The Magazine for the Industrial Ethernet Standard

Market Leaders Count On POWERLINK
EDITORIAL

A look at the big picture

To manufacturers, customers and experts in the automation industry, the competition taking place among industrial Ethernet systems seems to have much in common with auto racing.

And the comparison is more than apt: on the one hand, you have everyone jockeying to take the lead, and on the other hand one of the most important factors is speed. And just like in racing, communication systems must also push the envelope of physics to its limits in order to gain as much of an edge as possible. Where seconds matter for race cars, manufacturers of deterministic communication systems are fighting down to the microsecond. This is especially necessary when it comes to optimizing complex movements in motion control applications. Nevertheless, speed is not everything. The Formula 1 team that focuses solely on engine tuning is going to wind up with a car that heads into a curve way too hot. In order to achieve top performance, the aerodynamics of the car must be optimized, gear ratios must be properly adjusted and the tires need to be able to hold the road at extremely high speeds. With an industrial Ethernet system, the same principle holds. The shortest possible cycle times are important, but they offer little to no advantage if they result in an inflexible network structure, reduce the amount of payload data to a minimum or demand exorbitantly expensive controllers. This is why flexibility, cost effectiveness, user friendliness and high availability are counted among the most important characteristics that machine manufacturers and operators expect from their systems. In addition, safety is becoming a more and more critical aspect, which ties into the question of the availability of compatible safety solutions. POWERLINK offers all of this and more. Potential customers desiring comprehensive information about this technology aren’t looking for assurances, however; they are much more interested in tangible references. And that’s exactly what we would like to present, dear reader, with this issue of POWERLINK Facts. Our goal is to provide you with an overview of the different industries currently using POWERLINK and highlight the specific advantages this system offers for each. Before we address its practical applications, we would first like to get you acquainted with the functional, performance-related characteristics of POWERLINK as well as the cost-effective advantages that exist regardless of industry. I sincerely hope that you find this reading both interesting and enlightening.

Best Regards,
Anton Meindl
Director of the Ethernet POWERLINK Standardization Group
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The fundamental features of POWERLINK

Performance, flexibility, expandability and investment security - these are just some of the general properties that a data communication system needs to be able to provide when used in an industrial environment. The following table provides an overview of general functions and capabilities that set POWERLINK apart from other systems. Although this table reflects several important performance factors, due to the large number of individual applications with very specific demands on machines and systems, it is not exhaustive in scope.

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<th><strong>POWERLINK: Technical and commercial advantages</strong></th>
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| Simple installation | - Choice of any topology: Star, ring, line, tree and any combination thereof is permitted.  
- Node switches allow simple configuration of network stations using a screwdriver.  
- Extensive diagnostic capabilities are always available with a diagnostics channel that can’t be manipulated.  
- Standard Ethernet cabling  |
| Simple commissioning | - Automatic crossover detection  |
| Cable lengths and routing | - All Ethernet standards can be used: Copper, fiber optic, wireless  
- Possible to use any infrastructure components: Switches, hubs, repeaters  
- Possible to implement redundant cable routing for slip ring applications  |
| Comprehensive diagnostics | - Diagnostics channel always available with the asynchronous phase of the POWERLINK cycle  |
| Reliable, easy service | - Easy connections through hot plugging diagnostic devices and other components  
- Components can be swapped without reconfiguring; configuration takes place with the node switch.  
- Possible to easily unplug/replug cables for testing purposes  |
| Easy implementation in the automation system | - Easy to integrate components from different manufacturers using Electronic Data Sheets (EDS files)  |
| **Flexibility** |  |
| Modular machines | Requirements for a modular machine structure:  
- Cross-communication  
- Hot plugging capabilities, which allow modules and components to be unplugged and replugged during operation  
- Flexible cabling  
- The ability to use multi-controllers  
- Freedom to choose between a decentralized or centralized controller architecture.  
POWERLINK offers all of this.  |
| Interlinking machines | - POWERLINK’s communication structure allows 3rd-party systems to be connected easily.  
- Synchronized line architecture with POWERLINK  |
| Easily integrating 3rd-party components | - 3rd-party fieldbuses can be integrated into the asynchronous phase of the POWERLINK cycle.  
- Any user data can be sent via the asynchronous channel. In this way, devices such as IP cameras can be connected to the POWERLINK network.  
- Easy integration of components using Electronic Data Sheets  |
| Uncomplicated measuring | - Data is collected in the components in parallel.  
- Asynchronous phase for reading out data in real-time (e.g. oscilloscope function)  |
### Safety

| Integrated safety technology with openSAFETY | - Safety functions can be programmed freely and independently of the PLC.  
- One uniform bus for payload and safety data  
- Safety standard certified for SIL 3  
- openSAFETY provides a uniform safety protocol for POWERLINK, SERCOS III, EtherNet/IP, Modbus TCP and Profinet. |
| Fast safety responses | - Safety architecture with cross-communication allows increased safe production. |

