STEERING THE FUTURE OF INNOVATION

Automotive Semiconductor Solutions for a safe and secure driving experience
BIG IDEAS FOR EVERY SPACE

Engineers in the world face significant challenges when working on innovations to shape a better future.

Innovations need ideas.
Renesas is at the core of the technological innovation. Customers trust in our quality, reliability and market leadership.
Our leading-edge embedded solutions allow customers to focus their resources on innovation.
When it comes to realizing ideas, we want the engineers to remember Renesas first. Because Renesas is the enabler of Big Ideas.

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THE WORLD LEADING EMBEDDED SOLUTION PROVIDER

WHO WE ARE

Renesas is a global semiconductor company delivering trusted embedded design innovation with complete semiconductor solutions that enable billions of connected, intelligent devices to enhance the way people work and live—securely and safely. A global leader in microcontrollers, analog, power, SoC products and integrated platforms, Renesas provides expertise, quality, and comprehensive solutions for a broad range of Automotive, Industrial, Home Electronics, Office Automation and Information Communication Technology applications to help shape a limitless future.

- Global leader in Microcontrollers, Analog, Power and SoC products
- Supports a broad range of Automotive, Industrial, Home Electronics, Office Automation, and Information Communication Technology applications
- 715.7 billion yen revenue in 2020
- 21,000 employees worldwide
- Headquartered in Tokyo, Japan with a strong global footprint

OUR HISTORY

Renesas is built on a strong historical foundation of technological innovation originating from Hitachi, Mitsubishi and NEC. Fueled by integrations with Intersil, IDT and Dialog, Renesas is now poised to extend its share in fast-growing data economy markets such as infrastructure and data center, and strengthen its presence in the industrial and automotive segments.

- NEC Electronics
  - Spin-off from NEC
- Renesas Electronics
  - Started operation
  - NEC Electronics and Renesas Technology merged
- Acquisition of Intersil
  - Expanded lineup of analog products
- Acquisition of Dialog
  - Expanded lineup of analog products
- Acquisition of IDT
  - Expanded lineup of analog products
- Investment by INCJ
- Renesas Technology
  - Spin-off from Hitachi and Mitsubishi merger
OUR MISSION IS TO MAKE CARS SAFER, MORE COMFORTABLE & ENVIRONMENTALLY FRIENDLY

RENESSAS & AUTOMOTIVE

The Renesas Automotive Solutions Business Unit addresses the specific requirements of the automotive industry. Thanks to the combination of leading-edge technologies and the company’s deep understanding of customer’s requirements, Renesas offers a wide range of innovative solutions. Embracing customer needs, i.e. zero accidents, zero stress, and zero emissions, we design our solutions to make cars safer, more comfortable and environmentally friendly.

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.

Automotive Competence

Renesas

... is a leading MCU/SoC supplier  
W/W shipments reached over 1,4b units in 2020

... offers advanced process technologies  
16nm FinFET for SoC and 28nm for MCU

... is best in quality  
Extremely low failure rate at 0.1ppm

... is dedicated to support on both local and global levels

... is a committed long-term partner

... is the preferred supplier to almost all system suppliers and car manufacturers

... provides of an Open Solution Platform accelerating time to market  
With our partners we offer a robust ecosystem increasing development efficiency
**CASE: CONNECTED - AUTOMATED - SAFE - ELECTRIFIED**

**WE FOLLOW THE MEGATRENDS THAT DRIVE THE CHANGE**

**CONNECTED CAR**
With Renesas’ solutions cars are connected safe & secure from vehicle to cloud.

**ADAS/AUTOMATED DRIVE**
Renesas offers solutions for sensing, analyzing and controlling for a safe, secure and comfortable driving experience.

**xEV**
Renesas’ robust, reliable and safe powertrain solutions help to manage efficient use of energy.

**GATEWAY/CAR SERVER**
Renesas support car makers’ vision to “drive” the evolution of the connected car towards a smartphone on wheels. We are committed to supporting a system chipset solution for Connected Gateway/Car server applications beyond just providing silicon.

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### Product Portfolio

#### Microcontrollers

<table>
<thead>
<tr>
<th><strong>Microcontrollers</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="RL78" /></td>
</tr>
<tr>
<td><strong>16-bit ultra low power MCU</strong></td>
</tr>
<tr>
<td>Sensing and motor control</td>
</tr>
<tr>
<td><img src="image2" alt="RH850" /></td>
</tr>
<tr>
<td><strong>32-bit high-performance MCU</strong></td>
</tr>
<tr>
<td>Rich functional safety and security features</td>
</tr>
</tbody>
</table>

