Multivac: Embedded PCs and TwinCAT provide reliable and flexible control for packaging machines

Perfect packaging with PC Control

Multivac, the packaging machinery specialists with headquarters in Wolfertschwenden, Germany, makes its mark with peer-less competence in packaging, products and applications. Multivac thermoformers are considered by many in the packaging industry to be the best in the world. But the company also represents top quality and unique solutions as a manufacturer of traysealers and chamber machines. For control technology, Multivac relies on PC-based control from Beckhoff.

Whether in the refrigeration room of a meat products plant, in the clean room of a sterile goods producer
or on the deck of an offshore fishing trawler: Multivac packages the goods anywhere, anytime.

TwinSAFE: safety technology directly in the I/O system

PC Control on the DIN rail: Multivac has gone into large-scale production since the beginning of 2007 and has so far delivered approx. 1,500 packaging machines equipped with the CX1020 Embedded PC.

Packaging machines from Multivac are efficient, robust and reliable. The development, design, manufacture and mounting of the machines is carried out exclusively in-house, so that all development and production processes dovetail precisely. Total commitment to quality is Multivac's recipe for success. This means that the company's expectations on its business partners, the manufacturers and suppliers of components and accessories, is equally high. Multivac only uses individual components with optimum functionality and the highest possible performance.

Performance, price and strength of innovation are what count

The Multivac R 535 thermoformer series raises the bar for performance: it fully and automatically packs the most varied food products, such as sausage, fish and cheese, but also industrial goods and sterile medical goods in – depending on requirements – vacuum, protective gas, skin or blister packs. "With a cut-off length of 1,600 mm and up to 30 cycles per minute, the R 535 is currently the best thermoformer on the market," according to Alois Allgaier, division manager for control technology at Multivac. One of the many ways the R 535 sets itself apart from previous thermoformers is its innovative control technology.

When choosing the control technology, Multivac investigated a total of 10 leading companies in the automation industry. The selection requirements were: modularity with a wide range of functionality, optimum networking capability, scalability, reliability, ease of maintenance, simple operation and open architecture. The decision was finally made in favor of Beckhoff. "We were able to implement all the requirements set out in our specification book for the 'New Generation of Control Technology' project using the Embedded PC solution from Beckhoff," explains Alois Allgaier. "PC-based technology has been tried and tested for years and is widely used. Using Beckhoff, the technology leader in PC-based control technology, we are confident not only of meeting our current requirements, but also of being able to react early and quickly to new trends and rising market demands looming in the future, guaranteeing our technical advantage," Claus Botzenhardt, departmental manager for software development at Multivac, explains the decision, adding: "Naturally, the impressive price-to-performance ratio was also a deciding factor."

Multivac machines can package food, medical products and pharmaceuticals, industrial products, household care products and hygiene articles, DIY products, vehicle accessories and many more with the most diverse package shapes, materials and functions.

Alois Allgaier, division manager for control technology at Multivac, and
Claus Botzenhardt, departmental manager for software development at Multivac

Embedded PCs at the core of the control system

Multivac now employs PC-based control technology from Beckhoff in all fully automated machines in its production range. At the core of the machine control systems are Embedded PCs from the Beckhoff CX series loaded with Windows XP Embedded as the operating system and TwinCAT automation software. "It all began with the development of the new R 535 thermoformer," recalls Claus Botzenhardt. "At the end of 2005 we used the CX1000 Embedded PC in our first prototypes. We have gone into large-scale production since the beginning of 2007 and have so far delivered approx. 1,500 packaging machines equipped with the CX1020 Embedded PC."

The space-saving CX1020 controller for the terminal stations is located in the control cabinet. "Depending on the complexity of the machines and the control technology, we install an Embedded PC with the appropriate performance level. We use it for the PLC, Motion Control and our visualization developed in Java. Installing the PC Control technology with Microsoft Embedded operating system provided the opportunity for integrating the HMI in the control system. This meant we could do without an additional PC for visualization," explains Alois Allgaier. The Multivac operating panel is connected to the CX via DVI/USB. The Ethernet interfaces allow integration into the company network and provide the Internet connection, giving the option of remote maintenance. CX system interfaces and fieldbus connections (which can be added as modules) can integrate motion solutions using CANopen or DeviceNet, for instance.

