



PLC/NC software controls new generation of gantry robots

PC control for flexible packaging

Machine controllers based on PCs opens up new dimensions for production output: This „guiding principle“ of automation has been consistently put into practice by Windmüller & Hölscher of Lengerich in Germany, with its redesigned „ARCOMAT® 2“ gantry robot. The new series of palletising robots is fitted with universal, PC-based control technology made by Beckhoff, consisting of Industrial PC, fieldbus technology and PLC/NC software.

Windmüller & Hölscher designs and manufactures complete production lines for the manufacture and processing of flexible packaging, such as, for example, carrier bags, films and industrial sacks. „The most modern PC control technology is used in the current version of the palletising robot, because we want to be right in the mainstream of technological development“, stresses Rainer Henze, head of technology in the processing machines' department of Windmüller & Hölscher.

For him the decision to use PC control technology made by Beckhoff was not purely a matter

of chance: Windmüller & Hölscher had after all been working together with the automation firm for a very long time and was convinced of the know-how of the control experts from Verl (Germany). In addition Beckhoff produces a completely harmonised system solution based upon the Industrial PC as central controller.

Universal PC control technology in the production line

The palletising robot is used in a three-stage production line for manufacturing paper sacks, consisting of tuber and bottomer,

which for many years have also been fitted with Beckhoff control solutions; together with transporting or feeding devices, the so-called material flow automation. Tubers, which are combined plants for pasting, folding and separating, make the initial product for the sacks - the paper tube. At this stage up to four sheets of paper are drawn off reels and laid one on top of another. Then the sheets are perforated with needle rollers so that the air can escape from the sacks when they are filled later on. Rotating knives take care of the cross perforation on the endless sheet of paper; then in a further

The „ARCOMAT 2“ gantry robot made by Windmüller & Hölscher is fitted with PC-based control technology by Beckhoff



process the continuous tube is cut into individual sections. The sheets are finally glued together cross-wise and horizontally. The valve for subsequent filling, together with the bottom sections are fitted into the paper sack in the bottomer. The finished paper sacks are made up into bundles and subsequently transported further using automatic devices.

In the third section of the production line the gantry robot lays the bundles of sacks on pallets of up to 1.50 m x 1.60 m in size. This process runs according to a pre-set palletising pattern. The patterns are therefore dependent upon the type of sack or on the formats of the paper sacks to be stacked. The gripper will be positioned in X and Y direction, according to the instructions from the palletising pattern in question. During the positioning process the gripper is turned with the aid of a C-axis and the pallet lifting table (Z-axis) raised or lowered depending on the stack height.

Multiple possibilities from the creation of palletising patterns

Up until now instructions for palletising were either loaded from a memory module with CMOS-RAM or transmitted from a process planning computer via a serial

Machines for environmentally-friendly packaging solutions

WINDMÜLLER & HÖLSCHER (W&H), founded in 1869, is an internationally-active and globally-leading manufacturer of machines for flexible packaging. The firm employs about 1700 staff at its headquarters in Lengerich and in 1999 achieved a turnover of 500 million marks.

The product range includes film extrusion systems, flexographic and gravure presses, laminators, machines for the manufacture of bags, sacks and shopping bags, packaging machinery as well as machines for the conversion of plastic webs.

The gripper is positioned using TwinCAT PLC/NC software. During the positioning process the gripper is turned with the aid of a C-axis and the pallet lifting table (Z-axis) raised or lowered depending on the stack height.



interface. Beckhoff's new PC control technology goes a significant step further: „The customer can now create the palletising pattern directly on the machine - while production is continuing“, emphasises Rainer Henze. That naturally saves personnel and money. At the same time the customer can also fall back on a network solution (ethernet) or diskette, should the operating concept or the „production philosophy“ not permit creation on-site.

The Industrial PC and the TwinCAT automation software are the main pillars of the new palletising robot control system. As a result of the consistent change-over to PC technology, manufacturing costs in the field of automation should be reduced and machine capacity increased. Here, too, the PC solution plays its part, combining PLC and NC in one system, as is pointed out at Windmüller & Höscher. Amongst the functionalities used in the TwinCAT automation software is included the PLC, programmable according to IEC 61131-3; there are also comprehensive mechanisms for positioning and controlling the axes, diagnostic possibilities and data connection with the standards of the PC world.

The PC control technology of the ARCOMAT® 2 is the combi-

nation of many strengths, which a software solution provides in any case. These strengths are given full rein through the modular built-in Industrial PC C3220. Installed are Windows NT, TwinCAT NC PTP control software, which contains all the PLC functionalities, as well as PC Anywhere for remote diagnostic purposes. In addition a Visual Basic application runs on the same system for process visualisation, based on an Access data bank for the palletising patterns.

A PC replaces PLC hardware and positioning robot control

The C3220 Industrial PC consists of a compact PC with integrated TFT display and up to three ISA- and three PCI-slots. This provides the opportunity to put in additional plug-in cards, such as fieldbus connections, additional serial interfaces, an internal UPS, modem card and, if necessary, additional interfaces for specific applications. The front of the PC is finished in IP 65 and is designed to be installed in a control cabinet. In the new Windmüller & Höscher solution all the necessary hardware and software interfaces are integrated in a single Industrial PC, additional hardware to control the machine is no longer necessary, as it was in the earlier ARCOMAT® version.

