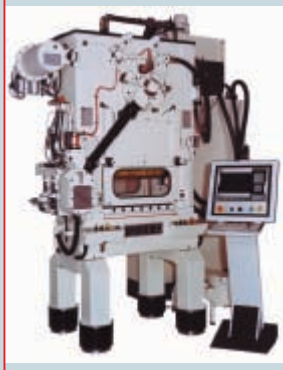
Hayes-Lemmerz AG based in Germany, established the most advanced wheel production facility in the world. For automation, Beckhoff technology is used exclusively: including PC-based TwinCAT controllers, Industrial PCs and Beckhoff Lightbus for I/O communication. It's a long way from sheet metal to the finished wheel: Initially, the wheel disc and wheel rim are produced in separate production processes and subsequently welded together in an assembly line. The different production processes are interlinked in a 200 m long production line. The assembly system features a total of 57 servo axes. The servo axes and an additional 1,500 digital and analog machine I/Os are controlled via a single TwinCAT controller. Overall, the production line features 120 Lightbus Bus Terminal stations with 5,000 digital and 1,000 analog Bus Terminals.

Due to their flexible concept, Beckhoff Bus Terminals can be used as a universal I/O system in a wide range of industries. The electronic terminal blocks are in use in many applications worldwide, from machine construction to building technology. Examples of different applications are described below, ranging from "classic" to more "unique".

Bus Terminals in use worldwide

Husky Injection Molding Systems Ltd., Canada, one of the world's leading manufacturers of plastic injection molding machines, uses Beckhoff technology for control purposes throughout. Many plastic products, ranging from electrical wall plugs to car hoods, are produced using injection molding techniques. The PC-based control concept adopted by Husky combines all control functions of the complex production process in an Industrial PC. The main areas covered by the control system are hydraulics, temperature, robotics and visualization. The plastic injection molding machine signals are picked up or issued via PROFIBUS Bus Terminals.



The **Swiss company Bruderer AG** manufacturers high-performance automatic punching presses for customers worldwide. The term "high-performance" encompasses a wide range of features such as fast, accurate, durable, safe, flexible, simple operation and integration options. A high-performance controller is needed for meeting all of these requirements. Bruderer has been using Beckhoff as their single-source system supplier of I/O components, Industrial PCs and control software for years. One of the requirements for the I/O system was flexible wiring. This is where the Bus Terminal system could fully demonstrate its power and flexibility. It offers wiring of the field devices locally at the machine, quick integration of new functions through connection of a Bus Terminal, and simple replacement of the Bus Couplers when the fieldbus system is changed.

The tire manufacturing giant, **Continental AG** uses PC-based automation technology from Beckhoff. Far in excess of 1,000 Beckhoff controllers are used in Continental plants worldwide for controlling tire production machines. The system consists of: Industrial PCs, Control Panels, TwinCAT for PLC and motion control applications, drive systems and Bus Terminals as the I/O system. One application example is the Continental plant at the Romanian town of Timisoara, Europe's most advanced factory for mass-produced automobile tires. All production machines and systems are equipped with Beckhoff control technology throughout. More than 230 IPC controllers are used, plus more than 250 Beckhoff servo axes. The plant is networked via Bus Terminals, Lightbus and PROFIBUS DP.

Bertelsmann in Germany has been a Bus Terminal customer right from the start. The company uses the electronic terminal blocks for a wide range of applications. One example is the company's distribution center at Harsewinkel, from which large customers are supplied at short notice with printed advertising material, forms and a wide range of office supplies. The carton conveyor system for the distribution center (with a floor area of 20,000 sqm) was based on PC control technology, including Bus Terminal technology. The Beckhoff Lightbus fieldbus is used for interference-proof data transfer. The control components for each individual conveying unit are mounted in terminal boxes, for example, at the roller conveyor. The signals for bar code scanners, light barriers, etc. are picked up locally via a Bus Terminal system.

ALmix Asia, Asphalt Equipment Pte. Ltd., Singapore manufactures hot mix plants equipped with complex and highly-automated control systems. "In the past ALmix had seen many control technology developments that promised open and adaptable systems. But only Beckhoff, with their open Bus Terminal technology, provided us with the opportunity to completely separate the application layer from the physical layer," said Mohamed Zubir Baboo, system manager at ALmix. "The Beckhoff Bus Terminals offer unlimited autonomy with regard to the different hardware components. This is a prerequisite for us due to the different concepts for the individual projects we deal with. The technology enables us to increase our product flow while maintaining the reliability and quality of our products."

