

STEERING THE FUTURE OF INNOVATION

Renesas and IDT join forces to contribute to the industrial, infrastructure, and automotive markets where high data processing performance is crucial

RENESAS AND IDT STEERING THE FUTURE OF INNOVATION TOGETHER



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Renesas and IDT are steering the future of innovation together. By joining forces, these leaders in embedded solutions and analog mixed-signal products will help customers succeed in developing fast-growing applications in the industrial, infrastructure, and automotive segments. Their combined portfolios will contribute to markets where high data-processing performance is crucial.

Renesas Portfolio

- Microcontrollers (MCUs) & Microprocessors (MPUs)
- Automotive MCUs & MPUs
- Automotive Systems-on-Chip (SoC)
- Automotive Power Management
- Automotive Battery Management
- Automotive Video & Display
- Embedded System Platforms
- Analog ICs
- Power Management ICs
- Space & Harsh Environment ICs

IDT Portfolio

- Clocks & Timing
- Memory & Logic
- Interface & Connectivity
- Power Management
- RF Products
- Sensor Products
- Wireless Power

Not all products in this brochure are available through distribution.
Please contact your local distributor to confirm availability.

RENESAS AND IDT WINNING COMBINATIONS

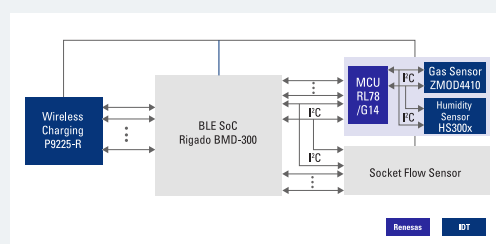
To immediately showcase how Renesas and IDT's complementary product portfolios work together to deliver comprehensive solutions, Renesas and IDT developed more than a dozen "Winning Combinations," compelling Renesas-plus-IDT product combinations that capture and highlight the technological advantages Renesas and IDT provide as a combined company.

Examples of Winning Combinations include IDT automotive timing plus Renesas R-Car processor solutions for automotive infotainment applications, an IDT gas sensor plus Renesas MCU for IoT building automation air quality control and other Winning Combinations for base station, wireline and server applications.

To learn more about the Renesas and IDT Winning Combinations, visit www.renesas.com/solutions/idt.html

INDUSTRIAL IOT

Air Quality Control for IoT Building Automation



Recommended Products

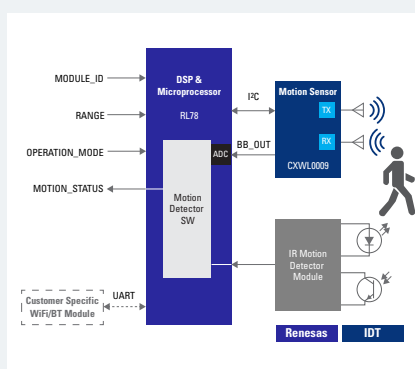
| | | |
|-----------------|---------------|--|
| MCU | RL78/G14 | Low Power, High Performance General-purpose MCUs |
| Gas Sensor | ZMOD4410 | Indoor Air Quality Sensor Platform |
| Humidity Sensor | HS300x Family | Relative Humidity Sensor ICs |
| Wireless Power | P9225-R | Dual Mode Wireless Power Receiver |

More Industrial IoT winning combo block diagram:

- CPAP Flow Sensor
- Flow Sensor for Industrial Applications
- HVAC Air Quality Sensor
- HVAC Humidity Sensor
- Industrial Sensing with IO-Link Interface
- Pulse Oximeter for Fitness and Medical Applications

INFRASTRUCTURE

Ultra-wideband Motion Detector



Recommended Products

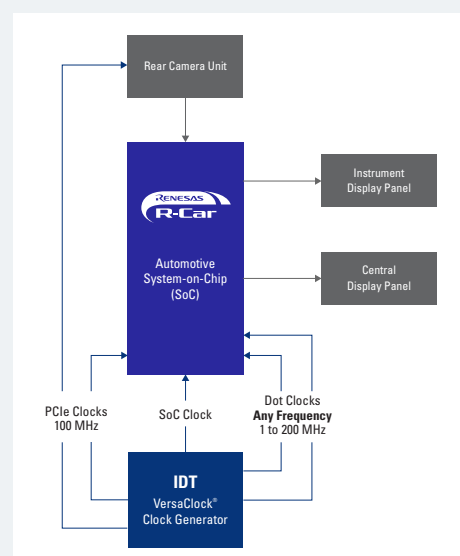
| | | |
|-------------------|-------------|-----------------------------------|
| MCU | RL78 Family | 16-bit Ultra-low Power MCUs |
| UWB Motion Sensor | CXWL009 | Ultra-wideband Motion Detector IC |