Apart from the pure PLC functionality, the palletising robot's six SIMOVERT® MASTERDRIVES servo-axes are also regulated by the TwinCAT control software. For this, Point-to-Point movements of several individual axes are carried out. The position pattern pre-set by the operator is converted in a Visual Basic application into target co-ordinates for the NC and passed on to the PLC via an open TwinCAT communications' interface (ADS). These target co-ordinates for each axis involved in the movement are to be found in a data array for every bundle of sacks. The PLC controls the process and is responsible for ensuring that the target co-ordinates are transmitted to the NC at the correct time. After transmission of the start commands the NC software positions the axes in a separate, independent TwinCAT run-time environment. During the positioning phase the PLC monitors both the axes' movements as well as the technical processes. Once a bundle of sacks is put down a new process cycle starts with different target co-ordinates.

Since the positioning procedures involve control processes, „hard“ real-time is absolutely necessary, so that dead times in the control loop are constant and there are no oscillations or even



positioning inaccuracies. The hard real-time on the PC is provided by TwinCAT using the Windows NT/2000 operating system, without expenditure on hardware add-ons. This enables cycle times to be adjusted down to 50 uses.

The ACROMAT® operates with an PLC cycle time of 10 ms, the position control cycle for the positioning axes was pre-set at 2 ms. Setting and configuring the fieldbus levels as well as the axes and their parameters is made possible in a simple way using the TwinCAT System Manager, the configuration centre for system.

Fast and interference-free optical fibre communication

The fast Beckhoff Lightbus, which was specially developed for fast machine controls, is used as the bus system. The sensor and actuator signals are acquired directly via the Beckhoff Bus Terminals and the Lightbus modules. With the open and flexible bus terminal system (available for all current I/Os and fieldbusses) the required input/output channels are plugged together like standard terminal blocks according to their specific application. From the wide range of signal terminals it is possible to tailor a specific solution, as if from a toolkit.

PLC and NC software on the PC

The Beckhoff TwinCAT Software System turns any compatible PC into a real-time controller with a multi-PLC system, NC axis control, programming environment and operating station. TwinCAT replaces conventional PLC and NC controllers

The central pillar of automation software

Conceived as a pure software PLC without additional hardware, TwinCAT PLC allows programming in accordance with IEC 61131-3 of up to four virtual „PLC CPUs“, each running up to four user tasks, on one PC. TwinCAT PLC running under the Windows NT/2000 operating systems includes both the programming environment and the run-time system without an additional programming device.

NC functionality in the PC

The NC software consists of positioning (set value generation and position control), integrated PLC with NC interface, operating programs for commissioning and the I/O connection for axes via the fieldbus. The position controller is calculated on the PC processor and cyclically exchanges data via the fieldbus with drives and measurement systems.

The PC's performance allows axes to be moved at the same time that the PLC is running, the position controller being calculated on the PC processor. The power of a PC means that a number of axes can easily be simultaneously positioned.

The three-stage production line for manufacturing paper sacks consists of the tuber, the bottomer and the palletising robot, which are fitted with universal control solutions made by Beckhoff.



The Lightbus enables both the process periphery for the PLC as well as the interfaces necessary for the drives (± 10 V speed set value and incremental inputs for position feedback values for the central position controller via TwinCAT) to operate using a single bus system. The individual bus devices of the Lightbus system are connected via an optical fibre, so that electromagnetic disturbances, which always arise in the field surrounding drive amplifiers, cannot have any effect upon the bus devices or the controller. Because of its high speed, priority control and the possibility of working with up to 255 devices on a single bus, the Lightbus provides considerable reserves of capacity and, therefore, investment protection.

In concrete terms, apart from the 4 main axes of the machine, an additional 2 servo axes for the sliding table and the alignment, 2 fast/crawl axes for use in the position control as well as approx. 270 digital channels with a high update-rate are provided with equidistant data via the Lightbus.

PLC- and NC-diagnosis via remote maintenance

New fields of application for remote diagnosis or remote maintenance are also opened up via PC control technology. „Before this

remote diagnosis functioned only in the pure PLC-section“, explains Rainer Henze. Things are different today. Using PC technology the system experts at Windmüller & Hölscher can now „look in“ on almost every component part of the plant. Apart from the PLC it is now possible to take an analytical look at the NC part. Conditions and diagnostic data about the fieldbus, fieldbus devices and drives can also be remotely accessed without any problem.

And in matters relating to increased output as a result of the perfect interplay between control and flawless mechanism a concrete figure is to hand at Windmüller & Hölscher: throughput could be increased by about 15%. Production output is naturally dependent upon external processing conditions, such as, for example, the material used, palletising pattern and dimensions of the sacks. The poll position in technology held by Windmüller & Hölscher is above all the result of effective engineering. Qualified staff are among the firm's most important resources. This is all the more applicable to Windmüller & Hölscher since in the future its market position will be further strengthened and expanded.