Industrial Communications in Automation

The desire for faster throughput, greater flexibility, and lower cost of ownership is driving the adoption of higher performance, standardised Industrial communications. Renesas is at the forefront of this trend delivering class leading solutions from Industrial Ethernet to sensor networks.

There are 3 key drivers for improved industrial communication in automation applications.

Absolute integration

Industrial Ethernet is a big part of achieving absolute transparency within the plant, and between the plant and enterprise networks. A common base technology serves to standardise and open the plant floor to the advantages of unbridled connectivity.

Distributed intelligence

Manufacturing is being driven towards an increasing trend of individualised products requiring significant flexibility in the plant. This can only be achieved through distributed intelligence. More and more processing power is needed within individual plant components this is driving the need for higher performance semiconductor products at all levels of the plant hierarchy.

Vertical transparency

The cost of deployment and maintenance is related to the visibility of automation equipment in the plant. The ability to adjust parameters and configure individual machines, I/O devices, and processes is becoming a firm requirement. Standardisation plays a big part in this and has resulted in the popularity of standards such as PROFINET and IO-Link. The ability to remotely configure the plant in real time is the ultimate goal of vertical transparency.
TPS-1: Single chip for PROFINET – all inclusive

The PROFINET IO Device Chip TPS-1 is designed for easy and cost-efficient implementation of PROFINET IO interfaces for automation devices. It is a highly integrated single chip solution that meets all requirements of the PROFINET IO protocols. The configurable host interfaces facilitate the flexible realization of different use cases like direct connection of an external host CPU or digital I/Os without additional circuitry.

Certified RT/IRT functionality for PROFINET V2.3

The TPS-1 complies with PROFINET IO Conformance Class C. The integrated components realize the complete interface functionality. The internal structure is designed to fulfill the requirements of the IRT protocol. Special synchronous signals are available to realize all synchronization tasks. To support line topologies in PROFINET IO networks, the TPS-1 is equipped with two integrated PHys and an integrated IRT switch. Time-critical PROFINET IO protocols are supported by hardware.

Integration – ideal for your device applications

For the complete implementation of a PROFINET IO device interface, only the TPS-1, a serial Flash device, an oscillator, and the physical adaptations for the Ethernet interface (transformers and connectors) are needed. The serial Flash component contains the individual chip configuration and firmware for the PROFINET IO CPU.

Efficiency – sustainable low cost

Due to the low space requirement (just 260 mm²) and low power dissipation (0.8 W) of the TPS-1, a PROFINET IO interface can also be integrated into automation devices with special requirements regarding housing size and protection classes. Conductor routing between the balls is still possible in order to keep down PCB cost.
ERTEC for Real Time Ethernet Communications

Supporting backwards compatibility through vertical integration

The ERTEC device when running PROFINET can behave as a proxy so that standard fieldbuses can be integrated easily. Proxy operation includes support for DeviceNet, Interbus, Profinet, HART, and Fieldbus Foundation. By using ERTEC in your automation applications you can save your customers in total cost of ownership by enabling support for legacy fieldbus devices. ERTEC not only supports fieldbus integration but also integration of sensor/actuator communications. IO-Link enabled sensors/actuators can also be encapsulated using ERTEC and PROFINET enabling sensors at the very bottom of the automation pyramid to be visible at the highest levels.

Integrating standard, real time, and ‘isochronous’ real time Ethernet

The ERTEC family of real time Ethernet controllers all include a dedicated hardware switch which enables the integration of various types of Ethernet traffic. The hardware controlled switch directs real time traffic around the standard Ethernet software stack when necessary. Therefore the response time for real time data packets becomes very fast and deterministic making it ideal for real time applications. A unique fact about this hardware switch is that it was designed very closely and in conjunction with the development of the PROFINET standard. Therefore developers can be assured that it is fully compliant and very robust for PROFINET.

High performance enabling high local intelligence

The future of factory and process automation is that intelligence be distributed throughout the plant. It is only in this way that manufacturers will be able to truly exploit the advantages of flexibility. The ERTEC200 and ERTEC400 devices can deliver up to 200 MIPS of CPU performance and support up to 128 Mbytes of external memory allowing complex and highly intelligent applications to be designed for local level machines. A single ERTEC device can manage up to 150 axes and still leave 50% of Ethernet bandwidth for standard traffic.
Best in class Industrial Ethernet PHY

Delivering on performance
Renesas Industrial Ethernet PHY family exhibits very competitive round trip delay for a discrete Ethernet PHY device. Therefore developers experience lowest node latency and system jitter, two features that are required for reliable high performance real time Ethernet systems. As Ethernet based technologies becomes more and more popular in Industrial Automation, traditional discrete Ethernet PHY products will not enable the differentiation demanded by application developers. Renesas Ethernet PHY family shows our expertise in cutting edge technology and architecture.

