Using EtherCAT and PC Control, CycloneCarrier delivers a data-driven distribution center solution that cuts hardware costs 25% in warehouses

Swisslog shuttle system gets smart to meet e-commerce demands
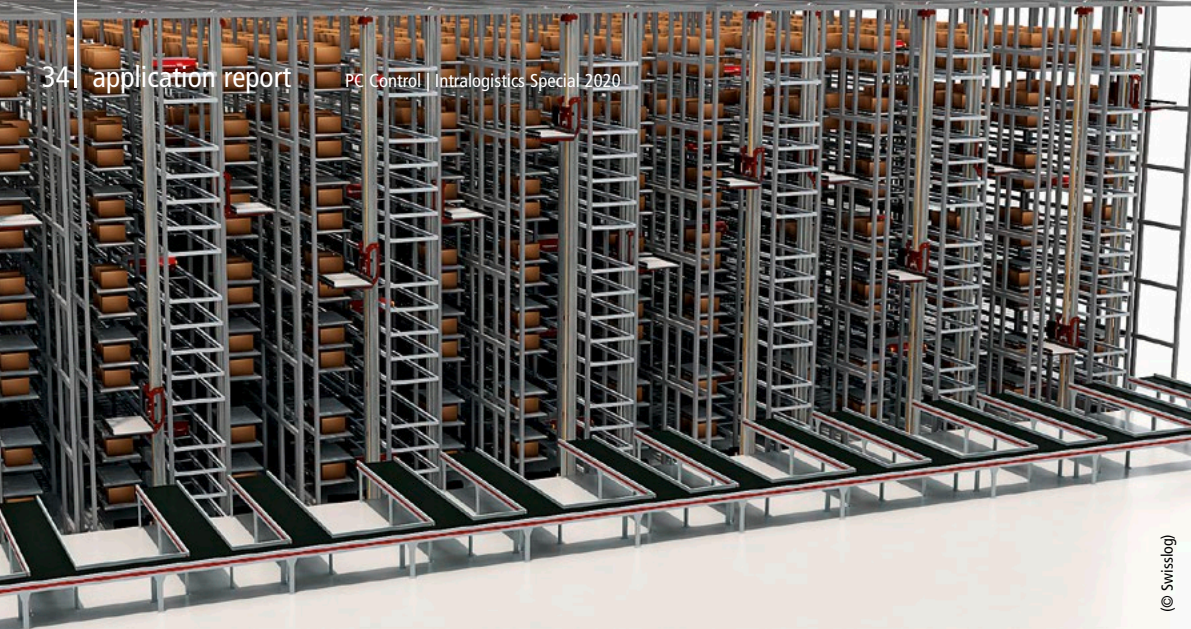
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With growing e-commerce demands and tight labor market pressures, today's smart warehouses and distribution centers require increasingly data-driven technologies. For intralogistics specialist Swisslog, addressing this challenge requires machines with greater intelligence, such as the CycloneCarrier shuttle system. "E-commerce is the fastest growing segment of the U.S. economy," says Tom Rentschler, Head of Marketing for Swisslog Warehouse and Distribution Solutions – Americas. "Intralogistics operations need much more flexible, scalable, adaptable and user-friendly solutions. These technologies can augment, rather than replace, human beings, helping workers increase throughput in the distribution center while no longer requiring them to walk 15 miles each day to pick items."

Swisslog accomplishes this with a broad portfolio of logistics solutions, including SynQ™ Warehouse Management System (WMS) software, ItemPiQ robot-based item picking, ACPaQ case palletizing, CarryPick mobile robots that move shelves to picking stations and many others. The company is also the leading integrator of the AutoStore bot system. Additionally, Swisslog provides traditional warehousing systems, such as palletizers, pallet cranes and pallet conveying technologies. The Swiss company, which was founded in 1994 but has a history dating back to 1900, became fully integrated into the KUKA Group in 2015. While the U.S. headquarters for Swisslog Logistics are in Newport News, Virginia, the multi-division, global company maintains a presence across Europe, the Americas and Asia-Pacific, particularly in China. The logistics division primarily serves major retailers, distributors and third-party logistics (3PL) providers.