Otto Nußbaum GmbH & Co. KG, based in Germany, manufactures high-quality lifting equipment. The company uses electronic Bus Terminals from Beckhoff for their latest parking system for Smart. Fully automatic parking systems offer room for up to 35 Smart cars on several levels. The cars are presented behind a glass façade. The system has a very small footprint of only 67.24 sqm. The average duration of a parking or removal procedure is only about 2.5 minutes. Inductive sensors and light barriers provide extensive checks on presence and monitoring of position. The electronic Bus Terminals transfer the signals for the necessary control information to the control PC via CAN bus.

At the **Microsoft headquarters in Munich, Germany** intelligent building control is realized with PC- and Ethernet-based control technology. The Microsoft head office comprises two main buildings and nine office buildings with a total floor area of 27,600 sqm. In each building, an Industrial PC with TwinCAT automation software controls central building functions and deals with the coordination of the decentralized Bus Terminal stations. In 2000, the Microsoft project in Munich was the first to use Ethernet Bus Terminals for building automation. More than 12,000 data points for HVAC, security, access and other functions are monitored by about 200 Ethernet Bus Terminal stations. Signals for light, temperature, shade and HVAC control are handled directly in the BC9000 Ethernet Bus Terminal Controller so that if there should be a network failure all functions affecting safety remain intact.

The **Hungarian company, Nitrogen Work** is a major producer of fertilizers. For the redesign of its production facilities, the company was looking for a software-based recording device for monitoring a two-stage turbine and for logging temperature, flow and pressure data. The device switches the turbine off when a temperature exceeds the set value. Miklós Resz, director of maintenance at Nitrogénművek, had a compact solution in mind, consisting of a PLC and a data acquisition device that doesn't need paper or ink. "The Embedded CX and the wide range of Bus Terminals available from Beckhoff provides us with the flexibility we need – and at a reasonable price."

Control functions in today's automation engineering are moving to be housed locally at the machine. In addition to Bus Terminals in protection class IP 20, fully sealed Fieldbus Box modules in protection class IP 67 are ideally suited for this purpose. **Leonhard Moll Betonwerke GmbH & Co.** in Germany uses a combination of both Beckhoff I/O systems at their production plant for concrete sleepers. Together with the PC-based control platform TwinCAT, both the efficiency and the quality of the concrete sleepers produced could be significantly improved. The fieldbus system is based on PROFIBUS DP with 12 Mbaud.

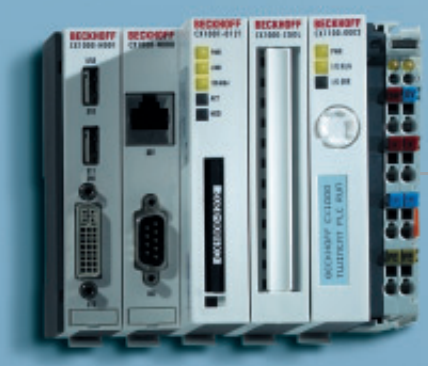
"Auf Schalke" is one of the most advanced stadiums in Europe and will be a venue for the 2006 Football (Soccer) World Cup in Germany. Technical highlights of the multi-purpose arena are the movable stands, the unique roof construction and the 11,500 ton pitch area (playing field) that can be moved via Beckhoff Bus Terminals. Four hydraulic grippers drive the movable pitch. A total of nine Bus Terminal stations that are connected via PROFIBUS deal with control and monitoring functions. Four BC3100 Bus Terminal Controllers synchronize the movement of the pitch slab. Displacement sensors in the advance cylinders are used to measure the cylinders' positions, and the data is passed to the Bus Terminals via the SSI interface. Other parameters measured are the clamping and shifting pressure of the cylinders. The proportional valves for the synchronous movement of the pitch are also controlled. Other Bus Terminal stations with BK3100 Bus Couplers are responsible for supervising the lubrication and for the operating panel. This provides the operator with all the position data as well as the oil temperature in the cylinders via a display. At several locations, eight PT100 sensors measure the precise temperature profile of the pitch at different depths.