#### System-on-Chip Solutions

<table>
<thead>
<tr>
<th><strong>System-on-Chip Solutions</strong></th>
</tr>
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<tbody>
<tr>
<td><img src="image3" alt="R-Car" /></td>
</tr>
<tr>
<td><strong>64-bit ARM-based high-end SoC</strong></td>
</tr>
<tr>
<td>High performance, low power consumption, graphics and machine learning accelerators</td>
</tr>
</tbody>
</table>

#### Analog & Power Products

- Bluetooth Low Energy (BLE)
- Haptics Driver
- LED Driver
- Clocks and Timing Solutions
- Sensor Solutions
- Power Management IC (PMIC)
- Battery Management IC (BMIC)
- Video Signal Processing (VSP)
- Wireless Power Charging IC
- Automotive HD Link (AHL)
- Gate Driver Unit (GDU)
- PowerMOSFETs
- IGBT
- Intelligent Power Devices (IPD)
To showcase how our complementary products work together to deliver comprehensive solutions, we’ve developed many “Winning Combinations”, compelling Renesas-plus-Intersil-plus-IDT-plus-Dialog product combinations that capture and highlight the technological advantages Renesas and the 3 acquired companies can provide as a combined company. Our complementary product portfolios of Analog + Power + Embedded Processing work together to deliver comprehensive solutions that help our customers accelerate their designs and get to market faster.

To learn more about our Winning Combinations, visit https://www.renesas.com/eu/en/solutions/automotive.html

**Automotive Battery Management System**

- Best BMS accuracy and long-term drift (LTD), which extend driving range and battery life performance, with superior accuracy of \(<\pm2\text{mV}\) and \(<\pm6\text{mV} \times \sigma \text{LTD}\)
- Lowest BOM cost and best FuSa/EMC/hot-plug solution, which alleviates R&D effort and is easy to use with Renesas’ RH850 MCU Family (with dedicated drivers and software for BMS)
- MCU line-up supporting functional safety features up to ASIL-D as well as required security
- Intelligent power device (IPD) 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
- ISL78714
- RV1S27520**
- uPD166031A-34**
- RAJ2800024/34/44**

**Optional Devices**

- RAA270005

**Reference Board**

![Block Diagram](image)

System Benefits

<table>
<thead>
<tr>
<th>Block Diagram</th>
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<tbody>
<tr>
<td>12V Battery</td>
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<tr>
<td>IPD</td>
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<td>IPD</td>
</tr>
<tr>
<td>IPD</td>
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<tr>
<td>IPD</td>
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<tr>
<td>MCU RH850/P1M</td>
</tr>
<tr>
<td>CAN</td>
</tr>
<tr>
<td>Lin</td>
</tr>
<tr>
<td>Ether</td>
</tr>
<tr>
<td>12V Battery</td>
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<tr>
<td>IPD</td>
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<td>IPD</td>
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<td>IPD</td>
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<td>IPD</td>
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<td>MCU RH850/P1M</td>
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<tr>
<td>CAN</td>
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<tr>
<td>Lin</td>
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<tr>
<td>Ether</td>
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</tbody>
</table>
**BLDC Motor Control Using Inductive Position Sensor**

**System Benefits**
- High precision motor control based on inductive position sensing technology.
- Effective torque control under all load conditions. Low noise and vibration. High precision during brake&hold functions.
- Cost effective – no additional magnet or sensor cost. Shielding is not required.
- Wide array of MCU line-up supporting functional safety features (FuSa) as well as security features (various ICU classes supported via integrated HW) and AUTOSAR (MCAL).

**Block Diagram**

![Block Diagram](image)

<table>
<thead>
<tr>
<th>BOM List</th>
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<tbody>
<tr>
<td>RH850/F1KM-S1</td>
</tr>
<tr>
<td>IPS2550</td>
</tr>
<tr>
<td>NP50N04YUK</td>
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<table>
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<tr>
<th>Starter Kit</th>
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</thead>
<tbody>
<tr>
<td>Y-BLDC-SK-RH850F1KM-S1-V2</td>
</tr>
</tbody>
</table>

The kit includes:
- Y-BLDC-SK-RH850F1KM-S1 Starter Kit with BLDC Motor
- IPS2550 Inductive Position Sensor
- NP50N04YUK Power MOSFET

**Low-Cost Digital Instrument Cluster Reference Design**

**System Benefits**
- Low Cost Digital Instrument Cluster reference design using MCU + VSP scaler
- Less software work to support multiple display resolutions with a single design
- Generate cluster graphics in one resolution with the RH850 MCU, then easily scale to different resolutions using the RAA278840 LCD controller
- Uses the RAA278840 LCD controller to upscale the graphics to 1920x720 to support an upgrade option to a 12.3-inch panel for premium trim vehicle models
- Utilizes the RAA278840 LCD controller for “fast boot” to display tell-tale lamps at ignition (<500ms to display OSD through the RAA278840), allowing the MCU software time to boot up properly
- Optimized power management ICs for the camera and ECU