Compared to similar systems on the market, the CycloneCarrier and other Swisslog solutions offer key advantages due to a robust PC-based automation platform. "What differentiates Swisslog from others in the market is how we integrate our solutions and use information systems and software to improve efficiencies," explains Paul Douglas, Senior Vice President of Operations – Americas. "Furthermore, the world is talking about the Internet of Things and Industrie 4.0. Our latest development efforts push Swisslog's capabilities into that space."

Intralogistics applications move toward PC Control

"The CycloneCarrier is a high-throughput storage and delivery solution," Douglas says. "The system takes in cartons and totes, stores them briefly and then rapidly removes them in sequence or groupings to pick stations or palletizing robots." The compact shuttle vehicles travel at speeds up to 4 m/s across the shelving, which can reach up to 150 m long and 25 m high. The vehicles' load-handling arms extend to either side and can adjust the space between arms to safely handle items of varying widths. The shuttles unload items onto transfer conveyors that serve as buffers to dynamic single- or double-deck vertical lifts. Depending on the shelving size and number of shuttles, the system can achieve a throughput of tens of thousands of items per hour. Each shuttle must communicate frequently with SynQ™ to log item locations in the constantly rotating inventory. "It must react quickly if, for example, an order changes or there is a change in the SKU sequencing requirements," Douglas adds.

With the CycloneCarrier, Swisslog provides a modular, high-throughput storage and delivery solution based on PC Control from Beckhoff.

The compact shuttle vehicles travel at speeds up to 4 m/s across the shelving, which offers a maximum footprint of 150 m long and 25 m high.

(© Swisslog)

A dynamic double-deck lift transfers cartons and totes pulled by CycloneCarrier shuttles to pick stations or palletizing robots.

The shuttle vehicles' load-handling arms extend and adjust to handle cartons and totes of varying widths.

More than a decade ago, Swisslog recognized the need for a controls platform that could handle increased quantities of data and communicate horizontally and vertically, even up to the cloud if needed. This realization coincided with the development of SynQ™ and the need for greater connectivity across the company's systems. As a result, Swisslog began to transition its portfolio to PC-based control technology, standardizing on hardware and software solutions from Beckhoff Automation. "We made this strategic decision because Beckhoff had, at the time, the most complete and cost-effective portfolio available," Douglas says. "Swisslog's intention is that it will transition every product offering to include PC-based control in the near future, including the more traditional pallet cranes and conveyors. So far, we have installed more than 1,000 machines worldwide that are equipped with Beckhoff controls."

When Swisslog began CycloneCarrier development in 2013, the system benefited greatly from this decision. "With our control platform for the CycloneCarrier and other systems, the first step was to provide the industry what it really needed to meet today's challenges. Second, we needed to keep our cost down. Lastly, we needed to select flexible technologies that could be used more than once, allowing us to create libraries to use in various applications throughout the industry," Douglas says. "We recognized that Beckhoff, as a true automation innovator, could provide leading-edge control technologies with high stability, speed and bandwidth, along with the necessary ease of use, to enable our vision for the future."

Automation solutions deliver results for CycloneCarrier

Among the automation technologies from Beckhoff, the CycloneCarrier system relies on CX5120 Embedded PCs for controller hardware. The DIN rail-mounted CX5120 measures only 124 mm x 100 mm x 92 mm. With just a single-core Intel Atom® processor, the mid-range controller easily handles all machine logic and data acquisition processes with fast cycle times, according to Douglas. "The CX5120 provides us with the processing power needed to reliably handle all machine functions. Form factor was also a concern, but the compact embedded PC easily fits inside the shuttles without issue," he says. "The controller hardware offers the universality and extendibility that we need to continue developing the shuttle system."

As the CX5120 runtime and engineering environment for machine programming, TwinCAT 3 automation software provides similar benefits, in part through the extreme portability of code to new projects. While the integration of

Each CycloneCarrier has multiple EtherCAT I/O and TwinSAFE modules and a CX5120 Embedded PC onboard, which enables fast and reliable communication to Swisslog's SynQ™ WMS software.

