

Reduce BOM Costs and Development Efforts for EtherCAT and Other Industrial Ethernet-compatible Servo Systems

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Overview

EtherCAT and other industrial Ethernet systems are expanding into fields beyond factory networks. On the other hand, the conventional implementation style of industrial Ethernet introduces the issue of rising BOM costs due to an increase in the number of required components. Moreover, supporting multiple industrial Ethernet protocols require more reusable software other than industrial Ethernet protocol stack to increase development efficiency. Using servo systems for the purpose of discussion, this white paper introduces leverage of the new Renesas RZ/T2L microprocessor to achieve broad reductions in BOM costs and enhanced development efficiency when expanding EtherCAT-ready devices to support other protocols with RZ/T2M microprocessor that supports multi-protocol industrial Ethernet.

Industrial Ethernet demonstrates growth

Field networks are factory networks linking the PLC control master with slave interfaces such as servo, inverter, gateway, and remote I/O and other control and measurement equipment. Conventionally comprised of serial fieldbuses, field network equipment has been replaced by industrial Ethernet due to demands for greater speed and capacity, along with real-time processing, of inter-device data since the year 2000. The number of industrial Ethernet device nodes is said to have overtaken serial fieldbuses in 2018.

Industrial Ethernet has demonstrated remarkable growth, with EtherCAT's substantial growth translating into an expanding market share (Figure 1). EtherCAT is an open-field network developed in 2003 by Beckhoff Automation, a German firm, and is managed and run by the ETG (EtherCAT Technology Group), which welcomes over 400 new corporate members each year.

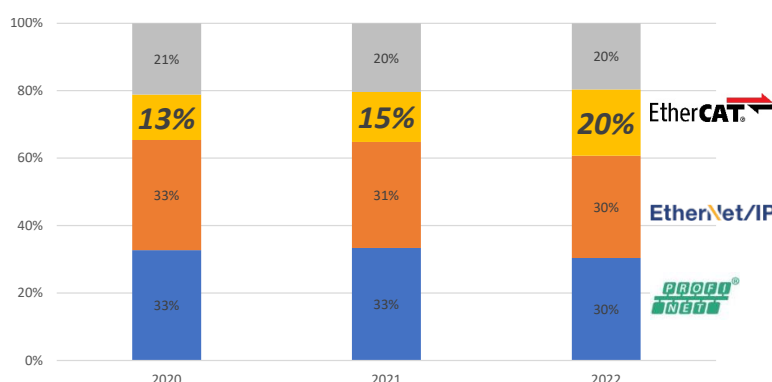


Figure 1: Industrial Ethernet Share by Protocol (research by [HMS Networks](#))

The servo system is one of the applications promoted by industrial Ethernet. Servo systems can control the position, speed, and torque of servo motors with great precision, and have multiple applications including industrial robots, machine tools, and medical equipment. Multiple servo motors are used in many of these cases, and the drive timing of each servo motor must be controlled. This is where industrial Ethernet plays a major part, as it enables multiple servo systems to share synchronous timing and the drive timing of each servo motor to be controlled with high precision.

Realizing BOM cost reductions for industrial Ethernet-compatible servo systems

Conventional EtherCAT-compatible servo systems used FPGAs to realize communication between EtherCAT-dedicated ASIC, microcontrollers performing system control, and absolute encoders which detect motor position. The FPGA was also used to performed high-speed motor control processing. This increasingly large number of components gave rise to the problem of high BOM costs.

RZ/T2L offers a solution to this problem. The RZ/T2L is equipped with a Beckhoff EtherCAT Slave Controller (ESC) and an absolute encoder interface supporting multiple encoder protocols, enabling EtherCAT communication, system control, and motor control to be realized with a single chip. This in turn enables a reduction in BOM costs due to fewer components and a reduced board area (Figure 2).

