EtherCAT in industrial measurement systems for the steel, aluminum and other metal industries

Flexibility and precision, even with red-hot steel
Huge masses that must be moved, extreme ambient temperatures and the need for exact process control – these are just some of the challenges IMS faces with its industrial measurement systems for the steel, aluminum and other metal industries. Top priorities include precision, reliability and flexible adaptability to individual requirements. A modular system that leverages integrated, high-performance EtherCAT technology forms the basis of the IMS solution.

IMS Messsysteme GmbH is one of the world’s leading manufacturers of isotope, X-ray and visual measurement systems for application in the steel, aluminum and other metal industries. Founded in 1980, the company has its head office in Heiligenhaus, Germany, and now has more than 350 employees on five continents. The precise measurement technology from IMS is used in harsh environments typical in the production of flat steel and tubes, for material testing, pipe production and processing, in coating systems for steel finishing, for continuous, contact-free measurement, for control of production lines and for quality management.

At the core of the IMS portfolio are X-ray measuring systems, which the company has been offering for 20 years, and which today represent the best solutions available in terms of strip thickness, accuracy and handling in most applications. They are used both in hot strip applications at temperatures up to 1,200 °C and in cold steel processing up to 150 °C.

Measurement and application-specific requirements

In terms of measurement techniques both applications are very similar, although in hot strip applications it is often still necessary to use isotope measuring techniques due to the larger thicknesses. The respective application reflects the characteristics of the measuring equipment: In cold processing it is possible to use compact measuring equipment, which can measure in non-contact mode at small distances, while in hot strip applications rim widths of up to 3 m are required. Another factor is that in hot strip applications the forces encountered are often enormous due to the high masses, for example, if a steel strip deviates from the designated route. Peter Bierwolf, software development team coordinator at IMS, explained that, although cold applications are much more common, hot strip applications are a great deal more complex.

The big advantage of IMS systems is that they can be custom-designed, so that they exactly meet individual customer requirements. In addition, IMS offers high quality and comprehensive standard service. Peter Bierwolf added: “Our mission is to not only supply measurement systems to our customers, but also to offer plenty of support. After all, the measurement system is integrated in the production facility, which usually means that the production can only run if the measurement system is working properly. IMS systems feature customized measuring and electrical components, exceptional quality and comprehensive service.”
User requirements are essentially determined by the configuration of the rolling mill and the required functions. In many cases the travel path of the measurement equipment is rather long, in order to cope with maintenance requirements. Other requirements relate to the materials being produced, as Peter Bierwolf explains: “The required measurement functions are quite varied and individualized. Accordingly, we have detailed discussions with our customers, and also with Beckhoff as our automation partner.” Wilm Schadach, a member of the sales team at the Beckhoff Rhine/Ruhr branch, confirms the close cooperation: “The implementation and integration of the IMS systems is innovative and sophisticated. In conjunction with the flexibility of EtherCAT technology, our long-standing, close cooperation has facilitated the successful implementation of an advanced and integrated solution.”

**EtherCAT system as the highly efficient and open foundation**

All measuring equipment from IMS features the specific MEVInet automation system developed in-house, which is based on Beckhoff components. The starting point here was the use of EtherCAT as a high-performance, Ethernet-based bus system. Building on this foundation, the TwinCAT I/O real-time Windows driver and TwinCAT System Manager are used for creating the EtherCAT configuration automatically without great engineering effort. TwinCAT shows the connected I/O channels as a clearly arranged structure and organizes the data traffic mappings. In terms of hardware, the EtherCAT system is complemented by a wide range of I/O components such as EK1100 EtherCAT couplers, EL1809/EL2809 digital EtherCAT input/output terminals, EL32xx analog input terminals and EL6751 CANopen master terminals for connecting traditional fieldbus devices.