Designed for Industrial

<table>
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<tr>
<th>New market requirements</th>
<th>PHY related function requirements</th>
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<tbody>
<tr>
<td>Deterministic environment</td>
<td>Low round-trip delay</td>
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<tr>
<td>Prioritised link up of de-central periphery</td>
<td>Enhanced link-up and link-down handling</td>
</tr>
<tr>
<td>Error free communication</td>
<td>Enhanced Line quality monitoring and TDR mechanism</td>
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<tr>
<td>Ability of synchronising nodes</td>
<td>Special timestamping method and clocking scheme</td>
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Industrial Ethernet places new demands on technology and Renesas’ Ethernet PHY family delivers on these. Increasingly the ability to quickly swap out tools and machines is becoming more and more important and this requires enhanced handling of link-up and link-down procedures. Monitoring cable quality for maintenance cycles is crucial for maintaining high system reliability and availability. Renesas’ Ethernet PHY family implements line quality monitoring features, which makes it easier to monitor the quality of the line. To properly implement most real time industrial Ethernet protocols Precision Time Protocol (PTP) must be implemented. In order to do this, an IEEE1588 PTP timer is necessary, which is included on the enhanced variants of Renesas’ Industrial Ethernet PHY. These key features differentiate our industrial Ethernet PHY family and provide developers of Industrial Ethernet applications unique qualities not available in existing implementations.

Supporting legacy and integration
An important feature of the Ethernet PHY family is that it is completely backwards compatible with standard Ethernet communications allowing the integration of enterprise and industrial environment to occur more smoothly. The family is compliant with the IEEE802.3 standard. It has also been quality tested for robust environment making possible even to bring enterprise applications to the plant floor. Renesas’ industrial PHY family supports the absolute integration within a plant and prepares systems to future needs. Furthermore the Ethernet PHY family is complimentary to our other Ethernet based products like RX and V850 microcontrollers and ERTEC Industrial Ethernet controllers. Developers can find a complete solution portfolio to support legacy and aid the integration of Ethernet in industrial automation.
Integrated single chip IO-Link

What is IO-Link?
The distribution of intelligence around the plant also stretches down to the I/O level in sensors and actuators. Increasingly plant managers need to be able to see and control the sensors and actuators at the lowest levels of the automation network. Therefore sensors need the ability to communicate and the intelligence to reconfigure based on instructions from plant controllers. The latest and most popular technology for enabling this is IO-Link. It is a serial digital protocol that is fieldbus neutral and backwards compatible with existing connectors and cabling making it very easy to deploy. Excellent noise immunity allows for the use of un-shielded cables making it a low cost solution for intelligent sensor deployment.

Completely integrated solution in a single chip
In order to implement IO-Link in a sensor or actuator typically users require a micro-controller and a transceiver circuit. This transceiver circuit could require up to 60 components if assembled using discrete transistors. Renesas’ single chip solution reduces this device count from over 60 components to a single integrated device. In addition developers would need to create embedded drivers to integrate the software protocol stack with the transceiver and MCU. With Renesas’ single chip solution the software stack is part of the complete solution, but developers have the option of using their own stack if preferred. Therefore significant time and development cost can be saved by using our integrated solution rather than developing and integrating separate components.

Leading technologies from leading partners
Renesas has secured alliances with leading technology providers for the key components of the IO-Link solution. This ensures that the quality of our integrated product is of the highest level. Our relationships are long term and involve many products now and in the future and this proves all partners are committed to supporting IO-Link as the next global standard in automation I/O devices. Even though Renesas has created an alliance of partners for the IO-Link chip, developers need not worry about multiple contacts. Renesas’ well established and highly reputable microcontroller helpdesk will support all aspects of the solution directly with customers.
RX62N/RX63N Industrial Communications Microcontrollers

The speed of a RISC architecture with the flexibility and code efficiency of a CISC core

The RX Core marries the speed of a RISC architecture with the flexibility and code efficiency of a CISC architecture. The CPU interacts with the Flash and SRAM through an enhanced Harvard design. The RX Core leverages the industry’s fastest Flash memory, delivering 1.65 DMIPS/MHz and 2.77 CoreMark/MHz without wait states. Tightly coupled to the RX Core are the FPU, MAC, and RMPA (Repeat Multiply Accumulate), which are efficiently driven by DSP and floating point instructions to meet the growing demand of DSC (Digital Signal Controller) type applications.

