

PC Control

BECKHOFF

The New Automation Technology Magazine

products

CP6xxx series Panel PCs are optimized for installation in the control cabinet front and offer numerous application options. The combination of built-in Control Panel and a total of three different add-on PCs creates a wide variety of variants in terms of design, function and housing size.

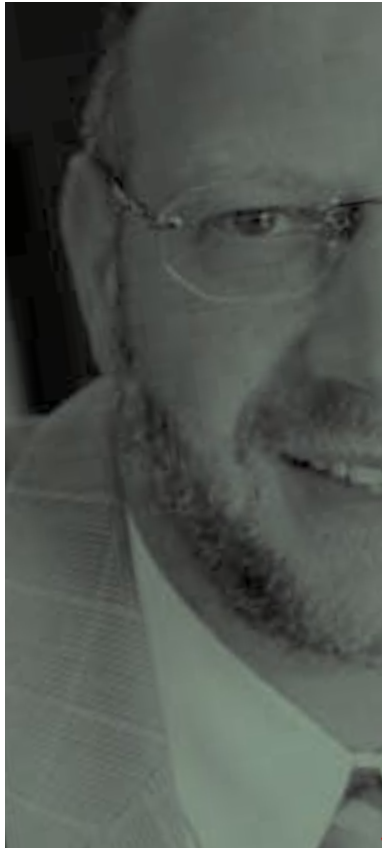
special Fieldbus Box

Application examples and new developments for the Beckhoff I/O system in protection class IP 67 are presented in the "Special Fieldbus Box". The modules are used in a variety of industries and enable application at machine level without additional control cabinet or terminal box.

title

Choosing a controller appropriate for a particular task often calls for a balancing act between the computing performance, complexity and the cost. With new products for mid-range control technology, Beckhoff offers a wide choice of different performance classes and therefore "customized automation".





The German sales network

PC Control conquers Baden-Württemberg

Germany is one of the world's leading machine and plant construction countries. In this field, "Made in Germany" is still a sign of quality, reliability, performance and innovation. Following the first commercial activity in its home area of Westphalia, the young and innovative automation company, Beckhoff, began to overcome both the German and world markets, single-mindedly developing its own sales network. This marked the future path from a project-oriented sales strategy to one oriented around products as an automation manufacturer.

The northern sales office in Hanover and the southern office in Balingen were founded as the first bases almost a decade ago. Both were structured as "home offices", and each was manned by one sales engineer working alone. Over recent years other offices have been opened in the German sales area, so that a solid sales network has now been formed with nine sales and technical offices. Beckhoff are now represented in more than 30 countries around the world through subsidiary and partner companies.

From the original southern home office, the Balingen site has developed into a larger office with six employees. At the beginning, the few customers came from Beckhoff's "home sectors" of woodworking machines, window construction

machines and press engineering. The Baden-Württemberg area now has about 600 customers, ranging from large companies to engineering consultancies, all looked after by the office in Balingen. In Baden-Württemberg the Beckhoff automation products are distributed over all sectors of the machine and plant construction industry. In addition to the sectors where Beckhoff began, new specialist fields have developed, in packaging machines for instance, in assembly and test engineering, in special machines and in building management systems. New industrial sectors too, such as machines for laboratory automation (see report on page 51, accelab) or semiconductor manufacture are of course ideally suited to Beckhoff solutions using PC control technology.

In Baden-Württemberg, the end customer market is dominated by the automobile industry and its suppliers. Here again, PC-based controller technology from Beckhoff is making more and more inroads into conventional solutions and historically based specifications for operating equipment. Whereas PC control technology, consisting of an Industrial PC, fieldbus system and control software had to be presented to customers with "missionary zeal" by Beckhoff's sales department only a few years ago, all three components are now established in the industrial environment.

The pioneer work has paid off. PC control technology is recognized on the market now as a proven solution, and as an open, high-performance and economical alternative to classical controller technology. One guarantee for this certainly is the far reaching and complete Beckhoff controller environment for all automation tasks, as is described in the title story, "customized automation".

Beckhoff subsidiary offices here look after customers through sales, support, training and application support on site, of course bearing special regional features in mind. You should know that we can do anything in Baden-Württemberg, except speak "high German"!

Frank Saueressig

→ Manager of the Balingen office



Frank Metzner is
Manager Marketing
Communications

The demand for information is growing

Beckhoff's success is a result of expanded global sales network, listening to the automation market requirements and then quickly developing the product range to meet the market requirements. This fast pace product development has also increased the demand for information exchange and communication. In response, beginning next year we will publish an additional issue of PC Control. Three times a year, our customer magazine will provide information about current developments and worldwide application examples of Beckhoff technology.

The focus of the magazine will continue to be on PC-based control technology, which can be used in a variety of applications, as described in this issue: for example in the advanced car production line at the Volkswagen factory in South Africa (page 43).

Furthermore, you will find information and product updates and additional developments: On the software side, TwinCAT forms the basis for real time control and programming. With the new version 2.9 (page 24), users are offered expanded functionality and new tools for more convenient engineering. Among the most important hardware innovations are the extension of the Industrial PC family, product extensions in the range of fieldbus components and linear drives.

This issue of PC Control introduces a new section, "Product Special", in which we provide details of products with background information, application examples or new developments. We kick off with a special feature about the "Fieldbus Box" (page 30). The I/O system in protection class IP 67 has since been implemented in a wide variety of industries. The "Fieldbus Box Special" also contains details of a joint Beckhoff/Festo AG & Co. project (page 38). A valve terminal with IP-Link interface was developed in co-operation. This synergy effect opens up the complete fieldbus and I/O variety from Beckhoff to Festo customers, while Beckhoff customers are now able to integrate valve terminals into the IP-Link system.

We look forward to your suggestions and feedback:

→ editorial@pc-control.net

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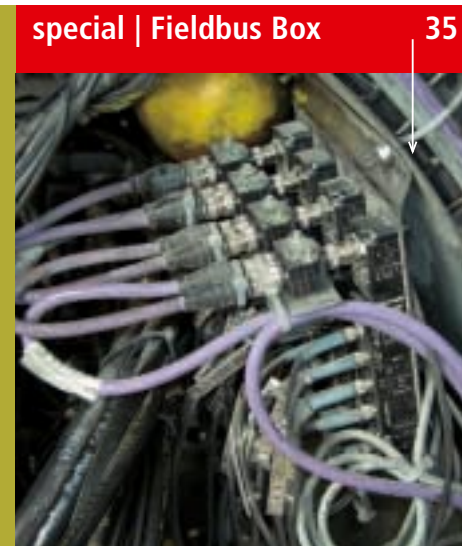
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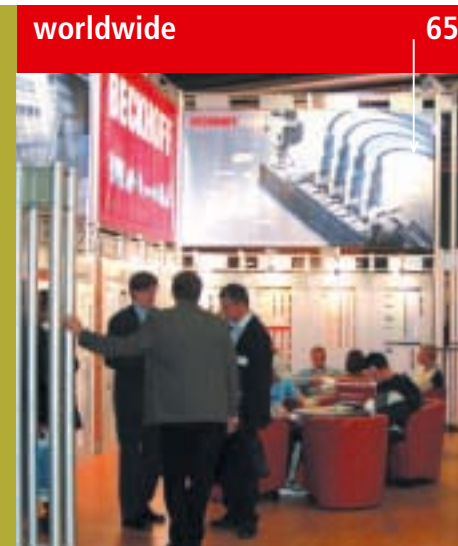
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Customized Automation

→ What has boxing got to do with automation technology? Not a lot, at first sight, but wouldn't it be nice if there were classifications in automation technology as clear as there are in boxing? – onto the scales before the fight, check the weight, and from that get a fair idea of what sort of performance can be expected. – Choosing a controller appropriate for a particular task often calls for a balancing act between the computing performance, complexity and the cost. Clear performance categories that would make the "painful choice" easier are absent even from the most clearly structured catalogs.



Bus Terminal Controller BC



Bus Terminal Controller BX

It would be possible, in analogy to boxing, to make the clock rate of the CPU used into an indicator of the "weight class". The hardware properties listed in the table on page 7 allow the controllers in the Beckhoff range to be allocated to four basic categories:

- | Bus Terminal Controller BC (lightweight)
- | Bus Terminal Controller BX (middleweight)
- | Embedded PC CX (light-heavyweight)
- | Industrial PC (heavyweight)

Bus Terminal Controller BC

The devices in the BC series of Bus Terminal Controllers have been on the market for some years now. They are aimed at the small automation applications sector, where either an autonomous automation task, or a distributed task, configured as a subsidiary controller in a fieldbus topology, is to be implemented. Put simply, a BC is a mini PLC with a slave connection to the associated bus system. It is either programmed over the fieldbus from a central PC, or by means of the serial programming interface with which all such devices are fitted. The full range of Bus Terminals is available in modular form as the I/O level. Although no other communication interface is available immediately at the BC, facilities are available in the Bus Terminal program for the exchange of data with other devices using, for instance, RS232/RS484. Only the BC9000, however, is capable of being connected to Ethernet. The BC family is used for all applications in which it is necessary for a program to be executed autonomously, such as when controlling relatively independent machine aggregates like conveyors or sorters, the regulation of critical processes (temperature, pressure, tension control) or in building automation (room temperature, shade, lighting). The size of the user program is restricted by the amount of memory installed.

Bus Terminal Controller BX

New on the outside, new on the inside, new all-over – Beckhoff's BX device family will be introduced for the first time at the end of November, 2002 at the SPS/IPC/DRIVES exhibition in Nuremberg, Germany. The level of its fittings and its performance place it between the BC and the CX. Similarly to the BC, it is a microcontroller-based device that can operate as an autonomous controller or as a fieldbus slave. The housing design is based on that of the CX1000, and allows any BX controller to be given a Compact Flash card for mass storage. The principal feature distinguishing the BC from the BX is the greater amount of memory fitted to the BX (see table), and what is expected to be the somewhat higher computing capacity. The BX devices also have two serial interfaces – one for programming, and the other one free – as well as the Beckhoff Smart System Bus (SSB) with which other peripheral devices such as displays can be connected. The device itself includes an illuminated 2 line x 16 character FSTN LCD display and an RTC (real-time clock). The Bus Terminals can be connected directly in the usual way. This series will find similar applications to that of the BC series, with the difference that the larger memory of the BX will allow significantly more complex, larger programs to be executed, and more data to be managed locally (recording history and trend data, for example), which can then later be fetched over the fieldbus or Ethernet.

Embedded-PC CX1000

The CX1000 system represents a transition in Beckhoff's range of products between controllers based on microcontrollers and those based on PCs, and has some features of both a hardware controller and of an Industrial PC. The housing can be mounted on 30 mm DIN rail; the I/O modules can be aligned adjacently; no moving components are used, and the system can be operated



Embedded PC CX



Industrial PC

The high end controller: Industrial PC

The Industrial PC family represents the most powerful class of devices. All the same, the performance is scalable to a high degree within this range of products through the selection of particular components (CPU and memory). It begins at 266 MHz with 64 Mbyte RAM and ends, presently, at 2.8 GHz with 1 Gbyte RAM. In between we find the typical "workhorses", such as a Pentium III 850 MHz with 128 Mbyte RAM, a configuration that is quite sufficient for a large number of demanding and extensive control tasks, and yet which represents a reasonable price/performance ratio. The available mechanical constructions are very flexible: the housing design permits components to be accessed from different sides, and the PCs can be mounted as built-in or add-on variations in a control cabinet or on support arms systems. The PCs may have a TFT display attached directly, or may be attached via CP-Link technology to the Beckhoff Control Panel, which may be up to 100 m away. The trend here is clearly moving in the direction of increased performance density in a smaller space, as illustrated by the new, compact C6300 series. Generally speaking the I/O level is connected via PC fieldbus cards, although onboard interfaces such as RS 232, USB or Ethernet can also be "abused" to implement a low price fieldbus.

	Beckhoff Controller	CPU	Fre- quency	Memory Flash	Memory RAM	Compact Flash Card	FPU	RTC	NOVRAM	Supported Fieldbus Systems	Fieldbus Master/ Slave	Other Interfaces	
	BC2000	µC	16 MHz	256 kB	64 kB	-	Emula- tion	-	512 Byte	Lightbus	Slave	RS232	
	BC3100			(max. 96 k available)						Profibus			
	BC4000										Interbus		
	BC7300										Modbus		
	BC8000										RS232		
	BC8100										RS485		
	BC9000		20 MHz		128 kB				4 kByte	Ethernet			
	BX3100	µC	25 MHz	1 MB	1 MB	optional	Emula- tion	yes	2 kByte	Profibus	Slave	SSB	
	BX5120			(max. 256 k available)						CANopen		RS232/485	
	BX5200										DeviceNet		
	BX8000										RS232		
	BX9000										Ethernet		
	CX1000	x86 Pentium MMX compa- tible	266 MHz	16 MB (64 MB)	32 MB (128 MB)	yes	yes	yes	8 kByte	Lightbus Profibus CANopen DeviceNet Sercos	Master/ Slave	Ethernet USB, DVI, 2xRS232 1xRS485 Audio,Video	
	Industrial PC	Intel Pentium	850 MHz (e.g.)	40 GB hard disk	256 MB (e.g.)	optional	yes	yes	32 kByte optional	Lightbus Profibus	Master/ Slave	all standard PC interfaces	
										Interbus			
										CANopen			
										DeviceNet			
										Sercos USB, RS232			



Many controllers – one programming software

All Beckhoff controllers, regardless of the performance class to which they belong, have one thing in common: they are all parameterized and programmed with one and the same software – TwinCAT. This gives the customer the freedom to make last-minute decisions: If the planned controller is no longer adequate, the next most powerful device can be used instead. Normally it is not necessary to make any changes in the user program for this purpose. The user continues to work with the same, familiar TwinCAT tools (e.g. the PLC programming interface, System Manager and TwinCAT scope), and only when the program is downloaded does he decide which device will execute it. Not every TwinCAT component, however, is supported by every platform. The Motion Control functionality, for instance, is only possible on devices at the CX level and above.

Consistent interconnection with ADS

A second important aspect is the possibility of programming centrally in plants where Beckhoff devices are networked. Segments where the physical transmission layer takes different forms may be bridged with the Beckhoff ADS protocol. It is possible, for instance, to use a programming station (PC) that communicates over Ethernet in order to program a BC3100, but for this to be connected via Profibus to a second PC in the Ethernet network. The following table summarizes which TwinCAT functionalities are available on particular devices. TwinCAT PLC here refers to the execution of a IEC 61131-3 program, while TwinCAT NC handles Motion Control (i.e. point to point movement of axes), including special functions such as camshafts/flying saw. TwinCAT NC I includes interpolating 3-D movements; TwinCAT CNC is the quintuple interpolation package for machine tools and other machining centers.

	Beckhoff Controller	Operating System	TwinCAT					OPC Server
			I/O	PLC	PTP	NC I	CNC	
	BCxx00	Beckhoff BCOS	direct	R	-	-	-	R (via ADS)
	BXxx00	Beckhoff BCOS	direct	R	-	-	-	R (via ADS)
	CX1000	Windows CE.NET, XP Embedded	R	R	R	R	-	R
	Industrial PC	Windows CE.NET, NT, NT Embedded, 2000, XP XP Embedded	R+T	R+T	R+T	R+T	R+T	R+T

The table illustrates whether only the runtime components can be executed on the destination device (R=Runtime), or whether the programming tool can also execute (T=Tool).

Scalable computing capacity

For historical reasons, the computing time required for 1024 PLC commands is often used as a reference for a controller’s performance. This is a very imprecise measure, because the commands to be measured and the operand types differ from one manufacturer to another. It does, however, at least give some guide to the running time to be expected for a PLC program, and allows different controllers from one manufacturer to be compared, provided the same test programs are used in every case. A set of three programs is used here for the test:

Test program 1:

A test program with BOOL, INT, WORD; assignment, arithmetic, limiting, bit-string logic, shift/rotate, bitwise logic and comparisons

Test program 2:

A test program with BOOL, INT, DINT, WORD, DWORD; assignment, arithmetic, limiting, bit-string logic, shift/rotate, bitwise logic and comparisons

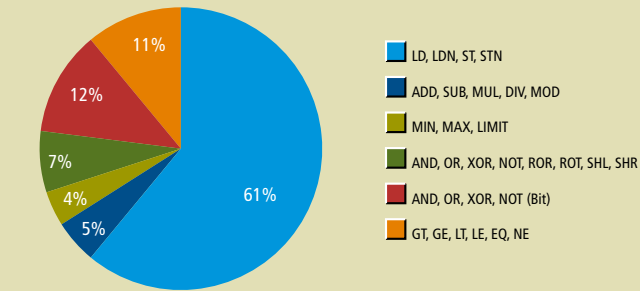
Test program 3:

A test program with 32 bit floating point values and including types BOOL, INT, WORD, DWORD, REAL; assignment, arithmetic, limiting, bit-string logic, shift/rotate, bitwise logic and comparisons

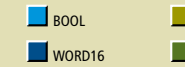
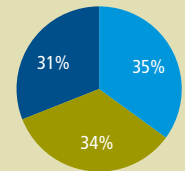
IL (Instruction List) is used as the test language, because it allows the number of instructions to be most effectively quantified. The instructions used and their proportion of the total program is illustrated in Figure 1. The running times measured for the execution of 1000 IL lines on the different CPUs are recorded in Figure 2. A BC9000 Ethernet Bus Terminal Controller was tested as a representative of the BCs, a CX1000 represented the Embedded PCs, while an Industrial PC C6140 with an 850 MHz PIII and a Pentium 4 running at 2.8 GHz with a 533 MHz frontside bus represented what is technically possible nowadays. At the time of going to press, there were still no reliable values for the new generation of BX controllers. It is, however, expected that they will be 20% faster than a BC9000 in normal operating mode. For the sake of clarity, let us repeat that the values indicated in Figure 2 represent the time required to execute the PLC test code, and not the controllers’ cycle times. Effective cycle times are generally longer, because I/O times, system administration time and time slices for the operating system will have to be added.

Diagram 1

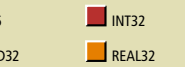
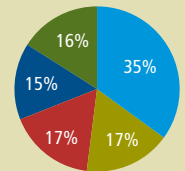
Test Program 1...3 – Commands



Program 1 – Datatypes



Program 2 – Datatypes



Program 3 – Datatypes

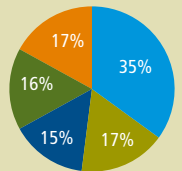
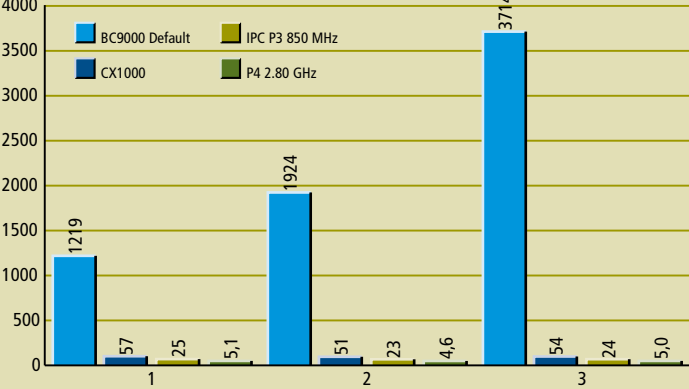


Diagram 2 | PLC Code Execution Time Benchmark

Execution Time – Absolute Scale [µs/1000 Code Lines]



- | Even within the range of Beckhoff products, PC technology is increasingly gaining ground at the expense of microcontrollers. This is a powerful endorsement of the correctness of the direction Beckhoff have been taking: Flexible and innovative PC technology instead of rigid hardware solutions.
- | The bottleneck for automation is again found amongst the peripherals: automation technology does not need new controllers, but does have a use for faster fieldbusses and faster signal acquisition.
- | Even automation engineers will soon have to become used to quoting times in nanoseconds.

Conclusion and outlook

BC, BX, CX, IPC – Beckhoff’s range of controllers is comprehensive. TwinCAT provides consistent programming and parameterization of all devices – both for PLCs and for Motion Control. What has been mentioned above, of course, is just a snapshot of Beckhoff’s controllers at the end of 2002. The next generation of microcontrollers and x86-compatible CPUs, some of which have already been announced, make it clear that the performance of Beckhoff controllers will continue to rise next year, and that new series of devices will emerge: It is quite conceivable, for instance, that the Beckhoff Control Panel, so far only used as a display device, could also take over control functions, so that the PC in the control cabinet would become unnecessary. The monitor screen would become a controller, although only 30 mm thick! In addition to increased performance, a second trend can be recognized for 2003: The PC (or whatever serves that purpose) is extending its range of applications in the direction of medium-sized to small controllers – the motto is “embedded PC control”. Once again, industrial automation is profiting here from the consumer sector and its efforts to implement high computing capacity with low-power consumption in the smallest possible space. And there's nothing wrong with that.

→ Andreas Thome, Product Manager PC Control

Beckhoff Panel PC CP6xxx

Built-in Panel PC Series:
CP64xx, CP65xx and CP63xx
(left to right)

A strong combination

→ In the class of PC-based control technology, the Industrial PCs are the most powerful hardware platform. The Panel PCs are optimized for installation in the control cabinet front and offer a variety of application options. The combination of built-in Control Panel and a total of three different add-on PCs creates a wide variety of variants in terms of design, function and housing size.

Similar to the CP7xxx series Control Panels for support arm installation, the CP6xxx series built-in variant offers many display sizes and options. Both Control Panel series can be operated as detached operating and display elements. For the connection to the PC, the user has a choice: The inexpensive DVI/USB standard is suitable for distances of up to 5 m; the CP-Link connection is ideal for distances up to 100 m. In combination with the add-on PCs, the Control Panels form a complete Panel PC with high computing power. Together with the TwinCAT automation software, they offer the basis for real-time controls for PLC and motion control applications.

The Beckhoff Industrial PC family is complemented by the CP63xx, CP64xx and CP65xx Panel PCs. In contrast to the CP71xx Panel PC with IP 65 aluminum housing for support arm installation, the built-in Panel PCs are designed for installation in control cabinets or control desks. The fronts are designed as IP 65 and are dust-proof and splash-proof; the backside PC housing is designed in protection class IP 20. The housing of the built-in Control Panel is designed for harsh conditions and is machined from an aluminum block. This results in low weight, high strength and excellent resistance to environmental stresses.

The CP63xx, CP64xx and CP65xx add-on PCs complement all types of the built-in Control Panel by a full IPC. They are equipped with 10, 12, 15, 18 or 20 inch TFT display, as monitors without keys or with keyboards of various sizes. A touch screen or touch pad is optionally available. A large number of expansion options with electromechanical keys are also available. The finely scalable modular system offers the right display and the right computer kernel for all applications.

On the PC side there are three types that differ in the quantity of free slots and thus in the size of the housing. Overall, more than 150 variations of built-in Panel PCs are available.

The power part: compact, flat or universal

The most compact design is offered by the add-on PC CP63xx, which enables controls to be realized on very little space. A plug-in card motherboard for Intel Celeron or Pentium III up to 850 MHz is integrated into the housing with the dimensions of 212 x 194 x 93 mm. A free PCI slot and the room for a PC104 card are available. All PC connections are on one side of the housing.

During the development of the add-on PC CP64xx, the focus was mainly on space-saving installation. The 4-slot add-on PC CP64xx is mounted in a flat PC housing at the rear of the Control Panel. With its dimensions of 329 x 302 x 79 mm, it takes up little space inside the control cabinet. It is equipped with Intel Celeron or Pentium III up to 850 MHz on an all-in-one plug-in card motherboard with passive backplane. A PCI and a combined ISA/PCI slot are freely available for additional plug-in cards.

The focus during the conception of the add-on PC CP65xx was on system extension through a large number of free slots. The 7-slot add-on PC CP65xx is located in an ATX PC housing, which is equipped with Intel Celeron or Pentium III up to 850 MHz on an ATX motherboard. With 7 slots, of which 6 are freely available, it is universally expandable with fieldbus interface cards, network cards, interface cards, modem or ISDN adapter. The housing with

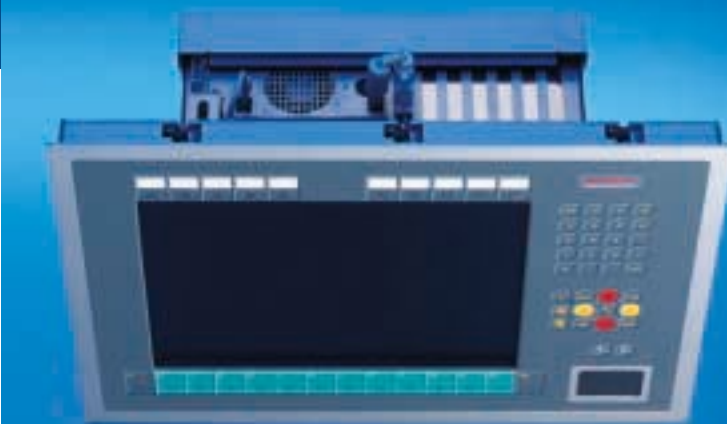
the dimensions of 333 x 308 x 165 mm contains all the connections at the top. The three PCs can additionally be equipped with a CD-ROM or CD-RW drive. The Control Panel is connected to the PC via DVI and USB. Power is supplied from the PC. The permissible operating temperature range for all built-in types is 0... 55 °C.

The display

The add-on PCs can be expanded with different TFT displays, available in sizes of 10, 12, 15 or 18 inch. The add-on PC CP65xx is additionally also available with the largest variant, the 20 inch TFT display with a resolution of 1600 x 1200 pixels. The built-in Control Panels are optionally available with touch screen or touch pad, as monitors without keyboard or with different membrane keypad models including full alphanumeric keyboards with 10 special PLC keys and 10 LEDs. Different versions of keyboard extensions with electromechanical keys are available. In harsh industrial environments, the robust membrane keypad ensures lasting compliance with protection class IP 65.

From the control cabinet wall, only 4 mm of the front of the built-in Control Panel are visible. Installation is via pull-out clamping levers, making the process very simple. There are no loose parts.

The universal built-in Panel PC CP65xx



Adaptable - the customer-specific solution

The optional extension modules resemble a construction kit: Not only the membrane keypad can be customized, but also the connection of hand wheels, potentiometers, push buttons, switches, optical indicators or other components. Each variant thus becomes a unique optimized system. A housing that can be dimensioned precisely in line with the needs of the particular application according to the customer's wishes can be combined with an individually designed membrane keyboard.

Panel PC = built-in Control Panel + add-on PC



The built-in Control Panels form the front of the Panel PC



Pre-programmed growth

The range of the Panel PCs continues to grow. A further variant in the form of a panel extension through the modular CX1000 Embedded PC is in preparation. This variant additionally offers the option of installing I/Os in the form of the Beckhoff Bus Terminals directly behind the panel. In combination with the operating systems Windows CE.NET or Windows XP Embedded and the Beckhoff software PLC/NC TwinCAT CE, a wide variety of industrial application options are thus available. The basic CPU module with the dimensions of 57 x 100 x 91 mm contains an Ethernet and a RS232 interface, as well as a 266 MHz CPU that is compatible with Pentium MMX. The internal flash memory of 16 Mbyte for operating system and applications is expandable to 64 Mbyte. Further characteristics: 32 MB RAM (expandable to 128 MB), a Compact Flash type II slot for commercially available Compact Flash cards, which are today offered in sizes from 4 Mbyte up to 1 Gbyte.