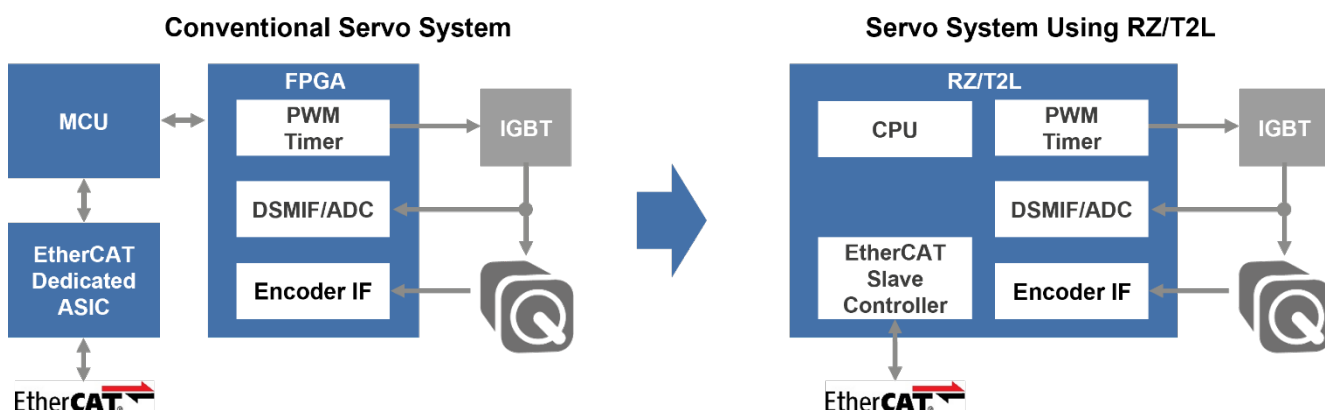
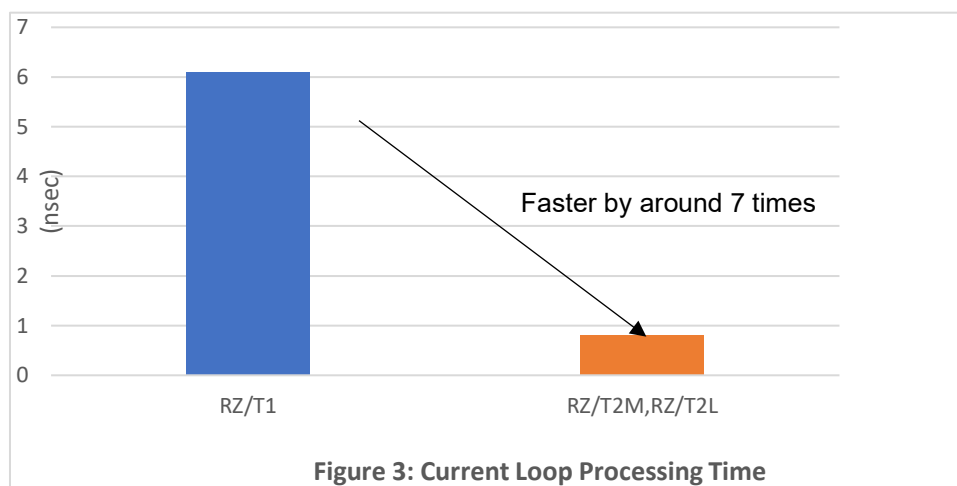


Figure 2: Single-chip AC Servo Solution with RZ/T2L

RZ/T2L offers high real-time performance, allowing motor control algorithms previously processed in FPGA to be handled by the CPU. RZ/T2L is equipped with Arm Cortex®-R52 which operates at 800MHz and a large-capacity tight coupling memory (TCM) totaling 576KB and directly linked to the CPU. Use of cache memory eliminates execution-time fluctuations and enables deterministic fast-response processing. It is also equipped with a trigonometric function unit as the hardware accelerator, performing high-speed trigonometric functions used in motor-control algorithms. Moreover, peripheral functions for motor control are placed on a dedicated bus (Low Latency Peripheral Port) directly linked to the CPU, enabling high-speed register access. High-speed current loop processing is needed in motor control, and the above-mentioned RZ/T2L functions represent a significant improvement over those incorporated in the Renesas RZ/T1, achieving current loop performance of under 1µsec (Figure 3).



Easily supports industrial networks other than EtherCAT

When supporting industrial network protocols other than EtherCAT, such as EtherNet/IP or PROFINET, or multiple protocols such as fieldbuses, creating common, non-network software is necessary to optimize development and avoid a significant increase in development efforts.

RZ/T2L uses the same hardware architecture as the high-end RZ/T2M line-up, including CPU and operating frequency, TCM size, peripheral functions, and internal bus configuration to deliver compatible real-time performance and functions. When expanding device developments to support multiple protocols like EtherNet/IP and PROFINET, software developed for RZ/T2L motor control and system control, can also be easily applied to RZ/T2M.

Moreover, as the RZ/T2L line-up offers versions with and without EtherCAT support, the non-EtherCAT version can be selected for serial fieldbus device development, enabling significant cost savings.

Category	RZ/T2L	RZ/T2M
CPU	800MHz Single Arm® Cortex®-R52	800MHz Dual Arm® Cortex®-R52
Tight coupling memory (TCM)	576KB	
Industrial Ethernet	EtherCAT (Option)	EtherCAT, EtherNet/IP, PROFINET
System SRAM (internal RAM)	1MB	2MB
DSMIF	3ch x 2 Unit	
ADC	Unit0 4ch, Unit1 4ch	Unit0 8ch, Unit1 16ch
PWM timer (GPT)	18ch	
Trigonometric Function Unit	1 Unit	
Encoder interface	A-format, BiSS-C, EnDat2.2, FA-CODER, HIPERFACE DSL	
Package	BGA 196pin	BGA 320pin & 225pin

Table 1: RZ/T2L and RZ/T2M Specification Overview

Conclusion

In this white paper, we introduced BOM cost savings achieved through use of RZ/T2L in servo systems and the efficiency of software development by taking advantage of the hardware compatibility between RZ/T2L and RZ/T2M. The rich Renesas product line-up of industrial Ethernet-ready microcomputers delivers a scalable platform contributing to accelerated client development of devices supporting industrial Ethernet.

Related Information

- [RZ/T2L](#) - High-Performance MPU Realizing High-Speed and High-Precision Real-Time Control with EtherCAT
- [RZ/T2L RSK](#) – Renesas Starter Kit+ for RZ/T2L
- [RZ/T2M](#) - High-Performance Multi-Function MPU Realizing High-Speed Processing and High Precision Control for Industrial AC Servos and Controllers
- [RZ/T2M RSK](#)— Renesas Starter Kit+ for RZ/T2M
- [Industrial Ethernet](#) – A summary of products available to support Industry 4.0 and Industrial Internet of Things (IIoT)

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