BOSCH REXROTH ACCELERATES SOFTWARE-DEFINED AUTOMATION WITH AMD ADAPTIVE SoCs & FPGAs

CASE STUDY

AMD × rexroth A Bosch Company



EXECUTIVE SUMMARY

Bosch Rexroth and AMD have brought together the "ctrlX OS" open automation architecture from Bosch Rexroth with AMD Zynq™ UltraScale+™ adaptive SoCs and Spartan™ FPGAs to advance the future of software-defined automation. The result is a scalable industrial platform that merges real-time control, edge computing, AI enablement, and industrial cybersecurity into a single, compact architecture.

At the center of the solution is ctrlX CORE X3, Bosch Rexroth's high-performance industrial control platform designed to replace traditional PLC-centric architectures with a modern, app-based automation ecosystem available in the ctrlX OS Store. The digital marketplace offers a wide range of innovative apps from Bosch Rexroth and other partners. Powered by ctrlX OS, a real-time Linux® operating system, the ctrlX AUTOMATION platform enables customers to deploy modular automation applications, edge analytics, robotics, industrial networking, and AI workloads using a harmonized hardware and software foundation.

ctrlX AUTOMATION allows industrial customers to simplify machine architecture, accelerate deployment, and scale from compact edge gateways to advanced AI-enabled automation systems while maintaining deterministic industrial performance and compliance with stringent cybersecurity requirements.

"ctrlX AUTOMATION is the smartphone of automation," said Dr. Karsten Kreusch, product manager for ctrlX I/O products at Bosch Rexroth. "It's complete automation based on scalability and security, and it's open."

ABOUT THE COMPANY

Bosch Rexroth is a leading global provider of drive and control technologies. As industrial markets began transitioning from hardware-centric automation toward software-defined architectures, Bosch Rexroth recognized the need for a fundamentally new approach to industrial control.

"We could see that the market would change from mechanical engineering more into software engineering," explained Kreusch. "The skills of young talent are changing from classical PLC programming to more modern programming languages – and now toward AI. Therefore, we decided not for an evolution, but for a revolution."

This vision led to the development of ctrlX AUTOMATION, an open, software-defined automation ecosystem designed to simplify industrial control while dramatically increasing flexibility and scalability.

INDUSTRY

Industrial, Robotics

CHALLENGES

Bosch Rexroth set out to build an open, compact, secure automation platform that combined deterministic real-time control with Linux flexibility, cloud/AI integration, third-party applications, and scalable cybersecurity while reducing hardware complexity.

SOLUTION

Bosch Rexroth uses AMD Zynq UltraScale+ SoCs, combining ARM processing and FPGA programmability for ctrlX CORE X3 to deliver compact, real-time industrial control, modular apps, Linux-based openness, and scalable ecosystem integration. The company also uses Spartan 7 FPGAs in its I/O modules to handle communication and logic.

RESULTS

An open, scalable automation ecosystem that simplifies deployment, enables AI and edge computing, accelerates partner innovation, and supports diverse industries through ctrlX AUTOMATION and adaptive SoC technologies.

AMD TECHNOLOGY AT A GLANCE

AMD Zynq™ UltraScale+™ adaptive SoCs; AMD Spartan™ 7 FPGAs

Today, cntrlX AUTOMATION serves industries including automative manufacturing, robotics, building automation, agriculture, energy infrastructure, packaging, and smart manufacturing environments.

CHALLENGE

Bosch Rexroth faced major challenges in designing an industrial automation platform capable of supporting both modern software requirements and traditional deterministic industrial control.

Existing PLC-based systems were often rigid, proprietary, and difficult to integrate with modern IT environments. Customers increasingly demanded flexible platforms capable of supporting multiple programming models, cloud connectivity, AI applications, and modular deployment architectures.

The company also recognized that future industrial systems would require significantly greater openness. Customers wanted the ability to integrate third-party software, deploy custom applications, and leverage modern development tools while still maintaining the deterministic behavior required for industrial motion control and safety-critical systems.

"We needed something completely new," said Kreusch. "We couldn't evolve the existing systems with all the constraints. We wanted new concepts and a universal Data Layer where every provider and consumer could plug in and subscribe to the data they want."