→ The Bus Terminals that have been used for years around the world in many industrial applications are making inroads into the field of intelligent building automation. Innovations in this particular field are currently extending Beckhoff's "automation construction kit".

New Bus Terminals for flexible building automation

Additions to the construction kit

In modern building automation, the air conditioning and heating technology is becoming increasingly powerful. A large number of sensors acquire temperatures, flow rates, pressures, the sunshine and many other physical magnitudes at various locations around a building. Actuators such as valves, regulating flaps, pumps and fans implement the commands from the "intelligent" building controller conveniently and with less power requirements. Connections between the controller, sensors and actuators are increasingly being implemented in the form of bus systems in buildings, as has been done for years in automation technology. This has many advantages: Assembly is easier, diagnostic and servicing facilities are improved, and the building's fire load is significantly reduced. A large number of proprietary controllers and systems can be integrated if the infrastructure is developed starting with the planning phase and making consistent use of the latest technology. An entire building can be controlled and serviced over an Ethernet network; all the control tasks are handled by a PC-based platform.

Ethernet is an economical bus system, but nevertheless it is still generally not worthwhile to have a connection at every sensor, for cost reasons alone. The more economical alternative is to use a gateway through which a number of sensors

and actuators are connected. The wide range of Bus Terminals provides the right range of capacity for the bus connection: More than 80 different Bus Terminals make an optimum interface available for every kind of signal. These nodes can include up to 255 Bus Terminals of any type at one Bus Coupler.

Providing shade with persistence

Beckhoff are offering solutions expertise to additional application fields through new Bus Terminals. This includes the direct control of power components such as the motors for blinds, servomotors and other 230 V AC actuators with right/left running functions. The KL2722 and KL2732 output terminals use a pair of power switches to control AC voltage from 12 V up to 230 V AC.

The contact burn that often results from switching large inductances with high starting currents is not a problem for the KL2722. The switching element is a triac, and therefore free from wear. It has a high current carrying capacity of more than 40 A. The steady load capacity of a digital output is 1 A. Switching on as the voltage is transiting zero and switching off when the current is transiting zero ensure that the semiconductor switch is not excessively loaded, and protects the connected motor. Both Bus Terminals have a pair of mutually locked outputs, so that simultaneously running to the right and left is prevented. The KL2732 operates without power contacts using two potential-free switches.

Artificial sun with digital connections

Connecting to price-sensitive actuators in a controller system is a challenge for a universal gateway. A building's illumination is typically implemented through a large number of devices. The price of a lamp, and therefore of the connection to a control system, is thus of great significance. The Digital Addressable Lighting

Interface, DALI, is a simple bus system for building automation that transmits the signals for the digital operation of lighting devices. The lamp, sensor, button and switching elements are wired in parallel, and are linked through the controller. DALI offers two advantages: It is an economical interface, easy to install, and it offers fully digital connection of lamps and comparable devices. The new KL6811 Master Terminal closes the gap between the lighting controller and the lamp, and permits up to 64 DALI devices or DALI slaves to be connected.

The DALI Master is integrated into the Bus Terminal system as a normal Bus Terminal, and is therefore independent of the fieldbus in use. The DALI data is then passed on to the controller through the relevant Bus Coupler. When starting up, the KL6811 DALI Master performs the search for addresses, and supports the user in configuring his equipment. The 24 V supply unit integrated into the master terminal supplies the DALI slaves with the appropriate voltage; no other additional components are needed for operation. DALI is supported by most lighting control manufacturers. However other actuators, such as heating control

valves or the motors for operating blinds are increasingly being put under digital control.

Digital alarm unit

The new KL1362 digital input terminal carries alarm signals in a very direct format. This terminal analyzes the input signal from break-in sensors using a current loop. Alarm contacts with a fixed resistance ratio can be monitored safely. In the process image, the state of the sensor is indicated by one bit each. A further bit reports short circuits or line interruptions. It is thus possible to use, for instance, a BC9000 Bus Terminal Controller with Ethernet connectivity, to transmit the alarm signals even over the Internet for remote diagnosis or remote alarm purposes. This can include the subsequent reaction, in the form of appropriate remote control signals used by actuators.

Power budget in the mains grid

The new KL3403 Bus Terminal for power measurement in three-phase networks allows power management to be implemented using any fieldbus system. The basic technical principle of the KL3403 Bus Terminal, which permits the measurement of all the relevant electrical data in a three-phase power supply network, is based on that of the KL8001 Power terminal. (See page 14 for further information about the KL3403.)

The new Bus Terminals, along with the electronic terminal blocks already used in many applications, permit a powerful and extremely flexible building management system to be implemented. If extended by Beckhoff Industrial PCs and Control Panels, integrated solutions can be created reaching from the control station out to the operation of pump drives, or linked over the Internet, and including such features as seasonally dependent power management and daylight-responsive illumination. Because building management, in contrast to applications in factory automation, is characterized by the control of devices that are not highly time-critical, Ethernet and web-based control concepts represent very flexible and powerful platforms. Beckhoff's control construction kit offers all the products, components and tools needed from one source.



New version of the KS2000 configuration software

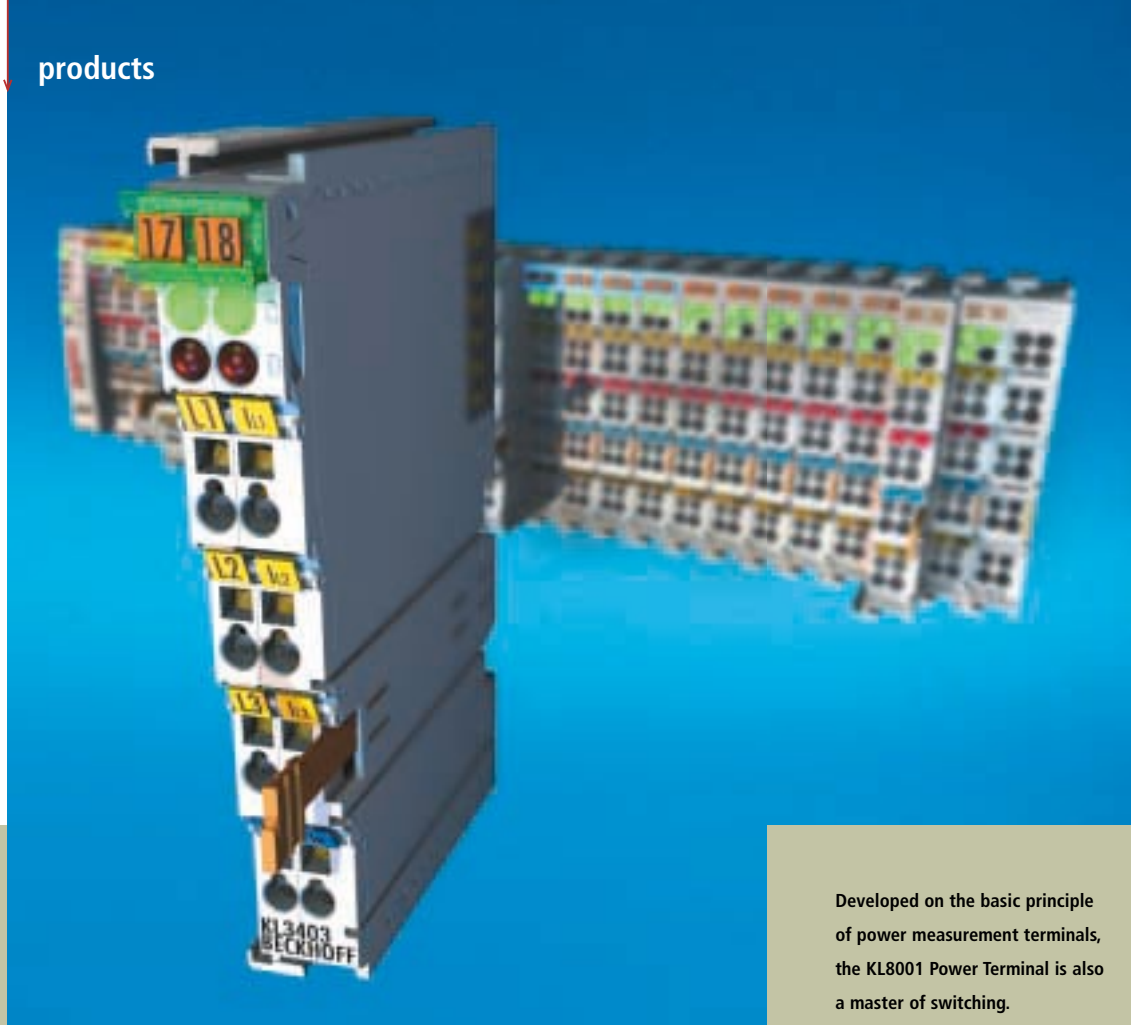
In version 4.0, Beckhoff are presenting a more developed version of their KS2000 configuration software. The software allows for easy parameterization and rapid diagnosis of the Bus Terminal system, and now includes the Fieldbus Box product. The KS2000 software has been completely reworked, and includes an entirely new approach to data backups based on XML. The most important innovations at a glance:

- | Online monitoring: the state of an output changes with a short click on the output terminal.
- | Scope function for digital and analog values simplifies setup and diagnosis.
- | Ethernet bus couplers can be addressed directly from the KS2000 software using a standard Ethernet cable. Firmware can also be downloaded over Ethernet.
- | If the bus stations are operated with a different type of controller it is possible to print out the Bus Terminal mapping information – making it easy to map hardware points to memory locations.
- | Complex bus terminals such as the AS-i Master Terminal or the oscilloscope terminal can be parameterized easily by means of a dialog window.

Three-phase power measurement terminal extends I/O system

Power management with the fieldbus terminal

A new three-phase power measurement Bus Terminal for the Beckhoff I/O system allows power management using any fieldbus system.



Optimization of energy use has long been a desirable goal, for more reasons than environmental conservation. Reduced energy consumption can be achieved through active power management with the new KL3403 Bus Terminal. Measuring and analyzing electrical current is the basis for monitoring and reduction of energy consumption.

The measuring facilities and the compact form of the new KL3403 Bus Terminal make it scalable and economical for any power measurement task. Special energy management systems, whose function revolves exclusively around monitoring power, optimizing consumption and load interruption can be extended by the KL3403. A wide range of communication interfaces allows the terminal to be integrated into very different systems.

Fieldbus-independent transmission of measurements

Users can integrate expense/benefit optimization into their application by using the consumption data obtained from the connected loads. This includes, for instance, controlled switching on or off of electrical equipment, or statistical monitoring of electromotive consumers, leading to decisions related to preventive maintenance. A significant benefit is the possibility of broadening power management from a local fieldbus segment up to the possibility of global management functions. The KL3403 is operated like other Bus Terminals, and the measurements taken can be transferred via the Bus Coupler to various fieldbus systems, or, for instance, over Ethernet, to higher level control systems.

The possibilities of power management are of particular interest in the field of building automation. It can, for instance, be counter-productive for heating units to continue operating in a building with controlled air-conditioning at the beginning of the working period, when electrical consumption is running at a high level. The electrical power consumption can be used to provide "pre-regulation" to the heating controller, so that the increased production

of heat does not inevitably lead to increased power consumption in the cooling system by the air-conditioning plant and fans. Hidden loads that unintentionally remain switched on overnight and at the weekend can be tracked down through the KL3403 Bus Terminal by detecting their consumption of electrical energy. Correlation of production figures, numbers of staff on site, external temperature and electrical energy consumption allow new possibilities for energy-saving to be found.

Comprehensive network analysis

The new KL3403 Bus Terminal enables the measurement of all relevant three phase electrical data. The voltage is measured via the direct connection of L1, L2, L3 and N. The current of the three phases L1, L2 and L3 is fed via simple current transformers. All measured currents and voltages are available as root-mean-square values. In the KL3403 Bus Terminal, the effective power and the energy consumption for each phase are calculated. All other information such as the apparent power or the phase shift angle $\cos \varphi$ can be derived through the relationship of the root-mean-square values of voltage x current and the effective power P. For each fieldbus, KL3403 provides a comprehensive network analysis and an energy management option.

The basic technical principle of the KL3403 Bus Terminal is based on the KL8001 Power Terminal. The KL8001 Terminal, like a standard motor protection relay, is fitted to a power contactor up to a switching capacity of 5.5 kW. The power terminal switches the installed contactor and takes over all the functions of the motor protection relay. The power terminal can also carry out numerous diagnostic functions on the motor and make the information available to the controller via the fieldbus. The same applies to the KL3403 Bus Terminal. A combination of switching and control is not, however, necessary for every application. For this reason, only the measurement functions are integrated into the stackable standard Bus Terminal.

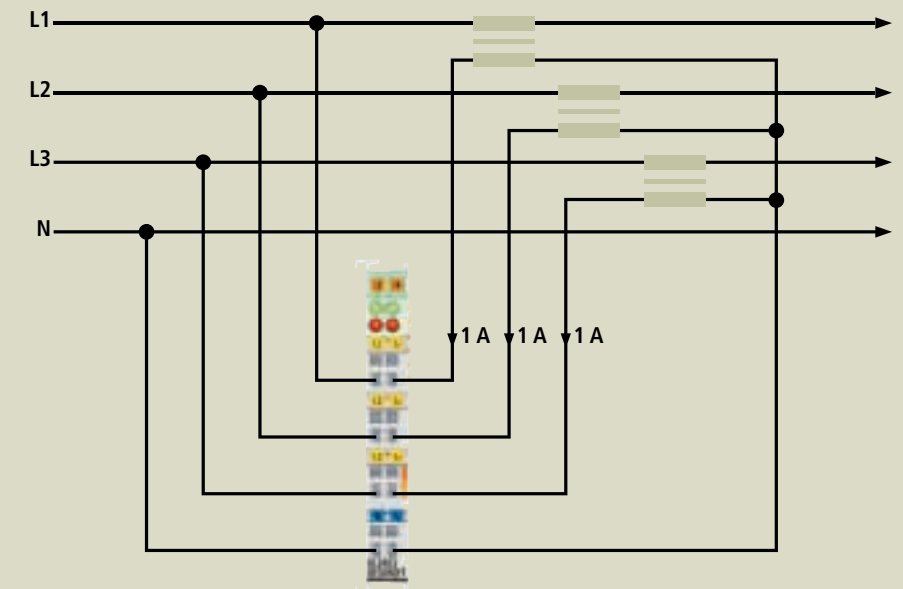
Developed on the basic principle of power measurement terminals, the KL8001 Power Terminal is also a master of switching.



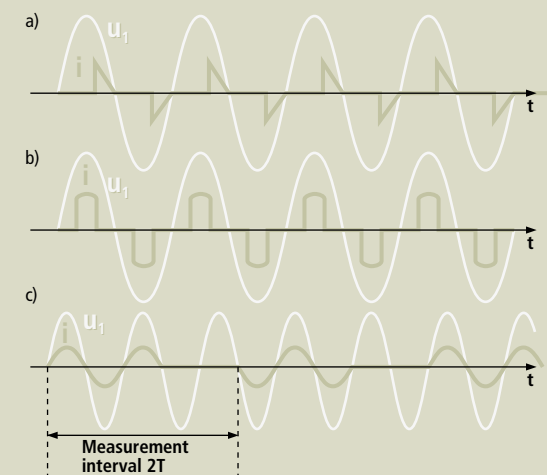
Energy management and analysis in the terminal

The KL3403 Bus Terminal supplies the necessary electrical data for power management with "any" fieldbus connection similar to the KL8001 Power Terminal which supplies the necessary data for motor management. The KL3403 terminals data allows plant operators to control specific drives or machine components in an optimized manner, protecting them from damage or failure.

In addition to straightforward measurements based on instrumentation transformers, a wide range of diagnosis can be carried out with the KL3403 Bus Terminal. The mains voltage and phase angle are determined in addition to the current measurement function. The KL3403 calculates the apparent and active power of the loads that are actively connected from the voltage



Types of current that can be measured:
The KL3403 can handle voltage and current curves under phase control (a), pulse duration control (b) and burst firing control (c). For burst firing control (c), the measurement interval of the KL3403 is set to equal the control interval, in this case 2 T. The KL3403 this always makes the current value available – without the necessity for further calculation.



and current. These values can be transmitted as instantaneous values, permitting very rapid reaction to changes. The calculation of the true effective value in the KL3403 Bus Terminal makes useful information available in the process image, which does not presuppose high computing power on the part of the controller. Even non-sinusoidal voltage and current curves can be read-in with a practical accuracy of 1 % to 5 %, depending on the type of curve. The cut-off frequency of the calculations amounts to 2 KHz. As the time interval for calculating the values can be adjusted, optimization is possible under a very wide range of circumstances.

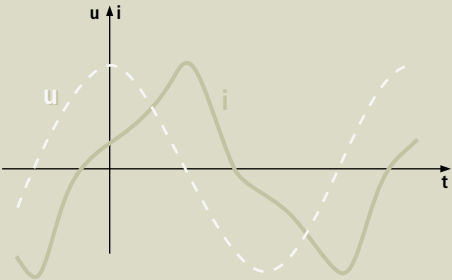
The evaluation for each phase takes place independently. Adaptation for a very wide range of currents is achieved through external current converters. Failure of a conductor, or asymmetry in the current, is detected by

the KL3403 terminal, as is the fault current resulting from an earth short. The usable resolution of 16 bits means that a difference of 10 mA can be reliably detected when the full scale value is 60 A. The precision of the current measurement is largely determined by the quality of the instrumentation transformer. The use of electronic transducers also allows non-sinusoidal currents and DC to be measured. It is possible to determine the effective value and the power consumption of a load operating under phase control.

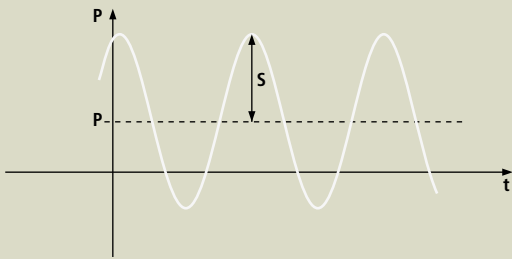
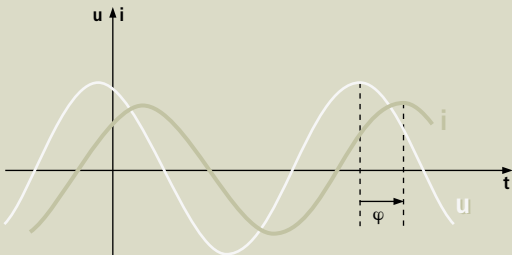
In-house energy counter

The KL3403 can be used as an energy counter for internal purposes. The counter can be read at any time, although resetting, in contrast, is protected by a pass-

word. This information is retained in the KL3403 Bus Terminal even when the power supply is switched off. The KL3403 Bus Terminal is mounted on the mains voltage side. It can therefore continue to measure the mains voltage if the load is switched off in the course of power management. Integrated phase sequence monitoring protects against serious equipment damage, and configurable switch-off and alarm thresholds are used to monitor current and voltage. Critical conditions can be detected promptly in this way, and damage can be avoided. Measuring the current by means of transformers allows the installation at any location within the plant. The KL3403 requires a 4-wire connection. The low internal resistance of 33 mΩ minimizes transducer errors, and means that power dissipation is small.



Complex current curves in a coil: The KL3403 determines the root-mean-square value of the current along with the power dissipation and the apparent power from the complex current curve in a coil. It is possible to draw conclusions about the quality, loading or mechanical magnitude.



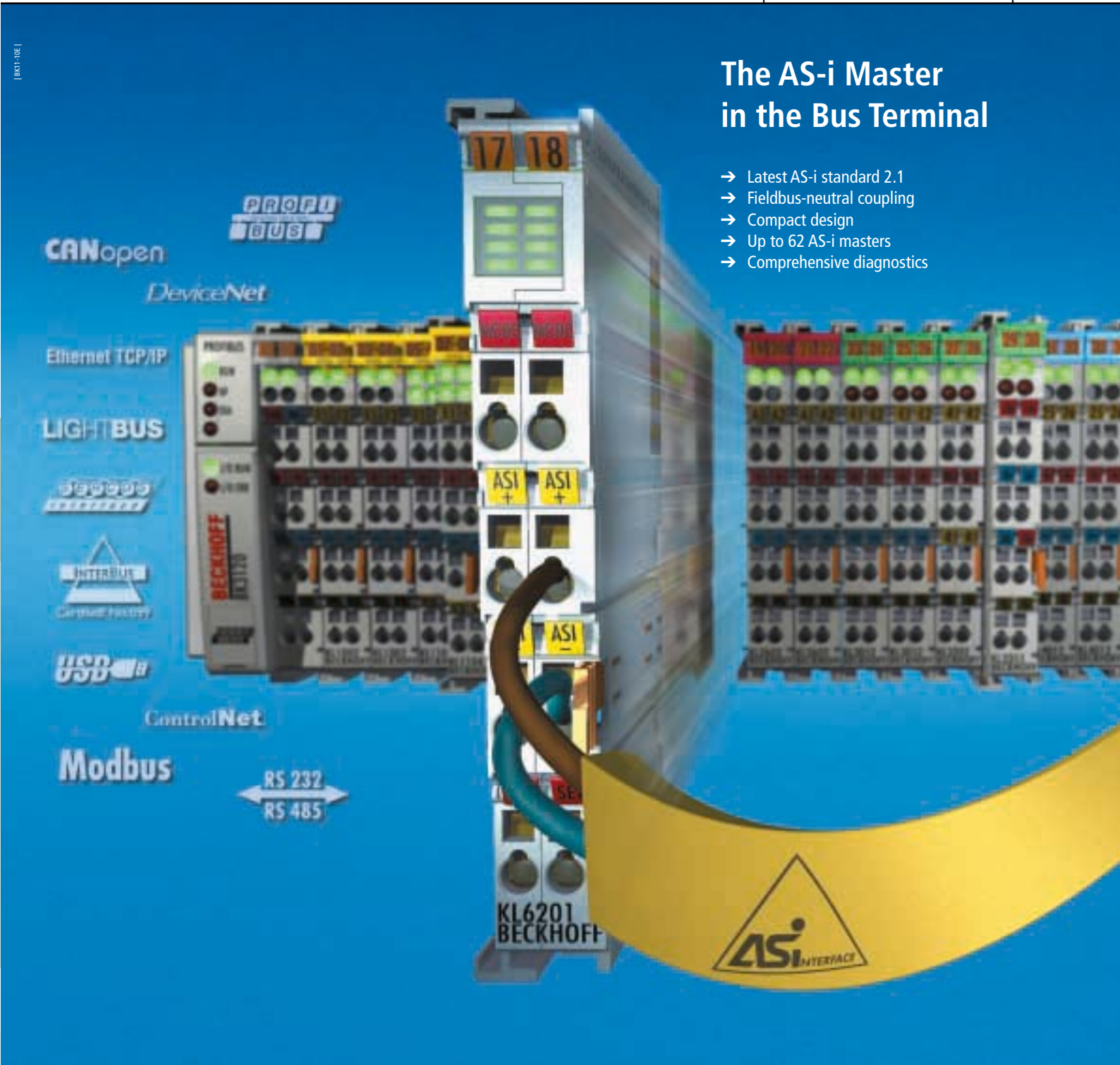
Calculating the power: The apparent power, S, is calculated from the product $u \times i$. This calculation is performed 64,000 times a second. The effective power, P, is the mean of these values, and depends on the phase angle, φ , in addition to the amplitude of u and i. The interval over which the effective power is to be calculated can be selected over a range from 5 ms up to several seconds, depending on the application. Periods of 5 ms, 10 ms, 20 ms or multiples of 20 ms are useful for 50 Hz mains.

Bus Coupler connects I/Os with Universal Serial Bus

The BK9500 USB Bus Coupler enables the integration of I/O signals without “real-time demand” into the PC world. Application examples are general metrology, environmental engineering, laboratory applications, collection of operating data or data loggers, among others. The advantage is that no additional hardware, such as PC card or interface adapter, is required, since nearly all PCs have a USB interface. In the Full Speed Version used, the transfer rate of 12 Mbaud is several times higher than with RS232. The connection to the fast peripheral bus is established via the standardized USB connector, the distribution of the peripheral devices via hubs. A bus system with a maximum of 127 devices can thus be configured. System integration is straightforward and is done via the TwinCAT System Manager from version 2.8 .

The AS-i Master in the Bus Terminal

- Latest AS-i standard 2.1
- Fieldbus-neutral coupling
- Compact design
- Up to 62 AS-i masters
- Comprehensive diagnostics



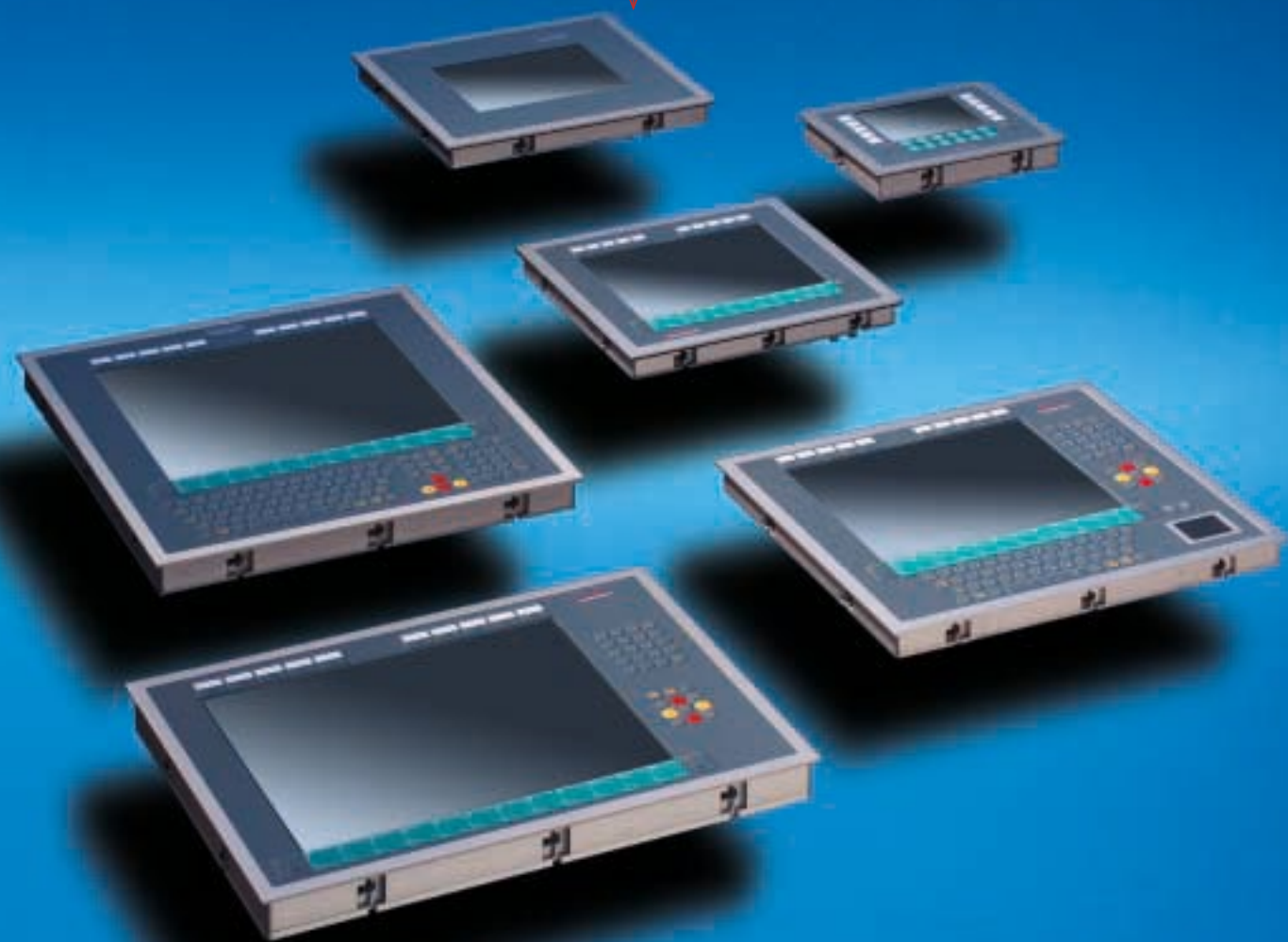
The AS Interface master terminal for 12 different fieldbus systems

The integration of the KL6201 AS-i master terminal into the Beckhoff Bus Terminal system enables the integration of any number of AS Interface slaves into 12 different fieldbus systems. Due to the economic and simple AS-i installation technology,periphery devices can easily be coupled with

any Beckhoff Bus Coupler. The compact design and the option of using several master terminals in a fieldbus station enables cost-efficient AS-i applications.