More Infrastructure winning combo block diagram:

- Cellular Base Station
- Enterprise Server
- Optical Interconnect for Computing and Communications
- Wireline Infrastructure Computing

AUTOMOTIVE

Automotive Infotainment and Dashboard



Recommended Products

| | | |
|-----------------|--------------|---|
| SoC | R-Car Family | R-Car H3/M3/E3 |
| Clock Generator | 5P49V60 | VersaClock® 6E Programmable Clock Generator |

More Automotive winning combo block diagram:

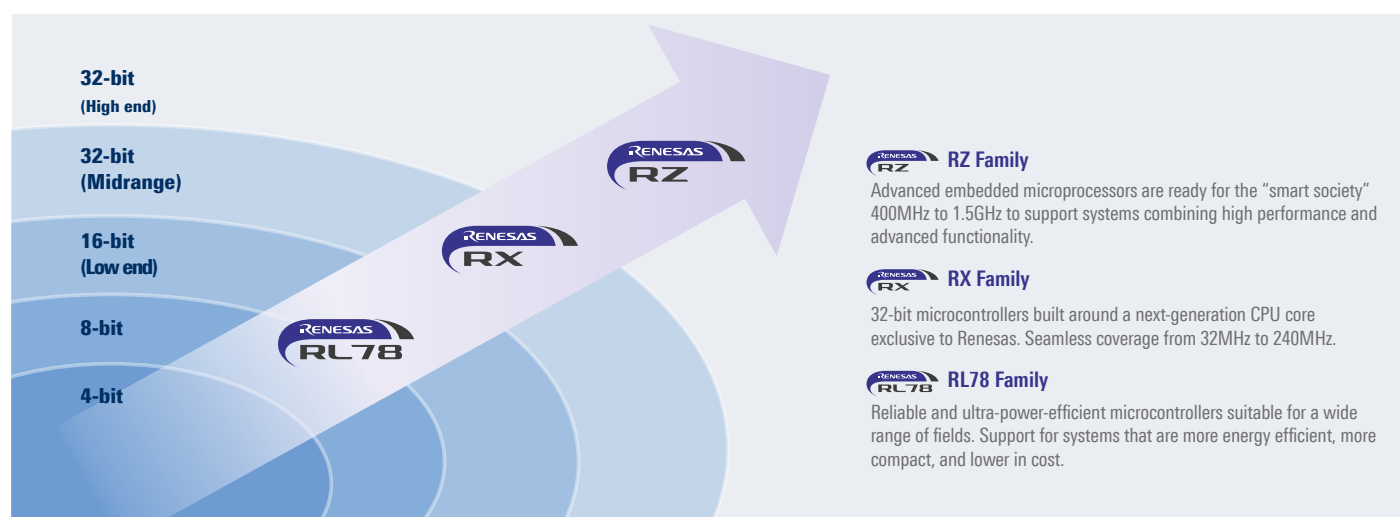
- 48V BLDC Motor
- Gasoline Direct Injection Engine System
- Gasoline Engine System

BEST AND MOST POWERFUL SOLUTIONS MCUs AND MPUs

In response to user requirements that are rapidly expanding in scope, Renesas offers microcontroller (MCU) and microprocessor (MPU) 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 and MPUs 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, they are used in a wide array of applications, including demanding fields requiring high quality and high reliability such as the automotive industry.



| Family | | RL78 | RX | RZ |
|---------------------|---|--------------------------|--|-------------------------------------|
| Features | | Ultra-low power, Low-pin | High power efficiency, High capacity ROM | High performance, High capacity RAM |
| CPU Core | | RL78 core (16-bit) | RX core (32-bit) | Arm® core (32/64-bit) |
| Processing Capacity | | Max 32MHz | Max 240MHz | Max 1.5GHz/8 cores |
| Flash Memory | | Built-in | Built-in | External |
| Main Function | e-AI | - | ● | ● |
| | HMI | - | ● | ● |
| | Capacitive Touch | - | ● | - |
| | Motor Control | ● | ● | ● |
| | LCD Display Function | ● | ● | ● |
| | Network | - | ● | ● |
| | Security | ● | ● | ● |
| | Bluetooth® Low Energy Sub-GHz Band Wireless Communication | ● | ● | - |

RZ FAMILY ARM®-BASED HIGH-END MPUs



The Renesas RZ Family of high-end 32 and 64-bit Arm-based MPUs enables the solutions required for the smart society of the future. Through a variety of Arm® Cortex®-A7, A9, A15, A53, A57, and R4-based devices, engineers can easily implement high-resolution human machine interfaces (HMI), embedded vision, embedded artificial intelligence (e-AI), real-time control, and industrial ethernet connectivity.

