



PC-based control technology in automated component assembly

## Accelerating high-precision assembly of micro-optics

Aixemtec GmbH in Herzogenrath, Germany, develops automated solutions for the precision assembly of electro-optical systems. Founded in 2016 as a spin-off from the Fraunhofer Institute for Production Technology (IPT), the high-tech company offers customized solutions based on a modular system, covering everything from material feeding and handling to micromanipulation and measurement for ultra-precise assembly, rounded off with quality assurance. PC-based control from Beckhoff, including TwinCAT Vision software, ensures both accurate and rapid process workflows.

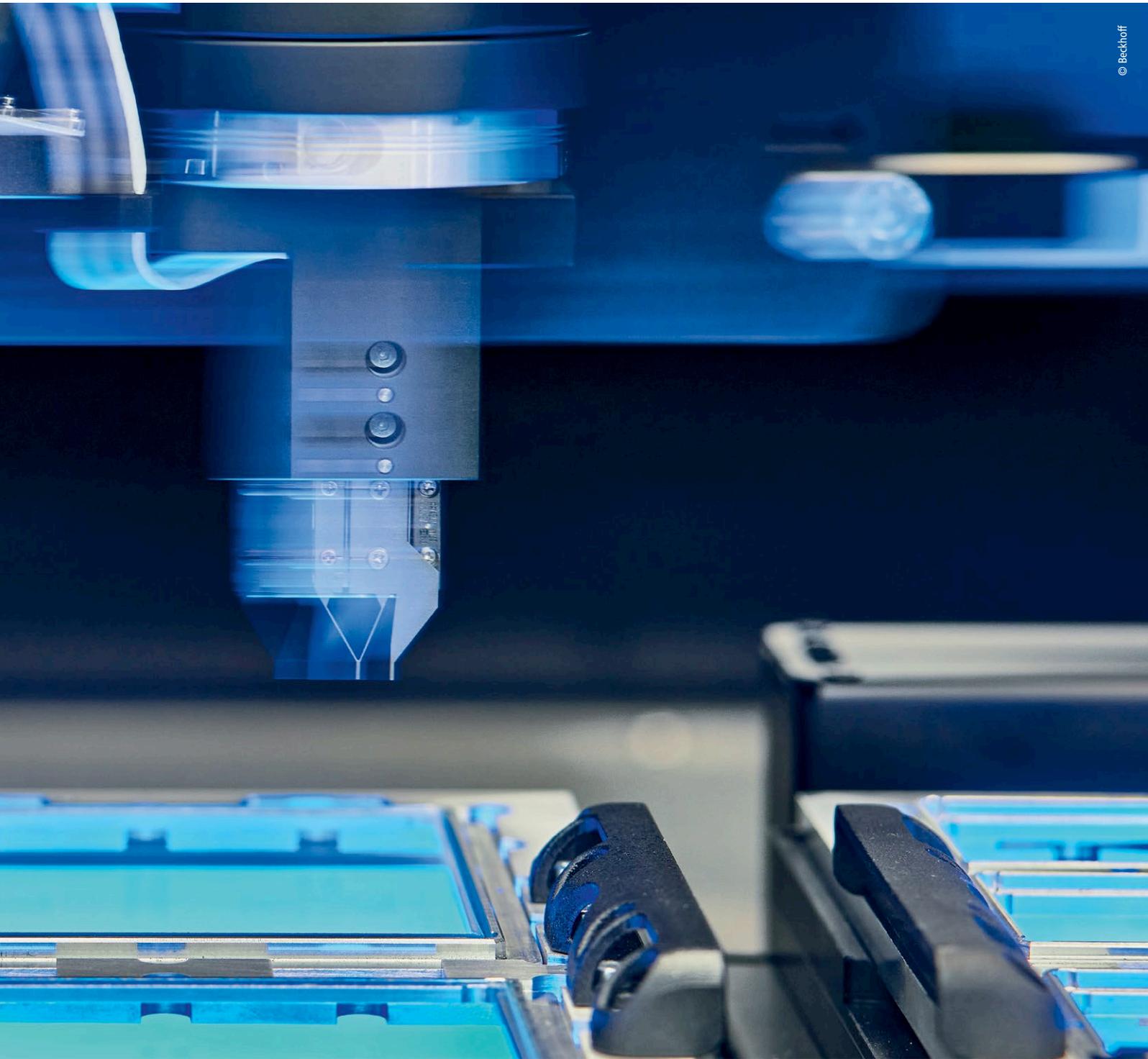
Modular and highly precise assembly system from Aixemtec



