

C Code Reaches New Heights at Nord-Micro

- Code generation twice as fast with TargetLink
- Easy code verification
- Reliable C code production for airborne systems

Nord-Micro develops and manufactures cabin pressure control systems (CPCS) for aircraft manufacturers worldwide. This system includes software that has to meet the highest requirements regarding safety and comfort. With TargetLink, the dSPACE production code generation software, Nord-Micro successfully generated C code for all demanding control tasks. From releasing the software requirements to the first running prototype, the team needed only 9 months in comparison to 18 months for former projects that were conducted without TargetLink.

For the safety and comfort of the passengers and crew in an aircraft, the air pressure has to be suitably controlled. Nord-Micro develops and produces digital cabin pressure control systems (CPCS) that do not require any crew intervention. The CPCS consists of a redundant pressure controller, sensors and valves, both electromechanical and pneumatic. The CPCS ensures that all of the safety and comfort requirements of cabin pressure are fulfilled.

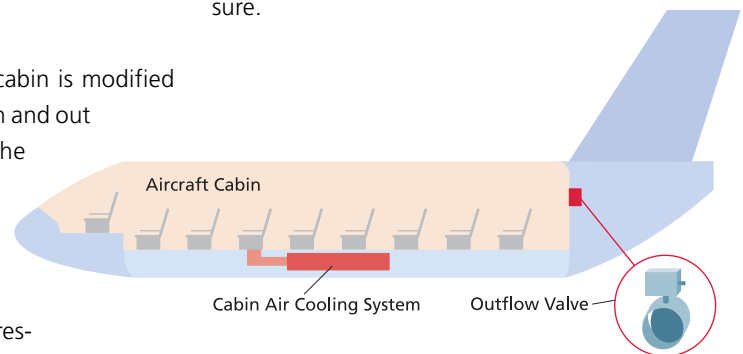
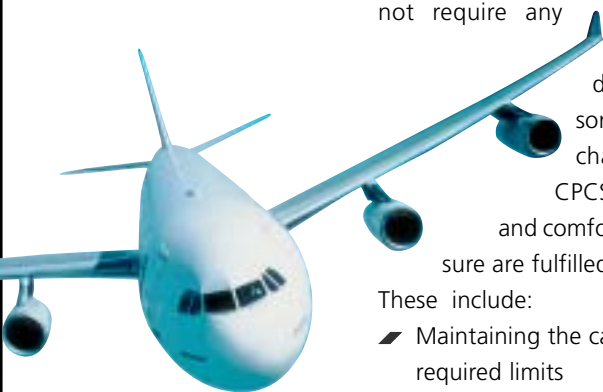
These include:

- Maintaining the cabin pressure within the required limits
- Slow change of pressure rate in the cabin
- Adaptation of cabin pressure to the altitude of take-off and landing sites
- Protection against damage to the aircraft structure caused by excessive pressure differences

The pressure level in the aircraft cabin is modified with the amount of air that flows in and out of the cabin. Fresh air enters the cabin continuously through the air-conditioning system, and the corresponding amount of air is let out through outflow valves, thus maintaining a certain cabin pressure. The valves change their flow-through diameter if necessary and determine the amount of air mass that exits the cabin.