Human Machine Interface (HMI)

RZ/A Series

RZ/A Series MPUs for Display Systems and Human Machine Interface

KEY FEATURES

RZ/A Series MPUs combine the ease-of-use of Renesas microcontrollers (MCUs) with advanced microprocessor features

- 32-bit Arm Cortex processors
- Up to 10 MB of on-chip SRAM
- Buffer up to WXGA resolution without external RAM

The RZ/A2M devices feature Renesas' proprietary Dynamically Reconfigurable Processor (DRP) technology for up to 10 times faster image processing for computer vision and were winners of Electronic Products' 2018 Product of the Year Award.



RZ/G Series

RZ/G Series MPUs for 3D Graphics and Full-HD Video Display

KEY FEATURES

RZ/G Series MPUs extend the capabilities of RZ/A MPUs to deliver high-end performance for graphics, multi-stream video, and embedded vision

- 32-bit and 64-bit Arm Cortex A-Series cores
- MIPI camera input
- 3D graphics accelerators
- Up to 4K UHD video codecs
- High-Reliability internal and external ECC memory
- Full suite of memory and I/O interfaces
- Free RZ/G Linux Platform tools reduce design cost
- Super-Long Term Support Linux kernel from CIP



Industrial Network & Real-time Control

RZ/T Series

RZ/T Series MPUs for Real-Time Control

KEY FEATURES

- High-performance, high-speed real time control
- R-IN engine industrial Ethernet communications accelerator
- Integrated peripheral functions



RZ/N Series

RZ/N Series MPUs for Industrial Networking

KEY FEATURES

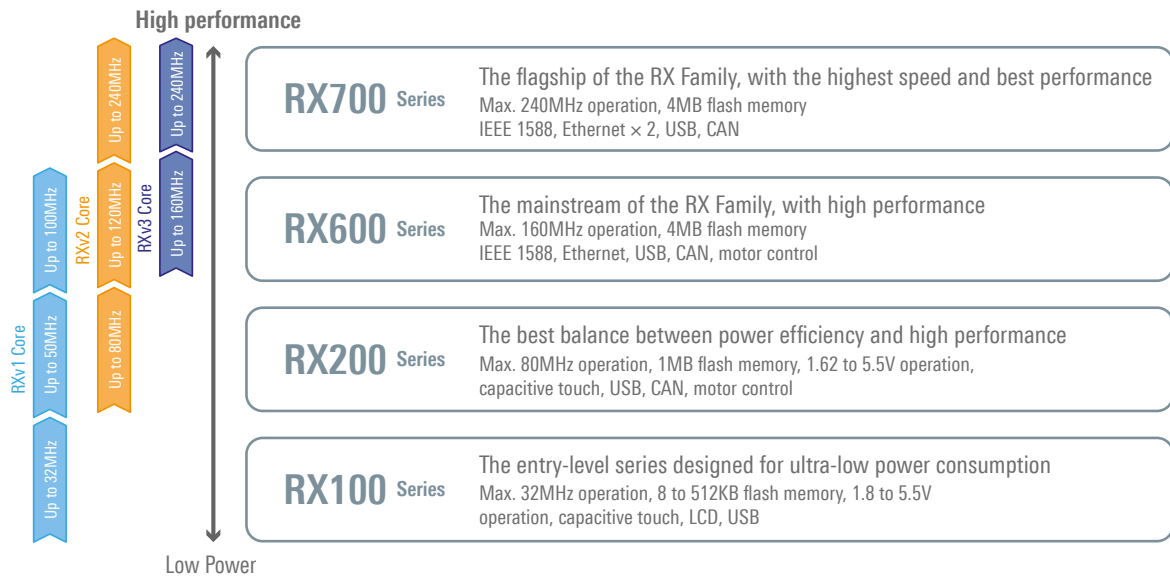
- Optimized MCUs for a variety of industrial networking applications
- R-IN engine enables implementation of major industrial Ethernet protocols (slave)
- Redundant network configuration reduces network downtime to zero



32-BIT HIGH POWER EFFICIENCY MCUs (RX)



The RX Family is the new generation of MCUs built around the revolutionary RX core, which combines the strengths of RISC and CISC architectures. Products in the RX Family feature integrated digital signal processor (DSP) and floating point arithmetic processor modules. The RX700 and RX600 Series are optimized for high speed and superior performance. The ultra-low-power RX200 and RX100 Series are designed to deliver excellent power efficiency.



