Highly complex movements of 21 axes safely implemented, all in a compact footprint

Durrer Spezialmaschinen AG, based in Küsnacht am Rigi in Switzerland, develops specialized machines for a wide range of industries. Case in point, Durrer manufactures the REGA 3 for the paper processing industry, used to cut step indexes for printed material such as catalogs. This highly complex process not only requires exact cutting of the pages for the respective sections, but also precise page counting for a wide range of different paper types. Durrer revolutionized this process years ago with fully automatic machines. More recently, the company developed a new machine generation that accomplishes these tasks faster, more flexibly, and with increased process safety, based on compact, integrated drive and control technology from Beckhoff.

As a special-purpose machine manufacturer, Durrer benefits from years of experience in a wide range of applications with demanding motion control requirements. The latest REGA 3 machine provides a case in point. Thanks to the compact OCT (One Cable Technology) Drive Technology from Beckhoff, it was possible to implement highly complex motion systems in a cabinet measuring only 2.8 x 1.8 x 2.0 m. The REGA 3 consists of two independent manual infeed and delivery stations, which operate in conjunction with the fully automatic counting and cutting unit to process products such as address registers, catalogs, or lexicons. The processing station itself consists of a transfer unit, a parallel-edge counting unit with counting control, a cutting unit, a mobile worktable for the counting and cutting unit, and a conveyor belt for disposing of paper scraps.

Patrick Suter, Head of Development at Durrer, describes the key features of the machine: "The REGA 3 machine can process hard and soft cover products with formats up to 350 x 350 mm, and with all mechanically countable paper types. The parallel edge-counting unit enables automatic control during the counting process. The machine offers a high degree of operator comfort, thanks to simple parameter input with menu control via the machine terminal. The number of pages and cutting parameters such as length and cut depth can be programmed individually for each cutting operation. For example, they can be stored in the form of 'recipes' and retrieved for periodic processing of annual catalogs."

Special-purpose engineering benefits from open and flexible control technology
Durrer has been using PC-based control from Beckhoff for special-purpose machine automation since 2008. According to Patrick Suter, key factors included the openness, flexibility, and modularity of this control technology. "PC-based control is able to handle all control and drive requirements for a wide range of products. Moreover, thanks to innovations such as XFC (eXtreme Fast Control) technology or the eXtended Transport System (XTS), we have plenty of flexibility for future developments without having to overhaul the system. Further impor-
tant features included the high product quality and comprehensive technical support provided by Beckhoff."

Openness and flexibility are also key benefits of EtherCAT as a communication system. On the one hand, according to Patrick Suter, it offers an Ethernet-based bus, which means it adheres to IT standards and therefore offers the capability to implement future innovations. On the other hand, EtherCAT has established itself as a widely used standard, which means there is plenty of choice when it comes to sensor components from third-party suppliers. Moreover, safety-related communication is part of the integrated functionality of EtherCAT, to easily implement safety into the overall control system. In this way, it is possible to implement customized protection of machine operators from the 40 cm pinch knife via TwinSAFE I/Os or the optional AXS805 TwinSAFE drive card. This also includes monitoring of protective doors and gates, light curtains and terminal strips, activation/deactivation of the pneumatic main valves, and control of the servo axes via SS1, SOS, and STO.

The REGA 3 machine from Durrer enables the full automation of complex step index cutting processes.

At a glance:

**Special-purpose machine engineering**
Highly precise and safe axis control during cutting of step indexes

**Customer benefit**
Compact machine design with fully automatic machining process

**Applied PC control**
AX5000, EL7201 and AM8000: the highly dynamic and compact drive solution with One Cable Technology
IP 67 I/O modules: space-saving data acquisition directly in the process minimizes wiring
TwinSAFE: safety solution with hardware and software that is seamlessly integrated into the overall system
The REGA 3 machine also enables processing of print products with hard covers, shown here in the infeed and delivery station.

