IMA Klessmann: System conversion to EtherCAT for edge banding machine

Smooth transfer to Ethernet protocol

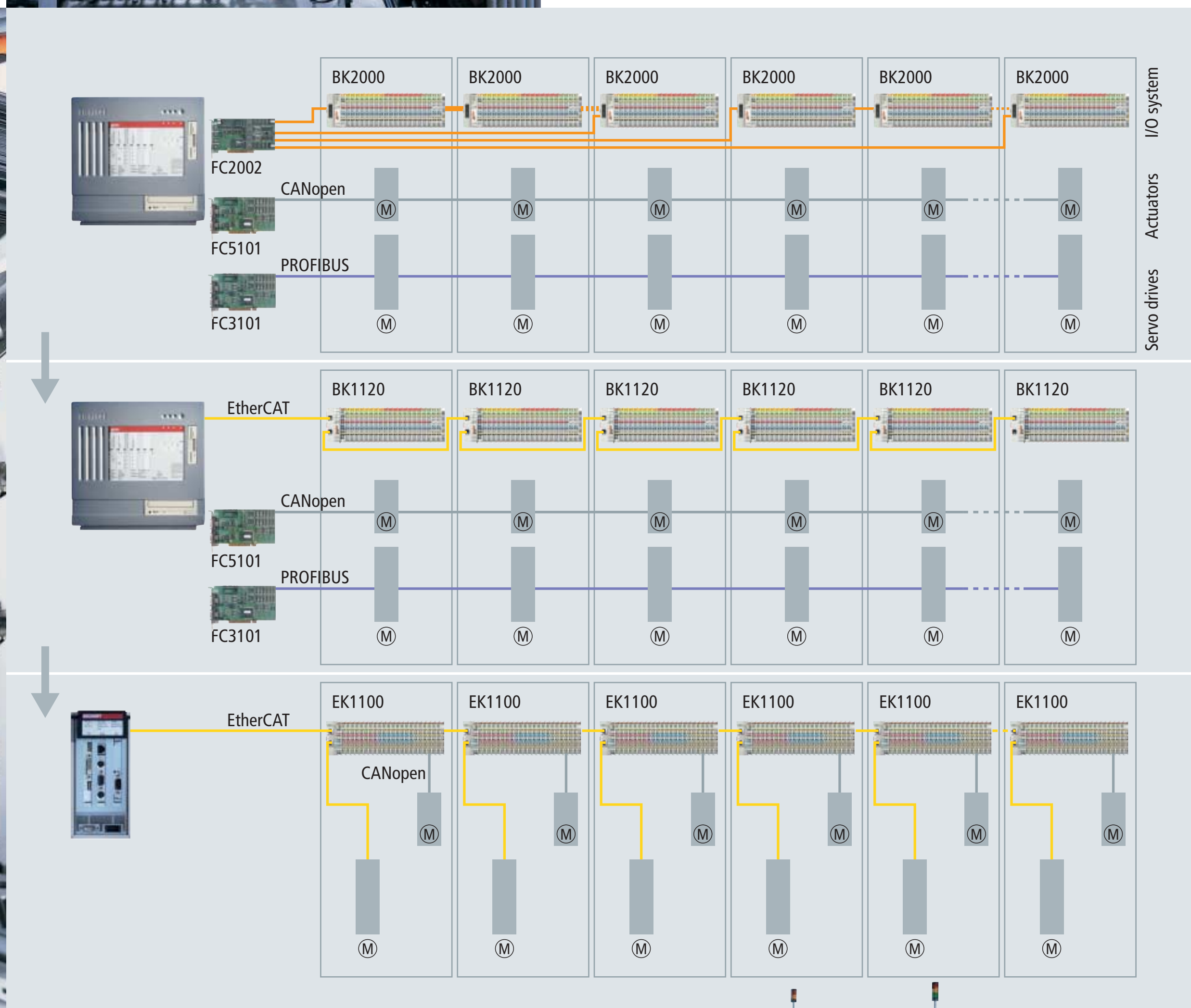
Most manufacturers associate a change in technology with an expectation of significant cost savings and performance increases. Hesitation regarding implementation is often based on doubts relating to unpredictable expenses or fears of almost unsolvable engineering tasks. The conversion of an edge banding machine from the Lightbus communication system to Ethernet-based EtherCAT at IMA Klessmann demonstrated that such doubts are unfounded, at least when it comes to EtherCAT. A smooth change-over – including the integrated system bus planned in detail – opened up a straightforward path into the new Ethernet world.

