2 | 2003

PC control

BECKHOFF

The New Automation Technology Magazine

www.pc-control.net

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Further milestones!

For Beckhoff, the slogan of this year's Hanover Fair 2003, "Milestones in innovation", is part of the company's philosophy. Within the Factory Automation section, Beckhoff presented itself on more than 500 m^2, a 12-fold increase since the first trade fair presence in 1990. The fair was successful for Beckhoff even though overall fair attendance was down 18 %.

Future fairs at Hanover will alternate annually between production and process automation with next year's fair being production focused. Beckhoff, which covers a wide range of sectors due to the universally applicable open control technology, will support both segments of the fair with its complete range of products. Another new and positive initiative is the integration of the Interkama fair into the Hanover Fair network. This was agreed by Messe Düsseldorf GmbH and Deutsche Messe AG Hanover, who will jointly act as organizers of Interkama within the framework of the Hanover Fair 2004. Hanover thus confirms its position as the main international automation fair. Beckhoff once again supports the fair with the presence of more than 35 Beckhoff partners and subsidiaries located worldwide.

One of the technological highlights at this year's Hanover Fair was the new real-time Ethernet solution EtherCAT from Beckhoff. EtherCAT attracted significant interest from visitors, customers and the trade press, but also from the competition. EtherCAT, short for Ethernet for control automation technology, is also the main topic of the current issue of PC-Control (page 6). Managing director Hans Beckhoff regards the EtherCAT project as one of the main milestones in the Beckhoff history, comparable with the introduction of the Bus Terminals in 1995.

As a representative of "New Automation Technology", Beckhoff demonstrates that "new" automation technology is still possible. EtherCAT brings new impetus to automation in terms of costs and performance. Industrial PCs become simpler, more compact and less expensive - fieldbus cards and additional slots are no longer required. The prototype of this new control generation is the control cabinet PC C6920 (page 17). It is equipped with two Ethernet ports and is embedded in a housing that is only slightly bigger than, say, a 600-page book.

Many visitors were very impressed with the EtherCAT performance, e. g. in the form of the Ethernet terminals, yet at the same time they asked themselves: "Do I really need such ultra high speed transfer?" Probably not for standard applications such as building automation – the main advantages here are cost savings and simple installation. However, EtherCAT technology opens up completely new areas of application for automation technology, the so-called "life below 1 ms". Examples are fast control technology, e. g. drive or hydraulics controls, or fast metrology, e.g. the recording of analog signals with high sampling rates.

Since the fieldbus is no longer the bottleneck within the system, the computing capacity of PC-based controls can be fully utilized. PC control technology, the focus of our company magazine, is also developing further due to the latest processor and memory generation. The article "Software PLC at blazing speeds" on page 24 shows that the link time of the TwinCAT system for 1000 lines of IL code can now be pushed below 1 µs.

Due to the EtherCAT presentation, other product innovations from Beckhoff at the Hanover Fair were somewhat pushed into the background. However, from a technology point of view, the activities in the area of safety technology are just as exciting. The TwinSAFE solution (page 14) is integrated into the Beckhoff Bus Terminal system and is based on the PROFIsafe technology. Another potentially record-breaking innovation is the 8 channel analog Bus Terminal (page 12). Within a standard Bus Terminal housing with a width of only 12 mm, analog input and output signals are arranged in an ultra-compact way. Here too the aim was to become smaller, better, cheaper.

The current issue of PC-Control provides information about a large number of small and large "New Automation Technology" milestones.

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Beckhoff maintains turnover

Notwithstanding the weak overall economic situation and low investment activity within the mechanical engineering sector, Beckhoff Industrie Elektronik is quite satisfied with the financial year 2002: Revenue decreased slightly from 77 million euros to 76 million euros, which is equivalent to a drop of only 1.3 percent. In its core business, the specialist for PC-based control technology even achieved growth of 4.6 percent. A decline was particularly noticeable in the OEM business. Following this breathing space caused by the weak economy, Beckhoff plans on the new financial year bringing the usual above-average growth rates of previous years. Expansion is planned particularly for the export segment.

After some "breathing space", new growth targets are being aimed for

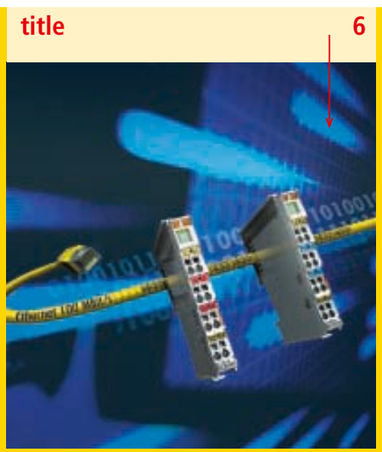
With a stable "support leg" on the international market, Beckhoff intends to become more independent of the sluggish domestic economy. "The fact that we have once again nearly reached our record sales of 2001 during the second crisis year in a row, and even achieved growth in our core business, is a very acceptable result for us", said general manager Hans Beckhoff. "New Automation Technology" has thus almost maintained the high level of 2001, when the company generated strong growth of 16 percent despite an already weak market. "This showed that our technology segments of PC control and fieldbus technology continue to gain significant market shares in industrial automation," Beckhoff continued.

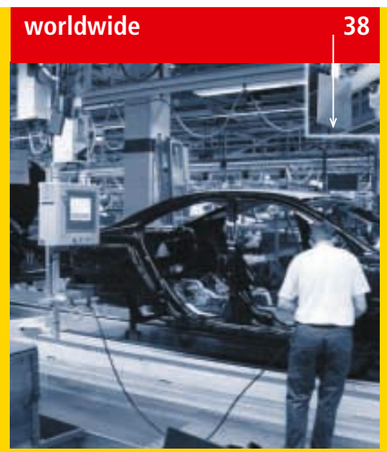
24 % growth in the first quarter

Beckhoff is very confident about the current financial year: New product ranges and the introduction of new basic technologies should lead to growth above market average. The first quarter of the current financial year gives reason to hope that the economic trough may have been passed - and at the same time indicates that many investments that were originally due in 2002 had been postponed to this year. This is how Beckhoff explains the remarkable jump in sales of 24 percent during the first quarter of 2003 compared with the first three months of 2002.

At the same time, the resolute expansion of the distribution network is intended to bring about additional dynamics. The emphasis is clearly on the international business. The establishment of our own subsidiaries in Sweden, Poland and Italy last year already marked the beginning of a new trend. The Austrian branch, in existence since June 1997, was transferred into an independent subsidiary as of June 1, 2002. For the markets of the Czech Republic and Slovakia, a new distribution partnership with Dyger s.r.o. was sealed last year.

This year, attention will be on central and eastern Europe, Asia and North America. "The export quota, already around 30 percent in 2002, should grow further", says Beckhoff about the company direction. Forecasts indicate that export sales could grow significantly by more than 20 percent this year.





Beckhoff EtherCAT – Ethernet for Control Automation Technology

Product announcement

Real-time Ethernet: Ultra high speed right up to the I/O

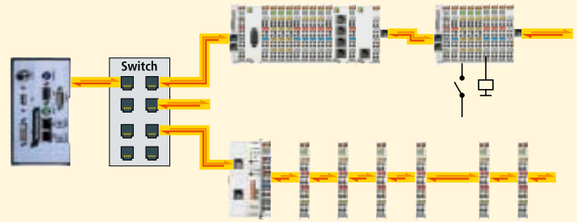
It was presented for the first time at the Hanover exhibition in Germany, and provided a talking point amongst automation engineers: EtherCAT – the new, real-time Ethernet network from Beckhoff. EtherCAT is remarkable for its exceptional performance, extremely easy wiring, and its openness to other protocols. Where conventional fieldbus systems come up against their limits, the real-time Ethernet system is setting new standards.

The properties speak for themselves: 1000 I/O in 30 µs, optionally twisted pair cable or optical fiber and, thanks to Ethernet and Internet technologies, optimum vertical integration. EtherCAT gives you the option of using the classic more expensive star topology or a simple low cost line structure - no expensive infrastructure components are required. EtherCAT uses very cost-effective standard Ethernet cards (NIC) while other real-time-Ethernet approaches require special and expensive cards in the controller.

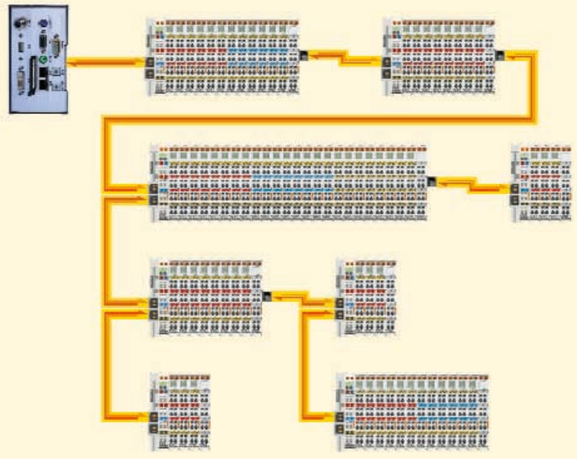
The EtherCAT operating principle

With EtherCAT technology, Beckhoff overcomes the system limitations of other Ethernet solutions: The Ethernet packet is no longer received, then interpreted and copied as process data at every connection. The newly developed FMMU (fieldbus memory management unit) in each I/O terminal reads the data addressed to it, while the telegram continues through the device. Similarly, input data are inserted while the telegram passes through. The telegrams are only delayed by a few nanoseconds.

Other Ethernet approaches cannot match the EtherCAT real-time capability. One approach includes disabling the CSMA/CD access procedure via higher level protocol layers and replacing it with a time slice procedure or a polling procedure. Another approach uses special switches that distribute Ethernet packets in a precisely controlled timely manner. These other approaches are all capable, to a certain degree, of quickly and accurately transferring data from the controller to the Ethernet node. However, these other approaches are limited because of delays from the Ethernet node to the actual I/O or drive controllers. The other approaches require a sub bus especially when using modular I/O systems. The other Ethernet approaches are made faster through synchronization of the sub bus system much like Beckhoff has done in the past with other existing fieldbus networks. However, the synchronization creates small delays to the communication bus that cannot be avoided. Beckhoff takes the next step in technology using the FMMU technology in EtherCAT.



Full duplex Ethernet in the ring, one telegram for many devices:
The EtherCAT system architecture increases the "communication efficiency".



Maximum flexibility for wiring: with or without switch, line or tree topologies can be freely selected and combined. Cost-effective twisted pair cable, selection of the transfer physics depending on requirements. Address assignment is automatic; no IP address setting is required.

Ethernet up to the terminal – complete continuity

The Ethernet backplane for the I/O modules is called E-bus. The E-bus transfers the data from one I/O point to another using a different electrical signal but not changing the Ethernet data. The first Ethernet node, called the Bus Coupler, converts the electrical signal from standard twisted pair or fiber optics to E-bus. The signal is converted to E-bus to meet electronic terminal block electrical signal requirements. The signal type within the terminal block (E-bus) is also suitable for transfer via a twisted pair line over short distances (up to 10 m). The terminal block can thus be extended very cost-efficiently. Subsequent conversion to Ethernet is possible at any time since the Ethernet data is never changed.

On the control side, very inexpensive, commercially available standard network interface cards (NIC) are used as hardware in the controller. The cards offered by Beckhoff bundle up to 4 Ethernet channels on one PCI slot and are based on the same architecture. The common feature of these interface cards is data transfer to the PC via DMA (direct memory access), i.e. no CPU capacity is taken up for the network access.

The NIC cards use the TwinCAT Y driver which operates seamlessly with the software operating system and the real-time system. This means the TwinCAT Y driver functions as a compatible network driver, and additionally as a TwinCAT Ethernet fieldbus card. The real-time system Ethernet frames have priority over the general operating system frames using an internal prioritization system. The general operating system's Ethernet frames, such as print spooling, Internet, and mail, are 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.

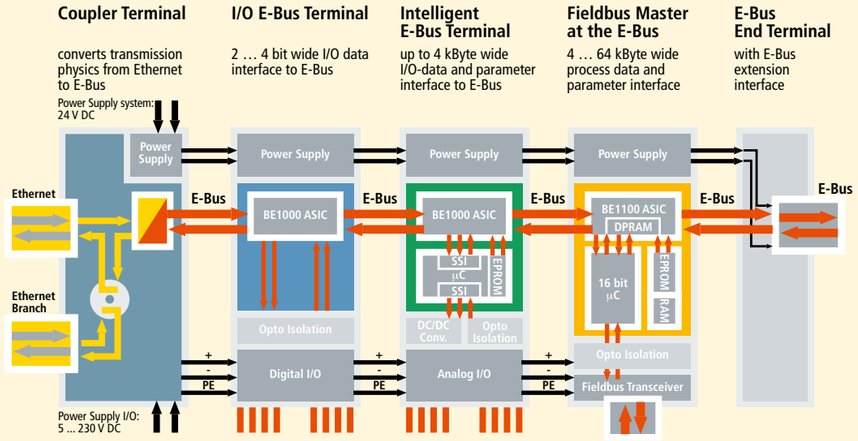
Since the Ethernet functionality of the operating system is fully maintained, all operating system-compatible protocols can be operated in parallel on the same physical network. This not only includes standard IT protocols such as TCP/IP, HTTP, FTP or SOAP, but also practically all Industrial Ethernet protocols such as Modbus TCP, ProfiNet or EthernetIP.

Optimized protocol directly within the Ethernet frame

The EtherCAT protocol uses a special Ether-type inside the Ethernet Frame. The Ether type allows transport of control data directly within the Ethernet frame without redefining the standard Ethernet frame. The frame may consist of several sub-telegrams, each serving a particular memory area of the logical process images that can be up to 4 gigabytes in size. Addressing of the Ethernet terminals can be in any order because the data sequence is independent of the physical order. Broadcast, Multicast and communication between slaves are possible. Transfer directly in the Ethernet frame is used in cases where EtherCAT components are operated with TwinCAT and in the same subnet as the control computer.

However, EtherCAT applications are not limited to TwinCAT as the control system: EtherCAT UDP packs the EtherCAT protocol into UDP/IP datagrams. This enables any control with Ethernet protocol stack to address EtherCAT systems. Even communication across routers into other subnets is possible. In this variant, system performance obviously depends on the real-time characteristics of the control and its Ethernet protocol implementation. The response times of the EtherCAT network itself are hardly restricted at all: The UDP datagram only has to be unpacked in the first station.

Protocol processing completely in hardware: The protocol ASICs are flexibly configurable. Process interface from 2 bit to 64 kB.



1000 I/Os in 30 µs | 200 analog I/Os in 50 µs | 100 axes in 100 µs

EtherCAT reaches new dimensions in network performance. Thanks to FMMU in the terminal and DMA access to the network card in the master, the complete protocol processing takes place within hardware and is thus independent of the run-time of protocol stacks, CPU performance or software implementation. The update time for 1000 I/Os is only 30 µs - including terminal cycle time. Up to 1486 bytes of process data can be exchanged with a single Ethernet frame - this is equivalent to almost 12000 digital inputs and outputs. The transfer of this data quantity only takes 300 µs.

The communication with 100 servo axes only takes 100 µs. During this time, all axes are provided with set values and control data and report their actual position and status. The distributed clock technique enables the axes to be synchronized with a deviation of significantly less than 1 microsecond.

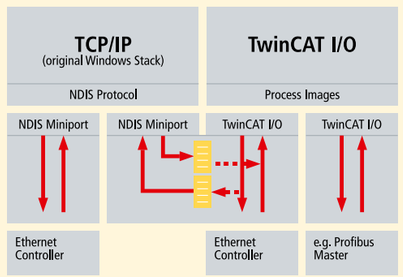
The extremely high performance of the EtherCAT technology enables control concepts that could not be realized with classic fieldbus systems. For example, the Ethernet system can now not only deal with velocity control, but also with the current (torque) control of distributed drives. The tremendous bandwidth enables status information to be transferred with each data item. With EtherCAT, a communication technology is available that matches the superior computing capacity of modern Industrial PCs. The bus system is no longer the "bottleneck" of the control concept. Distributed I/Os are recorded faster than is possible with most local I/O interfaces. The EtherCAT technology principle is scalable and not bound to the baud rate of 100 MBaud – extension to GB Ethernet is possible.

Topology – maximum flexibility

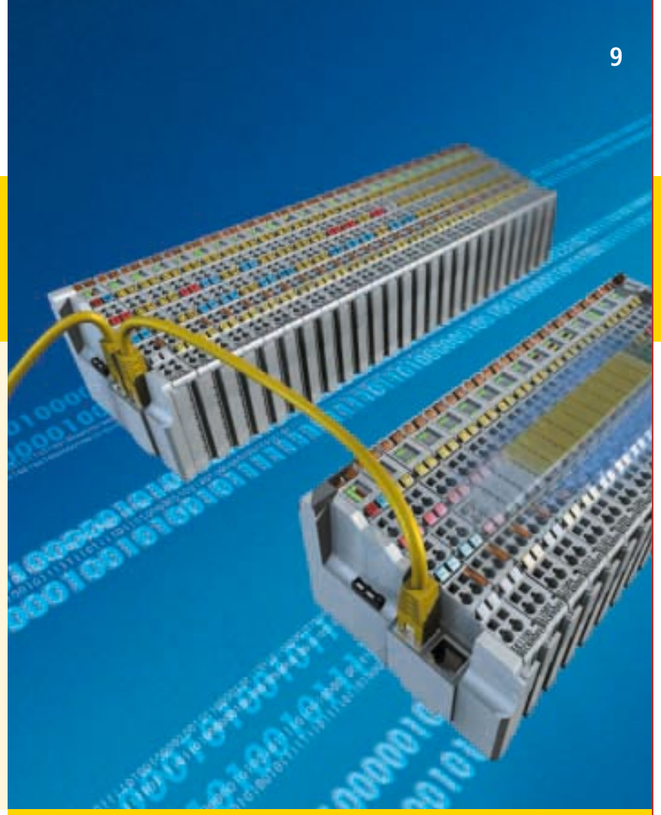
Line, tree or star: EtherCAT supports almost any topology. The bus or line structure known from the fieldbusses thus also becomes available for Ethernet. Particularly useful for system wiring is the combination of line and branches or stubs: The required interfaces exist on the couplers; no additional switches are required. Naturally, the classic switch-based Ethernet star topology can also be used.

