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Editor's note

Welcome to the DigiKey eMagazine Volume 30 – Energy and Sustainability.

Industrial technology is changing fast—and it's getting smarter, more efficient, and more sustainable along the way. In this issue, we take a look at some of the innovations helping industries work better today while preparing for what's next.

You'll read about intelligent UPS systems that can think ahead when it comes to power reliability, along with solar-powered VFDs that are changing the way industrial pumping systems approach sustainability. We also explore how compact PLCs are making a big impact—from powering connected smart manufacturing at the edge and in the cloud, to delivering impressive results in green energy, building automation, and industrial applications.

This edition also dives into motion and control solutions that boost efficiency, precision pneumatic pressure monitoring for robotics and automation, and modular pushbutton systems that make control panel design more flexible and easier to manage. Rounding things out, we look at contactless power and data transmission technologies that reduce wear and maintenance while improving reliability.

Together, these articles highlight a common theme: smarter design, lower energy use, and systems built to last. We hope this issue gives you fresh ideas, practical insights, and a clearer view of where industrial technology is headed.

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Intelligent energy management for Industry 4.0: UPS systems that think ahead

PHŒNIX CONTACT

Anyone who has lost work due to a sudden power outage understands how unforgiving hard shutdowns can be. Try scaling that to industrial PCs, which interface with far more expensive and complex equipment. An industrial PC might be coordinating motion, logging process data, and managing several control loops at once. When the power drops unexpectedly, it's not just one task that stops.

Power events can cause big headaches in manufacturing environments where systems must run continuously. Production lines are a prime example, where a mid-cycle stop can turn in-process material into scrap. Conveyors and feeders that suddenly go idle can leave product stranded between stations. In tightly timed process control, even a brief interruption can knock sequencing out of step. Monitoring and data collection are another consideration, especially when teams are in the middle of tracking quality, alarms, and overall system status.

Programmable logic controllers, industrial PCs, sensors, and other control components rely on stable DC power to function correctly. An abrupt shutdown can disrupt automated processes, corrupt data, and require manual intervention before operations can safely resume. As systems become more interconnected, there is even less tolerance for uncontrolled downtime.

Figure 1: The TRIO3 family of DC uninterruptible power supplies. Source: Phoenix Contact

Phoenix Contact's TRIO3 DC uninterruptible power supplies help ensure that systems don't panic when the lights flicker. Through an integrated USB interface, TRIO3 UPSs supply DC loads long enough to maintain operation until power is restored, or until systems are shut down properly.

Standout features of TRIO3 DC uninterruptible power supplies

In industrial settings, power issues often become apparent only after something stops working—at which point the system may already be offline. Troubleshooting then becomes more difficult due to limited visibility into what happened.

The TRIO3 series is built to make those moments easier to identify. Multicolor LEDs and signal contacts provide immediate visual feedback about system status, so maintenance staff can quickly see

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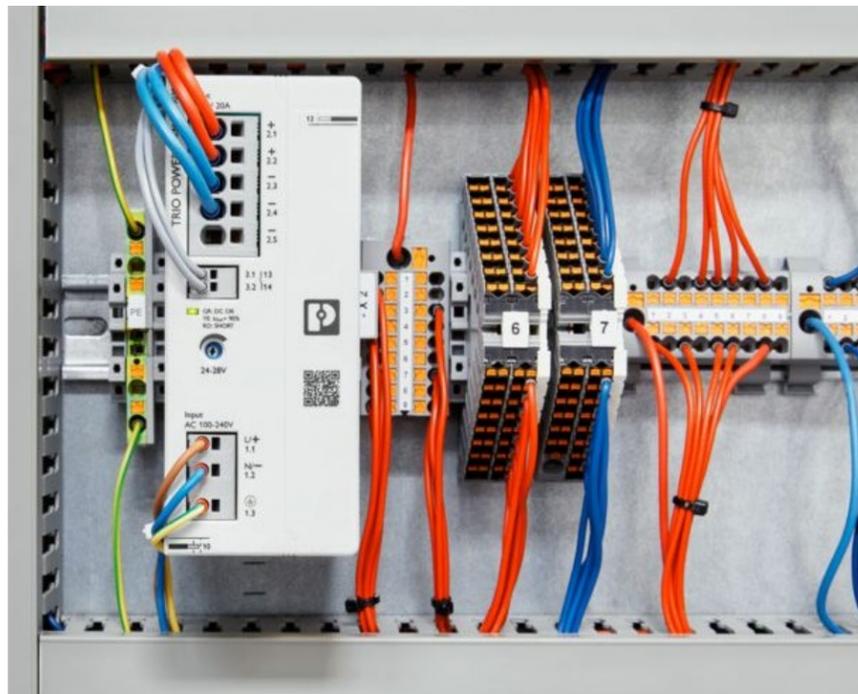
Source: Phoenix Contact

whether the unit is on mains power, running on battery, or flagging a fault. This transparency can shorten the gap between an outage and a useful response, allowing teams to address issues before they escalate.

Monitoring and diagnostics are paired with configuration capabilities through Phoenix Contact's Power Management Suite software. Using the software interface, TRIO3 users can monitor the UPS and adjust how it behaves based on application needs.

Not every power interruption looks the same. Some are brief blips that last only long enough to reset equipment. Others stretch out

for hours. This brings about the concept of smart parametrization: not every application needs the UPS to behave the same way. Some systems need every possible second of ride-through time and prioritize keeping loads running as long as possible during an outage. Others are better served by reserving enough energy to execute a controlled shutdown. Software makes it possible to tune the UPS for those different priorities instead of applying one default approach to every installation.

The same idea applies to charging and load support. Industrial power conditions aren't perfect; loads change. Demand fluctuates as motors start, valves actuate, and heaters cycle. TRIO3 is designed

with that in mind, offering features like dynamic boost and intelligent battery-charging behavior.

This flexibility shows up on TRIO3's hardware side too. Space is limited in control cabinets, and wiring can get crowded fast. In traditional setups, a power supply and a UPS are often separate devices. That means more components to mount, more wiring to manage, and more potential failure points to account for during installation and maintenance.

TRIO3 combines both the power supply and UPS into a single housing, which helps reduce the overall footprint and simplify panel design. With fewer devices involved, layouts can be cleaner, and commissioning can be more straightforward. It also enables tool-free wiring with push-in connections, making installation faster and reducing wiring effort.

TRIO3 supports a wide selection of battery modules, allowing users to tailor backup time to their specific application. Another practical advantage is that it can start up from the battery module even without mains input. This can be useful during commissioning or service work when incoming power isn't yet available.

A closer look at one TRIO3 configuration

One way to see how these features come together is to look at a specific configuration, such as the

Figure 2: The TRIO3-UPS/1AC/24DC/5/485-USB (Part No. 1359612).
Source: Phoenix Contact

TRIO3-UPS/1AC/24DC/5/485-USB (Part No. 1359612). This model delivers a nominal 24 VDC output at 5 A, a common voltage level for industrial control components. USB-C and RS-485 (Modbus RTU) interfaces give users a direct way to monitor the UPS and adjust its settings through Phoenix Contact's Power Management Suite, as discussed earlier.

During brief power spikes, the TRIO3 can supply extra current above its nominal rating for short periods instead of immediately dropping loads. For example, dynamic boost allows the output current to rise to 7.5 A for up to five seconds. Higher current levels are

also available for short durations during battery operation, depending on how the system is configured.

Battery backup is handled through compatible 24 V battery modules, with supported capacities ranging from 1.2 Ah to 40 Ah based on how long the system needs to remain powered during an outage. Charging current can be adjusted to match the size of the connected battery; this helps manage how quickly batteries recharge and avoids putting unnecessary strain on upstream power sources. When the UPS is running on battery power, the output voltage is maintained within a defined DC range that industrial control components can tolerate (approximately 19.2 V to 32 V).

Power continuity in connected manufacturing

Reliable power matters in almost every industrial environment, regardless of sector. Whether the setting is manufacturing, automation, pharmaceuticals, or chemicals, power interruptions can throw systems out of sequence, potentially damaging equipment and complicating recovery. After

an outage, teams are left sorting out what stopped, what kept running, and what needs to be checked before restarting. The more automated a system is, the harder it is to treat power events as minor inconveniences.

Uninterruptible power supplies play an important role in industrial design. Beyond keeping the lights on, a UPS is about buying time and preserving control.

In connected manufacturing environments, devices are increasingly expected to communicate status clearly, support monitoring, and allow configuration that matches how the system is actually used. TRIO3 reflects that through its combination of diagnostics, interface connections, and Power Management Suite software. Rather than treating backup power as a fixed, one-size-fits-all function, it supports a more adaptable approach. This kind of visibility and flexibility fits into broader Industry 4.0 goals, aligning with digital transformation on the plant floor.

To learn more, visit TRIO3 Uninterruptible Power Supplies.

Source: Phoenix Contact

Driving sustainability: how solar-powered VFDs are transforming industrial pumping systems

Pumps do a lot of heavy lifting in industrial water systems. They run for long stretches and consume a surprising amount of electricity in the process. For companies looking to lower both their operating costs and carbon footprint, pumping is one of the places where changes can actually make a noticeable difference.

Solar is one promising way to offset the energy used by pumping, but it comes with trade-offs. It's common knowledge that the power you get from a photovoltaic (PV) array is not the same at 9 a.m. as it is at 2 p.m., and it can decline quickly when the weather shifts. This can be a problem for pumps that require steady operation.

One way to handle that variability is to add energy storage, like batteries, to help smooth out the supply. But storage comes with its own considerations; it adds another system that has to be sized and installed correctly and maintained over time. That extra layer can change the overall cost and complexity of the project.

Schneider Electric aims to address these challenges with its family of Altivar Machine ATV320 Solar smart variable frequency drives (VFD) (Figure 1), designed for pumps that can run directly from a PV array. The series is built to make solar-powered pumping simpler to implement, thanks to the ATV320 Solar's ability to switch to grid power when solar output isn't sufficient.

Figure 1: Schneider Electric Altivar machine drive ATV320 solar are ideal for pumps from 0.37 kW to 15 kW (0.5 HP to 20 HP) with photovoltaic arrays
Source: Schneider Electric

Standout features of Altivar Machine ATV320 Solar VFDs

The Altivar Machine ATV320 Solar series supports pumps from 0.37 kW to 15 kW (0.5 HP to 20 HP). Each variable frequency drive controls motor operation by adjusting speed and torque, rather than running a pump at one fixed point. This gives the system more flexibility: it can ramp up or down, match output to demand, and avoid wasting energy when the pump doesn't really need to run at full capacity. According to Schneider Electric, the ATV320 Solar can lower energy use by up to 30% in pumping applications.

In a solar-powered setup, speed control becomes even more important because available power fluctuates constantly. The drive essentially acts as the link between variable PV input and steady pumping needs, intelligently managing the motor so that the pump can keep working optimally as the available sunlight changes. A key part of that is ATV320 Solar's built-in maximum power point tracking (MPPT) management, which helps the system extract the most power from the PV array to maximize flowrate.

For operations that need the pump to keep running, the ATV320 Solar can connect to both PV and grid power. When solar power is available, the drive can prioritize it

Dry run protection tackles a different problem—running a pump without enough water. Because dry running can generate excess heat and shorten the pump's service life, early detection helps protect pump longevity.

With sensorless output flow estimation, the drive can provide insight into flow behavior without requiring a dedicated flow sensor in every setup. This can help operators get a better sense of how the pump is performing and catch issues earlier.

