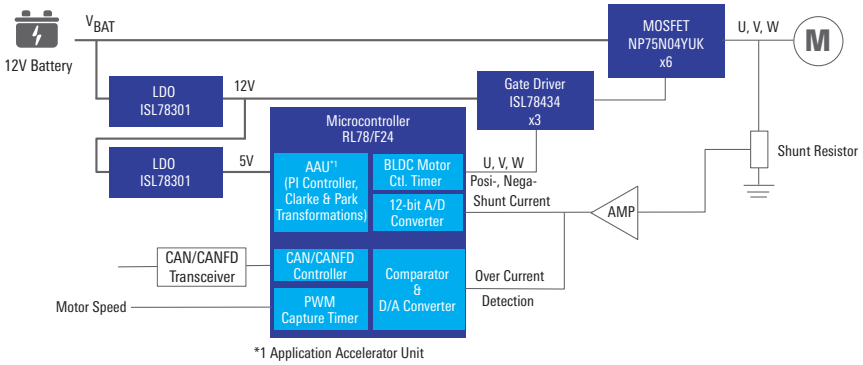
System Overview

Best practical BLDC motor control system development kit for Pumps and Fans.
Realizes three control methods (FOC 3-/1-shunt, trapezoidal) utilizing RL78/F24 peripherals.

System Benefits

- Easy to Start
  - Complete reference design (circuit diagram, PCB design) including characteristic data.
  - Provides three types of sample control software (FOC 3-/1-shunt, Trapezoidal).
- Design Flexibility
  - Sample hardware and software to support motor control development.
  - Reference design capable of driving motors up to 100W.
- Cost efficiency
  - Small board size, designed to incorporate into the motor housing (60mm × 56mm).
  - Sensorless FOC control (1-shunt) uses new timer function (asymmetric PWM output), and a built-in comparator circuit for overcurrent detection.

Block Diagram



*1 Application Accelerator Unit

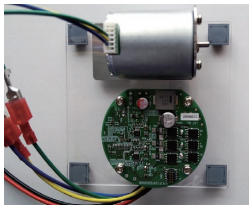
Recommended Devices

RL78/F23, F24	16-bit MCU
RL78/F13, F14	16-bit MCU
RH850/F1KM-S1*2	32-bit MCU
ISL78301	LDO
ISL78434	Gate Driver
NP75N04YUK	N-ch. MOSFET

*2 32-bit microcontroller (RH850/F1KM-S1) version is also available.

Reference Board

Model: RTK7F124FGS00000BJ (RL78/F24 version)
RTK7F70169S00000BJ (RH850/F1KM-S1 version)



PMSM

Inverter Board with MCU
(60mm × 56mm)
– RL78/F24 (48-pin)
– RH850/F1KM-S1 (48-pin)

Sample software (Included in the BLDC-RSSK):
- Sensorless FOC control (3-shunt)
- Sensorless FOC control (Single-shunt)
- Sensorless trapezoidal control

Sensor Reference Solution

https://www.renesas.com/application/automotive/body/sensor-reference-solution

System Benefits

- Sensor solution is used for many kinds of car applications which are pressure monitor (HVAC, Oil) and position monitor(liquid level) etc. And Renesas sensor solution can provide flexible and high accuracy sensor system with SSC, DCDC, MCU and LIN IF.
- Easier integration of SSC in the car network with CAN and LIN interfaces
- MCU extends SSC functionality and off-loads processing from the main ECU
- Reduces customer's R&D costs with Renesas's SW support
- Easy SSC configuration with existing communication board and user friendly GUI SW
- Flexible & low-cost reference board add-on for RL78/F1x Starter Kit

Recommended Devices

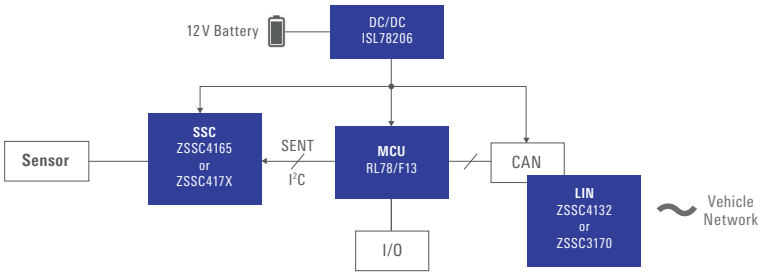
RL78/F13	16-bit MCU
ZSSC4165	Sensor Signal Conditioner(SSC)
ISL78206[*1]	DC/DC
ZSSC4132	SSC + LIN/LIN2
ZSSC417x[*1]	SSC (Voltage Source Sensor Appl.)
ZSSC3170[*1]	SSC + LIN/PWM