Wiring flexibility is further maximized through the choice of different cables. Flexible and inexpensive standard Ethernet patch cables transfer the signals optionally in Ethernet mode (100Base-TX) or in E-bus signal representation. Plastic fiber optics (PFO) can be used in special applications. The complete bandwidth of the Ethernet network – such as different fiber optic and copper cables – can be used in combination with switches or media converters.

Fast Ethernet or E-bus can be selected based on distance requirements. The Fast Ethernet physics enables a cable length of 100 m between devices while the E-bus line is intended for distances of up to 10 m. The size of the network is almost unlimited since up to 65535 devices can be connected.

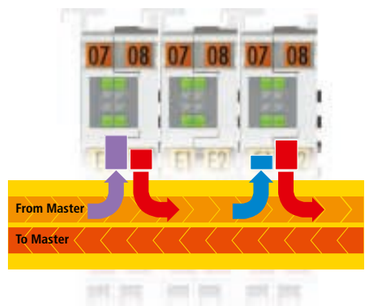


TwinCAT Y driver:
operating system-compatible



EtherCAT instead of PCI

The central PC becomes smaller and more cost-effective because additional slots are not needed for interface cards since the onboard Ethernet port can be used. With increasing miniaturization of the PC components, the physical size of Industrial PCs is increasingly determined by the number of required slots. The bandwidth of Fast Ethernet, together with the data width of the EtherCAT communication hardware (FMMU chip) enables new directions: Interfaces that are conventionally located in the IPC are transferred to intelligent interface terminals at the EtherCAT. Apart from the decentralized I/Os, axes and control units, complex systems such as fieldbus masters, fast serial interfaces, gateways and other communication interfaces can be addressed. Even further Ethernet devices without restriction on protocol variants can be connected via decentralized "hub terminals". The central IPC becomes smaller and therefore more cost-effective, an Ethernet interface is sufficient for the complete communication with the periphery.



FMMU (fieldbus memory management unit):
Telegram processing completely in hardware

Precise synchronization through distributed clock

Accurate synchronization is particularly important in cases where widely distributed processes require simultaneous actions. This may be the case, for example, in applications where several servo axes carry out coordinated movements simultaneously.

The most powerful approach for synchronization is the accurate alignment of distributed clocks, as described in the new IEEE 1588 standard. In contrast to fully synchronous communication, where synchronization quality suffers immediately in the event of a communication fault, distributed aligned clocks have a high degree of tolerance from possible fault-related delays within the communication system.

With EtherCAT, the data exchange is completely hardware based on "mother" and "daughter" clocks. Each clock can simply and accurately determine the other clocks' run-time offset because the communication utilizes a logical and full-duplex Fast Ethernet physical ring structure. The distributed clocks are adjusted based on this value, which means that a very precise network-wide time-base with a jitter of significantly less then 1 microsecond is available.

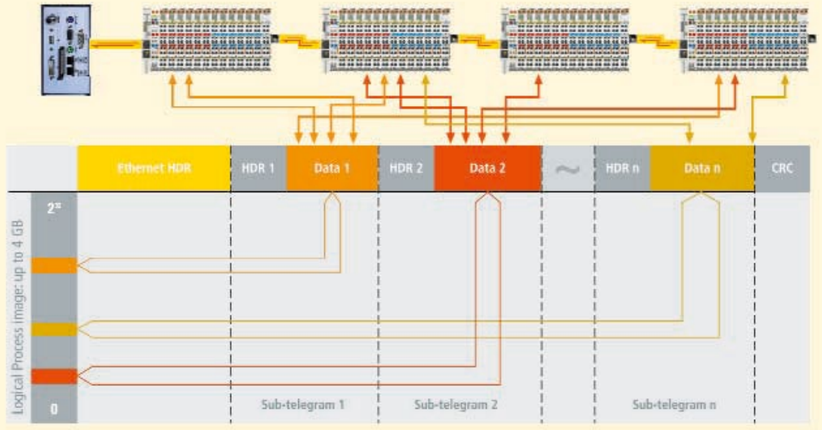
However, high-resolution distributed clocks are not only used for synchronization, but can also provide accurate information about the local timing of the data acquisition. For example, controls frequently calculate velocities from sequentially measured positions. Particularly with very short sampling times, even a small temporal jitter in the displacement measurement leads to large step changes in velocity. With EtherCAT, Beckhoff introduces new, expanded data types (time-stamp data type, oversampling data type). The local time is linked to the measured value with a resolution of up to 10 ns, which is made possible by the large bandwidth offered by Ethernet. The accuracy of a velocity calculation then no longer depends on the jitter of the communication system. It is orders of magnitude better than that of measuring techniques based on jitter-free communication.

Hot connect and diagnosis

The Hot Connect function enables parts of the network to be linked and decoupled or reconfigured "on the fly"; offering flexible responses to changing configurations. Many applications require a change in I/O configuration during operation. Examples are processing centers with changing, sensor-equipped tool systems or transfer devices with intelligent, flexible workpiece carriers. The protocol structure of the EtherCAT system takes account of these requirements.

Special attention was paid to exemplary diagnostic features during the development of EtherCAT. The Beckhoff comprehensive experience with fieldbus systems shows that availability and commissioning times crucially depend on the diagnostic capability. Only faults that are detected quickly and accurately and located unambiguously can be rectified quickly.

During commissioning, the actual configuration of the I/O terminals is checked for consistency with the specified configuration. The topology should also match the configuration. I/O verification is possible during start-up and also via automatic



The process image allocation is freely configurable. Data are copied directly in the I/O terminal to the desired location within the process image: no additional mapping is required. Very large address space of 4 GB.

Openness

Beckhoff has taken every effort to ensure EtherCAT technology is fully Ethernet-compatible and truly open. The protocol tolerates other Ethernet-based services and protocols on the same physical network – usually even with minimum loss of performance. There is no restriction on the type of Ethernet device that can be connected within the EtherCAT strand via a hub terminal. Devices with fieldbus interface are integrated via EtherCAT fieldbus master terminals. The UDP protocol variant can be implemented on each socket interface. Finally, the intention is to disclose the technology once the development work is completed.

configuration upload because of the built-in topology recognition.
Bit faults during the data transfer are reliably detected through evaluation of the 32 bit CRC checksum, which has a minimum hamming distance of 4. The EtherCAT protocol, transfer physics and topology enables quality monitoring of each individual transmission segment. The automatic evaluation of the associated error counters enables precise localization of critical network sections. Gradual or changing sources of error such as EMC influences, defective push-in connectors or cable damage are detected and located, even if they do not yet overstrain the self-healing capacity of the network.

Ethernet Terminals
The existing wide range of K-bus I/O terminals from the proven Beckhoff Bus Terminal line can be networked with EtherCAT. The range includes appropriate bus couplers which are the network interface for the modular I/O terminals. This ensures compatibility and continuity with the existing system. Existing and future investments are protected.

EtherCAT Highlights

Performance
| 256 digital I/Os in 12 µs
| 1000 digital I/Os in 30 µs
| 200 analog I/Os (16 bit) in 50 µs, corresponding to 20 kHz sampling rate
| 100 servo axes in 100 µs
| 12000 digital I/Os in 350 µs
| Throughput: 10 kB/ms, distributed to 1,500 devices

Topology
| Line, tree or star topology
| Up to 65,535 devices
| Network size: almost unlimited (> 500 km)
| Operation with or without switches
| Cost-effective cabling: standard Ethernet patch cable (CAT5)
| Twisted pair physical layer:
| Ethernet 100BASE-TX, up to 100 m between 2 devices
| E-bus, industrial grade Ethernet, up to 10 m between 2 devices
| Optional fiber optic cable from 50 to 2000 m
| Hot connect/disconnect of bus segments

Address space
| Network-wide process image: 4 GB
| Device process image: 2 bit to 64 kB
| Address allocation: freely configurable
| Device address selection: automatically via software

Protocol
| Optimized protocol directly within the Ethernet frame
| Fully hardware-implemented
| For routing and socket interface: UDP datagram
| Processing while passing
| Distributed clock for accurate synchronization
| Time stamp data types for resolution in the nanosecond range
| Oversampling data types for high-resolution measurements

Diagnostic
| Breaking point detection
| Continuous “quality of line” measurement enables accurate localization of transmission faults

Interfaces
| Hub terminal for standard Ethernet devices
| Fieldbus terminals for fieldbus devices
| Decentralized serial interfaces
| Communication gateways

Openness
| Fully Ethernet-compatible
| Operation with switches and routers possible
| Mixed operation with other protocols also possible
| Internet technologies (web server, FTP, etc.)
| Compatible with the existing Bus Terminal range
| Disclosure in preparation

Ethernet is becoming established as the standard communication medium for automation technology. Beckhoff expands the Ethernet market with new, powerful components. PCI Ethernet cards and Ethernet switches complement the Beckhoff system solution (for example EtherCAT), but they can also be used outside automation in any IT application requiring robust industrial technology. The network cards and switches meet the special requirements of real-time-capable Industrial Ethernet solutions through several outstanding features.

Industrial Ethernet components

PCI Ethernet cards
The features of FC900x Ethernet PCI network cards from Beckhoff make them suitable for a range of applications in office and automation networks. Up to four Ethernet channels are bundled on one slot, saving space and costs. Furthermore, the Ethernet network cards have a plug & play interface and can be used with a standard operating system driver. The baud rate is 10/100 MBaud in full duplex mode. The baud rate is set automatically for each channel according to IEEE 802.3u. Hardware-integrated checksum creation and verification ensure maximum performance. Furthermore, the hardware side supports Quality of Service (QoS) through prioritized multiple queues. The PCI cards support all Ethernet-based protocols. For each channel, a RJ45 socket is available as interface: 10BASE-T/100BASE-TX Ethernet. Naturally, the cards (or individual channels) can also be operated with TwinCAT drivers – and therefore in real-time.

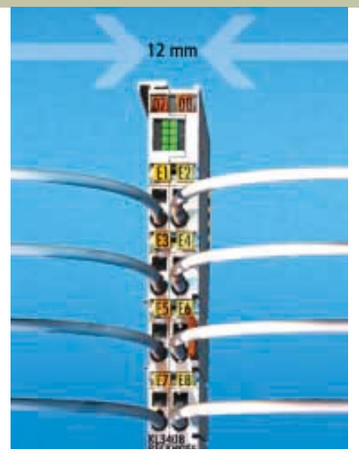
Ethernet switches
The Beckhoff Ethernet switches ES2008 and ES2016 offer 8 or 16 RJ45 Ethernet ports. Switches relay incoming Ethernet frames to the destination ports. In full duplex mode, they prevent collisions. They can be used universally in automation and office networks. The switches are easily mounted on standard DIN rail via the integrated adapter.
The robust and user-friendly DIN rail design, i. e. a compact size, stainless steel housing make the switch ideal for industrial environments. The baud rate is 10/100 MBaud, in semi or full duplex mode, with automatic baud rate detection and adjustment. Crossover detection enables automatic detection and correction of crossover and straight-through Ethernet cables. 3 LEDs for each Ethernet port enable quick diagnostics. The switches meet the special requirements of real-time-capable Industrial Ethernet solutions through several outstanding features:
| All Ethernet (IEEE 802.3) based protocols are supported, store-and-forward switching mode
| Optional broadcast filtering supports the integration of any Ethernet devices in real-time environments
| Optional packet-based or port-based prioritization (QoS, VLAN)
| 10BASE-T/100BASE-TX Interface with 8 x RJ45 or 16 x RJ45
| Cable length up to 100 m twisted pair, switches cascadable without restriction
| Baud rate: 10/100 Mbit/s, IEEE 802.3u auto-negotiation, half or full duplex at 10 and 100 Mbit/s possible, automatic settings
| Hardware diagnosis: 3 LEDs per channel (link/activity, 10/100 Mbit, collision/full duplex)
| Power supply: 24 (18 … 30) V DC, 200 mA

Product announcement

Estimated market release of the FC900x PCI Ethernet cards and the ES20xx Ethernet switches 3rd quarter 2003. We reserve the right to make technical changes.

Ultra-compact: 12 mm wide 8-channel analog I/O modules

More compact, more powerful and less expensive - these are the aims of the new extensions for the Bus Terminal system. The Beckhoff I/O system now supports more than 150 Bus Terminals and is the most comprehensive and proven I/O system on the market. The most recent highlight is the 8-channel analog Bus Terminals. Analog inputs or outputs are compacted into a 12 mm wide Bus Terminal housing.



Beckhoff has expanded the analog type of bus terminals by 24, not to mention the other signals which have been added. Optimizing cost and increasing the channel density was the Beckhoff development focus. The standard analog signals of ± 10 V, 0 … 10 V, 0 … 20 mA and 4 … 20 mA are available as 1-, 2-, 4-, and 8 channel variants within a standard size housing. Customers can configure their analog I/O right down to the exact number of I/O needed. Gone also is the need for added spares since additional I/O is easily added.

The KL30x1 and KL40x1 single-channel analog terminals mean you get only one channel when you need only one channel. A further advantage is offered for applications where electrical isolation is required between the channels. In the new KL34x4 and KL44x4 4 channel bus terminals, the four inputs are 2-wire versions and have a common ground potential. The KL3454 is a special version, enabling direct connection – without auxiliary voltage – of 4 … 20 mA sensors, which are supplied via the sensor current.

The KL34x8 and KL44x8 variants combine 8 channels in one housing and are particularly suitable for space saving installation in control cabinets. The use of single wire connection technology enables the connection of multi-channel sensor technology with minimum space requirements.

New relay and power supply unit terminal

Remember we said Beckhoff has developed other terminals besides the 24 new analog terminals? Now there is the KL2641 Relay Terminal, which is optimally tailored to the requirements of building automation through optional manual operation. Now the Bus Terminal system using the KL2641, rated for 440 V AC and 16 A, can directly turn devices on and off without additional costly contactors.

The Bus Terminal system was also expanded in terms of power supply unit terminals. Auxiliary voltages can be generated directly in the bus terminal station. In addition to the new KL9512 for 12 V DC, power supply unit terminals for the following voltages are available: 5 V DC, 8 V DC, 10 V DC and 15 V DC.

Product announcement

Estimated market release for the 4/8 channel analog terminals 3rd quarter 2003. The 1 channel Bus Terminals and the KL2641/KL9512 are already available. We reserve the right to make technical changes.

Overview of the new analog input/output terminals

Signal	Analog Input			Analog Output		
	1 channel	4 channel	8 channel	1 channel	4 channel	8 channel
± 10 V	KL3001	KL3404	KL3408	KL4031	KL4434	KL4438
0 … 10 V	KL3061	KL3464	KL3468	KL4001	KL4404	KL4408
0 … 20 mA	KL3011	KL3444	KL3448	KL4011	KL4414	KL4418
4 … 20 mA	KL3021	KL3454	KL3458	KL4021	KL4424	KL4428

Uncoupled AS-Interface networks

The KL9520 AS-i potential feed terminal represents an optimum extension of the AS-Interface product range. The KL9520 complements the existing KL6201 AS-i master terminal and the KL9528 power supply terminal, enabling space saving and cost-effective integration of AS-i networks.

The AS Interface master terminal enables the direct connection of AS-i slaves. The AS-i compliant interface supports digital and analog slaves, versions 2.0 and 2.1. The KL9528 power supply terminal generates the required voltage from the 24 V DC control voltage via high-frequency decoupling.

The new potential feed terminal with KL9520 filter closes a further gap towards smaller and more price-sensitive applications. Instead of a power supply unit, this terminal includes a filter and the switch component for generating the required signal voltage. The AS-i network is fed directly from the 24 V supply. This voltage level is adequate for a large number of applications and offers a significant price benefit.

A further application for the KL9520 is uncoupling of AS-i networks, for example for supplying a "large" AS-i power supply unit with an output current of up to 8 A. Using a KL9520 filter terminal and a KL62x1 AS-i master terminal, a further AS-i network can be configured and supplied from a power supply unit.

Product announcement

Estimated market release for the potential feed terminal KL9520 3rd quarter 2003.

→ www.beckhoff.com/KL6201/

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

- → universal built-in PC
- → more than 50 front variants
- → 10, 12, 15, 18 or 20 inch TFT display
- → 7 slot ATX motherboard

The Beckhoff Built-in Control Panel with Add-on PC

The CP65xx add-on PC from Beckhoff transforms all versions of the built-in Control Panels into powerful Panel PCs:

- → 7 slot ATX motherboard with Intel Celeron or Intel Pentium III 850 MHz
- → optional CD-ROM or CD-R/W drive in addition to the floppy drive
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- → drives and plug-in cards are accessible quickly and easily
- → all connections are located on the top

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BECKHOFF New Automation Technology

Safety technology with TwinSAFE Bus Terminals and PROFIsafe technology

Fieldbus technology has benefited users in nearly all automation applications. The wiring effort has been reduced, and the machines and systems have become more modular and smaller. New techniques and components tap further potential for rationalization. A previously unexploited aspect of fieldbus technology, safety technology, is now attracting more and more attention.

Fieldbus technology? – A safe bet!

The wiring of Emergency Off switches, light barriers and other components ensuring machine safety now takes up a significant proportion of the space available in cable ducts and control cabinets. High time for fieldbus technology to deal with the transfer of safety-relevant signals. Technically this has already been possible for some time, but the problem so far has been the absence of a manufacturer-independent open interface with a certificate guaranteeing adequate safety.

With the integration of safety technology into the Beckhoff Bus Terminal system, the advantages of the fieldbus system now also apply to applications in the machine and plant safety sector. The new TwinSAFE Bus Terminals are PROFIsafe-compatible and can be operated in stand-alone mode or with an associated fail-safe control.

The I/O construction kit is extended "safely"

The merging of safety and I/O equipment in the Bus Terminal system provides added benefits to the customer. The total solution costs in terms of components, assembly and planning work are minimized. A reduced number of interfaces makes the system easier to comprehend, and simplifies access to all safety-relevant information.