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





Beckhoff has expanded the Control Panel and Panel-PC series by adding 6.5 inch, 18.1 inch and 20.1 inch TFT displays. The displays come in two styles, robust aluminum housing, types. The CP7000 series for wall or support bracket mounting has IP 65 splash proof rating protection on all sides. The design of the Control Panel CP6000 is intended for control cabinet mounting and meets IP 65 at the front and IP 20 at the rear.

Extending the product range, upwards and downwards

New display sizes for the Control Panel family

Beckhoffs extensive Control Panel offering now includes six different display sizes as well as a wide range of options for both form and function. The 640 x 480 pixels in the new 6.5 inch TFT display offer high-resolution in a small area. The display is integrated into an extremely compact Control Panel housing, whose resolution makes it easy to operate through Microsoft Windows, and still can display easily readable text. Connection to the PC can be made by means of CP-Link technology or DVI/USB interface. With CP-Link the PC can be up to 100 m apart, or via DVI/USB, offering an economical solution for connections up to 5 m

apart. The Ethernet Control Panel offers a new option, where a 266 MHz processor PC is integrated into the 38 mm deep housing. This location-independent version can be operated as an independent PC or as a terminal client to a Windows terminal server.

18 and 20 inch TFT displays for complex visualizations

The new 18.1 inch TFT display, with its 1280 x 1024 pixels, offers a large working area for the display of complex graphics and for the presentation of detail images



"Schneider/Télémécanique TeSys Model U with Beckhoff Module"

at high resolution. The larger version, a 20.1 inch TFT display with a resolution of 1600 x 1200 pixels, has a 24 bit color depth, corresponding to 16.7 million colors. The Control Panel picture remains sharp because of the digital connection technology. The user can choose from a wide range of available front designs; from a display with no keyboard, optionally with a touch screen, up to a display with a full PC keyboard and with customer-specific design. The 18.1 and 20.1 inch Control Panels are connected to their PCs via a USB/DVI interface.

Many variations with the add-on PC

In addition to the options mentioned, all Control Panel types can be extended through the use of the add-on PC to form a complete Industrial PC of compact form. In the case of the built-in Control Panel series, the add-on PC CP63xx, CP64xx or CP65xx, is mounted at the rear (additional information on page 10). The Control Panel CP7000 for wall or bracket mounting can be extended by means of an add-on PC CP7100 with a freely selectable front design. The Control Panel and the add-on PC are built with robust aluminum housings, and are implemented to IP 65 on all sides.

Schneider Electric has introduced a newly designed product family for protecting and switching motors within the "TeSys" product line. Télémécanique TeSys Model U is a very compact motor starter that can be connected directly with the Bus Terminal system via the KL8601 communication module developed by Beckhoff. Schneider customers therefore benefit from almost unlimited fieldbus systems. Similar to the KL8001 Power Terminal, the motor starter integrates seamlessly into the Terminal Bus.

The motor starter is integrated into the fieldbus systems via a common, shielded RJ45 cable and a new adapter terminal, type KL8610. The RJ45 cable can also handle the 24 V supply needed for the contactor. 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. Remote mounting of I/O and power components is thus possible within the control cabinet. The user is provided with a true "Plug & Play" solution.

This cooperation leads to a significant expansion of the range of Beckhoff Power Terminals. Additional information in the next PC Control issue.

→ www.schneider-electric.com

i Product announcement Estimated market release 1st quarter 2003. The KL8601 communication module, the KL8610 adapter terminal and the cable can be ordered from Schneider Electric/Télémécanique or Beckhoff. The motor starter can be ordered only from Schneider. The fieldbus system can be ordered from Beckhoff. We reserve the right to make technical changes.



Ethernet communication in real-time

Ethernet takes the next step as a “fieldbus” in Beckhoff’s TwinCAT control system. In addition to tough real-time requirements, it permits the use of standard components “on the same wire”. The BK9000 Ethernet Bus Coupler and the AX2000-B900 servoamplifier are the first fieldbus components to benefit from the real-time capability. New network variables accelerate the real-time data exchange between controllers, making it as easy to implement as connecting another digital input.



- Beckhoff’s range of Ethernet products has been in use for years, and is becoming increasingly popular. The advantages of using the office Ethernet standard communication method in industrial settings are clear:
- | Standard hardware components can be used
 - | Standard protocols can be employed
 - | Data transmission rates are high
 - | Linking the network to the rest of the world over the Internet is straightforward
 - | Remote maintenance and diagnosis

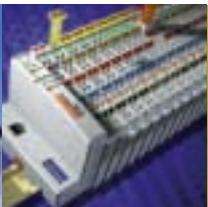
Communication over Ethernet has now become accepted in industrial automation and many groups and committees are concerning themselves with this topic. The absence of effective real-time capability, however, is a problem, which has limited Ethernet’s use in the classical fieldbus area. Some techniques do allow a certain degree of real-time capability, but are based on proprietary systems, and do not allow standard components and protocols to be used at the same time.

- “Real-time capability” is a somewhat flexible term when used in control theory. “Real-time” depends heavily on the requirements of the particular application and the control loops in which the automation components are used. However, from the point of view of automation engineering, and against the background that fieldbus specialist Beckhoff have to offer, a rough division can be drawn:
- | The toughest requirements involve cycle times of around 50 µs and permissible jitter (deviations from the desired cycle time) of around 10 µs. Requirements tighter than this are currently still handled with the aid of special hardware rather than directly over fieldbusses.
 - | Typical cycle time requirements with position-controlled drives are in the range of milliseconds (1-4 ms), in which case jitter times should be less than 20 µs.
 - | Pure PLC applications often require cycle times no shorter than 10 ms; correspondingly, jitter times may here be significantly longer, and lie in the millisecond range.
 - | Data communication between the controller and the supervisory system can often satisfactorily be handled with cycle times in the range of seconds. In fact it may not be configured cyclically, but may be event driven.

Servoamplifier with Ethernet interface AX2000-B900



Ethernet Bus Coupler BK9000



Ethernet’s operating principle



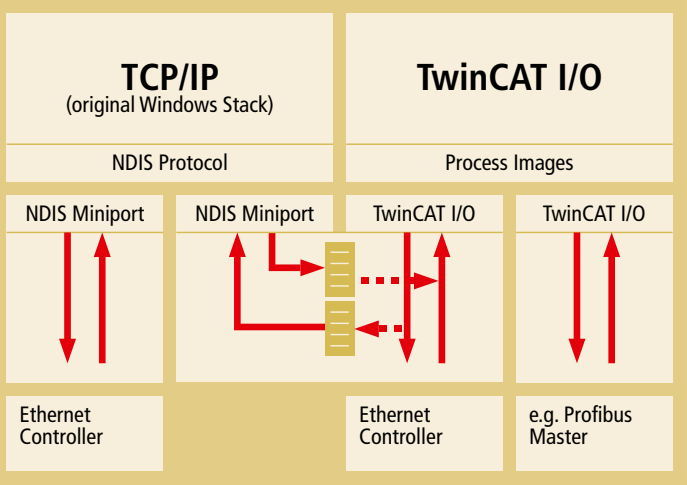
- | Remote servicing and diagnosis should also be mentioned. Cycle and jitter times here are less relevant than reaction times and the general possibility of being able to communicate across the boundaries of networks. TwinCAT automation software now offered with Real-time Ethernet means that all the communication requirements that have just been mentioned can be satisfied using one and the same technology, both from the point of view of the devices used and of the protocols employed.

Principle of operation

The TwinCAT network card driver is linked into the system in such a way that it appears as a network driver, compatible with the operating system, and additionally as a TwinCAT fieldbus card. An internal prioritization system and buffer is provided at the transmitter end which always finds a free transmission channel for Ethernet frames from the real-time system that may be queuing. The operating system’s Ethernet frames are only later transmitted in the “gaps” if sufficient time is available. At the receiving end, all the Ethernet frames received are examined by the TwinCAT I/O system, and those with real-time relevance are filtered out. All other frames are passed on to the operating system after examination, outside the context of the real-time system. Using commercially available switches, all of which support full duplex operation at 100 Mbaud, the transmitted frames are passed on to the receiver with a constant delay. A switch ensures that collisions are avoided and only delays occur. In a cyclic control system it is therefore only necessary to ensure that all the relevant input information has arrived before the next cycle starts. When, or in what sequence, they have arrived is not significant. If the number of participating devices or the frame rate is restricted in accordance with the required cycle time, the preconditions for Ethernet communication with real-time capability are satisfied.

Operating modes/protocols

In contrast to the widely used TCP/IP and UDP/IP protocols, which are responsible for the provision of individual Ethernet frames around the world, real-time communication does not leave the local subnet. The overhead involved in TCP/IP, and even that of UDP/IP, can be omitted, and the devices can be addressed directly by means of the hardware addresses (MAC-ID) of the network cards. The structure of Ethernet frames ensures that it is always possible to co-exist with other protocols; even the “real-time frames” can, if necessary, be transmitted with TCP or UDP, if they have to leave their own subnet. A number of different operating modes have been defined for use in control engineering. They serve different communication tasks, and can, of course, be employed simultaneously.

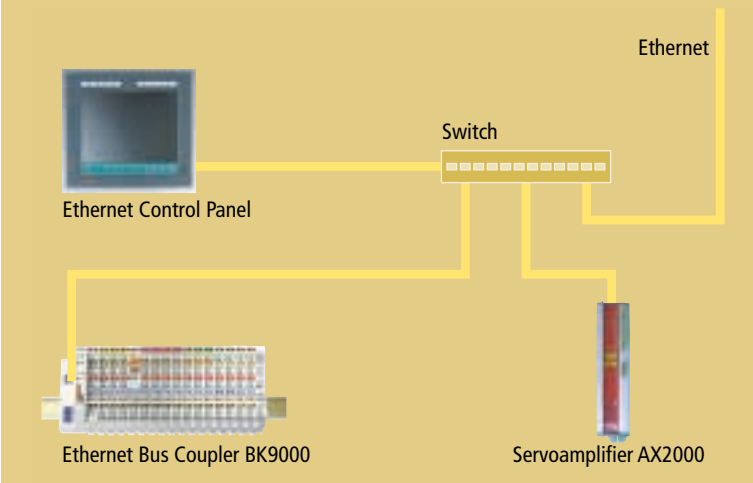


- | **Master-slave process data communication**
Cyclic or event-driven transmission of I/O data – the typical use of modern fieldbusses
- | **Publisher-subscriber process data communication**
Process data according to the publisher-subscriber model (also referred to as network variables) is used for regular communication between controllers when a fixed master-slave relationship would not be appropriate. The publisher sends out its information without concerning itself with where it is going. The communication is only monitored in the subscriber. Mutual publisher-subscriber relationships permit bi-directional and multi-directional communication. The publisher can be configured to send the data by broadcast, multicast or unicast. Multicasts reduce the loads at the network devices’ receive queues, because the messages are evaluated as soon as they reach the Ethernet controller. Only if unicasts are used the switch (without extensive configuration) can open parallel communication paths and increase the useful bandwidth.
- | **Data communication as required**
This is a type of communication made possible in the TwinCAT system through ADS communication, and which sends communication strings from one device to another “as required”. Services are executed and parameters exchanged in this way.

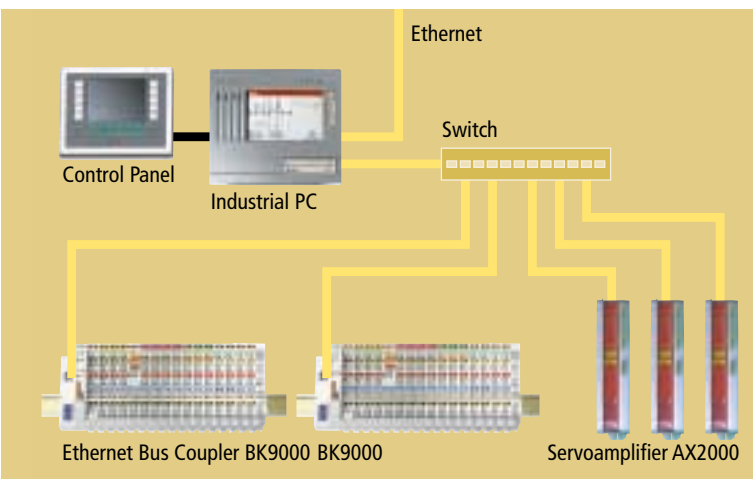
The chosen protocol structure means that other operating modes or communication profiles can easily be integrated in the future, and can co-exist with the existing modes without difficulty.

Compatible components

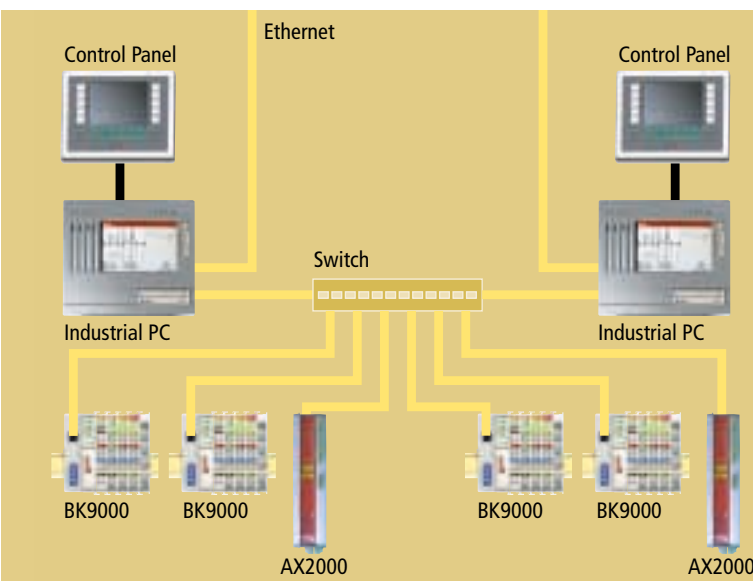
The first components from the Beckhoff product range to have been extended for real-time Ethernet application are the BK9000 Ethernet Bus Coupler and the AX2000-B900 Drive Controller. These two components open up almost the entire range of industrial signals and applications. All TwinCAT controllers (from Version 2.9 onwards) are compatible, and can participate both as “fieldbus masters” and in communication using network variables. TwinCAT supports all Ethernet controllers of the Intel 8255x family. This is one of the most widespread Ethernet controllers, a component in the latest Intel chip set, which already include a compatible network connection. Support for further Ethernet controllers in the future may be considered – in the light of the wide popularity of the Intel family and its compatibility even with Gigabit Ethernet (Intel 8254x family) – but not absolutely essential. The new Embedded-PC CX1000 small controller is, of course, always fitted with an appropriate Ethernet controller.



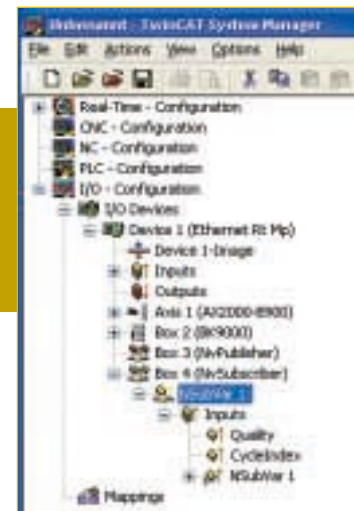
Application example 1: Relatively simple applications can manage with a single Ethernet connection, both for the real-time communication to the I/O level and for the higher-level communication for the purposes of administration and remote diagnosis. The prioritization that is used ensures that the real-time communication takes place without difficulty.



Application example 2: Larger applications make use of a second Ethernet connection, and divide the real-time communication and the higher level communication between two networks. The routing that is required in order, for instance, to remotely diagnose a drive that is connected to a real-time network is performed automatically by the operating system's IP stack, and does not require any proprietary conversion to a different protocol.



Application example 3: Very large applications, for which the computing power even of a 3 GHz system is insufficient, can distribute the control tasks between a number of PC controllers, and can exchange even large amounts of data quasi-synchronously with the cycles, (even at sub-millisecond speeds) using the real-time capable network variables.



Configuration with the TwinCAT System Manager

Performance

Judging the performance of a fieldbus system exclusively on the basis of the baud rate is, without doubt, too simple, ignoring as it does other significant communication parameters such as the efficiency of the protocols, reaction time, jitter, minimum telegram length, pause times and so forth. All the same, 100 Mbaud permit significantly faster data transfer than is usual at present in fieldbus environments. In addition to this, the protocols used provide a significantly improved efficiency in contrast with TCP or UDP communication, in particular when data telegrams are short.

One factor which is often ignored when considering the capacity of a fieldbus system is the transfer of data between the controller CPU to the communication chip or processor; that is to say, between the host system memory and the sub-system memory. In PC based controllers, the data is usually copied over the ISA or PCI bus into the DPRAM of a fieldbus master card, and vice-versa. Whereas PC processors have reached speeds of around 3 GHz, even the supposedly fast PCI bus has become a bottleneck, so that 20-30 % of the CPU performance is lost for PCI transfers.

Modern network controllers operate in what is known as the "bus master DMA mode", accessing the host system's memory directly. This occurs in parallel with other CPU tasks, and therefore significantly reduces the CPU load.

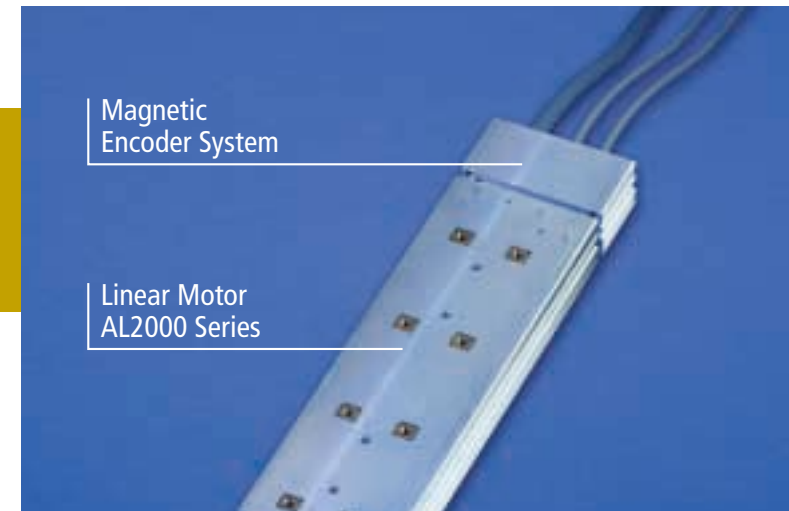
Applications/Linking to TwinCAT

The high data transfer capacity, the fundamental real-time capability and the protocols that are employed cover all the communication demands made by a fast machine controller. When all these features are considered we are soon led to the conclusion that classical fieldbusses are not longer needed.

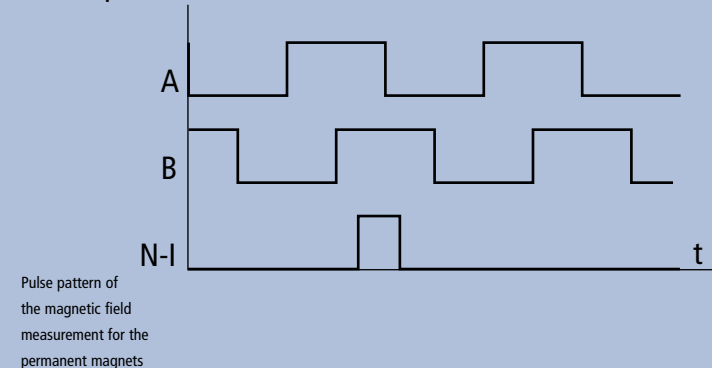
First of all, however, Ethernet technology must still be proven at the field level, and must meet all requirements such as those for simplicity of installation and configuration, mutual compatibility, EMC immunity and, not least, efficiency and device costs relevant to the industrial environment. Standard fieldbusses are widely accepted, and there are many devices offered by many vendors including Beckhoff. Therefore, they will continue to have great significance to the market.

Here once again, TwinCAT's flexible I/O system offers a way forward: It permits multiple fieldbusses to be operated in parallel, including, of course, the parallel operation of classical fieldbusses with real-time Ethernet – and all of this is entirely transparent to the application.

Scaleless feedback system for linear motors AL2000



Pulse pattern



In drive applications, linear servomotors are popular due to their excellent characteristics in terms of dynamics and synchronous operation. They are particularly advantageous if the installation of rotary motors is not possible due to the mechanical specification. The linear motors are not subject to mechanical wear and are easy to commission. These advantages are partly weakened by the higher costs for the feedback systems. The new magnetic encoder system from Beckhoff complements the linear technology market with an inexpensive alternative. The feedback system for the AL2000 series linear motors is scaleless and therefore independent of the length of the magnetic plates.

Innovation for linear drives

The operation of synchronous servomotors requires a feedback system for acquisition of the rotor position and speed for the commutation. Traditionally, a tachometer and a rotor position encoder have been used for this purpose. For some time now, resolvers enabling sinusoidal power supply of the synchronous motor have started to replace this system. The resolver is complemented by further possible feedback systems such as incremental transducers, absolute encoders, etc.

For the operation of linear motors, the feedback system is installed parallel to the travel path. It consists of a reader head, usually mounted on the motor slide, and a scale mounted parallel to the travel path. A distinction is made between absolute and incremental systems; both are subdivided into magnetic and optical systems, with precision and sensitivity playing a crucial role. Magnetic encoders do not quite reach the resolution of the optical models, but they are slightly cheaper.

However, the displacement measuring systems described above have the disadvantage that their costs increase with the length of the meas-

uring section. Linear motors are also increasingly used, for example, in gantry systems involving large distances. Here, the additional expenditure for the displacement measuring system is excessive and may make the whole machine concept financially questionable. Costs are also the reasons why the use of the above systems is often not justified for other applications with moderate precision requirements, for example for wood or Pick & Place machines.

For this reason, automation specialist Beckhoff has developed a measuring system that monitors the magnetic field of the permanent magnets of the magnetic plate and provides the AX2000 series servoamplifier with incremental transducer signals for commutation, speed and position control. The measuring system provides 1000 increments per logical motor revolution. A logical motor revolution corresponds to the distance between two homopolar magnets, i.e. for example between two north poles. With 24 mm, this distance is very short for the AL2000 series linear motors, resulting in very high resolution. This leads to particularly synchronous operation and low running noise.

A resolution of 0.1 mm is adequate for simple positioning tasks

A maximum resolution of 24 μm is adequate for simple positioning tasks. The achievable precision ranges between ± 0.1 mm and largely depends on the mechanical precision and position of the travel path magnets. The influence of temperature fluctuations and external interference fields is compensated.

However, the crucial advantage is the absence of the scale; this means no comprehensive alignment and installation is required, since the measuring system can be mounted directly on the motor. If the travel path is extended, no reinstallation or replacement of the scale is required. The magnetic encoder system for AL2000 series linear motors is only 36 mm wide and is mounted in front of the linear motors. The process is further facilitated by the use of pre-assembled cables. This means that the price remains constant, no matter what measuring length is required. Another advantage is the maximum possible travel path. With AX2000 servoamplifiers, this is 50 m.

Product announcement

Estimated market release
1st quarter 2003.

We reserve the right to make
technical changes.

TwinCAT automation software
version 2.9

Complex automation made simple



→ Today's control technology still has plenty of potential for savings in terms of its engineering. TwinCAT 2.9 meets these requirements. The further development of the engineering tools tackles the increasingly more complex automation. New features make configuration and programming significantly easier. Existing software components are reused easier, commissioning time is shortened, costs are reduced.

Configuring and commissioning with configuration mode

The new TwinCAT 2.9 configuration mode further simplifies the commissioning of I/O signals and axes. Initial commissioning can be carried out without PLC program. In configuration mode, all Beckhoff fieldbus components can be operated free running. Inputs can be read and outputs set in Force mode. Faults can be detected and rectified at an early stage. In addition to determining the existing fieldbus cards in the PC, it is also possible to read the individual nodes and existing Bus Terminals for all fieldbusses. Configuration errors can thus be prevented.

Version 2.9 of the TwinCAT System Manager can also be operated remotely. This means that a TwinCAT system that can be reached via TCP/IP can now be programmed and commissioned not only via the PLC control, but also with the TwinCAT System Manager. Systems can thus be conveniently configured remotely, using the familiar configuration and diagnostic tools of the System Manager.