*1 Not on the reference board

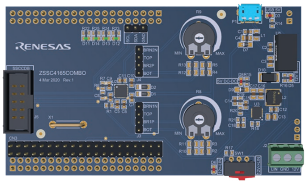
Optional Device

RH850/F1x	32-bit MCU

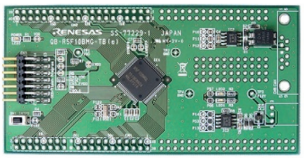
Block Diagram



Reference Boards



ZSSC4165 COMBO



RL78/F13 Starter Kit

Electric Power Steering System

https://www.renesas.com/application/automotive/chassis-safety/electric-power-steering-system

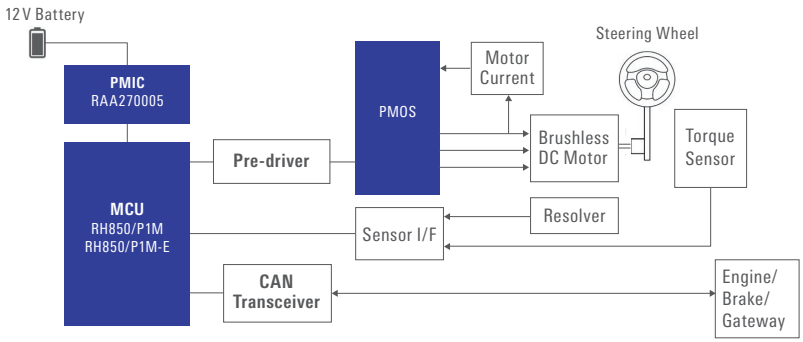
System Benefits

- The combination RH850/P1X and PMIC (RAA270005) can offer ideal solution for Electric Power Steering system
- PMIC is designed for RH850/P1X and a proven design can shorten R&D cost & period
- Optimized PMIC specification can reduce system BOM cost and its PCB space
- PMIC with various fault diagnosis and monitor functions can support ASIL-D system

Recommended Devices

RH850/P1M	32bit Microcontroller
RH850/P1M-E	32bit Microcontroller
RAA270005KFP	Power management IC
ANL2 Series	
NP180N04TUK	PMOS, 40V/180A, MP-25ZT/TO-263
NP110N04PUK	PMOS, 40V/110A, MP-25ZP/TO-263
NP109N04PUK	PMOS, 40V/110A, MP-25ZP/TO-263
NP100N04PUK	PMOS, 40V/100A, MP-25ZP/TO-263
NP89N04PUK	PMOS, 40V/90A, MP-25ZP/TO-263
NP89N04PDK	PMOS, 40V/90A, MP-25ZP/TO-263
NP90N04VUK	PMOS, 40V/90A, MP-3ZP/TO-252
NP90N04VDK	PMOS, 40V/90A, MP-3ZP/TO-252
NP90N04VLK	PMOS, 40V/90A, MP-3ZP/TO-252
ANL3 Series	
RBA160N04AHPF	PMOS, 40V/160A, MP-25ZU/TO-263-7P-SHL
RBA250N04AHPF	PMOS, 40V/250A, MP-25ZU/TO-263-7P-SHL

Block Diagram



Tire Pressure Monitoring System

https://www.renesas.com/application/automotive/chassis-safety/tire-pressure-monitoring-system

