» Application Story «

## CompactPCI® in Industrial Automation

Robust control technology in use underground worldwide

Shearer loader controls with an application-ready CompactPCI® platform from Kontron

Eickhoff shearer loaders use modular CompactPCI® hardware from Kontron and the CoDeSys Soft PLC together with Profibus and CANopen in a single-system solution. The bundle can also be purchased as a preconfigured, application-ready platform for any control application. In addition to the timesaving hardware/software integration, customers benefit from the ability to customize the system with in-house CPU cards and I/O assemblies.

Whatever its specification, the development of a dedicated PLC demands a tremendous amount of work. Among other things, complex control algorithms must be implemented and visualization and data exchange interfaces set up, which may appear different in every machine or facility. Thanks to IEC61131-3-compliant Soft PLCs, the programming interface for users is well abstracted and standardized, while the hardware is flexible and future-proof. However, an industrial PC does not become a dedicated PLC platform with all the appropriate functionality simply by sticking together hardware components and loading software: integration work is still necessary; for example the logical connection of objects in the upper layer in the Fieldbus protocol with the Soft PLC instructions. This is not a trivial issue; the Fieldbus interface is designed differently for every Fieldbus and manufacturer, and must be integrated cleanly into the interfaces for the Soft PLC. It is therefore very helpful for customers that they can rely on system solutions which are available ready-integrated, and so minimize the effort that they have to put in. This is the goal of Kontron's automation portfolio, which has also equipped industrial PC hardware to be application-ready as control platforms for Soft PLCs. A reference project with CoDeSys controls running under the VxWorks realtime operating system on standard hardware from Kontron and with Field bus cards for Profibus and CAN has been installed at Eickhoff Bergbautechnik as a shearer loader control.
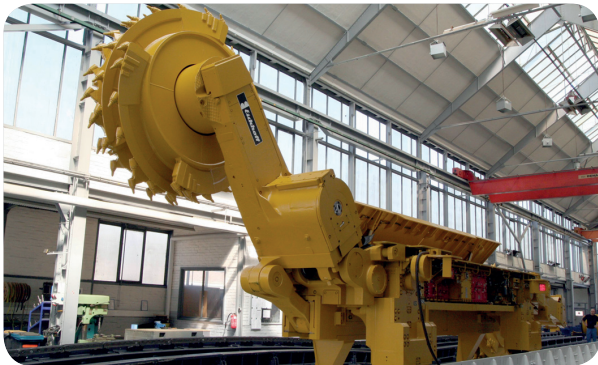
Increasing automation in coal mining

Shearer loaders have established a worldwide reputation in mining coal seams. Depending on their design, they cut coal from the longwall face laterally up to 110cm and at a height of up to 6m in one pass. Depending on the worked thickness, the cutting shearers have a diameter of 1.4 m – 3.2 m and adjustable height. The loosened coal falls onto the chain conveyor below the shearer and is transported away for further processing; hydraulically controlled safety shields secure the structure of the longwall during mining. In general, only one worker is needed to control the heavy machines, which weigh up to 130 metric tons. In 1950, the Eickhoff company built the first, then hydraulically-operated, longwall shearer loader. Since then, the system structure of shearer loaders has developed enormously, and the integrated control intelligence has increased steadily. In 1976, the first longwall shearer loader was equipped with electrical winches

and cutting engines on the supporting arms. Eickhoff built the first remote controlled shearer loaders in 1978, and the first high-voltage shearer loader in 1984. In 1990, the first remote microprocessors were brought on board and in 1992 the first sensor-controlled shearer loaders were tested with three-phase current winches to increase performance even further. Since 1997, winch revolutions have been controlled by frequency converters and, in 2001, the Eickhoff SL 500 achieved a cutting capacity of 2 x 825 kW, which is equivelant to the performance of around 16 mid-sized automobiles. With their increasing complexity and performance, the control requirements for these shearer loaders have also increased. Automatic operation, data transfer to control panels, and remote intelligence for adjusting the shearer loader to suit the geological conditions of the seam are vital features of today's system technology. For example, different cutting processes, which are used according to the geological conditions and mining planning to optimize production, must be controlled. The cutting drives and feed force must also be aligned automatically in order to avoid overloads and keep the system in balance. For all of these functions, which offer the same kind of ease of operation as the latest automobile electronics, there must be a controller. Until now, this has been based on a Motorola 68000 processor. However, this technology is reaching its performance limits, so developers were looking for a new control platform that would ideally last for many years. Because the vision for developing shearer loader technology is tending towards centralized control panel operation in order to optimize mining efficiency further, it was decided to use a system technology based on the x86 and thus in principle open in every direction.