Beckhoff Bus Terminals: The complete automation kit

Bus Coupler series BK, the link between Bus Terminals and fieldbus

Bus Terminal Controller series BC with integrated IEC 61131-3 PLC

Bus Terminal Controller series BX with integrated IEC 61131-3 PLC and extended interfaces

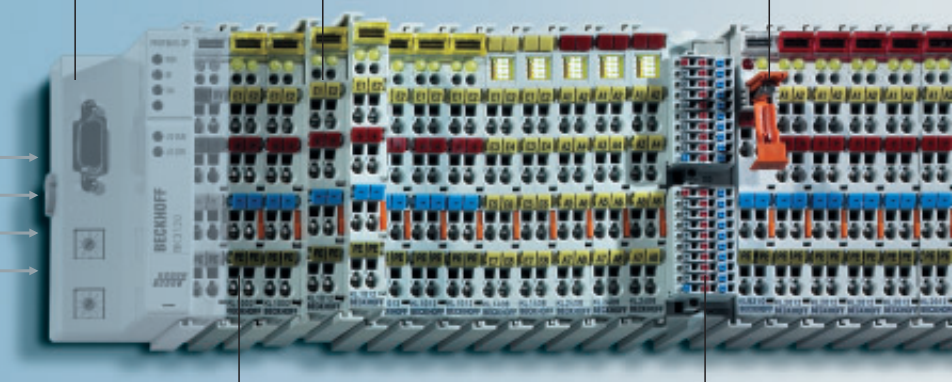


Embedded PC series CX for PLC and Motion Control applications

The head station of the Bus Terminals: from Bus Coupler with fieldbus interface to Embedded PC

Free mix of signals: More than 180 different Bus Terminals for connection to all common sensors and actuators

Potential feed terminals enable configuration of different potential groups



Bus Terminals in 1-, 2-, 4- and 8-channel modularity, no restriction on mixing of signal types

The terminal modules with plug-in wiring combine 16, 32 or 64 digital I/Os within a very small space and with high packing density

Bus Coupler/Controller					Digital input							Digital output						
Fieldbus	BK	BC	BX	CX	Channels	2	4	8	16	32	64	Channels	2	4	8	16	32	64
PROFIBUS	x	x	x	x	5 V DC		x					5 V DC		x				
Ethernet TCP/IP	x	x	x	x	24 V DC	x	x	x	x	x	x	24 V DC	x	x	x	x	x	x
EtherCAT	x			x	48 V DC	x						120 V AC/DC	x					
CANopen, DeviceNet	x	x	x	x	120 V AC/DC	x						230 V AC	x	x				
Lightbus	x	x		x	230 V AC	x						400 V AC	x					
Interbus	x	x			Thermistor	x						PWM	x					
RS232/RS485	x	x	x	x	NAMUR	x						Pulse train	x					
Modbus	x	x	x		Counter	x						Stepper motor	x					
SERCOS, USB	x			x	Safety		x					Safety		x				
ControlNet	x											Relay	x					
Fipio, CC-Link	x											Diagnostic	x					

The universal building block for automation

The Beckhoff Bus Terminal is the open and flexible I/O system for all common fieldbuses. The wide choice of electronic series terminals covers the full range of input and output channels required in automation – from the digital and analog world right through to the serial interface. Tailor-made solutions can be configured from a wide range of signal options. With the BC/BX series or the CX1000 Embedded PC, Bus Terminal Controllers are available in different performance classes. All Beckhoff controllers are programmed in IEC 61131-3 with the TwinCAT automation software.

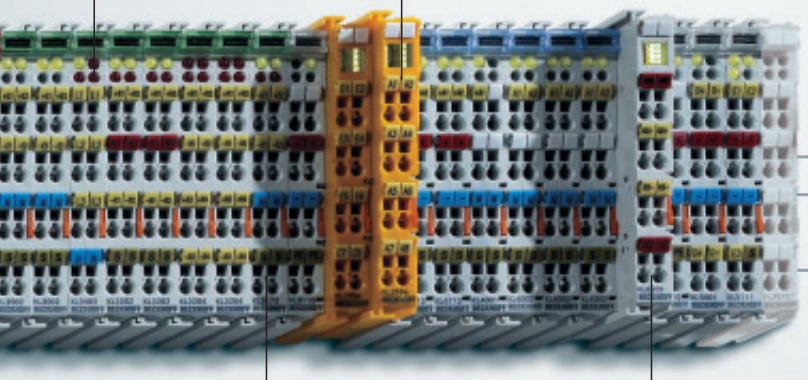
10 Years Beckhoff Bus Terminal

- More than 180 different standard Bus Terminals
- 57 Bus Couplers for all main fieldbus systems
- Low system costs through the use of 1-, 2-, 4- and 8-channel Bus Terminals

