Airbus high-lift system with high-speed EtherCAT control

The Airbus plant in Bremen (Germany) tests and produces the wings for the Airbus A380. Beckhoff Industrial PCs and EtherCAT are used in the test facilities.

At its facility in Bremen, Germany, Airbus features a number of test installations for the company's "high-lift" systems. This term encompasses all functional components that generate additional lift at the wings during different stages of a flight. The main components are the landing flaps, the slats and all drives and controls for this aircraft subsystem.

The dimensions of the test installations are scaled to match the dimensions of the system's original geometry. Huge steel frame structures contain all original functional components of the high-lift system in their original configuration, although only one wing is configured at a time, complete with the drive shaft assembly. To examine interactions between the drives and control systems in each case, the corresponding wing is modeled using a four-quadrant drive and a range of simulated signals.

The test installations are used for a range of studies. For example, aerodynamic loads acting on the components during different flight phases are simulated using hydraulic and pneumatic cylinders. In addition, long-term tests or studies of the response of the aircraft control computers in special situations, such as failure of a structural component, can be carried out. The functions of the high-lift components themselves, such as extending/retracting or tilting of the flaps, are controlled using the original aircraft control system, which operates independent of the control system of the test facility.

Control system for the test facility

The control concept of the test facility involves recording all operating parameters and control of the hydraulic and pneumatic cylinders that exert simulated aerodynamic loads on the aircraft components. In some cases, considerable forces are generated so that the operation of the facility requires special safety considerations. In addition to personal protection, the focus is on protecting the components, some of which may be prototyped or particularly expensive original parts. The control system also involves a complete safety concept with emergency stop chains, access control, redundant signal recording with plausibility check, and gradient and signal level limitation of the actuator signals.

Ingenieurgemeinschaft IgH, based in Essen, Germany, was commissioned with the task of designing the control system for the test facility. It was the first time that such a control system was implemented using EtherCAT technology. Ingenieurgemeinschaft IgH develops special systems focusing on test engineering and hydraulics. The team consisting of 15 experts with different backgrounds such as mechanical engineering, electrical engineering and IT specializes in complex customized solutions for SMEs and large companies.

EtherCAT Terminals as high-speed I/O system

The number of signals processed illustrates the scale of the high-lift system. There are around 500 digital and analog signals, of which around 100 actuator signals represent outputs from various control and monitoring circuits. All I/O data are processed via the Beckhoff EtherCAT Terminal system.

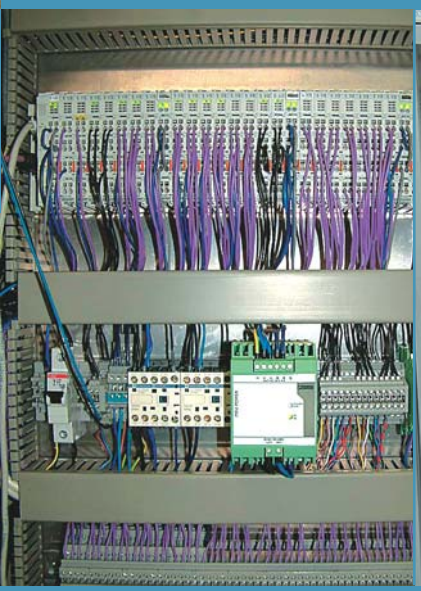
Dr. Torsten Finke, one of the three managers of Ingenieurgemeinschaft IgH, explains the benefits of EtherCAT technology, which were manifested in several ways in the control system for this test facility: "With Ethernet, the signals can be controlled in a technically simple, yet at the same time, reliable manner in the field. Longer distances are covered via digital signal transfer, while analog signal paths are shortened significantly. The flexible system elegantly adapts itself to the task in hand. The bus topology used instead of conventional star cabling significantly reduces wiring costs and possibility for error. EtherCAT offers very good transfer rates, both in terms of bandwidth and transfer speed. In addition, the system offers real-time capability with clock rates in excess of 10 kHz."

The open standard of the EtherCAT technology is particularly advantageous, because it enables platform-independent implementation of the master. For example, an EtherCAT master was developed under Linux and used successfully for this

View of the Airbus high-lift test facility

EtherCAT signal converter

EtherCAT terminal block
in the Airbus test facility

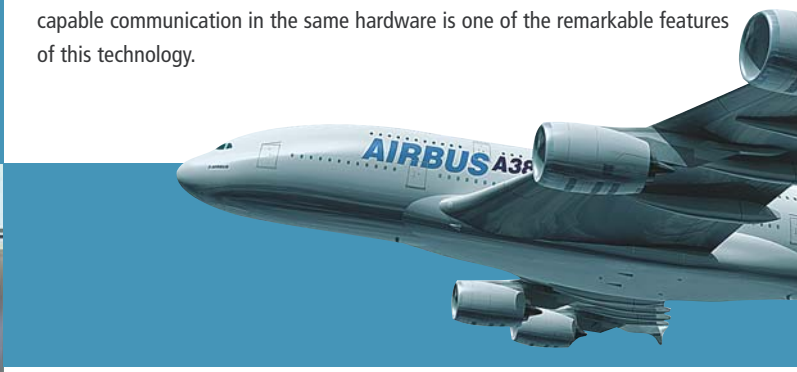


Control cabinet with networked
C51xx PC controllers

Graphical user interface of the control system

project. "This master runs on a standard Industrial PC that is equipped with standard components. No proprietary PLC is required. Linux is an advanced server operating system that has proven to be robust and efficient, especially in a network context", explained Dr. Torsten Finke. "The open architecture in conjunction with RTAI, the free real-time extension for the Linux kernel, enables the operating system to be extended with hard real-time capability without appreciable limitation of the scope for applications and services."

The C51xx Industrial PCs from Beckhoff used as control computers offer high computing power and all the benefits of advanced network technology. In addition to traditional services such as file and web service, this also applies to high-precision time synchronization of the networked systems, which is essential for thorough system analysis. EtherCAT offers the advantage of Ethernet over-EtherCAT transmission. The incorporation of real-time-critical and non-real-time-capable communication in the same hardware is one of the remarkable features of this technology.



Software

The control logic can be developed elegantly via a Matlab/Simulink® model. The model is transferred to C-source, compiled and loaded as a binary control module into the system kernel of the control computer. Communication with the control computer takes place via a client-server interface. An associated operator control program can easily be adapted to the respective test requirements. The software can run on any computer in the network.

The test operation is recorded via a special data logging service that runs on the control computer and has continuous access to the whole process image. The recording behavior can be configured in detail. Thus, continuous signals and discrete events can be recorded and made available for subsequent analysis. The data organization enables fast access to data from any time slot.

EtherCAT technology offers the advantage of very high data throughput, especially for pure measuring data acquisition where a certain amount of latency is acceptable. Thanks to EtherCAT, fieldbus technology is no longer the limiting factor for instrumentation engineering.

Dr. Torsten Finke summarizes the application of EtherCAT technology: "The Airbus scenario is undoubtedly very demanding for a test facility control system. For such tasks, EtherCAT offers a solution with technical characteristics, structural concepts and economic benefits that enables the creation of control systems with remarkable performance characteristics. The high-lift test rig at Airbus already takes advantage of this."

→ Airbus **www.airbus.com**

→ Ingenieurgemeinschaft IgH **www.igh-essen.com**