The new product family expands the Beckhoff control range by an extra performance class. The Bus Terminal Controllers series BX are positioned as micro controllers. Through a wide variety of integrated interfaces for the fieldbus, I/O and peripheral levels, the controllers are an inexpensive alternative for a large number of applications.

The company Alfred H. Schütte GmbH & Co. KG complements its PC product line with the A 36 PC CNC controlled multi spindle automatic machine. The machine is managed by Beckhoff control technology, i.e. an Industrial PC with TwinCAT NC I automation software and the newly developed AH2000 hydraulic controller with extremely small positioning tolerances.

The principle of PC-based automation is established in most areas of automation. Beckhoff offers a wide range of Industrial PC variants. The introduction of the C63xx series control cabinet PCs shows further developments are possible.
Opinions about Industrial Ethernet differ. Some protagonists shout: “We want it, it makes fieldbusses obsolete!” , using sometimes sound, sometimes questionable arguments (“consistency from sensor to CEO!” – but what CEO really wants to see the sensor data from his production on the desktop?!). “My management has read about Industrial Ethernet in some magazine or other and asks me to replace the fieldbus in the next project – please provide me with arguments against this approach, I’m just happy that we have mastered the fieldbusses!” This type of call is also becoming more frequent. Depending on the background, fierce arguments for or against Ethernet are brought forward. Fieldbus cable manufacturers warn of the “Ethernet Monster”. Companies who have put all their cards on Ethernet naturally have a different opinion. And the user? Should he trust the Ethernet hype or the sceptics?

As always, Beckhoff takes a differentiated and independent route. As a champion of open control technology, Beckhoff supports all open fieldbus standards with market significance. Beckhoff sits on the associated committees, has detailed knowledge of the advantages and weaknesses of the individual systems, can provide objective and sound advice, and doesn’t have to extol the virtues of an individual fieldbus system.

The same applies to Industrial Ethernet. At Beckhoff, Ethernet has already been state of the art for networking of controllers for some time – after all, the pioneer of PC-based control technology has been using mainstream technologies and their advantages for some time. Ethernet interfaces are “native” for PCs, and Beckhoff uses them accordingly.

But what about Ethernet on a sensor/actuator level? Here too, the proven Beckhoff strategy is used effectively: Getting involved early, building up know-how in-house, pushing ahead the technology independently and with commitment, and of course supporting open standards, as soon as these are available. Accordingly, Beckhoff already expanded its I/O range with Ethernet couplers and IEC 61131-3 programmable Ethernet controllers three years ago. In addition to Beckhoff ADS, ModbusTCP was implemented, since this simple protocol is widely used. Numerous applications were solved successfully with these products – some of them were presented in previous issues of PC Control. At the same time, the technology was developed further, and real-time Ethernet was introduced at the end of last year: to date the only Ethernet implementation with real-time capability that only uses standard Ethernet cards and switches. Even simultaneous TCP/IP communication on the same network is possible! This was achieved
through optimum integration of Ethernet drivers and Beckhoff real-time technology within the operating system. Once again the fact that all key technologies were developed in-house has paid off; particularly our own patented “real-time” under Windows was the basis for this success.

Is Ethernet already the better fieldbus? As expected, Beckhoff’s response is carefully considered: Depending on the application, the fieldbusses still have advantages in terms of infrastructure costs, wiring effort and the wide availability of equipment and tools with real-time capability. Nevertheless, for certain applications the Beckhoff real-time Ethernet has advantages: fast machine controllers with large quantities of process data, physically large systems or small networks, for which the cost advantage of “Ethernet instead of fieldbus card” is significant.

Real-time Ethernet is an important technology step – others will follow. The world of automation can again look forward to innovations from Beckhoff at the forthcoming Hanover Fair – particularly in terms of Ethernet!

Martin Rostan
Product Manager Ethernet and fieldbus systems
Beckhoff presents control cabinet
PC series C63xx: New mini PC with maximum features

IP 67 module with sine/cosine encoder interface: High-precision measuring in the μm range directly at the Fieldbus Box

Analog Bus Terminals now also available as single-channel variant
Beckhoff I/O system receives explosion protection approval

Bus Terminal Controllers series BX: Highly flexible small controller with universal interfaces

Embedded PC: First HMI for CX1000 with Windows CE.NET

Operator Interface Communication options for Beckhoff controllers

Industrial PC CS101/CS102: 19 inch device with new housing is gaining ground

Schneider Electric/Télémécanique TeSys model U with Beckhoff module: Compact multi-functional motor starter

Programming tips: Multi-configuration mode for Profibus DP Bus Coupler

TwinCAT CNC: New tasks, new solutions, new markets

The subject of the NC-Gesellschaft e. V.

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Beckhoff has expanded its comprehensive Industrial PC family with the C6130 and C6330 mini format control cabinet PCs. The fully-fledged Industrial PCs already convince from the outside through the look & feel of a PLC. In completely new “packaging”, the smallest variant only measures 93 x 196 x 226 mm (W x H x D). As the saying goes, “Don’t judge the book by its cover” and you should not judge the mini PC by its outside looks. The mini PC not only deals with PLC tasks, but in addition offers all operating and communication options of a modern PC, with its Intel Celeron or Pentium III processor and TwinCAT software.

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New Mini PC with maximum features

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Small, sound and inexpensive PLC substitute

All mechanical parts are simply designed and the drives and plug-in cards are easily accessible without compromising system performance or integrity. The internal chassis is particularly innovative. It is removable for configuration and maintenance purposes and is fully operational as a PC even when removed. The installation options are also well balanced. All PC connections are located on one side, while three mounting sides offer optimum installation variations in the control cabinet for the user.
From a computing point of view, the Industrial PCs with their PC Control CPU are the most powerful machine controllers. To this end, they are simply operated with the on-board Ethernet interface or with a PC fieldbus card. Space for a PC104 card and a free PCI slot are also available. In addition, the C6330 variant offers a CD-ROM or CD-RW drive and is only 14 mm wider than the C6320. Both types have DVI and USB interfaces for the connection of the Beckhoff Control Panels. The operator thus has a complete Industrial PC station available.

Very versatile

Equipped with these features, the control cabinet PCs are suitable for a diverse range of customer applications. For example, wherever standard PC technology with ultra-compact design is required. The robust construction offers stable, proven hardware for many years. Through its design and its positive price structure, the mini PC is also aimed at the PLC and motion control market segments. The PC variant without rotating storage media offers further application options. Instead of a hard disk, a flash card is integrated as memory medium. In the CP63xx Panel PC version, the housing is installed directly on a Beckhoff built-in Control Panel. The large number of available Control Panels means that there are more than 50 variants of the built-in Panel PC.

### Technical data:

**Control Cabinet PC C63xx**

| Processor Intel Celeron 733 MHz  
| (optionally Intel Pentium III 850 MHz)  
| Slot motherboard with Socket 370 for Intel Celeron or Pentium III  
| 3 slot passive backplane, 1 free PCI slot (plug-in cards up to 190 mm)  
| 128 MB SDRAM DIMM module, extendable up to 512 MB  
| on board graphic adapter, 2 MB, LCD interface, monitor connection (optional 4 MB for 18 inch displays)  
| IDE hard disc, 2 ¹⁄₂ inch, 20 GB  
| 2 serial RS232, 2 USB interfaces on-board  
| PS/2 keyboard and mouse connections  
| on board Ethernet adapter with 10/100 Base-T connection  
| 24 V DC power supply unit  
| Operating temperature range 0 to 55 °C  
| Options: Fieldbus interface, network card, interface card, modem or ISDN adapter  

**C6320**

| External dimensions (W x H x D) 93 x 196 x 226 mm without mounting plate  
| Weight of the basic unit 9.5 kg  

**C6330**

| IDE CD-ROM drive Slim Line (optionally as CD-RW version)  
| External dimensions (W x H x D) 107 x 196 x 226 mm without mounting plate  
| Weight of the basic unit 10 kg  

Depending on the mounting plate, the IPC can be installed at the rear or side wall.
Apart from the sine/cosine output signals, the probes also provide a reference mark. For measuring probes, this mark is located, for example, just before the upper or lower end of the measuring range. Once the mark is reached or passed, a signal is generated that is evaluated and stored by the downstream electronics. So subsequent referencing in the control is possible.

Sine/cosine interface overview

This interface is used in many applications including shaft encoders or measuring probes. Compared with devices with digital square wave signals, the transfer frequency on the signal input lines is reduced significantly, while the resolution is unchanged. Instead of transfer rates in the MHz range, the transfer rate at a speed of 6000 rpm, for example, is only 100 kHz.

The sinusoidal signals A and B are offset by 90°; hence the name sine/cosine interface. Signal levels are typically 1 V_{ss}. Current variants such as 11 µA_{ss} are also available.

Faster, Better, Cheaper! Pretty much sums up the growing demands in automation technology. In many automation areas, “small revolutions” take place every day. IP 20 class fieldbus systems enclosed in control cabinets or small terminal boxes have been state of the art for some time. The next step for decentralization is the use of IP 67 modules which are directly installed at the machine or plant without additional protective enclosures. This offers tremendous advantages, particularly where space is tight or there are extreme ambient conditions.
Data transfer to the control
The measuring sensor with sine/cosine output is usually connected via a sequential electronic system. The sampled signals are initially interpolated and converted into square wave signals. Subsequently, they are transferred via a Bus Terminal station with appropriate I/O terminal with incremental encoder input and via the fieldbus to the PLC.

With the new Beckhoff module, there is no need any more for sequential electronics. In the Fieldbus Box IP5209-Bxxx, interpolation electronics and fieldbus connections are consolidated in a single device. The measuring probe is directly connected to the Fieldbus Box via an IP 67 impermeable, industrial M23 connector. All signals are transferred via this connector, which also supplies the required voltage for the sensor.

In order to offer a wide range of application options, the Fieldbus Box series is designed for all common bus systems. The IP5209-B310 variant has a Profibus slave interface. After the system start-up, i.e. after the Industrial PC with integrated Profibus master connection and the associated software has been started, the current counter value of the measuring probe is available via the Profibus. The Fieldbus Box evaluates the sine/cosine signals of the probe and adds these quasi-incremental impulses to the internal 32 bit counter. This makes the system independent from the higher-level controller or the fieldbus. The counter value can be absolutely converted to a physical sensor position.

Evaluation/scaling of the measuring signals
The signals are evaluated in terms of zero crossing and through interpolation within the oscillation. Zero crossing evaluation achieves a resolution of measuring probe period/4. Example: for a measuring probe with a signal period of 2 µm, the resolution is 0.5 µm.

In the Fieldbus Box IP5209-Bxxx, interpolation electronics and fieldbus connections are consolidated in a single device.

The interpolation within the oscillation provides the complete image of a period to 11 bits, i.e. 2048 steps! Theoretically, the system could therefore measure with an accuracy of approximately 1 nm (2 µm/2048). In reality, this is limited by the system accuracy of the measuring sensor and the configuration of the overall system.

