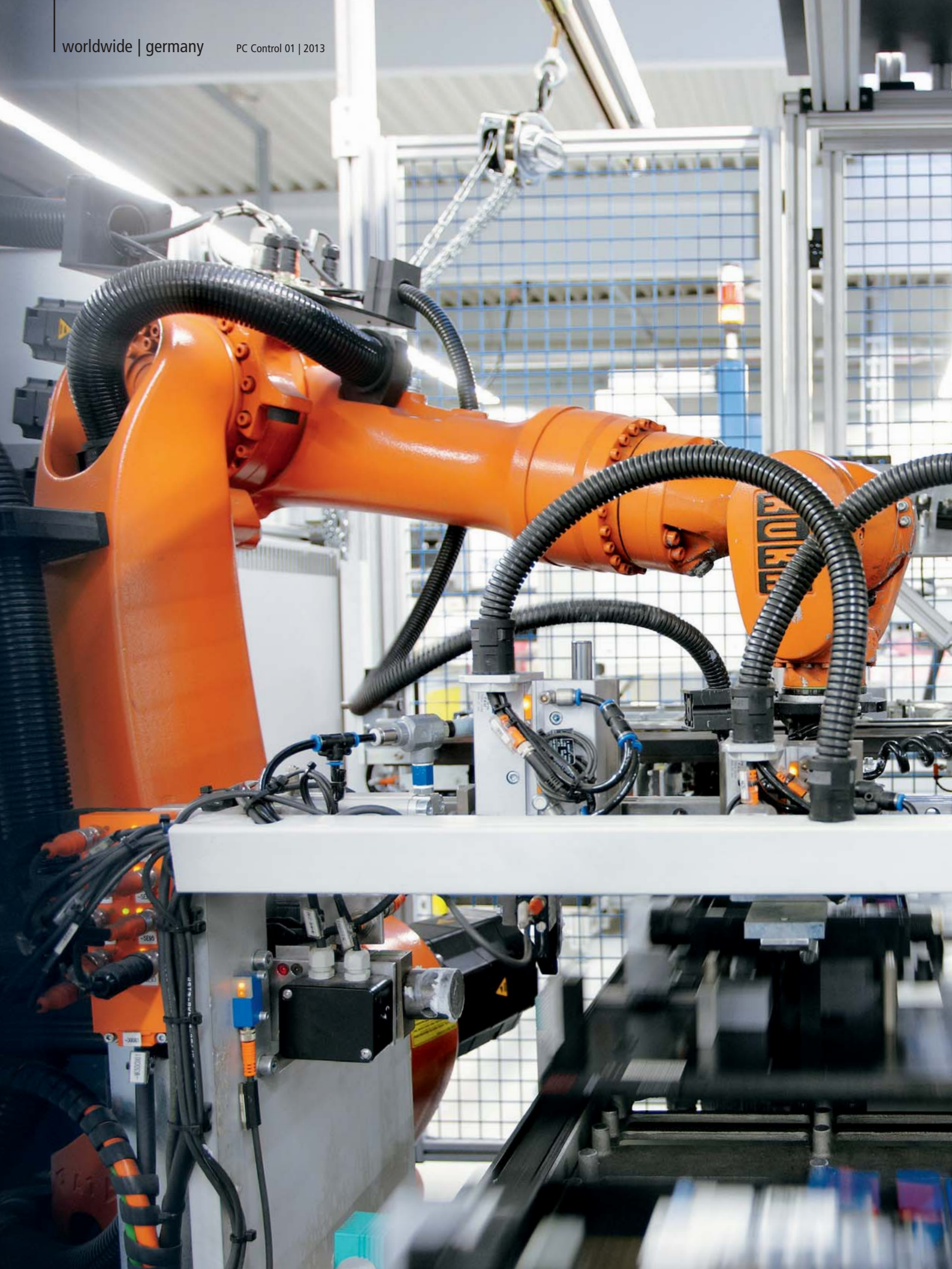


Automotive industry: Perfect communication between control and MES system ensures premium quality and safety standards

Assembly line produces more than 1 million electronic parking brakes per year

In cars, conventional hand brakes are increasingly replaced by electronic parking brakes (EPB). EPBs automatically apply the brake during parking and release it during hill starts while automatically adjusting the cable. The company Küster Automotive Control Systems GmbH (ACS) is part of the Küster Group and one of Europe's market leaders among EPB suppliers. In 2011 the company reported production of more than 1.2 million EPBs. The four assembly lines on which the EPBs are produced are fully automated with Beckhoff technology. Technological highlights include integrated, database-guided process monitoring and electronic calibration of the EPBs.