The "safety technology" in the I/O system opens new applications to the user, allowing machines and plants to become more compact and efficient. Applications automated with TwinSAFE offer significantly higher diagnostic levels and reduced downtimes. The user only needs to know one system, TwinSAFE, and not multiple safety systems.

With the new TwinSAFE Bus Terminals, Beckhoff offers the option of expanding the proven Bus Terminal system very easily with safety Bus Terminals, thereby replacing the complete cabling for safety circuits. "Safe" signals can be mixed with standard signals without restriction. This saves design effort, installation and material. Maintenance is simplified significantly through faster diagnosis and simple replacement of only a few components. The new TwinSAFE Bus Terminals only include three basic functionalities: digital KL19xx input terminals, digital KL29xx output terminals and a KL6900 link unit. This enables all common safety sensors and actuators to be connected, e.g. emergency off switch, safety lock, position switch, two-hand switch, cable-operated switch, light curtain, light barrier, laser scanner etc., as well as actuators such as contactor, protective door switch with tumbler, signal lamp or servoamplifier.

PROFIsafe-based safety concept

The TwinSAFE Bus Terminals are based on the new PROFIsafe standard. Together with a PROFIsafe-compatible fail-safe control, applications ranging from simple to complex can be realized. The Profibus User Organization (PNO) has created a "profile" for secure data transmission in PROFIsafe that permits safety devices to be operated within the Profibus network. No changes to the RS485 bus cable or the wiring are required. Only one fieldbus system for safety-related and non-safety-related automation tasks is implemented. PROFIsafe can be used for tasks up to SIL3 IEC 61508, Cat. 4 EN 954 or DIN V 19251 AK 6. Mechanisms were created for safeguarding the data against the following types of fault: repetition, loss, insertion, wrong sequence, corruption of the user data, delay, coupling of safety-relevant and non-safety-relevant data and incorrect addressing.

PROFIsafe offers consecutive numbering of the safety telegrams. The communication is time-monitored at the master and at the slave and is password-protected. For safeguarding data integrity, PROFIsafe uses a 16/32 bit CRC (cyclic redundancy check). A maximum of 12 (16 bit CRC) or 122 bytes (32 bit CRC) of fail-safe data can be transmitted per telegram. As part of the secure telegram, the PROFIsafe user not only transfers user data but also a status byte or a control byte. The state of the communication partner and of the data transmission link is checked for each telegram via the life counter, (sequenz number).

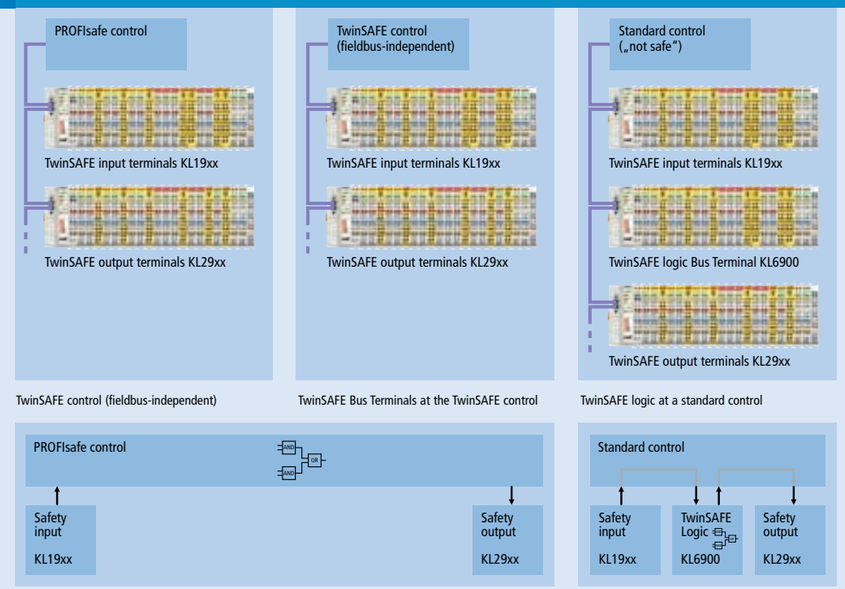
Fieldbus-independent solution

The mechanisms used by PROFIsafe keep the data inside a data frame safe from the possible effects of the transmission route. As well as Profibus, this route could include any other transmission system. From the point of view of a bus system, PROFIsafe represents a small data block that has to be transported coherently and without error – which is not a particularly difficult task for a fieldbus. The implementation of secure data packing in a Bus Terminal means that the secure data is available for any fieldbus. The only condition is that an appropriate Bus Coupler exists for the bus system. The facility for also transmitting the PROFIsafe data over a number of different bus systems at the same time is particularly helpful for users. "Secure data" can therefore be exchanged across the boundaries of different controllers and systems.

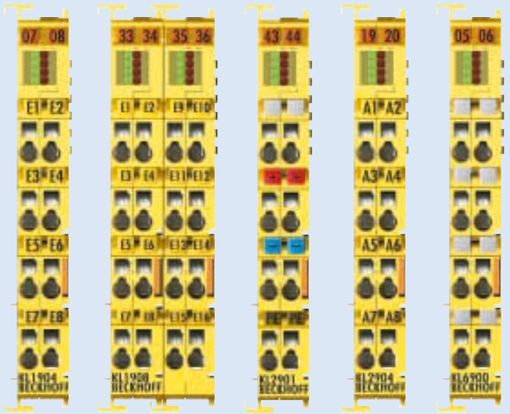
Fail-safe PLC functionalities in Bus Terminals

The current safety solution using one or more safety relays gets expensive because of the very limited possibilities for combining the signals logically. The classic safety PLC saves space and makes assembly easier, but can cost more than the drives, PLC, and HMI combined. The controller looks on either of these approaches as an isolated solution. The interface that is able to provide information about the status of the safety controller consists of a few digital signal contacts that are given additional wiring, or of a fieldbus interface that requires considerable effort to parameterize.

The TwinSAFE Bus Terminals operate together with PROFIsafe-compatible secure controllers. In small to medium-size applications, the secure inputs and outputs are operated on a "non-secure" controller with the KL6900 TwinSAFE Logic Bus Terminal. A higher-level PLC or a CX1000 Embedded PC or a series BC or BX Bus Terminal Controller with directly connected safety terminals can serve as controller. The TwinSAFE Logic Bus Terminal is the link unit between the safety input and output terminals. It enables the configuration of a simple, flexible and cost-effective decentralized fail-safe control with up to 64 channels. To this end, the required logical safety functions for linking the inputs with the outputs are implemented as a function block and are parameterized depending on the application. For small configurations, the tasks of a small fail-safe PLC can thus be handled within the Bus Terminal system. The additional expense required for the in-



Standard and safety I/Os in a single system



The KL1904 and KL1908 TwinSAFE Bus Terminals are digital input terminals with four and eight fail-safe channels respectively. With two-channel connection, the terminals meet the requirements of IEC 61508 SIL3 and EN 954 Cat. 4 or DIN V 19251 AK6.

The KL2904 TwinSAFE Bus Terminal is a digital output terminal with four channels. It switches 24 V DC actuators with up to 2 A. The safety standards SIL3 according to IEC 61508 or EN 954 Cat. 4 and DIN V 19251 AK6 are satisfied by the KL2904 Safety Bus Terminal. If the Bus Terminal detects a fault, it switches off automatically (fail stop).

The KL2901 TwinSAFE Bus Terminal is a potential feed terminal with integrated switch-off of the power supply. These feed terminals can be placed at any location between the input and output terminals of a Bus Terminals station. The potential is transferred to the subsequent Bus Terminal via the power contacts. This enables separate potential groups to be realized at a bus station. The KL2901 communicates with the fail-safe control via the PROFIsafe protocol and can be switched off by a higher-level fail-safe control. Switch-off also occurs if the terminal detects an internal fault (fail stop).

terface in the controller PLC is no longer needed. All the states of the "safe controller" are generally available. The KL6900 is suitable for applications up to SIL3 (Safety Integrity Level) according to IEC 61508 or EN 954 Cat. 4 and DIN V 19251 AK6.

The TwinSAFE Logic is easily parameterized via the Bus Coupler or the fieldbus. For the PC, the TwinCAT System Manager is available as a tool. Independently of TwinCAT, the KL6900 can be configured through the Bus Coupler using the KS2000 configuration software. Parameters that have once been chosen are stored in the terminal and secured against power failure or corruption. Access is password protected. Operation is only possible in a secured condition that has not been interfered with.

With the Beckhoff Bus Terminals and based on PROFIsafe, users can now install and operate comprehensive automation networks, including safety-relevant applications, very cost-efficiently. The TwinSAFE system offers open standard hardware and software interfaces for safety technology. Through co-operation in the working groups of different user organizations, Beckhoff have actively contributed to the implementation of new technologies in user-friendly standards.

Further developments

The Safety Logic KL6900 brings a new performance class to the world of secure signal processing: it is more than a relay, and less than a secure PLC. The KL6900 is limited to a maximum of 64 channels, in order to hold the cost down for small and simple applications. The number of channels can be increased by combining more than one KL6900. Using the Safety Logic at the various hierarchical levels of the secure signals makes an ideal adaptation to the requirements of the plant possible. Complex signal processing and reaction times below 50 ms remain tasks that must be undertaken by a secure PLC.

As a next step, Beckhoff will offer a fast, secure PLC. A total reaction time for the system of 2 ms and a link time of 100 µs for 1 kB commands are the targeted performance. The secure PLC is under development as a piggy back for plugging on to a PC fieldbus card or a fieldbus master in the CX1000 Embedded PC family. Programming is carried out, as usual, in IEC 61131-3. The link to the "non-secure" part of the PLC is automatically implemented by the system. From the user's point of view, the secure signals are simply "secure variables" that can be linked into the program at any location.

Product announcement Estimated market release for the TwinSAFE terminals KL190x, KL2904, Kl2901 4th quarter 2003. The TwinSAFE logic terminal in 1st quarter 2004. We reserve the right to make technical changes.

The C6920 control cabinet PC from Beckhoff is the first model of a new generation of Industrial PCs: small, compact, without extensions slots, and equipped with all basic interfaces. With the entry of real-time Ethernet into automation technology, the shape of housings is changing. Fieldbus cards are no longer needed - the standard Ethernet port is used as the communication interface. With two on-board Ethernet interfaces, the C6920 is therefore equipped for EtherCAT, the new Ethernet real-time solution from Beckhoff.

The new Industrial PC C6920 rounds off the Beckhoff lower end PC offering, in terms of design and price. The Industrial PC is designed for control cabinet installation and is equipped with a slot motherboard. Despite its very small design measuring only 82 x 160 x 215 mm (W x H x D), the Industrial PC with Intel Celeron 733 MHz or Intel Pentium III 850 MHz processor offers a powerful basis for PC-based control. The control cabinet PC integrates all main PC interfaces: 2 x RS232, 2 x USB, 1 x DVI, two PS/2 interfaces for keyboard and mouse connection and two Intel Ethernet adapters with 10/100 Base-T. Optionally, a flash disk can be used as memory medium instead of the 2 ½ inch IDE hard disk.

With regard to price and performance, the new C6920 is positioned between the C63xx series control cabinet PCs and the modular Embedded PC CX1000. The PC hardware platform for PLC and motion control tasks thus becomes even more finely scalable.

The robust stainless steel PC weighs only 3 kg and enables PC controllers with minimum space requirements. It is installed via the rear panel or alternatively via the side panel. The design enables it to be used in small switch or terminal boxes.

However, the smallest variant of the control cabinet PCs is not restricted to Ethernet-based controls. Optionally, standard fieldbus masters can be integrated, which are factory installed to the motherboard via the PC104 interface.

The IPC can be operated "headless" without monitor or via the DVI/USB interfaces with a Beckhoff Control Panel from the CP68xx or CP78xx range. In the Panel PC version, the Industrial PC is mounted behind the Beckhoff built-in Control Panel. The Panel PC series CP69xx is designed for installation in the front of a control cabinet. Built-in Control Panels with DVI and USB connection in the sizes 6.5, 10, 12, 15 or 18 inches form the front of the Panel PC. The right display size and keyboard are thus available for every application. The Panel PC variant has an external case made from aluminum.

Product announcement Estimated market release 3rd quarter 2003. We reserve the right to make technical changes.

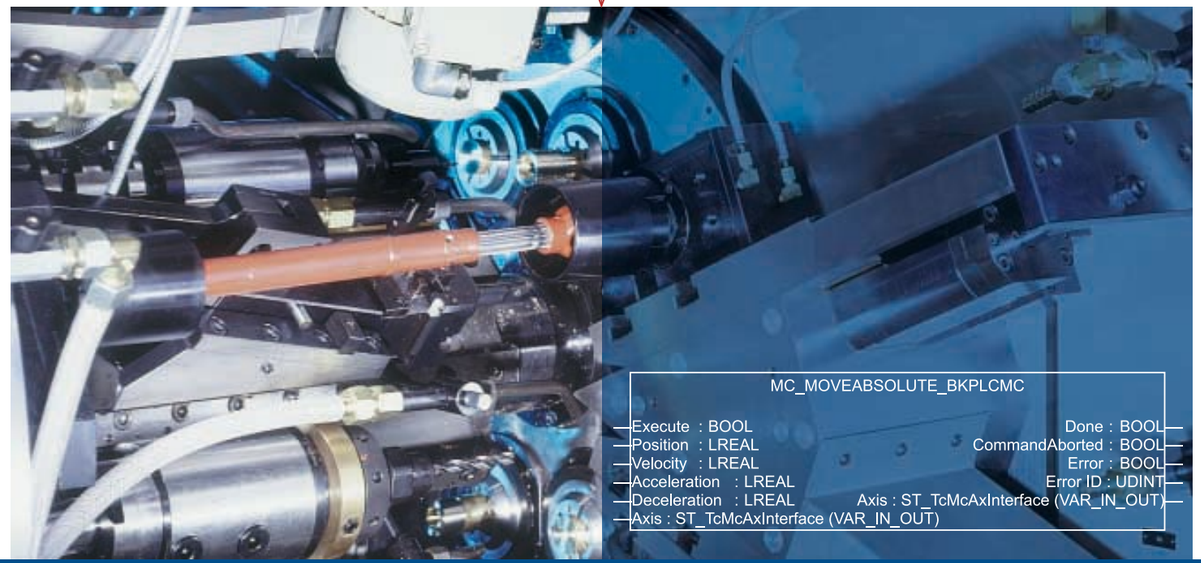
Features of the Control Cabinet PC C6920

Housing

- Industrial PC for space-saving control cabinet mounting,
- All connections on one side
- Detailed information about the PC configuration can be found on the housing
- Stainless steel housing in protection class IP 20
- Operating temperature 0 to 55 °C
- Weight with basic equipment approx. 3 kg
- External dimensions (W x H x D) 82 x 160 x 215 mm without mounting plate

Features

- Intel Celeron 733 MHz processor, optionally Intel Pentium III 850 MHz processor
- Slot motherboard with Socket 370 for Intel Celeron or Pentium III
- 128 MB SDRAM DIMM module, extendable up to 512 MB
- On-board graphics adapter, DVI interface, monitor connection
- DVI and USB interface for connecting a CP68xx or CP78xx Control Panel
- IDE hard disk, 2 ½ inch, 20 GB
- 2 serial RS232, 2 USB interfaces on-board
- PS/2 keyboard and mouse connections
- Dual Intel Ethernet adapter on-board with 2 x 10/100 Base-T connection
- 24 V DC power supply unit
- Optional: configuration as CP69xx Panel PC



Most motion control tasks are nowadays solved with electro-mechanical drives. Over recent years, applications using drive technologies have shifted away from hydraulics. The „old fashioned" reputation of hydraulics, however, is quite unjustified, because today there is still a wide range of applications in which its specific mix of properties matches the requirements ideally. Along with electrical drive technology, Beckhoff are also active with products and solutions in the hydraulic field.

Hydraulics are gaining force

There is still a significant number of specialized hydraulic controllers being used for one axis, or for a very small number of axes. These systems still require an additional PLC for automation purposes. PC-based control technology, like in so many other branches of automation, eliminates the need for separate hydraulic controller and PLC.

The TwinCAT automation software combines the PLC and Motion Control disciplines in one system. The Motion Control part is well known for its versatile and powerful handling of servo drives. This is well proven in a wide variety of applications now including hydraulic applications.

The wide variety of control elements, and the possibility of combining them (valves, adjustable pumps) and actuators (cylinders, motors) allows hydraulic drives to offer a wide spectrum of combinations of properties. A few hydraulic axes behave similarly to electrical drives, and can effectively be treated as such. Most of them, however, require a fundamentally different control technique.

Hydraulic drives have been replaced by electrical drives in many applications, because electrical drives are easier to implement, and still meet the particular requirements. Recently, this trend has lost some force for just the reason; hydraulic drives are better at handling large forces such as:

- Transporting heavy loads
- Bending, stamping and other forming processes
- Pressing and compressing
- Jointing and assembly

Hard real-time and high computing power

The universal Beckhoff automation tool box offers both standard components and special solutions for hydraulic drive technology. As far as software is concerned, TwinCAT offers the basis for the controller. The real-time performance of the TwinCAT controller easily achieves the lower millisecond range (typically 1 or 2 ms), and demonstrates, depending on the fieldbus in use, a jitter of some or a few tens of µs. The real-time performance of a TwinCAT controller is therefore on the same level as that of the usual, specialized hydraulic controller, and can also take over its function.

A modern PC CPU does not require any more time to execute the algorithms required for a hydraulic axis than it does for the corresponding mathematics for a servo drive. Beckhoff have proven many times, 10 to 50 axes can be operated with 1 or even 2 ms cycle times. The PLC program and the Hydraulic motion program are completed using TwinCAT software on a Beckhoff Industrial PC or any PC for that matter (currently this is typically a Pentium III or IV running at 1 GHz or more). TwinCAT comes in a base PLC package but also includes motion packages such as point to point motion (TwinCAT NC PTP) and interpolated motion (TwinCAT NC I), not to mention full CNC capability.

Even the standard TwinCAT PLC software package is suitable for controlling a few hydraulic axes. If linear zero-crossing valves are used with double rod cylinders, it is possible to exploit the full functionality of TwinCAT NC PTP, NC I and even CNC without any further extensions.