Another major challenge involved combining Linux O/S-based openness with deterministic real-time industrial performance. Bosch Rexroth wanted to create a platform where traditional automation functions such as PLC logic, motion control, and industrial communication could coexist alongside edge analytics, IoT applications, AI workloads, and web-based engineering tools.

The hardware architecture also needed to remain extremely compact while integrating high-performance compute, industrial networking, FPGA-based acceleration, and security functionality. The company was looking for a solution that could reduce overall board complexity while delivering industrial-grade reliability and long-term scalability.

"The ctrlX CORE X3 control platform is very small. We couldn't put too many chips on it," said Kreusch. "We needed FPGA technology, and it was very promising to put everything together on one chip."

In parallel, Bosch Rexroth needed to address increasing cybersecurity requirements across industrial environments. Modern industrial systems must comply with standards such as IEC 62443 while preparing for current and future regulatory frameworks, including the EU Cyber Resilience Act. Security therefore had to be integrated into the architecture from the beginning.

SOLUTION

Bosch Rexroth selected AMD Zynq UltraScale+ adaptive SoCs as the foundation for the ctrlX CORE X3 because the architecture provided the ideal combination of heterogeneous processing, FPGA programmability, compact integration, and industrial scalability.

ctrlX CORE X3 functions as the central automation controller for the ctrlX AUTOMATION solution. The platform combines PLC functionality, motion control, edge computing, industrial networking, IoT connectivity, cybersecurity, and AI enablement within a single compact industrial device. Rather than relying on fixed-function firmware, ctrlX CORE X3 uses a modular app-based architecture where customers can deploy functionality dynamically through the ctrlX OS Store.

ctrlX OS, Bosch Rexroth's Linux-based real-time operating system, was designed to decouple software from proprietary hardware while enabling deterministic industrial performance and modern software development workflows. The operating system supports microservices, containerized applications, secure OTA updates, and multiple programming environments including C++, Python, graphical engineering tools, ROS, and conventional PLC programming.

"We are using adaptive SoCs to bring functionality to our control hardware," said Kreusch. "We support a lot of programming languages, ROS systems, C++, Python, graphical programming, and also conventional PLC programming."

The AMD Zynq UltraScale+ adaptive SoC plays a critical role within the cntrlX CORE X3 architecture by combining quad-core ARM® Cortex®-A53 processing with integrated FPGA fabric. The ARM processing system executes ctrlX OS, application runtimes, motion control software, edge workloads, and AI-enabled applications. Meanwhile, the FPGA fabric handles deterministic industrial communication, fieldbus connectivity, TSN networking, EtherCAT implementation, and other time-sensitive functions. This heterogeneous architecture enabled Bosch Rexroth to consolidate multiple industrial subsystems into a single compact platform while maintaining real-time performance. "Performance for price, power, and board space were the best fit for us," said Kreusch.

The FPGA-based architecture also extends into Bosch Rexroth's ctrlX I/O systems. According to Andreas Bernhardt, area product owner for hardware and firmware development at Bosch Rexroth, Spartan 7 FPGAs are integrated

throughout the company's drives and I/O modules to manage communication interfaces and real-time industrial processing.

"In every I/O module there is a Spartan 7 FPGA handling communication and logic," Bernhardt explained. "We are doing EtherCAT systems and many interface functions that are only possible with FPGA technology."

The ctrlX OS Store has become another defining element of the platform. Similar to a mobile app marketplace, the store allows customers and partners to deploy modular industrial applications directly onto ctrlX CORE X3 platform. Today, more than 80 applications are available through the ecosystem, with about half developed by partners.

"The concept of an app system, backed by a broad partner network, is revolutionary," said Kreusch.

RESULT

The open, scalable automation ecosystem from Bosch Rexroth addresses a wide range of industrial applications. By standardizing on ctrlX OS and AMD adaptive SoC architectures in conjunction with the ctrlX CORE X3, Bosch Rexroth created a harmonized platform that allows customers to scale from compact edge devices to advanced AI-enabled automation systems while reducing integration complexity and accelerating deployment.