The ATV320 Solar also integrates Altivar logic programming through a built-in 'microPLC.' This means the drive can handle custom logic and certain control tasks on its own without needing a separate controller for every application. This can be useful in pumping setups like starting and stopping based on conditions, switching between operating modes, or running a simple sequence.

and keep the pump operating on solar input. When it isn't sufficient, the drive can switch from PV to grid power so pumping can continue through low sunlight periods. This dual power capability enables consistent pump operation while eliminating the need for stored energy solutions.

Pumps rarely work under perfect conditions. Depending on the application, they may be dealing with varying water levels, debris in the line, changing suction

conditions, or other system variables that wear equipment down over time.

The ATV320 Solar cuts down on avoidable maintenance through features like anti-jam, dry run protection, and sensorless output flow estimation. Anti-jam functionality is intended for situations where solids begin to restrict movement, allowing the system to respond before a full stoppage occurs.

distributed. Solar-powered pumping can be especially appealing in these settings because it can carry more of the pumping load during peak daylight hours, when irrigation demand is typically highest.

Drinking water is another major focus, including submersible pumps, surface-mounted water pumps, and pumps used for filling or maintaining water storage tanks. These use cases often connect to rural and remote installations, helping support a lower-cost drinking water supply. Off-grid solar-powered water systems are relevant here, especially in locations where bringing in fuel or scheduling maintenance visits is difficult and expensive.

The ATV320 Solar is also suited to water treatment plants, where pumps circulate water through successive stages of filtration and processing. These systems rely on steady pumping loads, making them a natural fit for efficiency improvements through variable speed control and solar support.

Top applications of Altivar Machine ATV320 Solar VFDs

The ATV320 Solar is positioned primarily for water-related pumping needs, with a strong focus on irrigation and water supply. In agriculture, that includes irrigation methods such as drip irrigation, sprinklers, micro-emitters, and flood irrigation. These systems can cover large areas, and pumping needs can shift throughout the day depending on how water is being

parameters, and troubleshoot issues during installation and throughout operation. The drive also features a dedicated "Sun" menu for simplifying commissioning.

The ATV320 Solar is RoHS and REACH compliant, meeting widely recognized restrictions on hazardous substances and regulated chemicals in electrical equipment. For projects with environmental or material requirements written into the specification, this can help streamline documentation and product selection.

As sustainability goals become more common in industrial planning, energy-intensive systems

Putting solar pumping into practice

Even with the right equipment, solar pumping still depends on thorough planning and setup. The ATV320 Solar ecosystem includes tools like Altivar Solar Sizer, which supports system sizing during the design phase. On the commissioning side, SoMove software provides a way to configure the drive, adjust

like pumping are getting a closer look. The focus is on upgrades that can maximize production efficiency and reduce OPEX, while still fitting into real operating requirements. Many facilities are also prioritizing automation architectures that can scale without requiring a full system redesign later. Drives like the ATV320 Solar that support both PV and grid input align with that direction, offering a practical path toward more resilient and energy-efficient processes.

To learn more, visit Altivar Machine ATV320 Solar Variable Frequency Drives.

How Eaton's easyE4 Nano PLC powers connected smart manufacturing

Written by Abhishek Jadhav

EAT•N

Legacy control systems were never designed with data flow in mind. PLCs, relays, and timers were engineered to perform deterministic logic by scanning inputs, processing logic, and driving outputs. They were not intended to serve as data sources for analytics platforms or cloud dashboards. Even extracting basic operational data from these control cabinets often requires additional hardware layers or custom-built interfaces.

This presents a complex infrastructure problem for control engineers. The addition of new hardware further increases wiring complexity, configuration effort, and potential failure points. Deterministic control logic must coexist with non-deterministic data paths to support the IIoT. The real challenge lies not only in connecting control systems to the cloud, but also in doing so without compromising the reliability that industrial control systems rely on.

To capture real-time data at the edge and feed it into higher-level analytics, Eaton's easyE4 nano PLC bridges traditional control tasks with the IoT and cloud connectivity. Instead of centralized control and occasional data exports, modern industrial factories distribute intelligence to the edge for quicker local responses and continuously stream data to the cloud for analysis and optimization.

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Compact design integrating multiple control functions

The Eaton easyE4 (Figure 1) replaces multiple single-purpose devices with a single unit by combining functionalities of relays, timers, counters, and special-purpose controllers into a palm-sized module. This compact DIN-rail mounted device measures approximately 71.5 mm x 90 mm x 58 mm.

For example, rather than using separate electromechanical timers or dedicated PID controllers, an easyE4 can implement complex control behavior through software programming. It can perform logic sequencing, timing delays, and event counting.

The compact easyE4 can therefore be deployed for small-scale automation tasks that once required many discrete modules. Typical applications range from building lighting timers and HVAC controls to small machinery and pump control in industrial settings.

The hardware potential of the easyE4 lies in the easySoft programming software development environment. It supports four languages: ladder Diagram, functional block diagram, structured text, and event-driven programming. The user-friendly environment lowers the barrier to configuring the device, which allows for fast development and modification of control logic.

Figure 1: The Eaton easyE4 nano programmable logic controller with native connectivity to Amazon Web Services.
Source: Eaton

To further support scalable engineering, easySoft allows users to create User Functional Blocks. An engineer can write a complex piece of logic, such as a standardized control sequence for a specific type of valve, including alarm handling and maintenance timers, and encapsulate it into a single block.

Flexible I/O expansion

Despite its compact footprint, the easyE4 Nano PLC offers significant scalability. Each base unit comes with 12 built-in I/O channels (digital inputs and outputs, with relay or transistor outputs available). For use cases that require more sensors or actuators than the base unit supports, Eaton provides a family of plug-in expansion modules that increase I/O count.

Up to 11 expansion modules can be added to a single easyE4 Nano PLC base unit, allowing a maximum of 188 I/O points on a single controller network. These expansion units come in various types to mix and match functionality as needed, including analog I/O modules, additional digital I/O, high-voltage AC I/O, and transistor outputs for faster switching.

This flexibility allows control engineers to start with a small configuration and incrementally expand the system's capabilities without replacing the controller. The module simply snaps onto the base controller via a connector.

For example, a legacy machine with 110 VAC limit switches can be upgraded with an easyE4 AC base unit, while 24 VDC sensors and safety devices can

be integrated via DC expansion modules. The easyE4 serves as the unifying logic between these two voltage domains without needing interposing relays.

The robust connectivity

The easyE4 supports a wide range of communication protocols. Every base unit is equipped with an integrated RJ45 Ethernet interface, which is a departure from older smart relays that require expensive, proprietary cables for programming or communication. The Ethernet port supports multiple simultaneous functions, including programming, peer-to-peer communication (easyNET), and Modbus TCP.

The module also supports Modbus RTU via expansion modules. It can read data from a serial variable-frequency drive (VFD) via Modbus RTU and expose it over Ethernet via Modbus TCP. This capability connects legacy equipment to a digital ecosystem to support the growing IIoT infrastructure in industrial plants.

Eaton integrates SmartWire-DT into the system. When equipped with the communication module, the easyE4 becomes the network coordinator and can map up to 99 SmartWire-DT devices directly into its memory. This changes the scope of data available at the edge by replacing the control panel wiring with a single, flat, eight-pole cable that connects all components.
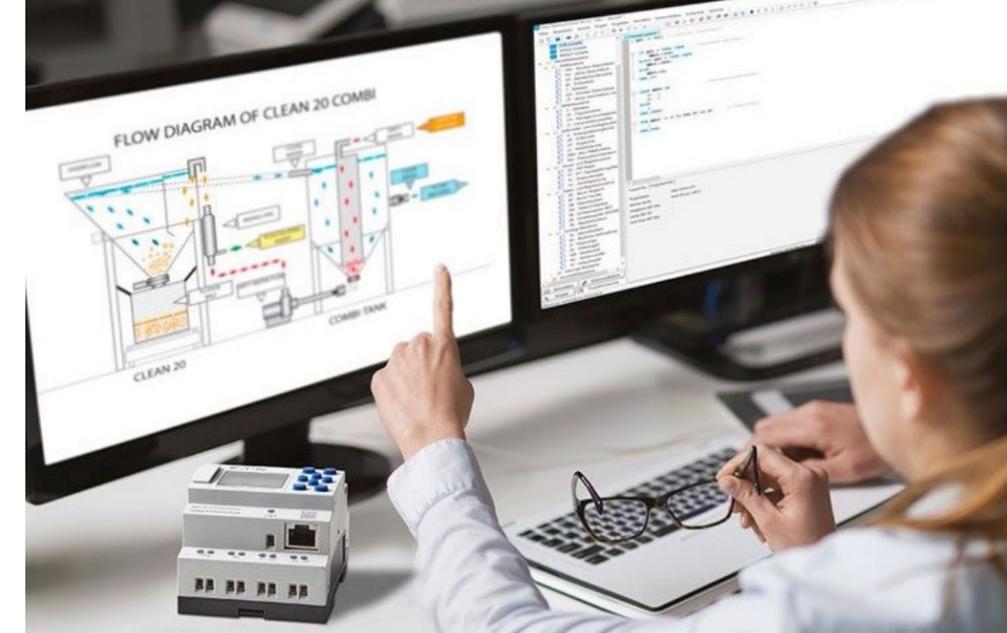
To leverage all the edge data, easy4 is designed with native connectivity to cloud services through a direct link to Amazon Web Services (AWS). The connectivity is built upon Messaging Queuing Telemetry Transport (MQTT), a lightweight, publish-subscribe protocol designed for constrained devices and unreliable networks.

The MQTT model allows the easyE4 Nano PLC to transmit only changing data to the cloud, rather than continuous polling of all data points. This approach results in more efficient utilization of network bandwidth and cloud resources, which is aligned with modern IIoT best practices.

The direct cloud connectivity with AWS also enables remote monitoring and analytics. Engineers can stream real-time data such as temperature and machine status to cloud dashboards and set up alerts based on specific conditions.

Additionally, this functionality opens the door for predictive analytics. For example, vibration or

cycle data sent to the AWS cloud feeds a machine learning service that predicts maintenance needs.

Conclusion

The approach taken by Eaton's easyE4 Nano PLC connects OT and IT without replacing the traditional control system. The control logic runs locally on the PLC along with a parallel data channel stream for non-critical information. This hybrid mechanism avoids making the control system "cloud-first" for operation, reducing the risk of latency and downtime.

A maintenance engineer can check machine status from a cloud dashboard in real-time, and an analytics algorithm can provide trends from a fleet of PLCs, all without affecting the machine's primary functions. This becomes a powerful enabler of Industry 4.0 use cases with real-time data access and remote visibility.

To learn more, visit Eaton easyE4 Nano PLC.

Driving efficiency and sustainability in industries with motion and control solutions

Written by Eric J. Halvorson

Figure 1: Water pumps in a large power plant.
Source: Getty Images

In the face of environmental challenges and the need for sustainable electronics, industries across the globe are seeking solutions to optimize their operations and minimize their carbon footprint. No matter the industry, there is a need to control processes to lower energy usage, minimize waste, and maximize output.

Motion and control products work together to manage the movement, speed, and position of mechanical elements within electronic applications. These products are designed to provide precise, efficient, and reliable control over various aspects of motion, enabling machines and equipment to perform their functions with optimal performance and minimal error.

DigiKey, a global distributor of electronic components, offers a broad selection of motion and control products from multiple suppliers, allowing customers to improve the sustainability and efficiency of their automated systems.

Core components of motion and control systems

At the heart of motion and control solutions are electric motors, which serve as the primary means of converting electrical energy into mechanical energy. There are several types used in applications, each with unique characteristics and advantages. For example, AC motors are known for their

Figure 2: Robotic vision sensor camera system in a smart factory.
Source: Shutterstock

durability, efficiency, and ability to operate at high speeds, making them suitable for use in industrial machines, HVAC systems, and other applications where reliable, long-term performance is essential. DC motors, on the other hand, offer excellent torque and speed control, making them well-suited for applications that require precise movement, such as robotics and automotive systems. Stepper motors provide highly accurate positioning and are used in 3D printers, CNC machines, and other devices that demand precise, incremental motion. Servo motors, with their fast response times and high torque output, are employed in applications that require quick, accurate movements, such as aerospace systems.