The scaling or adaptation of the values to the “real” world can therefore be carried out very quickly through right-shifting or division by 2. In our example, the measuring probe with a signal period of 2 µm and a total measuring path of 12 mm would therefore result in a total figure of 12 mm/2 µm * 2048 = 12,288,000.

The trend is clear – the machines are becoming more compact, physical size and costs are becoming increasingly important. The availability of various special functions for IP 67 Fieldbus Box applications enables cost-efficient optimization.
Choosing a controller appropriate for a particular task often calls for a balancing act between the computing performance, complexity and the cost. The BX series Bus Terminal Controllers extend the controller categories to four categories. These include: the most powerful hardware platform, the Industrial PCs, the CX1000 Embedded-PC, The BX series and the BC series. In terms of equipment and performance the BX small controllers are positioned between the BC series Bus Terminal Controller and the CX1000 embedded controllers.

The concept of autonomous control and the fieldbus slave function was adopted from the BC series. The enclosure concept originates from the CX1000 and allows modular expansion with a Compact Flash card as mass storage. The main features distinguishing BC and BX series are the larger memory and the expanded interfaces. The BX range of Bus Terminal Controllers consists of a programmable IEC 61131-3 controller with fieldbus and bus terminal interface. Additionally, the BX devices are equipped with two serial interfaces: one for programming, the other for free utilisation. The device itself comprises an illuminated LCD display with 2 lines of 16 characters each, a joystick switch and a real-time clock. CANopen slaves, e.g. displays, can be connected via the integrated Beckhoff Smart System Bus (SSB), a CANopen based subsidiary bus system.

Integrated I/O and fieldbus interface
The Beckhoff Bus Terminals can be directly attached as usual. The comprehensive range of different I/Os enables any input signal to be read and any output signal that may be required to be generated. This small controller therefore enables a wide range of automation tasks to be solved, from garage door controllers to autonomous temperature control at injection moulding machines. The BX family is also particularly suitable for a modular machine concept. Within a network, the Bus Terminal Controller can exchange data with other machine components via the fieldbus interfaces. The real-time clock also enables decentralized applications, where the time or day of the week play an important role. The variants of the BX series Bus Terminal Controllers differ in terms of their fieldbus interfaces.
Five different versions cover the main fieldbus systems: Profibus DP (BX3100), CANopen (BX5100), DeviceNet (BX5200) and Ethernet (BX9000). The Ethernet controller supports the ModbusTCP, ADS-TCP and ADS/UDP protocols. The BX8000 variant does not have a fieldbus interface and can be used as a stand-alone PLC with the RS232 or RS485 interfaces.

**TwinCAT – the basis for programming and configuration**

The BX devices are programmed according to the powerful IEC 61131-3 standard. Like for all other Beckhoff controllers, the TwinCAT automation software is the basis for parameterization, configuration and programming. Users therefore have the familiar TwinCAT tools available, e.g. PLC programming interface, System Manager and TwinCAT Scope. Data is exchanged optionally via the serial port COM1 or via the fieldbus through Beckhoff PC FCxxxx fieldbus cards. The fieldbus interface, the SSB bus and the real-time clock can be configured and parameterized via the TwinCAT System Manager.

First HMI for CX1000 with Windows CE.NET

Copa-Data GmbH introduces the zenOn HMI software package for the Beckhoff CX1000 embedded system. The zenOn editor enables convenient import of TwinCAT PLC projects with the latest version, 5.50 SP4. This means that zenOn projects are executable under Windows NT/2000/XP and CE. The significant advantage of the zenOn solution is that, once created, visualization projects can be loaded onto the target platform via TCP/IP. Dialogs may even be changed during runtime. Access to TwinCAT PLC variables is via an optimized ADS (Automation Device Specification) which is an innovative protocol developed by Beckhoff. The zenOn dialogs are created independent of the resolution and adjust themselves to the respective monitor resolution.

For the CX1000 with Windows CE.NET operating system, zenOn CE.NET runtime has been integrated and is available under the order number CX1800-0001 with immediate effect. The zenOn editor is available exclusively via Copa-Data.

Further information about zenOn can be found at:

[www.copadata.com](http://www.copadata.com)
Beckhoff controllers are structured into four classes of increasing power. The lower class controllers are the BC and BX Bus Terminal Controllers while the upper class are the Embedded PC CX1000 and Industrial PC. All four control classes are uniformly configured and programmed via the TwinCAT automation software. Interfaces for the communication between controller and operating terminals from other manufacturers include the following:

- Serial communication via ModbusRTU
- Ethernet connection via ModbusTCP
- Fieldbus connection

The interface used depends on the type, size and price of an application. The three options are briefly described below:

1. Communication via ModbusRTU
Most displays have a serial port as standard. Various drivers for the serial port can be downloaded to the terminals; a serial Modbus driver is usually available. For the Modbus interface, Beckhoff offers a function block that can be used for all four Beckhoff control levels. The Modbus protocol was chosen, because coverage by terminal manufacturers is nearly 100%. Moreover, it is an open protocol that is very simply structured and has very low protocol overhead. The physical transfer is via the standard interfaces RS232, RS485 or RS422.

The display usually works as a master (client) and the Beckhoff interface as a slave (server). The advantage resulting from this distribution of tasks is that the MMI, i.e. the operator, knows which data are required. Communication can thus be reduced to a minimum. A Beckhoff Bus Coupler, a communication Bus Terminal or a serial COM port can serve as interface.

The ModbusRTU library for BC, BX, CX and PC
The TwinCAT function block is connected, for example, via the serial RS232 KL6001 Bus Terminal with connected display. The Modbus module deals with the complete communication. If, for example, the Bus Terminal receives a Modbus telegram, the function block evaluates the telegram and automatically sends a response to the master. The data can be stored in three memories: an input memory with read access, an output memory with write access, and a flag memory with read and write access.

The minimum solution with Modbus Bus Couplers
An operator terminal with ModbusRTU interface is directly connected as a Modbus slave to one or several BK7300 Bus Couplers or BC7300 Bus Terminal Controllers. The terminal operates as a master and receives the data directly from the BK7300 or — pre-processed — from the BC7300.

Bus Terminal Controller BC with fieldbus interface
When used with the Bus Terminal Controller, the ModbusRTU function block is directly integrated into the mini PLC. The communication Bus Terminal KL60x1 transforms the respective controller into a Modbus slave. The displays connected via these Bus Terminals can simultaneously exchange data with the higher-level controller via the integrated fieldbus interface such as Lightbus, Profibus, CANopen etc.

Bus Coupler with fieldbus interface
This solution is almost identical to the previous one, except that the program for the communication is not executed decentrally in the Bus Coupler but on the PC control.
**Bus Terminal Controller BX**

The BX series Bus Terminal controllers do not require additional communication Bus Terminals, since these devices already have a free communication port as standard. Like in the BC solution, here too the Modbus library transforms the serial interface into a Modbus slave interface or optionally an RS232 or RS485 interface.

**Embedded PC CX1000**

Like the BX devices, these devices also have a serial port on-board and can therefore be used in the same way.

**Industrial PC: Direct connection to the COM port**

Via the COM interface of the PC, the display can be connected directly to the PC. The ModbusRTU slave library is then not connected to a serial Bus Terminal like in the previous solutions, but directly to the “KL6xx1 emulation” of TwinCAT.

**Overview of displays**

The communication between Beckhoff controllers and operating terminals from the following manufacturers has been tested successfully:

- **ModbusRTU**
  - Cimrex, Exor, Hakko, pro-face, SAE-Stahl, Siemens, Sütron

- **ModbusTCP**
  - Cimrex, pro-face, SAE-Stahl

- **Fieldbus Interface (Profibus DP)**
  - Cimrex, SAE-Stahl, Siemens

Through continuous co-operation with further manufacturers, the communication options and types are constantly expanded.

**2. Communication via ModbusTCP**

Like the serial Modbus communication, ModbusTCP provides simple, open communication via TCP/IP (Ethernet). The Beckhoff Ethernet components BK9000, BC9000 and BX9000 come with an integrated ModbusTCP communication interface. A Modbus server and client driver is available for the PC (TwinCAT). Any number of distributed operating terminals can therefore be connected to a TwinCAT PC control via Ethernet. The solution via Ethernet is recommended particularly for large systems such as building automation or conveying systems.

The ModbusTCP interface via Ethernet is usually offered as a server or client interface. Both solutions can be used in combination with the Bus Terminal controllers BC9000 or BX9000.

**Display as ModbusTCP slave**

In this case, the Bus Terminal Controllers BC9000 or BX9000 act as master and send event-driven ModbusTCP telegrams to the display. The BC9000/BX9000 contains a ModbusTCP library that can send all functions that are permitted by ModbusTCP.
The new 19 inch C5101 and C5102 rack mount Industrial PCs define added value for Beckhoff. These competitively priced computers are mounted in a newly designed housing measuring only 4 height units. The advantages include: a simple but attractive housing with the dimensions of 438 mm x 177 mm x 500 mm. In addition to the hard disk, three bays are available for 5 1/4 inch drives such as CD-ROM, CD-RW, DVD-ROM or DVD-RAM, or for additional hard disks. The clearly visible type plate shows the configuration details of the PC at a glance. All the information, for example about the drives, such as manufacturer and type, as well as information about the connection type, can be found here.

The new C51xx has improved ventilation technology that prevents any dust from penetrating the unit. This is accomplished through a slight overpressure inside the IP 60 PC housing. A robust card locating clip protects the electronic cards against impact and vibrations. The new housing is designed for long-term compatibility with all new PC components over the coming years. The lockable front door, behind which the four drive slots are located, provides added security.

The computing power can be expanded as required with anything the high-end PC market has to offer. The rack mount IPC C5101 is equipped with Intel Celeron or Intel Pentium III on a slot motherboard. The C5102 variant is equipped with a standard ATX motherboard and can additionally be equipped with a Pentium 4 processor. The 19 inch rack mount IPCs thus offer controls with maximum performance.
Analog Bus Terminals now also available as single-channel variant

**Increased granularity – improved cost effectiveness**

In many applications, a large number of digital signals are recorded, but only a few or only one analog signal has to be processed. For these applications, the two-channel analog terminals are not always ideal, since one channel remains unused. Other applications require an electrical isolated configuration. Where hitherto separate terminals had to be wired, the new single-channel Bus Terminals bring economic benefits through lower costs.

Overall, the Beckhoff Bus Terminal system can now be adapted even better to the respective application. 1-, 2- and 4-channel Bus Terminals are available for analog signals, 2-, 4- and 8-channel Bus Terminals for digital signals.

**Beckhoff I/O system receives explosion protection approval**

**Bus Terminal in areas of explosive hazard of zone 2**

The Beckhoff Bus Terminals are designed for use in areas of explosive hazard of zone 2. The area of application of the recently approved terminals is therefore expanded for further applications.

From July 2003, explosion protection regulations will be based on ATEX100a. European Union directive 94/9/EC is based on article 100a of the treaty establishing the EC. ATEX 100a is the working title and is derived from "atmosphères explosible". Implementation into national law was via the 11th regulation on the equipment safety law of the explosion protection regulation (ExVO). The transitional period finishes on 30.06.2003. From this date, only equipment with ATEX approval must be produced and sold for use in areas of explosive hazard within the EU. Switzerland and some eastern European countries have also implemented ATEX100a within their national legislation.