The platform's openness has allowed Bosch Rexroth to expand into multiple industries beyond traditional manufacturing automation. ctrlX AUTOMATION is now being used in robotics, warehouse automation, smart buildings, parking management systems, agriculture, indoor farming, energy infrastructure, and AI-enabled vision systems.

One example involves AI-based fire detection systems in building automation environments. Customers are using AI accelerator modules connected to ctrlX CORE X3 systems to analyze video feeds from low-cost cameras, shifting intelligence away from expensive smart camera hardware and into the centralized controller platform.

"The intelligence now goes into the controller instead of expensive cameras," said Kreusch. "Customers can use much cheaper camera systems."

The platform's open approach has also accelerated partner innovation. Bosch Rexroth now works with more than 100 ecosystem partners developing specialized applications, AI services, industrial communication tools, and analytics capabilities for deployment through the ctrlX OS Store. AMD provided Bosch Rexroth with significant engineering support throughout the development process, particularly in optimizing real-time behavior and heterogeneous processing performance.

> **"We really appreciate the strong support from AMD, especially in real-time optimization and the implementation of the TSN function."**
> Dr. Karsten Kreusch, Product Manager ctrlX I/O at Bosch Rexroth.

"There was really strong support from AMD. Optimizing real-time capabilities to the SoC architecture required significant collaboration," said Kreusch.

Bosch Rexroth successfully transformed industrial automation by combining open software architectures with adaptive computing technologies from AMD. The ctrlX AUTOMATION platform demonstrates how industrial control systems can evolve beyond traditional PLC-based models toward scalable, software-defined infrastructures capable of supporting AI, edge computing, and modern IT integration.

AMD Zynq UltraScale+ adaptive SoCs enabled Bosch Rexroth to integrate Linux-based software environments, deterministic real-time control, FPGA acceleration, and industrial networking into a highly compact and power-efficient platform. Spartan 7 FPGAs further extended flexibility across the company's I/O and drive architectures by enabling programmable communication and real-time interface handling.

One company that is planning to deploy Bosch Rexroth's ctrlX AUTOMATION platform is Siemens Energy. The company is actively shaping the shift towards decentralized plants, hybrid power plant concepts, and volatile energy markets with its modular Omnivise control system approach.

"In the future, ctrlX AUTOMATION from Bosch Rexroth will play a key role at Siemens Energy by contributing innovations from industrial automation and comprehensive IoT expertise," Kreusch said.

CONCLUSION

The ctrlX AUTOMATION platform demonstrates how industrial control systems can evolve beyond traditional PLC-based models toward scalable, software-defined infrastructures capable of supporting AI, edge computing, and modern IT integration.

AMD Zynq UltraScale+ adaptive SoCs enabled Bosch Rexroth to integrate Linux-based software environments, deterministic real-time control, FPGA acceleration, and industrial networking into a highly compact and power-efficient platform. Spartan 7 FPGAs further extended flexibility across the company's I/O and drive architectures by enabling programmable communication and real-time interface handling.

ABOUT BOSCH REXROTH

As one of the world's leading suppliers of drive and control technologies, Bosch Rexroth ensures efficient, powerful and safe movement in machines and systems of any size. The company bundles global application experience in the market segments of Mobile and Industrial Applications as well as Factory Automation. With its intelligent components, customized system solutions, engineering and services, Bosch Rexroth is creating the necessary environment for fully connected applications. Bosch Rexroth offers its customers hydraulics, electric drive and control technology, gear technology and linear motion and assembly technology, including software and interfaces to the Internet of Things.

Read more about Bosch Rexroth by visiting the company's website at: www.boschrexroth.com.

ABOUT AMD

For more than 50 years AMD has driven innovation in high-performance computing, graphics, and visualization technologies. Billions of people, leading Fortune 500 businesses, and cutting-edge scientific research institutions around the world rely on AMD technology daily to improve how they live, work and play. AMD employees are focused on building leadership high-performance and adaptive products that push the boundaries of what is possible. For more information about how AMD is enabling today and inspiring tomorrow, visit the AMD website (NASDAQ: AMD), LinkedIn, and X pages.

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