6-axis articulated robot during assembly of the housing cover. Before this, all components within the EPB are assembled.

Küster technology is used in millions of cars from a wide range of manufacturers. Küster components include mechanical or electronic parking brakes, window regulators, complete door systems as well as acoustic and exhaust dampers. Küster Automotive Control Systems GmbH (ACS), one of five Küster Group companies, is based in Ehringshausen, Germany, and produces electronic parking brakes for different European car manufacturers. Küster ACS has been using Beckhoff technology for controlling its production facilities since 2003. Today, PC-based automation technology from Beckhoff is a mainstay for large control systems at Küster ACS.

Meticulous documentation of production, testing and calibration processes

Unsurprisingly, the requirements for control and monitoring of EPB production are complex. On the one hand the production is subject to strong price pressures, which means that the assembly processes must be efficient and highly automated as basic requirements. On the other hand EPBs are safety-relevant vehicle components which are subject to strict testing and documentation requirements. An additional complication arises from the fact that an EPB is equipped with a dedicated electronic system, which subsequently communicates with the vehicle and therefore must be calibrated for different operating states (inclination angles, braking curves, etc.). During all production stages, including material delivery, the different manufacturing steps, calibration, function tests and shipping, the control and testing units of the production line all communicate with the central database via the C6140 Industrial PC from Beckhoff. The Industrial PC acts as a coupling system by automatically collecting the data from all system components and transferring them to the server in bundled form. The communication between the coupling system and the assembly stations takes place via TwinCAT ADS. The C6140 also deals with remote maintenance and diagnostics. The database grants approvals for all control commands and meticulously documents the whole production and calibration process and the subsequent function test. Each individual EPB is 100 % tested. "Therein lies the difference between 'normal' production, in which the parts are assembled and delivered based on a production plan. At Küster the finished product – the EPB – is measured, and correction values are applied as required," said Oliver Barwitzki, a member of the Beckhoff sales team at the company's Frankfurt branch. The data exchange takes place at very high speeds: depending on the scope, the response times for database queries in the control modules are around 100 ms per query on average. With annual production of 1.2 million EPBs, as was the case in 2011, around 130 GB of table data are generated.

Electronic parking brake (EPB) with an original rear car axle. The image shows the cable route, including the brake cables at the brake caliper.

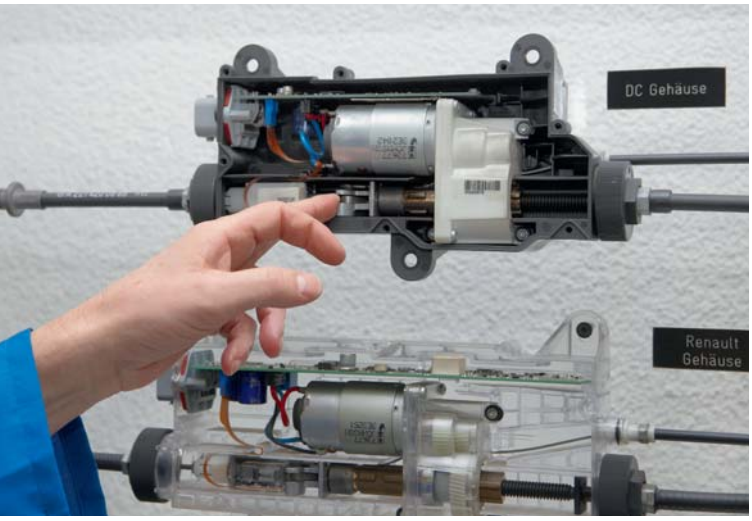
Control of the EPB production, the calibration and the test rigs is almost exclusively (98 %) handled by automation technology from Beckhoff. The Küster managers were impressed by the compactness and flexibility of the Beckhoff

Control cabinet for the calibration system

Pre-assembly of the motor and gear unit

Küster Automotive Control Systems GmbH is one of Europe's market leaders among suppliers of electronic parking brakes (EPB). The four assembly lines on which the EPBs are produced are fully automated with Beckhoff technology.

solution, the high process speed and the impressive price-to-performance ratio. "Another highlight of the Beckhoff control platform is the fact that, in addition to pure process sequence control, measurement technology (force and displacement measurement) can also be integrated in the control system," said Oliver Barwitzki. A further advantage is the fact that communication with the EPB control electronics can take place directly from the PLC via the FC5101 plug-in card and a vehicle-specific CAN bus protocol (with 11- or 29-bit CAN identifier).