In order to handle single rod cylinders and valves with a bend in the characteristic, the use of the optional TwinCAT Valve Diagram Editor (see text on page 21) is recommended. The AH2000 Hydraulic Controller, providing decentralized control, is available to meet the demands for precision of the high end sector, such as chip removal machine tools. The AH2000 converts the combination of valve, cylinder and displacement measuring system into a hydraulic servo, and this is handled by the machine controller in the same way as an electrical servo.

Hydraulic varieties: valves, actuators, sensors

Double rod cylinder and single rod cylinder

A distinction is made between double rod and single rod cylinders, depending on whether the active piston areas on the two sides of the hydraulic cylinder are equal or not. The structural reason for this is either that there is just one piston rod, on one side, or that the two piston rods on the two sides have different diameters. Single rod cylinders have a significantly asymmetrical behavior: the reference speed differs according to the direction of movement. If this is not considered in the feed forward control, then significant following errors proportional to velocity will arise in at least one direction.

Part-turn valve actuators and hydraulic motors

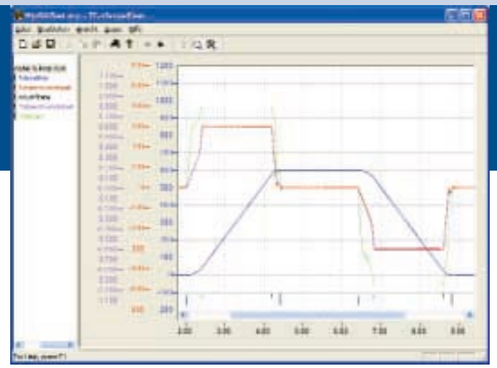
These are rotary actuators, whose working angle may or may not be limited. A wide variety of constructions are commonly found, differing in a number of details.

Positioned and position-controlled proportional valves

If the coil current is quasi-continuously controlled by a PWM signal, the valve opening, and therefore the oil flow, can be more or less finely controlled. This calls for an appropriate digital power stage, housed either as a plug-in unit or as an encapsulated module in the control cabinet, or given a sealed construction to be mounted directly on the valve. The return force is generated either by a spring or by a second electromagnet. If the moving part of the valve is fitted with a position sensor, then its movement and position can be controlled through suitable electronics. The properties of the valve (precision, resolution, repeatability, positioning speed, limiting frequency) can be significantly improved, although this does have a marked effect on price.

Servo valves

Whereas proportional valves are usually constructed according to the sliding vane principle, a small torque motor operating against a spring is



The hydraulic library movement profiles.

PLC libraries simplify programming

The TwinCAT PLC „Hydraulic Positioning" library for hydraulic control tasks simplifies the positioning of hydraulic axes and the synchronization with PLC operations. These IEC 61131-3 building blocks are not significantly different from their counterparts for electrical drives. The PLCopen Motion Control Standards specify the rules for axis operations. On the other hand, the hydraulic software runs in the standard PLC environment, and is fully transparent. If the appropriate care is taken, read and even write access can be made to internal data. This is the maximum achievable integration of motion control and automation.

High data throughput

Because the Beckhoff I/O products support a broad spectrum of fieldbusses, it is almost always possible to select an attractive version that meets the particular

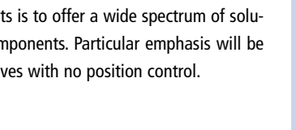
found inside a servo valve. It is often not necessary to regulate the valve. These valves are very fast, and are therefore used in test equipment; they are, however, only rarely found in machine and plant construction applications.

Typical valve characteristics

The construction of the openings in the valve can be used to adapt the transfer characteristics of a hydraulic axis to the special features of the particular application. Many valves have an unusable region close to the zero point. The position of the axis is then not practicably controllable, but it can be fitted, with no further difficulty, with an extremely effective holding brake that acts even when the power supply fails. In other valves, there is a bend in the curve at 40 or 60% drive. This must be compensated for in the feed forward and control of the axis, since otherwise highly variable following errors can occur, depending on the axis velocity, and they can be quite large.

Common sensors

As is the case with electrical drives, the position of the axis is acquired by means of incremental encoders or absolute SSI encoders. The principles employed for the measurement differ greatly, particularly with the latter type. Analog encoders in the form of linear or rotary potentiometers are, however, also often found. Non-contacting types are often used, in order to achieve a suitable service life. The relatively poor displacement resolution is often not a problem, since the positional accuracy only has to reach a few 1/10 mm. Piezo transducers are often used as pressure sensors, providing a 0…10 V or 0/4…20 mA signal.



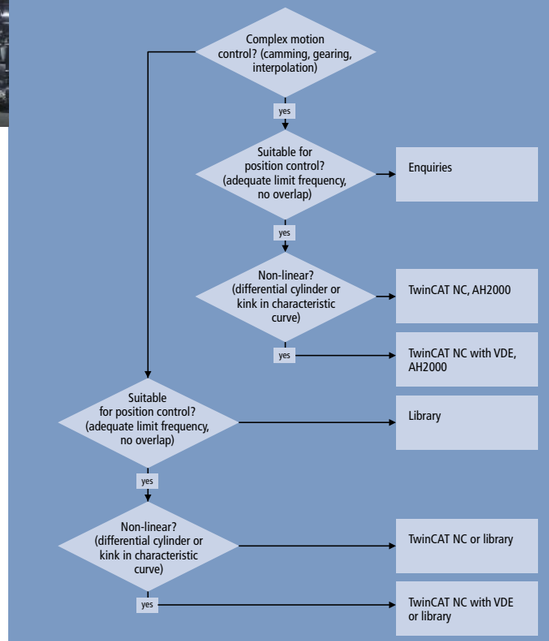
requirement. All the signals that occur in hydraulic applications are available in the Bus Terminal or Fieldbus Box product ranges. This applies both to actual values of position and pressure as well as to valve operation values. The EtherCAT system, the real-time Ethernet solution from Beckhoff, introduced at this year's Hanover exhibition, and the new Ethernet terminals that belong to it, will leave nothing to be desired even for the high end sector. Even the I/O systems of proprietary hydraulic controllers only rarely offer higher performance. The requirements of practically all industrial hydraulic systems can be implemented very economically.

Outlook

All the important functions of motional hydraulic systems are already available. The AH2000 is a complete controller that offers force regulation that simulates torque limitation by an electrical servo. The composition and form of the functions will be oriented towards practical requirements, and will be incorporated in the form of blocks in the PLC library.

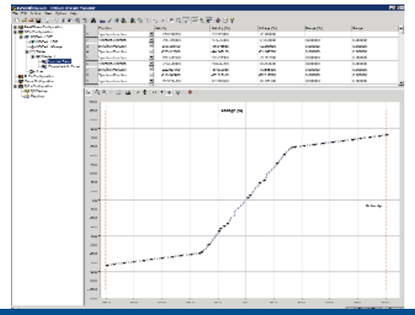
Software blocks with modern design make it as easy for the automation engineer to organize hydraulics as an electrical solution, because the different technologies can be freely mixed without restrictions arising from special controllers. The integration of Motion Control and machine sequences must be simple and effective.

The aim of the Beckhoff hydraulic specialists is to offer a wide spectrum of solutions with a large number of hydraulic components. Particular emphasis will be placed on economical versions, such as valves with no position control.



Which TwinCAT product?

The decision tree shown here gives an initial impression of the variety of software relevant to hydraulic applications. The details should, of course, always be analyzed together with the marketing staff and technical specialists. The very open system often allows exciting solutions, frequently taking creative leaps beyond the boundaries of conventional solutions.



The curve is drafted interactively using a graphical TwinCAT Valve Diagram Editor in the System Manager.

The linearization of characteristic curves with the TwinCAT Valve Diagram Editor

Hydraulic cylinders and their associated valves typically have a non-linear transmission behavior. The velocity of the hydraulic cylinder is therefore not proportional to the valve's drive signal. To drive these axes conveniently, the TwinCAT system permits the curve to be linearized in the NC real-time system. The curve is drafted interactively using a graphical editor (Valve Diagram Editor) in the System Manager. When the system starts, the characteristic curve data is transferred to the real-time system. The coupling can be implemented either via the TwinCAT System Manager, or by appropriate blocks in the PLC. Compensation values (offsets) can be taken into account either before or after the linearization process.

The non-linear curves (control voltage in percent, depending on velocity) are drawn with the TwinCAT System Manager's Valve Diagram Editor. The user's interface to the Valve Diagram Editor is largely graphical. The basic functionality of the graphical editor (zoom, shift, overview window etc.) corresponds to that of the Cam Design Editor. Following interactive graphic entry of the points in the graphic window, their co-ordinates are displayed in the table window above it. The points' properties can be interactively manipulated in the table window. The points are usually joined to one another by straight lines. The transitions at the bends can be rounded symmetrically, because these points are particularly critical for the linearization. Fixed area ratios between pistons are automatically taken into account. If the characteristic curve data is not available, the values can be measured with a PLC program. These measurements are shown in the background on the graph, and can be used to develop an idealized curve.

Digital Compact Servo Drive AX2500

Modular servo system

As an extension of the AX2000 servo drive product line, a modular drive concept is integrated into the Beckhoff system in the form of the AX2500 series. The AX2500 servo drives are fully software-compatible with the AX2000. In its maximum configuration, the multi-axis system comprises eight axes, i. e. a supply module with seven axis modules.

The supply module comprises a power supply, a mains filter for power and auxiliary voltage, a ballast circuit and resistor and a power output stage. The following axis modules are simply plugged directly onto the supply module and connected with each other in the intermediate DC circuit via a socket strip, which is also used for looping through the 24 V DC auxiliary voltage. This provides the user with a very compact, cost optimized servo system, which is flexibly adaptable to the respective requirements. Compared with single axes, the wiring and commissioning effort is reduced significantly. The modular concept also minimizes possible sources of error.

Similar to the AX2000 system, the variable fieldbus connection enables simple integration into various control worlds: Lightbus, Profibus DP, SERCOS interface and CANopen. The AX2500 servo drive can be used for motors with resolver or with single-turn/multi-turn absolute encoder. The operation of linear and asynchronous motors is also possible. Ready-made motor and feedback lines are offered as accessories.

Features:

- Mains connection
- Mains filter included centrally in the supply module
- Compliance with all relevant standards: CE, UL, cUL
- Screened connections directly at the AX2500
- 24 V DC/enable/RS232 connection
- Intermediate circuit coupling for all axes via socket strip
- BTB ("ready for operation") contact
- Device-dependent supply voltage:
  1 x/3 x 115 V AC … 230 V AC for supply module AX2503/AX2506,
  3 x 230 V AC … 400 V AC
  for supply module AX2513/AX2516
- Earth-free operation is acceptable
- Simple mechanical mounting via top hat rails
- Only two different housing widths
  for supply module/axis module 100 mm/50 mm
- Mounting on top hat rail for 300 mm control cabinets

KL6811 Master Bus Terminal for the new DALI standard

Digital light management integrated in I/O system

Modern building automation requires flexibility down to the last data point. PC and Ethernet-based automation enables complex control concepts to be realized at the medium and company-wide building management level. The new DALI standard now offers a further alternative for the lower automation level. The Digital Adressable Lighting Interface is an industrial standard for controlling digital electronic (mainly lighting) devices.

Fluorescent lamps have been a standard component of lighting systems for decades. High efficiency and long operating life are the main advantages compared with filament technology. The entry of electronics into this sector, in particular the development of electronic starters, led to noticeable improvements for the application. The electronic ballast controls the complete energy flow electronically. The lamp can be started quickly and gently. The efficiency of fluorescent lamps could be increased further, and they can now be dimmed without problem.

How does the user tell the electronic ballast the desired brightness value? A further cable is required. The electronic ballast fully controls the mains voltage to ensure the functionality of the lamp. It therefore seems pointless to additionally switch the mains voltage via a switching contact. The electronic ballast requires a digital interface that should be as cost-effective as possible and simple to handle. Ideally, all lamps should be operated in parallel from the 230 V AC mains supply and via a 2-wire bus. This would minimize the installation effort and the cost of materials. With DALI, several manufacturers of lamps and electronic ballasts have defined a standard that meets all requirements and opens up new options.

DALI master in standard bus terminal

Beckhoff regards itself as a specialist for communication technology and supports access to DALI networks in simple form. A type KL6811 Bus Terminal with an overall width of only 12 mm contains a DALI master and a DALI power supply unit for the operation of up to 64 DALI devices (slaves). As a DALI controller, the KL6811 searches the addresses during start-up and supports the user during commissioning of his system. Due to its design as a master terminal, the unit is independent of the Bus Coupler used. The DALI Bus Terminal can therefore be integrated as a subsystem in all common bus systems such as Ethernet, Profibus or CANopen.

DALI was designed as a standardized interface for the control of electronic ballasts for fluorescent lamps via digital control signals. Individual addressing is possible, which means that each lamp can be controlled individually. For each KL6811 Bus Terminal, 64 addresses can be assigned, which means that 64 digital devices can be connected and controlled independently via the same control line. The 64 devices can be grouped into a maximum of 16 groups. So-called broadcast addresses are available that offer the option of addressing all units connected to the KL6811 Bus Terminals independent of their individual device address.

The Digital Addressable Lighting Interface

DALI is not a building management bus system, but a signal for the digital control of lighting devices. To this end it links lighting, sensor, switch and contact elements with each other. These DALI connections can be changed without problem. The technical precursor of DALI was the Digital Serial Interface (DSI). The digital DSI control signal (8-bit serial) is transferred to the devices via two wires. The KL6811 Bus Terminal also supports DSI. DALI is an expanded DSI interface with a 19-bit command set and is supported by all main electronic ballast manufacturers. The additional information in the control code is mainly used to enable individual addressing (8 bit) of the individual electronic ballast lamps in one or several groups. The respective command comprises 8 bits; in addition there is 1 start bit and 2 stop bits. Like for DSI, DALI also provides fault feedback (11 bits, 1 start bit, 2 stop bits, 1 data byte) for devices.

DALI enables flexible lighting control for changing conditions, e. g. changes in room layout. Lamps and operation elements are reassigned. DALI is seen as future-proof and can easily be connected to higher-level bus systems and controlled via gateways. The DALI signal is protected against incorrect connection and interference and enables faultless transfer of the control information, even over long distances.

Simple installation

Installation of the DALI system is extremely simple and can be implemented via the mains voltage and a standard 5-wire line (NYM ribbon conductor or non-metallic sheathed cable). Since the DALI signal does not have any polarity, the possibility of a wrong connection is eliminated from the outset. Further protection is offered by the DALI Bus Terminal, which is not damaged if 230 V are connected accidentally, but switches off.

Today, the main DALI devices are electronic DALI ballasts. In order to reduce the load on the DALI interface, part of the intelligence of the DALI controller was moved into the electronic ballasts. Compared with previous models, they now have additional intelligence and are able to manage up to 16 light scenes and can save 16 light values. Changeover times and rates, and minimum and maximum values can also be set via the DALI interface. As a controller, the KL6811 Bus Terminal only sends control sequences such as ON, OFF, UP, DOWN, GO TO SCENE, ADD TO GROUP, etc. via the interface to the electronic ballast, for example, which executes the commands independently. Furthermore, the electronic ballast can communicate with the KL6811 Bus Terminal and transfer feedback regarding lamp faults, dimming value, error messages, etc.

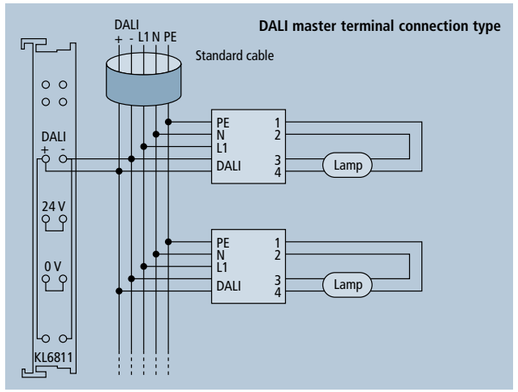
An ideal combination: Ethernet and DALI

The significance of Ethernet for building automation will continue to grow. EtherCAT opens up further options in terms of cost reductions and performance. The DALI standard is the ideal complement to Ethernet: low costs for actuator control, simple installation, low design effort.

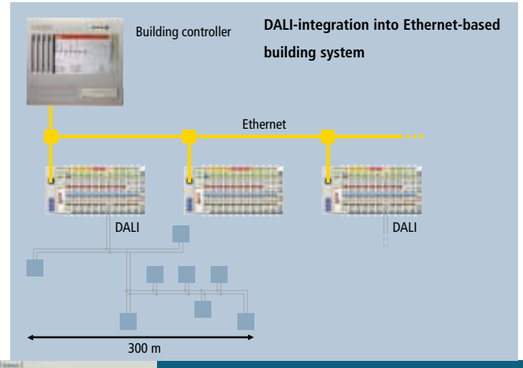
Features at a glance

- DALI definition in IEC 60 929
- User data transfer rates of 1200 bit/s enable failsafe operation
- Potential-free control input
- Two-wire cable, no polarity
- Up to 64 DALI devices
- Addressing options: all together, group-wise, individual
- Scene storage within the DALI device (maximum 16)
- Programmable dimming times, dimming range (depending on the electronic ballast used) 0.1 % – 100 %
- Feedback of information: ON/ OFF, current brightness value
- Cable lengths: up to 100 meters (0.5 mm² minimum diameter), 100-150 meters (0.75 mm²), more than 150 meters (1.5 mm²)
- Max. cable length between two connected system devices: 300 m

For further information:
DALI Activity Group
www.dali-ag.org



DALI master terminal connection type



DALI-integration into Ethernet-based building system

KS2000: Groups of lights are simply allocated via mouse click

The Beckhoff configuration software KS2000 enables simple configuration or commissioning of the DALI master terminals and the connected DALI devices. For each DALI device, the basic setting, variable changes and the group or scene allocation can be set. Direct or indirect lighting control according to the DALI specification can be implemented via the device settings. Buttons that send an associated DALI command to the selected device are available for the main functions.