The Multivac product series ranges from small machines for manual packaging up to complex packaging plants for large-scale production. In the fully automatic machines, the Embedded PC used as the central control unit ensures optimum machine processes. Due to the CX being directly connected to the I/O terminals, an additional fieldbus is unnecessary in the more compact models. A local control system with several Embedded PCs can be supplied for very large and complex packaging plants.

## Modularity permits individualized offerings

"Our packaging machines are a standard product to a large extent, however no one automated packaging line is like another. We develop our packaging solutions flexibly and in accordance with our customers' requirements," Alois Allgaier explains. "Our machines are constructed on a modular basis so that we can individually configure customized solutions and adapt the modules in the best possible way. The modular product range from Beckhoff suits us very well at the control technology level. For every configuration we are able to select the optimum components for each application, e.g. from the comprehensive Bus Terminal I/O product range."

In the R 535, Multivac integrates Beckhoff Bus Terminals and sensors for temperature recording using thermocouples or odometers with SSI sensor interfaces as well as ancillary equipment for printing or cutting the film in the control system. For example, special function I/O terminals are used to position the stepper motors in the printers. Communication terminals and the wide range of Bus Couplers can also integrate devices with serial interfaces and other fieldbuses such as CANopen or DeviceNet.

TwinSAFE: safety simplified

Safety components such as emergency stop switches and protective coverings provide the necessary safety elements for packaging machines. Previously, Multivac wired the safety components in a conventional way. In the R 535, the safety functions are integrated directly in the Bus Terminal system using TwinSAFE terminals. The safety data are recorded on site and evaluated in the TwinSAFE Logic Terminal. The certified TwinSAFE protocol ensures secure communication. "TwinSAFE drastically reduces the costs and time involved in wiring," according to Alois Allgaier. "The benefits of the modular, scalable technology from Beckhoff are obvious here too. We select the necessary TwinSAFE terminals depending on the
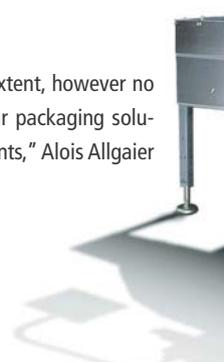
Traysealers package filled trays with the filling carried out on the machine or elsewhere. Traysealers can be quickly and easily converted to other formats.

The single and double chamber machines in the TC range package highly sensitive medical products under vacuum or protective gas in plastic pouches. The temperature-regulated sealing system enables control of all sealing parameters – a prerequisite for validation.

machine and integrate them in the control system. This is simple, convenient and cost-effective as well." In order to fully exploit the potential of TwinSAFE and to improve the reproducibility and precision of the machines through shorter cycle times, Multivac changed its control system to EtherCAT, the ultra fast Ethernet-based fieldbus for industrial applications. "EtherCAT brings us a big step forward technologically. The signals are captured more quickly and the machine cycle times are optimized. This enables us to better exploit the potential of the PC-based control system with its high-performance processors and to control the axis modules of our plant more rapidly and precisely. This means our machines will be even more efficient and reliable," remarks Alois Allgaier confidently on the introduction of EtherCAT technology and adds: "Thanks to the technological innovations from Beckhoff in the area of control technology, such as TwinSAFE and EtherCAT, we see ourselves well equipped for the future."

Implementing complex processes simply with TwinCAT

The R 535 thermoformers package large batches of product with optimum heat-sealed seam strength and functionally diverse labeling in a short space of time. TwinCAT controls the complex packaging processes such as molding, filling, sealing and cutting very precisely and reliably in real-time and synchronizes them.

However, Multivac uses TwinCAT not only as a control platform, but also as a development environment. "Programming our new modular software architecture according to IEC 61131 using structured text was managed without difficulty by our experienced C programmers. The debugging functions in the TwinCAT PLC controls in particular saved time in the case of complex function blocks," explains Alois Allgaier. PLC libraries with blocks based on PLCopen Motion Control and the OMAC PackSoft standard (PackAL) facilitate programming. Standards such as the OMAC Packaging Guidelines offer a consistent interface for packaging machines worldwide.