Bus end terminal

3-phase power measurement capability enables all relevant electrical data of the supply network to be measured

Integrated safety: The TwinSAFE Bus Terminals enable the connection of all common safety sensors and actuators



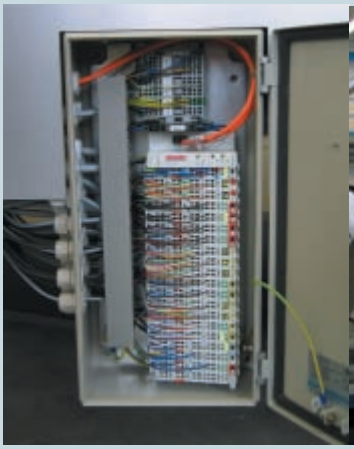
The terminal bus extension enables the connection of up to 255 Bus Terminals (instead of 64) to a single station

Bus Terminals with a maximum measurement error of ±0.01% expand the range of applications to high-precision measurement technology

Communication terminals enable the integration of subsystems such as AS-interface, RS232 and RS485

Analog input					Analog output					Position measurement, Communication	
Channels	1	2	4	8	Channels	1	2	4	8		
0 … 10 V	x	x	x	x	0 … 10 V	x	x	x	x	SSI-sensor	x
±10 V	x	x	x	x	±10 V	x	x	x	x	Incremental encoder	x
0 … 20 mA	x	x	x	x	0 … 20 mA	x	x	x	x	RS232	x
4 … 20 mA	x	x	x	x	4 … 20 mA	x	x	x	x	RS422/RS485	x
0 … 2 V		x								AS interface	x
±2 V		x								EIB	x
Thermoelements	x	x	x							LON	x
Resistance thermometer	x	x	x							DALI/DSI	x
Resistorbridge	x									EnOcean	x
Oscilloscope	x	x								Safety logic	x
Power measurement		x									

The power terminal transforms a standard contactor into a motor protection relay with comprehensive diagnostic functions

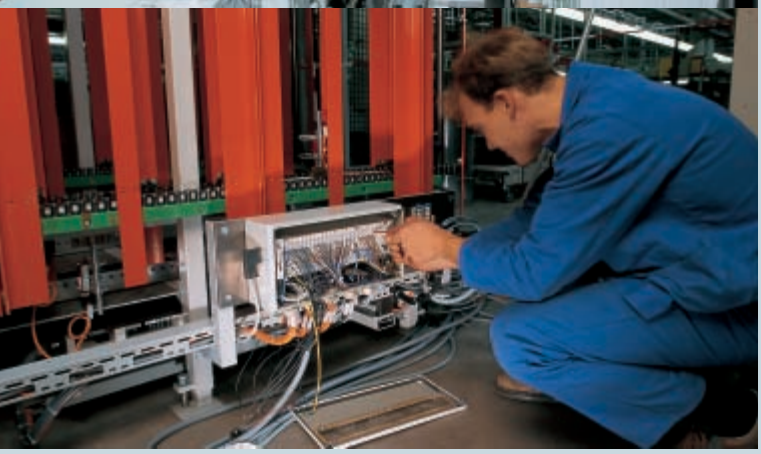


IMA Automation in Germany is part of the Feintool Automation Division and a leading global supplier of automatic assembly machines. "In 1997, we switched our complete control concept from a centralized hardware PLC to a PC-based control system from Beckhoff including Industrial PCs, the TwinCAT software PLC, and Bus Terminals," said Günter Sterk, director for electrical systems at IMA Automation. "We decided to use Lightbus as our standard fieldbus," explained Günter Sterk. "In the meantime, we have installed additional fieldbus systems: SERCOS for highly dynamic applications, DeviceNet for systems operating in conjunction with robot applications, PROFIBUS as the periphery for customer-specific systems, more recently also real-time Ethernet couplers," he continued. "Why do we use Beckhoff Bus Terminals? The main reasons are high modularity and a significant price advantage compared with other vendors' systems. Additional factors are the wide range of terminals with special functions, e.g. serial terminals for systems with up to 13 serial interfaces, oscilloscope terminals, AS interface master terminals, negative switching terminals, SSI, which we found very impressive," Günter Sterk stated on the 10th anniversary of the introduction of Beckhoff Bus Terminals.