To effectively control and regulate the operation of motors, motion and control solutions rely on a variety of drives and controllers. Variable frequency drives (VFDs) are used to manage the speed and torque of AC motors, enabling smooth, efficient operation and energy savings. Servo drives, specifically designed for servo motors, provide closed-loop control and enable highly precise positioning and motion. Motion controllers, capable of handling multiple axes of motion simultaneously, are employed in complex applications where they coordinate and synchronize the movement of various components for smooth and accurate operation.

Actuators also serve a crucial role in motion and control systems, as they are responsible for converting energy into motion and providing force to move mechanical components. Known for their high force output and ability to handle

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heavy loads, hydraulic actuators are utilized in construction equipment, industrial machinery, etc., where raw power is required. Pneumatic actuators, which rely on compressed air to generate motion and provide fast response times, are utilized in applications that involve quick, repetitive movements, such as packaging and assembly lines. Electric actuators, including linear and rotary types, provide precise control in applications such as medical, automotive, and aerospace devices and equipment.

Sensors, feedback devices, and control systems

To ensure that motion and control systems operate with the highest level of accuracy and reliability, sensors and feedback devices are used to monitor and measure various aspects of motion. Position sensors, such as linear and rotary potentiometers, provide real-time data on the exact location of mechanical elements, allowing for precise positioning and tracking. Encoders, such as incremental and absolute, are used to determine the angular position and velocity of rotating shafts, enabling accurate speed and position control. Resolvers, similar to encoders but designed for use in harsh environments, also offer high accuracy and reliability in sensitive applications.

Tying all these components together are the control systems

Motion and control solutions are crucial for enhancing efficiency, accuracy, and productivity in a broad range of industrial processes.

that orchestrate and manage the overall operation of motion and control solutions. Programmable logic controllers (PLCs), rugged industrial computers designed for control and automation, handle multiple input and output signals simultaneously in factory automation, process control, and other applications. Industrial PCs, which offer greater flexibility and processing power than PLCs, are often used in tandem with advanced motion control software to simulate motion control algorithms in complex, multi-axis systems.

Motion and control components in industrial applications

Motion and control solutions are crucial for enhancing efficiency, accuracy, and productivity in a broad range of industrial processes. For example, they manage equipment such as robotic arms and machine tools to enhance industrial operations and minimize errors. In automotive factories and warehouses, motion and control systems coordinate the movement of industrial robots, collaborative robots (cobots) and autonomous mobile robots (AMRs) to perform tasks like handling, assembly,

and inspection. Similarly, in industrial packaging applications, motion and control solutions pick and transport items like boxes and pallets using conveyor systems, sorting machines, and automated storage/retrieval systems (AS/RS).

In the medical sector, motion and control systems shape the way healthcare is delivered and research is conducted. They enable precise positioning, dosing, and automation in medical devices and equipment, such as surgical robots, diagnostic imaging systems, and laboratory instrumentation. For example, surgical robots equipped with motion and control components can perform procedures with

accuracy and minimal invasiveness, reducing patient recovery times and improving overall outcomes. Automated liquid handling systems in pharmaceutical research labs also use motion and control systems to accurately dispense and mix reagents, streamlining the drug discovery process and accelerating the development of new therapies.

The aerospace and defense industries also depend on precision motion and control solutions for mission-critical applications like satellite positioning, aircraft control systems, and missile guidance. In these sectors, even the slightest deviation from the intended motion or position can have a catastrophic impact. Motion and control technologies ensure that these systems operate with exceptional accuracy and reliability, allowing satellites to maintain orbits, aircraft to fly safely, and missiles to reach targets. Moreover, these solutions

enable the development and testing of new aerospace and defense technologies, allowing engineers to simulate and validate complex systems before they are deployed in the field.

Understanding DigiKey's multi-supplier strategy

By partnering with multiple suppliers, DigiKey ensures engineers and system designers have access to a broad selection of products. This strategy not only increases product variety but also improves availability, promotes competitive pricing, and provides access to a wealth of technical expertise. One clear advantage of DigiKey's multi-supplier approach is the ability to cater to a host of industrial requirements. Whether it's a compact stepper motor for precision instrumentation or a high-torque servo drive for heavy-duty automation, DigiKey's inventory offers a solution for all applications. This diversity enables engineers to find the most suitable products for their specific needs that can optimize overall system performance and efficiency. Moreover, by sourcing from multiple suppliers, DigiKey minimizes the risk of supply chain disruptions – when one manufacturer is experiencing production issues or delays, alternative products from other suppliers can be sourced, ensuring a reliable and consistent supply for customers. This resilience makes all the difference

in industrial facilities where even minimal downtime can have a significant impact on resources, budgets, and operations.

Advanced motion and control products from industry leaders

DigiKey's partnerships with leading manufacturers such as Schneider Electric, Siemens, and Omron shows its commitment to quality and innovation. These industry giants are renowned for their cutting-edge motion and control solutions, which incorporate advanced features and technologies to drive efficiency and sustainability.

Schneider Electric's Altivar™ Soft Starter ATS480 (Figure 3) builds on the start/stop performance of previous iterations to further

Figure 3: Schneider Electric Altivar™ Soft Starter ATS480.

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Figure 4: Schneider Electric TeSys Thermal Overload Relay.
Source: Schneider Electric

extend equipment lifetimes and maximize application availability in demanding environments. The Altivar 212 VSD provides maximum ease of use and security for system integrators and end-users in HVAC systems, saving energy and enhancing building comfort and management. Similarly, ATV320 VFDs provide safety, reliability, and simplicity in compact form factors for simplified installation and efficient use of space.

Schneider Electric's Easy TeSys line includes manual motor starters with magnetic protection at 13 times the maximum dial setting, thermal overload relays with screw clamp terminal connections, and 3-pole contactors offering a lifetime of approximately one million electrical operations. These devices are designed to switch and protect common motor applications. The TeSys™ island Communicating Motor Starters

eliminate control wiring and PLC IO with a single ribbon cable click, providing access to data via industrial communication protocols.

Siemens' SINAMICS V20 Drives, with their compact, robust, and rugged design, are ideal for use in a variety of basic drive applications in process and manufacturing facilities. Moreover, the SIRIUS 3RA23 Series Reversing Contactor Assemblies prevent wiring errors in the main and control circuits. Controls SIRIUS Contactors offer flexible options for switching electrical loads, with conventional and solid-state operating mechanism choices.

Omron's MX2 Series Variable Frequency Drives offer advanced motor and machine control using VFD technology for precise operation, energy savings, and fault protection. With their advanced design and algorithms, the MX2 provides smooth control down to zero-speed and torque control capability in open loop.

Improving sustainability in an automated production line

To illustrate the impact of motion and control technologies on sustainability, let's consider an automated production line in a manufacturing plant. From precise control of conveyor speeds and packaging machine motors to the integration of robotic arms and the implementation of safety

systems, these components enable manufacturers to achieve their goals of minimizing energy consumption and waste, while ensuring the safety and reliability of operations:

- *Conveyor Systems:* In the automated production line, conveyor systems play a key role in transporting materials and products between different stages of the manufacturing process. By incorporating Schneider Electric's Altivar 212 VSD or Omron MX2 Series VFD, the speed of conveyor motors can be controlled to match the required production rate. By ensuring that the conveyor runs at optimal speed, energy consumption is lower, and there is less wear and tear on mechanical components. Additionally, soft starters like Schneider Electric's Altivar™ Soft Starter ATS480 provide smooth start and stop of conveyor motors, reducing mechanical stress and extending the lifespan of the equipment.

- *Packaging Machines:* Packaging machines are an integral part of the automated production line, responsible for wrapping, sealing, and labeling products. These machines often require precise control of motor speed and torque to ensure consistent and accurate packaging. By integrating Schneider Electric's ATV320 VFDs, packaging machine motors can be controlled with high precision,

enhancing the system's overall performance and energy efficiency.

- *Robotic Arms:* Robotic arms are widely utilized in automated production lines for tasks such as material handling, assembly, and quality inspection. These tools require precise control of multiple axes of motion to perform their tasks accurately and efficiently. Schneider Electric's TeSys island Communicating Motor Starters offer control for robotic arm motors. By avoiding the need for complex wiring and PLC IO, the TeSys island also facilitates faster installation and easy configuration of the robotic arm's control system. The built-in digital interface and smart configuration tool simplifies commissioning and adjustment, while the ability to access critical data via communication protocols allows for remote monitoring and predictive maintenance.

- *Pumps and Fans:* Pumps and fans are vital in various aspects of an automated production line, such as cooling systems, hydraulic power units, and ventilation systems. Optimizing the performance of these components can lower the energy consumption and ensure maximum uptime. Siemens' SINAMICS V20 Drives, with their compact, ruggedized design, are suitable for controlling pumps and fans in industrial environments. The SINAMICS V20 Drives offer various

functions, including PID control, multi-pump control, and energy-saving modes.

- *Safety Systems:* Ensuring the safety of personnel and equipment is of utmost importance in manufacturing facilities. With safety-rated contactor assemblies, production lines can achieve a high level of safety, reducing the risk of accidents and downtime. Siemens' SIRIUS 3RA23 Series Reversing Contactor Assemblies can implement safety functions in the motor control system. These assemblies integrate seamlessly into functional safety systems according to international standards such as IEC 61508 and ISO 13849-1. The integrated mechanical and electrical interlocking features of the 3RA23 Series also avoid wiring errors and ensure safe operation of reversing motor circuits.

Conclusion

Advanced motion and control solutions are critical drivers of efficiency and sustainability in a wide range of industries. By integrating these technologies into automated production lines, manufacturers improve operational efficiency, reduce energy consumption, minimize material waste, and extend equipment lifetimes. DigiKey's portfolio of products sourced from multiple suppliers enables engineers and designers to create systems that deliver high performance while being eco-friendly. DigiKey provides a platform where engineers can explore, compare, and procure the most suitable motion and control products for their applications.