For areas of explosive hazard of zone 2, it is assumed that no hazards from explosive atmospheres such as gases, vapours or mist are present. Any such occurrences are rare and short-term. The Beckhoff Bus Terminals should be classified as category 3 devices. During normal operation, they meet the safety requirements for zone 2. The user should follow the special conditions for the safe use of the Bus Terminal system components that are certified for areas of explosive hazard.

List of certified products:  
www.beckhoff.com/certifications/
With the product TeSys model U, Schneider Electric takes a completely new route. The newly designed motor starter is a very compact and flexible solution, which is particularly suitable for users who wish to make modifications up to the last minute. The flexibility, with which this motor circuit can be quickly customized at any time, drastically reduces the commissioning effort and also enables cost savings through the simultaneous design of the mechanical and electrical system. A further highlight of this solution is the integration of the motor starter into the fieldbus world. Here, Schneider Electric relies on Beckhoff's experience and I/O product range.

The co-operation between Schneider Electric and Beckhoff is not new. As early as 1999, both companies realized joint products with the "Tego Power" series. Beckhoff's fieldbus know-how was used for the direct connection of contactors and motor protection. Compact modules for Profieldbus, Interbus, Interbus fibre optic, CANopen, DeviceNet and Fipio are available to customers. The integrated Beckhoff Bus Couplers are internally connected with the motor starters via ribbon cables.

**Schneider Electric worldwide**

With approximately 72,200 employees in more than 130 countries, Schneider Electric is one of the leading producers of electrical and automation technology worldwide. Schneider Electric can look back on a company history spanning more than 160 years. The products and services are structured according to the four main markets of power supply, industrial equipment, infrastructure/transport technology and building services. Established brand names are Merlin Gerin, Modicon, Square D and Télémécanique.

**More information about Schneider Electric:**

www.schneider-electric.com
Versatile motor circuit
The TeSys model U system, which is currently being introduced into the market, has been further optimized. The motor starter consists of a power base unit with plug-in control devices and communication modules. The control unit, available up to 32 A, comes in three variants – standard, advanced and multi-function – ranging from the simplest to very advanced protective functions. The latter is equipped with an integrated display on which the alarm limit values and the motor parameters (e.g. current or thermal condition, error overview or operation time) can be visualized in real-time. A wide variety of information is thus available, which is extremely important for both operation and maintenance, contributing to the optimization of the manufacturing facilities.

Open for all fieldbus systems
On a total area of only 150 mm x 45 mm for each motor circuit, the system offers the option of adding a communication module. Via the KL8601 communication module, the TeSys motor starter can be connected directly with the Beckhoff products.

“The combination of our know-how has led to an unsurpassed solution, offering maximum flexibility and performance.” Alain Dedieu, Vice President Protection and Control Power, Schneider Electric.

TeSys model U – the smart device

Alain Dedieu on the co-operation with Beckhoff:

With TeSys model U, Schneider Electric offers a very innovative motor circuit concept, a real "smart device". TeSys model U has the same dimensions as a standard motor circuit and is the first motor circuit to combine such a wide range of functions and intelligence including disconnecting, connecting of power, electronic protection as well as automation and communication functions. This greatly simplifies implementation and operation.

Within its (for a 15 kW motor circuit) extremely compact design and architecture, control and power functions are separated, simplifying the installation in automation applications. Furthermore, the modular design offers the option of selecting the protection specification at any time and of expanding the functions for providing tailor-made solutions.

The fact that our product ranges are characterized by common values such as compact design, modularity and openness has naturally led us to strengthen our partnership with Beckhoff as one of the market leaders for modular I/O systems.

The functions of control, monitoring, maintenance and asset management, created through the combination of Beckhoff Bus Terminals and TeSys model U, are available for all main common communication networks, thus ensuring additional openness.

The design of TeSys model U enables customers to install the motor circuits directly adjacent to the inputs/outputs, or with a distance of several metres, thereby separating the low-voltage signals from the power circuits. This provides high adaptation flexibility and offers customers the option of developing the automation structure progressively as required. In a single operation, the dialog connection and the supply of the motor circuit with 1 or 2 directions of rotation are established via a simple shielded RJ 45 cable.
Since May 2001, Beckhoff has focussed on expanding its OEM business. Key Account Manager Roland van Mark is responsible for this market segment. "The interfacing of the Schneider Electric/Télémécanique TeSys model U motor starter into the Beckhoff IP 20 fieldbus world bridges a significant gap. With its optimum price/performance ratio, the new Beckhoff module will influence numerous applications."

Bus Terminal system. The KL8601 communicates with the higher level automation device via the appropriate Bus Coupler. Users of TeSys modules therefore have the complete fieldbus range available. Like in the Beckhoff Power Terminal system, in which the KL8001 Power Terminal is screwed onto a standard contactor, the motor starter integrates seamlessly into the terminal bus.

The motor starter is integrated into the fieldbus system via the KL8610 adapter terminal and a common, screened RJ 45 cable. The 24 V DC supply of the contactor systems is also transferred via this patch cable. The maximum distance between the KL8610 and the first motor starter module is 5 m, the maximum distance between two starters is 0.5 m. Up to 8 starters can be connected in series. With the Terminal Bus Extension, the number can be increased even further. Spatial separation of I/O and power plane can thus be realized within the control cabinet.

Minimum inventory management with high availability reduces costs
A glance into the working world of control cabinet and machine construction and engineering shows that Schneider Electric and Beckhoff have consistently followed the market requirements: The integration of TeSys model U into the Beckhoff fieldbus world offers users one of the most comprehensive I/O systems. Optimum solutions for each application can thus be configured.

Standard plugs and cables simplify the wiring, increase security and minimize the costs. The spatial separation of control and power modules within the control cabinet prevents faults and increases plant availability.

The KL8601 communication module, the KL8610 adapter terminal and the accessory cables are available from Schneider Electric/Télémécanique and Beckhoff. The TeSys motor starters are only available from Schneider Electric, the Bus Terminal system only from Beckhoff.

Terminal Bus interface with high connectivity
The flexibility of the Bus Terminal system in terms of fieldbus and signal variety is well known. With a total of 15 supported bus systems and more than 130 different Bus Terminals, the Beckhoff I/O system, introduced in 1995, is considered to be one of the most comprehensive systems on the market. Further connection options are available through coupling to the internal Terminal Bus interface. With TeSys Model U from Schneider Electric/Télémécanique, the direct integration of a device from another manufacturer with the internal Beckhoff Bus Terminal system has now been realized.

The Bus Coupler communicates as a head station with the connected Bus Terminals via the internal, serial Terminal Bus. During “normal” operation, the 6-pin Terminal Bus is terminated via an end terminal; if the system is expanded, an appropriate adapter terminal is used instead of the end terminal. An example is the power terminal system, where the KL800x Power Terminal is connected with the Beckhoff Bus Terminal system via the KL9060 Adapter Terminal. Together with a power contactor, the KL8001 Power Terminal forms a complete distributed motor starter. Apart from all the protective functions of a motor protection relay the power terminal contains comprehensive diagnostics.

With the Bus Terminal extension system, the system, normally limited to 64 Bus Terminals, can be expanded to 255 terminals. A further advantage is the high spatial flexibility. The Bus Terminal extension now permits Bus Terminals to be divided into up to 31 blocks in the control cabinet or in the plant. The physical connection from the “master system” with the KL9050 Coupler Terminals is via the KL9020 Adapter Terminal. The coupler terminal starts a bus terminal block located further away, and establishes the logical connection to the bus coupler via a standard Ethernet cable.

All Bus Terminal extensions have one thing in common: The extension is transparent for the fieldbus and for higher-level systems, and therefore “fieldbus-independent”. The connected extension devices therefore have the complete fieldbus variety available for communication.
Beckhoff Panel PC – the slimline alternative for the control cabinet

➔ extremely slim built-in PC
➔ more than 50 front variants
➔ 10, 12, 15 or 18 inch TFT display
➔ slot motherboard
➔ 2 free slots

A strong combination: Built-in Control Panel + add-on PC = Panel PC

The CP64xx add-on PC from Beckhoff turns the built-in Control Panels into a powerful Panel PC:
➔ slot motherboard with Intel Celeron or Intel Pentium III 850 MHz
➔ 1 free PCI slot and 1 free combined ISA/PCI slot
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➔ optionally available with touch screen or with touch pad
➔ drives and plug-in cards are accessible quickly and easily

For further information and international sales contacts see: www.beckhoff.com
Users are already familiar with the option to reuse software modules and the flexible exchange of the fieldbus system through a simple Bus Coupler exchange without changes in Bus Terminals configurations. The multi-configuration mode for the Profibus DP Bus Coupler offers further optimization options, as shown in the following example. A machine with the machine extensions A, B and C, whose process signals communicate with the Beckhoff Bus Couplers BK3110, BK3120 or BK3520 via Profibus DP, could be structured as follows:

Control

PROFIBUS DP master interface

BK 1 BK 2 BK 3 BK 4

Controller (e.g. TwinCAT, S7-400, etc.), Profibus DP master interface (e.g. FC3101, CX1500-M310, etc.) for sending or receiving the process signals via the Profibus DP and Beckhoff Bus Coupler with Bus Terminals as interface to the machine process. The areas shown in white relate to machine parts that are available as standard. The machine extensions A, B and C are shown in red, green and blue. It can be seen that each extension is associated both with software modules within the control program and process signals that are connected to the controller via Bus Terminals.

It makes sense to design the control programs such that all options are included but only the required software modules are activated. Then the machine manufacturer does not have to maintain eight different control programs for all possible machine options. Writing a control program for all machine configurations requires the same I/O always appear at the same addresses in the control process image. This means that I/O can be added or taken from the machine without changing the control process image. It takes a good understanding of the various process images in a control system to really understand how adding and changing process signals affect the control process image. This is explained in further detail in the following paragraphs. In the case of Profibus, the programs control process image is linked to the Profibus DP master interface process image which is linked to the Profibus DP slave process image. A Profibus DP master interface must be reconfigured when I/O is added or removed from a DP slave. This ensures the master interface process image matches what is actually connected. With the Beckhoff Bus Couplers, reconfiguration is not necessary when additional I/O is added.

The advantage of this solution is that two machine configurations only differ in terms of the hardware used (machine components and Bus Terminals), but not in terms of the software. A machine extension only requires the additional Bus Terminals to be plugged in and wired and the associated extension to be activated (e.g. via the MMI interface of the machine); no software changes are required.

Process image interfaces

The interfaces between controller, Profibus DP master interface, Bus Coupler and Bus Terminals form process images, in which the process signals are stored according to certain algorithms:

The process signals of a DP slave (Bus Coupler BK3110, BK3120 or BK3520) are always transferred in a data exchange telegram, in which the outputs are sent by the DP master and the inputs are received in the associated telegram response. In the Profibus DP master interface, the process images exchanged with the Bus Couplers are mapped to the process images of the control according to a mapping rule.
Process images of the machine configurations
As shown in the two examples in the figure below, the mapping rule in the Profibus DP master interface changes, depending on which machine extensions are used:

In order to solve the problem of the modified mapping rule, with the Bus Couplers BK3110, BK3120 and BK3520 the mapping can already be carried out in the Bus Coupler (multi-configuration mode).

