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This paper includes two texts:

Two axes as a single CANopen node

Ferrocontrol, a daughter company of Eckelmann has extended its portfolio of 2-axes CANopen servo controllers. The units comply with CiA 402.

Ferrocontrol develops, manufactures, and distributes automation components and complete automation solutions in the field of drives technology (hardware and software) for the manufacturers of processing machines. "Our goal was to develop a controller that is easy to configure and maintain, even for complex systems, so that highly automated production processes can be designed efficiently and economically", Peter Schicker, technical sales department at Ferrocontrol, said. "To meet these requirements, we developed the FPGA-based drive controller E°Darc." The E°Darc family was introduced first at the SPS IPC Drives 2009.

Figure 1: New E°Darc C08D double axis module and compact dynamic servo motors by Ferrocontrol (Photo: Ferrocontrol)

The medium-sized company located in Herford, Germany, is one of the pioneers in the field of FPGA-based control algorithms for real-time processing in servo drives. The main advantages of this technology are a precise and fast current and position control by massively parallel processing and a more flexible architecture for application specific drive solutions. Ferrocontrol is a subsidiary of Eckelmann, Wiesbaden (Germany). Together, the companies act as a full-service supplier for machine automation worldwide. The product range includes drive and control technology as well as IPC technology and software.

The recent development is a powerful double-axis module. The E°Darc C08D integrates two power amplifiers and has a 2 x 8 A rated current. The design saves fieldbus interfaces as opposed to single-axis controllers and offers a cabling concept, which saves costs during purchase and assembly. FPGA-based control algorithms enable a dynamic control performance and positioning, depending on the configured control clock frequency (up to 12 kHz) for current control. The current measurement takes place virtually in real-time.
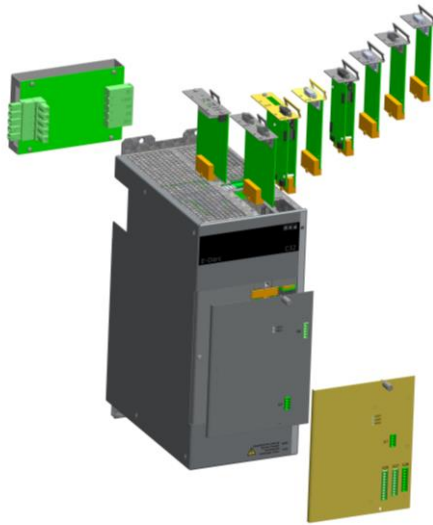
Figure 2: Modular Design of the drive control system E°Darc C, also suitable for customerspecific functions (Photo: Ferrocontrol)

In addition oversampling methods for position and current measurement acquisition improve the control quality without generating any latency within the control loops. This ensures that low-noise signals are available for current and position control. The main benefits of FPGA technology are therefore increased contour sharpness and higher production capacity. A pulse inhibitor STO (certified according to SIL 3), which is implemented as standard, ensures a reliable interruption of the power supply to the drive.

The E°Darc C08D is suitable for the controlled operation of synchronous and linear motors and can be operated with Ferrocontrol motors, which are optimally matched to the controllers. At the encoder interfaces, the controller is convincing by its diversity: resolver, Hiperface, Endat, Sincos, and incremental. The drives can be connected via a CANopen or Ethercat interface.

The CAN interface of the product has been realized as a multi-device according to CiA 402 series: one CAN interface hardware, one CAN address, and a doubled object directory for two drive axes. The module has a freely configurable PDO-mapping for cyclic process data communication. The following CiA 402-compliant standard operating modes are implemented:

- IPM (Interpolated Position Mode),

- PPM (Profile Position Mode),

- PVM (Profile Velocity Mode),

- HM (Homing Mode)

The service operation of the controllers is implemented via CiA's (CAN in Automation) remote-bit-mechanism. The service tool can use the connected PLC hardware as a "gateway" to the drive. Thus, no rewiring is necessary and the machine HMI can also be used as a typical commissioning notebook.

Despite the increasing use of Ethernet-based fieldbus systems, CANopen still plays an important role in the area of drive control and has a firm place in machine automation. This is thanks to CANopen's sophisticated and powerful application profiles, such as the CiA 402, which allows drives to be connected easily and flexibly. Nowadays, the CiA 402 series is one of the most commonly used drive profiles. Many standard tasks are covered, from tasks such as positioning or speed control to controlling processes. However, it allows you, in addition, to implement your own special functions.

Peter Schicker emphasized: „As a provider of customer application- and customer-specific drive solutions, e.g. for profile machining centers, this flexibility is important to us."

Another advantage is the rapid and on-demand exchange of process data, i.e. of real-time data such as target and actual values. For example, multi-axis systems can be controlled precisely and with minimal response times via a synchronization pulse and without unnecessary overhead. And also for the efficient transfer of device parameters, such as when the machine is started up, CANopen offers a proven communication channel with Service Data Objects (SDO) to transfer such data cyclically. In the interest of a consistent communication, the drive system can be connected directly to the control via CAN network, such as, for example, the E°EXC controller from Eckelmann for CNC, Motion, and PLC applications. The controller can control up to four independent CAN networks.

Ferrocontrol designed the E°Darc system so that the entire drive control is on one FPGA in parallel, "cast in VHDL" so to speak. This quasi-analog control provides the greatest possible dynamics, even for position and rotational speed control.

As already stated, oversampling procedures are used for capturing position and current measurements to improve the quality of control without producing additional latencies within the control loop. Actual value filters are therefore not necessary.