**Block Diagram**

![Block Diagram](image)

<table>
<thead>
<tr>
<th>Recommended Devices</th>
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<tbody>
<tr>
<td>RH850/D1M1A</td>
</tr>
<tr>
<td>RAA278840</td>
</tr>
<tr>
<td>ISL78204</td>
</tr>
<tr>
<td>ISL78171</td>
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<tr>
<td>ISL78419</td>
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<table>
<thead>
<tr>
<th>Optional Devices</th>
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</thead>
<tbody>
<tr>
<td>ISL78206</td>
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<tr>
<td>ISL76683</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Reference Board</th>
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<tbody>
<tr>
<td><img src="image" alt="" /></td>
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</table>
Renesas provides cutting edge chip solutions for the quickly evolving and complex ADAS and Autonomous driving market. Our goal is to enable customers with high compute chips that are designed with focus on Functional Safety and Low Power consumption, two necessary requirements for in-vehicle deployment. Our highly scalable lineup allows flexibility to the customer to develop platform solutions with re-usable design and SW leading to lowered development costs and fast time to market.

To take all the HW benefice and to consider the HW constraint like Power, deterministic real-time SW, Renesas has developed an open and Integrated development environment based on enabling fast time-to-market for Computer Vision and Deep learning solutions. Easy to use debugging and tuning tools for heterogeneous multi-core hardware will enable efficient SW development while a comprehensive set of example applications and online help supporting self-education will enable a quick ramp-up to beginner. Qualified compilers and code generators for compliance with functional safety and cyber security requirements ensure Safe and secure SW development.
The integrated cockpit will evolve into a connected HMI by introducing new services through cloud connectivity in addition to the conventional cockpit. Renesas offers optimized, highly integrated cockpit solutions with safety, software portability, and performance scalability as key differentiators.

**R-Car Gen3e**

The R-Car Gen3e offers a scalable line-up for entry to mid-range automotive applications that require high-quality graphics rendering, such as integrated cockpit domain controllers, in-vehicle infotainment (IVI), digital instrument cluster, driver monitoring systems, and LED matrix light.

**R-Car Cockpit Trend**

<table>
<thead>
<tr>
<th></th>
<th>2019</th>
<th>2023</th>
<th>2027</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>With HV</strong></td>
<td><strong>Mid-High cockpit</strong></td>
<td><strong>R-Car M3e-2G/H3e-2G</strong></td>
<td><strong>R-Car Next</strong></td>
</tr>
<tr>
<td><strong>Entry-Mid cockpit</strong></td>
<td><strong>Cost saving &amp; Easy maintenance</strong></td>
<td><strong>R-Car E3e/M3Ne/M3e</strong></td>
<td><strong>R-Car Next</strong></td>
</tr>
</tbody>
</table>

- **Cluster app**
- **IVI app**
- **RTOS**
- **Open OS**
- **Hypervisor**
- **CA cores**
- **3D GPU**
- **Vout**

With HV

W/o HV
Digital transformation is accelerating. After changing from the "hardware fixed" world, incorporation of CI/CD on the premise of software download and agile development methods for automotive are required. Arbitration work with cloud computing is the key to design a in-vehicle computing architecture. In addition to conventional in-vehicle technology, the implementation of cloud technology into the vehicle and software DevOps become extremely important in automotive world as well as mobile phones.

**Renesas Connected Car Platform**

Renesas offers a cloud-native execution environment that utilizes virtualization technology to realize aka “Kubernetes for vehicles”, which includes the cloud-sync framework such as microservice deployment and container orchestration. It enables your engineers to focus on application development and system designing, even without embedded technology skills.
MEGATREND ARCHITECTURE TRANSFORMATION
CONNECTED GATEWAY / CAR SERVER

Introduction

Renesas supports car makers’ vision to “drive” the evolution of the conventional car towards a smartphone on wheels using our rich product portfolio. The challenges this vision creates are the exponential growth in data bandwidth together with the required service-oriented architecture (SOA). On top of that, advanced functional safety and security features are needed to enable secure data connection between the connected car and cloud services. This mega trend we address with our digital and analog chipset dedicated for Connected Gateway/Car Server applications - a smart chipset solution reducing ECU size and BOM cost.

Key Features R-Car S4 + PMIC + AutoClock™ Timing IC

The Renesas R-Car S4 SoC includes multiple ARM® Cortex® A55, Cortex R52 and is the first SoC offering a full RH850 MCU with multiple cores to control the domain and zone segment. R-Car S4 SoCs support a huge number of automotive interfaces such as 16x CAN FD, 16x LIN, 8x SENT, 1x FlexRay, 4x PCIe V4.0 and an integrated high-bandwidth 3 x 2.5Gbit Ethernet Switch TSN to enable rich communication and connectivity options both inside and outside of the vehicle. Multiple hardware security modules (HSM) provide enhanced security protection against cyber attacks. The entire chipset is being developed in compliance to ISO-26262 to be capable of supporting system safety requirements up to ASIL D.