Optical systems are used in a wide range of products, owing not least to the increasing miniaturization of core technological components. Other application examples can be found in sensors and cameras for autonomous driving (e.g. LiDAR and driver assistance cameras), for gesture recognition and for beam shaping of high-power lasers. The accuracy demands for the assembly of these optical systems range from a few micrometers to a few hundred nanometers. Combined with cycle times of less than one second and the production of several million components per machine and per year, special demands are placed on the entire automation system.

### Compact and flexible automation technology

Aixemtec offers assembly solutions for various application areas based on a comprehensive modular system platform. A scalable housing design concept is applied to each machine. Highly precise and highly dynamic linear drives are frequently used. Automation components from Beckhoff help optimize space utilization across the platform while also minimizing the system footprint. One example is the compact and modular AX8000 Servo Drives used to control some linear motors, requiring significantly less space in the control cabinet than before.



The high-performance C6032 ultra-compact Industrial PC is another key factor in reducing system size: Until now, a separate PC for image processing, HMI and sequential control was used alongside the CX5130 Embedded PC for machine control whereas the C6032 now takes over all of these tasks. The compact drive technology from Beckhoff, such as the EL72xx EtherCAT servo terminals with AM8100 servomotors, as well as the high-density (HD) EtherCAT Terminals, also ensures that space is saved on the DIN rail. "The small dimensions of each axis module, the possibility of lining up the modules beside each other and the integration of the safety function, with no additional wiring, but

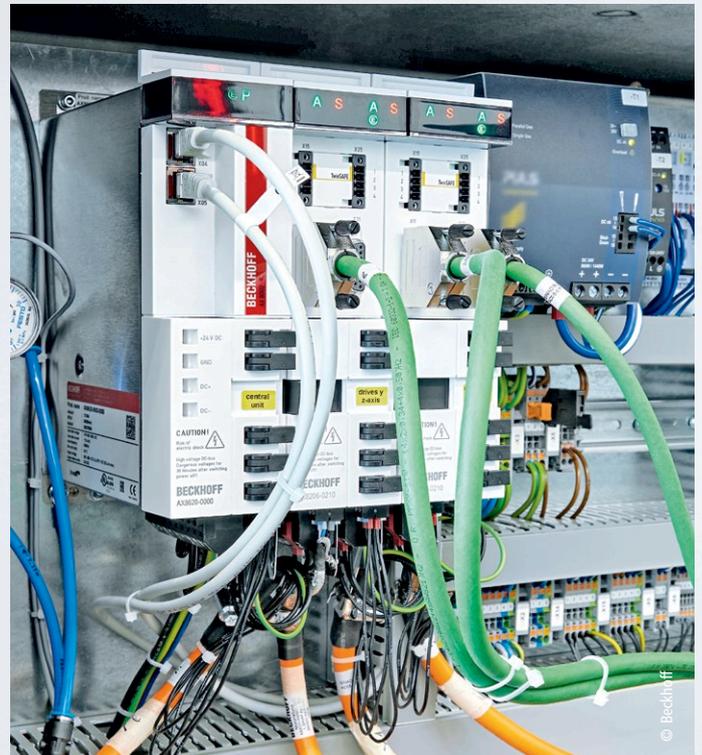
rather EtherCAT, have saved us 63% of space requirements on the mounting plate in comparison with our previous solutions, even though we can also control third-party drives with it," explained Sebastian Sauer, head of machine development at Aixemtec.

#### **Extensive range of hardware and software interfaces**

The central C6032 IPC controls all machine components with its powerful multi-core performance. On the software side, TwinCAT Vision is used alongside TwinCAT PLC, TwinCAT NC PTP, TwinSAFE and TwinCAT HMI, and it plays



The high-performance C6032 ultra-compact Industrial PC controls all machine and process sequences with numerous TwinCAT software functions, such as TwinCAT Vision.