Setting the Bus Terminal extension in the Bus Coupler
In multi-configuration mode, the Bus Coupler should be configured for the maximum number of Bus Terminals possible. This max Profibus DP setting ensures that the same process image is transferred between the Profibus DP master and the Bus Coupler at all times, irrespective of the machine or I/O configuration. The max Profibus DP configuration is sent by the Profibus DP master to the Bus Coupler during start-up of the Profibus DP bus. The Bus Coupler compares the max configuration received with its own Bus Terminal configuration which may not match because the Bus Coupler does not have the maximum number of I/O signals connected. Recall that the Bus coupler was configured for maximum number of I/O, this means that in the standard configuration mode the Bus Coupler configuration will represent the true number of connected I/O only if the coupler has a full rack of I/O connected. In all other cases the Bus Coupler configuration will think it has a full rack of I/O when there is really less I/O connected unless the Bus Coupler is operated in multi-configuration mode.

The mapping rule ensures that all I/O signals are mapped from the Bus Coupler DP slave to the Master interface even if the Bus Coupler is setup for maximum I/O but in reality there are less I/O connected. The process signals of the Bus Terminals are mapped to the DP process image according to a fixed algorithm (first complex, then digital terminals, in the respective pluggard order). The information actually available in the Bus Terminal designed via Profibus DP configuration is transferred via the acyclic DP-V1 Write or, for Profibus DP master interfaces that do not support Profibus DP-V1, via the 2-byte PLC interface. The acyclic DP-V1 Write is usually available via function blocks (TwinCAT: ADS Write) from the control program; the 2-byte PLC interface of the Bus Coupler is mapped directly into the process image of the controller. If a machine is extended, the control program can activate or deactivate the associated Bus Terminals (see examples above, inactive terminals are shown in yellow). Alternatively, the Bus Terminals can be set via the UserPrmData during DP start-up, but this usually requires the DP configuration in the master to be adapted.

State transitions in the Bus Coupler
If the Profibus DP configuration received does match the Bus Terminal configuration in multi-configuration mode, the Bus Coupler sets the ”static diagnostics” bit in the Profibus DP diagnostic data and delays the execution of a terminal bus cycle (I/O RUN LED remains off). As soon as the terminal assignment (activated/not activated) has been described by the Profibus DP master, the Bus Coupler carries out another check of the Profibus DP configuration and automatically enters cyclic data exchange: the ”static diagnostics” bit in the Profibus DP diagnostic data is deleted, and the terminal bus cycle is carried out cyclically (I/O RUN LED comes on). Furthermore, the terminal assignment is stored in the non-volatile memory of the Bus Coupler, so that during a restart of the Profibus DP, the Profibus DP master does not have to write the terminal configuration again.
Movement along the path –
Software CNC solves complex tasks

For years, the TwinCAT NC I (interpolation) software module from the TwinCAT product family has demonstrated that path control is possible as a pure software solution. The Beckhoff automation software has – added a new level called TwinCAT CNC – geared towards CNC solutions. TwinCAT CNC offers complete CNC functionality as a pure PC-based software solution. TwinCAT CNC covers the complete range of classic CNC path control, including high-end solutions for complex motion and kinematics requirements.

PC computing power without limits
Complex path movements with high velocity and precision place high demands on computing power, real-time capability and deterministic features of the control system in order to execute the tasks of CNC program execution, interpolation and position control. The powerful, continuously evolving PC platform with increasingly fast processors and the hard real-time base of the TwinCAT real-time kernel offer ideal preconditions for software CNC. The requirements of CNC path control, PTP positioning control, PLC sequential control and operation/visualization can easily be met with the single-processor PC-solution of the Beckhoff TwinCAT system.

The following diagram shows the different computing times of TwinCAT CNC for four different cases and with two common PC processor types. On an Industrial PC with Pentium 4/2.4 GHz processor, TwinCAT CNC needs 435 µs for set value generation and position control in an application for example with 8 interpolating axes and a controlled spindle in two independent CNC channels. In each CNC channel, a CNC program for high-speed cutting (HSC) with active polynomial over-grinding and real-time transformation is executed.

If the commonly used cycle time of 2 ms is assumed, for example in connection with SERCOS drives, this relates to a computer workload of approximately 22% for this complex CNC application. The remaining processor capacity is available for PLC, PTP and HMI functionality. The TwinCAT CNC software solution therefore does not have to shrink from comparisons with conventional hardware-oriented CNC controls, even for demanding and complex tasks. TwinCAT CNC can operate with up to 32 path axes and controlled spindles that can be distributed across up to 10 CNC channels with individual part programs. In one CNC channel, up to 32 axes and spindles can be interpolated simultaneously, enabling even the most difficult motion tasks to be solved. Axes can be exchanged and channels synchronized between the individual CNC channels. Based on these performance data, even large machining centers with several machining stations and integrated workpiece handling can be controlled with a single Industrial PC.

The range grows with demands
Since TwinCAT CNC is a member of the TwinCAT product range, the features of continuity and openness in terms of system functionality and the application of standardized programming tools and interfaces is a matter of course.
The familiar configuration, programming and diagnostic tools of the TwinCAT system (System Manager, ScopeView etc.) offer the user the peace of mind of a uniform CNC solution.

TwinCAT CNC is based on TwinCAT PLC, the proven IEC 61131-3 software PLC and therefore has a powerful sequential control. If TwinCAT NC PTP is used as the basis, powerful motion functionality for positioning tasks is also available. Like in TwinCAT NC I, part programming in TwinCAT CNC utilizes subroutine techniques and high-level language extensions according to DIN 66025.

There is no question about functionality
The required axis and spindle functions, interpolation and feed functions, tool and help functions according to DIN 66025, and with specific expansions, are available for a variety of machining technologies (e.g. milling, drilling, handling, special machines).

But TwinCAT CNC also offers appropriate CNC functionality for high-end applications. Suitable interpolation and transformation functions are available, particularly for HSC machining of freeform surfaces and the classic "5-axis machining", in which the CNC programs are usually generated via CAD/CAM systems. Apart from the classic linear, circular and helical interpolations, the software CNC additionally offers convenient spline interpolation, optionally based on Akima or B-splines, for reducing the number of NC blocks.

In the interest of simple and flexible operation and programming, 5-axis machining with complex machine kinematics for difficult machining tasks requires real-time CNC transformations. They are used, for example, for defining different coordinate systems within the machining process or for generating automatic compensating movements of rotary axes. Optimum tool alignment and real-time corrections are thus possible without changing the CNC program. TwinCAT CNC provides the required CNC functions:

- RTCP function (rotation tool center point)
- TLC function (tool length compensation)
- Kinematics selection from the kinematics library
- Definition of different coordinate systems
- Tool alignment in the chosen coordinate system
- Linking/transition of coordinate systems

CNC controllers:
The subject of the NC-Gesellschaft e. V.

In 1975, “NC” was the big innovation and led to the foundation of the NC-Gesellschaft e. V. (NC Society – Application of New Technologies). This led to the concrete technology transfer task of enabling an efficient dialog between the machine tool manufacturers, the control partner and of course the end user.

CNC controllers have therefore always formed one of the most important components in the process chain, which today has to be “uniform”. With comparisons of CNC controls, the international HSC acceptance standard (3-axis milling) and the involvement in the subject of parallel kinematic systems (PKM), the NCG has accompanied this dialog continuously and in a practice-oriented way.

When Beckhoff joined the NC-Gesellschaft e. V. in 1994, the company was mainly interested in the activities of the NCG in the timber processing sector with its demanding automation aims. Today, Beckhoff is a Global Player in terms of automation and its components. It is therefore only logical that also 5-axis CNC controls and their requirements and targets are now at the centre of attention. With TwinCAT CNC, modern, open, PC-based CNC control is now available in the market.

A “5 axes” NCG working group is in preparation, which will be shaped by end users, machine tool manufacturers and of course the CNC control partners. As a member of the NCG, Beckhoff is very welcome in this working group.

NC-Gesellschaft e. V.:

www.ncg.de
Fieldbus technology – openness for I/O and drive technology
In the CNC world, TwinCAT CNC offers a new and unique openness in terms of machine periphery and drive systems through the consistent utilization of fieldbus technology. A variety of I/O modules and further automation components such as valve terminals, frequency converters etc. can be connected via all common fieldbus systems, enabling modern, decentralized interfacing of the machine. The drive systems are also consistently connected with the CNC via fieldbus systems. Depending on drive type, this can either be implemented via the classic analog/encoder interface with associated fieldbus modules or directly via a digital fieldbus interface (e.g. Profibus MC, SERCOS interface, Lightbus). This offers the user maximum openness and flexibility in the choice of drive systems.

Tailor-made CNC solutions
With TwinCAT NC I and TwinCAT CNC, Beckhoff offers two CNC products within the TwinCAT system with subtle differences. TwinCAT NC I is a slimline, flexible and cost-effective solution for CNC applications that require no more than 3 interpolating path axes and 5 auxiliary axes in one CNC channel. Up to 31 channels with a total of up to 255 axes can be used. In combination with the integrated TwinCAT PTP functionality for the complex control of positioning axes (master/slave, electronic gearings, cam plate etc.), and through the option of online axis-exchange between TwinCAT PTP and NC I, an extremely flexible and powerful control solution for large systems with many axes and CNC channels is created.

In contrast, TwinCAT CNC is the solution for classic CNC application with up to 32 interpolating path axes and controlled spindles in one CNC channel or distributed across up to 10 CNC channels. In combination with comprehensive and powerful CNC functionality and the option of high-speed and 5-axis machining, TwinCAT CNC can cover the complete range of CNC applications in a variety of machining technologies.

With TwinCAT NC I and TwinCAT CNC, tailor-made software solutions are therefore available for the complete range of CNC path control, with a uniform PC-based hardware and software platform. What more could users wish for?!
### TwinCAT NC I and TwinCAT CNC – ideal software solutions for path control

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The strong competition in the furniture sector is characterized by increasing demands in terms of production costs, production speed, processing quality and flexibility. These demands are pushing machine suppliers to use state of the art technologies such as PC-based control, in order to meet market requirements. Weeke Bohrsysteme GmbH has been producing powerful woodworking machines for many years. The company specializes in the production of machines for processing wood panels. The product portfolio includes automatic high-performance drilling machines (BST) and CNC machining centers (BHC) for machining the workpieces in one chucking. Quite often, mixed versions are used, i.e. machines that deal with both CNC processing and drilling. The weighting may differ depending on the requirements. The consistent orientation towards advanced technology and optimum customer benefits recently prompted Weeke to implement a new control generation. “Of crucial significance was the availability of a unified platform for all machine types,” said Werner Birwe, manager of electrical design. “This means that a control system has to combine a large number of different functions.” This obviously requires a powerful system. The requirements of openness, good price/performance ratio, progress and investment protection inevitably led to a PC-based control system. The advantages offered by TwinCAT, the universal control platform from Beckhoff, made Weeke choose this system.
The more complex drilling processes of the z-axis are executed in individual NC I channels for each drill head.