Figure 5: Smart industrial robot arms for digital factory production.
Source: Shutterstock

Video spotlight

PROeco II Power Supplies

PANDUIT™
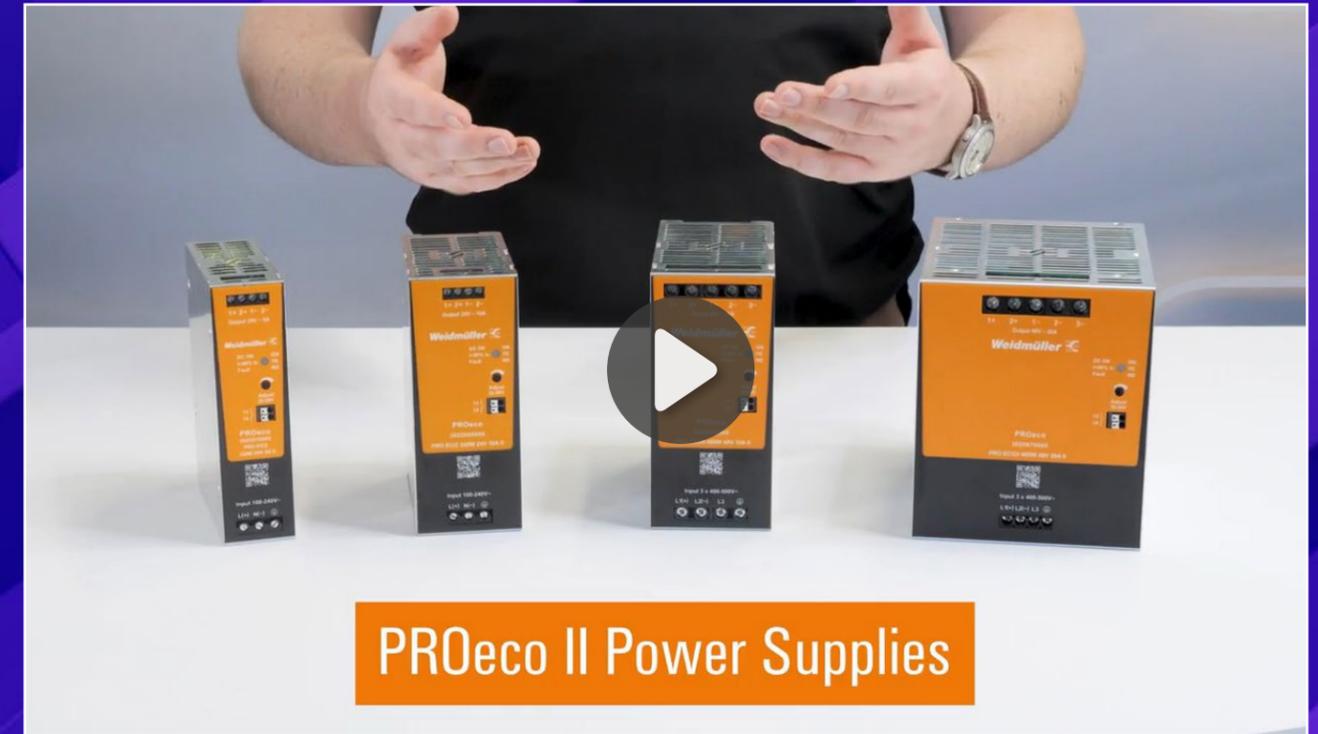
Electric Vehicle Supply Equipment Solutions (EVSE)

The featured video underscores our innovative offerings in electric vehicle charging infrastructure. It is initiated by recognizing the worldwide transition toward electric mobility and the surging need for dependable charging solutions.

Learn more

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Power Up with PROeco II Power Supplies

PROeco II Power Supplies deliver exceptional energy efficiency—up to 95%, minimizing power dissipation and significantly reducing heat generation and operating costs. Designed to be robust yet compact, these units ensure long-term reliability with an impressive MTBF exceeding one million hours, a feature typically reserved for premium power supplies. The result: sustainable performance and cost savings without compromising durability.

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Video spotlight
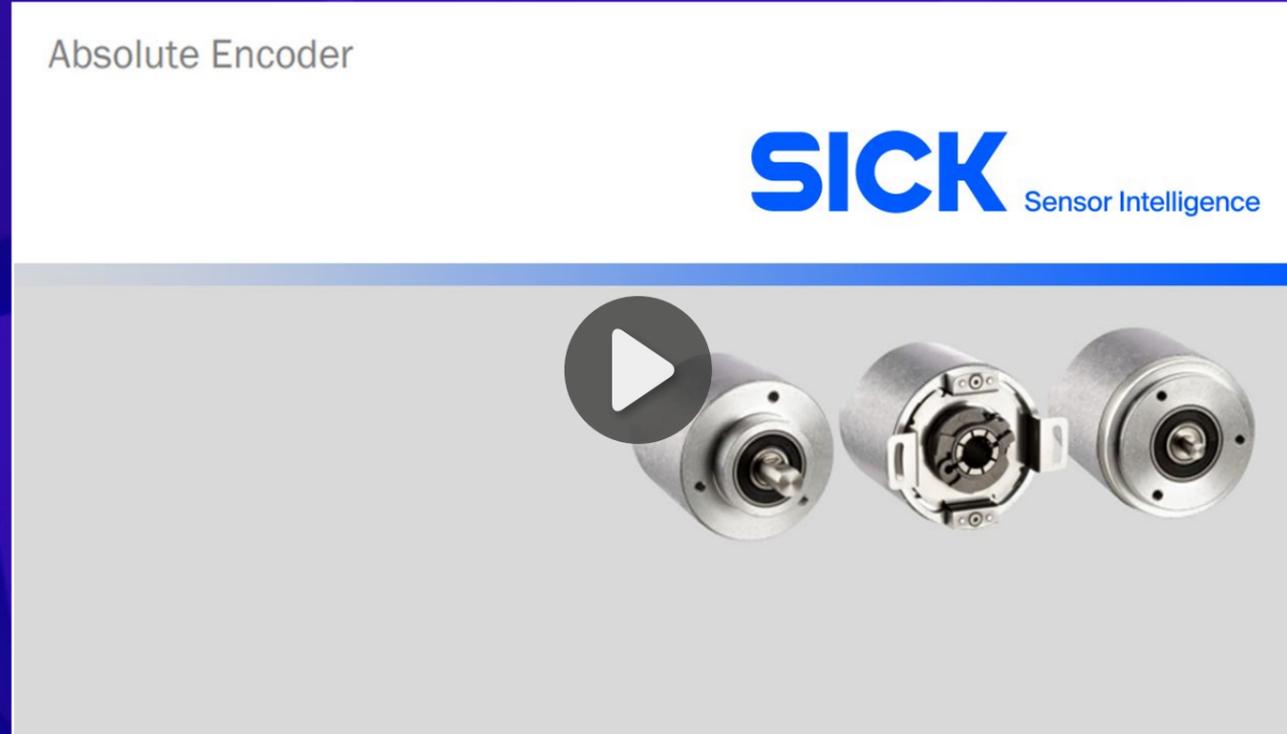
AFM60 Absolute Encoders

The SICK AFM60 absolute encoder is a cornerstone for smart manufacturing, delivering high-precision position and velocity feedback while enabling real-time connectivity across advanced industrial networks. With multi-protocol Ethernet support—including PROFINET, EtherNet/IP, and EtherCAT—the AFM60 integrates seamlessly into automated systems, ensuring fast, low-latency communication for time-critical applications.

Learn more

QX4 Analog Sensor

The Banner Q4X analog sensor enhances smart manufacturing by delivering precise, real-time measurement and flexible configuration for diverse applications. Its Class 1 laser CMOS technology provides reliable detection across a wide range of colors, materials, and surfaces based on distance.

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Precision pneumatic pressure monitoring for robotics and industrial applications

Written by Jeff Shepard

Precision pressure monitoring using pneumatic sensors is crucial in various robotics and industrial control applications. To ensure reliable operation, pressure monitors must have excellent overpressure and vacuum resistance and should include a measuring cell that's insensitive to liquids or deposits.

In addition to precise and robust operation, application flexibility is a key feature that can expedite initial installation and support configuration changes, enabling mass customization in Industry 4.0.

The monitor should include an easy-to-read display for quick status checks, programmable outputs for alarms, and local setup and operation using integrated pushbuttons. IO-Link is required for digital data transfer for remote process monitoring and configuration. In some installations, having an analog output is beneficial.

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Support for multiple mounting configurations can ensure compatibility with a wide range of system designs.

This article presents the PQ series of precision pressure monitors from ifm Efector (ifm) and details how they cater to diverse needs for pneumatic and compressed air systems in a wide range of industrial and robotics applications.

User interface

The visual interface is a key feature of the PQ series. It includes a 1" color TFT display, switch point LEDS, and switches for changing the display and setting parameters. The primary process value measured is pressure, and it can be displayed in various units, including bar, psi, or kPa. The vacuum level can also be represented as a percentage of the set point.

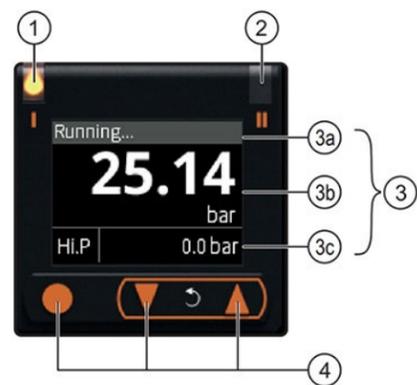The display can show the configuration set point (SP) and reset point (rP) for the digital

Figure 1: Layout of the PQ series user interface.
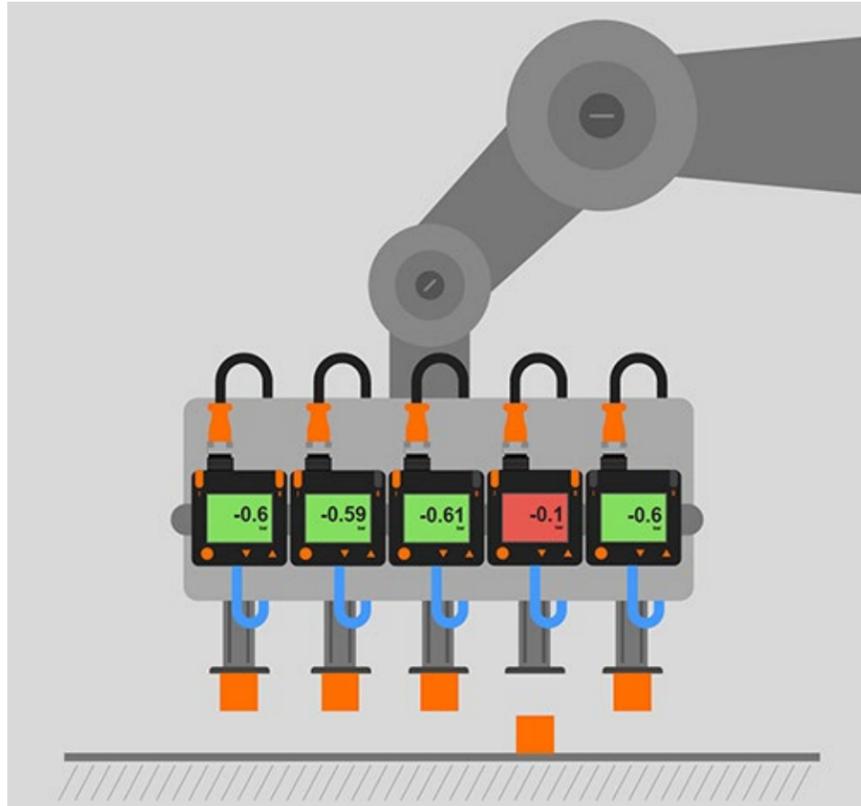*Source: ifm*

Figure 2: Diagram of PQ series pressure monitors used in a vacuum gripping application, showing one gripper with too low a vacuum (red display).
Source: ifm

outputs. Switch points are signaled using LEDs. For models with an analog output, the display can be used to set and show the analog start point (e.g., 4 mA) and end point (e.g., 20 mA) for scaling the signal. The user interface includes several elements (Figure 1):

1. Switching status LED lights if output 1 is active

2. Switching status LED lights if output 2 is active

3. TFT display elements:
   a. Device status
   b. Process value. The display can switch from a

standard color (green) to an alternative color (red), making it visually clear when the process value moves into or out of an acceptable range.

   c. Diagnostic and performance information, such as the number of switching cycles and the lowest or highest pressure recorded. In Figure 2, Hi.P indicates the highest measured value for pressure.

4. Keys for display configuration and parameter setting.

The PQ series is available with and without a configurable analog output. PQS models, such as the PQS812, have two digital outputs, while PQC models, like the PQC812, feature a configurable analog output in addition to the two digital outputs. The analog output on the PQC models can be used to send a proportional signal.

Machine and automation designers can select devices with specific measurement ranges. The PQS812 and PQC812 have measurement ranges of -1 bar to 10 bar (-100 kPa to 1,000 kPa, -14.5 psi to 145 psi). Models PQS816 and PQC816 are designed for lower-pressure and vacuum applications, with measurement ranges of -1 to 1 bar (-100 to 100 kPa, -14.5 to 14.5 psi). Applications that require only vacuum measurement can utilize the PQS819 and PQC819, which feature measurement ranges of -1 bar to 0 bar (-100 kPa to 0 kPa, -14.5 psi to 0 psi).