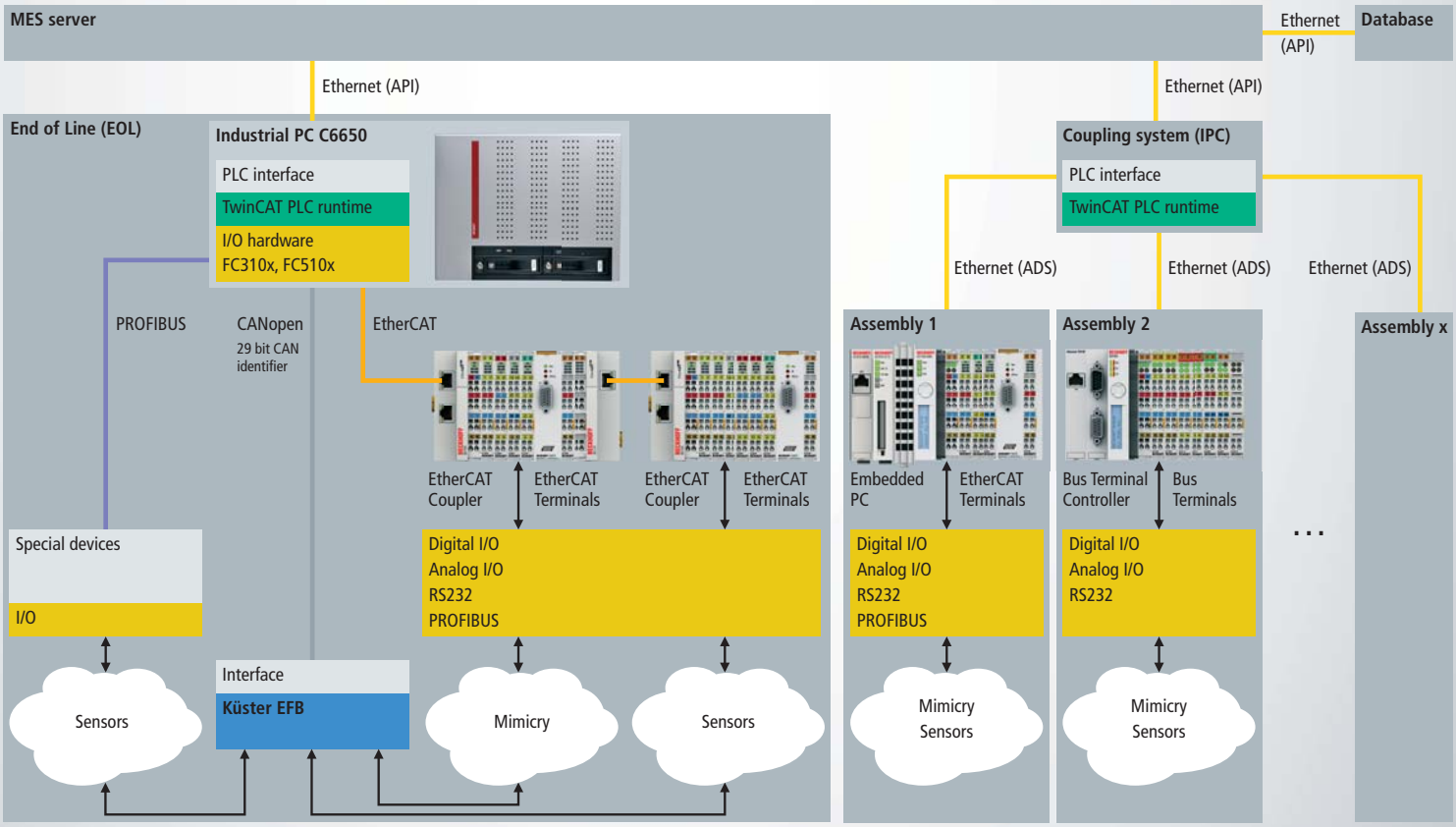


Küster uses the whole range of Beckhoff products that are scalable in terms of performance: control devices include Ethernet Bus Terminal controllers from the BX series, Embedded PCs and Industrial PCs from the C6650 generation as end-of-line computers. The software includes TwinCAT I/O, TwinCAT PLC and TwinCAT NC I. The common denominator is that all controllers are operating within one network and are in synergy with the database.