To learn more, visit: www.renesas.com/RX

16-BIT ULTRA-LOW ENERGY MCUs (RL78)



Ultra Low Power Microcontroller Family

The RL78 Family of MCUs combines advanced low-power technology, outstanding performance, and the broadest lineup in its class for the most demanding 8- and 16-bit embedded applications.

The RL78 MCUs' innovative "Snooze" mode achieves ultra-low power by allowing ADC operation and serial communication while the CPU is turned off. This makes the RL78 MCUs best-in-class for low-power applications.

To learn more, visit: www.renesas.com/RL78

| Group | Features | Pin Count | Flash (KB) |
|-----------------|--|-----------|------------|
| RL78/G10 | The low pin count group for sub-system control | 10 - 16 | 1 - 4 |
| RL78/G12 | The entry-level group for compact system design | 20 - 30 | 2 - 16 |
| RL78/G13 | The mainstream of the RL78 Family, with board lineup featuring various on-chip functions | 20 - 128 | 16 - 512 |
| RL78/G14 | The high performance group, integrating motor control timer and comparators | 30 - 100 | 16 - 512 |
| RL78/L13 | The low power segment LCD group. Max 47 segments x 8 commons. | 64 - 80 | 16 - 128 |

A COMPLETE PLATFORM FOR IOT RENESAS SYNERGY™

The Renesas Synergy™ Platform integrates a scalable family of microcontrollers with a commercial-grade real-time operating system and middleware, and provides application frameworks that expose scalable Application Programming Interfaces (APIs). All the elements of the Synergy Platform are designed from the ground up as a single platform to provide unprecedented scalability and compatibility, not just across hardware, but also across software, allowing unparalleled design reuse.

Standardized API

- Abstracts dependencies, ensures portability, and accelerates product development
- Provides easy access to the SSP and Software Add-ons

Powerful Software

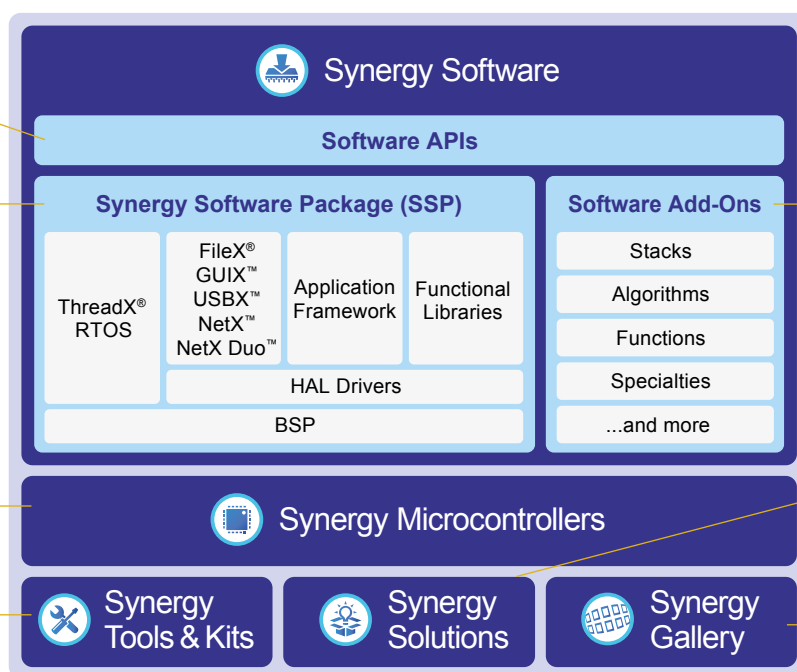
- Consists of widely-deployed, commercial-grade ThreadX® RTOS, extensive Middleware, Application Frameworks, Functional Libraries, and Hardware Abstraction Layer (HAL) Drivers

Versatile Microcontrollers

- Comprised of low-power Cortex® M0+ MCUs to high-performance Cortex M4-based chips
- Up to 4 MB of flash and cryptographic algorithms in hardware

Rich Tools & Kits

- Includes industry-leading IDE, debug and design tools: IAR Embedded Workbench® for Renesas Synergy™, C-RUN®, C-STAT®, GUIX™ Studio and TraceX®
- Development Kits to jump-start evaluation



Software Add-Ons

- Verified Software Add-ons (VSAs) add specialty functions from third-party experts; certified by Renesas to be SSP compatible
- Partner projects, application projects & module guides

Full Solution

- Application Examples (AEs) to highlight key technologies enabled by the Synergy Platform
- Product Examples (PEs) provide design instances of actual end products for a great start

Single-Source Delivery

- Implements the online destination for everything related to Synergy Software
- Go to production with simple click-through licensing
- Unlimited production licenses for SSP and tools available for no additional cost



ACCELERATE DEVELOPMENT

Let us take care of everything below the API so you can focus on differentiating your product.