Koch in Germany, makers of packaging machinery, uses TwinCAT control software for controlling medium-sized and large machines. One example for a typical application is a Varta AG blister line for packing flashlights, associated batteries and a product information sheet into a transparent dual blister pack. The automation system for the machine also features Bus Terminals that are connected to the PC controller via Lightbus. For packing machines using other fieldbus systems, only the Bus Couplers have to be replaced, without having to redesign the complete application.

Wheaton Brasil, based in São Bernardo do Campo, Brazil, supplies glass packaging for the cosmetics, pharmaceuticals and food industries. In one of the glass packaging machines, the mechanical camshaft for synchronizing the machine's sections was replaced with a BC9000 Ethernet Bus Terminal Controller. "The Beckhoff Bus Terminal system led to a significant reduction in changeover time for these machines. This will lead to higher production volume and greater precision," said Mauro Poltronieri, director for automation systems at Wheaton Brasil. "In our existing conventional machines we had to adjust settings during operation, resulting in a high risk of operator accidents, or we had to stop the plant and interrupt production. The Beckhoff system enables us to carry out adjustments 'online' via control software."

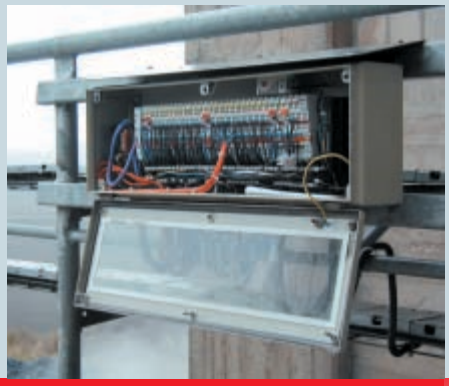
Fronius International GmbH of Austria is a leader in welding technology and a one-stop provider for welding products. "We have been using the Bus Terminal system from Beckhoff for many years. It enables our fully digital current sources to communicate with a wide range of robot systems," said Wilhelm Ortbauer, software developer for fieldbus communication at Fronius. "The Bus Terminal system reduces our development time, i.e. a new robot can be integrated into the overall system by simply replacing one of the modules. In this way we are able to offer rapid market availability and the system makes commissioning on site simple and safe. Our customers include well-known motor vehicle manufacturers such as Volkswagen AG. Our international presence also requires our system partners to offer rapid and competent support worldwide. With Beckhoff as a partner, Fronius manages to achieve successful synergy effects worldwide."



The **German company Miele & Cie. GmbH & Co.**, manufacturer of high-quality domestic appliances such as washing machines and dryers, was one of the first to use Beckhoff Bus Terminals in their production lines. The electronic terminal blocks enabled Miele engineers to implement tailor-made control solutions with cost-effective standard components. Miele's intention was to use a decentralized approach for reducing the costs for comprehensive and sophisticated control cabinets, cable routes and installations, and at the same time to reduce the effort involved in line conversions. For this reason, individual stations with Beckhoff Bus Terminals were installed at each assembly or supply port.