Compressed air treatment is a common operation in pneumatic systems. It's the process of removing contaminants, such as moisture, oil, and dirt, from the compressed air to protect pneumatic equipment, ensure system reliability, and maintain product quality.

The PQ series is especially suited for compressed air treatment systems since the coated and sealed silicon measuring cell maintains its performance in the
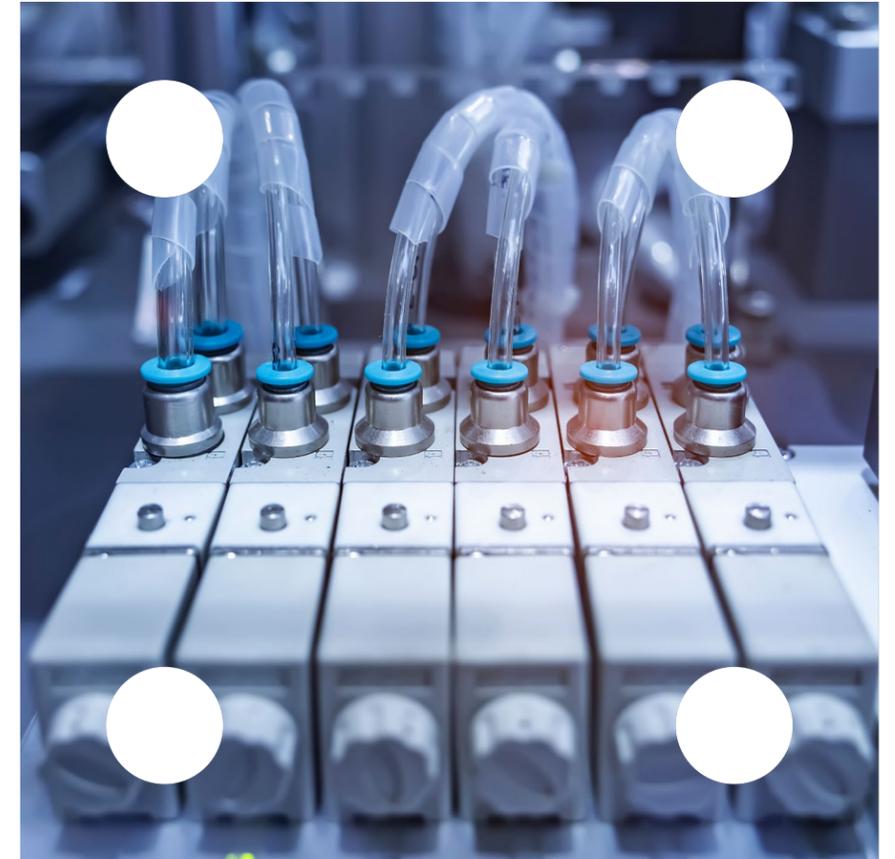
presence of air contaminated with water, dust, or oil.

Vacuum gripping applications are a common use of PQ series pressure sensors. These applications can include multiple pick-up effectors. The red/green color change of the display provides operators with an at-a-glance visualization of the process values of each pick-up (Figure 2).

Application versatility

The PQ Cube pressure sensors are suited for a variety of pneumatic applications, including food and beverage packaging, industrial palletizing

machines, consumer white goods manufacturing, and more.

In food and beverage operations, package seals are positioned using a vacuum gripper. In these packaging machines, the IP65 rating is an important feature. It indicates that the sensor is protected against low-pressure water jets from any direction.

To achieve optimal performance, the sensors in food and beverage packaging machines should be positioned as close as possible to the vacuum gripper, utilizing short hose lengths. That places the sensor within the cleaning area of the machine, subjecting

Figure 3: Palletizing machine showing the position of the PQ Cube sensors (middle frame). The sensor on the left has a red display indicating an out-of-specification condition
Source: ifm

it to sprays of water and cleaning chemicals that the PQ Cube easily handles with no loss of performance or reliability.

Vacuum gripper technology is also a key element of robot palletizing machines. PQ Cube pneumatic sensors accurately and quickly determine if sufficient vacuum is available to grip a box. Only when the box is correctly gripped will the machine move it into position on the palletizer (Figure 3).

White goods, such as dishwashers, can have dozens or even thousands of model variations in terms of size, shape, color, and technological features. With such a wide variety of components, the use of vacuum grippers is necessary to ensure efficient and smooth production.

The gripper must be actuated with a specific process pressure to secure delicate components without damaging them, and

then quickly place and release them during assembly. The 6 ms response time and high precision of PQ Cube sensors are important features in these robotic applications.

These machines often use two PQ Cubes. One for the placement of components and another for a maintenance unit that monitors the overall pneumatic system pressure and supplies two robotic assembly stations.

Custom build the machine

The application flexibility of PQ sensors extends to machine construction. The device can be installed in panels using the E30574 mounting kit. The E30576 wall mounting adapter is another option, and so is the E30575 DIN rail mounting kit.

The sensor can also be mounted to a panel without a mounting kit

using two cylindrical screws. For this purpose, the cylindrical screws are first screwed into the panel, then the device is placed on top and locked downwards.

That's not all. Connecting both process connections to pipes enables PQ sensors to be used as a pneumatic distributor without the need for additional adapters. In other applications, using one of the two connections on the sensor allows for flexible installation on a pipe, enabling precision pressure monitoring with the unused connection closed by a sealing plug.

As machines with PQ sensors are installed, technicians can utilize the installation wizard to expedite the process. The wizard can be implemented on the device using the integrated buttons. It's available in nine languages and steps through the setup and installation process by asking a series of questions. Installation can also be accomplished using IO-Link.

IO-Link boosts productivity

IO-Link enables digital connectivity beyond the machine to higher-level field buses, speeds up the installation and commissioning of new machines or replacement PQ sensors, and supports configuration changes in existing machines, as well as centralized performance monitoring and diagnostics.

A standard 3-wire sensor/actuator cable is used with IO-Link connections. The PQ Cube connects with an IO-Link master, which provides higher-level connectivity, typically via an industrial Ethernet protocol, to devices such as programmable logic controllers (PLCs) and human-machine interfaces (HMIs), including flat-panel monitors.

IO-Link enhances the performance of PQ series devices by enabling robust digital communication, providing high-resolution data, and supporting more advanced diagnostics. Instead of relying on traditional analog signals or the standard I/O (SIO) interface, IO-Link provides greater accuracy and reliability (Figure 4). SIO is the basic ability to operate as a binary switching sensor.

The onboard memory in these sensors can store operating hours and up to 20 events, such as pressure spikes that exceed a user-defined threshold. Additionally, the system temperature can be transmitted along with the pressure
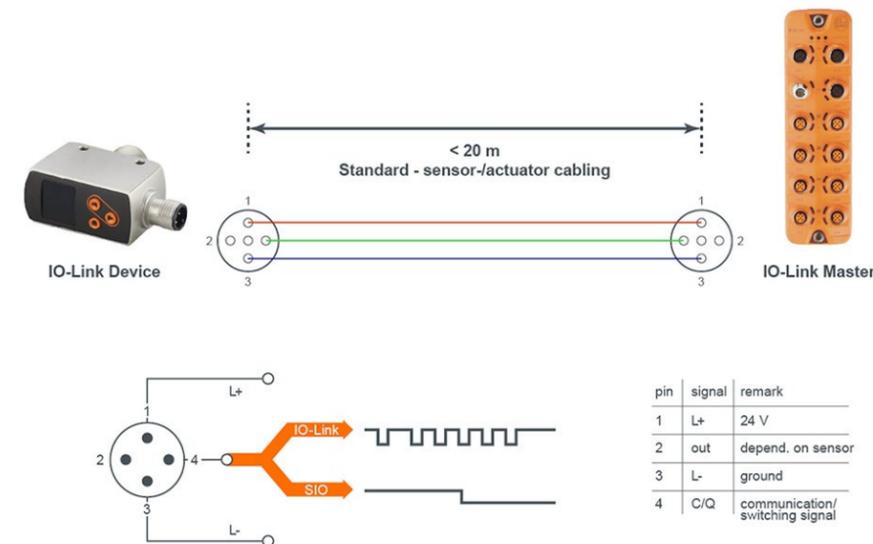

Figure 4: Example of SIO and IO-Link communication on pin 4.
Source: ifm

and process values, enabling predictive maintenance.

Using ifm's moneo software supports remote configuration and adjustments of sensor settings. In the rare event of a device failure, the moneo software can automatically transfer the necessary configuration to the replacement sensor, minimizing downtime.

Conclusion

PQ Cube sensors from ifm feature robust construction, user-friendly operation, versatile communication options, and flexible installation, making them ideal for a range of pneumatic applications. They have fast response times, high precision, and advanced features needed in Industry 4.0 automation and robotics systems.

Suggested reading

1. How to Make Smart Factory Actuators More Productive Using IO-Link

2. Working Through the Complexities of Selecting the Right Safety Controller

3. Sorting Through Proximity and Distance Sensor Technology Choices

4. Optimizing Industry 4.0 Communication Architectures using Multi-Protocol I/O Hubs and Converters

5. Using Cybersecure PLCs with Integrated Safety for High-Speed Industrial Automation

we get technical

Modular pushbutton system snaps together for flexible control panel designs

Written by Kenton Williston

When I was a child, my father would often take me to the pharmaceutical plant where he worked. I still remember marveling at the control panels full of lights and buttons that kept everything running.

Decades later, those pushbutton control panels remain ubiquitous. But today's control stations are rich with innovations that make pushbuttons more sophisticated yet easier to deploy.

With its modular, snap-together architecture, the SIRIUS ACT 3SU1 series from Siemens is a prime example. This series allows designers to easily mix and match buttons, selector switches, indicator lights, and enclosures, thanks to its largely tool-free assembly process.

This convenience is paired with a rugged design that is ready for demanding environments. The 3SU1 modules are available in both metal and high-grade plastic construction, with ingress protection to IP69K and robust NEMA ratings such as NEMA 4. Global certifications, including parts with ATEX and SIL safety certifications, enable use cases such as emergency stop even in hazardous areas.

What's more, the 3SU1 series supports networks like AS-Interface, IO-Link, and PROFINET in addition to traditional hard wiring. Among other benefits, these networks enable integration with the Siemens Totally Integrated Automation (TIA) Portal,

which provides hardware configuration, fault diagnostics, and data management.

Anatomy of a 3SU1 command point

To understand how the system works, consider the elements required for a front-mounted illuminated pushbutton (Figure 1). The core of the system is a holder with a mounting hole that accepts the pushbutton from the front and module slots that accept contacts, LEDs, and other accessories from the rear.

This modular concept extends to the broader 3SU1 range. For example, the system includes enclosures that can house up to six controls in a single weatherproof unit, labeling systems for custom identification, and protective collars to prevent accidental activation of critical controls.

Example build-out: an illuminated start button

Let's examine a widely used control element: the start pushbutton. One good option for this control is the 3SU10510AB400AA0 (Figure 2). This illuminated pushbutton features metal construction with a high-gloss ring surrounding a green plastic button.

The actuator's environmental credentials are impressive.

Figure 2: The 3SU10510AB400AA0 is an illuminated start pushbutton designed for harsh environments.
Source: Siemens

It boasts an IP69K protection rating, meaning it can withstand dust, water jets, and even high-pressure, high-temperature cleaning. It also meets NEMA ratings 1, 2, 3, 3R, 4, 4X, 12, and 13. With an operating temperature range of -25 to 70°C and a mechanical life expectancy of 3 million operations, this component is clearly built for demanding industrial applications.