Other system requirements were
» Based on recognized, official standards
» High design flexibility
» High system availability
» Extremely high shock and vibration resistance
» Protective lacquer coating
» Dedicated approval for a temperature range from
  0° C to 70° C
» CAN and Profibus interfaces
» VxWorks support for both the latest and older versions
» CoDeSys libraries ideally already available
» Long-term availabilityt

System evaluation led unequivocally to CompactPCI®

The requirements to meet official standards and to offer high design flexibility quickly eliminated a large number of robust industrial PCs from the selection process. This is because in this segment the only established standards are those from PICMG: PICMG 1.x and PICMG 2.x. Since PICMG 2.x (CompactPCI®) is fundamentally more robustly designed, the choice between them was also made relatively quickly. It was found that in principle the 3U the form factor best met the requirements of the application, based on the compactness of the machine and the consequent need to save space. However, a few critical points still needed to be tested to make a standard IPC in accordance with PICMG 2.x into a mining-capable system. The circuit boards had to have a protective coating to meet the high protection requirements in an environment containing conductive and explosive coal dust. Testing to ensure that the system satisfied the high requirements for mechanical stability in mining had to take place at the same time. In the DIN EN 60068-2-27 test, continuous shocks are applied to the system for twice as long as usual (30 g over 18 ms instead of 9 ms); for vibrations, the DIN EN 60068-2-6 test description requires an amplitude of 0.35 mm at 5-60 Hz and an acceleration of 5 g over a frequency range of 60-500 Hz, which are significantly higher requirements in both directions than is otherwise called for in industrial use. It was also necessary to ensure that the complete system guarantees an operating temperature of 0-70° C with passive cooling. Comprehensive VxWorks support (both older and newer versions) and the convenient integration of the fieldbuses in the SoftPLC runtime system were also important. On the hardware side, the solutions for CompactPCI® from Kontron could fulfill most requirements without customer-specific adaptations, because at Kontron, most CompactPCI® products are already designed for more severe industrial conditions. Furthermore, there is the so-called Value Line for cost-sensitive projects without special requirements. The Value Line system chassis was used with the assemblies for the highest requirements. However, a few adaptations had to be made to the hardware: for one thing, the standardized CP-POCKET system chassis was reinforced so that it could meet the higher requirements for shock and vibration resistance. For another, the option of battery-buffered storage of the retained variables (storage of control variable to be retained in the event of power loss) had to be created and, at the same time, a battery on the processor board had to be avoided because of mining standards: an already existing expansion card docked on the CPU card was provided with a small "mining" designed circuit with non-volatile RAM (NVRAM). Mining here means that the RAM battery requires series resistance and that a specific electrical distance must be maintained in the circuit in order to ensure protection against explosion. The RAM is connected to the CPU via a plugged LPC interface, which is more than sufficient, since high access speeds are not necessary. Thus, the CPU clock battery can also be banished from the CPU board as required so that it corresponds even to the world's toughest requirements from the Australian government's certification board TestSafe Australia. The first systems are already in use. As a result, the hardware system specifications could be implemented relatively quickly and could also be replaced or expanded with comparable standard products from other manufacturers; this is also important for Eickhoff, because they want to be as independent as possible through the use of standards. This is an essential advantage of CompactPCI® systems over any other IPC systems.

Application-ready platforms offer crucial added value

Furthermore, Kontron's offer to prepare application-ready platforms is particularly convenient for users: practically every component necessary to build an IPC-based PLC can come from one source. The crucial factor here is the additional function of Kontron as a system integrator, executing the integration to the finished platform and maintaining it as a product. In practice, this comprehensive support is only needed for the hardware platform, not for the integration of the Soft PLC, because the engineers at Eickhoff have a great deal of expertise in this and integrate as much as possible themselves. For any other user, however, it is very important to know that application-ready platforms from Kontron are function tested and have a uniform interface for service and support. As needed, they also come bundled with preinstalled, demo control tested Soft PLC. It was also vitally important for Eickhoff that Kontron has supported the VxWorks realtime operating system for many years, so that even existing solutions could be equipped with new hardware without changing the software. "Overall, we have found the ideal partner for our shearer loader controls with Kontron," Bernhard Hackelbörger, Development Manager with Eickhoff, confirms his total satisfaction with the new Kontron solution. The Kontron solution thus recommends itself not just for mining, but for any developer of robust controls in industry. The new system is ready to use just as quickly when purchased as an application-ready platform. Since the API for the PLC programming is always the same, the control application is ported simply by being loaded on the new system. This is especially convenient, because if, for example, the controls become more complex, they can be equipped with increased performance simply by changing the processor card, which is available as a standard component from Kontron up to the current Intel® Core™ Duo technology. With the modular construction of CompactPCI®, an I/O or

fieldbus card can also be expanded, dropped, or exchanged atany time. That makes the total solution particularly flexible and, along with the robustness and compact design, is an essential decision criterion for 3U CompactPCI® from Kontron. As a result, OEMs can concentrate fully and completely on their core competencies: the development of the actual control application.