Küster ACS relies heavily on TwinCAT software. TwinCAT NC I, for example, was used for the first time in an end-of-line assembly line for modular production of EPBs, which was delivered to Shanghai in 2010. The EPB housings must be absolutely tight, since vehicles come into contact with water on a regular basis. The sealing process is realized via an XY table with a TwinCAT NC I controller. This is the only way possible to ensure constant path velocity and continuous application of sealing compound.

The EPB components: at the top is the control PCB with tilt sensor. In the center is the (DC) motor/gear unit. The tightening force is generated from the rotary movement via the spline shaft of spindle, which is additionally equipped with a force sensor and an emergency release mechanism. All components are assembled into a finished EPB and then tested.

The EPB housing cover can be seen on the product carrier in the foreground, behind it is the EPB housing with a PCB that has just been fitted. The next step is assembly of the motor/gear unit.



Küster – system partner for the automotive industry

The Küster Group, with headquarters in Ehringshausen, Germany, is an international system partner for the automotive industry. The family enterprise, which was founded in 1926, particularly focuses on operation, door and gear systems. A common characteristic of all Küster products is their cable-based operating principle.

The company's strong position in the highly competitive automotive supplier market is based on commitment to innovation, adaptability in the face of volatile market conditions, production efficiency and compliance with strict quality standards. In the automotive sector Küster has more than 30 car manufacturers among its customers, among them all large European brands. Since 2000 the Küster Group has been able to more than double its sales. In 2011 the company generated sales of 420 million euros with 3,000 staff.

Calibrated EPBs in the work piece holder. The last part to be fitted to the housing is the vehicle model-specific support.

Beckhoff control technology as standard

The application of Beckhoff technology at Küster is a success story that started in 2003 as a trial on the test rig for the first EPB production and has continued ever since. Beckhoff scored with open control technology and flexibility, and quickly became established as the standard control supplier for Küster. Today, Beckhoff controllers are used by the whole Küster Group, and this upward trend is set to continue. In the meantime Küster also specifies Beckhoff technology for its suppliers, and technologically the relationship between Küster and Beckhoff has advanced continuously. When the Lightbus protocol was no longer able to meet Küster's speed requirements, Beckhoff developed the EtherCAT fieldbus just at the right time.

Perfect communication between control and MES system

The control architecture is shaped by the requirement that each step of EPB production must be approved, tested and documented. (see diagram) Again, it consists of the system computer, a C6650 Control cabinet Industrial PC with TwinCAT PLC automation software, which controls the production. The Manufacturing Execution System (MES) database documents everything in the process. The interactions between the Beckhoff controller and the MES system are intensive. A suitable programming interface for this was implemented within a short period of time via the cooperation between iTAC software AG (suppliers of the Oracle database), Beckhoff and the Küster production equipment division.

Around 100 controllers are connected to the database, which means that it must cope with huge quantities of data. For each electronic parking brake, approximately 250 measured values and test data are stored, of which around 150 are gathered during final, end-of-line acceptance. The documentation ensures that only approved parts are used and that the product meets the highest quality and safety standards. For each EPB produced, it is possible to trace each component and find from which batch a screw, gasket or housing originated. This is helpful in the event of a complaint, if a supplier has to concede quality defects, or in the event of transport damage. The traces can go back and find exactly which batches are affected.

Küster is always on the front line of technological development, both in terms of automation and control of the production processes and product development itself. A recent example is the implementation of remote maintenance for EPB production in China. On the product front there have also been newsworthy developments. With automatic exhaust and acoustic dampers, which have the potential to revolutionize exhaust technology, Küster is ready to launch the next potential bestseller. The Küster production equipment division has already assembled the first production line, naturally with a Beckhoff controller.

Further Information:
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