TwinCAT into Microsoft Visual Studio® enables programming in computer science languages, it is also ideal for all IEC 61131-3 programming languages, including object-oriented extensions. Swisslog engineers appreciated this capability because, prior to standardizing on Beckhoff, they wrote most of their code using IEC 61131-3 languages such as structured text (ST) and function block diagram (FBD). "The function blocks cover everything from motion control and safety to order picking and communication to SynQ™. Our R&D department puts each function block through rigorous testing, and once it is approved, it does not change," Douglas explains. "Because the function blocks were so foundational, we didn't want to lose development work when moving to other projects, and Beckhoff made code reuse possible and uncomplicated."

For networking, the CycloneCarrier uses the EtherCAT industrial Ethernet system. As the fastest protocol available, EtherCAT provides flexibility in topologies and supports up to 65,535 devices on a single network. Cross-vendor communication is another hallmark of EtherCAT and the Beckhoff I/O system, allowing Swisslog to connect to third-party PROFINET or EtherNet/IP devices as needed. However, the company strongly prefers to select devices such as barcode scanners that specifically support EtherCAT. In terms of hardware, the CycloneCarrier uses compact yet expandable EL series EtherCAT I/O modules, which connect directly to the CX5120 via a shared backplane and can be widely distributed across applications via EtherCAT Couplers and junction terminals.

TwinSAFE programmable safety terminals are integrated in the same segment as non-safety I/O in the shuttles. The "black channel" approach of Safety over EtherCAT (FSoE) provides TÜV-certified communication over the standard EtherCAT network. "Using integrated safety components allows us to reliably and safely control each CycloneCarrier according to the latest safety standards without the need to stop the entire system. Because of these benefits, we use TwinSAFE on every project," Douglas says. "Of course, safety is a requirement for every application by default, but having it integrated to this extent really answers our overall design requirements."

Control cycle times and costs keep pace with e-commerce
By leveraging automation technologies from Beckhoff, Swisslog created a flexible, scalable and adaptable shuttle system for today's distribution centers. A recent project for a major U.S. retailer, for example, involved 65 shuttles working round-the-clock to process 650,000 SKUs per day. Implementing the CycloneCarrier system boosted throughput for the company while saving work-

ers significant physical exertion. According to Rentschler, this showcases the great potential of automation technology to aid, rather than replace, human labor: "The adoption of goods-to-person technology with reliable automation technology is really important to our customers, since they can no longer scale up their labor force seasonally, for example."

By consolidating machine control and communication on a single embedded PC and using compact EtherCAT I/O, Swisslog also experienced significant savings. "Overall hardware costs are roughly 25% lower by using the Beckhoff solutions compared to what would be required to accomplish the same tasks with another vendor's components," Douglas explains. The CycloneCarrier achieved these capabilities through high-speed EtherCAT communication and the processing power of Beckhoff PC-based control. With CX5120 Embedded PCs and TwinCAT 3, the Swisslog machines achieve cycle times in microseconds, rather than the milliseconds they needed with previous solutions. The smart machines can also acquire critical data beyond performance data, such as temperature irregularities in facilities that handle perishable products, and display this information via dashboards built into SynQ™.

While traditional palletizing equipment usually remains in the same location, unchanged for a decade or more, new e-commerce solutions need to offer greater flexibility to meet changing consumer or corporate requirements. The modular controls platform Swisslog implemented enables customization to shelf and shuttle setups, whether to modify slightly or completely disassemble and rebuild the system in a different configuration, in an entirely different warehouse. "Through our standard platform based on Beckhoff PC-based control, we could use a CycloneCarrier shuttle in a small system targeted to a specific application and then use the same machine in a much bigger facility doing a completely different job," Douglas says. "To accomplish these feats, all of that flexibility must be built into the automation system from the beginning."

Further information:
www.swisslog.com/cyclonecarrier
www.beckhoffautomation.com