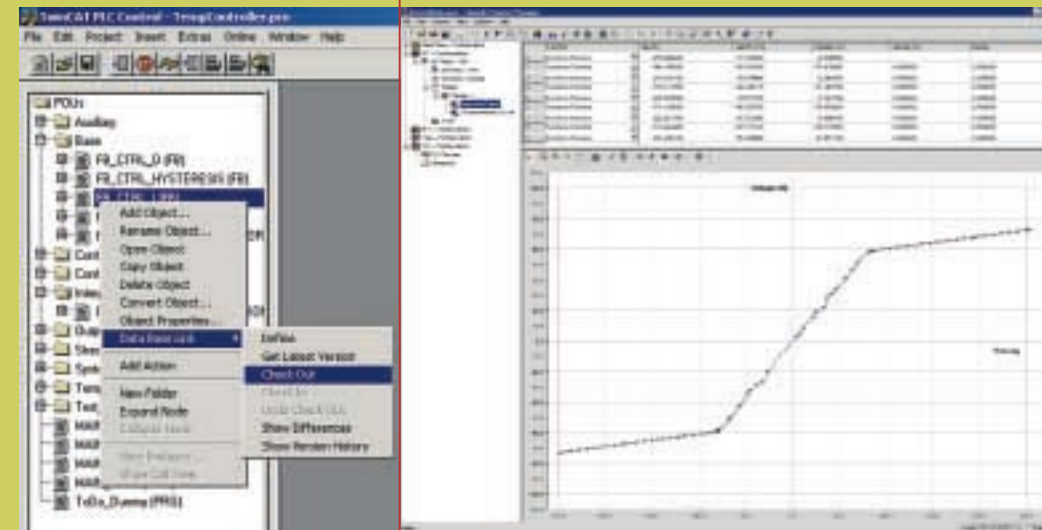
Engineering Interface

In cases where several programmers work on a PLC project, in the past the question kept recurring of how to integrate the work of the different programmers in a single project. Up to now, this was only possible by comparing, importing and

copying. In version 2.9 it is possible to co-ordinate the work via a source code management system. To this end, the Engineering Interface (ENI) Server is installed on a central server. It provides a shell for a variety of source code management systems. Under this shell, Microsoft Visual Source Safe or MKS Source Integrity may be operated. The creation of individual drivers for other tools is possible. In the PLC development environment, a certain version of a project or a component can be called up from the database. For processing the component, the object must be checked out. This means that it is locked for all other users. Once processing is complete, the object is checked in again. The history of all formerly generated versions of an object can be called up at any time. Comparisons of different versions are possible.

COM interface for software PLC

All commands that were previously made available via the batch interface are now also accessible via a COM interface. These commands can thus be executed from a Visual Basic program, a Delphi program or simply via a Visual Basic script. Some additional commands make the use of the batch interface even more convenient. Within a batch, wildcards now exist for the current project and for various paths.



Source code management via Visual
Source Safe or MKS Source Integrity

TwinCAT Valve Diagram Editor

TwinCAT Valve Diagram Editor

In order to linearize non-linear characteristic curves of hydraulic valves, a velocity curve that has been measured for the output voltages has to be read in and approximated by a characteristic curve. The measured characteristic curve is displayed in the TwinCAT valve diagram editor and can easily be linearized graphically. Only a few reference points are required. A straight line or a 5th degree polynomial are placed between these reference points. The determined characteristic linearization is then loaded into the TwinCAT NC real time and taken into account when the voltages are output in the drive. Online monitoring is possible at any time.

External set value generation for TwinCAT NC PTP

Thanks to the new external set value generation option, from TwinCAT version 2.9, it will be possible to superimpose own set value generators, written in the PLC, or different set value generators with the standard set value generator of the NC PTP. This opens up a variety of new applications. On the one hand, special set value generators that are optimized for a certain application can be written in the PLC. On the other hand, interpolating movements of several axes can be combined with NC PTP features such as the flying saw. CNC machining of moving workpieces can thus be realized. The handling of the new function is supported by a number of new PLC components.

Motion laws in real-time

The increasing performance of PCs means that the complex motion laws described in VDI 2143 can now be calculated directly at NC runtime. This has numerous advantages. On the one hand, only very few reference points have to be transferred into the TwinCAT NC real time. While previously several thousand reference points had to be transferred, today a few are sufficient. Existing points can be modified online, or the laws associated with the points modified. This enables very flexible cam plate applications.

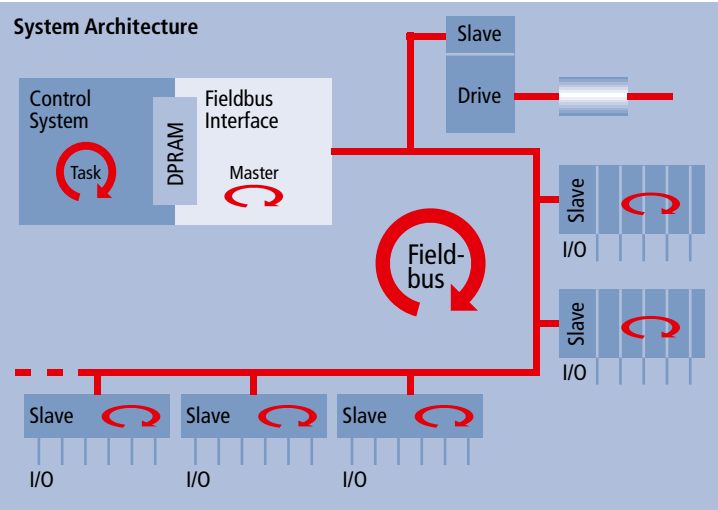
TwinCAT NC I news

If, for example, the saw blade is found to be blunt and has to be replaced during a sawing process, the new NC-I emergency stop is activated. After the saw blade has been replaced, the axes are repositioned, and the part program continues where it stopped once the stop function is released. The emergency stop can stop with parameterizable, even high decelerations. After the stop function has been released, the part program can continue to be executed immediately. The retrace function interrupts the execution of the current part program, and the program is processed in reverse order back to the start, if necessary. If, for example, a thread breaks in a sewing program during the execution of a part program for sewing clothes, then the path needs to be partly retraced and the program restarted at the right position.

The performance of fieldbus systems in production applications is often described in terms of the achievable communication cycle times. The real-time capability of the different systems is then often assessed based on these figures. Other approaches also take into account the repeatability of the communication cycles. However, more critical parameters are usually ignored, such as the synchronization behavior of both the central control applications and the subordinate, decentralized application parts with the fieldbus cycle.

Performance of fieldbus systems in production applications

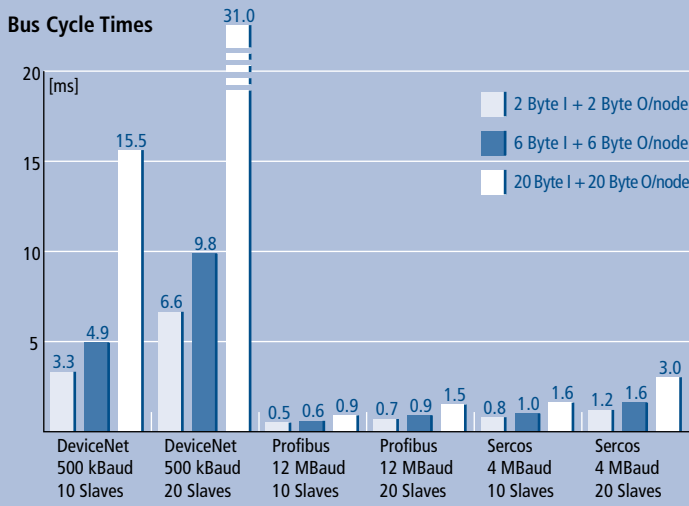
Cycle time is not everything



Comparing fieldbus systems topology in production applications is secondary for analyzing the performance parameters: The differences in physical propagation times of bus, ring and tree structures are comparatively small. However, the baud rates and particularly the protocol efficiency are significant. In cyclic systems, this is particularly relevant for the overall cycle time.

System structure

Let us take a closer look at a control system with decentralized fieldbus devices. The control (e.g. an IPC or a PLC) cyclically executes one or several application programs (e.g. Motion or PLC tasks). The fieldbus interface is designed as a plug-in card with a dedicated processor. Process data are exchanged with the control via a shared memory area (DPRAM-Dual Port RAM), which is accessed alternately. The simplest – and most common – communication principle for fieldbus systems is cyclic data exchange between a central fieldbus master and many decentralized fieldbus slaves. In this context it is initially irrelevant whether the data exchange and the bus access occurs via polling (e.g. Profibus), via time slicing (e.g. Sercos) or via the shift register principle (e.g. Interbus). Even the CAN-based DeviceNet,



with bus access according to the multi-master principle, is nearly always a polling system at the protocol level and can therefore usually be treated as a cyclic fieldbus. A CANopen system, typically using event-driven communication in multi-master mode, can be operated in strictly cyclic mode – e.g. for controlling axes. For the general fieldbus systems under consideration, the controllers’ fieldbus interface acts as the master that controls the bus cycle. Correspondingly, the decentralized fieldbus devices are slaves. They only respond to requests from the master and can therefore communicate new input data only in line with the bus cycle.

Fieldbus cycle time

The cycle time of the fieldbus systems is the best-known parameter. It predominantly depends on the baud rate and the protocol efficiency. The Figure “Bus cycle” provides an overview of typical cycle times for some fieldbus systems, depending on the baud rate, the number of devices and the number of data bytes exchanged. Naturally, these calculations are based on several assumptions: For DeviceNet, a bus load of 80% was assumed for pure polling operation. For Profibus, a delay of 0.3 ms was assumed between two cycles (e.g. for accessing the DPRAM). The protocol time constants (e.g. the station response time) for typical devices also had to be estimated.

Master cycle delay/Master firmware cycle

An intelligent fieldbus control interface with dedicated processor has been assumed. This fieldbus master copies the process output image to the slaves via the fieldbus and gathers the input data. The input process image is copied to the DPRAM of the control. For reasons of data consistency, in most implementations the input process image is only copied to the DPRAM of the control once it is complete. In a cyclic fieldbus system, therefore, this only occurs once the fieldbus cycle is complete. Copying of the input data may also be delayed, because initially enabling of the DPRAM has to be awaited. Delay times in fieldbus masters typically range between 0.1 and 3 ms.

Control cycle time (“task”)

The fieldbus performance should normally reasonably match the performance of the associated control. For typical applications, a sensible parameter is the cycle time of the associated control task. For PC-based control systems, task cycle times of well below 1 ms are achieved due to the high performance of the PC processors. This is particularly useful for fast tasks, such as axis control. For typical PLC applications, cycle times between 2... 10 ms are usually chosen. For “classic” PLC solutions, typical cycle times of 10... 20 ms are still common.

Slave cycle delay/Slave firmware cycle

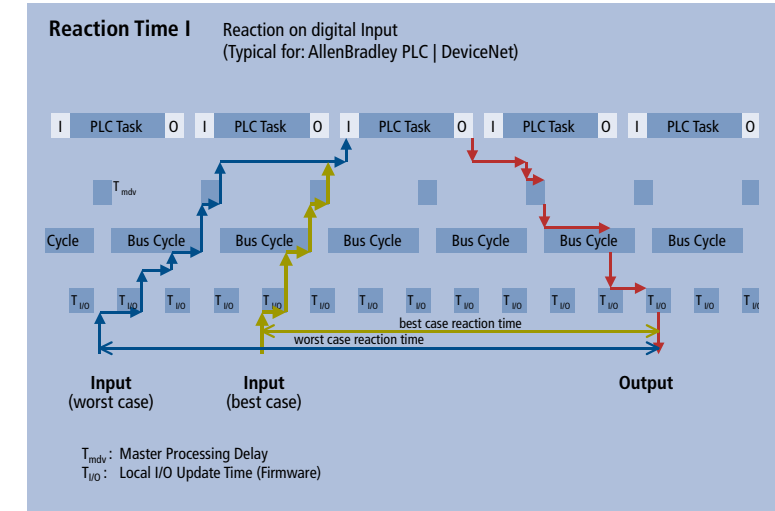
In most fieldbus systems, the slave devices also have a processor with associated firmware. This is polled cyclically by the fieldbus master and then queries the inputs and copies the output data to the outputs. Modular slave devices such as the Beckhoff Bus Terminal system have a local bus that connects the I/O modules with the actual fieldbus device, the Bus Coupler. Depending on the configuration, a complete update can take between 0.1... 2 ms, even with the very fast Beckhoff K-bus. But even for devices with fixed configuration, the local firmware cycle cannot be ignored – the inputs are queried and the outputs updated according to its cycle.

Interfaces: Synchronization or free running

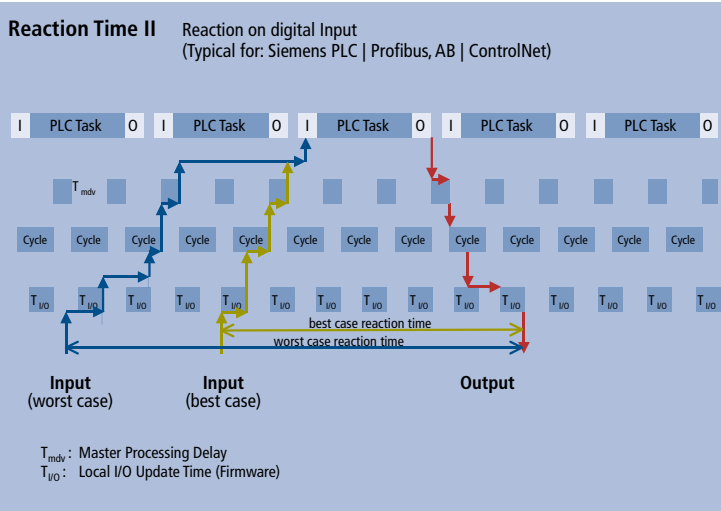
The typical fieldbus system under consideration is a multi-processor system with a large number of interfaces. The programs on the different processors usually run cyclically, in rare cases event-driven (interrupt-driven). The simplest operating mode for the processes is free running: Decoupled via a shared memory area, both cyclic and event-driven processes can be processed largely independent from each other. The fieldbus itself can also be interpreted as a distributed shared memory area. Alternatively, the different processes may be synchronized. For the slave side this means that the firmware cycle or the local bus cycle is synchronized with the fieldbus cycle. The outputs of an I/O module are immediately updated once the new output data is received from the most recent fieldbus cycle. The input data is immediately read by the local slave but not communicated until the next fieldbus cycle. Of particular interest is the synchronization of the fieldbus master with the control. In fast bus systems, fieldbus cycle and control task happen one after the other, so that the control task receives current input data each time. The outputs are written directly after completion of the control task with the next fieldbus cycle. For very fast control tasks (e.g. NC tasks for axis control) or relatively slow bus cycle times, the input and output data can be copied at the start of the control task, and the bus cycle can run at the same time as the control task. In this case the input data is from the previous bus cycle. Therefore, the control task does not have to wait for the current bus cycle to be completed. The effects of the parameters on the response time and the determinism of the system are described below with the aid of various example configurations.

Scenario I: Continuous free running, “medium-fast” bus system

In this scenario, the bus cycle time is similar to the task cycle time. The fieldbus cycle is free running relative to the control task. The local I/O cycle is not synchronized with the bus cycle either. We will now look at the response time to an arbitrary input signal. In the worst case, the input signal changes straight after the local I/O cycle has queried the inputs (or is just passing through the hardware input filter). The system must wait for the next local firmware cycle, until the firmware of the decentralized I/O node has detected the event. However, it can communicate this information only during the next polling of the input data through the fieldbus – in the worst



case it will have to wait for a whole fieldbus cycle. Once the fieldbus cycle is complete, the input information is in the fieldbus master, i.e. in the scanner module of the control. The master copies the data into the DPRAM of the control and then releases the DPRAM – the time required is the master cycle delay. In the worst case, in a free running system the control task will start before the master module releases the DPRAM, i.e. the input data are not processed by this task. It will therefore take another complete control task until the input data in the DPRAM is read and processed by the control task. In the worst case, we also have to assume longest time to write the outputs: The control task does not finish before the start of the next fieldbus cycle. Therefore the master module does not have the most recent output data from the control task. In this scenario an additional fieldbus cycle has to be awaited. The output data is now transferred and just misses the local I/O cycle. As can be seen from the chart, with unfortunate timing the response time in such a system adds up to > 4 bus cycle times or a corresponding number of PLC task times. Even the jitter between ideal case and worst case – a measure of the determinism of the system under consideration – is in the range of 2 PLC tasks.



This shows that, in this case, the system-inherent determinism of the chosen fieldbus can be ignored.

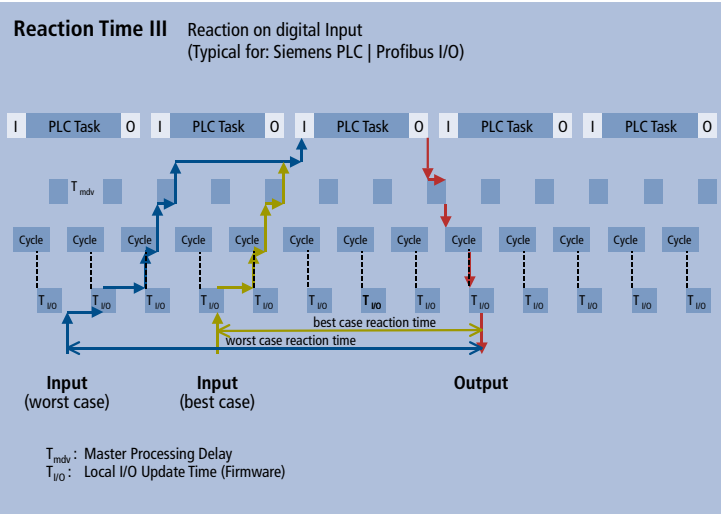
Scenario II: Continuous free running, faster bus system

We will now try to speed up the system through a faster fieldbus: The “medium-fast” fieldbus from scenario I is replaced with a fast fieldbus with only half the cycle time compared with the first case. The complete system remains in free running mode.

A comparison of the two charts reveals that, while the average response time has improved by approximately 20-25 %, the “best case” is the same in both cases. Overall a rather disappointing result, given that the bus was now twice as fast. We also note that the input data of some bus cycles have not been processed – they are overwritten by the next bus cycle, since no task has been started in the meantime. Furthermore, only every second or third bus cycle transports new output data. Whilst the fieldbus is faster, it is partly inefficient.

Scenario III: Master free running, slave synchronized

We will now try to improve the result further by introducing synchronization mechanisms. Initially, the slave firmware cycle or the local I/O update is synchronized with the fieldbus cycle. This only leads to an improvement in the response behaviour on the output side: The outputs are always updated directly once new data have been received. The average improvement corresponds to half the duration of a local firmware cycle on the I/O module. The determinism of the system improves correspondingly.



Scenario IV: Fast bus, fully synchronized

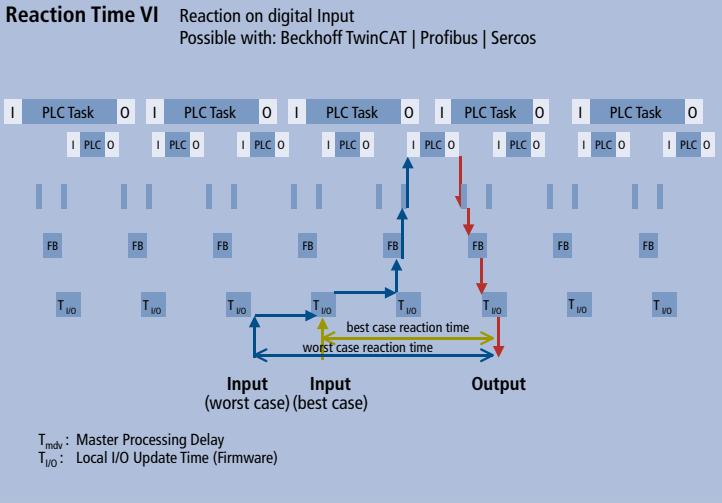
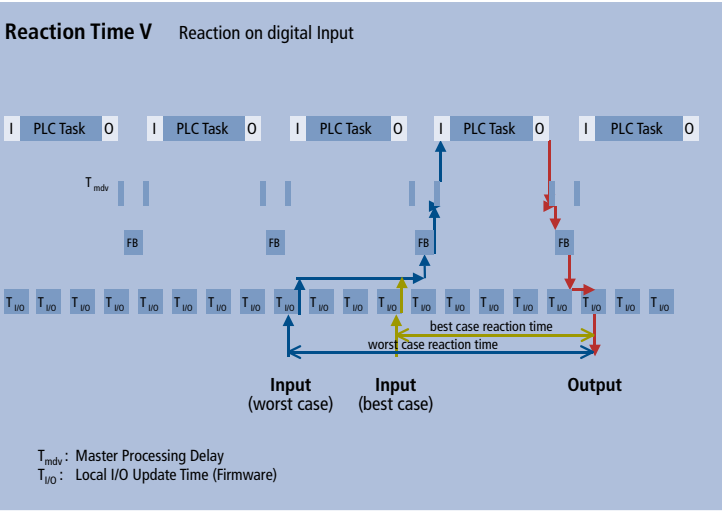
The fieldbus cycle is now also synchronized with the control task. The response behavior on the output side is optimal, the outputs are set deterministically as quickly as possible. Nevertheless, several task cycles (or bus cycles) still pass on the input side, before the input information can be processed. While the determinism of the system is good (it corresponds to the task time), the overall response time remains unsatisfactory. It is also interesting to note that the faster bus (1 ms instead of 5 ms) has done little to improve the response time.

Scenario V: Synchronized on the master side, free running slave

While free running slave firmware (relative to the bus cycle) is slightly disadvantageous on the output side - the input side now also captures information arriving between the “extended” bus cycles. For time conditions as shown in the graphs – task slow relative to local firmware cycle – the response time in particular has improved.

Scenario VI: Multi-tasking system, synchronized throughout

A further improvement of the response time – but mainly of the determinism – can only be achieved by shortening the task cycle time. For a given CPU performance, the simplest way of achieving this is via a multi-tasking control system: The time-critical tasks are programmed in a short task, which is synchronized with the (fast) fieldbus system. All other application parts can then be realized in slower tasks. This scenario offers optimum response times, and at the same time optimum determinism. This is the usual system architecture of the Beckhoff TwinCAT control system.



Scenario VII: Event-driven communication

Up to now, we have considered cyclic bus systems. Some systems – e.g. CANopen or DeviceNet – can also be operated in event-driven mode. In DeviceNet, this mode is called “Change of State”. A change of an input is regarded as an event and is communicated automatically, without request by a master. The results of measurements for a CANopen system with event-driven communication: Despite a comparatively low baud rate (500 kBaud), the response time approaches that of a comparable Profibus system. However, the Profibus system shows this response time for all inputs, while in the CANopen system delays will have to be expected with high bus loading.

Results

A comparison of the different scenarios provides the following results:

- | The performance of a fieldbus-networked control system cannot be determined via a single parameter.
- | The pure cycle time of the chosen bus system is usually secondary. Even for the assessment of the real-time behavior of the bus system, the cycle time is only partly useful: In many cases the synchronization behavior is the crucial factor.
- | In most cases, the cycle time of the control is more important than the cycle time of the bus system: Even with a fast fieldbus, a slow control will not achieve real performance.
- | The following generally applies for the fieldbus cycle time: “Fast enough” means faster than the cycle time of the control.
- | Synchronization initially improves the determinism of the system, but not necessarily the response time.

- | Bus systems with event-driven communication have very short response times.
- | An optimum response time with low jitter can only be achieved by tuning the system. This requires knowledge of the different temporal factors – and a system that permits such “tuning”.
- | A short response time is only one of several criteria for determining the system performance. For many applications, the determinism of the system may be the crucial factor.

Summary

For determining the performance of a fieldbus system, the bus cycle time is only one of many parameters. Other important parameters are the synchronization behavior and the fieldbus firmware cycle times on the master and slave side. Knowledge of the control cycle times is very important for selecting a suitable bus system. Some typical scenarios serve to describe the interrelationships of the parameters. The scenarios prove that the bus cycle time alone can only provide an estimation of the achievable response times and determinism – and thus about crucial real-time characteristics. The synchronization mechanisms of modern fieldbus systems can also be applied usefully outside drive communication applications. A fully synchronized communication system improves the determinism, but not necessarily the response time. The optimum choice or tuning of the bus system always requires an analysis of the real-time requirements: Different parameters have to be chosen, depending on whether the application to be solved is determined by response time or determinism.

→ Martin Rostan, Product Manager Fieldbus Systems



→ The "Special Fieldbus Box" contains the Beckhoff I/O system in protection class IP 67, which was developed as an extension to the Bus Terminal system in IP 20. The robust, fully potted housing enables operation at machine level.



31 | Fieldbus Box modules in action in a continuous casting plant at SMS Demag AG



34 | Waterproof mini-PLC with compact design

Fieldbus Box Module with integrated T-piece



35 | I/O modules with protection class IP 67 for more competitive production at Leonhard Moll Betonwerke GmbH & Co.



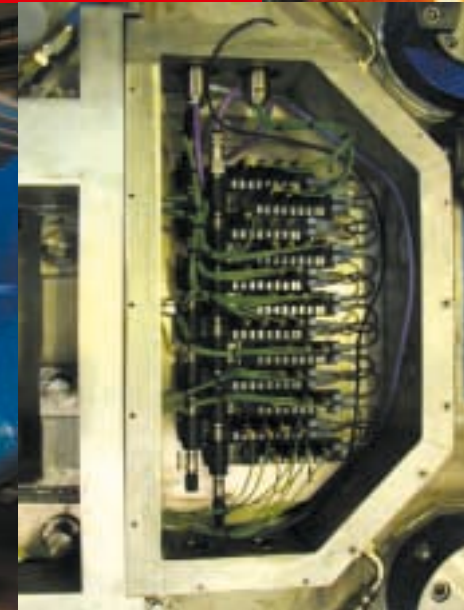
38 | IP-Link interface connects Festo CPV valve terminal to the I/O environment



Fieldbus Box modules in action in a continuous casting plant at SMS Demag AG

Data acquisition for breakout prediction systems

→ SMS Demag sets standards in the introduction of innovative technologies for breakout prediction systems in continuous casting applications. Temperature measurement via thermocouples has proven to be the most suitable and reliable technique. The Fieldbus Box modules in protection class IP 67 offer the basis for safe local signal acquisition.



In the continuous casting plants from SMS Demag, up to 100 thermocouple sensors are connected to the Fieldbus Box modules.

SMS Demag AG, headquartered in Germany, is an internationally leading manufacturer of metallurgical plant and rolling mill equipment. The company has been active for nearly 200 years and develops, constructs and builds machines and plants for the steel, aluminum and copper industries around the world. The range includes both system and automation solutions for the complete process chain, from iron making via steel plant, continuous casting, rolling mill and pipe technology to finishing lines for hot and cold rolled strip.

The continuous casting plants are used for the production of steel slabs that can be further processed into flat steel bars, so-called coils or wires, for example in rolling mills. The steel is liquefied in a blast furnace and vertically poured into a mold. The mold is the first part of a continuous casting plant and is decisive for the shape and first solidification of the subsequent product. The profile is almost rectangular; the length in the direction of production is approximately 1 m. On the inside, the mold is clad with copper plates that are equipped with thermocouple sensors for measuring the temperature.

During the start of casting, the mold is closed at the lower end with a dummy bar head, so that a stable skin can form in front of the plug and at the sides. Once this has solidified, the plug is removed and the slab is turned horizontal via appro-

prate rollers. It is then cut and further processed or transported to a warehouse. During the production, a quantity of steel that matches the quantity removed is continuously poured into the mold. The flow rate must be adjusted in such a way that the bar can form a firm skin in the mold. Notwithstanding the addition of casting flux as a lubricant and the vertical oscillation of the mold there is a risk of the skin sticking to the copper plates and tearing. Approximately 80 % of all breakouts are caused in this way. In order to prevent this, as many temperatures as possible are recorded and evaluated via gradient analysis. If irregularities are detected early, i.e. whilst the affected part of the slab is still in the mold, they can be healed, e.g. by reducing the flow rate.