### Performance

| Axis synchronization / short machine cycle times / precisely synchronized sensors and actuators / motion control | - Minimal jitter  
- Shortest cycle times  
- Cross-communication for maximum efficiency  
- Network structures with distributed intelligent axis controllers  
All of these aspects form the foundation for maximum deterministic performance in any application with POWERLINK. |
| Special open and closed-loop functions | - The power of POWERLINK allows control circuits, e.g. hydraulic control circuits, to be closed from the bus.  
- Cross-communication makes it possible to optimally synchronize distributed intelligent controllers.  
- Cross-communication reduces the load on the controller. |

### Reliability

| Machines and systems with high availability | - Redundant cabling possible  
- Hot plugging allows devices and components to be connected or replaced during operation.  
- Multi-master: redundant master in standby mode  
- Slip ring redundancy  
- Comprehensive diagnostic tools always available |
| High degree of reliability and immunity to interference | - Minimal EMC disruptions through the sending of individual telegrams  
- Few points of contact  
- Electrical isolation of transmitters, optional usage of fiber optic cables |

### Security

| Cost effective | - Cost-effective connections with FPGAs  
- No licensing fees |
| International availability | - POWERLINK is an international IEC standard.  
- Internationally active user organization |
| Second source components | - Internationally renowned manufacturers offer POWERLINK components.  
- Open technology  
- POWERLINK is solely software based.  
- Free source code for all functions  
- Open user organization  
- Unpatented technology  
- License-free  
- No dependence on proprietary hardware |
| Proven technology | - Of all available real-time Ethernet systems, POWERLINK has been on the market the longest.  
- More than 215,000 machines operate with POWERLINK worldwide. |
| Standardized bus system | - POWERLINK and openSAFETY are certified according to IEC standards. |
| Areas of use | - Supports both centralized and decentralized controller architectures equally  
- Suitable for all industries  
- Also established in process automation |
| Optimized energy consumption | - Modularity allows individual machine or system components to be switched on or off during operation.  
- Performance monitoring constantly available in every cycle’s asynchronous phase. |
In the textile industry, the quality of the finished product and high production output are two of the most important goals. From the time that the raw materials are prepared to the packaging of finished textiles, there is a broad spectrum of processes that have many different demands that need to be met. From ginning, winding, combing and drawing through spinning, folding and dressing, until finally the fibers are spun, folded, twisted, printed, washed, dyed and bleached—all of these automated processes require an extremely high degree of precision control. Take spinning, for example: In order for the product to turn out flawlessly every time while handling large amounts of material, modern spinning machines require spindle movements that are perfectly synchronized. Whereas it used to be necessary to employ stepless gears and cam profiles for the power transmission, this can now be handled using a system consisting of programmable servo drives. The large number of axes and spindle rotations at approximately 25,000 rpm demand an extremely fast and reliable communication medium to ensure that data is exchanged smoothly between the I/O system, the controller and the drives. Real-time POWERLINK technology guarantees this type of efficient data exchange. With extremely short cycle times and very low jitter, POWERLINK provides maximum precision.
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Fast product cycles, wide diversification and individual packaging designs are decisive for a company’s market positioning. For packaging production without downtime, automated product and format changes need to take place with the line moving at full speed. Maximum flexibility, which is important for packaging systems like never before, requires both master encoder signals that are precisely synchronized as well as a modular structure of the machines and systems being used.

POWERLINK provides the ideal infrastructure for decentralized automation with modularized control units. The basic requirements necessary for a modular system structure as well as system expansion include the ability to handle cross-communication and being able to freely choose the network topology to be used. The fastest possible speeds as well as the ability to transport service data as needed – even when the transfer bandwidth is being used to its fullest – make it possible to seamlessly integrate all automation processes and components into a single network: from filling, bolting, cartoning and printing all the way to product tracking, including CAM and ERP.

Packaging makes the difference
SPECIAL FACTS
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No run-of-the-mill solution:

POWERLINK for woodworking machines

When automating woodworking processes, the performance of the machines, minimal downtime, simple system diagnostics and uncomplicated integration into the automation environment are all decisive factors. In addition, the machine environment requires a suitable safety system to prevent hazardous conditions that could injure operating personnel.