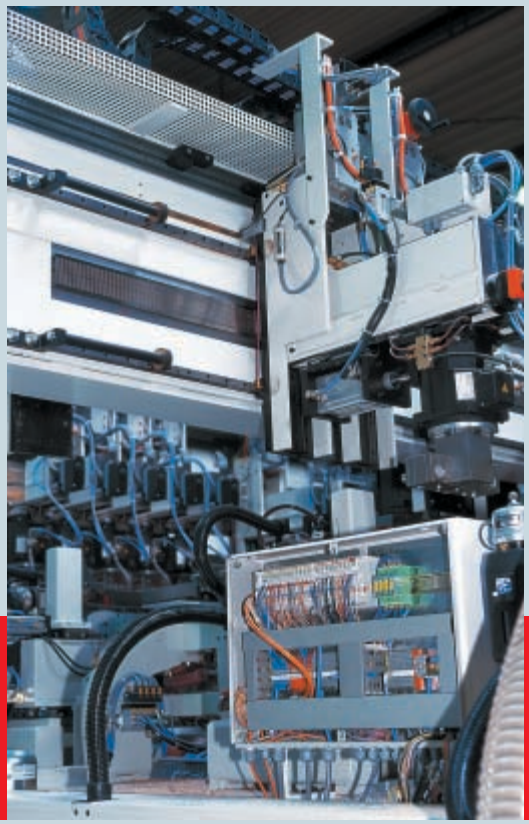
Pilkington Italia SpA, based in San Salvo, Italy, manufactures glass and glass products for buildings and cars. It operates production facilities in 24 countries on five continents and sales offices in 130 countries worldwide. With the production of glass for car windows, the Pilkington subsidiary at San Salvo generates an annual turnover of approx. 400 million euros. In 2004, the plant started using the Bus Terminal I/O system from Beckhoff, which led to a significant increase in productivity.

Cement manufacturing is a world in itself. The production process cannot be measured against ordinary standards, since it is subject to high temperatures and vibrations. Here too, distributed Bus Terminal stations are used. The cement plant at Höver is one of several cement, lime and ready-mixed concrete production facilities in Germany operated by **Holcim AG**. The strategy adopted at the Höver facility is one of decentralized automation. The system involves about 100 terminal boxes distributed across the plant, featuring more than 2000 Bus Terminals for transferring process signals to the control center via PROFIBUS Bus Couplers. Conversion to a standardized I/O system not only reduced the cabling work, but also led to improved transparency of the system for the individual stations of the concrete production.



The **German company IMA Klessmann Maschinenfabrik** has been a trendsetter for wood processing technologies for several years. In collaboration with Beckhoff, IMA realized a concept for PC-based control of edge processing machines, including the "Combima" machine series. All hardware components such as fieldbus devices, valves, drives etc. are directly located at the unit. The I/O data generated in the machine are recorded via the Bus Terminals. Communication between the controller and the decentralized I/Os is via Lightbus. EtherCAT terminals are now used in more recent machine designs.

Beds with variably adjustable wooden slat frames can be a significant factor for ensuring a good night's sleep. Woodworking machines from **Koch-Maschinenbau in Germany** play an important role here. Equipped with advanced Industrial PC Control technology, they ensure the dimensional accuracy of the bore holes and milled slots. Like for other machines, Koch uses Beckhoff hardware and software for this application, consisting of an Industrial PC with TwinCAT NC PTP, a 15-inch Control Panel, 30 AL2000 linear servomotors and Bus Terminals as the I/O system for accurate positioning of the processing heads.



The **Spanish company, Ecotècnia** has been involved with renewable energy projects since 1981. It designs, manufactures and operates wind power plants and turnkey wind parks. Beckhoff Bus Terminals have become the standard control system for the company's wind turbines. Jordi Roca, director of Ecotècnia's electronic systems section, said: "In our wind parks in Spain, we have installed more than 1000 DeviceNet Bus Couplers and a variety of Bus Terminals from Beckhoff". "In conjunction with Ecotècnia's know-how in this market segment, the combination of operator convenience, modular design and flexibility offered by the Beckhoff Bus Terminals leads to an end product that offers excellent performance."

Billhöfer of Germany is a worldwide supplier of machines, systems and components for coating, refinement and connection of planar substrates made from paper, metal, textiles, plastic and other materials. "We have been using Beckhoff Bus Terminals in our machines since 1991," said Peter Miczka, director for electronic systems at Billhöfer. "At that time we switched from a centralized control configuration to a modular machine concept with local control. The Bus Terminal system from Beckhoff offers a key advantage – the same periphery can be connected to different bus systems by simply replacing the Bus Coupler, which makes service and inventory management much easier," said Peter Miczka's colleague, Gerhard Wüchner. "Due to the modularity of the system, only those inputs and outputs that are actually required have to be connected. This means that the system can be very compact and space-saving. This in turn leads to a price advantage we can capitalize on."