Data acquisition – yesterday and today

The basis for successful early breakout detection (BPS, Breakout Prediction System) is reliable logging of the up to 100 thermocouple sensors that are located in several rows on the copper plates of the mold. Up to now, the usual method of recording the thermocouple signals was via multi-function couplers. A single coupler was used to record approximately 25 thermocouples, i.e. four such couplers were used in a mold. The sensors were connected with the



System topology and key data of breakout prediction systems

Fieldbus technology:

- | Profibus Fieldbus Box modules with IP-Link extension modules (extremely EMC-safe through fibre optic connection of the extension modules)
- | Protection class IP 67
- | Extremely compact design
- | Wiring of the sensors via pre-assembled cable sets
- | Robust special plug connectors for Profibus hybrid line (fieldbus + supply voltage)

Real-time computer as data concentrator and evaluation system

- | Industrial PC Pentium III, 850 MHz, 256 MB RAM, Profibus interface
- | Real-time extension for Windows NT/2000/XP, 1 ms tic time, jitter $\pm 15 \mu\text{s}$
- | Programming in IEC 61131-3
- | Real-time router with ADS system interface
- | Standard ActiveX interface for visualization, diagnostics and database connection, techniques for accessing process and diagnostic data
- | TCP/IP interface for remote access (network, remote service)
- | Online visualization, online diagnostics
- | Offline diagnostics for thermocouples and fieldbus modules (workshop system)
- | Real-time database for trend analysis and process modeling

multi-function coupler via temperature-resistant master cables. This solution had the following disadvantages:

- | High capital costs for the multi-function coupler
- | High additional expenditure for installation and maintenance
- | Limited diagnostic options

New solution – fieldbus technology directly at the mold

For these reasons, SMS Demag has developed a new data acquisition system, consisting of:

- | Fieldbus Box modules in protection class IP 67 for acquisition and digitizing of the temperature signals
- | Signal transfer via a Profibus network
- | Industrial PC with TwinCAT automation software as a data concentrator

The temperature signals are recorded directly on the mold and transferred via Profibus to the PC control, which is equipped with the TwinCAT software PLC. The signals are recorded and pre-processed in real-time with a cycle time of approximately 250 ms, depending on the configuration of the bus system. The same PC also contains a real-time database that reads the data, detects impending breakouts via appropriate trend monitoring and evaluation algorithms, and initiates countermeasures.

However, in steel production applications, this data transfer system, which has already been the standard in general mechanical engineering applications, is subject to particularly extreme boundary conditions:

- | Ambient temperatures up to 100° C
- | Humidity up to 99 %
- | Aggressive environment through the formation of hydrofluoric acid

All this calls for appropriate installation and protective measures, which have been developed along with the system and checked in test runs over several months. These measures are now successfully used in practice.

The first attempts

The history of the development provides insight into the obstacles that had to be overcome. The first approach to a solution, which mainly focused on monitoring the environmental conditions, consisted of a terminal box with integrated

SMS Demag AG – High-tech for maximum cost effectiveness

The SMS Demag AG was formed in 1999 through the merger of SMS Schloemann-Siemag Aktiengesellschaft and the metallurgy arm of Mannesmann Demag AG. This merger combines two strong partners, whose ranges complement and strengthen each other optimally. SMS Demag AG is a company within SMS AG, the holding company of a group of international systems and mechanical engineering companies that process steel, non-ferrous metals and plastics. The group is subdivided into the sections of metallurgical and rolling mill technology, pressing and forging technology, and plastics technology. In 2001, around 9,700 employees worldwide generated sales of approximately 2.25 billion euros.

→ www.sms-demag.com



Beckhoff Bus Terminals in protection class IP 20 for recording the temperature and the humidity. No further protective measures, e.g. cooling, were implemented. This exercise revealed temperatures of up to 85° C and humidity values of up to 99 % directly adjacent to the mold. A further difficulty was that extremely high moisture levels and, correspondingly, large quantities of condensation water were generated within the terminal box. This was due to the extreme temperature fluctuations within a very short space of time (e.g. directly prior to the end of the pouring process, the water cooling for the bar is switched off, which leads to a short-term temperature peak, followed by the plant cooling down to room temperature).

It therefore was apparent that the next attempt would require measures to ensure ambient temperatures in which the fieldbus technology could survive. The next terminal box was equipped with a sophisticated water cooling system that reliably limited the temperatures to a maximum of 40° C; however, the problem of the condensation water was still unresolved.

Practical, cost-effective and flexible solution

These considerations led to the use of the Fieldbus Box modules, designed in protection class IP 67. With the fully sealed, waterproof modules the formation of condensation water does not affect the safe operation of the data acquisition system. At the same time, SMS Demag implemented a special protective housing directly at the mold, which is surrounded by water for cooling and protects the Fieldbus Box modules from the aggressive hydrofluoric acid.

This system has been used since early 2001 in practice and has so far been installed at Aceria Compacta de Bizkaia S.A. (ACB) in Spain, ThyssenKrupp Nirosta

Picture bottom left: The compact IP 67 modules are integrated into the water-cooled protective housing and thus protected from hydrofluoric acid at the same time.

Picture bottom right: A hybrid cable for bus and power supply replaces the multi-core master cables used in the previous solution.



in Germany and ThyssenKrupp Acciai Speciali Terni S.p.A. in Italy. The multi-core master cables have been replaced with a hybrid cable for bus and power supply. Two special plug connectors that were specially developed for the harsh ambient conditions supersede the fault-prone and expensive multi-function coupler.

Comprehensive diagnostics

The Fieldbus Box modules for recording the thermocouple signals each provide connection options for up to four sensors. Each channel can be monitored individually for measuring range violations (broken wire or short-circuit). These diagnostic functions can be used both during production and offline in the workshop.

SMS Demag developed a suitable diagnostics interface that accesses the variables from the TwinCAT PLC via the standard ActiveX Control interfaces and – after appropriate processing – displays them as process data (temperature) or diagnostic information (Profibus diagnostics, sensor diagnostics).

For the offline test, a system was developed as standard workshop equipment, which also consists of a TwinCAT computer with fieldbus interface and appropriate diagnostic software. It can be used to check all sensors of the dismantled mold. In the event of a thermocouple being faulty, the sensor plug simply has to be disconnected, and the thermocouple removed and replaced with a new one. The same applies for a faulty fieldbus module.

Waterproof mini-PLC with compact design



→ The Fieldbus Box with integrated IEC 61131-3 controller offers PLC functionality in a very small, waterproof and dustproof housing. The programmable PLC Box modules offer versatile application options, for example as autonomous mini-PLC or for distributed intelligent control. The complete range of I/O signals can be connected via the modularly expandable Extension Box modules.

PLC Box with IEC 61131-3 controller for Profibus DP

The PLC Box is very similar to the Coupler Box because both have a fieldbus interface and integrated I/O, whereas the PLC Box includes PLC functionality. The programmable PLC Box modules can be used as autonomous mini-PLCs for the control of parts of a plant or of small machines, and for distributed intelligent control of the I/O signals in complex systems. The separation of smaller application components from the central control provides relief for the CPU and the fieldbus. Decentralized counting, control or switching are typical applications for the intelligent Fieldbus Box modules. With dimensions of only 175 x 30 x 26.5 mm, the PLC Box is extremely compact and is therefore particularly suitable for applications where there is very little space available. The low mass makes them useful for applications where the I/O interface is moved (e.g. on a robot arm). The PLC Box modules IL230x-C310 for Profibus combine four digital inputs and four digital outputs on a single device. The outputs handle load currents of up to 0.5 A, are

short-circuit proof and protected against inverse polarity. The signals are optionally connected via Ø 8 mm snap type connectors or screw type M8 or M12 connectors. The PLC Box device series is currently available for Profibus DP with 12 MBaud. The PLC data are accessed cyclically via DP Data-Exchange or acyclically via DP-V1. Further types for other fieldbus systems are in preparation.

Free signal mix through extension modules

Almost unlimited I/O options are available by extending the PLC Box with the Extension Box modules via the quick and safe IP-Link system. The IExxxx extension modules cover the full range of I/O signals: digital inputs with different filters, digital outputs with 0.5 or 2 A output current, analog inputs and outputs with 16 bit resolution, thermocouple and RTD inputs. The communication modules allow decentralized connection of serial devices such as identification systems. Modules for path and angle measurements as well as encoders and SSI interfaces are in preparation.

The Extension Box modules communicate via a quick and safe optical fiber connection, the IP-Link. "Wiring" is easy and time-saving via plug-in optical fibers. They can either be delivered ready-made or installed on site. Up to 120 extension modules with 504 bytes of input and 504 bytes of output can be addressed directly from the PLC program.

Comfortable programming according to IEC 61131-3

Programming does not depend on the equipment manufacturer, and is carried out with TwinCAT BC in accordance with IEC 61131-3, using the same programming environment as for the TwinCAT PC control system. The program download occurs either via the fieldbus or via the programming interface. Extensive debugging functions (breakpoint, single step, monitoring, etc.) are also available. The Fieldbus Box series with PLC functionality uses a powerful 16 bit controller, 32/96 Kbyte program memory and 32/64 Kbyte data memory. A further 512 bytes of non-volatile memory are available for remanent flags.

Fieldbus Box module with integrated T-piece

Reduce the amount of wiring

The new Fieldbus Box modules with integrated T-pieces bring a significant simplification to fieldbus wiring. The T-piece that used to be necessary is replaced by a second M12-type fieldbus input/output integrated on the module. A further advantage is that this gives the cabling a significantly flatter structure. Straight or angled versions of pre-assembled plugs or field-assembled plugs can be used. The IP 67 modules with integrated T-pieces extend the range of Compact and Coupler Box Module products for the Profibus, CANopen and DeviceNet fieldbus systems.

Product announcement

Estimated market release 1st quarter 2003.
We reserve the right to make technical changes.

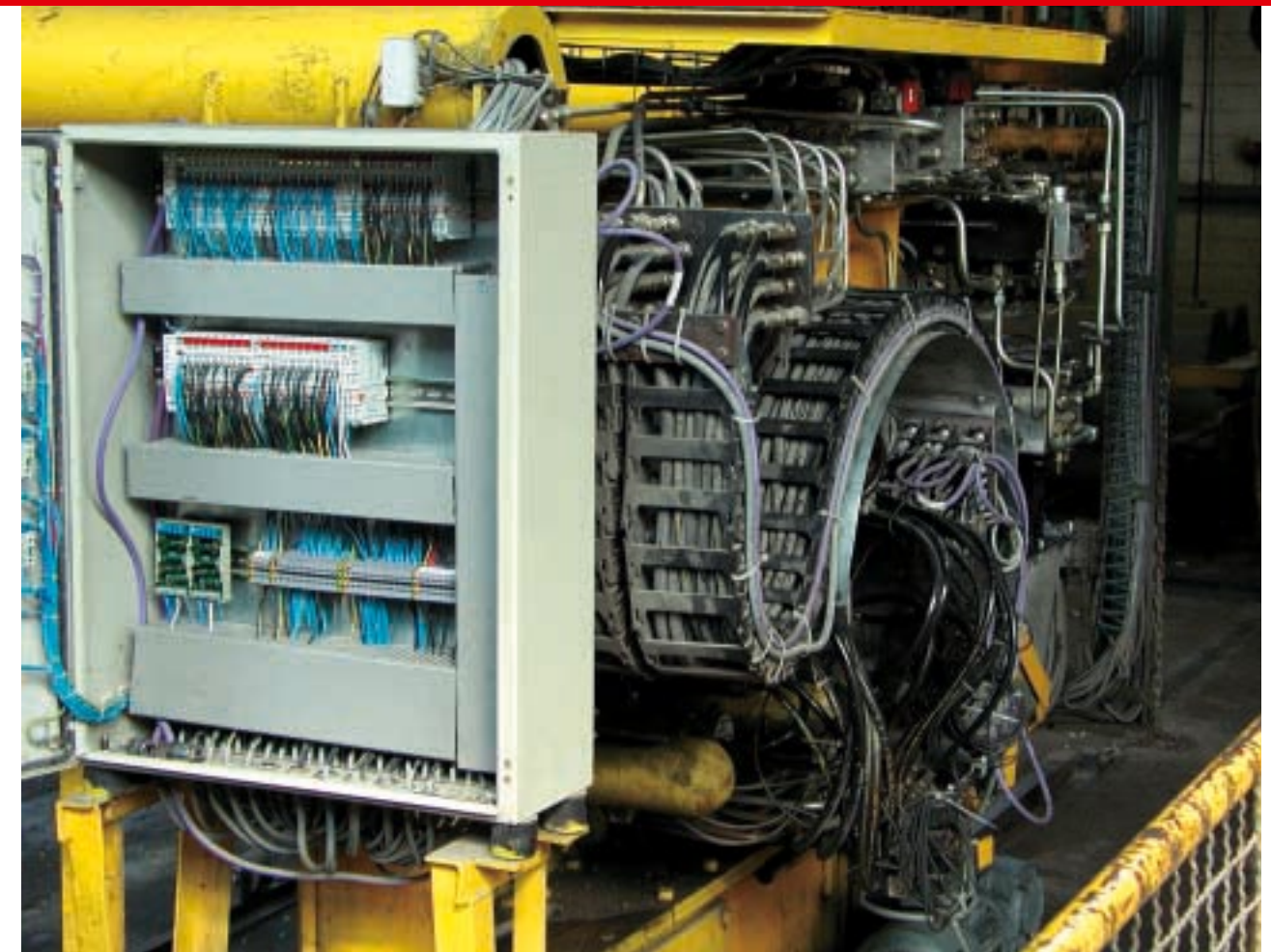


I/O modules with protection class IP 67 for more competitive production

Concrete ties – High-tech product?



→ Control functions in today's automation engineering are moving closer to the sensors and actuators and away from the control cabinet. The fully potted Fieldbus Box modules, in protection classes IP 65/66/67, are ideally suited to this kind of application. The robust and compact I/O modules can be mounted directly on a machine without the need for additional terminal boxes. Leonhard Moll Betonwerke GmbH & Co. is also taking advantage of this in their production plant for concrete ties. The efficiency and the quality of the concrete ties produced could be significantly improved with the PC-based control platform TwinCAT and I/O.



In the production unit for railroad ties, the company Leonhard Moll Betonwerke GmbH & Co. relies on robust and compact fieldbus technology.

The patent for the manufacture of pre-tensioned concrete ties for railroad tracks was applied for by businessman Leonhard Moll – a pioneer in this field – back in 1937. If the railroad technology of those days is compared with that of the modern, high speed world, it is hardly a wonder that the requirements for what might seem to be such a simple product as a railroad tie have risen enormously. The portfolio of tie products includes track and points ties for German railroads, ties for transport services, longitudinal ties for lawn tracks and rail fastening systems. More than 1,000 railroad ties are produced each day at the factory in Braunschweig, Germany.

The challenge of producing concrete ties of high quality and correct dimensions for an optimum cost in a highly competitive marketplace can only be met with the help of automated machinery. Leonhard Moll GmbH's Braunschweig factory has converted completely to PC-based control technology from Beckhoff, in accordance with a decision taken by Dieter Oelmann, the man responsible for control technology. Several Beckhoff Industrial PCs, Control Panels, fieldbus components in protection class IP 20 and IP 67 and the automation software TwinCAT are being used. Leonhard Moll made the decision to use the "copper version" of Profibus DP at 12 Mbaud for the fieldbus system.



More than 1000 railroad ties are produced every day at the factory.



The man responsible for the control technology, Dieter Oelmann, uses Beckhoff automation components.

The facility involved is actively engaged in production, so automation is taking place continuously. This means that relatively simple modules such as material acceptance are automated and then integrated into the Profibus network.

The production of concrete ties has little connection with concrete pouring as is done, for instance, for the foundations of a single family house; we are dealing here with cost-optimized series production of the various tie types. A distinction is made between different manufacturing processes: in contrast to "late demolding", the factory in Braunschweig makes use of "immediate demolding".

As the name might suggest, in this process the concrete tie is taken out of the mold immediately for further handling, without having to wait for long drying times in the mold. This makes it possible to work with a limited number of molds, and these move cyclically through the production process. One disadvantage, however, is the effect often seen when building sandcastles: If the mixing ratios are not 100 % correct, the tie can either not be removed from the formwork, or it collapses. With an average weight of 300 kg, and a length of about 260 cm, the demands placed on the mixing process and therefore on the control technology are indeed high.

The IP 67 I/O components are particularly well suited for rough industrial environments.



Distributed I/Os directly on the machine

Production begins with delivery of the basic materials: cement, sand, stone chips, water and diabase (broken granite). An average 450–500 ties are produced in each shift, so that 150 t of material are moved. The elevator controller and the scales, which have a BC3100 Bus Terminal Controller with a Profibus interface, transport material to the mixer. At the same time so-called matrices are drawn into the molds. These provide the necessary hollows into which the tensioning steels with their cut threads will later be located, giving the concrete tie its final strength. The molds are then passed to the formwork removal machine. A cover is placed on, and the mould is turned over.

The concrete factory's control engineer, Dieter Oelmann, decided that Fieldbus Box Modules from Beckhoff would be fitted locally. The compact, fully potted modules might almost have been designed for this application. Very tough ambient conditions and heavy exposure to dust, water and oil require particularly robust devices. Eight Fieldbus Box modules, each having eight digital 24 V DC inputs, are fitted here directly on the machine. M8 connections with pre-assembled sensor cables were selected so that the wiring could be implemented as securely as possible.

Efficiency and quality improved

After removal from the molds, the ties are given the correct dimensions. The dimensional tolerances are ± 1.5 mm outside and ± 0.5 mm inside; hardly what one might imagine for a "simple" concrete tie. After adjustment the ties are transported by means of a high rack storage and retrieval device to the drying stores, where they will remain for 24 hours. A distributed Profibus Bus Terminal Station is used here again. It is wired through a 50 m long power supply chain, using a cable suitable for use with drag chains. In the subsequent final assembly area the tensioning steels are inserted and the final tension of 80 kN is applied. When the ties have finally been sealed, they are moved to the external stores.

The test laboratory is involved throughout the production process to ensure

consistent quality. The raw materials, finished concrete, dimensional correctness and much more are all inspected. Acceptable limits specified by the company are a great deal tighter than those required by the various official standards. In the TwinCAT system and fieldbus components from Beckhoff, the company, which is certified to DIN ISO 9001, is relying on a technology that is both innovative and yet well proven. Over recent years it has been possible to improve the efficiency and quality of the delivered products while reducing costs at the same time. Concrete ties – a high-tech product? That is a moot point. What is clear, however, is that more is involved than we might first think.

→ Leonhard Moll Betonwerke GmbH & Co.
www.moll-betonwerke.de

Reinforcement for fieldbus marketing

Dipl. Ing. Dirk Bechtel studied electrical engineering at the Technical College in Bielefeld, Germany. Following his thesis on the subject of handheld computers, he worked in the area of portable operating terminals for four years. For the last 10 years, he has worked in international product management and marketing for industrial fieldbus technology. His activities



ranged from proprietary systems to the currently market-leading Profibus. Since January 2002, Dirk Bechtel looks after the fieldbus marketing and, as "IP 67 specialist", particularly the Fieldbus Box modules at the Beckhoff headquarters in Verl. With these compact units, Beckhoff opens up applications that could not be served optimally with the existing IP 20 Bus Terminal solution.

IP-Link interface connects Festo CPV valve terminal to the I/O environment

A great leap to system diversity



Usually, combining and integrating valve terminals with I/O modules requires a lot of work. Thanks to the new Festo CPV valve terminal from Beckhoff with its integrated IP-Link interface, the task is no longer a problem. The CPV valve terminal allows merging of pneumatics and electronics in less space, is easily programmed and requires minimal installation work thus saving money.

The CPV valve terminals are optionally available in 10 mm (CPV10-VI-IP-8) and 14 mm (CPV14-VI-IP-8) sizes



The professions of electronics engineer and fitter used to involve quite different kinds of work. Today the two professions work seamlessly hand in hand, forming the basis for machine design, and indeed providing the conditions in which machines and plant can be constructed successfully. The new profession of the “mechatronics engineer”, combining electronics and mechanics, underlines this trend, and is closing the gap. A comparable synergy is arising from the combination of pneumatics and intelligent fieldbus electronics. In the past, valves were almost exclusively connected directly. Nowadays many valve manufacturers are offering what are called “valve terminals”, often already being fitted with directly integrated fieldbus connections. Nevertheless, typical applications still face the constructor and designer with the difficult task of fitting together distributed peripherals, including the pneumatics and a wide range of I/Os, in a way that is compact, economical, easily serviced and provides facilities for extension. Flexibility in the choice of fieldbus is a further requirement.

Pneumatics and I/O technology united
With the new CPV valve terminal with IP-Link interface, Festo AG & Co. and Beckhoff have together pursued these system considerations all the way to a conclusion. The integration of the valve terminals in the Beckhoff Fieldbus Box system offers the user several hundred different I/O combinations, capable of handling almost any application. The Festo CPV Direct Valve Terminal (Compact Performance) offers everything that the user of modern valve systems expects: It is extremely compact, robust, optimized for cost and has been tested a thousand times. Up to 8 bistable valves can be controlled. Even applications that necessitate short switching times can be implemented, thanks to the small distance between the valve and the actuator. The low weight, furthermore, means that they can be fitted in almost any location. The long service life and short down-times complement the other features. The mature I/O and fieldbus technology, meeting protection class IP 65,



→ Festo AG & Co.
www.festo.com

“Success factors for the development of a small mechanical workshop to a world leader in technology”

Over more than 75 years of the company’s history, Festo AG & Co., whose headquarters are in Esslingen, Germany, has developed into one of the leading suppliers of pneumatic components and systems. In 176 countries around the world more than 10,000 employees look after more than 300,000 customers. 2,800 patents underline Festo’s claim to be technological leaders in the valve terminal and system sector.

We asked Dipl.-Ing. Rudi Menrad, Member of the Board, Sales Management at Festo AG, Esslingen, to comment:
Every company once had a small beginning. But in Festo’s case there are few special points. Both the owners recognized at an early stage that pneumatics, which in those days was a new field of technology,

needed to be made more accessible to their customers, and formed Festo Didactic in order to have the capacity to train their customers. In contrast to its competitors, the company has continued to reinvest its financial yield, not just into further development but also into the 52 direct marketing companies that are now operating around the world.

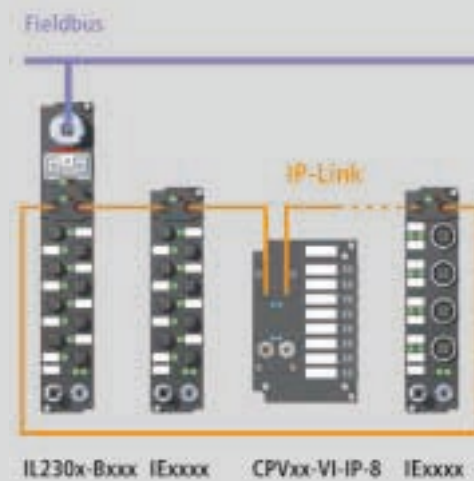
Our philosophy of presenting ourselves to customers as complete suppliers is a further important point. The focus here is placed on technology, quality and innovation. This means that the company must embody a great deal of knowledge. Nearly all our field service staff, and more than 25 % of the entire workforce are engineers. On top of this, we invested very early in electronic data processing, and standardized the most important systems around the world.

Emphasis is furthermore placed on high production depth and competence in our production departments. And, last but not least, we handle 75 % of our customers’ orders on the day they arrive. For this purpose we have a most effectively functioning logistics center at Rohrbach, in the Saarland region.

(Reprinted from KEM, dated 08/2002)

Dipl.-Ing. Rudi Menrad,
Member of the Board, Sales Management
at Festo AG & Co.





Typical circuit diagram of the CPV
with IExxxx Extension Box modules



is integrated in the CPV Direct over the IP-Link interface. The direct integration of IP-Link is thus an extension of the existing valve terminals. This compact interface contains the IP-Link inputs and outputs, as well as the power supply and downstream power feed. The development, which involved a close co-operation between Festo and Beckhoff, was carried out in response to the demands of the market. The full extent of the Fieldbus Box range is available to the user: 9 different fieldbusses, 25 different signal types and up to 3 different methods of connection provide the appropriate solution for almost any application. Conceived as an I/O system for distributed use, the robust Fieldbus Box modules can be used directly on the machine or plant in wet, dirty or dusty environments. With the Coupler Box as a fieldbus station, up to 120 extension modules can be connected via IP-Link. The IP-Link system is an internal communication connection, transporting the data for individual devices quickly and reliably over optical fibers at a transmission rate of 2 Mbit/s.

Full integration in TwinCAT

The valve terminal from the CPV Direct series is easily inserted into the Fieldbus Box system, like an analog Extension Box. It is integrated into the TwinCAT automation software, and behaves like an analog module with 16 output bits in compact mode, or with 24 input and output bits in complex mode.

Just like the Extension Boxes, the valve terminals can be located up to 5 m apart. Both the IP-Link signal and the electrical power supply can conveniently be wired as a ring. No special configuration is required in the system integration, because the Coupler Box automatically recognizes the modules. The Coupler Box appears, from the fieldbus point of view, along with all of the networked extensions, as a single participating bus device with a corresponding number of I/O signals. The direct combination of pneumatics with fieldbus and I/O diversity opens previously undreamed-of benefits and applications to the user. Reduced cost and wiring radically decreases installation time and other downtime. Distributed machine units can be implemented quickly and reliably. The wide range of I/O components ensures high modularity, so permitting cost-optimized plant construction. Because the number of fieldbus nodes decreases, programming and commissioning are greatly simplified. For all these reasons, the use of the CPV Direct Valve Terminals with IP-Link interface increases the competitiveness of machines and of plant.

i Product announcement Estimated market release 1st quarter 2003.
Valve terminals obtained from Festo AG & Co.
Fieldbus Box modules obtained from Beckhoff.
We reserve the right to make technical changes.

The compact Industrial PC with fast access time

- High computing power
- Pentium 4 processor
- 7-slot ATX motherboard
- All connections at the front
- Fast access to the components



The Industrial PC for optimum space utilisation in the control cabinet

The Industrial PC C6250 is designed for installation in control cabinets. Together with a Beckhoff Control Panel as operating unit, it offers the ideal combination for a powerful controller. The PC from the highest performance class is easily accessible and contains all connections at the front.

