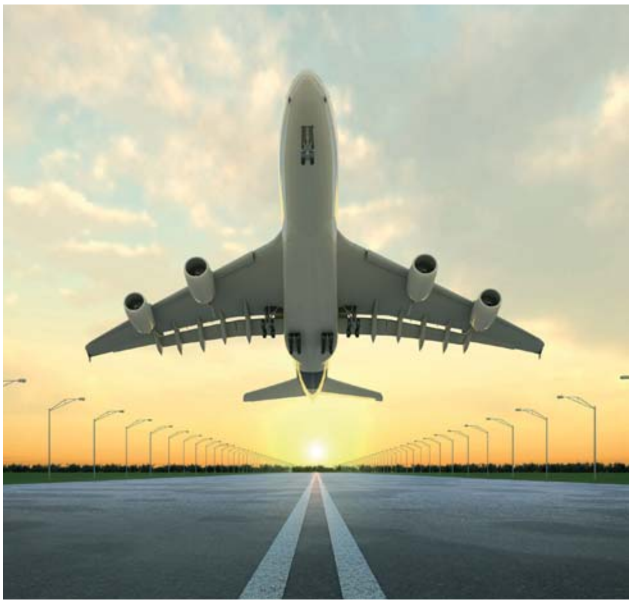
Simulation of electric aircraft solutions

Werner Brandis

Author
Werner Brandis
Hesch Industrie-Elektronik GmbH
Boschstr. 8
DE-31535 Neustadt
Tel.: +49-5032-9535-0
Fax: 05032-9535-99
info@hesch.de

Link
www.hesch.de

Figure 1: Switch cabinet developed by engineers at Cassidian



Today, hydraulically operated landing gears and actuators, pneumatic air conditioning, electric avionics and mechanical drive trains operate side by side inside all standard aircraft of existence. This diversity of systems causes a high degree of technological complexity, resulting in increased fuel consumption, more frequent and more expensive maintenance and higher energy expenditure. For this reason, intensive international research has been conducted over the past ten years to assess how aircraft can be operated only electrically in the ideal scenario. Worldwide projects for "More Electric Aircraft" (MEA) have the goal of converting as many components as possible to electric actuation.

In the area of civil aviation, initial progress in this direction is apparent in the fact that the Airbus A 380 is the first aircraft to have a thrust reverser that operates electrically, instead of hydraulically or pneumatically as it is usual. Boeing is also going new ways, for example with the 787 "Dreamliner". Instead of zap air for the air conditioning and deicing systems, two 250-kVA generators (one for each engine) are used, which also power the electric motors for starting the engines. The consistent use of efficient electric systems reduces the on-board power consumption. In addition, load management of the numerous potential consumers allows optimization of the electric loads.

Load simulation

The potential of the MEA development is higher in military aircraft than in civil aviation. Since fighter jets, drones, etc. contain a great deal of technology in a very small space, the use of different energy systems side by side, and therefore with numerous redundant components, has a negative effect in the case of such aircraft. In one MEA project, the engineers at Cassidian (an EADS subsidiary in the German Manching) developed a simulation switch cabinet with four identical 270-V_{DC} channels for simulation of inductive and capacitive loads in the 270-V_{DC} network commonly used for military aircraft. By switching the different R, L and C components on and off, different types of loads are applied to the SSPC (Solid State Power Controller) of a 270-V_{DC} power supply. This allows the simulation of every conceivable operating and load scenario for electric aircraft components, as well as entire systems. The channels are centrally controlled via a CAN network. For process control and monitoring, Cassidian uses the process I/O modules by Hesch Industrie-Elektronik. In addition to the central CAN network controller, the modular simulation system features actuation modules for the individual loads such as digital input modules that monitor the return values. The contactors are controlled separately by relay modules, in order to switch the required input current for the contactors. For each C and L module there are eight condensers or coils, and four load resistors for each load path.

Control and monitoring

The internal control and monitoring of the system ▷

Summary

In today's civil and military aircraft, electric, hydraulic, pneumatic and mechanical actuating components operate side by side. This conglomeration complicates the construction and maintenance of the aircraft. That is why companies and research institutes worldwide are working on projects for "More Electric Aircraft" (MEA), with the goal of converting as many components as possible to electric actuation. For this purpose, the EADS (European Aeronautic Defence and Space) subsidiary Cassidian developed a 270-V_{DC} CAN-connected overall system rig, which allows engineers to simulate the possible electric loads in aircraft. Since the engineers did not have all of the electric consumers at their disposal, Cassidian also developed a switch cabinet that simulates these consumers. The cabinet is equipped with CAN-capable process I/O modules from Hesch Industrie-Elektronik (Germany).

Company background

In addition to the production of automation components such as the IMOD I/O system, Hesch is also specialized in the development and manufacturing of customized hard- and software solutions. For more than 30 years the company has developed and produced analog and digital measuring and control instruments, electronic controllers, sensors and transducers.

Further to individually developed products and systems, the manufacturer offers production facilities in an SMD assembly line. The portfolio also includes measuring instruments, controllers and switch cabinets for the cleaning of industrial filter systems.

Figure 2: "Hot swap" exchange of devices

Figure 3: Digital input modules HE 5820 and HE 5822

load simulations in the switch cabinet is achieved with the I/O modules. The CANopen field bus coupler HE 5811 connects the control cabinet with the CAN network, controlling up to 64 modules and supplying up to 16 of those modules with electric power. Together with the power module HE 5850 for 16 additional I/O modules, all control devices are power supplied without additional wiring. For the control of the loads, Cassidian used relay output modules HE 5826, which transfer the signals from the network via 4-V free changeover contacts. The digital input modules HE 5820 and HE 5822 monitor eight and four binary return values and transfer them to the CAN network. The modules used in the system provide several configurable functions. This reduced the number of different modules, as well as the costs of acquisition and inventory.

Configuration during operation

For a complex simulation system with high loads, it is important for the modules to feature the "hot swap" function. This makes it possible to exchange single modules at any time, even when the system is in operation. A separate address is assigned to each module through the internal automatic self-configuration by the CAN network coupler. When a module is exchanged, the address and the configuration data of the previous module will be automatically assigned to the new module. The node-ID of the CAN coupler is designed for user-specific configuration with two rotary switches.

In case limit values have to be adapted to the actual operating requirements, system configuration is possible while the system is in operation. Configuration may be done by using the Smart Control software either from a higher-level control unit (PC station) via the CAN network or from a laptop directly via the respective CAN coupler. The corresponding interface is integrated in the front cover of the coupler.

The modules are capable of processing incoming signals internally so that they no longer have to be converted by a higher-level controller. This reduces the computing load of the controller and regulator, which is then available for other applications. Many processes in process technology may therefore be accelerated and streamlined.

Power for the modules is provided by the HPR (high performance rail) line, which is integrated in the standard top hat rail. It consists of several plug-in sockets for a quick module expansion. The HPR connectors are also used for system communication, so the modules do not require additional wires. Module's functions may be adapted to specific customer applications. For example, the modules feature galvanic insulation and monitoring of short circuits to prevent damage as well as functions for detecting burnouts. Separate components for these functions are not needed. To ensure the reliable control of processes in case of malfunction, the modules continue operating with substitute values. These values are individually configurable, not only to ensure the continuation of the processes, but also to prevent dangerous situations. ◀