IMA Klessmann GmbH, based in Lübbecke, Germany, manufactures special purpose machines for the furniture industry, in particular, edge banding machines and processing centers. The edge banding machines are high-performance systems that apply edges to sheet material such as chipboard or light building board (honeycomb board). During their passage through the machine the workpieces are milled, an edge is banded and trimmed at the ends, and edges and contours are finished and polished. Further intermediate stations may be required, depending on the board material, the type of edge, and the shape of the workpiece. The Novimat Concept is a single-sided, automatic edge banding machine specially developed for jointing, edge banding and edge finishing in throughfeed operation. "Single-sided" in this context means that one edge of the workpiece is processed while it passes through the machine.

Modular, precise system

The Novimat Concept basically consists of several modularly configurable processing units, such as a milling and edge banding unit, an edge banding magazine, a trimming unit, a finishing unit (a scraper, for example), and a smoothing unit. The system enables several workpieces to be processed at the same time,

Gentle change-over: IMA implemented the change-over from "conventional" fieldbus technology to the real-time Ethernet solution in two stages. During the first phase, the Bus Couplers of the Bus Terminal stations were switched from Lightbus to EtherCAT. During the second phase the Bus Terminals were replaced with EtherCAT Terminals. Fieldbus slaves without EtherCAT interface can be integrated into the EtherCAT network via associated master terminals.

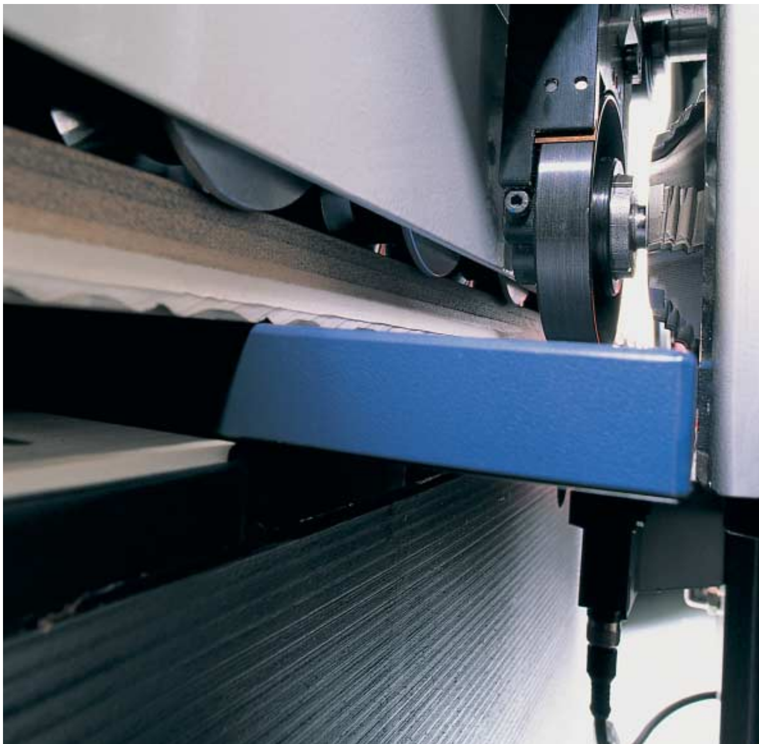


Novimat Concept from IMA Klessmann for high-quality edge banding.