Benefits

Renesas offer a complete and scalable chipset solution including a tailored PMIC and the new AutoClock™ timing IC and allows an optimized ratio of computing performance versus low power consumption.

By adopting this next generation R-Car S4 customers are able to re-use up to 80% of software code developed for 3rd generation (Gen3) R-Car SoCs and RH850 MCU applications – a clear benefit because it reduces overall project development time/ cost/ risk and allows a better time-to-market. The software package supports real-time cores with various drivers and basic software such as Linux BSP and hypervisors. In addition, a virtual platform (VPF) is available from a partner company, enabling early software development and evaluation.

Samples and evaluation boards are now available for selected customers.

<table>
<thead>
<tr>
<th>MCU Feature</th>
<th>Multi-protocol Gateway</th>
<th>Network Security</th>
<th>OTA Update</th>
<th>Application Server</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low power scheme: cyclic wake-up, deep standby mode</td>
<td>CAN / Ethernet routing, Gbit Ethernet, CAN-Ethernet conversion</td>
<td>Firewall, IPS, Message Authentication, Encryption</td>
<td>Update agent, OTA orchestration, Enhanced Security, FuSa</td>
<td>Domain integrated application, Hypervisor, Cloud-related service</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Communication Gateway R-Car S4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi Gigabit Ether</td>
</tr>
<tr>
<td>Ethernet Switch</td>
</tr>
<tr>
<td>CAN FD</td>
</tr>
<tr>
<td>CAN FD ASIL D</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Sensing</th>
<th>Cognitive</th>
<th>Cockpit</th>
</tr>
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<tbody>
<tr>
<td>Camera</td>
<td>Navigation</td>
<td>Cockpit</td>
</tr>
<tr>
<td>Radar</td>
<td>Meter</td>
<td></td>
</tr>
<tr>
<td>LiDAR</td>
<td>Rear Monitor</td>
<td></td>
</tr>
<tr>
<td>Sonar</td>
<td>Cockpit</td>
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<table>
<thead>
<tr>
<th>Timing IC</th>
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<tbody>
<tr>
<td>PMIC</td>
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<tr>
<td>Timing Input (10G)</td>
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</tbody>
</table>
Car body and convenience applications are ever evolving to increase the comfort of both drivers and passengers. Car makers need scalable solutions to have the flexibility to cover a wide range of car models and a broad range of options.

**Improved E/E Architecture**
- Enhanced Functional Safety
- Handle increasing amounts of data
- Energy efficient operation modes
- Over the air SW updates

Reneshas provides cost effective solutions for those challenges by offering scalable roadmaps.

Product range starts at actuator MCU with low pin count (20pin) and extreme low power operation to super high end Zone/Domain controller with 4 times 400MHz CPU operation in a 516BGA package.

Because of that you can find our MCU’s in nearly all Body applications like Zone/Domain ECU, BCM, Lighting, Car access, Wiper, HVAC, Seat, Door, Roof Modules to name only a few.

**Benefit of RENESAS RL78 MCU**
- Scalable line-up from 20pin to 144pin QFP and 16KB to 512KB Flash Memory
- Best-in-class power consumption, and high compute performance, are both possible at low frequency
- High Temperature support Ta=150°C
- Hard-&Software Compatibly within the line-up
- Built-in optimal high-precision / speed on-chip oscillator, power-on reset, etc.

**Benefit of RENESAS RH850 MCU**
- Scalable Line-ups from 48pin QFP to 516pin BGA and 1MB to 16MB FLASH memory
- Performance up to 7000 DMIPS real-time performance
- ASIL B/D Support
- Hard-&Software Compatibly across the line-ups
- Evita-Full/-Mid Security Standard
- Expanded Network I/F: Gbit ETH, 16xCAN-FD,…
- Hypervisor Support
- Full OTA Swap A/B
For chassis systems, the volume of information from sensors is increasing due to the need to coordinate with advanced driver assistance systems (ADAS). Thus, high-speed communication functions as well as high information processing capabilities are needed.

### Electric Power Steering

As part of efforts to make their vehicles more environmentally friendly, carmakers have increasingly been switching from hydraulic steering assist systems to electric power steering (EPS) using electric motors in order to reduce weight and boost fuel efficiency. In recent years, there has been a trend toward linking functions that assist the driver in operating the vehicle to the EPS system, for example by providing continuously variable steering gear ratio adjustment according to the running speed and steering angle, in addition to simple power steering functionality.