Ethernet TCP/IP

Remote mainte-nance

Operating panel

PDA

PDA terminal with OPC interface

DVI/USB

Modem

USB

Embedded PC

K-bus

CANopen

Emergency stop

Stepper motor

Emergency stop
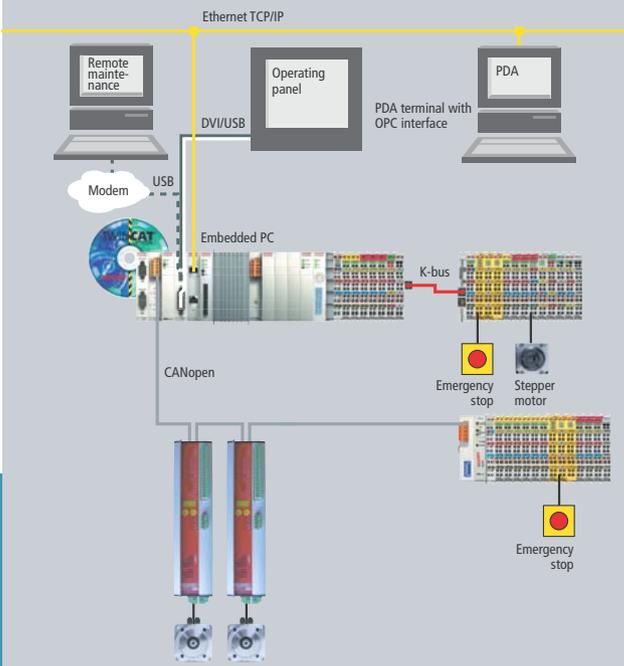
The core of the R 535 ther-moformer control system is the CX1020 Embedded PC.

With the new CIP self-cleaning system the R 535 almost cleans itself. TwinCAT automates and logs the cleaning process.

Thermoformers are ideal for the fully automated packaging of identical products. They can be used to produce vacuum, protective gas, skin and blister packs. R 535 – the new generation of thermoform-ers – is a prize winner in the iF Packaging Awards 2008, presented by the internation-ally renowned iF Industry Forum Design.

MULTIVAC R 535

Important parameters for the quality of the packaging are well molded cavities, a precise posi-tioning of the lower film in relation to the upper film and strong sealed seams. This requires precise control of temperature, time and pressure and printing mark control. For the controllers, Multi-vac makes use of the comprehensive TwinCAT libraries. The temperature con-troller sets the heating temperature for molding the cavities and for sealing. In thermal sealing, the temperature is controlled in such a way that a homogeneous temperature distribution is produced and as a result, reliable and strong sealed seams can be made even under conditions which are not quite optimal. Posi-tioning of the lower and upper films with one another is carried out using the printing mark control system. By stretching the upper film, the product imagery is aligned with the cavity and is positioned on the packaging with great preci-sion.

One machine, many diverse applications
Repeated change-overs are no problem for the R 535. Depending on the pack-aged goods, one machine can produce both round, angular and oval packages as well as tall or flat ones. The machines are equipped with several format settings for this. A change of format can be initiated at the touch of a button i.e. the mold-ing plate and the sliding sealing unit are exchanged and new instructions are loaded and started in the machine control system. "Using TwinCAT we are able to perfectly coordinate all components and configurations in the machine. This re-

sults in high relia-bility and perfect packaging results all the time," says Claus Botzenhardt and adds: "Independent of the hardware, we are able to use applications developed using TwinCAT on dif-ferent types of packaging machines." For example, Multivac transferred the ap-plication software for the R 535 thermoformers to chamber machines in the Mul-tivac TC range, which are based on a different functional principle.
"This level of flexibility is unique to-date. We equip simpler machines with an ex-isting, more complex software and achieve additional functionalities as well as standards which enable completely new applications," adds Alois Allgaier. For in-stance, it was possible to integrate the temperature controller for the thermo-former into the chamber machine in the TC range in order to achieve validation of the sealing temperature. In addition, the operating software for the chamber

Multivac

Multivac has created innovative packaging solutions for over 45 years. Multivac's thermoformers, traysealers, chamber machines and special machines package food, industrial products and consumer goods as well as medical products and pharmaceuticals safely, reliably and hygienically. Every year Multivac produces over 1,200 automated packaging machines and more than 4,200 semi-automatic machines and is a worldwide market leader in the thermoformer sector. Developing countless customized packaging solutions has resulted in an unsurpassed expertise in the market sector. The global company has over 2,600 employees today.