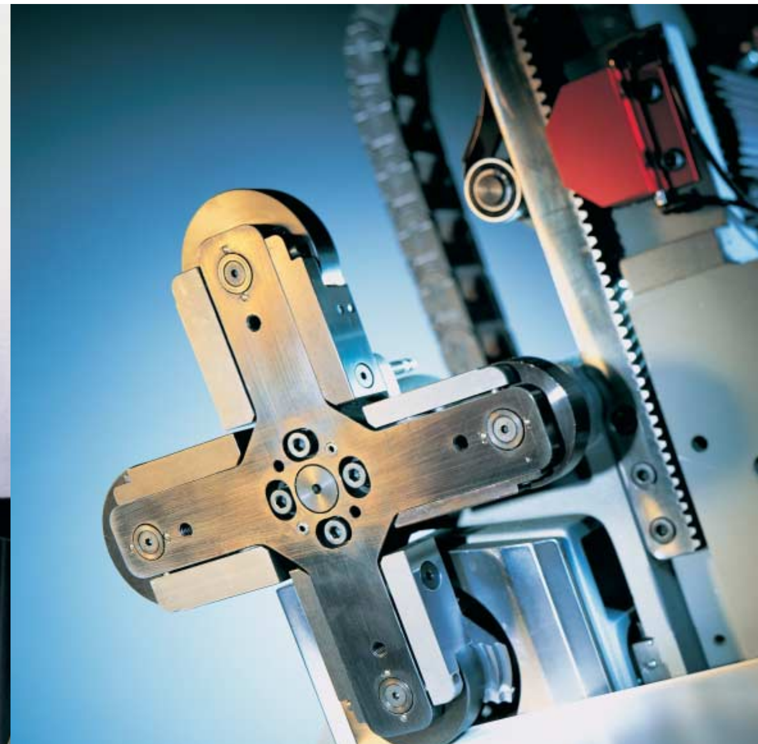
with the workpiece positions being monitored and controlled precisely via continuous path control. Accordingly, the automation part of the Novimat Concept is rather complex and involves around 250 I/O points, 12 axes and 30 path signals. The Lightbus-based automation technology that was previously used in the IMA woodworking machines uses PC-based visualization and control. Each machine unit features a Bus Terminal station coupled via Lightbus (internally via K-bus communication), servo drives coupled via PROFIBUS for the actual processing, and actuators communicating via CAN. This machine was recently modernized mainly in terms of the control technology and the fieldbus.

Future-proof thanks to EtherCAT

In the previous Novimat Concept model, IMA used a Beckhoff PC controller with DOS operating system. Since the other IMA machines already use a Windows-based automation platform, the company wanted to take a further step towards modern PC technology. Günter Redeker, director for electrical design at IMA, said, "As part of the modernization, we used the machine as a pilot application for EtherCAT since we intend to use this Ethernet-based communication system as our standard in the future." There are many reasons for this: "We have very complex machines with several thousand I/Os and more than 100 axes, i.e. with very

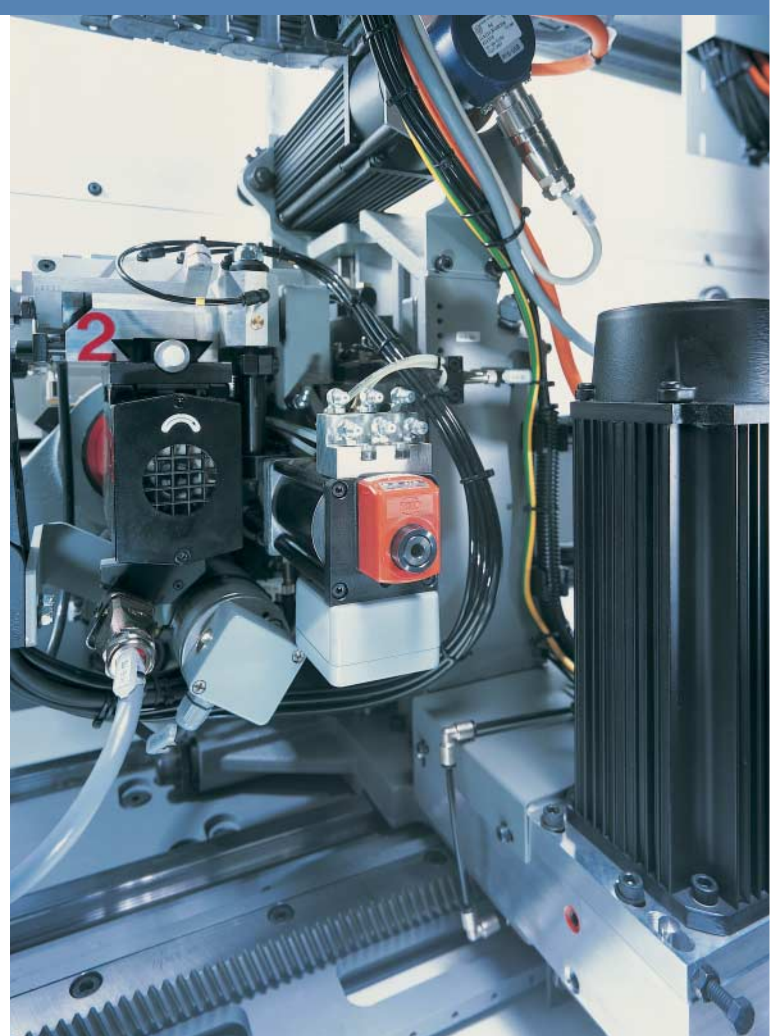


The Novimat Concept is a single-sided, automatic edge banding machine specially developed for jointing, edge banding and edge finishing while the material passes through the machine.