### Brake System

There are many types of brake systems, including ABS*, antiskid functions for maintaining vehicle stability, regenerative braking and brake control systems for hybrid and electric vehicles, and central vehicle control systems supporting interoperation with other systems such as the engine. As a result, there is demand for MCUs with a variety of functions and performance levels. As with steering systems, the very highest level of functional safety is essential.

*ABS: Anti-lock Brake System

### Benefits for chassis & safety application in Renesas Electronics

The demand for MCUs capable of supporting
- Dedicated motor control timer units
- High-performance CPU core with lock step
- High-precision A/D converters
- Interfaces for communicating with other control units.
- Variable safety mechanism for supporting ASIL-D*

*ASIL: Automotive Safety Integrity Level. ASIL-D is the highest Automotive Safety Integrity Level.*
The powertrain segment remains focused on further reduction of emissions and fuel consumption through optimization of traditional ICE engine control concepts.

Domain Controller is becoming a common approach to manage the overall driving strategy between ICE and Electric drive as well as the charging of the car. Renesas’ comprehensive product portfolio is committed to automotive quality and ready to cover a wide range of applications, including Diesel- or Gasoline direct /MPI injection, transmission control, powertrain DCU or powertrain Integration concepts:

- **RH850 MCU family** with dedicated products for ICE, including IP’s for combustion engine control like GTM, MSC and DS-ADC to reduce the CPU load significantly.
- A full line-up for analog powertrain components including gate driver, bridge driver, solenoid as well as tailor-sized power management ICs and discrete MOSFET components.
- Broad product portfolio for sensor ICs for manifold air pressure, High temperature sensing, differential pressure (particle filters), air mass flow, position and angle sensing.

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THE DRIVING FORCE OF EFFICIENCY

POWERTRAIN

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32bit Microcontroller ➞ RH850 E2x Series
- Multi-core, ~400MHz
- Integrated IPs for engine control Quality ➞ AECQ100
- Safety ➞ ASIL-D
- Security ➞ EVITA Medium

Sensor Signal Conditioners ➞ SSC family
- ZSSC31xx & ZSSC41xx
- LIN, PWM, SENT, analog & switch out
- Up to ASIL C support.

Power Supply PMIC ➞ RAA27xx family
- Fault diagnosis, ASIL

Inductive Position Sensors ➞ IPS2550
- Integrated H-Bridge for Throttle, ETC
- Solenoid & BLDC driver
- Gate pre-driver

Intelligent Power Devices ➞ RAJ28000x
- Single Channel High Side Switch
- Full Diagnosis & Protection

Power Stage ➞ ANL, ANM series
- 12v and 48v PMDS
- Discrete MOSFETs

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The electrification of the powertrain is mandatory to comply with emission regulation. In addition to mild and full hybrids vehicles, the share of pure electric cars is increasing. Renesas’ robust, reliable and safe powertrain solutions help to manage efficient use of energy for the applications mentioned above. Renesas offers many xEV inverter reference solutions:

- Practical inverter specification for xEV 100kW class motor
- Reference solution kit including Inverter reference design, software, model based design and calibration tool
- Function and performance verified on Renesas dynometer test bench
- 3.9L compact volume by highly integrated products and temperature management
- Superior power efficiency, Achieved 99% maximum inverter efficiency
- Function proven in real car demo

**BOM List for Reference Design**

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RH850/C1M-A2</td>
<td>32bit Microcontroller embedded</td>
</tr>
<tr>
<td>RAA270000</td>
<td>Power management IC</td>
</tr>
<tr>
<td>R2A25110</td>
<td>Gate driver IC</td>
</tr>
<tr>
<td>RJQ7031/RJU7032</td>
<td>IGBT and FRD</td>
</tr>
<tr>
<td>RV1S2752Q</td>
<td>Photo coupler</td>
</tr>
</tbody>
</table>

**Block Diagram and Reference Board**

- External I/F
- Photo coupler RH850/C1M-A2
- Microcontroller X6
- Gate driver IC
- IGBT
- Inductive Position Sensor
- Digital
- Analog Power
COMPREHENSIVE SOLUTIONS FOR AUTOMOTIVE
PRODUCT PORTFOLIO

Microcontroller

- 16-/32-bit MCUs (RL78 & RH850)
- Functional Safety
- Security
- AUTOSAR

System-on-Chip Solutions

- R-Car 64-bit SoC Family
- Software Support
- R-Car Consortium

Analog & Power Products

- Bluetooth Low Energy (BLE)
- Haptics Driver
- LED Driver
- Clocks and Timing Solutions
- Sensor Solutions
- Power Management IC (PMIC)
- Battery Management IC (BMIC)
- Video Signal Processing (VSP)
- Wireless Charging IC
- Automotive HD Link (AHL)
- Gate Driver Unit (GDU)
- PowerMOSFETs
- IGBT
- Intelligent Power Devices (IPD)
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 applications – meeting the high quality and high reliability standards of the automotive industry.