The **Dutch company ASML,** one of the world's leading manufacturers of high-tech machines for the semiconductor industry, developed a production line for 300 mm wafers using TWINSCAN. The control solution for monitoring and diagnosis of the complete system was realized with Beckhoff components. The system monitors all safety and emergency systems and logs any alarms. At the same time, the current state of production is visualized on two 10-inch Control Panels. Apart from PC Control, eight Bus Terminal stations for monitoring and diagnostic functions are integrated for each production line at the I/O level. DeviceNet is used as the fieldbus – increasingly establishing itself as the standard for the semiconductor industry.

At their plant in **Genk, Belgium**, car manufacturer **Ford** was faced with the task of replacing their 40-year-old mechanical kWh measuring instruments with a new, modern energy measuring system that stores measured data in such a way that they can be retrieved again. The new system had to be affordable and more cost-effective than simply replacing the existing kWh measuring instruments. Ford decided to use the KL3403 3-phase power measurement I/O terminals from Beckhoff. The Bus Terminal is currently only used for kWh measurements. However, in the future the company also intends to record the phase shift angle cos φ and peak currents in order to obtain more detailed energy consumption information. This enables Ford to meet the Kyoto standard for environmental protection, which came into force in Belgium on 16 February 2005.

Over the past few years, nearly all the lines in the engine assembly area at the **VW factory at Uitenhage in South Africa** have been converted to PC-based control technology from Beckhoff. There are also TwinCAT controlled lines in final assembly and body shop. In the past, the production plant was expanded for the PQ24 Polo (a light passenger vehicle), for example. The control system – consisting of seven C33xx type Industrial PCs – was optimized for process security during production and machine control with integrated data acquisition and monitoring of the subsystems. The I/O data required to control the conveying systems, special purpose machinery, bolting and pressfit systems are transferred across the entire assembly area reliably and rapidly over Lightbus. The Lightbus ring passes through a series of Bus Terminal stations with their associated digital, analog and serial I/O terminals.

Came Security of Italy specializes in PC-based control and monitoring for ships and yachts. "Came Security was one of our first Italian customers to use Bus Terminals from Beckhoff," said Pierluigi Olivari, managing director of Beckhoff Italy. "The huge savings in terms of space and wiring time offered by the system proved very useful and advantageous in shipbuilding applications," explained company director Riccardo Matteucci. "The CX1000 Embedded PC and the TwinCAT software PLC are ideal for controlling all electrical systems on a yacht."

Wuhu Cigarettes, Jiang Cheng, China. "Our plant has a very high throughput with demanding requirements for our control system," said Huai Zhe, works engineer at Wuhu cigarette factory. "One of the key features of this tobacco cutting line is that all components, such as vibratory conveyors, rollers and conveyor belts are driven by motors with less than 5.5 kW capacity. In order to ensure robust, interruption-free operation it is particularly important that status and fault displays are available without any delays. The KL8001 power terminal from Beckhoff makes this possible. What's more, each motor can be controlled via the same terminal type. The system also offers significant benefits during installation, leading to reduced maintenance time and costs. Compared with previous control systems, the plant now operates at much higher speed, leading to significant productivity improvements."

The **German company, Team GmbH** was established in 1984 and specializes in control and visualization technology. Improving cost-effectiveness was the main driving force behind a recent project involving the conversion of a floating dredger for sand and gravel extraction to fully automatic control. "The DredgerControl control system we specially developed for this purpose is based on Beckhoff Bus Terminals and the TwinCAT software PLC. During the actual operation, it exceeded our expectations," said Bernd Wittenberg from Team GmbH. "Dredger production increased by around 22 percent. So far, the system has suffered no control-related downtime since it was installed more than two years ago. A further advantage of the Bus Terminal system is its expandability. The recent extension involving a booster station only took a few hours to implement, including commissioning."

The densely populated **"Xu Jia Hui" district in the southwest of Shanghai** is a flourishing business quarter in China. The speed of the economic development and intense construction activities meant that the old waste water system could no longer cope with demand and a major reconstruction was required. In the second development phase of the project, a new pumping station was connected to the central monitoring and control system of the "Zhao Jia Bang" waste water treatment plant. All I/O points in the field from a total of 38 distributed Beckhoff Bus Terminal stations are connected with the central control system via DeviceNet. In order to optimize the price/performance ratio, "Compact" and "Low Cost" type Bus Couplers were used.

→ Additional applications and solutions using Beckhoff Bus Terminals can be found at:
www.beckhoff.com/applications/