Determining the Set Value for Cabin Pressure

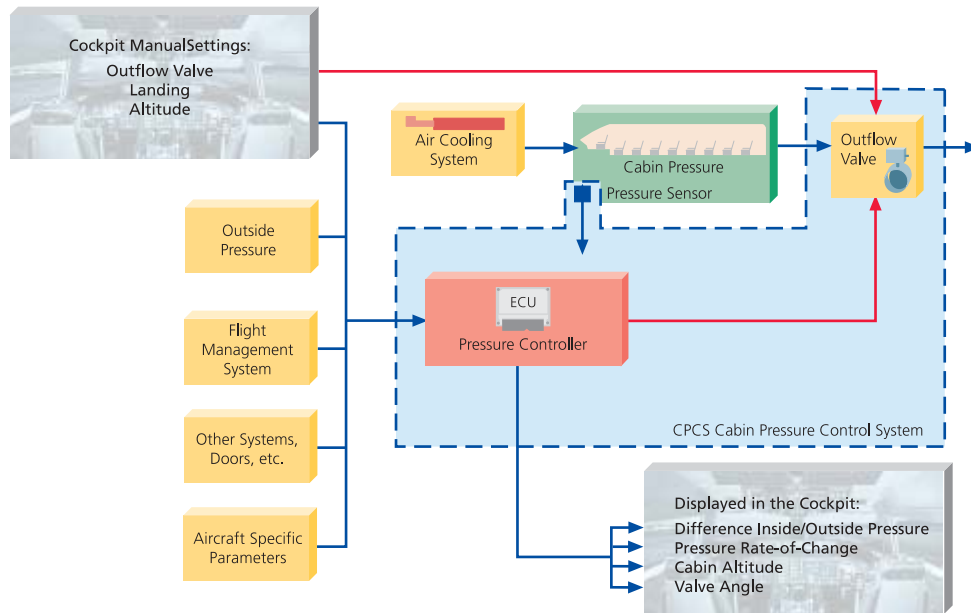
The pressure controller measures several parameters and controls the outflow valves accordingly. These parameters include the actual cabin pressure and the outside pressure. The Flight Management System (FMS) calculates other relevant parameters, like take-off and landing sites, entered by the pilot before departure. There are also aircraft specific parameters that determine the maximum difference between the cabin and the outside pressure, so that the structure of the aircraft is not damaged. With these parameters, the pressure controller calculates the set-value for the cabin pressure. The difference between the set value and the actual cabin pressure is fed to the control unit as the actuating signal. The control unit calculates the respective adjustment signal for the outflow valve, which modifies its flow diameter accordingly, thus influencing the outflow airflow and the cabin pressure.



Cooling system and outflow valve regulate the amount of air that enters and exits the cabin.

Coding – Easy with TargetLink

The high requirements for airborne software are laid down by the European Organisation for Civil Aviation Equipment. "Level A" software was developed for this control system. Therefore, the functionality of every single source code module had to be tested and its structure had to be analyzed. According to the system requirements agreed on with



Sensitive cabin pressure control in an aircraft.

the aircraft manufacturer, we designed the cabin pressure control functions in a MATLAB/Simulink model. We then tested and corrected this model with floating-point simulation and converted it to a TargetLink model. We divided the TargetLink model into sensible function blocks and single files, so that each individual software module could be tested.

Early Function Test Results

The results of the fixed-point simulations on the evaluation board, like storage efficiency and execution time, could immediately be used in the software design in order to increase code efficiency. Formerly, these results were not available before the production hardware was ready, and testing could be done on the plant. Now with TargetLink we performed this step at an early stage in an integrated testing environment. A further advantage was that source code was 100% reproducible up to object level code, with which we could then generate former versions of the Simulink model and modify them. TargetLink also enabled us to trace TargetLink model modifications down to C code. This was easily done as TargetLink's C code is always consistent to the model. All relevant requirements were met except the fact that the date and time were generated into the sources, which meant that the model was modified even if the source code itself had not changed. This made the configuration test slightly difficult but it is something that can be solved.

Finally we designed access functions in the handwritten code as our design rules require that access to variables is executed via accessor functions. These accessor functions have to be manually written and are easily included in TargetLink via the external variable class.

Exceptional dSPACE Support

We would like to emphasize the exceptional consulting offered by dSPACE. Due to the strict aviation requirements, we sometimes had to adapt the standard TargetLink configuration. But thanks to the cooperation with dSPACE's technical support, we always found a suitable solution. Due to our success we plan to use TargetLink in all future projects whenever code generation is required.

Trusting TargetLink Code for Aviation Applications

From releasing the features of this completely new software, to the first running prototype, we needed only 6 months. Furthermore, we came to the conclusion that the generated code fulfills the high aviation requirements. We plan to make the first test flight with TargetLink generated code soon.

*Andreas Alaoui
Nord-Micro
Germany*