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Linear-Position Sensors

MTS SENSORS

New Developments in Position Sensing Solutions to Address the Demands of Industrial Ethernet

White Paper

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The prevalence of Industrial Ethernet technology is expanding all the time. Companies serving a wide range of industry sectors (manufacturing, petrochemical and avionics to name just a few) are migrating away from the slow and inflexible interfaces that were previously used and seeking out higher speed alternatives. Market analyst firm Technavio has predicted that the global Industrial Ethernet business will experience a compound annual growth (CAGR) of 9.5% between now and 2019.

Industrial Ethernet is far more versatile than the serial interfaces, like RS232, RS422 and RS485, which were employed in industrial automation systems in the past. Through its deployment major improvements can be made to the efficiency of communication infrastructure and marked reductions in day-to-day running costs witnessed. In simple terms it relies on Cat 5 and Cat 6 cables that are identical to the ones used by Ethernet technology in offices, data centers and suchlike for several decades. Like conventional Ethernet, Industrial Ethernet permits the transfer of a variety of different media over a single cable (video, data, voice, etc.). Furthermore, it has the same protocol characteristics and offers equivalent data performance (carrying up 100Mbps), but with one very notable aspect added - that of augmented robustness. The constituent components in an Industrial Ethernet system are designed to cope with being located in the most difficult of settings. As a result the system's working lifespan is not impinged upon by heavy vibrations, elevated temperatures, exposure to electro-magnetic interference or high levels of humidity. The upshot of this is that higher bandwidth connectivity can be benefitted from without the risk of operational failures occurring.

INDUSTRIAL ETHERNET - IMPORTANT DISTINCTIONS FOR STANDARD ETHERNET

In enterprise type applications, such as corporate IT systems (where connectivity between computer peripherals, servers, or data storage resources is being provided), Ethernet communication is typically not deterministic in nature. Response times of 100ms to 150ms are typically acceptable. In industrial applications, however, things are quite different. Here this sort of latency cannot be tolerated and responses must be deterministic. Ethernet packets being transferred across a network do not typically come with consistent delivery times that industrial automation systems dictate. Requirements will vary of course. They will be dependent on the particular type of component involved. High-speed devices, such as drives, will call for update times of below 1µsec, while controllers and terminals might only need updates at intervals of 100µsec.

Another consideration for Industrial Ethernet implementation is the adding of devices into a network can potentially be a complicated process, with gateways or bridges being mandated. In order to address the need for faster responsiveness and determinism, as well as allowing better scaling of the network, a number of protocols for Industrial Ethernet have emerged.

INDUSTRIAL ETHERNET PROTOCOLS

The 4 principal protocols for Industrial Ethernet are ProfiNet, EtherCAT, Ethernet Powerlink and EtherNet/IP. Through these various different network topologies can be made use of (star, ring, tree, line, point-to-point, etc.). What basically differentiates these protocols is how they achieve the network traffic switching and timing that is required for deterministic purposes. A short description of each of them follows.

ProfiNet is a high level network topology that has seen quite a lot of traction in industrial automation applications, because of its high data transfer and real-time capability. It has proved especially popular in Europe. This protocol uses traditional Ethernet hardware/software as a basis for the network structures - with a decentralized topology. Through this, in addition to data transfer, diagnostics mechanisms can be benefitted from. There are 3 communication channels involved in the data transmission process. These are:

- The standard transport control protocol over IP (TCP/IP) channel
- The real time (RT) channel
- The isochronous real time (IRT) channel

EtherCAT - Ethernet for control automation (EtherCAT) stems from the widely implemented CANopen (EN 50325-4) standard. Reliant on unconventional Ethernet hardware, it has full duplex Ethernet PHYs (using the same bandwidth to deal with both input and output data). Through this it can achieve short cycle times (down to 100µsec) plus a high degree of synchronization. What is more this protocol supports a broad range of different network topologies.

Ethernet Powerlink - Just like EtherCAT, Ethernet Powerlink is a derivative of CANopen, but this time uses standard Ethernet hardware. Each controlled device within the network transmits and receives data in accordance with a predefined schedule. It is through this that the protocol can deliver adequate levels of speed and determinism for industrial tasks, offering cycle times in the region of 200µsec.

EtherNet/IP - Originally developed by Rockwell Automation, the EtherNet/IP protocol is now recognized as an open standard. This protocol, which was first introduced in 2001, combines many of the features to be found in DeviceNet and ProfiNet. It allows a straightforward network architecture to be implemented, dispensing with the need for additional external components or cabling (and thereby lowering bill of materials costs). Responsibility for the proliferation of this protocol is taken care of by the Open DeviceNet Vendors Association (ODVA). At the foundation of EtherNet/IP (as well as DeviceNet) is the common industrial protocol (CIP). This presents the industry with a highly effective, universal communication architecture. It comprises an expansive suite of messages and services that are of great value to industrial automation tasks - among these are control, synchronization, motion, configuration, etc.). CIP defines profiles for the array of industrial devices that might be incorporated into the network (drives, motors, sensors, actuators, controllers, etc.). Systems using EtherNet/IP can be configured in either a master/slave arrangement or a distributed control arrangement using peer-to-peer communication topologies. It is a highly scalable protocol, with extra nodes or devices being relatively easy to add to the network.