Based on a hard real-time environment that forms the TwinCAT foundation, each machine has access to the PLC functionality contained within TwinCAT as standard. Up-to-date programming uses one of the programming languages consolidated under the IEC 61131-3 standard. The integrated PTP control deals with simple PTP positioning tasks and coupled movements. More complex movements in the form of interpolating axes are either solved under TwinCAT NC I (interpolation) or under TwinCAT CNC, depending on the requirements.

A CNC for any application
The variety of Weeke machines place very different demands on the control system. On the one hand we have the highly dynamic drilling center with many I/Os and up to 100 positioning axes, on the other hand we have the processing center with relatively little sensor and actuator technology, but complex motion processes. In both cases, the options and characteristics of the CNC functions integrated in TwinCAT are the crucial factor for the quality and speed of the machining process.

Automatic high-performance drilling machine BST
Weeke builds two drilling machine variants: the BST 500, with up to 2 horizontal and 20 vertical fixed drill heads, and the BST 100, with usually up to 8 horizontal and 8 vertical drill heads with individually selectable spindles. The latter may justifiably be identified as the "high end" of drilling machine technology. A drill head is a complete drilling unit with room for up to 40 individual drills that either replicate the motion of the drill head (BST 100) or can perform different individual motions in each cycle (BST 500). During machining, the drill head does not perform simple PTP movements, since the drilling process consists of a range of process-dependent, clearly defined individual movements. To name but one example, the drill head (z-axis) approaches the workpiece with as high as possible velocity, the surface is drilled with reduced velocity, the drill head moves through the material with higher velocity, the velocity is reduced again before the rear of the workpiece is penetrated, and the drill head is retracted after the drilling process. During the movement of the z-axis, individual drill spindles, provided

Functional variety through boundless openness
During the processing of wooden parts, the machines from Weeke perform a large number of axis movements that were controlled by a range of special hardware platforms. Proprietary PLC systems, positioning controls, classic CNCs, various drive and fieldbus systems offer a heterogeneous picture of the control world within the machines. Together with the existing operating PC, this hotchpotch of components was not only complicated, but also expensive. All this will now be a thing of the past; on the hardware side, the system consolidated to a single Industrial PC, and all control functions are dealt with by the TwinCAT software modules.
They can be selected individually, can be withdrawn, e.g. for drilling a blind hole, depending on the part being processed. Parts can thus be processed flexibly with variable drilling patterns and with extremely short cycle times.

In short: The TwinCAT NC I control package runs on an Industrial PC equipped with a Pentium 4 CPU. The user-friendly visualization application called “Top Drill” enables the selection of the drilling programs, tool data management, diagnostics etc. From this interface, the program “Wood WOP” for graphic part programming and drill optimization can be accessed. The interfaces were created in Visual Basic or Visual C. With ADS OCX they use a standard Microsoft technology for accessing all the data of the TwinCAT PLC and NC/CNC world.

TwinCAT receives its data essentially from Wood WOP. The result of the graphic part programming is made up of the data about hole positions (surface data X, Y), drilling depths (Z), bore diameter and drilling speed (depending on the material) of the individual holes. Due to the large number of bore holes, a significant amount of data may be generated, which is transferred to the PLC via the ADS OCX. The data are then processed in TwinCAT PLC and distributed to the NC or NC I as required. The planar positioning movements of the drill heads (X, Y) are PTP movements, which are dealt with by the PTP control integrated in TwinCAT. There is no restriction on axis coupling. The more complex drilling processes (z-axis) are carried out in individual NC I channels for each drill head to ensure optimum velocity for each motion. In the most recent machine built by Weeke, type BST 100, 10 z-axes are controlled in individual NC I channels, plus approximately a further 40 PTP axes.

Since TwinCAT NC I enables the interpolation of up to 3 axes and a further 5 auxiliary axes per channel, the intention is to run typical CNC-based functions, such as corner rounding, notching and grooves on the same machine in further NC I channels. No structural changes of the control system are required, neither on the software side nor on the hardware side and, even more importantly: no changes are expected to be required in future either.

**The suitable fieldbus for every function**

TwinCAT supports all market-relevant fieldbus systems as standard. In this concrete case, the complete drive technology (Indramat DKC) is operated via a SERCOS interface. Approximately 500 digital inputs and outputs and a few ana-
log channels for the spindle drives are simultaneously controlled via Profibus. The Beckhoff Bus Terminal System is used as an I/O module. It is available for a large number of bus systems. At a later stage, the additional use of CANopen is envisaged, perhaps for special field devices.

In the PC, appropriate master interfaces are required, both for SERCOS (FC750x) and for Profibus (FC310x). Here too, Beckhoff offers suitable single-channel or twin-channel PCI cards.

**BHC processing center**

Different variants of the processing centers are available. The main differences are in the size of the processing space in the three spatial co-ordinates or in the number of axes, which have an immediate effect on the variety, but also on the speed of the machining.

In terms of the control, the distinction with regard to the processing options and, often related, the number of axes, is relevant. They range from small 3-axis processing centers with interpolation in the Cartesian space (BHC 250/350) via classic processing centers with integrated c-axis (BHC 550/750) to large centers with interpolation of 8 or 9 path axes and co-ordinate and kinematic transformation (BHC650/850). So-called throughfeed processing centers (BHT) round off the range.

The main feature is that not much changes in terms of control or hardware. Due to the more comprehensive demands on the CNC, such as spindle functions, interpolation of more than 3 path axes per channel, transformations with different kinematics, the variant TwinCAT CNC is used instead of TwinCAT NC I. Apart from the CNC part, both systems are identical; TwinCAT CNC includes all the typical elements of a classic CNC mentioned above.

The control configuration can be explained quickly: Everything more or less corresponds to the control technology for drilling machines. For graphical part programming, Wood Wop can be called up from the MCC operating environment, which is programmed in Visual Basic/Visual C like for the drilling machines. After completion, the post-processor (PP) integrated in Wood Wop generates a CNC program according to the familiar DIN 66025. This CNC program in ASCII format is loaded from the PLC into the actual CNC and started. Like under TwinCAT, the usual communication routes between PLC and CNC are simple and standardized.

SERCOS is again used as a fast drive bus. Due to the relatively small number of digital and analog inputs/outputs (100-200), in addition to the drives it additionally operates a SERCOS Bus Coupler BK7500 with an associated number of I/O terminals.

**Hardware-independent control**

"Hardware independence is a big topic for us," said Ralph Kottmann, software development manager at Weeke. "We thus open up the otherwise not obvious option of being able to purchase the best components required at the time on the world market without restriction."

Weeke can offer its customers real added value in terms of plant availability and investment protection through simple diagnostics and service options — even deep down in the control — and through simple methods for control networking and master computer interfacing and automatic homogeneous further development of the PC-based control platform. In addition, the integration of the CNC functionality within the TwinCAT software package makes the control hardware attractively clear and inexpensively. Who would want to challenge the role of the Industrial PC as the spearhead of industrial control technology?
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For a long time, hydraulic systems were somewhat frowned upon among machine tool manufacturers, but they are becoming increasingly acceptable again. For Detlef Langer, chief designer for multi-spindle automatic lathes at the machine manufacturer Schütte, they are more than just another automation option. He has concrete data that confirms the dynamics that can currently be realized with hydraulics and sophisticated electrical control technology: “For accelerating an axis to its absolute operating velocity in our new PC series 8-spindle machines, during thread cutting we often only have a path of 1.5 mm and a time of 20 ms available. Furthermore, our hydraulic axes operate with a positioning tolerance of less than 1 µm.” In his machines, the engineer with a doctorate realizes all linear movements hydraulically, while all rotating movements are realized with electrical drives. In order to reconcile the two different systems, Detlef Langer uses the principle of the virtual control shaft: “It resembles a running time axis, to which all movements can be referred to. Unlike with an interpolator, all axes always operate synchronously.” The virtual control shaft used by Schütte in the automatic CNC lathes utilizes the PC-based TwinCAT NC I control software from Beckhoff. The mechanical engineering company has thus realized an ambitious concept, whereby TwinCAT is used as a software kit
that was complemented with customized additional components. They include a converter that implements the NC program for a cam plate module. Its virtual control shaft controls all movements of the Schütte machines. “This,” explains Detlef Langer, “enables us to produce very complex parts on our automatic CNC machines.”

**The optimum solution for time-controlled set value specification**

In order to be able to control the hydraulic actuators, at Schütte’s suggestion Beckhoff developed a decentralized hydraulic controller, the AH2000. It is considered to be the only module on the market that is addressable by controllers via fieldbus in the required way. Detlef Langer is therefore convinced: “There is currently no other approach that covers time-controlled set value specification in such an ideal way. Other systems only operate with a command interface or with a less highly clocked set value interface.”

What servoamplifiers do for electric drive technology, the AH2000 series hydraulic controllers do for hydraulic axes. Together with a sensor for the position, a proportional valve, a hydraulic cylinder, pressure sensors, digital inputs and outputs and the TwinCAT automation software, complete axis drives can be built. The controllers control the velocity and position of the cylinders. Interfacing of the drives is achieved in the Schütte machine through 5 of the 6 fieldbus branches (see system overview) via Profibus MC (DP-V2). The 2-channel PC fieldbus cards FC3102 from Beckhoff are used as control interface. Depending on the configuration, for example 24 of the maximum 48 axes may be connected to up to 16

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**The advantages at a glance**

- The set value specification is transmitted to the individual decentralized hydraulic controllers via a Profibus network.
- The AH2000 hydraulic controllers now deal with position control and velocity control.
- The control modules are combined with a direct position sensor system with a resolution of < 0.1 µm.
- The very high pulsing of the control modules, representing a synchronous multiple of the fieldbus clock rate, enables accurate control with regard to path characteristics, positioning accuracy, acceleration and dynamics.
AH200x drive controllers. In this case, the AH2003 hydraulic controllers deal with the position control. The solution is suitable both for metal cutting machine tools and for positioning technology tasks.

Short cycle times for quick velocity control

The AH2000 range comprises two different versions: the AH2001 variant has one controller, the AH2003 variant has three controllers. The hydraulic controllers with integrated Profibus interface contain a powerful PC-based computer core. A 266 MHz Pentium I processor provides the necessary computing power. The control functions are realized via the TwinCAT automation software under the operating system Windows NT Embedded. Due to their extremely short cycle time of 250 µs, they also manage to deal with velocity control for very fast control valves. Depending on the application, either a central control or the hydraulic controller itself deals with position control.

In terms of the Schütte solution this means: The AH2000 hydraulic controller receives the set values from the PC control via Profibus and the actual values from the process periphery, i.e. directly from the valves and the encoders. This information is converted into a control loop and forms the control value and actual value information. Via Profibus, the values flow back to the central controller as directly usable actual values. In the previous solution, the sensors were directly linked to

Dr.-Ing. Detlef Langer, chief designer for multi-spindle automatic lathes: “There is currently no alternative to the AH2000 solution, because it deals with time-controlled set value specification so directly and processes it so accurately.”