System Benefits

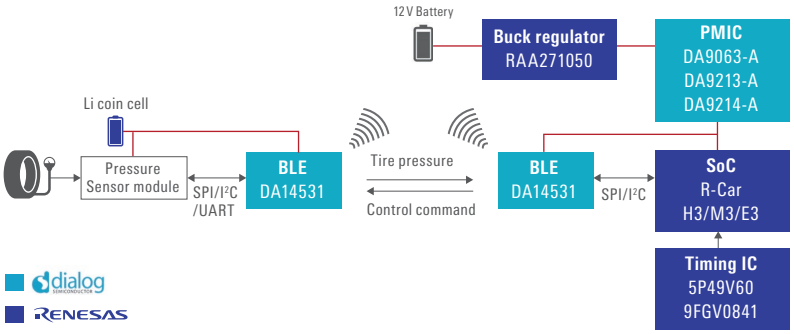
- Tire pressure monitoring system monitors air pressure and temperature, alerting drivers of improperly-inflated tires or other safety information in real time
- SmartBond TINY™, the world's smallest and lowest power Bluetooth low energy 5.1 SoC, brings down the cost of adding Bluetooth low energy in automotive system
- Addresses BOM cost reduction through a PCB pattern antenna and a highly integrated low power Bluetooth low energy SoC
- No dedicated receiver is necessary in the vehicle infotainment system
- A flexible system PMIC can supply a wide range of multicore SoCs and integrates full power rail management with multiple sleep modes for an optimized system solution
- Reduces R&D cost and development time using PMICs verified for R-Car SoCs
- Reference boards provide a quick and easy start to development

Recommended Devices

R-Car H3/M3/E3	SoC
RAA271050*1	Buck regulator
DA9063-A	Power management IC
DA9213-A	Multiphase 20A Sub-PMIC
DA9214-A	Multiphase 2x10A Sub-PMIC
DA14531*2	Bluetooth low energy SoC
5P49V60/9FGV0841	Clock generator

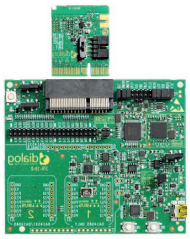
*1 Not on the reference board
*2 Industrial grade. Bluetooth low energy devices are AEC-Q100 qualification under planning.

Block Diagram

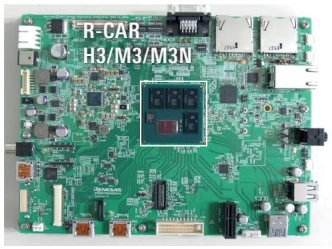


Reference Boards

DA14531 development kit



R-Car reference board Salvatore-XS



Automotive Monitoring Function Extension

https://www.renesas.com/application/automotive/automotive-monitoring-function-extension

System Benefits

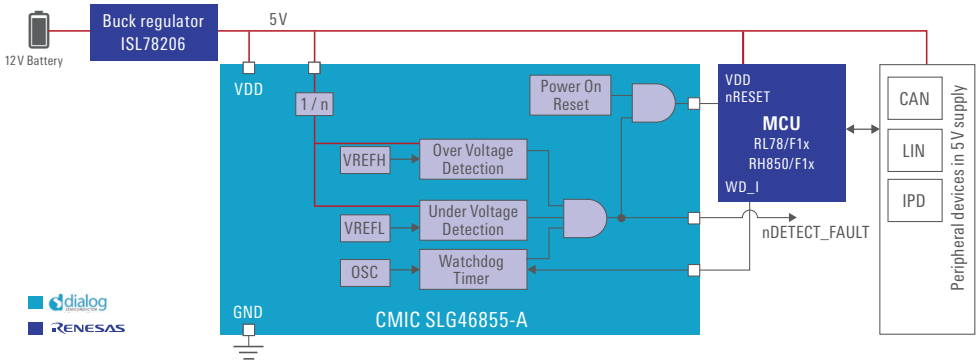
- 5V power supply is often used in automotive systems, and monitoring functions can be easily added by using CMIC.
- CMIC GreenPAK™ is a cost-effective NVM programmable device that allows automotive designers to integrate many system functions while minimizing component count, board space, into a single AEC-Q100 qualified IC
- Provides monitoring functions to low-cost & simple voltage regulator, including over/under voltage detection, watchdog timer and reset control during failure detection
- Enables retrofitting CMIC to existing designs
- With GreenPAK designer software/development kit, quickly respond to changing design requirements and increase productivity at the design and prototype verification stages

*1 CMIC: Configurable Mixed-signal IC

Recommended Devices

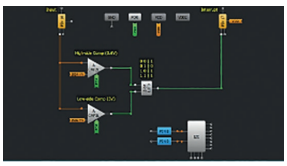
RL78 / F1x	16 Bit MCU
RH850 / F1x	32 Bit MCU
ISL78206	Buck regulator 2.5A
SLG46855-A	CMIC