REDUCE TOTAL COST OF OWNERSHIP

Lower your costs from start to finish – technology, development, and maintenance are all included.



ELIMINATE BARRIERS TO ENTRY

Innovate without facing obstacles of upfront costs, complicated licensing, or starting from square one.

To learn more, visit: renesas.com/synergy

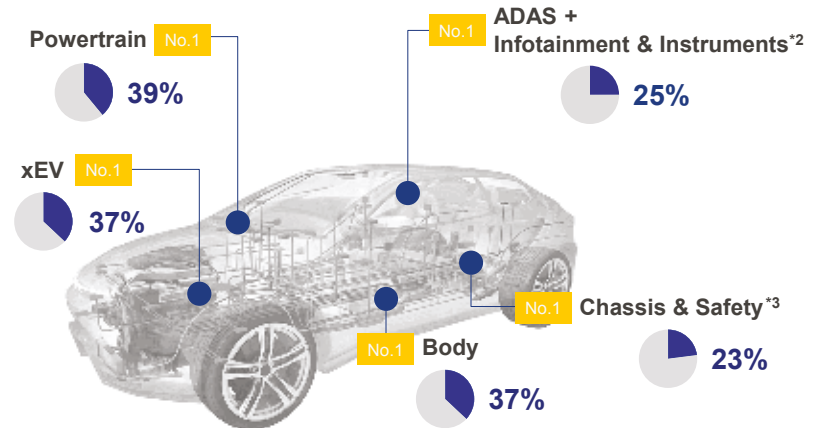
FOR A SAFE AND SECURE DRIVING EXPERIENCE AUTOMOTIVE SOLUTIONS

As the number one supplier of vehicle control microcontrollers and SoC products for the automotive industry, we are focused on helping our customers realize their vision for the future of the automobile. With billions of SoCs and MCUs supplied to our global customers, Renesas is also a proven partner, true to our policy of "Quality First." Our technologies address the latest trends in fuel economy, engine efficiency, driver-assist systems, body control, infotainment, connectivity, security, and reliability.

To learn more, visit:

www.renesas.com/automotive

MARKET SHARE IN AUTOMOTIVE MCU/SoC (CY17)*1

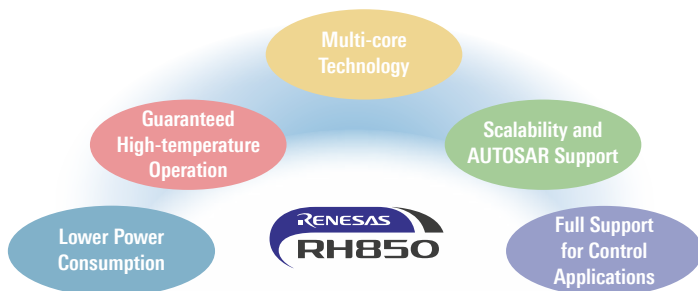


*1: Renesas' revenue estimate in each segment is based on the market analyses by Strategy Analytics 2018. / *2: Including infotainment and instrument according to the definition of Strategy Analytics. / *3: Excluding ADAS. / MCU: Microcontrollers / SoC: System-on-a-chip

AUTOMOTIVE 28nm MCUs (RH850)



The RH850 is Renesas Electronics' latest automotive MCU family that offers high performance balanced with very low power consumption over a wide and scalable range of products. This family offers rich functional safety and embedded security features needed for new and advanced automotive applications.



To learn more, visit: www.renesas.com/RH850

AUTOMOTIVE SoC "R-CAR"



Renesas' system-on-chip (SoC) family, R-Car, designed for car information systems, ADAS and AD (autonomous drive).

R-Car's scalable hardware and flexible software cover the full product range, from the premium class to the entry level. Plug-ins are available for multiple open-source software tools.