The hydraulic controllers offer comprehensive peripheral connection options. Hydraulic valves from Rexroth or Bosch with 12-pin connectors or a variety of valves from other manufacturers may be connected with appropriate cable sets. The controller deals with the power supply and the monitoring function for the valve. Incremental encoders with sine/cosine signals (1 V_{pp}) or TTL signals, e.g. from Heidenhain, may be used as position sensors. Furthermore, analog displacement sensors with 4–20 mA signals, e.g. from Balluff, may be used.
The Schütte Group is one of the leading machine tool manufacturers worldwide. Via domestic and foreign subsidiaries and sales and trading partners, Schütte is represented on all continents.

The fieldbus, and had to be retrieved and processed by the central controller. All this is now much more direct and thus more dynamic.

This leads to more dynamic controller structures, as Detlef Langer attests: “At a velocity of more than 7 m/min, for example, an axis remains within a following tolerance precision window of 2/100th of a millimeter over the whole turning length. For the chancing of threads this is an advantage that should not be underestimated.” And a further special feature exemplifies the benefits of the Schütte solution: Analog sine/cosine encoders from Heidenhain are used instead of purely digital encoders. “This,” says the chief designer, “provides significantly better path resolution via intermediate interpolation and achieves 10-fold improvements in terms of path accuracy.” The automatic machines become more dynamic, resulting in shorter production times.

Today, most motion tasks can no doubt be solved electromechanically. During the last 25 years, this has shifted the relative shares of the drive technologies at the expense of hydraulics. However, the reputation of hydraulics as being “old-fashioned” is unjustified, because even today there is a comprehensive range of applications where its specific mix of characteristics matches the requirements very well. It should not be overlooked that hydraulics too was able to benefit from progress, be it in production engineering, electronics or computer science. Beckhoff will continue to actively support hydraulic motion technology. In this context, the AH2000 has to be seen as the high-end product. In addition, wide-ranging support is being established within the product range, which is recognized as being modern, in open concepts with a high degree of integration.
Robust and compact signal variety

- fully potted modules
- protection class IP 65/66/67
- robust and compact design
- integrated T-connector
- low system costs

The new Fieldbus Box modules series integrates two M12 fieldbus connections. No additional T-connector is required. Through the direct fieldbus input/output, the modules are even more compact, and the device is significantly slimmer overall. The Fieldbus Box variant with integrated T-connector is available for Profibus, CANopen and DeviceNet.

For further information and international sales contacts see: www.beckhoff.com
Tire retreading? Many people would turn up their nose at this when it comes to their own car. And for cars, tire retreading is indeed quite insignificant. However, the situation is completely different for aeroplane and lorry tires. Aeroplanes and lorry tires are so expensive that they are even retreaded several times. Collmann builds suitable machines for the first step, i.e. buffing of the tread. For this process, the tire is fixed in the machine and buffed, for example with the buffing device, at a rotational speed of up to 400 m/min. What appears to be quite simple at first glance is in fact a complex procedure, since each type of tire – particularly for lorries and aeroplanes – is designed for a specific task and is subjected to quite different stresses than a normal car tire. The buffing device follows the basic tread of the tire. This is realized through a 2-axis kinematic system with tangential tracking through the NC I kernel of TwinCAT. A further difficulty is the fact that foreign objects that may have penetrated the tread (stones, nails) have to be removed manually. After this process, the NC program has to resume flawlessly. Here, the advantage offered by the high degree of integration of PLC and NC becomes apparent.

The distance of the buffing device from the steel belt can be measured with an analog inductive sensor connected via the Bus Terminals with Lightbus interface, and the machine can be controlled in such a way that the process can run fully automatic.

**Special requirements for aeroplane tires**

For aeroplane tires, which usually do not have steel belts, the machine control fulfills a further task: The stress during start and during landing makes the tires oval. The high flexibility of the Bus Terminal enables the connection of different sensors for the metrological examination of the tire during the operation. For particularly fast measurements for quality assurance purposes, the KL3362 Oscilloscope Terminal is used. This enables the buffing device to follow the ovality of the tire during the buffing process.

The signals are transferred to the C6140 control PC via the fast Lightbus, which is optical fibre-based. Collmann customers fully benefit from the open control technology from Beckhoff, based on Industrial PCs: The machine can be integrated simply and economically into the production network. Access to the process planning databases, communication with other systems and production monitoring via bar code are no problem.

The Scada system ProCon Win from GTI is used for machine visualization. Interfacing with the TwinCAT system is via the integrated ADS driver. These data are displayed on a customer-specific Control Panel, which, connected to the PC via CP Link, is available to the operator wherever it is required. The Control Panel is designed in such a way that it can even be operated with thick work gloves.
Flexible motion control solution
Collmann also uses Beckhoff technology for further innovations on their machines. The high adaptability of TwinCAT NC I enable the new tire buffing machines to carry out additional processes such as peeling and grinding of tires. This requires only a change of tools and/or the selection of another process in the software. For the peeling process, the buffing device is turned through 180°, so that the peeling knife mounted at the rear of the device can process the tire.

The differences are quite significant: During peeling, up to 30 mm are removed from the tire, during buffing up to 10 mm, while during grinding imbalances of 1/10 mm are compensated. The Beckhoff technology thus enables very flexible application of the machines during production. Jürgen Kuhn, responsible for control technology at Collmann:

“Without the use of Beckhoff components, the machine would have been very difficult to realize!” In future, drives from the company Lenze, which hitherto had analog control, can be integrated with high precision via CANopen (see “High-precision drive synchronization with CANopen”, PC Control 1/2002).
The German company Albert Weber GmbH is at its best when it comes to high end components and systems for the automotive industry: the product portfolio includes production of cylinder blocks, cylinder heads, crankshafts, chargers, gearbox housings and other cubic parts. Many of the largest and well known car manufacturers are customers of Albert Weber GmbH.

To change a crankshaft production to a fully automated three shift system, the company started a pilot project with the manufacturing system suppliers SAP, Güdel in Switzerland and Beckhoff. The partnerships goal was to achieve a tight integration between the SAP/R3-System with the Beckhoff cell controller automation system, on basis of standardized communication and computing technologies.

In case of the Albert Weber crankshaft production, seven cell computers control the manufacturing machines of the individual production cells with TwinCAT, the Beckhoff automation software for PLC and Motion tasks. Parts are transferred overhead via a transfer system – the primary loop – from machine to machine. Carrier robots travel autonomously on a rail system and communicate job orders via Wireless LAN (IEC802.11b). The Roboloop robots made by Güdel, are controlled by Beckhoff as well – in this case TwinCAT is used in an Industrial PC with Embedded NT operating system with a size of about 20 Mbyte on a flash drive media.

To exchange production data, a direct connection between the SAP/R3 system and the cell controller OPC servers was established, connecting about 3000 data tags. A new feature of this pilot implementation was the introduction of the OPC-Alarm&Event-Client of SAP: for SAP, Beckhoff’s Alarm&Event server builds the reference. With the help of this technology, finished production steps create an event driven communication directly to the PPS system to initiate the sequence of commands for the individual production steps.

The OPC server of the production cell controller communicates via TwinCAT ADS layer with the automation software system. The TwinCAT IEC 61131-3 PLC and the motion control software with PLCopen compatible command interface build software control modules on a PC platform without further hardware use for sequence or motion tasks. To create a highly deterministic real time tick, TwinCAT does not require any additional hardware other than a PC. Messages are exchanged between software servers (for PLC or NC) via a standardized ADS-interface (Automation Device Specification) and protocol by a message router. The TwinCAT message router distributes messages system wide based on TCP/IP. The advantage of ADS proves in its flexibility: ADS allows for horizontal and vertical application-to-application communication throughout various platforms (Windows NT/CE, TCP/IP, various fieldbusses).
ADS enables the OPC server to communicate locally, network wide, or via fieldbus protocols to various automation software modules e.g. PLC, Motion Control. In this way, TwinCAT avoids the well-known OPC-DCOM problems: some platforms, e.g. Windows CE, do not support DCOM, additionally, timeout events for interrupted media are not handled by DCOM in a way that would be appropriate for automation tasks. With TwinCAT, the OPC-server has access to e.g. a Pocket PC like the IPAQ via a wireless LAN for diagnostic purposes. ADS allows a wider variety of data compared to OPC: next to the typical PLC variables, complex operating system commands can be issued as well.

In this pilot project SAP collects PLC variable data via the TwinCAT OPC server and a dedicated OPC client, both running on the cell controllers. Status information of the assembly line, of individual manufacturing cells and machines as well as the E-Stop system status are communicated into the SAP PPS system. For material handling tasks, source and destination of product palettes cruising on the primary loop and the insertion of parts via the loop and cell interfaces are communicated by the PPS. Manufacturing and quality data, linked by serial number to each individual part, are documented and stored in the SAP-R3 system during the manufacturing process.

Without additional middleware software the complex interfacing task between the powerful SAP-R3 system and the manufacturing software TwinCAT could be accomplished by using standardized mainstream software technologies. The real time execution of automation tasks and the efficient ADS router guarantee fast data transmission without overhead and unnecessary load of threads to the Windows operating system. Interfacing problems are avoided by using the OPC standards for communication. The design of such a complex interface through a proprietary software driver would have resulted in a significantly longer implementation time.

PC based Control as an automation platform and the use of standardized communication technologies like OPC together with mainstream, powerful Industrial PC hardware with IEC 61131-3 automation software and Windows operating systems show their power end efficiency once it comes to deliver on the promise of integrated manufacturing.

Customer-orientation and local technical support are high priorities for Beckhoff and are – along with the development of innovative products – the basis for the company’s success. “Beckhoff Switzerland” has achieved the aim of providing comprehensive and intensive customer care by establishing contact points in each economic region and in the appropriate language. Since the beginning of 2003, in addition to the head office in Schaffhausen and the sales office in Montagny-Près-Yverdon, a new support center has been operational in the Italian-speaking part of Switzerland, providing customer support for all technical and application-specific issues. The partner company Rigatron took over the function of Fluidpower, the former Beckhoff support center, in order to ensure continuity in customer care. With Giorgio Rigamonti (47), we have found an experienced PC-based automation technology engineer for this task. Rigatron will therefore also become active as system partner in Ticino and will be able to take on development orders from Beckhoff. The connection with Beckhoff was established some years ago. Giorgio Rigamonti stressed that “as a developer” he has “always used Beckhoff components”. Gerhard Meier, managing director of Beckhoff Switzerland, sees the co-operation with the new support and system partner as a good opportunity for providing continued support of the highest standard for existing customers and for gaining new customers in southern Switzerland.

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Emanuele Mazzoli,
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"Appealing design, innovative technology and optimum price/performance ratio for our products“ – for Pierluigi Olivari these are key points for expanding the Beckhoff position in the Italian market. Beckhoff strengthened its international business with the addition of its ninth foreign agency which opened under the management of Olivari earlier this year. Italy is considered to be the second largest machine market in Europe and therefore promises tremendous potential for modern automation systems based on PC-based control technology.