Mounting the pushbutton with a metal holder

Our selected button integrates with a variety of holders, including the 3SU15500AA100AA0 (Figure 3). This model is constructed of metal and features a twist-resistant design to ensure proper orientation. The rear of the holder comprises three slots to easily accommodate the contact and LED modules required for this application.

Siemens also offers plastic holders, as well as holders with one to four

Figure 3: The 3SU15500AA100AA0 is a metal holder with three module slots and a twist-resistant design.
Source: Siemens

slots to match the complexity of the control function. Modules can even be stacked two deep, enabling sophisticated multi-function control points in a compact footprint.

High-reliability control and illumination with snap-in modules

The 3SU14001AA101BA0 (Figure 4) provides the actual electrical switching function. This normally-open (NO) contact module handles up to 10 amperes (A) and 500 volts AC (VAC). Its silver alloy contacts ensure reliable switching over the product's electrical life of 10 million cycles. Mounting this contact block into the holder is a simple matter of snapping it into place.

The 3SU14011BB401AA0 (Figure 5) completes our start button by

providing illumination. This green LED module operates on 24 volts AC (VAC) or DC (VDC) and delivers up to 1,400 millicandelas (mcd) for enhanced visibility even in bright environments. Like the contact module, the LED module snaps into the holder.

Beyond standard pushbuttons, the 3SU1 family includes emergency stop mushroom buttons, key-operated switches, and other specialized parts. Similarly, the range of contacts, lighting, and other accessories is comprehensive.

Conclusion

The Siemens 3SU1 series introduces modern innovation to control panels, a fundamental element in industrial automation. The series' modular, snap-together design simplifies both specification and installation, while support for networks like PROFINET and AS-Interface connects these traditional controls to today's industrial automation infrastructure. The control panels that captivated me as a child might look the same, but, under the hood, they've clearly evolved!

Figure 4: The 3SU14001AA101BA0 is an NO contact with screw terminals.
Source: Siemens

Figure 5: The 3SU14011BB401AA0 module features a green 1,400 mcd LED and screw terminals for a 24 volt supply.
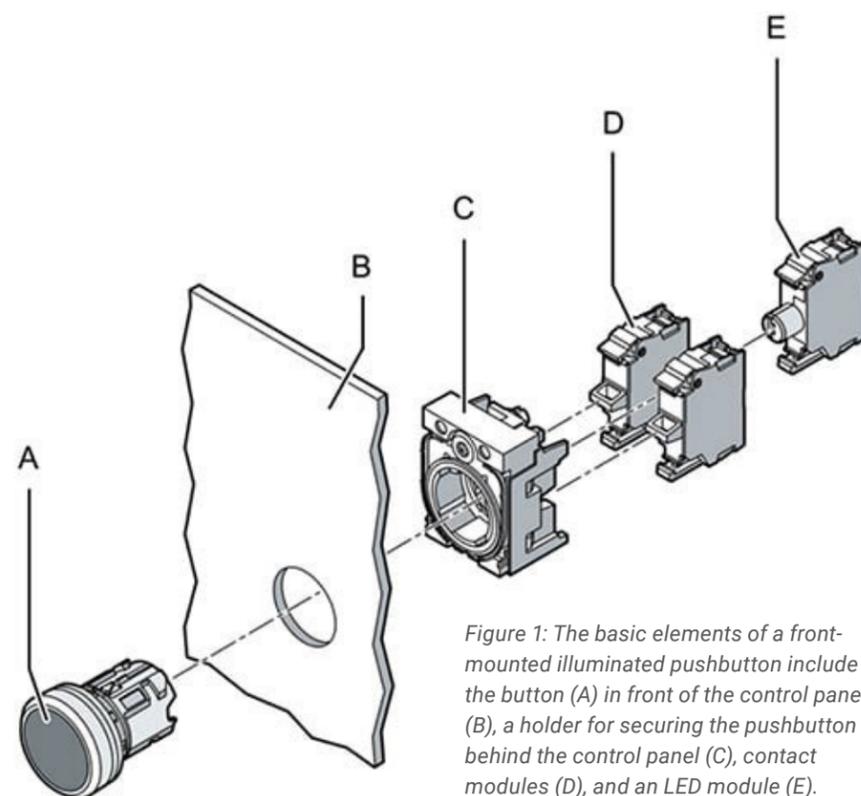*Source: Siemens*

Figure 1: The basic elements of a front-mounted illuminated pushbutton include the button (A) in front of the control panel (B), a holder for securing the pushbutton behind the control panel (C), contact modules (D), and an LED module (E).
Source: Siemens

DigiKey

we get technical

How to use compact PLCs to get big results in green energy, building automation, and industrial systems

Written by Jeff Shepard

Industrial network designers are being pressed to integrate traditional programmable logic controller (PLC) and industrial Internet of Things (IIoT) technologies in cramped spaces to support high performance in smaller automation and digitalization projects.

The controller must be compact but still able to bridge traditional automation with the IIoT and integrate information technology (IT) and operational technology (OT) networks. It needs a powerful dual-core processor, a microSD card slot, and at least 18 analog and digital I/O channels.

To maximize flexibility, the I/O should include an RS-485 serial port and a USB-C port for direct configuration connection. Some applications benefit from an optional CANopen communication port. To support OT and IT integration, it must have two Ethernet ports that can support two unique IP addresses, one for field-level devices and the second for SCADA or Cloud connectivity.

To expedite deployment, support for the CODESYS 3.5 integrated development environment (IDE) should be included, which allows users to build automation projects and systems quickly. Support for Docker containers in running open-source applications can further enhance flexibility and speed up deployment.

This article highlights the numerous capabilities of the WAGO Compact Controller 100 Series. It demonstrates how these controllers facilitate the rapid development and deployment of highly capable automation solutions for various applications, including building automation, battery energy storage, microgrids, industrial machines, green energy systems, and more.

The Compact Controller 100 (CC100) PLCs measure only 55 mm (L) x 108 mm (W) x 90 mm (H)

Figure 1: The CC100 model 751-9401 has the same mix of I/Os as model 751-9301, plus a CANopen interface (right-hand corner).
Source: WAGO

and fit in the palm of a hand. The diminutive dimensions significantly understate their powerful potential for digitizing a wide range of automation functions.

Does the application require up to four digital outputs, eight digital inputs, and up to two analog inputs and two analog outputs, an RS-485 interface for protocols such as Modbus RTU, and temperature inputs for platinum (Pt) or nickel (Ni) resistance sensors? Model 751-9301 has them. If the application also needs a CANopen connection, designers can use model 751-9401 (Figure 1).

Can the application benefit from dual configurable Ethernet ports that can be used as a switch or for two separate IP addresses, supporting a dedicated connection to field and OT devices, as well as a separate connection to SCADA,

IT, or Cloud systems? Plus, is there support for industrial Ethernet protocols like Modbus TCP/UDP, EtherNet/IP, and EtherCAT, and support for IIoT and cloud connectivity using protocols like MQTT?

Are cybersecurity features such as SSH, SSL/TLS encryption, a firewall, and network broadcast protection essential for securing the network? Both models in the CC100 series have all that, and more.

In addition to these important features and capabilities, the CC100 PLCs offer a USB programming port to simplify and speed up configuration, as well as

a Micro SD card slot for firmware updates and other functions. As DIN-rail devices (per DIN 43880), both models can also be quickly mounted on small distribution boards.

Programming and power

To complete a basic installation, these PLCs require programming and power. Again, the CC100 series deliver big performance and possibilities. It can be programmed using CODESYS 3.5 in one or more of the IEC 61131-3 languages like Ladder Diagram (LD), Function Block Diagram (FBD), Sequential Function Chart (SFC), Structured Text (ST), and Instruction List (IL), or with options like Node-RED, C++, and Python.

The CC100 series supports Docker containers, enabling the running of additional applications and

Figure 2: This 787-2850 power supply is well matched to the needs of CC100 PLCs.
Source: WAGO

expanding their functionality. The built-in web server allows for the creation of HTML5 visualizations, facilitating easy operation and maintenance.

These PLCs can be enabled with utility-based protocols, including DNP3, used in electric and water utilities for monitoring and controlling remote equipment in SCADA systems. IEC61850 and IEC60870 are commonly used in electric substations, microgrid automation, and renewable energy and storage systems. Additionally, they support BACnet communications for building automation applications.

WAGO's 787-2850 power supply delivers 1.25 A at 24 VDC and is the ideal power source for the CC100 series PLCs since it's also designed to fit into compact installations (Figure 2). It features an electrically isolated output voltage that meets the requirements of safety extra-low voltage (SELV) and protective extra-low voltage (PELV) as per EN 61010-2-201/UL 61010-2-201, and an impressive MTBF of over 2.5 million hours at +40°C (per EN/IEC 61709).

Expansive possibilities

The integrated I/Os in the CC100 series provide a solid foundation, not a limitation, for implementing automation solutions. The I/O capacity can be expanded using combinations of 750 series I/O modules (over 500 are available) and I/O couplers.

Figure 3: The 750-348 is a CANopen fieldbus coupler.
Source: WAGO

For example, I/O module 750-1506 can be used to add eight digital inputs and eight digital outputs to basic CC100 PLCs. Various 750 couplers can be added to provide the required fieldbus connectivity. The coupler connects to the CC100 using an Ethernet cable and serves as a bridge, linking the CC100 to various fieldbuses.

For example, the 750-348 is a CANopen fieldbus coupler used to expand the I/O capacity of the CC100 by interfacing the modular WAGO 750 Series I/O system with a CANopen network (Figure 3). The 750-362 coupler supports connection with a Modbus network. Other couplers are available for EtherNet/IP or EtherCAT as a master.

Once a coupler is connected, it's a simple matter to use the CODESYS 3.5 software to program the PLC. The controller will then communicate with the I/O modules via the coupler to manage all the I/O points. The various couplers automatically detect all connected I/O.

For example, the 750-362 is a fourth-generation Modbus TCP/UDP fieldbus coupler. It translates signals from attached I/O modules (digital, analog, etc.) so they can communicate over a Modbus TCP/UDP network. It features two 10/100 Mbit/s Ethernet ports to support a daisy-chain topology, along with an integrated DIP switch for setting the IP address and an integrated web server for configuration and management.

Simple and powerful network management

CC100 is compatible with WAGO's web-based management (WBM) software that provides a user interface for configuration, operation, and maintenance through a web browser using the CC100's built-in web server and an Ethernet connection.

Users can develop and run HTML5 visualizations and manage secure access with features such as an integrated firewall, Transport Layer Security (TLS) encryption, and Virtual Private Network (VPN) capabilities, to protect against cyberattacks.

The HTML5 visualizations are hosted on the CC100 and can be remotely viewed on most web browsers. Basic information, such as controller status and system, network, and I/O states, can be viewed locally on the controller using integrated LED arrays.