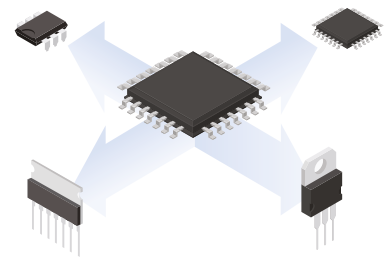


To learn more, visit: www.renesas.com/r-car

NEXT-GENERATION POWER MANAGEMENT AND PRECISION ANALOG PRODUCTS

COMPLETE SYSTEM SOLUTIONS AT YOUR FINGERTIPS

In today's fast-paced technology environment, designers need to be innovative without compromising time to market. Thinking at the system level is crucial to being able to address design challenges upfront. By offering quality solutions for the two most critical parts of your design, processors and power, Renesas accelerates your development and enables differentiation, while bringing predictability to your application. Whatever your product field – automotive, industrial, home electronics, office automation, or information communication technology – Renesas is the partner you can rely on from design to production.



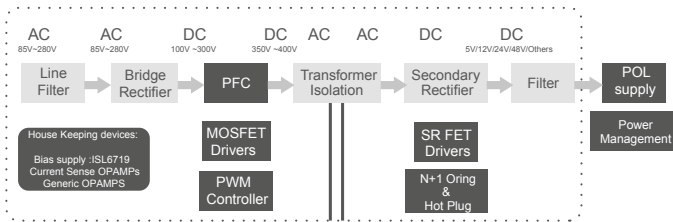
A top-to-bottom, front-to-back product offering will help speed design and bring quality, compatibility, and predictability to your applications.

POWER MANAGEMENT AND PRECISION ANALOG PRODUCTS

| Power Management | Amplifiers & Buffers | Audio & Video | Data Converters | Switches & Multiplexers | Optoelectronics | Timing & Digital |
|--|--|---|--|---|---|---|
| <ul style="list-style-type: none">• Discrete DC/DC Converters• Battery Management Systems (BMS)• Computing Power VRM/IMVP• Digital Power• Display Power and Backlighting• Hot Swap & ORing• Isolated Power Supply• LED Drivers• LNB Regulators• Low Dropout Regulator ICs• MOSFET Drivers• PMIC• Power Modules | <ul style="list-style-type: none">• Buffers• Comparators• Current Sense• Differential Amplifiers• Display Amplifiers and Buffers• Gain Blocks• High-Speed Op Amps• Instrumentation Amplifiers• Line Drivers• Precision Op Amps• Sample and Hold Amplifiers• Transistor Arrays | <ul style="list-style-type: none">• Switches• Automotive Infotainment & Security Surveillance• Buffered Video MUXs• Audio Processor• DVI/HDMI• Display ICs• HD Video Analog Front End (AFEs)• Surveillance ICs• Video Decoders/Encoders• Video ICs | <ul style="list-style-type: none">• D/A Converters• Digital Potentiometers (DCPs)• High-Speed A/D Converters• Precision A/D Converters• Voltage References | <ul style="list-style-type: none">• High Voltage• Low Voltage• Medium Voltage• USB<ul style="list-style-type: none">– High-Speed– High-Speed plus 2ch Stereo Audio– High-Speed UART Dual 3-1 MUX | <ul style="list-style-type: none">• Ambient Light Sensors• Ambient Light and Proximity Sensors• Laser Diode Drivers (LDD)• Proximity Sensors | <ul style="list-style-type: none">• Clock Generators• Counters/Time Base ICs• DSP• Memory• Microprocessors and Peripherals• Real Time Clocks |
| | | | | | <div>Interface</div> <ul style="list-style-type: none">• RS-485 & RS-422• RS-232• 2-Wire Bus Buffers• Signal Integrity | <div>Space & Harsh Environment</div> <ul style="list-style-type: none">• Radiation Hardened• Defense & Hi-Reliability |

INDUSTRIAL POWER MANAGEMENT SOLUTIONS

Renesas offers a complete portfolio of high-performance power solutions for processor, controller, DSP, FPGA, CPLD, DDR memory, or other load in your system. Whether you need standard linear regulators, highly flexible PWM controllers, or fully integrated plug-and-play power modules, these products are tailored to meet your design challenges.



LDOs

- Fast transient response
- Best-in-class $\pm 0.5\%$ initial accuracy and $\pm 1.8\%$ total DC accuracy over full temp range
- Very low dropout (81mV @ 2A typ)
- Best-in-class package power density (Up to 3A per 9mm²)

Switching Regulators

- Complete portfolio
- Robust and reliable
- High integration

Analog Controllers

- Remote sense, Power-Good, Enable, adjustable soft-start
- Extensive protection (OCP, OVP, OTP, SCP)
- Reference tracking, voltage margining
- Pre-biased startup, external compensation
- External frequency synchronization

FPGA Power Solutions

- Xilinx
- Intel (formerly Altera)
- Microsemi
- Lattice

Learn more about Renesas power management ICs, visit: renesas.com/products/power-management

INTERSIL SPACE PRODUCTS

Highly reliable, efficient and accurate radiation-hardened power and analog ICs for space applications and other radiation environments.