With DALI, intelligence is not fully centralized in the master, but is stored in the ballasts in the form of variables. The light values can be changed via the "variables" setting. In addition, each DALI device can be assigned to one or several groups simply by clicking. For each DALI master, up to 16 groups are possible. If a DALI device receives a command in combination with a group number that is parameterized for the device, this command is executed. The assignment of up to 16 different scenes, in which the light intensity can be defined, is just as simple.

Like for other bus terminals, a connection between the PC and the respective bus coupler is established for configuring the DALI master terminals. If Ethernet is used as the building bus, the KS2000 functionalities can also be operated via the network.

TwinCAT performance in new dimensions through new generation of processors

Software PLC at blazing speeds

Beckhoff have succeeded in reducing the execution time of the TwinCAT, software based PLC system to below 1 µs, for the classic 1 k line IL code part. For Beckhoff this was not difficult since using the latest generation of processors and memory options. Therefore, TwinCAT performance is attributed to processors with ever higher clock rates and ever faster memory access. As you may surmise, the limit has yet to be reached.

Nevertheless, the question arises as to whether such performance reserves are really necessary for a particular application. The answer is simple: New options invariably open up new applications. Applications that previously required several CPUs are now concentrated on a single PC. Controllers that previously were equipped with decentralized intelligence are today dealt with cost-effectively through software on the PC. Utilizing the performance of the PCs, motion control applications that were regarded as impossible only a few years ago can also be realized in software. Not only the number of axes that can be position-controlled on a PC is increasing constantly; complex algorithms such as cam plates and synchronous movements can also be dealt with. There still remains PC control processing power for ergonomic visualizations.

Since there is not a standard PLC performance measurement test, Beckhoff explain their performance test. The Beckhoff performance test, for PLC systems includes averaging over 1000 randomly selected lines of IL code. These lines include load, memory and arithmetic operations. As data types, boolean and bit data types in a certain ratio are used and complemented with operations with REAL types. In order to eliminate caching effects in the PC, in addition several hundred thousand lines of code are calculated and subsequently averaged. This test is comparable with real PLC projects. Here too, we have a mixture of various commands and data types.

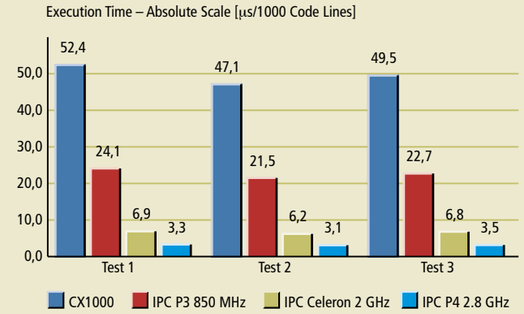
The results of this performance test are shown in the diagram. The test was carried out for the Beckhoff Embedded PC CX1000 with a Pentium I compatible CPU with 266 MHz. As pure PCs, Intel Pentium III with 850 MHz, Intel Celeron with 2.0 GHz and Intel Pentium 4 with 2.8 GHz were included in the test. As expected, the test showed particularly good results, if 32 bit integer or REAL data types were used. REAL operations were naturally calculated with the Floating Point Unit (FPU) of the processor. With an Intel Pentium 4, 3.0 GHz processor and still faster memory access, link times of less than 1 µs are possible under optimum conditions.

Furthermore, the reduction in engineering costs through the reduction in the time required for programming and commissioning should not be underestimated. Increasing PC performance also leads to reduced turn-around times: Every programming/compiling/testing process is shortened.

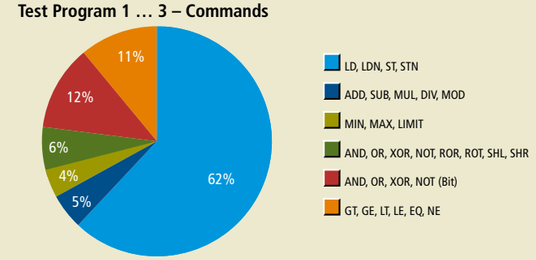
In the past, such gains in PC performance through new generations of processors and memory were frequently held up by the fieldbusses. Over recent years, there has been little movement in this area. Through the new Beckhoff EtherCAT system, a new, faster fieldbus enters the market, which meets the increased requirements and can keep up with the increased performance of PC-based control technology. A standard open Ethernet PCI master bus card allows DMA (direct memory access) and replaces the "slow" PCI bus fieldbus cards. The high Ethernet bandwidth of 100 Mbit enables the collection of a large number of data at very short cycle times.

The PC will thus be able to enter new automation regions, which previously could only be handled by very fast special hardware with special busses. With EtherCAT as a fieldbus, fast control technology and measurement tasks can now be realized with normal PCs.

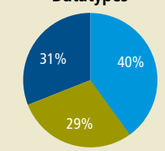
PLC Code Execution Time Benchmark [CX & PCs Program 1 … 3]



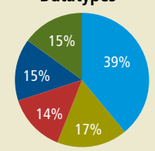
Test Program 1 … 3 – Commands



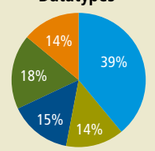
Program 1 – Datatypes

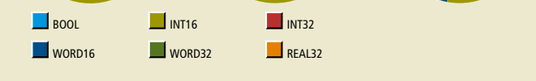


Program 2 – Datatypes



Program 3 – Datatypes





Control Cabinet PC C6325 and C6335

The compact C63xx series control cabinet PCs now have two models without fans; the C6325 and C6335. Cooling fins on the left side wall provide the required cooling effect. The heat sink is connected via an aluminum block in a heat-conducting way with the processor, the chipset and other heat sources on the motherboard. The operating temperature of the variant without fan is between 0 and 45 °C.

The Industrial PC series C63xx is designed for the installation in a control cabinet in combination with a DVI/USB Control Panel CP68xx or CP78xx. The PC can be separate components or attached to make a Built-in Panel PC, CP63xx. The PC is equipped with a slot motherboard on a passive backplane. The control cabinet PC variant without fan opens up new areas of application, for example, in environments where noise is to be avoided. Application examples are office environments or machine hall control rooms.

Industrial PCs without fans

PC without moving parts: In combination with a flash disk – instead of a hard disk – and Microsoft Windows XP Embedded, the C6325 (variant without CD-ROM) represents a complete Industrial PC without moving parts.

Germany:
Improving productivity with special machines from Koch, page 27

Netherlands:
When it comes to automation, Stork MPS relies on Beckhoff technology, page 36

Turkey:
New distribution partner in Turkey, page 43

Schuler AG uses PC-based motion control with TwinCAT, page 32

Belgium:
Volvo – Controlled production down to the last screw, page 38

USA:
CTR Inc. automates gas bottling plants using Beckhoff systems, page 44

Austria:
Upper Austria sales office has new location, page 40

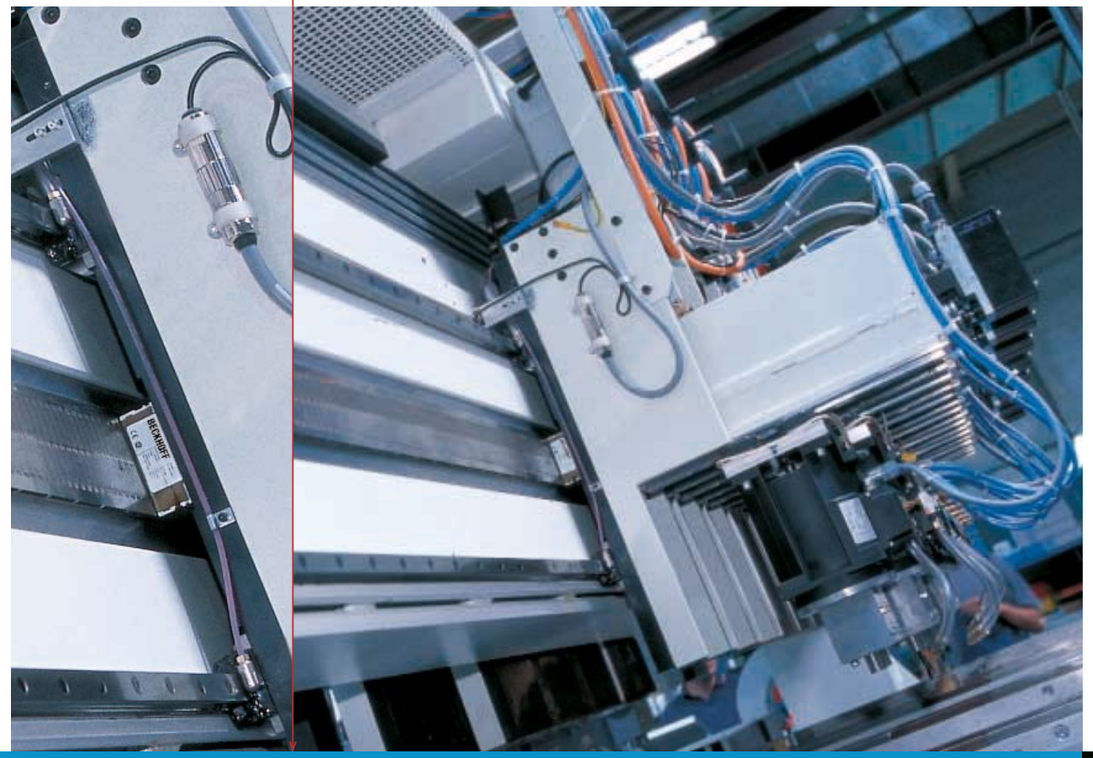
Switzerland:
Transformer winding machines with PC control, page 41

China:
New agency in Shanghai opened, page 46

Improving productivity with special machines from Koch

Direct drives from Beckhoff perform positioning with precision and economy

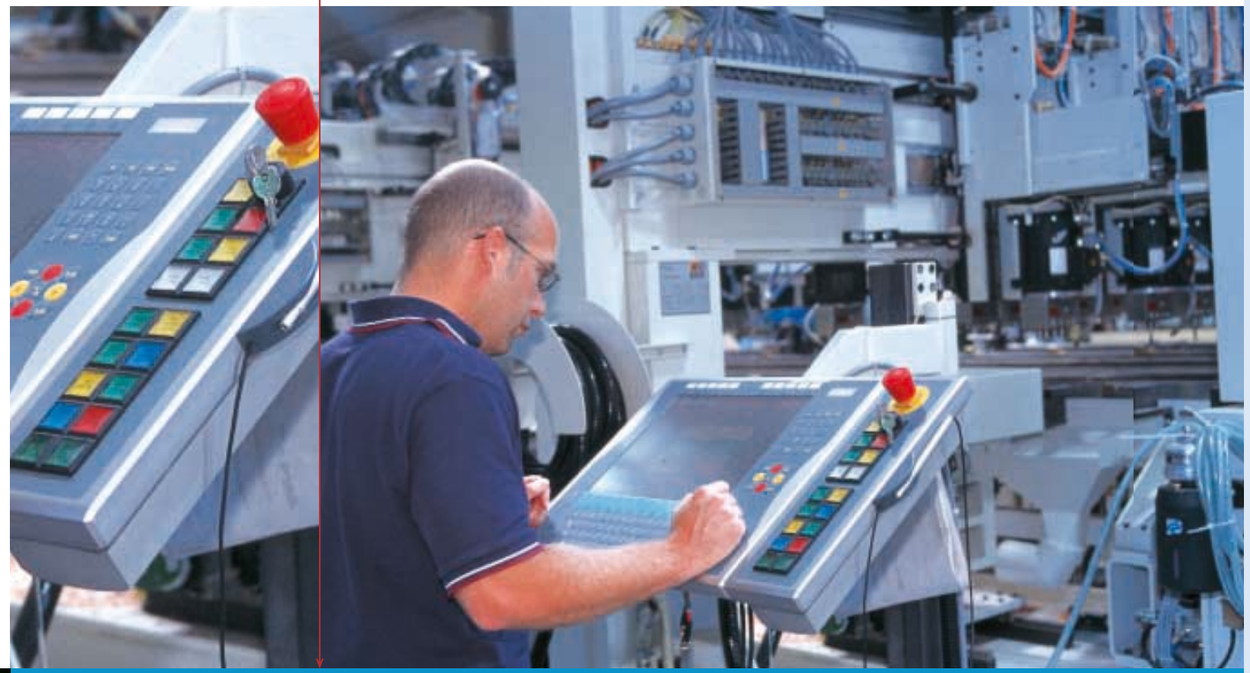
The developers at Koch made use of the Beckhoff know how to achieve a rapid conversion from rotary to linear motion.



Ask the average consumer what a variable, adjustable wooden slatted frame is and you will probably get a blank look, even though it might be providing them a peaceful night's rest. Ask a Koch engineer the same question and you will probably hear how the SBFD-B-NC machine using Beckhoff linear motors and PC control is making the above frames faster, better, and cheaper. Fitted with modern Industrial PC controller equipment, the 31 linear motors in particular belonging to an SBFD-B-NC machine ensure that the drilled holes and milled slots fit correctly.

As a manufacturer of special woodworking machines, Koch Maschinenbau, based in Germany cannot waste time if they want to build 500 frames per hour. Well, maybe they can afford a little time because they are committed to using the Beckhoff advanced Industrial PC technologies. Beckhoff has a history of helping Koch save time with such technologies as simulation of commissioning on a PC and remote servicing/diagnosis using standard Windows software. In the search for yet more time savings and better optimization, a technique has been developed to improve the positioning of drilling heads by means of rotary drives in the machining stations. Leo Gövert, control technology manager, immediately thought of the linear drives used in the electronics industry to position circuit boards accurately for SMD components to be mounted. Because their automation partner, Beckhoff, are also active in that sector, the idea was born: a design for the SBFD-B-NC machine was developed jointly. The Koch management gave the green light, and an extraordinarily powerful woodworking machine needing minimum servicing and fitting times was developed.

From the very start of the solution development, effort was focused on improving the machine's positioning. The rotary drives used on the toothed racks were replaced by linear drives, so that the positioning process could be faster and more precise. The machine, which measures about 10 m x 15 m, divides the wood for the slatted frame simultaneously into head, middle and foot sections. The operator then selects the processing steps for a right-hand or left-hand part. Finally, the chain conveyor transports the wooden blank in the Y-axis to the nine machining stations one after another. In the conventional solution, drills and milling machines mounted on overhead carriers, moved by means of toothed racks, make



In the woodworking plant for slatted frames, 31 linear motors driven by Beckhoff AX2000 servo drives ensure correct placement of the drilled holes and slots. All the drive data passes along four Lightbus rings for further processing in the IPC.

the drilled holes and slots that have previously been programmed. This is where the rotary drives were to be replaced by linear drives, so that the positioning process could be faster and more precise. Generally speaking, linear motors are suitable for use wherever the rotary type of construction comes up against mechanical limits, or where a special drive behavior in terms of dynamics, synchronism or acceleration is required.

Direct drives bring a 10 percent cost advantage

"This seemed to us to be the right technology," claimed Gövert, "because it is still true that the overhead carriers at the individual stations must accept up to nine drills and move them into position." The Beckhoff AL2000 linear motors are ideal for this task. They achieve travel velocities of up to 10 m/s, and can do this with a high acceleration. "From the management point of view, the comparable individual direct drives could then be forgotten, because all the linear motors in one station share a single magnetic track, making them more economical", explained control expert Gövert.

Gövert concedes that the attachment of an external measuring system does eat into the cost advantage to some extent, "but the bottom line is that with eight drives, there is a saving of 10 percent." In addition to economy, Koch was also sharply aware of the technical features, including the following particular points:

- Linear servomotors are not subject to mechanical wear,
- Linear servomotors allow positioning to be carried out very quickly without overshoot,
- They are easy to commission,
- A number of motors can perform their operations simultaneously on one track.

"For the machine constructor, this benefit should not be underestimated, because in the absence of a crown gear the travel distance can be almost unlimited", adds Oliver Bexte, responsible at Koch for software engineering. He sees the time advantage as the major item on the plus side. The biggest difference is not in the actual machining of the workpieces, but in setting up and refitting the heavy drills. The required positioning accuracy was tightened from 1/10 mm to 1/100 mm. The repeatability offered by linear technology is also impressive. Bexte is convinced by the technology, explaining that "in a practical test, we drove several hundred times against a dial gauge, and a comparison showed no difference in positioning accuracy". The fact that this all takes place without the transient phenomena familiar from rotary drives means that setting up with uncomplicated control parameters is a great deal simpler.

The instrumentation is also easily managed

The instrumentation techniques applied to Koch's special machine was also crucial to precision. The developers made use of a magnetic encoder system from Sony that is cut to length from rolled continuous material, and only needs to be glued to the track. The advantage of this was the existence of a reference cam and the high resolution of the reader head. Bexte pointed out that "this kind of sensor can be adjusted, with a little practice, in no more than five minutes". Care is only required during handling, warns the software engineer, because magnetic tools can damage the measuring system. The Beckhoff developers are working at present on this restriction. They are working on a procedure that will be added to the linear motor making it insensitive to external influences. The measuring principle involves using the magnets of the secondary section to determine

Beckhoff Industrial PC controls 69 axes

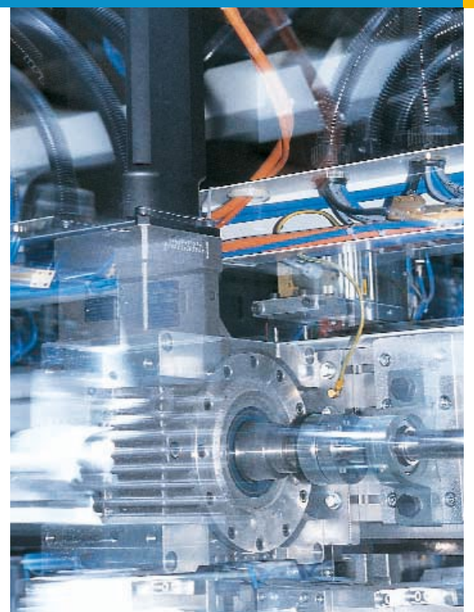
The SBFD-B-NC woodworking machine is an automatic machine for drilling and milling wooden parts from which slatted frames are manufactured. The plant is controlled by an Industrial PC with a Pentium 4 processor and with a decentralized 15 inch Control Panel. Windows 2000 Professional serves as the operating system, while the automation software is TwinCAT NC PTP with a PLC cycle time of 10 ms.