Stepping up sales activities in Italy with our own subsidiary

"Bella Macchina“ offers accurate PC control

The goal of the new subsidiary is to significantly strengthen the sales activities in Italy, which as early 1997 with a distribution partner, and at the same time keep the competition on their feet. Beckhoff Automation S.r.l. was established at the beginning of the year and will initially operate with head office in Milan and a sales office in Bologna; further locations will follow soon. Beckhoff Italy thus continues the activities of the former distribution company SIEI-Peterlongo S.p.A., which had already managed to win over a number of well-known clients from the machine construction and engineering sector to use Beckhoff control systems. Timber, plastics and packaging are the main sectors of the Italian machine market.

Managing director Pierluigi Olivari who is a pioneer of automation technology in plant engineering is responsible for the destiny of the company. “Modern technologies from Beckhoff already have a good reputation in Italy. We want to build on this basis and strengthen our competitive position step by step,” said the 47-year-old father of two children about the challenge ahead. “Beckhoff products lend themselves as solutions for mechanical engineering applications in the timber, plastics and packaging sectors,” he says based on his knowledge about target groups from the Italian machine construction and engineering sector. The ceramics producers based in northern Italy also increasingly use automated and efficiently production processes. Compared with the competition, the Beckhoff export manager Kai Ristau sees a clear advantage for Beckhoff products: “We are one of the few automation supplier who can supply both components and complete systems from a single source.”

Benefits for the user: The scalable systems from Beckhoff meet the requirements of the particularly price-sensitive Italian mechanical engineering market for technologically leading yet efficient solutions. “Users who use Beckhoff systems open up optimization potential which they can pass on as a price benefit compared with the competition,” explains Ristau. “At the same time, we are trying to meet the demands in terms of design, which are particularly strong in Italy. For a long time, Italian machine manufacturers had the upper hand over their German competitors in this respect,” says Ristau. “We have consciously followed this route at an early stage and are able to offer, for example with our Control Panels or our compact control cabinet PCs, technically high-quality, but at the same time user-friendly and good looking solutions.” An additional benefit is having custom designs with company colours, or logos or completely customer-specific developments.

Beckhoff Automation S.r.l. head office is located in the industrial metropolis of Milan, a further sales office was opened in Bologna. But that’s not enough: Starting with an experienced staff of four, by the end of the year Beckhoff plans to open two further branches in Padua and Turin, while at the same time increasing the number of staff to ten. Sales professionals and automation specialists serve the market. They offer the Italian mechanical engineering industry solutions for the modern, “intelligent“ factory of the future from a single source: from direct sales and support to the service for all Beckhoff products. Local system training opportunities are offered for users. Rooms dedicated to this purpose are available in the 480 square metre Italian head office.
During the “MCS”, which took place from 19 to 21 February in Bologna, the Beckhoff team had the opportunity to welcome customers and business partners at the stand and to introduce themselves.

Export manager Ristau sees the future of the new subsidiary in an optimistic light: “The option of sales and support from central locations directly in important foreign markets enables continuous growth for us.” On the Italian market, Ristau already expects a good business performance for the current year: “The Italian market is receptive to the software-based automation solutions for PLC and Motion Control.”

This is demonstrated by numerous application examples in Italy, to which Beckhoff can already refer to today. The Italian manufacturer SIPA, for example, uses efficient, cost-optimized and rapid production processes for his injection moulding machines for PET bottles – made possible not least thanks to the modern PC control technology from Beckhoff. This enables SIPA customers to achieve time and cost advantages during PET processing, which can be crucial in tight markets.

Similarly, Beckhoff is already present in the Italian timber processing sector – based mainly in the north of the country – and in the packaging industry. Particularly for sophisticated packaging produced in large quantities, the Italian plant manufacturers have a reputation for being very competitive. Best example: the huge volumes unprinted, flexible packaging materials required by the tobacco industry.

The new Italian branch brings the number of foreign Beckhoff subsidiaries and agencies to nine. Together with our distribution partners, Beckhoff “New Automation Technology” is represented in more than 35 countries worldwide. For Hans Beckhoff, a presence in around 50 leading industrial nations around the world is a target to aim for. The export quota is expected to increase from 35 percent today to over 50 percent – with simultaneous growth on the domestic market.

Pierluigi Olivari

Before Pierluigi Olivari took over the management of the Italian subsidiary, he learned mechanical engineering by proverbially working his way up from the bottom. He studied electrical engineering in parallel to his job at the time, and has 20 years of professional experience in automation technology. He was there when computer-controlled CNC-production made its entry into the production halls, and he made his mark both in service and in constructive product development. His sales activities led Olivari to Siemens and Osai, among others. He kept being fascinated by the rapid development of Beckhoff as an SME company, but also by the technologically leading role of the Beckhoff PC-based control systems. This is reason enough for him to now shape a part of the future company history.
Slovenia was regarded as the economically leading republic of the former Yugoslavia. An assessment, which is confirmed by the economic and socio-political development of Slovenia since independence in 1991 and the admission to the EU in 2004.

The company Genera was founded in 1998 and has since generated average annual growth of over 50%. It currently employs more than 30 staff. With its head office in the capital Ljubljana, Genera is positioned in the largest industrial region of the country. Customer-oriented, complete technical solutions of the highest standard with associated customer care and support are among Genera’s aims. Apart from the distribution of components, project design of large water treatment plants and solutions for the energy and process automation are one of Genera’s main business areas.

For Kenan Aktas, a member of Beckhoff’s export team, the partnership is very positive: “With Genera we have found an innovative and qualified partner, who fully supports the Beckhoff philosophy of modern control technology.”

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Bus Terminal Controller as the basis

The GsmBox essentially consists of a Beckhoff BC series Bus Terminal controller and a GSM modem with magnetic aerial and IP 56 protective housing, designed for direct connection to the power supply and the GSM network. For future projects, the BX Bus Terminal controllers and the CX1000 Embedded PC control can also be used. Depending on the application and the requirements, the device can optionally be expanded for the connection of sensors, measuring instruments, drives and electrical equipment via the Bus Terminals. When a BX or CX controller is used, the software can be expanded with local control functions.

The GsmBox is alternatively used only with a GSM phone or in combination with the WebControl web application. The main functions of the GsmBox can be utilized via GSM phone. These include entering building parameters, reading of status and measurement values, remote on/off switching, setting of certain values and automatic remote alarming. If a GsmBox is used in combination with WebControl, several other functions are available, including calling up the total operating hours of the monitored equipment and information about preventive maintenance activities. Furthermore, scheduled tasks and data archiving operations can be controlled.

Through its multi-functional character and the flexible communication and connection options, the GsmBox is equally suitable for application in simple environments with only a few monitoring positions or in more complex systems.

Miniature controls for remote monitoring via GSM

As one of the first applications with Beckhoff control technology, Genera has developed the GsmBox, a powerful GSM device for remote alarming, control and monitoring. It is used in buildings that do not require permanent monitoring, offering options for appropriate measures in the event of an alarm. The GsmBox is mainly used by private customers and for monitoring of smaller installations such as hydroelectric plants, transformer stations, water treatment plants, water storage tanks, pumping stations, environmental monitoring stations, boiler rooms, cold storage rooms, lifts, churches and business premises.
Fronius is a complete supplier specializing in the robotics sector and is therefore responsible for the precise interaction between the Fronius components (such as current source, welding torch, remote control, feed) and the robot control. "Flexibility and user-friendliness in synergy with the welding system/robot were a priority for us right from the start," says Thomas Eder, robot product manager at Fronius.

For communication tasks, Fronius relies on the flexibility of the Beckhoff Bus Terminal system. The KL6021 Bus Terminal with serial RS422/485 interface form the gateway between robot and fieldbus system. The protocol developed by Fronius is transferred to the Terminal Bus protocol and to further protocols through signal openness. The integration of a new robot into the complete system is therefore possible by simply exchanging a module. All common robot bus systems (such as Profibus, Interbus, DeviceNet, CANopen) are covered – "All systems that are also supported by Beckhoff," smiles Eder. Cases of "Doesn’t fit!" are therefore unknown.

Beckhoff Austria was very open for these adaptations and the associated training that was required. This enabled a perfect solution to be found for the current system integration according to the requirements of the customer.

Fronius’ customers include globally active and internationally renowned companies, mainly from the automotive, ship building, railway vehicle construction and plant & vessel construction industries as well as the offshore sector, who expect optimum velocity and quality for their robot applications.

www.fronius.com
The purpose of the “Automation in Motion” seminar is to bring customers information about new Beckhoff products and to provide a forum for industry professionals. Beckhoff Finland’s Managing Director Mikko Uuskoski opened the seminar with an overview of the company’s operations in Finland. Technical Support Manager Antti Airto and Key Account Manager Matti Korhonen introduced the Beckhoff products. Over the course of the day, some Beckhoff Automation Oy customers reported on projects they have implemented using Beckhoff products.

This year the very popular event brought in more than 80 participants from the process, sawmill, electronics and plastics industries as well as representatives from production automation and machine engineering companies. Additionally, participants from Finnish colleges and universities were also present.

Engineering Manager, R&D, Heikki Saariluoma, Pivatic Oy: “Beckhoff’s fieldbus products are market forerunners.”

Pivatic Oy designs, manufactures and markets sheet machining solutions for industries needing sheet metal. In 2001 the company’s net sales totaled 15 million euros, and it had 70 employees. The company’s 15-person Designing department is headed by Engineering Manager, R&D, Heikki Saariluoma. He points out that over 90 percent of Pivatic’s production is exported, and the company has representatives in 32 countries. “With Flexible Fabricating Systems (FFS) we can produce different kinds of product family components to exact specifications and flexibly. A variety of special tasks or robots for handling finished product pieces can also be integrated into the Pivatic lines.”

Pivatic Oy’s automation planning uses Beckhoff’s fieldbus technology. According to Saariluoma, it enables modular designs and shortened throughput times. “We chose the Beckhoff products because they are forerunners in fieldbus technology. The cost of the solution was manageable and the components used are durable.”

Heikki Saariluoma believes that PC-based and open controls will become more common and that they will be utilized also in bigger systems than those of today. At the Beckhoff “Automation in Motion” seminar he found the German customer cases of particular interest as well as the embedded control system CX1000.
Project Engineer
Jani Gröndahl, Swisslog Oy:
“The advantage of the Beckhoff’s system is flexibility.”
Swisslog Oy in Ulvila, Finland, is Swisslog’s competence center in robotics and has over 200 employees. The company provides integrated robotic and picking solutions for manufacturing, warehouse and distribution applications. According to Project Engineer Jani Gröndahl, Swisslog robots are used for various handling tasks in a number of industries and the customers are all over the world. “The focus is in automating manufacturing processes in the TV tube, glass and automotive industries as well as in developing high-tech handling solutions for distribution of food and beverages. There are, however, ideal applications for Swisslog robots in other industries as well, such as the paper and printing and metal industries.”
Swisslog Oy uses the Beckhoff Bus Terminals as well as digital I/O and other modules. “It is important to us that the Beckhoff system does not depend on the fieldbus used. It is also good that same components can be used in the inputs and outputs connected to the bus, and they can be standardized regardless of the bus that is used. Moreover, the modules are relatively small and the system is easy to expand,” notes Gröndahl.
Jani Gröndahl believes that use of the PC-based control and fieldbus technology will become more common in the future. “In bigger systems the traditional wiring of inputs and outputs from sensors will likely be completely eliminated, and all control data from the sensors will be transferred to system control using fieldbus technology.” At the Beckhoff “Automation in Motion” seminar he was interested in practical examples of Beckhoff components in use in Finland and abroad.