A Beckhoff CX2020 Embedded PC with Intel® Celeron® CPU, 1.4 GHz clock frequency, and Windows Embedded Standard 7 operating system handles the control functions of the REGA 3 machine. TwinCAT PLC HMI software and the 15.6” CP2916 multi-touch Control Panel are used for visualization of the machine data. Here, too, Patrick Suter sees notable benefits for future HMI concepts: “Thanks to its widescreen format, the Control Panel optimally supports our HMI interface. Its multi-touch functionality provides enormous innovation potential for future visualization developments, not to mention an advanced and elegant panel design.”

**Dynamic servo technology enables sophisticated Motion Control**

The following technical data illustrate the stringent requirements of the REGA 3 index cutting machine, in terms of dynamics and precision of the axis movements: a total of 21 servo axes ensure that up to 50 sheets of paper per second can be counted, and that cutting can take place up to six times per second. 17 axes are controlled via a single-channel AX5112 Servo Drive, or via nine two-channel AX52xx servo controllers. Dynamic servomotors from the AM8000 series – with or without a holding brake – are used for the axis movements. In some cases AM85xx servomotors are used, which offer particularly high control quality due to increased rotor moment of inertia. The other four axes, used for counting, are very compact in their implementation, featuring EL7201 servomotor terminals and corresponding AM8100 servomotors.

Specifically, the 21 servo axes perform the following motion tasks: the feed and delivery stations feature an axis for book transport, as well as y- and z-axes for bending the books upward. In the counting unit, a z-axis moves the format jaw, while servomotor terminals each control counting and buffering of the paper pages. In addition, there are two axes for tilting and four axes for moving the mechanical counting system. Two of these axes are coupled via electronic gearing. During cutting, three servo axes are used for precise infeed, and a further axis controls the cutting movement of the blade.

All servomotors used in the system benefit from One Cable Technology (OCT), which combines power and feedback systems into a single, standard motor cable. Patrick Suter explains the benefits: “The fact that the motor connection only requires a single cable reduces the wiring effort by 20 to 30%. We were able to simplify the design of some of the machine components as well, since they only have to accommodate a single cable.” Further benefits include safety integration and simplified software engineering. “A large part of our software development work relates to positioning calculations. The standard TwinCAT motion function blocks offer significant benefits in this regard. They simplify axis programming considerably and cover all our movement requirements,” noted Suter.

**Local I/O modules reduce installation effort**

In addition to the OCT solution, installation effort is further reduced by means of IP 67 EtherCAT Box modules, which can be installed remotely from the machine to handle the bulk of the I/O signals for the machine. The control cabinet itself only houses eight digital inputs/outputs, in the form of EL1008 and EL2008 EtherCAT Terminals, and twelve safety inputs and four safety outputs, in the form of EL6900 TwinSAFE PLC and the EL1904 and EL2904 TwinSAFE Terminals. All other I/Os are distributed throughout the plant with EtherCAT Box modules – 56 digital inputs, 24 digital outputs, and 16 digital safety inputs in total. The system features two EP2339 (16-channel digital input or output), three EP2316...
Via high-precision mechanics and Motion Control, the number of pages for each section can be counted exactly and reliably for all mechanically countable paper types.

Patrick Suter explains the design benefits: “Thanks to the EtherCAT Box modules, we were able to make the cable harness smaller and reduce the wiring effort by 50 %. We are now able to capture the digital signals directly in the process, transfer them to the compact IP 67 I/O modules, and forward them to the control cabinet via EtherCAT. The machine wiring has also become much simpler thanks to pre-assembled cables.”

For Patrick Suter, Head of Development at Durrer, the key benefits of the PC control solution are flexibility, openness, and capability to implement future technologies.

Due to their small dimensions and high dynamics, the OCT servo-motors of the AM8000 series are ideally suited for demanding motion tasks in applications where space is limited.

Further information:
www.durrer.com
www.beckhoff.com/AM8000
www.beckhoff.com/OCT
www.beckhoff.ch