Five machining stations, with a total of 31 AL2000 linear servomotors offering maximum velocities of 1000 mm/s ensure precise positioning of the machining heads. These drives, along with another three rotary servomotors, are coupled to the system through four Lightbus rings. The chain conveyor for static positioning is linked via CANopen. The plant includes also more than 27 positioning drives with CAN Bus interfaces, along with seven fast and crawl axes. The total number of inputs and outputs is 1134.

position and velocity. An incremental transducer signal having 1000 increments/24 mm is generated from their magnetic field strengths (24 mm corresponds to one logical rotation of the linear motor). Fed into the AX2000 drive amplifier, this yields a positioning accuracy of 0.1 mm.

In contrast to applications in machine tools, where high powers require water-cooled linear drives, and where a high precision also makes expensive optical measurement systems necessary, the solution described here is ideal for applications in the woodworking industry or on packaging machines. Another reason why direct drives are favored by the control engineers at Koch is that they can be integrated seamlessly into the existing automation concept with TwinCAT. The servo amplifiers are positioned via the Beckhoff Lightbus, while the drives for simple positioning tasks are operated with CANopen.

A Beckhoff Industrial PC C6150 with the PLC/NC TwinCAT software is the master of a total of 69 axes.



Practical tips: What advantages can be expected from linear drives?

→ We asked Leo Gövert and Oliver Bexte what required special attention when converting to linear drive technology.

PC-Control: Mr. Gövert, you have been positioning the drilling stations on your machines using the directly driven linear drives from Beckhoff for a good year now. Have you regretted this step?

Leo Gövert: No, quite the contrary. We did not just choose an accurate, low-maintenance technology, but in our case it was also the most economical.

So are linear drives cheaper than rotary ones?

Leo Gövert: If you compare the single drives of each technology, then not at this time. But in our machining stations, up to nine drives work on one track, and that is where the saving comes from.

How many drives must you use on one track in order to cover the costs?

Oliver Bexte: Roughly speaking, we can say that the break-even point is at four drives. With eight drives, we had a 10 per cent advantage.

And where does the increased precision come from?

Oliver Bexte: We achieve high force constants for accurate positioning through a very good force to weight ratio. On top of this, there is the direct measurement system, which yields a better resolution than the resolver technology used in conventional motors. If we then compare the freedom of wear of the linear components in comparison with toothed racks and the wear on bearings, we also expect significantly better results over the long term.

What changed conditions have to be taken into account?

Oliver Bexte: The foundations for the machines have to be made more stable if they are to accept the increased forces from the linear motors without vibration.

Was that the only difficulty?

Leo Gövert: Well we did have to shield the magnetic encoder system for displacement measurement to protect it from the electromagnetic effects emanating from power lines. Once you know that this is necessary, it's no longer a problem.

Could you summarize the advantages again?

Leo Gövert: As we said, with the 31 linear servo drives we don't just achieve accurate positioning in a smaller construction. The parameterization is also a lot easier to do. Besides, the drives could be smoothly integrated into the existing TwinCAT automation scheme.

Schuler AG uses PC-based motion control with TwinCAT

Quick axes under pressure

Transfer presses from Schuler are used in the production of ready-to-fit serial parts in the automotive industry, at suppliers for the automotive industry, in the electrical and domestic appliances industry, in equipment manufacturing, and in further specialized industries. Transfer presses are the alternative to individual presses operated in series. Depending on the load distribution and part size, single or multi-slide presses are used. Various transfer systems provide fast and reliable parts transport between the metal forming stations in the transfer presses.

With ProfiLine, Schuler has created a modular concept for press systems and their automation that is tailored to manufacturers from the automotive suppliers sector, who have to respond quickly to orders. ProfiLine offers standardized basic units that can be expanded with optional modules and configured individually.

The standardization of the components reduces the effort for engineering, production, assembly and commissioning and makes the systems available for the customer significantly more quickly. The core of ProfiLine comprises individual presses or press lines (with press forces from 2,000 to 20,000 kN) and transfer presses (with press forces of 2,000 to 20,000 kN). For ProfiLine transfer presses, modular 3-axis transfer systems are used as a link concept.

Clement Peters, control technology group leader at Schuler Automation in Heßdorf and Frank Saueressig, manager of the Beckhoff branch in Balingen (left to right).

→ The globally active Schuler AG sees itself as "pacemaker" for metal forming. The new, fast transfer system for modular ProfiLine press systems, which was developed specially for the requirements of the automotive suppliers sector, is based on the TwinCAT PLC and motion control system from Beckhoff.

Schuler AG

As a system partner for the metal processing industry, Schuler offers comprehensive market-oriented solutions and consulting services for a range of sectors, including the automotive and supply industry, the electrical and domestic appliances industry and mint facilities. The Schuler AG offers a powerful combination of state of the art production facilities, efficient tools and comprehensive process know-how. With production locations in Germany, France, Brazil, the USA and the People's Republic of China, Schuler comprises an international production association. Worldwide, around 4,000 employees ensure the success of the Schuler Group.

→ www.schulergroup.com

Completion and development of a transfer system

Schuler is renowned as manufacturer and supplier of complete metal forming systems of different complexity. Until now, Schuler had used 2- or 3-axis transfer devices from various manufacturers for automating the modular ProfiLine press systems. With the in-house development of a 3-axis transfer system, customers can now obtain all components optimally coordinated from one supplier. "We concentrated this development particularly on the automotive suppliers sector, which requires powerful and cost-effective systems", said Dipl.-Ing. Clement Peters, control technology group leader at Schuler Automation in Heßdorf/Germany and manager of the team responsible for the motion control of the transfer system. A further aim is the integration into the overall automation concept of the Schuler Group. To this end, interdisciplinary consultation and co-operation discussions about the selection and application of hardware and software systems are taking place with the other companies of the Schuler Group, beyond the Heßdorf location. "Important aspects are software standards, engineering, local data management, symbolic addressing and similar aspects", said Peters, noting that Schuler is committed to implementing a unified strategy across the group.

Automation becomes a must

Transfer devices are used for automating the workpiece flow in presses. 3-axis transfer systems are used primarily for mechanical presses with crank or hinged drives and for hydraulic presses. The range of parts to be transported includes chassis parts such as sill covers, exhaust parts, wheel rims, parts for clutches, brakes etc.

Over the last few years, there is an apparent change in the supply industry's transfer devices. Mechanical transfer devices are increasingly being replaced with electrical/NC transfer devices. The benefits are:

- Short change-over times,
- High product flexibility through freely programmable axes,
- High number of strokes through optimized movement processes,
- Economic production of small batch sizes.

Structured approach to design and production

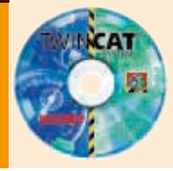
Apart from the mechanics, a process-oriented control and drive structure is required for ensuring high output and operational reliability. For the team around Mr. Peters, the motion control concept aim is to develop a cost-effective, powerful and modular/hierarchic structure that enables short engineering and commissioning times, simple operation and a fast service for the customer. Customer-specific requirements can be incorporated in the concept without significant additional effort, and existing presses can be upgraded with this transfer device at any time and without excessive expense.

At its Heßdorf location, the control group has been working on the development of a hierarchic and modular software system structure for more than two years. In view of the control platforms to be used, the program structure and the philosophy, significant differences between the systems should be avoided, since the same staff has to operate different control systems. "Compliance with international standards, such as the IEC 61131-3 directive and the specifications of the PLCopen organization, through the control manufacturers is a basic prerequisite for the realization of an object-oriented software structure across the group", commented Peters.

These basic considerations have been accounted for in the development of the transfer application, with the requirements for the motion control concept being defined significantly more widely. An example for in-house co-operation is the development of the motion control library for applications within the Schuler Group. "We can use the same functions in a roller feed device, a blankloader, a modular

TwinCAT NC PTP – point-to-point axis positioning

Schuler decided to use a PC-based motion control concept, i.e. position control of the 3-axis transfer system via a PC solution. This consists of a hardware platform and the TwinCAT NC PTP software control system.
One of the reasons why Schuler decided to use TwinCAT was the embedding of the axis function within the IEC 61131-3 PLC system via function block libraries. Within the TwinCAT NC PTP system structure, axes are structured into channels for PTP motion and interpolating motion. The axes are controlled via variables for encoder, drive and controller. The axis can be linked to I/O interfaces, and parameters can be set. Positioning is executed with a powerful, modern positioning algorithm, in which profiles are generated with jerk limitation and with pre-control of speed and acceleration to minimize the following error.
The TwinCAT Cam Design Tool is available for the development of electronic cam plates. It is fully integrated into the System Manager. Cam plates represent the relationship between the positions of different axes. The independent axis is referred to as the master axis, while the dependent axis is called slave axis. The position of the slave axis is uniquely functional dependent on the position of the master axis.



Dr. Pögel, Director of Product Development at Schuler Automation, commented on customer expectations for a press with NC transfer devices and the significance of simulation systems

"Even before they make their investments, customers have very concrete expectations. On the one hand they expect information about the productivity in order to know when the investment will have paid for itself. Other customer requirements are high flexibility, short set-up times, simple operation and high cost effectiveness even for the production of small batch sizes. Simulations carried out in advance can make an important contribution.
Simulations are used for optimizing the movement processes and therefore for determining the number of strokes (output), and they supply the clearance curve which is the basis for tool construction."

Dr. Pögel commented on the harmonic synergy of the individual components within the overall system:
"It is not the individual components of a transfer system, e. g. a powerful controller, a highly dynamic drive system or sophisticated mechanics, that make for successful and highly productive metal forming systems, but their optimized and harmonic synergy. The associated requirements are high flexibility, short set-up times and economic production, even for small quantities. Such systems are not commissioned by the automotive industry, but by its suppliers, who are subject to very high price pressures. For this clientele the only significant factor is the productivity of their ProfiLine system, because they have to deliver just in time, based on reliable production systems."

Dr. Pögel said: "While transfer systems are already very reliable, the avoidance of an additional NC axis contributes to increasing operational reliability even further."

transfer device for large body presses or even in a 3-axis transfer system for ProfiLine", said Peters about the benefits. Schuler Automation decided to use the TwinCAT software systems from Beckhoff as a control platform. "In our experience, TwinCAT is currently one of the most flexible and powerful systems", said Peters, substantiating the company's decision. "We see TwinCAT as a continuation of our approach to modular system concepts. Current product developments within the group are undertaken on this basis, and the system has now become the standard for our ProfiLine product sector."

From selection to co-operation
A company like Schuler is difficult to serve for a control system supplier, since the tasks and requirements are multi-faceted. For this kind of co-operation, Schuler therefore requires a partner with a certain technological and entrepreneurial edge. "In addition to technological aspects, our internal discussions also considered local and global presence", explained Peters. "This was a significant decision criterion during our selection process. Beckhoff has the width and the potential to meet Schuler's requirements profile."
"This is a declared aim of Beckhoff", underlined Dipl.-Ing. Frank Saueressig, who is responsible for the Schuler Group at Beckhoff. Moreover, for the motion control expert there can be no doubt that the Beckhoff orientation towards widely accepted practices and international standards has had a positive influence. "Unlike some of our competitors, Beckhoff has relied on standards and therefore on mainstreams from a very early stage. We were thus able to save a lot of time and costs in development and market introduction", said Saueressig, explaining the company philosophy.
For Schuler, an important prerequisite for the application of an automation solution is the availability of adequate performance for motion tasks, due to fast axis movements. For Saueressig, this is one of the Beckhoff core competencies: "We are not just a software PLC supplier – our origins are in fast axis controls. Beckhoff also serves many more areas of application with high demands on axis performance, such as woodworking, press applications and packaging technology, among others. The Beckhoff forte is quick and precise movement. Real-time capability is therefore an important feature for all Beckhoff products. This applies not only to TwinCAT, but also for IPC systems, fieldbus concepts and bus terminals."

Connections for the operator
ProfiLine automation solutions include Schuler Basic View, which was developed in-house. This visualization concept emerged in co-operation with the Faculty for Production Automation (PAK) at Kaiserslautern University, which carried out customer surveys and studies on man/machine interaction for Schuler. The result is a user interface tailored to this product sector.
Standard TwinCAT interfaces are used for visualization connections. A cost-effective advantage is therefore the option to run the control and visualization systems on the same PC platform. Peters describes the approach as follows: "This aspect demonstrates the Beckhoff openness. Beckhoff carried out studies to establish to what extent the executability of TwinCAT is ensured, if our preferred visualization system is installed in parallel on the PC platform."
In this case, the visualization was integrated via TwinCAT OPC. "From the Beckhoff point of view, OPC has proved fully reliable, despite the fact that it is not based on institutionalized standards, but on standardization from within the industry", said Saueressig. "This shows that product developers (not only Beckhoff) are no longer forced to develop solutions for their own proprietary environment, but are operating OPC-compliant, thus enabling the use of alternatives. Times have passed in which special drivers had to be developed, which invariably used to raise the question of who would pay for it."

En route to successful application
Suppliers and users have to co-operate closely whenever new products have to be developed with new control systems. This was also the case during the development of the motion control for the transfer system, as Peters explained: "Apart from meeting the fundamental requirements, Beckhoff has emerged as a very powerful partner for our development activities. Additional requirements were taken on board swiftly and implemented in the TwinCAT system within a short space of time, so that the new functions could immediately be used for our application development." The additional functionality required by Schuler essentially covered the following areas:

- Handling of the motion functions, which enable very good connection to the visualization for the graphic representation of the motion functions and effective drive monitoring,
- Implementation of additional motion rules and functions within the TwinCAT CAM design tool,
- General functions of the program editors.

According to Peters, the motivation of the team from Heßdorf regarding the functional expansion was not so much the development of Schuler-specific functions. It was more the integration of in-house know-how into a clever and effective engineering approach, rather than the independent extension of the tools used. Schuler Automation's team of six therefore works flat out and confidently on the completion of the development, because the date for the premiere is getting closer and closer.

When it comes to automation, Stork MPS relies on Beckhoff technology

Robots make their entrance in the meat industry

Stork MPS, located in the Netherlands, claims to sell more meat processing advanced slaughtering and logistics systems worldwide than anyone else in the industry. The company contributes their success to continuous development and commitment to innovation.

Stork MPS developed two fully automatic product lines with support from the Beckhoff distributor, IAL (Industrial Automation Link). The two lines are the F-line slaughtering robot and the MM-Meat Mover, warehouse and management system based on Beckhoff components.

The meat processing industry must adjust their production and marketing techniques in order to meet the industry's high quality and safety standards for food stuff. More and more stringent requirements in terms of meat quality and hygiene with simultaneous cost pressures require advanced processing systems, in order to produce valuable food stuff from animal products.

F-line – a new generation of modular pig slaughtering robots

For the development of F-line, Stork MPS deliberately chose a modular system. The basis is a universal motion generator with state of the art control technology. A variety of machining tools are used for the different production stages involved in processing the product.

The basic element of each F-line component is an anodized aluminum frame with servo drives for movements in the X-, Y- and Z-axis, which are controlled by the Beckhoff Industrial PC C6140 and the TwinCAT software PLC/NC. I/O interfacing is via Bus Terminals and Profibus DP. The controller configuration is identical for all F-line modules. The only difference is in the tools used.

Jos Out, general manager of IAL, explained: "Accurate meat processing is a highly complex tasks and is carried out with TwinCAT NC I, the NC system for interpolating path movements". TwinCAT NC I offers 3D interpolation (interpreter, set value generation, position controller), an integrated PLC with NC interface and I/O connection for axes via the fieldbus. "Every year we supply approximately 50 systems consisting of IPC, TwinCAT and Bus Terminals to Stork MPS", said Jos Out.

"Contact-free" operation

The synchronized robot, which is mounted stationary, moves with the animal carcass during the operation. Synchronization is ensured through mechanical connection with the slaughtering conveyor belt. This means that fewer tools are required for positioning and fixation, and contact with the animal carcass has to be made less frequently. "Contact-free" operation significantly reduces the risk of cross-contamination. Furthermore, in contrast to manual processing, machines offer consistent hygienic performance, thus ensuring consistent product quality and significantly higher yield.

The fully automatic F-line robot modules are suitable for a wide range of processing capacities and carcass weight classes. The crucial advantage of this system is the option to quickly convert or adapt existing systems, and to expand them with new functions. Different processing capacities can be realized through the installation of one or two tools within a frame, or through the installation of machines in series.

Standardized operator training, lower maintenance effort and fewer specific replacement parts are further significant arguments in favor of the F-line modules. Furthermore, process automation reduces labor costs, results in ergonomic improvements in working conditions and reduces the risk of injury.

Meat Mover – state of the art control for storage and management

If a dynamic storage system or shelving system is used, the Meat Mover manages the handling of the boxes. The type of warehouse and the storage or retrieval function determine the respective device type for box handling. Servo drives are used for horizontal transport (movement of the Meat Mover in X-direction) and for lifting (movement of the lifting device in Y-direction). Both drives are equipped with electromechanical brakes. The brakes are only active during maintenance and in an emergency. The Meat Movers are also controlled by a Beckhoff Industrial PC and Bus Terminals.

A bar code scanner at the box handling device identifies the box. The scanner is connected to the Beckhoff Industrial PC via Profibus. In 1998, Stork MPS started to replace the so-called "position cards" with PCs based on Windows NT or Windows 2000 and TwinCAT, thus enabling integration into a system. One of the benefits of PC-based controls is the option to process enormous amounts of data, since a whole range of statistical data are stored for each animal carcass.

Remote customer service

Via a modem connection, system support staff from Stork MPS can analyze the required statistics for a certain machine at any time and immediately rectify a fault, if necessary. The system can be configured to automatically send an e-mail to the Stork customer service department in the event of a machine failure. In theory, it is therefore possible for Stork MPS to be aware of a problem before the customer himself becomes aware of it.

PC-based control enables preventive maintenance measures to be carried out remotely. If, for example, a knife gradually becomes blunt, a message appears, indicating that it should be replaced within a certain period. In this way, the machine creates its own maintenance schedule and enables Stork MPS to schedule their own customer service staff effectively, and to keep the spare parts stock down to a reasonable level.