Software support is becoming a critical competitive advantage

"As an IPC solution provider for OEMs, we always want to save our customers as much unnecessary work as possible," says Norbert Hauser, Vice President with Kontron. What counts here, especially in automation, is the trouble-free operation of the individual hardware components for a wide variety of solutions such as Soft PLCs and other system monitoring functions like OPC or webservers and much more. With increasing plug & work functionality in the conventional PC environment and stronger hardware abstraction, software support in IPC systems and previously executed and validated integration services for standard components have gained a decisive role. With this offer, Kontron acts as a precursor among IPC manufacturers; as a result, users need no longer wonder whether to expect any problems with the interoperability of components. "Ultimately, the user should know: if it comes from Kontron, it works," summarizes Hauser. Besides CompactPCI® (the 3U CP-Pocket Control and the 6U XP-Pocket Control), Kontron offers four more control platforms that are ready for most control tasks: the most important new platforms are the ThinkIO-P top-hat rail PC, with optional integrated Wago I/O system 750/753, and its smaller brother ThinkIO-C (ThinkIO Control), the compact JRex-IBOX (JRex-IBOX Control) box PC, and the integrated control and visualization platforms Microclient Control and V-Panel Control. All systems come in a variety of performance classes and interface versions, so that a suitable solution at Kontron can be found for all standard controls – and as needed, for customized designs as embedded systems based on related assemblies.

Die Steuerung für die Walzenlader Eickhoff SL 300 und Eickhoff SL 500 im Detail

CPU-Baugruppe: CP303 mit Mobile Pentium III-M Prozessor Erweiterung: CP350 (2 x CAN) und CP353 (Profibus DP Master & Slave) Softwaresupport: VxWorks BSPs & CoDeSys SoftPLC Anschluss folgender Peripherie: Bis zu 7 Motoren 2 davon über Frequenzumrichter geregelt. 90 digitale und analoge Sensoren, 40 digitale und analoge Aktoren über einen CAN –Bus sowie einen Profibus. Datenverbindung zur Leitstation über RS485 oder Ethernet Schnittstelle.

Einsatz der Walzenlader von Eickoff

Die Walzenlader Eickhoff SL 300 und Eickhoff SL 500 sind weltweit im Einsatz. Zu den bekanntesten Betreibern zählen die Bergbaugesellschaft X Strata in Australien, Shenhua in China, Consol Energy in USA, Mittal-Steel in Karaganda sowie Suek in Russland.

Feedback Control System Concept
Eickhoff Company
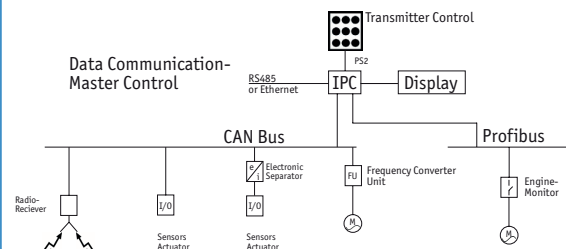
About Eickhoff

Eickhoff Bergbautechnik GmbH is one of four companies in Gebr. Eickhoff Maschinenfabrik und Eisengießerei GmbH. Eickhoff offers customers everything from one source – from parts to construction components to complete facilities. The Eickhoff name stands for proven quality, years of experience, absolute reliability – and, of course, close cooperation with customers. The latest technologies are a matter of course for Eickhoff, in order to manufacture firstclass products cost-effectively. At the same time, innovative design and foresighted action ensure Eickhoff's lead. The Eickhoff Group employs over 1,000 people. Company headquarters and the site of the main plant are in Bochum, Germany, with a total area of 100,000 square meters. Eickhoff has a mid-sized structure, operates in international markets, and offers its customers sales and service facilities around the world.

About Kontron

Kontron is a global leader in embedded computing technology. With more than 40% of its employees in research and development, Kontron creates many of the standards that drive the world's embedded computing platforms. Kontron's product longevity, local engineering and support, and value-added services, helps create a sustainable and viable embedded solution for OEMs and system integrators.

Kontron works closely with its customers on their embedded application-ready platforms and custom solutions, enabling them to focus on their core competencies. The result is an accelerated time-to-market, reduced total-cost-of-ownership and an improved overall application with leading-edge, highly-reliable embedded technology.

Kontron is listed on the German TecDAX stock exchanges under the symbol "KBC". For more information, please visit: **www.kontron.com**

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