WBM can also support network data management by facilitating the transfer of data to cloud solutions or utilizing protocols like MQTT to distribute data to other systems. The configuration for the cloud connection itself (like the cloud provider URL, security certificates, and authentication details) can be set up via the controller's WBM interface.
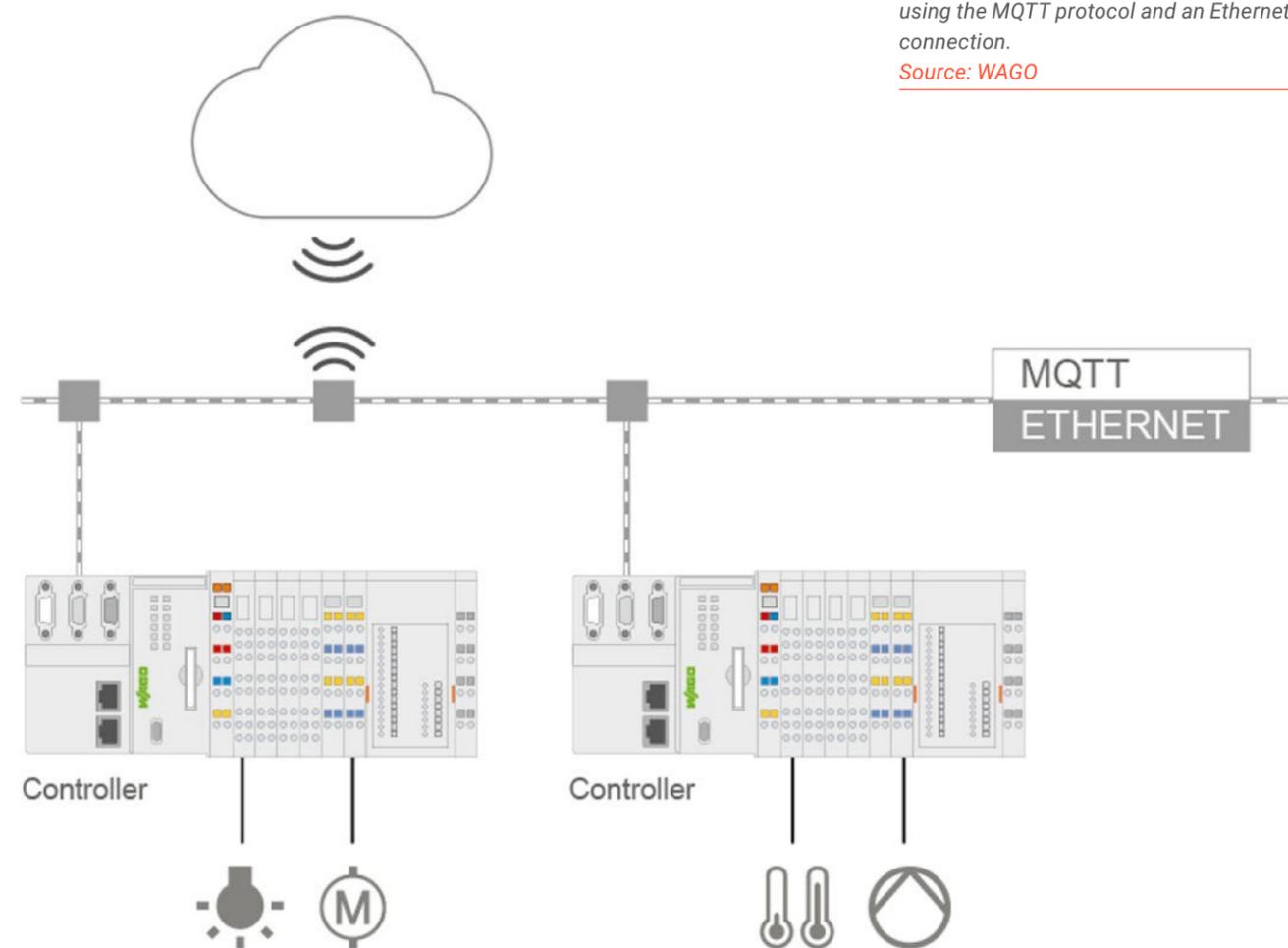
Figure 4: CC100 PLCs can reach the cloud using the MQTT protocol and an Ethernet connection.
Source: WAGO

Cloud connections

With cloud connectivity, the CC100 can serve as a gateway for IIoT applications. The communication parameter is configured in the WBM, and the data to be exchanged between the cloud and controller is configured using the WAGOAppCloud library for CODESYS, which can handle tasks such as configuration details.

The CC100 can access the Internet via the built-in Ethernet interface and send the data to the cloud. Users can specify the cloud service to use, with Microsoft Azure, Amazon Web Services, and IBM Cloud available options (Figure 4).

Function blocks and libraries are available that abstract the complex communication processes (like establishing a secure connection, formatting data into JavaScript Object Notation (JSON) format, and handling data transfer) into simple, reusable code that can be called from within a standard IEC program.

The IEC application also allows users to select which control variables, like sensor readings or machine status, should be sent to the cloud. Users can control data flow and decide when and how data is sent, for example, event-driven transmissions versus periodic transmissions. The application can also implement pre-processing of data on the CC100, thereby reducing the required bandwidth for cloud connectivity.

Conclusion

The diminutive size of WAGO's CC100 controllers belies their ability to support big performance in smaller automation and digitalization projects for a range of applications, including building automation, green energy, microgrids, electric and water utilities, and industrial systems. Their expandability also enables them to grow and adapt as requirements change. Their network management and cloud connectivity capabilities provide strong support for integrating IT and OT systems.

Suggested reading

1. Using Energy Storage Systems to Optimize Datacenter Reliability and Sustainability

2. Optimizing Cable Management to Ensure Safety and Efficiency in Utility Scale PV Systems

3. How Microgrids and DERs Can Maximize Sustainability and Resilience in Industrial and Commercial Facilities

4. New PLCs Help Speed the Deployment of Complex and Critical Automation Processes

5. How to Quickly Connect IoT Nodes to Amazon AWS and Microsoft Azure Clouds

Source: WAGO

DigiKey

we get technical

Use contactless power and data transmission for wear-free and low-maintenance industrial solutions

Written by Jeff Shepard

Flexible and highly reliable connections are essential in industrial applications, such as those used in robot tools and rotating devices like precision indexing tables. Those systems experience high movement and rotation and are often exposed to dirt and vibration that can cause conventional connectors or slip rings to fail.

Designers need new options to overcome the limitations of conventional solutions in these and other challenging applications. The new option must be able to support secure duplex Ethernet connections up to 100 Mbps and transfer up to 50 W of power for sensors and other components across a gap of 12 mm (or 40 mm for data only).

Flexible mounting options are necessary to support a wide range of system designs, and a simple, visible LED indicator is required for quick diagnostics.

Operation in harsh industrial settings requires an IP65 environmental rating, and the solution must meet IK06 per EN 62262, indicating that it can withstand external mechanical impacts with an energy of up to 1 Joule. Simple installation or replacement can minimize maintenance costs and downtime.

This article begins with a brief review of the challenges associated with using conventional connectors and slip rings in various industrial applications. It then delves into the capabilities of the NearFi couplers from Phoenix Contact, detailing how they address the electrical, mechanical, and security needs for contactless power and data transmission in challenging industrial applications.

Source: Phoenix Contact

Robot reliability challenges

Frequent tool changes for robots used in automated assembly processes can present significant challenges for connectors. Those tool changes can require hundreds of mating/unmating cycles every day.

Each cycle exposes the contacts to contaminants and causes wear due to contact friction. If the connectors are not precisely aligned, contacts can get bent.

The result is reduced connector reliability and unpredictable downtime for maintenance. In addition to connectors for tool attachment, some robots utilize slip rings for the transmission of data and power in rotating arms and joints.

Slip ring limitations

Slip rings can also be found in wind turbines, as well as in food and pharmaceutical processing and packaging lines, and other industrial processes. Like conventional connectors, slip rings can be damaged by exposure to contaminants and can experience excessive mechanical wear.

Slip rings can become hot due to friction and may require attention to thermal management. In some applications, slip rings can be subjected to strong vibrations or sudden impacts that can result in damage, cause unstable contact pressure, or even mechanical failure.

Both conventional connectors and slip rings can create machine design challenges related to size and movement constraints, as well as access requirements for maintenance. This adds to the numerous application challenges, including intermittent connections caused by vibration, dust, dirt, and contact wear, among others.

NearFi solution

Using "better" connectors may offer an opportunity for incremental improvement in performance or reliability. But what's really needed is an out-of-the-box approach that eliminates the most vexing connector challenges. That's NearFi.

NearFi is a non-contact technology that supports wear-free and reliable communication and power delivery across an air gap of a few centimeters or through non-metallic materials, such as plastic, glass, and wood. When transmitting only data, NearFi can connect across an air gap of 40 mm. Power, or combined power and data transmissions, can connect across an air gap of 12 mm.

NearFi uses 60 GHz wireless technology to transmit data and inductive coupling to deliver power from a base coupler to a remote coupler. Couplers feature a housing rated IP65 and IK06, along with M12 connection technology, ensuring wear-free and maintenance-free operation in demanding industrial environments.

The NearFi system gives designers a choice of three solutions:

- Data and power can be transferred simultaneously using the 1234224 base coupler with the 1234225 remote coupler.
- Power can be coupled without data support using the 1234226 base with the 1234229 remote.
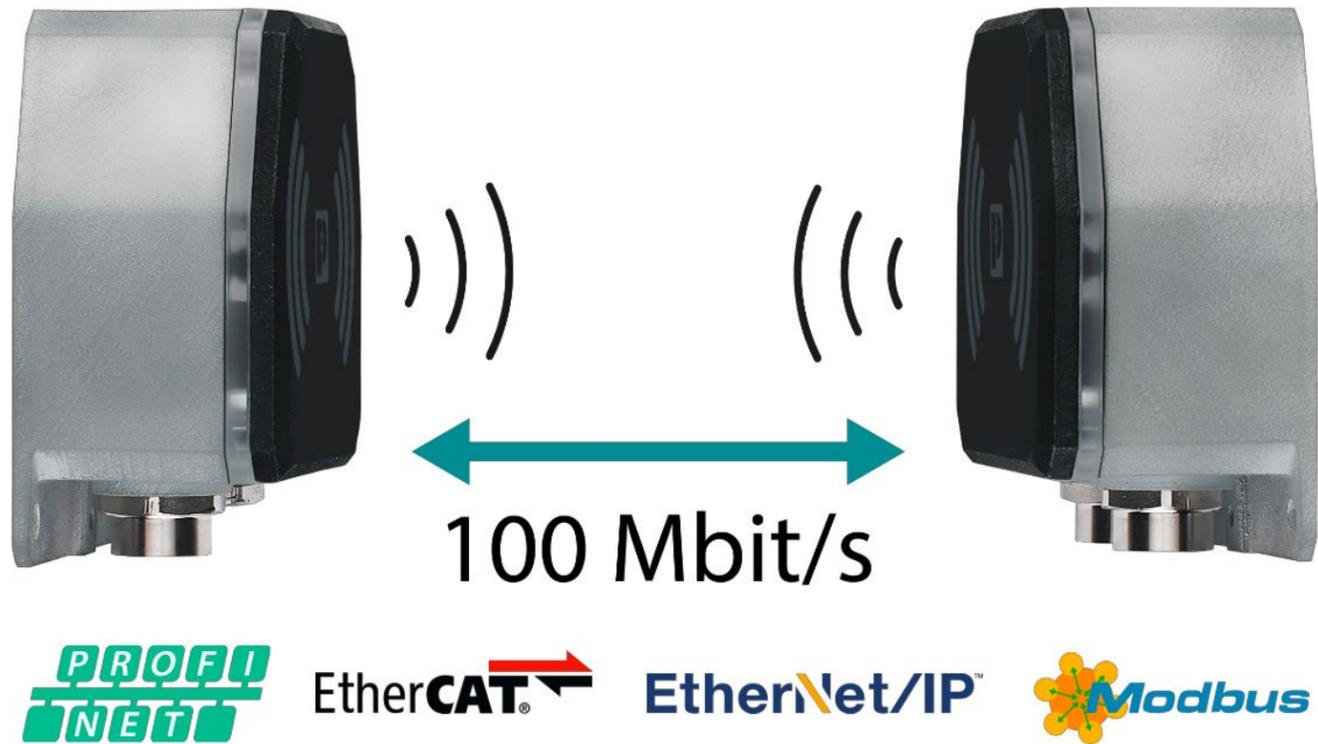
we get technical

Figure 1: NearFi supports protocol-agnostic, full-duplex 100 Mbit/s Ethernet.
Source: Phoenix Contact

- Data can be transmitted without power using the 1234232 base with the 1234234 remote.