Overlaid functionalities such as the profile generator and the controller's state machine are executed on a soft-core processor. Because this processor is also on the FPGA, there is one central component that executes the entire firmware of the axle controller. The control algorithm has been developed with Matlab / Simulink and later translated with a VHDL autocoder.

The E-Darc's modular axle controller design contains not only pluggable incremental encoder cards, but also field bus cards. Even customer-specific modules are available, e.g. a Torque-Level-Trigger, which can recognize a faulty equipment or tool breakage.
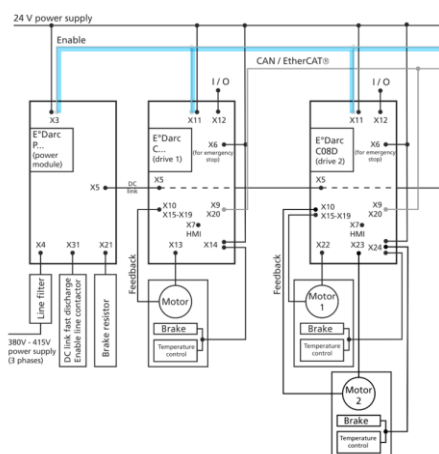

Figure 3: E°Darc C Power module, single and double axis modules connected to the controller as CANopen master device, e.g. an E°EXC embedded controller by Eckelmann (Photo: Ferrocontrol)

How is CANopen implemented?

Two slots are available for a wide variety of application cases. The plug-on field bus module ensures that the system is upgradable and independent of any specific field bus system; the modules currently available are for CANopen and Ethercat.

To ensure the axle controller has high interference immunity, the individual modules are connected to one another via purely digital interfaces (SPI, Serial Peripheral Interface). This enables the test and development of individual modules independently of the axle controller.
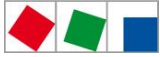
The modular servo drive system by Ferrocontrol is especially suitable for multi-axle applications in drives and automation technology, such as in timber processing or window-frame machining centers, and for CNC processing centers in general. E°Darc C axle modules with output currents from 4 A to 75 A and supply modules in a range of 5 kW to 25 kW cover a wide range of user requirements. In machining centers, the new double-axis module has already proven its value repeatedly. It is used here to control the A and C axes. The controller is also attractive for the control of tool spindle modules with integrated axis mechanics.
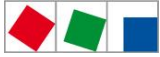
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ECKELMANN

Eckelmann celebrates 40th company anniversary

An interview with Dr.-Ing. Marco Münchhof

In 1977, the success story of Eckelmann in Wiesbaden took its start. Since then the engineering firm of the founder Dr.-Ing. Gerd Eckelmann has grown into a prospering medium-sized company group, whose automation solutions are used in many sectors all over the world. Whereas earlier Eckelmann focused on microprocessors for industrial application, today the company is an experienced partner in digitalizing and connecting industries.

Eckelmann and its subsidiary companies in Germany, Czech Republic, and China count about 450 employees. In 2016 the revenue amounted to 60 million euros. Ferrocontrol; Herford is a subsidiary of Eckelmann since 2006.

Q: Good morning, Dr. Marco Muenchhof, you are a member of the Management Board of Eckelmann. One of the main focus has always been the machine automation, which you now provide as a complete equipment supplier together with your subsidiaries Ferrocontrol and Rex Automatisierungstechnik. What is so special about the machine solutions from Eckelmann of yesterday and today?

A: Eckelmann's experience with CNC controllers in fact dates back to its founding years. Following an initially strong customer and technology-specific phase, the company changed its focus during the course of the years to universal controllers to cover a broad application range. What has not changed over the years is our strong focus on high quality and reliability of our products as well as our passion for engineering. We strive to make complex things simple to use. Therefore, we also offer complete solutions for different industrial branches as e.g. cutting, window processing and SMT processing.

Dr.-Ing. Marco Münchhof (Photo: Eckelmann)

Also, close customer relationships have been and will always be important for us. Therefore, customer-specific extensions and functions continue to be strength of our controllers.

Q: How important are standards such as CANopen for your solutions?

A: Since the mid 1990's, our E°EXC controller supports CANopen as a powerful, flexible, and robust fieldbus protocol. Several thousand machines have been automated successfully using CANopen. In our endeavour to make complex things simple, we have equipped our controllers with plug&play functionality. For example, if an E°Darc C drive controller is connected, the controller already takes care of the correct network communication initialization. By offering up to four independent CAN segments, we have never encountered problems due to limits in busload or communication speed on the CAN segments. In fact, even in highly dynamic multiaxes applications using several drive controllers, we have

always been able to provide a high level of synchronicity. Our standard controllers provide up to 32 CNC axes and 64 motion axes, which can also act as combined axes. However, we have also provided an application with 12 CAN segments that controlled over 700 drive controllers.

Q: What are the main advantages of CANopen from your point of view?

A: It's extreme reliable and robust and is designed for real-time communication from the very beginning. Despite the advent of Ethernet-based protocols, I still see a long future ahead for CANopen. It is a well-established protocol and we will also continue our support for CANopen in parallel to Ethernet-based field busses. There are a lot of machines out there based on CANopen communication and these also have to be supported in the future, not only with spare parts, but also with new functionalities e.g. in retrofit. In addition, CANopen is still an attractive choice in terms of easy wiring and low wiring cost. Especially in small embedded solutions it will be a good choice, also for the future.

E°EXC 88 embedded controller for PLC, motion control and CNC solutions (Photo: Eckelmann AG)

Further information:

[Machine Automation](#)

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