- Pentium 4 processor of the latest generation with 533 MHz bus and DDR RAM
- 7-slot ATX motherboard with up to 220 mm long plug-in cards
- CD/DVD-ROM, CD-RW or DVD-RAM drive available as floppy drive alternatives
- Horizontal or vertical installation possible

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



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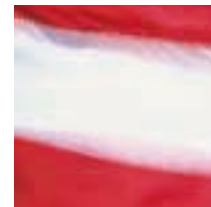


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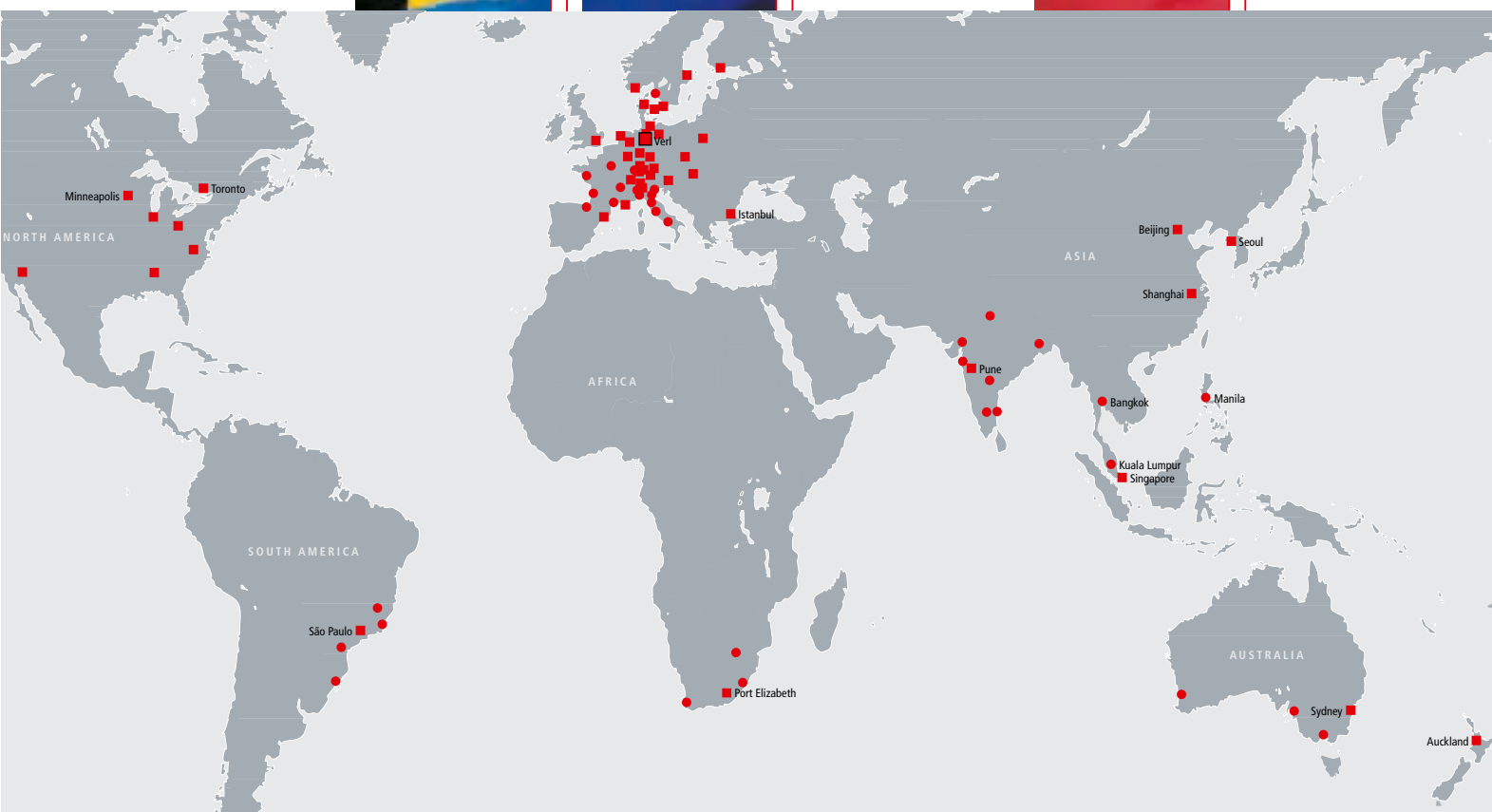
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New partner sells products in the Czech Republic and in Slovakia, page 61



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Over the last five years nearly all the assembly lines in the engine assembly area at the VW factory at Uitenhage in South Africa have been converted on the basis of PC-based control technology from Beckhoff. There are also TwinCAT controlled lines in final assembly and body shop. So far, more than 20 TwinCAT licenses and about 6000 I/O have been installed at Uitenhage. This ensures correct process reliability and data warehousing of all production processes.



High end Industrial PCs control the Volkswagen South Africa assembly lines in South Africa

PC control for Polo engine production

The latest production line to be added to the Volkswagen plant is that of the PQ24 Polo, a light passenger vehicle. At present the Polo is being produced for the South African market and for export to Japan. Beckhoff's partner, Jendemark Automation, was responsible for the automation and process control of this new production line in which the engines, sub-frames, rear-axles and front struts are all assembled. The general aim for the design of the control system was a scalable, reliable system that could link the entire production set-up into a single control network. As a result, a control architecture emerged in which sub-systems operate independently of one another, but are linked together and guarantee precise process execution through their flexibility. The controller system is optimized for process reliability in production, and for machine control while incorporating data collection and sub-systems tracking.

Seven Beckhoff Industrial PCs series C3330 and C3350 control the production lines via Lightbus and Interbus components. TwinCAT PLC is the controlling software, and has interfaces to Visual Basic via TwinCAT ADS, and using Microsoft SQL Server as database. The TwinCAT programming environment was used to implement software modules that have been specially customized to meet Volkswagen's requirements.

Data transfer via fibre optic

The I/O data required to control the conveying systems, special purpose machinery, bolting and press fit systems is transferred across the entire assembly area reliably and rapidly on the Beckhoff Lightbus. The Lightbus ring passes through a series of Bus Terminal stations with their associated digital, analog and serial I/O terminals. In order to minimise downtime and to assist the traceability of faults, any fault that occurs within the entire fieldbus network is automatically rectified, logged and reported using the special functions that are integrated into the PLC code. Interbus provides the connection to the user interface (HMI) and to the electronic bolting spindles that are used when assembling the components.

The individual assembly stations are situated on a conveyor system that feeds the assembly line with pallets. The pallets transport the parts for assembly, and are fitted with RFID (Radio Frequency Identification Device) transponders that follow the route of each single part down the entire line. All the information relevant

Volkswagen South Africa

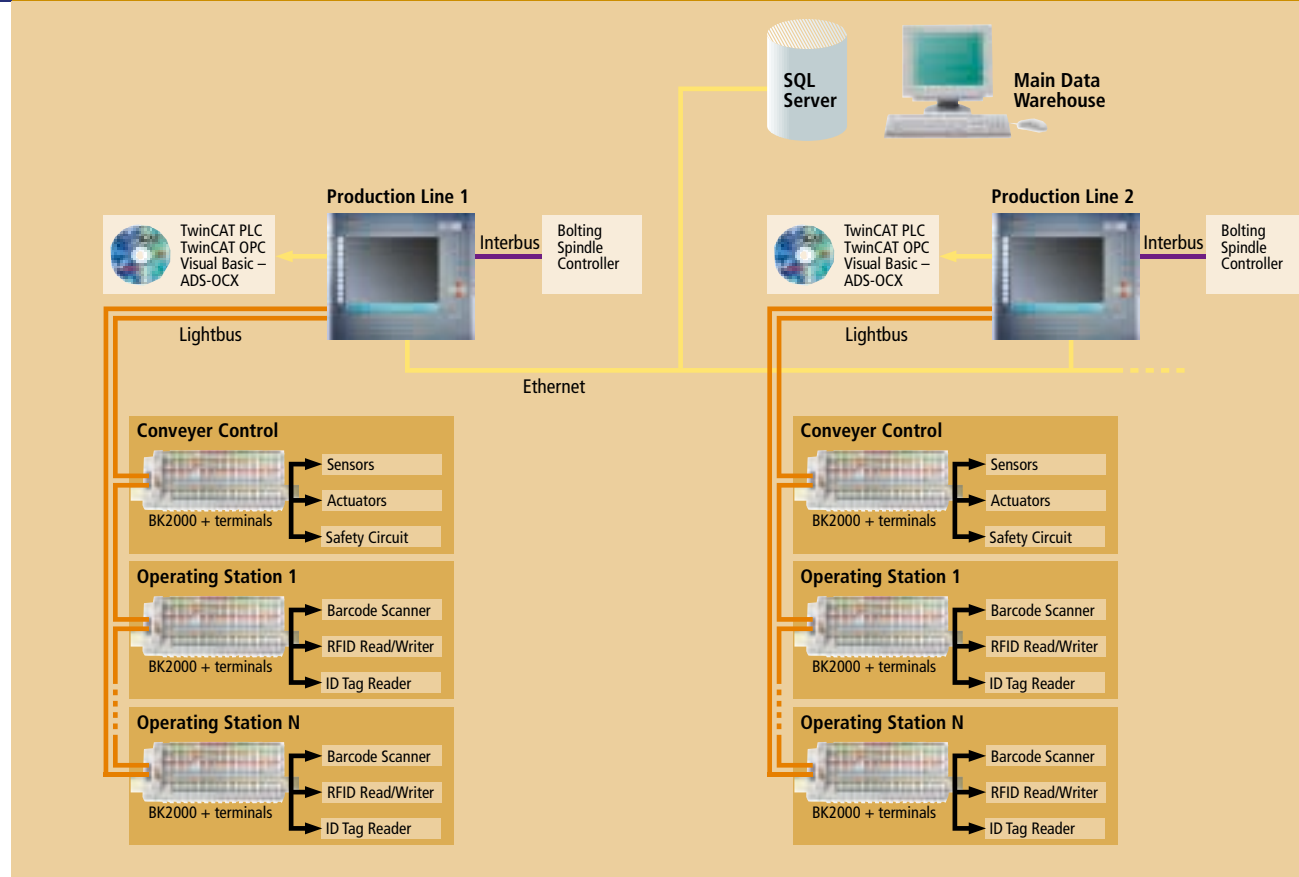


Formed in 1946, Volkswagen of South Africa can be found on the outskirts of the industrial town of Uitenhage, 35 kms from the Indian Ocean of Port Elizabeth in the Eastern Cape province. Volkswagen South Africa has come a long way

since the first Beetle rolled off the line on August 31, 1951. As one of seven passenger car manufacturers in South Africa, the market share has more than doubled since the mid-80's. As the largest foreign employer in South Africa, Volkswagen

employs 5,500 workers and more than 2,500 suppliers, plus a national network of 152 Dealerships.

→ www.vw.co.za



to a particular part can be obtained through the transponder from the SQL database, so that any necessary assembly information can be read at the pallet. The transponder readers are connected directly to the Bus Terminals, and achieve a very high data transfer rate since the data is transferred over Lightbus. Any station can thus obtain production-specific information such as set points, identification and variant information for the part that is about to be processed. If a new variant or a new specification comes into use for a line, it is not necessary for every station to be supplied with the program changes. In this kind of production field, which is subject to continuous change, scalability is an important factor.

Database-supported part tracing

The work proceeds as follows: The new engine is introduced on a pallet at the start of the assembly line. The serial number is detected using barcode and barcode scanning technology. This number is stored in the database and associated with the transponder number on the pallet. As soon as the pallet arrives at a new assembly station, the transponder is read, and all the necessary information is requested. The ID of the operator is checked against the database for security reasons, and approved for the operation if authorized. The working stage can involve any number of fitting and assembly techniques. The TwinCAT PLC reports all the

resulting data to the SQL Server for permanent storage, and is checked for integrity and validity. Only when the planned stage of manufacture has been completed does the system allow the part to be transported on to the next station. At some stations the pallet is supplied with additional sub-components; barcode-scanning technology is used again here. The serial numbers of these parts are then associated with the engine, which is the master part, and the transponder number. This co-ordinates all the information, and permits traceability of the data from the individual sub components up to the completed assembly.

User interfaces (HMI) are provided at every station in order to assist processing. They provide the user with instructions for each working step, and ensure that the correct procedure is followed for each variant being built. The HMI also displays process results and statistics. If a station detects the ID of a supervisor, the HMI will provide a supervisory interface to the production line, so that, if necessary, the system can be halted, or a parts shortage can be recorded in the database. This may be in order to trigger further action, or may be for report purposes.

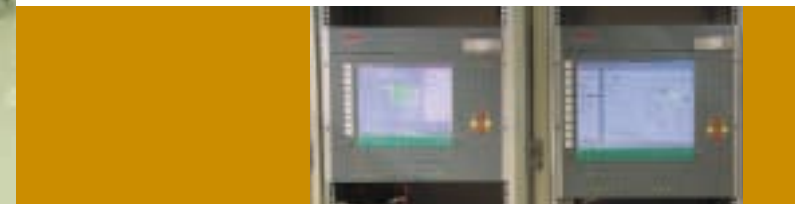
The data available on the server permits performance assessments in respect of downtimes – including their reasons, and the persons responsible – assembly statistics and complete assembly reports regarding every item built on the line. This data is made available through the powerful TwinCAT PLC Software, and is prepared and displayed for the relevant station by means of Visual Basic applications. These applications have interfaces to the database, and permit authorized staff to manage line operations, performing tasks such as assigning rights to the operating personnel, specifying shift and cycle times, and setting the control parameters for production.

Wonderware Intouch, linked with TwinCAT via the OPC Server, is used as the SCADA System. The SCADA package provides maintenance staff with an overview of the active processes on the production line, and also provides access for the execution of defined maintenance functions to control the line with the aid of the easily operated 19 inch built-in IPCs.

Uniform coding standard

The PLC coding is based on the IEC 61131-3 coding languages, as used throughout the entire Volkswagen concern. Volkswagen's maintenance staff have now received training in the individual programs, so that all the functions relevant for this system are properly understood. By combining the structured coding, careful fieldbus layout, safety mechanisms, data collection and distribution, database connectivity and process reliability in a single system, you start to realize the capabilities that are presented to you by PC control.

The new PQ24 product line represents a leap in technological quality for Volkswagen South Africa, and illustrates the capacity and flexibility of Beckhoff's distributed fieldbus systems and PC controller technology.



Jendemark Automation, South Africa

Based in Port Elizabeth, Jendemark Automation is a leading turnkey solution provider to the Automotive, Tanning, Pharmaceutical, Food and Beverage and Packaging Industries. With thirteen years of Turnkey Projects and Special Purpose Machinery experience, Jendemark is able to provide production lines to export orientated customers. They

have become one of the leading suppliers of PC-based automation solutions. Their major automotive customers include Volkswagen, BMW, ZF Lemforder, Daimler Chrysler and Ford, Fresenius Kabi. Lately their involvement has extended into the fast growing and competitive exhaust manufacturing and catalytic converter market.

Jendemark's projecting capability encompasses conceptual and final

design, manufacture, assembly, software engineering, commissioning, training and after sales service. As Southern African agents for a number of international companies, Jendemark has a successful component sales and marketing team with representatives countrywide. Their Technical Training facility completes the circle of service provided by Jendemark Automation by providing training courses on all the products that they resell including Beckhoff TwinCAT training.

Jendemark Automation was formed in 1989 by the current managing director, Gary Klare and is co-owned by the operations director, Quinton Uren and the technical director, Duane Orton. Since its inception, Jendemark has grown from 2 people in the beginning days, to over 80 employees today.

→ www.jendemark.co.za

Industrial PC controls production at Leoni cable manufacturing plant

Competitive through the latest automation



Until 10 years ago, most mains connection cables were manufactured manually. Since then, the majority of manufacturing has been shifted to low-wage countries, where wage costs are more than 17 times lower than those in Europe. Leoni CWA Cable in Hasselt, Belgium, represents an exception. Their production capacity for mains connection cables is still relatively large. This plant can hold its place against the competition because of advanced automation and rising productivity.

The production at Cable and Wire Assemblies in Hasselt can remain competitive thanks to more and more powerful automation. The factory in Belgium is the largest producer of electric razor cables in the world.

A mains connection cable consists of a plug, a cable and an appropriate socket for connection to a specific device. The plugs may be standardized for particular countries, or even for groups of countries, but electrical devices – whether toasters, razors, televisions, PCs or washing machines – have connections that are specific to the make, or even to the particular model, which means that there is a very large number of different mains connection cables. Automation of the manufacturing process for this essentially simple product calls for a large number of relatively complex handling operations: The cable must be cut to the correct length, outer cladding removed and insulation stripped from the conducting wires, the loose pins, or a bridge with pins, must be fixed to the conducting wires by soldering or clamping, and the housing must be molded around it in two further working steps. This is followed by a number of tests and checks, because an extension cable must be safe, and may well have to accord with the safety regulations applicable in particular countries.

Higher quality in spite of falling prices

The drop in prices in the cable manufacture sector of the market has been extreme: Whereas a cable cost 0.50 EUR about 20 years ago (which corresponds to about 1.50 EUR when converted to today's prices) the same cable is now sold for less than 0.30 EUR, although the requirements for quality have risen sharply. Thanks to ever-increasing automation that is able to hold the price at the same level while ensuring uniform quality of the highest class, production at Leoni CWA Cable is still competitive. In co-operation with Multiprox, Beckhoff's partner in Belgium, Leoni's technical management decided in favor of an automation concept based on the software PLC/NC TwinCAT, and for automation components from Beckhoff. The first production equipment was converted to use Beckhoff components in March 2000, and the third machine is already being fitted in the same way at the moment.



Continuous optimization of the machines

The production site in Hasselt can look back over many years of tradition in automation. Until 1990, the factory maintained a large internal development department for the construction of the machines. Nowadays development is carried out in co-operation with suppliers, while the construction has entirely been handed over to other companies. The automation concept is developed, and certain particular adaptations are carried out, by the company's own engineers. The factory in Hasselt has 10 production units, which start with the manufacture of a cable and take it up to the fully processed mains connection cable. Part of the manufacturing work must still be carried out manually for a few types of cable. It is planned that the machines will systematically be automated further, so that a dark room production unit will be achieved.

The oldest machines reached the limits of their development capacity two years ago: The capacity of the PLCs was too small, and not enough I/Os were available. The expansion that was then on the agenda called for comprehensive modernization, one reason for which was the fact that the electrical cabling was becoming more and more entangled and difficult to comprehend. At the same time the number of suppliers for machine parts was reduced.

Less for more

The decision in favor of TwinCAT as a replacement for the proprietary controllers was reached on the basis of a comparison of the price/performance ratios. An Industrial PC with a software PLC is cheaper than a conventional PLC offering the same facilities. Further advantages include the rapid, reliable transfer of data through optical fiber over the Lightbus system, and the flexibility of the Beckhoff Bus Terminals. TwinCAT, furthermore, itself offers short cycle times for the transfer of data over the fieldbus, so that a pulse generator on the machine (100 pulses in 1.5 s) can be directly read via one input without the need for special count-



Some examples of mains connection cables.

LEONI Cable Assemblies (Belgium) NV

Leoni CWA Cable was founded in 1964 as a division of Philips for the manual production of mains connection cables. In 1990 this division was turned into an independent company, Cable and Wire Assemblies, and was taken over in 1998 by Leoni, a German group specialized in the production of cables and wires, and which can look back over 400 years of company tradition. Leoni operates six factories in the mains connection cable sector, which is a sub-division of cable production: Two are in China, and there is one each in Brazil, Morocco (a subsidiary of CWA), the Czech Republic and Belgium. The largest production capacity however is still located in Hasselt, Belgium.

Since the beginning of the 1980s, production in Hasselt has been automated, and has specialized in the manufacture of larger series (piece counts of between 5000 and 10000) of cables with “category 2” connecting plugs. Hasselt is the largest producer in the world of spiral cables for electric razors. The production of “power plugs”, in which a 220 V to 12 V conversion facility is integrated into the plug, will begin soon. A total of about 1.5 million cables of all types are produced each week. With 200 employees, the annual turnover is 37.5 million EUR.

→ www.leoni.be



The robot, controlled by two Beckhoff servoamplifiers, installs the cables within the spray lines.



er cards. The PC controller is programmed in accordance with the IEC 61131-3 standard. Every machine fitted with TwinCAT has a Beckhoff Control Panel. Operation is easy to understand, so that fault finding on the machine has become much easier and faster. Downtime is thus reduced to a minimum. The extensive and flexible possibilities for further expansion are yet another advantage. Expansion of the system with additional fieldbus devices can be done quickly with an additional PC card.

Integration of axis control

A robot developed by Leoni themselves is planned for the new project. It has two degrees of freedom – longitudinal and vertical movement. Its purpose is to accept the mains connection cables that have been prepared in the previous stages and to apply the pins to a positioning plate. This plate is then pushed into the injection nozzle by means of a conveying system. This allows the molding of the plug to be integrated into the automatic production process. Because it is necessary for the robot’s movement to be controllable both in height and velocity (fast movement followed by slow positioning at the precise position), it is not possible to use linear pneumatic elements here, but only axis controllers with servomotors. The AX2000 servoamplifier and servomotors from the AM2000 series offering 8 Nm, 3,000 rpm, and having permanent magnet rotors and built-in resolvers are used.

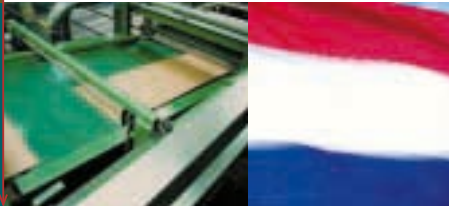
Leoni have preferred the Beckhoff solution also for the motors, drives and the NC software necessary on the PCs for control of the robot movement. The TwinCAT NC PTP software can run on the same Industrial PC (Celeron 700 MHz, 64 MB SDRAM) as the TwinCAT software PLC, resulting in a machine controller that is both economical and yet very powerful. The decision was taken to use the Lightbus again for communication between the PC and the drives, as well as for the I/Os.

Theoretically, the Beckhoff NC controller can control up to 255 axes with an Industrial PC. If the NC communication is given precedence, above, for example, the PLC tasks, then the fastest task can be executed within a cycle time of 50 µs. The IPC used only requires 13 µs to process each axis.

→ www.multiprox.be



→ Cardboard production is generally a mature technology. Gains are only made through improvements in logistics, and above all through rapid processing with no malfunctions. One of the most awkward bottlenecks is represented by the interface between the actual production unit and the stacking and transport facilities.



Universal Corrugated bases stacking device on Beckhoff technology

Software PLC takes center stage

Universal Corrugated B.V. are specialists in delivery appliances and systems for sheet goods found in the corrugated board and cardboard markets. Universal, whose headquarters are in Almelo, Netherlands, was founded in 1957, and is a subsidiary of the German company of MINDA Industrieanlagen GmbH. Sales manager Ad Jongmans knows how centrally important his systems are: “If only the tiniest thing goes wrong in our equipment, the whole production line jams.” Thanks to a range of innovative developments, and through the use of the TwinCAT software PLC, Universal have achieved a leading position in their sector, with a market share of between 10 and 15 %.

Stacking the individual sheets of cardboard as they are cut from the roll is not, in itself, problematic. The sheets slide up to a stop on a table that is gradually lowered. In the past, the sheets were temporarily held on the conveyor by hand, and the stack was removed, at which point the table returned to its original height. At speeds of up to 400 meters a minute, human intervention is both impossible and undesirable. Universal have developed a special system in which the rear of the first sheet of a new stack that is to be formed is held in place by a vacuum strip. The sheets of the new stack continue to move on at a low velocity, held in place by the vacuum strip moving along with them. This makes it possible to empty the table that is located behind them, and to bring it back into position. In order to prepare for the action of the vacuum strip, a braking stage is installed before the stacker, which causes the sheets to lie over one another like roofing tiles.

Determining the exact moment at which the vacuum strip should begin to act presents the automation engineer with a difficult task. Picking up a sheet too early or too

late leads to incorrect job sizes. Because jobs sizes are tending to shrink, changing the product within a few minutes is now more the rule than the exception.

Up to 250 job changes per shift

The stacking system represents an important element within the whole production line, starting at the cardboard machine itself and finishing in the temporary stores. So that the job change and the activity of the vacuum strip are properly synchronized, the first steps are carried out well before the stacker itself. Sensors are attached to the cutting machine and to the subsequent conveyor to follow the process. Software engineer Johan Oude Wesselink: “A signal is passed from the cutting machine to the stacker at every job change. As well as indicating the time at which the rear of the first sheet from the new order passes the vacuum strip, dimension data is also transmitted, so that the stop bar is brought to the correct position at the correct moment.” This information is passed on to the equipment that transports the stack away to the intermediate stores. No monitoring cameras are used in the system. The process is followed by electronics alone.

Ad Jongmans likes to compare today’s technology with the traditional, manual procedure: “The docket that used to be given to the cutting machine along with a job has been replaced by an electronic “docket” that follows the progress of the job millisecond by millisecond. This electronic production note is entered in preparation for the work, and passed on to the other devices that do further processing at our parent company, MINDA.”

Because of the increasing speed and the reducing size of orders, the number of job changes is very large. In the most convenient cases, a job takes several minutes to pass through, but there are also machines that undergo 250 changes within 8 hours. The job change, including the formation of a more slowly running stack with the aid of the vacuum strip, takes a few seconds to occur, so that a fast job change means that a temporary stack is formed and then removed. Error-free communication within the production line is essential for smooth operation.

From relay to software PLC

Until 1986, this system was controlled by relay technology. The various types of hardware PLC then followed. Because of the large quantities of data that must be processed in a very short time, and the ever increasing production speed, Universal changed to the DOS based S2000 from Beckhoff, one of the first software-based PLC systems. They were supported in this project by IAL, Beckhoff's exclusive partner for the Netherlands.

The change to TwinCAT, running under Windows NT, took place five years ago. This control software is particularly suitable for transferring large quantities of data. A Control Panel with a touchscreen has taken the place of the traditional monitor. The display was programmed in Visual Basic by Universal's engineers.

Fieldbus quartet: Profibus, Lightbus, AS-Interface and Ethernet

Data is communicated between the stacker's Industrial PC and the machines in front of and behind it through Ethernet carried by optical fibers. All-plastic fibers are used for shorter links (up to about 30 meters), while "true" fiber optic cable is used over greater distances. The frequency controllers are operated via Profibus network, which can also be used to calibrate the frequency controllers. In this way a new frequency controller installed after a fault is adjusted automatically. In the meantime, security components have also been integrated into the bus system. Universal used the KL6201 AS-i Master Terminal for this purpose. It imple-

ments all the functions of the "classical" AS-i Master in the form of a normal Bus Terminal. This has brought a considerable reduction in the amount of cabling. According to Oude Wesselink, the great advantage of this bus system is the easy programmability. "The AS-i is inadequate for a large number of security systems, but the 32 slaves in the traditional version were more than enough for us."

The control functions are carried out by three Beckhoff C6150 Industrial PCs running TwinCAT. Each has a Profibus connection to the frequency controllers and a Lightbus connection to the Bus Terminals in the control cabinet and to the terminal boxes. The subsidiary AS-i bus is also coupled to the PC controller through these fieldbus stations. The Industrial PCs are connected to one another via Ethernet.

Nearly all the stacker's elements are driven by frequency controlled three-phase motors. A few items are still pneumatically driven; hydraulic actuators are no longer in use.

Commissioning and servicing

From construction through to on-site installation, commissioning and servicing, the series machines built at the Almelo works are managed by a fixed team of mechanics, electricians and software engineers. Most after-sales service is provided remotely, over an (analog) modem connection to the PC-based controllers. The communication uses PC-Anywhere; an Internet connection is planned for the future.