### FACILITATING FLEXIBILITY

**MICROCONTROLLER**

- 32-bit high-performance MCUs
  - All range application covered at Automotive
  - 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

- 16-bit ultra-low power MCUs
  - All Actuator/Sensor application 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
Together with our customers around the world, and as the holder of a premiere global share in the automotive semiconductor business, Renesas has been investigating state-of-the-art functional safety technologies. We have been participating in ISO Working Group for ISO 26262 and other standardization activities to lead the development of functional safety and security technologies globally. Leveraging our core competencies of the vast experience gained through these activities and our proven track record recognized by our many customers, we propose new system solutions that are optimized to our customers’ systems and that can easily satisfy functional safety requirements.

ISO26262 is the industry’s decisive functional safety standard for electrical and/or electronic systems in automotive. Although not legally binding, Renesas is fully committed to this standard, developing all RH850 MCUs and R-Car products according to ISO26262, thus achieving the required automotive safety integrity level: ASIL A, B, C, or even D.

Renesas functional safety products are well recognized by industry leading customers and partners providing well-thought-out and reliable Safety Element out of Context (SEooC) solutions satisfying a very broad range of applications like safety relevant Motor Control or advanced Automated Driving applications.


Customer centricity and time to market are the key success factors for Renesas, to make it easier for you to implement functional safety solutions, Renesas offers the “Safety Support Program for Automotive”. Among other things, the integrated package solution incorporates ISO26262 work products and – an advanced support package – a sophisticated FMEDA (Failure Modes, Effects and Diagnostic Analysis) tool named „CAR“ (Customizable Analysis Report, https://www.renesas.com/us/en/products/automotive/car-tool.html) and versatile software solutions like software test libraries which are developed according to ISO 26262.

The automotive industry is transforming due to the Connected, Autonomous, Shared, and Electrification (CASE) megatrends; over the past 5 years the importance of vehicle security has taken on a new meaning. Renesas is utilizing our expertise in advanced functional safety in building a robust security culture through industry participation and cybersecurity technology development. Renesas is a contributing member to several national and international security standards such as IEC62443, ISO/SAE 21434, and SAEJ3101. Renesas uses these as a foundation for the Renesas Security Design Lifecycle (SDL) to promote best practices throughout the product lifecycle. Concerning specific technology, Renesas has an important role as the provider of the Root of Trust within an ECU. Through our innovative portfolio of Hardware Security Modules (HSM), cryptographic accelerators, and security software, Renesas offers security solutions to meet customer requirements across product domains. Furthermore, Renesas strives to meet the State of the Art for advanced cybersecurity features such as cryptographic algorithms, side channel attacks mitigation and data latencies concerns; we are constantly monitoring the market to make sure our IP will meet or exceed the current industry demand while anticipating future cybersecurity needs through a holistic approach to our next generation SoCs and MCUs.
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.

**COMPUTING POWER MEETS VISION PERFORMANCE**

**R-CAR SYSTEM-ON-CHIP SOLUTIONS**

- 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

**Connected Gateway (In-Car and to the cloud)**

- R-Car S series

**R-Car Key Features**

- Cloud

**R-Car in The Future Car Architecture**

**R-Car Key Features**

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- 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 support of customer systems
- Contribution to BOM cost reduction
- Combination of CNN and image recognition engines realizes advanced computer vision processing
The R-Car Consortium brings together system integrators, middleware/application developers, and operating system and tools vendors who are developing solutions for the Connected Car & ADAS market. With highly reliable and technically advanced SoCs from Renesas, and end-to-end development support, customers can get optimal solutions for their requirements. Members of the Consortium receive evaluation boards and software to help co-develop advanced Connected Car & ADAS solutions.

R-Car Consortium: https://www.renesaspartners.com/
Renesas launched online Market Place, which offers a one-stop source of solutions that help accelerate technical innovation for the future mobility market. Developers can download various solutions designed for Renesas’ R-Car automotive system-on-chips (SoCs) directly from the Market Place. Developers can also use the Market Place as a portal to obtain reference evaluation software from R-Car Consortium Proactive Partners or contact Proactive Partner companies directly, allowing for timely support to match customer requirements. Through the Market Place, developers can quickly and easily access R-Car evaluation software, documentation such as hardware manuals, technical updates, application notes, and basic software such as Linux and Android board support packages (BSPs).

**Online Market Place for R-Car**

Renesas Shifts Mobility System Development Into High Gear With Its Online Market Place for R-Car SoC

**Proactive Partners**

**Proactive Partners 2021**

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**R-Car Solution Matching System**
AUTOSAR is a worldwide development partnership of car manufacturers, suppliers and other companies from the electronics, semiconductor and software industry targeting software architecture standardization of Electronic Control Units (ECUs).