Comprehensive on-chip peripherals

RX621/62N/631/63N MCUs provide extensive communication peripherals with options for Ethernet, up to three CAN, and up to two USB-FS 2.0 channels, each operating as USB Host, USB Device, or USB OTG (On the Go). Additionally, they offer up to thirteen SCI, three SPI, and four FC serial channels. Among their other peripherals are analog interfaces; timers; RTC and POR/LVD functions; and more.

RX for connectivity

RX MCUs provide built-in hardware for implementing efficient communications with external peripherals, systems, test equipment and networks such as the Internet. The Ethernet, USB and CAN connectivity modules are well-proven, reliable designs.

### Advanced Peripherals

<table>
<thead>
<tr>
<th>Connectivity</th>
<th>Advanced Motor</th>
<th>Memory</th>
<th>Analog</th>
<th>Timers</th>
<th>Communication</th>
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</thead>
<tbody>
<tr>
<td>Ethernet RJ45/MAC</td>
<td>12-bit</td>
<td>Flash (max)</td>
<td>SRAM (max)</td>
<td>ADC 10-bit</td>
<td>ADC 12-bit</td>
</tr>
<tr>
<td>USB 2.0 Host/Device/OTG</td>
<td>12-bit</td>
<td>Data Flash</td>
<td>AIC 12-bit</td>
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<td>21</td>
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<tr>
<td>CAN</td>
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<td>128 KB</td>
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<td>21</td>
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<tr>
<td>RX62N</td>
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<td>512 KB</td>
<td>2</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>RX63N</td>
<td>12-bit</td>
<td>2 MB</td>
<td>128 KB</td>
<td>8</td>
<td>21</td>
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**Ethernet MAC**
- 10/100 Mbps
- 2 KB TX FIFO
- 2 KB RX FIFO
- MII, RMII connection to PHY
- Wake on LAN

**USB**
- Host/Device/OTG
- 12 Mbps
- Up to 2 ports
- 10 Endpoints
- 2 KB FIFO

**CAN**
- ISO11898-1
- 1 Mbps
- 32 Mailboxes

**SPI/SCI**
- Up to 18 MHz (SPI Master)
- Flexible configurations
Getting started with Industrial Automation Development Kits

Starter Kit for TPS-1 PROFINET IO Device Chip
The TPS-1 Starter Kit is an all-in-the-box evaluation tool for the TPS-1 PROFINET IO device chip. It includes all required hard- and software for a simple PROFINET IO network including demonstration programs and it serves as a starting point for customer’s own developments.

PROFINET Development Kit with ERTEC
Two kits are available for the development of PROFINET applications. A fully featured version includes an IRT capable host controller so that developers can create a real IRT network to test the application. A simpler, lower cost kit is also available that allows RT operation with a PC-based host controller. Developers can use this lower cost kit to get started and learn how PROFINET works without a large investment. Almost all of the functionality is available at a fraction of the cost for a full system.

Ethernet PHY Starter Kits
The 10/100 Single Ethernet PHY is a fully integrated physical layer device to connect to standard IEEE802.3 Ethernet networks. The starter kits allow developers to investigate the physical layer for Ethernet communication without designing their own system. Especially applications related to the industrial networking require real time and secure operations. Special features support these requirements and can be tested with these starter kit. Starter kits are available for the single and dual channel versions of the PHY.

“Link it!” 78K0R IO-Link Development Kit
A complete solution including hardware, software, and development tools, the Link-It! development kit has all the components required to successfully begin developing an IO-Link slave application. The kit even comes with an M12 IO-Link connector allowing you to connect directly to an existing IO-Link master to prove your application.

Renesas RX62N/RX63N Starter Kits (RSK)
This complete RX600-based hardware/software platform for in-depth application design includes the E1 Debugger, a trial version of the HEW/e’s studio IDE, and demonstration firmware. The RSKs are specifically designed to be both an evaluation and development system. The kit includes everything that an engineer needs to be up and running within only a few minutes.

Before purchasing or using any Renesas Electronics products listed herein, please refer to the latest product manual and/or data sheet in advance.