Block Diagram

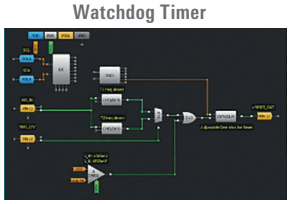


Used CMIC Components

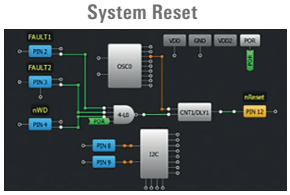
Window Comparator



Watchdog Timer



System Reset



MEMO

MEMO

Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You shall be responsible for determining what licenses are required from any third parties, and obtaining such licenses for the lawful import, export, manufacture, sales, utilization, distribution or other disposal of any products incorporating Renesas Electronics products, if required.
5. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
6. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.
   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.
   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.
   Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user's manual or other Renesas Electronics document.
7. No semiconductor product is absolutely secure. Notwithstanding any security measures or features that may be implemented in Renesas Electronics hardware or software products, Renesas Electronics shall have absolutely no liability arising out of any vulnerability or security breach, including but not limited to any unauthorized access to or use of a Renesas Electronics product or a system that uses a Renesas Electronics product. RENESAS ELECTRONICS DOES NOT WARRANT OR GUARANTEE THAT RENESAS ELECTRONICS PRODUCTS, OR ANY SYSTEMS CREATED USING RENESAS ELECTRONICS PRODUCTS WILL BE INVULNERABLE OR FREE FROM CORRUPTION, ATTACK, VIRUSES, INTERFERENCE, HACKING, DATA LOSS OR THEFT, OR OTHER SECURITY INTRUSION ("Vulnerability Issues"). RENESAS ELECTRONICS DISCLAIMS ANY AND ALL RESPONSIBILITY OR LIABILITY ARISING FROM OR RELATED TO ANY VULNERABILITY ISSUES. FURTHERMORE, TO THE EXTENT PERMITTED BY APPLICABLE LAW, RENESAS ELECTRONICS DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO THIS DOCUMENT AND ANY RELATED OR ACCOMPANYING SOFTWARE OR HARDWARE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE.
8. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
9. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
11. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
12. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
13. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
14. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.
(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.5.0-1 October 2020)

SALES OFFICES

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

Renesas Electronics Corporation
TOYOSU FORESIA, 3-2-24 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Renesas Electronics America Inc. Milpitas Campus
1001 Murphy Ranch Road, Milpitas, CA 95035, U.S.A.
Tel: +1-408-432-8888, Fax: +1-408-434-5351

Renesas Electronics America Inc. San Jose Campus
6024 Silver Creek Valley Road, San Jose, CA 95138, USA
Tel: +1-408-284-8200, Fax: +1-408-284-2775

Renesas Electronics Canada Limited
603 March Road, Ottawa, ON K2K 2M5, Canada
Tel: +1-613-595-6300, Fax: +1-613-595-6329

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
Room 101-T01, Floor 1, Building 7, Yard No. 7, 8th Street, Shangdi, Haidian District, Beijing 100085, China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai 200333, China
Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

Renesas Electronics Hong Kong Limited
Unit 3501-03, 35/F, One Kowloon, 1 Wang Yuen Street, Kowloon Bay, Hong Kong
Tel: +852-2265-6688, Fax: +852 2886-9022

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
80 Bendemeer Road, #06-02 Singapore 339949
Tel: +65-6213-0200, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.
Unit No 3A-1 Level 3A Tower 8 UOA Business Park, No 1 Jalan Pengaturcara U1/51A, Seksyen U1, 40150 Shah Alam, Selangor, Malaysia
Tel: +60-3-5022-1288, Fax: +60-3-5022-1290

Renesas Electronics India Pvt. Ltd.
Bagmane Tech Park, Municipal No. 66/1-4, Lakeview Block, Block B, Ground Floor, Krishnappa Garden, C V Raman Nagar, Bengaluru, Karnataka 560 093, India
Tel: +91-80-67208700

Renesas Electronics Korea Co., Ltd.
7F, Hae-seong 2nd building, 508, Teheran-ro, Gangnam-gu, Seoul, Korea 06178
Tel: +82-2-558-3737, Fax: +82-2-558-5338

Renesas Electronics Corporation

www.renesas.com

Document No. R30CA0181ED0200