→ www.stork-mps.com

Volvo sets more and more stringent quality standards

Controlled production down to the last screw

A total of 125 workstations are being converted in this way. The modification is carried out simultaneously in Gent and in the Volvo factory in Sweden. Both factories separately decided to use Beckhoff after an intensive supplier comparison and evaluation which included prototypes designed to meet Volvo's requirements. Volvo chose the American manufacturer GSE tech-motive tool for the electric screwdrivers. For both plants, De Jaeger Automation bvba developed the IT infrastructure using workstations. The system offers maximum security for the operator: It checks whether screw connections were made with the right program and registers the results.

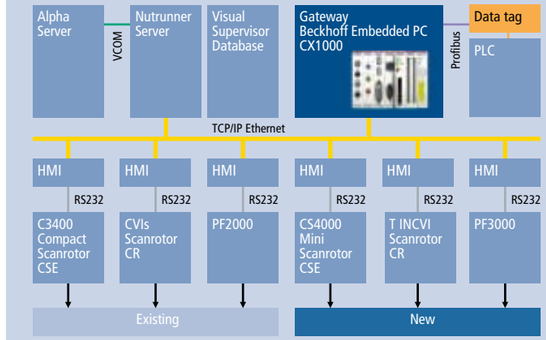
For this particular application, managers at the Gent plant decided to use the CX1000 Embedded PC control from Beckhoff. This small-format PC integrates software PLC, network and Internet access via Ethernet interface, Profibus connection, an interface for the Control Panel and the K-Bus interface for the bus terminals. Multiprox, the exclusive Beckhoff agency in Belgium, supplied the first CX1000 prototypes to Volvo around mid-2002.

→ **The production line at Volvo Cars in Gent, Belgium, is being modified to enable production of the new V40 model in addition to the S60 and the V70 models. Concurrently, the production line is being enhanced to meet future, "follow-up", production requirements. Electric screwdrivers have replaced pneumatic models for all main screw connections, and are controlled with a PC-based controller. The controller's data, including tightening forces, is transferred to a central database, where it is easily retrieved over the car's production lifespan.**

Traceability of class 1 screws

Volvo Cars is a manufacturer with very high quality standards. After the takeover by Ford, traceability was looked at and it was decided to implement better controls for all "class 1 screws" in the Volvo Cars factories, and to record the results. One control look at is measuring actual force that a screw exerts versus just the torque. Pneumatic tools allow for a torque setting, but the tightening force cannot be controlled. This requires an electric screwdriver and a very sophisticated electrical control system with a converter used for feedback. Both the speed and the screw curve, including the force exerted at the respective torque, can thus be programmed for the complete screw cycle. An automatic control checks whether the torque increases along the right curve, e. g. for detecting broken screws. Moreover, an alarm system is provided in case a screw cycle was not executed properly for some reason. However, Volvo required even more control: they also wanted to know whether the pre-programmed screw cycle was actually executed and second – for the purpose of traceability – the tightening torque data for each screw were to be recorded.

There are several manufacturers of such electrically driven screwing tools, but not many have integrated a direct PC interface. Both factories in Belgium and Sweden decided to go for a solution based on electric screwdrivers from GSE. The workstation consists of the electric screwdriver from GSE and the IT infrastructure that ensures the PLC-specific tasks. Among other things it can be used to control which screw cap was used by the screw cap selector and inserted into the electric screwing tool. This decides which cap and which program is used. Furthermore, the screw movement is controlled, and the correct angular rotation is verified. Analog measurements are carried out using a Banner laser distance meter. This operation can only be carried out within a certain "range" of the production line, since the devices are not operational outside this range.



With the CX1000, **Volvo Cars in Gent, Belgium,** uses mid-range PC-based control technology for controlling the electric screwdrivers. In the final set-up, the following components are used:

- **Controller:** 125 x CX1001-0121
- 128 MB RAM
- 1 GB IBM Microdrive
- Windows XP Embedded
- TwinCAT PLC Runtime
- DVI/USB Interface CX1000-N001
- Profibus Slave-Interface CX1500-B310
- 24 digital and 2 analog I/Os per system

- **Control Panel:** 125 x CP6801-0001
- Built-in Control Panel
- DVI/USB Interface
- 12 inch display, resolution 800 x 600
- Touch Screen

Each screw is recorded

In addition there are PC tasks, e. g. storage and activation of the "tasks" for each screw, recording of the task executed and establishing the Ethernet connection for transporting the required data to a higher IT level. As soon as the chassis is placed on the assembly line, the screw tasks are passed on to the tooling station by a central server. They have to be tracked locally, until the chassis number has been read at the workstation. The operator then receives a list of tasks that specifies which screws have to be tightened. By selecting the screw head, he indicates which screw is to be tightened. If the operator activates the electric screwdriver, the task program for the respective screw, i. e. the way in which it is to be tightened, is converted into an instruction program for the device.

The fitters can work at four vehicles at the same time. The task program received by the operator depends on the current position of the fitter with the device. Through appropriate selection of the wiring, the operator can only work at one vehicle and receives the corresponding tasks to be carried out, once the workstation is located. Execution is controlled. If everything goes according to plan, the system receives an "OK" as feedback. In the event of a fault, an alarm is triggered, so that the fitter can correct the fault. If the problem cannot be rectified with the appropriate measures, this is registered and the vehicle is removed at the end of the production line, so that the respective screw connection can be reapplied.

All data for each screw connection is stored locally as an XML file and then fed to a central server at production control room level via the Ethernet network (LAN). Here, the frequency and type of problems is analyzed, and statistical quality control is carried out. At this level the XML files are "cleaned", and only the relevant data are relayed to the production tracking system, from where they are stored in the "production archive".

PLC and PC in a single unit

I/O-specific real-time tasks require a PLC, others require a PC. Independent integration of the two systems into the application would be comparatively expensive. For this reason, De Jaeger Automation chose the modular Industrial PC CX1000 as IT basis. The CX1000 device series combines the best of two worlds – Industrial PC and hardware PLC – and is suitable for control tasks in the medium performance range. The modular control system can be mounted on standard DIN rails; the elements are assembled depending on the task. A further basis for the decision was the price, which is lower than that of an Industrial PC.

The CX1000 is equipped with a serial interface and an Ethernet interface as standard. Additional fieldbus interfaces (Profibus, CANopen, DeviceNet and SERCOS interface) can be added without problem. The Beckhoff Control Panel is connected via the modular DVI/USB interface.

Communication between the CX1000 and the GSE electric screwdriver is optionally via RS232 or Ethernet. In order to be "universally" applicable, the control was designed in such a way that Power Focus 2000/3000 screw tools from Atlas Copco can also be connected. With the aid of connection cables with special terminal strips in the connector, the system detects whether a screwdriver from GSE or Atlas Copco screwdriver is connected, and the associated program loads automatically.

Upper Austria sales office has new location

In January, the sales office for Upper Austria took up residence in the Hagenberg software park. "More than 100 sqm of floor space leave sufficient room for development over the coming years", said Klaus Wurm, who has been managing the Upper Austria sales region for the last 3 years.

With the software park, Hagenberg, situated not far from Linz, has created the most dynamic and most successful technology center in Austria. So far, 5 university institutes, 1 competence center, 7 university of applied science courses and 30 companies have relocated to the park, and the second stage of this ambitious project is imminent. Klaus Wurm described the benefits of the new location: "From the synergies of economy and research, Beckhoff Austria expects benefits in the positioning of our company name, as well as for finding new customers. It opens up a range of co-operation options".

The sales office was operating as a "home office", and was simply no longer able to meet the increased demand. Upper Austria is the region with the strongest economy in the country and is responsible for a significant proportion of the total turnover of the Austrian Beckhoff subsidiary.

The move to representative office premises offers the opportunity to carry out customer training on site, "but it also opens up the option of employing new staff", added sales engineer Klaus Wurm.

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Beckhoff Switzerland:
Tailor-made systems at short notice

Transformer winding machines with PC control

The winding machines from the company Tuboly are used worldwide in the production of transformers for power stations. An Industrial PC with software PLC controls the largely automated winding machine. Tuboly produces sophisticated, usually customer-specific machines. The scalable Industrial PCs and object-oriented programming under the Windows operating system enable tailor-made systems to be supplied at short notice.

The transformer winding machines from the company Tuboly are made in Dottikon, Switzerland, and sold worldwide. The winding machines processing the wire or foil for transformers in power stations or for magnetic resonance image (MRI) tomographs meet state of the art requirements. Tuboly produces the winding machines, the customer produces the coils.

Requirements for customer-specific machines

The winding machines from Tuboly are highly automated. The control calculates the foil feed and the weld points. In conventional winding machines, the operator has to advance the coil, indicate the weld points and then unwind the coil for welding, which is not very time-efficient.

Tuboly produces the winding machines according to customer requirements – each machine is an individual product. Naturally, the basic elements of the construction and the basic software functions remain essentially the same. The operator controls the principal axis with the transformer coil. The control deals with the material supply and with auxiliary axes. For special applications, the response times of the real-time control must not exceed 1 ms.

Industrial PC with software PLC

For controlling the winding machines, the developers at Tuboly use Beckhoff Industrial PCs with software PLC/NC TwinCAT, whose modular design enables the rapid development of customer-specific solutions. The Industrial PC as a platform enables optimum scaling of the computing capacity according to customer requirements. The costs can thus be optimized. Since the software is based on Windows standards, the visualization and the connection to the network or other pro-

The winding machine for transformers winds the wire with up to 600 meters per second. Foil feed and welding positions are calculated automatically.

grams can be solved elegantly. Tuboly decided to use the PC control from Beckhoff, because it combines process control, axis control and visualization in a single system.

Coils from 1 kilogram to 20 tons

The machines of Tuboly can deal with coils with weights between 1 kilogram and 20 tons. The wire is wound with a speed of up to 600 meters per second. The operator controls the process via robust hand switches or pedals. A display provides information and guides him through the process. An Industrial PC with a Pentium III processor with 256 MB RAM controls up to 12 axes. The PC uses Windows NT as the operating system, or optionally Windows 2000 or XP.

The system is defined and the application-specific functions are embedded in the TwinCAT software PLC/NC. The developers from Tuboly program the actual machine function and the visualization. They use the object-oriented programming environment and software modules from previous projects. The TwinCAT system supports the developers with software libraries, e.g. for NC axis positioning. Software development takes approximately one man-month to complete. The winding machine is normally delivered six months after the order is received. If an existing design is used, the delivery time may be reduced to 4 months, depending on the utilization of the production facilities.

Connection via fiber optic

The sensors and the motor control communicate via the Lightbus. The fiber optic is insensitive to EMC interferences and works reliably even in the harsh industrial environment with welding machines. The modular bus terminal system also enables applications with Profibus, if the customer wishes to use an existing infrastructure. Safety functions such as emergency stop push buttons are controlled directly via the control cabinet.

Customers are not very keen on safety barriers and fences, since they obstruct the workflow. Accordingly, a compromise has to be found through appropriate measures that ensure high productivity, but also the safety of the operating personnel. The process control system or other administrative programs can be integrated via an OPC interface. The Windows operating system provides remote maintenance functions as standard. They are used to establish a connection via the company network or a modem. With conventional PLC controllers, the customer had to purchase an expensive additional module.

Amortization after eight months

The costs of a new or refurbished winding machine are quickly recovered, in some cases after only eight months. The high degree of automation saves staff costs. Accordingly, the trend is towards fully automated winding machines. Every push button or switch that can be saved reduces hardware and production costs. The software deals with the associated functions. The additional development costs for the software only have to be paid once, and the software modules can often already be reused in the next project.

Since nearly every winding machine represents a new development, developers are often confronted with new problems, mainly in terms of the software. The developers at Tuboly therefore value the close contact with Beckhoff in Switzerland and with the specialists at the German headquarters. Tuboly staff receive little feedback about the operation at the customers, which is a sign of a smooth production process. Usually only mechanical wear and tear parts have to be replaced.

→ Tuboly AG www.tuboly.ch

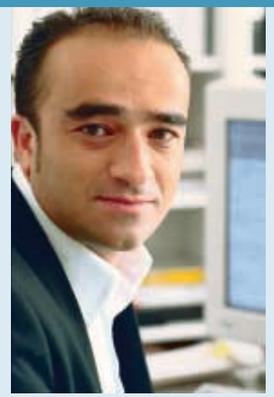
Christoph Müller, manager of electrics and software at Tuboly, operates a transformer winding machine. Operation is largely automated.

Key data of winding machines	
Wire speed	600 meters/minute
Foil speed	250 meters/minute
Weight of transformer coil	1 kilogram ... 20 tons
Number of controlled axes	2 ... 12
Cycle time	1 ms
Real-time load	approx. 40 %
Industrial PC processor	Pentium III, 850 MHz
Main memory (RAM)	256 MB
Operating system	Windows NT/2000/XP

Co-operation with Siskon Otomasyon Ltd. is another milestone in the development of the Beckhoff export activities

(From left to right) Cem Ayday, General Manager of Siskon in Istanbul and Muvaffak Amasya, General Manager of Siskon in Izmir

New distribution partner in Turkey



"Turkey, with its continuous economic growth, is without doubt an interesting market with a future" is how Kenan Aktas of the Beckhoff export department explains the optimistic view held at Siskon and Beckhoff.

Turkey, generally associated with sunshine and sea, and a popular holiday destination, is increasingly developing into a commercial region worthy of attention. Investment funds benefiting from tax incentives, and the lifting of controls on the participation of foreign investors in the capital market, have turned Turkey into a production location that is both interesting and lucrative for many companies. The automobile sector is the most significant of these. To respond appropriately to this development, and to be able to offer the best possible service and support on-site for customers there, Beckhoff was keen to obtain a competent distribution partner for co-operation in Turkey.

A reliable partner was found in Siskon Otomasyon Ltd., an engineering office founded in 1997 with particular expertise in the process and industrial automation industries. With headquarters in Istanbul and Izmir, Siskon is advantageously located for Turkey's principal industrial regions. Muvaffak Amasya, General Manager of Siskon in Izmir, and Cem Ayday, General Manager of the Istanbul branch, see the company's goal as providing customers with innovative technologies and products, professional consultation and with individual solutions customized to the particular application. Siskon additionally offer microcontrollers specially developed for the textile industry, customer-specific software solutions, consultation, project analysis, commissioning and turnkey projects.

As well as providing service and support, Siskon are concerned to obtain new customers and to market the full range of Beckhoff products in Turkey. This strategy – making the name of Beckhoff familiar in Turkey – has also been pursued in the last two years with a joint appearance at the "World Of Industry", Turkey's largest industrial exhibition. Both partners could be very happy with the response from a total of more than 600 customer contacts.

Following the economic crisis of recent years – due not least to the severe earthquake catastrophe in 2001 – the present development in Turkey looks very positive.

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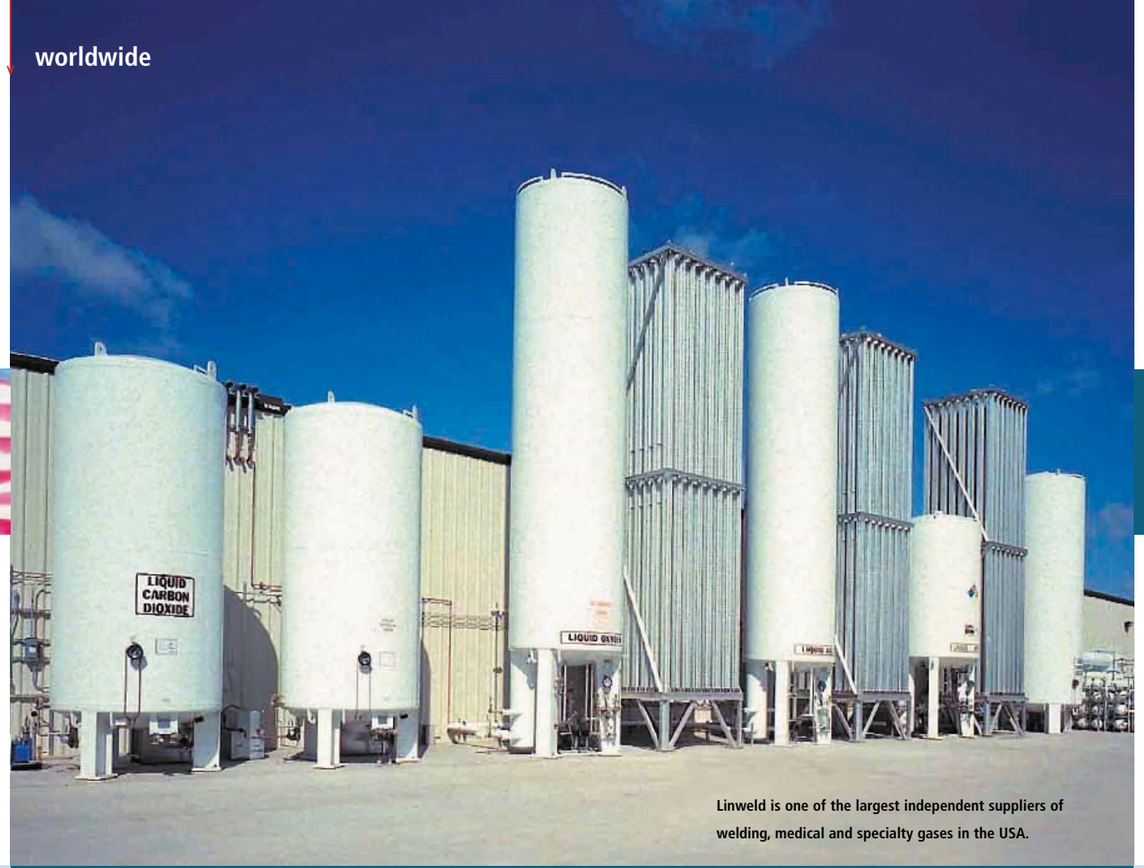
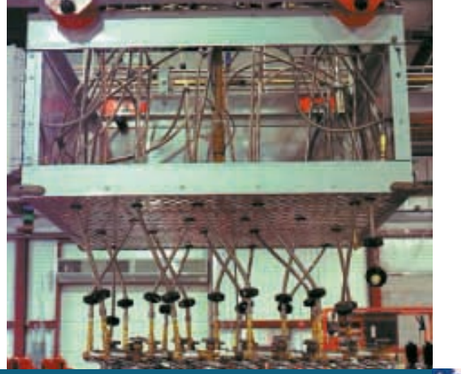


Linweld is one of the largest independent suppliers of welding, medical and specialty gases in the USA.