Renesas, registered as Premium member of the AUTOSAR partnership, is deeply involved in standardization activities resulting in developing and releasing of MCAL (Microcontroller Abstraction Layer) software optimized for their RH850 and R-Car product series.

AUTOSAR BSW packages for Renesas MCU's and SoC's are available by major 3rd party cooperation partner.
NEW CAPABILITIES BY JOINING FORCES
ANALOG & POWER PRODUCTS

By joining forces, Renesas, Intersil, IDT and Dialog, have created the leading embedded solutions and analog mixed-signal products company, uniquely positioned to help customers succeed in developing innovative applications in the automotive segment. Our combined portfolio will contribute to accelerating your development and enabling differentiation, while bringing predictability to your application.

Analog & Power Product Line Up

Rich analog and power products to cover growing application fields

<table>
<thead>
<tr>
<th>Application Domains</th>
<th>ADAS</th>
<th>Cockpit</th>
<th>E/E Architecture</th>
<th>Powertrain</th>
<th>xEV</th>
<th>Chassis &amp; Body</th>
</tr>
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<tbody>
<tr>
<td>Power Management IC (PMIC)</td>
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<td>Configurable Mixed-Signal IC (CMIC)</td>
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<td>LED backlight driver</td>
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<td>Haptics driver</td>
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<tr>
<td>Video Signal Processor</td>
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<tr>
<td>Analog HD Link</td>
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<tr>
<td>Timing IC</td>
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<td>LiDAR</td>
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<td>Wireless Charging</td>
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<td>Connectivity (BLE)</td>
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<td>Sensor Conditioner</td>
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<td>Position Sensor</td>
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<td>Gate Driver</td>
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<td>IGBT</td>
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<td>MOSFET</td>
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</table>
NEW CAPABILITIES BY JOINING FORCES
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 synthesizer products, we deliver leading-edge system timing solutions to resolve timing challenges in virtually any application.

- Timing Features
  - Lowest phase noise and highest performance <500fs and PCIe Gen5 clock on 5P49V60A
  - Industry’s broadest and deepest portfolio
  - Proven expertise in both analog and digital timing
  - Advanced timing technology
  - Offer flexibility for diversified timing Requirement (Any frequency support on 5P49V60A)

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

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

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
NEW CAPABILITIES BY JOINING FORCES
ANALOG & POWER PRODUCTS

Power Management IC

Renesas power management IC’s are designed as the complimentary power solutions for Renesas MCU’s and SoC’s. Their optimized performance helps to reduce system BOM cost, PCB area and system design development time.

- **Features**
  - Ideal power solution for Renesas MCU and SoC (e.g. RH850/E1x/C1x/P1x, R-Car V3x)
  - Integrated fault diagnosis and monitor functions for ASIL applications

- **Benefits**
  - Optimized specifications help reduce system BOM cost and PCB area
  - Closely aligned MCU/SoC and PMIC Solutions offer optimized development times

**Application Example Connected to RH850/E1x/C1x**

Battery Management IC

Battery management IC’s have the best voltage measurement accuracy (<±2mV) and Long-Term Drift (<±6mV@6σ after 15 years on board). ASIL-D Battery Management System (BMS) Design Solution available in combination with RH850/P1M.

- **Features**
  - Class leading on-board accuracy
    * ±2mV ±3D post solder
  - ISO26262 ASIL-D
  - ±5V cell input measurement range
    * For Fuel Cells & Bus Bars
  - Low power, high security Daisy Chain
    * Capacitor or Transformer coupling
  - System level S/W Drivers/Support
    * ASIL-D Complex Device Drivers

- **Benefits**
  - BMS Reference Design with ISL7814 (BMIC) & RH850/P1M (MCU)
  - Available Complex S/W Drivers
  - Reduce R&D Effort
  - Lowest BOM Cost
  - Excellent Hot-Plug performance
  - Best Long-Term Drift measurement accuracy
  - Balance All Cells Simultaneously

**BMS Reference Design**

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 (<500ms)

- **Benefits**
  - Video Decoders provide superior video quality with low power consumption
  - LCD Controllers add versatility and reliability 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

**Video Decoders**

**LCD Display Controllers**
NEW CAPABILITIES BY JOINING FORCES
ANALOG & POWER PRODUCTS

**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 20W 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 30m 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

**Gate Driver Unit (GDU)**
GDU includes 2 kinds of ICs which are High-Voltage (HV) GDU for xEV inverter and 48V (48) GDU for Mild HEV.