Sales Manager Osmo Vainio, ABB Oy:
“Solutions that work for us and good technical support”
ABB is the leading power and automation technology company employing 150,000 people in more than 100 countries. ABB in Finland has about 10,000 employees in over 50 municipalities, and the company’s net sales total more than 1.8 billion euros. ABB Oy’s cooperation with some of its utility and industry customers has lasted more than a century.
Sales Manager Osmo Vainio is responsible for ABB Oy’s food industry automation project sales. He says that the company uses the Beckhoff Industrial PC solutions in its products. “Beckhoff Automation Oy has provided us solutions that work for our deliveries as well as good technical support.”
Osmo Vainio notes that the PC-based control is a growth area in automation, but in ABB Oy’s business area in heavy industry the advancement of the technology is likely much slower than in the piece goods industry. “The demand for fieldbus technology has continuously increased, and it is only now that it seems to be making the long-awaited breakthrough.” At the Beckhoff “Automation in Motion” seminar Vainio was especially interested in new, AS-i bus-based products and new Industrial PC solutions.

Markku Levanen, Manager, Process Automation, Metso Panelboard:
“Technical solutions are well suited for our products”
Metso Panelboard is one of the leading suppliers of complete lines, single machines and after-market services for Medium Density Fiberboard (MDF), particleboard and Oriented Strand Board (OSB) industries. The company is part of Metso Corporation’s Metso Ven-
PC-Control: What are the options for Beckhoff in the Indian automation market?

Sunil Raibagi: In the early days, the Indian market for control and automation technology was limited to production and machine automation. As a result of the PC technology and of software developments, the market has changed: The trend is now towards the automation of complete processes. Production automation also increasingly focuses on the integration of business processes. Today, complete process automation and the integration of machines within an ERP system are in demand.

Beckhoff offers complete system solutions comprising of Industrial PCs, fieldbus components and the TwinCAT automation software. Based on our know-how about system integration and software development, we can offer the Indian industry comprehensive compatible control systems for open automation technology. While we entered the market relatively late, I am sure that Beckhoff will become the first address on the Indian market for control and automation technology.

How is the Beckhoff product range positioned compared with the competition? What is its competitive advantage?

Sunil Raibagi: With TwinCAT and a comprehensive range of Industrial PCs, Beckhoff offers complete PC-based solutions for factory and motion control. Furthermore, through fieldbus compatibility Beckhoff also offers comprehensive I/O solutions. Hitherto, the Indian market has been flooded with proprietary hardware solutions. Beckhoff can stand out from this.

Machine manufacturers prefer controls with open architecture, with their know-how embedded in the software, which can be protected. Ideas can be more easily converted into functioning software solutions than in comparatively tedious hardware solutions. Inteltek has extensive experience in terms of system implementation, and software development is one of our strengths. We are the ideal partner for machine manufacturers when it comes to the optimization of production processes. Our actual competitive advantage lies in the combination of Beckhoff components with our own ideas.
You have started receiving orders from Indian customers. What were the initial hurdles and how did you overcome them?

**Sunil Raibagi:** Beckhoff was new on the Indian market, and PC-based drive controls and the software PLC/NC were new concepts. We presented the product at the Elecrame in Mumbai, the largest exhibition for electrical systems and controls. A number of other trade fairs followed, including Automation 2002 and Amtex. Furthermore, we offered presentations and seminars for Beckhoff fieldbus technology and PC-based products to large end customers from the automotive, glass and machine industry.

Our engineers were trained at the Beckhoff company headquarters in Germany, and the acquired knowledge was then passed on to our service personnel. We have also used Beckhoff products in our project area, thus creating references for Indian customers. In this way we managed to introduce the Beckhoff name as a supplier of standard components to globally renowned companies from the automotive industry such as Cummins, TATA, Hindustan Motors etc.

Would you like to tell us a little about the solutions you have created with Beckhoff?

**Sunil Raibagi:** We have already completed a number of solutions. Recently, we used Beckhoff for the control of nut runner spindles and for the synchronization and sequencing for Cummins diesel engines.

We are currently carrying out a large project in the largest steel plant in India, dealing with the alignment of blanks at merchant bar systems via recognition through a video camera. The alignment is implemented via hydraulic servo valves, the control via TwinCAT.

What are the major challenges you are currently facing?

**Sunil Raibagi:** The biggest hurdle at present is the lack of references. The largest suppliers in India have been in business for 20 years, and a breakthrough is therefore important for us in every sector. We have an extensive network of distributors, and we see the co-ordinated co-operation between marketing and sales teams as the key to success. Based on customer requirements, we need a Beckhoff specialist in every branch; we will concentrate our investments this year in this area.

What are your strategies for establishing Beckhoff on the Indian market?

**Sunil Raibagi:** The most important strategy for making the Beckhoff name known widely is via advertisements, seminars, trade fairs and our in-house publication Automate. As a form of support for machine manufacturers we offer joint development of prototypes, so that they can familiarize themselves with Beckhoff products. For smaller system integrators we offer training opportunities, thereby trying to establish solution competency near each industrial center.

How do you envisage your future?

**Sunil Raibagi:** Based on our core competencies, our prospects for the future are excellent, particularly considering the changes in the market. We are within easy reach of all industrial centers, and we have a well-trained development team (25 engineers) that has been working with drive controls for 15 years. The trend in mechanical engineering and in the process technology is away from the product towards the solution, with the emphasis on design. We see a successful future for ourselves, since we can rely on highly motivated specialists who always keep their know-how up to date through training measures.
Trade shows and events 2003

**Germany**
- **HMI – Hanover Fair**
  April 07–12, 2003
  Hanover
  Hall 9, Stand F06
  www.hannovermesse.de

- **Ligna Plus**
  May 26–30, 2003
  Hanover
  Hall 19, Stand D20
  www.ligna.de

- **Husumwind**
  September 23–27, 2003
  Husum
  Hall 3
  www.husumwind.de

- **SPS/IPC/DRIVES**
  November 25–27, 2003
  Nuremberg
  www.mesago.de/sps

**China**
- **INTERKAMA China**
  Process & Manufacturing,
  Automation and Integrated IT-Solutions
  March 18–21, 2003
  Shanghai
  www.interkama.com

  The 2nd Intern’l Exhibition on
  Factory Automation & Instrumentation
  April 01–04, 2003
  Shenzhen

  The 3rd Intern’l Fieldbus & Industrial
  Automation Exhibition & Technical
  Exchange Conference
  April 22–25, 2003
  Beijing
Finland
Automatio 2003
September 09–11, 2003
Helsinki

Italy
Intel Mailand
May 20–24, 2003
Milano
www.intel.com/italiano

Austria
VIET
September 30 – October 03, 2003
Vienna
www.viet.at

Poland
Automaticon
April 01–04, 2003
Warsaw

Switzerland
Ineltec – Internationale Fachmesse
für industrielle Elektronik, Energie, Installation und Licht
September 02–05, 2003
Basle
www.ineltec.ch

USA
South Pack
April 30 – May 01, 2003
Atlanta
www.devicelink.com/expo/southpack03/

AM-Expo
May 06–08, 2003
Greenville
www.am-expo.com/

Semi-CON
July 16–18, 2003
San Francisco
http://events.semi.org/semiconwest/

Assembly show
September 23–25, 2003
Chicago
Stand 16131
www.assemblytechnologyexpo.com

Midpack
October 15–16, 2003
Minneapolis
www.devicelink.com/expo/

For additional information on our worldwide subsidiaries and partner companies trade show schedule please check:
www.beckhoff.com
The Beckhoff internet presence offers comprehensive product and system information, technical data, documentation – basically everything that is worth knowing on more than 1,500 web pages. The complete online presence is available in German at www.beckhoff.de and in English at www.beckhoff.com.

This online service has recently been expanded, and the international Beckhoff subsidiaries now have their own internet presence. Under the relevant internet domain, you will find country-specific information such as contacts for sales, support or service, as well as current training and trade fair dates in the respective local language.

### Overview of the international online presence:

| Beckhoff Switzerland:       | www.beckhoff.ch |
| Beckhoff Austria:           | www.beckhoff.at |
| Beckhoff Italy:             | www.beckhoff.it |
| Beckhoff Finland:           | www.beckhoff.fi |
| Beckhoff Sweden:            | www.beckhoff.se |
| Beckhoff Poland:            | www.beckhoff.pl |
| Beckhoff China:             | www.beckhoff.com.cn |
| Beckhoff USA/Canada:        | www.beckhoffautomation.com |

The online version of the Beckhoff company magazine can be found at www.pc-control.net. All contributions are available both in German and in English as web pages or as pdf files. The reports are supplemented with links to background or other additional information.

The previous four issues of PC Control are available in the archive for online viewing or for downloading.
New Beckhoff main catalog: New Automation Technology 2003

In the new edition of the main catalog, Beckhoff offers a complete overview of the product range: Industrial PC, fieldbus components, drive technology and automation software. The updated version includes new products such as new Industrial PC series and CX1000, the new control generation for medium-range control applications.

The 600-page catalog provides a clearly structured overview of the Beckhoff “automation kit” and simplifies finding the right solution. Apart from the product and system solutions, the document, which is available in German and English, also contains information about training opportunities and all contact addresses of subsidiaries and partner companies in 35 countries worldwide.

With the electronic version on CD, the main catalog is also available for PCs. The package is complemented by the new “Software Products” CD containing all Beckhoff software products including documentation.

The Beckhoff information media can now also be ordered online:

www.beckhoff.com/info/
Built-in Control Panel:
Everything under control

- high-quality aluminum housing
- 6.5, 10, 12, 15, 18 or 20 inch TFT displays
- optional touch screen or touch pad
- membrane keypad in different variants
- easy installation
- expandable with add-on PC

Different perspective for the control cabinet
The Beckhoff built-in Control Panel CP6xxx for desk or control cabinet installation:
- 6.5, 10, 12, 15, 18 and 20 inch TFT display, with touch screen or touch pad
- optionally with DVI/USB (5 m) or CP Link interface (100 m distance to the PC)

- Displays optionally as monitor without or with membrane keypad in different variants up to full alpha-numerical keyboard with special PLC keys
- Add-on PC options CP63xx, CP64xx or CP65xx turn the Control Panel into a complete built-in Panel PC with high computing power

For further information and international sales contacts see: www.beckhoff.com