Full-duplex Ethernet

With NearFi, data is exchanged simultaneously in both directions without latency. The use of two parallel 60 GHz connections on separate frequency bands, one for the uplink and one for the downlink, enables full-duplex real-time data transmissions. This makes it suitable for time-critical industrial protocols, such as PROFINET and EtherCAT. Since the transmission technology is protocol-independent, it can be used with any standard Ethernet protocol (Figure 1).

The use of near-field communication (NFC) is a key factor in NearFi performance. Unlike conventional far-field communication, which relies on propagating electromagnetic waves that travel indefinitely through space, the energy in NFC does not radiate out indefinitely. It decays rapidly with distance. NFC is a low-power technology that further mitigates the possibility of electromagnetic interference (EMI).

The use of NFC also ensures reliable coexistence with existing wireless technologies, such as WLAN or Bluetooth. Also, standard industrial interference spectrums don't impact NearFi transmissions, eliminating the need for frequency planning when deploying NearFi.

The limited range means that multiple NearFi links can be run in proximity without interference.

The bottom line is that NFC enables reliable, maintenance-free, high-speed data transmissions with substantial immunity to EMI. Finally, an LED ring on the coupler housings displays the connection status and facilitates troubleshooting, thereby speeding up setup and diagnostics.

Bit-oriented transmissions

The use of a synchronous, bit-oriented transmission technology is another key to NearFi's performance. Bit-oriented technology contrasts with the packet-oriented transmission of other wireless communications.

Packet-oriented implementations generally suffer from significant latency. The data arrives at the transmitter and must be put into packets before transmission. At the receiver end, the packets are unpackaged before the data is output to the system.

In NearFi synchronous transmissions, data is sent directly, bit by bit, as it arrives, with no packing or unpackaging. That produces a continuous data stream and virtually eliminates latency. That's why NearFi is well-suited for time-critical industrial Ethernet protocols, such as time-sensitive networking (TSN), PROFINET, and EtherCAT (Figure 2).

In addition, since the data is transmitted without buffering or packaging, NearFi is protocol-transparent and can handle any Ethernet protocol without requiring configuration.

NearFi addresses security concerns by limiting communication to a short distance. It can also support high-level security measures, such as encryption, authentication, and tokenization.

Delivering power

The NearFi system utilizes inductive power transmission with a frequency range of 100 to 148.5 kHz, similar to that used in some smartphone wireless chargers. Up to 50 W (24 VDC, 2 A) can be transmitted, and with parallel connection, up to 100 W.
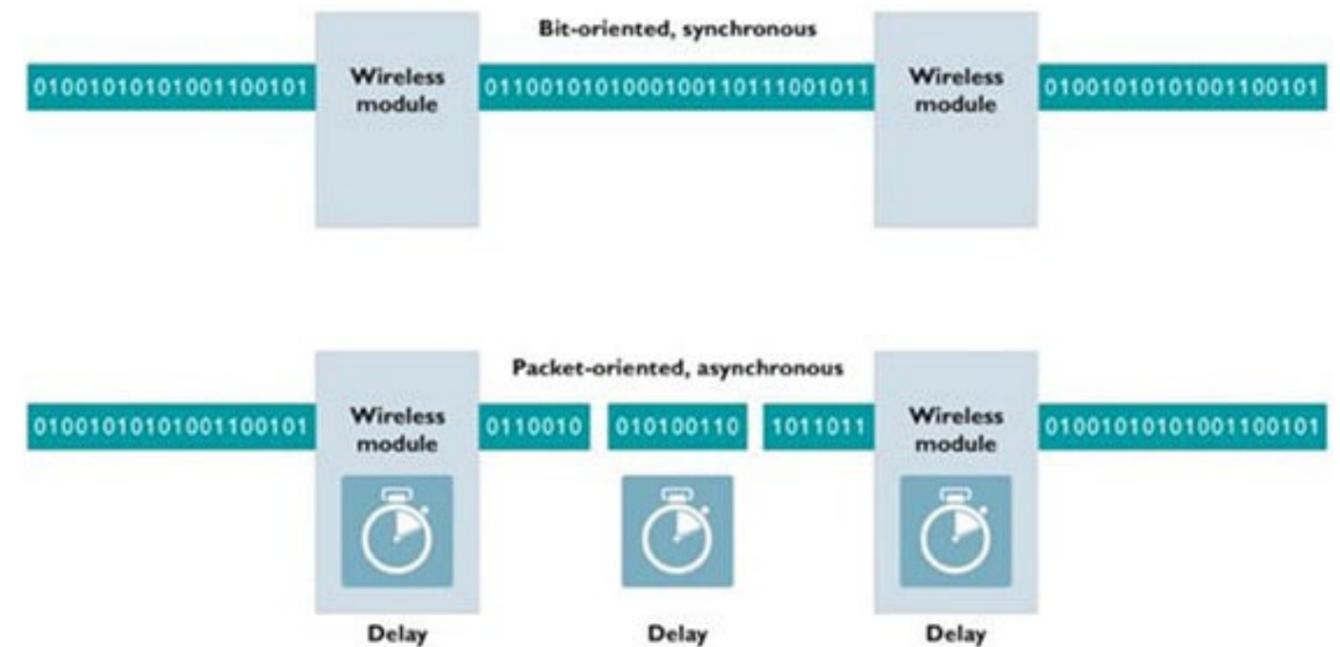

Figure 2: NearFi utilizes bit-oriented transmissions to mitigate latency challenges commonly associated with traditional packet-based communication.
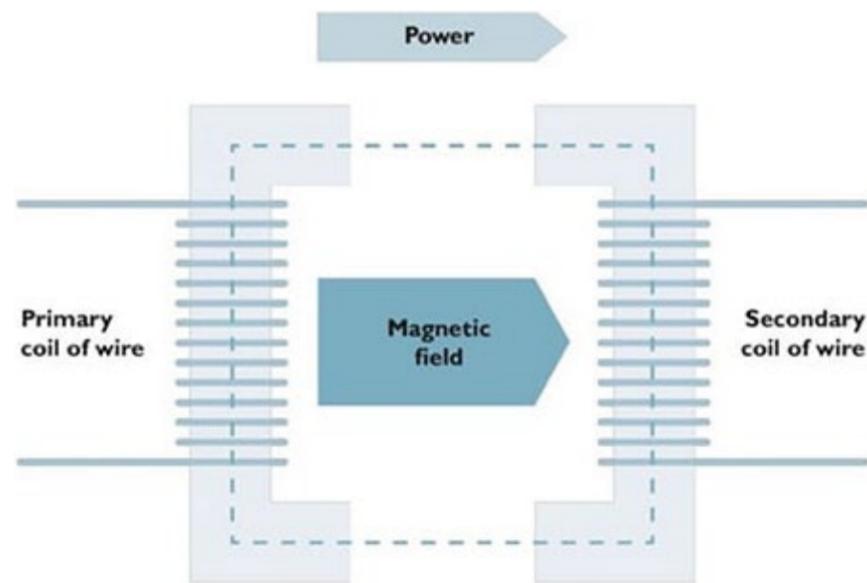*Source: Phoenix Contact*

Figure 3: Power is inductively coupled between the base coupler to the remote coupler.
Source: Phoenix Contact

Active closed-loop control delivers constant power transmission over the entire working area. The transmission of two electrically isolated voltages (each 50 W) is also supported. Like data connections, power delivery uses a base coupler and remote coupler.

The base coupler receives 24 VDC power from a source, such as a controller. The integrated communication power/sensor voltage converter, also known as the US converter (where "U" is the notation for voltage in German), converts the 24 VDC power into high-frequency power for inductive transmission. The remote coupler receives high-frequency inductive power and converts it back to 24 VDC in the UA (actuator voltage) converter for use in I/O, switches, sensors, actuators, and other functions (Figure 3).

Fast Startup

The NearFi Fast Startup function enables the quick (<500 ms) reestablishment of real-time links. That's possible because
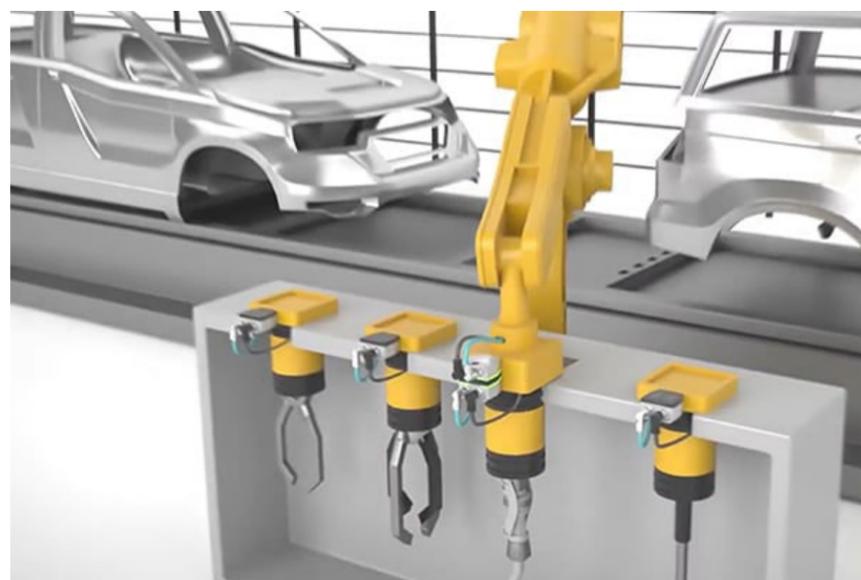
power transmission and data communication begin while the NearFi couplers are still in the process of approaching each other.

Fast Startup can significantly reduce cycle times in applications like robot tool changes (Figure 4). The bidirectional data transfer capability of NearFi also enables the new tool (or other attachment) to identify itself to the system, confirming that it's the correct item.

More application ideas

NearFi couplers can be brought together facing each other, with an offset, or at a tangential angle. They can also be used in applications where the base coupler is stationary while the remote coupler rotates (Figure 5). NearFi couplers are ready to use out of the box, eliminating the need

Figure 4: Possible use of NearFi in a robot tool changing station.
Source: Phoenix Contact

Figure 5: In this application, the remote coupler on the left is rotating while the base coupler on the right is stationary.
Source: Phoenix Contact

for programming and speeding up application development and deployment.

The same features that make NearFi suitable for use in robot tool changes can also support the needs of applications such as automated guided vehicles (AGVs) and material and workpiece carriers.

Rotating antennas, such as those found at airports, can benefit from replacing conventional slip rings with NearFi couplers. Similarly, precision indexing tables are used in industrial applications, as well as in bottle fillers within the food and beverage and pharmaceutical industries.

Conclusion

NearFi technology solves a host of seemingly intractable problems. It wirelessly delivers protocol-agnostic 100 Mbit/s Ethernet, plus 50 W of power, and is flexible and easy to use. NearFi couplers are designed for use in harsh industrial settings, featuring IP65 and IK06 ratings, as well as M12 connectivity. How will you use NearFi to differentiate your next design?

Suggested reading

1. New PLCs Help Speed the Deployment of Complex and Critical Automation Processes

2. Deploying Predictive Maintenance for the Maximum Benefit in Industry 4.0 Facilities

3. Motion Performance Considerations when Selecting VFD Cables for Robotics

4. Optimizing Industry 4.0 Communication Architectures using Multi-Protocol I/O Hubs and Converters

5. How to Overcome the Challenges of Developing Engaging User Interfaces for the Metaverse

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