Because it conforms to the Ethernet standard, POWERLINK ensures that systems can be diagnosed using standard tools and devices. Due to its communication structure, POWERLINK always has a portion of its bandwidth reserved for performing diagnostics, a portion that can never – even purposely – be used for anything else. Additional advantages that come from conforming to the standard include the high availability of necessary network components as well as a structure that can use any topology. In other words, during system expansions the network form being used does not have to be taken into consideration in order to maintain POWERLINK’s real-time capabilities. To ensure the safety of both man and machine, the openSAFETY safety protocol replaces traditional safety wiring with intelligent electronics. Compact machine and line constructions are made possible thanks to the fastest safety circuit response times as well as the highest degree of flexibility in the design of the automation architecture. These can be implemented easily with maximum design freedom and a level of safety that cannot be topped.
SPECIAL FACTS
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The success of print media depends on the material’s timeliness, print quality and variety. In addition, the expanded use of individualized media for marketing to specific target groups has led to an increase in the importance of short print runs. Keeping up with these demands requires top-performance production systems with high availability and the shortest possible production times. The only way to guarantee efficiency, therefore, is with a high degree of automation across the entire spectrum. The most decisive factors include flexibility, minimum downtime and setup times as well as machines that can be interlinked efficiently. Modern printing machines print sheets of material at speeds up to 100 meters per minute; even the smallest tolerances lead to deficiencies that must be rejected. Nonetheless, print motifs and the print material itself need to be replaced on the fly. This results in a multitude of challenges with regard to closed-loop control. For example, the position and rotating angle of the print cylinder needs to be synchronized within a matter of microseconds to the circumference and position of the impression cylinder, the sheet of material needs to be held at a suitable tension on its track and, last but not least, allowances must be made for the natural resonance of the mass oscillator. Since the quality of the entire control procedure depends on the coordination of the drive controllers, a communication system with short cycle times and minimal jitter is indispensable. And where time-critical drive functions must be controlled and coordinated in rigid real time, the cross-communication capabilities of POWERLINK and its ability to be used with any network topology make it the ideal infrastructure for all decentralized automated tasks.

Ultimate closed-loop control: Printing machines
Fantastic plastic: POWERLINK in the plastics industry

In a world becoming more and more connected, modularly designed plastic manufacturing systems from different manufacturers need to be able to communicate with each other – usually over open bus systems like CANopen or industrial Ethernet. POWERLINK offers both: This real-time protocol is also referred to as "CANopen over Ethernet" since it uses the same object directories as well as the same communication mechanisms such as process data objects, service data objects and network management. With injection molding machines, the response times of both the measurement chain and the machine’s controller are of extreme importance for product quality. Switching over to hold-on pressure, for example, which guarantees the even distribution of the injected plastic melt, depends on the high-speed processing of pressure and temperature signals. As infrastructure without time lag, POWERLINK’s extremely short communication cycles make it especially well suited for these control loops. In addition, the ability to handle cross-communication allows this real-time protocol to precisely synchronize several axes, which is essential in ensuring high product quality. POWERLINK is already well established in the plastics industry. This is one reason why EUROMAP, the European committee representing manufacturers of plastics and rubber machinery, has included POWERLINK in its specification.
The technologies used in manufacturing and processing materials in the metal industry are many and varied. They range from molding and milling using metal-cutting processes, bending, grinding and polishing to punching, soldering and welding. The level of automation needed in all of these processes is very high, and the use of CNC and robots in production has become essential. High demands are also placed on the speed of networks used in automation. Speed is not everything, however; just as decisive is providing sufficient flexibility to handle the various controller requirements in different production scenarios. The uses of POWERLINK range from simple tasks such as speed control or closed-loop hydraulic control all the way to CNC control of multi-axis applications. Thanks to its extremely short cycle times and typical Ethernet bandwidth, POWERLINK is just as suitable for centrally organized network architectures, which allow even highly dynamic control loops to be handled via the bus, and centralized networks with subordinate control loops as it is for decentralized architectures, in which e.g. servo drives with integrated positioning controllers are used. High performance and absolute flexibility make POWERLINK a cost-effective solution that meets every demand.
There’s probably not an industry out there that is subject to as much pressure as the semiconductor field when it comes to innovation. This accelerated development constantly requires increased productivity while simultaneously keeping costs optimized. Speed, precision and versatility are the most important factors here. Powerful control electronics with self-contained intelligence check the processes in the microsecond range. The foundation for this synchronous cooperation between the individual subprocesses is POWERLINK. With the increase in real-time demands, decentralized controller structures with distributed intelligence are gaining in importance, but they require a communication system that supports this network architecture. POWERLINK is suitable for both centralized as well as decentralized structures, thus guaranteeing absolute flexibility. The openness of this communication system therefore provides a maximum degree of investment security.
Better safe than sorry: Highly available POWERLINK networks for process automation

Automation in process manufacturing places considerably higher demands on controllers and networks than is the case in discrete manufacturing. Whereas in the production of goods, stopping machines and switching off systems for maintenance work is undesired but possible, many processes such as generating electricity or those connected with the chemical industry can only be interrupted, if this is even possible, with substantial negative repercussions. For this reason, data infrastructure must be absolutely fail-proof. Redundant systems are necessary that can immediately register a malfunction in the main controller and take control over the network within just a few communication cycles. This type of system also requires redundant wiring and the right equipment to manage the secondary infrastructure. Highly available POWERLINK networks provide these types of safety measures while also minimizing response times and employing real-time synchronization and diagnostic capabilities. Needless to say, they are already being used in several fields in the process industry. These networks allow the integration of several redundant network masters that constantly monitor the active master as well as all other stations on the network. Dual data lines provide every network node with the redundancy they need.
Challenging the competition:
The world’s Number One – with 215,000 production machines in operation.

That’s true capability.