The modular AX8000 Servo Drive saves significant space in the control cabinet.

a key role in connecting up to eight industrial cameras. Certain preparations for the process chain are carried out outside of the real-time environment in a specially developed high-level language program. Here, the PC-based control system from Beckhoff allows TwinCAT and user-specific programs to be seamlessly integrated on the same IPC. To this end, TwinCAT supports the necessary communication between different software systems with universal communication interfaces such as ADS or OPC UA.

Sebastian Sauer points out another aspect: "Aixemtec and Beckhoff follow a very similar philosophy: We want to be there for our customers as a partner throughout their entire product chain. It is for this reason that Beckhoff has become our main partner for automation technology, providing cross-interface support from motion to HMI and image processing from a single source and with short lines of communication. The 'friction losses' we have saved as a result are tremendous."

#### Highly dynamic pick-and-place process for micro-lenses

A prime example of the high demands is seen in the pick-and-place process for micro-lenses: To prepare the randomly fed in micro-lenses for assembly, they must first be arranged in a specific orientation on a tool carrier. The aim

is to position the fragile components quickly and precisely in a workpiece magazine. In many cases, these components have a cross-section no wider than a few hairs.

The micro-lenses are fed in bulk on a backlit surface. This surface is scanned with a camera via XYZ kinematics. The result is a 2D panorama of the area being examined. By means of precise time synchronization of TwinCAT NC axis control with TwinCAT Vision – with the help of the distributed clocks function of EtherCAT – image capture can be precisely aligned with axial positioning. Where before a time-consuming PTP process was used, TwinCAT Vision can reduce the setup time of this process by at least a factor of eight. It is not necessary to stop for each individual image capture. The individual images created in this way during the "fly-over" are inserted into an overall image with pixel accuracy in real-time. Using this overall image, the micro-lenses are identified by image processing and their current orientation is measured. This results in an efficient work plan for how the pick-and-place system should pick up the individual lenses, orient them in all spatial dimensions and place them. The linear axes controlled by the AX8000 enable highly dynamic and yet highly precise movement of the entire kinematics.



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From left to right: Aixemtec Managing Director Sebastian Haag, Christian Kukla, Application and University Management at the Beckhoff Aachen Office, and Sebastian Sauer, Head of Machine Development at Aixemtec, standing in front of the component assembly system

The micro-lenses that have been prepared for assembly are bonded with a light source in a subsequent step. For this purpose, an adhesive dispenser applies a fixed amount of adhesive to the micro-lens. Precise dosing is essential for correct assembly, which is why the drop flow is continuously monitored and adjusted by a camera system during the dispensing process. In the future, this task will also be taken over by TwinCAT Vision, as drop triggering, image capture and exposure can be ideally synchronized with the EL2596 LED strobe control terminal and the distributed clocks function. Before the adhesive cures, the optical function of the system to be assembled is optimized with the help of a 6D manipulator in a closed control loop.

### Conclusions

Sebastian Sauer summarizes: "The complete package with hardware and software, including TwinCAT Vision, is an ideal solution for us. We are able to retain our modularity by using distributed clocks and XFC technology. TwinCAT Vision allows us to remain completely in the real-time environment even in the context of image processing. One particular advantage for us and our customers is that we already rely almost entirely on OpenCV for applications outside the real-time environment. The fact that Beckhoff has also adopted this as a foundation for their products means that we can build on our existing expertise."

The comprehensive product range from Beckhoff allows uniform workflows during the engineering process and also a high-performance and yet compact machine design. Owing to versatile interfaces for software and hardware connection, all challenges can be overcome in a consistent manner. The open system solution from Aixemtec offers maximum flexibility so that any customer-specific process can be mapped. "Industrial image processing has long been state of the art and one of the cornerstones of our machine architecture. With TwinCAT Vision, this can now be integrated into process control in a cycle-synchronous manner," says Aixemtec Managing Director Sebastian Haag, explaining the advantages of the development.

More information:

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