Multivac thermoformers

Thermoformers provide the most diverse packaging solutions for food, industrial and consumer products and sterile medical goods: from the high-speed packaging line for 40,000 hypodermic needles or 3,000 kilograms of meat per hour, to the flexible packaging center for small batches with programmable format change. Molding, filling, sealing and cutting take place inline on the same machine, but at successive stations. The packing material for the lower web is pulled from a roll, heated in a molding tool and shaped into cavities. The cooled packing cavities are filled manually or automatically. The upper web packing material (lid film) is pulled from a second roll and positioned on the filled cavities. In the sealing station, the air is evacuated; if necessary, a protective atmosphere is added and the package is sealed using heat and pressure. Finally, the web of packs is divided up, first cross-wise and then length-wise.

machine supports customers in complying with the strict US FDA regulations, CFR21 Part 11 "Guidance for Industry Part 11, Electronic Records; Electronic Signatures – Scope and Application." The FDA (US Food and Drug Administration) is a public authority and is responsible for US legislation on food, drugs and cosmetics. This means that the chamber machines in the TC range can be used in medical technology without restriction.

The king of clean

The food and medical industries in particular demand the highest cleanliness and sterility standards. For the R 535, Multivac developed a novel cleaning process, currently unique to thermoformers, the CIP self-cleaning system (Clean in Place). The CIP automates the chemical cleaning of chain carriers, chain profiles and internal components using a comprehensive system of nozzles and pipes. After pre-cleaning, a simple touch of a button starts a standardized cleaning program which proceeds in clearly-defined stages. The process is automated and logged in the machine control system using TwinCAT. Users can employ a set cleaning program from Multivac or define one of their own and integrate it into TwinCAT. Depending on the program selected, TwinCAT loads the correct instructions and processes them. The cleaning process proceeds in full each time with consistent thoroughness and can be documented and followed at all times.

Networked and reliable

Packaging alone is not enough – only integration with upstream and downstream components leads to a complete packaging line. Depending on the application, the automatic packaging machines are combined with slicers and infeed, dosing, weighing, labeling, testing and discharge systems of all kinds. The additional modules are registered in TwinCAT and integrated in the machine process sequence. Additional test programs for optimizing individual parameters and fine adjustment can be easily integrated in TwinCAT. The machine control synchronizes all the modules, irrespective of whether they are before, on or after the machine, and controls the timing.

The automated packaging machines must be able to operate with high productivity and reliability. Current machine data, production volume, current process status and errors must be recorded, analyzed and evaluated. The Embedded PC

records all machine data and stores it for further applications. The data can be accessed via the Internet for remote maintenance of the machine. The recorded data can be exchanged between the machine control of a packaging plant and production data acquisition (PDA) using Ethernet and the optional TwinCAT OPC interface. Here, data is stored, evaluated and visualized. The easily operated process control enables rapid recognition of deviations from the desired condition so that counter-measures can be taken immediately. This guarantees permanently stable machine performance and consistently high daily reproducible packaging quality with more calculable running costs.

Packaging long-term success

Thanks to its presence in over 100 countries with almost 60 of its own marketing companies and decentralized spare parts distribution, Multivac guarantees on-schedule delivery, a reliable spare part supply with availability even after 20 to 30 years, as well as rapid response to market requirements. In line with this, Multivac also places obligations on its suppliers to adhere to a demand-oriented component supply in accordance with the Kanban principle.

Claus Botzenhardt is satisfied with the control system solution for the R 535: "This new generation of machines – and the control technology which goes with them – is significantly more complex than our earlier range of models. But despite the higher complexity, we can offer the dependability and process reliability typical of Multivac automatic packaging machines using the Beckhoff control system." "This control solution also has the considerable advantage for us that a system with such scalable capacity also meets our economic requirements. Due to the modular design we can react in a flexible way to future demands," concludes Alois Allgaier.

→ Multivac **www.multivac.com**
→ TwinCAT **www.beckhoff.com/TwinCAT**
→ EtherCAT **www.beckhoff.com/EtherCAT**
→ TwinSAFE **www.beckhoff.com/TwinSAFE**
→ Embedded PC **www.beckhoff.com/Embedded-PC**