Safety technology can also be integrated as required via the EL6900 TwinCAT Safety PLC and the EL1904/EL2904 TwinSAFE digital input/output terminals. Peter Bierwolf explains: “Each measuring point in our systems is protected by its own emergency stop. Information that is taken into account includes the status of the X-ray tube shutter, so that the high-voltage can be switched off if the shutter is not closed, for example. Other features include “safe stop” in relation to access doors, for which the X-ray tubes are not switched off but the shutters are closed so that the system restart times are reduced significantly. Thanks to the modular Beckhoff system, advanced safety functions according to specific application requirements are easy to implement, e.g. based on the number of measuring points or in the form of a higher-level emergency stop in addition to the standard local emergency stop for each measuring point. The required adaptation of the safety PLC is very user-friendly.” Peter Bierwolf continues: “TwinSAFE and EtherCAT enable the integration of all the safety requirements for advanced measuring systems in a standard bus and therefore in the overall system configuration. The result is a particularly high degree of safety monitoring.”

Important requirements in the development of the IMS automation system were system openness, e.g. in terms of interfacing with the tried and tested visualization system and the heterogeneous world of automation in rolling and smelting works, and vendor independence in terms of the required computer hardware. Both aspects led to the consistent utilization of Ethernet interfaces for I/O purposes. Peter Bierwolf said: “In the early days we allowed the use of a traditional and rather slow fieldbus for the interface, since the system had evolved that way. However, thanks to EtherCAT, all I/Os have been fully Ethernet-based since
This also applies to our measuring transducers, which amplify the X-ray and isotope signals picked up by the ionization chambers and convert them to Ethernet UDP frames. These are read via real-time Ethernet drivers, as are the data for the automation equipment that controls the roll stands."

**System configuration made simple**

With the switch to EtherCAT, IMS started to use TwinCAT software because it then became possible to directly use an EtherCAT master from Beckhoff. TwinCAT I/O thus forms the layer between EtherCAT and the IMS software. On the one hand this meant that there was no need to write a dedicated EtherCAT master, and on the other hand the use of TwinCAT I/O means that the system will automatically benefit from further EtherCAT developments. The TcTimer extension for TwinCAT I/O also contributed to the successful implementation at IMS, because it enabled the integration of existing software into the Windows CE operating system. Peter Bierwolf said: “TwinCAT permitted us to combine existing solutions with modern standardization and safety requirements. The open architecture helped us migrate the programs, into which we had already invested many man-years of work, over to the advanced TwinCAT environment.”

Important aspects for the measurement systems of IMS include series-production readiness and consideration of customer-specific requirements. In order to master this balancing act, all software tools must offer suitable support and integration capabilities. The Elektro-CAE system, for example, exports the specifications for the whole bus configuration, which is subsequently generated automatically via the Automation Interface in TwinCAT System Manager and an auxiliary program provided by IMS. Peter Bierwolf is convinced of the benefits: “It makes our job much easier. A push of a button is sufficient, without the need to use further tools between the development tools for transferring or renaming variables, for example. The good cooperation with Beckhoff became particularly clear in the development our auxiliary program for the Automation Interface. We were able to realize special terminal configurations, the generation of a suitable process image and simple import of variable lists.” Peter Bierwolf cites the integration of the CAN bus-based measurement devices as a further example for the reliable support from Beckhoff. It meant that all devices which must be integrated can now be configured automatically via the TwinCAT Automation Interface.

**Fast communication and customizable system configuration**

The starting point to select EtherCAT as the communication system was the desire for high-performance data communication. In the past, large plants often necessitated two traditional fieldbus systems, due to performance limitations and because the cycle time depended on the extent of the topology. Since Ethernet was already used to connect the transducers, an Ethernet-based fieldbus system was the clear choice. According to Peter Bierwolf the choice to use EtherCAT was also clear: “At the time Beckhoff undoubtedly offered the most advanced system and was the only supplier who actually had suitable components available for our applications.” The large number of components – more than 300 EtherCAT Terminals alone – is still a big advantage: “EtherCAT is not only flexible in terms of the possible bus topology, but also in terms of the respective measurement requirements thanks to the wide and ever-growing range of special function terminals.”

Rolling and smelting works are characterized by processes that are generally regarded as rather slow. Peter Bierwolf explains that data processing speed is nevertheless an important factor: “For us speed means a cycle time of up to 1 ms, and with bus systems of any size at that. This was only possible with EtherCAT and is important for transferring control parameters such as set value deviation, often at very high strip output speeds, in some cases exceeding 1000 m/min.

Further information:
www.ims-gmbh.de

Peter Bierwolf (left) from IMS and Wilm Schadach from Beckhoff are delighted about their long-standing, close and successful cooperation.