SEVEN DECADES OF FLIGHT EXPERIENCE

Intersil's (now Renesas) history and experience in the space and defense industries spans almost seven decades beginning with the founding of Radiation, Inc. in 1950. Today, we continue to support and release new SMD-based, Class-V/Q radiation hardened (rad hard) products for the Hi-Reliability and Space marketplaces.

The low dose rate total ionizing dose response of semiconductors has become a key issue in space applications. We are addressing this changed market through wafer-by-wafer low dose rate acceptance testing as a complement to current high dose rate acceptance testing.

All of our SMD products are MIL-PRF-38535/QML compliant and are 100% burned in.

Learn more about Intersil Space ICs, visit: renesas.com/products/space-harsh-environment





RF PRODUCTS

IDT's RF products are best-in-class in dealing with unwanted interference from an increasingly crowded radio spectrum. Today's higher data rates drive the need for better radio signal-to-noise ratios, which translates to the need for IDT's higher linearity RF components. IDT's unique patented RF solutions enable green networks with minimal power consumption and will serve as a company growth driver for years to come.

RF solutions from IDT address the evolving needs of a wide range of applications, including cellular 4G and 5G base stations, Active Antenna Systems for both sub-6 GHz and mmWave frequencies, and SATCOM phased array antennas.

IDT's innovative silicon-based products utilize CMOS, SOI, and SiGe processes. To continue advancing our portfolio, IDT adds in III-V technologies to enable further improvements in device performance, as needed, for next-generation designs.

With a combination of technologies and advanced IP, IDT delivers unique solutions to the design challenges faced by designers.



| Product Categories | Features | Applications | |
|---|---|---|---|
| <ul style="list-style-type: none">■ Integrated Receive RF Front-ends■ Transmit Chains■ mmWave Beamformers■ Digital step attenuators (DSA)■ Variable voltage attenuators (VVA)■ RF switches■ Broadband mixers■ Variable gain amplifiers (VGA)■ Amplifiers■ Broadband modulators■ DPD Demodulators with integrated DSA, RF switch and LO switch | <ul style="list-style-type: none">■ Highly differentiated RF products■ Smart Silicon enables unique technical innovations<ul style="list-style-type: none">- Low noise- High linearity- Low power- Small form factors■ Scalable RF Solutions for increased integration | Wireless Infrastructure <ul style="list-style-type: none">■ 4G / 5G macro base stations■ Active antenna systems (AAS)■ 5G mmWave■ Distributed antenna systems (DAS)■ Repeaters■ Microwave (RF/IF) point to point SATCOM <ul style="list-style-type: none">■ Phased Array Antenna | Industrial <ul style="list-style-type: none">■ Military/tactical communication systems■ FMCW Radar■ Public Safety■ Test and Measurement Broadband CATV <ul style="list-style-type: none">■ Headend (CMTS)■ Distribution nodes■ Fiber repeaters■ Cable modem, set-top box■ Satellite receivers and modems |

To request samples, download documentation, or learn more, visit: [idt.com/rf](https://www.idt.com/rf)



SENSING TECHNOLOGIES AND SENSOR SOLUTIONS

With more than 20 years of industry experience, IDT 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, IDT will create unique and differentiated sensor solutions.

SENSORSHARE™ TECHNOLOGY

Connects IDT's array of environmental sensor solutions designed to measure, monitor, and sense smart devices and industrial end applications