The Novimat Concept series from IMA features a comprehensive, modular set of units for individual machine equipment.

High edge quality and performance through servo technology.



comprehensive periphery. In order to control these machines via bus systems we use up to four Lightbus strands that collect or transfer a wide range of data with the sampling rate required for the machine. This is the only way to achieve the required performance," Redeker said. "However, a good deal of computing power is required for handling the large amount of data, since the processor has to copy the data from Lightbus into the memory and back again. It also has to sort the input/output data according to the process image. With EtherCAT, this is not necessary since the DMA controller deals with the data traffic between the Ethernet interface and the memory, resulting in a significant improvement for us."

According to Redeker, another factor is the general trend in PC technology away from computers with PCI plug-in cards for extensions; Ethernet is available as a standard fieldbus for this purpose. Safeguarding for the future is another key aspect: "While the speed of currently available fieldbus systems tends to be adequate for many applications, significantly higher bandwidth and better integration is called for in many cases due to the continuously increasing complexity of the machines. The additional potential offered by EtherCAT is particularly useful for continuous path control. It enables the workpieces to be tracked in the machine for precise control of the units during the passage, or for synchronizing parts for flying machining. The workpieces (e.g. chipboard) move through the machine with a speed of up to 60 m/min, corresponding to 1 mm of travel and an associated potential deviation per millisecond. At 2 ms for continuous path control, the resulting inaccuracy over a machine length of 60 m is already 2 mm. This is a borderline value, especially since the precision requirements are continuously increasing. Only a high-performance bus such as EtherCAT and a powerful computer can help reduce cycle times in this situation," Redeker said.

The decision to use EtherCAT as an Ethernet-based communication system wasn't difficult for the experts from IMA. In addition to the impressive performance of EtherCAT, the proven co-operation with Beckhoff over more than 10 years also provided the required peace of mind when it came to the decision. "Continued co-operation with our long-standing partner was important to us and enabled us to use the bus system that is ideally supported by the control specialists from Beckhoff," Redeker said.

New technology introduced "gently"

IMA implemented the change-over from "conventional" fieldbus technology to the real-time Ethernet solution in two stages. During the first phase, the Bus Couplers of the Bus Terminal stations were switched from Lightbus to EtherCAT (the BK2000 Lightbus couplers were replaced with BK1120 EtherCAT couplers). During the second phase, the Bus Terminals were replaced with EtherCAT Terminals. The EtherCAT Terminals maintain the Ethernet protocol down to the individual I/O terminals without the need for a further sub-bus.

The introduction of EtherCAT will also lead to a significant reduction in the complexity of the machine automation system: a fieldbus card will no longer be required in the PC. This means that fewer slots are required in the computer, and the PCs can be smaller. The substitution of various bus systems with EtherCAT significantly reduces the effort required for installation and training. Engineering also becomes simpler, since system behavior, which tended to cause problems due to different cycle times, is no longer an issue."

Not surprisingly, Günter Redeker is satisfied with the progress of the pilot project. "The test phases at IMA have already been completed. The machine runs absolutely robustly at three pilot customers. Early next year, we will start converting the machine type fully step by step in order to ensure that staff and distribution partners can be trained accordingly," he said. A further aim is integration of the drives, which are currently coupled via PROFIBUS, into the EtherCAT-based system. This also applies to the intelligent auxiliary servo drives that are operated via CAN bus, which will then be integrated via an EtherCAT/CAN gateway. "We will continue to monitor developments in this area and use servo drive technology that supports EtherCAT in the future. Several drive suppliers already support EtherCAT," Redeker noted.

Redeker sees long-term potential in a full EtherCAT implementation, which enables the utilization of the latest, most powerful computer technology. The largest machine lines currently require two computers – one for the user interface and one for real-time control. "In the future, we expect one PC to be sufficient even for these systems. As already mentioned, engineering and service will become simpler, if only one bus system has to be dealt with. EtherCAT is also advantageous for networking of systems, i.e. real-time coupling between multiple machines," Redeker concluded.