The heart of the automated gas fill operation is the C6130 cabinet mounted Industrial PC.



Once the empty cylinders are connected to the filling manifold, the automated filling process can begin.

The entire gas fill operation can be controlled using Beckhoff CP7002 – 15 inch touch-screen Control Panels.

CTR, Inc. is a company in Rock Hill, SC, that designs and builds industrial gas plants for customers who supply high-pressure bottles of welding and medical gases. Since 1992, the company has constructed gas plants in Minnesota, Oklahoma, Nebraska, Alabama, Illinois, and New Mexico, and projects are under construction in Ohio and California. As a leader in cylinder fill plant equipment design and manufacturing, CTR relies on products from Beckhoff USA to help them automate the operation of the completed plants that CTR builds for its customers.

PC control puts gas cylinders under pressure

One such CTR customer is Linweld, one of the largest welding supply distributors and independent processors of industrial, medical and specialty gases in the US. Linweld's new gas fill plant in Lincoln, NE, is a state-of-the-art example of an automated facility that reduces labor expense, and improves productivity and product quality. In the Linweld plant, CTR is making use of Beckhoff Industrial PCs, remote touch-screens and IP 20 I/O systems to automate and control all gas filling operations.

"We use PC-based products from Beckhoff in the entire cycle of process control at the plant we built for Linweld," says John Greene of CTR, Inc. "We selected Beckhoff because they offered features that we couldn't find anywhere else. We first went to them for a customer who needed a remote-mounted touch-screen, and Beckhoff provided a nice, easy solution. The modularity of their systems is great for replacements, flexibility and expandability."

Controlling the process

The Linweld plant is an industrial gas fill plant that fills high-pressure bottles (3,000 to 5,000 psi) with single gases – typically, argon, nitrogen, oxygen, acetylene, CO2 and helium – or mixed gases. The primary use of these gases is in the welding industry. In the filling process, an operator sets empty cylinders in a filling rack and hooks them up to the supply connection. Then, he uses the Beckhoff CP7002 15-inch touch-screen Control Panel to select the proper gas or recipe of gases that are stored in the Beckhoff C6130 Industrial PC.

If there is residual gas in the cylinder, the system will vent it and pull a vacuum. When the vacuum reaches a predetermined set-point, a series of valves open, and the gas pump starts filling the cylinder. The cylinder rests on a sensitive scale which weighs the amount of gas being pumped in. Greene says that the PC-based controls permit this "gravimetric" filling system – a big improvement over traditional cylinder filling methods that rely on temperature/pressure charts and operator skill.

"The gravimetric system saves a lot of labor and is ideal for quality control," says Greene. "In a conventional plant, as you fill the bottles, their temperature (and pressure) rises due to the heat of recompression. The operator has to watch the temperature of the bottle, and then constantly go to a chart and equate that temperature with what the pressure (and, therefore, the volume of gas) would be at ambient temperature. You're at the mercy of how fast the bottle is transferring heat, and it's just not that accurate."

"With the gravimetric system, Linweld is able to actually weigh the gas with a scale that the cylinder sits on. This weight is not affected by temperature and is much more precise than traditional manual systems," he says. "This accuracy is very important in making a consistent product, batch after batch."

Advantages of a PC-based system

There are many advantages in using an Industrial PC for process control. Not only does it allow better control of complex industrial processes, it provides a production data stream that is not possible with PLC systems. Of prime importance to Linweld is that data on each filled cylinder is stored in the PC and can be printed out for a complete record of the production run. "This production reporting leads to better quality control and better control of the bottom line," says Greene. Another advantage is that the system reduces labor and operator errors; and it is easy to learn. With standard Windows based programming, even operations where there are multiple shifts or high operator turnover, training can be accomplished more easily than with proprietary control systems.

The Beckhoff Control Panel and the control cabinet PC C6130 make an ideal combination, representing a powerful platform for a variety of plant engineering applications. The CP7002 Control Panel has a CP-Link interface that allows it to be located up to 100 meters from the remote-mounted IPC C6130 – permitting maximum flexibility for the operator and plant production design.

The remote-mounted CP7002 Control Panels are an integral part of the Linweld process, according to Greene. Being able to locate the operator interface near to the filling process and distant from the PC, creates greater flexibility for the operator. Since the filling process requires the operator to mount the gas cylinders prior to filling, having the Control Panel nearby saves steps and time. Also, remote-mounting of the Control Panel permits the PC to be located in a more protected environment.

Other CTR applications at Linweld

While the Linweld's major application is PC-based and is capable of complex operations, expansion and flexibility, other CTR gas-fill applications in the plant don't require that level of automation. For the filling of medical gas bottles, the CTR-designed system features the Beckhoff Bus Terminal Controller BC9000 IEC 61131-3 PLC running TwinCAT PLC software with locally connected Bus Terminals. While the BC9000 can easily manage gas cylinder filling for the lower-volume medical gas application, it does not have the production reporting capability of the PC-based system.

The integration of a full range of Beckhoff Industrial PCs, Control Panels, I/O, and PLC controllers into CTR-designed gas fill production facilities has improved Linweld's productivity, flexibility and product quality.

Beckhoff strengthens its presence in China

Two years after the establishment of the Beijing branch, on March 1 2003 Beckhoff China opened a second office in Shanghai, China's main industrial and trade metropolis.

New agency in Shanghai opened

The establishment of a further branch reflects the enormous potential market in China, and particularly the economic growth in Shanghai and the neighboring provinces. A number of factors influenced the selection of the location, such as its geographic position, the large and highly qualified workforce, and an excellent infrastructure, which make Shanghai the leading industrial and trade center in China.

The dynamic economic development in the provinces adjacent to Shanghai, Jiangsu and Zhejiang, were also part of the considerations: "In recent years, about half of our trade with China originated from Shanghai and its neighboring provinces. Consequently, more and more customers in this region require technical support and support on site", said Liqiang Liang, General Manager of Beckhoff China.

For the year 2001, economic statistics showed a total of 19,273 industrial companies in Shanghai from a variety of sectors such as steelworks, car manufacture, machine and plant engineering, power generation, water treatment, chemical and textile industry, pharmaceutical and light industry, tobacco industry, electronics etc. Growth was continuous with an average rate of 12 percent.

"China's joining of the World Trade Organization (WTO) and the continuing opening process towards the west, combined with the quick economic growth in Shanghai, particularly the development of Pudong, have promoted the boom of export-oriented companies relying on advanced technologies and foreign investments," as Liang described the underlying conditions for a positive development of Beckhoff China.

The office of Beckhoff Shanghai is located on the 36th floor of the Golden Bund Center, a 50-story building very close to Pudong, the new up-and-coming industry and business district. Initially, the office will have a staff of two, among them a specialist for CNC and motion control. The aim is to offer customers in this region not only easy access to Beckhoff products, but also a direct consulting service, technical support and training on site.

The marketing activities of Beckhoff China will be further strengthened by the new Shanghai branch. "Only a few days after the office was opened, we were represented at the Interkama (international trade fair for automation), which took place from March 18 to 21, 2003 at Shanghai New International Exhibition Center. After the fair, from March 24 to 25 we took part in an IEC 61131-3 seminar organized by the China PLC Association, which was attended by more than 120 participants," said Liang, summarizing the initial activities of the Shanghai branch.

The general manager of Beckhoff China also detects positive signals from the Chinese government, such as the call for conversion of the industrial production to IT systems, and the active support of innovations in automation technology. Fieldbus technology is also becoming more and more wide-spread and accepted in China. Furthermore, the China PLC Association is currently trying to establish the IEC 61131-3 standard as a national standard for PLC programming. "These measures create a good environment for marketing Beckhoff products based on fieldbus technology and PC control solutions," said Liang.

"The presence of Beckhoff in the global metropolis of Shanghai is an important step for supplying eastern China, i.e. the main industrial region of the country. A successful future therefore appears secured."

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Hanover Fair 2003

From April 7 to 12, Beckhoff presented the complete New Automation Technology product range at the Hanover Fair. The main fair for automation technology was attended by all Beckhoff partner companies and subsidiaries from more than 35 countries. In addition to product highlights, such as the new EtherCAT and TwinSAFE system, further additions from all product lines were presented.

At the Hanover Fair, Hans Beckhoff presented the new real-time Ethernet network: "EtherCAT sets new standards where conventional fieldbus systems reach their limits in terms of performance, costs, wiring and openness for other protocols."

TwinSAFE – safety technology from Beckhoff. At the Hanover Fair, the new TwinSAFE Bus Terminals containing only three basic functionalities were presented: digital KL19xx input terminals, digital KL29xx output terminals and a KL6900 link unit. This enables all common safety sensors and actuators to be connected.

The first Beckhoff stand party was held at the Hanover Fair. Around 700 international guests had an informal get-together on the Beckhoff stand at the end of the second trade fair day.

In contrast to the general trend, visitor numbers at the Beckhoff stand reached the same level as in 2002. Particularly promising were new, qualified contacts to markets that had hitherto not been covered, such as Russia, Japan and South America.

Between March 5 to 7, 2003, the most important tyre manufacturers and machine constructors in the world met at the exhibition grounds in Hamburg, Germany for the Tire Technology Expo 2003. ThyssenKrupp Elastomertechnik used the opportunity to invite the tire manufacturers to an in-house exhibition. More than 100 guests from the tire industry, including Bridgestone, Pirelli, Continental, Michelin and Hankook accepted the invitation. As suppliers of control technology, Beckhoff were represented with an exhibition stand, and presented the latest automation solutions.

Tire manufacturers under one roof

ThyssenKrupp Elastomertechnik's rubber engineering division, based in Hamburg, offers a comprehensive range of products: processing extruders, extrusion lines, tire construction machines, hot tire presses and complete fabrication installations for the tire industry, along with degassing extruders, shear head equipment, process control systems and production lines for rubber profiles.

During the exhibition, ThyssenKrupp Elastomertechnik presented their skill in the rubber processing industries for all the important procedures from raw-material acceptance and preparation through all the further processing stages up to vulcanization. In addition to new extrusion equipment, hot presses and tire construction machines, a study on the new development of a 24 inch construction machine was also presented.

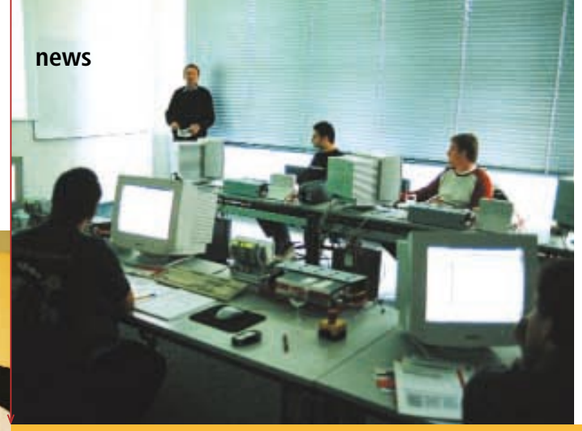
Joachim Bieber, head of the Beckhoff branch in Hanover, was very pleased with the presentation at the in-house exhibition: "This forum gave us an opportunity to present our many years of experience in the automation of tire construction machines." And Bieber added that "On top of this we were able to demonstrate the good partnership and co-operation between ThyssenKrupp Elastomertechnik and Beckhoff."

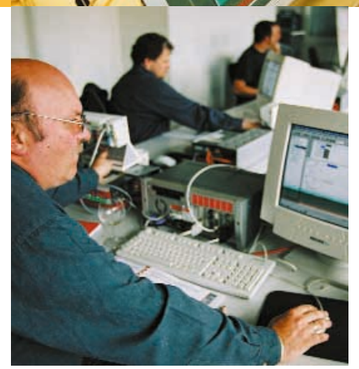
→ www.thyssenkrupp-elastomertechnik.com

PLCopen establishes new Safety working group

The growing interest in the subject of safety prompted PLCopen to establish a Safety Task Force and hold a kickoff meeting. The aim of this working group is the development of standardized IEC 61131-3 libraries for PLC programs for safety-relevant applications. During the first meeting, held on April 29 at the Beckhoff headquarters in Germany, the discussions focused on what function blocks such a library should include – for example two-hand or protective door switches – Eelco van der Wal, General Manager of PLCopen, welcomed representatives from Bosch Rexroth, Elau, KW Software, Lenze, Omron, Rockwell Automation, Sick, Siemens and Beckhoff. The next meeting will take place on June 23, 2003 at Siemens in Erlangen/ Germany.

→ www.plcopen.org





More training requires more space

The growth of Beckhoff sales has created large demand for training and thus more space is needed. Beckhoff Germany has responded, in the usual fast way, by relocating the training centers to a new facility in Gütersloh. The new facility is approximately 8 km away from the original headquarters location. The new location will allow for two parallel training sessions, thus meeting the new demand for training. The training team is located in the IT Academy building which is centrally located. Ulrich Laker, training manager at Beckhoff, commented on the new training location by saying "As usual, all future training for Beckhoff components will be carried out under the guidance of experienced Beckhoff staff."

A catering service provides refreshments for the participants during breaks; lunch is taken in the nearby restaurant. The training center has optimum transport connections: Gütersloh main station is approximately 7 minutes' walk away from the IT Academy. A car park is available directly outside the IT Academy.

Extended training opportunities

The comprehensive range of TwinCAT training offers has been expanded with the "TwinCAT programming for Embedded-PC CX1000" course. The 2-day course includes an introduction to remote configuration and programming of the CX1000 with TwinCAT. Further training priorities are network communication via real-time Ethernet and network variables, and basic principles of Windows CE.NET 4.1 and of the creation of user interfaces using VisualStudio.NET.

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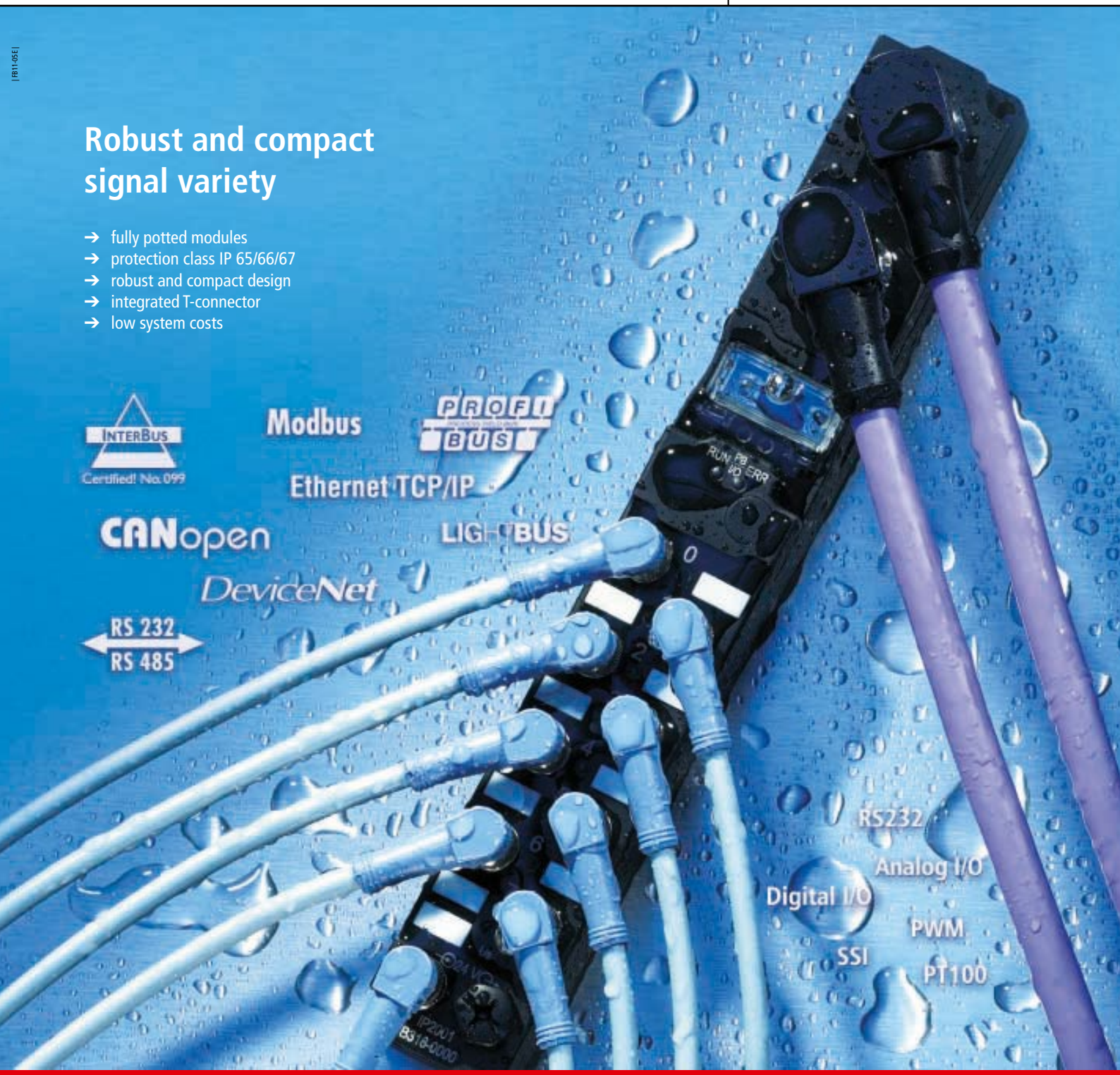

Beckhoff Fieldbus Box with integrated T-connector – slim and compact design

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

Beckhoff Fieldbus Box: rugged signal variety for "almost any" bus system
Fieldbusses – Lightbus, Profibus, Interbus, CANopen, DeviceNet, Modbus, RS232, RS485 and Ethernet TCP/IP
Signal types – digital I/O, ± 10 V, 0...20 mA, thermocouple, PT100, counter, PWM, RS 232, RS 485, TTY, SSI, SIN/COS, incremental encoder interface

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

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