BREADTH OF EXPERIENCE

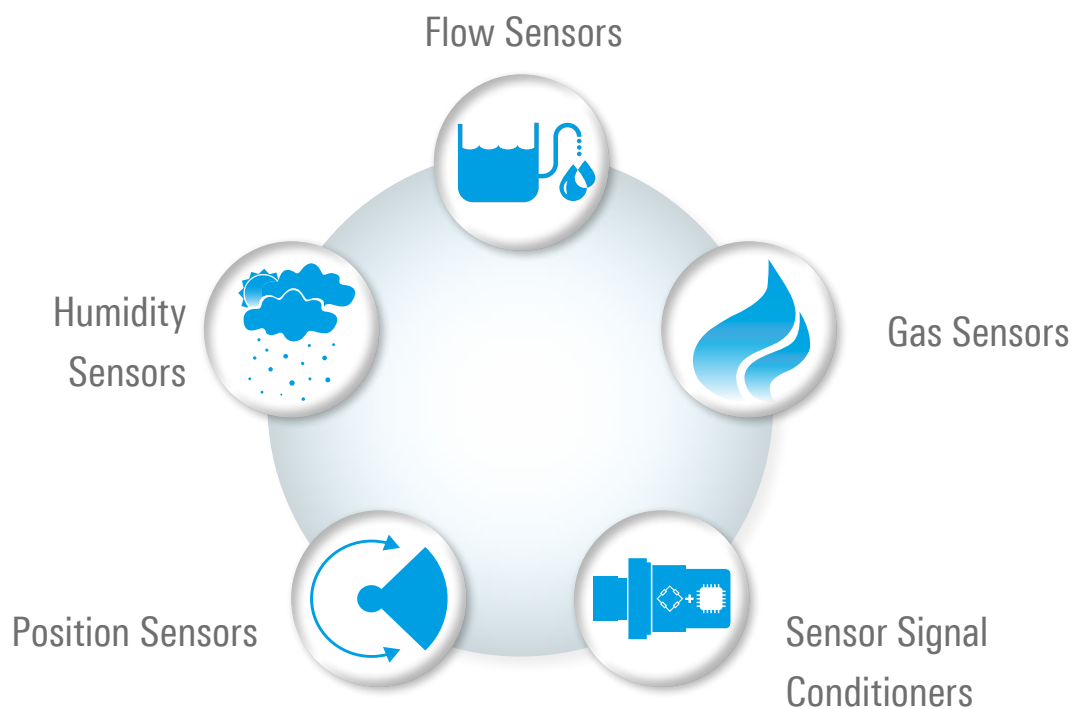
Bringing decades of knowledge, know-how, and data from our technologies today into our solutions of the future

TRUSTED, RELIABLE PARTNER

A proven supplier who has shipped millions of parts into major consumer and automotive manufacturers

BEST-IN-CLASS PERFORMANCE

Featuring low-power, high-accuracy solutions meeting ISO 26262, Automotive EMC, and reliability requirements



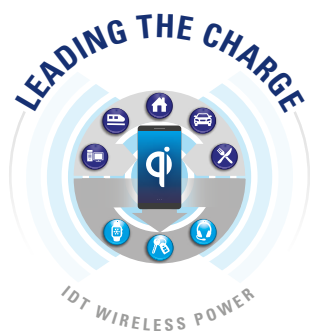
To request samples, download documentation, or learn more, visit: idt.com/sensors



WIRELESS POWER

Leverage IDT's leading-edge technology in your wireless power design with a portfolio that delivers the industry's best flexible SoC architecture, efficiency, and hardware/algorithm implementation.

IDT's highly integrated transmitter ICs are designed for use in fixed and portable charging bases, while the ultra-compact, low-power receiver ICs are targeted at portable devices and accessories. With variations in input voltages, wireless



power standards support, and coil types/numbers, IDT's wireless power solutions are suitable for a wide range of applications spanning virtually all markets and industries. In addition, some wireless charger ICs can provide additional benefits for increased wattage and control when paired together.

Because implementing wireless charging technology is complex, IDT complements its solutions with reference designs, support tools,

and design-in documentation – streamlining the design-in process as much as possible.

IDT is a member of the Wireless Power Consortium (WPC) and develops wireless power ICs and reference design certified to the Qi standard.

IDT Advantages

- Industry first, flexible ARM® Cortex®-M0-based SoC architecture
- Industry-leading efficiency
- Unique and proven hardware / algorithm implementation
- Widest portfolio of wireless power Tx and Rx ICs provides distinct advantages in:
 - Integration
 - Ease-of-use
 - Power efficiency
 - Flexibility
- Qi-compatible wireless charging ICs
- Design support
 - Reference design kits enable fast prototyping and time to market
 - Extensive documentation library
 - Application notes
 - Design guides
 - User manuals
 - Online support tools



To request samples, download documentation, or learn more, visit: idt.com/wirelesspower



TIMING SOLUTIONS

IDT 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 applications. With proven expertise spanning more than twenty years in both analog and digital timing, our portfolio features the lowest phase noise and highest performance advanced timing technology.

IDT TIMING FEATURES

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

IDT TIMING BENEFITS

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

APPLICATIONS

- Wireless infrastructure
- Networking
- Datacenters
- Consumer electronics
- Industrial systems
- Automotive infotainment and navigation



To request samples, download documentation, or learn more, visit: idt.com/timing



Notice

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 - 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.
 - 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.
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