Remote servicing is only provided for the first two years following installation. After this initial phase, the workers on site are sufficiently familiar with the system to avoid or to rectify the most frequent malfunctions. The use of the Bus Terminal system and of self-calibrating frequency controllers means that both the frequency and the duration of down times are very limited.

→ www.ial.nl

In the highly productive automation solutions from accelab GmbH, Beckhoff Industrial PCs and fieldbus products are part of the central nervous system

Biotechnology and modern laboratory automation

→ The company accelab GmbH based in Kusterdingen, Germany, deals with solutions for accelerating laboratory processes. The motto of the specialists for innovative laboratory automation is the guiding principle "creativity for people – routine for machines". As a pragmatic implementation of this motto, the scientists, engineers and computer scientists from accelab create customer-specific partial and complete solutions for high sample throughput in the laboratory.



Automation system for fully automatic process optimization for chemical reactions.

Dr. Martin Winter, managing partner of accelab GmbH, describes the activities of the company as follows: "Laboratory automation places particular demands on the classic automation technology that are characterized by the large number and uniqueness of the processes and products. These individual process components are usually essential, i.e. they cannot simply be removed from the process, and have a high value. For example, tasks in the pharmaceutical, chemical or biotechnological industry often deal with small product quantities that may nevertheless represent the world reserves of a substance. Any samples removed from this quantity can therefore not simply be blown out of the process."

From engineering concept to laboratory facility

The activities of the customers require highly flexible plants, combined with high productivity, as far as the plant supplier accelab is concerned. This is the particular difficulty. On the one hand, it means very high demands on the hardware, which has to be very reliable. "For example, in our automation solutions we have to integrate a lot of functionality in very little space", said Dipl.-Ing. Frank Greiner, authorized signatory responsible for system and equipment technology at accelab. Frank Greiner continued: "On the other hand, sophisticated software is required. This also results in a special requirements profile for the control

technology. We need high signal throughput, in order to integrate and use the sensors and actuators appropriately."

Customers from the pharmaceutical, chemistry and biotechnological industries use the systems designed and created by accelab for advancing their research into active substances. This means that a large number of chemical compounds have to be produced, processed and characterized. The substances are initially synthesized with different, parallelized techniques. Subsequently, analysis techniques are used to check the chemical identity of the substances. After synthesis and purification, the samples need to be prepared, so that the subsequent tests can be carried out with high throughput. This "High Throughput Screening" ensures, for example in pharmaceutical research, that several hundred thousand individual chemical substances can be checked for their efficiency in a defined test procedure. It is thus possible to determine relatively quickly which chemical substances are potentially interesting and may be suitable as active ingredients for new drugs. Once an active substance has been developed, the synthesis conditions have to be optimized in order to minimize the creation of waste products during large-scale production and to ensure that the product is as clean as possible. For this task, accelab offers sophisticated parallelized synthesis robots.

Up- and downstacker

In addition to the downstacker – in which the table moves downwards – Universal have also developed a system in which the conveyor belt rises slowly (in step with the material supply): the upstacker. In this case the table remains at the same height. The upstacker allows work to proceed more quickly, because it is easier to remove the stack, and

the conveyor belt can return to its original position in the meantime.

It is, furthermore, possible to form small packs, and these can then be assembled into a single large stack on a separate machine. This technique is particularly useful when space is restricted or for products that tend to warp. Alternate pack-

ages are turned over before stacking in such cases. Visual checks from time to time are also possible.

→ www.universal-corrugated.com



Proven components and in-house developments

Some of the units and peripheral devices used in the accelab automation solutions are in-house developments or joint developments with co-operation partners, or devices from qualified partner companies. accelab's know-how is in system development and system integration, including engineering. One of the requirements of the accelab plant technology is the capability to handle toxic or aggressive materials. "Via a central robot control, we are able to operate flexible structures", said Frank Greiner. Robot technology is thus a very important system component in automation solutions. In this respect, the company remains flexible. Frank Greiner explains: "We don't use a specific robot. We use the most appropriate type of robot for each task."

Flexible control technology for flexible automation solutions

Bus Terminals and Industrial PCs from Beckhoff are used in the automation solutions from accelab. The Bus Terminals are available as both digital and analog terminals to cater for all types of systems. "Since each new accelab automation system is different from the previous one, the technical system variety and the so-called fine granularity of the Bus Terminals is very welcome", said Dipl.-Ing. Frank Würthner from the Beckhoff branch at Balingen. Even for the first projects, the flexibility of the Bus Terminals in particular proved to be very useful. In addition, the Bus Terminal Controllers can be used as mini-PLCs and can be operated decentralized as local control units. "In terms of communication,

we recommend either Profibus or Ethernet, depending on the application," said Frank Würthner, pointing out that this recommendation was partly determined by the time requirements and the amount of data to be transferred. Data throughput will no doubt continue to play an important role in future projects, i.e. when Control Panels are used in addition to Bus Terminals. "The mail function used in conjunction with visualization causes the amount of data to be transferred to be larger," said Frank Würthner. The C6110 Industrial PCs from Beckhoff that are used are slot versions with passive backplane, which is very compact and is therefore ideally suited for this plant concept, which is also very compact. Apart from TwinCAT, part of the "Workflow Manager" laboratory control software developed by accelab also runs on the Industrial PC. According to the accelab description, the Workflow Manager is an IT solution for integrating stand-alone laboratory apparatus, robot stations and analyzers in a unified, programmable laboratory control system. The high function density and resulting extremely compact configuration of biotechnological systems means that another feature of the Beckhoff Industrial PC is particularly advantageous. "All Beckhoff products are specified for temperatures between 0 to 55° C, which means that no additional air-conditioning devices are required," said Frank Würthner. While the ambient temperature is not the critical factor during the operation of the accelab systems, the permanently



Dr. Martin Winter,
managing partner

Dipl.-Ing. (FH) Frank Greiner,
authorized signatory and responsible for system and equipment technology (automation) at accelab



Biotechnological automation
solution from accelab with
turboscara platform

→ www.accelab.de

Laboratory facility for carrying
out feasibility studies that feed
into the estimated price offers



high performance requirements for the process computer and the resulting warming of the individual devices have to be considered over-proportionally, so that the temperature specifications of the Beckhoff devices ensure trouble-free operation.

Variable connection and installation

In each system, between 100 and 160 solenoid valves have to be controlled, some of them pneumatic or hydraulic valves. In each system, 200 to 250 digital input signals and up to 20 analog sensor signals (4 to 20 mA, 0 to 20 mA or 0 to 10 V DC) have to be logged and processed on the input side. To deal with this, on average up to 5 Bus Terminal Controllers are used in each automation system. "The BC9000 Bus Terminal Controllers enable us to also utilize PLC func-

tionality locally", said Frank Greiner, noting that to this end the Bus Terminal Controllers are addressed via Ethernet (TCP/IP) and thus control complicated sensor systems such as detectors for phase separation or the superposition of the axis data in the robot motion control, which represent special measures within the system control and require local intelligence. The flexibility mentioned also applies for cases, in which accelab customers require the Profibus to be used as the system fieldbus. For this too, Beckhoff offers the appropriate intelligent controllers and Bus Couplers. The system includes gripper changing stations for the handling of the different vessels and devices by the robot. These grippers can deal with a variety of handling tasks and have various mechanical and technological interfaces at the change-over flange, for example for compressed air or inert gas. The specific sensors and actuators in the respective robot gripper are linked via special plug connectors. For accelab, flexibility is a very important prerequisite, due to the changing and varying nature of tasks. According to Frank Greiner, PC control technology and decentralized control technology are particularly suitable for this purpose. "Software is also a very important factor for us, which we address through high reusability of the software components," said Frank Greiner. In his opinion, this strategy works very well with Beckhoff products, since this combination makes it possible to tackle a wide variety of tasks from a common platform.

PC-based automation for open-air installations and greenhouses

Ethernet inside – Lightbus outside



Implementation of BKN Strobel's concepts set some high targets: Top technological demands and compact automation units at a reasonable price/performance ratio – just the job for the engineering office of Kaiser Müller Gerdes GmbH (KMG) in Schortens, who were charged with the design. In close co-operation with the firm of Detlev Coldewey, Westerstede, a range of possible solutions was considered, and a decision was taken in favor of Beckhoff's technology. A modern plant, with 60,000 m² of growing area and a high level of automation arose from that. BKN Strobel are using a high level technology so that nothing in the growth and care of the high quality roses and nursery shrubs is left to chance.

TwinCAT and Beckhoff fieldbus technology for automation

From Beckhoff's comprehensive range, the Industrial PC C6250 was chosen as the hardware platform for the TwinCAT software PLC. The advantages of using the Beckhoff Lightbus to handle the input and output signals from the open-air areas and from the greenhouses were convincing:

- | Fast transmission of the field signals allows the watering trolleys to be positioned using standard input and output terminals.
- | Pulse sequences < 20 ms need to be evaluated over the optical fiber fieldbus to execute the positioning.
- | The optical fiber bus technology means that it is not necessary to take additional measures to protect the bus stations against lightning.
- | The fieldbus nodes in the optical fiber ring, which has a total length of 3,000 meters, are economical and can be installed quickly. Special glass fibers are not needed, which means that even the customer can wire them up on site using appropriate tools.

Since 1989 the Beckhoff Lightbus has been used around the world in a very wide variety of applications. Immunity from interference and high transmission speed mean that fibre optics are ideal for fieldbus systems such as Motion Control tasks with fast cycle times, or for applications that are widely distributed. An example of this is provided by BKN Strobel's tree nurseries at Holm, north Germany, which have an area of 65,000 m², making them one of the largest single tree nursery areas in Europe. Altogether 1000 I/Os are linked over a total reach of 3 km. The building automation inside the greenhouses uses Ethernet.



PC-Control: Mr Kaiser, what were the main reasons why you chose Beckhoff technology to automate the greenhouses and open areas?

Kaiser: The simple and economical configuration of bus stations, and also the very small number of necessary spare components. We of course found the integration of the optical fiber interface into the Bus Coupler very appropriate for the open-air applications. The maximum channel cost of 15 EUR for a simple station with 8 digital inputs and 8 digital outputs, including the fibre optic interface, was then crucial for the decision in favor of Beckhoff technology.

PC-Control: You are using the Beckhoff Lightbus for the open areas and greenhouses, and you are also using Ethernet for the building automation. What have you found to be the benefits of the continuity of the TwinCAT system in the configuration and programming?

Kaiser: The same function blocks can always be used in the controller for data exchange with all the components throughout the entire system. This leads to simple programs which, most importantly, can easily be understood, and the time saved as a result is noticeable, particularly when setting up and fault finding. Only one interface to the central engineering PC in the control room is necessary for remote servicing.

59 Bus Couplers in a 3 km fibre optic ring

The open-air installations and greenhouses are automated with the aid of BK2010 and BK2020 Bus Couplers, connected to the central C6250 automation controller via the FC2001 Lightbus PCI master card. At particularly critical locations, where local functionality must still be ensured during repair or servicing work on the bus system, the BC2000 intelligent Bus Terminal Controller is used. This mini PLC undertakes the automation tasks locally, and only transmits its data for display purposes or for data exchange with the fieldbus system's master. The Bus Terminal Controllers are also programmed by the same TwinCAT system that is used for the central automation tasks. The advantages of a consistent programming system and uniform tools are exploited here to the full.

OPC – free selection for the display of 8,000 data points

The TwinCAT OPC Server offers full selection facilities for the display of the data points, of which there are about 8000. All of the data points are directly available to the OPC client. It has access to the bus stations' process image and also to the central TwinCAT PLC's variables area. The data points configured in the TwinCAT system are available to the OPC server through a symbol file that is generated when the system is compiled. The following control functions are implemented for the open-air areas and the greenhouses:

- | Shade: Energy screens of fabric laminated with aluminum. Incoming sunlight can be restricted, and heating to protect from frost is not necessary for temperatures down to -3° C.
- | Watering: Individual time and location patterns for watering trolleys, overhead irrigation and fertilization
- | Ventilation: Supply of fresh air through continuous flap control
- | Heating: Heating pipes in the glass houses for winter operation



The existing Ethernet infrastructure in the administration area could also be used for the building automation, and this yielded considerable cost reductions. The same software is used for the programming and for managing the building automation, and the same standard components from the Beckhoff Bus Terminal system are used. The BC9000 Ethernet controllers in the different wings of the building can exchange data between themselves without using the central PLC controller. The telegram transfer times that have been achieved, and the insignificant degree of the increased Ethernet bus loading, confirm that our decision in favor of the Beckhoff solution was the right one.

PC-Control: Industrial PC C6250 with SCSI Raid Controller technology: What experience have you gained of the system as a whole in terms of reliability and data security? What advantages do you see in the use of Beckhoff Industrial PCs?

Kaiser: One partner when support or service are needed. Carefully thought out, solid industrial quality that can be integrated into a control cabinet, with no ifs or buts. The control cabinet constructor, for instance, finds a familiar connection technology using spring loaded terminals for connecting the mains power. Because both the necessary operating elements and the connections are located on the front of the PC, we do not need to use

A weather station records all the weather data required for control, such as temperature, wind direction and strength, the presence and amount of precipitation. The data acquired in this way is processed by the Beckhoff automation system, and transferred over the Beckhoff Lightbus to the central TwinCAT software PLC.

Building technology using the ready-made solutions in the TwinCAT system

In building technology too, a decision has been taken in favour of an open system using solutions from Beckhoff. The TwinCAT function blocks and libraries offer the user ready-made solutions for the integration of standard functions such as intruder detection, access control, heating, ventilation, air conditioning, lighting and sun protection systems. The I/O terminal systems that have already been used for many years in industry are being applied in building technology as well with the BC9000 Bus Terminal Controller.

The BC9000 exploits the Ethernet infrastructure present in the building for communication. The design of the Ethernet network and the use of Ethernet switches allows "point-to-point" connections also to be implemented here with Ethernet's high transmission rates.



Thomas Kaiser, General Manager of KMG Umwelttechnik GmbH

made it possible to make the final installation without upgrading the control platform. We are very happy with the whole system.



Dipl.-El.-Ing. Heinz Radde,
chief editor "Aktuelle Technik",
Schlieren (Zürich),
www.aktuelletechnik.ch. (left)

Martin Knuchel from Güdel AG,
Jürg Eggimann from TAS
Engineering AG and Gerhard Meier
from Beckhoff Automation AG.
(left to right)



Users of drive technology are primarily looking for manufacturers to provide greater safety in their products and well-protected investment, according to participants in a discussion of drive technology with "Aktuelle Technik". This is no surprise, because the export proportion in this sector is extremely high. Economical service and continuity play a large role here.

Safety and protected investment

Radde: Where is the trend in drive technology leading? There are a few new system announcements, such as from Siemens with Simotion; Rockwell, Mitsubishi and others also have made announcements. Beckhoff are following the PC road. What do users actually want nowadays?

Knuchel: From the user's point of view, there are two trends in automation. The most important points for the future are:

1. Global functionality must be provided. In other words, we would really like an open system, so we can use this drive here, that bus there, and so on. This is incredibly important, because we have different markets (USA, Asia, Europe), and each has somewhat different needs. We don't want to keep developing things from scratch, but want to use the modules again and again.
2. Safety meeting Category 3 must without question become standard throughout the industry. We must offer drives that meet this requirement, both in terms of the controller as well as the drive itself. It's my personal opinion that the frequency converter is dead. Nowadays, a servo system costs about the same as a frequency controlled system but has much greater capability and better properties. A servo system also has the great advantages of the permanently excited motor: easier cooling, and greater torque. In highly dynamic situations, PC technology is of enormous advantage. We have programmed the movement as a 5th order polynomial. That cannot be done with a fixed system, or at least only with huge difficulty.

Radde: Does "open systems" mean that you want to be able to connect together modules from different suppliers even within a single application?

Knuchel: Without question we would like to be able to use a PC based system, such as is offered by Beckhoff. Under that I might want to have an Intermax

drive, but in the USA I might want to use an Allen Bradley drive. 90 % of our output goes to export. It is necessary to establish conventions. They are on the horizon, but they are not here yet.

Eggimann: It is also very important for the drive interface to be standardized, such as is done with SERCOS. The great advantage of the Beckhoff controller is that all the features of a drive, whether it's cam plates or geared couplings, are provided in software form on the PC, rather than in the drive. That's the only way to be compatible. Special drive features, such as those of Indramat and Allen Bradley, are not the same – that is firmware. We can define it by software – the drive does whatever the PC controller tells it to do.

Knuchel: This is just where we have a great advantage, such as for remote diagnosis. I can log into a normal PC-based system, where I can use simple remote diagnosis involving little overhead and fast response time, and I can check the full range of features. I can't do that if I have different systems, or if the intelligence is located in various sub-systems.

Radde: Do you mean diagnosis via internet or Intranet? Is it really necessary to change every single bit in the drive, or isn't that rather just something that it is nice to have?

Eggimann: Nowadays we can inspect and set every single bit in the drive over a standard modem. For example: The two master front axle transducers that are fixed to the press are checked every 2 ms to see that they have the same value. It is possible that as a result of a certain amount of play in the press, the comparison of the two press transducers reveals some difference. I might, therefore, have to increase the tolerance a bit. Nowadays we do that via modem. Or if the end user exchanges a drive, we load the drive data by modem. We have already done that.



"It is also very important for the drive interface to be standardized, such as is done with SERCOS."

[Jürg Eggimann, TAS Engineering AG]



"We will continue to work consistently with Microsoft technology. .NET will now provide a big step forward."

[Gerhard Meier, Beckhoff]

Knuchel: We do that practically every week all over the world, mostly in the USA and Mexico. Sometimes we have a second telephone line open, so that we can say when things are switched on or off. That, of course, is something that has a big effect on cost.

Radde: So you don't just use remote diagnosis for display, you control and program as well?

Eggimann: Even program changes that are made here are loaded onto the system by remote service and immediately tested with the customer. It is important for PC-based systems that the HMI (Human Machine Interface) has been integrated at the same time. This is not just a matter of fixing bugs, but of helping the customer, because the same remote diagnosis allows us to see his interface screen, and to support him over a second line. It is possible, for example, to correct mistaken operations, just as if we were standing in front of the machine.

Radde: In which parts of the open system are the suppliers still most failing you? What do you miss?

Knuchel: It's mainly the communication interfaces; either the display system itself, or from the controller to the display system, or from the controller to the drive. There are still big differences there, and these swallow a lot of the engineering time. Something still has to be done. The PC-based systems are, of course, best here, because they can use the standard communication tools that are available for the Microsoft environment in any part of the world. That has to be the way of the future. OPC communication, for instance, is a simplification for the display and visualization system. It is not really suitable for rapid processes, but at least it is possible to generate a standard so that data can be exchanged with a reasonable effort. In the case of drives, however, there is still a lot to do.

Meier: Some are even pulling out, sadly. There may be a world-wide SERCOS standard, but not everybody is sticking to it.

Knuchel: It works for those who are maintaining the SERCOS standard. It means we are able to exchange drives nowadays without having to make other modifications. It must be admitted, unfortunately, that it is the big manufacturers who are holding things up. We would like to use Allen Bradley drives, but that manufacturer uses the SERCOS protocol in accordance with their own standard. Layer 7 is still "crooked" there.

Eggimann: Nowadays we are also running the soft PLC on PCs from Allen Bradley, Beckhoff or Siemens, for instance, and it works with no problem. That is open control technology. It does not mean that you can only incorporate things from one manufacturer. I need to use what the customer wants, and what makes sense, and not the things that the manufacturer wants me to use.

Radde: What have Beckhoff got to offer for the future?

Meier: .NET will now provide a big step forward. The operating system makes full use of Internet technology. And the XML-based features will also find their way into control technology. An XML file can be used, for instance, to configure the system manager as early as the project planning stage, not just at the controller. The XML format also allows the documentation to be included immediately, without having to write the same thing again on a different system. The full connection to the visualization system is available. If I can say in the variable declaration that this variable is an OPC variable, then I don't have to declare the same variable again in a visualization section. The integration of .NET will give another powerful push forward. The second level on which we are active is that of small CE-based controllers, where we can extend the Bus Coupler/Controller through bus

“We would really like an open system, so we can use this drive here, that bus there.” [Martin Knuchel]

“Nowadays we can inspect and set every single bit in the drive over a standard modem.” [Jürg Eggimann]

Radde: You are relying entirely on Microsoft. That almost sounds like a conspiracy!

Meier: We have been on the market now for over 10 years with PC-based controllers. The first soft PLCs were even based on DOS. We then converted to Windows NT, then to Windows NT Embedded, Windows 2000 and now XP. This has not given us any problems. Microsoft can offer this upwards compatibility. And that means that our investment is secure for a long time.

Eggimann: ... and then it is still possible to optimize, so the best can be leveraged out of the new computer platform. But basically we must port, and everything runs as it did on the old system. Here, of course, Microsoft carries a great deal of responsibility towards users, to guarantee this portability. Other operating systems, OS/2 for instance, have disappeared from the market, and the software must, to all intents and purposes, be thrown away.

Knuchel: I believe that basing ourselves on worldwide standards is the right way forward. It takes us further forward, provides simplification and increases the benefits. We Europeans are masters of new standards, but this time we must leave it to one side.

Radde: What is your opinion of Ethernet’s continuity?

Eggimann: As far as PCs are concerned, this question has now been defused. Accessing the data from a sensor from somewhere else has long been a reality for Beckhoff. From any location I have access via Ethernet through the controller down to the sensor. This continuity is already available. This is unlike the situation, for instance, with Profinet, where gateways must be created. The PC does not need this, because it is itself the gateway.

Knuchel: Yes, and communication with nearby or supervisory installations is also straightforward if we can communicate using standards like Ethernet and TCP/IP.

Eggimann: So even if it isn’t actually yet real-time capable, I still think this system has the best chance for the future. This will be made possible in the future

through rising performance. Just four years ago we could not have imagined that we could operate 30 axes and cam plates by software in a 2 ms cycle.

Radde: What is at present your biggest technical problem with drives?

Knuchel: The most important points in the drives field are safe stopping and safe slow travel when setting up. This has to be secure – the problem must be solved. Every vertical axis is included in the position control, and somewhere it has a weight of 200 kg, and this can cause irreparable damage to humans. That is why we must achieve Safety Category 3.

Eggimann: It is true that this is nowadays specified in the standard, but there is hardly any drive manufacturer who has properly implemented it. Bosch have led the way, and Bosch-Rexroth are now following. Siemens are doing it by having the PLC and CNC parts monitor the safety part. That is also one way in which this safety category can be achieved. But it means that it is again necessary to get everything from the same manufacturer. That’s why we favor safe technology in the drive – open systems.

(Reprinted from “Aktuelle Technik”)

Certification documents were presented to Beckhoff’s system partners at go.automation (left to right): Jürg Eggimann and Egon Wassmer, both of TAS Engineering AG; Roland Jacquério of ALRO Engineering SA; Gerhard Meier, General Manager of Beckhoff’s Swiss subsidiary; Jörg Maurer and Guido Maurer, both of Kirchhofer AG

Beckhoff at the go.automation.days 2002

At the beginning of September, Beckhoff Automation AG presented themselves at the go.automation.days, the International automation trade exhibition in Basel. The full range of automation components was presented to visitors on the large exhibition stand. Center stage, however, was taken by the CX1000 Embedded PC, Beckhoff’s most recent development, a modular hardware platform for PLC and Motion Control applications. Gerhard Meier, general manager of Beckhoff’s Swiss subsidiary, sees the trend moving towards consistent, scalable system solutions, capable of the necessary communication, and based on open architectures.

The exhibition also provided an opportunity for presentation of the certification document to the engineering companies TAS AG, ALRO SA and Kirchhofer AG. This gave official recognition to the successful co-operation between Beckhoff Automation AG and their system partners.

Beckhoff Austria: New representation in Lower Austria

Outside view of the
Berndorf Innovation Center.



Kurt Korinek, manager of the
new sales office in Lower Austria.



The newly founded Beckhoff subsidiary in Austria, expanded by adding a branch in Berndorf, south of Vienna. Beckhoff's goal is to provide comprehensive customer support everywhere in the Austrian region through new sales offices. The new branch in the Berndorf Innovation Center represents an important step closer to this target.

Kurt Korinek has been available to customers as the responsible manager beginning in June 2002. The 45 year-old has many years of experience as a technician and a sales representative in automation technology. "I have had a long connection to Beckhoff. In my professional career I have come across Beckhoff products repeatedly, as they are used in so many places. I was fascinated again and again, by the distinctive opportunities offered to customers by the wide range of products," explained the new

sales manager. From the new base, Kurt Korinek provides customer support to Beckhoff's customers in Vienna and in the regions of Lower Austria, Steiermark, Burgenland, Kärnten and East Tyrol. A programmer will in future assist customers with individual solutions and the adaptation of Beckhoff products.

Co-operation with the team at Beckhoff's headquarters at Bürs am Vorarlberg is outstanding. From this head office, Michael Jäger provides technical support for the customers of the Lower Austrian office. Kurt Korinek is assisted with on site project design when necessary by Armin Pehlivan, managing director of Beckhoff Austria, or by Klaus Wurm, manager of the Beckhoff representation in Linz. Contact is also continuously maintained with the company's central offices in Verl, so that customers are

offered the benefits of Beckhoff's consistent company network.

The customer potential in Austria is large, and the market relatively small. Beckhoff's strategy of expanding step-by-step through small, skilled teams who can react flexibly and quickly is exactly right for such an environment.

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(left to right) Bernd Pelzer (Export),
Jiri Holik (Dyger) and Managing
Director Hans Beckhoff.
The distribution agreement was signed
at the Hanover Fair in April 2002.

Beckhoff is set to expand and concentrate on business activities in the central and eastern European market. During the Hanover Fair in Germany, the company signed an exclusive distributor contract with Dyger s.r.o. covering the sale of Beckhoff products in the Czech Republic and in Slovakia.

Coming soon:

Beckhoff Italy

The expansion of Beckhoff's international sales network continues. The new target of the export activities is Italy with its strong machine construction and plant engineering base. In early 2003, Beckhoff will start its activities by establishing its own subsidiary. This will make direct distribution, support and service available to the Italian industry. The head office of the new Beckhoff branch is located in Milan. Additional sales offices for customer-orientated support are in preparation. Initially, the new managing director Pierluigi Olivari will run the show with four further members of staff.

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New partner sells Beckhoff products in the Czech Republic and in Slovakia

The course is set for the future

In Dyger, Beckhoff has found a strong distribution partner that is well established in the industrial automation sector in the central and eastern European markets. At the same time, this strategic partnership will strengthen Beckhoff's activities in the mechanical engineering sector. Dyger's managing director, Jiri Holik (35), has been successfully involved in the distribution of well-known automation brands for many years.

Dyger has its head office in the Czech city of Brno, a highly industrialized region of the Czech Republic. From this location, the sales activities for Slovakia will also be controlled on behalf of Beckhoff. Three members of staff will deal with sales and support for the Beckhoff products and for software applications. All three have long-standing experience with industrial automation.

For Jiri Holik, the reasons for the co-operation with Beckhoff are simple: "We want to offer products and solutions that are competitive worldwide and that help not only us, but also our customers to be successful. In our opinion, Beckhoff meets these requirements precisely. With their innovations in industrial automation, they are one of the leading suppliers worldwide."