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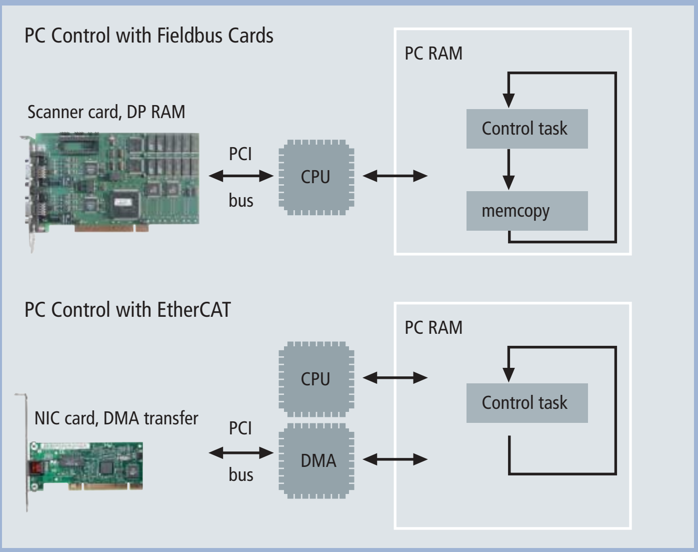
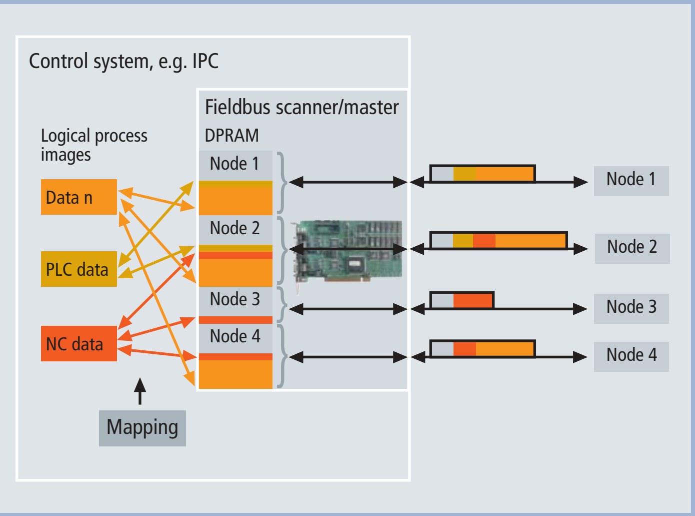
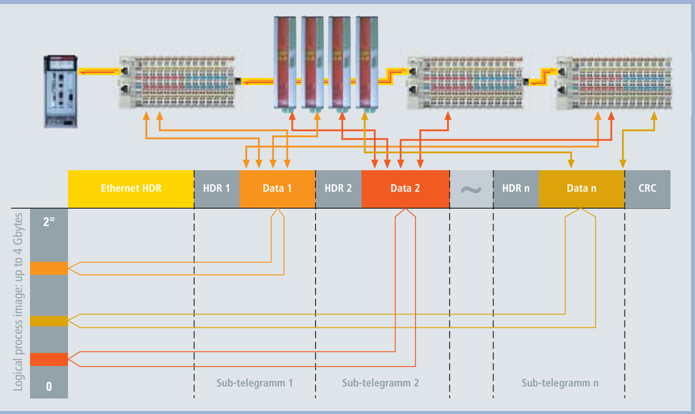


EtherCAT improves control system performance in a variety of ways. Besides the high speed network communication itself, the systems CPU is relieved by replacing the fairly slow byte-wise access to DPRAM of the fieldbus card by the Direct Memory Access (DMA) capabilities of the Ethernet Controller. Without CPU interaction data is made available in the main memory, which saves up to 30 % processing power.



Conventional fieldbus systems generate a physical process image by collecting data of various types from the distributed nodes. The resorting (mapping) of the physical process image to provide a logical process image has to be done by the controller CPU.



With EtherCAT, mapping is shifted into the fieldbus slaves and processed in hardware in the slave controller chips. The EtherCAT frame thus contains the logical process image directly. This takes further load off the master, since the resorting process is minimized.