Trigger numerous sensors highly accurately:

Synchronous measuring with Standard Ethernet

Modern industrial applications focus on quality, precision and speed. Precision measuring plays an important role when implementing these objectives in production and processing plants. At the same time, at the communications level, a migration is taking place towards Industrial Ethernet. There is still some uncertainty amongst users as to whether it will be possible to manage the ever more demanding tasks in the area of measuring using the standard concepts of Ethernet now and in the future.

There is, however, no doubt that Ethernet and TCP/IP will become the dominant communication system in industrial production in future. The benefits of a common standard for factories, the office, the Internet and other areas of use are obvious. A standard system throughout operation enables not only unlimited data flow between management, control and sensor/actuator levels, but also creates an optimum basis for data availability and communication in all corporate areas, including more convenient options for monitoring and remote maintenance.

Ethernet problem at the sensor/actuator level

The problem with Ethernet at the sensor/actuator level is, however, a lack of real time capability. When recording measurements a clear indication of time is normally a prerequisite for processing the data sensibly. Special real-time enhancements, such as Ethernet Powerlink, Ethercat or Profinet, do exist. They are designed for highly dynamic drive technology applications; however, this article focuses on the subject of measuring technology only. In terms of open, flexible and cost-efficient systems, users in this area do well to favour solutions which get by without proprietary approaches. Here it must be asked what options are currently available for measuring technology based on Standard Ethernet. The necessary requirements regarding synchronous data acquisition must be taken into account if there are a lot of measuring points.

Non-deterministic access procedures

In principle, connecting sensors to Ethernet does not present any difficulties as the market provides various connecting modules with industry standard plug-in/screw connections. Ethernet's handicap is the CSMA/CD (Carrier Sense Multiple Access with Collision Detection) access procedure which has been retained with despite all subsequent developments and improvements in order to maintain upwards compatibility. Collisions occur if different subscribers access the transmission medium at the same time. These cost time and, if network utilisation is high, significantly lower performance. Which subscriber will picked up first and be

able to transmit is ultimately determined by chance. With such a non-deterministic system you therefore never know which measuring data will arrive at the control exactly when and in what order. In the other direction, it cannot be determined in advance when a specific sensor, e.g. a trigger impulse, receives a signal if the control transmits trigger signals to several sensors.

Speed instead of real time

In practice, the situation described here is normally much less dramatic than it first sounds, as the incomparably higher bandwidth of Ethernet compensates for the lack of real time capability in most cases. Fast Ethernet, which is now the defacto standard, with a transfer rate of 100 Mbit/s provides speeds which are around nine times faster than the fastest field buses with RS-485 technology and 12 Mbit/s. In the foreseeable future, even faster Ethernet variants with 1,000 and 10,000 Mbit/s are likely to be implemented all over the country.

Flexible topology and structured networking

An interesting property of the Ethernet is its huge flexibility as regards topology. Switching Ethernet enables star, tree and linear structures, including all conceivable combinations of these. For transmission paths focusing on particularly high resilience, even redundant ring-structured Ethernet threads can be used if you connect the open ends of a line via a redundancy manager.

The structured networking makes use of the topology properties to minimise the frequency of collisions or to eliminate them completely. The more lines and switches the network load is distributed over, the fewer collisions will occur. Fully collision-free operation is achieved where, in the extreme case, a separate channel or a separate line is reserved for each measuring point. Although this contradicts the actual idea of a bus and increases networking costs, it shows how versatile and adaptable Ethernet is when it comes to individual cases.

Numerous sensors scan surfaces

The system is faced with particular challenges when using Ethernet in automation when numerous measuring values are to be recorded accurately and synchronously. An example of this is provided by the automotive industry when measuring engine pistons and cylinders with numerous transducers. When manufacturing pistons and cylinders, small but not insignificant tolerances occur in the micrometre range. Comparable measuring tasks for recording surfaces or workpiece dimensions highly accurately are also found in several other manufacturing and quality assurance processes.

Intelligent Ethernet connections are an advantage

The solution for measuring technology applications of this type is thorough localisation via intelligent Ethernet connection modules. A significant step is digitising the analog data as far as

possible to the measuring point, giving it a time stamp and only then forwarding it via Ethernet. Thus when transmitting data to the parent controller, the assignment of the measuring values to the corresponding cylinder coordinates will no longer be lost. In the control or inspection unit, complete measurement sequences can be uniquely reproduced, regardless of the transmission time and sequence. A buffer provides a valuable service in preventing individual values from being lost in the event of high network loads. As explained above, a large number of sensors cannot be synchronised or triggered accurately enough via Ethernet. The remedy is a separate Ethernet-independent hardware trigger line which connects all the relevant switching modules.

Modular and happy to communicate

As traditional passive Ethernet connections cannot satisfy such extensive requirements, intelligent Ethernet modules are called for, e.g. with integrated embedded system based on an economical and high performance ARM9 Risc processor together with an embedded Linux operating system. With the built-in intelligence, the measuring data can not only be digitised on site but is also pre-processed in almost any way. Data can be packaged in packets with a time stamp, average values calculated, interpolated or simply buffered in the onboard RAM. Ethernet and TCP/IP in conjunction with the Simple Object Access Protocol (SOAP) enable standardised access by remote computers. An implemented embedded web server also enables simple configuration of the Ethernet modules. Various request options are useful here, e.g. an auto refresh mode, which continually updates the memory with current measuring values, as well as a sequence mode, which supplies predefined data packages. Robust M12 and M18 screw connectors and housing variants with protection classes IP65 and IP40 meet industry standards.

Synchronisation via hardware trigger

According to this concept, the measurement technology specialist Addi-Data has developed intelligent Ethernet modules with various basic functions. Several modules can be cascaded via the integrated Ethernet 2-port switch. In addition, there are inputs/outputs for an external 24 V hardware trigger signal and the 24 V power supply; both can also be connected through module to module. Each Ethernet module provides 4, 8 or 16 input channels. Modules with analog inputs, digital inputs, counter inputs and modules to connect inductive displacement transducers are available. With the latter devices, in the example application of piston measurement, the existing synchronisation input can be fed with the signals from an incremental shaft encoder so that measurements can be triggered simultaneously depending on the defined winding pitch.

Summary

The right combination of intelligent local modules enables users to combine high performance virtual measuring systems with the necessary interface types and numbers of channels. Without any special solutions, multi-channel, synchronous measuring equipment based on Standard Ethernet can then be implemented in a cost-efficient manner. With regard to the spatial distribution of the measuring points and the data volumes to be managed, Ethernet enables optimum adaptation to specific requirements with its support of various networking topologies and structured networking.

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