The Czech and Slovak markets, with particular emphasis on automotive, rubber and plastics, foodstuffs and chemistry, have significant growth rates. The partnership with Dyger not only strengthens Beckhoff's presence in eastern Europe, but also optimizes the transfer of know-how: Customers benefit from local services and training. Initial seminar units are already utilized by well-known international partners such as Skoda/Volkswagen and Continental.

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www.dyger.cz

“In addition to direct sales of our technologies, beyond the products themselves we offer our customers application support,” says Zbigniew Piatek, Managing Director of Beckhoff Poland, about their sales activities. The establishment of the subsidiary in Poland is Beckhoff’s response to the growing demands in this developing market.



Zbigniew Piatek, Managing Director Beckhoff Poland



Zbigniew Baginski, Sales Engineer



Anna Oltarzewska, Sales & Marketing

Beckhoff establishes subsidiary in Poland

Expansion leads to central and eastern European markets

Stronger and more active representation in the booming central and eastern European market is a particular focus for Beckhoff. The establishment of its own subsidiary in Poland will strengthen automation products sales and end user support. The Warsaw branch was opened in July 2002 and is managed by Zbigniew Piatek. Piatek (33) has long-standing experience in the field of industrial automation, particularly in the areas of systems, process control and environmental and building services.

The Warsaw industrial market, as the capital of Poland and thanks to its central position, has many applications which are well suited for Beckhoff technology. Poland, a country with a population of 40 million, aims to join the EU, which means that consistent economic growth can be expected.

“Polish entrepreneurs are very open towards new technologies from western Europe,” says Piatek and continues:

“The expected growth in exports points to increased interest in automation technology. Increasingly, demand from modern companies will orientate itself on open systems such as PC-based automation systems from Beckhoff.”

The Poland Beckhoff team plans to expand their market presence, differentiate from the competition and establish a sound basis for automation technology. Customer focus is very important: In addition to a close cooperation network with system integrators, the establishment of sound relationships with end customers is also planned. “Thanks to the comprehensive product portfolios, Beckhoff has much more to offer than components. Today, customers require complete solutions, which we supply as turnkey solutions,” says Piatek.

Further activities of the sales team in Poland include technical support and services for international customers who export their machines and control sys-

tems, equipped with Beckhoff technology, to Poland. “Beckhoff’s advantage lies in the long-standing, proven experience in the area of PC-based automation,” says Piatek about the mood in the market. He also provides an insight into the strategy of his team: “We also offer solutions for the more conservative customer segment, where hardware PLCs have been traditionally employed. The latest innovation from Beckhoff builds a bridge between the two areas and combines Industrial PC and PLC in a single leading edge product. The CX1000 system provides proof that single-function PLC systems are no longer appropriate based on the positive market feedback. It is becoming apparent that PC-based control systems in scalable Bus Terminal format are the future and that PC-based solutions will generally dominate the market. With its ‘New Automation Technology’, Beckhoff offers highly innovative products and solutions.”

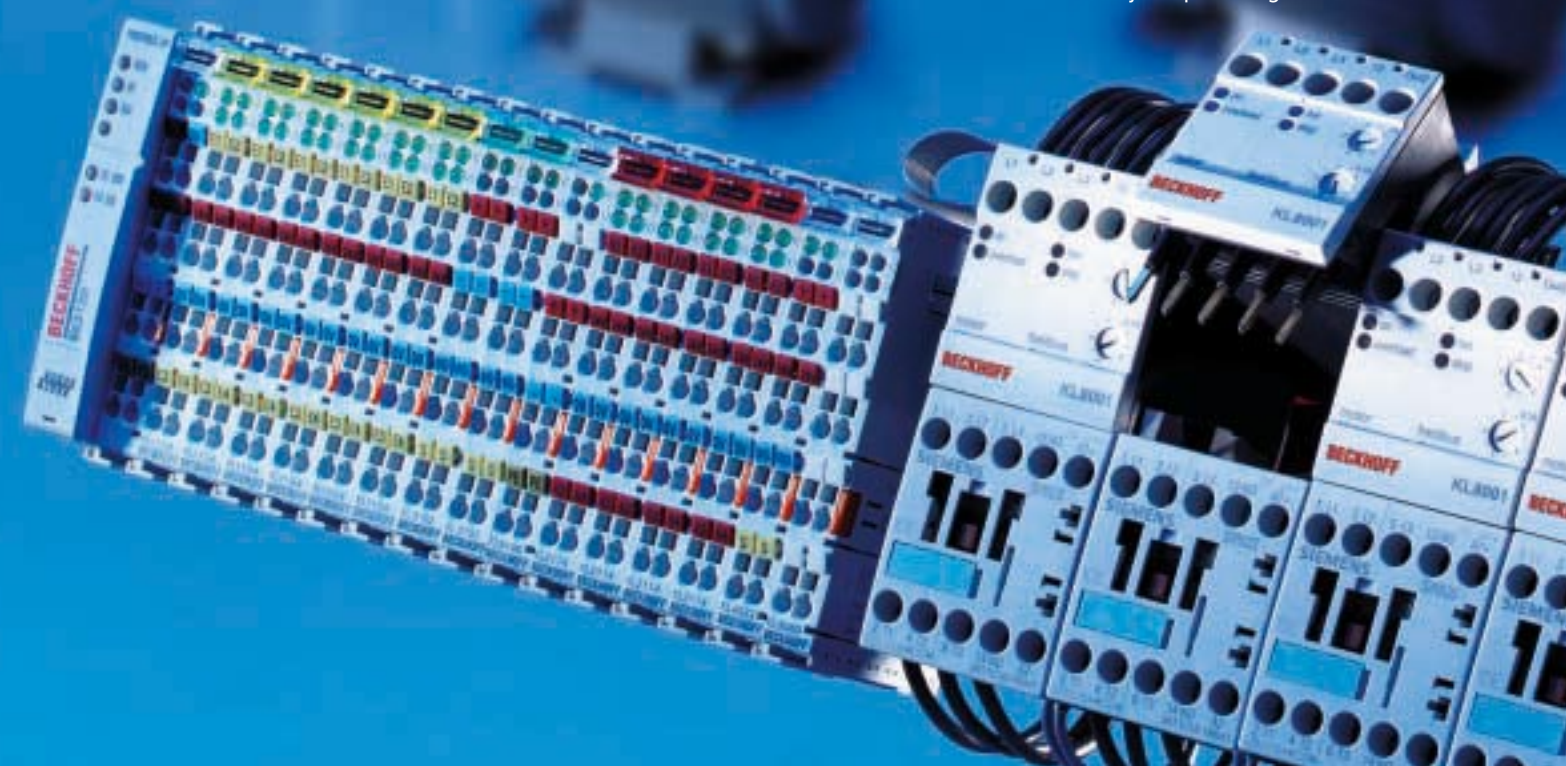
Initially, the team of Managing Director Zbigniew Piatek will consist of two further staff for sales and support. The Polish branch increases the number of Beckhoff subsidiaries to six: Switzerland, Austria, Finland, Sweden, Poland, USA plus two Beckhoff branches in Canada and China. Furthermore, through cooperation partners, Beckhoff is represented in more than 30 countries worldwide.

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Complete motor control: The Beckhoff Power Terminal

- Switching up to 9.9 A
- True r.m.s. measurement U, I
- Effective power measurement P
- Motor diagnostics up to 5.5 kW
- Operating data via fieldbus
- Very compact design



The standard contactor with fieldbus connection

Space is saved and functionality increased: The compact, bus-capable KL8001 Power Terminal from Beckhoff replaces traditional common motor protection relays and expands their functionality. The KL8001 supplies all main operating data such as motor load, current, voltage, phase fault/failure, overload, underload.

This transparency enables preventive maintenance and early detection of faults for every controller. The Power Terminal is simply installed on the contactor and connected with the Beckhoff Bus Terminal system via an adapter. The advantage: low space requirement and communication option via fieldbus.

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



BECKHOFF

New Automation Technology



(left to right)
Patrick Fredriksson, Sales
Office West, Göteborg,
Bjorn Forssberg, Managing
Director Beckhoff Sweden
and Hakan Brandt, Sales
Office South, Malmö.

→ The automation specialist Beckhoff and the Swedish distributor TR Electronics Sweden AB have a long-standing successful co-operation. The success has resulted in establishing a Beckhoff's Automation AB subsidiary in Stockholm. The new Swedish subsidiary will facilitate further expansion of Beckhoffs position in the Swedish market.

Beckhoff Sweden

Presence in Scandinavia strengthened

Beginning July 1, 2002, the subsidiary will take over sales of Beckhoff products from TR Electronics Sweden AB. TR Electronics and Beckhoff established a business relationship in 1990. This was one of Beckhoff's first official foreign agencies. Currently, Beckhoff has representations in 30 plus countries through subsidiaries or partner companies. The new managing director of Beckhoff Sweden is Björn Forssberg (54), founder of TR Electronics Sweden. Reflecting on the past, Forssberg said that the first major breakthrough occurred in 1993, when Volvo Torslanda became a customer for the Lightbus I/O system. Today, Beckhoff sells the complete range of "New Automation Technology" products on the Swedish market. The head office of the Swedish subsidiary

is located in Täby, 20 km northwest of Stockholm. Additional sales offices in Göteborg and Malmö ensure customer focus in western and southern Sweden. Björn Forssberg is supported by an experienced team, consisting of two sales and support engineers and two admin staff, who were also taken over from TR Electronics Sweden. Their knowledge of the Swedish market and long-standing experience with Beckhoff products will ensure support of existing customers and new customers. The most important industries for the manufacturer of PC-based control technology are the Swedish metal and metal processing industry and the timber processing industry. Hans Beckhoff, Managing Director of Beckhoff, comments on the decision of estab-

lishing a Swedish subsidiary: "Beckhoff's independent representation in Sweden and also in Finland demonstrates the significance of the northern European market for the automation industry. The market is particularly keen to embrace technological progress."

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The Tekniikka in
Jyväskylä is one of
the largest automation
fairs in Scandinavia.

Beckhoff Finland: Latest technologies at the Tekniikka 2002

→ Tekniikka 2002, one of the largest automation fairs in Scandinavia, took place September 25-27, in Jyväskylä, central Finland. The Tekniikka is held bi-annually and alternates with the Automaatiopäivät in Helsinki. A total of 160 exhibitors presented automation components and system solutions from over 1000 companies and 20 countries in five halls.



Mikko Uuskoski,
Managing Director
of Beckhoff Finland,
presented the Embed-
ded PC CX1000 at
the Tekniikka.



The Beckhoff subsidiary, active in Finland since early 2000, was represented in Jyväskylä for the second time. The complete range of "New Automation Technology" products was presented in a 150 m² booth. The new CX1000 Embedded PC generated particular interest. Mikko Uuskoski, managing director of the Finnish subsidiary, said: "The CX1000 is a good addition to the product family for medium-range control tasks. Its flexible application options and good price/performance ratio makes it ideally suited for a large number of applications." Uuskoski continued: "In Finland, particularly compact machines are developed that require small and inexpensive control units with open interfaces."

Implementing new concepts quickly and effectively

By now, Beckhoff has achieved a good position in Finland. Mikko Uuskoski sees the reasons for the continuing success in the strongly technologically oriented thinking of the Finns: "The Beckhoff control system offers the latest technologies in hardware and software with open standards. This enables our customers to implement their concepts quickly and effectively." The presence at the trade fair reinforced the growing presence of Beckhoff in Finland. The result after three days was highly successful. "Many visitors have found good solutions for their applications," said Matti Korhonen from the Finnish sales department. The new 18 and 20 inch display sizes for the Control Panels also received a lot of attention. Visualization tasks often require larger monitors, which are now also available as industry-variant in protection class IP 65.

Automation in Motion

From the middle to the end of October, the presentation of Beckhoff technology was continued with a series of seminars entitled "Automation in Motion". The TwinCAT software-based control technology and product innovations such as the CX1000, were presented in the towns of Kuopio, Oulu, Jyväskylä, Tampere, Turku and at Beckhoff's Finnish head office in Hyvinkää.

Beckhoff expands its business in China



Since the "Beckhoff China" representative office was opened in April of 2001, the company's presence in the Chinese market has grown dramatically. Forecasted sales for 2002 are on target to double last year's sales.

To achieve this ambitious goal the number of workers employed at the Beijing office has been increased from two to four. It is planned to open a second office in Shanghai, one of China's most important industrial metropolises, by the end of 2002.

Beckhoff China's, wide range of activities undertaken have provided the basis for the continuous increase in business volume:

Trade fairs

Participation in the Industrial Automation & Control Expo in Shanghai (IAC), one of the leading exhibitions for China's automation industry, between June 5 and 8, 2002, was very successful, establishing more than 700 customer contacts from a wide range of industrial sectors. Support was provided by Kai Ristau, the Beckhoff Export Manager, and by the firm of INSOFTE, system integrators and business partners to Beckhoff in Shanghai. Between January and August 2002, the company was present, in co-operation with partners, at seven other exhibitions in Jinan, Wuhan, Shenyang, Changchun, Beijing, Tianjin and Qingdao.

Presentations

Presentations and seminars on Beckhoff fieldbus technology and on PC-based controllers were held in Beijing, Hangzhou, Shanghai, Anshan, Pan Zhihua and Kungmin, involving 150 inter-

(left to right) The Beckhoff team in China: Zhenping Chen (Technical Manager), Qingyan Li (Sales & Marketing Assistant), Liqiang Liang (Managing Director), Weilie Liu (Sales).

Below: Industrial Automation & Control Expo in Shanghai (IAC 2002).

ested participants. The rapid growth in the IT industry and the wide acceptance of the IEC 61131-3 programming standard are leading to a rising interest in PC-based control technology in China. A 2-day training course in TwinCAT PLC, which was repeated this year, increases the demand for PC-based control technology, and is an excellent marketing tool.

Extending the sales network

Developing the sales network requires adapting to the special features of the Chinese market. The experience of other foreign firms that have been successful has been integrated into the growth strategy. At present, Beckhoff China are working in co-operation with 10 distributors in different important cities such as Beijing, Tianjin, Shanghai, Wuhan, Shenzhen, Chengdu and Qingdao. A promising partnership has also been developed with the automation company Pepperl+Fuchs, based in Shanghai.



In co-operation with Industrial Software Co., Ltd (INSOFT), a system integrator based in Shanghai, Beckhoff have implemented a fully automatic production plant for PVC doors and windows.

PC-based controller technology on production equipment for PVC doors and windows

Successful projects

In the meantime it has been possible to complete a number of projects successfully. In the I/O sector: projects in the automobile, textile, tire, glass and tobacco industries, and in the manufacture of monitoring systems for trucks and of intelligent control systems for use in urban infrastructure, building automation and so forth.

In the PC-based controller sector: door and window manufacture, remote monitoring and control systems for distributed low-voltage systems. In addition to this, more and more machines and production equipment containing Beckhoff components and control systems are being imported into China from Europe and the USA in the wake of the rapidly growing Chinese economy. An important task therefore required of the Chinese subsidiary company is technical support and service for Beckhoff customers operating internationally, such as Zimmer AG, Herkules, Jagenberg, Continental AG, KAMPF and Dr. Wirth Holding GmbH. Through these services, Beckhoff China are making an important contribution to the worldwide growth of Beckhoff's automation business.

The performance features required of the system included the shortest possible production times in combination with maximum precision, integration of the remote diagnosis functionality as well as making all production data available across the company network. This was implemented with the TwinCAT automation software, which integrates PLC, NC (motion control) and CNC functionality.

In terms of the electromechanical control of the plant, it had been necessary to consider that, even in just one machine, more than 40 air cylinders are to be controlled by sequential logic pressure change and temperature PID controllers at 5 heating points in 3 movement axes. In order to implement fully automatic motion control it was also necessary to use frequency converters to regulate the speed and position of various AC motors along the whole production line.

Transmission of the process and material data relating to the current process to the subsequent process was also automated. When a partly finished workpiece is passed to a subsequent machine, the new controller must make use of the received data to choose the tool and set the appropriate processing data needed to execute its process. An interface to a database was also integrated. Its data, gathered from different machines, is used along with functions for the automatic transmission of material data for demonstrations and simulations of the tool movements. It is, additionally, possible for the production line to be linked to the Internet in accordance with the customers' requirements, so that diagnostic data can be transferred.

Using the TwinCAT ADS interface, INSOFTE implemented a powerful link between the real-time controller program (PLC and NC), the HMI, the database for tool and materials management and the customer logs with their production data. The TCP/IP network functions integrated into TwinCAT, and the standard LAN cards fitted in the PC, support online data exchange between varied plant components and a network based on the TCP/IP protocol. The data necessary for processing a workpiece can be transferred between the individual plant components and the network for the production line. Alternatively, information can be transferred from the PC responsible for real-time control back to the server for the company platform, and linked with the ERP system. This provides a considerable improvement to the management and use of the production data.

With the aid of Windows NT and TwinCAT, INSOFTE were able to specify the mechanical and electrical design, to program the real-time controller and the HMI for the entire production plant, providing a functionality that embraces everything from the logical PLC control, through pinpoint multiple axis motion control (TwinCAT NC PTP) up to the complex synchronized control of multiple axes (TwinCAT NC I). Since the database functions are also available for use at the automatic production line, an installation was created offering coupled network functionality and a high level of automation. From the economic point of view, the combination and integration of a production plant with PC systems enables the plant's user to achieve a significant improvement in competitiveness. The TwinCAT controller platform represents an effective tool for shortening production development times and for extending system features.



“A modern automation system has to support all communication routes and options of this world.”

→ Web technologies had and have significant influence on man-machine communication and are generally accepted. The area of operator control and process monitoring is also being shaped by Ethernet technologies. In an interview with Markt&Technik, Hans Beckhoff states his views on current developments.



Ethernet shapes the function of operator control and process monitoring

The influence of web technology is increasing

Ines Näther, editor of Markt&Technik: Mr. Beckhoff, what growth rates can be expected over the next five years for operator control & process monitoring systems (O&M systems)?

Hans Beckhoff, Managing Director, Beckhoff: Quantitatively, the market will develop in parallel to the general automation market. However, we expect a shift within the different device categories and see a trend towards IT-based products, since they enable the increasing demands on graphics and communication features to be met. We feel that this will lead to increased deployment of Industrial PC types and to over-proportional growth in sales.

How is the market for operator control & process monitoring systems currently developing? What are the trends in technical development from your point of view?

We expect a strong development towards O&M devices with graphic displays, combined with the utilization of standard operating systems as a basis for this device category. In addition to the other Microsoft operating systems, Windows CE will become the standard.

New control concepts in combination with integrated Ethernet networking have been making their entrance into automation technology for some time. What effects does this have on O&M?

On one hand, Ethernet replaces proprietary communication systems, therefore O&M devices need an Ethernet connection. An Industrial PC, in many cases installed upstream of a classic PLC as a universal O&M and communication device, has advantages compared with classic O&M technology. Beckhoff has integrated a complete Pentium PC into the Control Panel series. The result are robust IP 65 O&M devices with displays from 6.5 to 15 inch and a depth of only 30 mm, naturally with integrated Ethernet connection.

For PC-based automation, the “Windows-based Terminal” philosophy enables new operating principles. The drivers integrated into the Microsoft operating system deal with the communication between the application and the remote operator interface.

What influence does the development of web technologies have on O&M devices? What role will global networking play in future (e-mail, SMS from HMI)?

A modern automation system has to support all communication routes and options of this world. Here too, the PC Control philosophy has a “natural edge” on the classic, non-IT-oriented control world.

Integrated PLC/MMI solutions have been available for some time, but most users still use separate units. Is the PLC/MMI a flop?

This device class has emerged from the classic PLC world. It does indeed appear to be the case that users stick with the classic separation of PLC and O&M. For PC Control automation, the integration of O&M with the control function on a single hardware platform – the Industrial PC – has become the norm and is seen by users as a big advantage.



Beckhoff integrates global sales at ISM 2002

First International Sales Meeting at Beckhoff



On 12/13 April 2002, Beckhoff invited its sales staff and distribution partners to the first International Sales Meeting at the company headquarters in Verl, Germany. The event was held at the attractive Marienfeld venue, approximately 30 km from Verl. The 108 meeting participants made for an air of excitement and enthusiasm. Managing director Hans Beckhoff welcomed the delegates from 26 countries and 25 different subsidiaries and partner companies. The meeting was divided into a German speaking national part, and an English speaking international part. 18 speakers presented on topics from their respective fields. The agenda also included the exchange of experience and information based on Beckhoff's global sales activities and exports business. The presentation of new

Beckhoff products, in advance of their official launch at the Hanover Fair, was a highlight of the meeting. After the sales meeting, participants visited the 450 m² Beckhoff stand at Hanover.

Beckhoff management intends to focus on export issues at regular future ISMs because the foreign markets are becoming increasingly significant. They are intended to intensify and promote the integration of the global distribution network with the Beckhoff company headquarters in Germany. The event was also intended to provide inspiration and new ideas regarding Beckhoff's international expansion from 30 to 50 countries and increased exports business. The ISM created the foundation for better cooperation and, transnational dialogue.

More and more users demand unified configuration and programming of the complete automation solutions (PLC, MMI, Drive). How do you respond to this demand?

There is no doubt that there is room for further refinement within automation. With the TwinCAT automation software, Beckhoff has a comprehensive tool offering a unified programming environment and system configuration for all control levels.

How can the problem of mouse vs. Industrial PC be solved? Currently, there is no technically and ergonomically satisfactory solution.

Our customers use touch screens, touch pads, in rare cases trackballs and – in clean environments – naturally also standard mice. All variants have proven reliable in industrial applications. Many applications continue to be operated via the PC function keys. Located at the bottom of the screen, they enable simple assignment of menu functions. Functions that are available at any time are assigned to so-called PLC menu function keys. These are integrated into the operator interface of the IPC, but are logically assigned directly to the PLC and not to the PC.

Which touch technology and which display technology has the biggest future in your opinion? How do you see the relationship between touch panel and conventional devices (key and display)? Will one type prevail?

We have been using resistive touch technology for years as standard, and our experience has been very good. Approximately 50-60 % of Beckhoff IPCs are equipped with this technology.



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**Austria**

Viet 2003
Sept 30 – Oct 3, 2003
Vienna

Italy

MCS Bologna
February 19–21, 2003
Bologna

Intel Milan

May 20–24, 2003
Milan

Poland

Automaticon
April 01–04, 2003
Warsaw

Finland

Automaatio 2003
September 09–11, 2003
Helsinki

Sweden

Svenska Mässan
November 18–21, 2003
Göteborg

Germany

HMI – Hannover Messe
April 07–12, 2003
Hanover
www.hannovermesse.de

Autom@tion 2003
May 20–23, 2003
Stuttgart

Ligna Plus
May 26–30, 2003
Hanover
www.ligna.de

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

Switzerland

September 02–05, 2003
Ineltec – International trade fair
for Power + Building, Lighting,
Electronics, Basel
www.ineltec.ch

**USA**

Pacific Design and MFG,
(co located with MD&M
and WestPack)
February 19–21, 2003
Anaheim

National Manufacturing Week
March 01–06, 2003
Chicago

South Pack

April 30 – Mai 01, 2003
Atlanta

AM-Expo

May 06–08, 2003
Greenville

Control Systems Expo
May 20–22, 2003
Boston

Semi-CON

July 16–18, 2003
San Francisco

Assembly show

September 23–25, 2003
Chicago

China

The 5th Intern'l Automation
& Instrument Exhibition
February 26–28, 2003
Chongqing

INTERKAMA China (Process
& Manufacturing Automation
Integrated IT Solutions)
March 18–21, 2003
Shanghai

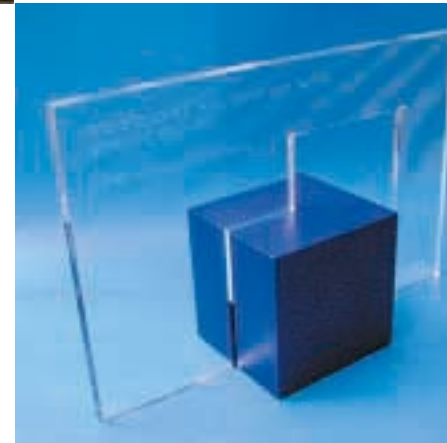
The 2nd Intern'l Exhibition
on Factory Automation &
Instrumentation
April 01–04, 2003
Shenzhen

The 3rd Intern'l Fieldbus
& Industrial Automation
Exhibition & Technical Exchange
Conference
April 22–25, 2003
Beijing

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news

Stephan Lauer from Wieland Electric GmbH, Professor Dr. Ludger Hovestadt from RaumComputer AG and Georg Schemmann from Beckhoff received the innovation prize on behalf of their respective companies.

**Light + Building 2002 | Innovation prize for architecture and technology**

The innovation prize for architecture and technology was awarded at the Light + Building trade fair in Frankfurt, Germany, in April 2002. The prize had been announced by the technical journals AIT and "Intelligente Architektur" in co-operation with Messe Frankfurt GmbH. In the "Building technologies" category, the 1st prize went to the project "RaumComputer" – a co-operation between the companies RaumComputer AG from Karlsruhe, Wieland Electric

GmbH from Bamberg and Beckhoff. The focus was not so much on the products themselves but on the co-operation between companies and architects.

The panel, consisting of architects and representatives from the Light + Building sponsor associations, explained their decision as follows: As an innovative building automation system, the RaumComputer forms an "open and comprehensive, Internet- and software-

oriented information and communication platform" for integrated building services. "Open, because it operates exclusively with standard software. Comprehensive, because it expands and integrates classic building automation with the issues of security, telecommunication, facility management and e-commerce and combines the building services across all trade boundaries."

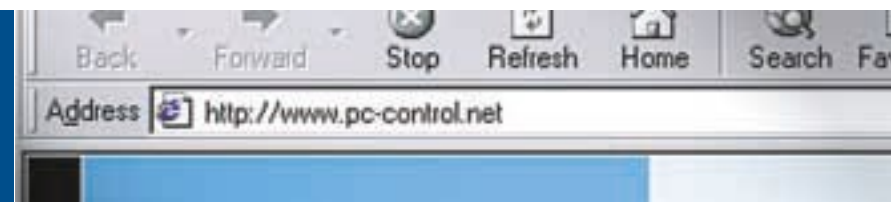
The RaumComputer applies definitions

at the levels of management, automation, field and user interfaces. The communication between the different levels is based on Ethernet TCP/IP and XML/XSL. At the field level, the Beckhoff Bus Terminal system is used, among others, preferably with Ethernet controllers.

→ www.raumcomputer.com

**Trade show dates
2003**

For additional information on our worldwide subsidiaries and partner companies trade show schedule please check:
www.beckhoff.com

**PC-Control –
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PLC and Motion Control on a 30 mm DIN Rail

- Modular control system
- No fans, no rotating storage media
- Pentium MMX-compatible 266 MHz processor
- Master or Slave Fieldbus connection options
- PLC and Motion Control
- I/O expansion via IP 20 or IP 67 modules



The modular Industrial PC for mid-range control

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