- **Features**
  - (HV) Low Ron (1 ohm max.), IGBT gate driver with 2.5k Vrms isolation
  - (48) Optimized for 48 V MHEV and electric 2 or 3-wheeler motor inverter, up to 100V breakdown
  - (48) Non-isolated solution for 1-8 kW motor applications

- **Benefits**
  - (HV) Provides cost-effective solution (20% BOM Cost reduction expected)
  - (HV) Contributes to reduced engineering development workload
  - (48) Supports to comply to VDA320 and ISO21780 test standards
  - (48) Contributes BOM & PCB size reduction

Solution Example
Inverter reference design with 48V GDU-L

*In case of 3 phase*
NEW CAPABILITIES BY JOINING FORCES
ANALOG & POWER PRODUCTS

AUTOMOTIVE 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.

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<td>• Capable of measuring resistive bridge sensor signals</td>
<td>• Flexible adoption of the bridge sensor technology, offering offset compensation and high analog gain</td>
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<td>• Best-in-class signal processing technology delivering highly accurate and enhanced output signal</td>
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<td>• Ability to cover large sensor span &amp; high accuracy over the entire temp. range (-40°C to 150°C)</td>
<td>• Minimal EOL (end-of-line) production costs during mass production using digital calibration</td>
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<td>• Over-voltage and reverse polarity protection, robust EMC performance, and multiple diagnostic features</td>
<td>• Minimum amount of external components to design of sensor modules with best-in-class form factor</td>
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GreenPAK™ CONFIGURABLE MIXED-SIGNAL ICs (CMICs)

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

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BLUETOOTH LE (BLE)

Ultra low power, ultra compact Bluetooth LE IC for wireless sensor applications.

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NEW CAPABILITIES BY JOINING FORCES
ANALOG & POWER PRODUCTS

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

- 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

- 80% lower idle current than the competition
- AEC-Q100 Grade 2, 3x3mm WFQFN package

LED BACKLIGHT DRIVER
Advanced technology solutions enable local dimming, high-contrast, high-quality, large displays

- 16 channels
- Integrated current sink MOSFETs
- External current sense resistors for flexibility and accuracy in broad range of LED applications
- Comprehensive protection features

- 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
NEW CAPABILITIES BY JOINING FORCES
ANALOG & POWER PRODUCTS

Renesas offers an extensive lineup of power MOSFET products covering a wide range of voltage and current ratings as well as different package types to enable customers building various types of electric equipment to select the optimal device for their specific application. We also supply bare-die IGBT products that enable customers to achieve an ideal match with the modules they design as well as IPDs (intelligent power devices).

**Power MOSFETs**

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

<table>
<thead>
<tr>
<th>Features</th>
<th>Benefits</th>
<th>Low Ron package Tape &amp; Reel</th>
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<tbody>
<tr>
<td>• WW Top class Low Ron with Super junction structure</td>
<td>• High efficiency based on excellent Ron and switching performance</td>
<td>TO-263-7 for Bare Die</td>
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<tr>
<td>• Extensive lineup for 12V / 48V battery application</td>
<td>• Down-sizing by selecting optimized package from product line-up and bare die support options</td>
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<tr>
<td>• Excellent quality</td>
<td>• Robust design with high withstanding capability and sensing option</td>
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<tr>
<td>• Customized Bare Die support for pad layout &amp; shipment form</td>
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</table>

**IGBT**

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

<table>
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<tr>
<th>Features</th>
<th>Benefits</th>
<th>Thin Wafer Technology</th>
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</thead>
<tbody>
<tr>
<td>• High performance &amp; high quality IGBT bare die for HEV/PHV/EV</td>
<td>• High efficiency and low heat generation based on low power consumption</td>
<td>IGBT &amp; FRD Pair products</td>
</tr>
<tr>
<td>• WW Top level performance achieved with low Vce (sat) and faster switching</td>
<td>• Enable to adopt various mounting method with top metal options</td>
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<tr>
<td>• Voltage rating variations from 650V to 1200V</td>
<td>• High quality based on various testing options and qualification test</td>
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<td>• Current and Temp sensing (optional)</td>
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**Intelligent Power Device (IPD)**

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

<table>
<thead>
<tr>
<th>Features</th>
<th>Benefits</th>
<th>Solution Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Proven MOSFET and Control-Chip Technology in a single package</td>
<td>• Mechanical relay replacement offering better lifetime, size, weight and functionality</td>
<td>IPD outputs power supply and protects itself &amp; loads</td>
</tr>
<tr>
<td>• Low ON-Resistance and wide SOA</td>
<td>• Switching of high currents of more than 30A</td>
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<tr>
<td>• Self-protection against short circuit, overcurrent and overtemperature</td>
<td>• Easy control by MCU with reduced power consumption</td>
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<tr>
<td>• Self-diagnostic and monitoring functions</td>
<td>• Contributing to high system reliability by integrated smart protections</td>
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<tr>
<td>• High max operating temperature</td>
<td>• Efficient drive of resistive, inductive or capacitive loads</td>
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<tr>
<td>• AEC-Q100 qualified and RoHS compliant</td>
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