THE FUTURE POTENTIAL OF ETHERNET/IP

By categorizing messaging data as either explicit or implicit message types, Ethernet/IP is able to deliver real-time performance. Explicit messaging, via the TCP, is used for client-server type information such as diagnostics and configuration, where a specific request is responded to but speed is not a vital aspect. Conversely, implicit messaging, via the user datagram protocol (UDP), is optimized for applications that are time critical, as it is significantly faster than explicit messaging. It is thus employed in the capturing and processing of the real-time data that is be passed to and from actuators and sensors. With Ethernet/IP incorporating quality of service (QoS) functionality, it is able to prioritize the delivery of implicit messages.

When implementing a communication network based on Ethernet/IP through which industrial automation processes can be carried out, it should be ensured that the constituent components have already been conformance tested for by the ODVA. A declaration of conformity (DoC) is provided by this body for every product that complies with Ethernet/IP requirements. Conformance testing makes system assembly easier, as it means that configuration issues can be avoided. The adding of a device to an Ethernet/IP network is not complicated, as the need for bridging or switching components has been eliminated. With an EDS Add-On-Profile (AOP), the sensor parameters and configuration data are automatically loaded, so the only step required to add a new device to the network is setting the IP address.

SENSOR DEVICES ADOPT INDUSTRIAL ETHERNET PROTOCOLS

There are countless applications within the industrial sphere where access to accurate positioning information is needed so that actions can be trigged in real time - including processing plants, steel mills, wood presses, factory automation lines, etc. In the past this information would have been transferred from the position measuring device through the system in the form of an analog signal, or in some cases via a dedicated fieldbus network (for example CANbus, DeviceNet or Profibus). However, as we have seen the expectations that have been set by modern industrial networking are now reaching way beyond this.

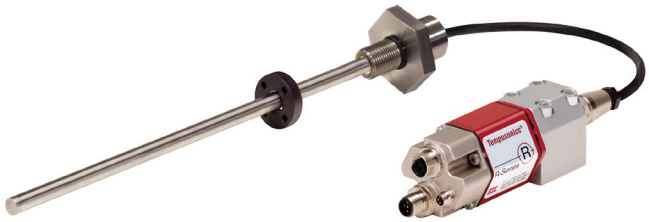

Figure 1: MTS Sensor's RD4 device for industrial networking

MTS Sensors recognized that by providing position sensing hardware that was compliant with the Industrial Ethernet protocols discussed it would be better able to attend to the ever growing industrial automation market. Based on proprietary Temposonics® technology, the R-Series of high performance magnetostrictive sensors is offered in rod style, profile style and flex style sensor housings, with an extensive range of stroke lengths covered. These devices deliver repeatable data - keeping within a ±0.001% (full stroke) margin. The company's Model RH and Model RP high accuracy linear position sensors both provide EtherNet/IP functionality and have already been specified into a multitude of customer applications. The built-in device-level-ring (DLR) capability enables direct connection of these sensors to networks that have ring topologies without the use of external switching components. The highly advanced Model RD4 has a linear deviation of below 0.02%. Its detached electronics arrangement means that delicate components can be kept away from potential sources of harm that might be present close to the sensor head (vibration, heat, heavy shocks, etc.). In addition to traditional voltage and current outputs, an expansive array of other outputs can be chosen from - including SSI, CANbus, DeviceNet, Profibus, EtherCAT and EtherNet/IP.

MTS Sensors has now made further enhancements to the R-Series so that it conforms to the latest version of EtherNet/IP protocol, recertifying it in accordance with the ODVA's EtherNet/IP CT12 composite conformance test revision. The upgraded devices are better able to meet the needs of modern industrial networking systems, interfacing with a broader spectrum of hardware that is EtherNet/IP compliant. Also, thanks to the DLR feature, it is far simpler to integrate them into an Industrial Ethernet network.

MAGNETOSTRICTIVE SENSING TECHNOLOGY

The innovative Temposonics position sensing technology developed by MTS Sensors allows the company to differentiate its sensor devices from those of the competition. Temposonics relies on magnetostriction to accurately determine absolute position. Sensor devices that are based on this technology are optimized for use in the most uncompromising of industrial environments (such as those previously described).

CONCLUSION

As already detailed, the main obstacle that needed to be overcome in order to apply Ethernet connectivity to the industrial automation sphere was achieving the required levels of speed and determinism. Through the introduction of Ethernet/IP as well as other sophisticated Industrial Ethernet protocols, and their increasing propagation, this is now possible. By sourcing a linear position sensing device that fully supports a relevant Industrial Ethernet protocol, engineers can place it, along with other component parts involved in the specific industrial automation task, on a unified, cost-effective and simple to operate network. Reliability can be improved substantially and fault tolerance requirements adhered to. Sensor manufacturers need to keep pace with the industry bodies. They should be in a position to supply their customers with devices that conform to the latest versions of the protocols. Through this Ethernet will move closer to being ubiquitous in the industrial as well as the IT domain.

ABOUT MTS SENSORS

MTS Sensors is a division of MTS Systems Corporation (NASDAQ: MTSC) and is recognized worldwide as a leader in the design and manufacture of high precision, robust position sensing solutions for industrial, mobile hydraulic and liquid level sensing applications. Among the key sectors it serves are industrial machines, power generation, construction/ agricultural vehicles, textiles, paper production, steel plants and saw mills. Sensors from MTS are often implemented in safety-critical applications, including hazardous areas. MTS Sensors has manufacturing facilities in the United States, Germany and Japan. Customers are supported by an extensive global partner network including cylinder manufacturers. Through its research, development and production of leading-edge sensing technologies, MTS Sensors provides its customers with a comprehensive and constantly expanding product portfolio and is continually working with them to improve performance and reduce downtime in their operations.

For more information on MTS Sensors, please visit www.mtssensors.com or contact a local MTS representative.

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LEGAL NOTICES

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